

Particle Physics Research Strategy

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Fermilab Institutional Review
June 6-9, 2011

Outline

- Mission of the Particle Physics Sector
- Organization
- Overview of Activities, Goals and Plans

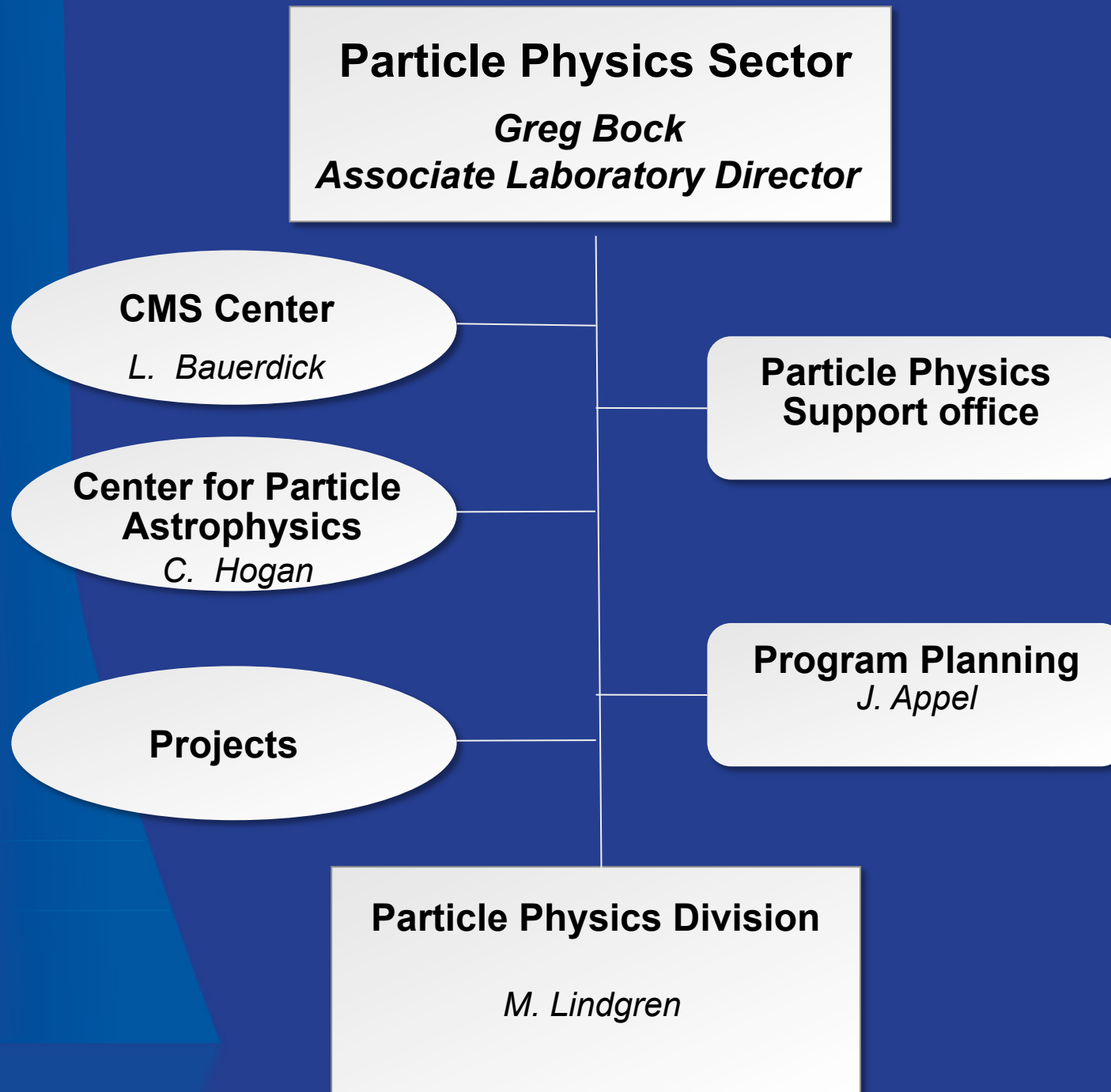
Particle Physics Sector is aligned with the OHEP Mission

- Support the US HEP program mission to understand how the universe works at its most fundamental level by:
 - Designing, building, and operating experiments for the Energy, Intensity, and Cosmic frontiers
 - Providing a “home” for most of the Laboratory users that make up the OHEP experimental community
 - Leading a focused, efficient program of detector R&D in collaboration with university researchers and other national labs
 - Hosting a leading theoretical physics program aligned with the three frontiers

Particle Physics Sector Strategic Goals

- Energy Frontier
 - Deliver on timely and full completion of the Tevatron program
 - Exploit the full potential of the LHC through our CMS participation
- Intensity Frontier
 - Understanding of neutrinos, search for rare decays - new physics
 - Ensure the delivery of a world leading neutrino program in the near term through operations and analysis
 - In the longer term, delivery of world class experiments in future short and long baseline neutrino modes, and in rare muon and kaon decay modes.
- Cosmic Frontier
 - Provide leadership in Ground based Dark energy and dark Matter
 - Exploit the ongoing ultra-high energy cosmic ray research
- Research and develop new detector technologies
 - Partnership with universities, labs, and industry for the future HEP experimental program needs
- Continue to produce world class theory research in support of the mission

Particle Physics Sector Organization



CMS Center at Fermilab

Serves as home base for all CMS experimenters at Fermilab

- Provides a central focus for all CMS efforts at the lab

Unique role in the US CMS program: providing research, operations, computing, and administrative services for CMS users and visitors

- Fermilab has 67 CMS authors, large contribution to physics analysis

 - 14 of ~50 submitted CMS papers of 2010 data have Fermilab main authors

- The LHC Physics Center on WH11/10 enables US physicists to participate in CMS remotely, economically, and transparently

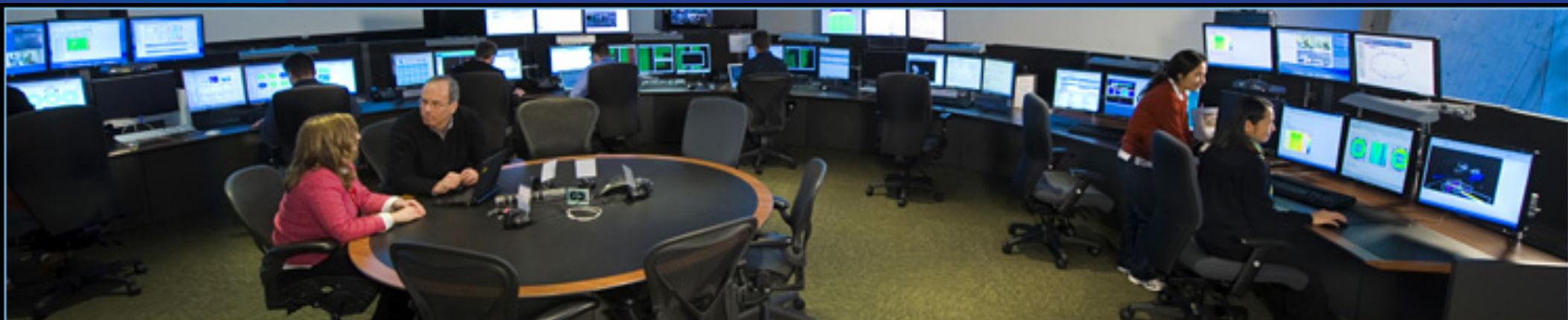
- The Remote Operations Center on WH1 for CMS operations, shifts

- Computing and software: 40% of Tier-1 computing, LPC analysis facility

- Upgrade R&D and detector improvements: Hadron Cal, Pixel, Sim, ...

- Large role in CMS leadership in all areas

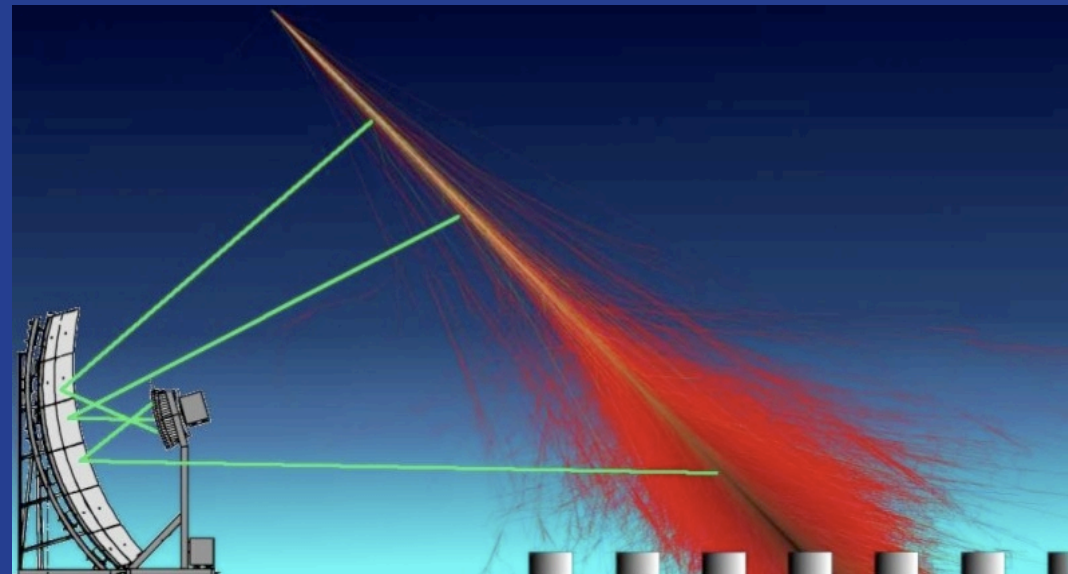
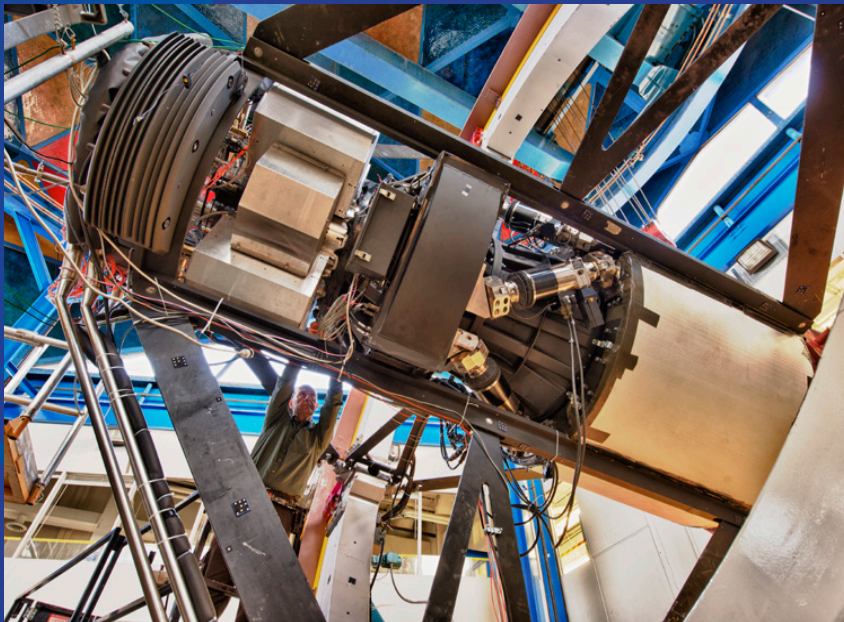
LHC run going very well, exciting discovery opportunities this year



Fermilab Center for Particle Astrophysics

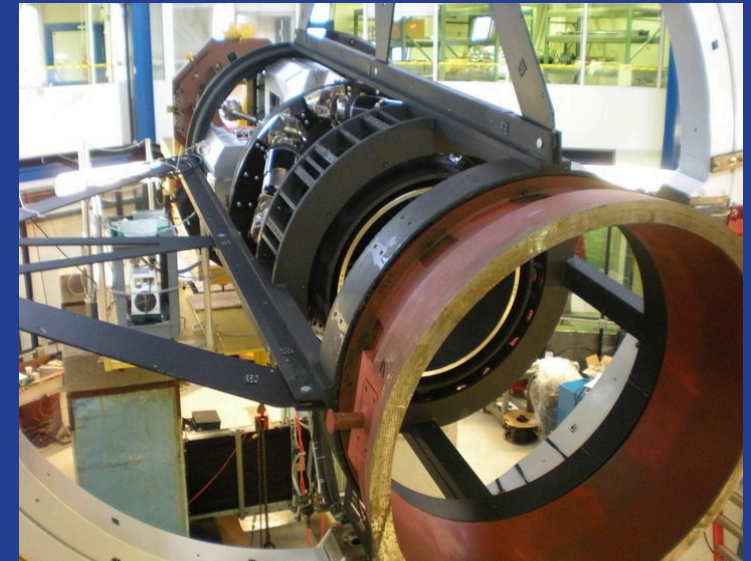
Center unifies the astrophysics program at Fermilab across organizations
Provide a framework for initiating new ideas and developing new techniques
International center where scientists from Fermilab and the world user community can come to learn about and participate in the interface of particle physics and cosmology

Focused program in Dark Energy, Dark Matter, Ultra-high-energy cosmic rays

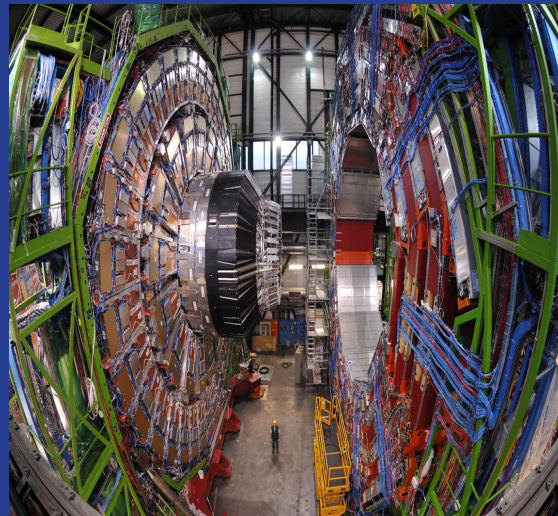
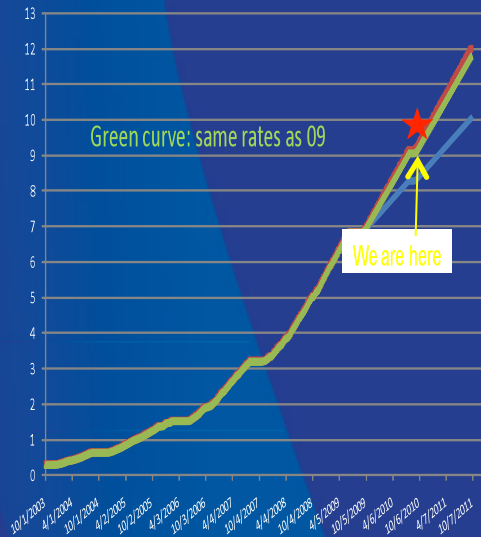


Particle Physics Division

- Organizational home for most of the experimental and theoretical particle physicists at the Laboratory
- Strong teams of engineers and technical staff with tremendous experience in designing, building, and operating experiments
- Supports the US community and participates in tackling the most fundamental physics questions of our era
- Partners with the universities and other laboratories
- Enable and participate in delivery of the science



Energy Frontier Timeline

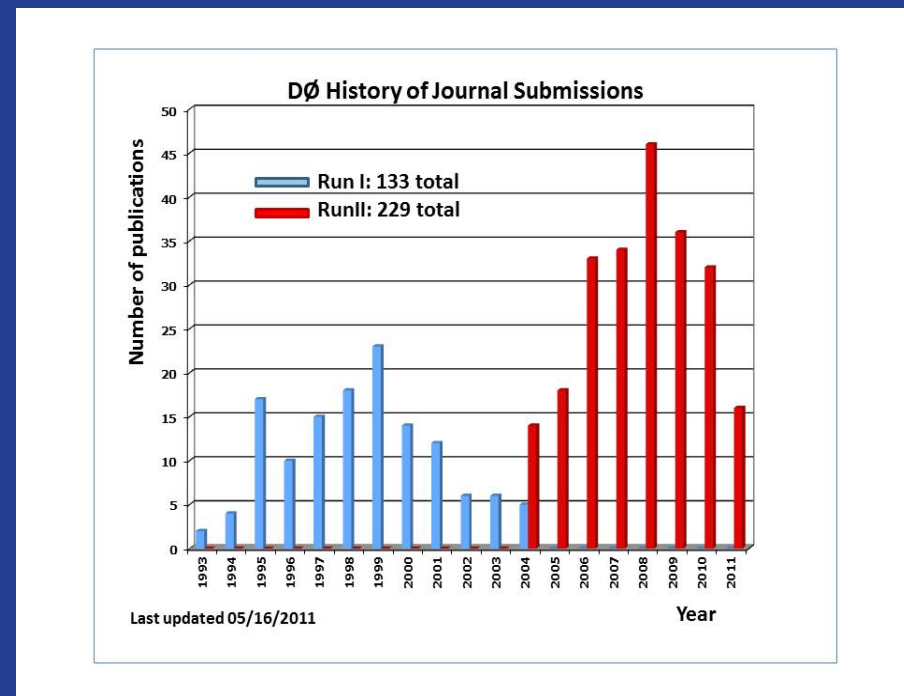


Energy Frontier Goals

- Deliver on timely completion of the Tevatron program
 - Continued effective, safe operations of CDF and D0
 - Tevatron running ends in FY11 – experiments will have projected data sets in hand
 - Plan is rapid exploitation of full data sets to produce time critical results while still competitive with LHC
 - 3+ sigma results may herald discoveries with full data sets
 - Produce legacy measurements that will take a long time to surpass
 - Top and W mass, etc.
 - Some analyses that are not competitive with LHC may not be done
- Exploit the full potential of the LHC through our CMS participation
 - LHC will be the Energy frontier for many years
 - Goal is strong participation, and to remain a central hub for US CMS – ROC, LPC
 - Design and build experiment upgrades aligned with the laboratories experiment responsibilities and technical strengths

Energy Frontier Activities - Tevatron

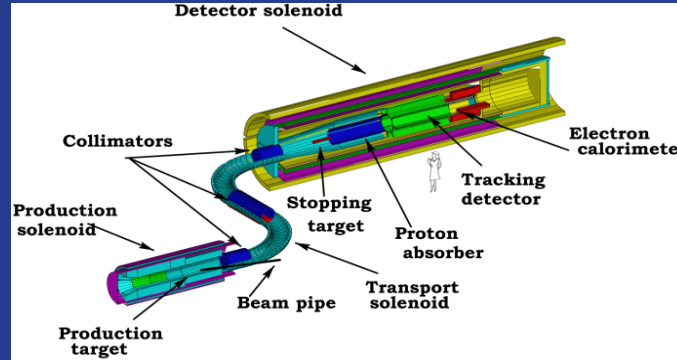
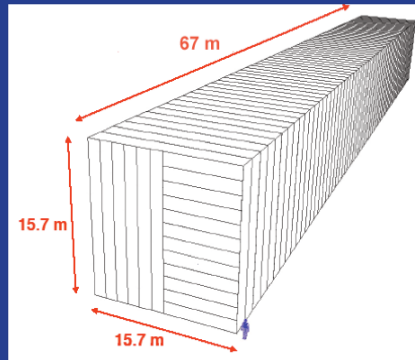
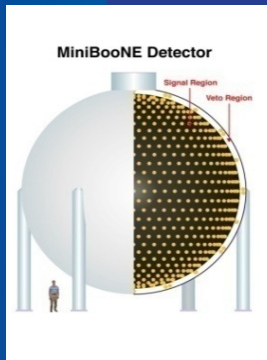
- Both experiments continue strong publication record
- Both experiments are operating with fewer people, as transition to LHC and Intensity Frontier ramps up
- Operational efficiencies are running at historical levels through continued efforts at reducing personnel needs
- Very interesting results expected with full data sets
- Decommissioning plans are being actively developed



Energy Frontier Activities - CMS

- Fermilab is the largest US group on CMS, and the second largest group after CERN on the experiment
 - Numerous leadership roles
- Experiment is recording data efficiently even as the luminosity ramps up dramatically
- **14 publications submitted** in the last 12 months, several more preliminary results in preparation
- Increasing work and coordination of upgrade planning
 - Deputy Upgrade Coordinator for CMS
 - US CMS upgrade steering committee formed
 - Major role in SiPM, QIE development for Hadron Calorimeter, pixel upgrades, and tracking and trigger upgrades for Phase 2
- Continue to operate the US CMS operations Office, Remote Operations Center, and LPC
 - Home to ~100 CMS physicists at any one time

Intensity frontier Timeline



<p>MINOS</p> <p>MiniBooNE</p> <p>MINERvA</p> <p>SeaQuest</p>	<p>NOvA</p> <p>MicroBooNE</p> <p>g-2</p> <p>MINERvA</p> <p>MINOS</p>	<p>NOvA</p> <p>g-2</p> <p>LBNE</p> <p>Mu2e</p>	<p>Project X+LBNE</p> <p>μ, K, nuclear, ...</p> <p>ν Factory ??</p>
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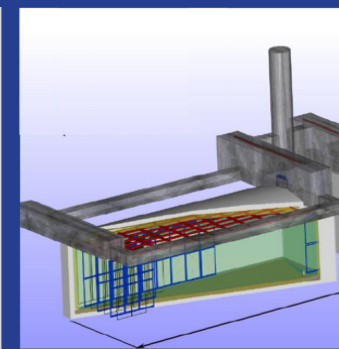
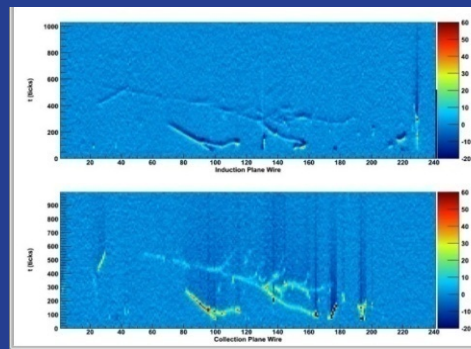
Now

2013

SeaQuest 2016

2019

2022



Intensity Frontier Goals

- Ensure the delivery of a world leading neutrino program in the near term
 - Continued excellent operations efficiency and safety record
 - MINOS, MiniBooNE, Minerva, running now, SeaQuest soon
 - Support for operations at Soudan
- Effective collaboration and leadership in design, construction, and management of the next generation of projects:
 - Nova, MicroBooNE, MINOS+
- In the Intermediate term, delivery of world class experiments in short and long baseline neutrino modes, and in rare muon and kaon decay modes.
 - LBNE, Mu2E, g-2, COUPP, Future Kaons, etc.
- Longer term focus on Project X physics program

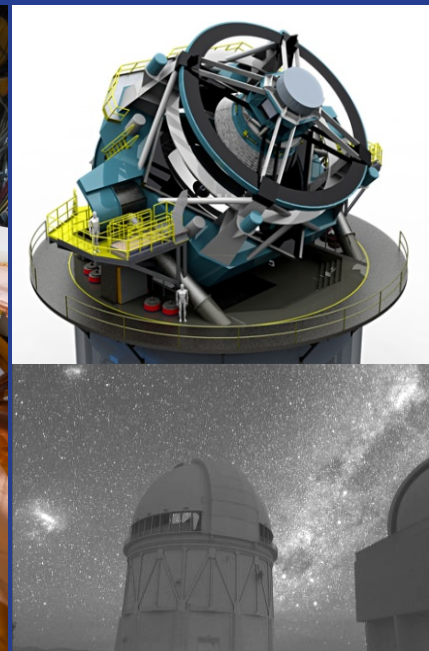
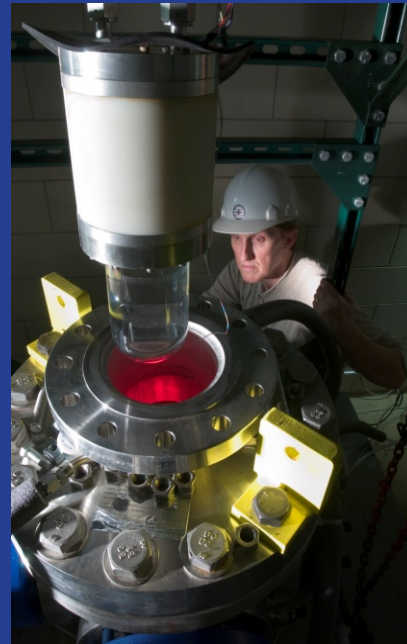
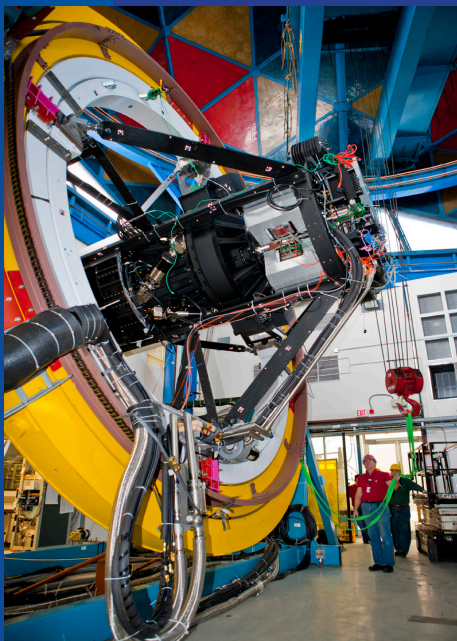
Intensity Frontier Activities

- To meet the ambitious goals, we are refocusing the scientific and technical organization.
 - From Energy Frontier-over a dozen senior scientists
 - New hires – several associate scientists, RA's
 - Joint Appointments – Virginia and Syracuse
 - Technical staff – Key engineering and support resources already transitioning from CDF and D0
- Experiments are running in combined control room
 - XOC is next step in integrated, efficient Intensity Frontier detector operations
- Transition planning for dedicated operations staffing as at Tevatron

XOC – Intensity Frontier Operations Center



Cosmic Frontier Timeline



<p>DM: ~10 kg DE: SDSS P. Auger</p>	<p>DM: ~100 kg DE: DES P. Auger Holometer?</p>	<p>DM: ~1 ton DE: LSST WFIRST?? BigBOSS??</p>	<p>DE: LSST WFIRST??</p>
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Now

2013

2016

2019

2022

Cosmic Frontier Goals and Activities

- Explore nature of Dark Energy and Dark Matter
 - Understanding Dark energy in targeted experiments
 - Commission and exploit physics potential of DES
 - Participate in future ground based telescopes - LSST
 - Play a major role in Dark Matter searches through participation in CDMS, COUPP, LAr (Darkside)
 - Establishing scalable “zero-background” technologies is crucial
- Continue operations and science with Pierre Auger
- Explore potential of interferometer technologies

R&D Goals

- Develop technology critical to near and far term future experimental projects:
 - Generic and directed Detector R&D
 - LHC experiments: Pixels, FEL, Cooling, Advanced Triggering
 - Mu2E, g-2: low-mass traws in vacuum
 - LBNE, MicroBooNE, DarkSide : LAr TPC electronics, LAr handling and purification
 - CDMS, Holographic noise, and other Particle-Astro and DM Exp,
 - ILC/HINS/Project-X/Muon collider: Low mass electronics
- Continued development and safe operation of Test Beam Facility

R&D Activities

- Formation Detector Advisory Group
- Major contributions to Liquid Argon Technology
 - Some time spent catching up to European knowledge, we are now leading in critical technologies for large scale LAr detectors – LAPD, materials test stand, Purification
- Continued leadership in electronics R&D
 - 3-D ASIC's are a vital technology for the future, and are beginning to have practical applications now
- The test beam facility will open a second beam line
 - World wide demand for test beams – schedule is full
 - Instrumentation provides excellent PID, Timing, Spatial resolution

Theory Goals

- Continue to produce world class physics:
 - All members are active and well cited in their own research areas: 15 APS Fellows, 1 AAAS Fellow, 4 Sakurai winners, 1 National Academician, 1 Royal Society mem., 3 Humboldt's, etc.
- Remain centrally connected to and significantly enhance the laboratory mission:
 - Perturbative QCD , Beyond Standard Model, Flavor Physics, Neutrino physics, Lattice Gauge Theory, Applied Formal Physics, Cosmology+Astrophysics
 - intellectual environment for the laboratory and theoretical physics hub for the national program
- Provide leadership in the HEP/Astrophysics communities and in National and Lab Service

PAC Major Recommendations & Issues

June, 2010:

Considered 3-yr extension of Tevatron Collider run, MAP, Proj. X physics.

Recent antineutrino results from MiniBooNE and MINOS and possible further antineutrino running in the BNB and NuMI.
Particle astrophysics program focus and funding.

August, 2010:

Strong endorsement of 3-yr extension of Tevatron Collider run

November , 2010

COUPP at SNOLAB.

Added running of antineutrinos in BNB for MiniBooNE.

Recommended rejection of Med. Energy Antiproton Expt., MIPP-II, SciNOvA outside of NOvA project.

June, 2011 Key Issues:

LBNE/DUSEL plans (jointly with the DUSEL PAC).

MINOS running in the NOvA era.

MINERvA additional H₂/D₂ target running.

Summary

- The Particle Physics Strategy has several elements
 - Continued leadership role in US CMS
 - Transition from the Tevatron experiments to the Intensity Frontier, to maintain and strengthen the world leading program
 - Continued strong but focused participation in Dark Energy and Dark Matter searches and ultra-high energy cosmic ray research
 - Development of detector technologies and concepts that are required to build the experiments that will answer the fundamental questions of our era
 - Theoretical physics research at the forefront of the three frontiers
- We play critical roles at all stages of the experiment life cycles, from inception to decommissioning
- Activities in the Particle Physics Sector are well-aligned with the Missions and Plans of the DOE OHEP and the other Laboratory Sectors