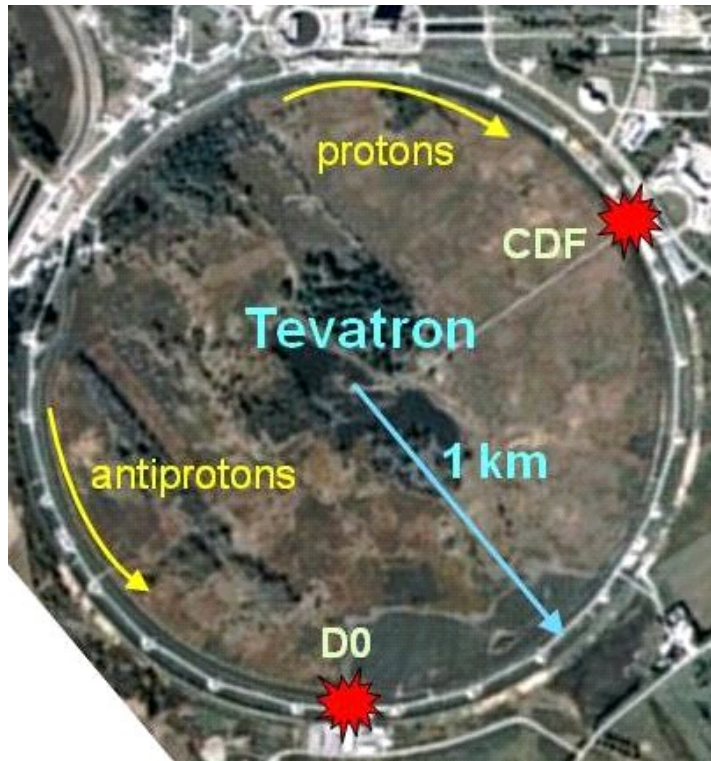




Tevatron Accelerator Studies



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Outline



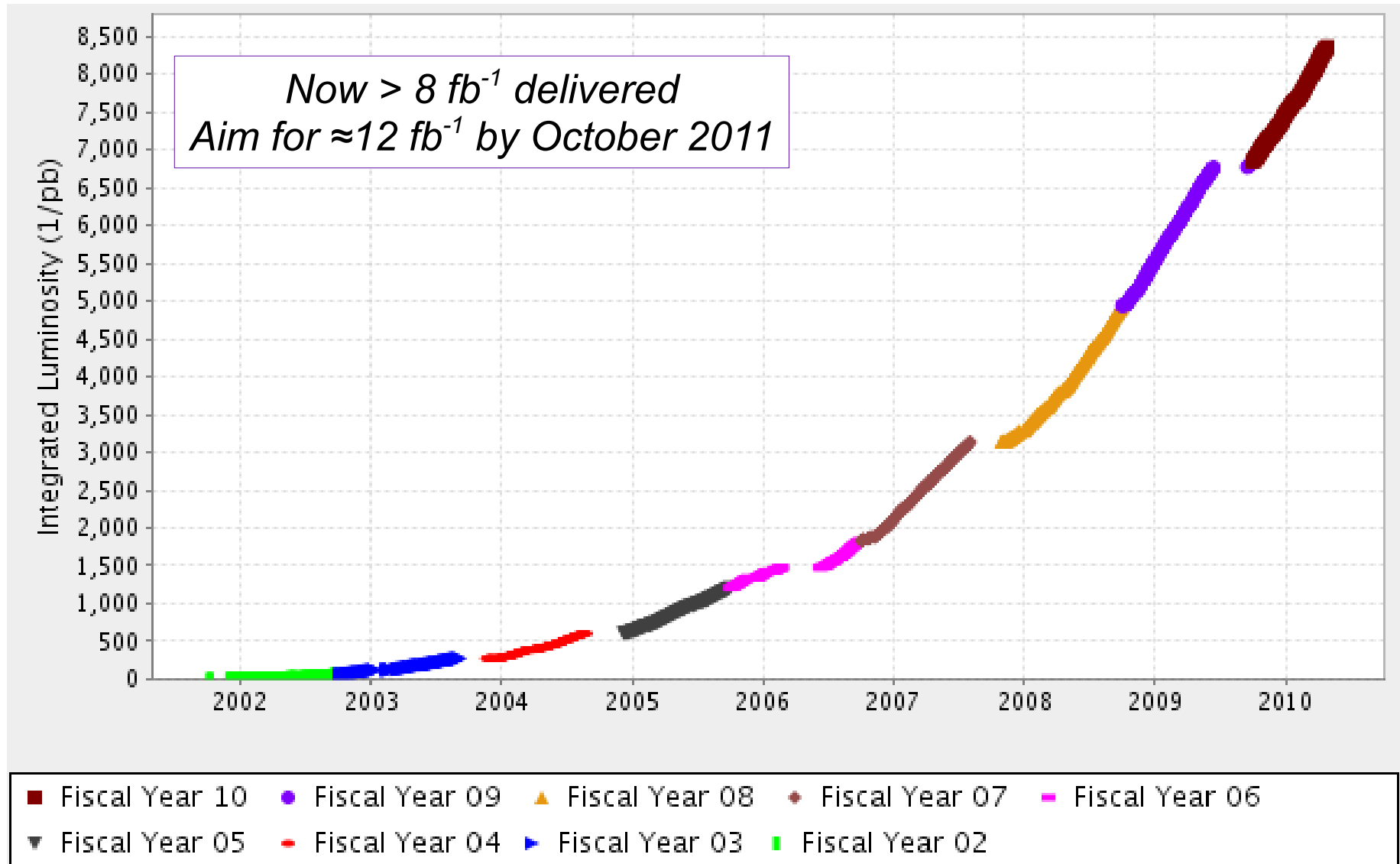
-
- Overview for program
 - Topics discussed at workshop + others
 - What next?
 - Summary



Tevatron's Day Job = Deliver Luminosity



Run 2 Integrated Luminosity





What else can be done?



- Tevatron does some moonlighting for T-980 crystal collimator studies
 - Some beam-beam compensation with electron lenses, too
- Fermilab Directorate seeking interest in using Tevatron for experimental accelerator physics program
 - Get sense of scale: # experiments, duration of such a program
 - During collider operation, dedicated run, or both?
 - Lots of flexibility at this point, but no promises
- Tevatron Accelerator Studies Workshop held here 13-14 January 2010
 - Organizers: R. Moore, T. Markiewicz, W. Fischer, F. Schmidt
 - ~35 people attended - good mix from FNAL, BNL, CERN, LARP
 - Agenda with presentation slides are available [here](#)
- Assumptions for such a program
 - Use Tevatron essentially “as-is” for collider operation
 - Studies possible during collider operation (like T-980) and dedicated run

Draft 2010-13 Fermilab Accelerator Experiments' Run Schedule

Typically Revised Annually - This Version from October, 2009

Calendar Year	2010	2011	2012	2013
Tevatron Collider	CDF & DZero	CDF & DZero	OPEN	OPEN
Neutrino Program	B MiniBooNE	MiniBooNE		OPEN
	OPEN	OPEN		MicroBooNE
	MINOS	MINOS		OPEN
	MINERvA	MINERvA		MINERvA
	ArgoNeuT			
			NOvA	NOvA
SY 120	MT Test Beam	Test Beam		Test Beam
	MC OPEN	OPEN		OPEN
	NM4 E-906/Drell-Yan	E-906/Drell-Yan		E-906/Drell-Yan

This draft schedule is meant to show the general outline of the Fermilab accelerator experiments schedule, including unscheduled periods.

Major components of the schedule include shutdowns:

In Calendar 2010, a 4-6 week shutdown for maintenance is shown.

In Calendar 2011, no shutdown for maintenance is shown.

A 2012-3 11-month shutdown is shown to upgrade the proton source and change the NuMI beam to the Medium Energy (ME) config.

- RUN/DATA
- STARTUP/COMMISSIONING
- INSTALLATION
- M&D (SHUTDOWN)

19-Oct-09

- Tevatron Collider Run 2 expected to continue through Sept 2011
- Few months “available” for dedicated running before 2012 shutdown



Collimation



- Crystal collimation
 - Strong support from CERN
 - N. Mokhov outlined plan for continued T-980 studies during Run 2
 - Including end-of-store studies and full store operation
 - Also expressed desire for collider and proton-only stores in dedicated run
 - D. Carrigan discussed negative-particle channeling with antiprotons
 - Reconfigure hardware (+ new instrumentation?) for dedicated pbar-only stores.
- Hollow e-beam
 - Strong support from CERN
 - G. Stancari described ongoing work, plans (tied to beam-beam compensation)
 - Simulation and test bench for generating hollow electron beam
 - Replace gaussian e-gun in TEL-2 with hollow beam gun (summer shutdown)
 - Request end-of-store studies throughout Run 2
 - Dedicated running also useful (guess: 5 8-hour shifts)



Beam-Beam Compensation



- Interest from both CERN and BNL
- Electron lenses (head-on compensation)
 - A. Valishev described ongoing program at Tevatron (gaussian e-beam)
 - Have used both proton-only and colliding beam stores effectively
 - C. Montag outlined BNL's desires – overlap with Tevatron plans
 - Christoph has visited FNAL to participate in studies
- Wire-based BBC (long-range interactions)
 - Of interest for LHC, not RHIC
 - 1 wire unit will become available from RHIC, but likely difficult for Tevatron



Miscellaneous Collider



- $\frac{1}{2}$ integer working point
 - Considered several years ago for operation, too much time to implement
 - Collider run has been essentially year-to-year since that time
 - Some preparatory work already done
 - Larger available tune space (especially for beam-beam spread on protons)
 - Need several weeks dedicated studies/running
 - Implement new lattices and helical orbits, beta-beat correction circuits
 - Run colliding-beam stores 36x36 for high peak luminosity or 1x1 just to demonstrate high beam-beam parameter
- AC dipole measurements
 - M. Bai described dynamic aperture measurements in RHIC
 - CERN interested in measuring beam-beam resonances
- Luminosity leveling (*dynamic β^* squeeze, bunch length control via RF voltage*)
 - Interest from CERN
 - Considered in past for Tevatron, but experiments always able to cope



Others relevant to LARP



- Generation of Flat Bunches (*C. Bhat*)
 - Interest from CERN for large Piwinski angle
 - Need to install a 2nd or 3rd harmonic cavity
 - 106 MHz cavity in Main Injector currently used for coalescing protons, pbars
 - 159 MHz cavity is available
 - Where/how to install? Difficult in short time.
 - Seems unlikely due to time constraints?
- Electron Cloud (*X. Zhang*)
 - Simulations and studies in conjunction with Main Injector
 - Have observed vacuum activity and emittance growth consistent with e-cloud
 - Uncoalesced (pilot) proton bunch trains (30 bunches in 53 MHz buckets)
 - Could add instrumentation, clearing electrode fairly easily
 - Don't need/want to duplicate efforts elsewhere



- Tevatron as 120/150 GeV Stretcher Ring (*M. Syphers*)
 - Considered for post-collider fixed-target operation
 - Investigate b_2 effects and drifts @ 120 GeV
 - Push proton intensities (lower impedances and dampers)
- Space-Charge Compensation with Electron Column (*G. Stancari*)
 - Use existing TEL apparatus to trap electrons from ionized gas (beam-induced)
 - Proton-only stores during Run 2 and dedicated run (guess: 4 8-hour shifts)
- Exotica (*not necessarily in short study period*)
 - Plasma wakefield acceleration with hadron drivers
 - Demonstrate self-modulation through a plasma?
 - Optical stochastic cooling
 - Heavy ion fusion?
 - Upcoming discussion with folks from LBNL



- Smorgasbord of leftover Run 2 topics + others (*V. Shiltsev*)
 - Beam-beam effects
 - Lifetime vs tunes (for benchmarking simulations)
 - Lifetime vs helix size (separation)
 - Test effect of phase advance between IPs, phase averaging (σ_s/β^*)
 - Look for coherent beam-beam modes by exciting single bunch, observe others
 - Instabilities
 - Try to run at zero chromaticity; need stronger dampers
 - What is origin of longitudinal instabilities?
 - Instrumentation
 - Understand turn-by-turn OTR profile differences
 - Try to observe optical/infrared diffractive radiation for beam imaging
 - Design, install, test electron beam profile scanner
 - Other
 - Measure beam lifetime contributions: IBS, vacuum, noise (for simulations)
 - Apertures (transverse, momentum) at high energy (for future ideas)



CERN Support (letter from Steve Myers)



We are strongly interested in, or would like to propose, the following experiments and tests with Tevatron beam:

- Tests of hollow e-beam scraping of proton beams for improved LHC collimation.
- Tests of crystal-based halo cleaning for improved LHC collimation.
- Tests of cryogenic beam loss monitors for improvements of present LHC IR's and future IR upgrades.
- Tests of luminosity leveling with dynamic beta squeeze or dynamic crossing angle variation for future LHC performance upgrades.
- Measurements of equilibrium proton beam distribution for improved benchmarking of diffusion and halo models.
- Measurements of transverse resistive impedance from collimators for improved benchmarking of impedance models.
- Measurements of intra-beam scattering (IBS) with various intensities for improved benchmarking of IBS theory and models.
- Measurements of beam-beam resonances using an AC dipole.
- Measurements of beam-beam effects with various harmonic transverse perturbations for improved benchmarking of emittance growth models.
- Measurements of beam-beam effects for different schemes of transverse bunch splitting.
- Collisions with large Piwinski angle, and possibly with longitudinally flat bunches.
- Study of noise effects in collision, in view of future LHC crab cavities.

Proposals for additional experiments and measurements will likely originate from LHC beam experience in 2010. We estimate that the above-mentioned studies require about 25 shifts of 8 hours, which should be distributed over a period of 6-8 weeks.



What's Next?



- Letter from Steve Myers outlined CERN's strong interest
 - Inter-laboratory cooperation is strong motivator
- Presentations at July meeting of AAC (Accelerator Advisory Committee)
 - Agenda still being developed
- Continue crystal collimator, electron lens activities as planned
 - Take advantage of existing study opportunities
 - Installing new crystals, instrumentation; hollow e-beam gun this summer
- Need more formal proposal/approval mechanism for studies (*BNL APEX*)
 - Get better estimates of time and other needed resources
- What about Collider Run 3?
 - Yes, while useful discussions are happening, but they are only discussions
 - No impact on accelerator studies at this point – would represent major change



Summary



- Strong interest in experimental accelerator program using the Tevatron
 - During ongoing Run 2 and a dedicated program
 - CERN, BNL, FNAL all interested
 - LARP can be big player
- Plenty of ideas discussed at Tevatron Accelerator Studies Workshop
- A few months seems to be right scale for duration of dedicated run
 - Certainly not just 1 week, not 1 year
 - Like a gas fills its container, confident all provided study time would be used
- Program to discussed at July meeting of Fermilab AAC
- Take advantage of the existing opportunities like T-980, electron lenses!