U.S. DEPARTMENT OF ENERGY | Office of Science

Office of High Energy Physics (HEP) → Budget & Program Update

AAAC Meeting

March 28, 2019

Kathleen Turner

Program Manager for the Cosmic Frontier

Office of High Energy Physics

U.S. DEPARTMENT OF
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Budgets

FY 2019 & FY2020

- **On September 21, 2018**, President Trump signed into law a bipartisan minibus (Senate 92-5, House 377-20) spending package consisting of three FY 2019 spending bills: Energy and Water, Military Construction and Veterans Affairs, and Legislative Branch.

  ➔ **Department of Energy was funded for FY19**

FY2019 Language:

High Energy Physics.—Within available funds, the agreement provides $15,000,000 for PIP-II; $6,250,000 for ongoing efforts for commissioning and initial operation of the camera for the Large Synoptic Survey Telescope Camera; $10,000,000 to continue the upgrade of FACET II; $105,000,000 for the HL-LHC Upgrade Projects; and $22,450,000 to complete the dark energy and dark matter experiments, of which $5,450,000 is for DESI and $14,450,000 is for LUX ZEPLIN.

➢ **On March 11, 2019, the FY2020 President's Request was released.**

FY20 President's Request Budget: HEP Budget $768M

($K)

	FY 2018 Enacted	FY 2019 Enacted	FY 2020 Request	FY 2020 Request vs FY 2019 Enacted	
				$	%
Science					
Advanced Scientific Computing Research	810,000	935,500	920,888	-14,612	-1.6%
Basic Energy Sciences	2,090,000	2,166,000	1,858,285	-307,715	-14.2%
Biological and Environmental Research	673,000	705,000	494,434	-210,566	-29.9%
Fusion Energy Sciences Program	532,111	564,000	402,750	-161,250	-28.6%
High Energy Physics	908,000	980,000	768,038	-211,962	-21.6%
Nuclear Physics	684,000	690,000	624,854	-65,146	-9.4%
Workforce Development for Teachers and Scientists	19,500	22,500	19,500	-3,000	-13.3%
Science Laboratories Infrastructure	257,292	232,890	163,600	-69,290	-29.8%
Safeguards and Security	103,000	106,110	110,623	+4,513	+4.3%
Program Direction	183,000	183,000	183,000	0	N/A
Total, Science	**6,259,903**	**6,585,000**	**5,545,972**	**-1,039,028**	**-15.8%**

$768M for High Energy Physics (HEP), $212M below 2019 Enacted, supports research to understand how the universe works at its most fundamental level by discovering the most elementary constituents of matter and energy, probing the interactions among them, and exploring the basic nature of space and time. The Request supports LBNF/DUNE, the High-Luminosity Large Hadron Collider (HL-LC) Accelerator and Detector Upgrade projects at CERN, and the Muon to Electron Conversion Experiment project. The request also funds QIS research and Artificial Intelligence.

FY 2018-2020 HEP Budget

HEP Funding Category ($ in K)	FY 2018 Actual	FY 2019 Enacted	FY 2020 Pres. Request	FY 2020 vs. FY 2019
Research	359,177	380,847	301,357	-79,490
Facilities/Operations	270,488	260,803	239,746	-21,057
Projects	278,335	338,350	226,935	-111,415
Total	**908,000**	**980,000**	**768,038**	**-211,962**

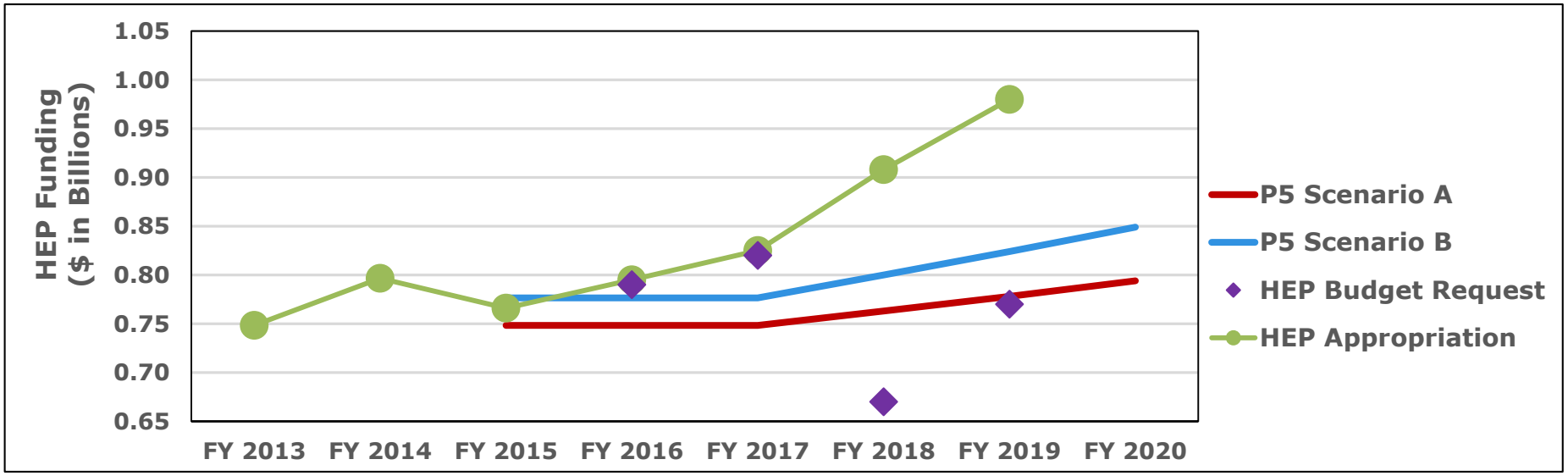
FY2019

- Appropriations supports the SC and P5 priorities
  - SC: interagency partnerships, national laboratories, accelerator R&D, QIS
  - P5: preserve vision, modify execution
- HEP Budget continues support for P5-guided investments in mid- and long-term program
  - "Building for Discovery" by supporting highest priority P5 projects to enable future program
  - Research support advances P5 science drivers and world-leading, long-term R&D in Advanced Technology, Accelerator Stewardship, and Quantum Information Science
  - Operations support enables world-class research at HEP User Facilities

FY2019: Continues U.S. Congress Support of the P5 Strategy

- FY 2019 Senate Energy and Water Development Appropriations Report:
  - "The Committee recommends $1,010,000,000 for High Energy Physics. **The Committee strongly supports the Department's efforts to advance the recommendations of the Particle Physics Project Prioritization Panel Report [P5],** which established clear priorities for the domestic particle physics program…"

"Four years into executing the P5, the Committee commends the Office of Science and the high energy physics community for achieving significant accomplishments and meeting the milestones and goals set forth in the strategic plan…"



FY 2018-20 Funding by Subprogram

HEP Funding Category ($ in K)	FY 2018 Actual	FY 2019 Enacted	FY 2020 Pres. Request	FY 20 vs. FY 19
Energy Frontier	183,219	238,920	197,599	-42,321
Intensity Frontier	247,048	240,980	193,682	-47,298
Cosmic Frontier	119,630	101,036	57,468	-43,568
Theoretical, Computational, and Interdisciplinary Physics	76,176	89,834	94,705	+4,871
Advanced Technology R&D	125,643	113,506	91,707	-21,799
Accelerator Stewardship	15,885	15,724	12,877	-2,847
Construction (Line Item)	140,400	180,000	120,000	-60,000
Total	**908,000**	**980,000**	**768,038**	**-211,962**

FY2019:

- Energy: +54M HL-LHC Projects
- Intensity: -8.1M PIP-II other project costs
- Cosmic: -25M LSSTcam, DESI, LZ, SuperCDMS-SNOLAB projects; Operations ramps up
  - All MIE projects complete project funding (LSSTcam completed in FY18)
- Theory, Computational, and Interdisciplinary: +9.5M (now $27M) Quantum Information Science (QIS)
- Advanced Technology: -9M Accelerator Improvement Projects at LBNL and SLAC

Cosmic Frontier FY 2018-2020 Program

Cosmic Frontier ($ in K)		FY 2018 Actual	FY 2019 Enacted	FY 2020 Pres. Request	FY 20 vs. FY 19
Research		47,008	50,741	31,140	-19,601
Facilities/Operations		17,300	20,076	23,230	+3,154
Projects		52,835	27,350	1,000	-26,350
	LSSTcam	*9,800*	*-*	*-*	*-*
	DESI	*20,000*	*9,350*	*-*	*-9,350*
	LZ	*14,100*	*14,450*	*-*	*-14,450*
	SuperCDMS	*7,400*	*2,550*	*-*	*-2,550*
SBIR/STTR		2,487	2,869	2,098	-771
Total		**119,630**	**101,036**	**57,468**	**-43,568**

- **Research:** World-leading research efforts in support of design and optimization on dark matter and dark energy experiments in their fabrication and commissioning phases, as well as on planning for future experiments, including CMB-S4.
- Note: FY19 Enacted is the planned amount for the whole year. The Cosmic Frontier's currently approved spend plan is less; will have to compete with other Frontiers for some of the funds (primarily Research; for Early Career etc). The approved spend plan (as of March 2019) for Cosmic is $44,827K (Research), $20,748K (Operations), $28,850 Projects (Future R&D $2,500K; DESI MIE $9,350K; LZ $14,450K; SuperCDMS $2,550K)
- **Operations:** Start of installation and commissioning activities for the LSSTcam, as well as early planning for LSST facility and science operations. Planning, commissioning, and pre-operations activities will begin for DESI, LZ, and SuperCDMS-SNOLAB. Support for the currently operating experiments will continue.
- **Projects:** Completion of fabrication and installation of the LZ dark matter project, and will support the fabrication of the DESI dark energy project and the SuperCDMS-SNOLAB dark matter project. All MIE funding completed in FY2019!

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Cosmic Frontier Experimental Research

Program Managers:
Kathy Turner
Drew Baden (IPA)
Karen Byrum (Detailee)
Eric Linder (IPA)

Dark Energy

Precision measurements to differentiate between cosmological constant 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~~ Complete!:

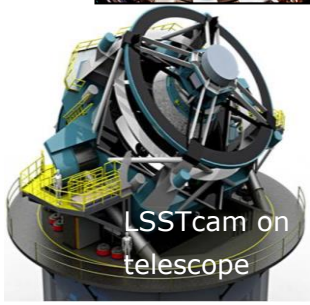
– *eBOSS* (spectroscopic) started in 2015, ended Feb 2019

– *DES* (imaging) started 5-year survey in late FY13, ended Jan 2019

In Fabrication phase:

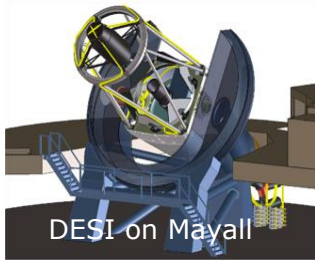
– *Large Synoptic Survey Telescope* (LSST, Stage 4 imaging)

- I&T plans to begin integration of production Raft Tower Modules in the second quarter of 2019



– *Dark Energy Spectroscopic Instrument* (DESI, Stage 4 spectroscopic)

- Commissioning camera installed ~ 3/26/19 & testing has commenced.
- On sky testing will start next week.



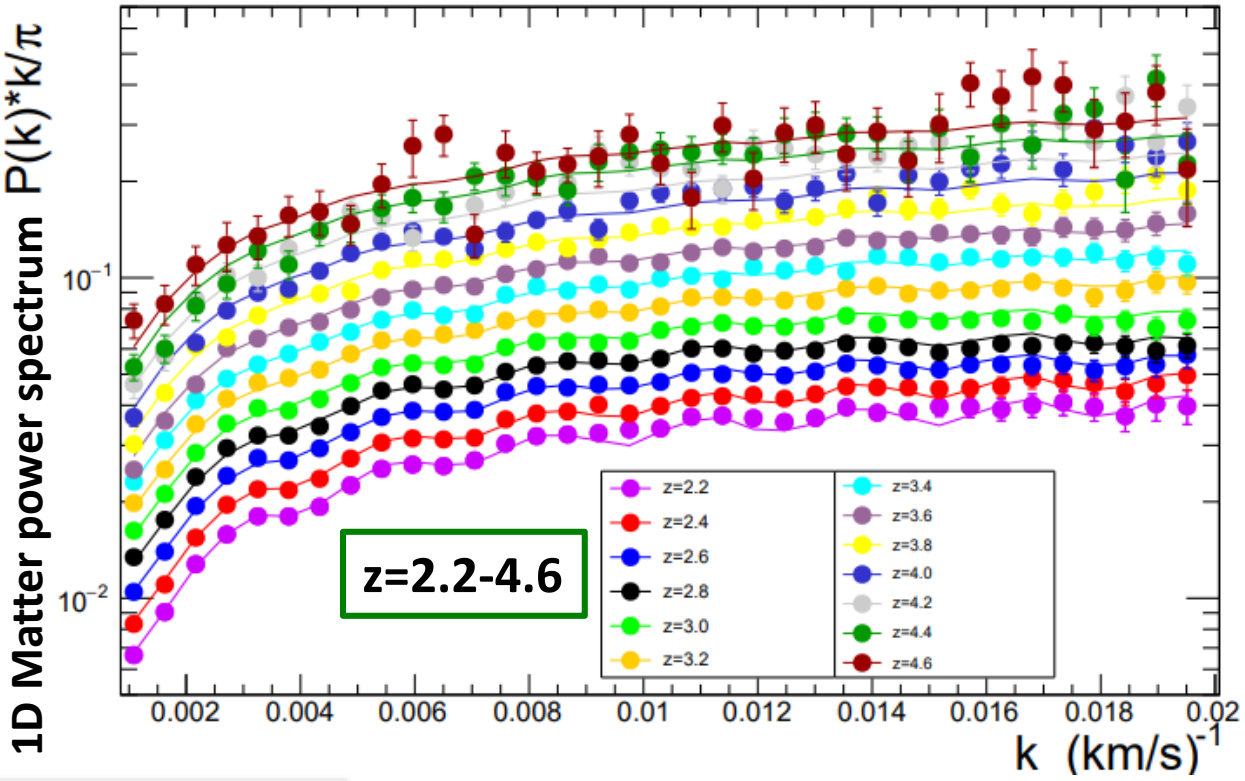
Science Highlight – Extended Baryon Oscillation Spectroscopic Survey (eBOSS)

Major Milestone: 1D power spectrum from Lyman-alpha forest (Chabanier+ 1812.03554)

- Three-fold improvement over results from BOSS (2013)
- Find matter power spectrum described by σ_8=0.820±0.021 and n_s=0.955±0.005

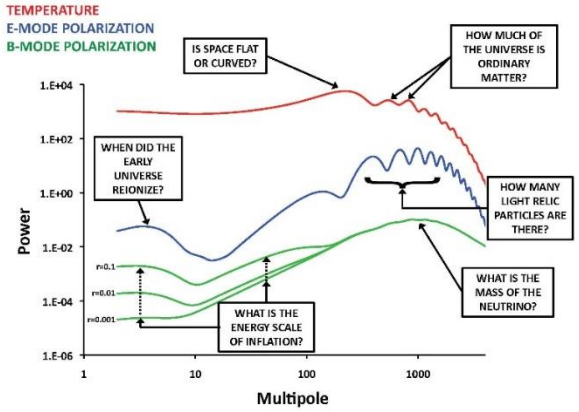
Implications for Cosmology: Test of neutrino physics and models of dark matter at 2<z<5

Also: 1901.01950 – first BAO measurement using MgII (z=0.3-1.6; 4.7%); important systematic crosscheck



Cosmic Microwave Background – Stage 4

➔**CMB-S4 Community-based Collaboration** brought together ground bas community to plan future; Collaboration Science & Technology books: https://arxiv.org/abs/1610.02743 ; https://arxiv.org/abs/1706.02464



Full Science drivers include:

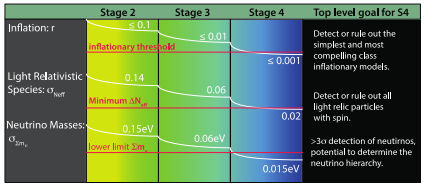
- B-mode polarization search for primordial gravitational waves, inflation
- Light relics particles; neutrino mass scale
- Dark Energy test through growth of structure, CMB-Lensing cross-correlation with galaxy density and shear surveys, e.g., LSST.
- Baryonic Feedback constraints on galaxy Formation and evolution

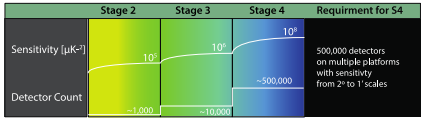
HEP interests: Gain insight into **inflationary epoch** at the beginning of the universe, **dark energy & neutrino properties** by studying oldest visible light.

Guidance:

- **2014 P5 report recommended support of CMB experiments as a core part of the HEP program**
- **CMB-S4 intended to be the next flagship project for Cosmic Frontier**

HEP is continuing planning in coordination with NSF AST/OPP/PHY.





Cosmic Microwave Background – Stage 4

HEP labs & community started heavy involvement in R&D following P5 report

Fall 2017: Report approved for the AAAC Concept Definition Task Force (CDT)

- **Charge: develop science requirements & conceptual strawperson design/cost/schedule** Sites at South Pole and Chile
- Large and Small aperture telescope deployment and throughput
  - 3 large aperture telescopes of 6m diameter,
  - 14 small aperture cameras of 0.5m diameter
- 9 frequency bands from 20 – 220 GHz

Early 2018: pre-Project Design Group

HEP labs spearheaded formation of pPDG (chair Jim Yeck)

Spring 2018: Collaboration formally set up

- John Carlstrom & Julian Borrill co-spokespersons

Current:

- pPDG & Collaboration working together on planning concept & developing a technically driven project plan
  - includes full CATEable schedule, management plan, bottoms up costing, and with proposed NSF and DOE roles and responsibilities defined.
  - basis for documentation for Decadal Survey and to advance through DOE CD and NSF phases.
  - Full report will include Science, Science flow down to measurements, reference design and project plan.
  - Held review of the DSR Dec 11 – 13, 2018, co-chaired by Mark Reichanadter and Steve Ritz.
  - Now working on technology study.

CMB-S4 – Agency Planning & Coordination

DOE Planning

- Supportive of the Team's plan & working towards supporting pPDG and Collaboration's schedule
- DOE provided $1.5M FY18 R&D funding, went through pPDG to design/engineering (+LDRD+Research)
- FY19 funding being planned.

DOE HEP planning CD0, start of project process, in spring 2019

DOE and NSF coordination:

NSF/DOE Joint Coordination Group meets biweekly/monthly

- Agencies, pPDG, spokespeople in close communication
- Will work to enable synchronization of DOE and NSF timescales & processes

Astro2020 Decadal Survey - HEP

DOE, NASA, NSF worked together to deliver a statement of task to the National Academy of Sciences for Astro 2020 Decadal Survey.

→DOE-HEP continues to support detector development & experiment concept development for the future.

→Community has been actively planning:

CMB – CMB-S4 will be proposed to Astro 2020 for partnership of DOE-HEP, NSF-AST/PHY/OPP

Dark Energy – science ideas for enhancing and going beyond DESI and LSST will be proposed to Astro2020; small, medium, large scale project ideas

Dark Matter Direct Detection – excluded in SOT due to purview of HEP/Particle Physics community; fully informed by HEPAP/P5

Other timelines: From a DOE perspective, the earliest that new "Snowmass," NAS Elementary Particle Physics Decadal Survey, and P5 processes could begin is 2020

- European Strategy for Particle Physics report 2020
- Relative timing of Snowmass, P5, and NAS EPP Decadal survey tbd
- Enables receiving next P5 recommendations in time to inform FY 2024/25 budget

Closing Remarks

- **Excellent science results continue to be produced from our operating experiments!**
- **Broad support is enabling us to implement the P5 strategic plan and achieve its vision**
  - Thanks to DOE Management, Administration, & Congress for support
  - SC programs in QIS, computing, and SLI provide additional support to enable P5
  - **Community continues to be unified in support of P5 strategy**
- **The FY 2019 appropriation will enable continued P5 progress**
  - Maintaining a healthy research budget is an ongoing challenge
- **The particle physics community continues to perform well on delivering projects, a foundation of the long-term strategy**

Congratulations DES and eBOSS!

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