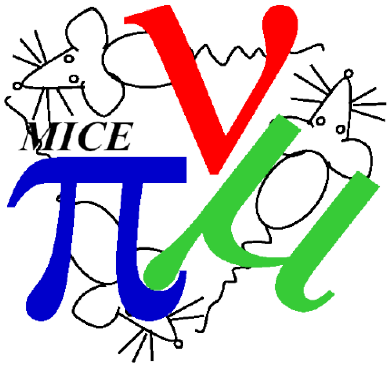
MICE at Step IV without SSD



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M1/SSD

- Match coil 1 in SSD failed about a month ago
- Material physics measurements are largely unaffected
  - May be some detriment in rate
- Reduction in normalised emittance measurement needs study
- Indirect measurement should be possible
  - Project tracks to the absorber from upstream and downstream
  - Study emittance change
- Direct measurement is desirable
  - Measure emittance at the upstream and downstream tracker
  - Study emittance change
- To maintain direct measurement, seek revised optics
  - Means loosening “matching” constraints
- Details in MICE Note 475

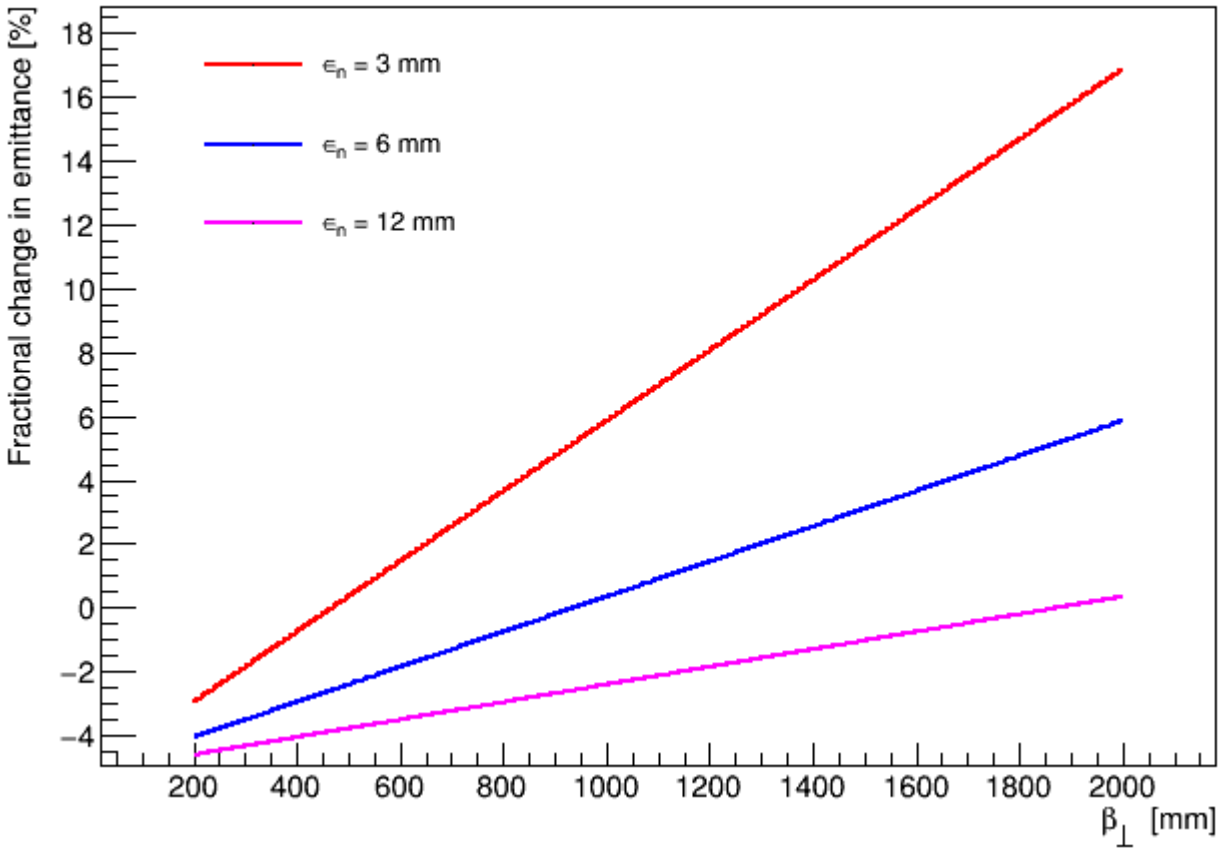
Optimisation

- “Optics” approach to optimisation
- Seek a reasonably tight beta function at the absorber
  - Necessary for good cooling
  - < 1 m is a good guideline
- Seek a reasonable acceptance
  - Ratio of “acceptance” to “equilibrium emittance” is crucial parameter
- Assume various boundary conditions and constraints
- Baseline assumed
  - Constant beta in SSU/SSD
  - Beta and Bz symmetric or antisymmetric about FC
- Let's relax those constraints

Optimisation (cont)

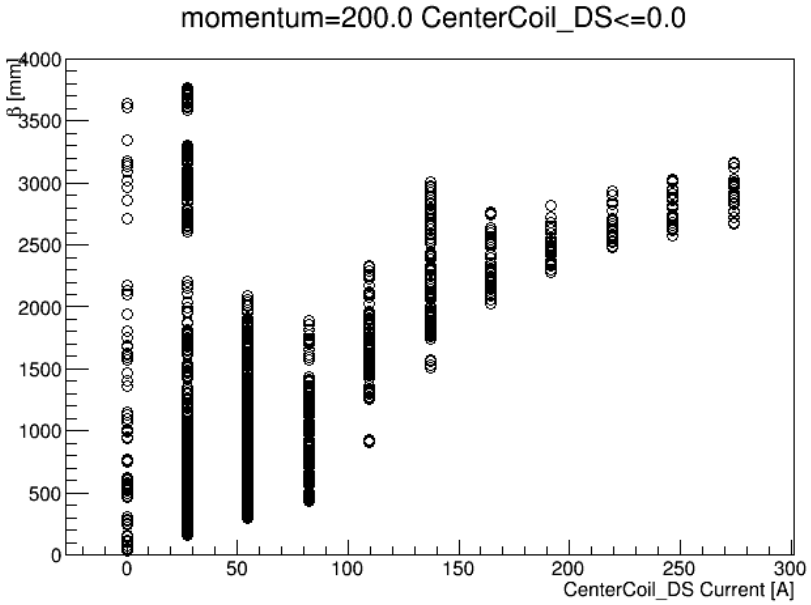
- Optimisation 1
  - Beta constant in SSU/SSD
  - Bz <= 4 T in SSU/SSD
  - Beta asymmetric about FC
- Optimisation 2
  - Beta beating in SSU/SSD
  - Bz = 4 T in SSU/SSD
  - Beta symmetric about FC
- Optimisation 3
  - Beta beating in SSU/SSD
  - Bz = 4 T in SSU/SSD
  - Beta asymmetric about FC

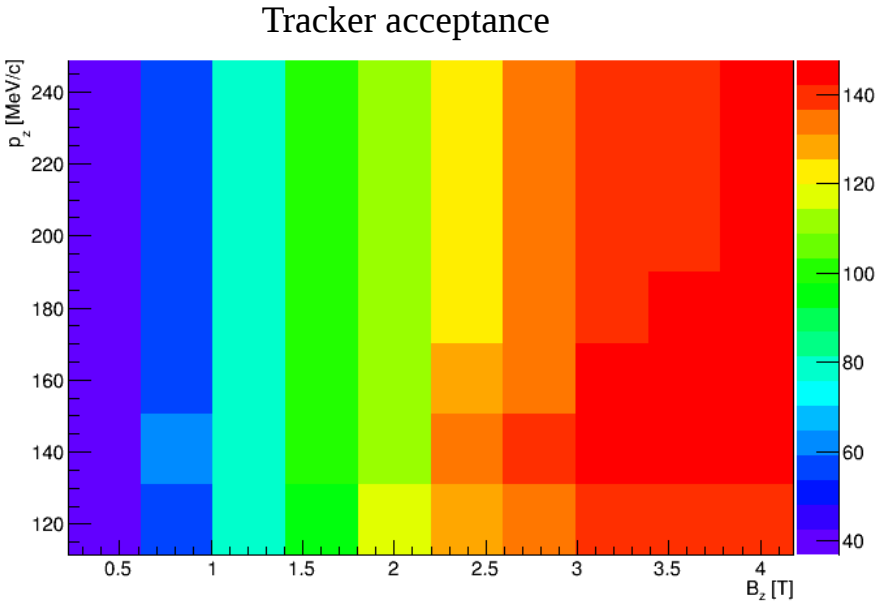
Linear approx – emittance reduction



- Given linear approximation, emittance reduction is shown

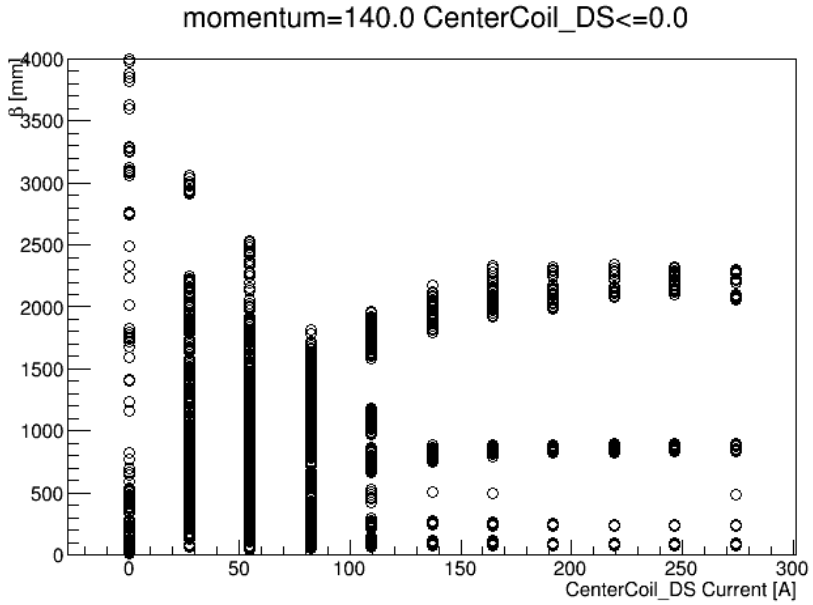
Optimisation 1 – 200 MeV/c

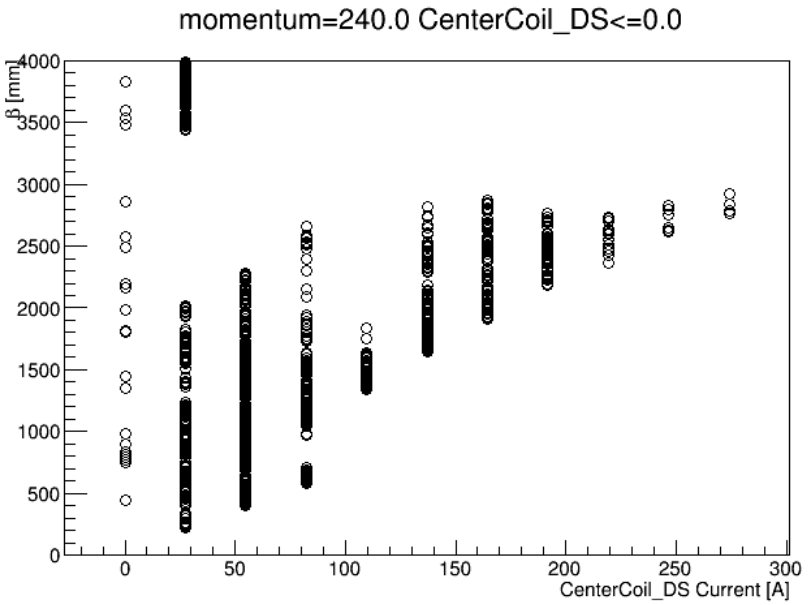




- Optimisation 1
  - Beta constant in SSU/SSD
  - Bz <= 4 T in SSU/SSD
  - Beta asymmetric about FC
- Beta < 1000 mm requires SSU ~ 1.2 T

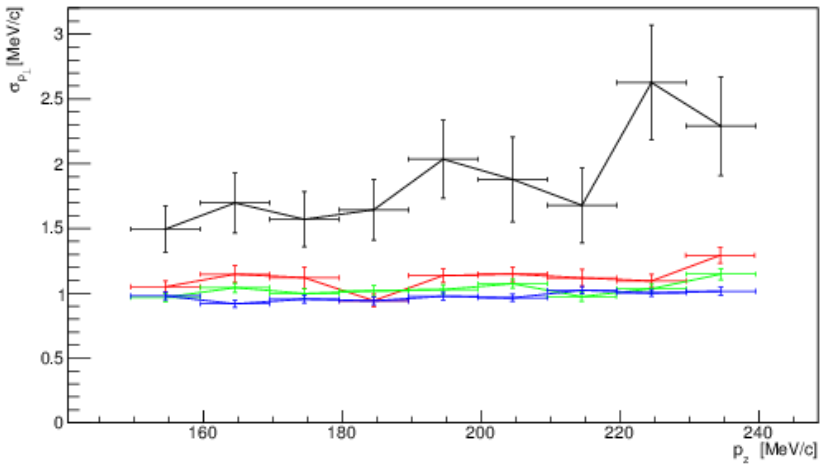
Optimisation 1 – 140 and 240

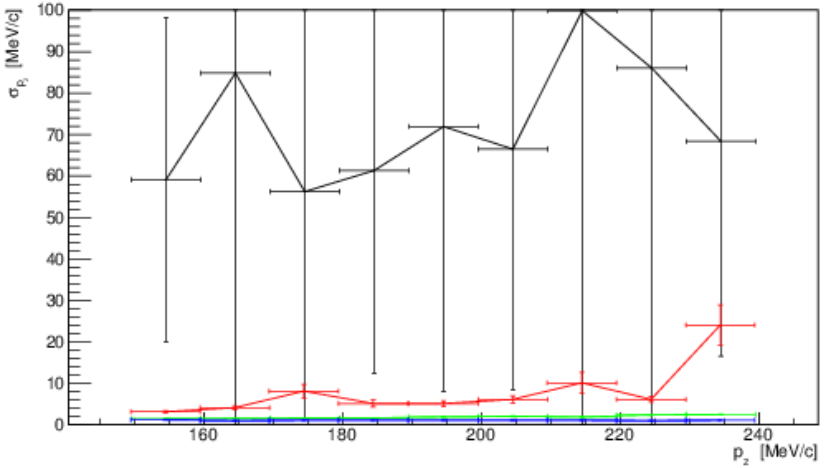




- 140 MeV/c has options with Bz = 4 T
  - But... tracking...

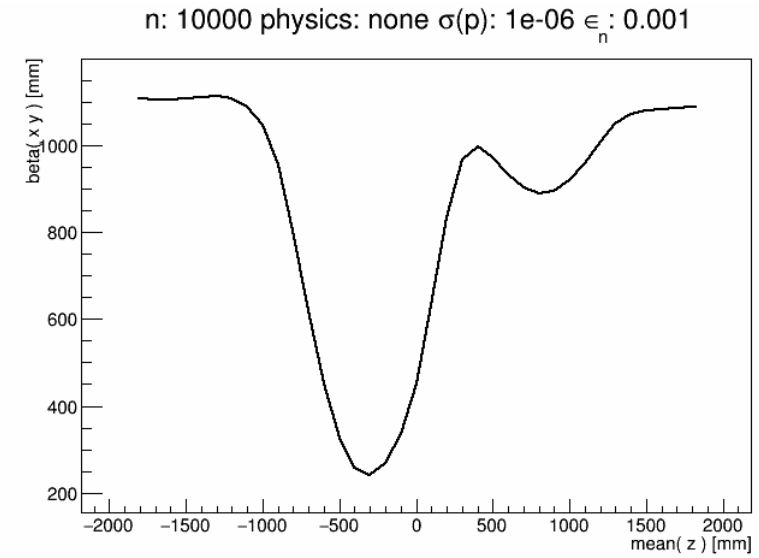
Optimisation 1 – p resolution

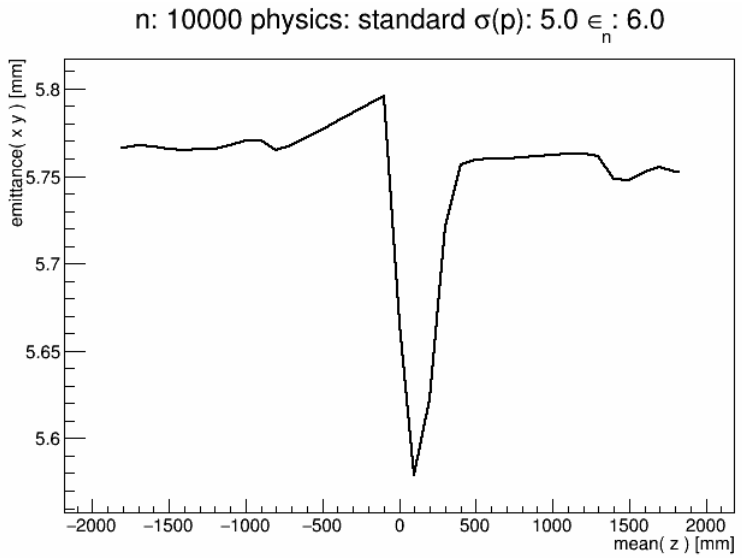




- Beta < 1000 mm requires SSU ~ 1.2 T (at 4 T)

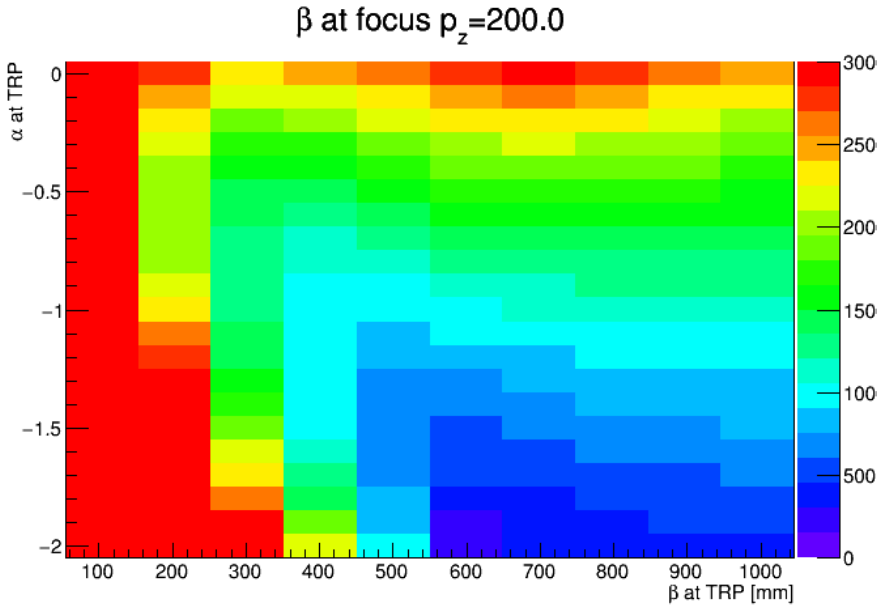
Optimisation 1 - Tracking

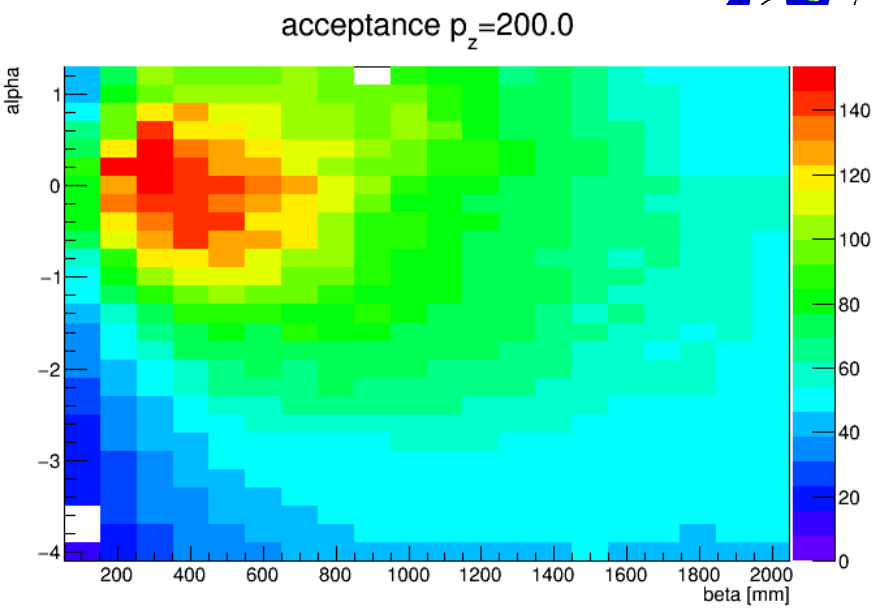




- Not looking great

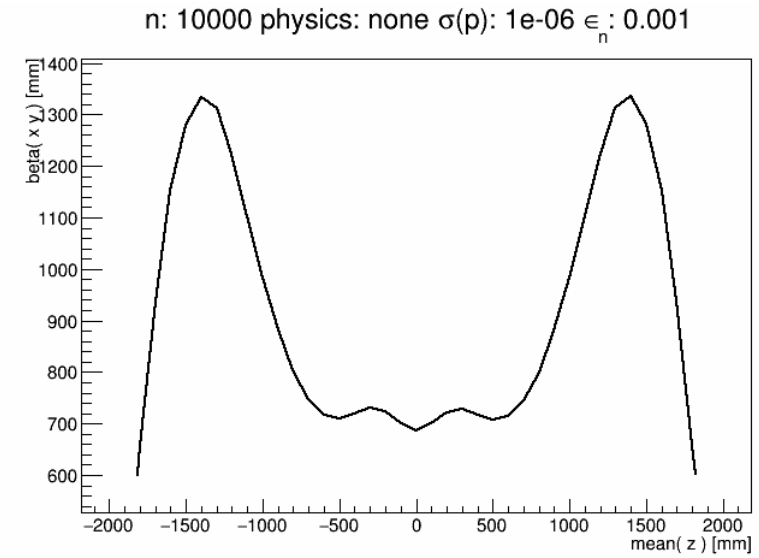
Optimisation 2

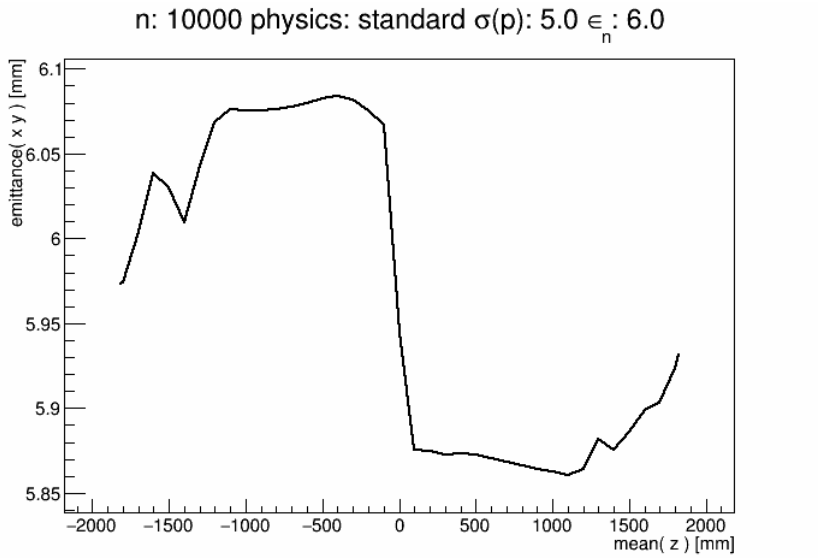




- Optimisation 2
  - Beta beating in SSU/SSD
  - Bz = 4 T in SSU/SSD
  - Beta symmetric about FC

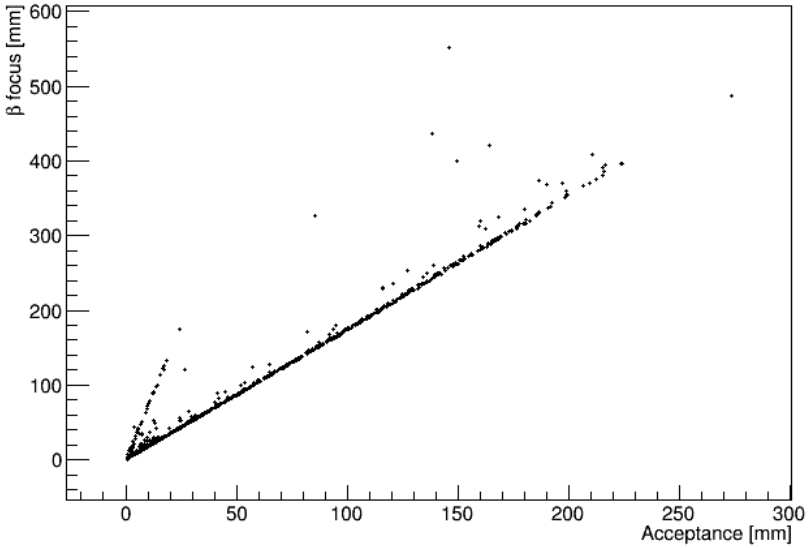
Optimisation 2 - Tracking





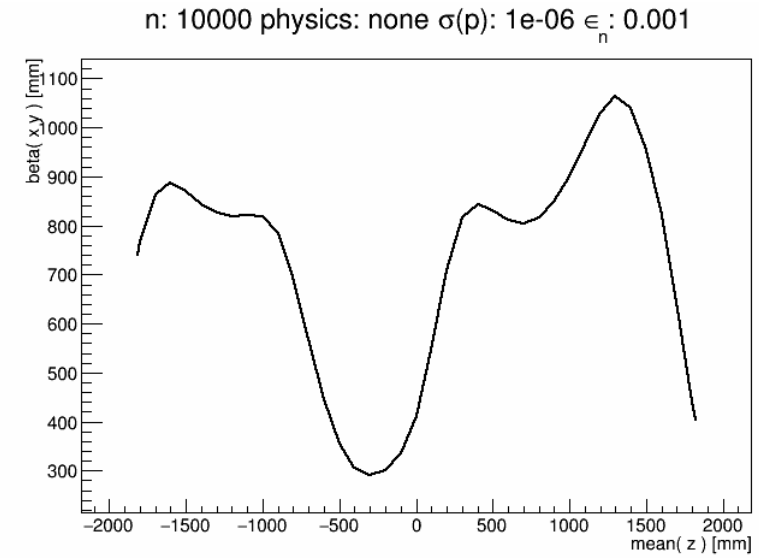
- Not looking the best

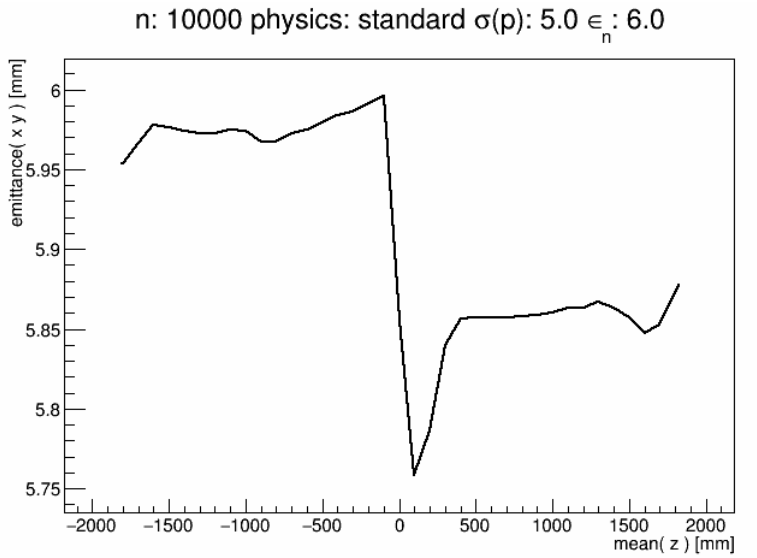
Optimisation 3



- Optimisation 3
  - Beta beating in SSU/SSD
  - Bz = 4 T in SSU/SSD
  - Beta asymmetric about FC
- “Acceptance” assumes linear approximation and some naïve model for apertures
- Tracker fiducial volume is included but diffuser is not

Optimisation 3 - Tracking

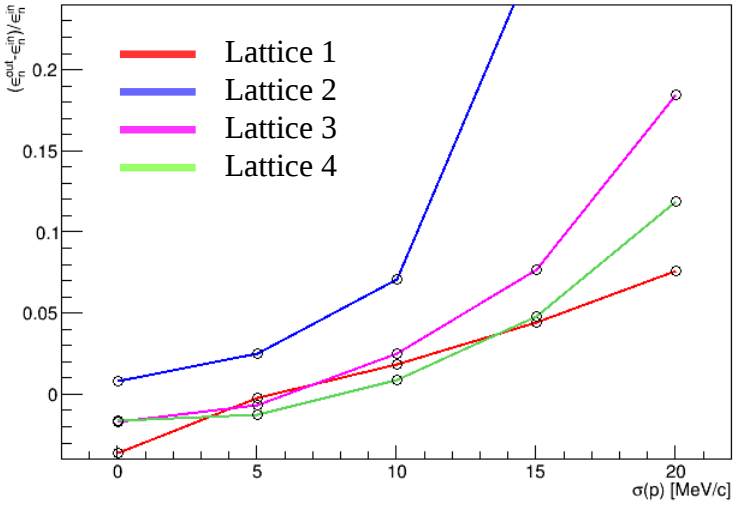




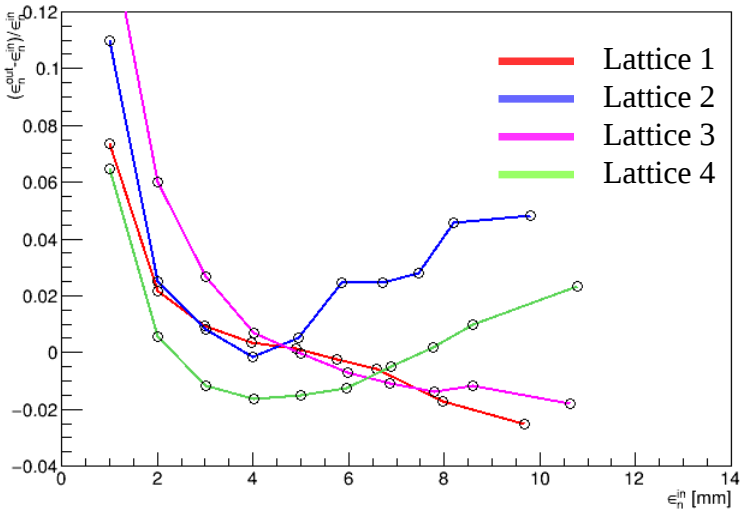
- Again, lots of aberrations

Dependence on emittance, σ(p)

ε=6 mm

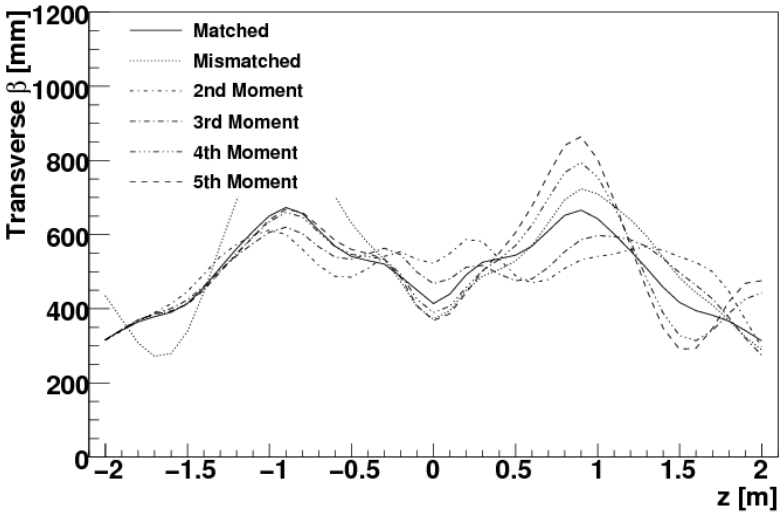


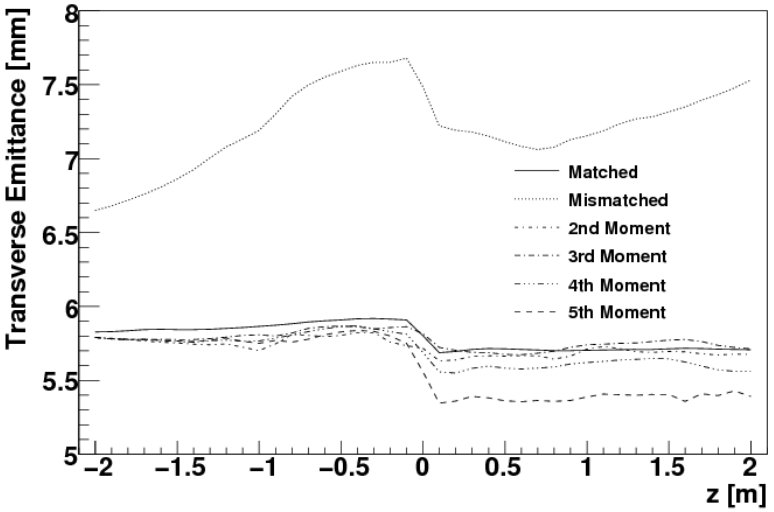
σ(p)=5 MeV/c



- Sensitivity to momentum spread
  - Chromatic aberrations
- Sensitivity to emittance
  - equilibrium emittance
  - Spherical aberrations
- We still don't really understand these aberrations

Non-linear Matching





- Non-linear matching procedure used in wedge simulations
  - MICE Note 262
  - Used G4BL simulated beamline beam
  - Non-linearities generated by dispersion in this instance
  - Note weighting routines generated negative statistical weights

Conclusions

- Solutions for optics settings
  - Probably down-select option 1
  - Probably keep option 2 and 3
- Next jobs
  - Investigate tracking level optimisations
  - Investigate better emittance analyses
    - e.g. “95%” emittance which excludes tails
    - e.g. calculate phase space density
  - Investigate non-linear matching and beam weighting