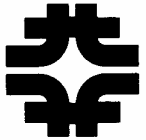


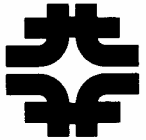
Research Program at the Fermilab accelerators

Michael Witherell

HEPAP

May 19, 2005

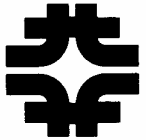
The Fermilab research program



Fermilab

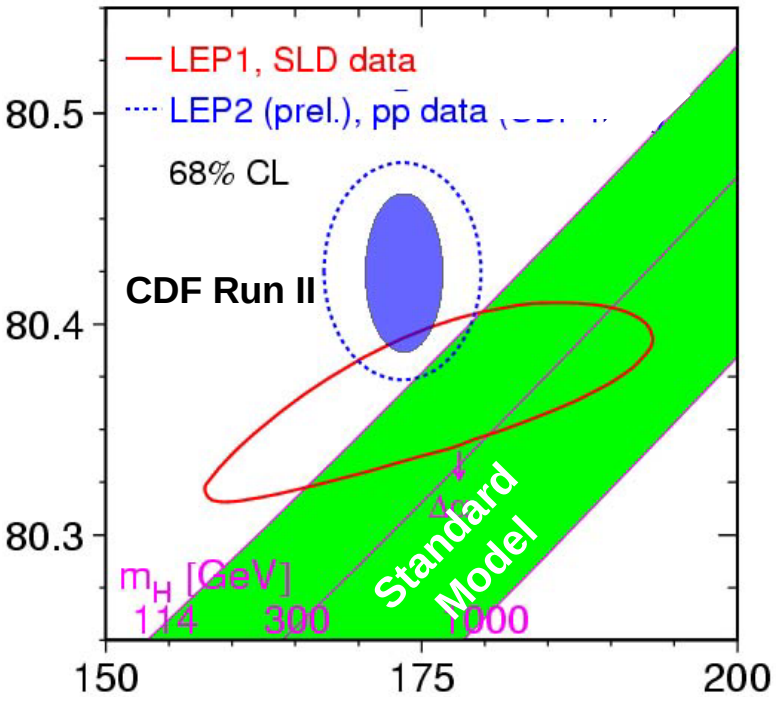
- operates the Tevatron program;
  - CDF and Dzero
- operates a unique neutrino program;
  - MINOS with NuMI νs
  - MiniBooNE with Booster νs
- is building up the CMS research program to optimize the advantage to US researchers and to CMS.
- conducts a growing R&D program on the accelerators and detectors that are needed for the future;
- develops excellent particle astrophysics experiments;
- nourishes theoretical groups who work on the issues that drive experimental particle physics.

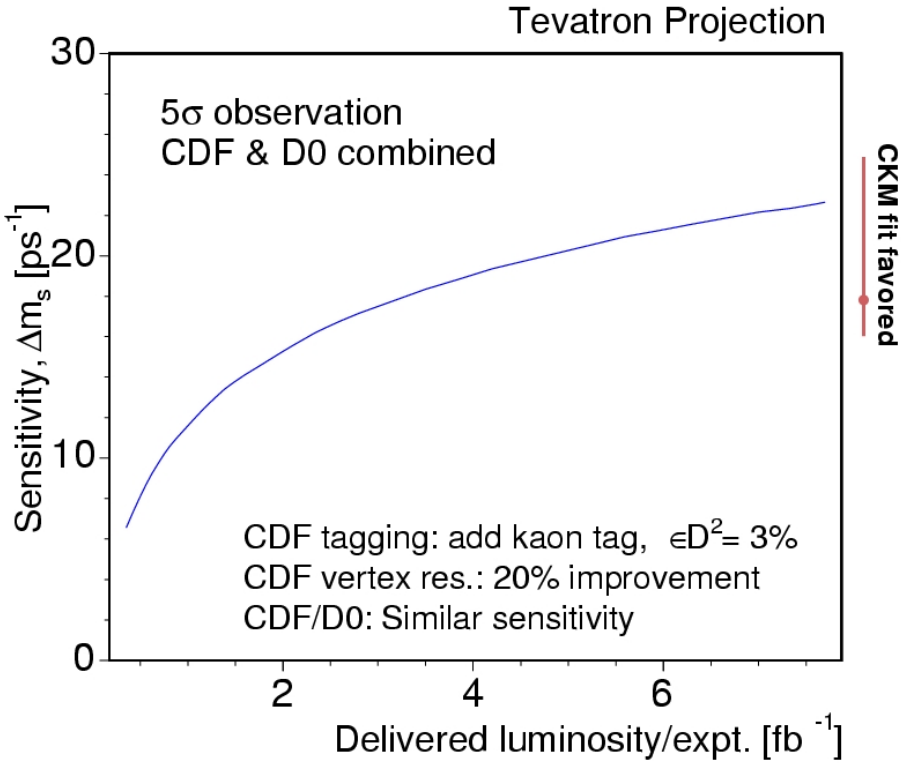
The Run II Campaign



- We are in the middle of 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.
  - Grow the computer capacity to keep up with the growing data sample.
  - Work with the collaborations to do the best the physics possible with Run II data.

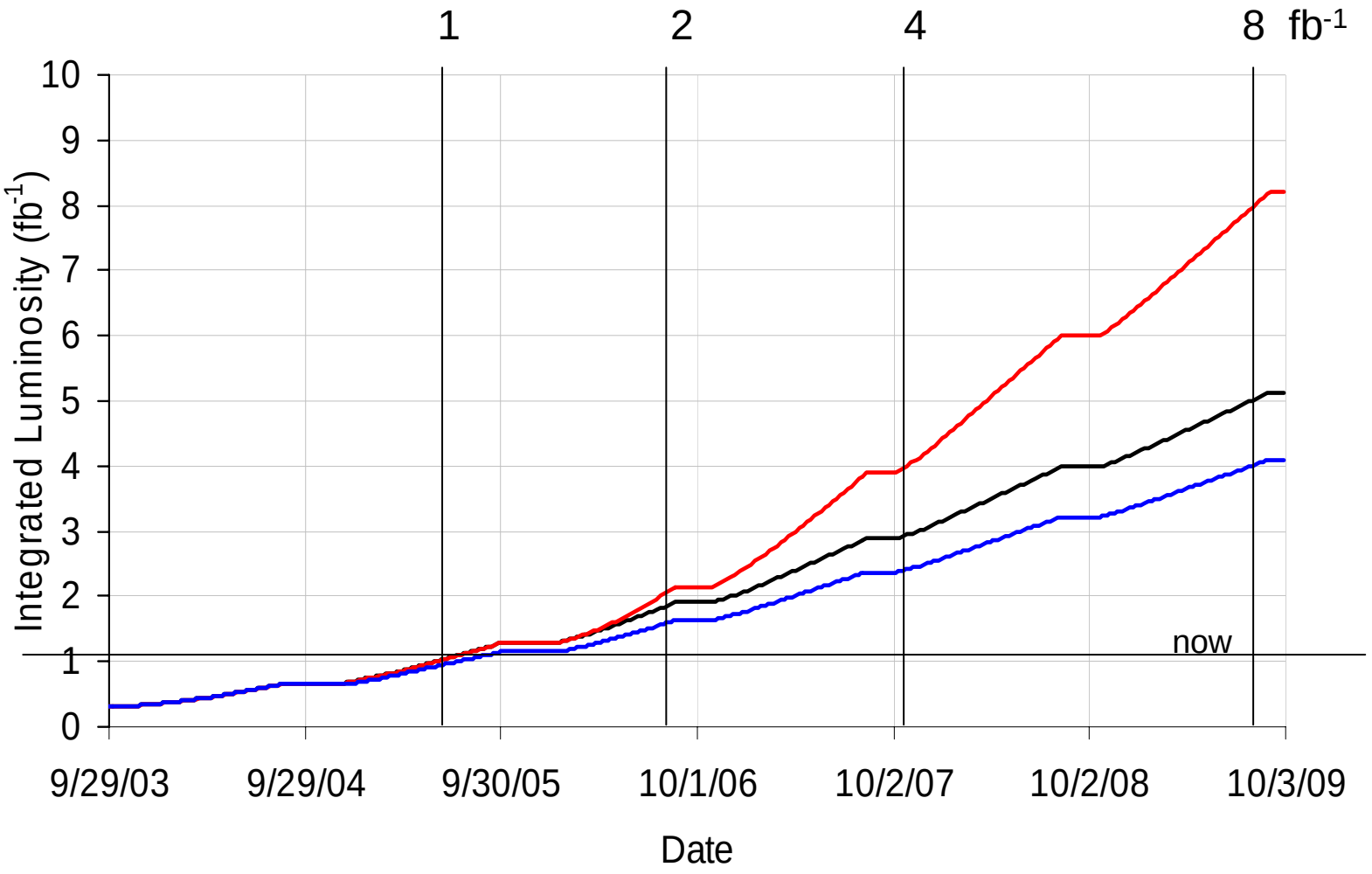
Run II physics examples



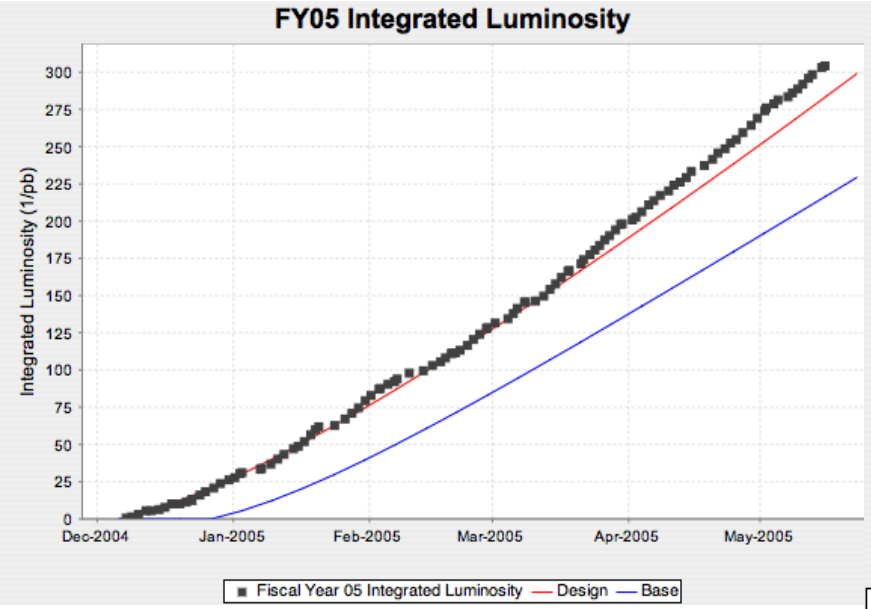


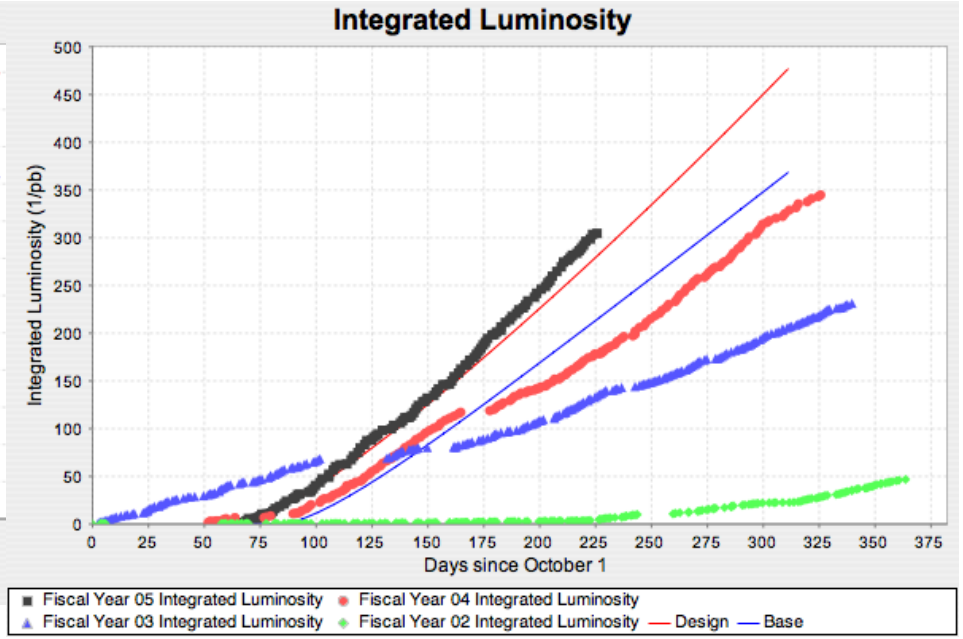
- Test SM Higgs, constrain mass
- Discovery Potential over most of B_s mixing expected region

Projected Integrated Luminosity



Run II: FY 2004 Plan and Status





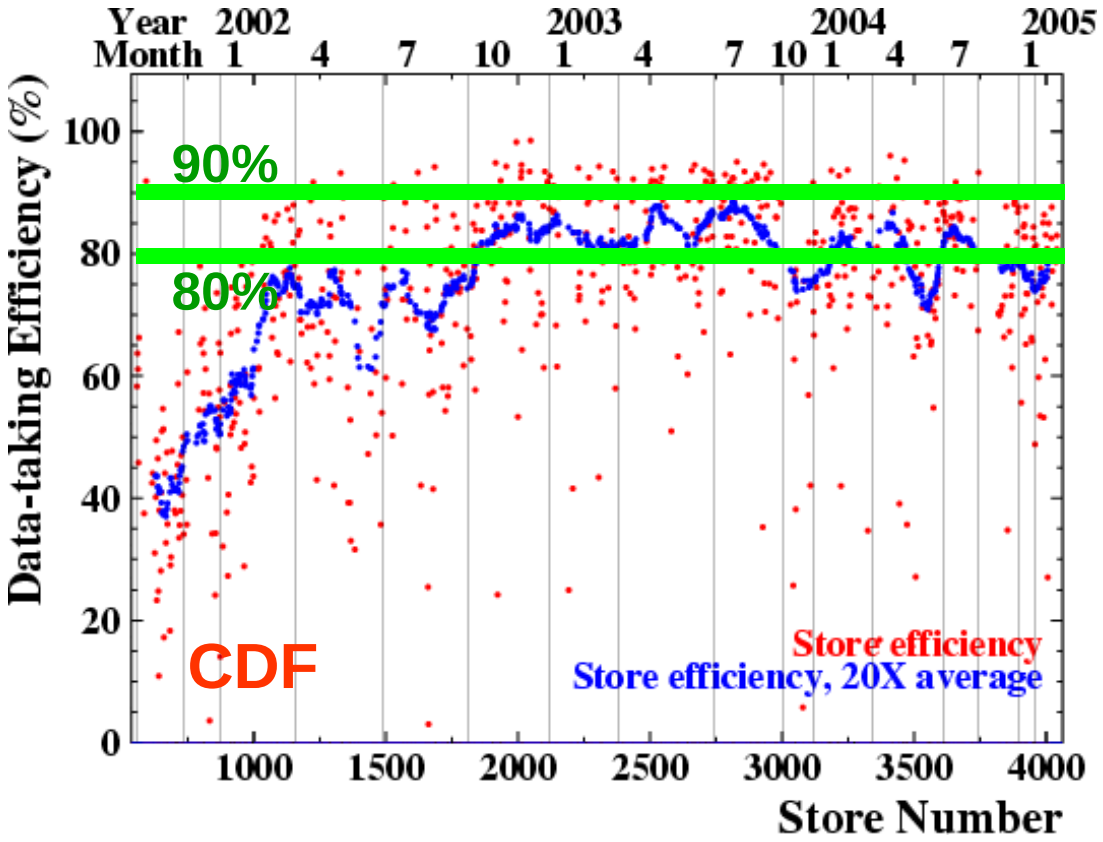
Run II Integrated luminosity ~0.65 fb^{-1} on 10/04; plan ~1.1 fb^{-1} by 10/05; in mid-June we will pass 1 fb^{-1}.

As of 5/17/05, 9 days ahead of the FY05 design curve with 0.31 fb^{-1}.

Record week 4/26-5/2: 21 pb^{-1}. Record day 5/14: 4.3 pb^{-1}.

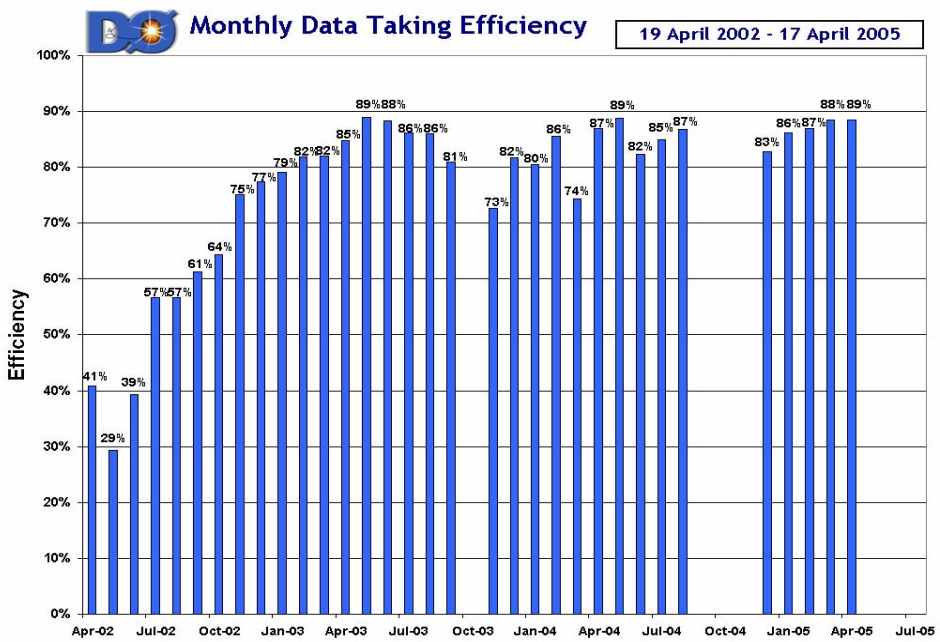
Record luminosity 5/13: $1.27 \times 10^{32} cm^{-2} s^{-1}$

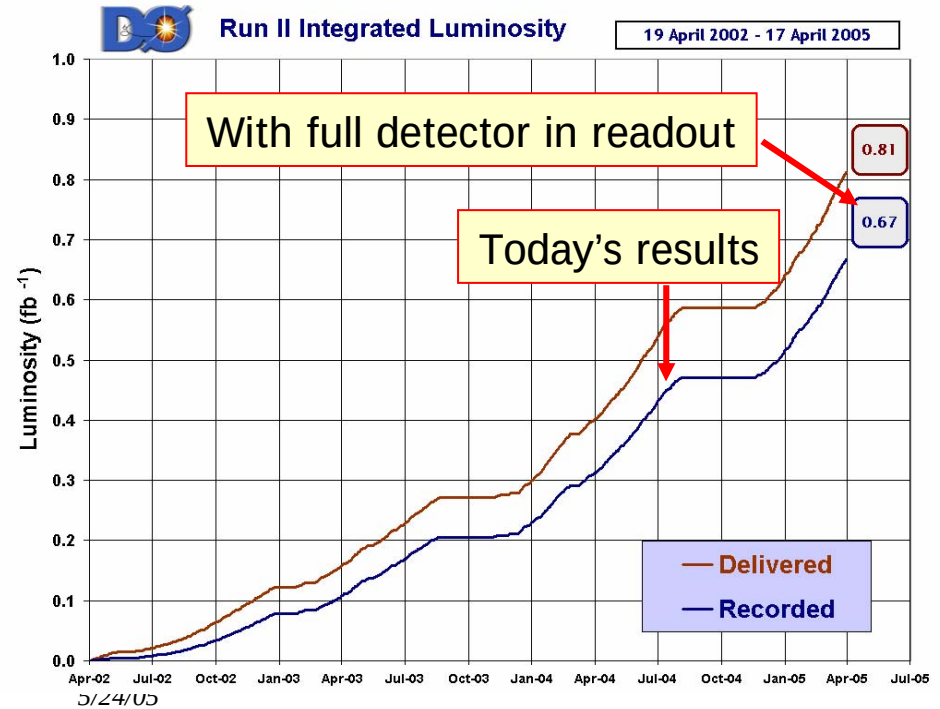
CDF Data Taking Efficiency



- trigger deadtime is typically 5% averaged over store
- beam-related issues also a major source of inefficiency
- myriad sub-detector, DAQ issues contribute remainder

Operations





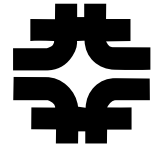
- The experiment is operating well and recording physics quality data with ~90% efficiency
  - Typical "good" day 2 pb^{-1}
  - Typical "good" week 14 pb^{-1}
    - Run I top quark discovery in 3-4 weeks!
- 90% data taking efficiency
  - 5% are trigger system disables
  - 5% are begin/end stores, failures
- As of today DØ has ~0.7 fb^{-1} on tapes
  - All detectors functioning well
  - Most physics results are from data collected before end of 2004 shutdown

On-line data quality monitoring

"remote" shifters from all over the World: Europe, Brazil, India, China...

Thanks to Accelerator Division for luminosity!

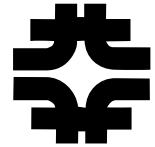
CDF Physics



- All aspects of analysis are mature
- 14 Publications
  - 2003 : 3
  - 2004 : 4
  - 2005 : 7 (so far)
- 5 Accepted
- 8 Submitted

Another 31 are presently under internal review.

CDF Physics: Recent Highlights



- World's Best Top Mass (better than world average)
  - Using 318/pb of data

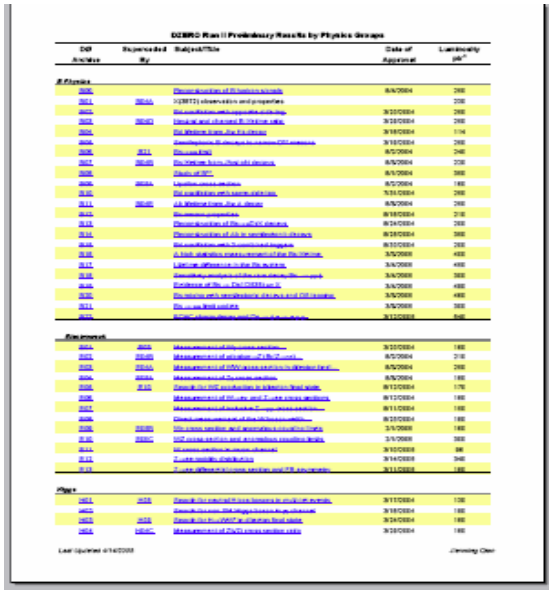
$$M_t = 173.5^{+4.1}_{-4.0}\ \mathrm{GeV/c^2}$$

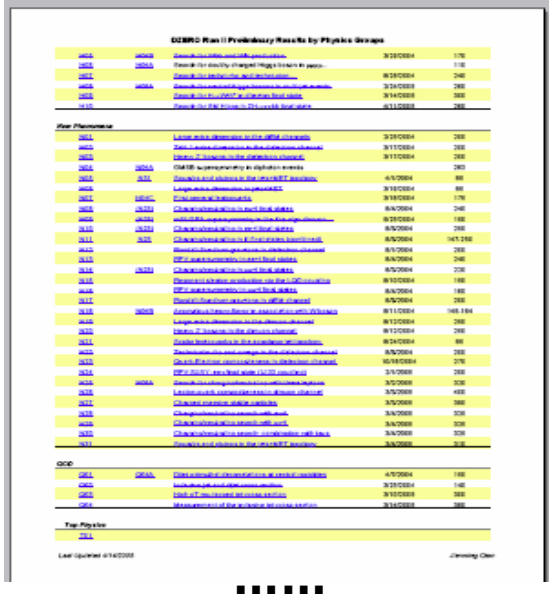
- First Preliminary B_s Mixing Result
  - Using semi-leptonic and fully-hadronic decays
  - Sensitivity: 8.4 ps^{-1}, Observed: 7.9 ps^{-1}
  - With ~2/fb: Sensitivity over full Standard Model (SM) range
- A slew of "World's Best" Results
  - B hadron masses, Branching Ratios, etc.
  - Top Quark cross-sections and properties
  - Limits on New Physic beyond the Standard Model

Summary of Results, Talks, Publications

- 20 publications over last year
  - Quantum leap from 2 by April 2004
- 74 new results approved for Conferences
  - Most will be published
- >250 invitations to Conferences per year
  - Invited talks at major Conferences

Too many to fit on 3 pages...





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For full list of DØ approved results and publications visit

http://www-d0.fnal.gov/Run2Physics/WWW/results.htm

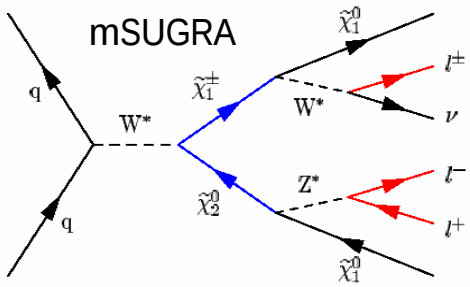
including plain-English summaries

Celebrating World Year of Physics!

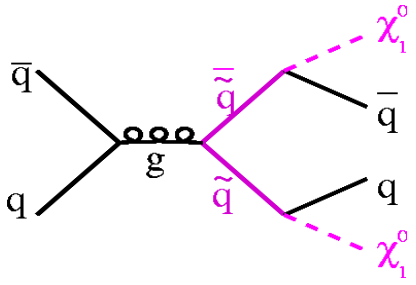
Search for SUSY

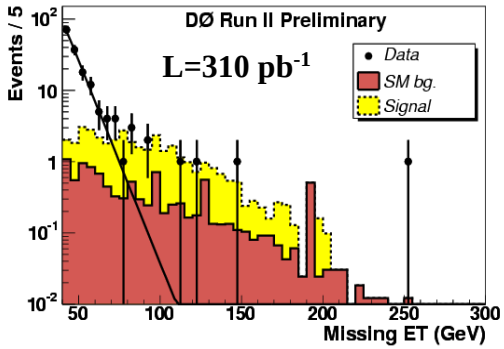
SUSY solves "Hierarchy Problem", provides Grand Unification at the 10^{16} GeV scale, and is a good Dark Matter Candidate (LSP)…

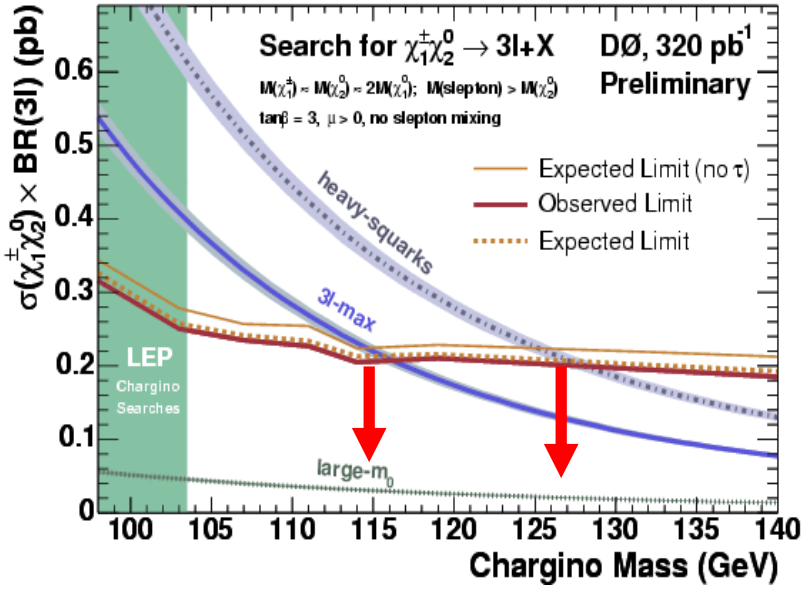
Chargino / Neutralino production in 3l+$\not{E}_T$

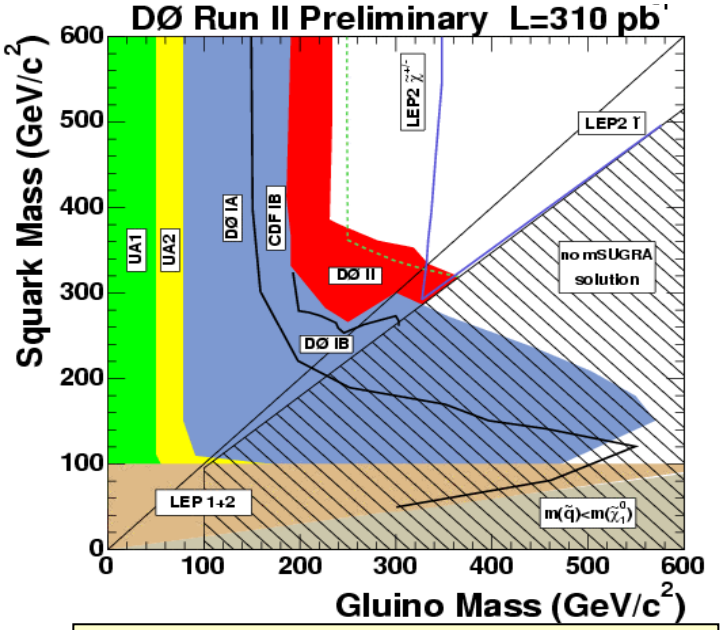


Squarks and Gluinos in jets+$\not{E}_T$





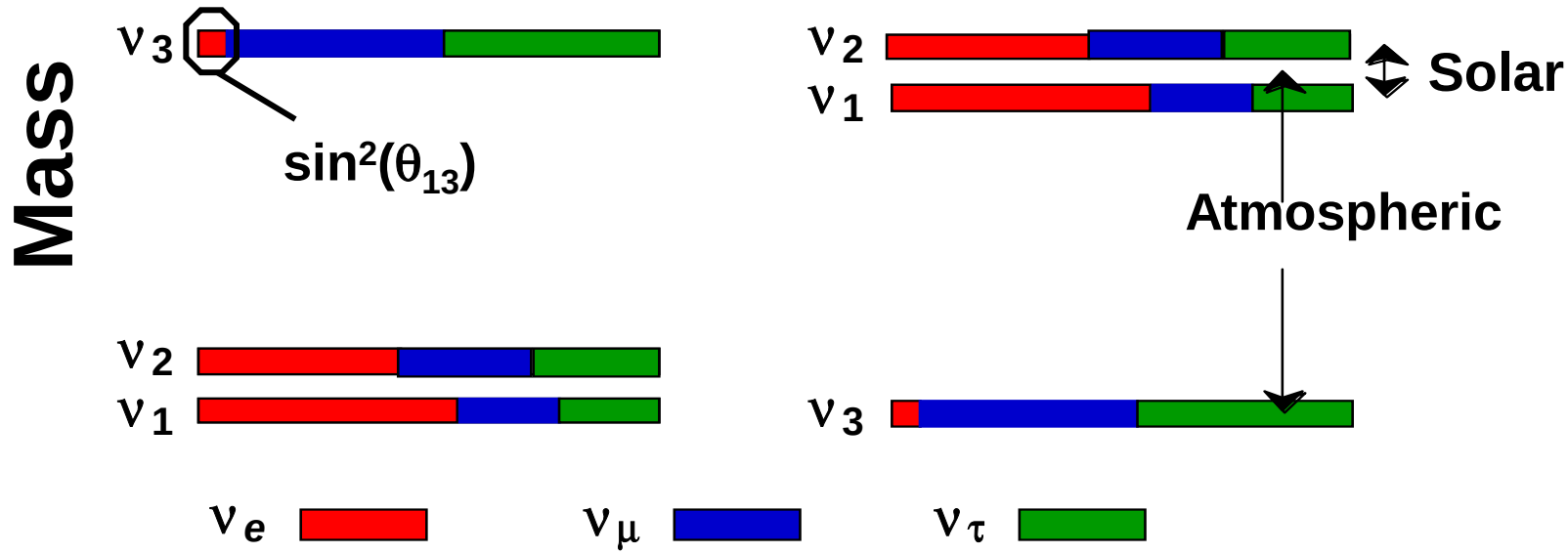




Much better then Run I limits of 1.6 pb

DØ extends LEP mSUGRA reach!

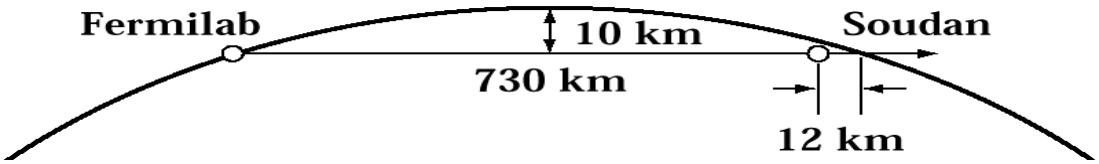
The Neutrino Program



- Fermilab has the only experiments now operating with accelerator-produced neutrinos.
  - MiniBooNE with Booster Neutrino Beam
  - NuMI/MINOS with NuMI neutrino beam

MINOS

- Verify dominant $\nu_\mu \rightarrow \nu_\tau$ oscillations
  - See the characteristic oscillation energy dependence
  - Set a limit on sterile neutrino contributions
  - Study unconventional explanations: neutrino decay, extra dimensions, etc.
- Precise measurement of the atmospheric Δm_{23}^2: ~10%
- Search for $\nu_\mu \rightarrow \nu_e$ oscillations: 3 σ discovery about a factor of 2 below the CHOOZ limit.



NuMI-MINOS status

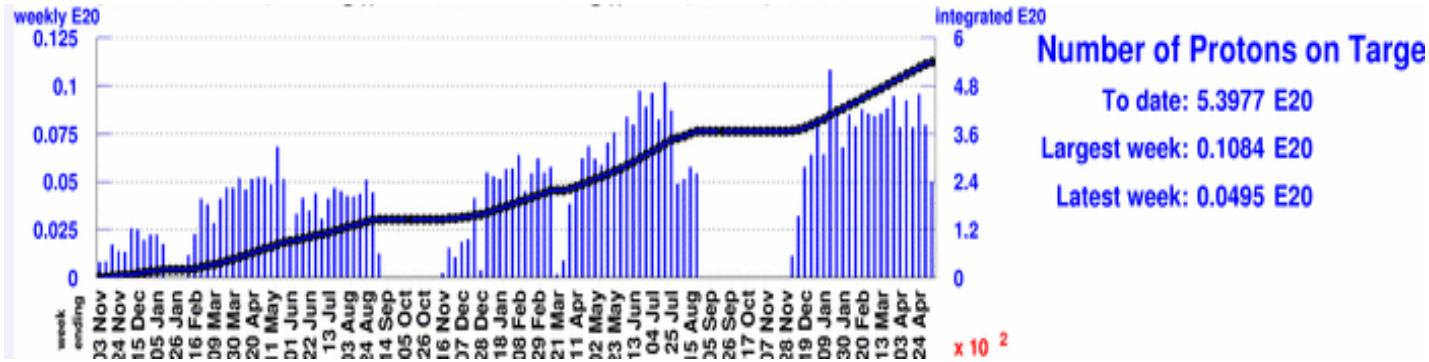
The NuMI construction project is complete.

- MINOS is starting to operate for physics.
  - developed technique for operating with small leak in target cooling system
  - running with intensity of ~1.0×10^{13} @ 0.4 Hz

1/21:The first event in the near detector
3/20: The first event in the far detector

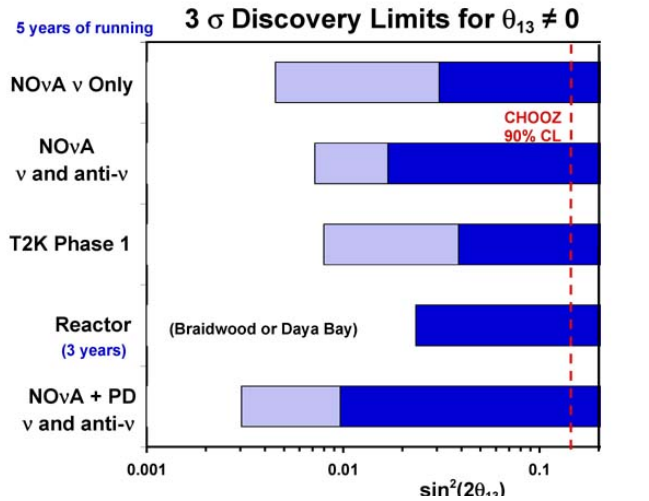
MiniBooNE

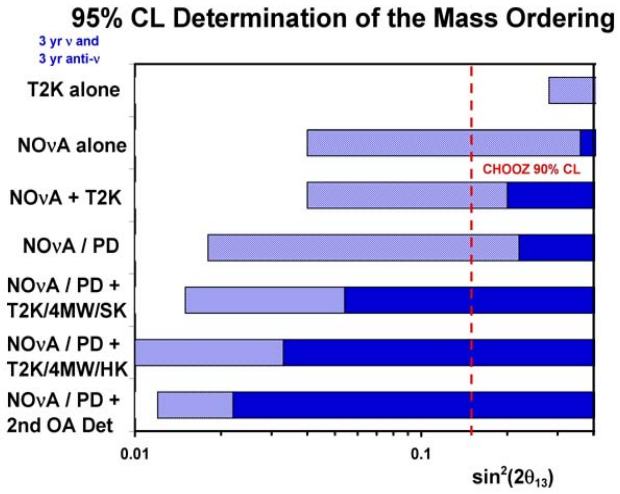
- MiniBooNE is designed to follow up on the LSND evidence of a ν_μ–ν_e oscillation at high Δm^2.
  - If MiniBooNE confirms LSND, it will change the worldwide neutrino program overnight.
- The beam and experiment are running well.
  - Installed new horn during shutdown.
  - Reached 5.45×10^{20} p.o.t., beyond the demanding milestone of 5×10^{20}
- The result on ν_e appearance will be known by the end of 2005.



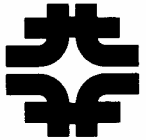
NOνA

- We have granted stage 1 approval to NOvA, a large off-axis neutrino experiment using the NuMI beam. It provides
  - the most sensitive search for $\nu_\mu \rightarrow \nu_\varepsilon$ at the wavelength of atmospheric oscillations;
  - a good measurement of θ_{13} if it is not too small; and
  - a unique capability to resolve the mass hierarchy.
- NOνA is the first stage of a flexible program where each stage can be planned according to what has been learned in previous stages.



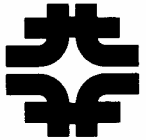


The last year at Fermilab



- Run II
  - Increased Run II integrated luminosity from ~0.5 to 1.0 fb^{-1}.
  - Increased record luminosity from 0.7 to 1.23 x 10^{32} cm^{-2} s^{-1}.
  - Integrated Recycler into routine operations.
  - Set new records for stacking rate using slip-stacking.
  - Installed the e-cooling apparatus into the Recycler.
  - Produced a lot of physics results
- Neutrinos
  - Completed NuMI project and celebrated.
  - Commissioned NuMI beamline.
  - Started MINOS operation.
  - Increased MiniBooNE total POT from 2.6E20 to 5.5E20.
  - Installed Replacement MiniBooNE horn.

Summary



- The Fermilab accelerators are simultaneously providing beams for unique particle physics programs.
  - CDF and DZero at the Tevatron
  - MINOS in the NuMI neutrino beam
  - MiniBooNE in the Booster neutrino beam
  - MIPP with secondary hadron beams
- The collider is operating at record levels.
- The neutrino beams are operating reliably.
- All experiments are running well.
- Exciting physics is coming out and it will get better.
- In addition, CDMS has the best limits on dark matter by x10 and Auger results will be the highlight of the cosmic ray conference in August.