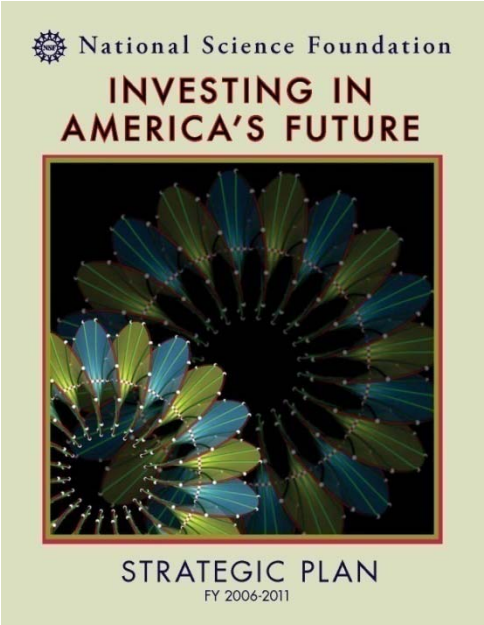
Overview of NSF Directorate for Mathematical and Physical Sciences

NSF Regional Grants Conference
March 2011

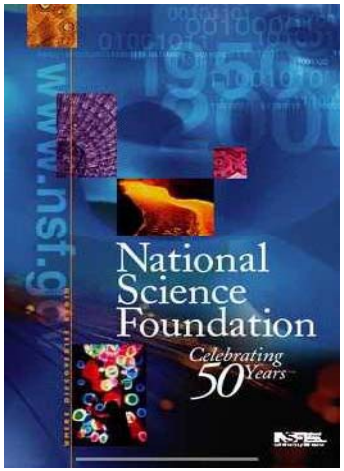
Morris L. Aizenman
Senior Science Associate
Directorate for Mathematical and Physical Sciences

NSF Vision and Goals

- Vision
  - » Advancing discovery, innovation and education beyond the frontiers of current knowledge, and empowering future generations in science and engineering
- Goals
  - » Discovery
  - » Learning
  - » Research Infrastructure
  - » Stewardship

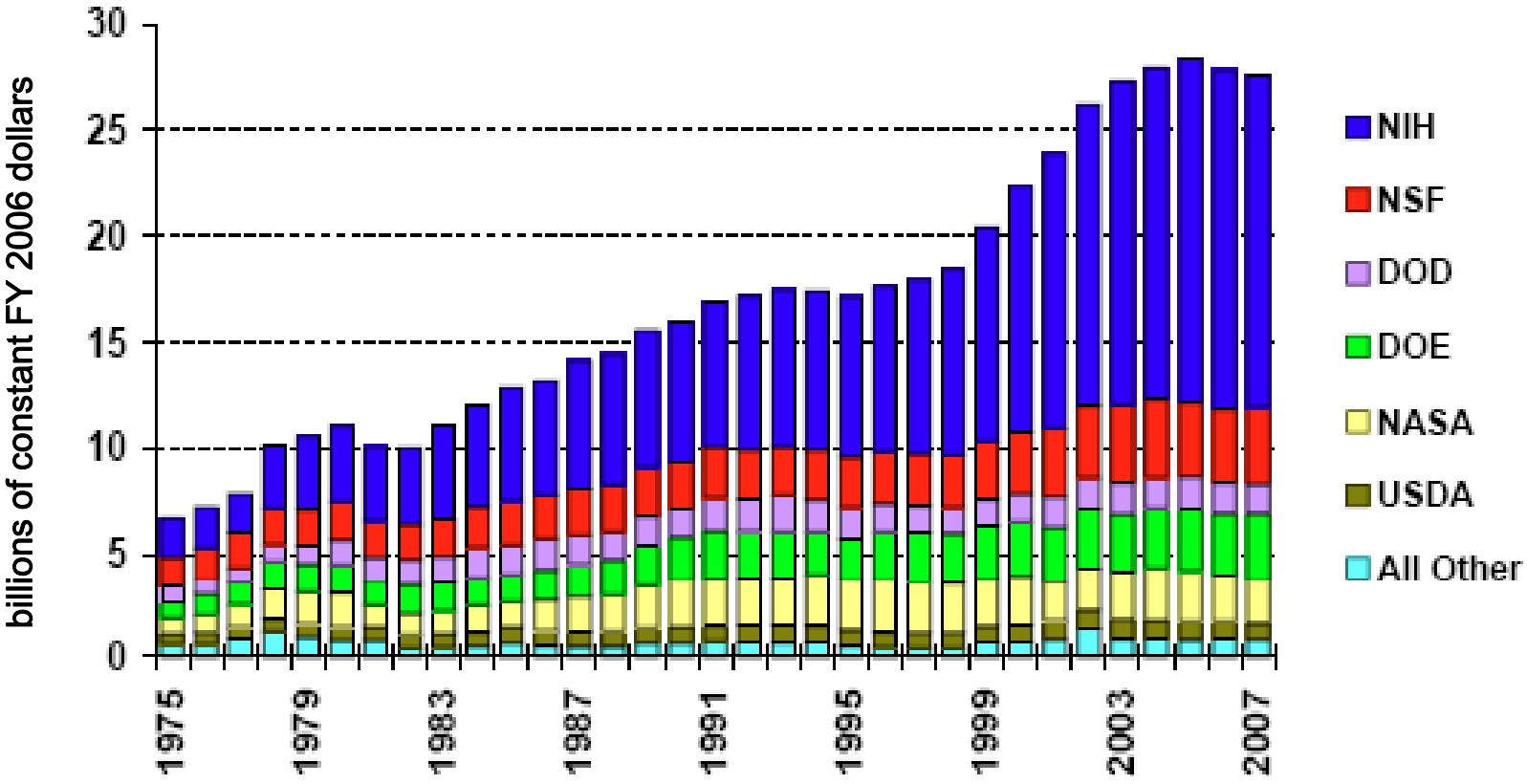


NSF in a Nutshell



- Independent agency
- Support basic research and education
- Use grant mechanism in two forms:
  - » Unsolicited, curiosity driven (majority of $)
  - » Solicited, more focused
- Peer reviews: intellectual merit & broader impacts
- Support all fields of science/engineering
- Discipline-based structure
- Cross-disciplinary mechanisms
- Support large facilities

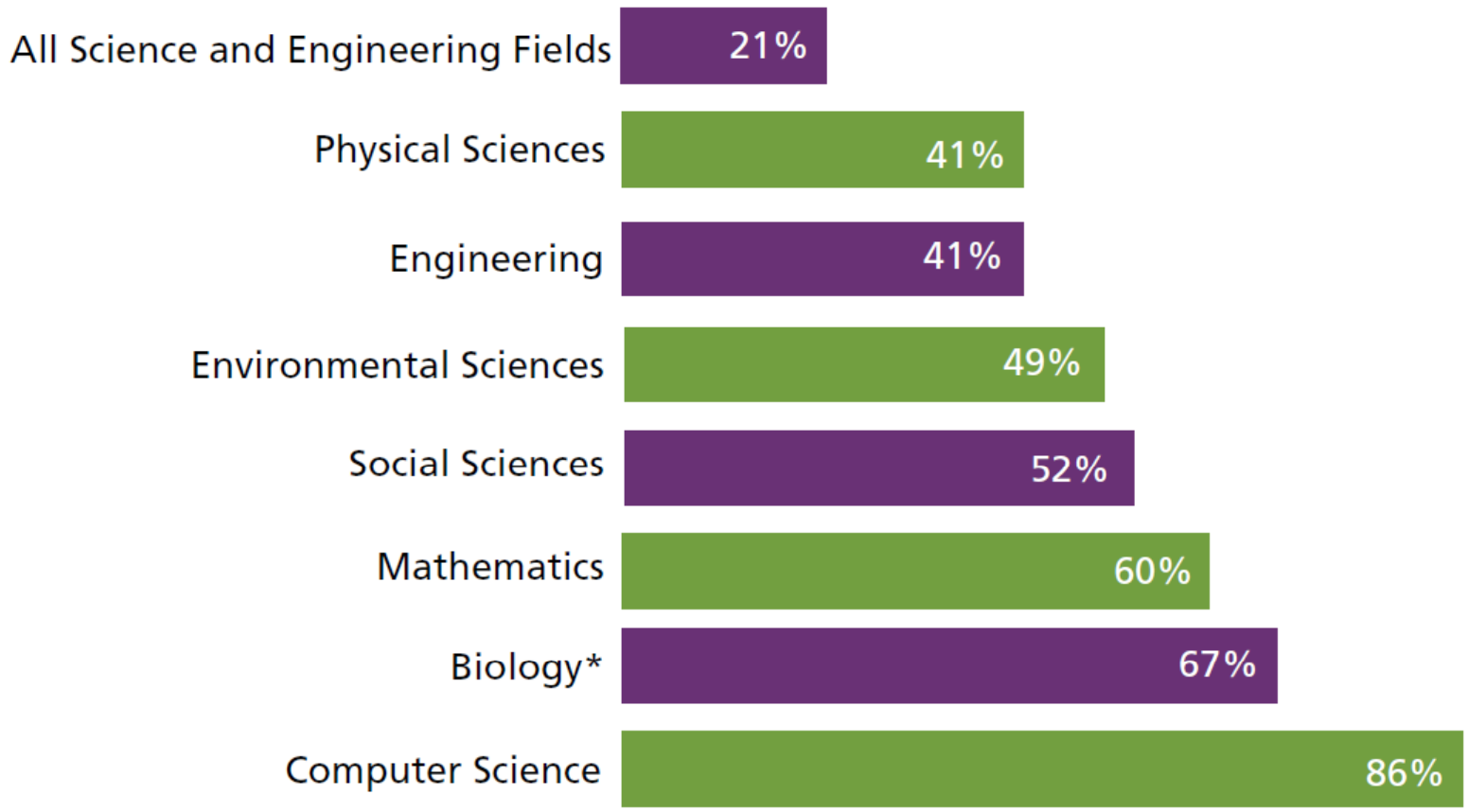
Trends in Basic Research by Agency Fiscal Year 1975-2007



Source: AAAS analyses of R&D in *AAAS Reports I-XXXI.* FY 2007 figures are President's request. Basic research only. March '06 © 2006 AAAS.

NSF SUPPORT OF ACADEMIC BASIC RESEARCH

(as a percentage of total federal support)

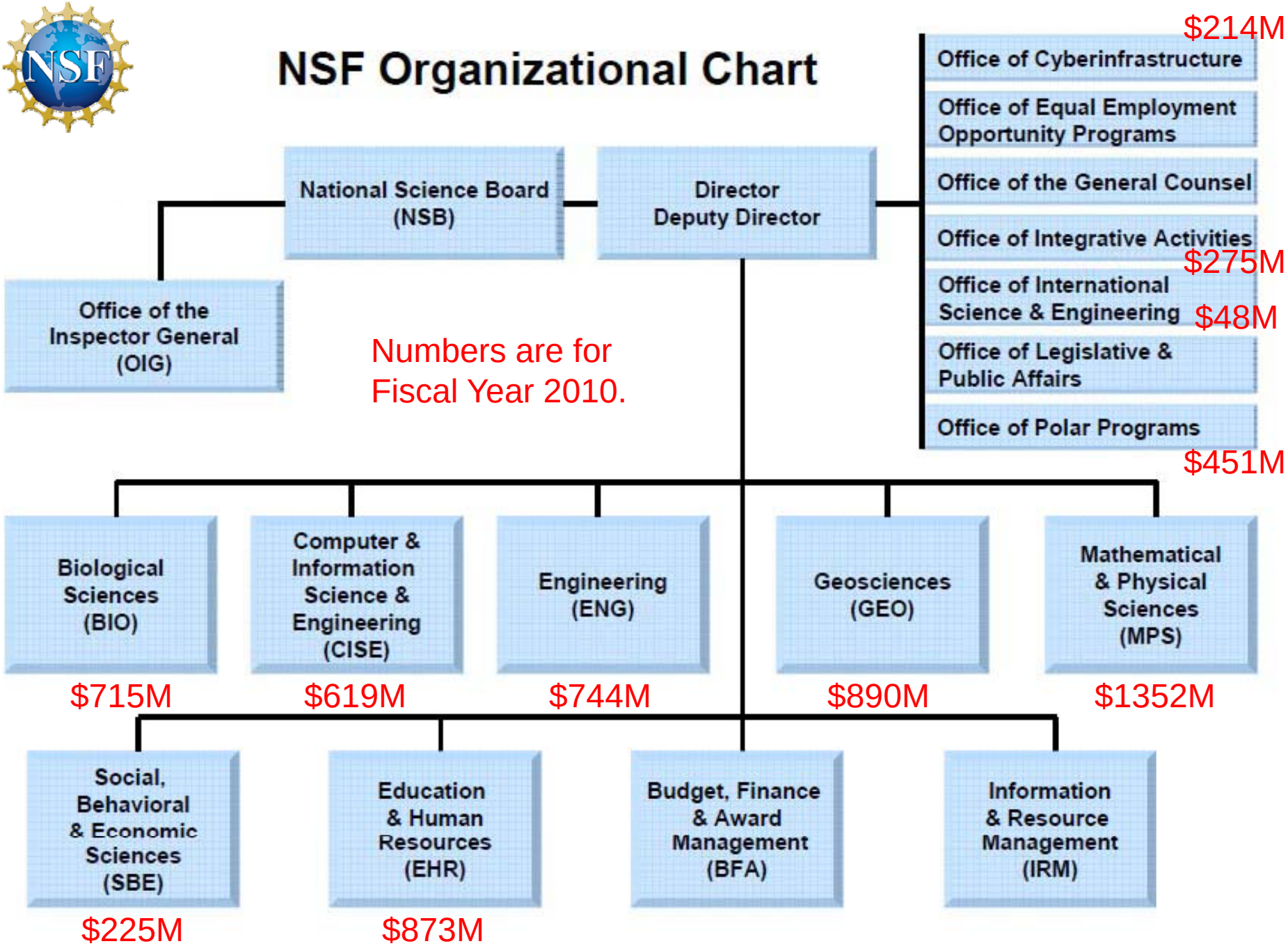


*Excludes the National Institutes of Health.

Source: NSF Survey of Federal Funds for Research and Development.

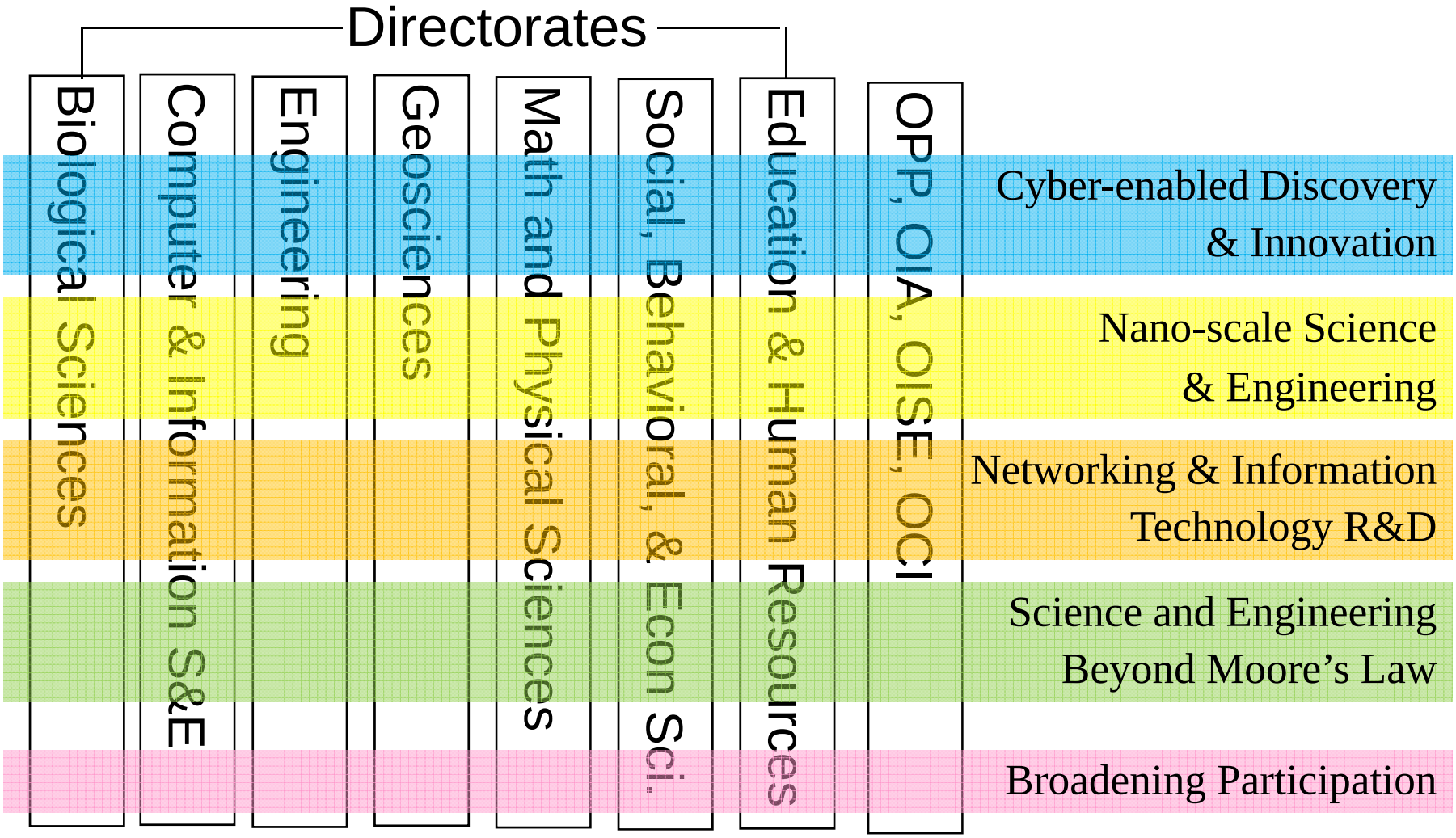
FY 2008 Performance Highlights, NSF 09-26

NSF Organizational Chart

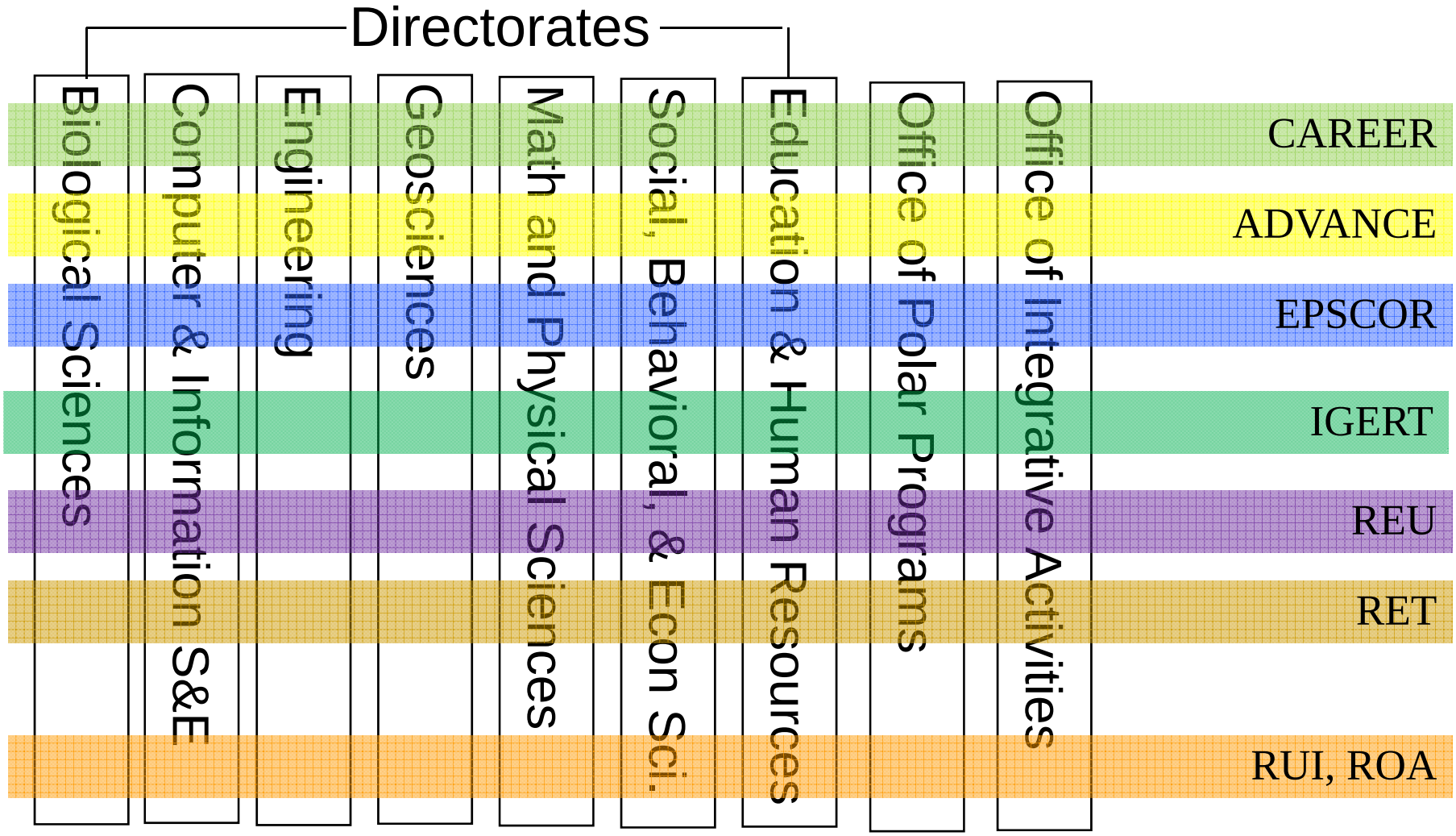


Numbers are for Fiscal Year 2010.

NSF-Wide Scientific Investments

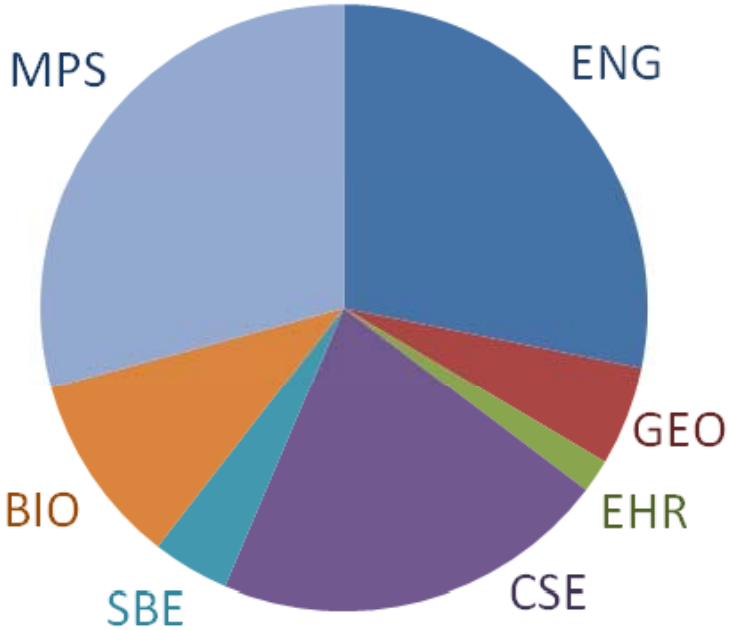


NSF-Wide Programs



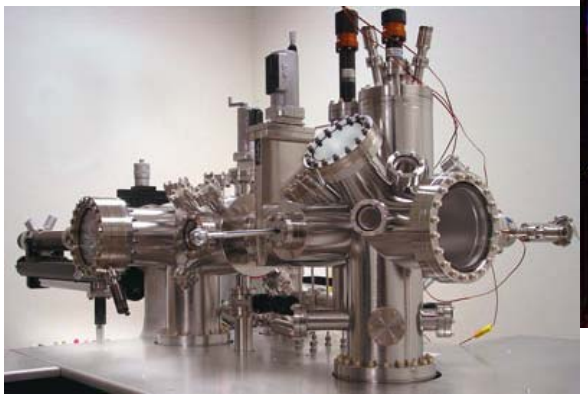
CAREER Program

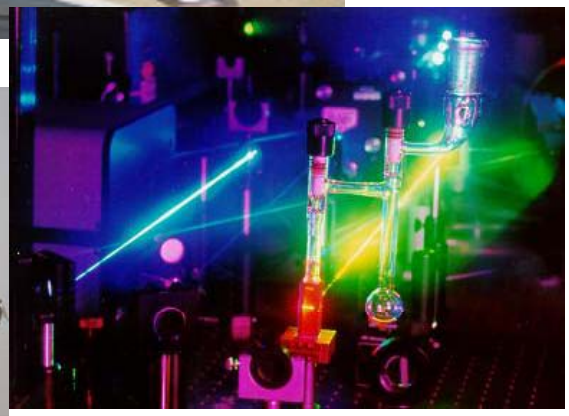
- NSF's most prestigious awards for junior faculty.
- Awardees are selected based on their plan of outstanding research, excellent education, and the integration of research and education within the context of the mission of their organizations, building a firm foundation for a lifetime of leadership.
- Increased participation of those traditionally under-represented in science and engineering is encouraged.



Instrumentation

- Both acquisition and development
- Major Research Instrumentation (MRI)
- Divisional instrumentation programs
- Research grants





MPS

Directorate for Mathematical and Physical Sciences

MPS Mission Statement

- To make discoveries about the Universe and the laws that govern it;
- To create new knowledge, materials, and instruments which promote progress across science and engineering;
- To prepare the next generation of scientists through research, and to share the excitement of exploring the unknown with the nation.

MPS Scientific Themes

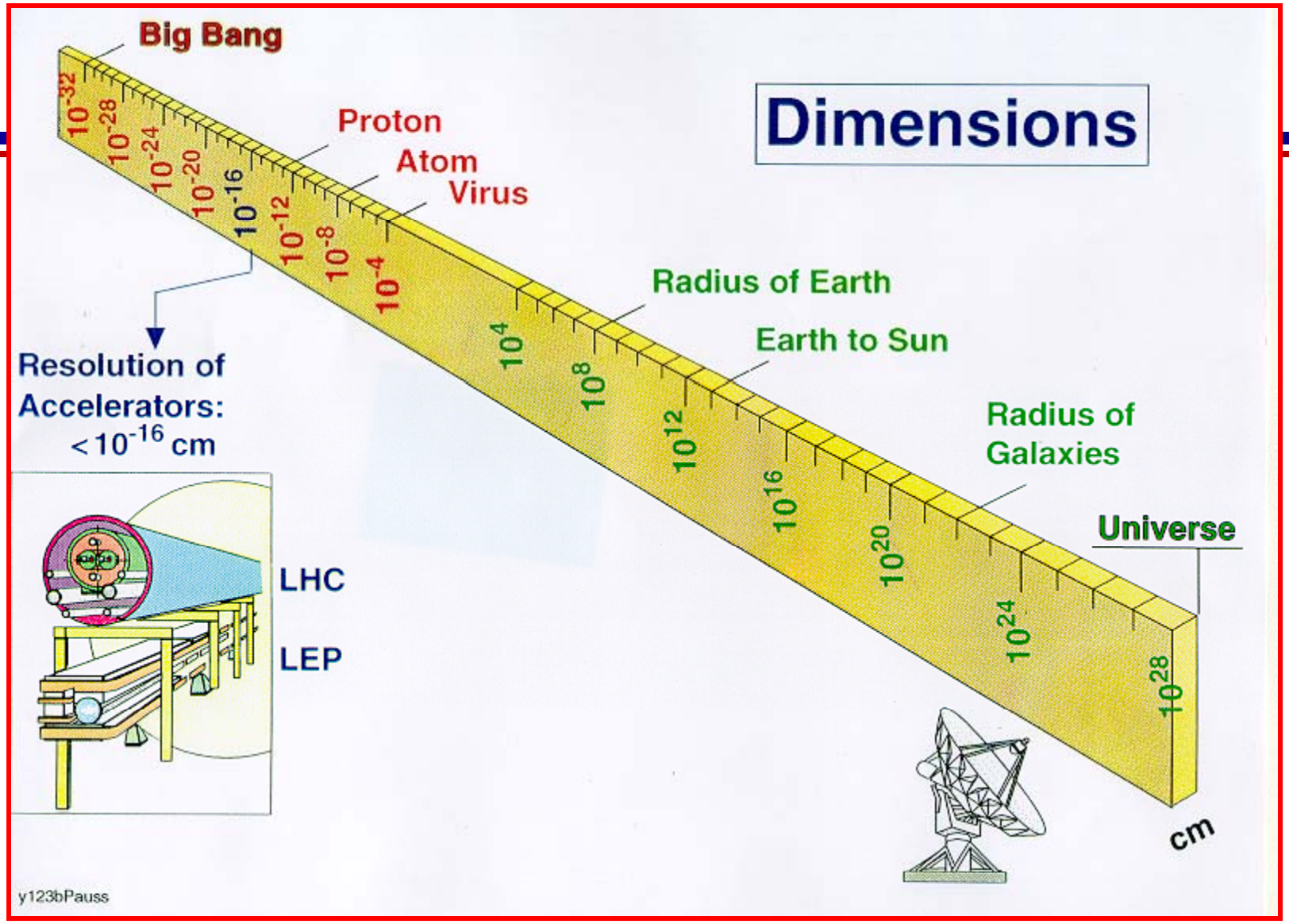
- Charting the evolution of the Universe from the Big Bang to habitable planets and beyond
- Understanding the fundamental nature of space, time, matter, and energy
- Creating the molecules and materials that will transform the 21st century
- Developing tools for discovery and innovation throughout science and engineering
- Understanding how microscopic processes enable and shape the complex behavior of the living world
- Discovering mathematical structures and promoting new connections between mathematics and the sciences
- Conducting basic research that provides the foundation for our national health, prosperity, and security

About the Directorate of Mathematical and Physical Sciences

- Most extensive & diverse scientific portfolio in NSF
- Fundamental discovery to innovative technologies
- Largest budget in NSF:
- Develops & supports major facilities
- Diverse approaches: small PI grants, major facilities, centers/institutes

About the Directorate of Mathematical and Physical Sciences

- Largest directorate
  - ~25% of R&RA, ~18% of proposals, FY11 request $1410m
- Nearly half of NSF's large facilities
- Responsible for the three "core" university disciplines - Physics, Chemistry, Mathematics – plus Astronomy and Materials Research
- Over 40% of university federal funding in the physical sciences
  - More than 80% in mathematics, and (was) growing
  - Federal steward for ground-based astronomy
- Science scope - extension on every scale
  - Femtoseconds and attoseconds to petaseconds and exaseconds
  - From the Planck size to the Cosmic size
  - From nanoKelvin to GigaKelvin
  - From fundamental research to marketable technologies
  - Every mental horizon from n-dimensions to infinity and beyond …


Dimensions
Big Bang
Proton
Atom
Virus
Radius of Earth
Earth to Sun
Radius of Galaxies
Universe
Resolution of Accelerators: $< 10^{-16}$ cm
LHC
LEP
10^{-32}
10^{-28}
10^{-24}
10^{-20}
10^{-16}
10^{-12}
10^{-8}
10^{-4}
10^{4}
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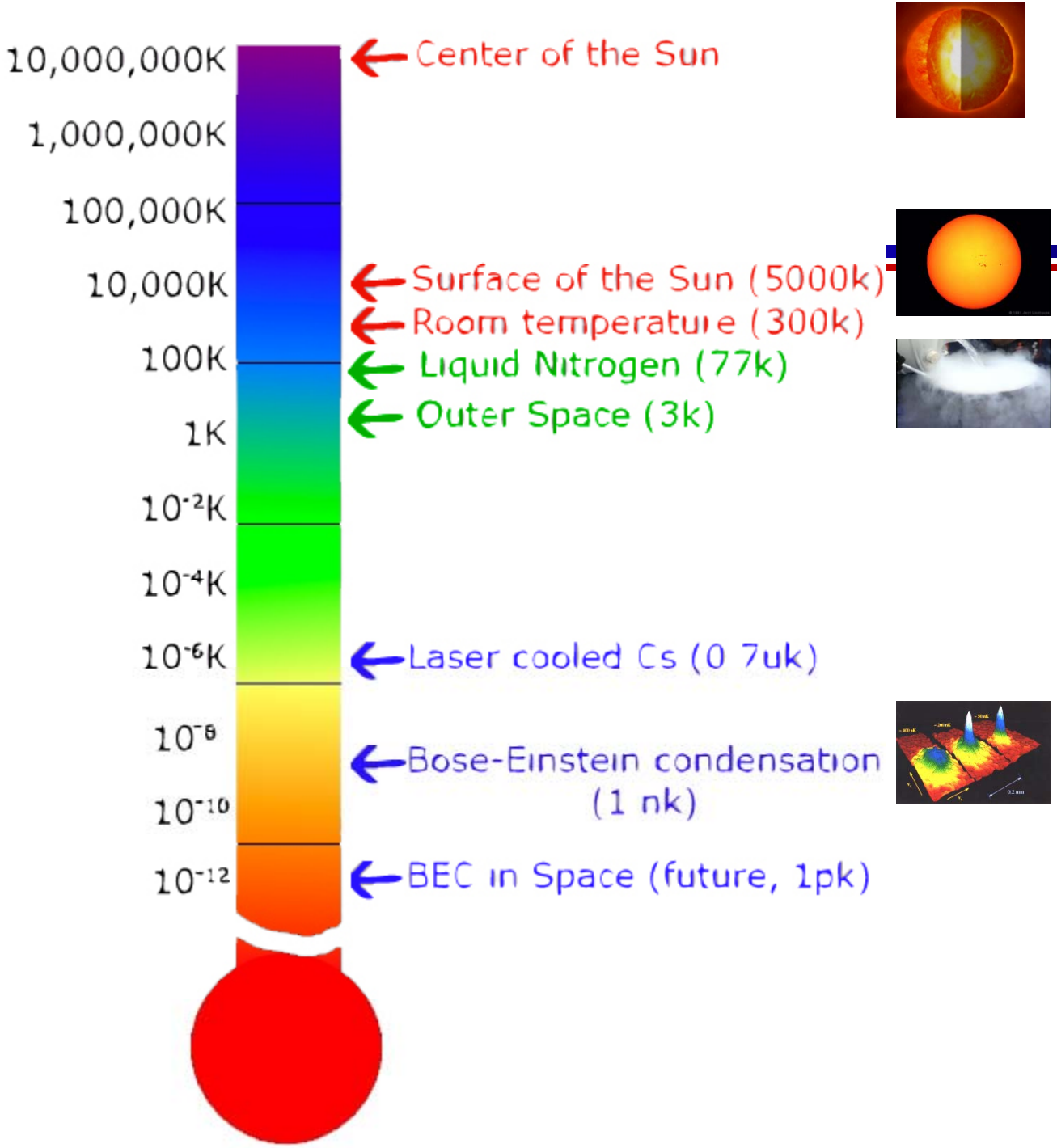
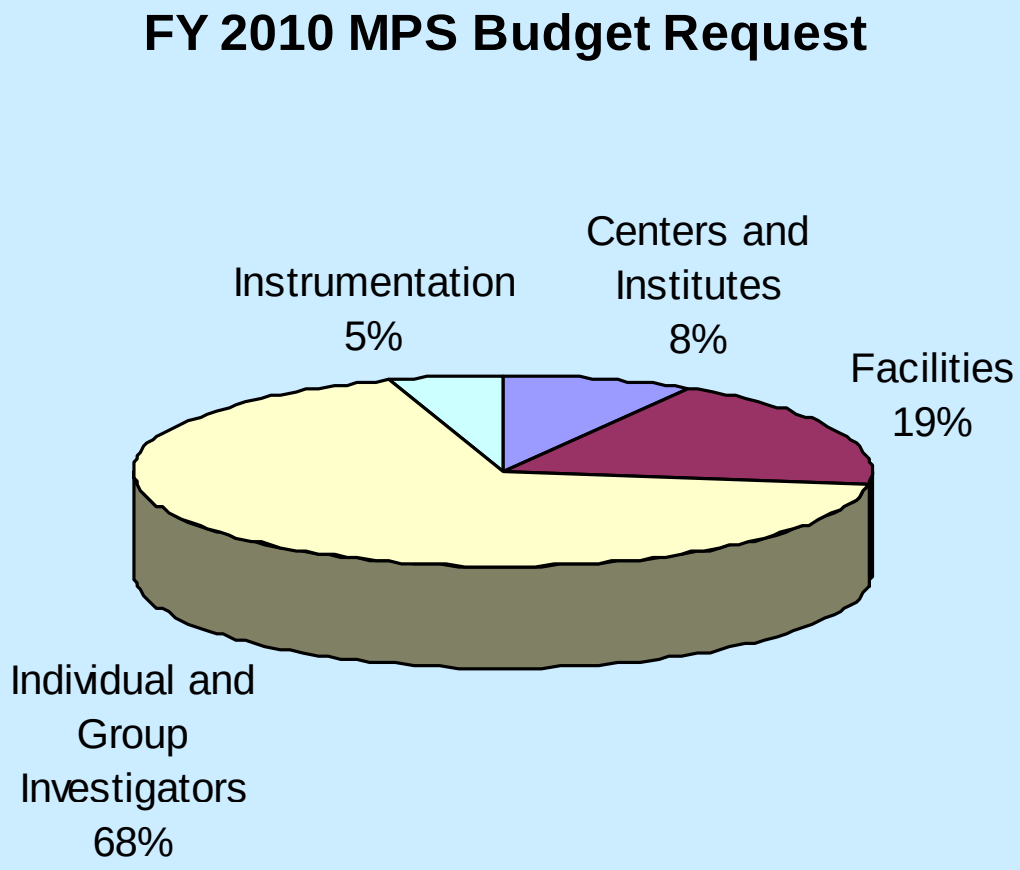
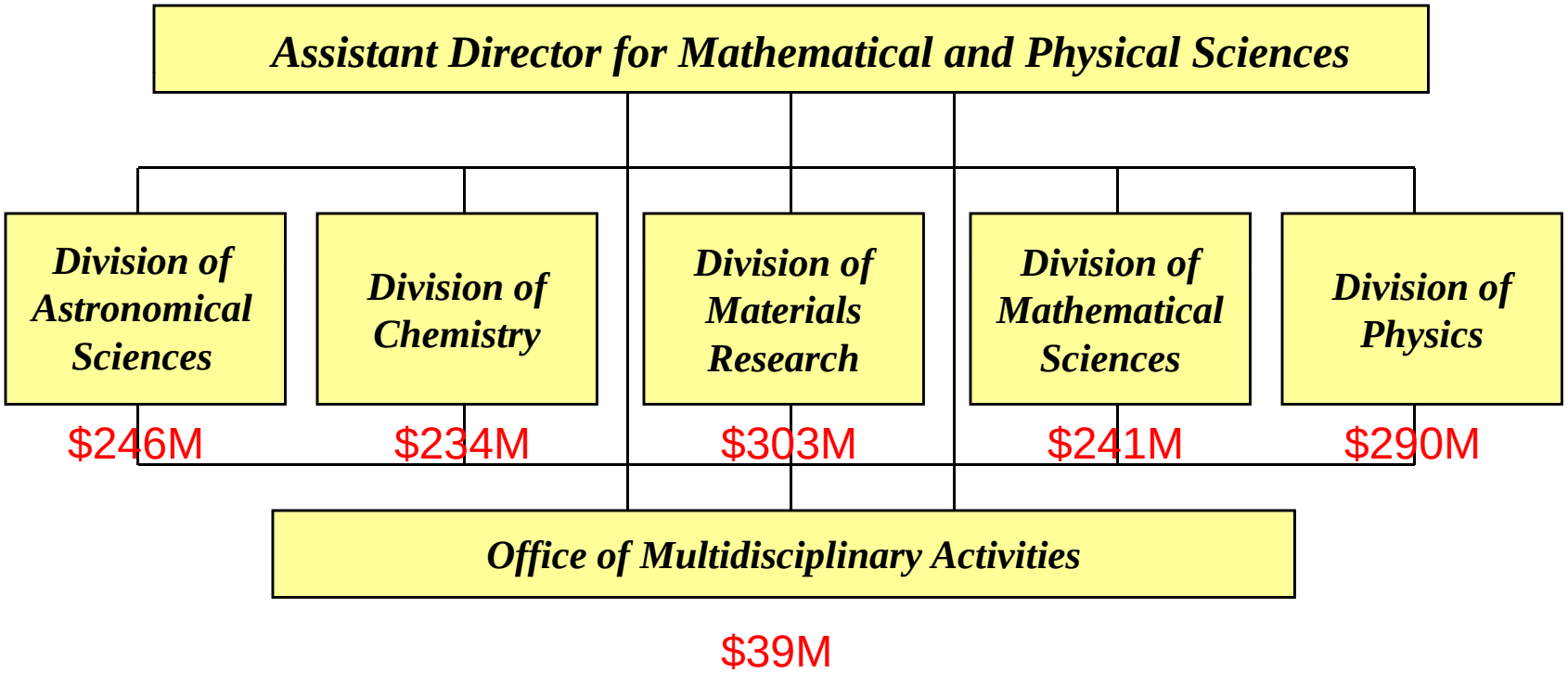
cm
y123bPauss


10,000,000K
1,000,000K
100,000K
10,000K
100K
1K
10^{-2}K
10^{-4}K
10^{-6}K
10^{-8}
10^{-10}
10^{-12}
Center of the Sun
Surface of the Sun (5000k)
Room temperature (300k)
Liquid Nitrogen (77k)
Outer Space (3k)
Laser cooled Cs (0 7uk)
Bose-Einstein condensation
(1 nk)
BEC in Space (future, 1pk)

MPS Funding Modality in the FY2010 Budget Request

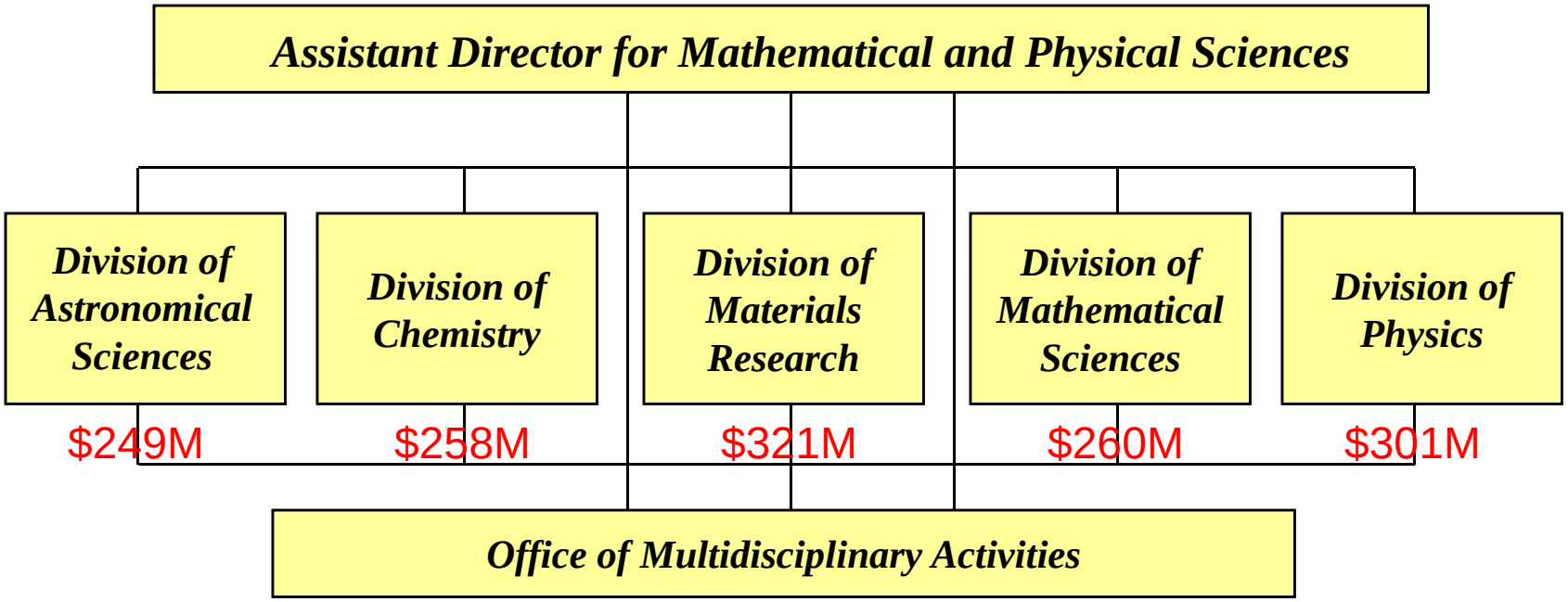


Directorate for Mathematical and Physical Sciences (MPS)



Numbers are for Fiscal Year 2010.
Total =$1368M

Directorate for Mathematical and Physical Sciences (MPS)



$43M

Fiscal Year 2012 Request
Total =$1433M

MPS Division Funding

(dollars in millions)

MPS Funding

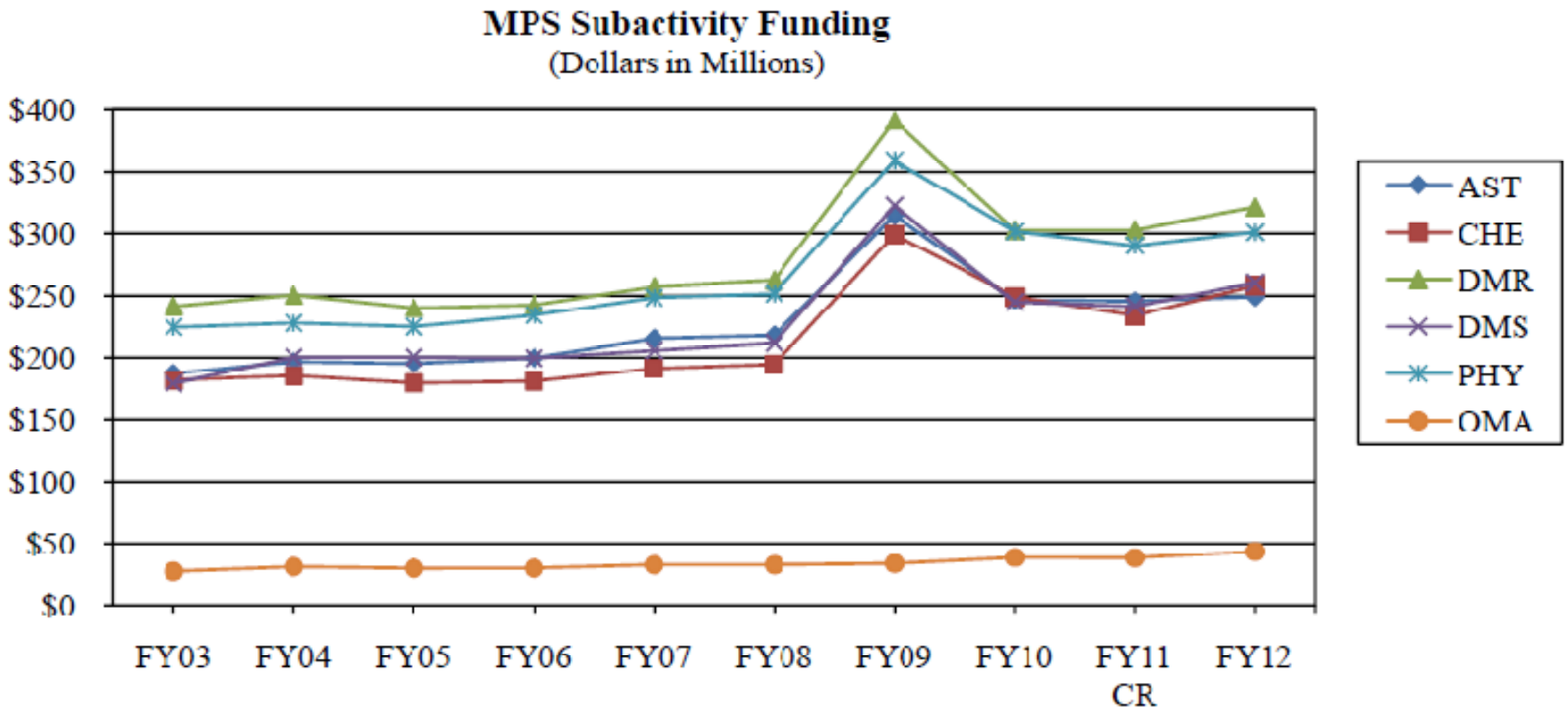
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Division of Astronomical Sciences (AST)	$246.53	-	$245.69	$249.12	$3.43	1.4%
Division of Chemistry (CHE)	233.68	15.70	233.73	258.07	24.34	10.4%
Division of Materials Research (DMR)	302.57	-	302.67	320.79	18.12	6.0%
Division of Mathematical Sciences (DMS)	244.92	-	241.38	260.43	19.05	7.9%
Division of Physics (PHY)	301.66	-	290.04	300.91	10.87	3.7%
Office of Multidisciplinary Activities (OMA)	38.58	-	38.33	43.41	5.08	13.3%
Total, MPS	**$1,367.95**	**$15.70**	**$1,351.84**	**$1,432.73**	**$80.89**	**6.0%**

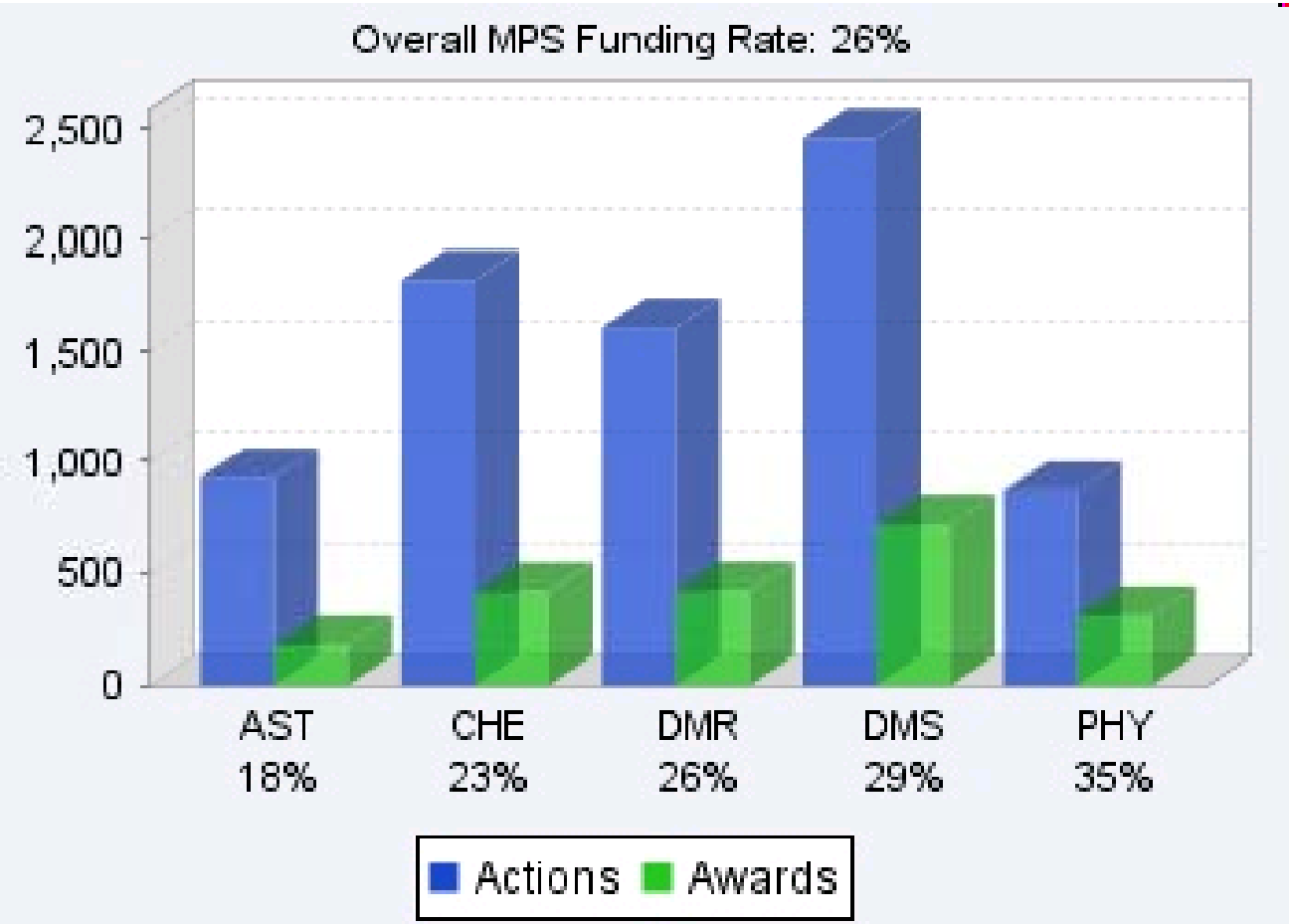
Totals may not add due to rounding.

MPS Division Funding

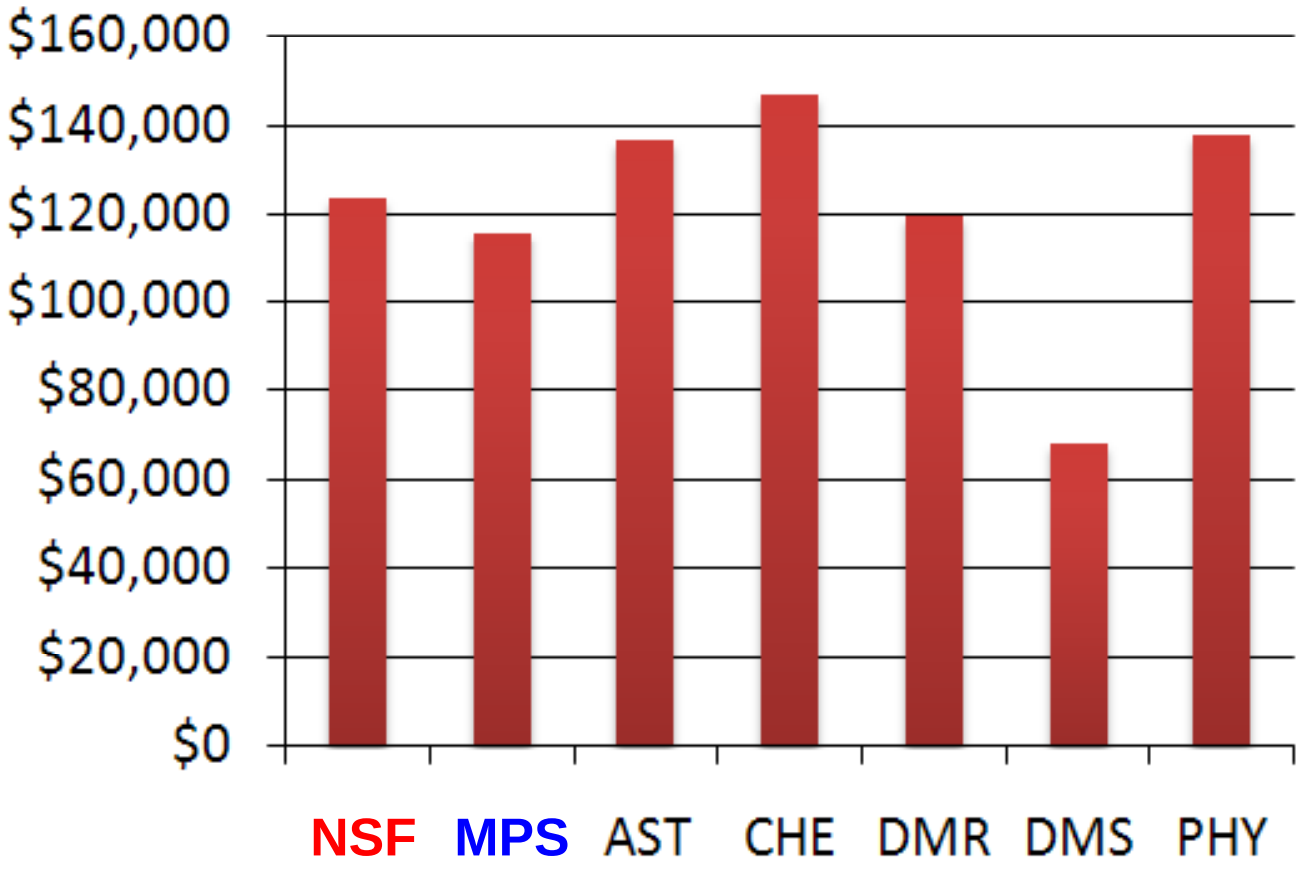
(dollars in millions)



Funding Rates (2010)

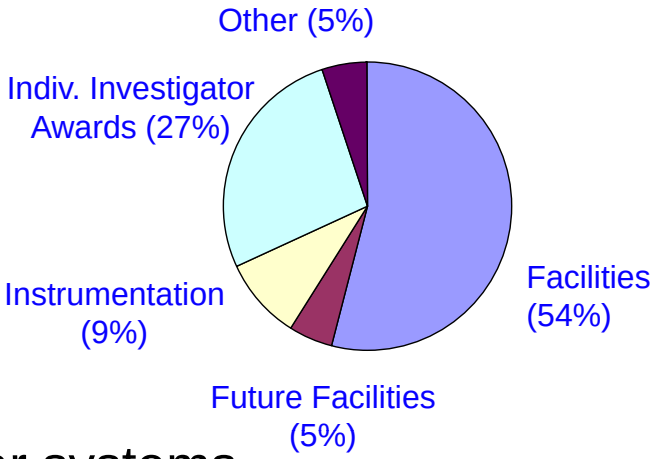


Median Annualized Award Size (2010)



Mean Award Duration: About Three Years

Astronomical Sciences (AST)



- From the Big Bang to DNA
  - » Origin and evolution of the Universe
  - » Origin and evolution of galaxies
  - » Origin and evolution of planetary and stellar systems
- National astronomy portfolio
  - » Three agencies – NSF, NASA, and DoE – and international partnerships
  - » Strong tradition of private funding
  - » NSF assigned federal stewardship of ground-based astronomy
  - » **Includes open-access facilities and mission-free unrestricted grants**

AST has a strong program in Education and Special Programs (including a major investment in post-docs)

Chemistry (CHE)

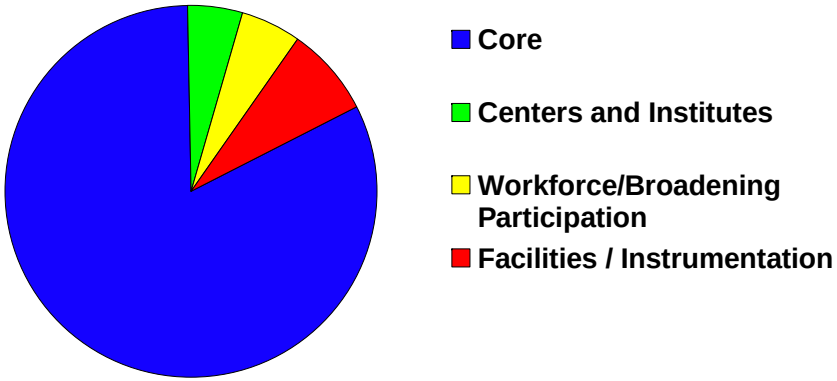
- Chemical Synthesis
- Chemical Structure, Dynamics, and Mechanisms
- Theory, Models, and Computational Methods
- Chemical Measurement and Imaging

Integrative Chemistry Activities

- Centers
- Education and Broadening Participation
- Facilities and Instrumentation

- Environmental Chemical Sciences
- Chemistry of Life Processes
- Chemical Catalysis
- Macromolecular, Supramolecular, and Nanochemistry

- Major CAREER and REU support
- Centers program growing
- Collaborations with NIH and DOE
- Critical areas of research for FY 2010: Energy, Element and Molecule Recycling, Designed Emergent Behavior, Imaging the Ultrasmall

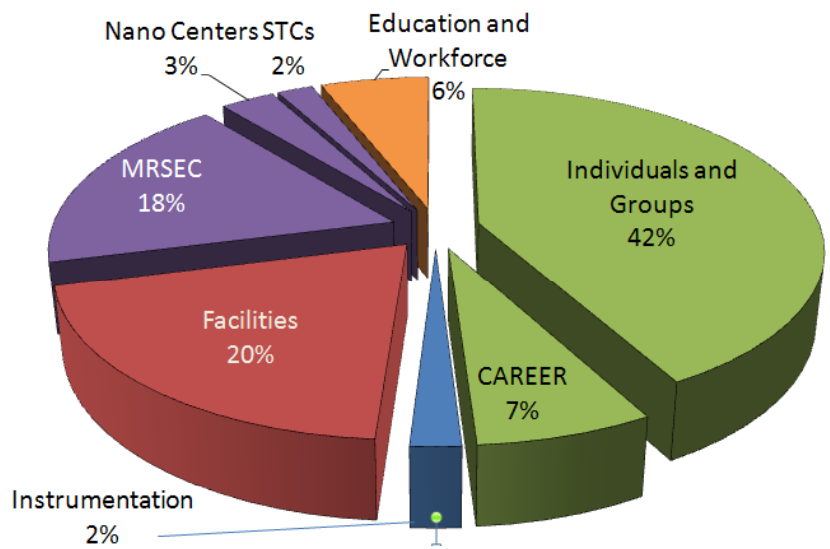


Materials Research (DMR)

DMR Programs:

- Ceramics, Electronic and Photonic Materials, Metals and Metallic Nanostructures
- Condensed Matter Physics, Condensed Matter and Materials Theory
- Biomaterials, Polymers, Solid-Sate and Materials Chemistry
- Materials Research Science and Engineering Centers
- National Facilities and Instrumentation
- Office of Special Programs (international collaboration; education)

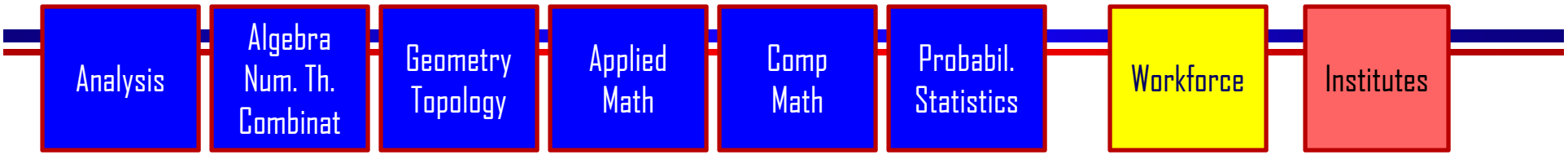
DMR supports a wide breadth of science – fundamental research to the development of technological applications.



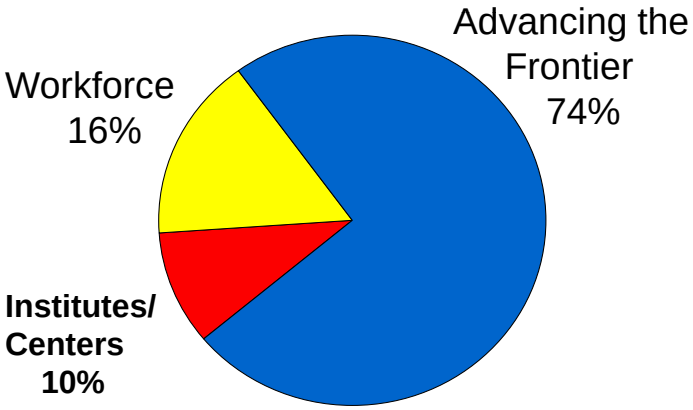
Key Research Areas for FY 2010:

» Environmental, energy, and economic sustainability
» Matter by design
» The quantum realm
» Physical-chemical-biological interfaces

Mathematical Sciences (DMS)



- "Core business:" single investigator and group proposals through targeted solicitations
  Covers the entire mathematical spectrum
- Institutes: 5 NSF-initiated, support for 3 others
  - » Visitors to long term programs, workshops
- Workforce: responding to a major challenge.
  - » EMSW21 training grants
  - » Postdoctoral fellowships
  - » Research for Undergraduates



In addition to the fundamental research in mathematical sciences, DMS plays an enabling role of all other sciences; DMS has been successful in partnering with other NSF Divisions and Directorates and with other government agencies.

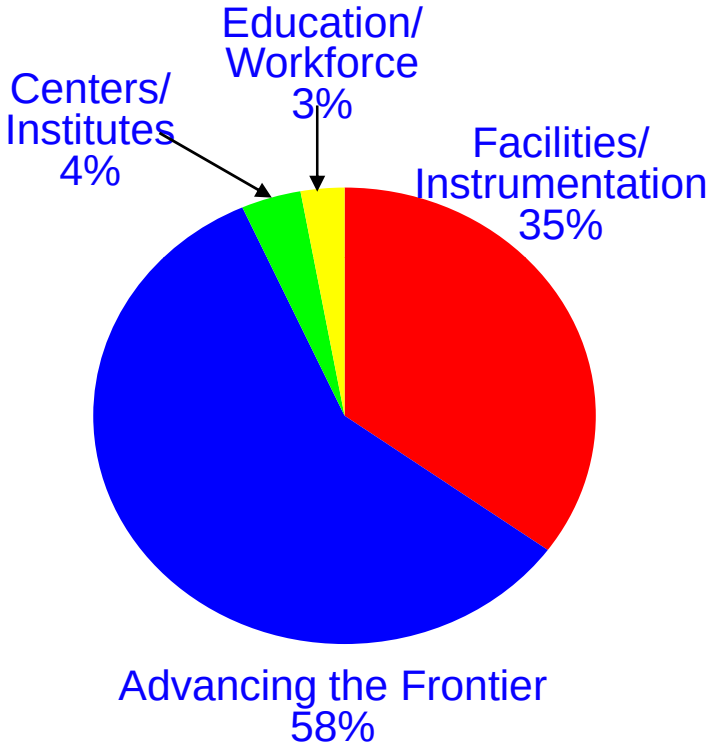
Physics (PHY)

Facilities:

LHC, LIGO, IceCube, NSCL, …

Programs:

- Atomic, Molecular, Optical, and Plasma Physics
- Biological Physics
- Elementary Particle Physics
- Gravitational Physics
- Nuclear Physics
- Particle and Nuclear Astrophysics
- Physics at the Information Frontier
- Physics Frontiers Centers
- Theoretical Physics
- Education and Interdisciplinary Programs



PHY collaborates closely with DOE and international partners to support science at large facilities. NSF's physics portfolio is more diverse than physics portfolios at any other federal agency.

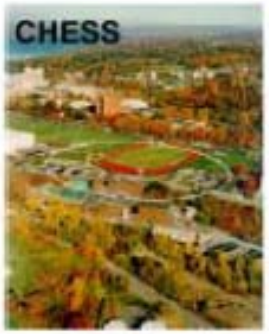
Office of Multidisciplinary Activities (OMA)

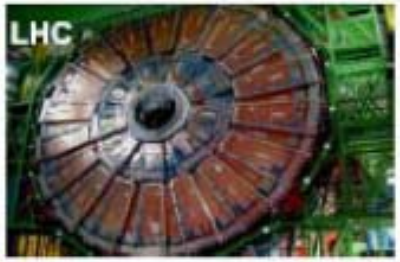
- Catalyzes cross-cutting research in areas of strategic emphasis in MPS, as well as areas that may emerge as strategic
- Facilitates partnerships with other agencies, industries, state and local governments, and international organizations
- Supports innovative experiments in education and broadening participation

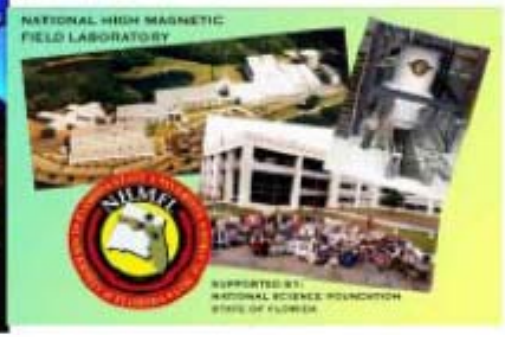
OMA neither receives nor reviews proposals; rather, OMA co-invests with MPS Divisions

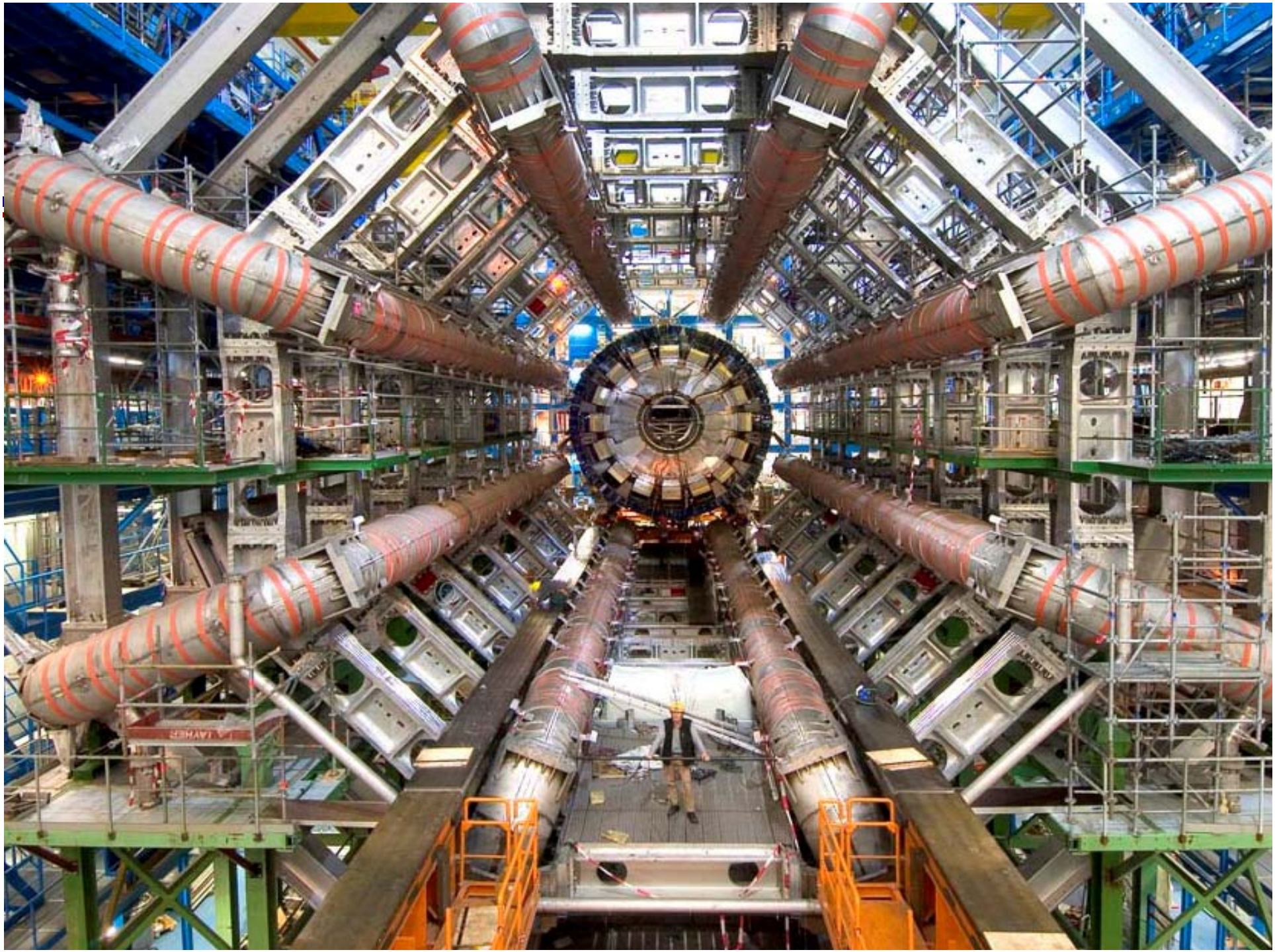
World Class Major Facilities

Keep University Researchers at the Frontier





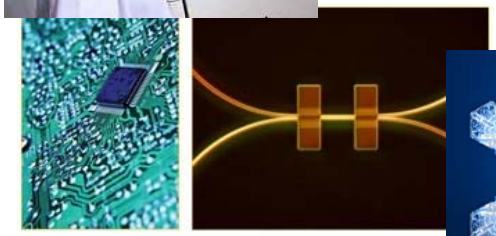


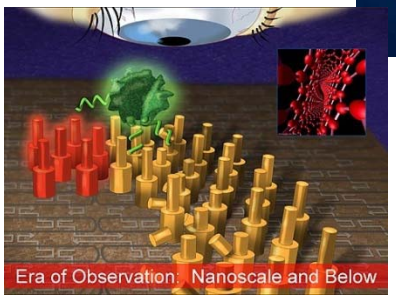


Merit Review Criteria

Merit Review Criteria: Intellectual Merit

- How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields?
- How well qualified is the proposer (individual or team) to conduct the project?
- To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts?
- How well conceived and organized is the proposed activity?
- Is there sufficient access to resources?





Merit Review Criteria: Broader Impacts

- How well does the activity advance discovery and understanding while **promoting teaching, training, and learning**?
- How well does the proposed activity broaden the participation of **underrepresented groups**?
- To what extent will it enhance the **infrastructure** for research and education, such as facilities, instrumentation, networks, and partnerships?
- Will the **results be disseminated** broadly to enhance scientific and technological understanding?
- What may be the benefits of the proposed activity to **society**?

Solicitations

Merit Review Criteria

Intellectual Merit

Broader Impacts

+

Solicitation Specific Criteria

What Makes a Strong Proposal?

- New and original ideas (what?)
- Sound, succinct, detailed focused plan (how?)
- Preliminary data and/or feasibility calculations
- Relevant experience (why me/us?)
- Clarity concerning future direction (so what?)
- Well-articulated broader impacts

NSF Proposal Preparation

- Read the funding opportunity (program descriptions, solicitations) carefully, and ask an NSF Program Director for clarifications if needed
- Contact the Program Director(s) to discuss your project: email with 1-2 page description and questions, call, visit
- Be familiar with programs and funded projects
  - Guide to Program:
    http://www.nsf.gov/funding/browse_all_funding.jsp
  - Award information, including abstracts:
    http://www.nsf.gov/awardsearch
- Know the audience for your proposal's review - it is a competition!

NSF Proposal Submission

- Know and follow the ***current*** Grant Proposal Guide (GPG) - it changes! (data management, postdoc mentoring, …)
- ***Explicitly*** address Intellectual Merit and Broader Impacts in both the Project Summary and Project Description
- Match and justify the budget to the scope of the proposed work - ask for what you need
- Submit proposals before the last day/hour
- Download your completed proposal back to you to check it's what you sent

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National Science Foundation
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Funding Opportunities
Find Funding Opportunities
Upcoming Due Dates
How to Prepare Your Proposal
Funding Trends
Program Areas
Select One
Quick Links
Select One
Search Funding Opportunities
Special Notices
NSF is currently accepting nominations for the 2011 Alan T. Waterman Award (deadline: October 30, 2010)
NSB is currently accepting nominations for the 2011 Vannevar Bush Award and the 2011 NSB Public Service Award (Deadline: November 3, 2010)
NSF Information Related to the American Recovery and Reinvestment Act of 2009
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Released September 23, 2010
Press Release
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NSF at a Glance
News
For the News Media
Special Reports
Discoveries from NSF Research
Research Overviews
Speeches & Lectures

Get Involved

- Proposals: Send your best ideas to NSF
- Reviewers and panelists: Create an informative web site and update it at least once a year
- Workshop participants and organizers
- Rotators

For information on a particular MPS division and program, go to the following web address and pick a Division:

http://www.nsf.gov/home/mps

Contact NSF Program Directors for questions & suggestions

Some Useful Web Sites

- NSF: www.nsf.gov
- MPS: http://www.nsf.gov/home/mps
- Guide to Program: http://www.nsf.gov/funding/browse_all_funding.jsp
- Award information: http://www.nsf.gov/awardsearch
- FastLane: https://www.fastlane.nsf.gov
- Broader impacts: http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf
- Data management plan: http://www.nsf.gov/bfa/dias/policy/dmp.jsp
- CAREER: http://www.nsf.gov/CAREER

Contact Information

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- Division of Chemistry: 703-292-8840
- Division of Materials Research: 703-292-8810
- Division of Mathematical Sciences: 703-292-8870
- Division of Physics: 703-292-8890