Tevatron End of Run Studies Plan

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Fermilab All Experimenters Meeting
Motivation and History

- Over the course of Run II, Tevatron was successfully used to develop new accelerator/beam physics concepts: electron lens for beam-beam compensation, novel methods of optics measurements, crystal collimation, hollow electron beam collimation, etc.
- Most of the studies were performed parasitically during HEP stores or made use of end of store time.
- There is strong interest from FNAL, CERN/LHC/LARP, BNL to explore a number of accelerator physics topics at Tevatron before it is switched off forever.
- Many require special beam conditions conflicting with HEP operation.
- Originally, the idea was to perform studies both during collider run and have a dedicated program after Run II (“open” time between October 1, 2011 and NOvA shutdown).
- Since the Run II extension denied, the decision was made to schedule periods of studies during the collider run.
Motivation and History continued

- Tevatron Accelerator Studies Workshop (*January 13-14, 2010*)
  - [https://indico.fnal.gov/conferenceOtherViews.py?view=standard&confId=2921](https://indico.fnal.gov/conferenceOtherViews.py?view=standard&confId=2921)
  - Generated long list of studies to be considered, rough plans

- Fermilab AAC meeting (*July 28-30, 2010*)
  - [https://indico.fnal.gov/conferenceDisplay.py?confId=3475](https://indico.fnal.gov/conferenceDisplay.py?confId=3475)
  - Strong support for an accelerator studies program

- DOE Institutional Review of Fermilab (*June 6-9, 2011*)
  - [https://indico.fnal.gov/conferenceDisplay.py?confId=4263](https://indico.fnal.gov/conferenceDisplay.py?confId=4263)
  - Support of the proposed accelerator studies
Motivation and History continued

- Guidelines for the Accelerator Studies Program were outlined by R. Moore in a AEM talk on February 14, 2011
  - [http://www.fnal.gov/directorate/program_planning/all_experimenters_meetings/special_reports/Moore_TevStudies_02_14_11.pdf](http://www.fnal.gov/directorate/program_planning/all_experimenters_meetings/special_reports/Moore_TevStudies_02_14_11.pdf)
  - Prioritized the list of studies and consolidated into blocks requiring similar beam conditions
- First period for experiments with Crystal Collimation and Hollow Electron Beam – two weeks in May, 2011
  - Excellent results + still integrated luminosity at a good rate
- Collimation with Hollow Electron Beam – parasitic during HEP
  - See G. Stancari’s AEM talk: [http://www.fnal.gov/directorate/program_planning/all_experimenters_meetings/special_reports/Stancari_Hollow_Electron_beam_07_25_11.pdf](http://www.fnal.gov/directorate/program_planning/all_experimenters_meetings/special_reports/Stancari_Hollow_Electron_beam_07_25_11.pdf)
  - Demonstrated viability of the concept, many good results in a short period of time
Current Study Period – 8/15-26

• The experiments during this period are devoted to studies of beam-beam effects
  • Strong interest from CERN/LHC and BNL/RHIC – the two current hadron colliders. Five experts from CERN, BNL, LBNL are here to participate
  • A number of unanswered questions in the Tevatron beam physics

• These studies require special beam conditions
  • 3x3 or 1x1 colliding stores – this makes the beam-beam system simpler and allows to simulate the experiments reliably
  • Some of the studies require excitation of the beam motion, potentially generating losses – less likely to cause a quench with small intensity
List of Topics

1. AC Dipole with colliding beams
   • AC dipole is a device that adiabatically excites transverse oscillations of the beam. Turn-by-turn detection of oscillations at the excitation frequency allows to restore the beam optics.
     • This technology was in part developed at the Tevatron (M.Syphers, A.Jansson, R.Miyamoto)
     • AC dipole is THE method used to measure LHC beam optics
     • CERN is interested to explore the possibility to use the method while the beams are in collision

2. Coherent Beam-Beam Modes
   • Colliding beams represent a system of coupled oscillators with their eigenfrequencies determined by beam and machine properties.
     • The modes are an important tool for diagnostics
     • In some circumstances, the modes can become unstable
     • There are conflicting results from different simulations, and the experiment will provide an ultimate benchmark
3. Beam-Beam Resonances vs Separation
   • Study the importance of transverse beam-beam misalignment
     • There are conflicting results from different simulations, and the experiment will provide an ultimate benchmark

4. Betatron Phase Averaging
   • Theory predicts that the magnitude of beam-beam effects is strongly affected by the ratio of transverse beta-function to the bunch length.
     • The goal is to collide bunches at several values of $\beta^*/\sigma_z$ and measure the effect on beam and emittance life time.

5. Diffusion Driven by Beam-Beam Resonances
   • Beam-beam effects interplay with other diffusion and noise sources
     • The goal is to introduce diffusion of varying magnitude and measure the relative effect of beam-beam on the beam life time.
Organization and Scheduling

- We have requested 40 hours of beam time over the two week period
  - This will be split into 8-hour shifts, each consisting of 2 to 3 3x3 stores
  - The 8-hour periods are scheduled every other day with normal HEP running in between. The Tevatron will be used ‘as is’, only the beam configuration is different from the nominal.
  - Plan for the day will be discussed and decided at the 9AM meeting
  - Some studies will provide stable beam conditions, and will allow experiments to take data

- A technical note summarizing the results will be published