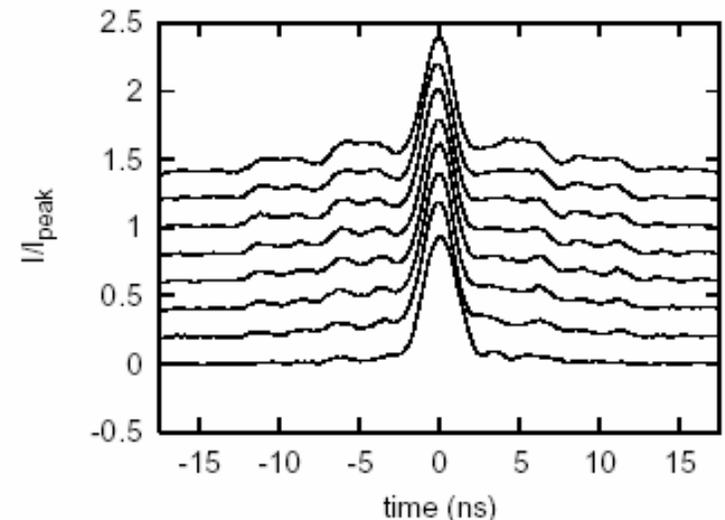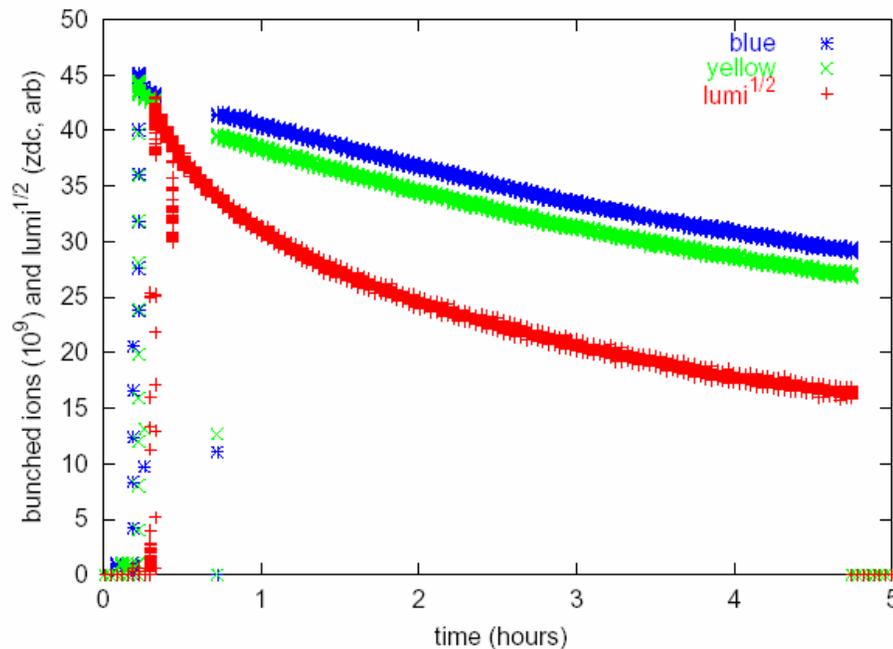# Stochastic Cooling for RHIC

Team: M. Blaskiewicz, J.M. Brennan, J. Wei, RF and instrumentation groups

Goal: To provide microwave stochastic cooling at a level which will improve integrated luminosity by a significant factor (maybe 2) within the next few years. Confine beam halo when electron cooling arrives.

Current Situation:

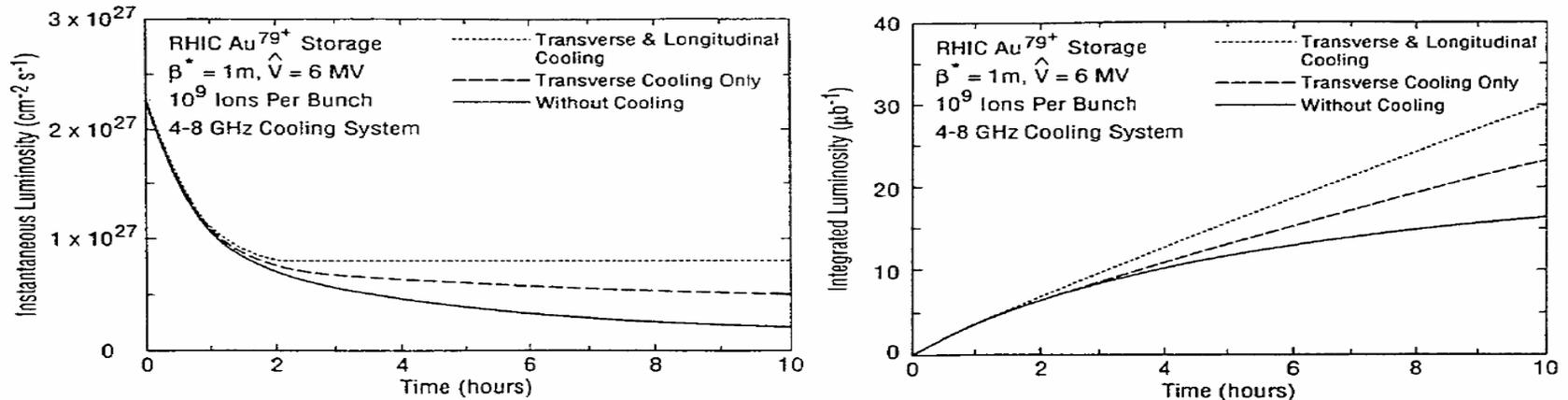# Cooling Calculations from a bunched beam FP code

Figure 3: Improvements on a) instantaneous and b) integrated luminosity in RHIC when stochastic cooling is applied.

Figure above from J. Wei CERN/94-03 (1993).

A full turn of delay was assumed.

With 2/3 turn delay things improve (page 5)

Basic considerations

Need 1 to 3.6 kV rms

transfer impedance for one kicker $V_k^2 = P_{in} Z_t(f)$

M frequency bands with N kickers per band $V_b^2 = M(NV_k)^2$

multi-slot kicker, length L $Z_t \propto L^2, \Delta f \propto 1/L \propto 1/M$

For each kicker $Z_t = \hat{Z} M^2$

Total power $P_{tot} = NMP_{in}$

Total voltage $V_b^2 = NM^2 \hat{Z} P_{tot}$

Each kicker should have a different center frequency.

Kicker Impedance for FNAL copy

Need an efficient kicker structure.

The FNAL Antiproton Accumulator has $\gamma = 9.5$

Pickup structure D. McGinnis PAC99, p1713

Reciprocity holds

$Z_t > 500\Omega$
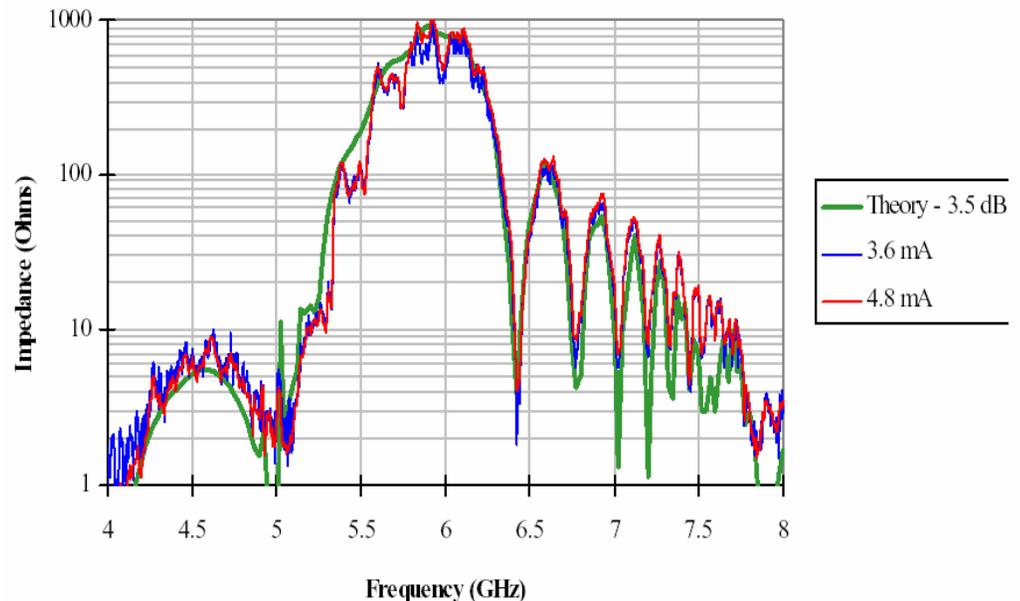
over

$\Delta f = 500 MHz$

for each kicker

Figure 7. Sum response of the slow wave pickup.

Filter Cooling

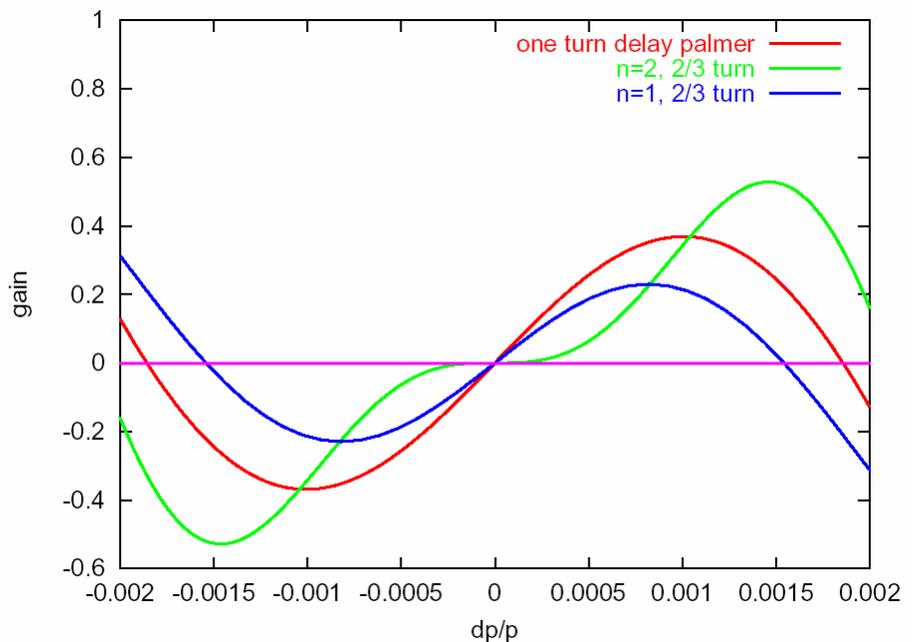8 kickers, 250 Watts/kicker gives 1kV on beam

Marginal for Palmer cooling

We won't cool the core of the beam.

filter cooling

$$S(t) = (1 - e^{-j\omega T_{rev}})^n I_b e^{j\omega t}$$

Needs to be included in the
BBFP code.

Pulse Compression

5 ns bunch length

100 ns bunch spacing

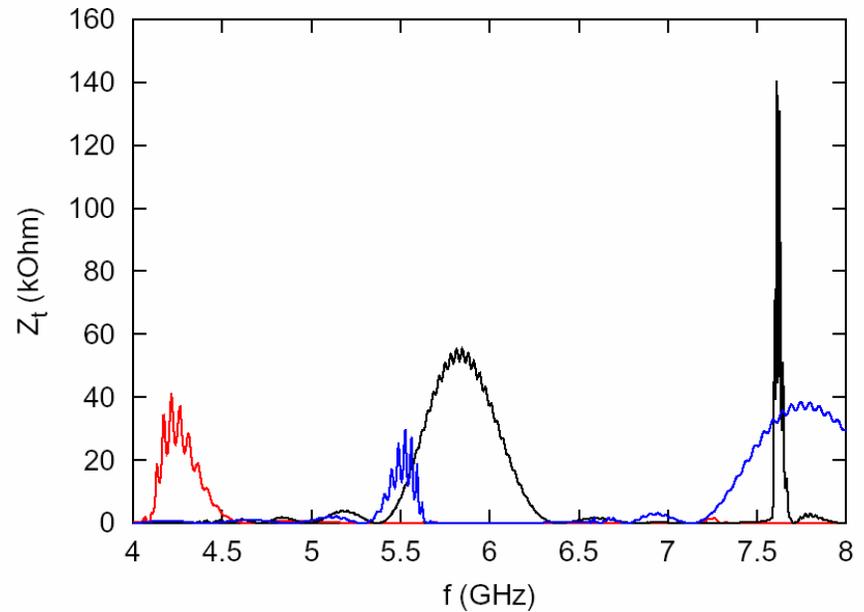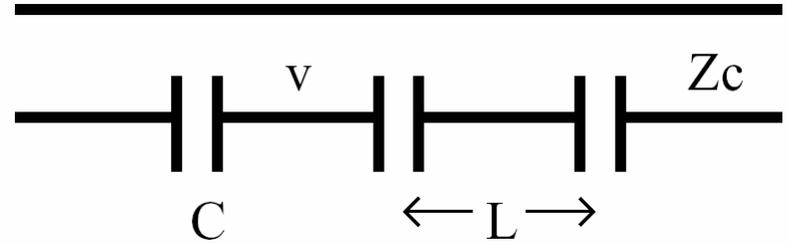Dispersive waveguide between amp and kicker.

$$T = \frac{T_\infty}{\sqrt{1 - (\omega_c / \omega)^2}}$$

Waveguide insertion loss limits to a factor ~4   pulse compression
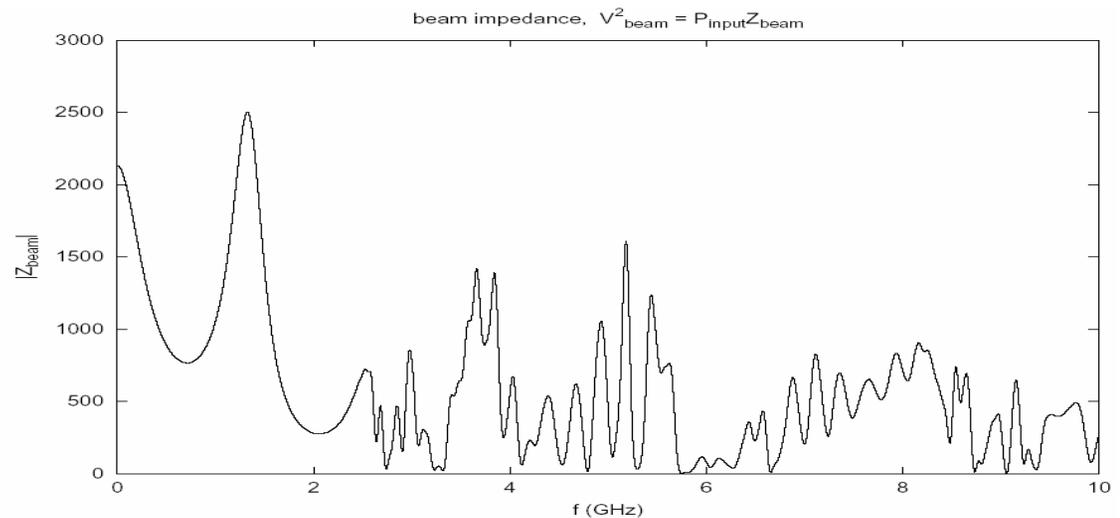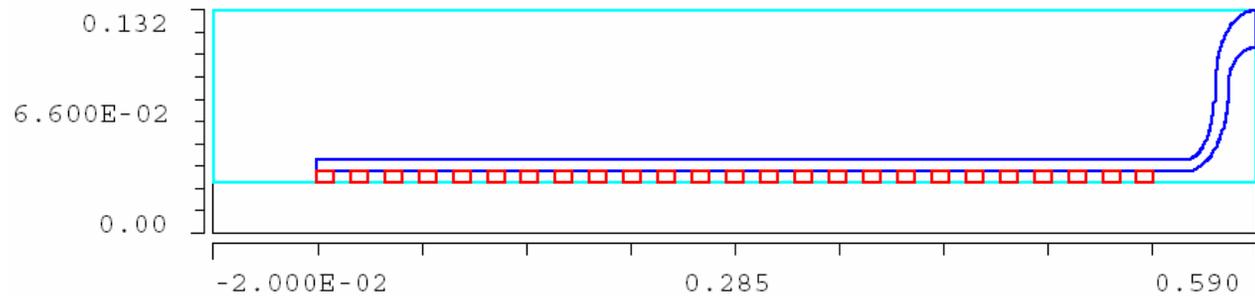
Kicker improvements

- Transmission line Model
- Zc=10Ω

C(pF)	v/c	N	L(cm)	band(GHz)
6	0.90	50	4	4
5	0.95	100	4	6
5	0.95	100	2.5	8

MAFIA runs

3cm pipe radius can be reduced

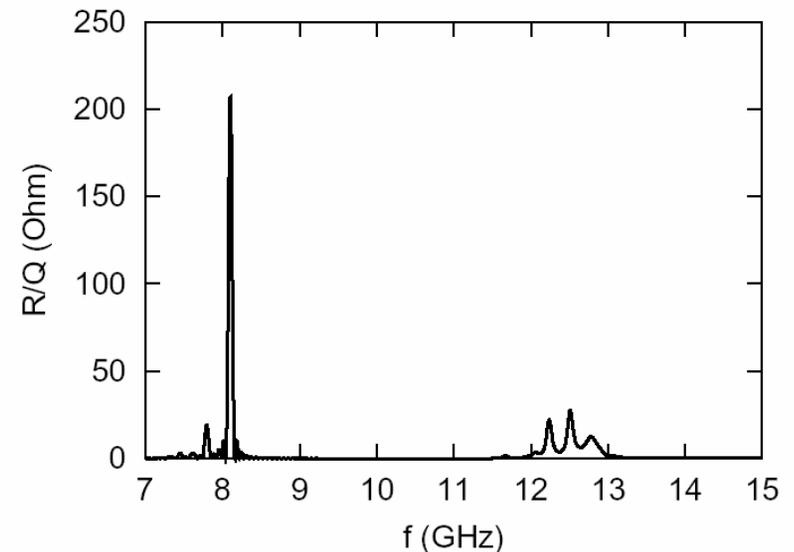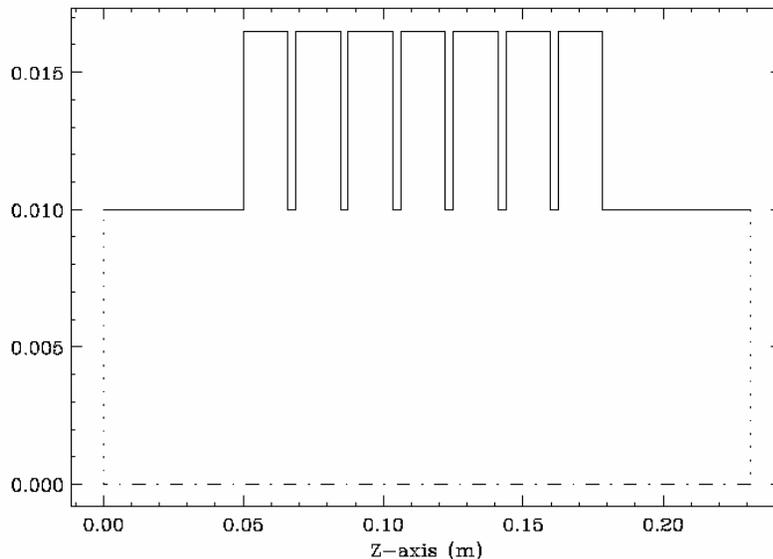transfer impedance is not smooth

More to do

Exploit $\tau_b = 5ns$ bunch length

Fourier Series for voltage

$$V(t) = \sum_n A_n \sin(2\pi nt / \tau_b + \theta_n)$$

A_n and θ_n vary from one bunch to the next

100 ns bunch spacing

A B C I 9.2.1 : RHIC cooling cavity
DDZ= 0.500 mm, DDR= 0.500 mm

20 bands, 10 Watts each, R/Q=200 Ohm, and Q=100 gives 2kV rms on the beam

Kicker Calculations courtesy Dave McGinnis

- 4+ cm aperture
- 20 cm long