



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

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HEP PROGRAM – MODEL, GUIDANCE, STRATEGIC PLANNING



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HEP Program Model

The DOE Office of Science is a part of a mission agency

- Provide science leadership and support to enable significant advances in specific science areas
- Labs with a variety of resources needed to design, build, operate selected facilities & projects
- Lab infrastructure, including computing facilities (NERSC, SCiDAC program etc)
- Encourage scientific teams with expertise in required areas to participate in all phases in order to produce science results
- Partnerships as needed to leverage additional science and expertise

The Office of High Energy Physics

- **Long Term View:**
 - Develop and support a specific portfolio of selected facilities & experiments to obtain the science
 - Plan stages of experiments for ever-increasing precision
 - Long-term support for our responsibilities in designing, building and operating projects, as well as research support, for significant advances in science.
 - Support a science collaboration in all stages, leading to the best possible science results
- **Collaboration/Teamwork:**
 - People have long term commitments, responsibilities on the experiments, in addition to science research, to bring together all the tools needed to accomplish the science
- **Complementary Approaches**
 - e.g. searching for dark matter particle detection using accelerators, direct detection underground experiments and indirect searches from gamma-ray surveys

HEP Program Guidance

- **FACA panels & subpanels provide official advice:**
 - High Energy Physics Advisory Panel (HEPAP)
 - Reports to DOE and NSF
 - Provides the primary advice for the program
 - Subpanels for detailed studies (e.g. Particle Astrophysics Science Assessment Group “PASAG”, Particle Physics Project Prioritization Panel (“P5”))
- **Astronomy and Astrophysics Advisory Committee (AAAC)**
 - Reports to NASA, NSF and DOE on areas of overlap
- **Other**
 - e.g. National Academies of Science studies, community science studies, reviews, etc.
- **Strategic Program Planning**
 - HEPAP unanimously approved a new long term strategic planning report from P5 in May 2014



Strategic Planning – Goals & Process

Optimally exploring new physics possibilities on all frontiers requires strategic US participation as part of a coordinated global effort

- “Get a plan and stand behind it” –*E. Moniz, Secretary of Energy*

Strategic Planning Goals & Process:

→ HEP needs a compelling & executable strategic plan, with community behind it

- APS-DPF led community planning process in 2013 (“Snowmass”)
- HEPAP P5 Subpanel in 2013/2014 (Steve Ritz, Chair) used Snowmass and other inputs to develop a strategic plan for the field
 - Plan to be executed over a ten year timescale in the context of a 20-year global vision for the field
 - P5 process was carried out in the context of realistic budget scenarios provided by the funding agencies in the charge

→ The P5 report “Strategic Plan for US Particle Physics in the Global Context” was delivered and approved by HEPAP in the May 22-23, 2014 meeting.

P5 Report Take-Away Messages



- **P5 plan is a compelling, unified vision for HEP – 5 science drivers**
 - 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
- **A balanced approach is critical**
 - The report recognizes the challenging funding landscape, where choices have to be made & resources stewarded carefully, and confronts these challenges head on.
 - An important reason the P5 plan has widespread HEP community support is its balanced approach:
 - Time-phased, projects of different scales, science goals, on- and off-shore, short-term and longer-term
- **P5 Plan**
 - Highest priority major projects are Large Hadron Collider (LHC) detector (ATLAS, CMS) upgrades in the near-term and Long Baseline Neutrino Facility (LBNF; aka LBNE) in the mid-term; Near term Cosmic Frontier projects are ready to go
 - LBNF will be the first truly international experiment hosted by the US
- **HEP share's the community's enthusiastic response to the P5 strategic plan**
 - HEP is developing & aligning the Program along P5 recommendations
 - Implementation strives to maintain the recommended balance; currently moving forward in target areas
 - But...given the current fiscal environment, full implementation of the plan will take some time, as we work with partners and stakeholders: DOE management, HEP community, DOE Laboratories, Congress, OMB, other US and international Agencies, etc.



HEP PROGRAM – BUDGET



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HEP Budget Notes – FY15

FY 2015 Budget planning:

- The FY15 President's Request for HEP was below P5 funding Scenario A
- Based on the FY15 House and Senate markups of the appropriation bills, we anticipated that we will be able to implement Scenario B
FY 2015 House & Senate bills: House \$775M, Senate \$774.5M
 - Gave specific amounts for each area (e.g. Cosmic Frontier)
 - Provided \$35M for LSST-camera and \$6M for DM-G2 projects (both as planned)
 - HEP should adjust Budget Request to align with P5 recommendations
 - HEP should develop a work plan to advance dark matter program, CMB Stage IV and DESI
- We were asked to make adjustments to the HEP Program budget and we had provided OMB with a reworked FY15 plan (in relation to the President's Request) for the \$775K that responded to P5.

Start of FY2015 (Continuing Resolution)

Beginning of FY2015, we had to plan to FY2015 President's Request (\$744M)

- Continue planned funding for existing projects: **LSST-camera**, **muon g-2**, **Belle-II**, **Mu2e**
- Move forward on **ATLAS/CMS upgrades**
- Continue design studies for **LBNf**, **R&D for DM-G2**, **DESI**
 - HEP will work to move forward on the high-priority near-term efforts at the Cosmic Frontier following a budget approval in FY 2015.

FY 2015 HEP – President's Request Budget

HEP Funding Category (\$ in K)	FY 2013 Current	FY 2014 Current	FY 2015 Request	Explanation of Changes (FY15 vs. FY14)
Energy Frontier	149,446	154,687	153,639	<i>Reduction for Tevatron completion offset by LHC upgrade activities</i>
Intensity Frontier	274,412	275,043	251,245	<i>Reductions for NOvA project completion, Belle II offset by increase for beam line ops & refurbishment at FNAL</i>
Cosmic Frontier	80,063	99,080	101,245	<i>Ramp-up of LSSTcam</i>
Theoretical and Comp.	66,398	62,870	58,850	<i>Reduced to offset investments in future facilities</i>
Advanced Technology R&D	142,291	122,291	114,242	<i>Reduced to offset project increase, shift towards directed R&D</i>
Accelerator Stewardship	3,132	9,931	19,184	<i>Support new R&D efforts, open accelerator test facilities to industry</i>
Construction	11,781	51,000	25,000	<i>Mu2e on profile; LBNE reduced in FY15 req. (req. made during P5 report development)</i>
SBIR/STTR	0	21,619	20,595	
Total	727,523	796,521	744,000	
DOE Office of Science (SC):	4,681,195	5,066,372	5,111,155	

HEP Budget Notes – FY15

FY 2015 Budget approved:

- The approved Omnibus HEP Budget approved is \$766M, between P5's scenario A&B and less than we had been planning for. Office of Science is \$5,071M.

For HEP, there was guidance on particular projects in the Cosmic Frontier:

- There was specific language that provided \$6.787M for the new Cosmic Major Item of Equipment (MIE) projects (LZ, SuperCDMS-SNOLab, DESI). This was less than the ~ \$11M planned for the reworked plan in response to P5 for the President's Request.
 - We are still planning on moving forward with all of these MIE's and are working on adjustments by the projects to the new funding amounts.
- **These were all approved as new project starts!!**
- SPT-3G and ADMX-G2 are not included in this budget cap since they are below the MIE project cutoff but are going forward with funding as planned.

→ In early January, the “cap” on the budget for the MIE Cosmic Frontier projects was lifted by the Senate, though we had to provide any additional funds needed to keep them going out of our approved budget. We had to justify any changes to the Senate. The new amounts will keep each of the projects on track, but may have a somewhat slower start than originally planned.

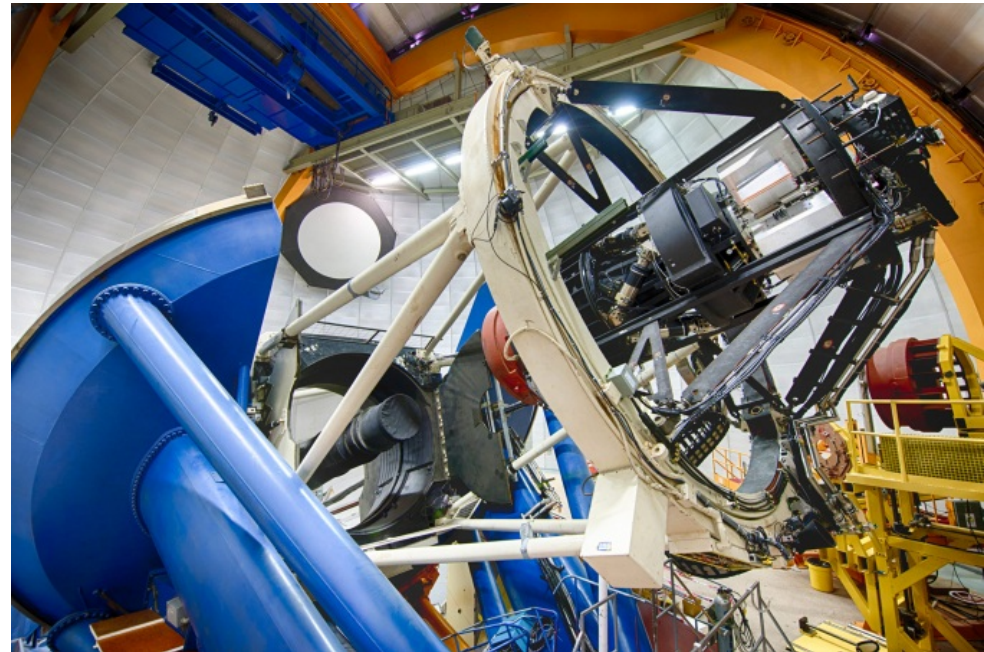
Cosmic Frontier

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:

- **Working on optimizing program following the P5 report**



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FY2013 - FY2015 Budget: Cosmic Frontier

Cosmic Frontier (\$K)	FY 2013 Actual	FY 2014 Actual	FY 2015 Pres. Req.	FY 2015 Current
Research	48,652	52,712	45,435	47,835
<i>Grants</i>	<i>12,233</i>	<i>13,157</i>		
<i>National Laboratories</i>	<i>36,419</i>	<i>39,555</i>		
Facility Operations and Experimental Support	10,111	10,357	7,238	8,790
Projects	19,159	30,705	41,000	
<i>MIE</i>	<i>9,500</i>	<i>22,900</i>	<i>41,000</i>	
<i>HAWC - FY13 completed</i>	<i>1,500</i>	<i>...</i>	<i>...</i>	
<i>LSST camera – FY14 start</i>	<i>8,000</i>	<i>22,000</i>	<i>35,000</i>	<i>35,000</i>
<i>Second Generation Dark Matter (DM-G2) – LZ, SuperCDMS SNOLab</i>	<i>...</i>	<i>900</i>	<i>6,000</i>	<i>4,800</i>
<i>DESI</i>				<i>3,078</i>
<i>Small Project Fabrication (FY15: SPT-3G, ADMX-G2)</i>				<i>1,025</i>
<i>Future Project R&D (FY15: SPT-3G, ADMX-G2)</i>	<i>9,659</i>	<i>7,760</i>		<i>1,200</i>
TOTAL	77,951	93,729	93,673	101,728
Other Costs	2,112	3,198	7,572	5,832
Total – Cosmic	80,063	96,927	101,245	107,560



Cosmic Frontier – Guidance & Considerations

Build Program with:

- Staged implementation & results
- Mix of smaller, larger projects, using multiple methods and technologies as needed
- Balance between thrusts
- Balance of speculative efforts with ones that guarantee results

Considerations

PASAG → P5 Criteria:

- Science goals and how it will address DOE-HEP goals?
 - Experiments which are directly-aligned with goals
 - Experiments in which only part of the data is of interest to the HEP program
- What does HEP Community bring to the experiment? Visible, leadership contributions?

Other considerations

- Are HEP project contributions in line with % of the project relevant to our science goals?
- Are roles and responsibilities on the project in line with our contributions?
- Partnerships - plusses and minuses
- Don't "mayonnaise" funds all over many small efforts.
- Domestic vs off-shore

→ The PASAG/P5 criteria and the above considerations can be applied to determining what projects we support and at what level as well as research funding priorities.





Projects:

The Cosmic Frontier has high priority projects ready to go in the near term (DESI and DM-G2) and HEP is working towards getting the additional funds (over the lowest funding scenario) to do DESI and an expanded dark matter program.

Priorities for funding:

- Following the P5 criteria, it will be a priority to support projects in which HEP has a major/visible role and in which there are significant leaps in capabilities and/or science.
- The priority for research funding will be to sufficiently support the science collaborations to carryout the project fabrication + operations and to deliver the science.
 - Ensure some room in the research program for development of ideas for new projects that are aligned with the science drivers.
- Research efforts on projects that are aligned with P5 science drivers, but which don't have HEP participation, will also be considered, taking into account the above and based on funding availability.



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
 - *Dark Energy Spectroscopic Instrument* (DESI, Stage IV spectroscopic)
 - CD-1 review Sept. 2014; Plan CD-1 approval in Feb. 2015
 - Plan approval to spend “fabrication” equipment funds in mid-2015
 - CD-2 “baseline” review in late FY2015
 - Plan to sign agreement with NSF soon for agreement 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
- **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 MIE projects are planning for fabrication start in FY16
 - LZ CD-1 review planned for March 2015

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; fully 300 tanks to be completed ~ Feb. 2015

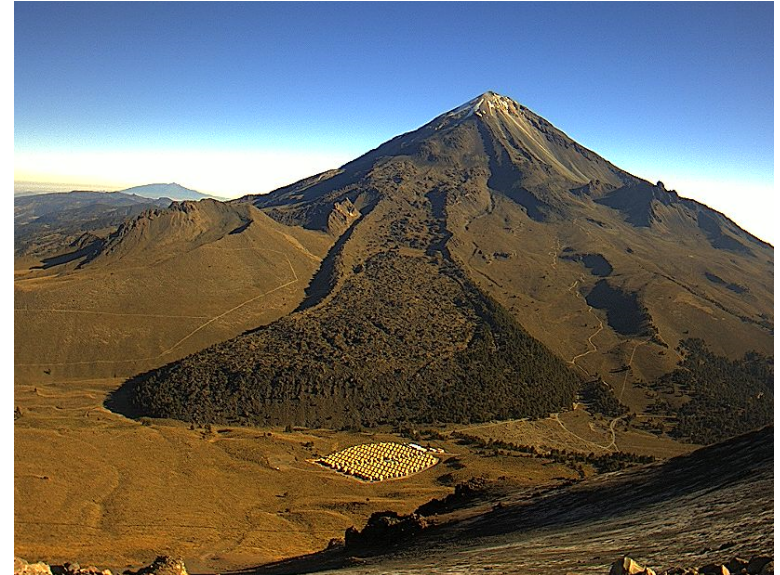
Cosmic Microwave Background (CMB)

- **Operating:**
 - *South Pole Telescope polarization (SPTpol)*
- **Fabrication:**
 - *SPT-3G* had successful review of DOE roles/responsibilities in September 2014 & we have approved funding for the fabrication phase (FY15,16)
- **Planning:**
 - Community planning for a CMB Stage IV experiment

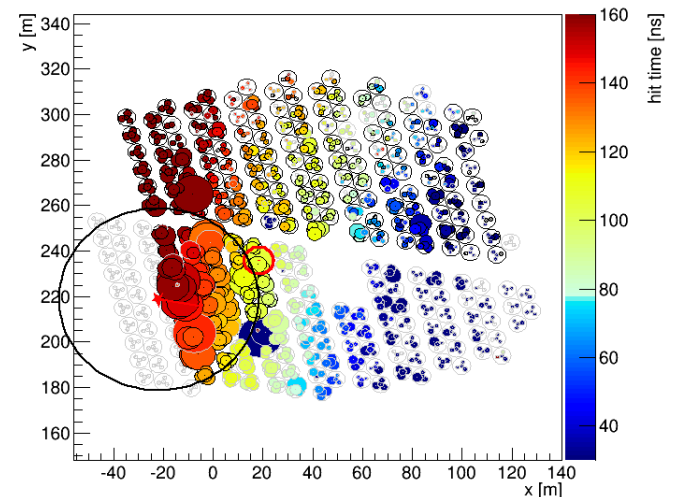
Cosmic Frontier Highlight:

HAWC-250 Array Taking Data

- **High-Altitude Water Cherenkov Observatory (HAWC) in Sierra Negra, Mexico, is now taking data**
 - Joint project between DOE, NSF and CONACYT (Mexico)
 - Will perform high-sensitivity synoptic survey of the sky at wavelengths between 100 GeV and 100 TeV
 - Instantaneous aperture covers >15% of the sky and will be exposed to 2/3 of the sky each day
- **Currently running with 250 tanks in place**
 - Entire HAWC-300 array will be completed by February 2015
 - Filling at 4-5 tanks per week



Run 2105, Time slice 140025, Event 89



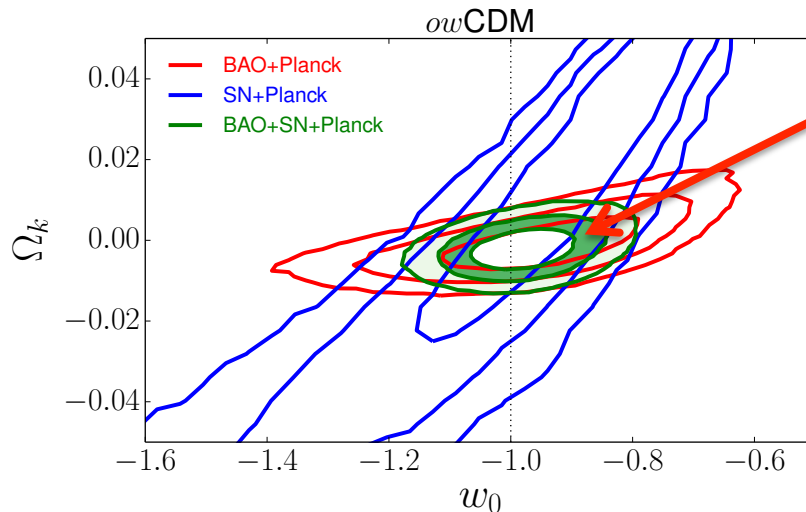
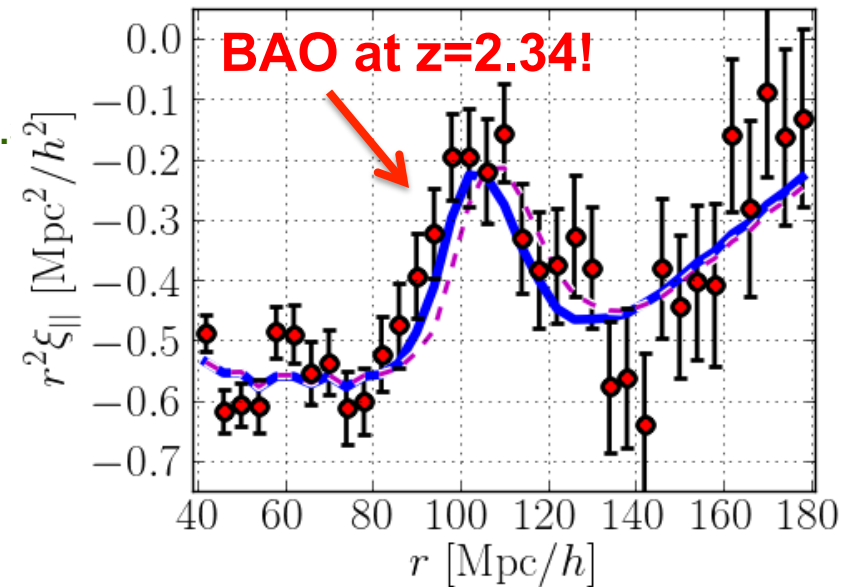
Highlight: Baryon Oscillation Spectroscopic Survey (BOSS)

April 2014: New analysis & robust detection of BAO in clustering of the intergalactic medium at $z=2.3$

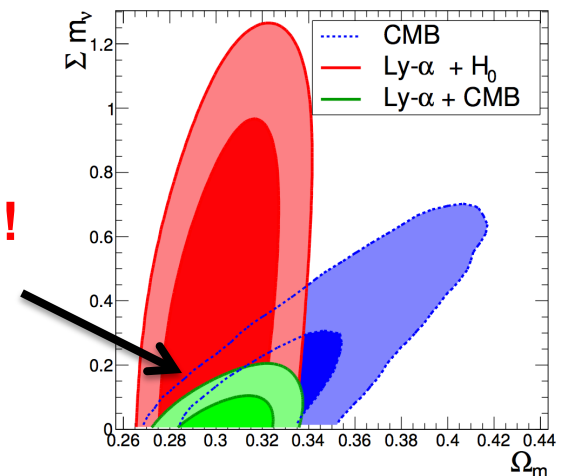
- Triples volume of earlier analysis
- 2.2% measurement of expansion rate of Universe at $z=2$.

October 2014: Limit on neutrino mass from small-scale clustering of the intergalactic medium:
 $<0.14 \text{ eV}/c^2$ at 95% CL for sum of the masses of 3 species.

November 2014: Cosmological parameter analysis of all current BAO results. Continued strong support for a flat Universe with a cosmological constant.



BAO measures w and curvature!
BOSS limits m_ν !



HEP PROGRAM – FOA'S



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HEP Funding Opportunity Announcements

- **Scientific Discovery through Advanced Computing (SciDAC) FOA is open (High Energy Physics joint with ASCR) – closed Jan 7, 2015. Reviews are underway.**
 - http://science.energy.gov/~media/grants/pdf/foas/2015/SC_FOA_0001210.pdf
- **The HEP research FY2015 Funding Opportunity Announcement (FOA) is closed and we are performing the comparative review**
 - Review process underway and PIs will start to be informed of funding decisions are being made. Final results will come out within a few months.
- **The Accelerator Stewardship FOA is now closed**
 - Reviews completed, consulting with partners in SC and other agencies
 - Final decisions will not be made until after FY15 appropriation
- **Early Career Research Program FOA is now closed**
 - Proposals were due by November 20, and we are now preparing for review
- **DOE Office of Science Graduate Student Research (SCGSR) Program is now closed**
 - Review process completed and results coming out soon. Preliminary results: 65 fellowships totaling \$1.6 M awarded across SC, with 11 awards in HEP



SUMMARY

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

