OSC Updates

- Goals for cooling?

Lebedev ICFA Paper

- Transverse cooling proportional to $J_1(a_x)J_0(a_p)$

- Longitudinal cooling proportional to $J_0(a_x)J_1(a_p)$

- $a_x = k*sqrt(\epsilon[\beta(M_{51})^2 - 2\alpha M_{51}M_{52} + \gamma(M_{52})^2])$

- $a_p = k(M_{51}\eta + M_{52}\eta' + M_{56})(\Delta p/p)$

- (All optics at pickup, k is wavenumber of light)

Limits for Cooling in Transverse and Longitudinal

- $\varepsilon < (\mu_0)^2/(k^2[\beta(M_{51})^2 - 2\alpha M_{51}M_{52} + \gamma(M_{52})^2])$
  (Set by longitudinal constraint)

- $\Delta p/p < \mu_0/(k[M_{51}\eta + M_{52}\eta' + M_{56}])$
  (Set by transverse constraint)

  (μ_i is 1st zero of $J_i(x)$)

Limits for Transverse Cooling Only

- $\varepsilon < (\mu_1)^2/(k^2[\beta(M_{51})^2 - 2\alpha M_{51}M_{52} + \gamma(M_{52})^2])$

  (Set by **transverse** constraint)

- $(\mu_1/\mu_0)^2 \approx 2.54$

- Numbers quoted for bypass limit last week were for the stricter limit – would have emittance acceptance ratio of 17.3 instead of 6.8 if we only care about transverse limit

Cooling Rates

- $k\xi/2 * (M_{51}\eta + M_{52}\eta')$ for transverse

  (2.17 sec from OSC, 0.48 sec normally)

  (0.39 sec combined)

- $k\xi/2 * (M_{51}\eta + M_{52}\eta' + M_{56})$ for longitudinal

  (210 sec from OSC, 0.25 sec normally)

  (0.25 sec combined)

  (Both assume 100 meV energy transfer)

Prospects for Longitudinal Damping

- The knob to increase damping rate is exactly the same as the one that reduces longitudinal acceptance

- Requires **at least** $\Delta p/p < \mu_1 \xi/(2\lambda)$, where λ is damping rate, to say nothing of transverse plane

- To get 1% of non-OSC damping rate gives momentum acceptance of 0.004 (10x momentum spread), assuming 200 meV energy transfer

- Good news is that longitudinal anti-damping does not seem important for transverse cooling experiment

Conclusions

- If ignore longitudinal damping constraints, current optimizations of lattices have emittance acceptance ratio of over 17, rather than below 7

- Ignoring longitudinal (anti-)damping seems reasonable

Future

- Optimize also on the nonlinearities and the transverse cooling rate

Backup Slides

- Lower momentum acceptance to raise emittance acceptance

Best Optimized Lattice

Emittance: 2.77 nm

Acceptance: 18.9 nm

Ratio: 6.82

Momentum acceptance: 0.99%
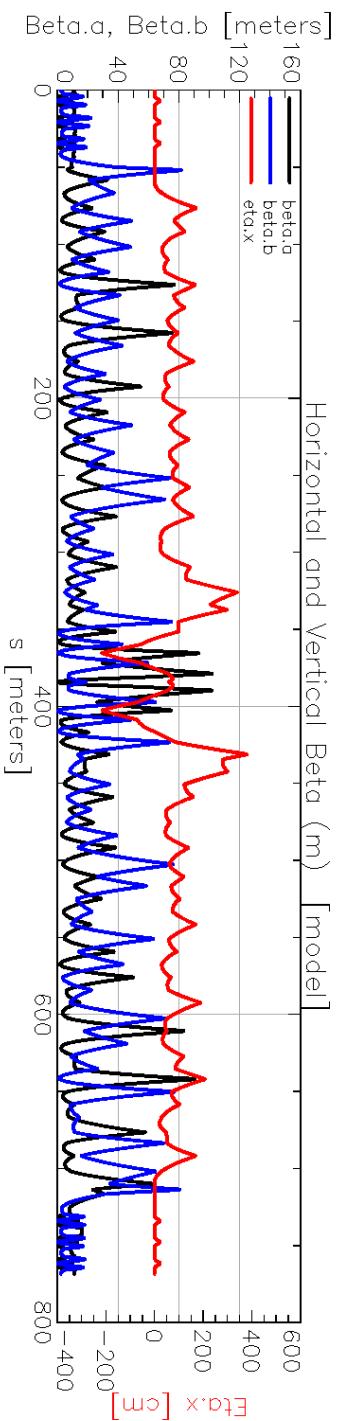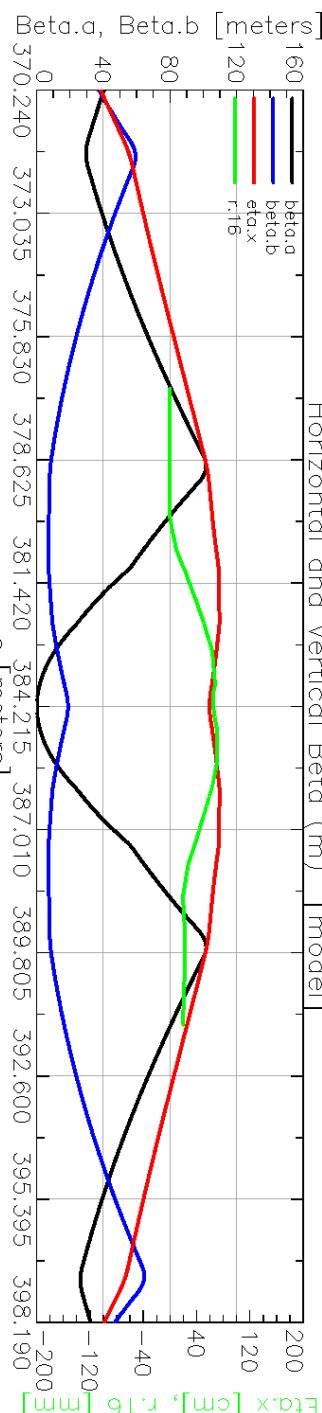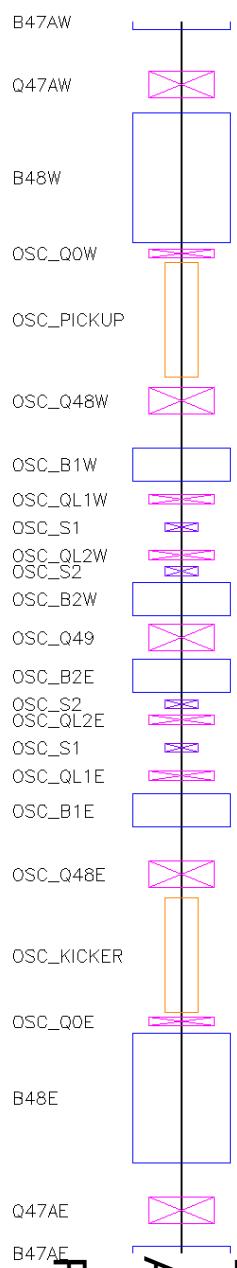
Lattice with Lowered Momentum Acceptance

Emittance: 2.70 nm

Acceptance: 19.0 nm
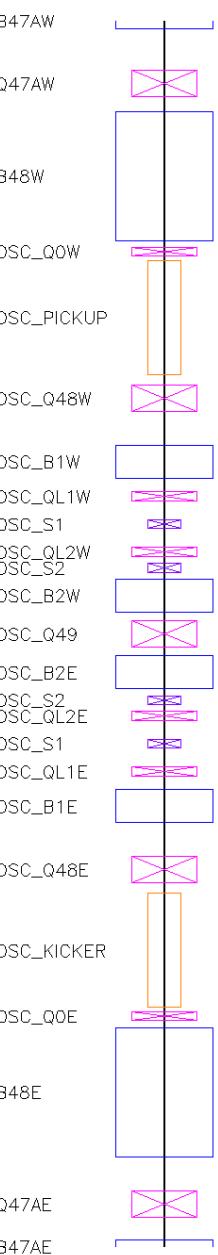
Ratio: 7.02

Momentum acceptance: 0.40%