



U.S. DEPARTMENT OF
ENERGY

OFFICE OF
SCIENCE

DOE High Energy Physics Program

**HEPAP Meeting
August 27, 2012**

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Office of High Energy Physics
Office of Science, U.S. Department of Energy**

Outline

HEP Strategic Plan Status

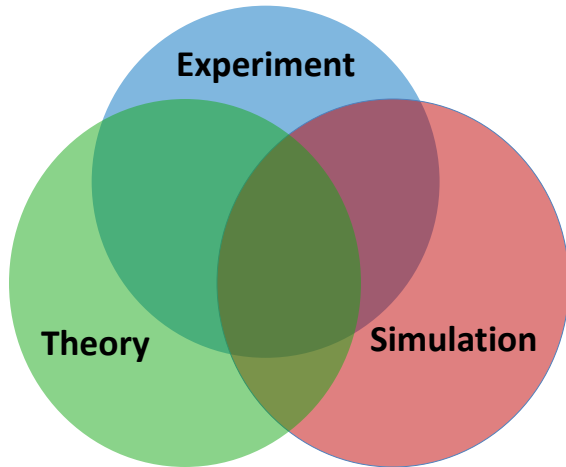
Near Term Priorities

Long-Term Priorities

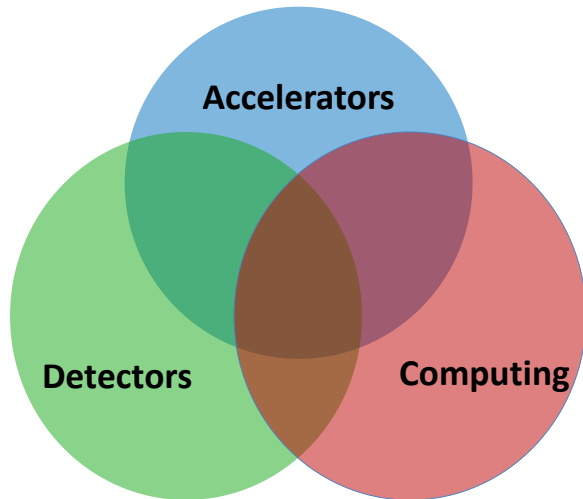
Accelerator Stewardship

HEP STRATEGIC PLAN -- STATUS

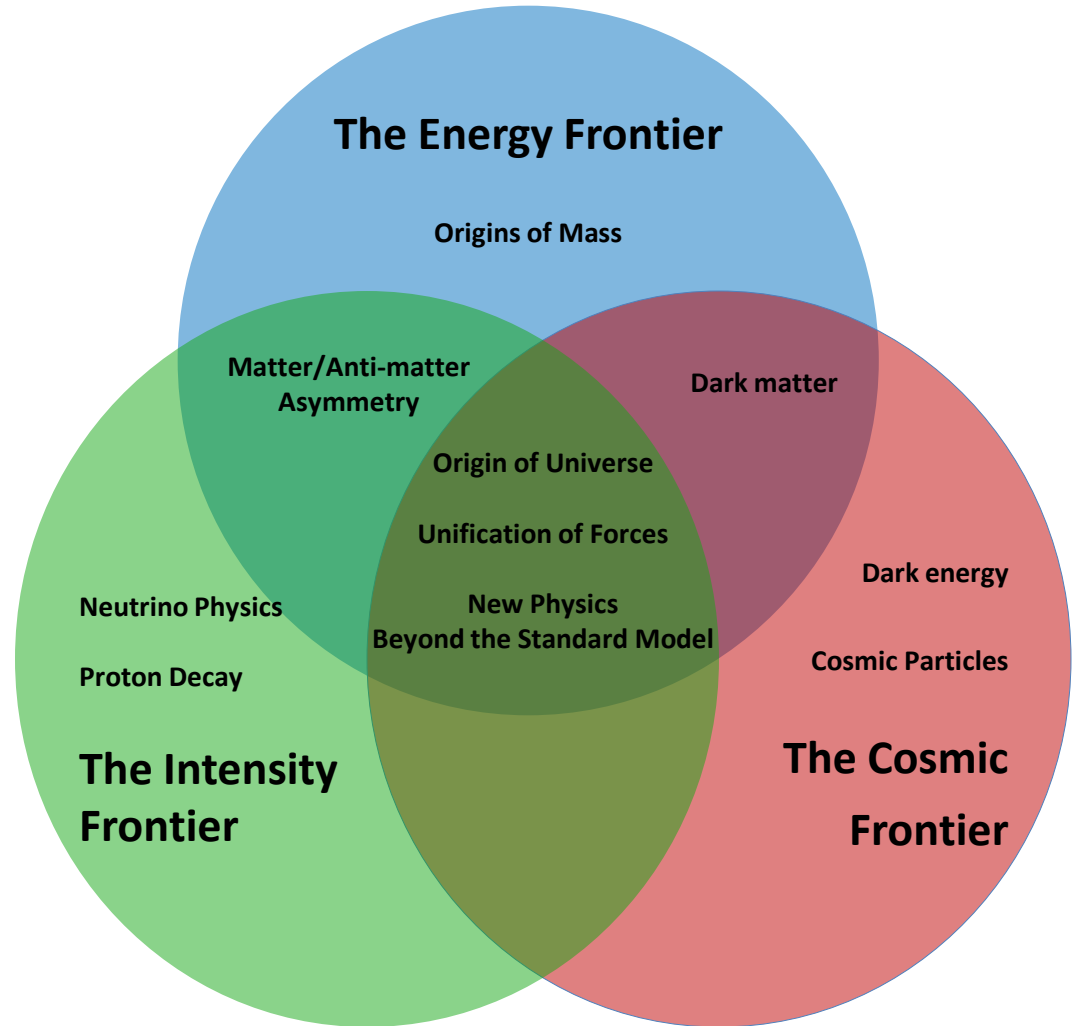
HEP Program



Along Three Paths



Enabled by
Advanced Technologies



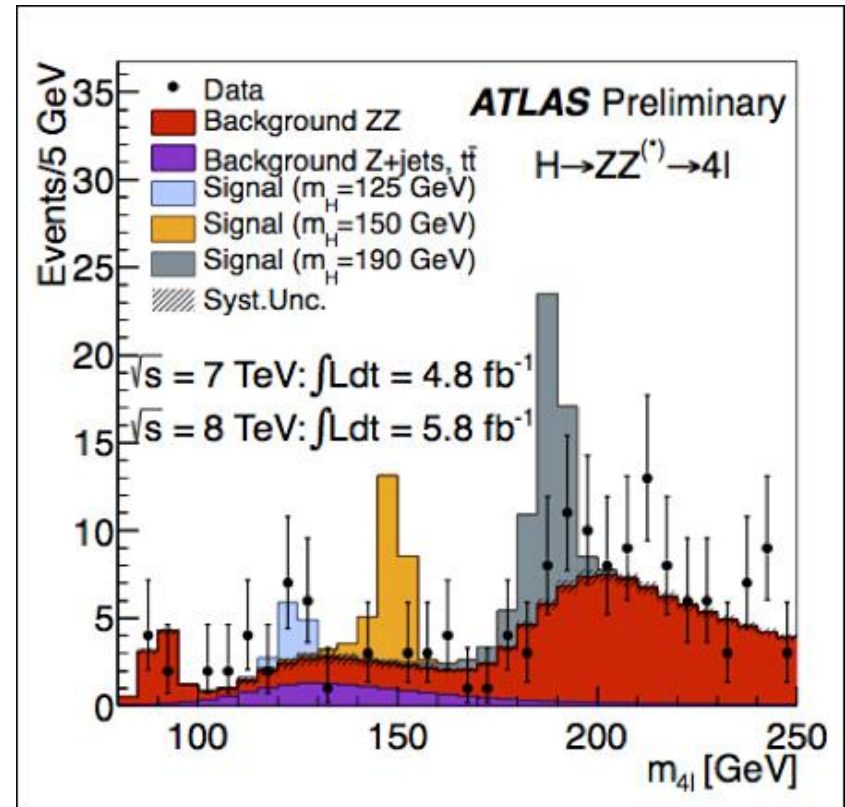
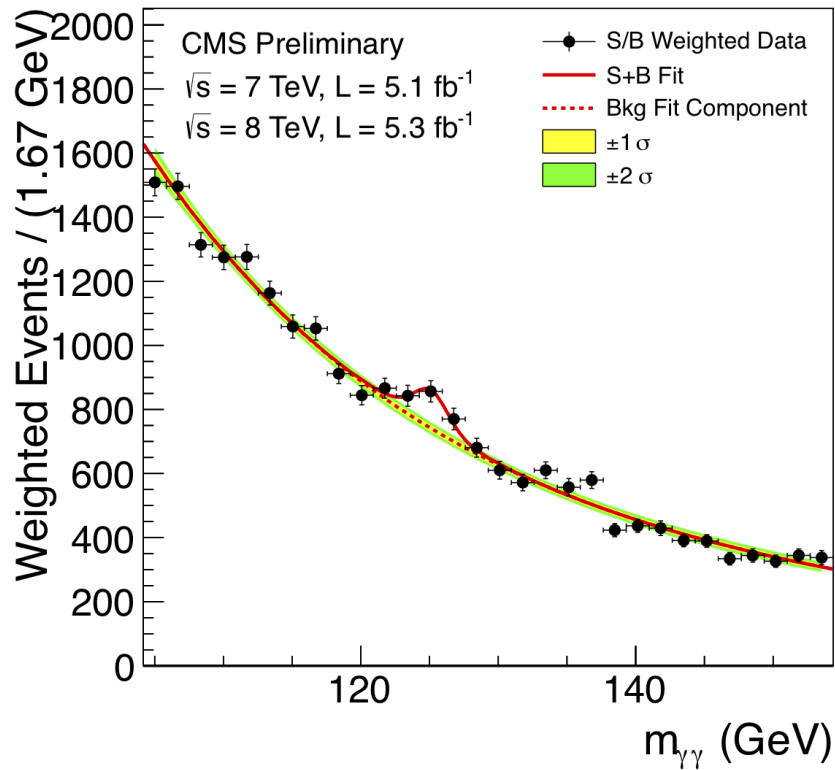
Physics Frontiers

Energy Frontier Plan

- **Science goals**
 - Explore the TeV scale. Is there anything there but a SM-like Higgs?
- **Recent results**
 - There is a Higgs-like boson at 125 GeV. Physics talks later today.
 - There are many predictions to test to see if it is the “real McCoy”.
- **Near term**
 - Continued LHC running through 2012.
 - Repair splices in LHC magnets in 2013/2014.
 - Resume running at ~14 TeV in 2014.
- **No new facilities under construction at this time**
- **Planned program of major projects:**
 - **LHC Detector Upgrades:** (2017-8) to cope with increased data rates
 - Participate in the LHC-High Luminosity upgrade with installation ~ 2022.



The Wait is Over!



CERN's LHC Accelerator Upgrade Timeline

2009

Start of LHC

Run 1: 7 TeV center of mass energy, luminosity ramping up to ~30% of nominal; 5.7 fb⁻¹ delivered, expect 10-15fb⁻¹ in 2012

2013/14

LHC shut-down to prepare machine for design energy and nominal luminosity

Run 2: Ramp up luminosity to nominal; 14 TeV CM energy; 156 fb⁻¹

2017 or 18

Injector and LHC Phase-I upgrades to go to ultimate luminosity

Run 3: Ramp up luminosity to 2.2 x nominal, reaching ~100 fb⁻¹ / year accumulate 400 hundred fb⁻¹

~2021/22

Phase-II: High-luminosity LHC. New focussing magnets and CRAB cavities for very high luminosity with levelling

Run 4: Collect data until > 3000 fb⁻¹

2030

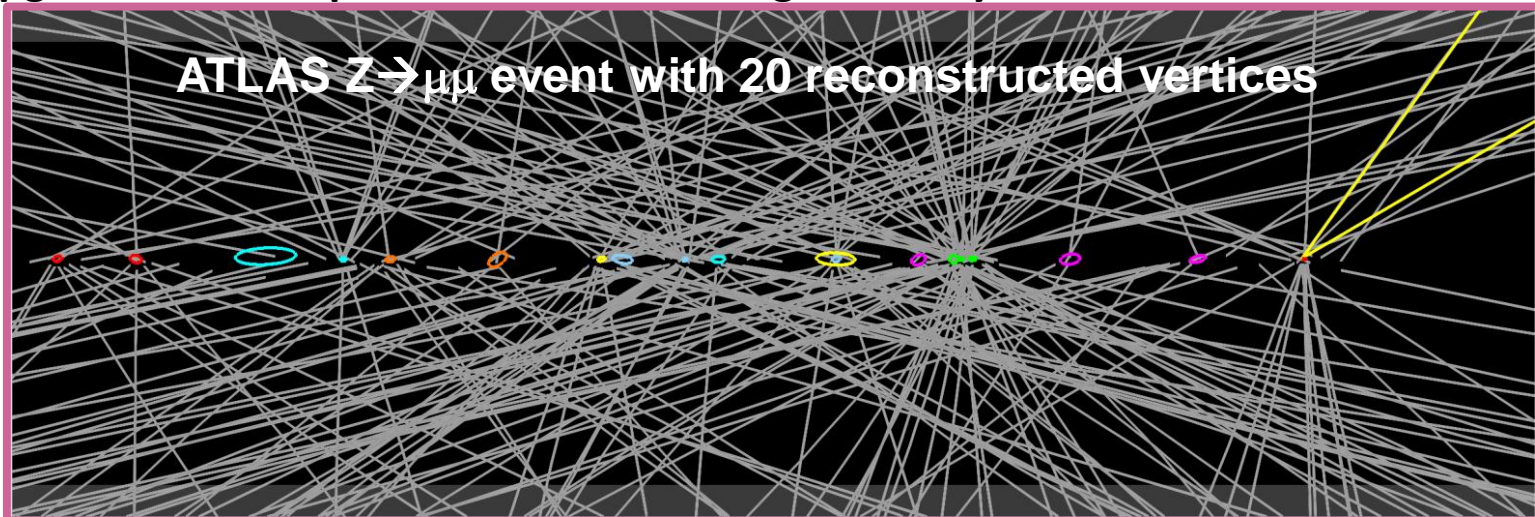


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Developing a Mission Need Statement

- **HEP will work with the collaborations and CERN to understand the impact of the CERN LHC upgrades on detectors:**
 - What are the critical needs for detector upgrades?
 - What responsibilities does CERN want the US to take on?
 - In what technical areas does the US possess leading or unique capabilities?
- **Analyze the schedule needed to deliver upgraded detector components.**
- **Develop a cost estimate and plan to have the funding available in the HEP budget.**
- **Goal is to complete a Mission Need Statement in FY 2012 for the near-term upgrades that keep the detectors running smoothly**

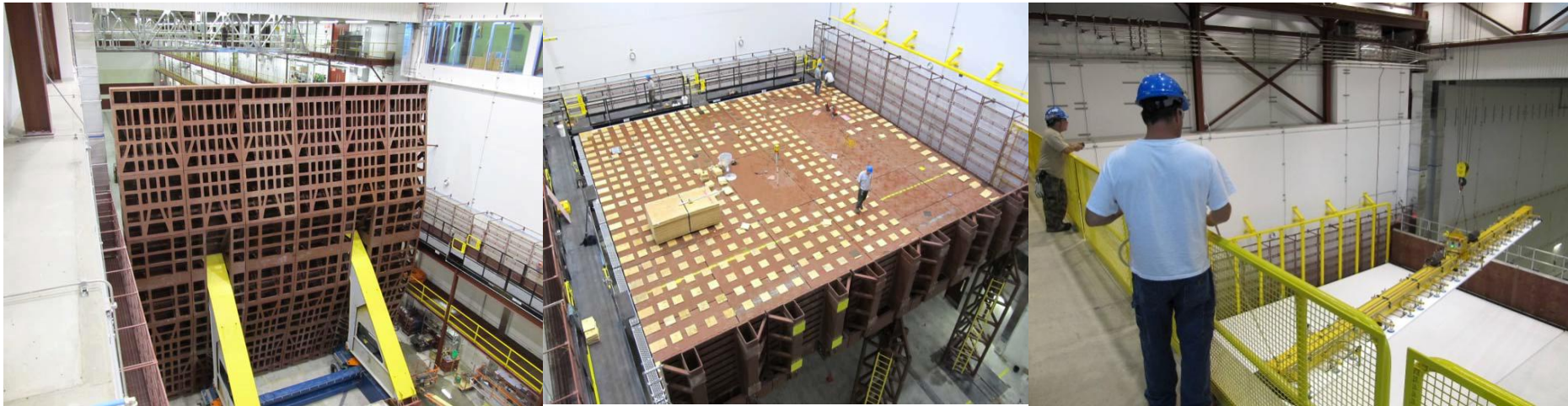
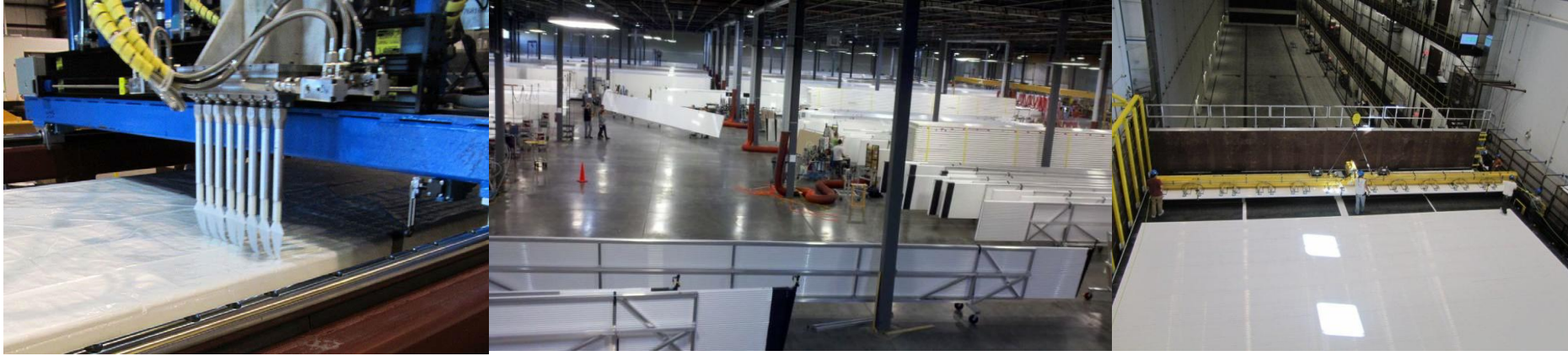


Intensity Frontier Plan

- **Near-term Science goals :**
 - Implement comprehensive program to understand neutrino mixing
 - Deliver much improved limits (measurements?) of charged lepton mixing and hidden sector phenomena
- **Recent results**
 - **Daya Bay reactor neutrino experiment** definitively shows that the unmeasured neutrino mixing is large (of order 10%)
 - Valuable info for LBNE restructuring
- **New facilities under construction:**
 - **NuMI** upgrade + **NOvA** progressing well
- **Planned program of major projects:**
 - **Mu2e** to explore charged lepton mixing (CD-1 approved July)
 - **LBNE** to make definitive measurements of neutrino properties
 - Aiming for CD-1 by the end of the year.



NOvA Status: First Block Coming Together



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Recent LBNE Decisions

- **Fermilab led an effort to redesign LBNE to achieve physics sooner and cheaper.**
 - The Steering Group had broad community participation.
 - Considered:
 - liquid argon detector underground at Soudan, MN
 - liquid argon detector on the surface at Ash River, MN
 - liquid argon detector on the surface at Lead, SD
 - Chose the last option since it provided the best long term program.
- **This plan was presented to SC management and a decision to go for CD-1 was made.**
 - The goal is to complete the CD-1 approval this year.
 - Will seek international partners to strengthen the effort.
 - Will continue to engage the community in developing the science: we expect CD2 to take some time to reach.

Reuse the NuMI Beam

Build a new beam

Cosmic Frontier Plan

- **Near-term Science goals :**
 - Discover (or rule out) the particle(s) that make up Dark Matter
 - Advance understanding of Dark Energy
- **Recent results :**
 - **2011 Nobel Prize** awarded for the measurement of the acceleration of the Universe: Permuter, Schmidt, and Riess.
 - **BOSS** has measured the characteristic length scale of the universe using baryon acoustic oscillations.
- **New facilities under construction:**
 - **Dark Energy Survey** commissioning. See talk by J Freiman tomorrow.
- **Planned program of major projects:**
 - **Large Synoptic Survey Telescope** is the longer-term centerpiece of this program; aims to make definitive ground-based Dark Energy measurements using “weak lensing”. DOE CD-1 approved, NSF moving ahead also. See talk by J Ulvestad tomorrow.



Implementing Cosmic Program Plans

- **Dark Matter:**

- DOE Funding Opportunity for R&D on 2nd Generation direct detection experiments closed, peer review panel meets Sep 12-14
- Working closely with NSF on coordinated program
- We anticipate further selection of DM-G2 experiments after this phase, leading to project(s) starting no earlier than FY14
- The DPF cosmic frontier group will investigate all ways of searching for the particle nature of dark matter (direct, indirect, accelerator production of DM)

- **Dark Energy:**

- Pro-actively developing a balanced, robust dark energy program in HEP – our own independent plan
 - With near term and low cost options, using multiple methods
- First step was a community study to look at the science reach of current and planned projects; then to identify key missing components and opportunities for reaching full “Stage-IV” levels (see talk by Rocky Kolb tomorrow)
 - Working on mid-size Dark Energy Spectroscopic Instrument for CD-0 approval
- Next step is in determining facilities needed to fill in the gaps in the program and working with other agencies to investigate models for gaining access, and project interdependencies



Developing Cosmic Frontier Plans

•Other areas:

Cherenkov Telescope Array (CTA): Astro2010 recommended US contribution to CTA in higher budget scenarios (4th on list of ground-based experiments) and that funding be split approximately 2/3 NSF and 1/3 DOE.

DOE/HEP recently gave guidance to the US collaboration that

- Following the Astro2010 recommendation, we consider NSF to be in the lead for considering the project
- We have no funding identified for a contribution to CTA in the foreseeable future and therefore don't plan to fund R&D towards it.
- We are not in the business of building telescopes, including their structures or optics, therefore we would not consider this part of the US plan as an HEP contribution.

▪Future Plans:

- HEP will continue to use PASAG criteria when considering contributions to projects and research efforts.
 - HEP will consider community inputs (e.g. the dark energy science white paper, DPF process) in developing a staged, strong science program at the Cosmic Frontier
 - We reserve the right to approve agreements on data policies and other aspects so that we can assure maximum science from the investment portfolio.
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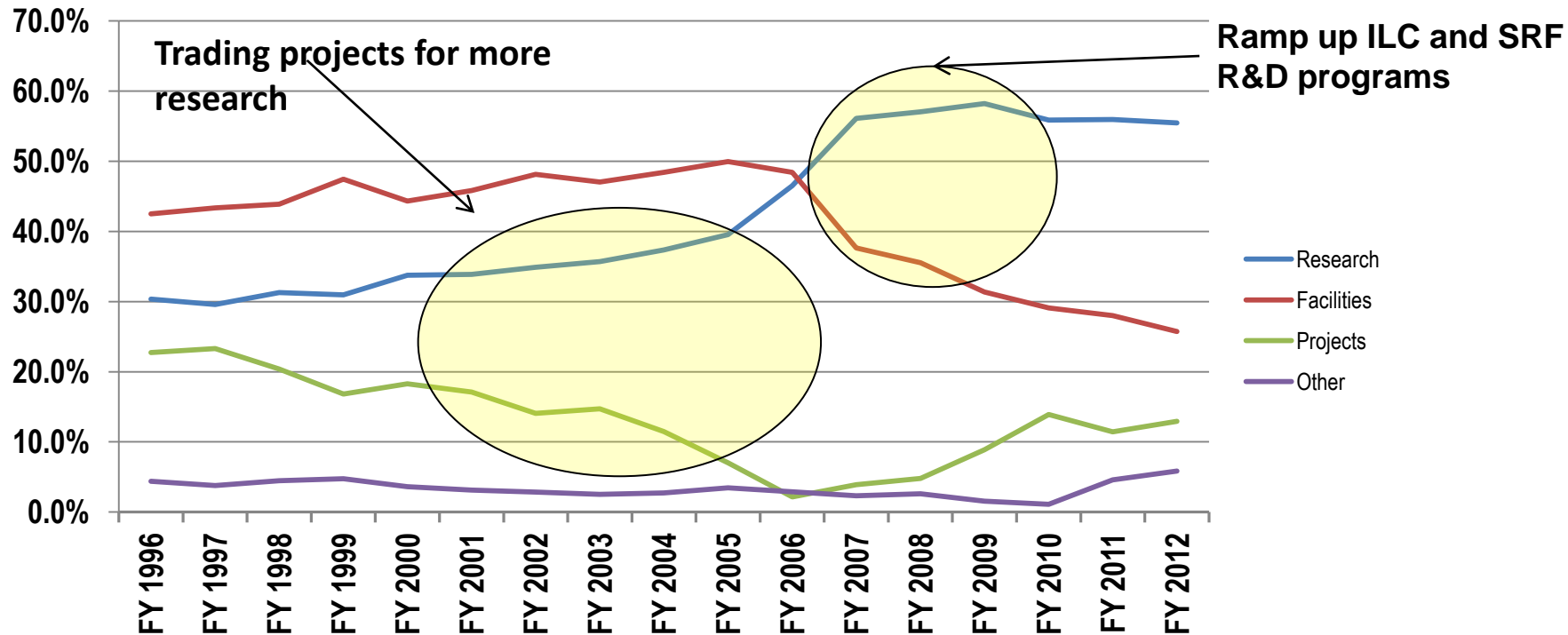


NEAR TERM PRIORITIES

Working through Office Priorities for the FY 2012

- Develop Mission Need statement for US participation in LHC detector upgrades
 - Nearing Completion
- Make critical decisions on Long Baseline Neutrino Experiment
 - Done. Pursuing CD-1 based on a surface detector at Homestake Mine
- Issue solicitation for R&D leading to Next Generation Dark Matter Experiments and make selections
 - Solicitation is closed, panel review in September
- Develop strategic plans for Intensity Frontier and Accelerator R&D programs
 - Working through Departmental concurrences

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.

Implementing the Priorities

- **Research funding will decrease at ~2% a year for the next several years.**
 - Program priorities and comparative reviews will be used to implement the cuts.
 - Both the universities and the laboratories will be affected.
 - Comparative lab reviews in Energy Frontier and detector R&D this year
 - Cosmic and Intensity Frontiers next year; Accelerator Science TBD
- **Operations funding approximately flat-flat**
- **Seeking approval of CD-0 for mid-scale dark matter, dark energy; ATLAS and CMS upgrades; and muon g-2 this fall.**
 - Investing in cosmic, energy, and intensity frontiers.
 - CD-1 approved for LSST; CD-1 review for LBNE in Oct
- **Embarking on a community planning process.**
 - APS Division of Particle and Fields is organizing it.
 - Working groups meeting now.
 - Major meeting next summer.



LONG TERM PRIORITIES

Next Steps : Energy Frontier

- **Discussions with CERN about follow-on to LHC Agreement proceeding**
 - Necessary precursor to planning for future upgrades
 - DOE and NSF agree on framework principles
- **Energy Frontier science plan will require high-energy LHC running**
 - What is the real physics of the TeV scale?
 - This will likely take a few years to sort itself out
 - US “Snowmass” process is an important element, along with European and Japanese HEP strategies
- **New world-wide linear collider organization to replace ILC-GDE**
 - ILC TDR complete by end of 2012 with major milestones met
 - Lyn Evans to be the Director of the new effort
 - New org. will balance ILC-CLIC as well as Physics & Detectors
- **Significant collaborations with other regions on future colliders will require a high-level approach between governments**



Next Steps : Intensity Frontier

- We view (reconfigured) LBNE as the last major piece of the 2008 P5 Plan and are trying to implement that
- **We recognize there have been changes since 2008**
 - Significant recent discoveries : theta_13, “Higgs-like Boson”
 - Other talks at this meeting cover some physics implications
 - The reconfigured LBNE has resulted in reduced scope for first phase and some in the community are dissatisfied with this outcome
 - We agree that a new “Snowmass” process is warranted to re-examine the science cases on the 3 Frontiers
 - BUT we don’t regard this as a necessary precursor to proceeding with LBNE
 - There are additional reasons for moving ahead with LBNE in a timely fashion
 - We are working with the DPF to help make Snowmass process a success



Next Steps : Cosmic Frontier

Dark Matter:

- Path for direct detection dark matter experiments is clear
- Comparative review of DM-G2 efforts in FY13, leading to future project start
- Plan for other methods of detection developing in parallel with DPF process

Dark Energy:

- Have science plan for developing balanced, staged program from DES→LSST; --
- Now need to investigate other projects/facilities needed
- Talking with other agencies to consider needs & current assets

Other areas:

- Consider other program areas in parallel with DPF process

Overall program

- using Sept. operations review to get a handle on portfolio and budget of operating experiments over the coming years; need to shut off some experiments to make room to start new ones.



Past Performance in Planning

- **P5 Plan and Impact**
 - Diverse scientific portfolio embraced by stakeholders
 - Clear priorities set
 - Realistic budgets, although we are at/below the lower limit by now
 - Very, very positive impact
- **Need to lay the foundation to update P5 plan as the next step. Need more details.** ‘You guys have great questions, but what about answers?’
- **Look at what other parts of Office of Science have done** – e.g., Basic Energy Sciences (BES)
 - Very successful, but ~\$200M/yr for projects is the empirical limit.



Future Plans for Portfolio Development

- **DPF Planning process – frontier oriented**
 - In partnership with DOE/NSF, supported by all the labs
 - Must develop more project ideas than we can afford + more affordable ideas
- **SCIENCE CASE FIRST!**
 - Then worry about experiments. Remember we need continuous science output
 - Snowmass is NOT a shootout. It is not a love fest either. We must be critical about science goals & think out of the box
 - Worthy science goals married to implausible assumptions do not advance the discussion
- **Consider novel ideas for packaging our programs (BES used EFRC's, Hubs, etc.)**
 - Will a critical mass of program elements, industrial participation, computing, materials, technologies, etc. make a difference to how fast we can move on our science or in broader impacts?
- **Compelling ideas have the potential to raise the budget and expand our scope and impact if we have the patience and skill to develop them!**



Program Planning : Goals

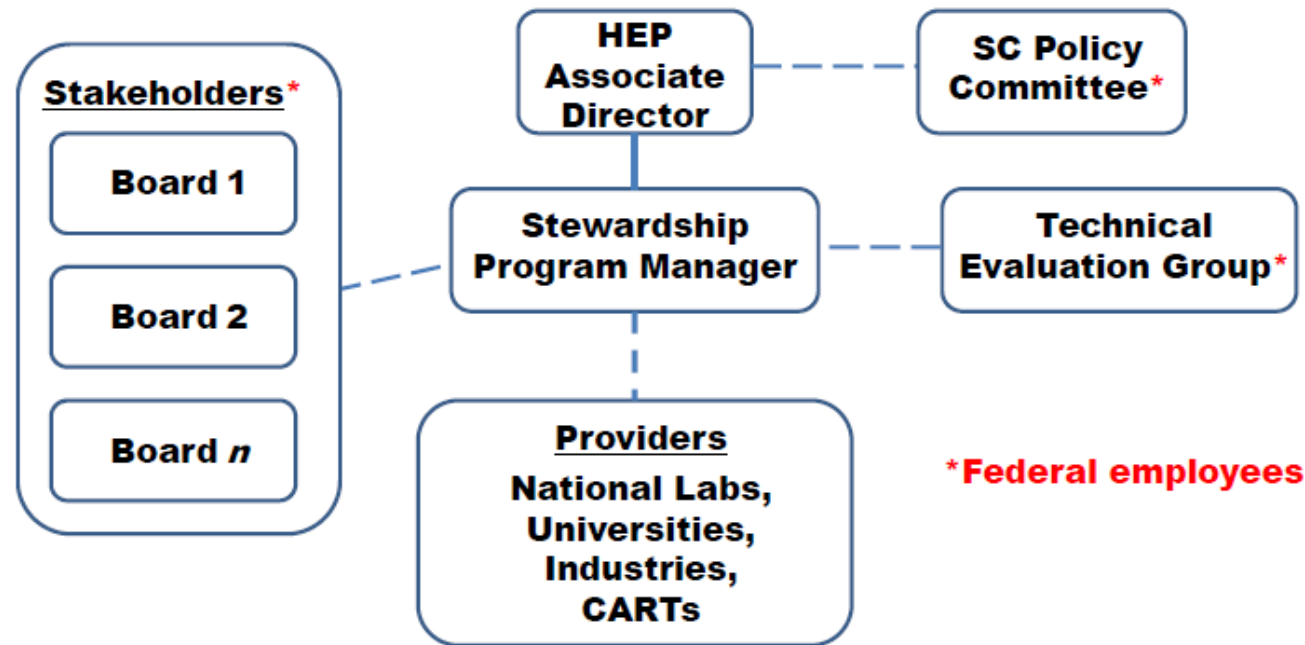
- The HEP program will have a coherent program plan for each of our frontiers: Cosmic, Energy, and Intensity – plus accelerator research, theory, etc. Then it needs to be integrated into 1 overall, coherent, coordinated plan, and prioritized.
 - Eg Snowmass → Update HEPAP/P5 plan → DOE/NSF implementation
- The plan doesn't need to be a consensus; rather it can show the range of options available.
- The plan will show the current science reach and potential future science reach that can be achieved by experiments in the HEP program to make significant advances in the coming years.
- The plan should exhibit compelling science as well as technical and fiscal realism

ACCELERATOR R&D STEWARDSHIP PROGRAM

Organization

- **Diagram shows stewardship program organization**

- overall responsibility rests with HEP Associate Director
 - in consultation with SC policy committee
- stewardship program manager works with
 - technical evaluation group (other SC accelerator program mgrs.)
 - stakeholder boards (programmatic)
 - providers



Accelerator Stewardship Status I

- **Strategic plan for Congress prepared**
 - awaiting DOE and OMB approval before submitting
- **Key elements (presented at previous HEPAP meeting)**
 - make National Lab technical infrastructure more widely open to industry
 - solicited input from Lab Directors on available infrastructure
 - working with DOE Tech Transfer staff to develop ground rules
 - modified HEP B&R code structure to accommodate stewardship tasks
 - no major shift in emphasis before FY14
 - solicit community input for two new initiatives
 - laser R&D program aimed at improved accelerator capabilities
 - organizing workshop (West Coast venue) for early CY2013
 - program to improve ion beam therapy delivery system (“gantry”)
 - organizing workshop (DC area venue) for early CY2013
 - ◆ jointly with NIH/NCI and DOD

Accelerator Stewardship Status II

- **Both workshops will help us develop ideas for accelerator stewardship R&D tasks in support of new initiatives**
 - information will be used in FY14 to develop **open solicitations** for R&D proposals aimed at innovative solutions
 - in consultation with other SC program offices
- **Proposal process will be transparent and inclusive**
 - evaluations done by peer review using broad spectrum of experts
 - potential for application outside of HEP will be a strong consideration



HEP OFFICE NEWS

Comings and Goings

- **Imminent departures**

- **Eli Rosenberg** returning to Iowa State after 4 years of meritorious service as an IPA

- **Imminent arrivals**

- **Peter Kim** (SLAC) started detail in Aug : Detector R&D
- **Abid Patwa** (formerly at BNL) joining as Fed program manager for Energy Frontier (vice Gonzalez)
- **Jim Stone** (BU) joining as an IPA : Energy Frontier, LHC Ops
- **Tim Bolton** (Kansas State) joining as an IPA : Intensity Frontier

- **Transitions**

- **Fred Borcharding** now full-time on Projects
- **Simona Rolli** transitions from (Energy Frontier + Theory) to (LHC Upgrades + Theory)
- HEP Budget restructuring along Frontiers basis approved for FY2013



Summary

- The P5 Strategic Plan is still our roadmap.
 - Balanced program across the three frontiers.
 - Near-term implementation understood and moving forward on all Frontiers
- HEP has under invested in new facilities in the recent past.
 - Correcting this will squeeze research for several years.
- Updates and revisions to P5 plan for longer-term starts with Snowmass process
 - Recognizing new physics landscape
 - Driven by compelling science but also realistic
- Accelerator Stewardship initiative continues to move forward.

BACKUP

Accelerator Stewardship Mission

- **The mission of the HEP long-term accelerator R&D stewardship program is to support fundamental accelerator science and technology development of relevance to many fields, and to disseminate accelerator knowledge and training to the broad community of accelerator users and providers**
- **Accomplished through:**
 - improving access to national laboratory accelerator facilities and resources for industrial and for other U.S. government agency users
 - working with accelerator user communities and industrial accelerator providers to develop innovative solutions to critical problems, to the mutual benefit of our customers and the DOE discovery science community
 - serving as a catalyst to broaden and strengthen the community of accelerator users and providers

Accelerator Stewardship Plans

- **First step: open Lab infrastructure to US industry**
 - HEP requested information from the labs on what infrastructure is available.
 - HEP will provide funding for the incremental costs of opening up the infrastructure.
 - HEP will coordinate with other SC programs that pay for the infrastructure.
 - Working with DOE Tech Transfer on understanding the procedures for opening up the infrastructure.

Accelerator Stewardship Plans II

- **Two new areas selected (each with a stakeholder board)**
 - particle therapy beam delivery improvements
 - present gantry systems are large, heavy, and costly especially for ^{12}C beam
 - goal: design smaller gantry and fabricate prototype magnet
 - also demonstrate fast energy and/or transverse position control
 - laser development program to enhance accelerator capabilities
 - desired features are high peak power, high average power, high electrical efficiency
 - need dedicated R&D program to make progress (long-term effort)
 - proposal-driven, with national lab, university, and industry participants
 - synergies with other programs, but complementary
- **New initiatives to be launched via open solicitations (FY14)**
 - preceded by workshops to define requirements

NSF/DOE Coordination on Dark Matter

- **NSF Dear Colleague Letter (DCL) review and awards now complete.**
 - DCL encompassed all of underground physics.
 - For DM, support of R&D to allow preparation for G2 down-select.
 - <http://www.nsf.gov/pubs/2012/nsf12043/nsf12043.pdf>
- **DOE FOA for G2 DM published; proposal review in September.**
 - One year of R&D support, followed by down-select for construction in FY13.
 - http://science.doe.gov/grants/pdf/SC_FOA_0000597.pdf
- **G2 construction proposals* to be submitted to the agencies in FY13.**
 - NSF Particle Astrophysics (PA) program (Oct 2013).
 - *DOE lab FWP for construction phase (end CY13, open only to those selected in initial round).
- **NSF & DOE will discuss and, as warranted, coordinate the funding for G2 construction awards. Award decisions will be made independently by each agency.**
 - NSF/DOE co-review of the proposals under discussion.

