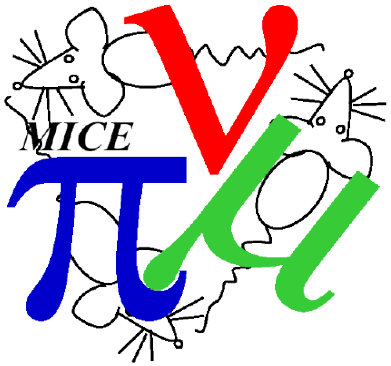
Derating MICE magnets



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Intro

- New requirement, M1=0 on SSD
- Symmetric solutions
  - SS at 4 T
  - Derate solenoid (scale solenoid down)
  - Use E1 for match – not studied yet
- Asymmetric solutions

Geometry

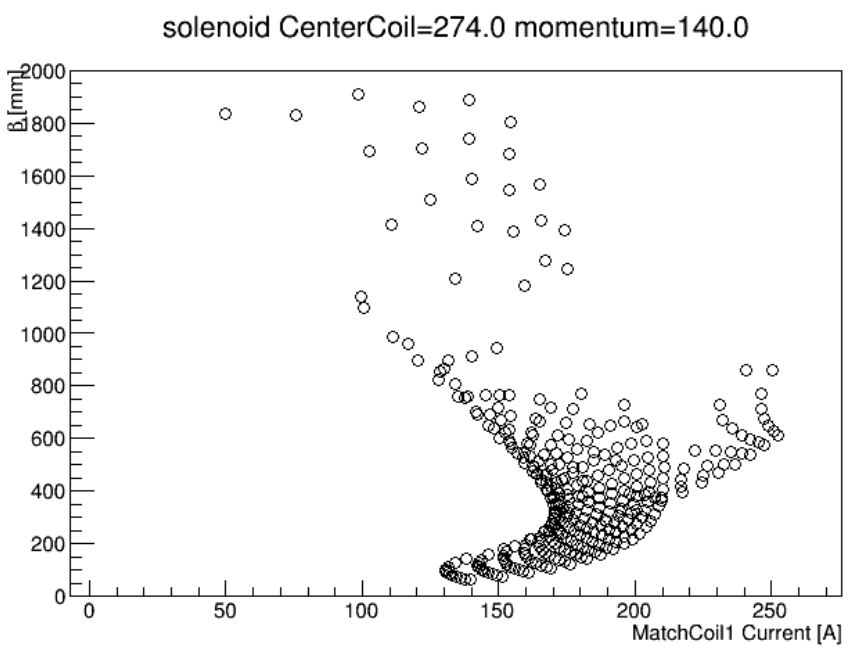
- MAUS says:

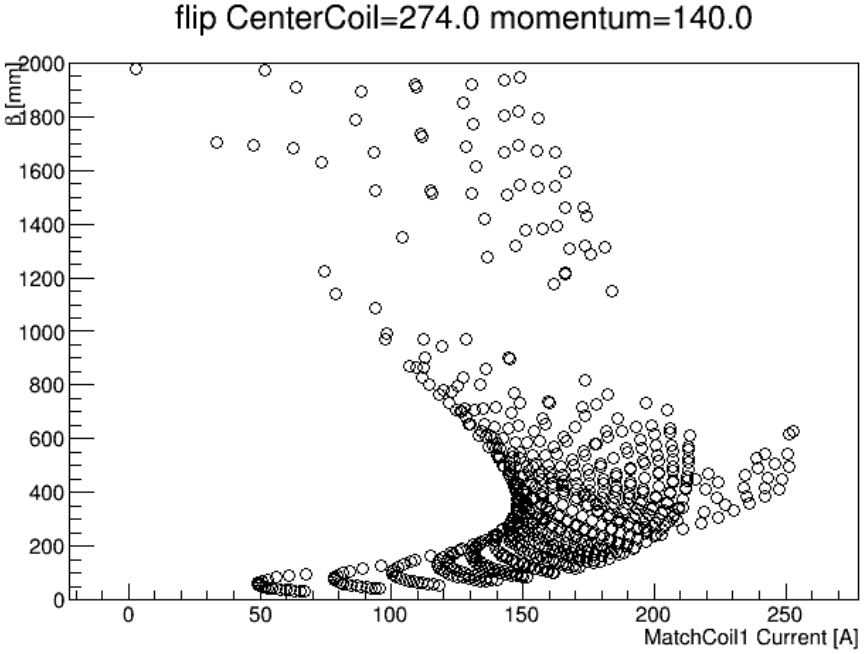
Solenoid Length: 213.3 Inner Radius: 267 Thickness: 94.8 position: (0,0,-202.75) name: FocusCoil_US
Solenoid Length: 213.3 Inner Radius: 267 Thickness: 94.8 position: (0,0,202.75) name: FocusCoil_DS
Solenoid Length: 201.268 Inner Radius: 258 Thickness: 46.483 position: (0,0,861) name: MatchCoil1_DS
Solenoid Length: 199.492 Inner Radius: 258 Thickness: 30.608 position: (0,0,1300) name: MatchCoil2_DS
Solenoid Length: 110.642 Inner Radius: 258 Thickness: 61.638 position: (0,0,1700) name: EndCoil1_DS
Solenoid Length: 1314.3 Inner Radius: 258 Thickness: 22.416 position: (0,0,2450) name: CenterCoil_DS
Solenoid Length: 110.642 Inner Radius: 258 Thickness: 68.22 position: (0,0,3200) name: EndCoil2_DS
Solenoid Length: 201.268 Inner Radius: 258 Thickness: 46.165 position: (0,0,-861) name: MatchCoil1_US
Solenoid Length: 199.492 Inner Radius: 258 Thickness: 30.925 position: (0,0,-1300) name: MatchCoil2_US
Solenoid Length: 110.642 Inner Radius: 258 Thickness: 60.905 position: (0,0,-1700) name: EndCoil1_US
Solenoid Length: 1314.3 Inner Radius: 258 Thickness: 22.125 position: (0,0,-2450) name: CenterCoil_US
Solenoid Length: 110.642 Inner Radius: 258 Thickness: 67.783 position: (0,0,-3200) name: EndCoil2_US

SS at 4T

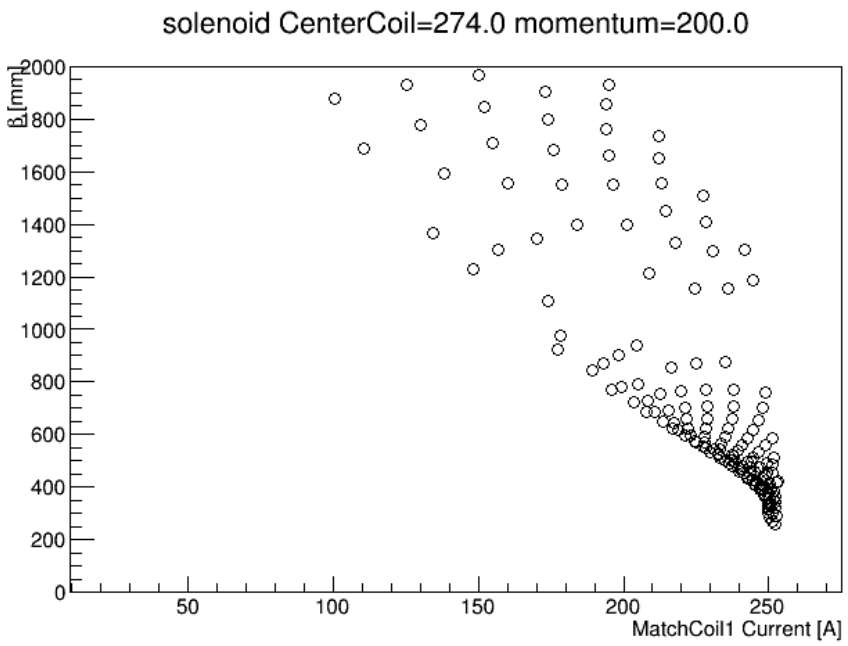
- What is the “lay of the land”?
- How do existing optics solutions depend on M1 current?

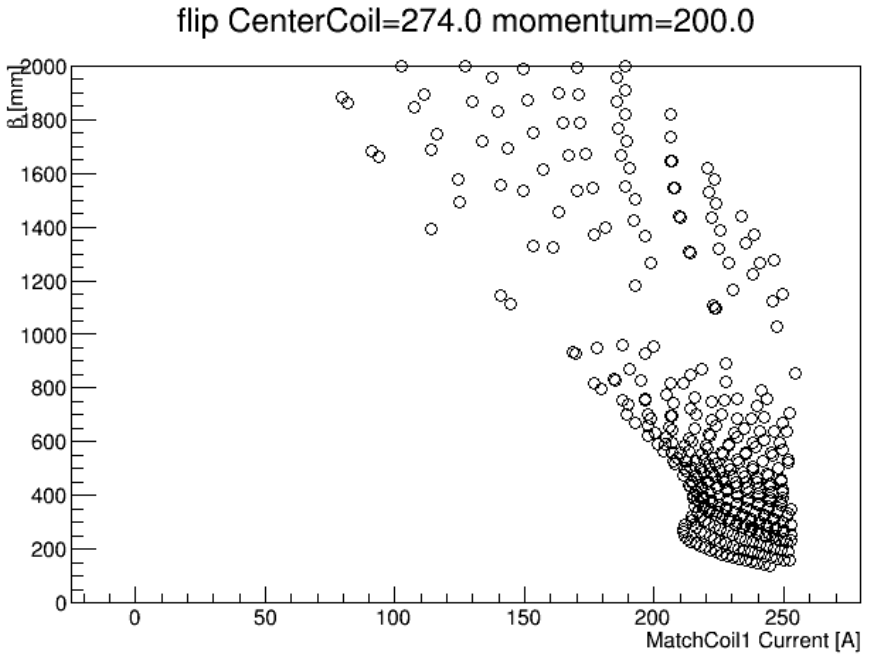
SS at 4 T, 240 MeV/c



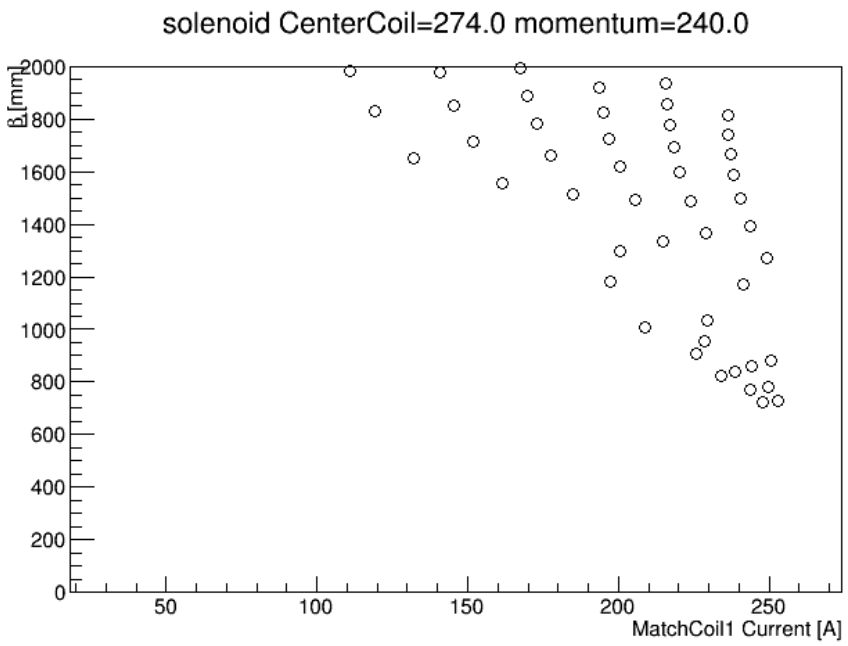


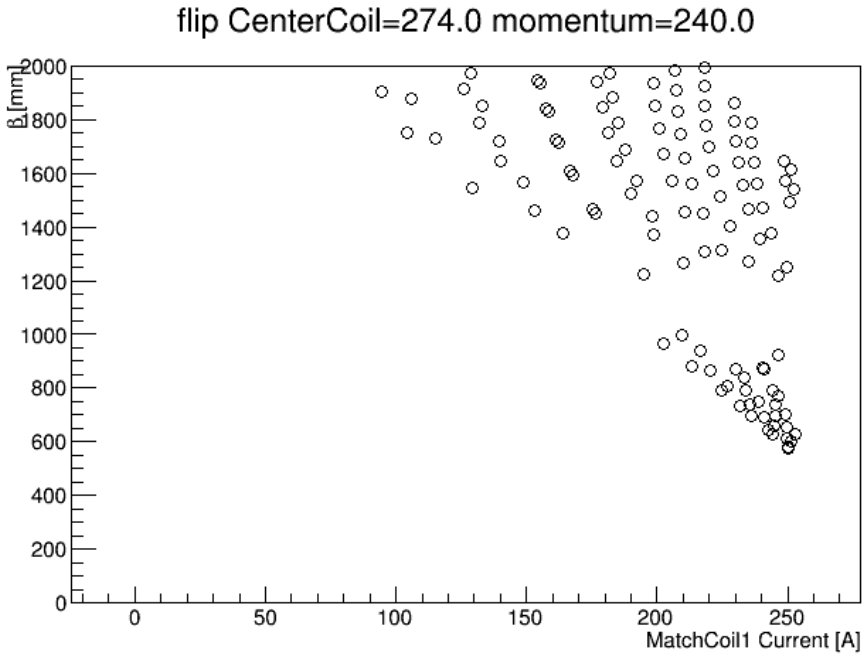
SS at 4 T, 200 MeV/c





SS at 4 T, 240 MeV/c

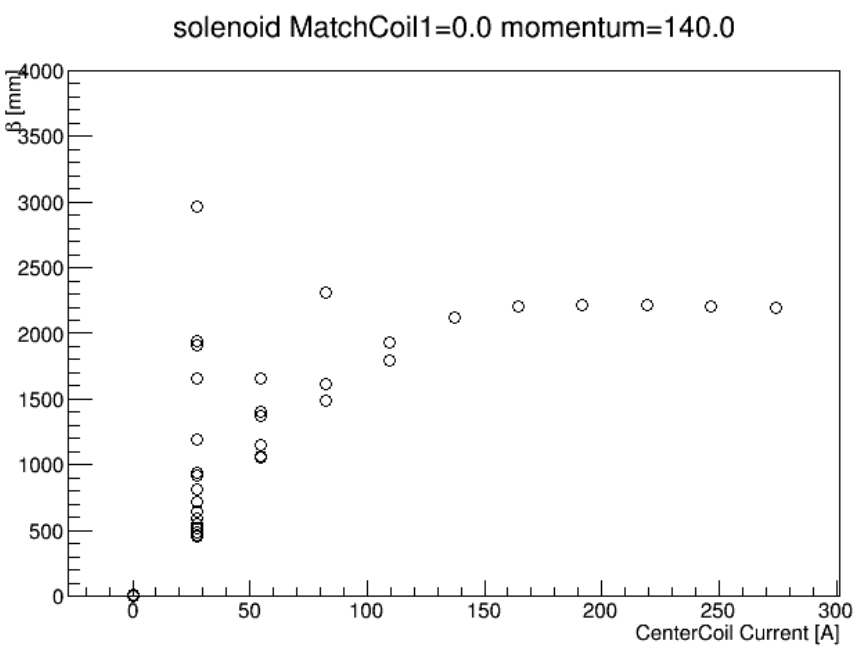


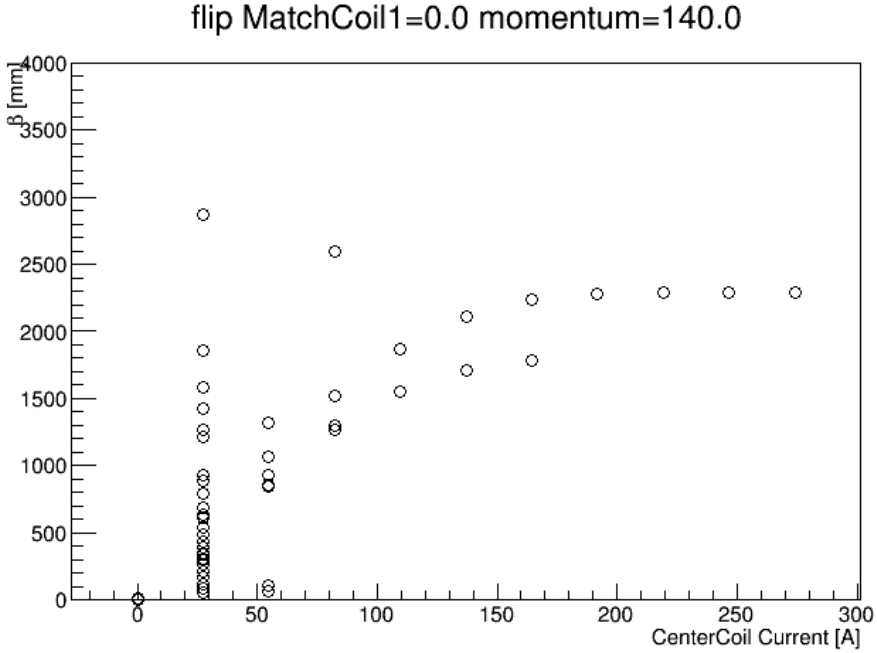


Scaled SS

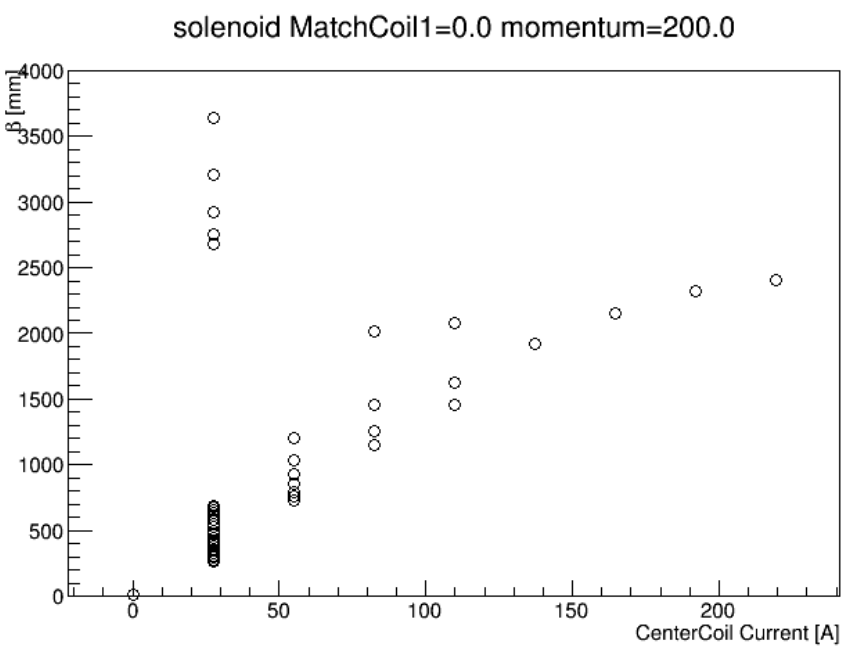
- No symmetric solutions with M1 = 0, beta < 2000 mm, SS at 4 T
- Try scaling down SS
  - Use SS as a match coil
  - Choose initial beta to be constant in the (derated) solenoid field
  - $\beta = 2p/(cB_z)$
  - Note this makes the solenoid the limiting aperture
    - $\sigma(x) = \sigma(y) = \varepsilon_n \, m \, c \, \beta \, / \, p_z$
  - In following slides, CC is plot axis, E1 and E2 are also scaled by the same factor
- Vary FC, M2 freely to get a match
- I make no comment about tracker reconstruction

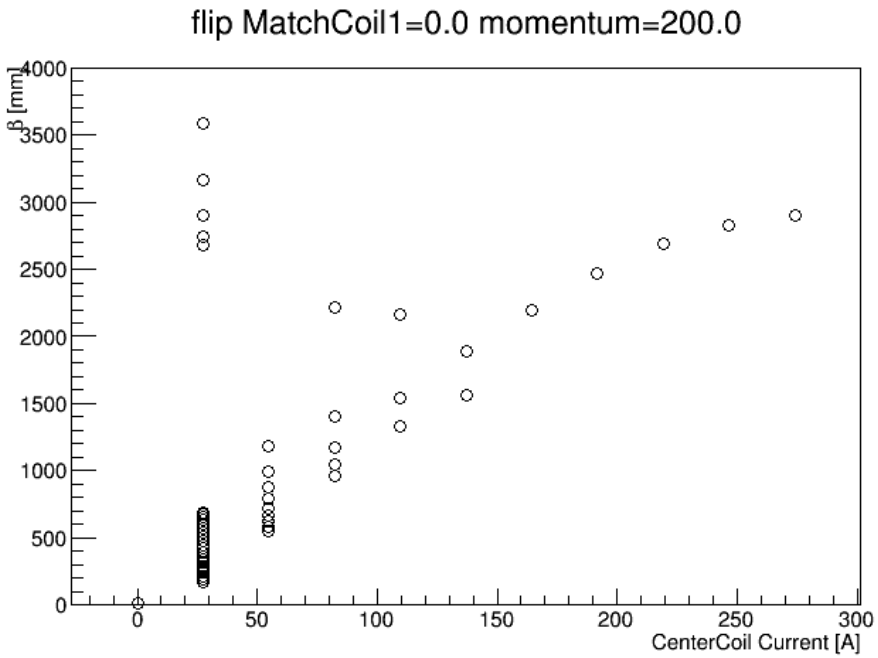
Scale SS – 140 MeV/c



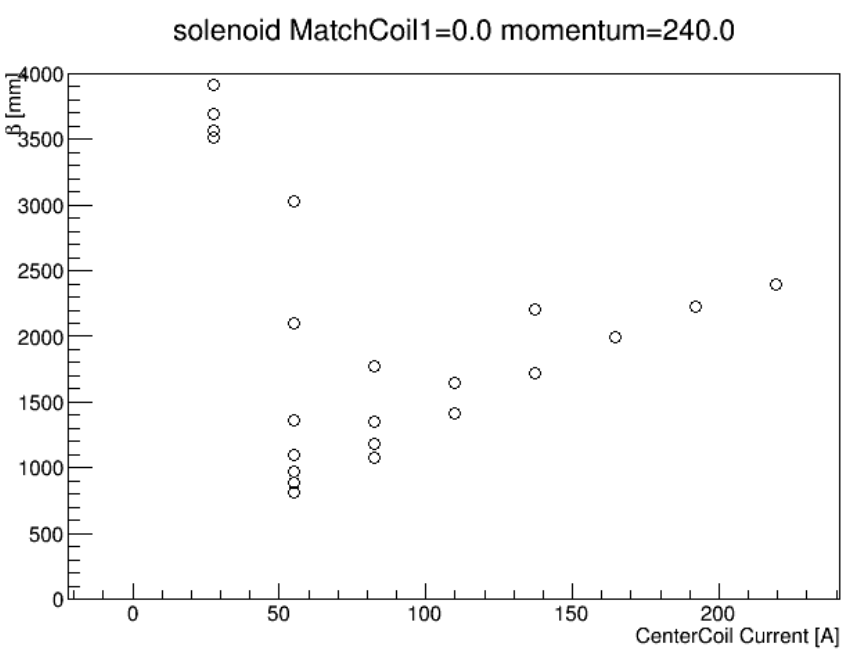


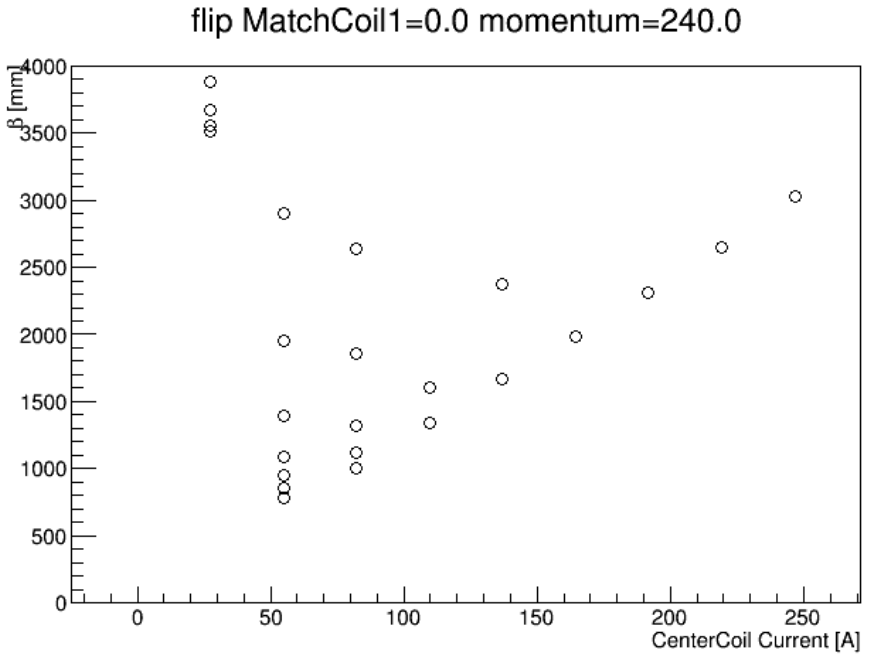
Scale SS – 200 MeV/c





Scale SS – 240 MeV/c



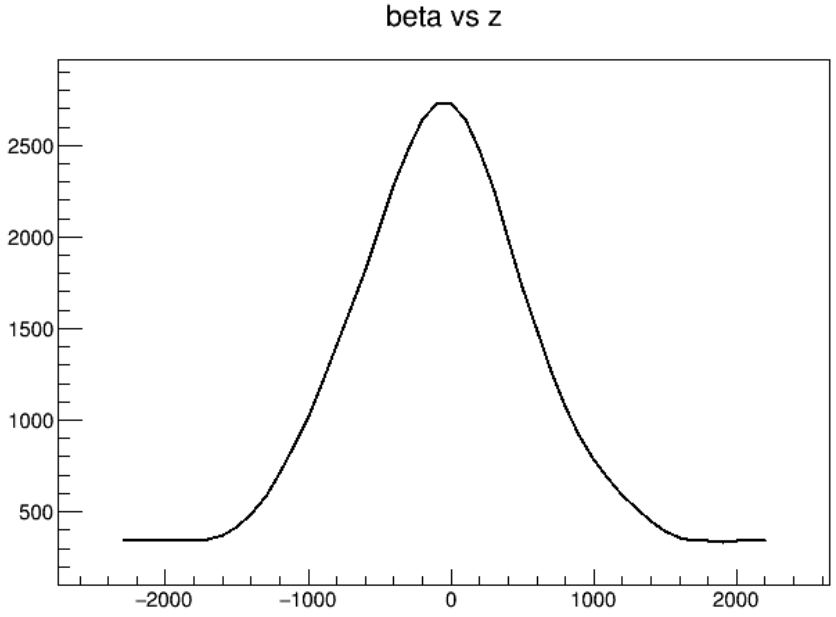


Asymmetric Solution

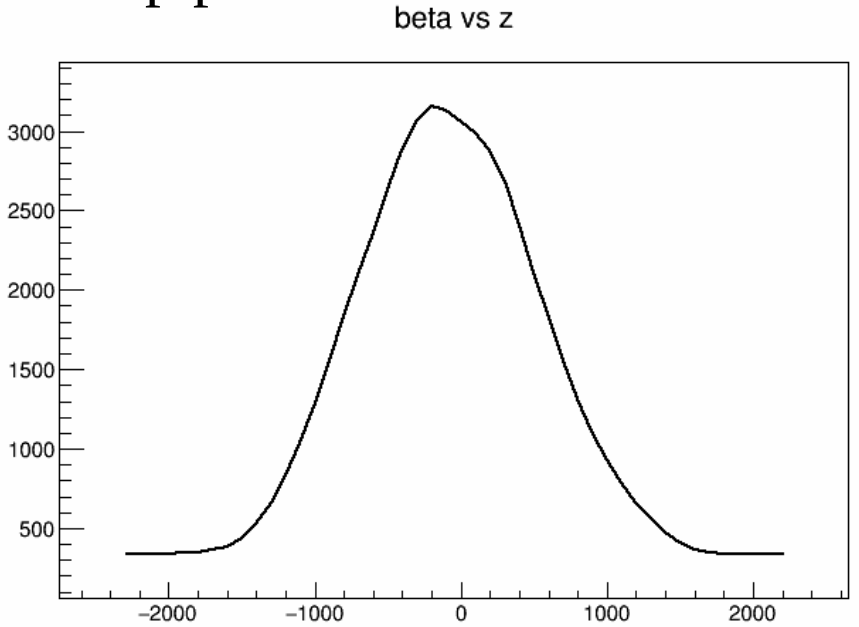
- We can get symmetric solutions with SS dialled down
- This is probably undesirable for tracker reconstruction
- Can we find an asymmetric solution?
  - Nb the usual linear approx cooling formulae do hold with alpha =/= 0
  - But why on earth would anyone not put the absorber at the focus?
- Consider beta = const in tracker regions as a “boundary condition”
  - Impically, beta beating in the constant field region gives lots of emittance growth (beta beat frequency is p-dependent?)
- Nb: still working on lattice optimisation algorithms for asymmetric case

SS at 4 T , Asymmetric

Solenoid p = 200 MeV/c



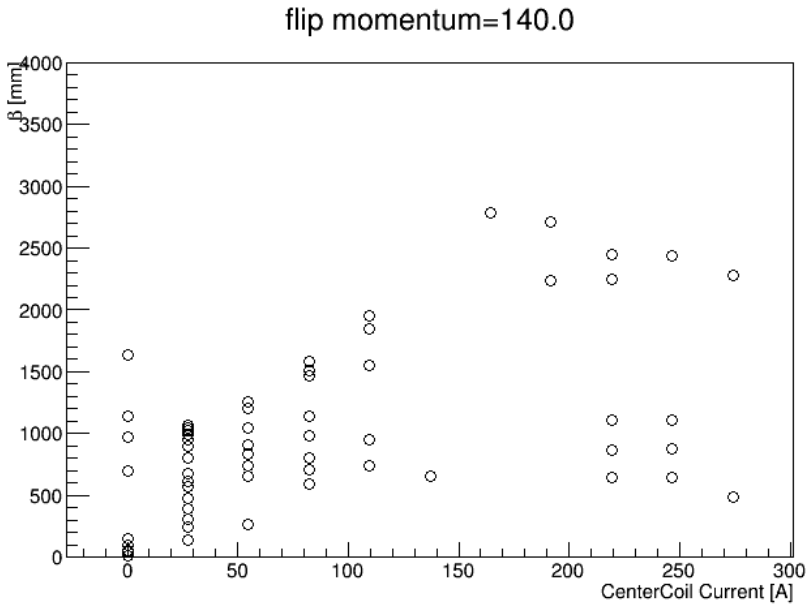
Flip p = 200 MeV/c



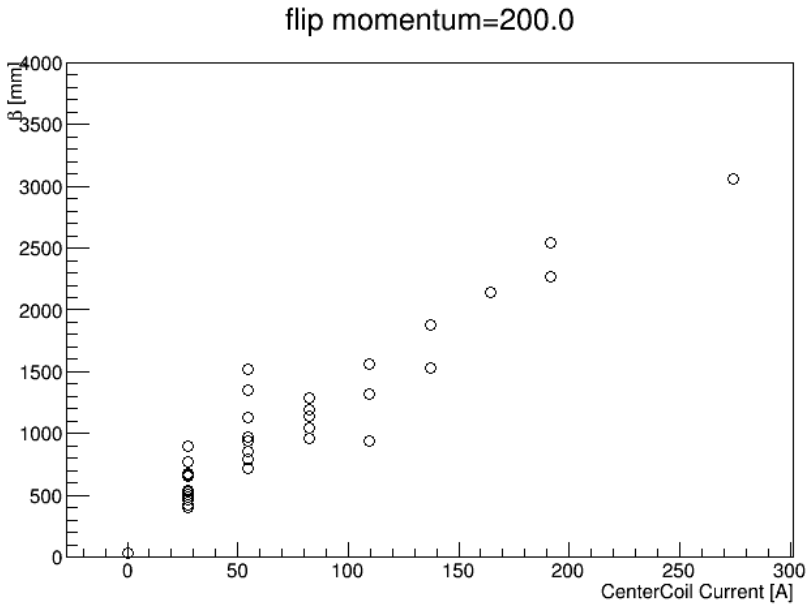
Scale SS, asymmetric

- Looks pretty crummy
  - The (de)focus has moved ~ few hundred mm to the right
  - Not enough field to get a focus in the FC
- Try allowing the SS to scale?

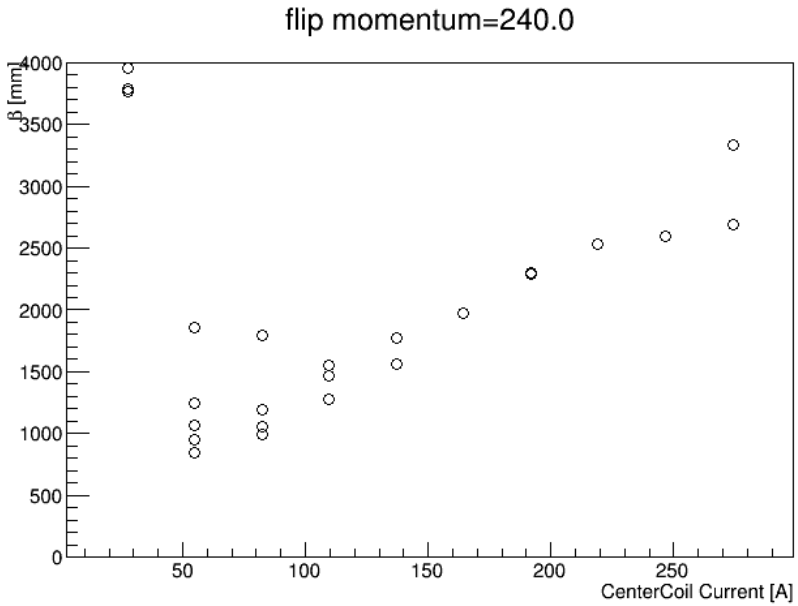
Scale SS, asymmetric



Scale SS, asymmetric



Scale SS, asymmetric



Scale SS, asymmetric

- By allowing asymmetry, looks like a new set of solutions have appeared in 140 MeV/c situation
  - Can we find something similar for other momenta? (My search algorithm is not exhaustive in asymmetric case)
  - What about solenoid mode
  - Do we need to hold “constant beta in solenoid”
  - To Be Continued…
- This is a glitch, but not entirely unexpected, and is manageable
- Life gets harder if we lose another coil e.g. FC or M2