NATIONAL SCIENCE FOUNDATION

FY 2011 Budget Request to Congress

February 1, 2010

About the Cover: **Stretchable and Twistable Electronics**
Researchers Yonggang Huang at Northwestern University and John Rogers at the University of Illinois at Urbana-Champaign have developed circuits that can stretch, bend and even twist! In the past there have been limits for the use of electronic components--which have been flat and unbendable--due to the fact they are made primarily of silicon, which is brittle and inflexible. Bending or stretching would make the component useless. Now, Huang and Rogers have developed a process to produce stretchable electronics, increasing the stretching range by as much as 140 percent and allowing users to subject circuits to extreme twisting. The new technology improved upon several past developments by the pair. This emerging technology will be ideally suited in instances where flat, unbendable electronics would fail. Potential uses include flexible sensors, transmitters and new photovoltaic and microfluidic devices, as well as areas of medicine and athletics. Huang and Rogers are also looking into possible application of their technology in solar panels. This research was supported by NSF and the Department of Energy.

For more information see: www.nsf.gov/news/mmg/mmg_disp.cfm?med_id=65335

Credit: John Rogers, University of Illinois.

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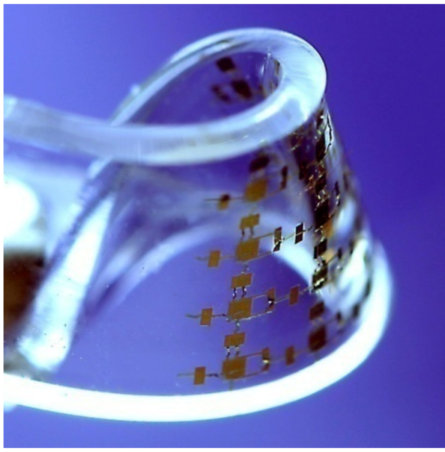


NSF FY 2011 Budget Request to Congress

The National Science Foundation Act of 1950 (Public Law 81-507) sets forth our mission: ***To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense.***

NSF's Strategic Plan 2006-2011 defines our vision: ***Advancing discovery, innovation, and education beyond the frontiers of current knowledge, and empowering future generations in science and engineering.***

The National Science Foundation is the only federal agency dedicated to the support of basic research and education across all fields of science and engineering. For 60 years, we have been exploring the frontiers of scientific knowledge and extending the reach of engineering by encouraging, identifying, and funding the best ideas and most promising people. The high-risk, potentially transformative investments we make generate important discoveries and new technology, create and train a dynamic workforce, and spark the curiosity and creativity of millions. Our investments in research and education help ensure that our Nation remains globally competitive, prosperous, and secure.

NSF's FY 2011 Budget Request is $7.424 billion, an increase of $551.89 million (8 percent) over the 2010 enacted level.

NSF Funding by Account
(Dollars in Millions)

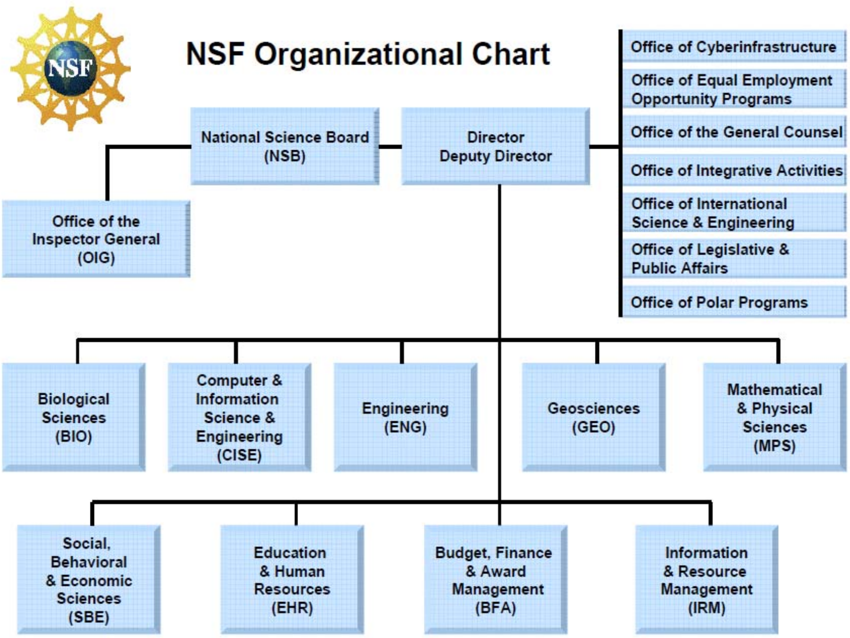
	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate	
					Amount	Percent
Research & Related Activities[1]	$5,152.39	$2,062.64	$5,563.92	$6,018.83	$454.91	8.2%
Education & Human Resources	845.52	85.00	872.76	892.00	19.24	2.2%
Major Research Equipment & Facilities Construction	160.76	254.00	117.29	165.19	47.90	40.8%
Agency Operations & Award Management	294.09	-	300.00	329.19	29.19	9.7%
National Science Board	4.02	-	4.54	4.84	0.30	6.6%
Office of Inspector General	11.99	0.02	14.00	14.35	0.35	2.5%
Total, NSF	**$6,468.76**	**$2,401.66**	**$6,872.51**	**$7,424.40**	**$551.89**	**8.0%**

Totals may not add due to rounding.

[1] Funding for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

Organization and Role in the Federal Research Enterprise

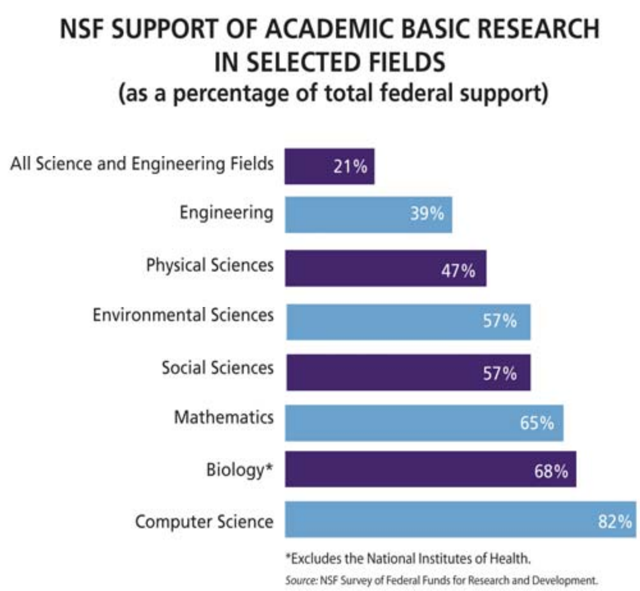
NSF-funded research is characterized by its breadth. NSF prioritizes the integration of education into its research programs, and takes into account the broader societal impacts of the work it funds, such as the training that students and young researchers receive in the research process, and the educational opportunities the work and its people can then provide to the larger community of K-16 students and teachers and the general public.



NSF's comprehensive and flexible support of meritorious projects with broad societal impacts enables the Foundation to identify and foster both fundamental and transformative discoveries within and among fields of inquiry. NSF has the latitude to support emerging fields, high-risk ideas, interdisciplinary collaborations, and research that pushes, and even transforms, the very frontiers of knowledge. In these ways, NSF's discoveries inspire the American public—and the world.

NSF's organization mirrors the major science and engineering fields, including the biological sciences; computer and information science and engineering; engineering; geosciences; mathematics and physical sciences; and social, behavioral, and economic sciences. NSF also carries out specific responsibilities for education and human resources, cyberinfrastructure, integrative activities, international science and engineering, and polar programs. The 25-member National Science Board sets the overall policies of the Foundation.

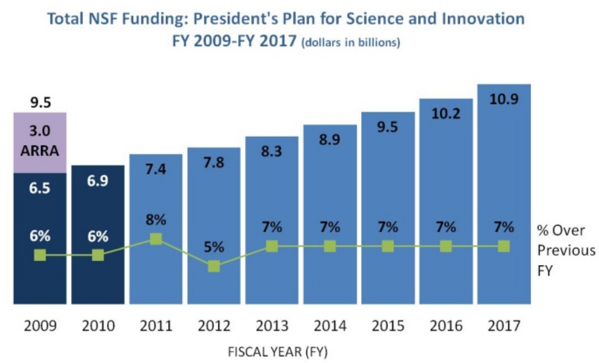
NSF's annual budget represents 21 percent of the total federal budget for basic research conducted at U.S. colleges and universities, and this share increases to 61 percent when medical research supported by the National Institutes of Health is excluded. In many fields NSF is the primary source of federal academic support.



National Innovation Strategy

NSF's contribution to the Administrations' Innovation Strategy stems from its longstanding role in strengthening the building blocks of American innovation. This begins with investments in fundamental research and education of the next generation of scientists and engineers. It also includes more focused research on topics that advance vital capabilities – such as sustainability, secure networks, and leading-edge technologies – and fostering and facilitating partnerships that reach across today's global innovation enterprises.

Restore American Leadership in Fundamental Research. Since innovation depends on the foundation of earlier investments, NSF's foremost responsibility in innovation is to continue to support fundamental research and education in all fields of science and engineering. The President's Plan for Science and Innovation aims to double the federal investment in basic research agencies. This investment will be vital to the effort to increase national research and development investments to 3 percent of Gross Domestic Product.



Educate the Next Generation with 21st Century Knowledge and Skills While Creating a World-Class Workforce. NSF's FY 2011 investments will reach nearly 215,000 scientists, engineers, teachers, and students who are directly engaged in work at the frontiers of learning and discovery. Priorities include:

- **RE-gaining our ENERGY Science and Engineering Edge (RE-ENERGYSE),** ($19.4 million) is located at the intersection of energy, environment, and human factors. It is a partnership between the Department of Energy (DOE) and the National Science Foundation that will help the Nation regain its leadership position in science and engineering by attracting and educating future scientists in the clean energy field. By 2015, RE-ENERGYSE would prepare up to 8,500 highly educated young scientists and engineers for clean energy careers and provide training for thousands of skilled clean energy technicians. NSF and DOE also have a continuing partnership in public awareness and outreach activities that support the goals of RE-ENERGYSE.

- **The Graduate Research Fellowship (GRF)** program, (16 percent increase to $158.2 million); an Administration priority, supports the development of the Nation's future scientists and engineers. FY 2009 marked the beginning of a growth trajectory to triple the number of new awards made each year to 3,000 by FY 2013.

Support Research for Next-Generation Information and Communications Technology, and Secure Cyberspace. While nobody can predict which of today's fundamental discoveries will become tomorrow's new products and processes, a number of NSF programs support the Strategy's goal to promote innovation. These include:

- **Science and Engineering Beyond Moore's Law,** (50 percent increase to $70.2 million). In 10 to 20 years, current silicon technology will reach the limits of Moore's Law – the empirical observation that computing power doubles roughly every 18 months. These transformational activities accelerate innovation and create partnering opportunities with the private sector and national laboratories.

- **Cyber-enabled Discovery and Innovation,** (3 percent increase to $105.5 million) supports transformative, multidisciplinary science and engineering research made possible by innovations and advances in computational concepts, methods, models, algorithms, and tools. Breakthroughs advance one or more of the three themes: From Data to Knowledge; Understanding Complexity in Natural, Built, and Social Systems; and Building Virtual Organizations.

- **Cybersecurity,** (11 percent increase to $144.6 million). NSF's basic research into usability, theoretical foundations, and privacy supports the aims of the Comprehensive National Cybersecurity Initiative.

- **Transformative Interdisciplinary Research in areas of national interest**. NSF's support of all science and engineering fields enables it to contribute to the jobs and industries of the future.
  - The intersection of the biological and physical sciences and the creation of a "bio-economy" that uses biotechnology to make "green" chemicals (as described in the National Academies' reports *Research at the Intersection of the Physical and Life Sciences* and *A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution*).
  - The integration of nanotechnology and/or cyber-physical systems with traditional manufacturing industries (as discussed in the National Economic Council's *Framework for Revitalizing American Manufacturing*).

Encourage High-Growth And Innovation-Based Entrepreneurship, And Create Competitive Communities By Promoting Regional Innovation Clusters

Partnerships for Innovation, (109 percent increase to $19.2 million) bring together colleges, universities, state and local governments, private sector firms, and nonprofit organizations. In FY 2011, $12.0 million will be invested in a new "NSF Innovation Ecosystem" component, which aims to: increase the engagement of faculty and students across all disciplines in the innovation and entrepreneurship process; increase the impact of the most promising university innovations through commercialization, industry alliances, and start-up formulation; and develop a regional community that supports the "innovation ecosystem" around the university.

Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR), (14 percent increase to $142.9 million). These business-centered programs support innovation research and build partnerships between the academic and industry sectors. They support the innovation economy by funding translational research at U.S. small businesses on topics that span the breadth of NSF scientific and engineering research and that reflect national and societal priorities.

Grant Opportunities for Academic Liaison with Industry, (0.4 percent increase to $18.6 million) seeks to increase partnerships between the academic and industrial communities and provide opportunities to accelerate innovation by strengthening the discovery knowledge base for a quicker translation of discovery to societal benefit. The program leverages its budget with support from other NSF academic research programs by a factor of four to one.

Centers programs, (9 percent increase to $313.8 million). NSF supports over 100 centers in seven interdisciplinary program areas. Centers exploit opportunities in science, engineering, and technology in which the complexity of the research problem or the resources needed to solve the problem require the advantages of scope, scale, duration, equipment, facilities, and students. Centers often leverage their activities through partnerships with academic institutions, national laboratories, industrial organizations, and/or other public/private entities, and via international collaborations, as appropriate.

Learning and Workforce Development

For America to continue to lead the world in science and technology innovation, it must have the most knowledgeable and skilled science, technology, engineering, and mathematics (STEM) workers in the world. The National Innovation Strategy includes programs that support scientists and engineers at the beginning of their careers, prepare the next generation of Americans to understand and meet environmental challenges, and educate the next generation with 21st century knowledge and skills while creating a world-class workforce.

Administration Priority Programs

The FY 2011 budget maintains strong levels of support for four key Administration priority programs which were strongly supported in the FY 2010 Budget Request. The Graduate Research Fellowship (GRF) Program and the Faculty Early Career Development Program (CAREER) support the most promising students and early-career researchers in order to cultivate the next generation of STEM knowledge workers. Climate Change Education targets learning at all levels and is designed to develop the next generation of skilled, educated, and climate-savvy Americans. Advanced Technological Education supports new and enhanced two-year college programs that educate technicians for the high-technology workforce.

- **The Graduate Research Fellowship (GRF)** program supports the development of the Nation's future scientists and engineers. FY 2009 marked the beginning of a growth trajectory to triple the number of new awards made each year to 3,000 by FY 2013.
- **The Faculty Early Career Development Program (CAREER)** develops the future scientific and technical workforce through support of young faculty who are dedicated to integrating the excitement of research with inspired teaching and enthusiastic learning. Growing this program at the same rate as the overall agency budget is an Administration priority.
- **Climate Change Education** is designed to develop the next generation of skilled, educated, and climate-savvy Americans. It catalyzes activity at the national level in four strands of STEM education: preparation of a climate science professional workforce; public understanding and engagement; resources for learning; and local and national STEM education policy.
- **Advanced Technological Education** supports new and enhanced two-year college programs that educate technicians for the high-technology workforce. It is on a growth trajectory begun in FY 2010 to increase the program's funding to $100 million by FY 2013.

FY 2011 Administration Priority Programs
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Graduate Research Fellowship Program	$115.49	$46.94	$135.92	$158.24	$22.32	16.4%
Faculty Early Career Development	186.55	166.20	196.39	209.16	12.77	6.5%
Climate Change Education Program	9.95	-	10.00	10.00	-	-
Advanced Technological Education	51.85	-	64.00	64.00	-	-

Learning and Broadening Participation

"…Expand opportunities for all our young people, including women and minorities who too often have been underrepresented in scientific and technological fields, but who are no less capable of succeeding in math and science and pursuing careers that will help improve our lives and grow our economy."
–President Obama, November 23, 2009

Broadening Participation (3 percent increase to $788.2 million). The FY 2011 Budget maintains strong support for agency-wide efforts to bring a fuller array of perspectives and participants to advancing discovery and innovation. Investments across NSF seek to broaden participation among people, institutions, and geographical regions.

Comprehensive Broadening Participation of Undergraduates in STEM, ($103.1 million). With an FY 2011 investment of $103.1 million, NSF will implement a new consolidated program, which will realign and build on existing programs and activities: Historically Black Colleges and Universities Undergraduates Program, Louis Stokes Alliances for Minority Participation, Tribal Colleges and Universities Program, and NSF's support for Hispanic-serving institutions. This new program's objective is to break down programmatic stovepipes in order to build sustainable partnerships and alliances among institutions with strong track records in producing underrepresented science, technology, engineering, and mathematics (STEM) graduates, thereby building capacity for the STEM field across a range of institutions. These comprehensive partnerships will increase the institutions' competitiveness by:

- strengthening STEM curricular offerings, enhancing STEM faculty development, and increasing competencies and competitiveness of students;
- transforming infrastructure, operations, and resources;
- increasing support for and engagement in frontier scientific research and access to advanced research instrumentation, and maximizing undergraduate research opportunities;
- facilitating expanded collaboration between scientists and educators at minority-serving institutions with those at majority institutions; and
- stimulating innovation and creativity from the nation's education and research enterprise through support of effective collaborations between minority–serving and majority institutions, especially research-intensive universities with NSF Science and Technology Centers, Materials Research Science and Engineering Centers, and Engineering Research Centers.

Experimental Program to Stimulate Competitive Research (EPSCoR), (5 percent increase to $154.4 million) EPSCoR stimulates sustainable improvements in research participation from institutions in geographical areas that are underrepresented in NSF activities. Strategies include supporting research infrastructure improvement, co-funding disciplinary and interdisciplinary research, and conducting outreach and workshops.

Government-wide Strategy for STEM Education. In addition to its support for the programs and priorities already mentioned, NSF is actively engaged as a leading participant in the coordinated, government-wide strategy for STEM education. NSF is poised to build on previous and emerging collaborations with the U.S. Department of Education, and to use NSF's unique experience and knowledge base in STEM education to identify research and evaluation priorities and to consider appropriate standards of evidence for various stages of research and development cycles. The agencies are embarking jointly on possible collaborations and complementary initiatives to help states improve K-12 student learning in STEM by building and sharing knowledge of effective curricular and instructional practices, and how they can be implemented at scale.

Investment Portfolios

A portfolio investment strategy specifically addresses our role in addressing national challenges, such as stimulation of economic growth, promotion of innovative energy technologies which can help mitigate the impact of climate change, training of a world-class STEM workforce, and nurturing a scientifically literate population.

A wide range of ongoing NSF investments contribute directly to energy technologies, understanding and mitigating climate change, and promoting green jobs. The FY 2011 Request presents a new framework for coordinating and enhancing these investments. To leverage NSF's strengths towards addressing the challenges we face, NSF proposes to focus on the full portfolio of activities in two key areas of national importance.

Science, Engineering, and Education for Sustainability (SEES), (16 percent increase to $765.5 million) will integrate NSF's efforts in climate and energy science and engineering to generate the discoveries and capabilities needed to inform societal actions that lead to environmental and economic sustainability. SEES addresses recommendations from the August 2009 report from the National Science Board, *Building A Sustainable Energy Future*, which emphasized systems approaches to research programs, education and workforce development, public awareness and outreach, and the importance of partnerships with other agencies, states, universities, industry, and international organizations.

Cyberlearning Transforming Education (CTE), (63 percent increase to $41.3 million). This new multidisciplinary research program is intended to fully capture the transformative potential of advanced learning technologies across the education enterprise. CTE will enable wholly new avenues of science, technology, engineering, and mathematics (STEM) learning for students and for workforce development. Collaborating with the Department of Education to bring advances in technology to learners at all educational levels will advance the Nation's ability to study the learning process itself.

FY 2011 Investment Portfolios
(Dollars in Millions)

	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate	
			Amount	Percent
Science, Engineering and Education for Sustainability (SEES)	$660.74	$765.50	$104.76	15.9%
Cyberlearning Transforming Education (CTE)	25.33	41.28	15.95	63.0%

Interagency Activities

As the leading federal agency funding basic research, all directorates and offices within NSF participate in a number of interagency partnerships and collaborations coordinated by the National Science and Technology Council (NSTC). NSF adds value to these activities through its support of basic research that covers all fields of science and engineering. NSF's support for such fundamental research provides a sound basis for decisions and policies by federal, state, regional, and local authorities, and participation in this research trains the next generation of scientists and engineers in the problems of the future.

U.S. Global Change Research Program (USGCRP), (16 percent increase to $369.9 million). The USGCRP engages thirteen U.S. agencies in a concerted program of basic research, comprehensive observations, integrative modeling, and development of products for decision-makers. Primary FY 2011 research foci are climate variability and change across temporal and spatial scales, study of terrestrial and marine ecosystems, human contributions and responses to climate change, and the general processes used by organizations to identify and evaluate policies for mitigation, adaptation, and other responses to varying environmental conditions.

Networking and Information Technology Research and Development (NITRD), (7 percent increase to $1.170 billion). NITRD coordinates the unclassified networking and information technology research and development investments across thirteen federal agencies. These agencies work together to develop a broad spectrum of advanced networking and IT capabilities to power federal missions, economic competitiveness, and science, engineering, and technology leadership. NSF is a leader in the program and NITRD activities represent 16 percent of NSF's FY 2011 budget. Funding foci for FY 2011 include large scale networking, cybersecurity and information assurance, high confidence software and systems, human-computer interaction and information management, and software design and productivity.

National Nanotechnology Initiative (NNI), (4 percent decrease to $401.3 million). NSF's NNI program is coordinated with 25 departments and agencies across the federal government. NNI encompasses the systematic understanding, organization, manipulation, and control of matter at the atomic, molecular, and supramolecular levels in the size range of 1 to 100 nanometers. NSF's investment in this activity increases in two key areas in FY 2011: nanomanufacturing (44 percent increase to $32.2 million) and Environmental, Health and Safety (11 percent increase to $33.0 million).

Homeland Security Activities, (4 percent increase to $405.4 million). NSF funds homeland security by funding research in two general areas: protecting critical infrastructure and key assets and defending against catastrophic threats. 75 percent of these funds are applied towards research in cybersecurity, emergency planning and response, and risk management, modeling, and simulation of resilient infrastructure.

FY 2011 Interagency Activities
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
U.S. Global Change Research Program	$269.26	$120.54	$319.06	$369.91	$50.85	15.9%
Networking and Information Technology R & D	1,011.62	347.16	1,090.48	1,170.07	79.59	7.3%
National Nanotechnology Initiative	408.62	101.20	417.69	401.25	-16.44	-3.9%
Homeland Security Activities	378.40	43.08	390.03	405.43	15.40	3.9%

Major Research Equipment and Facilities Construction

NSF exercises stewardship of the Nation's research infrastructure through its investments in Major Research Equipment and Facilities Construction (MREFC). By constructing major research facilities, platforms, and networks, NSF seeks to advance the frontiers of science and engineering, enable the training of a world-class workforce, and provide equipment and services to industry partners.

In FY 2011, NSF plans to initiate construction of the **National Ecological Observatory Network (NEON)**. NEON is designed to detect and enable forecasting of ecological change at the continental scale over multiple decades. It will collect data on the impacts of climate change, land use changes, and invasive species on natural resources and biodiversity. NEON data will contribute to multi-scale models of global change that will support local, regional, national, and global analyses of potential scenarios for adapting to and mitigating climate change.

In addition, NSF continues its support of four ongoing construction projects:

- **Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO).** A planned upgrade of the existing Laser Interferometer Gravitational-Wave Observatory (LIGO), AdvLIGO will be ten times more sensitive, powerful enough to approach the ground-based limit of gravitational-wave detection.
- **Advanced Technology Solar Telescope (ATST).** ATST will enable study of the Sun’s magnetic fields, which is crucial to our understanding of the types of solar variability and activity that affects Earth’s civil life and may impact its climate.
- **Atacama Large Millimeter Array (ALMA).** ALMA will provide a testing ground for theories of planet formation, star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself.
- **Ocean Observatories Initiatives (OOI).** OOI will enable continuous, interactive access to the ocean via multiple types of sensors linked by cutting-edge cyberinfrastructure, which will produce never-before-seen views of the ocean’s depths.

MREFC Account Funding, by Project
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request
Advanced Laser-Inferometer Gravity-wave Observatory (AdvLIGO)	$51.43	-	$46.30	$23.58
Advanced Technology Solar Telescope (ATST)	-	-	13.00	17.00
Alaska Region Research Vessel (ARRV)	14.13	148.07	-	-
Atacama Large Millimeter Array (ALMA)	82.25	-	42.76	13.91
IceCube Neutrino Observatory	11.85	-	0.95	-
National Ecological Observatory Network (NEON)	-	-	-	20.00
Ocean Observatories Initiative (OOI)	-	105.93	14.28	90.70
South Pole Station Modernization (SPSM)	1.10	-	-	-
Total, MREFC	**$160.76**	**$254.00**	**$117.29**	**$165.19**

Totals may not add due to rounding.

Stewardship, Evaluation, and Performance

Since 2001, the number of proposals submitted to NSF has increased by over 50 percent. In that time, staffing has increased by only 19 percent. To support NSF's excellence in science and engineering research and education, NSF must invest in expanding and developing its workforce and resources to maintain a capable and responsive organization.

Stewardship

The FY 2011 Request includes $468.8 million (+$39.1 million) for activities aimed at assuring that NSF will be able to effectively and efficiently manage its operations. Funds will support:

- **Staff,** 40 additional full-time equivalents (for a total of 1,350 FTE) and eleven additional IPAs are requested;
- **IT investments,** such as the expansion of Research.gov, modernization of the NSF financial system, and improvements in the reliability and security of NSF's operational IT systems; and
- **Acquisition,** ($2.0 million). This increase is part of the government-wide effort to strengthen the acquisition workforce. A key priority for NSF is improving capabilities in the pre-solicitation phase of major acquisitions.

Evaluation and Performance

NSF is committed to promoting strong, independent evaluation that can inform its policy decisions, program management, and performance. NSF participates in the Administration's government-wide initiative to strengthen program evaluation and performance measurement, and shares its commitment to post the status and findings of this and other important publicly available evaluations online.

- **High-Priority Performance Goal:** NSF's goal for the end of FY 2011 is to develop evaluation and assessment systems for STEM education and workforce programs that can provide findings leading to program re-design or consolidation.
- **Foundation-wide planning, analysis, and evaluation.** $1.0 million will support additional staff and associated resources for the establishment of a centralized NSF capability for assessment and evaluation. This would bring greater attention and analysis to such areas as comparing different types of programmatic investments and identifying the most effective means for continuous improvement across the NSF portfolio.

Stewardship by Appropriations Account

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate: Amount	Percent
Agency Operations and Award Management	$294.09	-	$300.00	$329.19	$29.19	9.7%
Office of Inspector General	11.99	0.02	14.00	14.35	0.35	2.5%
National Science Board	4.02	-	4.54	4.84	0.30	6.6%
Research & Related Activities	88.25	-	96.47	104.32	7.85	8.1%
Education and Human Resources	13.08	-	14.74	16.12	1.38	9.4%
Subtotal, Program Support	101.34	-	111.21	120.44	9.23	8.3%
Total, Stewardship	**$411.44**	**$0.02**	**$429.75**	**$468.82**	**$39.07**	**9.1%**

Totals may not add due to rounding.

American Recovery and Reinvestment Act

A primary purpose of the American Recovery and Reinvestment Act of 2009 is to "increase economic efficiency by spurring technological advances in science and health." NSF's role in stimulating the American economy was acknowledged by its inclusion in the Act. In FY 2009, NSF's investments created and sustained research jobs; addressed the national need to increase the pool of qualified K-12 STEM teachers; and met facilities and infrastructure needs, including deferred maintenance.

NSF obligated $2.4 billion (80 percent) of its total ARRA funding in FY 2009. As a direct consequence of ARRA funding, NSF was able to:

- Increase its funding rate to 32 percent in FY 2009, the highest since FY 2000;
- Fund 318 proposals (7 percent) that had been declined earlier in the year due to budgetary constraints even though they were rated very good to excellent;
- Increase the number of CAREER and GRF awardees;
- Increase funding for new principal investigators and co-investigators;
- Significantly boost its investment in climate and energy research;
- Reinvest in facilities where maintenance and improvements had been deferred or staff had been reduced; and
- Support projects in all 50 states, the District of Columbia, and Puerto Rico.

FY 2009 ARRA Results

Program/Activity	Funds Received ($ millions)	Funds Obligated ($ millions)	Measure	Result
Research & Related Activities (R&RA)	$2,500	$2,063	Number of competitive awards *(target: 4,000)*	4,599
			Number of investigators supported on competitive awards *(target: 6,400)*	6,762
			Number of new investigators supported on competitive awards *(target: 2,400)* [1]	2,352
Education & Human Resources (EHR)	$100	$85	Number of awards *(target: 76)*	76
Major Research Equipment and Facilities Construction (MREFC)	$400	$254	Number of awards	2
TOTAL	**$3,000**	**$2,402** *(80%)*		**4,677**

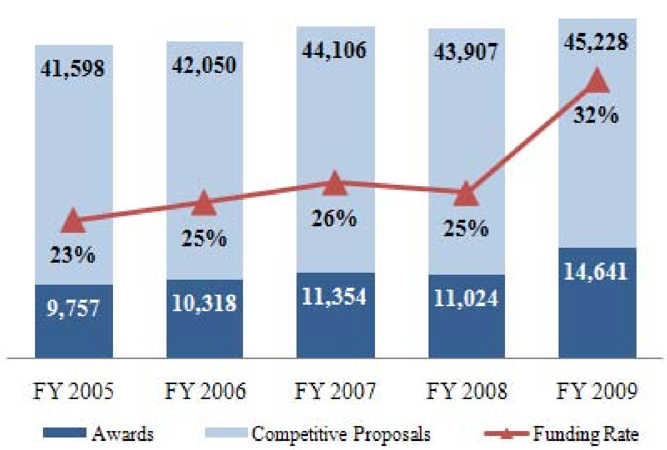
[1] This goal set a target that exceeded the baseline level (FY 2008) by roughly 20 percent. The level reached (2,352 new investigators) fell 2 percent short of this ambitious target. See the Performance chapter for further discussion.

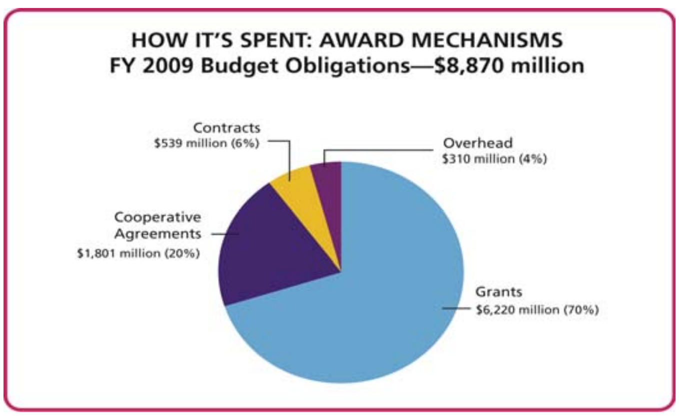
NOTE: The Office of Inspector General received $2.0 million for oversight activities.

NSF by the Numbers

In FY 2009, NSF evaluated 45,228 proposals and made 14,641 new awards, of which 4,677 were funded by the American Recovery and Reinvestment Act (ARRA). ARRA boosted NSF's FY 2009 funding rate to 32 percent, the highest since FY 2000. Nearly 239,000 proposal reviews were conducted, involving almost 46,000 external reviewers. NSF awards were made to 1,967 colleges, universities, and other public and private institutions in 50 states, the District of Columbia, and Puerto Rico. NSF supports approximately 241,000 researchers, postdoctoral fellows, trainees, teachers, and students.

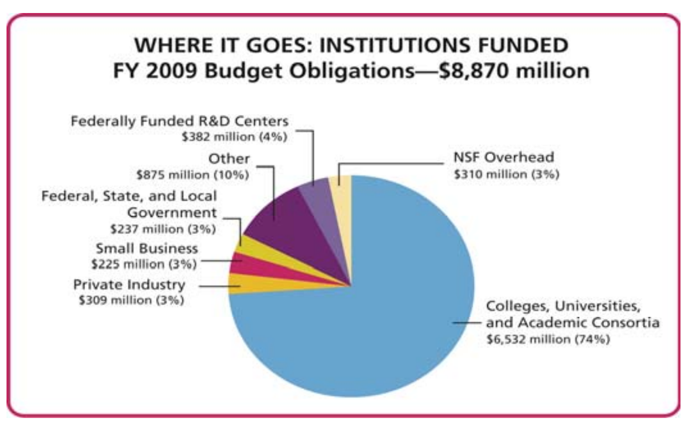
Number of NSF Competitive Proposals and Awards and Funding Rates





90 percent of NSF's FY 2009 projects were funded using grants or cooperative agreements. Grants can be funded either as standard awards in which funding for the full duration of the project is provided in a single fiscal year, or as continuing awards, in which funding for a multi-year project is provided in increments. Cooperative agreements are used when the project requires substantial agency involvement during the project performance period (e.g., research centers, multi-user facilities, etc.). Contracts are used to acquire products, services, and studies (e.g., program evaluations) required primarily for NSF or other government use.

Most NSF awards are to academic institutions. Nonprofit organizations include state and local governments and international organizations. For-profit businesses include private and small businesses. Federal agencies and laboratories include funding for Federally Funded R&D Centers.



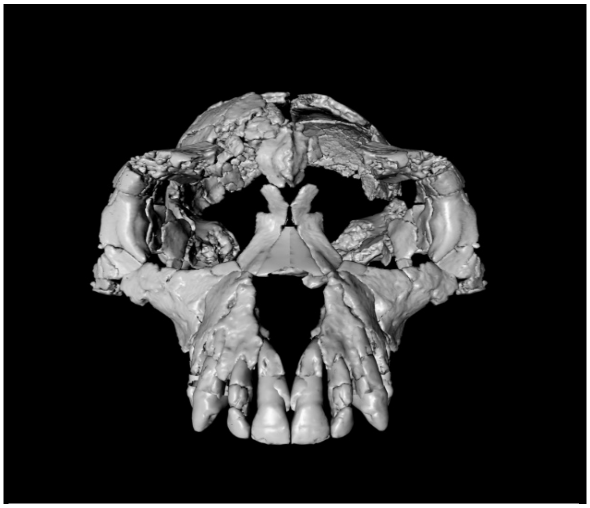


Image Credit: © 2009 Tim White and Gen Suwa, rendered by Primary Pictures.

Science's Breakthrough of the Year: Researchers Discover a New Hominin, _Ardi_

In a large scientific collaborative effort, scientists discovered a female skeleton, *Ardipithecus ramidus*. Nicknamed *Ardi*, the female skeleton is 4.4 million years old, 1.2 million years older than "Lucy", the fossil previously recognized as the earliest hominid skeleton ever found. *Ardi* represents a new kind of hominin, the family that includes humans and our ancestors, but does not include ancestors of other living apes. *Ardi's* anatomy is unusual and is not similar to living apes or later hominins including *Lucy*. Her bones indicate that she walked upright while still living in the woodland suggesting that our ancestors started walking upright on branches. The discovery of *Ardi* was named the Breakthrough of the Year by the journal *Science*.

Kraken: One of the Fastest Supercomputers

The supercomputer Kraken, the Cray XT5 supercomputer at the National Institute for Computational Sciences at the University of Tennessee, was rated as one of the world's fastest supercomputers--one of only four computers in existence that can perform more than 1,000 trillion calculations per second, known as a petaflop. Kraken was used to simulate a 7.8 magnitude earthquake in Southern California. This simulation produced hazard maps that illustrated where the ground was most sensitive to movement. The simulation results were incorporated into building codes, preparing future structures for a big earthquake and saving lives and dollars when the next earthquake hits.

Image Credit: © 2010 Jupiter Images Corporation

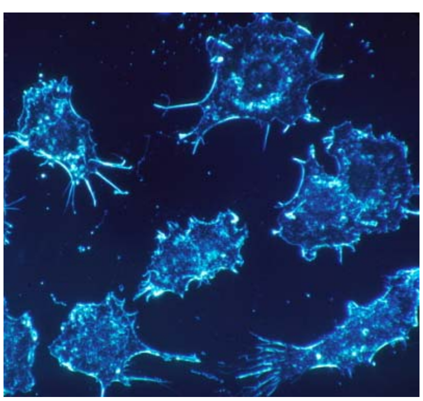


Image Credit: Dr. Cecil Fox, NCI.

Cancer Tumors Impact Surrounding Cells

A new study by Northwestern University researchers of human colon, pancreatic and lung cells is the first to report that cancer cells and their non-cancerous cell neighbors, although quite different under the microscope, share very similar structural abnormalities on the nanoscale level. This finding confirms the "field effect", a phenomenon where cells located a distance away from a malignant or premalignant tumor undergo molecular and other abnormal changes. Moreover, the researchers found that the same abnormalities found in the nanoarchitecture of the colon cells were also found in both the pancreas and lung, suggesting a commonality across three different organs.

Highlights

Stomach Bacteria Alters Its Environment

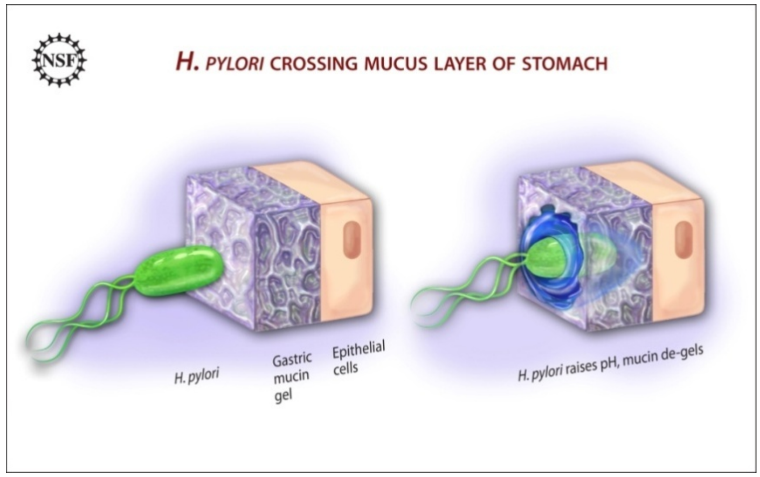


Image Credit: *Zina Deretsky, National Science Foundation.*

A team of researchers from Boston University, Harvard Medical School and the Massachusetts Institute of Technology showed that *Helicobacter pylori*–the bacterium that inhabits various areas of the stomach where it causes chronic, low-level inflammation and is linked to gastric ulcers and stomach–uses a clever biochemical strategy to alter the physical properties of its environment, allowing it to move and survive and further colonize its host. In order to colonize the stomach, *H. pylori* must cope with highly acidic conditions in which other bacteria are unable to survive. It has been known that *H. pylori* survives by producing ammonia to neutralize the acid, but this research demonstrates for the first time that *H. pylori* also changes its environment to enable freer movement by increasing the pH of its surroundings and changing a protein in the layer of the stomach to a liquid, allowing it to swim across the mucus barrier, establish colonies, attack surface cells, and form ulcers.

Discovery of a New Super-Earth

Astronomer David Charbonneau from Harvard University and his research team discovered a "super-Earth" planet orbiting a red dwarf star only 40 light-years from Earth, using a small fleet of ground-based telescopes. A super-Earth is a planet between one and ten times the mass of the Earth. This planet is 6.5 times the size of the Earth, has a temperature of 400 degrees Fahrenheit, and orbits a small, red type M star about one-fifth the size of the Sun. Despite its extreme temperature, this new super-Earth is a waterworld and is more Earthlike than any previously discovered exoplanet. This new super-Earth could be the first one confirmed to have an atmosphere, although that atmosphere probably would not be hospitable to life as we know it. Since the planet is only 40 light-years from Earth, the research team is planning to use NASA's Hubble Space Telescope to detect and determine the content of the atmosphere.

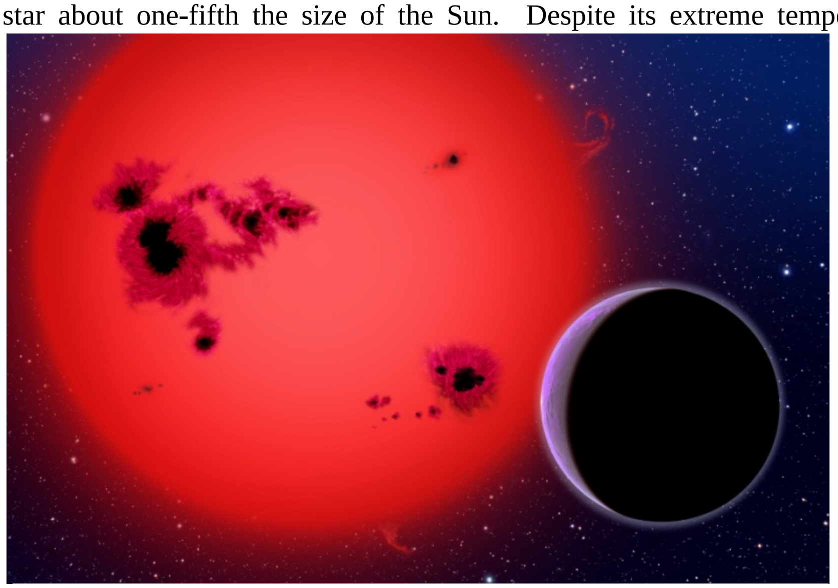


Image Credit: *David Aguilar, Harvard-Smithsonian CfA.*

Discovery of a New Meat-eating Dinosaur, *Tawa halla*

A research team led by Sterling Nesbitt of the University of Texas at Austin unearthed a previously unknown meat-eating dinosaur, *Tawa halla,* in New Mexico. The discovery of *Tawa* sheds light on dinosaur evolution and helps unite all Triassic carnivorous dinosaurs into one group, the theropods, which is the same group that included *Tyrannosaurus rex* and now includes modern birds. This discovery supports the hypothesis that dinosaurs originated in present day South America and then diverged into theropods, sauropodomorphs (the group that includes ground-shaking giants like *Apatosaurus*) and ornithischians (the group that includes *Stegosaurus* and *Triceratops).*

Image Credit: Jorge Gonzalez.

Improved Diagnostic Test for Sleep Apnea

A computer scientist from the University of Houston and a doctor of sleep medicine at the University of Texas Health Science Center at Houston teamed up to create a new, less invasive method of diagnosing sleep apnea. Sleep apnea is a serious disorder that causes people to momentarily stop breathing while they sleep, sometimes hundreds of times a night. Sleep apnea is associated with serious health problems including depression, heart disease and stroke. The new procedure developed by the research team to diagnose sleep apnea uses a thermal infrared camera to monitor breathing and airflow as the person breathes in and out of their nose. This new diagnostic procedure is less invasive and provides doctors with more information about the patient's breathing.

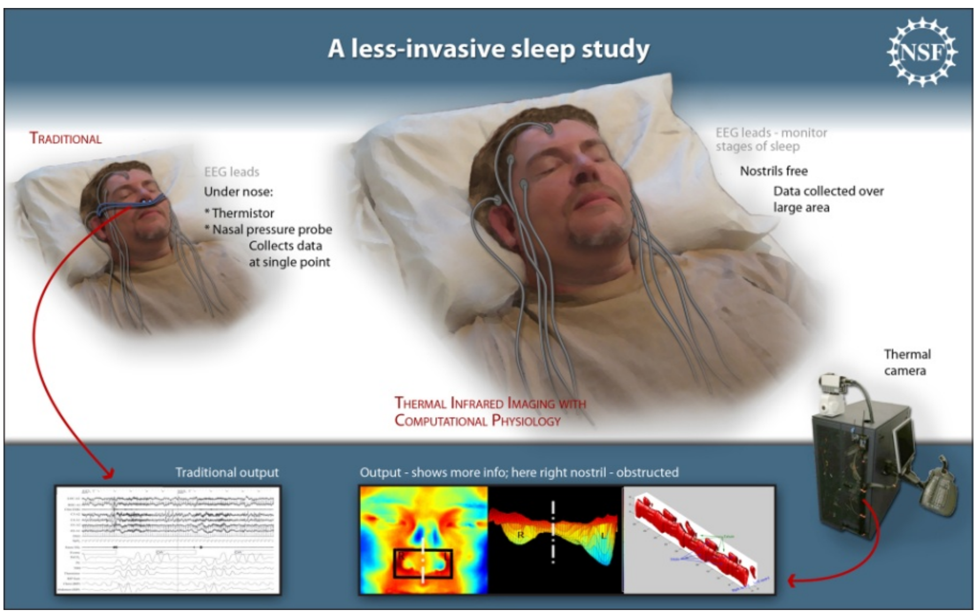


Image Credi: Zina Deretsky, National Science Foundation.

Highlights

Teachers in the Lab Lead to Higher Student Test Scores

Image Credit: Summer Research Program for Science Teachers, Columbia University.

Samuel Silverstein and his colleagues at Columbia University found that research experiences for science teachers can have a direct impact on the achievement of their students, significantly increasing student performance on state assessment tests. Silverstein is the founder and director of Columbia University's Summer Research Program for Secondary School Science Teachers (CUSRP), a program that gives middle and high school science teachers from New York City an opportunity to work on research projects at Columbia University. Silverstein found that students of teachers who had participated in CUSRP for more than two years scored 10 percentage points higher on the New York State's Science Regents examinations as compared to students whose teachers had not participated in CUSRP.

Deepest Erupting Volcano Recorded

Scientists have recorded in high definition video the deepest erupting volcano yet discovered. The West Mata Volcano is nearly 4,000 feet below the surface of the Pacific Ocean, in an area bounded by Fiji, Tonga and Samoa. The volcano was recorded by an underwater robot and eruption sounds were recorded by a hydrophone. The West Mata Volcano produced boninite lavas, a type of lava seen before only on extinct volcanoes more than a million years old, and the hottest on Earth today. The video captured glowing red vents exploding lava into the sea, and was the first time that researchers had observed molten lava flowing across the deep-ocean seafloor.

Image Credit: NSF/NOAA.

Highlights

Mountain Range Discovered Under the East Antarctic Ice Sheet

A U.S.-led, international research team confirmed the existence of an Alps-like mountain range under the East Antarctic Ice Sheet and created a detailed picture of the rugged landscape buried under more than four kilometers (2.5 miles) of ice. Working in some of the harshest conditions with temperatures averaging -30 degrees Celsius (-22 degrees Fahrenheit), the team flew twin-engine light aircraft the equivalent of several trips around the globe and established a network of seismic instruments across an area the size of Texas. This large mountain range under the ice is likely to have caused the massive East Antarctic Ice Sheet, which extends over more than 10 million square kilometers atop the bedrock of Antarctica, to form. The mountain range has peaks and valleys, similar to the European Alps, and it is likely the ice sheet formed quickly, not slowly, as previously thought.

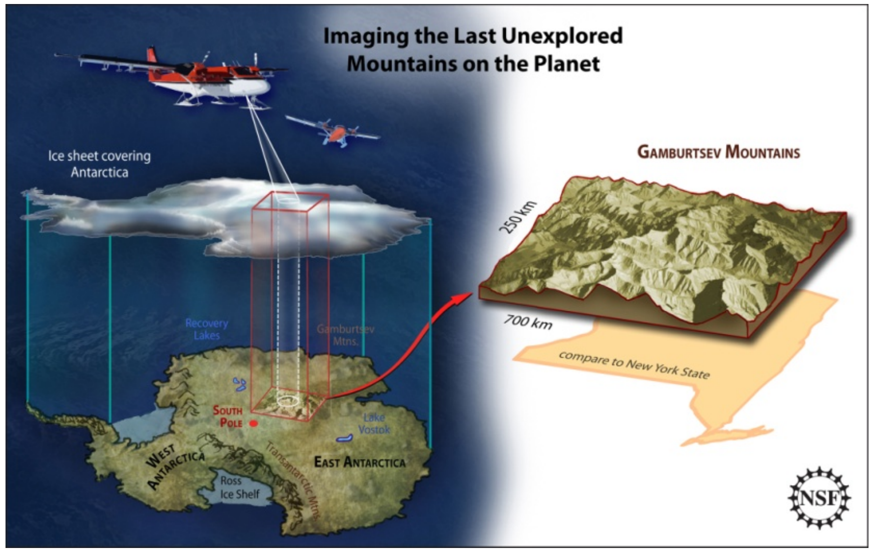


Image Credit: Zina Deretsky, National Science Foundation.

Chicxulub Crater May Not Be Responsible Dinosaur Extinction

A research team, led by Gerta Keller of Princeton University and Thierry Adatte of the University of Lausanne, Switzerland, has challenged the popular theory that an asteroid collision led to the demise of dinosaurs and other species some 65 million years ago. The theory is that the Chicxulub crater, discovered in 1978 in northern Yucatan and measuring about 180 kilometers (112 miles) in diameter, records a massive extra-terrestrial impact that caused the demise of the dinosaurs along with many animal and plant species. The latest research by Keller and Adatte uses evidence from Mexico to suggest that the Chicxulub impact predates the Cretaceous-Tertiary (K-T) boundary by as much as 300,000 years. The researchers found the same level of species diversity in fossils present below and above the impact layer, indicating that the Chicxulub impact did not have a dramatic impact on species diversity. Their research suggests that the Chicxulub impact and the mass extinction at the end of the Cretaceous period may not be linked. Instead, Keller proposes that the massive volcanic eruptions at the Deccan Traps in India may be responsible for the extinction.

Image Credit: NASA.

SUMMARY TABLES

National Science Foundation
Summary Tables
FY 2011 Request to Congress

(Dollars in Millions)

NSF by Account	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	FY 2011 Request over: FY 2009 Omnibus Actual Amount	Percent	FY 2010 Estimate Amount	Percent
BIO	$656.62	$260.00	$714.54	$767.81	$111.19	16.9%	$53.27	7.5%
CISE	574.50	235.00	618.83	684.51	110.01	19.1%	65.68	10.6%
ENG	664.99	264.99	743.93	825.67	160.68	24.2%	81.74	11.0%
ENG Programs	*574.60*	*215.08*	*618.16*	*682.81*	*108.21*	*18.8%*	*64.65*	*10.5%*
SBIR/STTR	*90.39*	*49.91*	*125.77*	*142.86*	*52.47*	*58.0%*	*17.09*	*13.6%*
GEO	808.53	347.00	889.64	955.29	146.76	18.2%	65.65	7.4%
MPS	1,243.88	474.97	1,351.84	1,409.91	166.03	13.3%	58.07	4.3%
SBE	240.56	84.97	255.25	268.79	28.23	11.7%	13.54	5.3%
OCI	199.23	80.00	214.28	228.07	28.84	14.5%	13.79	6.4%
OISE	47.45	13.98	47.83	53.26	5.81	12.2%	5.43	11.4%
OPP\1	473.55	171.89	451.16	527.99	54.44	11.5%	76.83	17.0%
IA	241.58	129.85	275.04	295.93	54.35	22.5%	20.89	7.6%
U.S. Arctic Research Commission	1.50	-	1.58	1.60	0.10	6.7%	0.02	1.3%
Research & Related Activities	**$5,152.39**	**$2,062.64**	**$5,563.92**	**$6,018.83**	**$866.44**	**16.8%**	**$454.91**	**8.2%**
Education & Human Resources	**$845.52**	**$85.00**	**$872.76**	**$892.00**	**$46.48**	**5.5%**	**$19.24**	**2.2%**
Major Research Equipment & Facilities Construction	**$160.76**	**$254.00**	**$117.29**	**$165.19**	**$4.43**	**2.8%**	**$47.90**	**40.8%**
Agency Operations & Award Management	**$294.09**	**-**	**$300.00**	**$329.19**	**$35.10**	**11.9%**	**$29.19**	**9.7%**
National Science Board	**$4.02**	**-**	**$4.54**	**$4.84**	**$0.82**	**20.3%**	**$0.30**	**6.6%**
Office of Inspector General	**$11.99**	**$0.02**	**$14.00**	**$14.35**	**$2.36**	**19.7%**	**$0.35**	**2.5%**
Total, NSF	**$6,468.76**	**$2,401.66**	**$6,872.51**	**$7,424.40**	**$955.64**	**14.8%**	**$551.89**	**8.0%**

Totals may not add due to rounding.

\1 Funding for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

(Dollars in Millions)

NSF by Strategic Goal	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	FY 2011 Request over: FY 2009 Omnibus Actual Amount	Percent	FY 2010 Estimate Amount	Percent
Discovery	$3,448.63	$1,546.60	$3,813.20	$4,168.46	$719.83	20.9%	$355.26	9.3%
Learning	905.12	249.37	967.38	1,013.05	107.93	11.9%	45.67	4.7%
Research Infrastructure\2	1,703.57	605.68	1,662.18	1,774.07	70.50	4.1%	111.89	6.7%
Stewardship	411.44	0.02	429.75	468.82	57.38	13.9%	39.07	9.1%
Total, NSF	**$6,468.76**	**$2,401.66**	**$6,872.51**	**$7,424.40**	**$955.64**	**14.8%**	**$551.89**	**8.0%**

Totals may not add due to rounding.

\2 Funding for Research Infrastructure for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

National Science Foundation
By Account and Strategic Outcome Goal
FY 2011 Request to Congress

(Dollars in Millions)

				FY 2011 Request								
									Change over FY 2009 Omnibus Actual		Change over FY 2010 Estimate	
NSF Accounts	**FY 2009 Omnibus Actual**	**FY 2009 ARRA Actual**	**FY 2010 Estimate**	**Discovery**	**Learning**	**Research Infrastructure**	**Stewardship**	**FY 2011 Request**	Amount	Percent	Amount	Percent
FY 2009 Omnibus Actual	**$6,468.76**	**$2,401.66**		**$3,448.63**	**$905.12**	**$1,703.57**	**$411.44**					
FY 2010 Estimate			**$6,872.51**	**$3,813.20**	**$967.38**	**$1,662.18**	**$429.75**					
BIO	$656.62	$260.00	$714.54	$577.84	$52.45	$123.23	$14.29	$767.81	$111.19	16.9%	$53.27	7.5%
CISE	574.50	235.00	618.83	600.87	38.84	30.60	14.20	684.51	110.01	19.1%	65.68	10.6%
ENG	664.99	264.99	743.93	703.36	73.99	33.33	14.99	825.67	160.68	24.2%	81.74	11.0%
ENG Programs	*574.60*	*215.08*	*618.16*	*560.50*	*73.99*	*33.33*	*14.99*	*682.81*	*108.21*	*18.8%*	*64.65*	*10.5%*
SBIR/STTR	*90.39*	*49.91*	*125.77*	*142.86*	*-*	*-*	*-*	*142.86*	*52.47*	*58.0%*	*17.09*	*13.6%*
GEO	808.53	347.00	889.64	504.35	45.50	387.60	17.84	955.29	146.76	18.2%	65.65	7.4%
MPS	1,243.88	474.97	1,351.84	972.35	65.01	349.10	23.45	1,409.91	166.03	13.3%	58.07	4.3%
SBE	240.56	84.97	255.25	201.00	15.67	46.36	5.76	268.79	28.23	11.7%	13.54	5.3%
OCI	199.23	80.00	214.28	73.12	11.21	138.66	5.08	228.07	28.84	14.5%	13.79	6.4%
OISE	47.45	13.98	47.83	38.77	12.83	0.10	1.56	53.26	5.81	12.2%	5.43	11.4%
OPP[\1]	473.55	171.89	451.16	123.96	6.99	391.15	5.89	527.99	54.44	11.5%	76.83	17.0%
IA	241.58	129.85	275.04	179.80	21.83	93.04	1.26	295.93	54.35	22.5%	20.89	7.6%
U.S. Arctic Research Commission	1.50	-	1.58	1.60	-	-	-	1.60	0.10	6.7%	0.02	1.3%
Research & Related Activities	**$5,152.39**	**$2,062.64**	**$5,563.92**	**$3,977.02**	**$344.32**	**$1,593.17**	**$104.32**	**$6,018.83**	**$866.44**	**16.8%**	**$454.91**	**8.2%**
Education & Human Resources	**$845.52**	**$85.00**	**$872.76**	**$191.44**	**$668.73**	**$15.71**	**$16.12**	**$892.00**	**$46.48**	**5.5%**	**$19.24**	**2.2%**
Major Research Equipment & Facilities Construction	**$160.76**	**$254.00**	**$117.29**	-	-	**$165.19**	-	**$165.19**	**$4.43**	**2.8%**	**$47.90**	**40.8%**
Agency Operations & Award Management	**$294.09**	-	**$300.00**	-	-	-	**$329.19**	**$329.19**	**$35.10**	**11.9%**	**$29.19**	**9.7%**
National Science Board	**$4.02**	-	**$4.54**	-	-	-	**$4.84**	**$4.84**	**$0.82**	**20.3%**	**$0.30**	**6.6%**
Office of Inspector General	**$11.99**	**$0.02**	**$14.00**	-	-	-	**$14.35**	**$14.35**	**$2.36**	**19.7%**	**$0.35**	**2.5%**
Total, National Science Foundation	**$6,468.76**	**$2,401.66**	**$6,872.51**	**$4,168.46**	**$1,013.05**	**$1,774.07**	**$468.82**	**$7,424.40**	**$955.64**	**14.8%**	**$551.89**	**8.0%**
Percent Increase over Prior Year				9.3%	4.7%	6.7%	9.1%					
H-1B Visa	*$89.08*		*$100.00*					*$100.00*				
Reimbursables	*119.27*											
Trust Fund	*56.81*											
Total NSF, Including H-1B Visa, Reimbursables & Trust Fund	*$6,733.92*	*$2,401.66*	*$6,972.51*	*$4,168.55*	*$1,013.10*	*$1,774.14*	*$468.91*	*$7,524.40*	*$790.48*	*11.7%*	*$551.89*	*7.9%*

Totals may not add due to rounding.

[\1] Funding for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

National Science Foundation
Research Infrastructure Summary
FY 2011 Request to Congress

(Dollars in Millions)

					FY 2011 Request change over:			
	FY 2009 Omnibus Actual	**FY 2009 ARRA Actual**	**FY 2010 Estimate**	**FY 2011 Request**	**FY 2009 Omnibus Actual**		**FY 2010 Estimate**	
					Amount	Percent	Amount	Percent
Facilities	**$930.28**	**378.54**	**880.46**	**991.90**	**61.62**	**6.6%**	**111.44**	**12.7%**
Academic Research Fleet	$88.95	$18.00	$80.00	$77.00	-$11.95	-13.4%	-$3.00	-3.8%
Regional Class Research Vessels	*0.88*	-	*2.00*	*2.00*	1.12	127.5%	-	-
RHOV Construction (R/V Alvin Replacement)	-	-	*5.00*	*2.00*	*2.00*	*N/A*	*-3.00*	*-60.0%*
R/V Langseth Construction (R/V Ewing Replacement)	*1.00*	-	-	-	*-1.00*	*-100.0%*	-	*N/A*
Ship Operations and Upgrades	*87.07*	*18.00*	*73.00*	*73.00*	*-14.07*	*-16.2%*	-	-
Academic Research Infrastructure[1]	-	-	-	-	-	*N/A*	-	*N/A*
Cornell High Energy Synchrotron Source (CHESS) / Cornell Electron Storage Ring (CESR)	13.60	14.99	9.00	13.45	-0.15	-1.1%	4.45	49.4%
EarthScope: USArray, SAFOD, PBO	24.29	9.00	25.05	26.00	1.71	7.1%	0.95	3.8%
Gemini Observatory	18.71	-	19.10	19.58	0.87	4.6%	0.48	2.5%
Incorporated Research Institutions for Seismology	12.00	-	12.36	12.73	0.73	6.1%	0.37	3.0%
Integrated Ocean Drilling Program	47.95	25.00	43.40	46.41	-1.54	-3.2%	3.01	6.9%
Large Hadron Collider	18.00	-	18.00	18.00	-	-	-	-
Laser Interferometer Gravitational Wave Observatory	30.30	-	28.50	30.30	-	-	1.80	6.3%
National Astronomy & Ionosphere Center[2]	9.60	3.10	10.60	9.00	-0.60	-6.2%	-1.60	-15.1%
National High Magnetic Field Laboratory	26.50	5.00	35.56	34.00	7.50	28.3%	-1.56	-4.4%
National Nanotechnology Infrastructure Network (NNIN)	16.67	10.27	16.26	16.26	-0.41	-2.5%	-	-
National Solar Observatory	7.83	1.40	9.10	9.51	1.68	21.5%	0.41	4.5%
National Superconducting Cyclotron Laboratory	20.50	2.00	21.00	21.50	1.00	4.9%	0.50	2.4%
Network for Earthquake Engineering Simulation	20.98	-	22.00	22.50	1.52	7.3%	0.50	2.3%
Other Facilities[3]	5.60	4.99	7.02	7.65	2.05	36.5%	0.63	9.0%
Polar Facilities and Logistics[4]	341.38	22.50	312.27	381.38	40.00	11.7%	69.11	22.1%
Other Facilities Investments								
Major Research Equipment & Facilities Construction[5]	199.74	257.10	163.54	214.69	14.95	7.5%	51.15	31.3%
Pre-construction Planning[6]	27.67	5.20	47.70	31.94	4.27	15.4%	-15.76	-33.0%
Federally Funded R&D Centers	**201.10**	**24.20**	**198.63**	**212.24**	**11.14**	**5.5%**	**13.61**	**6.9%**
National Center for Atmospheric Research	106.79	13.20	97.00	108.00	1.21	1.1%	11.00	11.3%
National Optical Astronomy Observatories	30.48	5.60	31.50	33.33	2.85	9.3%	1.83	5.8%
National Radio Astronomy Observatories[7]	60.79	5.40	67.09	67.87	7.08	11.6%	0.78	1.2%
Science and Technology Policy Institute[8]	3.04	-	3.04	3.04	-	-	-	-
Other Research Instrumentation and Infrastructure	**573.02**	**202.94**	**583.36**	**570.22**	**-2.80**	**-0.5%**	**-13.14**	**-2.3%**
Major Research Instrumentation	99.98	99.85	90.00	90.00	-9.98	-10.0%	-	-
National Stem Education Distributed Learning	15.83	-	16.25	16.00	0.17	1.1%	-0.25	-1.5%
Networking & Computational Resources Infrastructure & Services	164.17	17.00	150.38	138.66	-25.51	-15.5%	-11.72	-7.8%
Polar Environment, Health & Safety	6.12	-	7.01	7.27	1.15	18.8%	0.26	3.7%
Research Resources[9]	248.73	86.09	285.50	281.87	33.14	13.3%	-3.63	-1.3%
Science Resource Statistics	38.18	-	34.22	36.42	-1.76	-4.6%	2.20	6.4%
Subtotal, Research Infrastructure Support	**$1,704.39**	**$605.68**	**$1,662.45**	**$1,774.36**	**$69.97**	**4.1%**	**$111.91**	**6.7%**
Research Infrastructure Stewardship Offset	**-$0.82**	-	**-$0.27**	**-$0.29**	**$0.53**	**-64.8%**	**-$0.02**	**7.4%**
RESEARCH INFRASTRUCTURE TOTAL	**$1,703.57**	**$605.68**	**$1,662.18**	**$1,774.07**	**$70.50**	**4.1%**	**$111.89**	**6.7%**

Totals may not add due to rounding.

[1] Awards for the Academic Research Infrastructure program, funded through ARRA, will be made in FY 2010.

[2] NSF will decertify NAIC as a Federally Funded Research and Development Center (FFRDC) upon award of the next cooperative agreement for its management and operation in FY 2011.

[3] Other Facilities includes support for other physics and materials research facilities.

[4] Polar Facilities and Logistics funding includes support for the operations and maintenance of the South Pole Station Modernization (SPSM) project. Funds provided through the MREFC account for SPSM, totaling $1.10 million in FY 2009, are included on the MREFC Projects line. In FY 2010, Polar Facilities and Logistics excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

[5] Funding levels for MREFC Projects in this table include support for: a) concept and development associated with ongoing and requested MREFC projects provided through the R&RA account, specifically for NEON, OOI and ATST; b) initial support for operations and maintenance provided through the R&RA account (except for ALMA, which is included in the funding for NRAO); and c) implementation support provided through the MREFC account. Final MREFC support for SPSM is also included in this line.

[6] Preconstruction Planning includes funding for the Deep Underground Science & Engineering Lab (DUSEL), and next generation physics and astronomy facilities, including: high intensity synchrotron radiatio ray sources; large aperture optical telescopes; fast, wide-field telescopes; and meter/centimeter wavelength radio telescopes.

[7] The Science and Technology Policy Institute (STPI) is a Federally Funded Research and Development Center (FFRDC), but not a research platform. STPI is therefore not included in the Facilities chapter, and the FFRDC subtotal in the tables in that chapter exclude its funding.

[8] Funding for the National Radio Astronomy Observatory (NRAO) includes operation and maintenance support for the Atacama Large Millimeter Array (ALMA). Construction funding for ALMA is included in the MREFC projects line above.

[9] Funding for Research Resources includes support for the operation and maintenance of minor facilities, infrastructure and instrumentation, field stations, museum collections, etc.

National Science Foundation
Selected Cross-Cutting Programs
FY 2011 Request to Congress

(Dollars in Millions)

Selected Cross-Cutting Programs		FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	FY 2011 Request change over: FY 2009 Omnibus Actual Amount	Percent	FY 2010 Estimate Amount	Percent
ADVANCE	Research & Related Activities	$19.57	$1.00	$19.49	$20.12	0.55	2.8%	0.63	3.2%
	Education & Human Resources	1.18	-	1.53	1.53	0.35	30.0%	-	-
	Total, NSF	**$20.74**	**$1.00**	**$21.02**	**$21.65**	**$0.91**	**4.4%**	**$0.63**	**3.0%**
Climate Change Education Program	Research & Related Activities	-	-	4.50	4.50	4.50	N/A	-	-
	Education & Human Resources	9.95	-	5.50	5.50	-4.45	-44.7%	-	-
	Total, NSF	**$9.95**	**-**	**$10.00**	**$10.00**	**$0.05**	**0.5%**	-	-
Faculty Early Career Development - CAREER	Research & Related Activities	186.55	166.20	196.39	209.16	22.61	12.1%	12.77	6.5%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$186.55**	**$166.20**	**$196.39**	**$209.16**	**$22.61**	**12.1%**	**$12.77**	**6.5%**
Graduate Research Fellowship - GRF	Research & Related Activities	8.50	46.94	33.34	50.66	42.16	496.3%	17.32	51.9%
	Education & Human Resources	107.00	-	102.58	107.58	0.58	0.5%	5.00	4.9%
	Total, NSF	**$115.49**	**$46.94**	**$135.92**	**$158.24**	**$42.75**	**37.0%**	**$22.32**	**16.4%**
Graduate STEM Fellows in K-12 Education - GK-12	Research & Related Activities	7.08	2.50	5.31	4.67	-2.41	-34.1%	-0.64	-12.1%
	Education & Human Resources	49.26	-	49.00	48.18	-1.08	-2.2%	-0.82	-1.7%
	Total, NSF	**$56.34**	**$2.50**	**$54.31**	**$52.85**	**-$3.49**	**-6.2%**	**-$1.46**	**-2.7%**
Integrative Graduate Education and Research Traineeship - IGERT	Research & Related Activities	38.36	14.22	39.37	32.30	-6.06	-15.8%	-7.07	-18.0%
	Education & Human Resources	25.41	-	29.86	29.50	4.09	16.1%	-0.36	-1.2%
	Total, NSF	**$63.77**	**$14.22**	**$69.23**	**$61.80**	**-$1.97**	**-3.1%**	**-$7.43**	**-10.7%**
Total, Graduate Fellowships & Traineeships	Research & Related Activities	53.94	63.66	78.02	87.63	33.69	62.5%	9.61	12.3%
	Education & Human Resources	181.67	-	181.44	185.26	3.59	2.0%	3.82	2.1%
	Total, NSF	**$235.61**	**$63.66**	**$259.46**	**$272.89**	**$37.28**	**15.8%**	**$13.43**	**5.2%**
Long-Term Research Sites - LTER	Research & Related Activities	32.29	7.53	27.94	28.10	-4.19	-13.0%	0.16	0.6%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$32.29**	**$7.53**	**$27.94**	**$28.10**	**-$4.19**	**-13.0%**	**$0.16**	**0.6%**
Research Experience for Teachers - RET	Research & Related Activities	6.31	2.54	5.64	5.52	-0.79	-12.5%	-0.12	-2.1%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$6.31**	**$2.54**	**$5.64**	**$5.52**	**-$0.79**	**-12.5%**	**-$0.12**	**-2.1%**
Research Experience for Undergraduates - REU	Research & Related Activities	74.47	26.00	66.66	67.27	-7.20	-9.7%	0.61	0.9%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$74.47**	**$26.00**	**$66.66**	**$67.27**	**-$7.20**	**-9.7%**	**$0.61**	**0.9%**
Research Experience for Undergraduates - REU - Sites Only	Research & Related Activities	50.14	25.44	49.70	50.60	0.46	0.9%	0.90	1.8%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$50.14**	**$25.44**	**$49.70**	**$50.60**	**$0.46**	**0.9%**	**$0.90**	**1.8%**
Research Experience for Undergraduates - REU - Supplements Only	Research & Related Activities	24.33	0.56	16.96	16.67	-7.66	-31.5%	-0.29	-1.7%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$24.33**	**$0.56**	**$16.96**	**$16.67**	**-$7.66**	**-31.5%**	**-$0.29**	**-1.7%**
Research in Undergraduate Institutions - RUI	Research & Related Activities	39.36	12.33	37.32	37.45	-1.91	-4.8%	0.13	0.3%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$39.36**	**$12.33**	**$37.32**	**$37.45**	**-$1.91**	**-4.8%**	**$0.13**	**0.3%**
Science and Technology Centers - STCs	Research & Related Activities	62.46	-	57.77	66.03	3.57	5.7%	8.26	14.3%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$62.46**	**-**	**$57.77**	**$66.03**	**$3.57**	**5.7%**	**$8.26**	**14.3%**

Totals may not add due to rounding.

NSF Funding Profile

Approximately half of the awards supported in a particular fiscal year are competitively reviewed in that year through NSF's merit review process. Other awards are continuations of projects that were competitively reviewed in a prior year.

Statistics for Competitive Awards: The Funding Rate is the number of competitive awards made during a year as a percentage of total proposals competitively reviewed. This indicates the probability of receiving an award when submitting proposals to NSF.

Statistics for Research Grants: Research Grants are grants limited to research projects and exclude other categories of awards that fund infrastructure-type activities, which do not require multi-year support, such as equipment and conference awards. Annualized Award Size shows the annual level of research grants provided to awardees by dividing the total dollars of each award by the number of years over which it extends. Both the average and the median annualized award size for competitively reviewed awards are shown. Average Duration is the length of the award in years.

The Quantitative Data Tables, provided under a separate tab in this submission, are based on obligations made, including competitive awards, contracts, cooperative agreements, supplements, and amendments to existing grants and contracts.

National Science Foundation Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Statistics for Competitive Awards:			
Number of Proposals	45,106	48,725	50,908
Number of New Awards	14,605	11,387	12,291
Regular Appropriation	9,994	11,387	12,291
ARRA	4,611	-	-
Funding Rate	32%	23%	24%
Statistics for Research Grants:			
Number of Research Grant Proposals	34,783	37,805	39,607
Number of Research Grants	9,900	7,181	7,776
Regular Appropriation	6,245	7,181	7,776
ARRA	3,655	-	-
Funding Rate	28%	19%	20%
Median Annualized Award Size	$126,240	$125,666	$126,986
Average Annualized Award Size	$163,145	$158,986	$159,186
Average Award Duration, in years	3.0	3.0	3.0

National Science Foundation
NSTC Crosscuts Summary
FY 2011 Request to Congress

(Dollars in Millions)

	Climate Change Technology Program				U.S. Global Change Research Program			
	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request
BIO	-	-	-	-	$61.00	$20.00	$81.00	$89.00
CISE	-	-	-	-	-	-	-	-
ENG	$24.00	$2.00	$25.75	$26.75	1.00	-	-	-
GEO	-	-	-	-	160.00	50.00	194.00	225.00
MPS	-	-	-	-	13.48	2.75	7.28	7.63
SBE	-	-	-	-	15.48	3.00	18.48	25.98
OCI	-	-	-	-	-	-	-	-
OISE	-	-	-	-	-	-	-	-
OPP	-	-	-	-	18.30	44.79	18.30	22.30
IA	-	-	-	-	-	-	-	-
R&RA	**$24.00**	**$2.00**	**$25.75**	**$26.75**	**$269.26**	**$120.54**	**$319.06**	**$369.91**
EHR	-	-	-	-	-	-	-	-
NSF Total	**$24.00**	**$2.00**	**$25.75**	**$26.75**	**$269.26**	**$120.54**	**$319.06**	**$369.91**

	Networking and Information Technology Research and Development				National Nanotechnology Initiative			
	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request
BIO	$86.15	-	$93.00	$93.00	$56.60	-	$56.60	$56.60
CISE	574.50	235.00	618.83	684.51	11.65	1.43	11.00	11.00
ENG	20.75	3.30	23.70	23.70	140.02	35.00	148.00	156.37
GEO	18.98	-	22.98	22.98	0.85	-	6.33	0.85
MPS	85.01	24.24	85.39	84.51	194.27	64.77	190.59	172.26
SBE	17.50	4.62	22.80	23.80	1.73	-	1.67	1.67
OCI	199.23	80.00	214.28	228.07	-	-	-	-
OISE	-	-	-	-	-	-	-	-
OPP	-	-	-	-	-	-	-	-
IA	-	-	-	-	-	-	-	-
R&RA	**$1,002.12**	**$347.16**	**$1,080.98**	**$1,160.57**	**$405.12**	**$101.20**	**$414.19**	**$398.75**
EHR	**$9.50**	-	**$9.50**	**$9.50**	**$3.50**	-	**$3.50**	**$2.50**
NSF Total	**$1,011.62**	**$347.16**	**$1,090.48**	**$1,170.07**	**$408.62**	**$101.20**	**$417.69**	**$401.25**

National Science Foundation
Homeland Security Activities Summary
FY 2011 Request to Congress

(Dollars in Millions)

	BIO	CISE	ENG	GEO	MPS	SBE	OCI	OPP	IA	R&RA	EHR	AOAM	Total, NSF
FY 2009 Omnibus Actual	**$15.00**	**$169.80**	**$160.20**	-	**$4.87**	**$4.50**	**$1.02**	**$2.68**	**$2.82**	**$360.89**	**$14.88**	**$2.63**	**$378.40**
Protecting Critical Infrastructure & Key Assets	-	**$169.80**	**$160.20**	-	**$4.87**	**$4.50**	**$1.02**	**$2.68**	**$2.82**	**$345.89**	**$14.88**	**$2.63**	**$363.40**
Antarctic Physical Security	-	-	-	-	-	-	-	0.28	-	0.28	-	-	0.28
Counterterrorism	-	27.00	-	-	-	-	-	-	-	27.00	-	-	27.00
Cybersecurity	-	113.50	3.20	-	-	-	1.02	-	0.20	117.92	-	-	117.92
Electronic Commerce	-	4.50	3.50	-	-	-	-	-	-	8.00	-	-	8.00
Emergency Planning & Response	-	24.80	26.00	-	1.97	-	-	-	-	52.77	-	-	52.77
Energy Supply Assurance	-	-	29.00	-	1.70	-	-	-	-	30.70	-	-	30.70
IT Security	-	-	-	-	-	-	-	2.40	2.62	5.02	-	2.63	7.65
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	98.50	-	1.20	4.50	-	-	-	104.20	-	-	104.20
Scholarships for Service / Cybercorps	-	-	-	-	-	-	-	-	-	-	14.88	-	14.88
Defending Against Catastrophic Threats	**$15.00**	-	-	-	-	-	-	-	-	**$15.00**	-	-	**$15.00**
Research to Combat Bioterrorism	15.00	-	-	-	-	-	-	-	-	15.00	-	-	15.00
Microbial Genomics, Analysis & Modeling	*15.00*	-	-	-	-	-	-	-	-	*15.00*	-	-	*15.00*
FY 2009 ARRA Actual	-	**$34.00**	**$7.00**	-	**$2.08**	-	-	-	-	**$43.08**	-	-	**$43.08**
Protecting Critical Infrastructure & Key Assets	-	**$34.00**	**$7.00**	-	**$2.08**	-	-	-	-	**$43.08**	-	-	**$43.08**
Cybersecurity	-	34.00	-	-	-	-	-	-	-	34.00	-	-	34.00
Emergency Planning & Response	-	-	1.00	-	0.58	-	-	-	-	1.58	-	-	1.58
Energy Supply Assurance	-	-	1.00	-	1.20	-	-	-	-	2.20	-	-	2.20
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	5.00	-	0.30	-	-	-	-	5.30	-	-	5.30
FY 2010 Estimate	**$15.00**	**$179.80**	**$160.50**	-	**$3.80**	**$4.50**	**$4.00**	**$2.68**	-	**$370.28**	**$15.00**	**$4.75**	**$390.03**
Protecting Critical Infrastructure & Key Assets	-	**$179.80**	**$160.50**	-	**$3.80**	**$4.50**	**$4.00**	**$2.68**	-	**$355.28**	**$15.00**	**$4.75**	**$375.03**
Antarctic Physical Security	-	-	-	-	-	-	-	0.28	-	0.28	-	-	0.28
Counterterrorism	-	27.00	-	-	-	-	-	-	-	27.00	-	-	27.00
Cybersecurity	-	123.50	3.20	-	-	-	4.00	-	-	130.70	-	-	130.70
Electronic Commerce	-	4.50	3.50	-	-	-	-	-	-	8.00	-	-	8.00
Emergency Planning & Response	-	24.80	26.30	-	3.10	-	-	-	-	54.20	-	-	54.20
Energy Supply Assurance	-	-	29.00	-	-	-	-	-	-	29.00	-	-	29.00
IT Security	-	-	-	-	-	-	-	2.40	-	2.40	-	4.75	7.15
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	98.50	-	0.70	4.50	-	-	-	103.70	-	-	103.70
Scholarships for Service / Cybercorps	-	-	-	-	-	-	-	-	-	-	15.00	-	15.00
Defending Against Catastrophic Threats	**$15.00**	-	-	-	-	-	-	-	-	**$15.00**	-	-	**$15.00**
Research to Combat Bioterrorism	15.00	-	-	-	-	-	-	-	-	15.00	-	-	15.00
Microbial Genomics, Analysis & Modeling	*15.00*	-	-	-	-	-	-	-	-	*15.00*	-	-	*15.00*
Delta from FY 2010 Estimate to FY 2011 Request	-	**$15.00**	**$1.60**	-	-	-	**-$1.20**	-	-	**$15.40**	-	-	**$15.40**
Protecting Critical Infrastructure & Key Assets	-	**$15.00**	**$1.60**	-	-	-	**-$1.20**	-	-	**$15.40**	-	-	**$15.40**
Antarctic Physical Security	-	-	-	-	-	-	-	-	-	-	-	-	-
Counterterrorism	-	-	-	-	-	-	-	-	-	-	-	-	-
Cybersecurity	-	15.00	0.05	-	-	-	-1.20	-	-	13.85	-	-	13.85
Electronic Commerce	-	-	0.05	-	-	-	-	-	-	0.05	-	-	0.05
Emergency Planning & Response	-	-	0.25	-	-	-	-	-	-	0.25	-	-	0.25
Energy Supply Assurance	-	-	0.25	-	-	-	-	-	-	0.25	-	-	0.25
IT Security	-	-	-	-	-	-	-	-	-	-	-	-	-
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	1.00	-	-	-	-	-	-	1.00	-	-	1.00
Scholarships for Service / Cybercorps	-	-	-	-	-	-	-	-	-	-	-	-	-
Defending Against Catastrophic Threats	-	-	-	-	-	-	-	-	-	-	-	-	-
Research to Combat Bioterrorism	-	-	-	-	-	-	-	-	-	-	-	-	-
Microbial Genomics, Analysis & Modeling	-	-	-	-	-	-	-	-	-	-	-	-	-
FY 2011 Request	**$15.00**	**$194.80**	**$162.10**	-	**$3.80**	**$4.50**	**$2.80**	**$2.68**	-	**$385.68**	**$15.00**	**$4.75**	**$405.43**
Protecting Critical Infrastructure & Key Assets	-	**$194.80**	**$162.10**	-	**$3.80**	**$4.50**	**$2.80**	**$2.68**	-	**$370.68**	**$15.00**	**$4.75**	**$390.43**
Antarctic Physical Security	-	-	-	-	-	-	-	0.28	-	0.28	-	-	0.28
Counterterrorism	-	27.00	-	-	-	-	-	-	-	27.00	-	-	27.00
Cybersecurity	-	138.50	3.25	-	-	-	2.80	-	-	144.55	-	-	144.55
Electronic Commerce	-	4.50	3.55	-	-	-	-	-	-	8.05	-	-	8.05
Emergency Planning & Response	-	24.80	26.55	-	3.10	-	-	-	-	54.45	-	-	54.45
Energy Supply Assurance	-	-	29.25	-	-	-	-	-	-	29.25	-	-	29.25
IT Security	-	-	-	-	-	-	-	2.40	-	2.40	-	4.75	7.15
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	99.50	-	0.70	4.50	-	-	-	104.70	-	-	104.70
Scholarships for Service / Cybercorps	-	-	-	-	-	-	-	-	-	-	15.00	-	15.00
Defending Against Catastrophic Threats	**$15.00**	-	-	-	-	-	-	-	-	**$15.00**	-	-	**$15.00**
Research to Combat Bioterrorism	15.00	-	-	-	-	-	-	-	-	15.00	-	-	15.00
Microbial Genomics, Analysis & Modeling	*15.00*	-	-	-	-	-	-	-	-	*15.00*	-	-	*15.00*

NSF Programs to Broaden Participation
FY 2011 Request to Congress

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	FY 2011 Request change over: FY 2009 Omnibus Actual Amount	Percent	FY 2010 Estimate Amount	Percent
ADVANCE	$20.74	$1.00	$21.02	$21.65	$0.91	4.4%	$0.63	3.0%
ADVANCE - R&RA	*19.57*	*1.00*	*19.49*	*20.12*	*0.55*	*2.8%*	*0.63*	*3.2%*
ADVANCE - EHR	*1.18*	-	*1.53*	*1.53*	*0.35*	*30.0%*	-	-
Advanced Technological Education (ATE)	51.85	-	64.00	64.00	12.15	23.4%	-	-
Alliances for Graduate Education and the Professoriate (AGEP)	17.18	-	16.75	16.75	-0.43	-2.5%	-	-
Broadening Participation in Computing (BPC)	14.00	-	14.00	14.00	-	-	-	-
Research Initiation Grants in Biology (RIG)\1	1.75	-	2.00	2.00	0.25	14.3%	-	-
Centers of Research Excellence in Science and Technology (CREST)	30.42	5.00	30.53	30.53	0.11	0.4%	-	-
CREST - R&RA	-	*5.00*	-	-	-	*N/A*	-	*N/A*
CREST - EHR	*30.42*	-	*30.53*	*30.53*	*0.11*	*0.4%*	-	-
Comprehensive Broadening Participation of Undergraduates in STEM\2	87.02	-	90.10	103.10	16.08	18.5%	13.00	14.4%
Cyberinfrastructure Training, Education, Advancement and Mentoring (CI-TEAM)	-	-	5.00	5.00	5.00	N/A	-	-
Experimental Program to Stimulate Competitive Research (EPSCoR)	133.00	30.00	147.12	154.36	21.36	16.1%	7.24	4.9%
GEO LSAMP Linkages	1.00	-	1.00	1.00	-	-	-	-
Graduate Research Diversity (GRD) - ENG	0.81	-	1.50	1.50	0.69	85.2%	-	-
Graduate Research Fellowship - Women in Engineering and Computer Science	8.13	6.89	9.55	6.55	-1.58	-19.4%	-3.00	-31.4%
H-1B Nonimmigrant Petitioner Fee programs	89.08	-	100.00	100.00	10.92	12.3%	-	-
Informal Science Education (ISE)	65.72	-	66.00	64.40	-1.32	-2.0%	-1.60	-2.4%
Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM)	2.71	-	2.70	2.70	-0.01	-0.4%	-	-
UBM - R&RA	*2.11*	-	*2.10*	*2.10*	*-0.01*	*-0.5%*	-	-
UBM - EHR	*0.60*	-	*0.60*	*0.60*	-	-	-	-
Math and Science Partnership (MSP)	60.99	25.00	58.22	58.22	-2.77	-4.5%	-	-
Minority Post-Docs	2.06	3.00	3.50	3.50	1.44	69.9%	-	-
BIO Minority Post-Docs	*1.10*	*3.00*	*2.50*	*2.50*	*1.40*	*127.3%*	-	-
SBE Minority Post-Docs	*0.96*	-	*1.00*	*1.00*	*0.04*	*4.2%*	-	-
Next Generation Workforce (NGW) - SBE\3	1.03	-	1.00	-	-1.03	-100.0%	-1.00	-100.0%
Noyce Scholarships	55.00	60.00	55.00	55.00	-	-	-	-
Opportunities to Enhance Diversity in the Geosciences (OEDG)	4.83	6.96	4.60	3.60	-1.23	-25.4%	-1.00	-21.7%
Partnerships for Innovation (PFI)	9.19	-	9.19	19.19	10.00	108.8%	10.00	108.8%
Partnerships for Research and Education in Materials (PREM) - MPS	6.98	9.60	5.53	6.00	-0.98	-14.0%	0.47	8.5%
Research in Disabilities Education (RDE)	6.88	-	6.50	6.50	-0.38	-5.6%	-	-
Research on Gender in Science and Engineering (GSE)	11.40	-	11.50	10.50	-0.90	-7.9%	-1.00	-8.7%
Research Partnerships for Diversity (RPD) - MPS	1.00	-	2.00	2.00	1.00	100.0%	-	-
Science, Technology, Engineering and Math Talent Expansion Program (STEP)	29.09	-	32.53	32.53	3.44	11.8%	-	-
STEP - R&RA	-	-	*1.00*	*1.00*	*1.00*	*N/A*	-	-
STEP - EHR	*29.09*	-	*31.53*	*31.53*	*2.44*	*8.4%*	-	-
Significant Opportunities in Atmospheric Research and Science (SOARS) - GEO	0.61	-	0.60	0.60	-0.01	-1.6%	-	-
Tribal College Pathways - ENG	-	-	-	-	-	N/A	-	N/A
Undergraduate Research Collaboratives (URC) - MPS\3	2.16	-	1.00	-	-2.16	-100.0%	-1.00	-100.0%
Undergraduate Research Mentoring in Biology (URM)	3.00	1.68	3.00	3.00	-	-	-	-
Subtotal, R&RA	**$211.21**	**$64.14**	**$233.18**	**$245.52**	**$34.31**	**16.2%**	**$12.34**	**5.3%**
Subtotal, EHR	**$417.32**	**$85.00**	**$432.26**	**$442.66**	**$25.34**	**6.1%**	**$10.40**	**2.4%**
Subtotal, H-1B Nonimmigrant Petitioner Fees	**$89.08**	-	**$100.00**	**$100.00**	**$10.92**	**12.3%**	-	-
TOTAL, NSF	**$717.61**	**$149.14**	**$765.44**	**$788.18**	**$70.57**	**9.8%**	**$22.74**	**3.0%**

Please note that this table displays a subset of the overall Broadening Participation portfolio. This list comprises the standard set of programs that have been historically tracked as Broadening Participation for budget purposes.

\1 Broadening Participation in the Biological Sciences is renamed to Research Initiation Grants in Biology (RIG) to clarify the program's intent.

\2 Comprehensive Broadening Participation of Undergraduates in STEM is a new EHR-managed program proposed for FY 2011, enfolding Historically-Black Colleges and Universities-Undergraduate Program (HBCU-UP), Louis Stokes Alliances for Minority Participation (LSAMP), and Tribal Colleges and Universities Program (TCUP) with new activities, as described in the EHR

\3 The Next Generation Workforce (NGW) and the Undergraduate Research Collaboratives (URC) programs' final year of funding is FY 2010.

National Science Foundation
Learning Funding by Level of Education
FY 2011 Request to Congress

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	FY 2011 Request change over: FY 2009 Omnibus Actual		FY 2010 Estimate	
					Amount	Percent	Amount	Percent
K-12 Programs	$60.07	$25.00	$57.17	$57.06	-$3.01	-5.0%	-$0.11	-0.2%
Undergraduate Programs	266.07	85.51	288.60	291.07	25.00	9.4%	2.47	0.9%
Graduate & Professional Programs	328.32	119.84	366.72	379.36	51.04	15.5%	12.64	3.4%
Multi-level and Other Programs	250.67	19.02	254.89	285.56	34.89	13.9%	30.67	12.0%
TOTAL, NSF	**$905.12**	**$249.37**	**$967.38**	**$1,013.05**	**$107.93**	**11.9%**	**$45.67**	**4.7%**

Number of People Involved in NSF Activities

Estimates are that in FY 2011 more than 214,000 people will be directly involved in NSF programs and activities, receiving salaries, stipends, or participant support. Also, NSF programs indirectly impact millions of people. These programs reach K-12 students and teachers, the general public, and researchers through activities including workshops; informal science activities such as museums, television, videos, and journals; outreach efforts; and dissemination of improved curriculum and teaching methods.

Number of People Involved in NSF Activities

	FY 2009 Omnibus Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	41,971	12,408	44,770	46,580
Other Professionals	11,868	3,546	13,030	13,490
Postdoctorates	5,989	1,945	6,760	7,050
Graduate Students	37,621	15,945	41,320	43,620
Undergraduate Students	24,899	7,868	24,840	25,860
K-12 Students	13,001	500	13,010	13,650
K-12 Teachers	62,206	1,075	62,310	64,190
Total Number of People	**197,555**	**43,287**	**206,040**	**214,440**

Senior Researchers include scientists, mathematicians, engineers, and educators receiving funding through NSF awards. These include both researchers who are principal or co-principal investigators on research and education projects, and researchers working at NSF-supported centers and facilities.

Other Professionals are individuals who may or may not hold a doctoral degree or its equivalent, are considered professionals but are not reported as senior researchers, postdoctoral associates, or students. Examples are technicians, systems experts, etc.

Postdoctoral Associates are individuals who have received Ph.D., M.D., D.Sc., or equivalent and are not faculty members of the performing institution. About 98 percent are supported through funds included in research projects, centers, or facilities awards. Others are recipients of postdoctoral fellowships.

Graduate Students include those compensated from NSF grant funds. About 14 percent receive support through programs such as NSF Graduate Research Fellowship and NSF Graduate STEM Fellowships in K-12 Education. The balance assists senior researchers or postdoctoral associates in performing research and is supported through funds included in research projects, centers, or facilities awards. NSF provides support for about 5 percent of the science and engineering graduate students in the U.S.

Undergraduate Students include students enrolled in technical colleges or baccalaureate programs compensated from NSF grant funds. They may be assisting senior researchers or postdoctoral associates in performing research, or participating in NSF programs aimed at undergraduate students, such as Research Experiences for Undergraduates.

K-12 Students are those attending elementary, middle, and secondary schools. They are supported through program components that directly engage students in science and mathematics experiences.

K-12 Teachers include teachers at elementary, middle, and secondary schools. These individuals actively participate in intensive professional development experiences in the sciences and mathematics.

NSF By Account

(Actual Dollars in Millions - Current Dollars)

Fiscal Year	Research & Related Activities	Education & Human Resources	Academic Research Infrastructure	Major Research Equipment & Facilities Construction	Agency Operations & Award Management	Office of Inspector General	National Science Board	NSF
1951	0.03	-	-	-	0.13	-	-	0.15
1952	1.40	1.54	-	-	0.53	-	-	3.47
1953	2.14	1.41	-	-	0.88	-	-	4.43
1954	4.52	1.89	-	-	1.55	-	-	7.96
1955	8.86	2.08	-	-	1.55	-	-	12.49
1956	10.79	3.52	-	-	1.68	-	-	15.99
1957	21.98	14.30	-	-	2.35	-	-	38.63
1958	27.37	19.21	-	-	2.93	-	-	49.51
1959	66.33	61.29	-	-	5.26	-	-	132.88
1960	88.35	63.74	-	-	6.51	-	-	158.60
1961	103.98	63.44	-	-	7.57	-	-	174.99
1962	173.26	78.58	-	-	8.98	-	-	260.82
1963	218.90	90.99	-	-	10.87	-	-	320.75
1964	239.95	102.58	-	-	12.05	-	-	354.58
1965	282.44	120.41	-	-	13.12	-	-	415.97
1966	328.63	124.31	-	-	13.09	-	-	466.02
1967	327.70	123.36	-	-	14.04	-	-	465.10
1968	350.20	134.71	-	-	15.38	-	-	500.29
1969	292.90	123.11	-	-	16.49	-	-	432.50
1970	316.41	126.41	-	-	19.68	-	-	462.49
1971	369.37	105.00	-	-	21.77	-	-	496.14
1972	482.43	93.73	-	-	24.56	-	-	600.72
1973	519.42	62.23	-	-	28.62	-	-	610.27
1974	533.29	80.71	-	-	31.66	-	-	645.65
1975	581.23	74.03	-	-	37.87	-	-	693.13
1976	619.72	62.48	-	-	42.23	-	-	724.42
1977	671.98	74.26	-	-	45.53	-	-	791.77
1978	734.69	73.86	-	-	48.70	-	-	857.25
1979	791.76	80.41	-	-	54.77	-	-	926.93
1980	836.83	80.06	-	-	58.24	-	-	975.13
1981	900.36	75.70	-	-	59.21	-	-	1,035.27
1982	909.75	26.20	-	-	63.18	-	-	999.14
1983	1,013.02	22.98	-	-	65.70	-	-	1,101.69
1984	1,177.70	62.97	-	-	66.26	-	-	1,306.92
1985	1,344.56	90.56	-	-	71.95	-	-	1,507.07
1986	1,329.64	91.69	-	-	71.84	-	-	1,493.17
1987	1,439.97	109.88	-	-	77.77	-	-	1,627.62
1988	1,481.31	156.79	-	-	84.47	-	-	1,722.57
1989	1,600.53	194.06	-	-	91.29	-	-	1,885.88
1990	1,696.56	230.41	0.41	-	96.35	2.33	-	2,026.06
1991	1,868.45	331.91	39.02	-	101.23	2.89	-	2,343.49
1992	1,940.48	459.44	33.36	-	109.99	3.86	-	2,547.13
1993	2,046.31	505.06	49.75	34.07	110.84	3.69	-	2,749.73
1994	2,168.36	569.03	105.38	17.04	123.49	3.92	-	2,987.21
1995	2,281.46	611.88	117.46	126.00	129.01	4.46	-	3,270.27
1996	2,327.80	601.16	70.89	70.00	132.50	3.98	-	3,206.33
1997	2,433.93	619.14	30.02	76.13	134.27	5.33	-	3,298.82
1998	2,572.62	633.16	-	78.21	136.95	4.80	-	3,425.73
1999	2,821.61	662.48	-	56.71	144.08	5.41	-	3,690.28
2000	2,979.90	683.58	-	105.00	149.28	5.60	-	3,923.36
2001	3,372.30	795.42	-	119.24	166.33	6.58	-	4,459.87
2002	3,615.97	866.11	-	115.35	169.93	6.70	-	4,774.06
2003	4,054.43	934.88	-	179.03	189.42	8.70	2.88	5,369.34
2004	4,293.34	944.10	-	183.96	218.92	9.47	2.22	5,652.01
2005	4,234.82	843.54	-	165.14	223.45	10.17	3.65	5,480.77
2006	4,351.03	798.48	-	233.81	247.06	11.47	3.94	5,645.79
2007	4,656.33	797.76	-	166.21	248.49	11.92	3.65	5,884.37
2008	4,853.24	766.26	-	166.85	282.04	11.83	3.82	6,084.04
2009 Omnibus Actual	5,152.39	845.52	-	160.76	294.09	11.99	4.02	6,468.76
2009 ARRA Actual	2,062.64	85.00	-	254.00	-	0.02	-	2,401.66
2010 Estimate	5,563.92	872.76	-	117.29	300.00	14.00	4.54	6,872.51
2011 Request	6,018.83	892.00	-	165.19	329.19	14.35	4.84	7,424.40

NSF By Account

(FY Actuals - FY 2010 Constant Dollars in Millions)

Fiscal Year	Research & Related Activities	Education & Human Resources	Academic Research Infrastructure	Major Research Equipment & Facilities Construction	Agency Operations & Award Management	Office of Inspector General	National Science Board	NSF
1951	0.19	-	-	-	0.91	-	-	1.10
1952	9.82	10.78	-	-	3.72	-	-	24.32
1953	14.71	9.70	-	-	6.02	-	-	30.43
1954	30.72	12.85	-	-	10.51	-	-	54.07
1955	59.74	14.03	-	-	10.42	-	-	84.19
1956	70.91	23.13	-	-	11.04	-	-	105.09
1957	139.29	90.62	-	-	14.90	-	-	244.80
1958	168.40	118.14	-	-	18.04	-	-	304.58
1959	402.07	371.50	-	-	31.88	-	-	805.45
1960	528.91	381.58	-	-	38.96	-	-	949.46
1961	613.89	374.56	-	-	44.69	-	-	1,033.14
1962	1,011.73	458.85	-	-	52.42	-	-	1,523.01
1963	1,262.34	524.70	-	-	62.66	-	-	1,849.71
1964	1,367.48	584.61	-	-	68.69	-	-	2,020.77
1965	1,581.34	674.16	-	-	73.45	-	-	2,328.94
1966	1,801.94	681.63	-	-	71.77	-	-	2,555.34
1967	1,741.22	655.47	-	-	74.62	-	-	2,471.32
1968	1,797.41	691.40	-	-	78.93	-	-	2,567.75
1969	1,437.18	604.07	-	-	80.91	-	-	2,122.16
1970	1,473.44	588.66	-	-	91.63	-	-	2,153.74
1971	1,637.99	465.63	-	-	96.54	-	-	2,200.16
1972	2,042.72	396.88	-	-	104.00	-	-	2,543.60
1973	2,107.33	252.47	-	-	116.11	-	-	2,475.91
1974	2,018.92	305.55	-	-	119.85	-	-	2,444.32
1975	1,991.54	253.66	-	-	129.75	-	-	2,374.94
1976	1,980.99	199.72	-	-	134.98	-	-	2,315.70
1977	1,998.56	220.86	-	-	135.41	-	-	2,354.83
1978	2,046.97	205.80	-	-	135.67	-	-	2,388.44
1979	2,041.74	207.34	-	-	141.23	-	-	2,390.31
1980	1,982.83	189.70	-	-	138.00	-	-	2,310.53
1981	1,941.94	163.27	-	-	127.70	-	-	2,232.91
1982	1,836.47	52.89	-	-	127.54	-	-	2,016.90
1983	1,958.77	44.43	-	-	127.03	-	-	2,130.23
1984	2,196.09	117.41	-	-	123.55	-	-	2,437.06
1985	2,428.49	163.56	-	-	129.95	-	-	2,722.00
1986	2,347.18	161.86	-	-	126.81	-	-	2,635.85
1987	2,476.10	188.94	-	-	133.73	-	-	2,798.77
1988	2,468.04	261.23	-	-	140.73	-	-	2,870.00
1989	2,566.97	311.24	-	-	146.41	-	-	3,024.62
1990	2,624.38	356.41	0.63	-	149.04	3.60	-	3,134.07
1991	2,784.82	494.69	58.16	-	150.87	4.30	-	3,492.84
1992	2,818.73	667.38	48.45	-	159.77	5.60	-	3,699.94
1993	2,908.07	717.76	70.71	48.42	157.51	5.24	-	3,907.71
1994	3,017.68	791.92	146.65	23.72	171.86	5.45	-	4,157.27
1995	3,109.13	833.86	160.07	171.71	175.82	6.08	-	4,456.67
1996	3,112.20	803.73	94.78	93.59	177.14	5.31	-	4,286.76
1997	3,195.48	812.86	39.41	99.95	176.28	7.00	-	4,330.99
1998	3,335.17	820.83	-	101.39	177.54	6.22	-	4,441.14
1999	3,610.12	847.61	-	72.55	184.34	6.92	-	4,721.55
2000	3,738.88	857.69	-	131.74	187.30	7.03	-	4,922.63
2001	4,133.56	974.98	-	146.16	203.88	8.07	-	5,466.64
2002	4,360.35	1,044.41	-	139.10	204.91	8.08	-	5,756.85
2003	4,789.14	1,104.29	-	211.47	223.75	10.28	3.40	6,342.33
2004	4,944.61	1,087.31	-	211.87	252.13	10.91	2.56	6,509.38
2005	4,723.09	940.80	-	184.18	249.21	11.34	4.07	6,112.70
2006	4,692.23	861.10	-	252.14	266.43	12.37	4.25	6,088.52
2007	4,879.46	835.99	-	174.17	260.40	12.49	3.82	6,166.34
2008	4,970.45	784.77	-	170.87	288.85	12.11	3.92	6,230.97
2009 Omnibus Actual	5,198.53	853.09	-	162.19	296.72	12.10	4.06	6,526.69
2009 ARRA Actual	2,081.12	85.76	-	256.27	-	0.02	-	2,423.17
2010 Estimate	5,563.92	872.76	-	117.29	300.00	14.00	4.54	6,872.51
2011 Request	5,953.18	882.27	-	163.39	325.60	14.19	4.79	7,343.41

Totals may not add due to rounding.

NSF AUTHORIZATIONS

National Science Foundation Current Authorizations

LEGISLATION	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	Authorization Levels FY 2009	FY 2010	FY 2011
			(Dollars in Millions)			
National Science Foundation Act of 1950 (P.L.81-507)[1]						
Scholarships and Graduate Fellowships				*within limits of funds made available for this purpose*		
General Authority				*within the limits of available appropriations*		
Administering Provisions				*to make such expenditures as may be necessary*		
International Cooperation and Coordination with Foreign Policy				*within the limit of appropriated funds*		
Contract Arrangements				*utilize appropriations available*		
America COMPETES Act (P.L.110-69)[2]	**$6,468.76**	**$2,401.66**	**$6,872.51**	**$7,326.00**	**$8,132.00**	
Account and Program Specific						
Research and Related Activities[3]	**$5,152.39**	**$2,062.64**	**$5,563.92**	**$5,742.30**	**$6,401.00**	
Experimental Program to Stimulate Competitive Research	*$133.00*	*$30.00*	*$147.12*	*$133.20*	*$147.80*	
Faculty Early Career Development (CAREER) Program	*$186.55*	*$166.20*	*$196.39*	*$183.60*	*$203.80*	
Graduate Research Fellowship Program	*$8.50*	*$46.94*	*$33.34*	*$10.00*	*$11.10*	
Integrative Graduate Education and Research Traineeship Program	*$38.36*	*$14.22*	*$39.37*	*$52.50*	*$58.30*	
Major Research Instrumentation	*$99.98*	*$99.85*	*$90.00*	*$123.10*	*$131.70*	
Professional Science Master's Degree Program	-	-	-	*$12.00*	*$15.00*	
Research Experiences for Undergraduates	*$74.47*	*$26.00*	*$66.66*	*$68.40*	*$75.90*	
Education and Human Resources	**$845.52**	**$85.00**	**$872.76**	**$995.00**	**$1,104.00**	
Advanced Technology Education	*$51.85*	-	*$64.00*	*$57.70*	*$64.00*	
Graduate Research Fellowship Program	*$107.00*	-	*$102.58*	*$107.20*	*$119.00*	
Integrative Graduate Education and Research Traineeship Program	*$25.41*	-	*$29.86*	*$30.10*	*$33.40*	
Mathematics and Science Education Partnerships	*$60.99*	*$25.00*	*$58.22*	*$111.00*	*$123.20*	
Science, Mathematics, Engineering, and Technology Talent Expansion Program	*$29.09*	-	*$31.53*	*$50.00*	*$55.00*	
Robert Noyce Scholarship Program	*$55.00*	*$60.00*	*$55.00*	*$115.00*	*$140.50*	
Major Research Equipment and Facilities Construction	**$160.76**	**$254.00**	**$117.29**	**$262.00**	**$280.00**	
Agency Operations and Award Management	**$294.09**	**-**	**$300.00**	**$309.76**	**$329.45**	
National Science Board	**$4.02**	**-**	**$4.54**	**$4.19**	**$4.34**	

Office of the Inspector General	**$11.99**	**$0.02**	**$14.00**	**$12.75**	**$13.21**	

				Authorization Levels		
LEGISLATION (cont.)	**FY 2009 Omnibus Actual**	**FY 2009 ARRA Actual**	**FY 2010 Estimate**	**FY 2009**	**FY 2010**	**FY 2011**
Federal Ocean Acidification Research and Monitoring Act of 2009 (P.L.111-11)	**$10.37**	**$9.92**	*	**$6.00**	**$8.00**	**$12.00**
National Earthquake Hazards Reduction Program Reauthorization Act of 2003 (P.L.108-360)	**$56.00**	**$20.20**		**$42.77**		
Consolidated Appropriations Act, 2001 (P.L.106-554); Small Business Technology Transfer Program Reauthorization Act of 2001 (P.L.107-50)						
Small Business Innovation Research (SBIR) Program [4]	*$86.80*	*$44.85*		*2.5% of research funds (SBIR)*		
Small Business Technology Transfer (STTR) Program [5]	*$3.59*	*$5.05*		*0.3% of research funds (STTR)*		

[1] Organic language establishing NSF, authorization and appropriation language may not correspond to current accounts and programs.

[2] Authorizes agency funding for FYs 2008-10; authorizes agency, account, and various program levels.

[3] FY 2010 Estimate for Research and Related Activities excludes $54.0 million transferred to the U.S. Coast Guard.

[4] SBIR is currently authorized through January 31, 2010.

[5] STTR is currently authorized through January 31, 2010.

*Actual amounts will be reported after awards are completed.

REPORT ON RESEARCH IN UNDERGRADUATE INSTITUTIONS PROGRAM

As required by Section 7014(d) of the America COMPETES Act, the table below provides award counts and funding rates for the various categories of institutions submitting proposals to the Research in Undergraduate Institutions (RUI) program.

The Research in Undergraduate Institutions activity supports research by faculty members of predominantly undergraduate institutions through the funding of (1) individual and collaborative research projects, (2) the purchase of shared-use research instrumentation, and (3) Research Opportunity Awards for work with NSF-supported investigators at other institutions.

Proposal and Award Counts and Funding Rates

Highest Academic Degree Conferred by Institution	FY 2008			FY 2009			FY 2010\1		
	Proposal Count	Award Count	Funding Rate	Proposal Count	Award Count	Funding Rate	Proposal Count	Award Count	Funding Rate
2 Year	1	-	-	2	-	-	2	-	-
4 Year	117	26	22.2%	100	30	30.0%	100	20	20.0%
Master's	224	46	20.5%	245	74	30.2%	245	50	20.4%
Ph.D.	118	12	10.2%	129	38	29.5%	129	26	20.2%
Other/2	2	1	50.0%	4	3	75.0%	4	2	50.0%

\1 FY 2010 data is an estimate based on FY 2009 funding rate actuals and the FY 2010 Estimate

\2 The Other category includes awards to U.S. government agencies and awards in collaboration with a RUI to non-academic institutions.

In FY 2009 ARRA funds allowed NSF to significantly increase the number of RUI awards as compared to FY 2008. ARRA funds were utilized to support 71 RUI awards; 74 awards were supported with FY 2009 Omnibus funds.

RESEARCH AND RELATED ACTIVITIES (R&RA) $6,018,830,000

+$454,910,000 / 8.2%

The FY 2011 Budget Request for the Research and Related Activities (R&RA) Appropriation is $6,018.83 million, an increase of $454.91 million, or 8.2 percent, above the FY 2010 Estimate of $5,563.92 million. Support from the R&RA Appropriation enables U.S. leadership and progress across the frontiers of scientific and engineering research and education.

Sustained, targeted investment by NSF in fundamental science and engineering advances discovery and learning and spurs innovation. Such transformational work holds great promise for meeting the myriad social, economic, and environmental challenges faced by both the Nation and the world.

In FY 2011, funding within the broad and flexible R&RA portfolio underscores the Administration's priorities for science and innovation with a focus on new faculty and young investigator support; graduate research fellowships; support for students to pursue careers in science and engineering related to clean energy; and support for climate and energy multidisciplinary research.

R&RA Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Biological Sciences	$656.62	$260.00	$714.54	$767.81	$53.27	7.5%
Computer & Information Science & Engineering	574.50	235.00	618.83	684.51	65.68	10.6%
Engineering	664.99	264.99	743.93	825.67	81.74	11.0%
Geosciences	808.53	347.00	889.64	955.29	65.65	7.4%
Mathematical & Physical Sciences	1,243.88	474.97	1,351.84	1,409.91	58.07	4.3%
Social, Behavioral & Economic Sciences	240.56	84.97	255.25	268.79	13.54	5.3%
Office of Cyberinfrastructure	199.23	80.00	214.28	228.07	13.79	6.4%
Office of International Science & Engineering	47.45	13.98	47.83	53.26	5.43	11.4%
Office of Polar Programs[1]	473.55	171.89	451.16	527.99	76.83	17.0%
Integrative Activities	241.58	129.85	275.04	295.93	20.89	7.6%
U.S. Arctic Research Commission	1.50	-	1.58	1.60	0.02	1.3%
Total, R&RA	**$5,152.39**	**$2,062.64**	**$5,563.92**	**$6,018.83**	**$454.91**	**8.2%**

Totals may not add due to rounding.

[1] Funding for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

RESEARCH AND RELATED ACTIVITIES

~~(including transfer of funds)~~

Appropriation Language

For necessary expenses in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of aircraft; and authorized travel; ~~$5,617,920,000~~*$6,018,830,000*, to remain available until September 30, ~~2011,~~*2012*, of which not to exceed ~~$570,000,000~~*$590,000,000* shall remain available until expended for polar research and operations support, and for reimbursement to other Federal agencies for operational and science support and logistical and other related activities for the United States Antarctic program, *including up to $54,000,000 for the procurement of polar icebreaking services from the Coast Guard: Provided,* That ~~from funds specified in the fiscal year *2010* budget request for icebreaking services, $54,000,000 shall be transferred to the U.S. Coast Guard "Operating Expenses" within 60 days of enactment of this Act~~ *the National Science Foundation shall only reimburse the Coast Guard for such sums as are agreed to according to the existing memorandum of agreement: Provided further*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation~~: *Provided further*, That not less than $147,120,000 shall be available for activities authorized by section 7002(c)(2)(A)(iv) of Public Law 110-69~~.

R&RA
FY 2011 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover	Recoveries	Transfers[1]	Expired	Total Resources	Obligations Incurred/ Est.
FY 2009 Omnibus	$5,183.10	$0.56	$11.05	$3.07	-$0.80	$5,196.98	$5,152.39
FY 2009 ARRA	2,500.00	-		-	-	2,500.00	2,062.64
FY 2010 ARRA	-	437.36		-	-	437.36	437.36
FY 2010 Estimate	5,617.92	44.59		-54.00	-	5,608.51	5,608.51
FY 2011 Request	6,018.83	-		-	-	6,018.83	6,018.83
$ Change from FY 2010 Estimate							$410.32
% Change from FY 2010 Estimate							7.3%

Totals may not add due to rounding.

[1] In FY 2009, NSF obligated incoming transfers of $3.07 million from the U.S. Agency for International Development for the U.S. Civilian Research and Development Foundation into the Research and Related Activities account. In FY 2010, NSF transferred $54.0 million to U.S. Coast Guard Operating Expenses account for ice breaking services.

Explanation of Carryover

For information on the Explanation of FY 2009 Carryover of funds into FY 2010 from Research and Related Activities, please refer to the Technical Information section.

FY 2011 Performance Highlights

The table below shows the strategic planning and evaluation framework for activities funded through the R&RA Appropriation. This framework was established in the NSF Strategic Plan for FY 2006-2011. NSF's strategic outcome goals are assessed annually by the Advisory Committee for GPRA Performance Assessment. Additional details are available in the Performance Information section of this document.

R&RA
By Strategic Outcome Goal
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate	
					Amount	Percent
Discovery	$3,269.89	$1,546.60	$3,621.96	$3,977.02	$355.06	9.8%
Learning	266.67	164.37	316.58	344.32	27.74	8.8%
Research Infrastructure[1]	1,527.58	351.68	1,528.91	1,593.17	64.26	4.2%
Stewardship	88.25	-	96.47	104.32	7.85	8.1%
Total, R&RA	**$5,152.39**	**$2,062.64**	**$5,563.92**	**$6,018.83**	**$454.91**	**8.2%**

Totals may not add due to rounding.

[1] Funding for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO) $767,810,000

+$53,270,000 / 7.5%

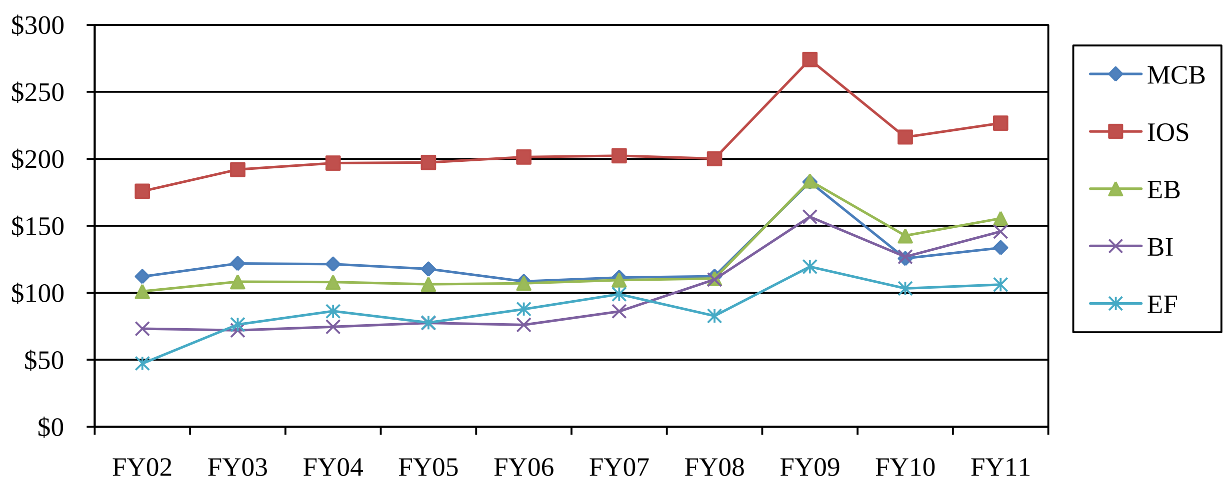
BIO Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Molecular & Cellular Biosciences (MCB)	$121.28	$61.53	$125.59	$133.69	$8.10	6.4%
Integrative Organismal Systems (IOS)	212.34	61.71	216.25	226.70	10.45	4.8%
Environmental Biology (DEB)	120.37	63.23	142.55	155.59	13.04	9.1%
Biological Infrastructure (DBI)	117.95	38.74	126.86	145.63	18.77	14.8%
Emerging Frontiers (EF)	84.68	34.80	103.29	106.20	2.91	2.8%
Total, BIO	**$656.62**	**$260.00**	**$714.54**	**$767.81**	**$53.27**	**7.5%**
Research	502.57	230.56	520.64	577.84	57.20	11.0%
Education	36.01	18.45	45.66	52.45	6.79	14.9%
Infrastructure	107.20	10.99	135.45	123.23	-12.22	-9.0%
Stewardship	10.84	-	12.79	14.29	1.50	11.7%

Totals may not add due to rounding.

The mission of BIO is to enable discoveries for understanding life. Through its investments in innovative and transformative research, BIO advances the frontiers of knowledge in the life sciences by increasing our understanding of complex living systems. BIO-supported projects also provide the theoretical basis for advancing the growing body of research being done by other science and engineering fields that involves applying biological principles or employing biological systems or processes.

BIO Subactivity Funding
(Dollars in Millions)



BIO in Context

BIO provides about 68 percent of federal funding for non-medical, basic research at academic institutions in the life sciences including environmental biology, a critical research area needed to answer questions related to climate change. Issues of national importance related to the environment, economy, agriculture, and human welfare require an understanding of how complex living systems function and interact with non-living systems. Research supported by BIO enhances this understanding. As the physical, computational, mathematical, and engineering fields increasingly use living systems to address major questions in their areas, NSF's robust investment in the non-medical biological sciences becomes increasingly relevant to tackling these multidisciplinary challenges.

Biological concepts are integral to wide-ranging areas of science essential to human welfare and the bio-economy, including national priorities such as climate change science, biotechnology and bioengineering. BIO supported research has been responsible for a wide range of critical breakthroughs essential to the Nation's prosperity, economic competitiveness, and quality of life. Living organisms have evolved mechanisms for efficiently using energy, producing an endless array of novel compounds, and storing information in a highly compact, adaptable format. Fundamental biological research is working to make this 3.5 billion years of biological innovation available to inform the next generation of nano-, bio-, and information technologies. BIO's investments focus on understanding the changing dynamics of the biosphere, research on the fundamental characteristics of biological energy systems, and efforts to enhance education and broaden participation. An example is the Basic Research to Enable Agricultural Development (BREAD) program begun in partnership with the Bill and Melinda Gates Foundation. This program supports basic research to test innovative hypotheses and novel approaches and technologies for sustainable, science-based solutions to problems of agriculture in developing countries.

To identify new opportunities and challenges for transformative research, the directorate supports numerous workshops, conferences, and projects each year. In addition, other reports, workshops, and conferences influence the direction of science supported within the biological sciences as well as the development of new programs and activities. Examples of these are:

- Reports by the National Research Council of the National Academies:
    - *Restructuring Federal Climate Research to Meet the Challenges of Climate Change (2009);*
    - *A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution (2009); and*
    - *Research at the Intersection of the Physical and Life Sciences (2009).*
- *Transitions and Tipping Points in Complex Environmental Systems (2009)*, a report by the NSF Advisory Committee for Environmental Research and Education.
- *National Plant Genome Initiative: 2009 – 2013 (2009)*, National Science and Technology Council (NSTC), Committee on Science, Interagency Working Group on Plant Genomes.
- *Preliminary Findings from the NSF Survey of Object-Based Scientific Collections (December 2008)*, Science and Technology Policy Institute (STPI).
- *Scientific Collections: Mission-Critical Infrastructure for Federal Science Agencies (2009)*, NSTC, Committee on Science, Interagency Working Group on Scientific Collections.
- Workshops such as:
    - *Future Directions in Biodiversity and Systematics Research (3 workshops): May, September, and October 2009;*
    - *Enabling Biodiversity Research: The Roles of Information and Support Networks: December 2009;*
    - *Conference on Water-Ecosystem Services, Drought and Environmental Justice: November 2009;*
    - *Tools for 21st Century Biology: March 2009;*
    - *Opportunities and Challenges in the Emerging Field of Synthetic Biology: July 2009;*
    - *Exploring Science Needs for Predicting Organismal Responses to Rapid Directional Environmental Change: November 2008; and*
    - *Variable Atmosphere Laboratory (VAL): Extremely Large-scale "Growth Chambers" for Physiological Studies: August 2009.*

Factors Influencing the Allocation Across Divisions and Major Programs

Sustaining core funding, implementing Administration priorities such as climate change research, supporting cutting edge transformative research, developing new scientific areas, and broader support for students and new faculty are the principal factors that influence allocations across divisions.
Specific factors include:

- Developing new scientific areas and implementing Administration priorities – new emphases are reflected in FY 2011 allocations across divisions.
  - Science, Engineering, and Education for Sustainability (SEES): +$5.0 million (to a total of $126.0 million) to increase efforts in integrating NSF's climate and energy science. Activities to receive enhanced funding in FY 2011 include Coupled Natural and Human Systems and support for a new center for environmental synthesis. Activities begun in FY 2010 as part of the climate research investment (Ocean Acidification, Water, Modeling, and Dimensions of Biodiversity) will continue. Increased support for SEES is focused in the Division of Environmental Biology (DEB); other climate research activities are supported across all divisions.
  - U.S. Global Change Research Program (+$8.0 million, to a total of $89.0 million): BIO will increase support for core research to ensure support for a broad research portfolio related to climate change and the biological drivers of change.
  - Bio-economy: $20.0 million total to leverage core investments in the biological sciences in order to acquire knowledge that can contribute to new or improved products and services for the "bio-economy" – e.g. the discovery, development and use of biological products and processes that boost productivity of agriculture and industrial processes. Support will be focused within the Molecular and Cellular Biosciences (MCB) and Integrative Organismal Systems (IOS) divisions.
  - Intersection of the Biological Sciences and Physical Sciences: Two recent reports from the National Academies of Science highlighted exciting research opportunities at the intersection of the biological and physical sciences (*Research at the Intersection of the Physical and Life Sciences* and *A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution)*. BIO will invest $5.6 million total to work in partnership with the Directorate for Mathematical and Physical Sciences (MPS) to identify and support potentially transformative research projects that explore this interdisciplinary interface. Support is focused across all BIO divisions.
- Cyber-enabled Discovery & Innovation: +$2.0 million (to a total of $3.0 million) to increase investment in the existing program. The Division of Biological Infrastructure (DBI) will increase support for Cyber-enabled Discovery and Innovation (CDI) to enable revolutionary biological discoveries through the innovative use of advances in computational concepts, methods, models, algorithms, and tools. Investments will be focused on multidisciplinary activities that, through computational thinking, promise radical, paradigm-changing research findings and on transformative research that leads to productive intellectual partnerships involving U.S. and international investigators from academe, industry and/or other types of organizations. Support is focused in DBI.

- The "Vision and Change" conference emphasized new approaches to transform undergraduate biology education (www.visionandchange.org). An increase of $5.0 million (to a total of $15.9 million) is focused in DBI.
  - Beginning in FY 2010, BIO began investment in a new activity to transform undergraduate biology education. New activities will be carefully baselined and assessment metrics developed to allow for evaluation of all new programs. Guided by recommendations stemming from the 2009 "Vision and Change" conference and building on investments initiated in FY 2010, BIO

will increase support for the Research Coordination Networks – Undergraduate Biology Education (RCN-UBE) program, collaborate with Education and Human Resources (EHR) in supporting a new STEM Talent Expansion Program (STEP) Center, and invest in faculty development activities. All new programs will be informed by baselining assessment activities conducted in FY 2010, and appropriately rigorous evaluations will guide program evolution.

  - Multiple programs are being reduced within BIO (ADVANCE, IGERT, and GK-12) in order to target investments on these new undergraduate programmatic activities.

- NEON: With the FY 2011 MREFC funding request to begin NEON construction, the project emphasis begins to shift from project planning to construction. New programs such as macrosystems biology and multi-scale modeling will continue to support foundational research activities by the community of potential NEON users. Support is focused in Emerging Frontiers (EF).

- Digitization: A total of $10.0 million will continue support for efforts to digitize and network U.S. specimen-based research collections. These collections provide proper validation of species including a wealth of ancillary data such as DNA samples and environment/habitat information. These data provide the baseline from which to begin further biodiversity studies and provide critical information about the existing gaps in our knowledge of life on Earth. Filling these gaps is crucial to a complete understanding of the biodiversity of the planet, both in space and time, and the history of climate change. Support is focused in EF.

- Innovation: Support is sustained in all divisions ($2.0 million in each) and in EF ($8.0 million to leverage division investments) to allow for a continuing emphasis on innovation, interdisciplinary research, and transformation.

BIO Funding for Centers and Facilities

BIO Funding for Centers and Facilities
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Centers	**$30.83**	**-**	**$33.62**	**$34.15**	**0.53**	**1.6%**
National Center for Ecological Analysis & Synthesis	*3.71*	-	*3.70*	-	*-3.70*	*-100.0%*
Environmental Synthesis Center	-	-	-	*4.00*	*4.00*	*N/A*
National Evolutionary Synthesis Center	*2.55*	-	*5.50*	*5.32*	*-0.18*	*-3.3%*
National Institute for Math & Bio Synthesis	*1.85*	-	*2.35*	*2.35*	-	-
iPlant (formerly Plant Science Cyber Collaborative)	*9.11*	-	*10.97*	*11.38*	*0.41*	*3.7%*
Centers for Environmental Implications of Nanotech.	*5.10*	-	*5.10*	*5.10*	-	-
STC: Behavioral Neuroscience	*2.51*	-	-	-	-	*N/A*
STC: Microbial Oceanography: Research & Ed.	*4.00*	-	*4.00*	*4.00*	-	-
SLC: Temporal Dynamics of Learning	*2.00*	-	*2.00*	*2.00*	-	-
Facilities	**$13.61**	**-**	**$25.80**	**$15.35**	**-$10.45**	**-40.5%**
Nanofabrication (NNIN)	*0.35*	-	*0.35*	*0.35*	-	-
National Ecological Observatory Network (NEON)	*13.26*	-	*25.45*	*15.00*	*-10.45*	*-41.1%*

Detailed information on individual Centers can be found in the NSF-Wide Investments chapter. For further detail about individual facilities, please see the Facilities chapter.

Centers

- FY 2010 will be the final year of funding for the National Center for Ecological Analysis and Synthesis (NCEAS). However, given the success of NCEAS in demonstrating the value of synthetic approaches in advancing ecology and the role of ecological synthesis in addressing societal issues, support will be provided in FY 2011 for a new environmental synthesis center to stimulate research, education, and outreach at the interface of the biological, geological, and social sciences. This new center will foster synthetic, collaborative, cross-disciplinary efforts to understand the complex interactions among ecological populations, communities and ecosystems, the geophysical environment, and human actions and decisions that underlie global environmental change.
- A small increase is provided for iPlant (formerly Plant Science Cyber Collaborative) as part of the existing cooperative agreement for an annual increment.

Facilities

- BIO requests $15.0 million to finalize the baseline design of the National Ecological Observatory Network (NEON) prior to beginning construction in late FY 2011. The FY 2011 MREFC request includes funding to begin NEON construction. The Final Design Review (November 2009) determined that NEON was ready to begin construction. Both the preliminary design review (PDR) in June 2009 and the final design review (FDR) in November 2009 included recommendations for finalizing the design. R&RA funds in the FY 2010 current plan and as part of the FY 2011 request will be used to finalize prototyping for the cyberinfrastructure, Fundamental Sentinel Unit (FSU), and Fundamental Instrument Unit (FIU), three major components of the NEON design. The prototyping will be completed early in FY 2011, and remaining FY 2011 funds will support the project team until the beginning of construction. An operations review is scheduled for April 2010. During FY 2010, BIO will document existing intra-agency, inter-agency, and international collaborations and agreements directly related to NEON, and will develop new collaborations as it coordinates with the other Federal agencies funding relevant ecological observation networks.

BIO Administration Priority Programs and NSF Investments

BIO Administration Priority Programs and NSF Investments
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Faculty Early Career Development (CAREER)	$24.52	$38.04	$29.06	$31.11	$2.05	7.1%
Graduate Research Fellowships (GRF)	-	7.11	-	6.87	6.87	N/A
Climate Change Education Program (CCE)	-	-	1.50	1.50	-	N/A
Science, Engineering, and Education for Sustainability (SEES)	N/A	N/A	121.00	126.00	5.00	4.1%

BIO's FY 2011 budget will continue and expand support in key NSF programs for students, early-career researchers, and the next generation of environmentally engaged scientists and engineers. The budget also encourages potentially transformative research and supports critical priorities in a new investment framework – Science, Engineering, and Education for Sustainability (SEES). The goal of SEES is to integrate NSF's efforts in climate and energy science and engineering research to enable discoveries that can inform societal actions aimed at achieving a sustainable Earth.

In support of Administration priorities and other NSF investments, BIO activities include:

- CAREER: BIO will increase its investment in CAREER by $2.05 million within MCB, IOS, DBI, and DEB.
- Graduate Research Fellowship program (GRF): BIO will provide new funding totaling $6.87 million for graduate research fellowships in FY 2011.
- Climate Change Education (CCE): BIO will provide a total of $1.5 million to support CCE in order to prepare a scientific and technical workforce to engage in climate change and energy R&D; identify approaches to develop more effective instructional materials about climate change; engage the general public with climate change issues; and establish models for teaching and learning. CCE will promote partnerships among K-12 education, higher education, the private sector, and related non-profit organizations, in formal and informal settings, as well as relevant education and/or climate-related policymakers.
- Science, Engineering, and Education for Sustainability (SEES): In FY 2011, BIO will invest $126.0 million (+$5.0 million) in the SEES portfolio to integrate efforts in climate and energy science and engineering. BIO will support projects that include modeling the interaction of biological, physical and human systems; fundamental research on living systems to achieve predictive understanding of how they drive and respond to environmental change; environmental observatories and long term projects; and research on sustainable adaptation and mitigation strategies for both natural and human systems in a changing climate.

For more information on Administration priorities and NSF investments, please refer to the Overview and NSF-Wide Investments sections.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

In FY 2009, BIO held two COVs – one in June 2009 for the Division of Environmental Biology and the second in September 2009 for Emerging Frontiers. The Directorate for Biological Sciences Advisory Committee (BIO AC) met twice in FY 2009: April and September 2009.

In FY 2010, BIO COV reviews will take place for the Division of Biological Infrastructure and for the Plant Genome Research Program within the Division of Integrative Organismal Systems. All BIO divisions are responding to and implementing recommendations from recent COVs.

Two reports from the National Academies of Science were recently released: *Research at the Intersection of the Physical and Life Sciences* and *A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution*. Report recommendations are under review by directorate senior management and will also be evaluated at the Spring BIO AC meeting for implementation of recommendations and incorporation into future fiscal year program planning.

The “Vision and Change” conference emphasized new approaches to transform undergraduate biology education. The recommendations from that conference provided the basis for new programmatic activities requested in the FY 2010 and FY 2011 budgets. Beginning in FY 2010, baselining activities will occur for all recommended new programs. This will determine the data collection and evaluation methodologies necessary for assessment of the effectiveness for all programs implemented with the FY 2011 request.

Number of People Involved in BIO Activities

	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	4,439	1,538	4,547	4,800
Other Professionals	1,533	490	1,838	1,880
Postdoctorates	1,377	516	1,561	1,670
Graduate Students	2,800	1,812	3,123	3,520
Undergraduate Students	4,067	2,017	3,995	4,290
Total Number of People	**14,216**	**6,373**	**15,064**	**16,160**

BIO Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Statistics for Competitive Awards:			
Number of Proposals	6,574	7,150	7,690
Number of New Awards	1,823	1,370	1,475
Regular Appropriation	1,261	1,370	1,475
ARRA	562	-	-
Funding Rate	27.7%	19.2%	19.2%
Statistics for Research Grants:			
Number of Research Grant Proposals	5,590	6,080	6,540
Number of Research Grants	1,316	930	1,000
Regular Appropriation	858	930	1,000
ARRA	458	-	-
Funding Rate	23.5%	15.3%	15.3%
Median Annualized Award Size	160,001	165,500	167,000
Average Annualized Award Size	199,695	206,500	208,500
Average Award Duration, in years	3.1	3.1	3.1

DIVISION OF MOLECULAR AND CELLULAR BIOSCIENCES (MCB) — $133,690,000 / +$8,100,000 / 6.4%

MCB Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
MCB	**$121.28**	**$61.53**	**$125.59**	**$133.69**	**$8.10**	**6.4%**
Research	121.28	61.53	125.59	133.69	8.10	6.4%

MCB supports fundamental research to understand the dynamics and complexity of living systems at the biochemical, molecular, and cellular level. Priorities include projects that address the organization, function, and regulation of genes and genomes, the structure and properties of biomolecules, supramolecular complexes, and subcellular systems, as well as the genetic and metabolic complexity of living systems. MCB research often integrates theory and experimentation in an iterative way and increasingly utilizes tools and technologies derived from biological, physical, mathematical, computational, and engineering sciences. Genome-wide or metagenomics approaches are encouraged when applied to specific questions of interest to the division.

In general, 40 percent of the MCB portfolio is available for new research grants. The remaining 60 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across MCB Programs

- Foundational research in molecular and cellular biology that will inspire high impact technologies and the production of novel materials remains a priority. Multidisciplinary studies in many MCB areas have the potential to spawn new, and support emerging, technologies such as synthetic biology, which will promote the development of a vibrant economy based on biologically-based industries of the future ($8.0 million total in FY 2011).
- MCB will support innovative projects that address the biochemical, molecular, and cellular underpinnings of climate change. Knowledge about adaptation and feedbacks is critical to inform predictions and construct simulation models about the impact of climate change on living organisms. To address one area of this research, MCB will invest in understanding the molecular basis of the biological drivers and effects of ocean acidification.
- MCB will expand knowledge of energy capture and conversion through increased investments in potentially transformative research in these areas. The capture and conversion of solar energy on Earth is largely mediated by photosynthetic organisms, and fundamental information about these processes will inform our ability to provide sustainable sources of energy and food for the future.
- The division will also support molecular studies that take a systems-level approach to understanding the diversity of biological networks, to define, assemble, and characterize the interaction of intracellular components, including genes, proteins, and metabolites. High throughput technologies now allow surveying the components and the systems properties of living organisms at a scale unprecedented in the history of biology. These surveys provide a broad view of the operation of living systems and guidance for focusing on controlling events. Understanding the complexity of molecular systems that provide the basis for organismal properties and responses will be encouraged in the core programs in MCB.

- All BIO divisions will work in partnership with MPS to identify and support potentially transformative research projects that explore the interdisciplinary interface between physical and life sciences ($5.6 million total in BIO).

DIVISION OF INTEGRATIVE ORGANISMAL SYSTEMS (IOS) $226,700,000
+$10,450,000 / 4.8%

IOS Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
IOS Funding	**$212.34**	**$61.71**	**$216.25**	**$226.70**	**$10.45**	**4.8%**
IOS Project Support	111.12	61.71	113.86	121.31	7.45	6.5%
Plant Genome Research Program	101.22	-	102.39	105.39	3.00	2.9%
Research	175.99	61.71	179.36	189.81	10.45	5.8%
Infrastructure	36.35	-	36.89	36.89	-	-

IOS supports research and education aimed at understanding the diversity of plants, animals, and microorganisms as complex systems. Reaching a systems level understanding of organisms will require a new emphasis on interdisciplinary approaches and development of new tools. These approaches span computational, molecular, cellular, and population levels of inquiry. Many activities supported by IOS focus on biological processes that affect organismal development, structure, performance, and interactions under varying environmental conditions. IOS-supported research focuses on understanding organismal performance in an environmental context, which is significant for understanding reciprocal interactions between the biosphere and drivers of global climate change. The activities of the Plant Genome Research Program contribute to a systems level understanding of plants of economic importance and plant processes of potential economic value.

In general, 47 percent of the IOS portfolio is available for new research grants. The remaining 53 percent funds continuing grants made in previous years. In general, 48 percent of the Plant Genome Research Program portfolio is available for new research grants. The remaining 52 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across IOS Programs

- Strengthening core program activities through IOS project support is a high priority, especially through support of emerging areas integrating tools and resources, developing new computational and modeling approaches, and taking increasing advantage of data integration. There is an emphasis on cross-disciplinary, integrated approaches to understand organisms as complex systems, especially as they relate to identification of novel biological materials and processes of potential economic importance that could stimulate the foundation of new biologically-based industries ($12.0 million total in FY 2011).
- IOS will give priority to projects that lead to a greater understanding of the mechanisms and principles that allow organisms to survive, adapt to, and transform their environment, since this knowledge enhances our ability to predict organisms' responses to climate and environmental change and suggests potential strategies for adaptation and mitigation. As part of these activities, IOS will invest in understanding organismal responses to, and feedback on, ocean acidification.
- The Plant Genome Research Program (PGRP) increases by $3.0 million (to a total of $105.39 million) to support genome-scale research to accelerate basic discoveries of potential application in crop improvement, development of new sources of bio-based energy, development of sources of bio-based materials, and adaptation to global climate change. Guided by recommendations in the National Plant Genome Initiative strategic plan (*National Plant Genome Initiative: 2009 – 2013*,

National Science and Technology Council (NSTC), Committee on Science, Interagency Working Group on Plant Genomes), PGRP will focus funding on basic research while capitalizing on previous investments in infrastructure to enable this new level of analysis and integration leading to a "systems" understanding of plants. The Basic Research to Enable Agricultural Development (BREAD) Program will continue support for basic research to test innovative hypotheses, approaches, and technologies for sustainable, science-based solutions to problems of agriculture in developing countries. BREAD in FY 2011 is supported by NSF ($6.0 million) and the Bill & Melinda Gates Foundation ($6.0 million) through funding provided to NSF.

- All BIO divisions will work in partnership with MPS to identify and support potentially transformative research projects that explore the interdisciplinary interface between physical and life sciences ($5.6 million total in BIO).

DIVISION OF ENVIRONMENTAL BIOLOGY (DEB) $155,590,000

+$13,040,000 / 9.1%

DEB Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
DEB	**$120.37**	**$63.23**	**$142.55**	**$155.59**	**$13.04**	**9.1%**
Research	120.37	63.23	142.55	155.59	13.04	9.1%

DEB supported research on complex ecological and evolutionary dynamics improves our ability to understand and mitigate environmental change, and informs essential considerations of environmental sustainability. Long-term DEB research is critical to understanding the feedbacks between natural and human systems. Scientific foci in DEB address the process of evolution; describe the genealogical relationships of all life; elucidate the spatial and temporal dynamics of species interactions that govern the assembly of functional communities; and determine the flux of energy and materials through ecosystems. This theoretical and empirical research in ecology, evolution, and biodiversity is enhanced by dynamic interactions with the fields of genomics, computer science, and mathematics.

In general, 48 percent of the DEB portfolio is available for new research grants. The remaining 52 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across DEB Programs

- Strengthening core program activities is a high priority, especially through increasing investments in the long-term research necessary to identify warning signs of abrupt, potentially irreversible changes or tipping points in natural and coupled human-natural systems; in multi-scale modeling efforts to advance understanding of processes that occur across diverse spatial (local-regional-global) and temporal scales, and in infusing evolutionary dynamics and historical perspectives into studies of the dynamics of complex environmental systems.
- DEB investments, focusing on the priorities as identified under the Science, Engineering, and Education for Sustainability (SEES), will integrate efforts in fundamental environmental biology with research in climate and energy science ($5.0 million total). A key focus will be to understand the scope and role of biodiversity in adaptation and ecosystem sustainability. Cross-disciplinary research that integrates genetic, taxonomic, and functional aspects of biodiversity is the core of a new activity begun in FY 2010 – Dimensions of Biodiversity – to define the dimensions of biodiversity and their consequences for ecosystem services and human well-being. Influences of, and feedbacks to, climate change are included in the activity. In addition, increased DEB investments ($6.0 million total) in the Dynamics of Coupled Natural and Human Systems program will improve our understanding of the basic feedbacks between socio-economic, ecological and evolutionary, and geophysical systems that influence global change and human well-being.
- All BIO divisions will work in partnership with MPS to identify and support potentially transformative research projects that explore the interdisciplinary interface between physical and life sciences ($5.6 million total in BIO).

DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI) $145,630,000
+$18,770,000 / 14.8%

DBI Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
DBI	**$117.95**	**$38.74**	**$126.86**	**$145.63**	**$18.77**	**14.8%**
Research	30.83	9.20	33.62	34.15	0.53	1.6%
National Center for Ecological Analysis & Synthesis	*3.71*	-	*3.70*	-	*-3.70*	*-100.0%*
Environmental Synthesis Center	-	-	-	*4.00*	*4.00*	*N/A*
National Evolutionary Synthesis Center	*2.55*	-	*5.50*	*5.32*	*-0.18*	*-3.3%*
National Institute for Math & Bio Synthesis	*1.85*	-	*2.35*	*2.35*	-	-
iPlant (formerly Plant Science Cyber Collaborative)	*9.11*	-	*10.97*	*11.38*	*0.41*	*3.7%*
Centers for Environmental Implications of Nanotech	*5.10*	-	*5.10*	*5.10*	-	-
STC: Behavioral Neuroscience	*2.51*	-	-	-	-	*N/A*
STC: Microbial Oceanography: Research & Ed	*4.00*	-	*4.00*	*4.00*	-	-
SLC: Temporal Dynamics of Learning	*2.00*	-	*2.00*	*2.00*	-	-
Education[1]	31.90	18.45	33.30	50.99	17.69	53.1%
Infrastructure	53.08	11.09	57.10	55.33	-1.77	-3.1%

[1]Funds for Transforming Undergraduate Biology Education (TUBE) activities are shifting from EF to DBI in FY 2011.

DBI empowers biological discovery by supporting the development and enhancement of biological research resources, human capital, and centers. In particular, DBI supports the development of, or improvements to, research infrastructure, including instruments, software, and databases; and improvements to biological research collections, living stock collections, and field stations and marine labs. These investments underpin advances in all areas of biological research as well as databases, resources and tools for the entire biology community. DBI also supports the development of human capital through support of undergraduate, graduate, and postdoctoral research experiences. DBI is leading BIO efforts both to transform undergraduate biology education based on the recommendations of the "Vision and Change" Conference of July 2009 and to prepare the climate change research workforce (Climate Change Education). Support of center and center-like activities creates opportunities to address targeted but deep biological questions that have major societal impact.

DBI supports research resources that include the development of research tools, acquisition of instrumentation, and infrastructure improvements; human resource activities; and centers. Approximately 36 percent of the DBI budget is available for new awards each year, with approximately 20 percent available for new research grants. Approximately 29 percent supports Centers, while the remainder is distributed through grants for various DBI and BIO priorities and continuing funds for grants made in previous years.

Factors Influencing the Allocation Across DBI Programs

- Undergraduate biology education activities initiated in EF are being integrated with the rest of BIO's education portfolio in DBI; thus, the EF funds for these activities are transferred to DBI in FY 2011. Focus will be on transforming undergraduate biological education by integrating education and research experiences that involve experiential, hands-on exposure to science to build a diverse citizenry well-prepared to understand and apply information about the biological world in their daily lives. Guided by recommendations stemming from the 2009 "Vision and Change" conference and building on investments initiated in FY 2010, DBI will increase support for the Research

Coordination Networks – Undergraduate Biology Education (RCN-UBE) program, collaborate with EHR to support a new STEP Center, and invest in faculty development activities. New undergraduate biology education programs will be informed by baselining assessment activities conducted in FY 2010 (+$5.0 million, to a total of $15.9 million).

- DBI will refocus investments in human capital activities and decrease funding for ADVANCE, GK-12, and IGERT in order to increase funding for Transforming Undergraduate Biology Education (TUBE) activities. Support will be provided in FY 2011 ($4.0 million total) for a new Environmental Synthesis Center to stimulate research, education, and outreach at the interface of the biological, geological and social sciences. It will foster efforts to understand and predict the complex interactions among ecological populations, communities and ecosystems, the geophysical environment, and human actions and decisions that underlie global environmental change. The center will also play a pivotal role in generating the knowledge base for adaptive responses to environmental change.

- DBI will increase support for Cyber-enabled Discovery and Innovation (CDI) in order to enable revolutionary biological discoveries through the innovative use of advances in computational concepts, methods, models, algorithms, and tools. Investments will be focused on multidisciplinary activities that promise radical, paradigm-changing research findings and on transformative research that leads to productive intellectual partnerships involving U.S. and international investigators from academe, industry, and/or other types of organizations (+$2.0 million, to a total of $3.0 million).

- All BIO divisions will work in partnership with MPS to identify and support potentially transformative research projects that explore the interdisciplinary interface between physical and life sciences ($5.6 million total in BIO).

- Increasing support for BIO-related instrumentation from the Major Research Instrumentation (MRI) program and a new emphasis on human resources has led to a slight decrease in funding available for research resources/infrastructure programs in DBI (-$1.77 million, to a total of $55.33 million).

DIVISION OF EMERGING FRONTIERS (EF) $106,200,000
+$2,910,000 / 2.8%

EF Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
EF	**$84.68**	**$34.80**	**$103.29**	**$106.20**	**$2.91**	**2.8%**
Research	71.42	23.80	56.94	81.20	24.26	42.6%
Education[1]	-	-	10.90	-	-10.90	-100.0%
Infrastructure	13.26	11.00	35.45	25.00	-10.45	-29.5%
National Ecological Observatory Network	*13.26*	-	*25.45*	*15.00*	*-10.45*	*-41.1%*

[1]Funds for Transforming Undergraduate Biology Education (TUBE) activities are shifting from EF to DBI in FY 2011.

EF identifies, incubates, and supports infrastructure and research areas that transcend scientific disciplines and/or advance the conceptual foundations of biology. Typically, developing programs and priority areas begin in EF and then shift to other BIO divisions as core research. Examples include the Assembling the Tree of Life and Ecology of Infectious Diseases programs, as well as Transforming Undergraduate Biology Education programs in FY 2011. Supporting biological research that crosses scales of organization and involves multiple disciplines continues to be a high priority, and is particularly relevant for research questions related to global change. EF also facilitates the development and implementation of new forms of merit review, and mechanisms to support transformative research and stimulate creativity. These goals are accomplished by promoting cultural change within and across scientific disciplines to increase and strengthen multidisciplinary collaborations, by encouraging curiosity and exploration through novel mechanisms and investments, and by facilitating support of research areas relevant to all of biology by targeted co-funding throughout the directorate.

In general, 90 percent of the EF portfolio is available for new research grants. The remaining 10 percent is used primarily to fund continuing grants made in previous years.

Factors Influencing the Allocation Across EF Programs

- The Transforming Undergraduate Biology Education (TUBE) activities, initiated and incubated in EF, are being integrated with the rest of BIO's education portfolio in DBI; thus, the EF funds for these activities are transferred to DBI in FY 2011 (-$10.9 million).
- Support will continue in EF for efforts to digitize and network U.S. specimen-based research collections. These collections and data provide critical information about existing gaps in our knowledge of life on earth. Filling these gaps is crucial to a complete understanding of the biodiversity of the planet, both in space and time, and the history of climate change ($10.0 million total).
- To facilitate the support of transformative research, and to encourage development of innovative forms of merit review, EF will maintain an innovation fund of $8.0 million total to co-fund activities in other BIO divisions that use innovative mechanisms for identifying and reviewing exceptionally novel and high impact research projects.
- As construction of NEON begins, EF will focus on supporting research activities relevant to NEON, including macrosystems biology and multi-scale modeling (total of $10 million).

DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING (CISE) $684,510,000 +$65,680,000 / 10.6%

CISE Funding

(Dollars in Millions)

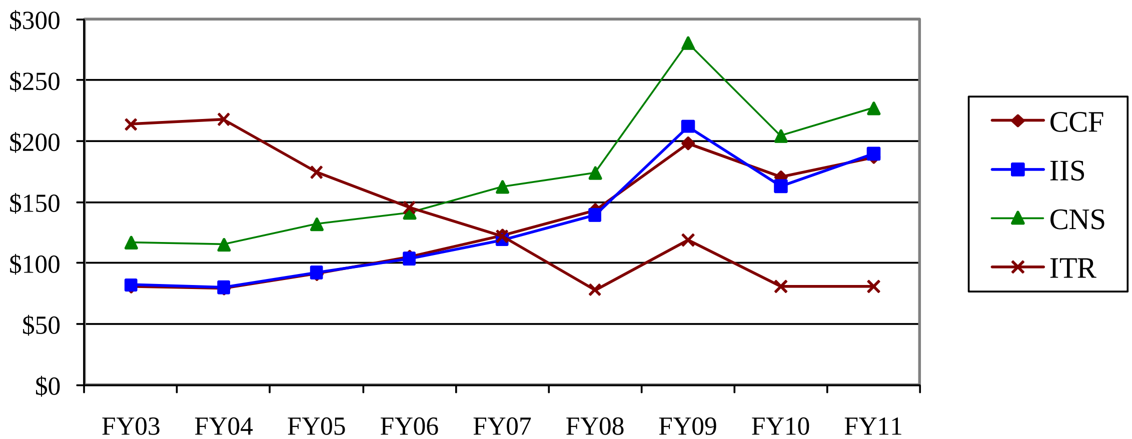
	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Computing and Communication Foundations (CCF)	$156.92	$41.17	$170.35	$186.95	$16.60	9.7%
Computer and Network Systems (CNS)	188.30	92.25	204.42	227.08	$22.66	11.1%
Information and Intelligent Systems (IIS)	150.93	61.17	163.32	189.74	$26.42	16.2%
Information Technology Research (ITR)	78.35	40.41	80.74	80.74	-	-
Total, CISE	**$574.50**	**$235.00**	**$618.83**	**$684.51**	**$65.68**	**10.6%**
Research	476.24	192.29	$535.90	600.87	64.97	12.1%
Education	56.92	10.74	38.84	38.84	-	-
Infrastructure	28.45	31.97	30.60	30.60	-	-
Stewardship	12.89	-	13.49	14.20	0.71	5.3%

Totals may not add due to rounding.

CISE's mission is to enable the U.S. to uphold a position of world leadership in computer and information science and engineering; to promote understanding of the principles and uses of advanced computer, communications, and information systems in service to society; and to contribute to universal, transparent, and affordable participation in an information-based society. CISE supports ambitious, long-term research and research infrastructure projects within and across the many sub-fields of computing, contributes to the education and training of computing professionals and, more broadly, informs the preparation of a U.S. workforce with computing competencies essential to success in an increasingly competitive, global market.

CISE Subactivity Funding

(Dollars in Millions)



CISE in Context

NSF provides approximately 82 percent of the total federal support for basic research at academic institutions in computer science. In recent years, these investments and the research outcomes they have produced have provided significant value-added to the U.S. economy. Since 1995, networking and information technology (IT) industries have accounted for 25 percent of the Nation's economic growth, although they represent only three percent of the gross domestic product.[1]

Essentially all practical applications of IT are based on ideas and concepts that emerged from basic research investments. These fundamental ideas and concepts have enabled innovative product and application developments that now permeate most areas of modern life. IT not only forms a sizeable portion of the economy in its own right, but drives discovery and innovation in many other areas, including advanced scientific research, healthcare, national and homeland security, and public and private organizational effectiveness and efficiency. Innovation in IT will remain an essential and vital force in productivity gains and economic growth in both the manufacturing and service sectors for many years to come, positioning NSF and CISE as central and essential actors in improving the Nation's economic outlook and advancing a highly trained, technologically astute workforce.

CISE continues to play a leadership role in the multi-agency subcommittee on Networking and Information Technology Research and Development (NITRD), which is co-chaired by the CISE Assistant Director. All research, education, and research infrastructure projects supported by CISE enrich the agency's NITRD portfolio.

CISE supports workshops, conferences, and projects each year that inform and guide the evolution of the research portfolio. Recent examples from 2008 and 2009 include:

- the National Cyber Leap Year Summit;
- Workshop on the Science of Power Management;
- 1st International Conference on Computational Sustainability Future Internet Architectures Summit;
- The First International Workshop on Cyber-Physical Systems, International Conference on Distributed Computing Systems (ICDCS);
- Robotics and Cyber-Physical Systems;
- Workshop on Cyber-Physical Systems: Closing the Loop;
- National Workshop on Research on Transportation Cyber-Physical Systems: Automotive, Aviation, and Rail;
- National Cyber Defense Financial Services Workshop: Usability, Security, and Privacy of Information Systems;
- NSF Security-Driven Architectures;
- Discovery and Innovation in Health IT; and
- Computational Thinking for Everyone: A Workshop Series.

In FY 2011, CISE will continue to strengthen the intellectual foundations of computing, supporting research in algorithms and theoretical computer science, computer architecture, cryptography, information theory, network and communication theory, parallel computing, programming languages, semantics and logics, software engineering, and in emerging models and substrates of computation. As computing systems provide richer functionalities, faster performance, and more efficient energy usage, as they become more ubiquitous and pervasive, and as user and societal expectations of them increase, CISE

[1] *Leadership Under Challenge: IT R&D in a Competitive World*, President's Council of Advisors on Science and Technology (PCAST) 2007.

investments in the fundamental research essential to systems design for properties such as reliability, security, privacy, and usability become increasingly important. As we seek to better understand human intelligence and to use computing to enhance our quality of life, CISE will continue to invest in forward-looking research in areas such as artificial intelligence, computer vision, graphics, machine learning, intelligent decision-making, natural language processing, robotics, speech, search, information retrieval, and technologies for learning and collaboration.

CISE will play a leadership role in the new multi-directorate, multidisciplinary Cyberlearning Transforming Education (CTE) program to harness the transformative potential of advanced learning technologies across the education enterprise. The directorate will continue to support the preparation of a world-class computing workforce through two programs in particular: CISE Pathways to Revitalized Undergraduate Computing Education (CPATH) and Broadening Participation in Computing (BPC). These programs aim to increase American competitiveness in the global economy.

Factors Influencing the Allocation Across Divisions and Major Programs

The focus of CISE's FY 2011 Request is on stimulating transformative research in emerging high-priority areas such as the multi-agency Comprehensive National Cybersecurity Initiative, which totals $55.0 million in FY 2011, Cyber-Physical Systems, Cyberlearning Transforming Education, Science and Engineering Beyond Moore's Law, and Cyber-enabled Discovery and Innovation, while maintaining viable support levels for the core areas of computing.

Assuring U.S. leadership in advanced manufacturing is an Administration priority as outlined in the National Economic Council's *Framework for Revitalizing American Manufacturing* (December 2009). Through investments in programs such as Cyber-Physical Systems (CPS), i.e., those systems that combine computational and physical elements such as smart cars and embedded medical devices, CISE's Request recognizes the significant role computing will play in this effort. The CPS program, which CISE supports in partnership with the Directorate for Engineering (ENG), seeks to develop new foundations, methods, and tools that will bridge the gap between approaches to the cyber and physical elements of cyber-physical systems design.

CISE Funding for Centers

CISE Funding for Centers
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Centers	**$8.00**	**-**	**$9.82**	**$9.16**	**-0.66**	**-6.7%**
STC: Center for Embedded Networked Sensing (CCF)	4.00	-	3.32	2.66	-0.66	-19.9%
STC: Team for Research in Ubiquitous Secure Technology (CCF)	4.00	-	4.00	4.00	-	N/A
SLC: Pittsburgh Science of Learning Center for Robust Learning (ITR)	-	-	2.50	2.50	-	N/A

Detailed information on individual Centers can be found in the NSF-Wide Investments chapter.

Centers

- Funding for the Center for Embedded Networked Sensing is reduced as the center moves towards its tenth year of operation in FY 2011.

CISE Administration Priority Programs and NSF Investments

CISE Administration Priority Programs and NSF Investments
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Faculty Early Career Development (CAREER)	$42.73	$21.83	$50.96	$54.57	$3.61	7.1%
Graduate Research Fellowships (GRF)	1.16	2.82	2.55	2.55	-	-
Science, Engineering and Education for Sustainability (SEES)	N/A	N/A	17.00	29.36	12.36	72.7%
Cyberlearning Transforming Education (CTE)	N/A	N/A	-	15.00	15.00	N/A
Science and Engineering Beyond Moore's Law (SEBML)	4.00	-	15.00	15.00	-	-

CISE's FY 2011 budget will fund two key NSF programs that support students and early-career researchers. The budget also encourages potentially transformative research and supports critical priorities in global climate change.

Contributing to the development of current and future generations of computing faculty is a priority in the FY 2011 Request and is reflected in CISE's commitment to the CAREER and Graduate Research Fellowship programs.

CISE's FY 2011 Request emphasizes potentially transformative research in multidisciplinary areas such as:

- Science, Engineering, and Education for Sustainability (SEES): In FY 2011, CISE will invest $29.36 million in the NSF-wide SEES portfolio to integrate efforts in climate and energy science and engineering. CISE will contribute to this agency-wide effort with an emphasis on energy-intelligent computing to optimize energy-computational performance in computing and communications systems. CISE also will stimulate research advances in computing and communications to reduce energy consumption in key application areas. For example, advances in computing will enable more efficient, reliable energy delivery in the Smart Grid and will help reduce energy consumption in the Smart Home. Research supported in this area will provide new foundational understanding of the energy requirements inherent in computation and communication.
- Cyberlearning Transforming Education (CTE): In FY 2011, CISE, in partnership with the EHR and SBE directorates, will establish NSF's new multidisciplinary research program designed to fully capture the transformative potential of advanced learning technologies across the education enterprise. The CTE program seeks to enable wholly new avenues of science, technology, engineering, and mathematics (STEM) learning for students and for workforce development and to advance the Nation's ability to study the learning process itself.

In response to the Administration's report, *A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs* (September 2009), CISE's FY 2011 Request emphasizes investments in the next generation of information and communications technologies, in programs such as

Science and Engineering Beyond Moore's Law (SEBML). SEBML addresses the hardware and software challenges associated with exploiting all the performance opportunities associated with new multi-core computing technologies. In addition, SEBML will support fundamental research to identify promising new technologies for computing, notably in quantum information science.

For more information on Administration priority programs and NSF investments, please refer to the Overview and NSF-wide Investments sections.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

During FY 2009 CISE held three Committees of Visitors who together examined and assessed the quality of the entire CISE portfolio. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are factored into the performance assessment process.

Evaluation is a vital part of CISE's STEM education and learning programs such as CPATH and BPC. CPATH evaluation is overseen by SRI International, an independent evaluation firm, with NSF overseeing the overall evaluation process. The evaluation of CPATH is expected to be completed in the summer of 2010. For BPC, the American Association for the Advancement of Science (AAAS) oversees the individual evaluations of BPC Alliances with each BPC project required to run its own evaluation as well. The AAAS evaluation of the BPC Alliances is due in 2010.

Number of People Involved in CISE Activities

	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	5,234	1,534	5,700	6,150
Other Professionals	512	170	550	600
Postdoctorates	330	120	350	400
Graduate Students	5,813	2,343	6,200	6,850
Undergraduate Students	2,151	773	2,350	2,500
Total Number of People	**14,040**	**4,940**	**15,150**	**16,500**

CISE Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Statistics for Competitive Awards:			
Number of Proposals	5,661	5,900	6,200
Number of New Awards	1,735	1,450	1,650
Regular Appropriation	1,356	1,450	1,650
ARRA	379	-	-
Funding Rate	31%	25%	27%
Statistics for Research Grants:			
Number of Research Grant Proposals	5,374	5,600	5,800
Number of Research Grants	1,484	1,220	1,370
Regular Appropriation	1,128	1,220	1,370
ARRA	356	-	-
Funding Rate	28%	22%	24%
Median Annualized Award Size	$150,000	$140,000	$140,000
Average Annualized Award Size	$188,082	$180,000	$180,000
Average Award Duration, in years	3.1	3.0	3.0

DIVISION OF COMPUTING AND COMMUNICATION FOUNDATIONS (CCF) $186,950,000 +$16,600,000 / 9.7%

CCF Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
CCF	**$156.92**	**$41.17**	**$170.35**	**$186.95**	**$16.60**	**9.7%**
Research	150.85	40.15	167.05	183.65	16.60	9.9%
STC: Center for Embedded Networked Sensing	*4.00*	-	*3.32*	*2.66*	*-0.66*	-19.9%
STC: Team for Research in Ubiquitous Secure Technology	*4.00*	-	*4.00*	*4.00*	-	-
Education	5.47	1.02	2.70	2.70	-	-
Infrastructure	0.60	-	0.60	0.60	-	-

CCF supports research and education on: algorithmic foundations to help us understand the fundamental limits of resource-bounded computation and to obtain optimal solutions within those limits; algorithms that are applicable to areas both within and outside computer science; the theoretical underpinnings and current and future enabling technologies for information acquisition, transmission, and processing in communication and information networks; the foundational aspects of hardware and software, i.e., the reasoning, comparing and establishing properties of existing and newly-conceived software and hardware components, systems, and other artifacts, which are essential to advance the capability of computing systems; and the design of new computing devices based on nanotechnology, biotechnology, or quantum physics. CCF will continue to support two Science and Technology Centers: the Center for Embedded Networked Sensing (CENS) at the University of California at Los Angeles and the Center for Research in Ubiquitous Secure Technology at the University of California at Berkeley (TRUST).

In general, 60 percent of the CCF portfolio is available each year for new research grants, with 40 percent used primarily to fund continuing grants made in prior years.

Factors Influencing the Allocation across CCF Programs

In FY 2011 the allocation of CCF funds is designed to provide increased support for priority core research for the next generation of information and communications technology. The CCF allocation also targets high-priority research areas such as SEES, the Comprehensive National Cybersecurity Initiative (CNCI), and Science and Engineering Beyond Moore's Law (SEBML). In FY 2011, CCF will:

- Support SEES through research in energy-intelligent computing to optimize energy-computational performance in computing and communications systems. Advances will require new foundational understanding of the energy requirements inherent in computation and communication.
- Increase support for the Trustworthy Computing (TwC) program, which includes support for the CNCI, with a focus on the foundations of trustworthy systems, including the science of security, models and logic for privacy, and new cryptographic techniques and applications.
- Explore the emerging interface between computer science and economics, including algorithmic game theory, automated mechanism design, computational tractability of basic economic problems, and the role of information, trust, and reputation in markets.

- Continue emphasis on Cyber-enabled Discovery and Innovation (CDI) through investments in new computational abstractions to represent and manage data and in future generations of computational algorithms and concepts that enable better understanding of complex systems.
- Continue support of SEBML through CCF-supported research to address all the hardware and software challenges associated with exploiting multi-core technologies. In addition, CCF will support fundamental research to identify promising new technologies for computing, notably in quantum information science.

As with all three CISE disciplinary divisions, CCF will participate in CISE crosscutting research, education, and infrastructure programs, including Data-intensive Computing.

DIVISION OF COMPUTER AND NETWORK SYSTEMS (CNS) $227,080,000
+$22,660,000 / 11.1%

CNS Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
CNS	**$188.30**	**$92.25**	**$204.42**	**$227.08**	**$22.66**	**11.1%**
Research	116.51	61.56	141.68	164.34	22.66	16.0%
Education	43.94	8.72	32.74	32.74	-	-
Infrastructure	27.85	21.97	30.00	30.00	-	-

CNS supports research and education activities that advance our understanding of the fundamental properties of computer systems and networks and their complexity, explore new ways to address the limitations of existing computer and networked systems to make better use of these technologies, and develop better paradigms, abstractions, and tools for designing, analyzing, and building next generation computer and networked systems that are robust, secure, and trustworthy. CNS investments in computer systems research focus on: distributed, mobile, and embedded systems; sensing and control systems; dynamically configured, multiple-component systems; and parallel systems. CNS investments in fundamental network research create new insights into the dynamics of complex networks and explore new architectures for future-generation networks and services. CNS provides scientific leadership in trustworthy computing, supporting research and education activities that will ensure that society's increasingly ubiquitous and distributed computing and communication systems deliver the quality of service they are designed to achieve, without disruption, while enabling and preserving privacy, security, and trust.

CNS also plays a leadership role in coordinating CISE investments in research infrastructure resources and in the development of the computing workforce of the future. Through the Computing Research Infrastructure (CRI) program, which is targeted to the research needs of CISE investigators rather than those of all scientific disciplines, CNS supports the acquisition, enhancement, and operation of state-of-the-art infrastructures and facilities that enable high-quality computing research and education in a diverse range of institutions and projects. CNS supports the BPC program to significantly increase the number and diversity of U.S. citizens and permanent residents receiving post secondary degrees in the computing disciplines, and the CPATH program to identify and define the core computing concepts, methods, technologies, and tools to be integrated into promising new undergraduate education models.

In general, about 50 percent of the CNS portfolio is available for new grants. The remaining 50 percent is used primarily to fund continuing grants made in previous years.

Factors Influencing the Allocation Across CNS Programs

In FY 2011 the allocation of CNS funds is designed to provide increased support for priority core research for the next generation of information, networking, and communications technology. The CNS allocation also targets high-priority research areas such as the Comprehensive National Cybersecurity Initiative (CNCI), SEES, and Cyber-Physical Systems. In FY 2011, CNS will:

- Increase support for the Trustworthy Computing program, which includes support for the CNCI, with a focus on new computing and networking security and privacy architectures.

- Contribute to participation in SEES by supporting research to optimize energy-computation performance in computer and network systems and to explore the use of information technology in smart sensing systems that promise to save energy and reduce greenhouse gas emissions.
- Support forward-looking research on Cyber-Physical Systems motivated by grand challenge applications ranging from advanced manufacturing and transportation to healthcare and the environment.
- Continue emphasis on Cyber-enabled Discovery and Innovation (CDI), supporting research leading to a better understanding of how complex systems and networks behave at scale and evolve over time.
- Continue support for the creation, enhancement, and operation of world-class computing research infrastructure that will further CISE research and for education and outreach activities designed to ensure the development of a diverse computing workforce.

As with all three CISE disciplinary divisions, CNS will participate in CISE cross-cutting research programs such as Data-intensive Computing.

DIVISION OF INFORMATION AND INTELLIGENT SYSTEMS (IIS) — $189,740,000 / +$26,420,000 / 16.2%

IIS Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
IIS	**$150.93**	**$61.17**	**$163.32**	**$189.74**	**$26.42**	**16.2%**
Research	143.44	60.17	159.92	186.34	26.42	16.5%
Education	7.49	1.00	3.40	3.40	-	-

IIS supports research and education that: develops new knowledge to support people in the design and use of information technology; enhances the capabilities of people and machines to create, discover, and reason by advancing the ability to represent, collect, store, organize, visualize, and communicate data and information; and advances knowledge about how computational systems can perform tasks autonomously, robustly, and flexibly.

IIS research investments support the exploration of novel theories and innovative technologies that advance our understanding of the complex and increasingly coupled relationships between people and computing. Investments in information integration and informatics focus on the processes and technologies involved in creating, managing, visualizing, and understanding diverse digital content as it relates to individuals, groups, organizations, and societies, and as it is hosted on engineered systems ranging from individual devices to globally-distributed systems. IIS also invests in research on artificial intelligence, computer vision, human language research, robotics, machine learning, computational neuroscience, cognitive science, and related areas leading to the computational understanding and modeling of intelligence in complex, realistic contexts.

In general, 55 percent of IIS funding is available for new research grants. The remaining 45 percent is used primarily to fund continuing grants made in previous years.

Factors Influencing the Allocation Across IIS Programs

In FY 2011 the allocation of IIS funds is designed to provide increased support for priority core research for the next generation of information and communications technology. The IIS allocation also targets high-priority research areas such as CTE, CNCI, and SEES. In FY 2011, IIS will:

- Spearhead CISE's participation in CTE through support for research on new modalities of learning including: virtual laboratories and access to remote scientific instruments; the use of mobile and handheld devices, virtual environments, simulations, and serious games in learning; the use of machine learning and data mining on educational data for assessment and learning purposes; the development of social technologies to create and enhance learning communities and support and expand learning's many stakeholders; mobile technologies and new, rich interfaces to facilitate "anytime, anywhere learning;" and the use of affective and assistive technology innovations to tailor learning to individual circumstances.
- Increase support for the Trustworthy Computing program, which includes the Comprehensive National Cybersecurity Initiative, with a focus on research on privacy and usability, reflecting the growing volume of online sensitive information as the public puts more and more of their data "in the cloud", and as electronic health records become a reality.

- Contribute to participation in SEES by supporting research to optimize energy usage through intelligent decision-making for compute- and data-intensive systems.
- Support CDI research, particularly the Data to Knowledge theme, targeting new data technologies that scale to the quantities, speed, dimensionality, and complexity of data that challenges innovation in science and engineering. IIS will also focus on research that enables large-scale collaboration within and across scientific and engineering domains, supporting the Virtual Organizations theme of CDI.
- Continue support for the Social-Computational Systems (SoCS) program, in collaboration with colleagues in the human sciences, to reveal new understanding about the properties that systems of people and computers together possess, and to develop a practical understanding of the purposeful design of systems to facilitate socially intelligent computing.
- Continue support for Collaborative Research in Computational Neuroscience (CRCNS) to make significant advances in the understanding of nervous system function, mechanisms underlying nervous system disorders, and computational strategies used by the nervous system (in collaboration with NIH and other NSF directorates).

As with all three CISE disciplinary divisions, IIS will participate in CISE cross-cutting research, education, and infrastructure programs such as Data-intensive Computing.

DIVISION OF INFORMATION TECHNOLOGY RESEARCH (ITR) $80,740,000
+$0 / 0%

ITR Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
ITR	**$78.35**	**$40.41**	**$80.74**	**$80.74**	**-**	**-**
Research	78.33	30.41	80.74	80.74	-	-
SLC: Pittsburgh Science of Learning Center for Robust Learning	-	-	*2.50*	*2.50*	-	-
Education	0.02	-	-	-	-	N/A
Infrastrucuture	-	10.00	-	-	-	N/A

The ITR subactivity provides support for transformative explorations in computer and information science and engineering research and related education activities, emphasizing the funding of high-risk, multi-investigator, often multidisciplinary projects.

In general, 70 percent of the ITR portfolio is available to make new awards. The remaining 30 percent is used primarily to fund continuing grants made in previous years.

Factors Influencing the Allocation Across ITR Programs

In FY 2011 the allocation of ITR funds is designed to:

- Continue support for the Expeditions in Computing program. In planning and implementing *Expeditions*, researchers are encouraged to come together within or across departments or institutions in the identification of compelling, transformative research agendas that promise disruptive innovations in computing and information for many years to come. Funded at levels up to $10 million, *Expeditions* projects represent some of the largest single investments currently made by CISE.
- Continue support to the Pittsburgh Science of Learning Center (SLC) for Robust Learning.
- Provide flexibility for emerging high-priority areas of potentially transformative research.

DIRECTORATE FOR ENGINEERING (ENG) $825,670,000

+$81,740,000 / 11.0%

ENG Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Chemical, Bioengineering, and Transport Systems (CBET)	$146.00	$60.57	$156.82	$169.07	$12.25	7.8%
Civil, Mechanical, and Manufacturing Innovation (CMMI)	174.93	57.96	188.00	206.50	18.50	9.8%
Electrical, Communications, and Cyber Systems (ECCS)	87.21	45.57	94.00	103.00	9.00	9.6%
Engineering Education and Centers (EEC)[1/]	118.23	32.18	124.11	138.40	14.29	11.5%
Industrial Innovation and Partnerships (IIP)[2/]	112.12	54.70	152.00	177.70	25.70	16.9%
SBIR/STTR	*90.39*	*49.91*	*125.77*	*142.86*	*17.09*	*13.6%*
Emerging Frontiers in Research and Innovation (EFRI)	26.50	14.00	29.00	31.00	2.00	6.9%
Total, ENG	**$664.99**	**$264.99**	**$743.93**	**$825.67**	**$81.74**	**11.0%**
Research	565.42	224.22	634.25	703.36	69.11	10.9%
Education	52.17	30.49	62.71	73.99	11.28	18.0%
Infrastructure	31.89	10.27	32.83	33.33	0.50	1.5%
Stewardship	15.51	-	14.14	14.99	0.85	6.0%

Totals may not add due to rounding.

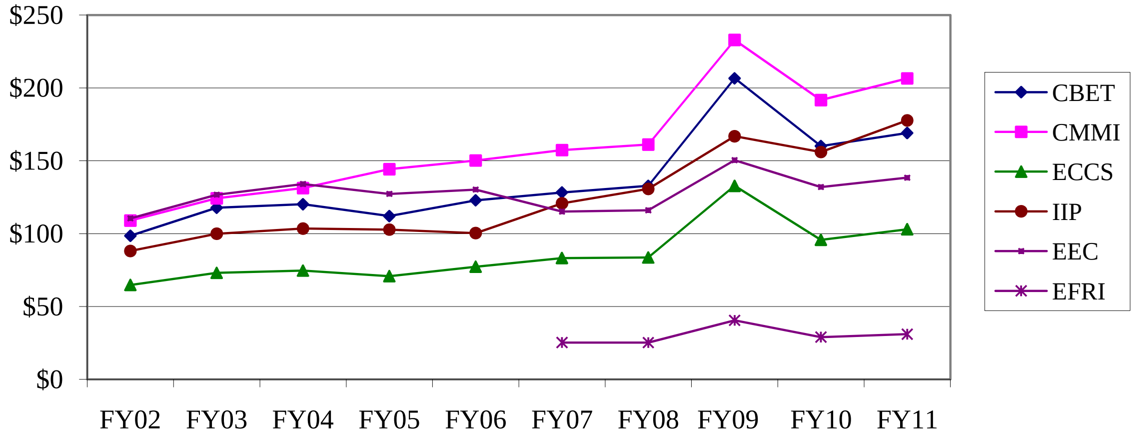
[1/] Funding for the Science of Learning Center (SLC) within the Division for Engineering Education and Centers is included for all years for comparability. SLC is cofunded with the Directorate for Social, Behavioral and Economic Sciences beginning in FY 2010.

[2/] Funding for Partnerships for Innovation (PFI) was transferred in FY 2010 from Integrative Activities (IA) to the Directorate for Engineering, which manages the program. Funding for PFI is shown for all years for comparability.

ENG provides critical support for the Nation's engineering research activities and is a driving force behind the training and development of the U.S. engineering workforce. ENG supports fundamental research, the creation of cutting-edge facilities and tools, and broad interdisciplinary collaborations. ENG also enhances U.S. innovation through its centers, partnerships, and small business programs.

ENG Subactivity Funding

(Dollars in Millions)



ENG in Context

ENG provides approximately 35 percent of the total federal support for university-based, fundamental engineering research. The directorate's work impacts students and the research community, the business community, and the Nation as a whole. By making education an essential element of its grants and centers, and by supporting research experiences for teachers, undergraduates, graduate students, and new faculty, ENG helps prepare the future engineering workforce to innovate and compete in the global economy. By emphasizing interdisciplinary, high-risk, and potentially transformative engineering research, the directorate encourages the research community to advance the frontiers of knowledge and tackle increasingly complex problems. Through its centers and the Small Business Innovation Research program, the directorate speeds the translation of promising fundamental research into innovations that can be commercialized.

ENG has supported a wide range of critical breakthroughs essential to the Nation's prosperity, security, quality of life, and capacity for innovation. These include creative ways to make the Nation's physical infrastructure more sustainable and resilient; revolutionary advances in sensor technologies; catalytic methods for creating biofuels; new techniques for medical diagnostics and treatments; commercial-scale production of high-quality nanomaterials; novel methods for monitoring and treating drinking water supplies; and a host of others in a portfolio generated by thousands of grantees.

To identify new opportunities and challenges for transformative engineering research, the directorate supports workshops and projects each year. Examples of recent workshops held in 2009 are:

- Frontiers of Engineering Symposium;
- Designing Cyber for Future Energy Systems;
- Enhancing the Post-9/11 Veterans Educational Benefit;
- First International Congress of Sustainability Science and Engineering: Where Science and Engineering Meet the Needs of Society;
- International Assessment of Research and Development in Flexible Hybrid Electronics;
- Life Cycle Aspects of Nanoproducts, Nanostructured Materials, and Nanomanufacturing: Problem Definitions, Data Gaps, and Research Needs (NSF–EPA workshop); and
- Opportunities and Challenges for the Emerging Field of Synthetic Biology.

The FY 2011 Request for ENG includes $37.0 million to leverage activities across the directorate aimed at increasing support for transformative research. Examples of potential foci for these investments include innovative processes for identifying potentially transformative research, special solicitations and competitions, and increased use of specialized funding mechanisms, notably NSF's EAGER (EArly-concept Grants for Exploratory Research).

Factors Influencing the Allocation Across Divisions and Major Programs

- ENG priorities were influenced by the American Recovery and Reinvestment Act, and the America COMPETES Act, which called for renewed emphasis on: high-risk, high-reward research in areas such as sustainable energy, healthcare technology, and security; support for students and young investigators in engineering; and translation of discoveries from fundamental research into innovative technologies to promote economic growth and job creation.
- ENG also considered several recent reports from the engineering community, including:
  - ARISE: Advancing Research in Science and Engineering (American Academy of Arts and Sciences, 2008);
  - Engineering for a Changing World (Duderstadt/Univ. of Michigan, 2008);
  - Grand Challenges for Engineering (National Academy of Engineering, 2008); and

  - Rising Above the Gathering Storm (National Academies, 2007).

- ENG will strengthen programs supporting early-career researchers and engineering innovation. Increased support for engineering students and early-career faculty will help ensure the Nation's future supply of university educators and investigators and of industry innovators. ENG programs will place a stronger emphasis on preparing engineers who understand the connections between fundamental research and national and industry needs and who are adept at transforming discoveries into innovative technologies.

- ENG will increase support for interdisciplinary teams of investigators, particularly to address high-risk, high-reward challenges in energy and sustainability, healthcare, infrastructure resiliency, and other areas of national and community importance.

- The directorate will maintain funding levels for ENG facilities in accordance with their cooperative agreements, enabling these valuable resources to continue serving the research community and to advance collaboration in vital areas.

- ENG will eliminate funding for the planned Water and Environmental Research Systems (WATERS) Network project. An independent scientific assessment of this joint ENG/GEO/SBE venture was supportive of the project's research goals, but found that the case for a large dedicated facility was lacking. ENG intends to continue to allocate funding towards important related research efforts but does not intend to pursue design or construction funding for the WATERS Network as a major facility project.

ENG Funding for Centers and Facilities

ENG Funding for Centers and Facilities

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Centers	$93.39	-	$85.22	$96.47	$11.25	13.2%
Eng. Res. Centers (EEC)	*61.42*	-	*54.91*	*67.50*	*12.59*	*22.9%*
Nanoscale Sci. and Eng. Centers (Multiple)	*25.26*	-	*24.75*	*24.75*	-	-
STC: Advanced Materials for Water Purification (CBET)	*6.71*	-	*3.36*	*2.02*	*-1.34*	*-39.9%*
SLC: Excellence for Learning in Education, Science, and Technology (CELEST)	-	-	*2.20*	*2.20*	-	-
Facilities	$31.89	$10.27	$32.83	$33.33	$0.50	1.5%
NEES (CMMI)	*20.97*	-	*22.00*	*22.50*	*0.50*	*2.3%*
NNIN (Multiple)	*10.92*	*10.27*	*10.83*	*10.83*	-	-

Detailed information on individual Centers can be found in the NSF-Wide Investments chapter. For further detail about individual Facilities, please see the Facilities chapter.

Centers

- Funding for the Engineering Research Centers (ERC) program will increase by $12.59 million in FY 2011, to a total of $67.50 million. Increased funding will support five new Generation-3 Centers and the planned growth of the FY 2008 class of ERCs. The original schedule called for three new ERC awards at the end of FY 2010 and two additional centers in early FY 2011, bringing the total portfolio to 18 centers. However, due to a delay in the current ERC competition, the three awards planned for FY 2010 will be made in FY 2011. Consequently, the portfolio of 13 ERCs in the FY 2010 Estimate will require funding at a level that is $8.29 million lower than the amount in the FY 2010 Request. Those funds have been reallocated to other critical ENG needs in the FY 2010 Estimate.

- ENG funding for the Science and Technology Center (STC) for Advanced Materials for Water Purification, which was established in 2002, will decrease by $1.34 million to a total of $2.02 million in FY 2011, as the planned NSF support for the Center begins to wind down.

Facilities

- In FY 2011, funding for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) will increase by $500,000 to $22.50 million.

- The National Nanotechnology Infrastructure Network (NNIN) will receive steady support from ENG for FY 2011 as planned.

ENG Administration Priority Programs and NSF Investments

ENG Administration Priority Programs and NSF Investments

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Faculty Early Career Development (CAREER)	$47.61	$29.28	$46.98	$50.30	$3.32	7.1%
Graduate Research Fellowship (GRF)	6.97	4.08	7.00	8.28	1.28	18.3%
Science, Engineering and Education for Sustainability (SEES)	N/A	N/A	108.20	120.00	11.80	10.9%
Science and Engineering Beyond Moore's Law (SEBML)	3.00	-	10.00	20.00	10.00	100.0%

ENG's FY 2011 budget will make significant contributions to four key NSF activities that support students, early career researchers, and the next generation of scientists and engineers engaged in sustainability research and the creation of revolutionary communications/computing technologies. The budget also encourages potentially transformational research and supports critical priorities in global climate change and information technology innovation. For more information on Administration priority programs and NSF investments, please refer to the Overview section.

Specific ENG investments include:

- Increased support for CAREER awards to a total of $50.30 million, bolstering ENG's substantial investment with eight additional awards.

- Strengthened support for the Graduate Research Fellowship program to a total of $8.28 million; additional funding of $1.28 million will increase the number of engineering fellows by 25.

- In FY 2011, ENG will invest $120.0 million in the NSF-wide Science, Engineering, and Education for Sustainability (SEES) portfolio to integrate efforts in climate and energy science and engineering. The portfolio will support research and education related to sustainable energy and the environment, and energy manufacturing, including the scale-up of manufacturing technologies that enable the economic conversion of sunlight, air, and water, using a biological intermediary such as algae, into hydrocarbons. Research will focus on civil infrastructure resilience and sustainability to elucidate the complex interdependencies that must be understood to design energy-efficient buildings, infrastructure, and their associated communities. Support will also be provided for micro-grid and smart-grid approaches to next-generation power distribution systems, advances in power system devices, advanced technologies for energy harvesting and for solar, wind, and other alternate energy sources, and new optical device technologies for smart lighting.

- Doubled support for Science and Engineering Beyond Moore's Law (SEBML) to $20.0 million, in recognition of the opportunity for engineering contributions to overcome the scaling limits of silicon technology while improving energy efficiency and performance capabilities.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

ENG convenes Committees of Visitors, composed of qualified external evaluators, to review each division every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of results of NSF's investments. The Chemical, Bioengineering, Environmental, and Transport Systems (CBET) and Civil, Mechanical, and Manufacturing Innovation (CMMI) divisions were reviewed in FY 2009. The Engineering Education and Centers (EEC) and the Industrial Innovation and Partnerships (IIP) divisions will be reviewed in FY 2010, and the Electrical, Communications, and Cyber Systems (ECCS) division and the Office of Emerging Frontiers in Research and Innovation (EFRI) will be reviewed in FY 2011.

Number of People Involved in ENG Activities

	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	6,376	2,289	6,695	7,096
Other Professionals	1,148	466	1,205	1,278
Postdoctorates	356	141	374	396
Graduate Students	6,653	2,404	6,986	7,405
Undergraduate Students	2,155	668	2,263	2,399
Total Number of People	**16,688**	**5,968**	**17,523**	**18,574**

ENG Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Statistics for Competitive Awards:			
Number of Proposals	10,613	11,674	12,258
Number of New Awards	2,691	2,252	2,594
Regular Appropriation	1,774	2,252	2,594
ARRA	917	-	-
Funding Rate	25.4%	19.3%	21.2%
Statistics for Research Grants:			
Number of Research Grant Proposals	8,752	9,627	10,108
Number of Research Grants	1,804	1,365	1,585
Regular Appropriation	1,198	1,365	1,585
ARRA	606	-	-
Funding Rate	20.6%	14.2%	15.7%
Median Annualized Award Size	100,001	101,000	101,500
Average Annualized Award Size	120,510	115,000	115,500
Average Award Duration, in years	3.0	3.0	3.0

DIVISION OF CHEMICAL, BIOENGINEERING, ENVIRONMENTAL, AND TRANSPORT SYSTEMS (CBET) **$169,070,000**
+$12,250,000 / 7.8%

CBET Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
CBET	**$146.00**	**$60.57**	**$156.82**	**$169.07**	**$12.25**	**7.8%**
Research	142.30	57.17	153.12	165.37	12.25	8.0%
Nanoscale Sci. and Eng. Centers (NSEC)	*5.85*	-	*5.90*	*5.90*	-	-
STC: for Advanced Materials for Water Purification	*6.71*	-	*3.36*	*2.02*	*-1.34*	*-39.9%*
Infrastructure	3.70	3.40	3.70	3.70	-	-
NNIN	*3.70*	*3.40*	*3.70*	*3.70*	-	-

CBET investments in fundamental research and education contribute significantly to the knowledge base and workforce development for major components of the U.S. economy—including food, natural resources, utilities, microelectronics, medical devices, pharmaceuticals, and chemicals—impacting important national priorities such as environmental sustainability, security, healthcare, and energy.

CBET supports a diverse range of disciplinary research involving the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. CBET also fosters research and education in the highly interdisciplinary areas of bioengineering/healthcare and the energy/water/environment nexus.

In general, 65 percent of the CBET portfolio is available for new research grants. The remaining 35 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across CBET Programs

- Maintaining healthy core disciplinary programs is CBET's highest priority.
- CBET will increase support for interdisciplinary teams of investigators, particularly to address high-risk, high-reward challenges in energy, sustainability, and healthcare, as well as other areas of national and community importance. These include:
  - Continued support of fundamental research for sustainable energy, including a funding partnership with DOE focusing on thermoelectric energy conversion for waste heat recovery in vehicles.
  - Fundamental research on sustainably producing chemicals and energy from biological materials and organisms—the essential feature of a bio-economy. The division plans to continue a national leadership role in potential transformative research to advance biomass conversion into green gasoline.
  - Strengthening its program on environmental, health, and safety issues, particularly as they relate to nanotechnologies.
  - Growth in the area of environmental sustainability, particularly to support emerging research related to water sustainability as part of the SEES investment.

    - Support for nano-bioengineering research to advance environmental and healthcare technologies, as part of its contribution to Science and Engineering Beyond Moore's Law (SEBML).

- Potentially transformative research and strengthening support for engineering innovation.

- Increased support for engineering students and early-career faculty to help ensure the Nation's future capacity for university educators and investigators and for industry innovators.

- As part of its commitment to broadening participation in engineering, CBET will strengthen its program for research to aid persons with disabilities in several ways, including supporting more researchers with disabilities as grantees to enrich contributions to the program.

- CBET support for the STC for Advanced Materials for Water Purification will decrease by $1.34 million as the center begins a planned phase-down as it approaches the final year of NSF support.

DIVISION OF CIVIL, MECHANICAL, AND MANUFACTURING INNOVATION (CMMI) — $206,500,000 +$18,500,000 / 9.8%

CMMI Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
CMMI	**$174.93**	**$57.96**	**$188.00**	**$206.50**	**$18.50**	**9.8%**
Research	152.06	56.20	164.10	182.10	18.00	11.0%
Nanoscale Sci. and Eng. Centers (NSEC)	*6.01*	-	*5.45*	*5.45*	-	-
Facilities	22.87	1.76	23.90	24.40	0.50	2.1%
NEES	*20.97*	-	*22.00*	*22.50*	*0.50*	*2.3%*
NNIN	*1.90*	*1.76*	*1.90*	*1.90*	-	-

CMMI supports fundamental research and education to bring about advances that promote manufacturing innovation; enhance the sustainability and resiliency of the Nation's civil infrastructure, including buildings, transportation, and communications networks; help protect the Nation from natural and extreme events; and apply engineering principles to improve the Nation's service enterprise systems, such as healthcare. These investments contribute broadly to the engineering knowledge base and build the human capital capacity needed for major components of U.S. industry to compete in a global economy.

CMMI programs are organized into four clusters: Advanced Manufacturing, Mechanics and Engineering Materials, Resilient and Sustainable Infrastructures, and Systems Engineering and Design. CMMI supports disciplinary and interdisciplinary research conducted by the mechanical, industrial, civil, materials, systems, structural, electrical, manufacturing, and bioengineering communities.

Approximately 69 percent of the funding allocated to the division is available to initiate new projects, with the remaining 31 percent applied primarily to fund continuing awards made in previous years.

Factors Influencing the Allocation Across CMMI Programs

- CMMI will allocate funds to high-quality proposals across its programs to enable the division to raise its success rate. Investment in thematic areas across CMMI will include those addressing national needs and priorities. These include:
  - Research to support transformative manufacturing technologies consistent with the Administration's R&D priorities for revitalizing U.S. manufacturing, including nanomanufacturing and the application of nanotechnology to existing manufacturing industries; fundamental research associated with SEBML manufacturing challenges and opportunities; and basic research efforts on manufacturing enterprise systems and complex systems design and manufacturing.
  - Support of the Science, Engineering, and Education for Sustainability (SEES) initiative including research efforts in energy manufacturing and energy efficient materials engineering;

- Research on civil infrastructure resilience and sustainability to provide fundamentals necessary to design energy-efficient buildings, infrastructure, and associated communities;
- Participation in the RE-ENERGYSE initiative via graduate student support in areas such as energy manufacturing, energy efficient materials processing, and energy supply chain and logistics;
- Research to enable the vision of SEBML through the nanoscale engineering of non-silicon semiconductor materials, the creation of manufacturing equipment and processes for them, and the design of efficient and economical facilities;
- Investigations into complexity that focus on the quantification of uncertainty in modeling and simulation and on decision-making in difficult environments with less-than-perfect information, which can impact health-care delivery, design and manufacturing, and a wide range of other areas; and
- Simulation-based engineering and science to capitalize on advances in high-performance computational tools and physics-based models for design, materials processes, manufacturing, and mechanics as advocated in recent reports from the National Research Council and the World Technology Evaluation Center.

- CMMI will focus on building capacity within the research community and on developing early-career faculty by active mentoring (for example via proposal writing workshops) and by continuing to emphasize CAREER awards.

- The division will continue support of interdisciplinary research by funding high-quality research that lies at the interface of traditional engineering disciplines and is best pursued through collaboration by multiple investigators.

- CMMI will increase its investment in the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) by $500,000 to a total of $22.50 million to provide the community with state-of-the-art facilities to conduct earthquake engineering research and improve the safety of buildings and infrastructure.

DIVISION OF ELECTRICAL, COMMUNICATIONS, AND CYBER SYSTEMS (ECCS) — $103,000,000 +$9,000,000 / 9.6%

ECCS Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
ECCS	**$87.21**	**$45.57**	**$94.00**	**$103.00**	**$9.00**	**9.6%**
Research	81.98	40.46	88.77	97.77	9.00	10.1%
Nanoscale Sci. and Eng. Centers (NSEC)	*3.40*	-	*3.40*	*3.40*	-	-
Infrastructure	5.23	5.11	5.23	5.23	-	-
NNIN	*5.23*	*5.11*	*5.23*	*5.23*	-	-

ECCS addresses fundamental research issues underlying electronic and photonic devices and component technologies, nano-electronics, energy, power, smart-grid, controls, computation, networking, communications, and cyber technologies. The division supports the integration and networking of intelligent systems principles at multiple scales for applications in energy, healthcare, disaster mitigation, telecommunications, environment, manufacturing, and other systems-related areas. ECCS research and education investments emphasize interdisciplinary collaboration and the convergence of technologies to take on major technological challenges for the next generation of innovative devices and systems.

The ECCS Division is organized around three programs that focus on research and educational issues of device and component technologies, network and computational technologies, and systems engineering:

- Electronics, Photonics and Device Technologies (EPDT),
- Power, Controls and Adaptive Networks (PCAN), and
- Integrative, Hybrid and Complex Systems (IHCS).

In general, 88 percent of the ECCS portfolio is available for new research grants. The remaining 12 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across ECCS Programs

- Maintaining healthy disciplinary programs is ECCS's top priority.

- Fostering a technically competent workforce remains a priority and is reflected in the division's strong support for CAREER awards.

- ECCS will invest in interdisciplinary awards in the areas of Cyber–Physical Systems (CPS), alternative energy and smart grid technologies, and bioelectronics, and Science and Engineering Beyond Moore's Law (SEBML). To overcome charge leakage effects and related thermal limitations of additional scaling, the ECCS investment in SEBML will address novel device design concepts, multi-scale modeling and simulation, and quantum information science and engineering (QISE).

- ECCS will support projects for broadening participation with enhanced funding for Graduate Research Supplements.

- Recognizing a shortage of certain laboratory equipment important for research progress, particularly in the areas of device and circuit characterization and fabrication, ECCS provides equipment funding to principal investigators who require such tools to conduct their research.

- ECCS encourages industry collaborations through the Grant Opportunities for Academic Liaison (GOALI) program.

DIVISION OF ENGINEERING EDUCATION AND CENTERS (EEC) $138,400,000 +$14,290,000 /11.5%

EEC Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
EEC	**$118.23**	**$32.18**	**$124.11**	**$138.40**	**$14.29**	**11.5%**
Research	82.78	1.73	78.60	91.61	13.01	16.6%
Eng. Res. Centers (ERC)	*61.42*	-	*54.91*	*67.50*	*12.59*	*22.9%*
Nanoscale Sci. and Eng. Centers (NSEC)	*10.00*	-	*10.00*	*10.00*	-	-
SLC: Excellence for Learning in Education, Science, and Technology (CELEST)	-	-	*2.20*	*2.20*	-	-
Education	35.45	30.45	45.51	46.79	1.28	2.8%

EEC promotes and facilitates university interdisciplinary research and curricula by supporting innovative programs that integrate research and education, improve the quality of the engineering workforce, cut across disciplines, develop partnerships with industry, and enable a breadth of investigation that spans the inception of an idea to proof of concept.

The division's programs are divided into three major categories: (1) Major Centers (Engineering Research Centers (ERC), Nanoscale Science and Engineering Centers (NSEC), and a Science of Learning Center (SLC)), for the support of interdisciplinary research that fosters partnerships among academe, government, and industry; (2) Engineering Education Research, for advancing the quality and productivity of both undergraduate and graduate engineering pedagogy; and (3) Human Resources, for the development of a diverse and capable engineering workforce. EEC programs address issues that are critical to all fields of engineering and complement the research and education portfolios of the other divisions of the Directorate for Engineering.

In years with no new ERC awards, 15 percent of the EEC budget is typically available for new grants, while 85 percent is used primarily to fund grants made in previous years for centers, graduate fellowships, and undergraduate programs. In FY 2011, with new ERC awards expected, the investment in new awards will approximately double to 30 percent.

Factors Influencing the Allocation Across EEC Programs

- EEC will support the growth of Engineering's flagship Engineering Research Centers (ERC) program by $12.59 million, to a total of $67.50 million. In FY 2011, EEC anticipates investing in 18 ERCs, including five new ones. Generation-3 ERCs place increased emphasis on innovation and entrepreneurship, partnerships with small research firms, and international collaboration and cultural exchange. These added dimensions speed the translation of fundamental research to innovations in U.S. industry and prepare engineering graduates to succeed in a global economy. Centers proposed for funding in FY 2011 have a specific focus on energy and infrastructure research—two national needs—and broaden a portfolio of ERCs investigating topics that include biomaterials for implants, power electronics, detection and warning systems for severe storms, and systems for delivery and management of renewable electric energy.

  - The FY 2011 ERC increase will also provide for the planned phased growth of recently awarded centers. The increase will enhance economic competitiveness and stimulate job creation in two ways: by initiating collaborative research partnerships to translate ERC research advances into innovative new products; and by increasing the involvement of pre-college teachers to bring engineering to pre-college classrooms and stimulate student interest in engineering careers.

- Support to research programs for engineering education ($12.85 million) as a platform for transforming engineering education, to encourage engineering schools to recruit and serve veterans, and to address the barrier between research in engineering education and its successful implementation in the classroom. With the Directorate for Education and Human Resources (EHR), EEC will invest in a new program to establish Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) Centers that focus on research in energy education and translational educational research.

- Continued investment in developing the engineering workforce through important human resources programs: Research Experiences for Undergraduates (REU) Sites ($10.50 million), Research Experiences for Teachers (RET) ($4.20 million), and increased investment in the Graduate Research Fellowship program (GRF) (+$1.28 million, to a total of $8.28 million) including the Innovation Fellows program which seeks to encourage more domestic students to enter engineering Ph.D. programs.

- Maintaining support for the ongoing NSECs ($10.0 million), where research advances the ultra-small technologies that will transform electronics, materials, medicine, and many other fields. The NSECs will also engage key partners from industry, national laboratories, and other sectors; furthermore, NSECs will continue to support education programs from the graduate to the pre-college levels designed to develop a highly skilled workforce. Funds are also provided to smaller interdisciplinary teams and to the Network for Computational Nanotechnology (www.nanoHub.org), a web-accessible repository of simulations of nanoscale phenomena for research and education.

DIVISION OF INDUSTRIAL INNOVATION AND PARTNERSHIPS (IIP) — $177,700,000 +$25,700,000 / 16.9%

IIP Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
IIP	**$112.12**	**$54.70**	**$152.00**	**$177.70**	**$25.70**	**16.9%**
Research	112.12	54.70	152.00	177.00	25.70	16.9%
Small Business Innovation Research (SBIR)	*86.80*	*44.85*	*112.47*	*127.76*	*15.29*	*13.6%*
Small Business Technology Transfer (STTR)	*3.59*	*5.05*	*13.30*	*15.10*	*1.80*	*13.5%*
Industry/University Coop. Res. Centers (I/UCRC)	*8.43*	*3.24*	*7.85*	*7.85*	-	-

IIP supports the NSF innovation environment by 1) spurring translation of fundamental research, 2) encouraging collaboration between academia and industry, and 3) educating to innovate.

IIP is home to two NSF small business research programs, the Small Business Innovation Research (SBIR) program and the Small Business Technology Transfer (STTR) program. These small business-centered programs support innovation research and build partnerships between the academic and industry sectors. These programs support the innovation economy by funding translational research at U.S. small businesses on topics that span the breadth of NSF scientific and engineering research and that reflect national and societal priorities.

In addition, IIP leverages industrial support through three research programs, the Industry/University Cooperative Research Centers (I/UCRC) program, the Grant Opportunities for Academic Liaison with Industry (GOALI) program, and the Partnerships for Innovation (PFI) program. These university grantees work closely with industry to create enabling technologies for national needs, such as managing the electrical power system, improving manufacturing and biological processing, and supporting new healthcare information and telecommunications technologies. Furthermore, these programs prepare students to become globally aware leaders in innovation by working closely with industry.

In general, 95 percent of the IIP portfolio is available for new research grants. The remaining 5 percent of funding supports continuing grants made in previous years, primarily to the long-duration I/UCRCs. All other programs are managed with standard grants.

Factors Influencing the Allocation Across IIP Programs

- Increases in the SBIR, $15.29 million, to a total of $127.76 million and STTR, $1.80 million, to a total of $15.10 million program investments are in line with federal mandates. IIP will seek to strengthen the connections between these small business research programs and the university-based research programs to foster the translation of important discoveries into commercial products.

- Responding to national need in the area of innovation. IIP will invest $12.0 million in a new aspect of the PFI program for the "NSF Innovation Ecosystem." The division will provide research grants to universities in partnership with other institutions to increase the economic and social impacts of university research. The goals of the grants would be to (1) increase the engagement of faculty and students across all disciplines in the innovation and entrepreneurship process; (2) increase the impact of the most promising university innovations through commercialization, industry alliances, and start-up formulation; and (3) develop a regional community that supports the "innovation ecosystem" around the university.

- Industry-University collaboration and translational research. IIP will maintain I/UCRC funding at the FY 2010 level of $7.85 million as the program continues to establish new, innovative centers and to extend support for current, successful centers. The division will also create mechanisms to spur collaboration between the centers and the NSF SBIR/STTR grantees. These collaborations are expected to speed the translation of fundamental research discoveries into innovations that benefit challenges of importance to both industry and the Nation.

- Core Reallocation. IIP will reallocate $3.38 million in core funding from the GOALI ($1.38 million, to a total of $7.80 million) and PFI (-$2.0 million, to a total of $7.19 million) programs as the focus shifts to activities associated with the "Innovation Ecosystem."

EMERGING FRONTIERS IN RESEARCH AND INNOVATION (EFRI) — $31,000,000 +$2,000,000 / 6.9%

EFRI Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
EFRI	**$26.50**	**$14.00**	**$29.00**	**$31.00**	**$2.00**	**6.9%**
Research	26.50	14.00	29.00	31.00	2.00	6.9%

EFRI was created within the Office of the Assistant Director for Engineering in FY 2007 to enable ENG to strategically pursue important emerging areas in a timely manner. Each year EFRI recommends, prioritizes, and funds interdisciplinary topics at the frontiers of engineering research and education that have the potential for transformative impacts on national needs and/or grand challenges. Recent EFRI research topics have included renewable energy storage; integrated systems designed to make U.S. infrastructure more resilient to disasters; optimal methods for obtaining hydrocarbons from plants and microorganisms; and regeneration of some of the body's most complex tissues.

EFRI encourages the engineering community to come forward with new and paradigm-shifting proposals at the interface of disciplines and fields. Their discoveries may potentially lead to: new research areas for NSF and other agencies; new industries or capabilities that result in a leadership position for the country; and/or significant progress on a recognized national need or grand challenge.

Technological innovations have given rise to new industries, expanded access to quality healthcare, and fueled national prosperity even as global competition has grown. To help ensure the Nation's continued success, EFRI will provide critical, strategic support of fundamental discovery, particularly in areas that may lead to breakthrough technologies and strengthen the economy's technical underpinnings. EFRI will have the necessary flexibility to target long-term challenges, while retaining the ability and agility to adapt as new challenges demand.

In general, 95 percent of the EFRI portfolio is available for new research grants while 5 percent is used primarily to fund grants made in previous years.

Factors Influencing the Allocation Across EFRI Programs

- Potentially transformative frontier research and national needs are the principal drivers for funding allocations in EFRI and will likely result in funding of 15 total awards.

- EFRI seeks to invest in engineering research opportunities that would be difficult to fund with other NSF mechanisms. Successful projects usually require small- to medium-sized interdisciplinary teams of researchers and significant funding for several years in order to make substantial progress and to provide evidence for additional follow-on funding through other established mechanisms.

- Topics for EFRI support typically address research areas important to NSF, the research community, and the Nation as a whole. Research may relate to the grand challenges identified by

National Academy of Engineering (www.engineeringchallenges.org), and, beginning in FY 2010, EFRI has provided the opportunity for the research community to directly submit topic ideas through the NSF website.

- EFRI will also consider seed funding for potential areas of interest; for example, with co-funding from the MPS Division of Mathematical Sciences in FY 2009, EFRI invested in a handful of exploratory research projects on complex systems.

DIRECTORATE FOR GEOSCIENCES (GEO) $955,290,000

+$65,650,000 / 7.4%

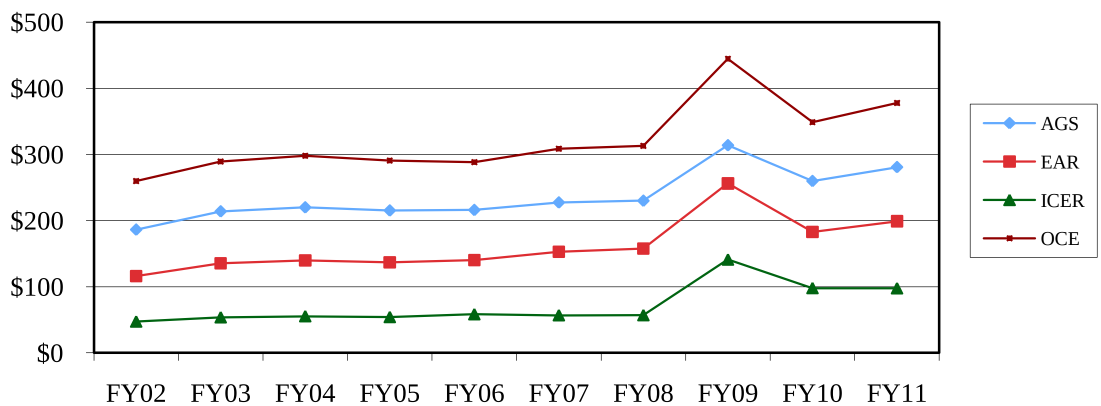
GEO Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Atmospheric and Geospace Sciences (AGS)	$245.54	$68.20	$259.80	$280.80	$21.00	8.1%
Earth Sciences (EAR)	171.01	85.22	183.00	199.00	16.00	8.7%
Integrative and Collaborative Education & Research (ICER)	61.47	79.58	97.92	97.60	-0.32	-0.3%
Ocean Sciences (OCE)	330.51	114.00	348.92	377.89	28.97	8.3%
Total, GEO	**$808.53**	**$347.00**	**$889.64**	**$955.29**	**$65.65**	**7.4%**
Research	389.11	224.69	464.12	505.17	41.05	8.8%
Education	31.82	35.98	41.40	44.68	3.28	7.9%
Infrastructure	374.10	86.34	367.79	387.60	19.81	5.4%
Stewardship	13.51	-	16.33	17.84	1.51	9.2%

Totals may not add due to rounding.

As the principal source of federal funding for university-based fundamental research in the geosciences, the Directorate for Geosciences addresses the Nation's need to understand, predict, and respond to environmental events and changes. GEO-supported research also advances our ability to predict natural phenomena of economic and human significance, such as climate changes, hurricanes, and earthquakes.

GEO Subactivity Funding
(Dollars in Millions)



GEO in Context

GEO provides about 63 percent of the total federal funding for university-based, basic research in the geosciences. In addition to playing a critical role in addressing the Nation's need to understand, predict, and respond to environmental events and changes, GEO also helps to determine the best use of Earth's resources. Fundamental research in the geosciences advances scientific knowledge of resources such as fresh water, energy, minerals, and biological diversity, leading to improved future quality of life. GEO investments include many environmental studies coordinated through the U.S. Global Change Research Program.

GEO supports basic research that advances the frontiers of knowledge and drives technological innovation while improving our understanding of the many processes that affect the global environment. These processes include the role of the atmosphere and oceans in climate, the planetary water cycle, and ocean acidification. Support is provided for interdisciplinary studies that contribute directly to national research priorities: hydrologic systems, biogeochemical dynamics, ecological systems and dynamics, solid earth processes, and solar influences on the Earth system. Lives are saved and property is preserved through better prediction and understanding of natural environmental hazards such as earthquakes, tornados, hurricanes, tsunamis, drought, and solar storms. Basic research supported by GEO enables preparation for and subsequent mitigation of, or adaptation to, the effects of these and other disruptive natural events.

The FY 2011 Request for GEO includes $8.0 million to leverage activities across the directorate aimed at increasing support for transformative research, including highly innovative research and education projects across the entire range of geoscience interests. Special attention will be paid to challenges associated with understanding the dynamic processes impacting the physical earth system. GEO will also utilize NSF's innovative processes for identifying potentially transformative research, such as special competitions and increased use of specialized funding mechanisms, notably NSF's EAGER (EArly-concept Grants for Exploratory Research) grants.

Factors Influencing the Allocation Across Divisions and Major Programs

In consultation with the Advisory Committee for Geosciences, GEO developed a set of principles to guide budget allocations and decisions. These are:

Advance science

- Foster generation of new ideas and innovative science, including those that cross traditional programmatic boundaries;
- Provide adequate resources to accomplish project goals;
- Assure appropriate program balance and diversity in the portfolios;
- Identify and nurture partnerships within NSF, with other Federal agencies, and internationally to leverage GEO research funding and support GEO goals;
- Maintain flexibility to pursue new lines of research by continuing to avoid over committing resources in future years;
- Involve the community in long-term planning and maintain effective and timely communications with the community; and
- Be mindful of societal needs to ensure that fundamental research serves the Nation.

Maintain and enhance the health of the scientific community

- Ensure that the intellectual capital of research communities is maintained and renewed;
- Develop a diverse geoscience community;
- Promote innovative approaches to geoscience education and outreach; and
- Communicate GEO-supported activities in order to promote public awareness of the geoscience enterprise.

Preserve and invest appropriately in infrastructure

- Continue to plan in order to take advantage of new opportunities as they arise;
- Maintain productive scientific infrastructure, including cyberinfrastructure, and avoid irreversible losses to capabilities;
- Provide new research tools and facilities, assure that they are maintained, and support the science that exploits these tools;

- Consider full life-cycle costs of infrastructure, including the costs of associated science; and
- Consider infrastructure implications when committing to a major science program.

Major investments in FY 2011 that shaped the distribution of funds across the divisions include continued investment in the NCAR-Wyoming supercomputer center and increased emphasis on climate research. The new supercomputer center will enable expansion of the computational resources available to the community, and is expected to cost approximately $70.20 million - $25.0 million in 2010, $19.2 million in 2011, and $6.0 million in 2012 from NSF, and an additional $20.0 million from the State of Wyoming. This activity is inherently multidisciplinary and plays an important role across the geosciences; therefore, support for the center is provided through AGS, EAR and OCE in FY 2011. Supporting the increase in operations funds needed for the Ocean Observatories Initiative (OOI) being constructed through the MREFC Account was also a significant consideration.

GEO Funding for Centers and Facilities

GEO Funding for Centers and Facilities
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Centers	**$18.51**	**-**	**$14.89**	**$13.57**	**-$1.32**	**-8.9%**
Nanoscale Science and Engineering Centers (ICER)	0.25	-	0.25	0.25	-	-
STC -- Coastal Margin Observation and Prediction (OCE)	4.00	-	4.00	4.00	-	-
STC -- Earth Surface Dynamics (EAR)	3.60	-	3.32	2.66	-0.66	-19.9%
STC -- Integrated Space Weather Modeling (AGS)	4.00	-	3.32	2.66	-0.66	-19.9%
STC -- Multi-scale Modeling of Atmospheric Processes (AGS)	4.00	-	4.00	4.00	-	-
STC --Sustainability of Semi-Arid Hydrology and Riparian Areas (EAR)	2.66	-	-	-	-	N/A
Facilities	**$374.10**	**$86.34**	**$367.79**	**$387.60**	**$19.81**	**5.4%**
National Astronomy and Ionosphere Center (AGS)	-	-	2.20	3.00	0.80	36.4%
National Center for Atmospheric Research (AGS)	106.79	13.20	97.00	108.00	11.00	11.3%
National Nanotechnology Infrastructure Network (ICER)	0.60	-	0.60	0.60	-	-
Academic Research Fleet (OCE)	88.95	18.00	80.00	77.00	-3.00	-3.8%
Integrated Ocean Drilling Program (OCE)	47.95	25.00	43.40	46.41	3.01	6.9%
Incorporated Research Institutions for Seismology (EAR)	12.00	-	12.36	12.73	0.37	3.0%
EarthScope (EAR)	24.29	9.00	25.05	26.00	0.95	3.8%
Ocean Observatories Initiative (OCE)	17.84	-	16.50	27.50	11.00	66.7%

Detailed information on individual Centers can be found in the NSF-Wide Investments chapter. For further detail about individual Facilities, please see the Facilities chapter.

<u>Centers</u>

- GEO oversees the activities of five Science and Technology Centers (STCs). In accordance with NSF guidance, several of these centers are reaching the end of their planned period of support and their funding is beginning to ramp down or has ceased. FY 2011 will be the final year of support for the Center for Integrated Space Weather Modeling at Boston University and the Center for Earth-Surface Dynamics at the University of Minnesota.

Facilities

- Funding for the National Astronomy and Ionosphere Center (NAIC) is increasing to provide support for upper atmospheric observing infrastructure located at the facility.
- Support for the National Center for Atmospheric Research (NCAR) will increase by $11.0 million in FY 2011. This augmentation will enable increased support for climate change activities as well as preparation for the transition of computing operations to the new Wyoming Supercomputer Center.
- Support for the operation of the Academic Research Fleet decreases by $3.0 million from the FY 2010 estimate. Construction funding for the replacement human occupied submersible is ramping down in accordance with plans.
- Operations support for the Integrated Ocean Drilling Program (IODP) is planned to increase in FY 2011, allowing enhanced investment in downhole instrumentation to study the deep, sub-seafloor biosphere, in partnership with a private foundation.
- Operation of the Incorporated Research Institutions for Seismology (IRIS) facility will be maintained, with a small increase for costs associated with personnel and equipment.
- Operation of EarthScope will continue with approximately the same level of activity as in FY 2010; with a small increase for costs associated with personnel and equipment.
- Operations support for the Ocean Observatories Initiative (OOI), being constructed through the MREFC account, will increase significantly in FY 2011 in order to prepare for the maintenance of in-water assets being deployed in FY 2012.

GEO Administration Priority Programs and NSF Investments

GEO Administration Priority Programs and NSF Investments

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Faculty Early Career Development (CAREER)	$12.45	$9.60	$12.60	$13.00	$0.40	3.2%
Graduate Research Fellowships (GRF)	-	8.99	1.00	2.74	1.74	174.0%
Climate Change Education Program	-	-	1.50	1.50	-	N/A
Science, Engineering, and Education for Sustainability (SEES)	N/A	N/A	195.50	230.70	35.20	18.0%

GEO's FY 2011 budget will significantly expand key NSF programs that support students, early-career researchers, and the next generation of environmentally engaged scientists and engineers. The budget also encourages potentially transformative research and supports critical priorities in global climate change.

In FY 2011, GEO will invest $230.70 million in the NSF-wide Science, Engineering, and Education for Sustainability (SEES) portfolio to integrate efforts in climate and energy science and engineering. GEO will initiate additional research competitions to study regions that are highly susceptible to the impacts of environmental changes, such as coastal areas subject to sea-level rise, the Arctic where permafrost is changing rapidly, and the Antarctic where sub-ice sheet conditions are being explored and modeled. GEO will also provide support for the new NCAR-Wyoming Supercomputer Center, which will enable a significant expansion of the U.S. academic community's capability to model the climate system, is also included.

For more information on Administration priority programs and NSF investments, please refer to the Overview and NSF-Wide Investments chapters.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

Number of People Involved in GEO Activities

(Dollars in Millions)

	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	4,780	2,006	5,200	5,600
Other Professionals	2,553	824	2,800	3,000
Postdoctorates	524	210	600	600
Graduate Students	2,166	1,854	2,400	2,500
Undergraduate Students	1,150	898	1,300	1,300
Total Number of People	**11,173**	**5,792**	**12,300**	**13,000**

GEO Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Statistics for Competitive Awards:			
Number of Proposals	4,166	4,400	4,600
Number of New Awards	1,840	1,200	1,250
Regular Appropriation	1,067	1,200	1,250
ARRA	773	-	-
Funding Rate	44%	27%	27%
Statistics for Research Grants:			
Number of Research Grant Proposals	3,609	3,800	4,000
Number of Research Grants	1,421	900	950
Regular Appropriation	813	900	950
ARRA	608	-	-
Funding Rate	39%	24%	24%
Median Annualized Award Size	$124,399	$125,000	$130,000
Average Annualized Award Size	$173,377	$175,000	$180,000
Average Award Duration, in years	2.8	3.0	3.0

DIVISION OF ATMOSPHERIC AND GEOSPACE SCIENCES (AGS) $280,800,000
+$21,000,000 / 8.1%

AGS Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
AGS	**$245.54**	**$68.20**	**$259.80**	**$280.80**	**$21.00**	**8.1%**
Research	107.67	47.54	130.12	130.12	-	-
Center for Integrated Space Weather Modeling	*4.00*	-	*3.32*	*2.66*	*-0.66*	*-19.9%*
Center for Multi-scale Modeling of Atmospheric Processes	*4.00*	-	*4.00*	*4.00*	-	-
Education	0.93	0.73	1.13	1.23	0.10	8.8%
Infrastructure	133.19	19.92	125.70	144.25	18.55	14.8%
National Astronomy and Ionosphere Center	-	-	*2.20*	*3.00*	*0.80*	*36.4%*
National Center for Atmospheric Research	*106.79*	*13.20*	*97.00*	*108.00*	*11.00*	*11.3%*

AGS supports activities to further our understanding of the physics, chemistry, and dynamics of the Earth's atmosphere, from the Earth's surface to the sun, on timescales ranging from minutes to millennia. AGS provides support for: 1) basic science projects and 2) the acquisition, maintenance, and operation of observational and cyberinfrastructure facilities and services that enable modern day atmospheric and geospace science research activities. Although the majority of AGS support is through traditional "individual investigator" merit-reviewed, multi-year grants, the division also supports small scale, limited-duration exploratory research projects; collaborative or multi-investigator group projects focusing on a particular project, subject, or activity; large center or center-like projects; and funding for the research conducted by NSF's National Center for Atmospheric Research (NCAR), which extends and enhances research at universities. More information on NCAR is available in the Facilities chapter. The division will increase support in key areas of fundamental atmospheric and geospace science including space weather, the genesis and dynamics of storms and severe weather, and biogeochemical cycling. In addition, the division will also strongly support research in NSF's Science, Engineering, and Education for Sustainability (SEES) investment.

Approximately 50 percent of the annual budget of AGS is used to support NCAR and other observational and computational facilities and 50 percent for individual, small group, and center-like research grants. Approximately 19 percent of the division's funding is available to support new research grants.

Factors Influencing the Allocation Across AGS Programs

- Maintaining healthy core disciplinary programs is AGS's highest priority.
- Taking advantage of special research opportunities such as NSF's Climate Research investment to promote rapid progress in the development of new understandings of the climate systems and using this understanding to model and predict previous and futures states of climate.
- Continuing to place a priority on workforce development through the support of CAREER and other young investigator awards as well as increasing the support of undergraduate, graduate and postgraduate scholars.
- Supporting the construction of the NCAR/Wyoming Supercomputer Center in FY 2011 at a level of $6.0 million.

- Funding NCAR to enhance scientific and engineering support for making high end computing available to more new university investigators and research teams.

DIVISION OF EARTH SCIENCES (EAR) $199,000,000 +$16,000,000 / 8.7%

EAR Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
EAR	**$171.01**	**$85.22**	**$183.00**	**$199.00**	**$16.00**	**8.7%**
Research	98.27	65.52	113.08	121.79	8.71	7.7%
Center for Earth Surface Dynamics	*3.60*	-	*3.32*	*2.66*	*-0.66*	*-19.9%*
Center for Sustainability of Semi-Arid Hydrology of Riparian Areas	*2.66*	-	-	-	-	*N/A*
Education	3.49	2.07	4.93	4.97	0.04	0.8%
Infrastructure	65.91	17.63	61.59	68.64	7.05	11.4%
Incorporated Research Institutions for Seismology	*12.00*	-	*12.36*	*12.73*	*0.37*	*3.0%*
EarthScope	*24.29*	*9.00*	*25.05*	*26.00*	*0.95*	*3.8%*

EAR supports fundamental research into the structure, composition, and evolution of the Earth, and the life it has sustained, over the four and a half billion years of Earth history. The results of this research will lead to a better understanding of Earth's changing environment (past, present, and future), the natural distribution of its mineral, water, biota, and energy resources, and provide methods for predicting and mitigating the effects of geologic hazards such as earthquakes, volcanic eruptions, floods, and landslides.

Through its Surface Earth Processes section, EAR supports research in geomorphology and land use, hydrologic science, geobiology and low temperature geochemistry, and sedimentary geology and paleobiology. The Division's Deep Earth Processes Section maintains programs in geophysics, tectonics, petrology and geochemistry, and continental dynamics. The newest program in EAR is EarthScope, a $200 million facility and science program focused on studying the structure and tectonics of the North American continent. In addition to these core programs, EAR has an Instrumentation and Facilities program that supports community-based, shared use facilities and the acquisition and development of instrumentation by individual investigators, and an education program that funds a number of activities to attract and support students and young investigators to the field of Earth science.

Approximately 62 percent of EAR's budget is used to support individuals and small groups of researchers while about 35 percent of the budget goes to instrumentation and facilities. The two largest facilities supported by EAR are EarthScope and IRIS, a community-based seismic instrumentation facility. In general, 20 percent of EAR's portfolio is available for new research grants. The remaining 80 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across EAR Programs

- Maintaining a healthy portfolio of core science programs and the critical facilities and instrumentation needed to support those programs;
- Participation in SEES through EAR's continued support of NSF's Climate Research investment (CRI), EAR's Critical Zone Observatory program, and supporting the NCAR-Wyoming Supercomputer Center construction at a level of $5.0 million;
- Expanding support for research into Earth's Dynamic Systems, especially for large, interdisciplinary projects that cannot be supported through EAR's core programs;

- Expanding support for EarthScope science, including collaboration with the Division of Ocean Sciences on ocean-land experiments along the margins of the North American continent (e.g. Cascadia);
- Supporting development of advanced geoinformatics, computational infrastructure, and models to facilitate the dissemination and utilization of data acquired by Earth scientists;
- Increasing support for REU, EAR post-doctoral fellowships, and CAREER awards to attract and retain a new and more diverse generation of students to pursue careers in Earth science.

INTEGRATIVE AND COLLABORATIVE EDUCATION AND RESEARCH (ICER) — $97,600,000 / -$320,000 / 0.3%

ICER Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
ICER	**$61.47**	**$79.58**	**$97.92**	**$97.60**	**-$0.32**	**-0.3%**
Research	38.95	38.93	41.65	64.14	22.49	54.0%
Education	19.55	31.17	26.97	28.71	1.74	6.5%
Infrastructure	2.24	-	27.60	2.60	-25.00	-90.6%
National Nanotechnology Infrastructure Network	*0.60*	-	*0.60*	*0.60*	-	-
Academic Research Fleet	*1.64*	-	*2.00*	*2.00*	-	-

ICER supports novel, complex, or partnership projects in both research and education. These investments cut across traditional boundaries within the geosciences, encouraging interdisciplinary activities and responding directly to critical needs of the entire geoscience community. ICER's principal goals are to develop innovative means to initiate and support geoscience education, attract underrepresented groups to careers in the geosciences, foster the interchange of scientific information nationally and internationally, and to join with other parts of NSF in major integrative research and education efforts. In FY 2011, the division will make strategic investments in climate research, high-risk/high-reward science, and education, diversity, and human resource development.

In general, 54 percent of the ICER portfolio is available for new research grants. The remaining 46 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across ICER Programs

Investments made through ICER typically cut across disciplines – both within GEO and across the Foundation. In FY 2011, the increase in ICER represents increased investment in climate modeling associated with NSF's SEES investment and increased support for the Graduate Research Fellowship program. In FY 2010, $25.0 million to support construction of the NCAR-Wyoming supercomputer center was included in ICER; support for the center is provided through AGS, EAR and OCE in FY 2011, freeing up funds for investment in climate change research as well as studies of other dynamic earth processes.

DIVISION OF OCEAN SCIENCES (OCE) $377,890,000 +$28,970,000 / 8.3%

OCE Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
OCE	**$330.51**	**$114.00**	**$348.92**	**$377.89**	**$28.97**	**8.3%**
Research	144.21	63.21	181.32	188.87	7.55	4.2%
Center for Coastal Margin Observation and Prediction	*4.00*	-	*4.00*	*4.00*	-	-
Education	7.84	2.00	8.37	9.77	1.40	16.7%
Infrastructure	172.76	48.79	152.90	172.11	19.21	12.6%
Academic Research Fleet	*87.31*	*18.00*	*78.00*	*75.00*	*-3.00*	*-3.8%*
Integrated Ocean Drilling Program	*47.95*	*25.00*	*43.40*	*46.41*	*3.01*	*6.9%*
Ocean Observatories Initiative	*17.84*	-	*16.50*	*27.50*	*11.00*	*66.7%*

Research, education, and infrastructure funded by OCE address the central role of the oceans in a changing Earth and as a national strategic resource, as recognized in the White House Council on Environmental Quality's *Interim Report to the President on A National Ocean Policy*. OCE supports interdisciplinary research of the water column to better understand changing ocean circulation and temperature, the health of marine ecosystems, and changing ocean chemistry with implications for ocean acidification. OCE also supports research on the geology of the ocean margins and sub-seafloor to investigate past ocean and climate conditions, stability of methane hydrates, natural hazards associated with earthquakes and volcanic eruptions, and microbial life deep below the seafloor. Ocean education, formal and informal, draws on the interdisciplinary nature of ocean sciences, sophisticated visualization capabilities and the impact of the oceans on environmental change. Since ocean science requires access to the sea, OCE supports research vessels, deep submergence capability including submersibles and autonomous vehicles, and technologically advanced sensors and instrumentation. In FY 2011, OCE will emphasize research on environmental sustainability, including marine biodiversity and the impact of increased atmospheric CO_2 on ocean acidification, construction of the NCAR Wyoming Supercomputer ($8.20 million in FY 2011) and ramping up operations and maintenance for the Ocean Observatories Initiative (OOI).

In general, 31 percent of the OCE portfolio is available for new research grants. The remaining 69 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across OCE Programs

- OCE gives high priority to participating in NSF's SEES program, including ocean acidification, addressing the role of the oceans in climate change, the integration of marine ecosystem models with climate change models, interactions between warming oceans and ice-sheets, and integrated social and natural science models of our coasts. Building the next generation computational capacity at the NCAR Wyoming supercomputer to advance such research is a new and high priority for OCE.
- Under ARRA, construction of OOI began in FY 2009, with a contract to lay a cable of the Pacific Northwest and development of prototype instrumentation for highly capable tethered moorings. In FY 2011, OOI operations and maintenance costs will ramp up to allow mooring infrastructure and instruments for post-construction use to be built in parallel with construction to maximize savings on later operations and maintenance (O&M) costs. First data flow from an OOI mooring is expected in FY 2013.

- Increased funds are requested for the Integrated Ocean Drilling Program, to allow enhanced investment in downhole instrumentation to study the deep, sub-seafloor biosphere, in partnership with a private foundation.
- Despite significant investments in new enabling technology and infrastructure, research support will also grow modestly. Emphases will include the Dynamic Earth and climate change, incorporating topics highlighted in the interim report of the National Ocean Policy Task Force, such as changing ocean-ice interactions, the impact of climate change on the oceans and vice-versa, the impact of ocean acidification, and dynamics of marine ecosystems.
- OCE will continue its partnership with the National Oceanographic and Atmospheric Administration (NOAA) on programs such as the Comparative Analysis of Marine Ecosystem Organization and with the National Institute of Environmental Health Sciences on Oceans and Human Health.
- In FY 2011, OCE will complete a full-scale assessment of the Academic Research Fleet. This assessment includes: a recently completed National Research Council (NRC) study on the fleet of the future sponsored by Office of Naval Research (ONR) and NSF; the impact of Navy decisions regarding ocean class ships on fleet size; and systematic inspections on each ship by OCE staff together with NSF contractors to determine the potential to extend ship life in science- and cost-effective ways. The apparent reduction in fleet support is related to the conclusion of planned funding for the replacement human occupied vehicle. Additional information on the academic research fleet is contained in the Facilities chapter.
- In FY 2011, OCE will receive the results of an NRC study evaluating the impact of scientific ocean drilling on the geosciences and assessing a new Science Plan, developed by the international community, for a possible new ocean drilling program post-FY 2013.
- Increasing ocean and earth system literacy for the general public, enhancing the diversity of the ocean sciences, and supporting the development of a technologically savvy work force remain a priority, as reflected in the increases requested for education activities.
- GEO will continue to invest in Ocean Research Priority Plan (ORPP) near-term activities in FY 2011 with the Comparative Analysis of Marine Ecosystem Organization (CAMEO) program and Atlantic Meridianal Overturning Circulation (AMOC) investments being comparable to FY 2010, up to $5.0 million and $4.0 million, respectively. Investment in sensors is expected to be approximately $3.0 million in FY 2011, up from zero in FY 2010. Support for the longer-term ORPP priority of Ocean Acidification will be up to $8.0 million in FY 2010 and FY 2011.

DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES (MPS)

$1,409,910,000
+$58,070,000 / 4.3%

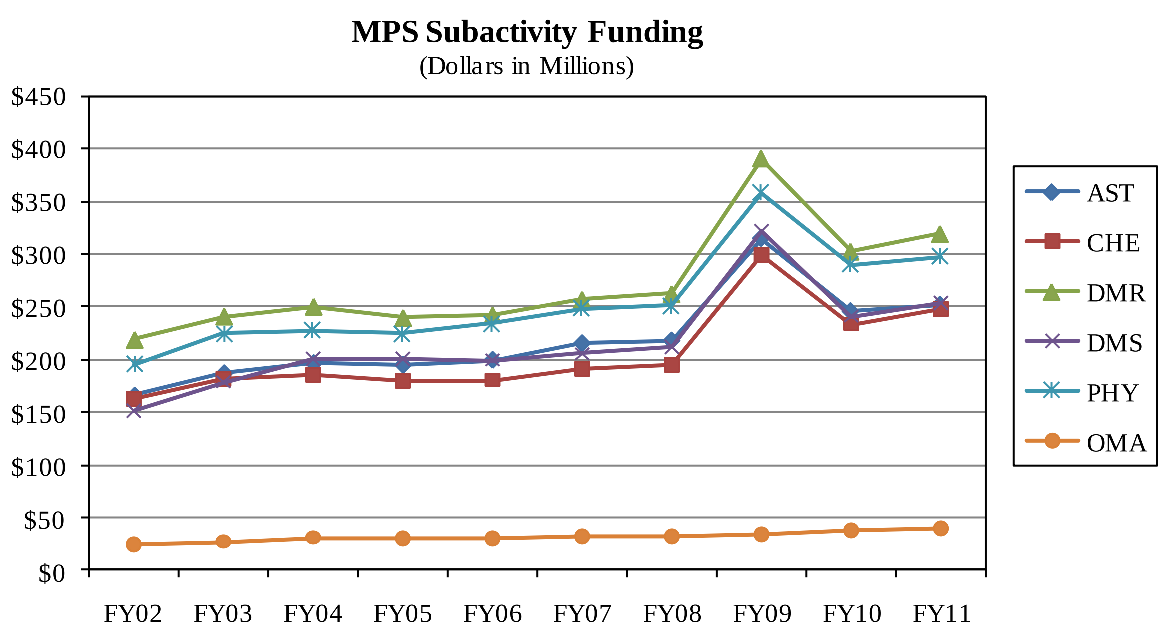
MPS Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Astronomical Sciences	$228.67	$85.80	$245.69	$251.77	$6.08	2.5%
Chemistry[1]	211.67	87.36	233.73	247.56	13.83	5.9%
Materials Research	282.52	108.17	302.67	319.37	16.70	5.5%
Mathematical Sciences	224.84	97.34	241.38	253.46	12.08	5.0%
Physics	262.47	96.30	290.04	298.19	8.15	2.8%
Office of Multidisciplinary Activities	33.70	-	38.33	39.56	1.23	3.2%
Total, MPS	**$1,243.88**	**$474.97**	**$1,351.84**	**$1,409.91**	**$58.07**	**4.3%**
Research	840.82	357.50	911.09	972.35	61.26	6.7%
Education	61.68	44.71	65.54	65.01	-0.53	-0.8%
Infrastructure[1]	322.58	72.76	353.73	349.10	-4.63	-1.3%
Stewardship	18.80	-	21.48	23.45	1.97	9.2%

Totals may not add due to rounding.

[1] $15.0 million of FY 2009 ARRA funding was carried over into FY 2010.

MPS supports a broad portfolio of investments in fundamental research, facilities, and instruments that enable discovery and development as well as in integrated education and research activities that contribute to the development of the science and engineering workforce. The portfolio includes MPS participation in NSF-wide and interagency research and education, and emphasizes discovery, innovation, and learning aligned with the overall goals of the Administration and NSF's mission and vision.



MPS in Context

MPS provides approximately 50 percent of the total federal support for basic research at academic institutions in the mathematical and physical sciences, ranging from about 35 percent in physics to over 60 percent in the mathematical sciences.

MPS-supported research in the physical and mathematical sciences provides the basis for advances in other engineering, technical, and health-related disciplines and for industrial and technological development. MPS researchers investigate the structure and evolution of the universe and the fundamental particles and processes of matter, the behavior and control of molecules at the nanoscale to the complexity of their chemical interactions in materials and life processes. Research in MPS fields has resulted in the development of new mathematical structures and theories and connections to computation, experimentation, and observation. MPS-supported research has contributed to the technological leadership of the United States.

MPS is the steward of numerous major research facilities (astronomical observatories, gravitational-wave and neutrino observatories, light sources, high magnetic field laboratories, nuclear physics laboratories), which together form an important component of the Nation's scientific research infrastructure. MPS strategically invests in the development of the next generation of facilities and is increasing its Centers programs while protecting funding for individual investigators and small group investigators. MPS emphasizes the entire pipeline of the science and technology workforce, supporting undergraduate and graduate students as well as postdoctoral fellows.

MPS also invests in research in sustainable energy, climate, nano-science, cyber-enabled discovery and innovation, and the interface of the physical sciences with the life sciences.

Factors Influencing the Allocation Across Divisions and Major Programs

- In FY 2011, maintaining a healthy core program is the top priority for MPS and is reflected in the requested increases for all divisions.
- Additional funding requested in FY 2011 for Science, Engineering and Education for Sustainability will be used to support research in existing programs in this area. SEES funding impacts the budgets in CHE, DMR, and DMS.
- Training a technically competent scientific workforce remains a high priority for NSF in FY 2011 and is reflected in the MPS funding levels requested for CAREER and the Graduate Research Fellowship (GRF) program. Increases for both programs are requested in all five divisions; the largest increases for CAREER are requested in CHE, DMR, and PHY, while the largest increases for GRF are in CHE and PHY.
- MPS requests funding for pre-construction planning for facilities; this planning is required in order to fully understand the resources needed for potential new Major Research Equipment and Facilities Construction (MREFC) projects. Funding for pre-construction planning is requested in FY 2011 for AST, DMR, and PHY.
- As scientific questions become more complex, some MPS divisions have found that the Centers model is an effective way to encourage interdisciplinary approaches; therefore, funding for two MPS Centers programs (Centers for Chemical Innovation in CHE and Materials Research Science and Engineering Centers in DMR) is increased in FY 2011.
- In partnership with the Directorate for Biological Sciences (BIO), MPS will invest $5.57 million to identify and support potentially transformative research projects that explore the intersection of the biological and physical sciences: Support is focused across CHE, DMS, DMR, and PHY.
- In FY 2011, MPS will meet its international agreements for facilities operations.

- Where able, MPS has increased FY 2011 operational budgets for facilities to maintain facilities operations at the FY 2010 level. Where increases were not possible, MPS has maintained facilities' operations budgets as close to constant as possible.

MPS Funding for Centers and Facilities

MPS Funding for Centers and Facilities
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Centers	**$107.48**	**-**	**$105.06**	**$107.98**	***$2.92***	**2.8%**
Nanocenters	*13.67*	-	*13.56*	*7.50*	*-6.06*	*-44.7%*
STC: Center for Adaptive Optics	*2.66*	-	-	-	-	*N/A*
STC: Center for Environ. Responsible Solvents & Processes	*2.66*	-	-	-	-	*N/A*
STC: Materials & Devices for Inform. Tech. Research	*4.00*	-	*3.32*	*2.66*	*-0.66*	*-19.9%*
STC: Center for Biophotonics Science & Eng.	*3.96*	-	*3.28*	*2.62*	*-0.66*	*-20.1%*
STC: NSF Center for Layered Polymeric Systems	*4.00*	-	*4.00*	*4.00*	-	-
Centers for Analysis & Synthesis	*0.20*	-	*0.20*	*0.20*	-	-
Centers for Chemical Innovation	*15.50*	-	*24.00*	*28.00*	*4.00*	*16.7%*
Materials Research Sci & Engr Ctrs	*60.84*	-	*56.70*	*63.00*	*6.30*	*11.1%*
Facilities	**$251.35**	**$45.58**	**$259.80**	**$269.07**	***$9.27***	**3.6%**
Adv. Tech. Solar Telescope (ATST)	*3.57*	*3.10*	*0.00*	*2.00*	*2.00*	*N/A*
Atacama Large Millimeter Array (ALMA)	*11.00*	-	*17.57*	*23.50*	*5.93*	*33.8%*
Cornell High Energy Synchr. Source\ Cornell Electron Storage Ring (CHESS\CESR)	*13.60*	*14.99*	*9.00*	*13.45*	*4.45*	*49.4%*
GEMINI Observatory	*18.71*	-	*19.10*	*19.58*	*0.48*	*2.5%*
IceCube Neutrino Observatory	*2.16*	-	*2.15*	*2.50*	*0.35*	*16.3%*
Large Hadron Collider (LHC)	*18.00*	-	*18.00*	*18.00*	-	-
Large Interfer. Grav. Wave Observatory (LIGO)	*30.30*	-	*28.50*	*30.30*	*1.80*	*6.3%*
Nat'l Astronomy and Ionosphere Ctr. (NAIC)	*9.60*	*3.10*	*8.40*	*6.00*	*-2.40*	*-28.6%*
Nat'l High Magnetic Field Laboratory (NHMFL)	*26.50*	*5.00*	*35.56*	*34.00*	*-1.56*	*-4.4%*
Nat'l Nanotechnology Infra. Network (NNIN)	*3.71*	-	*3.38*	*3.38*	-	-
Nat'l Optical Astronomy Observatory (NOAO)	*30.48*	*5.60*	*31.50*	*33.33*	*1.83*	*5.8%*
Nat'l Radio Astronomy Observatory (NRAO)	*49.79*	*5.40*	*49.52*	*44.37*	*-5.15*	*-10.4%*
National Solar Observatory (NSO)	*7.83*	*1.40*	*9.10*	*9.51*	*0.41*	*4.5%*
Nat'l Superconducting Cyclotron Lab (NSCL)	*20.50*	*2.00*	*21.00*	*21.50*	*0.50*	*2.4%*
Other MPS Facilities [1]	*5.60*	*4.99*	*7.02*	*7.65*	*0.63*	*9.0%*

[1] Other MPS Facilities: Synchrotron Radiation Center (SRC), Center for High Resolution Neutron Scattering (CHRNS), and ChemMatCARS.

Centers

MPS manages or co-funds more than forty different individual centers in five centers program areas. Major funding changes in FY 2011 include:

- *Nanocenters (-$6.06 million to a total of $7.50 million).* The Class of 2001 Nanocenters had their last year of funding in FY 2010; the investment of $7.50 million maintains the remaining centers as intended.

- *Science and Technology Centers (STCs) (-$1.32 million to a total of $9.28 million).* The Class of 2000 STCs (Center for Adaptive Optics and Center for Environmentally Responsible Solvents and Processes) sunsets in FY 2010. The Class of 2002 STCs (Materials and Devices for Information Technology Research and the Center for Biophotonics Science and Engineering) ramps down in FY 2011 as they receive their tenth and final year of funding; this results in a decrease of -$1.32 million to a total of $5.28 million. FY 2011 support for the Class of 2006 STCs (NSF Center for Layered Polymeric Systems) remains flat with the FY 2010 estimate of $4.0 million.
- *Centers for Chemical Innovation (CCI) (+$4.0 million, to a total of $28.0 million).* CCIs promote the integration of research and education through the extensive involvement of students and postdoctoral fellows in all phases of work, as well as partnerships with industry and National Laboratories. CCIs are expected to be agile, responding to opportunities as they arise, and to creatively engage the public. The request reflects the establishment of one additional Phase II Center (for a total of six) and four new Phase I Centers (for a total of twelve).
- *Materials Research and Engineering Centers (MRSEC) (+$6.30 million, to a total of $63.0 million).* MPS will run a MRSEC competition in FY 2011 with two distinct award categories: larger and smaller awards. The FY 2006 class will be able to recompete in the FY 2011 competition. It is anticipated that 25 MRSECs will be funded, including four to six new centers established as a result of the FY 2011 competition.

Detailed information on individual Centers can be found in the NSF-Wide Investments chapter.

Facilities

- As mentioned above, MPS has increased operational budgets for facilities to maintain facilities operations at the FY 2010 level. Where increases were not possible, MPS has maintained operational budgets as close to constant as possible.
- Although the budgets appear to increase for CHESS\CESR, ARRA funding in FY 2009 allowed MPS to forward-fund $4.27 million in FY 2010 operations for these facilities, resulting in a distorted lower FY 2010 funding level.
- Funding for ALMA increases by $5.93 million to a total operations budget of $23.50 million consistent with the planned ramp-up of operations. Base funding for the National Radio Astronomy Observatory drops $5.15 million to a total of $44.37 million due to the planned roll-off of construction funding for the Expanded Very Large Array. Funding for the National Astronomy and Ionosphere Center drops in line with recommendations of the 2006 Astronomy Senior Review, while funding for the Gemini Observatory, the National Optical Astronomy Observatory and the National Solar Observatory are held relatively constant.
- The $350,000 increase in FY 2011 for the IceCube Neutrino Observatory at the South Pole is part of the post-construction ramp-up in operations. MPS cofounds this observatory in partnership with the Office of Polar Programs.

For further detail about individual Facilities, please see the Facilities chapter.

MPS Administration Priority Programs and NSF Investments

MPS Administration Priority Programs and NSF Investments
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Faculty Early Career Development (CAREER)	$53.53	$49.23	$47.92	$50.68	$2.76	5.8%
Graduate Research Fellowships (GRF)	-	17.40	4.11	6.62	2.51	61.1%
Science, Engineering, and Education for Sustainability (SEES)	N/A	N/A	87.00	110.50	23.50	27.0%
Science and Engineering Beyond Moore's Law (SEBML)	36.53	9.82	18.68	32.18	13.50	72.3%

MPS's FY 2011 budget will significantly expand two key NSF programs that support students, early-career researchers, and the next generation of environmentally engaged scientists and engineers. The budget also encourages potentially transformative research and supports critical priorities in global climate change, sustainable energy research, and Science and Engineering Beyond Moore's Law.

- MPS will increase its investment in CAREER by $2.76 million in FY 2011 to a total of $50.68 million. The CAREER program remains the primary mechanism for jump-starting junior faculty toward independent careers in research and education, an Administration priority. All MPS divisions invest in CAREER.
- To promote the education and participation in the research enterprise of the next generation of mathematical and physical scientists, MPS is contributing to the NSF-wide Graduate Research Fellowship (GRF) program. This is part of an Administration priority to triple the number of new fellowships by FY 2013. MPS will continue its support of GRF with a total investment of $6.62 million in FY 2011, an increase of $2.51 million over the FY 2010 Estimate.
- MPS will increase its investment in Science, Engineering and Education for Sustainability (SEES) by $23.5 million to a total of $110.50 million in FY 2011. This increase will be used to support research in sustainable energy and related areas.
- MPS leads NSF's effort in Science and Engineering Beyond Moore's Law (SEBML), a multidisciplinary research investment with strong ties to economic competitiveness and potential for transformation. SEBML activities include research into new materials, devices, and processes that exploit the capability to create and manipulate specific quantum states and new algorithms that take advantage of hardware and architecture characteristics to deliver maximal total computing power, including those that use quantum interactions. MPS works with other directorates in appropriate SEBML research areas. For more detail on SEBML, see the NSF-wide Investments section.

For more information on Administration priority programs and NSF investments, please refer to the Overview and NSF-wide Investments sections.

Program Evaluation and Performance Improvement

In February of FY 2010, there will be Committee of Visitors (COV) reviews for the Divisions of Chemistry and Mathematical Sciences. COVs for the Divisions of Materials Research and Astronomical Sciences are planned for FY 2011. The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

MPS program evaluations assess program quality and impact, and the results of these evaluation activities are essential in the continued shaping of program directions and emphases. For example, MPS relied on performance information and external program evaluation in deciding to end the Grants for Vertical Integration of Research and Education (VIGRE) program. At NSF's request, the National Research Council of the National Academy of Sciences appointed a committee to conduct an assessment of VIGRE. Overall, the committee found that the goals of the VIGRE program are worthwhile and that VIGRE is an appropriate way to foster these goals. The committee recommended the continuation of VIGRE; however, the committee believed VIGRE should continue only if eight further recommendations are implemented, including allowing international students and postdoctoral fellows to receive financial support through VIGRE projects. This recommendation was particularly problematic as international students cannot be funded on such training grants. Internal review of the VIGRE program's performance information revealed that the two most recent competitions yielded a very small number of proposals, a sign that the program had reached its final stage. Thus, while the overall external evaluation recommended continuation of the program, the low proposal pressure and the fact that the additional recommendations would make the program unsustainable led to the decision to terminate the VIGRE program.

The full external evaluation report may be found at: nap.edu/catalog.php?record_id=12716.

Number of People Involved in MPS Activities

	FY 2009 Omnibus Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	7,078	1,544	7,639	7,801
Other Professionals	2,171	376	2,363	2,393
Postdoctorates	2,124	558	2,297	2,341
Graduate Students	7,472	3,757	8,042	8,235
Undergraduate Students	5,553	1,642	5,986	6,120
K-12 Students	501	-	538	552
K-12 Teachers	146	-	157	161
Total Number of People	**25,045**	**7,877**	**27,022**	**27,603**

MPS Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Statistics for Competitive Awards:			
Number of Proposals	7,887	8,500	8,700
Number of New Awards	3,128	2,150	2,200
Regular Appropriation	2,006	2,150	2,200
ARRA	1,122	-	-
Funding Rate	39.7%	25.3%	25.3%
Statistics for Research Grants:			
Number of Research Grant Proposals	6,754	7,200	7,400
Number of Research Grants	2,445	1,600	1,650
Regular Appropriation	1,501	1,600	1,650
ARRA	944	-	-
Funding Rate	36.2%	22.2%	22.3%
Median Annualized Award Size	113,207	115,000	117,000
Average Annualized Award Size	138,302	140,000	142,000
Average Award Duration, in years	3.1	3.1	3.1

DIVISION OF ASTRONOMICAL SCIENCES (AST) $251,770,000 +$6,080,000 / 2.5%

AST Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
AST	**$228.67**	**$85.80**	**$245.69**	**$251.77**	**$6.08**	**2.5%**
Research	61.86	54.81	70.26	71.02	0.76	1.1%
STC: Center for Adaptive Optics	*2.66*	-	-	-	-	*N/A*
Education	6.27	5.12	7.09	6.63	-0.46	-6.5%
Infrastructure	157.30	25.86	164.42	169.88	5.46	3.3%
Gemini Observatory	*18.71*	-	*19.10*	*19.58*	*0.48*	*2.5%*
Atacama Large Millimeter Array (ALMA)	*11.00*	-	*17.57*	*23.50*	*5.93*	*33.8%*
Nat'l Astronomy & Ionosphere Ctr (NAIC)	*9.60*	*3.10*	*8.40*	*6.00*	*-2.40*	*-28.6%*
Nat'l Optical Astronomy Observ. (NOAO)	*30.48*	*5.60*	*31.50*	*33.33*	*1.83*	*5.8%*
Nat'l Radio Astronomy Observ. (NRAO)	*49.79*	*5.40*	*49.52*	*44.37*	*-5.15*	*-10.4%*
National Solar Observatory (NSO)	*7.83*	*1.40*	*9.10*	*9.51*	*0.41*	*4.5%*

AST is the federal steward for ground-based astronomy in the U.S., working in partnership with private institutions to enhance overall observing capacity and capability. Research support covers observational, theoretical, computational, and laboratory work to understand the origins and characteristics of planets, the Sun, other stars, our galaxy, extragalactic objects, and the structure and origin of the Universe through awards to individual investigators, small groups, and national facilities. AST supports the development of advanced technologies and instrumentation, the planning and design of future facilities, and management of the electromagnetic spectrum for scientific use. AST provides U.S. funding for operation and maintenance (O&M) of the international Gemini Observatory and the international Atacama Large Millimeter/submillimeter Array (ALMA). AST also supports O&M for the national facilities: NAIC, NOAO, NRAO, and NSO. These major world-class facilities provide access to a wide range of observational resources on a competitive basis and serve thousands of users each year. Funding is also provided to various private facilities with varied arrangements for community access, as part of the ground-based public-private U.S. astronomy system.

In general, about 12 percent of the AST portfolio is available for new research grants. The remaining 88 percent funds continuing grants made in previous years, including facility support at about 54 percent of the division’s budget.

Factors Influencing the Allocation Across AST Programs

- Funding for ALMA increases consistent with the planned ramp-up of operations.
- Funding for NAIC, the Arecibo radio telescope, decreases as recommended by the Senior Review of AST-supported facilities and programs. A new cooperative agreement with sufficient funding to preserve a viable base facility is expected to be issued as a result of a solicitation in 2010;
- NSO is now presented separately from NOAO; new, separate, cooperative agreements will be executed in FY 2010;

- The reduction in base funding for NRAO is a planned roll-off of construction funding for the Expanded Very Large Array; and
- Planning continues for a wide array of potential future facilities, coming out of the latest Astronomy and Astrophysics Decadal Survey report by the National Research Council, expected in early FY 2011.

DIVISION OF CHEMISTRY (CHE) $247,560,000 +$13,830,000 / 5.9%

CHE Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual[1]	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
CHE	**$211.67**	**$87.36**	**$233.73**	**$247.56**	**$13.83**	**5.9%**
Research	182.86	63.18	202.25	218.55	16.30	8.1%
STC: Center for Environmentally Responsible Solvents and Processes	*2.66*	-	-	-	-	*N/A*
Centers for Chemical Innovation	*15.50*	-	*24.00*	*28.00*	*4.00*	*16.7%*
Nano Science & Eng Centers	*2.85*	-	*2.85*	*1.55*	*-1.30*	*-45.6%*
Education	10.23	9.45	12.30	12.47	0.17	1.4%
Infrastructure	15.27	14.73	15.40	12.40	-3.00	-19.5%
Nat'l High Magn. Field Lab. (NHMFL)	*1.50*	-	*4.06*	*1.50*	*-2.56*	*-63.1%*
Nat'l Nanofabrication Infra. Network (NNIN)	*0.40*	-	*0.40*	*0.40*	-	-

[1] $15.0 million of FY 2009 ARRA funding was carried over into FY 2010.

The Division of Chemistry (CHE) supports a large and vibrant research community engaged in fundamental research linked to key national priorities. Basic research in chemistry underpins improving climate models, understanding the environmental health and safety of nanoparticles, developing catalysts that enable sustainability and energy research, and the molecular basis of the life sciences. CHE has recently realigned its programs incorporating input from its stakeholders and partners. The new disciplinary research programs include Chemical Structure; Dynamics and Mechanisms; Chemical Synthesis; Chemical Measurement and Imaging; Theory, Models and Computational Methods; Environmental Chemical Sciences; Chemistry of Life Processes, Chemical Catalysis and Macromolecular, Supramolecular and Nanochemistry. These new programs are poised to collaborate with other agencies and other divisions of NSF.

In general, 38 percent of the CHE portfolio is available for new research grants. The remaining 62 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across CHE Programs

- The major driver for the increase in Research (+$16.30 million) is the positive response of the chemistry research community to programmatic realignment within the Chemistry Division. Also, a recategorization of CHE’s instrument development program shifted $3.0 million from Infrastructure into Research. Under its new structure, CHE expects an increase in interdisciplinary proposals that advance fundamental chemical sciences and education, capitalize on FY 2009 ARRA investments, and impact national priorities.
- Within the Research portfolio, CHE has significant investments planned for key priority areas, including Science, Engineering and Education for Sustainability (SEES)/Energy and Climate Research ($50.50 million), Science and Engineering Beyond Moore’s Law ($9.68 million), and Environmental Sciences ($25.15 million);

- The request also supports the Centers for Chemical Innovation program, which inspires research on strategic, transformative “big questions” in basic chemical research. CHE will invest an additional \$4.0 million for a total of \$28.0 million. The request reflects the establishment of one additional Phase II Center (for a total of six) and four new Phase I Centers (for a total of twelve). One Nano Center is phasing out in FY 2011 for a decrease of \$1.30 million;
- The Discovery Corps Fellowship Program will merge with the American Competitiveness in Chemistry Fellowship Program, which provides consistent bridges to the top ranked young talent in chemistry as they progress to the professoriate. CHE will increase its contribution to the Graduate Research Fellowship Program from \$1.59 million to \$2.56 million. The Undergraduate Research Collaborative program will phase out in FY 2011 resulting in a decrease of \$1.0 million; and
- Within infrastructure, the CHE Request includes increased investments (+\$3.0 million) in a multi-user instrumentation acquisition program and other research resources. The FY 2010 Estimate for the National High Magnetic Field Laboratory (NHMFL) includes a one-time award of \$2.56 million for development of a magnet. In FY 2011, base funding for NHMFL is maintained at \$1.50 million.

DIVISION OF MATERIALS RESEARCH (DMR) $319,370,000 +$16,700,000 / 5.5%

DMR Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
DMR	**$282.52**	**$108.17**	**$302.67**	**$319.37**	**$16.70**	**5.5%**
Research	221.61	75.46	220.78	230.87	10.09	4.6%
Materials Research Sci. & Engr. Ctrs.	*60.84*	-	*56.70*	*63.00*	*6.30*	*11.1%*
Nanoscale Sci. & Engr. Centers	*8.04*	-	*8.31*	*4.81*	*-3.50*	*-42.1%*
STC: Materials and Devices for Inform. Technology Research	*4.00*	-	*3.32*	*2.66*	*-0.66*	*-19.9%*
STC: NSF Center for Layered Polymeric Systems	*4.00*	-	*4.00*	*4.00*	-	-
Education	10.22	3.82	9.48	10.05	0.57	*6.0%*
Infrastructure	47.24	28.89	67.93	73.82	5.89	8.7%
Nat'l High Magn. Field Lab. (NHMFL)	*25.00*	*5.00*	*31.50*	*32.50*	*1.00*	*3.2%*
Cornell High Ener. Synchr. Source (CHESS)/ Cornell Electron Storage Ring (CESR)	*4.10*	*13.70*	*9.00*	*13.45*	*4.45*	*49.4%*
Nat'l Nanofabrication Infra. Network (NNIN)	*2.98*	-	*2.65*	*2.98*	*0.33*	*12.5%*
Other MPS Facilities [1]	*5.60*	*4.99*	*7.02*	*7.65*	*0.63*	*9.0%*

[1] Other MPS Facilities: SRC, CHRNS, ChemMatCARS

Awards from DMR cover a wide spectrum of materials research and education ranging from condensed matter and materials physics, solid-state and materials chemistry, multifunctional, hybrid, electronic, photonic, metallic, superconducting, ceramic, polymeric, biomaterials, composites, and nanostructures. These awards enable the DMR community to make new discoveries about the fundamental behavior of matter and materials from the biological and molecular realm to metallic nanostructures. The community creates new materials and new knowledge about materials, such as their optoelectronic, structural, and thermoelectric properties. Materials phenomena are also studied, including carrier charge transport and superconductivity. Awards enable researchers to address questions about materials that often transcend traditional scientific and engineering disciplines and lead to new technologies. Preparing the next generation of materials researchers, developing and supporting the instruments and facilities that are transforming the field, and sharing the excitement and significance of materials research with students (K-12 and beyond) and the public are also important aspects of the Division's mission.

In general, 21 percent of the DMR portfolio is available for new research grants. The remaining 79 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across DMR Programs

- Increases in the Research portfolio (+$10.09 million) emphasize materials research relevant to Science and Engineering Beyond Moore's Law (SEBML), Cyber-Enabled Discovery and Innovation (CDI), and Science, Engineering, and Education for Sustainability (SEES)/Energy Research;
- Centers include the Materials Research Science and Engineering Centers (MRSEC) competition, which will be run in FY 2011 (allowing the FY 2006 class to recompete) with a new format involving larger and smaller awards. Center decreases include the phase-out of a "sunsetting" Science and

Technology Center (STC) at the University of Washington and the closing of five Nanoscale Science and Engineering Centers (NSEC) as they complete their 10-year life cycle;

- The Education portfolio emphasizes a continued strong commitment to Research Experiences for Undergraduates (REU) as well as the Integrative Graduate Education and Research Traineeship (IGERT) program, both level with FY 2010. The Graduate Research Fellowship (GRF) program is increased 62 percent (+$310,000) over FY 2010 and the ADVANCE program is increased 23.9 percent (+260,000) over FY 2010; and
- Facilities include a $4.45 million increase for the operation of the Cornell High Energy Synchrotron Source/Cornell Electron Storage Ring (CHESS/CESR) as it converts from a high energy physics facility to a photon science facility, where research utilizing X-ray synchrotron radiation is conducted. This CHESS/CESR facility serves also as a platform for coherent light source research and development. FY 2011 provides phase-out support for the Synchrotron Radiation Center (SRC) as well as increased support for upgrades and operational costs of the National High Magnetic Field Laboratory (NHMFL), the Center for High Resolution Neutron Scattering (CHRNS) at NIST, and ChemMatCARS at the Advanced Photon Source. Funding ($4.24 million) is requested in FY 2011 for research and development of a potential future energy recovery linac project. This project is co-funded by the MPS Office of Multidisciplinary Activities (OMA) at $3.0 million for a total investment of $7.24 million.

DIVISION OF MATHEMATICAL SCIENCES (DMS) **$253,460,000** **+$12,080,000 / 5.0%**

DMS Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
DMS	**$224.84**	**$97.34**	**$241.38**	**$253.46**	**$12.08**	**5.0%**
Research	194.82	75.11	209.52	223.17	13.65	6.5%
Centers for Analysis and Synthesis	*0.10*	-	*0.10*	*0.10*	-	-
Education	25.56	22.23	27.15	25.05	-2.10	-7.7%

NSF plays a critical role in the mathematical sciences, as it provides more than 60 percent of all federal support for basic research in the Nation's colleges and universities. In certain core areas of the mathematical sciences this percentage is even higher, since NSF supports a broader range of fundamental and multidisciplinary research topics than do other federal agencies.

DMS supports research at the frontiers of fundamental, applied and computational mathematics and statistics and enables discovery in other fields of science and engineering. In turn, advances in science and engineering – especially those generating large data sets or that are driven by powerful computing environments – require development of ever more sophisticated mathematical tools. DMS plays a key role in training the Nation's scientific and engineering workforce.

DMS supports core research programs in algebra & number theory; analysis; applied mathematics; computational mathematics; geometry & topology; mathematical biology; probability, combinatorics & foundations; and statistics. In addition, DMS supports national mathematical sciences research institutes; postdoctoral, graduate and undergraduate training opportunities; and infrastructure, such as workshops, conferences, and equipment.

In general, 60 percent of the DMS portfolio is available for new research grants. The remaining 40 percent is used primarily to fund continuing grants made in previous years.

In FY 2009, DMS received 2,306 research proposals and made 844 awards using the FY 2009 appropriation and ARRA funds for a funding rate of 37 percent.

Factors Influencing the Allocation Across DMS Programs

- *Core Research Programs (+$13.55 million to a total of $219.74 million).* Maintaining adequate support for investigator initiated research in the mathematical sciences is the division's top priority. DMS continues support for Mathematical Sciences Research Institutes in FY 2011.
- *Climate and Energy Research (+$2.50 million to a total of $9.50 million).* As part of the Science, Engineering, and Education for Sustainability (SEES) portfolio, DMS will support development of potentially transformative mathematical, statistical, and computational methods needed for analysis and simulation of climate models and will increase its investment in the CHE-DMR-DMS Solar Energy Initiative (SOLAR), a program supporting multi-disciplinary teams engaged in research on the efficient harvesting, conversion, and storage of solar energy.
- *Science and Engineering Beyond Moore's Law (SEBML) (+$1.20 million to a total of $3.95 million).* In parallel with Moore's Law for hardware, SEBML continues the algorithmic "Moore's Law", i.e.,

the exponential increase in speed of basic computations due to innovative new algorithms, and develops new mathematical frameworks for computation.

- *MPS-Life Sciences Interface (+$2.39 million to a total of $2.39 million).* This interdisciplinary activity supports potentially transformative research in mathematical and computational biology.
- *Consolidation of Workforce and Infrastructure Portfolios (Net reprogramming of $3.54 million).* DMS will terminate the following programs: Vertical Integration in Research and Education (VIGRE), Proactive Recruitment in Introductory Science and Mathematics (PRISM), Scientific Computing Research Environments in the Mathematical Sciences (SCREMS), Interdisciplinary Grants in the Mathematical Sciences (IGMS), University-Industry Cooperative Research Programs in the Mathematical Sciences, and Computational Science Training for Undergraduates in the Mathematical Sciences (CSUMS). The Division will re-invest savings of this consolidation in higher priority workforce and infrastructure programs.

DIVISION OF PHYSICS (PHY) $298,190,000
+$8,150,000 / 2.8%

PHY Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
PHY	**$262.47**	**$96.30**	**$290.04**	**$298.19**	**$8.15**	**2.8%**
Research	156.11	88.93	173.79	193.54	19.75	11.4%
STC: Center for Biophotonics Science & Eng.	*3.96*	-	*3.28*	*2.62*	*-0.66*	*-20.1%*
Nanoscale Sci. Eng. Centers	*2.40*	-	*2.40*	*1.14*	*-1.26*	*-52.5%*
Education	6.91	4.08	9.42	10.61	1.19	12.6%
Infrastructure	95.47	3.29	102.65	89.30	-13.35	-13.0%
Cornell High Ener. Synchr. Source (CHESS)/ Cornell Electron Storage Ring (CESR)	*8.50*	*1.29*	-	-	-	*N/A*
Large Hadron Collider	*18.00*	-	*18.00*	*18.00*	-	-
Large Interfer. Grav. Wave Observatory (LIGO)	*30.30*	-	*28.50*	*30.30*	*1.80*	*6.3%*
Nat'l Superconducting Cyclotron Lab (NSCL)	*20.50*	*2.00*	*21.00*	*21.50*	*0.50*	*2.4%*
Ice Cube	*2.16*	-	*2.15*	*2.50*	*0.35*	*16.3%*

PHY supports fundamental research addressing frontier areas of physics that lead to the understanding of the make-up of the Universe, from the formation of stars and galaxies to the principles of life processes on earth. This research is spread across a range of physics subfields: atomic, molecular, optical and plasma physics, elementary particle physics, gravitational physics, nuclear physics, particle and nuclear astrophysics, physics of living systems, physics at the information frontier, and theoretical physics. PHY is the primary supporter of all U.S. research in gravitational physics and the leading supporter of fundamental research in atomic, molecular, and optical physics in the U.S. PHY is a partner with the Department of Energy (DOE) in support of elementary particle physics, nuclear physics, and plasma physics. PHY also has the only U.S. program designed for the support of physics research in living systems. The development of the most advanced cutting-edge computational resources, innovative technology, and new instrumentation is a key part of physics research, and tools developed by the physics community continuously have major impact in other scientific and engineering fields.

In general, 14 percent of the PHY portfolio is available for new research grants. The remaining 86 percent is used primarily to fund continuing grants made in previous years (48 percent) and to support operations and maintenance for four facilities that are a key part of the division portfolio (25 percent): LIGO, LHC, NSCL, and IceCube.

Factors Influencing the Allocation Across PHY Programs

- An increase of $19.75 million to a total of $193.54 million for Research will enable increased support of projects at the discovery frontiers of physics. Special emphasis will be given to:
  - Increases in those programs that support quantum information science as part of Science and Engineering Beyond Moore's Law (+$3.0 million to a total of $6.0 million);
  - Physics research on living systems (+$2.40 million to a total of $9.90 million);

  - Support for increasing the number of junior investigators through CAREER awards (+$1.40 million to a total of $7.0 million); and
  - Center decreases include the phase-out of a "sunsetting" Science and Technology Center (STC), the Center for Biophotonics Science and Engineering (-$660,000), and the closing of one Nano Center (-$1.26 million) as they complete their 10-year life cycle.

- Funding for Infrastructure decreases by $13.35 million to a total of $89.30 million. Changes include:
  - An increase of $1.80 million in funding for the LIGO facility to a total of $30.30 million reflects a change in the operations and maintenance profile to coordinate with the construction profile for the Advanced LIGO project. (See the Major Research Equipment and Facilities Construction (MREFC) chapter for more details on Advanced LIGO);
  - An increase of $500,000 for NSCL to a total of $21.50 million maintains the funding level at the planned funding profile;
  - An increase of $350,000 for IceCube to a total of $2.50 million as part of the post-construction ramp-up in operations; and
  - A total of $12.0 million is requested for pre-construction planning and related research and development for the Deep Underground Science and Engineering Laboratory (DUSEL), reflecting the planned conclusion of preliminary design activities in FY 2011. Funding for these activities was provided in FY 2009 and FY 2010. The MPS Office of Multidisciplinary Activities provides an additional $700,000, for total FY 2011 of $12.70 million. The next step in the planning phase will be an interagency review of NSF and DOE's roles and responsibilities for this proposed joint project. A key resource for this interagency review will be input from the ongoing study of DUSEL by the National Research Council.

Detailed narratives on each facility can be found in the Facilities chapter.

OFFICE OF MULTIDISCIPLINARY ACTIVITIES (OMA) $39,560,000
+$1,230,000 / 3.2%

OMA Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
OMA	**$33.70**	**-**	**$38.33**	**$39.56**	**$1.23**	**3.2%**
Research	23.55	-	34.49	35.20	0.71	2.1%
Center for Analysis & Synthesis	*0.10*	-	*0.10*	*0.10*	-	-
Education	2.48	-	0.10	0.20	0.10	100.0%
Infrastructure	7.30	-	3.33	3.70	0.37	11.1%
NNIN	*0.33*	-	*0.33*	-	*-0.33*	*-100.0%*
Cornell High Ener. Synchr. Source (CHESS)/ Cornell Electron Storage Ring (CESR)	*1.00*	-	-	-	-	*N/A*

OMA enables and facilitates MPS support of novel, challenging, or complex projects of varying scale, in both research and education, which are not readily accommodated by traditional organizational structures and procedures. This is done primarily in partnership with MPS disciplinary divisions and is especially directed at activities by multi-investigator, multidisciplinary teams.

Factors Influencing the Allocation Across OMA

- In FY 2011, OMA will focus on multidisciplinary research addressing the fundamental science critical to advancing computing and communications technologies beyond Moore's Law; multidisciplinary research into controlling, manipulating, and exploring the behavior of quantum matter and the limitations of quantum information processing; multidisciplinary research emphasizing the mathematical and physical scientific foundations of energy sustainability, climate, and the environment; multidisciplinary research at the interface between the mathematical and physical sciences and the life sciences to provide insight into the molecular basis of life processes; and team efforts aimed at developing next-generation instrumentation to enable fundamental advances across a wide spectrum of disciplines.
- OMA will continue to support the National Institute for Mathematical and Biological Synthesis, a Center for Analysis and Synthesis primarily managed by the Directorate for Biological Sciences, at the level of $100,000 in FY 2011.
- OMA will begin co-funding of research and development for a potential future energy recovery linac project in FY 2011 at $3.0 million.
- OMA support for the National Nanofabrication Infrastructure Network will end in FY 2010 resulting in a $330,000 decrease in FY 2011. This decrease is offset by an increase in the Division of Materials Research.
- OMA investment in pre-construction planning for the Deep Underground Science and Engineering Laboratory (DUSEL) is ramping down by $2.30 million for a total of $700,000 with the conclusion of preliminary design activities.

SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES (SBE) $268,790,000 +$13,540,000 / 5.3%

SBE Funding
(Dollars in Millions)

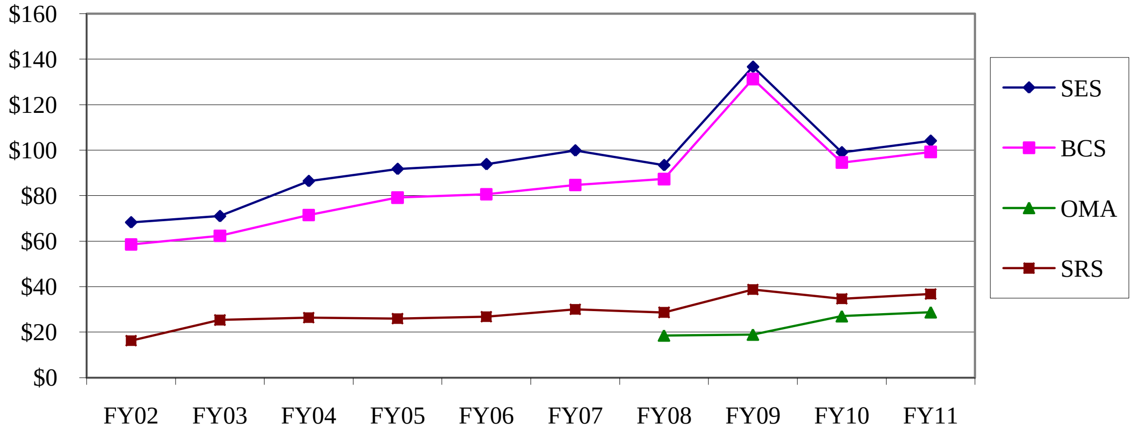
	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Behavioral and Cognitive Sciences (BCS)	$88.12	$43.16	$94.58	$99.21	$4.63	4.9%
Social and Economic Sciences (SES)	94.82	41.10	99.05	104.12	5.07	5.1%
Science Resource Statistics (SRS)	38.71	-	34.62	36.72	2.10	6.1%
Office of Multidisciplinary Activities (OMA)	18.91	0.71	27.00	28.74	1.74	6.4%
Total, SBE	**$240.56**	**$84.97**	**$255.25**	**$268.79**	**$13.54**	**5.3%**
Research	175.89	77.78	194.02	201.00	6.98	3.6%
Education	13.65	7.19	12.20	15.67	3.47	28.4%
Infrastructure	46.65	-	43.56	46.36	2.80	6.4%
Stewardship	4.38	-	5.47	5.76	0.29	5.3%

Totals may not add due to rounding.

SBE supports fundamental research and related activities addressing the dynamics of cognition and behavior, as well as of social, political, and economic interactions that yield new knowledge of human cognition, social and economic organization, and patterns of development and change. In recent decades, SBE research has resulted in new understandings of human development and social dynamics; of perception, memory, linguistic, learning, and reasoning processes; of how people behave as individuals and as members of groups and organizations; and of key social institutions and indicators of their health. SBE participates in inter-directorate, interagency, and international research and education activities, and encourages and supports many forms of transformative research. Policy makers at all levels of government have drawn on the results of SBE-supported research for decision-making and risk management. SBE supported research is beginning to provide a better understanding of the innovation process.

The SBE portfolio also includes major surveys that provide broad-based infrastructure for the research community, while providing policy makers with needed information. The Division of Science Resources Statistics (SRS) is the designated federal statistical entity with responsibility for the S&E enterprise writ large, and its data collections and analyses are important for evaluating overall U.S. competitiveness in science and engineering.

SBE Subactivity Funding
(Dollars in Millions)



SBE in Context

SBE provides about 58 percent of federal funding for basic research at academic institutions in the SBE sciences. In some fields, including archaeology, political science, linguistics, non-medical anthropology and sociology, SBE is the predominant or exclusive source of federal basic research support. SBE also provides predominant federal support for the social aspects of psychology.

Over the past decade, three key elements have allowed research in the SBE sciences to undergo dramatic changes: (1) new technologies, analytical techniques, and cyber capabilities; (2) new approaches to shared infrastructure; and (3) partnerships for exploring dynamics in human and social systems.

For example, functional Magnetic Resonance Imaging (fMRI) techniques have enabled behavioral scientists to link behavior to brain activity, opening new channels for investigation. Likewise, the integration of genomic analysis and Geospatial Information Systems (GIS) into existing and novel analyses has led to new insights on human origins. New analytical techniques and enhanced cyber capabilities have combined for pervasive transformative impact across the human sciences, creating new approaches to shared infrastructure, making survey information and databases more broadly accessible and enabling links across datasets collected for different purposes. This new infrastructure encourages the analysis of human behavior at a finer resolution and allows complex human systems to be explored across a broad spectrum of research areas.

SBE researchers are now exploring the processes and implications of constantly changing systems, with partners across NSF who share an interest in the way human and social behavior interacts with natural and built systems, influences learning, and mediates the interaction between basic research results and marketable technologies. This has led to collaborative enterprises with other directorates focusing on the human dimensions of many aspects of science and engineering as well as STEM learning and education.

This confluence of drivers positions SBE well to contribute toward meeting major national challenges. SBE will continue as an active partner in government-wide activities such as the U.S. Global Change Research Program (USGCRP), the National Nanotechnology Initiative (NNI), and the Networking and Information Technology Research and Development (NITRD) program, and will continue to support the Administration's programmatic priorities relating to homeland security. In addition, SBE's Science of Science and Innovation Policy program (SciSIP) contributes to government-wide efforts to assess tangible and intangible returns from investments in research and development, creating better understanding of the likely returns from future investments. NSF-wide investment portfolios, such as Science, Engineering, and Education for Sustainability (SEES) and Cyberlearning Transforming Education (CTE) provide a good context for SBE's contributions to interdisciplinary and interagency activities.

SBE's Science Resources Statistics (SRS) Division conducts, analyzes, and disseminates survey results relating to science and engineering (S&E). SRS activities, products, and services provide critical information on research and development (R&D), the S&E workforce, the international S&E enterprise, the role of U.S. S&E in a globalized economy, and the outputs of the S&E enterprise such as patents and scientific publications. In addition to the biennial publications *Science and Engineering Indicators* and *Women, Minorities and Persons with Disabilities in Science and Engineering*, SRS provides access to a variety of data on S&E through its website (www.nsf.gov/statistics) and online databases.

The FY 2011 Request for SBE includes $5.0 million to leverage activities across the directorate aimed at increasing support for transformative research. Examples of foci for these investments include research on complex human and social systems and potentially transformative infrastructure. Large-scale interdisciplinary projects may also provide the arena for potentially transformative contributions.

Factors Influencing the Allocation Across Divisions and Major Programs

- Maintaining a healthy research base, with particular attention to the support of potentially transformative research, is the top priority for SBE. Ensuring optimal use of program resources to address this priority will lead to some realignment of standing programs and other significant research activities within SBE divisions.
- Enhancing the capabilities for research and education of current and future scholars in the SBE scientific workforce remains a priority. This is reflected in the increases requested for CAREER and GRF.
- SBE's participation in the NSF-wide SEES portfolio investment integrates activities across components of climate, energy, and the environment by supporting research in the human and social dimensions of sustainability. Additional funding for climate and energy research will enable SBE scientists to develop, evaluate, and refine new approaches to the mitigation of and adaptation to climate change, while advancing their fields through exploration of the complex, interacting social, economic, natural, and technological systems of sustainability. Specific areas for research include:
    - social and cultural influences on human perception of value and risk;
    - the influence of perceptions on decision-making under uncertainty;
    - the interplay of individual and collective decisions and actions;
    - changing land use and migration patterns;
    - the life cycles and governance of socio-technological systems, particularly energy-based technologies;
    - the role of social networks in influencing behavior; and
    - the social and political trade-offs of taking costly actions today for uncertain benefits in the future.
  - SBE researchers will continue to enhance capabilities for analysis in the areas of complex human and social systems, transforming data to information, and understanding virtual organizations and their role in SBE sciences.
  - Setting the stage for a new generation of potentially transformative infrastructure across SBE will require an investment for FY 2011 at the intersection of potentially transformative ideas and the feasibility of infrastructure to inform future directions.

- SBE will further the directorate's investment in a variety of activities aimed at learning systems, ranging from partnership with MPS and ENG in exploring how the physical system of the brain enables function to participation in the NSF-wide CTE investment.
- Key changes in SRS include starting development of an entirely new module on innovation for the Business R&D and Innovation Survey; development of a Microbusiness R&D and Innovation Survey; beginning full-scale implementation of a postdoc survey; a new sample frame for the National Survey of College Graduates; and a initiating a transition from current online data delivery systems to an alternative that provides users with access to data through improved, more flexible interfaces.
- The SciSIP program will create a specific focus aimed at research that can influence the development of decision support tools for those in policy positions affecting science and innovation (+$500,000 to a total of $14.25 million, funded through OMA and SRS).

SBE Funding for Centers and Facilities

SBE Funding for Centers and Facilities

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Centers	**$12.55**	**$0.73**	**$19.90**	**$19.90**	**-**	**-**
Science of Learning Centers (SLC)	*10.51*	-	*19.10*	*19.10*	-	-
Long Term Ecological Res. (LTER)	*0.92*	*0.73*	*0.20*	*0.20*	-	-
Nano Centers	*1.12*	-	*0.60*	*0.60*	-	-
Facilities	**$0.40**	**-**	**$0.40**	**$0.40**	**-**	**-**
National Nanotechnology Infrastructure Network (NNIN)	*0.40*	-	*0.40*	*0.40*	-	-

Detailed information on individual Centers can be found in the NSF-Wide Investments chapter. For further detail about individual facilities, please see the Facilities chapter.

<u>Centers</u>

- Funding for the Science of Learning Centers (SLCs) will continue at $19.10 million, providing continued funding for the six current SLCs. There is matching co-funding from disciplinary partners in BIO, CISE, and ENG in the amount of $6.70 million for a total of $25.80 million.
- Funding for the Long Term Ecological Research (LTER) program will continue at $200,000.
- Funding for the Centers for Nanotechnology in Society (NSEC) will continue at $600,000.

<u>Facilities</u>

- Funding for the National Nanoscale Infrastructure Network (NNIN) will continue at $400,000.

SBE Administration Priority Programs and NSF Investments

SBE Administration Priority Programs and NSF Investments
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Faculty Early Career Development (CAREER)	$5.63	$13.86	$5.16	$5.53	$0.37	7.2%
Graduate Research Fellowships (GRF)	0.36	4.19	-	4.57	4.57	N/A
Science, Engineering, and Education for Sustainability (SEES)	N/A	N/A	20.78	27.98	7.20	34.6%
Cyberlearning Transforming Education (CTE)	N/A	N/A	-	1.20	1.20	N/A

SBE's FY 2011 budget will significantly expand two key NSF programs that support students and early-career researchers. SBE will also make significant research investments in the SEES and CTE activities.

Specific SBE investments include:

- Support for CAREER awards (+$370,000 to a total of $5.53 million) in social and behavioral sciences, across all disciplines, for jump-starting junior faculty toward independent careers in research and education;
- New funding totaling $4.57 million for graduate research fellowships in FY 2011;
- In FY 2011, SBE will invest $27.98 million (+$7.20 million) in the NSF-wide Science, Engineering, and Education for Sustainability (SEES) portfolio to integrate efforts in climate and energy science and engineering. SBE research will bring in the human and social dimensions of sustainability.
- Investment of new funding totaling $1.20 million for Cyberlearning Transforming Education (CTE) in FY 2011.

For more information on Administration priority programs and NSF investments, please refer to the Overview and NSF-wide Investments sections.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

In FY 2011, SBE is scheduled to hold two Advisory Committee (AC) meetings. The SBEAC includes liaison members to other NSF Advisory Committees, and there is regular attention to how SBE's programs and performance link with those of NSF's broader investment portfolios in areas such as climate and environment, cyberinfrastructure, and broadening participation. In addition, a Committee of Visitors (COV) meeting is scheduled for the Office of Multidisciplinary Activities (OMA).

Number of People Involved in SBE Activities

	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	3,387	1,113	3,478	3,600
Other Professionals	409	147	441	450
Postdoctorates	251	66	259	270
Graduate Students	2,346	882	2,462	2,600
Undergraduate Students	2,459	431	1,330	1,380
Total Number of People	**8,852**	**2,639**	**7,970**	**8,300**

SBE Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Statistics for Competitive Awards:			
Number of Proposals	4,525	5,000	5,200
Number of New Awards	1,337	1,187	1,230
Regular Appropriation	1,056	1,187	1,230
ARRA	281	-	-
Funding Rate	30%	24%	24%
Statistics for Research Grants:			
Number of Research Grant Proposals	3,221	3,600	3,800
Number of Research Grants	794	720	745
Regular Appropriation	535	720	745
ARRA	259	-	-
Funding Rate	25%	20%	20%
Median Annualized Award Size	$100,557	$104,086	$106,000
Average Annualized Award Size	$113,647	$121,873	$124,000
Average Award Duration, in years	2.6	3.0	3.0

DIVISION OF BEHAVIORAL AND COGNITIVE SCIENCES (BCS) $99,210,000
+$4,630,000 / 4.9%

BCS Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
BCS	**$88.12**	**$43.16**	**$94.58**	**$99.21**	**$4.63**	**4.9%**
Research	81.65	41.07	88.09	90.75	2.66	3.0%
Science of Learning Centers	*4.00*	-	*6.20*	*6.20*	-	-
Nano Centers	*0.18*	-	*0.18*	*0.18*	-	-
LTER	*0.92*	*0.73*	*0.20*	*0.20*	-	-
Education	4.51	2.09	3.91	5.74	1.83	46.8%

BCS supports research and related activities that advance fundamental understanding in the behavioral, cognitive, anthropological, and geographic sciences. Strong core programs are complemented by active involvement in competitions that support collaborative and cross-disciplinary projects. The division seeks to advance scientific knowledge and methods focusing on human cognition and behavior including perception, thought processes, language, learning, and social behavior across neural, individual, family, and group levels. The division also supports activities focusing on human variation at the scales of society, culture, and biology, and how these variations and related patterns develop and change across time and space. The division aims to increase basic understanding of geographic distributions and relationships as well as the capabilities to explore them, with an emphasis on interactions among human and natural systems on the Earth's surface. BCS research is helping us prepare for and mitigate the effects of natural and human-initiated disasters, predict and address how people respond to stressors, improve methods for effective learning, enhance the quality of social interaction, and respond to issues such as globalization, terrorism, and climate change.

In general, 70 percent of the BCS portfolio is available for new research grants. The remaining 30 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across BCS Programs

- $1.68 million will enable the division to maintain healthy core programs while operating in an interdisciplinary context. In addition, these funds will facilitate the highest quality and most innovative investigator-originated projects. Particular attention will be focused on projects with the potential to transform scientific paradigms. Ensuring optimal use of program resources to address this priority will lead to some realignment of standing programs and other significant research activities within BCS.
- $2.46 million will allow additional support for enhancing research and educational capabilities of current and future scholars in the psychological, anthropological and geographic sciences by expanding support for CAREER and GRF awards.
- $490,000 will provide additional support for research that advances fundamental knowledge about the complex ways that people interact with climate and other natural systems including larger-scale, longer term research that bridges the human sciences with the natural sciences and engineering, and research that focuses on cultural, social and psychological factors that affect perceptions, attitudes, decision making and other forms of human behavior, particularly those associated with environmental sustainability.

- Support for research and methodological development on learning and adaptive systems includes interdisciplinary research across the appropriate directorates.
- Continue support for behavioral and cognitive research that informs our understanding of critical issues facing the Nation. Topics include the motivation of terrorists, communication regarding emergent phenomena such as pandemics, and behavioral components of energy use and conservation.
- Communicate the benefits and utility of behavioral and cognitive scientific research for addressing critical issues, such as terrorism, climate change, and sustainability, to policy-makers, decision-makers and the public.
- Determine future shared infrastructural needs that enable research and education within and beyond the psychological, anthropological, and geographic sciences including shared databases, observational centers and other innovative facilities and resources, as recommended by the recent BCS Committee of Visitors.

DIVISION OF SOCIAL AND ECONOMIC SCIENCES (SES) $104,120,000 +$5,070,000 / 5.1%

SES Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
SES	**$94.82**	**$41.10**	**$99.05**	**$104.12**	**$5.07**	**5.1%**
Research	78.98	36.00	82.69	85.17	2.48	3.0%
Nano Centers	*0.94*	-	*0.42*	*0.42*	-	-
Education	5.58	5.10	4.72	6.56	1.84	39.0%
Infrastructure	8.46	-	9.34	9.94	0.60	6.4%
NNIN	*0.40*	-	*0.40*	*0.40*	-	-

SES supports research and related activities, conducted within the U.S. and globally, that improve systematic understanding of economic, political, and social institutions and how individuals and organizations behave within them. SES also supports research and related activities associated with risk assessment and decision-making by individuals and groups; the nature and development of science and technology and their impact on society; methods and statistics applicable across the social, economic, and behavioral sciences; scholarly career development; and broadening participation in the social, behavioral, and economic sciences. Its discipline-based programs include sociology, economics, and political science, while interdisciplinary programs support fields such as decision-making and risk, law and social science, and science and technology studies. In many of its programs, SES is the major, if not only, source of federal funding for fundamental research, making important investments in the data resources and methodological advances that produce transformative research.

SES supports research and education through grants that range in size from small supplements for undergraduate collaboration with faculty on research projects and awards to doctoral students for support of dissertation research expenses to multi-million dollar survey awards such as the American National Elections Studies (ANES), the Panel Study of Income Dynamics (PSID), and the General Social Survey (GSS). These surveys, and others supported in SES, are national resources for research, teaching, and decision-making that have become models for similar undertakings in other societies.

With an investment totaling $1.67 million in FY 2011, SES also coordinates the Ethics Education in S&E Program, supporting (with other NSF directorates) the Online Ethics Center for Engineering and Science, and manages the Centers for Nanotechnology in Society. SES is also a participant in a number of Nanoscale Science and Engineering Centers and the National Nanoscale Infrastructure Network. In addition, SES plays a major role in managing the Decision Making Under Uncertainty collaborative projects.

In general, 65 percent of the total SES portfolio is available for new research grants. The remaining 35 percent is used primarily to fund continuing grants made in previous years.

Factors Influencing the Allocation Across SES Programs

- $2.09 million will provide additional support to maintain healthy core programs while operating in an interdisciplinary context. SES will strengthen fundamental research that has the potential to address complexity research and large-scale interdisciplinary research. SES will give particular emphasis to research that has transformative potential for the social and economic sciences. Ensuring optimal use of program resources to address this priority will lead to some realignment of standing programs and other significant research activities within SES.

- $2.48 million will provide additional support for encouraging a technically competent scientific workforce, which remains a priority and is reflected in the increases requested for CAREER and Graduate Research Fellowship.
  - $800,000 will increase support for major infrastructure projects – the ANES, the GSS, and the PSID – while exploring new types of infrastructure for the future. These projects are important national resources that generate requisite data for innovative research on a broad range of highly important political, social, and economic topics relevant to emerging national and global challenges.
  - SES will maintain its support for research on fundamental questions associated with climate, environmental change, and levels and patterns of energy consumption as part of the SEES portfolio. SES can make important contributions to understanding key questions related to energy consumption, the adoption of new and alternative forms of energy, and the implications this has for climate change and national security. Since these important questions involve complex social, political, and economic systems, it is important to bring to bear the full breadth of SES research.
  - SES will partner with CISE in exploring the emerging interface between computer science and economics, including algorithmic game theory, automated mechanism design, computational tractability of basic economic problems, and the role of information, trust, and reputation in markets.

DIVISION OF SCIENCE RESOURCES STATISTICS (SRS) $36,720,000
+$2,100,000 / 6.1%

SRS Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
SRS	**$38.71**	**-**	**$34.62**	**$36.72**	**$2.10**	**6.1%**
Education	0.10	-	0.10	-	-0.10	-100.0%
Infrastructure	38.18	-	34.22	36.42	2.20	6.4%

The legislative mandate for SRS, as stated in the National Science Foundation Act of 1950, as amended, is "…to provide a central clearinghouse for the collection, interpretation, and analysis of data on scientific and engineering resources and to provide a source of information for policy formulation by other agencies of the Federal Government…."

To meet this mandate, SRS, in its role as the federal statistical agency with responsibility to cover the S&E enterprise, provides policymakers, researchers, and other decision makers with high quality data and analysis on R&D, innovation, the education of scientists and engineers and the S&E workforce for making informed decisions. The work of SRS involves survey development, methodological and quality improvement efforts, data collection, analysis, information compilation, dissemination, web access and customer service to meet the statistical and analytical needs of a diverse user community, as well as preparation of the congressionally mandated biennial reports — *Science and Engineering Indicators (SEI)* and *Women, Minorities and Persons with Disabilities in Science and Engineering (WMPD)*. The data collected by SRS serve as important tools for researchers in SBE's Science of Science and Innovation Policy (SciSIP) program and as the major component of the content of *SEI.*

The funding portfolio for SRS includes ongoing, cyclical surveys; reports and other products; and projects accomplished primarily through contracts and also a few standard grants.

Factors Influencing the Allocation Across SRS Programs

NSF investment will increase by $2.10 million to a total of $36.72 million in FY 2011.

- $900,000 will expand activities to develop improved data on innovation activities. The new Business R&D and Innovation Survey (BRDIS) will be in its third fielding cycle in FY 2011. SRS will direct resources from the survey development phase to the development of an innovation module planned for the BRDIS 2011. In conjunction with the SciSIP program, SRS will update user needs requirements for business sector innovation data and explore how best to collect the necessary data.
  In FY 2011, SRS will begin full scale implementation of a data collection system on those in postdoctorate appointments in the academic sector, collecting basic socio-economic and demographic data, work characteristics data, country of Ph.D., and source of financial support by specific government agency. The resulting data will provide significantly improved estimates of foreign postdocs with non-U.S. PhDs and will provide comprehensive aggregate statistics for postdocs in the academic sector.
- In FY 2011, SRS will invest $1.0 million to initiate a transition from its current online data systems to an alternative that provides users with access to its data through improved and more flexible interfaces. With this change, SRS would move from multiple, incompatible custom-built data access systems to a commercial off- the-shelf single system.

- As part of its SciSIP role, $200,000 will provide support for an improved data set on innovation activities in the U.S.; SRS is developing a Microbusiness R&D and Innovation Survey for firms with less than five employees. SRS and the Statistics of Income Division of the Internal Revenue Service (IRS) have in place a Memorandum of Understanding to facilitate the collection. Data collection is expected to begin in late 2011.
- The SESTAT suite of surveys, which includes the National Survey of College Graduates (NSCG), National Survey of Recent College Graduates (NSRCG), and Survey of Doctorate Recipients (SDR), will be fielded in 2010 with a new sample design for the NSCG based on data collected on the American Community Survey (ACS). Once the NSCG sample redesign is fully operational (at least two cycles), the role of the NSRCG needs to be re-evaluated. In FY 2011, SRS will begin multi-year activities to assess the future role and scope of the NSRCG.

OFFICE OF MULTIDISCIPLINARY ACTIVITIES (OMA) $28,740,000 +$1,740,000 / 6.4%

OMA Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
OMA	**$18.91**	**$0.71**	**$27.00**	**$28.74**	**$1.74**	**6.4%**
Research	15.26	-	23.24	25.08	1.84	7.9%
Science of Learning Centers (SLC)	*6.50*	-	*12.90*	*12.90*	-	-
Education	3.45	-	3.47	3.37	-0.10	-2.9%

OMA provides a focal point for programmatic activities that cut across SBE disciplinary boundaries, including the agency-wide Science of Learning Centers (SLCs). OMA also funds Science of Science and Innovation Policy (SciSIP), $8.05 million; Research Experiences for Undergraduates (REU) Sites programs, $2.37 million; and Minority Postdoctoral Research Fellowships (MPRF), $1.0 million. Co-funding with other divisions in SBE and with divisions in other directorates is typical for OMA, as is participation in interagency activities. While all SBE divisions are expected to pursue an appropriate range of interdisciplinary work, OMA assists with seeding multidisciplinary activities for the future. All areas of SBE sciences are represented in the OMA portfolio.

In general, 50 percent of the OMA portfolio is available for new research grants. The remaining 50 percent funds continuing grants made in previous years, including all funding for SLCs.

The SLC program is the largest in OMA; it moved from Integrative Activities to SBE in FY 2010. OMA houses management of the six current SLCs, with matching co-funding from disciplinary partners in BIO, CISE, ENG, and SBE/BCS. SBE transferred programmatic responsibility for SciSIP, REU sites, and MPRF, previously shared by BCS and SES, to OMA in FY 2010, as well as providing additional funds for seeding transformative multidisciplinary research.

Factors Influencing the Allocation Across OMA Programs

- SBE provides multidisciplinary oversight for the SLC program, which ensures that all Centers are managed appropriately toward their goals and objectives, and develops appropriate mechanisms to share outcomes.
- Increases in funding for research and education grants and infrastructure are primarily for SciSIP and for seeding cross-directorate partnerships in research and education, including activities in the CTE and SEES portfolios.

OFFICE OF CYBERINFRASTRUCTURE (OCI) $228,070,000

+$13,790,000 / 6.4%

OCI Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Software	$11.96	$41.34	$12.50	$28.77	$16.27	130.2%
Data	11.28	-	12.27	22.04	9.77	79.6%
Other Disciplinary and Interdisciplinary Research	6.44	19.16	23.78	22.31	-1.47	-6.2%
Education	1.35	2.50	10.77	11.21	0.44	4.1%
High Performance Computing	153.93	17.00	113.00	110.30	-2.70	-2.4%
Other Networking and Computational Programs	10.24	-	37.38	28.36	-9.02	-24.1%
Stewardship	4.03	-	4.58	5.08	0.50	10.9%
Total, OCI	**$199.23**	**$80.00**	**$214.28**	**$228.07**	**$13.79**	**6.4%**
Research	29.68	60.50	48.55	73.12	24.57	50.6%
Education	1.35	2.50	10.77	11.21	0.44	4.1%
Infrastructure	164.17	17.00	150.38	138.66	-11.72	-7.8%
Stewardship	4.03	-	4.58	5.08	0.50	10.9%

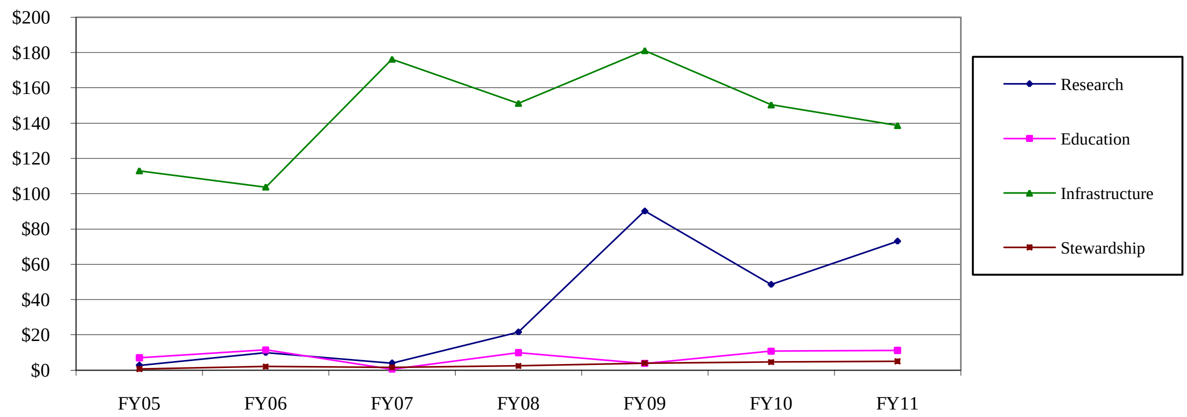
Totals may not add due to rounding.

OCI supports research, development, acquisition, and operation of advanced shared and connecting cyberinfrastructure (CI) that enables otherwise unrealizable advances in 21st century science and engineering research and education. It increasingly supports the use of advanced CI to address frontier science problems through the growing discipline of computational science and engineering, as well as the computational scientists who develop and use it. OCI capitalizes on a broad range of fundamental scientific and engineering research and education to create and expand the next generation of CI. CI is used in converting data to knowledge, understanding complexity through simulation and prediction, and creating more systematic knowledge about the social and technical issues of large-scale, multidisciplinary collaborative communities, known as virtual organizations, needed to address complex problems and grand challenges facing science and society.

OCI-supported CI includes the comprehensive set of deployable hardware, software, and algorithmic tools that support research, education, and collaboration across and among all research disciplines, whether they are experimental, theoretical, and/or computational. CI consists of computing systems, data storage systems, data repositories, advanced instruments, visualization environments, people, and the necessary intellectual capital, all linked together by software and advanced networks to sustain and improve scholarly productivity and enable breakthroughs in complex problem solving. OCI supports socio-technical research on the use of CI and on ways of improving its effectiveness. It supports training in the development and use of advanced CI as well as research on its use to enhance learning. OCI also supports the scientific and engineering professionals who create and maintain these leading-edge resources and systems, and who provide the Nation's researchers and educators with essential CI services. OCI makes investments that improve CI for science and engineering research, funding the deployment of current CI and innovative developments in future CI. In doing so, it both leverages and complements investments made by other federal agencies. For example, some of NSF's high-end computing investments take advantage of expertise at laboratories funded by the Department of Energy (DOE) and hardware and software developments funded by the Department of Defense's Defense Advanced Research Projects Agency (DARPA). In addition, OCI investments in petascale applications and tools complement those of DOE's Scientific Discovery through Advanced Computing (SciDAC) program, and

OCI's TeraGrid infrastructure is used by researchers funded by the National Institutes of Health (NIH), DOE, and other agencies.

OCI Funding
(Dollars in Millions)



OCI in Context

Science is increasingly data-, compute- and collaboration-driven, requiring access to a diverse set of data, computational resources, storage resources, remote instruments, and services to support their integration and use. Beyond the world-class computational capabilities that already exist, future large-scale and data intensive systems require investment in hardware acquisition, software development and support, and workforce development. Each of these areas requires long term commitments in CI that provide the stability necessary for application support and the incentives for innovation for new capabilities because each area requires multiple years of development in order to achieve the level of performance and maturity useful for science and engineering. Their integration with each other, with discipline specific CI activities, remote instruments, and campus environments supports next generation science activities such as data, visualization, networking, and virtual organizations.

OCI supports the development and deployment of CI that is shared by all scientific and engineering disciplines, making possible potentially transformative basic research in areas such as nanotechnology, physics, chemistry, materials science, sustainable energy, climate/weather, and engineering. It also promotes interoperability between components of CI here in the U.S. and abroad. Approximately two-thirds of NSF's investments in CI are made by the directorates and offices responsible for fundamental domain specific research and education in science and engineering, with the remaining one-third provided by OCI. Through coordinated planning and investments facilitated by NSF's Cyberinfrastructure Council, OCI works to support integrated applications and teams that use advanced CI to solve complex multidisciplinary science and engineering problems, providing economies of scale and scope to ensure that NSF's CI portfolio delivers the highest returns on the Nation's investment.

OCI's investments are guided by NSF's *Cyberinfrastructure Vision for 21st Century Discovery* (www.nsf.gov/dir/index.jsp?org=OCI), a comprehensive CI strategic plan for the Foundation; by many blue-ribbon panel and advisory reports, such as the 2005 President's Information Technology Advisory Committee (PITAC) report (www.nitrd.gov/Pitac/reports/20050609_computational/computational.pdf); by the America COMPETES Act of 2007; and by the opportunities identified by the academic and industrial research community through workshops and white-papers. The America COMPETES Act calls for the Foundation to conduct long-term basic and applied research on high-performance computing and networking. OCI's investments are central to advancing that goal.

OCI activities are key components in the federal government's Networking and Information Technology Research and Development (NITRD) program. The technologies developed and the systems deployed by OCI facilitate discovery and innovation and bolster national competitiveness. PITAC specifically recommended in 2005 that federal agencies reorganize to more effectively support multidisciplinary computational science, which it called the "third pillar" of science and engineering of the 21st century. OCI was created in 2005, and is now specifically taking on a role as steward of computational science activities in coordination with directorates and offices across the Foundation.

Factors Influencing the Allocation Across Major Programs

Research and Education Grants

- The FY 2008 OCI Committee of Visitors (COV) recommended that OCI *"...address needs in other program areas such as networking, data, virtual organizations, learning, and workforce development. Failure to address this imbalance imperils the overall program. OCI has established itself as program with core research strengths, and is developing a workforce to address the challenges faced by the nation*." In response to the COV report, OCI continues to place increased emphasis on data, virtual organizations, learning, and workforce development.
- In FY 2011 OCI will fund data seed grants and other data activities with the goal of addressing challenges in data that have been highlighted in recent reports such as: NSB report 05-40, "Long-Lived Digital Data Collections Enabling Research and Education in the 21st Century," PCAST: "Leadership Under Challenge: Information Technology R&D in a Competitive World," and "Harnessing the Power of Digital Data for Science and Society," report of the Interagency Working Group on Digital Data to the National Science and Technology Council, January 2009.
- Software must be continually refined to reflect, at one end, new advances in the discipline, and at the other end, to adapt and exploit advances in computing hardware. The NSF *Cyberinfrastructure Vision for 21st Century Discovery* outlined the importance of supporting the continued development, expansion, hardening, and maintenance of end-to-end software systems in order to bring the full power of a national cyberinfrastructure to communities of scientists and engineers. An NSF workshop report on *Planning for Cyberinfrastructure Software* recommended that NSF establish new programs to support multidisciplinary projects of substantial size and duration, so as to engage major scientific communities in the application and adoption of CI software within the context of CI goals. A new Software Institutes program, being initiated in FY 2011, will collectively support a vibrant community of partnerships among academia, government laboratories, and industry for the development and stewardship of sustainable software to establish U.S. leadership in the global knowledge economy. This activity will support open science academic communities while the DoE Office of Science (SC) Scientific Discovery through Advanced Computing (SciDAC) Institutes focus primarily on the national laboratories: (see www.scidac.gov/institutes.html).
- In FY 2011 OCI will invest in Cyberinfrastructure Training, Education, Advancement, and Mentoring for Our 21st Century Workforce (CI-TEAM). This program will position the national science and engineering community to engage in integrated research and education activities promoting, leveraging, and utilizing cyberinfrastructure systems, tools, and services. It will prepare current and future generations of scientists, engineers, and educators to design and develop as well as adopt and deploy cyber-based tools and environments for research and learning, both formal and informal. It will expand and enhance the participation in cyberinfrastructure science and engineering activities of diverse groups of people and organizations, with particular emphasis on the inclusion of traditionally underrepresented individuals, institutions (especially minority serving institutions), and communities as both creators and users of cyberinfrastructure.

Networking and Computational Resources and Infrastructure

- To move beyond the current incarnation of cyberinfrastructure requires a new vision for cyberinfrastructure that is significantly more comprehensive and highly integrated so that multiple science communities can more easily work together to address complex problems, enabling collaborative data- and compute-intensive science.
- OCI will increase support for the Innovative High Performance Computing (HPC) program from \$10.0 million in FY 2010 to \$30.0 million in FY 2011. These awards will include high-risk/high-payoff approaches to HPC systems capable of meeting the growing demands of the open science and engineering communities.
- In FY 2011, funding is also included for eXtreme Digital (XD) – the successor to TeraGrid. Additional information on XD is provided later in this chapter.

The FY 2011 Request for OCI includes \$2.0 million to leverage activities aimed at increasing support for transformative research. Examples of potential foci for these investments include the Strategic Technologies for Cyberinfrastructure (STCI) program and EArly-concept Grants for Exploratory Research (EAGER). The primary purpose of the STCI program is to support work leading to the development and/or demonstration of innovative cyberinfrastructure services for science and engineering research and education that fill gaps left by more targeted funding opportunities. In addition, STCI considers highly innovative cyberinfrastructure education, outreach, and training proposals that lie outside the scope of targeted solicitations. The EAGER mechanism supports high-risk, exploratory, and potentially transformative research.

OCI Administration Priority Programs and NSF Investments

OCI Administration Priority Programs and NSF Investments
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Faculty Early Career Development (CAREER)	-	\$4.00	\$3.71	\$3.97	\$0.26	7.0%
Graduate Research Fellowships (GRF)	-	2.00	1.00	1.00	-	-
Science, Engineering, and Education for Sustainability (SEES)	N/A	N/A	5.50	5.00	-0.50	-9.1%
Science and Engineering Beyond Moore's Law (SEBML)	-	-	3.00	3.00	-	-

OCI’s FY 2011 budget will fund two key NSF programs that support students and early-career researchers. The budget also encourages potentially transformative research and supports critical priorities in global climate change.

Specific OCI investments include:

- The CAREER program remains the primary mechanism for jump-starting junior faculty toward independent careers in research and education. The program has been very successful in supporting traditional areas of science but less so in computational science. In order to address this, OCI will support CAREER awards in computational science across all disciplines. These will support outstanding young faculty who prototype and develop the next generation of cyberinfrastructure and/or apply it to advance their basic science disciplines.

- In response to the Administration's plan to triple the number of NSF's new Graduate Research Fellowship awards by FY 2013, OCI is contributing to NSF's commitment to encourage more highly talented students to pursue graduate education in science and engineering. GRF is widely recognized as a unique fellowship program because it supports the development of world-class scientists and engineers across all science and engineering fields supported by NSF as well as international research activity.

- In FY 2011, OCI will invest $5.0 million in the NSF-wide Science, Engineering, and Education for Sustainability (SEES) portfolio to integrate efforts in climate and energy science and engineering. OCI investments will increase capacity for peer-to-peer collaboration and new modes of education based upon broad and open access to leadership computing; data and information resources; online instruments and observatories; and visualization and collaboration services.

- In conjunction with NSF's other research directorates and offices, OCI will participate in Science and Engineering Beyond Moore's Law (SEBML). SEBML activities include research into new materials, devices, and processes that exploit the capability to create and manipulate specific quantum states and new algorithms that take advantage of hardware and architecture characteristics to deliver maximal total computing power, including those that utilize quantum interactions. Related to both nanotechnology and cyberinfrastructure, it builds on past NSF investments in these areas and energizes them with new directions and challenges.

For more information on Administration priority programs and NSF Investments, please refer to the Overview and NSF-wide Investments sections.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

The most recent OCI Committee of Visitors met in FY 2008. The COV focused on two specific areas in the context of OCI's four focus areas of High Performance Computing, Data, Virtual Organizations, and Learning and Workforce Development: (1) assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and (2) comments on how the outputs and outcomes generated by awardees have contributed to the attainment of NSF's mission and strategic outcome goals. The COV made a number of recommendations that OCI is currently addressing.

The Office of Cyberinfrastructure is working with NSF's Advisory Committee for Cyberinfrastructure (ACCI) to gather input from the researchers and educators who use computing and the technologists who develop high-performance computing on future requirements and opportunities for the national CI. The NSF-wide ACCI has established 6 Task Forces and has asked them to address long-term cyberinfrastructure issues. The Task Forces are:

- Campus Bridging;
- Data;
- Grand Challenges;
- High Performance Computing;
- Software and Tools; and
- Work Force Development.

These Task Forces are composed of NSF program officers from each of the NSF research directorates and offices as well as a set of distinguished members from the external science and engineering community. The Task Forces are beginning to explore, discuss, and generate a set of recommendations and ideas.

Number of People Involved in OCI Activities

	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	395	425	455	425
Other Professionals	233	165	205	210
Postdoctorates	19	77	50	55
Graduate Students	111	384	200	210
Undergraduate Students	104	46	75	80
Total Number of People	**862**	**1,097**	**985**	**980**

OCI Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Statistics for Competitive Awards:			
Number of Proposals	337	510	535
Number of New Awards	192	103	107
Regular Appropriation	97	103	107
ARRA	95	-	-
Funding Rate	57%	20%	20%
Statistics for Research Grants:			
Number of Research Grant Proposals	307	490	515
Number of Research Grants	165	97	103
Regular Appropriation	72	97	103
ARRA	93	-	-
Funding Rate	54%	20%	20%
Median Annualized Award Size	$199,743	$225,000	$230,000
Average Annualized Award Size	$568,144	$395,550	$400,000
Average Award Duration, in years	2.7	2.4	2.5

Office of Cyberinfrastructure High Performance Computing Portfolio

OCI High Performance Computing Funding
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request
TeraGrid[1]	N/A	$102.93	$30.98	-	-	-
Track 1	20.00	13.65	64.73	-	90.00	48.50
Track 2	75.03	14.19	55.00	-	10.00	6.80
Innovative HPC Program	N/A	N/A	N/A	N/A	10.00	30.00
TeraGrid - Phase III (XD)	-	-	3.22	17.00	3.00	25.00
Total	**$95.03**	**$130.77**	**$153.93**	**$17.00**	**$113.00**	**$110.30**

Totals may not add due to rounding.

[1] Transition from TeraGrid to eXtreme Digital (XD) in FY 2010 - refer to section on XD for more information.

Track 1 – Blue Waters

Description:
The National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign will provide the capability for researchers to tackle much larger and more complex research challenges than previously possible, across a wide spectrum of domains. NCSA will acquire, deploy, and operate a petascale sustainable, architecturally coherent, innovative, leadership-class, high-performance computational resource, to be known as Blue Waters, for the science and engineering research community. The DoE SC leadership hardware peaks at petascale, while Blue Waters will provide sustained petascale performance. Also, while the DoE microprocessors are commodity processors, the microprocessors in Blue Waters were altered to address the specific needs of the HPC community. This system will be sited at University of Illinois at Urbana-Champaign (UIUC) where it will be operated by NCSA and its partners in the Great Lakes Consortium for Petascale Computing (GLC).

The Blue Waters project also includes education and outreach programs that will target pre-college, undergraduate, graduate, and post-graduate levels. A Virtual School of Computational Science and Engineering will be established to create courses that focus on petascale computing and petascale-enabled science and engineering. The Virtual School will explore new instructional technologies and create courses, curricula, and certificate programs tailored to science and engineering students. It will also sponsor workshops, conferences, summer schools, and seminars.

The project will include an annual series of workshops targeted at the developers of simulation packages and aspiring application developers. In addition, the project will include two industrial partnership activities: The Industry Partners in Petascale Engagement (IPIPE) program will provide industrial partners with a first look at the technological and scientific developments that flow from the petascale program. The Independent Software Vendor Application Scalability Forum will promote collaborations among Consortium members, independent software vendors, and the industrial end-user community.

The broader impacts of this award include: provisioning of unique infrastructure for research and education; extensive efforts to accelerate education and training in the use of high-performance computation in science; training in petascale computing techniques; promoting an exchange of information between academia and industry about the applications of petascale computing; and broadening participation in computational science through NCSA's Girls Engaged in Mathematics and Science (GEMS) program. GEMS is designed to encourage middle-school girls to consider mathematicsoriented and science-oriented careers.

Science and engineering research and education activities enabled by Blue Waters:
This award will permit investigators across the country to conduct innovative research demanding petascale capabilities. Allocations have been requested for research on: complex biological behavior in fluctuating environments, the electronic properties of strongly correlated systems, the properties of hydrogen and hydrogen-helium mixtures in astrophysically relevant conditions, the electronic and magnetic structures of transition metal compounds, the molecular dynamics responsible for the properties of liquid water, the propagation of seismic energy through a detailed structural model of Southern California together with the predicting of ground motion and the modeling of the response of buildings and other structures, testing hypotheses about the role of cloud processes and ocean mesoscale eddy mixing in the dynamics of climate and improving climate models, the formation of the first galaxies, turbulent stellar hydrodynamics, binary black hole and neutron star systems as sources of gamma ray bursts and other intense radiation phenomena, contagion, and particle physics.

Management and Oversight:

NSF Structure: The project is managed and overseen by OCI program staff and a grants officer from the Division of Grants and Agreements (DGA). These NSF staff members receive advice from NSF's High-Performance Computing Coordinating Group, which includes representatives from the various directorates and offices and is led by OCI. Advice from the Office of General Counsel (OGC) is sought as necessary.

The contract between UIUC and IBM, the principal sub-awardee, includes milestones at which progress by IBM is assessed through a series of deliverables, including software packages and demonstrations, tests of preliminary hardware, simulators, technical specifications, and programmer guides.

External Structure: During the development and acquisition phase of this project, UIUC oversees work by a number of sub-awardees, conducts software development, and assists competitively selected research groups to prepare to use the Blue Waters system. The primary sub-awardee, IBM, is responsible for implementation of the hardware, system software, and main program development tools. Other sub-awardees work on performance modeling, the evaluation of an astrophysical modeling framework, the engagement of applications groups, scalable performance tools, undergraduate training, and broadening the participation of underrepresented groups in high-performance computing. Following system testing and acceptance in mid-2011, the Blue Waters project will enter a five-year operations phase. A proposal from UIUC for operations is anticipated in mid-2010. The project team is advised by a Petascale Executive Advisory Committee composed of senior personnel with technical and management expertise in high-performance scientific computing, the management of acquisition contracts for leading-edge computing systems, and the operation of large computing centers.

Risks: Any activity of this nature, and at this scale, comes with a certain element of risk. The extensive review process, prior to award, reviews and analyzes the risks as presented in the proposal and identifies any additional risk that should be considered. The Track 1 award required that risks be identified, analyzed, and a mitigation plan created and adhered to. One of the activities of the periodic NSF external reviews, by a panel of experts, is to revisit and assess the risk situation and make recommendations as deemed necessary. Risks that are no longer applicable are retired. New risks may be added, or degree of risk promoted or demoted as necessary, all of which is documented in a risk register. Discussion of risks is part of the bi-weekly discussions between UIUC and NSF.

Reviews: The project was selected through a competitive review in 2007. An external review panel of experts, selected by NSF, reviews the progress of the project including project management, risk management, hardware and software development, and the provision of advanced user support to research groups receiving provisional resource allocations on the Blue Waters system. One of the important roles of this external review panel is to analyze the awardee's assessments of the deliverables from its sub-awardees, together with the awardee's and sub-awardees' plans for remedial action, when necessary, and provide NSF with advice on whether these assessments and plans are reasonable. At the time of writing, these external reviews had been conducted in February 2008, April 2008, October 2008, April 2009, July 2009 and December 2009 with further reviews planned for April 2010 and at 4-6 month intervals thereafter. In addition, NSF conducts site visits.

Current Status: The project is currently proceeding as planned. External reviews have praised the technical collaboration between the awardee and the primary vendor.

Track 2

The Track 1 system is targeted to provide sustained petascale performance, while the Track 2 systems provide, at most, petascale peak performance. While each Track 2 system is capable of supporting hundreds of researchers (over the course of a year) doing leading-edge science and engineering, the Track 1 system is expected to support on the order of a dozen projects, each capable of producing break-through results as a direct result of having access to such a facility. In FY 2011, funding will be provided for Track 2D awards only. In previous years funding was provided for Track 2A and 2B awards that have transitioned into production TeraGrid resources. No funds will be awarded for Track 2C.

There is a direct relationship between the Track 2 awards and the TeraGrid activity. Track 2 provides the acquisition process for new systems that will become part of TeraGrid. Track 2 awards are made to an institution following an extensive external review process. Proposals submitted consist of two parts: a) an acquisition component (and associated funding) and b) an operations and maintenance component (and associated funding). All award funding goes to the institution. The institution issues a sub-award to the vendor and perhaps other sub-awards as may be deemed necessary. The vendor receives its funding from the NSF awardee following a successful acceptance process agreed upon by NSF. The acquisition phase is completed when there are no further payments due to the vendor. At that point, the Track 2 award transitions into the TeraGrid with the institution taking on the role of a TeraGrid resource provider. Once the institution is integrated into the TeraGrid it has access to the operations and maintenance funding component of the award.

Immediately below is information that is common to the Track 2D program and hence is applicable to all Track 2D awards. Any differences or project-specific information are discussed in that award's section.

Science and engineering research and education activities enabled by Track 2D:
- The complete spectrum of scientific research is supported, including: climate and weather modeling, cosmology and astrophysics, geosciences, physics, chemistry, biology and medicine, earthquake engineering, and mechanical engineering.
- TeraGrid is required to provide evidence of outreach activities that include various education and training opportunities being made available. These are evaluated as part of the annual review process.
- In addition, part of the Track 2D acquisition review process includes an assessment of education and outreach activities being considered.

Management and Oversight for Track 2D:

NSF Structure:
- NSF oversight is provided by OCI program officers who provide direct oversight during both the

acquisition and operations phase and the system integration into the TeraGrid and the follow-on eXtreme Digital (XD) activity.
- Formal reporting consists of quarterly and annual reports. These are reviewed by the program officer. There are also bi-weekly teleconferences with NSF program officers.

Risks: Any activity of this nature, and at this scale, comes with a certain element of risk. The review process, prior to award, reviews and analyzes the risks as presented in the proposal and identifies any additional risk that should be considered. The Track 2D award process requires that risks be identified, analyzed, and a mitigation plan created and adhered to. One of the activities of the periodic NSF external reviews, by a panel of experts, is to revisit and assess the risk situation and make recommendations as deemed necessary. Risks that are no longer applicable are retired. New risks may be added, or degree of risk promoted or demoted as necessary, all of which is documented in a risk register.

Reviews:
- Annual reviews are performed as part of the TeraGrid annual review.
- Semi-annual reviews are performed as part of the acquisition phase. The reviews are arranged by the NSF program officer. The reviewers' backgrounds include scientific research, project management, and large scale systems acquisitions and operations, and include familiarity with projects funded by NSF as well as other federal agencies. To the extent possible, continuity through the series of reviews is provided by using the same set of reviewers.

External Structure:
- Each Track 2D award will be managed under a cooperative agreement. Each Track 2D awardee will be responsible for the satisfactory completion of milestones in order for the spending authorization to be raised. Progress will be determined by the review process and the NSF program officer.
- Each project has a detailed management plan in place. Each cooperative agreement includes the management structure, milestones, spending authorization levels, and review schedule.

Current Status:
- The Track 2D cooperative agreement awards were made in FY 2009 and are proceeding as planned.

<u>Track 2Da - Gordon Data Intensive Computing at San Diego Supercomputer Center (SDSC)</u>

<u>Description:</u>
- The University of California at San Diego (UCSD) will provide a ground-breaking new computing facility, Gordon, which will be made available to the research community together with advanced user support for researchers with data intensive problems that may not parallelize well or will require access to very large amounts of memory.
- The system will become part of the NSF TeraGrid and the follow-on eXtreme Digital cyberinfrastructure in FY 2011.

<u>Science and engineering research and education activities enabled Gordon:</u>
- It is expected that data-centric/intensive science research will be enabled by this system. This system will be optimized to support research with very large data-sets or very large input-output requirements. It will provide a step-up in capability for data-intensive applications that scale poorly on current large-scale architectures, providing a resource that will enable transformative research in many research domains.
- Examples of scientific challenges that this resource will allow researchers to tackle include the following:

  - De Novo Genome Assembly: Gene sequencers produce information about many small fragments of a genome. Some recent assembly algorithms use a graph-based approach, much more readily executed on a shared-memory system. Using Gordon, researchers will be able to rapidly assemble complex genomes such as mammalian genomes.
  - Astronomy: Modern astronomy databases can be large; for example, the Sloan Digital Sky Survey is approximately six terabytes in size. Typically, the analysis algorithms that researchers use to perform complex searches for astronomical phenomena can be implemented more easily on shared-memory systems. Gordon will enable researchers to load a copy of the Sloan Digital Sky Survey into the flash memory associated with a super-node, greatly extending the types of analyses astronomers can make.
  - Interaction Networks: Interaction networks, graphs representing the relationships between objects, are used in research in areas such as epidemiology, phylogenetics, systems biology, and population biology. These interaction networks can represent relationships between types of data stored in different databases; for example, the combination of social network databases with medical records and genomic profiles to explore questions such as genetic resistance to disease. Gordon will speed analysis of large interaction networks because the databases can be stored on solid-state disks, greatly reducing access time and permitting more complex types of analysis.
- The project will leverage a number of ongoing educational activities at UCSD to expand and diversify the community of users that can utilize this computational resource, including successful outreach programs for women and minorities from underrepresented groups in science and engineering. The project will also create a summer training program for undergraduates.

Track 2Db – Keeneland Experimental High Performance Computing at Georgia Institute of Technology

Description:
- The Georgia Tech Research Corporation (GTRC) will provide a new experimental high performance computing facility with unconventional architectures, Keeneland, to scientific and engineering researchers so they can evaluate the merit of these architectures.
- The distinguishing feature of Keeneland is the inclusion of General-Purpose computation on Graphics Processing Units (GPGPU) processors as general purpose compute accelerators in a sufficiently large system to address computational problems that are challenging to more conventional supercomputing architectures. Productivity is of particular interest in using Open Computing Language (OpenCL) as a mechanism to program the GPGPUs.
- Applications will require additional development and testing to be appropriately prepared to effectively use this new type of architecture.
- An initial system will be deployed that will allow researchers lead time in order to prepare their applications for the full scale system to be installed two years later.
- The system will become part of the NSF TeraGrid cyberinfrastructure in FY 2012.

Science and engineering research and education activities enabled by Keeneland:
- The Georgia Institute of Technology (Georgia Tech) and its partners, the University of Tennessee at Knoxville and the Oak Ridge National Laboratory, will initially acquire and deploy a small, experimental, high-performance computing system. The project team will use this system to develop scientific libraries and programming tools to facilitate the development of science and engineering research applications. The project team will also provide consulting support to researchers who wish to develop applications for the system using OpenCL or to port applications to the system.
- The final system has the potential to support many different science areas. Possible areas of impact include some of the scientific domains in which GPU-based acceleration has already been demonstrated

to have an impact at smaller scale; for example, chemistry and biochemistry, materials science, atmospheric science, and combustion science.
- In addition to providing infrastructure for science and engineering research and education, the project partners will educate and train the next-generation of computational scientists on cutting-edge computing architectures and emerging programming environments using the experimental computing resource.

Track 2Dc - FutureGrid Experimental High Performance Grid Testbed at Indiana University (IU)

Description:
- This project provides researchers with the capability to tackle complex research challenges in computer science related to the use and security of grids and clouds.
- The project team will provide a significant new experimental computing grid and cloud test-bed, named FutureGrid, to the research community, together with user support for third-party researchers conducting experiments on FutureGrid.
- The test-bed includes a geographically distributed set of heterogeneous computing systems, a data management system that will hold both metadata and a growing library of software images, and a dedicated network allowing isolatable, secure experiments.
- The test-bed will support virtual machine-based environments as well as native operating systems for experiments aimed at minimizing overhead and maximizing performance.
- The project partners will integrate existing open-source software packages to create an easy-to-use software environment that supports the instantiation, execution, and recording of grid and cloud computing experiments.
- Part of the FutureGrid evaluation, and part of the review process, will be a determination of its efficacy as a component in XD.

Science and engineering research and education activities enabled by FutureGrid:
- FutureGrid will support research on topics ranging from authentication, authorization, scheduling, virtualization, middleware design, interface design, and cybersecurity, to the optimization of grid-enabled and cloud-enabled computational schemes for researchers in astronomy, chemistry, biology, engineering, atmospheric science, and epidemiology.
- Researchers will be able to measure the overhead of cloud technology by requesting linked experiments on both virtual and bare-metal systems. U.S. scientists will be able to develop and test new approaches to parallel, grid, and cloud computing, and collaborate with international efforts in this area.
- It will provide an experimental platform that accommodates batch, grid, and cloud computing, allowing researchers to attack a range of research questions associated with optimizing, integrating, and scheduling the different service models.
- It will provide a test-bed for middleware development and, because of its private network, allow middleware researchers to do controlled experiments under different network conditions and to test approaches to middleware that include direct interaction with the network control layer.
- It will develop benchmarks appropriate for grid computing, including workflow-based benchmarks derived from applications in astronomy, bioinformatics, seismology, and physics.
- Education and broader outreach activities include the dissemination of curricular materials on the use of FutureGrid, pre-packaged FutureGrid virtual machines configured for particular course modules, and educational modules based on virtual appliance networks and social networking technologies that will focus on education in networking, parallel computing, virtualization, and distributed computing.
- The project will advance education and training in distributed computing at academic institutions with less diverse computational resources. It will do this through the development of instructional resources that include preconfigured environments that provide students with sandboxed virtual clusters. These can be used for teaching courses in parallel, cloud, and grid computing. Such resources will also

provide academic institutions with a simple opportunity to experiment with cloud technology to see if such technology can enhance their campus resources.

Innovative HPC Program

Using lessons learned during the execution of the HPC Track 2 program and informed by the NSF ACCI's High Performance Computing Task Force, a new Innovative HPC program will be created in FY 2010. This program will provide production ready HPC systems as well as opportunities for investigating innovative high-risk/high-payoff approaches to providing the necessary computational resources requested by the science and engineering community. The new program will be aligned with the eXtreme Digital activity, TeraGrid Phase III, in a manner similar to the association between Track 2 and TeraGrid.

TeraGrid Phase III: eXtreme Digital (XD)

Description:

- The TeraGrid (TG), predecessor to XD, is an advanced, nationally distributed, open cyberinfrastructure comprised of supercomputing, storage, analysis, and visualization systems, data services, and science gateways, connected by high-bandwidth networks, integrated by coordinated policies and operations, and supported by computing and technology experts.
- It enables and supports leading-edge scientific discovery and promotes science and technology education.
- XD takes a significant step forward by encouraging innovation in the design and implementation of an effective, efficient, increasingly virtualized approach to the provision of high-end digital services – extreme digital services – while ensuring that the infrastructure continues to deliver high-quality access for the many researchers and educators that use it in their work.

Science and engineering research and education activities enabled by XD:

- XD will enable transformative advances in science and engineering research, in the integration of research and education, and in broadening participation in science and engineering by under-represented groups, by providing researchers and educators with usable access to extreme-scale digital resources, beyond those typically available on most campuses, together with the interfaces, consulting support, and training necessary to facilitate their use.
- XD will provide high-performance computing services, enable researchers to manipulate extremely large amounts of digital information from simulation, sensors, and experiments, and add needed capabilities in remote visualization, an increasingly important analysis tool for modern science and engineering.
- Outreach and training critical to reducing the barriers to the use of advanced digital systems by the research and education community will be provided. XD will incorporate new ideas and technologies to enable researchers and students to move transparently between local and national resources, substantially lowering the barrier to an effective use of cyberinfrastructure and promoting enhanced productivity.

Management and Oversight:

NSF Structure:

- XD will consist of several inter-related parts: a High Performance Computing and Storage Service (HPCSS), a High-Performance Remote Visualization Service (HPRVS), a Coordination and Management Service (CMS), a Technology Audit and Insertion Service (TAIS), an Advanced User Support Service (AUSS), and a Training, Education and Outreach Service (TEOS).

    - These elements are designed and implemented in a way that is consistent with sound system engineering principles, clearly tied to the user requirements of the science and engineering research community using a flexible methodology that permits the architecture to evolve in response to changing user needs and presenting the individual user with a common user environment regardless of where the resources or user are located.
    - The HPCSS, consisting of four to six nodes, will be identified and funded beginning in FY 2011.
    - The HPRVS was reviewed in FY 2009 and two awards were made, one to the University of Texas ($7.0 million) and one to the University of Tennessee ($10.0 million). The TAIS component of XD was reviewed early in FY 2010 and an award is planned for mid FY 2010 in order to impact the existing TeraGrid extension award and to ease the TeraGrid to XD transition.
    - The final phase of XD, involving the other three services, is scheduled to come on line in March 2011. The total anticipated funding for all four services is approximately $25 million in FY 2011.
- Similar to TG, XD will be managed by OCI, informed by the Cyberinfrastructure Council (CIC), the Cyberinfrastructure Coordinating Committee (CICC), and various working groups, in particular the internal high-performance computing working group and an external Science Advisory Board similar to the TG Science Advisory Board.
- OCI will hold weekly teleconferences with XD senior personnel.

External Structure:
- The final configuration of XD will consist of a number of sites, containing a range of high performance computing platforms, large disk storage devices, computational platforms specifically tailored for remote visualization, high-bandwidth networks, a broad set of user services and an education, outreach, and training component designed to fulfill the needs of current users of high-performance computing as well as to broaden participation to new communities and under-represented groups in science and engineering.

Reviews:
- There is a well planned external review process underway to ensure that the NSF will provide the U.S. scientific and engineering community with the highest quality state of the art computational facilities to carry out world-class science. It is expected that the review process will be completed during FY 2010.

Current Status:
- Phase I – Two planning grants, one to UCSD ($1.60 million) and one to UIUC ($1.62 million), were made in FY 2009 to obtain community input and engagement in order to develop the ideas and expanded horizons that will be required to deploy the advanced infrastructure required for XD. The same two organizations have been authorized to submit full proposals subject to further review internally and externally of the deliverables required in the preliminary proposals.
- Phase II – The full proposals will be reviewed by an external panel of experts during FY 2010 and a recommendation will be made. NSF expects to make an award in FY 2011.
- NSF expects to have all components of XD in production between FY 2011 and FY 2013.

OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING (OISE) $53,260,000 +$5,430,000 / 11.4%

OISE Funding
(Dollars in Millions)

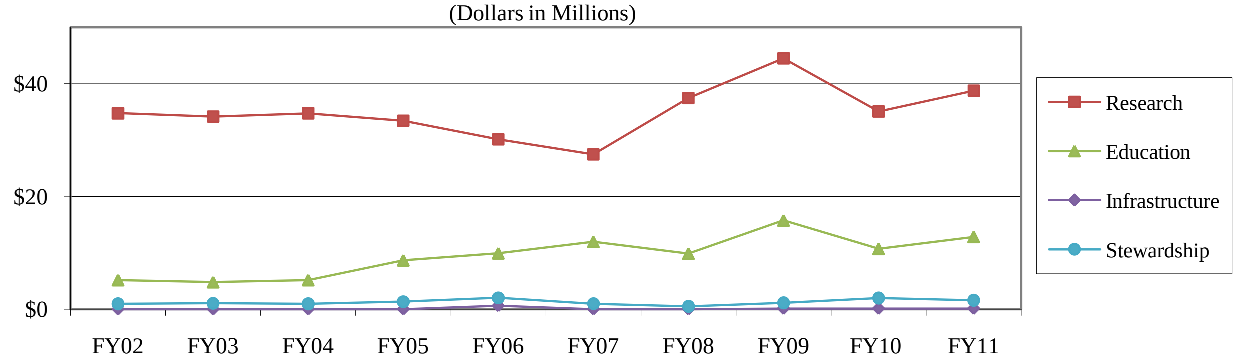
	FY 2009 Omnibus Actual[1]	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Total, OISE	**$47.45**	**$13.98**	**$47.83**	**$53.26**	**$5.43**	**11.4%**
Research	42.73	1.76	35.07	38.77	3.70	10.6%
Education	3.53	12.22	10.70	12.83	2.13	19.9%
Infrastructure	0.10	-	0.10	0.10	-	-
Stewardship	1.10	-	1.96	1.56	-0.40	-20.4%

Totals may not add due to rounding.

[1] FY 2009 Actual includes $3.07 million in funds provided by the U.S. Department of State for an award to the U.S. Civilian Research and Development Foundation that was carried over from FY 2008 and obligated in FY 2009.

OISE serves as the focal point, both inside and outside of NSF, for international science and engineering activities. OISE promotes the development of an integrated, Foundation-wide international strategy and manages international programs that are innovative, catalytic, and responsive to a broad range of NSF and national interests. Recognizing that scientific discovery is a global enterprise, OISE supports U.S. scientists and engineers engaged in international research and education activities in all NSF supported disciplines involving any region of the world.

OISE Funding
(Dollars in Millions)



OISE in Context

Science and engineering are international enterprises critical to addressing societal challenges, competitiveness, and security. Bold exploration at the frontiers of science and engineering increasingly requires international partnerships. NSF — as the Nation's principal source of support to U.S. universities for fundamental science and engineering research and education — plays a unique role in leading the worldwide efforts of the U.S. science, engineering, and education communities.

OISE programs and activities are designed to complement and enhance the Foundation's broad research and education portfolio and to overcome barriers involved in international collaboration. America's next generation of scientists and engineers must be able to work effectively in the global arena and marketplace. OISE supports programs that enable students and researchers to experience and engage in international research and educational activities across such areas as cyberinfrastructure, complex biological systems, natural hazards prediction and mitigation, nanotechnology, water resources, climate change, and energy sustainability. OISE carries out its functions by working closely with the other NSF directorates and offices as well as through its own programs. In addition, OISE manages NSF's offices in Beijing, Paris, and Tokyo that report on and analyze in-country and regional science and technology developments and policies, promote greater collaboration between U.S. and foreign researchers, liaise with foreign counterpart agencies and research institutes, and facilitate coordination and implementation of NSF research and education programs.

OISE will apply a portion of the FY 2011 increase towards two new areas of emphasis: Muslim-Majority Countries and Developing Countries. These are discussed separately below.

Muslim-Majority Countries - The President has called for U.S. engagement with the Muslim world on the basis of mutual respect and mutual benefit. In his June 4, 2009 speech in Cairo, the President called for the establishment of "centers of scientific excellence in Africa, the Middle East and Southeast Asia," and appointment of "science envoys to collaborate on programs that develop new sources of energy, create green jobs, digitize records, clean water, and grow new crops." OISE can play a critical role, in partnership with other agencies, to advance research and education engagements with Muslim-majority countries. OISE program mechanisms will include international supplements for current NSF center grantees, Partnerships for International Research and Education (PIRE), Advanced Studies Institutes (ASI), International Research Experiences for Students (IRES), International Research Fellowship Program (IRFP), planning visits, workshops, pilot projects, and co-funding with other NSF units. OISE will apply $2.50 million of the FY 2011 increase towards activities that focus on Muslim-majority countries.

Developing Countries - Increasing collaboration with developing countries addresses several themes emphasized by the Obama Administration, especially with respect to expanded university-based research, information technology, climate change, science diplomacy, and capacity building. OISE's existing funding mechanisms, together with the potential for involving new funding partners, provides the vehicle for enabling more and stronger research and education collaborations with developing countries. The NSF-USAID Memorandum of Understanding provides a framework for OISE to support U.S. participants and USAID to support developing country partners in PIRE projects. Other OISE program mechanisms that will be used to catalyze new research and education collaborations with developing countries include ASI, IRES, IRFP, planning visits, workshops, pilot projects, and co-funding with other NSF units. OISE will apply approximately $2.50 million of the FY 2011 increase towards activities that focus on developing countries.

OISE will continue to provide approximately $8.0 million per year in support of U.S. participation in international organizations such as the Civilian Research and Development Foundation, the Global Science Forum, the Human Frontier Science Program, the International Institute of Applied Systems Analysis, the International Neuroinformatics Coordinating Facility, and the International Council for Science.

OISE Funding for Facilities

OISE Funding for Facilities
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Facilities	$0.10	-	$0.10	$0.10	-	-
National Nanotechnology Infrastructure Network	0.10	-	0.10	0.10	-	-

OISE will continue to provide $100,000 in support of the National Nanotechnology Infrastructure Network (NNIN). For further detail about individual Facilities, please see the Facilities chapter.

OISE Administration Priority Programs and NSF Investments

OISE Administration Priority Programs and NSF Investments
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Science, Engineering, and Education for Sustainability (SEES)	N/A	N/A	$2.50	$8.20	$5.70	228.0%

In FY 2011, OISE will invest $8.20 million in the NSF-wide Science, Engineering, and Education for Sustainability (SEES) portfolio to integrate efforts in climate and energy science and engineering.

For more information on Administration priority programs and NSF investments, please refer to the Overview and NSF-wide Investments sections.

Factors Influencing the Allocation Across Major Programs

- The OISE portfolio of programs and activities is designed to complement and enhance the Foundation's broad research and education portfolio and to strengthen international collaboration. In order to emphasize the development of a globally engaged U.S. science and engineering workforce, OISE will selectively utilize FY 2011 funding to augment support of two programs. The International Research Fellowship Program (IRFP) will increase from $4.50 million to $5.50 million, which will begin to improve the funding rate towards the goal of 30 percent from the current rate of 24 percent. Funding for the International Research Experience for Students (IRES) program will increase from $3.15 million to $4.25 million and will allow for funding IRES awards at a higher level than the current $150,000 cap, which was set more than five years ago.

- Existing OISE programs will be used to catalyze new research and education collaborations with Muslim-majority nations and developing countries, including PIRE, IRFP, IRES, ASI, planning visits, workshops, pilot projects, and co-funding with other NSF units.

- When non-discretionary items, such as continuing grant increments and international organization dues, are removed from the budget, OISE's allotments for research and education activities are approximately equal. OISE believes the equal weighting of research and education is the proper proportion for effective international engagement and to help ensure that the U.S. STEM workforce can compete and operate successfully within the global arena.

- Longitudinal studies of the IRFP and the East Asia and Pacific Summer Institutes Program (EAPSI) have begun and will be completed in 2012. These longitudinal studies will provide valuable input to future programmatic decisions and investments.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

OISE has a contract with Abt Associates to evaluate the International Research Fellowship Program (IRFP) and the East Asia Pacific Summer Institutes (EAPSI) Program. These evaluations will focus on four tasks: 1) a study of the IRFP and EAPSI fellows' experiences in applying for and participating in the programs; 2) a comparative data analysis of professional outcomes (educational and occupational) for EAPSI and IRFP awardees and other applicants; 3) an analysis of the impact IRFP and EAPSI have on U.S. academic institutions and on the foreign institutions that host IRFP and EAPSI fellows; and 4) the bringing together of an advisory group to ensure the quality of the evaluation process.

Number of People Involved in OISE Activities

	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	1,153	67	1,250	1,385
Other Professionals	47	8	50	55
Postdoctorates	555	85	600	670
Graduate Students	2,088	221	2,260	2,510
Undergraduate Students	1,247	281	1,350	1,500
Total Number of People	**5,090**	**662**	**5,510**	**6,120**

OISE Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Statistics for Competitive Awards:			
Number of Proposals	782	820	820
Number of New Awards	429	365	410
Regular Appropriation	340	365	410
ARRA	89	-	-
Funding Rate	55%	45%	50%
Statistics for Research Grants:			
Number of Research Grant Proposals	354	375	375
Number of Research Grants	83	70	80
Regular Appropriation	47	70	80
ARRA	36	-	-
Funding Rate	23%	19%	21%
Median Annualized Award Size	$24,826	$50,000	$25,000
Average Annualized Award Size[1]	$32,618	$180,000	$50,000
Average Award Duration, in years	2.0	2.0	2.0

[1] The significant increase in the FY 2010 average annualized award size is due to the awards for the PIRE competition, which are larger than other OISE awards, being made in FY 2010.

OFFICE OF POLAR PROGRAMS (OPP) $527,990,000

+$76,830,000 / 17.0%

OPP Funding
(Dollars in Millions)

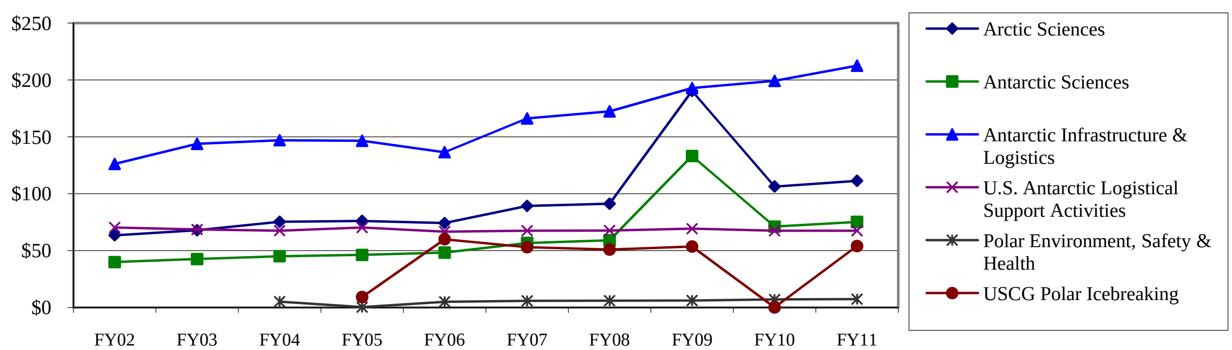
	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Arctic Sciences (ARC)	$98.60	$91.86	$106.31	$111.36	$5.05	4.8%
Antarctic Sciences (ANT)	68.64	64.53	71.08	75.18	4.10	5.8%
Antarctic Infrastructure & Logistics (AIL)	246.66	15.50	266.76	280.18	13.42	5.0%
U.S. Antarctic Logistical Support	*69.24*	-	*67.52*	*67.52*	-	-
Polar Environment, Health & Safety (PEHS)	6.12	-	7.01	7.27	0.26	3.7%
U.S. Coast Guard Polar Icebreaking[1]	53.52	-	[54.00]	54.00	54.00	N/A
Total, OPP	**$473.55**	**$171.89**	**$451.16**	**$527.99**	**$76.83**	**17.0%**
Research	113.75	147.29	117.06	123.96	6.90	5.9%
Education	5.23	2.10	7.28	6.99	-0.29	-4.0%
Infrastructure	349.67	22.50	321.43	391.15	69.72	21.7%
Stewardship	4.90	-	5.39	5.89	0.50	9.3%

Totals may not add due to rounding.

[1] Funding for U.S. Coast Guard Polar Icebreaking for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

Polar research provides insights into ice sheets, the atmosphere, oceans, and solid earth, without which the behavior of and changes in the global climate system cannot be understood. For example, the study of polar ice sheets reveals how the Earth's climate has changed in the past and provides information essential to predicting future global sea level change. Polar regions also offer important opportunities for environmental research. The extreme sensitivity of polar ecosystems to changes in climate enables study of the linkages between the physical and living components of the coupled earth systems. A key goal of these studies is to predict climate change and its impacts on a regional scale. In addition, the Arctic and Antarctic are premier natural laboratories whose extreme environments and geographically unique settings enable research on phenomena and processes not feasible elsewhere. For example, the cold, dry environment and high altitude at the South Pole make it the world's best location for key astrophysics measurements, and research in polar regions reveals how organisms have adapted to the extreme polar environment at a genetic level.

OPP Subactivity Funding
(Dollars in Millions)



NOTE: U.S. Antarctic Logistical Support Activities are shown separately from the Antarctic Infrastructure & Logistics Division, where it is administered. Funding for USCG Polar Icebreaking for FY 2010 excludes a one-time appropriation transfer of $54.0 million to USCG per P.L. 111-117.

OPP in Context

OPP provides primary U.S. support for fundamental research in polar regions through several mechanisms. In addition, NSF provides interagency leadership for U.S. activities in polar regions. In the Arctic, NSF leads research planning as directed by the Arctic Research Policy Act of 1984. The NSF Director chairs the Interagency Arctic Research Policy Committee created for this purpose. In the Antarctic, per Presidential Decision Directive, NSF manages all U.S. activities as a single, integrated program, supporting the U.S. governance role through the Antarctic Treaty and making research possible in Antarctica by scientists supported by NSF and by U.S. mission agencies. The latter includes the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, the Smithsonian Institution, and the Department of Energy.

Research in polar regions addresses critical aspects of the global earth system – glacial and sea ice, permafrost, terrestrial and marine ecosystems, the ocean, and the atmosphere – that help shape the global environment and climate. This work addresses the Administration's focus on making the U.S. a world leader on climate change and builds on a foundation established during the International Polar Year (IPY) 2007-2009. The vision for IPY established by the National Academies of Science/Polar Research Board included an "… intense, coordinated campaign of polar observations, research, and analysis … that will benefit society by exploring new frontiers and increase understanding of the key roles of the polar regions in globally linked systems." Although IPY has officially concluded, continuing and future synthesis of the research results will provide much needed information about climate evolution and will improve the reliability of the prediction of future climate change on both regional and temporal scales. OPP continues to place a high priority on these investments in climate change research and the necessary observing systems, as well as in climate change education. Research in polar regions also offers opportunities for fundamental advances in each of the disciplinary sciences, ranging from the behavior of the Earth's inner core, the formation of galaxies, the biology of life in the cold and dark, and how Arctic residents and institutions are affected by environmental change.

The Administration is assessing the overarching issues facing the Arctic, including those associated with impacts of climate change, increased human activity, new or additional information needs, and conservation of Arctic resources. This approach will necessarily include identifying implementation issues associated with the U.S. Arctic Policy released in January 2009.

Since 1958, the Nation has reviewed the U.S. Antarctic Program roughly once a decade to determine whether it is effectively structured, appropriately balanced, and in line with national goals. The landmark Antarctic Treaty marked its 50th anniversary on December 1, 2009, and the time is particularly ripe for a high-level strategic review of the U.S. Antarctic Program for several reasons: the new South Pole Station is nearing completion, the official IPY activities have just concluded and they point to new research directions and modalities, and the last such strategic review was completed in 1996/1997. During FY 2010, NSF—which administers the U.S. Antarctic Program on behalf of the U.S. Government—will initiate a new independent review of the program. The results of the review will inform the FY 2013 budget request for NSF and other affected agencies.

OPP's priorities support national energy security goals. The seasonal and permanent research facilities supported by OPP in the Arctic and the Antarctic are served by sea and air links and have been powered mostly via conventional fossil fuels. Reducing our usage of fossil fuels will reduce our impact on polar and global environments while also improving the quality of measurements in these pristine environments. The requested funding for increased reliance on renewable energy sources will also reduce costs over the longer term.

The FY 2011 Request for OPP continues a $4.0 million investment to leverage activities across the office aimed at increasing support for transformative, high-risk/high-reward research. Special attention will be focused on processes for identifying potentially transformative research, and on assessing whether they are successful.

Factors Influencing the Allocation Across Divisions and Major Programs

Maintaining a balance of research and education with the need to provide support for that research and education in remote and harsh environments is an essential element in determining the allocation of OPP funds. Research in the Antarctic, for example, cannot be done without significant investments in a transportation system to deliver people and supplies, in the instrumentation necessary for their productivity, and in the infrastructure that ensures their safety. While these same requirements exist for Arctic-based research and education, it is in most instances more readily available and less costly to acquire. Use of renewable and alternative energies to reduce reliance on fossil fuels is a priority for both Arctic and Antarctic stations.

System-level study is necessary to address the complexity of current research questions, and the manner of support for research and education evolves as the frontiers of science advance. OPP is responding to this evolution through the continued development of its system science programs. System Science is an example of the "open innovation model", whereby inputs from various constituents such as multiple research communities and eventual user communities participate in the design and execution of a research program. In the case of climate change, this is evidenced by the participation of and linkages with the world meteorological community in the development of research programs studying climate change. OPP's Arctic Sciences Division has a well-developed system science program under which the Arctic Observing Network (AON) was launched. The success of this program spurred the Antarctic community to incorporate similar inter- and multi-disciplinary approaches in designing their research programs and, as a result, the Antarctic Sciences Division developed a system science program to strengthen studies of ice-ocean-atmosphere interactions and to support research to integrate information about sub-ice sheet conditions, such as hydrological information, into ice sheet models. In addition, support is provided for research to integrate physical observations associated with ocean acidification into ecosystem models.

OPP will continue to develop its emphasis on climate change research and education, a topic of clear interest and importance to researchers and policy-makers, by providing the science to inform policy and advance knowledge. For example, the IPY research focus areas responded to knowledge gaps identified by the influential Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment and, in turn, research results will inform the next assessment. Surveys of the public's awareness of polar research issues, conducted before IPY and scheduled to be conducted again following the conclusion of IPY, will provide an indication of the success of the IPY public education component.

The need for additional observational data is recognized as a major shift in climate change research, informing regional climate modeling. OPP will continue to address this need through development of finer-grained observational systems increasingly linked with funding for climate modeling. The use of advances in cyberinfrastructure, such as simulations, will improve the models and their usefulness. Investments include sensitivity analyses for assessing where model assumptions are weakest and to show where further development is needed for AON, a cornerstone in interagency and international efforts to provide a comprehensive data stream for system modeling. Development will likely be most rapid in the physical systems (atmosphere, ocean, and ice), but it is anticipated to progress quickly in the biological and chemical realms as well.

OPP will continue support of the Graduate Research Fellowship program to increase the number and diversity of participants in polar research. The significance of polar research to issues of global importance, such as climate change, and the need to develop system level thinkers drives OPP to encourage those at the beginning of their careers in participating in its programs. Coupled with the successful Polar Postdoctoral program, this strategy is responsive to Administration priorities by increasing the productivity of the research and education enterprise and broadening participation in STEM.

In the Antarctic, continuing to ensure the resupply of McMurdo Station, increasing the use of alternative and renewable energies throughout the U.S. Antarctic Program, and maintaining communications and data handling capabilities to support science and operations are high priorities. In the Arctic, the same priority applies to increasing alternative and renewable energies, as well as improving the sustainability, cost-effectiveness, and efficiency of Summit Station in Greenland through innovations in transportation and building technologies.

Based on U.S. Coast Guard estimates, OPP is requesting $54.0 million for the operations and maintenance of the polar icebreakers *Polar Sea* and *Healy* in FY 2011, which includes significant funding for a triennial dry dock for each vessel.

OPP Funding for Centers and Facilities

OPP Funding for Centers and Facilities

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Centers	**$4.45**	**-**	**$4.45**	**$4.45**	**-**	**0.0%**
STC: Center for Remote Sensing of Ice Sheets (ANT)	*4.45*	*-*	*4.45*	*4.45*	*-*	*-*
Facilities	**$349.66**	**$22.50**	**$321.43**	**$391.15**	**$69.72**	**21.7%**
Arctic Research Support & Logistics (ARC)	*43.42*	*7.00*	*45.51*	*47.20*	*1.69*	*3.7%*
IceCube Neutrino Observatory (ANT)	*2.16*	*-*	*2.15*	*2.50*	*0.35*	*16.3%*
U.S. Antarctic Facilities & Logistics (AIL)	*175.20*	*15.50*	*199.24*	*212.66*	*13.42*	*6.7%*
U.S. Antarctic Logistical Support (AIL)	*69.24*	*-*	*67.52*	*67.52*	*-*	*-*
Polar Environment, Health & Safety (PEHS)	*6.12*	*-*	*7.01*	*7.27*	*0.26*	*3.7%*
U.S. Coast Guard Polar Icebreaking (USGC-PI) \1	*53.52*	*-*	*[54.00]*	*54.00*	*54.00*	*N/A*

\1 Funding for USCG Polar Icebreaking for FY 2010 exncludes a one-time appropriation transfer of $54.0 million to USCG per P.L. 111-117.

Detailed information on individual Centers can be found in the NSF-Wide Investments chapter. For further detail about individual facilities, please see the Facilities chapter.

Centers

STC: Center for the Remote Sensing of Ice Sheets (CReSIS)

- The Center's research and education program is aimed at determining ice sheet thickness and the nature of the lithosphere/ice sheet interface that are critical to developing models of ice sheet behavior and that will result in improved understanding of the contribution of ice sheets to sea level rise.
- CReSIS has been credited internationally for development of ice penetrating radar data analysis methods that improve existing data sets by removing clutter and other confounding effects.
- Funding for CReSIS remains unchanged in FY 2011.

Facilities

- Changes in research directions lead to changes in science support, and a systems approach is central to efficient and effective infrastructure and logistics. The FY 2011 request includes funds for a review of U.S. Antarctic Program facilities and logistics. This review will take a systems approach to reviewing science drivers and identifying the complementary logistics and infrastructure that are needed to support that science into the next decade and beyond.
- Priorities remain ensuring the resupply of McMurdo Station, increasing the use of alternative and renewable energies throughout the U.S. Antarctic Program, and maintaining communications and data handling capabilities to support science and operations.
- A comprehensive review of McMurdo Station's energy supply and usage was recently completed, setting the stage for improvements and savings in FY 2011. As an example, $3.0 million is requested to fund energy upgrades at McMurdo Station's Black Island Telecommunications Facility.
- At Summit Station in Greenland, energy needs are being reduced as a result of innovations in transportation and building technologies, as well as through alternative and renewable energy systems, thereby improving sustainability, cost-effectiveness, and efficiency.
- Shifts in funding may be made necessary by increases in the cost of fuel and fuel-dependent services such as airlift.

OPP Administration Priority Programs and NSF Investments

OPP Administration Priority Programs and NSF Investments

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Faculty Early Career Development (CAREER)	$0.01	$0.35	-	-	-	N/A
Graduate Research Fellowships (GRF)	-	-	0.20	0.20	-	-
Climate Change Education Program	-	-	1.50	1.50	-	-
Science, Engineering and Education for Sustainability (SEES)	N/A	N/A	65.26	69.26	4.00	6.1%

OPP's FY 2011 budget will continue funding for NSF programs that support students, early-career researchers, and the next generation of environmentally engaged scientists and engineers. The budget also encourages potentially transformative research and supports critical priorities in global climate change.

Specific OPP investments include:

- Continued support of the Graduate Research Fellowship program to increase the number and diversity of participants in polar research. The significance of polar research to issues of global importance, such as climate change, and the need to develop system level thinkers drives OPP to encourage the participation of those at the beginning of their careers in its programs. Coupled with the successful Polar Postdoctoral program, this strategy is responsive to Administration priorities by increasing the productivity of the research and education enterprise and broadening participation in STEM.
- Participation in the multidisciplinary, multi-faceted climate change education program, engaging the full spectrum of its research and education communities. OPP will continue its existing investment of $1.50 million supporting this program.

- Participation in the NSF-wide investment of Science, Engineering, and Education for Sustainability (SEES). Current OPP investments in climate change research total $65.26 million, with an additional $4.0 million planned for FY 2011. One emphasis area focuses on funding for observation, analysis, and modeling of regional climate change, human interactions with the Bering Sea ecosystem, global patterns in the human response to ecological change on millennial time scales, and changing permafrost. Another is a system approach to climate change research through further study of ecosystem response to change, including ocean acidification, the interplay of atmospheric and oceanic circulation in adding or removing mass from the ice sheets, and advancing ice sheet dynamics research and modeling to reduce uncertainties in future sea level rise.

For more information on Administration priority programs and NSF Investments, please refer to the Overview and NSF-wide Investments sections.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

As stated previously, the planned review of the U.S. Antarctic Program will inform the FY 2013 budget request for NSF and other affected agencies.

Aspects of the Office of Polar Environment, Health and Safety requiring medical input are reviewed annually by a medical panel. Specialized reviews, such as that of the scientific diving program, are conducted periodically.

Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into OPP's program evaluation and performance improvement processes.

Number of People Involved in OPP Activities

	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	927	1,007	1,048	1,060
Other Professionals	652	706	742	762
Postdoctorates	102	172	114	116
Graduate Students	338	604	378	397
Undergraduate Students	236	429	272	282
Total Number of People	**2,255**	**2,918**	**2,554**	**2,617**

OPP Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Statistics for Competitive Awards:			
Number of Proposals	859	1,071	1,105
Number of New Awards	420	310	325
Regular Appropriation	117	310	325
ARRA	303	-	-
Funding Rate	49%	29%	29%
Statistics for Research Grants:			
Number of Research Grant Proposals	822	1,033	1,069
Number of Research Grants	388	279	293
Regular Appropriation	93	279	293
ARRA	295	-	-
Funding Rate	47%	27%	27%
Median Annualized Award Size	$174,709	$154,342	$158,900
Average Annualized Award Size	$218,102	$189,400	$193,800
Average Award Duration, in years	2.8	2.8	2.8

DIVISION OF ARCTIC SCIENCES (ARC) $111,360,000
+$5,050,000 / 4.8%

ARC Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
ARC	**$98.60**	**$91.86**	**$106.31**	**$111.36**	**$5.05**	**4.8%**
Research	54.43	84.86	59.30	62.66	3.36	5.7%
Education	0.75	-	1.50	1.50	-	-
Infrastructure	43.42	7.00	45.51	47.20	1.69	3.7%
Arctic Research Support & Logistics	*43.42*	*7.00*	*45.51*	*47.20*	*1.69*	*3.7%*

ARC is organized into several programs that support research in social science, earth system science, and a broad range of natural science. Educational projects are also supported. The Research Support & Logistics program assists researchers with access to the Arctic, improves safety and environmental stewardship, and increases the ability of researchers to share plans and results with local Arctic communities. The Arctic is at the forefront of global climate change. Observations have revealed an estimated 14 percent per decade reduction in sea ice extent in the Arctic over the past 30 years, and significant summer melting of the Greenland Ice Sheet. These and many other phenomena are forcing change and uncertainty in traditional Arctic populations, present challenges and opportunities for industry and commerce, and have the potential to affect the global population through changes in sea level. Arctic Sciences funds a broad range of activities to provide an integrated understanding of environmental change in the Arctic, including study of significant, system-scale environmental change and its human dimension.

The Research Support & Logistics program is driven by and responds to research and education funded by the division. Funding is provided directly to grantees or to key organizations that provide or manage Arctic support and logistics. Emphasis will be placed on improving access to and the energy security of the remote facilities used by Arctic researchers and educators.

In general, 60 percent of the division's portfolio is available for new research grants. The remaining 40 percent funds continuing grants made in previous years, and research support and logistics.

Factors Influencing the Allocation Across ARC Programs

- Shifts in funding may be made necessary by increases in the cost of fuel and fuel-dependent services such as airlift.
- ARC will emphasize funding for observation, analysis, and modeling of regional climate change, human interactions with the Bering Sea ecosystem, global patterns in the human response to ecological change on millennial time scales, and changing permafrost. This work is part of the larger climate change research program, providing an additional $2.0 million in FY 2011 for a total investment of $38.45 million.
- Development of the cyberinfrastructure tools needed to support all aspects of ARC-supported work is a priority. In FY 2011, ARC continues a $3.0 million investment to undertake a much-needed comprehensive design effort using approaches such as observing system simulation experiments for AON.
- Building on the successful polar education program developed during IPY, ARC maintains its investment in polar education ($750,000) and participates in the multidisciplinary, multi-faceted

climate change education program, engaging the full spectrum of its research and education communities ($750,000).

- Planning for more energy efficient, modular building systems at Summit Station in Greenland will continue with the Department of Energy for future implementation.

DIVISION OF ANTARCTIC SCIENCES (ANT) $75,180,000
+$4,100,000 / 5.8%

ANT Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
ANT	**$68.64**	**$64.53**	**$71.08**	**$75.18**	**$4.10**	**5.8%**
Research	$65.73	$64.53	$67.43	$71.18	$3.75	5.6%
STC: Center for Remote Sensing of Ice Sheets	*4.45*	-	*4.45*	*4.45*	-	-
Education	0.75	-	1.50	1.50	-	-
Infrastructure	2.16	-	2.15	2.50	0.35	16.3%
IceCube Neutrino Observatory	*2.16*	-	*2.15*	*2.50*	*0.35*	*16.3%*

ANT funds research in all areas of science that can only be done, or is best done, in Antarctica. Antarctic Sciences enables research on Earth's physical, biological, geological, glaciological, oceanographic, and atmospheric processes in Antarctica, as well as on interactions between the ice sheets, the underlying continent, the surrounding ocean, and the overlying atmosphere, toward a comprehensive understanding of Antarctica's role in the evolution of Earth and life on Earth, as well as the Antarctic environment's role in the whole Earth system. In particular, a new programmatic emphasis fosters linkages across the disciplines in order to better advance understanding of Antarctic climate as a system. Antarctic Sciences also enables research in astronomy and astrophysics to advance understanding about high-energy phenomena such as supernovae and events associated with black holes, about the nature of dark energy and dark matter (which is now known to be a major component of the universe), as well as advancing general understanding about the origin and evolution of the universe.

In general, 40 percent of the Antarctic Sciences portfolio is available for new research grants. The remaining 60 percent is used primarily to fund continuing grants made in previous years.

Factors Influencing the Allocation Across ANT Programs

- An international collaboration growing out of IPY led to strong interest for geological and paleontological work in the Central Transantarctic Mountains. ANT will give priority to supporting small and medium-sized projects in this region to investigate deep-time paleoclimate change.
- Priority is given to completion of IPY projects which had been deferred due to budget constraints in prior years.
- Development of instrumentation and equipment for making critical scientific observations with the potential to transform data collection, monitoring, and modeling in all areas of Antarctic science is a continuing priority, increasing $1.0 million to $3.0 million. Examples are gliders and oceanographic drifters, and sensors and systems for airborne research. A successful program would reduce "boots on the ground" and energy requirements, and also make the resulting data more widely available and accessible.
- Efforts to implement new system-scale research to integrate information about sub-ice sheet conditions, such as hydrological information, into ice sheet models, as well as research to integrate physical observations associated with ocean acidification into ecosystem models will continue. This work is part of the larger climate change research program, providing an additional $2.0 million in FY 2011 for a total investment of $30.81 million.

- Building on the successful polar education program developed during IPY, ANT maintains its investment in polar education ($750,000) and participates in the multidisciplinary, multi-faceted climate change education program, engaging the full spectrum of its research and education communities ($750,000).

DIVISION OF ANTARCTIC INFRASTRUCTURE AND LOGISTICS (AIL) — $280,180,000 +$13,420,000 / 5.0%

AIL Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
AIL	**$246.66**	**$15.50**	**$266.76**	**$280.18**	**13.42**	**5.0%**
Infrastructure	246.66	15.50	266.76	280.18	13.42	5.0%
U.S. Antarctic Facilities & Logistics	*177.42*	*15.50*	*199.24*	*212.66*	*13.42*	*6.7%*
U.S. Antarctic Logistical Support	*69.24*		*67.52*	*67.52*	-	-

AIL supports research through a network of stations, labs, equipment, and logistics that enable research activities in Antarctica. This includes operation of a year-round inland research station at the South Pole; two year-round coastal research stations (McMurdo and Palmer) with extensive laboratory, transportation, housing, communication, and computing capabilities; summer camps as required for research; icebreaking research ships—the *Laurence M. Gould* and the *Nathaniel B. Palmer*; small fixed-wing aircraft and helicopters; and icebreakers for channel breaking and ship escort at McMurdo Station. The division uses a mix of government and civilian contract service providers for research support activities in Antarctica.

The U.S. Antarctic Logistical Support budget line funds support provided by the U.S. Department of Defense (DoD). DoD operates as a primarily logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations, maintenance, and facilities support of the 109th Airlift Wing (AW) of the New York Air National Guard in Scotia, New York, and Antarctica; transportation and training of military personnel supporting the U.S. Antarctic Program; support for air traffic control, weather forecasting, and electronic equipment maintenance; the charter of Air Mobility Command airlift and Military Sealift Command ships for the resupply of McMurdo Station; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of DoD satellites for communications.

Factors Influencing the Allocation Across AIL Programs

- Shifts in funding may be made necessary by increases in the cost of fuel and fuel-dependent services such as airlift.
- Priorities remain ensuring the resupply of McMurdo Station, increasing the use of alternative and renewable energies throughout the U.S. Antarctic Program, and maintaining communications and data handling capabilities to support science and operations.
  - A study of the feasibility and benefits of shifting the McMurdo Station resupply effort was recently concluded and is under review. The study will inform decisions concerning a new resupply plan as early as FY 2011, subject to funding availability and the conclusions of the study.
  - A project to install "smart grid" technology for power distribution at McMurdo is planned to continue in FY 2011 ($2.0 million). This project will install metering and networked direct digital controls to enable monitoring and management of power, lighting, heating, and water for more cost-effective and efficient operation of the McMurdo Station power grid. The system will be scalable and adaptable to meet future distribution configurations and new technologies.

    - Energy upgrades at McMurdo's Black Island Telecommunications Facility are fully funded with a $3.0 million investment in FY 2011. This facility provides mission essential satellite communications supporting McMurdo as well as the National Polar-Orbiting Operational and Environmental Satellite System (NPOESS) and NASA's Ground Networks for the relay of data. The project will maximize wind and solar energy generation, introducing redundancy to ensure services continue in the event of a fire or other potentially disruptive event.
    - Work continues on the proof of concept for a more energy-efficient South Pole Summer Camp; production of modular berthing/living units is planned for future years.
    - Funds are allocated toward sustaining communications capability from the South Pole Station due to increased usage fees from NASA to access its next-generation satellite – Flight 3, or "F3". The cost increases by approximately $1.0 million to $2.0 million per year.
    - Construction of the earth station to replace MARISAT capability with access to SkyNet-4C, providing high quality data/voice connectivity to South Pole to fill a critical gap in continuous communications coverage formerly filled by the MARISAT satellite, will proceed in FY 2011. Approximately $1.0 million is needed to begin this effort.
- The FY 2011 request includes funds to complete the review of U.S. Antarctic Program facilities and logistics being started in FY 2010. This review will take a system approach to reviewing science drivers and identifying the complementary logistics and infrastructure that are needed to support that science into the next decade and beyond.

OFFICE OF POLAR ENVIRONMENT, HEALTH AND SAFETY (PEHS) — $7,270,000 +$260,000 / 3.7%

PEHS Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
PEHS	**$6.12**	**-**	**$7.01**	**$7.27**	**0.26**	**3.7%**
Infrastructure	6.12	-	7.01	7.27	0.26	3.7%
Polar Environment, Health & Safety	*6.12*	-	*7.01*	*7.27*	*0.26*	*3.7%*

PEHS within OPP manages and oversees the environmental, health and safety aspects of research and operations conducted in polar regions. It ensures compliance with environmental, safety, and health related regulatory, statutory, and international treaty requirements. The Office has overall responsibility for guiding the implementation of both environmental protection and environmental stewardship to minimize the environmental impact of OPP-supported activities in polar regions. The Office also develops and oversees programs to ensure the safety and health of all participants.

Factors Influencing the Allocation Across PEHS Programs

- Priority is given to ensuring continued protection and stewardship of the environment and attention to the immediate health and safety needs of participants in polar field work.
- PEHS will continue a long-term initiative to establish an electronic medical records system, adding $250,000 in FY 2011 to prior investments of approximately $100,000.

U.S. COAST GUARD POLAR ICEBREAKING $54,000,000

$54,000,000 / N/A

U.S. Coast Guard Polar Icebreaking Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
U.S. Coast Guard Polar Icebreaking	**$53.52**	**-**	**[$54.00]**	**$54.00**	**$54.00**	**N/A**
Infrastructure	53.52	-	[54.00]	54.00	54.00	N/A
U.S. Coast Guard Polar Icebreaking	*53.52*	-	*[54.00]*	*54.00*	54.00	N/A

Funding for U.S. Coast Guard Polar Icebreaking for FY 2010 excludes a one-time appropriation transfer of $54.0 million to USCG per P.L. 111-117.

This budget line item funds the operation and maintenance of the *Polar Sea* and the *Healy* in support of NSF science and, on a reimbursable basis, the needs of other federal agencies. The U.S. Coast Guard estimates that $54.0 million will be needed to fund operation and maintenance of the two vessels in FY 2011, which includes significant funding for a triennial dry dock for each vessel.

INTEGRATIVE ACTIVITIES (IA) $295,930,000
+$20,890,000 / 7.6%

IA Funding
(Dollars in Millions)

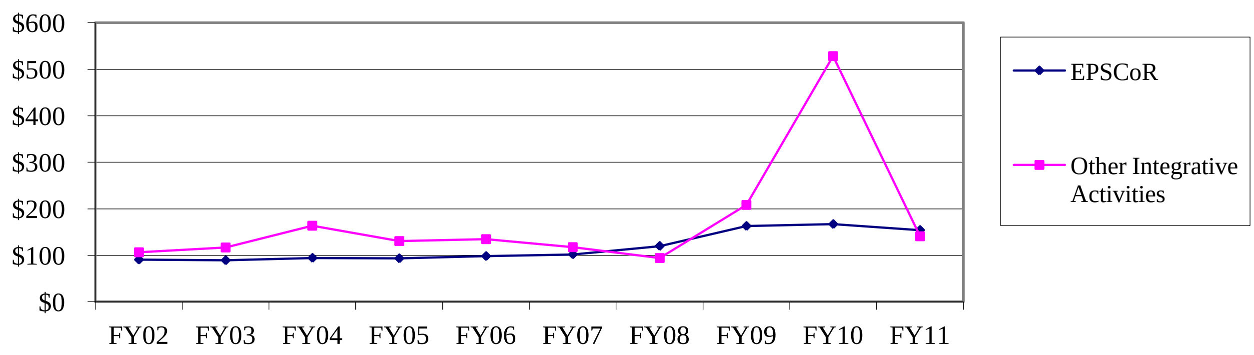
	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 ARRA Estimate[1]	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Total, IA	**$241.58**	**$129.85**	**$420.15**	**$275.04**	**$295.93**	**$20.89**	**7.6%**
EPSCoR	133.00	30.00	20.00	147.12	154.36	7.24	4.9%
Science and Technology Centers	1.26	-	-	13.40	26.30	12.90	96.3%
Major Research Instrumentation	99.98	99.85	200.15	90.00	90.00	-	-
Academic Research Infrastructure	-	-	200.00	-	-	-	N/A
Communicating Science Broadly	4.30	-	-	4.00	4.00	-	-
Graduate Research Fellowships	-	-	-	17.48	17.83	0.35	2.0%
Science and Technology Policy Institute	3.04	-	-	3.04	3.04	-	-
STAR METRICS	-	-	-	-	0.40	0.40	N/A

Totals may not add due to rounding.

[1] Within IA, NSF carried forward $420.15 million from the ARRA appropriation because solicitations occurred late in FY 2009. Awards will be made in FY 2010.

IA supports emerging, cross-disciplinary, and potentially transformative research and education, recognizing the importance of integrative efforts to the future of science and engineering. IA is a source of federal funding for the acquisition and development of research instrumentation at U.S. academic institutions and for strengthening the research and educational infrastructure throughout the Nation. Additionally, IA invests in a number of integrative research and education centers and programs that enhance NSF research investments in discovery and workforce development. Support for communications programs synthesize for the general public NSF's contributions in science and engineering, and research and education.

IA Subactivity Funding
(Dollars in Millions)



IA in Context

IA programs are cross-disciplinary research and education activities, and initiatives that enhance scientific discovery, invest in research infrastructure, and strengthen the Nation's technically trained workforce. Moreover, the increasing complexity of today's challenges requires solutions that span traditional scientific and engineering disciplines. For example, NSF's investments in the Science and Technology Centers (STCs) create vital platforms to support interdisciplinary exchange and discovery. The STC

Integrative Partnerships program (STC) — which currently funds 17 centers nationwide — supports innovative, potentially transformative, and complex research and education projects that require large-scale, long-term efforts. STCs engage the Nation's intellectual talent through partnerships between academia and other sectors including industry, national laboratories, and government. These collaborations create synergies that enhance innovation and the timely transfer of knowledge and technology from the laboratory to industry and policymakers; they support the training of the next generation of scientists, engineers and educators; and they foster the launch of spin-off companies and the creation of job opportunities. According to a National Academies' assessment, *An Assessment of the National Science Foundation's Science and Technology Centers Program*, STCs have outstanding records of research achievement as well as effective partnerships with the K-12 and informal education communities.

The Major Research Instrumentation (MRI) program is a Foundation-wide, crosscutting program that strengthens the U.S. scientific enterprise by investing in state-of-the-art research instrumentation at our Nation's institutions of higher education, research museums, and non-profit research organizations. Scientific advances in many fields are critically dependent on sophisticated instrumentation. The MRI program promotes the acquisition and development of instrumentation for shared use. The MRI program invests in the development of a diverse workforce and the next generation of instrumentation. The program facilitates academic/private sector partnerships that create new products with wide scientific and commercial impact. MRI funds impact a broad spectrum of institutions nationwide; for example, MRI supports teaching-intensive and minority-serving institutions, including Historically Black Colleges and Universities, Hispanic-Serving Institutions, Tribal Colleges and Universities, and community colleges, with proposal success rates comparable to those for research-intensive universities.

A leading-edge communications effort may contribute to public acceptance and support of science and engineering. "Traditional media" – television networks, newspapers, and magazines – are giving way to internet news sites, web logs, personal-device downloads, wireless transmissions, and the like, competing among a population that has become highly pluralized not only in its requirements for information, but also in its cultural demographics. In today's technological culture, opportunities for learning abound in both community and personal settings. The Office of Legislative and Public Affairs' (OLPA) effort, "Communicating Science Broadly Through Multi-media Platforms," creates products and processes that make learning and understanding science, technology, engineering, and mathematics part of everyday life. By concentrating its informative efforts toward students and young people on the value of science in their lives, OLPA seeks to increase diversity among the Nation's future scientists, engineers, and researchers.

The Experimental Program to Stimulate Competitive Research (EPSCoR) provides strategic programs and opportunities to build the research capacity of states that have historically received lesser amounts of NSF R&D funding. These programs are designed to catalyze sustainable improvements in R&D capacity and competitiveness, and to advance science and engineering capabilities in EPSCoR jurisdictions for discovery, innovation, and discovery-based economic development.

NSF supports science and technology policy studies undertaken on behalf of the President's Council of Advisors on Science and Technology (PCAST) and the Office of Science and Technology Policy (OSTP) by the Science and Technology Policy Institute (STPI). OSTP and agencies of the National Science and Technology Council (NSTC) have recently undertaken an effort to develop a data-driven analytical capability for assessing impacts of the investments of federal science and technology agencies through the Science and Technology in America's Reinvestment – Measuring the Effect of Research on Innovation, Competitiveness and Science (STAR METRICS) project. Resources are also provided to develop a research-oriented community and to communicate methods, models, and outcomes in conjunction with STAR METRICS.

This is part of a government-wide effort in 2011 to strengthen the quality and rigor of Federal program evaluation and provide new resources and approaches for evaluation and assessment. NSF will work with evaluation experts at the Office of Management and Budget and the Council of Economic Advisers during the planning, design, and implementation stages of the project. NSF is committed to promoting strong, independent evaluation that can inform policy and program management decisions, and it will make the status and findings of this and other important evaluation activities publicly available online.

IA Funding for Centers

IA Funding for Centers
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Centers	$1.26	-	$13.40	$26.30	$12.90	96.3%
Science and Technology Centers	1.26	-	13.40	26.30	12.90	96.3%

Detailed information on individual centers can be found in the NSF-Wide Investments chapter.

STCs advance discovery and innovation in science and engineering through the integration of cutting-edge research, excellence in education, targeted knowledge transfer, and the development of a diverse, globally competitive U.S. workforce. Partnering with academic institutions, national laboratories, and industrial organizations, STCs support potentially transformative, complex research and education projects that require large-scale, long-term investment.

Centers

- A $12.90 million increase in STC funding will support full funding for five new STCs that were funded at the 50 percent level in FY 2010 during their start-up phase;
- For the six STCs established in FY 2002, FY 2011 represents the tenth and final year of NSF support.

IA Administration Priority Programs and NSF Investments

IA Administration Priority Programs and NSF Investments
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Graduate Research Fellowships (GRF)	-	-	$17.48	$17.83	$0.35	2.0%
Science, Engineering, and Education for Sustainability (SEES)	N/A	N/A	26.50	26.50	-	-

IA's FY 2011 budget will invest in key NSF programs that support students, early-career researchers, and the next generation of environmentally engaged scientists and engineers. Specific IA investments include:

- $17.83 million for the Graduate Research Fellowship program in FY 2011; and

- $26.50 million in FY 2011, utilizing EPSCoR programs, for the NSF-wide Science, Engineering, and Education for Sustainability (SEES) portfolio to integrate efforts in climate and energy science and engineering.

For more information on Administration priority programs and NSF investments, please refer to the Overview and NSF-wide Investments sections.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate/office Advisory Committees. Please see this chapter for additional information.

A number of program evaluation and performance improvement activities are underway or planned for in FY 2010 and FY 2011.

- Activities to evaluate the STC program will continue and be augmented. A review of the STC program, organized by the American Association of the Advancement of Science, initiated in FY 2009, will be concluded in early FY 2011. The review will assess outcomes and major impacts of the program since FY 2000 and provide guidance to NSF on future directions. In FY 2010, an STC education directors workshop was held at which participants shared evaluation resources and exchanged information on how to strengthen the contributions of STCs to K-16 science education. In addition, a Committee of Visitors (COV) for the STC program will be convened in FY 2011 to assess the quality and integrity of program execution.
- OIA will convene a Committee of Visitors for MRI in FY 2010 to assess the quality and integrity of program execution. The 2005 MRI COV report found that the MRI program supports "extremely high-risk projects that present important opportunities to explore new scientific ideas." The FY 2010 COV will also review how results from MRI-funded activities advance NSF's mission and strategic goals. In FY 2010, OIA plans to initiate an assessment of the accumulative impact of MRI investments on science and engineering across the full range of NSF-supported disciplines. OIA also plans to conduct site visits to selected institutions as part of OIA's post-award management of awards funded through the American Recovery and Reinvestment Act of 2009 (ARRA).
- Oversight and reviews of awards for the Academic Research Infrastructure competition (a one-time initiative called for in ARRA) will be undertaken in FY 2011 to ensure that NSF and ARRA-specific post-award requirements are met.
- EPSCoR will identify and charge an independent, external organization with conducting an evaluation of the NSF EPSCoR program. This evaluation will focus on progress in research competitiveness, infrastructure development, broadened participation in science and engineering, and STEM workforce development within EPSCoR jurisdictions. Eligibility criteria for participation in NSF EPSCoR programs will be examined to identify changes that would enhance the effectiveness of the NSF EPSCoR investment toward strengthening research and education in science and engineering throughout the United States.

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)

$154,360,000
+$7,240,000 / 4.9%

EPSCoR Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 ARRA Estimate[1]	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
EPSCoR	**$133.00**	**$30.00**	**$20.00**	**$147.12**	**$154.36**	**$7.24**	**4.9%**
Co-Funding	41.14	-	-	31.18	41.00	9.82	31.5%
Outreach	0.54	-	-	1.50	1.50	-	-
Research Infrastructure Improvement (RII)	91.31	30.00	20.00	114.44	111.86	-2.58	-2.3%

Totals may not add due to rounding.

[1] Within EPSCoR, NSF carried forward $20.0 million from the ARRA appropriation because solicitations occurred late in FY 2009. Awards will be made during FY 2010.

EPSCoR utilizes three major investment strategies to achieve its goal of improving the R&D competitiveness of researchers and institutions within EPSCoR jurisdictions. These strategies are:

- **Research Infrastructure Improvement (RII):**
  RII Track-1 awards provide up to $4.0 million per year for up to five years. They are designed to improve the research competitiveness of jurisdictions by strengthening their academic research infrastructure in areas of science and engineering supported by the National Science Foundation and critical to the particular jurisdiction's science and technology initiative or plan. These scientific and engineering areas are identified by the jurisdiction's EPSCoR governing committee as having the best potential to improve the jurisdiction's future R&D competitiveness.

  RII Track-2 awards provide up to $2.0 million per year for up to three years as collaborative awards to consortia of EPSCoR jurisdictions to support innovation-enabling cyberinfrastructure of regional, thematic, or technological importance. These awards facilitate the enhancement of discovery, learning, and economic development of EPSCoR jurisdictions through the use of cyberinfrastructure and other technologies.

- **Co-Funding of Disciplinary and Multidisciplinary Research:**
  EPSCoR co-invests with NSF directorates and offices in the support of meritorious proposals from individual investigators, groups, and centers in EPSCoR jurisdictions that are submitted to the Foundation's research and education programs, and crosscutting initiatives. These proposals are merit reviewed in NSF disciplinary programs and recommended for award, but cannot be funded without the combined, leveraged support of EPSCoR.

- **Outreach and Workshops:**
  The EPSCoR Office solicits requests for support of workshops, conferences, and other community-based activities designed to explore opportunities in emerging areas of science and engineering, and to share best practices in strategic planning, diversity, communication, cyberinfrastructure, evaluation, and other capacity-building areas of importance to EPSCoR jurisdictions.

In general, 65 percent of the EPSCoR portfolio is available for new research awards. The remaining 35 percent funds continuing awards made in prior years.

Factors Influencing the Allocation Across EPSCoR

The allocation across EPSCoR program activities reflects the relative reach and impact of these investment strategies that are designed to catalyze sustainable growth in research competitiveness across EPSCoR jurisdictions. The FY 2011 decrease to RII and increase in Co-funding activities relative to the FY 2010 funding level reflects a rebalancing of the EPSCoR portfolio following full implementation of RII Track-2 and the ARRA-supported RII Intercampus and Intracampus Cyber Connectivity programs in FY 2009 and FY 2010. The FY 2011 Request level of $154.36 million for EPSCoR is consistent with the three-year growth trend for the R&RA account for FY 2009 through FY 2011.

- RII awards support complex, multifaceted, statewide activities that develop the human, physical, and cyberinfrastructure essential to building the capacity of institutions and investigators to compete more effectively for NSF research funding. These awards broaden participation in STEM activities by institutions and individuals, foster collaborative partnerships, and promote development of a technically engaged workforce.

- Co-funding facilitates broader integration of EPSCoR scientists and engineers in the entire spectrum of Foundation research and education programs and initiatives. This strategy is implemented with particular attention to proposed research projects that develop human and physical infrastructure.

- Outreach travel to EPSCoR jurisdictions enables NSF staff from all directorates and offices to work with the EPSCoR research community regarding NSF opportunities, priorities, programs, and policies. Such travel also serves to more fully acquaint NSF staff with the science and engineering accomplishments, ongoing activities, and new directions and opportunities in research and education in EPSCoR jurisdictions.

Number of People Involved in EPSCoR Activities

	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2010 ARRA Estimate	FY 2011 Estimate
Senior Researchers	482	53	533	90	558
Other Professionals	222	83	246	25	256
Postdoctorates	72	-	80	10	84
Graduate Students	514	34	569	60	596
Undergraduate Students	442	3	489	60	512
K-12 Students[1]	-	-	-	-	600
K-12 Teachers[1]	-	-	-	-	1,829
Total Number of People	**1,732**	**173**	**1,917**	**245**	**4,435**

[1] Beginning in FY 2011, EPSCoR will begin reporting the number of K-12 students and teachers supported.

U.S. ARCTIC RESEARCH COMMISSION (USARC) $1,600,000

+$20,000 / 1.3%

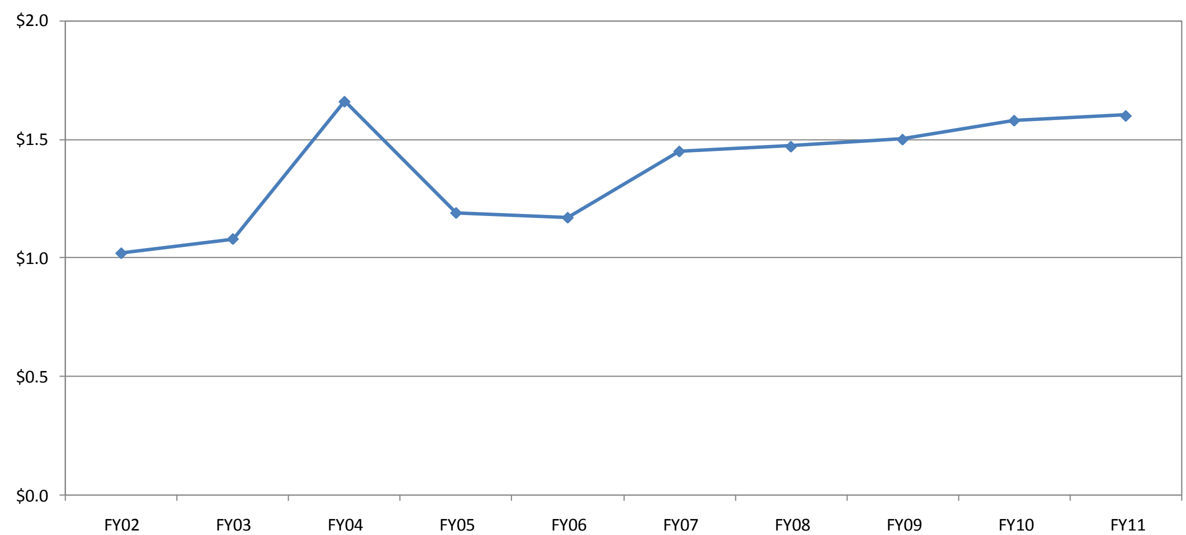
USARC Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Total, USARC	**$1.50**	**-**	**$1.58**	**$1.60**	**$0.02**	**1.3%**

USARC was created by the Arctic Research and Policy Act of 1984, (as amended, P. L. 101-609), to establish the national policy, priorities, and goals necessary to construct a federal program plan for basic and applied scientific research with respect to the Arctic, including natural resources and materials, physical, biological and health sciences, and social and behavioral sciences. This request provides funds to promote Arctic research, to recommend Arctic research policy, and to communicate research and policy recommendations to the rest of the Administration and the Congress, as well as supporting close collaboration with the National Science Foundation (NSF) as the lead agency responsible for implementing Arctic research policy and supporting cooperation and collaboration throughout the Federal Government. In addition, USARC gives guidance to the Interagency Arctic Research Policy Committee (IARPC) to develop national Arctic research projects and a five-year plan to implement those projects. USARC also supports interaction with Arctic residents, international Arctic research programs and organizations, and local institutions, including regional governments, in order to obtain the broadest possible view of Arctic research needs. USARC is an independent federal agency, funded through NSF's appropriations, specifically as an activity in the Research and Related Activities account.

The USARC is requesting an increase of $20,000 above the FY 2010 Estimate. Currently, there are four FTE funded at the USARC, with a total of seven compensated personnel authorized in P.L. 101-609.

U.S. Arctic Research Commission Funding
(Dollars in Millions)



Note: The increase in FY 2004 reflects a one-time recovery of $370,000.

DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES (EHR)

$892,000,000
+$19,240,000 / 2.2%

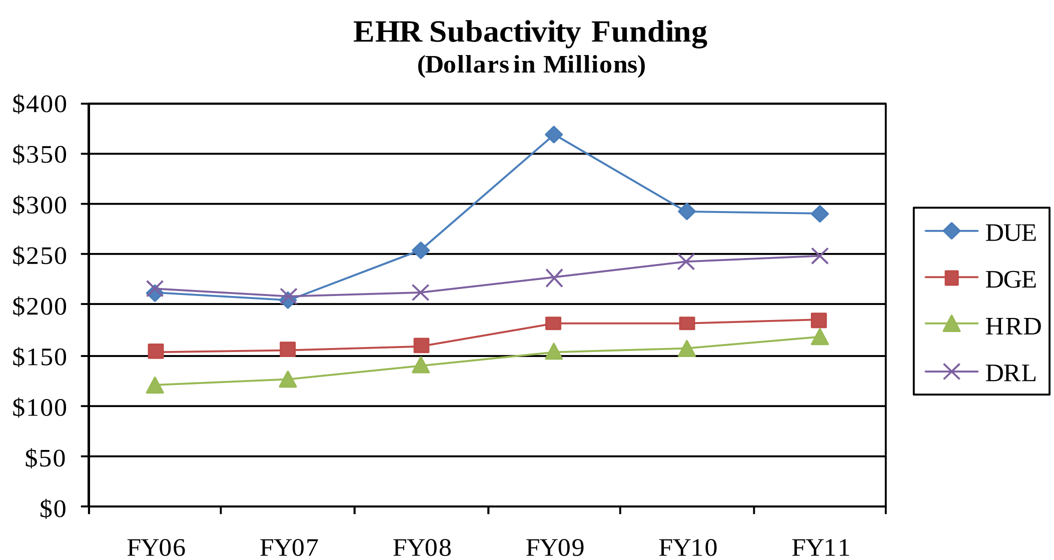
EHR Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual[1]	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Division of Human Resource Development (HRD)	$154.08	-	$156.91	$168.91	$12.00	7.6%
Division of Graduate Education (DGE)	181.67	-	181.44	185.26	3.82	2.1%
Division of Research on Learning in Formal and Informal Settings (DRL)	226.68	-	242.00	247.85	5.85	2.4%
Division of Undergraduate Education (DUE)	283.08	85.00	292.41	289.98	-2.43	-0.8%
Total, EHR	**$845.52**	**$85.00**	**$872.76**	**$892.00**	**$19.24**	**2.2%**
Research	178.74	-	191.24	191.44	0.20	0.1%
Education	638.45	85.00	650.80	668.73	17.93	2.8%
Infrastructure	15.24	-	15.98	15.71	-0.27	-1.7%
Stewardship	13.08	-	14.74	16.12	1.38	9.4%

Totals may not add due to rounding.

[1] NSF carried forward $15.0 million in ARRA appropriations for the Science Masters program. Awards will be made in FY 2010.

EHR promotes excellence in science, technology, engineering, and mathematics (STEM) education and learning in support of continued U.S. economic and research preeminence. The goal of EHR activities is to strengthen U.S. STEM learning at all levels, in both formal and informal learning environments. EHR promotes excellence in STEM education through its highest priorities: the development of a diverse and well-prepared workforce of scientists, technicians, engineers, mathematicians, and educators; creation of a well-informed citizenry; and the design, development, and evaluation of new tools, approaches, and models for learning. These priorities support access to the ideas and tools of science and engineering for all. EHR's investment in education, research, and infrastructure enhances the quality of life of all citizens and the health, prosperity, welfare, and security of the Nation while educating the STEM workforce of the future.



Appropriation Language

For necessary expenses in carrying out science, mathematics and engineering education and human resources programs and activities pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including services as authorized by 5 U.S.C. 3109, authorized travel, and rental of conference rooms in the District of Columbia, ~~$872,760,000~~*$892,000,000*, to remain available until September 30, ~~2011: *Provided*, That not less than $55,000,000 shall be available until expended for activities authorized by section 7030 of Public Law 110-69: Provided further, That not less than $32,000,000 shall be available until expended for the Historically Black Colleges and Universities Undergraduate Program~~*2012*.

Education and Human Resources
FY 2011 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Expired	Total Resources	Obligations Incurred/Est.
FY 2009 Omnibus	$845.26	$0.28		$845.54	$845.52
FY 2009 ARRA	100.00			100.00	85.00
FY 2010 ARRA	-	15.00		15.00	15.00
FY 2010 Estimate	872.76	0.02		872.78	872.78
FY 2011 Request	892.00			892.00	892.00
$ Change from FY 2010 Estimate					$19.22
% Change from FY 2010 Estimate					2.2%

Totals may not add due to rounding.

Explanation of Carryover

Regular Discretionary

Within the **Education and Human Resources (EHR)** appropriation, a total of $19,473 was carried forward into FY 2010.

American Recovery and Reinvestment Act of 2009 (ARRA)

Note: The ARRA chapter contains an obligation plan for all ARRA appropriated funds carried forward into FY 2010.

Within the **Education and Human Resources** appropriation, the Division of Graduate Education carried forward a total of $15.0 million for the Science Masters program.

- Reason for Carryover: Solicitation was issued late in FY 2009.
- Expected Obligation: Awards expected in Q2/Q3 FY 2010.

EHR in Context

Solving today's challenging education problems and anticipating tomorrow's learning opportunities are key to preparing a STEM workforce ready for innovation and a public informed about science in their lives. EHR provides national leadership by investing in research and development to build evidence, knowledge, and experience that serve as the basis for solving problems and creating opportunities for STEM learning.

The Nation's capacity for STEM innovation requires the full engagement of all people in the Nation, including women, persons with disabilities, and members of groups historically underrepresented in STEM. Building the STEM workforce for tomorrow involves offering cutting-edge educational opportunities at all levels, focusing on both the interdisciplinary and specialized knowledge needed by Ph.D.-level scientists and K-12 teachers, and the general understanding of scientific inquiry needed by a STEM-literate populace.

President Obama has said, "the countries that out-teach us today will out-compete us tomorrow." Building and sustaining a K-12 STEM teaching force and equipping them with the most innovative and effective tools and models for their classrooms is essential to the Nation's future. It is also essential to improving student learning and performance on standards-based assessments both in mathematics and science. In this cyber age, methods and tools for learning can be accessed by any learner, at anytime, anywhere, and EHR is a leader in stimulating the research and development to bring such tools to learners effectively. All of this requires a foundation in research and evidence. This research base allows for strategic investments in development of innovations with real promise of promoting learning. It also provides a sound basis for scaling-up the most effective innovations in collaboration with other agencies, such as the U.S. Department of Education.

EHR is key in enacting NSF's charge, in accordance with the NSF Act of 1950, as the principal federal agency to promote science and engineering (S&E) education. EHR supports projects across S&E disciplines, as well as efforts to prepare the workforce and citizenry in science and technology. Programs in the directorate support the design, development, implementation, and study of innovations in this cyber era. EHR programs feature strategic partnerships and collaborations; identification and development of the knowledge and skills needed for the workforce of tomorrow; and research on STEM learning and education. EHR programs emphasize the development of the workforce through scholarships and fellowships to graduate and undergraduate students in STEM fields and the preparation and continuing professional development of STEM teachers.

EHR is committed to participation in a coordinated STEM education research and evaluation agenda across the government. In particular, EHR is poised to build on previous and emerging collaborations with the U.S. Department of Education, and to use NSF's unique experience and knowledge base in STEM education to identify research and evaluation priorities and to consider appropriate standards of evidence for various stages of research and development cycles. Specifically, the two agencies are embarking jointly on possible collaborations and complementary initiatives to help states improve K-12 student learning in STEM by building and sharing knowledge of effective curricular and instructional practices, and how they can be implemented at scale.

Factors Influencing the Allocation Across Divisions and Major Programs

The EHR FY 2011 Request reflects the directorate's commitment to advancing three priority areas:

- *Preparing a STEM workforce ready to lead innovation and address national needs:* This requires the involvement of the full range of talent and diversity in the Nation. The EHR FY 2011 Request reflects a new investment ($103.10 million) within the Division of Human Resource Development (HRD) for a comprehensive program aimed at increasing participation of students from groups traditionally underrepresented in STEM. This effort will engage undergraduates at historically Black, Tribal, and Hispanic-serving institutions to build capacity by drawing on research and best practices across the range of institution types represented in HRD programs. It will realign and build on the existing undergraduate HRD programs: Historically Black Colleges and Universities-Undergraduate

Program (HBCU-UP), Louis Stokes Alliances for Minority Participation (LSAMP), and Tribal Colleges and Universities Program (TCUP).

- *Increasing the number of NSF graduate fellows*: This is essential in building the capacity of the future STEM workforce, a high priority for EHR and the Division of Graduate Education (DGE). In FY 2011, EHR continues to work toward the goal of tripling the number of new graduate research fellows by FY 2013.
- *Expanding evaluation activities, specifically to build capacity, tools, and methods in STEM education program evaluation, and for program improvement:* This is supported in FY 2011 by increased investment in the program evaluation activities of the Division of Research on Learning in Formal and Informal Settings (DRL). As part of the Administration's government-wide initiative to strengthen program evaluation, these resources will also allow cross-agency collaboration to improve STEM education program evaluation, particularly in the areas of teacher professional development and immersive science research experiences for teachers. Evaluation experts at the Office of Management and Budget and the Council of Economic Advisers will work with NSF, the Department Education, and other research agencies during the planning, design, and implementation of these STEM education studies.

In addition, efforts in the Division of Undergraduate Education (DUE) to transform undergraduate STEM education are sustained in FY 2011 through strategic focus in its core programs. This includes the identification of effective approaches to increasing undergraduate STEM program completion and entry into STEM or STEM-related fields. For instance, the Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) supports the adaptation and implementation of best practices that will lead to an increase in the number of students obtaining STEM degrees.

EHR Administration Priority Programs and NSF Investments

EHR Administration Priority Programs and NSF Investments

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Graduate Research Fellowship (GRF)	$107.00	-	$102.58	$107.58	$5.00	4.9%
Advanced Technological Education (ATE)	51.85	-	64.00	64.00	-	-
Climate Change Education Program (CCE)	9.95	-	5.50	5.50	-	-
Science, Engineering and Education for Sustainability (SEES)	N/A	N/A	11.50	12.00	0.50	4.3%
Cyberlearning Transforming Education (CTE)	N/A	N/A	25.33	25.33	-	-

In FY 2011, EHR will focus on NSF programs that support students and the next generation of environmentally engaged STEM scientists and engineers. The budget also invests in the education of technicians and critical priorities in climate change education.

Specific EHR investments include:

- *Graduate Research Fellowship (GRF) program:* The GRF program, housed in DGE, will focus on enhancements to the current reporting and communication system to effectively support the projected increase in the number of active fellows. As a component of NSF's High Priority Performance Goal on workforce, NSF will enhance the current reporting system to allow effective extraction of data from the reporting of annual activities on innovations and such research themes as climate change, clean energy, cyber science, and other emerging research areas. Total NSF funding for GRF increases by $22.32 million to $158.24 million and EHR's contribution increases by $5.0 million to $107.58 million, supporting the Administration priority to triple the number of new graduate research fellowships from 1,000 in FY 2008 to 3,000 by FY 2013.

- *Advanced Technological Education (ATE)*: ATE, housed in DUE and co-led by DRL, focuses on educating technicians who have the understanding, knowledge, and abilities to creatively support science and engineering. ATE expects to receive many proposals in a variety of energy fields that include all forms of alternative energy, including wind and solar power, biofuels, and alternative fuel vehicles. ATE program leaders will collaborate with representatives from other governmental agencies and will engage in a series of regional meetings about renewable energy and other related energy issues. As an Administration priority, this program is on a growth trajectory begun in FY 2010 to increase funding to $100.0 million by FY 2013. In FY 2011, ATE requests continued support of $64.0 million.
- *Climate Change Education (CCE):* As an Administration priority, the total NSF request for CCE remains at $10.0 million in FY 2011, including the EHR continuing contribution of $5.50 million. The Directorates for Geosciences (GEO) and Biological Sciences (BIO) and the Office of Polar Programs (OPP) are maintaining support for this multi-disciplinary, multi-faceted climate change education program to enable a variety of partnerships, including those among K-12 education, higher education, the private sector, and related non-profit organizations, in formal and informal settings, as well as relevant education and/or climate-related policymakers. A key goal will be to increase knowledge about the science of climate change in formal and informal learning settings. It will support individual investigators and multidisciplinary teams of STEM researchers and educators in a range of activities, including those local, regional, and/or global in scope.
- *Science, Engineering, and Education for Sustainability (SEES):* In FY 2011, EHR will invest $12.0 million in the NSF-wide Science, Engineering, and Education for Sustainability portfolio to integrate efforts in climate and energy science and engineering. EHR's investment will create and study efforts to inspire young people to pursue careers in renewable energy, sustainable development, and the environment. Additionally, STEM educators and researchers will participate in activities focused on integrating research into deliberations on pressing problems in renewable energy and sustainable development.
- *Cyberlearning Transforming Education (CTE):* EHR will invest $25.08 million in this new multidisciplinary program to fully capture the transformative potential of advanced learning technologies across the education enterprise. This will catalyze new approaches to STEM learning for students and for workforce development. Additionally, it will provide the pathways and resources to study the learning process itself. The total FY 2011 Request for CTE is $41.28 million and includes support from the Directorates for Computer and Information Science and Engineering (CISE) and Social, Behavioral, and Economic Sciences (SBE). EHR's investment is focused through the following programs: Discovery Research K12 (DR-K12), $4.08 million; Informal Science Education (ISE), $2.50 million; Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (TUES), $1.50 million (this program was formerly known as Course, Curriculum and Laboratory Improvement (CCLI)); Centers of Research Excellence in Science and Technology (CREST), $1.0 million; and the National STEM Education Distributed Learning (NSDL) program's budget of $16.0 million.

For more information on Administration priority programs and NSF investments, please refer to the Overview and NSF-wide Investments chapters.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

All EHR programs require project-level evaluation, and findings from these are aggregated and considered in program-level strategic planning and refinement at the program and division level. In addition, program evaluations are ongoing to assess program quality and impact, and the results of these formative and summative evaluation activities are essential in the continued shaping of program directions and emphases. See the Performance Information chapter for additional information.

To ensure the quality of EHR's processes for handling proposals and recommending proposals for awards, EHR convenes Committees of Visitors (COV) comprised of expert external evaluators to review all programs every three years. In FY 2011, COV reviews are scheduled for DRL (Informal Science Education (ISE) and Innovative Technology Experiences for Students and Teachers (ITEST), DUE (Math and Science Partnership (MSP) and the Robert Noyce Teacher Scholarship (NOYCE) Program), DGE (Graduate STEM Fellows in K-12 Education (GK-12) and Integrative Graduate Education and Research Traineeship Program (IGERT), and HRD (Louis Stokes Alliances for Minority Participation (LSAMP)).

Number of People Involved in EHR Activities

	FY 2009 Omnibus Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	7,720	832	8,130	8,100
Other Professionals	2,388	111	2,570	2,600
Postdoctorates	279	-	470	450
Graduate Students	7,320	1,650	8,645	8,800
Undergraduate Students	5,335	680	5,365	5,500
K-12 Students	12,500	500	12,470	12,500
K-12 Teachers	62,060	1,075	62,150	62,200
Total Number of People	**97,602**	**4,848**	**99,800**	**100,150**

DIVISION OF HUMAN RESOURCE DEVELOPMENT (HRD) $168,910,000 +$12,000,000 / 7.6%

HRD Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Total, HRD	**$154.08**	-	**$156.91**	**$168.91**	**$12.00**	**7.6%**
Undergraduate/Graduate Student Support	87.02	-	90.10	103.10	13.00	14.4%
Research and Education Infrastructure	47.59	-	47.28	47.28	-	-
Opportunities for Women and Persons with Disabilities	19.46	-	19.53	18.53	-1.00	-5.1%

Totals may not add due to rounding.

HRD implements programs and activities that enhance the quantity, quality, and diversity of human capital engaged in U.S. science, technology, engineering, and mathematics (STEM). A principal focus of HRD is to ensure access to and full participation in STEM through increased, improved, and diversified opportunities; enhanced quality in the educational experience; and hands-on research experiences. In particular, HRD plays a central role in increasing opportunities in STEM education for individuals from historically underserved populations - minorities, women and persons with disabilities - and supports the development of the educators, researchers, and institutions dedicated to serving these populations. HRD programs also build a research knowledge base about effective practices in achieving these goals.

HRD programs are funded through three budget lines: Undergraduate and Graduate Student Support; Research and Education Infrastructure; and Opportunities for Women and Persons with Disabilities. Previously, the Undergraduate and Graduate Student Support line included the Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), the Louis Stokes Alliances for Minority Participation (LSAMP), and the Tribal Colleges and Universities Program (TCUP). In FY 2011, HRD will combine these graduate and undergraduate student programs into a single underrepresented group program as discussed further in the following section. The Research and Education Infrastructure line includes the Alliances for Graduate Education and the Professoriate (AGEP) and the Centers of Research Excellence in Science and Technology (CREST) program. The Opportunities for Women and Persons with Disabilities line includes ADVANCE, the Research in Disabilities Education (RDE) program, and the Research on Gender in Science and Engineering (GSE) program.

Factors Influencing the Allocation Across HRD Programs

In FY 2011, HRD will continue leadership in broadening participation in the Nation's science and engineering enterprise of all persons historically underserved and underrepresented – minorities, women, and persons with disabilities. HRD also gains insight from programs that have established records of increasing access and opportunity for learning and research for minority students pursuing STEM careers. With a FY 2011 investment of $103.10 million, HRD will implement a new consolidated program, which realigns and builds on the existing undergraduate HRD programs HBCU-UP, LSAMP, and TCUP. As authorized in Section 7033 of the America COMPETES Act, this effort will invite proposals from Hispanic-serving institutions (HSIs). Support for this program underscores HRD's mission of broadening participation and workforce development from the undergraduate level to terminal employment.

Realignment of HRD Programs

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Historically Black Colleges and Universities Undergraduate Program	$31.13	-	$32.00	-	-$32.00	N/A
Louis Stokes Alliances for Minority Participation	42.50	-	44.75	-	-44.75	N/A
Tribal Colleges and Universities Program	13.39	-	13.35	-	-13.35	N/A
Comprehensive Broadening Participation of Undergraduates in STEM	-	-	-	103.10	103.10	N/A
Total, Realigned Programs	$87.02	-	$90.10	$103.10	$13.00	14.4%

Totals may not add due to rounding.

The overall objective of this new program is to engage undergraduates at historically Black colleges and universities, Tribal colleges and universities, and HSIs. It will also build capacity by drawing on research and best practices across the range of institution types represented in HRD programs. Investments in this area can lead to strong alliances and high-quality institutional efforts to broaden participation.

A comprehensive HRD undergraduate program that is enabling to all minority-serving and majority institutions focusing on minority undergraduate student STEM education will cultivate a world-class broadly inclusive science and engineering workforce. By building on and realigning existing undergraduate programs, this approach:

- Combines expertise developed previously in separate programs in order to promote opportunities to build sustainable partnerships and alliances among the historically black colleges and universities, Hispanic-serving institutions, tribal colleges and universities, and Louis Stokes Alliances for Minority Participation institutions with strong track records in producing underrepresented STEM graduates, thereby building capacity for the STEM field across a range of institutions.
- Promotes strengthening of STEM curricular offerings, enhancements in STEM faculty development, and increases in competencies and competitiveness of students at minority-serving institutions and majority institutions with strong track records in producing underrepresented STEM graduates.
- Supports transformation of the infrastructure, operations, and resources at minority-serving institutions to promote excellence in science and engineering education and research across the Nation's largest producers of underrepresented STEM graduates at the baccalaureate level.
- Increases support for and engagement in frontier scientific research and access to advanced research instrumentation for STEM faculty and students at minority-serving institutions in preparation for global competitiveness.
- Stimulates innovation and creativity from the Nation's education and research enterprise through support of effective collaborations between minority–serving and majority institutions, especially research-intensive universities with NSF Science and Technology Centers (STC), Materials Research Science and Engineering Centers (MRSEC), and Engineering Research Centers (ERC).
- Maximizes undergraduate research opportunities across the nation's minority-serving and majority institutions for students underrepresented in STEM fields.
- Facilitates expanded collaboration between scientists and educators at minority-serving institutions with those at majority institutions increasing the effectiveness of STEM education.

DIVISION OF GRADUATE EDUCATION (DGE) $185,260,000
+$3,820,000 / 2.1%

DGE Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual[1]	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Total, DGE	**$181.67**	**-**	**$181.44**	**$185.26**	**$3.82**	**2.1%**
Graduate Research Fellowship Program	107.00	-	102.58	107.58	5.00	4.9%
Graduate STEM Fellows in K-12 Education	49.26	-	49.00	48.18	-0.82	-1.7%
Integrative Graduate Education and Research Traineeship	25.41	-	29.86	29.50	-0.36	-1.2%

Totals may not add due to rounding.

[1] NSF carried forward $15.0 million in ARRA appropriations for the Science Masters program. Awards will be made in FY 2010.

DGE supports U.S. graduate students and innovative graduate programs that prepare tomorrow's leaders in science, technology, engineering and mathematics (STEM). DGE meets its objectives through a portfolio of three graduate education programs that vary in their designs and in the options and opportunities provided to graduate students. All three programs are funded NSF-wide and managed by DGE.

- *The Graduate Research Fellowship program*, established in early years of NSF, provides the Nation's most promising graduate students with great flexibility in selecting the university of their choice and gives them the intellectual independence to follow their research ideas unfettered by the exigencies of mode of support. With the addition of 2,000 new fellows in FY 2011, the GRF program will have an estimated 6,700 fellows. Of these, it is anticipated that an estimated 3,400 will choose to receive a stipend and cost-of-education (COE) allowance in FY 2011; fellowships provide students up to three years of support over a five year period.
- *The Graduate STEM Fellows in K-12 Education (GK-12)* program supports 875 graduate students in STEM disciplines and provides associated training that enables them to acquire additional skills that will broadly prepare them for professional and scientific careers. Through interactions with teachers and students in K-12 schools, graduate students improve their communication and teaching skills while enriching STEM education in these schools.
- *The Integrative Graduate Education and Research Traineeship (IGERT)* program, based on transformative interdisciplinary research, provides 1,500 doctoral students with a strong collaborative research foundation, innovative educational programs to help them cross disciplinary boundaries, and development of personal and professional skills to prepare them for careers of the future.

Factors Influencing the Allocation Across DGE Programs

- Funding graduate education of the future leaders in STEM is the division's top priority.
- Each of the three programs has ongoing program-level evaluations and follow-up studies of program graduates that will inform both program structure and funding.
- Because the GRF program is an Administration priority program, funding increases are requested to continue this program on its path to triple the number of new fellowships awarded by FY 2013.

DIVISION OF RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS (DRL) $247,850,000 +$5,850,000 / 2.4%

DRL Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Total, DRL	**$226.68**	**-**	**$242.00**	**$247.85**	**$5.85**	**2.4%**
Discovery Research K-12	108.41	-	118.50	118.73	0.23	0.2%
Informal Science Education	65.72	-	66.00	64.40	-1.60	-2.4%
Research and Evaluation on Education in S&E	42.60	-	45.50	45.72	0.22	0.5%
Project and Program Evaluation	9.94	-	12.00	19.00	7.00	58.3%

Totals may not add due to rounding.

DRL invests in research, evaluation, and development to improve the learning and teaching of science, technology, engineering, and mathematics (STEM). DRL's core programs fund research and development from preschool to graduate school and from museums to cyberspace. DRL is concerned with STEM learners of all ages and audiences of all types, ranging from adults interested in science, to STEM teachers, to after-school program providers. The division is organized in three clusters: Lifelong Learning; Knowledge Building; and Resources, Models, and Tools. These clusters provide intellectual direction and operational coordination for the division's programs and activities.

Funding at the requested level enables DRL to position its entire portfolio to address critical challenges and emerging new opportunities in STEM education and learning. The division's investment priorities are shaped by such ongoing educational challenges as reaching *all* learners with substantive opportunities to engage in STEM, and bringing effective STEM learning innovations to scale. In addition, tomorrow's imminent challenges, such as learning in cyber environments, blurring the boundaries between formal and informal learning settings, and learning about the impact of STEM education investments through innovative evaluation techniques, are equally important to the division. DRL areas of emphasis in FY 2011 will include research and development on cyberlearning, public understanding of current key topics such as climate change and clean energy, and the preparation and professional development of providers of STEM education.

Focus on STEM program evaluation design, research, and implementation is a high priority for the division with this Budget Request. The Division will expand programmatic activity to enrich the tools, methods, and designs available for innovation in the evaluation of STEM learning programs and projects. In addition, DRL will assume a key role within EHR for building capacity and expertise in STEM education program evaluation and will be deeply engaged in collaborations with the U.S. Department of Education and other agencies in the planning and implementation of cross-agency evaluation efforts in STEM teacher professional development.

Factors Influencing the Allocation Across DRL Programs

- The increased allocation for Project and Program Evaluation (PPE) will enable the division to issue a solicitation calling for research and development work that can expand capacity in the STEM education field for engaging in innovative, cyber-oriented program evaluation. In addition, this increase will allow enhanced efforts at capacity building, study, and piloting of performance management systems in a diverse set of STEM education programs.

- Increased resources (+$6.0 million) for two program evaluations under the government-wide evaluation initiative will also allow EHR/DRL to play a leading role in cross-agency collaborations to design and undertake STEM education program evaluation. NSF and the Department of Education's Institute of Education Science will design and conduct a rigorous study of mathematics professional development for teachers that focuses on fraction topics at grade four and possible adjacent grades. The study will address the effectiveness of such professional development and why, for whom, and under what conditions the professional development is likely to be effective. NSF will also lead a multi-agency effort to design an impact study on immersive science research experiences for teachers by funding planning and initial data collection and design activities. With increased resources for PPE, the Research and Evaluation on Education in Science and Engineering (REESE) program will scale back its investments in evaluation research and increase its focus on building a research knowledge base across the cognitive, learning, and STEM education sciences for advances in cyberlearning, interdisciplinarity, and policy.
- The Discovery Research K-12 (DR-K12) and REESE programs will coordinate closely in sharpening emphasis areas, so that the knowledge base developing through REESE-funded research supports and helps improve the research and development for resources, models, and tools in DR-K12 that anticipate the learner and learning environment of the future.
- The Informal Science Education (ISE) program will focus its portfolio in concert with recommendations in the recent National Research Council synthesis study, *Learning Science in Informal Environments: People, Places, and Pursuits*, which calls for increased emphasis on research and development to build the knowledge base about learning in informal settings. It also will heighten program focus on climate change and cyberlearning.

DIVISION OF UNDERGRADUATE EDUCATION (DUE) $289,980,000

-$2,430,000 / -0.8%

DUE Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
Total, DUE	**$283.08**	**$85.00**	**$292.41**	**$289.98**	**-$2.43**	**-0.8%**
Curriculum, Laboratory and Instructional Development	66.13	-	63.46	$61.03	-$2.43	-3.8%
Workforce Development	100.96	-	115.73	115.73	-	-
Teacher Education	115.99	85.00	113.22	113.22	-	-
Selected Programs:						
Advanced Technological Education	*51.85*	-	*64.00*	*64.00*	-	-
Climate Change Education	*9.95*	-	*5.50*	*5.50*	-	-
Robert Noyce Teacher Scholarship Program	*55.00*	*60.00*	*55.00*	*55.00*	-	-
Math and Science Partnership	*60.99*	*25.00*	*58.22*	*58.22*	-	-

Totals may not add due to rounding.

DUE is the NSF focal point for transforming undergraduate STEM education to meet the needs of the 21st century. DUE's objectives are to strengthen the science and engineering workforce and prepare all undergraduate students for an increasingly technological global society. DUE programs emphasize innovation and ongoing improvement in curricula, teaching procedures, and laboratories, so that the next generation is continuously learning with the tools and methods of inquiry used by working professionals. Collaborations are encouraged among institutions and across sectors (higher education, industry, and K-12). So that best practices penetrate deeply into the undergraduate education community, DUE provides support for faculty development, support for new instructional materials, the reform of courses, laboratories, and curricula, and assessment of outcomes.

In addition to its core activity of improvement in undergraduate curriculum and teaching practice, DUE leads EHR's efforts in teacher education and cyberlearning. It contributes directly to the development of the scientific and technical workforce via the Advanced Technological Education (ATE) and the Federal Cyber Service: Scholarship for Service (SfS) programs. The STEM Talent Expansion Program (STEP) further contributes to the Nation's technical workforce by increasing the number of students completing STEM degrees.

Factors Influencing the Allocation Across DUE Programs

DUE's FY 2011 funding request, especially the ATE program, specifically supports the commitment to workforce development, by continuing funding at the level to which it was substantially increased in FY 2010. Support will enable the expansion of critical work with two-year colleges and increase capacity to fund clean energy-related projects.

DUE programs were historically funded through two budget lines. Included in the Curriculum, Laboratory and Instructional Development line were the Course, Curriculum, and Laboratory

Improvement program (CCLI), renamed in FY 2010 to Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (TUES), the National STEM Education Distributed Learning (NSDL) program, and STEP. Workforce Development included ATE, SfS, the Robert Noyce Teacher Scholarship Program (NOYCE), the Excellence Awards in Science & Engineering (EASE), and beginning in FY 2009, Climate Change Education (CCE). When the Math and Science Partnership (MSP) program was transferred to DUE in FY 2008, it came as its own budget line.

DUE requests that, beginning in FY 2011, its programs be realigned to better reflect their foci, as follows:

- Re-title the budget line previously titled Math and Science Partnership as Teacher Education, and assign the NOYCE program to that line. Together MSP and NOYCE broadly address the well-documented national need to increase the pool of qualified STEM teachers in K-12;
- Move STEP from Curriculum, Laboratory, and Instructional Development to Workforce Development to better reflect its explicit goal of increasing the STEM pipeline; and
- Move CCE from Workforce Development to Curriculum, Laboratory, and Instructional Development, to better reflect that its awards will focus on instructional approaches to advancing climate change education.

All DUE programs address the Administration priority of building the STEM workforce by addressing the critical juncture between K-12 education and adult working competencies, but it is useful to manage the funds at the division level based on the nature of the approaches taken, or in the case of Teacher Education, to reflect the total commitment to this critical special workforce. The realignment requested provides a more realistic account of the focus of each program.

H-1B NONIMMIGRANT PETITIONER FEES **$100,000,000** **+$0/0%**

In FY 2011, H-1B Nonimmigrant Petitioner Fees are projected to be $100.0 million, equal to the FY 2010 projection.

H-1B Nonimmigrant Petitioner Fees Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Estimate	Change over FY 2010 Estimate Amount	Percent
H-1B Nonimmigrant Petitioner Fees Funding	$89.08	-	$100.00	$100.00	-	-

Beginning in FY 1999, Title IV of the American Competitiveness and Workforce Improvement Act of 1998 (P.L. 105-277) established an H-1B Nonimmigrant Petitioner Account in the general fund of the U.S. Treasury for fees collected for each petition for alien nonimmigrant status. That law required that a prescribed percentage of funds in the account be made available to NSF for the following activities:

- **Computer Science, Engineering, and Mathematics Scholarships (CSEMS)**. The program supported grants for scholarships to academically-talented, financially needy students pursuing associate, baccalaureate, or graduate degrees in computer science, computer technology, engineering, engineering technology, or mathematics. Grantee institutions awarded scholarships of up to $2,500 per year for two years to eligible students.
- **Grants for Mathematics, Engineering, or Science Enrichment Courses.** These funds provided opportunities to students for enrollment in year-round academic enrichment courses in mathematics, engineering, or science.
- **Systemic Reform Activities.** These funds supplemented the rural systemic reform efforts administered under the former Division of Educational System Reform (ESR).

In FY 2001, Public Law 106-311 increased the funds available by increasing the petitioner fees. Also, the American Competitiveness in the 21st Century Act (P.L. 106-313) amended P.L. 105-277 and changed the way petitioner fees were to be expended.

- The CSEMS activity continued under P.L. 106-313 with a prescribed percentage of H-1B receipts. The maximum scholarship duration was four years and the annual stipend was $3,125. Funds for this scholarship program totaled 59.5 percent of the total H-1B funding for NSF.
- Private-Public Partnerships in K-12: P.L. 106-313 directed the remaining 40.5 percent of receipts toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, and mathematics and science teacher professional development.
- Information Technology Experiences for Students and Teachers (ITEST) developed as a partnership activity in K-12 to increase opportunities for students and teachers to learn about, experience, and use information technologies within the context of STEM, including Information Technology (IT) courses.

In FY 2005, Public Law 108-447 reauthorized H-1B funding. NSF was provided with 40 percent of the total H-1B receipts collected. Thirty percent of H-1B receipts (75 percent of the receipts that NSF receives) are to be used for the Low-income Scholarship Program. Ten percent of receipts (25 percent of the receipts that NSF receives) are designated for support of the Grants for Mathematics, Science, or Engineering Enrichment Courses.

Low-income Scholarship Program. Eligibility for the scholarships was expanded from the original fields of computer science, engineering, and mathematics to include "other technology and science programs designated by the Director." The maximum annual scholarship award amount was raised from $3,125 to $10,000. NSF may use up to 50 percent of funds "for undergraduate programs for curriculum development, professional and workforce development, and to advance technological education." Because of the changes, the program was renamed in 2006 from CSEMS to Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM).

Since its inception the low-income scholarship program has received approximately 2,906 proposals from all types of colleges and universities and has made awards for 1,015 projects. Approximately 53,000 students have received scholarships ranging from one to four years, and many new grants have yet to award all their scholarships. In addition to scholarships, projects include student support activities featuring close involvement of faculty, student mentoring, academic support, and recognition of the students. Such activities are important in recruiting and retaining students in high-technology fields through graduation and into employment. Approximately 90 awards are anticipated in FY 2011.

ITEST Grants for Mathematics, Science, or Engineering Enrichment Courses. The ITEST program invests in K-12 activities that address the current concern about shortages of STEM professionals and information technology workers in the U.S. and seeks solutions to help ensure the breadth and depth of the STEM workforce, including education programs for students and teachers that emphasize IT-intensive careers. The program supports the development, implementation, testing, and scale-up of models, as well as research studies to improve the STEM workforce and build students' capacity to participate in the STEM workforce, especially the information and communication technology (ICT) areas. The solicitation places emphasis on capturing and establishing a reliable knowledge base about the dispositions toward and knowledge about STEM workforce skills in U.S. students.

Since its inception, ITEST has received 1,325 proposals and funded over 200 projects that allow students and teachers to work closely with scientists and engineers on extended research projects, ranging from biotechnology to environmental resource management to programming and problem-solving. Projects draw on a wide mix of local resources, including universities, industry, museums, science and technology centers, and school districts in order to identify the characteristics that engage a wide range of young people in STEM, especially those not successful in traditional school settings. Through a projected $168 million federal investment, ITEST impacts an estimated 190,000 students (grades K-12), 6,800 educators, and 2,000 parents and caregivers. In FY 2009, ITEST received 222 full proposals and funded 31 awards.

H-1B Financial Activities from FY 1999 - FY 2009
(Dollars in Millions)

	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Receipts	**$26.61**	**$48.61**	**$88.34**	**$61.04**	**$65.34**	**$0.57**	**$83.68**	**$105.32**	**$107.36**	**$104.43**	**$88.66**
Obligations incurred:											
Computer Science, Engineering, and Mathematics Scholarships	0.26	23.16	68.37	34.69	25.30	33.91	0.54	80.95	100.04	92.40	61.22
Grants for Mathematics, Engineering or Science Enrichment Courses	-	0.20	4.22	5.83	16.27	-	-	-	-	-	-
Systemic Reform Activities	-	1.70	3.70	3.97	5.00	2.50	2.72	-	-	-	-
Private-Public Partnership in K-12[1/]	-	-	2.22	12.82	-	20.87	22.69	18.45	45.90	28.72	27.86
Total Obligations	**$0.26**	**$25.06**	**$78.51**	**$57.31**	**$46.57**	**$57.28**	**$25.95**	**$99.40**	**$145.94**	**$121.12**	**$89.08**
Unallocatted Recoveries											2.20
Unobligated Balance end of year	**$26.35**	**$49.89**	**$59.72**	**$63.45**	**$83.90**	**$29.10**	**$89.58**	**$98.19**	**$63.37**	**$50.83**	**$52.62**

Totals may not add due to rounding.

1/ P.L 106-313 directs that 15 percent of the H-1B Petitioner funds go toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, math and science teacher professional development, etc.

Explanation of Carryover

An amount totaling $52.62 million was carried over into FY 2010. NSF's carryover for H-1B funded programs consists of $45.06 million in S-STEM and $7.56 million in ITEST. (These amounts include $17.0 million in fourth quarter receipts received too late to be obligated by the end of the fiscal year.) All carryover funds were obligated in the first quarter of FY 2010.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

Major Research Equipment and Facilities Construction Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Major Research Equipment and Facilities Construction	$160.76	$254.00	$117.29	$165.19	$47.90	40.8%

The Major Research Equipment and Facilities Construction (MREFC) account supports the acquisition, construction, and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Initial planning and design, and follow on operations and maintenance costs of the facilities are provided through the Research and Related Activities (R&RA) account.

MREFC Account Funding, by Project
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate
AdvLIGO	$51.43	-	$46.30	$23.58	$20.96	$15.17	$14.92	-	-
ATST[1]			13.00	17.00	20.00	20.00	20.00	20.00	20.00
ARRV	14.13	148.07	-	-	-	-	-	-	-
ALMA	82.25	-	42.76	13.91	3.00	-	-	-	
IceCube	11.85	-	0.95	-	-	-	-	-	-
NEON	-	-	-	20.00	87.92	101.07	103.43	86.23	32.07
OOI	-	105.93	14.28	90.70	102.80	46.80	20.00	-	-
SPSM	1.10	-	-	-					
MREFC Account Total	**$160.76**	**$254.00**	**$117.29**	**$165.19**	**$234.68**	**$183.04**	**$158.35**	**$106.23**	**$52.07**

Totals may not add due to rounding.
[1]Funds appropriated for ATST through ARRA in FY 2009, totalling $146.0 million, were obligated in January 2010.

The future progress of some subfields of research depends heavily upon access to new generations of powerful research tools. Increasingly, these tools are large and complex, and have a significant information technology component.

In order for a project to be considered for MREFC funding, NSF requires that it represent an exceptional opportunity that enables research and education. In addition, the project should be transformative in nature in that it should have the potential to shift the paradigm in scientific understanding and/or infrastructure technology. The projects included in this budget request meet these criteria based on NSF and National Science Board (NSB) review.

All of the projects in the MREFC account have undergone major cost reviews to establish baseline definitions of each project's scope, budget, and schedule, as required by guidelines instituted by NSF over the last few years. Most recently, the projects that received funding through the American Recovery and Reinvestment Act of 2009 (ARRA), the Alaska Region Research Vessel (ARRV), the Ocean Observatories Initiative (OOI), and the Advanced Technology Solar Telescope (ATST), completed Final

Design Reviews and have subsequently received approval from the NSF Director and NSB to initiate construction.

In FY 2011, NSF requests funding to continue construction of four projects: Advanced LIGO (AdvLIGO), the Atacama Large Millimeter Array (ALMA), ATST, and OOI. In addition, NSF requests $20.0 million to initiate construction of the National Ecological Observatory Network (NEON).

NSF maintains a "no cost overrun" policy, which requires that each project's total cost estimate developed at the preliminary design stage include adequate contingency to cover all foreseeable risks, and further requires that any total project cost increases not covered by contingency be accommodated by reductions in scope. NSF senior management has instituted agency-wide procedures to assure that the cost tracking and management processes are robust and that the project management oversight has sufficient authority to meet this objective. If total project estimates for the current slate of projects are revised, NSF will identify potential mechanisms for offsetting any cost increases in accordance with this policy.

<u>Appropriation Language</u>

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including authorized travel, ~~$117,290,000,~~*$165,190,000,* to remain available until expended~~: *Provided*, That none of the funds may be used to reimburse the Judgment Fund~~.

Major Research Equipment and Facilities Construction
FY 2011 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Transfers	Total Resources	Obligations Incurred/ Estimated
FY 2009 Omnibus	$152.01	$66.48		$218.49	$160.76
FY 2009 ARRA	400.00			400.00	254.00
FY 2010 ARRA	-	146.00		146.00	146.00
FY 2010 Estimate	117.29	57.73		175.02	175.02
FY 2011 Request	165.19			165.19	165.19
$ Change from FY 2010 Estimate					-$9.83
% Change from FY 2010 Estimate					-5.6%

Totals may not add due to rounding.

<u>Explanation of Carryover:</u>

Regular Discretionary

Within the **Major Research Equipment and Facilities Construction (MREFC)** appropriation, a total of $57.73 million was carried forward into FY 2010. This includes:

Alaska Region Research Vessel (ARRV):	$33.23 million
Ocean Observatories Initiative (OOI):	$5.91 million
IceCube Neutrino Observatory (IceCube):	$7.39 million
South Pole Station Modernization (SPSM):	$1.20 million
Advanced Technology Solar Telescope (ATST):	$7.0 million
National Ecological Observatory Network (NEON):	$3.0 million

- Reason for Carryover: For continuing costs associated with multi-year construction project.
- Expected Obligation: Funds will be obligated and expended over the remaining period of construction.

American Recovery and Reinvestment Act of 2009 (ARRA)

Within the **Major Research Equipment and Facilities Construction** appropriation, a total of $146.0 million was carried forward for the Advanced Technology Solar Telescope (ATST).

- Reason for Carryover: Cooperative agreement currently being implemented. Approved by NSB in August.
- Obligated: January 2010.

<u>The MREFC Account in FY 2011:</u>

The following pages contain information on NSF's ongoing and requested projects in FY 2011, organized by sponsoring directorate. These are:

BIOLOGICAL SCIENCES

The National Ecological Observatory Network $20,000,000

The FY 2011 Budget Submission for the National Ecological Observatory Network (NEON) is $20.0 million, which represents the first year of a five-year project that spans six fiscal years and totals an estimated $433.72 million.

Appropriated and Requested MREFC Funds for the National Ecological Observatory Network
(Dollars in Millions)

	Prior Years[1]	FY 2009	FY 2010 Estimate	FY 2011 Request	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	Total Project Cost
Regular Appropriations	$3.00	-	-	$20.00	$87.92	$101.07	$103.43	$86.23	$32.07	$433.72
Total, NEON	**$3.00**	**-**	**-**	**$20.00**	**$87.92**	**$101.07**	**$103.43**	**$86.23**	**$32.07**	**$433.72**

[1] Per P.L. 110-161, $4.0 million was rescinded from prior year unobligated balances.

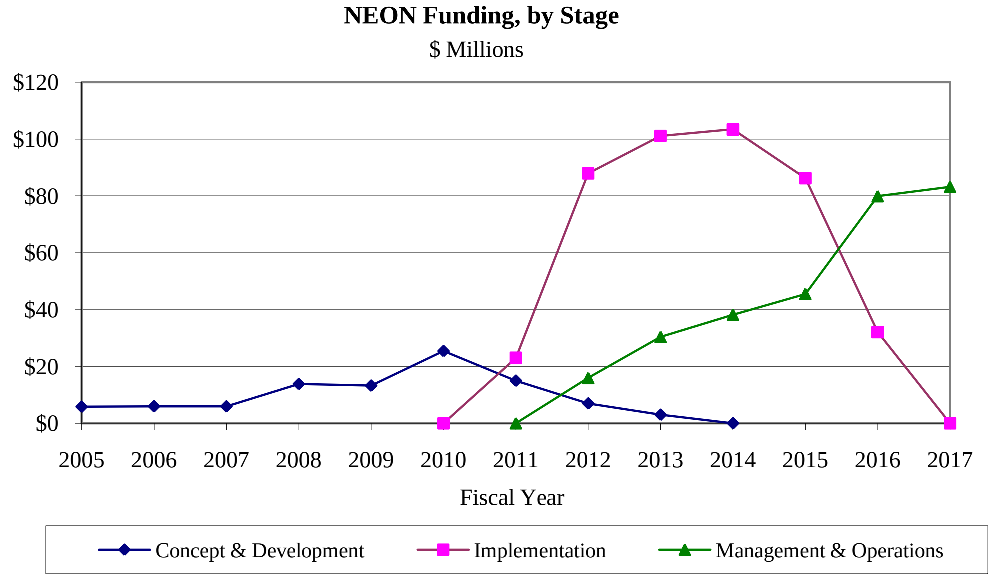
Baseline History: In 2004 the National Research Council (NRC) evaluated the original NEON design of loosely confederated observatories and recommended that it be reshaped into a single integrated platform for regional to continental scale ecological research. Congress appropriated a total of $7.0 million through the MREFC account for NEON in FY 2007 and FY 2008, $4.0 million of which was rescinded in FY 2008. At that time, the total estimated cost for construction was $100.0 million. A Preliminary Design Review (PDR) was completed in June 2009; a Final Design Review (FDR) was completed in November 2009; project planning will continue through FY 2010; and construction is scheduled to begin in 2011. A formal construction baseline review and cost review occurred as part of the Final Design Review (FDR) and an additional baseline review will be conducted in early FY 2011 prior to initiation of construction to ensure there are no significant changes to cost and the estimated schedule baselines.

NEON will consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research. Cutting-edge sensor networks, instrumentation, experimental infrastructure, natural history archive facilities, and remote sensing will be linked via the internet to computational, analytical, and modeling capabilities to create NEON's integrated infrastructure.

Total Obligations for NEON
(Dollars in Millions)

	Prior Years	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
R&RA Obligations:									
Concept & Development	$31.58	$13.26	$25.45	$15.00	$7.00	$3.00	-	-	-
Management and Operations	-	-	-	-	15.93	30.39	38.18	45.51	79.91
Subtotal, R&RA Obligations	31.58	13.26	25.45	15.00	22.93	33.39	38.18	45.51	79.91
MREFC Obligations:									
Implementation	-	-	-	23.00	87.92	101.07	103.43	86.23	32.07
Subtotal, MREFC Obligations	-	-	-	23.00	87.92	101.07	103.43	86.23	32.07
Total: NEON Obligations	**$31.58**	**$13.26**	**$25.45**	**$38.00**	**$110.85**	**$134.46**	**$141.61**	**$131.74**	**$111.98**

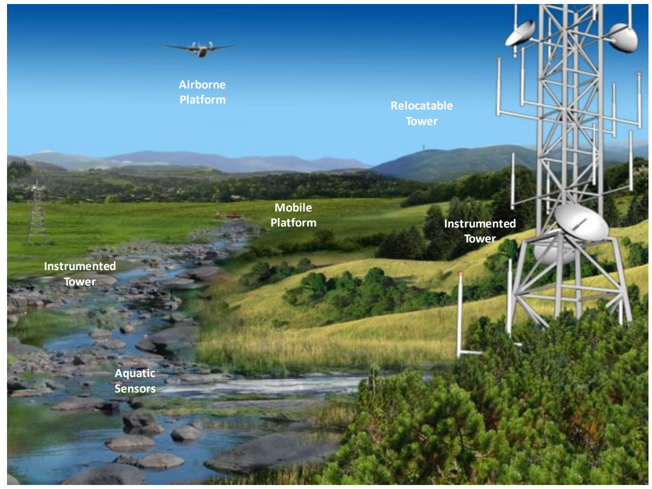
Totals may not add due to rounding.



Since NSF supports 63 percent of the fundamental environmental biology research at U.S. academic institutions, advances in the field of ecology and the infrastructure to enable those advances depend largely on support from NSF. Current research infrastructure is inadequate to enable studies to address the complex phenomena driving ecological change in real time and at the scales appropriate for studying many grand challenge questions in ecology. The Long Term Ecological Research (LTER) program is an ecosystem based research program. NEON is a research facility that will enable research at regional to continental scale. NEON infrastructure will be co-located at eleven LTER sites. When operational, NEON will not replace LTER, but will allow LTER researchers to expand the scale of their research to understand larger scale dynamics affecting their ecosystems. As a continent-wide research instrument, NEON will support a large and diverse group of organizations and individuals; foremost are the scientists, educators, and engineers who will use NEON infrastructure in their research and educational programs. A NEON cyberinfrastructure gateway will provide resources to support formal and informal public education and provide opportunities for citizens to participate in scientific investigations. Data from standard measurements made using NEON will be available in "near real time". The basic NEON datastreams will be open-access via web portals and available as soon as possible once basic QA/QC procedures have been applied.

Recent USGCRP assessments indicate that U.S. ecosystems will experience abrupt and unpredictable changes from a suite of human-driven processes in the near future. The Administration has identified these environmental issues as among the most important, demanding, and urgent global problems of our time, and scientific discovery and science-based decision making are critical to selecting mitigation and adaptation policies and strategies. NEON is the platform to provide the scientific foundation needed to address these environmental challenges, and the urgency of these issues to our national resources, economic vitality, health, quality of life, and national security supports beginning to build NEON in FY 2011. With a construction start in FY 2011, NEON will provide an unprecedented opportunity to detect environmental signals as early as FY 2012.

NEON will enable research on the impacts of climate and land use change, unsustainable water use, and invasive species on the Nation's living ecosystems at the temporal and spatial scales that are relevant to human well-being. NEON will be the first research platform and the only national experimental facility specifically designed to enable such basic research. All prior basic research infrastructure was designed



Caption: NEON infrastructure on the landscape will include sensors deployed on towers at the Core site, towers that can be relocated, mobile tower systems to study acute or episodic phenomena, below the soil, and in proximate water bodies such as streams or lakes. These sites will be sampled routinely by airborne sensing to permit the site based sensor information to be scaled to the landscape and regional scales. *Credit: CH2M Hill for the NEON Environmental Assessment.*

and deployed on an ad hoc, question-, mission-, or site basis. NEON is unique. Its statistically-determined, continental-scale design, with data products, data management, and standardization will support research on the dynamics of complex coupled systems needed for modeling and understanding rates of change on regional and continental scales. No other standalone system – federal or private – can provide the scientifically validated suite of data measurements that NEON anticipates providing. For example, federal operational agencies, such as EPA, provide comprehensive, sustained, and dependable observations in real time on a broad geographic basis, similar to the observations supporting the forecasts of the National Weather Service; these observations support information needs and forecasts for resource management. In contrast, NEON will provide infrastructure to enable hypothesis-driven basic biological and ecological research, with data and high-level data products available in close to real-time. NEON scientists will develop and use the latest technologies and sensors to push the envelope of knowledge. Just as NEON researchers will benefit from access to data from Federal Agency networks that provide spatial and temporal coverage of the US, so will federal agencies benefit as the techniques, sensors and knowledge gained through NEON-enabled activities migrate from research to societal applications and inform management decisions.

NSF and NEON, Inc. coordinate with other federal agencies through the NEON Federal Agency Coordinating Committee, Memorandum of Understanding (MOU), Memoranda of Agreements, and Cooperating Agency Agreements. Areas of coordination include planning, design, construction, deployment, environmental assessment, data management, geospatial data exchange, cyberinfrastructure, research, and modeling. In addition, NSF will continue to seek opportunities for new interagency and international partnerships. Examples of current partnerships include:

- Design: Jet Propulsion Laboratory (JPL) designed and is building the hyperspectral sensor for the NEON airborne observation platform;
- NEON infrastructure deployment sites: USDA Forest Service, USDA Agricultural Research Service, Bureau of Land Management, Department of Energy (DOE), and National Park Service;
- Sharing of geospatial data, in-situ verification, and archival of NEON aerial remote sensing data with the U.S. Geological Survey (USGS);
- Partners in research; modeling; data exchange, standards, and protocols: National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and Environmental Protection Agency (EPA); and
- International: Discussions have begun between NEON, Inc. and Mexican and Canadian scientists to broaden linkages with NEON and expand the research capability to the North American continent.

Private organizations (e.g., the Heinz Center, Nature Serve, and the Science and Engineering Alliance) participated in NEON design and development activities. The Science and Engineering Alliance and the Ecological Society of America are assisting NEON, Inc. with education and inclusion of minority serving institutions in NEON science and education. Building enhanced accessibility for all institutions into the design will broaden the impact of NEON science and education to the next generation of scientists and educators. While the bulk of NEON's infrastructure and instrumentation will be "commercial off-the-shelf", NEON's scientific and networking design required certain technological innovations. Consequently, BIO has provided Research and Related Activities funds for advanced research and development (R&D) activities in the areas of sensors and cyberinfrastructure.

Project Report:

Management and Oversight:

- NSF Structure: The NEON program is managed in the BIO Office of the Assistant Director (OAD/BIO) as part of Emerging Frontiers. OAD/BIO provides overall policy guidance and oversight, and the location of the NEON program in Emerging Frontiers fosters its interdisciplinary science connections. The NEON program is managed by a dedicated program officer. A business oversight team chaired by the NEON program officer advises and assists with the business framework of the project. A BIO-NEON committee, which includes the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA), and a cross-NSF Program Advisory Team (PAT), formulates program planning for NEON. The NEON program officer is the contracting officer's technical representative (COTR) for the NEON environmental assessment and is assisted by the NEON Environmental Assessment Team (EA) that provides technical advice on environmental assessment, National Environmental Policy Act (NEPA) compliance, and NSF environmental policy.

- External Structure: The NEON project is funded through cooperative agreements with NEON, Inc., a non-profit, membership-governed consortium, established to oversee the design, construction, management and operation of NEON for the scientific community. Within that organization, the CEO provides overall leadership and management; the project manager oversees all aspects of the project design, review, construction, and deployment; and the director of computing is responsible for oversight of the cyberinfrastructure and embedded sensor development. A Board of Directors, a Science, Technology, and Education Advisory Committee (STEAC) and a Program Advisory Committee (PAC), composed of members of the NEON user community, each provide oversight and guidance to the project and help ensure that NEON will enable frontier research and education.

- Reviews:

    - Technical reviews: The NEON Observatory Design Review (including site selection and deployment design) was successfully completed in February 2009.
    - Management, Cost, and Schedule reviews:
        - The Conceptual Design Review (CDR) was held in November 2006;
        - A combined Preliminary Design Review (PDR)/Final Design Review (FDR) of the airborne observation platform was successfully completed in February 2009;
        - A PDR for the entire project was successfully completed in June 2009;
        - An FDR was successfully completed in November 2009, including construction and cost reviews;
        - An operations review of the project's operating plan and anticipated budget is scheduled for April 2010; and
        - An additional baseline review, to ascertain readiness to begin construction, is scheduled for FY 2011 prior to construction.

Current Project Status:

In November 2009, the final design, scope, schedule, and risk-adjusted costs were reviewed and the project's baseline scope, budget, and schedule were found to be credible. The review panel endorsed the remaining pre-construction planning activities slated for this year that will enable the project to commence construction should the proposed FY2011 budget be available. Following the recommendations of the FDR panel, contingency has been increased to cover known risks. The NEON, Inc. Project Office has completed the final design, NEON project execution plan (PEP), and maintenance and operations plan. The site selection and associated deployment plan is complete and has been merit reviewed. The NEPA environmental assessment was completed in November 2009 and a "Finding of No Significant Impact" was signed by NSF in December 2009. This will allow construction to commence as soon as MREFC funds are available.

Cost and Schedule:

The projected length of the project is five years covering six fiscal years, with a six-month schedule contingency. The risk adjusted cost of $433.72 million includes a contingency budget of 19 percent.

Support is requested through the Research and Related Activities (R&RA) account for the NEON Project Office, housed in Emerging Frontiers (EF). R&RA funds will be used to scale up final project activities, including retiring risk and completing detailed construction-ready design documents. Activities include establishment of the NEON Calibration/Validation Laboratory for sensors and instrumentation; advanced design for the first six NEON domains and all NEON core sites; and biological assessment and permitting for the first six domains.

Funding appropriated through the MREFC account in FY 2008 will continue to be carried over. Contingent on approval of a construction award by the NSB, MREFC funds will be used to begin construction of NEON in the fourth quarter of FY 2011. Early construction focuses on establishment of the NEON Data Center and beginning construction of two domains.

NEON project planning will continue through FY 2010, and construction will begin in 2011.

Risks:

- Technical: Dependence on commercial off-the-shelf technology will be mitigated by long-lead purchase orders and alternative vendors. Production quality, embedded and system-level cyberinfrastructure will be addressed by a combination of "in-house" design, commercial, contracts, and targeted research (e.g., cyber-dashboard).

- Deployment: Environmental assessment and permitting may impact schedule and costs. These risks have been and continue to be addressed through multiple means, including: the direct contracting of the environmental assessment by NSF; the hiring of two national firms by NEON, Inc. for engineering and permitting; by identification of alternative sites if the primary sites are determined to have significant risk; and the allocation of two full-time equivalents (FTE) by the U.S. Forest Service to assist with environmental compliance issues on Forest Service lands.

- Geospatial Data Acquisition: A potential risk is the long-term availability of satellite (e.g., LANDSAT and MODIS) borne sensors. This risk is mitigated through a partnership with the USGS EROS Data Center that has the federal responsibility for curation and management of LANDSAT and MODIS images and having alternative satellite sensor sources to purchase images (e.g., SPOT -

France, AWIFS – India, Terra and Aqua - US). The proposed NEON airborne observatory platform (AOP) sensor system design and aircraft availability are a source of technical and implementation risk. To minimize this risk, the AOP is being developed by the Jet Propulsion Laboratory (JPL); similar instrument packages are being prototyped by NASA and Carnegie Mellon Institute at Berkley University. The sensor system fits multiple aircraft, including commercial aircraft. Experienced flight design engineers were contracted by NEON, Inc. to provide the baseline operations plans, aircraft analysis, and assessment of commercial companies that could support NEON flight operations and experienced research aircraft pilots serve on the design team.

Future Operations Costs:

Preliminary management and operations costs were reviewed at the NEON FDR in November 2009. A final operations review, specifically focused on anticipated maintenance and operations (M&O) costs for the project, is scheduled for April 2010. NEON is reliant on sensors and cyberinfrastructure that have a defined lifecycle. Operations costs include scheduled replacement and refreshing of sensor, instrumentation, and cyberinfrastructure technology. NEON operations also include significant labor costs due to the labor-intensive processes required as part of the Fundamental Sentinel Unit (FSU), which is a major component of each domain.

GEOSCIENCES

Alaska Region Research Vessel $0

The FY 2011 Budget Submission does not request funds for the Alaska Region Research Vessel (ARRV). The remaining project balance was provided through the American Recovery and Reinvestment Act of 2009 (ARRA) as shown in the table below. The estimated project cost is $199.50 million.

Appropriated and Requested MREFC Funds for the Alaska Region Research Vessel
(Dollars in Millions)

	FY 2007	FY 2008	FY 2009	FY 2010 Request	FY 2011 Request	Total
Regular Appropriations	$9.43	$42.00	-	-	-	$51.43
ARRA	-	-	148.07	-	-	148.07
Total, ARRV	**$9.43**	**$42.00**	**$148.07**	**-**	**-**	**$199.50**

Baseline History: NSF first requested construction funding for the ARRV through the MREFC account in FY 2007. The project received an initial appropriation of $9.43 million in that year followed by an additional appropriation of $42.0 million in FY 2008. In FY 2009, NSF delayed acquisition of the ARRV to incorporate updated pricing information into the construction plan. Rapid inflation in the shipbuilding industry made it difficult to accurately project the final construction cost for the ARRV. A revised project estimate was provided during the Final Design Review (FDR) held in October 2008. The new baseline, which was presented to and approved by the National Science Board in March 2009, incorporates an updated technical scope for the ship in order to meet current regulatory requirements, proper administrative support by the awardee, a realistic construction schedule, and an independent, risk-adjusted cost estimate for construction. The final construction baseline against which progress will be monitored is under development according to a schedule agreed upon by NSF and the awardee.

Total Obligations for the ARRV
(Dollars in Millions)

	Prior Years	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
R&RA Obligations:									
Concept & Development	$2.24	-	-	-	-	-	-	-	-
Management and Operations	-	-	-	-	-	-	4.17	8.34	8.50
Subtotal, R&RA Obligations	2.24	-	-	-	-	-	4.17	8.34	8.50
MREFC Obligations:									
Implementation	4.06	14.13	40.00	-	-	-	-	-	-
ARRA	-	148.07	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	4.06	162.20	40.00	-	-	-	-	-	-
Total: ARRV Obligations	**$6.30**	**$162.20**	**$40.00**	**-**	**-**	**-**	**$4.17**	**$8.34**	**$8.50**

Totals may not add due to rounding.

The ARRV will replace the R/V *Alpha Helix*, which, at 40 years of age prior to its decommissioning, was the oldest ship in the national Academic Research Fleet. Science activities in the Arctic have been limited by the capabilities of the *Alpha Helix*, which was restrictively small and could not operate in ice or in severe winter weather in the open seas. With its ice-strengthened hull, the ARRV has been designed to operate year round in the challenging waters of the Chukchi, Beaufort, and Bering Seas, as well as the open Gulf of Alaska, coastal Southeast Alaska, and Prince William Sound, including operations in seasonal ice up to 3.9 feet thick.

Satellite observations have shown that the perennial ice in the Arctic is thinning at a rate of 9 percent per decade, which is beginning to have major regional and global consequences. Research is urgently needed on topics ranging from climate change, ocean circulation, ecosystem studies, and fisheries research to natural hazards and cultural anthropology. Furthermore, the ARRV will provide a sophisticated and significantly larger platform for scientists, graduate, and undergraduate students to participate in complex multidisciplinary research activities and will enable the training of the next generation of scientists with the latest equipment and technology. Broadband satellite communications capable of relaying data, including high definition video from tools such as remotely operated vehicles that explore under the ice and the ocean depths, will bring research into the K-12 classroom and to the general public.

This image is an artist's rendition of the ARRV, which will replace the R/V *Alpha Helix*.

The construction phase of the project is being led by the University of Alaska, Fairbanks (UAF). A complete contract level design package has been completed by UAF's naval architect, The Glosten Associates, Inc. It is anticipated that the ARRV will greatly expand research capabilities in the region, going from a maximum of 160 ship operating days with the R/V *Alpha Helix*, up to 270-300 days with the ARRV. The vastly increased capability of the ARRV, both with regard to its ability to accommodate much larger interdisciplinary research teams and greatly enlarged geographical and seasonal ranges, will dramatically increase the number of proposals addressed to NSF for its utilization. Individual projects vary greatly in cost, as do the number of projects supported onboard at any given time. Assuming two simultaneous projects onboard for 3-4 weeks at a time and the average grant size in the Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO), over $17.0 million in research would be supported annually.

Project Report:

<u>Management and Oversight:</u>

- NSF Structure: NSF oversight is described in the Program's Internal Management Plan (IMP). The NSF Program Officer for Ship Acquisition and Upgrades has primary responsibility for oversight of the project and resides within the Integrative Programs Section (IPS) of the Division of Ocean Sciences (OCE), Directorate for Geosciences (GEO). Periodic oversight is provided by a Project Advisory Team (PAT) which includes staff from GEO and OPP, the Division of Acquisition and Cooperative Support (DACS), the Large Facilities Office (LFO), the Office of the General Counsel (OGC), and Office of Legislative Public Affairs (OLPA). Additional staff from IPS, the LFO, and DACS, as well as external consultants, help provide the Program Officer with routine project management and technical assistance.

- External Structure: UAF has established a project management office in Fairbanks, AK, a component of which will eventually include an on-site team that will remain in the shipyard throughout the construction process. The ARRV Oversight Committee (AOC), which includes community experts in research vessel design, construction, and operations, has been commissioned and convenes monthly to review project status and provide technical and science support advice to both UAF and NSF.

- Reviews:
  - Final Design Review (FDR): FDR was completed in October 2008. The Panel advised that both the design and Project Execution Plan were "sound" and ready to proceed with construction. UAF presented a risk adjusted project baseline that was considered realistic based on market conditions just prior to FDR. NSF used Panel recommendations to increase confidence levels and account for recent global market volatilities to arrive at the final estimated project cost of $199.50 million.
  - Acquisition Strategy Review: NSF conducted a final review of UAF's vessel and propulsion acquisition strategies in January 2009 based on Panel comments from FDR. Final NSF guidance was given to UAF and revised documents have been received and approved by NSF.
  - Consent Reviews: NSF has conducted two internal reviews during Phase II to evaluate UAF's shipyard and thruster (Z-drive) selection processes. A third consent review was conducted following receipt of cost proposals and UAF's "best value" determination in November 2009.
  - Upcoming Reviews: NSF will conduct annual project reviews once construction begins using panels of experts familiar with ship construction, project management, and earned value management (EVM) reporting. The first such panel is expected to convene in mid-2010.

<u>Current Project Status:</u>

Thruster selection is complete and the contract with the vendor has been executed. Proposals from interested U.S. shipyards have been received and evaluated by UAF. The shipyard contract was signed on December 18, 2009.

<u>Cost and Schedule:</u>

The total estimated project cost following FDR is $199.50 million. The majority of this total, an estimated $123.18 million or 55 percent, is the fixed price contract with the shipyard. UAF management, including purchase of propulsion units as Owner-Furnished Equipment, is $21.40 million, or 11 percent. Final outfitting, science trials, and delivery are $23.60 million, or 12 percent. Due to extreme global market volatility, the total required project contingency is $44.50 million, or 22 percent.

Construction is anticipated to take thirty to thirty-six months. Preliminary vessel acceptance from the shipyard is anticipated for mid-FY 2013 followed by a year of science trials, final outfit, and transit to Alaska. The transition to operations is anticipated to take place in conjunction with a partial operating year in FY 2014 with the first full year of operations occurring in FY 2015.

<u>Risks:</u>

A formal risk assessment and management plan was developed by UAF in accordance with NSF guidelines and presented at FDR. Following FDR, the Risk Management Plan and Risk Register will be formally updated monthly by UAF and reviewed by NSF on a routine basis. Significant risks at this stage of the project include:

- Technical Risk: Any component of the vessel not meeting technical requirements of the specifications resulting in loss of capability or increased costs to correct after installation or delivery.

- Change Risk: Shipyard contract disputes and claim potential associated with design development due to changing regulatory body requirements and owner initiated design changes.
- Schedule Risk: Extension of the construction and delivery schedule which would result in project cost increases due to inflation and UAF standing army costs.

Mitigation strategies have been employed by UAF and the risk analysis indicates that sufficient contingency is currently in place to handle these project risks. The bid risk for the thrusters has been retired. Costs came in lower than FDR estimates due to a reduction in demand that has followed a slower global ship construction market. Proper change and contingency management control processes are in place to facilitate the project coming on time and within budget.

Future Operations Costs:

Vessel operations will be governed by the terms of a separate cooperative agreement with UAF through the Ship Operations Program within IPS. Daily rate estimates for both the ship and technical services were provided by UAF at FDR. It is anticipated that OCE will pay for approximately 65 percent of the annual vessel operating costs ($8.40 million per year) based on historical data from other global ships within the academic research vessel fleet. The remaining 35 percent of the funding support for the ARRV is expected to come from the Office of Polar Programs (OPP) and other federal agencies. In short, the ARRV will fold into an already well established framework for operating the academic research vessel fleet.

Ocean Observatories Initiative $90,700,000

The FY 2011 Budget Submission for the Ocean Observatories Initiative (OOI) is $90.70 million, which represents the second year of a six year construction project totaling $386.42 million.

Appropriated and Requested MREFC Funds for the Ocean Observatories Initiative
(Dollars in Millions)

	Prior Years[1]	FY 2009	FY 2010 Estimate	FY 2011 Request	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	Total
OOI Regular Appropriations and Requests	5.91	-	14.28	90.70	102.80	46.80	20.00	280.49
ARRA	-	105.93	-	-	-	-	-	105.93
Total, OOI	**$5.91**	**$105.93**	**$14.28**	**$90.70**	**$102.80**	**$46.80**	**$20.00**	**$386.42**

Per P.L. 110-161, $5.12 million was recsinded from prior year unobligated balances.

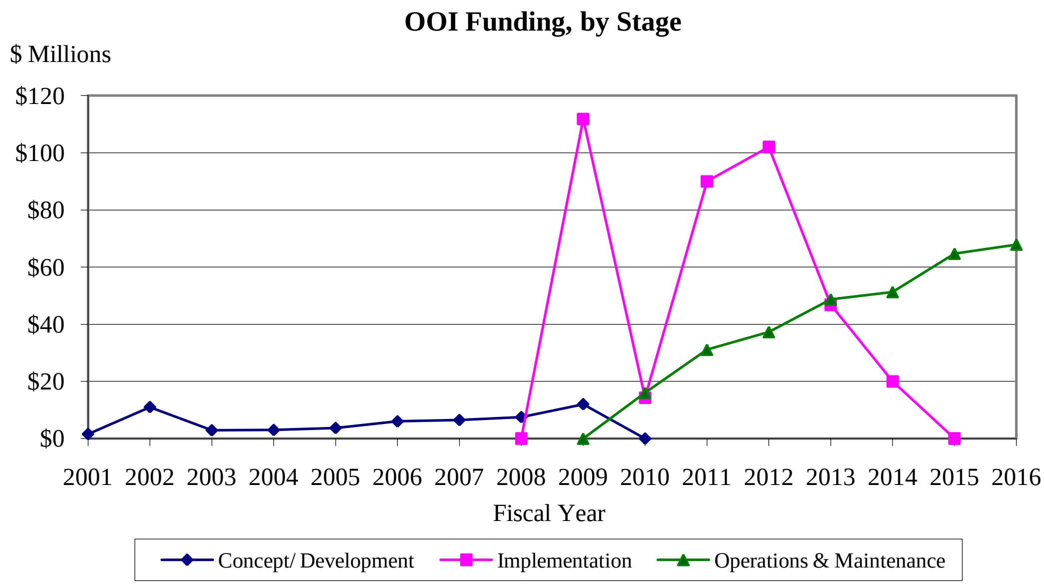
The OOI will consist of an integrated observatory network that will provide the oceanographic research and education communities with continuous, interactive access to the ocean. The OOI will have three elements: 1) deep-sea buoys with designs capable of deployment in harsh environments such as the Southern Ocean; 2) regional cabled nodes on the seafloor spanning several geological and oceanographic features and processes; and 3) an expanded network of coastal observatories. A cutting edge, user-enabling cyberinfrastructure will link the three components of the OOI and facilitate experimentation using assets from the entire OOI network.

Baseline History: NSF first requested construction funding for OOI through the MREFC account in FY 2007 and received an initial appropriation of $5.12 million in that year. The OOI has undergone a series of technical reviews, with the Final Design Review (FDR) conducted on November 6-7 and 12-14, 2008. The FDR panel determined that OOI was ready to move to construction assuming some adjustments to the baseline with respect to schedule and overall project contingency. Following the FDR, in an effort to focus OOI more specifically on high priority science issues related to climate change, ocean acidification, carbon cycling, and ecosystem health, NSF initiated a rapid turn-around process to develop a modified network design in January 2009, referred to as the Variant Design. An additional Science Review Panel and Cost/Schedule Review Panel convened by NSF in March 2009 supported proceeding with the Variant Design and the project was approved at the May 2009 National Science Board meeting.

Total Obligations for OOI
(Dollars in Millions)

	Prior	FY 2009	FY 2010	FY 2011	ESTIMATES				
	Years	Actual	Estimate	Request	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
R&RA Obligations:									
Concept & Development	$57.06	$17.84	-	-	-	-	-	-	-
Management and Operations			16.50	27.50	35.70	47.20	52.30	64.70	67.90
Subtotal, R&RA Obligations	57.06	17.84	16.50	27.50	35.70	47.20	52.30	64.70	67.90
MREFC Obligations:									
Implementation	-		20.19	90.70	102.80	46.80	20.00	-	-
ARRA	-	105.93	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	-	105.93	20.19	90.70	102.80	46.80	20.00	-	-
Total: OOI Obligations	**$57.06**	**$123.77**	**$36.69**	**$118.20**	**$138.50**	**$94.00**	**$72.30**	**$64.70**	**$67.90**

Totals may not add due to rounding.



NOTE: FY 2009 implementation funding includes $105.93 million provided through the American Recovery and Reinvestment Act.

Deployed in critical parts of the global and U.S. coastal ocean, OOI's 24/7 telepresence will capture climate, carbon, ecosystem, and geodynamic changes on the time scales at which they occur, rather than when research vessels are able to be in the area. Data streams from the air-sea interface through the water column to the seafloor will be openly available to educators and researchers in any discipline, making oceanography available to citizens and scholars who might never go to sea. Science themes for OOI include the ocean carbon cycle and its response to global change, ocean acidification, the impact of climate variability and ocean circulation, coastal ocean dynamics and ecosystem response, and the interplay of tectonically-driven fluid flow on the carbon cycle, deep ocean ecosystems, and earthquakes.

The education and public engagement infrastructure of OOI will complement and leverage existing ocean education efforts, and build off of the cyberinfrastructure to provide an interactive digital presence to educators and the public alike. Educational links will be made with the Division of Ocean Sciences (OCE) Centers for Ocean Science Education Excellence (COSEE). In addition, with the establishment of the National Integrated Ocean Observing System (IOOS), there will be an unprecedented need for a STEM workforce and oceanographers skilled in the use and manipulation of large, oceanographic, time-series datasets. The facilities comprising OOI will provide the ideal platforms to train this new generation of oceanographers. These activities will include rigorous evaluation and measurement.

Some of the component technologies that are part of OOI are currently in use or in development as part of the telecommunication and exploration industries. These groups have been engaged in drafting components of the OOI Network Design as well as in reviews of OOI planning. Industry will also be important participants in the construction and implementation phase of OOI, as well as in the future development of sensors critical to the evolution of the OOI network. Most recently, industry representatives joined with the OOI Project Team to discuss OOI sensor requirements at a joint workshop.

OOI will be coordinated with the IOOS to support operational mission objectives of agencies such as the National Oceanic and Atmospheric Administration (NOAA), the U.S. Navy, the National Aeronautics and Space Administration (NASA), and the U.S. Coast Guard.

Science proposals using the OOI network will be solicited as part of the normal competition for funds in OCE. The research envisioned for OOI encompasses a broad range of disciplines, and therefore no special research program will be established. Instead, proposals will be reviewed and competed with other research proposals submitted to OCE.

Project Report:

Management and oversight:

- NSF Structure: The project is managed and overseen by a program manager in OCE in the Directorate for Geosciences (GEO). The program manager receives advice and oversight support from an NSF Project Advisory Team (PAT) that includes representatives from GEO, the Directorates for Biological Sciences (BIO) and Engineering (ENG); the Office of Budget, Finance and Award Management (BFA); the Office of International Science and Engineering (OISE); the Office of General Counsel (OGC); and the Office of Legislative and Public Affairs (OLPA). The Deputy Director for Large Facility Projects (DDLFP) in BFA is also a member of the PAT and provides advice and assistance.

- External Structure: For the construction phase of OOI, management, coordination, and oversight of OOI is the responsibility of the OOI project director operating from the Ocean IES Project Office (systems integrator) at the Consortium for Ocean Leadership (Ocean Leadership), established through a cooperative agreement with NSF in 2004. This project director is accountable to NSF, the Ocean Leadership Board of Trustees, and an external scientific and technical advisory committee. The OOI Project Advisory Committee membership is drawn from individuals with expertise in ocean observing science and engineering. Subawards have been issued by Ocean Leadership to establish three Implementing Organizations (IOs). These IOs provide the detailed management and oversight for implementation of the regional cabled observatory (led by the University of Washington), cyberinfrastructure (led by the University of California-San Diego/Scripps Institution of Oceanography), and coastal/global observatories (led by Woods Hole Oceanographic Institution). These IOs report directly to the Project Office, which ensures cooperation and coordination between the IOs.

- Reviews:

  - Technical reviews: NSF organized a series of external science reviews for OOI, including the Blue Ribbon Review in July 2006, which assessed whether the ocean observing network proposed in the OOI Conceptual Network Design (CND) would provide the capabilities for the ocean researchers to answer high priority science questions that require *in situ*, real-time measurements across the three scales of OOI. A second Blue Ribbon Review in October 2007 assessed whether the OOI Preliminary Network Design provided the experimental capabilities needed to address the scientific scope outlined for OOI. These science reviews provided a general endorsement of OOI, supplemented by a series of recommendations for improvement. These reviews also served as input to the paired design reviews (Conceptual and Preliminary). NSF convened a Blue Ribbon Review in March 2009 to assess a modified OOI network design and its ability to provide transformative research capabilities for the ocean science community. This OOI Variant Design is a modification to the existing network design that more closely focuses OOI infrastructure on climate processes, carbon cycling, ocean acidification, and ecosystem health. The Blue Ribbon Review panel noted that the OOI, as described by the Variant Network Design, remains a worthy investment, providing a transformative capability for the ocean science community.

- Management, Cost, and Schedule reviews:
  - The OOI Conceptual Design Review (CDR), held August 2006, reviewed the scope and system level implementation plans for OOI, including management plans and budgeting. It discussed whether all major risks with this project have been identified and whether appropriate initial system development specifications (performance requirements, major system components, and interfaces) have been established for each sub-element of OOI.
  - The Preliminary Design Review (PDR) in December 2007 assessed the robustness of the technical design and completeness of the budget and construction planning for the OOI. The PDR panel also reviewed progress made by the OOI Project Team on the findings of the CDR.
  - The FDR in November 2008 assessed whether OOI's project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.
  - A Cost-Schedule Review Panel in March 2009 assessed whether the OOI Variant Design project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.

- Upcoming reviews:
  - Semi-annual and/or annual external reviews of the OOI Project will occur during the construction phase. A semi-annual review cycle is planned for the first year of construction.

<u>Current Project Status:</u>

In FY 2009, the OOI received $105.93 million of ARRA funds to initiate construction, and a Cooperative Agreement was awarded in September 2009 to the Consortium for Ocean Leadership. These funds will support a suite of efforts across the OOI project in the first two years of construction, including production engineering and prototyping of key coastal and global components (moorings, buoys, sensors), award of the primary cable contract, completion of the shore station, data sensing and acquisition digital capabilities, and instrument agent development. The initial construction activities of hiring project staff, mobilizing project control systems, and entering into major subawards are underway. Subawards to University of California at San Diego, Woods Hole Oceanographic Institution and University of Washington were completed in October/November 2009.

<u>Cost and Schedule:</u>

In FY 2009, OOI received ARRA funding in the amount of $105.93 million to initiate construction. In addition, $5.91 million was appropriated in FY 2008 and was carried over into FY 2009. These funds will support a suite of efforts across the OOI project in the first two years of construction, including production engineering and prototyping of key coastal and global components (moorings, buoys, sensors), award of the primary cable contract, completion of the shore station, data sensing and acquisition digital capabilities, and instrument agent development. An $89.0 million contract for the Primary Undersea Cable Infrastructure was awarded in November 2009. Initiation of such activities during FY 2009 and FY 2010 will provide risk reduction for the project.

Estimated requests in FY 2011 and beyond, totaling $260.30 million for construction and an estimated $223.40 million for initial operations will enable the completion of construction activities and initiation of the operations phase. Construction activities include acquisition and deployment of OOI instruments and sensors as well as coastal and open ocean moorings. Initial operations include post commissioning activities such as network sensing, data acquisition, and data delivery to the scientific community.

Risks:

- Oversight risk: The complexity of the OOI and the need for the Project Office and Implementing Organizations to coordinate and integrate construction activities and network implementation under the schedule, cost, and scope constraints of the project presents a project risk. OOI relies heavily on open lines of communication and effective cooperation between the managing entities (Project Office and IOs) and NSF. Both the PDR and the FDR panels were very supportive of the management structure. To ensure effective management and oversight, monthly and annual reports provided by the Project Office and IOs will be closely monitored by the OOI Program Manager and Contracts Officer for deviations from established baselines (using Earned Value Management) and annual site visits and reviews will be used to gain a more detailed understanding of the integrative nature of the project teams. In addition, weekly teleconferences with the program staff from both the Project Office and IOs will help ensure that all groups are up to date with current activities. NSF will conduct programmatic reviews on an annual or semi-annual basis, as needed, in addition to assessments by an external scientific oversight committee. Lastly, NSF's OOI Program Director will attend the Project Office's own internal reviews to ensure that OOI implementation is proceeding according to established principles as outlined in the cooperative agreement.

- Scope contingency: The Project Team has provided an appropriate level of contingency for OOI as dictated by a comprehensive (top-down and bottom-up) risk analysis. Should this contingency be exhausted, reductions in the scope of the OOI network plan will be required. These potential reductions, or scope contingency, must be implemented based on clearly articulated scientific priorities. Any changes to scope (as well as cost or schedule) will follow the OOI Change Control Process, which has a tiered evaluation process for evaluating and determining any change to the project.

- Risks Related to the OOI Cyberinfrastructure (CI): The OOI CI will not only provide the network integration needed to achieve the scientific goals of OOI, but a robust, user-friendly CI will be essential to develop a vigorous OOI user community. Ensuring the "usability" of the CI was a key topic of discussion at the preliminary and final design reviews. Addressing recommendations from the FDR, the CI Implementing Organization was required by NSF to incorporate continued engagement of the user community during development and testing of the cyberinfrastructure. Additionally, continued involvement of Office of Cyberinfrastructure (OCI) Program Managers, via the PAT, and participation in reviews of the OOI network, will help mitigate risks associated with development and construction of the OOI CI.

Future Operations Costs:

Operations costs will ramp up to $64.70 million in FY 2015 as depicted in the obligations table. The expected operational lifespan of this project is 25 years. Operations cost reviews will be conducted prior to and throughout the operations phase to assess the project and inform future budget requests.

MATHEMATICAL AND PHYSICAL SCIENCES

<u>Advanced Laser Interferometer Gravitational-Wave Observatory</u> $23,580,000

The FY 2011 Budget Request for the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO) is $23.58 million, which represents the fourth year of a seven-year project totaling an estimated $205.12 million.

Appropriated and Requested MREFC Funds for the Advanced Laser Interferometer Gravitational-Wave Observatory

(Dollars in Millions)

FY 2008	FY 2009	FY 2010 Estimate	FY 2011 Request	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	Total
$32.75	$51.43	$46.30	$23.58	$20.96	$15.17	$14.92	$205.12

<u>Baseline History</u>: NSF first requested FY 2008 construction funds for AdvLIGO through the MREFC account in the FY 2006 Budget Request to Congress. The original proposal received in 2003 estimated a total construction cost of $184.35 million. A baseline review in June 2006 established the project cost at $205.12 million, based upon known budget inflators at the time and a presumed start date of January 1, 2008. A second baseline review, held in June 2007, confirmed this cost, subject to changes in budget inflators. Final Design Review in November 2007 recommended that construction begin in FY 2008. The National Science Board approved the project at a cost of $205.12 million in March 2008, and the project began in April 2008.

AdvLIGO is the planned upgrade of the Laser Interferometer Gravitational-Wave Observatory (LIGO) that will allow LIGO to approach the ground-based limit of gravitational-wave detection. LIGO consists of the world's most sophisticated optical interferometers, operating at two sites 3,000 km apart: Hanford, WA and Livingston, LA. These interferometers measure minute changes in arm lengths resulting from the passing of wave-like distortions of spacetime called gravitational waves, caused by cataclysmic processes in the universe such as the coalescence of two black holes or neutron stars. LIGO is sensitive to changes as small as one one-thousandth the diameter of a proton over the 4-km arm length; AdvLIGO is expected to be at least 10 times more sensitive. The LIGO program has stimulated strong interest in gravitational-wave research around the world, producing vigorous programs in other countries that provide strong competition as well as highly beneficial collaborations. LIGO has pioneered and led the field of gravitational-wave detection, and a timely upgrade is necessary to sustain progress in this area.

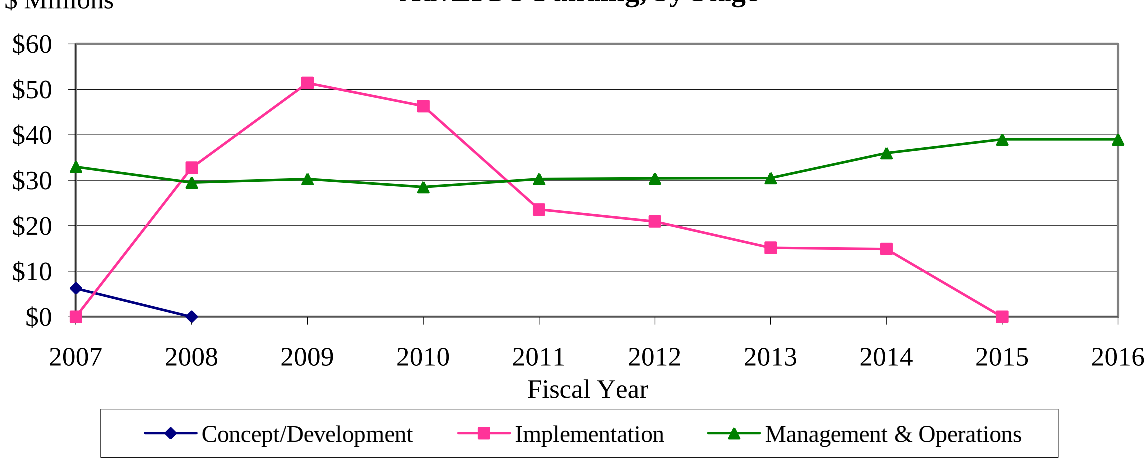
Total Obligations for AdvLIGO

(Dollars in Millions)

	Prior Years	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
R&RA Obligations:									
Concept & Development	$40.74	-	-	-	-	-	-	-	-
Management & Operations	29.50	30.30	28.50	30.30	30.40	30.50	36.00	39.00	39.00
Subtotal, R&RA Obligations	70.24	30.30	28.50	30.30	30.40	30.50	36.00	39.00	39.00
MREFC Obligations:									
Implementation	32.75	51.43	46.30	23.58	20.96	15.17	14.92	-	-
Subtotal, MREFC Obligations	32.75	51.43	46.30	23.58	20.96	15.17	14.92	-	-
Total: AdvLIGO Obligations	**$102.99**	**$81.73**	**$74.80**	**$53.88**	**$51.36**	**$45.67**	**$50.92**	**$39.00**	**$39.00**

Totals may not add due to rounding.

AdvLIGO Funding, by Stage



Note: Management & Operations refers to the continued operations of LIGO during the construction phase and the onset of operations for the newly constructed AdvLIGO in FY 2015.

Active outreach programs have been developed at both the Hanford and Livingston sites. Teams at both sites have provided visual displays, hands-on science exhibits, and fun activities for visiting students and members of the public. In the last three years an average of over 2,000 students per year have taken advantage of this opportunity. More formal programs at the sites include participation in the Research Experiences for Teachers (RET) program, a set of "scientist-teacher-student" research projects in support of LIGO, and participation in the Summer Undergraduates Research Fellowships/Research Experiences for Undergraduates (SURF/REU) programs for college students. Both sites have developed web-based resources for teachers that include information on research opportunities for schools and a set of standards-based classroom activities, lessons, and projects related to LIGO science. The LIGO Science Education Center at the Livingston site contains many Exploratorium exhibits and is the focal point for augmenting teacher education at Southern University and other student-teacher activities state-wide through the Louisiana Systematic Initiative Program. The LIGO Science Education Center's programs include funding for an external evaluation firm that provides both assistance in aligning future activities with proposed goals and evaluating outcomes.

Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in the LIGO projects, with some partnerships leading to the development of new products. Areas of involvement include novel techniques for fabrication of LIGO's vacuum system, seismic isolation techniques, ultrastable laser development (new product introduced), high-power active optical components (new products), the development of new ultra-fine optics polishing techniques, and the development of new optical inspection equipment (new product).

LIGO has extensive international ties. The LIGO Scientific Collaboration, which sets the scientific agenda for LIGO, is an open collaboration that has established formal ties with institutions from 13 foreign countries. Close collaboration is maintained with two other gravitational-wave observatories: GEO, a UK-German collaboration, and Virgo, a French-Italian collaboration. LIGO has signed an agreement with Virgo under which all data will be shared and analyzed cooperatively and all discoveries will be jointly credited. New technologies critical to AdvLIGO are being contributed by foreign institutions: the pre-stabilized laser source, funded and developed by the Max Planck Gesellschaft; the mirror/test mass suspension systems, funded and developed by the GEO collaboration; and the auxiliary optical components, developed by the Australian National University and Adelaide University. The laser has essentially attained its design specifications; the suspension systems are being tested in European gravitational-wave facilities; and prototypes of some of the auxiliary optical components have been tested with LIGO's current configuration.

Assembly and testing of AdvLIGO optical suspension components for use in high vacuum. *Credit:* LIGO Laboratory.

Project Report:

Management and Oversight:

- NSF Structure: NSF oversight is coordinated internally by a dedicated LIGO program director in the Division of Physics (PHY) in the Directorate for Mathematics and Physical Sciences (MPS), who also participates in the LIGO Advisory Team (LIGO PAT). The LIGO PAT includes staff from the Offices of Budget, Finance, and Award Management (BFA), General Counsel (OGC), and Legislative and Public Affairs (OLPA). Formal reporting consists of submitted quarterly and annual reports and brief monthly status reports to the LIGO program officer, who in turn reviews, edits, comments, and submits the reports to the Deputy Director for Large Facility Projects.

- External Structure: LIGO is managed by California Institute of Technology under a cooperative agreement. The project has a detailed management structure in place.

- Reviews:
  - Technical Reviews: NSF conducts annual scientific and technical reviews involving external reviewers, participates in meetings of the LIGO Scientific Collaboration (LSC), and conducts site visits to the Hanford and Livingston interferometers.
  - Management, Cost, and Schedule Reviews: (1) AdvLIGO construction proposal review in 2003; (2) first baseline review in June 2006; (2) second baseline review in June 2007; (3) final readiness review in November 2007.
  - The first AdLIGO review of the active project was held in November 2008.

- AdvLIGO's first annual review was held in April 2009, and an interim review was conducted in December 2009; the second annual review is scheduled for April 2010; and the third will be held in April 2011.
- Continuing annual reviews will be conducted by external panels throughout construction; these reviews will be supplemented by smaller interim reviews held concurrently with the LIGO facility annual reviews, which are held in the November/December timeframe each year.

Current Project Status:

The National Science Board approved funding for the AdvLIGO in March 2008, and the project began in April 2008. Major initial activities include the placing of long lead-time orders and the preparation of the sites for the upgrade. The project has met its milestone dates so far, including the ordering of major items such as core optics blanks and their polishing and coating, and the ordering of components for the seismic isolation systems. The current performance is consistent with ending on time and on budget. Total project contingency usage as of November 2009 is $1.72 million of an initial $39.10 million, or 4.4 percent of contingency for 16.1 percent of the project completed.

Shutdown of the LIGO observatories is not planned until autumn 2010 and winter 2011. Until that time, the LIGO Laboratory has incorporated some AdvLIGO components into the two 4-km interferometers and is conducting a science run (S6) at higher sensitivities than was attained with the initial LIGO interferometers. The primary purpose of this run is to test AdvLIGO components; the run is a success from both a scientific and a technical standpoint. Minor redesigning of some AdvLIGO components is proceeding, and the sensitivity of the S6 run in its early stages is about 50 percent higher than that at the beginning of the S5 run.

Cost and Schedule:

The projected length of the project is seven years, with an 11-month schedule contingency. The risk-adjusted cost of $205.12 million included a contingency budget of 23.7 percent (at the time of the award).

Risks:

The AdvLIGO project underwent a comprehensive external annual review in April 2009. The review panel found the project "…to be on-track. The budget, schedule, contingency, and risk are being managed well." The panel believed the current contingency level, which is slightly above the initial level, to be adequate. NSF program staff are confident that risk is being managed effectively but are monitoring progress and conducting frequent reviews.

Technical risks include uncertainties about such topics as eliminating parametric instabilities in the optical cavities, the minimization of thermal noise in the mirror optical coatings, and the mitigation of possible electrical charges on optical elements. The LIGO Laboratory has been conducting research to minimize these risks, and an internal risk management team oversees these efforts. Risk management and its results are topics of internal and biannual external reviews.

Management risks include the planned decommissioning and installation procedures as well as risks involving adherence to the project timelines and budget. NSF staff conduct weekly meetings with the project management to oversee the progress of the project; monthly, quarterly, and annual reports, as well as annual reviews (supplemented by interim reviews), are also important project monitoring instruments. The project status is tracked with earned value management parameters.

Environmental risk is being effectively mitigated. The freely-suspended optical elements at the core of the observatory are carefully protected from earthquakes. Anthropogenic noise at the Livingston site due to logging and oil exploration has been mitigated by communication with local industry and by the early adoption of AdvLIGO seismic noise isolation technology.

Safety is maintained by adherence to institutional guidelines and to published LIGO Laboratory safety practices, overseen by dedicated safety officers at both facility sites. Hazard analysis is conducted before work is begun, and hazard mitigation is performed. External review panels have consistently found safety procedures to be satisfactory.

<u>Future Operations Costs:</u>

Future operations and maintenance costs will be approximately $39.0 million per year and will be funded through NSF's Division of Physics.

Advanced Technology Solar Telescope $17,000,000

The FY 2011 Budget Request for the Advanced Technology Solar Telescope (ATST) is $17.0 million. FY 2011 represents the second year of an eight-year construction project. The total project cost, $297.93 million, was finalized after a Final Design Review (FDR) in May 2009. The National Science Board approved an award for this amount at the NSF Director's discretion, contingent upon completion of compliance with relevant environmental and cultural/historic statutes.

The environmental compliance requirements were completed on November 20, 2009, and the Record of Decision authorizing the construction was signed by the NSF Director on December 3, 2009.

Appropriated and Requested MREFC Funds for the Advanced Technology Solar Telescope
(Dollars in Millions)

	FY 2009	FY 2010 Estimate	FY 2011 Request	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate	Total
Regular Approps	$7.00	$13.00	$17.00	$20.00	$20.00	$20.00	$20.00	$20.00	$14.93	$151.93
ARRA	146.00	-	-	-	-	-	-	-	-	146.00
Total, ATST	**$153.00**	**$13.00**	**$17.00**	**$20.00**	**$20.00**	**$20.00**	**$20.00**	**$20.00**	**$14.93**	**$297.93**

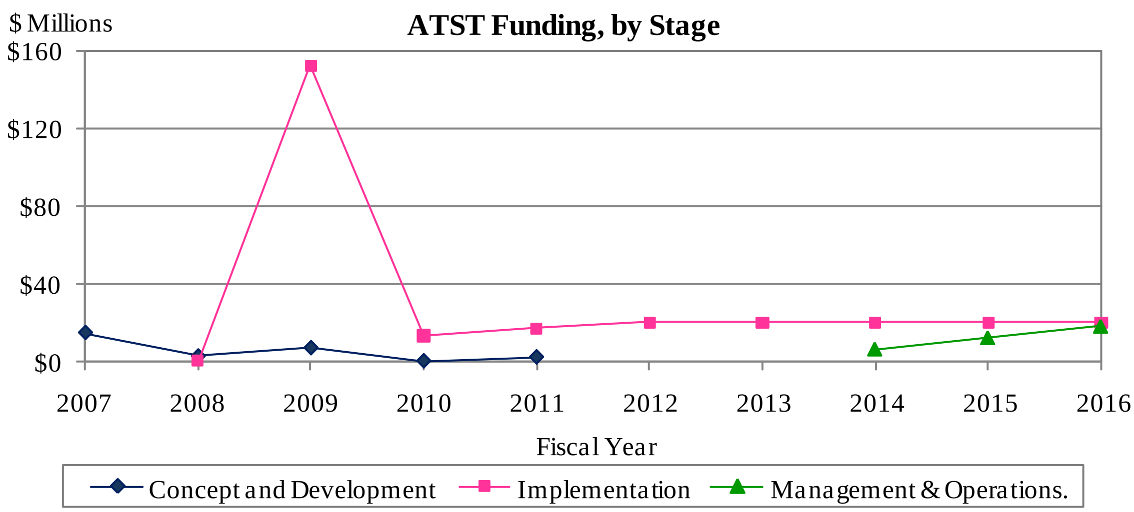
Baseline History: Beginning in 2001, NSF provided funds to the National Solar Observatory (NSO) for an eight-year design and development program for ATST and its initial complement of instruments through the Division of Astronomical Sciences (AST) and the Division of Atmospheric and Geospace Sciences (AGS; formerly ATM). The current ATST design, cost, schedule, and risk were scrutinized in an NSF-conducted Preliminary Design Review (PDR) in October-November 2006. The Final Design Review (FDR) held in May 2009 determined that the ATST project is fully-prepared to begin construction. A number of specific panel recommendations on contracting strategy, contingency estimating, and other items, were subsequently included in the project execution plan.

In FY 2009, $6.67 million was provided in the R&RA account to support design activities to complete a construction-ready design. Of these R&RA funds, $3.10 million was appropriated through the American Recovery and Reinvestment Act of 2009 (ARRA) for risk reduction, prototyping, and design feasibility and for cost analyses in areas identified at preliminary and systems design reviews. The funds will also support several new positions to complete preparation for the start of construction. Also in FY 2009, $153.0 million was provided through the MREFC account to initiate construction. Of these MREFC funds, $146.0 million was appropriated through ARRA. Construction is scheduled to commence in FY 2010.

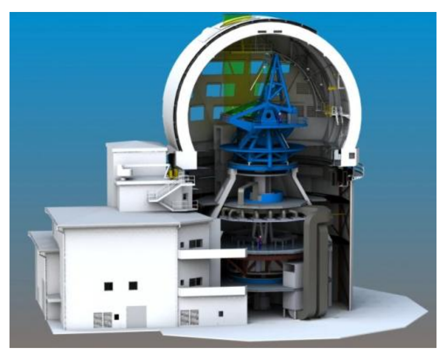
Total Obligations for ATST
(Dollars in Millions)

	Prior Years	FY 2009	FY 2010 Estimate	FY 2011 Request	ESTIMATES				
					FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
R&RA Obligations:									
Concept & Development	$16.84	$3.57	-	$2.00	-	-	-	-	-
Management & Operations	-	-	-	-	-	-	6.00	12.00	18.00
ARRA		3.10	-	-	-	-	-	-	-
Subtotal, R&RA Obligations	16.84	6.67	-	2.00	-	-	6.00	12.00	18.00
MREFC Obligations:									
Implementation	-	-	20.00	17.00	20.00	20.00	20.00	20.00	20.00
ARRA	-		146.00	-	-	-	-	-	-
Subtotal, MREFC Obligations	-	-	166.00	17.00	20.00	20.00	20.00	20.00	20.00
Total: ATST Obligations	**$16.84**	**$6.67**	**$166.00**	**$19.00**	**$20.00**	**$20.00**	**$26.00**	**$32.00**	**$38.00**

Totals may not add due to rounding.



ATST will enable the study of magneto-hydrodynamic phenomena in the solar photosphere, chromosphere, and corona. Determining the role of magnetic fields in the outer regions of the Sun is crucial to understanding the solar dynamo, solar variability, and solar activity, including flares and mass ejections, which can affect civil life on Earth and may have impact on the terrestrial climate.



Cutaway view of the ATST Facility. *Credit: National Solar Observatory.*

The project is a collaboration of scientists and engineers at more than 20 U.S. and international organizations. Other potential partners include the Air Force Office of Scientific Research and international groups in Germany, the United Kingdom, and Italy. Now that there is firm funding for construction, details of these partnerships are being discussed. Currently:

- The US Air Force has recently replaced the aluminizing chamber at the AEOS telescope on Maui and sized it to accommodate the ATST mirror. This obviates the need to build a dedicated chamber for the ATST primary;
- Kiepenheuer Institut fuer Sonnenphysik (Freiburg, Germany) plans to contribute a narrow-band visible tunable filter, a first-light instrument;
- Queens University Belfast is considering contributing very high speed cameras for ATST instrumentation; and
- Arcetri Observatory (Italy) is considering the design and construction of an adaptive secondary (an upgrade to the current plans), as well as an infrared tunable filter.

Discussions of other possible contributions for second-generation instruments are continuing.

Project Report:

<u>Management and Oversight:</u>

- NSF Structure: Oversight from NSF is handled by a program manager in the MPS AST Division working with staff from the Offices of Budget, Finance and Award Management (BFA), General Counsel, Legislative and Public Affairs, and AGS in GEO. The Deputy Director for Large Facilities in BFA also provides advice and assistance.

- External Structure: The ATST project is managed by NSO. NSO operation and maintenance and ATST design and development are funded by NSF via a cooperative agreement with the Association of Universities for Research in Astronomy, Inc (AURA). The NSO Director serves as the director of the ATST project; a senior NSO scientist is the project scientist; and an experienced full-time project manager coordinates the project activities. Several councils and working groups provide input from the solar and space physics communities.

- Reviews:
  - Technical Reviews: Reviews have been conducted throughout the design and development phase. The preliminary design was found to be robust in the NSF-conducted Conceptual Design Review in March 2005 and Preliminary Design Review in October-November 2006. The project has completed a comprehensive set of system-level design reviews for all major sub-systems.
  - Management, Cost, and Schedule Reviews: The ATST cost, schedule, and risk were scrutinized and validated at the Preliminary Design Review.
  - The Final Design Review (FDR): The FDR was held on May 18-21, 2009 in Tucson, Arizona. The unanimous finding of the review panel was that the ATST project is fully-prepared to begin construction. A number of specific panel recommendations on contracting strategy, contingency estimating, and other items, were subsequently included in the project execution plan.
  - Upcoming Reviews: Annual reviews of the construction will start in mid-FY 2010.

<u>Current Project Status:</u>

Current activities include finalizing the design and retiring the remaining areas of risk. The project has chosen the Haleakala High Altitude Observatory on the island of Maui, Hawaii as the ATST site. The Final Environmental Impact Statement was submitted to the Environmental Protection Agency on July 24, 2009. Consultation with Native Hawaiian stakeholders has resulted in a fully-executed programmatic agreement that details steps to minimize the impact on the traditional cultural assets on Haleakala, thereby completing compliance with the National Historic Preservation Act. All environmental compliance requirements are now complete. Application for final construction permits required for the ATST site is underway now that the record of decision (ROD) authorizing the commencement of construction in FY 2010 was published in the Federal Register on December 9, 2009.

Costs and Schedule:

The baseline not-to-exceed cost was established following the FDR. Funding will derive from ARRA ($146.0 million) and expected annual appropriations in the MREFC account ($151.93 million). Because it is necessary to clearly separate funds from the two sources, the project developed two separate statements of work, dividing their resource-loaded Work Breakdown Structure (WBS) between large contracts to be funded early in the project by ARRA, and smaller procurements and project costs such as labor and rent, to be funded by future annual MREFC appropriations. In January 2010, the project submitted a revised budget for the construction proposal for use of MREFC funds, along with a revised statement of work and budget justification for funds from the ARRA. The resulting funding profile extends for nine years. The extreme front-loading of funding as well as judicious choice of the WBS elements expected to be funded by future MREFC appropriations, allow for a constant funding ramp in the outyears while maintaining a reasonable spend-and-commit profile for both cost and contingency. Assuming a construction start in FY 2010, full science operation will begin in FY 2017.

The $3.10 million of ARRA funding within the R&RA account is being used to fund risk-reduction work, prototyping and design feasibility, and cost analyses. The highest priority of these activities is the completion with industry of the site architectural and engineering work required for the detailed foundation design. These studies drive the schedule for work on site and therefore drive the construction critical path. Other recommended work includes adaptive optics deformable mirror prototyping ($400,000) and wavefront sensor camera development ($400,000), and software and controls development. These risk-reduction efforts with industry flow directly from recommendations made by design and cost-review committees. This funding has also allowed staff additions to the project, including an experienced contracts officer and engineers, to complete preparation and planning for construction.

Risks:

Cost and contingency have been validated and essentially all technical risks have been retired. The design is mature and ready for construction contracts to be let. Project management control, interface control, and change control, have all been established. If construction begins early in FY 2010, ATST can be built and commissioned on schedule for a risk-adjusted not-to-exceed cost of $297.93 million.

Technical: The remaining technical risk is very low as a result of the long design and development phase. Risk reduction undertaken post-FDR using $3.10 million of ARRA funds includes the prototyping of a cooled deformable mirror, development of high-speed cameras, and completion of the foundation design.

Environmental and Cultural Compliance: Given the recent history of telescope construction on mountains sacred to Native American and Native Hawaiian people, there is still risk of delay in obtaining permission to begin construction. The Division of Astronomical Sciences, NSF's Office of the General Counsel, and the ATST project have worked carefully through the processes of the applicable statutes such that a protracted delay is not expected. However, a delay early in the construction process may result in the construction missing the first construction window constrained by the breeding season of the Hawaiian Petrel (April-July) but, as noted by the FDR panel, the completion schedule would only slip by three months as a result. The schedule and cost contingency include estimates for such a delay.

Geological: While Haleakala is a dormant volcano, the Hawaiian Islands are seismically active. ATST has been designed according to the required building codes for the appropriate level of earthquake activity, as are other telescopes located in active regions. On the morning of October 15, 2006, a magnitude 6.6 earthquake occurred with its epicenter between Maui and Hawaii. While there was essentially no impact on the existing facilities on Haleakala, several of the large telescopes on Mauna Kea suffered some damage. None of the damage was extensive and all were returned to operation within weeks. Through the Gemini Observatory, NSF convened a lessons-learned workshop involving all of the Hawaiian observatories (including ATST) in March 2007, recommendations from which have been incorporated in the ATST design and operations plan.

Environmental Health and Safety: NSO has a well-developed safety program that is engendered in the ATST project. However, it is imperative that a culture of safety be imposed on the contractors on site. The NSF Program Officer will require the project to develop a site safety plan and conduct a construction readiness review prior to starting construction.

Future Operations Costs:

Estimates for annual ATST operations cost are $12.0 to $14.0 million. A revised operations plan was presented at FDR. Since ATST will become the flagship solar telescope of NSO and will render several telescopes obsolete, about $5.0 to $7.0 million per year of NSO operations cost will be recovered from the closure or divestment of redundant facilities. NSO has developed a preliminary transition plan that will be revised and externally reviewed after approval of construction funds.

Atacama Large Millimeter Array $13,910,000

The FY 2011 Budget Request for the Atacama Large Millimeter Array (ALMA) is $13.91 million, which represents the tenth year of an eleven-year project totaling an estimated $499.26 million.

Appropriated and Requested MREFC Funds for the
Atacama Large Millimeter Array
(Dollars in Millions)

FY 2006[1] & Earlier	FY 2007	FY 2008	FY 2009	FY 2010 Estimate	FY 2011 Request	FY 2012 Estimate	Total
$190.97	$64.30	$102.07	$82.25	$42.76	$13.91	$3.00	$499.26

[1]An additional $31.99 million was appropriated through the MREFC account prior to FY 2005 for concept and development.

Baseline History: A $26.0 million, three-year design and development phase was originally planned for a U.S.-only project, the Millimeter Array. NSF first requested funds for the design and development for this project in FY 1998. In June 1999, the U.S. entered into a partnership via a Memorandum of Understanding (MOU) with the European Southern Observatory (ESO), a consortium of European funding agencies and institutions. The MOU committed the partners to construct a 64 element array of 12-meter antennas. NSF received $26.0 million in appropriations between FY 1998 and FY 2000. Because of the expanded managerial and technical complexity of the joint U.S./ESO project, now called ALMA, an additional year of design and development was provided by Congress in FY 2001 at a level of $5.99 million. In FY 2002, $12.50 million was appropriated to initiate construction of ALMA; the U.S. share of the cost was estimated to be $344.0 million. The National Research Council (NRC) of Canada joined ALMA as a partner in 2003. In 2004, Japan entered under the provisions of a MOU between NSF, ESO, and the National Institute of Natural Sciences of Japan.

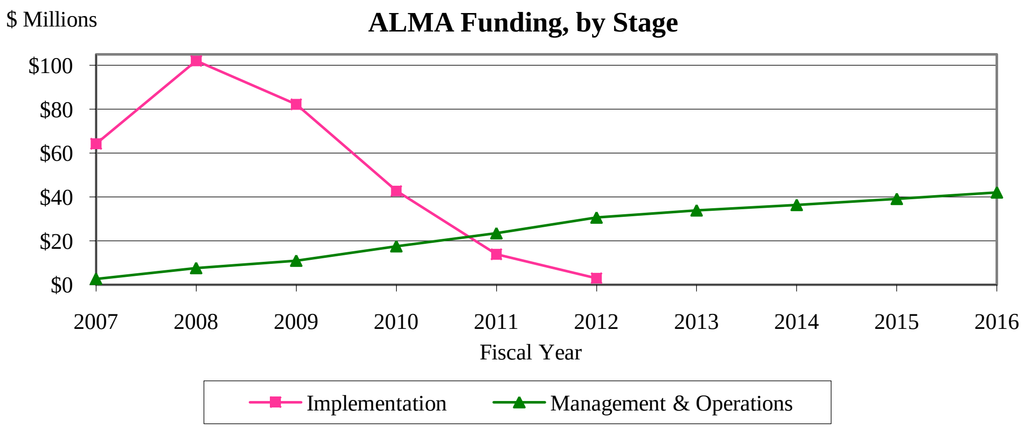
The ALMA Board initiated rebaselining in the fall of 2004 under the direction and oversight of the Joint ALMA Office (JAO) Project Manager. The project was at that point sufficiently mature that the baseline budget and schedule established in 2002, prior to the formation of the partnership, could be refined based on experience. The rebaselining process took approximately one year, scrutinizing cost and schedule throughout the project, assessing technical and managerial risk, and ultimately revising the assumptions on the scope of the project. The new baseline plan developed by the JAO assumed a 50-antenna array as opposed to the original number of 64, extended the project schedule by 24 months, and established a new U.S. total project cost of $499.26 million. The FY 2009 Request was increased by $7.50 million relative to the rebaselined profile in order to allow more strategic use of project contingency to buy down near-term risk, as recommended by the 2007 annual external review. The increase in FY 2009 was offset by a matching decrease in FY 2011.

The global ALMA project will be an aperture-synthesis radio telescope operating in the wavelength range from 3 to 0.4 mm. ALMA will be the world's most sensitive, highest resolution, millimeter-wavelength telescope, combining sub-arcsecond angular resolution with the sensitivity of a single antenna nearly 100 meters in diameter. The array will provide a testing ground for theories of planet formation, star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself. The interferometer is under construction at 5,000 meters altitude near San Pedro de Atacama in the Antofagasta (II) Region of Chile, the ALMA host country.

Total Obligations for ALMA
(Dollars in Millions)

	Prior Years	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
R&RA Obligations:									
Concept & Development	$6.50	-	-	-	-	-	-	-	-
Management & Operations	7.64	11.00	17.57	23.50	30.65	33.92	36.41	39.17	42.10
Subtotal, R&RA Obligations	14.14	11.00	17.57	23.50	30.65	33.92	36.41	39.17	42.10
MREFC Obligations:									
Concept & Development	31.99	-	-	-	-	-	-	-	-
Implementation	357.34	82.25	42.76	13.91	3.00	-	-	-	-
Subtotal, MREFC Obligations	389.33	82.25	42.76	13.91	3.00	-	-	-	-
Total: ALMA Obligations	**$403.47**	**$93.25**	**$60.33**	**$37.41**	**$33.65**	**$33.92**	**$36.41**	**$39.17**	**$42.10**

Totals may not add due to rounding.



Once completed, ALMA will be the most capable imaging radio telescope ever built and will bring to millimeter and submillimeter astronomy the high-resolution aperture synthesis techniques of radio astronomy. ALMA will image at 1 millimeter wavelength with the same 0.1 arcsecond resolution achieved by the Hubble Space Telescope at visible wavelengths, and will form a critical complement to the leading-edge optical, infrared, ultraviolet, and x-ray astronomical instruments of the twenty-first century.

ALMA will help educate and train U.S. astronomy and engineering students; at least 15 percent of ALMA's approximately 1,000 yearly users are expected to be students. There is already substantial involvement by graduate students in applied physics and engineering at universities participating in the ALMA Design and Development program, providing an opportunity to broaden participation in science and engineering by members of underrepresented groups.

Extensive public and student ALMA outreach programs will be implemented in North America, Europe, and Chile as ALMA approaches operational status. ALMA education and public outreach (EPO) programs are funded regionally, through the Associated Universities Incorporated/ National Radio Astronomy Observatory (AUI/NRAO), ESO, and the National Astronomical Observatory of Japan (NAOJ), and jointly by the ALMA partnership in Chile. AUI/NRAO's request for NSF funding (including partnership activities) will be critically evaluated as a component of the proposal review in mid-2010 and thereafter as part of the annual external reviews. NRAO's EPO activities are included in

The first US (left) and Japanese (right) antennas, now at the high altitude site of the ALMA Observatory in Chile.
Credit ALMA/ESO/NAOJ/NRAO.

their annual program plan and the status, performance, and issues are assessed by program staff through regular quarterly reports. ESO and NAOJ will follow their own processes for review of their contributions. These reviews include consideration of plans for educational evaluation and measurement of all programs. A visitors' center will be constructed at the 2,800 meter-altitude Operations Support Facility gateway to the ALMA site near San Pedro de Atacama in northern Chile. The project also supports a fund for the Antofagasta (II) Region of Chile that is used for economic, scientific, technical, social, and cultural development, particularly within the nearby towns of San Pedro de Atacama and Toconao.

North America and Europe are equal partners in the core ALMA instrument. Japan joined ALMA as a third major partner in 2004, and will deliver a number of enhancements to the baseline instrument. The North American side of the project, consisting of the U.S., Canada, and Taiwan, is led by AUI/NRAO. Funding and execution of the project in Europe is carried out through the ESO. Funding of the project in Japan is carried out through the National Institutes of Natural Sciences of Japan and project execution is the responsibility of the NAOJ.

From an industrial perspective, ALMA instrumentation will push gallium arsenide and indium phosphide transistor amplifier technology to high frequencies, will challenge production of high-density, high-speed integrated circuits for computational uses, and is expected to stimulate commercial device and communication technologies development.

Peer-review telescope allocation committees will provide merit-based telescope time but no financial support. NSF will not provide awards targeted specifically for use of ALMA. Most U.S. users will be supported through NSF or National Aeronautics and Space Administration (NASA) grants to pursue research programs that require use of ALMA.

Construction progress continues in FY 2010, both at the site in Chile and within the ALMA partner countries. In FY 2009, five production antennas have been delivered to Chile and acceptance testing for two antennas has been completed. In FY 2010 the first antennas will be transported to the final, high-altitude site and science commissioning will begin. Early science operations are expected to commence in FY 2011 and completion of the construction project and the start of full science operations are planned to occur around the end of FY 2012.

Project Report:

Management and Oversight:

- NSF Structure: Programmatic management is the responsibility of the ALMA program manager in the Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS). An NSF advisory group consisting of representatives from the Office of General Counsel, the Office of Budget, Finance, and Award Management, the Office of International Science and Engineering, and the Office of Legislative and Public Affairs, serves as a standing ALMA Project Advisory Team (PAT). The NSF Deputy Director for Large Facility Projects (DDLFP) is a member of the PAT and provides advice and assistance.

- External Structure: An international ALMA Management Advisory Committee (AMAC) advises AST and the ALMA Board. Management of the NRAO effort on ALMA is carried out under a cooperative agreement with AUI. Oversight of the full international project is vested in the ALMA Board, whose membership includes an NSF member; coordination and management of the merged international efforts is the responsibility of the Joint ALMA Office (JAO), whose staff includes the ALMA Director, project manager, and project engineer.

- Reviews:
  - Technical reviews: The JAO holds frequent technical and schedule reviews at appropriate design and fabrication milestones. For example, a series of reviews to assess the robustness and risks to the schedule was held in November 2008 through January 2009. An operational readiness review of NRAO's receiver integration center was held in April 2009 and others are planned for FY 2010. A function of the AMAC is to conduct project-wide external reviews and to audit internal reviews on behalf of the ALMA Board.
  - Management, Cost, and Schedule reviews: NSF, through the ALMA Board, holds external reviews of the broad project and in targeted areas. A review of the operations plan was conducted in February 2007. A project-wide annual review, held in December 2008, assessed management, cost and schedule performance, status, issues, and risks. NSF also requests broad external assessments, such as the aforementioned management review, and specific assessments, such as the safety review conducted in October 2008. The project-wide annual reviews will continue. A review of schedule and schedule drivers was held in July 2009. This review found that the project is taking all appropriate steps to complete the North American work within budget, that the current forecast completion date of end-2012 is aggressive, and that the budget contingency appears to be sufficient.
  - Upcoming reviews: There will be a performance review of the labor management and practices at the Chilean sites in mid 2010. Annual external reviews occur in November 2009 and late 2010, and a full operations review is planned in 2010.

<u>Current Project Status:</u>

- Major project milestones attained in FY 2009 included:
  - Acceptance of the first three North American and the first Japanese antennas;
  - Continued delivery of North American antennas at a rate of one every two months. By the end of FY 2009, thirteen North American antennas were in Chile at various stages of assembly and test;
  - Delivery of the first European antennas to Chile;
  - Delivery of the second quadrant of the correlator;
  - Delivery of the third and fourth North American and East Asian receivers;
  - Test interferometry at the mid-level facility in Chile using two antennas; and
  - The first three antennas were transported to the final, high-altitude site and their signals combined in a nascent array in late CY 2009.

- Major milestones for FY 2010 are expected to include:
  - Acceptance of the first European antennas;
  - Continued delivery of North American antennas at a rate of one every two months;
  - Acceptance of the fourth through fourteenth North American antennas and the remaining three Japanese antennas;
  - Transport of accepted antennas to the high-altitude site in Chile; and
  - Start of commissioning.

- Major milestones for FY 2011 are expected to include:
  - Acceptance of first Japanese 7-meter antenna;
  - Installation and acceptance of third and fourth quadrants of the correlator;
  - Installation and acceptance of central local oscillator (serves all ALMA Antennas);
  - Call for proposals for early science; and
  - Start of early-science (August 2011).

Cost and Schedule:

The current schedule performance is slightly behind plan due to equipment delivery delays, in particular delivery of the first antennas and receivers. Consequently, the major milestones of early-science and full-science are forecast to be delayed by three to nine months, although schedule recovery is possible. Cost performance is very good at this stage in the project — cost variance is –1 percent and schedule variance is –5 percent relative to the 2005 baseline — with about 40 percent contingency remaining in the uncommitted budget. A cost-to-complete exercise is underway to assess the remaining work, likely liens and other risk-weighted costs against the remaining budget. Significant expenditure of budgeted contingency is foreseen during the remainder of the project.

Risks:

- Full handover of the first North American and Japanese antennas will enable the other delivered antennas to be tested and accepted swiftly. The schedule for production of the European antennas should begin to stabilize once the first few antennas are delivered to Chile. Acceptance of European antennas in Chile is a pacing item for the schedule.
- While fabrication of the individual receiver components is making good progress, their integration into complete receiver systems and subsequent testing are the pacing items for the schedule and will be one of the key challenges for the project in the coming months.
- For operations, the principal challenge is to ramp-up the staffing to 200 technically qualified personnel over the next two years.
- The schedule for the start of initial scientific observations in 2011 depends upon successful commissioning of the first three antennas at the final high-altitude site during 2010.
- Note that the earlier problem of the supply of power to ALMA (a European deliverable) has been resolved and will be accomplished using multi-fuel generators located at the mid-level site.

Future Operations Costs:

Operations and maintenance funds phase in as initial site construction is completed and antennas begin to be delivered. Funds will be used to manage and support site and instrument maintenance, array operations in Chile, early-science (FY 2011) and eventually full-science operations, and in support of ALMA observations by the U.S. science community. Full ALMA science operations are anticipated to begin around the end of FY 2012. An operations plan and a proposal for North American operations were externally reviewed in FY 2007 and a funding profile through FY 2011 was authorized by the National Science Board in December 2007. The operations estimates for FY 2012 and beyond are based on current cost projections. The anticipated operational lifespan of this project is at least 30 years.

MATHEMATICAL AND PHYSICAL SCIENCES/POLAR PROGRAMS

IceCube Neutrino Observatory $0

The FY 2011 Budget Request does not request MREFC funds for the IceCube Neutrino Observatory. The FY 2010 Budget Request to Congress requested $950,000, which represented the final amount necessary to complete the nine-year project, totaling an estimated $279.47 million. $242.07 million of the total project cost has been funded through NSF's MREFC account, and the balance of $37.40 million has been provided by foreign partners in the project. Operations funding is provided through the Research and Related Activities account.

Appropriated and Requested MREFC Funds for the IceCube Neutrino Observatory
(Dollars in Millions)

FY 2004 & Earlier	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010 Estimate	Total
$81.29	$47.62	$49.85	$28.65	$22.38	$11.33	$0.95	$242.07

Total may not add due to rounding.

Baseline History: Congress provided initial appropriations for IceCube of $15.0 million in FY 2002 and $24.54 in FY 2003 for "Start-up Activities", including development of an enhanced hot water drill. NSF requested construction funding for IceCube in the FY 2004 Budget Request, and the total cost of the project (including start-up activities) was estimated to be $271.77 million at that time ($242.07 from NSF and the balance from the international partners). NSF carried out a comprehensive external baseline review of the entire project, including cost, schedule, technical, and management review, in February 2004; this rebaselining effort confirmed the U.S. total project cost of $242.07 million.

The IceCube hot-water drilling rig set up at South Pole Station. *Credit: Jim Haugen, University of Wisconsin.*

Foreign partners provided an additional $7.70 million in FY 2009 to provide additional sensor strings that will add to the capability of instrument. This increase in non-U.S. contributions brings the total project cost to $279.47 million. NSF's cost, however, remains constant at $242.07 million.

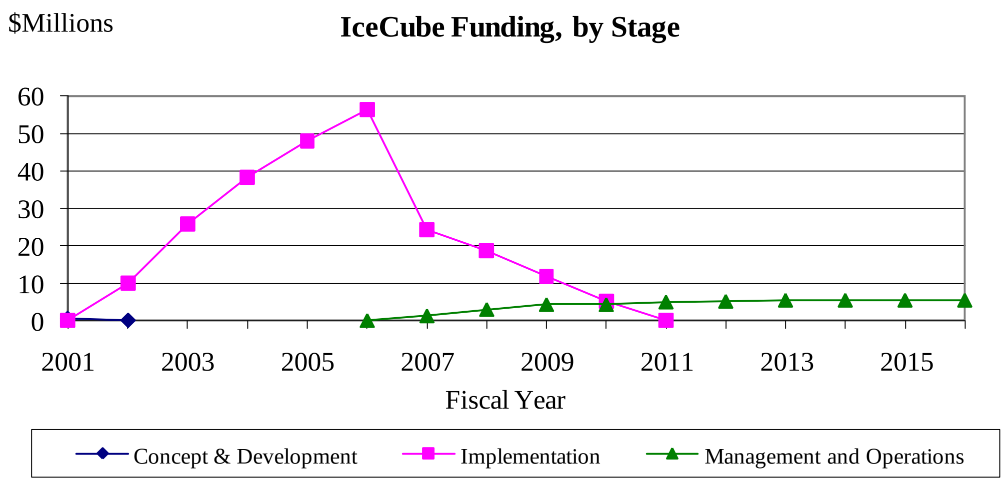
IceCube is the world's first high-energy neutrino observatory, located deep within the ice cap under the South Pole in Antarctica. It represents a new window on the universe, providing unique data on the engines that power active galactic nuclei, the origin of high energy cosmic rays, the nature of gamma ray bursters, the activities surrounding supermassive black holes, and other violent and energetic astrophysical processes. Approximately one cubic kilometer of ice is being instrumented with photomultiplier (PM) tubes to detect neutrino-induced, charged reaction products produced when a high energy neutrino interacts in the ice within or near the cubic kilometer fiducial volume. An array of Digital Optical Modules (DOMs), each containing a PM and associated electronics, will be distributed uniformly from 1.5 km to 2.5 km beneath the surface of the South Pole ice cap, a depth where the ice is highly transparent and bubble-free. When completed, IceCube will record the energy and arrival direction of high-energy neutrinos ranging in energy from 100 GeV (10^{11} electron Volts [eV]) to 10 PeV (10^{16} eV).

The project includes a Deep Core Array (DCA), situated within the geometry of the larger IceCube Observatory. The DCA will be composed of six strings with the DOMs concentrated in the lower-middle part of the array. The tighter spacing of the DOMs will allow the observatory to detect lower energy neutrinos (down to about 10 GeV), thus opening the door to studies of neutrino oscillation measurements and studies of Weakly Interacting Massive Particles (WIMPs) below 250 GeV. In essence, this change closes the energy gap between the IceCube Observatory and the SuperKamiokande detector in Japan. This positioning will also allow effective observations of high energy neutrinos entering from the sky of the southern hemisphere.

Total Obligations for IceCube
(Dollars in Millions)

	Prior Years	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
R&RA Obligations:									
Concept & Development	$0.50	-	-	-	-	-	-	-	-
Operations & Maintenance (OPP)	1.50	2.16	2.15	2.50	2.60	2.75	2.75	2.75	2.75
Operations & Maintenance (PHY)	1.50	2.16	2.15	2.50	2.60	2.75	2.75	2.75	2.75
Subtotal, R&RA Obligations	3.50	4.32	4.30	5.00	5.20	5.50	5.50	5.50	5.50
MREFC Obligations:									
Implementation	221.90	11.85	5.20	3.12	-	-	-	-	-
Subtotal, MREFC Obligations	221.90	11.85	5.20	3.12	-	-	-	-	-
Total: IceCube Obligations	**$225.40**	**$16.17**	**$9.50**	**$8.12**	**$5.20**	**$5.50**	**$5.50**	**$5.50**	**$5.50**

Totals may not add due to rounding.



The principal tasks in the IceCube project are: production of the needed DOMs and associated electronics and cables; production of an enhanced hot water drill and a DOM deployment system capable of drilling holes for and deploying DOM strings in the ice at the Pole; refurbishment and outfitting of the IceCube Laboratory (ICL) at the South Pole; the actual drilling of the deep-ice holes, deployment of the needed DOMs, and their commissioning and verification; installation of a surface array of air shower detectors ('IceTop') to both calibrate and eliminate background events from the IceCube DOM array; construction of data acquisition, handling, archiving, and analysis systems; and associated personnel and logistics support.

IceCube construction is being carried out by the IceCube Collaboration, led by the University of Wisconsin (UW). The IceCube Collaboration consists of 12 U.S. institutions and institutions in three other countries: Belgium, Germany, and Sweden. NSF's foreign partners are contributing approximately $37.40 million to the project, as well as a pro rata share of IceCube operations and maintenance costs based on the number of PhD-level researchers involved. NSF's share of the operations and maintenance costs is estimated at approximately $5.0 million in FY 2011. Future operations and maintenance costs are currently under review.

View down one of IceCube's deep ice holes during hot-water drilling. *Credit: Jim Haugen, University of Wisconsin.*

NSF will support activities at U.S. institutions working on more refined and specific data analyses, data interpretation (theory support), and instrumentation upgrades through ongoing research programs. The annual support for these research activities at U.S. institutions will be provided through the R&RA account in response to merit-reviewed proposals.

IceCube provides a vehicle for helping to achieve national and NSF education and outreach goals. Specific outcomes include the education and training of next-generation leaders in astrophysics, including undergraduate students, graduate students, and postdoctoral research associates; K-12 teacher scientific/professional development, including development of new inquiry-based learning materials and using the South Pole environment to convey the excitement of astrophysics, and science generally, to K-12 students; increased opportunity for involvement of students in international collaborations; increased diversity in science through partnerships with minority institutions; and enhanced public understanding of science through broadcast media and museum exhibits (such as the Adler Planetarium) based on IceCube science and the South Pole environment. Education and outreach activities so far have been supported principally by participating institutions, leveraged by the IceCube construction and research activities. NSF expects to support evaluation and measurement-based education and outreach programs under separate R&RA grants to universities and other organizations that are selected following standard NSF merit review.

Project Report:

<u>Management and Oversight:</u>

- NSF Structure: Oversight responsibility for IceCube construction is the responsibility of OPP, and a project coordinator manages and oversees the NSF award. Support for operations, research, education, and outreach will be shared by OPP and MPS as well as other organizations and international partners. Besides annual progress reviews and other specialized reviews (e.g., a safety review), the project provides monthly progress reports and quarterly reports. NSF conducts site visits, weekly teleconferences with the project managers, and internal NSF project oversight and management meetings.

- External Structure: The UW management structure for the IceCube project includes leadership by a project director and a project manager. At lower levels, project management includes international participation as well as participation by staff at collaborating U.S. institutions. This framework was put in place during the start-up phase of IceCube and provided a sound basis for initiation of full construction with FY 2004 funding as soon as the project was baselined. UW has in place an external Scientific Advisory Committee, an external Project Advisory Panel, and a high-level Board of Directors (including the UW Chancellor) providing awardee-level oversight of the project.

- Reviews: NSF carried out a comprehensive external baseline review of the entire project (including cost, schedule, technical, and management) in February 2004. There was a follow-up external cost review in Fall 2004. Comprehensive external reviews are held each spring following the annual deployment season; such reviews were held annually from 2005 through 2009. The next review is scheduled for May 2010.

Current Project Status:

- In FY 2009, the project exceeded the season's goal of deploying 14-16 new DOM strings by deploying 19 strings, including one Deep Core Array prototype string. In FY 2010, the project met its stretch goal by deploying 20 strings,bringing the total number of strings to 79. A UW proposal to authorize placement of six Deep Core Array strings was presented as a Director's Review Board (DRB) information item in June 2009, presented to the National Science Board as an information item in August 2009, and subsequently approved. This array is in the lower-middle part of the overall IceCube Observatory allowing measurements to lower energy and effectively removing the observational energy gap between IceCube and the SuperKamiokande detector in Japan.

Cost and Schedule:

- IceCube is 94.3 percent complete (as of 1 November 2009) in terms of earned value measures, well within the originally proposed budget and approximately on schedule. Contingency is $6.85 million, or approximately 44.4 percent of the value of the remaining work. Contingency continues to be carefully managed to ensure the successful completion of the project.

- Projected out-year milestones (FY 2010-2011) are based on current project planning and represent a general outline of anticipated activities. These activities are also dependent on weather conditions and the Antarctic logistics schedule. These include:
  - Continue DOM and IceTop module production and testing, and continue to drill, deploy, test, and commission strings and the corresponding IceTop modules, including installation and testing of the associated data acquisition (DAQ) elements;
  - Complete installation and commissioning of the Deep Core Array within the authorized funding for the IceCube Observatory; and
  - Ramp up to full operation and scientific exploitation of IceCube in FY 2011.

Risks:

- The enhanced hot water drill used to melt the 2.5 km water columns, into which the strings of DOMs are deployed, continues to perform well, with fuel efficiency better than planned and with a penetration rate that meets specifications. Of the DOMs deployed thus far, 98.5 percent are now working at or better than design specifications. Based on performance thus far, a mean-time-to-failure analysis predicts a survival fraction of just over 97 percent after 15 years, better than the original 95 percent reliability specification for the project. Installation of the IceTop surface array is proceeding according to schedule, with elements deployed on the surface at each string location. DOM production and cold-testing facilities in the U.S. and Europe continue to work with high efficiency, producing reliable DOMs that continue to meet or exceed requirements.

- Based on the above achievements, the project has retired major technical risks. A key factor to the success of IceCube, and a remaining risk, is the logistics support chain required to transport all material and personnel to the South Pole, and this, too, continues to perform at a very high level.

Future Operations Costs

Operations and maintenance in support of scientific research began in FY 2007, and will ramp up in subsequent years to full science operations in FY 2011 following completion of drilling and DOM deployment in that year. The associated costs are and will continue to be shared by the partner funding agencies – U.S. (NSF) and non-U.S. – on a pro rata basis according to the number of PhD researchers involved (currently about 55:45). In FY 2010, the U.S. share of operations and maintenance is currently budgeted at $4.30 million pending NSF review of an updated operations and maintenance proposal.

The annual cost of the data analysis that will be carried out by the collaborating U.S. and foreign institutions in FY 2010 is estimated at $9.0 million, of which $5.0 million will come from NSF for support of the U.S. analytical groups, and which is separate from support for operations and maintenance (e.g., the data acquisition and data handling systems, data quality monitoring, information technology (IT) upgrades). In FY 2011, the U.S. share of data analysis and modeling costs is estimated at $5.5 million.

The general operations of South Pole Station, reported in a separate section, also contribute to supporting IceCube. The cost of IceCube operations shown in the table herein includes only those that are project-specific and incremental to general South Pole Station operations. Progress in IceCube operations will be reviewed annually. The expected operational lifespan of this project is 25 years beginning FY 2011.

STEWARDSHIP

The NSF Strategic Plan for FY 2006-2011 defines Stewardship, the Foundation's fourth strategic goal, as supporting excellence in science and engineering research and education through a capable and responsive organization. Excellence in NSF's stewardship is essential to carrying out the Foundation's mission and accomplishing its other strategic goals: Discovery, Learning, and Research Infrastructure.

The activities that advance NSF's Stewardship goal are funded through five appropriations accounts. Additional details on each account are provided in the respective chapters.

Agency Operations and Award Management (AOAM) increases by $29.19 million, or 9.7 percent, to $329.19 million in FY 2011. These resources include funding for personnel compensation and benefits, information technology (IT) that supports administrative activities, staff travel, training, rent, and other operating expenses necessary for effective management of NSF's research and education activities.

Office of Inspector General (OIG) increases by $350,000, or 2.5 percent, to $14.35 million in FY 2011. These resources include funding for personnel compensation and benefits, contract audits, training and operational travel, office supplies, materials, and equipment.

National Science Board (NSB) increases by $300,000, or 6.6 percent, to $4.84 million in FY 2011. These resources include funding for personnel compensation and benefits, employment of external experts and consultants, contracts, training and operational travel, office supplies, materials, and equipment.

Program Accounts - Research and Related Activities (R&RA) and **Education and Human Resources** (EHR) – Stewardship funding from program accounts increases by $9.23 million, or 8.3 percent, to $120.44 million in FY 2011. Program funded stewardship activities include Intergovernmental Personnel Act (IPA) agreements and certain Foundation-wide activities such as major studies, evaluations, outreach efforts, information technology investments that are directly related to the mission of the Foundation, and NSF contributions to interagency e-Government activities.

Stewardship by Appropriations Account

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Agency Operations and Award Management	$294.09	-	$300.00	$329.19	$29.19	9.7%
Office of Inspector General	11.99	0.02	14.00	14.35	0.35	2.5%
National Science Board	4.02	-	4.54	4.84	0.30	6.6%
Research & Related Activities	88.25	-	96.47	104.32	7.85	8.1%
Education and Human Resources	13.08	-	14.74	16.12	1.38	9.4%
Subtotal, Program Support	101.34	-	111.21	120.44	9.23	8.3%
Total	**$411.44**	**$0.02**	**$429.75**	**$468.82**	**$39.07**	**9.1%**

Totals may not add due to rounding

NSF WORKFORCE

NSF Workforce
Full-Time Equivalents (FTE)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
AOAM FTE Allocation					
Regular	*1,295*	*1,310*	*1,350*	*40*	*3.1%*
Student	*40*	*40*	*40*	*-*	*-*
Subtotal, AOAM FTE Allocation	*1,335*	*1,350*	*1,390*	*40*	*3.0%*
AOAM FTE Usage (Actual/Projected)					
NSF Regular	1,266	1,285	1,350	65	5.1%
NSF Student	34	40	40	-	-
Subtotal, AOAM FTE[1]	1,300	1,325	1,390	65	4.9%
Office of the Inspector General[2]	69	73	74	1	1.4%
Regular	64	67	67	-	-
Student	5	6	7	1	16.7%
National Science Board[3]	17	17	18	1	5.9%
Arctic Research Commission[4]	4	4	4	-	-
Total, Federal Employees	1,390	1,419	1,486	67	4.7%
IPAs	164	211	222	11	5.2%
Detailees to NSF	3	6	6	-	-
Contractors (est.)	415	449	512	63	14.0%
Total, Workforce	**1,972**	**2,085**	**2,226**	**141**	**6.8%**

[1]Additional information regarding FTEs funded through the AOAM appropriation are available in the AOAM chapter.

[2]The Office of Inspector General is described in a separate chapter and is funded through a separate appropriation.

[3]The National Science Board is described in a separate chapter and is funded through a separate appropriation.

[4]The U.S. Arctic Research Commission is described in the Research and Related Activities chapter and is funded through the R&RA appropriation.

In FY 2011, NSF's total federal workforce will increase by 42 FTE and 11 IPAs over the FY 2010 level. The staffing profile in the table above shows that a small but significant percentage of the NSF workforce included in the FY 2011 Request – 222 people or approximately 10 percent – consists of temporary employees hired through the authority provided by the Intergovernmental Personnel Act (IPA). IPAs do not count as federal FTE. A smaller number of visiting staff – roughly 40 people annually – are employed through NSF's own Visiting Scientist, Engineer, and Educator Program (VSEE). VSEEs count as federal FTE and are included in the Federal Employees total (see table above). The use of IPAs and VSEEs, commonly referred to as rotators, has been a defining characteristic of NSF since its inception in 1950, as it gives NSF a direct connection to the researchers and educators working at the frontiers of science and engineering.

INFORMATION TECHNOLOGY INVESTMENTS

Information Technology (IT) Investments by Appropriation
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Agency Operations and Award Management	$34.48	$26.10	$27.00	$0.90	3.4%
Program Related Technology	52.00	56.00	61.50	5.50	9.8%
R&RA	*44.72*	*48.72*	*53.50*	*4.78*	*9.8%*
EHR	*7.28*	*7.28*	*8.00*	*0.72*	*9.9%*
Total	**$86.48**	**$82.10**	**$88.50**	**$6.40**	**7.8%**

Totals may not add due to rounding.

Information Technology (IT) Investments by Appropriation and Activity
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Agency Operations and Award Management (AOAM)					
Applications Services and Support	$13.37	$11.81	$12.75	$0.94	8.0%
Associated IT Operations and Infrastructure	17.98	11.50	11.46	-0.04	-0.3%
Security and Privacy Services and Support	3.13	2.79	2.79	-	0.0%
Subtotal, AOAM	34.48	26.10	27.00	0.90	3.4%
Program Related Technology					
Mission-Related Applications Services	34.09	39.13	43.50	4.37	11.2%
Associated IT Operations and Infrastructure	15.29	13.91	14.80	0.89	6.4%
Related Security and Privacy Services	2.62	2.96	3.20	0.24	8.1%
Subtotal, Program Related Technology	52.00	56.00	61.50	5.50	9.8%
Total, Information Technology Investments	**$86.48**	**$82.10**	**$88.50**	**$6.40**	**7.8%**

Totals may not add due to rounding.

Total funding for NSF's Information Technology (IT) investments in FY 2011 is $88.50 million, an increase of 7.8 percent over FY 2010.

- $61.50 million is for Program Related Technology (PRT) activities that relate directly to NSF's programmatic investments, such as Research.gov, eJacket, FastLane, and Reviewer Management. PRT is funded with direct program resources from the R&RA and EHR accounts. Further information on PRT-funded IT investments begins on page five of this section.

- $27.0 million in IT investments is funded with AOAM resources and will support routine administrative activities, such as human resources, financial statement preparation, procurement, etc. Further information on AOAM-funded IT investments can be found in the Agency Operation Award Management chapter of this Request.

PROGRAM-FUNDED STEWARDSHIP

R&RA and EHR Program Support funds account for about a quarter of the total Stewardship portfolio. There are two activities that comprise Program-Funded Stewardship – Intergovernmental Personnel Act (IPA) costs and Program Related Administration.

Summary of Program-Funded Stewardship
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
IPA Costs	$38.71	$47.12	$49.44	$2.32	4.9%
Program Related Administration	62.62	64.09	71.00	6.91	10.8%
Program Related Technology	*52.00*	*56.00*	*61.50*	*5.50*	*9.8%*
Other Program Related Admin	*10.62*	*8.09*	*9.50*	*1.41*	*17.4%*
Total, Program Funded	**$101.33**	**$111.21**	**$120.44**	**$9.23**	**8.3%**

Totals may not add due to rounding.

IPA Costs

The following table breaks down the IPA costs by appropriation into basic compensation, travel, and other benefits.

IPA Costs by Appropriation
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
R&RA					
IPA Compensation	$28.42	$33.63	$35.14	$1.51	4.5%
IPA Lost Consultant & Per Diem	3.44	4.07	4.25	0.18	4.4%
IPA Travel	2.42	2.86	2.99	0.13	4.5%
Subtotal, R&RA Costs	34.28	40.56	42.38	1.82	4.5%
EHR					
IPA Compensation	3.65	5.39	5.81	0.42	7.8%
IPA Lost Consultant & Per Diem	0.58	0.86	0.92	0.06	7.0%
IPA Travel	0.21	0.31	0.33	0.02	6.5%
Subtotal, EHR Costs	4.44	6.56	7.06	0.50	7.6%
Total, IPA Costs	**$38.71**	**$47.12**	**$49.44**	**$2.32**	**4.9%**

Totals may not add due to rounding.

IPAs are considered federal employees for many purposes during their time at NSF, even though they remain employees of their home institutions. They are not paid directly by NSF and are not subject to federal pay benefits and limitations. NSF reimburses the home institution for the IPA's salary and benefits using the traditional grant mechanism. IPAs are also eligible to receive per diem, relocation expenses, and reimbursement for any income foregone because of their assignment at NSF (i.e., lost consulting fees). While at NSF, rotators function in a manner virtually identical to the Foundation's permanent staff – leading the merit review process, overseeing awards, and shaping future program directions.

Program Related Administration

Program Related Administration includes two components: Program Related Technology and Other Program Related Administration.

Program Related Administration

(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Program Related Technology	$52.00	$56.00	$61.50	$5.50	9.8%
Other Program Related Admin	10.62	8.09	9.50	1.41	17.4%
Total, Program Related Administration	$62.62	$64.09	$71.00	$6.91	10.8%

Totals may not add due to rounding.

Program Related Technology (PRT) (+$5.50 million, to a total of $61.50 million)

PRT investments support NSF program staff as they formulate and announce program opportunities; accept proposals; conduct the merit review process; make awards to fund proposals that have been judged the most promising by the rigorous and objective merit-review process; monitor program performance and results; and disseminate results of NSF funded research. Major IT systems funded through PRT include Research.gov, Reviewer Management, eJacket, and FastLane. In addition, PRT activities further enable NSF to meet the requirements of the American Recovery and Reinvestment Act of 2009 by

- improving capabilities to help manage and report on Recovery Act awards;
- enhancing operational processing capabilities to support over 45,000 proposals, 10,000 awards, and thousands of electronic reviews;
- improving access to proposal, award, and related financial and performance information NSF staff need for key decision making;
- eliminating paper by electronically archiving records; and
- improving routine IT operations leveraging virtual technologies, networking innovations, and new IT service delivery models to support these mission-related IT investments.

The PRT budget includes:

Mission-Support Applications Services (+$4.37 million, to a total of $43.50 million)

- Research.gov (+$2.50 million to a total of $17.50 million) will provide staff with new and improved capabilities to plan and manage programs and to promote scientific innovations and discoveries, including tools to support broadening participation by enabling a more diverse set of institutions, investigators, and reviewers greater access to NSF funding opportunities.
  Research.gov is NSF's critical investment providing new and modern services to meet the high priority needs of NSF staff and the research community, consistent with new government-wide standards, and in concert with the broader research community. Research.gov:
  - Provides NSF staff new services via an intuitive, easy to use desktop portal, providing critically needed new tools and an integrated environment for staff to work.
  - Will launch "Science and Innovation," a new public service to demonstrate how NSF research and education programs benefit society, often beyond scientific discoveries, in FY 2010.
  - Fulfills an America COMPETES Act requirement to make project outcome reports public.
  - Will begin to implement the new government-wide Research Performance Progress Report standard in FY 2010, in partnership with other federal agencies.

- Other mission-related applications and services (+$1.87 million, to a total of $26.0 million) to support program staff tools such as eJacket, to manage proposal and program portfolios through such steps as eliminating paper by electronically archiving records, as well as the continued planning and pre-acquisition activities associated with the iTRAK project, which will replace NSF's current financial management system (FAS).

Associated IT Operations and Infrastructure (+$890,000, to a total of $14.80 million). This funding increase will ensure high quality, reliable, and secure mission-related applications and associated IT infrastructure support and services.

Related Security and Privacy Services (+$240,000, to a total of $3.20 million).
Continued investments will secure mission-related applications and protect sensitive information.

NSF's business cases can be found at: http://it.usaspending.gov/

Other Program Related Administration (+$1.41 million, to a total of $9.50 million).
Other Program Related Administration includes funding for Foundation-wide activities such as major studies, evaluations, and NSF's costs associated with interagency e-Government activities. These activities include verification and validation of performance information; surveys of scientists, engineers, and educators who submit proposals for NSF awards; the Waterman Award which recognizes an outstanding young researcher in any field of science or engineering supported by NSF; AAAS fellowship program and internships; and external evaluations of cross-foundational programs.

E-Government Activities

NSF is providing funding in FY 2010 and FY 2011 to these E-Government Activities:

NSF FY 2010 Funding for E-Government Initiatives

Initiative	FY 2010 Agency Contributions	FY 2010 Agency Svc. Fees	NSF Total	Appropriations Account AOAM	R&RA	EHR
Grants.gov	$475,294	-	**$475,294**	-	$413,506	$61,788
Grants Management LoB	174,360	-	**174,360**	-	151,693	22,667
E-Travel	-	150,038	**150,038**	150,038	-	-
Geospatial LoB	15,000	-	**15,000**	-	13,050	1,950
E-Training	-	370,000	**370,000**	370,000	-	-
E-Rulemaking	-	5,100	**5,100**	5,100	-	-
Recruitment One-Stop (USA Jobs)	-	4,871	**4,871**	4,871	-	-
E-HRI	-	48,724	**48,724**	48,724	-	-
Integrated Acquisition Environment	-	18,866	**18,866**	18,866	-	-
Human Resources Management LoB	65,217	-	**65,217**	-	56,739	8,478
Financial Management LoB	44,444	-	**44,444**	-	38,666	5,778
Budget Formulation/Execution LoB	95,000	-	**95,000**	-	82,650	12,350
E-Payroll (incl. Shared Services)	-	304,704	**304,704**	304,704	-	-
Total	$869,315	$902,303	**$1,771,618**	$902,303	$756,304	$113,011

Totals may not add due to rounding.

The total for all NSF FY 2010 inter-agency E-Government and Line of Business contributions for the initiative funding levels reported, and including any new development items, is not currently projected by the Federal CIO Council to change significantly from the FY 2009 aggregate level. Specific levels presented here are subject to change, as redistributions to meet changes in resource demands are assessed.

NSF FY 2011 Funding for E-Government Initiatives

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Benefits realized through the use of these activities are:

- *Grants.gov*
  The Grants.gov Initiative provides grant applicants with a single source to search and apply for funding opportunities from all Federal grant-making agencies using common forms, processes, and systems. With NSF's full implementation of Grants.gov, the research community can now find and apply for NSF funding opportunities on Grants.gov as well as through NSF's FastLane web site.

  NSF recognizes the benefits that Grants.gov provides to the research community through use of standardized terminology, application forms and electronic submission processes. NSF has leveraged Grants.gov in the development of five agency specific forms (of which only 2 are required) and has used them 100 percent of the time; NSF uses government-wide forms 100 percent of the time for its application packages. In FY 2009, NSF published 36 funding opportunities on Grants.gov and published associated application packages for 32 of those opportunities. NSF received 640 electronic applications through Grants.gov in FY 2009.

- *Grants Management Line of Business (GM LoB)*
  NSF anticipates the key benefit of the GM LoB will be having a common place for grantees to track the status of applications, find award information, and submit grant progress and financial reports. Automated business processes available through Consortia will decrease agency reliance on manual and paper-based processing. The GM LoB will lead to a reduction in the number of systems of record for grants data across NSF and the government and will foster the development of common reporting standards, improving NSF's ability to provide agency- and government-wide reports on grant activities and results.

As a GM LoB Consortium lead, NSF has developed Research.gov, in partnership with NASA, the Defense Research Agencies, and USDA National Institute of Food and Agriculture. Research.gov is a web portal containing government-wide resources and tools for research institutions to conduct grants business with Federal research agencies.

By leading the GM LoB Consortium, NSF will receive the following benefits:

- Avoiding costs related to developing and implementing online grants management services;
- Supporting federal agencies' efforts to promote their common research mission;
- Fulfilling federal mandates (Public Law 106-107, President's Management Agenda, E-Government Act, and the Federal Funding Accountability and Transparency Act); and
- Organizing information into a single access point throughout the grants management business process.

Service to constituents will be improved through the standardization and streamlining of government-wide grants business processes. The public will receive time savings as a result of quicker notification and faster payments due to an automated system for grants processing. Furthermore, GM LoB will minimize complex and varying agency-specific requirements and increase grantee ease of use on Federal grants management systems. Constituents will benefit from having fewer unique agency systems and processes to learn; grantees' will benefit from ease in learning how to use the system and reduced need to rely on call center technical support.

- *Geospatial Line of Business*
  NSF supports basic research at the frontiers of discovery across all fields of (non-medical) science through competitive proposals that are evaluated using merit-based peer review. To advance its mission, NSF actively participates in activities that shape and enhance the scientific enterprise. Although NSF is not currently a provider of a geospatial data, it does consider proposals for support of fundamental research that utilizes or enhances the value of geospatial information. NSF recognizes the importance of the LoB in establishing a more collaborative and performance-oriented culture within the Federal geospatial arena that should optimize investments in data and technology and yield many long-term benefits to the nation.

- *Human Resources Management Line of Business (HR LoB)*
  NSF benefits through its use of best-in-class HR services and systems provided by one of the approved service providers, the Department of Interior's National Business Center. Through its adoption of an approved service provider, NSF achieves the benefits of "best-in-class" HR solutions and offers employees across the agency improved HR services without the costs of developing and maintaining their own HR systems. Participation in HR LoB allows NSF to participate in the implementation of modern HR solutions and benefit from best practices and government-wide strategic HR management.

- *Financial Management Line of Business (FM LoB)*
  NSF will realize the following benefits through participation in FM LoB and usage of a FM Shared Service Provider (SSP):
  - Cost Savings;
  - Minimizing Risk: SSP customers will be able to minimize risk by implementing and using financial systems that are already operating with standard operating procedures;

- Avoiding Duplicate Operational Costs: Reducing redundant costs by using standard business processes and a common system software certified by the Financial System Integration Office in the General Services Administration; and
- Facilitating Best Practices/Standardization: Key tools such as a Request for Proposal framework and Service Level Agreement guides will be provided to NSF to help in the development of agency agreements with SSPs.

- *Budget Formulation and Execution Line of Business (BFE LoB)*

  BFE LoB provides significant benefits to partner agencies by encouraging best practices crossing all aspects of Federal budgeting -- from budget formulation and execution to performance to collaboration to human capital needs. To benefit all agencies, BFELoB continues to support idea of shared service budget systems. NSF has not yet chosen a budget system; however, a shared service budget system is an option.

  BFE LoB's "MAX Federal Community", a secure government-only collaborative website, provides significant benefits for collaboration across and within agencies, as well as knowledge management. NSF currently has 223 users registered for the MAX Federal Community. The Community site is commonly used for sharing information, collaboratively drafting documents (including the direct-editing of documents posted on the site), supporting workgroups, submitting central reports, and much more. NSF also has the option to use BFELoB's online meeting tool for NSF budget meetings.

AGENCY OPERATIONS AND AWARD MANAGEMENT $329,190,000
+$29,190,000 / 9.7%

Summary of Agency Operations and Award Management
Major Categories
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Human Capital					
Personnel Compensation & Benefits	$186.61	$203.66	$217.89	$14.23	7.0%
Management of Human Capital	12.90	8.92	12.46	3.54	39.7%
Operating Expenses	14.07	14.11	16.50	2.39	16.9%
Travel	6.22	9.00	9.50	0.50	5.6%
Subtotal, Human Capital	219.80	235.69	256.35	20.66	8.8%
Technology and Tools					
Information Technology	34.48	26.10	27.00	0.90	3.4%
Space Rental	24.42	26.00	26.39	0.39	1.5%
Other Infrastructure	15.39	11.40	15.45	4.05	35.5%
Subtotal, Technology and Tools	74.29	63.50	68.84	5.34	8.4%
Future NSF HQ	-	0.81	4.00	3.19	393.8%
Total, AOAM	**$294.09**	**$300.00**	**$329.19**	**$29.19**	**9.7%**

Totals may not add due to rounding.

AOAM in Context

Investments in Agency Operations and Award Management (AOAM), as part of the Foundation's Stewardship Strategic Goal, continue to be NSF's highest priority as this activity provides the fundamental framework through which the Foundation's science and engineering, research, and education programs are effectively and efficiently administered. AOAM funding covers NSF's scientific, professional, and administrative workforce, the physical and technological infrastructure necessary for a productive, safe and secure work environment, and the essential business operations critical to NSF's administrative processes.

AOAM is contained within Stewardship, one of NSF's four Strategic Goals. Long-term priorities for AOAM, as well as agency Stewardship include:

- Strengthening partnerships and developing new collaborations with key stakeholders in the research and education community;
- Improving processes to recruit and select highly qualified reviewers and panelists;
- Developing and implementing a suite of Human Capital Management initiatives including recruiting, hiring, and empowering highly qualified staff who reflect the diversity of our community; developing mechanisms to improve training and mentoring for program officers; implementing NSF's Human Capital Management Plan; and enhancing NSF as a learning organization;
- Improving the transparency, consistency, and uniformity of the merit review process; and
- Enhancing processes for management and oversight of large facilities.

The 1,350 FTE level represents an increase of 40 full-time equivalents (FTE) over the FY 2010 Estimate and is based on a workforce and staffing forecast that is commensurate with the portfolio of activities contained in the FY 2011 Request. The FY 2011 Personnel Compensation and Benefits (PC&B) increase over the FY 2010 Estimate includes $2.76 million to fund the estimated 1.4 percent cost of living adjustment which impacts both salaries and benefits, as well as $6.28 million for salaries and benefits to fund 40 additional FTEs. See the PC&B section for more details on the justification for this increase.

FY 2011 Request by Major Category

HUMAN CAPITAL ($256.35 million)

Human Capital Funding
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Personnel Compensation & Benefits	$186.61	$203.66	$217.89	$14.23	7.0%
Management of Human Capital	12.90	8.92	12.46	3.54	39.7%
Operating Expenses	14.07	14.11	16.50	2.39	16.9%
Travel	6.22	9.00	9.50	0.50	5.6%
Total, Human Capital	**$219.80**	**$235.69**	**$256.35**	**$20.66**	**8.8%**

Totals may not add due to rounding.

AOAM NSF Workforce
(Full-Time Equivalent (FTE) and Other Staff)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
NSF AOAM -- Regular	1,266	1,310	1,350	40	3.1%
NSF AOAM -- Student	34	40	40	-	-
Subtotal, FTE Allocation	1,300	1,350	1,390	40	3.0%
Detailees to NSF	3	6	6	-	-
Total, Workforce	**1,303**	**1,356**	**1,396**	**40**	**2.9%**

NSF funding for Human Capital covers four general areas:

- Personnel Compensation and Benefits funds the salaries of NSF's federal employees and students, as well as the costs related to their employee benefits;
- Management of Human Capital encompasses a broad array of personnel-related services including recruiting, classification and staffing, workforce planning, policy development and execution, competency modeling, succession planning, and talent management. Resources devoted to this strategic investment ensure that the agency has highly qualified, motivated, and trained staff to facilitate the grant making process and assure that the best science, engineering. and education research is funded;
- Operating Expenses includes funding for supplies and equipment, as well as contracts for post-award monitoring and financial services consulting; and
- Travel includes outreach activities, post-award oversight and monitoring, and site visits.

Detailed justifications for each of these areas are provided on the following pages.

Personnel Compensation and Benefits (+$14.23 million, to a total of $217.89 million)

Personnel Compensation & Benefits

(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Regular FTE Allocation	1,295	1,310	1,350	40	3.1%
Regular FTE Usage (actual/projected)	*1,266*	*1,285*	*1,350*	*65*	*5.1%*
Regular Salary					
Base Salary[1]	$142.93	$149.14	$156.59	$7.45	5.0%
Salary Cost of Additional FTE	-	2.20	4.92	-	-
COLA & Locality Pay[2]	-	2.71	2.76	-	-
Subtotal, Regular FTE Salary	$142.93	$154.05	$164.27	$10.22	6.6%
Student FTEs	*34*	*40*	*40*	-	-
Student Salary	$1.23	$1.49	$1.52	$0.03	2.0%
Total, FTEs	*1,300*	*1,325*	*1,390*	*65*	*4.9%*
Subtotal, FTE Pay	$144.16	$155.54	$165.79	$10.25	6.6%
Benefits and Other Compensation[3]	42.45	48.12	52.10	3.98	8.3%
Total, PC&B	**$186.61**	**$203.66**	**$217.89**	**$14.23**	**7.0%**

[1]The increase in the FY 2011 base salary reflects the full annual cost of employees hired throughout FY 2010.

[2]The pay increase includes the annualization of the FY 2010 pay raise, nine months of the projected FY 2011 pay raise, as well as anticipated within grades and promotion increases.

[3]This category includes employee benefits, detailees to NSF, terminal leave, awards, and other benefits.

- Personnel Compensation and Benefits (PC&B) funds the salaries of NSF's federal employees and students, as well as the costs related to their employee benefits.

The FY 2011 Request of $217.89 million for PC&B represents an increase of $14.23 million, or 7 percent over NSF's FY 2010 Estimate of $203.66 million. The FY 2011 PC&B cost projection is based on salaries and benefits for 1,350 regular FTEs and also includes funding for a 1.4 percent pay raise, general workforce performance awards (GWFPA), and SES pay for performance salary increases.

The 1,350 FTE level represents an increase of 40 FTE over the FY 2010 Estimate and is based on a workforce and staffing forecast that is commensurate with the anticipated workload associated with the total NSF portfolio in FY 2011. Of this increase, 11 FTE will be assigned to the Division of Acquisition and Cooperative Support to support the strengthening of NSF acquisition's activities by improving the capacity, capabilities, and effectiveness of the acquisition workforce. This increase is part of the government-wide effort to strengthen the acquisition workforce. A key priority for NSF is improving capabilities in the pre-solicitation phase of major acquisitions. In addition; as part of the Administration's government-wide initiative to strengthen program evaluation, 4 new FTE will be dedicated for the establishment of a centralized NSF capability for assessment and evaluation. The FY 2011 PC&B increase over the FY 2010 Estimate includes $2.76 million to fund the estimated 1.4 percent cost of living adjustment which impacts salaries and benefits, as well as an additional $6.28 million for salaries and benefits to fund 40 additional FTEs.

NSF uses a workforce and staffing forecast model to provide a data-driven rationale for NSF's annual staffing request. The analysis incorporates the relationship between NSF's budget and workload and takes into consideration the directorate workload, including: the volume and dollar threshold of awards; the number of declinations; the number of post award activities; the number of pre-proposals; and the historical ratio between support and program staff. The analysis is based primarily on the workload demands of activities related to merit review and the funding of awards on a transaction basis and does not include the additional and increasing responsibilities related to program planning and evaluation and the added demands of increased levels of reporting and accountability.

Management of Human Capital (+$3.54 million, to a total of $12.46 million)

Funding for the Management of Human Capital includes:

- Services in support of effective recruitment, marketing and outreach, employment and retention of staff;
- Health and employee assistance services, benefits and retirement counseling;
- Workforce and succession planning and implementation;
- Organizational development;
- Performance management system implementation;
- Training and talent management services to create and provide learning opportunities for NSF staff;
- Payments to shared service providers, such as the Department of the Interior's National Business Center, which provides central personnel and payroll services.

The $3.54 million increase in FY 2011 will address improvements in agency management of human resources, giving priority to issues raised in the recent Federal Human Capital survey. Specifically, additional funds would be focused on the creation of a comprehensive management and leadership development training program, enhanced learning activities in support of staff development, improved performance management to include a focus on the assessment of rotator staff and on the skills needed to effectively address poor performance, and an in-depth review of workforce analysis and planning processes to implement more effective succession management and to review the optimal mix of permanent versus rotator staff.

Operating Expenses (+$2.39 million, to a total of $16.50 million)

- Operating Expenses includes funding for supplies and equipment, as well as contracts for post-award monitoring and financial services consulting.

The FY 2011 Request of $16.50 million for Operating Expenses represents an increase of $2.39 million, or 16.9 percent over the FY 2010 Estimate. The FY 2011 estimate includes funding for contracts for post-award monitoring, the e-procurement system, the Budget Internet Information System, Contracting Officer's Technical Representative (COTR) training, A-123 Internal Controls Monitoring, and financial services consulting. Operating expenses also include other general expenses such as the costs of supplies, equipment, training for individual staff members, and other operating expenses necessary for the management of NSF's award processing. The additional funding is for estimated contractual increases, the augmentation of NSF's acquisition capabilities, necessary resources for the establishment of a centralized NSF capability for assessment and evaluation, as well as additional supplies and equipment to support the expanded workforce.

Travel (+$500,000, to a total of $9.50 million)

- Travel includes funding for NSF staff to attend program-related meetings, conferences, and workshops as well as conduct outreach activities, post-award oversight and monitoring, and site visits.

The FY 2011 Request of $9.50 million for Travel represents an increase of $500,000 over the FY 2010 Estimate. The additional travel resources are required to accommodate the growing workforce and to conduct the travel necessary to meet programmatic needs and to carry out the necessary level of site reviews, post-award monitoring and oversight, and outreach activities

TECHNOLOGY AND TOOLS ($68.84 million)

Technology and Tools Funding
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Information Technology	$34.48	$26.10	$27.00	$0.90	3.4%
Space Rental	24.42	26.00	26.39	0.39	1.5%
Other Infrastructure	15.39	11.40	15.45	4.05	35.5%
Total, Technology and Tools	**$74.29**	**$63.50**	**$68.84**	**$5.34**	**8.4%**

Totals may not add due to rounding.

Information Technology for Administrative IT Investments (+$900,000, to a total of $27.0 million)

The FY 2011 Information Technology request for Agency Operations is $27.0 million. This level will ensure high quality, reliable, and secure administrative applications and associated IT infrastructure support and services to meet the needs of the Foundation, including:

- Human Resource Information Systems supporting Workforce/Succession Planning, Performance Management, and Benefits/Retirement Management;
- Legacy financial accounting system and interfaces to payroll, travel, and training systems;
- Applications supporting NSF's administrative functions such as property tracking, time and attendance tracking, and conference room management;
- Infrastructure and operational support to maintain these applications; and
- Security and Privacy support to secure these applications and to protect the data that resides in them.

NSF funds administrative IT applications from the Agency Operations and Award Management account while mission-related IT investments are funded from Program Accounts. Resources to support mission-related IT investments, associated IT operations and infrastructure, and IT security and privacy services and support are discussed in the Program Related Technology (PRT) section of the Stewardship chapter.

Summary of Agency Operations Information Technology (IT)

(Dollars in Millions)

Agency Operations Information Technology	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Applications Services and Support	$13.37	$11.81	$12.75	$0.94	8.0%
Associated IT Operations and Infrastructure	17.98	11.50	11.46	-0.04	-0.3%
Security and Privacy Services and Support	3.13	2.79	2.79	-	-
Total, Information Technology	**$34.48**	**$26.10**	**$27.00**	**$0.90**	**3.4%**

Totals may not add due to rounding.

Administrative Applications Services and Support (+$940,000, to a total of $12.75 million) Investments in this category support administrative applications such as NSF’s human resources management systems, property system, procurement system, SharePoint system, external website, and maintenance of NSF's legacy financial and accounting system and related functions.

Associated IT Operations and Infrastructure (-$40,000, to a total of $11.46 million)
Investments in this category provide basic maintenance and operations levels for ongoing activities and support. This includes funds for systems administration and operations, network, phone, email, and remote access services related to administrative applications and technologies. Routine upgrades and periodic technology refresh are required to provide highly available, high quality performance and consistent operational stability of NSF administrative systems.

Security and Privacy Services and Support (unchanged from FY 2010, a total of $2.79 million)
Investments in this category include automated configuration management tools that manage security patches and provide proactive protection from viruses, spyware, and other threats. This includes the relative portion of NSF’s network security, application security, security control testing and tools, automated vulnerability assessment tools, and remediation and intrusion detection services related to administrative applications.

NSF’s business cases can be found at: http://it.usaspending.gov/

Summary of Space Rental and Other Infrastructure by Function
(Dollars in Millions)

Space Rental & Other Infrastructure	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Space Rental	$24.42	$26.00	$26.39	0.39	1.5%
Other Infrastructure	15.39	11.40	15.45	4.05	35.5%
- Administrative Contracts	*9.42*	*6.00*	*9.44*	*3.44*	*57.3%*
- Government Goods and Services	*1.50*	*1.35*	*1.51*	*0.16*	*11.9%*
- Administrative Services Equipment & Supplies	*4.47*	*4.05*	*4.50*	*0.45*	*11.1%*
Total, Space Rental & Other Infrastructure	**$39.81**	**$37.40**	**$41.84**	**$4.44**	**11.9%**

Space Rental (+$0.39 million, to a total of $26.39 million)

- Space Rental includes GSA rent, utilities, taxes, and security.

The FY 2011 request for Space Rental is $26.39 million, an increase of $390,000, or 1.5 percent, over the FY 2010 Estimate. NSF currently occupies 650,000 square feet of space, primarily in two adjoining, leased office buildings located in Arlington Virginia. Efforts are underway in FY 2010 to acquire approximately 10,000 additional square feet to accommodate existing staff. The additional $390,000 being requested will support increased GSA rental costs, real estate taxes, utility costs, and the annualized cost for any additional space acquired in 2010.

Other Infrastructure (+$4.05 million, to a total of $15.45 million)

Other Infrastructure funding supports the following major sets of activities:

Administrative Contracts
Funds programs such as the physical security of the NSF workplace, conference room, meeting and travel management support, infrastructure maintenance and building services, records management, the intranet, and the transit subsidy program. The additional $3.44 million being requested will support the re-competition of a multi-million dollar facilities support contract, enhanced meeting and travel management support to meet increased demands for services, and funding the agency's electronic records management system in support of the "Open Government Directive".

Government Goods and Services
Funds security guards, infrastructure maintenance and building services, building improvements, and reconfiguration and office space realignments. The additional $160,000 is needed to support energy efficiency programs in compliance with Executive Order 13514.

Administrative Services Equipment and Supplies
Funds a full range of office machine and office furniture purchases, upgrades and installations, subscriptions to scientific and engineering databases and periodicals that support the NSF programs, and further development of video conferencing and other virtual technologies. The additional $450,000 is to support administrative services and supplies necessary for the expanded workforce.

FUTURE NSF HQ ($4.00 million)

Future NSF HQ
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Future NSF HQ	-	$0.81	$4.00	$3.19	393.8%

Totals may not add due to rounding.

Future NSF HQ – Agency Headquarters Space Analysis and Planning *(+$3.19 million, to a total of $4.0 million)*

In preparation for the expiration of the current NSF Headquarters lease in 2013, the FY 2011 Request includes funding for the planning activities necessary to enter into a new long term lease arrangement as soon as possible, following the procedures and policies of the General Service Administration. Even though the costs analyses and negotiations are not yet complete, NSF expects that there will be substantial costs associated with this multi-year project over the next several fiscal years.

The major cost components for the Future NSF Headquarters Project in the FY 2011 Request include:
(a) Program Management Costs for contractor support including a technology manager, project architect, relocation planning services, and a special program consultant.
(b) Furniture and technology pilot and demonstration costs: includes costs associated with acquiring, installing and testing employee pilot projects for future office furniture and materials, virtual technology and/or other communications systems.
(c) Technology design: design for the infrastructure for NSF's data, voice, and video distribution systems.

Agency Operations and Award Management by Object Class

The following table shows the planned distribution of general operating expenses (GOE) by object class. A brief explanation of each general operating expenses category follows.

AOAM Expenses by Object Class
(Dollars in Thousands)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Personnel Compensation	$152,326	$165,107	$176,821	$11,714	7.1%
Personnel Benefits	36,001	38,553	41,070	2,517	6.5%
Travel and Transportation of Persons	6,228	9,000	9,500	500	5.6%
Transportation of Things	547	441	543	102	23.1%
Rental Payments to GSA	23,529	26,000	26,390	390	1.5%
Rental Payments to Others	987	797	979	182	22.8%
Communications, Utilities and Misc. Charges	2,030	1,638	2,014	376	23.0%
Printing and Reproduction	254	205	252	47	22.9%
Advisory and Assistance Services	46,431	37,474	46,069	8,595	22.9%
Other Services	9,092	7,338	9,021	1,683	22.9%
Purchases of Goods & Srvcs from Gov't. Accts	7,629	6,157	7,569	1,412	22.9%
Operation and Maintenance of Equipment	66	53	65	12	22.6%
Supplies and Materials	4,727	3,815	4,690	875	22.9%
Equipment	4,240	3,422	4,207	785	22.9%
Total, AOAM	**$294,087**	**$300,000**	**$329,190**	**$29,190**	**9.7%**

Totals may not add due to rounding.

A description of categories:

- **Personnel Compensation and Benefits:** Personnel compensation funds pay, awards/bonuses, details to NSF, overtime, and terminal leave. Benefits include the Government's contribution towards retirement systems, health and life insurance, thrift saving plans, special overseas allowances, and unemployment insurance.

- **Travel and Transportation of Persons:** These resources fund travel required for planning, outreach, and increased oversight of existing awards as recommended by the agency's Inspector General.

- **Transportation of Things:** This category consists of household moves associated with bringing new staff to NSF.

- **Rental Payments to GSA:** This category includes the rent charged by GSA for NSF's facility in Arlington, Virginia, and additional floors in an adjacent building.

- **Rental Payments to Others:** This category includes rent paid to a non-Federal source for rental of space, land, and structures.

- **Communications, Utilities, and Miscellaneous Charges:** This category includes all costs for telephone lines and services, both local and long distance, and postage.

- **Printing and Reproduction:** This category includes contract costs of composition and printing of NSF's publications, announcements, and forms, as well as printing of stationery and specialty items.

- **Advisory and Assistance Services:** This category includes development, learning, and career enhancement opportunities offered through the NSF Academy, contracts for human capital operational activities, work life initiatives, outreach and related services, assistance in award oversight and monitoring, and A-123 review.

- **Other Services:** This category includes warehousing and supply services, mail handling, proposal processing, equipment repair and maintenance, building-related costs, furniture repair, contract support for conference room services, security investigations, and miscellaneous administrative contracts.

- **Purchases of Goods and Services from Government Accounts:** This category includes reimbursable services purchased from GSA. These costs include security guard services, some electrical upgrades, and modest renovation services.

- **Operation and Maintenance of Equipment:** This category includes management and operation of the central computer facility 24x7 year-round; operation of the customer service center and FastLane help desk; maintenance of database server hardware and related peripherals; software licensing fees; data communications infrastructure and network systems support; electronic mail support; and remote access (e.g., internet and World Wide Web).

- **Supplies and Materials:** This category includes office supplies, library supplies, paper and supplies for the NSF central computer facility, and miscellaneous supplies.

- **Equipment:** This category includes new and replacement computing equipment, desktop computers, data communications equipment, video-teleconferencing equipment, office furniture, file cabinets, and support equipment such as audio-visual equipment.

Appropriation Language

For agency operations and award management necessary in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); services authorized by 5 U.S.C. 3109; hire of passenger motor vehicles; not to exceed ~~$9,200~~*$9,000* for official reception and representation expenses; uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; rental of conference rooms in the District of Columbia; and reimbursement of the Department of Homeland Security for security guard services; ~~$300,000,000.~~*$327,190,000: Provided*, That contracts may be entered into under this heading in fiscal year ~~2010~~*2011* for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year.

Commerce, Justice, Science Appropriations Title V General Provisions:

SEC. 525. For an additional amount for the "Agency Operations and Award Management", National Science Foundation account, $2,000,000, to increase the agency's acquisition workforce capacity and capabilities: Provided, That such funds shall be available only to supplement and not to supplant existing acquisition workforce activities: Provided further, That such funds shall be available for training, recruitment, retention, and hiring additional members of the acquisition workforce as defined by the Office of Federal Procurement Policy Act, as amended (41 U.S.C. 401 et seq.): Provided further, That such funds shall be available for information technology in support of acquisition workforce effectiveness or for management solutions to improve acquisition management.

Agency Operations and Award Management
FY 2011 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Transfers[1]	Expired	Total Resources	Obligations Incurred/Est.
FY 2009 Appropriation	$294.00		0.15	(0.06)	$294.09	$294.09
FY 2010 Current Plan (CP)	300.00				300.00	300.00
FY 2011 Request	329.19				329.19	329.19
$ Change from FY 2010 CP						29.19
% Change from FY 2010 CP						9.7%

Totals may not add due to rounding.

[1]FY 2009 Actual includes $147,900 in funds provided by the U.S. Department of State for an award to the Civilian Research and Development Foundation that was a carryover from FY 2008 and obligated in FY 2009.

NATIONAL SCIENCE BOARD (NSB) $4,840,000
+ 300,000 / 6.6%

The FY 2011 Request for the National Science Board is $4.84 million, an increase of $300,000, or 6.6 percent, over the FY 2010 estimate of $4.54 million. The FY 2011 Budget Request will enable the Board to fulfill its policy-making responsibilities for NSF and provide advice to the President and Congress on significant national policy issues in science and engineering (S&E) research and education. This increased funding will allow the Board to enhance its responsibilities related to the American Recovery and Reinvestment Act of 2009 (ARRA), increase activities in the review of major research facilities projects, and to complete three studies on merit review criteria, data policies and the support framework for leading-edge, transformative research.

NSB Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Personnel Compensation and Benefits	$2.45	$2.86	$3.10	$0.24	8.4%
Other Operating Expenses	1.58	1.68	1.74	$0.06	3.6%
Total, NSB	**$4.03**	**$4.54**	**$4.84**	**$0.30**	**6.6%**
Full-Time Equivalent Employment	17	17	18	1	5.9%

Totals may not add due to rounding.

Appropriation Language

For necessary expenses (including payment of salaries, authorized travel, hire of passenger motor vehicles, the rental of conference rooms in the District of Columbia, and the employment of experts and consultants under section 3109 of title 5, United States Code) involved in carrying out section 4 of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), ~~$4,540,000:~~*$4,840,000: Provided*, That not to exceed ~~$2,800~~*$2,500* shall be available for official reception and representation expenses.

National Science Board
FY 2011 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Expired	Total Resources	Obligations Incurred/Est.
FY 2009 Appropriation	$4.03	-$0.01	$4.02	$4.02
FY 2009 ARRA	-	-	-	-
FY 2010 Estimate	4.54	-	4.54	4.54
FY 2011 Request	4.84	-	4.84	4.84
$ Change from FY 2010 Estimate				$0.30
% Change from FY 2010 Estimate				6.6%

Totals may not add due to rounding.

National Science Board in Context

As an independent federal agency, NSF does not fall under any cabinet department; NSF's activities are guided by the National Science Board within guidelines provided by the President and Congress. The Board, established by the Congress in 1950, has dual responsibilities to: a) provide national science policy advice to the President and Congress; and b) establish policies for NSF. The Board is composed of 25 presidentially appointed, Senate-confirmed members, including the NSF Director, representing the broad U.S. science and engineering community. Board Members, who serve 6-year terms on staggered appointments, are drawn from industry, academe, non-profit organizations and professional scientific societies, and represent the breadth of S&E disciplines and geographic areas. They are selected for their eminence in research, education, or public service.

The Board meets several times a year to review and approve major NSF awards and new programs, oversee and provide policy direction to NSF, and address significant science and engineering related national policy issues. It initiates and conducts studies and reports on a wide range of policy topics, analyzes NSF's budget to ensure progress and consistency along the strategic direction set for NSF and to ensure balance between new investments and core programs. The Board also identifies issues that are critical to NSF's future.

Summary of FY 2011 Request

Staffing
Most of the Board's FY 2011 Budget Request supports a small and independent core of full-time policy, administrative, and operations staff. Over 64 percent of the 2011 request, or $3.10 million, is for Board member and staff salaries and benefits. The Board Office staff provides both the independent resources and capabilities for coordinating and implementing S&E policy analyses and development, and the operational support that is essential for the Board to fulfill its mission. An independent attorney, reporting to the Board not the NSF Director, is under recruitment. Additional staff support is needed for the portfolio review of facilities, including major facilities, being undertaken by the Board's Subcommittee on Facilities, and for support of major Board studies currently underway.

New Activities
For FY 2011, the Board intends to complete several studies critical to the functioning of the agency. These include a reconstitution of the 1996 Task Group on Review Criteria to examine the agency's merit review process with a focus on the two merit review criteria. The Board will also develop a report on data policies to ensure that data collected through NSF sponsored research is available to the broad science, engineering and education communities. Another area of interest to the Board is the support structures for potentially transformative and interdisciplinary mid-to-large-scale research. In addition to these reports, the Board will continue to address the appropriate and proper use of Intergovernmental Personnel Act (IPA) personnel in senior management positions.

Ongoing National Science Board Activities

Policy Guidance
The Board issues policy guidance in the form of official statements, resolutions, and reports to the President and Congress. Recent reports have examined topics such as cost sharing, science and engineering education, the science and technology workforce, Major Research Infrastructure program, and research and development efforts of alternative sustainable energy. In FY 2010, the Board expects to release findings on factors impacting the next generation of Science, Technology, Engineering and

Mathematics (STEM) Innovators, and a policy statement Companion Piece to *Science and Engineering Indicators 2010*, its statutory biennial statistical report. For FY 2011, the Board will continue work on three priority studies: Merit Review, data policies, and the support framework for transformative research at NSF.

Experience has shown that the Board will receive requests from the President and/or Congress asking for reports on a range of national policy topics related to S&E research and education. The Board welcomes such requests, and will also continue to identify high priority topics focused specifically on NSF, or more broadly on national S&E policy issues, in FY 2011.

Other Responsibilities
The Board expects to continue to be significantly engaged with assisting the agency in its responsibilities stemming from the American Recovery and Reinvestment Act. Additional responsibilities specific to FY 2011 also include NSF's implementation of components of the Action Plan for STEM Education and new efforts to be implemented regarding enhancement of NSF support for potentially transformative research as a result of new Board guidance.

The Board's on-going activities include review of the following:

- OIG Semi-annual Reports to Congress and NSF management responses;
- The NSF Budget Submission for transmittal to OMB;
- NSF's research infrastructure portfolio;
- Foundation's annual Merit Review Report; and
- Large awards or proposal funding requests.

The Board has established several standing committees to assist with its responsibilities. The Committee on Audit and Oversight reviews the operations of the Foundation's Office of Inspector General (OIG), as well as NSF compliance with procedures for financial accountability and information technology security. The Committee on Strategy and Budget (CSB) focuses on strategic planning and new investments for NSF. Review of the Foundation's budget request is also vested in CSB. The Board recently established within CSB the Subcommittee on Facilities (SCF) to provide increased guidance and review of the NSF-funded research equipment and facilities portfolio, including both MREFC-funded and R&RA-funded facilities.

The Committee on Education and Human Resources (CEH) focuses on Foundation activities in such priority areas as S&E workforce development, math and science education, and underrepresented populations and regions in S&E programs. The newly constituted Committee on Science and Engineering Indicators (SEI) manages the process for development and review of the Board's biennial report, *Science and Engineering Indicators,* and associated products.

The Board is responsible for direct review and approval of the Foundation's largest awards, and is responsible for the review and approval of Major Research Infrastructure projects at all stages of development, including budget planning, review of proposals and management effectiveness, and approval of awards. The members of the Committee on Programs and Plans (CPP) review proposals for major awards, the health of the Foundation's peer review system, and program performance and accountability. The Board monitors the critical infrastructure that supports research in Antarctica through the CPP Subcommittee on Polar Issues.

The Executive Committee acts on behalf of the Board between meetings on grants, contracts, or other arrangements, and other instances where an immediate decision is required. In addition, the Committee has developed a prioritization process for the full Board to determine major Board policy activities for subsequent fiscal years.

Science and Engineering Indicators

In January 2010, the Board delivered *Science and Engineering Indicators (SEI) 2010* to the President and to Congress, in keeping with its statutory responsibility. SEI is an important biennial statutory publication of the major, high quality quantitative data on the status of U.S. science and engineering. Over the past several years, the Board has heightened its efforts to expand the audience for *Indicators*, implementing several enhancements that encourage audiences outside the normal community of users to become familiar with the data resources in *Indicators* and to facilitate the use of *Indicators* data in policy decisions and analyses. Planning for the 2012 edition of *SEI* will continue into FY 2011.

Research Facilities Guidance and Oversight

In FY 2011, the Subcommittee on Facilities will continue its review of the development, construction, operations, maintenance, and decommissioning of research equipment and facilities supported by NSF. This is an essential component of annual and long-term budget planning undertaken by the National Science Board. Subcommittee responsibilities include:

- Undertaking an annual review of the portfolio of all NSF-funded research facilities. This review considers projects from the Major Research Equipment and Facilities Construction (MREFC) account, as well as large and mid-size research facilities and infrastructure funded by the Research and Related Activities (R&RA) account. The review considers currently operating facilities, as well as those under construction and in early and late-stage planning. The review considers impacts on the long-term budgets of NSF divisions, directorates, and the Foundation as a whole; and further considers potential partnership among NSF directorates and offices and with other organizations.
- Providing to the Board a clear assessment of the impact that specific projects and the overall facilities portfolio will have on long-term budget planning at NSF. This includes consideration of whether existing facilities continue to be the best use of NSF's limited resources given alternative potential uses of funding for research facilities and individual investigator-led research.
- Recommending to the Board guidance to be provided to NSF management on the prioritization of all projects that have completed a Conceptual Design Review (CDR) and are being considered for further funding to develop preliminary designs.

Effective Communication with the Public

Effective communications and interactions with our constituencies contribute to the Board's work of identifying priority science and technology issues, and developing policy advice and recommendations to the President and Congress. To this end, the Board will continue to increase communication and outreach with the university, industry, professional scientific societies, the broader science and engineering research and education community, Congress, federal science and technology agencies, and the public. To enhance and improve upon outreach activities, it is important to make the Board's discussions on policy decisions and recommendations more accessible and widely-available. To this end, in FY 2010 the Board is upgrading the technology in the Board Room and plans, with help from the Office of Legislative and Public Affairs, to webcast addresses by prominent scientists in honor of NSF's 60th anniversary, during 2010 and 2011. The Board recently implemented a new website focused on the Board's policy functions and will work to enhance its functionality for the public and for secure access to documents by Board members.

Electronic Records for Researchers and Public
One of the major functions of the Board Office is to keep the records of Board decisions and policy pronouncements. The records of these decisions, and policy statements and reports on national science and engineering policy issues prepared for the President and Congress, are currently housed in various formats and media. Electronic and paper documents are not easily accessible to the public, other Federal agencies, or staff of the Foundation because they are maintained in inconsistent systems of records, as individual reports and statements, or in testimony, letters and other communications with Congress and other agencies. For older records, many have been archived as paper documents and their existence relies merely on the memory of staff who participated in the policy discussions. This situation creates substantial barriers to frequent requests by interested members of the public, science historians, and NSF staff who wish or need to understand the underlying process for particular decisions or to obtain original documents relevant to a policy position.

The Board will continue development of electronic resources to search, identify and retrieve relevant documents, in a common format, for use by stakeholders including members of the public, Congress, other agencies, and NSF staff. Most records of the Board, throughout its 60 year history, are still in paper format. This work will permit historians, the media, policy analysts, and other members of the public and federal establishment to feel confident in the completeness of the information they are obtaining on Board discussions and decisions, facilitate NSF staff implementation of Board policies within the Foundation, and reduce the administrative cost and effort associated with information retrieval.

Other costs associated with Board activities support website maintenance; transcription services; report printing; and logistical support for Board meetings, workshops and roundtables. The Board's logistical support provides limited services for events including: travel planning assistance for invited speakers and participants; mailing of announcements and invitations; local transportation planning, printing, audio-visual and other services for off-site events; and additional low-level meeting, workshop and roundtable support.

National Science Board
Personnel Compensation and Benefits and General Operating Expenses
(Dollars in Thousands)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Personnel Compensation and Benefits	$2,450	-	$2,860	$3,099	$239	8.4%
Staff Development & Training	36	-	47	49	2	4.3%
Advisory & Assistance Services	1,015	-	980	990	10	1.0%
Travel & Transportation of Persons	232	-	330	350	20	6.1%
Communications, Supplies and Equipment	291	-	320	350	30	9.4%
Representation Costs	3	-	3	3	-	-
Total, NSB	**$4,027**	**-**	**$4,540**	**$4,841**	**$301**	**6.6%**
Full-Time Equivalent	17		17	18	1	

Totals may not add due to rounding.

OFFICE OF INSPECTOR GENERAL (OIG) $14,350,000 +350,000 / 2.5%

The Appropriations Act that funds the National Science Foundation provides for a separate appropriation for NSF's Office of Inspector General (OIG). Accordingly, the FY 2011 Budget Request identifies the resources needed to support OIG, including amounts for personnel compensation and benefits, contract services, training, travel, supplies, materials, and equipment.

The FY 2011 Budget Request for OIG is $14.35 million, which represents an increase of $350,000 over the FY 2010 estimate of $14.0 million.

OIG Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Personnel Compensation and Benefits	$9.65	$0.01	$11.02	$11.30	$0.28	2.5%
Other Operating Expenses[1]	2.35	0.00	2.98	3.05	0.07	2.3%
Total, OIG	**$12.00**	**$0.02**	**$14.00**	**$14.35**	**$0.35**	**2.5%**
Full-Time Equivalent Employment	69		73	74	1	1.4%

Totals may not add due to rounding.

[1] Includes the costs of the annual financial statements audit and the outsourcing of contracting services.

Appropriation Language

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, ~~$14,000,000,~~*$14,350,000 to remain available until September 30, 2012.*

Office of Inspector General
FY 2011 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Rescission	Expired	Total Resources	Obligations Incurred/Est.	Carryover/ Recoveries
FY 2009 Omnibus	$12.00	-	-$0.01	$11.99	$11.99	
FY 2009 ARRA	2.00	-	-	2.00	0.02	1.98
FY 2010 Estimate	14.00	-	-	14.00	14.00	
FY 2011 Request	14.35	-	-	14.35	14.35	
$ Change from FY 2010 Estimate					$0.35	
% Change from FY 2010 Estimate					2.5%	

Totals may not add due to rounding.

Explanation of Carryover

American Recovery and Reinvestment Act of 2009 (ARRA)

Note: The ARRA Chapter contains an obligation plan for all ARRA appropriated funds carried forward into FY 2010.

Within the **Office of Inspector General** appropriation, $1.98 million was carried forward.

- Reason for Carryover: Five year funds intended explicitly for ARRA use.
- Expected Obligation: Will be obligated over the 5 year availability of the funds.

OIG RESPONSIBILITIES

In February 1989, the National Science Board established OIG pursuant to the Inspector General Act Amendments of 1988. The statute confers on OIG the responsibility and authority to:

- Conduct and supervise audits of NSF programs and operations, including organizations that receive NSF funding;

- Conduct investigations concerning NSF programs and operations, including organizations that receive NSF funding;

- Evaluate allegations of research misconduct, such as fabrication, falsification, or plagiarism, involving individuals who participate in NSF-funded activities;

- Provide leadership, coordination, and policy recommendations for:
    - Promoting economy, efficiency, and effectiveness in the administration of NSF programs and operations, and
    - Preventing and detecting fraud and abuse in NSF programs and operations;

- Issue semiannual reports to the National Science Board and Congress to keep them informed about problems, recommended corrective actions, and progress being made in improving the management and conduct of NSF programs.

As set forth in the OIG Strategic Plan, the primary functions of the office are to perform audits, reviews, and investigations. Because diverse skills, training, and experience are necessary to oversee NSF's varied programs, the OIG staff includes scientists, attorneys, certified public accountants, investigators, evaluators, and information technology specialists. The subjects of investigations, audits, and other reviews are varied, and may include: an individual grant recipient or institution; a broad program or functional area of NSF; or a project involving multiple disciplines or entities. In FY 2011, the office will continue to be significantly involved in audits and investigations of NSF programs, grants, contracts and other activities associated with funding provided by the American Recovery and Reinvestment Act of 2009.

OIG performs audits of grants, contracts, and cooperative agreements funded by NSF's programs. The office also conducts audits and reviews of both internal agency programs and external organizations that receive NSF funding to ensure that financial, administrative, and programmatic activities are conducted economically, effectively, and in compliance with agency and federal requirements. OIG is also responsible for overseeing the audit of NSF's annual financial statements, which are required for all NSF accounts and activities by the Government Management Reform Act of 1994. The office contracts with a public accounting firm to conduct the financial statements audit. Since FY 2006, funds to cover the complete cost of the financial audit have been requested in this appropriation. OIG also audits financial, budgetary, and data processing systems used by NSF to develop the financial statements. In addition, the office performs multi-disciplinary reviews – involving auditors, attorneys, management analysts, investigators, and others as needed – of financial, management, and program operations to identify broader problems and highlight best practices.

OIG investigates possible wrongdoing by organizations and individuals who seek or receive NSF funds such as those who submit proposals to, receive awards from, conduct business with, or work for NSF. Allegations of research misconduct are also investigated. OIG assesses the validity and seriousness of all the allegations it receives and recommends proportionate action. When appropriate, the office refers the results of these investigations to the Department of Justice or other authorities for criminal prosecution, civil litigation, or resolution via settlement agreements and institutional compliance plans. OIG refers other cases to NSF for administrative resolution and when needed will recommend modifications to agency policies and procedures to ensure the integrity of NSF's business systems. The office works closely with institutions on the conduct of their internal investigations and performs outreach activities aimed at preventing and detecting fraud, waste, and abuse; and at raising the awareness of funded researchers, institutional administrators, and agency employees about the OIG's role and NSF's rules and expectations.

Personnel Compensation and Benefits and General Operating Expenses

(Dollars in thousands)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Personnel Compensation and Benefits	9,655	11,020	11,295	$250	2.3%
Travel & Transportation of Persons	210	230	240	20	8.0%
Advisory & Assistance Services[1]	1,901	2,471	2,526	70	2.4%
Communications, Supplies and Equipment, and Other Services[2]	234	279	289	10	6.9%
- Training	*98*	*110*	*115*	*5*	*4.3%*
- Council of Inspectors General for Integrity and Efficiency Assessment	*29*	*34*	*34*	*-*	*N/A*
- Other	*107*	*135*	*140*	*5*	*3.6%*
Total	12,000	14,000	14,350	$350	2.4%

Totals may not add due to rounding.

[1] Includes the costs of the annual financial statements audit and the outsourcing of contracting services.

[2] The amounts spent on Training and CIGIE Assessment are presented separately as required by the IG Reform Act of 2008 but also in the total for Communications, Supplies and Equipment, and Other Services.

The increase of 2.4 percent requested in the FY 2011 budget level will enable OIG to add one staff person to support its audit and investigative programs, continue its outreach efforts, particularly with regard to research misconduct and financial fraud, and make modest systems and equipment upgrades. In recent years, OIG's operational costs have risen faster than our funding. Personnel costs, which consume approximately 80 percent of the annual OIG appropriation, continue to rise. Travel, which is essential to conducting nationwide audits and investigations, has become more expensive due to the increased cost of gasoline. Meanwhile the average cost of a contracted audit has risen from approximately $100,000 in FY 2004 to $130,000 in FY 2009.

Therefore, OIG has steadily reduced discretionary expenditures to stay within its budget. In particular, OIG spending for audit contracts (excluding the escalating cost of the annual financial statement audit) declined by 47 percent, from $1.55 million in FY 2006 to $825,000 in FY 2009, resulting in decreased oversight of institutions receiving NSF funding. We have also had to postpone the replacement of obsolete equipment and defer the acquisition of electronic-workpaper and other software vital for conducting audits and investigations efficiently. Finally, we have also suspended the filling of critical vacancies and postponed important audit and investigative work that we have not been able to conduct due to workload imbalances.

The increase requested for FY 2011, combined with the increase in our FY 2010 appropriation, will enable us to address these shortcomings and significantly improve the efficiency and impact of OIG in performing its oversight role. The additional funds requested will primarily cover increased personnel costs, including the addition of one FTE; the rising costs of audits conducted by Certified Public Accounting firms under contract to OIG; essential technology upgrades to replace aging personal computers and other business equipment; and if funds allow, the need for software and training that will provide more effective support for our investigations and audits. The additional funding will cover the contribution, equaling 0.24 percent of OIG's appropriations, that is assessed government-wide to fund the new Council of Inspectors General for Integrity and Efficiency (CIGIE).

Finally, the requested funding will allow OIG to perform more contracted audits and thereby keep pace with NSF's increased financial exposure in awarding billions of dollars in grants and contracts each year. As the agency's funding grows, so does this risk -- and the concomitant need for increased OIG oversight. The additional audit and contract resources will enable OIG to strengthen its oversight of NSF awards categorized as high-risk. As recently as 2007, the OIG had resources to audit only four percent of the total $9.6 billion of NSF funds in this category. The requested increase would enable us to reverse these trends and expand our audit coverage.

The requested funding level would also support performance audits that reflect important federal and OIG priorities, including reviews of: 1) NSF's management of its rotating program officer workforce (i.e. temporary employees who typically return to their home institution after a few years), 2) NSF's handling of conflicts of interest involving its grantee institutions and principal investigators, 3) the effectiveness of NSF's acquisition program and its ability to meet existing and newly implemented federal requirements, and 4) the adequacy of NSF's workforce to meet its increasing programmatic and financial accountability and oversight responsibilities. Funds will also be used to complete two ongoing series of audits: labor effort charged to NSF awards by large universities; and the adequacy of NSF's cooperative agreements to manage and oversee its large facility awards. Finally, funds are needed to perform audits that are mandated by law, including the annual Financial Statement Audit, the related Federal Information Security Management Act independent evaluation report, and the triennial audit of the National Science Board's compliance with the Government in the Sunshine Act.

Additional funds are also necessary for OIG to keep pace with an expanding investigative workload driven by: NSF's increased budget, expectations that OIGs become more proactive, and the increasing complexity of the fraud and internal cases being investigated. In the past 10 years, OIG has experienced almost a 300 percent increase in caseload across the spectrum of civil/criminal/administrative and research misconduct matters for which we are responsible. Over the same period, OIG has registered a 10-fold increase in financial recoveries and agency and/or law enforcement actions based on its investigative work and a 20-fold increase in referrals to the Department of Justice.

Our civil and criminal cases frequently produce both financial settlements for institutional fraud and compliance agreements for correcting the underlying systemic problems, thus providing greater protection for future federal funding. Monitoring institutions' efforts to meet the terms of their five-year compliance plans is vital to preventing fraud from recurring, but it is also very time consuming. The systemic problems that have allowed fraud to occur take time to correct, and ongoing oversight is required to ensure that the flaws in the systems are not further exploited. Our investigative workload is growing rapidly in other areas as well. Over the past few years, there has been an increase in serious data fabrication and falsification cases, and in the incidence of fraud in international collaborations. The latter, in particular, require substantial resources to determine their scope and complexity and to perform more intricate investigations.

The requested level of funding will make it possible to consolidate and extend the gains we have made by acquiring needed electronic case management software to increase productivity and streamline the process of preparing for prosecutions and public information requests. We will be able to continue the development of proactive reviews including an analysis of fraud and duplicative funding within the Small Business Innovation Research program. It would also permit us to increase our forensic accounting program to more effectively pursue complex financial fraud cases, and to fund case-related travel necessary to support investigations that occur nationwide.

As the administration and Congress emphasize the importance of assuring the scientific integrity of federally funded research, studies consistently indicate that between 25 to 30 percent of scientists engage in questionable research practices. Drawing on our extensive experience in dealing with occurrences of grant fraud and research misconduct, OIG's outreach program continues to play a key role within the federal and research communities in attempting to prevent these problems.

This budget increase will enable OIG to address the issues underlying the increasing number of egregious allegations that we are investigating, many of which are related to the employment of scientists from other countries. Universities continue to request our attendance at conferences and other events to help educate faculty, students, and principal investigators regarding the indications and consequences of research misconduct and financial fraud. OIG's audit staff is also involved in outreach activities aimed at informing NSF and its awardee community of the recurring issues we are finding in our audit work. However, our ability to accommodate these requests and accomplish our outreach mission is limited and must depend on whether our staffing and travel budget is sufficient to support our urgent investigative and audit priorities.

While the OIG received a separate $2.0 million appropriation to handle its Recovery Act responsibilities through 2013, we estimate that this amount will not be adequate to fund all of the audit and investigative work we anticipate. In fact, the FY 2010 Annual Audit Plan is largely focused on the Recovery Act activities at NSF and its awardees, and we expect to allocate at least 50 percent of our current audit staff and contract audit resources to Recovery Act reviews. While it is difficult to project the level of audit and investigative work associated with the Recovery Act in FY 2011 and beyond, it is very likely that the additional workload over the four year period will exceed the special appropriation OIG received. Therefore, we consider the additional $350,000 in funds requested to be essential to continuing our oversight of NSF's regular appropriation, while also meeting our additional responsibilities for Recovery Act funds. The initial budget request presented to the agency for $14.98 million was revised to $14.35 million after further review of the work planned for FY 2011.

MAJOR MULTI-USER RESEARCH FACILITIES $1,201,100,000

$125,050,000 / 11.6%

Major Multi-User Research Facilities Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Facilities	$930.27	$378.55	$880.46	$991.90	$111.44	12.7%
Federally Funded R&D Centers	198.06	24.20	195.59	209.20	13.61	7.0%
Total, Major Multi-User Research Facilities	**$1,128.33**	**$402.75**	**$1,076.05**	**$1,201.10**	**$125.05**	**11.6%**

NSF investments provide state-of-the-art tools for research and education, such as multi-user research facilities, distributed instrumentation networks and arrays, accelerators, telescopes, research vessels, aircraft, and earthquake simulators. In addition, investments in internet-based and distributed user facilities are increasing as a result of rapid advances in computer, information, and communication technologies. NSF's investments are coordinated with those of other organizations, agencies, and countries to ensure complementarity and integration. Planning, and operations and maintenance of multi-user facilities are funded through the Research and Related Activities (R&RA) account, and most major construction projects are funded through the Major Research Equipment and Facilities Construction (MREFC) account.

This chapter provides descriptions of each major multi-user research facility supported through the R&RA account and provides funding information by life cycle phase for each facility. The information presented for each facility follows the overall framework established by NSF for large facility projects. Information on the construction projects funded through NSF's MREFC account is provided in the MREFC chapter.

Major Multi-User Research Facilities Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Engineering						
National Nanotechnology Infrastructure Network	16.67	10.27	16.26	16.26	-	-
Network for Earthquake Engineering Simulation	20.98	-	22.00	22.50	0.50	2.3%
Geosciences						
Academic Research Fleet	$88.95	$18.00	$80.00	$77.00	-$3.00	-3.8%
EarthScope	24.29	9.00	25.05	26.00	0.95	3.8%
Incorporated Research Institutes for Seismology	12.00	-	12.36	12.73	0.37	3.0%
Integrated Ocean Drilling Program	47.95	25.00	43.40	46.41	3.01	6.9%
Mathematical and Physical Sciences						
Cornell High Energy Synchrotron Source/ Cornell Electron Storage Ring	13.60	14.99	9.00	13.45	4.45	49.4%
Gemini Observatory	18.71	-	19.10	19.58	0.48	2.5%
Large Hadron Collider	18.00	-	18.00	18.00	-	-
Laser Interferometer Gravitational Wave Observatory	30.30	-	28.50	30.30	1.80	6.3%
National Astronomy and Ionosphere Center[1]	9.60	3.10	10.60	9.00	-1.60	-15.1%
National High Magnetic Field Laboratory	26.50	5.00	35.56	34.00	-1.56	-4.4%
National Solar Observatory	7.83	1.40	9.10	9.51	0.41	4.5%
National Superconducting Cyclotron Laboratory	20.50	2.00	21.00	21.50	0.50	2.4%
Polar Programs						
Polar Facilities and Logistics[2]	341.38	22.50	312.27	381.38	69.11	22.1%
Other						
MREFC Projects[3]	199.75	257.10	163.54	214.69	51.15	31.3%
Other Facilities[4]	5.60	4.99	7.02	7.65	0.63	9.0%
Preconstruction Planning[5]	27.67	5.20	47.70	31.94	-15.76	-33.0%
Federally Funded Research and Development Centers[6]						
Geosciences						
National Center for Atmospheric Research	106.79	13.20	97.00	108.00	11.00	11.3%
Mathematical and Physical Sciences						
National Optical Astronomy Observatory	30.48	5.60	31.50	33.33	1.83	5.8%
National Radio Astronomy Observatory[7]	60.79	5.40	67.09	67.87	0.78	1.2%
Total	**$1,128.34**	**$402.75**	**$1,076.05**	**$1,201.10**	**$125.05**	**11.6%**

[1]NSF will decertify NAIC as an FFRDC upon award of the next cooperative agreement for its management and operation in FY 2011.

[2]Polar Facilities and Logistics funding includes support for the operations and maintenance of the South Pole Station Modernization (SPSM) project. Funds provided through the MREFC account for SPSM, totaling $1.10 million in FY 2009, are included on the MREFC Projects line. In FY 2010, Polar Facilities and Logistics excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

[3]Funding levels for MREFC Projects in this table include support for: a) concept and development associated with ongoing and requested MREFC projects provided through the R&RA account, specifically for NEON, OOI and ATST; b) initial support for operations and maintenance provided through the R&RA account (except for ALMA, which is included in the funding for NRAO); and c) implementation support provided through the MREFC account. Final MREFC support for SPSM is also included in this line.

[4]"Other Facilities" includes support for other physics and materials research facilities.

[5] Preconstruction Planning includes funding for next generation physics and astronomy facilities, including: an underground physics laboratory, high intensity synchrotron radiation x-ray sources; large aperture optical telescopes; fast, wide-field telescopes; and meter/centimeter wavelength radio telescopes.

[6]"Federally Funded R&D Centers" does not include support for the Science and Technology Policy Institute, which is an FFRDC but not a research platform.

[7]Funding for the National Radio Astronomy Observatory includes operations and maintenance support for the Atacama Large Millimeter Array (ALMA). Construction funding for ALMA is included in the MREFC Projects line above.

NSF's Facilities Investments in FY 2011:

The following pages contain information on NSF's ongoing facilities in FY 2011, organized by sponsoring directorate. These are:

Facilities

Federally Funded R&D Centers

ENGINEERING

National Nanotechnology Infrastructure Network

$16,260,000
+$0 / 0%

The National Nanotechnology Infrastructure Network
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
The National Nanotechnology Infrastructure Network	$16.67	$10.27	$16.26	$16.26	-	-

The National Nanotechnology Infrastructure Network (NNIN) is now in the final five-year funding period from FY 2009-2013. NNIN comprises 14 university sites that form an integrated national network of user facilities supporting research and education in nanoscale science, engineering, and technology. The NNIN provides users across the Nation with access, both on-site and remotely, to leading-edge tools, instrumentation, and capabilities for fabrication, synthesis, characterization, design, simulation, and integration. The broad scope of NNIN coverage includes areas of physics, chemistry, materials, mechanical systems, geosciences, biology, life sciences, electronics, optics, molecular synthesis, and molecular scale devices, among others.

Total Obligations for NNIN
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$16.67	$16.26	$16.26	$16.26	$16.26	$16.26	$16.26	$16.26
ARRA Actual	10.27	-	-	-	-	-	-	-
Total, NNIN	**$26.94**	**$16.26**	**$16.26**	**$16.26**	**$16.26**	**$16.26**	**$16.26**	**$16.26**

Totals may not add due to rounding.

NNIN's broad-based national user facilities enable the Nation's researchers from academia, small and large industry, and government to pursue transformative research, to seek new discoveries and applications in a broad range of domains of nanoscale science and engineering, and to stimulate technological innovation. The network also develops the infrastructure and intellectual and institutional capacity needed to examine and address societal and ethical implications of nanotechnology, including issues of environment, health, and safety.

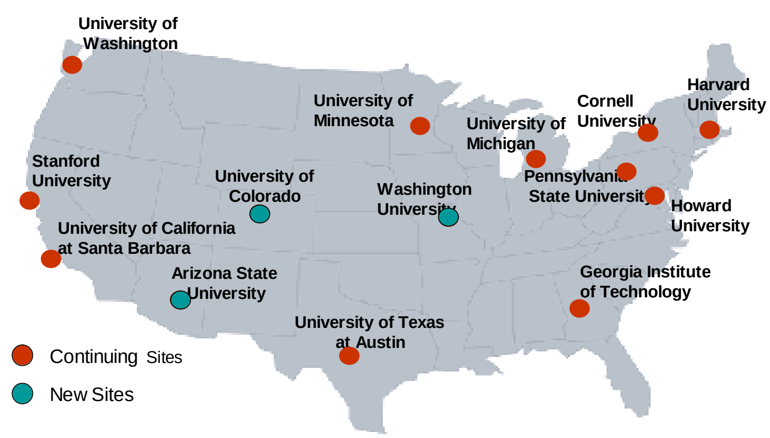
NNIN undertakes on a national scale a broad spectrum of innovative activities in education, human resource development, knowledge transfer, and outreach to the science, engineering, and technological communities. Special emphasis is placed on education and training of a diverse science and engineering workforce that involves non-traditional users and under-represented groups, including women and minorities.

NNIN seeks to leverage its capabilities through connections and collaborations with national and industrial laboratories and with foreign institutions. Through such partnerships, joint meetings, and workshops, the network shares expertise and perspectives, provides specialized training opportunities, coordinates access to unique instrumentation, and transfers newly developed technologies.

NNIN leverages research strengths of the university to bring them to the external community. The institutions comprising the NNIN have strong underlying internal research programs that provide the knowledge base for developing new processes, methodologies, and instrumentation, as well as much of the capital infrastructure. NSF and other agencies independently award research grants to principal investigators who use the NNIN facilities to carry out some aspects of their research projects.

Three institutions joined the network in the renewal period, each bringing new capabilities: the University of Colorado, which focuses on research in energy-related problems and in precision sciences that include measurements, standards, and systems; Arizona State University, which focuses on organic/inorganic interfaces in electronics, biodesign, implantable devices, flexible electronics, sensors., and outreach to underrepresented communities in the Southwest; and Washington University in St. Louis, whose research focuses on nanomaterials and nanosciences for environment, health, and safety. NNIN, through lead efforts at the University of Washington and University of Michigan, is also serving as a technology source to facilitate collaboration between the ocean sensing infrastructure geoscienses community and the nanotechnology sensor community.

In its fifth year of operation encompassing 2008-2009, NNIN served approximately 5,100 unique users from 180 institutions, resulting in over 3,100 attributed publications. During the first 6 months of 2009, approximately 4,000 unique users have been served, of whom 3,200 were Ph.D students. NNIN affords a major avenue for affordable development and commercialization for small companies in nascent application areas. Some 590 industrial users including over 270 small companies also used NNIN facilities during this 6-month period. Over the period of a year, NNIN estimates that it has enabled in excess of 1,000 PhD awards and leveraged over $500 million in research investments through use of its facilities. NNIN continues strong education outreach and diversity-oriented efforts, which include its network-wide Research Experience for Undergraduates (REU) program, Nanotechnology Showcase for Students, and Laboratory Experience for Faculty from underrepresented institutions.



Facility Report:

<u>Management and oversight:</u>

- NSF structure: NSF provides oversight of the NNIN under a cooperative agreement. The program officer for the NNIN activity resides in the Division of Electrical, Communications and Cyber Systems (ECCS) in the Directorate for Engineering (ENG). The program officer coordinates NNIN oversight with the NNIN working group comprised of representatives from all NSF research and education directorates. NNIN is reviewed annually through site reviews held at one of the network sites. These reviews involve an external team of experts selected by NSF staff. In addition to the annual site reviews, semi-annual briefings of NSF staff are held at the NSF attended by the NNIN network director, site directors, and area coordinators.

- External structure: NNIN is managed as a cohesive and flexible network partnership through a Network Executive Committee derived from the individual Site Directors, and the Education/Outreach and Society/Ethics Coordinators. The Network Director, is from the lead institution, Cornell University, and provides intellectual leadership for the network, is responsible, in cooperation with the Network Executive Committee, for developing strategies, operational plans, and coordination of the activities of the network, and serves as the principal contact on behalf of the network with the NSF. An external Network Advisory Board meets at least annually and provides independent advice and guidance to the Network Director and Executive Committee concerning the network's programs, activities, vision, funding allocations, and new directions. The Advisory Board shares its major recommendations with the NSF. The Site Directors are responsible for local management functions of the individual user facilities, for interfacing with other facilities and with the management team for the overall network, and for connections with the outside communities.

- Reviews:
  - The first comprehensive annual review of the NNIN was held following an initial 9 months of operation at the Georgia Institute of Technology site in December 2004. The second annual review was held at the University of Texas-Austin site in February 2006. The third annual review was held at the University of Michigan site in May 2007. The fourth annual review was held at Stanford University in May 2008. This review also served to evaluate the NNIN renewal proposal for the five-year period FY 2009-2113. A mid-year informational review was held at NSF in October 2009.
  - Upcoming reviews: A fifth annual review will be held in Spring 2010.

NNIN was awarded $10,000,000 in ARRA funds in FY 2009 to acquire advanced nanofabrication and characterization instrumentation and tools at each of its network sites to enable users to accomplish state-of-the-art research projects. Availability of these funds helped address challenges the network has faced in maintaining its capital equipment base through acquisition of new instrumentation and replacement of old or high-demand equipment.

<u>Renewal/Recompetition/Termination:</u>

The National Science Board approved NSF's review-based recommendation in December 2008 and authorized renewal of the NNIN award for a final five-year period from FY 2009-2013. In FY 2011, the third year of this final award period, NSF plans to convene a panel of recognized national experts to evaluate the needs of, and appropriate future investments in, the national infrastructure for nanotechnology.

Network for Earthquake Engineering Simulation

$22,500,000
+$500,000 / 2.3%

Network for Earthquake Engineering Simulation
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Network for Earthquake Engineering Simulation	$20.98	-	$22.00	$22.50	$0.50	2.3%

The Network for Earthquake Engineering Simulation (NEES) is a national, networked simulation resource of 14 advanced, geographically distributed, multi user earthquake engineering research experimental facilities with telepresence capabilities. NEES provides a national infrastructure to advance earthquake engineering research and education through collaborative and integrated experimentation, computation, theory, databases, and model-based simulation to improve the seismic design and performance of U.S. civil infrastructure systems. Experimental facilities include shake tables, geotechnical centrifuges, a tsunami wave basin, large-scale laboratory experimentation systems, and mobile and permanently installed field equipment. NEES facilities are located at academic institutions (or at off-campus field sites) throughout the U.S., networked together through a high performance Internet2 cyberinfrastructure system (NEEShub). NEES completed construction on September 30, 2004, and opened for user research and education projects on October 1, 2004. NEES was operated during FY 2005-FY 2009 by NEES Consortium, Inc., located in Davis, CA. During FY 2008 and FY 2009, NSF recompeted NEES operations using program solicitation NSF 08-574 George E. Brown, Jr. Network for Earthquake Engineering Simulation Operations (NEES Ops) FY 2010-FY 2014. The outcome of that competition was an award to Purdue University to operate NEES from FY 2010-FY 2014. Through a five-year cooperative agreement with NSF (FY 2010-FY 2014), Purdue University operates the NEES experimental facilities and cyberinfrastructure; coordinates education, outreach, and training; and develops national and international partnerships.

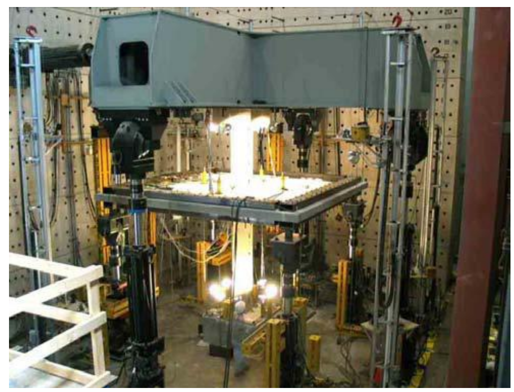
Total Obligations for NEES
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$20.98	$22.00	$22.50	$22.50	$23.00	$23.00	$23.00	$23.00

NEES' broad-based national research facilities and cyberinfrastructure enables new discovery and knowledge through capabilities to test more comprehensive, complete, and accurate models of how civil infrastructure systems respond to earthquake loading and tsunamis. This enables the design of new methodologies, modeling techniques, and technologies for earthquake and tsunami hazard mitigation. NEES engages students in earthquake engineering discovery through on-site use of experimental facilities, telepresence technology, archival experimental and analytical data, and computational resources with the aim of integrating research and education. NEES operates under an education, outreach, and training strategic plan to develop a broad spectrum of education and human resource development activities with special emphasis on non-traditional users and underrepresented groups through its Research Experiences for Undergraduates (REU) program. NEES also organizes an Annual Meeting for NEES users/researchers and facility operators.

Through the National Earthquake Hazards Reduction Program (NEHRP), the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), and the NSF support research related to earthquake hazard mitigation. Connections to industry include private engineering consultants and engineering firms engaging in NEES research or using data and models developed through NEES. NEES is leveraging and complementing its capabilities through connections and collaborations with large testing facilities at foreign earthquake-related centers, laboratories, and institutions. NSF has developed a partnership to utilize the NEES infrastructure with the 3-D Full-Scale Earthquake Testing Shake Table Facility (E-Defense), built by the Japanese National Research Institute for Earth Science and Disaster Prevention (NIED) and operational in 2005. To facilitate NEES/E-Defense collaboration, in September 2005, NSF and the Japanese Ministry of Education, Culture, Sports, Science, and Technology signed a Memorandum Concerning Cooperation in the Area of Disaster Prevention Research. Planning meetings were held at NSF in January 2009 and at E-Defense in September 2009 to explore research topics for a second five-year NEES/E-Defense collaboration. Two NSF-supported research projects used the E-Defense facility during FY 2009 to test new seismic design methodologies for mid-rise wood frame buildings and steel frame structures.

Along with direct operations and maintenance support for NEES, NSF separately provides support for research to be conducted at the NEES experimental facilities through ongoing research and education programs. The NEES cyberinfrastructure also provides a platform for the earthquake engineering and tsunami communities, as well as other communities, to develop new tools for shared cyberinfrastructure. The annual support for such activities, funded through annual NEES research program solicitations, is estimated to be up to $12.5 million in FY 2010. These awards support basic research in multi-hazard engineering involving experimental and computational simulations at the NEES facilities, addressing important challenges in earthquake and tsunami engineering research.



Slab-column subassembly being tested as part of a NSF-supported NEES research award at the NEES Multi-Axial Subassemblage Testing (MAST) Laboratory at the University of Minnesota. *Courtesy of the MAST Laboratory at the University of Minnesota.*

Facility Report:

Management and oversight:

- NSF structure: NSF provides oversight to NEES operations through a cooperative agreement with Purdue University during FY 2010-FY 2014. NEES operations are reviewed through annual site visits and through periodic site visits to the individual NEES facilities. The annual site reviews are held at either the headquarters or one of the network facilities. All reviews involve an external team of experts selected by NSF staff. The NSF Program Manager for NEES is located in the Division of Civil, Mechanical and Manufacturing Innovation (CMMI) in the Directorate for Engineering (ENG). The Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA) provides advice and assistance.

- External structure: Purdue University provides the headquarters and staffing to coordinate network-wide operation of the NEES experimental facilities, cyberinfrastructure, and education, outreach, and training activities, and to develop national and international partnerships. Day-to-day operations of the network are overseen by the headquarters staff led by a Center Director. A Governance Board meets several times a year and provides independent advice and guidance to the Center Director concerning the network's programs, activities, vision, funding allocations, and new directions. The Governance Board shares its major recommendations with the NSF. Each of the experimental facilities has an on-site director responsible for local day-to-day equipment management, operations, and interface with Purdue, other NEES facilities, users, and the NEES cyberinfrastructure for network coordination. The NEES cyberinfrastructure provides telepresence, data, collaborative, simulation, and other related services for the entire NEES network.

- Reviews:
  - Management reviews: NSF BFA Business Systems Review: May 2006
  - Mid-award operations reviews: NSF Annual Merit Reviews: June 2005, April 2006, July 2007
  - Experimental facility reviews: NSF Periodic Merit Reviews: FY 2006-FY 2008
  - Transition review: Spring of FY 2010
  - Management reviews: NSF BFA Business Systems Review: FY 2011
  - Mid-award operations reviews: NSF Annual Merit Reviews: FY 2010-FY 2013
  - Experimental facility reviews: Up to three annually: FY 2010-FY 2013

<u>Renewal/Recompetition/Termination:</u>

In FY 2008, NSF made the decision to recompete NEES operations for a second five-year period from FY 2010-FY 2014. The competition was announced in program solicitation NSF 08-574, George E. Brown, Jr. Network for Earthquake Engineering Simulation Operations (NEES Ops) FY 2010-FY 2014. As an outcome of that competition, the National Science Board, at its August 5-6, 2009 meeting, approved NSF's recommendation for a five-year cooperative agreement (FY 2010-FY 2014) to Purdue University. Annual funding to Purdue University for NEES operations is based upon satisfactory progress and availability of funding. During FY 2010, the prior NEES operations awardee, NEES Consortium, Inc., is supported by NSF to provide continuity of operations and help transition software, documents, and other inventory to Purdue University and to complete its own award close-out. In FY 2010, NSF will fund an assessment of the NEES experimental facilities, NEES cyberinfrastructure, and earthquake engineering experimental facilities available worldwide. This assessment is expected to be completed in FY 2012 and will form the basis for determination by NSF of whether to recompete or scale back NEES operations at the end of FY 2014.

GEOSCIENCES

<u>Academic Research Fleet</u> **$77,000,000**
-$3,000,000 / -3.8%

Academic Research Fleet

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Academic Research Fleet	$88.95	$18.00	$80.00	$77.00	-$3.00	-3.8%

The Academic Research Fleet consists of 21 vessels in the University-National Oceanographic Laboratory System (UNOLS). These vessels range in size, endurance, and capabilities, enabling NSF and other federally-funded scientists with the means to conduct ocean science research with a diverse fleet capable of operating in coastal and open ocean waters. Funding for the Academic Research Fleet includes investments in ship operations; shipboard scientific support equipment; oceanographic instrumentation and technical services; and submersible support. Funding levels reported here reflect investments in the Directorate of Geosciences (GEO) by the Division of Ocean Sciences (OCE) and the Division of Innovative and Collaborative Education and Research (ICER). In addition to operations, OCE has undertaken selected construction projects based on an inter-agency fleet renewal status plan.

Total Obligations for the Academic Research Fleet

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$87.07	$18.00	$73.00	$73.00	$74.00	$74.00	$75.00	$77.00	$77.00
Fleet Renewal:									
Human Occupied Vehicle	-	-	5.00	2.00	-				
R/V Langseth (Seismic Ship)	1.00	-	-	-	-				
Regional Class Research Vessel	0.88	-	2.00	2.00	20.00	20.00	20.00	20.00	20.00
Total, Academic Research Fleet	**$88.95**	**$18.00**	**$80.00**	**$77.00**	**$94.00**	**$94.00**	**$95.00**	**$97.00**	**$97.00**

Totals may not add due to rounding.

The Academic Research Fleet serves as the main platform for the collection of data and testing of hypotheses about the structure and dynamics of the oceans. Scientists contribute to advances made in areas such as climate variability, marine ecosystems, fisheries, and ocean-related natural hazards such as tsunamis through use of these facilities. Vessels in the Academic Research Fleet provide about 62,000 scientist days at sea and permit shipboard training of future oceanographers, with students forming about 25 percent of the sea-going science parties. Participating graduate and undergraduate students interact with scientists and marine technicians, enabling them to gain first-hand exposure to ocean science field research. Increasingly, technological innovations allow research conducted at sea to be transmitted via satellite back to the classroom, broadening the educational impact of the vessels to a wider audience, including K-12 students.

The Academic Research Fleet is supported through an interagency partnership, principally with the National Oceanic and Atmospheric Administration (NOAA) and the Office of Naval Research (ONR) via a Memorandum of Understanding (MOU). The operating costs for the Fleet are divided proportionally among the vessel users based on usage; NSF supports approximately 70 percent of the total. NSF also coordinates with ship-operating and ship-user academic institutions through UNOLS.

Support for scientists using the Fleet is provided by both NSF and other state and federal agencies. Within NSF, science is supported via competitive peer-reviewed proposals, most typically funded within OCE and through selected programs in the Division of Earth Sciences (EAR) and the Division of Atmospheric and Geospace Sciences (AGS), and also through the Office of Polar Programs (OPP) and the Directorate for Biological Sciences (BIO). Approximately 30 percent of the GEO proposals request ship time; GEO-funded shipboard science has ranged from about $35.0 million to $45.0 million per year over the last five years. Not reflected in this number is the science that utilizes samples or data collected on prior cruises, scientists piggy-backing on scheduled cruises to accomplish additional science, international scientists sailing with the U.S. Academic Research Fleet, and science funded by other agencies.

The significant temporary increase in funding for support of ship operations in FY 2009 reflects the large number of awards that NSF funded through ARRA that require ship support. This temporary increase reflects approximately 600 additional ship days for a total of 3,300 days. The FY 2011 Request of $77.0 million will support approximately 2,500 ship days.

Project Report:

<u>Fleet Operations:</u>

- Oversight: NSF provides oversight to the Academic Research Fleet through cooperative agreements with each ship-operating institution and through a separate cooperative agreement with the UNOLS Office. In addition, NSF oversees the fleet through the Large Facilities Office via the Business Systems Review (BSR) of selected operating institutions, site visits, ship inspections, and participation at UNOLS Council and Subcommittee meetings by NSF program directors. Several program directors within OCE at NSF, at NOAA, and at ONR are involved in the activities and overall oversight of the Academic Research Fleet. NSF reviewed two large Academic Research Fleet operating institutions through the Large Facilities office via a BSR in CY 2008. A third BSR will be conducted on another operating institution in CY 2010.

- Management: Management of an operating institution's ship-operating facilities varies with the scale of the operation, but the core responsibility typically resides with the Director of the Institution, the Marine Superintendent (for all aspects of the facility), and the Ship's Captain (for at-sea operations). For larger multi-ship-operating institutions, a Chief of Marine Technicians, schedulers, and finance administrators may also be involved in facility management

- Reviews: Based on projected science requirements identified in recent reports and workshops, a fleet of vessels supporting ocean science research will be needed far into the future. The most recent document stating this need is an October 2009 report by the National Research Council (NRC), *Science at Sea: Meeting Future Oceanographic Goals with a Robust Academic Research Fleet*. In coordination with the other federal agencies with ocean research investments and UNOLS, the Interagency Working Group for Facilities (IWG-F) published a *Federal Oceanographic Fleet Status Report* in December 2007 reviewing the status and describing plans for renewal of the federal and academic oceanographic research and survey fleet. In addition to these plans, several activities are underway to support the upgrade of the Academic Research Fleet using FY 2009 ARRA funding. Ship operations and technical services activities are reviewed internally on the basis of detailed annual reports provided by the operating institutions. Ship operations proposals are exempt from external review by peers, and budgets are negotiated yearly since they are dependent on the number of days the ships will be at sea in support of NSF-funded research programs. Technical services awards are reviewed every three years and negotiated annually.

Fleet Renewal:

- Oversight: The NSF coordinator for fleet renewal activities is the Program Director for Ship Acquisitions and Upgrades, within the Integrative Programs Section (IPS) in OCE, with additional IPS staff providing project management assistance as required.

- The Hybrid-ROV Nereus successfully completed sea trials to the deepest part of the world's ocean, the Challenger Deep in May and June 2009. The Nereus can operate either autonomously or tethered to a tender ship via a hair-thin fiber optic cable. The Nereus is now conducting research for scientists supported by NSF and other agencies.

- Regional Class Research Vessel (RCRV): NSF and the Navy's Program Executive Office Ships (PEO Ships) ended a MOU for the acquisition of the RCRV in January 2009. The process produced two designs by late 2008 but was halted before a down-select to a single design was made because adequate construction funds could not be identified. To move the replacement effort forward, NSF convened a Panel of Experts in October 2009 to conduct a technical evaluation of the two designs and make a recommendation to NSF using a rigorous down-select process. NSF expects to begin working with UNOLS to identify needed enhancements to the ship design. Funds in FY 2011 will support design refresh activities needed to comply with any regulation changes and, potentially, to issue a shipyard RFP, with construction anticipated to begin in FY 2012.

- Alaska Regional Research Vessel (ARRV): This project represents NSF's first major contribution to fleet renewal in over twenty years. Construction of the ARRV was funded completely through the MREFC account and ARRA, and is described separately in the MREFC chapter. Shipyard selection will be complete in early FY 2010 with construction beginning shortly thereafter. Science operations are anticipated to begin in mid-calendar year 2014 at which time operational funding will be supported by OCE.

Other Ongoing Activities:

- Development and construction of a deep submergence capability to replace the submersible human occupied vehicle (HOV) ALVIN continues in FY 2010. This project, begun in FY 2004, experienced significant cost over-runs in 2008 and was subsequently re-scoped and placed on a revised review path, which includes a Preliminary Design Review (PDR) in December 2009 with a Final Design Review (FDR) planned in May 2010. Following a successful FDR, NSF will authorize continued expenditures on the project.

  Integration of a new titanium 6,500 meter-capable personnel sphere with existing ALVIN vehicle components is planned during FY 2011. Initial Phase I operations are anticipated in 2012 with a depth capability of 4,500 meters, the limit of the current ALVIN and the infrastructure components to be shared across both platforms. Upgrades to permit operations at a depth of 6,500 meters could follow in three to five years, pending availability of funds and priority evaluations. The cost increase over previous estimates is due to delays in schedule, increases in labor costs and levels of effort, and a rise in titanium costs. Approximately $5 million remains unspent of the original $22.90 million awarded. Additional increases will be shared by the awardee.

- The NRC report, *Science at Sea: Meeting Future Oceanographic Goals with a Robust Academic Research Fleet* made several recommendations on fleet renewal, including the "Recommendation: The future academic research fleet requires investment in larger, more capable general purpose Global and Regional class ships to support interdisciplinary, multi-investigator research and advances in ocean technology". NSF will consider this recommendation, along with those from the RCRV Design Down-select panel report and the current U.S. Navy efforts to replace two aging Global class ships with Ocean class vessels, in determining the way ahead for construction of the RCRV. Funds in FY 2010 will allow coordination with the UNOLS community to make any required refinements to the RCRV requirements documentation and to prepare a solicitation for selection of an academic institution to design/build the RCRV. NSF plans to use the same process currently being used for the design and construction of the Alaska Region Research Vessel, which is proving to be highly successful.

EarthScope **$26,000,000**
+$950,000 / 3.8%

EarthScope
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
EarthScope	$24.29	$9.00	$25.05	$26.00	$0.95	3.8%

The EarthScope facility is a distributed, multi-purpose geophysical instrument array that is making major advances in our knowledge and understanding of the structure and dynamics of the North American continent. EarthScope instrumentation is expected to be located in nearly every county within the U.S. over the 10 year life span of the program. Construction of EarthScope was completed September 30, 2008. FY 2009 was the first year of operation of the full EarthScope.

Total Obligations for EarthScope
(Dollars in Millions)

	Prior Years	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations & Maintance	$51.39	$24.29	$25.05	$26.00	$26.65	$27.25	$28.05	$28.86	$29.70
ARRA Actual		9.00							
Total, EarthScope	**$51.39**	**$33.29**	**$25.05**	**$26.00**	**$26.65**	**$27.25**	**$28.05**	**$28.86**	**$29.70**

Totals may not add due to rounding.

EarthScope seeks to enhance our understanding of the structure and evolution of the North American continent, including earthquakes and seismic hazards, magmatic systems and volcanic hazards, lithospheric dynamics, regional tectonics, continental structure and evolution, fluids in the crust, and associated educational aspects. Science and non-science students will be engaged in geosciences discovery through the use of technology in real-time or retrospectively with the aim of integrating research and education.

The U.S. Geological Survey (USGS), the National Aeronautics and Space Administration (NASA), the Department of Energy (DOE), and the International Continental Scientific Drilling Programme are partners with NSF in EarthScope. Project partners also include state and local governments, geological and engineering firms, and Canadian and Mexican agencies. Over 3,000 Earth scientists and students are expected to use the facility annually. Geotechnical and engineering firms directly use data and models that are enabled by EarthScope. Instrumentation firms are collaborating on development for state-of-the-art seismic systems, down-hole instrumentation, and high-precision GPS antenna designs.

Along with direct operations and maintenance support for EarthScope, NSF will support research performed utilizing the facility through ongoing research and education programs. The annual support for such activities is approximately $6.20 million.

Facility Report:

Management and Oversight:

- NSF Structure: The EarthScope Program Director, located in the Division of Earth Sciences (EAR) in the Directorate for Geosciences (GEO), provides NSF oversight. The Deep Earth Processes Section Head and Division Director in EAR provide other internal oversight.

- External Structure: The external management structure includes the community-based EarthScope National Office, currently located at Oregon State University; an independent steering committee consisting of scientists from the EarthScope community including two subcommittees, one devoted to education and outreach and one devoted to cyberinfrastructure; and external management oversight committees for each of the EarthScope facility components.

- Reviews: Each year, NSF convenes a panel of external experts to review project management, cost, schedule, and technical status of the EarthScope facilities and to provide advice for the EarthScope managers and NSF.

Current Project Status:

EarthScope completed its construction phase on-time and on-budget on September 30, 2008 and is now fully operational. The USArray component of EarthScope is a continental-scale seismic and magnetotelluric observatory designed to provide a foundation for integrated studies of continental lithosphere and deep Earth structure over a wide range of scales. USArray consists of four major components: (1) a Reference Network of permanent seismic stations, (2) a Transportable Array of ~400 seismic stations, (3) a Flexible Array pool of seismic instruments for use in specific experiments, and (4) a Magnetotelluric Array with permanent and transportable instruments. The Plate Boundary Observatory (PBO) component of EarthScope is a geodetic observatory designed to study the three-dimensional strain field resulting from deformation across the active boundary zone between the Pacific and North American plates in the western United States. PBO includes 1,200 geodetic and 79 strain meter/seismic stations. The San Andreas Fault Observatory at Depth (SAFOD) is a 3-kilometer deep hole drilled directly into the San Andreas Fault midway between San Francisco and Los Angeles, near Parkfield, CA. Located in an area that has ruptured six times since 1857, the hole is providing the first opportunity to observe directly the conditions under which earthquakes occur, to collect rocks and fluids from the fault zone for laboratory study, and to continuously monitor the physical condition within an active earthquake nucleation zone. The EarthScope seismic and geodetic instruments consistently exceed 90 percent uptime, and have provided nearly 30 terabytes of data for the scientific community. EarthScope's open access data policy is having an impact on how experiments are planned and carried out and is resulting in more scientists making data available to the community in real-time.

Although it became fully operational only during FY 2009, EarthScope has already led to a number of important scientific advances. EarthScope is aiding in the development of predictive models for earthquakes by unraveling the dynamic processes along faults, from stress build-up to catastrophic rock failure. While the unique SAFOD core from the San Andreas Fault is just beginning to be analyzed, early mineralogical analysis has already answered key questions about why sections of the fault exhibit slip in the form of creep. The combined use of PBO geodetic and strain data, and USArray seismic data, has documented a wide range of seismic and aseismic signals associated with different modes of fault slip along the Cascadia subduction zone and provided unique new insight into spatial and temporal relationships between earthquakes (large and small), tremor, and slow slip. These exciting new results may have important implications for assessing seismic risk along a plate boundary that is capable of a magnitude 9+ earthquake similar to the great Sumatra earthquake and tsunami of December 2004. PBO's regional scale geodetic network has also provided surprising new information on the Pacific-North American plate boundary, showing for example that extension in the Basin and Range province is not uniform as was once widely believed, but instead focused near its western and eastern edges. New advances are also being made in joint modeling of EarthScope seismic and strain data with other data types such as geochemistry and structural geology. EarthScope data have been used to develop a revolutionary new tomographic technique for imaging crust and upper mantle structure in western North America that utilizes seismic signals previously considered to be noise. Finally, EarthScope data are being used for unexpected discoveries with potentially transformative impact, including the use of EarthScope GPS measurements to understand the distribution of soil moisture, a key input to climate models, across the western U.S. These new results are being incorporated in an updated science plan for EarthScope under development through an extensive community process.

EarthScope has engaged a broad and steadily growing community of scientists. More than 110 unique investigators have received NSF funding through the EarthScope science program, including eight early career scientists in FY 2009; at the same time, success rate has remained fairly steady at about 30 percent. About 300 scientists came together for the May 2009 EarthScope National Meeting in Boise, ID, and during the 2009 American Geophysical Union meeting, there were more than 30 special sessions relevant to EarthScope science, covering eight different areas of AGU, and including a Union session focused on EarthScope. Scientific results utilizing data collected by the EarthScope facility have already been presented at national meetings and in professional publications.

Operations costs:

Annual operations costs for EarthScope are anticipated to remain approximately steady, with annual adjustments for inflation. EarthScope received $9.0 million in ARRA funds in FY 2009. Of those, $4.0 million were allocated to fill a budget shortfall caused by smaller than anticipated growth of the EarthScope operations budget in FY 2008. The ARRA funds allowed the full EarthScope facility to operate throughout FY 2009, avoiding a potential reduction in operations staff and loss of scientific data. The remaining $5.0 million funded facility enhancements to support onshore/offshore experiments of interest to EarthScope and MARGINS, with the first deployment in the Cascadia region.

<u>Incorporated Research Institutions for Seismology</u> **$12,730,000**
$370,000 / 3.0%

Incorporated Research Institutions for Seismology
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Incorporated Research Institutes for Seismology	$12.00	-	$12.36	$12.73	$0.37	3.0%

The Incorporated Research Institutes for Seismology (IRIS) operates a distributed national facility for the development, deployment, and operational support of modern digital seismic instrumentation to serve national goals in basic research in the Earth sciences, in earthquake research, global real-time earthquake monitoring, and in nuclear test ban verification. It is managed via a consortium of 113 U.S. universities and non-profit institutions with research and teaching programs in seismology. IRIS led the construction of the USArray component of the EarthScope project and it is now operating USArray as part of the EarthScope Facility.

Total Obligations for IRIS
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$12.00	$12.36	$12.73	$13.09	$13.48	$13.89	$14.31	$14.75

The Earth's interior remains a major scientific frontier holding the key to understanding the origin of the planet. Recent developments in seismic sensor design, and the acquisition, transmission, and storage of data have resulted in dramatic improvements in the resolving power of seismic imaging of the interior. To serve the research needs of the broad national and international seismology community, IRIS is organized in four major core program elements:

- The Global Seismographic Network (GSN), which currently consists of a global deployment of over 150 permanently-installed broadband digital seismic stations, most of which have real-time data access;
- The Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL), which manages a pool of portable seismometers that are made available to the seismology research community for scheduled regional and local scale studies;
- The IRIS Data Management System (DMS), which provides the national and international seismic research community with timely access to data from the GSN and PASSCAL (105 terabyte archive);
- The IRIS Education and Outreach (E&O) Program, which enables audiences beyond seismologists to access and use seismological data and research for educational purposes, including teacher workshops, student internships, museum exhibits, educational materials, and programs for under-resourced schools.

In addition, IRIS operates the USArray component of EarthScope. The USArray is a continental-scale seismic and magnetotelluric observatory designed to provide a foundation for integrated studies of continental lithosphere and deep Earth structure over a wide range of scales.

Besides its role in providing the observational data essential for basic research in geophysics and earthquake dynamics, IRIS also plays a significant role providing real-time seismic data to the U.S. Geological Survey and the National Oceanic and Atmospheric Administration for global earthquake and tsunami monitoring, in seismic monitoring of the Comprehensive Test Ban Treaty, and in bringing seismology to students and the public through the activities of its education and outreach program.

IRIS is heavily involved in partnership activities, many international in nature. Installation and operation of the GSN has put IRIS in contact with scientists as well as government and non-government organizations from around the world. Many international IRIS GSN stations are designated as the official stations for nuclear test-ban monitoring in their host countries. The IRIS facilities also are multi-use resources for other government agencies that have responsibilities for development of a nuclear test-ban monitoring capability and for monitoring global seismicity. For these purposes, agencies in partnership with NSF have provided substantial support to IRIS for accelerated development of the GSN (Department of Defense), shared operation and maintenance of the GSN (U.S. Geological Survey), and accelerated development of the PASSCAL instrument pool (Department of Energy).

Global Seismic Station SPA at South Pole, Antarctica. Shown is a prototype borehole sensor package being tested in a shallow vault. This prototype was eventually deployed at the new South Pole seismic station QSPA, located 5 miles from SPA. *Credit: IRIS*

The use of IRIS PASSCAL instruments for investigations of the shallow crust provides opportunities for collaboration with the petroleum exploration industry. Many students involved in these experiments receive training in techniques that prepare them for careers in the exploration industry. In a broader sense, IRIS continues to collaborate closely with industry in development of seismic instrumentation and software.

The Geophysics, Tectonics, and Continental Dynamics Programs in the Division of Earth Sciences (EAR); the Marine Geology and Geophysics Program in the Division of Ocean Sciences (OCE); and the Geology and Geophysics and Glaciology Programs in the Antarctic Research Section of the Office of Polar Programs (OPP) provide most of the funds for NSF-sponsored research making use of the IRIS facilities, totaling approximately $15.0 million per year. Funds permit deployment of PASSCAL instruments and use of GSN data stored at the DMS to solve major Earth science problems.

Facility Report:

<u>Management and Oversight:</u>

- NSF Structure: EAR, through its Instrumentation & Facilities Program (IF), provides IRIS with general oversight to help assure effective performance and administration. The program also facilitates coordination of IRIS programs and projects with other NSF-supported facilities and projects and with other federal agencies and evaluates and reviews the scientific and administrative performance of IRIS.

- External Structure: IRIS is incorporated as a non-profit consortium representing 113 U.S. university and non-profit organizations with research and teaching programs in seismology. Each member institution appoints a representative. However, all IRIS program and budget decisions are made by a nine-member Board of Directors. These decisions are made after consultation with the IRIS advisory committees (four standing committees for each of the four IRIS programs and additional ad hoc working groups appointed for special tasks). The Board of Directors appoints a president of IRIS to a two-year term. The president is responsible for IRIS operations, all of which are managed through the IRIS Corporate Office.

<u>Reviews & Renewal</u>:

A five-year cooperative agreement with the IRIS Consortium for the continued management of the IRIS core facilities (2006-2011) was approved by the NSB in May 2006 and finalized in September 2006. All major ongoing geoscience facilities routinely undergo mid-award reviews of their management in addition to peer review of proposals for new or continued support. A management review of IRIS took place in April 2009. Although a number of specific recommendations were made by the review committee, overall the committee found that IRIS is an extremely well-managed and effective organization that has, through its commitment to the collection and open dissemination of the highest quality seismological data, transformed the discipline of seismology. A review of the IRIS Education and Outreach (E&O) Program also took place during 2009. The review panel found the E&O Program to be healthy but made a number of recommendations that will be considered by the seismological community as it prepares a new Strategic Plan for this program in 2010. A proposal from IRIS for renewed support is anticipated, however of approximately two years duration to synchronize the IRIS award with the complementary EarthScope activity.

The Integrated Ocean Drilling Program and the Scientific Ocean Drilling Vessel **$46,410,000 +$3,010,000 / 6.9%**

The Integrated Ocean Drilling Program

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Integrated Ocean Drilling Program	$47.95	$25.00	$43.40	$46.41	$3.01	6.9%

The Integrated Ocean Drilling Program (IODP), which began in FY 2004, is an expanded successor program to the Ocean Drilling Program (ODP) and represents an international partnership of the scientists, research institutions, and funding organizations of 24 nations to explore the evolution and structure of Earth as recorded in the ocean basins. The IODP is co-led by NSF and the Ministry of Education, Culture, Sport, Science and Technology (MEXT) of Japan. IODP platforms provide sediment and rock samples (cores), in-situ monitoring, sampling, and measurement from borehole observatories, shipboard and shorebased descriptive and analytical facilities, downhole geophysical and geochemical measurements (logging), and opportunities to conduct experiments to determine in-situ conditions beneath the seafloor.

SODV Underway for Initial Science Expedition, March 10, 2009. *Credit: NSF*

Total Obligations for IODP

(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$47.95	$43.40	$46.41	$46.41	$46.41	$47.00	$47.00	$47.00
ARRA Actual	25.00	-						
Total, IODP	**$72.95**	**$43.40**	**$46.41**	**$46.41**	**$46.41**	**$47.00**	**$47.00**	**$47.00**

Totals may not add due to rounding.

Operations and maintenance funds support the operation and maintenance of the Scientific Ocean Drilling Vessel (SODV).

NOTE: The IODP program officially ends in 2013 but may be renewed. NSF activities regarding IODP renewal, including overall program review, are expected to commence in FY 2011. IODP scientific community planning efforts for a possible post- FY 2013 science program commenced in FY 2009. Funding for FY 2014, FY 2015, and FY 2016 is estimated assuming renewal of the program.

Annual operations and maintenance support for IODP includes the costs of operating the platform itself and is based on NSF experience in management of the ODP and the contract with the SODV operator. Maintaining databases, preparing scientific publications emerging from IODP expeditions, and management of the international program are additional IODP science integration costs, made minimal to NSF because of international contributions to the IODP program. In addition, NSF provides support for U.S. scientists to sail on IODP drilling platforms and to participate in the IODP Science Advisory

Structure through an associated grants program. The annual costs for the associated science integration and science support (not included in the table above) are estimated to be about $12.0 million.

The IODP Scientific program includes emphasis on the following research themes:

- Deep Biosphere and the Sub-seafloor Ocean;
- Processes and Effects of Environmental Change; and
- Solid Earth Cycles and Geodynamics, including study of tsunami-producing seismogenic zones and other geohazards.

Undergraduate and graduate students participate in drilling expeditions, working with leading scientists to help become future leaders themselves. Other students and the public are engaged in geoscience discovery through distance learning initiatives (including remote broadcasts from the drillship), classroom teaching modules on IODP research initiatives, outreach displays for museums and educational/teaching institutions, and lecture programs. During each fiscal year, an estimated 180,000 K-12, 10,000 undergraduate and 10,500 graduate students, and 35,000 teachers are engaged in or supported by IODP education and outreach efforts.

MEXT and NSF are equal partners in IODP and contribute equally to program operation costs. The European Consortium for Ocean Research Drilling (ECORD; representing 16 European countries and Canada), the People's Republic of China, Korea, India, Australia, and New Zealand have also officially joined IODP and provide financial contributions. IODP partners, including NSF, support IODP integrative activities including science planning, review, data management, drilling science-related engineering development, core and sample archiving, publishing, and international outreach.

Over 2,200 scientists from 40 nations have participated on ODP and IODP expeditions since 1985, including approximately 1,000 U.S. scientists from over 150 universities, government agencies, and industrial research laboratories. Samples and data have been distributed to more than 800 additional U.S. scientists.

NSF is contracting the services of the light drillship from a leading offshore drilling contractor. A commercial contractor provides downhole-logging services. In addition, scientists from industrial research laboratories propose and participate in IODP cruises, are members of the program's scientific and technical advisory committees, and supply data for planning expeditions and interpretation of drilling results.

Facility Report:

<u>Management and Oversight:</u>

- NSF Structure: The Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO) manages the SODV and the IODP under the NSF Ocean Drilling Program. NSF's Ocean Drilling Program is located within the Marine Geosciences Section, with several program officers dedicated to its oversight. One of the program officers serves as the contracting officer's technical representative for the Central Management Office (CMO) contract and the System Integration Contractor (SIC) contract.

- External Structure: NSF and MEXT have signed a Memorandum of Cooperation, which identifies procedures for joint management of a contract to an IODP CMO. A non-profit corporation of U.S., Japanese, and other international institutions (IODP Management International, Inc.) has been contracted by NSF for the CMO activity. The CMO coordinates and supports scientific planning, drilling platform activity, data and sample distribution, and publication and outreach activities through its management of commingled international science funds, collected and provided by NSF. Drillship providers are responsible for platform operational management and costs. NSF provides the light drillship through contract with the U.S. SIC, an alliance formed by the Consortium for Ocean Leadership, Inc. (COL) together with subcontractors Texas A&M University and Lamont-Doherty Earth Observatory, Columbia University. MEXT manages its drillship through the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), while the British Geological Survey manages ECORD drilling contributions.

Scientific advice and guidance for IODP is provided through the science advisory structure (SAS). The SAS consists of a Science Advisory Structure Executive Committee (SASEC) and a series of committees, panels, and groups headed by the Science Planning Committee (SPC). The CMO is responsible for coordinating the SAS committees, panels, and groups, and for integrating the advice from the SAS into drilling and operational guidance for IODP. Representation in the SAS is proportional to IODP member's financial contribution.

- Reviews: Both the CMO and SIC contracts call for management reviews every three years by independent, external panels. Both the SIC and CMO contracts will undergo external review in FY 2010. Reviews for each expedition are carried out on a regular basis to evaluate operational and scientific performance, with review of scientific progress in broader thematic areas conducted by independent panel every several years.

Renewal/Recompetition/Termination:

IODP international agreements and contracts cover activities through FY 2013. NSF activities regarding IODP renewal, including overall program review, are expected to commence in FY 2011. IODP scientific community planning efforts for a possible post-FY 2013 science program commenced in FY 2009.

Scientific Ocean Drilling Vessel (SODV)

The SODV project was funded through the Major Research Equipment and Facilities Construction (MREFC) account and supported the contracting, conversion, outfitting, and acceptance trials of a deep-sea drilling vessel for long-term use in the IODP. The total NSF cost of the project was $115.0 million appropriated through the MREFC account over three years, with FY 2007 representing the final year of appropriations. The ship operator, Overseas Drilling Limited (ODL), is covering certain construction costs in exchange for a higher day rate charge during the operations phase. Construction activities have been completed and the ship commenced international scientific operations on March 5, 2009. The outfitted drillship is capable of operating in nearly all ocean environments (subject to limitations regarding minimum water depth and surface ice coverage), and accommodates a scientific and technical staff of up to 60 persons.

Project Report:

Management and Oversight:

- NSF Structure: The project was overseen by a program director in the OCE in GEO with advice and oversight support from a NSF Project Advisory Team (PAT), including representatives from GEO, the Office of Polar Programs, the Office of Budget, Finance and Award Management (BFA), and the Office of General Counsel. The BFA Deputy Director for Large Facility Projects participated as a member of the PAT, providing advice and assistance.

- External Structure: A SODV Independent Oversight Committee provided technical, financial and scheduling recommendations and advice for the SODV project to top-level management. A Program Advisory Committee (PAC), comprised of members of the science and drilling communities, provided ongoing assessment of the design plans for the on-board science and drilling capabilities, to assure that the converted vessel reflects the needs of the scientific communities.

- Reviews:
  - A two-phase independent readiness assessment of the SODV science systems was completed in February and March 2009 by a group of ocean drilling veteran scientists.

Current Project Status:

Shipyard conversion of the vessel was completed in early January 2009. Initial load-out and shakedown activities were conducted and the SODV commenced IODP scientific operations on March 5, 2009. The ship has since completed 5 IODP expeditions with exceptional reliability and demonstrably superior coring capability (the global piston coring depth record – with virtually 100% recovery – has been broken three times since commencement of operations, to a depth of over 458 meters below sea floor).

Cost and Schedule:

Refitting of the ship is completed. Due to the enormous worldwide demand for shipyard services during the SODV refit period, actual shipyard work lagged planned progress, resulting in significant delay in return of the vessel to science operations. Various project costs are still under review but current indications are that the NSF portion of the SODV refit has been completed within the MREFC project funding profile established in early FY 2005.

Risks:

None remaining.

Future Operations Costs:

Future operations costs are described in the obligations table above.

MATHEMATICAL AND PHYSICAL SCIENCES

Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring **$13,450,000 +$4,450,000 / 49.4%**

Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Cornell High Enegry Synchrotron Source/ Cornell Electron Storage Ring (CHESS/CESR)[1]	$13.60	$14.99	$9.00	$13.45	$4.45	49.4%

Totals may not add due to rounding.

[1] The combined reporting of CHESS/CESR began in FY 2009.

The Cornell High Energy Synchrotron Source (CHESS) is a high-intensity, high-energy X-ray facility supported by NSF with partial interagency support from the National Institutes of Health (NIH). It uses synchrotron light given off by charged particles, both electrons and positrons, as they circulate at nearly the speed of light around the Cornell Electron Storage Ring (CESR). CHESS provides state-of-the-art capabilities for X-ray research in physics, chemistry, biology, materials, and environmental sciences. Areas of emphasis include soft matter and thin film studies, solution scattering, nanomaterials, high-pressure science, structural biology, time-resolved studies of materials, and X-ray studies of items of art and archaeology. The mission of CHESS also includes X-ray technology development. Support and oversight of CHESS is provided through the Division of Materials Research (DMR) within the Directorate for Mathematical and Physical Sciences (MPS).

CESR was constructed and operated for many years to support elementary particle physics research, serving a dual role by also providing the electrons and positrons for the operation of CHESS. Over the last few years, elementary particle physics research at CESR was phased out and a larger fraction of CESR operations was dedicated to support CHESS. As of FY 2010, this is CESR's primary function. Concomitant with this transition, funding and oversight of CESR is transferred from the Division of Physics (PHY) in MPS to DMR. Because some of the FY 2010 obligations were met using FY 2009 ARRA funds, the FY 2010 request is less than originally planned.

Total Obligations for CHESS/CESR

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
CHESS/CESR-Ops & Maintenance	$13.60	$13.69	$9.00	$13.45	$18.45	$20.93	$22.19	$22.54	$23.81
CHESS/CESR-R&D	-	$1.30	-	-	-	-	-	-	-
Total, CHESS/CESR	**$13.60**	**$14.99**	**$9.00**	**$13.45**	**$18.45**	**$20.93**	**$22.19**	**$22.54**	**$23.81**

Totals may not add due to rounding.

In FY 2011, $13.45 million will allow for expanded operation of the facilities in support of synchrotron light users as well as in X-ray technology development.

CHESS/CESR staff assists in transferring Superconducting Radio Frequency (SRF) technology to industry. Several CHESS/CESR users are from industry, including pharmaceutical corporations (such as Rib-x Pharmaceuticals) and the research arms of Eastman Kodak, Xerox, and General Motors. Some medical institutions also make use of CHESS/CESR (Dana Farber Cancer Institute, Boston Biomedical Research Institute, and Memorial Sloan-Kettering Institute). CHESS/CESR also has partnerships with DOE-supported synchrotron facilities such as the Advanced Photon Source and the National Synchrotron Light Source.

CHESS/CESR supports and enhances Ph.D. level graduate education, postdoctoral research, and research experiences for undergraduates and for K-12 science teachers. Each year about 100 Ph.D. thesis projects result in more than 25 degrees granted. More than 60 undergraduates participate in research at the facility during the academic year; about 16 undergraduates and 10 pre-college teachers participate during the summer.

Project Report:

<u>Management and Oversight:</u>

- NSF Structure: Through FY 2008, NSF oversight of CESR was provided through PHY and involved panel evaluation of the CESR continuation proposal as well as a site visit by NSF staff and external reviewers. As CESR transitioned from supporting elementary particle physics research to a dedicated source of electrons for CHESS, oversight and funding of CESR shifted from PHY to DMR in FY 2010. CHESS is supported by DMR and by NIH. CHESS also hosts MacCHESS, a NIH-funded macromolecular crystallography program at Cornell. NSF and NIH provide management oversight for CHESS through regular site visits by external reviewers.

- External structure: Both CESR and CHESS are administered by the Cornell Laboratory of Accelerator-based Sciences and Education (CLASSE), which reports to Cornell's Vice-Provost for Research. CHESS/CESR is operated by Cornell University in accordance with cooperative agreements with NSF that set goals and objectives for the facilities.

- CHESS is a national user facility accessed on the basis of competitive proposal review. The primary function of the CHESS staff is to maintain and operate the facility and to assist users. A policy and advisory board, appointed by the Cornell Vice President for Research, provides advice to the director of CHESS on policies related to the use and development of CHESS facilities and equipment for user experiments. A users committee appointed by the users of CHESS advises the director on matters of facilities operations and priorities for the users. An annual users meeting and several workshops help disseminate results from the facility.

- Reviews:
  - Recent reviews conducted (CESR):
    - Review for phase-out of facility particle physics operations, FY 2008.
  - Recent reviews conducted (CHESS):
    - Proposal review including site visit review with panel of external experts, FY 2008.
    - Review of combined CHESS/CESR with panel of experts, May 2009.
  - Upcoming reviews:
    - Review of CHESS operations, planned in fall 2010.

Renewal/Recompetition/Termination:

CESR is currently funded through a five-year cooperative agreement initiated in 2003 and extended in 2008 to allow time to implement the transition of CESR from a high energy physics facility to a facility fully dedicated to support photon science. Use of CESR as a facility for particle physics concluded with final phase out during FY 2008 and FY 2009. As of FY 2010, CESR is dedicated entirely to support the CHESS operation. CHESS is currently funded through a cooperative agreement also initiated in 2003. In FY 2009, NSF completed the review of a proposal for the continued operation of CESR/CHESS in support of X-ray photon science. In December 2009, the National Science Board authorized NSF to make a four-year award for CHESS/CESR starting on April 1, 2010.

Gemini Observatory **$19,580,000**

+$480,000 / 2.5%

Gemini Observatory
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Gemini Observatory	$18.71	-	$19.10	$19.58	$0.48	2.5%

The Gemini Observatory consists of two 8-meter telescopes, one in the northern hemisphere, in Hawaii, and one in the southern hemisphere, in Chile. The Hawaiian telescope, Gemini North, is optimized for infrared observations and is located on Mauna Kea at an altitude of 4,200 meters. The telescope in Chile, Gemini South, is located on Cerro Pachon, also an outstanding photometric site, at an altitude of 2,700 meters. This siting of the two telescopes assures complete coverage of the sky and complements the observations from space-based observatories. It provides access to the center of our own Galaxy, as well as the Magellanic Clouds, our nearest galactic neighbors. Both telescopes are designed to produce superb image quality and both use sophisticated adaptive optics technology to compensate for the blurring effects of the Earth's atmosphere.

Total Obligations for the Gemini Observatory
(Dollars in Millions)

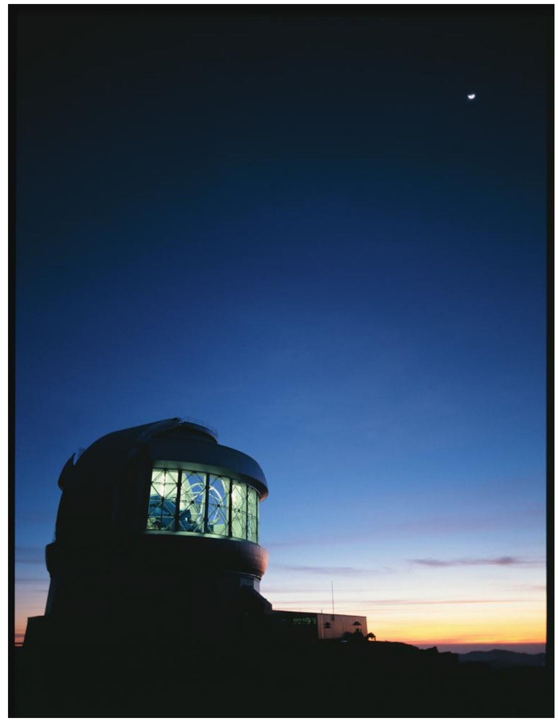
	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$18.71	$19.10	$19.58	$20.07	$20.57	$21.08	$21.61	$22.15

Astronomers need to resolve important questions about the age and rate of expansion of the universe, its overall topology, the epoch of galaxy formation, the evolution of galaxies, including our own once they are formed, and the formation of stars and planetary systems. The current generation of optical/infrared telescopes with significantly larger aperture (8-meter diameter) than previous instruments provides better sensitivity and spectral and spatial resolution. Technological advances in a number of key areas of telescope construction and design optimize the telescopes' imaging capabilities and infrared performance, and compensate for the blurring effects of the Earth's atmosphere.

The Gemini telescopes help educate and train U.S. astronomy and engineering students. An estimated 10 percent of the roughly 500 U.S. users per year are students. Gemini is also providing a focus for public outreach and high school student training in all the partner countries, including "sister city" arrangements between Hilo, Hawaii and La Serena, Chile involving students and teachers at high school and elementary school levels. Gemini staff also provide guidance and support to the Imiloa Science Center, a public astronomy and cultural center in Hilo.

Gemini is an international partnership with the United Kingdom, Canada, Australia, Chile, Argentina, and Brazil. Construction of the telescopes and their instrumentation has involved a large number of industrial entities in several partner and non-partner countries. These industrial entities have involved firms specializing in large and/or complex optical systems, aerospace industries, electronics, and engineering, etc. Continued involvement of such industries is part of the instrumentation and facilities renewal activities included in the operating budget of the Gemini Observatory.

Peer-review telescope allocation committees provide merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of Gemini. Many U.S. users are supported through separate NSF or NASA grants to pursue scientific programs that require use of Gemini.



The Gemini South telescope on Cerro Pachon in Chile prepares for the beginning of observation. The telescope is visible through the three-storey-high vents on the rotating dome, which allow a strong air flow across the telescope to provide good image quality. This late twilight shot also shows the crescent moon in the western evening sky. *Credit: Gemini Observatory/Association of Universities for Research in Astronomy*

Laser guide star systems, which greatly improve the telescopes' ability to correct for atmospheric blurring, are being developed for both telescopes, with the laser on Gemini North in routine operation and integration of the system on Gemini South underway. An advanced "multi-conjugate" adaptive optics system, which will yield crisp images over a larger field of view, is in development on Gemini South and will start integration, commissioning on the telescope, and early-scientific operation in FY 2010. Several new instruments are in various states of development. These include a high-performance infrared spectrometer that was delivered to Gemini South in FY 2009 and is currently beginning early-science observations; and the Gemini Planet Imager, an advanced camera, currently under construction, that is designed to directly detect planets around nearby stars.

Budget projections for FY 2012 and beyond represent a fixed level of effort as approved by the Gemini Board and NSF.

Facility Report:

Management and Oversight:

- NSF Structure: NSF has one seat on the Gemini Board and an additional NSF staff members serves as the executive secretary to the board. Programmatic management is the responsibility of an assigned NSF program manager for Gemini in the Division of Astronomical Sciences in the Directorate for Mathematical and Physical Sciences. The program manager approves funding actions, reports, and contracts, and conducts reviews on behalf of the Gemini partnership.

- External Structure: The observatory is governed by the Gemini Board, established by the International Gemini Agreement signed by the participating agencies. NSF serves as the executive agency for the seven-nation partnership, carrying out the project on their behalf. An independent visiting committee, established by the Gemini Board, advises on the operation of the observatory and meets bi-annually. Gemini is managed by Associated Universities for Research in Astronomy (AURA), Inc. on behalf of the partnership through a cooperative agreement with NSF. AURA conducts its own management reviews through standing oversight committees.

- Reviews: In addition to a review held mid-way through the cooperative agreement, NSF conducts periodic reviews of AURA management and observatory programs as requested by the Gemini

Board. The mid-term management review was held in Hilo on September 23-26, 2008. In addition, NSF conducted a Business System Review of the observatory in March 2009.

Renewal/Recompetition/Termination:

The current International Gemini Agreement will expire at the end of calendar year 2012. The Gemini Board is developing the process and schedule for renegotiation of the agreement. At the November 2009 meeting of the Gemini Board, all partners with the exception of the United Kingdom expressed their intention to remain in the partnership in 2013 and beyond. In late December 2009, the United Kingdom officially announced its intention to withdraw from the partnership post-2012, guaranteeing that there will be changes in the partnership with attendant budgetary impact in the years following 2012. The Board has directed the observatory to prepare contingency plans for reduced operations scope in response to a potential budget reduction of 20 percent. Negotiations for the international agreement and the Gemini management scheme may require a number of years to complete, thus requiring extensions of the current agreements.

The current NSF cooperative agreement covers FY 2006-2010. On the basis of the mid-term management review of AURA's performance as the Gemini managing organization in November 2008, the Gemini Board recommended not to compete the management of the observatory when the current cooperative agreement expires. Furthermore, due to uncertainties in the international financial climate that make it difficult for some of the Gemini partners to commit to long-term funding, it may be necessary to extend the current cooperative agreement through at least 2012 in order to provide stable ongoing operations and management through the negotiations with the Gemini partners on their future involvement in the partnership.

Large Hadron Collider

$18,000,000
+$0.0 / 0.0%

Large Hadron Collider
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Large Hadron Collider	$18.00	-	18.00	$18.00	-	-

The Large Hadron Collider (LHC), an international project at the CERN laboratory in Geneva, Switzerland, is nearing completion of construction and will be the premier facility in the world for research in elementary particle physics. The facility consists of a superconducting particle accelerator providing two, counter-rotating beams of protons, each beam to have an energy up to 7 TeV (1TeV=10^{12} electron volts). The U.S. is involved in the maintenance and operation of two particle detectors, a Toroidal LHC Apparatus (ATLAS) and the Compact Muon Solenoid (CMS). These have been built to characterize the different reaction products produced in the very high-energy proton-proton collisions that will occur in intersection regions where the two beams are brought together. A total of 43 international funding agencies participate in the ATLAS detector project and 41 in the CMS detector project. NSF and the Department of Energy (DOE) are providing U.S. support. CERN is responsible for meeting the goals of the international LHC project. The ATLAS and CMS detectors are expected to take data approximately 200 days per year. The remaining time is to be used for maintenance and testing.

The U.S. LHC collaboration has been a leader in the development of Grid-based computing. The Grid will enable the enhanced participation of U.S. universities, and thus the training of students, in both state of the art science and computational techniques, in a project that is centered overseas. The Grid is expected to have broad application throughout the scientific and engineering communities.

Total Obligations for the LHC
(Dollars in Millions)

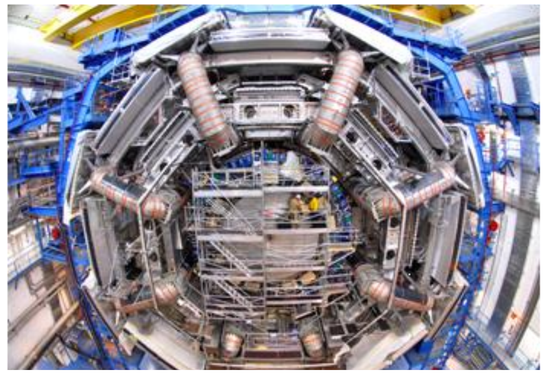
	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$18.00	$18.00	$18.00	$20.00	$20.00	$20.00	$20.00	$20.00

[1] The current cooperative agreement ends in FY 2011. Outyear funding estimates are for planning purposes only and do not reflect policy decisions.

The LHC will enable a search for the Higgs particle, the existence and properties of which will provide a deeper understanding of the origin of mass of known elementary particles. The LHC will also enable a search for particles predicted by a powerful theoretical framework known as supersymmetry, which may provide clues as to how the four known forces evolved from different aspects of the same "unified" force in the early universe, and can investigate the possibility that there are extra dimensions in the structure of the universe. Through the participation of young investigators, graduate students, undergraduates, and minority institutions in this international project, LHC serves the goal of helping to produce a diverse, globally-oriented workforce of scientists and engineers. Further, innovative education and outreach activities, such as the QuarkNet project, allow high school teachers and students to participate in this project (see http://quarknet.fnal.gov).

Major procurements of components of both warm and superconducting magnets, as well as high-speed electronics, are performed through U.S. industries. Major developments in Grid computing are also valuable outcomes. In the construction phase, approximately $45.0 million was devoted to materials procurements from industry. In FY 2011 the estimate for material procurements is approximately $4.50 million, which is included within the $18.0 million operating costs.

The U.S. LHC collaboration has completed installation of detector components in the experimental areas and has been actively engaged in the integration of these components with the rest of the detectors and the commissioning of the detectors using cosmic rays. This effort is proceeding on schedule and budget. However, the accelerator start-up schedule had been delayed due to failure in September 2008 of a high current line that caused arcing and destructive failure of a liquid helium cryogenic system. While the accelerator has been undergoing repairs for the past year, the collaboration did intensive commissioning of the detectors and the data analysis systems using cosmic rays with extended runs of several weeks at a time, 24 hours a day. First beams were delivered in December 2009; further detector commissioning is proceeding using the particle beams and will continue into early 2010. Data-taking is expected to begin when the beam performance stabilizes.



The ATLAS detector in February 2007. *Credit: CERN.*

Facility Report:

<u>Management and Oversight:</u>

- NSF Structure: A program director in the Division of Physics (PHY) is responsible for day-to-day project oversight. The NSF program director participates in an internal Project Advisory Team, including staff from the NSF Offices of Budget, Finance, and Award Management, General Counsel, Legislative and Public Affairs, and International Science and Engineering, as well as the Office of the Assistant Director for the Directorate of Mathematical and Physical Sciences (MPS).

- External Structure: U.S. LHC program management is performed through a Joint Oversight Group (JOG), created by the NSF and DOE. The JOG has the responsibility to see that the U.S. LHC program is effectively managed and executed to meet commitments made under the LHC international agreement and its protocols.

- Reviews: There is one major management/technical review each year with a panel of external, international experts, as well as bi-weekly telephone reviews by NSF/DOE program directors to monitor progress. The next major management/technical review is scheduled for May 2010. Two JOG review meetings per year monitor overall program management.

<u>Renewal/Recompetition/Termination</u>:

The LHC project is expected to continue at least through the end of the next decade. Since the present award extends to the end of calendar year 2011, it will require a renewal. The U.S. LHC collaboration is part of an international collaboration in which the U.S. contribution to the detector construction and operations is intimately connected to that of its international collaborators. Under these circumstances it would be difficult, if not unrealistic, to consider recompeting the U.S. role in the international collaboration when the present award ends.

Laser Interferometer Gravitational-Wave Observatory **$30,300,000** **+$1,800,000 / 6.3%**

Laser Interferometer Gravitational-Wave Observatory
(Dollars in Millions)

	FY 2009 Actual	FY 2009 ARRA Actual	FY 2010 Request	FY 2011 Request	Change over FY 2010 Request Amount	Change over FY 2010 Request Percent
Laser Interfer. Gravitational-Wave Observatory	$30.30	-	$28.50	$30.30	$1.80	6.3%

Einstein's theory of general relativity predicts that cataclysmic processes involving extremely dense objects in the universe will produce gravitational radiation. Detection of these gravitational waves is of great importance for both fundamental physics and astrophysics. The Laser Interferometer Gravitational-Wave Observatory (LIGO), the most sensitive gravitational-wave detector ever built, comprises two main facilities, one in Livingston Parish, LA and one in Hanford, WA. At each facility, a large vacuum chamber with two 4-km arms joined at right angles houses one or more optical interferometers; Hanford has a second 2-km interferometer in the same housing. The interferometers are used to measure minute changes in the distances between test masses at the ends of the arms caused by a passing gravitational wave. The predicted distortion of space caused by a gravitational wave from a likely type of source is on the order of one part in 10^{21}, meaning that the expected change in the apparent 4-km length is only on the order of 4×10^{-18} or about 1/1000th the diameter of a proton. The 4-km length for LIGO, the largest for any optical interferometer, was chosen to make the expected signal as large as possible within terrestrial constraints. Looking for coincident signals in all the interferometers simultaneously increases the likelihood for gravitational wave detection.

LIGO's current and projected operations and maintenance requests for FY 2009 – FY 2013 are less than the funding levels during the previous cooperative agreement for FY 2002 – FY 2008, since some employees and resources are being diverted to the Advanced LIGO (AdvLIGO) project funded through the Major Research Equipment and Facilities Construction (MREFC) account. LIGO operations will, however, continue to analyze data taken during the current and earlier runs and will also plan for, conduct, and analyze scientific runs from FY 2009 until a temporary shutdown of the detectors in FY 2011. LIGO operations will also include research and development for AdvLIGO during this period.

Total Obligations for LIGO
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$30.30	$28.50	$30.30	$30.40	$30.50	$36.00	$39.00	$39.00

LIGO has been a significant source of highly trained Ph.D. graduates for the country's workforce. The number of graduate students has grown from the beginning of LIGO's science runs in FY 2002 and will continue to do so. In addition, LIGO has a diverse set of educational activities at its different sites, activities that involve a large number of undergraduates (including those from minority-serving institutions), hands-on activities for K-12 classes and teachers at all levels, and informal education and outreach activities for the public. A visitors' center at the Livingston site, dedicated in November 2006, houses Exploratorium exhibits and is the focal point for augmenting teacher education at Southern University and other student-teacher activities state-wide through the Louisiana Systemic Initiative program, originally funded by NSF.

LIGO Laboratories at Livingston LA (upper) and Hanford WA (lower). *Credit: LIGO Laboratory.*

Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in LIGO projects with some leading to new products. Interactions with industry include exploring novel techniques for fabrication of LIGO's vacuum system, seismic isolation techniques, ultrastable laser development (new product), development of new ultra-fine optics polishing techniques, and optical inspection equipment (new product). LIGO has recently cooperated with the Defense Intelligence Agency on research investigating the use of LIGO interferometers as impulse seismic event detectors.

In 1997 LIGO founded the LIGO Scientific Collaboration (LSC), an open collaboration that organizes the major international groups doing research supportive of LIGO. The LSC now has more than 60 collaborating institutions with more than 740 participating scientists and LSC membership is growing at a rate of approximately 10 percent per year. A Memorandum of Understanding between the LIGO Laboratory and each institution determines the role and membership responsibilities of each participating institution. The LSC plays a major role in many aspects of the LIGO effort including: R&D for detector improvements, R&D for AdvLIGO, data analysis and validation of scientific results, and setting priorities for instrumental improvements at the LIGO facilities. Annual NSF support for science and engineering research directly related to LIGO activities through ongoing research and education programs is about $5.50 million.

LIGO concluded its mission-defining scientific run (S5), in which a year's accumulation of data was taken at its design sensitivity with all three interferometers operating in coincidence, in October 2007. These data were taken at a detector sensitivity in excess of the defined goal sensitivity outlined in the design specifications. The S6 Science run, which is testing technologies that will become part of AdvLIGO, began in July 2009. The detector sensitivity is higher than that during the previous S5 run, making the S6 science run a valuable testbed for AdvLIGO.

LIGO's operations during the AdvLIGO construction era will concentrate on:

- Planning for and operation of "enhanced" LIGO and the corresponding S6 science run at a sensitivity about twice that of initial LIGO in FY 2009 – FY 2011;
- Research and development to reduce risk for the AdvLIGO project, to enhance performance post-construction and to enable future enhancements;
- Data analysis and other science activities by staff of the LIGO Laboratory
- Education and outreach activities;
- Ramp-up of AdvLIGO commissioning activities.

For more information on AdvLIGO, see the MREFC chapter.

Facility Report:

Management and Oversight:

- NSF Structure: NSF oversight is coordinated internally by the LIGO program director in the Division of Physics (PHY), who also participates in the PHY AdvLIGO Project Advisory Team, comprising staff from the NSF Offices of General Counsel, Legislative and Public Affairs, International Science and Engineering , as well as the the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management,. .

- External Structure: LIGO is managed by the California Institute of Technology under a cooperative agreement. The management plan specifies significant involvement by the user community, represented by the LIGO Scientific Collaboration (LSC), and collaboration with the other major gravitational-wave detector activities in Asia, Europe, and Australia. External peer-review committees organized by NSF help provide oversight through an annual review.

- Reviews:
  - AdvLIGO Baseline Review, May-June 2006;
  - LIGO Annual Review, November 2006;
  - AdvLIGO Baseline Update Review, June 2007;
  - LIGO Annual Review and LIGO FY 2009-2013 Operations Proposal Review, November 2007;
  - LIGO Annual Review, November 2008;
  - AdvLIGO Annual Review, April 2009;
  - LIGO Annual Review and AdvLIGO Interim Review, December 2009;
  - AdvLIGO Annual Review, April 2010;
  - LIGO Annual Review and AdvLIGO Interim Review, November 2010; and
  - AdvLIGO Annual Review, April 2011.

Renewal/Recompetition/Termination:

LIGO began operating under a new five-year cooperative agreement at the beginning of FY 2009. As a condition of approval of this award (and a possible future award), the National Science Board stipulated that the operation of LIGO be recompeted no later than 2018. The projected lifetime of the LIGO facility is 20 years.

National Astronomy and Ionosphere Center **$9,000,000**
-$1,600,000/ - 15.1%

National Astronomy and Ionosphere Center
(Dollars in Millions)

	FY 2009 Omnibus Actual[1]	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
National Astronomy and Ionosphere Center	$9.60	$3.10	$10.60	$9.00	-$1.60	-15.1%

[1]A planned FY 2009 contribution of $2.10 million from AGS (formerly ATM) was obligated in FY 2008.

The National Astronomy and Ionosphere Center (NAIC) is a national research center focusing on radio and radar astronomy and atmospheric sciences. The center's principal observing facility is the world's largest single-dish radio/radar telescope, a 305-meter diameter reflector in western Puerto Rico. Located near the town of Arecibo on 120 acres of U.S. Government-owned land, the facility is known as Arecibo Observatory. NAIC is currently operated and managed by Cornell University under a cooperative agreement with NSF. NAIC provides telescope users with a wide range of research and observing instrumentation and serves over 400 users annually.

NAIC has a staff of about 120 full-time-equivalent positions, including those who support the Angel Ramos Visitor Center and Learning Center. A permanent staff of 17 scientists and 34 engineers/ technicians are available to help visiting investigators with their observation programs. The remainder includes 26 management, administrative and clerical positions, 37 maintenance staff, and several postdoctoral scholars and graduate students.

Total Obligations for NAIC
(Dollars in Millions)

	FY 2009 Actual[1]	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$9.60	$10.60	$9.00	$8.70	$8.30	$8.00	$8.00	$8.20
Astronomical Sciences (MPS)	*9.60*	*8.40*	*6.00*	*5.50*	*5.00*	*4.50*	*4.00*	*4.10*
Atmospheric & Geospace Sciences (GEO)	-	*2.20*	*3.00*	*3.20*	*3.30*	*3.50*	*4.00*	*4.10*
ARRA Actual (MPS)	3.10	-	-	-	-	-	-	-
Total, NAIC	**$12.70**	**$10.60**	**$9.00**	**$8.70**	**$8.30**	**$8.00**	**$8.00**	**$8.20**

Totals may not add due to rounding.
[1]A planned FY 2009 contribution of $2.10 million from AGS (formerly ATM) was obligated in FY 2008.

NAIC is jointly supported by the Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS) and the Division of Atmospheric and Geospace Sciences (AGS) in the Directorate for Geosciences (GEO). The AST Senior Review recommended an emphasis on observations in support of large astronomical surveys and a reduction in funding through AST to $8.0 million (FY 2006 dollars) for NAIC by 2010. In response, the managing organization, Cornell University, has modified the operating mode for astronomy observations and limited the observing time for astronomy projects. These changes also resulted in a reduction in force of 30 FTEs in FY 2007. In addition, availability of the S-band planetary radar system was reduced in FY 2008. The FY 2010 Budget Request reflected the planned ramp-down to meet the Senior Review recommendations. As AST ramps down support for NAIC in response to the Senior Review, in FY 2011 and beyond AGS funding will contribute substantively to general operations. In the past, AGS funding has primarily supported a research staff in the space and atmospheric sciences program and contributed only incrementally for basic operations costs.

The AST Senior Review also recommended that sufficient external financial or personnel contributions be found to operate NAIC with competitive scientific productivity after 2011 with an AST contribution not to exceed half of the expected costs, estimated in FY 2006 at $8.0 million. AST support for FY 2011–2015 is based upon the Senior Review recommendations, guidance from a third-party cost review of AST facilities, and a third-party estimate of NAIC's non-scientific costs.

Partnerships and Other Funding Sources: NAIC leverages NSF support with funding from other federal and non-federal sources. In FY 2008 – FY 2010, NAIC received $942,000 from the Defense University Research Instrumentation program at the Air Force Office of Scientific Research (AFOSR/DURIP) and the Office of Naval Research (ONR), and approximately $100,000 from other non-federal and private sources. In FY 2009 Cornell contracted for $2.35 million with the Puerto Rico Department of Education to provide student enhancement and teacher professional development programs at Arecibo through the site's Angel Ramos Visitor Center and Learning Center. In FY 2010, Cornell finalized an assistance agreement with the Puerto Rico Infrastructure Financing Authority to receive $3.0 million in support of major infrastructure improvements at Arecibo Observatory.

An image of the Arecibo Radio Telescope in Puerto Rico. The gregorian dome, which houses the main suite of research instruments, and its suspension structure are visible over the main reflector below. *Credit: Arecibo Observatory/NSF.*

A peer-review telescope allocation committee provides merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of Arecibo. Many users are supported through NSF or NASA grants to pursue scientific programs that require use of NAIC.

Education and Public Outreach: NAIC's primary education goal is to support and enhance the experiences of student researchers. Arecibo hosts a Research Experiences for Undergraduates (REU) site, and Ph.D. students receive training through use of the facility. In collaboration with the National Radio Astronomy Observatory, NAIC holds a summer school on single-dish radio astronomy techniques. NAIC also sponsors a major outreach program in Puerto Rico via the modern Angel Ramos Visitor Center and Learning Center, as well as summer workshops for K-12 teachers. The Angel Ramos Visitor Center attracts roughly 100,000 visitors each year, and with funds from the Puerto Rico Department of Education, NAIC has hosted up to 40,000 school children each year for science enrichment programs.

Operations and Maintenance, $9.0 million ($1.60 million below the FY 2010 Estimate of $10.60 million): NAIC administers observing time to the astronomy and aeronomy communities via competitive observing proposals and conducts educational and public outreach programs at all levels. Observing hours among science programs are based on the quality of observing proposals; the current average oversubscription rate of the telescope is approximately three to four. This metric accounts for the number of current astronomical surveys requesting time for a given area of sky, plus the time request in the program year for small radio astronomy projects, solar system observations, and atmospheric sciences programs.

- Division of Astronomical Sciences, $6.0 million ($2.40 million below the FY 2010 Estimate of $8.40 million): AST funds basic operations costs and science programs in passive radio astronomy and solar system radar astronomy. Radio astronomers and planetary scientists use the Arecibo facility to study diverse areas such as interstellar gas, galactic structure formation and evolution, pulsars and fundamental physics, the dynamic variations in Earth's ionosphere, and topics in solar system astronomy, such as the physical properties of asteroids, planetary surfaces and moons and the post-discovery characterization and orbital refinement of near-Earth asteroids. Funding for the Astronomy program decreases by $2.40 million from FY 2010 to FY 2011, following the recommendations of the AST Senior Review. Operational scope changes are anticipated in response to decreased AST funding, pending merit review of proposals received in response to an open competition for the next five-year award for NAIC management and operation.

- Division of Atmospheric and Geospace Sciences, $3.0 million (+$800,000 over FY 2010 Estimate of $2.20 million): AGS primarily funds a research staff in the space and atmospheric sciences program and has historically contributed only incrementally for basic operations costs. As stated above, in FY 2011 and beyond, AGS funding will contribute substantively to general operations.

- Approximately 60 percent of the astronomy observing time is dedicated to ongoing survey programs, most of which utilize the Arecibo L-band Feed Array (ALFA) receiver that was commissioned in 2005–2006. The installation and commissioning of new, wide-band spectrometers in FY 2008 allows up to three survey programs to be conducted simultaneously on each sky pointing, a capability unique to Arecibo Observatory. About 75 percent of astronomy users conduct their observing programs remotely via networked control software, while radar observations typically employ on-site users.

Facility Report:

<u>Management and Oversight:</u>

- NSF Structure: Ongoing oversight is provided by an assigned NSF program director in AST, in close cooperation with AGS and in consultation with community representatives. The program director makes use of detailed annual program plans, long range plans, quarterly technical and financial reports, and annual reports submitted to NSF by Cornell, as well as attending Cornell governance committee meetings as appropriate. To address issues as they arise, AST program managers work closely with other offices at NSF, particularly the Division of Acquisition and Cooperative Support, the Office of General Counsel, and the Large Facilities Project Office. The NSF program director and AGS program manager conduct periodic site visits.

- External Structure: Management is via a cooperative agreement with Cornell University. Cornell provides management and oversight through its own advisory and visiting committees. The NAIC Director is resident at Cornell and reports to the Vice Provost for Research in Physical Sciences and Engineering. The Arecibo Observatory Site Director reports to the NAIC Director.

- Reviews: Management reviews by external review panels are held midway into each 5-year cooperative agreement. The last management review was held in March 2007; a follow up assessment of Cornell's response to the AST Senior Review recommendations was completed in March 2008. NAIC underwent an NSF Business Systems Review in FY 2005. AST and AGS jointly conduct annual external reviews of NAIC program plans; the most recent review was held in November 2009. Future annual reviews will continue after review and recommendation of proposals received in response to the new management competition (see below).

Renewal/Recompetition/Termination:

The current cooperative agreement with Cornell for the management of Arecibo is in effect through September 30, 2010. Consistent with National Science Board policy, NSF will solicit proposals for a new, five-year cooperative agreement for the management and operation of NAIC through a competitive process. The program solicitation is under development with publication anticipated in the first quarter of calendar year 2010.

The Astronomy Senior Review report recommended that sufficient external financial or personnel contributions be found to operate NAIC with competitive scientific productivity after 2011, with an AST contribution not to exceed half of the expected operational costs. In response, AGS has increased support in FY 2011 and beyond, including support for general operations.

The program solicitation for the management and operation of NAIC will identify five-year budget guidance at a significantly reduced level relative to current operations. To sustain NAIC as a competitive scientific and educational facility that is responsive to its stakeholders in the scientific community and the Commonwealth of Puerto Rico, potential managing organizations will be encouraged to consider novel models of operations and governance, revisions to programmatic scope, and/or sources of additional funding.

NSF will decertify NAIC as a Federally Funded Research and Development Center (FFRDC) upon award of the next cooperative agreement for its management and operation. The decision to remove NAIC from the list of FFRDCs was made after careful consideration of the advantages and disadvantages this designation carries with it. Without restrictions imposed by the FFRDC designation, the NAIC managing organization will have greater freedom to establish partnerships beyond those permitted by government regulations applicable to FFRDCs.

National High Magnetic Field Laboratory $34,000,000

-$1,560,000 / -4.4%

National High Magnetic Field Laboratory
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
National High Magnetic Field Laboratory	$26.50	$5.00	$35.56	$34.00	-$1.56	-4.4%

The National High Magnetic Field Laboratory (NHMFL) is operated by Florida State University (FSU), the University of Florida (UF), and Los Alamos National Laboratory (LANL). The NHMFL develops and operates high magnetic field facilities that scientists and engineers use for research in physics, biology, bioengineering, chemistry, geochemistry, biochemistry, materials science, medicine, and engineering. It is the world's premier high magnetic field laboratory with a comprehensive assortment of high-performing magnet systems. Many of the unique magnet systems were designed, developed, and built by the magnet engineering and design team at the NHMFL in collaboration with industry. The facilities are available to all qualified scientists and engineers through a peer-reviewed proposal process. A FY 2009 ARRA award ($15.0 million) made in the first quarter of FY 2010 will enable the NHMFL to develop and build a world-record-holding advanced mass spectrometer capable of analyzing chemical samples of unprecedented complexity, such as biological fluids and biofuels, and with unprecedented speed. This new capability will have high impact in several areas including molecular biology and heavy petroleum analysis.

Total Obligations for NHMFL
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$26.50	$35.56	$34.00	$34.00	$37.50	$38.50	$39.50	$40.50
ARRA	5.00	15.00		-	-	-	-	-
Total, NHMFL	**$31.50**	**$50.56**	**$34.00**	**$34.00**	**$37.50**	**$38.50**	**$39.50**	**$40.50**

Totals may not add due to rounding.
[1] Outyear funding estimates are for planning purposes only and do not reflect policy decisions.

The FY 2010 includes a one-time award of $2.56 million for development of a magnet purchased with ARRA funds during the first quarter of FY 2010. Thus, the FY 2011 Request appears to be a decrease, but is actually an increase of $1.0 million with respect to the base NHMFL funding. This base increase will allow the facility to strengthen user support and in-house research, education, and training. Funding will allow completion of the planned split-magnet development, meet operations needs, such as electricity and cryogenics cost increases, and support technical staff, education, and training efforts.

The principal scientific goals of NHMFL are to provide the highest magnetic fields, state-of-the-art instrumentation, and support services for scientific research conducted by users from a range of science and engineering disciplines. In addition, the lab is an internationally recognized leader in magnet design, development, and construction. The Magnet Science and Technology (MS&T) Division of NHMFL has broad responsibility to develop high field magnets, as well as conducting and superconducting materials for future generation magnet wires in response to national needs. MS&T works with industry and other international magnet laboratories on a variety of technology projects. These include analysis, design, component development and testing, coil fabrication, cryogenics, system integration, and testing.

Current magnet development at NHMFL is focusing on design and construction of new energy-saving, high-field magnet technologies, including the design and construction of new, all-superconducting magnets based on high-temperature superconductor technology, and high field magnets for the Spallation Neutron Source at Oak Ridge National Laboratory, the nation's premier neutron facility. The NHMFL has collaborated with more than 60 private sector companies, including Cryomagnetics, Pfizer, and Oxford Superconductor Technologies, and national laboratories and federal centers, including those supported by the Department of Energy (DOE) such as the Spallation Neutron Source and the Advanced Photon Source. International collaboration includes magnet development with the Hahn-Meitner Institute in Berlin, the International Thermonuclear Experimental Reactor (ITER) in Switzerland, and the Korea Basic Science Institute.

NHMFL provides a unique interdisciplinary learning environment. Its annual K-12 outreach engages more than 7,000 students from Florida and Georgia in hands-on activities and tours of the lab. In addition, NHMFL conducts a College Outreach-Workforce Initiative program to increase diversity in lab programs. This has included outreach to approximately 200 undergraduates at historically-black colleges and universities. NHMFL hosts an annual one-day open house as well as tours in which about 10,000 college and pre-college students participate each year.

Facility Report:

<u>Management and Oversight:</u>

- NSF Structure: NHMFL is supported by the Division of Materials Research (DMR) and the Division of Chemistry (CHE) in the Directorate for Mathematical and Physical Sciences (MPS). Primary responsibility for NSF oversight is with the national facilities program director in DMR, with guidance from an ad hoc working group with members from CHE and the Directorates for Engineering and Biological Sciences. Site visit reviews are conducted annually. Representatives from other federal agencies such as DOE and the National Institutes of Health (NIH) are invited to observe.

- External Structure: A consortium of the three universities (FSU, UF, and LANL) operates the NHMFL under a cooperative agreement. FSU, as the signatory of the agreement, has the responsibility for appropriate administrative and financial oversight and for ensuring that operations of the laboratory are of high quality and consistent with the objectives of the cooperative agreement. The principal investigator serves as the NHMFL director. Four senior faculty members are co-principal investigators. The NHMFL director receives guidance and recommendations from an external advisory committee, the NHMFL executive committee, NHMFL science council, the NHMFL diversity committee, participating institutions, and the users' executive committee.

- Reviews: NSF conducts annual external reviews, which assess user programs; in-house research; long-term plans to contribute significant research developments both nationally and internationally; and operations, maintenance, and new facility development. Annual reviews also assess the status of education training and outreach, operations and management efficiency, and diversity plans. Recent reviews include:

  - Renewal Review, January 9-11, 2007;
  - Annual Review by external panel, December 2008;
  - Business System Review, conducted spring 2009;

- Annual Review by external panel, conducted October 2009;
- Mid-Term Review by NSF program directors planned Spring 2010; and
- Annual Review by external review planned October 2010.

Renewal/Recompetition/Termination:

A comprehensive renewal review was conducted in FY 2007. On August 8, 2007 the National Science Board approved NSF's recommendation for a five-year renewal award not to exceed $162.0 million for FY 2008-2012. This award allows NHMFL to increase its user program, continue development of new magnet systems, and support the strongest aspects of its in-house research efforts. The award ensures that the laboratory will remain the international leader in magnet research operations and development. NSF is currently examining options to recompete or renew the award in FY 2012.

National Solar Observatory **$9,510,000**
+$410,000 / 4.5 %

National Solar Observatory
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
National Solar Observatory	$7.83	$1.40	$9.10	$9.51	$0.41	4.5%

The National Solar Observatory (NSO) operates facilities in New Mexico and Arizona as well as a coordinated worldwide network of six telescopes specifically designed to study solar oscillations. NSO leads the community in design and development of the Advanced Technology Solar Telescope (ATST). (More information on this project may be found in the Major Research Equipment and Facilities Construction chapter). NSO makes available to qualified scientists the world's largest collection of optical and infrared solar telescopes and auxiliary instrumentation for observation of the solar photosphere, chromosphere, and corona. NSO provides routine, synoptic solar data used by many researchers and other agencies through its online archive and data delivery system.

NSO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals. They serve over 1,000 scientists annually. In FY 2009, NSO employed approximately 17 support scientists, 29 technical staff and 43 other personnel within the operating budget. In FY 2010, NSO will reduce staff by approximately three FTEs.

Total Obligations for NSO
(Dollars in Millions)

	FY 2009 Omnibus Actual	2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
NSO-Operations	$6.75	$1.40	$7.25	$7.58	$7.81	$8.02	$8.26	$8.51	$8.77
NSO-Development	0.78	-	1.50	1.57	1.61	1.67	1.72	1.75	1.80
NSO-Research & Ed.	0.30	-	0.35	0.36	0.37	0.40	0.41	0.45	0.46
ATST infrastructure	-	-	-	2.00	2.00	2.00	2.00	2.00	2.00
Total, NSO	**$7.83**	**$1.40**	**$9.10**	**$11.51**	**$11.79**	**$12.09**	**$12.39**	**$12.71**	**$13.03**

Totals may not add due to rounding.
[1] Funding levels displayed for FY 2012 through FY 2016 are planning estimates only.

Partnerships and Other Funding Sources: Thirty-four U.S. member institutions and seven international affiliate members comprise the Association of Universities for Research in Astronomy, Inc. (AURA), the management organization for NSO. Other partners include the U.S. Air Force Office of Scientific Research, U.S. Air Force Weather Agency, NASA, and industrial entities. Many universities and institutes collaborate with NSO on solar instrumentation development and on the design and development of ATST. Development of new telescopes, instrumentation, and sensor techniques is done in partnership with industry through subawards to aerospace, optical fabrication, and information technology companies. Observing time on NSO telescopes is assigned on the basis of merit-based review. No financial support accompanies telescope time allocation.

Education and Public Outreach: NSO supports U.S. education goals by promoting public understanding and support of science and by providing education and training at all levels. NSO introduces undergraduate students to scientific research by providing stimulating environments for basic astronomical research and related technologies through NSF's Research Experiences for Undergraduate students (REU) program. NSO has diverse education programs, including teacher training and curriculum development, visitor centers, and a web-based information portal at www.nso.edu. Starting in FY 2011 and continuing for ten years, $2.0 million will be funded for education and workforce development programs on Maui, Hawaii in partnership with Maui Community College. This program is part of the mitigation of the impacts of the ATST construction.

NSO-Operations, $7.58 million (+$330,000 above FY 2010 Estimate of $7.25 million): NSO Operations include facility operations at Sacramento Peak Observatory (SPO) in New Mexico, the world-wide Global Oscillations Network Group (GONG), and solar facilities based on Kitt Peak, Arizona. In FY 2009 this amount was reduced below the originally presented plan, partly due to separating out ATST funding. This reduction also required operational cuts, including freezing unfilled positions and postponing merit increases (FY 2009 ARRA funding was restricted to urgent repairs and upgrades that would reduce future operations and maintenance costs). Increasing support in FY 2010 and further in FY 2011 is intended to offset some of the impact of the reduced FY 2009 funding.

The SOLIS (Synoptic Optical Long-term Investigations of the Sun) facility for solar observations over a long time frame. *Credit: National Solar Observatory/NSF*

NSO-Development, $1.57 million (+$70,000 above FY 2010 Estimate of $1.50 million): In the FY 2009 estimate, this item included design and development of ATST, as well as development of new instrumentation for telescopes at KPNO and SPO. FY 2009 actual funding for ATST at $3.57 million has been separated out from the NSO base budget and is reported within the ATST narrative in the MREFC chapter. As discussed in the FY 2010 Request, NSO reporting now includes only work apart from ATST, notably for the SOLIS telescope (see picture). Small increases in FY 2011 and beyond will help maintain the scientific productivity of existing facilities as ATST enters construction and moves toward operations.

NSO-Research & Education, $360,000 (+$10,000 above FY 2010 Estimate of $350,000): NSO supports education of the public in solar physics through its education and public outreach office at SPO. This office provides science community outreach, a visitors' center, news and public information, and the activities on Maui in collaboration with Maui Community College.

ATST infrastructure, $2.00 million (+$2.00 million above FY 2010 Estimate of $0): NSO has agreed to mitigation activities related to ATST construction. The $2.0 million requested in FY 2011 is for education and workforce development programs on Maui in partnership with Maui Community College. Funding for these activities is not included in the MREFC construction project. This amount is therefore added over and above NSO's basic operations and maintenance support.

Facility Report:

Management and Oversight:

- NSF Structure: An NSF program director in the Division of Astronomical Sciences (AST) provides continuing oversight, including consultation with an annual NSF program review panel. The program director makes use of detailed annual program plans, annual long-range plans, quarterly technical and financial reports, and annual reports submitted by NSO as well as attending AURA Solar Observatory Council meetings. The latter committee is formed from the national solar physics community and provides a window into community priorities and concerns. The AST program manager works closely with other offices at NSF, particularly the Division of Acquisition and Cooperative Support, the Office of General Counsel, and the Large Facilities Project Office in the Office of Budget, Finance, and Award Management.

- External Structure: AURA is the managing organization for NSO. The NSO director reports to the president of AURA, who is the principal investigator on the FY 2010 NSF cooperative agreement. AURA receives management advice from its Solar Observatory Council, composed of members of its scientific and management communities. NSO employs visiting and users' committees for the purposes of self-evaluation and prioritization. The visiting committee, composed of nationally prominent individuals in science, management, and broadening participation, reviews for AURA all aspects of the management and operations of NSO. The users' committee, composed of scientists with considerable experience with the observatory, reviews for the Director all aspects of NSO that affect user experiences at the observatory.

- Reviews: In addition to reviews held mid-way through all cooperative agreements, NSF conducts both periodic and ad hoc reviews of AURA management, as needed, by external committees. The last extensive review for NSO was in FY 2008 which led to the award of a new and independent cooperative agreement, separate from the NOAO award, at the beginning of FY 2010. The last review of major NSO activities was conducted during the final design review of the ATST project in May 2009. Annual reviews are anticipated for both NSO program plans and the ATST project, beginning in summer 2010.

<u>Renewal/Recompetition/Termination:</u>

A management review of AURA's performance was carried out in August 2006. In response to the favorable review, the National Science Board extended the current cooperative agreement with AURA for eighteen months, through September 30, 2009. A proposal for renewal of the cooperative agreement was received from AURA in December 2007 and underwent review in 2008. The National Science Board authorized a new cooperative agreement with AURA for management and operation of NSO for the period October 1, 2009, through March 31, 2014.

National Superconducting Cyclotron Laboratory $21,500,000
+$500,000 / 2.4%

National Superconducting Cyclotron Laboratory
(Dollars in Millions)

	Fy 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
National Superconducting Cyclotron Laboratory	$20.50	$2.00	$21.00	$21.50	$0.50	2.4%

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University (MSU) is a national user facility. With two superconducting cyclotrons, K500 and K1200, it is the leading rare isotope research facility in the U.S. and is among the world leaders in heavy ion nuclear physics and nuclear physics with radioactive beams. Funding for NSCL also supports the MSU research program.

Total Obligations for NSCL
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations & Maintenance	$20.50	$21.00	$21.50	$21.50	$21.50	$23.50	$23.50	$23.50
ARRA Actual	2.00	-	-	-	-	-	-	-
Total, NSCL	**$22.50**	**$21.00**	**$21.50**	**$21.50**	**$21.50**	**$23.50**	**$23.50**	**$23.50**

Totals may not add due to rounding.

[1]The current cooperative agreement expires in FY 2011. Outyear funding estimates are for planning purposes only and do not reflect policy decisions.

NSCL scientists employ a range of tools for conducting advanced research in fundamental nuclear science, nuclear astrophysics, and accelerator physics. Applications of the research conducted at the NSCL benefit society in numerous areas, including new tools for radiation treatments of cancer patients and the assessment of health risks to astronauts. The K500 was the first cyclotron to use superconducting magnets, and the K1200 is the highest-energy continuous beam accelerator in the world. Through the recently completed Coupled Cyclotron Facility (CCF), heavy ions are accelerated by the K500 and then injected into the K1200, enabling the production of rare unstable isotopes at much higher intensities.

Scientists at NSCL work at the forefront of rare isotope research. They make and study atomic nuclei that cannot be found on Earth and perform experimental research using beams of unstable isotopes to extend our knowledge of new types of nuclei, many of which are important to an understanding of stellar processes. Research activities include a broad program in nuclear astrophysics studies, the studies of nuclei far from stability using radioactive ion beams, and studies of the nuclear equation of state. In addition, research is carried out in accelerator physics.

NSCL supports and enhances doctorate graduate education and post-doctoral research experiences. About 10 percent of all doctorates granted in nuclear physics in the U.S. are based on research at NSCL. Also, the site provides research experiences for undergraduate students and K-12 teachers.

NSCL occasionally enters into license agreements for cyclotron technology or nuclear electronics. An agreement with Accel Corporation exists for compact cyclotrons based on superconducting technology.

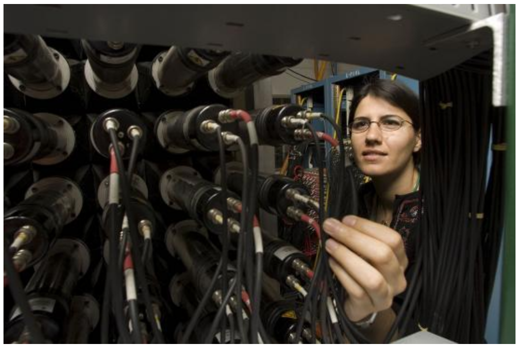
An experimental program using the coupled cyclotron facility is also underway. This effort is determined by beam use proposals. An external program advisory committee selects the best proposals at a typical success rate of about 50 percent. The science output of NSCL is driven by these experiments – many per year, with most running one to three days. The FY 2011 funding level is part of an overall five-year plan developed in response to recommendations from an external operations review committee in 2006. The committee recommended ramping up support such that NSCL runs at close to optimal operation, which is defined as the maximum amount of added beam time per extra dollar spent. FY 2011 marks the final year of the five-year plan and optimal operations will be achieved with the FY 2011 Request.

Facility Report:

Management and Oversight:

- NSF Structure: MSU operates NSCL under a cooperative agreement with NSF. The laboratory director is the key officer, who has the authority to appoint associate directors and designate responsibilities, notifying NSF of changes. NSF oversight is provided through annual site visits by the cognizant program officer of the Division of Physics and other staff, accompanied by external experts.

- External Structure: NSCL is managed by the laboratory director and four associate directors for research, education, operations, and new initiatives. NSCL's research program is guided by a program advisory committee of external experts as well as an in-house expert, and includes the chairperson of the full NSCL user group. The procedure for users includes writing and submitting proposals to the NSCL director and oral presentations. There are two opportunities for proposal submission each year. About 5,000 beam hours are provided for experiments each year, with a backlog of at least a year.



An NSCL research associate adjusts a cabling on a detector. *Credit: NSCL.*

- Reviews:
  - Latest Review: An annual review in FY 2009 covered results and achievements related to intellectual merit and broader impacts.
  - Next Review: An annual review is planned for February 2010. Review topics include science, operations, and future funding.

Renewal/Recompetition/Termination:

NSCL is funded through a cooperative agreement that was renewed in FY 2007 and will expire in FY 2011. NSF will address the appropriateness of recompetition for the facility as a part of the FY 2010 review. If it is determined that renewal is appropriate, NSF anticipates that MSU will submit a renewal proposal in FY 2011. Funding for FY 2012 and beyond will be determined by the outcome of the review process.

POLAR PROGRAMS

Polar Facilities And Logistics and the South Pole Station Modernization Project **$381,380,000 +$69,110,000 / 22.1%**

Polar Facilities and Logistics
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Polar Facilities[1]	$228.72	$15.50	$199.24	$266.66	$67.42	33.8%
Transfer to U.S. Coast Guard per P.L. 111-117	-	-	[54.00]	-	N/A	N/A
Polar Logistics	112.66	7.00	113.03	114.72	1.69	1.5%
Total, Polar Facilities and Logistics	**$341.38**	**$22.50**	**$312.27**	**$381.38**	**$69.11**	**22.1%**

Totals may not add due to rounding.

[1]Funding for Polar Facilities for FY 2010 excludes a one-time appropriation transfer to U.S. Coast Guard per P.L.111-117.

Polar Facilities:

The Office of Polar Programs (OPP) within NSF provides the infrastructure needed to support U.S. research conducted in Antarctica, including that funded by U.S. mission agencies, for year-round work at three U.S. stations, two research ships, and a variety of remote field camps. Examples of support to other agencies include mission essential satellite communications support at McMurdo Station for the National Polar-Orbiting Operational and Environmental Satellite System (NPOESS) and NASA's Ground Networks for the relay of data. In addition, OPP enables important climate monitoring activities for NOAA at the Clean Air Facility at South Pole Station, one of only five such sites around the globe, and OPP provides support for NASA's Long Duration Balloon program that enables research in fields ranging from astrophysics to cosmic radiation to solar astronomy.

All life support is provided by OPP, including transportation, facilities, communications, utilities (water and power), health and safety infrastructure, and environmental stewardship. The U.S. Antarctic Program (USAP) maintains the U.S. presence in Antarctica in accordance with U.S. policy, and supports Antarctic Treaty administration under State Department leadership.

Total Obligations for Polar Facilities
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Antarctic Infrastructure & Logistics	$175.20	$15.50	$199.24	$212.66	$216.70	$221.03	$225.46	$229.96	$234.56
South Pole Station Modernization Project	*15.76*	-	*15.93*	*16.15*	*16.46*	*16.79*	*17.12*	*17.47*	*17.82*
U.S. Coast Guard Icebreaker Support	53.52	-	[54.00]	54.00	54.00	54.00	54.00	54.00	54.00
Total, Polar Facilities	**$228.72**	**$15.50**	**$199.24**	**$266.66**	**$270.70**	**$275.03**	**$279.46**	**$283.96**	**$288.56**

Totals may not add due to rounding.

NOTE: Funding for the South Pole Station Modernization (SPSM) Project in this table is for the operation of the South Pole Station and is included in the amounts shown for Antarctic Infrastructure and Logistics. FY 2010 funding for U.S. Coast Guard Icebreaker Support excludes a one-time appropriation transfer of $54.0 million to USCG per P.L. 111-117.

OPP contracts with a prime contractor for science support, operations, and maintenance of the Antarctic stations and related infrastructure in New Zealand and Chile, and leasing of research vessels. The contractor is selected through a competitive bidding process. Rotary- and fixed-wing aircraft used in support of research are also provided through competitively awarded contracts. Other agencies and contractors provide technical support in areas of expertise such as engineering, construction, and communications.

Facility Report:

Management and Oversight:

- NSF Structure: OPP has overall responsibility for Polar Facilities. This line item also funds the operation and maintenance of the *Polar Sea* and the *Healy* in support of NSF science and, on a reimbursable basis, the needs of other federal agencies. The U.S. Coast Guard estimates that $54.0 million will be needed to fund operation and maintenance of the two vessels in FY 2011, which includes significant funding for a triennial dry dock for each vessel.

- External Structure: The current Antarctic support contract was recompeted and awarded to Raytheon Polar Services Company (RPSC) in FY 2000. There are many separate subcontractors for supplies and technical services.

- Reviews: OPP evaluates the performance of RPSC every year via a Performance Evaluation Committee and an Award Fee Board that includes representatives from OPP and the Office of Budget, Finance, and Award Management (BFA). In addition, OPP's performance is reviewed externally by Committees of Visitors and the OPP Advisory Committee.

Helicopters provide support to field parties in the McMurdo Dry Valleys in southern Victoria Land and at remote field camps. *Credit: Kristan Hutchison, RPSC.*

Current Status:

- All facilities (stations, research vessels, and field camps) are currently operating normally. The relatively poor condition of the USCG polar icebreaker *Polar Sea*, due to its age and the uncertainty regarding its future availability, prompted OPP and its Advisory Committee to identify and study options for reducing demands on the ship-based logistics system. OPP is implementing several projects as contingencies against a possible failure of that system.

Evolution:

U.S. policy directs NSF to maintain an active and influential presence in Antarctica, including year-round occupation of South Pole Station and two coastal stations. However, the research emphases at the three stations changes as the scientific forefronts addressed there evolve with time, as does the infrastructure needed to support it.

Recompetition:

NSF is currently engaged in an effort to recompete the Antarctic support contract. The most recent Antarctic support contract was recompeted and awarded to Raytheon Polar Services Company (RPSC) in FY 2000. After a five-month phase-in period, RPSC assumed responsibility for operations in March 2000. The contract's ten-year performance period is segregated into a five-year initial period and a five-year option period. NSF exercised its option to extend the performance period through March 31, 2010, and is in the process of extending the contract for an additional year. An award for the new support contract is expected to be made in FY 2011.

Polar Logistics:

Polar Logistics consists of two activities: the U.S. Antarctic Logistical Support program within the Division of Antarctic Infrastructure and Logistics, and the Research Support and Logistics program within the Arctic Sciences Division.

Total Obligations for Polar Logistics

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES				
					FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
U.S. Antarctic Logistical Support	$69.24	-	$67.52	$67.52	$67.52	$67.52	$67.52	$67.52	$67.52
Research Support and Logistics	43.42	7.00	45.51	47.20	48.10	49.06	50.04	51.04	52.06
Total, Polar Logistics	**$112.66**	**$7.00**	**$113.03**	**$114.72**	**$115.62**	**$116.58**	**$117.56**	**$118.56**	**$119.58**

Totals may not add due to rounding.

The U.S. Antarctic Logistical Support program funds support provided by the U.S. Department of Defense (DoD). The DoD operates as a primary logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations, maintenance, and facilities support of the 109th Airlift Wing (AW) of the New York Air National Guard in Scotia, New York, and Antarctica; transportation and training of military personnel supporting the U.S.

Antarctic Program; support for air traffic control, weather forecasting, and ground electronic equipment maintenance; the charter of Air Mobility Command airlift and Military Sealift Command ships for the re-supply of McMurdo Station; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of DoD satellites for communications.

The Research Support and Logistics program in the Arctic Sciences Division is driven by and responds to science supported by the division. Funding is provided directly to grantees or to key organizations that provide or manage Arctic research support and logistics. The current contract with CH2M HILL (previously, VECO USA) to provide research support and logistics services for NSF-sponsored activities in the Arctic was recompeted and awarded in January 2005. The contract has an initial term of four years and the possibility of three one-year extensions exercised on the basis of performance. Additional major support components include: access to U.S. Coast Guard and other icebreakers, University-National Oceanographic Laboratory (UNOLS) vessels and coastal boats; access to fixed- and rotary-wing airlift support; upgrades at Toolik Field Station, University of Alaska, Fairbanks' field station for ecological research on Alaska's North Slope; safety training for field researchers and funding for field safety experts; global satellite telephones for emergency response and improved logistics coordination; and development of a network of strategically placed U.S. Long-Term Ecological Research observatories linked to similar efforts in Europe and Canada.

Facility Report:

<u>Management and Oversight:</u>

- NSF Structure: OPP has overall responsibility for U.S. Antarctic Logistical Support and Arctic Research Support & Logistics. DoD operates as a primary logistical support provider on a cost-reimbursable basis. The agencies cooperate under a Memorandum of Agreement that includes guidance for planning and scheduling and sets forth the terms and conditions for reimbursement to DoD by NSF.

- External Structure: There are many separate subcontractors for supplies and technical services.

- Reviews: OPP's performance is externally reviewed by Committees of Visitors and the OPP Advisory Committee.

<u>Current Status:</u>

- All facilities (stations, research vessels, and field camps) are currently operating as normal.

<u>Renewal/Recompetition/Termination:</u>

U.S. policy directs NSF to maintain an active and influential presence in Antarctica, including year-round occupation of South Pole Station and two coastal stations. However, as discussed above, the research emphases at the three stations and at Arctic research sites change as the scientific forefronts addressed there evolve with time, as does the logistics support for these activities. Support contracts are recompeted as noted earlier.

South Pole Station Modernization (SPSM)

The SPSM project was funded through NSF's Major Research Equipment and Facilities Construction (MREFC) account, and supported procurement, construction, and commissioning. SPSM provides a new station to replace the previous U.S. station at the South Pole, built 30 years ago and inadequate in terms of capacity, efficiency, and safety. The new station is an elevated complex with two connected buildings, supporting 150 people in the summer and 50 people in the winter. The completed South Pole Station will provide a platform for the conduct of science at the South Pole and fulfills NSF's mandate to maintain a continuous U.S. presence at the South Pole in accordance with U.S. policy. FY 2008 represented the final year of MREFC appropriations for SPSM. Construction continues through FY 2010.

The prime contractor for the U.S. Antarctic Program is responsible for constructing the South Pole Station. In addition, there are many separate subcontractors for supplies and technical services.

NSF also supports education associated with the research projects at the South Pole. Along with direct operations and maintenance support for South Pole Station, NSF supports science and engineering research through ongoing programs. The annual support for such activities is currently estimated to be approximately $9.50 million.

Total Obligations for SPSM
(Dollars in Millions)

	Prior Years	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
R&RA Obligations									
Concept & Development	$16.40								
Management & Operations		15.76	15.93	16.15	16.46	16.79	17.12	17.47	17.82
Subtotal, R&RA Obligations	16.40	15.76	15.93	16.15	16.46	16.79	17.12	17.47	17.82
MREFC Obligations									
Implementation	147.23	1.10	0.96	-					
Subtotal, MREFC Obligations	147.23	1.10	0.96	-	-	-	-	-	-
Total, SPSM Obligations	**$163.63**	**$16.86**	**$16.89**	**$16.15**	**$16.46**	**$16.79**	**$17.12**	**$17.47**	**$17.82**

Totals may not add due to rounding.

NOTE: Funding for the operation of South Pole Station is provided through Antarctic Infrastructure and Logistics.

Project Report:

Management and Oversight:

- NSF Structure: OPP has overall responsibility for SPSM, including development of the basic requirements, design, procurement, and construction. The project status, including cost expenditures and cost projections, is monitored closely by the OPP Facilities Engineer and other OPP staff, and on a periodic basis by the project's Project Advisory Team, a group of experts drawn from all relevant NSF Directorates and Offices.

- External Structure: NSF has contracted for procurement and construction management for all phases of the project, including design reviews of all drawings and specifications; conformance of the designs and procurements with established standardization criteria; assistance in establishing functional interfaces; transition from the existing to the new facilities; and systems integration. Naval Facilities Engineering Command, Pacific Division (PACDIV) selects, monitors, and manages architectural and engineering firms for design, post-construction services, and construction inspection for the project.

The newly completed South Pole Station, January 2010.
Credit: Vladimir Papitashvili, NSF

- Reviews: Design, development, planning, and closely related activities in support of this project included preparation of more than 40 engineering studies and reports. The documents ranged widely in subject matter including subjects such as snowdrift minimization modeling, detailed analysis of power and heating requirements, preparation of a draft Environmental Impact Statement, energy conservation measures, efficiency and maintainability of diesel generators, fuel storage support system evaluation, design code criteria matrix, concept for signal/communication systems, gray-water system evaluation, minimization of ventilation requirements, control of diesel engine exhaust emissions, and jacking plan and concept.

  The OPP Facilities Engineer, other OPP and NSF staff, and subject matter experts attend quarterly reviews at the contractor's facility for the purpose of reviewing all aspects of the project including cost, schedule, and plans. In September 2006, an external panel of experts reviewed the scope, cost, schedule, and effectiveness of management processes to complete the final 10 percent of the project. As a result, the project's baseline was increased to $149.29 million. A review of the cost and schedule for the final year of the project is planned for early FY 2010.

<u>Current Project Status:</u>

- Tasking Completed in FY 2009:
  - Conditional Occupancy of the Logistics Facility and the Aircraft Fueling Module, the last major technical milestones

<u>Cost and Schedule:</u>

SPSM scope is approximately 96.5 percent complete, with the elevated station and all science facilities in full use. Project cost performance index (CPI) and schedule performance index (SPI) are presently ranked green, indicating variances are within 10 percent, and current forecasts show the project completing on schedule and within budget. Available contingency is approximately 4 percent of remaining costs

- Tasking Scheduled for FY 2010:
  - Complete Dome Demolition;
  - Retrograde Demolition Materials;
  - Install Logistics Facility Racks;
  - Complete Siding of the Elevated Station; and
  - Complete Punch List Items.

Risks:

Project performance could be affected if a full construction crew cannot be maintained for the remaining scope. Additional high impact risk elements to project completion include equipment failure, damaged materials, unforeseen downtime from power failures, inclement weather, and widespread illness – all of which have occurred to varying degrees. Risk management is ongoing and has produced multiple sets of back-up strategies to employ in the face of identified concerns.

Future Operations Costs:

Operational costs of the modernized station are expected to be higher than those of the previous station due to increased station size and increases in science support and information systems. A steady state of operational support is anticipated at $16.0 million, excluding inflation. The expected lifetime of the modernized station is 25 years, through FY 2031.

OTHER FACILITIES FUNDING

Major Research Equipment and Facilities Construction Account Projects

The MREFC account supports the acquisition, construction and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Projects supported by this account are intended to extend the boundaries of technology and open new avenues for discovery for the science and engineering community. Initial planning and design, and follow on operations and maintenance costs of the facilities are provided through the Research and Related Activities (R&RA) and Education and Human Resources (EHR) accounts.

For information on projects funded through this account, please see the MREFC chapter in this document.

Preconstruction Planning

Within the R&RA account, funds are provided for preconstruction planning activities for prospective large facility projects. The funding generally supports such activities as design, cost estimations, and other activities that prepare projects for oversight review and potential implementation. For FY 2011, these funds support next generation physics and astronomy facilities, including: an underground physics laboratory, high intensity synchrotron radiation x-ray sources; large aperture optical telescopes; fast, wide-field telescopes; and meter/centimeter wavelength radio telescopes.

FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS

GEOSCIENCES

National Center For Atmospheric Research

$108,000,000
$11,000,000 / 11.3%

National Center for Atmospheric Research
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
National Center for Atmospheric Research	$106.79	$13.20	$97.00	$108.00	$11.00	11.3%

The National Center for Atmospheric Research (NCAR) is a Federally Funded Research and Development Center (FFRDC) serving a broad research community, including atmospheric scientists and researchers in complementary areas of the environmental and geosciences. NCAR is managed under a cooperative agreement with NSF by the University Corporation for Atmospheric Research (UCAR), a university-governed and university-serving organization comprising 75 Ph.D. granting academic institutions.

The Mesa Laboratory, designed by architect I.M. Pei, in Boulder, CO. *Credit: NCAR.*

As of November 2009, there are a total of 783 FTEs in NCAR of which 354 are funded under the NSF primary award to UCAR.

Number of FTEs Supported at NCAR

FTEs	Primary Award[1]	All Funding
Career Scientists	95	135
Scientific Support[2]	235	519
Other Staff[3]	24	129
Total	**354**	**783**

[1]The primary award supports substantial facility infrastructure that does not include staff costs.
[2]Scientific Support includes Associate Scientists, Project Scientists, Post Docs, Software Engineers, Engineers, System Support and Technicians.
[3]Other Staff includes Administrative positions, Managers, Paid Visitors, Pilots and Mechanics.

NCAR provides facilities, including world-class supercomputing services, research aircraft, airborne and portable ground-based radar systems, atmospheric sounding, and other surface sensing systems for atmospheric research, to university, NCAR, and other atmospheric researchers. In addition, NCAR operates several facilities dedicated to the study of the Sun, solar phenomena, space weather, and the responses of the upper atmosphere to the sun's output. As an NSF sponsored facility, NCAR is committed to the dissemination of newly discovered knowledge in all the above areas.

Total Obligations for NCAR
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Aircraft Support[1]	$10.56	$10.70	$9.93	$10.23	$10.63	$11.06	$11.50	$11.96	$12.44
Computational Infrastructure[2]	21.17	2.50	22.00	24.25	25.22	26.22	27.27	28.36	29.50
Other Facility Support	27.55		23.42	26.88	27.95	29.06	30.23	31.43	32.69
Research & Education Support	47.51		41.65	46.64	48.50	50.44	52.46	54.56	56.74
Total, NCAR	**$106.79**	**$13.20**	**$97.00**	**$108.00**	**$112.30**	**$116.78**	**$121.46**	**$126.31**	**$131.37**

Totals may not add due to rounding.

[1]Includes about $150,000 for scientific research in areas such as biogeosciences and aerosols.

[2]Does not contain research funds

Partnerships and Other Funding Sources: NCAR leverages NSF support with funding provided by other federal agencies and non-federal sources. In FY 2009, NCAR received approximately $46.0 million in support from other federal agencies such as the National Oceanographic and Atmospheric Administration (NOAA) and the Office of Naval Research (ONR), and $26.0 million from non-federal sources, such as universities.

Major Investments in FY 2011: In FY 2011, investments at NCAR will focus on issues of societal importance in the areas of atmospheric chemistry, climate, including climate models, cloud physics, severe storms weather models, weather hazards to aviation, and interactions between the Sun and Earth. In all of these areas, NCAR scientists will work with their university colleagues to look closely at the role of humans in both creating climate change, responding to severe weather occurrences and to better understand the characteristics of the Sun and Sun-Earth connections. Example investments are an increased emphasis on preparing input for the next Intergovernmental Panel on Climate Change (IPCC) assessment and research into significantly enhancing our ability to understand and predict changes in hurricane intensity. In addition, UCAR will continue to invest NSF funds to refurbish NSF-owned infrastructure such as replacing the Mesa Lab access road and parking lot, which are beyond their designed life expectancy.

Aircraft Support: NCAR operates a C-130 and a Gulfstream-V (G-V, also known as the High Altitude Instrumented Airborne Platform for Experimental Research, or HIAPER), both of which are highly modified to enable the support of complex research measurements. The two aircraft will support several community-originated projects deemed by peer review to be of exceptional scientific merit. In 2011, aircraft support totals approximately $10.23 million.

Scheduled projects in FY 2010:

- The Bio-hydro-atmosphere interactions of Energy, Aerosols, Carbon, H2O, Organics & Nitrogen (BEACHON) program will study boundary layer evolution over the Manitou Experimental Forest in Woodland Park, Colorado. Two events will be targeted: a wet environment immediately following rainfall, and a drier period approximately one week after heavy rain. The principal investigators (PIs) plan to involve students from Colorado College and to conduct public outreach activities. The cost of this project is $78,000.
- Continued missions of the HIAPER Pole to Pole Observations (HIPPO) experiment, which measures cross sections of atmospheric concentrations of carbon cycle and greenhouse gases from the north to

the south polar areas four different times over a two year period. This experiment provides a comprehensive global survey of atmospheric trace gases covering the full troposphere in all seasons and multiple years. Conducted in Colorado, Alaska, Hawaii, American Samoa, New Zealand, Tahiti, Easter Island, and Costa Rica, HIPPO totals $2.96 million.

- The Inhibition of Snowfall by Pollution Aerosols (ISPA) project examines the link between riming of snow and aerosols. The study is centered around the Desert Research Institute's Storm Peak Laboratory (SPL) on Mt. Warner near Steamboat Springs, Colorado. SPL will operate a range of equipment (e.g., aerosol and cloud droplet samplers), while balloon-borne sounding systems will operate near the base of the mountain providing thermodynamic profiles through the clouds. Students will be involved in the project, and outreach activities are planned with local schools. The NCAR cost of ISPA is $200,000.
- The Profiling of Winter Storms (PLOWS) experiment is a study of the microphysical structures within banded features and their relation to mesoscale storm dynamics in mid-western snow storms. The goal of the proposed research is to improve our understanding of precipitation, thermodynamic, and kinematic sub-structures in the northwest and warm frontal quadrants of these storms. This project costs $2.22 million, which includes $1.55 million for C-130 operations.
- The HIAPER Equipment Flight Test for FY 2010 (HEFT-4) will provide extended flight testing of new research instruments on the G-V aircraft. The payload for HEFT-4 includes: HIAPER Atmospheric Radiation Package (HARP); Airborne Multi-AXis Differential Optical Absorption Spectroscopy (AMAX-DOAS) instrument; Laser Air Motion Sensor (LAMS); Holographic Detector for Clouds 2 (HOLODEC-2); Small Ice Detector, Version 2 (SID-2H); and the High Spectral Resolution Lidar (HSRL). Twenty-five flight hours are planned at a cost of $102,000.

Projects scheduled or under consideration for FY 2011:

- Genesis and Rapid Intensification Processes (GRIP) is a cost-recovery, NASA-funded field experiment to investigate tropical cyclones. NASA will use NCAR's Airborne Vertical Atmospheric Profiling System (AVAPS) GPS Dropsonde system on its DC-8 aircraft to study intensification of tropical cyclones in the western Atlantic, Caribbean, and Gulf of Mexico. The cost is $73,000.
- The Persistent Cold Air Pool Study (PCAPS) is designed to investigate the processes leading to the formation, maintenance, and destruction of persistent, multi-day, mid-winter temperature inversions or cold-air pools that form in the Salt Lake basin. This experiment will cost $534,000.
- The PRE-Depression Investigation of Cloud-systems in the Tropics (PREDICT) is a field experiment designed to improve our understanding of the dynamics of tropical cyclone formation and to dramatically improve the spatial and temporal sampling of tropical disturbances prior to, and during, genesis. The project will be located in St. Croix and totals about $3.0 million, including $1.76 million to support costs associated with HIAPER.
- The Western Airborne Mercury Observations (WAMO) experiment will measure gaseous elemental mercury (GEM) and reactive gaseous mercury (RGM) with high time (and spatial) resolution from the NSF/NCAR C-130. This experiment will cost $354,000.
- The HIAPER Equipment Flight Test for FY 2011 (HEFT-5) will test the performance of new research instruments on the G-V aircraft, specifically the HIAPER Cloud Radar (HCR) and the Time of Flight Aerosol Mass Spectrometer (ToF-AMS), and should cost approximately $100,000.

<u>Computational Infrastructure</u>: NCAR's computational facility is recognized as world-class. The latest addition to the facility, BlueFire, installed in November 2008, was ranked as the 43rd most powerful computer in the world by the top 500 Supercomputer Centers project.

Computational Infrastructure by Subcategory, FY 2011
(Dollars in Millions)

Operations Staff and Staff Related Costs	$11.19
IT and Facility Infrastructure, Utilities, Data Analysis, Mass Storage Equipment	5.40
Supercomputing Capital Equipment	4.25
Total	**$20.84**

BlueFire supports the Community Climate System Model (CCSM) which uses mathematical formulas to recreate the chemical and physical processes that drive Earth's climate, and was used by the Intergovernmental Panel on Climate Change (IPCC) to forecast future climate under a number of scenarios.

In FY 2011, NCAR will continue to oversee construction of a new computational facility. This activity is expected to receive $25.0 million in Research and Related Activities (R&RA) account funding in FY 2010, with $19.2 million and $6.0 million anticipated in 2011 and 2012 respectively. Although NCAR is overseeing the construction of this facility, construction funds are budgeted separately from NCAR's other activities and are not included in NCAR's budget. For this effort, NCAR is working with the University of Wyoming and other partners in the state. The Wyoming partners are providing the land, $20.0 million for the construction of the facility, and will also contribute $1.0 million annually toward the supercomputer and mass storage procurements. This 3-year effort would provide the physical infrastructure needed to expand NCAR's computational capability, and the building and computational resources are planned to be available to the community in FY 2012. Planning activities currently underway include a project development plan, an architectural and engineering study, an environmental assessment study, and a thorough external review of the proposed enhancement to NCAR facilities.

<ins>Other Facility Support</ins>: In addition to the C-130 and G-V, NCAR also provides support for a number of other atmospheric observing platforms through its Earth Observing Laboratory (EOL), including transportable Doppler radars, upper atmosphere observing capabilities, and other experimental systems. As well as the operation of a coronagraph as a community resource, NCAR also supports community models and other infrastructure facilities (see table below). These facilities are used by both NCAR and community researchers to undertake cutting edge research projects. Funding for other facilities at NCAR totals $26.88 million in FY 2011.

Other Facility Support by Subcategory, FY 2011
(Dollars in Millions)

Observing Platforms and Technology	
EOL Infrastructure (including Equipment)	$2.90
Field Proj. and Data Management	1.05
Design and Fabrication Services	1.24
CDS Systems Infrastructure	2.25
Dropsonde/Driftsonde	0.85
SPOL	1.08
Technology Developments	0.92
ISFS	1.43
ELDORA	0.53
ISS/GAUS	1.15
Subtotal, Observing Platforms and Technology	13.40
Community Models	
Community Climate System Model	$8.19
Weather Research and Forecasting model	2.00
Whole Atmosphere Community Climate Model	0.79
Subtotal, Community Models	10.98
Other Infrastructure	
Upper atmospheric observing facilities	$1.58
Chemistry instrumentation (ACD)	0.92
Subtotal, Other Infrastructure	2.50
Total, Other Facility Support	**$26.88**

Totals may not add due to rounding.

Research and Education Support: Funding for research and education support at NCAR totals $46.64 million in FY 2011. As an internationally recognized center of excellence, NCAR operates scientific research programs that include the following areas:

- studies of large-scale atmospheric and ocean dynamics that contribute to an understanding of the past and present climate processes and global climate change;
- global and regional atmospheric chemistry, including atmospheric connections to geochemical and biogeochemical cycles;
- the variable nature of the sun and the physics of the corona and their interaction with the Earth's magnetic field;
- the physics of clouds, thunderstorms, precipitation formation, and their interactions and effects on larger-scale weather; and
- the examination of human society's impact on and response to global environmental change.

Management at NCAR uses the NSF merit review criteria to allocate resources within NCAR. These allocations are subject to review and approval by the Division of Atmospheric and Geospace Sciences.

Research collaborations among NCAR staff and university colleagues are integral to its success as an institution, and serve as a focus and meeting point for the broader atmospheric and related sciences community. Further, NCAR works to develop new collaborations and partnerships with the private sector through directed research and technology transfer. These activities span improved capabilities for detecting, warning, and forecasting mesoscale weather phenomena of economic and social importance to the private and public sectors to longer term economic consideration of climate change issues. This research is performed in the Research Application Laboratory and currently receives $3.33 million in support.

Educational activities at NCAR are recognized as outstanding in their field, in particular the SOARS (Significant Opportunities in Atmospheric Research and Science) program is an undergraduate-to-graduate bridge program designed to broaden participation in the atmospheric and related sciences, which integrates research, education, and mentoring into an effective program.

In addition, NCAR further supports the scientific community by providing fellowships, internships, workshops, and colloquia for students and visiting scientists, and disseminates knowledge of the geosciences to the general public, K-12 schools, teachers and students, undergraduate and graduate institutions, postdoctoral and career scientists and researchers, as well as to policy and decision makers. Professional training courses, innovative and award-winning science education websites, as well as the directed activities of NCAR's Office of Education and Outreach are further examples of how NSF's goal of integrating research and education is attained through NCAR activities. Total support for education and outreach is $3.34 million, which includes the Advanced Study Program.

Facility Report:

Management and Oversight:

- NSF Structure: NSF's Division of Atmospheric and Geospace Sciences (AGS) along with the Division of Acquisitions and Cooperative Support (DACS), provide oversight of NCAR and the cooperative agreement with the University Corporation for Atmospheric Research (UCAR) for NCAR's management. The Cooperative Agreement between UCAR and NSF encourages interactions between NCAR scientists and AGS staff and ensures close coordination between AGS and NCAR management. The agreement contains requirements necessary for AGS's oversight of the NCAR program and UCAR management activities that affect NCAR. These include a requirement that UCAR submit an annual program plan for AGS approval that provides details on how resources will be used in that fiscal year. In addition, NCAR summarizes its past year's accomplishments in an annual scientific report. Annual strategic planning sessions between AGS, UCAR, and NCAR are held to ensure that scientific and facility priorities remain consistent with those of NSF. Previous COV reports offered positive and constructive comments on NSF's oversight of UCAR/NCAR. The most recent Committee of Visitors found that AGS's management of the NCAR program was "good to excellent."[1]

- External Structure: UCAR works in partnership with NSF and the university community to ensure the effective implementation of the strategic mission of NCAR to the benefit of the research community. In addition, other research sponsors such as the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the Department of Energy (DOE), the Department of Defense (DOD), the Environmental Protection Agency (EPA), and the Federal Aviation Administration (FAA) support research collaboration wherever it enhances NCAR's basic NSF-supported research goals or facilities missions.

[1] www.nsf.gov/geo/adgeo/advcomm/fy2009_cov/atm_ulafos_cov_report_2009.pdf

- Reviews:
    - Approximately mid-way through the current award (in FY 2012), AGS will conduct comprehensive reviews of science, facilities, and management.

Renewal/Recompetition/Termination Issues:

In May 2008, UCAR competed successfully for the management and operation of NCAR. The term of the award is for a period of 60 months, extensible for an additional 60 months subject to appropriate and successful review.

MATHEMATICAL AND PHYSICAL SCIENCES

National Optical Astronomy Observatory

$33,330,000
+$1,830,000 / 5.8%

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
National Optical Astronomy Observatory[1]	$30.48	$5.60	$31.50	$33.33	$1.83	5.8%

Totals may not add due to rounding.
[1] Includes the Telescope System Instrumentation Program (TSIP)

The National Optical Astronomy Observatory (NOAO) was established in 1982 by uniting operations of the Kitt Peak National Observatory (KPNO) in Arizona and the Cerro Tololo Inter-American Observatory (CTIO) in Chile. NOAO is a Federally Funded Research and Development Center (FFRDC) for research in ground-based, nighttime, optical, and infrared (OIR) astronomy. NOAO also is the gateway for the U.S. astronomical community to the International Gemini Observatory and to the "System" of federally-funded and non-federally-funded OIR telescopes through the Telescope System Instrumentation Program (TSIP) and the Renewing Small Telescopes for Astronomical Research (ReSTAR) program. For all NOAO and "System" telescopes, peer-review telescope allocation committees provide merit-based telescope time but no financial support. NOAO manages national community involvement in the development of potential future infrastructure projects such as the Giant Segmented Mirror Telescope (GSMT) and the Large Synoptic Survey Telescope (LSST), both of which are high priority recommendations of the 2000 Decadal Survey conducted by the National Research Council's Astronomy and Astrophysics Survey Committee.

NOAO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals. They serve nearly 1,000 scientists annually. In FY 2009, 85 thesis students and an additional 64 non-thesis graduate students used NOAO telescopes for their research. In FY 2010 NOAO employs nearly 360 personnel in Arizona and Chile, including 45 support scientists and 11 postdoctoral fellows.

Total Obligations for NOAO

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Plan	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
NOAO-Operations	$19.86	$5.60	$20.00	$20.33	$20.84	$21.36	$21.89	$22.44	$23.00
NOAO-Development	5.94	-	7.00	7.50	7.78	8.12	8.47	8.83	9.19
NOAO-Research & Ed.	0.68	-	0.50	0.50	0.55	0.57	0.59	0.61	0.65
TSIP[2]	4.00	-	4.00	5.00	5.00	5.00	5.00	5.00	5.00
Total, NOAO	**$30.48**	**$5.60**	**$31.50**	**$33.33**	**$34.17**	**$35.05**	**$35.95**	**$36.88**	**$37.84**

Totals may not add due to rounding.
[1]Funding levels displayed for FY 2012 through FY 2016 are planning estimates only.
[2]TSIP is the Telescope System Instrumentation Program.

Partnerships and Other Funding Sources: Thirty-four U.S. member institutions and six international affiliate members comprise the Association of Universities for Research in Astronomy, Inc. (AURA), the management organization for NOAO. Other partners include NASA and industrial entities. A large number of U.S. universities support their own astronomical facilities at KPNO and CTIO with reimbursed services provided by NOAO. Development of new telescopes, instrumentation, and sensor techniques is done in partnership with industry through subawards to aerospace, optical fabrication, and information technology companies. NOAO leverages NSF support with funding from other federal agencies and non-federal sources. In FY 2009, NOAO received about $5.11 million from partnerships, tenant observatory support, the Kitt Peak Visitors' Center, grants from other federal agencies, and NSF supplemental funding for GSMT, LSST, and ReSTAR. An additional $5.60 million of FY 2009 ARRA funds supported infrastructure improvements.

Education and Public Outreach: NOAO supports U.S. education goals by promoting public understanding and support of science and by providing education and training at all levels. Typically, a quarter of all doctorates awarded annually in astronomy in the U.S. involve use of NOAO facilities. The observatories introduce undergraduate students to scientific research by providing stimulating environments for basic astronomical research and related technologies through NSF's Research Experiences for Undergraduate Students (REU) program. NOAO has a diverse education program, visitor centers, and a web-based information portal at www.noao.edu.

The Cerro Tololo Inter-American Observatory 4-meter telescope dome. *Credit: M. Urzua Zuniga/Gemini Observatory.*

NOAO-Operations: $20.33 million (+$330,000 over FY 2010 Estimate of $20.0 million): NOAO-Operations cover the operation of facilities at KPNO, CTIO, and the headquarters, offices, laboratories and workshops in Tucson, Arizona and La Serena, Chile.. The majority of these funds will be used for the retention of key personnel.

NOAO-Development: $7.50 million (+$500,000 over FY 2010 Estimate of $7.0 million): Development support covers NOAO's share of the design and development of the LSST and the development of new instrumentation for telescopes at KPNO and CTIO. The Senior Review recommended that the instrumentation at KPNO and CTIO urgently be modernized. In FY 2010 NOAO began a multi-year effort to introduce new capabilities to the U.S. community. This investment in new instrumentation at KPNO, CTIO, and, perhaps, Gemini will continue with modest increases in this component. Design and development contributions to the LSST will also continue.

NOAO-Research & Education: $500,000 (equal to the FY 2010 Estimate): NOAO links the research conducted at its facilities to education of the public through its education and public outreach office in Tucson. Although this has historically been supported at a higher level, some programs are ending as planned, and other priorities currently preclude full exploitation of NOAO's many opportunities in the EPO area.

Telescope System Instrumentation Program (TSIP): $5.0 million (+$1.0 million over FY 2010 Estimate of $4.0 million): NOAO manages TSIP on behalf of NSF. This program supports the development and fabrication of instrumentation at non-federal observatories in return for competitively reviewed observing time for the national community. A recommendation of the 2000 Decadal Survey in astronomy, TSIP has proved extremely effective in gaining access for the Nation's community of researchers to non-federal observatories.. This program was funded at the $4.0 million level through FY 2010, and the FY 2011 request increases this to $5.0 million (roughly, 20 extra nights).

In FY 2009, $3.0 million was added to the NOAO budget for the award "Renewing Small Telescopes for Astronomical Research (ReSTAR)". The goal of this award is to improve the instrument capabilities and increase the availability to the community of telescope time on "small" non-federally-funded telescopes. In this context, "small" telescopes are from two to five meter size.

Facility Report:

<u>Management and Oversight:</u>

- NSF Structure: An NSF program director in the Division of Astronomical Sciences (AST) provides continuing oversight, including consultation with an annual NSF program review panel. The program director reviews detailed annual program plans, annual long range plans, quarterly technical and financial reports, and annual reports submitted by NOAO, and attends AURA governance committee meetings. Governance committees are formed from the national astronomical community and provide additional windows into community priorities and concerns. The AST program manager works closely with other offices at NSF, particularly the Office of General Counsel and the Division of Acquisition and Cooperative Support and the Large Facilities Project Office in the Office of Budget, Finance, and Award Management.

- External Structure: AURA is the managing organization for NOAO. The NOAO director reports to the president of AURA, who is the principal investigator on the FY 2010 NSF cooperative agreement. AURA receives management advice from an observatory council composed of members of its scientific and management communities. NOAO employs separate visiting and users committees for the purposes of self-evaluation and prioritization. The visiting committees, composed of nationally prominent individuals in science, management, and broadening participation, review for AURA all aspects of the management and operations of the observatories. The user committees, composed of scientists with considerable experience with the observatories, review for the NOAO Director all aspects of user experiences at the observatory.

- Reviews: In addition to reviews held mid-way through all cooperative agreements, NSF conducts both periodic and ad hoc external reviews of AURA management as.

<u>Renewal/Recompetition/Termination:</u>

A management review of AURA's performance was carried out in August 2006. In response to the favorable review, the National Science Board extended the previous cooperative agreement with AURA for eighteen months, through September 30, 2009. A proposal for renewal of the cooperative agreement was received from AURA in December 2007 and underwent review in 2008. The National Science Board authorized a new cooperative agreement with AURA for the management and operation of NOAO for the period October 1, 2009, through March 31, 2014.

National Radio Astronomy Observatory

$67,870,000
+$780,000 / 1.2%

National Radio Astronomy Observatory
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
National Radio Astronomy Observatory	$60.79	$5.40	$67.09	$67.87	$0.78	1.2%

The National Radio Astronomy Observatory (NRAO) provides state-of-the-art radio telescope facilities for scientific users. NRAO conceives, designs, builds, operates, and maintains radio telescopes used by scientists from around the world to study virtually all types of astronomical objects known, from planets and comets in our own Solar System to quasars and galaxies billions of light-years away.

The Very Large Array (VLA) telescope, located about 80 km west of Socorro, NM, is composed of 27 individual antennas arranged in a "Y" pattern. In their closest configuration (about 1 km wide), the VLA is able to image large portions of the sky. In its largest configuration (about 36 km wide) the VLA is able to home in on the fine details of astronomical objects. *Credit: Andrew Clegg, National Science Foundation.*

As a Federally Funded Research and Development Center (FFRDC), NRAO operates major radio telescopes in Green Bank, West Virginia, near Socorro, New Mexico, and at ten telescope array sites spanning the U.S. from the Virgin Islands to Hawaii. Headquartered in Charlottesville, Virginia, NRAO is the North American implementing organization for the international Atacama Large Millimeter Array (ALMA) project. These federally funded, ground-based observing facilities for radio astronomy are available to any qualified astronomer, regardless of affiliation or nationality, on the basis of scientific peer-reviewed proposals, and annually serve over 1,500 users worldwide. The Observatory allocates telescope time on the basis of merit but provides no financial support. NSF does not provide individual investigator awards targeted specifically for use of NRAO facilities. Many users are supported through NSF or NASA grants to pursue scientific programs that require use of the facilities.

NRAO staff includes 420 FTEs in the operations and maintenance component of the Observatory: 62 in Observatory Management, 316 in Observatory Operations, 28 in Science & Academic Affairs and Education and Public Outreach (EPO), and 14 in the Central Development Laboratory.

Total Obligations for NRAO

(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations & Maintenance	$43.60	$43.14	$43.24	$42.89	$44.33	$46.95	$49.25	$51.71
Observatory Management	*7.30*	*6.03*	*7.10*	*7.10*	*7.25*	*7.30*	*7.40*	*7.75*
Observatory Operations	*30.35*	*31.77*	*31.02*	*30.04*	*30.93*	*33.15*	*35.00*	*36.71*
Science, Academic Affairs, EPO	*4.26*	*3.62*	*3.62*	*4.25*	*4.40*	*4.50*	*4.60*	*4.75*
Central Development Lab	*1.69*	*1.72*	*1.50*	*1.50*	*1.75*	*2.00*	*2.25*	*2.50*
ARRA Actual	5.40	-						
Implementation of EVLA	6.19	6.38	1.13					
ALMA Operations	11.00	17.57	23.50	30.65	33.92	36.41	39.17	42.10
Total, NRAO	**$66.19**	**$67.09**	**$67.87**	**$73.54**	**$78.25**	**$83.36**	**$88.42**	**$93.81**

Totals may not add due to rounding.

[1]Funding levels under Operations and Maintenance in FY 2012 to FY 2016 are planning estimates only.

The major area of increased funding in FY 2011 is ALMA operations (+$5.93 million to $23.50 million). Base operations funding increased by $100,000 to $43.24 million. Funding for the implementation of the Expanded Very Large Array (EVLA), concludes in FY 2011 (decrease of $5.25 million to $1.13 million).

Partnerships and Other Funding Sources: NRAO supplements Division of Astronomical Sciences (AST) support with funding provided by other NSF sources, other federal agencies, and non-federal sources. In FY 2009, NRAO received approximately $1.0 million from non-AST sources at NSF, $250,000 from other federal agencies, and about $300,000 from U.S. universities, foreign scientific and technical institutes, and other non-federal and industrial sources. The development of new telescopes, instrumentation, and sensor techniques is completed in partnership with relevant industries through competitive subawards to various large and small aerospace companies, radio antenna manufacturing firms, and specialized electronics and computer hardware and software companies.

Education and Public Outreach: NRAO supports a comprehensive outreach program that makes information about radio astronomy available to the public (see www.nrao.edu/index.php/learn). NRAO facilities are also used by graduate students carrying out dissertation research and work experience programs and by undergraduate students participating in the Research Experiences for Undergraduates (REU) program, with over 150 students involved per year. NRAO sites also support visitor and education centers and conduct active educational and public outreach programs.

The Green Bank Science Center (now in full operation) and the redesigned visitor center at the Very Large Array (VLA) together attract about 68,000 public visitors each year.

Observatory Management, $7.10 million (+$1.07 million over FY 2010 Estimate of $6.03 million): Observatory Management includes the director's office, administrative services, the end-to-end data management initiative, and the New Initiatives Office. The FY 2010 Estimate is decreased due to a lower than anticipated outlay rate at the facility in FY 2009. The FY 2011 Request restores funding to the required obligation level.

Observatory Operations, $31.02 million ($750,000 decrease over FY 2010 Estimate of $31.77 million): The Observatory Operations programmatic area includes the support for operating facilities at Green Bank, West Virginia and in New Mexico, and the computer and information services that support the facilities. Decreased funding is part of the budget realignment plan to support ALMA operations.

Science & Academic Affairs and EPO, $3.62 million (equal to the FY 2010 Estimate): This area includes staff research, science training and education, science centers, the library, science community outreach, and news and public information. Funding is held constant to partially accommodate the ramp up in ALMA operations.

Central Development Laboratory (CDL), $1.50 million ($220,000 decrease below FY 2010 Estimate of $1.72 million): The CDL is developing next generation electronics and detectors for radio astronomy, making fundamental contributions to materials science, the physics of quantum detectors, electromagnetics, photonics, and radio propagation. Decreased funding is part of the budget realignment plan to support ALMA operations.

Implementation of EVLA, $1.13 million (-$5.25 million decrease below the FY 2010 Estimate of $6.38 million): FY 2011 funding includes a planned decrease as the construction phase ends. The Very Large Array (VLA) is undergoing an upgrade of electronics and communications systems, referred to as the Expanded Very Large Array (EVLA), to significantly enhance capabilities. Total project cost is $87.0 million. Construction of the EVLA began in FY 2001 and is proceeding on budget and on schedule according to original plans, for completion in calendar year 2012. The EVLA will provide a factor of ten improvement in capability in several areas over the VLA. More than half of the VLA antennas have been converted to EVLA standards and all remaining antennas will be retrofitted by the end of 2010. Canada is responsible for the correlator for processing EVLA data, and the first sections of the correlator arrived in the third quarter of 2008. Early scientific observations will begin in 2010, with full science operations by 2013. The transformation of the VLA into the EVLA has proceeded with little interruption to the regular VLA observing schedule.

ALMA Operations, $23.50 million (+$5.93 million over the FY 2010 Estimate of $17.57 million): NRAO is also engaged in construction of the international ALMA, which in FY 2011 will be entering the tenth year of its eleven year construction phase, funded through the Major Research Equipment and Facilities Construction (MREFC) account. Early operations funding for ALMA began in FY 2005 and ramps up sharply in FY 2008 to FY 2015. A funding profile through FY 2011 was authorized by the National Science Board in December 2007. The operations estimates for FY 2012 and beyond are based on current cost projections. Additional information on the ALMA project is available in the MREFC chapter.

In 2006 NRAO created the North American ALMA Science Center (NAASC) to support the broad user community in fully realizing the scientific capabilities of ALMA. The NAASC is ramping up its activity level in conjunction with the ramp up in ALMA operations. The NAASC serves two key functions: (1) supporting basic ALMA operations as an ALMA Regional Center (ARC), providing day-to-day support for ALMA operations carried out in Chile, and (2) providing easy access and strong support to the broad astronomical community that will be using ALMA. The NAASC organizes summer schools, workshops, and courses in the techniques of millimeter and submillimeter astronomy.

Facility Report:

Management and Oversight:

- NSF Structure: Continuing oversight and assessment is carried out in AST and in consultation with community representatives making use of detailed annual program plans, long-range plans, quarterly technical and financial reports, and annual reports submitted to NSF by NRAO, as well as by attendance at governance committee meetings of the managing organization, Associated Universities, Inc., (AUI). AST works closely with other NSF offices, such as the Office of General Counsel and the Division of Acquisition and Cooperative Support, and Large Facilities Project Office in Budget Finance and Award Management to address issues as they arise.

- External Structure: Management is through a cooperative agreement with AUI. AUI manages the observatory through its own community-based oversight and users' committees. The NRAO director reports to the president of AUI.
- Reviews: NSF conducts annual reviews of the NRAO Program Operating Plan, the Long Range Plan, and the AUI Management Report.

Renewal/Recompetition/Termination:

A new cooperative agreement is in place for the years FY 2010 through FY 2015.

NSF-WIDE INVESTMENTS

NATIONAL SCIENCE FOUNDATION CENTERS

NSF supports a variety of centers programs that contribute to the Foundation's mission and vision. Centers exploit opportunities in science, engineering, and technology in which the complexity of the research problem or the resources needed to solve the problem require the advantages of scope, scale, duration, equipment, facilities, and students. Centers are a principal means by which NSF fosters interdisciplinary research.

NSF Centers Funding

(Dollars in Millions)

	Program initiation	Number Centers 2009	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Centers for Analysis & Synthesis	1995	4	$17.41	-	$22.72	$23.25	$0.53	2.3%
Centers for Chemical Innovation	1998	12	15.50	-	24.00	28.00	$4.00	16.7%
Engineering Research Centers	1985	15	61.42	-	54.91	67.50	$12.59	22.9%
Materials Research Science & Engr. Centers	1994	31	60.84	-	56.70	63.00	$6.30	11.1%
Nanoscale Science & Engineering Centers	2001	19	46.97	-	46.26	40.20	-$6.06	-13.1%
Science & Technology Centers	1987	17	62.46	-	57.77	66.03	$8.26	14.3%
Science of Learning Centers	2003	6	12.51	-	25.80	25.80	-	-
Totals			**$277.11**	**-**	**$288.16**	**$313.78**	**$25.62**	**8.9%**

Totals may not add due to rounding.

CENTERS DESCRIPTIONS

Centers for Analysis and Synthesis (BIO)

The Centers for Analysis and Synthesis are designed to continue development of new tools and standards for management of biological information and meta-information, support data analysis capabilities with broad utility across the biological sciences, host workshops that bring together scientists from a variety of disciplines, and begin to host and curate databases. The centers have a critical role in organizing and synthesizing biological knowledge that is useful to researchers, policy makers, government agencies, educators, and society. In FY 2011, four Centers for Analysis and Synthesis are expected to be funded.

The National Center for Ecological Analysis and Synthesis (NCEAS) at the University of California at Santa Barbara promotes integrative studies of complex ecological questions and serves as a locus for the synthesis of large data sets. FY 2010 will be the final year of funding for NCEAS. Given the success of NCEAS in demonstrating the value of synthetic approaches in advancing ecology and the role of ecological synthesis in addressing societal issues, support will be provided in FY 2011 for a new environmental synthesis center to stimulate research, education, and outreach at the interface of the biological, geological, and social sciences. This new center will foster synthetic, collaborative, cross-disciplinary efforts to understand the complex interactions among ecological populations, communities and ecosystems, the geophysical environment, and human actions and decisions that underlie global environmental change.

The National Evolutionary Synthesis Center (NESCent) is a collaborative effort by Duke University, North Carolina State University, and the University of North Carolina at Chapel Hill to foster a greater conceptual synthesis in biological evolution by bringing together researchers and educators, extant data, and information technology resources. In 2009, a five year renewal award of approximately $5.0 million annually was made to NESCent, reflecting increased capacity of activities at the center over the next award period. NESCent will fund graduate students engaged in center activities, support activities to expand the conceptual reach of the center into targeted areas, and initiate a formalized, three-tiered assessment of the center that includes milestones for reporting on the impact of those activities.

The National Institute for Mathematical and Biological Synthesis (NIMBioS), located at the University of Tennessee-Knoxville, fosters cross-disciplinary approaches in mathematics and biology to address fundamental and applied biological questions, including national needs research in modeling of infectious diseases of plants and animals. The center will design education programs aimed at the mathematics-biology interface, thereby building the capacity of mathematically competent, biologically knowledgeable and computationally adept researchers needed to address the vast array of challenging questions in this century of biology. Although predominantly supported by BIO, MPS and the Department of Homeland Security also contribute. No major changes are planned for NIMBioS in FY 2011.

iPlant (formerly Plant Science Cyberinfrastructure Collaborative), led by the University of Arizona, uses new computer and information science, and cyberinfrastructure solutions to address an evolving array of grand challenges in the plant sciences. This center is a community-driven effort, involving plant biologists, computer and information scientists and engineers as well as experts from other disciplines, all working in integrated teams. A small increase is provided for iPlant in FY 2011 as part of the existing cooperative agreement for an annual increment.

Centers for Chemical Innovation (MPS)

The Centers for Chemical Innovation (CCI) are designed to support research on strategic, transformative “big questions” in basic chemical research. The program is stimulating the chemical sciences community to perform work that is high-risk and of potential high scientific and societal impact. CCIs promote the integration of research and education through the extensive involvement of students and postdoctoral fellows in all phases of the work. CCIs are expected to be agile, responding to scientific opportunities as they arise, and to creatively engage the public. Grand challenges include emulating and even surpassing the efficiency of the natural process of photosynthesis to capture the sun’s energy; activating strong bonds as a means to store and use chemical energy and to lower energy costs in chemical processing; and designing self-assembling, complex structures, such as molecular computers, with emergent and useful functions not yet known or foreseen.

The program is designed as a staged competition, supporting several Phase I centers, which then compete for the larger Phase II awards. The Phase II Center awarded in FY 2007 is developing chemistry needed to transform raw materials, such as plants, into high value organic compounds, such as fuels and chemicals for industry. The Phase II Center awarded in FY 2008 is researching the chemical fundamentals of solar energy capture and conversion to a chemical fuel.

In summer 2009, MPS engaged the Science and Technology Policy Institute (STPI) to assist in establishing a meaningful framework for effective programmatic evaluations in future years. MPS will use this opportunity to carefully consider the Phase I process, specifically whether this developmental grant is meeting objectives and providing a way for the MPS Division of Chemistry to develop a portfolio of research centers effectively targeting high-risk, high-reward science. Based on FY 2010 results, MPS, with STPI’s assistance, will revise and finalize the evaluation approach, and any requisite data collection templates to implement beginning in FY 2011.

In FY 2011, four new Phase I and one new Phase II awards are expected. This will bring the total support to $5.0 million for 12 Phase I centers and $23.0 million for six Phase II centers.

Engineering Research Centers (ENG)
NSF's Engineering Research Centers (ERCs) enable innovation, bridging the energy and intellectual curiosity of university research focused on discovery with real-world engineered systems and technology opportunities through partnerships with industry. These centers also are successful in educating a technology-enabled workforce with hands-on, real-world experience. These characteristics create an environment that catalyzes the development of marketable technologies to generate wealth and address engineering grand challenges, many of which intersect the National Academy of Engineering's Grand Challenges. This is particularly evident in ERCs that address the need for intelligent electric power grid systems to integrate the distribution of electricity from a range of variable sources including wind and solar, innovations in healthcare derived from tissue engineering and microelectronics research, sensing systems that improve the prediction of tornados, and intelligent robotic systems to assist the aging and disabled in daily tasks.

ERCs are also devoted to the integration of research and education by creating collaborative environments, and producing curricula and course materials for bioengineering, manufacturing, renewable resource use, optoelectronics, and other fields. Also, all ERCs have active programs that involve pre-college teachers and students to bring engineering concepts to the classroom to stimulate interest in engineering among pre-college students; several have sites at local museums to educate the general public about engineering and technology.

The ERCs face two renewal reviews, one in year three to determine if they are structured effectively to deliver on ERC program goals, and another in year six to determine if they are delivering effectively on those goals, making an impact, and contain challenging future tasks which warrant further support. The ERC program periodically commissions program-level evaluations by external evaluators such as SRI International, STPI, and ABT Associates, to determine the effectiveness of ERC graduates in industry and the benefits of ERC membership to industry and others.

In FY 2011, five additional ERCs are expected to be funded for a total of 18 ERCs. The new Gen-3 ERCs have added goals of speeding innovation through involvement with small firms in translational research and partnerships with state, local, and venture capital organizations devoted to innovations and entrepreneurship.

Materials Research Science and Engineering Centers (MPS)
Materials Research Science and Engineering Centers (MRSECs) address fundamental research problems of intellectual and strategic importance that will advance U.S. competitiveness and the development of future technologies. MRSECs also support shared experimental facilities, place strong emphasis on the integration of research and education at all levels, and provide seed money to stimulate emerging areas of materials research. They support cutting-edge areas such as electronic and photonic materials, polymers, biomimetic and biomolecular materials, magnetic and ferroelectric materials, nanoscale materials, structural materials, and organic systems and colloids. MRSECs have strong links to industry and other sectors, enabling the development of marketable technologies that depend on new classes of materials and the discovery, control, and innovative exploitation of materials phenomena. Areas of potential technological impact include computers and communications, transportation, energy conversion and storage, structural engineering, health, and medicine. MRSECs also foster partnerships among academic institutions in the U.S. as well as internationally. A significant component of new MRSEC awards are expected to tie to cross-Foundation activities, particularly Science and Engineering Beyond Moore's Law (SEBML).

Open competitions for MRSECs are held triennially. The FY 2008 competition yielded five new centers while four others are phasing out with final funding in FY 2009 and FY 2010. To maintain program effectiveness and be consistent with the 2007 report from the MRSEC Impact Assessment Committee convened by the National Research Council, the FY 2011 MRSEC competition will be structured to support small to large-size centers. In FY 2011, 25 MRSECs are expected to be funded, including four to six new centers established as a result of the FY 2011 competition.

Nanoscale Science and Engineering Centers (multi-directorate)
Nanotechnology, which addresses the smallest of scales, is projected to be one of the largest drivers of technological innovation for the next decade and beyond. This potential was recognized in the National Nanotechnology Initiative, particularly in the burgeoning area of nanomanufacturing. Research at the nanoscale through NSF-funded Nanoscale Science and Engineering Centers (NSECs) aims to advance the development of the ultra-small technology that will transform electronics, materials, medicine, environmental science, and many other fields. Each center has an extended vision for research. Together they provide coherence and a long-term outlook to U.S. nanotechnology research and education; they also address the social and ethical implications of such research. NSEC funding will also support education and outreach programs from K-12 to the graduate level, which is designed to develop a highly skilled workforce, advance pre-college training, and further public understanding of nanoscale science and engineering. These centers have strong partnerships with industry, national laboratories, and international centers of excellence, which puts in place the necessary elements to bring discoveries in the laboratory to real-world, marketable innovations and technologies.

The NSECs were evaluated by a Committee of Visitors (COV) in 2004 and SRI International in 2006. Also, NSECs were evaluated as part of the National Nanotechnology Initiative (NNI) flagship activities by the National Research Council (NRC) (2002 and 2006) and President's Council of Advisors on Science and Technology (PCAST) (2005 and 2008). NSECs currently are evaluated by the School of Public Policy, Georgia Institute of Technology for their research, education, and broader outcomes, the specific role of the centers, and recommendations for the future of the program.

The first class of NSECs receives final funding in FY 2010. In FY 2011, 19 NSECs are expected to be funded. Plans for the next round of centers with a nano focus are currently being developed.

Science and Technology Centers: Integrative Partnerships (multi-directorate)
The Science and Technology Centers: Integrative Partnerships (STC) program advances discovery and innovation in science and engineering through the integration of cutting-edge research, excellence in education, targeted knowledge transfer, and the development of a diverse workforce. The STC research portfolio reflects the disciplines of science and engineering supported by the NSF. Examples of continuing investment include cyber-security, advanced sensors and embedded networked sensing, revolutionary materials for information technology, advanced nano/microfabrication capabilities, new materials and technologies for monitoring water resources and water quality, modeling and simulation of complex earth environments for improving their sustainability, and weather/climate prediction.

STCs engage the Nation's intellectual talent and robustly draw from its full diversity through partnerships among academia, industry, national laboratories, and government. These partnerships enhance and ensure the timely transfer of knowledge and technology from the laboratory to appropriate industries, the application of patents derived from the work of the STCs, the launching of spin-off companies, and creation of job opportunities. STCs have impressive records of publications and research training of students, postdoctoral fellows, established researchers, and educators as well as strong partnerships with K-12 and informal education communities and industry.

A review of the STC program, organized by the American Association of the Advancement of Science, initiated in FY 2009, will be concluded in early FY 2011. The review will assess outcomes and major impacts of the program since FY 2000 and provide guidance to NSF on future directions.

After ten years of funding, support for five centers from the Class of 2000 ended in FY 2009. A new competition was initiated in FY 2009 to identify and fund up to five new STCs in FY 2010. The FY 2011 Request includes funding for a total of 17 new and continuing STCs. FY 2011 funding includes support for the five new STCs that were partially funded at the 50 percent level in FY 2010 during their start-up phase. Six Class of 2002 STCs will receive their tenth and final year of funding in FY 2011.

Science of Learning Centers (multi-directorate)

The Science of Learning Center (SLC) goals are to advance fundamental knowledge about learning, transform the way people learn and teach, secure the U.S. leadership role in innovation and technology, and prepare the Nation's workforce for the 21st century. The six SLCs will continue to harness and integrate knowledge across multiple disciplines to create a common groundwork of conceptualization, experimentation, and explanation that underlies new lines of thinking and inquiry leading to a deeper understanding of learning. The SLC portfolio represents synergistic, exciting research efforts that address different dimensions of learning, including:

- combined modeling and experimental studies to link brain function and behavior and inform innovations in technology;
- development of learning technologies to study robust learning in classrooms in support of educational data mining, machine learning, and developing principles to inform the use and design of new technologies that enhance learning;
- the processes involved in learning visual languages and how this knowledge can improve language processing and reading in deaf, hearing-impaired, and hearing learners;
- the influence of time and timing on learning across multiple scales and multiple levels of analysis, to inform understanding of learning from the cellular level to social interactivity in classrooms;
- the role of social interaction in learning, including the interplay between learning in informal and formal environments; and
- spatial intelligence and learning, the malleability of the underlying processes and how they can be enhanced to improve learning in STEM domains.

Each SLC award includes funding for an external evaluation of the Center. Annual meetings of the SLC evaluators contribute to consistency of information coming from these evaluations and its usefulness for program managers. An external evaluation of the SLC program is in planning stages.

In FY 2011, $25.80 million will fund six SLCs. This anticipates renewal of five of the centers. The Social, Behavioral, and Economic Sciences Directorate's Office of Multidisciplinary Activities will continue to oversee management of all six centers, with matching co-funding from other NSF directorates.

Estimates of Centers Participation in 2009

(Dollars in Millions)

	Number of Participating Institutions	Number of Partners	Total FY 2009 NSF Support	Total Est. Leveraged Support	Number of Participants
Centers for Analysis & Synthesis	309	102	$17	$7	2,231
Centers for Chemical Innovation	62	47	$16	$3	362
Engineering Research Centers	423	534	$61	$101	4,089
Materials Research Science & Engineering Centers	359	269	$61	$50	3,850
Nanoscale Science & Engineering Centers	522	544	$47	$71	3,754
Science & Technology Centers	140	510	$62	$31	3,140
Science of Learning Centers	33	54	$13	$11	1,137

No. of Participating Institutions: all academic institutions participating in activities at the centers.

No. of Partners: the total number of non-academic participants, including industry, states, and other federal agencies at the centers.

Total Leveraged Support: funding for centers from sources other than NSF.

No. of Participants: the total number of people who use center facilities, not just persons directly support by NSF.

Centers Supported by NSF in FY 2009

Center	Institution	State
Centers for Analysis and Synthesis		
National Center for Ecological Analysis and Synthesis	U of California-Santa Barbara	CA
National Evolutionary Synthesis Center	Duke, NC State U, U of N. Carolina	NC
National Institute for Mathematical & Biological. Synthesis	U of Tennessee- Knoxville	TN
iPlant (formerly Plant Science Cyberinfrastructure Collaborative)	U of Arizona	AZ
Centers for Chemical Innovation		
Center for Enabling New Technologies through Catalysis (phase II)	U of Washington	WA
Chemistry at the Space-Time Limit (phase II)	U of California-Irvine	CA
Powering the Planet (phase II)	California Institute of Tech	CA
[1]Center for the Chemistry of the Universe (phase I)	U of Virginia	VA
Center for Energetic Non-Equilibrium Chem. at Interfaces (phase I)	U of Chicago	IL
[1]Center for Green Materials Chemistry (phase I)	Oregon State U	OR
[1]Center for Molecular Interfacing (phase I)	Cornell	NY
Center for Molecular Spintronics (phase I)	North Carolina State U	NC
Center for Molecular Tools for Conjugated Polymer Anal. (phase I)	U of Texas Austin	TX
Center for Stereoselective C-H Functionalization (phase I)	Emory U	GA
Fueling the Future (phase I)	U of Massachusetts-Amherst	MA
The Origins Chemical Inventory & Early Metabolism Proj. (phase I)	Georgia Institute of Tech	GA
Engineering Research Centers		
Biomimetic Microelectronic Systems	U of Southern California	CA
Biorenewable Chemicals	Iowa State U	IA
Collaborative Adaptive Sensing of the Atmosphere	U of Mass-Amherst	MA
Compact and Efficient Fluid Power	U of Minnesota	MN
Extreme Ultraviolet Science and Technology	Colorado State	CO

Future Renewable Electric Energy Delivery & Mgmt. Systems	North Carolina State U	NC
Integrated Access Networks	U of Arizona	AZ
Mid-IR Tech for Health and the Environment	Princeton	NJ
Quality of Life Technology	Carnegie Mellon/U of Pittsburgh	PA
Revolutionizing Metallic Biomaterials	North Carolina A&T U	NC
Smart Lighting	Rensselaer Polytechnic Institute	NY
Structured Organic Composites	Rutgers	NJ
Subsurface Sensing and Imaging Systems	Northeastern	MA
Synthetic Biology	U of California-Berkeley	CA
Wireless Integrated MicroSystems	U of Michigan	MI
Materials Research Science and Engineering Centers		
Brandeis Materials Research Science and Engineering Center	Brandeis U	MA
Center for Complex Materials	Princeton	NJ
Center for Emergent Materials	Ohio State U	OH
Center for Materials for Information Technology	U of Alabama	AL
Center for Materials Research	Cornell	NY
Center for Materials Science and Engineering	Massachusetts Institute of Tech	MA
Center for Micro- and Nanomechanics of Materials	Brown	RI
Center for Multifunctional Nanoscale Materials Structures	Northwestern	IL
Center for Nanomagnetic Structures	U of Nebraska	NE
Center for Nanoscale Science	Pennsylvania State	PA
Center for Nanostructured Interfaces	U of Wisconsin	WI
Center for Nanostructured Materials	Columbia	NY
Center for Polymer Interfaces and Macromolecular Assemblies	Stanford, UC-Davis, IBM	CA
Center for Research on Interface Structures and Phenomena	Yale	CT
Center for Response-Driven Polymeric Films	U of Southern Mississippi	MS
Center for Science and Engineering of Materials	California Institute of Tech	CA
Center for Semiconductor Physics in Nanostructures	U of Oklahoma, U of Arkansas	OK, AR
Ferroelectric Liquid Crystals Materials Research Center	U of Colorado-Boulder	CO
Genetically Engineered Materials Science and Engineering Center	U of Washington	WA
Laboratory for Research on the Structure of Matter	U of Pennsylvania	PA
Materials Research Center	U of Chicago	IL
Materials Research Science and Engineering Center	Carnegie Mellon	PA
Materials Research Science and Engineering Center	Johns Hopkins	MD
Materials Research Science and Engineering Center	Harvard	MA
Materials Research Science and Engineering Center	Georgia Institute of Tech	GA
Materials Research Science and Engineering Center	New York U	NY
Materials Research Science and Engineering Center	U of California-Santa Barbara	CA
Materials Research Science and Engineering Center	U of Maryland	MD
Materials Research Science and Engineering Center	U of Minnesota	MN
Materials Research Science and Engineering Center on Polymers	U of Massachusetts	MA
Renewable Energy Materials Research Science and Engineering Center	Colorado School of Mines	CO
Nanoscale Science and Engineering Centers		
Affordable Nanoengineering of Polymer Biomedical Devices	Ohio State	OH
Center for Environmental Implications of Nanotechnology (CEIN)	Duke	NC
Center for Integrated and Scalable Nanomanufacturing	U of California-Los Angeles	CA
Directed Assembly of Nanostructures	Rensselaer Polytechnic Institute	NY
Electronic Transport in Molecular Nanostructures	Columbia	NY
High Rate Nanomanufacturing	Northeastern, U of New Hampshire, U of Mass-Lowell	MA, NH
Integrated Nanomechanical Systems	U of California-Berkeley, Cal Tech, Stanford, U of California-Merced	CA
Integrated Nanopatterning and Detection Technologies	Northwestern	IL
Molecular Function at the Nano/Bio Interface	U of Pennsylvania	PA

Nanotechnology in Society Network: Center at ASU	Arizona State U	AZ
Nanotechnology in Society Network: Center at UCSB	U of California-Santa Barbara	CA
Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems	U of Illinois-Urbana Champaign	IL
Nanoscale Systems in Information Technologies	Cornell	NY
Nanoscience in Biological and Environmental Engineering	Rice	TX
National Nanomanufacturing Network: Center for Hierarchical Manufacturing	U of Massachusetts-Amherst	MA
Predictive Toxicology Assessment & Safe Implementation of Nanotechnology in the Environment (CEIN)	U of California-Los Angeles	CA
Probing the Nanoscale	Stanford, IBM	CA
Science of Nanoscale Systems and their Device Applications	Harvard	MA
Templated Synthesis and Assembly at the Nanoscale	U of Wisconsin-Madison	WI
Science and Technology Centers		
Adaptive Optics	U of California-Santa Cruz	CA
Advanced Materials for Purification of Water Systems	U of Illinois-Urbana Champaign	IL
Behavioral Neuroscience	Georgia State U	GA
Biophotonics Science and Technology	U of California-Davis	CA
Center for Remote Sensing of Ice Sheets	U of Kansas	KS
Coastal Margin Observation and Prediction	Oregon Health and Science U	OR
Earth Surface Dynamics	U of Minnesota-Twin Cities	MN
Embedded Networked Sensing	U of California-Los Angeles	CA
Environmentally Responsible Solvents and Processes	U of North Carolina-Chapel Hill	NC
Integrated Space Weather Modeling	Boston U	MA
Layered Polymeric Systems	Case Western Reserve U	OH
Materials and Devices for Information Technology Research	U of Washington	WA
Microbial Oceanography: Research and Education	U of Hawaii-Manoa	HI
Multi-Scale Modeling of Atmospheric Processes	Colorado State U	CO
Nanobiotechnology	Cornell	NY
Sustainability of Semi-Arid Hydrology and Riparian Areas	U of Arizona	AZ
Ubiquitous Secure Technology	U of California-Berkeley	CA
Science of Learning Centers		
Center for Excellence for Learning in Education, Science, & Tech.	Boston U	MA
Pittsburgh Science of Learning Center - Studying Robust Learning with Learning Experiments in Real Classrooms	Carnegie Mellon	PA
LIFE Center - Learning in Formal and Informal Environments	U of Washington	WA
Spatial Intelligence and Learning Center	Temple	PA
The Temporal Dynamics of Learning Center	U of California-San Diego	CA
Visual Language and Visual Learning	Gallaudet	DC

[1] Ongoing centers forward funded in FY 2009 from FY 2008 funds.

CYBERLEARNING TRANSFORMING EDUCATION (CTE)

<u>Goal:</u> Capture the potential of cyber innovations to transform teaching and learning.

Cyberlearning refers to "the use of networked computing and communications technologies to support learning," as discussed in the 2008 report from the NSF Task Force on Cyberlearning, "*<u>Fostering Learning in the Networked World</u>.*" That same report sets the challenge for an NSF cyberlearning agenda:

> *Despite the revolutions wrought by technology in medicine, engineering, communications, and many other fields, the classrooms, textbooks, and lectures of today are little different than those of our parents. Yet today's students use computers, mobile telephones, and other portable technical devices regularly for almost every form of communication except learning. The time is now – if not long overdue – for radical rethinking of learning and of the metrics for success... and a transformation of how STEM is taught in K-12, higher education, and throughout the lifespan. We can anticipate that innovations will continue to be introduced over the coming decade and continually reconfigure the realm of possibilities for learning in a networked world.*

In FY 2011 NSF will establish a new multidisciplinary research program to fully capture the transformative potential of advanced learning technologies across the education enterprise. The Cyberlearning Transforming Education (CTE) program will seek to:

- enable wholly new avenues of science, technology, engineering, and mathematics (STEM) learning for students and for workforce development;
- advance the Nation's ability to study the learning process itself;
- bring advanced technologies to learners at all educational levels;
- identify the innovations that are yielding the most promising evidence of promoting learning, using appropriately rigorous evaluation to identify key features of these innovations and assess their suitability for scale-up; and
- collaborate with the Department of Education and other public and private-sector partners.

<u>Description and Rationale:</u> The education enterprise is at a crossroads. We have made great gains in the design of networked computing and communications technologies that support learning, teaching, and education. Such technologies now allow us to conduct investigations in education and learning with greater scale and in much more complex contexts than was ever previously possible. Technologies are already deeply entwined with our lives, especially so in the lives of young learners. Nonetheless, to date we have not fully embraced them as learning tools in the Nation's classrooms and laboratories, nor have we developed the capacity to integrate current and nascent technologies into our understanding of teaching and learning practices.

NSF's role in STEM education provides a critical focus for its proposed cyberlearning activities. The very nature of how science is conducted has been transformed through the advent of computing. Nonetheless, innovation in STEM teaching has been slow to make its way into formal education settings. The agency will draw upon its established track record in creating and using advanced cybertools, methods, and resources to revolutionize the conduct of scientific inquiry to similarly transform STEM education and learning.

NSF's future investments in CTE will be organized around three interrelated themes:

- **Anytime, Anywhere Learning.** Education today is largely tethered to formal institutions such as schools or colleges and universities, or to informal settings such as museums and afterschool centers. Cyberlearning offers opportunities to redistribute learning throughout the waking hours and throughout a lifetime, provide access to those who might otherwise be barred from valuable learning experiences, and transcend global boundaries.

- **Personalized Learning.** Cyberlearning can support new ways of learning as both a collaborative or social activity and in independent study. In fact, cyberlearning provides opportunities to provide more targeted learning experiences to individuals and to groups with shared characteristics. For example, cyberlearning enables the creation of learning experiences tailored to student traits, such as personality, learning style, motivation, culture, and ability. Similarly, cyberlearning experiences can be tailored to student states, such as affect, level of engagement, and level of understanding.

- **(Cyber)learning about (Cyber)learning.** Our body of knowledge about teaching and learning continues to grow. Cyberlearning allows us to advance fundamental knowledge bases in both technologies and learning sciences (including education and social sciences) in powerful new ways. As cyberlearning grows as a mechanism for learning, we are able to turn our sights to understanding what and why people learn well and don't learn well in both the cyberworld and the classroom. Cyberlearning also opens new doors to assessment, allowing us to embed assessment throughout learning and to use the results to reshape our understanding of how we learn.

NSF will establish a suite of Cyberlearning Collaboratoria to explore and assess the efficacy of learning systems that incorporate forward-looking cyberlearning technologies and approaches. The Collaboratoria will include representatives from colleges and universities, school systems, states or urban centers, industry, and/or nonprofits. As with the agency's Math and Science Partnerships, multidisciplinary teams of faculty – in this case with expertise in computing and learning – will play a pivotal role in funded projects; they will provide a tight coupling between state-of-the-art research in computing and related cyberlearning technologies, and rigorous ground-breaking research exploring the effectiveness of cyber-technologies in promoting and advancing learning. Projects funded will encompass school and informal environments, allowing learners and teachers to engage both independently and in virtual informal learning communities. Further, projects will support the effective transition of all stakeholders from highly structured classroom environments to learning models that promote and support anytime, anywhere, and personalized learning. The outcomes of these investments will be model learning tools/resources that have been tested and studied, and whose impacts on learning (or on advancing knowledge about learning) are well understood, as are the critical design and implementation features that led to that impact. CTE basic research outcomes are also expected to ultimately lead to applications which provide greater equity in opportunities to learn and experience authentic participation in STEM – enhancing America's potential to develop the diverse, cyber-savvy workforce of the future. All Cyberlearning Collaboratoria will have built-in evaluation requirements and expertise, while central resource projects will provide program-wide coordination of monitoring, performance measurement, and rigorous evaluation that is appropriate to the development effort.

Potential for Impact, Urgency, and Readiness: This cyberlearning investment is central to addressing significant national challenges. For example, CTE is aimed at improving STEM education and will simultaneously strengthen research and teaching institutions. Both strategies spur the economy and create jobs by producing a creative and innovative STEM workforce.

In the NSF Task Force report cited above and in numerous other reports[1], educators, scholars, and policy makers have showcased the opportunities that technology affords us for transforming how we learn and the consequences for failing to do so. Cyberlearning expands the access to and reach of education and learning. It strengthens established methods and enables new approaches to education and learning. Cyberlearning enables new scholarship about education and learning. It facilitates the scaling of educational innovation quickly and economically. Nonetheless, as indicated in a report recently released by the Department of Education[2], "Educators making decisions about online learning need rigorous research examining the effectiveness of online learning for different types of students and subject matter, as well as studies of the relative effectiveness of different online learning practices" (p. 54). CTE Cyberlearning Collaboratoria will produce just such a body of knowledge.

Leveraging Collaborations: NSF is uniquely positioned to target an ambitious agenda in the national context. Transforming education and learning through technological innovation requires multi-disciplinarity and collaboration. NSF's interdisciplinary research and education programs have already generated productive collaborations among learning scientists, computer scientists, engineers, interaction designers, subject matter experts, social scientists with varied expertise, designers of assessments, and educators. Programs such as the Math and Science Partnership have similarly generated productive collaborations among the various elements of the teaching and learning innovation enterprise, spanning science and technology scholars and educators, local education agencies, higher education enterprises, urban centers, industry, nonprofits, and other stakeholders in teaching and learning innovation. NSF is also this country's leading force in transforming science and engineering, and thus, is well-positioned to maintain timely connections among evolving scientific research and education knowledge, policy, and practice.

NSF has established relationships with key government agencies that have strong interests in transforming education and learning through technological innovations. For example, NSF has a long-standing and productive partnership with the Department of Education; the Department can help disseminate new knowledge about the benefits of cyberlearning in STEM education to the broader education enterprise. NSF also works closely with the Department of Defense, which has a strong track record of supporting advanced learning technology and education innovation in the training of the United States military. In addition, NSF is working with the Federal Communications Commission on its broadband initiative, helping to highlight the importance of universities as community anchors in broadband activities. The broadband initiative is a necessary enabler for cyberlearning activities and has broad reach. The cyberlearning activity is perfectly poised to leverage these efforts and forge partnerships with industry and private foundations.

The CTE and overall STEM education activities in NSF's FY 2011 Request will be part of a coordinated Federal strategy developed in collaboration with the Department of Education and other Federal agencies. The agencies will:

- Clarify and align evidence standards so that recipients of development grants for learning materials understand the type and quality of evidence their research projects must generate to be eligible for U.S. Department of Education validation or scale-up grants; and
- Identify the innovations that are yielding the most promising evidence of producing learning that would merit further Federal investment in development and validation using rigorous evaluation – to assess their suitability for replication, adaptation, and scale-up.

Management and Assessment: Plans for the monitoring and rigorous evaluation of the new multi-faceted cyberlearning program will draw on a variety of practices to ensure the quality and results of the program. External, independent experts will assist NSF and the Department of Education in developing program-wide monitoring systems and rigorous evaluation processes as solicitations are being developed. Core information required for the evaluation processes will be articulated in the solicitations and in award conditions. Plans for ongoing assessment and evaluation will be required as part of proposal submission and a significant consideration in the merit review process.

In addition to project-level evaluation, program level evaluation must assess overall changes in STEM education and learning (e.g., goals, processes, assessments) and include metrics that assess learning outcomes across cyber-enabled environments, the effectiveness of seamless cyber-transitions, and the effectiveness of tools developed through this activity. Innovations which show strong evidence of efficacy will be considered for scale-up by the Department of Education and others further down the development and deployment pipeline.

Funding: The FY 2011 Request is for $41.28 million to support research on innovative cyber-related paradigms in STEM teaching and learning. This investment will permit the launch of 8-15 Cyberlearning Collaboratoria (ranging from $1.0 to $3.0 million each) and integrated data collection and community building efforts through central resource projects.

Cyberlearning Transforming Education Funding
(Dollars in Millions)

	FY 2010 Estimate	FY 2011 Request
Total, CTE	**$25.33**	**$41.28**
Cyberlearning Collaboratoria		*35.00*
Central Resource Projects		*6.28*

[1] See, for example:

- The Opportunity Equation: Transforming Mathematics and Science Education for Citizenship and the Global Economy, Carnegie Corporation of New York-Institute for Advanced Study Commission on Mathematics and Science Education, 2009.
- Learning Science in Informal Environments, National Research Council, 2009.
- Learning 2.0: The Impact of Web2.0 Innovation on Education and Training in Europe, European Joint Research Center: Institute for Prospective Technological Studies, 2009
- 2020 Forecast: Creating the Future of Learning, KnowledgeWorks Foundation, 2009
- The Future of ICT and Learning in the Knowledge Society, European Joint Research Center: Institute for Prospective Technological Studies, 2008
- A Review of the Open Educational Resources (OER) Movement: Achievements, Challenges, and New Opportunities, William and Flora Hewlett Foundation, 2007
- Cyberinfrastructure for Education and Learning for the Future, Computing Research Association, 2005
- Planning for Two Transformations in Education and Learning Technology, National Research Council, 2003
- 2020 Visions, Transforming Education and Training Through Advanced Technologies, Department of Education, 2002
- Using Information Technology To Transform the Way We Learn, President's Information Technology Advisory Committee, 2001

[2] Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies, U.S. Department of Education, May 2009

NATIONAL NANOTECHNOLOGY INITIATIVE (NNI)

NSF's contribution to the multiagency National Nanotechnology Initiative (NNI) encompasses the systematic understanding, organization, manipulation, and control of matter at the atomic, molecular, and supramolecular levels in the size range of 1 to 100 nanometers. Novel materials, devices, and systems – with their building blocks designed on the scale of nanometers – open up new directions in science, engineering, and technology with potentially profound implications for society. With the capacity to control and manipulate matter at this scale, science, engineering, and technology are realizing revolutionary advances in areas such as individualized pharmaceuticals, new drug delivery systems, more resilient materials and fabrics, catalysts for industry, order-of-magnitude faster computer chips, and sustainable development in using water and energy resources.

NNI by Program Component Area
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request
1. Fundamental Nanoscale Phenomena & Processes	$143.59	$29.91	$152.57	$140.13
2. Nanomaterials	72.35	24.67	78.67	74.30
3. Nanoscale Devices & Systems	54.04	17.61	43.74	40.67
4. Instr. Research, Metrology, & Standards for Nanotech	21.39	4.52	18.34	16.58
5. Nanomanufacturing	27.67	6.05	22.43	32.20
6. Major Research Facilities & Instrumentation Acquisition	31.45	6.52	37.83	35.33
7. Environmental Health & Safety	26.84	3.38	29.82	33.01
8a. Education	26.99	8.04	28.44	23.75
8b. Societal Dimensions (ELSI)	4.31	0.50	5.85	5.28
Total, National Nanotechnology Initiative	**$408.62**	**$101.20**	**$417.69**	**$401.25**

Totals may not add due to rounding.

FY 2011 NNI Funding. NSF supports nanoscale science and engineering in all disciplines throughout all research and education directorates as a means to advance discovery and innovation and integrate various fields of research. NNI enables increased interdisciplinarity at atomic and molecular levels for about 5,000 active awards representing more than 10 percent of the NSF portfolio. About 10,000 students and teachers will be educated and trained in nanoscale science and engineering in FY 2011. NSF contributes to the goals and eight program component areas (PCAs) outlined in the NNI Strategic Plan (www.nano.gov). The largest increase in FY 2011 is for nanomanufacturing with a budget of $32.30 million. In FY 2011, funds are transferred from several PCAs to increase funding for the Environmental, Health and Safety (EHS) PCA to a total of $33.01 million. This shift reflects the prioritization of EHS within the overall NNI portfolio. Overall NNI funding in FY 2011 has been reduced by $16.44 million as compared to the FY 2010 Estimate. This reduction is due to decreased support from MPS and GEO based on the research priorities of these directorates.

Fundamental Nanoscale Phenomena and Processes. The FY 2011 Request includes $140.13 million, a reduction of $12.44 million as compared to the FY 2010 Estimate for fundamental research and education. A part of those funds have transitioned to other PCAs, as part of the competitive planning process in each directorate. Special emphasis will be on:

- *Novel phenomena, quantum control, and basic engineering processes* – to discover and understand phenomena and design processes specific at the nanoscale, including new phenomena in materials, mechanics, chemistry, biology, electronics, and optics. A focus will be on the understanding and use of self assembly from basic principles and on multiple scales. Potential applications include quantum information systems, novel products by multiscale self assembling, and new devices and sensors for industry and environmental monitoring. The program on "Macromolecular, Supramolecular and Nanostructures" has been established.

- *Biosystems at the nanoscale* – to support study of biologically based or inspired systems that exhibit novel properties and potential applications. Potential applications include improved drug delivery, biocompatible nanostructured materials for implantation, exploiting of functions of cellular organelles, devices for research in genomics, proteomics, and cell biology, food and plant systems, and nanoscale sensory systems, such as miniature sensors for early detection of cancer. A focus will be on understanding and simulation of cells, tissues, and nervous systems.
- *Converging science and engineering at the nanoscale* – The convergence of nanotechnology with information technology, modern biology, and social sciences will reinvigorate discoveries and innovation in almost all areas of the economy. Examples are the nano-biology interface, the nano-information interface, and nano-neurosciences.
- *Multi-scale, multi-phenomena theory, modeling, and simulation at the nanoscale* – to support theory, modeling, large-scale computer simulation and new design tools, and infrastructure in order to understand, control, and accelerate development in new nanoscale regimes and systems. A special focus will be on simulations with atomic precision, time resolution of chemical reactions, and for domains of engineering and biological relevance.

Nanomaterials. The FY 2011 Request includes $74.30 million for discovery of novel nanoscale and nanostructured materials, and improving the comprehensive understanding of the properties of nanomaterials (ranging across length scales and including interface interactions). A special focus will be gaining control of nanoscale features and devices with an atomic level of precision. Another focus will be design and synthesis, in a controlled manner, of nanostructured materials with targeted properties. Research on the discovery, understanding, and control of materials at the nanoscale will be critical to the development and success of innovative technologies, including advances in electronics beyond Moore's Law, catalysts, energy, healthcare, and manufacturing

Nanoscale Devices and Systems. The FY 2011 Request includes $40.67 million for R&D that applies the principles of nanoscale science and engineering to create novel, or to improve existing, devices and systems. A special focus will be on the architecture and emerging behavior of nanosystems, and on nanomanufacturing of active nanostructures and nanosystems. Nanoelectronics beyond silicon nanotechnology and complementary metal-oxide superconductors (CMOS) research will explore ultimate limits to scaling of features and alternative physical principles for devices employed in sensing, storage, communication, and computation. The research activity in this area will help develop innovative technologies, including replacing electron charge as information carrier, bottom-up device assembly technologies at the atomic and molecular levels, and new system architectures using nanoscale components. Another focus will be on building bio-systems and to regenerate the human body. Another focus will be on nano-informatics for better communication and nanosystem design.

Instrumentation Research, Metrology, and Standards for Nanotechnology. The FY 2011 Request includes $16.58 million for R&D to create new tools needed to advance nanotechnology research and commercialization. A special challenge is developing tools for measuring and restructuring matter with atomic precision, for time resolution of chemical reactions, and for domains of biological and engineering relevance. Another focus is on developing on-line process instrumentation for nanoscale characteristics.

Nanomanufacturing. The FY 2011 Request includes an increase of about $10.0 million to $32.20 million to support new concepts for high rate synthesis and processing of nanostructures, nanostructured catalysts, nanobiotechnology methods, fabrication methods for devices, and assembling them into nanosystems and then into larger scale structures of relevance in industry and in the medical field. R&D is aimed at enabling scaled-up, reliable, cost effective manufacturing of nanoscale materials, structures, devices, and systems. A special focus will be creating active nanostructures and complex nanosystems. The investment will emphasize (1) new tools for measuring and restructuring matter for production purposes; (2) hierarchical manufacturing of nanosystems by assembling nanoscale components into new architectures and fundamentally new products; (3) manufacturing by design using new principles, computer simulations, and nanoinformatics; and (4) hybrid nanomanufacturing, including nanobiotechnology and nanostructured catalysts. An overall goal will be advancing nanomanufacturing methods supporting sustainable development. NSF will strengthen the support for the National Nanomanufacturing Network composed of four Nanoscale Science and Engineering Centers in order to advance innovation, partner and implement the research results with industry, medical institutions, and other government agencies.

Major Research Facilities and Instrumentation Acquisition. The FY 2011 Request includes $35.33 million for user facilities, acquisition of major instrumentation, and other activities that develop, support, or enhance the scientific infrastructure for the conduct of nanoscale science, engineering, and technology research and development. It also supports ongoing operations of the National Nanotechnology Infrastructure Network (NNIN), the Network for Computational Nanotechnology (NCN), the National Network for Nanomanufacturing (NNN), and the National High Magnetic Field Laboratory (NHMFL). The networks are planned to have over 110,000 users in FY 2011. The investment will support facilities for 17 ongoing Nanoscale Science and Engineering Centers (NSEC).

Environmental, Health and Safety. The FY 2011 Request includes $33.01 million, an increase of $3.19 million over the FY 2010 Estimate for research primarily directed at environmental, health, and safety (EHS) implications and methods for reducing the prospective risks of nanotechnology development. NSF, the Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA), and the European Union (EU) will collaborate on implementation of a joint solicitation for nano EHS. Basic research will support understanding of underlying phenomena and processes. Research on both implications and applications of nanotechnology will address the sources of nanoparticles and nanostructured materials in the environment (in air, water, soil, biosystems, and working environments), as well as the non-clinical biological implications. Research on the safety of manufacturing nanoparticles is included in seven NSECs and NNIN. Environmental implications of nanotechnology, including development of new measurement methods for nanoparticle characterization and toxicity of nanomaterials will be investigated in two dedicated multidisciplinary centers (Centers for Environmental Implications of Nanotechnology at UCLA and Duke University). These centers aim to conduct fundamental research on the interactions between nano-particles and materials and the living world at all scales. An essential element of this will be research on methods and instrumentation for nano-particle detection, characterization, and monitoring, including interactions of nano-materials with cellular constituents, metabolic networks and living tissues, bioaccumulation and its effects on living systems, and the impacts of nanostructures dispersed in the environment. This work will support regulatory and mission agencies in developing science-based standards for risk assessments, such as those needed by the National Institute of Standards and Technology (NIST), EPA, the Food and Drug Administration (FDA) and other agencies to develop standards for and to regulate nano-materials. NSF will provide supplements to NSECs for nano EHS on a competitive basis.

Education and Societal Dimensions. The FY 2011 Request includes $29.03 million for research and other activities that address the broad implications of nanotechnology for society, including education and social aspects, including:

- Education-related activities, such as development of materials for schools, curriculum development for nanoscience and engineering, development of new teaching tools, undergraduate programs, technical training, and public outreach ($23.75 million). Two networks for nanotechnology education with national outreach will be supported: The Nanotechnology Center for Learning and Teaching (NCLT) and the Network for Nanoscale Informal Science Education (NISE); and
- Research directed at identifying and quantifying the broad implications of nanotechnology for society, including social, economic, workforce, educational, ethical, and legal implications ($5.28 million). The application of nanoscale technologies will stimulate far-reaching changes in the design, production, and use of many goods and services. Factors that stimulate scientific discovery at the nanoscale will be investigated, effective approaches to ensure the safe and responsible development of nanotechnology will be explored and developed, and the potential for converging technologies to improve human performance will be addressed. The Nanotechnology in Society Network will extend its national and international network. NSF will support activities of a new World Technology Evaluation Study to explore the potential of nanotechnology in the long-term.

Coordination with Other Agencies. The NSF program is coordinated with 25 departments and agencies through the National Science and Technology Council's subcommittee on Nanoscale Science, Engineering and Technology (NSET). Examples of specific coordination efforts are: Nanomanufacturing (Department of Defense (DOD)/NIST); Environmental issues (EPA/ National Institute of Environmental Health Sciences (NIEHS)/USDA); NSECs, NNIN and Network for Computational Nanotechnology (NCN) centers and networks (DOD/ National Aeronautics and Space Administration (NASA)/ Department of Energy (DOE)/ National Institutes of Health (NIH)); nanoelectronics (NIST, DOD), simulations in nanoelectronics (DOD/NASA); and research and training activities (DOD/NIH).

NNI Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request
Biological Sciences	$56.60	-	$56.60	$56.60
Computer and Information Science and Engineering	11.65	1.43	11.00	11.00
Engineering	140.02	35.00	148.00	156.37
Geosciences	0.85	-	6.33	0.85
Mathematical and Physical Sciences	194.27	64.77	190.59	172.26
Social, Behavioral and Economic Sciences	1.73	-	1.67	1.67
Subtotal, Research and Related Activities	405.12	101.20	414.19	398.75
Education and Human Resources	3.50	-	3.50	2.50
Total, National Nanotechnology Initiative	**$408.62**	**$101.20**	**$417.69**	**$401.25**

Totals may not add due to rounding.

NETWORKING AND INFORMATION TECHNOLOGY R&D (NITRD)

The National Science Foundation is a primary federal agency supporting the Networking and Information Technology Research and Development (NITRD) program. NSF's NITRD portfolio includes all funding in the Directorate for Computer and Information Science and Engineering (CISE) and the Office of Cyberinfrastructure (OCI), and all of the agency's directorates also contribute. NSF makes research, education, or research infrastructure investments in every NITRD Program Component Area (PCA). NSF's Assistant Director for CISE is co-chair of the NITRD Subcommittee of the National Science and Technology Council's Committee on Technology. In addition, NSF works in close collaboration with other NITRD agencies and participates at the co-chair level in five of the seven PCA Coordinating Groups.

NSF's FY 2011 Request continues strong support for NITRD at a level of $1.170 billion, a 7.3 percent increase over the FY 2010 Estimate. NITRD activities represent approximately 16 percent of NSF's FY 2011 budget. CISE and OCI's combined support comprises close to 80 percent of NSF's NITRD activities.

Several NSF-wide investments, both new and continuing, are reflected in various NITRD PCAs. The Science, Engineering, and Education for Sustainability (SEES) cross-Foundation investment supports activities in Large Scale Networking as well as in Software Design and Productivity. NSF's new multidisciplinary research program, Cyberlearning Transforming Education (CTE), will contribute to the Human Computer Interaction and Information Management area. NSF's ongoing Cyber-enabled Discovery and Innovation (CDI) investment is most prominent in the High Confidence Software and Systems and Human Computer Interaction and Information Management areas. NSF's investments in Science and Engineering Beyond Moore's Law (SEBML) are reflected in the High-End Computing R&D program component area.

NITRD by Program Component Area
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request
Large Scale Networking	$79.14	$53.22	$107.18	$113.57
Cybersecurity and Information Assurance	76.30	30.88	71.36	85.16
High End Computing R&D	80.79	39.84	98.54	92.78
High End Computing Infrastructure and Applications	331.77	58.49	310.87	317.83
High Confidence Software and Systems	59.04	33.09	73.08	83.29
Human-Computer Interaction and Info Management	234.11	88.01	280.70	310.43
Software Design and Productivity	48.36	18.08	57.58	73.92
Social/Economic/Workforce	102.11	25.55	91.17	93.09
Total, NITRD	**$1,011.62**	**$347.16**	**$1,090.48**	**$1,170.07**

Totals may not add due to rounding.

Large Scale Networking ($113.57 million): CISE will increase support for core fundamental network research to create new insights into the dynamics of complex networks and explore new architectures for future-generation networks and services. Through the SEES cross-Foundation investment CISE will support research to optimize energy-computation performance in computer and network systems and explore the use of information technology in smart sensing systems that promise to save energy and reduce greenhouse gas emissions.

OCI will continue its International Research Network Connections (IRNC) activity, which will include opportunities to fund experimental networks.

Cybersecurity and Information Assurance ($85.16 million): NSF will continue to fund research on cybersecurity foundations, network security, and systems software that support the objectives of the *Federal Plan for Cyber Security and Information Assurance Research and Development*. CISE will devote $55.0 million to research in usability, theoretical foundations, and privacy to support the Comprehensive National Cybersecurity Initiative. Support will continue for several centers. This includes one devoted to the scientific exploration of new technology that will radically transform the ability of organizations to design, build, and operate trustworthy information systems for critical infrastructure. It also includes one investigating software architectures, tamper-resistant hardware, cryptographic protocols, and verification systems as applied to electronic voting systems.

OCI will fund research and support for cybersecurity approaches and deployment of identity authentication and authorization systems including authorization infrastructure to support science and engineering applications and projects. Efforts include developing scalable cybersecurity approaches and systems for very large, complex, and highly distributed communities, from data integrity and confidence to secure transmission and collaboration technologies.

High-End Computing Research and Development (R&D) ($92.78 million): OCI and CISE will support the development of simulation, optimization, and analysis tools that exploit the potential of petascale computing to advance the frontiers of scientific and engineering research. Included in this PCA are NSF's investments in SEBML that will focus on advancing fundamental science that can revolutionize computing.

High-End Computing Infrastructure and Applications ($317.83 million): OCI will continue acquisition of a high performance computing (HPC) system. OCI is following-up the existing TeraGrid activity with eXtreme Digital (XD). XD will provide computational, storage, networking, and visualization resources to the open science and engineering communities. OCI also will initiate a new software activity in FY 2011, focusing on producing the complex middleware and application codes for new high-end computing architectures. The activity will address not only performance issues but also identification of common software infrastructure and/or approaches that could benefit a broad range of science areas.

CISE will invest in research infrastructure resources to support the acquisition, enhancement, and operation of state-of-the-art infrastructures and facilities that enable high-quality computing research and education in a diverse range of institutions and projects.

Several NSF directorates will continue their investments in this PCA to capitalize on the growing importance of cyberinfrastructure in furthering their research and education goals. For example:

- BIO will invest in activities to broaden access to and usability of high performance computing resources in the biological sciences. Current biology applications claim substantial HPC resources that are narrowly focused in specific areas of biology. With increasing availability of large amounts of diverse data from plant, animal, and microbial genomics to ecosystems modeling, additional areas of biology will likely require expanded access to and development of HPC resources.
- ENG will continue support of virtual organizations to leverage distributed physical experimentation, data collection, modeling, and analysis capabilities using high-end computing and large scale networking infrastructures.

- GEO will continue to support state-of-the-art computing systems and data management services at the National Center for Atmospheric Research (NCAR). Part of this high performance computing environment, the Climate Simulation Laboratory (CSL), helps keep the U.S. at the forefront of 21st century climate science.
- MPS will invest in new computational methods, algorithms, robust software, and other computational tools to support researchers in the mathematical and physical sciences including computational chemistry, materials research, physics, astrophysics, and biological chemistry, physics, and materials with a focus on advancing methods, algorithms, and software that will scale to the petascale and beyond.
- MPS will continue support of research and education activities that contribute to and utilize the Virtual Astronomical Observatory, a federation of astronomical databases. MPS will continue to support remote access to instrumentation and increased connection of institutions that are distant from each other, such as a minority institution and its partner.

High Confidence Software and Systems ($83.29 million): As part of the CDI investment, CISE will support research on software for tomorrow's complex cyber-physical systems, such as smart automobiles, sensor nets for environmental monitoring, and embedded medical devices, and similarly in mobile, portable, and pervasive computing devices, such as cell phones, digital cameras, flexible displays, radio-frequency identification (RFIDs), multi-media multi-modal handhelds, and household robots.

In partnership, CISE and ENG will support advanced manufacturing through research on cyber-physical systems that help better integrate information technology into manufactured goods.

Human Computer Interaction and Information Management ($310.43 million): CISE, in partnership with the EHR and SBE directorates, will establish NSF's new multidisciplinary research program, CTE, which is designed to fully capture the transformative potential of advanced learning technologies across the education enterprise. The CTE program seeks to enable wholly new avenues of science, technology, engineering, and mathematics (STEM) learning for students and for workforce development; advance the Nation's ability to study the learning process itself; and bring proven technologies to learners at all educational levels.

The multidisciplinary CDI emphasis will focus on creation of new knowledge from digital data, including novel algorithms, data mining, and dimension reduction methodologies, new visualization methods to enhance human cognition, and innovative technologies to address data confidentiality, privacy, security, provenance, and regulatory issues.

NSF will focus increased attention on the issues of federation, preservation, curation, and access to large, heterogeneous collections of scientific data and information. High capacity data management and high capacity computing are increasing challenges for a growing number of research communities. OCI will develop activities for a robust and resilient national and global digital data framework for preservation and access to the resources and products of the digital age. OCI will invest in data, modeling paradigm, and software interoperability in the area of virtual organizations.

Several other NSF directorates will continue their investments in this PCA, for example:

- BIO's investments will facilitate discovery through tools that integrate the published literature with the expanding universe of digital data collections, expand capacity for understanding through virtual environments that provide an intuitive display of the complex networks of interactions among organisms and their environments, and make it practical for scientists to search vast collections of biological images simply and quickly.

- ENG's investment in this area will focus on creating new pathways to connect researchers with each other and with state-of-the-art experimental facilities.
- MPS continues to invest in new and fundamental methods for analysis and computation with large data sets. These investments will be of value to all science and engineering disciplines.
- SBE and CISE will continue to support research on Socio-Computational Systems, encouraging the study of the interaction between people and machines.

Software Design and Productivity ($73.92 million): CISE will support research on the scientific and engineering principles for developing software for tomorrow's complex cyber-based systems. Advances in software foundations, including new computational models, techniques, languages, tools, metrics, and processes for developing and analyzing software for these complex systems, will be pursued. Through the SEES cross-Foundation investment, CISE will support research on the software advances needed to meet the energy requirements inherent in computation and communication.

As part of OCI's new software activity (also described under HEC I&A), research on topics such as software production, hardening, collaboration, and sustainability will be supported.

BIO, through its Biological Databases and Informatics program, will promote new ways of enabling science through the use of cyberinfrastructure, including new visual programming environments and integrated information systems that allow an entire community of experts to contribute simultaneously to understanding genome dynamics.

ENG will invest in developing new algorithms and software that can efficiently scale to the petascale level. ENG will also invest in virtual organizations to enhance the productivity of researchers by providing them access to computational tools, specialized facilities, and observational data from anywhere in the world.

Social, Economic and Workforce ($93.09 million): Through CDI, NSF will support investments that infuse computational thinking into computing education at all levels and in all fields of science and engineering.

CISE education and workforce activities, such as the Broadening Participation in Computing (BPC) and CISE Pathways to Revitalized Undergraduate Computing Education (CPATH) programs, are aimed at significantly increasing the number of students who are U.S. citizens and permanent residents receiving post secondary degrees in the computing disciplines. CISE will continue to support and refine these activities to help create and sustain a U.S. workforce with the computing competencies and computational thinking skills imperative to the Nation's health, security, and prosperity in the 21st century.

In collaboration with partners across NSF, OCI will support creative explorations and demonstrations of the use of cyberinfrastructure to integrate research with education, the development of innovative technologies that will facilitate the integration of research and education, and research on how educators and students interact with cyberinfrastructure along with exploring novel uses of cyberinfrastructure.

Activities in other directorates include:

- BIO investments to strengthen IT capabilities in all biological sub-disciplines through support for postdoctoral fellowships in bioinformatics; integrative graduate programs that combine training in biology and computer sciences (via the NSF-wide Integrative Graduate Education and Research Traineeship (IGERT) program); undergraduate summer institutes in bioinformatics through the interagency Bioengineering and Bioinformatics Summer Institutes program; and other mechanisms.

- EHR will continue to study the impact of information and communication technology on educational practice, new approaches to using technology in education, application and adaptation of technologies to promote learning in a variety of fields and settings, the effects of technology on learning, and efforts that advance teaching and learning opportunities utilizing cyberinfrastructure. In FY 2011, EHR will fund research that highlights the educational use of information tools that operate seamlessly across formal and informal learning environments and across traditional computers, mobile devices, and newly emerging information and communications.
- SBE will continue to study the impact of IT on educational practice, new approaches to using technology in education, application and adaptation of technologies to promote learning in a variety of fields and settings, the effects of technology on learning, and efforts that advance teaching and learning opportunities in nanotechnology and/or cyberinfrastructure through the Science of Learning Centers (SLC) program.

NITRD Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request
Biological Sciences	$86.15	-	$93.00	$93.00
Computer and Information Science and Engineering	574.50	235.00	618.83	684.51
Engineering	20.75	3.30	23.70	23.70
Geosciences	18.98	-	22.98	22.98
Mathematical and Physical Sciences	85.01	24.24	85.39	84.51
Social, Behavioral and Economic Sciences	17.50	4.62	22.80	23.80
Office of Cyberinfrastructure	199.23	80.00	214.28	228.07
Subtotal, Research and Related Activities	1,002.12	347.16	1,080.98	1,160.57
Education and Human Resources	9.50	-	9.50	9.50
Total, NITRD	**$1,011.62**	**$347.16**	**$1,090.48**	**$1,170.07**

Totals may not add due to rounding.

RE-ENERGYSE: A DOE–NSF Partnership in Research and Education on Renewable Energy and a Sustainable Environment

RE-ENERGYSE (REgaining our ENERGY Science and Engineering Edge) is a developing partnership between the Department of Energy (DOE) and NSF that will inspire more young people to pursue careers in renewable energy and related environmental areas. Its goals are to address what President Obama has identified as the "generational challenge" of clean energy and to secure U.S. leadership in sustainable energy by building the clean energy workforce of the future. This partnership will build on: the scientific and engineering expertise of both agencies in the energy field, NSF's successful track record of integrating research with education using proven programs developed over the past two decades, and NSF's experience in linking research on energy, technology, and the environment with social, behavioral and economic research.

NSF and DOE will explore additional planning workshops that focus on identifying educational opportunities for sparking interest in careers related to sustainable energy and the environment, and identifying future workforce needs in these areas. NSF and DOE also have a continuing partnership in public awareness and outreach activities that support the goals of RE-ENERGYSE.

In FY 2011, NSF will invest roughly $19.0 million in RE-ENERGYSE through five existing research and education programs that help develop the future STEM workforce. These programs provide fellowships, traineeships, and research opportunities for undergraduate and graduate students, as well as build collaboration between academia and industry. NSF will contribute at least 5 percent of its support for the following programs towards specific, energy-related awards:

- Graduate Research Fellowship (GRF);
- Graduate STEM Fellows in K–12 Education (GK–12);
- Integrative Graduate Education and Research Traineeship (IGERT);
- Support for community colleges through Advanced Technological Education (ATE); and
- Research Experiences for Undergraduates (REU) sites.

Through these investments, the Nation will prepare a generation of young people to meet the clean energy challenge.

SCIENCE AND ENGINEERING BEYOND MOORE'S LAW (SEBML)

Goal: Position the U.S. at the forefront of communications and computation capability beyond the physical and conceptual limitations of current technologies.

Description and Rationale: The transistor was demonstrated in 1947, and once multiple devices were simultaneously fabricated, the packing density of devices on a chip began to increase. Moore's Law is the empirical observation, made in 1965, by the co-founder of Intel, Gordon E. Moore, that semiconductor device density, and therefore computer processing power, doubles about every 18 months. Currently, many innovations are being pursued to prolong the scalability of computer processing power, but with silicon technology the fundamental physical and conceptual limits of Moore's Law are likely to be reached in 10 to 20 years.

To take computation *beyond* Moore's Law requires new scientific, mathematical, engineering, and conceptual frameworks. Fundamental research across many disciplines will lead to the new hardware and architectures needed to address challenges such as efficient input and output, data storage and communication, and reduction of energy consumption, as well as sheer computing power. Further, there are also great potential increases in speed of basic computations due to innovative new algorithms and software, and new mathematical frameworks for computation. In the near term, massively parallel machines require a fundamental shift from the traditional sequential model of computation in order to utilize distributed paradigms such as grid and cloud computing. In the longer term, a completely new physical and conceptual foundation of computing will be needed.

Science and Engineering Beyond Moore's Law (SEBML) is a multidisciplinary research investment with strong ties to economic competitiveness and potential for transformation. Tied to nanotechnology, computer science, chemistry, mathematics, materials science, and physics, it builds on past NSF investments in these areas and energizes them with new directions and challenges. Connections to the communications and computer industries ensure that SEBML will directly address economic benefits to the Nation. SEBML research will also enhance NSF investments in both the National Nanotechnology Initiative (NNI) and Networking and Information Technology Research and Development (NITRD).

Potential for Impact, Urgency, and Readiness: The U.S. has fundamental strengths in computers and information systems. In today's globalized enterprise, however, many other countries dominate parts of the hardware and software markets. The areas where the U.S. currently excels are in innovative state-of-the-art components, which require a continual investment in research and development. The reward of this approach has been continual leadership in the areas of the largest economic return. To continue U.S. leadership, a paradigm shift is required in the physical foundations of computing.

Fundamental research will focus on a number of areas, including:

- *New materials, devices, and processes* that exploit the capability to create and manipulate specific quantum states. Some possible candidates include optical and photonic systems, spin-based or single electron transistors, atom condensates, ions, non-equilibrium devices, and molecular-based approaches including biologically inspired systems.
- *New architectures*, particularly multi-core processors, with new control principles, massive parallelism, and designed asynchronicity and indeterminacy. Advances here may be applicable to other kinds of communication, distribution, and computing systems, leading to truly transformational outcomes.
- *New algorithms* that exploit hardware and architecture characteristics to optimize computing power, including those that exploit quantum behavior. The consideration of biological and social systems may lead to new approaches.

- *New software* that allows the effective use of new devices. New programming models will be needed, along with languages and compilers to support them. Tools for analyzing, monitoring, debugging, and documenting software on these parallel and distributed systems will be essential.
- *New paradigms* that take us from bits (binary logic) to quantum bits or qubits (non-binary logic). These programming models are shifts in our thinking that will change the conceptual foundations of computing.
- *New awareness* of power and energy considerations throughout the "computation stack" from physical devices to architectures to software and applications.

Integration of Research and Education: SEBML has the potential to take computing and communications to new levels of capability, making the development of a workforce trained in these new areas particularly important. All activities will seek creative ways to engage students and, as appropriate, take new ideas into formal and informal learning environments.

Leveraging Collaborations: NSF has in place proven partnerships among its directorates, connections with other communities (notably other governmental funding organizations and industry), and collaborations with international partners. Strong potential exists for interagency partnering with organizations such as the Department of Defense, Department of Energy, National Aeronautics and Space Administration (NASA), National Institutes of Science and Technology and the intelligence community. NSF, in particular the Mathematical and Physical Sciences (MPS), Engineering (ENG), and Computer and Information Science and Engineering (CISE) Directorates, and the Office of Cyberinfrastructure (OCI) has the broad responsibility for support of fundamental research needed to have a significant technological impact.

Evaluation and Management: While it may be 10 to 20 years before the full impact of the investment is known, indicators of success will be developed and monitored along the way. Indicators of a growing capability to conduct research in SEBML include: increased numbers of students involved in SEBML projects and related data on breadth/diversity of participation, degree completion, opportunities to participate in interdisciplinary teaming, and progression to higher levels of education or first professional jobs; increased numbers of researchers involved in SEBML projects; numbers of collaborative projects that span disciplines or institutions; increased partnerships with national laboratories and private sector organizations; and the development of curricular materials or informal education activities that convey aspects of SEBML research. Indicators of research progress include highlights demonstrating progress from NSF awards; publications and patents resulting from NSF awards in SEBML; and public or private sector adoption of ideas from NSF awards in developing new technologies that stimulate innovation.

Committees of Visitors and other external review panels involving all sectors of the economy will be involved in evaluating progress on SEBML research and education.

SEBML Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request
CISE	$4.00	-	$15.00	$15.00
ENG	3.00	-	10.00	20.00
MPS	36.53	9.82	18.68	32.18
OCI	-	-	3.00	3.00
Total, NSF	**$43.53**	**$9.82**	**$46.68**	**$70.18**

Totals may not add due to rounding.

SCIENCE, ENGINEERING, AND EDUCATION FOR SUSTAINABILITY (SEES)

Goal: To generate the discoveries and capabilities in climate and energy science and engineering needed to inform societal actions that lead to environmental and economic sustainability.

Description and Rationale: Major drivers for establishing the NSF SEES portfolio are the August 2009 report from the *National Science Board: Building A Sustainable Energy Future* and the *IPCC Fourth Assessment Report: Climate Change 2007.*

- The scope of the SEES portfolio parallels the NSB's call for integrated approaches that "increase U.S. energy independence, enhance environmental stewardship and reduce energy and carbon intensity, and generate continued economic growth." The NSB provided specific guidance to NSF that emphasized systems approaches to research programs, education and workforce development, public awareness and outreach, and the importance of partnerships with other agencies, states, universities, industry, and international organizations.
- The IPCC Synthesis Report presented a number of key scientific uncertainties that if resolved would improve our ability to predict future climate change, its consequences, and the potential success of mitigation and adaptation strategies.

The two-way interaction of human activity with environmental processes now defines the challenges to human survival and wellbeing. Human activity is changing the climate and the ecosystems that support human life and livelihoods. Reliable and affordable energy is essential to meet basic human needs and to fuel economic growth, but many environmental problems arise from the harvesting, generation, transport, processing, conversion, and storage of energy. Climate change is a pressing anthropogenic stressor, but it is not the only one. The growing challenges associated with climate change, water and energy availability, emerging infectious diseases, invasive species, and other effects linked to anthropogenic change are causing increasing hardship and instability in natural and social ecologies throughout the world.

Solutions to these emergent, coupled problems will have to be based on sound multi-disciplinary and quantitative principles derived from science, engineering, and technology. It is not only urgent, but also timely and achievable to generate understanding of the links between energy sources and systems, climate forcings and feedbacks of the Earth system, and social, educational, and policy responses. This research will lay the foundation for technologies to mitigate against, and adapt to, environmental change that threatens sustainability. By informing policy, education, and management decisions, we will address the major challenge of ensuring human wellbeing over the long term.

Integrated Science and Engineering Research in Climate Change and Energy: NSF has broad and long-standing investments in environment, energy, climate, social sciences, mathematics, and many other areas of research and education that provide insight into the challenges to sustainable well-being in the 21st century. Fundamental research that underpins the development of innovative solutions to pressing problems in sustainability will continue to be supported and emphasized across NSF. This research – in such areas as complex environmental and climate-system responses and pathways – will be complemented by activities focused on sustainable and renewable energy technologies.

NSF's unique mandate to support all areas of science, engineering, and science education allows it to now identify SEES research aimed at tackling the complex system level problems of sustainability. SEES research will investigate the fundamental role that social, economic, and political systems play in creating and addressing major issues in sustainability. It will include conceptual, theoretical, empirical, and computational research needed to further develop the basic science, engineering, education, and policy knowledge base, as well as address the multifaceted challenges of sustainability (energy-economy-environment) at both individual and systems levels.

The NSB report outlined a range of SEES research investments in the area of sustainable energy: novel energy storage schemas; ecosystem impacts of energy technologies; improving the efficiency and yield of established sustainable energy systems, e.g. wind, solar; and the discovery and development of novel energy sources, e.g. biofuels, ocean/kinetic power. Energy-intelligent computational performance in computer and network systems will be explored as well as the use of information technology in smart sensing systems that have promise to save energy. Energy efficiency in manufacturing and materials will be stressed.

Some key scientific uncertainties identified in the IPCC report that SEES research will address include: interactions between the climate, human and natural systems; feedbacks in the climate and especially carbon cycles; impacts of ice sheets dynamics on climate change and sea level rise; regional climate change and causes; the difference between low probability/high impact vs. high probability/low impact events on risk-based approaches to decision making; interactions between socio-economic factors and the evolution and utilization of adaptive and mitigating strategies; barriers, limits and costs of adaptation; effects of lifestyle and behavioral changes on energy consumption and climate.

Scientific and engineering research in SEES will benefit from creative mathematical, statistical and computational methods for analysis and simulation. Supercomputing capability will be enhanced in support of improved predictability and communication at the climate-energy-society nexus. Many efforts will build on the climate research emphasis initiated in FY 2010, including research on regions highly susceptible to the impacts of environmental changes, such as coastal areas subject to sea-level rise, the Arctic where permafrost is changing rapidly, and the Antarctic where sub-ice sheet conditions are being explored and modeled.

In addition to advances in research, these awards will_include activities that help prepare an informed, solutions-oriented citizenry and future work force to address the complex problems and decisions associated with sustainability. Experiences for undergraduate, doctoral and postdoctoral students will complement those supported by the Climate Change Education program.

Management and Assessment: As an investment portfolio, SEES will support research and education that span ten NSF directorates and offices. Because it will build on and initiate activities that are dispersed, there is a need to create an integrated management framework for the complex, highly interdisciplinary, yet integrated activities that will be effective in addressing the challenge of sustainability. For example, additional planning will occur during FY 2010 in order to consult with a wide spectrum of disciplinary communities, form partnerships, and identify shared priorities. Specific measures will therefore be established to provide coordination and guidance across this portfolio.

The organizational structure will include:

- A senior leadership committee composed of Assistant Directors/Office Heads to provide long-term planning and provide overall guidance;
- Working groups of program directors, each overseen by Assistant Directors/Office Heads/Division Directors who are most relevant to the specific activity to manage programs or activities; and
- Interagency working groups to coordinate interagency activities, which may require establishment of MOUs/MOAs and joint solicitations between the collaborating agencies.

Specific outcomes will include:

- Emergence of new areas of research, identified in FY 2010 and FY 2011, that help close key gaps in the knowledge base;
- Development of new models for the conduct of research, specifically employing integrative, systemic approaches. These will be used by investigators and evaluated between FY 2014 and FY 2016; and
- Generation of new integrated understanding of the interplay of environment, energy, and the economy. Communication and publication of results is expected primarily after awards conclude, beginning as early as FY 2014.

To develop the evaluation framework necessary to monitor progress toward these outcomes, the senior leadership committee will consider a matrix of assessment methods and measures that captures a range of outcomes and impacts. These outcome metrics and targets will be developed during FY 2010. The Advisory Committee for Environmental Research and Education, in addition to other existing NSF advisory committees, will provide input to the senior leadership committee and establish, as appropriate and timely, Committees of Visitors to assess outcomes of programs. NSF will engage the community through workshops in FY 2010 to gather input and explore potential approaches, including those emerging from NSF-funded work in the Science of Science and Innovation Policy program.

Funding: SEES is constructed as a portfolio of investments (e.g., individual investigators, small interdisciplinary teams, and larger groups) that include new as well as augmented ongoing activities in climate and energy research and education that are directly relevant to the SEES goal of informing societal actions needed for a sustainable Earth. This portfolio-based approach is intended to facilitate coordination, monitoring and impact across the major NSF investments.

Activities in FY 2011 include refreshing and integrating ongoing programs and issuing new solicitations for SEES. Identification of needs for further coordination and integration to address key science and engineering challenges will be an ongoing high priority.

SEES Portfolio Funding Levels

(Dollars in Millions)

	FY 2010 Estimate	FY 2011 Request
Biological Sciences	$121.00	$126.00
Computer and Information Science and Engineering	17.00	29.36
Engineering	108.20	120.00
Geosciences	195.50	230.70
Mathematical and Physical Sciences	87.00	110.50
Social, Behavioral and Economic Sciences	20.78	27.98
Office of Cyberinfrastructure	5.50	5.00
Office of International Science and Engineering	2.50	8.20
Office of Polar Programs	65.26	69.26
Office of Integrative Activities	26.50	26.50
Total, R&RA	**$649.24**	**$753.50**
Education and Human Resources	$11.50	$12.00
Total, NSF	**$660.74**	**$765.50**

Totals may not add due to rounding.

U.S. GLOBAL CHANGE RESEARCH PROGRAM (USGCRP)

Climate has a pervasive effect on the U.S. through its impact on the environment, natural resources, and the economy. The U.S. Global Change Research Program (USGCRP) is providing the Nation and the world with the science-based knowledge to predict climate change and environmental responses, manage risk, and take advantage of opportunities resulting from climate change and climate variability. Research conducted through the USGCRP (www.globalchange.gov) builds on the scientific advances of recent decades and deepens our understanding of how the interplay between natural factors and human activities affects the climate system. The USGCRP engages 13 U.S. agencies in a concerted interagency program of basic research, comprehensive observations, integrative modeling, and development of products for decision-makers. NSF provides support for a broad range of fundamental research activities that provide a sound scientific basis for climate-related policy and decisions.

The Earth's climate is determined by highly complex interactions between and among the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere – all significantly influenced by human activities. NSF programs address these components by investing in fundamental discovery, utilizing the full range of intellectual resources of the scientific community; research infrastructure that provides advanced capabilities; and innovative educational activities. As a key participating agency in the USGCRP, NSF encourages interdisciplinary activities and focuses particularly on Earth system processes and the consequences of change. High priorities for the agency include data acquisition and information management activities necessary for global change research; the enhancement of models designed to improve our understanding of Earth system processes and the feedbacks that link ecosystems and the physical climate; the development of new, innovative Earth observing instruments and platforms; and the development of advanced analytic research methods. NSF also supports fundamental research on the general processes used by organizations to identify and evaluate policies for mitigation, adaptation, and other responses to varying environmental conditions. NSF will be actively involved in the development of a new strategic plan for the USGCRP.

U.S. Global Change Research Program Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request
Biological Sciences	$61.00	$20.00	$81.00	$89.00
Engineering	$1.00	-	-	-
Geosciences	160.00	50.00	194.00	225.00
Mathematical and Physical Sciences	13.48	2.75	7.28	7.63
Social, Behavioral and Economic Sciences	15.48	3.00	18.48	25.98
Office of Polar Programs	18.30	44.79	18.30	22.30
Total, U.S. Global Change Research Program	**$269.26**	**$120.54**	**$319.06**	**$369.91**

Totals may not add due to rounding.

FY 2011 Areas of Emphasis:

NSF's FY 2011 investment in USGCRP increases by $50.85 million, or 15.9 percent, over the FY 2010 Estimate of $319.06 million. The Directorates for Biological Sciences and Geosciences together contribute the largest portion of this increase, a total of $39.0 million totaling $314.0 million in FY 2011. Other contributions come from the Directorate for Social, Behavioral and Economic Sciences, the Office of Polar Programs, the Directorate for Engineering, and the Directorate for Mathematical and Physical Sciences. Specific foci include:

- Supporting a broad research portfolio in carbon cycling, biodiversity, and ecological systems including major themes such as abrupt environmental changes; balancing the carbon budget; water, ice, and ecosystems; and the impact of ocean acidification;
- Enhancing scalability of climate and ecosystem models to move climate modeling from the global to regional and decadal scales; move ecological modeling from the local to the regional scale; and improve predictability at multiple scales to inform decision makers;
- Expanding research efforts on human, social, and economic dimensions of climate change, with particular attention to implications for government agencies, private organizations, and individuals faced with the need to make decisions regarding adaptation and mitigation in a new climatic environment;
- Improving, upgrading and deploying critical environmental observing platforms and systems; and
- Expanding the Nation's workforce trained to address complex environmental challenges.

The overarching themes of the USGCRP program in FY 2011 are as follows:

U.S. Global Change Research Program Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request
Atmospheric Composition	$30.67	$10.56	$28.90	$28.90
Climate Variability & Change	91.39	53.18	95.96	123.31
Water Cycle	27.18	9.93	40.18	42.18
Carbon Cycle	42.73	11.99	55.73	57.73
Land Use/Land Cover	8.30	-	8.30	8.30
Terrestrial & Marine Ecosystems	49.67	30.71	66.67	75.67
Human Contributions & Responses to Climate Change	18.32	4.17	23.32	33.82
Total, U.S. Global Change Research Program	**$268.26**	**$120.54**	**$319.06**	**$369.91**

Totals may not add due to rounding.

Atmospheric Composition – NSF programs in tropospheric and stratospheric chemistry will continue in FY 2011 to address the composition of the atmosphere and its relation to climate variability and change, and linkages between the atmosphere and the biosphere, land surface, oceans, and cryosphere. Studies of the transport and transformation of gaseous constituents and aerosols provide insights into the radiative and cloud nucleating properties of the atmosphere. Greenhouse gases are particularly important since they are the principal absorbers and re-radiators of heat. Results of these studies serve as important inputs for the assessment reports of the Intergovernmental Panel on Climate Change (IPCC).

Climate Variability and Change – In FY 2011, NSF programs will continue to emphasize climate variability and change across temporal and spatial scales, supporting observational campaigns, use of paleoclimate proxy information, and numerous analytical and modeling activities. These activities will improve parameterizations of unresolved dynamics and address biases in global climate models, including those related to the role of human activities. A continuing and important focus is on changes in the Atlantic Meridional Overturning Circulation and its interactions with the atmosphere to improve understanding of the processes and explore possible future changes, particularly those that may happen abruptly. The Community Climate System Model will continue to improve through incorporation of small-scale ocean processes, aerosol radiative forcing, stratospheric dynamics, interactive chemistry, and biogeochemical cycles. Coupled climate model studies on decadal predictability at regional scales will be initiated and will include exploratory research on initialized climate modeling. Significant new resources will be devoted to the intellectually challenging task of advancing climate modeling capabilities from global and centennial scales to decadal and regional scales. Analyses of model output will focus on extreme climate events, such as hurricanes, droughts, and major ecological disturbances, in order to determine the mechanisms responsible and to evaluate their representation in models. Studies of paleoclimatology will continue to be supported as a means to provide baseline data on natural climate variability from the past and from key climatic regions. These studies improve our understanding of the natural variability of the climate system and will enable reconstructions and evaluations of past environmental change as inputs for model validations.

Water Cycle – NSF supports research to understand all aspects of the global water cycle. Relevant programs will continue to explore ways to utilize more effectively the wide range of hydrologic data types – continuous and discrete information from a variety of platforms – for research purposes. A community-initiated Hydrologic Information System, which provides data access and analysis tools, continues to expand, serving both research and operational communities, and is considered a model to be emulated internationally. Data from process studies will be used to refine models through parameterizations of sub-grid processes, particularly the fluxes of water through the Earth system, including human-managed systems. High resolution cloud system models are being refined to address the persistent problems of moist convection and cloud processes – two of the more challenging and uncertain components in climate change calculations. Our ability to study integration and coupling of Earth surface processes as mediated by the presence and flux of fresh water has been greatly expanded with six Critical Zone Observatories.

Carbon Cycle – NSF provides support for a wide variety of carbon cycle research activities, from the underlying biological and geophysical processes to critical long-running oceanic time series stations and atmospheric records as well as planning and data management. FY 2011 investigations will continue to examine a wide range of topics in terrestrial and marine ecosystems and their relations to the carbon cycle. Research in terrestrial settings will explore, for example, carbon storage, delivery of carbon by rivers, carbon fluxes from wetlands and high-latitude soils, the role of microbial processes, and submarine groundwater discharge in the oceans, ocean acidification, and remineralization in mesopelagic zones. Studies on the role of ocean acidification and the capacity of the oceans to absorb carbon will be highlighted, as will research on the coupling of nitrogen and carbon cycles – both are critical to improvement of ocean and global carbon models. Carbon cycle studies will integrate observational data into models to provide insights for understanding key aspects of the global carbon cycle and feedbacks on the climate system and on strategies to investigate and adapt to climate change through CO_2 sequestration.

Land-Use and Land-Cover – Several NSF programs continue to address key aspects of land-use and land-cover change through studies in ecological rates of change and related aspects of biodiversity, Arctic systems, temporal variability, biophysical feedbacks to the climate system, water and energy influences on vegetative systems, and human influences on land use.

Terrestrial and Marine Ecosystems – Several NSF programs address terrestrial and marine ecosystems through observational, experimental, modeling, and laboratory studies. The Long Term Ecological Research (LTER) program supports the collection of time-series data on key ecosystem processes and funds research on the drivers of ecosystem change in terrestrial and marine systems. The Global Ocean Ecosystem Dynamics program and follow-on activities will continue studies on the impact of global ocean changes on marine ecosystems through specific syntheses focused on the North Atlantic, the North Pacific and the Southern Ocean. Research will continue to focus on understanding the impact of increasing carbon dioxide on ocean pH levels (ocean acidification) and the impacts on marine organisms, ecosystems, and chemistry from tropical coral reefs to polar regions. New efforts focused on the coastal ecosystem processes and macrosystems biology at regional to continental scales.

Human Contributions and Responses to Climate Change – NSF supports basic research on the processes through which people (individually or through organizations) interact with environmental systems. FY 2011 funding supports collaborative teams that focus on decision making under uncertainty associated with climate change. These teams are expected to produce new knowledge and tools that should facilitate improved decision making related to climate variability and change. In addition, climate studies will be a major theme in NSF's cross directorate program, Dynamics of Coupled Human and Natural Systems, which examines the complex interactions and feedbacks between these systems. Finally, NSF will fund basic research on climate-related decision support for government agencies, private organizations, and individuals facing a changing environment in which making decisions based on past climatic averages is no longer prudent.

SELECTED CROSSCUTTING PROGRAMS

NSF crosscutting programs include interdisciplinary programs and programs that are supported by multiple directorates. Examples of major crosscutting activities include the following:

ADVANCE: A budget of $21.65 million for ADVANCE in FY 2011, an increase of $630,000 above the FY 2010 Estimate of $21.02 million, will fund transformative efforts to address the systemic barriers to women's full participation in academic science, technology, engineering, and mathematics (STEM). ADVANCE will broaden the spectrum of institutions participating in the program. Predominantly undergraduate institutions, teaching intensive colleges, community colleges, minority-serving institutions, and women's colleges will be reached through the IT-Catalyst program component, which provides support to institutions to undertake institutional self-assessment activities. The funding will also support new awards under the Institutional Transformation (IT) program component as well as an overall program evaluation and data collection to capture the impact of prior ADVANCE awards. To this end, ADVANCE has initiated the process for an evaluation of its program, focusing primarily on awards that have completed their funding cycles. The two organizations leading this effort include Urban Institute and Westat. The Urban Institute will qualitatively evaluate awards from several components of the ADVANCE program including the Partnerships for Adaptation, Implementation and Dissemination (PAID), IT and Leadership awards. This evaluation component will highlight models of implementation through carefully designed case studies. It is expected that case studies will provide the ADVANCE program with valuable information on mechanisms of intervention implementation at a range of institutions, as well as an understanding of institutional barriers that promote the underrepresentation of women in the academic STEM disciplines and how these barriers can successfully be addressed. As a result, conclusive theories will be produced that can serve to guide future program directions. Secondly, Westat will provide a quantitative analysis of the ADVANCE program, focusing on both institutional transformation and fellows awards. To achieve this goal, this organization will not only conduct in-depth surveys of initial cohort institutions, but will also use national data sets to draw conclusions about program effectiveness. As a result, Westat's findings will inform the ADVANCE program of specific outcome measures for institutional transformation at the institutional and individual levels. The dissemination and adaptation of models and strategies that have demonstrated effectiveness, as well as research on gender in academics, will continue to be supported through the PAID program component.

Climate Change Education Program: The FY 2011 Request provides $10.0 million for the Climate Change Education (CCE) program, equal to the FY 2010 Estimate. The Directorates for Education and Human Resources, Geosciences, Biological Sciences, and the Office of Polar Programs will support this Administration priority program. CCE is a multi-disciplinary, multi-faceted climate change education program that will enable a variety of partnerships, including those among K-12 education, higher education, the private sector, and related non-profit organizations, in formal and informal settings, as well as relevant education and/or climate-related policymakers. It will support individual investigators and multidisciplinary teams of STEM researchers and educators in a range of activities, including those local, regional, and/or global in scope.

NSF has made an award to the National Research Council to implement an 18-month roundtable process that will examine key issues and needs inherent to climate change education. The roundtable is bringing together federal and state policymakers, educators, communications and media experts, and members from the business and scientific community. Insights gained through the roundtable are providing NSF with important foundational knowledge related to key aspects of CCE and learning, such as the nature and scope of existing efforts, achievable and measurable goals, challenges and opportunities inherent in developing a national level CCE initiative, and areas where investments in FY 2011 may provide the greatest leverage.

Faculty Early Career Development (CAREER): The FY 2011 Request provides $209.16 million for the CAREER program, which is a continuing Administration priority program. This is an increase of $12.77 million over the FY 2010 Estimate of $196.39 million. This will result in approximately 60 more CAREER awards than in FY 2010. CAREER awards support exceptionally promising college and university junior faculty who are committed to the integration of research and education and who are most likely to become the academic leaders of the 21st century.

Graduate Fellowships and Traineeships: The FY 2011 Request provides $272.89 million for NSF's three flagship graduate fellowship and traineeship programs. This funding will enable NSF to support an estimated 5,775 graduate students.

- $158.24 million for the Graduate Research Fellowship (GRF) program, an increase of $22.32 million over the FY 2010 Estimate of $135.92 million, will provide up to 3 years of support over a 5-year period to graduate students in all STEM fields. The GRF program is widely recognized as a unique fellowship grant program because it supports the broad array of science and engineering disciplines across all fields as well as international research activity. In FY 2010 NSF received thousands of applications for these highly prestigious and competitive awards, resulting in 2,000 new fellows. The GRF program expects to award 2,000 new fellows in FY 2011 as well. The table below contains the total number of fellows, number of new fellows, and number of fellows on tenure in FYs 2010 and 2011. The FY 2011 Request for GRF program is increased to provide funding for more U.S. citizens, nationals, and permanent resident aliens. As an Administration priority program, NSF has committed to tripling the number of new fellowships awarded over the FY 2008 level by FY 2013.

NSF Graduate Research Fellowship Program

	Total Number of Fellows	Number of New Fellows	Projected Fellows on Tenure
FY 2010 Estimate	5,600	2,000	2,500
FY 2011 Request	6,700	2,000	3,400

- $61.80 million for the Integrative Graduate Education and Research Traineeship (IGERT) program, a decrease of $7.43 million below the FY 2010 Estimate of $69.23 million. The decrease in funding reflects a reallocation of support to other activities, primarily within the Mathematical and Physical Sciences and Biological Science directorates. IGERT will support comprehensive Ph.D. programs that are innovative models for interdisciplinary education and research and that prepare students for academic and non-academic careers. Funding will support an estimated 1,500 IGERT trainees. Funds for this program are well justified. In 2009 Abt Associates, Inc. completed a survey of over 800 IGERT graduates in order to investigate the short-term professional outcomes of IGERT graduates and assess whether the IGERT program has prepared funded graduate students for successful STEM-related careers and developed their capacity for research, teaching, and leadership. Preliminary results show that IGERT graduates overwhelmingly reported that their graduate preparation gave them a competitive edge when applying for positions in the workforce and that their IGERT experience specifically helped them obtain a position. In addition, IGERT graduates credited their interdisciplinary experiences as influential in securing employment.

- $52.85 million for the NSF Graduate STEM Fellows in K-12 Education (GK-12) program, a decrease of $1.46 million below the FY 2010 Estimate of $54.31 million, will provide support to higher education institutions. This support will be used to transform their existing graduate training programs through strong partnerships with local school districts by innovative integration of leading STEM research findings and practices with K-12 education in a manner that benefits graduate fellows, teachers, and students. The GK-12 program provides value-added experiences to graduate fellows to improve their leadership, communication, teamwork, and teaching skills while providing professional opportunities for teachers and enriching STEM learning in K-12 schools. Preliminary evaluative findings conducted in 2005 by AIR Associates indicate that GK-12 is meeting its goal of enabling graduate students in STEM disciplines to acquire additional skills that will prepare them for professional and scientific careers. In 2007, the program engaged Abt Associates, Inc. in the development of a thorough evaluation of the program to provide data related to the success of GK-12. The first draft of the results is expected in early calendar year 2010. FY 2011 funding will support an estimated 875 graduate fellows.

Long-Term Ecological Research (LTER): The FY 2011 Request provides $28.10 million, an increase of $160,000 above the FY 2010 Estimate of $27.94 million. LTER supports fundamental ecological research that requires long time periods and large spatial scales. This program supports a coordinated network of more than two dozen field sites that focus on: 1) understanding ecological phenomena that occur over long temporal and broad spatial scales; 2) creating a legacy of well-designed and documented ecological experiments; 3) conducting major syntheses and theoretical efforts; and 4) providing information necessary for the identification and solution of environmental problems. LTER field sites represent a diversity of habitats in continental North America, the Caribbean, Pacific Ocean, and the Antarctic, including coral reefs, deserts, estuaries, lakes, prairies, various forests, alpine and Arctic tundra, urban areas, and production agriculture. The National Ecological Observatory Network (NEON) will begin construction in FY 2011, the first year of a six-year construction project. NEON infrastructure will be co-located at eleven LTER sites. This co-location will permit the integration of the historic long-term LTER research into NEON and allow scientists to scale the site based research to regional and continental scales. Increased support in FY 2011 covers planned periodic increases to cover higher costs as sites are renewed.

Research Experiences for Teachers (RET): The FY 2011 Request for NSF's RET program totals $5.52 million, a decrease of $120,000 below the FY 2010 Estimate of $5.64 million. Funding will provide pre-service and in-service K-12 teachers with discovery-based learning experiences.

Research Experiences for Undergraduates (REU): The FY 2011 Request for NSF's REU program totals $67.27 million, an increase of $610,000 above the FY 2010 Estimate of $66.66 million. The increase proposed for FY 2011 is consistent with the recent (July 2006) external evaluation of REU by SRI International. It found that undergraduate students who participate in hands-on research are more likely to pursue advanced degrees and careers in STEM fields. REU supplements support active research participation by undergraduate students in any area of research funded by the NSF by providing supplements to research grants. REU sites involve students in research who might not otherwise have the opportunity, particularly those from institutions where research programs are limited. A significant fraction of the student participants come from outside the host institutions. Some REU grants have been extended to the freshman and sophomore levels to enhance retention and graduation rates. Beginning in FY 2009, efforts have been made to create partnerships between community colleges and baccalaureate degree granting institutions to provide research opportunities for community college STEM students and faculty. This will continue to be a focus in FY 2011.

Research in Undergraduate Institutions (RUI): The FY 2011 Request for NSF's RUI program totals $37.45 million, an increase of $130,000 million above the FY 2010 Estimate of $37.32 million. The RUI activity supports research by faculty members of predominantly undergraduate institutions through the funding of (1) individual and collaborative research projects, (2) the purchase of shared-use research instrumentation, and (3) Research Opportunity Awards for work with NSF-supported investigators at other institutions.

Science and Technology Centers (STCs): The FY 2011 Request for the Science and Technology Centers program totals $66.03 million, an increase of $8.26 million above the FY 2010 Estimate of $57.77 million. For additional information, see the NSF Centers Programs section of this chapter.

FY 2010 SUPPORT FOR POTENTIALLY TRANSFORMATIVE RESEARCH

In FY 2010, each R&RA directorate has allocated a minimum of $2.0 million per research division ($94.0 million Foundation-wide) to explore methodologies that help support potentially transformative research (PTR). NSF identifies PTR as work that may lead to:

- Dramatically new ways of conceptualizing or addressing major scientific and technological challenges.
- New methods or analytical techniques that could put a discipline on a new scientific pathway, provide tools that allow unprecedented insights, or radically increase the rate of data collection.

A set of Foundation-wide processes and methods is in place and available to all directorates and offices to encourage innovation and identify potentially transformative research. Primarily, specialized solicitations, competitions, and funding mechanisms such as EAGER (EArly-concept Grants for Exploratory Research) are used. Some directorates have specialized activities, described below.

Approaches being explored at NSF in FY 2010 fall into several categories:

- Alterations to the merit review process
  - Training of reviewers to recognize PTR as a review criterion (CISE, BIO, GEO);
  - Creativity training for program managers (BIO); and
  - "Re-review": Use of secondary or shadow panels to focus on PTR (SBE/SES) and use of a second-dimension approach for rating proposals (CISE, ENG).

- Greater use of specialized award mechanisms
  - Venture funds for EAGER mechanisms (all DIRs and offices);
  - Creativity extensions/program officer challenges (incentivized by BIO); and
  - Seed grants (OCI).

- Novel uses of solicitations, competitions, and workshops to create change in the external community
  - "Emerging Frontiers" solicitation development model, wherein the science and engineering community is engaged in the development of solicitations over time (e.g. ENG/EFRI);
  - Radically new mechanisms such as the "sandpit" process for intense, rapid development of collaborative proposals (BIO/MPS/SBE, with the Engineering and Physical Sciences Research Council of the United Kingdom) and the crowd sourcing, clean slate, or prediction market paradigms (pioneered by BIO); and
  - Solicitations designed to bridge diverse topics and fields (SBE, CISE).

Below is more specific information on the planned approaches of NSF directorates for these funds.

BIO: $20.0 million
Anticipated Approaches: Efforts in BIO will be conducted through the Office of Emerging Frontiers (EF), which will lead efforts to:
- Identify and implement thematic research areas that transcend scientific disciplines and/or advance the conceptual foundations of biology; and
- Provide up to $2 million in matching funds to each of the four BIO divisions to develop one or more emerging thematic research areas that cross at least two divisions within BIO or elsewhere in NSF. It

is expected that, in addition to supporting innovative research, these activities will incorporate innovative processes, such as:

- Developing and implementing new forms of peer review; and
- Testing new mechanisms to support transformative research and stimulate creativity, such as crowd sourcing, clean slate, sandpits, or prediction markets.

CISE: $8.0 million
Anticipated Approaches: as noted above, CISE will rely principally on specific activities within the merit review process (such as special instructions to reviewers and the "re-review" of proposals), as well as special solicitations that bring diverse topics and fields (such as CreativeIT).

ENG: $37.0 million
Anticipated Approaches: The ENG directorate has a number of programs focusing on potentially transformative research, which facilitate the transfer of knowledge creation and discovery to products and processes of societal benefit. Two examples of such programs include:

- The Office of Emerging Frontiers in Research and Innovation, which evaluates, recommends, and funds interdisciplinary initiatives at the emerging frontiers of engineering research and innovation; and
- The Engineering Interdisciplinary Research (IDR) program supports potentially transformative, interdisciplinary research proposals which span the boundaries of traditional disciplines and engineering Divisions.

GEO: $8.0 million
Anticipated Approaches: As noted above, GEO will rely principally on specific activities within the merit review process (such as special instructions to reviewers). It also intends to support projects of a size and complexity that makes them difficult to support within existing programs, but that possess a potential for transformation and impact that makes the investment compelling.

MPS: $10.0 million
Anticipated Approaches:

- Support for new research networks that will provide new models for research collaboration;
- Approvals for two-year Creativity Extensions for high-risk, high-reward research that has already shown promising results;
- Support for EAGER proposals, especially in the area of untested approaches to MPS sciences;
- Additional funding for Centers conducting high-risk, high-reward research; and
- Investments in individual investigator proposals deemed by review panels to be the most innovative.

OCI: $2.0 million
Anticipated Approaches: As noted above, OCI will rely principally on specialized award mechanisms, such as seed grants, to leverage and foster PTR in FY 2010.

OPP: $4.0 million
Anticipated Approaches: OPP will focus on activities through the merit review process for identifying potentially transformative research, with follow-up assessment activities to compare the different approaches.

SBE: $5.0 million

Anticipated Approaches: Investments will draw from themes that are emerging in the social and behavioral sciences as these fields incorporate theoretical approaches, analytical techniques, models and innovative methodologies. These include development of enabling infrastructure and support of large-scale interdisciplinary work conjoining the human sciences with other disciplines in novel combinations. Challenge program officers and panels to articulate clearly the criteria by which they designate research as transformative.

Following this FY 2010 investment, NSF will engage in a number of activities to compare the different approaches, to determine the most effective approaches to employ in future years. These assessment will include traditional means, such as the use of Committees of Visitors, plus the development of tools particular to solicitations as they are developed.

PERFORMANCE INFORMATION

STATUS REPORT ON FY 2010-2011 PERFORMANCE ASSESSMENT FRAMEWORK

FY 2010 and FY 2011 will be transitional years for performance assessment and reporting at NSF. A number of recent developments and ongoing activities directly affect both NSF's current and future approach to these activities.

- The NSF Strategic Plan is being updated for FY 2011 to FY 2017. The new plan is expected to be completed by the summer of 2010.
- New approaches and methods are now available for assessing the performance of NSF's investments in science and engineering research and education. Many of these new approaches draw upon work supported by the NSF program in the Science of Science and Innovation Policy (SciSIP).
- NSF is also addressing recommendations from the FY 2009 report of the Advisory Committee for GPRA Performance Assessment (AC/GPA). The committee specifically examined alternative methods alternative approaches to performance assessment at NSF, and it recommended that NSF "c*onsider an assessment framework that uses multiple measures and methods, applied over various time scales."*

In light of these developments, a number of changes are already underway in FY 2010. Of particular note is that in FY 2010 NSF is employing a simplified and streamlined performance framework to meet the assessment and reporting requirements established by the Government Performance and Results Act (GPRA). This framework is presented in the next section of this chapter.

In addition, NSF is pursuing a number of activities to pilot and review new approaches to the assessment and evaluation of NSF's programs. These activities will be pursued in conjunction with the update of the NSF Strategic Plan. Examples of these activities include:

- The STAR METRICS project (Science and Technology in America's Reinvestment – Measuring the Effect of Research on Innovation, Competitiveness and Science). NSF is working with OSTP and other agencies of the National Science and Technology Council (NSTC) to develop a data-driven analytical capability for assessing impacts of federal investments in science and engineering research and education. For additional information, please see the Integrative Activities chapter.
- Initial planning activities related to establishing an NSF-wide capability for assessment and evaluation, as requested in FY 2011 under Agency Operations and Award Management. This centralized capability would bring greater attention and analysis to such areas as comparing different types of programmatic investments and identifying the most effective means for continuous improvement across the NSF portfolio. This effort is part of the Administration's government-wide initiative to build capacity within agencies to strengthen their program evaluation. NSF's development plan was approved by the Office of Management and Budget for FY 2011, and NSF will work with evaluation experts at OMB and the Council of Economic Advisers during the planning, design, and implementation stages.
- The continued development of goals and metrics for activities under the NSF learning portfolio (see next page).

NSF will also continue to engage external experts in keeping with the recent work of the AC/GPA on improving the NSF performance framework. Issues and questions likely to be addressed include:

- Which emerging approaches and methods provide the most useful insights into the performance of NSF's investments?
- What considerations should be incorporated into the new Strategic Plan to encourage the appropriate implementation of these new approaches?
- What key factors should be considered as NSF develops an agency-wide capability for evaluation and assessment?

The results of these FY 2010 activities will help to determine the NSF performance framework for FY 2011 and future years.

Development of Goals and Metrics: NSF Learning Portfolio

NSF's Directorate for Education and Human Resources (EHR) has strengthened internal capacity in STEM education program evaluation, and has continued to continue to increase expectations for the field that evaluation is central in the research and development work funded by EHR.

- All EHR programs are concerned with building knowledge of effective practices for improving STEM learning and require evidence at the project level, as appropriate, to both measure impact and to understand the impact of programmatic innovation on learning.
- A directorate working group has developed metrics for all EHR programs, and will continue to expand and refine those efforts in FY 2010 and FY2011.
- EHR will extend the internal professional development workshops that have been conducted for the staff to build understanding about the range of techniques appropriate for evaluation of STEM education research and development projects.
- EHR is launching several new program evaluations, and preparing to catalyze, through existing programs, increased research, theory-building, and tool development to advance the science of STEM education program evaluation.

In FY 2010, as noted in the Revised GPRA Performance Plan (see next section), goals and metrics will also be developed for R&RA-funded activities in the Learning portfolio.

Following are examples of the ways in which EHR is using metrics to assess programs and how results of a range of evaluation processes are being used to inform program improvements and new directions. A full list of EHR programs for which metrics have been devised can be found at www.nsf.gov/about/budget/fy2011.

PROGRAM	Integrative Graduate Education and Research Traineeship Program (IGERT)
EVALUATION APPROACHES	Annual on-line surveys Annual comprehensive external evaluations Input from Committees of Visitors (COV)
FINDINGS	• Surveying recent IGERT graduates provides information on the workforce outcomes of IGERT participation. A survey of over 800 graduates found that name recognition of the program and their interdisciplinary training gave graduates a competitive edge in the workforce and helped them obtain their current positions. • In response to COV input, the program is tracking the quality of publications at a greater level of detail, and reports that changes in data collection for this area are leading to improved data integrity.

IMPLICATIONS	The findings suggest that "number of contributions to the research enterprise" and "number and/or percentage of graduate traineeship recipients who complete a STEM graduate program" may be relevant metrics. This information is being used to inform the improvement of monitoring systems.

DIVISION: Human Resource Development. HRD sees evaluation as critical to the ongoing improvement of programs and its efforts to determine its effectiveness in addressing its key programmatic goals.

PROGRAM	Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)
EVALUATION FINDINGS	Independent evaluation of the HBCU-UP program reveals that HBCU-UP graduates outperform samples of STEM baccalaureate degree holders in degree completion and participation in the STEM workforce with graduate degrees.
IMPLICATIONS	Therefore, assessment of these programs has the potential to identify which strategies and interventions are most successful. Assessment of this program's success could also contribute to the body of scholarly work about theories and practice related to diversity in the scientific workforce.

PROGRAM	• Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (ADVANCE) • Alliances for Graduate Education and the Professoriate (AGEP) • Centers of Research Excellence in Science and Technology (CREST) • Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) • Tribal Colleges and Universities (TCUP)
EVALUATION APPROACH	Coordinated evaluations of these programs will yield important information for continued program realignment and improvement, in part by helping determine which metrics in which measures are most relevant to the goal of building the STEM workforce.
FINDINGS	Findings are not yet available, but some sample metrics might be: • the number of students who complete a STEM degree program (AGEP) • the retention rates of women faculty in STEM disciplines (ADVANCE) • the number of new STEM curricula, courses, and infusion of technology that enhance instruction (TCUP)

FY 2010 REVISED GPRA ANNUAL PERFORMANCE PLAN

As required by the Government Performance and Results Act, NSF will measure its performance in FY 2010 by working to achieve the following goals. These goals can be achieved with NSF's requested FY 2010 staff and budgetary resources.

Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit, and establishing the nation as a global leader in fundamental and transformational science and engineering.

Research & Related Activities	Education & Human Resources
$3,978.94 million	$191.44 million

Performance Goal	**Measure**		**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**FY 2009**	**FY 2010**
Time to decision*	For 70 percent of proposals, be able to inform applicants whether their proposals have been declined or recommended for funding within six months of deadline, target date, or receipt date, whichever is later.	**Target**						70%
		Result	73%	76%	75%	76%	89% in Q1**	

Potentially transformative research	As described in the FY 2011 NSF-Wide investments chapter, each R&RA directorate will invest a minimum of $2 million per research division to leverage and facilitate activities to foster potentially transformative research. The total NSF-wide investment in FY 2010 is projected to be $94 million.	New goal in FY 2010	$94 million
*Reported under "Stewardship" prior to FY 2010. **In FY 2009, this goal was in effect only for the period October 1 through December 31, 2008 (Quarter 1, FY 2009). The goal was suspended for all actions taking place between January 1, 2009 and September 30, 2009 to allow for a greater number of proposals to be processed with the additional funds from the American Recovery and Reinvestment Act of 2009.			

Learning: Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.

Research & Related Activities	Education & Human Resources
$342.40 million	$668.73 million

Performance Goal	Measure		FY 2009	FY 2010
Develop goals and metrics for NSF's programmatic investments in its Learning portfolio.	Percent of NSF Learning portfolio with established metrics.	**Target**	80%	100%
		Result	80%	

Research Infrastructure: Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure, and experimental tools.

Research & Related Activities	Education & Human Resources	Major Research Equipment & Facilities Construction
$1,593.17 million	$15.71 million	$165.19 million

Performance Goal	Measure		FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Major Research Equipment and Facilities Construction*	For all MREFC facilities under construction, keep negative cost and schedule variance at or below 10 percent	**Target**	100%	100%	100%	100%	100%	100%
		Result	79%	73%	90%	80%	100%	
Operational facilities*	For facilities in the operational phase, keep scheduled operating time lost to less than 10 percent for 90 percent of those facilities	**Target**	90%	90%	90%	90%	90%	90%
		Result	100%	95%	94%	100%	100%	

*Reported under "Stewardship" prior to FY 2010.

Stewardship: Support excellence in science and engineering research and education through a capable and responsive organization.

Research & Related Activities	Education & Human Resources	Agency Operations & Award Management, National Science Board, Office of the Inspector General
$104.32 million	$16.12 million	$348.38 million

<table>
<tr><th>Performance Goal</th><th>FY 2007-FY 2009 Results</th><th>FY 2010 Measure</th></tr>
<tr><td>Management of Large Facilities</td><td>New goal in FY 2008
FY 2008: Successful
FY 2009: Successful</td><td>Conduct a Business System Review at least once per 5-year award cycle for all institutions hosting NSF-supported large facilities, with a planned schedule of three to four reviews per year.

Target: 3 BSRs will be performed.</td></tr>
<tr><td rowspan="2">Merit Review</td><td rowspan="2">FY 2007: Successful
FY 2008: Successful
FY 2009: Successful</td><td>Provide a written context statement to the Principal Investigator (PI) whose proposal is awarded or declined that describes the process by which the proposal was reviewed and the context of the decision (such as the number of proposals and awards, information about budget availability, and considerations in portfolio balancing).

Target: 95% of PIs will receive context statements.</td></tr>
<tr><td>Continue analyzing Committees of Visitors reports in order to identify issues of quality and the transparency of the merit review process

Target: An assessment of the methods and results relating to this goal will be made at the end of FY 2010.</td></tr>
<tr><td>Post-Award Monitoring</td><td>FY 2007: Successful
FY 2008: Successful
FY 2009: Successful</td><td>Appropriately apply NSF’s risk assessment strategy to ensure adequate post-award financial and administrative monitoring of NSF’s riskiest awards.

Targets:
• Complete 95% of projected 30 site monitoring visits.
• Complete desk reviews for 95% of projected 73 desk reviews.
• Complete 95% of projected FFR transaction testing.
• Maintain ARRA recipient reporting rate at 98% for each quarter.*
• Maintain the uncorrected significant error rate on ARRA award recipients on Day 30 under one percent after federal review.**</td></tr>
<tr><td colspan="3">* The rate would is calculated by dividing the number of received reports by the total number of reports due each quarter.

** Day 30 is when the recipient reports become public and the federal review and recipient correction period ends. The rate is calculated by dividing the number of missing and erroneous reports by the total number of reports due each quarter.</td></tr>
</table>

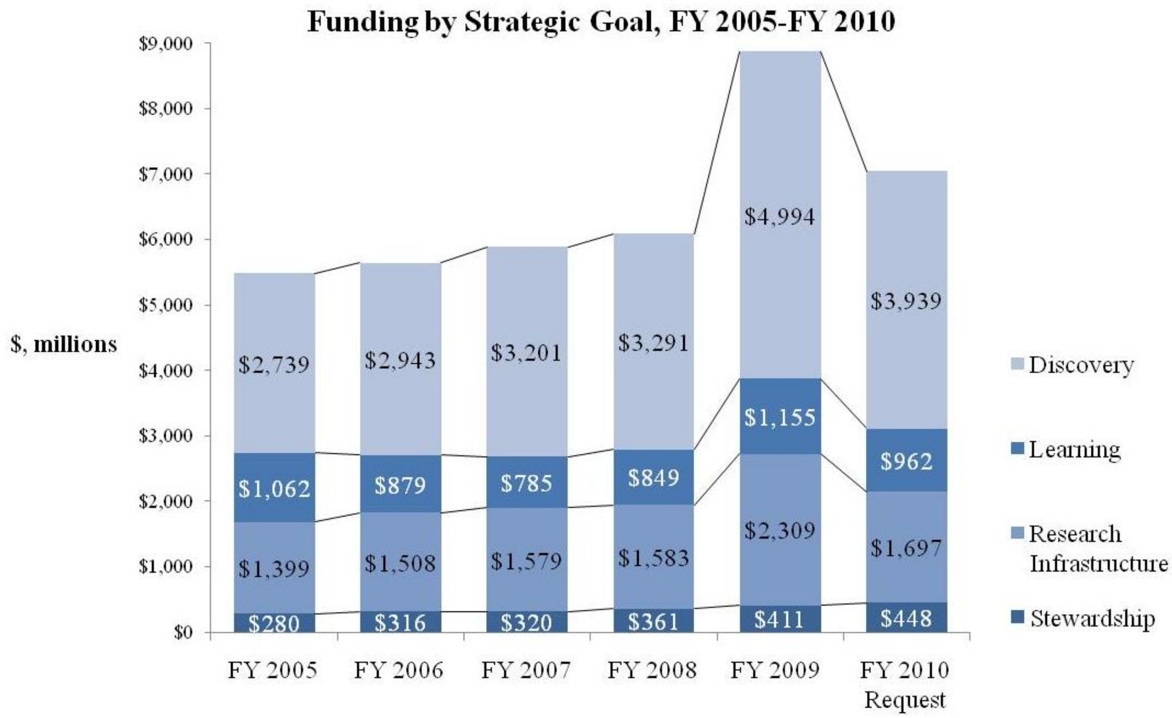
FY 2010 HIGH PRIORITY PERFORMANCE GOAL

As part of developing the FY 2011 budget and performance plan, the National Science Foundation has identified a high priority performance goal focused on evidence-based approaches to our *Science, Technology, Engineering, and Mathematics (STEM) workforce* development programs that will be a particular focus over the next two years. In addition to this high priority performance goal, there are a number of other goals used to regularly monitor and report performance. To view the full set of performance information please visit www.nsf.gov/about/performance/.

Goal: Improve the education and training of an innovative Science, Technology, Engineering, and Mathematics (STEM) workforce through evidence-based approaches that includes collection and analysis of performance data, program evaluation and other research.

> **Measure:** By the end of FY 2011, at least six major National Science Foundation STEM workforce development programs at the graduate/postdoctoral level have evaluation and assessment systems providing findings leading to program re-design or consolidation for more strategic impact in developing STEM workforce problem solvers, entrepreneurs, or innovators.

FY 2009 ANNUAL PERFORMANCE REPORT



NSF's Strategic Plan for FY 2006–2011 established four long-term strategic outcome goals for the agency's activities and performance: *Discovery*, *Learning*, *Research Infrastructure*, and *Stewardship*. The first three goals focus on NSF's long-term investments in science and engineering research and education. The fourth goal—*Stewardship*—is internally focused and emphasizes improving the effectiveness and efficiency of the agency's management practices. NSF's uses a combination of internal and external assessments to determine whether it is achieving its annual performance goals.

NSF by Strategic Outcome Goal

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
Discovery	$3,448.63	$1,546.60	$3,813.20	$4,170.38	$357.18	9.4%
Learning	905.12	249.37	967.38	1,011.13	43.75	4.5%
Research Infrastructure[1]	1,703.57	605.68	1,662.18	1,774.07	111.89	6.7%
Stewardship	411.44	0.02	429.75	468.82	39.07	9.1%
Total, NSF	**$6,468.76**	**$2,401.66**	**$6,872.51**	**$7,424.40**	**$551.89**	**8.0%**

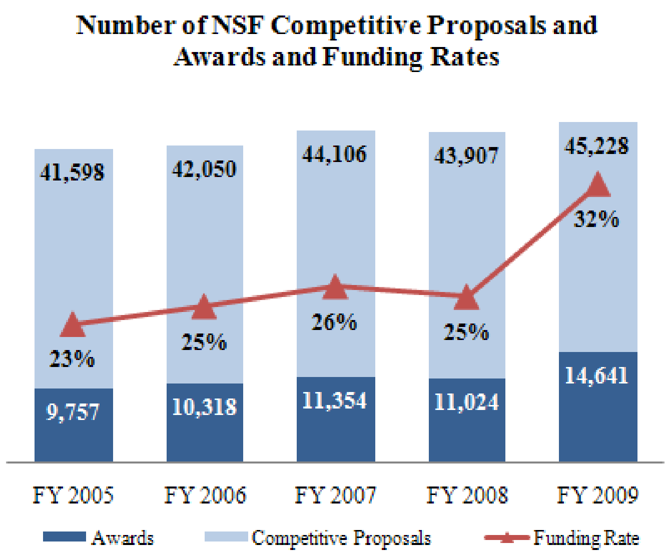
Totals may not add due to rounding.

[1] Funding for Research Infrastructure for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

In this report, NSF summarizes the results of the strategic outcome goals, as well as its performance on two other sets of goals which measure the performance of K-12 Math and Science Education programs and of the American Recovery and Reinvestment Act (ARRA) of 2009. More information on all of these goals may be found on NSF's Budget and Performance website: www.nsf.gov/about/performance.

In FY 2009, the National Science Foundation:

- **Demonstrated *significant achievement* for the three long-term strategic outcome goals in its 2006-2011 Strategic Plan: *Discovery*, *Learning*, and *Research Infrastructure*, according to an independent evaluation by the NSF Advisory Committee for GPRA Performance Assessment,**
- **Achieved all annual performance milestones and measures under the fourth strategic outcome goal of *Stewardship*,**
- **Achieved one out of the two performance measures reportable in FY 2009 for the K-12 Math and Science Education evaluation,**
- **Achieved four out of the five performance measures reportable in FY 2009 for the programs under the American Recovery and Reinvestment Act (ARRA) of 2009.**



Long-Term Strategic Goal Results

The Advisory Committee for GPRA Performance Assessment (AC/GPA) determined that in FY 2009 NSF demonstrated significant achievement for the three long-term, qualitative, strategic outcome goals in the 2006–2011 Strategic Plan: *Discovery, Learning,* and *Research Infrastructure*. The AC/GPA made this determination at its June 2009 meeting and issued a report to the Director, which is available at: www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf09068.

During its deliberations, the Committee discussed how NSF might undertake alternative methods of performance assessment in the future, focusing on producing a more holistic view and longer-term evaluation of achievement of its strategic goals. The Committee recommended that NSF:

- *Consider an assessment framework that uses multiple measures and methods, applied over various time scales. Use both quantitative and qualitative evidence, including highlights.*
- *Emphasize the dynamic relationships among strategic goals and outcomes.*
- *Use performance assessment as an opportunity and means to document the strategic value of NSF's science investments to the nation and the public.*
- *Engage the scientific community as a partner in performance assessment.*
- *Build assessment into the organizational and programmatic infrastructure of NSF.*

The timing of these recommendations coincides with the rewriting of NSF's Strategic plan in FY 2010. A discussion of NSF's response to these recommendations is located in the "Status Report" section of this chapter.

Long-Term Strategic Goal	Performance Goal	Results
DISCOVERY	Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit, and establishing the nation as a global leader in fundamental and transformational science and engineering.	FY 2005: Successful FY 2006: Successful FY 2007: Successful FY 2008: Successful FY 2009: Successful
LEARNING	Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.	
RESEARCH INFRASTRUCTURE	Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure, and experimental tools.	

At the programmatic level, NSF directorates, divisions, and programs use the recommendations of external experts in its decision-making (see Appendix, "Qualitative Information"). The benefits of the evaluations can be seen in the rich feedback produced, which informs decision-making in programmatic areas as well as at broad strategic levels. These evaluations can also facilitate ongoing feedback and rapport within new or existing scientific communities.

During FY 2009, seventeen external evaluations of NSF's existing programs and strategic investments were published and include the results of studies, reports, and workshops commissioned by various programmatic offices within the National Science Foundation. Examples of the types of results such evaluations can produce are listed below.

Programmatic Evaluations: Letter Report Assessing the WATERS Network Science Plan

- The National Resource Council's Water Science and Technology Board reviewed and evaluated the WATERS Network Science Plan, with a focus on whether the project should be established within the Major Research Equipment and Facilities Construction (MREFC) framework or not. The committee requested a stronger justification for a national network of environmental observatories aimed at studying water and also recommended considering an alternative mechanism rather than an MREFC.

Programmatic Workshops

- A workshop report prepared by Westat, Carol Van Hartesveldt, and Judith Giordan on the Integrative Graduate Education and Research Traineeship (IGERT) Program was conducted to define the progress of interdisciplinary research and graduate education and their impacts on academic institutions. The workshop report will be referenced as important guidance to both proposers and their institutions in the next IGERT solicitation.

Research-Focused Evaluations and Workshops

- A study was conducted by the World Technology Evaluation Center to assess international research and development activities in the field of simulation-based engineering and science (SBE&S), in order to benchmark NSF's related programs and provide input into to planning for the future of these programs. Study results are being used to conceptualize potential programs within NSF as well as collaborations with other agencies.

American Recovery and Reinvestment Act of 2009 (ARRA) Program Goal Results: Research and Related Activities

Account	Program/Activity	Metric	Target	Result	Rationale
Research and Related Activities (R&RA)[1]	Core Research, Facilities, and Infrastructure Investments Major Research Instrumentation Academic Research Infrastructure	Number of competitive awards[2]	4,000	4,599	This target was based on a formula taking into account the amount of funding and the average award size and duration. It assumed a $155,000 average annual award size and a three-year duration.
		Number of investigators supported on competitive awards	6,400	6,762	The target for the number of investigators was based on a ratio of 1.6 principal investigators per award, according to FY 2008 figures.
		Number of new investigators supported on competitive awards[3]	2,400	2,352[4]	The target for new investigators was adjusted upward from the ratio from FY 2008 to take into account the emphasis on supporting first-time investigators with ARRA funds.[4]

[1]"Research and related activities" include investigator-initiated research projects, postdoctoral fellowships, instrumentation awards, workshop and planning grants, and cooperative agreements for centers and facilities.

[2]ARRA enabled the funding of 318 of these awards (7 percent) that had been declined earlier in the year due to budgetary constraints even though they were rated very good to excellent.

[3]New investigators are those who have not served as the principal investigator or co-principal investigator on any award from NSF, with the exception of doctoral dissertation awards; graduate or postdoctoral fellowships; research planning grants; or conference, symposia, and workshop awards.

[4]NSF reached 98 percent of this goal. In FY 2008, the ratio of new investigators per award was 0.5, which would have led to a target of 2,000 new investigators. NSF chose to set a more ambitious target using a ratio of 0.60 new investigators per award, or 2,400 new investigators. The FY 2009 result of 2,352 new investigators corresponds to a ratio of 0.59 new investigators per award.

American Recovery and Reinvestment Act of 2009 (ARRA) Program Goal Results:
Education and Human Resources

NSF achieved the FY 2009 goals for the numbers of Noyce and MSP program awards. Other program goals focus on the number of participants supported over the five-year period of the awards, and reporting on them will begin in FY 2010.

<table>
<tr><th>Account</th><th>Program/Activity</th><th>Metric</th><th>Target</th><th>Result</th><th>Rationale</th></tr>
<tr><td rowspan="3">Education and Human Resources (EHR)</td><td>Robert Noyce Scholarship Program[1]</td><td>Number of awards</td><td>67</td><td>67</td><td>Reporting will begin on the following goals in FY 2010:
• Number of new pre-service teachers and teacher participants over five years.
• Number of new teachers in high-need districts over five years.</td></tr>
<tr><td>Math and Science Partnership Program[2]</td><td>Number of awards</td><td>9</td><td>9</td><td>Reporting will begin on the following goals in FY 2010:
• Number of MSP teacher leader/master teacher participants over five years.
• Number of post-baccalaureate credential or master’s degree recipients over five years.</td></tr>
<tr><td>Science Masters’ Program[3]</td><td colspan="4">To be determined in FY 2010.</td></tr>
<tr><td colspan="6">[1]The Robert Noyce Teacher Scholarship Program aims to encourage talented Science, Technology, Engineering, and Mathematics (STEM) majors and professionals to become K-12 mathematics and science teachers.

[2]The Math and Science Partnership (MSP) Program focuses on the development of STEM K-12 master teachers and school-based instructional leaders in mathematics and science education. It supports three kinds of efforts: new Teacher Institutes, new MSP-Start partnerships, and Phase II awards to existing MSP projects.

[3]The Science Masters’ Program is new in FY 2010.</td></tr>
</table>

Stewardship Goal Results

Stewardship is defined in the NSF Strategic Plan as *supporting excellence in science and engineering research and education through a capable and responsive organization*. The performance areas under *Stewardship* focus on the agency's efficiency and effectiveness not only in its internal operations and management but also in delivering essential services to its constituents in the science, engineering, and education community. NSF has been measuring Stewardship performance areas since FY 2007.

In FY 2009, NSF achieved all of its annual milestones and measures associated with the following eight performance areas under Stewardship:

Goal Name	Description	Result
Time to Decision	For 70% of proposals, be able to inform applicants of a decision within six months.	FY 2007: Successful FY 2008: Successful FY 2009: Successful
Merit Review	Improve the quality and transparency of the merit review process.	FY 2007: Successful FY 2008: Successful FY 2009: Successful
Customer Service	Improve customer service to the science, engineering, and education communities.	FY 2007: Successful FY 2008: Successful FY 2009: Successful
Broadening Participation	Expand efforts to increase participation from underrepresented groups and diverse institutions throughout the United States in all NSF activities and programs.	FY 2007: Successful FY 2008: Successful FY 2009: Successful
Management of Large Facilities	Ensure the effective management of the construction and operation of large facilities.	FY 2007: Not Successful FY 2008: Not Successful FY 2009: Successful
Post-award Financial Monitoring	Fully implement NSF's program of post-award and financial administrative monitoring.	FY 2007: Successful FY 2008: Successful FY 2009: Successful
Strategic Information Technology (IT) initiatives	Provide new tools /capabilities.	FY 2007: Successful FY 2008: Successful FY 2009: Successful
IT Security	Conduct a successful Federal Information Security Management Act (FISMA) IT program review.	FY 2007: Successful FY 2008: Successful FY 2009: Successful

Detailed results on each of these performance areas may be found on www.nsf.gov/about/performance.

Goal Name	Detailed Results
Time to Decision	Every year since 2002, the Foundation has exceeded its Time to Decision goal of informing at least 70 percent of principal investigators about funding decisions within six months of receipt of their proposals. In FY 2009, the Foundation adopted this goal, but amended it to take into account the greater number of proposals to be processed with the additional funds from the American Recovery and Reinvestment Act (ARRA) of 2009. The goal was in effect only for the first quarter of FY 2009, before the ARRA funds were received. The result for that quarter was 89 percent, well above the target.
Merit Review	• Instituted a new staff seminar on specific and timely issues involved in the merit review process, designed for new program officers as well as experienced staff. The course content will be updated on a regular basis. • Continued to analyze the external Committee of Visitors (COV) reports to identify common issues and concerns. Because COV reports are highly specific to each NSF program, identifying common issues raised by external experts helps the Foundation monitor and improve the COVs process. A primary issue of concern to most COVs is how to account for the broader impacts of NSF's research and education awards.
Customer Service	• Completed qualitative analysis of FY 2007 survey responses from the scientific community to assist NSF in assessing perceptions of the quality and fairness of the merit review process; • Released FAQs for the scientific community, and training materials for new NSF program officers, on potentially transformative research (PTR); • Implemented two new programs to replace the Small Grants for Exploratory Research (SGER) Program: (1) Early-concept Grants for Exploratory Research (EAGER) to support exploratory work in its early stages on untested, but potentially transformative, research ideas or approaches; and (2) RAPID awards to support projects requiring a rapid release of funds and thus an expedited merit review process; and • Held focus groups and town hall meetings to foster discussion among program officers about how to manage PTR and interdisciplinary research proposals within the Foundation.
Broadening Participation	• Published a broadening participation Framework for Action; • Developed a new Research.gov Program Desktop to provide tools to help program officers manage portfolios of proposals and awards and to find reviewers for NSF proposals from a broad range of institutions and fields of study. By increasing the diversity of the reviewer pool, especially for review panels, NSF hopes to increase the number of people from underrepresented groups and diverse institutions who receive awards; and • Continued to update its Broadening Participation portfolio, giving the public information on Foundation programs that have a focus or special

	emphasis on broadening participation.

Management of Large Facilities	• For all Major Research Equipment and Facilities Construction (MREFC) facilities under construction, negative cost and schedule variance was kept at or below 10 percent.
	• For facilities in the operational phase, operating time lost was kept to less than 10 percent for 90 percent of those facilities.
	• Conducted Business System Reviews for the following major NSF-supported facilities:
	  • EarthScope;
	  • USArray;
	  • Institutions affiliated with the Incorporated Research Institutions for Seismology (IRIS) in Socorro, NM and Seattle, WA; and
	  • The National High Magnetic Field Laboratory in Tallahassee, FL.

Post-award Financial Monitoring	Risk assessments, desk reviews, and site visits are post-award monitoring activities used by NSF to assess administrative regulations and public policy requirements; special and general terms and conditions, including those contained in NSF program solicitations and grants or cooperative agreements; and the award letter. NSF conducts an annual risk assessment of awards and grantee institutions to determine the level of risk.
	  • Applied the risk assessment results in order to develop the FY 2009 monitoring plan (on-site visits, desk reviews, and FCTR sampling efforts;
	  • Completed 100 percent of projected FY 2009 on-site monitoring visits;
	  • Completed 100 percent of projected FY 2009 desk reviews; and
	  • Completed 100 percent of projected FY 2009 FCTR/FFR transaction testing.

Strategic Information Technology (IT) initiatives	• Delivered initial new Research.gov tools and resources for NSF staff; • Developed “Division Director Concur” functionality in eJacket; and • Posted 100 percent of discretionary grant applications on Grants.gov.
IT Security	• NSF successfully completed its FISMA (Federal Information Security Management Act) IT program review, which ensured that 100 percent of the Foundation’s major applications and general support systems are certified and accredited; • 100 percent of NSF’s IT systems are installed in accordance with security configurations; and • 100 percent of NSF’s IT systems have undergone privacy impact assessments.

APPENDIX: TYPES, SOURCES, AND QUALITY OF DATA AND INFORMATION

Quantitative Data

Most of the information that informs the external expert review and assessment of outcomes under the strategic outcome goals originate outside the agency and are submitted to NSF by principal investigators through the Project Reporting System, which includes annual and final project reports for all awards. Through this system, information and data relevant to performance are available to program staff, third party evaluators, and other external committees.

Examples of types of information used to assess each Strategic Goal are:

Discovery

- Published and disseminated results, including journal publications, books, software, audio or video products;
- Contributions within and across disciplines;
- Organizations of participants and collaborators (including collaborations with industry);
- Contributions to other disciplines, infrastructure, and beyond science and engineering
- Use beyond the research group of specific products, instruments, and equipment resulting from NSF awards; and
- Role of NSF-sponsored activities in stimulating innovation and policy development.

Learning

- Student, teacher, and faculty participants in NSF activities;
- Demographics of participants; descriptions of student involvement;
- Education and outreach activities under grants;
- Demographics of science and engineering students and workforce;
- Numbers and quality of educational models, products and practices used/developed;
- Number and quality of teachers trained; and
- Student outcomes, including enrollments in mathematics and science courses, retention, achievement, and science and mathematics degrees received.

Research Infrastructure

- Published and disseminated results;
- New tools and technologies; multidisciplinary databases;
- Software, newly-developed instrumentation, and other inventions;
- Data, samples, specimens, germ lines, and related products of awards placed in shared repositories;
- Facilities construction and upgrade costs and schedules; and
- Operating efficiency of major multi-user facilities.

Most of the data supporting the annual quantitative performance goals may be found in NSF's central systems. These central systems include the Enterprise Information System; FastLane, with its Project Reporting System and its Facilities Performance Reporting System; the Program Information Management System (PIMS); the Proposal and Reviewer System; the Awards System; the Electronic Jacket; and the Financial Accounting System. These systems are verified and validated annually for accuracy and reliability.

Qualitative Information

In its annual review, the AC/GPA examines recent Committee of Visitor reports and program assessments conducted by external expert panels, principal investigator project reports, and award abstracts. Because it is impractical for an external committee to review the contributions to the performance goals by each of the more than 20,000 active awards, NSF program officers provide the Committee with summaries of notable results each fiscal year. These summaries of results, or "highlights," from awards, are a primary source for the AC/GPA determination of whether NSF demonstrated significant achievement in the strategic outcome goals of *Discovery*, *Learning*, and *Research Infrastructure*. The approach to highlights collection is a type of non-probabilistic sampling, commonly referred to as "judgmental" or "purposeful" sampling, which is best designed to identify notable examples and outcomes resulting from NSF's investments. It is the aggregate of collections of notable examples and outcomes that can, on their own, demonstrate significant agency-wide achievement of the strategic goals. Nevertheless, taken together, the highlights, COV reports, project reports, award abstracts, and other reports of notable accomplishments covers the entire NSF portfolio.

Committees of Visitors

The following Committees of Visitors were convened in FY 2009. COV reports can be found at nsf.gov/about/performance/.

Committees of Visitors, FY 2009	
DIR	**Program**
BIO	Environmental Biology Emerging Frontiers
CISE	Computing & Communication Foundations Computer & Network Systems Information & Intelligent Systems
EHR	Discovery Research K-12 (DRL) Research & Evaluation on Education in Science & Engineering (DRL) Advanced Technological Education Course, Curriculum, and Laboratory Improvement NOYCE Scholarships STEM Talent Expansion Program (STEP) Graduate Research Fellowships Gender Diversity in STEM Education Program on Research in Disabilities National SMETE Digital Library
ENG	Chemical, Bioengineering, Environmental and Transport Systems Civil, Mechanical and Manufacturing Innovation
GEO	Marine Geosciences Section Ocean Section ATM: UCAR and Lower Atmospheric Facilities Oversight Section OCE: Ocean Education
MPS	Physics
SBE	Behavioral and Cognitive Sciences Science of Learning Centers (OMA) Science Resource Statistics
OIA	Experimental Program to Stimulate Competitive Research

External Evaluations

In FY 2009, the following seventeen external evaluations of NSF's existing programs and strategic investments were published, including the results of studies, reports, and workshops commissioned by various programmatic offices within the National Science Foundation. Information on scope, findings, recommendations, and NSF's follow-up on all evaluations will be posted at nsf.gov/about/performance/.

External Evaluations, FY 2009			
DIR	**DIV (or Field)**	**Subject**	**Evaluator**
BIO	(Integrative Organismal Systems)	Exploring Science Needs for Predicting Organismal Responses to Rapid Directional Environmental Change	Workshop
EHR	Graduate Education	Integrative Graduate Education and Research Traineeship Program	Westat
EHR	Undergraduate Education	Noyce Scholarships	Noyce Program Evaluation Project
EHR	Research on Learning in Formal and Informal Settings	Learning science in informal environments	National Academies
ENG	Engineering Education and Centers	Research Experiences for Undergraduates: EEC Sites, ERC Supplements, ENG Supplements	SRI International
		ENG Research Experiences for Teachers Program	SRI International
		Bioengineering and Bioinformatics Summer Institutes	SRI International
		Faculty Early Career Development (CAREER)	Abt Associates Inc.
		EEC program areas	Science and Technology Policy Institute
GEO	Ocean Sciences	MARGINS program	MARGINS Decadal Review Committee
GEO	Office of the Assistant Director	Opportunities for Enhancing Diversity in the Geosciences (OEDG)	American Institutes for Research
ENG-GEO-SBE		WATERS Network Science Plan	National Academies
MPS	(Materials Research)	Polymer Science and Engineering	Interagency committee
MPS-ENG	(Civil, mechanical, and Manufacturing Innovation)	International Assessment of Research and Development in Catalysis by Nanostructured Materials	World Technology Evaluation Center

MPS-ENG	(Civil, mechanical, and Manufacturing Innovation)	International Assessment of Research and Development in Simulation-Based Engineering and Science	World Technology Evaluation Center
MPS	(Materials Research)	Inspired by Biology: From Molecules to Materials to Machines	National Academies
OD	(Office of Cyberinfrastructure)	Sustainable Software as Cyberinfrastructure	Workshop

Verification and Validation of Data Quality

As in prior years, NSF engaged an independent, external consultant to conduct a validation and verification (V&V) review of its annual performance information and data. IBM Global Business Services (IBM) completed a V&V review of the performance data and information reported for all the FY 2009 goals.

For the strategic outcome goals, IBM reviewed the processes NSF used to obtain external assessment of its goals. IBM's V&V review is based on guidelines issued by GAO that require federal agencies to provide confidence that the policies and procedures underlying performance reporting are complete, accurate, and consistent. (See *GAO Guide to Assessing Agency Annual Performance Plans*, GAO/GGD-10.1.20.) IBM assessed the validity of the data and reported results as well as verified the reliability of the methods used to collect, process, maintain, and report data. IBM also reviewed NSF's information systems based on GAO standards for application controls. The FY 2009 Performance Measurement Verification and Validation Report, dated October 23, 2009, Executive Summary concludes:

> As a federal agency, the National Science Foundation (NSF or Foundation) is subject to performance reporting requirements established by the Government Performance and Results Act (GPRA) of 1993 and Office of Management and Budget (OMB). With the passage of the American Recovery and Reinvestment Act (ARRA) of 2009, NSF and recipients of Foundation funds are subject to additional reporting requirements—as outlined in OMB guidance—to track and monitor all ARRA dollars in a manner that provides transparency and accountability to Congress and taxpayers.[1] NSF has developed a performance assessment and reporting framework to meet these reporting requirements and help the Foundation achieve its mission, goals, and objectives. Government Accountability Office (GAO) auditing standards indicate that federal agencies should provide confidence that the policies and procedures that undergird performance reporting are complete, accurate and consistent. As such, NSF tasked IBM Global Business Services with assessing the validity of the data and reported results of its performance goals and verifying the reliability of the methods used to compile and report data for these goals.
>
> NSF reports its performance though four long-term Strategic Outcome Goals and 15 annual performance goals. The Advisory Committee for GPRA Performance Assessment (AC/GPA) evaluates three of the four Strategic Outcome Goals—Discovery, Learning, and Research Infrastructure. For these Strategic Outcome Goals, IBM reviewed the reliability of the assessment processes. NSF evaluates the remaining Strategic Outcome Goal—Stewardship—through eight performance areas. Based on our FY 2009 V&V review, IBM verified and validated the reliability of the assessment processes for the three Strategic Outcome Goals evaluated through the AC/GPA. We

[1] OMB, *Updated Implementing Guidance for the American Recovery and Reinvestment Act of 2009*, M-09-15, (Washington, D.C.: April 3, 2009): www.whitehouse.gov/omb/assets/memoranda_fy2009/m09-15.pdf

also verified the reliability of the processes and validated the accuracy of the results for the eight Stewardship performance areas.

Further, IBM verified the reliability of the processes and validated the accuracy of the results for five of the 15 annual performance goals. For the remaining 10 annual performance goals, NSF requested that IBM review the proposed process to collect, process, maintain, and report future results. We were not, however, asked to verify and validate results as it is too early for NSF to report actual results at the time of this report. We were, however, able to verify that NSF is making progress towards achieving these goals in FY 2009.

Overall, we verify that NSF relies on sound business practices, internal controls, and manual checks of system queries to ensure accurate performance reporting. NSF maintains adequate documentation of its processes and data to allow for an effective V&V review. Based on our comprehensive review, IBM has confidence in the systems, policies, and procedures used by NSF to generate the described performance measures. NSF continues to take concerted steps to improve the quality of their systems and data. We commend NSF for this effort to confirm the reliability of its GPRA data and results, and the quality of its processes for collecting, processing, maintaining, and reporting data for its performance goals.[2]

Information on Use of Non-Federal Parties

The NSF Annual Performance report was prepared solely by NSF staff. External, non-federal sources of information used in preparing the report include:

- Reports from awardees demonstrating results
- Reports from facilities managers on construction cost and schedules and operations.
- Reports prepared by Committees of Visitors assessing NSF programs
- Reports prepared by an external, independent management consulting firm to validate and verity the procedures used to collect, process, maintain, and report performance goals. In Fiscal Year 2009 that firm was IBM Global Business Services.

Classified Appendixes Not Available to the Public

None

[2] The Executive Summary of the FY 2009 IBM Global Business Services *NSF Performance Measurement Verification and Validation Report* is available at www.nsf.gov/about/performance/FY 2009 _V_and_V_Exec_Summary.pdf.

TECHNICAL INFORMATION

FY 2011 Appropriations Language

National Science Foundation

RESEARCH AND RELATED ACTIVITIES

For necessary expenses in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of aircraft; and authorized travel; $6,018,830,000, to remain available until September 30, 2012, of which not to exceed $590,000,000 shall remain available until expended for polar research and operations support, and for reimbursement to other Federal agencies for operational and science support and logistical and other related activities for the United States Antarctic program, including up to $54,000,000 for the procurement of polar icebreaking services from the Coast Guard: *Provided*, That the National Science Foundation shall only reimburse the Coast Guard for such sums as are agreed to according to the existing memorandum of agreement: *Provided further*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation.

EDUCATION AND HUMAN RESOURCES

For necessary expenses in carrying out science, mathematics and engineering education and human resources programs and activities pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including services as authorized by 5 U.S.C. 3109, authorized travel and rental of conference rooms in the District of Columbia, $892,000,000, to remain available until September 30, 2012.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including authorized travel, $165,190,000, to remain available until expended.

AGENCY OPERATIONS AND AWARD MANAGEMENT

For agency operations and award management necessary in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); services authorized by 5 U.S.C. 3109; hire of passenger motor vehicles; not to exceed $9,000 for official reception and representation expenses; uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; rental of conference rooms in the District of Columbia; and reimbursement of the Department of Homeland Security for security guard services; $327,190,000: *Provided*, That contracts may be entered into under this heading in fiscal year 2011 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year.

Commerce, Justice, Science Appropriations Title V General Provisions:

SEC. 525. For an additional amount for the "Agency Operations and Award Management", National Science Foundation account, $2,000,000, to increase the agency's acquisition workforce capacity and capabilities: Provided, That such funds shall be available only to supplement and not to supplant existing acquisition workforce activities: Provided further, That such funds shall be available for training, recruitment, retention, and hiring additional members of the acquisition workforce as defined by the Office of Federal Procurement Policy Act, as amended (41 U.S.C. 401 et seq.): Provided further, That such funds shall be available for information technology in support of acquisition workforce effectiveness or for management solutions to improve acquisition management.

OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, $14,350,000, to remain available until September 30, 2012.

OFFICE OF THE NATIONAL SCIENCE BOARD

For necessary expenses (including payment of salaries, authorized travel, hire of passenger motor vehicles, the rental of conference rooms in the District of Columbia, and the employment of experts and consultants under section 3109 of title 5, United States Code) involved in carrying out section 4 of the National Science Foundation Act of 1950, as amended (42 U.S.C 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), $4,840,000: *Provided*, That not to exceed $2,500 shall be available for official reception and representation expenses.

SUMMARY OF FY 2011 BUDGETARY RESOURCES BY APPROPRIATION

(DOLLARS IN MILLIONS)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
RESEARCH AND RELATED ACTIVITIES						
Appropriation	$5,183.10	$2,500.00	$5,617.92	$6,018.83	$400.91	7.1%
Unobligated Balance Available Start of Year	0.56	-	$481.95			
Unobligated Balance Available End of Year	-44.59	-437.36				
Adjustments to Prior Year Accounts[1]	10.26	-				
Subtotal, R&RA	5,149.33	2,062.64	6,099.87	$6,018.83	-$81.04	-1.3%
Transferred to/from other funds[2]	3.07		-54.00	-		
Total Budgetary Resources	$5,152.39	$2,062.64	$6,045.87	$6,018.83	-$27.04	-0.4%
EDUCATION AND HUMAN RESOURCES						
Appropriation	$845.26	$100.00	$872.76	$892.00	$19.24	2.2%
Unobligated Balance Available Start of Year	0.01	-	15.02			
Unobligated Balance Available End of Year	-0.02	-15.00				
Adjustments to Prior Year Accounts[1]	0.28	-				
Total Budgetary Resources	$845.52	$85.00	$887.78	$892.00	$4.22	0.5%
MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION						
Appropriation	$152.01	$400.00	$117.29	$165.19	$47.90	40.8%
Unobligated Balance Available Start of Year	66.43	-	203.73			
Unobligated Balance Available End of Year	-57.73	-146.00				
Adjustments to Prior Year Accounts[1]	0.04	-				
Total Budgetary Resources	$160.76	$254.00	$321.02	$165.19	-$155.83	-48.5%
AGENCY OPERATIONS AND AWARD MANAGEMENT						
Appropriation	$294.00	-	$300.00	$329.19	$29.19	9.7%
Unobligated Balance Available Start of Year	-	-	-			
Unobligated Balance Available End of Year	-0.06	-				
Adjustments to Prior Year Accounts[1]	-	-				
Subtotal, AOAM	293.94					
Transferred to/from other funds[2]	0.15					
Total Budgetary Resources	$294.09	-	$300.00	$329.19	$29.19	9.7%

Totals may not add due to rounding.

[1]Adjustments include upward and downward adjustments to prior year obligations

[2]In FY2009, NSF obligated incoming transfers $3.22 million from USAID for Civilian Research and Development Foundation (CRDF). These transfers were allocated a follows: $3.07 million Research and Related Activities, $0.15M Agency Operations and Award Management. In FY2010, NSF transferred $54 million to U.S. Coast Guard Operating Expenses for ice breaking services.

SUMMARY OF FY 2011 BUDGETARY RESOURCES BY APPROPRIATION

(DOLLARS IN MILLIONS)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
NATIONAL SCIENCE BOARD						
Appropriation	$4.03	-	$4.54	$4.84	$0.30	6.6%
Unobligated Balance Available Start of Year	-	-				
Unobligated Balance Available End of Year	-0.01	-				
Adjustments to Prior Year Accounts[1]	-	-				
Total Budgetary Resources	$4.02	-	$4.54	$4.84	$0.30	6.6%
OFFICE OF INSPECTOR GENERAL						
Appropriation	$12.00	$2.00	$14.00	$14.35	$0.35	2.5%
Unobligated Balance Available Start of Year	-	-	1.98			
Unobligated Balance Available End of Year	-0.01	-1.98				
Adjustments to Prior Year Accounts[1]	-	-				
Total Budgetary Resources	$11.99	$0.02	$15.98	$14.35	-$1.63	-10.2%
TOTAL DISCRETIONARY, NATIONAL SCIENCE FOUNDATION	$6,468.76	$2,401.66	$7,575.19	$7,424.40	-$150.79	-2.0%
EDUCATION AND HUMAN RESOURCES, H-1B						
Appropriation, Mandatory	$88.66	-	$100.00	$100.00	$100.00	100.0%
Unobligated Balance Available Start of Year	50.83	-				
Unobligated Balance Available End of Year	-52.62	-				
Adjustments to Prior Year Accounts[1]	-	-				
Total Budgetary Resources	$86.87	-	$100.00	$100.00	$0.00	0.0%
TOTAL, NATIONAL SCIENCE FOUNDATION	$6,555.63	$2,401.66	$7,675.19	$7,524.40	-$150.79	-2.0%

Totals may not add due to rounding.

[1]Adjustments include upward and downward adjustments to prior year obligations

NSF FY 2011 FUNDING BY PROGRAM
(Dollars in Millions)

PROGRAM	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2009 Total Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
BIOLOGICAL SCIENCES							
MOLECULAR AND CELLULAR BIOSCIENCES	$121.28	$61.53	$182.81	$125.59	$133.69	$8.10	6.4%
INTEGRATIVE ORGANISMAL SYSTEMS	212.34	61.71	274.05	216.25	226.70	10.45	4.8%
ENVIRONMENTAL BIOLOGY	120.37	63.23	183.60	142.55	155.59	13.04	9.1%
BIOLOGICAL INFRASTRUCTURE	117.95	38.74	156.69	126.86	145.63	18.77	14.8%
EMERGING FRONTIERS[1]	84.68	34.80	119.48	103.29	106.20	2.91	2.8%
Total, BIO[2]	$656.62	$260.00	$916.62	$714.54	$767.81	$53.27	7.5%
COMPUTER AND INFORMATION SCIENCE AND ENGINEERING							
COMPUTING & COMMUNICATION FOUNDATIONS	$156.92	$41.17	$198.09	$170.35	$186.95	$16.60	9.7%
COMPUTER & NETWORK SYSTEMS	188.30	92.25	280.55	204.42	227.08	22.66	11.1%
INFORMATION & INTELLIGENT SYSTEMS	150.93	61.17	212.10	163.32	189.74	26.42	16.2%
INFORMATION TECHNOLOGY RESEARCH	78.35	40.41	118.76	80.74	80.74	-	N/A
Total, CISE[2]	$574.50	$235.00	$809.50	$618.83	$684.51	$65.68	10.6%
ENGINEERING							
CHEMICAL, BIOENGINEERING, ENVIRONMENTAL & TRANSPORT SYSTEMS	$146.00	$60.57	$206.57	$156.82	$169.07	$12.25	7.81%
CIVIL, MECHANICAL & MANUFACTURING INNOVATION	174.93	57.96	232.90	188.00	206.50	18.50	9.84%
ELECTRICAL, COMMUNICATIONS & CYBER SYSTEMS	87.21	45.57	132.78	94.00	103.00	9.00	9.57%
INDUSTRIAL INNOVATION & PARTNERSHIPS[3]	112.12	54.70	166.82	152.00	177.70	25.70	16.91%
SBIR/STTR	[90.39]	[49.91]	[140.3]	[125.77]	[142.86]	[17.09]	[13.59%]
ENGINEERING EDUCATION & CENTERS	118.23	32.18	150.41	124.11	138.40	14.29	11.51%
EMERGING FRONTIERS IN RESEARCH & INNOVATION	26.50	14.00	40.50	29.00	31.00	2.00	6.90%
Total, ENG[2]	$664.99	$264.99	$929.98	$743.93	$825.67	$81.74	10.99%

[1]Centers moved from Emerging Frontiers to the Division of Biological Infrastructure in FY 2010. Science of Learning Centers (SLC) is cofunded with the Directorate for Social, Behavioral and Economic Sciences as of FY 2010. Funding for the Science of Learning Centers (SLC) is shown comparably for all years.
[2]In FY 2010, Science of Learning Centers (SLC) is transferred from the Office of Integrative Activities and is co-funded by SBE, BIO, CISE, and ENG. Funding for SLC is shown comparably for all years.
[3]Management responsibilities for PFI and SLC are transferred to the Directorate for Engineering and the Directorate for Social, Behavioral and Economic Sciences, respectively, as of FY 2010. Funding for the Partnerships for Innovation (PFI) and Science of Learning Centers (SLC) is removed for all years for comparability.
[4]The SBE Office of Multidisciplinary Activities (OMA) is created in FY2010, and program funding responsibilities are transferred from SES and BCS to OMA. Also in FY 2010, Science of Learning Centers (SLC) is transferred from the Office of Integrative Activities to SBE and split between BCS and OMA. Funding for OMA and SLC is shown comparably for all years.
[5]Within IA, EPSCoR, MRI, and ARI carried forward a combined $420.15 million from the ARRA appropriation because solicitations occurred late in FY 2009. Awards will be made in FY 2010.
[6]Excludes $89.08 million in obligations in FY 2009, and an estimated $100.0 million in FY 2010 and FY 2011 receipts from H-1B Nonimmigrant Petitioner Fees.
[7]Funding for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

NSF FY 2011 FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2009 Total Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
GEOSCIENCES							
ATMOSPHERIC & GEOSPACE SCIENCES	$245.54	$68.20	$313.74	$259.80	$280.80	$21.00	8.1%
EARTH SCIENCES	171.01	85.22	256.23	183.00	199.00	16.00	8.7%
INTEGRATIVE & COLLABORATIVE EDUCATION AND RESEARCH	61.47	79.58	141.05	97.92	97.60	-0.32	-0.3%
OCEAN SCIENCES	330.51	114.00	444.51	348.92	377.89	28.97	8.3%
Total, GEO	$808.53	$347.00	$1,155.53	$889.64	$955.29	$65.65	7.4%
MATHEMATICAL AND PHYSICAL SCIENCES							
ASTRONOMICAL SCIENCES	$228.67	$85.80	$314.47	$245.69	$251.77	$6.08	2.5%
CHEMISTRY	211.67	87.36	299.03	233.73	247.56	13.83	5.9%
MATERIALS RESEARCH	282.52	108.17	390.69	302.67	319.37	16.70	5.5%
MATHEMATICAL SCIENCES	224.84	97.34	322.18	241.38	253.46	12.08	5.0%
PHYSICS	262.47	96.30	358.77	290.04	298.19	8.15	2.8%
MULTIDISCIPLINARY ACTIVITIES	33.70	-	33.70	38.33	39.56	1.23	3.2%
Total, MPS	$1,243.88	$474.97	$1,718.85	$1,351.84	$1,409.91	$58.07	4.3%
SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES							
SOCIAL AND ECONOMIC SCIENCES	$94.82	$41.10	$135.92	$99.05	$104.12	$5.07	5.1%
BEHAVIORAL AND COGNITIVE SCIENCES	88.12	43.16	131.28	94.58	99.21	4.63	4.9%
SCIENCE RESOURCES STATISTICS	38.71	-	38.71	34.62	36.72	2.10	6.1%
OFFICE OF MULTIDISCIPLINARY ACTIVITIES	18.91	0.71	19.62	27.00	28.74	1.74	6.4%
Total, SBE[2,4]	$240.56	$84.97	$325.53	$255.25	$268.79	$13.54	5.3%

[1]Centers moved from Emerging Frontiers to the Division of Biological Infrastructure in FY 2010. Science of Learning Centers (SLC) is cofunded with the Directorate for Social, Behavioral and Economic Sciences as of FY 2010. Funding for the Science of Learning Centers (SLC) is shown comparably for all years.

[2]In FY 2010, Science of Learning Centers (SLC) is transferred from the Office of Integrative Activities and is co-funded by SBE, BIO, CISE, and ENG. Funding for SLC is shown comparably for all years.

[3]Management responsibilities for PFI and SLC are transferred to the Directorate for Engineering and the Directorate for Social, Behavioral and Economic Sciences, respectively, as of FY 2010. Funding for the Partnerships for Innovation (PFI) and Science of Learning Centers (SLC) is removed for all years for comparability.

[4]The SBE Office of Multidisciplinary Activities (OMA) is created in FY2010, and program funding responsibilities are transferred from SES and BCS to OMA. Also in FY 2010, Science of Learning Centers (SLC) is transferred from the Office of Integrative Activities to SBE and split between BCS and OMA. Funding for OMA and SLC is shown comparably for all years.

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[6]Excludes $89.08 million in obligations in FY 2009, and an estimated $100.0 million in FY 2010 and FY 2011 receipts from H-1B Nonimmigrant Petitioner Fees.

[7]Funding for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

NSF FY 2011 FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2009 Total Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Change Over FY 2010 Estimate Percent
OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING	$47.45	$13.98	$61.43	$47.83	$53.26	$5.43	11.4%
OFFICE OF CYBERINFRASTRUCTURE	$199.23	$80.00	$279.23	$214.28	$228.07	$13.79	6.4%
OFFICE OF POLAR PROGRAMS							
ARCTIC SCIENCES	$98.60	$91.86	$190.46	$106.31	$111.36	$5.05	4.8%
ANTARCTIC SCIENCES	68.64	64.53	133.17	71.08	75.18	4.10	5.8%
ANTARCTIC INFRASTRUCTURE & LOGISTIC	246.66	15.50	262.16	266.76	280.18	13.42	5.0%
U.S. Antarctic Logistical Support Activities	[69.24]	[0.00]	[69.24]	[67.52]	[67.52]	-	-
POLAR ENVIROMENT, HEALTH & SAFETY	6.12	-	6.12	7.01	7.27	0.26	3.7%
USCG POLAR ICEBREAKING[7]	53.52	-	53.52	[54.00]	54.00	54.00	N/A
Total, OPP	$473.55	$171.89	$645.43	$451.16	$527.99	$76.83	17.0%
INTEGRATIVE ACTIVITIES[2]							
EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)	[133.00]	[30.00]	[163.00]	[147.12]	[154.36]	[7.24]	[4.9%]
MAJOR RESEARCH INSTRUMENTATION (MRI)	[99.98]	[99.85]	[199.83]	[90.00]	[90.00]	-	-
ACADEMIC RESEARCH INFRASTRUCTURE (ARI)	-	-	-	-	-	-	-
Total, IA[3,5]	$241.58	$129.85	$371.43	$275.04	$295.93	$20.89	7.6%
U.S. ARCTIC RESEARCH COMMISSION	$1.50	-	$1.50	$1.58	$1.60	$0.02	1.3%
Total, RESEARCH AND RELATED ACTIVITIES[7]	$5,152.39	$2,062.64	$7,215.02	$5,563.92	$6,018.83	$454.91	8.2%
EDUCATION AND HUMAN RESOURCES							
RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS	$226.68	-	$226.68	$242.00	$247.85	$5.85	2.4%
UNDERGRADUATE EDUCATION	283.08	85.00	368.08	292.41	289.98	-2.43	-0.8%
GRADUATE EDUCATION	181.67	-	181.67	181.44	185.26	3.82	2.1%
HUMAN RESOURCE DEVELOPMENT	154.08	-	154.08	156.91	168.91	12.00	7.6%
Total, EHR[6]	$845.52	$85.00	$930.52	$872.76	$892.00	$19.24	2.2%

[1]Centers moved from Emerging Frontiers to the Division of Biological Infrastructure in FY 2010. Science of Learning Centers (SLC) is cofunded with the Directorate for Social, Behavioral and Economic Sciences as of FY 2010. Funding for the Science of Learning Centers (SLC) is shown comparably for all years.

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[6]Excludes $89.08 million in obligations in FY 2009, and an estimated $100.0 million in FY 2010 and FY 2011 receipts from H-1B Nonimmigrant Petitioner Fees.

[7]Funding for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

NSF FY 2011 FUNDING BY PROGRAM
(Dollars in Millions)

PROGRAM	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2009 Total Actual	FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate Amount	Percent
MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION	$160.76	$254.00	$414.76	$117.29	$165.19	$47.90	40.8%
AGENCY OPERATIONS AND AWARD MANAGEMENT	$294.09	-	$294.09	$300.00	$329.19	$29.19	9.7%
NATIONAL SCIENCE BOARD	$4.02	-	$4.02	$4.54	$4.84	$0.30	6.6%
OFFICE OF INSPECTOR GENERAL	$11.99	$0.02	$12.01	$14.00	$14.35	$0.35	2.5%
NATIONAL SCIENCE FOUNDATION[7]	$6,468.76	$2,401.66	$8,870.42	$6,872.51	$7,424.40	$551.89	8.0%

Totals may not add due to rounding.

[1]Centers moved from Emerging Frontiers to the Division of Biological Infrastructure in FY 2010. Science of Learning Centers (SLC) is cofunded with the Directorate for Social, Behavioral and Economic Sciences as of FY 2010. Funding for the Science of Learning Centers (SLC) is shown comparably for all years.
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OBJECT CLASSIFICATION

NSF Consolidated Obligations

(Dollars in Millions)

Object Class Code	Standard Title	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request
11.1	Full-time permanent	$142	$156	$163
11.3	Other than fulltime permanent	13	13	15
11.5	Other personnel compensation	7	8	9
11.8	Special personal service payment	1	2	2
	Total personnel compensation	163	179	189
12.1	Civilian personnel benefits	38	40	42
21.0	Travel and transportation of persons	32	31	35
23.1	Rental payments to GSA	27	26	26
23.3	Communications, utilities, and miscellaneous charges	2	2	2
25.1	Advisory and assistance services	166	166	172
25.2	Other services	18	18	19
25.3	Purchases of goods and services from Government accounts	31	29	31
25.4	Operation and maintenance of facilities	444	444	444
25.5	Research and development contracts	19	19	19
26.0	Supplies and materials	6	6	7
31.0	Equipment	5	5	6
41.0	Grants, subsidies, and contributions	8,066	6,820	6,557
	Total, Direct obligations [1]	$9,017	$7,785	$7,549

Totals may not add due to rounding.

[1]Includes mandatory obligations, but excludes obligations for reimbursable accounts.

REIMBURSABLE ACTIVITY

Reimbursements for the Research and Related Activities Appropriation and the Education and Human Resources Appropriation are realized from other federal agencies that have entered into interagency agreements with the Foundation. NSF enters into agreements (including Memoranda of Understanding) with other U.S. government agencies, as authorized by the NSF Act, 42 U.S.C. 1870 (c) and the Economy Act: 31 U.S.C. 1535, under which NSF assumes some responsibility for activities supported by these agencies. These activities can include jointly funded projects and programs, support of research operations and logistics, and access to NSF supported research facilities.

Reimbursements by Agency

(Dollars in Millions)

DEPARTMENT/AGENCY	FY 2009 Actual
DEFENSE	
Air Force	$12.9
Army	$13.3
Other DOD (DARPA, NSA & Intelligence)	$19.4
Subtotal, DOD	$45.5
Commerce (Including Census, NOAA, & NIST)	$9.6
Education	$0.6
Energy	$4.5
Environmental Protection Agency	$1.4
State	$0.5
Agriculture	$2.6
Health & Human Services	$21.4
Homeland Security	$6.0
NASA	$8.8
National Archives	$1.9
Transportation	$8.8
OTHER (less than $500,000)	$2.1
TOTAL REIMBURSEMENTS	**$113.8**

Consistent with applicable legislation and GAO decisions, agreements include reimbursement for costs that are incurred in the management and administration of these awards.

In FY 2009, the largest portion of NSF's reimbursable activity came from joint activities with the Department of Defense (40.0 percent), the Department of Health and Human Services (18.8 percent), Department of Commerce (including Census, NOAA, & NIST) (8.4 percent), National Aeronautics and Space Administration (7.8 percent), the Department of Transportation (7.7 percent), the Department of Homeland Security (5.2 percent), and the Department of Energy (3.9 percent). Reimbursable activities with the Department of Defense were primarily for the management of the National Center for Atmospheric Research (NCAR). Reimbursable activities with the Department of Health and Human Services are for non-medical biological research such as the human frontiers science program and the Macromolecular Structure Database (MSD) program.

NSF Personnel Summary of Permanent Appointments

	FY 2009 Actual
Statutory Pay Systems	Appointments
ES	81
AD	332
GS/GM-15	90
GS/GM-14	134
GS/GM-13	132
GS-12	107
GS-11	72
GS-10	13
GS-9	78
GS-8	36
GS-7	84
GS-6	14
GS-5	4
GS-4	1
Subtotal, GS/GM	765
Total, Permanent Appointments	1,178
Average Salary	$112,450

All data are for permanent appointments.

EXPLANATION OF CARRYOVER FOR FY 2009 INTO FY 2010 BY ACCOUNT

The National Science Foundation's (NSF) total unobligated balance of $755.29 million from the FY 2009 Regular Discretionary, H-1B Nonimmigrant Petitioner account (Mandatory), and American Recovery and Reinvestment Act (ARRA) appropriations consist of amounts described below.

REGULAR DISCRETIONARY

Within the **Research and Related Activities (R&RA)** regular appropriation, NSF carried forward $44.59 million into FY 2010. The major items include: awards and contracts from various programs throughout NSF that were not ready for obligation in FY 2009.

$28.84 million: Directorate for Engineering: $3.59 million for Small Business Innovation Research (SBIR) Phase I; $16.19 million for SBIR Phase II; $6.10 million for Small Business Technology Transfer (STTR) Phase I; and $2.96 million for STTR Phase II.

- Reason for Carryover: The delay in obligation was due to two factors. First, ARRA provided for a significant increase in the total available funding for FY 2009, but the pool of candidate proposals in FY 2009 was received prior to the enactment of ARRA and therefore remained roughly the same as in previous years. Second, a significant influx of proposals was received in response to solicitations following the enactment of ARRA, but these were received too late to complete the merit review process by the end of the fiscal year.
- Obligated Q1 FY 2010: $1.14 million for SBIR Phase I.
- Expected Obligation: $27.70 million Q2 FY 2010.

$14.73 million: Directorate for Mathematical and Physical Sciences: $11.73 million for the Deep Underground Science and Engineering Laboratory (DUSEL); and $3.0 million for the Mathematical Sciences Research Institutes.

- Reason for Carryover for DUSEL: Adjustments to proposal were required before obligation.
- Obligated January 2010.
- Reason for Carryover for Mathematical Sciences Research Institutes: Activity was pending final review and recommendation.
- Expected Obligation: Q2 FY 2010.

$1.02 million: The remainder of R&RA regular appropriation carryover is for funding associated with projects/activities in various offices/directorates that were not ready for obligation. The delay in obligation is due to the significant increase in workload prompted by the receipt of Recovery Act appropriations. Obligation of these funds is expected in Q2 of FY 2010.

Within the **Education and Human Resources (EHR)** appropriation, a total of $19,473 was carried forward into FY 2010.

Within the **Major Research Equipment and Facilities Construction (MREFC)** appropriation, a total of $57.73 million was carried forward into FY 2010. This includes:

$33.23 million: Alaska Region Research Vessel (ARRV).
$5.91 million: Ocean Observatories Initiative (OOI).
$7.39 million: IceCube Neutrino Observatory (IceCube).
$1.20 million: South Pole Station Modernization (SPSM).
$7.0 million: Advanced Technology Solar Telescope (ATST).

$3.0 million: National Ecological Observatory Network (NEON).
- Reason for Carryover: For continuing costs associated with multi-year construction project.
- Expected Obligation: Funds will be obligated and expended over the remaining period of construction.

H-1B Nonimmigrant Petitioner Account (MANDATORY)

Within the **H-1B Nonimmigrant Petitioner** account (Mandatory), $52.62 million was carried over into FY 2010. NSF's carryover for H-1B funded programs consists of $45.06 million in S-STEM, and $7.56 million in I-TEST. (These amounts include $17.0 million in fourth quarter receipts received too late to be obligated by the end of the fiscal year.) All carryover funds were obligated Q1 FY 2010.

AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009 (ARRA)

Note: The ARRA Chapter contains an obligation plan for all ARRA appropriated funds carried forward into FY 2010.

Within the **Research and Related Activities** appropriation, a total of $437.36 million was carried forward into FY 2010. This includes:

Office of Integrative Activities: ($200.15 million for MRI-R^2; $200.0 million for ARI-R^2; and $20.0 million for EPSCoR)
- Reason for Carryover: Solicitations occurred late in the year. The review process is ongoing.
- Expected Obligation during FY 2010: Q2 for MRI-R^2, Q2/Q3 for ARI-R^2, and Q3 for EPSCoR.

Directorate for Mathematical and Physical Sciences: $15.0 million for upgrade at the National High Magnetic Field Laboratory (NHMFL)
- Reason for Carryover: Cooperative agreement was still under negotiation.
- Obligated December 2009.

Other R&RA funding ($2.21 million) is for activities that will be obligated in Q2 FY 2010.

Within the **Education and Human Resources** appropriation, the Division of Graduate Education carried forward a total of $15.0 million for the Science Masters program.
- Reason for Carryover: Solicitation was issued late in FY 2009.
- Expected Obligation: Awards expected in Q2/Q3 FY 2010.

Within the **Major Research Equipment and Facilities Construction** appropriation, a total of $146.0 million was carried forward for the Advanced Technology Solar Telescope (ATST).
- Reason for Carryover: Cooperative agreement was being implemented. Approved by NSB in August 2009.
- Obligated January 2010.

Within the **Office of Inspector General** appropriation, $1.98 million was carried forward.
- Reason for Carryover: Five year funds intended explicitly for ARRA use.
- Expected Obligation: Will be obligated over the 5 year availability of the funds.

Regular Discretionary, Mandatory, and ARRA Appropriations
Distribution of FY 2009 Carryover into FY 2010
(Dollars in Millions)

	FY 2010 Carryover from FY 2009	ARRA FY 2010 Carryover from FY 2009	Total FY 2010 Carryover
Research and Related Activities	$44.59	$437.36	$481.95
Education and Human Resources	0.02	15.00	15.02
Major Research Equipment and Facilities Construction	57.73	146.00	203.73
Office of Inspector General	-	1.98	1.98
Subtotal	**102.34**	**600.34**	**702.68**
H-1B Nonimmigrant Petitioner **(Mandatory)**	52.62	-	52.62
Total	**$154.96**	**$600.34**	**$755.30**

Totals may not add due to rounding.

FULL BUDGETARY COSTING

The tables below show two methods for allocating the full budgetary cost of the NSF FY 2011 Budget Request. The first shows the full budgetary costs allocated to each of NSF's operating directorates. The second shows these costs allocated to three of NSF's strategic outcome goals: Discovery, Learning, and Research Infrastructure. Stewardship, NSF's fourth strategic goal encompasses the indirect costs to be allocated under full budgetary costing. These allocations represent part of the process, using readily available information, by which NSF achieved the integration of budget, cost, and performance.

What is Full Budgetary Cost? OMB Circular A-11 defines "full-cost" as the sum of all budget resources used by an agency to achieve program outputs and outcomes. These include both *direct* program costs and *indirect* costs, which generally include administrative costs and other activities that are not directly attributable to a single program or activity. For two of NSF's appropriations, Research and Related Activities (R&RA) and Education and Human Resources (EHR), all funds are directly attributable to directorates and outcome goals. For NSF's other appropriations, Major Research Equipment and Facilities Construction (MREFC), Agency Operations and Award Management (AOAM), the National Science Board (NSB), and the Office of Inspector General (OIG) funds are distributed using the methodologies described below.

Allocation by Directorate

The current budget structure contains program activities within R&RA and EHR that equate to directorates. Therefore, R&RA and EHR funding is already aligned by directorate. MREFC funds projects that are managed by a particular NSF directorate. Therefore, each MREFC project can be directly associated with a particular directorate. In addition, each managing directorate is responsible for the initial planning, design, and follow-on operations and maintenance costs that are funded through R&RA. The MREFC program funds are assigned to the managing directorate responsible for oversight of a particular project. (Table 1)

All budget items funded through the AOAM, NSB, and OIG appropriations accounts are defined as Stewardship and are allocated to directorates. More than half of the AOAM account can be precisely associated with an individual directorate. These direct AOAM budget items consist of distributed funding for travel, training, equipment, supplies, incentive awards, and premium pay. Also, space rental and personnel compensation and benefits (PC&B) of employees in a particular directorate are attributed to that directorate in the financial accounting system.

Once direct AOAM budget items that are associated with a particular directorate have been assigned, then budget items associated with the Office of Information and Resource Management (IRM), Office of Budget, Finance and Award Management (BFA), the staff offices in the Office of the Director (OD), the NSB, and OIG are allocated. These indirect AOAM budget items are allocated to a particular directorate based on its proportion of the total FY 2011 Request. The FY 2011 NSB and OIG budgetary costs are assigned using the same methodology as the Indirect AOAM costs total. (Table 1)

Allocations by Strategic Outcome Goal

The full budgetary costing by Discovery, Learning, and Research Infrastructure was derived by using the same methodology as stated above, except the Direct AOAM budget items, Indirect AOAM budget items, and total NSB, and OIG funding were assigned using the strategic goal percentages for each directorate. (Table 2)

FY 2011 FULL BUDGETARY COSTING

Table 1: Allocation of Major Research Equipment and Facilities Construction (MREFC),
Agency Operations and Award Management (AOAM), National Science Board (NSB), and the Office of Inspector General (OIG)
(Dollars in Thousands)

FY 2011 Congressional Request	BIO	CISE	ENG	GEO	MPS	SBE	OCI	OISE	OPP	IA	SUBTOTAL	EHR	TOTAL
R&RA & EHR	**$767,810**	**$684,510**	**$825,670**	**$955,290**	**$1,409,910**	**$268,790**	**$228,070**	**$53,260**	**$529,590**	**$295,930**	**$6,018,830**	**$892,000**	**$6,910,830**
MREFC													
AdvLIGO					23,580						**$23,580**		**$23,580**
ALMA Construction					13,910						**$13,910**		**$13,910**
ARRV											-		-
ATST					17,000						**$17,000**		**$17,000**
EarthScope											-		-
HIAPER											-		-
IceCube Neutrino Observatory											-		-
NEES											-		-
NEON	20,000										**$20,000**		**$20,000**
OPP DOJ Judgment LC-130s											-		-
OOI				90,700							**$90,700**		**$90,700**
RSVP											-		-
Scientific Ocean Drilling											-		-
South Pole Station Modernization											-		-
Terascale Computing Systems											-		-
MREFC Subtotals	**$20,000**	**-**	**-**	**$90,700**	**$54,490**	**-**	**-**	**-**	**-**	**-**	**$165,190**	**-**	**$165,190**
Total FY 2011 Submission by Activity including MREFC	**$787,810**	**$684,510**	**$825,670**	**$1,045,990**	**$1,464,400**	**$268,790**	**$228,070**	**$53,260**	**$529,590**	**$295,930**	**$6,184,020**	**$892,000**	**$7,076,020**
STEWARDSHIP													
Direct AOAM													
Space Rental	4,953	2,644	5,205	4,281	5,330	4,491	420	1,637	1,805		$30,766	$5,624	$36,390
PC&B	29,655	15,833	31,163	25,634	31,917	26,891	2,513	9,801	10,807		$184,214	$33,676	$217,890
Distributed AOAM	1,858	992	1,952	1,606	1,999	1,685	157	614	677		$11,540	$2,110	$13,650
Direct AOAM Subtotals	**$36,466**	**$19,469**	**$38,320**	**$31,521**	**$39,246**	**$33,067**	**$3,090**	**$12,052**	**$13,289**		**$226,520**	**$41,410**	**$267,930**
Indirect AOAM Cost Allocation	8,338	4,451	8,762	7,207	8,973	7,560	707	2,756	3,038		$51,792	$9,468	$61,260
Direct & Indirect AOAM Subtotals	**$44,804**	**$23,920**	**$47,082**	**$38,728**	**$48,219**	**$40,627**	**$3,797**	**$14,808**	**$16,327**		**$278,312**	**$50,878**	**$329,190**
NSB Allocation	**$659**	**$352**	**$692**	**$569**	**$708**	**$597**	**$56**	**$218**	**$240**		**$4,091**	**$748**	**$4,840**
OIG Allocation	**$1,953**	**$1,043**	**$2,052**	**$1,688**	**$2,102**	**$1,771**	**$166**	**$645**	**$712**		**$12,132**	**$2,218**	**$14,350**
NSF TOTAL	**$835,226**	**$709,825**	**$875,496**	**$1,086,975**	**$1,515,429**	**$311,785**	**$232,089**	**$68,931**	**$546,869**	**$295,930**	**$6,478,555**	**$945,844**	**$7,424,400**

FY 2011 FULL BUDGETARY COSTING

Table 2: Allocation by Discovery, Learning, and Research Infrastructure
(Dollars in Thousands)

Total Directorate FY 2011	BIO	CISE	ENG	GEO	MPS	SBE	OCI	OISE	OPP	IA	R&RA	EHR	TOTAL
Discovery	623,936	636,291	759,595	534,073	1,023,765	238,257	76,104	51,692	131,115	180,569	$4,255,397	$206,732	**$4,462,130**
Learning	56,634	41,130	79,906	47,236	67,213	18,575	11,667	17,106	7,299	21,923	368,689	722,147	**$1,090,836**
Research Infrastructure	154,656	32,404	35,995	505,666	424,451	54,953	144,318	133	408,455	93,438	1,854,469	16,965	**$1,871,434**
FULL BUDGETARY COST	**$835,226**	**$709,825**	**$875,496**	**$1,086,975**	**$1,515,429**	**$311,785**	**$232,089**	**$68,931**	**$546,869**	**$295,930**	**$6,478,555**	**$945,844**	**$7,424,400**

Totals may not add due to rounding.

QUANTITATIVE DATA TABLE

NATIONAL SCIENCE FOUNDATION

Research and Development Special Analysis

(Dollars in Millions)

	FY 2009 Actual	FY 2009 ARRA	FY 2009 Total	FY 2010 Estimate[1]	FY 2011 Request
Support of R&D					
Conduct of Research and Development					
Basic Research	$3,956.92	$1,666.99	$5,623.91	$4,330.31	$4,668.06
Applied Research	330.62	140.66	471.28	343.16	435.44
Subtotal, Conduct of R&D	4,287.54	1,807.65	6,095.19	4,673.47	5,103.50
R&D Facilities					
Land, Building and Fixed Equipment	22.35	5.83	28.18	48.61	43.03
Major Equipment	418.74	382.66	801.40	400.31	400.48
Subtotal, R&D Facilities & Major Equipment	441.09	388.49	829.58	448.92	443.51
Total, Support of R&D	4,728.63	2,196.14	6,924.77	5,122.39	5,547.01
Non-Investment Activities	842.93	13.89	856.82	803.85	903.86
Education and Training	897.20	191.63	1,088.83	946.27	973.53
TOTAL	$6,468.76	$2,401.66	$8,870.42	$6,872.51	$7,424.40

Totals may not add due to rounding.

[1]Funding for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

QUANTITATIVE DATA TABLE

RESEARCH AND RELATED ACTIVITIES

Research and Development Special Analysis

(Dollars in Millions)

	FY 2009 Actual	FY 2009 ARRA	FY 2009 Total	FY 2010 Estimate[1]	FY 2011 Request
Support of R&D					
Conduct of Research and Development					
Basic Research	$3,887.92	$1,666.99	5,554.91	$4,259.09	$4,590.75
Applied Research	326.31	140.66	466.97	338.71	430.99
Subtotal, Conduct of R&D	4,214.23	1,807.65	6,021.88	4,597.80	5,021.74
R&D Facilities					
Land, Building and Fixed Equipment	22.35	5.83	28.18	48.61	43.03
Major Equipment	257.98	128.66	386.64	283.02	235.29
Subtotal, R&D Facilities & Major Equipment	280.33	134.49	414.82	331.63	278.32
Total, Support of R&D	4,494.56	1,942.14	6,437	4,929.43	5,300.06
Non-Investment Activities	497.43	13.87	$511.30	448.77	513.94
Education and Training	160.39	106.63	267.02	185.72	204.83
TOTAL	$5,152.38	$2,062.64	$7,215.02	$5,563.92	$6,018.83

Totals may not add due to rounding.

[1]Funding for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

QUANTITATIVE DATA TABLE

EDUCATION AND HUMAN RESOURCES

Research and Development Special Analysis

(Dollars in Millions)

	FY 2009 Actual	FY 2009 ARRA	FY 2009 Total	FY 2010 Estimate	FY 2011 Request
Support of R&D					
Conduct of Research and Development					
Basic Research...	$69.00	-	$69.00	$71.22	$77.31
Applied Research...	4.31	-	4.31	4.45	4.45
Subtotal, Conduct of R&D....................................	73.31	-	73.31	$75.67	$81.76
R&D Facilities					
Land, Building and Fixed Equipment........................	-	-	-	-	-
Major Equipment...	-	-	-	-	-
Subtotal, R&D Facilities & Major Equipment.......	-	-	-	-	-
Total, Support of R&D..	73.31	-	73.31	75.67	81.76
Non-Investment Activities...	35.40	-	35.40	36.54	41.54
Education and Training..	736.81	85.00	821.81	760.55	768.70
TOTAL..	$845.52	$85.00	$930.52	$872.76	$892.00

Totals may not add due to rounding.

QUANTITATIVE DATA TABLE

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

Research and Development Special Analysis

(Dollars in Millions)

	FY 2009 Actual	FY 2009 ARRA	FY 2009 Total	FY 2010 Estimate	FY 2011 Request
Support of R&D					
Conduct of Research and Development					
Basic Research...	-	-	-	-	-
Applied Research...	-	-	-	-	-
Subtotal, Conduct of R&D....................................	-	-	-	-	-
R&D Facilities					
Land, Building and Fixed Equipment........................	-	-	-	-	-
Major Equipment...	$160.76	$254.00	414.76	$117.29	$165.19
Subtotal, R&D Facilities & Major Equipment.......	160.76	254.00	414.76	117.29	165.19
Total, Support of R&D..	160.76	254.00	414.76	117.29	165.19
Non-Investment Activities...	-	-	-	-	-
Education and Training..	-	-	-	-	-
TOTAL..	$160.76	$254.00	$414.76	$117.29	$165.19

Totals may not add due to rounding.

QUANTITATIVE DATA TABLE

AGENCY OPERATIONS AND AWARD MANAGEMENT

Research and Development Special Analysis

(Dollars in Millions)

	FY 2009 Actual	FY 2009 ARRA	FY 2009 Total	FY 2010 Estimate	FY 2011 Request
Support of R&D					
Conduct of Research and Development					
Basic Research	-	-	-	-	-
Applied Research	-	-	-	-	-
Subtotal, Conduct of R&D	-	-	-	-	-
R&D Facilities					
Land, Building and Fixed Equipment	-	-	-	-	-
Major Equipment	-	-	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-	-	-
Total, Support of R&D	-	-	-	-	-
Non-Investment Activities	$294.09	-	$294.09	$300.00	$329.19
Education and Training	-	-	-	-	-
TOTAL	$294.09	-	$294.09	$300.00	$329.19

Totals may not add due to rounding.

QUANTITATIVE DATA TABLE

OFFICE OF INSPECTOR GENERAL

Research and Development Special Analysis

(Dollars in Millions)

	FY 2009 Actual	FY 2009 ARRA	FY 2009 Total	FY 2010 Estimate	FY 2011 Request
Support of R&D					
Conduct of Research and Development					
Basic Research..	-	-	-	-	-
Applied Research..	-	-	-	-	-
Subtotal, Conduct of R&D....................................	-	-	-	-	-
R&D Facilities					
Land, Building and Fixed Equipment.........................	-	-	-	-	-
Major Equipment..	-	-	-	-	-
Subtotal, R&D Facilities & Major Equipment.......	-	-	-	-	-
Total, Support of R&D...	-	-	-	-	-
Non-Investment Activities..	$11.99	$0.02	$12.01	$14.00	$14.35
Education and Training...	-	-	-	-	-
TOTAL...	$11.99	$0.02	$12.01	$14.00	$14.35

Totals may not add due to rounding.

QUANTITATIVE DATA TABLE

NATIONAL SCIENCE BOARD

Research and Development Special Analysis

(Dollars in Millions)

	FY 2009 Actual	FY 2009 ARRA	FY 2009 Total	FY 2010 Estimate	FY 2011 Request
Support of R&D					
Conduct of Research and Development					
Basic Research	-	-	-	-	-
Applied Research	-	-	-	-	-
Subtotal, Conduct of R&D	-	-	-	-	-
R&D Facilities					
Land, Building and Fixed Equipment	-	-	-	-	-
Major Equipment	-	-	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-	-	-
Total, Support of R&D	-	-	-	-	-
Non-Investment Activities	$4.02	-	$4.02	$4.54	$4.84
Education and Training	-	-	-	-	-
TOTAL	$4.02	-	$4.02	$4.54	$4.84

Totals may not add due to rounding.

AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009

NSF received $3.0 billion in funding under the American Recovery and Reinvestment Act (Public Law 111-5). This chapter of the FY 2011 Budget Request to Congress analyzes the results of our ARRA spending, reporting FY 2009 Actuals along with subsequent investment updates.

ARRA GOALS: NSF established a set of goals to be met with ARRA funding. These are listed in the chart below with the corresponding FY 2009 Actuals or results as of September 30, 2009.

Goal	Target	FY 2009 Actuals
Number of competitive R&RA awards	4,000	4,599
Number of competitive R&RA awards for MRI and ARI	500	TBD in FY 2010
Number of investigators supported on competitive R&RA awards	6,400	6,762
Number of new investigators or co-investigators on competitive R&RA awards	2,400	2,352

As of FY 2009, NSF has made 4,599 awards, 599 more competitive R&RA awards than expected with ARRA funding, and has supported 362 investigators above its target of 6,400 investigators. NSF set an ambitious target of 2,400 new investigators, a goal that exceeded the baseline level (FY 2008) by roughly 20 percent. The 2,352 new investigators funded by the Recovery Act fell 2 percent short of this aggressive target. The number of new investigators and co-investigators will be further discussed later in this chapter.

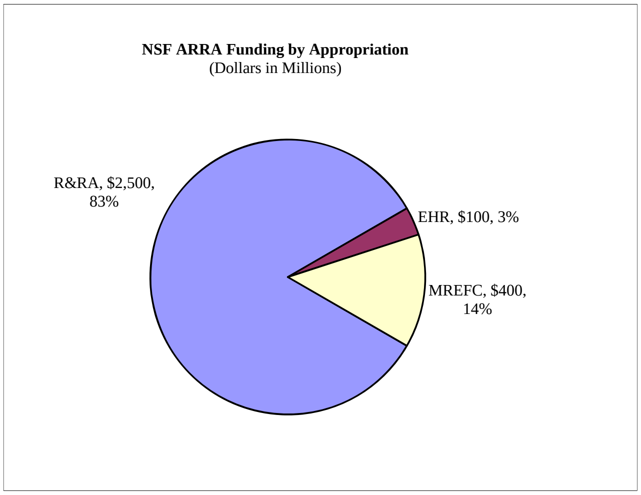
NSF obligated 80 percent of its ARRA funding by September 30, 2009. The largest carryover items include:

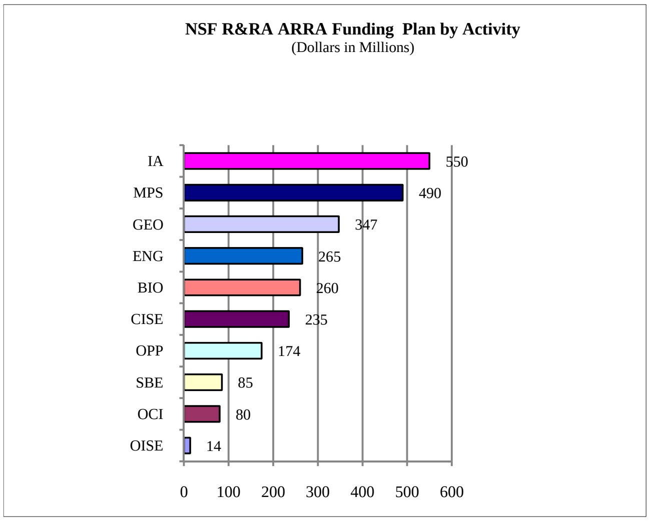
- Major Research Instrumentation ($200.15 million) – awards are expected in Q2 FY 2010;
- Academic Research Investment ($200.0 million) – awards expected in Q2/Q3 FY 2010;
- EPSCoR ($20.0 million) – awards are expected in Q3 FY 2010;
- 21-Tesla magnet for the National High Magnetic Field Laboratory ($15.0 million) was awarded in Q1 FY 2010;
- Science Masters program ($15.0 million) – awards are expected in Q2/Q3 FY 2010; and
- Construction funding for the Advanced Technology Solar Telescope ($146.0 million) was awarded in Q2 FY 2010.

Combining the recent FY 2010 awards cited above with FY 2009 Actuals raises NSF's obligation rate for ARRA funding to 85 percent at the time of this submission.

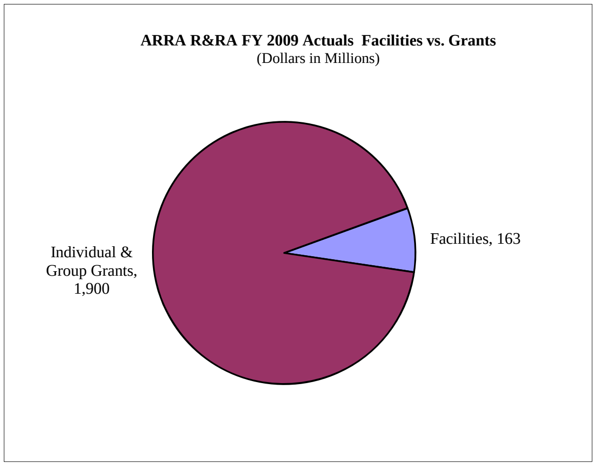
ANALYSIS OF NSF ARRA FUNDS:

Of the total $3.0 billion in funding provided to NSF by ARRA, $2.5 billion was slated for Research and Related Activities, including $300.0 million for the Major Research Instrumentation program and $200.0 million for the Academic Research Infrastructure program which are funded through Integrative Activities (IA). In addition, NSF received $100.0 million for programs in the Education and Human Resources Directorate, including a Science Masters program, and $400.0 million for construction projects in the Major Research Equipment and Facilities Construction account.





RESEARCH AND RELATED ACTIVITIES PLAN: Within R&RA, NSF used ARRA funding to invest in research in all of its programmatic directorates. Investment decisions were based on overall NSF and Administration priorities, including climate change and energy research as well as increasing the science and technology workforce and maintaining cutting-edge research infrastructure.



Most of NSF's ARRA funding (92 percent) in Research and Related Activities went into grants to individual investigators and small groups; however, a significant portion was used to support ongoing operations at NSF user facilities (8 percent). This chapter will go into additional detail for both of these categories.

EDUCATION AND HUMAN RESOURCES PLAN: The Recovery Act stipulated that funds be used by the Directorate for Education and Human Resources (EHR) for the following activities:

	ARRA Funding (in millions)
Undergraduate Education	$85.00
Robert Noyce Teacher Scholarship Program	$60.00
Math and Science Partnership	$25.00
Graduate Education	$15.00
Science Masters Program	$15.00
TOTAL	$100.00

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION PLAN: The Act designated $400.0 million for Major Research Equipment and Facilities Construction, supporting and accelerating development of the three U.S.-based facilities listed below.

	ARRA Funding (in millions)
Advanced Technology Solar Telescope (ATST)	$146.00
Ocean Observatories Initiative (OOI)	$105.93
Alaska Region Research Vessel (ARRV)	$148.07
TOTAL	$400.00

Detailed information on these activities can be found in the MREFC chapter.

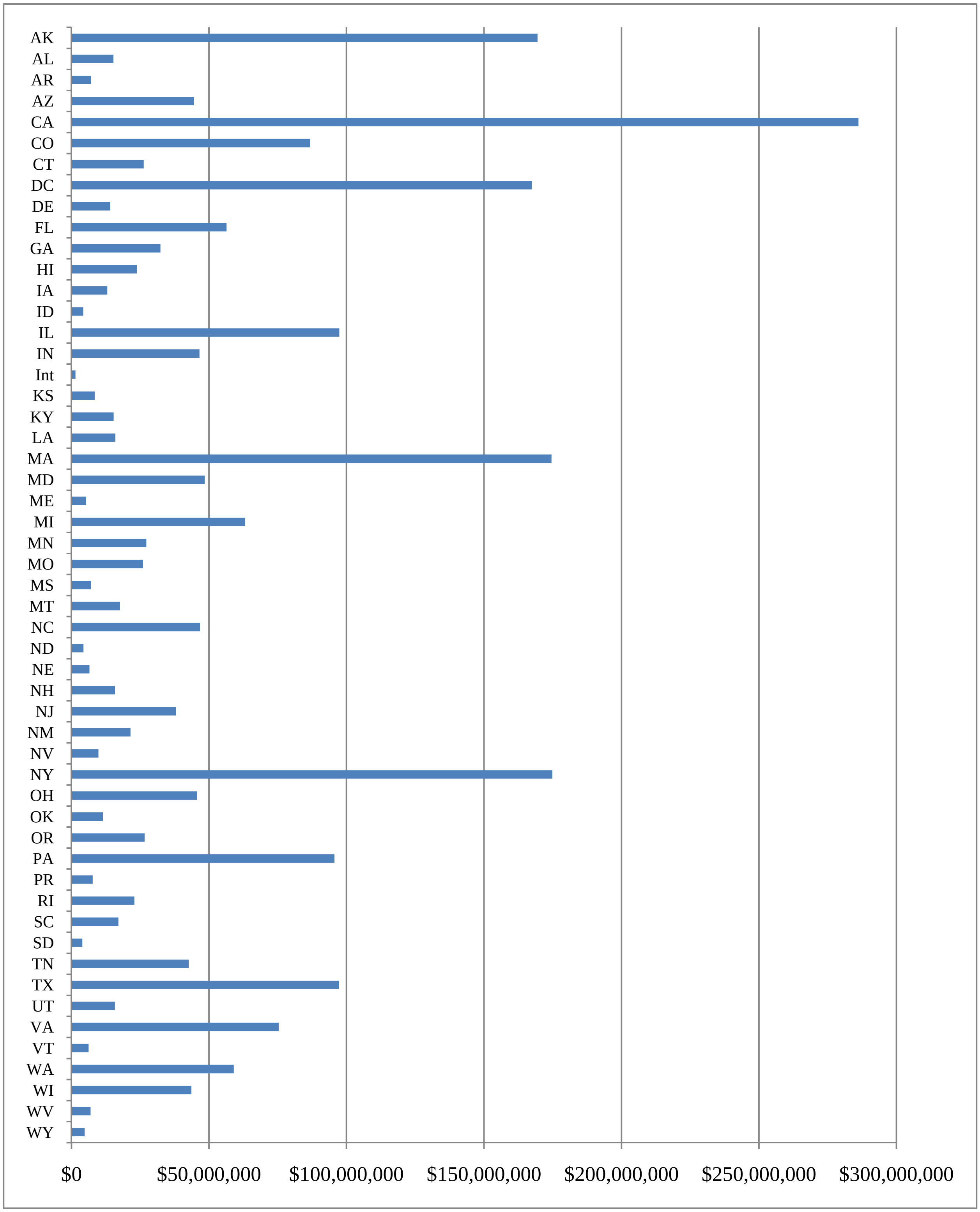
FUNDING OF YOUNG INVESTIGATORS: Since a major focus of the ARRA legislation was to develop a science and technology workforce, NSF invested a large amount of its ARRA funding in the Faculty Early Career Development (CAREER) and Graduate Research Fellowship (GRF) programs, making a strong push to support new[1] principal investigators and co-PIs with ARRA funds.

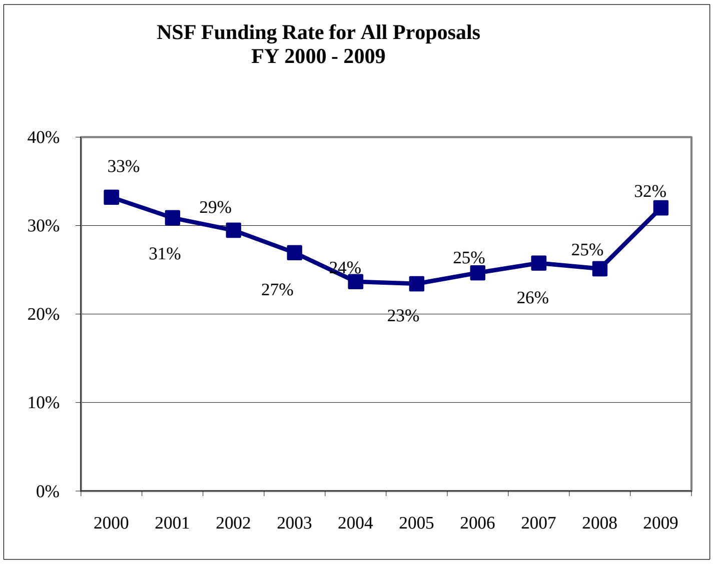
The three charts below show that NSF was successful at increasing the number of CAREER and GRF awardees, as well as funding new principal investigators and co-investigators. Increasing the number of individuals receiving CAREER and GRF awards and funding new PIs develop the science and technology workforce of the Nation, a stated goal of ARRA funding. The funding rate for new PIs for FY 2009 is 29 percent, compared to a funding rate of 23 percent in FY 2008. Our analysis shows that without the additional ARRA awards, the new PI funding rate would have dropped to around 19 percent.

GEOGRAPHICAL DISTRIBUTION: NSF put a strong emphasis on ensuring that ARRA funding was spread out across the United States; all 50 states received at least some funding. The figure below shows the amount of ARRA funding obligated by jurisdiction in FY 2009. With the exception of Alaska, which received significant ARRA funding in the Alaska Region Research Vessel, the geographical distribution of ARRA funding is similar to that of other funding years.

[1] A New PI is an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia and workshop grants).

FY 2009 ARRA Obligations by State





FUNDING RATE: The competition for NSF funds has always been intense, but it has grown more so in recent years. The overall average proposal funding rate for all NSF proposals decreased from 33 percent in FY 2000 to 23 percent in FY 2005, while the number of proposals grew 43 percent in this same time period. From 2005 to 2008, the number of competitive proposals received averaged around 43,000 per year and the funding rate hovered around 25 percent as the graph indicates. In FY 2009, NSF received slightly more proposals than previous years for a total of 45,228 proposals. At the same time, the additional Recovery Act funds enabled NSF to increase its funding rate to 32 percent in FY 2009, the highest since FY 2000.

PREVIOUSLY DECLINED PROPOSALS: ARRA funds were made available for obligation in May 2009, seven months into FY 2009. At that time, many programs had already declined proposals in the "very good" to "excellent" categories in order to meet their Government Performance and Results Act of 1993 (GPRA) goals of responding to proposals within a six-month window. NSF determined that, for FY 2009 only, programs could make awards to previously declined proposals. Three hundred eighteen proposals of the 4,599 awarded with ARRA funds fell into this category (7 percent).

ARRA SUPPORT FOR USER FACILITIES: Supporting NSF user facilities means not only maintaining the infrastructure that provides long-term economic benefit to the Nation, but also jobs in many different parts of the country, ranging from Alaska to Florida, Hawaii to Puerto Rico. The NSF was particularly interested in recapitalization of U.S. facilities where maintenance and enhancements had been deferred or staff had been reduced. Facilities supported by NSF ARRA funding include:

NSF User Facilities	FY 2009 ARRA Actuals (dollars in millions)
Antarctic Facilities and Operations	$15.50
Arctic Logistics	7.00
ARF- Academic Research Fleet, Ship Operations and Upgrades	18.00
Cornell Electron Storage Ring (CESR) & High Energy Synchrotron Source (CHESS)	14.99
EarthScope: USArray, SAFOD, PBO	9.00
Energy Recovery Linac (ERL)	5.20
Integrated Ocean Drilling Program (IODP)	25.00
National Nanotechnology Infrastructure Network (NNIN)	10.27
National Astronomy and Ionosphere Center (NAIC)	3.10
National High Magentic Field Laboratory (NHMFL)	5.00
National Optical Astronomy Observatories (NOAO)	5.60
National Radio Astronony Observatories (NRAO)	5.40
National Solar Observatory (NSO)	1.40
National Superconducting Cyclotron Laboratory (NSCL)	2.00
National Center for Atmospheric Research (NCAR)	13.20
Networking and Computational Resources Infrastructure and Services	17.00
Synchrotron Radiation Center (SRC)	4.99
TOTAL	**$162.64**

AWARD DURATION: A real concern with increasing the NSF budget by 50 percent in one year was the impact this would have in increasing renewal requests as those awards came to an end. Increasing the funding rate dramatically in FY 2009 could have potentially forced the funding rate to plummet in FY 2012, as about 40 percent of all NSF awards are 3-year awards.

NSF attempted to ameliorate this effect in a number of ways. First, by increasing the number of standard awards made with regular FY 2009 appropriations, out-year "mortgages" could be bought down. In an average year, 40 percent of NSF programmatic funds are already committed for annual increments on awards. By making more standard grants (full funding for an entire multi-year award obligated at once, rather than in yearly increments), NSF could ensure that there was more freedom in FY 2010, FY 2011 and FY 2012 to make new awards.

Second, with ARRA funds themselves, NSF changed the proportion of award durations. Below is a chart showing the distribution of award durations for FY 2007, FY 2008, FY 2009, and ARRA. With the increased number of 4- and 5-year awards made with ARRA funds, renewals for those awards will be submitted in FY 2013 and FY 2014, reducing the number of renewal submissions expected in FY 2012. The shift in average award duration from 2.5 and 2.6 years in FY 2007 through FY 2009 to 2.9 years for the ARRA portfolio reflects this purposeful change; NSF was able to increase both award duration and funding rate as a result of ARRA funding.