Office of High Energy Physics
Program Status and Response to Astro2010

AAAC Meeting
October 7-8, 2010

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DOE SC HEP’s Strategic Plan

The DOE SC High Energy Physics Strategic Plan:

• Addresses the scientific opportunities identified and priorities recommended by the community
• Builds on existing strengths and infrastructure
• Exploits opportunities in which the U.S. HEP can play leadership roles
• Positions the U.S. to deliver outstanding science, remain among the leaders, and maintain core competency

The major elements of DOE’s plan are to:

• Exploit the capabilities of the Tevatron and LHC at the Energy Frontier to make discoveries
• Implement a world-class Intensity Frontier program at Fermilab
• Address compelling high-impact scientific opportunities at the Cosmic Frontier
• Develop accelerator technologies needed by Nation and for a U.S. leadership role in particle physics

The implementation of the plan has evolved and reacted to:

• Changing circumstances
• Additional information and guidance
• Funding constraints
Program Planning

The Scientific community
- identifies the scientific opportunities and their priorities
- defines the scientific field and recommends future direction

Federal Advisory Committees
- DOE/NSF chartered High Energy Physics Advisory Panel (HEPAP) Reports
- Astronomy and Astrophysics Advisory Committee (AAAC)

Other Input
- Other scientific reports (National Academy studies, etc.)
- Lab program advisory committees, DOE Reviews, etc.
Progress in achieving the goals of particle physics requires advancements at the
- Energy, Intensity and Cosmic Frontiers
- Each provides a unique window for insight about the fundamental forces and particles of nature
- The U.S. should have a strong, integrated research program at all three frontiers

**Energy Frontier**
- Continued support for the Tevatron Collider program until LHC operating (next 1-2 years)
- LHC program has the highest priority, including US involvement in planned upgrades
- Accelerator and detector R&D program for next generation lepton collider

**Intensity Frontier**
- Recommends a world class neutrino program as a core component
- Long term vision includes a large detector at DUSEL and high-intensity neutrino source at Fermilab.
- Program of rare decays (e.g.: muon to electron conversion – Mu2e)

**Cosmic Frontier** with an emphasis on dark energy and matter
- Joint Dark Energy Mission (JDEM) in collaboration with NASA
- Large Synoptic Survey Telescope (LSST) in collaboration with NSF
- Direct dark matter search experiments

**HEP at its core is an accelerator based experimental science**
- Support accelerator R&D to develop technologies
  - that are needed by the field
  - that benefit the nation
What has changed?

Since P5 Report

**Energy Frontier:**
- LHC research program has been delayed
- Tevatron performance continues to be outstanding
- CERN has a new mid-term and long-range plan for LHC

**Intensity Frontier**
- Significant progress on initiating implementation of a U.S. leadership intensity frontier program
- Established a model for a joint agency DUSEL Physics program
  - This has been articulated in a draft DOE/NSF MOU now in concurrence
- Additional guidance obtained on other opportunities identified in HEPAP P5 Report

**Cosmic Frontier**
- Guidance received:
  - HEPAP (PASAG) Report: opportunities/priorities for HEP particle astrophysics program
  - Astro2010 Report: opportunities/priorities for the U.S. Astronomy/Astrophysics program
  - OSTP has worked for a coordinated agency (DOE, NASA and NSF) response

**Advanced Technology R&D**
- Delay in LHC schedule has driven delay in anticipated “decision” on next lepton collider
- Accelerator R&D Workshop Report provided guidance on opportunities/priorities

**Funding Projection**
- HEP budgets have been between FY2007 and FY2008 level-of-effort
FY 2010 Program

Highlights

- **The Tevatron and its detectors have performed outstandingly**: experiments now exclude a region of Higgs mass between 158 and 175 times the mass of the proton, continue to observe rare Standard Model processes, and reported indications of a possible anomalous CP violation in the mixing of neutral B mesons.

- **LHC began its program** at a center-of-mass energy of 7 TeV in March 2010, surpassing the Tevatron Collider as the world’s highest energy accelerator. ATLAS and CMS are fully functional.

- Two Fermilab neutrino experiments, **MINOS and MiniBooNE**, have collected data with an anti-neutrino beam and reported first results that show tantalizing hints regarding the fundamental properties of neutrinos, which may be an indication of new physics in the neutrino sector.

- **DOE laboratories** (as part of the ILC R&D effort) have successfully **increased the quality of superconducting radiofrequency (SRF) accelerator cavities**, with production accelerator gradients of 35 MeV per meter, through lab-industry partnerships to develop the production of cavities in **U.S. industry** and improve processing of the cavities at DOE laboratories.

- The Alpha Magnetic Spectrometer (**AMS**) was delivered to Kennedy Space Flight Center ready for installation on the Shuttle that is scheduled to take it to the International Space Station (ISS) February 2011.

- **All FY 2009 Recovery Act funding was obligated** by the end of FY 2010.
Building the Tools
For Discovery Science

- **Projects under construction**
  - Dark Energy Survey (cosmic)
  - Daya Bay (intensity)
  - NOvA (intensity)
  - MINERvA (intensity)
  - SuperCDMS-Soudan (cosmic)
  - BELLA (accelerator R&D)
  - FACET (accelerator R&D)

- **Projects recently receiving Mission Need approval**
  - Long Baseline Neutrino Experiment (intensity)
  - Muon to Electron Conversion Experiment (intensity)

- **Large Projects under consideration for the future**
  - Stage IV Dark Energy Experiment (cosmic)
  - LHC detector upgrades (energy)
  - Project X (intensity)
  - + other (cosmic)

- **Projects in design**
  - Accelerator Project for the Upgrade of the LHC (energy)
  - MicroBoone (intensity)
HEP Outyear Funding Projections

Significant Change/ Guidance

Funding FY 2009-2011: Program workforce and scope largely preserved – implementation slow

Funding is Between Scenario A and B (HEPAP (P5))

Guidance on HEP out-year funding has changed since last year

- Funding levels have been reduced (compared to last year) and force programmatic decisions
  - What initiatives should be pursued?
  - What is proper balance between development/operations of tools and research?

- The delay in the LHC program and decision to await Astro2010 have also postponed drastic (seminal) decisions

- Guidance from HEPAP (P5) - further amplified by HEPAP(PASAG) - is relevant
  - Dealt with mounting an optimum U.S. program with constrained funding (Scenario A)
  - Requires a downsizing and re-scoping of the program with an eye on the scientific priorities identified

- Priorities remain the same as those identified in HEPAP (P5) Report (and HEPAP (PASAG))
  - HEP has focused on developing domestic Intensity Frontier program for the future
  - Preserving key investments at Energy Frontier (LHC) and Cosmic Frontier (Dark Matter)
  - Take advantage of other scientific opportunities if investment is modest and provides important US role
Cosmic Frontier

Recent Activities

Received guidance from HEPAP (PASAG) – October 2009
- The findings and recommendations are important:
  • To help define the HEP “particle astrophysics” program
  • In setting priorities and articulating the scientific deliverables

DOE and NASA worked on a JDEM partnership
- Two concepts (IDECS and OMEGA) were presented to Astro2010 in June 2009.
- Costs are not compatible with current budget projections.
- Project Offices (GSFC and LBNL), with scientific input from the Interim Science Working Group
developed a “probe class” $650M-capped mission concept

Received guidance from Astro2010 – August 2010
- The findings and recommendations are important:
  • Influence the opportunities for HEP participation
  • Inform OHEP on scientific/technical aspects of particle astrophysics
    (e.g.; optimum dark energy strategy with available resources)

OECD Global Science Forum Astroparticle Physics Working Group – October 2010
- A 2-year study of global coordination and planning of astro-particle physics experiments
- Study report recommended annual agency-level meetings to coordinate our programs.
HEPAP (PASAG) Report

October 2009

Recommended an optimized program over the next 10 years in 4 funding scenarios:

- The panel laid out a prioritized program for an optimized cosmic frontier program over the next 10 years at various funding levels in the areas:
  - Dark matter, Dark Energy, High Energy Cosmic- and Gamma-rays, and Cosmic Microwave Background
- The findings and recommendations helped define the particle astrophysics program & will be used in setting priorities for the future.

Defined Prioritization Criteria for Contributions to Particle Astrophysics Projects

- Science addressed by the project necessary (significant step towards HEP goals)
- Particle physicist participation necessary (significant value added/feasibility)
- Scale matters (particularly at boundary between particle physics and astrophysics)

Dark matter & dark energy remain the highest priorities

Guidance:

- Dark energy funding (recommended for largest budget portion) should not significantly compromise US leadership in dark matter, where a discovery may be imminent
- Dark energy and dark matter together should not completely zero out other important activities
Budgetary scenarios

- Levels given by agencies:
  - DOE, NSF – constant with inflation
  - NASA – constant dollars

- Level used by Astro2010 for recommendations:
  - DOE, NSF – doubling trajectory
  - NASA – constant with inflation

Recommended a coordinated ground/ space-based Dark Energy program

- Highest priority in space: WFIRST
- Highest priority on ground: LSST

Recommendations to DOE:

- The optimistic funding profile allows investment in:
  - LSST – DOE should partner with NSF
  - WFIRST – DOE should contribute (note that this is not a dedicated dark energy mission)

- At lower funding level:
  - LSST is recommended as the priority because DOE role is critical

- Other identified opportunities:
  - Contributions to NSF mid-scale experiments (2nd priority in ground-based)
    e.g. BigBOSS, CMB, HAWC experiments, etc.
  - NSF & DOE contribute as a minor partner (4th priority in ground-based)
    to a European-led AGIS/CTA ground-based gamma-ray observatory
Budgetary scenarios:
- Our current projections tend towards the lower funding amounts
- Do not have the same profile as assumed by Astro2010.

DOE OHEP Objectives:
- Contributions to select, high impact experiments with discovery potential
- that address particle-astrophysics goals
- where DOE HEP researchers and investments can play a significant role in and make significant contributions (PASAG recommended criteria)
- Achieve earliest, best, and most cost-effective U.S. dark energy and dark matter science results
- Partnerships with NASA and NSF and international collaborators as appropriate

Priorities
- Dark matter – direct detection experiments are a priority (not part of Astro2010 study)
- Maintain a leading U.S. role in dark energy research (Astro2010 recommendation)
- Other opportunities for contribution as funding permits
Plan to follow HEPAP (PASAG) guidance on Dark Matter

• Work with NSF Physics to implement a staged strategy for dark matter experiments
  • Fund at least two technologies for next generation (~100kg) prototypes/experiments
  • Fund at least one large (~1 ton) dark matter experiment with most promising technology

Plan to follow PASAG/Astro2010 guidance on Dark Energy

• NSF Astronomy proposing to take LSST to National Science Board in August 2011
  • DOE HEP plans to get approval for CD-0 by early 2011.
  • DOE HEP plans to support R&D for LSST to match planned NSF schedule

• NASA is investigating how to implement Astro2010 recommendations
  • DOE HEP will support scientists on WFIRST/SDT (if selected) and explore partnership with NASA when appropriate

• DOE will consider other proposals and partnerships as appropriate (e.g. BigBOSS)

Plan to follow PASAG/Astro2010 guidance in other areas

• Cosmic-ray, Gamma-ray, CMB
HEP Non-Accelerator Physics

FY 2010 Program

Major Activities:

Cosmic Frontier

- Dark Matter: COUPP, SuperCDMS-Soudan, LUX, ADMX
- Dark Energy: BOSS, DES, Supernova searches
- Cosmic/Gamma: VERITAS, Auger-South (Argentina), AMS

TOTAL Cosmic Frontier 53,096 13,559 10,110 76,765

Intensity Frontier

- Neutrino studies – SuperK, Daya Bay, Double Chooz, EXO-200

TOTAL Non-Accelerator 63,575 13,559 21,110 98,244

Statistics (FY09 actual):

- Supports research groups at 45 universities and 7 labs
- Approximately 225 FTEs
  - (165 at Cosmic Frontier + 60 at Intensity Frontier)
    - 73 faculty/research scientists
    - 75 grad students
    - 43 postdocs
    - 34 engineers, techs, computer professionals

Percentage

- Dark Matter 22.3%
- Dark Energy 40.3%
- Cosmic/Gamma 26.4%
- Intensity 10.9%