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Perspectives from the Office of High Energy Physics

Fermilab User's Meeting

June 2-3, 2010
Batavia, Illinois

Dennis Kovar
Associate Director of the Office of Science
for High Energy Physics

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DOE Office of Science (SC)
Office of High Energy Physics (OHEP)

DOE SC OHEP Program is the U.S. Federal Steward of HEP research

- **providing over 90 % of federal support to**
  - **design, construct and operate the research facilities**
  - **support researchers at universities and laboratories**
  - **develop the advanced technologies and next generation scientific/technical workforce**

The Scientific community identifies the scientific opportunities and their priorities

- **defines the scientific field and future direction**
  - **DOE/NSF chartered High Energy Physics Advisory Panel (HEPAP) Reports**
  - **Other scientific reports (National Academy, AAAC, OECD GSF, etc.)**
  - **Facility PACs, DOE Reviews, etc.**

OHEP Mission is to maintain the Nation's competency/leadership in HEP research

- **with responsibilities to**
  - **establish a strategic plan that address the identified scientific opportunities**
  - **formulate, justify and defend Budget Requests to implement that plan**
  - **effectively manage the funding obtained to deliver significant outcomes**

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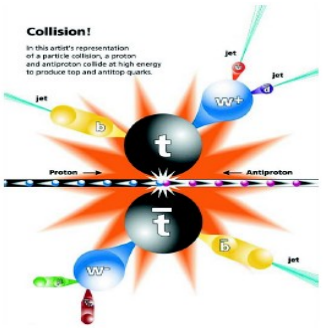
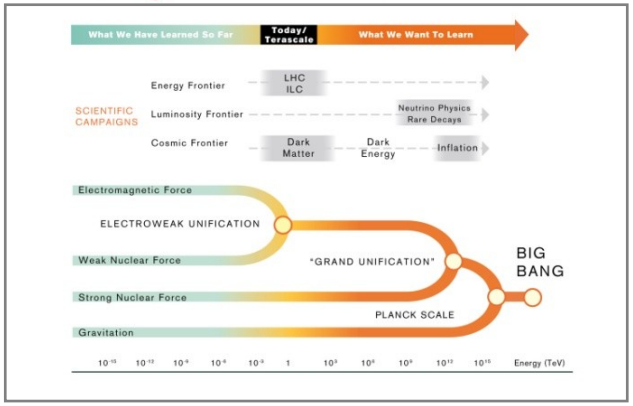
High Energy Physics Today:
The Three Scientific Frontiers

- **The Energy Frontier**, powerful accelerators create new particles, reveal their interactions, and investigate fundamental forces;
  - New particles (Higgs, SUSY)
  - Extra Dimensions

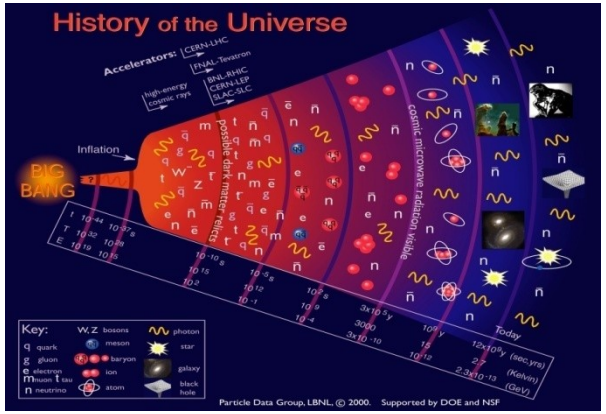


$E = mc^2$

- **The Intensity Frontier**, intense particle beams and highly sensitive detectors pursue alternate pathways to investigate fundamental forces and particle interactions by studying events that occur rarely in nature
  - Neutrino properties
  - Matter-Antimatter Asymmetry
  - Unification of Forces



- **The Cosmic Frontier**, ground and space-based experiments and telescopes make measurements that will offer new insight and information about the nature of dark matter and dark energy, to understand fundamental particle properties and discover new phenomena
  - Dark Energy →new forces ?
  - Dark Matter →new particles ?



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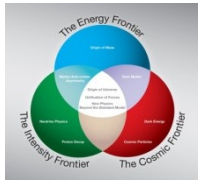
Strategic Plan
Positioning the U.S.



Program Elements	Goals *(discoveries/answers to questions)*	10-year Plan
Energy Frontier Physics	New particles (Higgs, SUSY) Extra dimensions	Complete the Tevatron Program. Partner with CERN to make discoveries and realize the benefits of investments at the LHC
Intensity Frontier Physics	Neutrino properties Matter- antimatter asymmetry Unification of Forces	Implement and carry out a U.S. world-leading Intensity Frontier program based at Fermilab and in partnership with NSF
Cosmic Frontier Physics	Dark Energy Dark Matter	Implement compelling particle astrophysics opportunities for discovery in partnership with other agencies as appropriate
Advanced Technology R&D	Position the U.S. to be at the forefront of accelerator and instrumentation technology	Maintain and nurture core competencies, encourage technology transfer, and mount campaigns to make technological breakthroughs that enable HEP and DOE/SC programs

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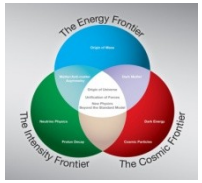
Strategic Plan
Developing Scientific Tools



	Tools Today	Possible Future Tools
Energy Frontier highest energy particle beams fundamental constituents and architecture of nature	Tevatron LHC (hadron) LHC Detectors (lepton) LQCD & SciDAC	 LHC upgrades LHC Detectors upgrades TeV Lepton Collider LQCD & SciDAC
Intensity Frontier intense particle beams and highly sensitive detectors unique investigations of fundamental interactions.	Fermilab/NuMi MINOS, Minerva EXO LQCD & SciDAC	NuMi (700kW)→ Project X (2000 kW) NOvA → LBNE Mu2e Double Beta Decay Daya Bay LQCD & SciDAC
Cosmic Frontier using particles from space to explore new phenomena and nature of dark matter and dark energy	BOSS (Dark Energy) Supernova Searches (Dark Energy) CDMS, ADMX (Dark Matter) COUPP-60 (Dark Matter) Fermi (GLAST) (Gammas) VERITAS (Gammas) Pierre Auger South (Cosmic Rays) SciDAC	DES, LSST JDEM SuperCDMS-Soudan LUX, Large DM experiment HAWC, VERITAS-upgrade. AGIS AMS, Pierre Auger – North SciDAC

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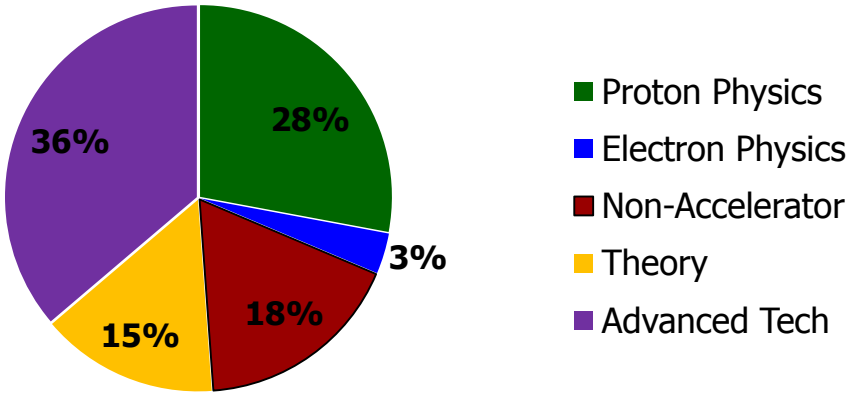
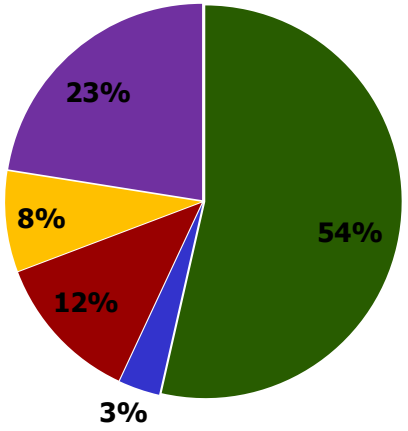
HEP FY2010 Funding
Budget Categories

Budget Categories	FY 2010 HEP Research		FY 2010 HEP Research, Projects and Operations
Proton Accelerator-Based Physics	125.4	28%	434.2
Electron Accelerator-Based Physics	15.4	3%	27.4
Non-Accelerator Physics	78.5	17%	99.6
Theoretical Physics	67.0	15%	67.0
Advanced Technology R&D	162.6	36%	182.3
High Energy Physics	448.9	55.4%	810.5

Research Funding



Program Funding



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HEP Budget Overview
HEP FY 2011 Budget Request

FY 2011 Request is a +2.3% increase compared to FY 2010 Appropriation

FY 2010 Appropriations were a +1.9% increase over FY 2009 Appropriations

(dollars in thousands)

	FY 2009 Current Appropriation	FY 2009 ** Current Recovery Act Appropriations	FY 2010 Current Appropriations	Delta	FY 2011 Request	Percent
High Energy Physics						
Proton Accelerator Based Physics	401,368	107,990	434,167	5,095	439,262	1.2%
Electron Accelerator Based Physics	32,030	1,400	27,427	-2,720	24,707	-9.9%
Non Accelerator Based Physics	101,138	4,445	99,625	-11,086	88,539	-11.1%
Theoretical Physics	66,148	5,975	66,962	2,562	69,524	3.8%
Adavanced Technolgy R&D	195,042 *	116,690 *	182,302	7,666	189,968	4.2%
Subtotal, High Energy Physics	795,726	236,500	810,483	1,517	812,000	0.2%
Construction	0	0	0	17,000	17,000	
Total, High Energy Physics	795,726 *	236,500 *	810,483	18,517	829,000	2.3%
			1.90%			

** The Recovery Act Current Appropriation column reflects the allocation of funding as of September 30, 2009.

- Total includes SBIR/STTR: $17,730,000 of which was transferred to the Small Business Innovation Research (SBIR) program and $2,128,000 of which was transferred to the Small Business Technology Transfer (STTR) program.

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FY 2011 Program Highlights

Energy Frontier

- Tevatron operates in FY 2011 (possibility of discovery or ruling out over a significant fraction of the allowed mass region for the Higgs boson in the Standard Model at the 95% confidence level).
- U.S. LHC program supported (at a level that will allow U.S. researchers to play a leading role in extracting physics from the data obtained and in planned upgrades).

Intensity Frontier

- On-going MIE projects (NOvA and Daya Bay) are supported on planned schedules
- First investments (MicroBooNE, Mu2e and LBNE) made for next generation U.S. leadership program

Cosmic Frontier

- Support ongoing programs (e.g.; Fermi, AMS, VERITAS, Pierre Auger, BOSS, CDMS-II, COUPP, LUX, ADMX)
- On-going MIE projects (DES, SuperCDMS-Soudan) are supported on planned schedules
- R&D for possible future experiments (guidance from HEPAP (PASAG) and ASTRO2010)

Core Research

- EPP Research supported at a level that will maintain scientific workforce and the ability to be productive
- Advanced Technology R&D supports high risk, high impact initiatives, development of infrastructure (e.g.; BELLA and FACET) and core competencies important for the U.S.

FY 2011 Budget Request
Breakout of Funding

Facility Operations are constant
Core Research and Projects maintained (grow somewhat)

HEP Functional Categories	FY 2009	FY 2009 ARRA	FY 2010	Delta	FY 2011 Request	vs FY10
Fermilab Accelerator Complex Operations	162.8	15.0	156.5	-1.4	155.1	-0.9%
LHC Detector Support/Operations	69.4	0.0	71.2	3.6	74.8	5.1%
SLAC Accelerator Complex Operations	15.3	0.0	12.1	-2.3	9.8	-19.0%
Facility Operations	**247.5**	**15.0**	**239.7**	-0.1	**239.6**	0.0%
EPP Research	284.5	24.8	286.3	10.9	297.1	3.8%
Advanced Technology R&D	167.2	78.9	162.6	4.1	166.7	2.5%
Core Research	**451.7**	**103.7**	**448.9**	15.0	**463.9**	3.3%
Intensity Frontier Projects	47.7	55.0	72.8	5.4	78.3	
Energy Frontier Projects	2.5	0.0	9.0	0.3	9.3	
Cosmic Frontier Projects	10.9	0.0	10.1	-6.1	4.0	
Technology Projects	8.0	33.7	0.0	3.2	3.2	
Projects	**69.1**	**88.7**	**92.0**	2.8	**94.7**	3.0%
Other (GPP/GPE/SBIR/STTR)	**27.5**	**29.1**	**29.9**	0.9	**30.8**	2.9%
High Energy Physics	**795.7**	**236.5**	**810.5**	18.5	**829.0**	2.3%

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FY 2011 Budget Request
Projects

HEP Projects (MIEs and Construction)	FY 2009	FY 2009 ARRA	FY 2010	Delta	FY 2011 Request	vs FY10
Project - NOvA - MIE	27.8	55.0	59.0	-12.8	46.2	
Project - Minerva - MIE	4.9	0.0	0.8	-0.8	0.0	
Project - MicroBooNE - MIE	0.0	0.0	2.0	6.0	8.0	←
Project - Mu2e - Construction (Ops & TEC)	0.0	0.0	0.0	10.0	10.0	←
Project - T2K - MIE	1.0	0.0	0.0	0.0	0.0	Ramping
Daya Bay - MIE	14.0	0.0	11.0	-8.9	2.1	up
Project - LBNE - Construction (Ops & TEC)	0.0	0.0	0.0	12.0	12.0	←
Intensity Frontier Projects	**47.7**	**55.0**	**72.8**	5.4	**78.3**	7.5%
LHC Accelerator Upgrade - APUL - MIE	2.5	0.0	9.0	0.3	9.3	
Energy Frontier Projects	**2.5**	**0.0**	**9.0**	0.3	**9.3**	2.8%
Project - DES - MIE	9.9	0.0	8.6	-4.6	4.0	
Project - Super CDMS - MIE	1.0	0.0	1.5	-1.5	0.0	
Cosmic Frontier Projects	**10.9**	**0.0**	**10.1**	-6.1	**4.0**	-60.4%
FACET	0.0	14.5	0.0	0.0	0.0	
Project - SRF Electron Beam Welder - MIE	0.0	0.0	0.0	3.2	3.2	
Project - BELLA - MIE	8.0	19.2	**0.0**	0.0	0.0	
Technology Projects	**8.0**	**33.7**	**0.0**	3.2	3.2	
Total, HEP Projects	**69.1**	**88.7**	**92.0**	2.8	**94.7**	3.0%

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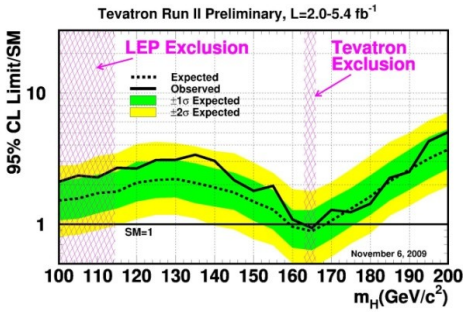
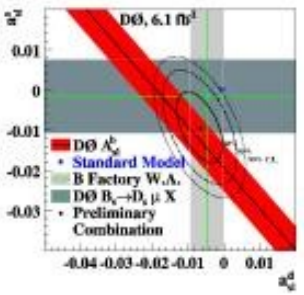
Energy Frontier:
Recent Activities & Plans

Tevatron

- Operate Tevatron in FY 2011
- Higgs: expand exclusion region or first hints
- Surprises welcome!





LHC Program

- Colliding and recording data at 7 TeV!
- CERN is in the process of defining its mid-term plan for the LHC program
  - U.S. is planning to participate in the LHC program
  - Participation includes detector / accelerator upgrades
  - Present US-CERN MOU lasts until 2017
  - CERN activities and plans for LHC are driving discussions of global projects

Next generation Lepton Collider

- Decision awaits results from LHC & commitments of interested participants
  - Envisioned to happen ~ FY 2012 – now expected to happen somewhat later
  - Working with ART to define a US ILC R&D FY2012–2015 program

Working to establish a five year national muon accelerator R&D plan

- Fermilab has been charged to organize this national effort

Investments in Plasma Wakefield Acceleration Demonstration Projects

- Recovery Act funding used to proceed on BELLA and FACET projects

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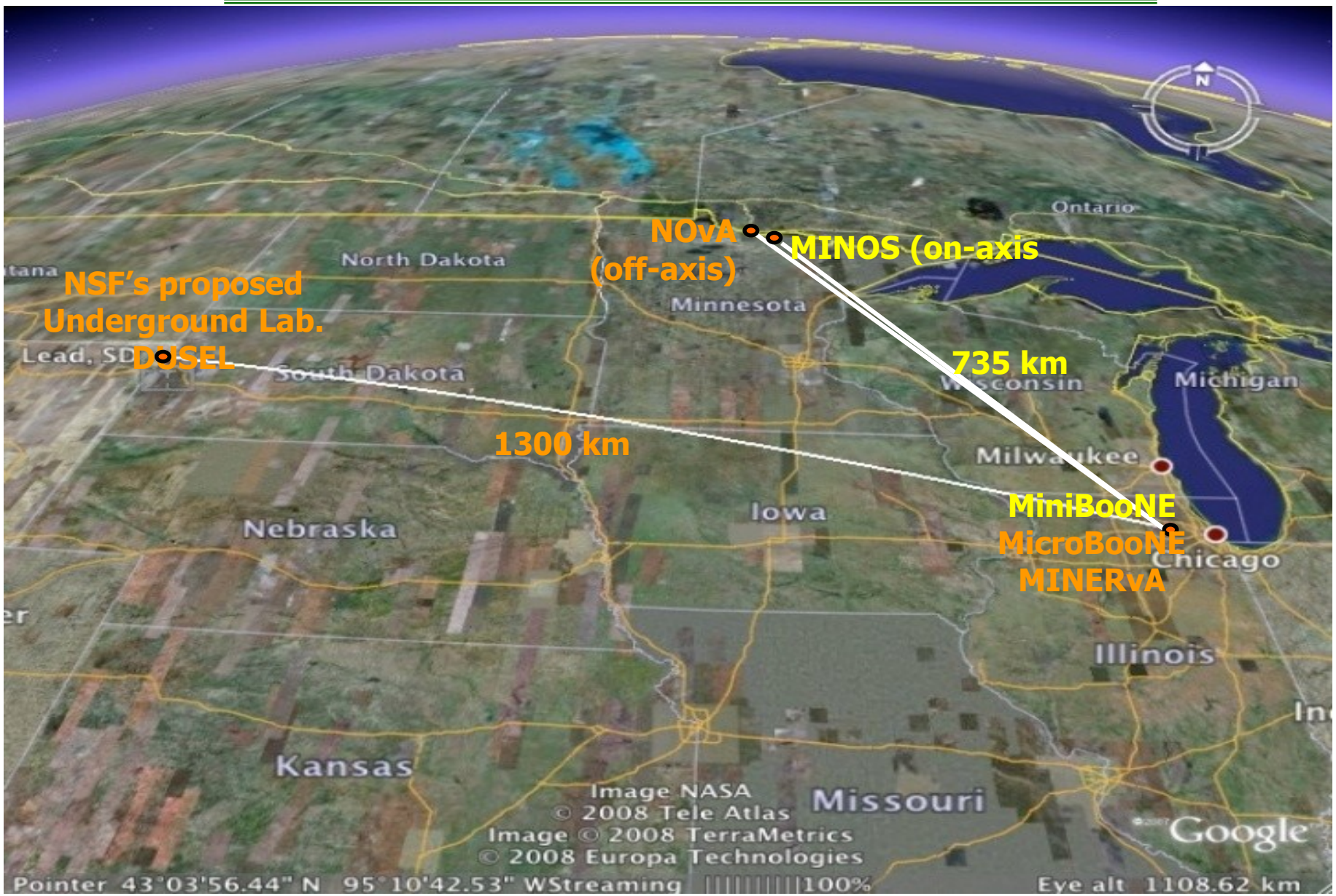
Intensity Frontier Implementation of a World-class Neutrino Program



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U.S. Intensity Frontier Program:
The Neutrino Program

Envisioned "world-class" intensity frontier program entails evolution of the Fermilab accelerator complex

- MINOS/Minerva → NOvA (700kW) → LBNE (700kW) → SLBNE (2000 kW)
- Accelerator infrastructure allow: SLBNE → neutrino factory → muon collider (regain the Energy Frontier)

Envisioned "world-class" intensity frontier program also entails development of an underground detector

- LBNE need a large underground detector (~100-300 ktons)
- A large detector (~300 kton) at the right depth (~5000 ft) detector can also do proton decay
- Physics goals: searches for CP violation and proton decay at factors of 10-100 greater sensitivity

Goals are ambitious and will take significant combined (DOE, NSF, other countries) resources

- NSF is proposing a Deep Underground Science and Engineering Laboratory (DUSEL)
- Europeans have a large underground detector in their strategic planning
- Japanese are also interested in the science
- Indian government has expressed an interest in participation.

DOE and NSF have had discussion with OMB and OSTP on how to coordinate planning

- NSF is supporting the preliminary design of the DUSEL facility and a suite of experiments
- DOE HEP has CD-0 approval for the LBNE (neutrino beam /near and far (large underground) detectors)
  - Working towards CD-1 approval in FY11.
- DOE and NSF are working together to coordinate their efforts, avoid duplication, and optimize their investments.
  - Holding frequent Joint Oversight Group meetings.
- DOE Undersecretary Koonin and NSF Director Bement submitted joint statement indicating support

Intensity Frontier:
Other Scientific Opportunities

Muon to electron conversion experiment (Mu2E)

- Has received Mission Need (CD-0)
- Broadens Intensity Frontier Program
- Significant funding requested in FY 2011.

Other Opportunities

- OHEP has received a report from SLAC on possible US options in SuperB (Italy)
  i. Provision of reusable PEP-II and BABAR components
  ii. i + additional funding for US participation in detector program
  iii. ii + additional funding for US participation in accelerator program
- OHEP expects to get a proposal for participation in Belle-II at SuperKEKB (Japan)
  - Participation in detector subsystems
- OHEP expects to get a proposal for implementing g-2 experiment at Fermilab
  - Utilizes existing Fermilab infrastructure and planned upgrades
  - Utilizes BNL D&D

OHEP will conduct peer-reviews of these scientific opportunities

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Cosmic Frontier:
Guidance from HEPAP (PASAG) Report

Optimized program over the next 10 years in 4 funding scenarios:

- Similar to P5 funding Scenarios

Prioritization Criteria for Particle Astrophysics

- 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)

Priorities are generally aligned with recommendations for Cosmic Frontier in the 2008 HEPAP (P5) Report

- Dark matter & dark energy both remain high priorities

Guidance:

- Dark energy funding (recommended for largest budget portion) should not significantly compromise US leadership in dark matter, where a discovery could be imminent
- Dark energy and dark matter together should not completely zero out other important activities
- HEP (along with NASA and NSF) awaits Astro2010 Report before decisions on proposed major projects (AGIS, Auger-North, BigBOSS, JDEM, LSST).

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Non-Accelerator Physics: Recent Activities and Plans

DOE and NASA continue to work to identify the path forward on a Joint Dark Energy Mission

- Two concepts (IDECS and OMEGA) presented to Astro2010 in June 2009.
- Costs are not compatible with current budget projections
- Project Offices (GSFC and LBNL) developing a $650M-capped mission concept
- Advice being provided by the Interim Science Working Group (since December 2009)
- European Space Agency (ESA)has interest in a partnership on their proposed DE mission
- NASA and ESA are studying a partnership

DOE and NSF charged HEPAP to assess opportunities in particle astrophysics

- HEPAP [Particle Astrophysics Scientific Assessment Group (PASAG)] Report submitted in 2009
- Guidance is being utilized in DOE SC HEP planning

Looking for guidance from Astro2010 - the findings and recommendations:

- Will influence the opportunities for HEP participation
- Will 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

- Global coordination and planning of astroparticle physics experiments
- Study report will be completed in Oct. 2010

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Accelerators for America's Future Symposium

The HEP sponsored Symposium and Workshop in 2009:

- Opportunities for better connection between fundamental accelerator R&D and applications
- Guidance on the needs of federal programs and the private sector

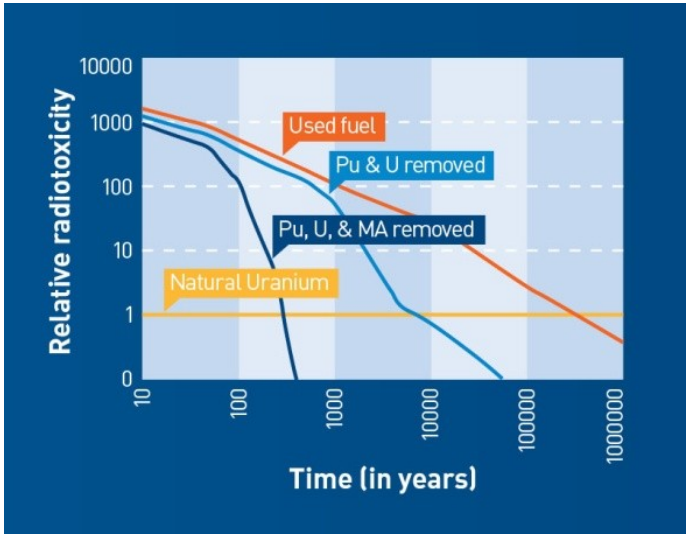
The Workshop Report will be use in developing plans for Accelerator Science/R&D programs.

- Thanks to Workshop co-chairs (Walter Henning and Charles Shank) and participants
- Thanks to the chief editors – Judy Jackson and Walter Henning.

HEP is considering new initiatives (workshops, R&D centers) based on identified accelerator opportunities , research priorities, and policy issues.

A few opportunities:

- Accelerator Driven Systems
- Treatment of flue gases, waste, and water
- Isotope generation and heavy ion therapy
- Environmentally friendly industrial use
- Defense, cargo interrogation, and monitoring
- Next generation discovery science machines



Some policy issues

- Demonstration facilities
- Improved interagency, agency- industry communication
- Strengthened educational programs

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Research Opportunities

Areas of R&D identified by each working group. All areas are of importance to each working group. Color coding indicates areas with greatest impact.

R&D Need	Energy & Environment	Medicine	Industry	Security & Defense	Discovery Science
Reliability					
Beam Power/RF					
Beam Transport and Control					
Efficiency					
Gradient (SRF and other)					
Reduced Production Costs					
Simulation					
Lasers					
Size					
Superconducting Magnets					
Targetry					
Particle Sources					

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Other Program Activities

HEPAP/Advisory

- HEPAP Committee of Visitors (COV) to examine/evaluate operations of the DOE SC OHEP

Office of HEP

- Two recent appointments
  - Fred Borcherding – Program Manager for Instrumentation
  - Michael Salamon – Program Manager for Non-Accelerator Physics
- Office significantly strengthened by for IPAs & Detailees (a number of appointments ending in FY2010 and FY2011)

Federal Vacancies

- Computational HEP Program Manager
- Theoretical Physics Program Manager
- Accelerator Science Program Manager

Early Career Awards

- Funding of $16M provided in FY 2009 ARRA (4 laboratory & 10 university 5-year awards)
- Coordinated/managed at Office of Science (SC) level
- Steady state funding of ~$16M will be established for such awards in out-years

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HEP Early Career Program

- **Supersedes HEP Outstanding Junior Investigator (OJI) program**

- **Breakdown of proposals:**

	Experiment	Theory	Total
Lab	41	6	47
University	64	43	107
Total	105	49	154

- **Three HEP panels met in early December:**
  - **Laboratory Experiment**
  - **University Experiment**
  - **Theory**

- **Statistics:**
  - **Theory: Six awards (49 proposals) spanning research frontiers ,mostly focused on LHC physics**
  - **Experiment: Eight awards (105 proposals); Three Energy Frontier; Three Intensity Frontier; Two Cosmic Frontier; One Accelerator R&D**
  - **Gender: Three women; Eleven men**
  - **Geography: Six East; Four Midwest; Four West**
  - **Evenly distributed in year since PhD**

Conclusions

- **We are working hard as stewards of high energy physics at the three Frontiers.**
- **Exciting progress at the Energy Frontier, investing heavily in medium- and long term initiatives.**
- **Working to establish a world leading U.S. Intensity Frontier program with new facilities centered at Fermilab.**
- **Pursuing some of the most significant and interesting questions at the Cosmic Frontier**
- **Interesting accelerator initiatives offer the opportunity for the discipline to progress while contributing to larger societal issues.**