U.S. DEPARTMENT OF ENERGY | Office of Science

Cosmic Frontier

DOE-PI Meeting at DPF 2017

DOE Office of High Energy Physics
Cosmic Frontier Program Managers:

Anwar Bhatti (IPA)

Eric Linder (presenting)

Michael Salamon

Kathy Turner

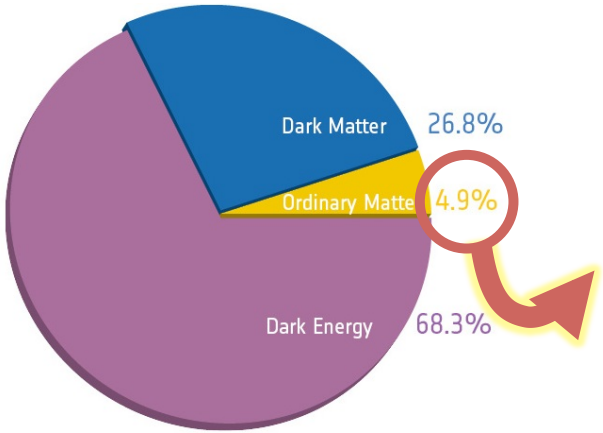
The High Energy Physics Program Mission

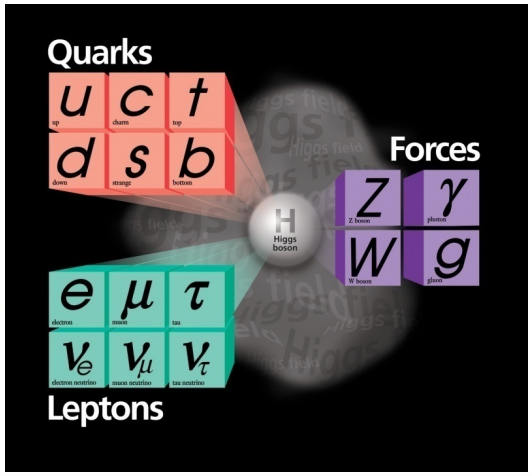
…is to understand how the universe works at its most fundamental level:

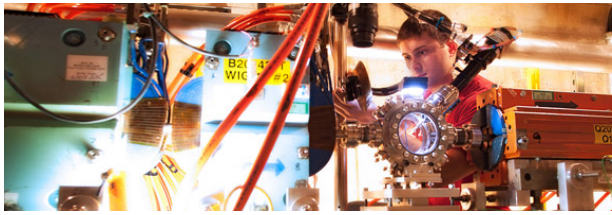
- Discover the elementary constituents of matter and energy
- Probe the interactions between them
- Explore the basic nature of space and time

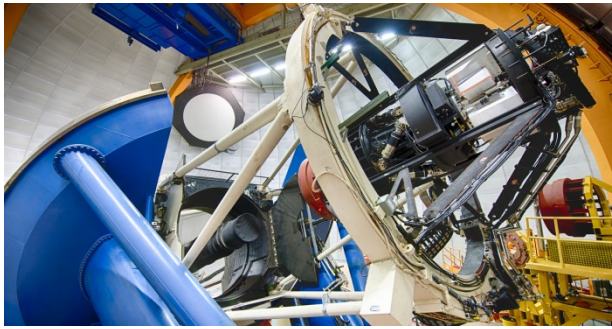
The Office of High Energy Physics fulfills its mission by:

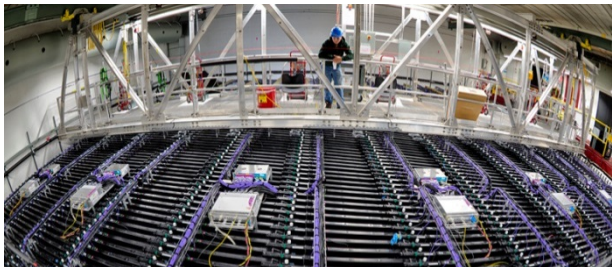
- Building **projects** that enable discovery science
- Operating **facilities** that provide the capability to perform discovery science
- Supporting a **research** program that produces discovery science





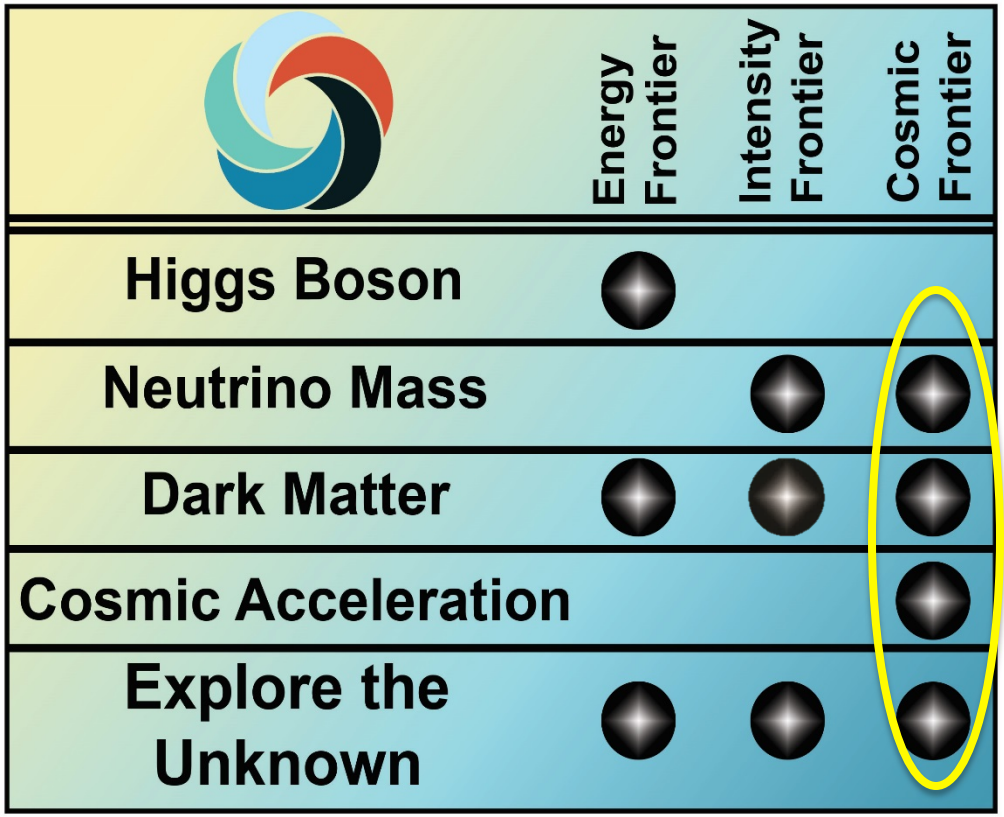






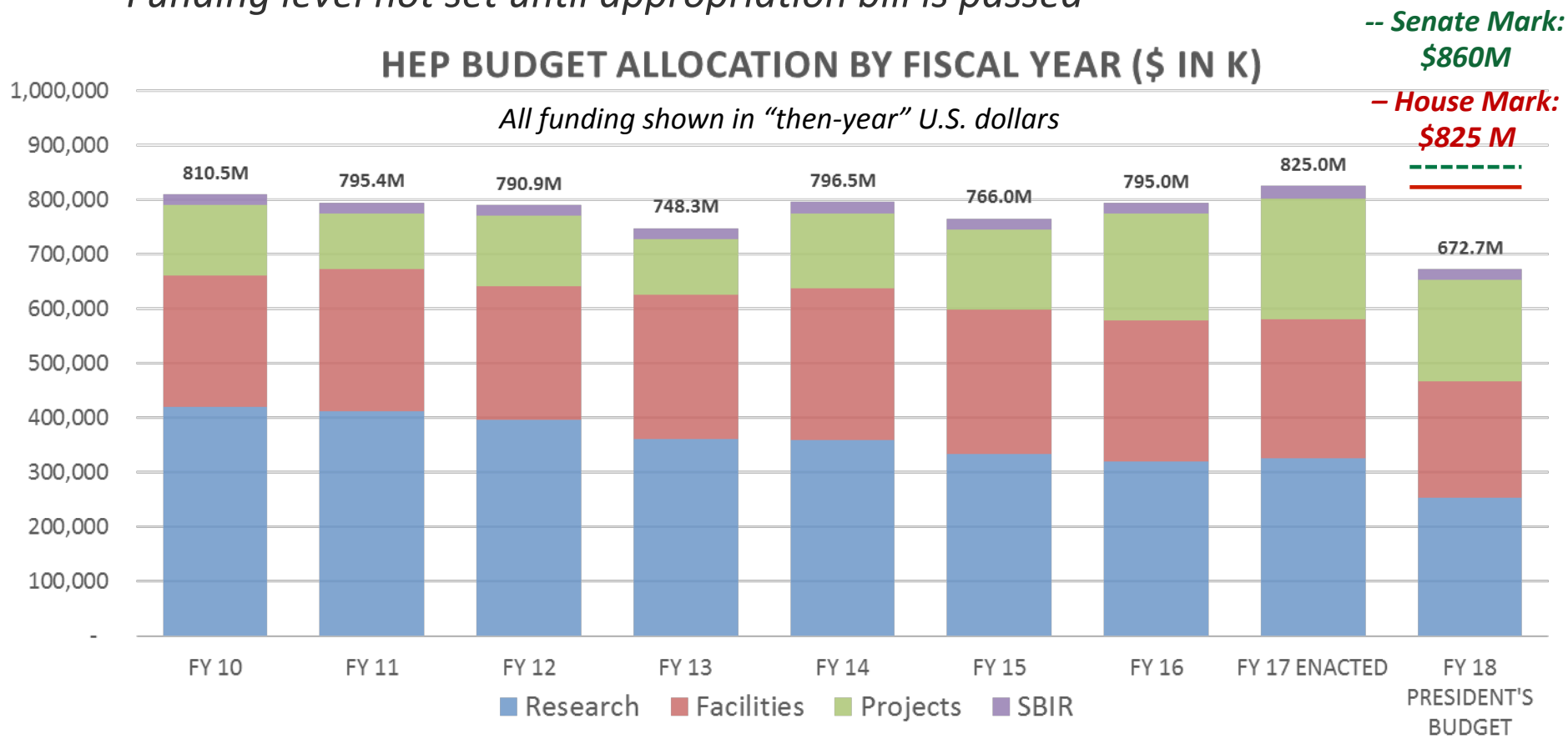
Enabling the Next Discovery

- **Science drivers identify the scientific motivation**
- **Research Frontiers are useful categorization of experimental techniques and serve as the basis of the budget process**
- **Research Frontiers are complementary**
  - No one Frontier addresses all science drivers
  - Each Frontier provides a different approach to address science driver
  - Enables cross-checking scientific results



Overall HEP Budget Trend

- **P5 strategy continues to define investments in future of the field**
- **President's FY18 Budget Request is down, current draft of House FY18 appropriations bill is flat, current Senate is up, relative to FY17**
  - *Funding level not set until appropriation bill is passed*



HEP MIE Project Status

Subprogram	TPC ($M)	CD Status	CD Date
INTENSITY FRONTIER			
Long Baseline Neutrino Facility / Deep Underground Neutrino Experiment (LBNF/DUNE)	1,300 – 1,900	CD-3A	September 1, 2016
Proton Improvement Project (PIP-II)	465-650	CD-0	November 12, 2015
Muon g-2	46.4	CD-3	August 20, 2015
Muon-to-Electron Conversion Experiment (Mu2e)	273.677	CD-3	July 14, 2016
ENERGY FRONTIER			
LHC ATLAS Detector Upgrade	33	CD-3	November 12, 2014
LHC CMS Detector Upgrade	33	CD-3	November 12, 2014
High-Luminosity LHC (HL-LHC) Accelerator Upgrade	180-250	CD-0	April 13, 2016
High-Luminosity LHC (HL-LHC) ATLAS Detector Upgrade	125-155	CD-0	April 13, 2016
High-Luminosity LHC (HL-LHC) CMS Detector Upgrade	125-155	CD-0	April 13, 2016
COSMIC FRONTIER			
LUX-ZEPLIN (LZ)	55.5	CD-3	February 9, 2017
Super Cryogenic Dark Matter Search - SNOLAB (SuperCDMS-SNOLAB)	16-21	CD-1	December 21, 2015
Dark Energy Spectroscopic Instrument (DESI)	56.328	CD-3	June 22, 2016
Large Synoptic Survey Telescope Camera (LSSTcam)	168	CD-3	August 27, 2015
ADVANCED TECHNOLOGY R&D			
Facility for Advanced Accelerator Experimental Tests II (FACET-II)	46-60	CD-1	December 21, 2015

HEP Program Guidance

FACA panels & subpanels provide official advice:

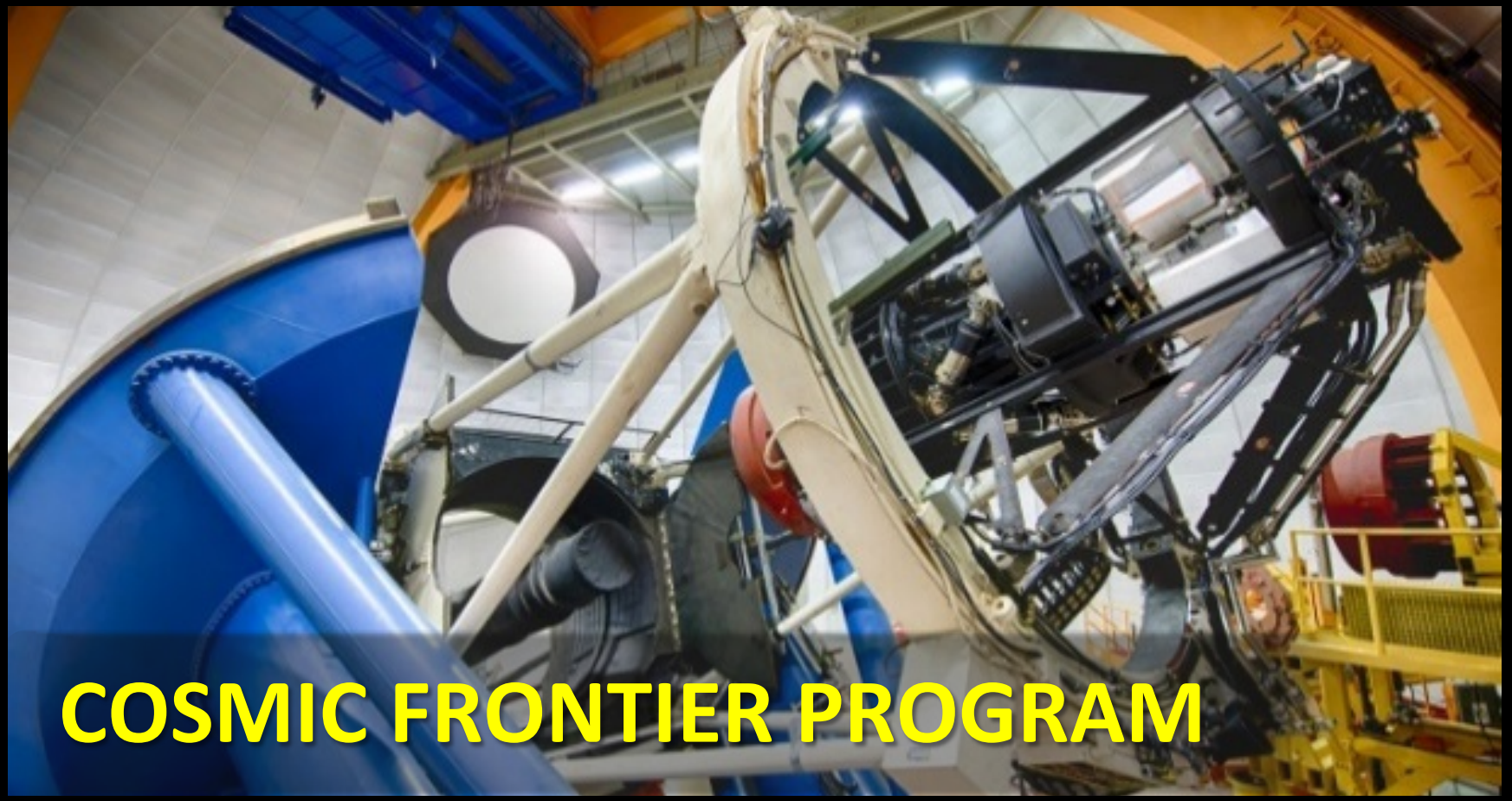
- **High Energy Physics Advisory Panel (HEPAP)**
  - Jointly chartered by DOE and NSF to advise both agencies
    - **Provides the primary advice for the program**
  - Subpanels for detailed studies (e.g. Particle Astrophysics Science Assessment Group "PASAG" in 2009, **Particle Physics Project Prioritization 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" (2016) in astronomy/astrophysics
  - 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) subpanel of AAAC
- Astro-Particle International Forum (APIF) – *Agency-level* group, now hosted by KIPAC (SLAC/Stanford)
- Tri-Agency Group (TAG) – DOE, NASA, NSF-AST meetings on LSST, WFIRST, Euclid to discuss commonalities, coordination, optimization of data, simulations, software


COSMIC FRONTIER PROGRAM

Cosmic Frontier Program

Study dark energy through staged program of complementary surveys (in partnership with NSF-AST)

- **Imaging surveys map cosmic structure over vast volumes of space:** *Dark Energy Survey (DES)* operating, *Large Synoptic Survey Telescope (LSST)* camera in fabrication
- **Spectroscopic surveys build deep, 3D maps of cosmic structure and growth:** *eBOSS* operating, *Dark Energy Spectroscopic Instrument (DESI)* in fabrication

Search for dark matter through direct detection experiments over a wide mass range (in partnership with NSF-PHY)

- **High- and low-mass WIMP sensitivity:** *LZ* and *SuperCDMS-SNOLAB*, in fab
- **Axion (ultralow mass) experiment:** *ADMX-G2* in operation

Search for high energy particles, e.g. from dark matter annihilations in cores of galaxies (in partnership with NSF, NASA)

- **Cosmic- and gamma-ray detectors on Earth and in space:** *HAWC*, *Fermi/GLAST*, *AMS* in operation

Study cosmic acceleration (inflation) at energies near the Planck scale and neutrino properties through the cosmic microwave background (CMB) (in partnership with NSF)

- **New generation South Pole experiment:** *SPT-3G* in operation
- **Next generation array 10x more sensitive:** *CMB-S4* in planning

HEP Cosmic Frontier Experiments

Activity	Location	Science	Current Status	# Collaborators	# Institutions	# Countries
Extended Baryon Oscillation Spectrosopic Survey (BOSS)	APO in New Mexico	dark energy stage III (spectroscopic)	operations started 2015	230 (150 US, 40 HEP)	(22 US, 8 HEP)	7
Dark Energy Survey (DES)	CTIO in Chile	dark energy stage III (imaging)	operations started Sept. 2013	300	25 (13 US, 9 HEP)	6
Large Synoptic Survey Telescope (LSST) - Dark Energy Science Collaboration (DESC)	Cerro Pachon in Chile	dark energy stage IV (imaging)	science studies, planning	269 (195 US, 47 HEP)	63 (43 US, 22 HEP)	15
Large Synoptic Survey Telescope (LSST) - LSSTcam Project	Cerro Pachon in Chile	dark energy stage IV (imaging)	FY14 Fab. start; CD3 Aug2015	142 (111 US, 111 HEP)	17 (11 US, 11 HEP)	2
Dark Energy Spectroscopic Instrument (DESI)	KPNO in AZ	dark energy stage IV (spectroscopic)	FY15 fab start; CD3 June 2016	179 (93 US, 74 HEP)	39 (21 US, 19 HEP)	9
DM-G1: Large Underground Xenon (LUX)	SURF in South Dakota	dark matter - WIMP search	Operations ended in 2016	102 (86 US, 64 HEP)	18 (15 US, 13 HEP)	3
DM-G1: Super Cryogenic Dark Matter Search (SuperCDMS-Soudan)	Soudan in Minnesota	dark matter - WIMP search	Operations ended in 2016	83 (72 US, 44 HEP)	20 (17 US, 7 HEP)	3
DM-G2: ADMX-G2	Univ Washington	dark matter - axion search	Operations started Jan. 2017	23 (21 US, 18HEP)	8 (7 US, 4 HEP)	2
DM-G2: SuperCDMS-SNOLAB	SNOLab in Canada	dark matter - WIMP search	FY15 fab start; CD1 Dec. 2015	109 (86 US, 57 HEP)	22 (16 US, 7 HEP)	5
DM-G2: LZ	SURF in South Dakota	dark matter - WIMP search	FY15 fab start; CD3 Feb. 2017	252 (174 US, 161 HEP)	36 (36 US, 23 HEP)	5
SPT-3G	South Pole	CMB stage 3	Operations started Feb. 2017	59	9 (7 US,5 HEP)	3
Very Energetic Radiation Imaging Telescope Array System (VERITAS)	FLWO in AZ	gamma-ray survey	HEP ops completed 2016	109 (76 US, 28 HEP)	20 (16 US, 5 HEP)	4
Pierre Auger Observatory	Argentina	cosmic-ray	HEP ops completed 2016	436 (61 US, 18 HEP)	90 (17 US, 6 HEP)	17
Fermi Gamma-ray Space Telescope (FGST) Large Area Telescope (LAT)	space-based	gamma-ray survey	June 2008 launch; operating	252 (104 US, 40 HEP)	115 (38 US, 3 HEP)	22
Alpha Magnetic Spectrometer (AMS-02)	space-based (on ISS)	cosmic-ray	May 2011 launch; operating	600	60 (6 US, 2 HEP)	16
High Altitude Water Cherenkov (HAWC)	Mexico	gamma-ray survey	Operations started Jan. 2015	120 (60 US, 7 HEP)	30 (13 US, 3 HEP)	4

Cosmic Frontier Status

Dark Energy - Staged program of complementary suite of imaging and spectroscopic surveys to determine its nature

- **BOSS** operations ended in FY14
- **eBOSS, DES** continue operations
- ***Large Synoptic Survey Telescope (LSST)*** received CD-3 in August 2015; fabrication started in FY14
- ***Dark Energy Spectroscopic Instrument (DESI)*** received CD-3 in June 2016; long-lead fabrication started in FY15

Dark Matter (direct detection) - Staged program experiments with multiple technologies

Completed operations on current, 1st generation **(DM-G1)** experiments in FY 2016: **ADMX-II, LUX, CDMS-Soudan, DarkSide-50, COUPP/PICO, DAMIC**

- Progress continues on **DM-G2** experiments selected by HEP & NSF-PHY (July 2014):
  - **ADMX-G2** is a small project (below MIE) and started at the end of FY14; taking data from Jan 2017
  - **LZ** received CD-2/3b in Aug 2016; approved as MIE fabrication start in FY15
  - **SuperCDMS-SNOLab** CD-1 approved December 2015; CD-2/3 review planned in FY18
- Concentrating on DM-G2 experiments; R&D for future will be limited in near term

Cosmic-ray, Gamma-ray – Ground & space experiments to perform indirect searches for dark matter, test space-time structure & explore particle acceleration mechanisms

- ***Fermi/GLAST, AMS,* and *HAWC*** continue operations
  HAWC gamma-ray observatory began full science operations in early 2015 – plan to operate for 5 years
- DOE operations efforts completed in FY 2016 for ***VERITAS* and *Auger***

Cosmic Microwave Background - Gain insight into the inflationary epoch; dark energy and neutrino properties

- ***South Pole Telescope polarization (SPTpol)*** completed operations in FY16
- ***SPT-3G*** operating from Feb 2017; partnership with NSF
- Planning continues for a **CMB Stage 4 (CMB-S4)** experiment

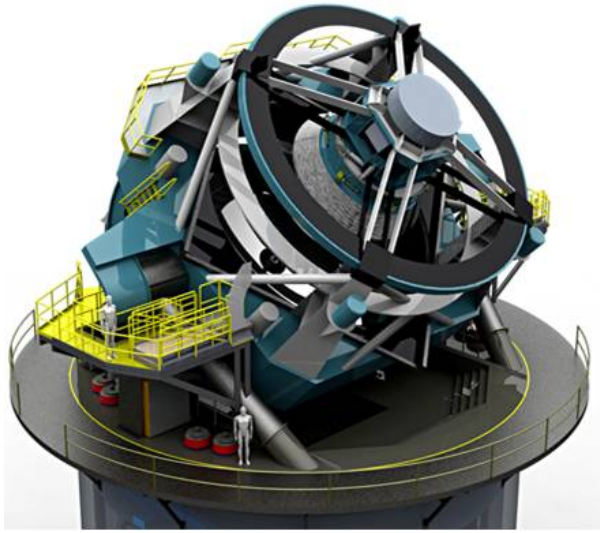
Cosmic Frontier: Status & Outlook

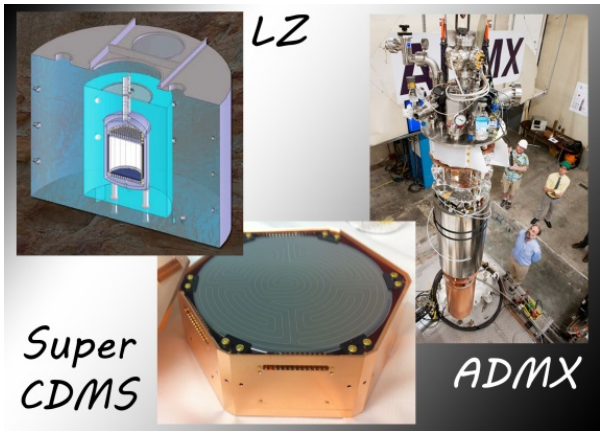
Project	TPC ($M)	CD0	CD1	CD2	CD3	CD4
Large Underground Xenon – Zeplin (LZ)	56	9/5/12	4/28/15 (CD1/3a)	8/9/16 (CD2/3b)	2/9/17	Baseline 3/18/22
Super Cryogenic Dark Matter Search at SNOLab (SuperCDMS-SNOLab)	16-21	9/5/12	12/21/15	Planned: 1QFY18	Planned: 1QFY18	Planned: 2Q FY21
Dark Energy Spectroscopic Instrument (DESI)	56	9/18/12	3/19/15	9/17/15	6/22/16	Baseline 4QFY21
Large Synoptic Survey Telescope Camera (LSSTcam)	168	6/20/11	4/12/12	1/7/15	CD3a: 6/5/14 CD3: 8/27/15	Baseline 3/31/22

- **Ongoing experiments continue:** ADMX, AMS, DES, eBOSS, FGST, HAWC, SPT
- **FY17 progress of the SuperCDMS project was slower than expected, so funding was reduced to meet the planned activities**
- **FY17 Congressional appropriation directed HEP to spend:**
  - $12.5M for LZ, an increase of $2M over the FY17 Request
  - $12M for TEC for DESI, an increase of $3M over the FY17 Request
- **FY18 President's Request:** prioritizes efforts on LSSTcam and LZ, slows DESI, SuperCDMS-SNOLAB
- **FY18 House Mark ($825M HEP):** full amount for LSSTcam, doesn't specify further
- **FY18 Senate Mark ($860M HEP):** full amount for LSSTcam, 17.5M DESI, 14.1M LZ, 7.4M SCDMS

Future Directions of the Cosmic Frontier

- The 8.4m Large Synoptic Survey Telescope (LSST) will scan the sky weekly with a 3.2 billion pixel digital camera
  - 15 Terabytes of data nightly
  - Constrain dark energy through five different cosmological probes
  - Produce 3D maps of the dark matter mass distribution in the Universe
- DESI will measure 30 million spectra of galaxies and quasars
  - Map the growth of cosmic structure over 10 billion years
  - Constrain dark energy thru both growth and distances
- Next generation of dark matter direct detection experiments: LZ, SuperCDMS-SNOLAB, ADMX-G2
  - Will improve sensitivity by over 10x first generation
  - Complement each other to cover a wide range of dark matter models
- CMB-Stage 4 community planning for an experiment studying cosmic inflation and the origin of structure
  - Current Concept Definition Team to report to AAAC in Oct 2017
  - DOE labs developing technology scaling

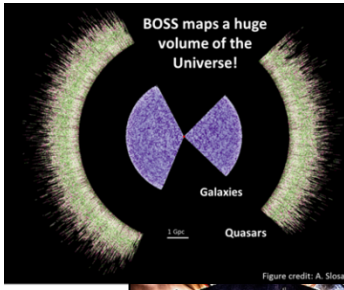


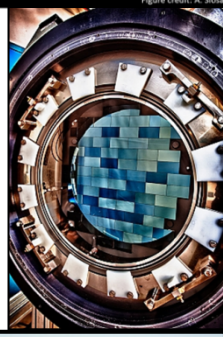


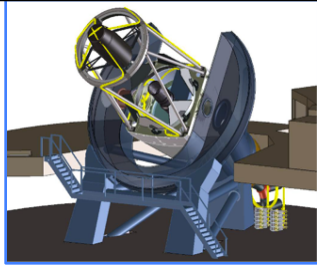
Dark Energy

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 telescope;
  - 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 FY19
- CD-3 (full fabrication approved) June 2016
- Planning for Mayall shutdown, ready for DESI 1QFY18 & Full Operations starting early FY20

Direct Detection Dark Matter

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

Operating:

Completed Operations on current DM-Generation 1 (DM-G1) experiments in FY16/17: **ADMX-II, LUX, CDMS-Soudan, DarkSide-50, COUPP/PICO, DAMIC**

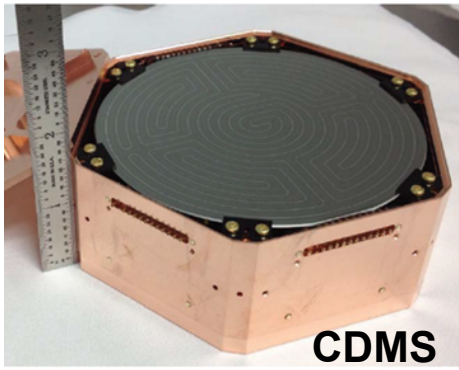
Design, Fabrication:

-- Progress continues on DM-G2's selected by HEP & NSF-PHY in July 2014

- **ADMX-G2** axion search at U.Wash. (HEP); operations started Jan 2017
- **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-3 construction Feb 2017
- **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
- Community workshop "New Ideas in Dark Matter" March 2017



Cosmic Microwave Background

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

Current Experiments:

- ***SPT-3G*** **– HEP provided support towards major upgrade of the camera to greatly increase sensitivity; Operations starting early 2017 (NSF-led)**

➔**CMB-S4 Community-based Collaboration brought 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**
- **Needs scale-up of detector fabrication, testing, and readout**

CMB-S4 Collaboration **Science Book** (220 pp), **Technology Book** (191 pp)
https://arxiv.org/abs/1610.02743 ; https://arxiv.org/abs/1706.02464

Future Planning:

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

- **HEP labs already heavily involved in R&D to align with P5**
- **HEP will coordinate efforts & roles within HEP program**

- **Working with NSF to coordinate planning and a path forward**
- **CMB-S4 Concept Definition Taskforce delivers report to AAAC ~Oct**

Cosmic-ray / Gamma-ray Physics

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**

HEP Operations Roles Completed in FY16:

VERITAS *(w/NSF)*
- HEP operations support completed; finalizing HEP-supported analysis

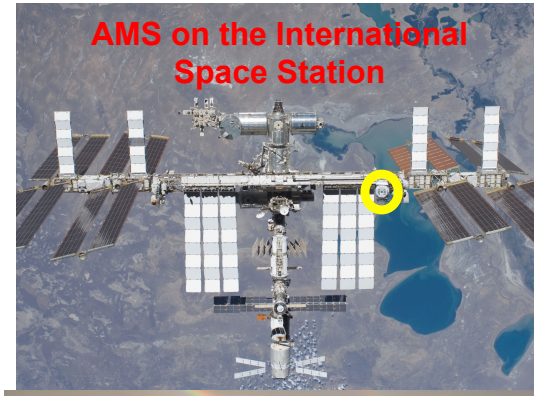
Auger *(w/NSF-PHY)*
- HEP participation in operations & research ramping down in FY16; no participation planned on upgrade

Operations continuing:

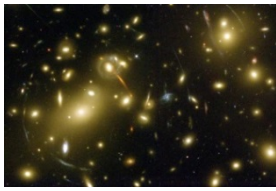
Fermi/GLAST *(w/NASA)*
- HEP is supporting the Large Area Telescope Instrument Science Ops Center at SLAC; In coordination with NASA, HEP is planning to continue support of critical efforts at SLAC if operations go past 10 years

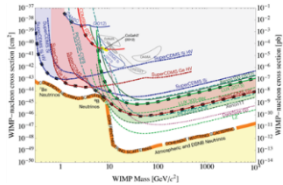
AMS *(w/NASA)*
- operations continuing

HAWC *(w/NSF)*
- 5 year HEP-supported operations started early 2015



Cosmic Frontier – looking towards the future





HEP "Cosmic Visions (CV)" groups in several areas – 3 groups set up

- Allows interactions with small HEP community groups as 2-way line of communication for HEP-funded efforts and directions recommended by P5

(NOTE: Of course, any HEP-funded R&D/technology plans need to be in the context of the larger non-HEP and global community)

CV-CMB: Coordinate HEP technology R&D & planning efforts for future CMB-S4

CV-DM: Coordinate HEP R&D (mainly DM-G2 science optimization now)

CV-DE: Investigate future HEP directions in the LSST & DESI era

CMB-S4 Concept Definition Team – AAAC subpanel

- Reporting on science goals & strawman concepts in October

Dark Matter Community workshop held March 2017 to update identification of scientifically compelling areas to search; concepts for small projects in new areas of phase space?

- https://arxiv.org/abs/1707.04591

Dark Energy future directions community workshop held – Investigate optimizing science in DESI/ LSST era and/or follow-on projects

- Workshop held in 2016 at UChicago; upcoming workshop Nov 14-15 at LBNL

Looking towards planning for the 2020 Astronomy/Astrophysics Decadal Survey

Other HEP Efforts Related to Cosmic Frontier

Theory program

- Vibrant Theory Program supporting all areas including Cosmic Frontier; Support for Theory centers and groups at several universities and labs.

Advanced Detector Development program

- Active R&D developing next generation detectors, including CCDs, TES superconducting bolometers, MKIDs, readout electronics, optics. Key elements for DES, LSST, CMB-S4. Important impact on X-ray detector, medical detectors.

Computational HEP program

- Coordinates DOE Supercomputer allocations via various ASCR and DOE Competitions
  - Cosmic Simulations, Emulators, Data Analysis
  - Computational HEP, SCIDAC – focused computational challenges
  - HEP Forum for Computational Excellence
- High Performance Computing – Comp HEP & ASCR coordination & partnerships on some efforts, including Cosmic Simulation and Data analytics
- Manages allocations on NERSC facility for HEP Cosmic Frontier Simulations and Experiments

Cosmic Frontier Computing

- COV recommended computing be included in experiment planning
- Labs-wide coordination of experiment computing needs/resources underway

Data Management

- Each Project/Experiment has provided a Data Management Summary to HEP
- Used for referencing in research proposals; also to check against *AAAC Principles for Access in Astrophysics* and *SC Statement on Digital Data Management*

Research Support – Priorities

Research budgets: Support scientists on all phases of an experiment

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!

- DOE is a science **mission** oriented agency: Support research efforts directly in line with program & project priorities, responsibilities & science goals
- Distribution of efforts across areas will necessarily change to support changing priorities
- Sufficiently support the Science Collaborations (HEP model) to carry out experiment in all phases - project's design, fabrication and operations & to plan and carry out data analyses to deliver the best science

Priority Areas:

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

Dark Energy :
Complete eBOSS analysis; DES operations & analysis; **construct and plan LSST and DESI**

CMB: Begin planning for CMB-S4

Cosmic/Gamma-ray/Other: Efforts completing on gamma-ray experiments

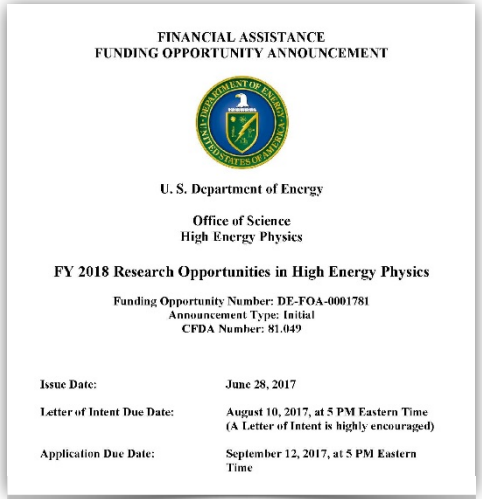
Not funded in our program: support for gravitational waves, planet searches, heavy ions, AMO, etc.


HEP FUNDING OPPORTUNITIES

FY18 HEP Comparative Review FOA and FAQ

- **DE-FOA-0001781 issued June 28, 2017**
- **Six HEP research subprograms**
  - Cosmic, Energy, and Intensity Frontiers
  - HEP Theory
  - Accelerator Science and Technology R&D
  - Detector R&D
- **Letter of Intent due August 10, 2017 by 5 PM Eastern Time**
  - Strongly encouraged
- **Final Proposal deadline September 12, 2017 by 5 PM Eastern Time**
- **In addition to the 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
  - Budget information and guidance on scope of request(s)
  - Letter of Intent
  - Information on overall scientific merit review process
  - Contacts for program- or system-related questions

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



FINANCIAL ASSISTANCE
FUNDING OPPORTUNITY ANNOUNCEMENT

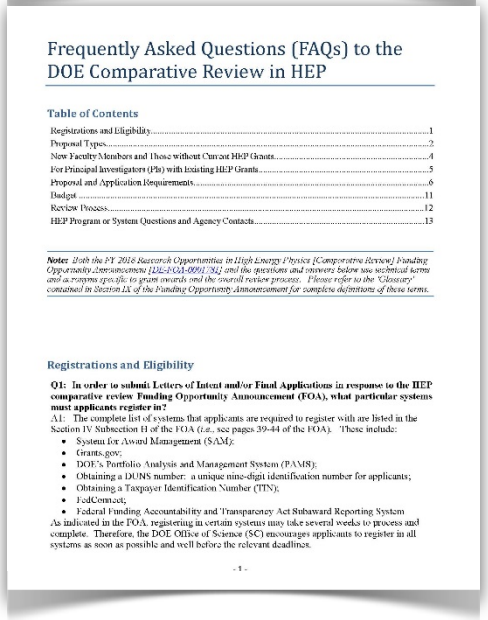
U. S. Department of Energy

Office of Science
High Energy Physics

FY 2018 Research Opportunities in High Energy Physics

Funding Opportunity Number: DE-FOA-0001781
Announcement Type: Initial
CFDA Number: 81.049

Issue Date:	June 28, 2017
Letter of Intent Due Date:	August 10, 2017, at 5 PM Eastern Time (A Letter of Intent is highly encouraged)
Application Due Date:	September 12, 2017, at 5 PM Eastern Time



Frequently Asked Questions (FAQs) to the DOE Comparative Review in HEP

Table of Contents

Notes: Both the FY 2018 Research Opportunities in High Energy Physics [Comparative Review] Funding Opportunity Announcement [DE-FOA-0001781] and the questions and answers below use technical terms and acronyms specific to grant awards and the overall review process. Please refer to the 'Glossary' contained in Section IX of the Funding Opportunity Announcement for complete definitions of these terms.

Registrations and Eligibility

Q1: In order to submit Letters of Intent and/or Final Applications in response to the HEP comparative review Funding Opportunity Announcement (FOA), what particular systems must applicants register in?

A1: The complete list of systems that applicants are required to register with are listed in the Section IV Subsection H of the FOA (i.e., see pages 39-44 of the FOA). These include:

- System for Award Management (SAM);
- Grants.gov;
- DOE's Portfolio Analysis and Management System (PAMS);
- Obtaining a DUNS number: a unique nine-digit identification number for applicants;
- Obtaining a Taxpayer Identification Number (TIN);
- FedConnect;
- Federal Funding Accountability and Transparency Act Subaward Reporting System

As indicated in the FOA, registering in certain systems may take several weeks to process and complete. Therefore, the DOE Office of Science (SC) encourages applicants to register in all systems as soon as possible and well before the relevant deadlines.

Recent FOA Changes

- **All *Research* proposals to DOE/SC must have a Data Management Plan (DMP)**
  - Includes HEP comparative review and Early Career, but not conferences, workshops, operations, projects
  - Any research thrust in a proposal without a DMP will be **declined without review**
- **All *Renewal* proposals must submit "proposal products" (publications, etc.) 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
  - These will eventually be captured with your annual Progress Report, but must be entered by hand during the transition phase
- **Eligible Applications (*new in FY 2018*):**
  - "All applications … **requesting support for more than one person** must propose a Program Director/Principal Investigator who is currently in a **tenure-track appointment**."
- **Recurring Submissions of Research Applications (*new in FY 2018*):**
  - "A previously declined application may be resubmitted to this FOA, but **only after it has undergone substantial revision**. An application submitted to this FOA that has not clearly taken into account the major concerns from prior DOE reviews may be **declined without review and will not be considered for funding**."
- **All FOAs have different eligibility, technical requirements, page limits, etc.**
  - ***Read the instructions carefully!***

DOE HEP Research Priorities: Snapshot

- **Energy Frontier**
  - Analysis of LHC Run 2 data
  - Contribute to operational responsibilities and complete "Phase I" upgrades
  - Support preparations for HL-LHC program
- **Intensity Frontier**
  - Neutrino Program
    - NOvA, T2K/SK, Minerva, MicroBooNE data analysis
    - Implement Fermilab Short-Baseline Neutrino Program and Intermediate Neutrino Program
    - Support ProtoDUNE, LBNF/DUNE, and PIP-II
  - Muon Program: Complete Mu2e, take data with Muon g-2
  - Heavy Flavor Program: Complete Belle-II and take data
- **Cosmic Frontier** ("Experimental Research at the Cosmic Frontier")
  - Dark Matter: Complete G1 analysis, construct G2 experiments, modest R&D
  - Dark Energy: Complete eBOSS, DES analysis; construct LSST and DESI
  - Continue planning for CMB-S4
- **Accelerator R&D**
  - Focus on outcomes and capabilities that will dramatically improve cost effectiveness for mid-term and far-term accelerators
  - Hosting workshops to develop and implement R&D plan following P5 and GARD panels
- **Detector R&D**
  - In process of seeking community input to identify highest priority R&D activities in wake of P5
  - Long-term "high-risk" R&D with potential for wide applicability and/or high-impact
  - "Blue-Sky" scientific research on innovative technologies not already in contention for implementation in future DOE HEP projects
- **HEP Theory**
  - Maintain an overall "thriving" program as per P5

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 **closely integrated** member of the collaboration.
- 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
- 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.

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)

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

Programmatic Considerations

- **Comparative Review: very useful to have head-to-head reviews of PIs working in similar areas, particularly for large grants**
  - Discussion of relative strengths and weaknesses of individual proposals and PIs

- **Many factors weigh into final funding decisions**
  - **Compelling research proposal for next ~3 years**
    - ☑ **Interesting? Novel? Significant? Plausibly achievable?**
    - ☒ **Incremental? Implausibly ambitious? Poorly presented?**
  - **Significant *recent* contributions in last 3-4 years**
    - **Synergy and collaboration within group (as appropriate)**
    - **Contributions to the research infrastructure of experiments**
  - **Alignment with HEP programmatic priorities**

- **Supportive of excellent people, including excellent *new* people, even when times are tough!**
- **Corollary: Some proposals or senior personnel ranked below average will not be funded.**

Key Items to Keep in Mind

- **Proposed research will review best if closely aligned with the DOE/HEP mission, its program, and the Particle Physics Project Prioritization Panel (P5) strategy**
  - Investigators 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
  - "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 Detector R&D programs, as appropriate
  - A confused reviewer may be a negative reviewer – be clear and complete.

- **Read the FOA carefully and follow 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, **5-10% of incoming proposals are declined without review.** Requirements that are most often missed or overlooked include:
    - Data management plans, page limits, separate budget sheets for each frontier (if needed), and inclusion of Personally Identifiable Information (PII)
    - Use the HEP-provided checklist at the front of the FOA!

Proposal Project Narrative

- **Project Narrative comprises the research plan for the project**
  - Should contain enough background material in the introduction to demonstrate sufficient knowledge of the research
  - Devote main portion to a description and justification of the proposed project, include details of the methods to be used and any relevant results
  - Indicate which project personnel will be responsible for which activities
  - Include timeline for the major activities of the proposed project
- **Must not exceed 9 pages per senior investigator when printed on standard 8 ½" x 11" paper with 1-inch margins (all sides). Font must not be smaller than 11 point.**
  - Senior investigator ≡ active tenured or tenure-track faculty member at sponsor institution
  - Non-tenure track faculty (*e.g.*, research scientists) or senior research staff with term appointments are not included in the 9-page limit per senior investigator unless they are the sole senior investigator on the application
  - Faculty members at collaborating institutions listed on the proposal are not included
- **Refer to Section IV of the FOA for useful information to help prepare the narrative**
  - What to address for the Background/Introduction
  - Multiple Investigators and/or Multiple Research Subprograms or Thrusts
  - Common narrative with overview of each group's activities in different research areas
  - Discussion of any synergies and connections between areas
  - Proposed Project Objectives, Research Methods, Resources
  - Timetable and Level of Effort of different activities, …

Office of Science (SC): Data Management Plan (DMP)

- **Focus of Digital Data Management is the sharing and preservation of digital research data**
  - Data management involves all stages of the digital data life cycle including capture, analysis, sharing, and preservation
  - See Dr. Laura Biven's presentation on SC Digital Data Management, Sep 2014 HEPAP meeting: http://science.energy.gov/hep/hepap/meetings/201409/
  - FOAs issued after October 1, 2014 require a DMP and compliance with the SC Statement
    - SC statement on DMP available at: http://science.energy.gov/funding-opportunities/digital-data-management/
    - See Section IV, the subsection on Appendix 8 of the FOA, for requirements pertaining to DMPs that must be included in your application
- **Most experiments have developed DMPs for their collaborations**
  - When applying for financial assistance (or submitting FWPs), PIs can cite the DMPs for their experiments with the appropriate links
    - If DMP cited, PIs must briefly describe how proposed research relates to the experiment
  - Theorists need DMPs: explain how theoretical/simulated data can be accessed/validated
  - If there is no data of any sort generated by the proposed research, the DMP must state this. **A DMP that is blank or states "not applicable" is not acceptable**

Each research thrust in a proposal requesting DOE research support, including the FY 2018 Comparative Review FOA, will require addressing the DMP requirements for it to be reviewed, and hence, to be considered for funding

Renewal Proposal Products

- **If you have received an award through the Comparative Review process, you are likely submitting a "Renewal" proposal**
  - Contact your PM if you have a question as to whether it is more appropriate to submit a "New" or "Renewal" proposal
- **Renewal Proposal Products [see Section II.G of the FY18 Comp Rev FOA]**
  - Since Feb 2015, PI must complete and submit 'Renewal Proposal Products' section in PAMS by entering each product created during the course of the previous project period
    - Details with step-by-step instruction set in PAMS Users' Guide, Sec. 9.2: https://pamspublic.science.energy.gov/WebPAMSEPSExternal/CustomInterface/Common/ExternalUserGuide.pdf
  - Types of products include:
    - Publications (for collaborators on large experiments, list those where you were primary)
    - Intellectual property, technologies or techniques
    - Databases or software (made public)
- **Renewal Proposal Products are submitted after the application submission**
  - DOE will assign the renewal proposal to a Program Manager, resulting in an automated email from PAMS to the PI with instructions ← ***watch for this email in your inbox***
  - Navigate in PAMS to 'Tasks' and enter all products within 5-days after the proposal submission
  - Application will not be considered complete and therefore cannot be reviewed until the product list has been submitted

Guidance Checklist for Comparative Review

- **As a convenience and courtesy, DOE/HEP has provided a checklist in the FOA**
  - The list, on the opening pages of the FOA, is not intended to be complete; applicants should review the FOA in-detail and follow all instructions

FY 2018 Comparative Review FOA – GUIDELINE FOR APPLICATION REQUIREMENTS	COMPLETED
Is the proposed research scope aligned with programmatic priorities of DOE-HEP?	☑
Personally Identifiable Information (PII): Do not supply any information, such as birth date or place, citizenship, home address, personal phone nos., etc., that should not enter into the merit review.	☑
A Data Management Plan is required for each research thrust (*e.g.,* ATLAS, LSST, lattice gauge theory, etc.). It must appear in Appendix 8 of the application and comply with page-limit requirements specified in the FOA.	☑
Project Summary/Abstract Page: contains the name(s) of the applicant, the project director/principal investigator(s) and the PD/PI's institutional affiliation, and any Co-Investigators and their affiliations.	☑
DOE Cover Page: list each HEP research subprogram (*e.g.,* Energy Frontier, HEP Theory) for which funding is requested. If there is more than one, be sure to attach the Cover Page Supplement.	☑
Page limits for each section comply with the FOA requirements (as defined in Section IV of the FOA).	☑
Biographical sketches carefully follow the FOA instructions and avoid PII.	☑
Current and Pending Support information completed, including an abstract of the scope of work.	☑
In addition to the budget information for the full proposal: separate budget and budget justification narratives for each HEP research subprogram in the proposal for each year in which funding is being requested and for the cumulative funding period has been provided in Appendix 7.	☑
Level of Effort Tables completed in Budget Justifications in Appendix 7: for each person for whom funding is requested in a research thrust, on the scope of activities during proposed project period.	☑
Post-submission of the application, timely submitted the Renewal Proposal Products (RPP) in PAMS.	☑

How to Prepare for an Early Career Proposal

- **Address the following questions:**
  - What **challenges/problems** are you trying to solve? Communicate this in the proposal.
  - Is **someone else** doing it already?
    - Alternatively, aren't those research activities already being funded elsewhere?
    - If you carry-out these efforts, why are they unique and require 'you'?
  - How does this research exploit/engage the **unique capabilities** of your institution?
  - What **resources** are needed to complete the project?
  - Does your proposal outline a **5-year timeline**, with key **deliverables and personnel profiled** during this project period? If funded, what will be the outcome after 5-years?
  - Have you led the activities that you are proposing? **Why are you a future leader in HEP?**
- **General observations of strong proposals**
  - Provide **unique** capabilities. What does not get done?
    - During preparation, PIs should address "why is it critical that I carry-out this research?"
    - How does your work impact the efforts within the international collaboration?
  - A **balanced** program: strong physics effort + a hardware project attached to an experiment, where PI takes a lead
  - For searches, discuss the **discovery reach** and do not just state: "in the absence of a signal, a 95% C.L. limit will be set."
- **Prior to submission, applicants may want to seek guidance from appropriate senior faculty and/or staff while preparing proposals (incl. narrative and budget)**
  - Applicants are encouraged to draw guidance from members within the collaboration

Cosmic Frontier Early Career Awards

2017: Results announced soon!
- Results announced soon
- Results announced soon

2016: Eduardo Rozo (University of Arizona)
- "Constraining Dark Energy with Galaxy Clusters and Baryon Acoustic Oscillations"

2014: C. Eric Dahl (Northwestern University)
- "A Scintillating Xenon Bubble Chamber for Dark Matter Detection"

2013: Adam Bolton (University of Utah)
- "Integrating Advanced Software and Statistical Methods for Spectroscopic Dark-Energy Surveys"

2013: Clarence Chang (Argonne National Lab)
- "Exploring Fundamental Physics through new Measurements of the Cosmic Microwave Background Polarization"

2012: Gianpaolo Carosi (Lawrence Livermore National Lab)
- "Searching for Dark Matter Axions with New High-Frequency Tunable Microwave Cavities"

2012: Rachel Mandelbaum (Carnegie Mellon University)
- "Optimal Cosmological Measurements with Weak Gravitational Lensing"

2012: Nikhil Padmanabhan (Yale University)
- "A Ruler to Measure the Universe: Probing Dark Energy with Baryon Acoustic Oscillations"

2011: Aaron Chou (Fermi Lab)
- "Search for Holographic Noise from the Planck Scale"

2011: Carter Hall (University of Maryland)
- "Search for weakly interacting dark matter with liquid xenon"

2011: Anze Slosar (Brookhaven National Lab)
- "Cosmology with the Lyman-alpha forest"

2010: Rupak Mahapatra (Texas A&M University)
- "Ton Scale Germanium: Beyond Zeptobarn WIMP Cross-section"

2010: Jeffrey Newman (University of Pittsburgh)
- "Overcoming Photometric Redshift Systematics in Dark Energy Experiments"

FY18 Early Career Research Program

Look for FOA soon!
https://science.energy.gov/early-career

DOE Office of Science Graduate Student Research Program

SCGSR provides funds for students to spend 3-12 months in research at DOE labs.

Look for FOA soon!
2 calls per year
https://science.energy.gov/wdts/scgsr/

Conclusion

- **HEP is maintaining the core of the DOE Science Mission**
  - P5 developed compelling, realistic strategic plan with a community consensus vision
  - We are delivering exciting discoveries, important scientific knowledge, and technological advances

- **An exciting time for the HEP Cosmic Frontier program!**
  - 4 MIE projects in fabrication!
  - Portfolio of experiments exploring four of the Science Drivers in pursuit of discovery: *neutrinos, dark matter, cosmic acceleration, explore the unknown*
  - Opportunities for contributing to experiments at all stages of lifecycle
- **Research funding will remain competitive**
  - Federal budget process is ongoing for FY 2018, funding level is not known until an appropriations bill has been passed
  - Program priorities will continue to be driven by the P5 strategy