

Women in Nano: Double Bind or Double Bonus?



Marjorie Olmstead

Department of Physics and Center for Nanotechnology

University of Washington, Seattle

olmstd@uw.edu



THE CENTER FOR
NANOTECHNOLOGY
AT THE UNIVERSITY OF WASHINGTON



Double Bonus: Nanotechnology has characteristics often associated with female scientists.

- Rapid rise over past 20 years
- Integrate biology and chemistry into physics and engineering
- Interdisciplinary team interactions
- Emphasis on societal impact

A WEALTHIER YOU!!!

Business Opportunity
71% Double Bonus Compensation Plan

- House Fund - 2%
- Car Fund 3%
- Year End Bonus - 2%
- Traveling Fund - 2%
- Leadership Bonus - 25%
- Achievement Bonus - 3%
- Manager Bonus - 14%
- Performance Bonus - 20%
- Retail Profit - 15% - 25%

We are fully committed helping people to succeed in Health, Wealth, and Total well being...

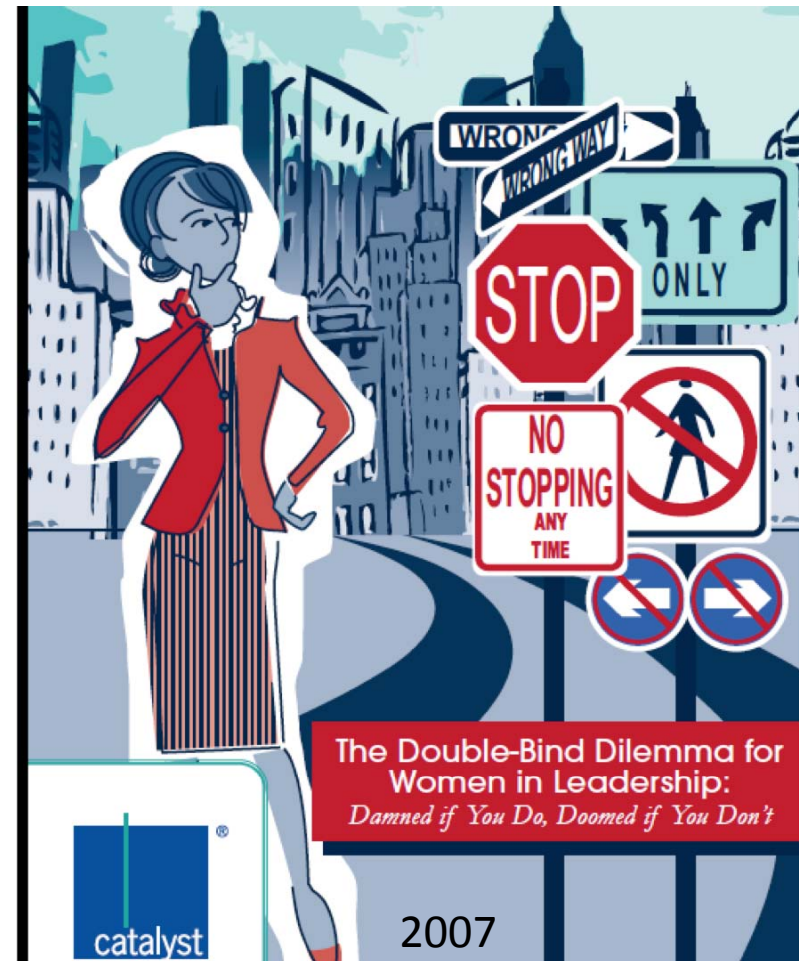


Double bind can show up as both internal and external constraints

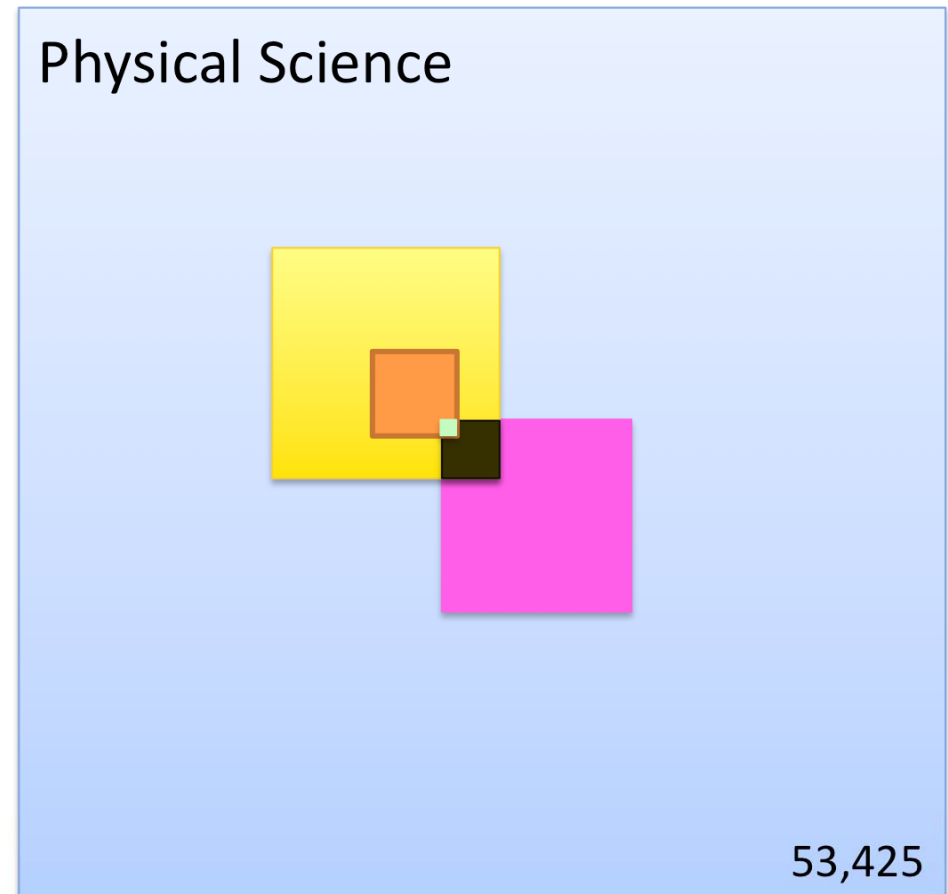
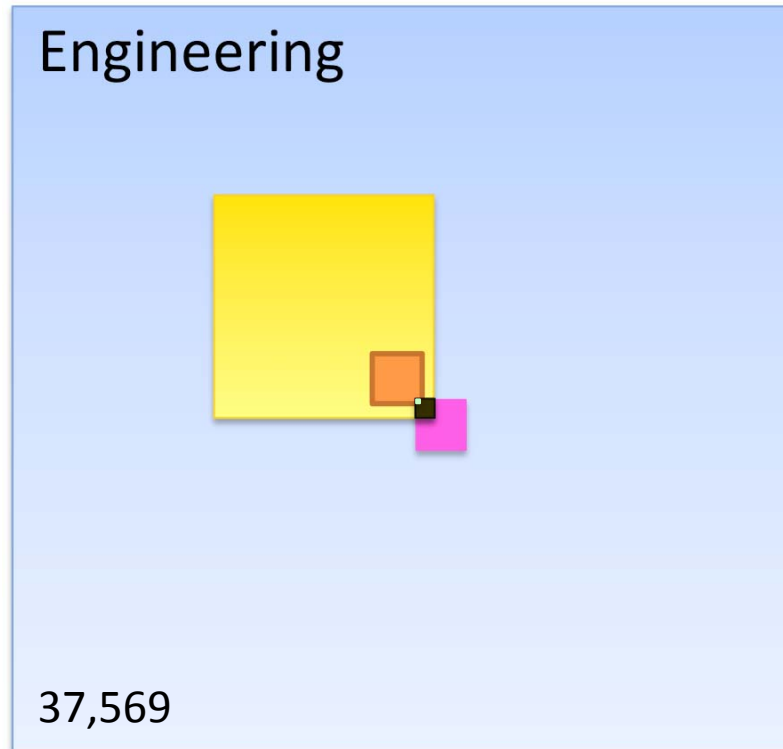
The Double Bind: The Price of Being a Minority Woman in Science

Shirley Mahaley Malcom
Paula Quirk Hall
Janet Welsh Brown

1975



1975 Workshop: The Double Bind: The Price of Being a Minority Woman in Science



White Males

Asian Males

Non-Asian, Non-White Males

White Females

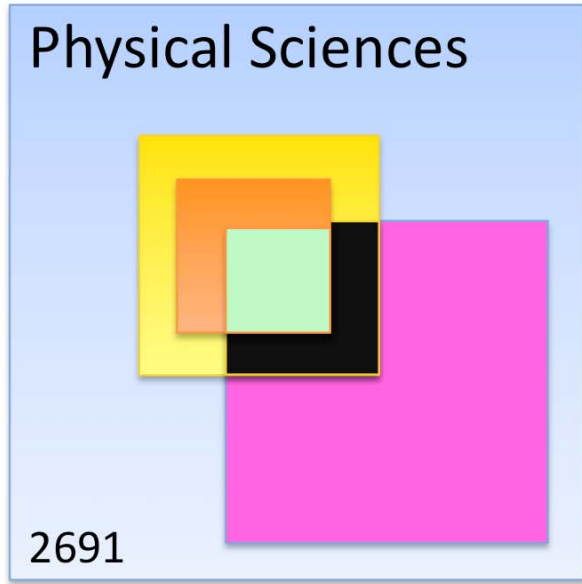
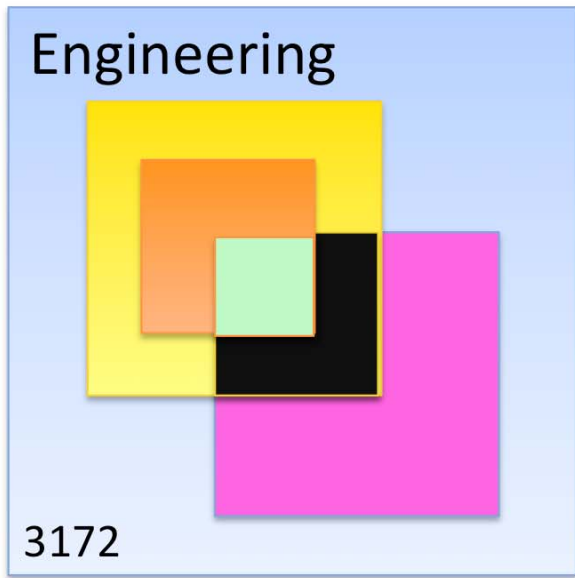
Asian Females

Non-Asian, Non-White Females

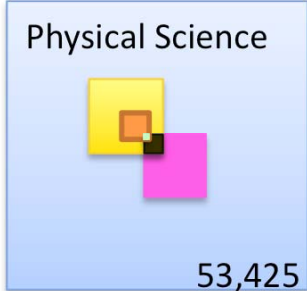
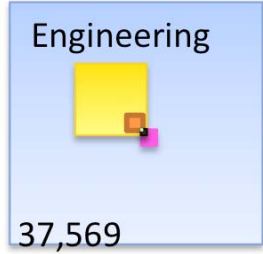
Data from 1973 NSF Report on Total Science & Engineering Workforce

Women and Minorities in STEM have greatly increased their participation since 1973.

But are still under-represented



2007 Awarded PhDs to US Citizens*

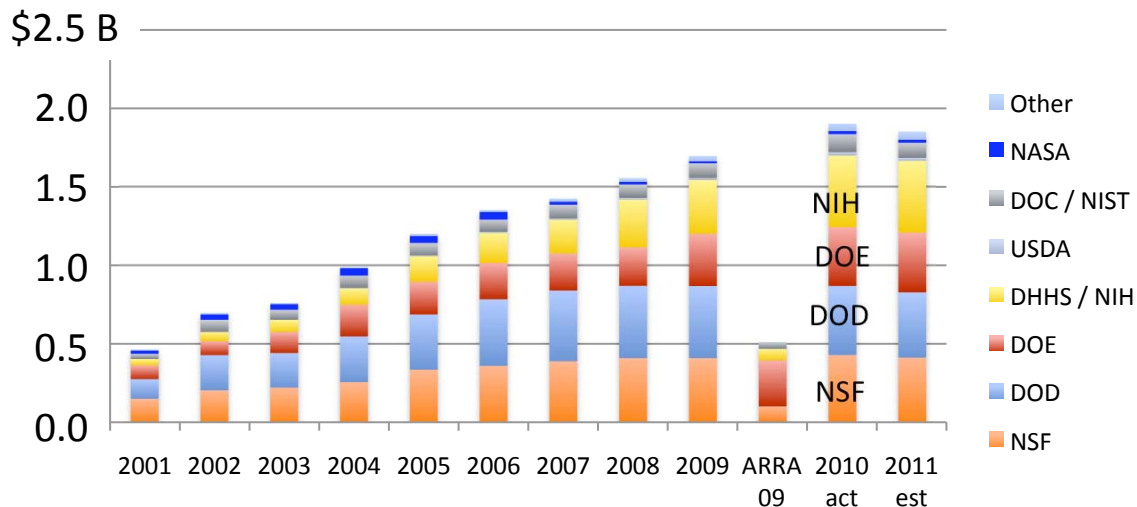


1973 Workforce

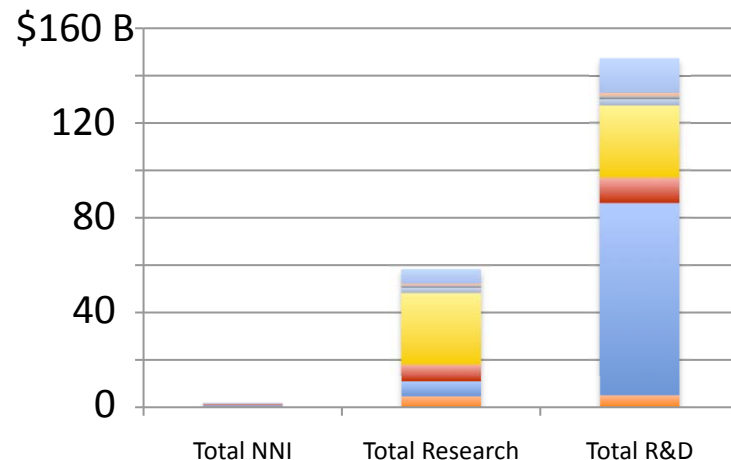
* National Center for Education Statistics

Nanotechnology is growing, but still a small fraction of overall research

NNI Funding 2001 to Present*



2010 Federal R&D Funding



Agency	Total NNI 2010*	% Research Budget
Commerce	\$114 M	11.9%
Health	\$378 M	1.2%
Energy	\$373 M	5.3%
Defense	\$436 M	6.9%
NSF	\$418 M	9.0%

*www.nano.gov

("Nano" + Female) vs. ("Minority" + Female) has similarities and differences

- "Nano" and "Minority" are both cultural subsets.
- BUT: "Nano" culture barely exists before college. Race does.

Rationale for this 2010 Conference:

"a small conference of the women themselves to find out exactly what the problems are, and in what respects they are similar to or different from those of ~~majority~~ women scientists, ~~minority~~ male scientists, and all other scientists."

nano

non-nano

How does the climate for women (of all races) in nanotechnology differ from that in more traditional science and engineering fields?

Social scientists have well-developed ways of figuring that out ...

The natural scientist needs to know more about what social science has done in developing methods for what he would call measuring “intangibles”. *Olmstead*

For the physicist, **variability** denotes lack of control – to the psychologist it denotes an essential condition of his universe. The physicist is equipped with methods for its elimination; the psychologist is equipped with methods for its examination. *Preston*

A scientist is not only a scientist, regardless of his specialty, but a man living in a social order and profoundly effected by trends and occurrences within that order. That these will influence his work as a scientist no less than his existence as an individual is as obvious as that his field will itself be affected by them. *Orens*

Dec. 1947 AAAS Symposium: What the Natural Scientist Needs from the Social Scientist

1. Introductory Remarks. J. S. Adams, Jr. - - - -	83
2. Some Thoughts on “What the Natural Scientist Needs from the Social Scientist.” P. Olmstead -	85
3. What the Physical Scientists Need from the Social Scientists. E. R. Phelps - - - - -	87
4. Physical Science and the Social Sciences. I. P. Orens - - - - -	90
5. Concerning An Essential Condition of Cooperative Work. Malcolm G. Preston - - - - -	96
6. Science and Social Responsibility. C. F. Butts - -	100
7. Do the Natural Sciences Have Need of the Social Sciences? R. W. Sellars - - - - -	104
8. On the Contribution of Sociology to the Physical Science. Frank E. Hartung - - - - -	109
9. Discussion. R. L. Ackoff - - - - -	116

Philosophy of Science

VOL. 15

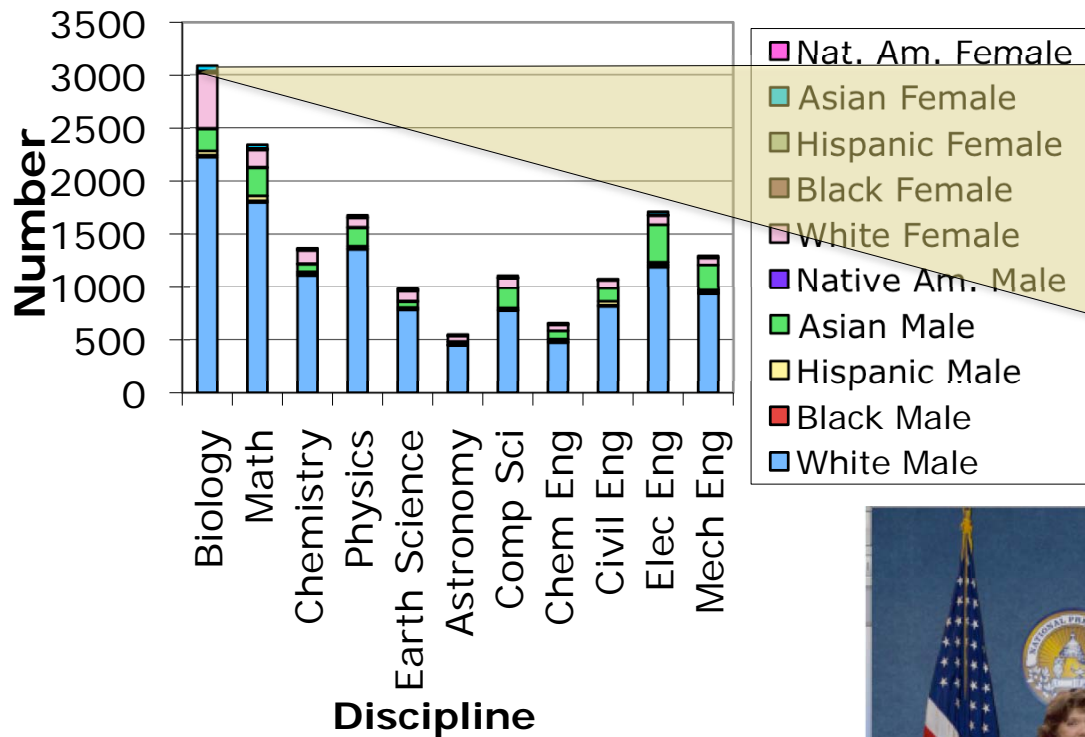
April, 1948

NO. 2

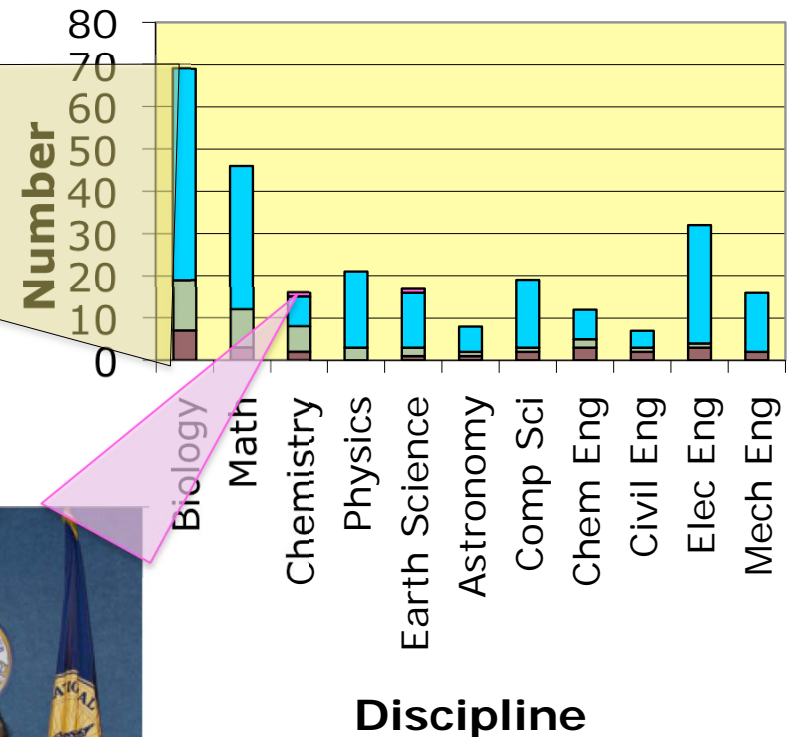


To understand the social context, we need data, and we need stories.

Tenured Faculty 2005 - Top 50

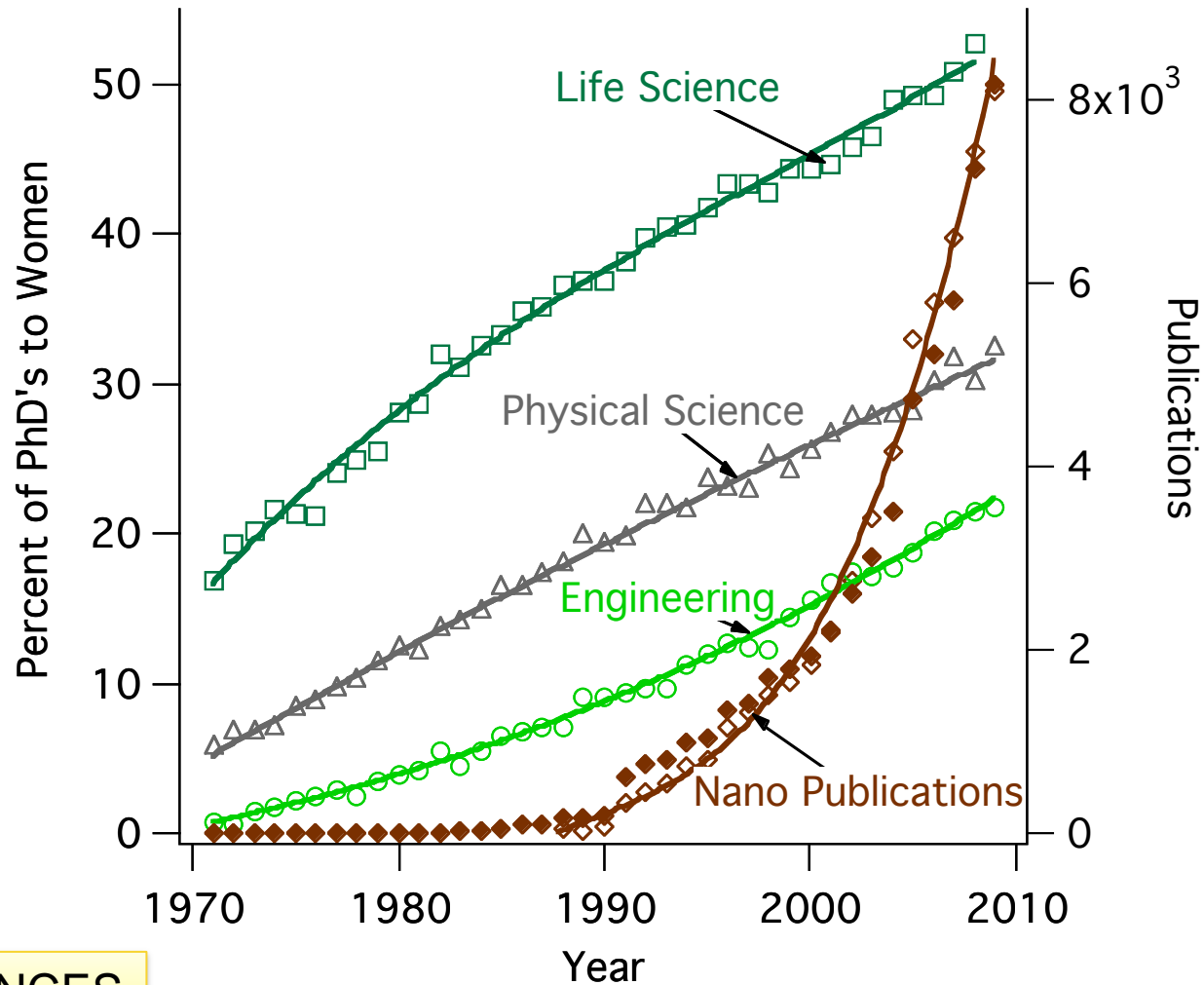


Tenured Women of Color



Donna Nelson
Univ. Oklahoma Chemistry

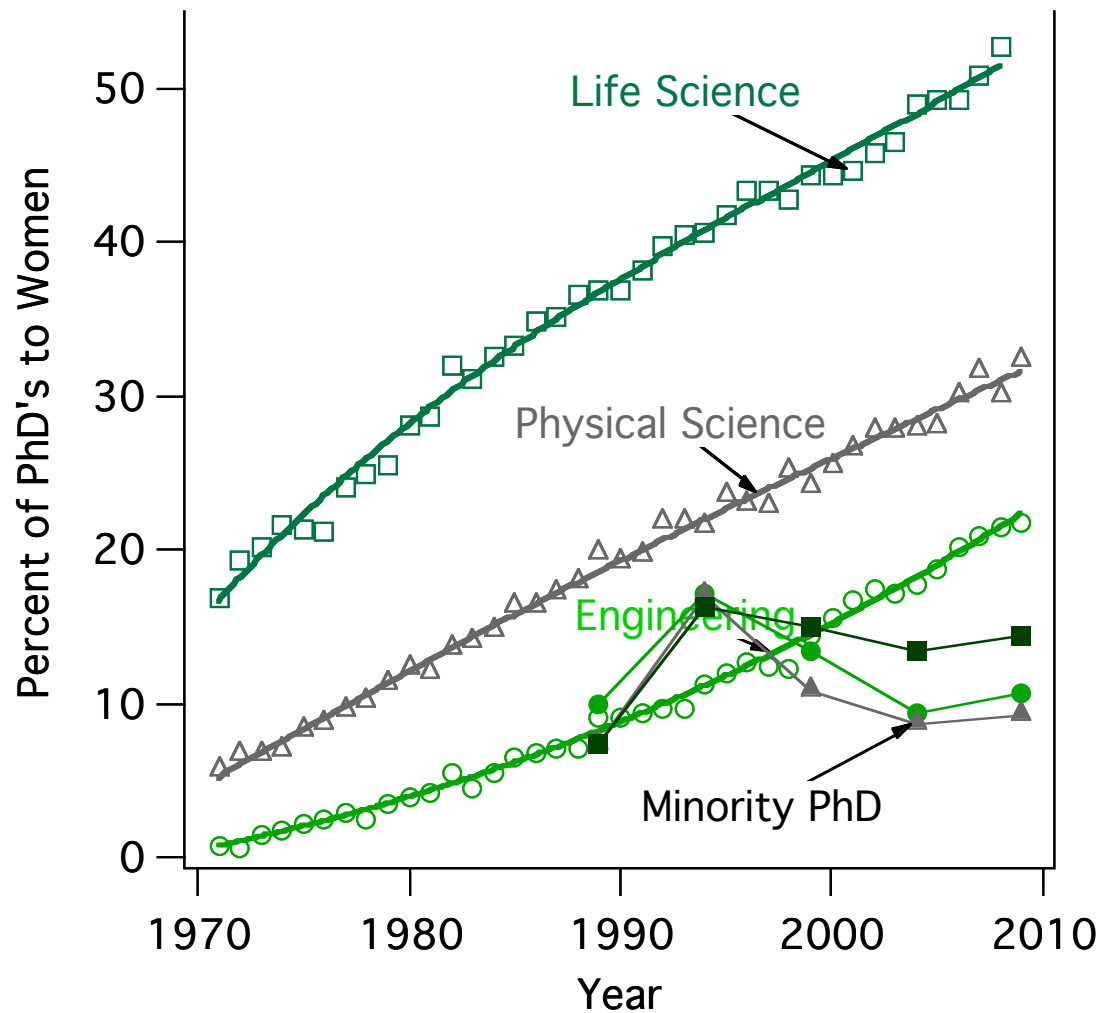
The rise of nanotechnology and women in STEM happened over similar time frames.



PhD data from NCES

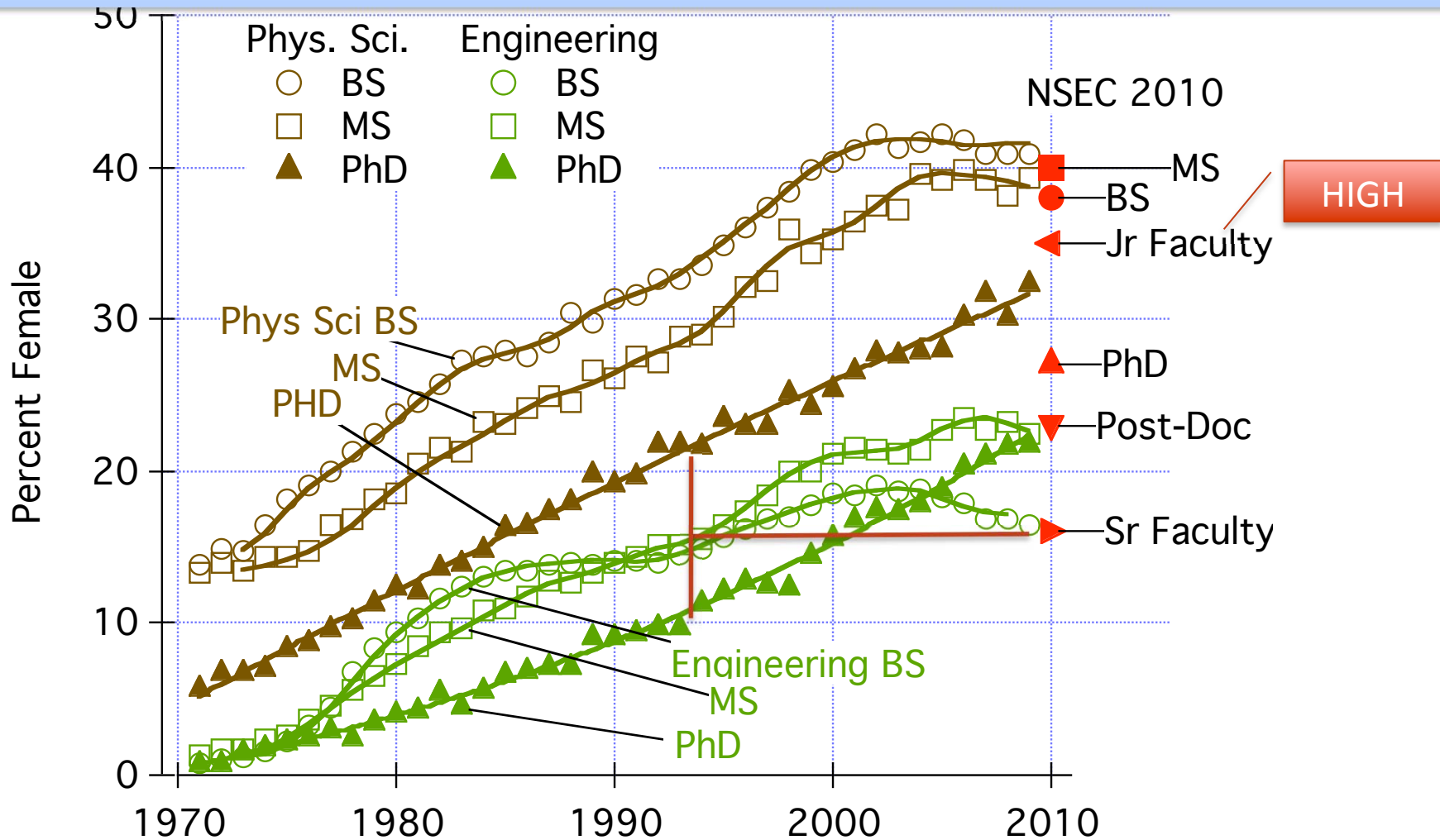
Nano Pubs from Web of Science: \diamond =(nanotech* OR nanoscale OR nanometer* OR nanoscience)
 \blacklozenge =.2* (quantum (well* or wire* or dot*)) or nanopart* or nanocryst* or nanotechnol* or nanosc*

The rise of nanotechnology and women in STEM happened over similar time frames.



US Citizen PhD data from NCES – disaggregated by both race and gender not available

NanoCenters have slightly larger proportion of women students and researchers than parent fields.

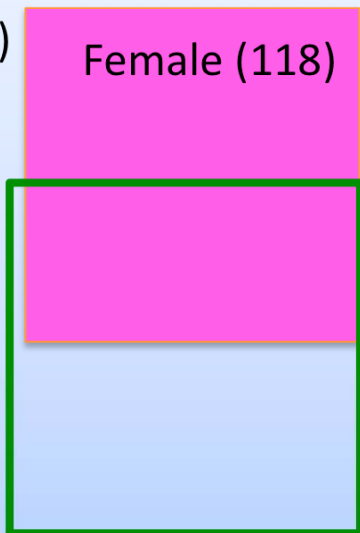


Degree data from nces.gov Year of Graduation
 NSEC data collected for this meeting by NSF

NSF-funded Nano-Centers have high proportion of women and minority junior faculty

Male (436)

Female (118)



Junior Faculty
(177/555)

URG
(39)

Minority (127)

Overlap with gender
not reported

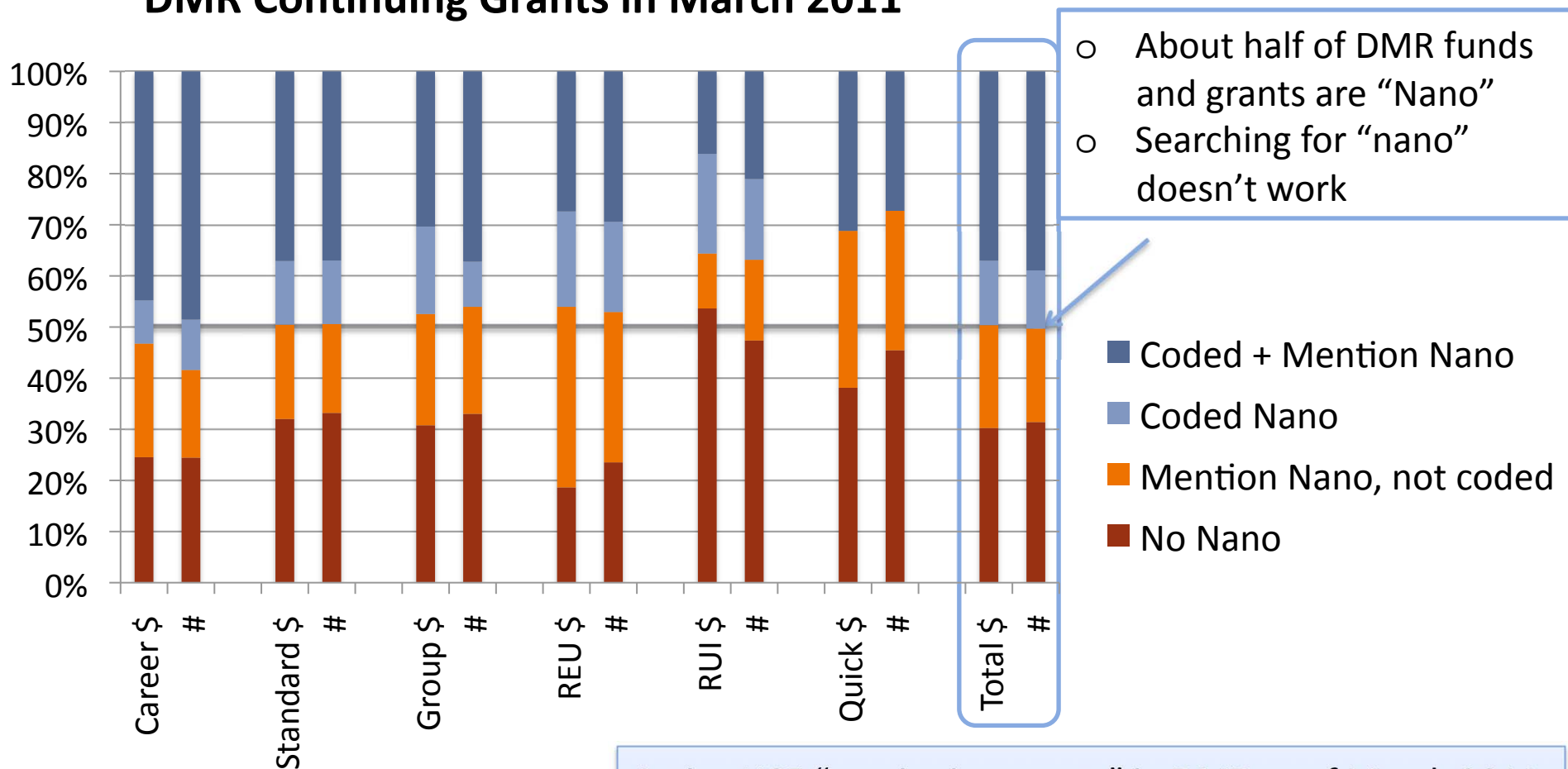
Group	Female since 1971	Female since 2001	Minority in 2007	URG in 2007
Phys. Sci.	19.6%	29.2%	17%	9%
Engineering	11.7%	19.4%	27%	8%
NSEC faculty	All: 22%	Jr: 32%	Jr: 26%	Jr: 9%
NSEC PhD		27%**	49%**	6%**

NSEC report data
NCES statistical data

** Data includes foreign students

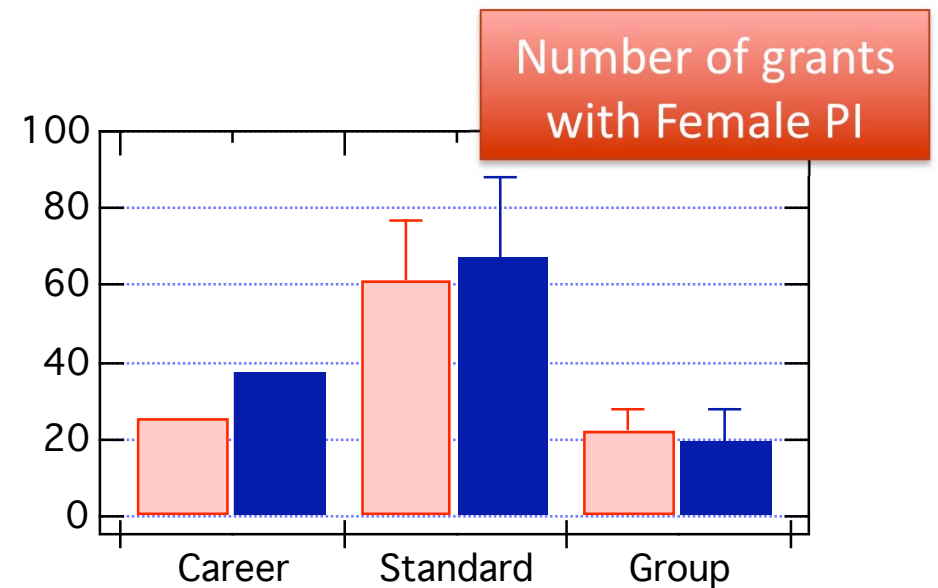
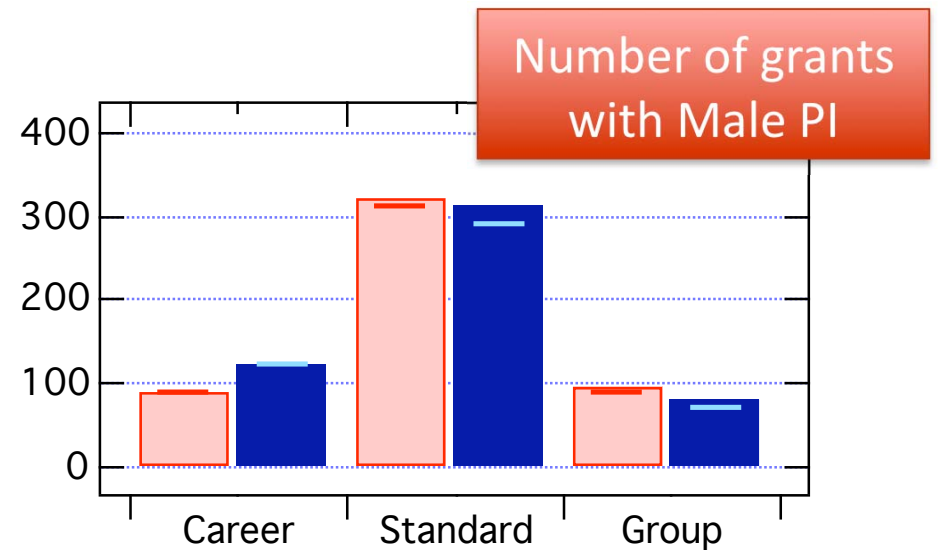
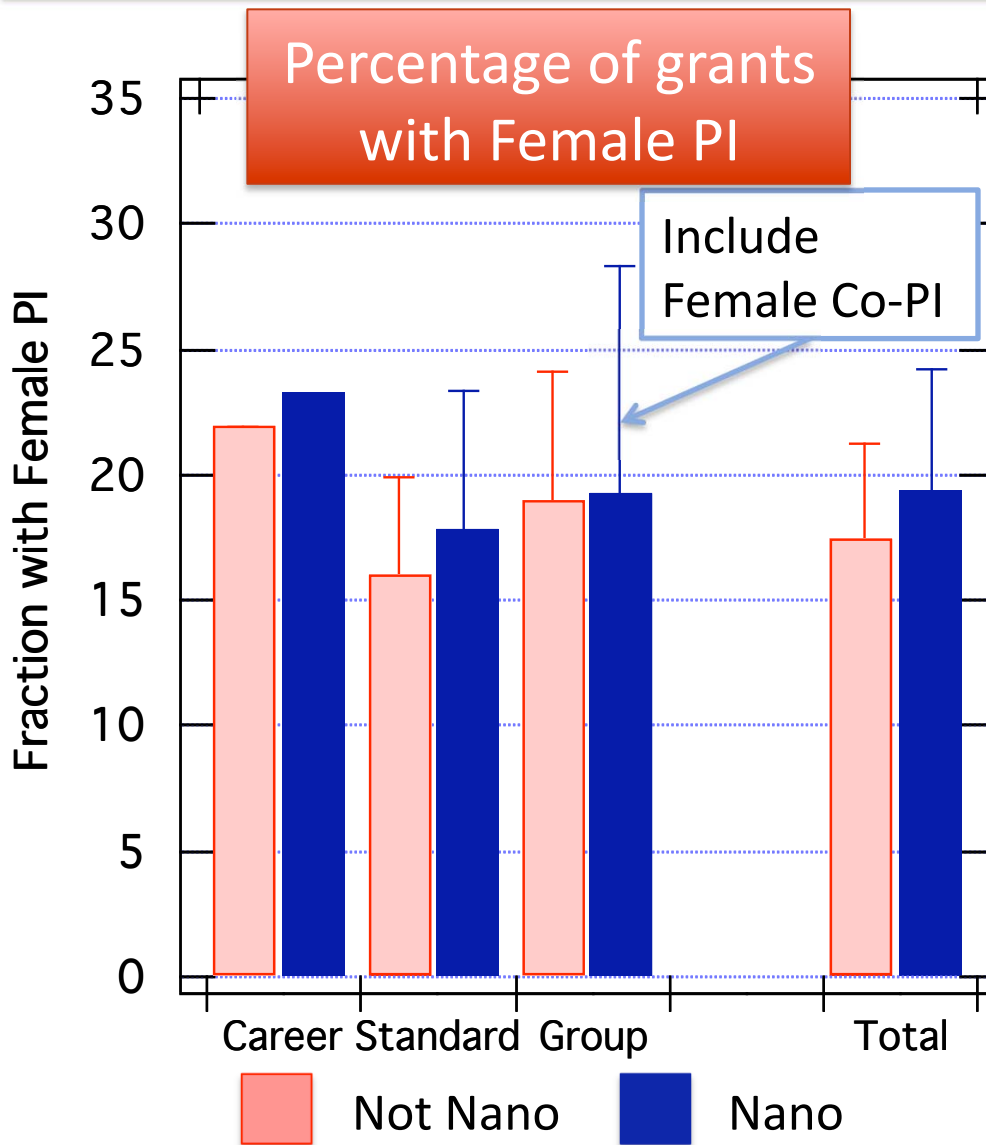
Nanotechnology research is about half of NSF-DMR

DMR Continuing Grants in March 2011



Active NSF "continuing grants" in DMR as of March 2011
 Downloaded from Fastlane
 "Coded Nano" = Reference code 7237
 "Mention Nano" = nano* in title or abstract

NSF DMR active grants show no statistically significant nano-gender difference.



No gender effect in nano for single/multi investigator or amount awarded to single PIs.

Fraction of Grants with Female PI

	Career	Other Single PI	Multi-PI
Not Nano	22%	15%	22%
Nano	23%	18%	18%

Fraction of PhDs to females

Field	since 2001	since 1971
Physical Science	29.2%	19.6%
Engineering	19.4%	11.7%

Amount awarded to single-PI DMR grants
Start date post April 2010

	Female PI	Male PI
Not Nano	\$140 ± 53k (N=19)	\$135 ± 53k (N=115)
Nano	\$127 ± 65k (N=24)	\$133 ± 53k (N=129)

Blue boxes: nsf.gov
Red box: NCES

Pre-Survey of Women Faculty in NSECs carried out in November 2010

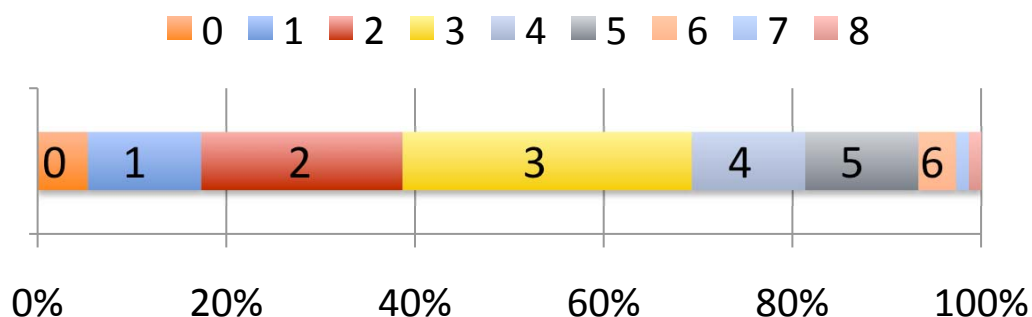
- UW Center for Workforce Development
- Suzanne Brainard and Vivien Savath
- 77 of 198 (39 %) Responded

Informed your invitation to this meeting

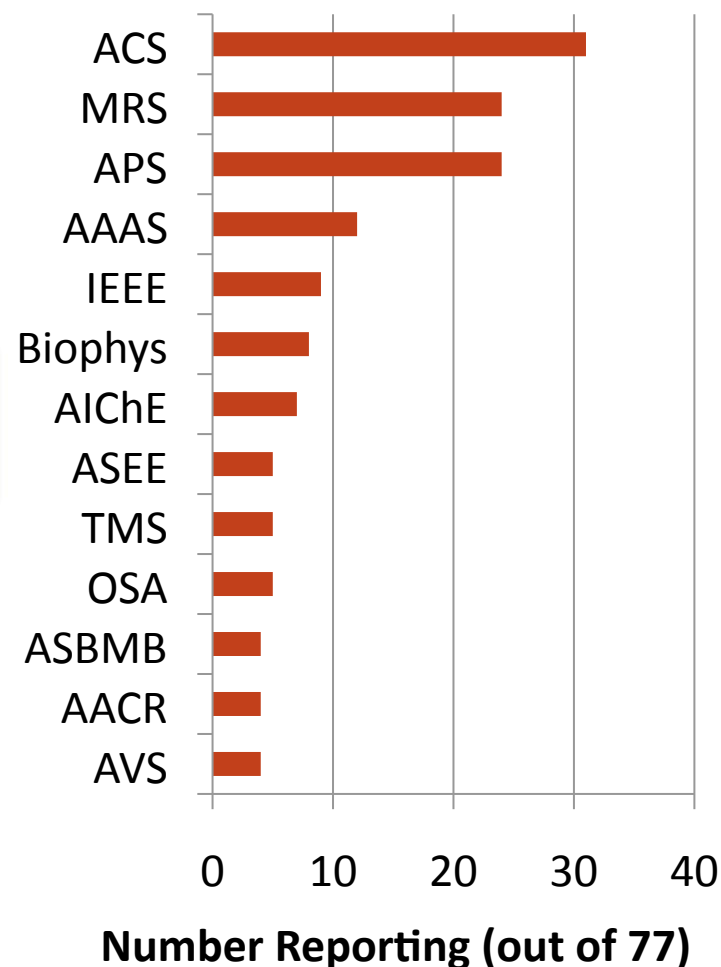
Data follow, occasionally augmented from UW Data I had access to

Women in NSEC have multiple professional homes.

Number of Professional Society Memberships



Most Popular (out of 78 mentioned)



Amer. Chemical Soc. 3/5 belong to 3 or more societies
 Materials Res. Soc. 2/3 belong to ACS, MRS a/o APS
 Amer. Physical Soc.
 Amer. Assoc. Adv. Sci.
 Inst. Elect. Electron. Eng.
 Biophysical Soc.
 Amer. Ins. Chem. Eng.
 Amer. Soc. Eng. Ed.
 The Metallurgical Soc.
 Optical Soc. Amer.
 American Society for Biochemistry and Molecular Biology
 American Association for Cancer Research
 AVS-The science and technology society

CWD-NSEC Survey

NSEC Women from many fields; > 1/3 report changing primary fields since PhD.

Same field: 48 (63%) New field: 29 (37%)

New Area: 15 (19%)

> 90% listed a secondary field

PhD Field	Current Field	Phys Sci	Mat Eng	Elec Eng	Life Sci	SS/Hum
Physical Science (Chem, Phys, Earth Sci)		18 +1	4		2	
Materials Engineering (Mat., Chem., Environ., Mech.)		3	19+3	1	1	
Electronic/Computer Eng		1	1	4	1	
Life Science (BioEng, Biol, BioChem, Med)		1			5+8	
Social Science/Humanities (Psych, Managem't, BioEthics, Relig.)						2+1

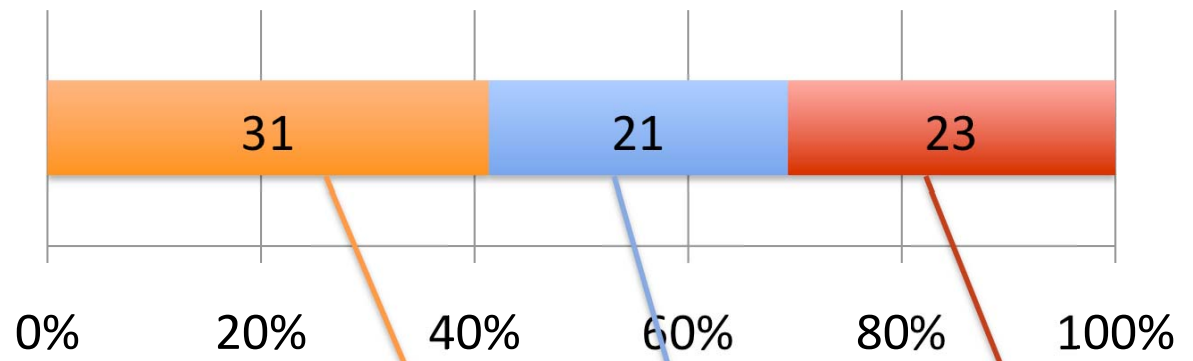
UW-CNT PhD Students*:

59% UG = Grad
 11% Double Major, picked one of them
 31% New Major

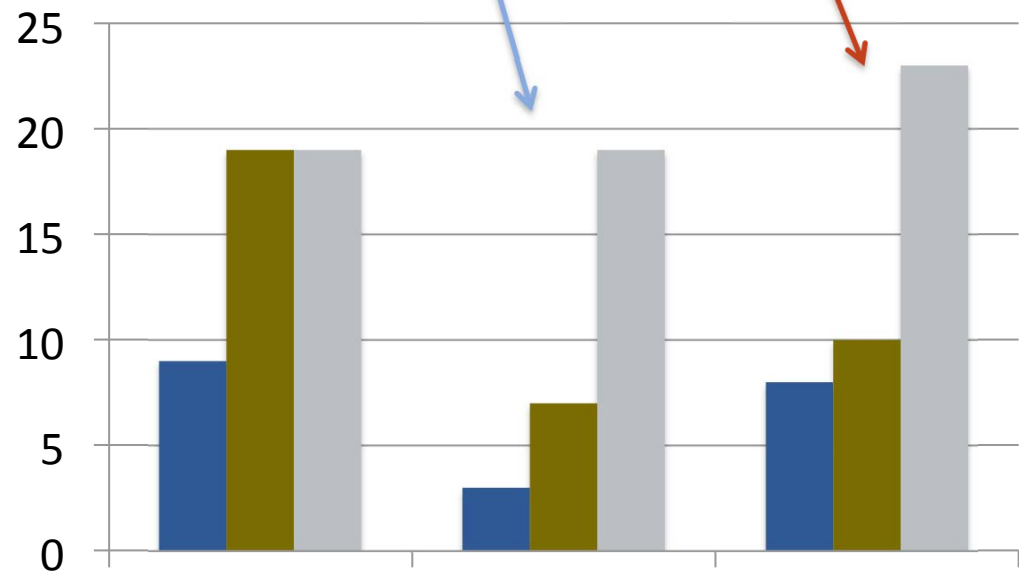
Interdisciplinary collaboration is key for NSEC women.

Close Collaborators in Current Research

- few: 1-5
- moderate: 6-10
- large: >10



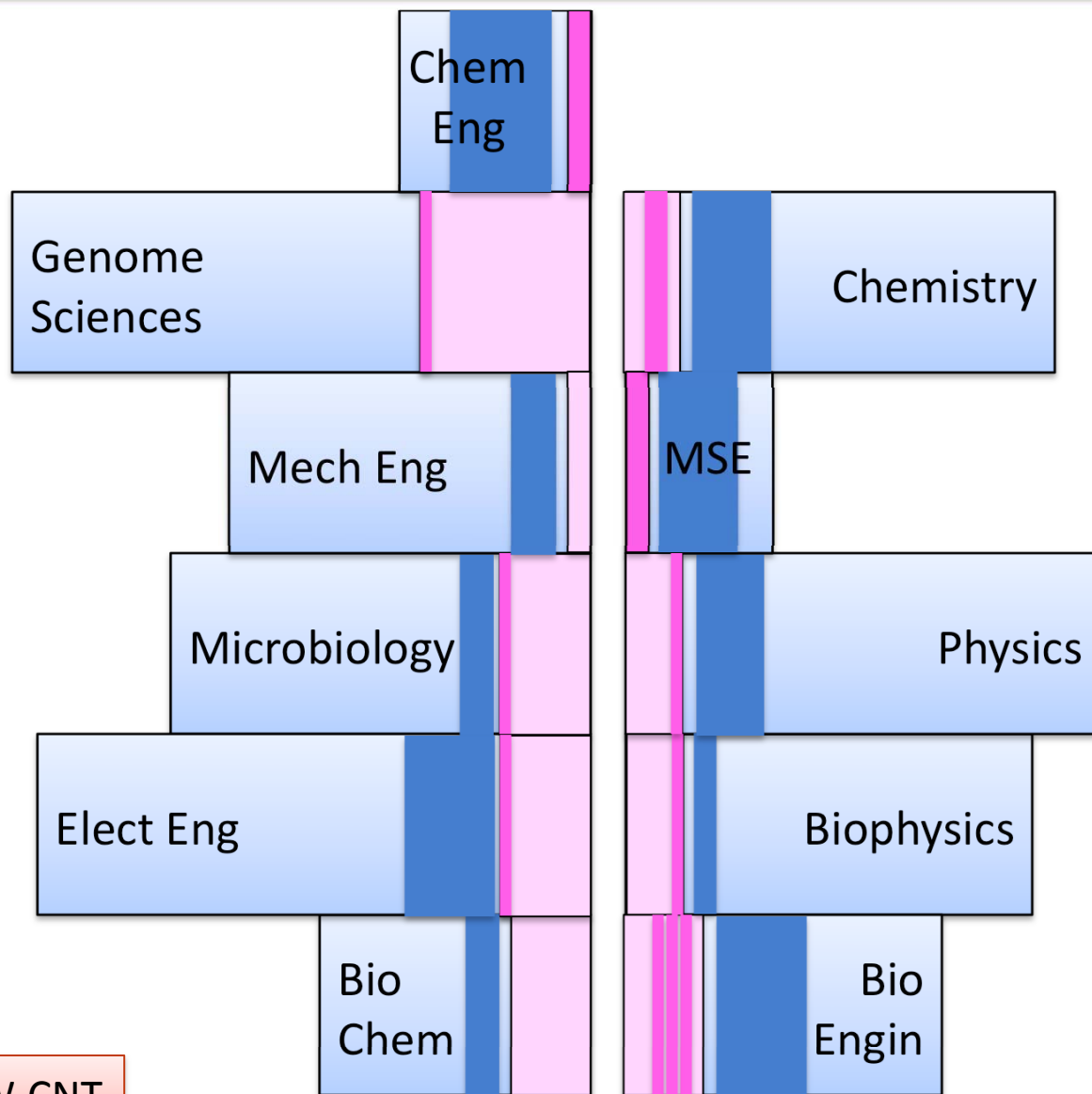
- my specific field (27%)
- closely related fields (48%)
- different disciplines (81%)



Women in nano are connected across campus, but may be isolated in their home department.

- Nano-Center
 - Larger network of women
 - Opportunity to act as “local expert”
 - Team and Center grants can help young people start
- Home department
 - Where merit is evaluated
 - Interdisciplinary science not always appreciated
 - Journals & conferences different from colleagues

Small numbers of “nano” and women can lead to isolation in ones home department.

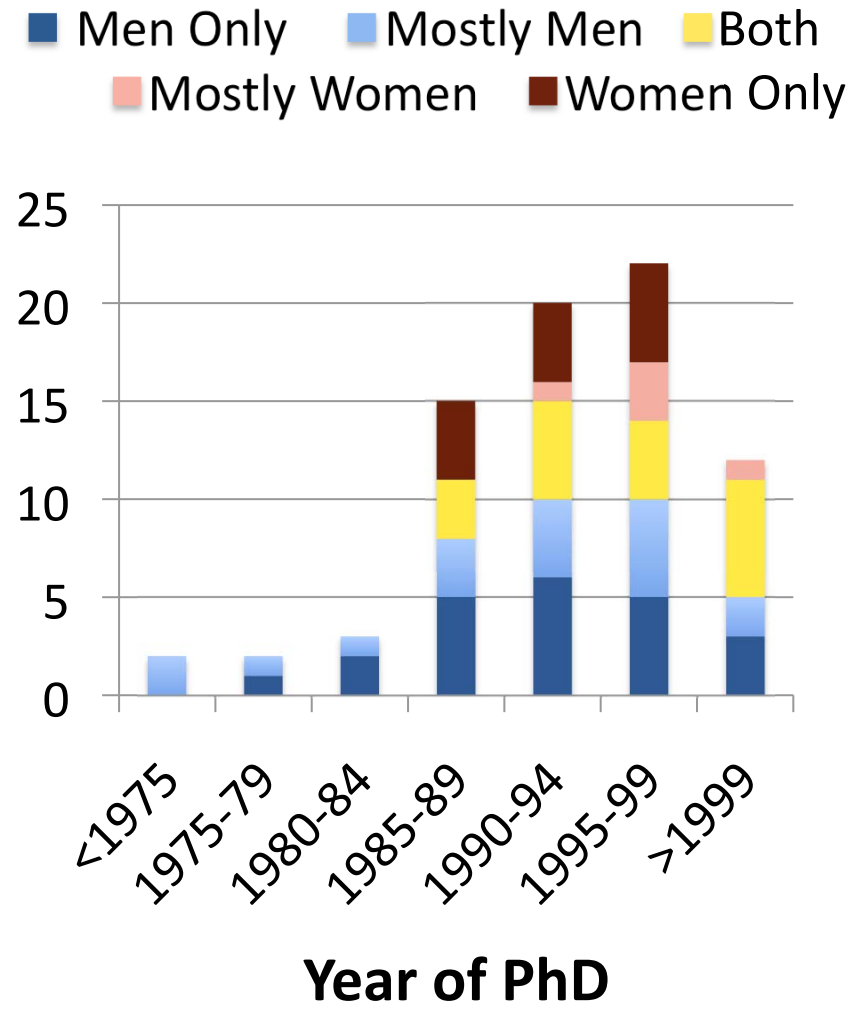
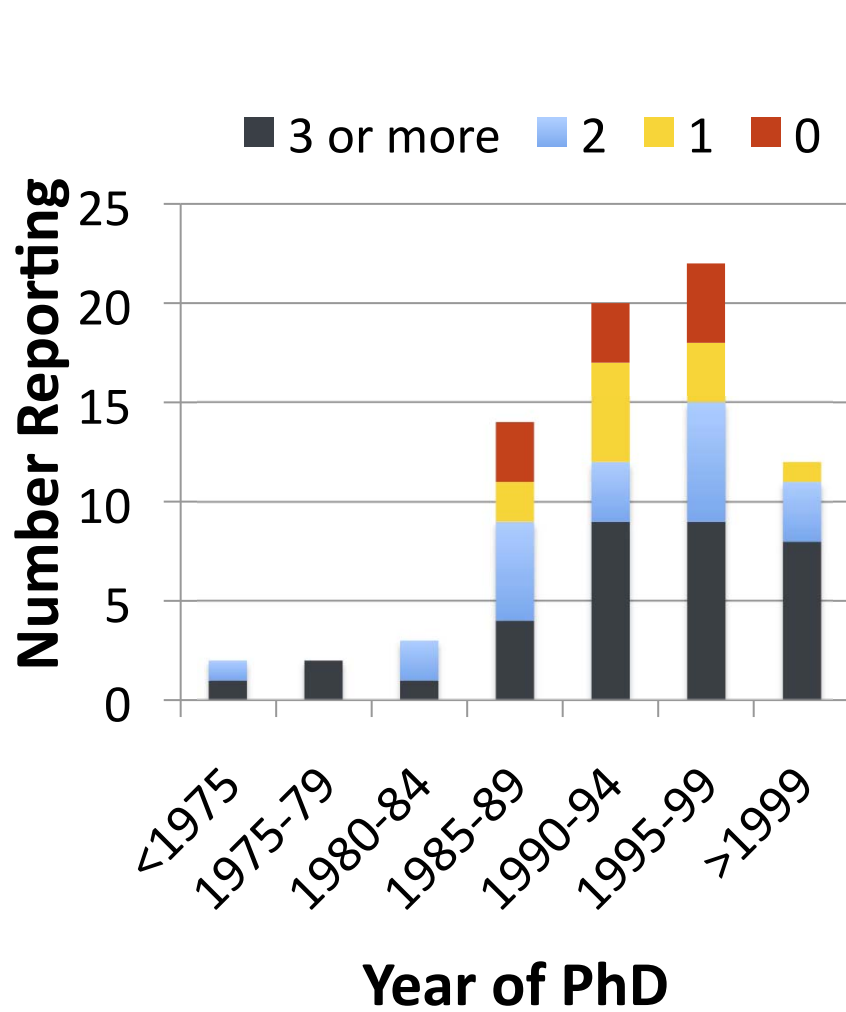


11 UW Depts	All	Female
Total Faculty	367	66
CNT Faculty	71	14*

UW-CNT

*2 foreign-BS Asian; 1 US-BS Asian, 11 US-BS White

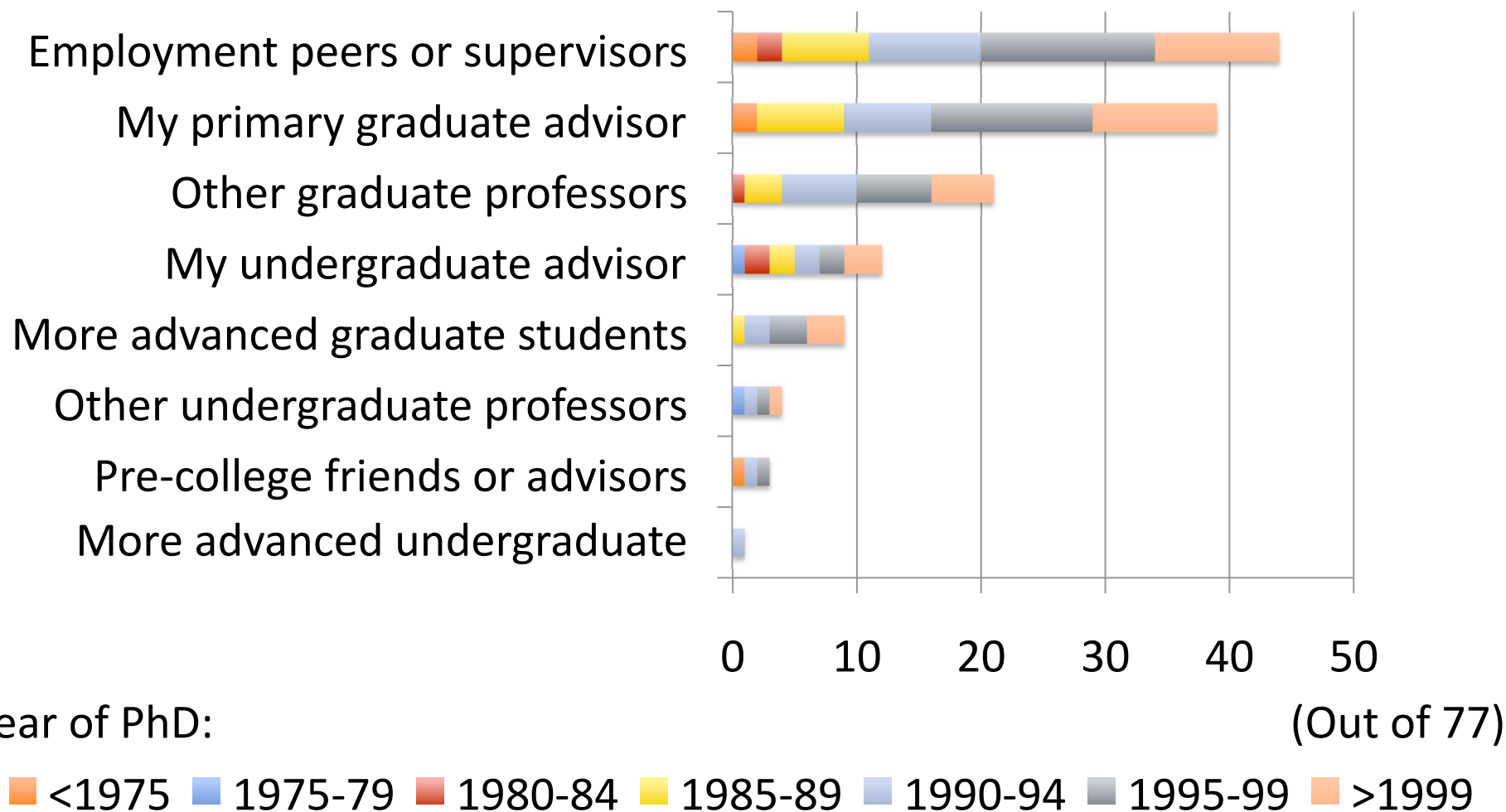
Women in NSEC of all professional ages report being mentored, older women mostly by men



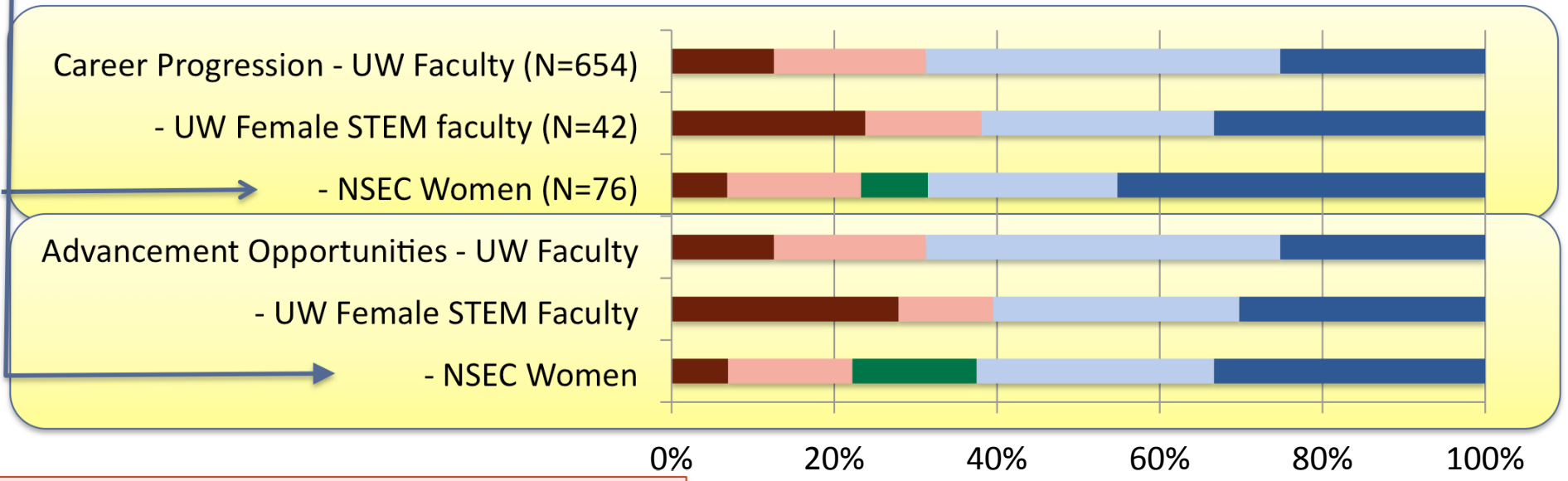
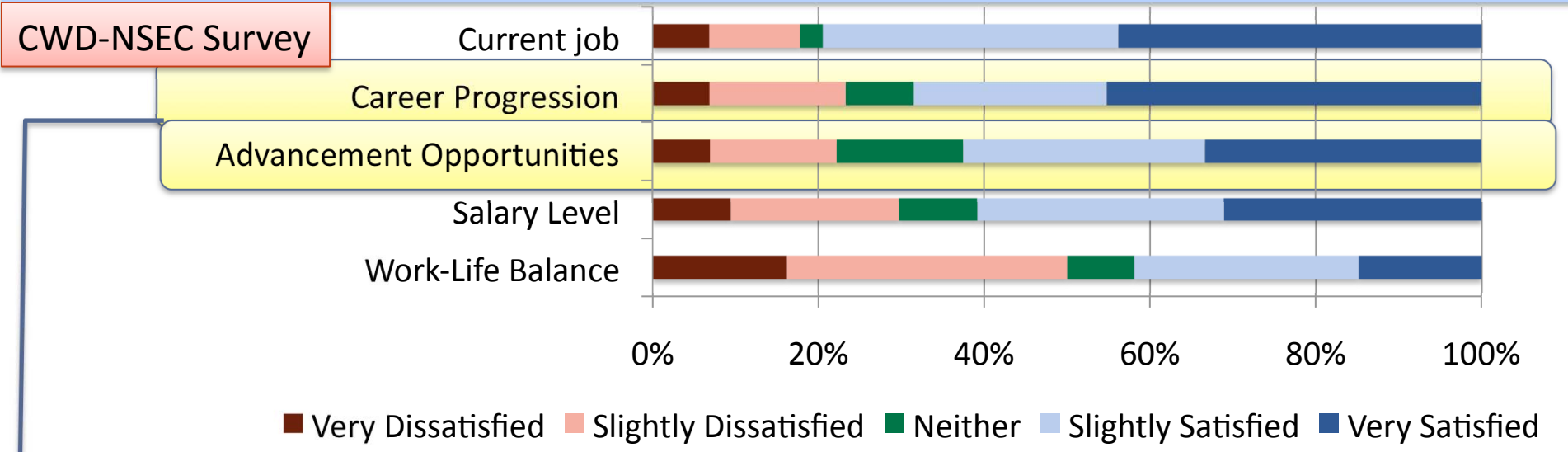
CWD-NSEC Survey

23 % report Mostly or All Female Mentors

Mentors are found in many places.



NSEC Women are generally satisfied with their jobs, but not with work-life balance.



Survey of UW Voting Faculty Spring 2008

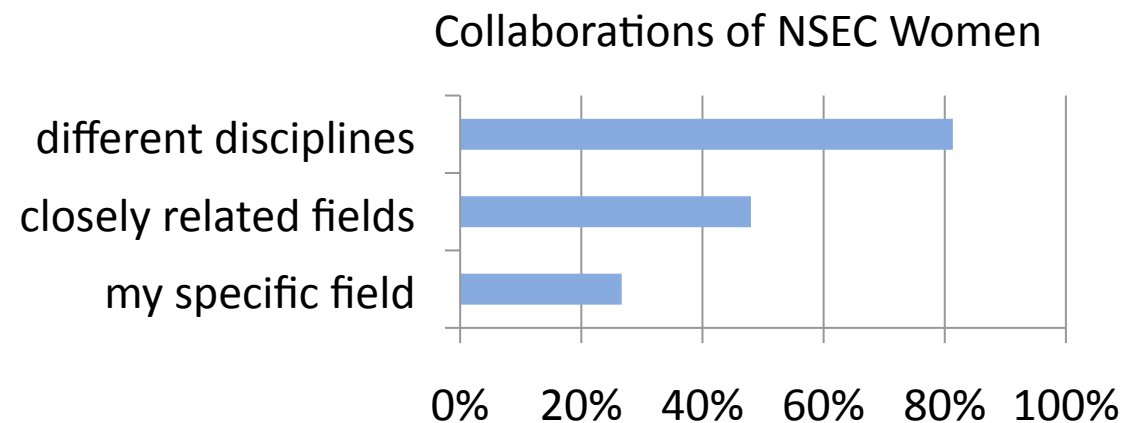
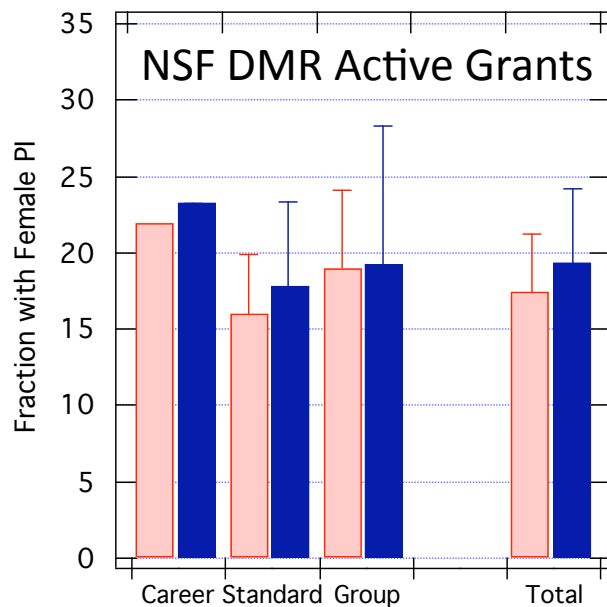
Similarities and Differences between “Nano” and traditional fields

- Similarities

- NSF Funding
- Job Satisfaction
- Female Representation

- Differences

- Interactions outside home discipline
- Not “core” to department



Double Bind: Women in Nanotechnology are isolated or invisible in home department.

- Science far from “core”
- Collaboration dilutes credit
- Center service not visible
- Teaching “outside” students
- Senior women in subfield likely in other depts
- MORE that you have seen??



Double Bonus: Nanotechnology is a great place to be a female scientist.

- Exciting science and technology
- Youthful practitioners
- Impact on Society
- Interdisciplinary teams
- Expanded network of women
- MORE that you have seen



Women in Nano: Double Bind or Double Bonus?

Let's discuss and
learn from each
other



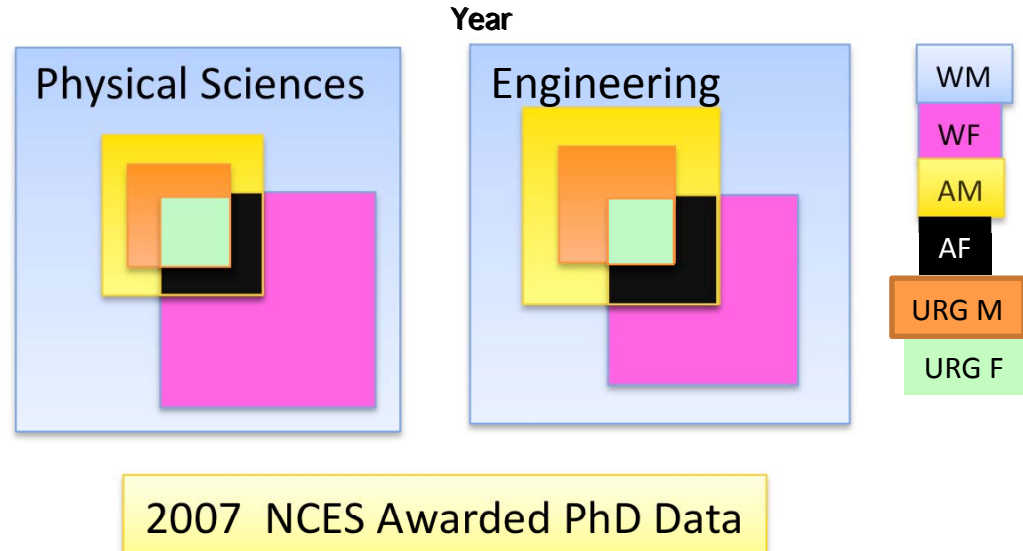
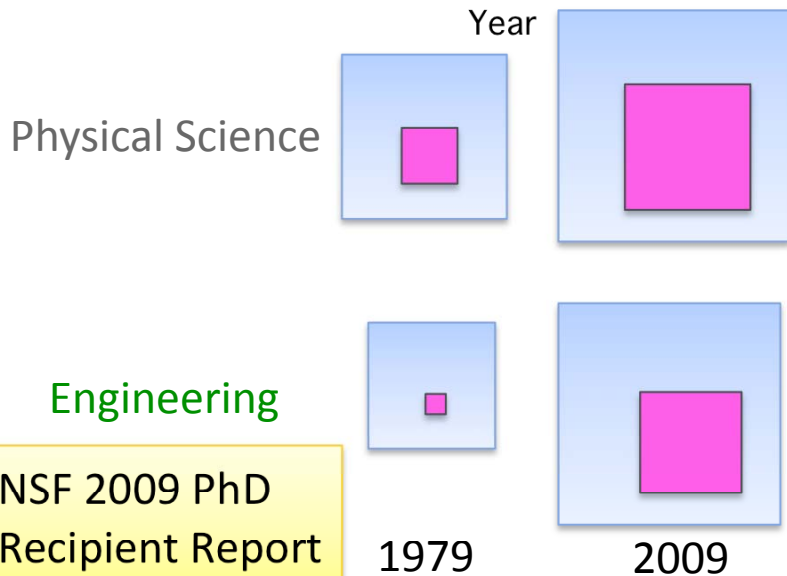
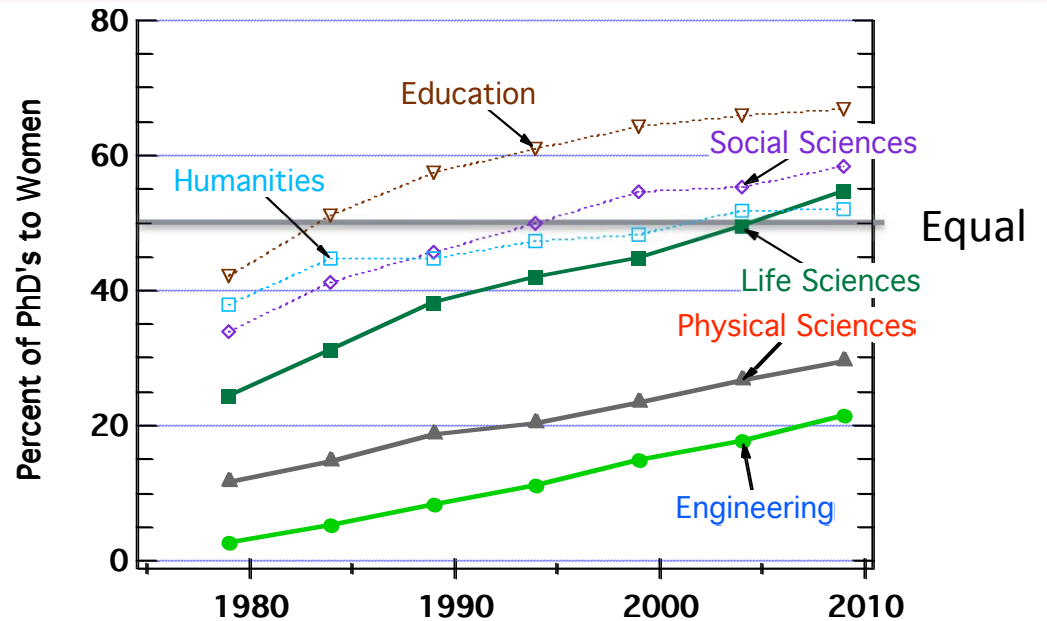
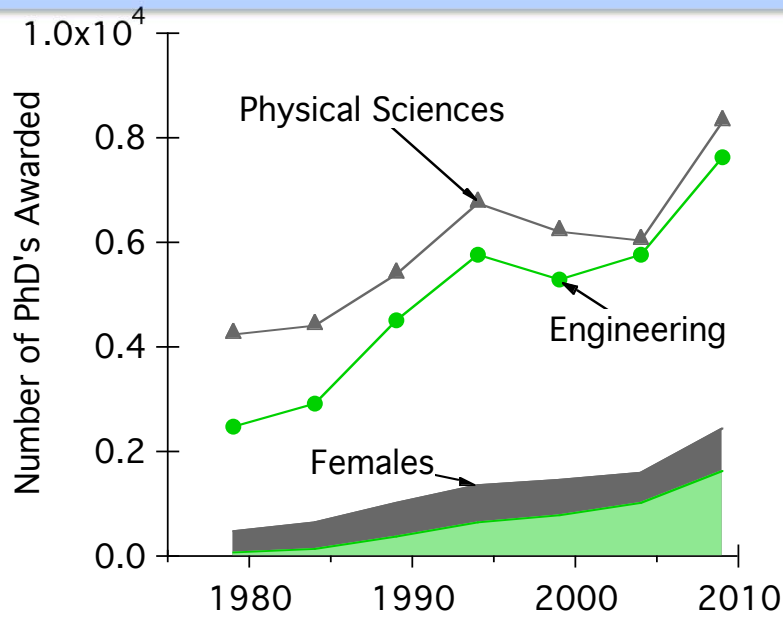
Marjorie Olmstead

Department of Physics and Center for Nanotechnology
University of Washington, Seattle

olmstd@uw.edu

Other data collected, but not used in presentation

Number of women in STEM has been steadily increasing, as has female fraction of PhDs



NSEC Women from many fields; > 1/3 report changing primary fields since PhD.

Same field: 48 (63%) New field: 29 (37%)

	Chemistry	Chem Eng	Mat. Sci.	Physics	Elect. Eng.	Mech Eng.	Civ/Env Eng	Biology	Bioengineering	Biochemistry	Medicine	Microbiology	Earth Science	Psychology	Management	Religion
Chemistry	8	1	1			1					1					
Chem Eng		5	2													
Mat. Sci.	2		9	1	1	1										
Physics			1	9		1		1								
Elect. Eng.				1	4			1								
Comp. Sci.						1										
Mech Eng.						3										
Civ/Env Eng							2									
Molec Cell Bio										4						
Biology												1				
Bioengineering					1				1							
Biochemistry	1							1		2	2					
Medicine											2					
Earth Science													1			
Marine Sci	1															
Psychology														1		
Management															1	
BioEthics																1

Data from
CWD Survey

Nanotechnology graduate students at UW* often report changing majors from BS to PhD

UG Major	Bioengineering	Chemical Engineering	Chemistry	Electrical Engineering	Mat Sci Eng	Microbiology	Physics
Biochemistry					1		
Bioengineering	3			1	3		
Chemistry, Bioengineering	1						
Chemical Engineering	1	10			1		
Chemistry		1	16		2		
Chemistry + Other			5				
Electrical Engineering			1	9	1		
Physics, Electrical Engineering				1			
Materials Science and Engineering					9		1
Microbiology						1	
Physics	1			1	2		2
Physics + Other				1			2
Appl. Math and Optics				1			
Cell biology					1		
Computer Science			1				
Cybernetics	1						
Mechanical Engineering				1	2		
Molecular Biology and Genetics					1		

59% UG = Grad
 11% Double Major, picked one of them
 31% New Major

*Students taking core course required for dual degree '06 to '11 (N=84)

Many factors attract or deter NSEC women from academic career.

■ Strongly Deterred
 ■ Slightly Deterred
 ■ No Effect
 ■ Slightly Attracted
 ■ Strongly Attracted

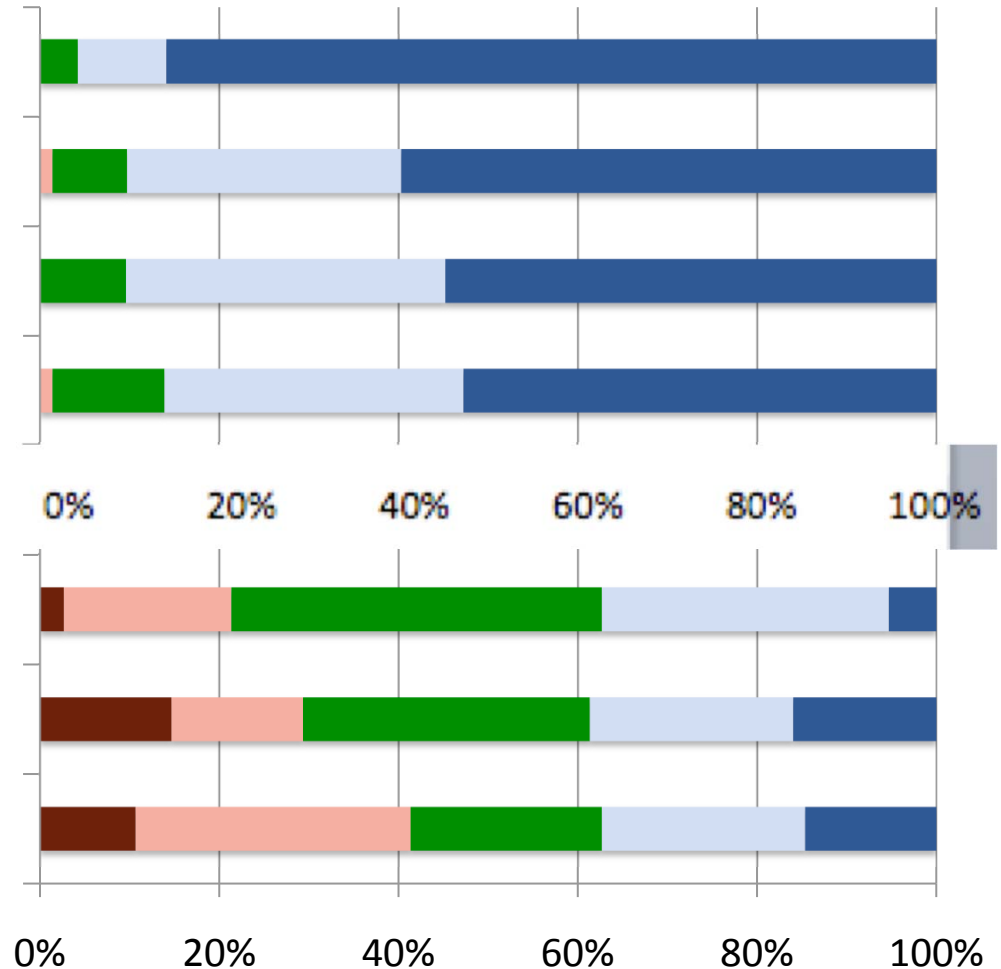
Autonomy to conduct your own research

Top 4 Attractions

Recognition as a researcher

Opportunity to mentor

Belonging to a research community



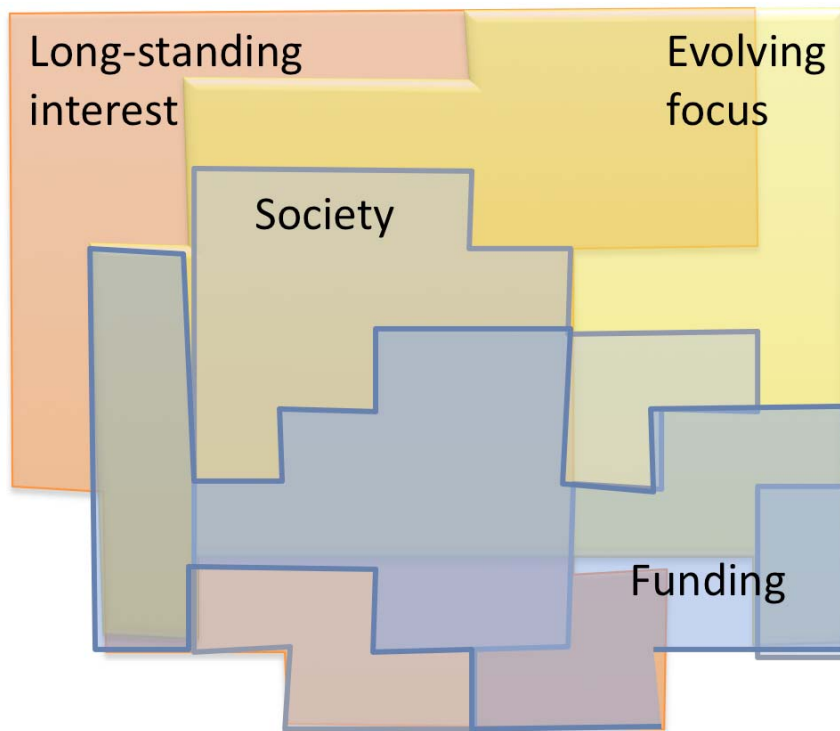
Top 3 Deterrents

Dual career opportunities (spouse/partner)

Work-life balance

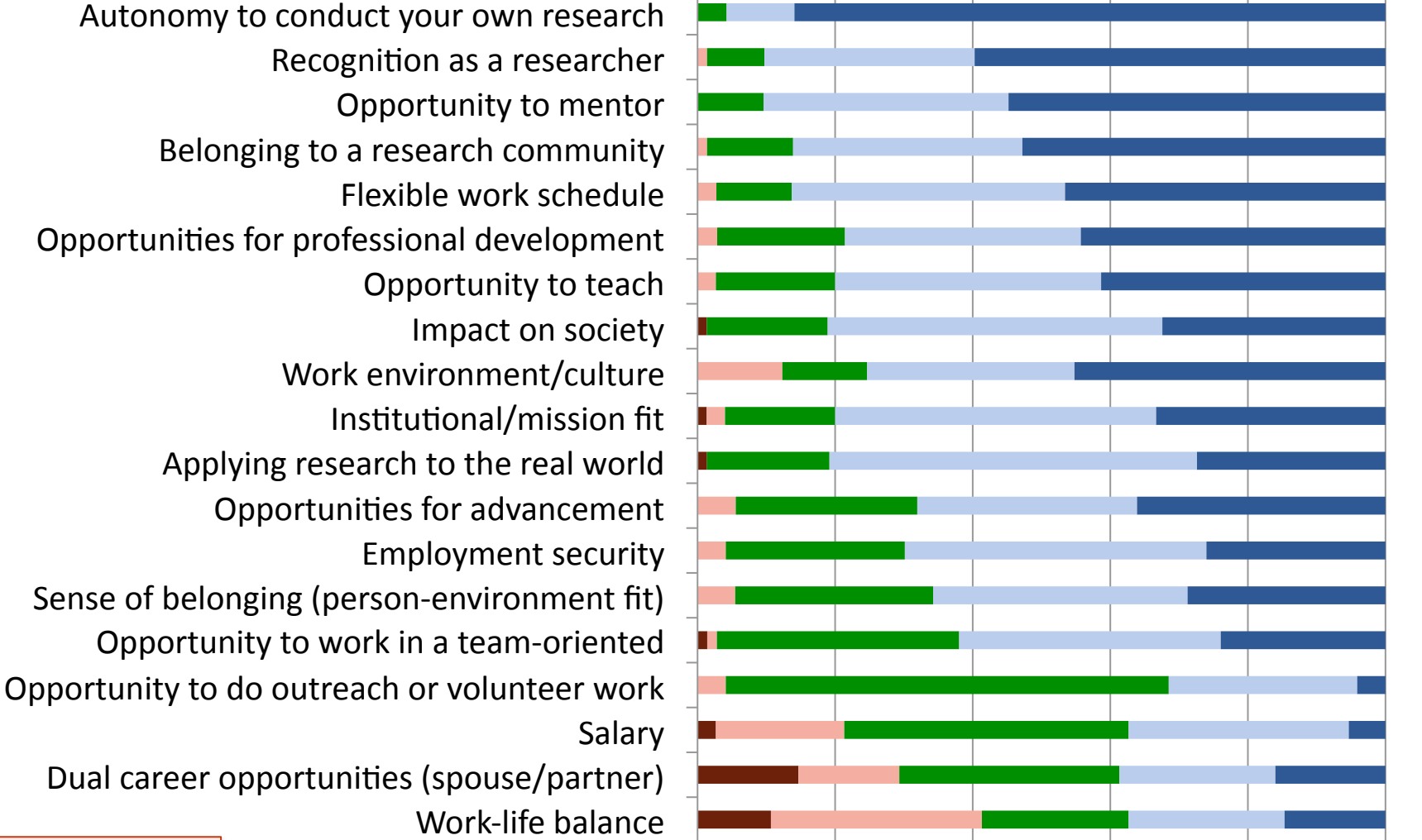
NSEC Women have overlapping reasons for choosing field

Long-standing interest in this specific area	71%	} 95 %
Evolving research focus based on earlier results	64%	
Benefit to society	38%	} 56 %
Availability of funding	34%	



L					LE			E
		LES						
	LEF							
				all		ES		
							EF	
								EFS
		LS		LFS		LF	F	

Factors that Attracted NSEC Women to Academia



CWD-NSEC Survey

■ Strongly Deterred
 ■ Slightly Deterred
 ■ No Effect
 ■ Slightly Attracted
 ■ Strongly Attracted

0% 20% 40% 60% 80% 100%

Primary Secondary Field of research -->

Field field_1_short	NR	Appl Math	Chem	Phys	Env Studies	Polymer	MSE	Chem Eng	EE	CSE	Civ/Env Eng	BioE	BioPhys	Bio	BioChem	MCB	Medicine	Policy	SEI	Other	Grand Total	
NR	1																					1
Chem	1				1		2	1			1				2							8
Phys	2		1				5															8
Env Studies																		1				1
ESS																					1	1
MSE	1	2	2	3		1	1	3	2			1									2	18
Chem Eng			1				2					1										4
EE				2			3		1													6
Mech E							2			1		1										4
Civ/Env Eng	1							1														2
BioE							1	2					1				1					5
BioPhys													1		1							2
Bio																1						1
BioChem			2													1						3
Genome Sci												1										1
MCB																	2					2
Medicine	1															1				1		3
Radiology																1						1
Neuro			1																			1
Path																	1					1
Psych	1																					1
Bioethics																					1	1
Management																			1			1
Grand Total	8	2	7	5	1	1	16	7	3	1	1	4	1	1	3	4	4	1	1	5		77

Mentors provide multiple types of support

64% Provided valuable professional contacts or introductions.

42% Helped me choose or refine my research focus.

34% Assisted me in securing funding.

26% Helped me in other ways*

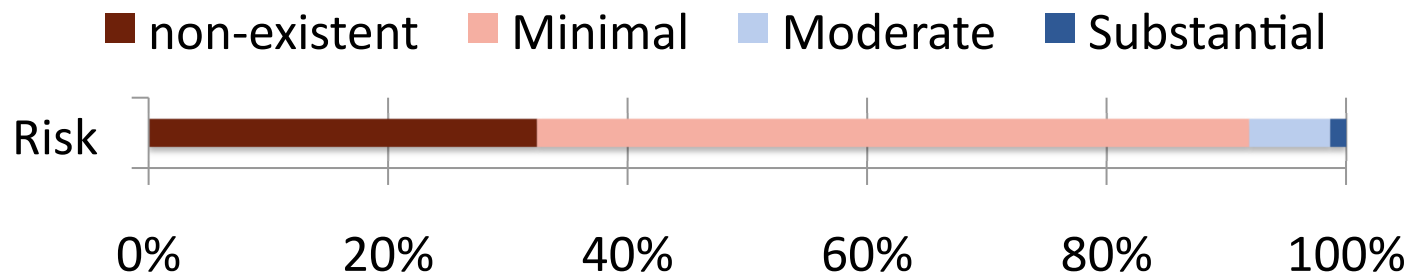
- General Advice
- Emotional Support
- Resolving discrimination issues
- Job search, promotion advice

About half of NSEC women primarily are users of nanoscale tools rather than focused on NT.

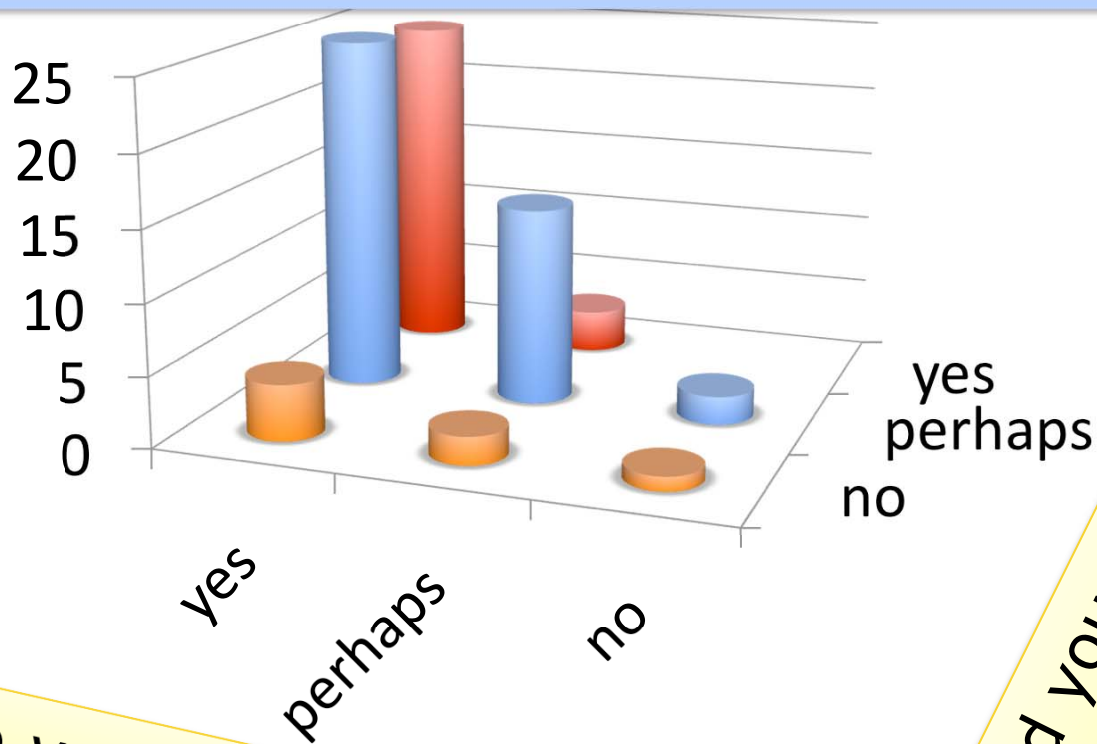
47 % Primarily focused on nanoscale science or technology

53 % Not primarily nano-focused, but uses nanoscience/
nanotechnology methods

My research involves _____ risk to myself or others.



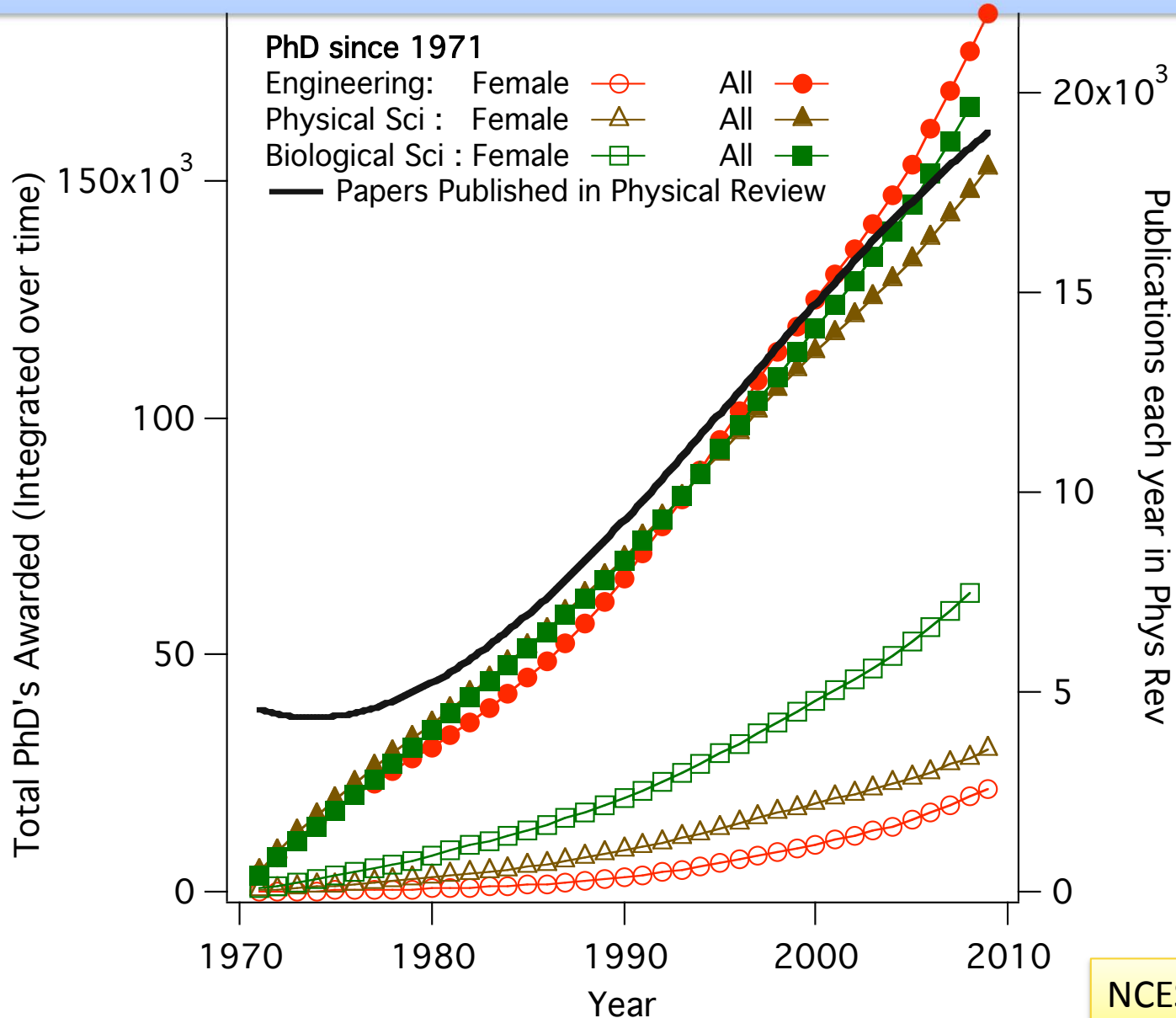
A large fraction feel they might benefit from joining a network of women in nanotechnology.



Do you feel that you would benefit from networking with others in similar fields?

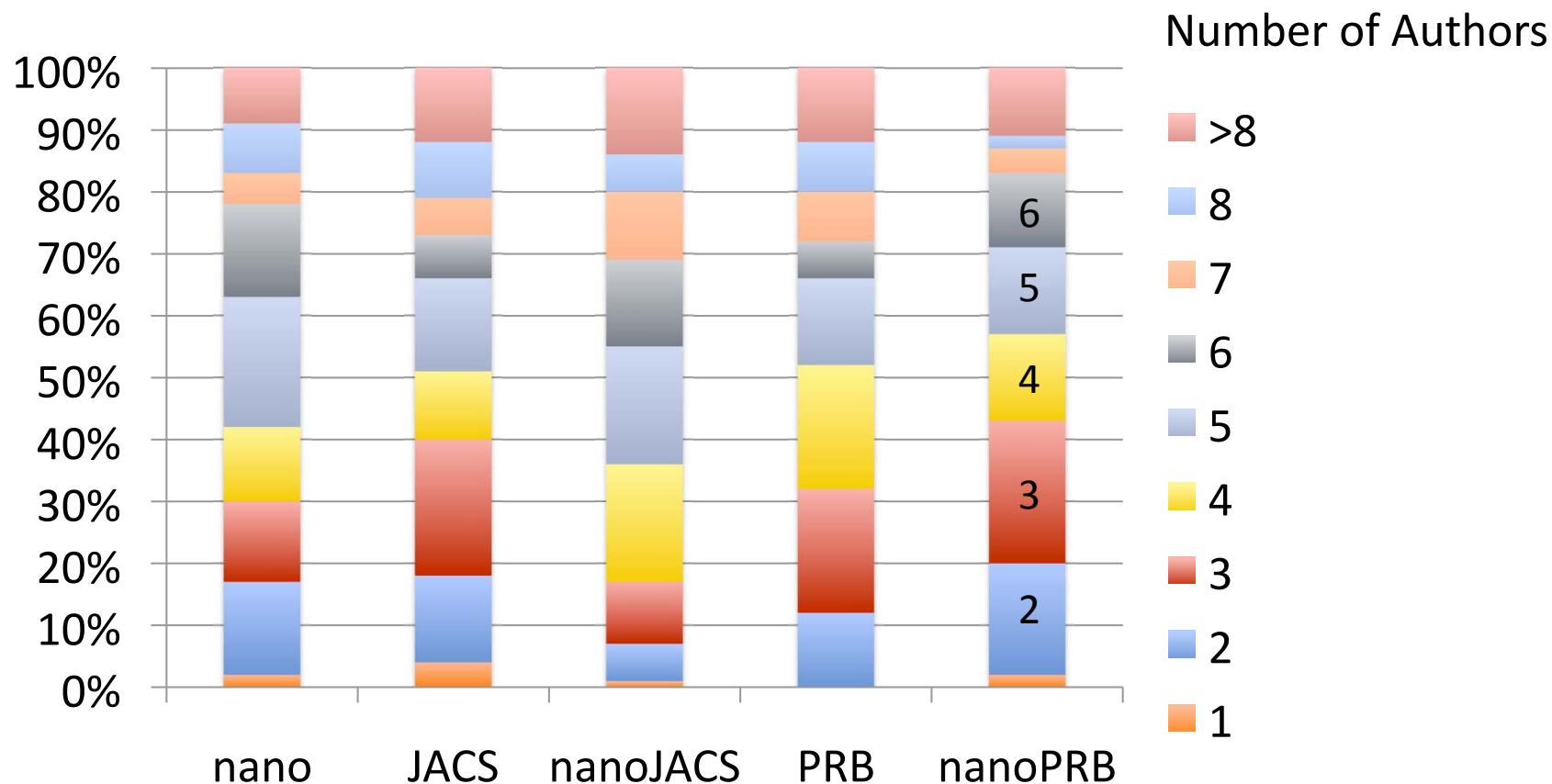
Would you like to be part of a professional network of women nanoscientists and nanoengineers?

Integral over 30 years shows even high current rates mean low fraction of women in STEM



NCES Data for PhDs

Number of Co-authors Similar Nano/Not-Nano



Papers published in 2009-2011 in JACS or PRB
 100 "nano" and 100 "not-nano" for each journal
 + 100 2011 "nano" papers in any journal