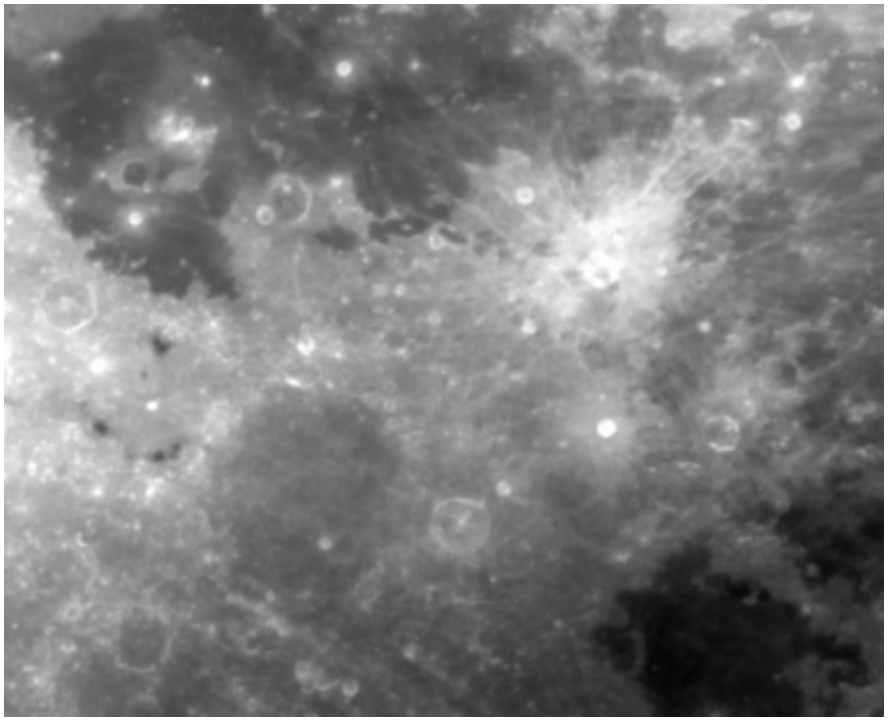
DOE High Energy Physics (HEP) Cosmic Frontier (CF)

report to

AAAC

25 February 2016

Kathy Turner



The IR Moon from the re-furbished Mosaic-3 on the Mayall.

HEP Cosmic Frontier Program Managers:
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Outline

- **Budgets**
- **Program Status**
- **Interagency efforts**
- **Future planning**

FY 2014-2017 HEP Program - Budget Status

	FY14 PRB	FY14 Actual	FY15 PRB	FY15 Enacted	FY16 PRB	FY16 Enacted	FY17 PRB
Energy Frontier	154,687	152,386	153,639	147,584	154,555	150,723	150,998
Intensity Frontier	271,043	250,987	251,245	264,224	247,196	243,121	234,144
Cosmic Frontier	**99,080**	**96,927**	**101,245**	**106,870**	**119,325**	**130,582**	**130,069**
Theory & Comp. Phys	62,870	64,275	58,850	59,274	60,317	59,083	59,656
Advanced Tech R&D	122,453	150,270	114,242	120,254	115,369	115,494	118,285
Accelerator Stewardship	9,931	9,075	19,184	10,000	14,000	9,000	13,744
SBIR/STTR	21,457	0	20,595	20,794	21,138	20,897	22,580
HEP Subtotal	741,521	723,920	719,000	729,000	731,900	728,900	729,476
Construction, Line Item	35,000	51,000	25,000	37,000	56,100	66,100	88,521
HEP TOTAL	**776,521**	**774,920**	**744,000**	**766,000**	**788,000**	**795,000**	**817,997**
Office of Science TOT	5,152,752		5,111,155	5,067,738	5,339,794	5,350,200	5,672,069

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

FY2016 Budget Notes

The FY16 budget was approved on 12/16/15.

Cosmic Frontier MIE projects:

- **LSST is being funding according to its planned profile.**
- **DESI is being funded at $5.0M more than requested in FY16 (budget guidance)**
- **LZ is being funded at $1.5M more than requested in FY16 (budget guidance)**
- **SuperCDMS-SNOLAB is being funded at $1M over the requested amount.**

Research budgets:

Even though the FY16 approved budget is more than the requested amount, due to the budget guidance we received and other constraints, the research budget is still planned at the Continuing Resolution (few % reduced) levels.

→ The program managers for each Frontier are preparing requests for additional funds available within HEP, there there still is the possibility of *limited* funds moving into Cosmic Frontier research from the overall HEP funds during FY16.

FY2017 – President's Request Budget Notes - Highlights

FY 2017 request ($818M) aims to continue the successful implementation of the P5 strategy

– Investing in portfolio of high-priority projects at the small, medium, and large cost scales

– Request is carefully balanced between support for projects ($212M), facility operations ($252M), and scientific research ($354M) in order to produce scientific results while "building for discovery"

The U.S.-hosted international Long Baseline Neutrino Facility and Deep Underground Neutrino Experiment (LBNF/DUNE) has made rapid progress in the past year and attracted the interest of international partners

– P5 recognized LBNF/DUNE as the highest priority project in its time frame

– Construction funding ($45M) enables necessary engineering design, site preparation and long-lead procurement for LBNF/DUNE to meet newly revised schedule, and will help solidify formal agreements with international partners

The High Luminosity Large Hadron Collider (HL-LHC) accelerator and detector upgrade projects will significantly extend the discovery reach of the world's highest energy collider

– P5 recognized LHC upgrades as the highest priority near-term large project

– MIE start ($2.5M) necessary to allow critical U.S. contributions to be delivered on schedule for global LHC program, better cancer treatment, pollution reduction, national security, and making unique test facilities available to industry

FY2017 – President's Request Budget Notes – Highlights cont.

As recommended by P5, a complementary suite of MIE projects will address dark matter and dark energy

– Planned fabrication funding increase supports LSSTcam ($45M), DESI ($10M), LZ ($10.5M), and SuperCDMS-SNOLab ($4M)

Facility for Advanced Accelerator Experimental Tests II (FACET-II) will enable continued R&D in the promising area of beam-driven plasma wakefield acceleration

– Will sustain the momentum of excellent achievements in the program and maintain U.S. leadership globally in this area

– MIE start ($8M) essential to support FACET-II efforts during critical construction window during Linac Coherent Light Source II (LCLS-II) installation

Accelerator Stewardship will advance U.S. competitiveness in accelerator technology

– Funding collaborative R&D ($13.7M) to put accelerator technology to work for better cancer treatment, pollution reduction, national security, and making unique test facilities available to industry

Cosmic Frontier Budget History – details

Cosmic Frontier ($K)		FY14 Actual	FY15 PRB	FY15 Actual	FY16 PRB	FY16 Enacted	FY17 PRB
Research+Other	All	52,712	45,435	48,779	50,079	49,910	49,934
Research	All	52,712	45,435	48,779	50,079	46,195	46,991
Research	*Grants*	*13,157*	*11,422*	*11,773*	*12,565*	*11,595*	*11,607*
Research	*Labs*	*39,555*	*34,013*	*37,006*	*37,514*	*34,600*	*35,384*
Other Res						*3,715*	*2,943*
Exp Operations+Other		10,357	7,238	9,185	7,120	13,837	9,935
Exp Operations		10,357	7,238	9,185	7,120	9,190	8,925
Other Ops						*4,647*	*1,010*
Projects	All	30,660	41,000	46,403	58,701	66,835	70,200
Projects	***MIE***	**22,900**	**41,000**	**44,178**	**57,100**	**64,600**	**69,500**
	LSSTcamera	*22,000*	*35,000*	*35,000*	*40,800*	*40,800*	*45,000*
	DM-G2	*900*	*6,000*		*11,000*		
	LZ			*3,050*		*10,500*	*10,500*
	SuperCDMS-SNOLAB			*2,250*		*2,500*	*4,000*
	DESI			*3,878*	*5,300*	*10,300*	*10,000*
Projects	***Small Proj Fab***			***1,025***	***1,601***	***2,035***	***0***
	All				*1,601*		*0*
	ADMX-G2			*925*		*935*	
	SPT-3G			*100*		*1,100*	
Projects	***Future Proj R&D***	***7,760***	***0***	***1,200***	***0***	***200***	***700***
	Undesig					*200*	*700*
	DESI (BigBOSS)	*1,100*					
	Dark Matter	*5,260*		*200*			
	SPT-3G	*1,400*		*1,000*			
TOTAL	All	93,729	93,673	104,367	115,900	122,220	126,116
TOTAL+Other	All	93,729	93,673	104,367	115,900	130,582	130,069

TOTAL is the amount CF spends; "Other" includes extra funds for program reviews & direction, etc.

FY2017 – President's Request Budget - Research

Included in the FY17 budget request is $100M for University Grants in Office of Science as Mandatory Funding (as opposed to the rest of the SC budget, which is Discretionary Funding). Discussion is on p20 here:
http://energy.gov/sites/prod/files/2016/02/f29/FY2017BudgetinBrief_0.pdf

"In addition to the FY 2017 Request, an authorization proposal for the Office of Science for $100 million of mandatory funding for University Grants will be transmitted to Congress, for a total FY 2017 Budget of $5.672 billion. Funding will be made available through a competitive merit-based review of proposals solicited from and provided by the university community. The solicitations will be designed to open new paths as well as accelerate ongoing activities of interest to the SC basic research endeavors in the mission areas of Advanced Scientific Computing Research, Basic Energy Sciences, Biological and Environmental Research, Fusion Energy Sciences, High Energy Physics and Nuclear Physics."

Cherry Murray's presentation
http://science.energy.gov/~/media/sc1/pdf/2012/Murray_2017_Budget_Presentation.pdf):

"HEP: Topics described in the 2014 HEPAP Long Range Plan and also topics that span multiple SC programs, including quantum information sciences/the entanglement frontier and quantum field theory across disciplines."

Cosmic Frontier – Experimental Research Support

FY16 Comparative Review process – for University Grants

- Had a dedicated Cosmic Frontier review panel
- Recommendations for funding for most of the successful proposals has gone out; few still being decided.
- Most declinations were sent in the last week.
- The next opportunity to propose is next year (proposals due ~ early September)

FY16 Early Career (all HEP proposals considered together) – open to University faculty and Lab scientists

– Had review panel earlier this month; results out April/May

Cosmic Frontier – Major Item of Equipment (MIE) Projects
→*There are 4 MIE Projects – LSST, DESI, LZ, SuperCDMS-SNOLAB*

Large Synoptic Survey Telescope **(LSST) – Dark Energy Stage IV Imaging**
NSF project, HEP providing the LSSTcam (SLAC managing)
- LSSTcam & overall LSST Project going well; In CD-3 (full fabrication phase); Status review early Feb. 2016

Dark Energy Spectroscopic Instrument **(DESI) - Dark Energy Stage IV spectroscopic**
"HEP experiment" with LBNL managing: build DESI instrumentation & data management system, install & operate it on the Mayall telescope
- DESI project recently re-furbished the Mosaic camera on the Mayall, with LBNL providing the CCD's and Yale the mechanical parts and software. With NOAO, they installed "Mosaic-3" to use for z-band "MzLS" 2-year targeting survey for DESI; Also available for astronomers for other research; data being made public

HEP coordinating with NSF-AST to use ("lease") the Mayall telescope
- MOA for FY16-18 signed – HEP ramps up, NSF ramps down funds for Mayall operations for transition phase
- MOA for FY19+ being worked on – HEP providing full costs for Mayall for dark energy science operations

Current schedule:
- CD-3 review (ready for full fabrication phase) in May 2016
- Mayall shutdown, ready for DESI 1QFY18; DESI+Mayall commissioning complete & data-taking starts 1QFY20

LZ at Homestake Mine - WIMP dark matter search through dual phase liquid Xe – higher mass range
HEP leads, LBNL Project Office
→CD-1/3a approved April 2015; CD-2 "baseline" review being held in April 2016

SuperCDMS-SNOLAB - WIMP search using cryogenic solid-state crystals – lower mass range
HEP+NSF-PHY partnership, SLAC Project Office; CD-1 approval in Dec. 2015; CD-2 planned for FY17

Cosmic Frontier - R&D & Future planning

➔R&D towards P5 recommendations for the future:

Cosmic Frontier R&D – minimal funding expected for FY16, $700K requested in FY17

Dark Matter (P5 recommended a DM-G3 R&D program)

- HEP concentrating on getting the DM-G2 experiments successfully started
- R&D in the next few years will support off-project studies for the DM-G2's, technologies for DM-G3; but NOT for DM-G3 concept design!
  - DM-G1 experiments completing in FY16 can apply for R&D funds for focused technology studies for the future

CMB-S4

- As recommended by P5, we are planning to do CMB-S4
- A small funding wedge in FY18 would put us in line with the P5 recommended project timeline
- Will work with NSF to develop possibilities

➔ Future Planning

"Cosmic Visions" groups: CMB, Dark Energy, Dark Matter (direct detection)

- HEP meetings with small HEP community groups monthly; info helps us to develop, guide and coordinate HEP plans and funding, as well as provide info to community and their efforts.

Cosmic Frontier - Interagency Activities, etc.

Interagency Coordination:

- We always coordinate efforts: NSF, NASA, DOE talk regularly about program planning, overlaps, issues
- Depending on science, project, contribution, and agency considerations, sometimes we partner on fabrication or provide facilities

Project Coordination & Oversight:

- Joint Oversight Group (JOG) : VERITAS, HAWC, LSST, DES, SuperCDMS-SNOLab
- Interagency Coordination Group (ICG): DESI, SPT-3G
- Finance Board meetings: Auger, FGST

Tri-Agency Group (TAG) – DOE, NASA, NSF-AST

Meeting monthly with US-leads on LSST, WFIRST, Euclid to discuss commonalities, coordination

International Efforts

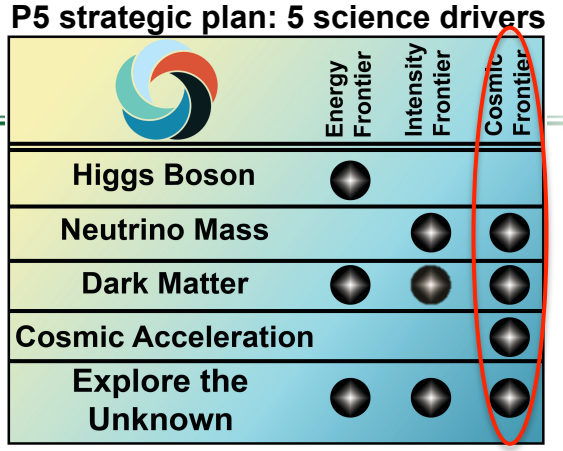
- DOE making country-level agreements to allow science partnerships to move forward.
- HEP participating on the Global Science Forum's Astro-particle Physics International Forum (APIF)

SUMMARY

- **An exciting time for HEP and the Cosmic Frontier!**
- **P5 developed compelling, realistic strategic plan with a consensus vision for US HEP**
- **→HEP is moving forward to implement it.**

BACKUPS

May 2014 P5 Report – Cosmic Frontier Recommendations



P5 report recommendations addressed to the Cosmic Frontier ➔

- **Dark Energy**
  - Build DESI as a major step forward in dark energy science
  - Complete LSST as planned
- **Dark Matter**
  - Proceed immediately with a broad second-generation (G2) dark matter direct detection program with capabilities described in the text
    - Invest in this program at a level significantly above that called for in the 2012 joint agency announcement of opportunity
  - Support one or more third-generation (G3) direct detection experiments
    - Guide G3 by the results of the preceding (G1, G2) searches
    - Seek a globally complementary program and increased international partnership in G3 experiments **(DM-G3 Project is in the P5 plan later in the decade.)**
- **Cosmic Microwave Background (CMB)**
  - Support CMB experiments as part of the core particle physics program
  - The multidisciplinary nature of the science warrants continued multi-agency support **(CMB-S4 Project is in the P5 plan later in the decade.)**
- **Cosmic Rays and Gamma Rays**
  - Invest in CTA only if the critical NSF Astronomy funding can be obtained
    - CTA has a broad science reach that transcends fields, with the dark matter detection capabilities of direct importance to particle physics; Using P5 Criteria, a de-scoped US component should be shared by NSF-AST, NSF-PHY and DOE.