First Look at Muon Chicane

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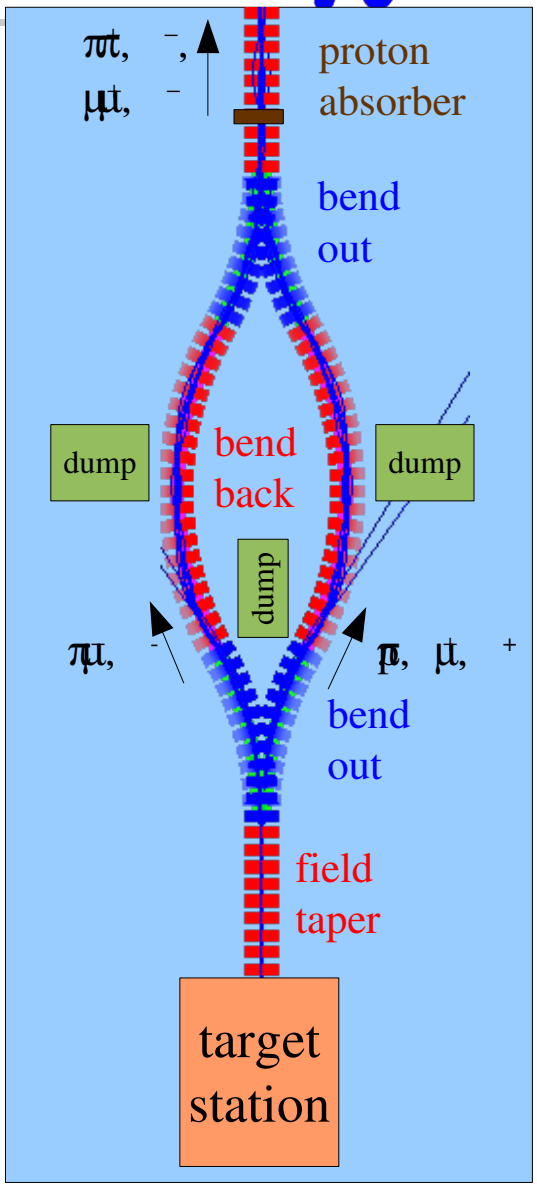
Overview

- Previously showed a proton absorber can take out protons with momentum <~ 500 MeV/c
  - “Shallow” study, needs more work
- Now go on to look at what can be achieved with chicane
  - Aim is to take out all particles with momentum >~ 500 MeV/c
  - Remember that muon momentum acceptance is ~ 100 - 400 MeV/c
- Preliminary design
  - Considerations
  - Initial parameter scans
  - Setting up for optimisation

Chicane concept

- Concept is “pair of double chicanes”
  - High energy particles hit a beam dump
  - Chicane area becomes radioactive
    - Probably part of target remote handling area
  - Beam dump has to handle significant beam energy
- Concentrate here on chicane optics (first look)
  - Propose using bent solenoid optics
  - Good acceptance for this momentum range
    - e.g. used by mu2e experiments
    - e.g. used by 6d cooling channels

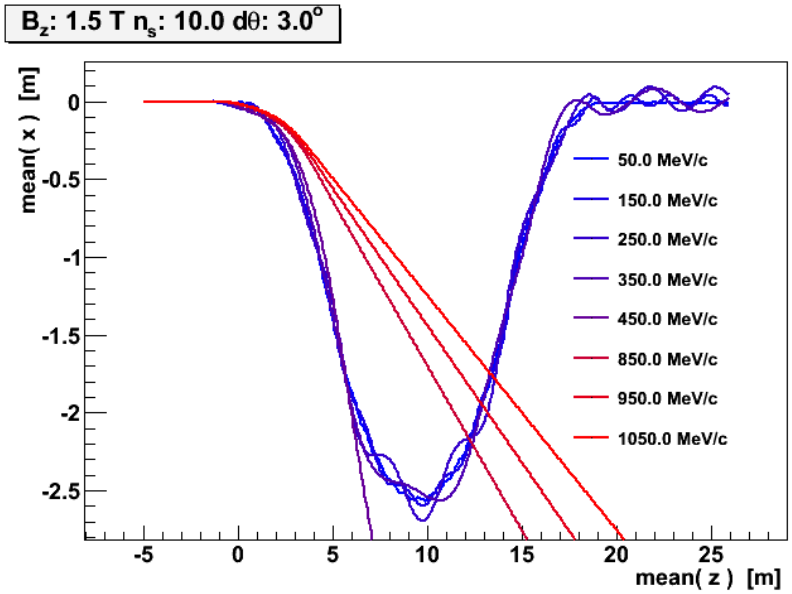


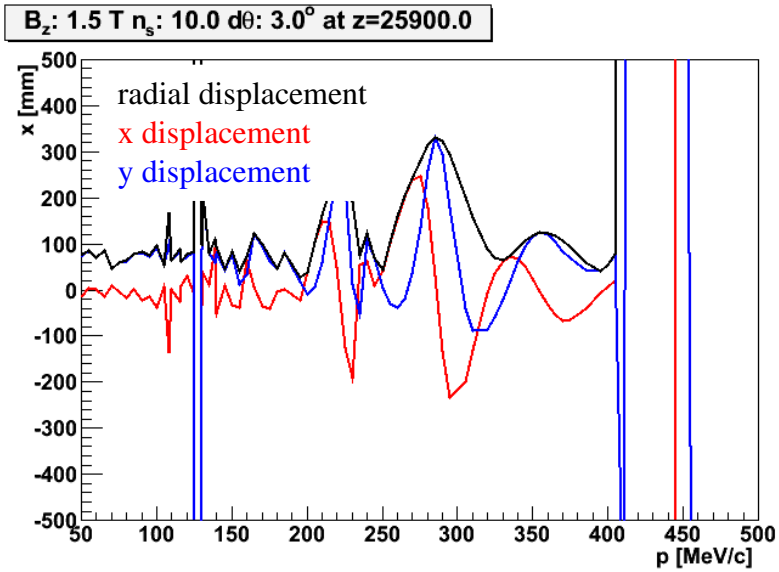
Chicane optics

- First try to get reasonable performance for single sign
  - Then start worrying about switch yards, beam dumps, etc
- Model with dipole field superimposed on solenoid field
  - Allows to conveniently change dipole field independent of solenoid
  - Would consider tilted solenoid later
  - Select dipole field to ~return nominal (200 MeV/c) particle to axis
- Three independent parameters
  - Number of coils in the bends
  - Bending angle per coil
  - Solenoid field strength

First Go

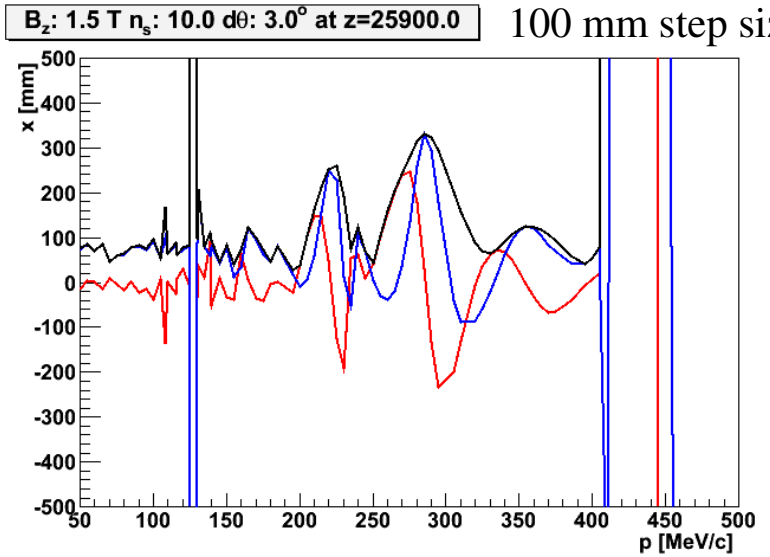
- Try with large aperture solenoids (0.6 m)
  - Displace beam by ~2 coil diameters (probably a bit too much)
  - Try:
    - 10 coils per bend with
    - 3° bend angle between coils
    - Use baseline 1.5 T B_z
  - Roughly correct momentum acceptance
  - But rather large radial displacement
  - Question tracking accuracy at low p



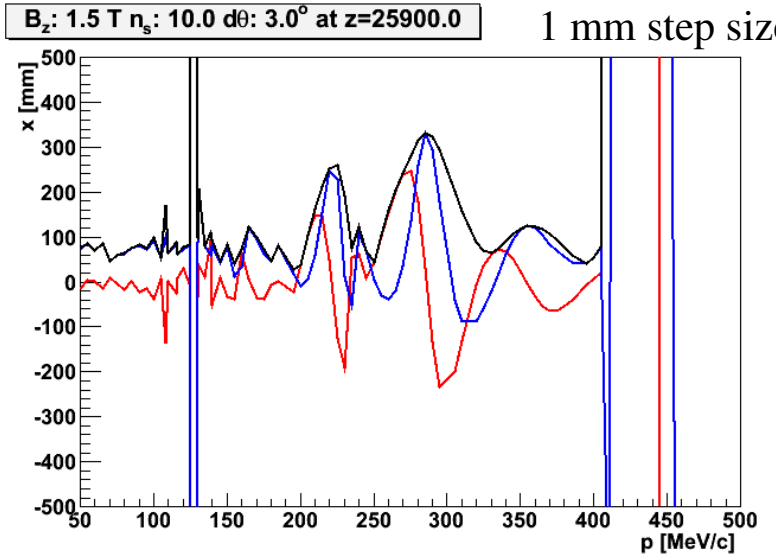


Tracking stability

- Low momentum behaviour looks rather like unstable tracking
  - (G4 4th order Runge Kutta)
- No apparent change when I go from 100 mm step size to 1 mm step size
  - dx ~ 0.1 mm



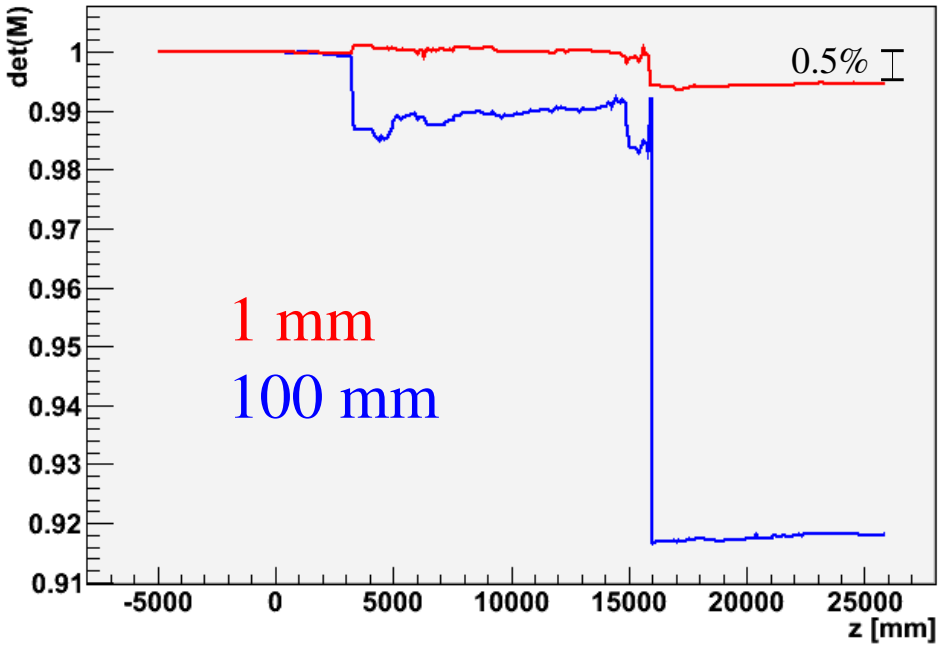
100 mm step size



1 mm step size

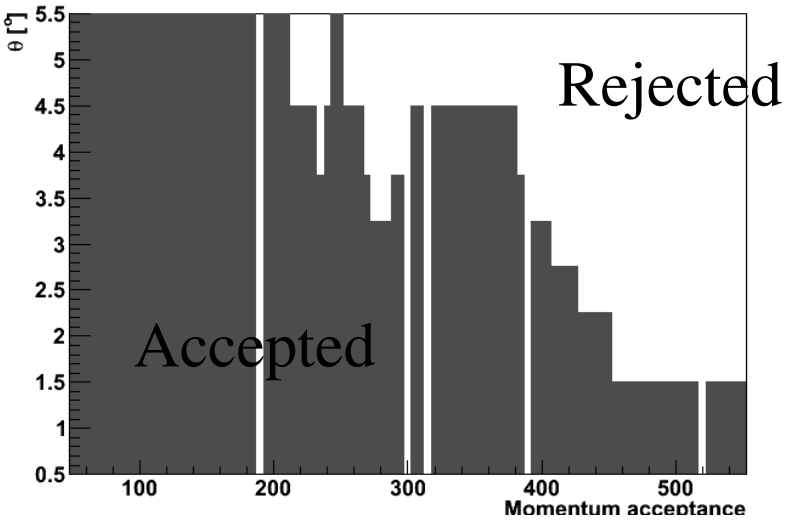
Tracking stability (Cont)

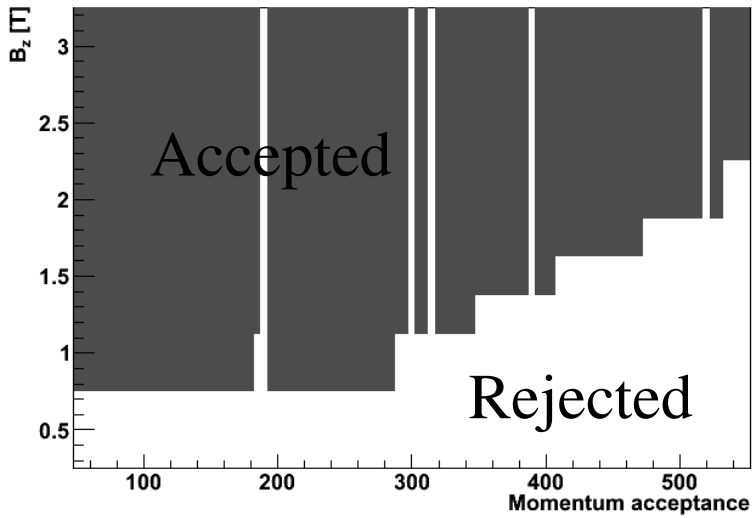
- Calculate 6D transfer matrix
  - Numerical derivative
  - Planes in z
  - 200 MeV/c muons
- Note some variation for 100 mm vs 1 mm steps
  - det(M) should be == 1
- Need some work to understand what causes instability
- For now work with 1 mm step size

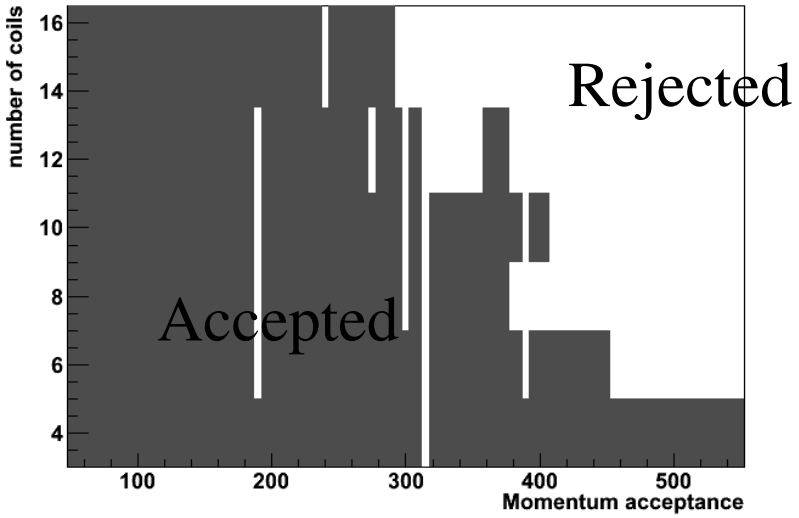


Momentum Acceptance

- How does acceptance vary?
  - Look at transmission of particles initially on-axis
  - Count r > 500 mm as rejected
  - Increasing Bz improves acceptance
  - Increasing dθ worsens acceptance
  - Increasing bend length worsens acceptance

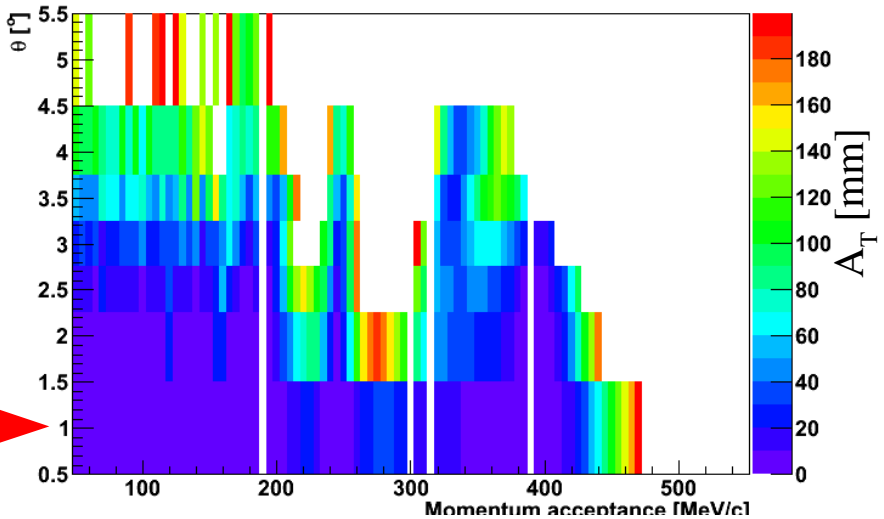


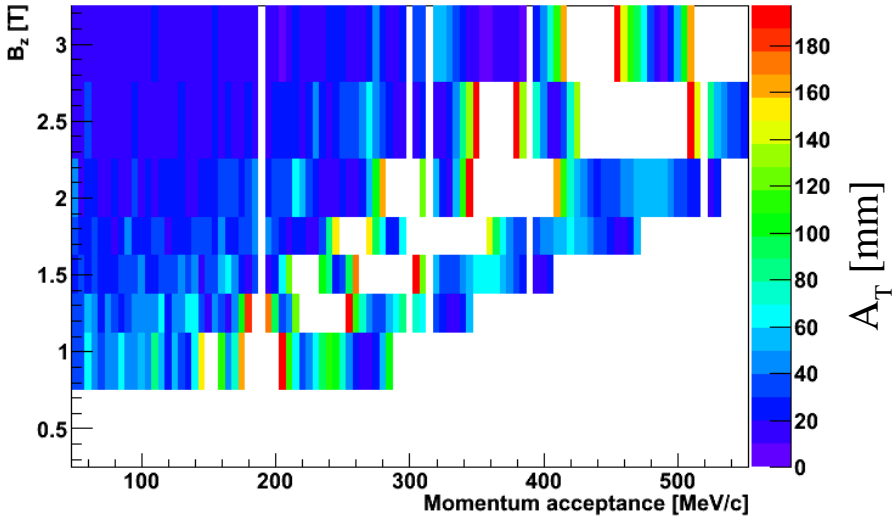


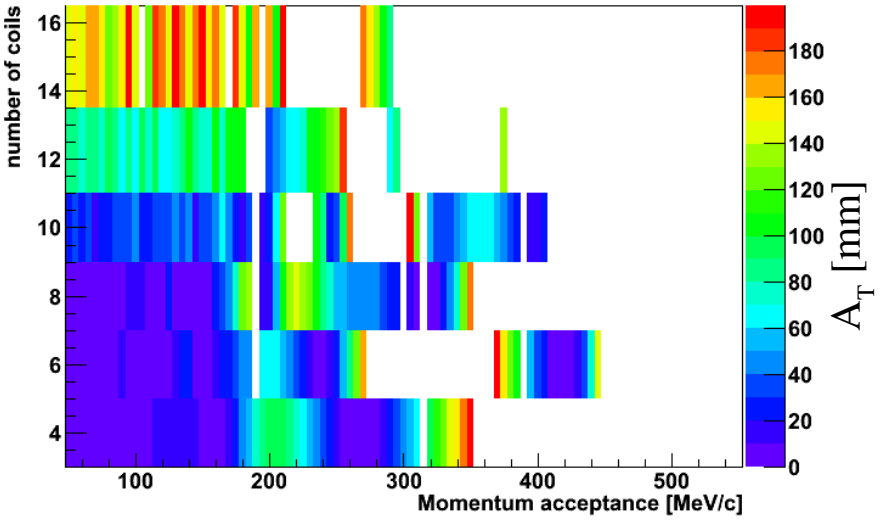


Amplitude increase vs lattice

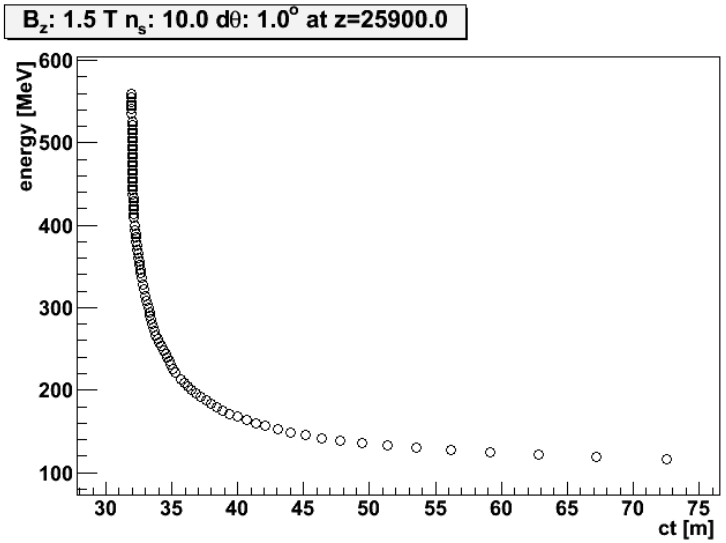
- Guestimate emittance growth
  - Look at A_T of reference trajectory
  - Don't count particles with $A_T > 200$ mm
  - $\delta\varepsilon_T \sim \delta A_T/4$
- Softer dθ looks like promising route
  - Needs more study

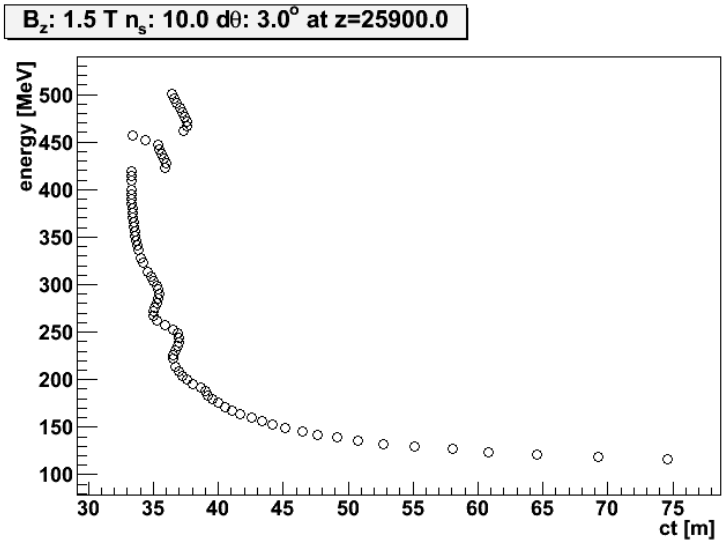


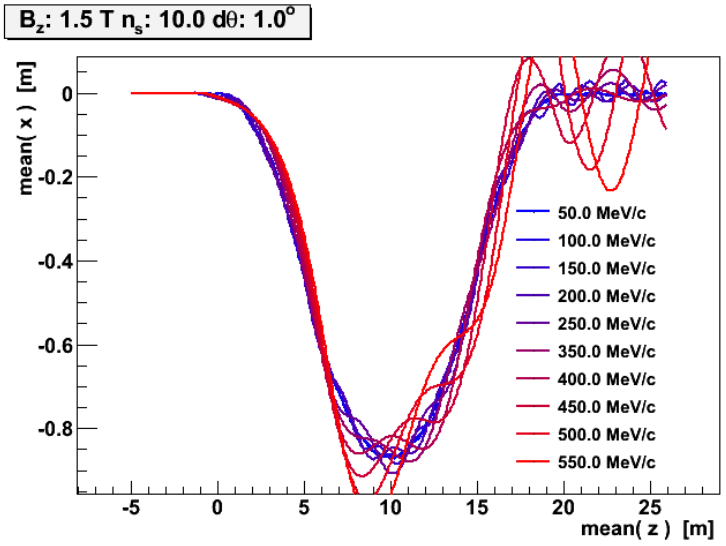


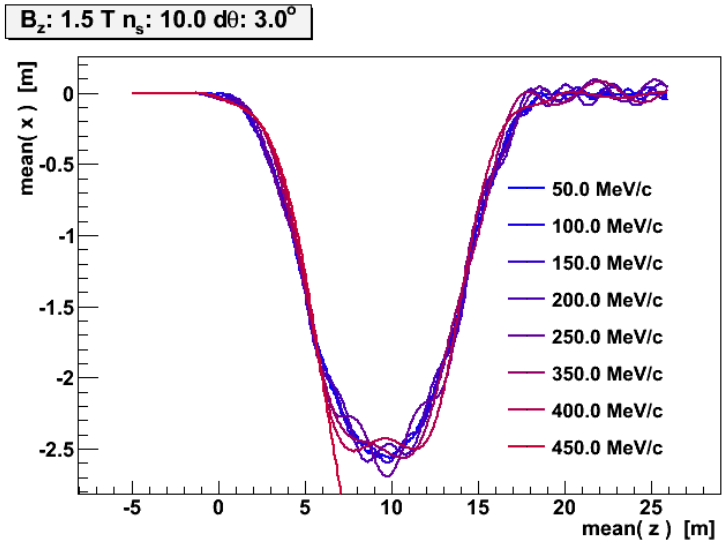


First optimisation









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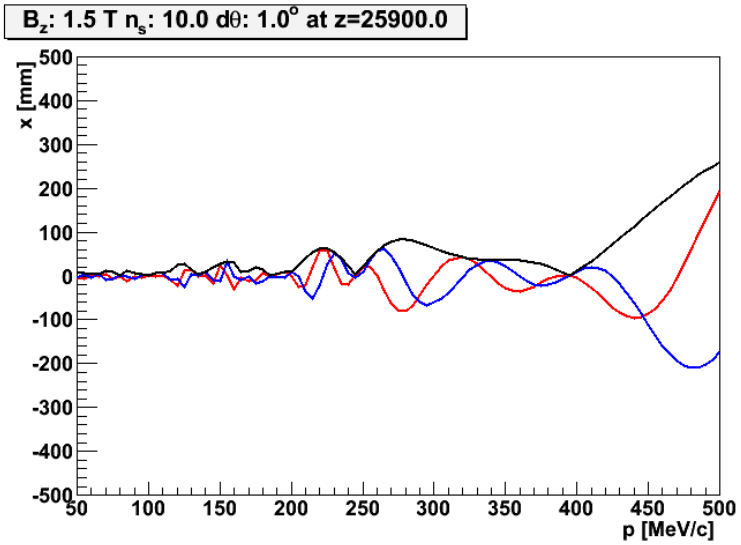

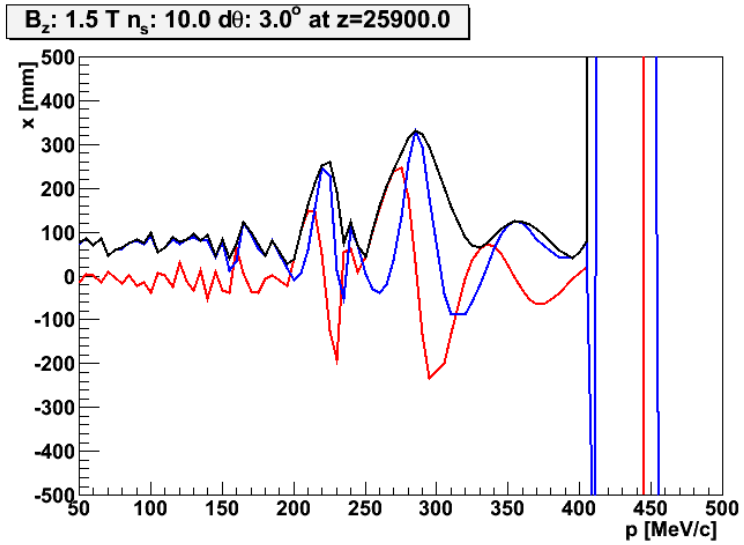

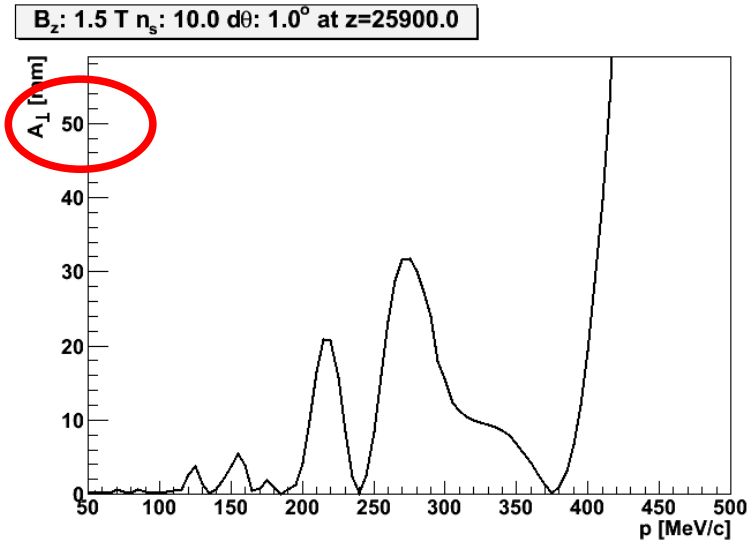

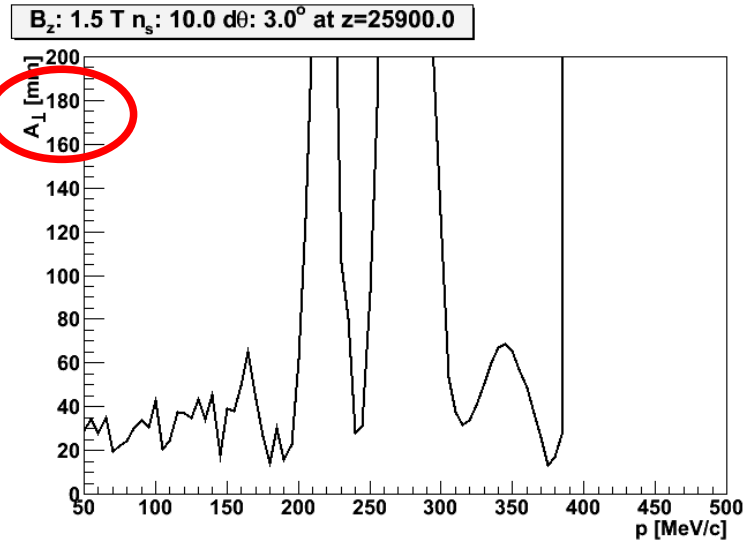

Plans

- Looks like softening the bending angle gives better transmission
- Some question over tracking accuracy
- Aim is to have a first optics design ready by IDS meeting in January
  - Finish optimisation
- Then look at switch yard, beam dumps, etc
  - Can't dump beam through coils
  - Can't build coils in aperture of -ve polarity beam
  - Integration with proton absorber
  - Integration with transverse collimation