



**DOE Office of Science (SC)
Office of High Energy Physics (HEP)
Cosmic Frontier Experimental Program**

**ICHEP Meeting
Chicago, IL
4 August 2016**

Cosmic Frontier Program Managers:

Kathy Turner (Presenter)

Anwar Bhatti (IPA), Eric Linder (IPA), Michael Salamon

HEP Presentations

This talk will emphasize the Cosmic Frontier program within the broader context of the overall HEP program

→ There is much more information in these slide than I have time so will concentrate on the priority information; rest is for later reference.

Other HEP Talks:

Energy Frontier	Aug. 4
DOE/HEP Civics Presentation	Aug. 5
Intensity Frontier	Aug. 5
HEP Theory	Aug. 5
Detector R&D	Aug. 6
DOE/HEP General Presentations	Aug. 10



Outline

- **SC, HEP Program, Guidance & Planning**
- **BUDGETS**
- **COSMIC FRONTIER PROGRAM DETAILS**
- **RESEARCH PROGRAM MODEL & SUPPORT CONSIDERATIONS**
- **FUNDING OPPORTUNITIES**
- **GRANTS PROCESS & RESULTS**



SC, HEP PROGRAM, GUIDANCE & PLANNING



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SC → HEP Program Mission

Office of Science → part of a “Mission” Agency (HEP 1 of 6 Office)

- Provides science leadership & support to enable significant advances in specific areas
- **Strategic planning process with community input to develop science drivers and a specific portfolio of facilities & experiments**
- Laboratory System with comprehensive resources & infrastructure to build & o facilities & projects to carry out program.

HEP Program Mission

...is to understand how the universe works at its most fundamental level:

- **Discover the most elementary constituents of matter and energy**
- **Probe the interactions between them**
- **Explore the basic nature of space and time**

HEP fulfills its mission by –

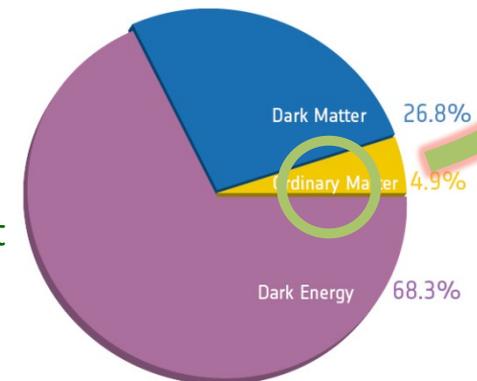
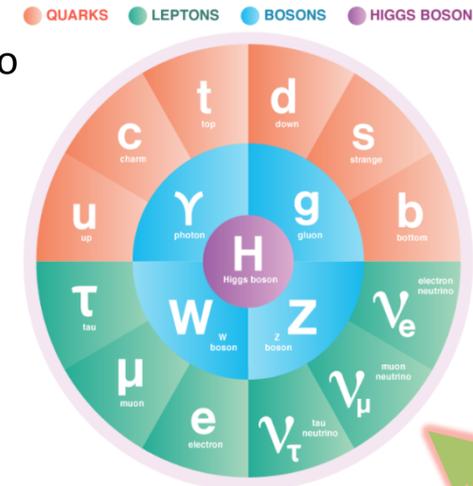
Develop program that follows the strategic plan

- Building projects that enable discovery science
- Operating facilities to provide the capabilities for discovery science
- Supporting a research program to produce discovery science

→ Support scientific collaborations to participate in all phases of experiment in order to produce the best possible science results.

Partnerships – Interagency & International partnerships maximize science.

- **NSF, NASA, DOE – regular discussions about planning, overlaps, issues**
- Country-level agreements to allow science partnerships to move forward.



Office of High Energy Physics

James Siegrist, Director

Sherry Pepper-Roby, Administrative Specialist
Michael Cooke

Accelerator Stewardship

Eric Colby

HEP Operations

Kathy Yarmas

HEP Connections

Lali Chatterjee

HEP Budget and Planning

Erin Cruz
Michelle Bandy
Alan Stone

International Agreements Program

Michael Salamon

Research & Technology Division

Glen Crawford, Director

Janice Hannan
Christie Ashton
David Bogley
Jasmine Shannon (Contractor)

Facilities Division

Mike Procaro, Director

Vera Bibbs

Physics Research

Energy Frontier

Abid Patwa
James Stone (IPA)

Intensity Frontier

Glen Crawford (Acting)

Cosmic Frontier

Kathy Turner
Michael Salamon
Anwar Bhatti (IPA)
Eric Linder (IPA)

Theoretical Physics

Simona Rolli
William Kilgore (Detailee)

Research Technology

General Accelerator R&D

L.K. Len
John Boger
Eric Colby
Ken Marken

Detector R&D

Helmut Marsiske

Computational HEP

Lali Chatterjee

SBIR/STTR

Ken Marken

Facility Operations

Fermilab Complex

John Kogut

LHC Operations

Abid Patwa
Simona Rolli

Other Operations
[SLAC/Other Labs]

John Kogut

Facilities Development

LARP

Bruce Strauss

Muon Accelerator (MAP)

Bruce Strauss

Instrumentation & Major Systems

NOvA – Ted Lavine
MicroBooNE – Ted Lavine
Mu2e – Ted Lavine
Muon g-2 – Ted Lavine
LBNF – Bill Wisniewski (Detailee)
PIP-II – Steve Peggs (Detailee)
APUL – Bruce Strauss
CMS Upgrade – Simona Rolli
ATLAS Upgrade – Simona Rolli
Belle-II – Mike Procaro
LSSTcam – Helmut Marsiske
DESI – Kathy Turner
LZ – Ted Lavine
SuperCDMS-SNOLAB – Simona Rolli



HEP Program Guidance

FACA panels & subpanels provide official advice:

- **High Energy Physics Advisory Panel (HEPAP)**
 - Jointly chartered by DOE and NSF to advise both agencies
 - **Provides the primary advice for the program**
 - Subpanels for detailed studies (e.g. Particle Astrophysics Science Assessment Group “PASAG” in 2009, **Particle Physics Project Prioritization Panel (“P5”)** in 2008, 2014)
- **Astronomy and Astrophysics Advisory Committee (AAAC)**
 - Advises DOE, NASA, and NSF on selected issues in astronomy & astrophysics of overlap, mutual interest and concern

Formal Advice Also Provided by:

- **National Academy of Sciences (NAS)**
 - Established by Congress in 1863 to advise the government on the arts and sciences
 - Reports: *New Worlds New Horizons* (2010), “mid-decade review” in astronomy/astrophysics report imminent
 - Ongoing: Board on Physics & Astronomy (BPA), Committee on Astronomy & Astrophysics (CAA)

Other:

- Community science studies and input (e.g. Snowmass, Dark Energy Task Force, DPF input).
- CMB-S4 Concept Design Team (CDT) being formed (more later)



2014 P5 strategic plan: Enabling the Next Discovery

P5 plan is a compelling, unified, global vision for HEP:

→ 5 Intertwined Science drivers motivate the program priorities

- Use the Higgs boson as a new tool for discovery
- Pursue the physics associated with neutrino mass
- Identify the new physics of dark matter
- Understand cosmic acceleration: dark energy and inflation
- Explore the unknown: new particles, interactions, and physical principles



Research Frontiers – HEP manages program according to experimental technique

- Cosmic, Energy, Intensity Frontiers; also Theory, Detector R&D & Accelerator R&D subprograms

DOE execution of the P5 strategy requires navigating many factors, including:

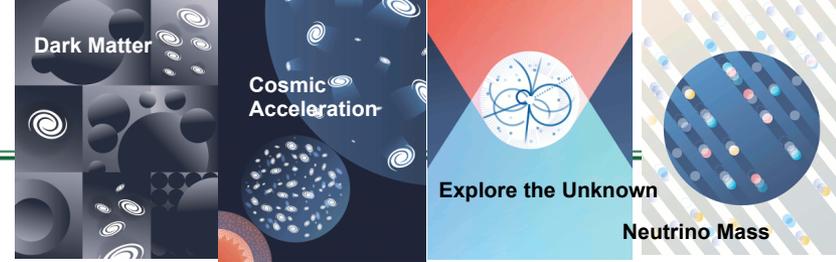
- Balancing scope of HEP program: projects, operations, research
- U.S. budget formulation and execution
- Coordination among U.S. and international partners

P5 strategic plan: 5 science drivers

	Energy Frontier	Intensity Frontier	Cosmic Frontier
Higgs Boson	●		
Neutrino Mass		●	●
Dark Matter	●	●	●
Cosmic Acceleration			●
Explore the Unknown	●	●	●

May 2014 P5 Strategic Plan

Recommendations - Cosmic Frontier



- **Dark Energy**
 - Complete LSST as planned
 - Build DESI as a major step forward in dark energy science
- **Dark Matter**
 - Proceed immediately with a broad second-generation (G2) dark matter direct detection program (**DM-G2**) with capabilities described in the text
 - Invest in this program at a level significantly above that called for in the 2012 joint agency announcement of opportunity
 - Support one or more third-generation (G3) direct detection experiments
 - Guide G3 by the results of the preceding (G1, G2) searches
 - Seek a globally complementary program and increased international partnership in G3 experiments (DM-G3 Project is in the P5 plan in later part of their 10 year plan)
- **Cosmic Microwave Background (CMB)**
 - Support CMB experiments as part of the core particle physics program
 - The multidisciplinary nature of the science warrants continued multi-agency support (**CMB-S4 Project** is in the P5 plan, starting about mid-way through their 10 year plan)
- **Cosmic Rays and Gamma Rays**
 - Invest in CTA only if the critical NSF Astronomy funding can be obtained
 - CTA has a broad science reach that transcends fields, with the dark matter detection capabilities of direct importance to particle physics; Using P5 Criteria, a de-scoped US component should be shared by NSF-AST, NSF-PHY and DOE.



P5 Report – Program & Project Criteria



HEP uses P5 criteria to develop the program and determine which projects, and at what level, to invest in. **The criteria can also be applied to Research efforts.**

- **Program optimization criteria**

- **Science:** based on the Drivers, assess where we want to go and how to get there, with a portfolio of the most promising approaches.
- **International context:** pursue the most important opportunities wherever they are, and host world-leading facilities that attract the worldwide scientific community; duplication should only occur when significant value is added or when competition helps propel the field in important directions.
- **Sustained productivity:** maintain a stream of science results while investing in future capabilities, which implies a balance of project sizes; maintain and develop critical technical and scientific expertise and infrastructure to enable future discoveries.

- **Individual project criteria**

- **Science:** how the project addresses key questions in particle physics, the size and relevance of the discovery reach, how the experiment might change the direction of the field, and the value of null results.
- **Timing:** when the project is needed, and how it fits into the larger picture.
- **Uniqueness:** what the experiment adds that is unique and/or definitive, and where it might lead. Consider the alternatives.
- **Cost vs. value:** the scope should be well defined and match the physics case. For multidisciplinary/agency projects, distribution of support should match the distribution of science.
- **History and dependencies:** previous prioritization, existing commitments, and the impacts of changes in direction.
- **Feasibility:** consider the main technical, cost, and schedule risks of the proposed project.
- **Roles:** U.S. particle physics leadership



BUDGETS



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The U.S. Federal Budget Cycle

Three Fiscal Year (FY) budgets being worked on at any given time

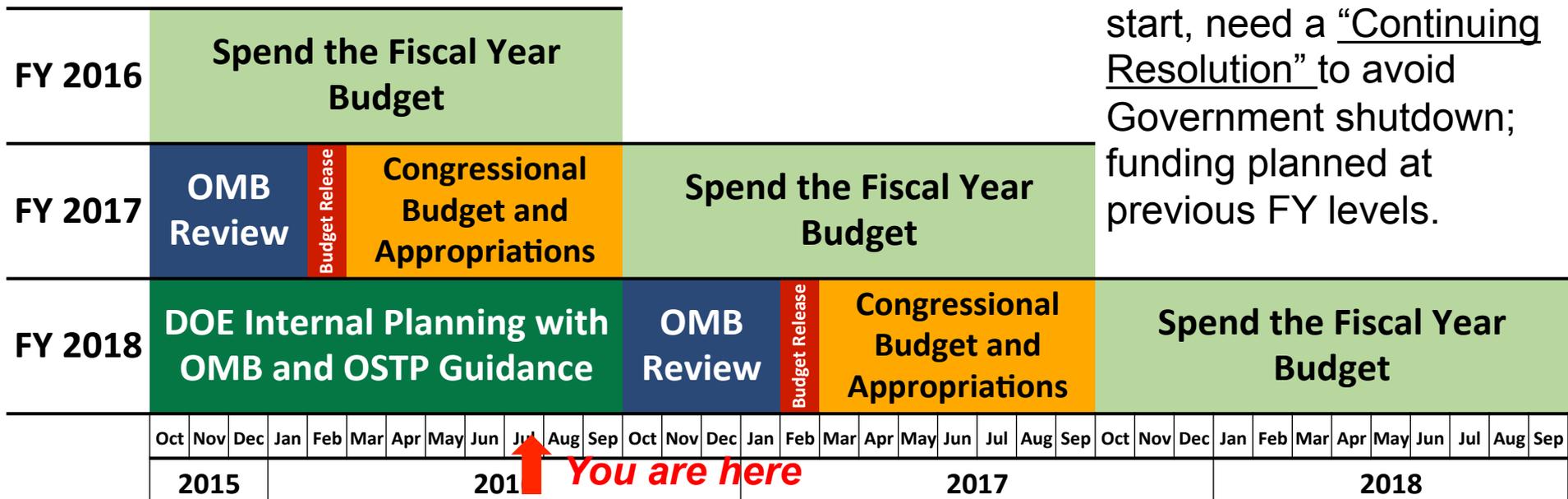
1. Current Fiscal Year being Executed (FY; October 1 – September 30)
2. FY+1: White House’s Office of Management and Budget (OMB) review and Congressional Appropriation

President Requests: using strategic plans, advisory panels, project performance, Agency management, planning, White House funding availability, policies, priorities

But...Congress “holds the purse” & makes appropriations

3. FY+2: Agency internal planning

*** If Congress doesn’t pass a budget by the FY start, need a “Continuing Resolution” to avoid Government shutdown; funding planned at previous FY levels.



HEP Budget Strategy

The enacted FY16 HEP Budget of \$795M was above the Request & squarely in P5 Scenario B.

FY17 President's Request for HEP (\$818M) aims to continue the successful P5 implementation:

- Investing in portfolio of high-priority projects at the small, medium, and large cost scales
- Request is carefully balanced between support for projects (\$212M), facility operations (\$252M), and scientific research (\$354M) in order to produce scientific results while “building for discovery”

The Request reflects the way that implementing the P5 strategy has evolved as the U.S. and international community has adopted and responded to it

- LHC (including upgrades) is still the highest near-term HEP priority
- LBNF/DUNE has been reconfigured and is gaining international support much more rapidly than anticipated in the P5 strategy
- U.S. Administration and Congress strongly support establishing LBNF/DUNE as the first U.S.-hosted international science facility

The Request presents an opportunity to advance the P5 strategy on a shorter time scale through additional funding: “Scenario B+”

- HL-LHC accelerator and detector upgrades per CERN schedule
- Support all other projects in P5's Scenario B
- Maintain balance between Research, Operations, and Projects
- Additional funding *beyond* the above priorities would support accelerating the implementation of LBNF/DUNE



HEP FY 2017 Budget: Research Priorities

- **Cosmic Frontier: Advance leadership efforts in the dark matter, dark energy programs**
 - Fabrication funding ramp-up in FY17 supports key P5 recommended Cosmic Frontier projects: LSSTcam, DESI, SuperCDMS-SNOlab, LZ
 - Below MIE projects, ADMX-G2 & SPT-3G, starting operations
 - Planning efforts for the future: CMB-S4, small R&D efforts on DM-G3
- **Energy Frontier: Continue to support leadership roles in the successful LHC program**
 - Initial (Phase-1) LHC detector upgrade project funding completes in FY17
 - Develop TDRs for High Luminosity (HL)-LHC experiments; CD-0 April 2016
 - Continue R&D/prototyping towards HL-LHC accelerator; CD-0 April 2016
 - Continue leadership role in LHC discoveries by remaining actively engaged in LHC operations and data analysis
- **Intensity Frontier: Solidify international partnerships for U.S.-hosted LBNF/DUNE**
 - Rapid progress on LBNF/DUNE has attracted attention from interested international partners and FY17 investments in site preparation and cavern excavation aim to solidify international partnerships
 - Fermilab will continue improvements to accelerator complex while serving high-intensity neutrino beams to short- and long-baseline experiments, enabling full utilization of the FNAL facilities
- **Theoretical Physics: Support a vibrant program that plays essential roles in all areas**
 - Interpreting results from current experiments, motivating future experiments, and pursuing the deepest questions about the foundations of particle physics

HEP Budget Planning for FY17: Given the current political climate, we expect a CR for at least part of FY 2017 and are planning accordingly.



Overall HEP Budget Trend

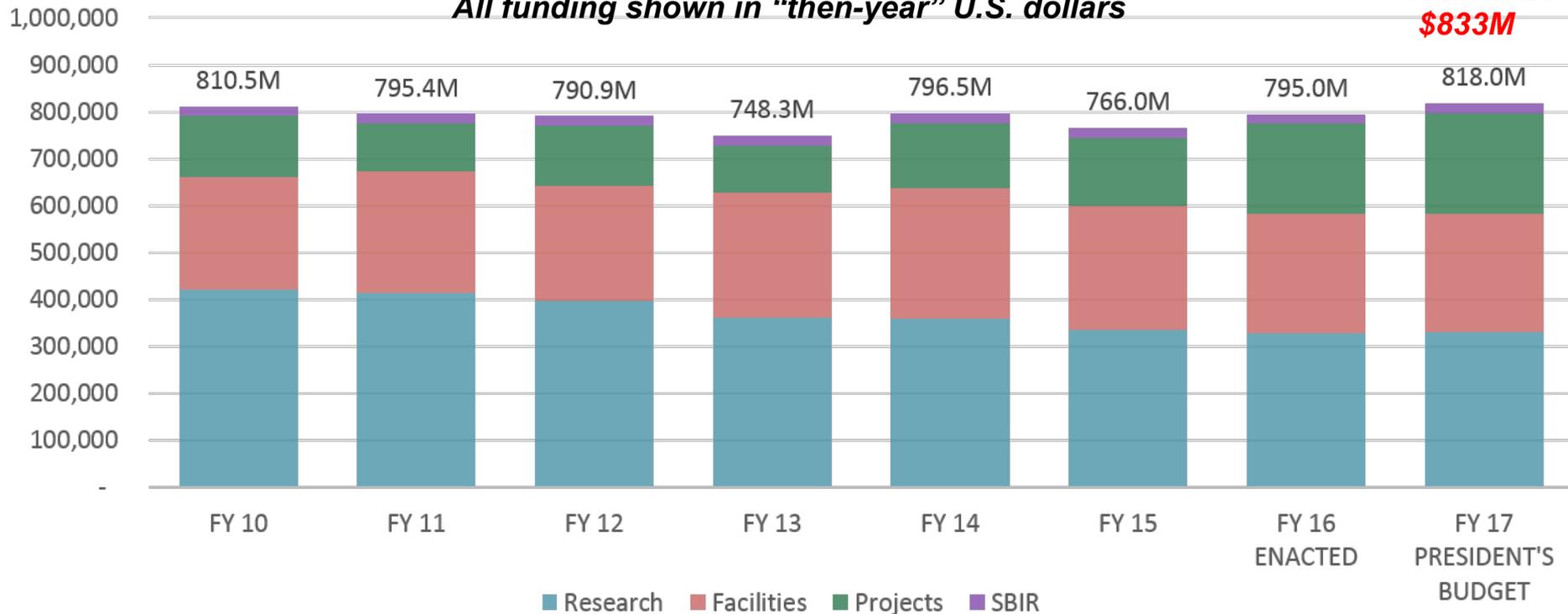
- Significant dip in FY13 from Congressional sequestration
- FY15 request developed prior to P5 report release

HEP BUDGET ALLOCATION BY FISCAL YEAR (\$ IN K)

House mark
\$823M

Senate mark
\$833M

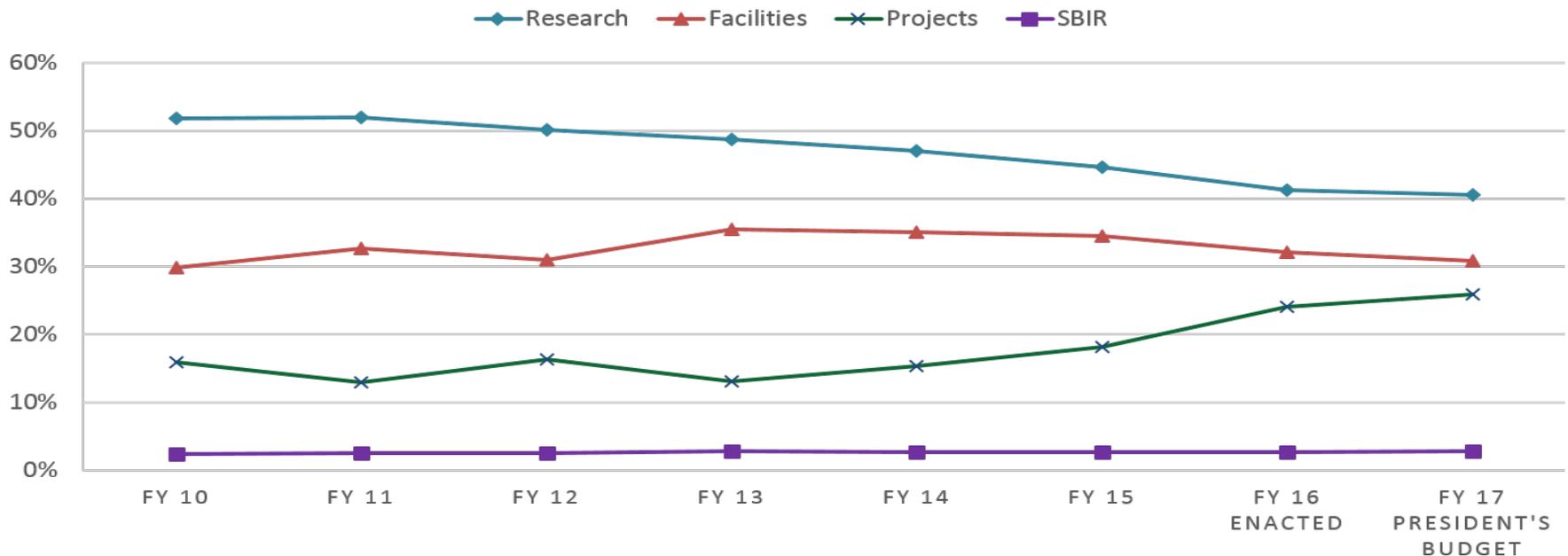
All funding shown in "then-year" U.S. dollars



HEP Budget Trend by Category

- HEP must coordinate **Projects**, **Facilities/Operations**, and **Research** efforts to succeed in its mission
- Recently, trading Research for Project investments
- **Research:**
 - Carefully planning the Research program to maximize science impacts enabled by the P5 strategy
 - Support is flat in the FY17 President's Budget Request

**HEP BUDGET ALLOCATION BY FISCAL YEAR
(% OF TOTAL HEP BUDGET)**



COSMIC FRONTIER: PROGRAM DETAILS



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Research at the Cosmic Frontier

→ Through ground-based telescopes, space missions, and deep underground detectors, research at the cosmic frontier aims to explore dark energy and dark matter, which together comprise approximately 95% of the universe.



Program Priority Areas:

- Study the nature of **Dark Energy**
- Direct Detection searches for **Dark Matter** particles
- **Cosmic-ray & Gamma-ray studies** – particle properties, high energy acceleration mechanisms, indirect searches for dark matter particles
- **CMB** – Inflationary Epoch, Dark Energy, Neutrino Properties

→ In other HEP programs: Related Theory, Computational efforts, Detector R&D.

Status & Path Forward

- Continue development of near-term projects recommended by P5
- Planning activities to support P5 recommendations later in the decade: CMB-S4, Cosmic Visions Groups
- Successfully complete current operating experiments.



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Cosmic Frontier – Dark Energy

Precision measurements to differentiate between Cosmological Constant and new fields or modification to General Relativity

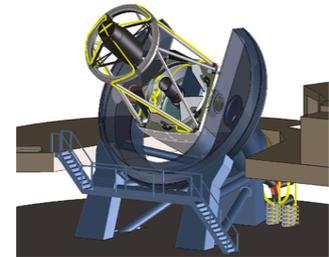
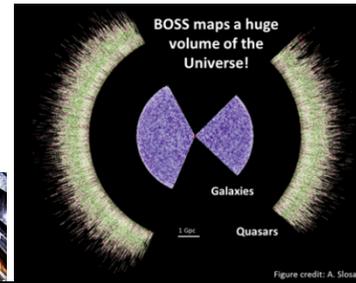
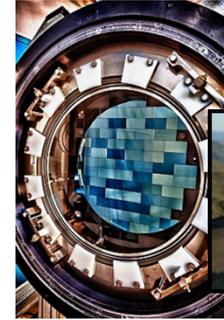
- staged, complementary suite of imaging, spectroscopy & supernova surveys

Operating/Completed:

- **BOSS (spectroscopic)** ended FY14; **eBOSS (spectroscopic)** started in 2015
- **DES (imaging)** started 5-year survey in late FY13; partner with NSF-AST

Design, Fabrication:

- **Large Synoptic Survey Telescope (LSST, Stage IV imaging)**
 - HEP and NSF-AST (lead agency) partnership; HEP responsible for the LSST camera (SLAC)
 - LSSTcam fabrication started FY14, CD-3 (full fabrication approved) Aug. 2015,
 - LSST Project Status review Aug 2016
 - LSST Facility Operations phase planning started
 - LSST Dark Energy Science Collaboration (DESC) Operations being planned.
- **Dark Energy Spectroscopic Instrument (DESI, Stage IV spectroscopic)**
 - “HEP experiment” with LBNL managing
 - build DESI instrumentation & data management system for use on Mayall telescope
 - HEP coordinating with NSF-AST to use (“lease”) the Mayall telescope;
 - HEP partial support in FY16-18; full support for dark energy operations starting in FY19
 - CD-3 (full fabrication approved) June 2016
 - Planning for Mayall shutdown, ready for DESI 1QFY18 & Full Operations starting early FY20



Cosmic Frontier: Direct Detection Dark Matter (DDDM)

→ Learn the identity and nature of Dark Matter with staged program of experiments with multiple technologies & methods

Operating:

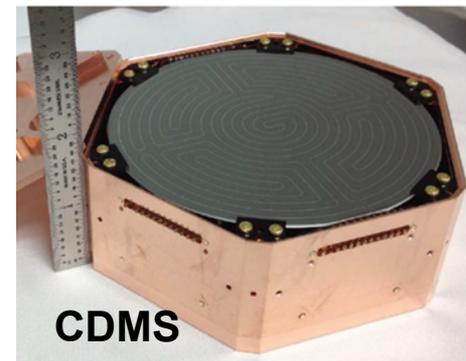
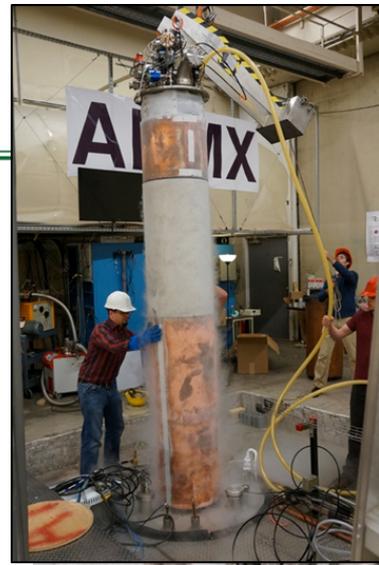
DM-Generation 1 (DM-G1): **ADMX-II, LUX, CDMS-Soudan, DarkSide-50, COUPP/PICO, DAMIC** – completing operations efforts by FY 2016

Design, Fabrication:

- Progress continues on DM-G2's selected by HEP & NSF-PHY in July 2014
 - **ADMX-G2** axion search at U.Wash. (HEP); operations starting, review Sept. 2016
 - **LZ** at Homestake Mine in South Dakota (HEP, LBNL project office)
 - WIMP dark matter search through dual phase liquid Xe – higher mass range
 - Fabrication start (CD-1/3a) in FY15; CD-2 approval planned Aug. 2016
 - **SuperCDMS-SNOlab** at Sudbury Neutrino Observatory in Canada
 - WIMP search using cryogenic solid-state crystals – lower mass range
 - HEP+NSF-PHY partnership, SLAC Project Office
 - CD-1 approval in Dec. 2015; Status review July 2016

HEP plans for future (P5)

- HEP concentrating on getting the DM-G2 experiment(s) successfully started
- Limited R&D support planned in FY17+ for optimizing DM-G2 science & continuing focused technology studies needed for the future



Cosmic Frontier: CMB

Gain insight into **inflationary epoch** at the beginning of the universe, **dark energy & neutrino properties** by studying oldest visible light.

In Atacama: CLASS, ACT, PolarBear/Simons



Fabrication:

SPT-3G – HEP provided support towards major upgrade of the camera to greatly increase sensitivity; Ops starting early 2017



As recommended by P5, HEP is planning to participate in a CMB Stage 4

- Working with NSF to coordinate planning and a path forward
 - HEP will coordinate efforts within HEP program and consider possible roles; HEP labs already involved in R&D

- ➔ CMB-S4 Community-based Collaboration bringing together ground based community to plan future
- Notional array of several telescopes in Chile & South Pole with on the order of 0.5 M detectors
 - Technology ready, but needs scale-up of detector fabrication, testing, and readout

CMB-S4 Collaboration draft Science Book:

https://cosmo.uchicago.edu/CMB-S4workshops/index.php/Main_Page

DOE/HEP and NSF (PHY, AST, Polar) recently sent a call out to the community to apply to be a member of the CMB-S4 Concept Definition Team

- Messages were sent to the CMB-S4 Collaboration and HEP Lab management
- This will be a small team to help develop concepts and options for a CMB-S4 project



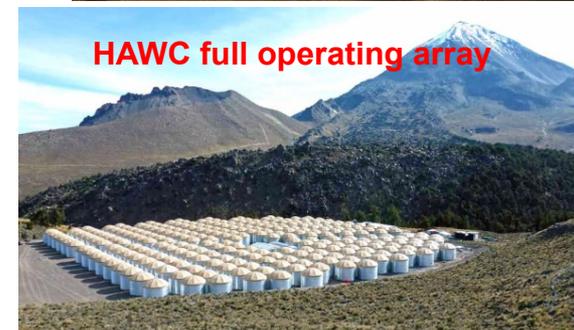
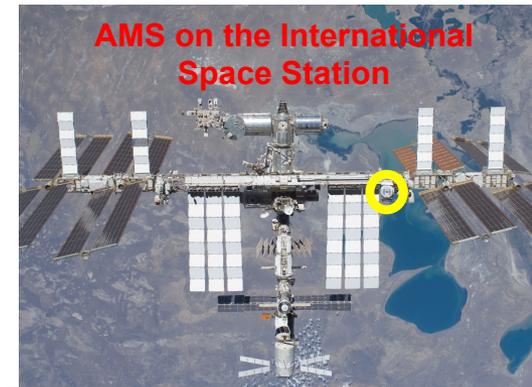
Cosmic Frontier – Cosmic-ray, Gamma-ray

Use ground-based arrays, space telescopes, and an experiment on the International Space Station to perform indirect searches for dark matter, fundamental physics

→ Significant inter-agency & international partnerships

Operating/Analysis:

- **Fermi/GLAST** (w/NASA)
 - HEP participation in coordination with NASA ;HEP is supporting the Large Area Telescope Instrument Science Ops Center at SLAC
- **VERITAS** (w/NSF)
 - HEP operations support completed; finalizing HEP-supported analysis
- **Auger** (w/NSF-PHY)
 - HEP participation in operations & research ramping down in FY16; no participation planned on upgrade
- **AMS** (w/NASA)
 - operations continuing
- **HAWC** (w/NSF)
 - 5 year HEP-supported operations started early 2015



Cosmic Visions (CV) Groups – looking towards the future

Following P5, HEP Labs & Community are redirecting programs to align with P5 priorities

HEP has started “Cosmic Visions (CV)” groups in several areas

- Allows interactions with small HEP community groups (~ monthly) as a 2-way line of communication for HEP-funded efforts.

NOTE: Of course, any HEP-funded R&D/technology plans need to be in the context of the larger non-HEP and global community (so as not to duplicate efforts or go off in directions that don't make sense)

CV-CMB

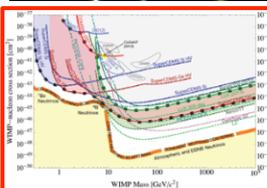
Coordinate HEP technology R&D and other efforts for future CMB-S4 planning

CV-DE

Investigate future directions following the end of construction of DESI and LSST; to complement, build on or extend these experiments in investigating the physics of dark energy.

CV-DM (Dark Matter Direct Detection)

Coordinate and investigate HEP technology R&D to optimize science from DM-G2 experiments and for future DM-G3 planning

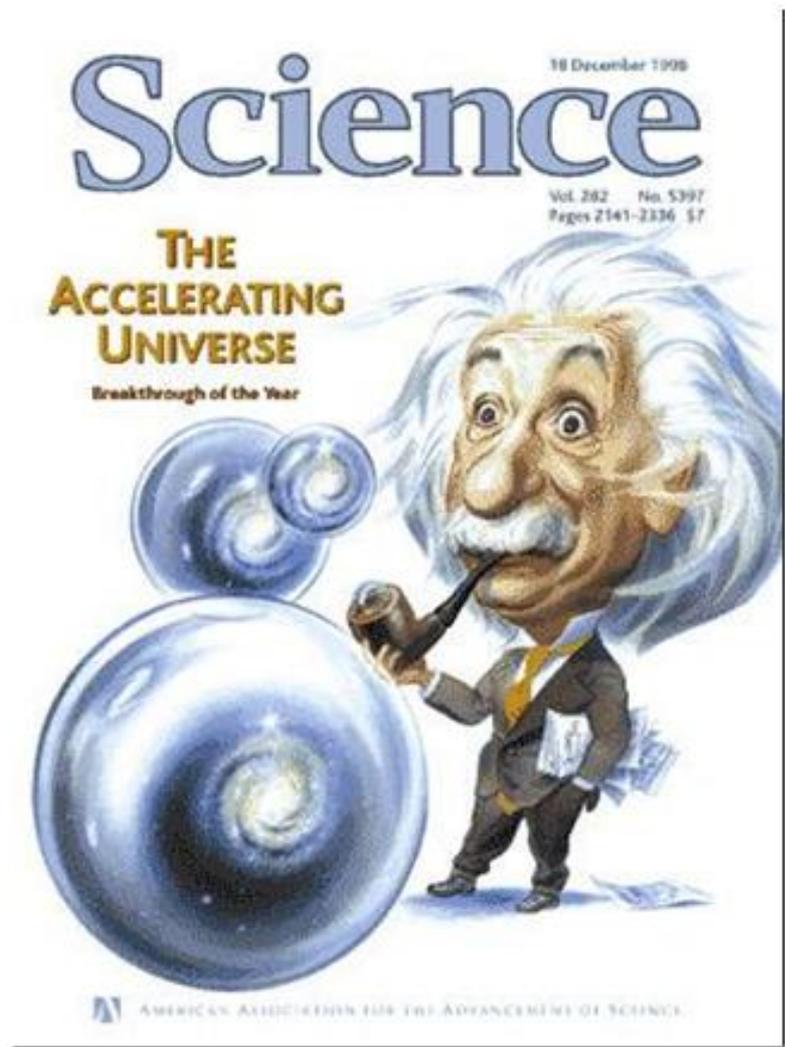


Cosmic Frontier Budget History – details

	in \$K	FY14 Actual	FY15 PRB	FY15 Actual	FY16 PRB	FY16 Current	FY17 PRB
Research	All	52,712	45,435	48,779	50,079	47,180	46,991
<i>Research</i>	<i>Grants</i>	<i>13,157</i>	<i>11,422</i>	<i>11,773</i>	<i>12,565</i>	<i>12,705</i>	<i>11,607</i>
<i>Research</i>	<i>Labs</i>	<i>39,555</i>	<i>34,013</i>	<i>37,006</i>	<i>37,514</i>	<i>34,475</i>	<i>35,384</i>
Exp Operations		10,357	7,238	9,185	7,120	10,274	8,925
Projects	All	30,660	41,000	46,403	58,701	67,780	70,200
Projects	MIE	22,900	41,000	44,178	57,100	64,600	69,500
<i>Projects</i>	<i>LSSTcamera</i>	<i>22,000</i>	<i>35,000</i>	<i>35,000</i>	<i>40,800</i>	<i>40,800</i>	<i>45,000</i>
<i>Projects</i>	<i>DM-G2</i>	<i>900</i>	<i>6,000</i>		<i>11,000</i>		
<i>Projects</i>	<i>LZ</i>			<i>3,050</i>		<i>10,500</i>	<i>10,500</i>
<i>Projects</i>	<i>SuperCDMS-SNOLAB</i>			<i>2,250</i>		<i>3,000</i>	<i>4,000</i>
<i>Projects</i>	<i>DESI</i>			<i>3,878</i>	<i>5,300</i>	<i>10,300</i>	<i>10,000</i>
Projects	Small Proj Fab			1,025	1,601	2,035	0
<i>Projects</i>	<i>All</i>				<i>1,601</i>		<i>0</i>
<i>Projects</i>	<i>ADMX-G2</i>			<i>925</i>		<i>935</i>	
<i>Projects</i>	<i>SPT-3G</i>			<i>100</i>		<i>1,100</i>	
Projects	Future Proj R&D	7,760	0	1,200	0	1,145	700
<i>Projects</i>	<i>All</i>						<i>700</i>
<i>Projects</i>	<i>DESI (BigBOSS)</i>	<i>1,100</i>					
<i>Projects</i>	<i>Dark Matter</i>	<i>5,260</i>		<i>200</i>		<i>1,145</i>	
<i>Projects</i>	<i>SPT-3G</i>	<i>1,400</i>		<i>1,000</i>			
TOTAL - Cosmic		93,729	93,673	104,367	115,900	125,234	126,116



RESEARCH PROGRAM MODEL & SUPPORT CONSIDERATIONS



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Budget Categories

Research budgets:

- **Support scientists on all phases of an experiment**
- **Budget categories for Labs and for Universities**
 - Support research efforts directly in line with our program and project priorities, responsibilities and science goals
 - Support science collaboration (HEP model) to carry out the experiment in all phases

University research is supported by a competitive, proposal-driven process

- Grants issued after peer review of proposals to Funding Opportunity Announcements (FOAs)
- Program alignment is built into proposal review process

Laboratory research is mission driven and funded through Field Work Proposals

- HEP holds comparative reviews of Lab research programs every ~ 3 years (Cosmic Frontier in July 2016)
- Program guidance to the Laboratories is provided by HEP with input from a variety of sources

Project Support budgets:

- **Supports engineers, technical staff, computing professional, Materials, Equipment**
- **Budget categories:**
 - R&D
 - Fabrication (typically called “Project” phase)
 - Experimental Operations



Cosmic Frontier – Research Support Priorities, aligned with P5

Dark Matter :

Complete G1 operations & analysis; **construct and plan G2 experiments**, modest future R&D

Dark Energy :

Complete BOSS analysis; DES operations & analysis; **construct and plan LSST and DESI**

CMB: Begin planning for CMB-S4

Cosmic/Gamma-ray: Efforts completing on gamma-ray experiments, Auger, Holometer

Priority – to support effort to plan and carry out priority science topics on our experiments, i.e. Need to make sure the science it was designed for is carried out!

- Need to make sure that our experiments are adequately supported before supporting or adding to research efforts for other programs!
- Ensure some room for development of ideas for new projects that are aligned with the science drivers.
- Need to sufficiently support the science collaborations to carry out our project's design, fabrication and operations & to plan and carry out data analyses to deliver the best science

Not funded in our program: Support for gravity wave, planet searches, Heavy Ions AMO



Cosmic Frontier – Research Funding Considerations (Lab & Univ)

Investigators & groups in experimental HEP research frontiers (Energy, Intensity, Cosmic) will review best if they are closely integrated into HEP experiment collaborations and have key roles and responsibilities on those experiments

Reviews reflect HEP traditions & P5 Strategic Plan & Criteria. Considerations →

- Does the activity directly support & significantly advance our science/experiment and priorities?
- For experiments with broad science program, is the effort are needed to support OHEP science interests? - Need to ensure that we are concentrating on the most important efforts for HEP program (e.g. dark energy on multi-use facility).
- What are the priority efforts needed now for a particular experiment?
- Will the effort make significant/visible/leadership impact & contributions?
- What is the experience, responsibilities and commitment (% time) of the researcher? Will they have time to make significant contribution?
- Will they support the collaboration in carrying out the project/experiment?
- Will they work in the “HEP model” by making significant, continuous contributions to the experiment, in addition to their own data analysis?

NOTE: Funding isn't optimized by funding small fractions of lots of different people!

Cosmic Frontier: Lab Research Support

Labs:

- Have significant roles & responsibilities in managing projects in design, fabrication and Operations phases
- Also charged with developing new ideas, concepts, R&D for future, technologies

If the lab is the “host” for a project, they must ensure they carry out all project fabrication phases successfully (through the Critical Decision process), plan the transition to and full operations phases, and ensure that the primary science for which HEP funded it is completed.

Lab Management develops a Program to carry out the Lab responsibilities

- Using unique, critical, leadership capabilities in terms of people & facilities (not just following all possible things they *could* do)
- Using Lab scientist input, PACs, HEP strategic plan, mission and directions etc.

Labs balance their programs in terms of people doing activities in different phases of an experiments, in terms of science analysis, near term and longer term planning & technologies.

- Scientists typically have significant roles & responsibilities on projects in the Lab’s program.

Lab submits an annual Field Work Proposal to HEP to request support.

Lab scientists can apply for Early Career awards to get additional funds to support their program

– need to plan well for when the award is completed.

Cosmic Frontier: Univ. Grants - Research Support

Cosmic Frontier experimental research budget covers:

- **Scientist support for our program**
 - Faculty, research scientist, postdoc, graduate student salaries & their expenses
 - May include small technical, engineering, equipment, etc for their efforts in their lab

Faculty support

- Typically, the full research time of the faculty member throughout the whole year is supported by providing 2 months summer salary and support for the group (students, postdocs, expense). Reduced levels of effort typically have reduced support.

Research Scientists (above a postdoc, but not a tenure-track faculty position)

- Support may be provided on case-by-case basis on merits:
 - whether the roles and responsibilities are well-matched with individual capabilities and cannot be fulfilled by a term position; priorities in the program etc.

What's not supported by research grants

- **Any significant operations and/or project-related activities:**
 - Engineering, Technicians, computer programming, other project/related personnel support, top-level project management, M&S, major items of equipment, consumables
 - These are typically supported through the central Project funding
- **Non-HEP related efforts:**
 - e.g. Gravity waves (LIGO), Heavy Ion (RHIC), AMO Science, etc.



Cosmic Frontier – University grants

Working in the program

Typical HEP researcher:

- Has an experimental program that may involve analysis on one experiment while constructing the next experiment.
- Makes long term commitments to our experiment/project/science as a member of the collaboration.
- He/she has specific commitments (service work) & responsibilities for our projects/experiments that may include analyzing data with one experiment while constructing or planning the next one – in addition to the science analysis. These responsibilities may evolve over time as the experiment progresses through phases.

-- Not funded for one particular study or effort here and there

In your proposal:

- Explain your long term program (past 3 years), how it progresses over time & how pieces fit together.
- Details on what you're doing the next 3 years, your responsibilities and efforts, why they're important to the project/experiment and why they're important and a priority NOW.
- Explain what fraction of time you're working on each effort (whether or not HEP funded)



Cosmic Frontier – University grants

Starting a New Effort & Applying for a Grant

Universities: Model for starting to work in the field & get a grant:

- Get involved in experiment/science and take on responsibilities for the collaboration and then submit proposal.
- Have involvement in the community so that you are part of the HEP community! (e.g. DPF meetings)
- Lot of science topics may be in dark energy plan or related to dark energy but need to think of what is the priority & main efforts needed and which are needed now!
- Have responsibilities for the experiment – not just your own science simulations & analysis.
- Many people have program working on a series of experiments (e.g.) DES operations/analysis while participating in LSST planning and construction. Not all has to be funded by HEP!
- Show track record and have responsibilities before funding starts.
- Transitioning to a new project/field requires a lot of work to get up to speed.
- best for faculty member to take the time to really learn the field and take on responsibility first

FUNDING OPPORTUNITIES - GRANTS



Schedule of DOE/HEP-based Solicitations

Ongoing: “FY 2016 Continuation of Solicitation for the Office of Science Financial Assistance Program” [DE-FOA-0001414]

- Also known as the “general or open annual DOE/SC solicitation”
 - SC-wide FOA that invites applications in support of work in any of six SC offices, incl. HEP research
- Published annually, typically at beginning of FY (October), remains open until successive issuance

New: “FY 2017 Research Opportunities in High Energy Physics” [DE-FOA-0001604]

- Issued for *new or renewing* grant applications, evaluated through comparative review (CR) process
 - Optional but encouraged Letter of Intent (LOI) due August 23
 - Final applications due September 20

New: “Early Career Research Program” [DE-FOA-0001625]

- SC-wide invitation for junior investigators (within 10-years post PhD) from labs or universities
 - Early career development of outstanding scientist’s research programs in areas supported by DOE/SC
 - Required pre-application due September 8, final applications due Nov 14

Upcoming: “Research Opportunities in Accelerator Stewardship”

- Specifically for accelerator R&D which predominantly impacts non-HEP applications
 - LOI will be required, resulting in encourage/discourage response
 - Eligibility will include academia, national labs, and industry



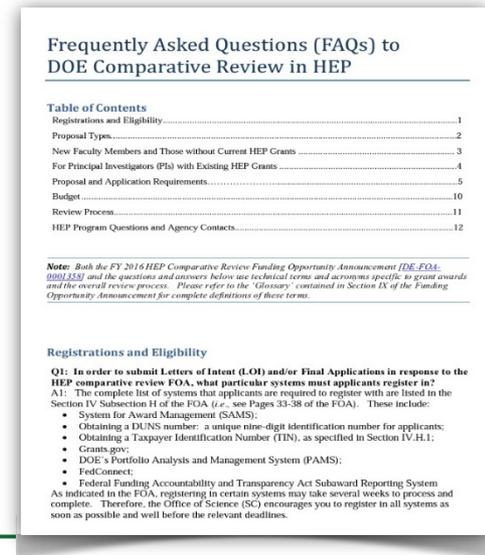
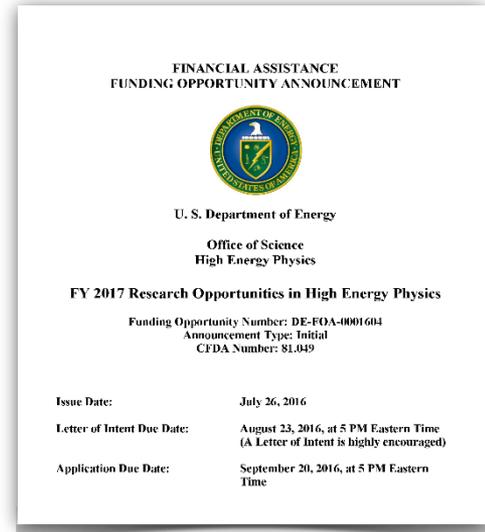
Recent FOA Changes

- **Data Management Plans (DMPs)**
 - All *Research* proposals to DOE/SC must have a data management plan
 - Includes HEP comparative review, Early Career
 - *Does not include* conferences, workshops, operations, projects
 - Please make sure applicants know that the requirement for a data management plan will be strictly enforced. Any research thrust in a proposal without a DMP will be declined without review.
- All *Renewal* proposals will need to also submit “proposal products” (essentially recent publications and other records of science outcomes from DOE-supported research) after the application is submitted
 - PIs will be notified by PAMS and have 5 days to respond
 - We cannot review incoming proposals until this step is completed
 - In the future, these will be captured with your annual Progress Report, but during the transition phase, you will need to enter them by-hand
- All FOAs have different eligibility, technical requirements, page limits, etc. Read the instructions carefully!



FY17 HEP Comparative Review FOA and FAQ

- **DE-FOA-0001604** issued July 26, 2016
- Six HEP research subprograms
 - Energy, Intensity, and Cosmic Frontiers
 - HEP Theory
 - Accelerator Science and Technology R&D
 - Detector R&D
- Letter of Intent due **August 23, 2016 by 5 PM Eastern Time**
 - *Strongly encouraged*
- Final Proposal deadline **September 20, 2016 by 5 PM Eastern Time**
- In addition to information provided in FOA, a FAQ is available and addresses topics on:
 - Registration and eligibility requirements
 - Proposal types and proposal requirements
 - Guidance for new faculty and those without current HEP grants
 - Guidance for PIs with existing HEP grants
 - Letter of Intent
 - Budget information and guidance on scope of request(s)



Both the FOA and FAQ available at: <http://science.energy.gov/hep/funding-opportunities/>

FY17 Early Career (EC)

- **FY17 FOA [DE-FOA-0001625; LAB_16-1625] posted July 28, 2016 at the EC website:**
 - <http://science.energy.gov/early-career/>
- **Read the FY17 FAQ, also available on the above website**
- **Features of FY17**
 - **PhD's no earlier than 2006 are eligible**
 - **Some population of candidates will no longer be eligible due to the "3-strikes rule"**
 - **Mandatory Pre-application requirement. Two pages.**
 - **Deadline: September 8, 2016 by 5 PM Eastern Time**
 - **All interested PIs encouraged to register as soon as possible in DOE/SC Portfolio Analysis and Management System (PAMS) for submission [link provided in EC website]**
 - **Encourage/discourage feedback: October 6, 2016**
 - **Full proposals due: November 14, 2016 by 5 PM Eastern Time**
 - **Candidates normally have more than 3 months to develop a plan, write a narrative, and submit an application**
- **Presidential Early Career Awards for Scientists and Engineers (PECASE)**
 - **PECASE-eligible candidates are selected from the pool of Early Career awardees**
 - <http://science.energy.gov/about/honors-and-awards/pecase/>

Key Items to Keep in Mind

- “Generic” research that is not to be carried out as part of a specific HEP experimental collaboration should be directed to the HEP Theory or Accelerator/Detector R&D programs, as appropriate.
- Read the FOA carefully and follow the requirements on content, length, etc.;
 - Several requirements in the FOA are set from outside the DOE/HEP office, and there is little to no flexibility to modify. Non-compliant proposals submitted to the FOA will not be reviewed.
 - In recent years, 10-15% of incoming proposals are declined without review. Requirements that are most often missed or overlooked include: data management plans, page limits, separate budget sheets (if needed) for each research subprogram or thrust, and inclusion of Personally Identifiable Information (PII)

GRANTS PROCESS & RESULTS



Cosmic Frontier – Statistics on Comparative Review Research Grants (Universities)

				FY12	FY13	FY14	FY15	FY16
Cosmic \$M request Y1				\$3.3	\$7.7	\$7.5	\$6.8	\$7.8
Cosmic \$M funded Y1				\$1.6	\$3.4	\$4.4 w/FFF	\$3.3 w/FFF	\$4.3M w/FFF
Cosmic - proposal counts								
		proposals received		11	33	29	27	43
		proposals reviewed		10	28	28	27	36
		proposals funded		6	18	19	14	21
		proposals success rate		60%	64%	68%	52%	58%
Cosmic CR - PI counts								
		PI's received		21	61	40	43	65
		PI's reviewed		20	54	38	43	55
		PI's funded		13	27	25	21	25
		PI's success rate		65%	50%	66%	48%	45%

Funding:

- Typically the total of all requests is for ~ twice the funds we have available.
- We typically fund the grants at less than their request.
- FY16 Cosmic requests \$26.5M(for full grant period) and \$7.8M for Year1.



Cosmic Frontier – Statistics on Early Career Awards

Awards (5-year):

FY10

Newman (Pitt)
Mahapatra (TAMU)

FY11

Chou (FNAL)
Slosar (BNL)
Hall (Maryland)

FY12

Mandelbaum (CMU)
Padmanabhan (Yale)
Carosi (LLNL)

FY13

Bolton (Utah)
Chang (ANL)

FY14

Dahl (Northwestern)

FY15: none

FY16

Rozo (Arizona)

	FY10	FY11	FY12	FY13	FY14	FY15	FY16
# received - Univ	11	8	12	16	6	7	7
# received - Lab	10	4	7	9	7	5	6
# funded - Univ	2	1	2	1	1	0	1
# funded - Lab	0	2	1	1	0	0	0

**We plan
increased
support for
Early Careers
in FY17 – now
is the time to
apply!**



Summary

An exciting time for the HEP Cosmic Frontier Program!

- 4 MIE Projects in Fabrication!

P5 developed compelling, realistic strategic plan with a community consensus vision →HEP is moving forward with NSF to implement it.

-- Close coordination with the other agencies; significant partnerships.

The HEP FY2016 Budget & FY 2017 Budget Request continues the implementation of the P5 global vision for particle physics

- **Opportunities exist to apply for research funding within the DOE/HEP-supported programs**
 - **Important that applicants carefully read the FOAs and corresponding FAQs for guidelines and requirements, available at: <http://science.energy.gov/hep/funding-opportunities/>**

