Tevatron Support

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Acknowledgments:

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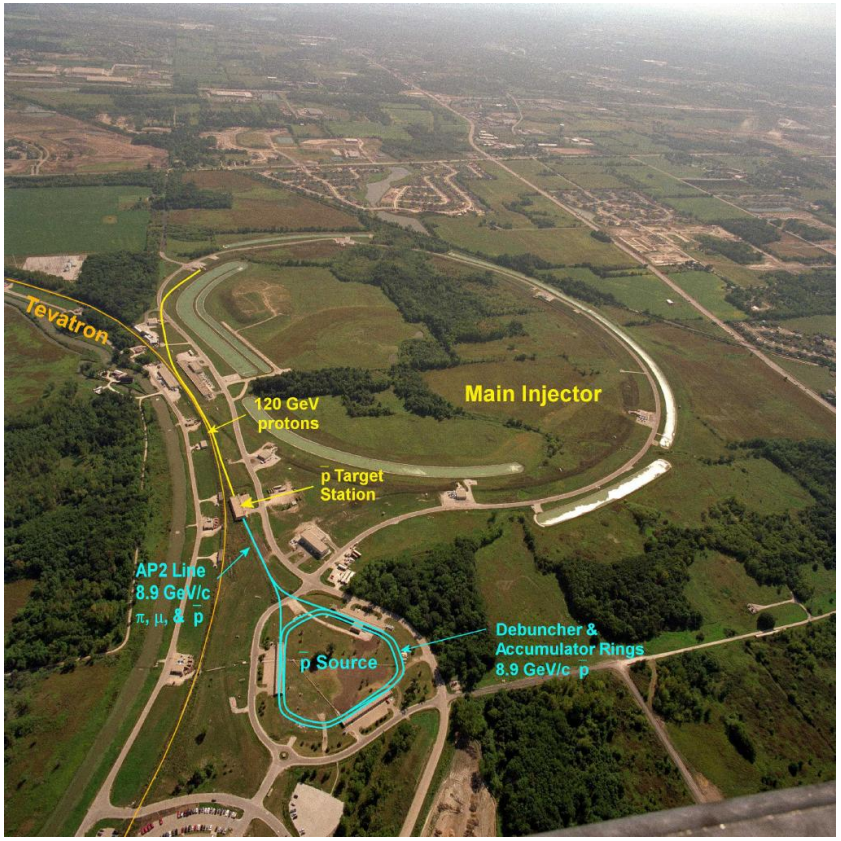
Beamline Layout



- AP2 transports anti-protons from the target to the Debuncher ring
- line starts with a lithium lens to focus the beam
- line consists of a FODO section and a bending section with matching sections in between and at the ends

The Problem

- After some upgrades the Debuncher will have an acceptance of 40π mm mrad and $\pm 2.25\,\%$
- Currently AP2 has an acceptance of about 20π mm mrad and $\pm 2.25\,\%$
- Anti-Protons are expensive $\Rightarrow$ need to maximize transmission
- Increase in acceptance increases anti-proton yield which in turn increases the luminosity
- Acceptance of AP2 has been studied before and upgrades have been implemented but so far the acceptance has not increased significantly

Measurements

- The beam consists of about 1 % anti-protons and 99 % other particles like kaons and muons with the same rigidity
- Decay particles make measurements difficult
- Not all instrumentation currently works for reverse protons
- Tuning is usually done on stacking efficiency in Debuncher which suffers from high shot-to-shot fluctuations

Current Schedule

by February 2004: Finish model including chromatic effects on anti-proton yield

Suggest some experiments to test model, some of which have already been done by Fermilab staff

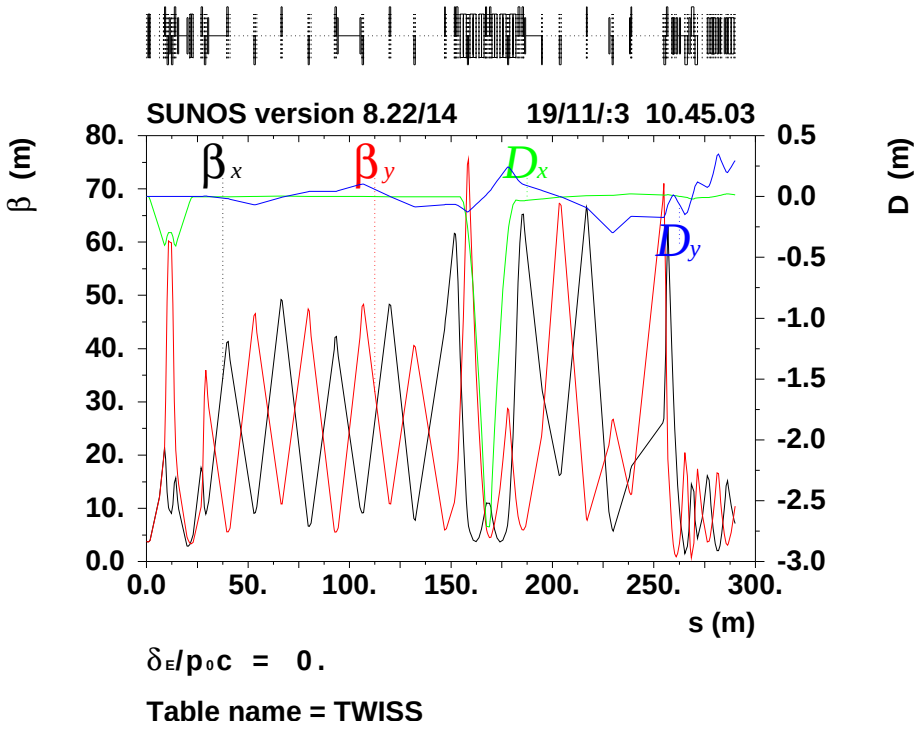
by July 2004: Analyze experiments and develop a lattice with reduced chromatic effects

by September 2004: Proposal for reducing chromatic effects (including cost estimate and schedule)

Studies Done so Far

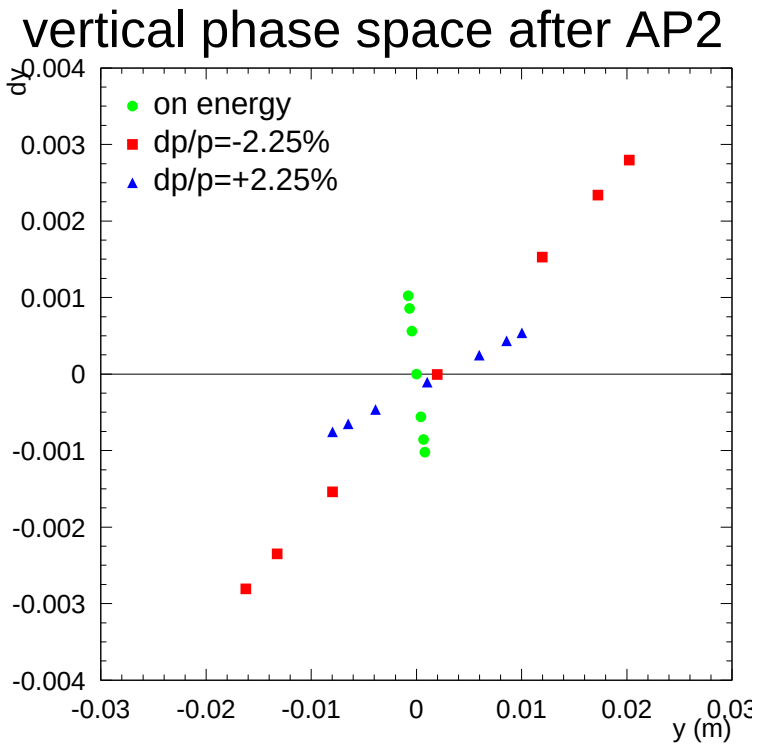
- Machine errors
  - Lithium lens mismatch
  - Mismatch into Debuncher
  - Random errors
- Problems due to limited number of corrector magnets
- Chromatic effects combined with large momentum spread
  - Tracking
  - W-Functions

Problems due to Residual Dispersion



- Large residual vertical dispersion can create aperture problems in small vertical apertures at the end of the line
- Caused by vertical alignment errors (0.5 mm RMS) of quadrupole magnets
- Particularly sensitive to alignment errors of first doublet/triplet

Chromatic Effects



- Chromatic Functions not matched into Debuncher
- Tracking particles with initial offsets (no angles) corresponding to 0,$\pm$12, $\pm$28 and $\pm 40\pi$ mm mrad
- final amplitudes and phases depend strongly on momentum deviation

Plans

- Study effect of measured fields in injection line quadrupoles
- Optimize lattice for better chromatic behavior
  - Rematch with existing hardware
  - Rematch allowing quadrupoles to move and/or add quadrupoles
  - Add sextupoles for chromatic corrections

Summary

- Increasing the acceptance of AP2 can significantly increase the anti-proton yield
- Problems due to large momentum spread
- Working on lattice with improved chromatic behavior