Debuncher Cooling Performance

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Design goals

Input:
2e8 antiprotons every 2 seconds
320 π mm mr (95% unnormalized)
∂p = 60 MeV/c (95%)

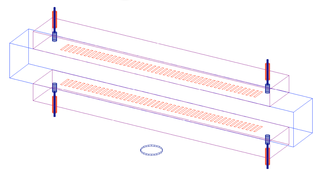
Output:
2e8 antiprotons every 2 seconds
45 π mm mr (95% unnormalized)
∂p = 6 MeV/c (95%)

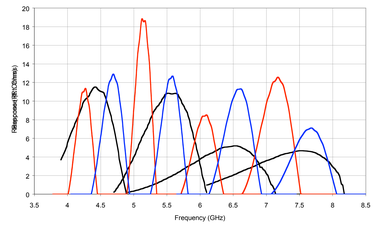
Density Increase 500x
Factor of 10 longitudinal
Factor of 7 both transverse planes

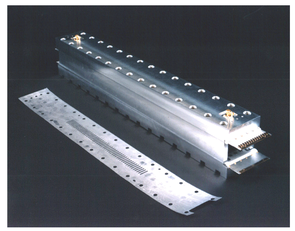
Abstract:
We present measurements of the Fermilab Debuncher momentum and transverse cooling systems. These systems use liquid helium cooled slotted waveguide pickups and slotted waveguide kickers covering the frequency range 4-8 GHz.

Slot Coupled Waveguides[1]

Cover 4-8 GHz
8 Pickup bands
Narrow band transversal filters to prevent overlap
Liquid Helium Cooled: 25 K noise temperature
4 Kicker Bands
Sum 2 Pickup Bands into one Kicker



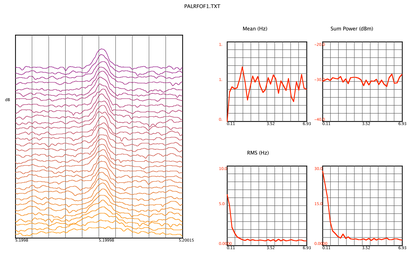


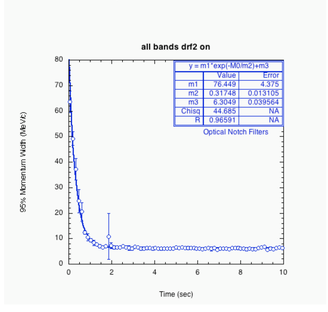


(1) D. McGinnis (Fermilab),, Mar 1999.
Contributed to IEEE Particle Accelerator Conference (PAC 99), New York, 29 Mar - 2 Apr 1999.
Published in "New York 1999, Particle Accelerator, vol. 3" 1713-1715

Momentum Cooling Performance

Down convert 5.2 GHz Longitudinal Schottky Signal and use Vector Signal Analyzer to take spectra. Average results of 5 pulses to measure performance.





Optical Notch Filters over 4-8 GHz
Ramp Gain down through the cycle, as notches fill up and beam heating becomes important. Asymptotic Width is lower by ~20% with 6 dB less gain after 2 seconds.

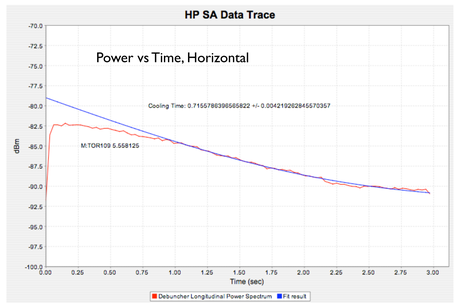
Measure: For 1e8 particles
Longitudinal: Factor of 12.8 in 2 seconds
limited by asymptotic width, not rate

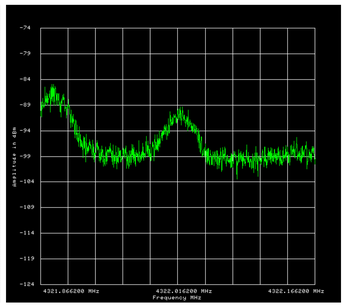
Transverse: Factor of 17 in 2 seconds
expect factor ~12 with 2e8 particles as limited by available power

Transverse Cooling Performance

Power in Transverse Schottky Sideband is directly related to dipole moment of the beam,which is directly related to the beam emittance. By measuring the power the Schottky Sideband vs time, we measure the transverse cooling rate.
Ramp the system gain to optimize cooling performance (approximately constant power)
For ~1e8 pbars, we measure cooling rates
0.69±0.03 s horizontally 0.74±0.03 s vertically

Horizontal Schottky Sideband





Model Predictions for 1e8 pbars:[1]0.74 s Horizontally 0.78 s Vertically

(1) J. Marriner (Fermilab),, Apr 1998. This model assumed constant power at the limit of available power.
Fermilab Pbar Note 573, http://www-bdnew.fnal.gov/pbar/documents/pbarnotes/pdf_files/PB573.PDF