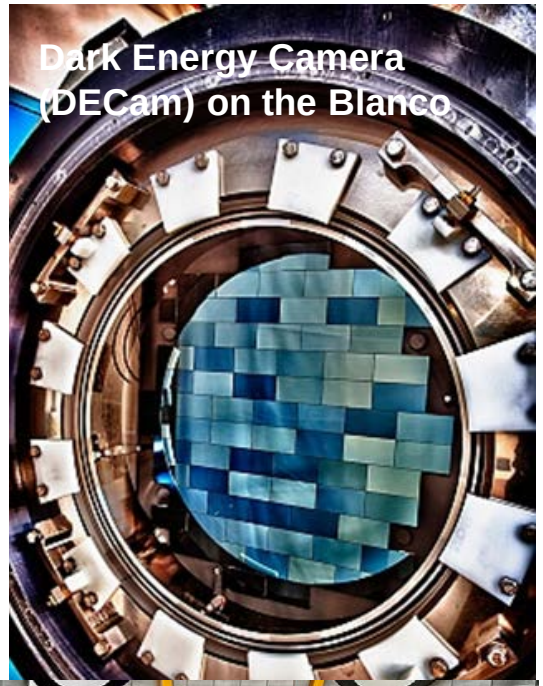
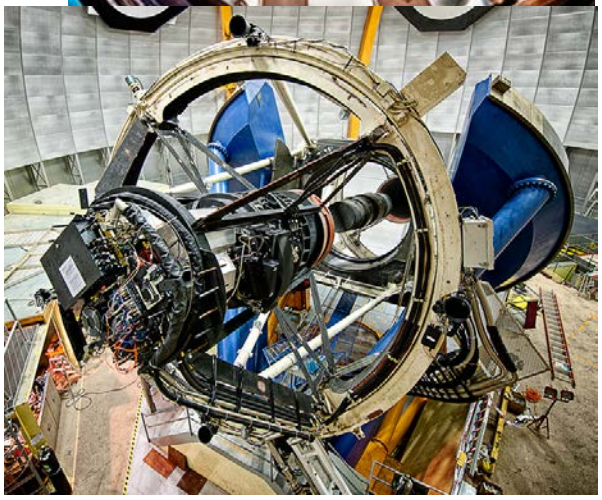
DOE High Energy Physics (HEP)

report to the

AAAC Panel


Dark Energy Camera (DECam) on the Blanco



September 27, 2017
Glen Crawford
Division Director for Research & Technology
DOE Office of High Energy Physics

PROGRAM MISSION & GUIDANCE

DOE Office of High Energy Physics (HEP) Program Mission

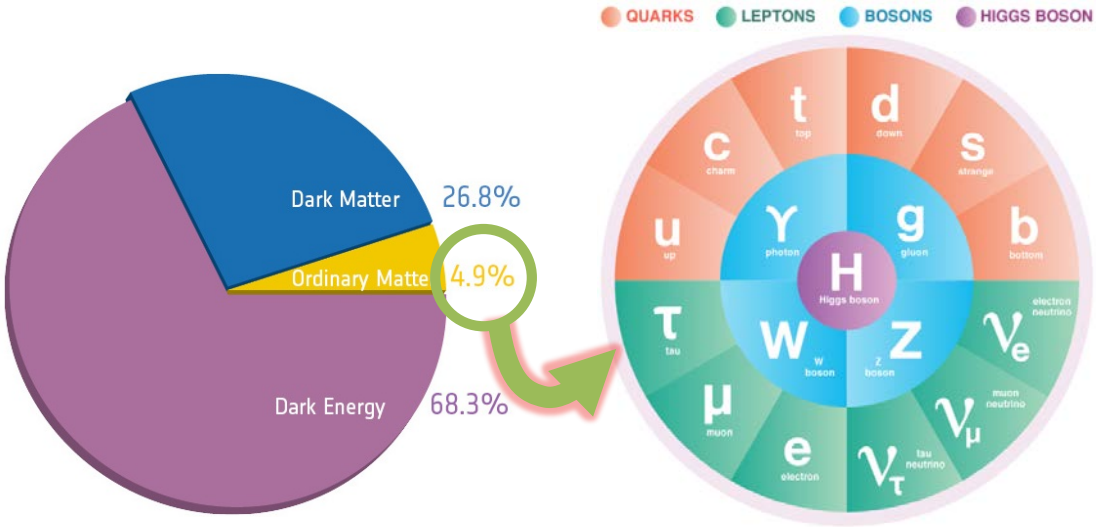
…is to understand how the universe works at its most fundamental level:

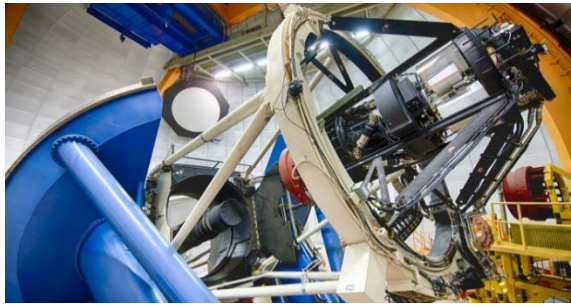
- Discover the elementary constituents of matter and energy
- Probe the interactions between them
- Explore the basic nature of space and time

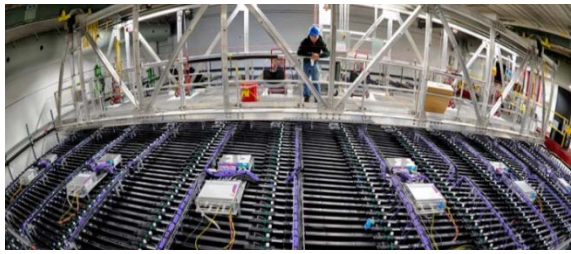
The Office of High Energy Physics fulfills its mission by:

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

HEP supports research efforts by scientists on collaborations through all phases of an experiment in order to world-leading science.







U.S. Department of Energy

Agency Organization

Boards & Councils
- Secretary of Energy Advisory Board
- National Laboratory Policy Council
- Energy Council
- Credit Review Board
- Cyber Council
- Nuclear Security Council
- Jobs Council
- ESAAB

Office of the Secretary
Rick Perry, Secretary
Dan Brouillette, Deputy Secretary
Brian McCormack, Chief of Staff

Associate Deputy Secretary

- Federal Energy Regulatory Commission
- Inspector General
- Ombudsman

Office of the Under Secretary for Nuclear Security and National Nuclear Security Administration
Frank G. Klotz, Under Secretary for Nuclear Security Administrator, NNSA
William White, Acting, Principal Deputy Administrator, NNSA

- Deputy Administrator for Defense Nuclear Nonproliferation
- Deputy Administrator for Naval Reactors
- Associate Administrator for Defense Nuclear Security
- Associate Administrator for External Affairs
- Associate Administrator for Management & Budget
- Office of General Counsel
- Deputy Administrator for Defense Programs
- Deputy Under Secretary for Counter-terrorism & Counter-proliferation
- Associate Administrator for Emergency Operations
- Associate Administrator for Safety, Infrastructure & Operations
- Associate Administrator for Acquisition & Project Management
- Associate Administrator for Information Management & Chief Information Officer

Office of the Under Secretary for Science & Energy
Patricia Hoffman, Acting, Under Secretary for Science and Energy

- Office of Science
- Assistant Secretary for Energy Efficiency and Renewable Energy
- Assistant Secretary for Fossil Energy
- Assistant Secretary for Nuclear Energy
- Assistant Secretary for Electricity Delivery and Energy Reliability
- Indian Energy Policy and Programs
- Office of Technology Transitions[2]

Office of the Under Secretary for Management & Performance
Matthew Moury, Acting, Under Secretary for Management and Performance

- National Laboratory Operations Board
- Associate Under Secretary for Environment, Health, Safety & Security
- Assistant Secretary for Environmental Management
- Economic Impact & Diversity
- Management
- Chief Human Capital Officer
- Chief Information Officer[1]
- Project Management Oversight & Assessments
- Legacy Management
- Hearings & Appeals

- Assistant Secretary for International Affairs
- Assistant Secretary for Congressional & Intergovernmental Affairs
- General Counsel
- Chief Financial Officer
- Intelligence & Counterintelligence
- Enterprise Assessments
- Public Affairs
- Small and Disadvantaged Business Utilization
- U.S. Energy Information Administration
- Advanced Research Projects Agency - Energy
- Energy Policy & Systems Analysis
- Loan Programs Office
- Bonneville Power Administration
- Southwestern Power Administration
- Southeastern Power Administration
- Western Area Power Administration

Office of High Energy Physics is within the DOE Office of Science

[1] The CIO reports directly to the Secretary for the purposes of carrying out responsibilities under Subchapter 44 U.S.C.§ 3506(a)(2)(A).
[2] The director of the Office of Technology Transitions also serves as DOE's Technology Transfer Coordinator who reports to the Secretary of Energy

HEP Program Guidance

- **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 Physics Project Prioritization Panel ("P5") in 2014**

- **Astronomy and Astrophysics Advisory Committee (AAAC)**
  - Advises DOE, NASA, and NSF on selected issues in astronomy & astrophysics of overlap, mutual interest and concern
    - **Subpanel: CMB-S4 CDT (in process)**

- **Formal Advice Also Provided by National Academy of Sciences (NAS)**
  - On request, advises agencies on particular matters
    - **Reports: New Worlds New Horizons (2010), "mid-decade review" (2016) in astronomy/astrophysics**

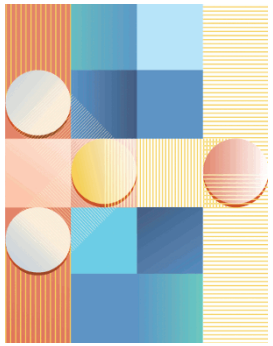
Long-term strategic plan for HEP

The U.S. has entered a new era of discovery.

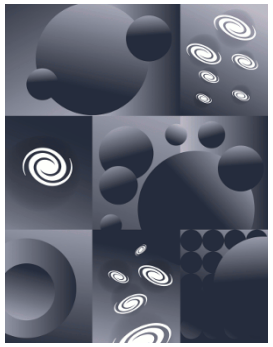
P5 assessed and prioritized HEP projects over a 20 year timeframe within reasonable budget assumptions & positions the U.S. to a be a leader in some (but not all) areas of HEP.

The P5 report identified five intertwined science drivers, compelling lines of inquiry that show great promise for discovery:

- **Use the Higgs boson as a new tool for discovery** **2013*
- **Pursue the physics associated with neutrino mass** **2015*
- **Identify the new physics of dark matter**
- **Understand cosmic acceleration: dark energy and inflation** **2011*
- **Explore the unknown: new particles, interactions, and physical principles**

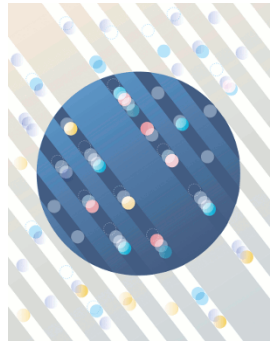


Higgs boson

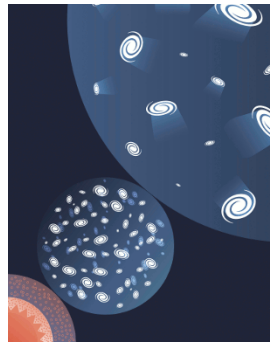


Dark matter

Explore the Unknown



Neutrino Mass

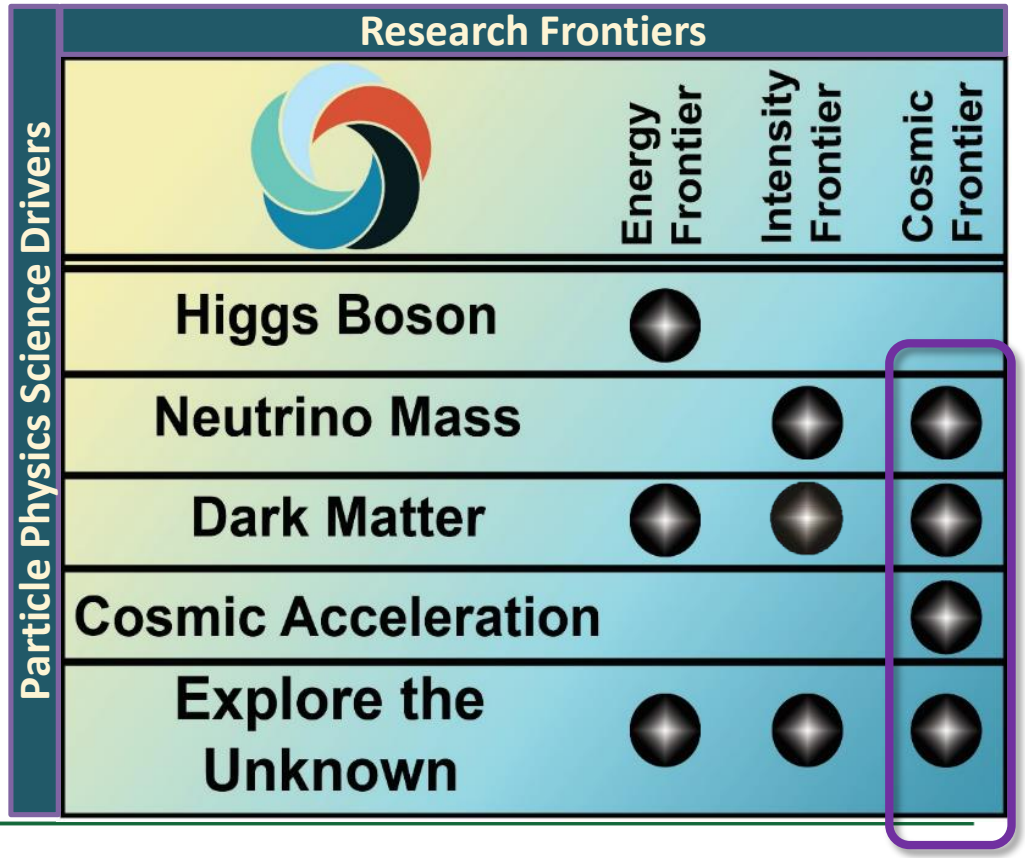


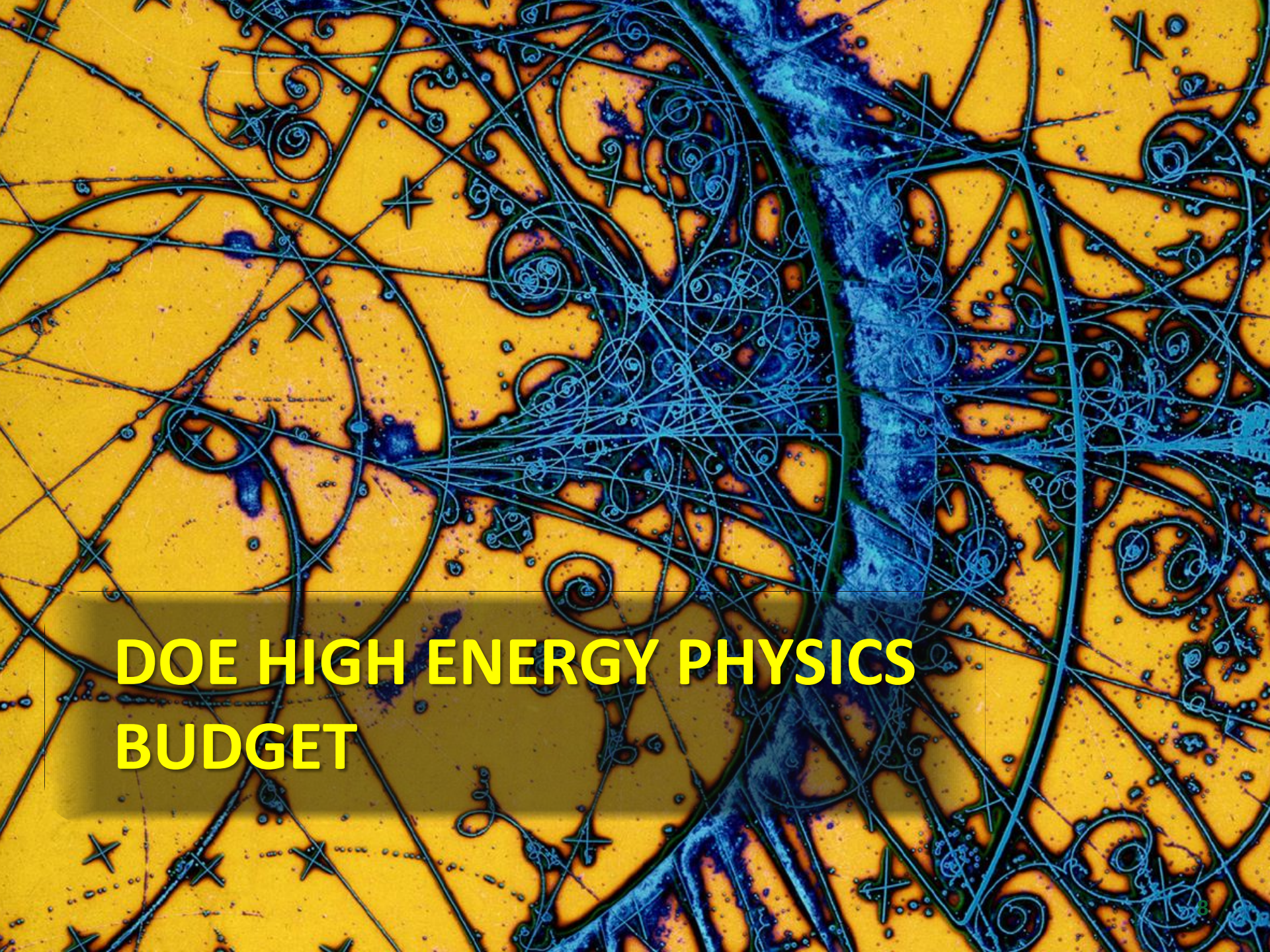
Cosmic acceleration

Enabling the Next Discovery

- **P5 (U.S. Particle Physics Project Prioritization Panel) identified 5 Science Drivers to address the scientific motivation of particle physics**
- **Research Frontiers are useful categorization of experimental techniques and serve as the basis of the budget process**

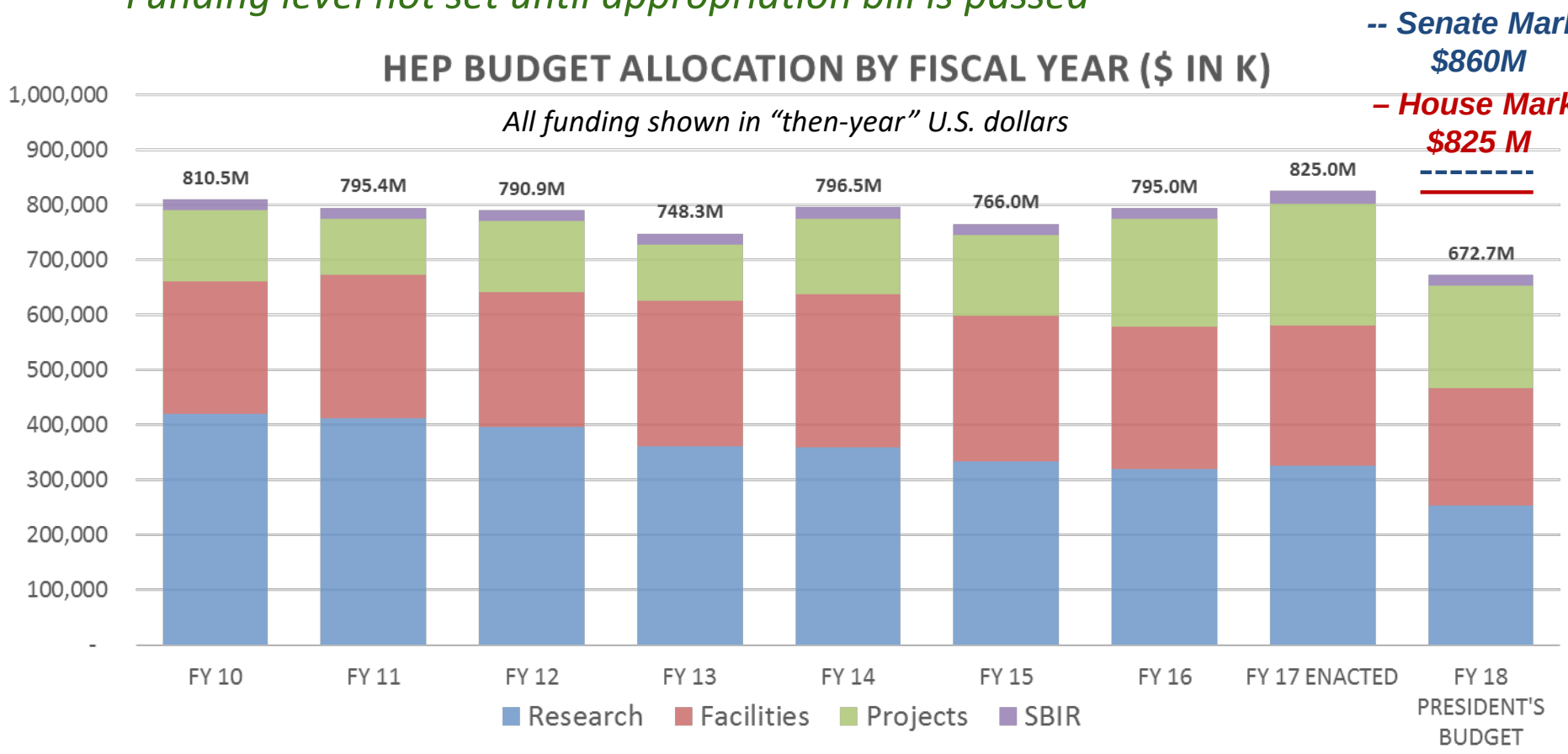
- **Research Frontiers are complementary**
  - No one Frontier addresses all science drivers
  - Each Frontier provides a different approach to address science driver
  - Enables cross-checking scientific results




DOE HIGH ENERGY PHYSICS
BUDGET

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*

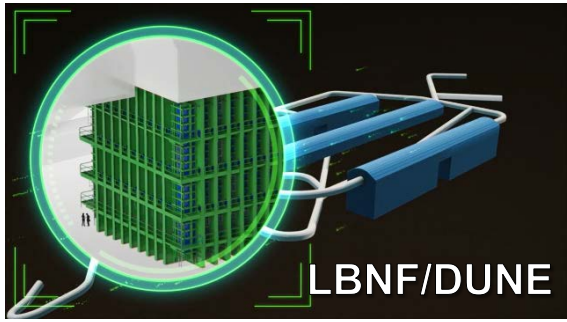


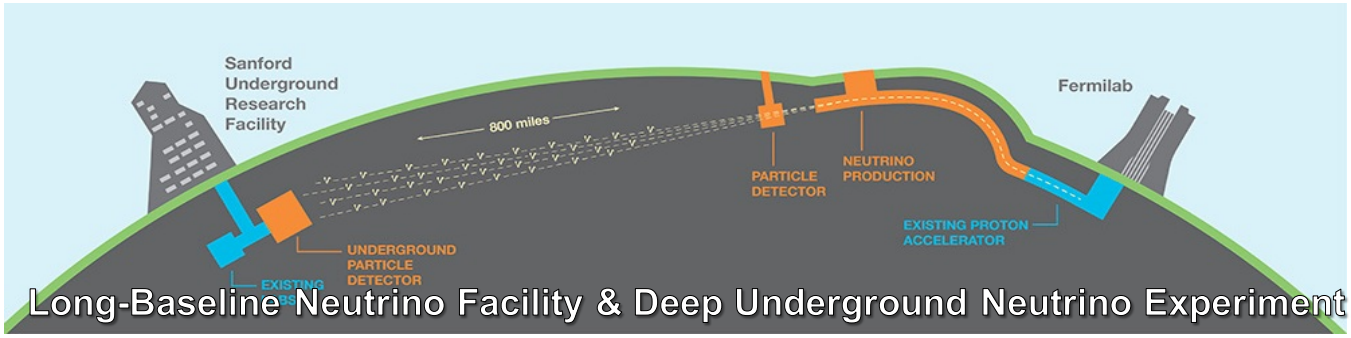
HEP FY18 Budget Request Strategy

HEP FY 2018 Request is guided by priorities of Administration, Office of Science, & P5 report strategy

Aim to continue the P5 priorities within the available budget by preserving the vision and modifying the execution:

- **Reduce near-term science for P5-guided investments in mid- and long-term program**
  - All projects continue, some with delays: Highest priority P5 projects supported with least adjustment possible to scope and schedule
  - Research maintained at 40% of the program budget
  - Operations support for ongoing experiments reduced to make this possible
  - Other efforts across Research, Facility Operations, and Projects have scope reduced or schedules delayed, based on factors including the P5 report strategy and project maturity





FY18 Cosmic Frontier Status & Outlook

Operating experiments will continue to advance & produce science results:

- **AMS-2, DES, eBOSS, FGST, HAWC**: data taking and analysis continues
- **SPT-3G, ADMX-G2**: small projects started science operations phase in 2017

Projects: Priority is on executing the 4 P5-recommended Major Item of Equipment (MIE) projects, currently in fabrication phase: **LSSTcam, DESI, LZ, SuperCDMS-SNOLAB**

  - FY18 Request prioritizes efforts on LZ, slows DESI and SuperCDMS-SNOLAB
  - House and Senate FY18 Marks address these issues.
- Efforts are also underway to plan the next phase
  - Develop and review each project's experimental operations plan
  - Task force to investigate optimizing computing needs across Cosmic Frontier

Future Planning: Laying ground work for the future (e.g. **CMB-S4** which starts later in P5 plan, and opportunities for small projects): mainly science studies; R&D funds are VERY limited.

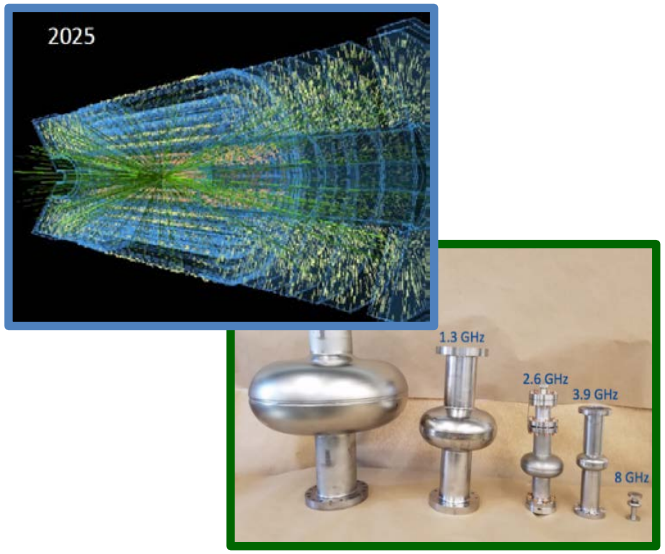
Status of FY 2018 Appropriations

- **U.S. House of Representatives released draft language for the FY 2018 budget in June 2017; U.S. Senate in mid-July 2017**
  - Language in both chambers of U.S. Congress supportive of HL-LHC Accelerator Project, HL-LHC ATLAS and CMS Upgrade projects, LBNF/DUNE, and Cosmic Frontier projects
  - Research funding will by necessity continue to be constrained, but efforts critical to executing the P5 recommendations remain a priority
- **Funding level is set once the Congressional appropriation bill has passed**

- **Fiscal Year 2018 begins on October 1, 2017, with a Continuing Resolution (CR) through December 8, 2017**
  - CR passed by U.S. Congress and has been signed by the President

Quantum Information Science for HEP

- **Emphasis is on HEP mission, science drivers, and advancement of QIS in the context of the broader SC initiative**
- **Program Manager for QIS at HEP: Lali Chatterjee**
- **FY 2018: Total of ~$15M for QIS, prioritized as:**
  - Fundamental HEP and QIS research
    - Foundational concepts of quantum information
    - Field theory and analog simulations
    - Experiments and emulators
  - Supporting technology for HEP
    - Quantum computing
    - Quantum controls and sensors



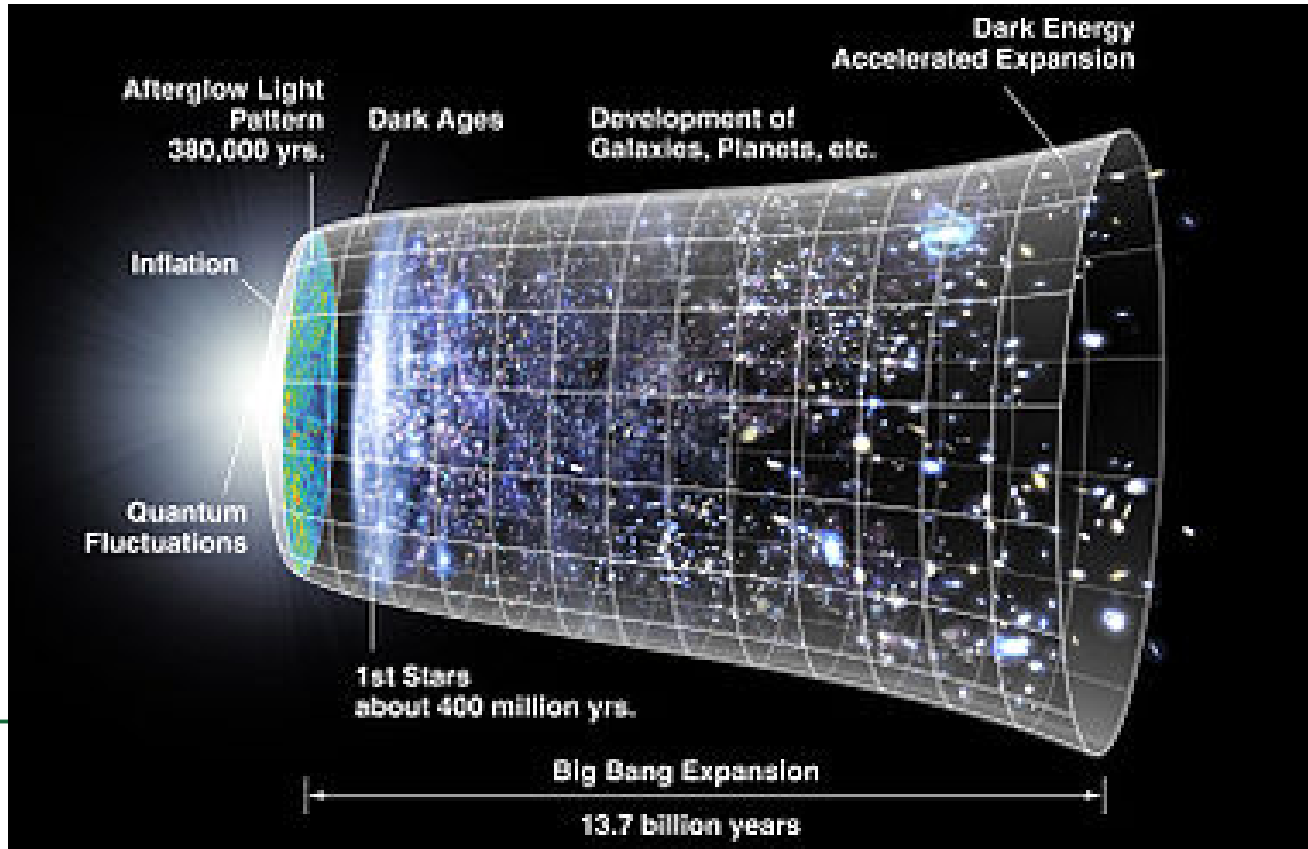
- **Funding Opportunity Announcement (FOA) and Lab Program Announcement**
  - in development for potential release after appropriations
- **Potential SBIR topics are being developed to support and complement HEP QIS activities**
- **Community input needed! Request For Information expected to be posted by HEP soon**

HEP Cosmic Frontier: program, planning, status

HEP Cosmic Frontier Program

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

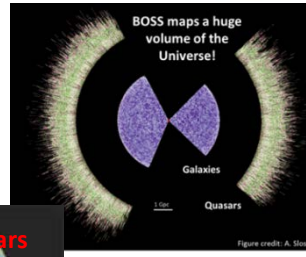
…and related Theory, Detector development, computational studies

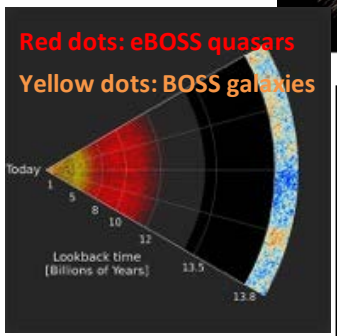


Dark Energy

Precision measurements to differentiate between: cosmological constant and/or new fields; or modification to General Relativity

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





Operating/Completed:

– ***BOSS* (spectroscopic)** ended FY14; ***eBOSS* (spectroscopic)** started in 2015

– ***DES* (imaging)** started 5-year survey in late FY13

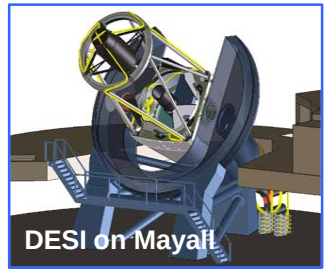
In Fabrication phase:

– ***Large Synoptic Survey Telescope* (LSST, Stage IV imaging)**

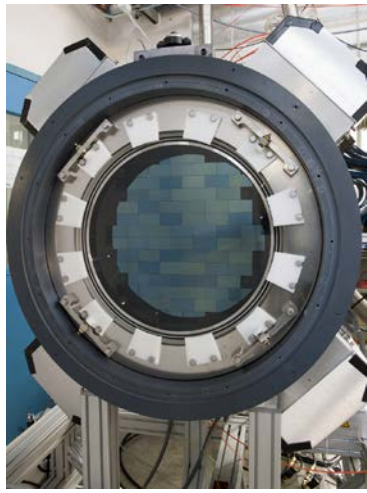
- HEP and NSF-AST (lead agency) partnership; HEP responsible for LSST camera (SLAC)
- LSST is under construction; science operations start FY23
- Planning started for LSST Facility Operations phase and Dark Energy Science Collaboration (DESC) Operations

– ***Dark Energy Spectroscopic Instrument* (DESI, Stage IV spectroscopic)**

- DESI is an "HEP experiment" in the fabrication phase; next review is Feb. 2018
  - Fabricate DESI instrumentation & data management system
  - HEP coordinating w/NSF-AST to use ("lease") the Mayall telescope; ramping up partial support in FY16-18; full support for dark energy operations starting FY19
- Planning for operations phase started



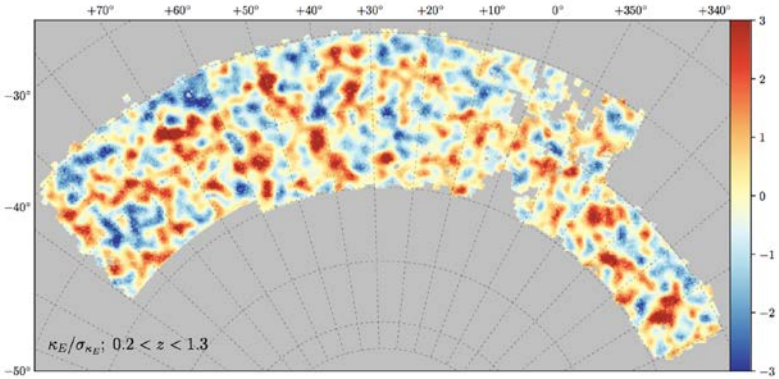
Science Highlight: Dark Energy Survey (DES)



- **DES probes nature of Dark Energy via survey of 300 million galaxies & 3000 supernovae, using 570-megapixel Dark Energy Camera on Blanco 4-meter telescope in Chile**
- Operations started August 2013; now in 5th year (of 5) of observing.
  - Data Release 1 (based on first 3 years of data) planned for December 2017

Results:

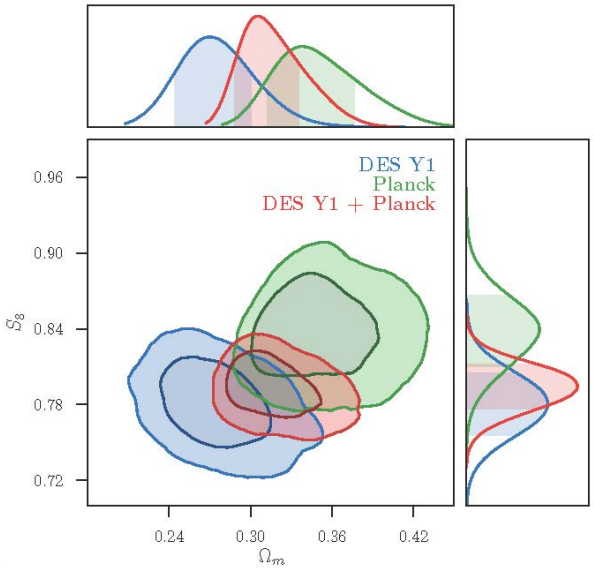
- **Aug. 2017: Year 1 Cosmology results (10 papers)** from galaxy clustering & weak lensing; constraints competitive with Planck CMB
- Well over 100 papers submitted; e.g., most distant supernova, new Milky Way dwarf satellites to constrain dark matter



DES Year 1: largest map of dark matter in the Universe. Based on weak lensing shape measurements of ~30 million galaxies, this map spans ~2.5 billion light years. (Chang, et al. 2017)

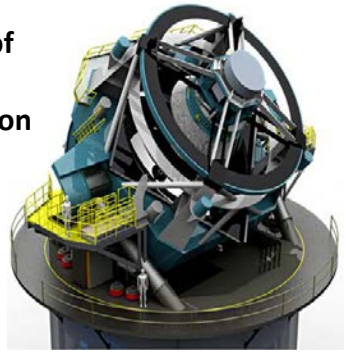
DES Year 1: cosmology results from galaxy clustering and weak lensing (DES Collaboration 2017). Consistent with Planck CMB within ΛCDM. Combined wCDM constraints with Planck, BAO, SN:

$$w = -1.00^{+0.04}_{-0.05}.$$



Large Synoptic Survey Telescope (LSST) status

Drawing of LSSTcam mounted on telecope facility.



The 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.

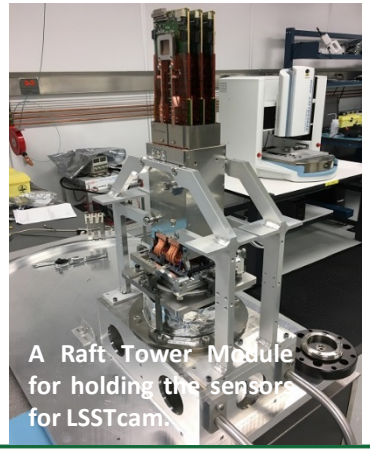
NSF leads the LSST project and is responsible for the 8.4m telescope facility and data management system. DOE is responsible for providing the LSSTcam.

Polishing the LSSTcam L3 lens

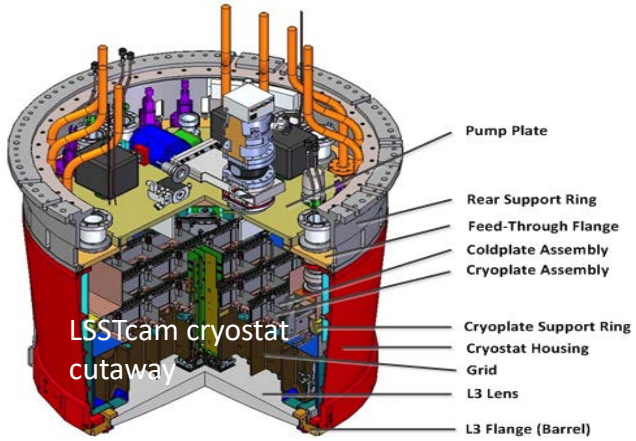
Status

- LSST Project Status review Sept. 2017
- LSST Facility Operations phase being planned
- Dark Energy Science Collaboration (DESC) Operations review spring 2017

The finished cryostat grid protected by a Plexiglas shield



A Raft Tower Module for holding the sensors for LSSTcam.



LSSTcam cryostat cutaway

Dark Energy Spectroscopic Instrument (DESI) status

DESI's spectroscopic survey will measure 30 million spectra of galaxies & quasars to map their 3-D positions and determine the growth of cosmic structure over 10 billion years

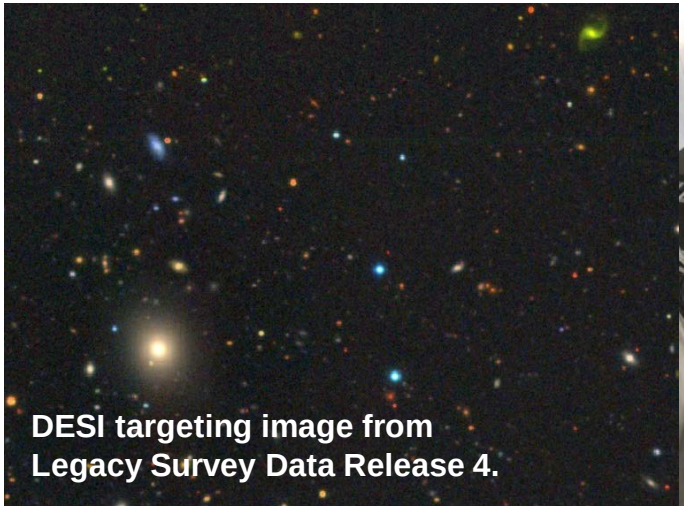
- Using Baryon Acoustic Oscillation and Redshift Space Distortion growth and other methods

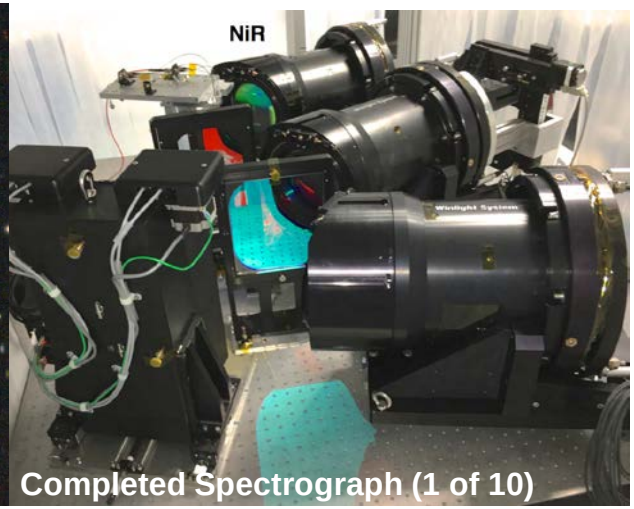
DOE leads the DESI project and is responsible for the spectrographs and associated systems. NSF is responsible for providing the Mayall telescope facility including infrastructure. DOE supports Mayall operations during the dedicated DESI survey.

Status

- Feb. 2018 : Review of Project status & Operations plan
- Mayall shutdown to get ready for DESI in FY18; Full dark energy survey operations starting early FY20

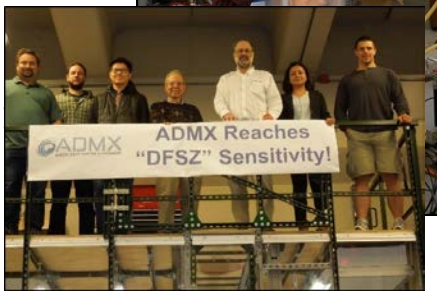

Lens C1 after AR coating. 5 of 6 lenses are now polished to spec.


DESI targeting image from Legacy Survey Data Release 4.



Completed Spectrograph (1 of 10)

Direct Detection of Dark Matter



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

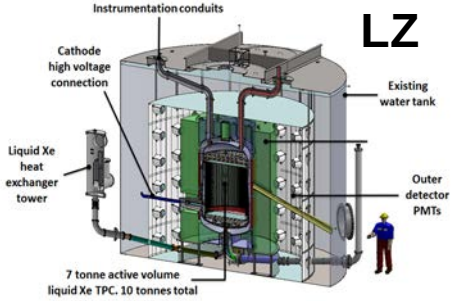
– High- and low-mass WIMP sensitivity; Axion (μeV mass) search

Operating/Completed:

Completed DOE funding for Operations of several current DM-Generation (DM-G1) experiments in FY16/17

In Design, Fabrication:

DM-G2's selected by HEP & NSF-PHY in July 2014 following P5 report:

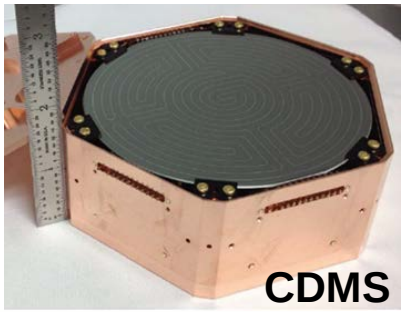


ADMX-G2 axion search at UWash (HEP); science ops started Jan 2017

- Uses a strong magnetic field to resonantly convert dark-matter halo axions into detectable photons; currently searching in range 0.1 to 2 GHz
- **Currently data-taking at design sensitivity!**

LZ at Homestake Mine in South Dakota (HEP)

- WIMP search through dual phase liquid Xe – ~10-1000 GeV mass range
- In fabrication; planning for operations phase started



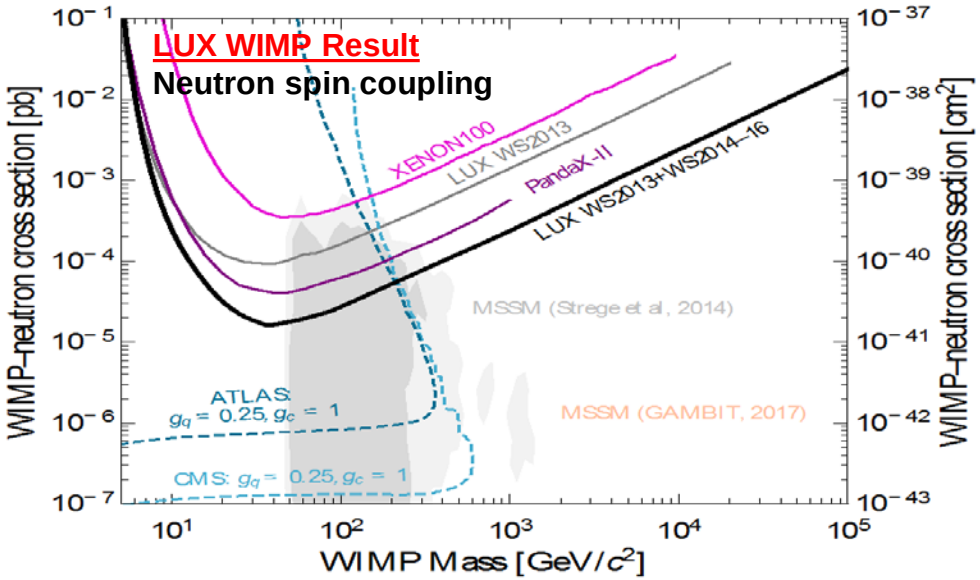
SuperCDMS-SNOLab in Canada (HEP+NSF-PHY partnership)

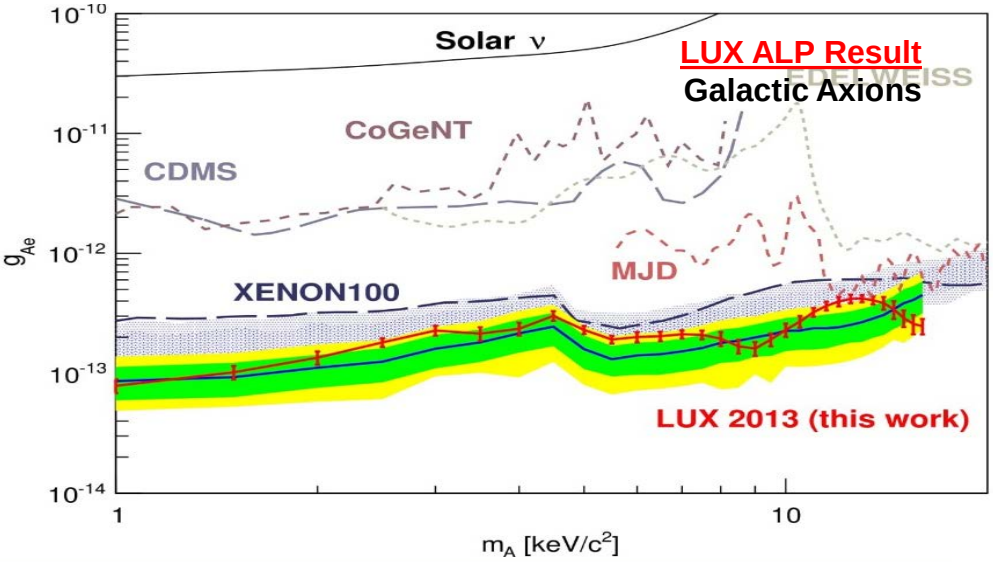
- WIMP search using cryogenic solid-state crystals – ~1-10 GeV mass range
- Baseline review Jan. 2018; planning for ops phase started

Science Highlight: Large Underground Xenon (LUX)

LUX collaboration (LZ precursor) has published experimental constraints on the *spin-dependent* WIMP particle interactions with nucleons (mainly neutrons within xenon nuclei), and on solar axions and galactic axion-like particles (ALPs).

- The results provide a 90% confidence level upper limit on the WIMP interaction cross section, a factor of 6 improvement over previous LUX spin-dependent results and the most sensitive constraints to date for WIMP-neutron interactions.





Cosmic Microwave Background

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

Operating

- ***SPT-3G*: HEP supported (with NSF) major upgrade of the camera; operations started Jan. 2017**
- Research-only activities on a number of the current experiments; lab involvement via internal development funds

Future planning

- Community planning → *CMB-S4 Collaboration* Science Book, Technology Book
  https://arxiv.org/abs/1610.02743 ; https://arxiv.org/abs/1706.02464

- **We look forward to the Concept Definition Team report**


South Pole Telescope (SPT) and BICEP/Keck Array

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

Many significant inter-agency & international partnerships

HEP Roles Completed:

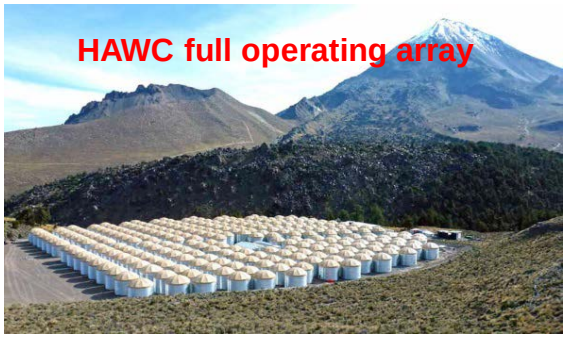
- VERITAS, Pierre Auger

Operations continuing:

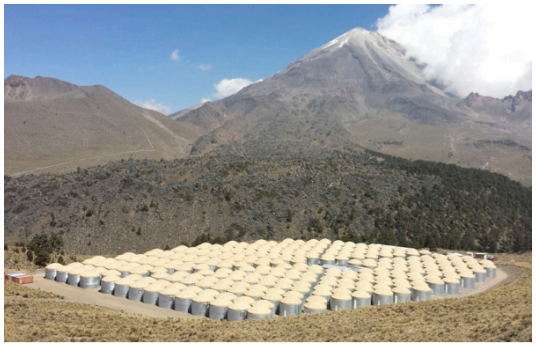
Fermi/GLAST (w/NASA)
- HEP is supporting the Instrument Science Ops Center at SLAC;
- In coordination with NASA, HEP is planning to continue support of critical efforts at SLAC if operations > 10 years

AMS (w/NASA)
- Operations continuing on ISS

HAWC (w/NSF)
- 5 year operations started early 2015
- Site and staff are safe following recent earthquakes



Science Highlight: High Altitude Water Cerenkov

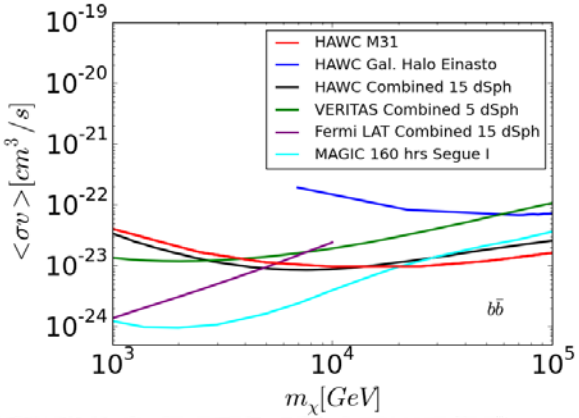


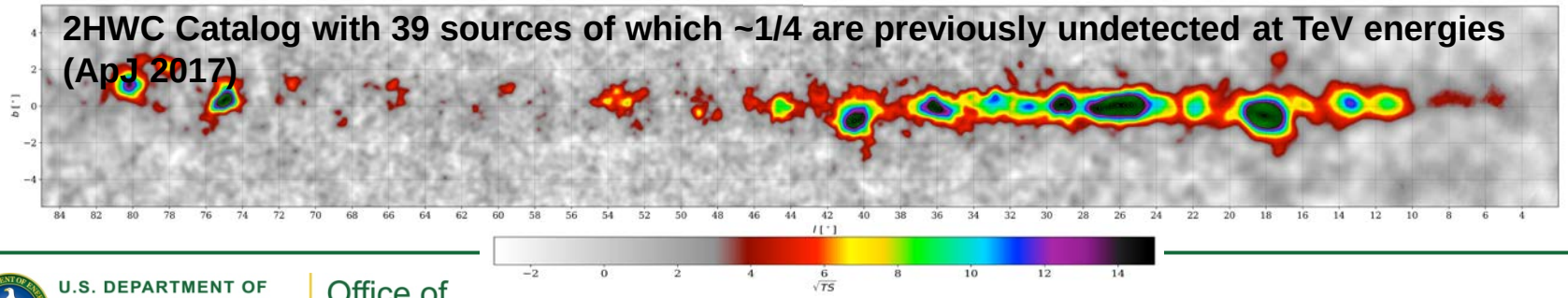
All-sky survey 100 GeV to > 100 TeV γ-rays, in Mexico

- Indirect dark matter search from γ-ray annihilation & decay
- Quantum gravity effects on propagation of γ-rays
- Particle acceleration in extreme magnetic and gravitational fields

Recent results: (July 2017)

- 6 publications in ApJ in last 2 months including catalog of 39 sources
- HAWC limits on dark matter annihilation constrain cross sections of multi-TeV mass candidates. 15 dwarf spheroidal combined limits submitted to ApJ (arxiv.org/abs/1706.01277)

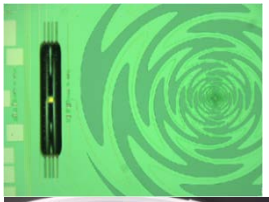


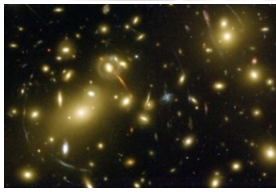


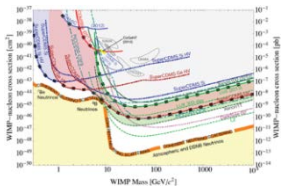
Cosmic Frontier – Future Plans

To facilitate community interactions concerning implementation of the P5 plan for Cosmic Frontier, DOE/HEP has formed "Cosmic Visions (CV)" discussion groups in several areas

- Active CV groups in CMB, Dark Matter, Dark Energy







Additional Community-based Efforts

CMB-S4 Concept Definition Team – AAAC subpanel

- Reporting tomorrow!

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:

- Community input on investigating optimizing science in DESI/LSST era and/or follow-on projects
- Community workshop held in 2016; upcoming workshop Nov. 2017 at LBNL

→Looking towards planning for the 2020 Astronomy/Astrophysics Decadal Survey

HEP PROGRAM PLANNING AND RESEARCH MODEL

Cosmic Frontier – Program Planning Process

HEP science priorities come from the community via our advisory panel HEPAP

These are expressed in a strategic plan that considers the critical scientific questions and opportunities and recommends a portfolio of facilities and projects to optimally address the science within realistic constraints

→ **Particle Physics Project Prioritization Panel ("P5")**

DOE/HEP follows the P5 Plan to advance leadership efforts aligned with P5 recommendations

This was a "10-year plan with a 20-year vision":

- Specific projects were recommended that could begin operations in <=10 years
- Full science payoff would stretch over 20 years or more
- R&D was recommended to be prepared for next-generation opportunities in 10+ years

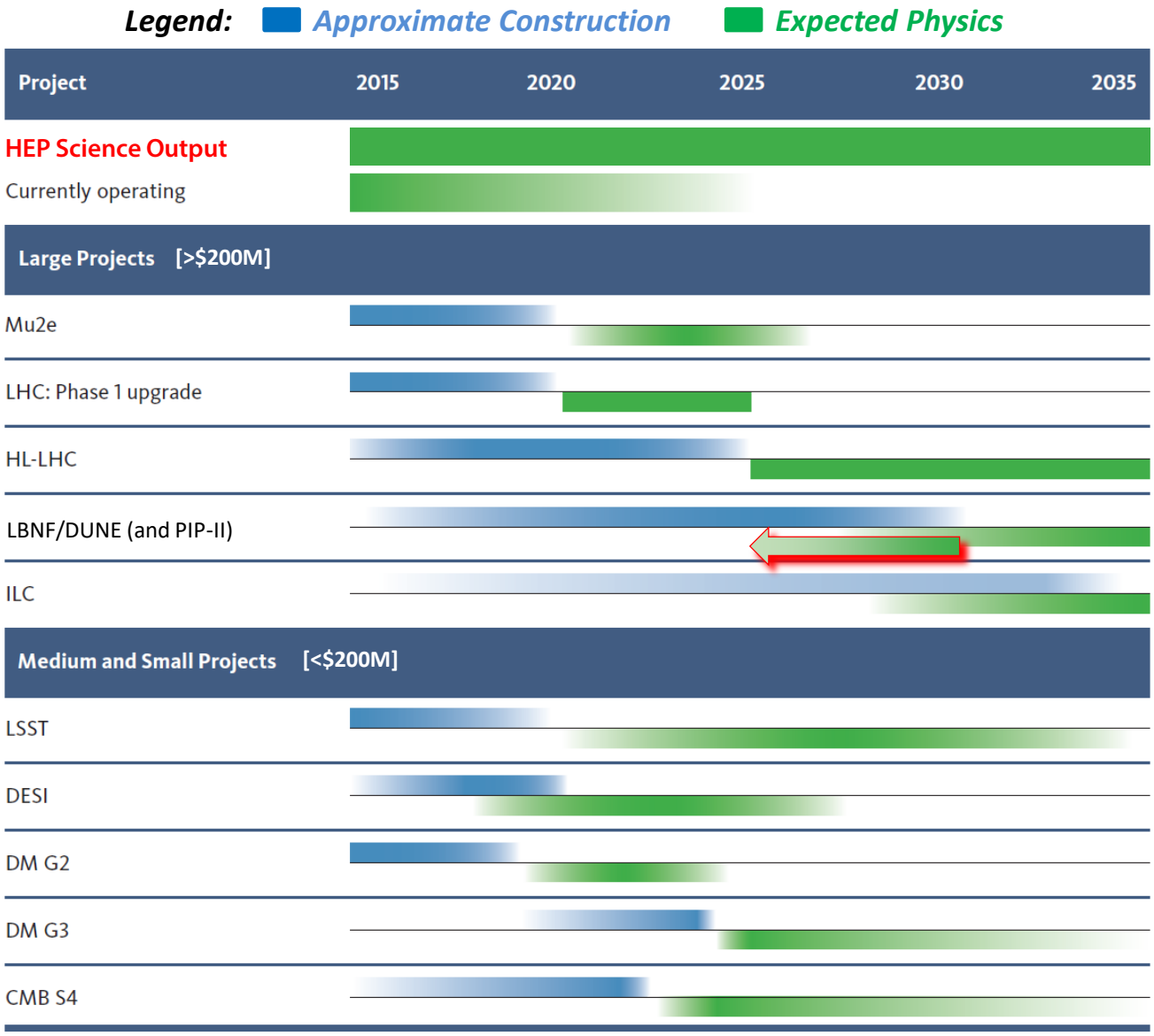
HEPAP/P5 Report (2014) recommended Cosmic Frontier science & project priorities in **Dark Energy, Dark Matter (direct detection), and CMB**

- Recommended specific projects: LSSTcam, DESI, SuperCDMS-SNOLab, LZ
- Recommended maintaining a portfolio of small projects: e.g., ADMX-G2 & SPT-3G
- Plan for the future: CMB-S4, future dark matter projects TBD

HEP Community support of this process is a critical element of its success

P5 Timeline

- **Next P5 anticipated to convene after the large projects, HL-LHC upgrades and LBNF/DUNE, are baselined (DOE CD-2)**
  - U.S. "Snowmass" process would begin in ~2019 to inform a new P5 in early-2020s to develop U.S. particle physics strategy for the next 10-year timeframe
  - While next P5 report may be after the release of the next European Strategy Update, the U.S. community is encouraged to participate in studies for all global planning efforts



Cosmic Frontier – Program Execution

DOE is a mission-oriented agency: priority is to support research efforts directly in line with HEP program & project priorities, responsibilities & science goals

- Therefore, not all Cosmic Frontier-related research will be supported.

DOE/HEP is not a unique supporter of Cosmic Frontier research; but HEP research community does bring some particular scientific expertise and technical resources

- **Therefore, consider P5 Criteria** to determine where, and at what level HEP participates in specific projects that make significant advances in science
  - Particularly where HEP community brings unique or leadership contributions

Particle Physics is Global

- Form partnerships or use other agency's/country's facilities when needed
- Most HEP projects have international contributions
- We have significant planning & coordination with multiple offices in other agencies: NSF-PHY, NSF-AST, NSF-PLR, NASA; and multiple international partners.

HEP Cosmic Frontier Experiments

Aug 2017

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 (26 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, 18 HEP)	109 (37 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

HEP Research Model

HEP science collaboration model strongly informs the DOE management approach

- Support HEP-style (highly structured) science collaborations to obtain the best possible results from complex, often multi-purpose apparatus
- Work proactively with our labs & community to plan and carry out the program
- Plan and provide support for our project responsibilities in all phases - designing, building and operating.
- Researchers are integrated into all phases of an experiment

Peer Review reflects HEP work style

- Research model that generally reviews best is for scientists to be closely integrated HEP experimental collaborations and have key roles and responsibilities on projects, operations and/or research

Research funding opportunities & reviews

- Comparative Review Funding Opportunity Annual call in Summer [now closed]
- Early Career (Office of Science program) - open to University faculty and Lab scientists
- Comparative Review of DOE Lab Research Programs (typically held every 3-4 years; Cosmic Frontier July 2016)

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:

- 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

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)

AAAC REPORT RESPONSES

AAAC Annual Report (2017)

Executive Summary

The Astronomy and Astrophysics Advisory Committee (AAAC) commends the NSF, NASA, and DOE for their successful efforts, with the support of Congress and the American people, to provide balanced and coordinated investments in basic research and world leading facilities to further the priorities of the National Research Council (NRC) of the National Academies' decadal survey *New Worlds, New Horizons in Astronomy and Astrophysics (NWNH)*.

We recommend sustaining a balanced and coordinated investment by NSF, NASA, and DOE in the observational, theoretical, and computational research, technology development, and major projects and facilities, that are required to achieve the goals of *NWNH*. This includes the completion of construction, deployment, successful operation, and support of the researchers using the Daniel K. Inouye Solar Telescope (DKIST), the James Webb Space Telescope (JWST), **the Large Synoptic Survey Telescope (LSST)**, and the Wide Field Infrared Survey Telescope (WFIRST). More broadly, providing (sometimes in partnership with others) the **necessary support of US researchers and our most critical facilities,** those identified in *NWNH* and associated reviews and reports, is essential to realizing the full scientific potential of the activities envisaged by *NWNH.*

DOE-HEP: We will continue to support completion of LSST, planning for the operations phase, and to support dark energy research efforts.

AAAC Annual Report (2017)
Section 3

Finding: US agencies are working well together to support the priorities of the astronomy and astrophysics research community, both in collaboration on large managed projects and through coordination of diverse research programs.

Finding: All current and planned cosmic surveys intend to publicly release their data and to provide suitable access tools which will further enhance the impact of these experiments.

Recommendation: We recommend that DOE, NSF, and NASA continue their successful cooperation in Astronomy and Astrophysics.

DOE-HEP: We will continue cooperating.

Finding: The tri-agency group considering LSST, WFIRST, and Euclid has begun the important process of coordinating between agencies by considering key parts of the dark energy science case for these missions and possible means of increasing the effectiveness of the missions in this area.

Recommendation: We recommend that the three agencies begin to develop a plan for including multiple stakeholders to consider the costs and benefits of coordination of LSST, WFIRST, and Euclid on the broad science areas these missions will advance.

DOE-HEP: DOE will continue to work within the Three Agency Group (TAG) to coordinate efforts and support working towards a plan forward.

AAAC Annual Report (2017)
Section 5 cont.

Recommendation: The AAAC supports the continued exploration, with the support of the agencies, into future directions and experiments, missions, and programs to be considered for support by the 2020 decadal survey.

DOE-HEP: We continue to support planning for the future as recommended by P5, with the relevant areas feeding into the decadal survey.

Recommendation: The AAAC recommends that the agencies work with the National Academies to ensure a timely beginning to the next decadal survey, along with updates to the structure as recommended by *NWNH-AMA*.

DOE-HEP: We will continue to work with NAS, NSF & NASA to plan the next decadal.

AAAC Annual Report (2017)
Section 6

Finding: Major flight and construction programs may be harmed by continued uncertainty in the budget, leading to cost overruns and schedule slips. The AAAC urges that special attention be paid to these programs at the time that the FY 2017 budget is finalized and the FY 2018 budget is formulated.

Recommendation: In formulating their programs for FY 2018, NSF, NASA and DOE should strive to maintain viable research grant programs and preserve the highest priority decadal survey recommended programs.

DOE-HEP: We are following our P5 strategic plan, which overlaps with the recommendations from the decadal survey. As recommended by P5, we are striving to support research at ~ 40% of our budget.

Conclusion

- **HEP is maintaining the core of the DOE Science Mission**

  ➔Program priorities will continue to be driven by the P5's compelling, realistic strategic plan

  - HEP is delivering exciting discoveries, important scientific knowledge, and technological advances

- **An exciting time for the HEP Cosmic Frontier program!**
  - Portfolio of experiments exploring four of the Science Drivers in pursuit of discovery: *dark matter, cosmic acceleration, neutrinos, explore the unknown*
  - Recent science highlights/results from eBOSS, DES, ADMX-G2, LUX
  - Operations started in 2017 for ADMX-G2 & SPT-3G
  - 4 projects in fabrication!
  - Active efforts in planning for the future

U.S. DEPARTMENT OF
ENERGY

Office of
Science