



U.S. DEPARTMENT OF
ENERGY

OFFICE OF
SCIENCE

Report from the Office of High Energy Physics

**LHC Users Organization Annual Meeting
October 30, 2010**

**Glen Crawford
Director, Research and Technology Division
Office of High Energy Physics**



- **Updating the P5 Roadmap**
- **The Program and the Budget**
- **The Research Frontiers**
- **The Office of High Energy Physics**

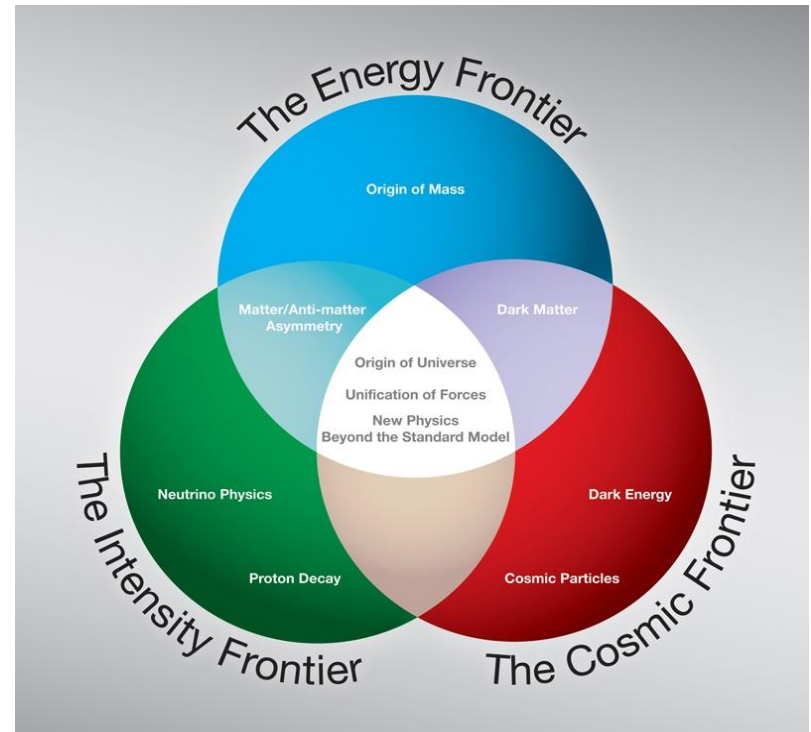


Updating the P5 Roadmap



The Scientific Frontiers

- **The Energy Frontier**, powerful accelerators are used to create new particles, reveal their interactions, and investigate fundamental forces;
- **The Intensity Frontier**, intense particle beams and highly sensitive detectors are used to pursue alternate pathways to investigate fundamental forces and particle interactions by studying events that occur rarely in nature; and
- **The Cosmic Frontier**, ground and space-based experiments and telescopes are used to make measurements that will offer new insight and information about the nature of dark matter and dark energy, to understand fundamental particle properties and discover new phenomena.



The three frontiers have been excellent framework for our discussions of the program with the Office of Science, DOE, OMB, and Congress.



What has happened?

Since 2008 P5 Report

Energy Frontier:

- LHC research program has been delayed
- CERN has a new mid-term and long-range plan for LHC
- Tevatron performance continues to be outstanding! → **Run in 2012-2014?**

Intensity Frontier

- Significant progress on initiating implementation of a U.S. leadership intensity frontier program
- Established a model for a joint agency DUSEL Physics program
 - This has been articulated in a draft DOE/NSF MOU now in concurrence
- Additional guidance obtained on other opportunities identified in HEPAP P5 Report

Cosmic Frontier

- Guidance received:
 - HEPAP (PASAG) Report: opportunities/priorities for HEP particle astrophysics program
 - Astro2010 Report: opportunities/priorities for the U.S. Astronomy/Astrophysics program
 - OSTP has worked for a coordinated agency (DOE, NASA and NSF) response

Advanced Technology R&D

- Delay in LHC schedule has driven delay in anticipated “decision” on next lepton collider
- Accelerator R&D Workshop Report provided guidance on opportunities/priorities

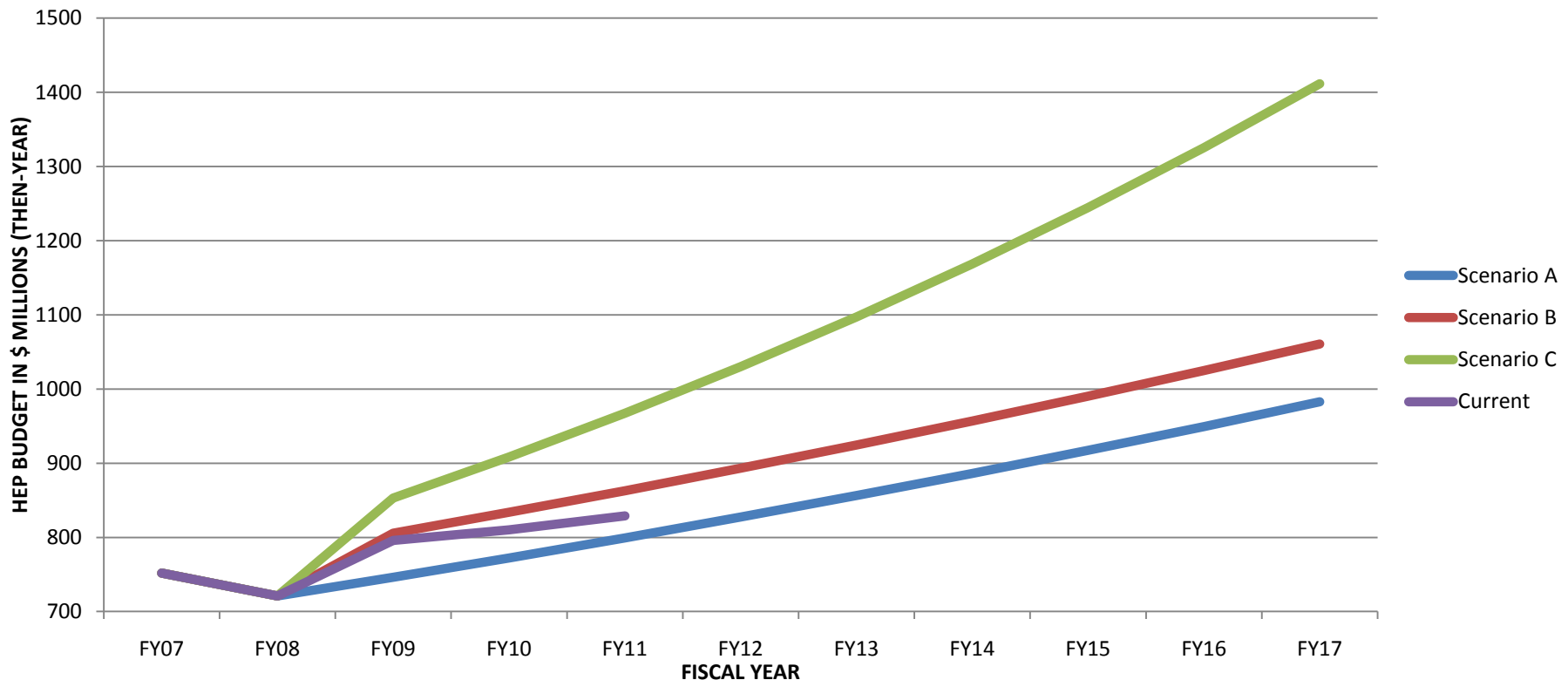
Funding Projections

- HEP budgets have been between FY2007 and FY2008 level-of-effort



Budget Projections

- P5 Report spells out what the nation will get with different investments
 - Scenario A (FY 2008 Approp + COL)
 - *unable to mount productive, world-class programs at all three frontiers*
 - Scenario B (FY 2007 Approp + COL)
 - *programs at all three frontiers*
 - Scenario C (FY 2007 doubling (+6.5%/yr))
 - *leadership programs – partner in TeV-scale facility*





The Program and the Budget



FY 2011 Budget Request to Congress

(B/A in thousands)

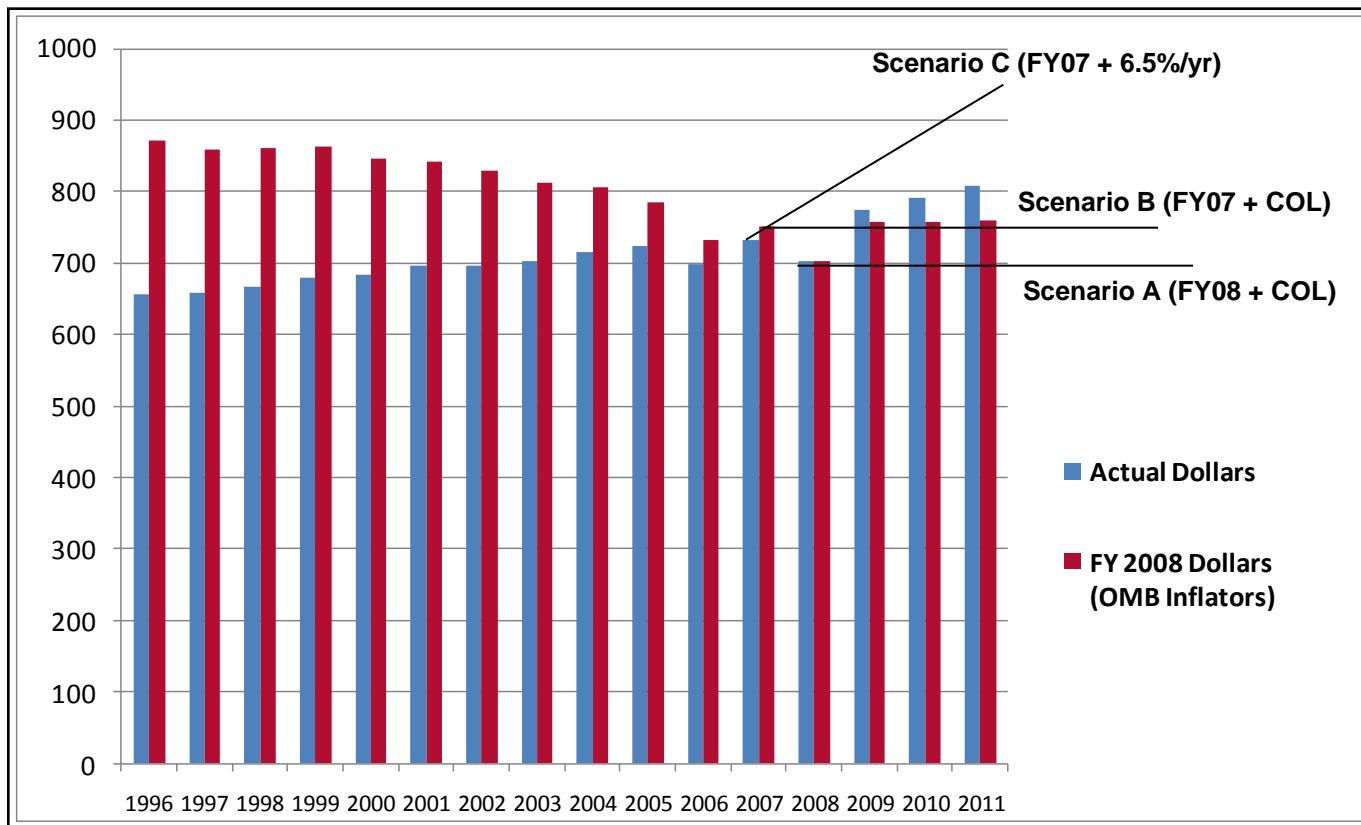
	FY 2009		FY 2010	FY 2011		
	Current Base Approp.	Current Recovery Act	Current Approp.	Request to Congress	Request to Congress vs. FY 2010 Approp.	
Advanced Scientific Computing Research.....	358,772	161,795	394,000	426,000	+32,000	+8.1%
Basic Energy Sciences.....	1,535,765	555,406	1,636,500	1,835,000	+198,500	+12.1%
Biological & Environmental Research.....	585,176	165,653	604,182	626,900	+22,718	+3.8%
Fusion Energy Sciences.....	394,518	91,023	426,000	380,000	-46,000	-10.8%
High Energy Physics.....	775,868	232,390	810,483	829,000	+18,517	+2.3%
Nuclear Physics.....	500,307	154,800	535,000	562,000	+27,000	+5.0%
Workforce Development for Teachers & Scientists.....	13,583	12,500	20,678	35,600	+14,922	+72.2%
Science Laboratories Infrastructure.....	145,380	198,114	127,600	126,000	-1,600	-1.3%
Safeguards & Security.....	80,603	—	83,000	86,500	+3,500	+4.2%
Science Program Direction.....	186,695	5,600	189,377	214,437	+25,060	+13.2%
Small Business Innovation Research/Technology Transfer (SC).....	104,905	18,719	—	—	—	—
Subtotal, Science.....	4,681,572	1,596,000	4,826,820	5,121,437	+294,617	+6.1%
Congressionally-directed projects.....	91,064	—	76,890	—	-76,890	-100.0%
Small Business Innovation Research/ Technology Transfer (DOE).....	49,534	36,918	—	—	—	—
Use of prior year balances.....	-15,000	—	—	—	—	—
Total, Office of Science.....	4,807,170	1,632,918	4,903,710	5,121,437	+217,727	+4.4%

HEP is about 17% of the Office of Science Budget



FY 2009-2010 and FY 2011 Request change trend but need above COL to implement the Plan

- HEP funding has been eroded by inflation: FY 2008 / FY 1996 ~ 20 % (OMB COL)
- HEP FY 2009 funding was +10 % compared to FY 2008 and above OMB COL from FY 2007
- HEP received 220.0 million in Recovery Act funding (additional \$16.5 million Early Career)
- HEP FY 2011 Request is above OMB COL (+2.3 %) compared to FY 2010





HEP FY 2010 Funding

Budget Categories

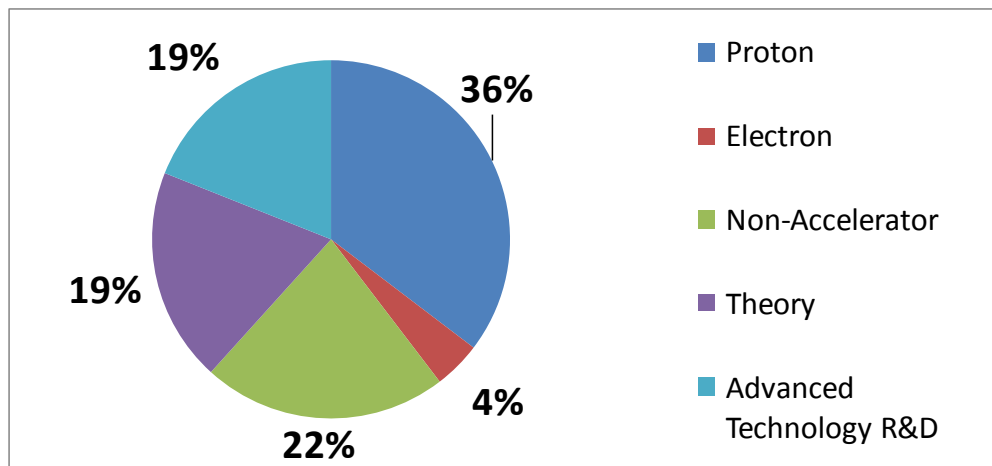
Energy Frontier Experimental Intensity Frontier Experimental	104.0	9.0	177.0 *	290.0	36%
Cosmic Frontier Experimental	48.1	91.0	61.5 *	200.7	25%
Theoretical Physics	65.3	10.1	0.0	75.4	9%
Advanced Technology R&D	68.4	0.0	0.0	68.4	8%
High Energy Physics	67.7	0.0	108.4 **	176.0	22%
	353.5	110.1	346.9	810.5	
	43.6%	13.6%	42.8%		

* Fermilab Operations pro rated
** Includes SBIR/STTR

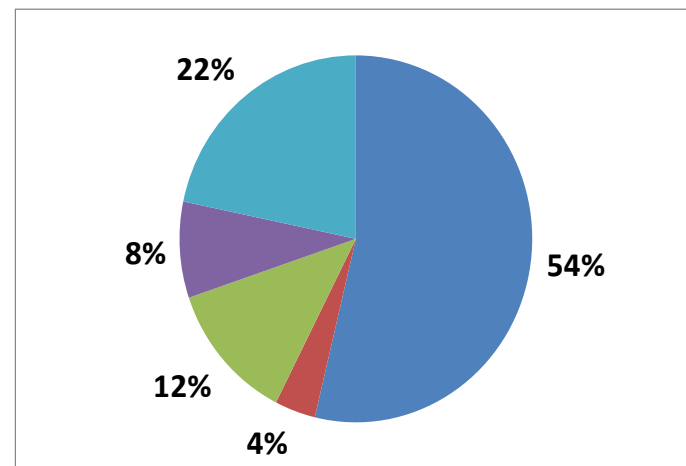
FY 2010

Budget Categories	Operations and Development			Total	
	Research	Projects	Development		
Energy Frontier Experimental Intensity Frontier Experimental	104.0	9.0	177.0 *	290.0	36%
Cosmic Frontier Experimental	48.1	91.0	61.5 *	200.7	25%
Theoretical Physics	65.3	10.1	0.0	75.4	9%
Advanced Technology R&D	68.4	0.0	0.0	68.4	8%
High Energy Physics	67.7	0.0	108.4 **	176.0	22%
	353.5	110.1	346.9	810.5	
	43.6%	13.6%	42.8%		

Research Funding



Program Funding





- Tevatron will operate in FY 2011 with possibility of observing hints of new physics or ruling out a significant fraction of the allowed mass region for the Higgs boson in the Standard Model at the 95% confidence level
- U.S. LHC program is supported at a level that will allow U.S. researchers to play a leading role in extracting physics from the data obtained and in planned upgrades to the detectors
- On-going MIE projects are supported on planned schedules to address physics at the Intensity Frontier (NOvA and Daya Bay), and Cosmic Frontier (DES)
- First investments (MicroBooNE, Mu2e and LBNE) are made to secure a U.S. leadership program at the Intensity Frontier
- Research program is supported at a level that will maintain scientific workforce and the ability to be productive
- Projects/Construction are down slightly overall as NOvA profile starts to roll off and new Intensity Frontier projects begin to ramp up
- Advanced Technology R&D is continuing to support high risk, high impact initiatives as well as developing infrastructure and maintaining core competencies important for the U.S.



▪ DOE/SC Early Career Program : 2011

- Five-year awards : approx. \$500k/yr for lab researchers, \$150k/yr for universities.
- Total of \$3M in new awards in FY2011.
- Replaced Outstanding Junior Investigator (OJI) program in HEP starting in FY 2010.
- Made 14 awards in HEP in 1st year from 154 proposals (about 3X typical OJI pool)
- **Proposals are due November 9. Pre-proposals required.**

Questions? See : http://www.science.doe.gov/SC-2/early_career.htm

▪ Advanced Detector Research

- One- or two-year awards. Total of \$750k available. Five awards made in FY2010.
- Targeted at prototyping/demonstrating new detector technologies for HEP applications
 - Recent topics awarded include: liquid crystal optical readouts for gas detectors, fast feature extracted high precision timing, design and prototyping of a high granularity silicon calorimeter
- **Proposals are due December 16.** Letters of intent welcome but not required.

Questions? See http://www.science.doe.gov/hep/hep_ADR/adrprogram.shtml



■ Collider Detector Research and Development

– **New effort planned for FY2011+**

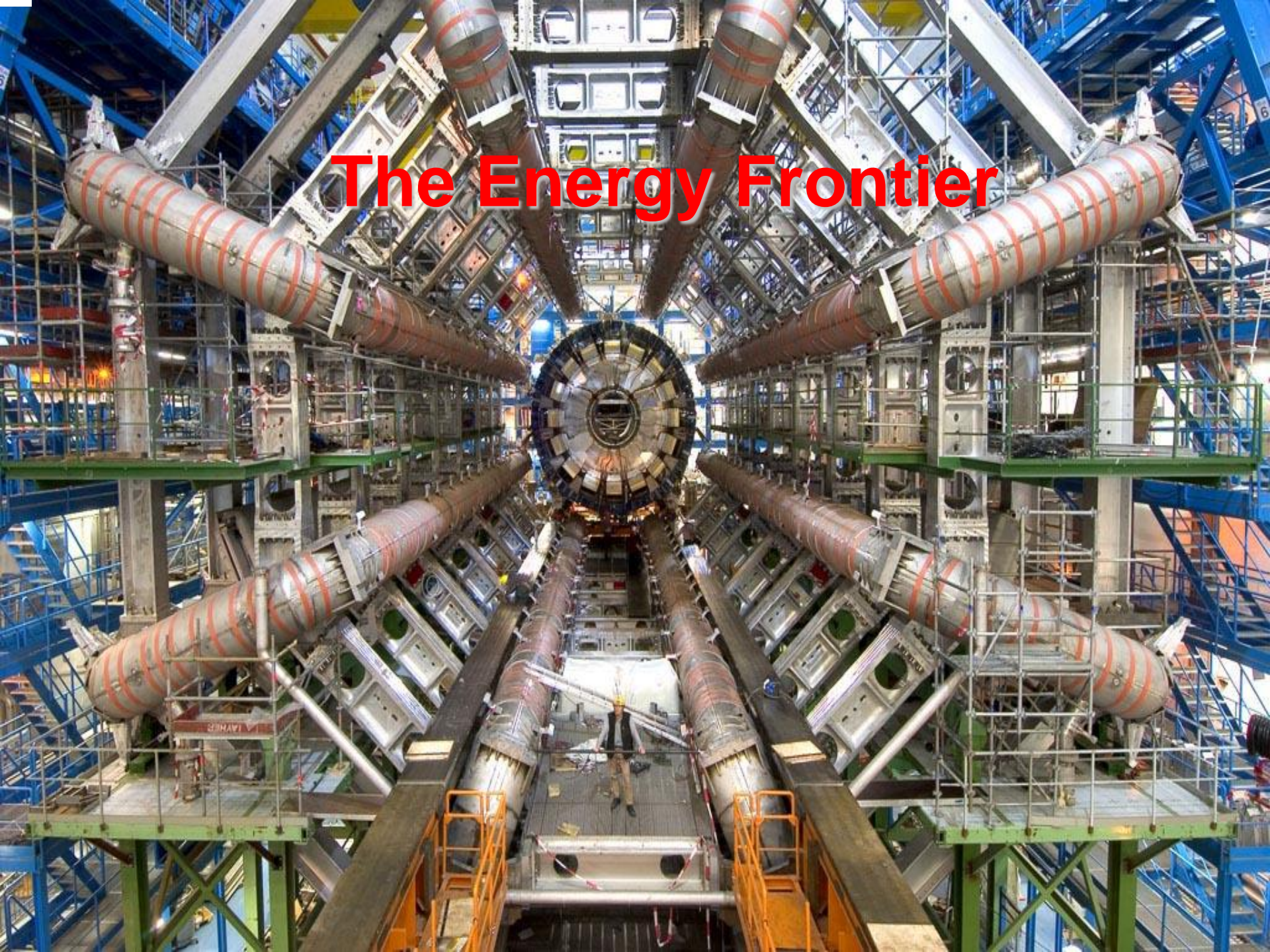
- Transition from *experiment-specific* R&D programs (LHC upgrade R&D, ILC detector R&D) to *technology-driven* R&D programs, e.g.:
 - Advanced pixel detectors
 - New approaches in calorimetry
 - Large area, inexpensive photo-detectors
- Community roles
 - Identify most promising technology areas (e.g., detector R&D workshop @FNAL Oct 7-9)
 - Create/define the proposed project(s) and collaborations
 - If selected for funding, execute the R&D, provide progress reports, etc.
- One- or multi-year awards. Approximately \$3M available.
- Letters-of-intent encouraged but not required.
- **Funding announcement out in the next month; check HEP website for details.**



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The Research Frontiers

The Energy Frontier





▪ Tevatron Program

- Many interesting new results : closing in on the Higgs, hints of BSM physics?
- **Supporting Tev Ops and analysis in FY2011 is an HEP priority**
- With the delay in the LHC there is a case for running the Tevatron in FY 2012-4
- Currently in the middle of FY2012 budget development
 - **HEPAP recommended extending Tevatron running if additional resources can be found**

▪ LHC Program

- Performance of accelerator, detectors, software and computing have been exemplary
 - **Support for LHC research is another HEP priority.**
 - US groups are very visible and active. On to the physics!
- CERN is in the process of defining its mid-term plan for the LHC program
 - U.S. is planning to participate
 - Participation includes detector / accelerator upgrades but **not** LHC operating costs
 - Present US-CERN agreement until 2017
- U.S. proposes that its relations with CERN remain basically the same as now:
- CERN activities and plans for the future of the LHC are driving discussions of global projects



Proton program at a glance

<u>FY 2009</u>	Labs		Universities		Total	
	FTE	Funding	FTE	Funding	FTE	Funding
Tevatron	91	\$17M	141	\$9M	232	\$26M
LHC	128	\$36M	560	\$42M	688	\$78M
Neutrinos	35	\$10M	111	\$7M	146	\$17M
Fixed target	6	\$3M	13	\$1M	19	\$4M
Total	260	\$66M	825	\$59M	1085	\$125M

>Plus LHC Detector Operations (\$59M) and LHCNet (\$2M) for Tier 1, M&O, R&D, software, computing, etc.

>In FY09, **46 Tier 3 centers** funded through ARRA (\$2M)

TOTAL DOE: ~\$140M/yr (not incl. LHC Accelerator upgrades, LARP)



The Intensity Frontier





DOE's Neutrino/Rare Decay Program at Fermilab

- MiniBooNE, MINOS, and MINERVA are taking data
- MicroBooNE will soon be in fabrication
- Mu2e, LBNE Project Engineering and Design (PED) in FY 2011
- Project X R&D and pre-conceptual design supported
- Muon Anomalous Magnetic Moment (G-2) - depends upon funding and reviews

Possible construction/running schedules (assuming Tevatron down in 2012)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Fermilab Projects					Shut										
MiniBooNE		Running			dow n	???									
MINOS		Running				???									
Minerva		Fabrication				Running									
NOvA		Fabrication					Running								
MicroBooNE		R&D	Fabrication			Running									
LBNE		R&D		PED		Construction							Running		
Project - Mu2e		R&D		PED		Construction		Running							
Project X				R&D		Construction							Running		
G-2						Fabricaton									



Intensity Frontier: Scientific opportunities of DUSEL

- NSF/DOE have established a DUSEL Physics Joint Oversight Group (JOG)
 - To coordinate & oversee DUSEL experimental physics program
- Agencies collaborating in defining the DUSEL physics program.
 - Agreed on DUSEL stewardship roles & core research program:

Program Element	Steward	Other
DUSEL facility	NSF	
Dark matter	NSF	DOE OHEP
Neutrino-less double-beta decay	DOE ONP	NSF, DOE OHEP?
Long baseline neutrinos	DOE OHEP	NSF
Proton decay	DOE OHEP	NSF
Other disciplines (Bio, Geo, Eng)	NSF	

- An Interagency Memorandum of Understanding (MOU) will define in more detail the roles and responsibilities

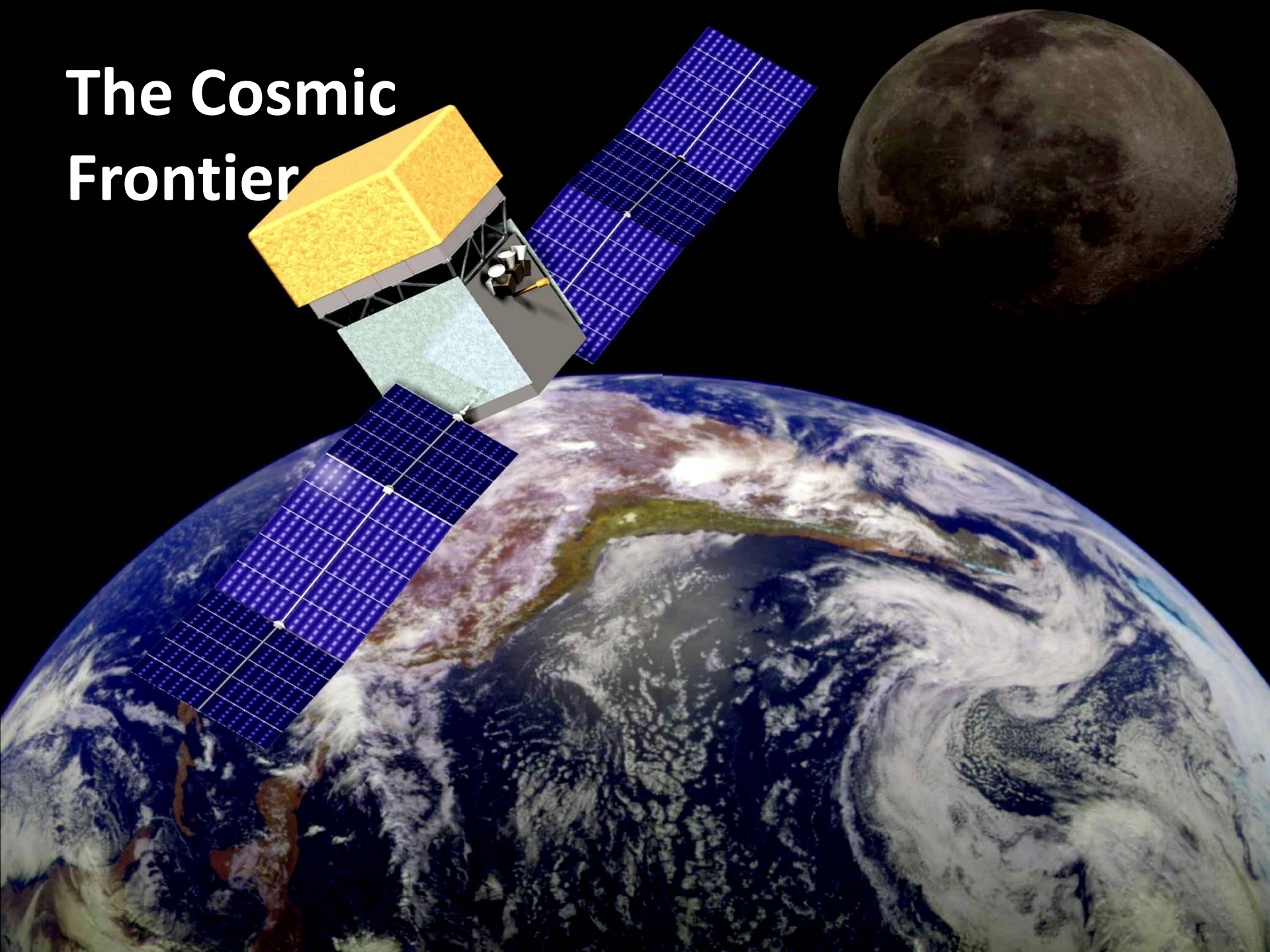


DOE/HEP has received proposals for 3 possible “small” Intensity Frontier projects:

1. US participation (SLAC + university groups) in SuperB/Italy at 3 different levels:
 - i. Provision of reusable PEP-II and BABAR components (est. 130MEuro value)
 - ii. i + additional funding for US participation in detector program
 - iii. ii + additional funding for US participation in accelerator program
2. US participation in Belle-II (university groups) at Super-KEKB/Japan
 - Participation in detector subsystems
3. Implementing/remounting g-2 experiment at Fermilab (universities + FNAL)
 - Utilizes existing Fermilab infrastructure and planned upgrades
 - Utilizes BNL D&D

**HEP has conducted a peer-review of these scientific opportunities.
Report expected next month.**

The Cosmic Frontier





DOE HEP comments

Budgetary scenarios:

- **Our current projections tend towards the lower funding amounts and may not have the same profile as assumed by Astro2010.**

DOE OHEP Objectives:

- **Achieve earliest, best, and most cost-effective U.S. dark energy and dark matter science results**
- **Maintain a leading U.S. role in dark energy research (responsive to Astro2010 recommendations)**
- **Work with NASA and NSF (and international collaborators) to establish partnerships where DOE HEP researchers and investments can play a significant role in and make significant contributions to the joint efforts.**

DOE has started meeting with NASA, NSF and OSTP to coordinate our efforts and plan a path forward for a program which optimizes the science for the investment.



DOE/HEP priorities are (per HEPAP/PASAG):

1. Dark Matter (with NSF). Emphasizes direct detection.

- a. R&D and prototype detectors
- b. Down select to a few solid/liquid/gas phase detectors for next generation
- c. Choose technology for one or two ton-scale detectors

2. Dark Energy. What is it? How does it evolve?

- a. Ground-based program with NSF (as a major partner)
- b. Space-based program with NASA (as a minor partner)

3. Cosmic Rays/High Energy gamma-rays

- a. Complete currently operating experiments—will review in 2011
- b. Not participating in Auger North given current budget projections
- c. Discussing role in AGIS/CTA merger

The Technology Frontier





Accelerator R&D Significant Changes

Accelerator R&D activities are in transition to better serve HEP, SC, and the Nation

- **Over last few years investments have developed US competency in SRF Technology**
 - This position US to construct Project X or participate in construction of an ILC
 - The funding for ILC and SRF R&D will be ramped down as planned activities are completed
- **Investments have been made in plasma wakefield acceleration demonstration projects**
 - Recovery Act funding used to proceed on BELLA and FACET projects
 - Will be operated over the next few years to determine the promise for future accelerators
- **Investments are planned for a five-year national muon accelerator R&D campaign**
 - To understand whether the technical challenges can be overcome
 - Fermilab has been charged to organize this national effort
- **Investments are planned to address opportunities identified in the Accelerator R&D Workshop**
 - With broader perspective
 - To better serve the needs of other scientific programs and national endeavors

Plan to go to HEPAP for an evaluation of Accelerator R&D Strategic Plan and get guidance for refinement and in particular how to incorporate information obtained from Accelerator Workshop



Accelerator R&D Workshop Research Opportunities

Areas of R&D identified by each working group. All areas are of importance to each working group. Color coding indicates areas with greatest impact.

R&D Need	Energy & Environment	Medicine	Industry	Security & Defense	Discovery Science
Reliability	Red	Red	Red	Blue	Red
Beam Power/RF	Red	White	Orange	Red	Red
Beam Transport and Control	Yellow	Red	Light Blue	Orange	Yellow
Efficiency	Orange	Light Blue	Orange	Blue	Yellow
Gradient (SRF and other)	Light Blue	Blue	Yellow	Red	Blue
Reduced Production Costs	Blue	Orange	Red	White	Blue
Simulation	Yellow	Blue	Light Blue	Orange	Light Blue
Lasers	Blue	White	White	Orange	Orange
Size	White	Orange	Blue	White	Orange
Superconducting Magnets	White	Yellow	Yellow	Yellow	White
Targetry	Orange	Yellow	White	Light Blue	White
Particle Sources	Light Blue	Light Blue	Blue	Light Blue	Light Blue

Color code: Increased priority

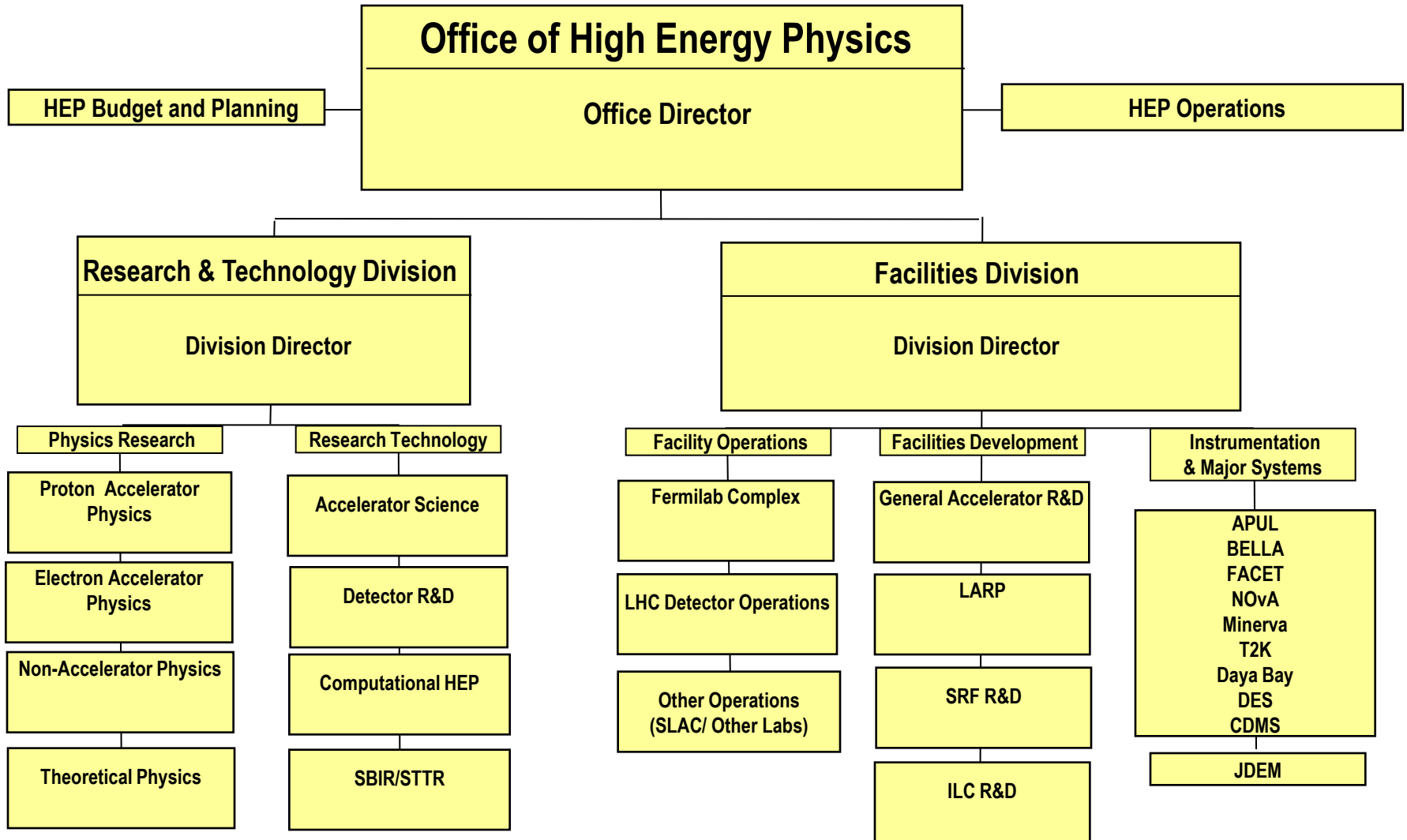


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New HEP Organization Chart





- **Currently have 12 Federal employees who are physicists, 4 visiting physicists, and 8 administrative employees.**
- **Research and Technology Division**
 - Recently added Michael Salamon as Non-Accelerator Program Manager
 - Federal staff positions: currently open [and close November 4:](#)
 - Theory Program Manager
 - Accelerator Science Program Manager
 - On hold (pending FY2011 CR): Computational HEP
- **Facilities Division**
 - Recently added Fred Borcharding in Project Oversight/Detector R&D
 - No current Fed staff positions, but particular needs in:
 - LHC Operations
 - Fermilab Complex
- **Ongoing need for term visitors in all areas. Rolling admissions!**