Women in Nano: Double Bind or Double Bonus?

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THE CENTER FOR NANOTECHNOLOGY AT THE UNIVERSITY OF WASHINGTON

UNIVERSITY OF WASHINGTON

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

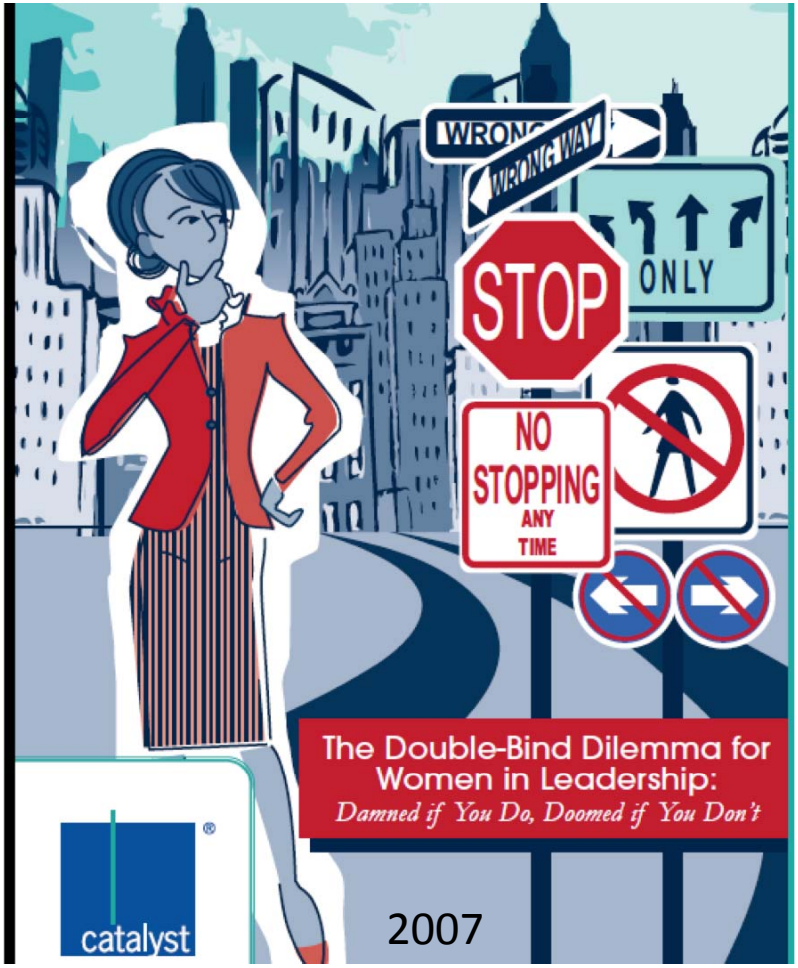
- Rapid rise over past 20 years
- Integrate biology and chemistry into physics and engineering
- Interdisciplinary team interactions
- Emphasis on societal impact

Double bind can show up as both internal and external constraints

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

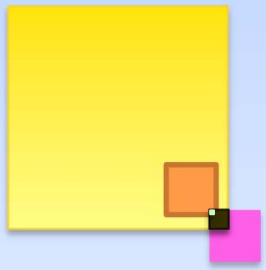
Shirley Mahaley Malcom
Paula Quick Hall
Janet Welsh Brown

1975



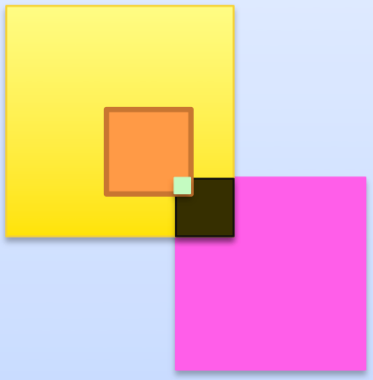
1975 Workshop: The Double Bind: The Price of Being a Minority Woman in Science

Engineering



37,569

Physical Science



53,425

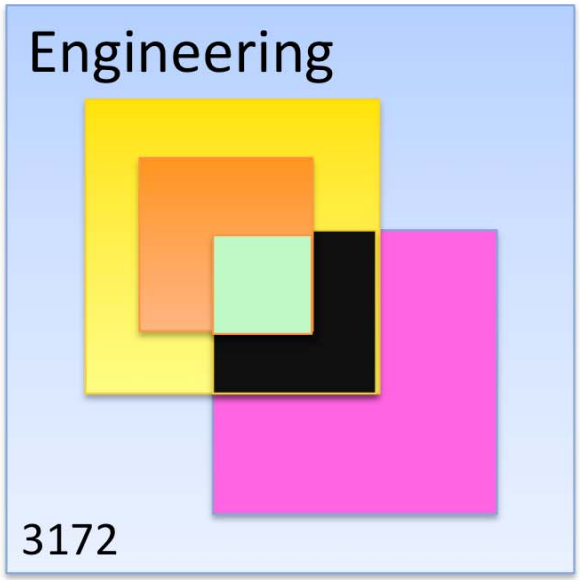
White Males | Asian Males | Non-Asian, Non-White Males

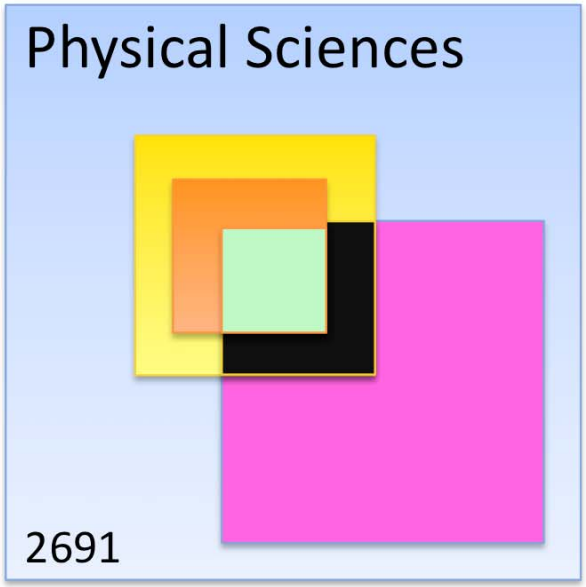
White Females | Asian Females | Non-Asian, Non-White Females

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*

White Males | Asian Males | Non-Asian, Non-White Males

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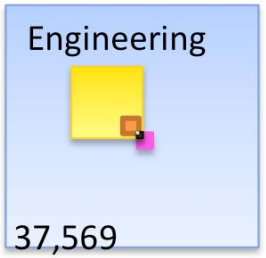
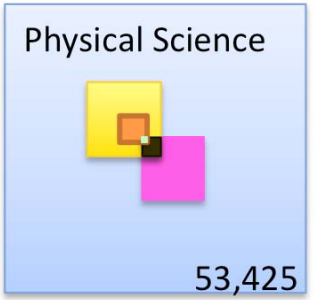
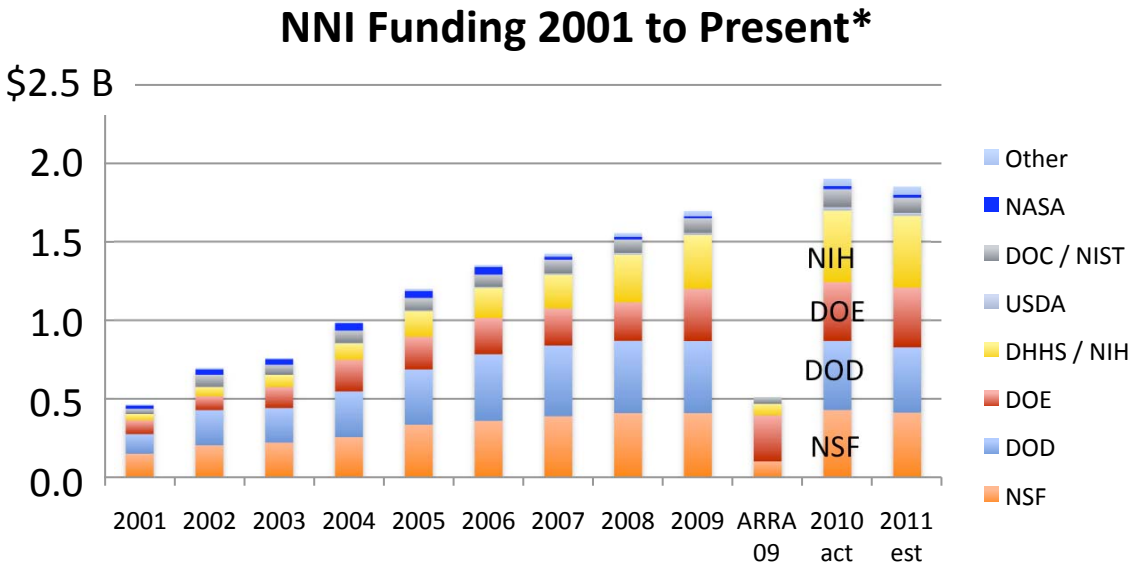


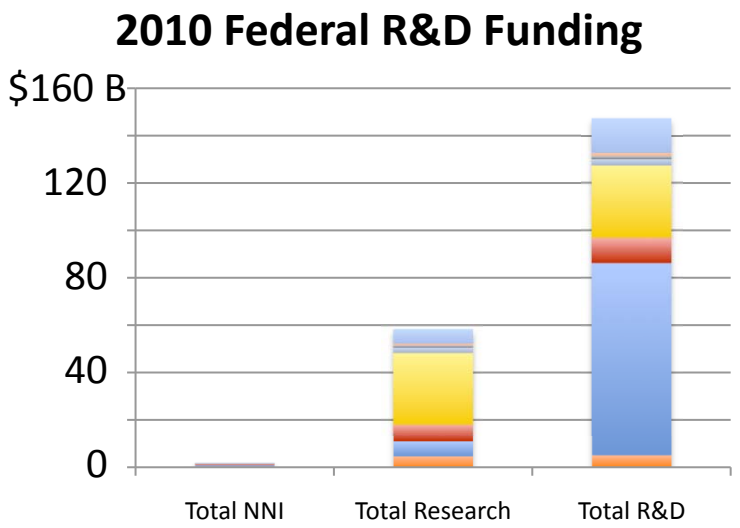


1973 Workforce

* National Center for Education Statistics

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





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.

this 2010

Rationale for 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."

non-nano

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*

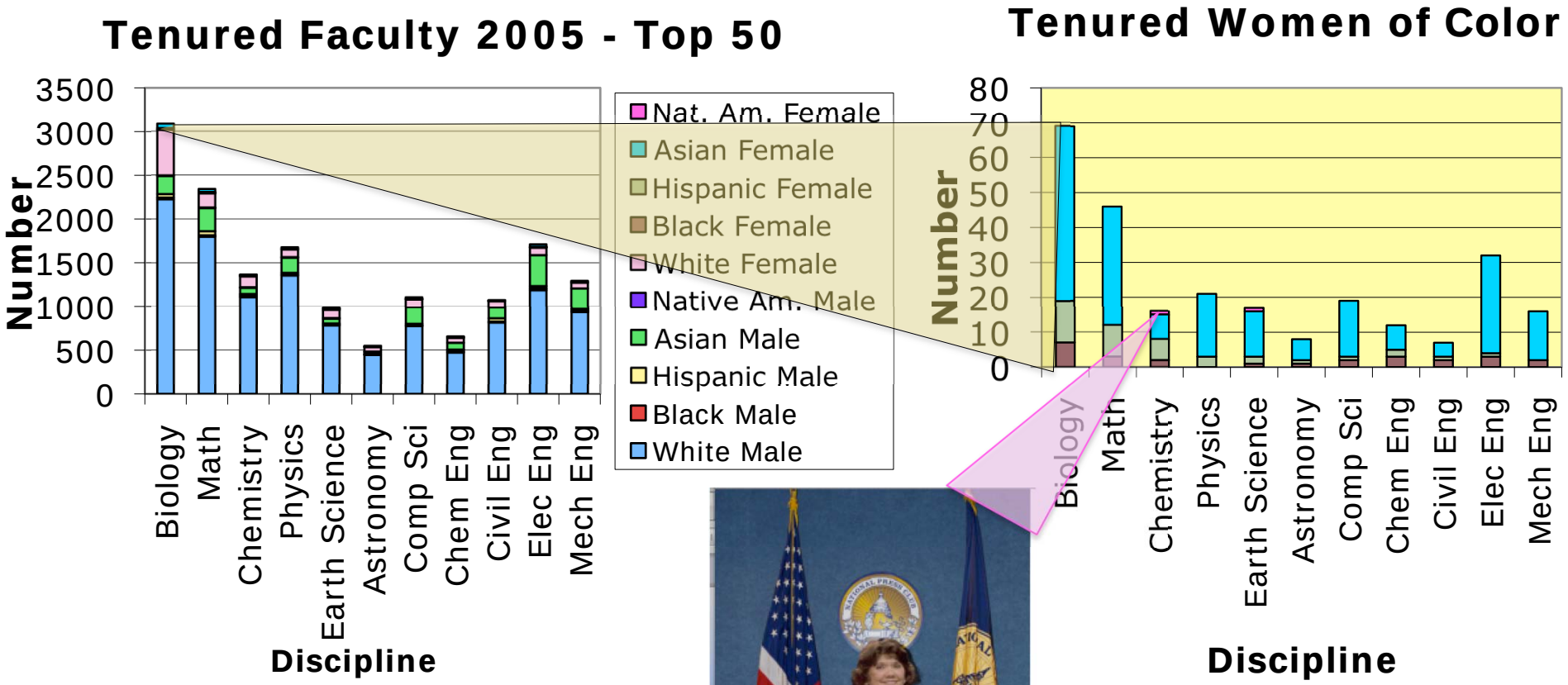
Dec. 1947 AAAS Symposium: What the Natural Scientist Needs from the Social Scientist

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

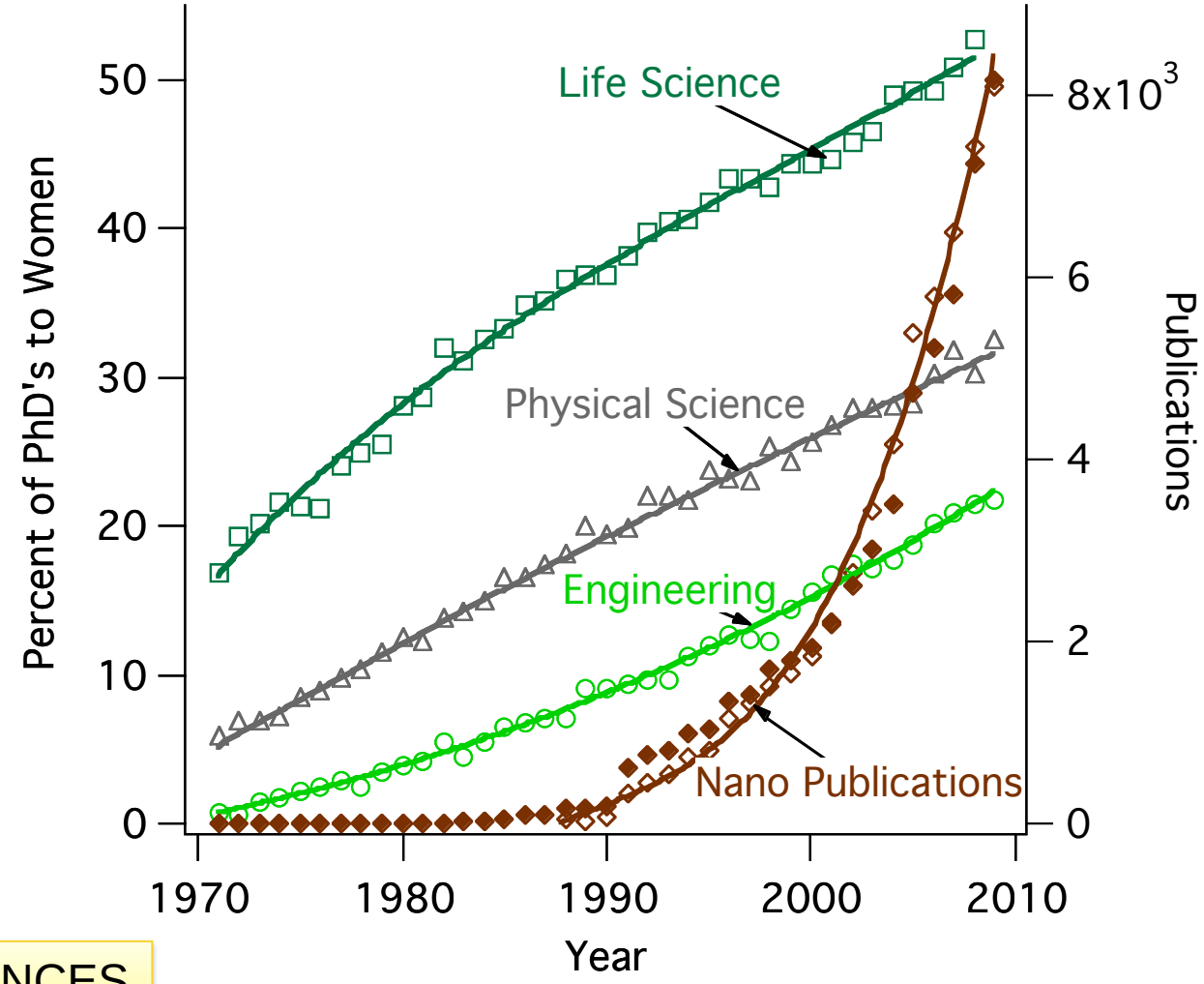
VOL. 15 April, 1948 NO. 2

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



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:◇=(nanotech* OR nanoscale OR nanometer* OR nanoscience)
◆ =.2* (quantum (well* or wire* or dot*)) or nanopart* or nanocryst* or nanotechnol* or nanosc*

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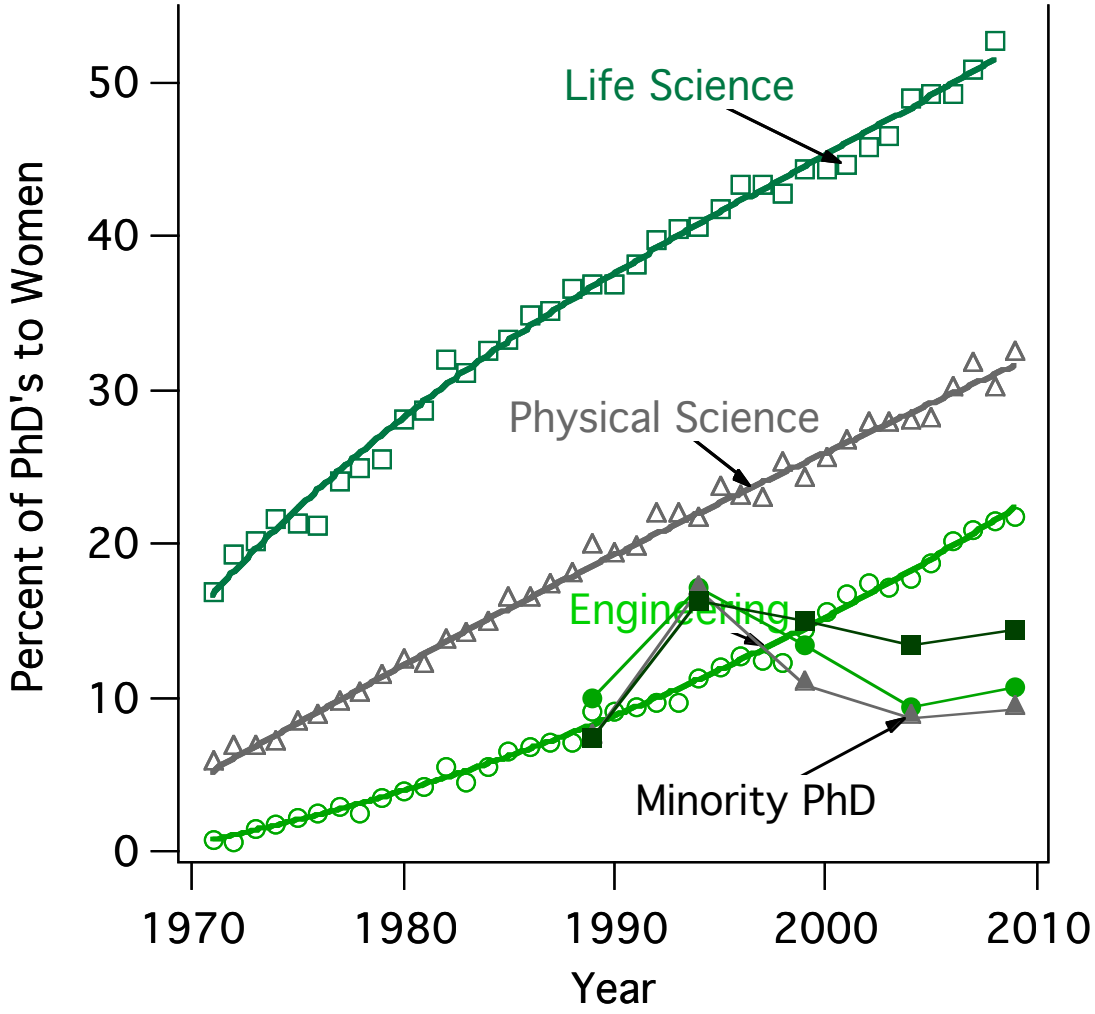
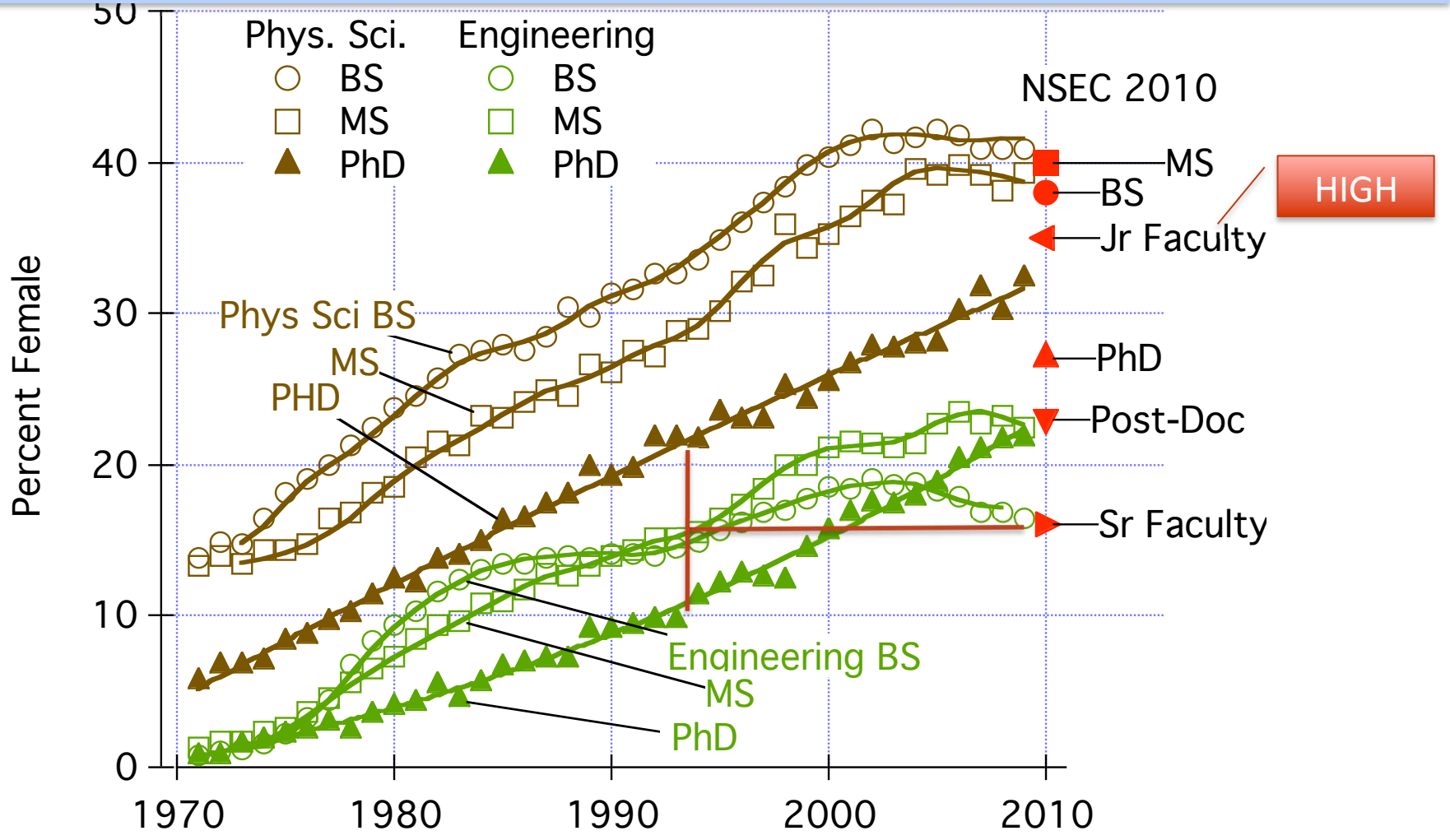


US Citizen PhD data from NCES – disaggregated by both race and gender not available

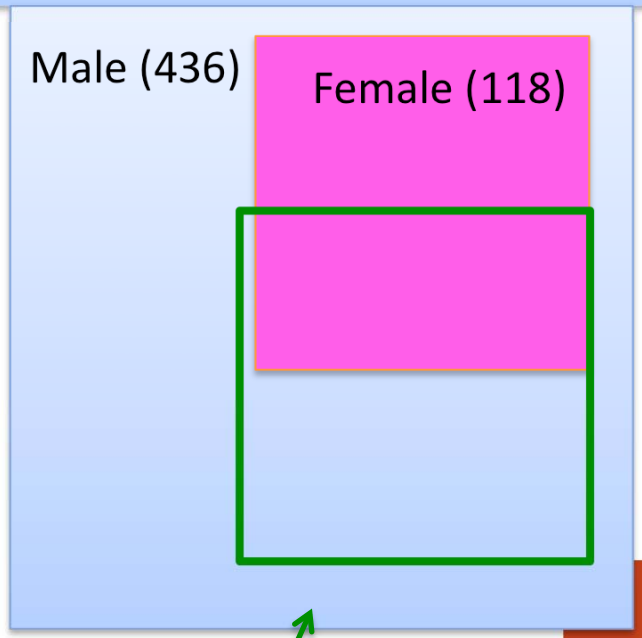
NanoCenters have slightly larger proportion of women students and researchers than parent fields.



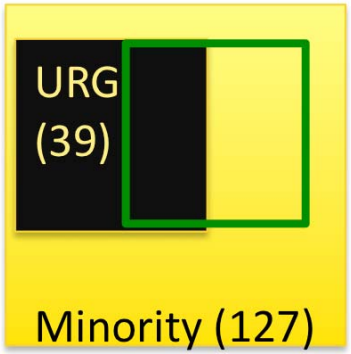
Degree data from nces.gov

NSEC data collected for this meeting by NSF

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



Junior Faculty (177/555)



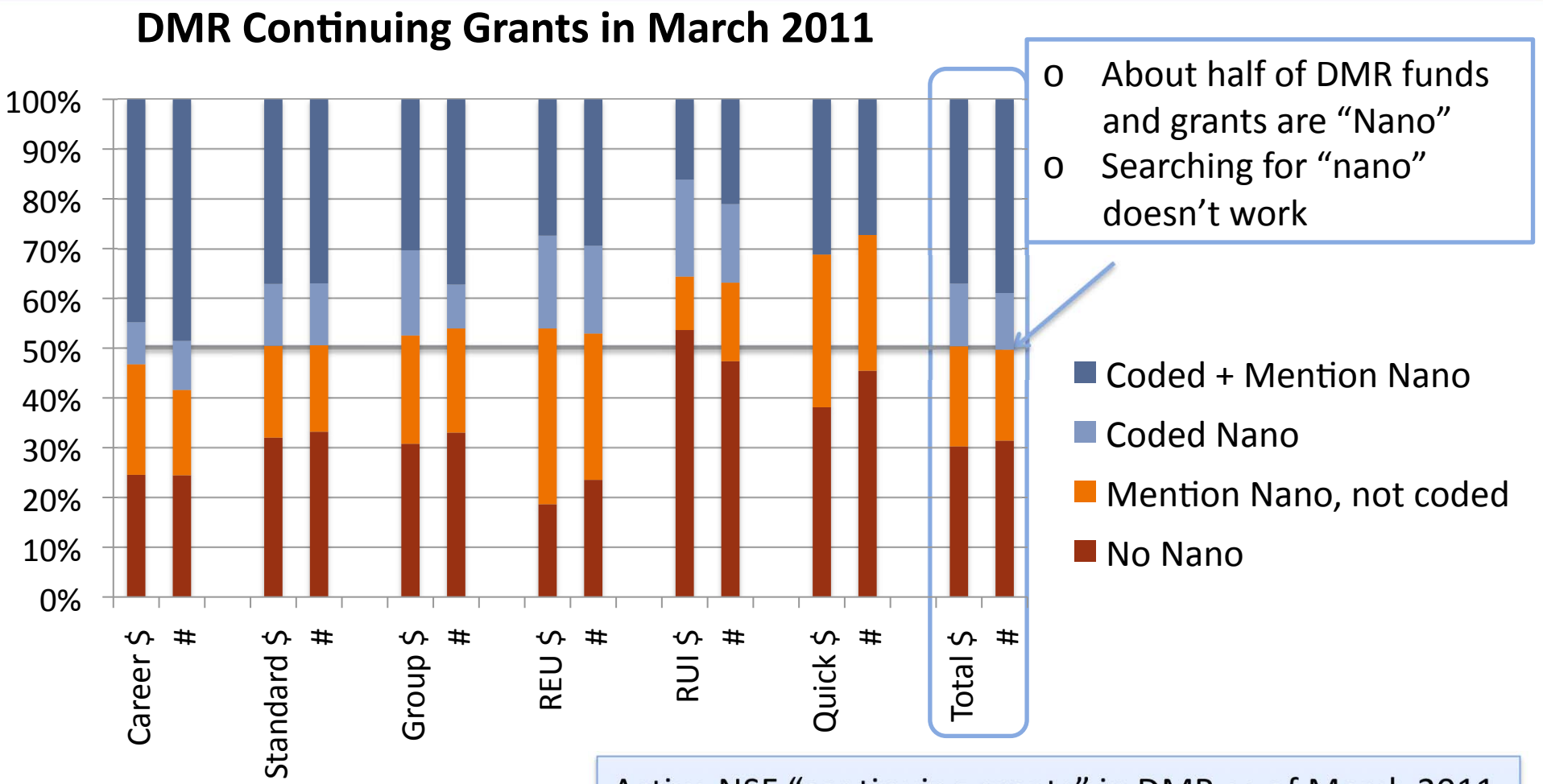
Overlap with gender not reported

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

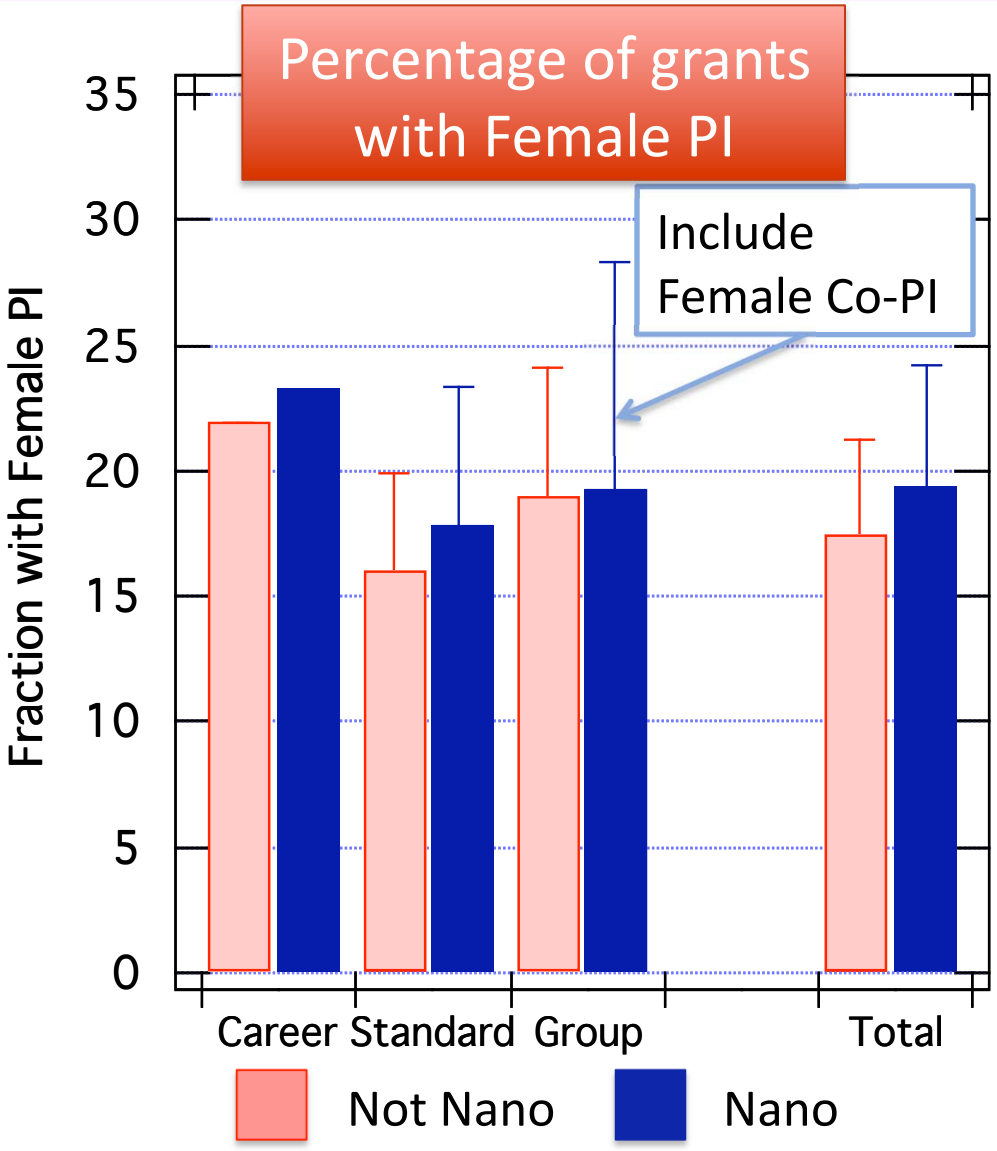
Nanotechnology research is about half of NSF-DMR

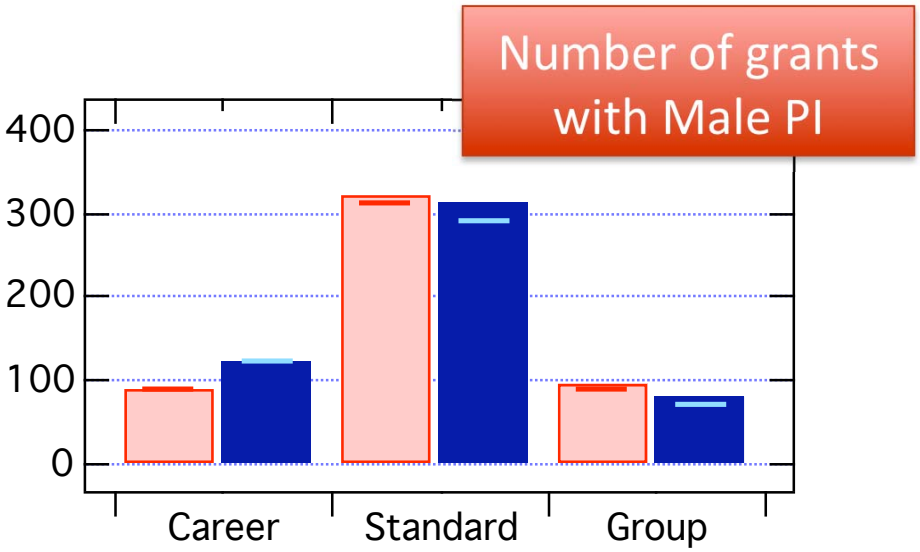


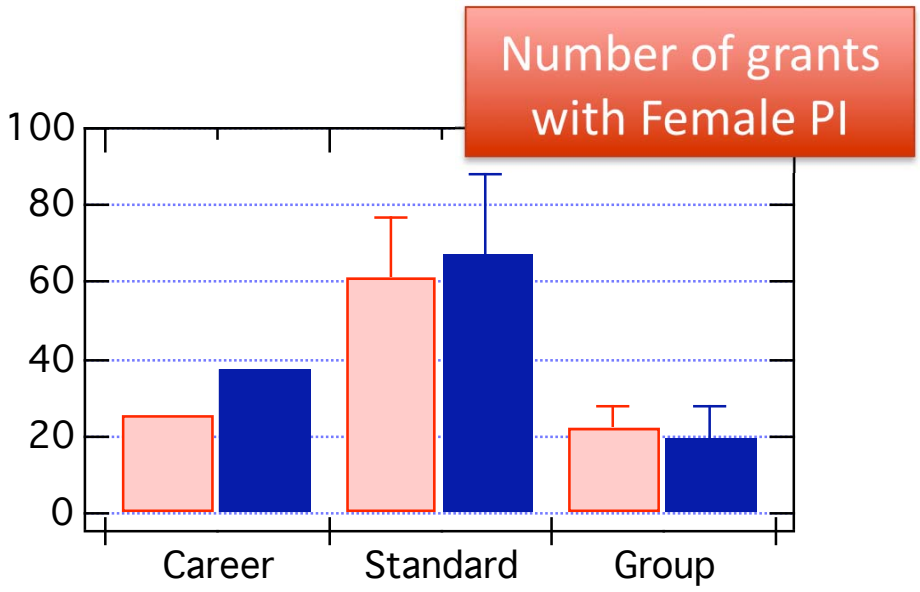
- About half of DMR funds and grants are "Nano"
- Searching for "nano" doesn't work

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

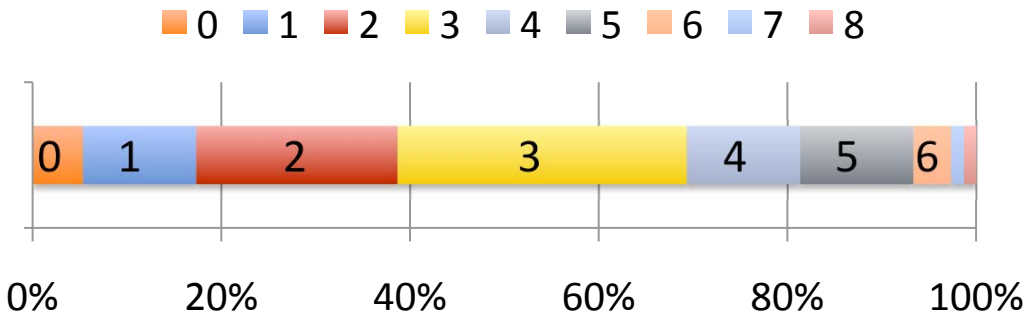
- UW Center for Workforce Development
- Suzanne Brainard and Vivien Savath
- 77 of 198 (39 %) Responded

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

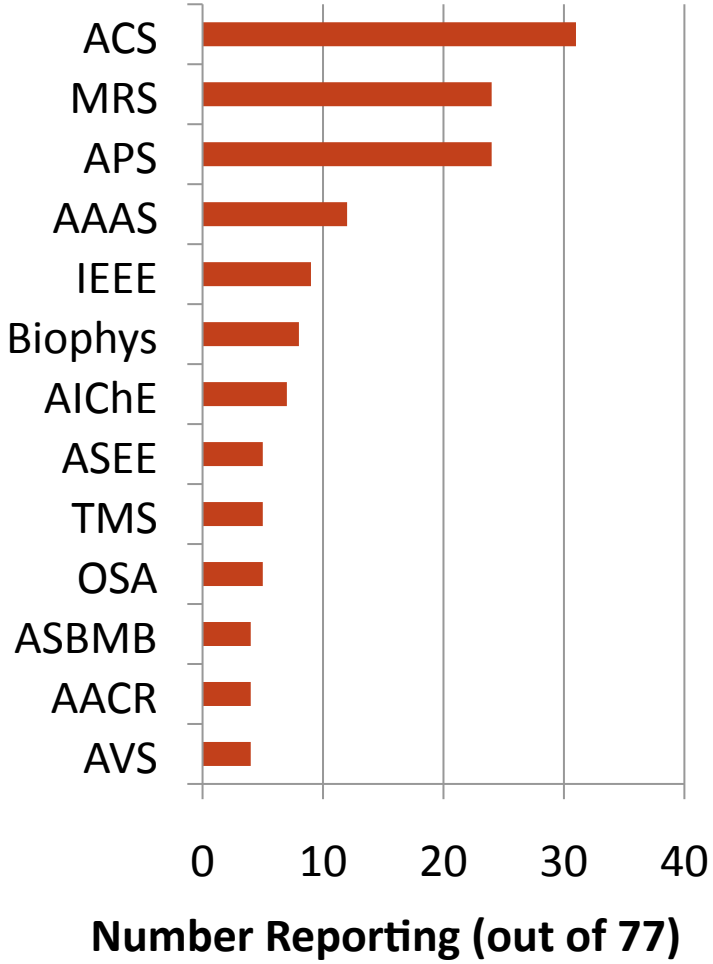


3/5 belong to 3 or more societies
2/3 belong to ACS, MRS a/o APS

Amer. Chemical Soc.
Materials Res. Soc.
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

Most Popular (out of 78 mentioned)



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

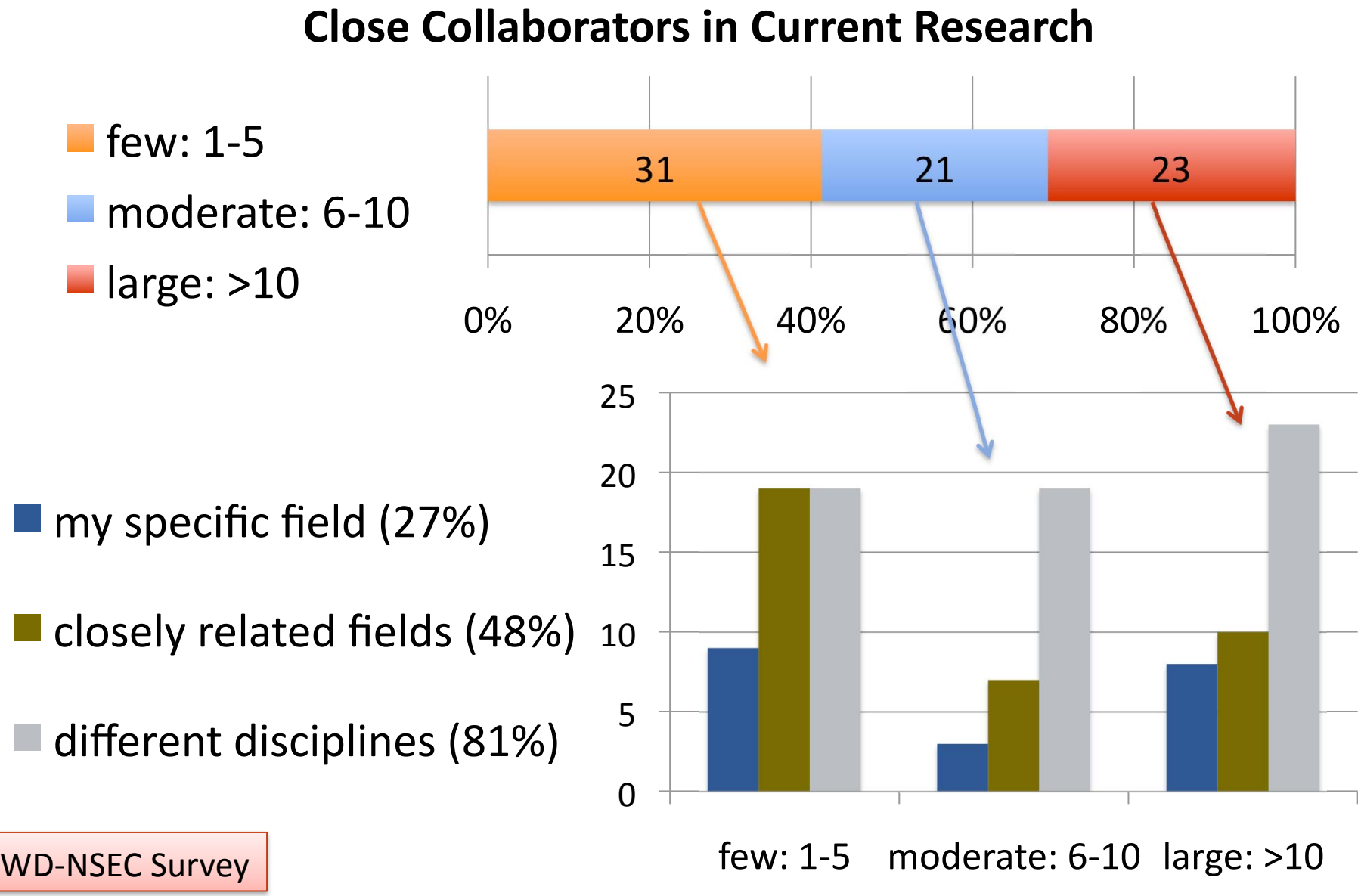
UW-CNT PhD Students*:

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

CWD-NSEC Survey

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

Interdisciplinary collaboration is key for NSEC women.

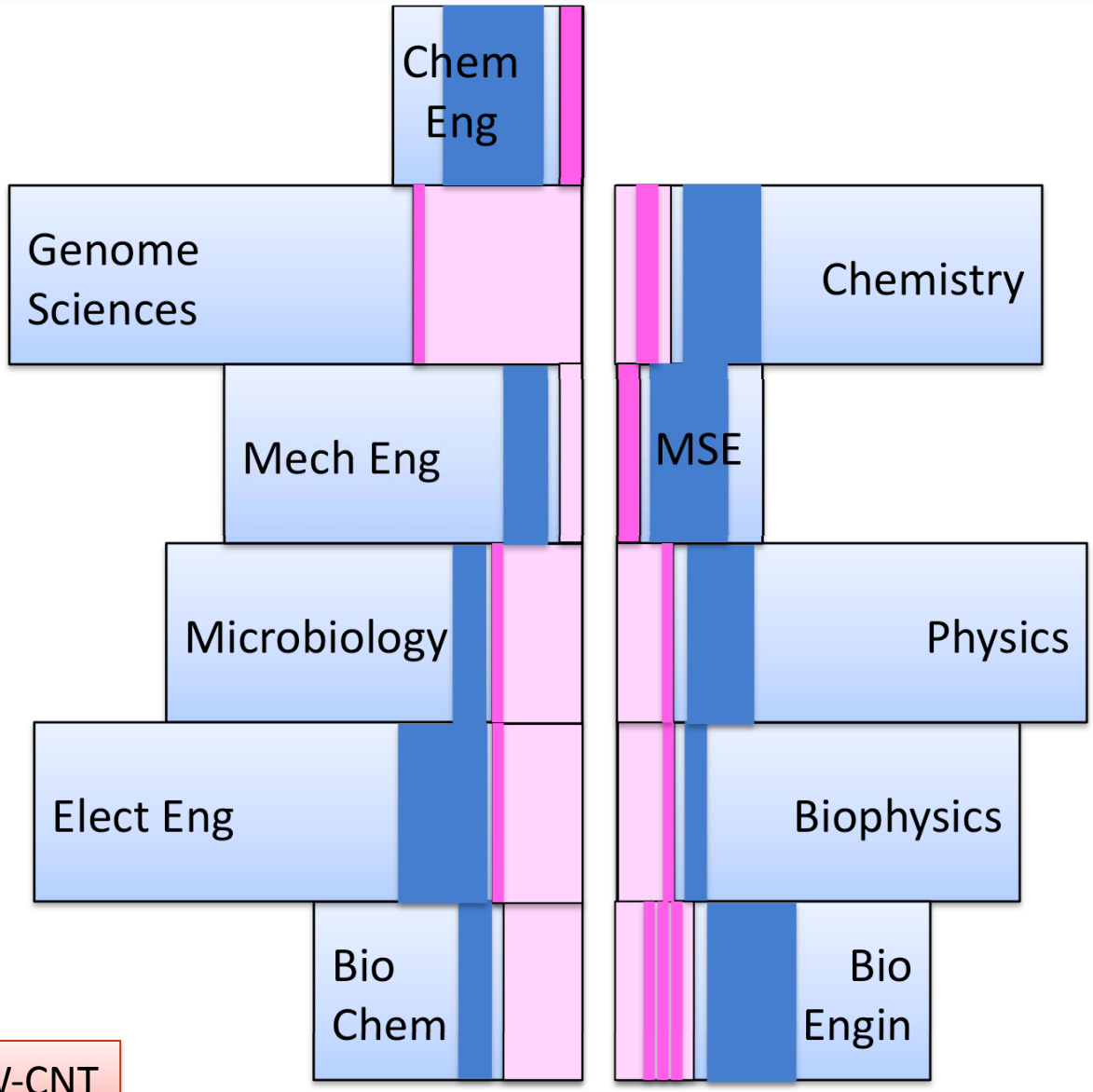


CWD-NSEC Survey

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.



Female non nano

Female nano

Male non nano

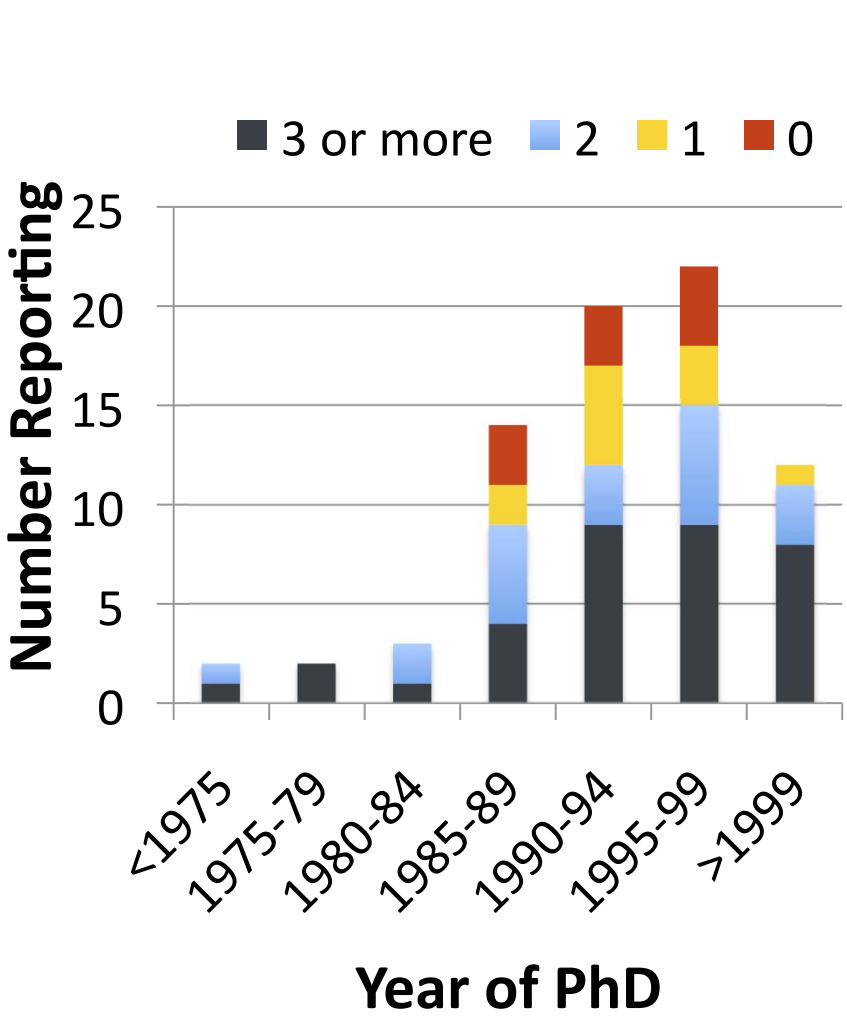
Male nano

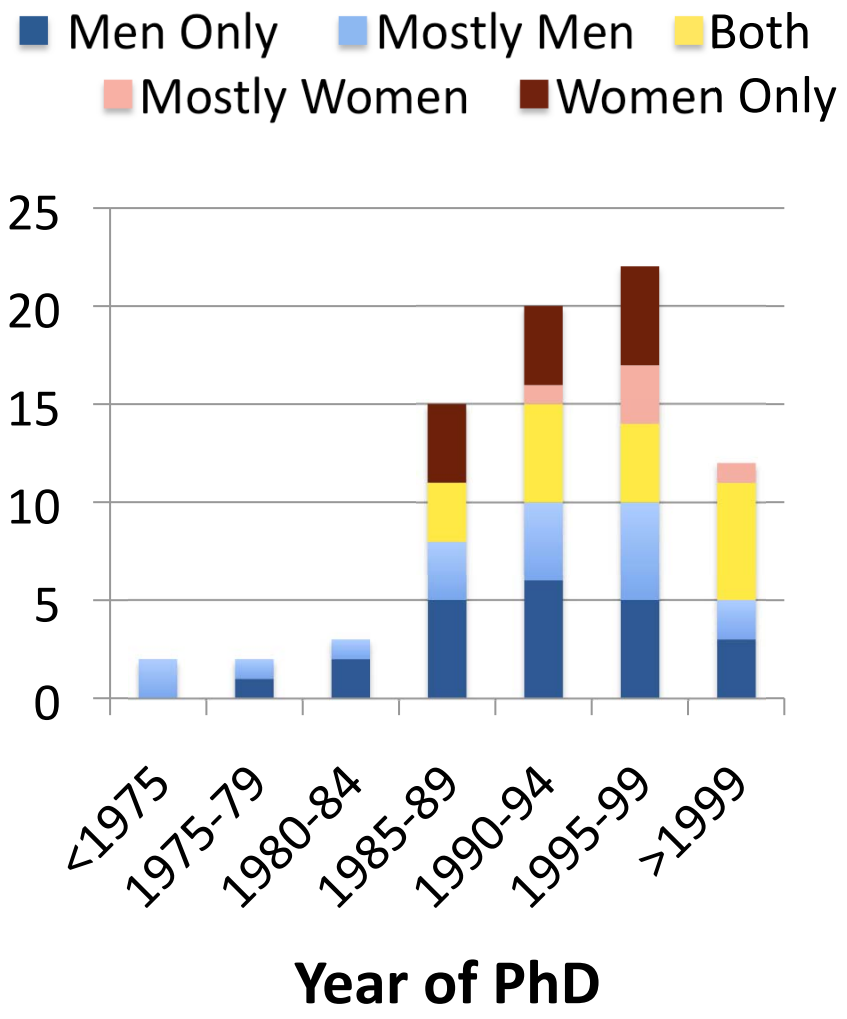
11 UW Depts	All	Female
Total Faculty	367	66
CNT Faculty	71	14*

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

UW-CNT

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

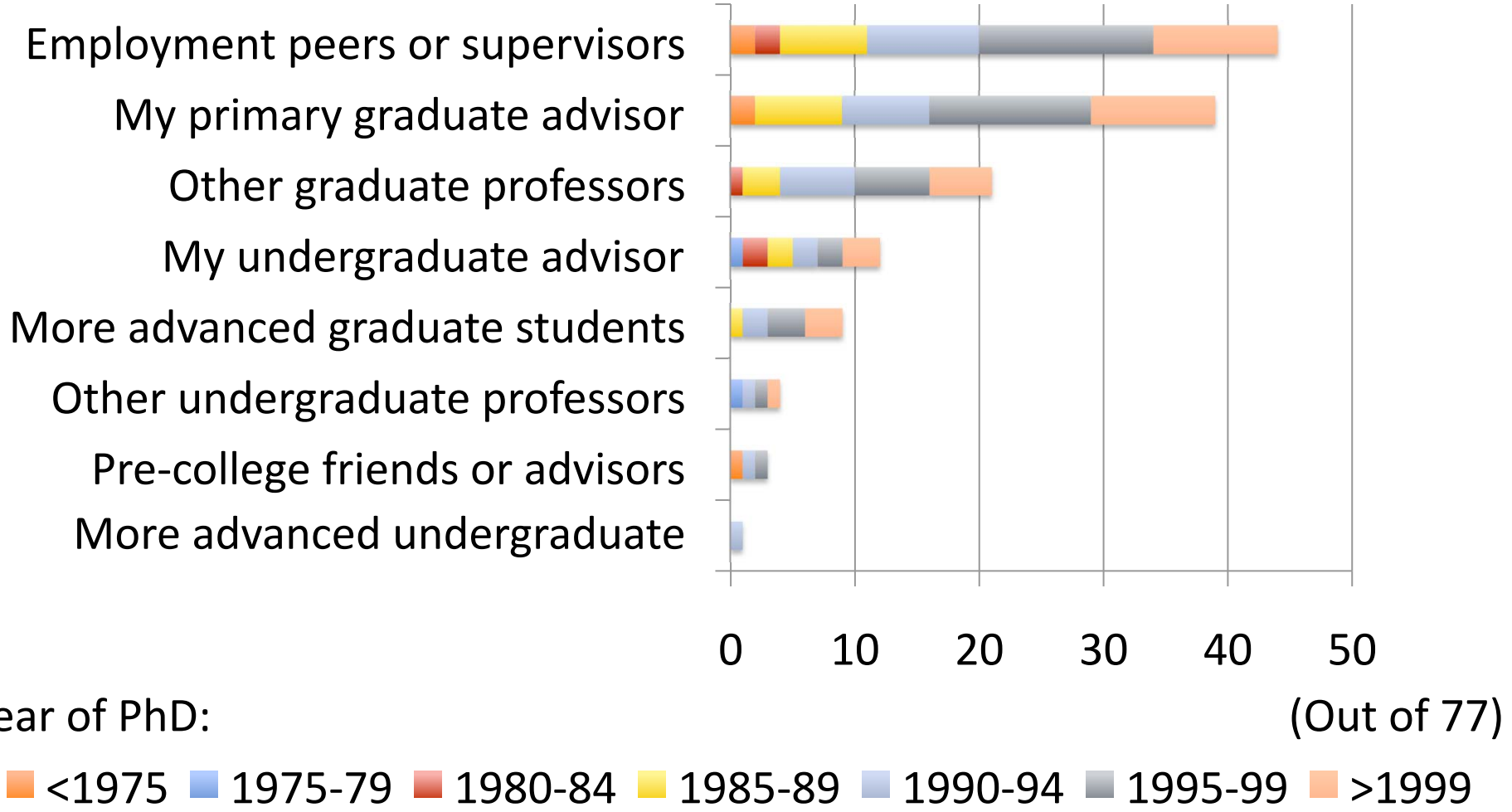




CWD-NSEC Survey

23 % report Mostly or All Female Mentors

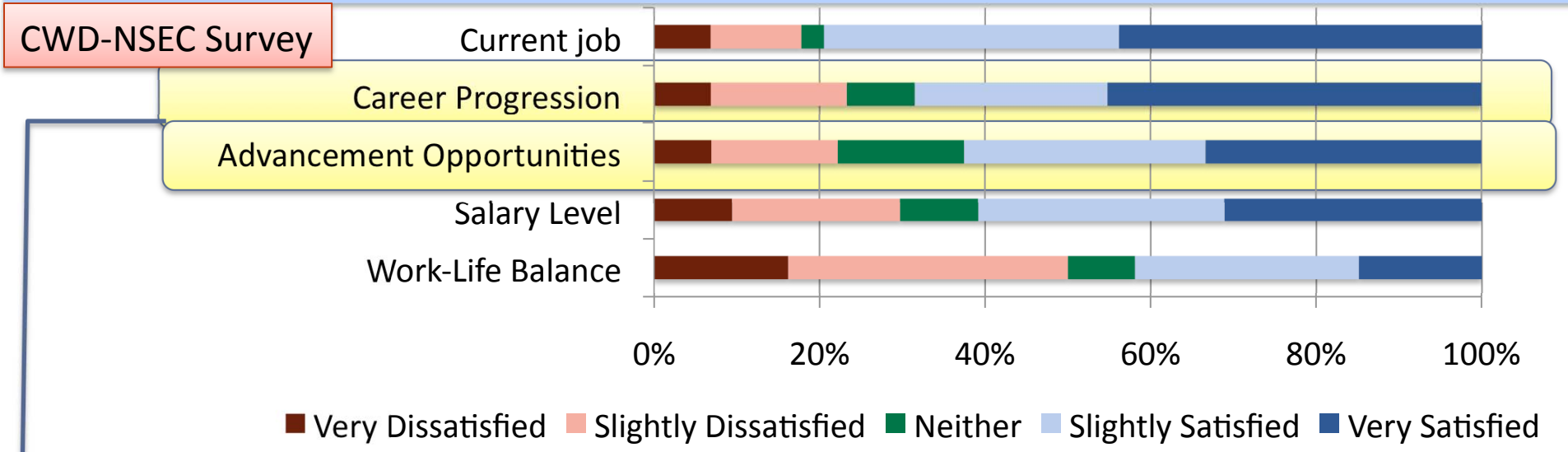
Mentors are found in many places.

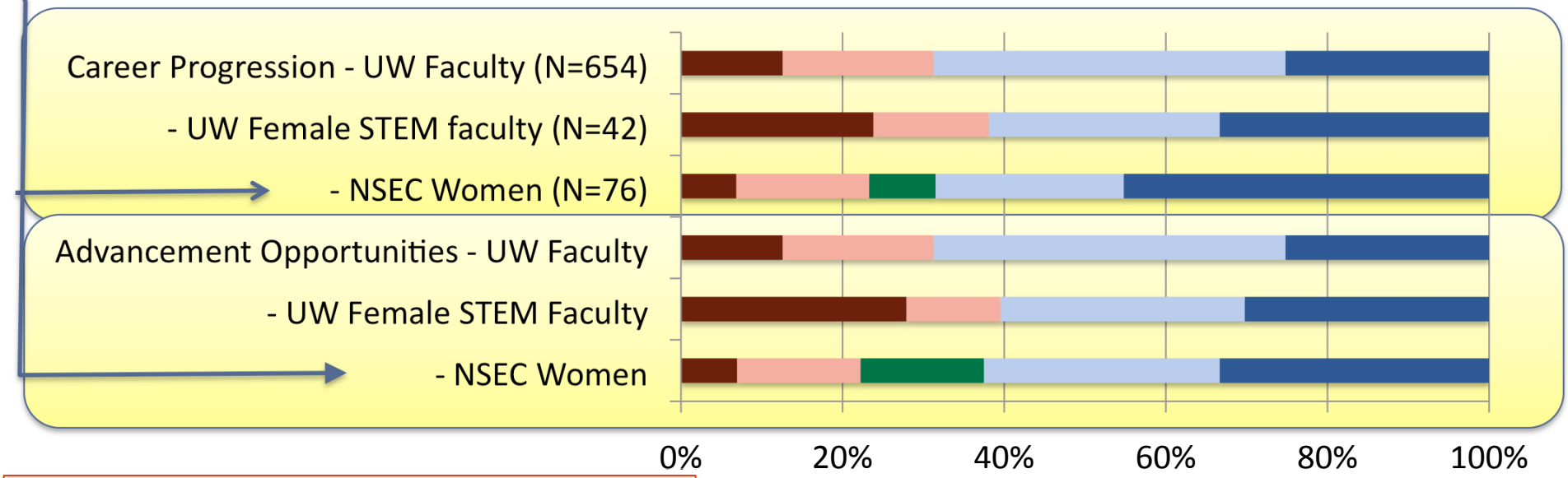


CWD-NSEC Survey

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

CWD-NSEC Survey

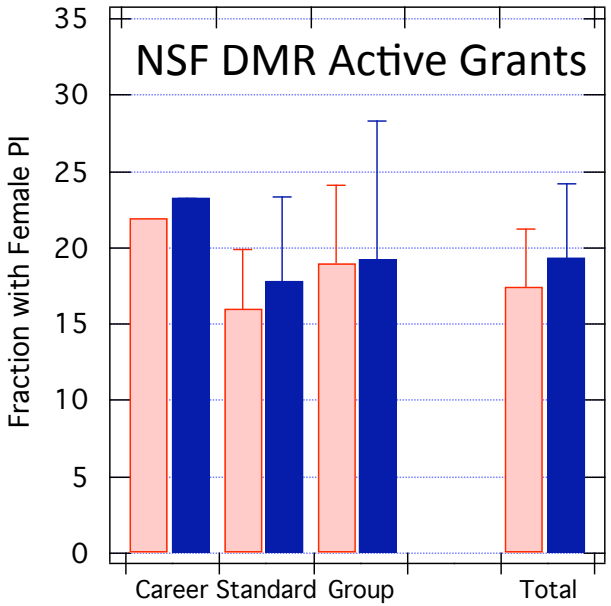


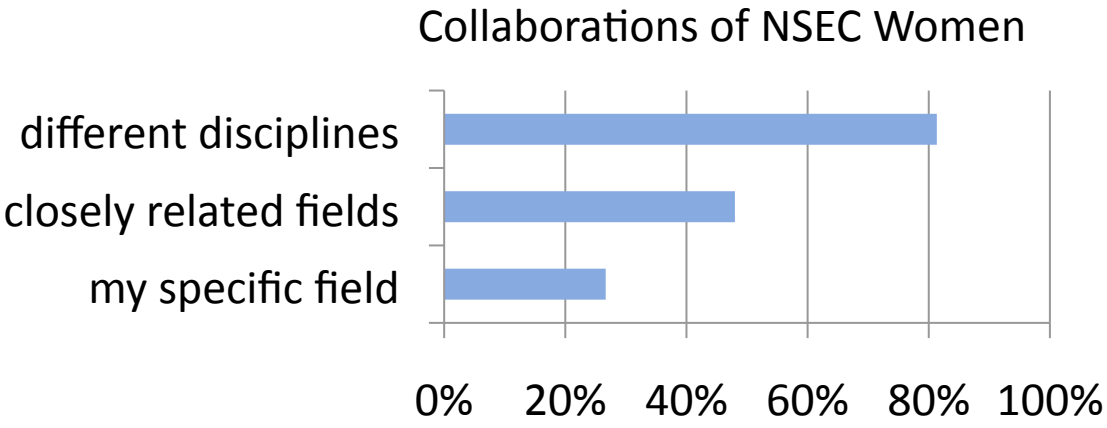


Survey of UW Voting Faculty Spring 2008

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

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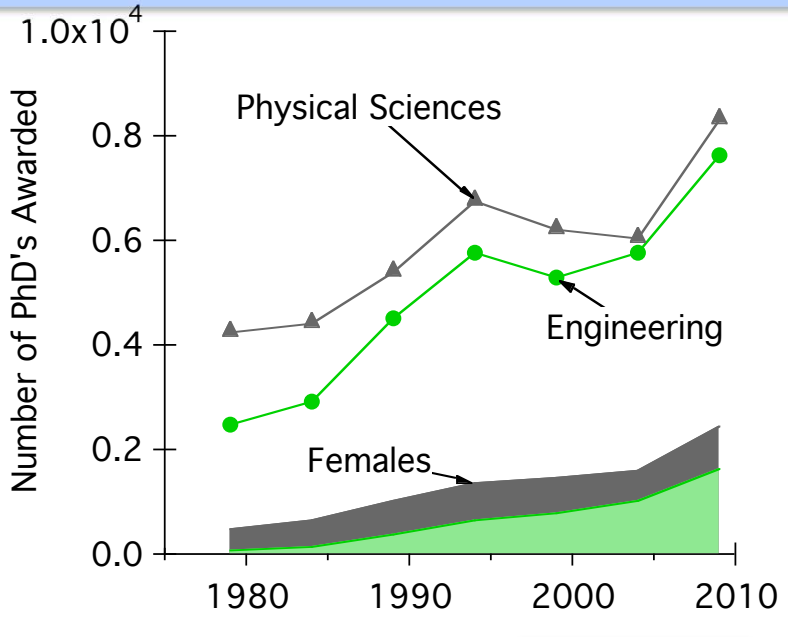
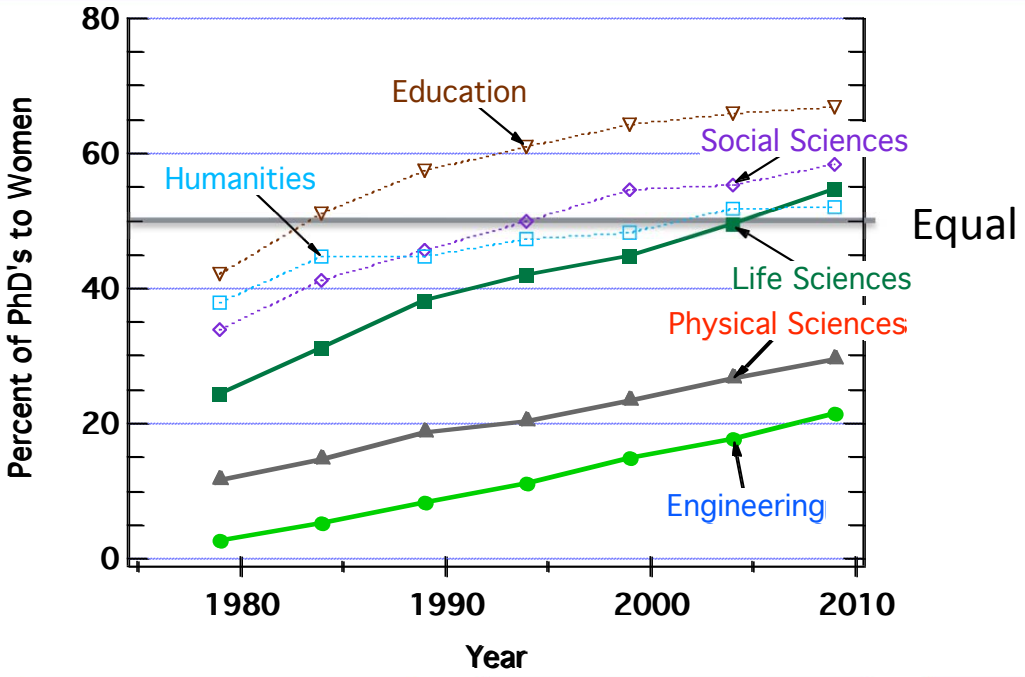
University of Washington, Seattle

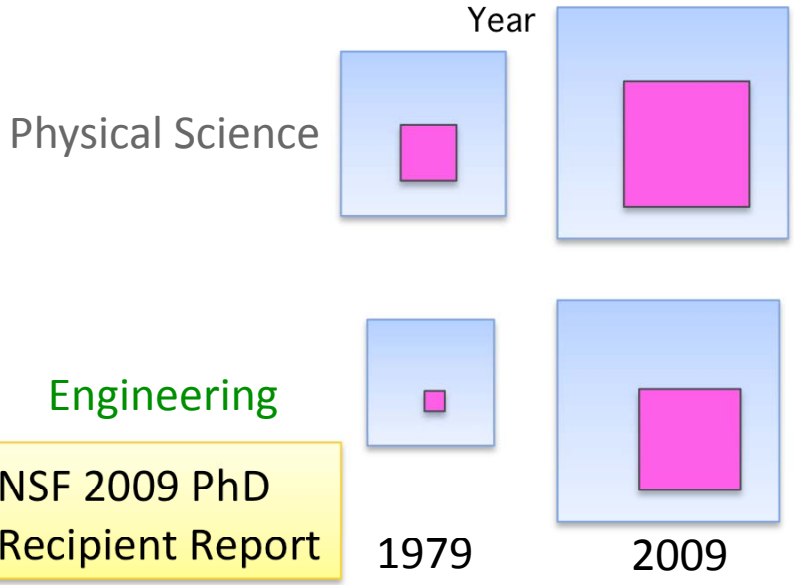
olmstd@uw.edu

Other data collected, but not used in presentation

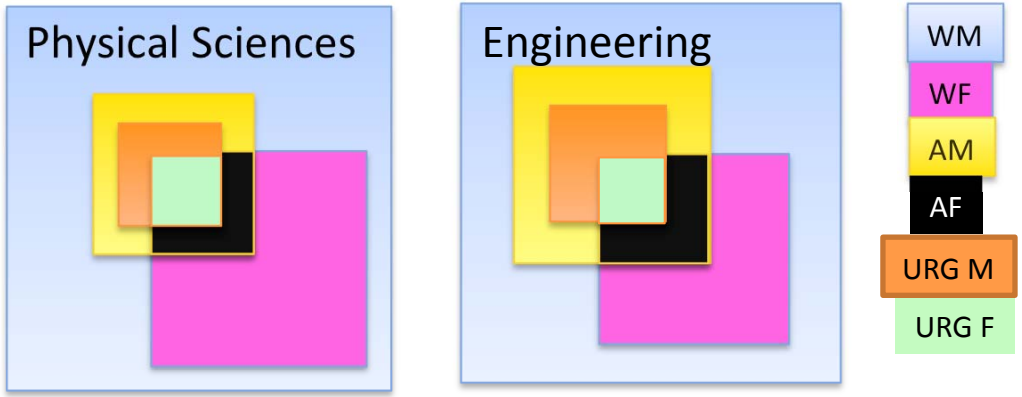
Number of women in STEM has been steadily increasing, as has female fraction of PhDs







NSF 2009 PhD Recipient Report



2007 NCES Awarded PhD Data

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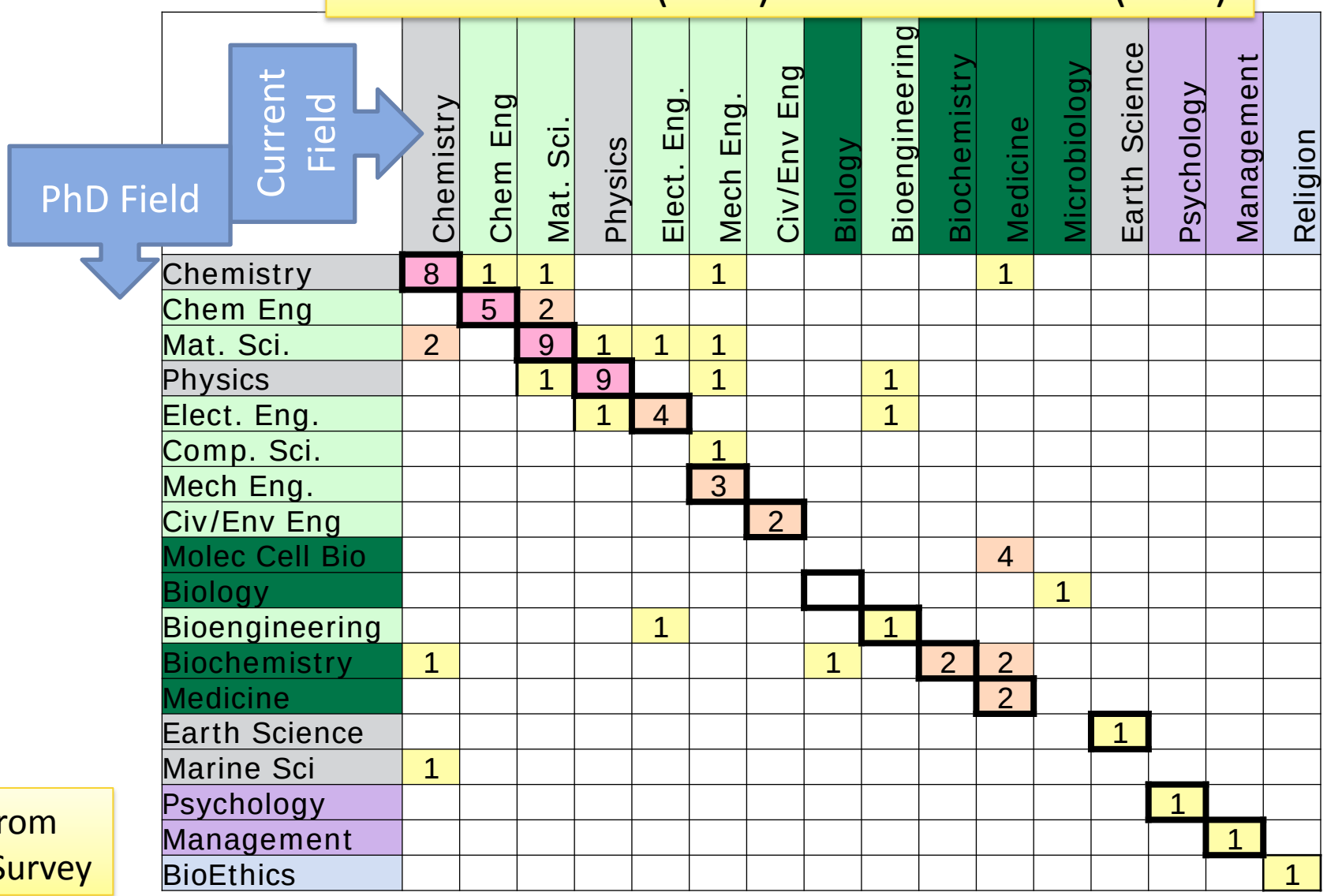


PhD Field \ Current Field	Chemistry	Chem Eng	Mat. Sci.	Physics	Elect. Eng.	Mech Eng.	Civ/Env Eng	Biology	Bioengineering	Biochemistry	Medicine	Microbiology	Earth Science	Psychology	Management	Religion
Chemistry	8	1	1			1					1					
Chem Eng		5	2													
Mat. Sci.	2		9	1	1	1										
Physics			1	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

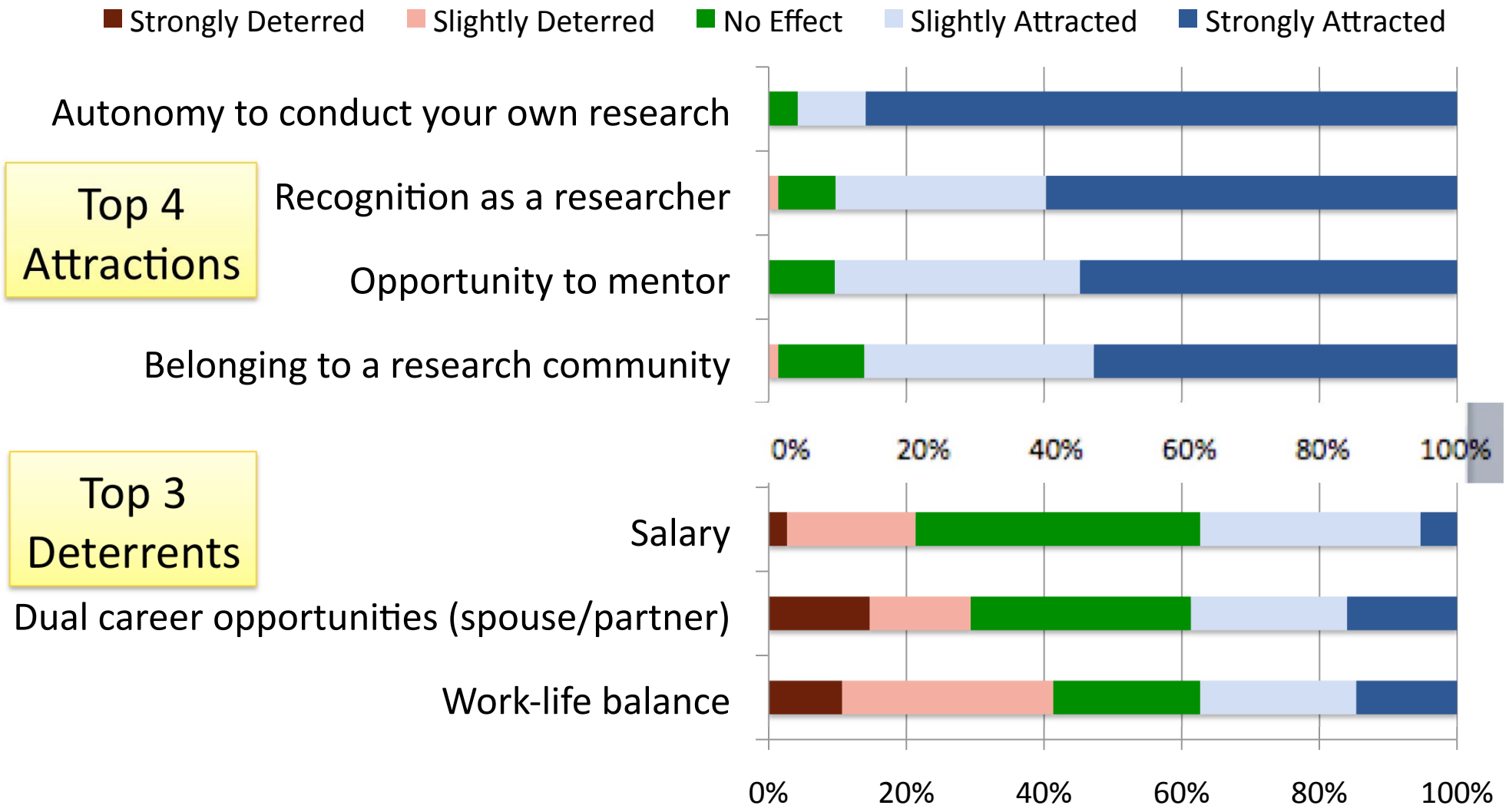
Nanotechnology graduate students at UW* often report changing majors from BS to PhD

UG Major \ Graduate Department	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.



Top 4 Attractions

Top 3 Deterrents

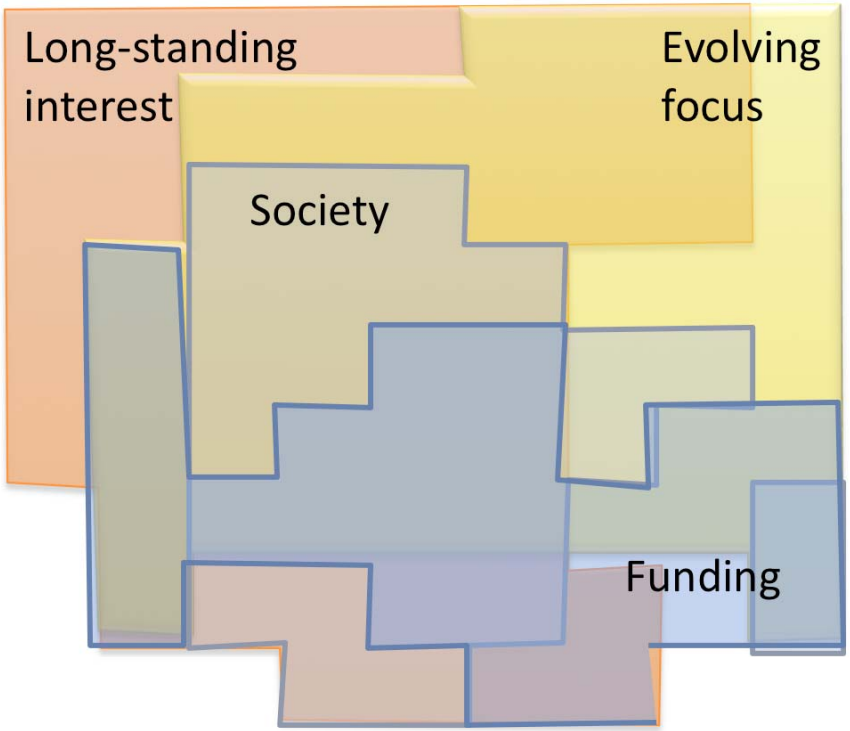
CWD-NSEC Survey

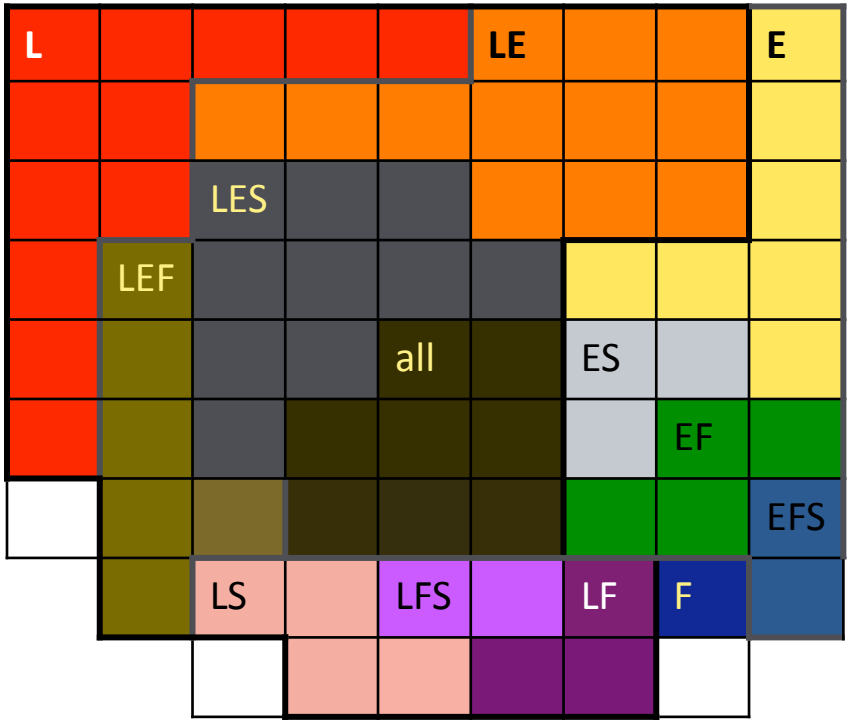
NSEC Women have overlapping reasons for choosing field

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

95 %

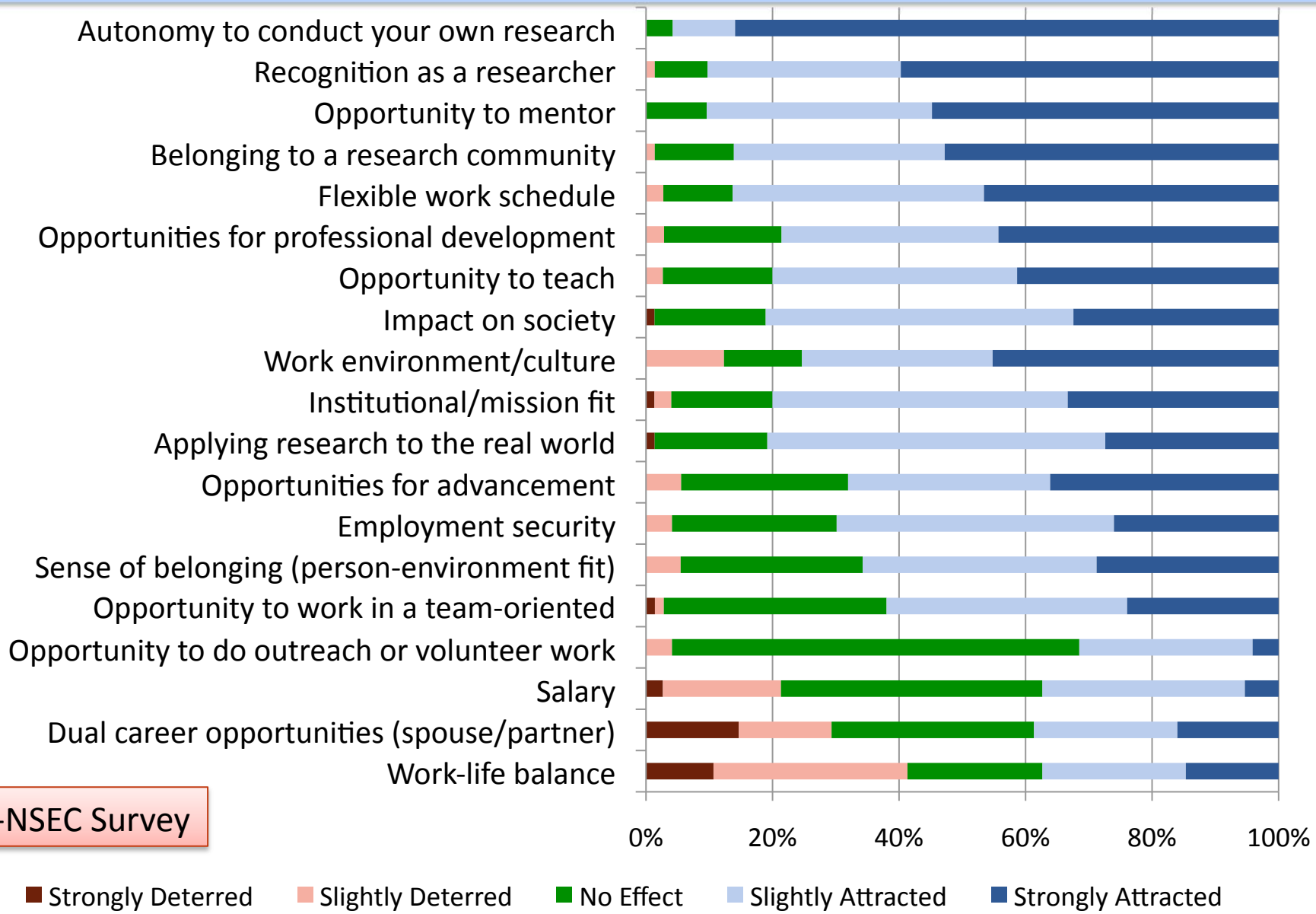
56 %





CWD-NSEC Survey

Factors that Attracted NSEC Women to Academia



CWD-NSEC Survey

Primary Field | Secondary Field of research -->

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*

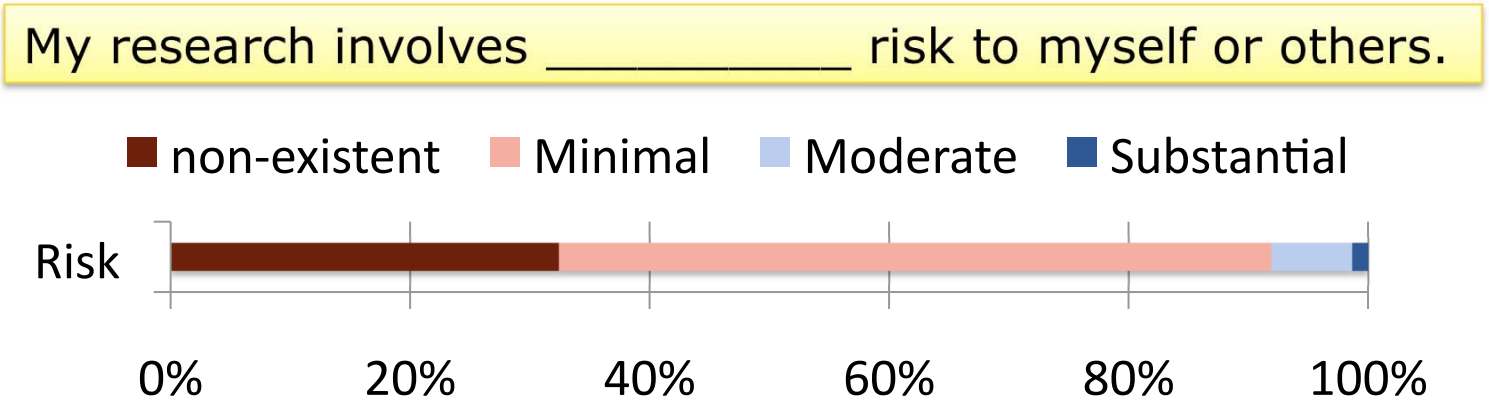
- General Advice
- Emotional Support
- Resolving discrimination issues
- Job search, promotion advice

CWD-NSEC Survey

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

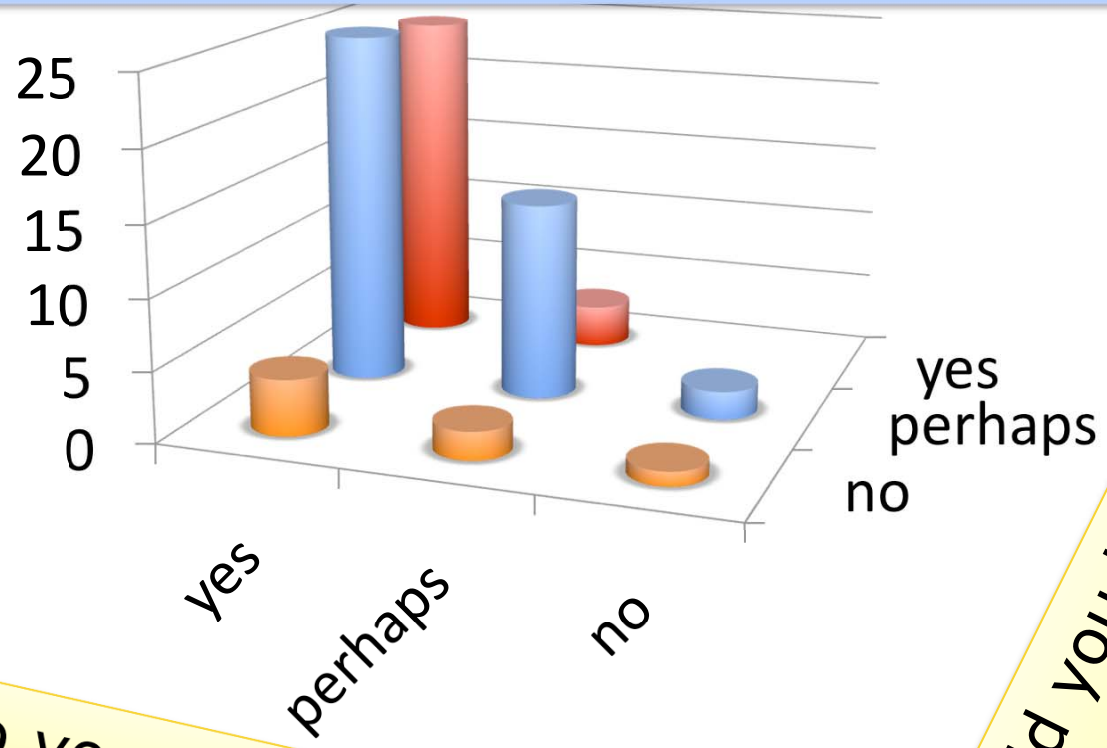
47 % Primarily focused on nanoscale science or technology

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



CWD-NSEC Survey

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

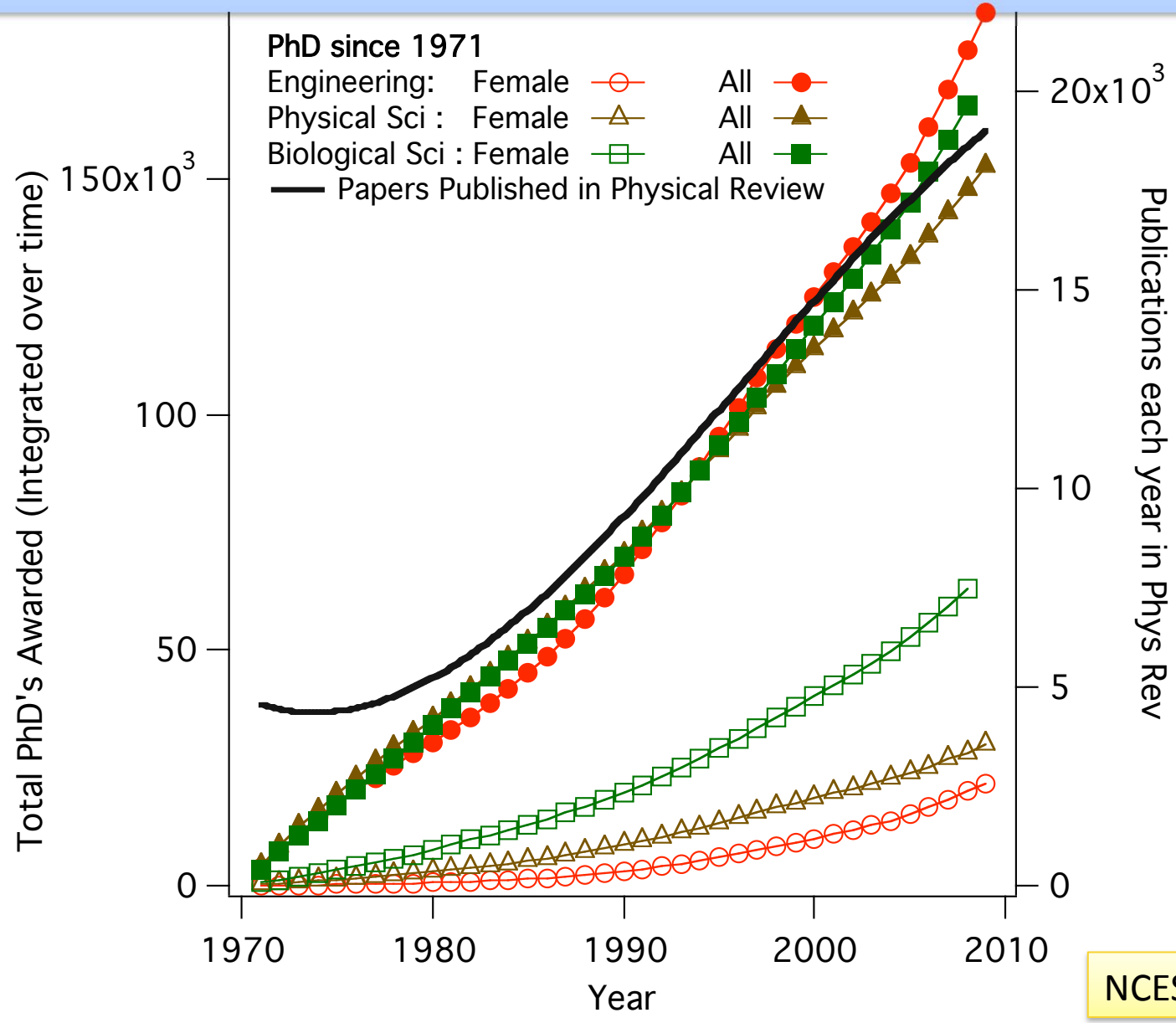


Would you like to be part of a professional network of women nanoscientists and nanoengineers?

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

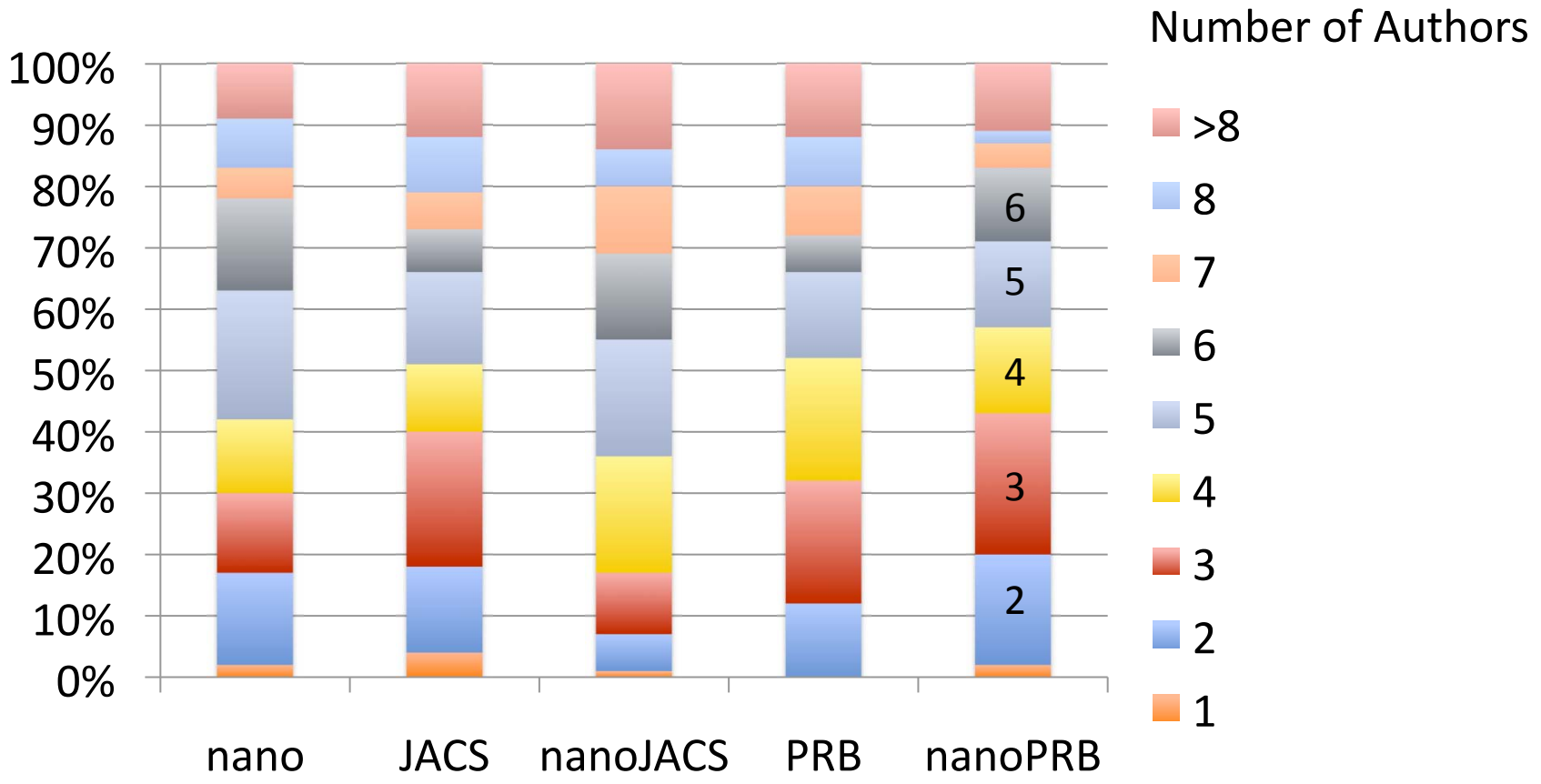
CWD-NSEC Survey

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