

Emittance Growth in MICE Lattice

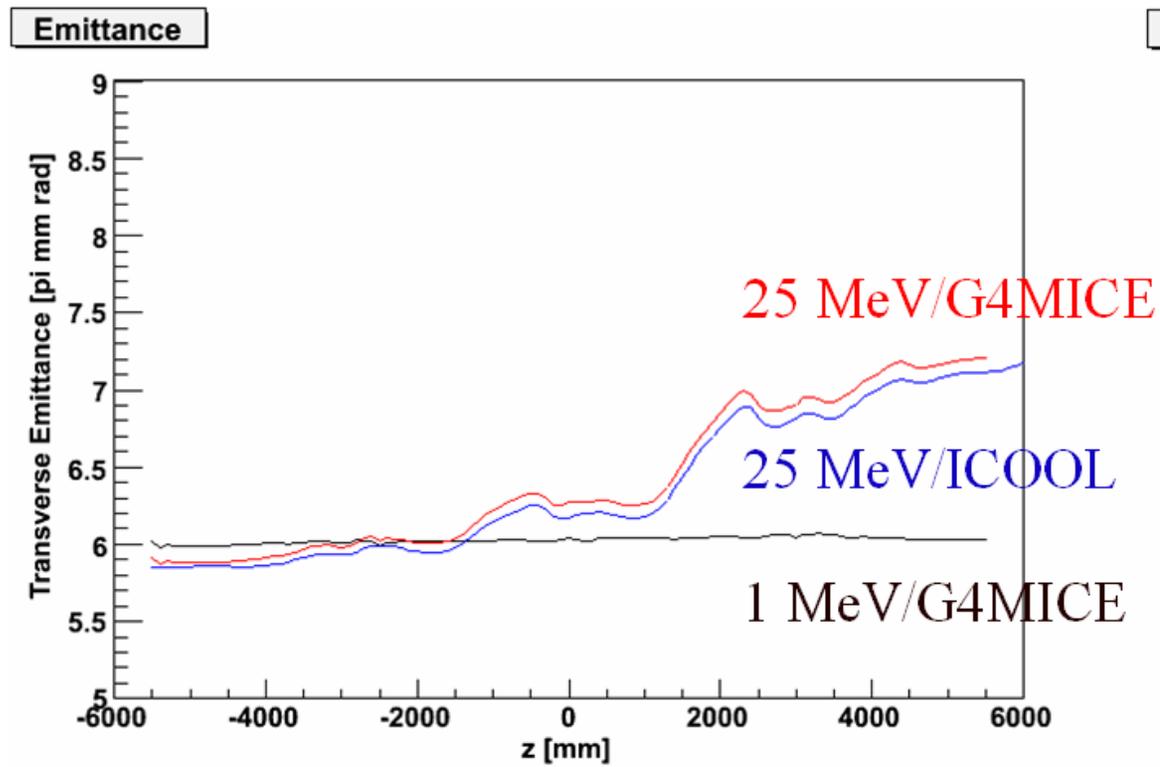
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Problem observed by Chris Rogers

Tracking Gaussian distributions through 2 MICE cells



- A common beta used for all tracks
- No emittance growth seen with small dp/p
- Serious emittance growth with $\sigma_p = 25$ MeV/c
- The beam was limited at a large 25 cm
- only "good" tracks used

Emittance will seem to rise if betas are not dependent on momentum

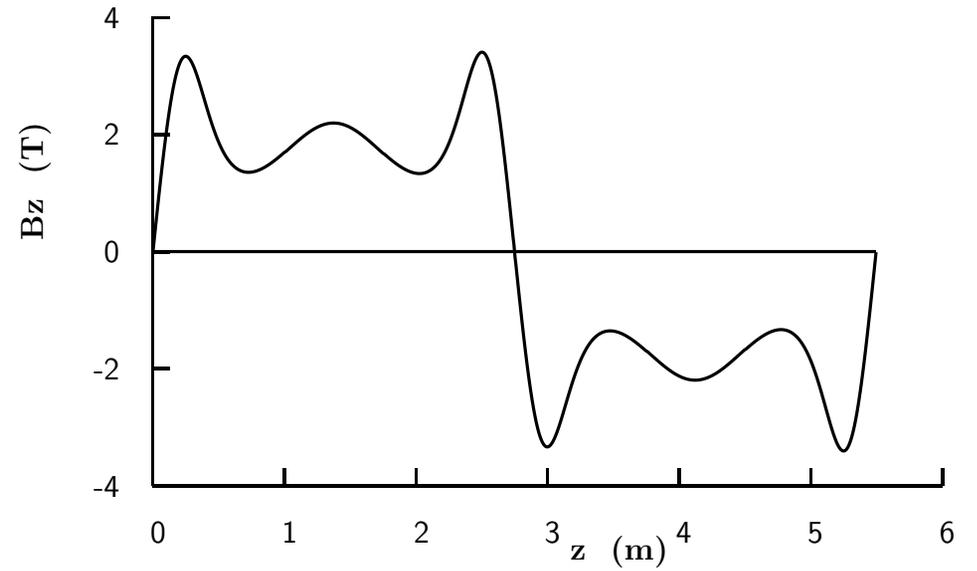
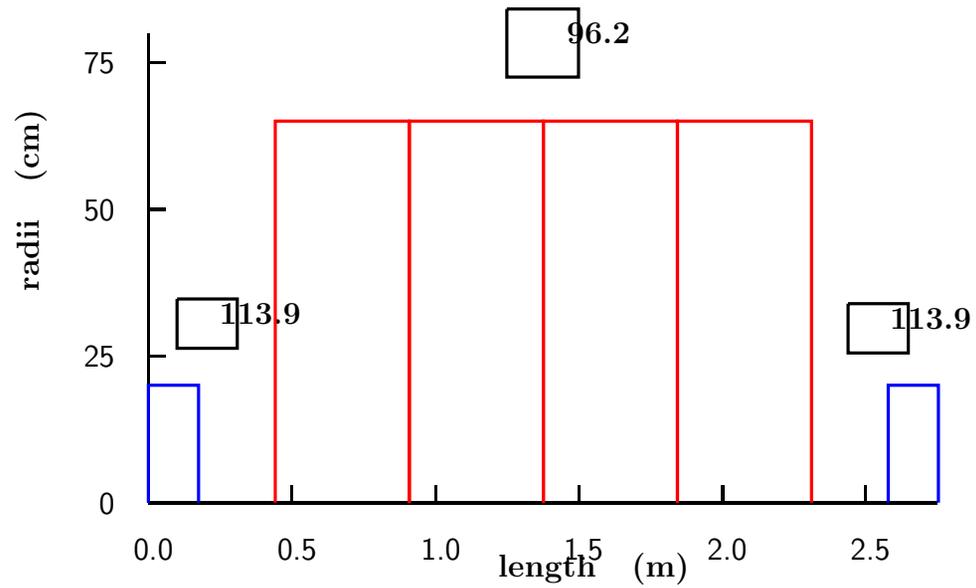
- Particles at a central momentum have initial upright Ellipse matched to the particles' motion down the channel.
- As they propagate, the shape of the ellipse does not change, particles merely rotate within it.
- The ellipse remains upright
- The emittance will remain constant by any method.

- Off momentum ellipses with the same beta will not match the channel beta.
- As they propagate there will be a "beta beat",
- The tilt of the ellipses will rotate,
- For a single off momentum ecalc9 will still not see emittance growth

- For a distribution of momenta ecalc9 can only analyze the blur formed by the superposition of the beating ellipses
- The program will perceive an emittance increase

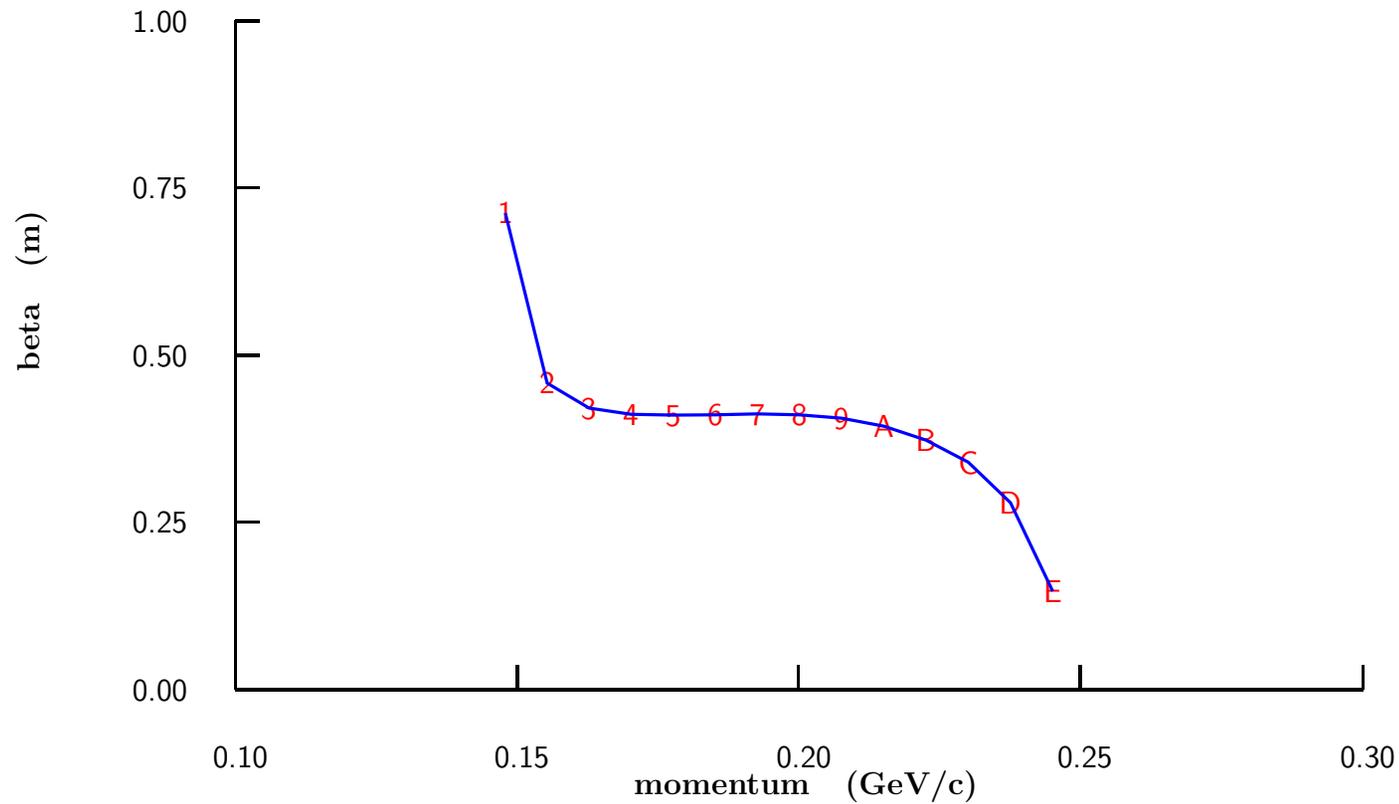
My ICOOL Study of problem

- Use exact MICE lattice parameters



Lattice and betas vs momentum

- Determine paraxial betas at 7 momenta from 155 to 245 MeV/c

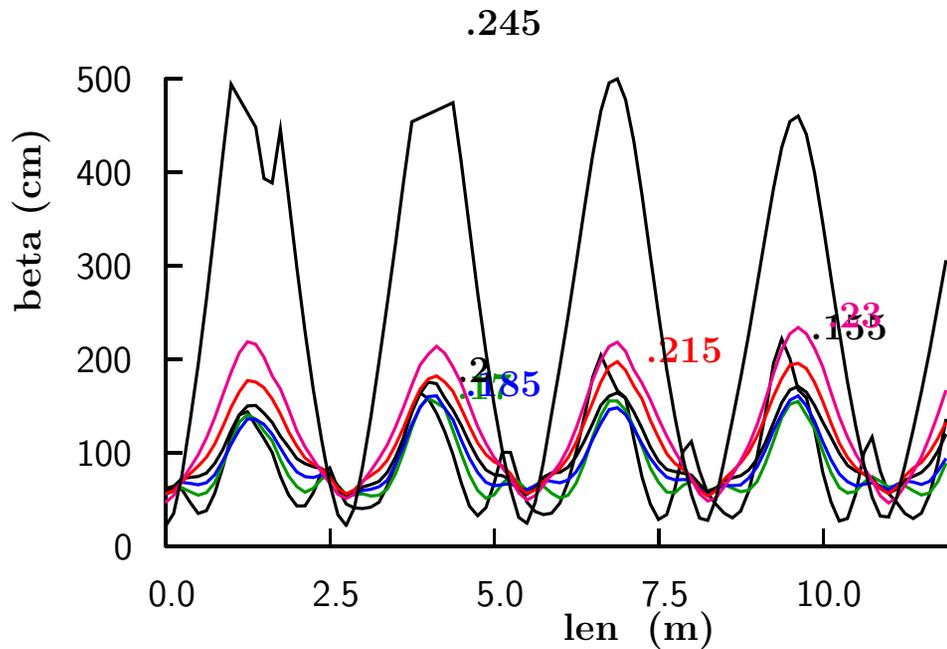


- Note resonances at approximately 150 and 250 MeV/c

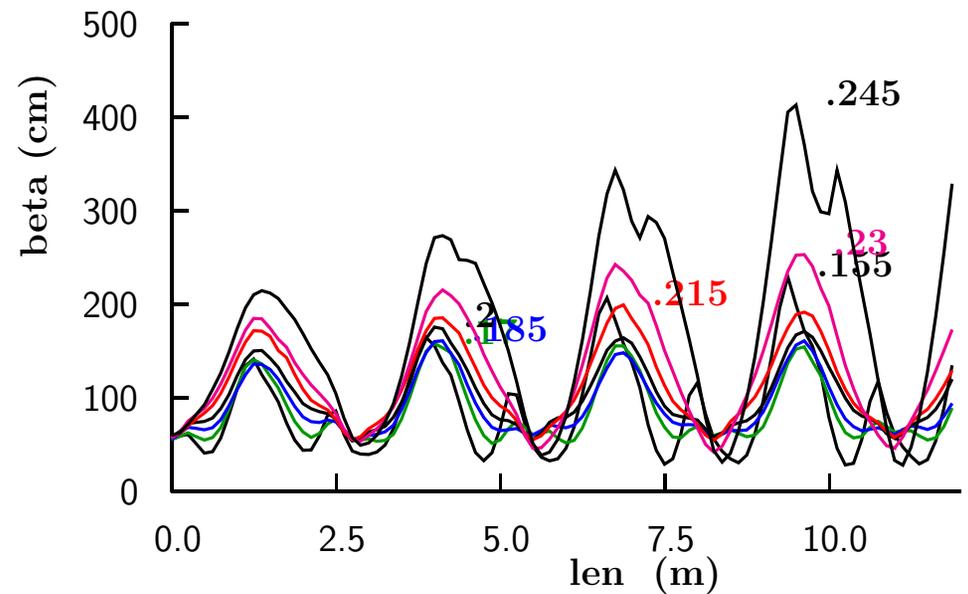
Observe betas vs length

- Generate 1000 Gaussian tracks at each momentum with either
 1. betas corresponding to channel betas determined above
 2. a common beta corresponding to the central momentum
- trace them through 5 cells and determine beta vs length for each momentum

individual betas

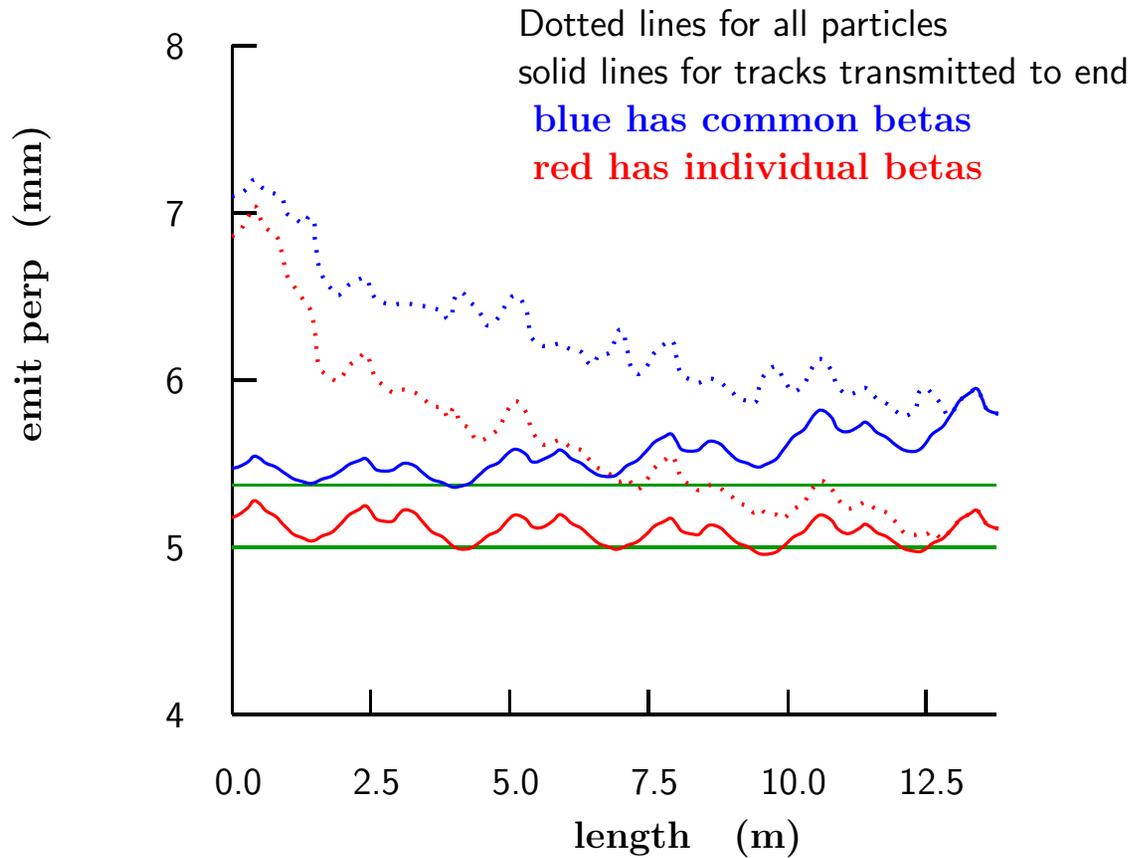


common betas



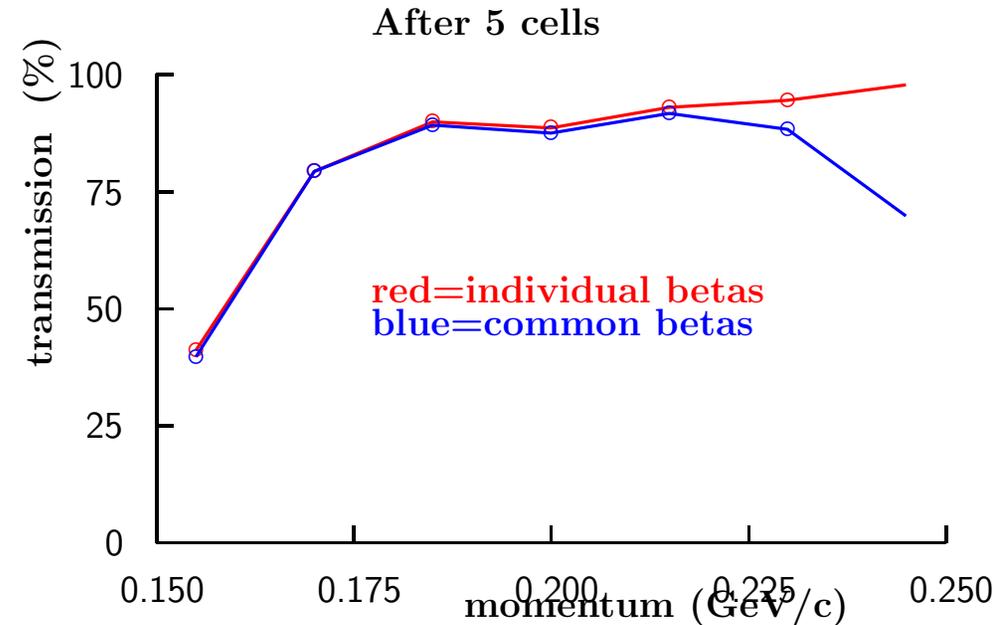
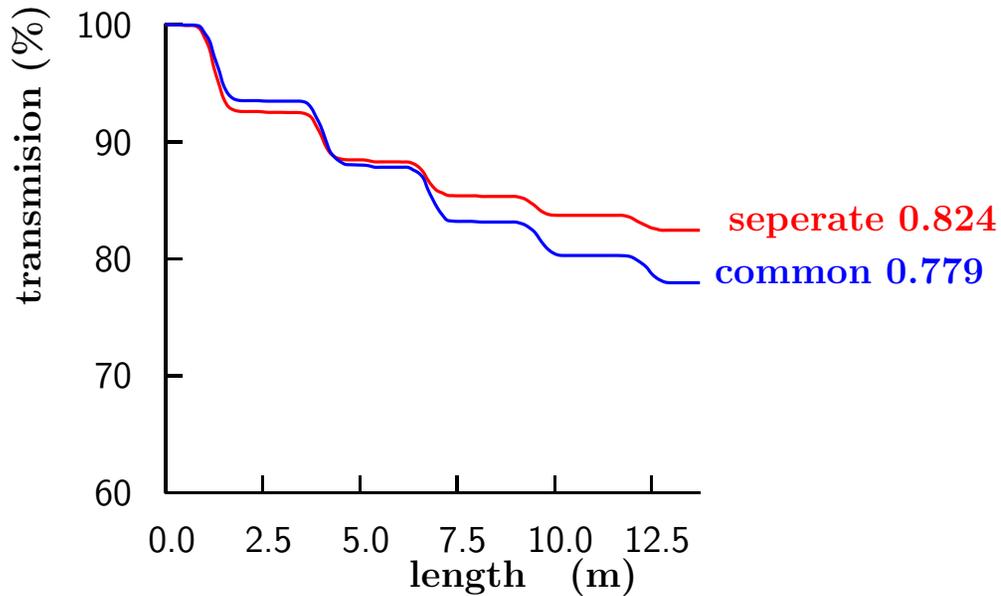
- With individual matched betas there is little beta beating
- When common betas are used there are obvious beta beats

Observe emittance (from ECALC9) vs length



- There is negligible emittance growth with individually matched betas
- .9 %
- There is significant emittance growth with common betas
+ 9.2 % in 5 cells

Observe transmission



- Transmission is worse with common betas
- The loss is as we approach the upper resonance
- The loss at lower momenta should be investigated
May be due to amplitude dependent effects

Conclusion

- I too observe a rise in emittance if a common beta is used
- The effect is less than Chris Rogers observed
- Possibly due to
 1. His wider momentum distribution
 2. His looser aperture constraints
- Matching betas at each momentum removes the effect
- Note that in FS2 care was taken to achieve such matches
- MICE should select track samples with betas matched to those of the channel at the same momentum