

# NSF Elementary Particle Physics and Accelerator Science

Jim Shank, NSF Program Director  
(Mark Coles, Randy Ruchti, Saul Gonzalez)

US LHC Users Association

ANL

13-14 November, 2014

# Overview

- NSF Organization
- Overall NSF Budget
- Some notes on Proposal preparation
- Mid-Scale Projects
- Recent EPP funding
- The New MPS/PHY/Accelerator Science Program
- The MPS Advisory Committee subpanel to explore NSF response to the P5 report.

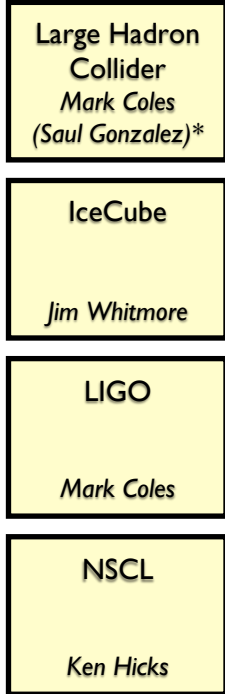


# Division of Physics

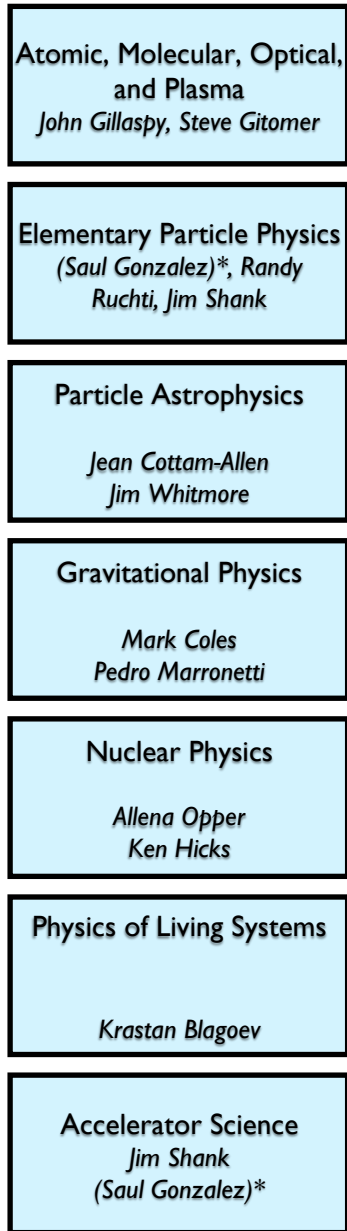
**Denise Caldwell**  
Director

**Brad Keister**  
Deputy Director

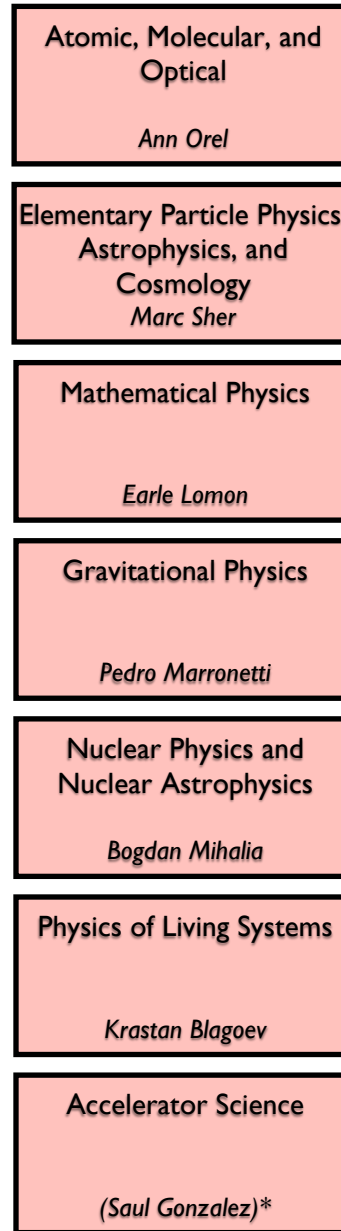
Facilities



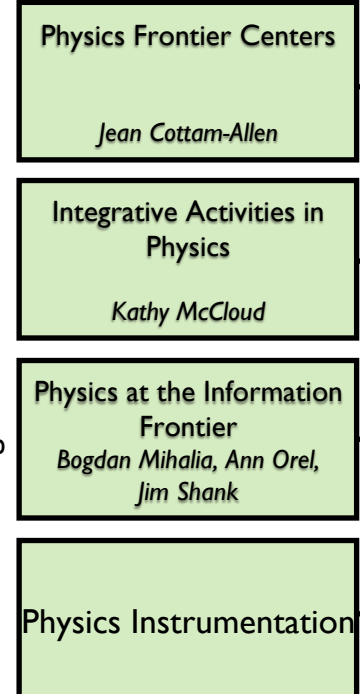
Experiment



Theory



Cross-cutting



\* On Detail at OSTP 11/05/2014



# Division of Physics

**Denise Caldwell**  
Director

**Brad Keister**  
Deputy Director



Facilities

Large Hadron Collider  
Mark Coles  
(Saul Gonzalez)\*

IceCube  
Jim Whitmore

LIGO  
Mark Coles

NSCL  
Ken Hicks

-  Core Particle Physics
-  Particle Physics Related

Experiment

Atomic, Molecular, Optical, and Plasma  
John Gillaspy, Steve Gitomer

Elementary Particle Physics  
(Saul Gonzalez)\*, Randy Ruchti, Jim Shank

Particle Astrophysics  
Jean Cottam-Allen  
Jim Whitmore

Gravitational Physics  
Mark Coles  
Pedro Marronetti

Nuclear Physics  
Allena Opper  
Ken Hicks

Physics of Living Systems  
Krastan Blagoev

Accelerator Science  
Jim Shank  
(Saul Gonzalez)\*

Theory

Atomic, Molecular, and Optical  
Ann Orel

Elementary Particle Physics, Astrophysics, and Cosmology  
Marc Sher

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

Integrative Activities in Physics  
Kathy McCloud

Physics at the Information Frontier  
Bogdan Mihalia, Ann Orel, Jim Shank

Physics Instrumentation

\* On Detail at OSTP 11/05/2014



## Particle Physics Program Staffing

- Incoming:
  - New Program Director in EPP – B. Meadows, Nov 2014
  - New Program Director in THY – K. Dienes, Jan 2015
- Outgoing:
  - EPP Program Director – R. Ruchti, Oct 10, 2014
  - THY Program Director – M. Sher, Jan 24, 2015
- Continuing:
  - EPP Program Director – J. Shank
  - PA Program Director – J. Whitmore
  - PA Program Director – J. Cottam
- On Detail:
  - To OSTP – S. Gonzalez, Sept 2014-2015
- On Facilities:
  - PHY Science Advisor – M. Coles, Sept 2014

# NSF Statistics



Physics Division

- Research and Related Activities

	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
	Actual	Actual	Actual	Actual	Estimate	<b>Request</b>
NSF Total	\$6,926	\$6,860	\$7,033	\$6,902	\$7,172	<b>\$7,255</b>
R&RA (req)	\$5,733	\$6,019	\$6,254	\$5,983	\$6,213	<b>\$5,807</b>
R&RA	\$5,615	\$5,564	\$5,719	\$5,559	\$5,809	<b>TBD</b>

Total includes agency operations  
Administration: ~2100 staff in Arlington, VA



- FY 2013:
  - Proposals received: 49,013
  - Proposals awarded: 10,844 (22%)



# NSF FY 2015 Budget Request

## R&RA Funding

(Dollars in Millions)

	FY 2013 Actual	FY 2014 Estimate	FY 2015 Request	Change over FY 2014 Estimate	
				Amount	Percent
Biological Sciences	\$679.21	\$721.27	\$708.52	-\$12.75	-1.8%
Computer & Information Science & Engineering	858.13	894.00	893.35	-0.65	-0.1%
Engineering	820.18	851.07	858.17	7.10	0.8%
Geosciences	1,273.77	1,303.03	1,304.39	1.36	0.1%
<b>Mathematical &amp; Physical Sciences</b>	<b>1,249.34</b>	<b>1,299.80</b>	<b>1,295.56</b>	<b>-4.24</b>	<b>-0.3%</b>
Social, Behavioral & Economic Sciences	242.62	256.85	272.20	15.35	6.0%
International and Integrative Activities	434.28	481.59	473.86	-7.73	-1.6%
U.S. Arctic Research Commission	1.39	1.30	1.41	0.11	8.1%
<b>Total, R&amp;RA</b>	<b>\$5,558.88</b>	<b>\$5,808.92</b>	<b>\$5,807.46</b>	<b>-\$1.46</b>	<b>-</b>



## FY 2015 PHY Funding Request

Under Negotiations with OMB/The Hill, etc. We still don't know our 2015 EPP budget.

### MPS Funding (Dollars in Millions)

	FY 2013	FY 2014	FY 2015	Change Over	
	Actual	Estimate	Request	FY 2014 Estimate Amount	Percent
Astronomical Sciences (AST)	\$232.17	\$239.06	\$236.24	-\$2.82	-1.2%
Chemistry (CHE)	229.39	235.79	237.23	1.44	0.6%
Materials Research (DMR)	291.09	298.01	298.99	0.98	0.3%
Mathematical Sciences (DMS)	219.02	225.64	224.40	-1.24	-0.5%
<b>Physics (PHY)</b>	<b>250.45</b>	<b>266.30</b>	<b>263.70</b>	<b>-2.60</b>	<b>-1.0%</b>
Office of Multidisciplinary Activities (OMA)	27.22	35.00	35.00	-	-
<b>Total, MPS</b>	<b>\$1,249.34</b>	<b>\$1,299.80</b>	<b>\$1,295.56</b>	<b>-\$4.24</b>	<b>-0.3%</b>





# PHY division proposal preparation

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- **NEW:** All proposals now go through a solicitation (14-576)
  - Not a Dear Colleague Letter
  - There are now multiple deadlines (not target dates)
    - EPP and PA – October 29, 2014
    - THY – December 4, 2014
    - Accelerator Science (AS) – February 4, 2015
  - There are additional requirements to be included in Current & Pending (or the Project Description)
    - Also: collaborators in Bio Sketches
      - Don't just list "ATLAS collaboration"
        - » List a subset that you work with directly
        - » Can be included in supplementary material so as not to fill up the Bio Sketch
  - The Grant Proposal Guide is occasionally updated
    - Old Timers: You need to read it again
    - Follow it to the letter, in particular, read:
      - "Results from Prior NSF Support", ([II.C.2.d.iii](#))
        - » This section has changed and many people are not following it correctly
          - Proposals could be returned without review
- [PHY Division solicitation](#)

# PHY Mid Scale Program

# Mid-Scale Instrumentation and Particle Physics

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One of the most critical needs of research projects funded through the Physics Division is that of having cutting-edge instrumentation that enables investigators to remain competitive in a rapidly-changing scientific environment.

- The Physics Division has established a Mid-Scale Instrumentation Fund.
  - [Dear Colleague Letter: Opportunity to Request Instrumentation Funding for Midscale Level Instrumentation in Physics Division](#)
  - This is not a separate program to which investigators can apply directly. PI's should request funding for specialized equipment as part of a regular proposal to a disciplinary program in the Division. The Program Officer can then request funds be provided through the Mid-Scale Instrumentation Fund.

# Background

- PHY midscale program was new in FY 2014
- Evolved from Accelerator Physics and Physics Instrumentation (APPI) program to meet community demand for midscale project funding
  - Total Project Cost > \$4M MRI cap and \$ < MREFC threshold (~\$130M)
  - New program includes well-defined budgetary and competitive selection process

# Features

- Selection based on merit review of unsolicited proposals representing exceptional opportunity and of high priority to research community
- Excludes:
  - planning and development funding for future midscale and MREFC candidates
  - O&M for facilities and funds for utilization of constructed/acquired infrastructure
  - educational outreach

# Status

- \$7.3M awarded in FY14
- \$8M requested in FY15
- Demand is much higher
  - Additional ~\$10M/yr over next 3 years, just for projects we already know about
  - Possibly +\$20M/yr looking out 5-10 years

# ALTAS Phase I Upgrade (NSF)

- 5 Year Cooperative Agreement started FY2014
- \$11.4 M Total. Original profile

FY14 (\$M)	FY15 (\$M)	FY16 (\$M)	FY17 (\$M)	FY17 (\$M)	Total (\$M)
2.4	2.85	3.2	2.75	0.2	11.4

- Lead Inst.: SUNY, StonyBrook
  - Sub-awards to
    - Columbia, Michigan State, Southern Methodist

# CMS Phase I Upgrade (NSF)

- 5 Year Cooperative Agreement started FY2014
- \$11.5 M Total. Original profile

FY14 (\$M)	FY15 (\$M)	FY16 (\$M)	FY17 (\$M)	FY17 (\$M)	Total (\$M)
2.55	3.0	2.7	2.18	1.09	11.5

- Lead Inst.: University of Nebraska, Lincoln
  - Sub-awards to
    - Cornell, Kansas, Northeastern, Purdue, Rutgers, SUNY Buffalo, U. of Illinois Chicago, Notre Dame



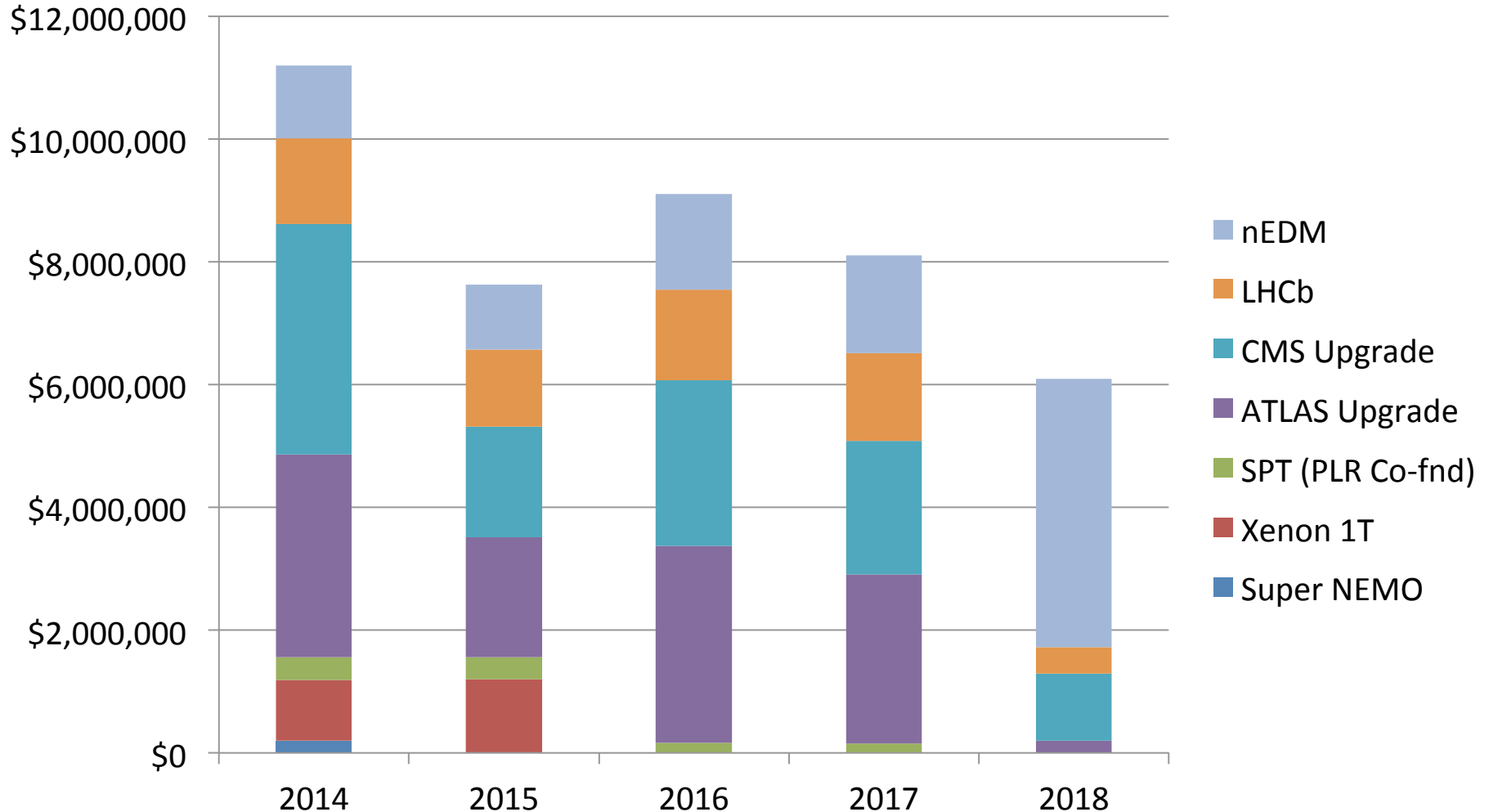
# LHCb Tracker Upgrade (NSF)

- Collaborative award to Syracuse University (lead)
  - Cincinnati, MIT, Maryland

FY14 (\$M)	FY15 (\$M)	FY16 (\$M)	FY17 (\$M)	FY17 (\$M)	Total (\$M)
1.16	1.49	1.48	1.43	0.44	6.0

# Funding profile of **current** PHY Mid Scale projects.

Does not include unapproved proposals which could start in this period.



# Particle Physics – Budgetary History FY08-FY14



Program Elements	Type	FY 2008 Actuals	FY 2009 Actuals	FY 2009 ARRA	FY 2010 Actuals	FY 2011 Actuals	FY 2012 Actuals	FY 2013 Actuals	FY 2014 Actuals
EPP Research	Base	20.5	18.8	14.0	25.8	25.0	24.7	21.8	18.7
LHC Ops	Operations	18.0	18.0		18.0	18.0	18.0	18.0	17.4
LHC Upgrades	Midscale								8.2
PA Research	Base	15.8	15.9	15.3	17.9	9.7	11.5	12.0	11.9
IceCube Ops	Operations	1.5	2.2		2.2	3.5	3.5	3.5	3.5
Underground Physics	Base					8.4	6.3	6.8	6.8
THY (EPP/Astro/Cosmo)	Base	11.7	12.0	6.8	13.2	14.1	13.6	12.1	12.1
CESR	CESR	13.7	8.5	1.3					
Accel/Instrumentation	APPI	4.0	2.2		3.0	4.1	11.9	4.5	
DUSEL Planning	DUSEL	2.0	22.0		28.9	10.2			
Underground R&D	DUSEL/APPI	5.0	4.0	5.6	4.6	6.0	11.0	3.9	
Accel Science									8.9
PFC		6.3	5.9		5.9	6.0	6.0	6.0	6.0
Allied Funding		7.2	4.9	0.5	12.7	12.3	24.7	20.8	12.9
<b>Total - Particle Physics</b>		<b>105.7</b>	<b>114.4</b>	<b>43.5</b>	<b>132.2</b>	<b>117.3</b>	<b>131.2</b>	<b>109.4</b>	<b>106.5</b>
<b>Total - Physics Division</b>		<b>285.0</b>	<b>275.5</b>	<b>102.1</b>	<b>307.8</b>	<b>280.3</b>	<b>277.4</b>	<b>247.4</b>	<b>260.0</b>



# Adding Value/Allied Funding

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- MRI
  - ATLAS (IBL, FTK, T3 Consortium, High Speed Datalinks)
  - LAr1ND, DarkLight-Phase 1, Plasma Mass Spectrometer, Muon g-2
  - LHCb/LIGO (High Throughput Computing)
  - LHCb/UT
- Scientific Computing
  - OSG
  - CONDOR
  - DASPOS
  - GPU/Multicore Architectures
- International (PIRE)
  - CMS Pixels
  - Data Intensive Computing
- Multidisciplinary Activity
  - AGEP
  - INSPIRE
- Education (Formal and Informal)
  - QuarkNet
  - Planetarium Show
  - IMAX Movie
  - Soudan Visitor Center

# Experimental Groupings in EPP

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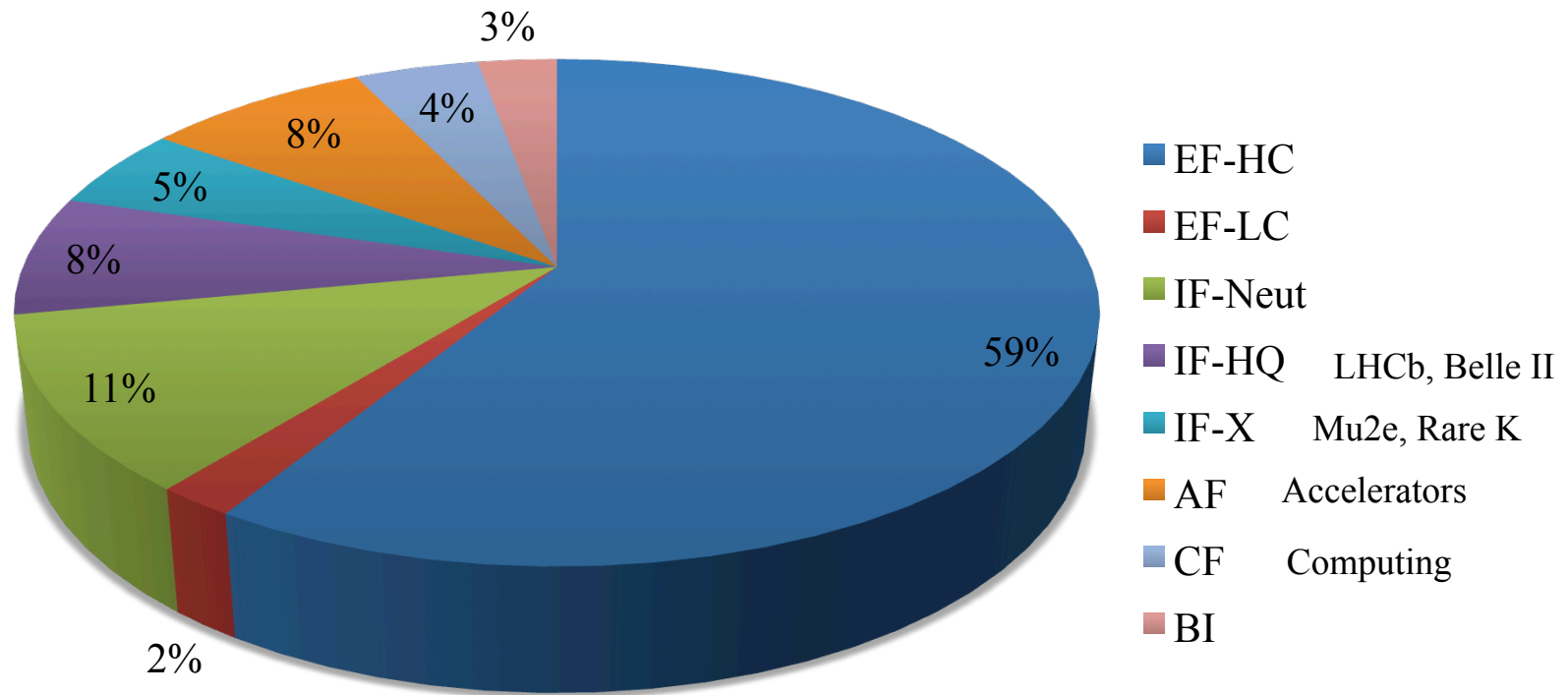


- ATLAS
- CMS
- LHCb
- Tevatron
- ILC
- LArIAT
- LAr1ND
- MicroBOONE
- Minerva
- MINOS, MINOS+
- NOvA
- DarkLight Phase-I (EHR)
- Electron EDM (AMO)
- Mu2e
- Muon g-2 (NP)
- Belle-II
- NA62 ( $K^+ \rightarrow \pi^+ \nu \nu$ )

# Program by PI Headcount (125 Total PIs)



## EPP Research By PI





## Major Research Instrumentation (MRI)

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- The Major Research Instrumentation Program (MRI) serves to increase access to shared scientific and engineering instruments for research and research training in our Nation's institutions of higher education, and not-for-profit museums, science centers and scientific/engineering research organizations.
- This program especially seeks to improve the quality and expand the scope of research and research training in science and engineering, by supporting proposals for shared instrumentation that fosters the integration of research and education in research-intensive learning environments. Two types.
  - Track (1) acquisition of a research instrument
  - Track (2) development of a research instrument.
- Proposals for \$100,000-\$4 million may be accepted from any MRI-eligible organization.
- Present Solicitation [15-504](#)
- [Deadline:](#) January 22, 2015.
- [http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=5260](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5260)
- Program Contact: Kathleen McCloud or EPP/PA program directors

# MRI Program – Impact in Particle Physics



- MRI Support has been significant to the various programs from FY08 – FY14, totaling \$26.3M
  - EPP related: \$15.9M
  - PA related: \$10M
  - Accelerator Science: \$2.4M
- In FY14 there were 3 MRI awards to Particle Physics totaling ~ \$2M.
  - Projects: LAr1ND, DarkLight Phase 1, Mass Spectrometry (mostly PA & NP)





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# PHY Accelerator Science Program



## NSF Perspective on Accelerator Science

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- 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
- 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 through research, and outreach activities – without preconceived preferences on direction
  - Programs evolve organically as scientific fields evolve and as new scientific opportunities emerge



## New in FY 2014: Accelerator Science

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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 have started an accelerator science program with the goal of enabling fundamental discoveries and train students and postdocs across disciplinary boundaries
  - Current Program Solicitation NSF 14-576: “Accelerator Science”
  - [http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=504937&org=PHY&from=home](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504937&org=PHY&from=home)
  - Program Contact: Jim Shank ([jshank@nsf.edu](mailto:jshank@nsf.edu))
- Broader impacts are significant: industrial applications, medical applications, homeland security, light sources
- Program focuses on transformational developments that are likely to come from curiosity-driven research with strong interdisciplinary link.
- Program will evolve with the community as new challenges are identified

In FY2014, a total of 60 proposals were received requesting ~ \$70M in funding. A dozen awards were made totaling \$8.9M. We look forward to FY15 for the next round of proposal submissions.



# Key Features of NSF Accelerator Science

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- Focus on fundamental science best done at universities
  - High risk, transformational, academic discipline
  - Cross-cutting with other disciplines
  - Can take place on campus or off campus (national lab, etc.)
- Workforce
  - Attract the best students/postdocs by tackling hard and interesting problems
- This program is NOT intended to be
  - Directed R&D towards a foreseen project or facility
  - Incremental improvement to an existing facility (unless it is proof of concept of a new idea)
  - “Supplement” to an existing DOE award or program (does not mean that NSF award will not be issued to DOE award recipient; scope must be different than DOE’s)
- [Accelerator Science NSF web page](#)
- Next solicitation deadline: Feb. 4, 2015
- Special thanks to LK Len, Department of Energy for help in getting this program started.

# Accelerator Science Program

- FY2014 Portfolio.

- 60 proposals, 52 projects (some proposals were collaborative)

- Request total

- \$70M

- 12 awards

- \$9M

	Amount	No. awards
	\$	
Beam Dynamics	520,397	2
Plasma	1,469,900	3
Sources	1,006,910	2
SRF	4,522,786	2
Education	700,000	1
Other	720,000	2
Total	8,939,993	12



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# MPS Directorate: Reaction to the P5 Report

# MPS Advisory Committee

- MPSAC
  - The Advisory Committee for Mathematical and Physical Sciences (MPSAC) provides advice and recommendations to the National Science Foundation's programs within the Directorate for Mathematical and Physical Sciences (MPS), addressing policies and directions MPS programs in science and education should follow; effective and efficient strategies for achieving overall program excellence; the appropriateness of current disciplinary boundaries; definition of the most effective investment strategies; and assessment of the success of the program and other appropriate aspects of program performance.
- P5 Report prompted PHY to call for a subcommittee of the MPSAC to advise on how to react to the report.

- The following slides are from Young-Kee Kim's presentation to the MPSAC on 4 November, 2014



# MPSAC Subcommittee on NSF Response to Strategic Plan for Particle Physics Membership

Marina Artuso

Frank Avignone

Patricia Burchat

Joel Butler

Marc Kamionkowski

Young-Kee Kim (chair)

Jay Marx

Luis Orozco

Bob Redwine

Hank Sobel

Syracuse University

University of South Carolina

Stanford University

Fermilab

Johns Hopkins University

University of Chicago

Caltech

University of Maryland

MIT

University of California, Irvine

# P5 Report

- Recommends a global program
  - with projects at all scales
  - from the largest international projects to mid- and small-scale projects
- Lists as the highest priority for large projects
  - LHC Phase 2 Upgrades in the near term
  - LBNF (Long Baseline Neutrino Facility) in its timeframe

# Charge to the subcommittee (1/2)

1. Based on the science drivers identified in the P5 report, how should the NSF target its investments in such a way that they maximize the NSF impact and visibility? Should the Physics Division target specific areas or should it invest broadly?
2. What criteria should the Physics Division use to balance support between small-scale, mid-scale and large projects?
3. How should the Division of Physics define a unique role in areas of common interest with DOE?

**The committee is not expected to revisit the P5 charge, priority, or conclusions, but to focus on the balance of NSF investments.**

# Charge to the subcommittee (2/2)

NSF is considering an investment in LHC Phase 2 Upgrades, ranging from the Midscale to the MREFC level, and Midscale investments in other scientific priority areas identified by P5. For this scenario:

4. Would proposed investments of this type best capture the strengths of NSF and result in NSF funding having a significant and identifiable impact in the field? What criteria should be used to determine whether or not the Physics Division should pursue this scenario?
5. What are the opportunity costs of such an investment strategy? Would required investments outside the MREFC budget line before, during, and after a construction project allow enough flexibility to respond to new, unforeseen particle physics opportunities? Is the balance between facility investments (pre-construction, construction, and operations and maintenance) and PI-driven research awards appropriate for particle physics at the NSF?

# Announcement to the particle physics community

- September 28
  - Denise Caldwell at the HEPAP meeting
- September 30
  - Subcommittee chair's message to APS Divisions
    - Particles & Fields, Physics of Beams, Astrophysics
  - Public web site
    - <http://p5response.uchicago.edu/>
    - Information about the subcommittee
    - Mechanism to receive feedback from the community

# Subcommittee meetings

- 5 teleconf. Meetings
  - ~2 hour long
  - NSF participants
    - Physics Division Director and Deputy Director
    - Program Directors
- Face-to-face meeting
  - November 1-2 in DC
- Plan to have weekly teleconf. meetings
  - November and December

# Next steps

- November 3, 2014
  - Status report at the November MPS AC meeting
- Weekly meetings
  - November and December
- Goals:
  - Produce a “polished” draft report by the end of December
  - Submit it to the MPS AC by early January 2015
- January 23, 2015
  - Report at the January MPS AC meeting
- We are on track to achieve the goals and the schedule

# Notice: PHY Division Director visit to CERN

- Denise Caldwell is visiting CERN 11-12 Dec.
- Meet with students/Postdocs in the afternoon of 11 Dec.
  - Just informal discussions—no presentations.