High Energy Physics (HEP) Program Status Report to the AAAC Meeting

February 27, 2015

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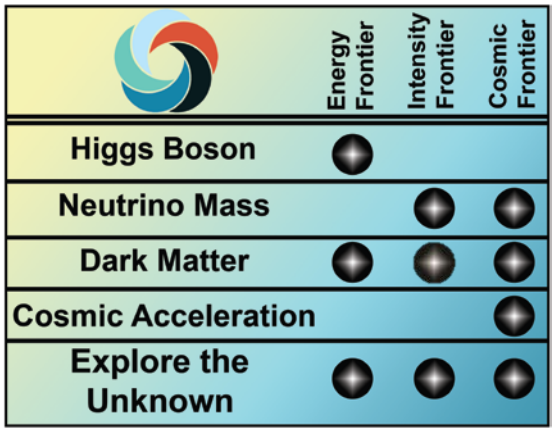
HEP PROGRAM – FY16 PRIORITIES & BUDGET

HEP Program: FY 2016 Priorities

- **HEP is implementing the strategy detailed in the May 2014 report of the Particle Physics Project Prioritization Panel (P5), formulated in the context of a global vision for the field**
  - HEP Addresses the five compelling science drivers with research in three frontiers and related efforts in theory, computing and advanced technology R&D
  - Increasing emphasis on international partnerships (such as LHC) to achieve critical physics goals

P5 strategic plan: 5 science drivers



- **Energy Frontier: Continue LHC program with higher collision energy (13+ TeV)**
  - The U.S. will continue to play a leadership role in LHC discoveries by remaining actively engaged in LHC data analysis and the initial upgrades to the ATLAS and CMS detectors
- **Intensity Frontier: Develop a world-class U.S.-hosted Long Baseline Neutrino Facility**
  - Continue the design process for an internationalized LBNF and development of a short baseline neutrino program that will support the science and R&D required to ensure LBNF success
  - Fermilab will continue to send world's highest intensity neutrino beam to NOvA, 500 miles away
- **Cosmic Frontier: Advance our understanding of dark matter and dark energy**
  - Development of new capabilities in dark matter detection continues with baselining of 2nd-generation experiments; and in dark energy exploration with baselining of DESI and continued fabrication of LSST camera.

HEP Program: FY 2016 Priorities

- **Accelerator Stewardship**
  - This subprogram focuses on the broader applications of accelerator technologies, including major thrusts in technology to enable ion-beam cancer therapy and R&D for high-power ultrafast lasers
  - The FY 2016 funding request provides support for a new research thrust in energy and environmental applications of accelerators and expands the open test facilities effort
  - The main facility supporting this subprogram, the Brookhaven Accelerator Test Facility (ATF), will undergo relocation and expansion in FY 2016 to accommodate more users

- **Construction/Major Items of Equipment (MIEs) support reflects P5 priorities:**
  - **The Long Baseline Neutrino Facility (LBNF)** continues its design phase as the project baseline cost and technical scope are revised while incorporating international in-kind contributions
  - The **LHC ATLAS and CMS Detector Upgrade** projects continue fabrication
  - **Muon g-2** continues accelerator modifications and fabrication of the beamline and detectors
  - **LSSTcam** fabrication support increases according to planned profile (fabrication started FY14)
  - Fabrication proceeds on the **Dark Energy Spectroscopic Instrument (DESI)**
  - Fabrication proceeds on the dark matter experiment MIEs: **SuperCDMS-SNOLab** and **LZ**
  - Construction continues for the **Muon to Electron Conversion Experiment (Mu2e)**

HEP Program: FY 2015 → FY 2016 Budget

FY15:

The **enacted FY15 Budget** for HEP is $766M, between P5's scenario A&B.

Cosmic Frontier Major Item of Equipment (MIE) projects (LZ, SuperCDMS-SNOLab, DESI).
➔**These were all approved as new project starts.**
The actual schedule for starting fabrication depends on each project's schedule, etc.

Note: SPT-3G and ADMX-G2 are also starting but are below the MIE project cutoff, so not called out directly in the budget documents.

FY16:

The **FY16 President's Request** for HEP is up relative to FY15:

+$44M over FY15 Request
+ $22M over FY15 Enacted

It is ~ $11.5M above the **FY14 Request** ($776M). If the Request is passed, this would be slightly above the P5 scenario B, which was flat-flat for 3 years starting with the FY14 Request and then increasing 3% per year.

FY 2016 High Energy Physics Budget

HEP Funding Category ($ in K)	FY 2014 Request	FY 2014 Actual	FY 2015 Request	FY 2015 Enacted	FY 2016 Request	Explanation of Changes (FY16 vs. FY15)
Energy Frontier	154,687	152,386	153,639	147,584	154,555	*LHC detector upgrade fabrication; R&D for high-luminosity LHC upgrades*
Intensity Frontier	271,043	250,987	251,245	264,224	247,196	*Operations and upgrade of NuMI for NOvA and MicroBooNE; R&D for LBNF and SBN*
Cosmic Frontier	99,080	96,927	101,245	106,870	119,325	*Planned ramp-up of LSSTcam; support of DESI and 2nd generation dark matter experiments*
Theoretical and Comp.	62,870	64,275	58,850	59,274	60,317	*Planned increase in Lattice QCD project; slight reduction in theory research efforts*
Advanced Technology R&D	122,453	150,270	114,242	120,254	115,369	*Reductions reflect shift to P5 priority areas; MAP reduction continues in response to P5*
Accelerator Stewardship	9,931	9,075	19,184	10,000	14,000	*Increase supports new research topic areas and expands open test facility efforts*
Construction (Line Item)	35,000	51,000	25,000	37,000	56,100	*Planned profile for Mu2e; engineering and design for LBNF*
SBIR/STTR*	21,457	0	20,595	20,794	21,138	
Total	**776,521**	**774,920**	**744,000**	**766,000**	**788,000**	

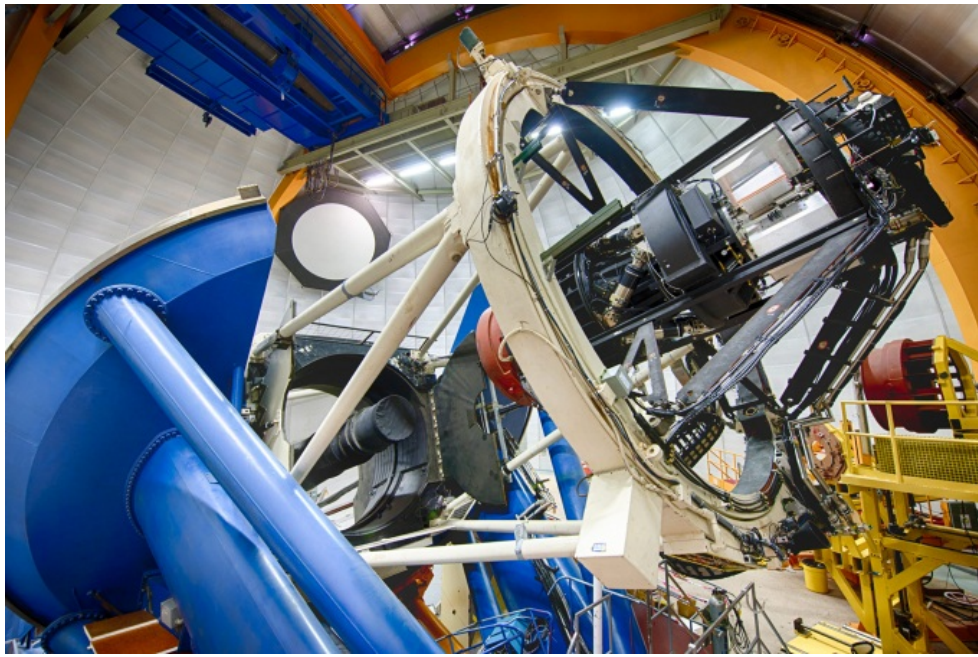
FY14 SBIR/STTR was ~ $21M, so FY2014 actual was ~ $796M.

COSMIC FRONTIER PROGRAM STATUS

Cosmic Frontier

Program thrusts:

- Studies of the nature of **Dark Energy** using imaging and spectroscopic surveys
- Direct detection searches for **Dark Matter** particles
- Study of the high energy universe and indirect dark matter searches using **Cosmic-ray, Gamma-ray** experiments
- **CMB, Other** efforts, including small contributions to
  - **CMB** experiments to study the nature of inflation, neutrino properties, and dark energy;
  - computational cosmology efforts;
  - other experiments



Future program:

- **Continue moving forward to get P5-recommended projects going and to align the program with P5 priorities.**

Cosmic Frontier Budget History

Budget in $K	FY 2013 Actual	FY 2014 Actual	FY 2015 Request	FY 2015 Enacted	FY 2015 Current (Feb. 2015 "snapshot")	FY 2016 Request
Research	48,652	52,712	45,435	47,735	47,835	50,079
Grants	*12,233*	*13,157*	*11,422*	*11,659*	*11,609*	*12,565*
National Laboratories	*36,419*	*39,555*	*34,013*	*36,076*	*36,226*	*37,514*
Facility Operations and Experimental Support	10,111	10,357	7,238	8,790	8,790	7,120
Projects	19,159	30,705	41,000	44,203	45,103	58,701
MIE	*9,500*	*22,900*	*41,000*	*41,878*	*42,878*	*57,100*
HAWC (FY13 MIE completed)	*1,500*	*…*	*…*			
LSST camera (FY14 fab start)	*8,000*	*22,000*	*35,000*	*35,000*	*35,000*	*40,800*
DM-G2: LZ, SuperCDMS-SNOLab (FY15 MIE approved)	*…*	*900*	*6,000*	*4,800*	*4,800*	*11,000*
DESI (FY15 MIE approved)				*2,078*	*3,078*	*5,300*
***Small Project Fabrication**, FY15: SPT-3G, ADMX-G2*				*2,225*	*1,025*	*1,601*
***Future Project R&D**, FY15: SPT-3G, ADMX-G2*	*9,659*	*7,760*		*100*	*1,200*	
TOTAL	**77,951**	**93,729**	**93,673**	**100,728**	**101,728**	**115,900**
Other Costs	2,112	3,198	7,572	4,817	5,832	3,425
Total – Cosmic	80,063	96,927	101,245	105,545	107,560	119,325

Cosmic Frontier Status

Dark Energy

- **Operating:**
  - *BOSS* (spectroscopic) ended in FY14, *DES* (imaging) started FY13, SN surveys
- **Fabrication:**
  - *Large Synoptic Survey Telescope* (LSST, Stage IV imaging)
    - LSST-camera CD-3a approved June 2014, CD-2 "baseline" approved Jan. 2015
    - CD-3 review scheduled for August 2015
  - *Dark Energy Spectroscopic Instrument* (DESI, Stage IV spectroscopic)
    - CD-1 review Sept. 2014; Plan CD-1 approval in March 2015
    - Approved as an MIE project in FY15
    - CD-2 "baseline" review scheduled for July 2015
    - Working on an agreement with NSF to start supporting NOAO operations costs in FY16, ramping up to full support for dark energy survey operations in FY2019.

Dark Matter (direct detection)

- **Operating:**
  - 1st generation (DM-G1) experiments:
    - ADMX, LUX, CDMS-Soudan, DarkSide, COUPP/PICO
- **Planning:**
  - DOE and NSF announced in July 2014 selection of DM-G2 experiments to move forward to fabrication phase: *ADMX-G2, LZ, SuperCDMS-SNOLab*
    - LZ & SuperCDMS-SNOLab are approved as MIE projects in FY15
    - LZ CD-1 review scheduled for March 2015
    - SuperCDMS-SNOLab CD-1 review planned for summer 2015
    - ADMX-G2 is a small project (below MIE) and started at the end of FY14.

Cosmic Frontier Status *(continued)*

Cosmic-ray, Gamma-ray

- **Operating:**
  - *Fermi/GLAST, VERITAS, Auger, AMS*
    - DOE operations efforts completed by FY16 for VERITAS and Auger
- **Fabrication:**
  - *HAWC* gamma-ray observatory began taking data with "baseline" array in late November 2014; full array of 300 tanks completed Jan. 2015; now taking data

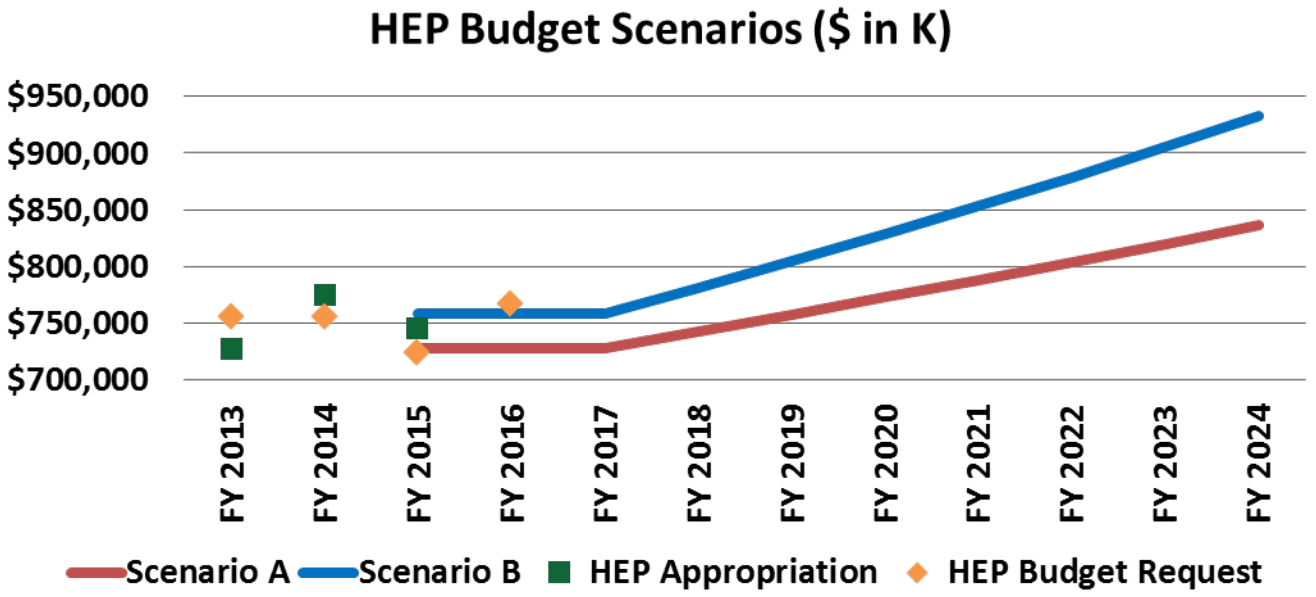
Cosmic Microwave Background (CMB)

- **Operating:**
  - *South Pole Telescope polarization* (SPTpol)
- **Fabrication:**
  - *SPT-3G* had successful review of DOE roles/responsibilities in September 2014; HEP has started funding for the fabrication phase (FY15,16)
- **Planning:**
  - Community planning for a CMB Stage IV experiment
    - HEP will oversee coordination of efforts within the HEP program

BACKUP

Context: P5 HEP Budget Scenarios

- **P5 was charged to consider three 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
  - Scenario B was a slightly higher constrained budget scenario
  - Scenario C was "unconstrained," but not considered unlimited



Budget Request and Appropriations do not include SBIR/STTR

FY 2016 HEP Funding by Activity

HEP Funding Category ($ in K)	FY 2014 Current	FY 2015 Enacted	FY 2016 Request	Explanation of Changes (FY16 vs. FY15)
Research	373,932	337,383	334,703	*Research reductions support project investments*
Facilities	278,683	265,125	262,658	*Maintain efficient operations of facilities and ongoing experiments*
Projects	71,305	105,698	113,401	
Energy Frontier Projects	*0*	*15,000*	*19,000*	*Ramp up in LHC detector upgrade fabrication*
Intensity Frontier Projects	*37,400*	*43,970*	*33,700*	*Continue g-2 and FNAL acc. upgrade profiles; some LBNE efforts move to construction*
Cosmic Frontier Projects	*30,705*	*45,728*	*58,701*	*Increase supports LSSTcam, DESI and second generation dark matter experiments*
Other Projects	*3,200*	*1,000*	*2,000*	*Planned Lattice QCD hardware acquisition*
Construction (Line Item)	51,000	37,000	56,100	*Planned profile for Mu2e; engineering and design for LBNE*
SBIR/STTR	0	20,794	21,138	
Total	**774,920**	**765,000**	**788,000**	