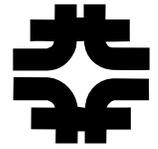




The Fermilab Program

Michael Witherell
Visiting Committee
March 14, 2003

The Fermilab Program



Area of Particle Physics

- Theoretical Physics, Phenomenology & Data Analysis
- Electroweak Physics
- Lepton Flavor Physics
- Quark Flavor Physics
- Unification Scale Physics
- Cosmology & Particle Physics
- Particle-Astrophysics

Fermilab program

Particle and Astro Theory
Lattice QCD
Tevatron*, LHC**, LC
NuMI*, MiniBooNE
BTeV, CKM

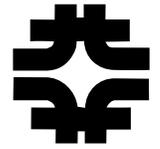
SloanDSS, CDMS*
Auger*

*ongoing construction projects

The breadth of the Fermilab program reflects the US HEP program.

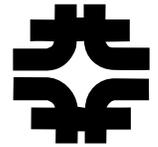
No experiments started since NuMI baselined in 1999.

Outline



- Tevatron collider program
- MiniBooNE
- Major projects
- Other research areas
- First look at budget impact
- Summary

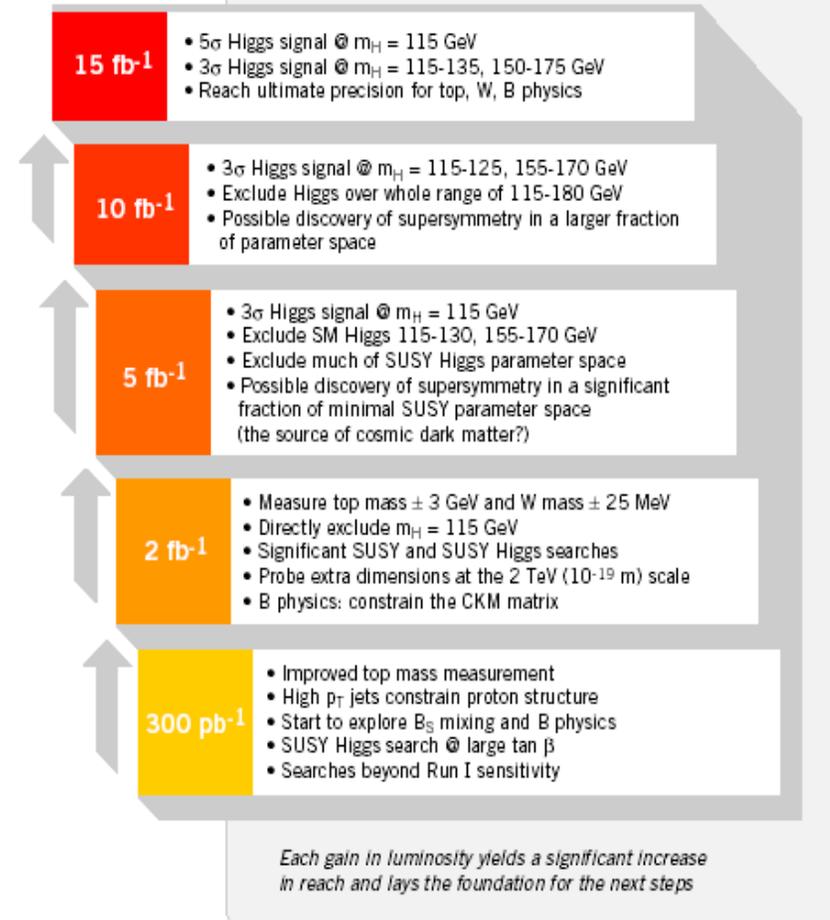
The Tevatron Collider Program



Next physics results

- Top measurements
- W measurements
- Searches for supersymmetry, extra dimensions, etc.
- B, B_s , Λ_b , charm physics
- QCD

Run II Physics Program

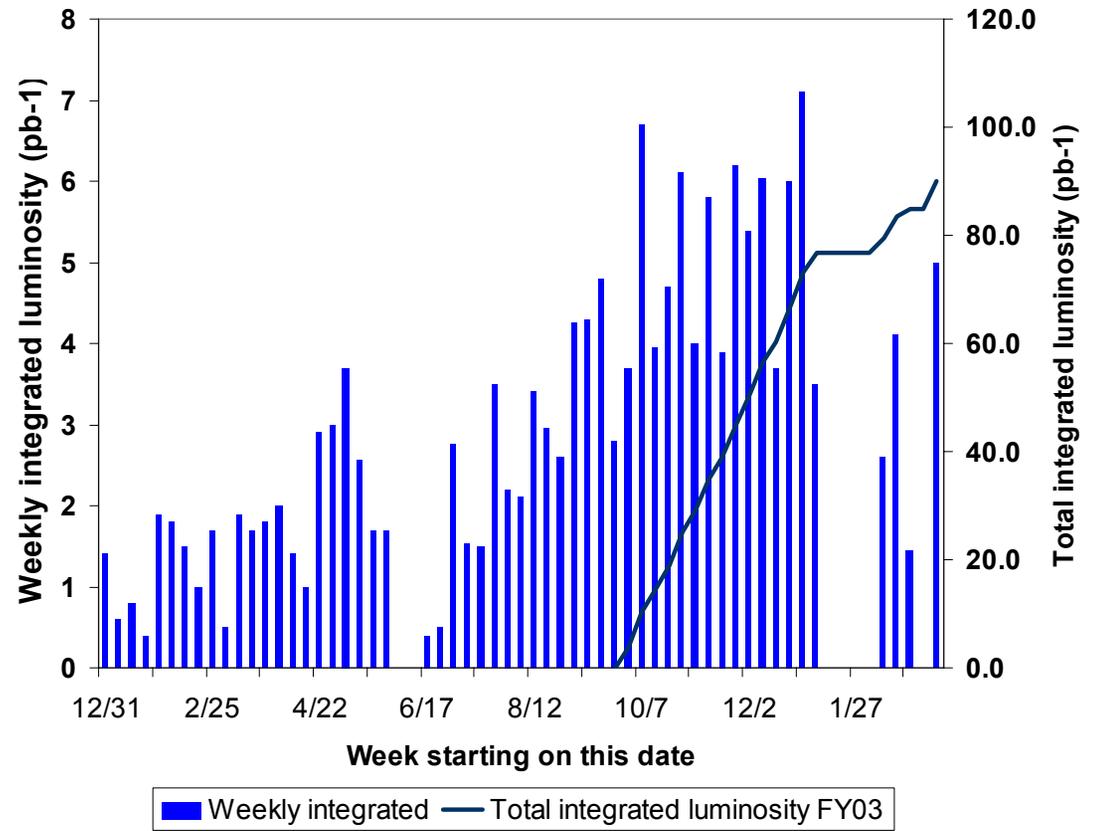


Weekly integrated luminosity

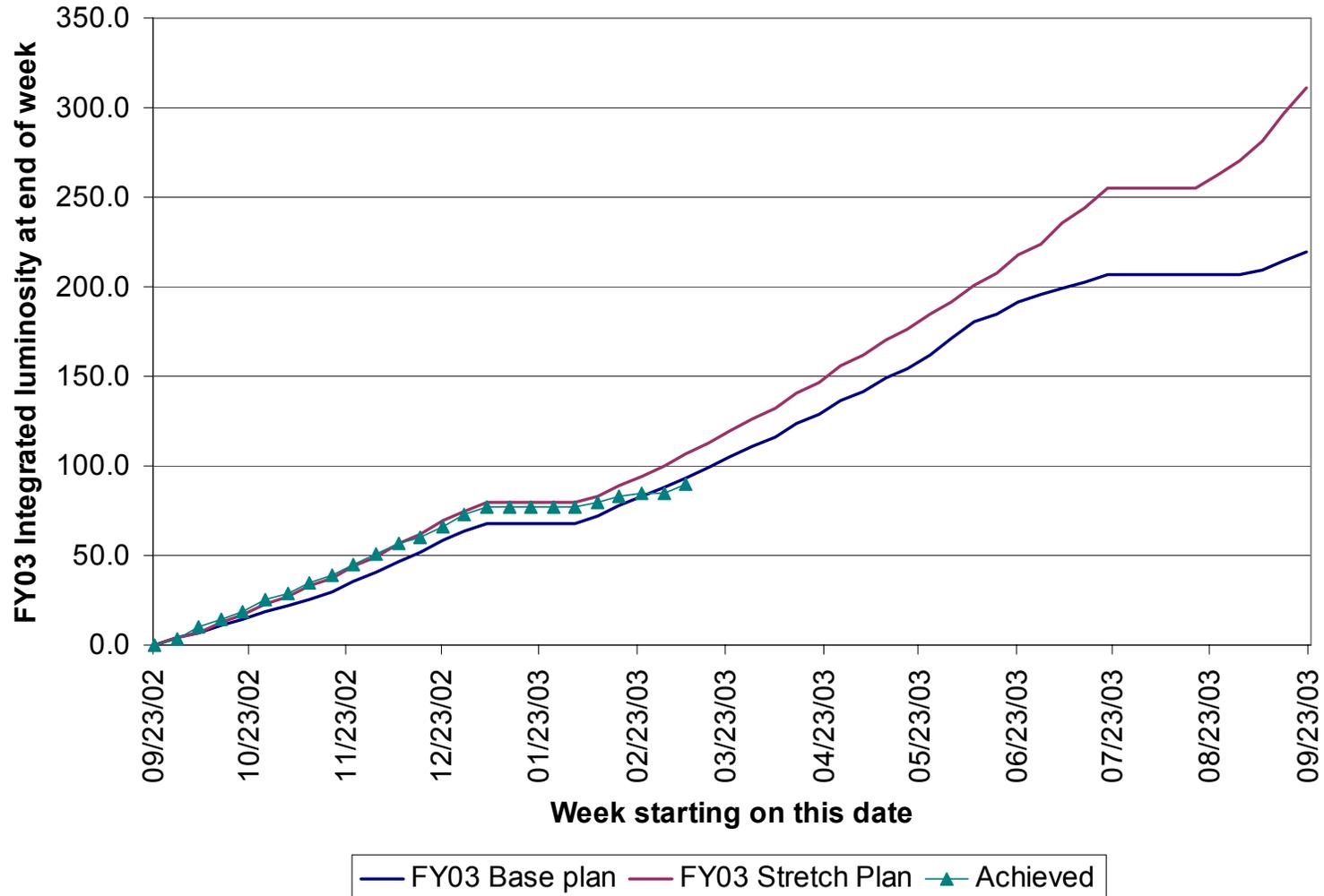
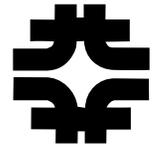
At end of CY 2002

- At start of year
- Best week = 7.1pb^{-1}
 - 1.4
- Typical week = $5\text{-}6\text{pb}^{-1}$
 - 1.0
- Best initial luminosity = $3.6 \times 10^{31}\text{cm}^{-2}\text{s}^{-1}$
 - 1.0

The shutdown was designed to remove at least one bottleneck.



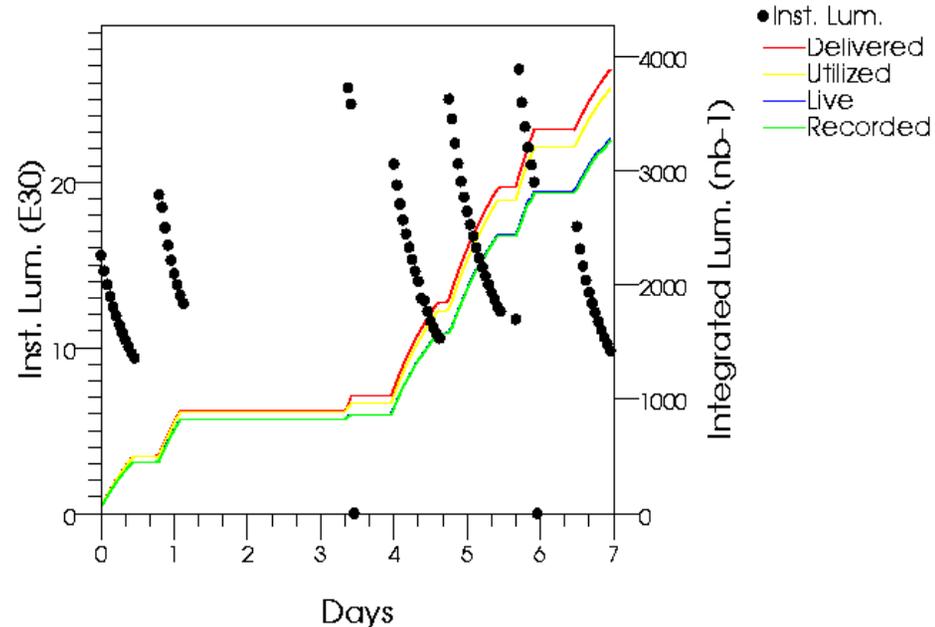
FY 2003 Plan



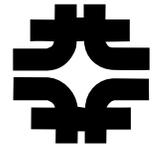
DØ Operations Status



- DØ is taking data with high efficiency and all detector systems in the readout
- Efficiency ~ 90% per run, 85% per week
- 10-15 million events recorded per week

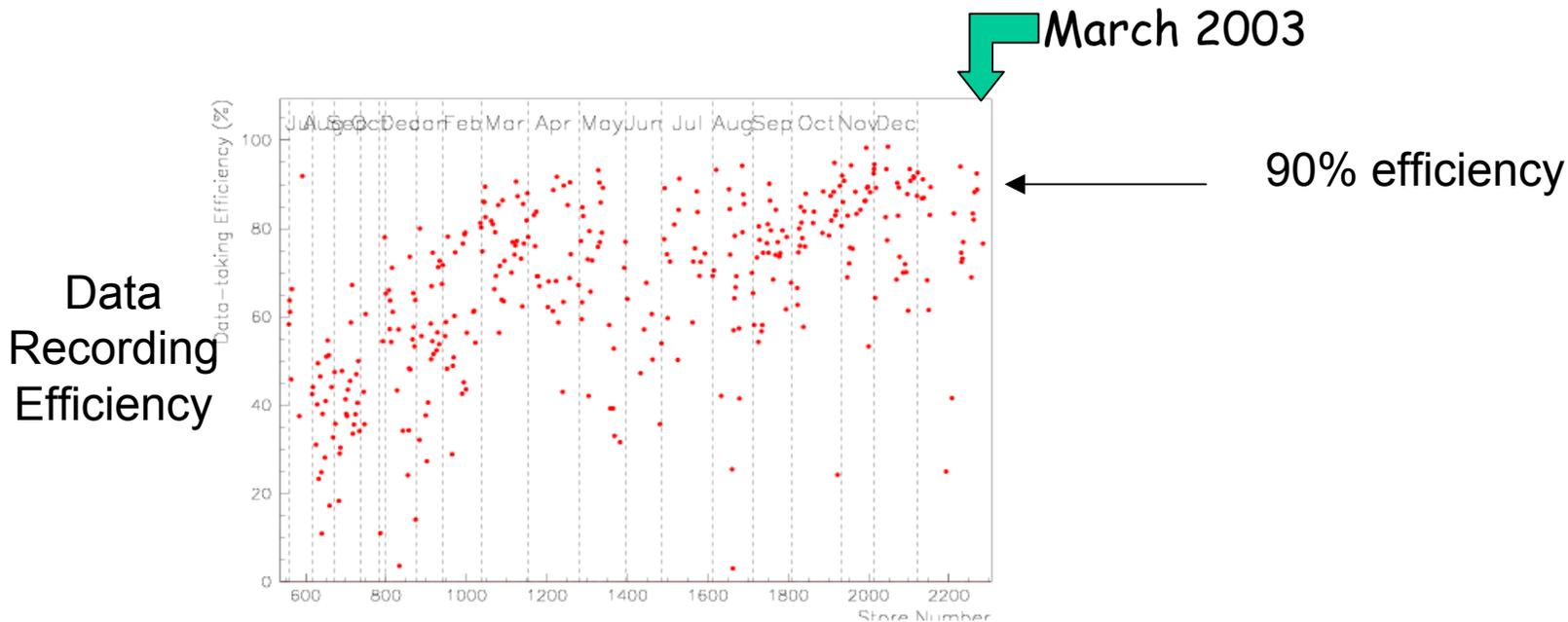


Days in the week
February 17th to 23rd



CDF Operations Status

- CDF is taking data with high efficiency and all detector systems in the readout
- Approaching 90% efficiency
- In October the silicon detectors were integrated in 98% of the data good for physics.



The scientific product:

Physics results from CDF & D0



- In 2002 many Run I results were published.
 - CDF 8 PRL, 14 PRD
 - D0 5 PRL, 4 PRD, 2 PL
- CDF and D0 are presenting the first batch of Run II results this month in 4 Wine & Cheese seminars
 - Recent results on new phenomena searches at D0
 - Recent D0 results in B, QCD, Electroweak and Top/Higgs Physics
 - Top, Electroweak, and Exotic Physics in CDF
 - Charm, B, and QCD Physics in CDF
- The full range of physics analyses will be evident this summer.

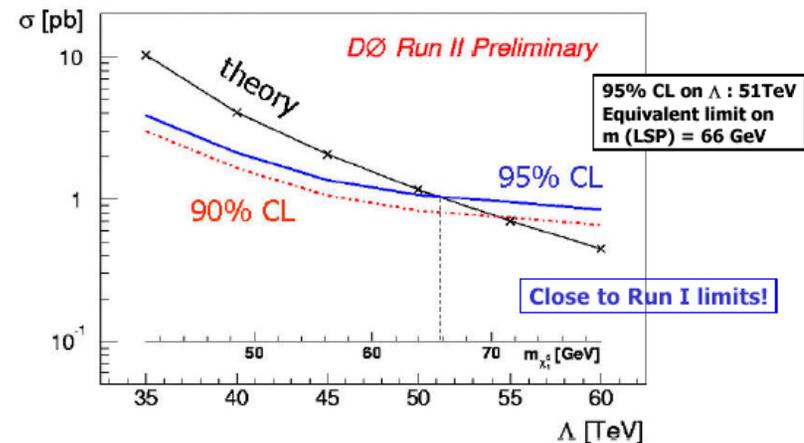
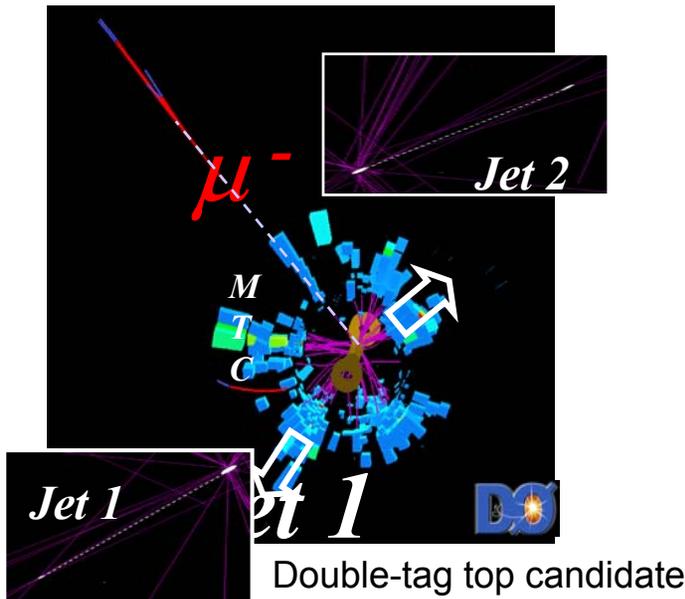


Top

- Search in 6 channels
- Top signal seen at ~ 3 standard deviation level
- Cross section at 1.96 TeV measured

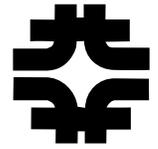
New Physics Searches

- Results from 7 new searches
 - Supersymmetry
 - Leptoquarks
 - Extra dimensions
- Limits already \sim Run I



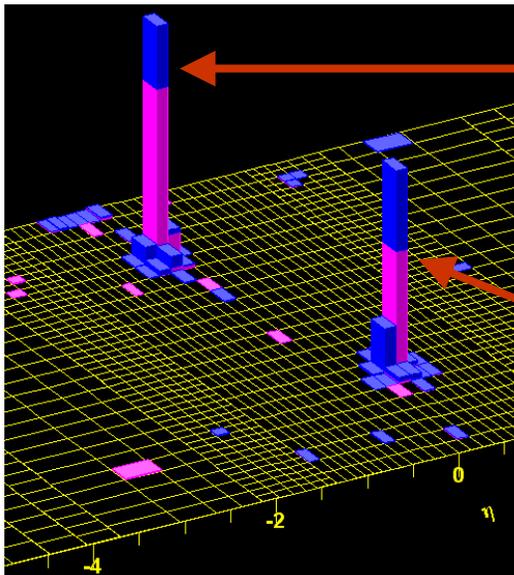
Limit on neutralino mass in gauge mediated SUSY using $2 \gamma s + E_T$

CDF Physics



- Particle searches w/ dijets
- W and Z boson production
- $W \rightarrow \tau \nu$ to study tau id
- Diboson production

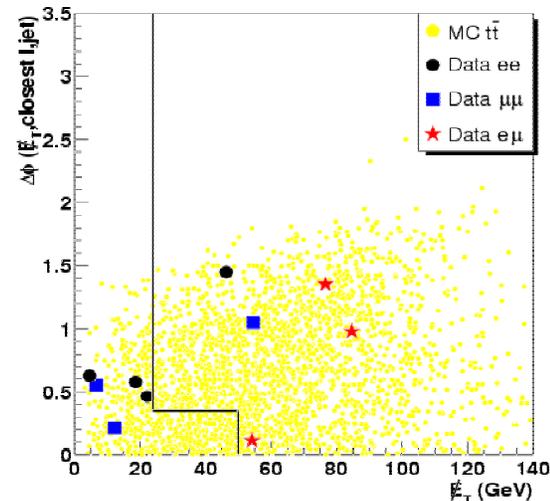
- top pair production using dileptons, lepton +jets
- top quark mass
- Z' and leptoquark searches
- Heavy flavor cross sections



$E_T = 528$ GeV
 $\eta = -0.55$

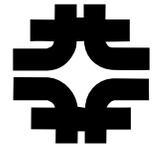
$E_T = 538$ GeV
 $\eta = 0.20$

Dijet mass
1146 GeV



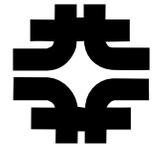
kinematics
of dilepton
top candidates

DOE Review of Collider Run II



- “The overriding impression of the Review Committee is that Fermilab has embraced the challenge of meeting the luminosity goals for the Tevatron complex and that the Laboratory realizes the significant level of challenges ahead.”
- “There has been excellent progress in the past year that serves as a solid platform for future progress and the increased focus of the Laboratory on this effort is a crucial factor.”
- “Reaching the base luminosity goal of 6.5 inverse femtobarns delivered by the end of the year 2008 will be a *significant challenge*. The committee found that a well thought out plan exists for luminosity improvement in FY 2003, but comparatively little detailed scheduling and resource planning beyond FY 2003.”
 - “The laboratory's technical approach for increasing luminosity over the next six years is sound and well motivated and, if successfully implemented, will maximize the integrated luminosity over this time period.”

Fermilab response on the future

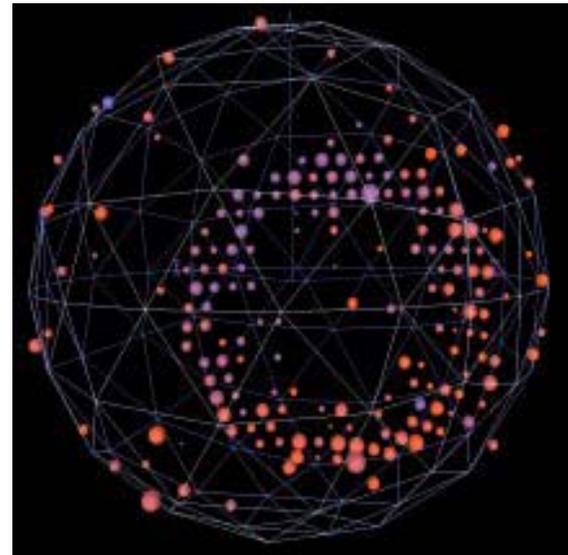
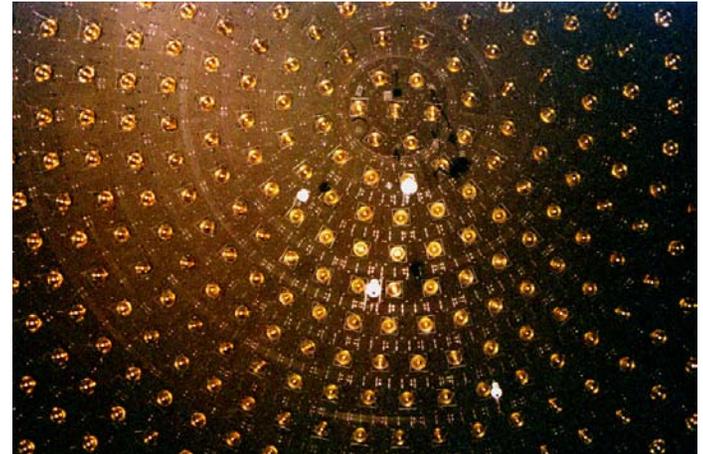


- **We agree.**
 - Reaching the base goal for integrated luminosity by FY 2008 presents a significant challenge.
 - Detailed schedule and resource plan beyond FY 2003 would be presented this summer.
- **Luminosity delivered per detector by the end of FY 2008(FY 2010):**
 - Base goal: $6.5(10)\text{fb}^{-1}$
 - Stretch goal: $11(17)\text{fb}^{-1}$
- **We will run CDF and DØ until the LHC experiments start to produce physics results that dominate our picture.**
 - We expect to be running to FY 2009-10.
 - Achievable outcome depends on available funding.

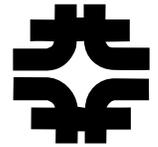
MiniBooNE is running.



- First event September 2002
- Neutrino Beam operates 140 hrs per week
- Events match Monte Carlo
- Ongoing program to reduce booster losses, which allows faster rep. rate for MiniBooNE.
- **News: record beam intensities**
 - 3 → 5.5×10^{16} p/hr standalone
 - 2 → 4×10^{16} p/hr with pbar stacking
- **Steps that led to these increases**
 - new MP02 Magnet and supply
 - shorter extraction notch
 - improved booster orbit
- **Next step to reduce losses**
 - Collimator shielding – designed, under construction, to be installed this summer.



Construction Projects



- We are executing a large number of construction projects because we are supporting a large part of U.S. HEP.
 - CDF and D0 upgrades
 - NuMI
 - US-LHC and US-CMS
- This is a major component of the Laboratory's effort, and of what we provide to US HEP.
- We have done well at managing those projects over the last year, as measured by Lehman reviews
 - We have made those reviews available for this committee.
 - We also collected a notebook of the Director's reviews.

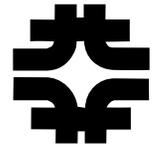
Project Management



- The process for managing projects has worked very well. We have 5 projects now undergoing regular Lehman reviews, 3 of which are >\$100M. All of them have been doing well, despite the fact that all are very difficult technical projects.

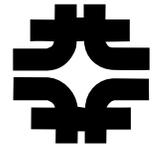
Project	TPC	% complete
– NuMI	\$171 M	78
– US-CMS	\$167 M	80
– US-LHC	\$110 M	82
– CDF	\$ 25 M	
– D0	\$ 21 M	

Run IIb Detector Upgrades



- In June, PAC recommended laboratory approval to CDF and D0 upgrade projects that would
 - replace radiation-damaged silicon detectors with new detectors of simpler design with more radiation-hard technology.
 - upgrade data acquisition and triggers to deal with higher luminosity.
- We held successful Lehman baseline reviews in September.
 - No action items, recommended reduced contingency, which we accepted
- External Independent Review completed in Nov. 2002
- ESAAB approval on December 17, 2002
- Sensor and SVX4 orders are going out

Lehman review report: CDF and D0 Projects 9/02

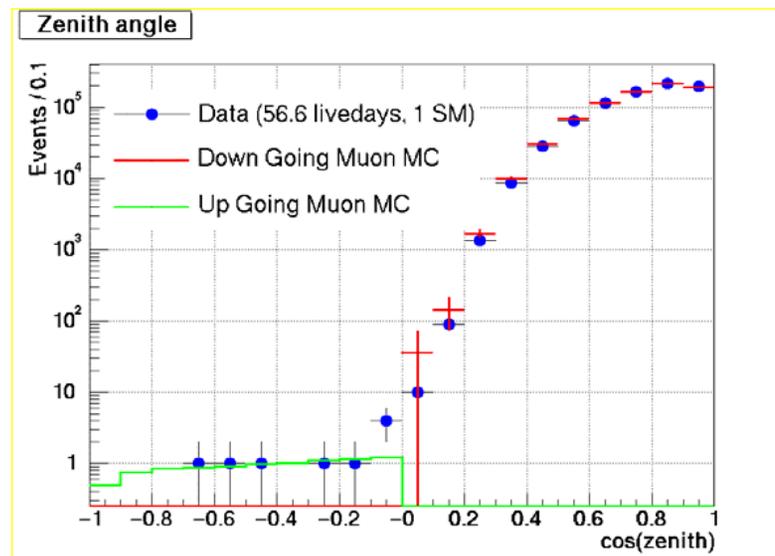
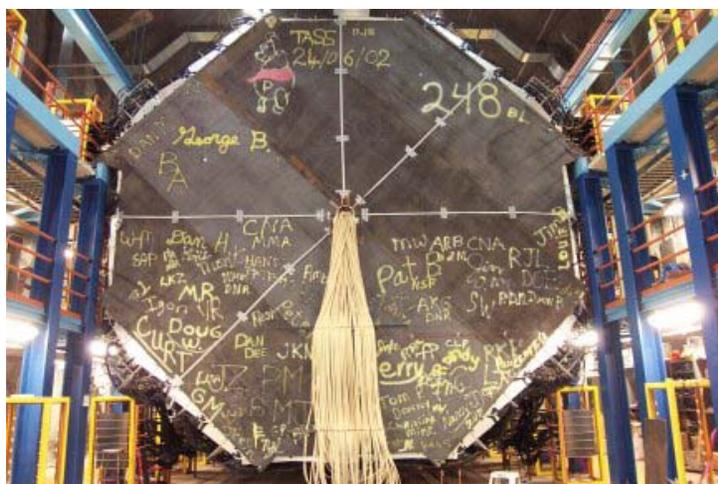


- The Committee commented on the advanced maturity of the technical design and concluded that the upgrades are technically ready to be baselined.
- The overall judgment of the Committee is that the Run IIb CDF and D-Zero Detector projects are technically advanced and have good management teams in place. Once the cost and schedule adjustments have been made, the Committee recommends that the projects should be baselined.
- The Committee sees no reason to delay the start of construction.

Status of the NuMI Project

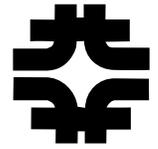


- Tunnels and Halls construction complete 11/22/02
- Surface Buildings and Outfitting construction started 11/1/02
- 426/484 planes of MINOS far detector installed and operating
- Cosmic ray studies underway



Lehman review of NuMI

12/11/02



- “The project’s current forecast for DOE Level 0 milestone CD-4 (Begin Operations) is January 19, 2005, which would leave 254 days of float until the baseline date of September 30, 2005. The Committee commended the project for accomplishing all DOE milestones since the last review (two for civil construction and one for NuMI) well ahead of the baseline schedule. However, the Committee is concerned about delays in completing the design of critical technical components. There are no funding issues with the project.”
- One Action Item: Conduct next review in March.

The LHC Projects

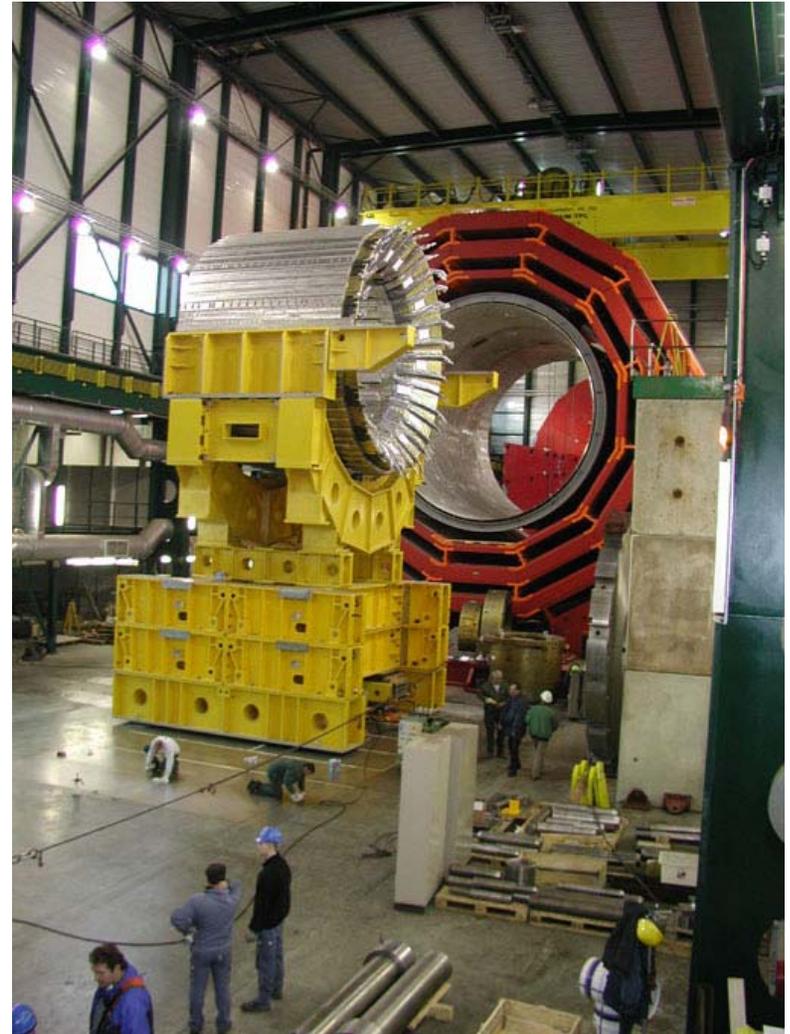


- US-CMS

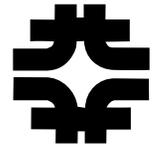
- Project ~80% complete
 - schedule performance good
 - adequate contingency
- Planning the transition to the CMS research program.

- US-LHC accelerator

- Project >80% complete
 - schedule performance good
 - barely adequate contingency
- Planning a US accelerator research effort with BNL, LBNL

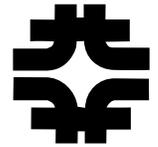


Assessment of LHC projects by DOE Project Managers



- “Cost performance (for the total U.S. LHC Construction Project) is good.”
- “Good technical progress continues across the project, and we remain confident that the U.S. deliverables to CERN can be realized with the planned funding.”
- “The U.S. LHC Accelerator project office continues to aggressively manage remaining contingency and work with all 3 Laboratories to identify potential risks and strategies for mitigation.”

Lehman review of US-LHC



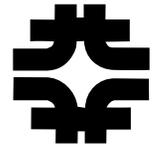
- “**Fermilab** is continuing to make good technical progress and has had a number of important technical accomplishments. **Most impressive is the results of the test of the first MQXB in its final cryostat.** This pair of magnets met its quench criteria on the second thermal cycle and one of the magnets met the field strength criterion without quenching on the first thermal cycle. There was no further training. Measurements of higher harmonics, quench protection and alignment were all within tolerance.”
- “The major challenge for the **Project Management Office** is to successfully complete the U.S. LHC project within budget. The contingency has remained at 16 percent since the June review. A major effort by the PMO briefly increased it to 19.3% but it was quickly eroded again. Since potential significant calls on contingency still exist, this will continue to require extremely careful management and control.”

Lehman mini-review of US-CMS 12/13/02



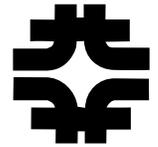
- “The U.S. CMS project is performing well with respect to technical, cost, and schedule goals. Overall, management of the project is very good. Planning for transition from the construction project to Maintenance & Operations (M&O) is well underway. This planning by U.S. CMS has occurred in concert with the detailed CMS planning.”
- “Overall, U.S. CMS management is doing a very good job. Proactive steps are being taken to adjust the organization to meet project needs as activities shift from construction to installation and M&O at CERN.”
- One action item: Conduct next review.

Experimental Astrophysics



- The experimental astrophysics effort is well established.
 - First-rate experiments: Auger, CDMS, SloanDSS
 - Important roles suited to Fermilab strengths
 - Modest investment of DOE-Fermilab resources
 - Good project management
- 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.

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.

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.

Computing at Fermilab



- Fermilab is a recognized leader in the development of the large-scale computing facilities needed for particle physics.
- Run II computing project was a success.
 - The computing systems were built at cost and are working well.
- Fermilab led development of LHC computing superstructure.
- Other special projects
 - Lattice QCD Center
 - Grid projects
 - Sloan DSS Data Processing
 - Tier1 Computing Center for US-CMS
 - Accelerator Simulation

Lattice QCD



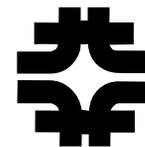
- Better lattice QCD calculations are needed to extract many Standard Model parameters from experiment:
 - Precise calculations of these quantities are needed to gain the full benefit from the experimental program.
- A new generation of computing facilities is needed to make it possible for U.S. physicists to contribute to these advances.
- Funded SciDAC proposal:
 - National Infrastructure for Lattice Gauge Computing**
 - R. Sugar, UCSB is Principal Investigator
 - About 60 lattice gauge physicists
 - We have built and are operating a commodity-computer cluster designed for this use.

Planning with a budget that does not cover present commitments



- In assessing what the laboratory has done and in planning what we will do, the overriding issue is how to optimize the effort in the context of a budget well below that needed to do the work.
- We continue making an extraordinary shift of resources within the laboratory to support the Tevatron collider program.
 - Operating accelerator and experiments efficiently
 - Building CDF, D0 upgrades according to project schedule
 - Following FY03 accelerator plan, developing full plan for FY04+
- We are maintaining schedule and funding profile on certain select projects and programs
 - NuMI and MiniBooNE
 - US-LHC, and US-CMS
 - Linear Collider R&D (at a small funding level)
- We have reduced support for future projects to the level below what is needed for reasonable progress.

FY04 budget request is bad for HEP, worse for Fermilab.

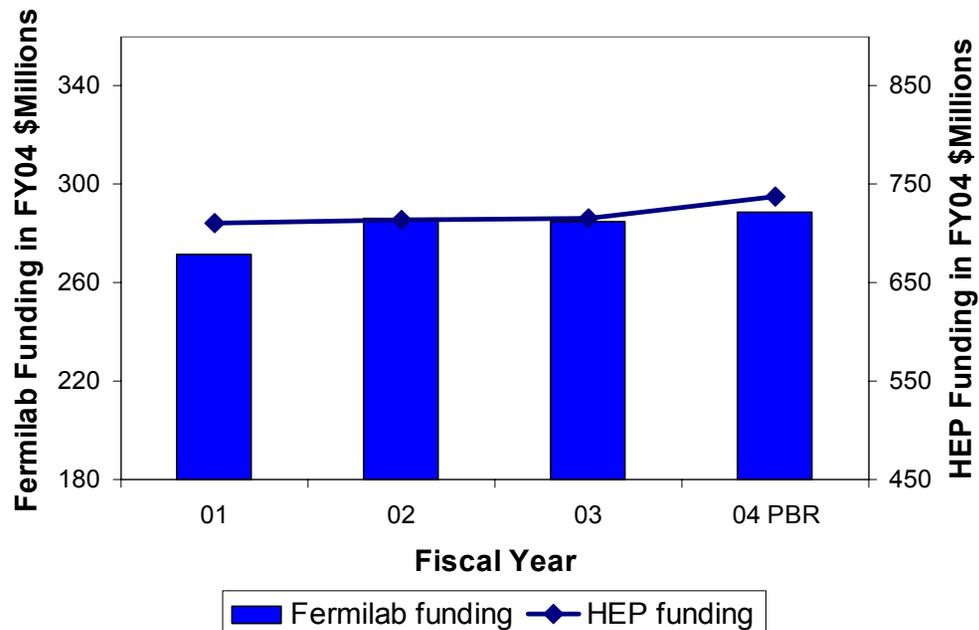


FY	02	03	04	02-04
HEP	713.2	715.7	738.0	3.5%
Fermilab base	286.2	284.8	288.5	0.8%
Fermilab total	310.6	311.6	303.3	-2.4%

Fermilab budget is \$288.5M.

This is down 7% relative to inflation since FY2002.

- These are the critical years for collider upgrade.
- General reduction will take it down further.
- The proposal for ambitious upgrading of the Tevatron has not yet been funded.



We are not able to prepare adequately for the future.



- The full brunt of tight budgets have fallen in two areas, accelerator R&D and experimental initiatives.
 - When the laboratory budget contract by a few percent, because most spending is tied to firm commitments, these areas receive large cuts.
- Accelerator R&D
 - Some efforts stopped or scaled back, others are subcritical.
 - The leaders of these efforts need to have predictable budgets to be able to draw up an effective work plan.
- BTeV & CKM
 - They have made reasonable progress despite impossible budget.
 - They are waiting for P5.

Linear Collider



- As a member of the US and International Linear Collider Steering Committees, I have been working to
 - organize the linear collider as a global project;
 - help make the case for the linear collider with government and with the public; and
 - in general, promote the linear collider.
- It has been impossible so far, however, to establish the requisite Fermilab role in the linear collider.
 - Accelerator R&D is set at \$2.4 M + G&A, room for little more than delivering a few structures
 - Starting up minimal physics and detector effort is difficult when the budget for all non-Tevatron activity is getting cut hard.
- The linear collider needs to appear on an Office of Science facilities plan with some increased R&D budget attached.

Accelerator R&D



- Three years ago at this review, I said:
 - We need to invest more in accelerator R&D.
- The fact is, we have invested less.
 - The budgets were not enough to support projects commitments and R&D on the future.
- We will not show good progress from year to year on any area of accelerator R&D without a substantial increase in budget.
 - It is very difficult to scale back goals as quickly as we have had to reduce budgets.
- At the same time, we have some excellent people who are able to do very good research on little budget, and we need to give them the opportunity to do that.
- We are also working with university programs to provide opportunities for training students.

New Experiments

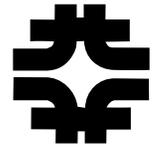


- BTeV
 - best B experiment in 2009+, ready to go
- CKM
 - best K experiment in 2009+, ready to go

Both are before P5. You will hear from them at this meeting.

- Neutrino options beyond MINOS
 - Many possibilities, all in early stage
 - Hugh Montgomery will talk some about what is going on in this area.

Reminder: one-time steps to deal with the FY2003 Budget



Our goal was to avoid drastic measures such as involuntary staff reductions. This looks possible at the currently projected funding level.

Some of the steps taken, in addition to reducing program, are:

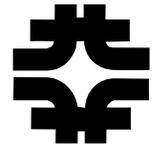
- We are offering an early retirement plan with incentives to about 700 employees.
- Only a small number of employees who terminate this year will be replaced. We anticipate a net staff reduction of about 100 people through attrition and retirements.
- Most employees must reduce their vacation accrual by 20% from the amount accrued as of September 30, 2002.
- 20% less travel (essential project travel favored, bigger reduction in conference travel), no vehicle replacements, fewer new copiers and desktop computers, etc.

Safety



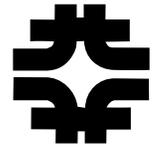
- The laboratory management and staff have embraced Integrated Safety Management and have worked hard to bring the accident rates down.
- It has been harder to integrate first-time contractors into the safety culture we maintain.
 - The NuMI tunnels and halls contractor raised our total accident rate significantly during the time they were on site.
- Total Lost workday case rate was ~3 in FY 1997, ~2 in 2002 (per 200,000 hours worked).
 - It needs to be less than 1.2 for us to get a rating of outstanding this year.
- 5+ months into FY 2003, LWCR is at ~0.6.
 - We need to keep it at the front of people's attention.

Concerns



- The future of US HEP
 - Meeting the commitments on projects and operations commits the funding completely.
 - This leaves nothing for even the highest priority new experiments or a viable level of accelerator R&D.
 - Both the mid- and long-term future are being sacrificed. This will lead to a precipitous loss of scientific opportunity in the U.S. program at the end of the decade. If we continue to lose inflation:
 - We will not have a viable domestic HEP program.
 - The linear collider will not get off the ground.
- This will be true even though the scientific opportunities are as great as they have ever been.
 - One year with an increase above inflation would have a disproportionately big positive effect, just as losing inflation in FY 2003 and again in FY 2004 does great damage.

Summary



- Run II physics is here.
- The integrated luminosity is near the plan, but we need to realize increased luminosity and regain the stability obtained before the shutdown.
- Miniboone is running well.
- Big projects, NuMI, US-LHC, US-CMS are in making good progress.
- Budgets have hit future experiments and R&D hard. They threaten the Run II upgrade in FY04.