Analysis of Balbekov Stage 1

J. Scott Berg
Brookhaven National Laboratory
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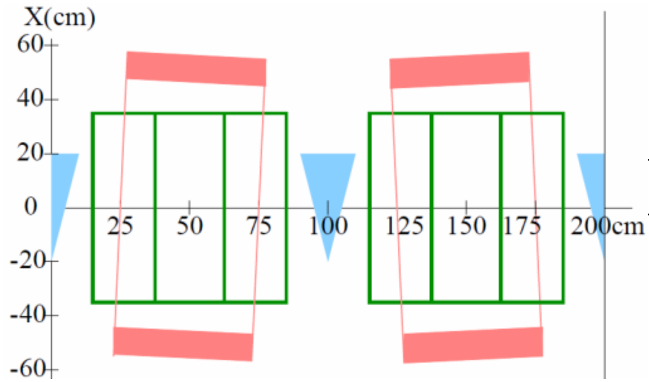
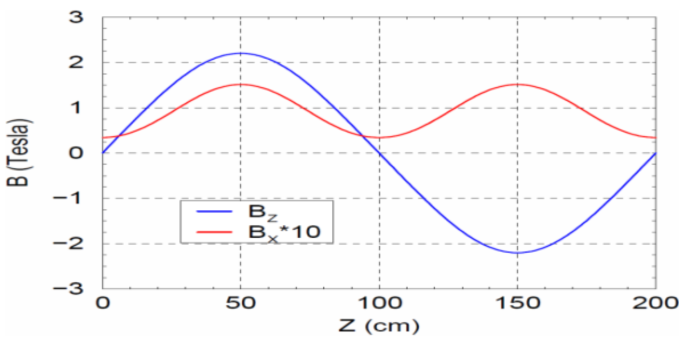
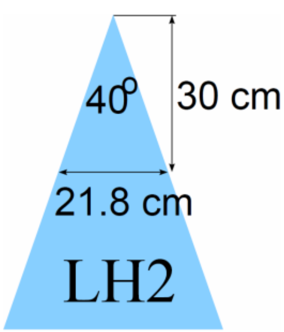
Balbekov Stage 1







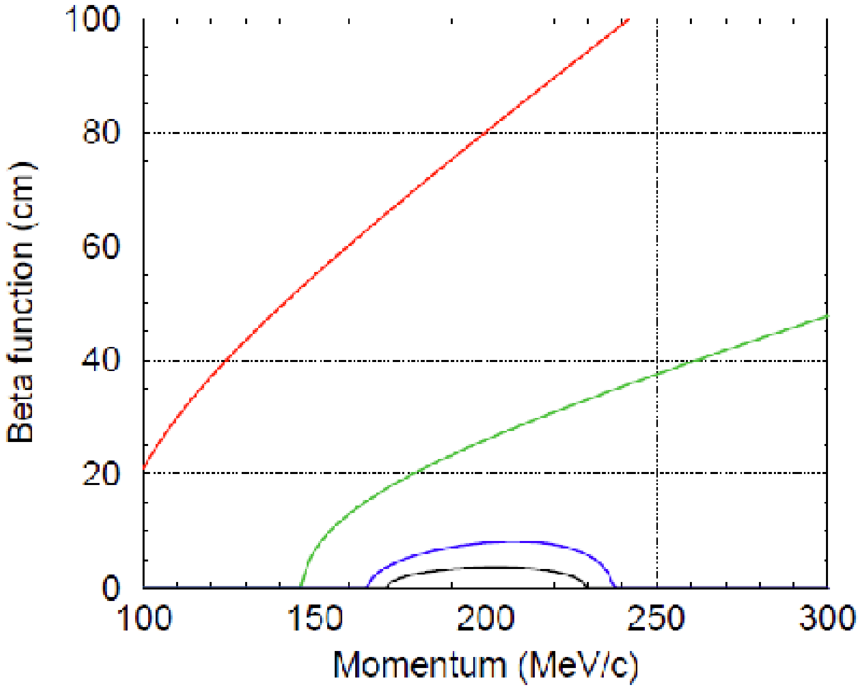
Everything to make the lattice:

Cell length (cm)	200
Coil length (cm)	50
Coil inner raius (cm)	45
Coil thickness (cm)	10
Coil tilt (mrad)	60
Current density (A/mm^2)	48.3

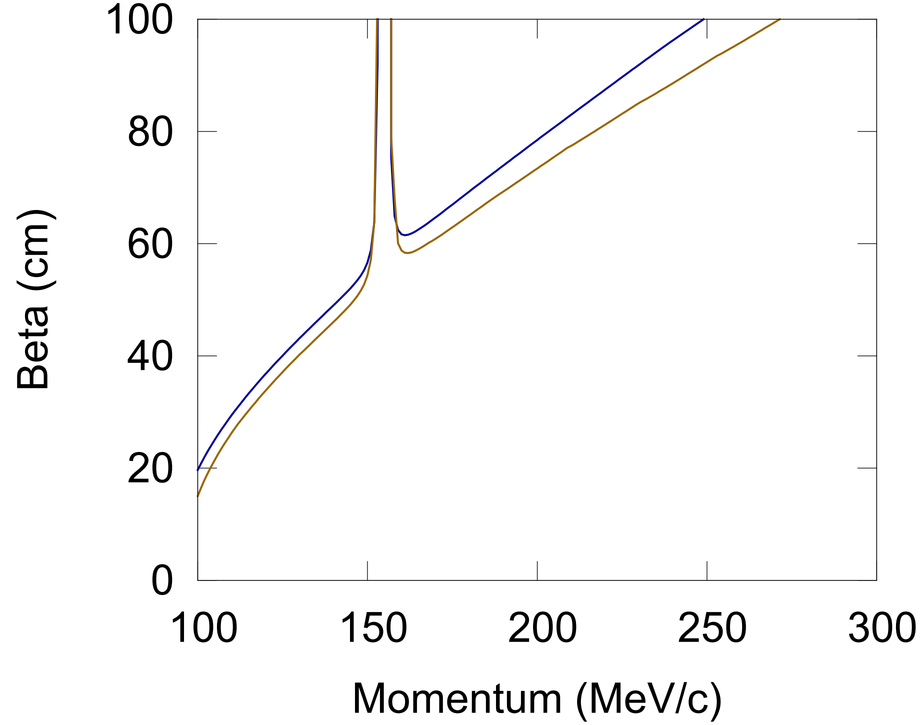
Comparison with Balbekov

- Diktys made field map; compare to Balbekov
- To eye, fields on axis agree
- Beta functions agree passably

Balbekov



Diktys' Field Map



Results from Simulation

- Use Balbekov's distribution
- Transmission is awful with Balbekov's wedge (30 mm to vertex)
  - $\epsilon_\perp = 4.1$ mm, $\epsilon_\parallel = 71$ mm (!), transmission 4%
  - Best performance with very high reference momenta
- Diktys found better performance with 10 mm to vertex
- I found best at 14 mm to vertex (parameter scanning)
  - $\epsilon_\perp = 6.1$ mm, $\epsilon_\parallel = 9.4$ mm, transmission 74%
- Nothing approaching Balbekov
  - $\epsilon_\perp \approx 4$ mm, $\epsilon_\parallel \approx 7$ mm, transmission $\approx 88\%$

Analysis

- Found 6-D fixed point with Balbekov, wedge 30 mm to vertex
  - Adjusted to get fixed point at 200 MeV/*c*
- Longitudinal eigenvalues were unstable
  - True with or without Al window on absorber
  - Improved somewhat when I removed the Al window, but still unstable
  - No Be windows on cavities in Diktys' simulation

Theory

- Ignore synchrotron oscillation, treat wedge as thin and a perturbation
- Transverse and longitudinal eigenvalue magnitude differences from 1

$$\frac{g(E)E}{2p^2c^2}(-L + 2n_W D\tan\theta)$$

$$-\frac{1}{2}g'(E)L - \frac{g(E)E}{2p^2c^2}2n_W D\tan\theta$$

  - g is dE/dx (value is positive)
  - D is the dispersion
  - L is the total absorber length (seen on the closed orbit)
  - n_W is the number of wedges, θ is half vertex angle

Numbers for Formulas

- At 200 MeV/c, $g = 31$ MV/m, $g' = -0.051\ \mathrm{m}^{-1}$
- 200 MeV/c closed orbit is at -7.9 cm
  - L totals 55 cm for both absorbers
  - Dispersion is -11.5 cm
- Results
  - Transverse, without coupling: -0.04834
  - Longitudinal, without coupling: $+0.01399$
  - Coupling term: $+0.01469$
    - Transverse with coupling: -0.03364
    - Longitudinal with coupling: -0.00070
- Simulated:
  - Transverse: -0.03660 and -0.04403
  - Longitudinal: $+0.00042$

Summary

- With Balbekov's lattices, poor performance
  - Looks like longitudinal instability
- Adjusting wedge position improves, but never as good as Balbekov (with his distribution)
- Eigenvalues for his wedge unstable
- Consistent with theory to within approximations
  - Didn't stabilize longitudinal enough
  - Thin wedges, no synchrotron oscillations can explain few percent deviation
- Theory shows why moving wedge helps: coupling increases relative to loss, stabilizing longitudinal

Update: Berg Standard Cavities

- Updated from recent cavity optimizations
- Shortened from before

Freq. MHz	Length cm	Grad MV/m	ΔE $v = c$ MeV	ΔE 200 MeV/c MeV
325	24	22	4.71	4.56
650	12	31	3.32	3.21
975	8	38	2.71	2.63