Optics design, measurements and tuning

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- Tevatron accelerator complex includes large number of accelerators and transfer lines
  - High quality operation requires good optics design and effective means of optics measurements and tuning
  - Life is much easier if one has uniform means to deal with optics problems
    - Optics files and optics software
    - Optics measurements and data analysis

Status of optics (lines/rings)

- **General status**
  - Good
    - Transfer lines:
      - 120 GeV protons from MI to target
      - 8 GeV pbar from Accumulator to MI
      - MI-8
    - Rings
      - MI
  - The rest, including Tevatron, requires significant improvements
- **Redesign and hardware corrections (quads, power supplies, etc)**
  - P1 and A1 lines – vertical dispersion correction
  - AP2 – high order optics correction and apertures
  - Debuncher – aperture
- Different lines/rings have different troubles but there are many common problems which can be addressed by the same or similar means

Optics design and optics files

- Lattice depository should address storing the information
  - To make optics information easy accessible and useful certain rules are necessary
    - All files through the entire complex has to be in a single coordinate frame and element positions should be crosschecked with alignment group
    - Names should coincide with names on drawings and control system names
    - The same files has to be used for design and data analysis
    - Optics (focusing) has to be bound to actual power supply currents
    - Beam instrumentation has to be in the optics files (BPMs, profile monitors, *etc.*)
- Presently we use
  - MAD, Tevlat, OptiM and Ming-Jeng VAX online program
- We plan to create new software which would combine all useful features
  - MAD like input language with required extensions
  - OptiM like GUI
  - Miltipoles and errors like in Tevlat
- New software will have effective means to analyze measurements
- Schedule
  - Long term vision proposal – 1 months
  - Beta-version for public tests – 6 month
  - Total duration of active development ~ 6 months

Measurements

- Automation of measurements
- Standardization of the measurements
  - Reference measurements – Easy way to figure out problems if something goes wrong
- **Measurements which presently used**
  - Differential optics measurements with **P163**
    - Four single correctors bumps and energy change
    - Measurements were performed in
      - Transfer lines: p – 120 GeV, pbar – 8 GeV
      - Rings – Tevatron, MI
  - Turn-by-turn measurements
    - MI, recycler
- **Planned measurements improvements**
  - Extend differential orbit measurements with SVD data analysis
    - Tevatron, Accumulator, Debuncher
  - Online optics measurements at injection to Tevatron

First impressions about linac booster optics status

- **Optics**
  - Linac
    - Need credible optics model verified by measurements
  - Transfer line
    - Need optics correction
      - Should be based on the measured beam envelope in the line
    - Differential orbit measurements
  - Booster
    - Looks like that further improvements can be done for dogleg compensation
    - Measurements verifying optics (turn-by-turn would be preferable)
- **Standard problems to be addressed**
  - Steering
    - Centering on apertures
    - Steering automation and steering software
    - Orbit stabilization during acceleration in the booster
      - Effective beam scraping cannot be achieved without it
- **All this does not solve the space charge and intensity problems directly but should significantly alleviate the problem**