DOE HEP Perspectives

DPF 2013 – UC Santa Cruz
August 14, 2013

Alan L. Stone
Program Manager
Office of High Energy Physics
Office of Science, U.S. Department of Energy
Message from “The Funding Frontier”

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Program Manager
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Outline

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PROGRAM OVERVIEW
From Deep Underground to the Tops of Mountains, HEP pushes the Frontiers of Research

**Research at the Energy Frontier** — HEP supports research where powerful accelerators such as the LHC are used to create new particles, reveal their interactions, and investigate fundamental forces, and where experiments such as ATLAS and CMS explore these phenomena.

**Research at Intensity Frontier** — Reactor and beam-based neutrino physics experiments such as Daya Bay, NOvA and LBNE may ultimately answer some of the fundamental questions of our time: why does the Universe seem to be composed of matter and not anti-matter?

**Research at the Cosmic Frontier** — Through ground-based telescopes, space missions, and deep underground detectors, research at the cosmic frontier aims to explore dark energy and dark matter, which together comprise approximately 95% of the universe.

**Theory and Computation** — The interplay between theory, computation, and experiment is essential to the lifeblood of High Energy Physics. Computational sciences and resources enhance theory and enable data analysis, detector and accelerator development.

**Accelerator Science** — Supports R&D at national labs and universities in beam physics, novel acceleration concepts, beam instrumentation and control, high gradient research, particle and RF sources, superconducting magnets and materials, and superconducting RF technology.
The Common Goal

A realistic, coherent, shared plan for US HEP:

- Enabling world-leading facilities and experiments in the US while recognizing the global context and the priorities of other regions
- Recognizing the centrality of Fermilab while maintaining a healthy US research ecosystem that has essential roles for both universities and multi-purpose labs
- Articulating both the value of basic research and the broader impacts of HEP
- Maintaining a balanced and diverse program that can deliver research results consistently
A Venn Diagram of Superhero Comic Tropes

You know that one superhero, right? The one that dons a cape and fights following their parents’ untimely death. Turn to this: the description matches more than just a few characters. Here’s what most have in common.
Well-attended sessions, high quality presentations, lively discussions and panels!

Congratulations to the American Physical Society Division of Particles and Fields, Chair Jonathan Rosner, past and future chairs, and the too-many-to-name committee members and conveners.

Kudos to the University of Minnesota for hosting Snowmass, and to Dan, Marvin, and a small army of energetic students who were central to a successful workshop.

SNOWMASS
or How I Spent My Summer Vacation
The 17 Physicists with Legible Handwriting
SNOWMASS OBSERVATIONS (I)

- Conference travel rules are onerous, but are unlikely to be relaxed
  - Which headline would you rather see make the news?
    - “DOE spending millions of dollars on a three-week conference at a ski resort.”
    - “600 particle physicists came together at the University of Minnesota.”
  - Take a proactive approach. Task Force?
    - Submit VERY early for conference approval & funding support
    - Coordinate with international hosts in setting registration deadlines

- Construction around University of Minnesota
  - Third trip since 2010. When are they going to finish the light rail?

- Program managers need to get out of Germantown more often
  - PI Meetings: Energy, Cosmic, Theory, Computing, Detector R&D
  - University site visits are rare due to shrinking DOE travel budgets
  - Ad-hoc meetings, lunch and dinner discussions
  - Young Snowmass presentation, Q&A
  - And trips to Ash River to inspect NOvA construction!

- Aisle seats are a commodity
  - Charge a premium?
SNOWMASS OBSERVATIONS (II)

- The Frontier depiction of the HEP experimental research program
  - We have established a recognized brand & aligned the budget to the brand
  - Program managers responsible for defending their budgets
  - The voices of dissatisfaction are hard to quantify or qualify
    - Correlated with reduction (loss) in funding?
    - What alternatives are being suggested that would bring more money to HEP?
    - What opportunities are lost due to the “restrictions” of the Frontiers?
  - Silent majority do not have many complaints
    - Correlated with satisfaction with funding?
    - Overwhelming majority of HEP research falls within a single thrust or frontier
    - For Cosmic or Intensity, physicists may be on multiple experiments, e.g. dark energy or neutrinos, but they are usually staged and complementary
  - HEP does not discourage work or proposal to work in more than one research area
    - Uncommon: Research with shared software or technology development is a good example, e.g. Dark Matter/LAr R&D
    - Rare: Researchers working on orthogonal efforts, e.g. LHC and X
    - Many of the current post-docs in Intensity Frontier experiments did their thesis on a Tevatron or LHC experiment
    - Theory is not a frontier.
  - Peer review provides input on who is or who is not active or credible

- Healthy interaction between Frontiers
  - Plenary and joint sessions; Tough Questions; Panel Discussions
  - Parallel sessions
HEP Budget

xkcd.com/1062/
Recent Funding Trends

- In the late 90’s the fraction of the budget devoted to projects was about 20%.
- Progress in many fields require new investments to produce new capabilities.
- The projects started in 2006 are coming to completion.
- New investments are needed to continue US leadership in well defined research areas.
- Possibilities for future funding growth are weak. Must make do with what we have.

Trading projects for more research

Ramp up ILC and SRF R&D programs
About 20% (relative) reduction in Research fraction over ~5 years.

- In order to address priorities, this will not be applied equally across Frontiers.

This necessarily implies reductions in scientific staffing.

- Some can migrate to Projects but other transitions are more difficult.

- We have requested labs to help manage this transition as gracefully as possible.
## FY 2014 High Energy Physics Budget
(Dollars in thousands)

<table>
<thead>
<tr>
<th>Description</th>
<th>FY 2012 Actual</th>
<th>FY 2013 July Plan</th>
<th>FY 2014 Request</th>
<th>Explanation of Change [FY14 Request vs. FY12 Actual]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Frontier Exp. Physics</td>
<td>159,997</td>
<td>148,164</td>
<td>154,687</td>
<td>Tevatron ramp-down offset by R&amp;D for LHC detector upgrades</td>
</tr>
<tr>
<td>Intensity Frontier Exp. Physics</td>
<td>283,675</td>
<td>287,220</td>
<td>271,043</td>
<td>Completion of NOvA (MIE), partially offset by Fermi Ops</td>
</tr>
<tr>
<td>Cosmic Frontier Exp. Physics</td>
<td>71,940</td>
<td>78,943</td>
<td>99,080</td>
<td>Ramp-up of LSST-Camera</td>
</tr>
<tr>
<td>Theoretical and Computational Physics</td>
<td>66,965</td>
<td>66,398</td>
<td>62,870</td>
<td>Continuing reductions in Research</td>
</tr>
<tr>
<td>Advanced Technology R&amp;D</td>
<td>157,106</td>
<td>131,885</td>
<td>122,453</td>
<td>Completion of ILC R&amp;D</td>
</tr>
<tr>
<td>Accelerator Stewardship</td>
<td>2,850</td>
<td>3,132</td>
<td>9,931</td>
<td>FY14 includes Stewardship-related Research</td>
</tr>
<tr>
<td>SBIR/STTR</td>
<td>0</td>
<td>0</td>
<td>21,457</td>
<td></td>
</tr>
<tr>
<td>Construction (Line Item)</td>
<td>28,000</td>
<td>11,781</td>
<td>35,000</td>
<td>Mostly Mu2e; no LBNE ramp-up</td>
</tr>
<tr>
<td><strong>Total, High Energy Physics:</strong></td>
<td><strong>770,533</strong>(a)</td>
<td><strong>727,523</strong>(b,c)</td>
<td><strong>776,521</strong></td>
<td>wrt FY13: Up +3.6% after SBIR correction</td>
</tr>
<tr>
<td><strong>wrt FY12:</strong></td>
<td><strong>727,523</strong>(b,c)</td>
<td><strong>776,521</strong></td>
<td><strong>wrt FY12: Down -2% after SBIR correction</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Ref: Office of Science (SC):**
- 4,873,634
- 4,621,075**(c)**
- 5,152,752

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(a) The FY 2012 Actual is reduced by $20,327,000 for SBIR/STTR.
(b) The FY 2013 July Plan is reduced by $20,791,000 for SBIR/STTR.
(c) Reflects sequestration.

SBIR = Small Business Innovation Research
STTR = Small Business Technology Transfer
The FY 2014 Request for HEP Research was $384M, about a 6% increase compared to FY 2013, but $26 million of this is planned to go to R&D for Dark Matter G2, MS-DESI, and LHC upgrades.

Our current FY 2014 planning is based on the House markup of the Energy and Water Appropriation which is overall slightly below the Request

- The House mark directed HEP to move $8 million to LBNE PED, $2 million to SURF, and lower the overall HEP budget by $4 million. The choice was made to take all of these reductions from Research due to our priority to increase Project spending.

These two effects reduce Research to $343M, about a 5% reduction w.r.t. FY 2013

At the beginning of the year it is necessary to hold back funds for decisions to be made later in the year, such as the Early Career Program and other needs.

- This results in an approximately 6% reduction relative to FY 2013 for the initial distribution of funds. This is the average effect on initial HEP research funding.

There is some small variation in the impact to individual HEP subprograms, and program managers have the authority to provide more or less than the average reduction based on program priorities and the results of merit review.

The House mark is a budget indicator but not the final word on FY 2014. When Congress passes a budget, there could be either an increase or a decrease in HEP research funding.
Major Item of Equipment (MIE) Issues

- We were not able to implement [most] new MIE-fabrication starts in the FY14 request
  - Muon g-2 experiment is the only new start in HEP that was not requested in FY13
  - LSST-Camera and Belle II, which did not receive approval in FY13, are requested again in FY14

- This upsets at least 2 major features of our budget strategy:
  - Strategic plan: “Trading Research for Projects”
  - Implementation of facilities balanced across Frontiers
Current LBNE Strategy

- We are trying to follow the reconfiguration [phased] plan for LBNE, though it has hit some snags
  - Out-year budgets are challenging
  - Some members of the community objected that the phased LBNE was not what the previous P5 (or they) had in mind

- The plan, as it currently stands:
  - Use time before baselining to recruit partners (international and domestic) that expand scope and science reach

- We also take note of the House language on LBNE:
  “The Committee recognizes the importance of this project to maintaining American leadership in the intensity frontier and to basic science discovery of neutrino and standard model physics. However, the Committee also recognizes that LBNE construction must be affordable under a flat budget scenario. As such, the Committee supports the Office of Science’s challenge to the High Energy Physics community to identify an LBNE construction approach that avoids large out-year funding spikes or to identify viable alternatives with similar scientific benefits at significantly lower cost.”
### HEP Project Status

<table>
<thead>
<tr>
<th>Subprogram</th>
<th>TPC ($M)</th>
<th>CD Status</th>
<th>CD Date</th>
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<tbody>
<tr>
<td><strong>INTENSITY FRONTIER</strong></td>
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<td></td>
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<tr>
<td>Long Baseline Neutrino Experiment (LBNE)</td>
<td>TBD</td>
<td>CD-1</td>
<td>December 10, 2012</td>
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<tr>
<td>Muon g-2</td>
<td>40</td>
<td>CD-0</td>
<td>September 18, 2012</td>
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<tr>
<td>Muon to Electron Conversion Experiment (Mu2e)</td>
<td>249</td>
<td>CD-1</td>
<td>July 11, 2012</td>
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<tr>
<td>Next Generation B-Factory Detector Systems (Belle II)</td>
<td>16</td>
<td>CD-3a</td>
<td>November 8, 2012</td>
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<tr>
<td>NuMI Off-Axis Electron Neutrino Appearance Exp’t (NOνA)</td>
<td>278</td>
<td>CD-3b</td>
<td>October 29, 2009</td>
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<tr>
<td>Micro Booster Neutrino Experiment (MicroBooNE)</td>
<td>19.9</td>
<td>CD-3b</td>
<td>March 29, 2012</td>
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<tr>
<td>Main INjector ExpeRiment for ν-A (MINERνA)</td>
<td>16.8</td>
<td>CD-4</td>
<td>June 28, 2010 [Finished]</td>
</tr>
<tr>
<td>Daya Bay Reactor Neutrino Experiment</td>
<td>35.5</td>
<td>CD-4b</td>
<td>August 20, 2012 [Finished]</td>
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<tr>
<td><strong>ENERGY FRONTIER</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>LHC ATLAS Detector (Phase-1) Upgrade</td>
<td>TBD</td>
<td>CD-0</td>
<td>September 18, 2012</td>
</tr>
<tr>
<td>LHC CMS Detector (Phase-1) Upgrade</td>
<td>TBD</td>
<td>CD-0</td>
<td>September 18, 2012</td>
</tr>
<tr>
<td><strong>COSMIC FRONTIER</strong></td>
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<tr>
<td>Dark Matter (DM-G2)</td>
<td>TBD</td>
<td>CD-0</td>
<td>September 18, 2012</td>
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<tr>
<td>Mid-Scale Dark Energy Spectroscopic Instrument (MS-DESI)</td>
<td>TBD</td>
<td>CD-0</td>
<td>September 18, 2012</td>
</tr>
<tr>
<td>Large Synoptic Survey Telescope (LSST)</td>
<td>173</td>
<td>CD-1</td>
<td>April 12, 2012</td>
</tr>
<tr>
<td>Dark Energy Survey (DES)</td>
<td>35.1</td>
<td>CD-4</td>
<td>June 4, 2012 [Finished]</td>
</tr>
<tr>
<td><strong>ADVANCED TECHNOLOGY R&amp;D</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Accelerator Project for the Upgrade of the LHC (APUL)</td>
<td>11.5</td>
<td>CD-2/3</td>
<td>July 29, 2011</td>
</tr>
<tr>
<td>Berkeley Lab Laser Accelerator (BELLA)</td>
<td>27.2</td>
<td>CD-4</td>
<td>January 17, 2013 [Finished]</td>
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<tr>
<td>Facility for Advanced Accelerator Experimental Tests (FACET)</td>
<td>14.5</td>
<td>CD-4</td>
<td>January 31, 2012 [Finished]</td>
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</tbody>
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14 Aug 2013
Strategic Planning
Implementation of 2008 Advisory Panel (P5)

- The HEP budget puts in place a comprehensive program across the three frontiers.
  - In five years:
    - NOvA, Belle II, Muon g-2 will be running on the Intensity Frontier
    - Mu2e will be commissioning for first data taking
    - The CMS and ATLAS detector upgrades will be installed at CERN
    - DES will have completed its science program and new mid-scale spectroscopic instrument and DM-G2 should begin operation
    - The two big initiatives, LSST and LBNE, will be well underway

- Need to start planning now for what comes next.
  - We have been engaging with the DPF community planning process starting at Fermilab in Oct 2012 and culminating in Minneapolis just last week
  - Will set up a prioritization process (a new P5) using that input.
Customized Implementation Strategies

- **Energy Frontier**
  - US has a leading role in LHC physics collaborations but does not own the facility
    - The issue is the scope and scale of US involvement. Requires US-CERN negotiation.
    - Could also be true for Japanese-hosted Linear Collider

- **Intensity Frontier**
  - US is the world leader and needs new facilities and/or upgrades of existing facilities to maintain its position
    - Has the potential to attract new partners to US-led projects
    - Portfolio of experiments and science case is diverse. This complicates the case. The scale of the projected investments is a big challenge

- **Cosmic Frontier**
  - US HEP has a leading role in a competitive, multidisciplinary environment
    - HEP component of the physics case is simple and compelling. Key issues are what levels of precision and sensitivity can be achieved and scientifically justified
    - DOE is a technology enabler, not a facilities provider (see NSF, NASA)
      - Analogous to LHC but the HEP physics goals are not those of the facility owners
    - DOE supports particle physics goals and HEP-style collaborations
      - Astronomy and astrophysics is not in our mission nor our *modus operandi*
Snowmass / P5 Interface

Some of what we heard at Snowmass:

– What are the most compelling science questions in HEP that can be addressed in the next 10 to 20 years and why

– What are the primary experimental approaches that can be used to address them? Are they likely to answer the question(s) in a “definitive” manner or will follow-on experiments be needed?

– What are the “hard questions” (science, technical,...) that a given experiment or facility needs to answer to respond to perceived limitations in its proposal?

These topics (and more) will be covered in the Snowmass reports and white papers. P5 will use these reports and white papers as its starting point.

– We expect to have the P5 panel selected and a formal charge issued by the time of the September 5-6 HEPAP meeting at NSF
Goals For The P5 Process

DOE/NSF agree on the goals:

- The P5 process will use the science goals of the community to construct a plan that is feasible and executable over a 10-20 year timescale.
- HEP MUST have a planning and prioritization process that the community can stand behind and support once the P5 report is complete.
- We also need a process that repeats at more or less regular intervals (5 years?)
  - We also want to allow for less comprehensive updates and modest course corrections to the plan along the way (a la P5 updates in 2009, 2010)
- Key elements and outcomes envisioned for the P5 process:
  - Revisit the questions we use to describe the field (e.g. Quantum Universe, updated and corrected)
  - Decide on the science and project priorities within budget guidance (in detail for the next 10 years, in broad outline beyond that)
  - Crisply describe the impact of HEP research on other sciences and society
  - Build on the investment in Snowmass process and outcomes
What P5 Is

P5 will articulate the vision for U.S. particle physics in a global context. It will prioritize HEP projects over a 10-20 year timeframe within reasonable budget assumptions.

- Discussion will include such issues as: The role of domestic HEP facilities in the context of the worldwide particle physics program; and US leadership roles and their importance.
- Prioritization will necessarily involve consideration of technical feasibility as well as plausible timescales and resources for future projects.

Fundamental questions for the field and how to unify/connect the Frontiers framework will also be discussed.

- Input from the Theory community will be especially important in this area.
What P5 Is Not

Technology support will NOT be a main focus of P5, but the panel will benefit from wisdom in the community in this area.

- E.g., Do we have a coherent technology R&D plan that dovetails with the science opportunities? If not, how do we get there?
- Note that ‘Accelerator Stewardship’ is an Office of Science wide initiative managed by the HEP office, so should be discussed for information, but will not be modified by P5.

Other issues will be addressed by HEPAP in the future, such as:

- Agency review processes
- Roles, responsibilities and funding of labs versus universities

Working with HEPAP Chair to identify the key topics to review

- We welcome input and discussion on what you think are the pressing structural issues for HEP
Moving Forward With The P5 Process

P5 composition:

- P5 will be chaired by Steve Ritz (UC Santa Cruz).
- The target size for P5 will be approximately same as in past, \textit{i.e.} \(\sim 20+\)
  - Chosen after considerable input and discussion
- Nominations have been sought from HEP and related communities through a “Dear Colleague” letter.

Community input:

- P5 will build on the investment in the Snowmass process and output,
  - But P5 may solicit additional material as needed.
- Community input and interaction will not stop with Snowmass.
- Process will include public presentations and town hall meetings.
  - Including inputs on prioritization criteria and other issues
  - Including open discussion of issues so the community can better understand the consideration and constraints, and hopefully reach broader agreement.

- Send input by email to sritz@ucsc.edu & andrew.lankford@uci.edu
More About The P5 Process

- Publicizing and explaining the outcome is an important function.
- We are considering breaking out important “supporting” work:
  - Two separate (non-P5) working groups:
    - Science Connections, highlighting the scientific areas where HEP advances, informs, and benefits from other DOE/SC programs. See e.g., 1998 National Academy EPP Decadal Survey (Winstein)
      - Co-chairs Shamit Kachru (Stanford/SLAC) & Curt Callan (Princeton)
    - HEP Impact, developing a potential list of messages for the U.S. HEP community to use in communicating the broad impact of HEP in technology, workforce development, and other societal benefits
      - Interested parties are strongly encouraged to engage with the Education and Outreach group at Snowmass
    - These groups would produce short reports to HEPAP/P5 by the end of the calendar year in order to provide timely input that can be integrated by P5
Evolving P5 Timeline

✓ May 2013: DOE and NSF agree on outlines of P5 process and inform community via presentations and “Dear Colleague” letter
✓ Jun 2013: Call for nominations to P5
✓ Jul 2013: Agencies draft P5 charge. HEPAP Chair reviews P5 nominations and begins selection process
✓ Aug 2013: Snowmass meeting. P5 charge sent to HEPAP Chair. (The budget guidance to P5 will be public as part of its charge.)
❖ Sep 2013: HEPAP Meeting (Sep 5-6 at NSF). Snowmass reports issued. P5 charge and membership formally announced. Timeline for P5 meetings announced.
❖ Fall 2013: Public Meetings (number, venues and topics TBD)
   ❖ Planning of meetings to derive from the charge
❖ Fall 2013 to Spring 2014: P5 meetings (phone in and face to face)
❖ Spring/Summer 2014: P5 report(s) due. Exact dates and deliverables to be spelled out in P5 charge.
MEANWHILE, AT THE HIGGS FAMILY RESIDENCE...

IT WAS UNDER THE CUSHION THE WHOLE TIME!

SUMMARY

Lukesurl.com. 2008
Take-Away Messages

- The U.S. HEP program is following the strategic plan laid out by the previous HEPAP/P5 studies
- Though some of the boundary conditions have changed, we are still trying to implement that plan within the current constraints
  - FY2014 request generally supports this, though funding constraints have led to delays in some key projects
  - Need to maintain progress with projects currently “on the books”
  - Working to attract partnerships that will extend the science impact
- Actively engaged with community in developing new strategic plan
- Increased emphasis on broader impacts via accelerator stewardship
- Leadership in the long-term will be through excellence in innovation and unique capabilities
  - Focus on areas where U.S. can have leadership
  - “High-risk, high-impact” as opposed to incremental advances
  - Note this is not an either/or proposition, we need both with appropriate balance
Thank you.

Questions?

Food and Drink!

xkcd.com/589/
AT THE 11TH ANNUAL
ZOMBIE CONFERENCE ON
STRING THEORY...

BRAAAANIES!!!

Lukesurl.com. 2010
Office of High Energy Physics

**HEP’s Mission:** To explore the most fundamental questions about the nature of the universe at the Cosmic, Intensity, and Energy Frontiers of scientific discovery, and to develop the tools and instrumentation that expand that research.

**HEP seeks answers to Big Questions:**
- How does mass originate?
- Why is the world matter and not anti-matter?
- What is dark energy? Dark matter?
- Do all the forces become one and on what scale?
- What are the origins of the Universe?

**HEP offers high-impact research opportunities for** small-scale collaborations at the Cosmic and Intensity Frontiers to full-blown international collaborations at the Energy Frontier. More than 20 physicists supported by the Office of High Energy Physics have received the Nobel Prize.
HEP Physics and Technology

The Energy Frontier
- Origins of Mass
- Dark matter

The Intensity Frontier
- Matter/Anti-matter Asymmetry
- Neutrino Physics
- Proton Decay
- Origin of Universe
- Unification of Forces
- New Physics Beyond the Standard Model

The Cosmic Frontier
- Dark energy
- Cosmic Particles

Along Three Paths
- Experimental
- Simulation
- Theory
- Accelerators
- Detectors
- Computing

Enabled by Advanced Technologies in:

Update?
Issues and Questions

Issues and questions we need to deal with when laying out longer term plan – and to be able to execute & defend the program

- Which are the most important science areas &/or projects that need to be emphasized to make significant advances towards HEP goals? Which areas of phase space do we emphasize? Are there efforts that need to be ramped down or terminated?

- In addition to looking for next steps following current program, are there gaps in the current program or other projects that need to be done in the future to fully exploit our program?

- Are there branch points where we choose a certain direction?

- How far do we need to go in precision &/or setting limits in each area, i.e. when do we stop going in a certain direction?

- What are other theory, computational resources and simulations needed?

- Need to build case with other Frontiers for the importance and priority of funding
# HEP Energy Frontier Experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Location</th>
<th>CM Energy; Status</th>
<th>Description</th>
<th># Institutions; # Countries</th>
<th>#US Institutions</th>
<th>#US Coll.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DZero</td>
<td>Fermilab Tevatron Collider [Batavia, Illinois, USA]</td>
<td>1.96 TeV; Operations ended: Sept. 30, 2011</td>
<td>Higgs, Top, Electroweak, SUSY, New Physics, QCD, B-physics</td>
<td>74 Institutions; 18 Countries</td>
<td>33 Univ., 1 National Lab</td>
<td>192</td>
</tr>
</tbody>
</table>

- **US-ATLAS comprises ~21% of the international ATLAS Collaboration**
- **US-CMS comprises ~33% of the international CMS Collaboration**
Energy Frontier Issues

- Discussions with CERN about follow-on to LHC Agreement proceeding
  - Necessary precursor to planning for “Phase-II” upgrades; US scope for “Phase-II” TBD

- Energy Frontier science plan will require high-energy, high-luminosity LHC running
  - What is the real physics of the TeV scale?
    - This will likely take a few years to sort itself out
  - US Snowmass/P5 process is an important element, along with European and Asian HEP strategies

- Significant collaborations with other regions on future colliders will require a high-level approach between governments
  - Modest ground-level R&D efforts can continue as funding allows
  - We support an international process to discuss future HEP facilities that respects the interests of major national and regional partners as well as realistic schedule and fiscal constraints
  - Once Snowmass/P5 studies and the community input are complete, we will be in a better position to evaluate future US priorities for the HEP program in detail
  - We encourage active engagement by all interested parties
HEP Cosmic Frontier Experiments

Current program

- Several operating experiments studying high-energy cosmic & gamma rays:
  - Fermi/GLAST, VERITAS, Auger, AMS
- Several 1st generation (G1) dark matter direct detection experiments operating:
  - ADMX, LUX, CDMS-Soudan, DarkSide
  - High Altitude Water Cherenkov (HAWC) starts operations in 2014
- Several dark energy experiments are operating:
  - BOSS, Supernova surveys; Dark Energy Survey (DES) is starting 5-year survey in Sept. 2013
- Other areas: SPTpol (CMB), Holometer

Planned program

- Large Synoptic Survey Telescope will make definitive ground-based Stage IV DE measurements
  - CD-1 for LSST-camera approved in April 2012
  - HEP requested an MIE fabrication start for LSST-camera in FY2014 President’s Request budget
- Dark Matter 2nd-Generation (DM-G2) experiments to probe most of preferred phase space
  - CD-0 approved in September 2012
  - FY13 R&D awards announced at March HEPAP meeting:
    - ADMX-Gen2, LZ, SuperCDMS-SNO, DarkSide-G2, COUPP-500
    - Down-selection for expt’s to move into fabrication phase expected to occur in late 2013
  - FY14 President’s Request - R&D continues; planning to request an FY15 start
- Mid-scale Dark Energy Spectroscopic instrument to complement DES/LSST
  - CD-0 approved in September 2012
  - FY13: HEP is working with NSF-AST to determine if preferred site to host the instrument is available in the timescale needed
  - FY14 President’s Request - R&D continues; planning to request an FY15 start
Cosmic Frontier Issues

- The HEP component of the physics case is simple & compelling
  - Key issues are what levels of precision and sensitivity can be achieved and scientifically justified

- HEP has a leading role in a competitive, multidisciplinary environment:
  - Make significant, coherent contributions to facilities/experiments selected for the program, including instrumentation, computing, and bring the tradition of science collaborations to all stages of the experiment
  - Form partnerships or use other agency’s facilities when needed (e.g. we don’t build telescopes); our science goals are often a subset of those of the facility owners

Program Guidance:

- FACA panels – official advice to the government:
  - High Energy Physics Advisory Panel (HEPAP): PASAG subpanel 2009 has been the main guidance for planning the program
  - Astronomy and Astrophysics Advisory Committee (AAAC): Reports to NASA, NSF and DOE on areas of overlap

- Other Input:
  - National Academies of Science - Astronomy & Astrophysics Decadal survey (New Worlds New Horizons 2010)
  - Specific studies, e.g. Dark Energy science group in summer 2012 → Science case for a HEP dark energy program developed by a task force at HEP request (Rocky Kolb, chair). This was seen as a good model for the different science areas

Future Directions

- Dark Matter & Dark Energy – We have a path forward for next steps
- Science case and role of other particle astrophysics areas needs to be better articulated
- Will further develop and optimize program starting with input from the Snowmass → P5 process

14 Aug 2013

Alan L. Stone  –  DPF UC Santa Cruz  –  DOE HEP Program
## HEP Intensity Frontier Experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Location</th>
<th>Status</th>
<th># Institutions</th>
<th>#Collaborators</th>
<th>#US Inst.</th>
<th>#US Coll.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belle II</td>
<td>KEK, Tsukuba, Japan</td>
<td>Physics run 2016</td>
<td>70</td>
<td>508+</td>
<td>10 Univ, 1 Lab</td>
<td>55</td>
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<tr>
<td>BES III</td>
<td>IHEP, Beijing, Ching</td>
<td>Running</td>
<td>50</td>
<td>363</td>
<td>6 Univ</td>
<td>26</td>
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<tr>
<td>CAPTAIN</td>
<td>Los Alamos, NM, USA</td>
<td>R&amp;D; Neutron run 2015</td>
<td>6+</td>
<td>20+</td>
<td>5 Univ, 1 Lab</td>
<td>20+</td>
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<tr>
<td>Daya Bay</td>
<td>Dapeng Peninsula, China</td>
<td>Running</td>
<td>38</td>
<td>229</td>
<td>13 Univ, 2 Lab</td>
<td>76</td>
</tr>
<tr>
<td>Heavy Photon Search</td>
<td>Jefferson Lab, Newport News, VA, USA</td>
<td>Physics run 2015</td>
<td>17</td>
<td>63+</td>
<td>8 Univ, 2 Lab</td>
<td>47</td>
</tr>
<tr>
<td>KOTO</td>
<td>J-PARC, Tokai, Japan</td>
<td>Running</td>
<td>16</td>
<td>66</td>
<td>3 Univ</td>
<td>12</td>
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<tr>
<td>LArIAT</td>
<td>Fermilab, Batavia, IL</td>
<td>R&amp;D; Phase I 2013</td>
<td>18</td>
<td>45+</td>
<td>11 Univ, 3 Lab</td>
<td>38</td>
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<tr>
<td>LBNE</td>
<td>Fermilab, Batavia, IL &amp; Homestake Mine, SD, USA</td>
<td>CD1 Dec 2012; First data 2023</td>
<td>65</td>
<td>366+</td>
<td>48 Univ, 6 Lab</td>
<td>336</td>
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<tr>
<td>MicroBooNE</td>
<td>Fermilab, Batavia, IL, USA</td>
<td>Physics run 2014</td>
<td>19</td>
<td>108</td>
<td>15 Univ, 2 Lab</td>
<td>101</td>
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<tr>
<td>MINERvA</td>
<td>Fermilab, Batavia, IL, USA</td>
<td>Med. Energy Run 2013</td>
<td>21</td>
<td>65</td>
<td>13 Univ, 1 Lab</td>
<td>48</td>
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<tr>
<td>MINOS+</td>
<td>Fermilab, Batavia, IL &amp; Soudain Mine, MN, USA</td>
<td>NuMI start-up 2013</td>
<td>27</td>
<td>75</td>
<td>15 Univ, 3 Lab</td>
<td>53</td>
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<td>Mu2e</td>
<td>Fermilab, Batavia, IL, USA</td>
<td>First data 2019</td>
<td>26</td>
<td>139+</td>
<td>15 Univ, 4 Lab</td>
<td>106</td>
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<tr>
<td>Muon g-2</td>
<td>Fermilab, Batavia, IL, USA</td>
<td>First data 2016</td>
<td>27</td>
<td>100+</td>
<td>13 Univ, 3 Lab, 1 SBI R</td>
<td>75+</td>
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<tr>
<td>NOvA</td>
<td>Fermilab, Batavia, IL &amp; Ash River, MN, USA</td>
<td>Physics run 2014</td>
<td>34</td>
<td>144</td>
<td>18 Univ, 2 Lab</td>
<td>114</td>
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<tr>
<td>ORKA</td>
<td>Fermilab, Batavia, IL, USA</td>
<td>R&amp;D; CD0 2017+</td>
<td>17</td>
<td>48+</td>
<td>6 Univ, 2 Lab</td>
<td>26</td>
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<tr>
<td>Super-K</td>
<td>Mozumi Mine, Gifu, Japan</td>
<td>Running</td>
<td>35</td>
<td>121</td>
<td>7 Univ</td>
<td>29</td>
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<tr>
<td>T2K</td>
<td>J-PARC, Tokai &amp; Mozumi Mine, Gifu, Japan</td>
<td>Running; Linac upgrade 2014</td>
<td>56</td>
<td>500+</td>
<td>10 Univ</td>
<td>70</td>
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<tr>
<td>US-NA61</td>
<td>CERN, Geneva, Switzerland</td>
<td>Target runs 2014-15</td>
<td>27 (NA61/SHINE)</td>
<td>144 (NA61/SHINE)</td>
<td>4 Univ, 1 Lab</td>
<td>15</td>
</tr>
<tr>
<td>US Short-Baseline Reactor</td>
<td>Site(s) TBD</td>
<td>R&amp;D; First data 2016</td>
<td>11</td>
<td>28+</td>
<td>6 Univ, 5 Lab</td>
<td>28</td>
</tr>
</tbody>
</table>
Intensity Frontier Research & Development

- Intensity Frontier R&D activities reviewed case by case
  - Target of opportunities: fast, cheap and compelling (discovery potential)

- What constitutes Intensity Frontier R&D?
  - Perform simulations and physics studies in support of the conceptual and preliminary design of a future experiment or project
  - Develop and demonstrate the technical feasibility of novel detectors or systems
  - Design, construct, commission, and operate a prototype experiment

- What are the ground rules?
  - Start at home. Seed support from Univ. start-up, LDRD, private foundation, etc.
  - There is not a separate pot of money. All funding comes out of research. Be thrifty. Be reasonable. R&D proposals should be mainly for technical support.
  - Form a strong & credible collaboration. Partnerships with labs and universities are preferred. International participation is encouraged.
  - Socialize with the funding agencies AND lab management at the earliest opportunity.
    - Briefings to DOE (or NSF). PAC(s) should have a voice.
    - How and when does this activity fit within the HEP mission and Intensity Frontier portfolio?
  - Technical proposal will be reviewed. Research will be reviewed. Separately.
# Current Intensity Frontier R&D Efforts

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Location</th>
<th>Status</th>
<th>Description</th>
<th>#US Inst.</th>
<th>#US Coll.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPTAIN</td>
<td>Los Alamos, NM, USA</td>
<td>R&amp;D; Neutron run 2015</td>
<td>Cryogenic apparatus for precision tests of argon interactions with neutrinos</td>
<td>5 Univ., 1 Lab</td>
<td>20</td>
</tr>
<tr>
<td>Heavy Photon</td>
<td>Jefferson Lab, Newport News, VA, USA</td>
<td>Physics run 2015</td>
<td>Search for massive vector gauge bosons which may be evidence of dark matter or explain g-2 anomaly</td>
<td>8 Univ., 2 Lab</td>
<td>47</td>
</tr>
<tr>
<td>Search</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>LArIAT</td>
<td>Fermilab, Batavia, IL</td>
<td>R&amp;D; Phase I 2013</td>
<td>LArTPC in a test beam; develop particle ID &amp; reconstruction</td>
<td>11 Univ., 3 Lab</td>
<td>38</td>
</tr>
<tr>
<td>ORKA</td>
<td>Fermilab, Batavia, IL, USA</td>
<td>R&amp;D; CD0 2017+</td>
<td>Precision measurement of $K^+\rightarrow\pi^+\nu\nu$ to search for new physics</td>
<td>6 Univ., 2 Lab</td>
<td>26</td>
</tr>
<tr>
<td>US-NA61</td>
<td>CERN, Geneva, Switzerland</td>
<td>Target runs 2014-15</td>
<td>Measure hadrons production cross sections crucial for neutrino beam flux estimations needed for NOvA, LBNE</td>
<td>4 Univ., 1 Lab</td>
<td>15</td>
</tr>
<tr>
<td>US Short-Baseline</td>
<td>Site(s) TBD</td>
<td>R&amp;D; First data 2016</td>
<td>Short-baseline sterile neutrino oscillation search</td>
<td>6 Univ., 5 Lab</td>
<td>28</td>
</tr>
<tr>
<td>Reactor</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

- **Heavy Photon Search**: Feb 2013 DOE Briefing; **July 11, 2013 DOE Panel Review**
  - Determine whether to fund the design, construction, commissioning, and operation of the first phase of the experiment for period of FY14-FY16
- **nEXO R&D**: Monthly DOE HEP/NP Phone Calls; **July 12, 2013 DOE Panel Review**
  - Determine whether to fund the 5 ton LXe TPC R&D program for period of FY13-FY16
- **US Short-Baseline Reactor**: Monthly DOE Phone Calls; Apr 2013 DOE Briefing
- **LArIAT**: Monthly DOE Phone Calls; Apr 2013 DOE Briefing; Jul 2013 NSF Briefing
- **ORKA**: May 2012 DOE Briefing; FNAL Stage 1
- **CAPTAIN**: Feb 2013 LANL Review (DOE Observer); Monthly DOE Phone Calls
- **nuSTORM**: Monthly DOE Phone Calls; Proposal to FNAL PAC in Jun 2013; FNAL Stage 1
- **US-NA61**: Aug 2013 DOE Briefing
- And more in pipeline to be considered: OscSNS, CHIPS, LAr1 Phase 1…

- Planning a LBNE-related R&D review in Spring 2014
Detector R&D Program

- Develop the next generation of detectors for particle physics and supports research leading to fundamental advances in the science of particle detection and instrumentation.
  - “Generic” research on the physics of particle detection that has potential for wide applicability and/or high impact.
  - Provide graduate and postdoctoral research training, equipment for experiments and related computational efforts
  - Support for engineering and other technical efforts and equipment required for experimental detector R&D and fabrication

- Establish Detector R&D Test Facilities at National Labs
  - Fermilab: ASIC Development and Testing Facility, Cryogenics and Vacuum Instrumentation Facility, Fixed Target Test Beams, Thin Film Support Facility, etc.
  - SLAC: ESTB Test Beam Facility

- Innovation through Partnerships
  - Fruitful collaboration already seen at Laboratories and Universities

- Many Suggestions from the HEP Community
  - Grand Challenges – Focused R&D; LAPPD as an example
  - Plans for better education of students and post-docs
  - EF/IF/CF support for the technical staff between Projects
  - Improved access to Lab engineering facilities
  - Work will continue via Coordinating Panel for Advanced Detectors (CPAD)
# Instrumentation Summary Strategic Themes

<table>
<thead>
<tr>
<th>Instrumentation Area</th>
<th>Possible Technology</th>
<th>Energy F.</th>
<th>Intensity F.</th>
<th>Cosmic F.</th>
<th>Nucl. Phys.</th>
<th>BES</th>
<th>Applied</th>
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<tr>
<td>Photodetectors</td>
<td>LAPPD or SiPM</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>Spectral Sensitive Pixels</td>
<td>MKID or Tiered Silicon</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>Calorimetry</td>
<td>Crystal EM calorimetry, compensating</td>
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<td>✓</td>
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<td>Low Background Techniques</td>
<td>Neutron veto detectors</td>
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<td></td>
<td>Photodetectors, materials</td>
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<td>✓</td>
<td>✓</td>
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<td>Intelligent Tracking</td>
<td>3D Silicon</td>
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<td>✓</td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td>Custom Electronics</td>
<td>Waveform sampling ASIC</td>
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<tr>
<td></td>
<td>Cold electronics</td>
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<td>✓</td>
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<td>Low-mass tracking</td>
<td>Carbon, G-pixel Si, power delivery</td>
<td>✓</td>
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<td></td>
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<tr>
<td>DAQ</td>
<td>ATCA, high-speed optical links</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

... more this week ...

Snowmass 2013 (CSS), Minneapolis, July 29 2013 - Marcel Demarteau (Instrumentation Frontier)
### HEP Theory Program

- Topics studied in theoretical high energy physics research **include, but are not limited to:** phenomenological and theoretical studies that **support** experimental HEP research at the three frontiers, both in understanding the data and in finding new directions for experimental exploration; development of analytical and numerical computational techniques for these studies; and construction and exploration of theoretical frameworks for understanding fundamental particles and forces at the deepest level possible.

- The program is centered across several research areas:
  1. **Standard Model Phenomenology**, which involves high precision calculations of Standard Model predictions such as Monte Carlo simulation, higher order calculations of particle production rates and distributions, radiative corrections, and extraction of parton distribution functions;
  2. **Beyond the Standard Model Phenomenology**, which studies the experimental consequences of extensions of the Standard Model as well as the search for new particles given their signatures in collider and astrophysical sources, and in rare processes;
  3. **Cosmology and Astroparticle theory**, which studies the early universe, inflation scenarios, large scale structure formation, particle models for Dark Matter and prospects for its detection, Dark Energy and its theoretical consequences, quantum gravity and black holes;
  4. **Lattice Field Theory**, which involves the study and simulation of lattice models of quantum field theory and its phenomenology;
  5. **Theoretical and phenomenological studies of neutrino physics**; and
  6. **Formal and mathematical aspects of quantum field theory**, including string theory.
HEP Theory Issues

Role of theory in DOE-supported research

- HEP mission at the frontiers
  - **Intensity Frontier** leadership → is the theory effort adequate?
  - **Energy Frontier** co-leadership → is the US effort comparable and competitive with the European one?
  - **Cosmic Frontier** co-leadership → DM and DE, relationship with astrophysics, active role of theorists in experimental collaborations

- Relationship with other sectors/agencies and fitting it within our budget envelope
  - **Nuclear Physics** → neutrino physics at low/medium energy; Heavy Ions Physics (holography applications); IF synergies
  - **BES and Condensed Matter** → the re-branding of String Theory?
  - **Computational aspects of HEP theory** → Cosmology initiatives; Lattice (HEP vs. NP); Monte Carlo simulation
HEP SciDAC focuses on partnership projects:

- SciDAC 3 Projects – (part of the Office of Science SciDAC Program)
  - In partnership with Office of Advanced Scientific & Computing Research (ASCR), DOE

- Transforming GEANT 4 to multicore systems –
  - A pilot project in partnership with ASCR Research Division

- Open Science Grid (OSG)
  - In partnership with National Science Foundation and Office of Nuclear Physics

- Other Pilot Projects with various partnerships including ASCR Facilities

- Scientific Computing: Community Data Tools, codes, Frameworks, Distributed Computing, Networks, Software, data workflow and analytics portals. Includes pilot projects to help kick off specific activities like transitioning LHC software to HPC machines and data initiatives
Computing HEP Issues

- Computing in the DOE program is organized and funded largely through large projects (ATLAS, CMS…) and labs (FNAL, SLAC…), with a modest “Computational” HEP program.
  - Most of computing is not managed as a whole
  - Are “cross-cutting” solutions or efficiencies missed through this organization?

- Would HEP benefit from a computing R&D program aimed at our specific needs? If so:
  - What initial topics could be addressed?
  - Why would they not be addressed as well within individual projects?

- Does HEP support and develop common tools (used across the field) appropriately?
  - What are the common tools that are most important to the field?
  - Are there tools that are needed but somehow not being developed?

- Would some of these issues be addressed by establishing a Virtual Center for HEP Computing, consisting of distributed experts in different aspects of computing made available broadly to the HEP community?

- How long must data be preserved and what are the technical and intellectual challenges involved?

- How do we best make use of “new” technology (and what happens if we don’t)?
  - Highly parallel supercomputers, Highly parallel processor chips (multicore), GPUs, Cloud computing

- Is there a software strategy to handle any (likely) computing architecture of the next several years.
  - Cannot rewrite software for each hardware change.

Lattice Gauge Theory teams have been at the forefront of evolving computing architectures for years and continue to work with industry and advanced prototypes.
HEP Accelerator R&D Mission

- Support world-leading research in the physics of particle beams and in accelerator R&D

- Mapped into three broad categories:
  - Near- to mid-term directed R&D for specific facilities or technologies in support of DOE projects (sometimes captured in project TPC)
  - Mid-term, facility-inspired R&D focused on specific concepts or technologies to demonstrate feasibility and engineering readiness
  - Long-term, proposal-driven research on the fundamental science underlying particle accelerators and beams to enable breakthroughs in size, cost, beam intensity, beam energy, and control

- The HEP Accelerator Stewardship Program will spin off from the third category
Accelerator R&D – Classification

Accelerator Research
• Explore concepts for future accelerators
  ▪ Applies to both HEP and non-HEP
• Support generic accelerator science of highest quality
  ▪ Understand limitations of present accelerators
    — Investigate how to circumvent or mitigate these
• Develop next generation of accelerator scientists

Accelerator R&D Stewardship
• Support accelerator research that benefits a broader community:
  ▪ Discovery science, industry, medicine, defense and security, energy and environment

Accelerator Development
• Improve facility performance;
• Develop accelerator technology for use at HEP facilities
  ▪ Magnets, RF devices, feedback systems, diagnostics,…

Program specific/directed R&D
• SRF Technology/Infrastructure;
• Muon Accelerator Program
• LHC Accelerator Research Program

Accelerator Facilities
• ATF; AWA; BELLA, FACET, HBESL
  — Test beds for new concepts
Stewardship Recent Activities and Plan

- Workshops organized to assess needs in identified target areas
  - Ion Beam Therapy Workshop (co-sponsored by NIH/NCI)
    - January 9-11, 2013 in Bethesda, MD
  - Laser Technology for Accelerators Workshop
    - January 23-25, 2013 in Napa, CA (Organized by LBNL)

- Both meetings were small and tightly focused
  - Attendance by invitation only
    - Limited number of industrial “observers” accommodated

- FY2014 Request identified a modest “start-up” program that redirects or relabels existing efforts that have broader impacts beyond HEP

- HEP Program managers generating proposals for new stewardship programs based on 2013 workshop outcomes
  - These would be vetted with SC partners and then (if successful) put into FY2015 Request
SBIR/STTR Program

- Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs
  - Established in 1982 to award federal research grants to small businesses
    - To spur technological innovation in the small business sector
    - To meet the research and development needs of the federal government
    - To commercialize federally funded investments

- Success stories: Symantec, Qualcomm, Genentech, ...
  - Qualcomm (Market Cap: $115 B) in SBIR Hall of Fame;
    - 10 SBIR awards (7 Phase I and 3 Phase II) between 1987 to 1990 for a total of $1.3 M

- Reauthorization in 2011 for 5 more years; $2B/year

- Office of SBIR and STTR Program at DOE (http://science.energy.gov/sbir/)
  - Section, Preparing a DOE SBIR/STTR Phase I Grant Application

- SBIR/STTR Program in Office of HEP ($21.5 M in FY2014)
  - Project Officer (K. Marken)
  - Technical Topic Managers: Computing (L.Price), Accelerator (E.Colby, K.Marken), Detector (P. Kim)

- FY13 SBIR/STTR/TTO Grants Awarded:
  - SBIR Phase I ($150K – one year) : 5
  - SBIR Phase II ($500K/year – two years): 2 new + 3 old continuing from last year
  - TTO Phase I ($450K – one year): 1 - LAPPD Technology Transfer
SBIR/STTR Review Process - FY14

- Phase I Topics released by DOE SBIR/STTR Office (July 15, 2013)
  
  http://science.energy.gov/sbir/funding-opportunities/
  
  Topics are chosen by HEP TTM after consulting with HEP community

  “All grant applications must clearly and specifically indicate their relevance to present or future programmatic activities as described in the Energy, Intensity, and Cosmic Frontiers.”

- Funding Opportunity Announcement: August 12, 2013
  
  • Must submit both Letter of Intent (LOI) and Application
  • LOI Due Date: September 3, 2013
  • Application Due Date: October 15, 2013

- Each application is reviewed by 3 or 4 reviewers in respective area of expertise
- HEP SBIR Project Manager submits recommendations to the DOE SBIR/STTR Office

- Award Start Date: Late February, 2014.

- FY14 Phase II has a slightly later timeline (See the above FOA web page).
Effective with all solicitations and invitations for research funding issued on or after October 1, 2013.

The DOE Office of Science Statement on Digital Data Management will require a Data Management Plan with all proposals submitted for Office of Science research funding.

See March 12, 2013 HEPAP presentation by Laura Biven:

More information will also be available in the FOAs, via the DOE Office of Science website, and on the High Energy Physics webpage.

Note: Proposals submitted to the FY14 HEP Comparative Review FOA [DE-FOA-0000948] or to the FY14 Early Career Research Program FOA [DE-FOA-0000958] that have already been posted will not require Data Management Plans.
CALVIN, YOUR MOTHER AND I HAVE DECIDED TO GIVE YOU AN ALLOWANCE.

IT'S IMPORTANT THAT ONE LEARNS THE VALUE OF MONEY.

MONEY! HA HA HA! I'M RICH! I'M RICH! I CAN BUY OFF ANYONE! THE WORLD IS MINE!

POWER! FRIENDS! PRESTIGE!

I BLEW IT AGAIN, DEAR!

I CAN BUY IT ALL! I'M FREE! HA HA HA HA!

Budget Reference Slides
The President’s Request (PR) budget usually comes out ~ February each year

- HEP FY14 PR budget submitted ~ November 2012; released ~ April 2013
- The ACTUAL budget that we get for the FY is usually different – following the House, Senate process & budget approval.
- Our budget that we plan to at the beginning of each FY is usually lower than the PR; if we get increased funds after the budget is approved, we can make changes to the program.

In developing the FY2014 PR budget, HEP philosophy was to enable new world-leading HEP capabilities in the U.S. through investments on all three frontiers
HEP Budget Overview

- FY2014 budget philosophy was to enable new world-leading HEP capabilities in the U.S. through investments on all three frontiers
  - Accomplished through ramp-down of existing Projects and Research
  - When we were not able to fully implement this approach, converted planned project funds to R&D: Research → Projects → Research
  - Therefore the FY14 Request shows increases for Research which are driven by this R&D “bump”, while Construction/MIE funding is only slightly increased

- Impact of these actions:
  - Several new efforts are delayed:
    - LBNE, LHC detector upgrades, 2nd Generation Dark Matter detectors, MS-DESI
  - US leadership/partnership capabilities will be challenged by others
  - Workforce reductions at universities and labs

- Key areas in FY2014 Request
  - Maintaining forward progress on new projects via funding lines for Construction and Research (including R&D for projects)
<table>
<thead>
<tr>
<th>Funding (in $K)</th>
<th>FY 2012 Actual</th>
<th>FY 2013 July Plan</th>
<th>FY 2014 Request</th>
<th>Explanation of Change wrt FY12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>391,329</td>
<td>362,284</td>
<td>383,609</td>
<td>Reduction mostly ILC R&amp;D</td>
</tr>
<tr>
<td>Facility Operations and Exp’t Support</td>
<td>249,241</td>
<td>265,305</td>
<td>271,561(a)</td>
<td>NOvA ops start-up and Infrastructure improvements</td>
</tr>
<tr>
<td>Projects</td>
<td>129,963</td>
<td>99,934</td>
<td>99,894</td>
<td>Phase-1 LHC detector upgrades</td>
</tr>
<tr>
<td>Energy Frontier</td>
<td>0</td>
<td>3,000</td>
<td>0</td>
<td>NOvA ramp-down, start Muon g-2</td>
</tr>
<tr>
<td>Intensity Frontier</td>
<td>86,570</td>
<td>62,794</td>
<td>37,000</td>
<td></td>
</tr>
<tr>
<td>Cosmic Frontier</td>
<td>12,893</td>
<td>19,159</td>
<td>24,694</td>
<td>LSST</td>
</tr>
<tr>
<td>Other</td>
<td>2,500</td>
<td>3,200</td>
<td>3,200</td>
<td>LQCD hardware</td>
</tr>
<tr>
<td>Construction (Line Item)</td>
<td>28,000</td>
<td>11,781</td>
<td>35,000</td>
<td>Mostly Mu2e; no LBNE ramp-up</td>
</tr>
<tr>
<td>SBIR/STTR</td>
<td>0</td>
<td>0</td>
<td>21,457</td>
<td></td>
</tr>
<tr>
<td>TOTAL, HEP</td>
<td>770,533</td>
<td>727,523(b)</td>
<td>776,521</td>
<td></td>
</tr>
</tbody>
</table>

(a) Includes $1,563K GPE.  
(b) Reflects sequestration.
FY 2014 Request Crosscuts

By Function
- Facilities $287M **
- Technology Research $112M
- EPP Research $272M
- MIE’s $39M
- Construction $45M *
- SBIR/STTR $21M

*Includes Other Project Costs (R&D) for LBNE
**Includes $15.9M Other Facility Support

By Frontier
- Intensity $261M
- Construction $45M*
- Cosmic $99M
- Advanced Tech $122M
- Energy $155M
- Theory $63M
- SBIR/STTR $21M

*Includes Other Project Costs (R&D) for LBNE
## HEP Physics MIE Funding

<table>
<thead>
<tr>
<th>Funding (in $K)</th>
<th>FY 2012 Actual</th>
<th>FY 2013 July</th>
<th>FY 2014 Request</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIE’s</td>
<td>55,770</td>
<td>45,687</td>
<td>39,000</td>
<td></td>
</tr>
<tr>
<td><em>Intensity Frontier</em></td>
<td>41,240</td>
<td>19,480</td>
<td>0</td>
<td>NOvA ramp-down</td>
</tr>
<tr>
<td><em>Intensity Frontier</em></td>
<td>6,000</td>
<td>5,857</td>
<td>0</td>
<td>MicroBooNE</td>
</tr>
<tr>
<td><em>Intensity Frontier</em></td>
<td>500</td>
<td>0</td>
<td>0</td>
<td>Reactor Neutrino Detector at Daya Bay</td>
</tr>
<tr>
<td><em>Intensity Frontier</em></td>
<td>1,030</td>
<td>5,000</td>
<td>8,000</td>
<td>Belle II</td>
</tr>
<tr>
<td><em>Intensity Frontier</em></td>
<td>0</td>
<td>5,850</td>
<td>9,000</td>
<td>Muon g-2 Experiment</td>
</tr>
<tr>
<td><em>Cosmic Frontier</em></td>
<td>1,500</td>
<td>1,500</td>
<td>0</td>
<td>HAWC</td>
</tr>
<tr>
<td><em>Cosmic Frontier</em></td>
<td>5,500</td>
<td>8,000</td>
<td>22,000</td>
<td>Large Synoptic Survey Telescope (LSST) Camera</td>
</tr>
<tr>
<td><strong>TOTAL MIE’s</strong></td>
<td><strong>55,770</strong></td>
<td><strong>45,687</strong></td>
<td><strong>39,000</strong></td>
<td></td>
</tr>
</tbody>
</table>
## HEP Physics Construction Funding

<table>
<thead>
<tr>
<th>Funding (in $K)</th>
<th>FY 2012 Actual</th>
<th>FY 2013 July</th>
<th>FY 2014 Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction - TPC</td>
<td>53,000</td>
<td>28,388</td>
<td>45,000</td>
</tr>
<tr>
<td>Long Baseline Neutrino Experiment</td>
<td>21,000</td>
<td>17,888</td>
<td>10,000</td>
</tr>
<tr>
<td>TEC</td>
<td>4,000</td>
<td>3,781</td>
<td>0</td>
</tr>
<tr>
<td>OPC</td>
<td>17,000</td>
<td>14,107</td>
<td>10,000</td>
</tr>
<tr>
<td>TPC</td>
<td>21,000</td>
<td>17,888</td>
<td>10,000</td>
</tr>
<tr>
<td>Muon to Electron Conversion Experiment</td>
<td>32,000</td>
<td>10,500</td>
<td>35,000</td>
</tr>
<tr>
<td>TEC</td>
<td>24,000</td>
<td>8,000</td>
<td>35,000</td>
</tr>
<tr>
<td>OPC</td>
<td>8,000</td>
<td>2,500</td>
<td>0</td>
</tr>
<tr>
<td>TPC</td>
<td>32,000</td>
<td>10,500</td>
<td>35,000</td>
</tr>
</tbody>
</table>

TEC = Total Estimated Cost (refers to Capital Equipment expenses)
OPC = Other Project Costs
TPC = Total Project Cost

14 Aug 2013

Alan L. Stone – DPF UC Santa Cruz – DOE HEP Program
## HEP Energy Frontier

<table>
<thead>
<tr>
<th>Funding (in $K)</th>
<th>FY 2012 Actual</th>
<th>FY 2013 July Plan</th>
<th>FY 2014 Request</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>91,757</td>
<td>86,172</td>
<td>96,129&lt;sup&gt;(a)&lt;/sup&gt;</td>
<td>Tevatron ramp-down offset by R&amp;D for LHC detector upgrades</td>
</tr>
<tr>
<td>Facilities</td>
<td>68,240</td>
<td>61,992</td>
<td>58,558</td>
<td></td>
</tr>
<tr>
<td><strong>LHC Detector Ops</strong></td>
<td>64,846&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>56,912</td>
<td>56,774</td>
<td>LHC down for maintenance</td>
</tr>
<tr>
<td><strong>LHC Upgrade Project</strong></td>
<td>0</td>
<td>3,000</td>
<td>0</td>
<td>LHC detector upgrades (OPC)</td>
</tr>
<tr>
<td>Other</td>
<td>3,394</td>
<td>2,080</td>
<td>1,784</td>
<td>IPAs, Detailees, Reviews</td>
</tr>
<tr>
<td><strong>TOTAL, Energy Frontier:</strong></td>
<td><strong>159,997</strong></td>
<td><strong>148,164</strong></td>
<td><strong>154,687</strong></td>
<td></td>
</tr>
</tbody>
</table>

<br>

<sup>(a)</sup> Includes $12M (= $6M CMS + $6M ATLAS) Phase-1 detector upgrades [R&D]; Therefore, Energy Frontier Core Research FY14 Request = 84,129k

<sup>(b)</sup> Per interagency MOU, HEP provided LHC Detector Ops funding during FY12 CR to offset NSF contributions to Homestake de-watering activities.
## HEP Intensity Frontier

<table>
<thead>
<tr>
<th>Funding (in $K)</th>
<th>FY 2012 Actual</th>
<th>FY 2013 July Plan</th>
<th>FY 2014 Request</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>53,261</td>
<td>52,108</td>
<td>53,562</td>
<td>Ramp-down of B-factory research offset by increased support for new initiatives</td>
</tr>
<tr>
<td>Facilities</td>
<td>143,844</td>
<td>172,318</td>
<td>180,481</td>
<td>Offshore and Offsite Ops</td>
</tr>
<tr>
<td>Expt Ops</td>
<td>6,615</td>
<td>7,354</td>
<td>7,245</td>
<td>Accelerator and Infrastructure improvements</td>
</tr>
<tr>
<td>Fermi Ops</td>
<td>119,544</td>
<td>143,128</td>
<td>156,438</td>
<td>Completion of BaBar D&amp;D</td>
</tr>
<tr>
<td>B-factory Ops</td>
<td>10,031</td>
<td>5,654</td>
<td>4,600</td>
<td></td>
</tr>
<tr>
<td>Homestake*</td>
<td>5,478</td>
<td>14,000</td>
<td>10,000</td>
<td>GPE and Waste Mgmt</td>
</tr>
<tr>
<td>Other</td>
<td>2,176</td>
<td>2,182</td>
<td>2,198</td>
<td></td>
</tr>
<tr>
<td>Projects</td>
<td>86,750</td>
<td>62,794</td>
<td>37,000</td>
<td>NOvA + MicroBooNE ramp-down</td>
</tr>
<tr>
<td>Current</td>
<td>73,770</td>
<td>52,794</td>
<td>27,000</td>
<td></td>
</tr>
<tr>
<td>Future R&amp;D</td>
<td>12,880</td>
<td>10,000</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>TOTAL, Intensity Frontier</td>
<td>283,675</td>
<td>287,220</td>
<td>271,043</td>
<td></td>
</tr>
</tbody>
</table>

*Per interagency MOU, HEP provided LHC Detector Ops funding during FY12 CR to offset NSF contributions to Homestake dewatering activities.
## HEP Cosmic Frontier

<table>
<thead>
<tr>
<th>Funding (in $K)</th>
<th>FY 2012 Actual</th>
<th>FY 2013 July Plan</th>
<th>FY 2014 Request</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>47,840</td>
<td>48,836</td>
<td>62,364</td>
<td>R&amp;D for G2 Dark Matter</td>
</tr>
<tr>
<td>Facilities</td>
<td>11,207</td>
<td>10,948</td>
<td>12,022</td>
<td>Offshore and offsite Ops</td>
</tr>
<tr>
<td>Projects</td>
<td>12,893</td>
<td>19,159</td>
<td>24,694</td>
<td></td>
</tr>
<tr>
<td><strong>Current</strong></td>
<td>9,153</td>
<td>9,500</td>
<td>23,200</td>
<td>LSSTcam fabrication begins</td>
</tr>
<tr>
<td><strong>Future R&amp;D</strong></td>
<td>3,380</td>
<td>9,659</td>
<td>1,484</td>
<td>Dark energy and dark matter projects move to conceptual design</td>
</tr>
<tr>
<td><strong>TOTAL, Cosmic Frontier</strong></td>
<td><strong>71,940</strong></td>
<td><strong>78,943</strong></td>
<td><strong>99,080</strong></td>
<td></td>
</tr>
</tbody>
</table>
## HEP Theory and Computation

<table>
<thead>
<tr>
<th>Funding (in $K)</th>
<th>FY 2012 Actual</th>
<th>FY 2013 July Plan</th>
<th>FY 2014 Request</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>64,465</td>
<td>63,198</td>
<td>59,670</td>
<td></td>
</tr>
<tr>
<td>HEP Theory</td>
<td>55,929</td>
<td>54,621</td>
<td>51,196</td>
<td>Follows programmatic reductions in Research</td>
</tr>
<tr>
<td>Computational HEP</td>
<td>8,536</td>
<td>8,577</td>
<td>8,474</td>
<td></td>
</tr>
<tr>
<td>Projects</td>
<td>2,500</td>
<td>3,200</td>
<td>3,200</td>
<td>Lattice QCD hardware</td>
</tr>
<tr>
<td>TOTAL, Theory and Comp.</td>
<td>66,965</td>
<td>66,398</td>
<td>62,870</td>
<td></td>
</tr>
</tbody>
</table>

14 Aug 2013
### HEP Advanced Technology R&D

<table>
<thead>
<tr>
<th>Funding (in $K)</th>
<th>FY 2012 Actual</th>
<th>FY 2013 July Plan</th>
<th>FY 2014 Request</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>134,006</td>
<td>111,888</td>
<td>105,303</td>
<td>Selected long-term R&amp;D moves to Accelerator Stewardship</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Accel. R&amp;D</td>
<td>59,280</td>
<td>61,791</td>
<td>57,856</td>
<td>Completion of ILC R&amp;D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Directed Accel. R&amp;D</td>
<td>46,587</td>
<td>22,692</td>
<td>23,500</td>
<td>Funding for liquid argon R&amp;D is reduced</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detector R&amp;D</td>
<td>28,139</td>
<td>27,405</td>
<td>23,947</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Completing SRF infrastructure at Fermilab</td>
</tr>
<tr>
<td>Facility Operations</td>
<td>23,100</td>
<td>19,997</td>
<td>17,150</td>
<td></td>
</tr>
<tr>
<td>TOTAL, Advanced Technology R&amp;D</td>
<td>157,106</td>
<td>131,885</td>
<td>122,453</td>
<td></td>
</tr>
</tbody>
</table>

- $24M originally set aside for Generic Detector R&D
- FY10-FY13 higher with infusion from ARRA, CDRD, Liquid Ar R&D
- Fraction of the University grants = ~1/8 of Det R&D over recent years
  - Plan is to try keeping it near last year’s level of $3.2M.
## Accelerator Stewardship

<table>
<thead>
<tr>
<th>Funding (in $K)</th>
<th>FY 2012 Actual</th>
<th>FY 2013 July Plan</th>
<th>FY 2014 Request</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>0</td>
<td>82</td>
<td>6,581</td>
<td>Recast of Accelerator R&amp;D activities relevant to broader impacts</td>
</tr>
<tr>
<td>Facility Operations</td>
<td>2,850</td>
<td>3,050</td>
<td>3,350</td>
<td>Incremental FACET ops for stewardship research</td>
</tr>
<tr>
<td>TOTAL, Accel. Stewardship</td>
<td>2,850</td>
<td>3,132</td>
<td>9,931</td>
<td></td>
</tr>
</tbody>
</table>
FY14 HEP Comparative Review FOA

- **DE-FOA-0000948**
  - Issued June 14, 2013
- **Six HEP research subprograms**
  - Energy, Intensity, and Cosmic Frontiers
  - HEP Theory
  - Accelerator Science and Technology R&D
  - Particle Detector R&D
- **Letter of Intent due July 15, 2013 by 5 PM Eastern Time**
  - Strongly encouraged
- **Final Proposal (i.e., Application) deadline Sept. 9, 2013 by 11:59 PM Eastern Time**

http://science.energy.gov/hep/funding-opportunities/
Early Career: Next Round in FY14

- FY14 FOA [DE-FOA-0000958] posted on July 23, 2013 at the Early Career website:
  - [http://science.energy.gov/early-career/](http://science.energy.gov/early-career/)
- Read the FY14 FAQ, also on above web site
  - Addresses most of the common Q&A collected over the last 4 years
- Features of FY14
  - Entering 5th year
    - Some population of candidates will no longer be eligible due to the “3-strikes rule”
  - Mandatory Pre-application requirement. Two pages.
    - Deadline: September 5, 2013, 5 PM Eastern
    - All interested PIs encouraged to register as soon as possible in DOE SC Portfolio Analysis and Management System (PAMS) for submission [link provided in EC website]
    - Full proposals due: November 19, 2013, 5 PM Eastern
      - Candidates will have more than 3 months to develop a plan, write a narrative, and submit an application
- Presidential Early Career Awards for Scientists and Engineers (PECASE)
  - PECASE-eligible candidates are selected from the pool of Early Career awardees
    - [http://science.energy.gov/about/honors-and-awards/pecase/](http://science.energy.gov/about/honors-and-awards/pecase/)
FY13 HEP Early Career Awards

Theory
- Stefan Hoeche (SLAC) “High Precision Event Simulation for the LHC”
- Clifford Cheung (California Institute of Technology) “The Higgs Frontier”
- Andrew Tolley (Case Western Reserve University) “Exploring the Fundamental Origin of Cosmic Acceleration”

Cosmic
- Clarence Chang (ANL) “Exploring Fundamental Physics through New Measurements of the Cosmic Microwave Background Polarization”
- Adam Bolton (University of Utah) “Integrating Advanced Software and Statistical Methods for Spectroscopic Dark-Energy Surveys”

Accelerator
- Matthew Jewell (University of Wisconsin Eau Claire) “Mechanical Performance of HTS Superconductor for HEP Applications”

Energy
- Toyoko Orimoto (Northeastern University) “Search for the Higgs and Physics Beyond the Standard Model with the CMS Electromagnetic Calorimeter”
- Andrew Ivanov (Kansas State University) “Quest for a Top Quark Partner and Upgrade of the Pixel Detector Readout Chain at the CMS”

Intensity
- Jelena Maricic (University of Hawaii) “Resolving Reactor Antineutrino Anomaly with Strong Antineutrino Source” [funded by HEP and DOE Experimental Program to Stimulate Competitive Research (EPSCoR)]
Review criteria for HEP Comparative Review and Early Career includes “leader within the proposed effort and/or potential future leader in the field”

- Important to seek out and/or volunteer for roles and responsibilities which increase visibility and provide career advancement opportunities
- Editorial Boards, Sub-detector systems, Physics Working Groups, Run Coordinator, etc.
- Service work for community is also valued, e.g. co-chairing a conference committee or serving on an NSF review panel

When asked to review, co-chair, attend, speak, etc. try NOT to say no!

- You need the experience
- Ask for feedback (if possible)
- Respond promptly to all communication

- HEPAP: High Energy Physics Advisory Panel
  - Meets ~3 times/year
  - Open meeting in DC area
    - Sept 5-6 2013 @ NSF
  - Prof. Andy Lankford (Chair)
  - Know your reps!

- P5. Particle Physics Project Prioritization Panel
  - Nomination period ended and selection process begins
  - Stay informed. Follow the town halls. Learn the membership. Ask questions. Provide feedback.

- Demographics.
- HEP Organization
Timescales for HEP projects from conception to first data will only get longer in the continued pursuit of discovery science due to cost, size and complexity.

HEP academic research track (Univ. or Lab) would benefit from developing a short-, mid- and long-term research plan:
- Balance research between ongoing experiment, upgrades and R&D with future experiment.

Starting Assistant Prof. at University will most likely continue research from most recent post-doc position:
- Will you be working on that same experiment in 5 years? How about 10 years?
- Optimize your start-up funds by expanding your research portfolio.

Are you up to the challenge to get involved early and help deliver projects like LBNE and LSST to successful completion?
- Don’t expect people to come knocking on your door.
- Sometimes it is about showing up.
- Often you have to earn trust and gain credibility.

This is HARD work!
- You are doing cutting edge high energy particle physics.
- The competition for jobs at all levels in HEP is still very high.
- It is not about the money.
- It’s about the SCIENCE!
Major Recommendations of 2008 Advisory Panel (P5)

- The panel recommends that the US maintain a leadership role in world-wide particle physics. The panel recommends a strong, integrated research program at the three frontiers of the field: the Energy Frontier, the Intensity Frontier and the Cosmic Frontier.

- The panel recommends support for the US LHC program, including US involvement in the planned detector and accelerator upgrades (highest priority)

- The panel recommends a world-class neutrino program as a core component of the US program, with the long-term vision of a large detector in the proposed DUSEL and a high-intensity neutrino source at Fermilab.
  - LBNE CD-0 received Jan 2010, and CD-1 received Dec 2012.

- The panel recommends funding for measurements of rare processes to an extent depending on the funding levels available... (Mu2e at FNAL, U.S. Belle II detector upgrade).
  - Mu2e CD-0 received Nov 2009, and CD-1 received July 2012.
  - Belle II CD-0 received Aug 2011, and CD-1 received July 2012.

- The panel recommends support for the study of dark matter and dark energy as an integral part of the US particle physics program.

- The panel recommends a broad strategic program in accelerator R&D, including work ..., along with support of basic accelerator science.

- These are still relevant, and this is still the plan.
Fundamentally...[planning] is a multi-step process with several important milestones over the coming year, and each step will inform and prepare for the next.

1. **HEP Facilities Subpanel**: Advise DOE/SC mgmt. on the scientific impact and technical maturity of planned and proposed SC Facilities, in order to develop a coherent 10-yr SC facilities plan
   - Subpanel can add or subtract from initial facilities list
   - Does not exclude/pre-empt later additions

2. **DPF/CSS2013 “Snowmass”**: identify compelling HEP science opportunities over an approximately 20 year time frame.
   - Not a prioritization but can make scientific judgments

3. **HEPAP/P5**: Develop new strategic plan and priorities for US HEP in various funding scenarios, using input from #1 and 2 above (among others)
## Public Policy Priorities for 2013

### Public’s Policy Priorities for 2013

<table>
<thead>
<tr>
<th>Priority</th>
<th>4 years ago Jan 2009</th>
<th>1 year ago Jan 2012</th>
<th>Now Jan 2013</th>
<th>4-year chg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strengthening economy</td>
<td>85</td>
<td>86</td>
<td>86</td>
<td>+1</td>
</tr>
<tr>
<td>Improving job situation</td>
<td>82</td>
<td>82</td>
<td>79</td>
<td>-3</td>
</tr>
<tr>
<td>Reducing budget deficit</td>
<td>53</td>
<td>69</td>
<td>72</td>
<td>+19</td>
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### Widest Partisan Gaps Over Environment, Gun Control, Health Care

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