DOE Program Status

HEPAP Meeting
March 12, 2013

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Outline

HEP Budget

Strategic Planning and Community Process

Program Status

Communications

Office News and Miscellany

HEP BUDGET

FY2013 High Energy Physics Current Budget

(Data in new structure, dollars in thousands)

Description	FY 2012 Actual	FY 2013 Annualized CR	FY 2013 CR - Seq
Energy Frontier Exp. Physics	159,997	155,468	152,468
Intensity Frontier Exp. Physics	283,675	298,610	284,270
Cosmic Frontier Exp. Physics	71,940	81,918	80,971
Theoretical and Computational Physics	66,965	65,110	65,110
Advanced Technology R&D	157,106	142,204	135,390
Accelerator Stewardship	2,850	2,932	2,932
SBIR/STTR	0	21,287	20,775
Construction (Line Item)	28,000	28,172	14,000
Total, High Energy Physics	**770,533***	**795,701**	**755,916**
Office of Science	**4,873,634**	**4,903,460**	**4,658,287**

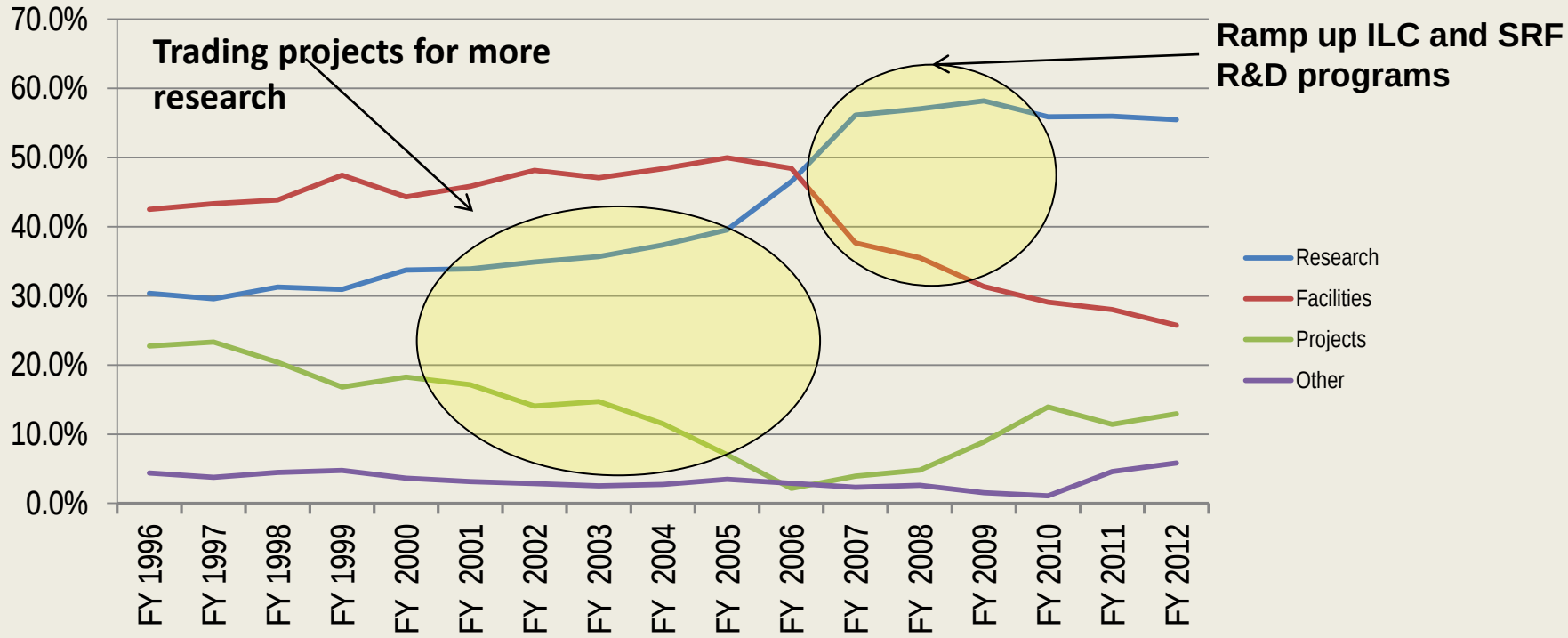
***The FY 2012 Actual is reduced by $20,327,000 for SBIR/STTR**

HEP Physics Funding by Activity

Funding (in $K)	FY 2012 Actual	FY 2013 CR - Seq	comment
Research	**391,329**	**367,202**	Reduction mostly ILC R&D
Facility Operations and Exp't Support	**249,241**	**265,786**	NOvA ops start-up and infrastructure improvements
Projects	**129,963**	**102,153**	
Energy Frontier	-	3,000	LHC Detector Upgrades
Intensity Frontier	86,570	62,794	NOvA ramp-down
Cosmic Frontier	12,893	19,159	LSST + G2 DM ramp-up
Other	2,500	3,200	LQCD hardware
Construction	28,000	14,000	Mu2e and LBNE
SBIR/STTR	**0**	**20,775**	
TOTAL HEP	**770,533**	**755,916**	

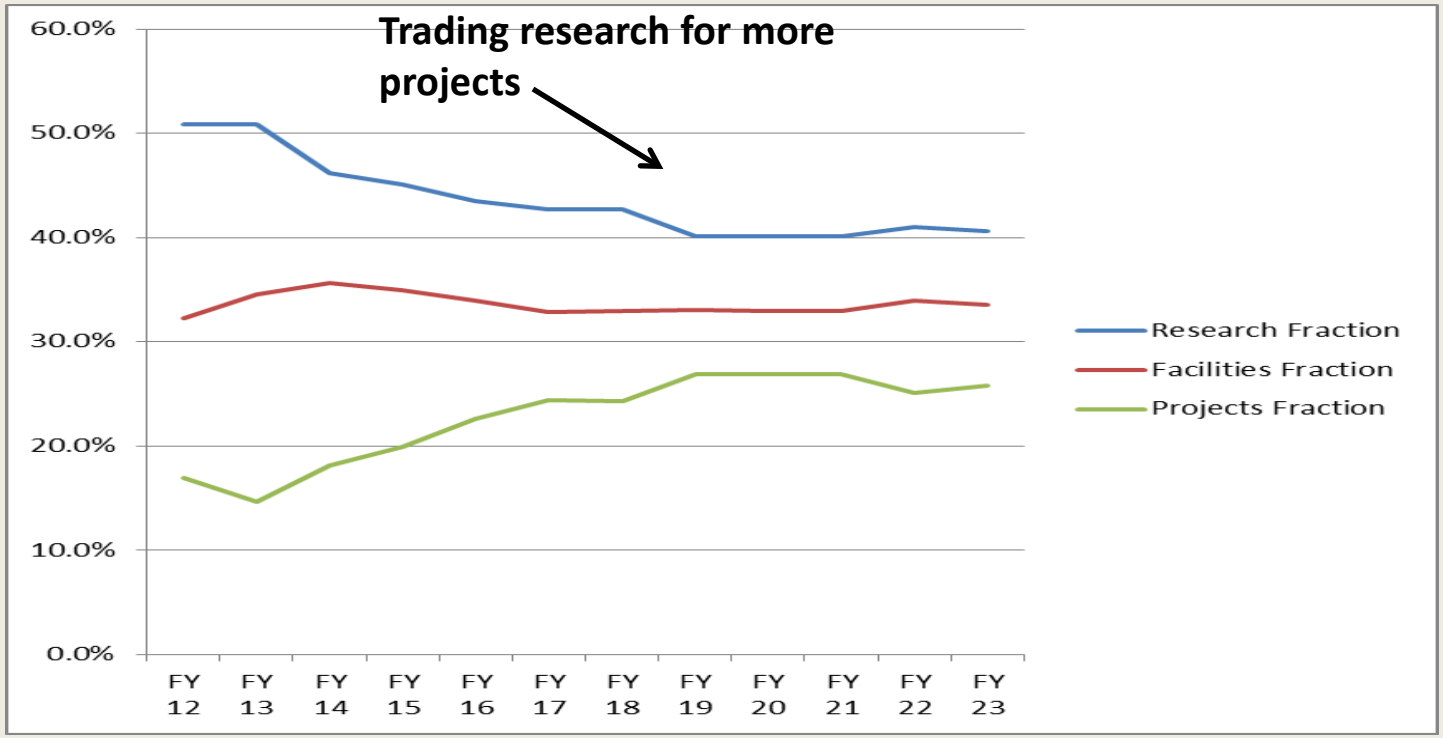
NB: FY 2013 column includes requested reprogramming from Construction to Facility Ops and Research

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.

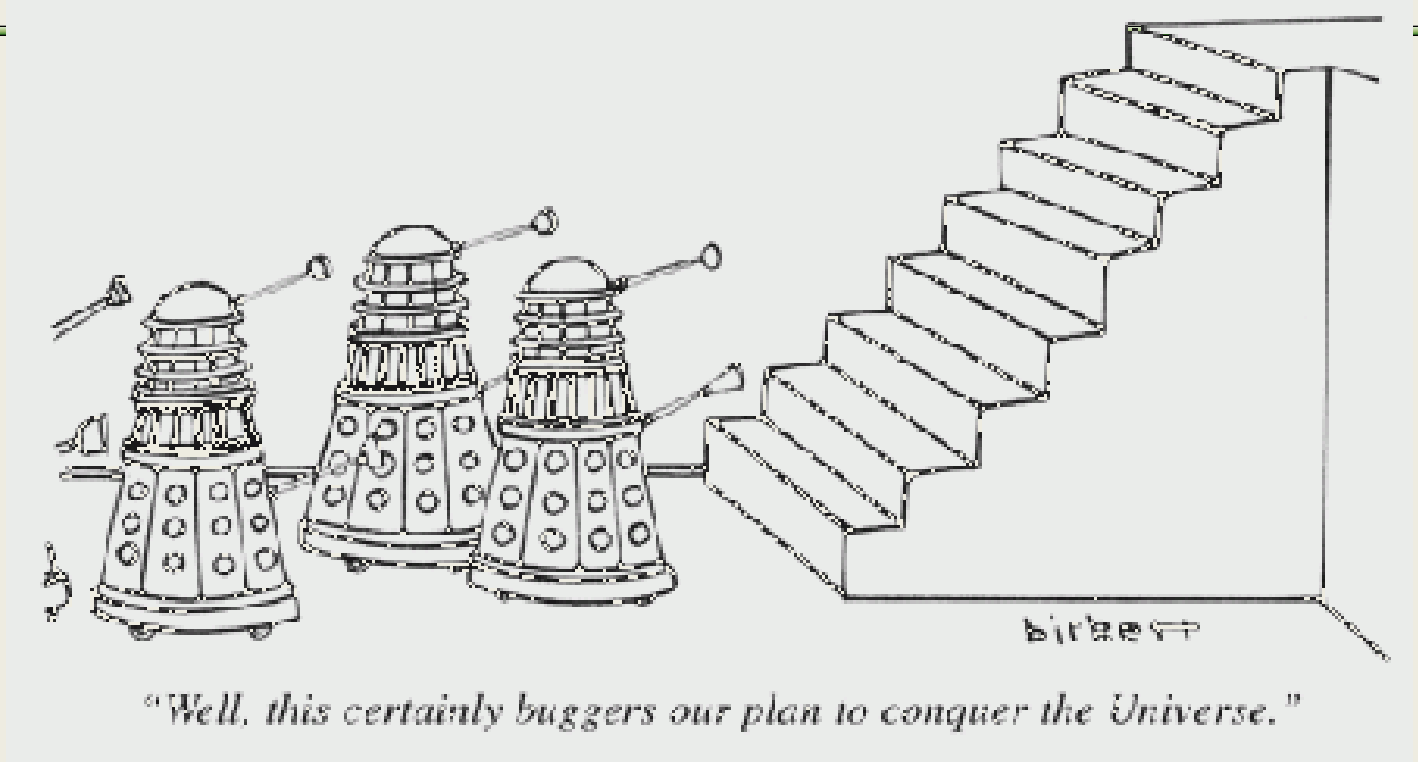
One Possible Future Scenario



- 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 will need help to manage this transition as gracefully as possible.

What We Read in the Papers

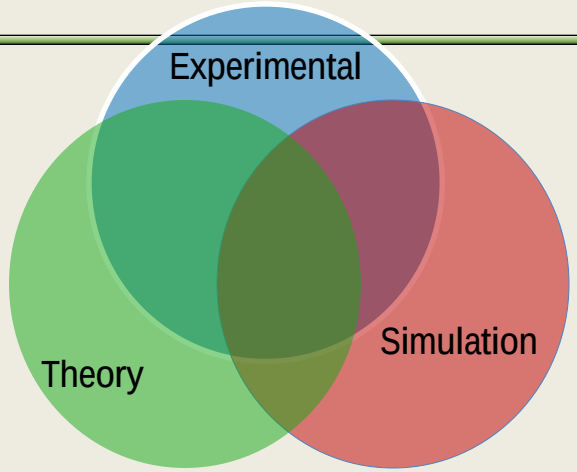
- **Sequestration and FY2013 Budget**
  - Actual sequester reductions in DOE HEP around 5% relative to FY13 CR level
    - Impacts will hit everyone at some level
      - Have taken reductions in Research already (through Comparative Review), so most additional cuts fall on Projects and Facility Ops
      - Not expecting to further reduce grants already in the pipeline
      - "No New Starts" likely but DOE is working this issue
  - Whatever happens will happen at the last minute
- **FY 2014 Budget**
  - Release in March. Or April.
    - Probably DOA in Congress, but short of a "grand bargain", they have to do something
    - Of course this is what we thought last year.
    - Not clear if sequester forces a reset on all discretionary funding for FY 2014.



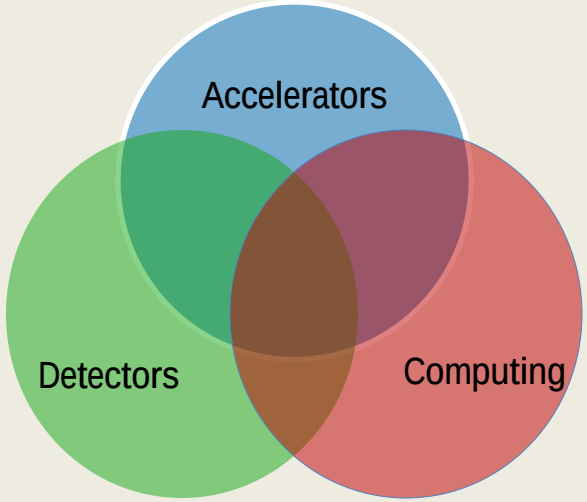
"Well, this certainly buggers our plan to conquer the Universe."

STRATEGIC PLANNING AND COMMUNITY PROCESS

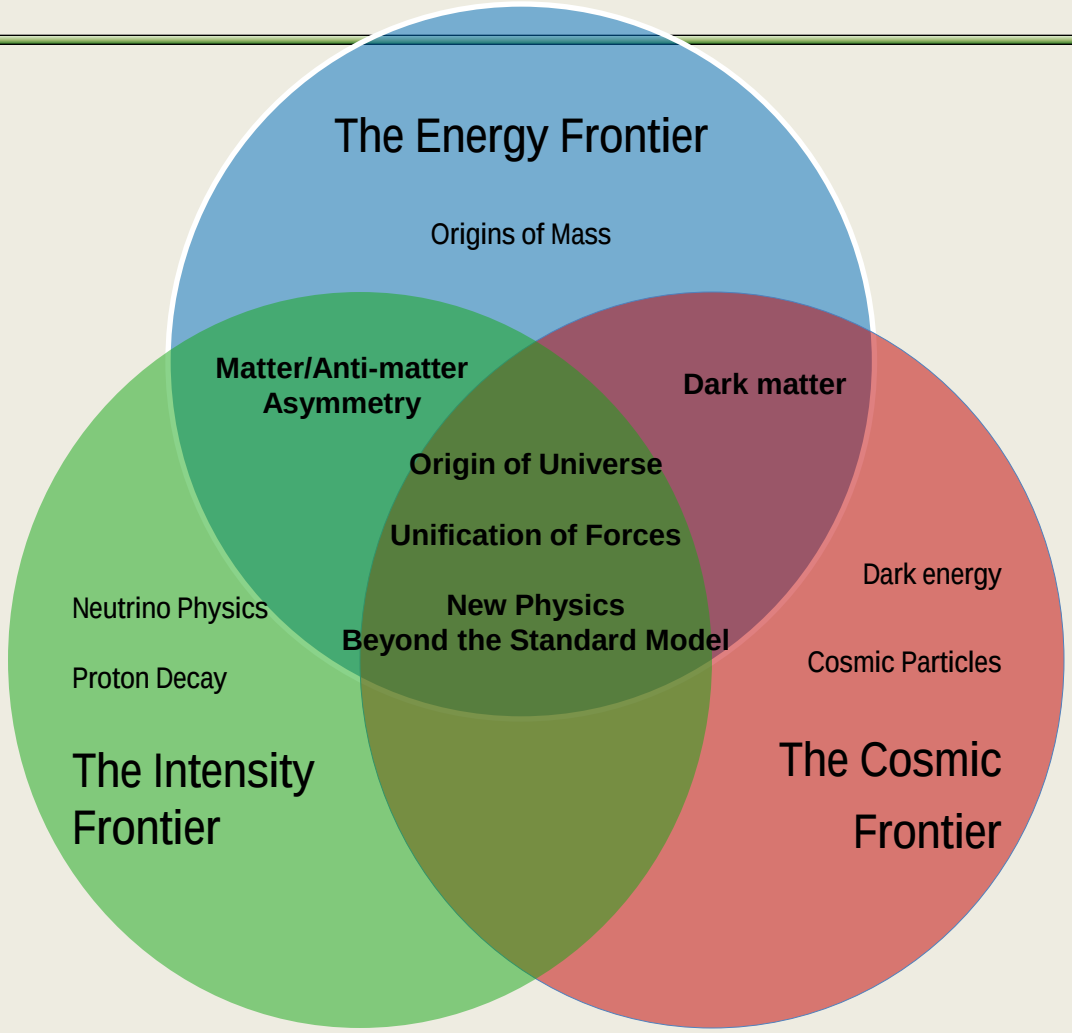
HEP Physics and Technology



Along Three Paths



Enabled by Advanced Technologies in:



Physics Frontiers

Major Recommendations of 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.
- The panel recommends funding for measurements of rare processes to an extent depending on the funding levels available… (Mu2e)
- 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.**

Strategic Planning

- **The HEP budget puts in place a comprehensive program across the three frontiers.**
  - In five years,
    - NOvA,Mu2e, g-2 will be running on the Intensity Frontier.
    - 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.**
  - Engaging with DPF community planning process that will conclude this summer.
  - Will set up a prioritization process (a la P5) using that input.
- **But first, a word or two about the current plan…**

Customized Implementation Strategies

- **Energy Frontier**
  - US has a leading role in LHC physics collaborations but is not the **driver**
    - The issue is the scope and scale of US involvement. Requires US-CERN negotiation.
    - Could also be true for Japanese-hosted ILC but requires *deus ex machina*
- **Intensity Frontier**
  - US is a (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 if we can get going
    - Portfolio of experiments (see next slide) 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
    - Technologies are diverse but HEP physics case is simple and compelling. Only question is how far one needs to go in precision/setting limits.
    - 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*

Intensity Frontier Experiments

Experiment	Location	Status	# Institutions	#Collaborators	#US Inst.	#US Coll.
Belle II	KEK, Tsukuba, Japan	Physics run 2016	70	508+	10 Univ, 1 Lab	55
Daya Bay	Dapeng Penisula, China	Running	38	229	13 Univ, 2 Lab	76
Heavy Photon Search	Jefferson Lab, Newport News, VA, USA	Physics run Spring 2015	17	63+	8 Univ, 2 Lab	47
K0TO	J-PARC, Tokai , Japan	Running	16	66	3 Univ	12
LArIAT	Fermilab, Batavia, IL	Phase I Sep 2013	18	45+	11 Univ, 3 Lab	38
LBNE	Fermilab, Batavia, IL & Homestake Mine, SD, USA	CD1 Dec 2012; First data 2023	65	366+	54	336
MicroBooNE	Fermilab, Batavia, IL, USA	Physics run 2014	19	108	17	101
MINERvA	Fermilab, Batavia, IL, USA	Med. Energy Run 2013	21	65	13 Univ, 1 Lab	48
MINOS+	Fermilab, Batavia, IL & Soudain Mine, MN, USA	NuMI start-up 2013	27	75	15 Univ, 3 Lab	53
Mu2e	Fermilab, Batavia, IL, USA	First data 2019	26	139+	15 Univ, 4 Lab	106
Muon g-2	Fermilab, Batavia, IL, USA	First data 2016	27	100+	13 Univ, 3 Lab, 1 SBIR	75+
NOvA	Fermilab, Batavia, IL & Ash River, MN, USA	Physics run 2014	34	144	18 Univ, 2 Lab	114
ORKA	Fermilab, Batavia, IL, USA	R&D; CD0 2017+	17	48+	6 Univ, 2 Lab	26
Super-K	Mozumi Mine, Gifu, Japan	Running	35	121	7 Univ	29
T2K	J-PARC, Tokai & Mozumi Mine, Gifu, Japan	Running; Linac upgrade 2014	56	500+	10 Univ	70
US-NA61	CERN, Geneva, Switzerland	Target runs 2014-15	27 (NA61/SHINE)	144 (NA61/SHINE)	4 Univ, 1 Lab	15
US Short-Baseline Reactor Expt.	Site(s) TBD	R&D; First data 2016	11	28+	6 Univ, 5 Lab	28

Some Frequently Asked Questions

Q: LBNE with a surface detector followed by Project X seems set in stone. Can we change the plan?

A: LBNE has not achieved CD-2/3 yet so in principle the plan for that project can change. Further, the current LBNE project is only the planned first phase of a proposed broader program which has not yet been approved. That said, the LBNE collaboration has spent considerable effort crafting a well-reviewed scientific case for LBNE, so any changes should have a significant science justification.

Q: Does LBNE make sense when we're talking about needing regular science output?

A: The timescale for LBNE is not unusual. NuMI/MiNOS, RHIC, LHC all had similar timescales from concept to data. The "regular science output" needs to be integrated over the whole Intensity Frontier program which is broad and has many experiments that will deliver physics in the interim (see previous slide).

Q: If the full scope of LBNE delivers the science we want to do, why don't we commit to that now?

A: The required annual funding level could not be supported within current or projected DOE/SC budgets.

Q: Are the agencies doing anything about working with foreign partners to try and get help with LBNE so that we can expand the science reach?

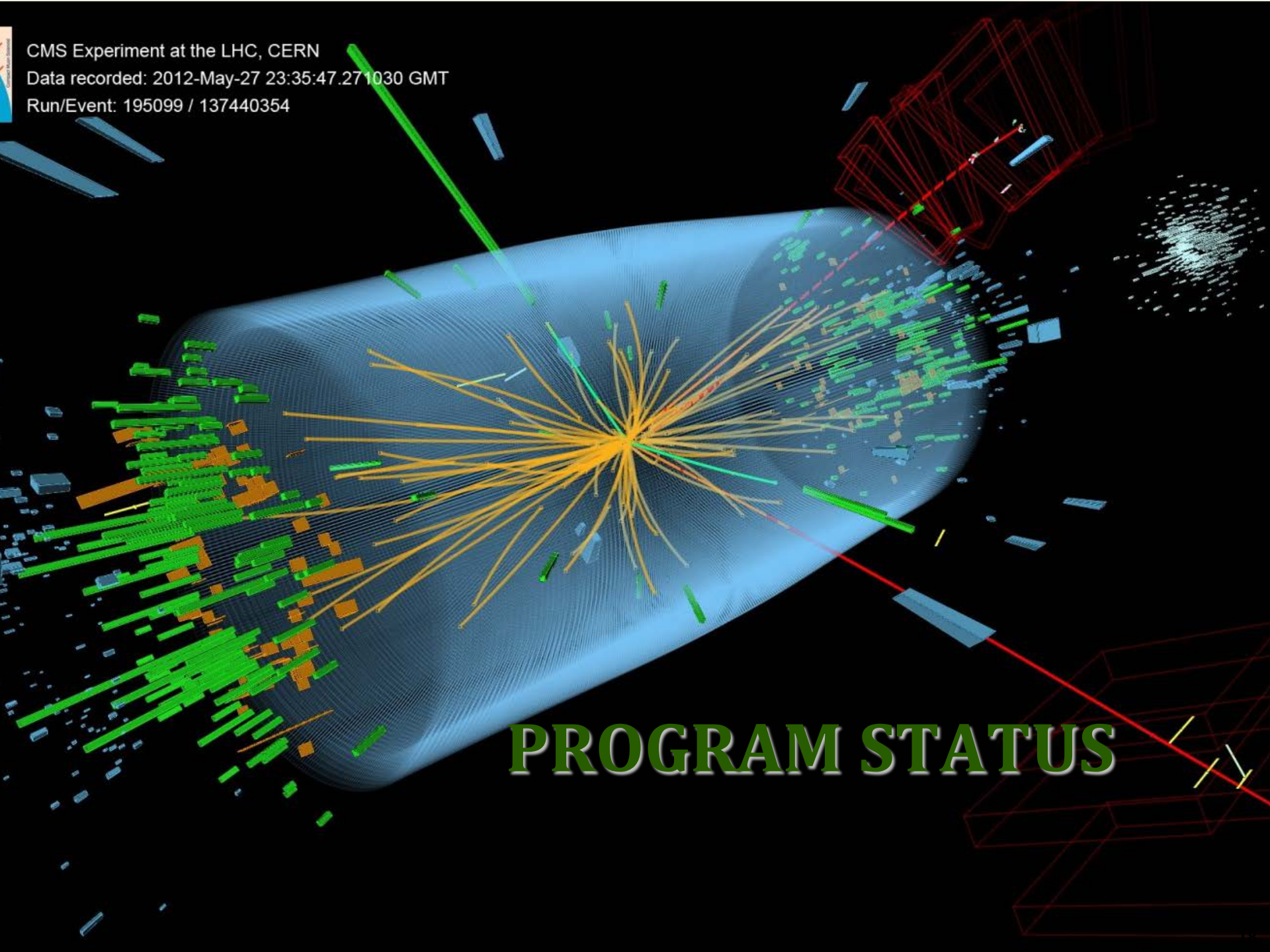
A: Yes. There are high-level discussions underway now but it is premature to comment on details. Several potential partners have indicated interest.

Boundary Conditions, As We See It

- **"Physics comes first."**
  - However there are important real-world considerations.
- **Note that a 'brute force' approach that seeks to spend vast sums in order to build some facility/physics capability simply will not work in today's fiscal environment. This has been empirically demonstrated.**
  - Most recently, via our discussions on LBNE, we have confirmed that single project expenditures must be somewhat smaller than $1B per stage.
- **Projects that build upon previous investments either scientifically or through recycling of infrastructure are generally well received.**
- **A plan that can produce a steady flow of scientific results is also highly desirable.**
  - We need more projects in the pipeline than we have budget to support, since we need to move construction money continuously from one project to the next
  - However an undifferentiated "laundry list" of projects from DPF/CSS2013 won't go far – need to include scientific judgments, branch points, options

Agency Letter to the Community

- 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)



PROGRAM STATUS

Energy Frontier Status

Fermilab Tevatron (DØ and CDF)

- Working with D0 and CDF collaborations on orderly completion of key analyses by the end of 2013.

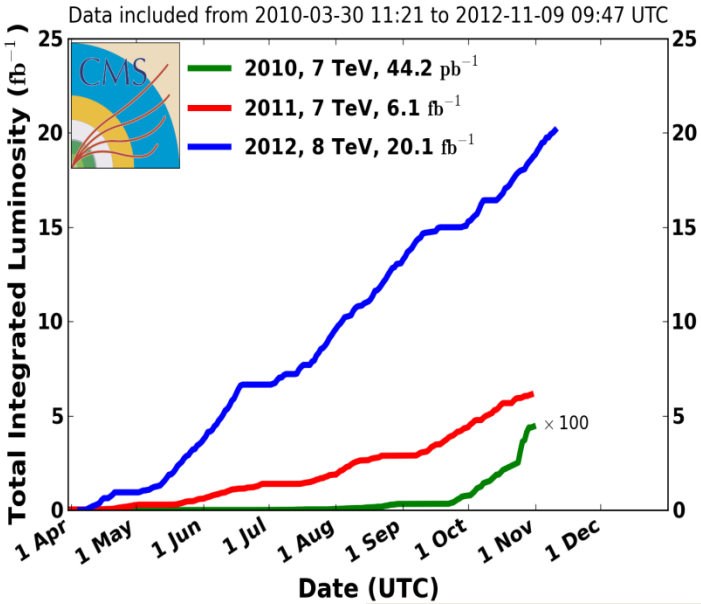
Large Hadron Collider (LHC) at CERN

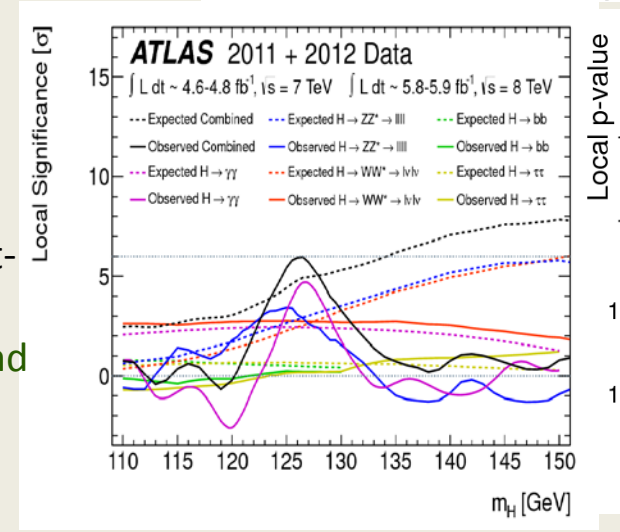
- Working with experiments to develop plan for contributions to “Phase-1” upgrades
- In discussions with CERN management on longer-term upgrade options.
  - US scope for later upgrades TBD
  - Not a “slam dunk”

Physics Status

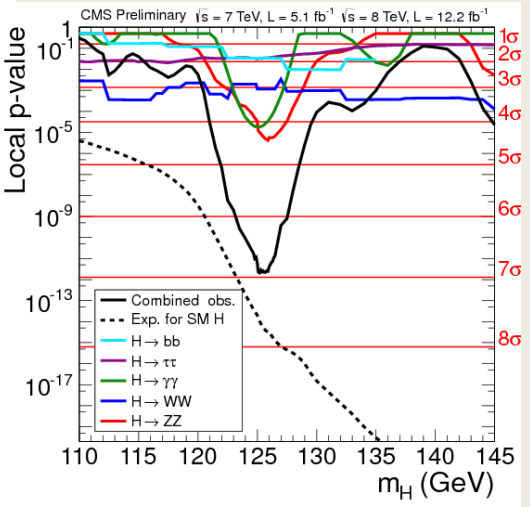
- Experiments are now shifting from a search-based strategy to a measurement-based program
  - “Higgs-like object” looking more and more like SM HIggs
- Still no smoking guns for physics beyond the SM
  - What will 14 TeV running tell us?

Projected by end-2012: ~25 fb^{-1} per CMS & ATLAS





ATLAS Observed Result (July 2012)



CMS Observed Result (as of HCP 2012)

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

Intensity Frontier Status

Current program: Minerva, NOvA, T2K, MicroBoone, Daya Bay, EXO-200

- **NOvA** and **MicroBoone** will complete construction in FY 2014 (see below + next slide), others taking data

Planned program: 4 projects in design/R&D phase; fabrication not approved yet

- **Belle-II**
- **Mu2e**
- **LBNE**
- **Muon g-2**

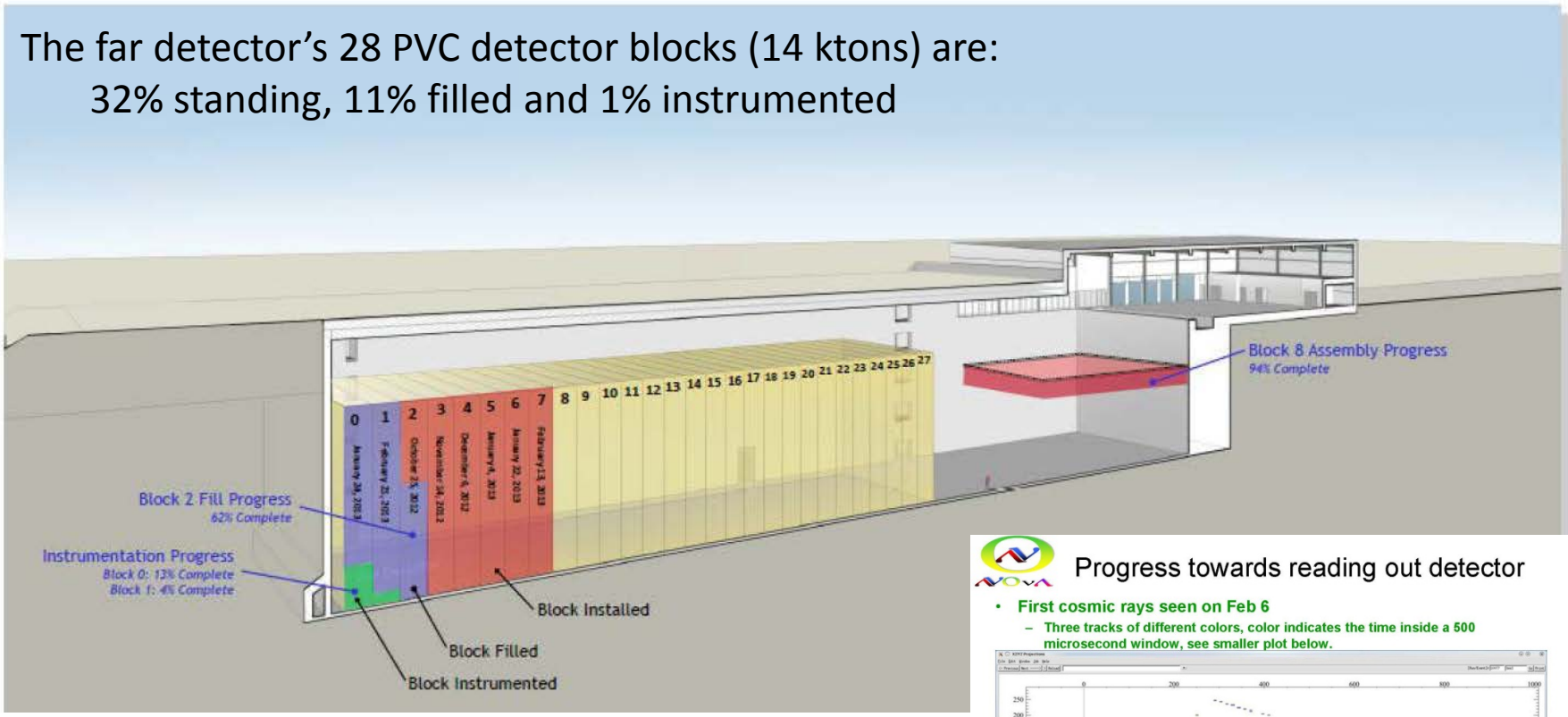
Physics Status

- **Daya Bay, T2K, NOvA**, et al. will usher in the era of precision neutrino physics with few % measurements
  - 1st steps in a comprehensive program

MicroBoone cryostat delivered on March 8 →

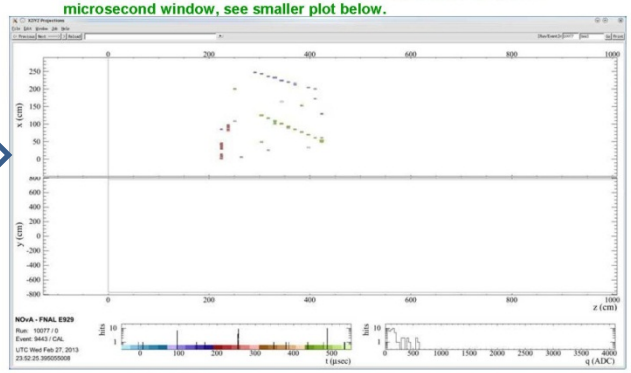
NOvA Far Detector Assembly Progress

The far detector's 28 PVC detector blocks (14 ktons) are:
32% standing, 11% filled and 1% instrumented



Progress towards reading out detector

- First cosmic rays seen on Feb 6
  - Three tracks of different colors, color indicates the time inside a 500 microsecond window, see smaller plot below.



- Cosmic-ray muons were observed February 6
- Neutrino beam from Fermilab will start up June 1 with ~ 3 kilotons fully instrumented!

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?

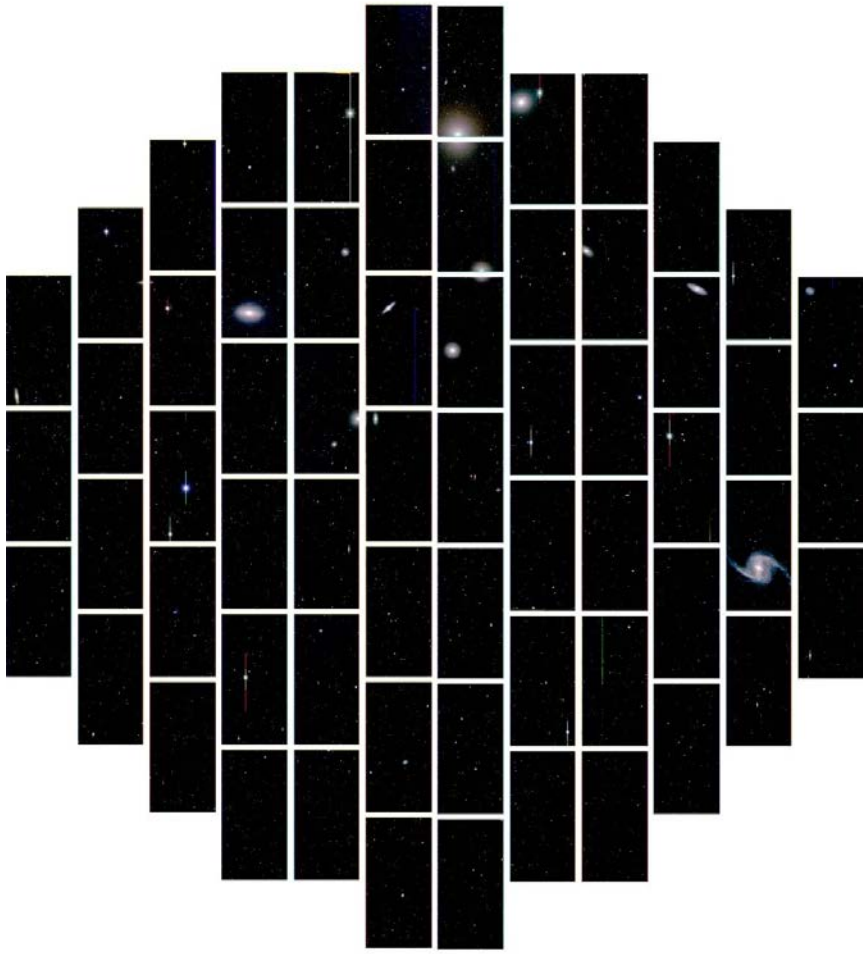
Cosmic Frontier Status

Current program

- Several operating experiments studying high-energy cosmic and gamma rays
  - **Fermi/GLAST, Veritas, Auger, AMS**
- Several 1st generation (G1) dark matter direct detection experiments operating: **ADMX, LUX, CDMS-Soudan, DarkSide, Xenon**
- Several dark energy programs underway using existing telescopes and cameras: **BOSS, supernova surveys**
  - **Dark Energy Survey** commissioning

Planned program

- **2nd-Generation Dark Matter** experiments to probe most of preferred phase space
- **Large Synoptic Survey Telescope** will make definitive ground-based Stage IV Dark Energy measurements
- **Mid-scale Dark Energy Spectroscopic instrument** to complement DES/LSST
- **High Altitude Water Cherenkov (HAWC)** starts operations in 2014



DES First Light

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

Dark Matter:

- **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.**

Dark Energy

- **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.


COMMUNICATIONS

The Communications Issue

- **We are in competition with other SC programs as well as other agencies for science funds**
  - To successfully develop, explain & defend the program, will need to have community buy-in to the *planning process* and to the *plan itself.*

- **Accumulating evidence that we may have a problem:**
  - Internal stakeholders not cognizant of major issues, planning process, existing plan
  - External stakeholders getting a mixed message about US HEP strategy and priorities
  - Other than LHC/Higgs, most of HEP press coverage in last 2-3 years is about what we are **not** doing (see examples next slide)
  - Lack of agreement or acknowledgment of process itself

Top Google HEP Search Results

- "US Particle Physics"
  1. Future of Top U.S. Particle Physics Lab in Jeopardy: Scientific Am.

  (2-5 FNAL, NSF, US News, Physics Today)

  6. Europe Overtakes *U.S.* in *Physics* Pursuing God *Particle* ...
- "US High Energy Physics"
  1. (DOE HEP home page)
  2. (HEPAP home page)
  3. Era of *US high-energy physics* draws to end – YouTube
- "US particle physics funding"
  1. (NSF EPP home page)
  2. (ditto)
  3. *US physics* suffers budget setbacks - *physicsworld*.com

The Common Goal

- **A realistic, coherent, shared plan for US HEP**
  - Enabling world-leading facilities/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 multipurpose 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
- **We think we need this in order to properly develop, explain & and defend the program.**
  - Does the community agree? Do they buy-in to the process?

The Communications Summit

- **Community involvement and ownership – with recognition of the realities of the fiscal environment, and the competitive landscape for science funding, are key for our success**
  - In parallel with our internal planning, we also need to convey to the outside world an understanding and appreciation of what we do
  - Collectively these present communication and coordination challenges that we need to work on- collaboratively
- **The first step is a Summit planned for Wednesday March 13th to discuss strategies to identify and overcome our perceived Communication and Coordination challenges :**
  - Where do our major communication and coordination challenges lie?
  - How do we formulate the upcoming P5 process to maximize success?
  - How do we best articulate the new and evolving scientific goals of HEP with compelling arguments outside the HEP community?
  - How do we design a message to gain societal and external recognition of the importance of what we do?

How Can We Make This Work?

- **In the face of: flat or declining budgets?**
  - Community needs to re-evaluate its expectations and appetites
    - E.g., “All or nothing” versus staged approach
    - “absolutely central” versus “important” science
  - Genuine joint planning with Europe and Japan
    - Minimizing overlap/duplication and maximizing bilateral support
    - Can expand science scope but leads to even longer project timescales
- **Increased scrutiny of projects and “deliverables”?**
  - Anything that is not curiosity-driven research needs to adopt project-like approach with milestones and sunsets
    - We continue to work this with advanced technology R&D
    - Projects and operating experiments need to deliver
- **Need to demonstrate relevance?**
  - Developing accelerator stewardship program
  - Stay in the news (for the right reasons)

What We Need

- **Ideas on how to revitalize the existing program (that don't require large infusions of cash):**
  - How best to assess/prioritize lab + univ infrastructure
  - How best to enhance sharing of univ + lab resources
  - Better ways to support young people
- **What are the best areas to make strategic/directed R&D investments, evaluated by:**
  - Potential for science impact (not necessarily just HEP)
  - Technological readiness and clear milestones
  - US leadership or unique capability
- **An implicit (or explicit) recognition of realistic budgets, timeframes, and programmatic priorities**

Take-Away Message

- **The U.S. HEP program is unlikely to be able to outspend our international competition**
- **The U.S. political system is averse to long-term investments and not strong in planning**
- **Our only hope to maintain leadership in the long-term is to out-innovate the competition, and exploit unique capabilities**
  - Focus on areas where US can have leadership
  - "High-risk, high-impact" as opposed to incremental advances
  - Note this not an either/or proposition, we need both with appropriate balance
- **We need your help**
  - Community engagement and buy-in
  - "Full and frank" discussions

OFFICE NEWS ETC

HEP Office News

- **Comings and Goings:**
  - Eric Colby (SLAC) joined office as IPA effective Feb 1, working on Accelerator R&D and stewardship
  - Fred Borcherding retired late 2012
  - Staff position for Physicist (Instrumentation): closed in late Jan., interviews underway
  - Discussions with two new IPA candidates underway
- **Conferences**
  - Trying to smooth implementation of DOE guidance where possible
  - We continue to spend a large number of person-hours on this

Current and Upcoming Reviews

Research Reviews

- Comparative university grant review panels held in Nov., decisions in Jan., grants start May 1
  - FY13 requests are 2-3x the available funding for most programs. See G. Crawford talk later.
- Comparative lab research reviews held summer 2012, reports out now (Energy) or soon (Det. R&D)
  - 2013 Reviews: Accelerator R&D (March), Intensity (May), Cosmic (Sept?)
- Office of Science Early Career review panels in Jan.
  - Expect ~10 HEP awards (lab + univ), announced late spring/early summer
  - FY2013 sequester forces reduction in number of new awards.

Operations Reviews

- Plan to institute reviews of operating (or near-operating) experiments on a regular schedule
  - Already do this for LHC experiments annually, also Fermilab operations review
  - Cosmic frontier ops review Sep 2012, Intensity frontier Univ. ops review Jan 2013
    - Review each experiment individually (i.e. didn't rank/prioritize against each other)
    - For experiments that don't already have an agreed-upon operations phase, we will use this as an opportunity to develop an operations plan and set the operations budget & schedule
    - Results will inform future program planning

Project Reviews

- Well established CD process continues