

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 vs
 - MiniBooNE with Booster vs
- 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.

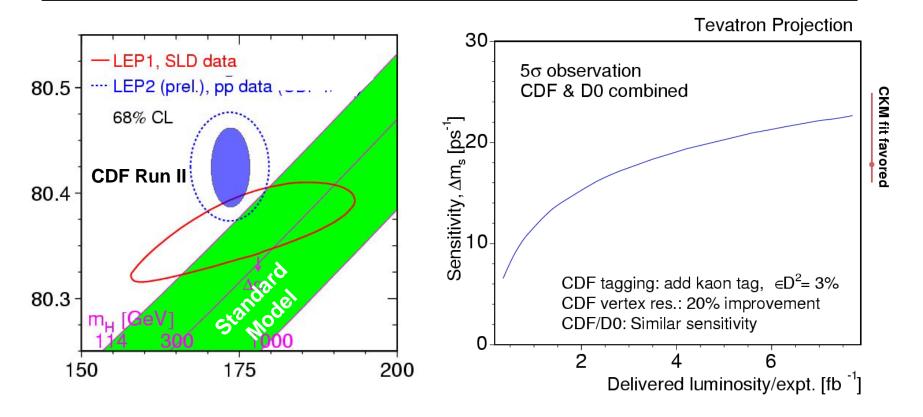
The Run II Campaign



- 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

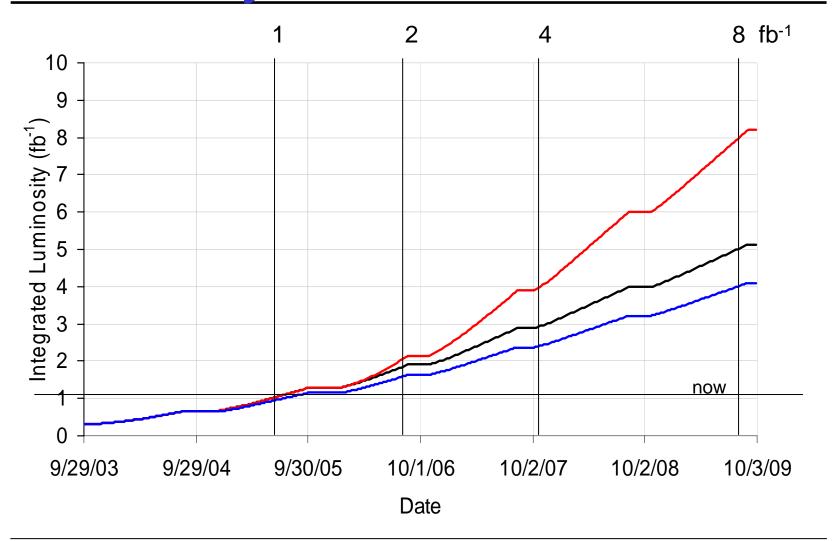




- Test SM Higgs, constrain mass
- Discovery Potential over most of B_s mixing expected region

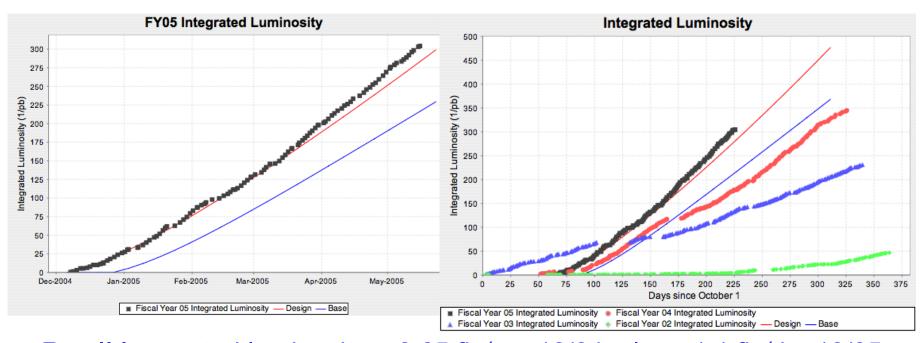
Projected Integrated Luminosity





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.

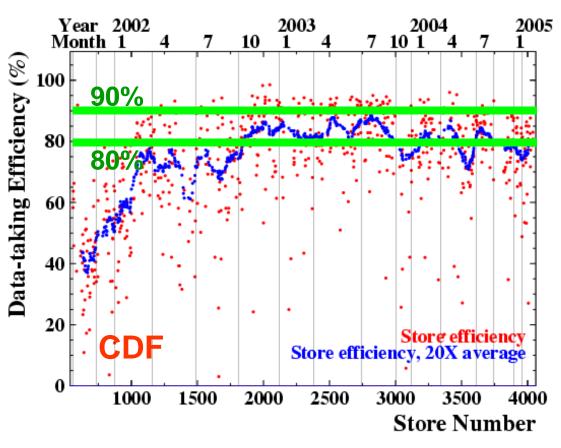
As of 5/17/05, 9 days ahead of the FY05 design curve with 0.31 fb⁻¹.

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

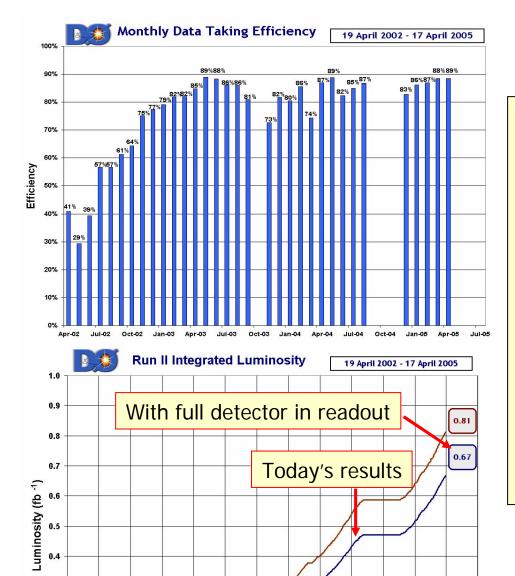
Record luminosity 5/13: 1.27x10³²cm⁻²s⁻¹

CDF Data Taking Efficiency





- trigger deadtime is typically5% 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!

0.1

3/24/03

Oct-02 Jan-03 Apr-03

Delivered

Recorded

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

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

- 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



11

- 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

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!

Delt	Superceded	Budgeskffiste	Bala of	Luminosity
Anches	**		Approved	per"
Charles				
500		People Socialists of Richardon Schools	8/4/2004	268
100	MO-AA	XQBET2) absences on and properties		208
207		District States and Appendix of the Pro-	3/10/0804	268
5073	100	Street of and observed Britishne sales	3/10/2004	260
1904		Sid Medican Street, Also Franchistan	3180004	1194
200		Sandaphore Schools in consens CSI consens	3100004	266
500	841	Discount Feet	85/2004	246
100	200-00	Dis Melline Sons Plant all designs	8/5/2004	208
500		Shall of St.	8/1/2004	360
200	2004	Updiscours Miller	8/3/2004	160
810		followith the rest same retains.	2/11/2004	260
811	10.00	All Medical Corp. Top 3. decays	8/9/2004	260
200		District properties	8187004	28
813		Person Secretary of Physiological Secretary	8340894	200
914		Person State State of All in complete and changes	8780004	SEE
215		A list digitals management for the literature.	8/10/0804 3/5/2008	100
202		Little officers in the Street er.	34200	400
216		Secretary and a little constant for most	34700	366
		Enthropy of the on Dail College II.	347000	- 100
520		Supplied with semilecturing distance and Citizanana.	3/5/2000	482
821		En complete and Park	3/2/2001	365
277		A STATE of the Control of the Contro	3/12/2008	546
_			412000	100
Sim reports				
2001	200	Management of the communities	3/10/0884	160
862	20.40	Measurement of all observed (Britzman)	8/3/2004	216
100	SEAA	Management of WWW groups are the tenth of the day for the	8/5/2004	268
200	2000	Management of Secretary and Sec.	8/9/2004	188
8104	810	Reports for INC production in Education final state.	8120894	176
9100		Management of Musey and Zoute many gestions	8120884	160
807		Management of Institute Company of the Association	8/11/2004	166
200		Charles and the control of the Market Control of the Control of th	8/28/28894	188
9100	2000	Minimum median and appropriate countries from	3/1/2008	160
8.10	1010	M2 consumers and anomalous country bridge	3/1/2008	366
200		Marco rediction because the said	3/10/2008	96
8.0		Zuste model discharge	3140000	346
8.0		Zuste Office Philosophy section and PfL asymptotic	3/11/2008	160
1401	100	Tourist the control is true because to multi-law events.	3/11/0804	106
-		Secretarion of Manager Street Co. Secretarion Str.	3/16/2004	188
1400	200	Reports the Pour WAY to otherwise fired state.	3/24/2004	160
1904	HEAC	Measurement of 2027 cross sention calls	3/20/2004	166

Too many to fit on 3 pages...

200	2000	Transfer Co. (1990) and Cold a	3/28/2884	176
1408	1404.6	Smooth for county charged ragge based in page.		110
HEET		Taxable for technique and technique	W280884	246
100	14004	Secretary and the second secretary and the second s	374000	280
1400		Specific for the CAST in clinical find state	374/2008	268
1910		Toronto Carlo Control Discover Associates	411200	280
r Manomera				
1981		Large with disserving to the diffet changels.	3/26/0804	288
1953		Test I was consisted to the Constant Association	3/11/0804	268
		Heavy 2 has part to the distriction charged.	31170804	
1404	1604.6	CMSB supersymmetry is alphabon events	4/3/2004	260
905	931	Sounds and plaining in the imposite account.		
MIL	HEAC	Large with discount in payora ET	3/16/0804	129
100	(922)	Charles and Automatic Charles and an investigation in sections of the section of the sectio	BACKET	246
1000	19070	Charles and the second		166
10.00	(922)	Characteristics in Characterist	8/25/0004 8/3/2004	260
BILL	825	Characteristics in Effect states (confident)	B/N/2004	165.250
211		Best Charles and the Adaptive Charles	8/1/2004	288
1933		PPV supersymmetry in earl first states.	BA200H	246
1934	(9428)	Charles and the hard the state.	8/3/2004	208
2010		Proposati shake analysise six the LDC-squares	W107884	188
200		The superconnection is used from super-	BA/2004	160
MIL		Participation assessed of a classed	8/9/2004	266
818	3013	Annother the other property of the con-	W11/2004	195.159
-	_	Large make discounter to the discount desired	W120004	266
1620		Heavy 2 Septembrille directo channel	W120884	288
1971		Reader best country in the a conference bett annulated.	WINDSEN.	86
200		Technique de sei compe le line difference chancel	MAY2004	288
1922		Court Flames consugates to debates change.	10/18/2004	276
1926		PERSONAL REVOKED AND CASE ASSESSED.	3/1/2008	288
200	2000	Transfer Continues to Continue	3/5/2008	308
1000		Lattice and consequent and disease chance	3/5/2008	400
MIL		Characteristic data carbon	3/5/2008	200
1628		Chapter bearing a second with and	3/4/2008	308
200		Characteristics work off and	3/4/2001	328
1430		Characteristics work contrades off this	3/6/2008	308
162.1		Report and advisors in the property boundary	3/4/2008	2.0
001	0045	Charles and the Charles of the Charl	4/9/2004	166
961		High off must be and other comments.	3/10/0804 3/10/0804	140
001		Management of the pulpoline by come and the	3/14/2008	200
		ACCURATION OF PARTY AND ADDRESS.	A 14 CHES	
Cop. Physica				
201				
encouraged activity	DOUG			January Clerk

5/24/05

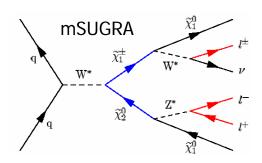


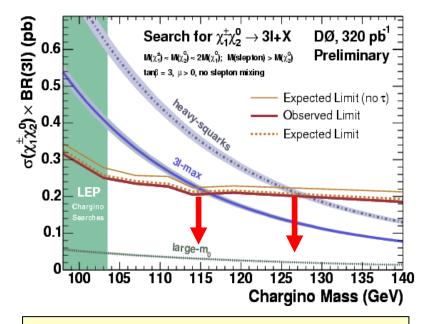
Search for SUSY



SUSY solves "Hierarchy Problem", provides Grand Unification at the 10¹⁶ GeV scale, and is a good Dark Matter Candidate (LSP)...

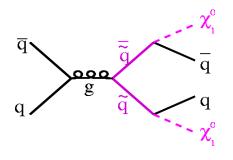
Chargino/Neutralino production in 3I+ ₱/ T

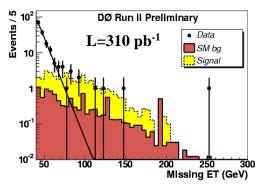


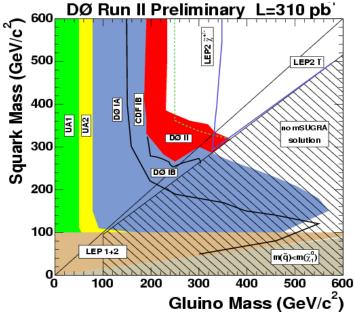


Much better then Run I limits of 1.6 pb

Squarks and Gluinos in jets+





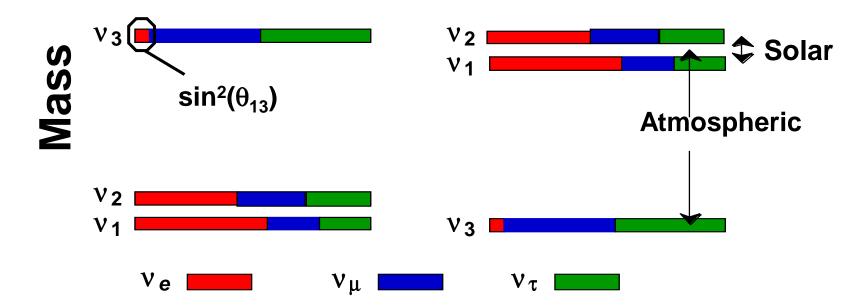


DØ extends LEP mSUGRA reach!

Annual Program Review

The Neutrino Program





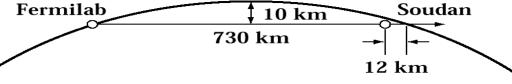
- Fermilab has the only experiments now operating with accelerator-produced neutrinos.
 - MiniBooNE with Booster Neutrino Beam
 - NuMI/MINOS with NuMI neutrino beam

MINOS



- Verify dominant $v_{\mu} \rightarrow v_{\tau}$ 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 $v_{\mu} \rightarrow v_{e}$ 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 ~1.0x10¹³ @ 0.4 Hz

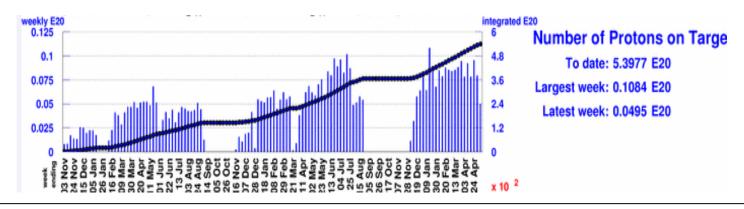


1/21:The first event in the near detector 3/20: The first event in the far detector

MiniBooNE



- MiniBooNE is designed to follow up on the LSND evidence of a v_u - v_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 5.45x10²⁰ p.o.t., beyond the demanding milestone of 5x10²⁰
- The result on v_e appearance will be known by the end of 2005.

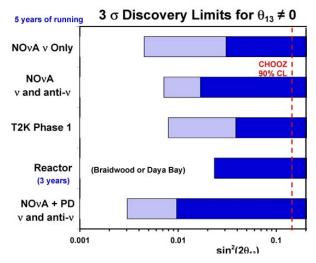


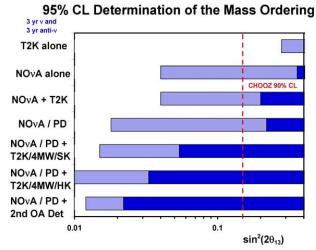
ΝΟνΑ



- We have granted stage 1
 approval to NOvA, a large off axis neutrino experiment using
 the NuMI beam. It provides

 - a good measurement of θ_{13} if it is not too small; and
 - a unique capability to resolve the mass hierarchy.
- NOvA 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 10³² 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.