Lattice optimization for the stochastic cooling in the Antiproton Source at Fermilab

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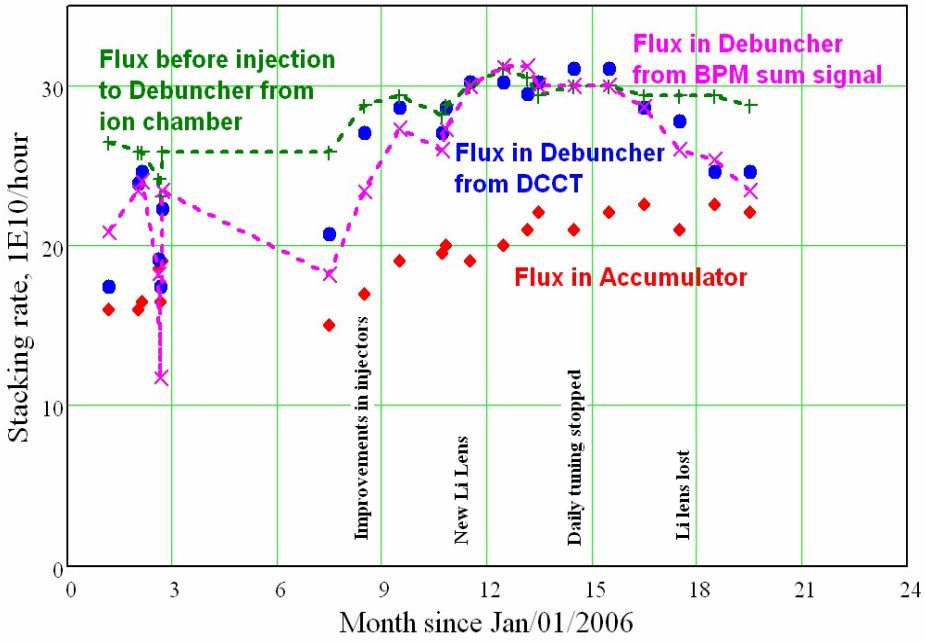
Recent efforts to increase the p-bar production rates

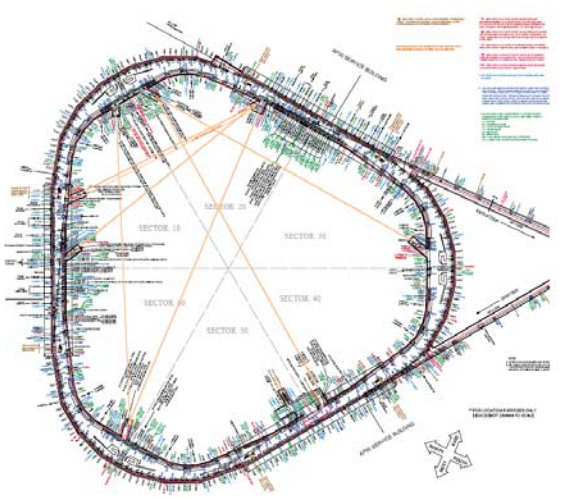
New efforts on p-bar production in 2006-2007:

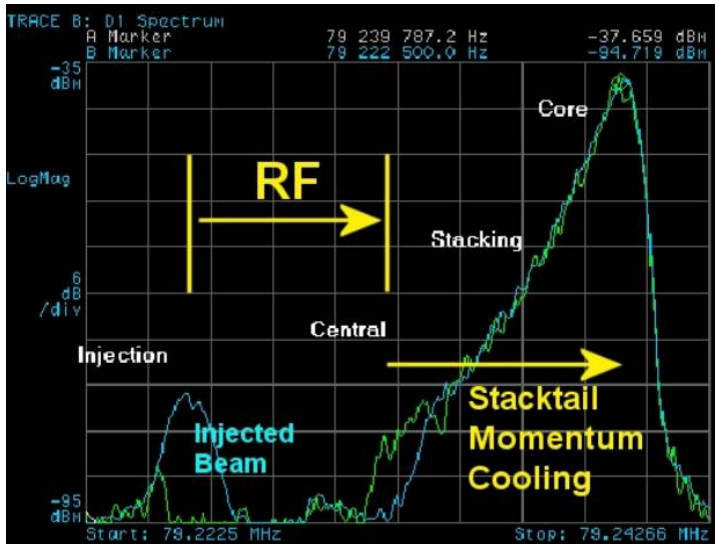
- Proton flux on target
- Collection yield:
  - Beam lines
  - Li-lens
  - Rings' acceptance
- Cooling in Debuncher
- Cooling in Accumulator

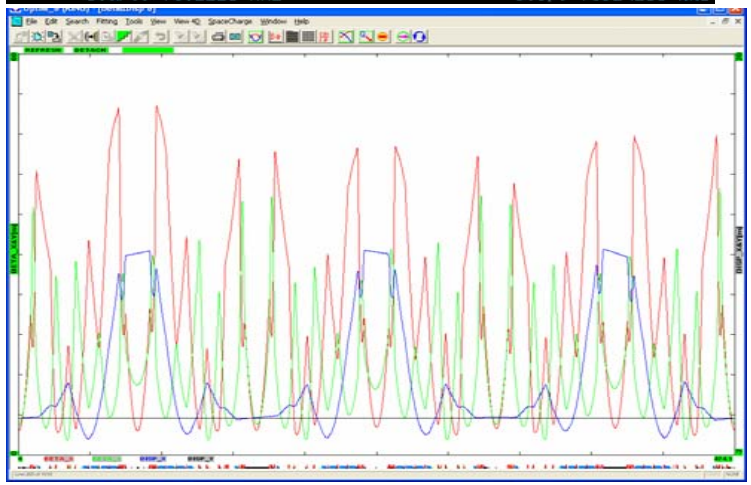


- Substantial progress in all components
- The most tight link: Accumulator Stack-Tail system
- Lattice optimization done in Debuncher and Accumulator

Accumulator lattice





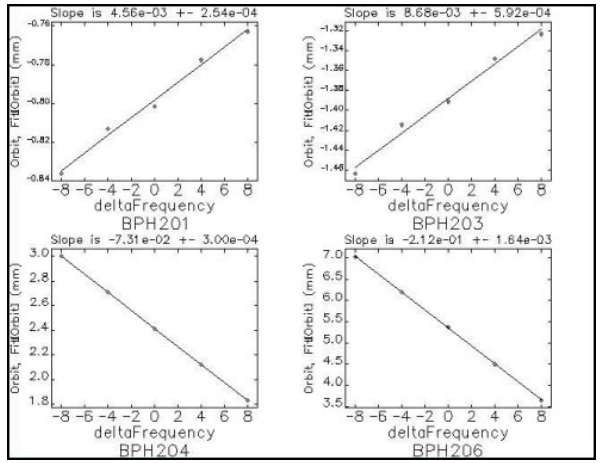


Main features:

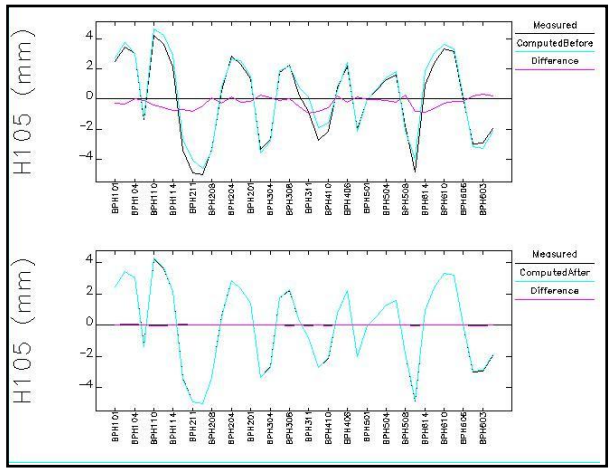
- Large momentum aperture
- Large dispersion in arcs
- Low dispersion in straights
- Narrow aperture in straights

Accumulator optics model

- Calculations: OptiM program
- Measurements
  - differential orbits for RM
  - dispersion: frequency scan
- Model parameters fit (LOCO)
  - quadrupole errors
  - PS corrections
  - trims and BPMs individual gains



Dispersion measurement:
Full $\Delta p/p = \pm 0.1\%$, $\delta D \sim 1$mm



Differential orbits fit with LOCO:
Rms = 10-15μ

Optics optimization for the stochastic cooling

New design objectives:

H=5168 (3.25 GHz)

Slip factor increase by 15%:

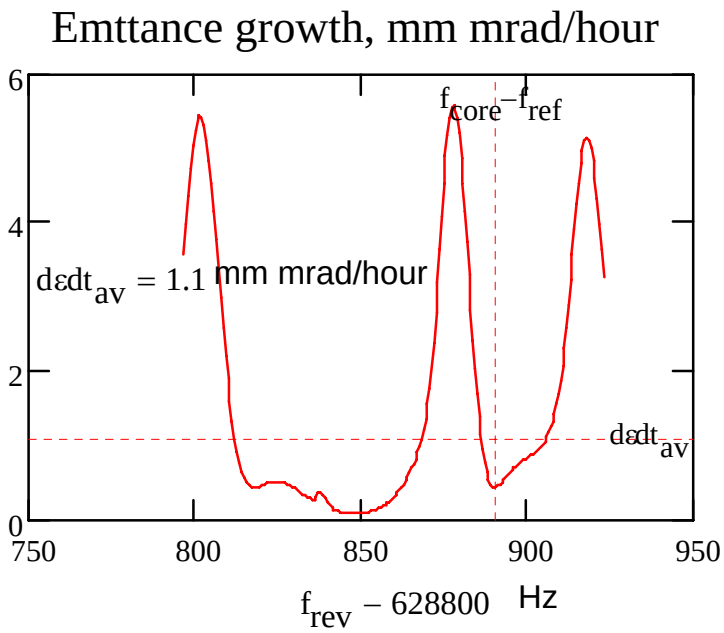
- helps stochastic cooling
  - $J_{\max} = T_0 |\eta| W^2 x_d$

Transverse heating:

- Mitigate "3.25GHz resonance"
- Suppress dispersion in straights
- Lower beta-functions (IBS)

Apertures:

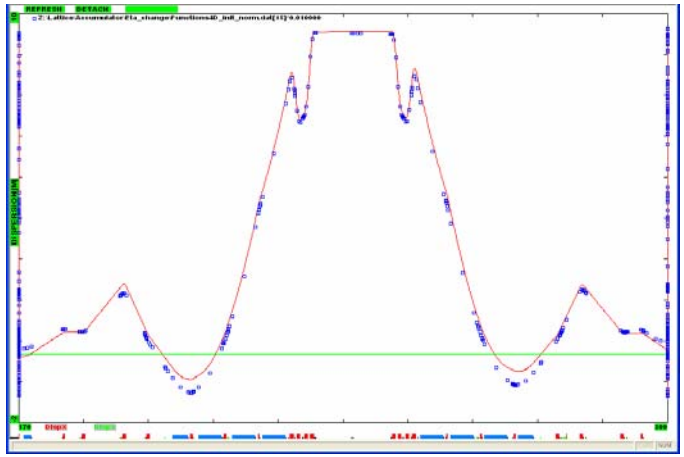
- Reduce beam size at tight locations

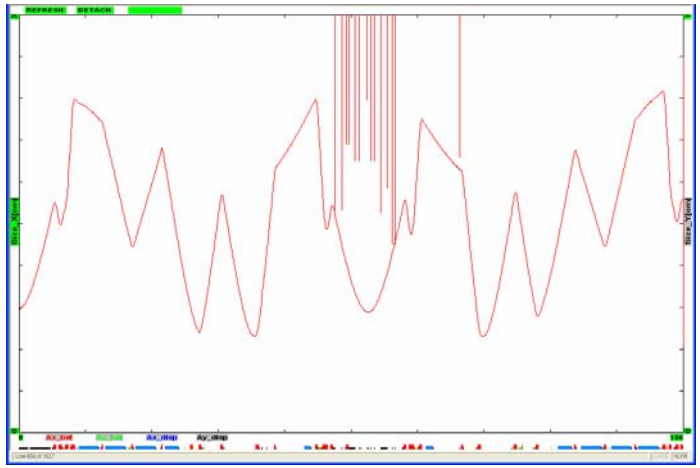


New lattice design

Approach:

- Dispersion in negative "wells"
- Beam line regime
- Iterations
- New hardware installed

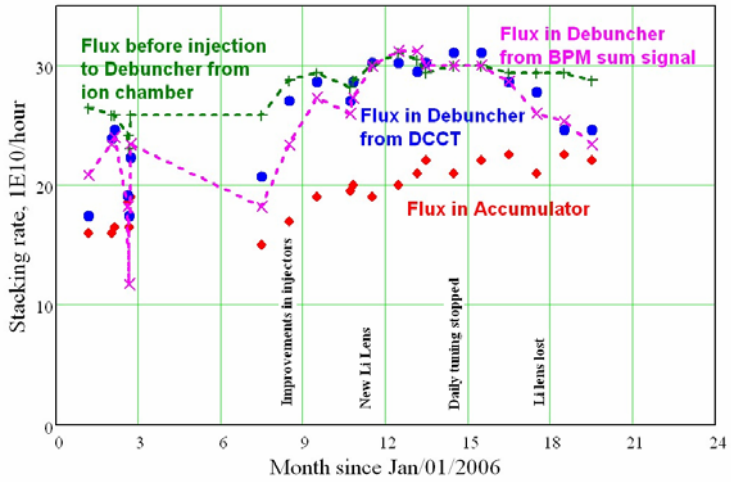


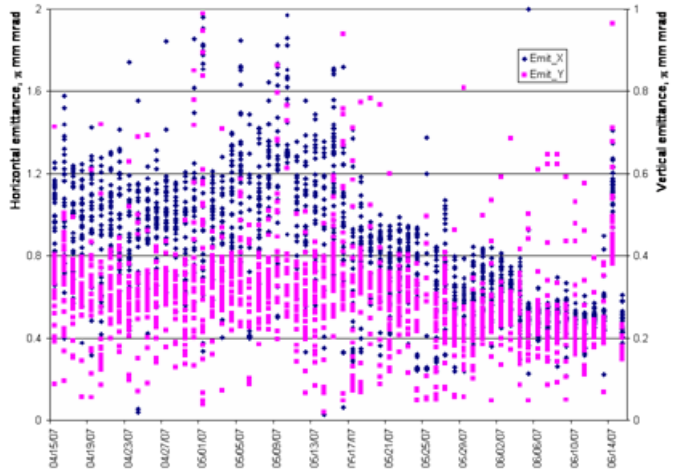


Results

Changes:

- Slip-factor change (+15%), verified
- Lowering beta-functions (12%for IBS)
- Apertures → 15π
  - 6 known locations, min =11π
- Dispersion in straights 15cm-> 2.5cm
- PU->KI Phase advances





Summary

1. Based on recent studies of the stack tail stochastic cooling system, new lattice parameters have been proposed.
2. Optics model of the Accumulator and its optimization have been worked out using OptiM and LOCO software.
3. 15% increase of the slip factor have been implemented.
4. Horizontal dispersion has been substantially reduced in the straight sections.
5. Design aperture of the Accumulator has been increased.
6. Substantial reduction of the core heating rate has been observed after implementation of the new lattice.
7. New lattice is also expected to help increasing the stack tail flux.

Optics of the Debuncher

Debuncher operation:

Fast antiproton beam compressing in 6D:

Bunch rotation, 3D cooling

~10 in each plane in a 2.4 sec cycle

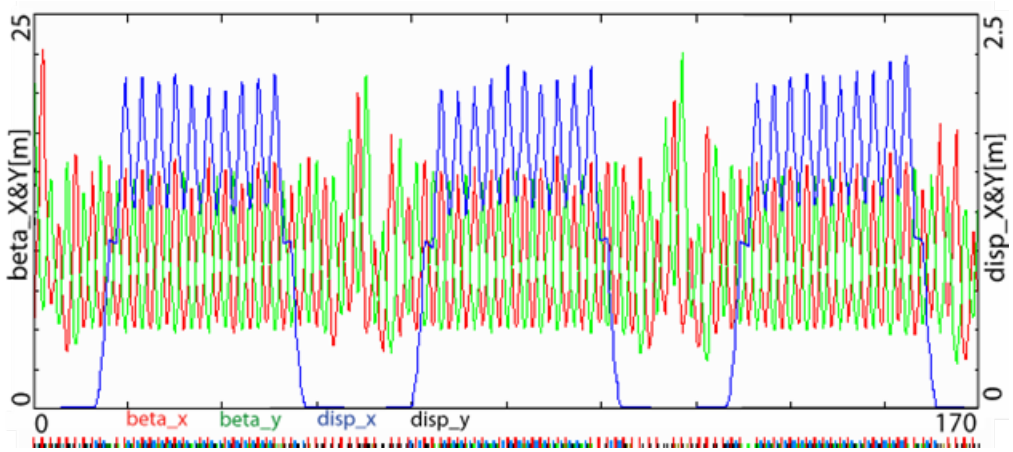
Debuncher lattice:

57 FODO cells, 60°

Dispersion cancelling

330π transverse admittance

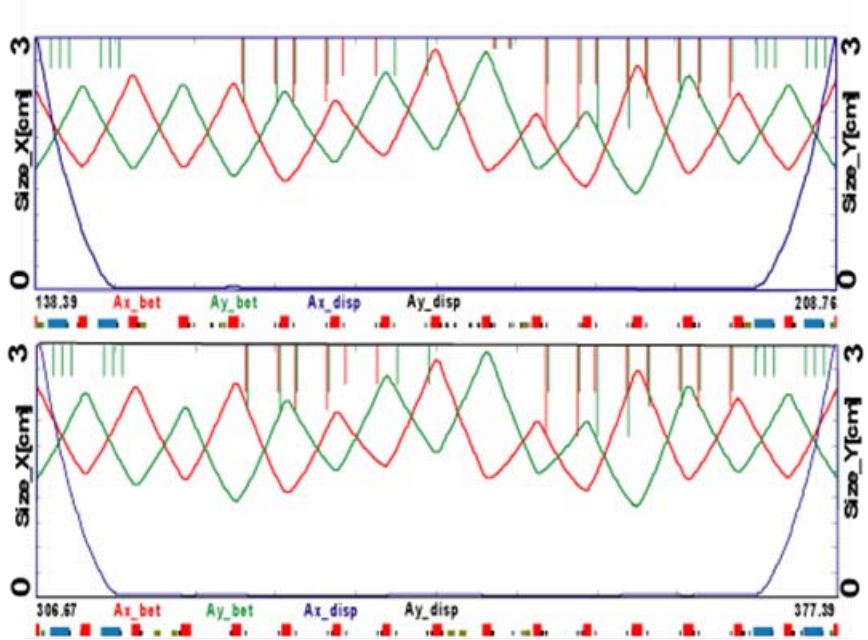
4.5% momentum aperture



Lattice optimization in the Debuncher

Conclusions:

- Increased machine acceptance
- Reduced beam size at limiting apertures
- Increased beam size in the cooling tanks within the design aperture
- Need to correct phase advances (will be implemented this year)



Best acceptances in 2005: 30π/25π (design 34π/31π)
Best acceptances in January 2006: 35.3π/34.6π (40.5π/37.5π)
(as measured!)

Lattice optimization also eliminated the need to redesign B4 tanks