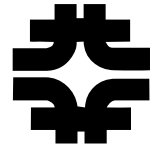


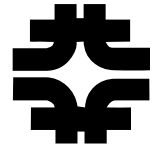
The Fermilab Program and the FY2003 Budget

Michael Witherell

HEPAP Meeting

November 7, 2002

Programs and Facilities

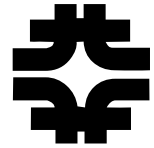


Program	Physicists	Facilities
Tevatron Run II	1200	collider, detectors, computing
Neutrino	260	neutrino beams, large detectors
US-CMS	300	detector, computing, research
US-LHC		accelerator systems
Astro	450	detectors
		telescope, data processing
Quark Flavor	210	accelerator complex, detectors
Lattice QCD	60	commodity cluster computing facility

We are fulfilling commitments to the elements of the experimental programs that were made over the period 1994-99.

As real budgets fall, these commitments saturate the available resources.

The Tevatron Collider Program

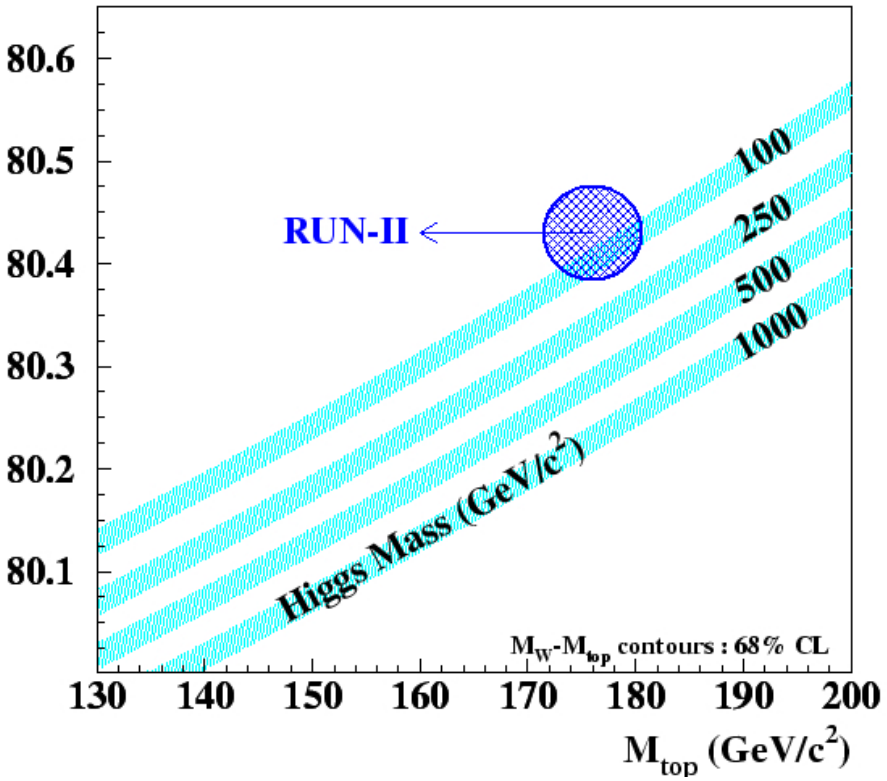


The Collider Run II is the most important activity at Fermilab.

- The only collider able to address the physics of the TeV scale
- Every factor-of-2 increase in the size of the data sample makes possible a new round of important physics results.

- Possible discoveries:
  - Supersymmetry
  - Extra dimensions
  - New dynamics (technicolor, new gauge bosons)
  - Quark or lepton compositeness
  - Higgs boson, with time
- Precise measurements to confront the Standard Model:
  - top quark and W boson properties
  - measurements of B mixing and CP parameters

Electroweak Measurements

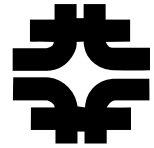


Expected measurement error for each experiment at 2 fb^{-1}

- Tevatron upgrades
  - Larger data samples
  - E = 1.96 GeV
    - $\sigma(W)$ ~10% higher
    - $\sigma(t\bar{t})$ ~ 35% higher
- Detector upgrades
  - Increased efficiency for b-jets, leptons
  - Performance as expected

Top quark events collected per pb^{-1} increased by factor 3+

Run IIa Luminosity Goals

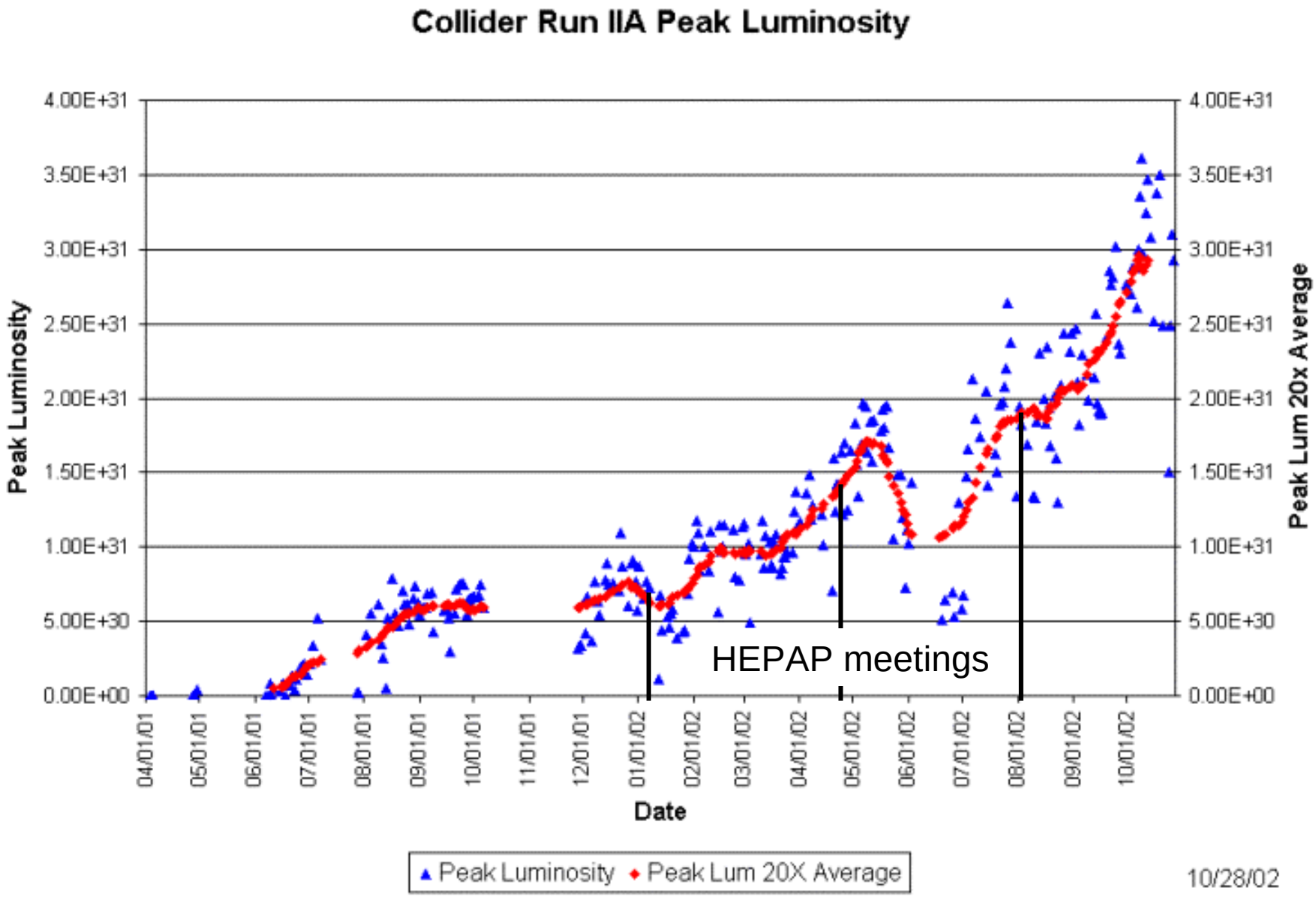


For Run I:

- Typical peak luminosity ~1.6x10^{31} cm^{-2} s^{-1}
- Typical weakly Integrated luminosity ~2 pb^{-1}
- Total integrated luminosity delivered ~0.14 fb^{-1}

- The official luminosity goal for Run IIa was defined in the data sheet for the Main Injector Project:
  - "The Tevatron proton-antiproton colliding beam luminosity will be increased to at least 5x$10^{31}$$cm^{-2}$$sec^{-1}$."
  - Total integrated luminosity of 2 fb^{-1}
- We are committed to exceed that official goal with additional effort and the Recycler. The limits are believed to be:
  - 8x10^{31} without the Recycler
  - 2x10^{32} with full benefit of the Recycler

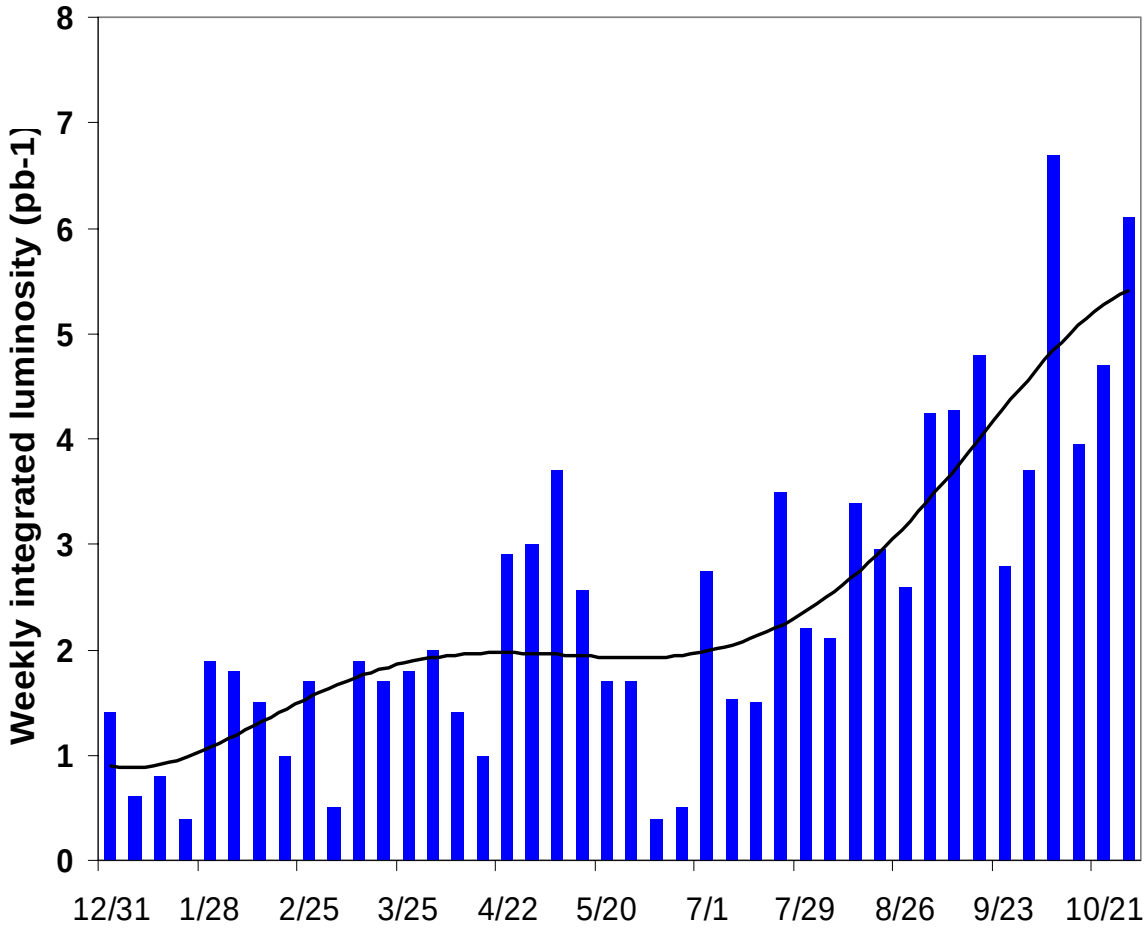
Peak Luminosity



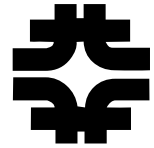
Weekly integrated luminosity

Compared with 3 months ago:

- Best week = 6.7 pb^{-1}
  - best was 3.8
- Typical week = 5 pb^{-1}
  - typical was 2.5
- October = 22 pb^{-1}
  - best was 11
- Best initial luminosity = 3.6 $cm^{-2}s^{-1}$
  - best was 2.6



Progress in 2002



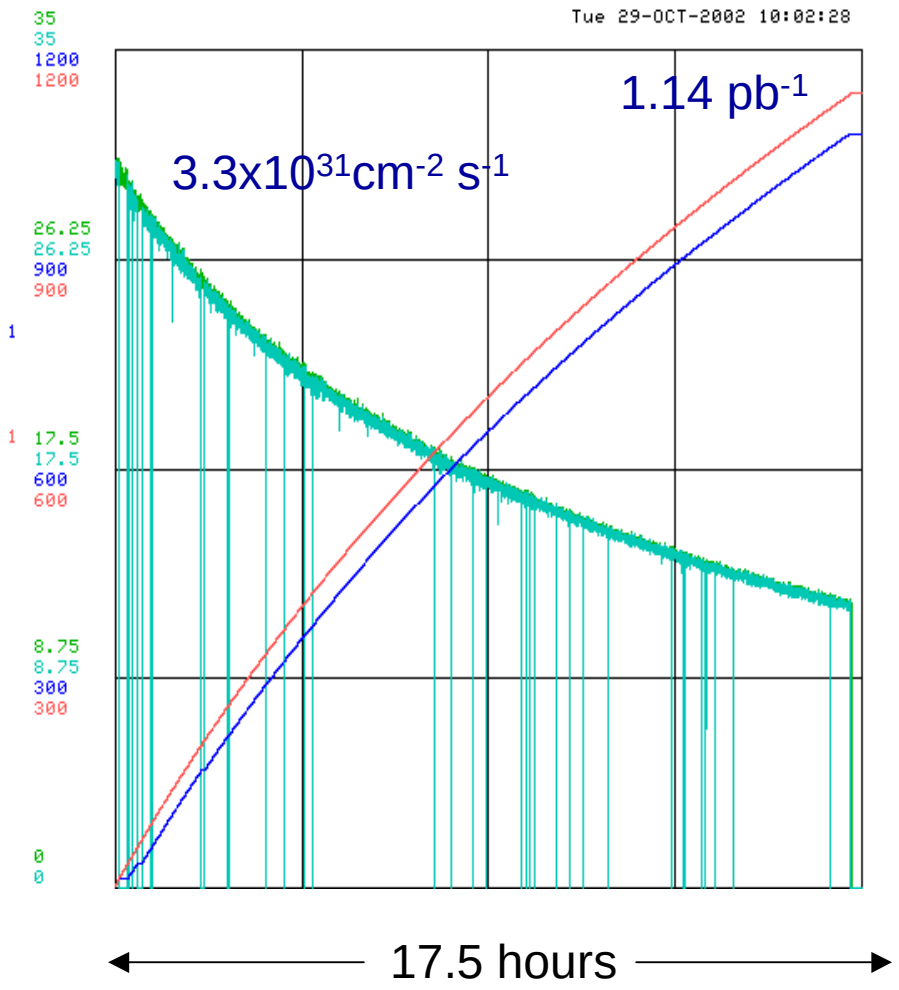
- Every performance improvement evident in the luminosity performance plot has been associated with a specific modification to the accelerator complex.
- Major modifications since January 1, 2002:
  - Accumulator->Main Injector transfer optics
  - Adjustment of tunes during low beta squeeze
  - Modified injection helix in Tevatron
  - Proton beam loading compensation in Main Injector
  - Accumulator (stochastic) cooling upgrade
  - Accumulator shot lattice
  - Antiproton beam loading compensation in Main Injector
  - Tevatron beam line tuner (BLT)
  - Tevatron tune/coupling drift compensation
  - Tevatron transverse dampers
- Steve Holmes note: $(1.15)^{10} = 4.0$

CDF is running well.

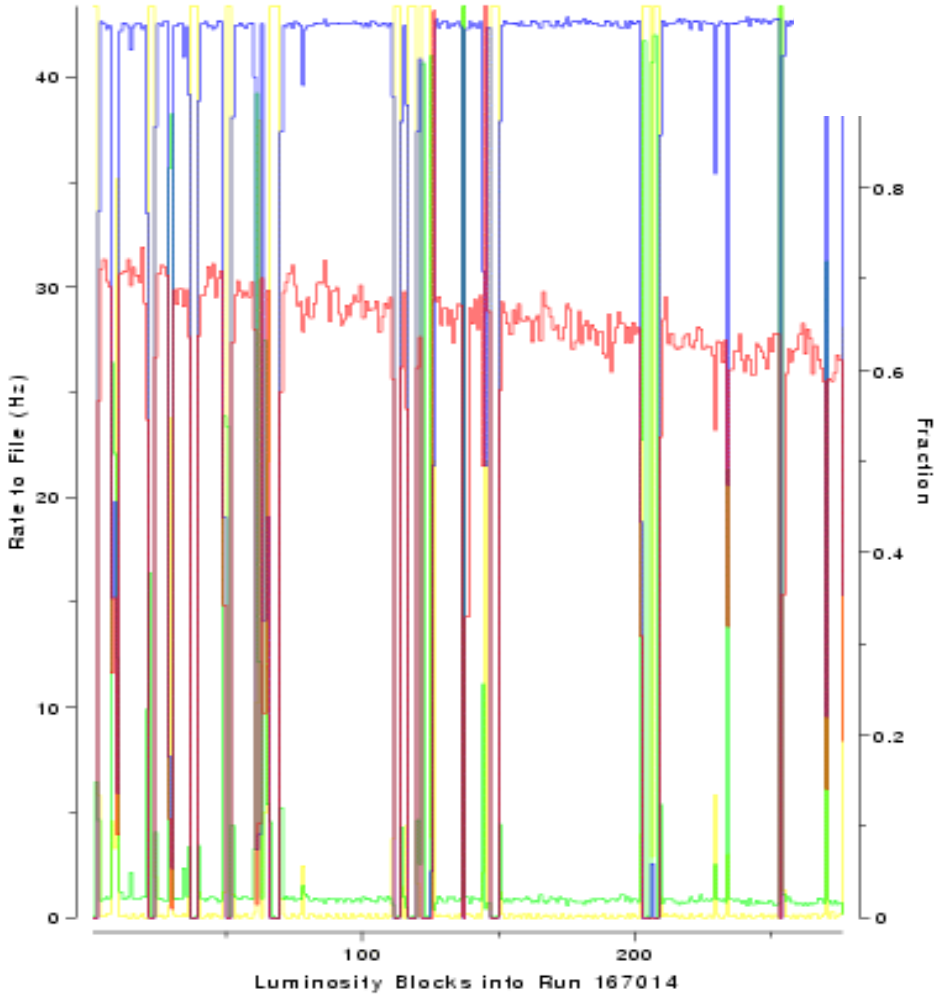
CDF Record Run Efficiency

- 1137 nb-1 delivered
- 1080 written to tape
- 94.5% eff. for store
- 98.6% eff. for shift

- Backgrounds are low.
- Efficiency last week = 85%. This is still rising.



DØ is also.



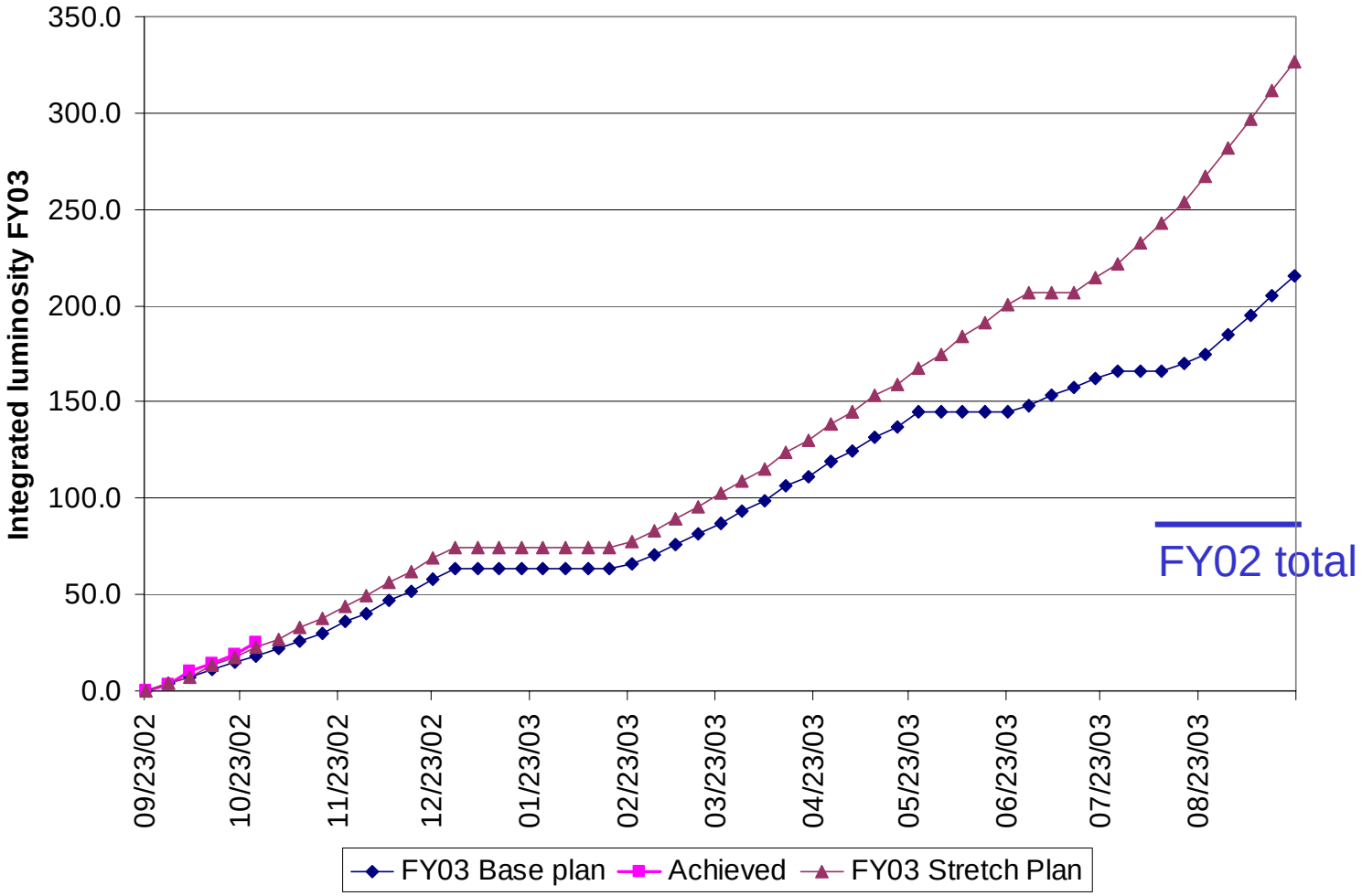
October 30, 2002 Run 167014
(Runs limited to 4.0 hrs)

Delivered Luminosity: 185 nb^{-1}
Blue Curve: Live Time Fraction
(Integrated Live-Time: **93%**)

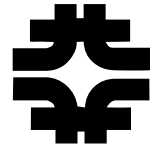
Red Curve: Rate to Tape ~30 Hz

Efficiency last week = 74%.
This is still rising.

FY 2003 Plan

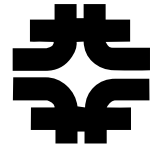

Integrated luminosity FY03
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
09/23/02
10/23/02
11/23/02
12/23/02
01/23/03
02/23/03
03/23/03
04/23/03
05/23/03
06/23/03
07/23/03
08/23/03
FY02 total
FY03 Base plan
Achieved
FY03 Stretch Plan

Run II Physics for Summer 2003



- Sample of ~200 pb^{-1} with more powerful detectors, somewhat higher energy
- Top quark measurements
  - # top produced 3x Run I; higher b tag efficiency
  - Lepton + 4 jets double tag 5 →20
  - Check anomalous indications from Run I dilepton sample
- Bottom quark measurements
  - First round of results with B,B_s,charm samples
  - B_s, Λ_b Lifetimes and hadronic ranching ratios, first look at B_s mixing
- Jet distributions at highest p_T
  - Constrain the gluon distribution at large x
- Searches
  - extend limits, follow up exotic events from Run I

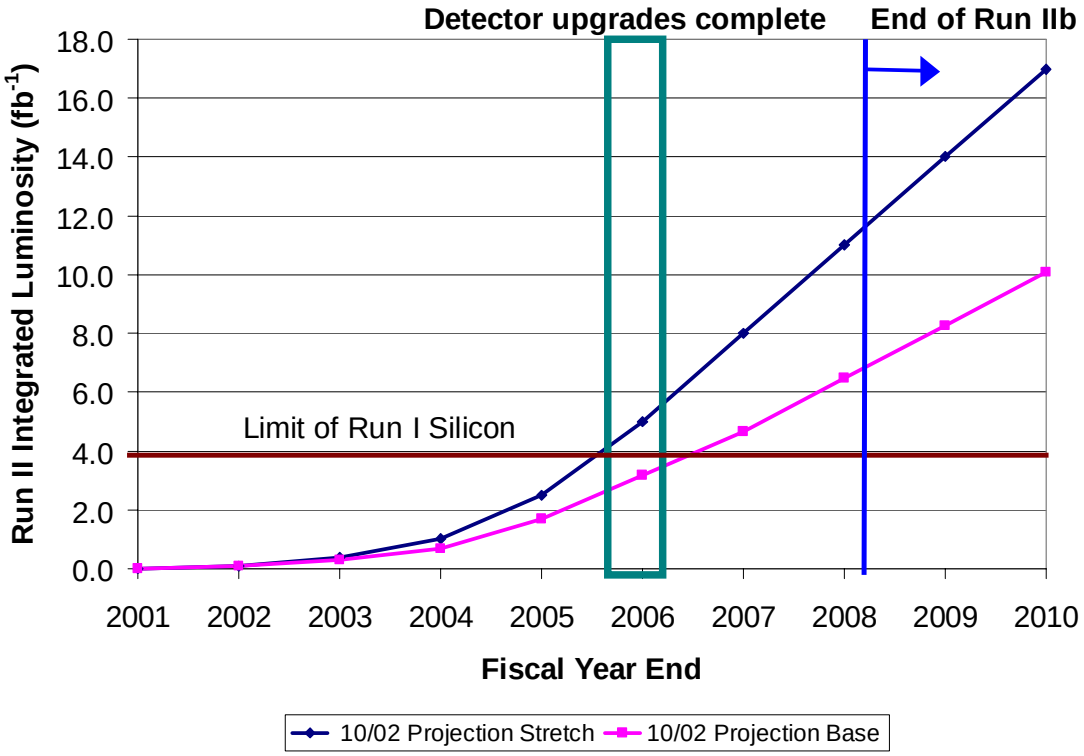
10/18/02 Director's Review of FY03 Accelerator Plan (Tigner Committee)



- The Panel was very favorably impressed with the progress in peak and integrated luminosity achieved in recent months.
- It appears highly likely that the base goal for integrated luminosity in FY03 (200 pb^{-1}) can be met or exceeded.
- The Laboratory has become highly focused on the colliding beam program with human resources drawn from across the Lab to meet the goals.
- The results of this focusing have been dramatic and the Lab is to be complimented for this accomplishment.

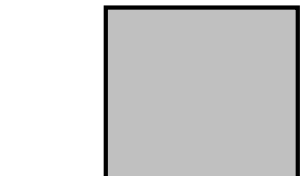
A look at the longer future

- Luminosity projections throughout Run II
  - We have done detailed studies of technical issues to be addressed.
- Caveats
  - R&D is still going on.
  - Detailed schedule and resource planning is still needed.
  - Funding is not known.

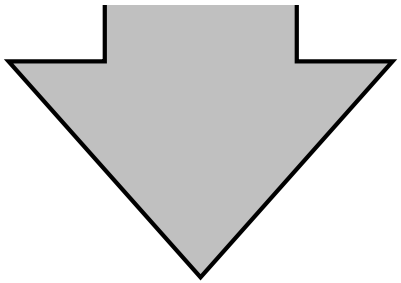


Higgs physics is a program

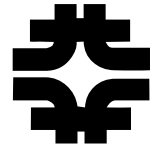
- $2fb^{-1}$
  - exclude m_H = 115 GeV
  - SUSY (h/H/A) at large tan β
- $5\ fb^{-1}$
  - 3σ signal for m_H = 115 GeV;
  - exclude 115-125, 155-175 GeV
  - exclude much of SUSY Higgs parameter space
- $10\ fb^{-1}$
  - 3σ signal for m_H = 115-125, 155-175 GeV;
  - exclude whole range 115-175 GeV
- $15\ fb^{-1}$
  - 5σ signal for m_H = 115 GeV;
  - 3σ signal for whole range 115-175 GeV



Each factor of two yields a significant increase in reach and lays the foundation for the next steps

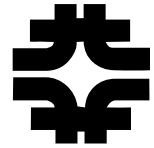


DOE Review of Collider Run II



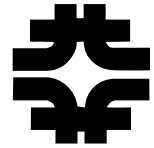
- The overriding impression of the Review Committee is that Fermilab has embraced the challenge of meeting the luminosity goals for the Tevatron complex and that the Laboratory realizes the significant level of challenges ahead.
- There has been excellent progress in the past year that serves as a solid platform for future progress and the increased focus of the Laboratory on this effort is a crucial factor.
- The Committee judges that there is a good likelihood that the "base" luminosity goal set for FY03 will be met or even exceeded.

DOE Review: Goals Beyond FY03



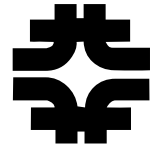
- The Laboratory's technical approach for increasing luminosity over the next six years is sound and well motivated and, if successfully implemented, will maximize the integrated luminosity over this time period.
- The Committee believes that reaching the base luminosity goal … will be a significant challenge.
- … adequate funding throughout the luminosity upgrade period is not assured and so constitutes a substantial risk to reaching the goals.
- The DOE should undertake a follow-up review in about 8 months…

Tevatron Run Plan



- We will run CDF and DØ until the LHC experiments start to produce physics results that dominate our picture.
  - Low mass Higgs searches are among the most challenging, even at the LHC.
- We must be prepared to run the Tevatron until 2010
  - The luminosity projections require that we upgrade the detectors, starting now.

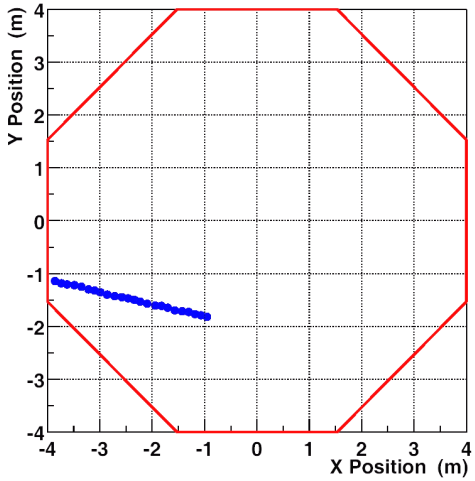
Run IIb Detector Upgrades

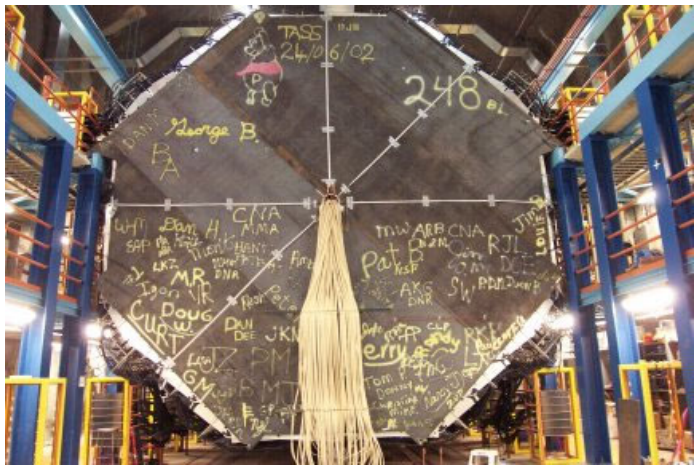


- In June we gave laboratory approval to CDF and D0 upgrade projects that would
  - replace radiation-damaged silicon detectors with new detectors of simpler design with more radiation-hard technology.
  - upgrade data acquisition and triggers to deal with higher luminosity.
- We held successful Lehman baseline reviews in September.
  - No action items, recommended reduced contingency, which we accepted
  - External Independent Review coming up
  - Need to start project by January to keep schedule

Status of the NuMI Project

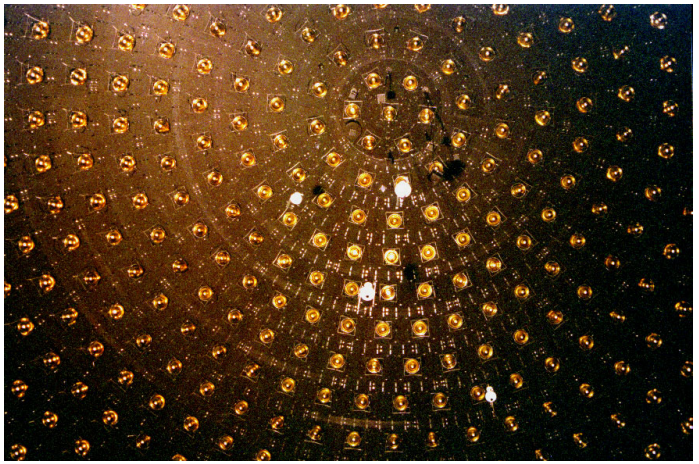
- Tunnels and Halls construction complete 11/22/02
- Surface Buildings and Outfitting construction started 11/1/02
- 326/484 planes of MINOS far detector installed and operating
- Cosmic ray studies underway

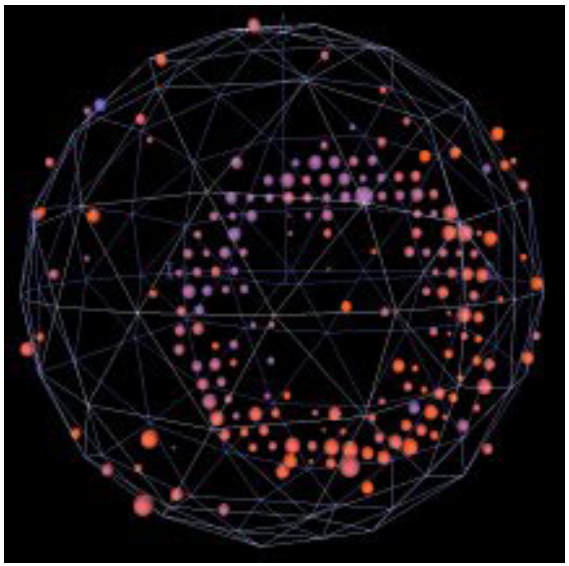




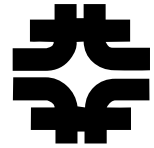
MiniBooNE has started

- First event September 2002
- The neutrino beam is running continuously without impact on the collider run
- Neutrinos per proton as expected
- Events match Monte Carlo
- We are working to increase the repetition rate for the Booster



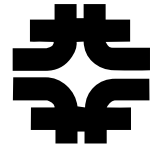


FY 2003 Budget
General Comments



- The budget presented for FY2003 at our Annual Program Review in March was $298.3 M.
  - This already reflects a budget pared to keeping programs going.
- We had to remove an additional $11.9 M from spending to meet the present guidance of $286.4 M.
  - This is a $0.1 M increase in base budget, $3.4 M cut in total budget, from FY2002. The employment inflation increase of 4% is about $13 M, so this represents a reduction in effort of about $13 M.

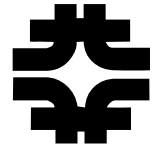
Budget changes, 02-03



	FY 2002	FY 2003	Δ, %
Beams Division excluding ν projects	71.2	78.4	10%
CDF/D0 including Run IIb upgrades	39.4	43.9	11%
ν projects	38.5	30.6	-21%
Other	88.2	81.6	-7%
Indirect Support	48.9	51.8	6%
TOTAL	286.2	286.3	0%

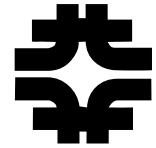
- Most program areas at about 7%, >10% in constant dollars.
  - Funding for projects is fixed.
  - Most administrative areas have fixed costs.
- We are giving the collider program highest priority.

What we can do in FY2003



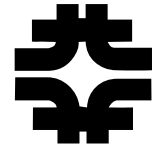
- Run II
  - **Keep improving luminosity, following the FY03 plan.**
  - Operate the collider and the experiments as effectively as possible, but without the reserve of effort needed to deal with problems as they come up.
  - Keep offline computing capable of handling data production.
  - Make great progress on detector upgrades.
- Neutrino program
  - Keep NuMI/MINOS construction on the new schedule.
  - Operate MiniBooNE efficiently.
- LHC
  - Keep US-LHC and US-CMS projects on schedule.
- Linear Collider
  - Satisfy the minimal commitments on NLC R&D.

What we cannot do in FY2003



- Run II
  - **Do all of the work needed to support luminosity gains in FY2004.**
  - **Keep the personnel needed in all Divisions to help support collider issues.**
- LHC
  - Provide additional help from the base program for the research program, both on the accelerator and for CMS.
- Accelerator R&D
  - Do the Linear Collider R&D needed to keep the US program on schedule.
  - Keep other programs lean but productive.
- BTeV & CKM
  - Do the R&D and engineering needed to be ready to start construction.

Additional one-time steps to deal with the FY2003 Budget

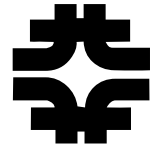


Our goal is to avoid drastic measures such as involuntary staff reductions. This looks possible at the currently projected funding level.

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.

Resources for the Collider Effort

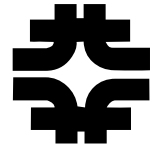


From the DOE Run II Review:

- Several important efforts to improve diagnostic instrumentation required for further luminosity improvements in FY03 and beyond could not be supported at this budget level.
- Clearly the overall funding level for the nation's high energy physics program and for Fermilab in FY04 and beyond is a major concern, one that could severely impact Fermilab's ability to deliver on the integrated luminosity goal for the Tevatron complex.

I agree with both statements.

The Distribution of Effort

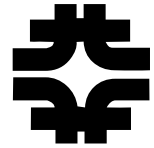


- The rough fraction of the laboratory research budget that supports the various programs:

Program	FY03 Funds ($M)	% of total research
Tevatron Collider	123	63
Neutrino Program	31	16
LHC*	3+10	1.5+5
Accelerator R&D	10	5
Exp. Astrophysics*	4+3	2+2
BTeV	2	1
CKM	2	1
Fixed Target	3.5	2
Theory	5	2.5

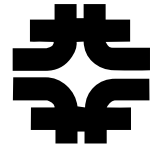
***First number is Fermilab base funding, second is from LHC project or outside sources.**

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 in 2008. 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 FY2003 does great damage.

Summary



- The Tevatron collider program is back.
  - We will achieve another factor of 2.5+ improvement in weekly integrated luminosity in FY2003.
  - The plan for future work was extensively reviewed.
  - Look for the results coming next summer.
- The Neutrino program is making good progress.
  - MiniBooNe is starting its physics run.
  - NuMI is proceeding toward a 2005 start.
- The FY2003 budget is having a negative impact that will endure.