Perspective from the National Science Foundation

Community Summer Study 2013
July 29, 2013

Jean Cottam-Allen, Keith Dienes
Saul Gonzalez, Randy Ruchti
Jim Whitmore
Program Directors, Physics Division, NSF

Outline

- NSF mission
- Division of Physics
- Particle physics at the NSF
- Budgets and outlook
- Comments on Snowmass 2013

NSF Perspective

- NSF Mission: "*to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes*"
  - Empowering university-based investigators
  - Educating and training an exceptional and diverse scientific workforce
  - Adding value through partnerships and broadening participation
- Program Coordination and Execution
  - Programs are coordinated with other U.S. and non-U.S. agencies and organizations
  - We solicit advice on scientific issues and strategic direction from advisory committees such as HEPAP, AAAC, NSAC, National Academy of Sciences, etc.
- The way we work: We fund grant proposals, evaluating them through intrinsic and comparative peer review according to the criteria:
  - What is the Intellectual Merit?
  - What are the Broader Impacts?
- We aim to fund the most compelling scientific research, education, and outreach activities – without preconceived preferences on direction
  - Programs evolve <u>organically</u> as scientific fields evolve and as new scientific opportunities emerge
  - "Proposal pressure" and cross-pollination with other NSF programs are also key elements

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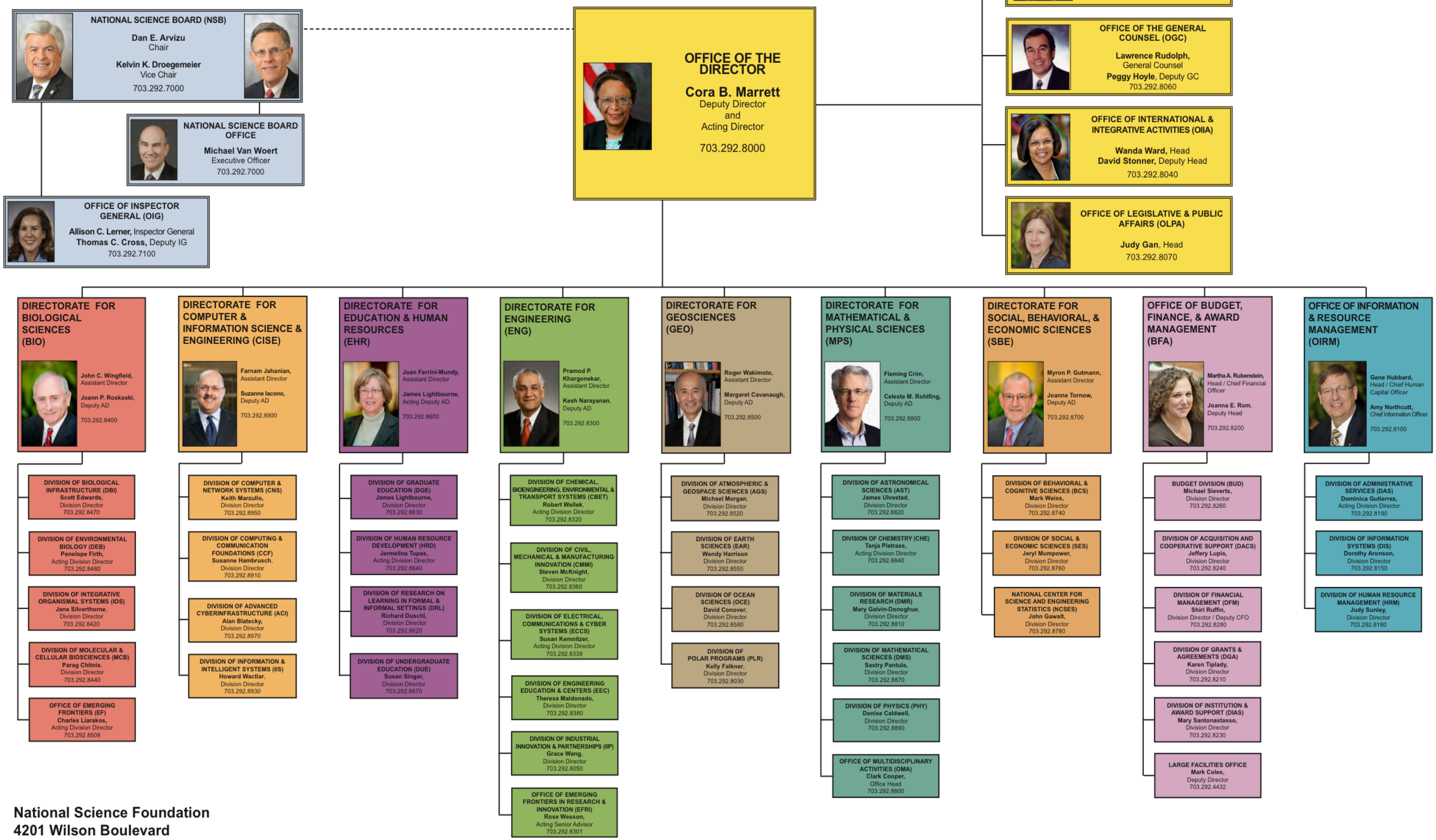

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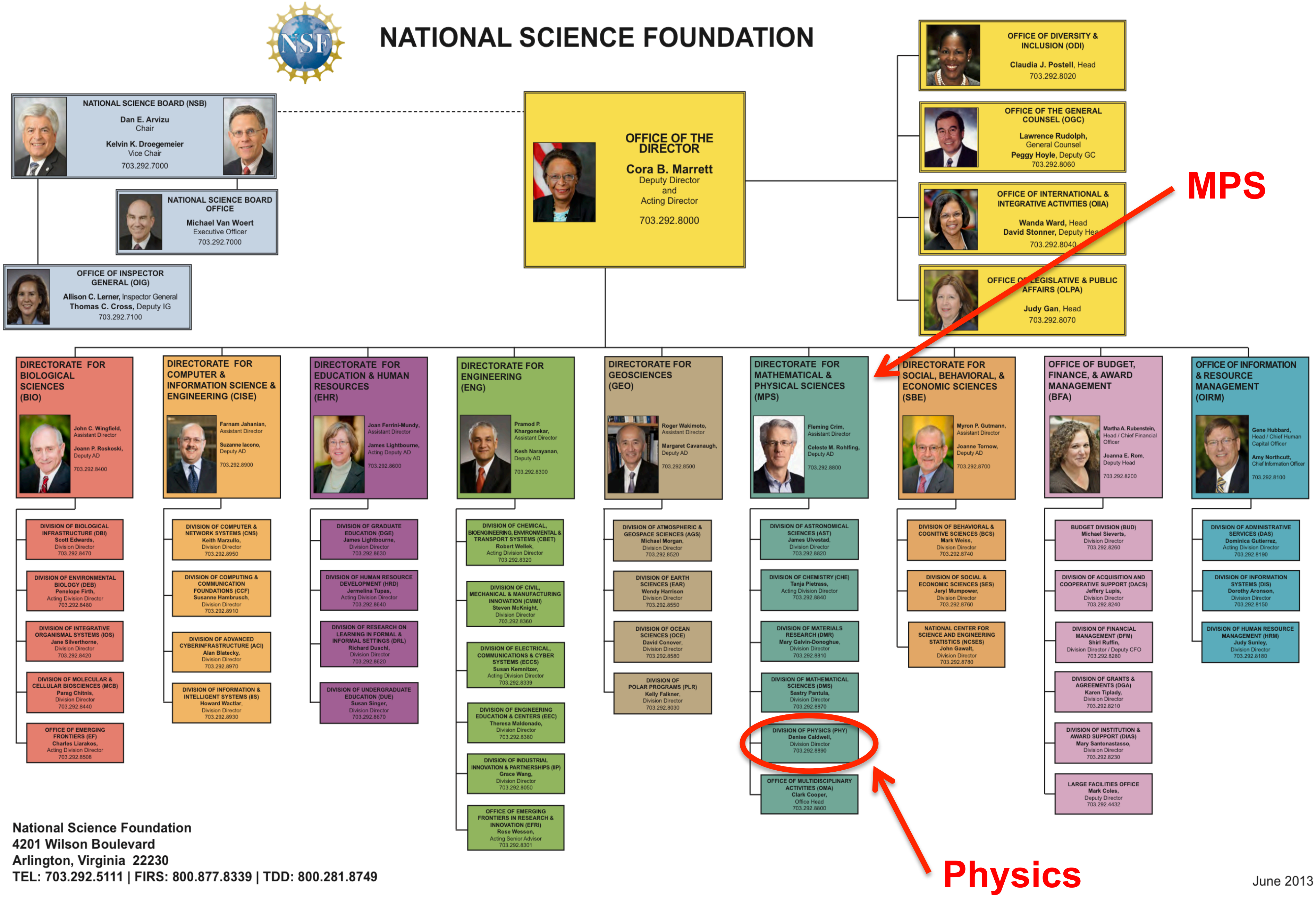
June 2013



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Division of Physics

Denise Caldwell
Director

Jim Whitmore
Deputy Director (Acting)

Facilities

- **Large Hadron Collider** — *Saul Gonzalez*
- **IceCube** — *Jim Whitmore*
- **LIGO** — *Mark Coles*
- **NSCL** — *Brad Keister*, *Gail Dodge*

Experiment

- **Atomic, Molecular, Optical, and Plasma** — *Siu Au Lee*, *Steve Gitomer*
- **Elementary Particle Physics** — *Saul Gonzalez*, *Randy Ruchti*
- **Particle Astrophysics** — *Jean Cottam-Allen*, *Jim Whitmore*
- **Gravitational Physics** — *Mark Coles*, *Pedro Marronetti*
- **Nuclear Physics** — *Brad Keister*, *Gail Dodge*
- **Physics of Living Systems** — *Krastan Blagoev*
- **Accelerator Science** — *Saul Gonzalez*

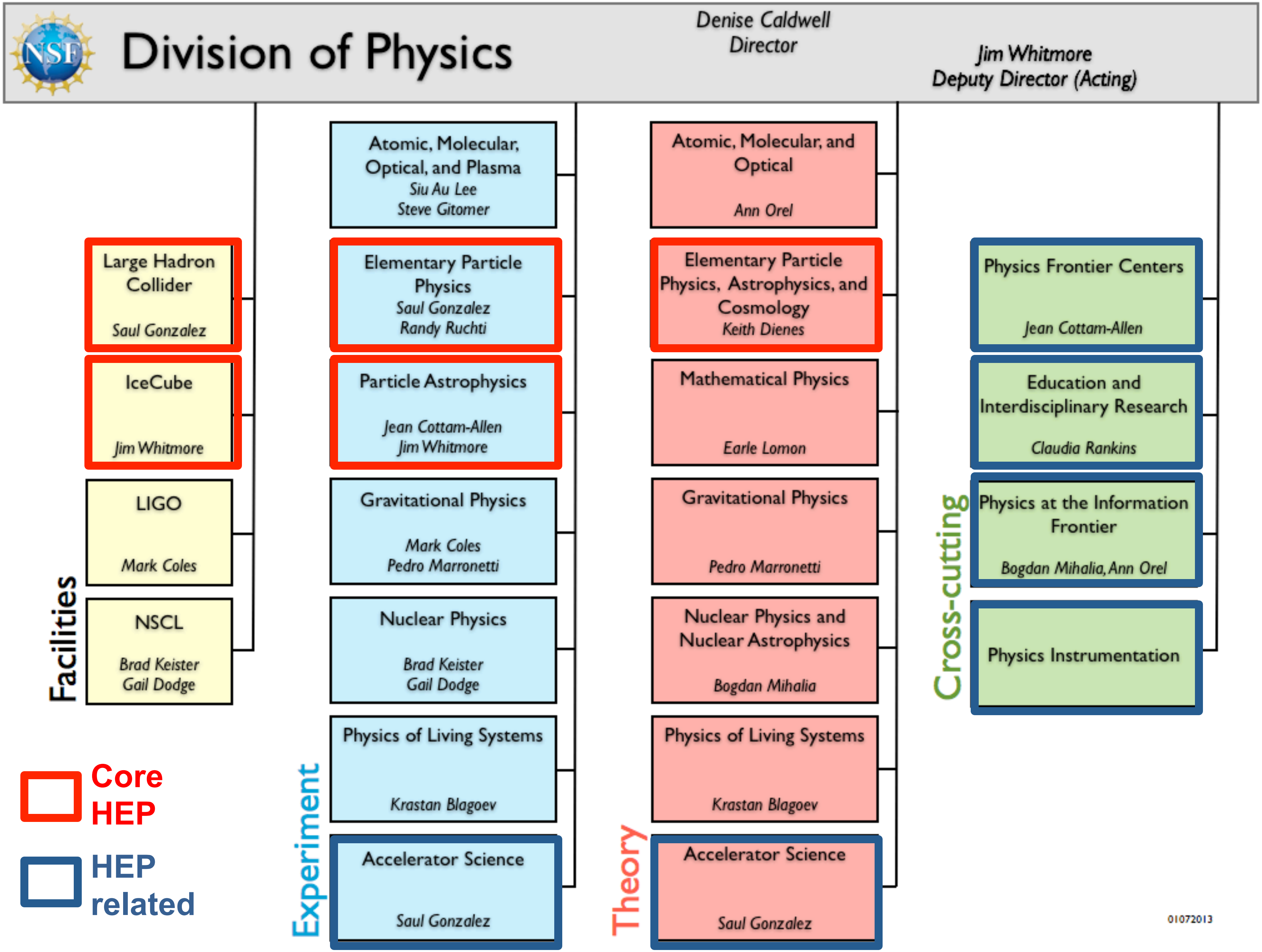
Theory

- **Atomic, Molecular, and Optical** — *Ann Orel*
- **Elementary Particle Physics, Astrophysics, and Cosmology** — *Keith Dienes*
- **Mathematical Physics** — *Earle Lomon*
- **Gravitational Physics** — *Pedro Marronetti*
- **Nuclear Physics and Nuclear Astrophysics** — *Bogdan Mihalia*
- **Physics of Living Systems** — *Krastan Blagoev*
- **Accelerator Science** — *Saul Gonzalez*

Cross-cutting

- **Physics Frontier Centers** — *Jean Cottam-Allen*
- **Education and Interdisciplinary Research** — *Claudia Rankins*
- **Physics at the Information Frontier** — *Bogdan Mihalia, Ann Orel*
- **Physics Instrumentation**

01072013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Physics Instrumentation
Core HEP
HEP related
01072013

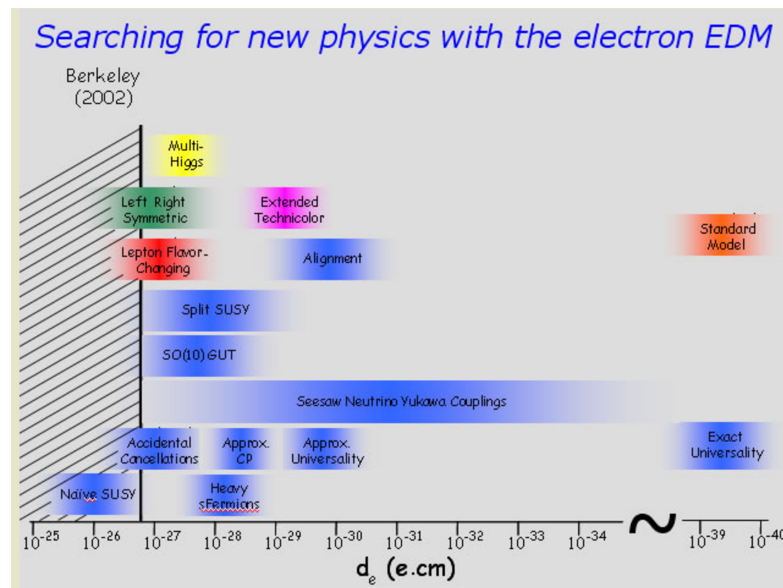
Physics Division: Symmetries

- Test of fundamental theories
  - CPT symmetry
  - Lorentz invariance
  - New physics
- Develop new AMO methodology
  - Clocks, cold atoms and molecules
  - Lasers and optics
  - Ultrasensitive detection

ATRAP
Trapped Antihydrogen and antiproton expt at CERN

Gabrielse (Harvard)

South pole Lorentz invariance test

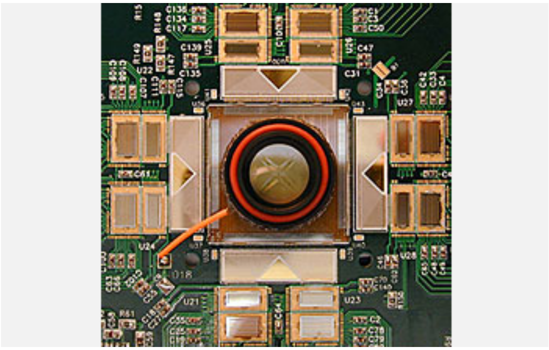


Predicted electron electric dipole moments (compiled by D. DeMille)

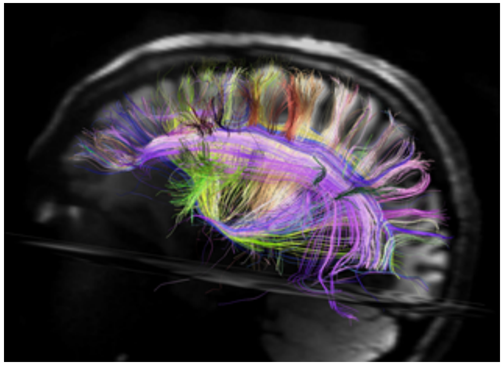
Physics Division: Living Systems

Physics of Living Systems addresses Fundamental Question: Life

Apply Physics approaches to biological problems



Analysis of optical signals from mammalian retina leads to discovery of new light processing unit – Litke et al., UCSC



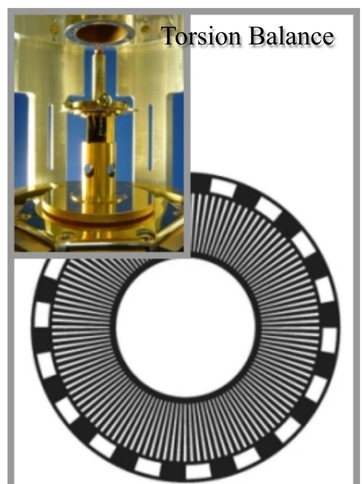
Diffusion MRI reveals layers within brain as opposed to spaghetti-like structure – Van Weeden, Stanley, MGH, BU

Physics Division: Gravitational Physics

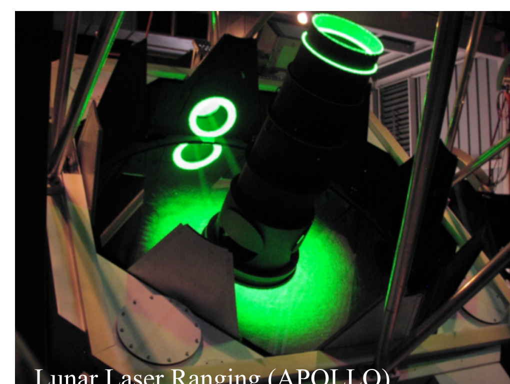
LIGO Scientific Collaboration

- 942 researchers world-wide in 17 countries.
- 528 investigators in the US.
- All GW Observatories: 1488 researchers.

Short Range Experiments
(10's microns)
- Deviations from $1/r^2$ law
- Weak Equivalence Principle
- Lorentz symmetry violations



Long Range Experiments
- Lunar laser ranging

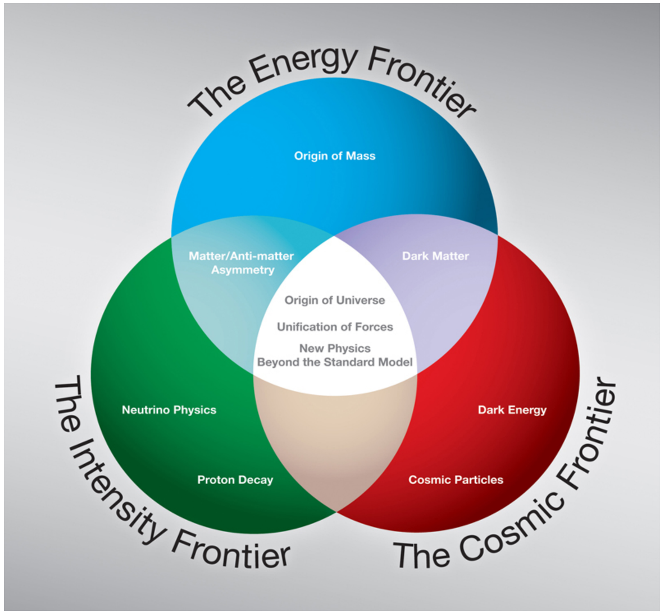


Particle Physics at the NSF

Programs: Elementary Particle Physics (EPP); Particle Astrophysics (PA); Particle Theory, Cosmology (Theory)

- Scientific Frontiers:
  - Energy Frontier – EPP, Theory
  - Intensity Frontier – EPP, PA, Theory
  - Cosmic Frontier – PA, Theory

- Applications and Broader Impacts:
  - Detector R&D
  - Computing / Data
  - Accelerator Science, R&D
  - Education and Outreach



Features of HEP Program at the NSF

Supported Personnel	Theory	EPP	PA	TOTAL
Awards	104	60	134	298
Senior investigators	186	181	63	430
Postdocs	50	104	64	218
Graduate Students	50	176	127	353

- Approximate numbers for FY 2012
- Distributed over many types of universities, including research, undergraduate, minority-serving, etc.

- People chase the best science, wherever it might be (US, Europe, Japan, China, Canada, Antarctic…)
- While majority of work is typically carried out at the home institution, many facilities are outside the U.S.

US-based physicists working on US/non-US facilities	Domestic	Abroad
Theory	100%	0%
Elem. Particle Physics	45%	55%
Particle Astrophysics	52%	48%
TOTAL	59%	41%

New in FY 2014: Accelerator Science

- The acceleration and control of charged particle beams are essential tools for discovery science within the Physics Division: from high to low energy beams, high intensity sources for secondary or tertiary beams (e.g., neutrinos), nuclear physics, nuclear astrophysics
- We are starting an accelerator science program with the goal of enabling fundamental discoveries and train students and postdocs across disciplinary boundaries
  - Program Description *PD 13-7243*
  - http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504937
  - Proposal target date: November 29, 2013
- Broader impacts are significant: industrial applications, medical applications, homeland security, light sources
- Program will likely focus on transformational developments that are likely to come from curiosity-driven research with strong interdisciplinary links
- Program will evolve with the community as new challenges are identified

Budgets

NSF MPS Budget

National Science Foundation
Funding Summary Table

(Dollars in Millions)

NSF by Account	FY 2012 Actual	Δ	FY 2013 Enacted	Δ	FY 2014 Request
BIO	$712.28	-4.7%	$678.93	12.0%	$760.58
CISE	937.16	-8.4%	858.53	10.7%	950.25
ENG	824.55	-1.3%	813.54	12.0%	911.10
GEO	1,321.37	-4.2%	1,265.84	10.1%	1,393.86
MPS	**1,308.70**	**-4.5%**	**1,249.50**	**10.9%**	**1,386.12**
SBE	254.19	-4.6%	242.51	12.3%	272.35
IIA	398.60	8.7%	433.47	23.8%	536.62
US ARCTIC RESEARCH COMMISSION	1.45	-4.1%	1.39	0.4%	1.40
Research & Related Activities	$5,758.30	-3.7%	$5,543.71	12.1%	$6,212.27
Education & Human Resources	$830.54	0.3%	$833.31	5.6%	$880.29
Major Research Equipment & Facilities Construction	$198.08	-1.0%	$196.17	7.1%	$210.12
Agency Operations & Award Management	$299.30	-1.9%	$293.60	3.6%	$304.29
National Science Board	$4.37	-5.7%	$4.12	8.5%	$4.47
Office of Inspector General	$14.82	-11.0%	$13.19	8.6%	$14.32
Total, NSF	$7,105.41	-3.1%	$6,884.10	10.8%	$7,625.76

MPS

Totals may not add due to rounding.
In FY 2013, a realignment of offices previously under the Office of the Director was implemented: the Office of Cyberinfrastructure (OCI) is now the Advanced Cyberinfrastructure (ACI) division in the Directorate for Computer and Information Science and Engineering (CISE); the Office of Polar Programs (OPP) is now the Division of Polar Programs (PLR) in the Directorate for Geosciences (GEO); and the Office of International Science and Engineering (OISE) has been merged with Integrative Activities (IA) to form International and Integrative Activities (IIA).

MPS PHY Budget

Physics Division

Mathematical and Physical Sciences (MPS) Funding

(Dollars in Millions)

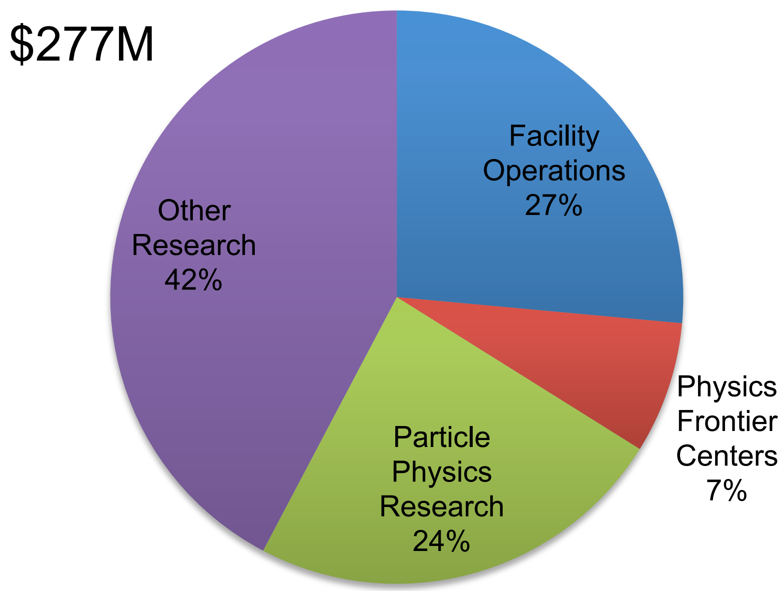
	FY 2012 Actual	Δ	FY 2013 Enacted	Δ	FY 2014 Request
Division of Astronomical Sciences (AST)	$234.72	-0.9%	$232.52	4.8%	$243.64
Division of Chemistry (CHE)	234.03	-2.2%	228.97	10.8%	253.65
Division of Materials Research (DMR)	294.40	-1.2%	290.74	8.2%	314.63
Division of Mathematical Sciences (DMS)	237.72	-7.8%	219.19	11.6%	244.54
Division of Physics (PHY)	**277.44**	**-9.6%**	**250.72**	**15.3%**	**289.02**
Office of Multidisciplinary Activities (OMA)	30.37	-9.9%	27.36	48.5%	40.64
Total, MPS	$1,308.70	-4.5%	$1,249.50	10.9%	$1,386.12

Totals may not add due to rounding.

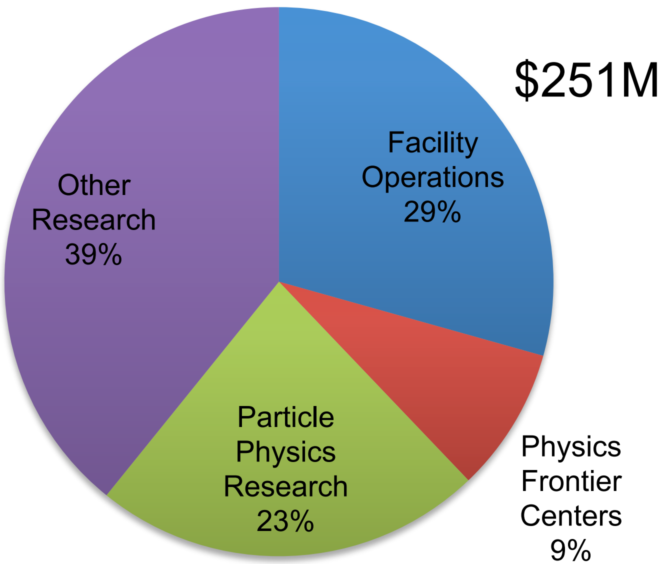
FY 2013 Reduction of -9.6% has serious impacts

FY 2013 Impacts

FY 2012 (by activity)



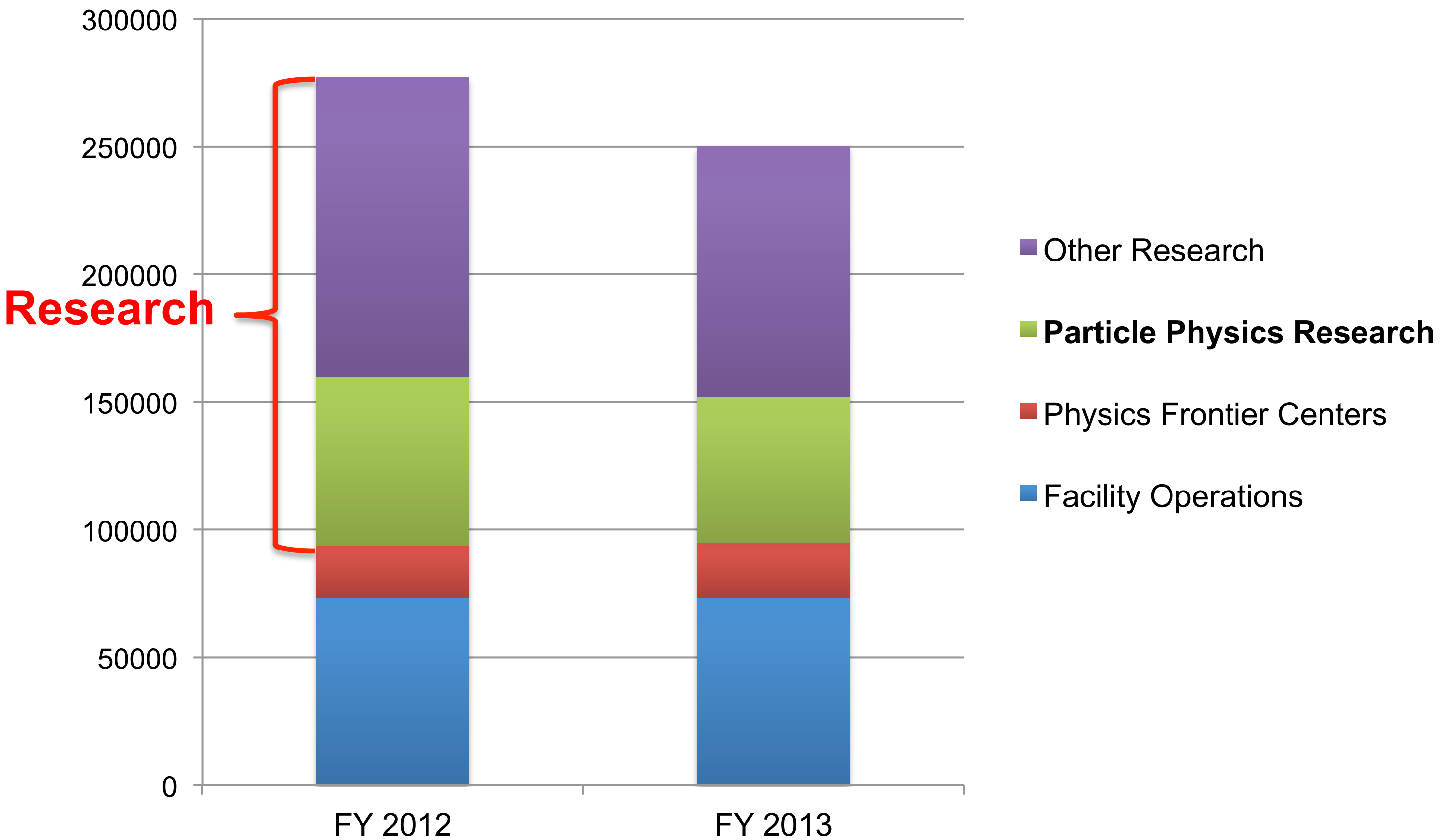
FY 2013 (by activity)



Instructed to protect ongoing commitments, including facilities

Biggest impact on research grants: approximately -12%

FY 2013 Impacts / 2



Impact in FY 2013:
Fewer awards, less faculty, postdocs, students supported

Particle Physics Funding - Details

(in M$)	FY 2008 Actuals	FY 2009 Omnibus	FY 2009 ARRA	FY 2010 Actual	FY 2011 Actual	FY 2012 Actual	FY 2013 Estimate
EPP Research	20.5	18.8	14.0	25.8	25.0	24.7	21.7
LHC Ops	18.0	18.0		18.0	18.0	18.0	18.0
CESR	13.7	8.5	1.3				
Accel/Instrumentation	4.0	2.2		3.0	4.1	11.9	4.5
Particle Astrophysics	15.8	15.9	15.3	17.9	9.7	11.5	10.4
IceCube Ops	1.5	2.2		2.2	3.5	3.5	3.5
DUSEL Planning	2.0	22.0		28.9	10.2		3.2
Underground R&D	5.0	4.0	5.6	4.6	6.0	11.0	3.4
Underground Physics					8.4	6.3	5.5
THY (EPP/Astro/Cosmo	11.7	12.0	6.8	13.2	14.1	13.6	12.1
Physics Frontier Centers	6.3	5.9		5.9	6.0	6.0	6.0
TOTAL Particle Physics	98.4	109.5	43.0	119.4	104.9	106.4	88.4
TOTAL Physics Divisior	285.0	275.5	102.1	307.8	280.3	277.4	250.7
% of Physics Division	34.5%	39.7%	42.1%	38.8%	37.4%	38.4%	35.2%
Allied Funding	7.2	4.9	0.5	12.7	12.3	24.7	20.8
Effective Total	105.5	114.4	43.5	132.1	117.2	131.1	109.2

Allied Funding

There is Hope

While the budget climate is not favorable at the moment, the science questions are more compelling than ever. We are therefore:

- Coordinating with DOE on Generation-II DM experiments
- Planning LHC Phase I Upgrades
- Working with DOE and CERN on the next phase of the DOE-NSF-CERN agreement
- Starting an Accelerator Science Program
- Continuing to seek new opportunities and partnerships for funding within and outside the NSF

Comments on Snowmass 2013

NSF view of Snowmass 2013

Captured in two "Dear Colleague" letters by DOE (Siegrist) and NSF (Crim)

Key elements:

- "*The DPF-led Snowmass process has been established to identify compelling science opportunities over an approximately 20 year time frame.*" → Science

- "*Make statements about the sense of the community regarding the importance and impact of these future concepts.*" Evaluate "*the extent to which each proposed project would address the most important scientific questions, and whether there are other ways to answer these questions*"

  → Make scientific judgments, look at alternative methods.

- Identify "*areas which need additional research and/or technology R&D*"

- Engage "*the entire US community in developing a common vision*"

  → As much as possible organize a common vision. Differing opinions may be expressed.

Letters to the community

"It is important to remember that ***P5 is expected to take the science vision of the HEP community and, together with agency-provided budget profiles, turn that vision into a plan*** that is both rich in scientific opportunities and executable over a 10 to 20 year timescale. We strongly encourage you to engage in the planning process through the ongoing DPF/Snowmass exercise and by providing input when requested by HEPAP. HEPAP/P5 is the primary mechanism that the agencies have for seeking advice from the scientific community. Broad community participation is essential for developing a long-range plan that captures a ***shared science vision that can be feasibly implemented***."

James Siegrist
Associate Director for High Energy Physics
DOE Office of Science

F. Fleming Crim
Assistant Director for Mathematical and Physical Sciences
National Science Foundation

DOE/NSF Programmatic Input
Community Science Input
→ HEPAP/P5 → (Strategic Plan) → DOE/NSF → (Implementation) → ?

NSF’s View of a Successful Snowmass

- A survey of the state of particle physics *science*
  - The compelling physics opportunities, accompanied by crisp arguments
  - In the U.S. and in the global context
  - Are there other ways to answer the questions?
- We do not expect a consensus, but we do hope for everyone to make a constructive case for the science
- This is the community’s voice. HEPAP and P5 will sort out *what we need and can afford* from *what we want* in order to address the important science questions

Final Comments

- We are in the midst of very challenging budgetary climate
- We must plan, focus, and coordinate resources on excellent science with well-defined goals and potential impact
- Past planning is important – we must keep it in mind and chart a rational, defensible path to new opportunities
- Communication is essential to success, including the broader scientific community
- We wish you well as you bring this important exercise to a conclusion
- The NSF is watching with great interest and will continue to engage in all phases of the planning process

- Other NSF Program Directors Attending Snowmass: Keith Dienes, Randy Ruchti, Jim Whitmore – we're happy to continue the conversation offline

Additional Material

Managing Expectations

- U.S. budgetary climate for fundamental research is very challenging
  - And a lot of competition for research funding
- For the most part, we are not aligned with the National Priorities (climate, energy, etc.)
  - But priorities change – we must be ready
- There is a community-driven roadmap
  - Any significant deviation from this roadmap needs to be very carefully considered
  - Maintaining credibility of the planning process is important
- Problem of long timescales for projects in the field
- Geography – how to tie to other regions' plans and make them relevant for the U.S.?

Beyond Snowmass

- Funding
  - Need crisp science arguments
  - Need to focus on what is needed to advance the science
  - Seek new partnerships and opportunities
- National Priorities
  - Show relevance and mid-term impacts
  - Articulate broader societal impacts
  - Make alliances with other scientific disciplines
- Planning process
  - Focus on the most important science questions
  - New investments should have well-defined science milestones
- Articulate the Return on Investment
  - What is the added value in terms of science if we build “X”? (even for upgrades!)
  - What is the added value in terms of broader impacts to society?
- All of the above need: Effective Communication