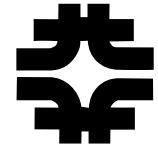


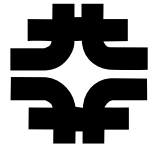
Overview of the Laboratory

Michael Witherell

Operations Review

March 16, 2004

Outline



- Introduction to Fermilab
  - scientific program
  - major projects
- Organization of the Directorate
- Facility operations: the Run II campaign
- Program planning
- A few areas of particular importance

An Introduction to Fermilab

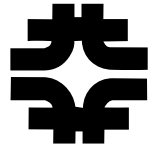
The mission of Fermilab is the goal of particle physics: unlocking nature's deepest secrets, and learning how the universe is made and how it works.

- Fermilab builds and operates the accelerators, detectors and other facilities that physicists need to carry out forefront research in high-energy physics.
- Fermilab is the largest particle physics laboratory in the United States.
  - 2100 employees
  - 2500 scientist-users from universities and laboratories
    - 1000 of these from foreign institutions
- The Universities Research Assocation manages and operates Fermilab.

About Fermilab

- Fermilab's Tevatron is the world's highest-energy particle accelerator and collider.
  - CDF and D0 experiments
  - BTeV starting in 2009
- Fermilab is also host to
  - the U.S. program in neutrino physics with accelerators;
  - the U.S. program for the LHC accelerator and CMS experiment; and
  - a strong program in particle astrophysics.

The Fermilab physics program



A. The Unification of Forces and
B. Electroweak Symmetry Breaking
   - Run II of the Tevatron: **CDF** and **D0**
   - **US-LHC** and **US-CMS**
   - Linear collider R&D

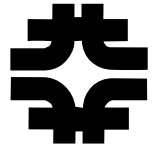
C. Three Generations of Quarks and Leptons

Neutrino and Lepton Flavor Physics
   - The US accelerator-based neutrino program: **MiniBooNE** and NuMI/**MINOS**

Quark Flavor Physics and CP violation
   - Quark flavor physics experiments to operate in 2009: **BTeV**

D. Particles and the Cosmos
   - **SDSS** -- Sloan Digital Sky Survey
   - The **Auger** Cosmic Ray Observatory
   - **CDMS** -- The Cryogenic Dark Matter Search

Run II



Why is gravity so weak?

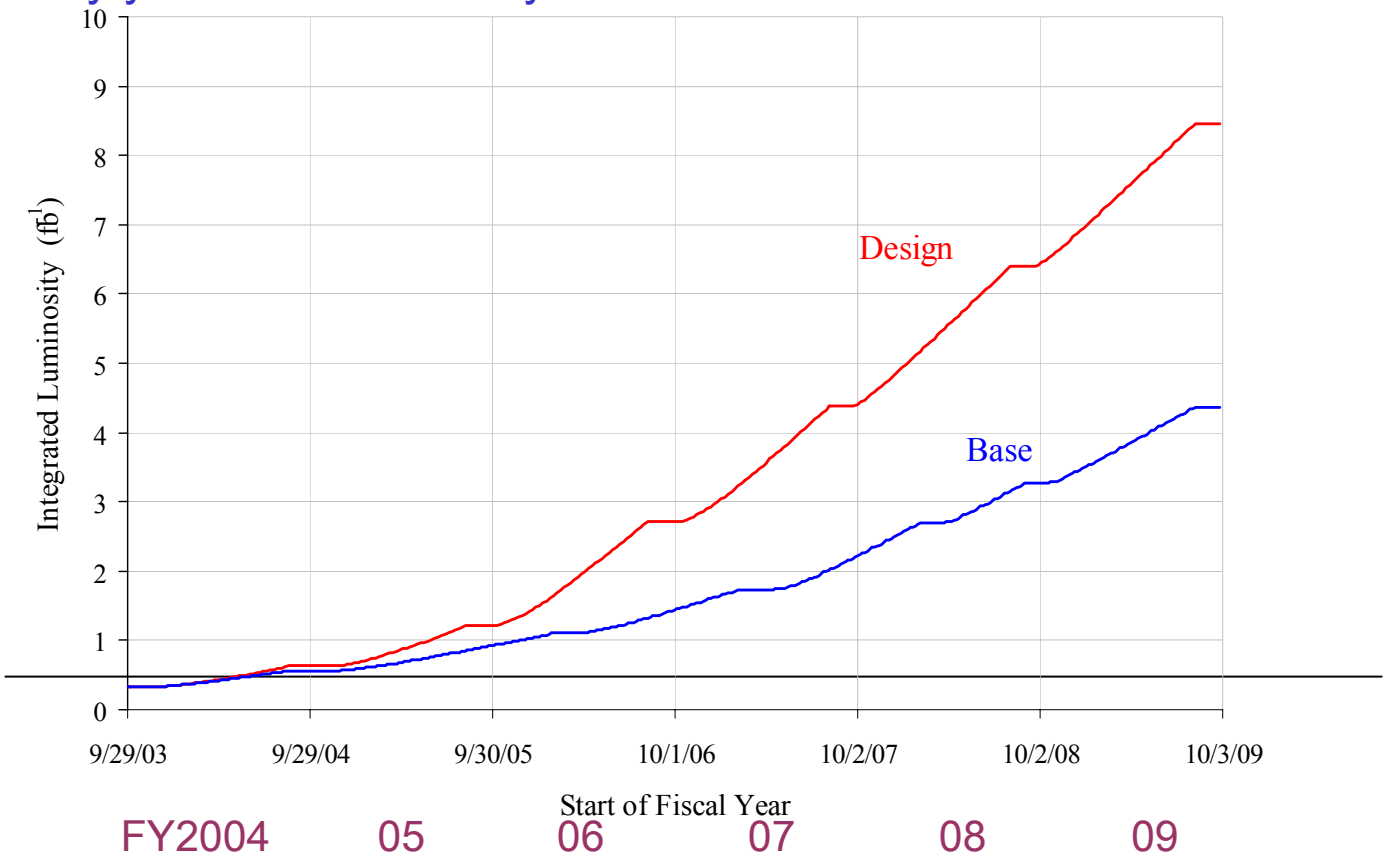
What causes the Higgs field?

These questions must be addressed with colliders operating at the energy frontier. For now, that means the Tevatron.

- P5: "The Tevatron is the world's highest energy accelerator and, until the LHC produces physics, it will have an unparalleled opportunity to address the major questions in elementary particle physics. The Run II program attacks the most fundamental questions facing particle physics."

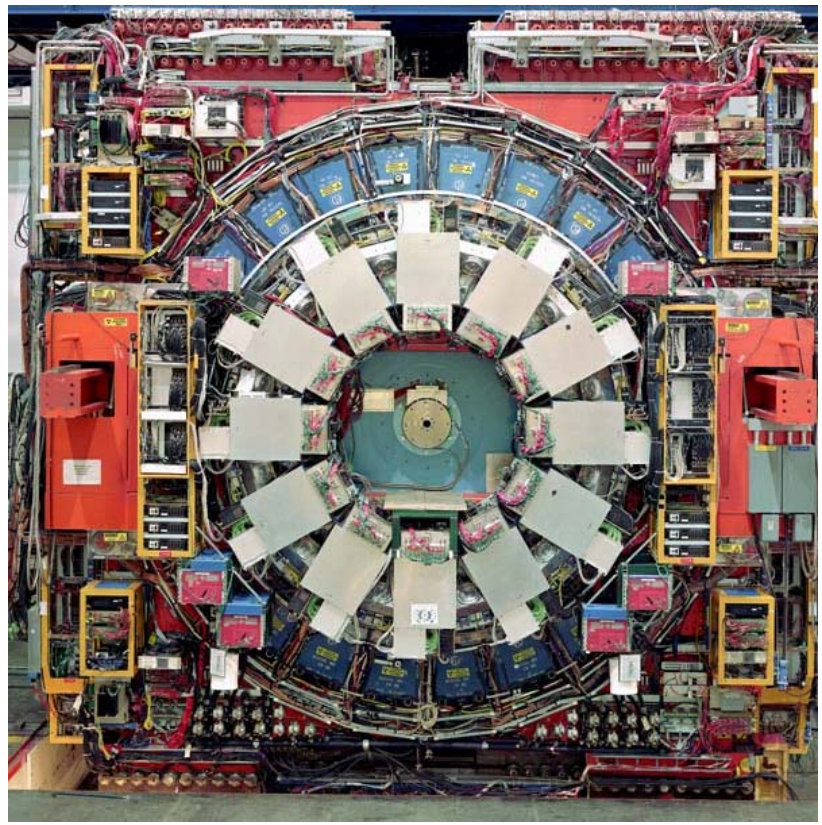
Projected Integrated Luminosity

The integrated luminosity measures the total number of collisions delivered to each experiment. This quantity will double about every year for the next 4 years.

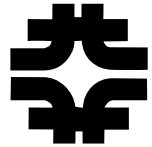


CDF and D0 at the Tevatron

Two detector facilities, each producing data for a 600-scientist collaboration.



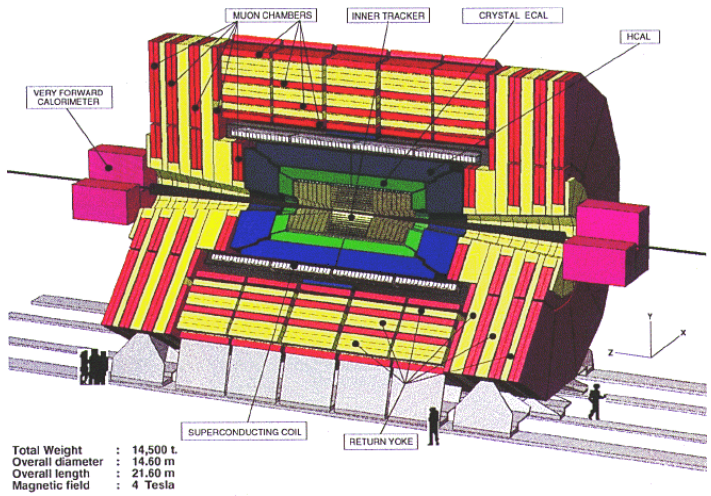
The Large Hadron Collider



- A revolutionary leap in our understanding of particle physics will come with the Large Hadron Collider (LHC), being built at CERN in Geneva, Switzerland.
- The DOE and NSF are investing in the LHC so that U.S. physicists can continue to work at the energy frontier.
- Fermilab is committed to its central role as the host laboratory for
  - the US-LHC accelerator project and research program and
  - the US-CMS detector project and research program.

US-LHC and US-CMS

- US-LHC
  - We are hosting the US-LHC accelerator project and LARP.
  - Construction project 92% complete by earned value
  - LARP established
- US-CMS
  - We are hosting the US-CMS detector project and the the research program.
  - Project proceeding according to plan
  - Planning the transition to research program

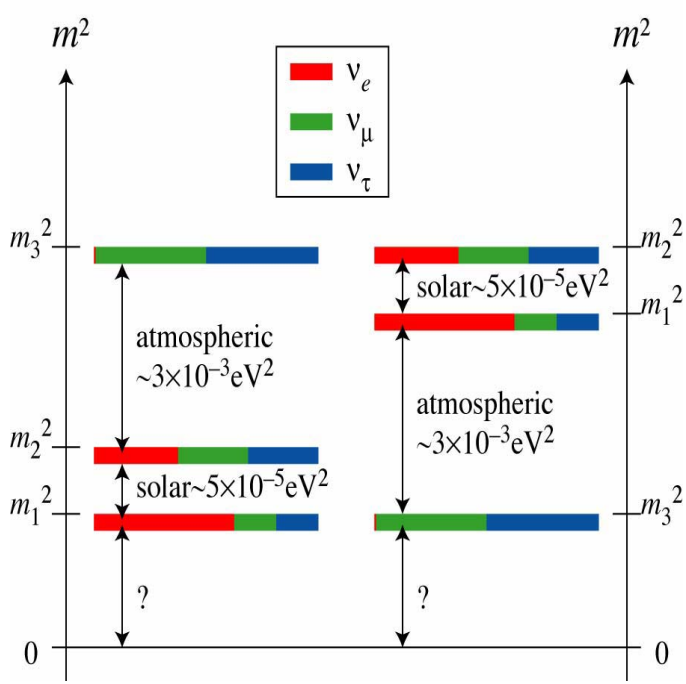


The Neutrino Program

Is neutrino mass the first sign of physics at much higher energy?

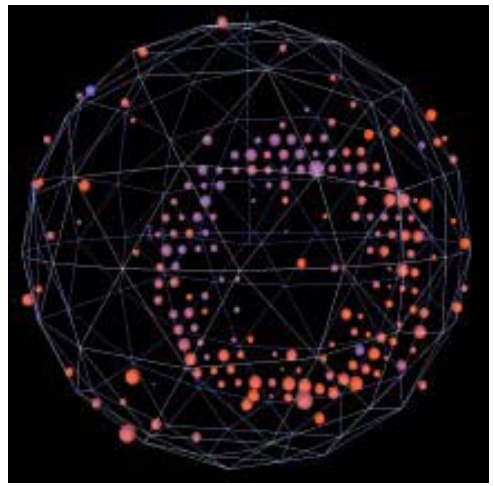
- The greatest experimental surprise of the last decade: neutrinos change their type.
  - Neutrino oscillations may signal new physics at a much higher mass scale.
  - They may also show a way to explaining baryogenesis.

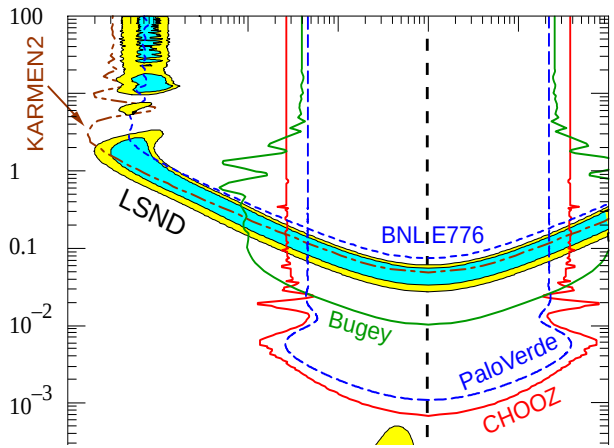
- Fermilab is home of the US accelerator-based neutrino program:
  - MiniBooNE
  - NuMI/MINOS



MiniBooNE

- MiniBooNE is designed to follow up on the LSND evidence of a $\nu_\mu - \nu_e$ oscillation at high Δm^2, requiring a sterile neutrino.
  - If MiniBooNE confirms LSND, it will change the worldwide neutrino program overnight.
- The experiment is running well.
- The goal of Booster work is to decrease losses, allowing increased flux to MiniBooNE.





MINOS

For atmospheric oscillation

- Demonstrate oscillations
- Measure precisely the fundamental parameters of the oscillation
  - Δm^2 to ~10%
  - $\text{Sin}^2\, 2\theta_{23}$ to ~5%
- Improved sensitivity to transition of ν_μ to flavors other than ν_τ
  - improved sensitivity to θ_{13}

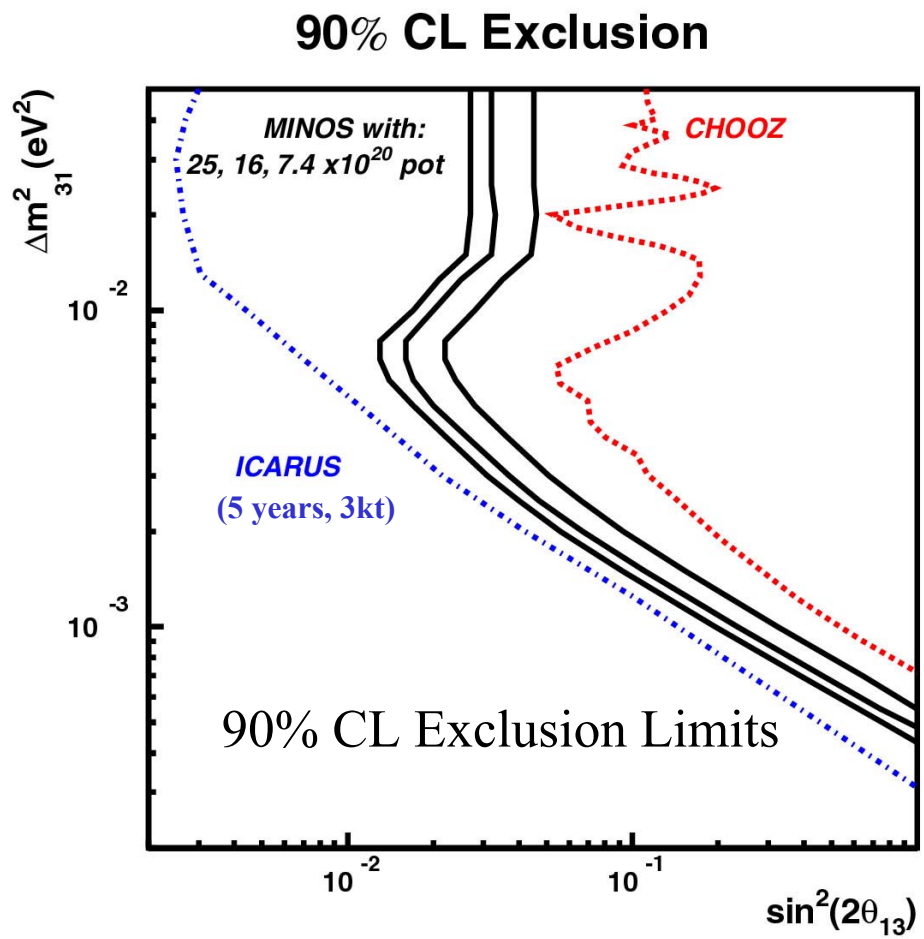
NuMI/Minos Project Status

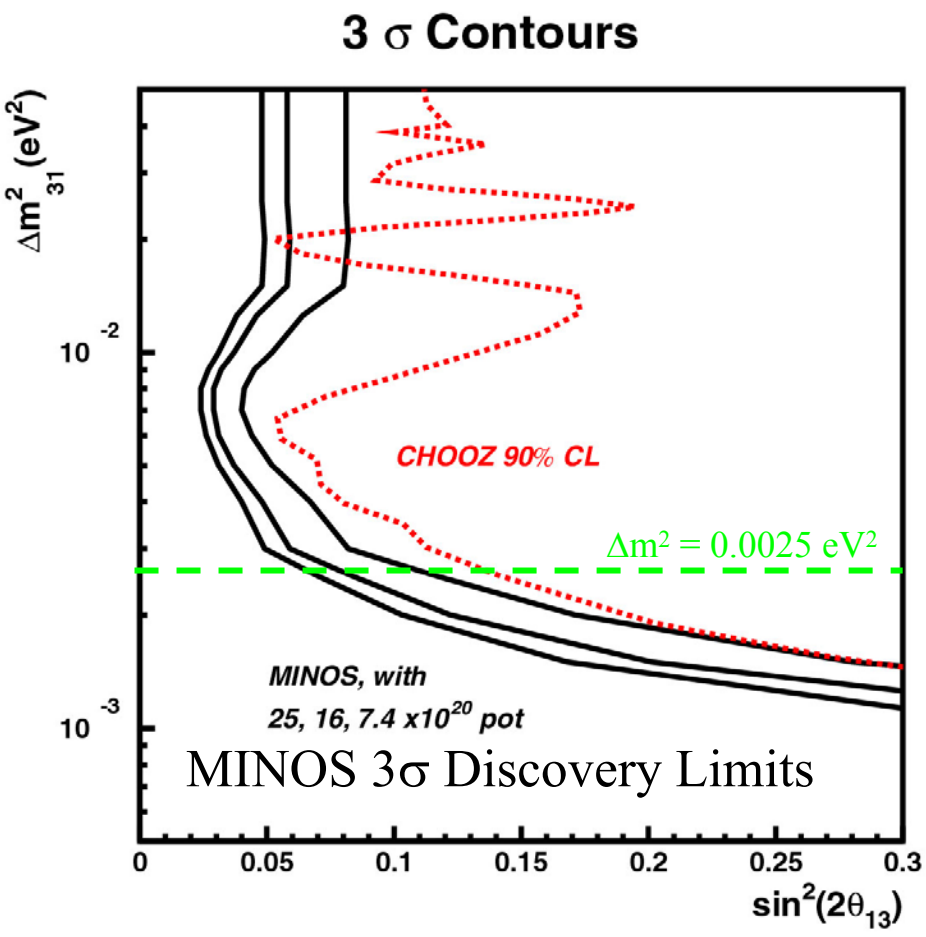
The project is on track to deliver neutrinos to Soudan around 1/1/2005.

- Surface Buildings and Outfitting construction is just complete.
- Beamline installation started in fall 2003 shutdown
- MINOS far detector installed and operating on cosmic rays
- Installation of MINOS near detector about to start

- The project is over 95% complete.

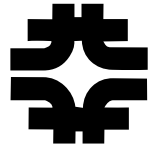
Appearance of Electrons





- MINOS sensitivities based on varying numbers of protons on target

BTeV



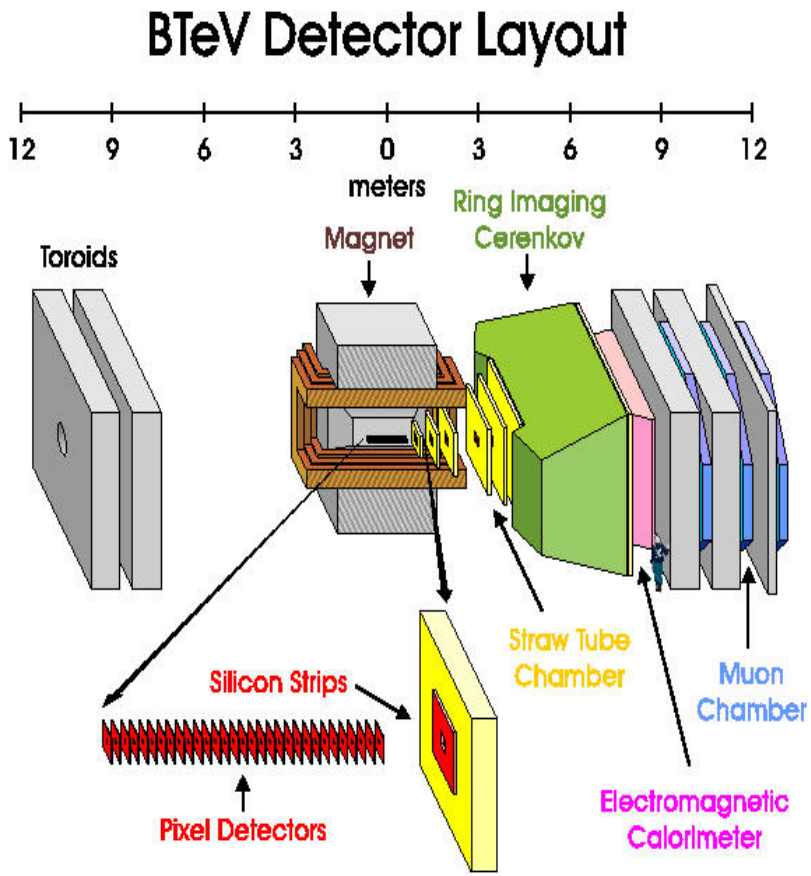
- BTeV will have a very broad particle physics program, including charm physics, but the primary motivation is the search for new physics through CP violation in the B_d and B_s systems.

- BTeV represents an innovative design for collider experiments.
  - The project is predominantly detector construction.
  - Collider performance achieved in Run II will be sufficient.
  - The new magnets for the interaction region will be installed in the Tevatron during the 2009 shutdown.

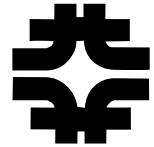
BTeV

P5:

- "The strength of the BTeV experiment comes from the combination of its vertex trigger with precision mass measurements for both charged and neutral decay modes and excellent particle identification capabilities."
- "P5 supports the construction of BTeV as an important project in the world-wide quark flavor physics area."
- Fermilab is developing the BTeV project with custom IR optics to optimize the luminosity.

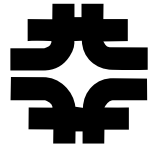


Experimental Astrophysics



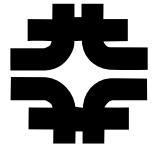
- The experimental particle astrophysics effort
  - Auger cosmic ray observatory taking data
  - Cryogenic Dark Matter Search taking data
  - SloanDSS producing discoveries steadily
- We are planning how this area will evolve.
  - Auger, CDMS are starting to operate while construction continues and planning next steps.
  - A Fermilab group has joined the collaboration developing a proposal for the Joint Dark Energy Mission.
  - Smaller project to build camera for the Cerro Tololo telescope is being considered.

R&D on Future Accelerators



- We are doing accelerator R&D aligned with the future facilities called out in the Fermilab Long-range plan and the SC facilities plan.
  - LHC luminosity upgrade
  - Linear collider
  - Proton driver
- We do a small amount of R&D toward the longer-term future.
  - High-field superconducting dipoles
  - Advanced accelerator R&D
- Other programs doing very good work have been curtailed.
  - Low-field superconducting magnets
  - Muon facilities
- R&D groups have made surprisingly good progress with very little budget.
- We are also working with university programs to provide opportunities for training students.

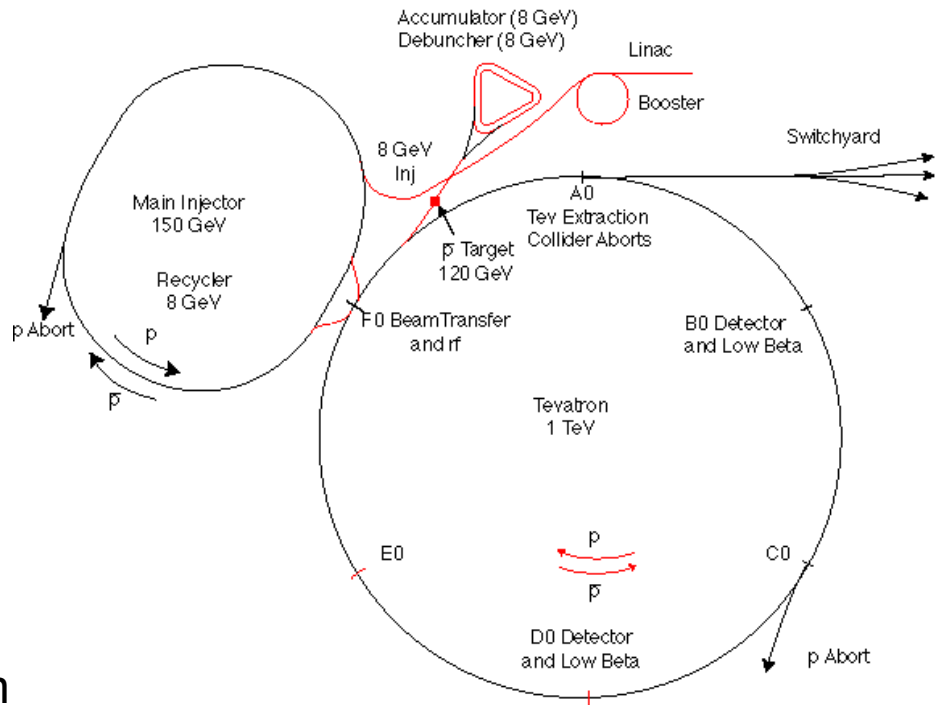
The Run II Campaign



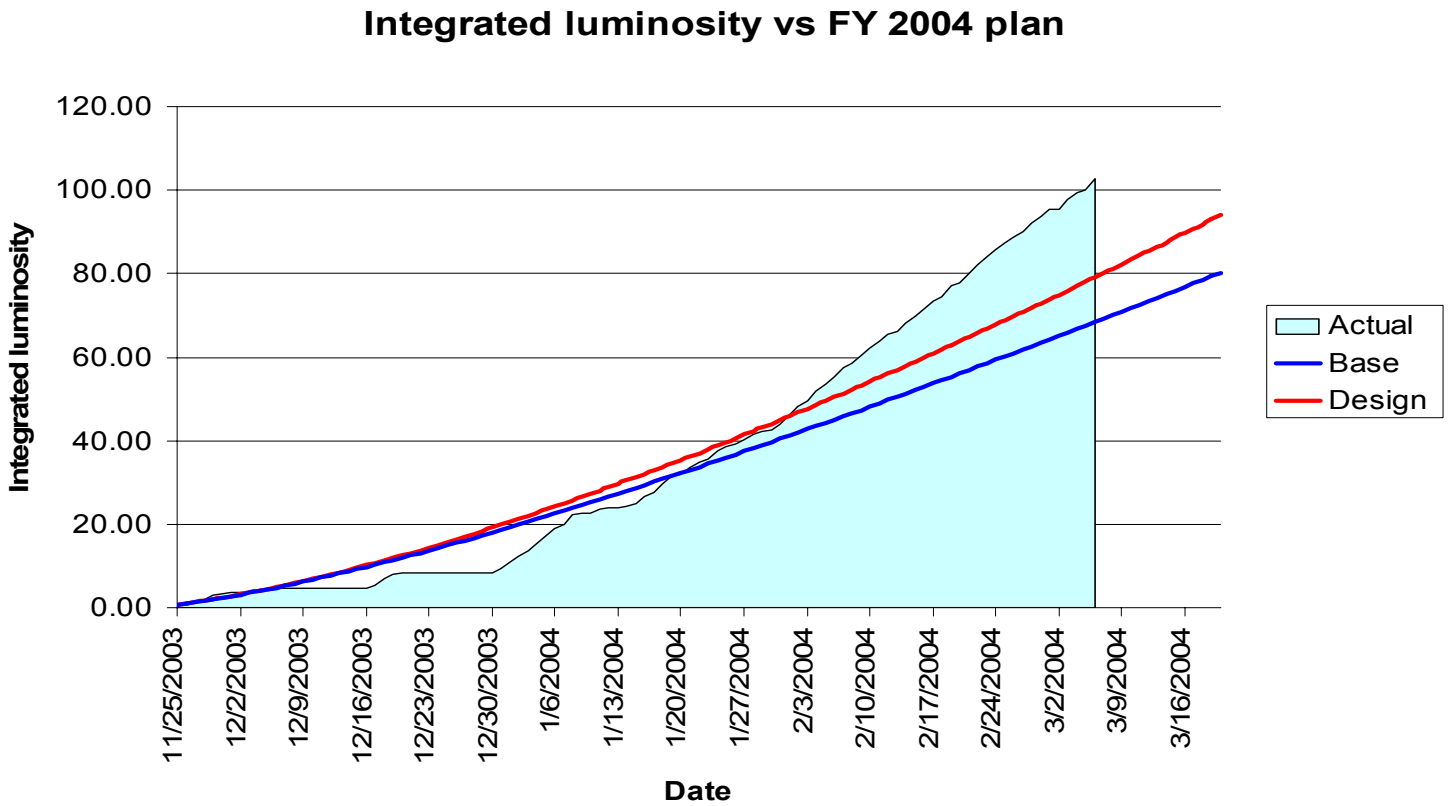
- The most important activity of the laboratory from now until 2009 is Run II.
- We have planned a campaign to optimize the science done throughout this period.
  - Organize entire laboratory to support the accelerator effort.
  - Build and install luminosity upgrade projects 2004-2006.
  - Deliver luminosity continuously 2004-2009.
  - Maintain efficient detector operation with modest upgrades.
- We are optimizing the science by delivering as much integrated luminosity as possible each year.

The Accelerator Complex

- Fermilab has by far the largest and most complex system of accelerators operating at any laboratory.
  - 8 GeV Proton source with Booster neutrino beam
  - Antiproton source
    - 8 GeV Debuncher
    - 8 GeV Accumulator
  - 8 GeV Recycler
  - 150 GeV Main Injector with NUMI neutrino beam and SY 120 beams
  - 980 GeV Tevatron with collider experiments



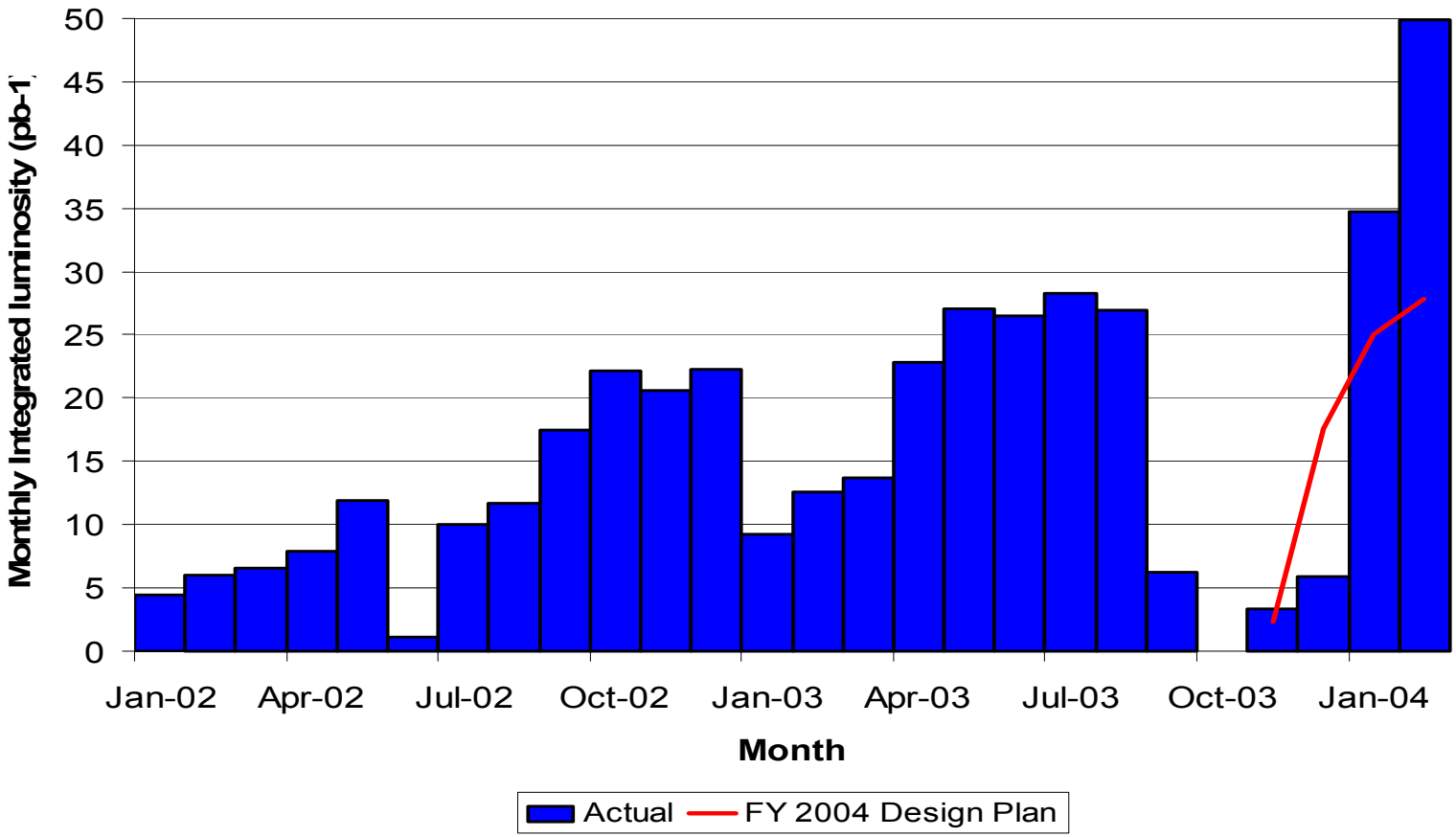
Tevatron Operations: FY 2004 Plan and Status



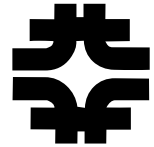
Physics total ~0.25 pb^{-1} on 10/03; plan ~0.55 pb^{-1} by 9/04

- As of 3/6/04, we are about 3 weeks ahead of design plan, with 2 week repair and maintenance shutdown to come

Progress of Run II



The last seven months

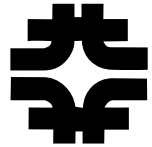


At the 7/21/03 accelerator review I said:

- "We will focus on
  - understanding and fixing limits to present luminosity, including several connected with the Tevatron,
  - reliability and maintenance issues,
  - Recycler commissioning, and
  - the upgrade program."

We have, and it has paid off.

DOE review closeout, 2/26/2004



Review Summary:

Great progress has been made since last review in July 2003.

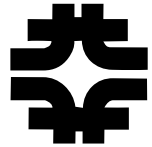
Successful shutdown – accomplished goals

The Tevatron complex has never performed better.

At last review we said –

"Success requires the new management team to effectively lead and integrate the many technically complex activities that make up Run II. The next 6 months will be critical."

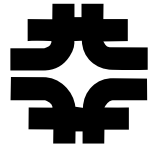
DOE review closeout (cont.)



The successes of the past 7 months are indicative of the very hard work of high quality staff working on Run II and the capabilities of the management team to lead and organize the Division's efforts.

The Laboratory as a whole appears to be focusing on run II and providing support at the level needed for success. This is important.

DOE review closeout (cont.)



So what's the bottom line?

We're very impressed with the progress in the past seven months.

We have increasing confidence that Run II will be successful.

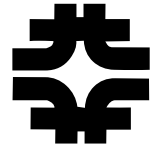
We look forward to continued progress toward the Tevatron complex being reliable and well characterized to serve as a platform for the cutting-edge upgrades.

But there's a long way to go in the complex campaign of operations, maintenance, upgrades, R&D, and studies that must succeed if the luminosity goals are to be reached.

We see a significant challenge in the installation and successful commissioning of electron cooling in the next 16 months.

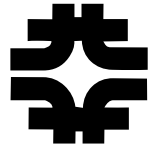
Keep up the discipline, focus, dedication and good work. We are very encouraged!!!

The last year at Fermilab



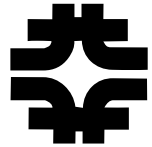
- Run II
  - Reorganized Accelerator Division for Run II.
  - Increased integrated luminosity per week by ~2x.
  - Delivered Run II total of 360 pb^{-1} total vs 120 pb^{-1} by 3/2003.
  - Brought Recycler up to specs for pbar storage.
  - Removed Silicon detectors from upgrade projects.
  - Made great progress on reconstruction, physics analysis.
- Neutrinos
  - Delivered MiniBooNE total 2.1E20 pot vs 0.4E20 by 3/2003.
  - Started MINOS far detector operation on cosmic rays
  - Completed NuMI construction contracts.
  - Installed NuMI beam line components during fall shutdown.

The last year



- External 120 GeV beams
  - Installed MIPP fixed target experiment and started to operate it.
  - Started operation of Main Injector test beam.
- Future experiments
  - BTeV endorsed by P5, Office of Science, given CD-0
  - BTeV language and funding in FY 2005 budget.
  - A fixed target experiment CKM was not endorsed by P5, despite a very high rating, because of insufficient budget.
- Experimental astrophysics
  - Completed initial CDMS-II and started operation in Soudan.
  - Building full Auger while taking data with largest operating array.
  - Completing SDSS survey while making regular discoveries.
  - Joined collaboration to develop the Joint Dark Energy Mission.

The last year

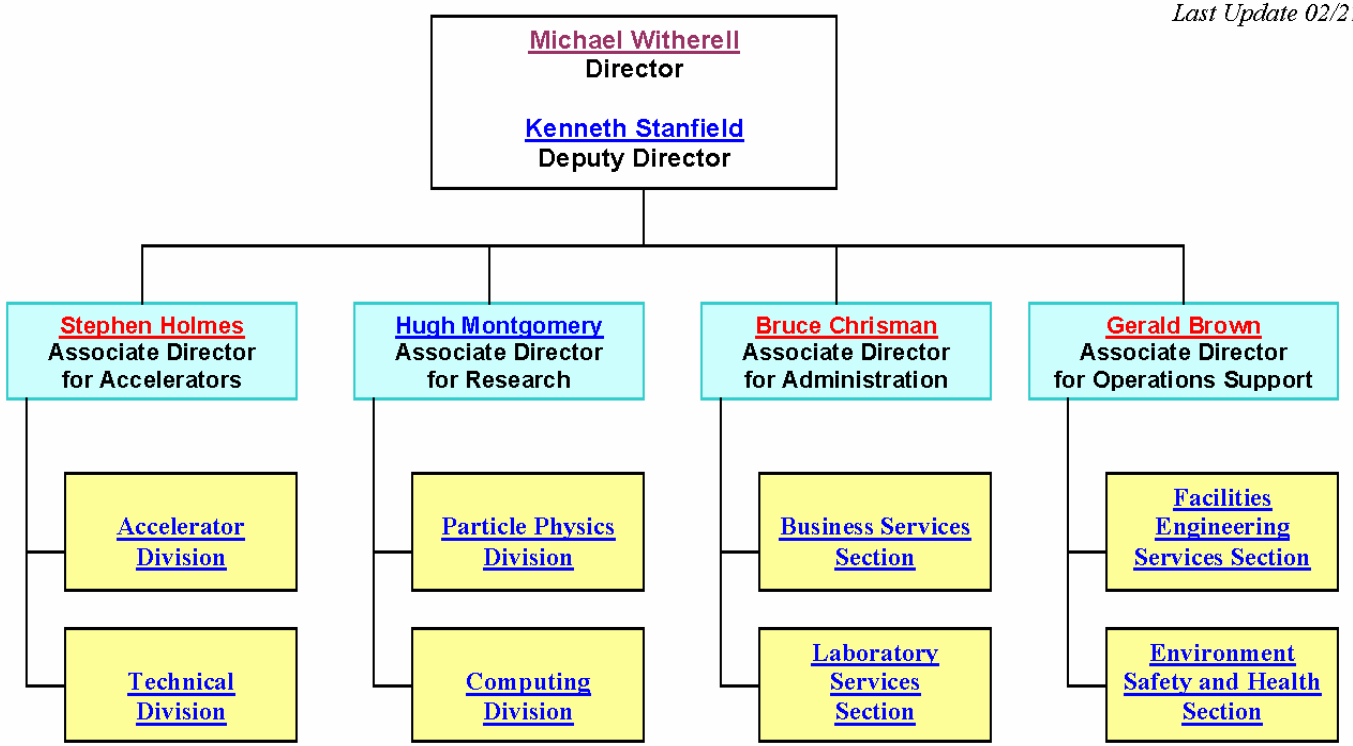


- Future planning
  - Long range planning committee almost complete
  - US-CMS and US-LHC research programs
  - Linear collider charge
  - Proton driver charge

The Directorate

Fermilab Directorate Organization Chart

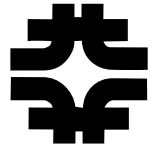
Last Update 02/27/04



The Directorate

- Other functions that reside in the Directorate
  - Budget office
  - Program Planning
  - Self-assessment and Quality
  - Project management oversight
  - Office of Public Affairs
  - Scientific personnel
  - International science
  - Laboratory historian and archivist
  - Arts coordinators

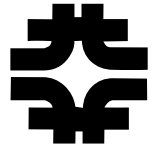
Optimizing the physics program



- Make sure the accelerators and detectors operate with good performance and high efficiency.
  - Organize the laboratory to support the program.
  - Improve the luminosity through 2006, then run efficiently
  - Maximize protons delivered to the neutrino experiments.
- Manage the projects well.
- Approve new experimental projects with highest possible standard, only if world-best; build them.
  - MINOS, BTeV
- Do accelerator R&D toward the future.
- Allocate resources appropriately.
- Improve efficiency of operations where possible.

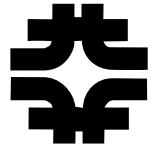
We have trimmed the program to match the resources.

Priorities



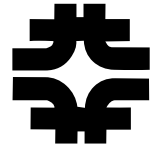
- We do the most important setting of priorities at the time of choosing projects.
  - A long and arduous process over some years, typically starting with the Physics Advisory Committee, moving through Director's reviews and HEPAP subpanels/P5, and ending up in the CD-0 approval.
  - Annual retreat with PAC and Long-range planning committee are used to look at the whole program over several years.
- In the shorter term, the most important decisions are about what is included in the plan of work.
  - We are committed to meet the project goals of NuMI in FY 2004, for example, and to follow the Run II plan.
  - Levels of support for analysis of data, R&D on future accelerators and experiments, and theory are annually adjusted to match lab priorities.

Analyzing and Mitigating Risk



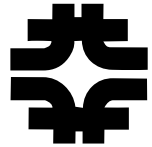
- Project managers, Division Heads, and Section Heads have primary responsibility for identifying and analyzing risks and developing a mitigation plan.
  - Risk that critical device will fail, shutting down program
  - Technological and schedule risks on projects and R&D
  - Risks to environment, safety, health, and security
  - Risk of noncompliance, for example, with DOE orders
  - Risk of damaging reputation of Fermilab or the DOE with neighboring communities or federal government
- Directorate has responsibility for setting priorities among these risks, evaluating mitigation plans, and providing resources those plans.
- We also have to consider the risk to the advance of particle physics if Fermilab does not have the strongest possible research program.

Program Planning and The Physics Advisory Committee



- We make good use of the Physics Advisory Committee in determining the scientific program of the laboratory.
- The Fermilab PAC does the most thorough review of experimental proposals of any similar committee in US HEP.
  - review by a technical committee
  - presentations and questions through several PAC meetings leading up to a presentation meeting in April followed by a weeklong retreat at Aspen
  - carefully written reports produced at the end of each meeting
  - extraordinary dedication of an excellent committee
- The Program Planning Office reports to the Associate Director for Research.

P5: The Roadmap in the intermediate term, ~2010



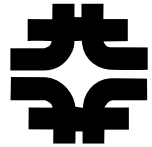
1. LHC
   - Atlas
   - CMS
2. Quark Flavor
   - BTeV
   - KOPIO
   - (CKM)

Fermilab is host laboratory of those in red.

(opportunities not yet recommended for funding)

3. Particle Astrophysics
   - Auger
   - GLAST
   - Ice Cube
   - CDMS +other DM searches
   - (SNAP)
4. Lepton flavor
   - NuMI-MINOS
   - MECO
   - (additional neutrino opportunities)

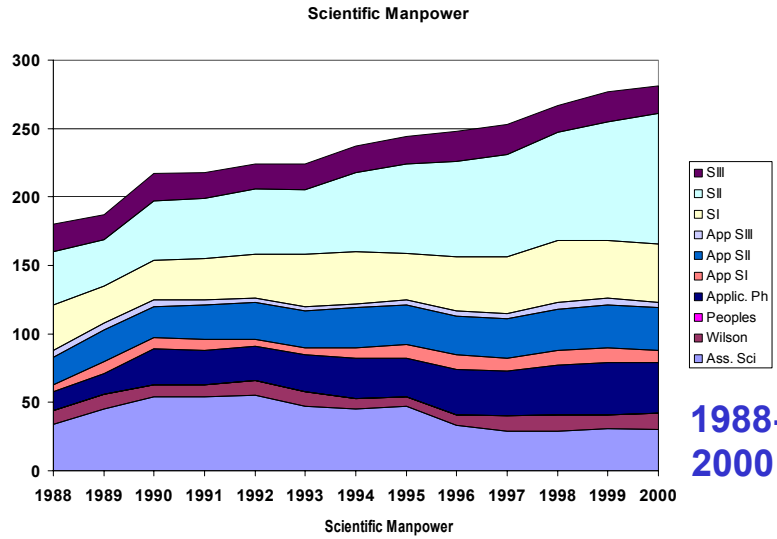
Project management



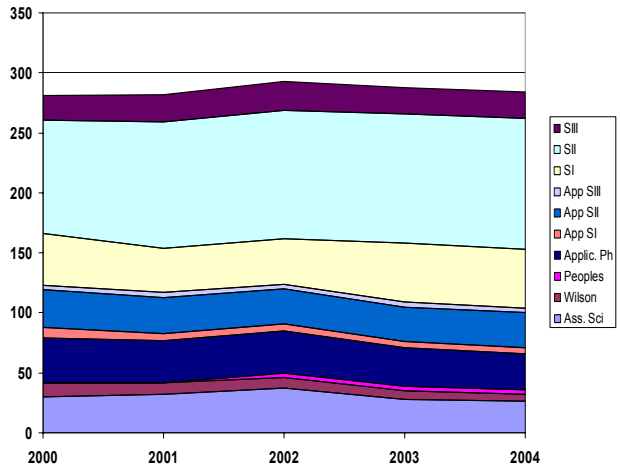
- We are well along on three construction projects in the $100-200 M range.
  - NuMI
  - US-LHC and US-CMS
- All of these are technically very difficult projects.
- The next project of this scale is BTeV.
- We have done well at managing those projects over the last two years, and the Lehman reviews have been very positive.
  - The Project Management Oversight office is important in this success.
  - We have added rigorous director's reviews, to make sure that we recognize problems early and move to correct them.
  - You should refer to the material and reports from recent DOE project reviews, which we have provided.

Scientific Staff Size

- From 1988-2000 the scientific staff (not including postdocs) grew from 180 to 281. This could not continue on a constant budget.
- Since 2000, we have been managing this number to be almost constant (281→284).
  - Wilson and Peoples fellows preserved as best source of new scientific talent
  - Accelerator scientists added in critical areas
  - Few Associate Scientists hired in other areas



1988-2000



2000-2004

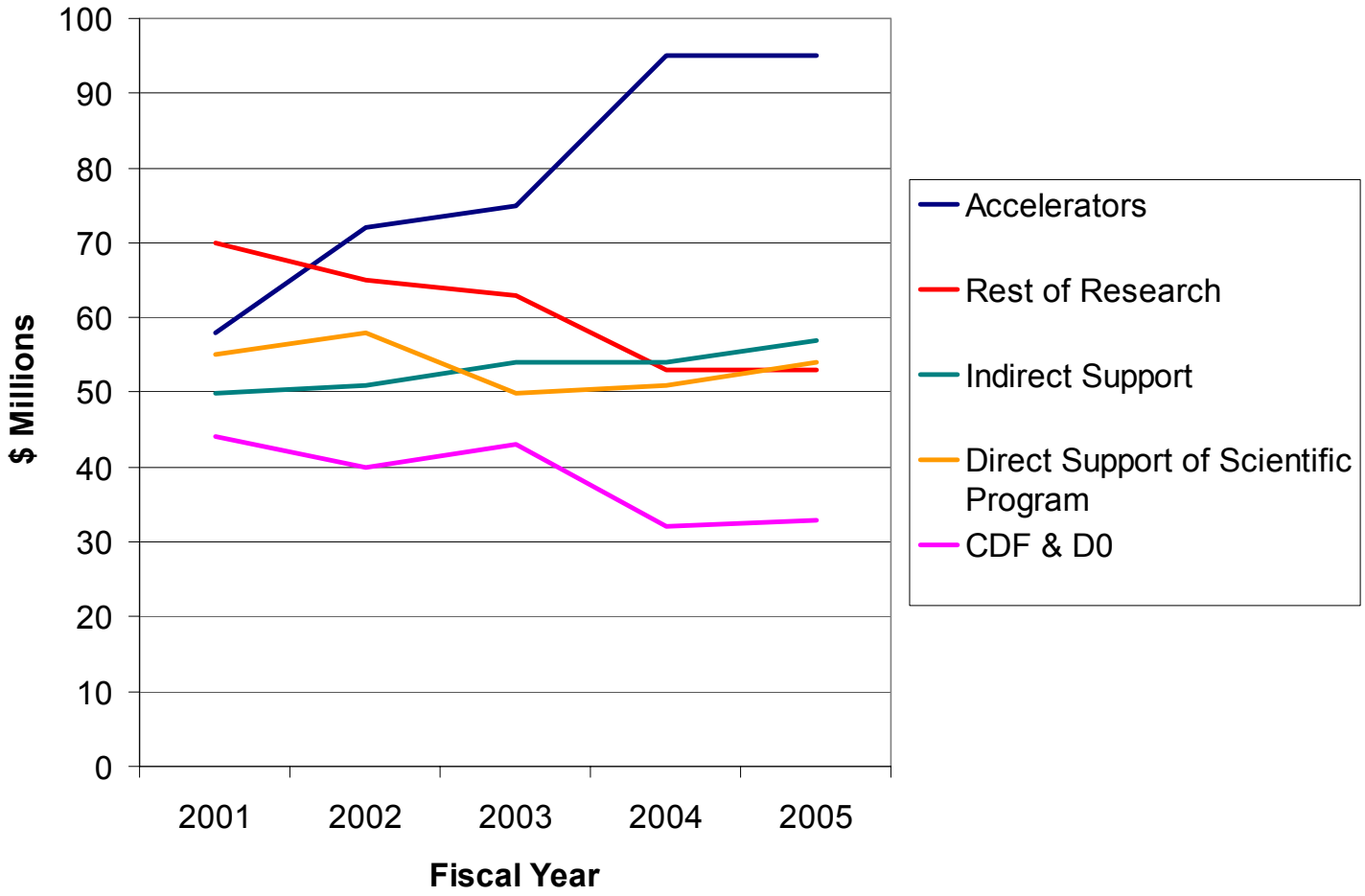
The FY 2005 Budget

FY	02	03	04	05	02-05
HEP	713	716	732	737	3%
Fermilab base	286	285	285	292	2%

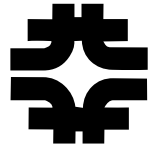
Annual budgets in $ millions

- Fermilab budget has been flat from FY 2002 to FY 2004, corresponding to ~$20 M less real effort.
  - We had a Voluntary Early Retirement Program in FY 2003.
- We have managed to support the full accelerator plan.
  - removing silicon detector upgrades
  - less work on the future, infrastructure than there should be
  - very little effort other than on existing commitments
  - redirecting manpower from inside laboratory
- In the President's budget, it will go up ~2% in FY 2005.
  - Run II accelerator improvements stay large.
  - NuMI project ends.
  - BTeV gets a small start.

Total budget is flat, but effort is effectively redirected within lab.

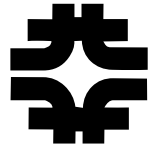


Budget Allocation



- We give initial guidance to the Divisions and Sections with their budget allocation and any new priorities or direction.
- In a series of budget presentations in the fall, the Division and Section Heads present to the Directorate and the other Heads:
  - their mission and task list for the year;
  - what can be done with the budget guidance;
  - the most important things that could not be done;
  - their concerns and issues.
  - We use these meetings to reach conclusions on what the laboratory is able to do each year.
- Meetings with Division and Section Heads throughout the year serve to update all of these areas.

Management meetings



- Weekly

  Directors | All Experimenters | Scheduling

- Biweekly

  Division Heads | Scientific Advisory

- Project Management Groups (mostly monthly)

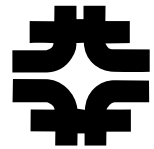
  NuMI | CDF upgrade | D0 upgrade

  Accelerator | US-CMS | US-LHC

- Other monthly

  Run II Strategy | Lab Administrative | Run II Task Force

Assessments: Advisory committees and major Fermilab and URA reviews

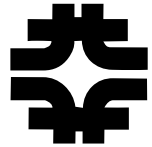


- 1 per year
  - URA Visiting
  - Administrative Peer review
- 2-4 per year
  - Physics Advisory Committee
  - Accelerator Advisory Committee
  - Board of Overseers
  - Run II Advisory Council
  - Director's Reviews
    - NuMI
    - BTeV
    - US-CMS
    - Run II accelerator
- Continuing program of self-assessment

Major DOE reviews

- Major annual reviews of the laboratory
  - Annual Program Review
  - Operations Review
  - Onsite Review by Office of Science
  - Budget meeting
- Semiannual (Lehman) reviews
  - Run II
  - NuMI
  - US-LHC
  - US-CMS
  - BTeV
- Advisory panels
  - HEPAP
  - P5

Infrastructure program

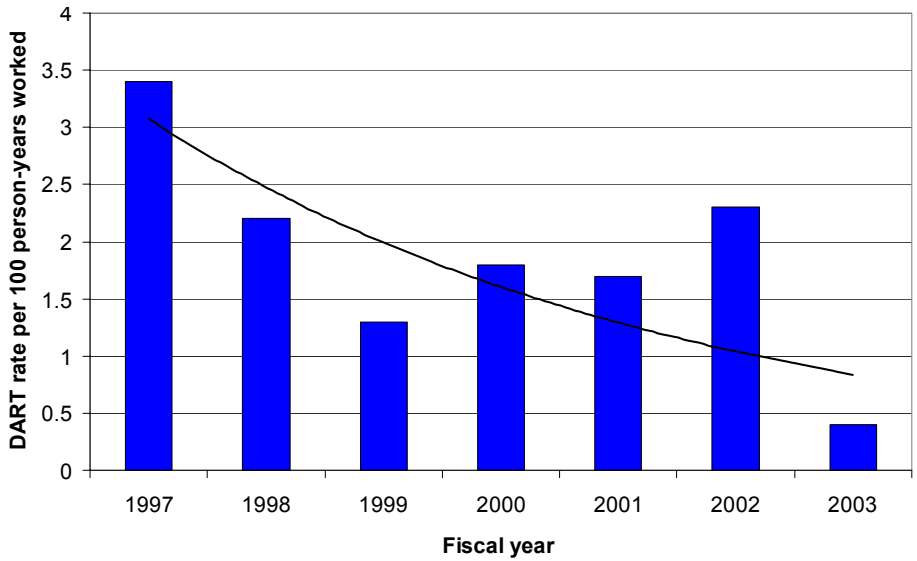


- The goal is to increase the reliability and robustness of the infrastructure that supports Fermilab's scientific program.
- The Utility Incentive Program (UIP) was very successful over 1998 – 2002 in working through backlog of projects.
  - It won DOE awards.
  - A legal opinion issued in 2002 killed the program.
- The most immediate need is work on the electrical distribution infrastructure.
  - Replace 2.4 miles incoming 345kV power line & poles
  - 9 miles of underground 13.8kV feeders and associated switches
- SLI program had this in funding plans starting FY 2005.
  - We recently learned that our project was delayed to at least 2011, years after the date by which we need to complete the work.
  - $12 M needed over 3 years, very soon

Safety

The laboratory management and staff have embraced Integrated Safety Management and have worked hard to bring the accident rates down.

- We have been working recently on the more difficult problem of integrating first-time contractors into the safety culture we maintain.



- We reduced the DART (Days Away, Restricted, and Transferred) rate for FY 2003 to a record low of 0.4 per 100 worker-years.
  - compared to 0.8 for the SC laboratories

Communication with the Fermilab Staff

Fermilab Today

Tuesday, March 2, 2004

Calendar

Tuesday, March 2
3:30 p.m. DIRECTOR'S COFFEE BREAK - 2nd Flr X-Over
4:00 p.m. Accelerator Physics and Technology Seminar - 1 West
Speaker: A. Diaz, Johns Hopkins University
Title: Novel Uses of Neutrons in Medicine and Radiobiology

Wednesday, March 3
3:30 p.m. DIRECTOR'S COFFEE BREAK - 2nd Flr X-Over
4:00 p.m. Fermilab Colloquium - 1 West
Speaker: A. Richter, Darmstadt University of Technology
Title: Playing Billiards with Microwaves: Quantum Manifestations of Classical Chaos

Cafeteria

Tuesday, March 2
Tuscan Vegetable soup
Penne w/grilled vegetables in a parmesean cream sauce $3.50
Golden fried chicken tenders w/a market side $3.50

OSHA Inspection Begins Today

A safety training class at Fermilab.

An OSHA Inspection Team begins its work at Fermilab today. Approximately 25 OSHA inspectors will be combing through our buildings and ES&H programs to identify areas that are not in compliance with the Occupational Safety and Health Administration standards. Based on the list of noncompliances, Fermilab will report a cost estimate for bringing our lab into full compliance. The inspection will also help Congress to determine whether to transfer regulatory authority for ES&H at Fermilab and nine other DOE Labs from DOE to OSHA.

There will be 10 inspection teams on site

Director's Corner

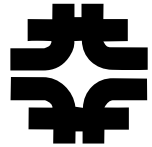
Good Morning!

Mike Witherell

The DOE review of the Run II accelerator campaign last week was a great success for Fermilab. In the Review Summary at the end of the closeout briefing, the committee included the following comments, along with many others:

- Great progress has been made since last review in July 2003.
- Successful shutdown -- accomplished goals
- The Tevatron complex has never performed better.
- We're very impressed with the progress in the past seven months.
- We have increasing confidence that Run II will be successful.
- We see a significant challenge in the installation and successful

Summary



- Fermilab has a broad physics program matched to the most compelling issues in particle physics.
- Run II represents the most important physics program now operating in particle physics.
  - We have the right plan to optimize the science.
  - We continue to focus the laboratory on following that plan.
- As real budgets tighten each year, we need to manage the resources actively to meet commitments.
  - During the last few years, this has meant building up the accelerator effort while reducing other areas.