U.S. DEPARTMENT OF ENERGY

OFFICE OF SCIENCE

HEP Program

Jim Siegrist
Associate Director
Office of High Energy Physics
Office of Science, U.S. Department of Energy

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Outline

Program Accomplishments

HEP Budget and Issues

Comparative Review Status

Strategic Planning and Community Process

Summary

Take-Away Messages

- **Recent results and Snowmass reports provide compelling evidence that the science focus is shifting "Beyond the Standard Model."**
  - We are adapting the program to the science opportunities.
  - Current P5 will elucidate a new scientific vision for HEP
- **Though some of the boundary conditions have changed, we are still trying to implement the 2008 strategic plan within the current constraints**
  - FY2014 Request generally supports this, though funding constraints have led to delays in some key projects
  - Action on the FY14 Request will be key in enabling near-term program
- **Actively engaged with community in developing new strategic plan. Now is the time for input into the P5 process!**
  - Meetings are underway; next at BNL Dec 15-18 (Energy Frontier + other topics)
  - We encourage you to make your voice heard
  - Also help us make your teams and colleagues aware
  - See S. Ritz talk for more details

HEP OVERVIEW

What Lies "Beyond the Standard Model"?

There is now a lot of "known" Beyond the Standard Model (BSM) physics, most of which is accessible to experiments:

- **Quantum Gravity**
  - We have no theoretical model that works yet (but lots of ideas)
- **Inflation of the Early Universe**
  - We have a theoretical idea that seems to work but no way to integrate it with the Standard Model. Is it really as simple as it seems?
- **Neutrino Masses**
  - Why are they so small? What is the mechanism that generates them?
- **Baryon Asymmetry**
  - Clearly, matter exists and antimatter (almost) doesn't. We still have no idea *why.*
- **Dark Matter**
  - Clearly it exists. We have ruled out a lot of possible candidates but no smoking gun for what it is made of; it seems the simple explanations may all be wrong.
- **Dark Energy**
  - Clearly it exists, but thus far very poorly understood.

What Lies "Beyond the Standard Model"?

Discovery of a SM-like Higgs *and nothing else* severely limits the possibilities for New Physics at the TeV scale. However, there are still possibilities ("known unknowns") for BSM physics that has not yet been discovered:

- **Higgs boson properties**
  - The LHC has discovered something that looks very much like a SM Higgs. Is it the real McCoy or an imposter? Is it alone? Why is its mass at the edge of vacuum stability?
- **Symmetry breaking**
  - Unification of electromagnetism and the weak nuclear force is the current model for broader unification of forces. Discovery of the Higgs opens the door to more incisive studies of whether this model really works as well as it seems.
- **New Physics at the TeV scale**
  - We have ruled out a lot of possible candidates (e.g., supersymmetry models) with the Tevatron and initial LHC data. What will the LHC see running at 14 TeV?
- **Flavor Physics**
  - Detailed studies of quark and lepton "flavor" (type) changing transitions have historically taught us a lot about the structure of the SM. Next-generation flavor experiments can probe well beyond the TeV scale in specific cases.

The Best of Times

- **We have several new results that point the way forward in several key areas:**
  - Energy Frontier: Discovery of the Higgs (and so far, nothing else) defines an extensive future work plan
  - Intensity Frontier : Measurement of (θ_{13}) enables qualitatively new investigations of fundamental questions with neutrinos
  - Cosmic Frontier : rapid advances in Dark Matter direct detection (and the lack of direct evidence for SUSY) is starting to challenge models and perhaps upend the "standard" DM picture
  - Technology R&D : recent progress in advanced accelerator concept R&D is spurring ideas for future accelerator testbeds that can exploit these successes

2013 Nobel Prize in Physics

François Englert and Peter Higgs were awarded the 2013 Nobel Prize in Physics for their contributions to our understanding of the origin of mass, confirmed by the discovery of the Higgs boson in 2012 by the ATLAS and CMS experiments at CERN's Large Hadron Collider.

The search for the Higgs at experiments at the Large Hadron Collider was an international effort involving thousands of people, with physicists and engineers from US institutions playing a significant role throughout.

See: http://www.symmetrymagazine.org/article/october-2013/us-participation-in-the-higgs-discovery

Higgs Statement of Work

1. ~~Spin 0~~
2. ~~Parity +~~
3. **The Higgs is elementary; that is, it has no structure.**
4. **The Higgs production cross sections are as predicted.**
5. **Higgs field gives mass to fermions.**
   - Higgs couples to fermions proportional to mass.
6. **Primordial partners give mass to the W/Z.**
   - Higgs couples to the W/Z with strengths proportional to the square of their masses
7. **It couples to itself**
8. **The decay width of the Higgs is as predicted.**

(see Snowmass Energy Frontier Report for more details)

Neutrino Statement of Work

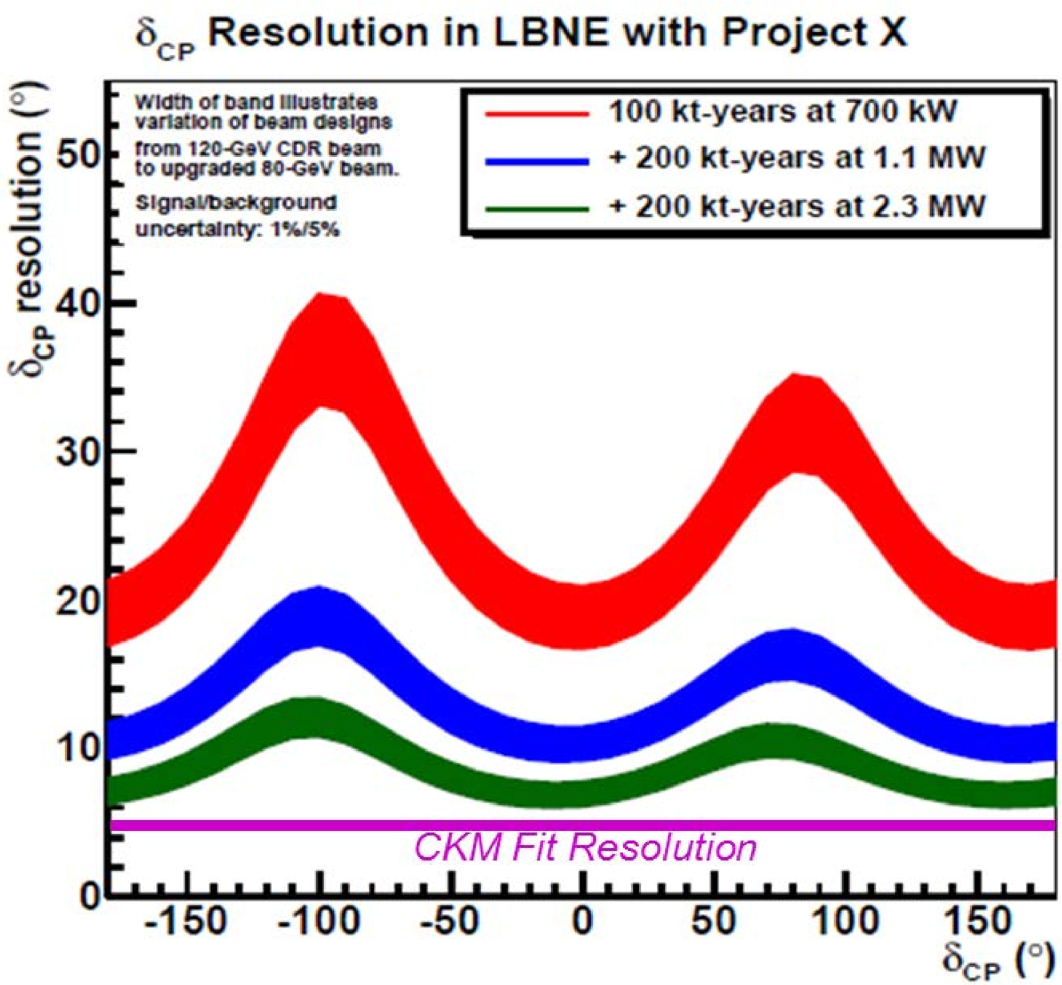
In no particular order:

- **Measure the mixing between neutrino types**
- **Measure the number of light neutrino types**
- **Is the neutrino its own antiparticle?**
- **Determine the absolute scale of neutrino masses**
- **Determine the ordering of neutrino masses**
- **Is matter-antimatter asymmetry present in neutrinos?**
- **Neutrino couplings to normal matter are as predicted**

New Horizons in Neutrino Physics

- **Example: CPV in the neutrino sector can be tested by exp't**

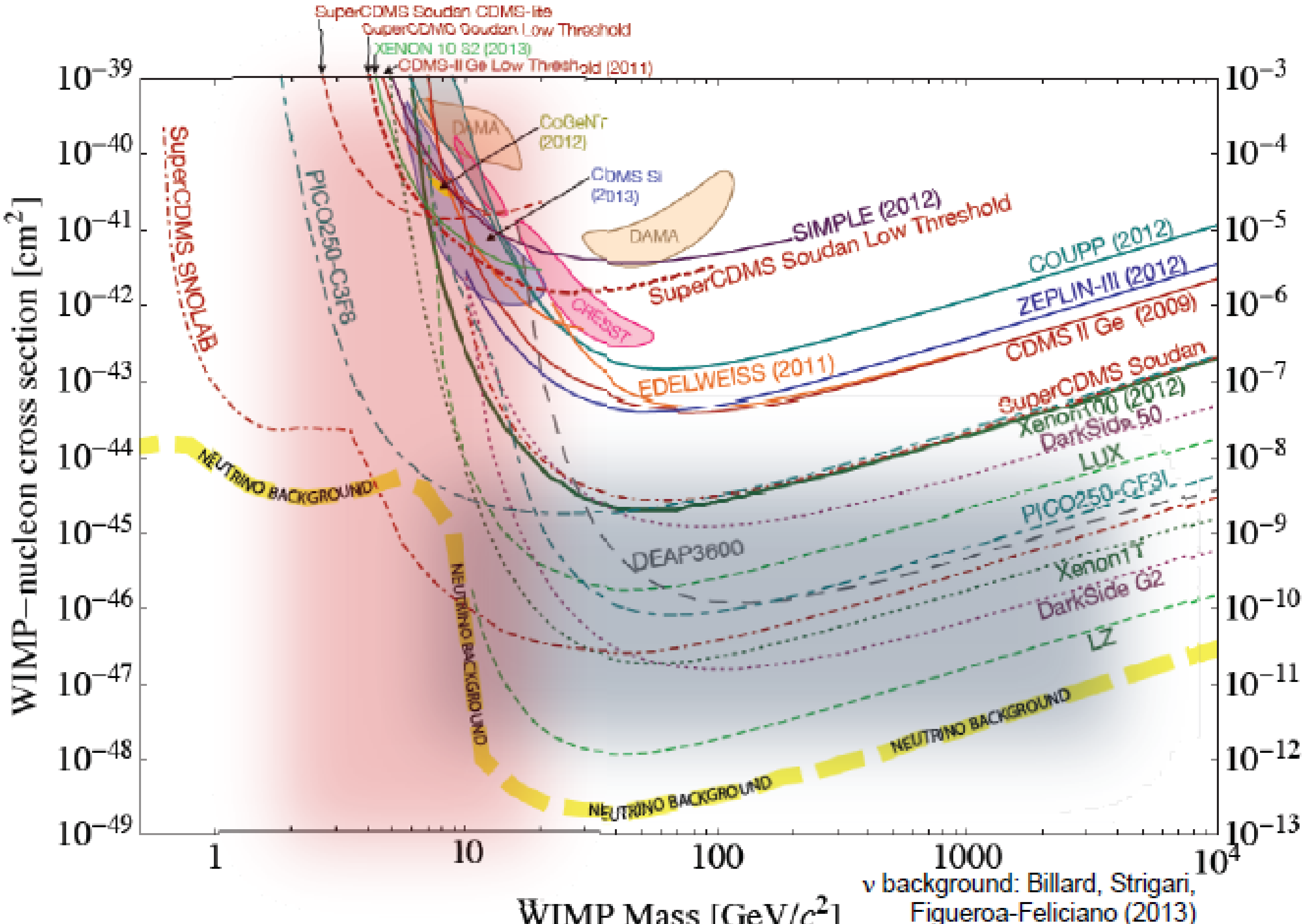
δ_{cp} Resolution



LBNE + MW beam enable an era of high-precision neutrino oscillation measurements.

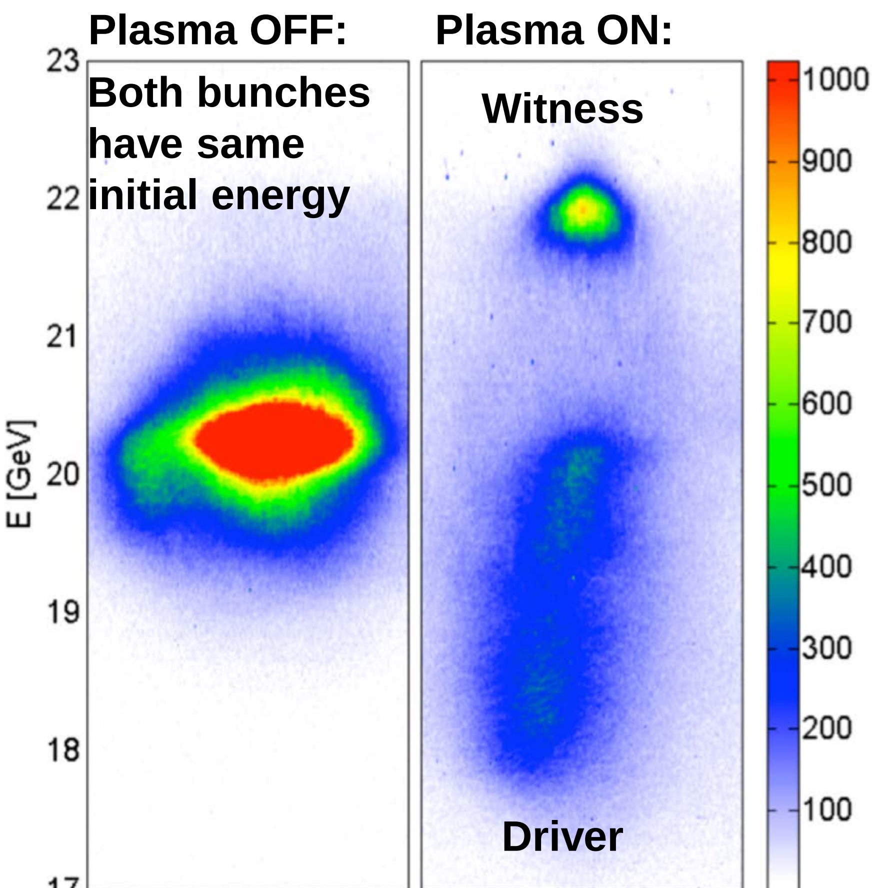
Need statistics:
target mass + MW beam

CURRENT STATUS AND FUTURE PROSPECTS



ν background: Billard, Strigari, Figueroa-Feliciano (2013)

Recent Major Accomplishments : Technology R&D



FACET data from SLAC

High quality e$^-$ beams in a 6 GeV/m acceleration field

- New FACET facility demonstrates first acceleration of a witness bunch in beam driven plasma wakefield
- Accelerating Field 6 GeV/m, which is 300x that of the SLAC linac
- Important step towards meter scale high-energy plasma based accelerator

Impact

New technology with potential for far lower accelerator size and cost

HEP BUDGET AND ISSUES

HEP Budget Overview

- **Budget philosophy is 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 in FY14, 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 delayed in FY14 planned to recur in FY15 request:
    - LBNE, LHC detector upgrades, 2nd Generation Dark Matter (G2-DM) detectors
  - 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 while minimizing the impact of Research reductions to the extent possible

HEP Budget Status

- **Currently on Continuing Resolution (CR) through Jan 15**
  - Funding at FY2013 levels and “no new starts.”
    - Note the FY13 level for HEP is well below FY14 Request and House/Senate marks.
  - DOE/SC has submitted a request for “anomalies” to allow new project starts even in the event of another, and/or year-long, CR
  - Likely these issues will get addressed at the time of the FY14 appropriation
- **Impacts:**
  - New projects that were proposed for FY13/14 are struggling to get started: LSST, Muon g-2, Belle-II
  - These will become serious issues if Appropriation is not passed by Jan 15.
  - If Appropriation is at ~FY13 level for HEP (e.g., year-long CR) there will be additional impacts to other Projects as well as Research
    - We were already projecting significant reductions (of order 5%) in ongoing Research activities with HEP budget at the level of the FY14 House Mark, in order to get new Projects going.

FY 2014: House and Senate Marks

	Funding (in $K)			
	FY 2013	FY 2014 President's Request	FY 2014 House	FY 2014 Senate
Research, Operations, Projects	715,742	720,064	708,308	730,133
SURF (non-add)	14,000	10,000	12,000	15,000
Accelerator Stewardship (non-add)	3,132	9,931	9,931	20,000
SBIR/STTR	**20,791**	21,457	21,213	21,457
LBNE (Project Engineering & Design, PED)	3,781	–	8,000	20,000
Mu2e (PED and Construction)	8,000	35,000	35,000	35,000
Total, High Energy Physics:	748,314[(a)]	776,521	772,521	806,590

[(a)] **Includes $20,791,000 for SBIR/STTR, reprogrammed to the SBIR/STTR program.**
FY13 Total also reflects sequestration, enacted March 1, 2013.

FY 2014 High Energy Physics Budget

(dollars in thousands)

Description	FY 2013 Actual	FY 2014 Request	FY2014 Current Plan
Energy Frontier	149,446	154,687	153,897
Intensity Frontier	274,412	271,043	244,957
Cosmic Frontier	80,063	99,080	95,668
Theory and Computation	66,398	62,870	61,533
Advanced Technology R&D	142,291	122,453	141,672
Accelerator Stewardship	3,132	9,931	2,944
SBIR/STTR	0	21,457	21,177
Construction (Line Item)	11,781	35,000	26,466
Total, High Energy Physics	**727,523***	**776,521**	**748,314**
Office of Science	**4,681,195**	**5,152,752**	

*The FY 2013 Actual is reduced by $20,791,000 for SBIR/STTR. The FY2014 Current Plan (under CR) is written to the overall FY13 funding level including SBIR/STTR

HEP Physics Funding by Activity

Funding (in $K)	FY 2013 Actual	FY 2014 Request	FY2014 Current Plan
Research	**364,766**	**383,609**	**377,583**
Facility Operations and Experimental Support	**265,123**	**271,561**	**266,988**
Projects	**97,634**	**99,894**	**82,566**
Energy Frontier	0	0	0
Intensity Frontier	63,494	37,000	30,000
Cosmic Frontier	19,159	24,694	22,900
Theory and Computation	3,200	3,200	3,200
Construction	11,781	35,000	26,466
SBIR/STTR	**0**	**21,457**	**21,177**
TOTAL HEP	**727,523***	**776,521**	**748,314**

*The FY 2013 Actual is reduced by $20,791,000 for SBIR/STTR. The FY2014 Current Plan (under CR) is written to the overall FY13 funding level including SBIR/STTR

HEP Physics MIE Funding

Funding (in $K)	FY 2013 Actual	FY 2014 Request	FY 2014 Current Plan	Description
Energy	0	0	0	LHC CMS Detector Upgrades
Energy	0	0	0	LHC ATLAS Detector Upgrades
Intensity	19,480	0	0	NOvA ramp-down
Intensity	5,857	0	0	MicroBooNE
Intensity	5,000	8,000	2,000	Belle-II
Intensity	5,850	9,000	9,000	Muon g-2 Experiment
Cosmic	1,500	0	0	HAWC
Cosmic	8,000	22,000	22,000	Large Synoptic Survey Telescope (LSSTcam) Camera
Cosmic	0	0	0	Second Generation Dark Matter (DM-G2)
Cosmic	0	0	200	DESI Conceptual Design
TOTAL MIE'S	**45,687**	**39,000**	**33,200**	

HEP Physics Construction Funding

Funding (in $K)	FY 2013 Actual	FY 2014 Request	FY2014 Current Plan
Construction	**28,388**	**45,000**	**36,466**
Long Baseline Neutrino Experiment (TPC)	**17,888**	**10,000**	**13,781**
TEC	3,781	0	3,781
OPC	14,107	10,000	10,000
Muon to Electron Conversion Experiment (TPC)	**10,500**	**35,000**	**22,685**
TEC	8,000	35,000	22,685
OPC	2,500	0	0

HEP COMPARATIVE REVIEWS

FY14 Comparative Review (I)

- **FY14 Comparative Review Funding Opportunity Announcement (FOA) issued: June 14, 2013**
- **Final application deadline: Sept. 9, 2013 by 11:59 pm Eastern Time**
  - **134 applications submitted for review among 6 different HEP subprograms**
    - Energy, Intensity, and Cosmic Frontiers
    - HEP Theory, Accelerator Science and Technology R&D, and Particle Detector R&D
  - **In Sept. 2013, after the FOA-deadline, all applications were pre-screened for compliance to FOA:**
    - verification of senior investigator status
    - compliance with proposal requirements: *e.g.,* page limits, appendix material, use of correct DOE budget and budget justification forms, …
    - responsive to subprogram descriptions

- **For review process, experts of panelists selected and convened during Nov. 12-22, 2013**
    - Panel deliberations discussed *each* proposal and *each* senior investigator, provided additional reviews for proposal(s), and for comparative evaluation of proposals and PIs

Subprogram	Panel Deliberations	# of Total Proposals [includes proposals containing multiple subprograms]
Intensity Frontier	November 12-13, 2013	26
HEP Theory	November 13-15, 2013	33
Accelerator Science and Technology R&D	November 14-15, 2013	31
Particle Detector R&D	November 18-19, 2013	14
Energy Frontier	November 19-20, 2013	20
Cosmic Frontier	November 20-22, 2013	28

FY14 Comparative Review (II)

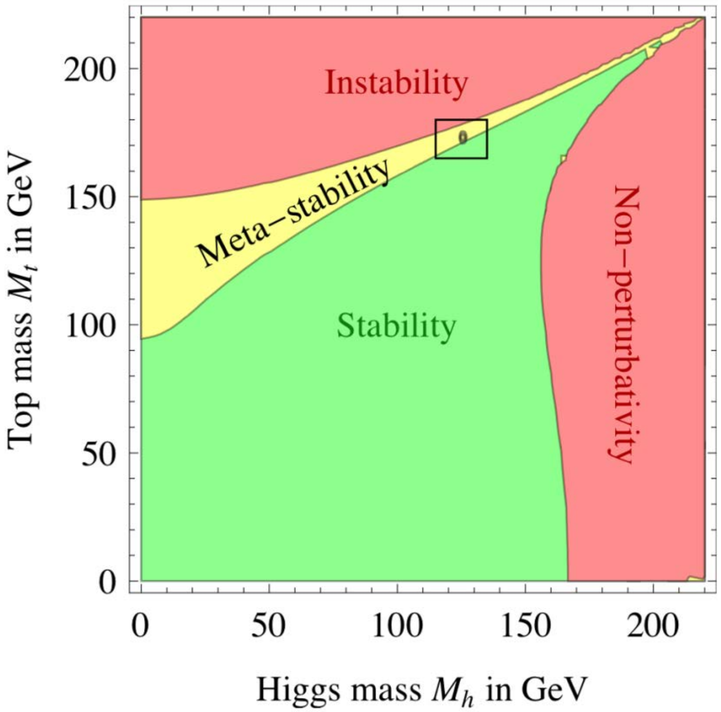
- Reviewer proposal assignments and input for reviews managed through DOE's Portfolio Analysis and Management System (PAMS)
  - Use of PAMS framework for the review process is new to DOE/HEP
  - First large-scale FOA within DOE/SC that was managed using PAMS
- In addition to reviewing merits of the senior investigators, the merit review process addressed 5 criteria items:
  - Scientific and/or Technical Merit of the Project
  - Appropriateness of the Proposed Method or Approach
  - Competency of Research Team and Adequacy of Available Resources
  - Reasonableness and Appropriateness of the Proposed Budget
  - Relevance to the mission of the Office of High Energy Physics (HEP) program
- Post-Panel review (currently in process: December 2013 – early January 2014)
  - Assess reviews at DOE OHEP on *each* proposal and *each* senior investigator in order to develop guidance and funding levels
    - in addition to reviews, solicit input from other DOE Program Managers & Grant Monitors
- January – April 2014:
  - By ~mid-January 2014, PIs will be given guidance and funding levels with request to submit revised budgets and justifications
  - Route proposal procurement packages through DOE/SC and DOE Chicago Operations Office
- Funded grants to begin 1st year: on or about May 1, 2014

Full Funding of Multi-Year Grants

- **Beginning FY14, DOE/SC will transition to full funding of multi-year grants and/or cooperative agreements received from academic institutions with total cost less than $1M.**
  - **"Full funding" implies funds for the *entire award* for the project period is obligated at the time the award is made, instead of funding year-by-year.**
- **Logistics on full funding:**
  - **Process for full funding applies to new, renewal, or supplemental grant awards that are made after the merit review process.**
  - **Transition is planned over the course of five years.**
  - **Grants and cooperative agreements with total cost of $1M or more – integrated over the project period approved for the proposal – are exempt from the transition.**
- **During the submission of a proposal along with conducting its merit review and making decisions on the award:**
  - **There will be no change to how an applicant applies for a grant or cooperative agreement.**
  - **There will be no change to the merit review process.**
  - **There will be no change to DOE Program Managers requesting revised budgets from PIs.**
- **DOE Program Managers (PM) will continue to have oversight of the research program by requiring PIs to submit an annual research performance progress report that must be approved by the PM prior to any funds being accessed by the PI the following year.**
- **SC program offices, including HEP, will aim to carry out the transition in a way that minimizes impacts on the scientific community and the mission needs served by the office.**

BACKUP

The Higgs may be telling us something…

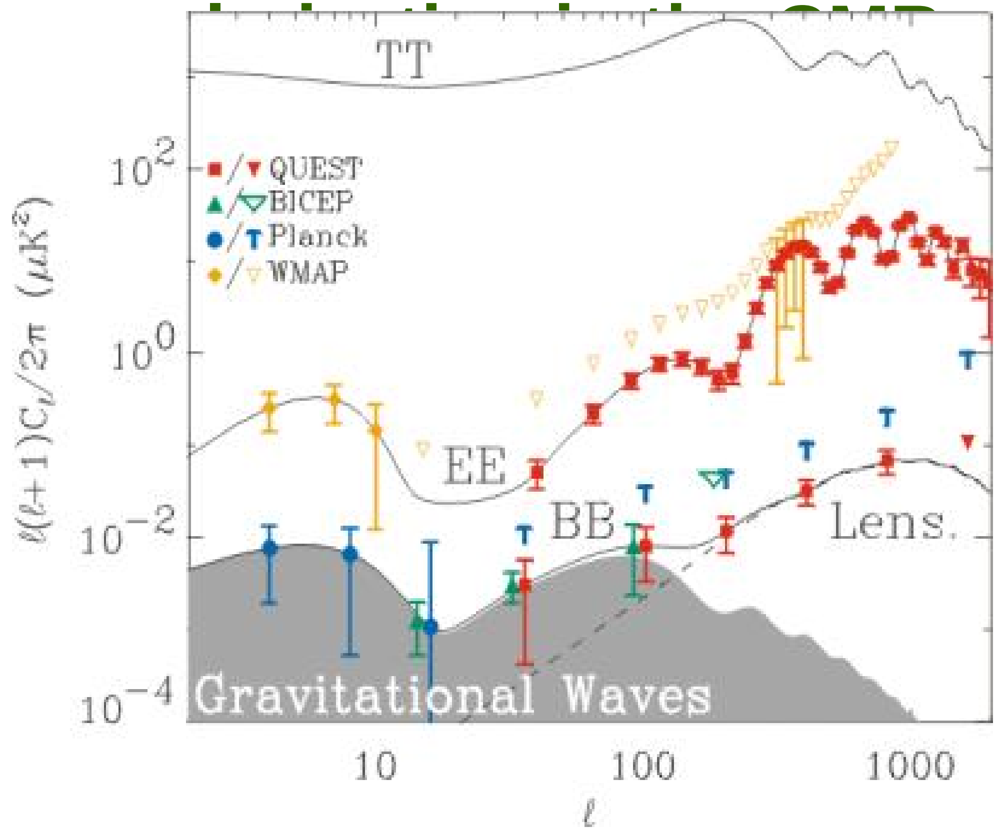


- Maybe just a coincidence
- But dismissing striking features of the data as coincidence has historically not been a winning strategy...

Courtesy Joseph Lykken

Polarization of the Cosmic Microwave Background (CMB)

South Pole Telescope is the first CMB telescope to measure "B-mode"



The B-mode signal seen by SPT is due to gravitational lensing.

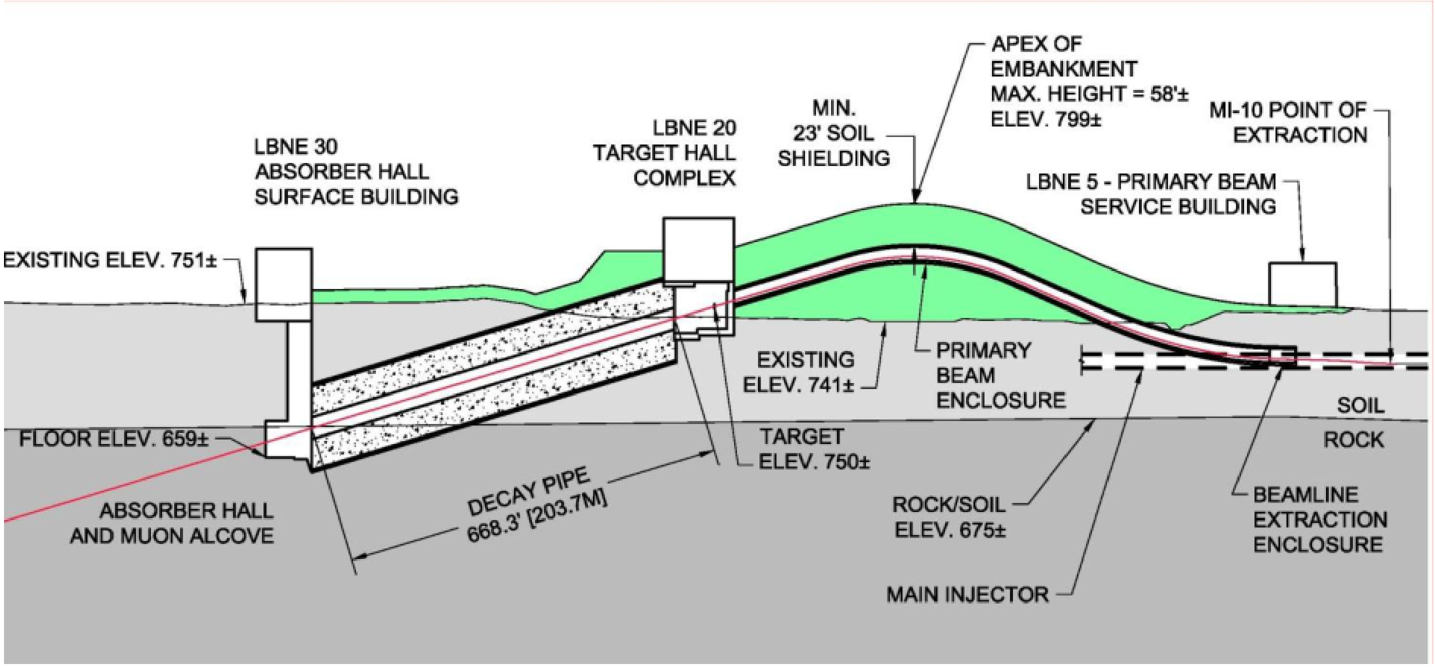
The Holy Grail: Detection of B-modes due to the imprint of primordial gravitational waves that are predicted by inflation

Current LBNE Strategy

- **We are trying to follow the reconfiguration (phased) plan for LBNE, though it has hit some snags**
  - Outyear budgets are challenging
  - Some members of the community objected that the phased LBNE was not what 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
  - Working to get more of the community on board
  - Need to get agreement on what is required for success

LBNE Progress, 2010-2013

- Daya Bay measurement of the 1-3 mixing angle has reduced the detector mass required for LBNE
- Reconfigured the project for phasing
- Selected liquid-argon TPC far detector technology
- Selected the shallow beam-line configuration
- Achieved CD-1 in December 2012



Development of the LBNE Concept

Original Proposal for LBNE to DOE

- New Fermilab neutrino source from a 700 kW proton beam, capable of 2.3 MW
- Highly-capable near detector system at Fermilab
- 34 kiloton liquid-argon detector
  - 800 miles away in South Dakota
  - 4850 feet underground
- Estimated Cost $1.6 billion

DOE rejected this proposal as too costly and would take too long to build.

- Fermilab and the project team were told to develop a less costly option.

Reconfigured LBNE

- CD-1 approved for this conceptual design in December 2012.
- Simplified near detector system
- 10 kiloton liquid-argon detector on the surface in South Dakota
- Unambiguous determination of mass hierarchy and best sensitivity to CP-violation among the options studied
- A leading facility capable of attracting international participation.
- Cost range is $800-1,100 million.

Attracting Partners

The approval of LBNE CD-1 has attracted interest of potential partners

- See next slide for details

Partners could enable *more* science and *better* science:

- Enhance the near detector system to improve neutrino mixing measurements and carry out other important neutrino physics measurements.
- Add mass to the far detector to improve the precision of the main physics goals.
    - Extends the reach to search for matter-antimatter asymmetry
- Move the detector underground
    - Allows measurements that require low-background conditions: search for proton decay, observe neutrinos from supernovae and other astrophysical sources

Steps Toward International LBNE Collaboration

- European Strategy recommends major participation in a US or Japan neutrino program
- Developing European, Asian and South American partnerships (in addition to scientific collaborations already formed or forming)

Plan to Go Forward

- The plan, as it currently stands:
  - Use time before baselining to recruit partners that expand science reach
  - DOE cost will not be increased once baselined
  - Get more of the (US and international) community on board
  - Get priority in the SC Facilities plan
- Engage with all stakeholders to improve the project.
- Serious discussions have begun with other countries.
  - Put in place an agreement with CERN that allows CERN to contribute to US projects.
    - The current agreement only concerns US contributions to the LHC.
  - There is interest in Italy to build another far detector module that would at least double the mass of the far detector.
  - Discussions are being held with Brazil, India, Japan and the UK.
  - Other countries will be looking for signals that the U.S. is committed to doing this project.
- Continue to do value engineering and risk reduction with available funds.

Next Steps

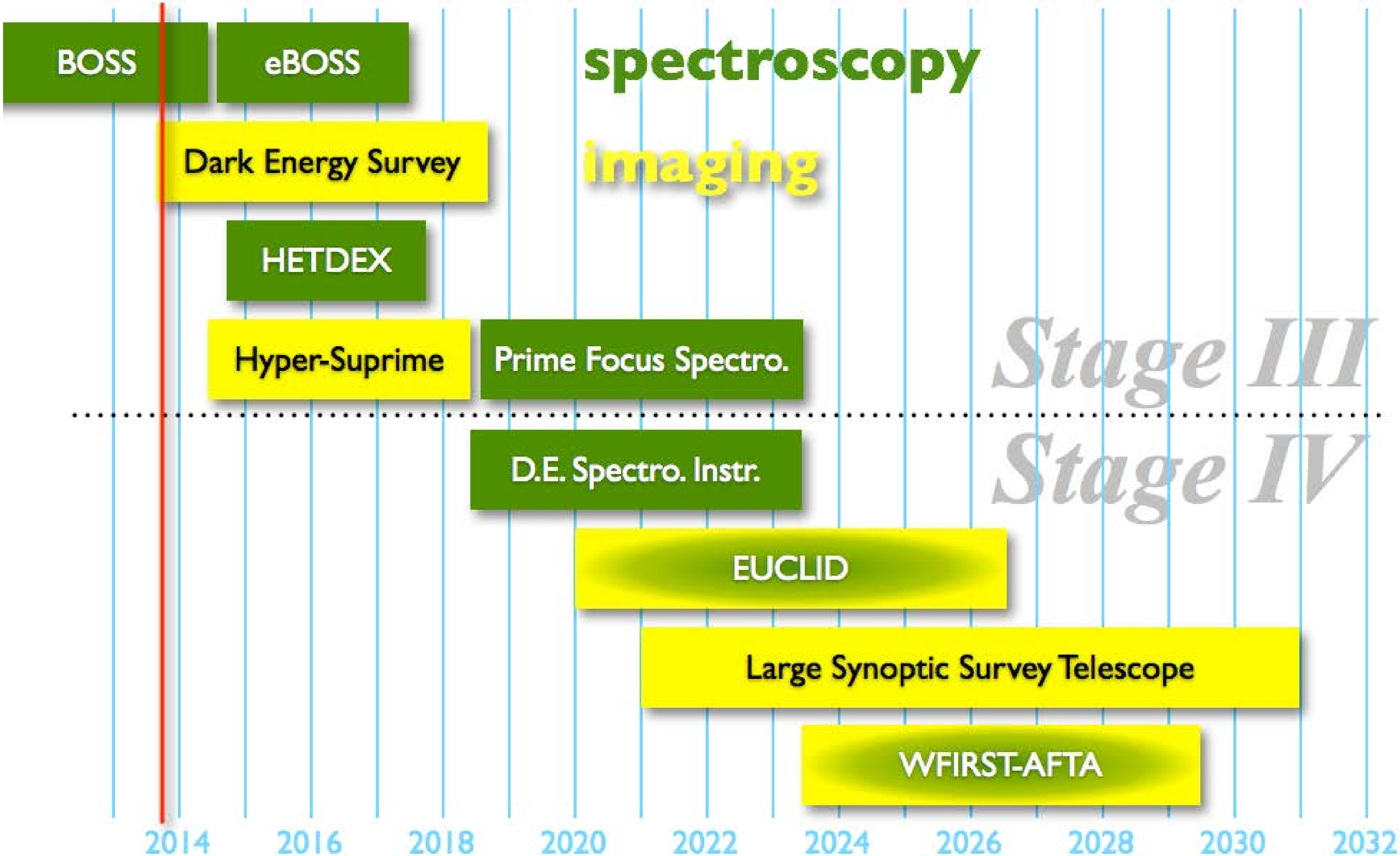
CD-1 marks completion of conceptual design. Next steps involve meeting significant engineering and R&D milestones to establish technical baseline:

R&D

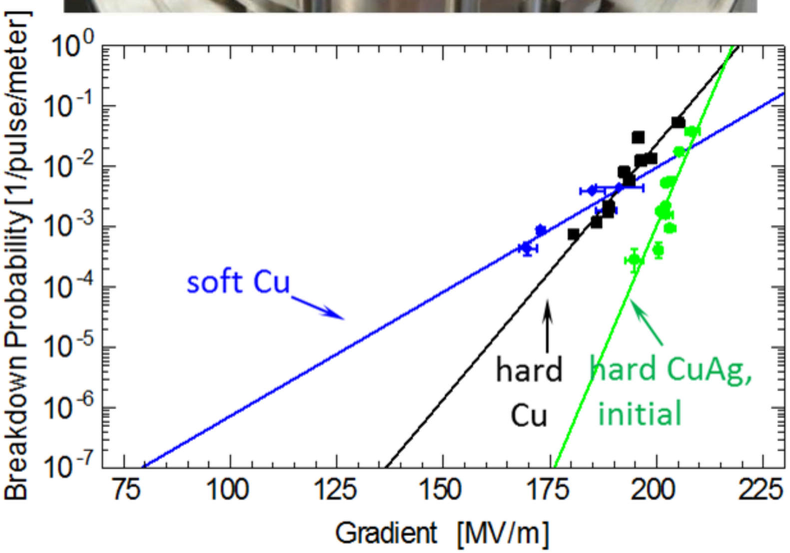
- Completion of critical detector prototypes;

Project Engineering & Design

- Awarding of contracts for preliminary design of conventional facilities at both Fermilab and SURF to stay on schedule for the start of construction of the beamline facilities in FY15 and excavation at SURF in FY17;
- Awarding of contracts for preliminary design of the far detector cryostat and detector components at Fermilab, BNL, and universities;
- Initiation of preliminary design for beamline equipment.


BOSS
eBOSS
spectroscopy
Dark Energy Survey
imaging
HETDEX
Hyper-Suprime
Prime Focus Spectro.
Stage III
Stage IV
D.E. Spectro. Instr.
EUCLID
Large Synoptic Survey Telescope
WFIRST-AFTA
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032

Record High Accelerating Fields Achieved



Achieved 175 MV/m in conventional structures

- Discovered the fundamental impact of surface magnetic fields on breakdown
- Developed new understanding of material properties that led to new use of alloys for high gradient structures
- Increased attainable gradients in accelerator structures by factor of ~3, from 65 MV/m to above 170 MV/m

Impact

Reduced size and cost of conventional accelerating structures

DOE Workshop on Laser Technology for Accelerators

January 23-25, in Napa, CA.

- Charge:
  - Identify several specific laser-based accelerator applications
  - Assess laser specifications for each application
  - Identify technical gaps between present and required laser performance
  - Specify R&D activities needed to bridge these gaps
  - Assess the proposed U.S. R&D activities against global laser R&D efforts
- Workshop outcome: a concise report describing:
  - Accelerator applications that drive laser R&D
  - Laser technology developments needed to enable these applications
  - A rough timeline of the needed laser R&D
- Attended by ~50 participants
  - ~10 industry, ~5 international.
  - Included members of DOE-HEP, DOE-BES, DOD, NSF, and the CRS.

Accelerator Project to Upgrade LHC

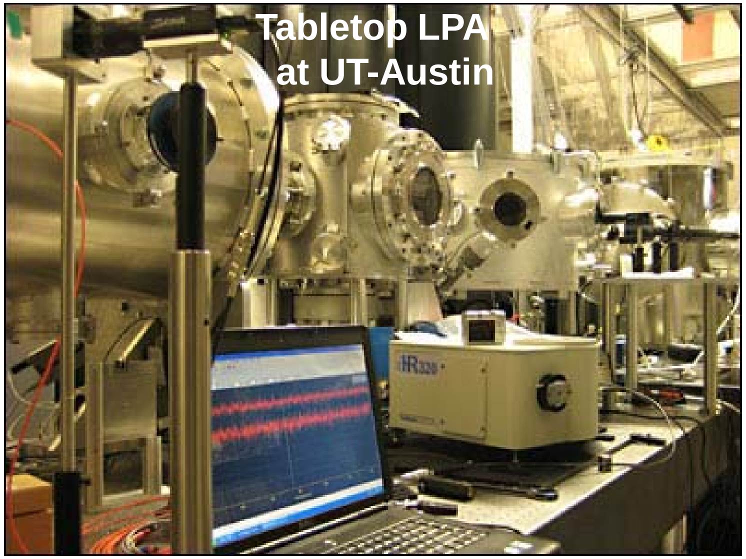
- **Scope: Two superconducting magnets for CERN's LHC**
- **Background: CERN requested the magnets to increase the reliability of spares. BNL made this type of magnet for US-LHC Project**

Total Project Cost: $11,440k

Schedule: CD4 – April 2014

Status: on track to finish on time, on budget

Multi-GeV Also Achieved in Laser Plasma Acceleration



2 GeV electron beam energy achieved over 2 cm distance

- With conventional technology this energy requires a 200 m long accelerator, a downsizing factor of 10,000
- Present investment in Laser Plasma Acceleration has potential to achieve ~10 GeV energy level in 2-3 years
- New BELLA facility commissions world-record petawatt laser for LPA science

Impact

New technology with potential for far lower accelerator size and cost

Ion Beam Therapy Workshop Charge

- Prepared jointly by DOE-HEP and NCI
  - Identify a set of representative clinical applications that span the range of expected future therapy requirements. These need to include capabilities for performing radiobiological experiments as well as human treatment protocols in order to explore the scientific principles underlying observed clinical results and point the way to promising protocol designs.
  - Assess the corresponding beam requirements (e.g., energy range and energy spread, intensity range and pulse-to-pulse intensity jitter, spot size and pulse-to-pulse position jitter, repetition rate, ion species) for future treatment facilities and compare these with today's state-of-the-art
  - Assess the corresponding beam delivery system requirements (e.g., energy and position adjustability, time scale for adjustments, size of footprint, component mass, transverse and longitudinal acceptance) for future treatment facilities and compare these with today's state-of-the-art
  - Identify R&D activities needed to bridge the gap between current capabilities and future requirements; include an assessment of which R&D investments are likely to have the highest near-term performance gains
    - this is the place where accelerator stewardship effort can help

What unique niche would this program occupy?

- Ultrafast lasers (<1 ps) operating at high average power (>1 kW), and highest power efficiency (>20%) as flexible, tunable, laboratory-based systems
  - 1 μJ x 1 GHz, optically phase locked
  - 1 J x 1 kHz, coherently combined, very high pulse contrast
  - 1 J x 10 kHz, coherently combined, very high pulse contrast
  - High peak power, high average power components
    - Linear materials—coatings, structured surfaces, and optics
    - Nonlinear materials—gain, frequency conversion
- Challenges
  - No PW/kW gain materials; too low damage threshold optics
  - Costly, inefficient pumps
  - Little experience coherently combining ultrashort pulse lasers
  - Pulse contrast and optical phase noise

Laser R&D Ecosystem

Domestic R&D

$300M DoD – CW/Long pulse, high power (kW-MW), deployable, efficient, compact, lightweight
$25M DOE-NNSA – Long pulse, high energy (MJ), high power, efficient
$5M DOE-SC – Broad (enabling tech.)
$2M NSF – Broad (enabling tech.)
$2M Others

Foreign R&D

$35M Fraunhofer ILT – near-term, mat'l proc.
$23M LZ Hannover – Ultrafast, mat'ls
$20M ENSTA – applications of UF lasers, LOA
Asia—Semiconductor Foundries ⇔ Communications lasers

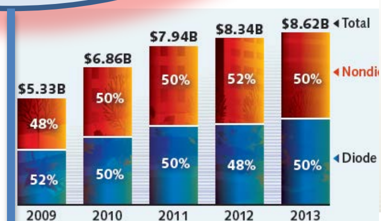
Laser R&D for Accelerators

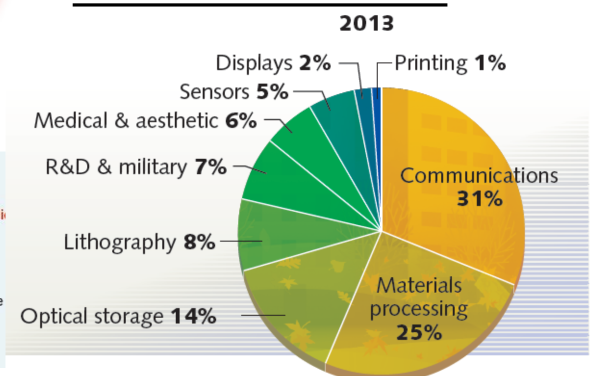
Ultrafast (<1 ps)
Efficient (>20%)
High Average Power (>1 kW)
Flexible, tunable
Laboratory systems
Very low MTTF

Research Locales

76% [Defense Contractors, Laser Industry]
14% [DoD Labs, DOE-NNSA Labs, DOE-SC Labs]
10% Academia

Worldwide Market





"Laser Markets Rise Above Global Headwinds", *Laser Focus World*, Jan 2013.

National Initiatives

National Photonics Initiative
NNMI: Additive Manufacturing Inst.+14 (1B$)

MIE Issues

- **We were not able to implement (most) new MIE starts in FY14 request**
  - Muon g-2 experiment is the only new start in HEP
- **Other new MIE projects begun in prior years have been "on hold" awaiting an appropriation to allocate fabrication funds**
  - Belle-II
  - Large Synoptic Survey Telescope
- **This upsets several major features of our budget strategy:**
  - Strategic plan : "trading Research for Projects"
  - Implementation of facilities balanced across Frontiers
  - Leveraging strategic partnerships with domestic and foreign agencies
- **Therefore we expect to request MIE starts for the highest priority new HEP facilities in the FY15 request:**
  - LHC detector upgrades
  - 2nd Generation Dark Matter detectors
- **Important but lower priority efforts have been put on hold**
  - Dark Energy Spectroscopic Instrument

Funding by Subprogram: HEP Energy Frontier

Funding (in $K)	FY 2013 Actual	FY 2014 Request	FY 2014 Dec Annual Plan	Comment
Research	**89,172**	**96,129**	**96,102**	Redirect research to LHC detector upgrades.
Facilities	**60,274**	**58,558**	**57,795**	LHC detector + computing operations support
Projects	**0**	**0**	**0**	
CMS Upgrade	**0**	**0**	**0**	New MIE Start
ATLAS Upgrade	**0**	**0**	**0**	New MIE Start
TOTAL Energy Frontier	**149,446**	**154,687**	**153,897**	

- **Will have to reduce level-of-effort in US LHC research to meet commitments to LHC detector upgrades**

Energy Frontier Issues

- **Discussions with CERN about follow-on to LHC Agreement proceeding**
  - Necessary precursor to planning for "Phase-II" upgrades
- **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
- **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 Intensity Frontier

Funding (in $K)	FY 2013 Actual	FY 2014 Request	FY 2014 Dec Annual Plan	Comment
Research	**52,860**	**53,562**	**54,384**	
Facilities	**158,058**	**180,481**	**160,573**	
Expt Ops	7,354	7,245	4,225	Offshore and offsite Ops
Fermi Ops	132,928	156,438	141,573	Full ops for NOvA
Bfactory Ops	1,594	4,600	940	End of BaBar disassembly
Homestake	14,000	10,000	13,200	
Other	2,182	2,198	635	GPE & waste management
Projects	**63,494**	**37,000**	**30,000**	
Current	52,794	27,000	21,000	Muon g-2 & Belle II ramp down plus LBNE OPC
Future R&D	10,700	10,000	9,000	
TOTAL Intensity Frontier	**274,412**	**271,043**	**244,957**	

Intensity Frontier Issues

- **We must have long-term goals for the precision with which we need to measure the neutrino mixing matrix elements.**
  - This is an essential element that will guide the development of the neutrino program.
- **This question is very important since it enables us to explain to all our stakeholders why we need a wide variety of neutrino experiments, and why it is a consistent *program.***
  - **It also guides our investment strategy on R&D** to support neutrino factories since small errors may require higher beam intensities than can be reached with conventional targets/beamlines.
- **Many other important areas of investigation were well summarized in 2011 intensity frontier workshop. We need to turn that into a situation analysis for each of the main areas.**
  - What are the technology capability gaps ?
  - Are there projects or pilots needed to fill out the program?

HEP Cosmic Frontier

Funding (in $K)	FY 2013 Actual	FY 2014 Request	FY 2014 Dec Annual Plan
Research	**48,652**	**62,364**	**59,516**
Facilities	**12,252**	**12,022**	**13,252**
Projects	**19,159**	**24,694**	**22,900**
Current	9,500	23,200	22,200
Future R&D	9,659	1,494	700
TOTAL Cosmic Frontier	**80,063**	**99,080**	**95,668**

Cosmic Frontier – Issues

• Which are the most important science areas to concentrate on make significant steps towards HEP mission goals?
• Are there branch points? Are we covering right phase space?

Dark Matter & Dark Energy:

- Have path forward; needs to be further developed & optimized

<u>Dark Matter:</u>

• Have plan for direct-detection DM-G2 experiments that will probe most of preferred phase space; will need this input to make the case for DM-G3
• Will have to make technology choices going forward.

<u>Dark Energy</u>

• Have ground-based plan to reach Stage-IV measurements using multiple methods: BOSS, DES → MS-DESI, LSST
• What other measurements or instrumentation will be needed to fully exploit these experiments? Are there areas we aren't covering, e.g. space?

Other particle astrophysics areas

-Science case and role needs to be better articulated
- CTA: Following Astro2010, we consider NSF to be in the lead; We haven't identified project funding and therefore aren't funding R&D efforts.

HEP Theory and Computation

Funding (in $K)	FY 2013 Actual	FY 2014 Request	FY 2014 Dec Annual Plan	Comment
Research	**63,198**	**59,670**	**58,333**	
Theory	54,621	51,196	50,271	Follows programmatic reductions in Research
Computational HEP	8,577	8,474	8,062	As above
Projects	**3,200**	**3,200**	**3,200**	Transition year
TOTAL Theory and Comp.	**66,398**	**62,870**	**61,533**	

- **LQCD completes a 5 year IT Project in FY 2014.**

HEP Advanced Technology R&D

Funding (in $K)	FY 2013 Actual	FY 2014 Request	FY 2014 Dec Annual Plan	Comment
Research	**110,802**	**105,303**	**109,154**	
General Accel R&D	60,705	57,856	59,463	Shift effort to directed R&D
Directed Accel R&D	22,692	23,500	25,091	Need to meet deliverables
Detector R&D	27,405	23,947	24,600	
Facility Operations	**31,489**	**17,150**	**32,518**	
TOTAL Advanced Technology	**142,291**	**122,453**	**141,672**	

- **Shifting effort to Directed R&D**
- **Need to demonstrate niobium-tin superconducting magnets can provide stronger focusing magnets needed for future accelerators.**
- **Demonstrate the operation of RF cavities in large magnetic fields**

Accelerator Stewardship

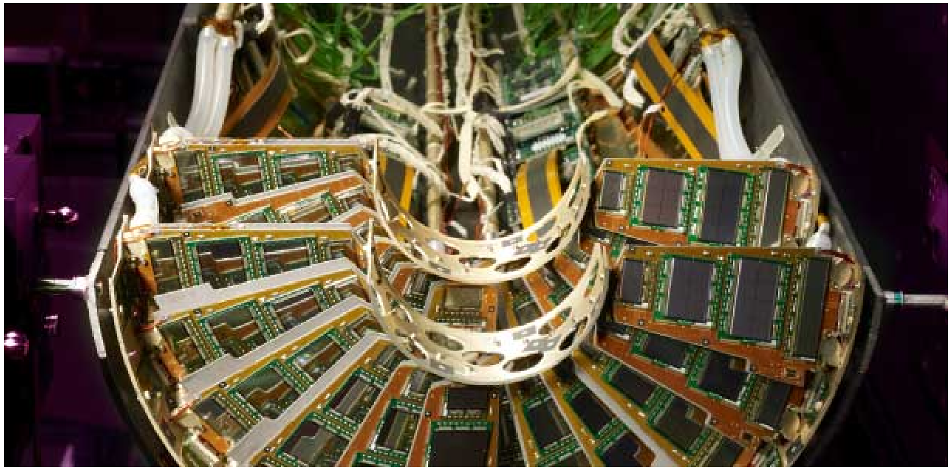
Funding (in $K)	FY 2013 Actual	FY 2014 Request	FY 2014 Dec Annual Plan
Research	82	6,581	94
Facility Operations	3,050	3,350	2,850
TOTAL Accel. Stewardship	3,132	9,931	2,944

- **Plan FOAs in ion beam therapy, lasers for accelerators, green RF power for accelerators, and energy and environment applications**

PROJECTS

LHC Detector Upgrade Projects

- **CD-0 was approved for upgrades to the ATLAS and CMS detectors on 9/18/2012.**
- **The cost ranges were both $22—34 million.**
- **The upgrades are a joint effort with NSF, which expects to contribute another $10—12 million per project.**
- **The scope in both cases is mostly related to improving the trigger and data acquisition systems to handle larger data rates.**
  – U.S. CMS is also building replacements for the endcap pixel detector.
- **CD-1 reviews have been held. CD-1 approval expected in October.**

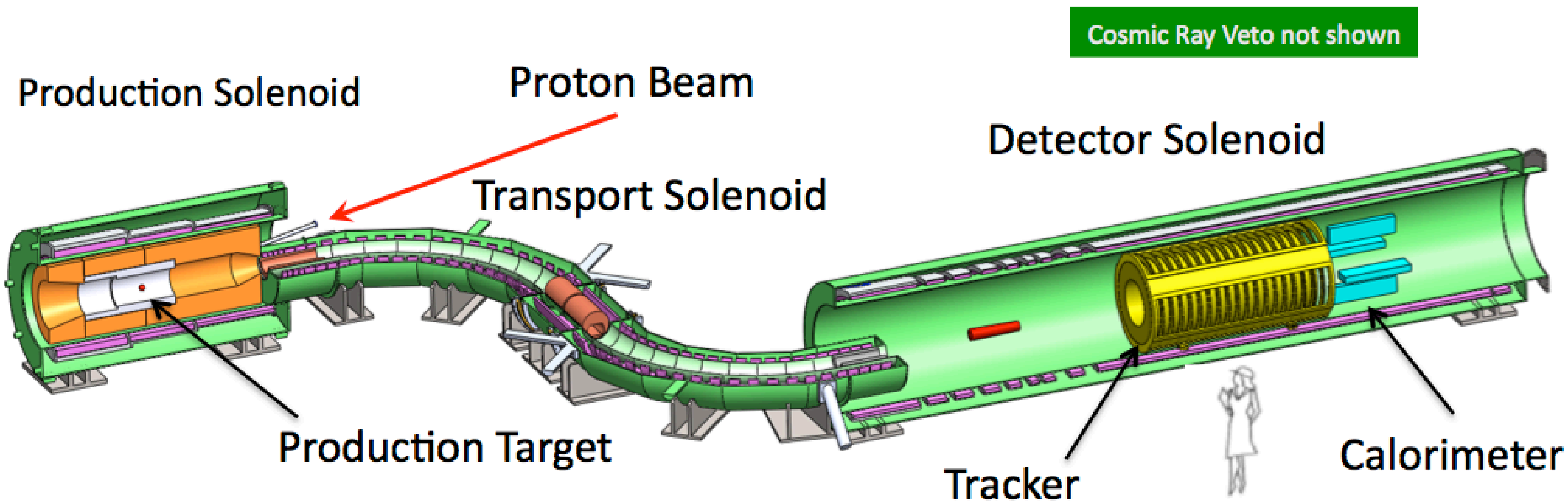


Existing CMS endcap pixel detector

- **The U.S. projects are integrated into an international effort to upgrade the detectors.**
- **There will be a long shutdown of the LHC in 2018 to install the upgrades.**
- **Requesting equipment funds in FY 2015.**

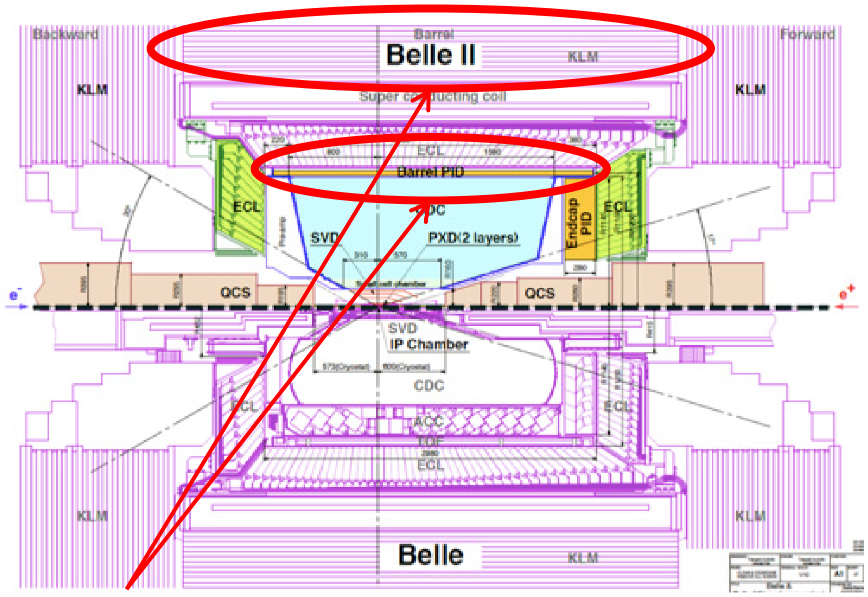
Muon to Electron Conversion Experiment

- **Search for conversion of a muon to an electron, a very rare event that would signal violation charged-lepton flavor symmetry and new physics beyond reach for the LHC.**
  - Recommended by P5 (2008) under any budget scenario.
- **CD-0 Nov 2009; CD-1 July 2012 ($200-310M)**
- **Currently carrying out design work funded with PED.**
- **FY 2014 request is PED and Construction funding.**
  - Will need a CR anomaly to maintain schedule if there is no appropriation within 6 months
- **FY 2015 request will be all construction.**



Belle II

- **CD-1 was approved 9/18/2012 with a cost range of $12—15 million.**
- **The U.S. will contribute new particle ID subsystems to the upgraded Belle detector at the SuperKEKB storage ring in Tskuba, Japan.**
- **SuperKEKB is an upgrade to the KEKB storage rings and will produce two orders of magnitude more data.**
  - The physics will be concentrated on rare decays of B mesons looking for new physics and precision studies of CP violation.



U.S. Scope

- **First request for equipment funding was in FY 2013 and now granted under the year long CR.**
- **Requesting a new start in FY 2014.**
  - Will need a CR anomaly if there is no appropriation by the end of the year.
- **The entire Belle II detector will be delayed without a new start of some kind.**

Muon g-2

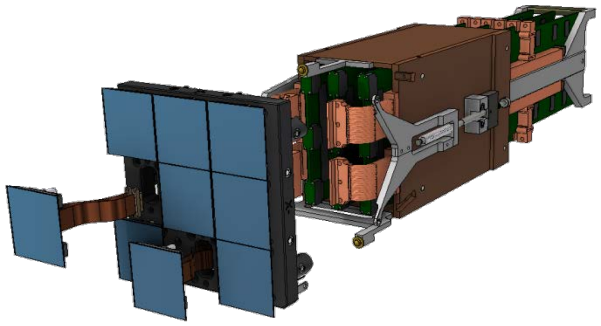
- Measure the anomalous magnetic moment of the muon.
- Existing measurements are ~3σ from the Standard Model prediction.
  - Could be evidence of new physics.
- CD-0 approved 9/18/2012 with a cost estimate of $30–60 million
- Move the existing muon storage ring from BNL to FNAL, where a more intense muon beam can be produced.
- CD-1 review was just held. Approval of CD-1 expected in October.
- Equipment funding was requested in FY 2014 budget.
  - Need a CR anomaly if budget is not passed by end of the year.

The muon g-2 storage ring arrives at Fermilab on July 26. 2013.

Requesting equipment funding in FY 2015

LSSTcam

- **The Large Synoptic Survey Telescope is a joint DOE/NSF project.**
  - DOE will supply the camera and NSF the telescope
  - DOE's interest is the study of dark energy.
  - NSF will support a broad program in astronomy.
- **CD-1 was approved 4/12/2012 with a cost estimate of $120—175 million.**
- **Equipment funding was requested in FY 2013, but no new starts prevented DOE from providing it.**
- **Equipment funding is requested again in FY 2014.**
  - Need a CR anomaly if budget is not passed by end of the year.
  - The camera is on the critical path. Without an appropriation or CR anomaly



Science Raft Tower, 161 MP Camera
Part of the DOE deliverables

LSSTcam Project Status

- DOE and NSF are managing the project jointly.
- Reviews are charged by one agency or the other with participation from both agencies.
  - May 2012 NSF held a Joint Interface & Management Review to look at interfaces between the telescope and the camera.
  - June 2013 - DOE Status Review of LSSTcam
  - NSF Final Design Review will be held in October
- MOU in place between DOE and NSF.
- Joint Oversight Group meetings held every two weeks.
- OSTP is briefed regularly.