Introduction to the Fermilab Program

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HEPAP meeting

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The Tevatron Collider Program

Run II

- Much of the accelerator complex is new or rebuilt.
- CDF and D0 were upgraded to match the higher luminosity.

Physics of the Weak Energy Scale

- Precise *t*, *W* mass measurements –
- Supersymmetry searches
- Search for new physics: hidden dimensions, strong dynamics, …
- Low-mass Higgs search, in time

CP Violation and Quark Flavors

- B_s mixing to determine V_{ts}
- CP-violating asymmetries

Luminosity Goals

- **Run IIA** refers to operations supported by the collider configuration envisioned during the Main Injector construction.
  - Luminosity:
    - $5x10^{31}$ (Main Injector Project baseline)
    - $8x10^{31}$ (renormalized when we exceeded our Run I goal by 60%)
    - $2x10^{32}$ (Recycler Ring incorporated into the Main Injector Project)
  - Integrated luminosity: 2 fb^{-1} over a 2-3 year period

The Collider Run II is the most important activity at Fermilab.

- It is critically important that we deliver as much integrated luminosity as possible over the next 6+ years.
- We must do so while keeping NuMI, LHC, CMS, MiniBooNE on schedule.

Steve Holmes will review the status and describe what comes next.

John Womersley and Al Goshaw will review the detector status.

Run IIb

- Run IIa represents a big improvement in supersymmetry searches, top and W mass measurements, B physics, and QCD studies.
- Additional luminosity provides greater precision for electroweak measurements, greater reach for exotic searches, plus the opportunity to observe a low-mass Higgs boson.
- Accelerator
  - Improve luminosity by factor of 2-3 with a number of modest upgrades.
  - Accelerator advisory committee reviewing progress.
  - Right now, the attention must be concentrated on run IIa.
- Detectors
  - Two upgrade projects:
    - Replace rad-damaged silicon detectors with new detectors of simpler design with more rad-hard technology.
    - Upgrade data acquisition and triggers to deal with higher luminosity.
  - PAC has been following projects, Stage 1 approval discussion in June
  - Two Director's reviews, one technical (Pilcher) and one on cost, schedule, management (Temple), to prepare for DOE baseline review.

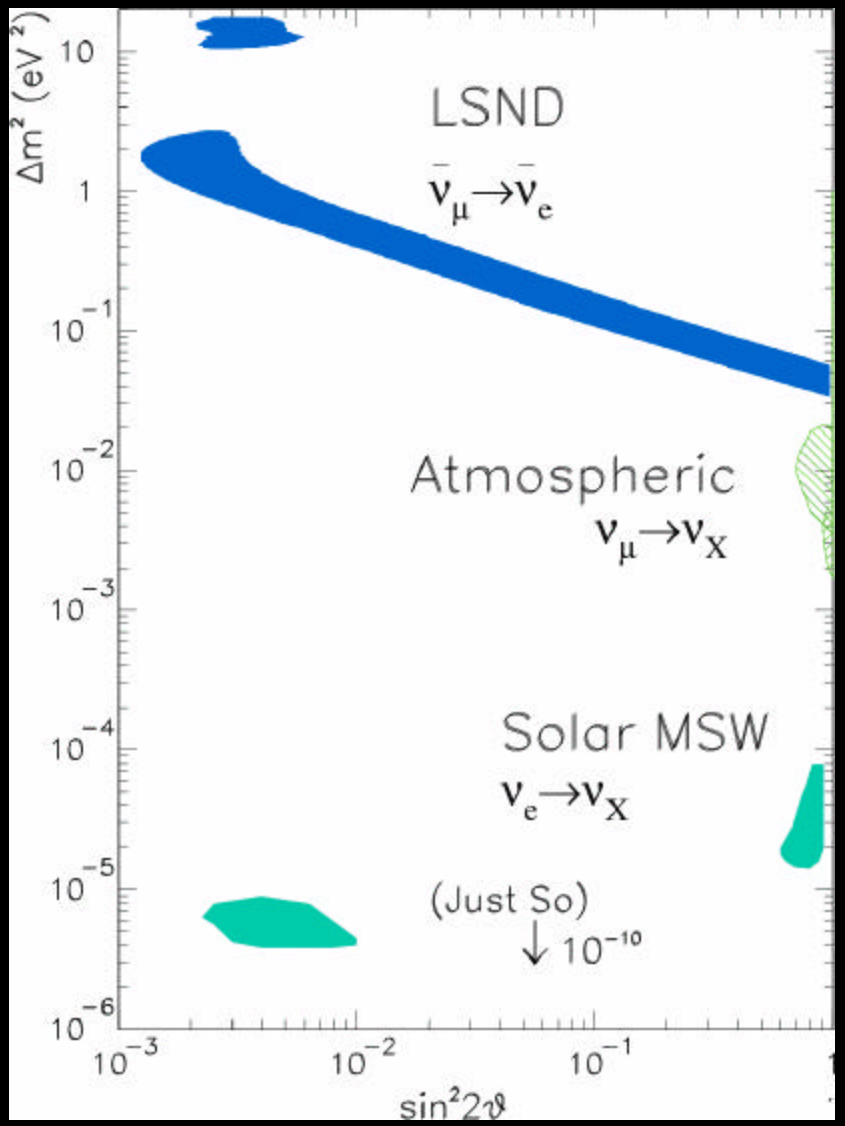
Ongoing Construction Projects

- Run 2b Upgrades (2005)
  - Accelerator luminosity
  - Detectors
- Neutrino Projects
  - NuMI/MINOS (2005)
  - MiniBooNE (2002)
- LHC (2005)
  - US LHC Accelerator project
  - US CMS
- Astrophysics
  - Auger Cosmic Ray Experiment
  - Cryogenic Dark Matter Search

The Neutrino Program

- **MiniBooNE**
  - will make possible a decisive check of the LSND anomaly.
  - will start operating this year.
  - uses 1 GeV ??@ 500 m
- **MINOS**
  - will observe and measure the atmospheric neutrino oscillation with high statistics and a controlled source;
  - will start operating in FY05.
  - uses 3-20 GeV ??@ 740 km

Mike Shaevitz will review the status of the neutrino program.

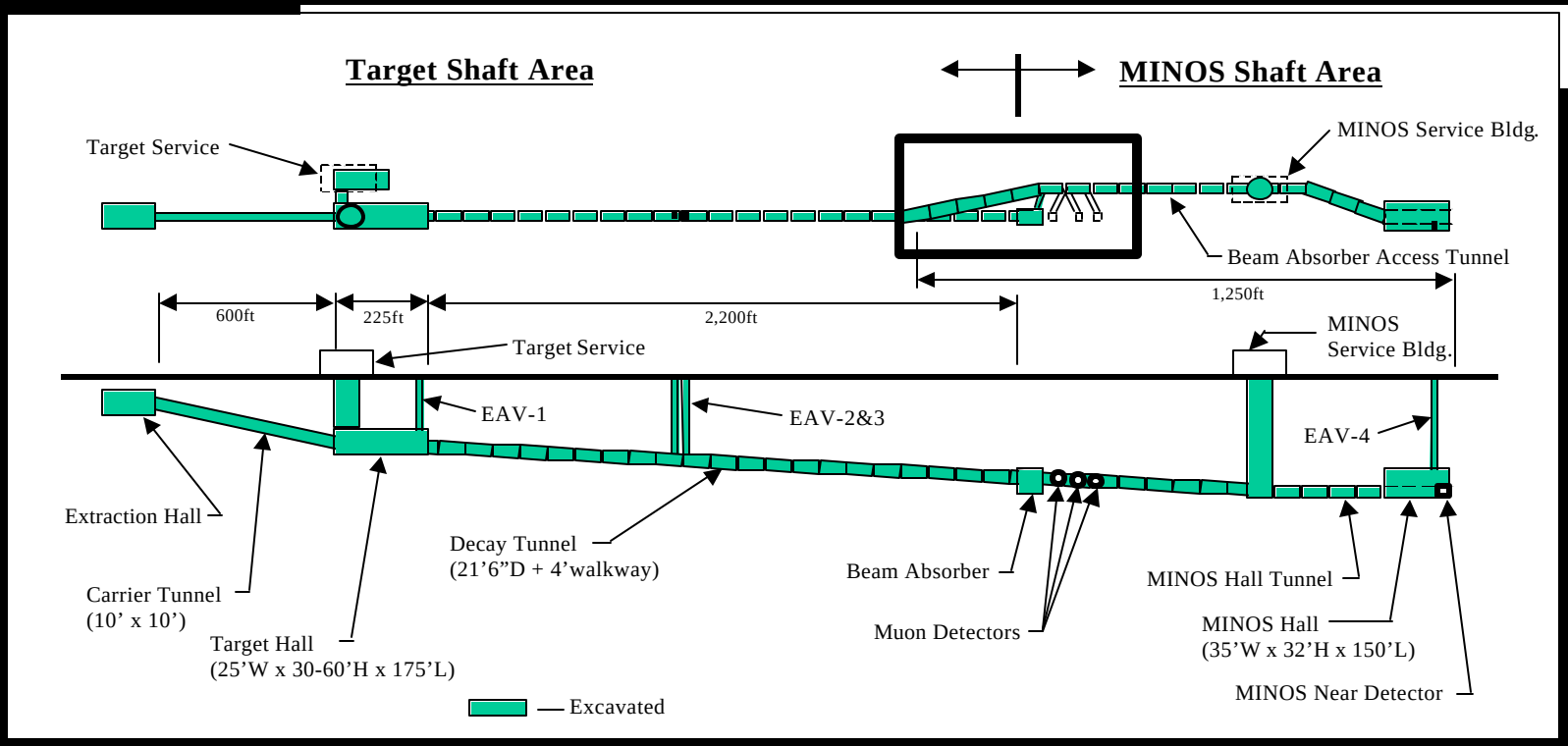


NuMI

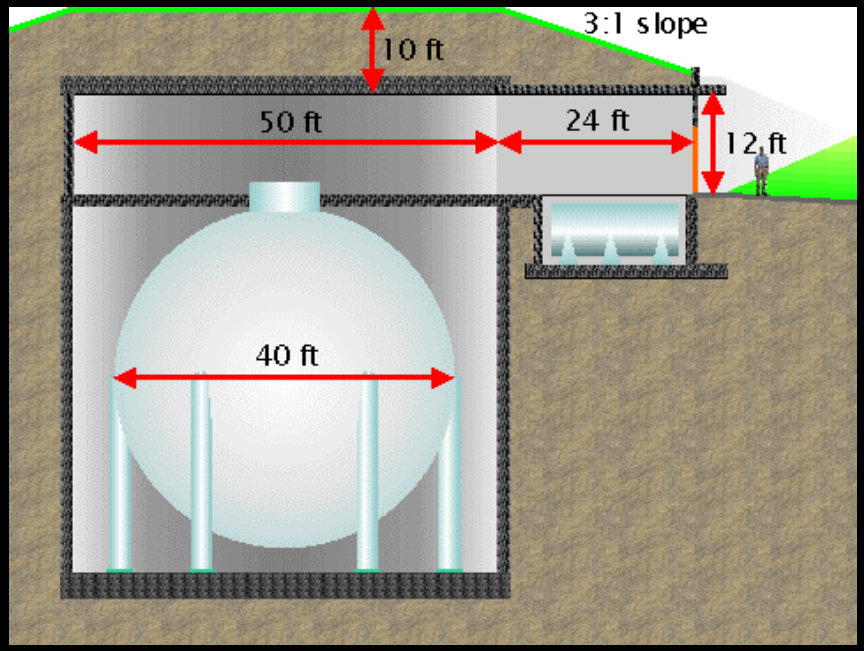
- The NuMI project went through major restructuring in 2001.
  - The original NuMI cost and schedule baselines were not sufficient to build the project.
  - The performance on the underground contract was a major problem, including in the area of safety.
  - We proposed a new baseline with a cost increase of about $33 M and a large slip in schedule.
  - We made changes in the project and throughout the laboratory to increase support for NuMI.
- The project is in much better shape.
  - The January minireview went fairly well.
  - We are still giving NuMI intense oversight, along with Run 2.
  - We still have a long way to go, but we are making steady progress.

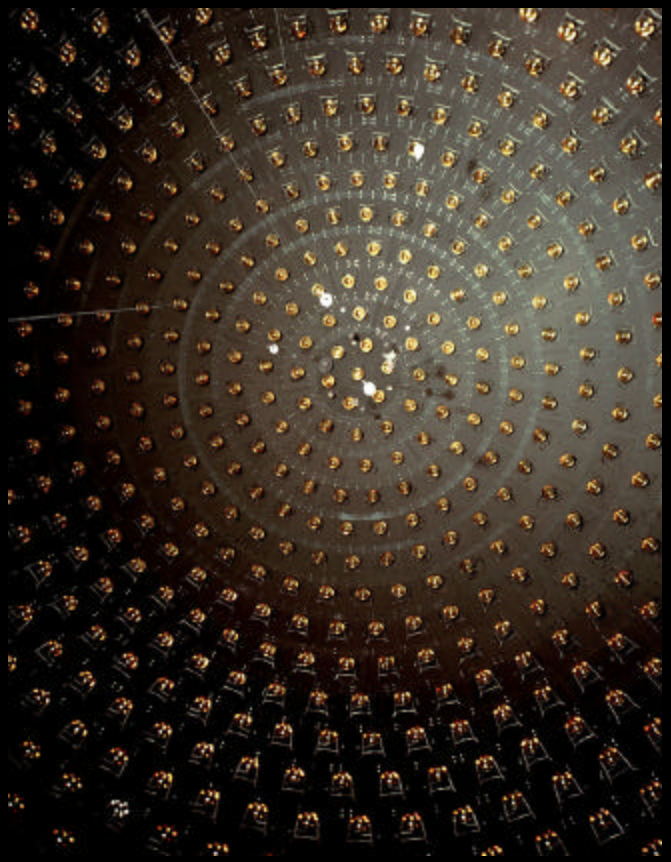
NuMI Status

- Excavation is 99.5% complete! Healy will complete contract late this year.
- The procurement process for the Surface Building and Outfitting contract is under way.
- NuMI beam line is making good progress, including on recent review.
- The MINOS detector installation is going very well.



MiniBooNE Experiment





- Excellent progress in last year
- Detector being commissioned
- Starting to commission beamline

On schedule for full operation in summer 2002.

US-LHC

- Project management (Fermilab)
  - 73% complete; schedule performance good
  - Recent reviews have been very positive.
- IR quadrupoles and integration (Fermilab)
- Beam separation dipoles (BNL)
- IR feedboxes and absorbers (LBNL)
- Cable testing (BNL)

This project is going well.

Jim Strait will review the status and discuss the future.

US-CMS

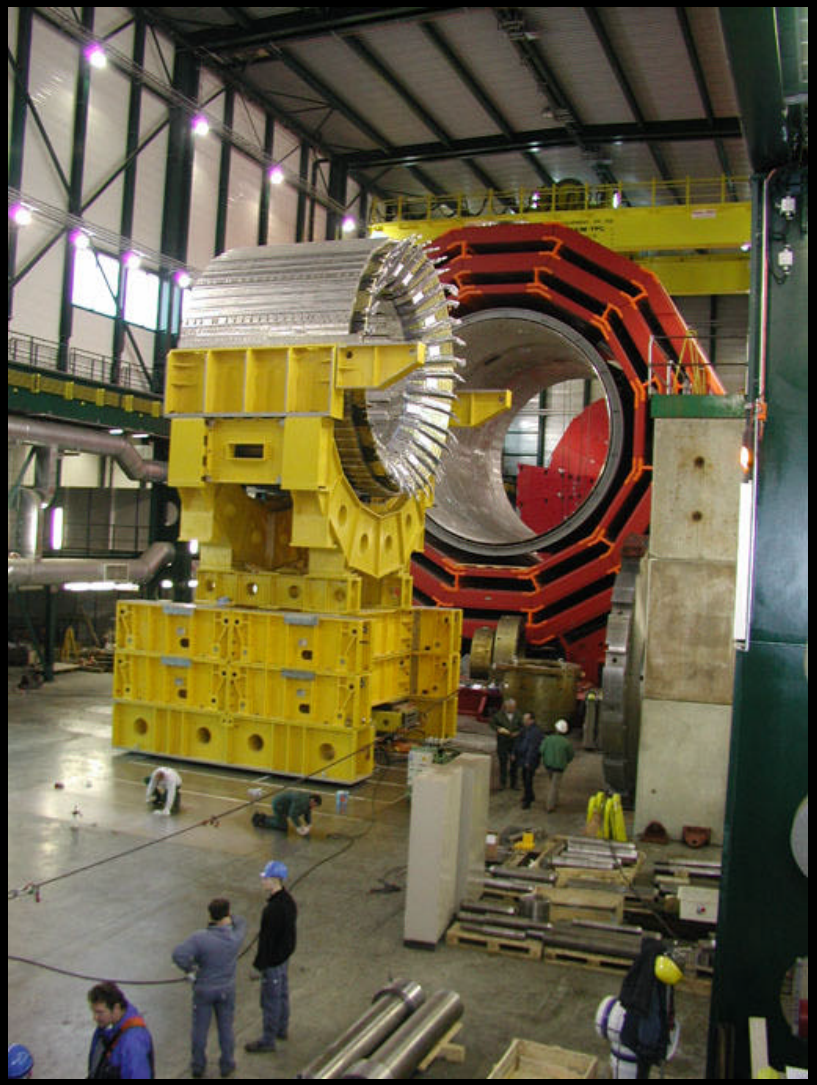
This project is also going well.

? The progress on US parts of CMS has been very good.

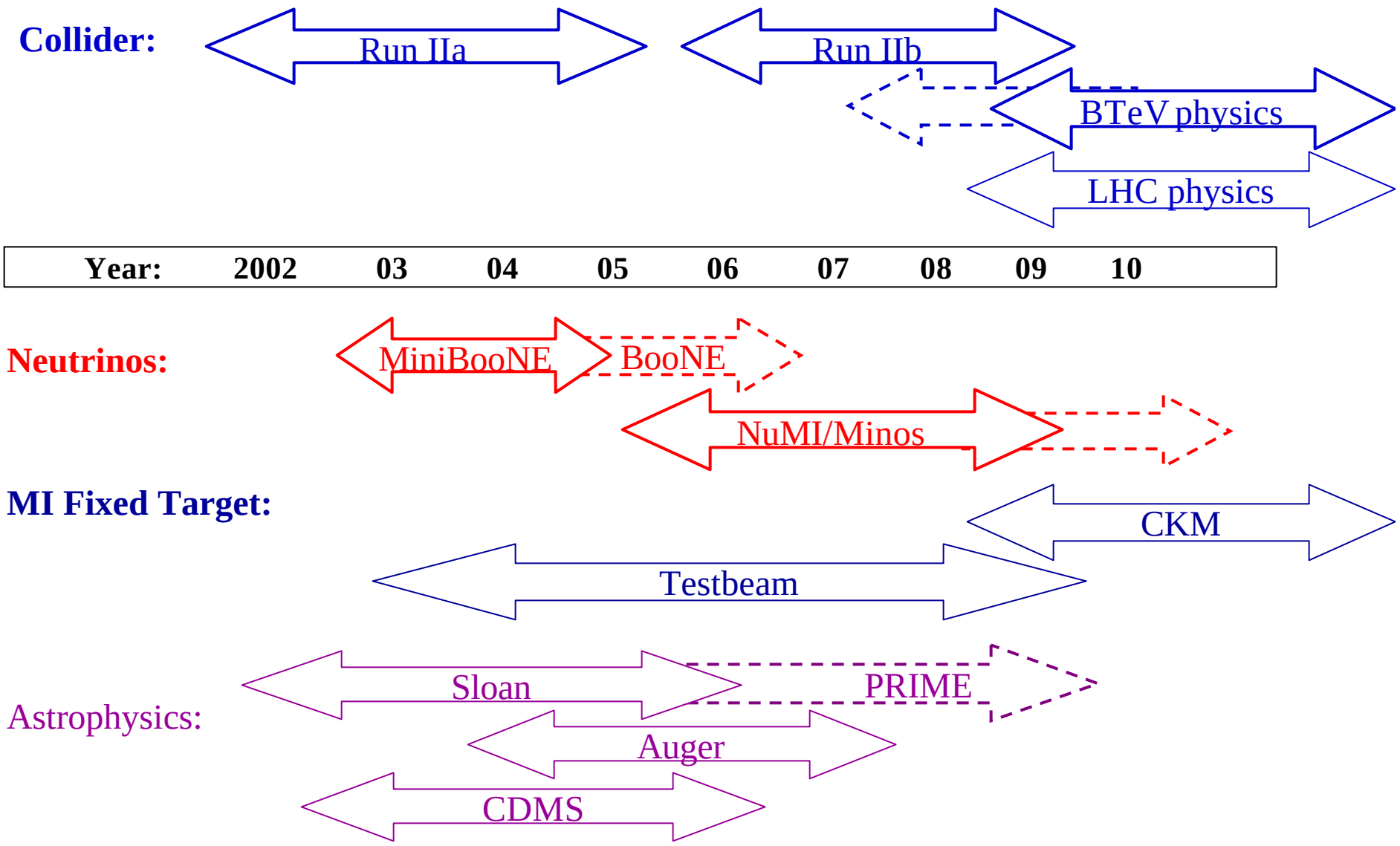
- About 65% of work complete.
- Much of contingency use has been for increased scope, such as Silicon.

- The planning for transition to the CMS research program is well along.
  - Software and computing project
  - Handoff to maintenance and operations
  - R&D for upgrades

Dan Green will review the status and describe the future.



Fermilab Research Program



BTeV and CKM

BTeV

? BTeV is the ideal next-generation experiment on CP violation in quarks.
  - Sensitive search for new physics by comparing CP asymmetries
  - Much larger samples in critical B_d modes than best present experiments in addition to all of those from the B_s
  - Innovative pixel-based trigger, precise em calorimetry

? We restructured the project to reduce cost, delay date of major spending, and remove early magnet work.

? New plan reapproved by PAC 2 weeks ago.

CKM

? CKM will be able to collect 100 $K^+ \to ????$ events to make a precise measurement of V_{td}.

? It will use a RF-separated kaon beam produced with 120 GeV protons from the Main Injector.

Joel Butler will review the status.

Linear Collider R&D

The HEPAP Subpanel:

- ***We recommend that the highest priority of the U.S. program be a high-energy, high-luminosity, electron-positron linear collider, wherever it is built in the world.***
- ***We recommend that the U.S. prepare to bid to host the linear collider, in a facility that is international from the inception, with a broad mandate in fundamental physics research and accelerator development.***

- Fermilab is working to follow these recommendations, but there are serious constraints.
  - The U.S. effort is working within the constraint of a fixed annual spending level of $19.2 M, $16.2 SLAC and $3.0 Fermilab.
  - If the U.S. and Fermilab are serious about hosting a linear collider, this must change quickly.

Bob Kephart will review Fermilab work.

Accelerator R&D

- Two years ago I said:
  - Fermilab will play a central role in developing the colliders of the future. We also need to make sure we take every advantage of the Tevatron. Inevitably, we need to invest more in accelerator R&D.
- The fact is, we have not invested more.
  - Tight budgets were not enough to support present projects and R&D on the future.
  - Present projects represent commitments made five years ago or more.
    - NuMI/MINOS
    - Tevatron Run II
    - US-LHC and US-CMS

Accelerator R&D

VLHC and Superconducting magnet R&D

- Fermilab has a special role in maintaining core strength in this area.
- HEPAP subpanel report said:
  - High-field magnet research is particularly important.
  - An international collaboration should be formed as early as possible.
  - We strongly support R&D toward such a machine at about the current level of effort.
- We are trying to follow those guidelines, but budgets make it difficult.
- With FY2002 budget and continuing budget pressure, we had to bring the successful low-field magnet program to an end.

Muon/Neutrino factory R&D

- HEPAP Subpanel report said:
  - We recommend continued R&D near the present level.
  - The level of effort is well below what is required to make an aggressive attack toward a neutrino factory.
  - International collaboration on the essential muon cooling experiment is very important.
- With FY2002 budget, we had to cut the materials budget effectively to zero. We are working with Muon Collaboration to sustain progress.

Experimental Astrophysics

- The experimental astrophysics effort is well established.
  - First-rate experiments: SloanDSS, Auger, CDMS, PRIME
  - Important roles suited to Fermilab strengths
  - Modest investment of DOE-Fermilab resources
  - We are committed to the success of these experiments.

- A significant part of the HEP community is now doing particle astrophysics experiments.
  - We provide the laboratory base needed for university-based collaborations like CDMS, Auger to build a big experiment.
  - The Fermilab role in project management helps make best use of funding from NSF, DOE university program, and (for Auger) foreign sources.

The experimental and theoretical astrophysics programs will be discussed by Josh Frieman.

Theoretical Physics at Fermilab

Particle Theory Group

- Accelerator laboratories are responsible for the training of theoretical particle physicists working on problems relevant to the experimental program.
- Our theory group has close ties with the experimental program here.
- The strong lattice gauge group has teamed with university groups in a successful proposal to the SciDAC program.

I will discuss the particle theory group briefly in my summary talk.

Theoretical Astrophysics Group

- The Fermilab Theoretical Astrophysics group has been a leader in research at the overlap of particle physics, cosmology, and astrophysics.
- Part of the support comes from NASA.
- Members of the group directly participate in the SDSS science.