

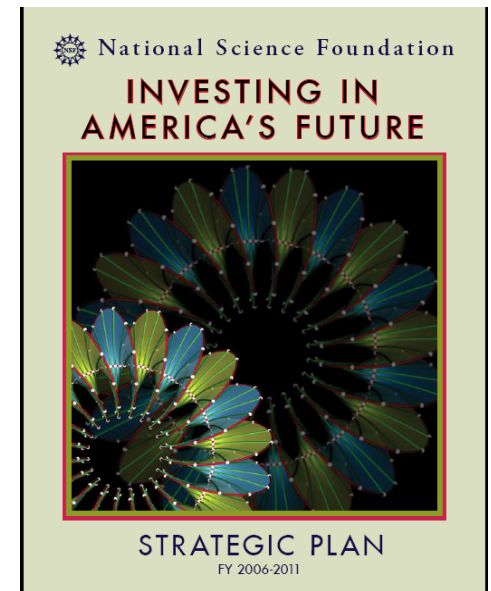


# Materials Research & Education at the National Science Foundation

Carmen Huber  
Executive Officer (Acting)  
Division of Materials Research (DMR)



**IMI-NFG Solar  
Energy Workshop  
November 2008**





# *NSF: Act of 1950*

- To promote the progress of science
- To advance the national health, prosperity, and welfare
- To secure the national defense



# NSF Mission

Support all areas of science & engineering  
except biomedical research

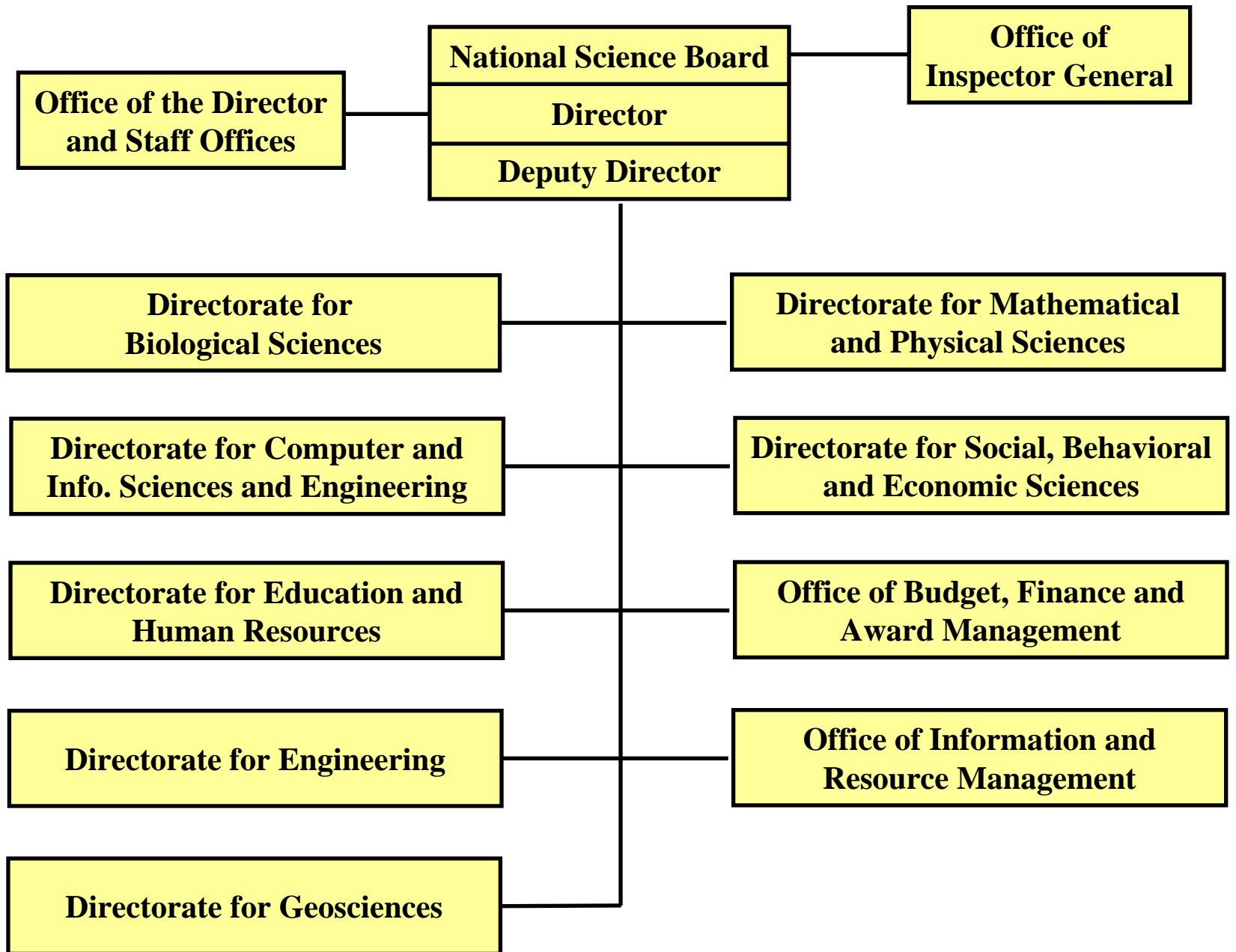
NSF is chartered by the US Congress not only to support current research, but also to assure that the resources, particularly human resources, are available to support future research and technological advances.

*“ASU Student Sets Up Microwave Processing Laboratory in South Africa”*

*Article in MRS Bulletin, November 2007*

*“Hydrogen Transport and Trapping in Ion-Cut Phenomena”, Arizona State U and U. of the Western Cape. Jointly funded by NSF and NRF-South Africa*





**Directorate for Mathematical  
and Physical Sciences**

**Division of Astronomy**

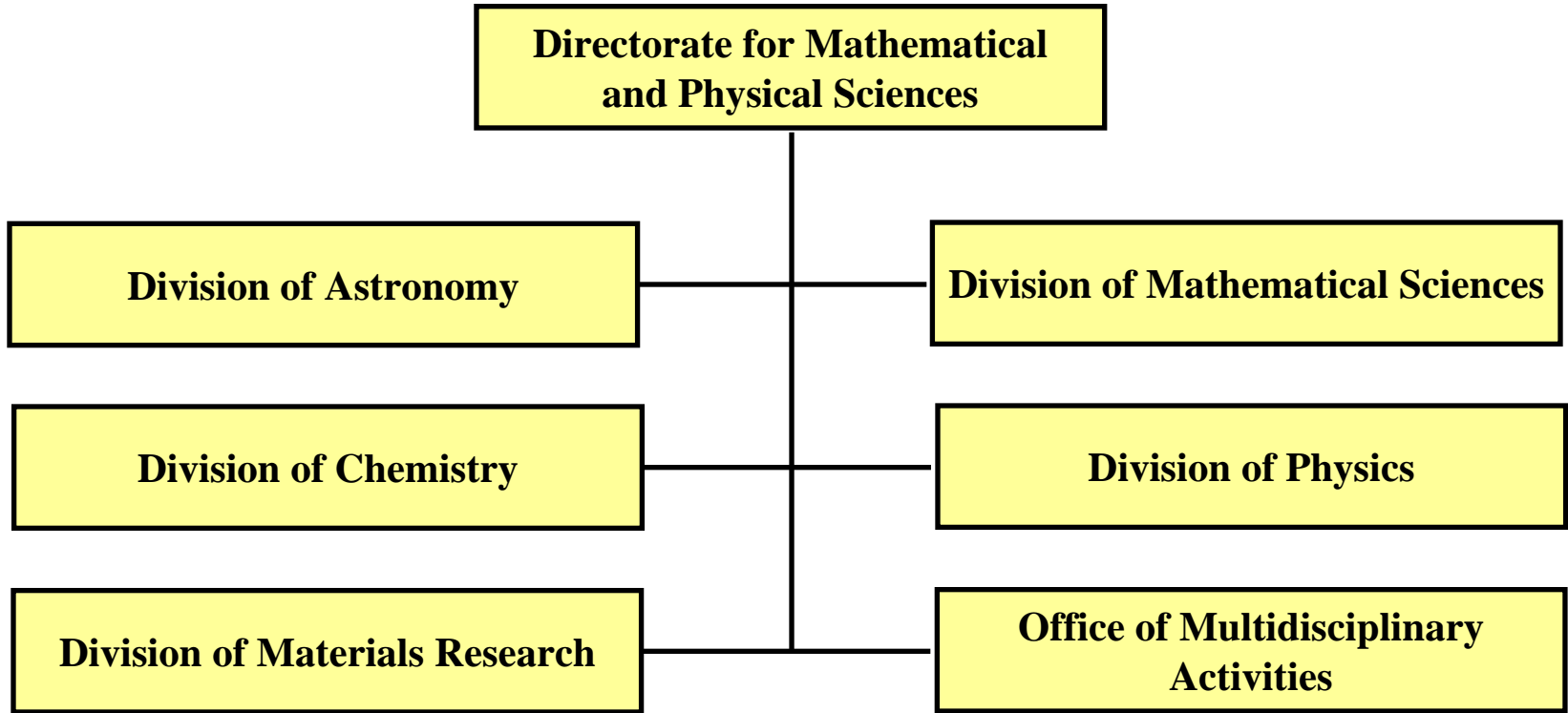
**Division of Mathematical Sciences**

**Division of Chemistry**

**Division of Physics**

**Division of Materials Research**

**Office of Multidisciplinary  
Activities**

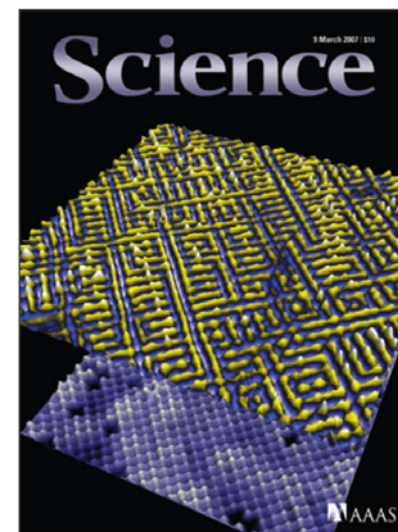




# NSF Support for Materials

- From fundamental materials phenomena to functional materials, devices, and systems.
- *Fundamental Research*: generation of basic knowledge, application-motivated, and often both
- Multiple disciplines: materials science, physics, chemistry, engineering, mathematics, biology, computer science, etc.
- *About 2/3 of materials investigations at NSF supported by the Division of Materials Research (DMR)*

*International Institute for Complex Adaptive Matter (I2CAM)  
D. Cox, UC-Davis. Support of K. Fujita on Junior Exchange  
Award between U. of Tokyo and Cornell U.*



# Division of Materials Research (DMR)

## OFFICE of the DIVISION DIRECTOR



Zakya Kafafi  
Division Director



Carmen Huber  
Executive Officer  
(Acting)



Neila Odom-Jefferson  
Operations Specialist

Vacant

Division Secretary

## ADMINISTRATIVE UNIT



Carol Savory-Heflin  
Program Support  
Manager



Denese Logan  
Program  
Analyst



Bill Daniels  
Program  
Specialist



Deborah E. Dory



Renée Ivey



Shirley Millican



Bernie Trumble

Senior Program Assistants

## Program Directors

### Condensed Matter & Materials Theory (CMMT)



Daryl W. Hess

Vacant

### Condensed Matter Physics (CMP)



Wendy Fuller-Mora

Vacant



Oscar O. Bernal



Udo Pernisz  
Dow Corning

### Solid-State & Materials Chemistry (SSMC)



Linda Sapochak

### Polymers (POL)



Andrew J. Lovinger



Freddy Khoury

### Biomaterials (BMAT)



David A. Brant



Joseph A. Akkara

### Ceramics (CER)



Lynnette D. Madsen

### Electronic Materials (EM)



LaVerne D. Hess



Z. Charles Ying

### Metals (MET)



Harsh D. Chopra  
SUNY

Vacant

### Materials Research Science & Engineering Centers (MRSECs)

Vacant



Thomas P. Rieker



Rama Bansil  
Boston U.

### Office of Special Programs (OSP)



Danielle Finotello  
Instrumentation for  
Materials Research (IMR)



Uma Venkateswaran  
National Facilities  
(NAF)



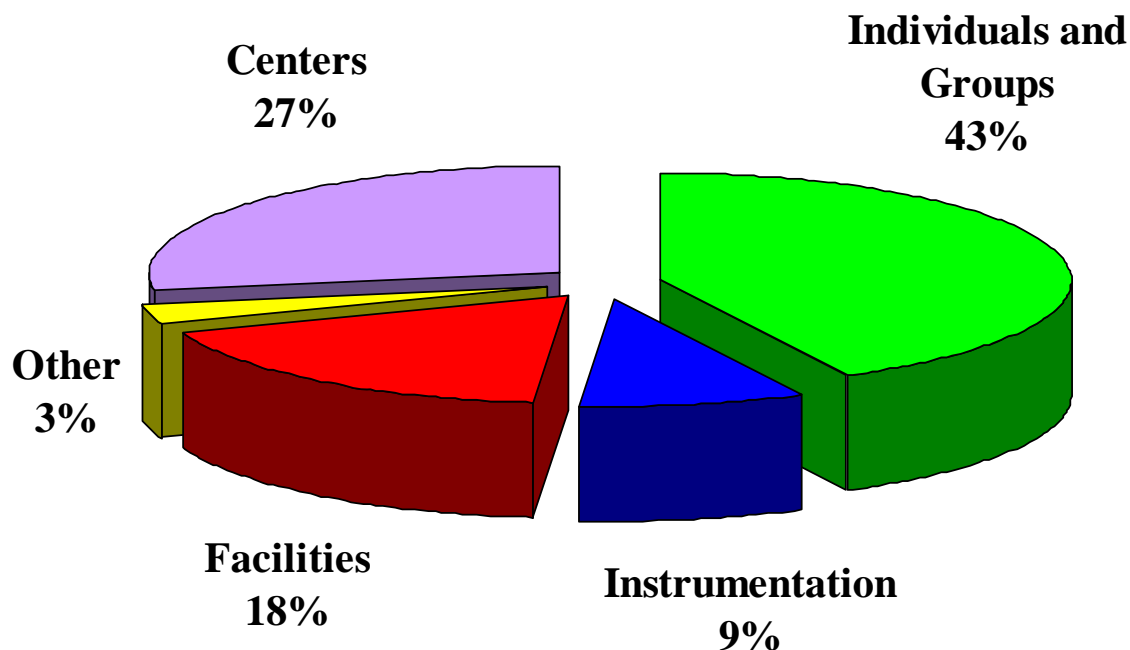
Charles Bouldin



Guebre X. Tessema



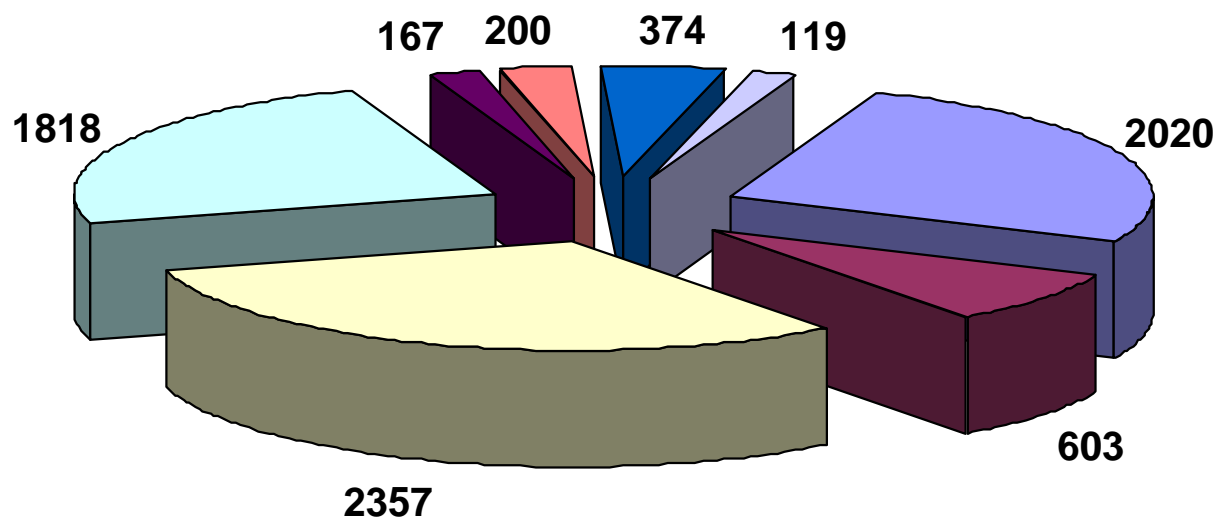
# DMR Support for Materials Research and Education (\$274 M in FY08)







# DMR Support for Materials Research and Education

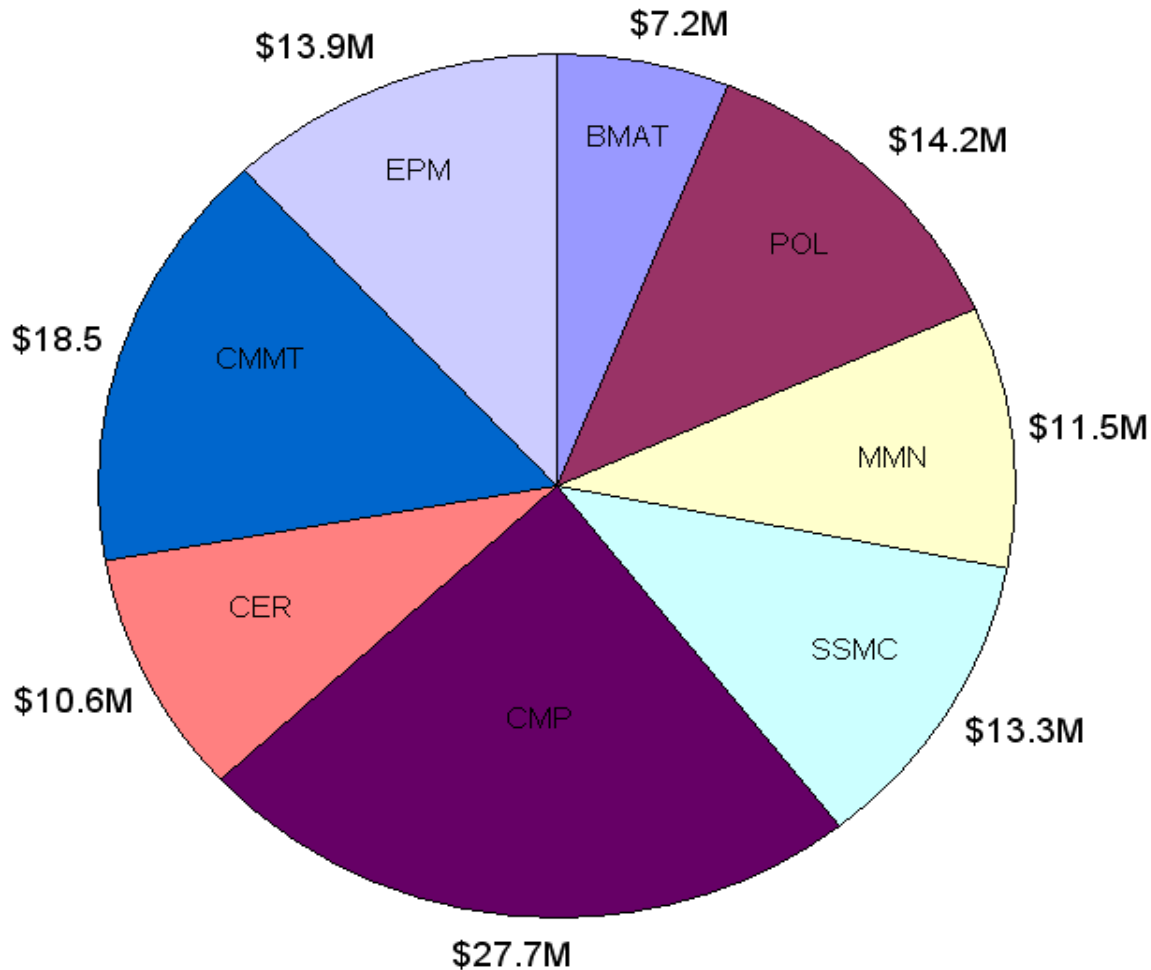


Faculty	Postdocs	Grads	Ugrads
K-12 Teachers	K-12 Students	Other Prof	Other

<http://www.nsf.gov/materials>



# DMR Individual Investigator Programs: The Great Invention Machine



FY08



Materials  
Research  
Science &  
Engineering  
Centers

National Science Foundation  
**MIRSEC**



**10**  
YEARS  
1994-2004

WEBSITE MENU

**27 University-Based Centers, \$1M - \$4M per year**

**FY08 competition: 14 awards, 6 new Centers established**

*~70 Interdisciplinary Groups address almost all areas of materials research*

**Biomolecular and biomimetic materials, self-assembly**

**Coatings, ceramics**

**Condensed matter phenomena, highly correlated systems**

**Electronic and photonic materials**

**Magnetic materials, ferroelectrics**

**Nanostructured / mesostructured materials**

**Nonequilibrium phenomena**

**Colloids, polymers, soft matter**

**Structural materials, metals, mechanics of materials**

**Surfaces and interfaces**

[www.mrsec.org](http://www.mrsec.org)



# Renewable Energy Materials Research Science and Engineering Center (MRSEC)

*Colorado School of Mines, DMR-0820518*

- ❖ Focus on research on materials for renewable energy applications: *photovoltaic materials* and *fuel-cell membranes*
- ❖ Partnership with National Renewable Energy Laboratory (NREL) and 20 companies



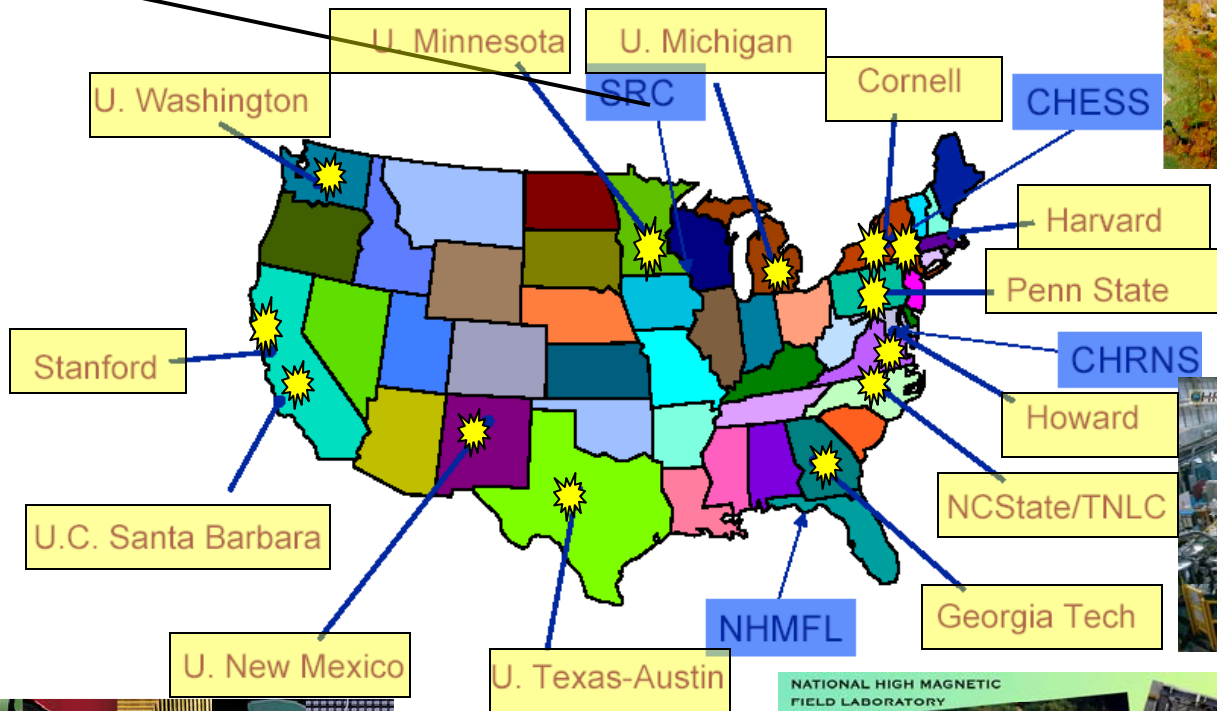


# DMR-Supported National User Facilities

\$ 42M ~ 6000 users annually

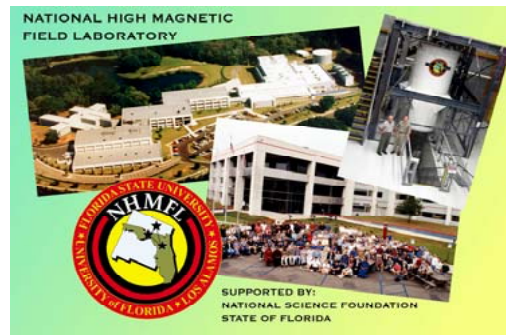


## National Facilities & NNIN Sites



National Nanotechnology Infrastructure Network

# NNIN







# DMR Support for Instrumentation at Neutron Scattering Facilities

Partnership with NIST CHRNS and DOE

IMR and IMR-MIP: less than \$10M



ORNL High Flux Isotope  
Reactor (HFIR)





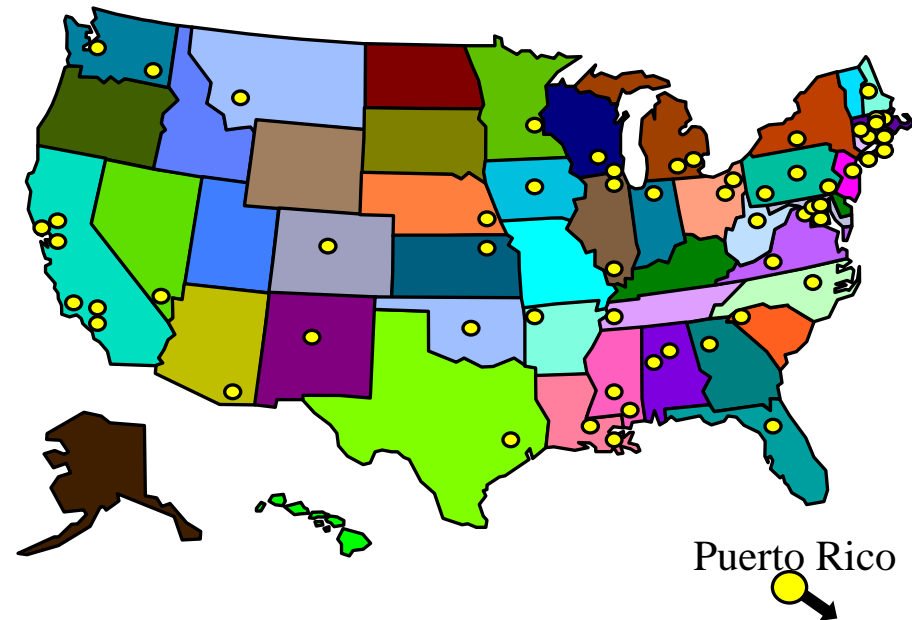
# Integration of Materials Research and Education

U Teach is featured in *Rising Above the Gathering Storm* as the first model program accompanying recommendation A-1:

**TEN THOUSAND TEACHERS FOR TEN MILLION MINDS**

**(PI is DMR grantee Mike Marder)**

- **Students at all levels**
- **Research experience for undergraduates and teachers**
- **Individual investigators & groups**
- **CAREER awards**
- **Centers & user facilities**
- **Partnerships & international activities**



*70 DMR REU Sites in 2008*



# A Vision for a Global Materials Network

- Connects diverse stakeholders (people, academic institutions, professional societies, government agencies, etc.) interested in materials research and education
- Based on joint ownership, mutual benefit, and universal participation
- Its mission is to serve the needs of materials stakeholders worldwide



*Microstructured Optical Fibers as High Pressure Microfluidic Reactors*, P. Sazio (UK), J. Badding (Penn State) et al, *Science*, March 2006





# MWN Partnerships: Support for International Collaborative Projects

- Global partnerships with 50+ foreign research funding organizations
- Jointly solicit proposals for collaborative projects
- Individual or group efforts
- Parallel and/or joint review
- Funding organizations make coordinated awards
- NSF funds US institutions (all research costs of US participants); organizations abroad fund their researchers



# International Materials Institutes (IMI)

Enhancing international cooperation in materials via a network of US nodes

## FY 2002, 2004 competitions

- *Princeton University*      *US/Africa Materials Institute*
- *U Tennessee*              *Neutron Scattering Network*
- *Iowa State / Maryland/ Florida International University*  
*Combinatorial Sciences / Materials Informatics*
- *UC Santa Barbara*        *Photonic/Electronic/Nano/Multifunctional Materials*
- *U California*              *Complex Adaptive Matter*
- *Lehigh / Penn State*      *New Functionality in Glasses*
  
- **New IMI competition (FY2009) currently ongoing**



# Materials Research and Education Areas of Great Opportunities

## **Sustainable Security**

- **Environmental sustainability:** important to preserve quality of life in our planet
- **Energy sustainability:** essential for humankind to engage in 21<sup>st</sup> century activities
- **Economic sustainability:** desired to preserve and improve our standard of living

Fundamental Mathematical and Physical Sciences can play a critical, and so far un-addressed role, in preserving our security

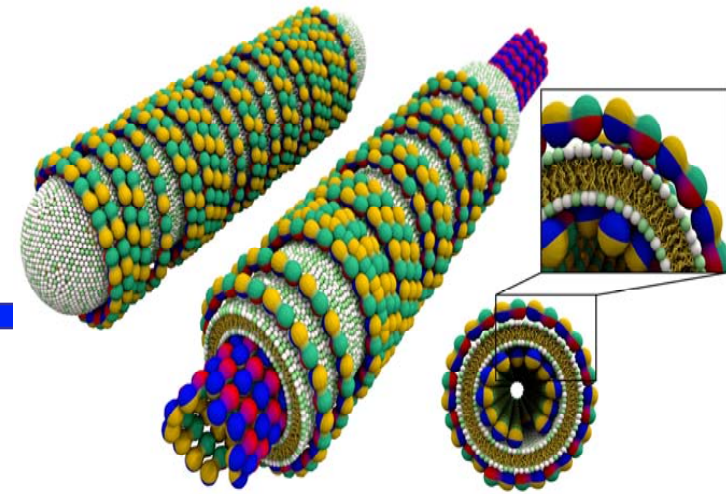
**Matter by Design**

**The Physical-Chemical-Biological Interfaces**

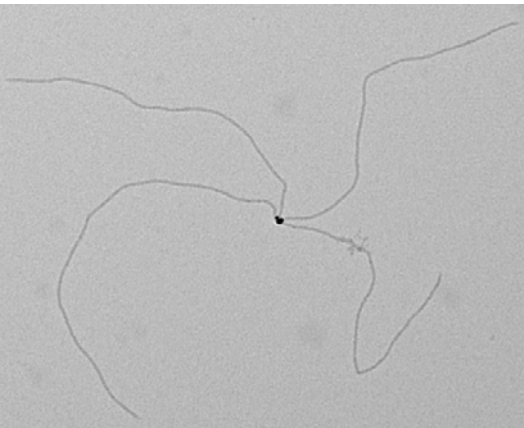
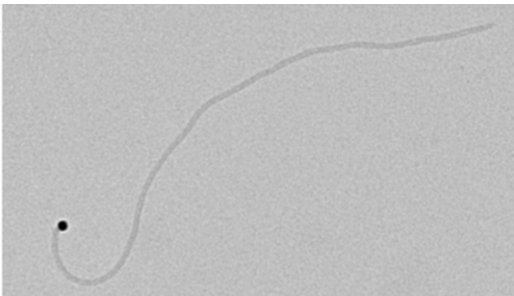
**The Quantum Realm**



# THE PHYSICAL / BIOLOGICAL FRONTIER



*Cyrus Safinya - UCSB*



- Can we understand and control biological function?
- Can we create complex hierarchical systems the way nature does?
- Can we enable direct electronic communication between computers and living systems?
- Can we use biology to understand complex self-assembly and systems far from equilibrium?
- Can we develop improved biocompatible materials for implants and artificial organs?
- Can we create and guide drug-delivery systems that cause no peripheral damage?

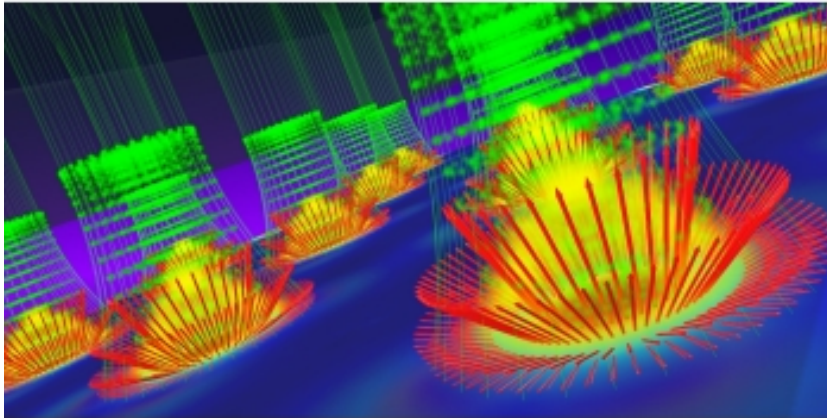
**IMPACT:** “Human repair” and quality of life. Control of biological processes. Potential for unraveling the physical basis of life.

*Seth Fraden - Brandeis*



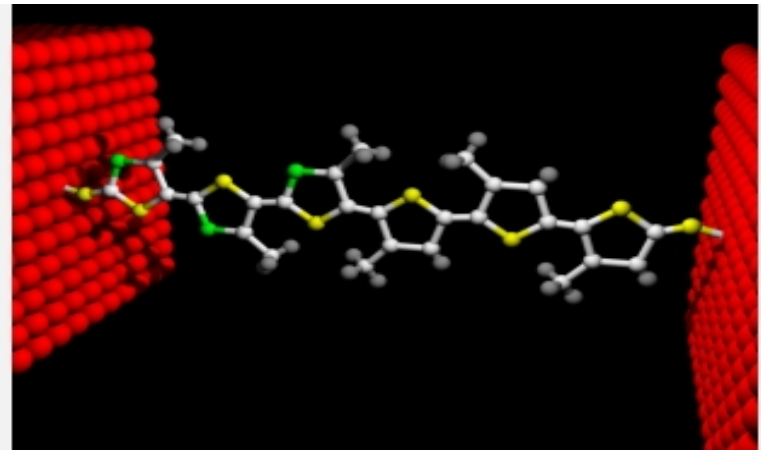
# Science & Engineering Beyond “Moore’s Law”

New science and technology, including novel algorithms and conceptual frameworks, are needed for future computing



*William G. Gilroy, University of Notre Dame*

Spintronics, in which information is carried out by electron’s intrinsic spin, is one of the possible candidates for future computing



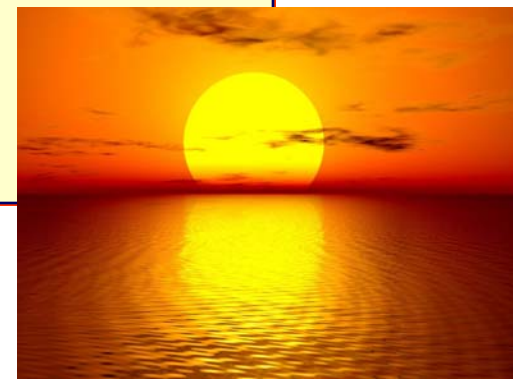
*Luping Yu, University of Chicago  
Ivan Oleynik, University of South Florida*

A single-molecule diode was designed to study and learn how to build electronic functionality into molecular architectures



# New CHE-DMR-DMS SOLAR Initiative for FY 2009

- Capitalizes on the unique strengths of the NSF Directorate of Mathematical and Physical Sciences (MPS) disciplinary communities
- Brings together mathematicians, chemists, and materials researchers, to address the scientific challenges of highly efficient harvesting, conversion and storage of solar energy
- Focus is on new fundamental chemical approaches, materials design, physical concepts, and mathematical algorithms
- NSF 08-598; pre-proposals due by Dec. 16, 2008



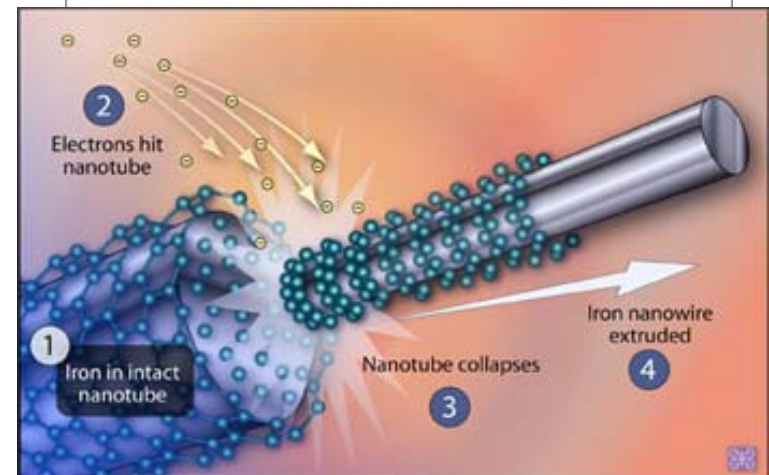
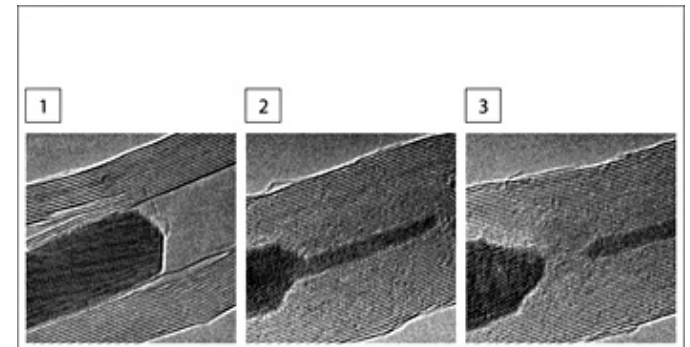




# A Global Materials Network

**NSF 08-590: MWN proposal deadline November 17, 2008**

- A materials network that links all talent available, regardless of geographical location
- IMIs evolve into US-based nodes of the network
- Seamless flow of people, information, materials, etc., through the network
- More and better utilization of cyber infrastructure in support and as a result of the network
- International research experiences as an integral part of undergraduate and graduate students' education



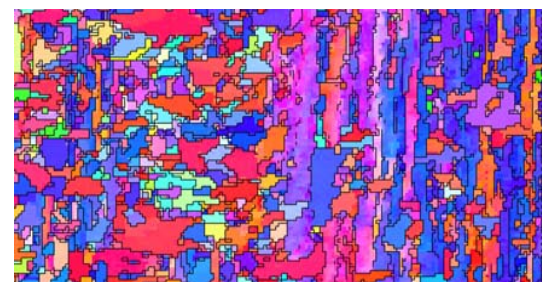
*Carbon Nanotubes as High Pressure Nanocylinders and Nanoextruders.* F. Banhart (Germany), P. Ajayan (RPI), M. Terrones (Mexico) et al, *Science*, May 2006



# Partnerships for Research and Education in Materials (PREM)

...broaden participation in materials research and education by stimulating the development of *long-term, collaborative partnerships between minority serving institutions and DMR-supported groups, centers and facilities*

- **Competitive award to minority serving institution**
  - Partnership based on intellectual connections
- **Competitions in 2004 and 2006**
- **10 Awards of ~ 500k/year for 5 years**
- **New competition in 2009**



Boundary levels: 15°  
60.00  $\mu\text{m}$  = 40 steps IPF [100]





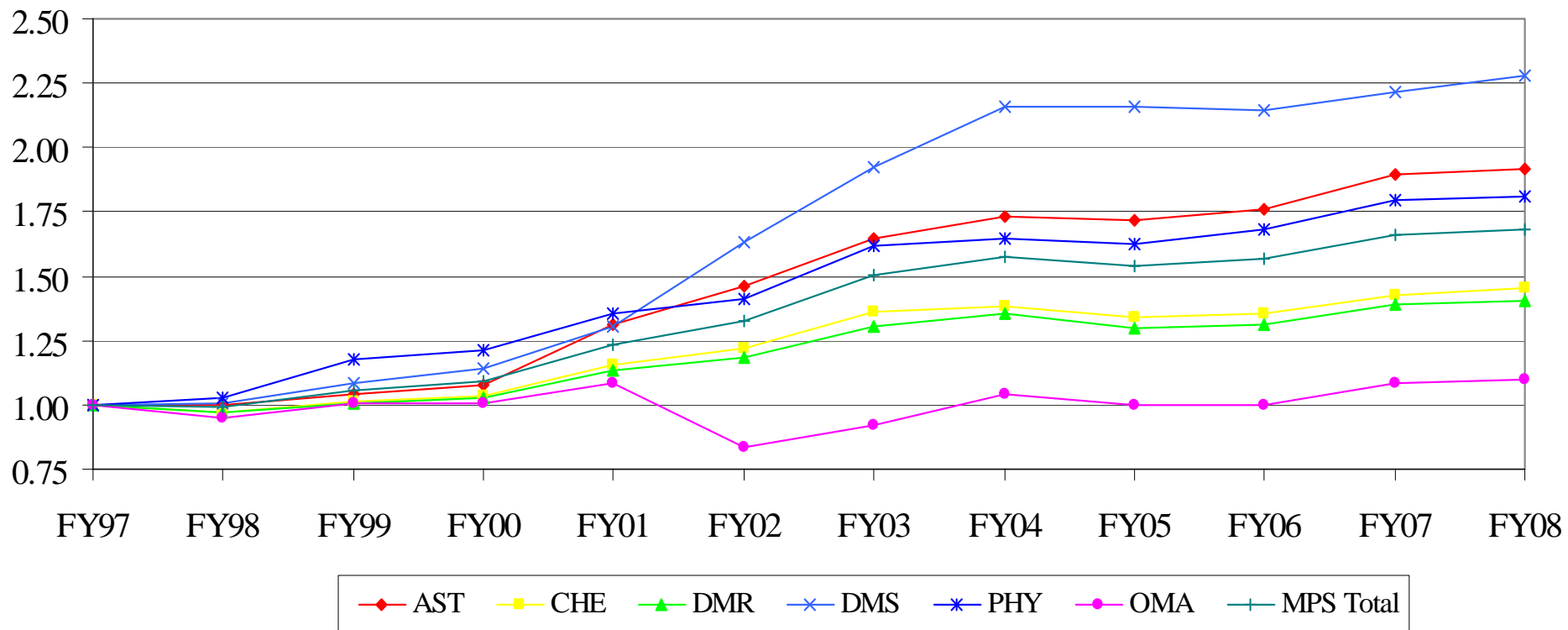
# DMR Sponsored Workshops in 2008/9

## Developing a Diverse Materials Research & Education Workforce

- Materials Science and Engineering **Gender Equity** Workshop, Adelphi, MD, May 18-20, 2008
- **Materials Science and Materials Engineering Education** Workshop, Arlington, VA, September 18-19, 2008
- Workshop on **Excellence Empowered by a Diverse Academic Workforce: Chemists, Chemical Engineers and Materials Scientists with Disabilities**, Arlington, VA, February 8-10, 2009.

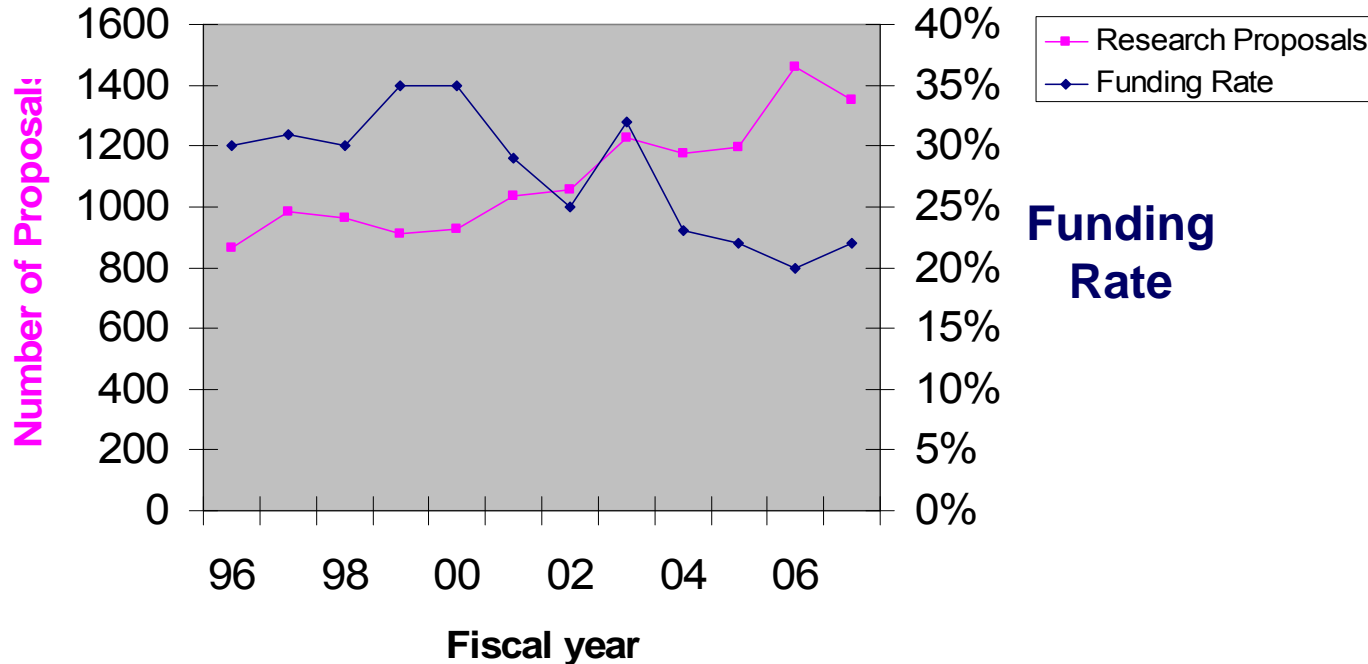


# Directorate for Mathematical & Physical Sciences Funding History, FY 1997 - FY 2008 Budgets normalized to FY 1997





# DMR Proposals & Funding Rates (Research Grants 1996 - 2008)



- Many strong proposals declined essentially for lack of funds
- Grant sizes not keeping pace with inflation
- Success rates vary but NSF-wide average is no better



# FY 2009 Budget Request by Division

## The “Good” News

### Mathematical and Physical Sciences Funding

(Dollars in Millions)

	FY 2007	FY 2008	FY 2009	Change over	
	Actual	Estimated	Request	FY 2008 Estimated Amount	Percent
Astronomical Sciences	\$215.39	\$217.86	\$250.01	\$32.15	14.8%
Chemistry	191.22	194.22	244.67	50.45	26.0%
Materials Research	257.27	260.22	324.59	64.37	24.7%
Mathematical Sciences	205.74	211.79	245.70	33.91	16.0%
Physics	248.47	250.52	297.70	47.18	18.8%
Multidisciplinary Activities	32.64	32.70	40.00	7.30	22.3%
<b>Total, MPS</b>	<b>\$1,150.73</b>	<b>\$1,167.31</b>	<b>\$1,402.67</b>	<b>\$235.36</b>	<b>20.2%</b>

Totals may not add due to rounding.

**NSF:  
\$6.854 B,  
+13.0%**



# Back to Reality

## FY2009 Continuing Resolution

- ❑ Flat Budget: Operating at  $\leq 90\%$  of FY2008 Budget through March 6, 2009
- ❑ Without FY2009 requested budget:
  - ✓ DMR will be **unable** to *increase* research and education support
  - ✓ Success rates for individual investigators will remain at historically low levels
  - ✓ DMR will be **unable** to *increase* support for centers
  - ✓ DMR will be **unable** to *enhance* research, user programs, instrument upgrades or education activities at the National High Magnetic Field Laboratory and other national user facilities

BUT, modest new investments will be made in awards relating to **mid-scale instrumentation, international materials institutes, minority participation** and in the recently established **biomaterials program**.



# Racing Forward

## **FY2009 Requested Budget will allow DMR to:**

- Increase number and size of grants
- Start new centers and institutes to enable focus on interdisciplinary, global materials research and education efforts
- Expand investments in workforce development, especially at the junior rank while broadening participation for women, minorities and scientists with disabilities
- Develop new education and outreach activities



*Thank you!*

<http://www.nsf.gov/materials>

*chuber@nsf.gov*