



U.S. DEPARTMENT OF
ENERGY

Office of
Science

Status of the DOE High Energy Physics (HEP) Program

The National Academy of Science

Committee on Astronomy & Astrophysics meeting

March 27, 2018

Kathy Turner - Program Manager, Cosmic Frontier

Office of High Energy Physics

- **HEP PROGRAM**
- **COSMIC FRONTIER**
- **HEP SCIENCE PORTFOLIO REVIEW**
- **QUANTUM INFORMATION SCIENCE (QIS)**
- **SUMMARY & CONCLUSION**
- **GRANTS, AWARDS**



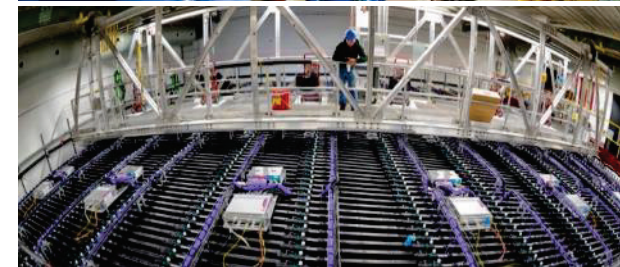
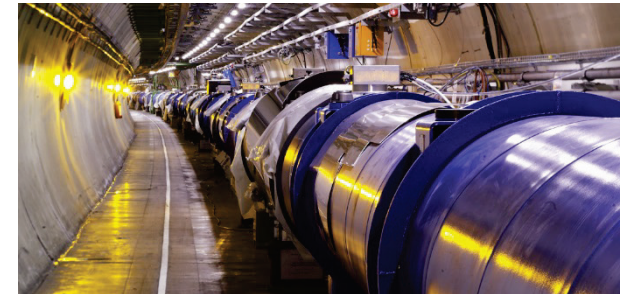
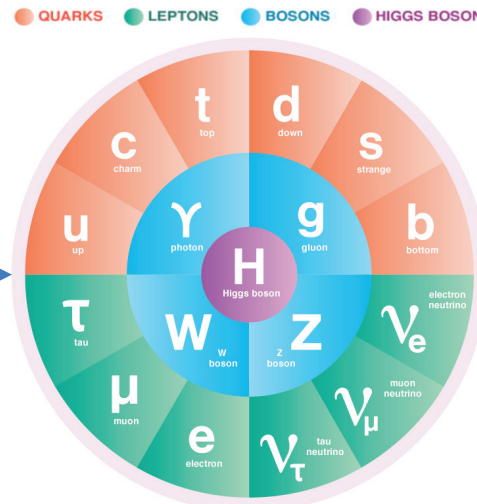
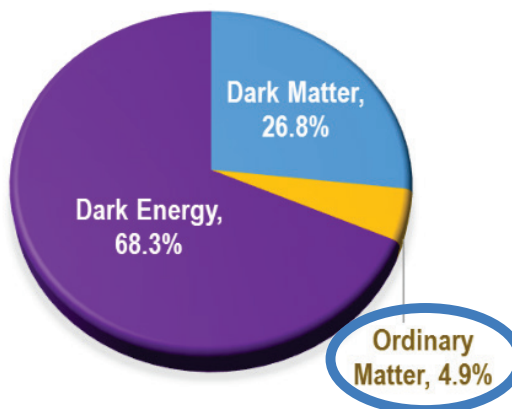
HEP Program – Mission, Planning, Budget



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 DOE Office of High Energy Physics fulfills its mission by:
- ▶ Building **projects** that enable discovery science
 - ▶ Operating **facilities** that provide the capability for discoveries
 - ▶ Supporting **research** efforts that produces discovery science
- HEP supports research efforts by scientists on collaborations through all phases of an experiment



Office of High Energy Physics

James Siegrist, Director

Administrative Specialist (Vacant)
Altaf Carim

Accelerator Stewardship

Eric Colby

HEP Operations

Kathy Yarmas

HEP Connections

Lali Chatterjee

HEP Budget and Planning

Erin Cruz
Michelle Bandy
Alan Stone
Michael Cooke

International Agreements Program

Altaf Carim

Research & Technology Division

Glen Crawford, Director

Janice Hannan
Christie Ashton
David Bogley
Andrea Peterson (AAAS Fellow)
Brian Morsony (AAAS Fellow)

Facilities Division

Mike Procario, Director

Physics Research

Energy Frontier

Abid Patwa
Thomas LeCompte (Detailee)

Intensity Frontier

Glen Crawford (Acting)
Michael Cooke
Kevin Flood (IPA)
Laurence Littenberg (Detailee)

Cosmic Frontier

Kathy Turner
Eric Linder (IPA)
Karen Byrum (Detailee)

Theoretical Physics

William Kilgore
Simona Rolli

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**

ATLAS Upgrade – Simona Rolli
CMS Upgrade – Simona Rolli
DESI – Kathy Turner
FACET II – Ted Lavine
HL-LHC ATLAS – Simona Rolli
HL-LHC AUP – Simona Rolli
HL-LHC CMS – Simona Rolli
LBNF-DUNE – Bill Wisniewski (Detailee)
LSSTcam – Helmut Marsiske
LZ – Ted Lavine
Mu2e – Ted Lavine
Muon g-2 – Ted Lavine
PIP-II – Mike Harrison (Detailee)
SuperCDMS-SNOLAB – Simona Rolli

NEWS (Feb 2018)

• Michael Salamon retired
• Karen Byrum (ANL) joined HEP as a Detailee

High Energy Physics Strategic Plan

In **May 2014**, the **Particle Physics Project Prioritization Panel (P5)** released **“Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context”**

► Provides a long-term strategic plan that enables discovery and maintains the U.S. position as a global leader in particle physics, while recognizing the global nature of the field.

► P5’s five intertwined **science drivers** identify the scientific motivation and show great promise for discovery:

- 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
- **Energy, Intensity, and Cosmic research frontiers** provide a useful categorization of experimental techniques

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

► The P5 report recommended a prioritized, and time-ordered list of experiments to optimally address the science drivers

- Investments in a portfolio of projects at the small, medium and large scales while maintaining balanced facility operations and research to produce results continuously throughout a 20-year timeframe
- Major elements of the P5 report strategy include High-Luminosity LHC (HL-LHC), LBNF/DUNE, LSST, and a healthy **cosmic program to study dark matter and dark energy**



HEP Budget Status: FY17 – FY19



➔**FY17:** HEP received **\$825M** in the FY 2017 Congressional Appropriation, about \$7M above the President's Request of ~ **\$819M**.

➔**FY18:** President's Request for HEP of **\$672.7M** was guided by priorities of Administration, Office of Science (SC), & 2014 P5 plan

- ▶ Congressional Marks in summer 2017 were significantly higher
 - ▶ Supportive of the P5 priority projects, including HL-LHC Accelerator Project, HL-LHC ATLAS and CMS Upgrade projects, LBNF/DUNE, and Cosmic Frontier projects
- ▶ HEP budget was on a series of Continuing Resolutions (CR) through 3/23/18.
- ▶ **On 3/23/18, the HEP Budget of \$908M was enacted**

➔**FY19:** President's Request for HEP of **\$770M** is guided by priorities of Administration, SC & the P5 plan.

➔Planning the HEP program is challenging due to the significant differences in the Request, House & Senate marks, and short term CRs.

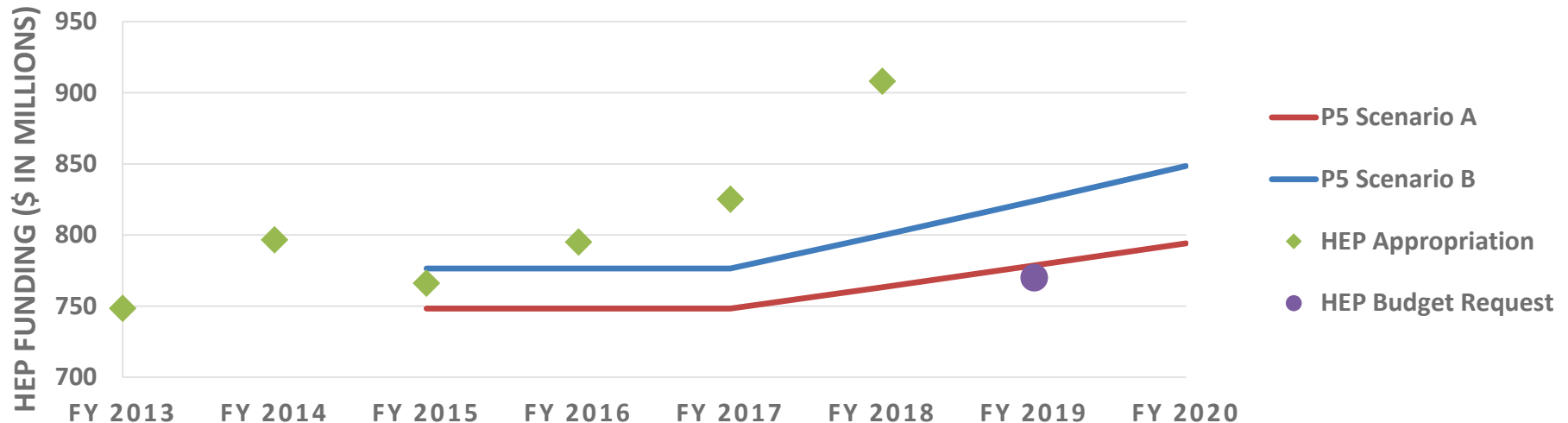


HEP Budget vs. P5 Funding Scenarios

P5 was charged to consider 10-year budget scenarios for HEP within the context of a 20-year vision for the global field

- ▶ Scenario A was the lowest constrained budget; Scenario B was slightly higher constrained budget
- ▶ **FY 2018 Appropriations** provides funding for all HEP Projects at their recommended profiles. Facilities and Experimental Operations are supported at their optimal levels. Research is funded above 40% of the total HEP budget.
 - ▶ Funding for specific projects was set in the budget appropriation. The exact splits for research, facility and experimental operations and for each frontier still to be determined.
- ▶ **FY 2019 President's Budget Request** reflects the P5 vision
 - ▶ Preserves flexibility *in situ* to continue or ramp down efforts contingent on what Congress appropriates

HEP BUDGET SCENARIOS

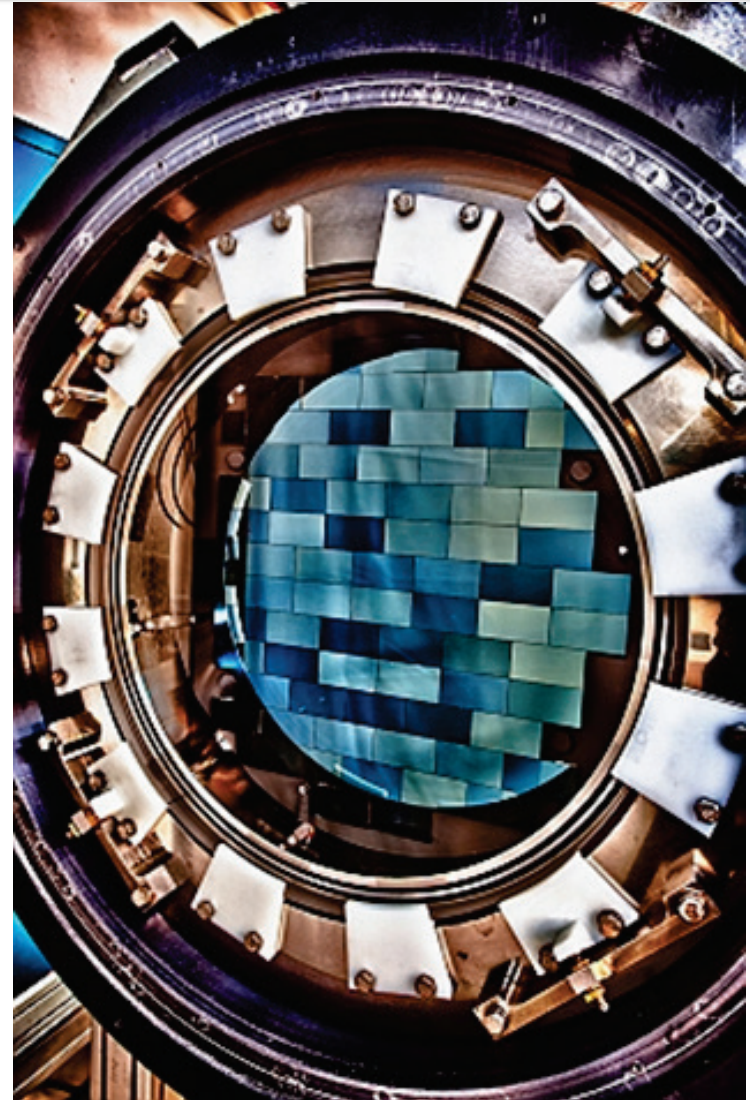


FY 2019 President's Budget Request

HEP Budget (\$ in thousands)	FY 2017 Enacted	FY 2018 Request	FY 2018 Appropriation	FY 2019 Request
Research	347,852	272,887		280,130
Facility/ Operations	255,162	213,813		211,020
Projects	221,986	186,000		278,850
Total, HEP	825,000	672,700	908,000	770,000

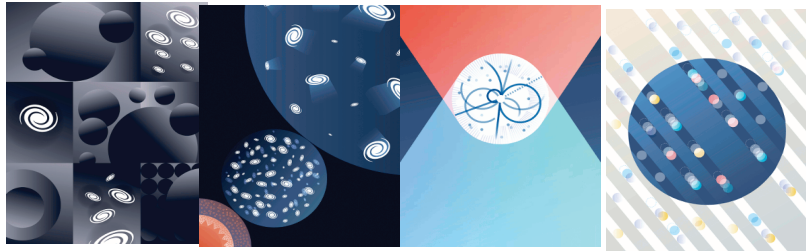
- ▶ The 2019 President's Budget Request for HEP is an overlay of:
 - ▶ Administration priorities
 - ▶ Office of Science (SC) priorities (interagency partnerships, national labs, accelerator R&D, QIS)
 - ▶ P5 priorities (preserve vision, modify execution)
- ▶ FY19 Budget Request reduces near-term science (research and operations) for P5-guided investments (projects) in mid- and long-term program
 - ▶ All projects continue
 - ▶ HL-LHC ATLAS and CMS Detector Upgrade Projects are new initiatives (MIE starts) in FY 2019
 - ▶ Research drops below 40% of the program budget to enable executing P5 priority projects
 - ▶ Operations support for ongoing experiments also reduced to make this possible
- ▶ The Administration supports the overall P5 strategy

COSMIC FRONTIER



Cosmic Frontier Experimental Program

→ Through ground-based telescopes & arrays, 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.



Dark Matter

Cosmic
Acceleration

Explore the Unknown
Neutrino Mass

→ Pursues 4 of the 5 science drivers from the 2014 P5 Strategic Plan

Science and program priorities are aligned with the 2014 P5 plan:

- P5 recommended a staged, complementary suite of projects to advance understanding of the nature of dark matter and dark energy, and to support CMB experiments as part of core program

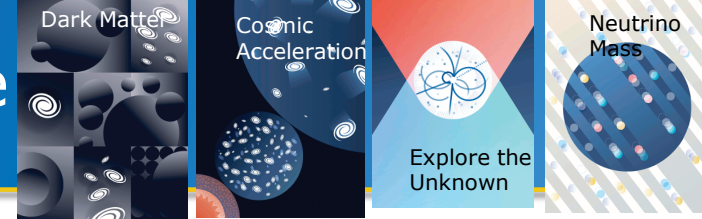
Program Areas:

Dark Energy, Dark Matter, CMB, Cosmic-ray & Gamma-ray experiments

- HEP-related efforts in Theory, Detector R&D, accelerator-based experiments

Notes: In addition to NSF and NASA, all experiments and projects have international partners or contributions and some also have private contributions
HEP Status at CAA, March 2018

Cosmic Frontier – Program Guidance



FACA panels & subpanels provide official advice:

- ▶ **High Energy Physics Advisory Panel (HEPAP)**

- ▶ Jointly chartered by DOE and NSF; **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)

Cosmic Frontier - P5 Strategic Plan (May 2014) Recommendations:

- Dark Energy: Complete LSST as planned; Build DESI
 - Dark Matter: Broad Dark Matter Generation 2 (DM-G2) program at higher than planned funding; DM-G3 starting later in P5 decade, guided by DM-G1,G2
 - Cosmic Microwave Background (CMB): support science as part of core program
 - Stage 4 project (**CMB-S4**) starts mid-way through the P5 decade.
 - Cosmic Rays and Gamma Rays - Invest in CTA only if NSF Astronomy moves forward
- ▶ **Astronomy and Astrophysics Advisory Committee (AAAC)**
 - ▶ Advises DOE, NASA, and NSF on areas of overlap, mutual interest and concern
 - ▶ Subpanels (some w/HEPAP): TFCR (2006), DETF (2006), DMSAG (2007), CMB-S4 CDT (2017)

Formal Advice Also Provided by: National Academy of Sciences (NAS)

- ▶ New Worlds New Horizons (2010) Decadal Review of Astronomy & Astrophysics Recommended that, at the lower funding scenario, DOE participate in LSST with NSF ahead of WFIRST with NASA since DOE is making a larger relative \$ contribution and its technical role is thought to be relatively more critical.

Cosmic Frontier Budget

- FY18 Appropriation & FY19 Request:

PROJECTS

FY18 - funding provided for all projects at their recommended levels; specific amounts provided in appropriation

‣ ***LSST Camera (LSSTcam) receives final funding in FY18***

FY19 - Projects fully supported according to planned funding profile:

- ***LZ and SuperCDMS-SNOLAB*** direct-detection dark matter experiments
- ***Dark Energy Spectroscopic Instrument (DESI)***

RESEARCH & EXPERIMENTAL OPERATIONS

FY18 - Experimental Operations are supported at their optimal levels. Research is funded above 40% of the total HEP budget.

- The exact splits for research, facility and experimental operations and for each frontier still to be determined.

FY19 - In midst of “Building for Discovery,” HEP must keep P5 projects on track. Request for Research & Operations adjusted in order to maintain project support

- **Research:** Higher priority for activities at Labs and Universities that are critical to executing the P5 recommendations
- **Facility & Experimental Operations**
 - Operations of current experiments continues planned ramp-downs, while support ramps-up for P5 projects to carry out pre-operations efforts

Cosmic Frontier Budget History & Status

Cosmic Frontier Funding (\$ in thousands)	FY 2017 Request	FY 2017 Actual	FY 2018 Request	FY 2018 Senate mark	FY 2018 House mark	FY 2018 Enacted	FY 2019 Request
Research	46,991	45,990	34,580				
<i>University Grants</i>	11,607	11,762					
<i>National Labs</i>	35,384	34,228					
Exp. Operations	8,925	10,055	4,789				
Projects	70,200	74,375	31,600			51,300	26,500
<i>MIE: LSST-camera</i>	45,000	45,000				9,800	0
<i>MIE: DESI</i>	10,000	12,800				20,000	7,500
<i>MIE: DM-G2</i>							
<i>MIE: LZ</i>	10,500	12,500				14,100	14,000
<i>MIE SuperCDMS-SNOLAB</i>	4,000	3,400				7,400	5,000
<i>R&D: Future</i>	700	675					
Cosmic Frontier Total	126,116	130,420	70,969				
HEP Total	817,997	825,000	672,700	860,000	825,000	908,000	770,000

Note: LSST-camera funding completed in FY18



Dark Energy

Staged, complementary suite of imaging and spectroscopic surveys (in partnership with NSF-AST)

- Will enable precision measurements to differentiate between: cosmological constant and/or new fields; or modification to General Relativity

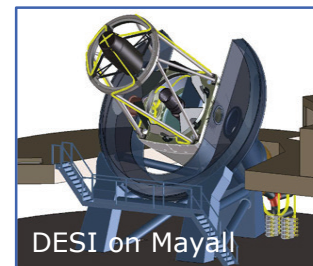
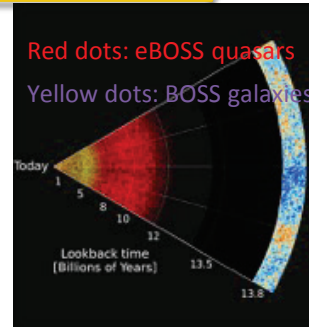
Operating:

- **eBOSS** – Stage III spectroscopic in New Mexico started in 2015 with current HEP grant through mid-FY18
- **Dark energy Survey** – *Stage III* imaging in Chile started 5-year survey in late FY13

In Fabrication phase:

- **Large Synoptic Survey Telescope (LSST)** - Stage IV imaging
- Dark Energy Spectroscopic Instrument (DESI)** - Stage IV spectroscopic

Future Planning: Dark Energy future directions community workshops held; Investigate optimizing science in DESI/LSST era and/or follow-on projects; Community White Paper posted at [arXiv:1802.07216](https://arxiv.org/abs/1802.07216)



Science Highlight – Dark Energy Survey (DES)

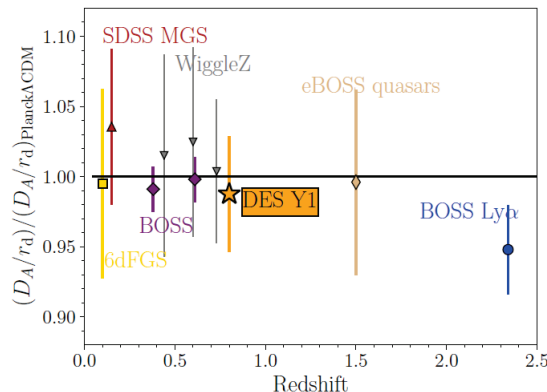
DES probes Dark Energy using the 570-megapixel Dark Energy Camera (DECam) on NSF's Blanco 4m in Chile

- ▶ Construction phase: DOE responsible for the DECam; NSF responsible for the Data Management (DESDM) system
- ▶ Operations phase is supported by both agencies.
- ▶ 2 interleaved imaging surveys: 5000 deg² *grizY* of 200 million galaxies, 100,000 clusters; 27 deg² *griz* time-domain survey: light curves for 2500 type Ia supernovae
- ▶ Operations started August 2013; have completed 5th year (of 5) of observing. Operations extended through Dec. 2018.

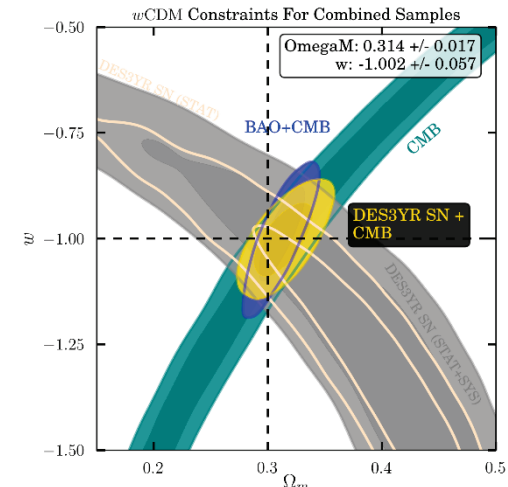
Results:

- ▶ Aug. 2017: Year 1 Cosmology results from galaxy clustering & weak lensing; constraints competitive with Planck CMB
- ▶ Dec. 2017: Year 1 Cosmology results from BAO to $z=1$; results competitive with WiggleZ, BOSS BAO measurements
- ▶ Jan. 2018: Data Release 1; first 3 years of survey data for full 5000 sq. deg. now public
- ▶ Just over 150 papers submitted and accepted; e.g., most distant supernova, new Milky Way dwarf satellites to constrain dark matter

Year 1 BAO measurements vs. Planck Λ CDM predictions. Consistent with previous BAO measurements.



Prelim Dark Energy Results from a few hundred spectroscopically confirmed Supernovae

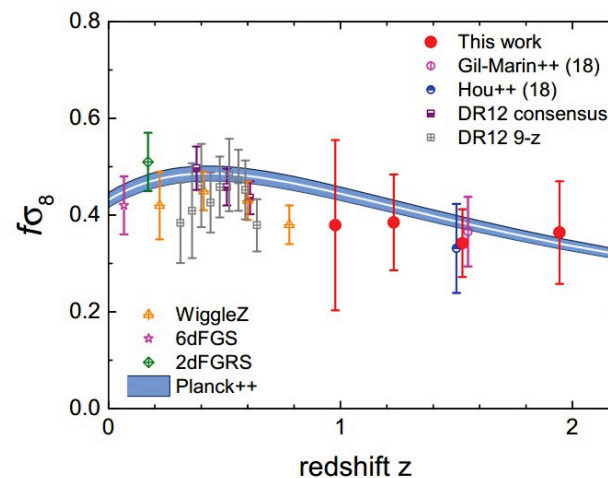
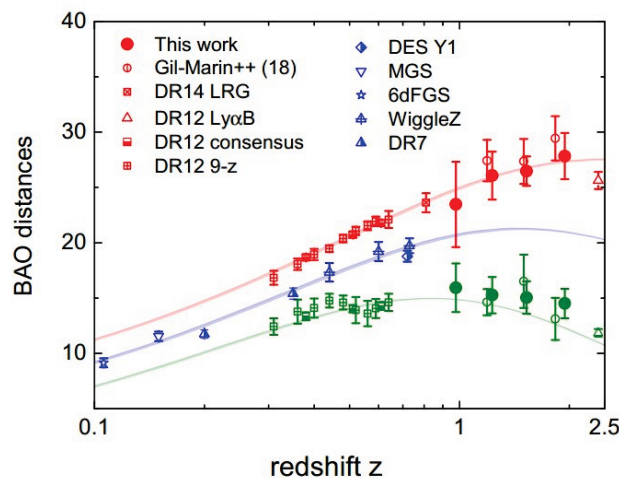


Science Highlight – eBOSS

- ▶ Extended Baryon Oscillation Spectroscopic Survey (eBOSS) is a cosmological spectroscopic survey on the 4th generation of the Sloan Digital Sky Survey (SDSS-IV) at Apache Point Observatory
 - ▶ DOE funded a spectrograph upgrade for SDSS-III (BOSS)
 - ▶ HEP grant to support eBOSS operations goes through mid-FY18

Results:

- ▶ May 2017: First measurement of BAO between $z = 0.8$ and 2.2
- ▶ Jan. 2018: First measurement of Redshift Space Distortions (RSD) using Quasars between $z = 0.8$ and 2.2
- ▶ Both consistent with Planck Λ CDM



eBOSS Quasar measurements of BOA parameters (left) and RSD (right) are filled circles, compared to other results. Bands are based on Planck Λ CDM parameters.

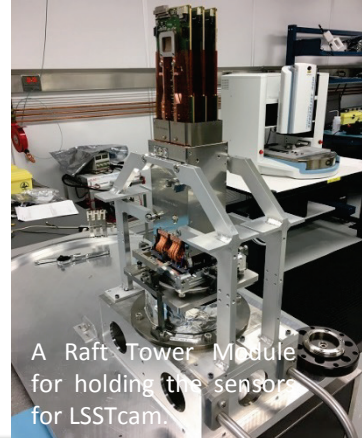
Large Synoptic Survey Telescope (LSST)



The Stage IV, next-generation, wide-field LSST facility in Chile is designed to provide deep images of half the sky every few nights, enabling study of the nature of dark energy using multiple cosmological probes.

DOE-HEP & NSF-AST partnership:

- NSF leads the LSST project and is responsible for the 8.4m telescope facility and data management system.
- DOE is responsible for providing the LSSTcam: CD-3 approval 2015; early delivery planned in FY20, followed by commissioning.



Status

- NSF & DOE Project Status review Sept. 2017; next July 2018
- LSST Facility Operations phase being planned
 - NSF & DOE review of proposal in Dec. 2017
 - Funding ramp-up starts FY19
 - Full science operations planned to start FY23
- Dark Energy Science Collaboration (DESC) operations plan review spring 2017; next one May 2018

Dark Energy Spectroscopic Instrument (DESI)

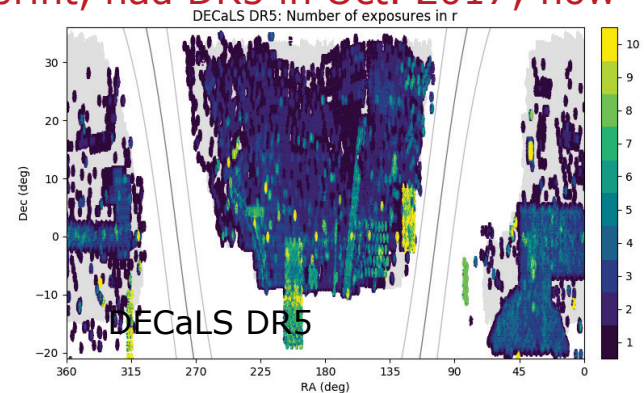
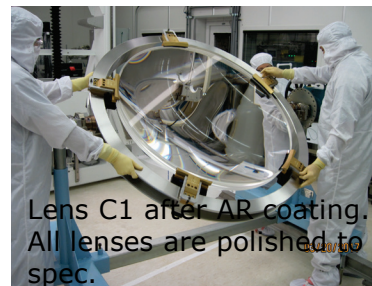
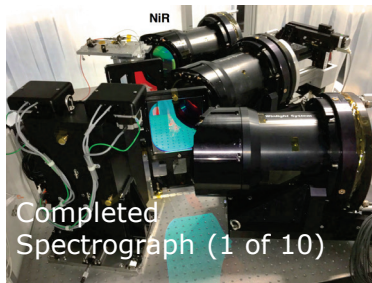
DESI's Stage IV spectroscopic survey will measure spectra of 35 million galaxies & quasars to map their 3-D positions and determine the growth of cosmic structure over 10 billion years; uses Baryon Acoustic Oscillation and Redshift Space Distortion growth and other methods

DOE leads the DESI experiment. The DESI project will provide the new spectrographs and associated systems to be mounted and operated on the NSF's Mayall telescope at Kitt Peak.

- HEP has MOU's w/NSF-AST to "lease" the Mayall telescope; ramping up partial support in FY16-18; full support for dark energy ops starting FY19

Status

- DESI project CD-3 approval June 2016
- Review of Project status & Operations plan in Feb. 2018
- Mayall shutdown in Feb. 2018; Full dark energy survey operations starting FY20
- ▶ All lenses polished and coated, all petals manufactured
- ▶ DECaLS: DECam Legacy Survey, covering 2/3 of DESI footprint, had DR5 in Oct. 2017; now 75% complete



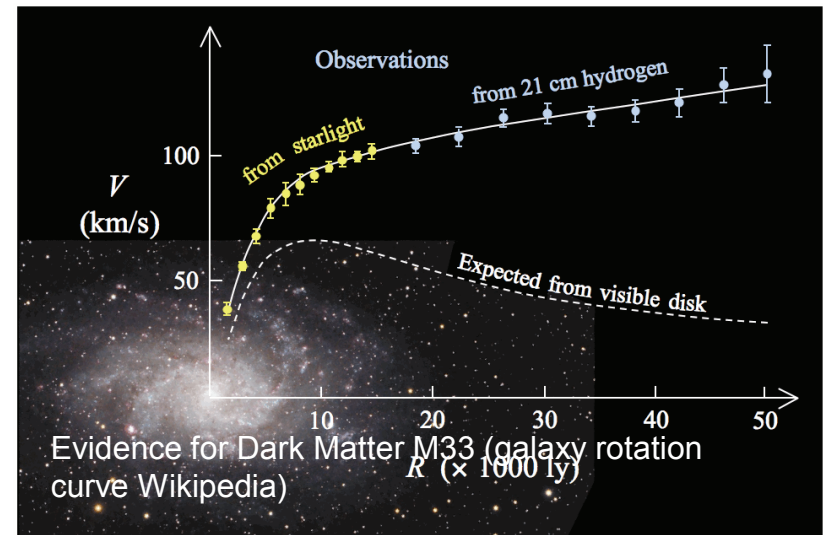
Direct Detection Searches for Dark Matter (DM)

Staged suite of complementary direct detection experiments with multiple technologies to search for dark matter particles

- 3 Generation-two projects were selected by HEP & NSF-PHY in July 2014 following P5 report: **ADMX-G2, LZ, SuperCDMS-SNOLAB**
- High- and low-mass WIMP sensitivity; Axion (very low mass) searches

Operating / Completed:

- ▶ Completed HEP support for operations on current DM-Generation 1 (DM- G1) experiments in FY16/17: ADMX-II, LUX, CDMS-Soudan, DarkSide-50, COUPP/PICO, DAMIC -- some continue with other funding sources
- ▶ HEP's **ADMX-G2** axion search at UW - Science operations started Jan 2017

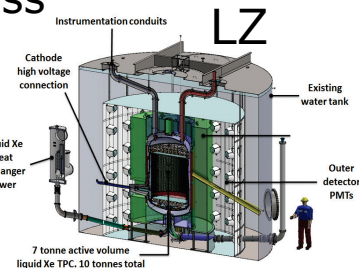


Direct Detection Searches for Dark Matter (DM) cont.

In Design, Fabrication:

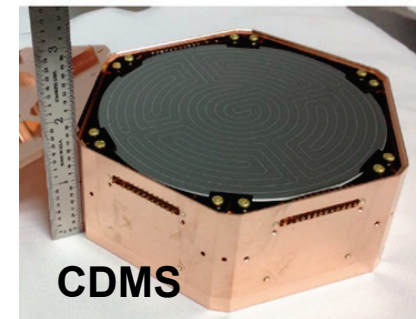
LZ at Homestake Mine in South Dakota (HEP)

- WIMP search through dual phase liquid Xe over ~ 10 -1000 GeV mass
- In fabrication phase; CD-3 approved Feb 2017; science ops starts FY21
- Review of Project status & Operations plan in Jan. 2018



SuperCDMS-SNOlab in Canada (HEP+NSF-PHY partnership)

- WIMP search using cryogenic solid-state crystals over ~ 1 -10 GeV
- In final design phase; CD-1 approved Dec. 2015; CD-2/3 approval planned for spring 2018; science operations starts FY21
- CD2/3a review Jan. 2018; Review of ops planning in June 2018



Future Planning:

→ P5 recommendation to include small projects in the program;

Planning for small Dark Matter project

- ▶ Dark Matter Community workshop held March 2017 to update identification of scientifically compelling areas to search, see <https://arxiv.org/abs/1707.04591>
- Next step, starting later in FY2018, is to determine which science areas DOE-HEP should focus on and whether there are concepts for small projects to investigate these.



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Science Highlight – ADMX-G2

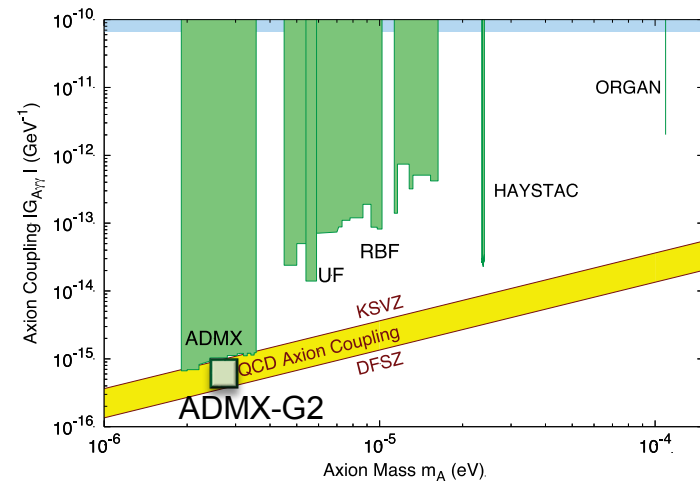
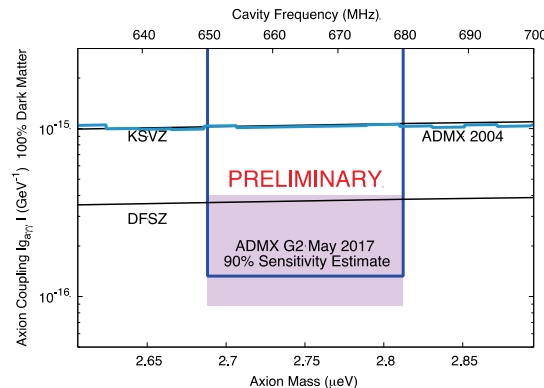
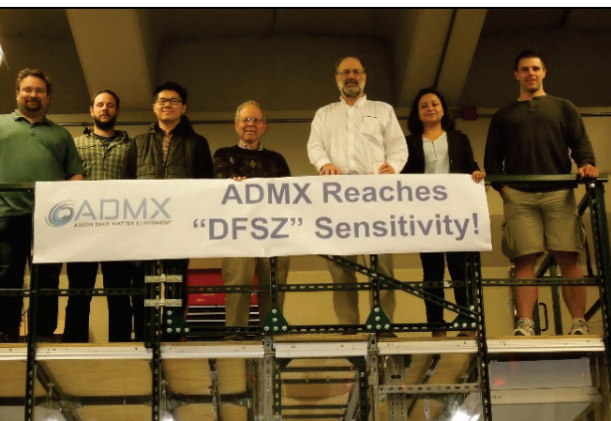
Axion Dark-Matter eXperiment Generation 2 at Univ of Washington

- ▶ Uses a strong magnetic field and resonant cavity to convert dark matter axions into detectable microwave photons
- ▶ Selected as one of three G2 dark matter experiments following P5
 - Currently stepping through range 0.5 to 2 GHz (~ 2 to 8 micro-eV)
 - Dec. 2017 review of operations status (now led by Fermilab)



Results:

- ▶ May 2017: ADMX reaches DFSZ sensitivity limit at 650 – 680 MHz. First time this limit reach for any axion mass range!



Cosmic Microwave Background (CMB)

Study cosmic acceleration (inflationary epoch) at energies near the Planck scale and dark energy and neutrino properties using the CMB, the oldest visible light (with NSF)

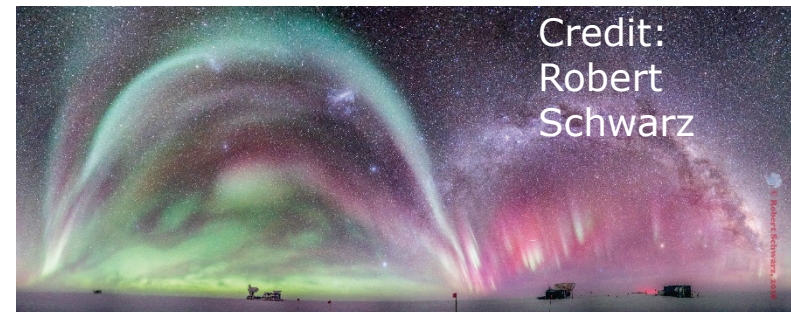
Operating

- **SPT-3G:** HEP support towards major upgrade of camera; Operations started Jan. 2017
- Research-only activities on a number of the current experiments; Lab involvement via LDRD

Future planning

As recommended by P5, HEP is planning to participate in a next-generation, 10x more sensitive array, the **CMB Stage 4 (CMB-S4)**

- AAAC approved the CMB-S4 Concept Definition Taskforce (CDT) report in Oct. 2017
 - Describes science goals, technical requirements, and a strawman concept(https://www.nsf.gov/mps/ast/aaac/cmb_s4/report/CMBS4_final_report_NL.pdf)
 - https://science.energy.gov/~media/hep/hepap/pdf/201712/Day2/Lawrence_CMB-S4_CDT_for_HEPAP_12-01-2017.pdf
- DOE/HEP and NSF continue meetings
- HEP lab groups, in coordination with the CMB-S4 collaboration, have set up a pre-Project Design Group (pPDG) for pre-conceptual planning and studies.



HEP Status at CAA, March 2018

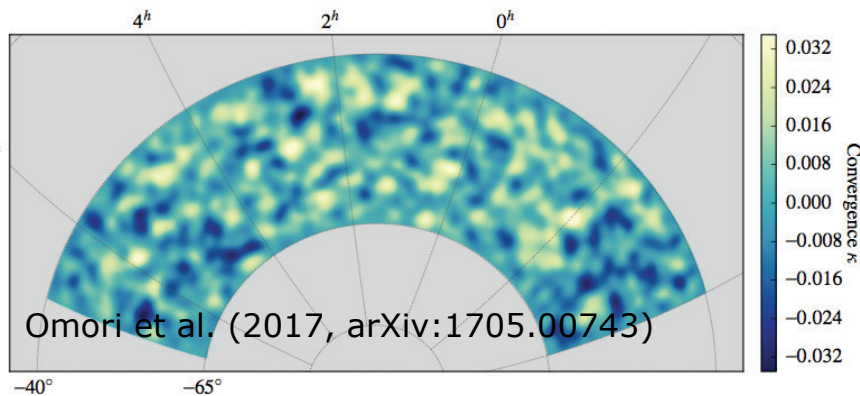
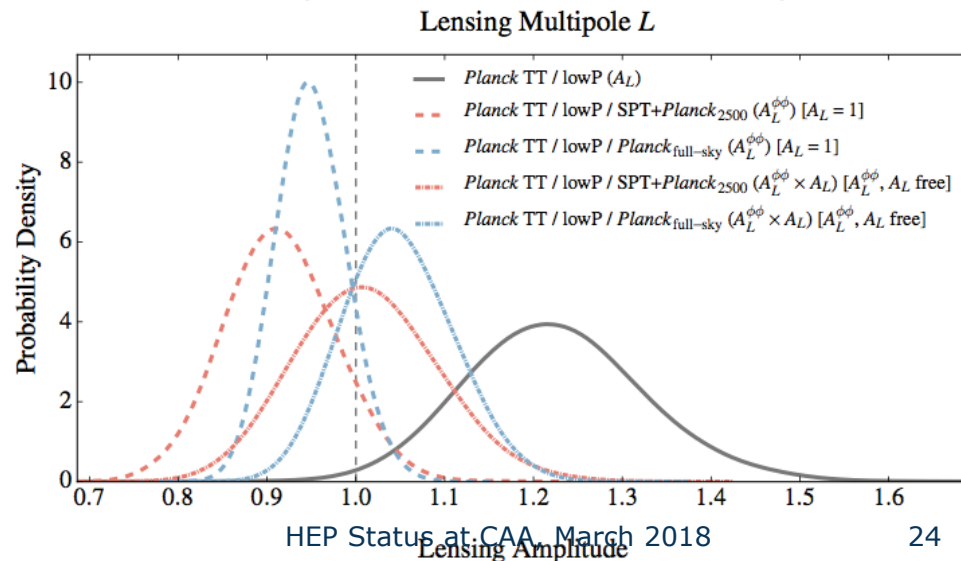
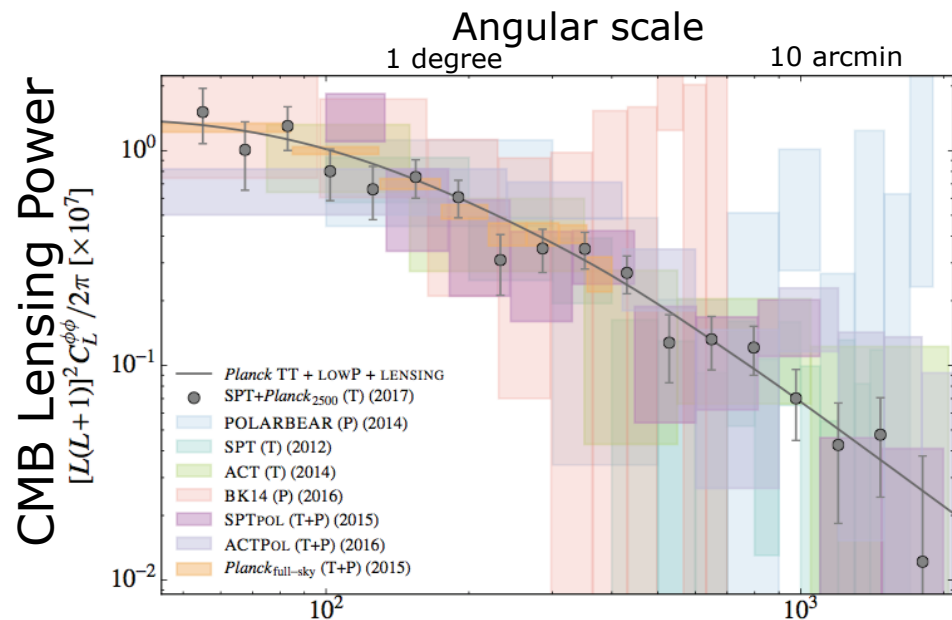


Science Highlight: South Pole Telescope

- Results from the 2500 sq deg survey (SPT-SZ)

Constraints on cosmology from gravitational lensing of the CMB Angular power spectrum of CMB lensing, as measured in the SPT-SZ 2500 deg² region

- ▶ Most sensitive measurement of lensing power spectrum at sub-degree scales; second only to Planck full-sky at all scales.
- ▶ No evidence of “extra lensing” compared to predictions of best-fit concordance cosmology, unlike Planck TT power spectrum.
- ▶ Further hints that lensing of the CMB is key to resolving current discordance in cosmology.
- ▶ Simard et al. (2017), arXiv:1712.07541

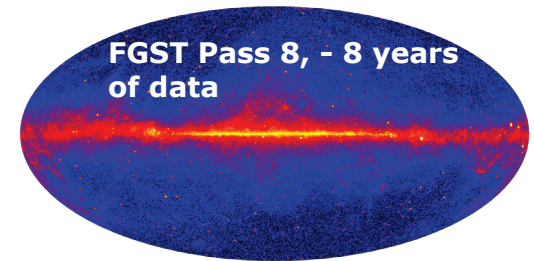


Cosmic-ray & Gamma-ray physics

- ▶ Use ground-based arrays, space telescopes, and an experiment on the International Space Station (ISS) to perform indirect searches for dark matter, fundamental physics & high energy acceleration mechanisms
 - Many significant inter-agency & international partnerships

Operations - HEP Roles Completed:

- VERITAS (2017), Pierre Auger (2016)



Operations - HEP Roles Continue:

- *Fermi/GLAST (w/NASA); launched June 2008*
 - HEP is supporting the 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) on the ISS; started 2011*
- *HAWC (w/NSF) in Mexico; 5 year operations started early 2015*



HAWC full operating array



VERITAS in Sonoran desert
Arizona



AMS on the International
Space Station

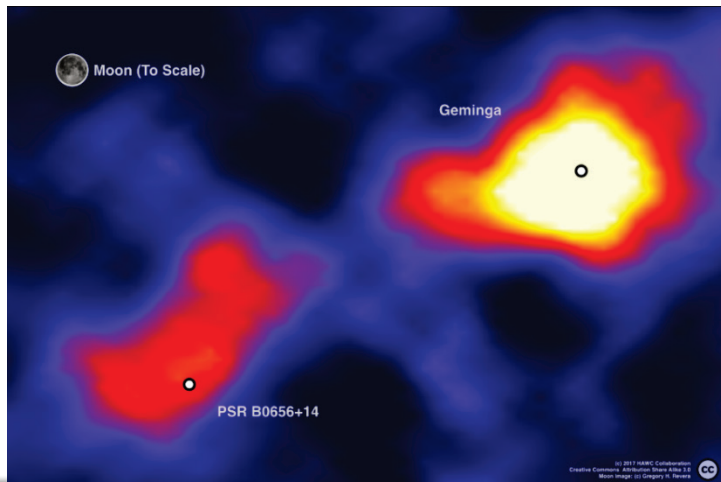


Science Highlight – High Altitude Water Cherenkov (HAWC)

- 100 GeV to > 100 TeV γ -rays, in Mexico
 - Indirect dark matter search from γ -ray annihilation & decay; Quantum gravity effects on propagation of γ -rays; Particle acceleration in extreme conditions
- 5 year all-sky survey started March 2015

Results: (Science, Nov 2017)

- ▶ HAWC detected TeV gamma rays from the two best-candidate pulsars for producing the local positron excess.
- ▶ The large measured TeV angular extent, which only a wide-field instrument can measure, implies positrons diffuse too slowly to contribute to local positron flux.
- ▶ Other explanations, such as dark matter, may be needed to account for positrons.



HAWC, with its wide field of view, sees the pulsars Geminga and PSR B0656+14 as broad beacons of gamma rays that appear much larger in angular extent than Earth's moon (which is shown for scale). Extended emission indicates positron diffusion is slow.

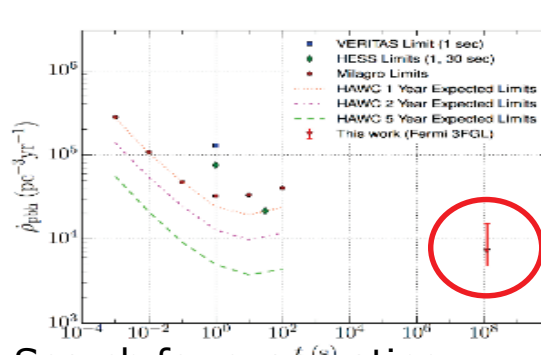
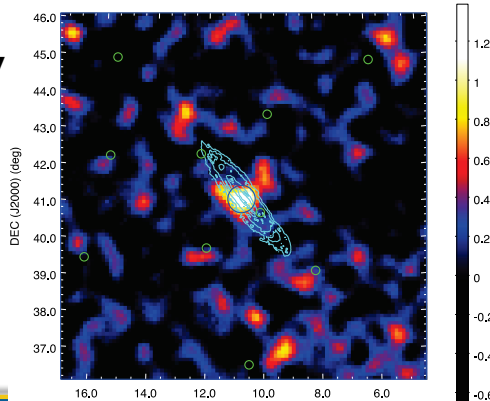
Science Highlight: Fermi Gamma-ray Space Telescope

- ▶ Study high-energy (~ 20 MeV- >300 GeV) gamma-rays using particle physics detector technology in space. Indirect Dark Matter (DM) detection; high-energy acceleration mechanisms
- ▶ Launched June 2008 for 5-year mission with 10-year goal; NASA Senior Review Panel (SRP) in 2016 recommended continuation of the Fermi science mission through FY18. SRP will review again in 2019 (SRPs now occur every 3 years).

Results

- ▶ May 2017: Gamma-ray emission of M31 (nearest large spiral galaxy) is correlated with its center. Competing interpretations are: unresolved pulsars or dark matter annihilation (would be in tension with dSph satellite limits)
- ▶ January 2018 (submitted): Competitive LAT limits on evaporation of primordial black holes; Deep search for gamma-ray sources in the inner Milky Way indicates that the GeV excess could be due to unresolved pulsars in Galactic halo.

LAT gamma-ray excess toward center of M31 (>1 GeV, foreground subtracted)

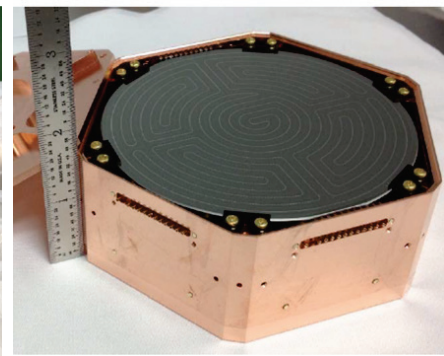
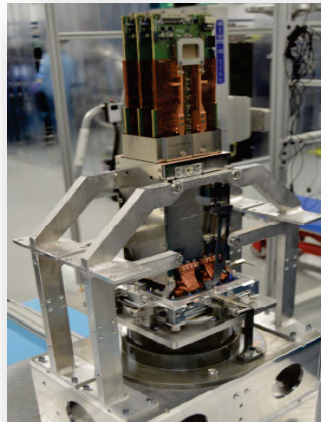
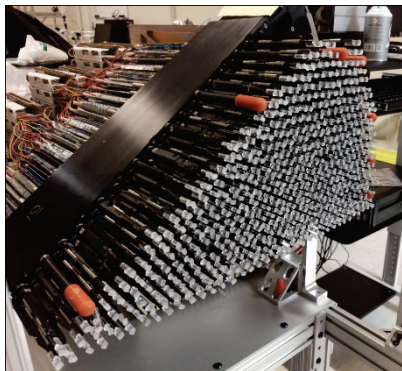


Search for evaporating black holes



Cosmic Frontier – Major Item of Equipment (MIE) Projects in Fabrication

Experiment	HEP Project \$M	Location	Critical Decision status	Full Operations Start (planned)	Recent Reviews
DESI	56.3	Arizona	CD-3 June.2016	(Jan.2020)	Feb 2018 Project & Ops plan
LSST	168	Chile	CD-3 Aug.2015	(Oct.2022)	Aug. 2017 Project, Dec. 2017 Facility Ops, March 2017 DESC
LZ	55.5	S. Dakota	CD-3 Feb.2017	(Sept.2020)	Jan 2018 Project & Ops plan
SuperCDMS-SNOLAB	18.6	Canada	CD-2/3 Spring 2018 (planned)	(mid-2020)	Jan. 2018 Project



LtoR DESI: completed fiber petal, LSST: completed raft tower
LZ: cryostat vessel, SuperCDMS-SNOLAB: izip detector

Cosmic Frontier – Operating Experiments

Area	Experiment	Location	DOE-HEP lead	Science Operations Start	Recent Reviews	Current Operations plans
CG	AMS	ISS	MIT	May 2011 launch	Portfolio Review	AMS plans operations through 2024
CG	FGST	space	SLAC	June 2008 launch	Portfolio Review	HEP Ops for critical SLAC efforts after FY18
CG	HAWC	Mexico	LANL	March.2015	Portfolio Review	Ops through 2019; HAWC plans to 2023
DE	DES	Chile	FNAL	Sept. 2013	Portfolio Review	Ops through end 2018
DE	eBOSS	New Mexico	Utah	July 2014	Portfolio Review	HEP support through spring 2018; eBOSS plans through FY19
DM	ADMX-G2	U. Wash	FNAL	Jan.2017	Oct. 2017 Ops	Ops through 2020/21 for 0.5 to 2MHz
CMB	SPT-3G	S. Pole	ANL	Feb.2017	Sept. 2014 Project, Dec. 2014 Ops	Ops through 2021

CG = Cosmic-ray, Gamma-ray; DE = Dark Energy; DM=Dark Matter



HEP SCIENCE PORTFOLIO REVIEW



DOE HEP Portfolio Review 2017-2018

HEPAP was charged (Oct. 2017) to carry out a Portfolio Review

-- Modeled on NSF Portfolio Review and NASA Science Reviews

Why:

- ▶ Given the current budget outlook, we think it is imperative to take a close and critical look at currently operating HEP experiments and how effectively they are advancing the P5 plan
 - ▶ Portfolio Review is the process we have created to implement this
 - ▶ Overarching goal is to maintain and optimally execute the P5 plan

Note: The Cosmic Frontier has had reviews of operating experiments in the past; what's new is it is now in the context of the entire program.

What:

- ▶ Independent peer review of currently operating experiments supported by HEP
- ▶ Will focus on scientific impact and productivity of HEP-supported contributions
- ▶ HEP will use the results to define a detailed implementation plan for P5 strategic vision in the FY19 to FY22 timeframe
- ▶ HEP management will ensure that key officials in institutions or agencies that are partners in operating experiments are apprised of the plans for the HEP Portfolio Review as well as resulting decisions.



DOE HEP Portfolio Review 2017-2018

Experiments being reviewed:

- ▶ Includes all currently-supported HEP experiments that have taken physics data for at least two years, and are expected to request significant DOE support for operations or related activities (e.g., computing) beyond FY 2018
- ▶ There are 2 separate subpanels:
 1. LHC subpanel is chaired by Hugh Montgomery & covers ATLAS and CMS
 2. "Main" subpanel is chaired by Paul Grannis covers **AMS, Fermi-GLAST, HAWC, DES, eBOSS in the Cosmic Frontier**, along with 8 Intensity Frontier experiments (Daya Bay, KOTO, MicroBooNE, Minerva, NA61/SHINE, NOvA, SuperK, T2K)

Schedule

- ▶ HEPAP charged Oct. 2017
- ▶ Proposals and materials are due Feb. 1, 2018
- ▶ Subpanels are meeting F2F at the end of February & end of March.
- ▶ Reports will be provided to HEPAP for approval in May 2018

More information →

- See Glen Crawford's HEPAP Dec. 2017 Presentation at:
https://science.energy.gov/~media/hep/hepap/pdf/201712/Day1/Crawford_2017-11-30_DOE_Portfolio_Review.pdf
- Charge letter, instructions and FAQ at: <https://science.energy.gov/hep/hepap/reports/>

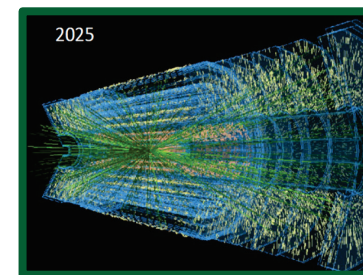


QUANTUM INFORMATION SCIENCE (QIS)



Quantum Information Science (QIS)

- ▶ QIS has been identified as an important cross-cutting topic with potential impact across all SC program offices
 - ▶ See 11/29/17 Dear Colleague letter at: https://science.energy.gov/~media/sc-2/pdf/presentations/2017/DOE-Office_of_Science_Dear_Colleague_Letter_on_QIS.pdf
- ▶ For HEP: Emphasis is on HEP mission, science drivers, and advancement of QIS in the context of the broader SC initiative
- ▶ FY 2018 Budget has approved support for QIS, with exact funding TBD (expected to be > \$15M).
- ▶ **Funding Opportunity Announcement (FOA)** for Universities & DOE Labs:
 - ▶ https://science.energy.gov/~media/grants/pdf/lab-announcements/2018/LAB_18-1893.pdf
 - ▶ https://science.energy.gov/~media/grants/pdf/foas/2018/SC_FOA_0001893.pdf



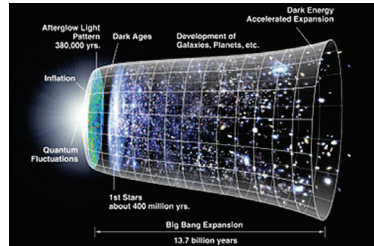
HEP Status at CAA, March 2018



SUMMARY & CONCLUSION



Summary & Conclusion



- ▶ HEP is maintaining the core of the DOE Science Mission
 - HEP is delivering exciting discoveries, important scientific knowledge, and technological advances
 - Program priorities will continue to be driven by the P5's compelling, realistic strategic plan
 - Cosmic Frontier has staged program of currently operating experiments, projects in fabrication and planning for the future, to make significant advances aligned with the P5 science drivers.
 - HEP looking forward to participation in the National Academy of Science's 2020 Astronomy & Astrophysics Decadal Survey



Grants, Awards



DOE Office of Science Early Career Awards

HEP had 11 awards in FY17
→ Winners in the Cosmic Frontier



Anja von der Linden
Stony Brook University
Galaxy clusters – for Dark Energy



Michael Schneider
Livermore National Lab
Weak lensing – for DE

... and Cosmic Frontier-related Detector R&D and Theory awards



Zeeshan Ahmed
SLAC
Expert in CMB detectors

Marilena LoVerde
Stony Brook University
Expert in cosmological neutrinos



Cosmic Frontier – Statistics on Comparative Review Research Grants

		FY12	FY13	FY14	FY15	FY16	FY17
Cosmic \$M request Y1-3		\$3.3	\$7.7	\$7.5	\$6.8	\$7.8	\$24.6
Cosmic \$M request Y1		\$3.3	\$7.7	\$7.5	\$6.8	\$7.8	\$7.6
Cosmic \$M funded Y1		\$1.6	\$3.4	\$4.4 w/FFF	\$3.3 w/FFF	\$4.3M w/FFF	\$4.7M w/FFF
Cosmic - proposal counts							
	received	11	33	29	27	43	31
	reviewed	10	28	28	27	36	26
	funded	6	18	19	14	21	18
	success rate	60%	64%	68%	52%	58%	69%
Cosmic CR - PI counts							
	received	21	61	40	43	65	49
	reviewed	20	54	38	43	55	43
	funded	13	27	25	21	25	26
	success rate	65%	50%	66%	48%	45%	60%

Notes:

- FFF = Fully Forward Funding required if grant < \$1M
- Typically the total of all requests is for ~2-3X the funds we have available.
- We typically fund the grants at less than their request; Reduced research scope is negotiated with PI(s) if needed
- FY18 grants are in process; funding very constrained while waiting for an approved budget



Cosmic Frontier – Statistics on Early Career Awards (universities & labs)

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17
# received - Univ	11	8	12	16	6	7	7	8
# received - Lab	10	4	7	9	7	5	6	5
# funded - Univ	2	1	2	1	1	0	1	1
# funded - Lab	0	2	1	1	0	0	0	1

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)

FY17

von der Linden (SUNY-SB)
Schneider (LLNL)





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