



# What HEP Told the Committee of Visitors

**Michael Procaro**  
**Office of High Energy Physics**  
**1 December 2016**

# Meeting with the COV

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The HEP staff and the COV met in this room for a full morning.

I will try to summarize what was said in 30 minutes.

# Outline

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- The Charge to the COV
- Overview
- The Research Division
- The Facilities Division

# Highlights of the Charge

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The full charge is available on the HEP website

Common charge elements for all programs

- Assess the **efficacy and quality of the processes** used during the past three years to solicit, review, recommend, and document application and proposal actions, and to monitor active awards, projects and programs.
- Within the boundaries defined by DOE mission and available funding, comment on how the award process has affected the **quality of the portfolio elements and the resulting portfolio as a whole**, including breadth and depth as well as the national and international standing of the portfolio.

HEP specific charge elements

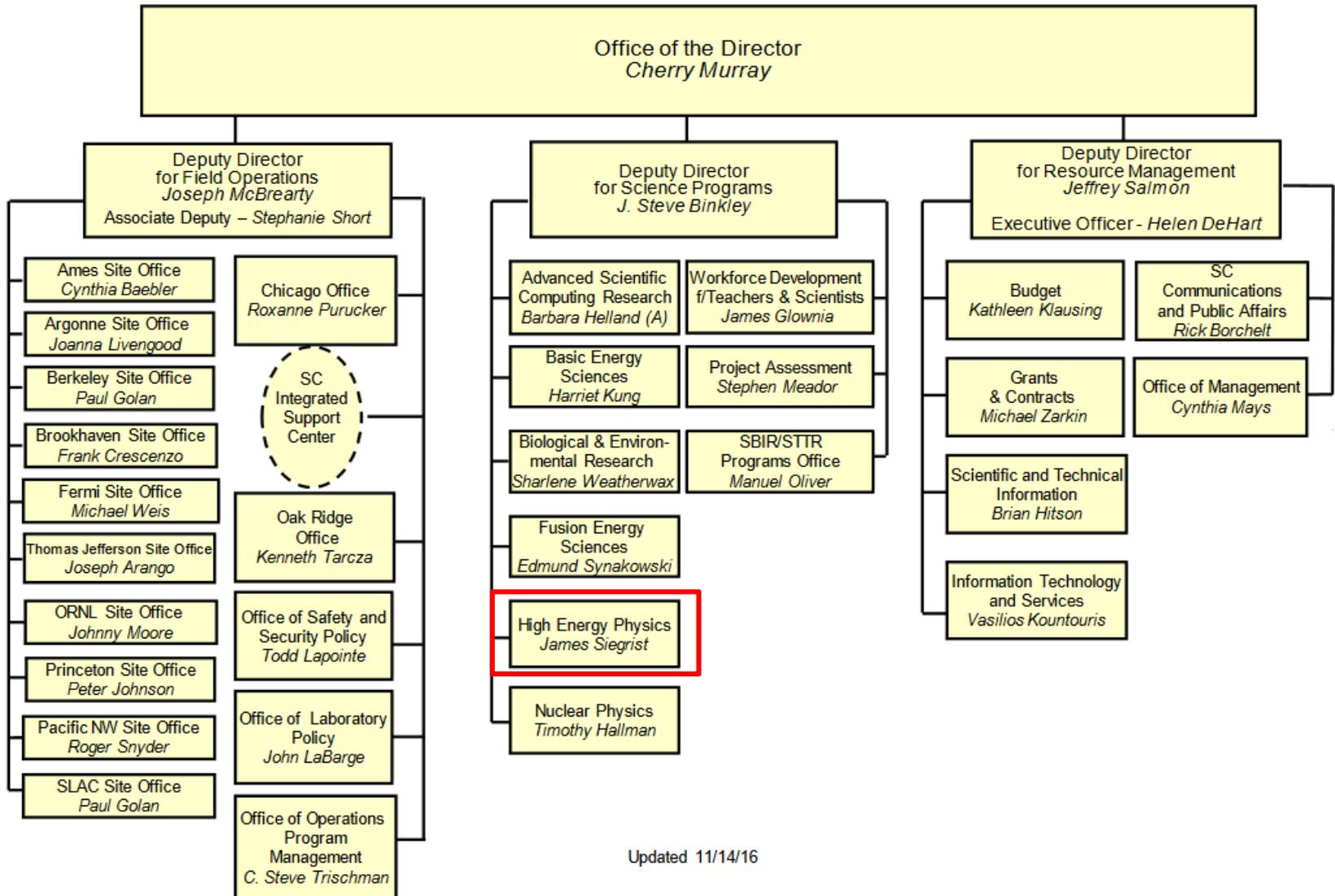
- Assess the effectiveness of the DOE implementation of P5 plan.
- Assess progress in addressing the recommendations of the previous (2013) COV.
- Identify any issues that the COV is not able to consider within the timespan of this review, but deserve subsequent consideration.

Covers FY 2013, 2014, and 2015. It is retrospective. How did we do?



# OVERVIEW

# DOE Office of Science



Updated 11/14/16

# HEP Mission/Strategies/Context

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## ■ Mission:

- *The High Energy Physics (HEP) program mission is to understand how the universe works at its most fundamental level, which is done by discovering the elementary constituents of matter and energy, probing the interactions between them, and exploring the basic nature of space and time.*

## ■ Strategies:

- Support innovative scientific research that advances our knowledge
- Build and operate the forefront scientific facilities needed to do the research
- Act as a steward of human resources, essential scientific/technology disciplines, institutions, and scientific user facilities.

## ■ Context:

- HEP is in DOE and SC and must support their missions. DOE is a “mission agency.”
  - *And work within established structures to carry out its own mission*
- Primary Federal builder/operator of forefront scientific facilities for HEP
- National Laboratories are central to carrying out HEP’s mission



# Executing the Mission: Strategic Planning

## Input (Selected, formal)

- HEPAP Reports (e.g. P5)
- AAAC Reports, NRC Reports (EPP2010, Astro2010), etc
- Community workshops and studies (e.g. Snowmass)
- Facility/Institution Reviews
- Lab Managers Budget Briefings
- HEP Office Retreats
- OMB, DOE, Congressional guidance

## Outputs (Not all public)

- DOE/SC Strategic Plans
- DOE Annual Performance Plan
- SC Facilities Plan
- President's Budget Requests and supporting docs
- Internal budget/planning exercises
- MOUs (NSF, NASA, other countries), etc.

*Items in Green charged or commissioned by DOE/HEP*



# Executing the Mission: Funding Decisions

## Inputs

- Appropriated Budgets
- Internal HEP budget plans
- International/interagency commitments
- Facility/Institution Reviews
- Program Reviews/Briefings
- Lab Managers Budget Briefings
- Lab Field Work Proposals (FWPs)
- University/other proposals
  - Proposal (peer) reviews

## Outputs (not all public)

- Initial financial plan (funding to DOE labs)
- Monthly Financial Plans (updates/increments to the above)
- Financial assistance awards (e.g. grants)

*Items in Red prepared in response to Funding Opportunity Announcements (FOAs) and Budget Calls*

# Where HEP Was in 2013

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## Energy Frontier

- LHC research program was well underway.
- The Higgs had been discovered by CMS and ATLAS.
- The Upgrade projects got CD-1 on 2012 and CD-1 in 2013

## Intensity Frontier

- Daya Bay had just shown that  $\theta_{13}$  was surprising large changing the prospects for the study of neutrinos.
- LBNF had CD-1 approved for a smaller less capable experiment than is now planned.

## Cosmic Frontier

- DES, BOSS, VERITAS, Auger, CDMS, LUX, GLAST, and others operating
- LSSTcam had CD-1 approval.
- Second generation dark matter R&D was funded.

## Advanced Technology R&D

- BELLA and FACET were in operation and beginning to demonstrate serious progress in plasma wakefield acceleration.
- ILC R&D funding ramps down and Fermilab joins the LCLS-II project to build cryomodules.

# Where HEP Is in 2016

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**We are implementing the 2014 P5 plan. FY 2016 was the first budget to reflect the P5 plan.**

## **Energy Frontier**

- LHC has run at 13 TeV and has exceeded its design luminosity.
- The is new US CERN agreement to support the US role in HL-LHC and the detector upgrades, which have been approved for CD-0.

## **Intensity Frontier**

- Nova and MicroBooNE are running.
- LBNE becomes LBNF/DUNE and the world joins in.
- US BELLE II is complete. Muon g-2 is approaching completion.

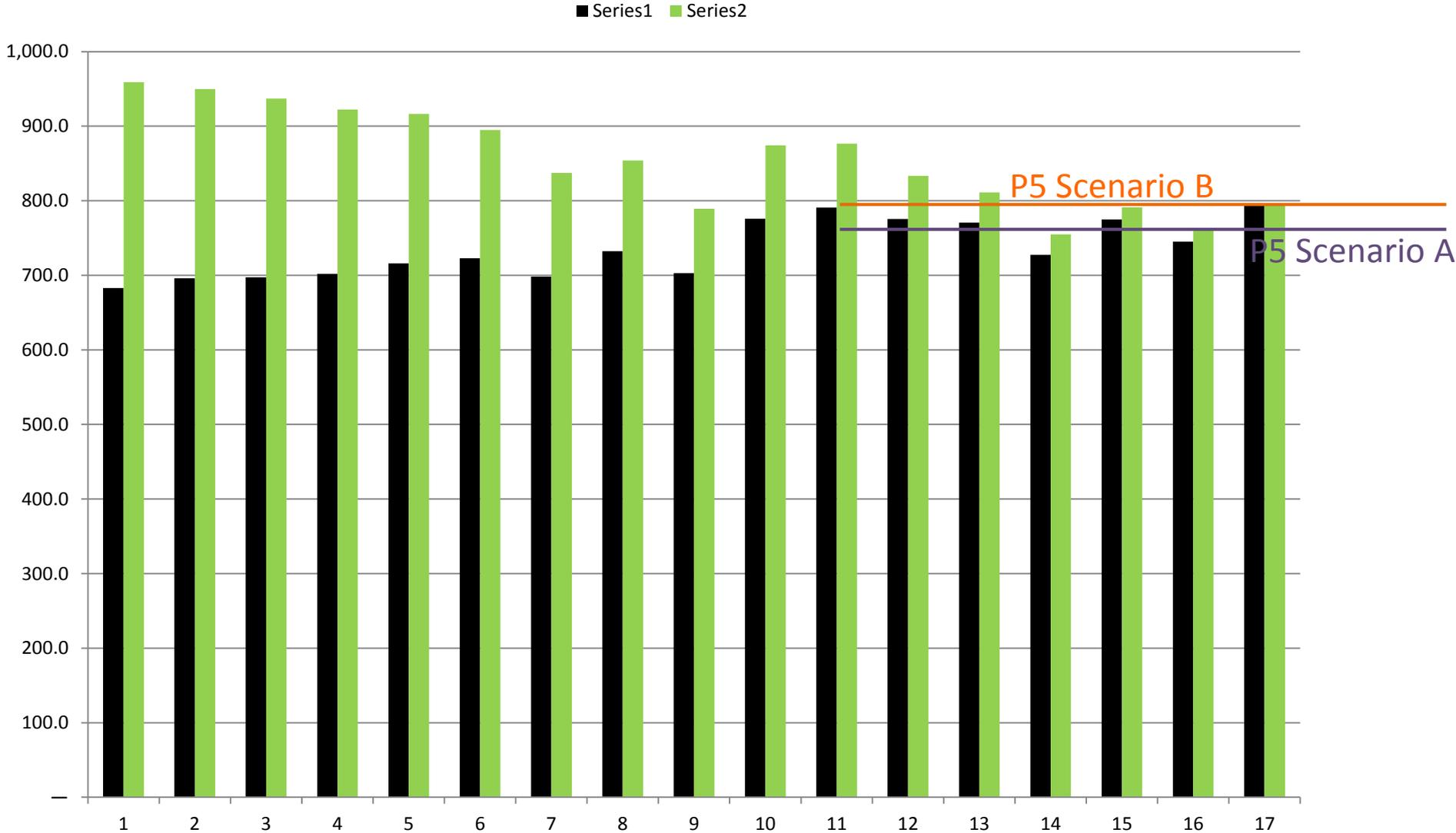
## **Cosmic Frontier**

- Moving from a large number of small operating experiments to fewer large experiments under construction.
- LSSTcam and DESI are in full fabrication. LZ is baselined. SuperCDMS has CD-1.

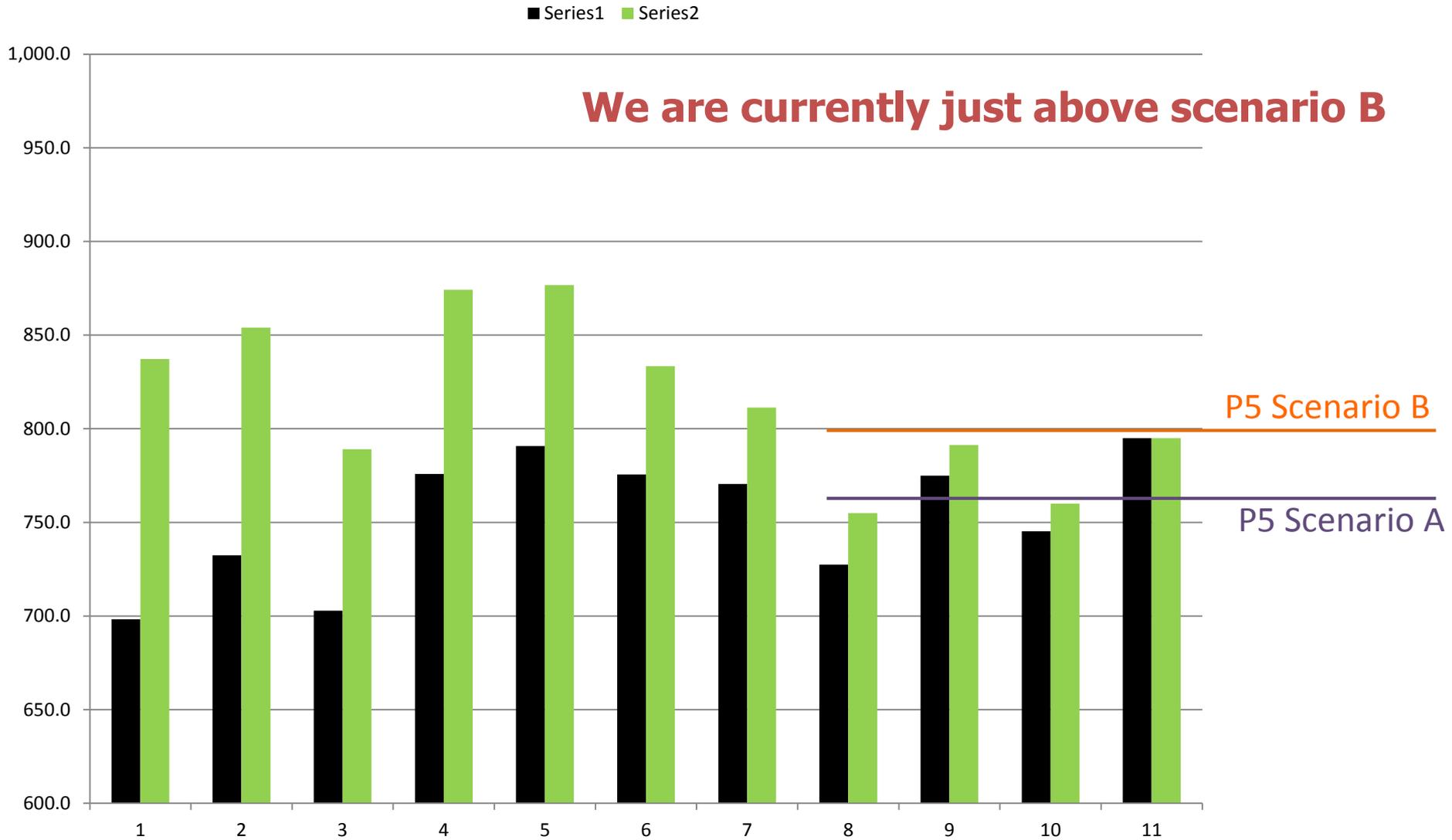
## **Advanced Technology R&D**

- LARP has demonstrated the needed gradients for the HL-LHC.
- Nitrogen doping has been shown to improve the  $Q_0$  of SRF cavities.
- FACET completes its run having made several major breakthroughs in beam driven plasma wakefield research. FACET-II gets CD-1.

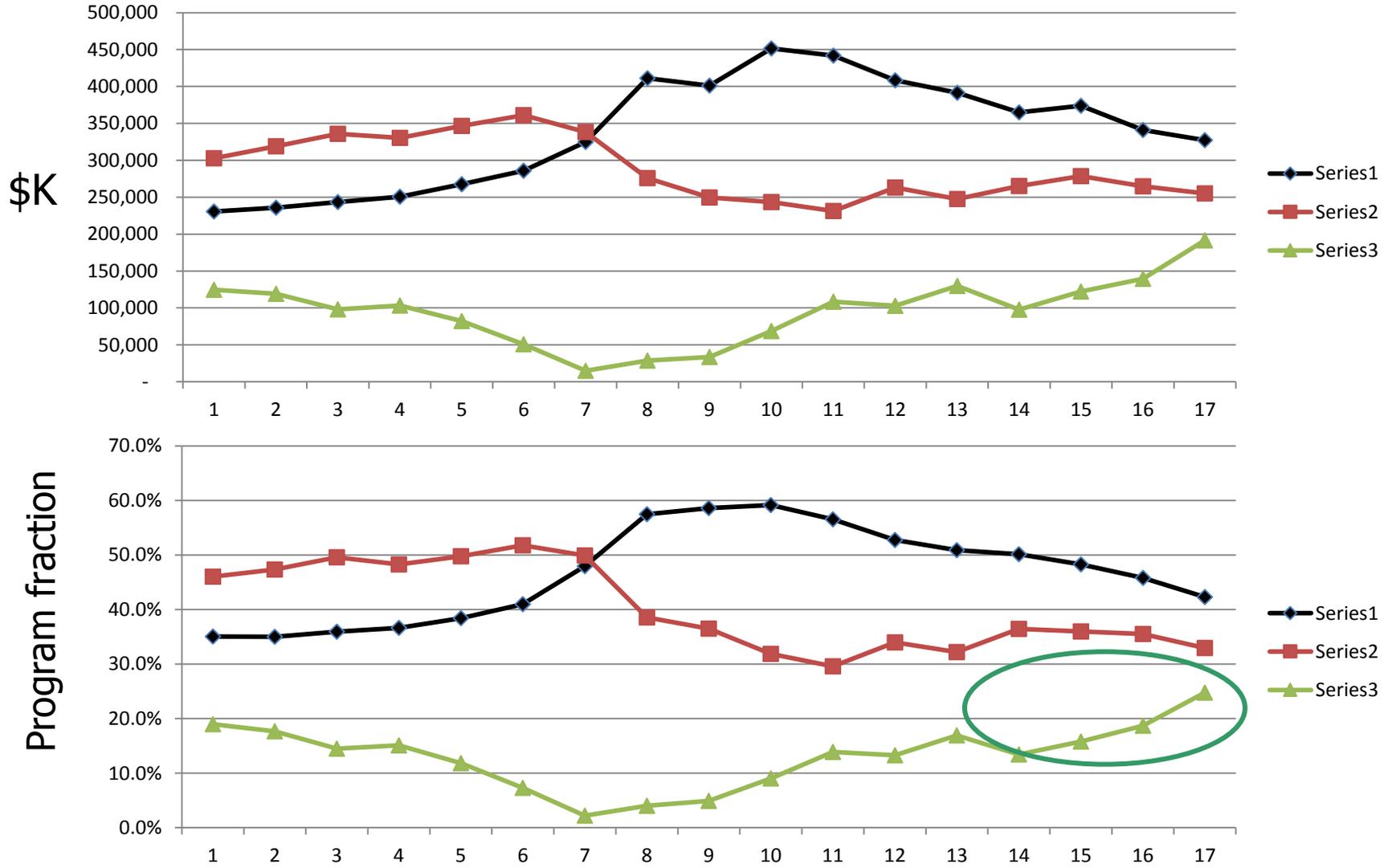
# Budget History and P5 Guidance



# Zoom In



# Research/ Facilities/ Projects



# Budget Management

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Accelerator Stewardship	Colby
AD Reserve	Siegrist
Computational HEP	Chatterjee
Cosmic Frontier	Turner
Detector R&D	Marsiske
EC Reserve	Crawford
Energy Frontier	Patwa
Facilities	Procario
HEP Directed Accelerator R&D LARP	Strauss
HEP General Accelerator R&D	Len
Intensity Frontier	Flood/Crawford
IT projects	Kogut
LHC Operations	Patwa
Projects	Procario
Theory	Rolli/Kilgore

Internally HEP uses these budget categories.

Budget Managers are given control totals that they have to hit.

The AD has a reserve to solve problems.

# HEP Workforce Overview

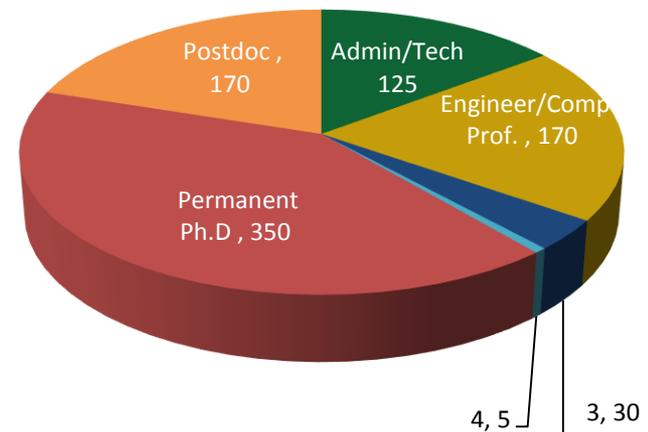
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- **In 2013, the entire DOE supported HEP workforce (Universities & Laboratories) consisted of ~4,300 FTEs**
  - ~2,500 engaged in Research across the Energy, Intensity, and Cosmic Frontiers, Theoretical and Computational Physics, and Advanced Technology R&D
  - Remaining ~1,800 FTEs provide administrative support and support for facility operations
- **Major activities at 5 national laboratories:**
  - Argonne National Laboratory (ANL)
  - Brookhaven National Laboratory (BNL)
  - Fermi National Accelerator Laboratory (FNAL)
  - Lawrence Berkeley National Laboratory (LBNL)
  - SLAC National Accelerator Laboratory (SLAC)
  - A few small, specialized research efforts at other SC and NNSA labs
- **University research program consists of ~250 active grants to >100 institutions, involving approximately 1,700 FTEs**

# Laboratory Support

- **Laboratory research is mission driven and funded through Field Work Proposals**
  - Program guidance to the Laboratories is provided by HEP with input from a variety of sources, including:
    - The Laboratories themselves
      - Local strengths and resources
    - Advisory committees
    - Institutional reviews
  - **HEP holds comparative reviews of the Research programs of the labs every 3 years.**
- **Research job classifications at Laboratories are similar to those at Universities**
  - Major exception is Senior Research Scientists in place of PIs

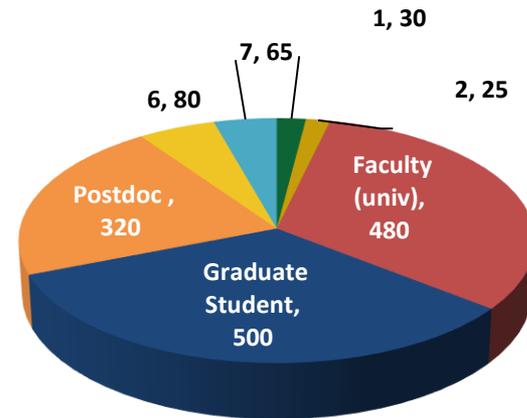
**2013 HEP Lab Research Workforce (FTEs)**



# University Support

- **University research is supported by a competitive, proposal-driven process**
  - Grants issued after comparative review of proposals submitted to Funding Opportunity Announcements
- **Research job classifications at universities, supported by HEP funding, include the following positions:**
  - **Principle Investigator (PI)**
    - Tenured or tenure-track permanent Ph.D. staff
  - **Research scientist**
    - Permanent, non-tenured staff
  - **Postdoctoral fellow**
    - Term employees with Ph.D.
  - **Graduate students**
  - **Administrative staff**
  - **Engineers**
  - **Computer professionals**

**2013 HEP University Research Workforce**



# Roles and Responsibilities

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- **Labs**

- **Facility Operations and Construction**

- Performance judged against specified metrics (*e.g.* protons-on-target; Earned Value Management System)
    - Includes maintenance, upgrades, planning for new facilities
    - User support

- **HEP Research and Technology R&D**

- Nurture and support HEP research collaborations to enable discovery science
    - **Participation in all phases – from design, construction, operations & analysis**
    - **Particular emphasis on:**
      - Management, design, construction and operation of HEP experiments
      - Integration of cross-cutting activities, *e.g.*: computation, simulation and theoretical research, in support of HEP program
      - Exploiting lab infrastructure and resources to develop next-generation particle accelerator and detector technologies for the advancement of HEP and science more broadly

- **Universities**

- **HEP Research and Technology R&D**

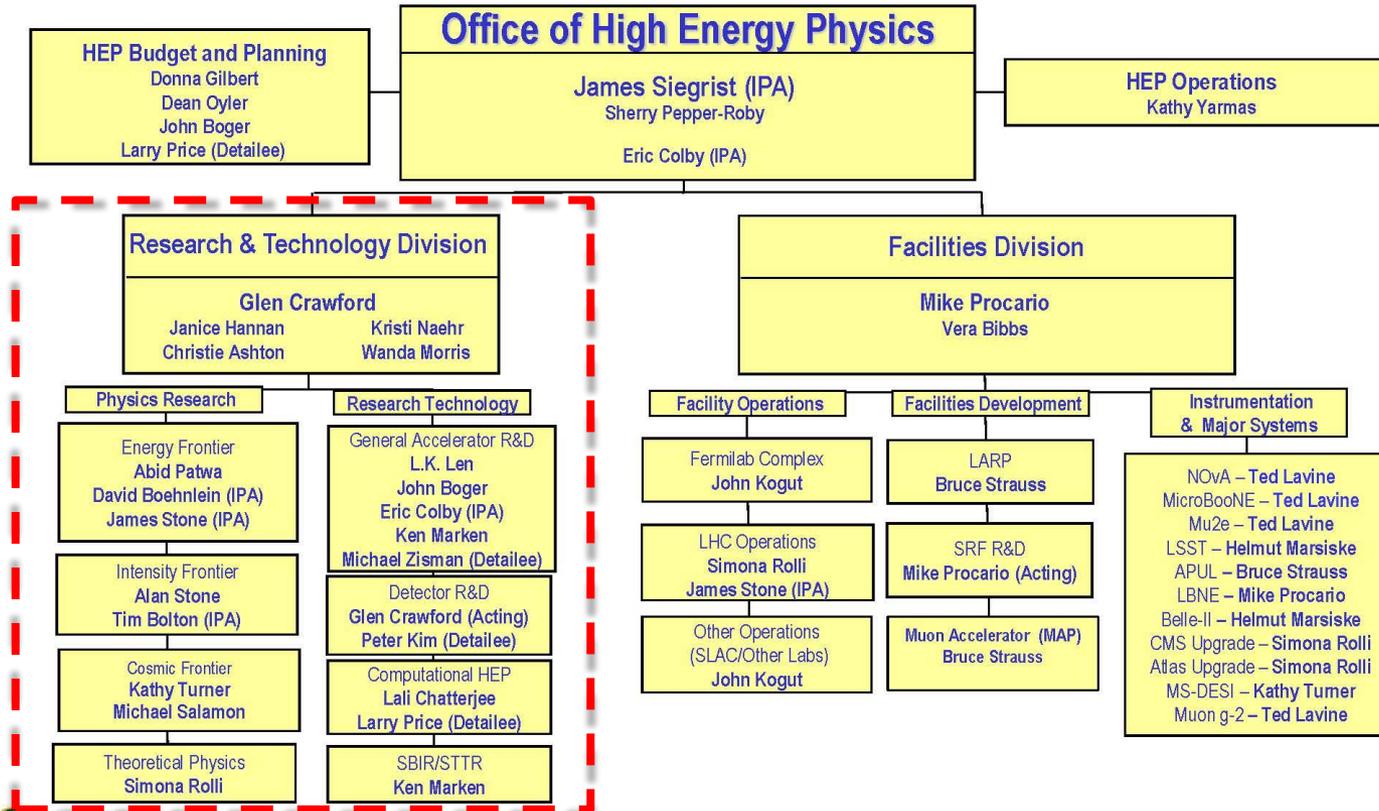
- **Contribute significantly to HEP research collaborations to enable discovery science**
    - **Participation in all phases – from design, construction, operations & analysis**
    - **Particular emphasis on:**
      - Advanced training of students and postdocs
      - Data analysis and comparison with theoretical models
      - Vision and theoretical framework for understanding the Standard Model and beyond
      - Novel and innovative concepts and approaches
      - Design of future HEP experiments



# RESEARCH DIVISION

# Research Division Staffing (2103)

## HEP Organization Chart



**Typical 2013-15 Staffing: 19-22 FTEs**  
**10 Scientists**  
**4 Admin/support**  
**8-9 IPAs/detailees**

# Review Overview

Since the advent of Comparative Review for HEP grants, the Research\* review cycle has become ~regularized:

Type of Review	Mail/Panel	Freq.	Cadence	# proposals	Days	Reviewers
University Grants Comparative	M+P	1/yr	3 yr cycle (most)	~150	9	~100 panel ~200 Mail
Lab Research Comparative	P	2/yr	3 yr cycle†	5-8 labs	3-4	20
HEP Lab Institutional	P	1/yr	4 yr cycle	6-10 areas	3	12-15
Small Lab Institutional	P	<1/yr	Varies	3-5 areas	2-3	5-10
Research Operations/ Small Projects	P, M+P	As needed	Varies	1-10	2-4	3-15
Early Career	M+P	1/yr	Annual	~80	3	15-30 panel ~100 mail
SBIR Phase I/II	M	2/yr	Annual	~200 + 30	n/a	~400 +100

# Reviews Available to the COV

Type of Review	2013	2014	2015	Comment
University Grants Comparative	all	all	all	All reviews available; selected funded and declined applications pulled in advance
Lab Research Comparative	Intensity Cosmic GARD	Theory	Energy	Detector R&D review moved to Feb 2016
HEP Lab Institutional	LBNL	BNL	ANL	SLAC reviewed in 2012 and 2016
Small Lab Institutional			LANL	
Research Operations/ Small Projects	IF Ops	CF Ops		See also detailed listings in IF, CF talks
Early Career	all	all	all	All reviews available; selected funded and declined applications pulled in advance
SBIR Phase I/II				Outside of this COV scope (there is a separate SBIR COV)

# HEP Comparative Review Timeline



- **August:** Letter of Intent (LOI) received from PI. Program planning at DOE/HEP.
- **September:** Proposal received. FOA compliance checks at DOE/HEP: PI qualifications, scope, page limits, budget pages, etc.

- **Sept-October:** Proposals assigned to *at least* three merit reviewers via DOE's Portfolio Analysis and Management System (PAMS);
- **October-November:** Reviewers' input written evaluations in PAMS.
- **November:** Panel discussion of all proposals and all senior personnel. Add additional reviews and make comparative reviews & evaluations.

- **December:** Assessment of each proposal and each PI by DOE/HEP using merit review, grant monitor input, programmatic priorities, budget constraints.
- **Early-to-mid January:** Prioritized budget guidance sent to PIs and requests for revised budgets and budget justifications using proper DOE forms.
- **End-January - March:** Route proposal's procurement packages through DOE/SC and DOE Chicago Operations Office for approval.
- **March-April:** Awards to university from DOE Chicago Operations Office.

**April-June:** Develop new FOA (+ concurrence)  
**July-August:** Announce FOA, socialize changes, PI meetings

**(Other Events or Reviews)**

Initial Fin Plan

OMB Budget

LHC Ops Review

OMB Passback

Budget Rollout

Early Career

SBIR Phase I

Lab Budget Briefings



# Early Career Outcomes

L = National Laboratory Proposal  
U = University Proposal

Subprogram Awards	FY10 (L/U)	FY11 (L/U)	FY12 (L/U)	FY13 (L/U)	FY14 (L/U)	FY15 (L/U)	FY16 (L/U)	Total (L/U)
Energy	3 (1/2)	3 (1/2)	1 (0/1)	2 (0/2)	2 (1/1)	0 (0/0)	2 (0/2)	13 (3/10)
Intensity	2 (1/1)	1 (0/1)	3 (2/1)	1 (0/1*)	1 (1/0)	2 (1/1)	1 (1/0)	11 (6/5)
Cosmic	2 (0/2)	3 (2/1)	3 (1/2)	2 (1/1)	1 (0/1)	0 (0/0)	1 (0/1)	12 (4/8)
HEP Theory	6 (1/5)	4 (0/4*)	3 (0/3)	3 (1/2)	1 (0/1)	3 (0/3)	1 (1/0)	21 (3/18)
Accelerator	1 (1/0)	2 (2/0)	2 (1/1)	1 (0/1)	1 (1/0)	0 (0/0)	2 (2/0)	9 (7/2)
<b>HEP Awards</b>	<b>14 (4/10)</b>	<b>13 (5/8)</b>	<b>12 (4/8)</b>	<b>9 (2/7)</b>	<b>6 (3/3)</b>	<b>5 (1/4)</b>	<b>7 (4/3)</b>	<b>66 (23/43)</b>
<b>Proposals</b>	<b>154 (47/107)</b>	<b>128 (43/85)</b>	<b>89 (34/55)</b>	<b>78 (29/49)</b>	<b>77 (36/41)</b>	<b>73 (27/46)</b>	<b>84 (27/47)</b>	<b>683 (243/440)</b>

\* Two awards funded by DOE Office of Basic Energy Sciences (BES) as an EPSCoR [Experimental Program to Stimulate Competitive Research] award with grant monitored by DOE Office of High Energy Physics (HEP).

- On track to meet HEP ECA annual investment goal (\$15M/yr) when full forward funding requirement hit in FY14
- Increasing investment in FY16+ to get back on track

# Full Funding of Multi-Year Grants

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- **The 2014 Consolidated Appropriations Act, Section 310(D) requires full funding of multi-year grants and/or cooperative agreements received from academic institutions with total cost less than \$1M.**
  - “Full funding” implies funds for the *entire award* for the proposal’s project period is obligated at the time the award is made, instead of funding year-by-year.
  - Requirement continues into FY 2015+ .
  - No exemptions from this provision apply, including Early Career awards
  - Performance against this requirement is tracked by SC management and Congress.
- **Pros/Cons:**
  - Fully forward-funded (FFF) awards reduces out-year “mortgages” and gives program more flexibility to respond to budget changes
  - During transition period (3-5 years) success rate for <\$1M awards goes down, mostly impacting small groups
- **Mitigations:**
  - For FY14/15 Comparative Review, during decision making process, DOE Program Managers may adjust the project period for the grant: for e.g., award a grant with a 2-year project period versus 3-years
  - Priority placed on supporting proposals and senior investigators for existing, on-going research projects
- **Impacts:**
  - FFF awards are ~35-40% of HEP awards but only ~7-10% of HEP funds (per annum).
    - **Varies widely by subprogram. Almost no impact on Energy, Intensity Frontier; significant impact elsewhere**
  - FFF commitments result in ~10-15% additional burden on Research budgets (relative to year-by-year)
  - Overall HEP proposal [PI] success rates went from 65% [72%] (FY12/13) to 47% [60%] (FY14/15).
  - New PI, Jr PI success rates do not appear to be strongly affected (again, varies across program)
  - **Largest impact on subprograms with many single, stand-alone PIs: Cosmic, Theory, Technology R&D (see Backup)**

# Net University PI Changes FY13-16

- Can go back and look at Comparative Review outcomes for last 4 years to determine net flow of new/existing PIs into/out of the HEP university subprograms (we did not break down the data in this way in the first year of HEP Comparative Review, FY12)
  - Can also ask whether the incoming/outgoing PIs are junior faculty
  - Only includes PIs who were reviewed (e.g., retirements not included)
- **Results:**
  - Most programs are strongly adding Jr (non-tenured) PIs (except Tech R&D)
  - PIs dropped due to poor reviews are dominantly Sr (tenured) PIs
  - Largest turnover in Cosmic, Accel R&D (relative to FY13-15 “core” PIs\*)

IN/OUT/Net	Energy (~200 PIs*)	Intensity (~120 PIs*)	Cosmic (~70 PIs*)	Theory (~230 PIs*)	Accel R&D (~45 PIs*)	Det R&D (~35 PIs)
All PIs	15/19/-4	28/23/+5	31/13/+18	27/52/-25	15/31/-16	13/17/-4
Jr PIs (non-ECA)	13/2/+11	15/3/+12	13/3/+10	17/2/+15	2/0/+2	1/1/0
Sr PIs	2/17/-15	13/20/-7	18/10/+8	10/50/-40	13/31/-18	12/16/-4



# **FACILITIES DIVISION**

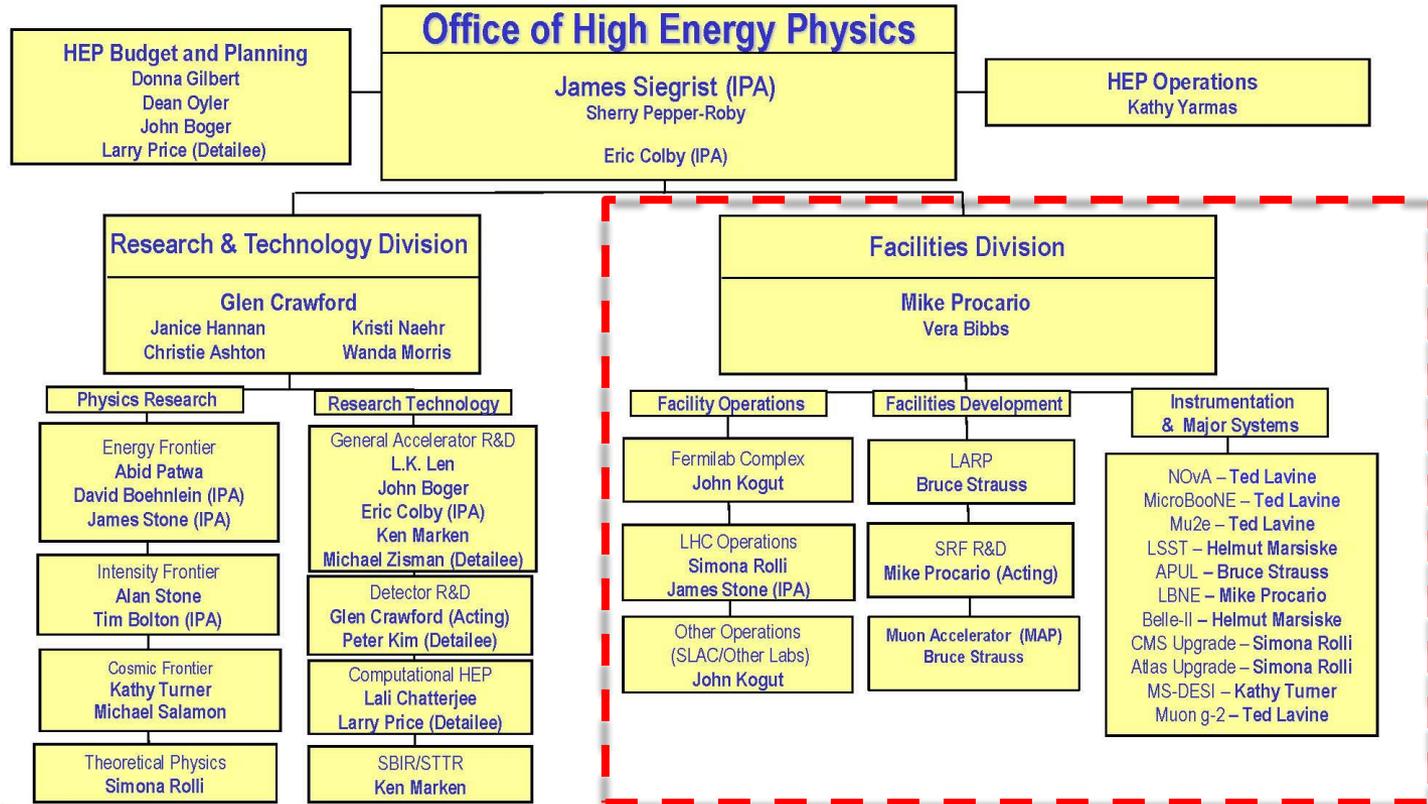
# FD Responsibilities

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- Projects that fall under DOE O413.3b. TPC > \$5 million.
  - Smaller projects are managed out the Research Division.
- User Facilities and large operations programs
  - Fermilab Accelerator Complex
  - LHC Operations Program
  - Facility for Accelerator Experimental Test (FACET)
  - Small operations programs such as DES, Daya Bay, EXO are managed out of the Research Division
- HEP Directed Accelerator R&D
  - LHC Accelerator Research Program (LARP) and Muon Accelerator Program (MAP)
  - Have management structures more like projects with real deliverables and milestones.

# Facilities Division Staffing (2103)

## HEP Organization Chart



**Typical 2013-15 Staffing: 7-8 FTEs**  
**6-7 Scientists**  
**1 Admin/support**  
**1-2 IPAs/detailees**  
**Help from the Research Division**

# User Facilities

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- **Official SC User Facilities have a higher level of scrutiny.**
  - There is a formal process to name a facility an SC User Facility.
  - Lab has deliver and program has to support appropriately.
- **HEP currently supports three official user facilities.**
  - Fermilab Accelerator Complex
  - FACET (shutdown now for LCLS-II and FACET-II work)
  - Accelerator Test Facility at BNL
- **There are two efforts that we are proposing to name as user facilities.**
  - CMS Center at Fermilab
  - ATLAS Center
  - Seek to have SC recognize the importance of these efforts in budgets and user counts.

# Facilities Budgets

	FY 2013	FY 2014	FY 2015
Fermilab Accelerator Complex	132,928	135,173	134,613
FACET	8,589	8,948	9,560
Accelerator Test Facility	-	-	-
B-factory	1,594	-	-
LHC Detector Support and Operations	56,912	54,103	51,500
Homestake	14,000	15,000	15,500
Other facilities	6,138	7,284	5,046
Experimental Operations and Support	43,415	57,235	48,415
<b>Total</b>	<b>263,576</b>	<b>277,743</b>	<b>264,634</b>

**Managed by the Research Division**

# Operations Goals and Reviews

- The goal for user facilities and other operations programs is support research effectively and efficiently.
- Metrics vary depending on the program
  - Neutrino beams: protons on target
  - LHC Ops
    - Computer uptime, jobs run, detector uptime, minimal downtime
  - FACET/ATF
    - Number of users, time needed to collect data
- Correlate metrics with science
  - Peer review of the science
    - Are high impact results coming out of the facilities?
  - Paper published/talks given
- Efficiency of operations
- Fermilab S&T Review
  - Accelerator performance, quality of the science, planning for the future. Held every 12-18 months.
  - Dedicated operations reviews have been held in the past.
  - One was just done in May. Outside the scope of the COV
- LHC Operations Review
  - Conducted jointly with NSF each year.
  - Looks at Tier1 and Tier 2 computing center performance.
    - Support of the users
  - Evaluates detector maintenance and operations performance.
  - Reviews the impact of the program on researchers
  - Do U.S. researchers have a significant impact on the LHC research program?
- LARP and MAP Reviews
  - Conducted every 12-18 months.

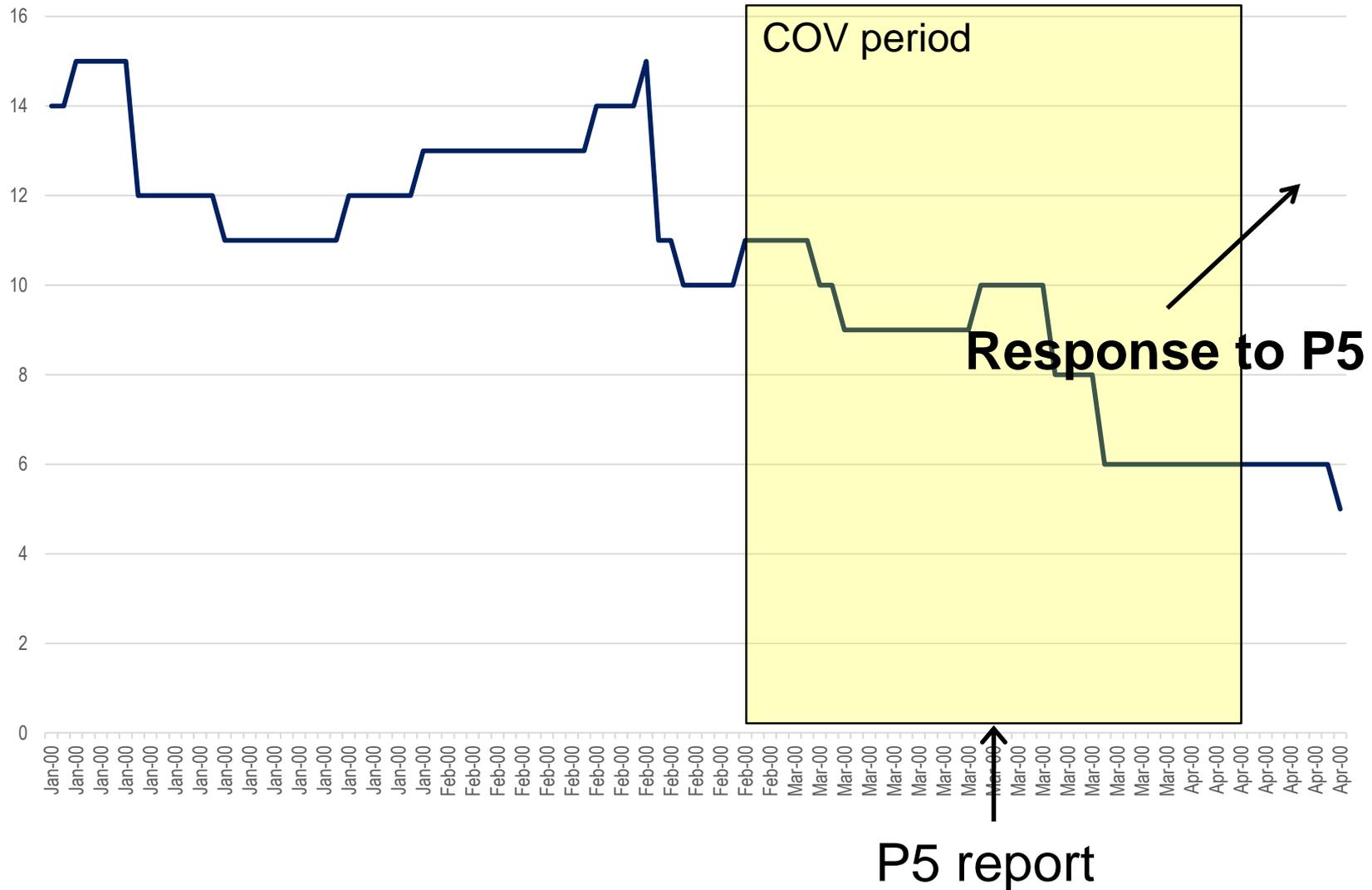
	FY 2013	FY 2014	FY 2015
FNAL S&T/Institutional	X		X
LHC operations	X	X	X
LARP		X	
MAP		X	

# Project Portfolio FY 13-15

Project	Laboratory	Type	TPC (\$M)	Next Step	Actual or Forecast	Manager
BELLA	LBNL	MIE	27.22	Completed	1/17/2013	Borcherding
Belle II	PNNL	MIE	15	Completed	7/18/20016	Procario
APUL	BNL	MIE	13	Completed	3/27/2014	Strauss
MicroBooNE	Fermilab	MIE	19.9	Completed	9/30/2015	Lavine
NOvA	Fermilab-UMinn.	MIE	274	Completed	11/31/2014	Lavine
LSST	SLAC	MIE	168	CD-4	March 2022	Marsiske
Mu2e	Fermilab	LIC	274	CD-4	December 2022	Lavine
Muon g-2	Fermilab	MIE	46	CD-4	June 2019	Lavine
LHC ATLAS Upgrade	BNL	MIE	33	CD-4	November 2018	Rolli
LHC CMS Upgrade	Fermilab	MIE	33	CD-4	July 2019	Rolli
DESI	LBNL	MIE	56	CD-4	Q4 FY 2021	Turner
LZ	LBNL	MIE	56	CD-3	March 2017	Lavine
FACET-II	SLAC	MIE	46-60	CD-2/3A	December 2016	Lavine
SuperCMDS	SLAC	MIE	16-22	CD-2	July 2017	Rolli
LBNF/DUNE	Fermilab	MIE	1,260-1,860	CD-2	Q1 FY 2021	Procario

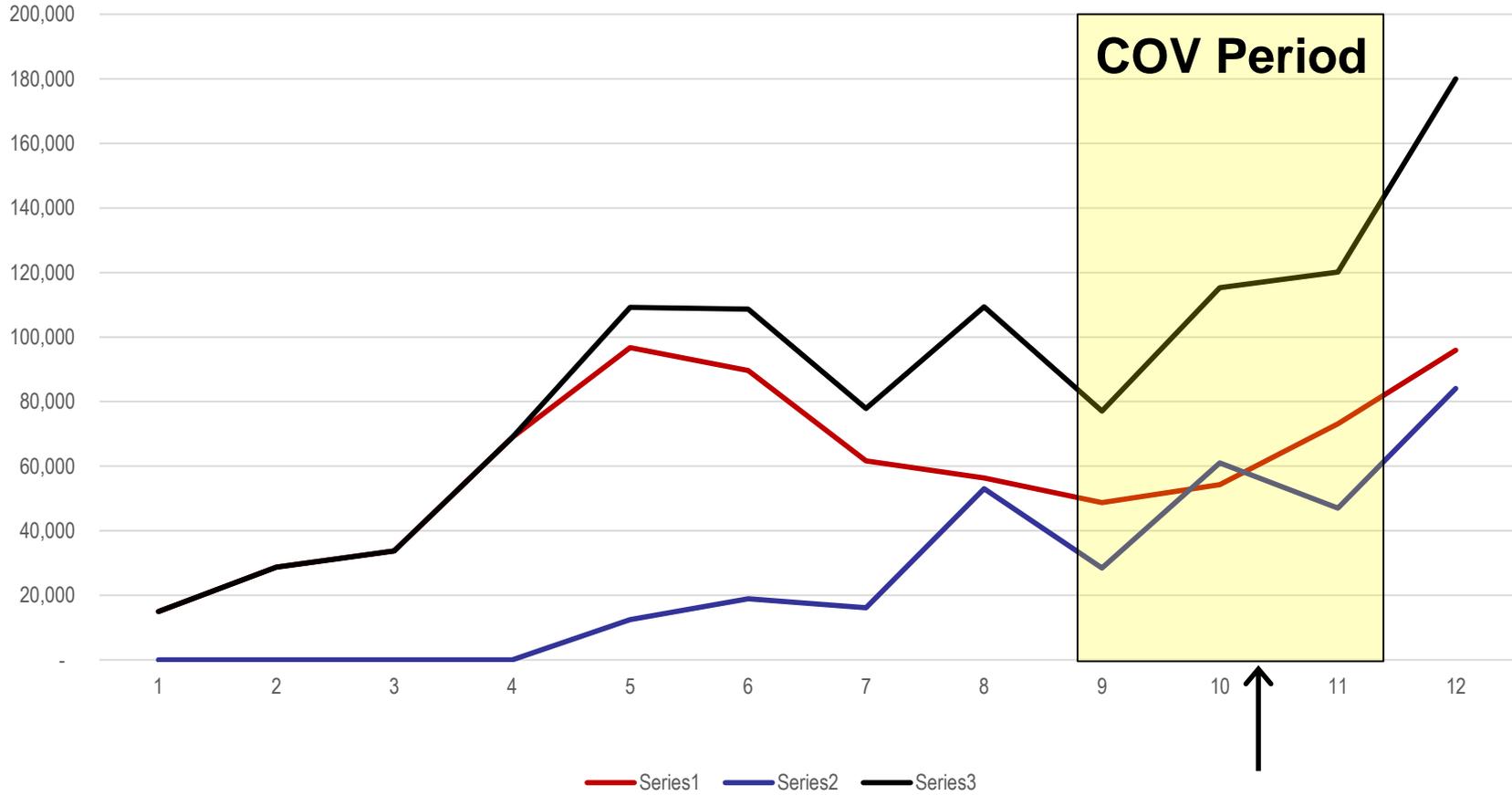
# Number of HEP Projects

Number of active projects per month



# Project Funding

HEP Project Funding  
\$K



P5 report

# OHEP PM Strategy

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- **Aligned with Office of Science Project Management Strategy**
- **Management goals**
  - **Develop high quality cost estimates then build to cost.**
  - **Develop realistic funding profiles and then stick to them.**
    - Still trying to frontload the funding more.
    - Successful at maintaining profiles we establish.
  - **Hold the contractor accountable for management of the project.**
    - Problems should be identified by the contractor.
    - Solutions should be proposed by the contractor.
  - **Strong communications at multiple levels.**
    - HEP AD – Lab ALD
    - HEP Program manager – Lab project manager
    - Horizontal and vertical communication.
    - The goal is no surprises.

# Project Communications

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- Integrated Project Team meets every 1-2 weeks, typically by teleconference
- Laboratory Oversight
  - At Fermilab, the Project Oversight Group (POG) meets monthly.
  - For Daya Bay, the Lab Oversight Group (IHEP, LBNL & BNL) meets monthly.
  - SLAC provides central oversight of all its projects through the Project Management Oversight Group.
- Program Office Oversight
  - Program Manager attends IPT & PMG meetings plus informal calls and/or site visits as needed. Receives status report from Contractor PM Office monthly.
  - HEP Director holds biweekly project-focused teleconference with the Labs.
  - Energy Systems Acquisition Advisory Board (ESAAB) is convened for Critical Decisions.
  - Independent Project Review by Office of Project Assessment,
  - SC Project Watch-list Meeting w/ Dehmer & Lehman hears projects' issues monthly.

# Project Specific Tailoring

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- **Phasing of Critical Decisions (CD) 3 or 4**
  - Advancement of Long-lead Procurement, CD-3a versus CD-3b
    - Seen in most projects
  - Advancement of Partial or Initial Operational Capability, CD-4a versus CD-4b
    - Beneficial for modular detectors since it allows operation of the detectors as soon as they are ready.
- **Combining of Critical Decisions in a small project, such as CD-1&2 or CD-2&3**
- **Authorizing small amounts of work that has a outside impact on the project.**
  - See Muon g-2 and DESI for examples

# Project Management Awards

Project	Laboratory	Award	Year
MicroBooNE	Fermilab	DOE Secretary's Achievement Award	2016
NOvA	Fermilab	DOE Secretary's Award of Excellence	2015
Pepin Carolan	Fermi Site Office	Federal Project Director of the Year	2015
BELLA	Berkeley Lab	DOE Secretary's Achievement Award	2014
NOvA Far Detector Building	Fermilab	American Council of Engineering Companies' Engineering Excellence Awards	2013
Daya Bay Reactor Neutrino Detector	Berkeley Lab	DOE Secretary's Achievement Award	2013
MINERvA	Fermilab	DOE Secretary's Achievement Award	2011