MICE Step IV without M1

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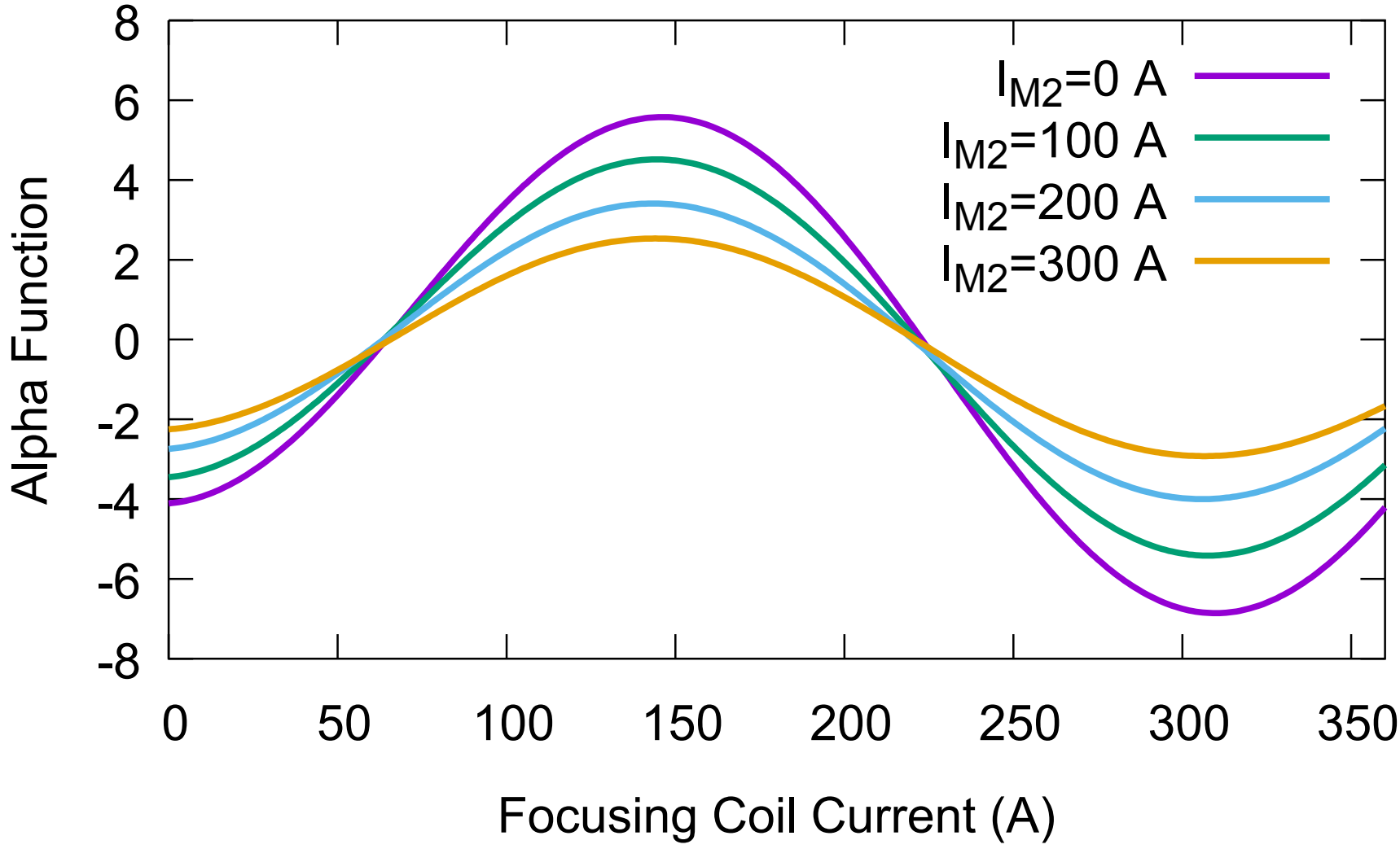
Introduction

- Solenoid mode only for now
- M1 off
- Vary M2
- SS, E1, E2 set with FC off, M2 on, to minimize maximum deviation from desired spectrometer field
  - Vary desired spectrometer field
- Two solutions, one for low and one for high FC current
  - Solution defined as $\alpha = 0$ at center
- Really just started, haven't analyzed any of these carefully

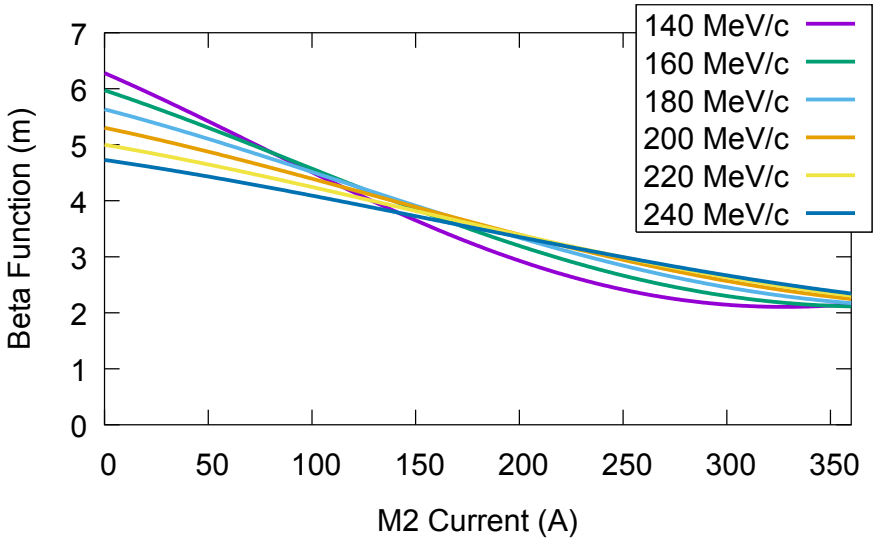
Two Solutions

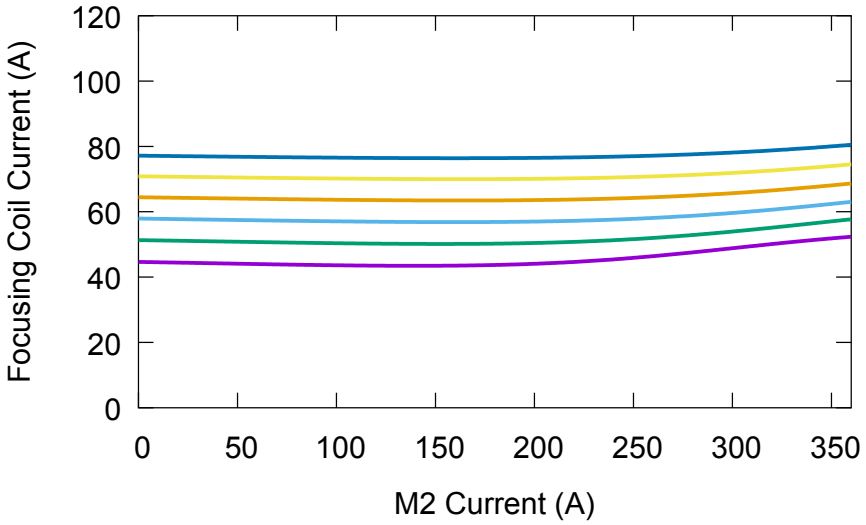


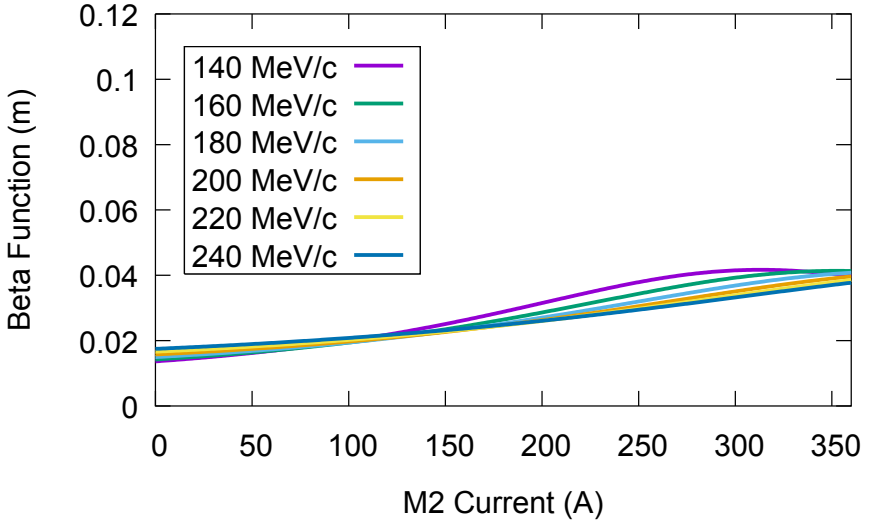
Vary M2 and Spectrometer Field

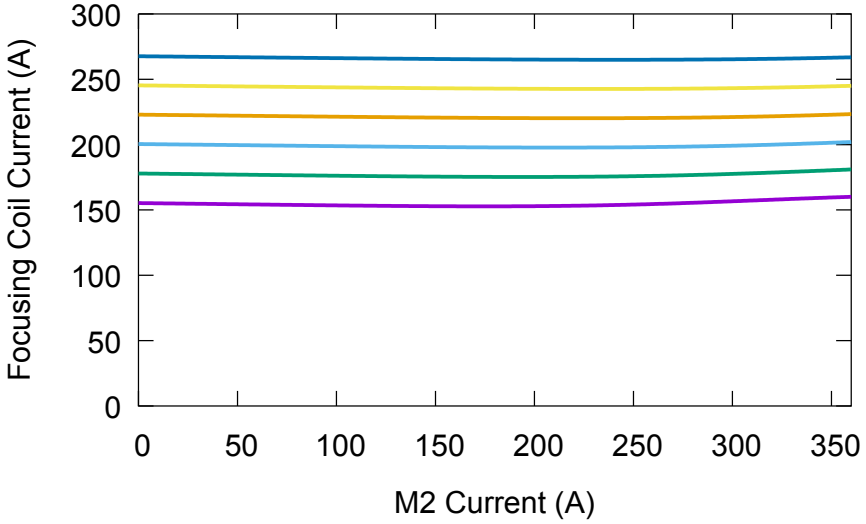
- Four slides, decreasing spectrometer field from 4 to 1 T
- Four plots per slide, plotted vs. I_{M2}
  - Two solutions, top and bottom
  - Beta functiosn to left
  - Focusing coil current to right
  - Curves for different design momenta

Solenoid, Spectrometer 4.0 T

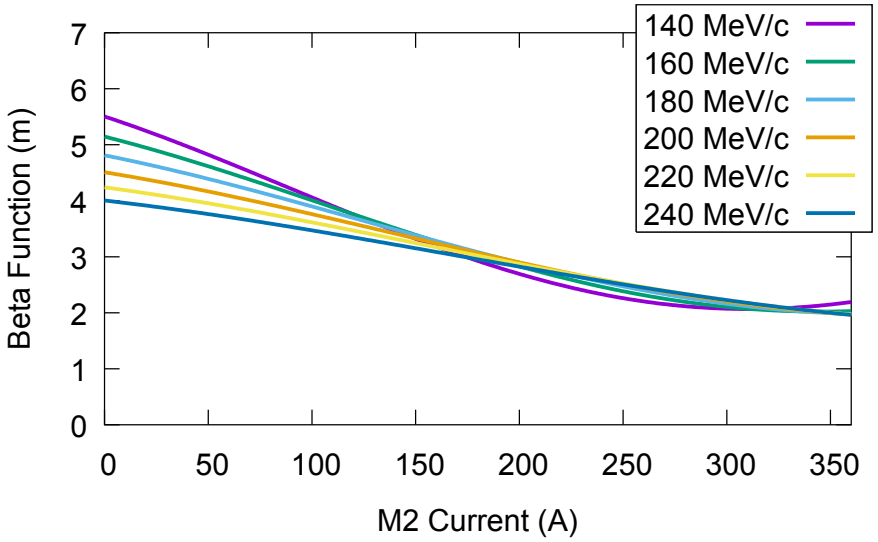


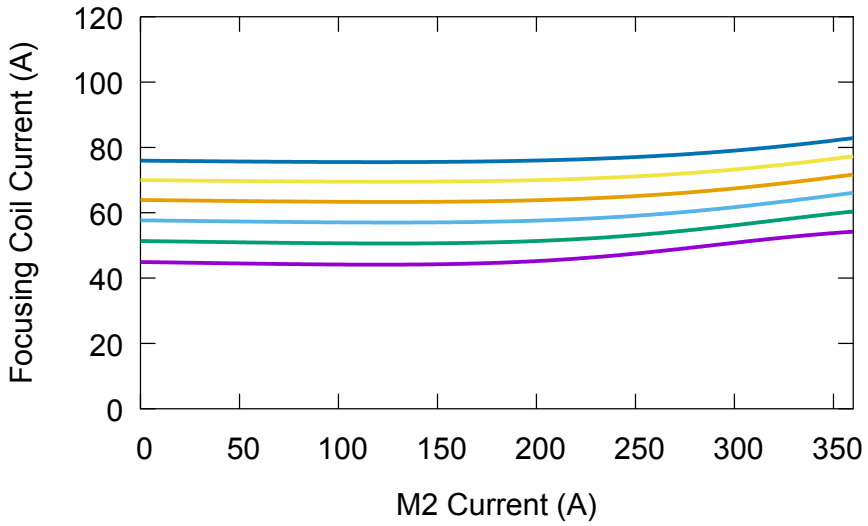


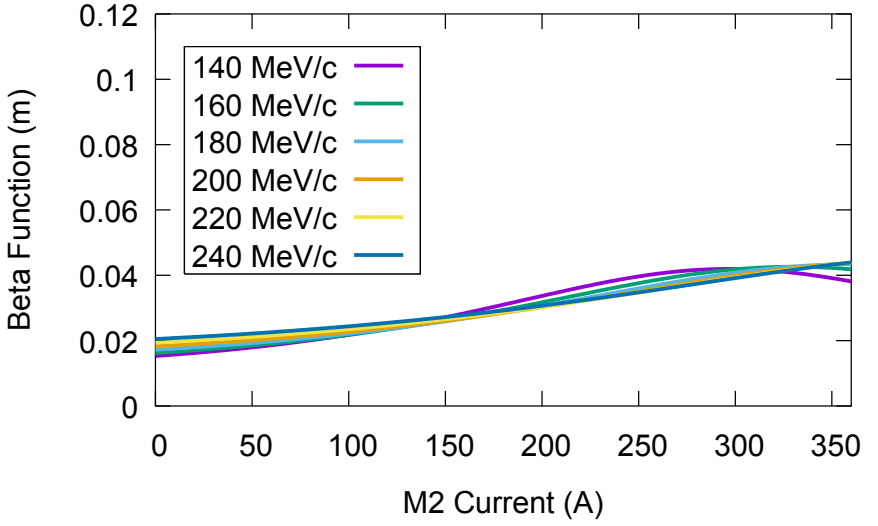


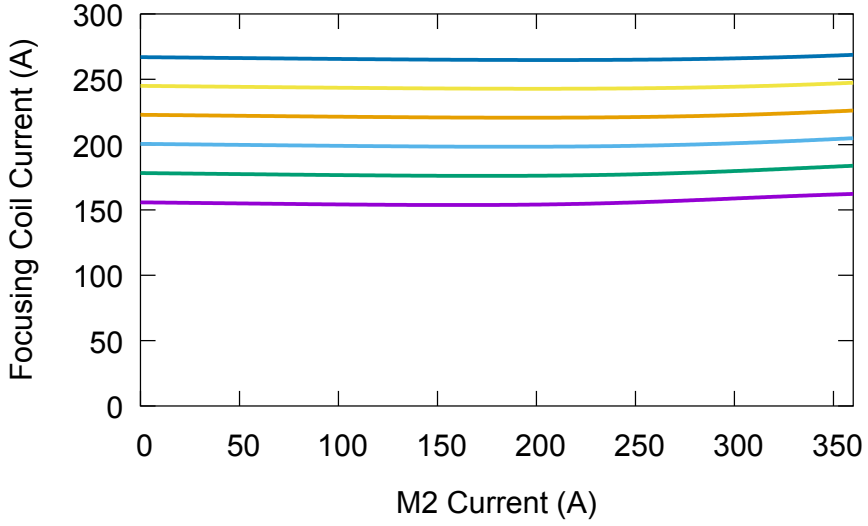


Solenoid, Spectrometer 3.0 T

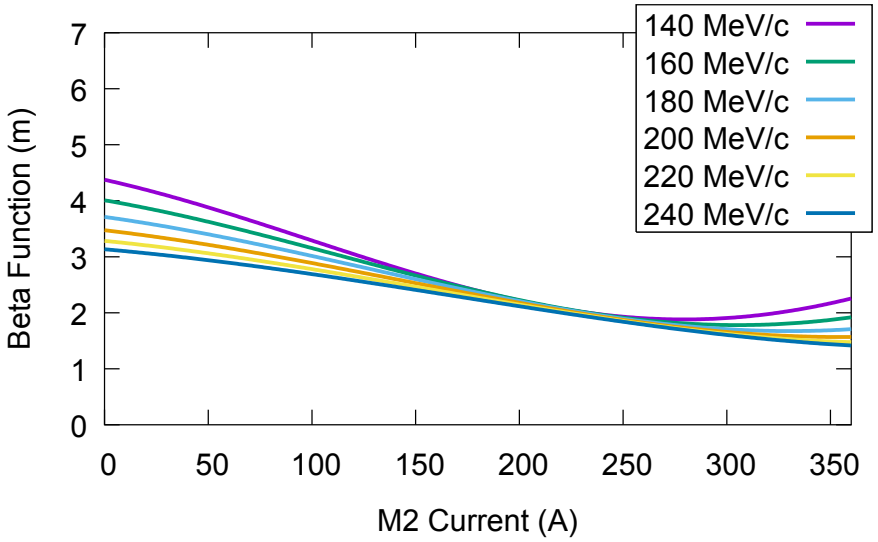


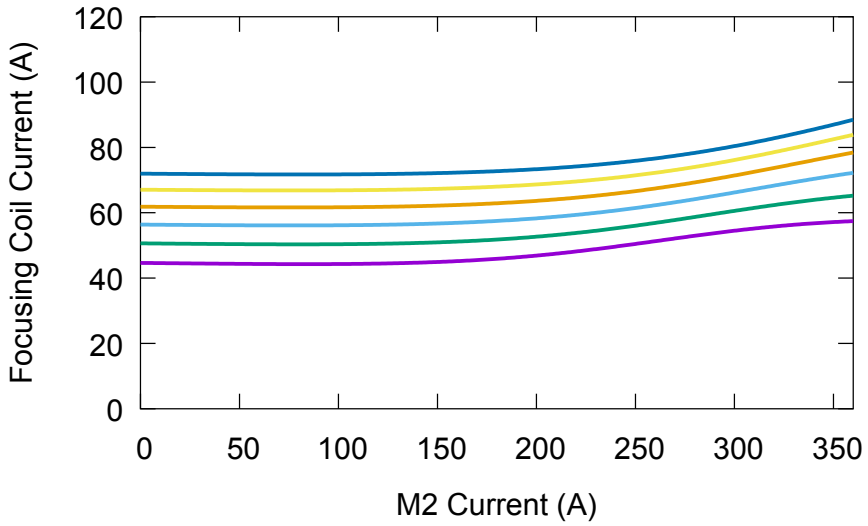


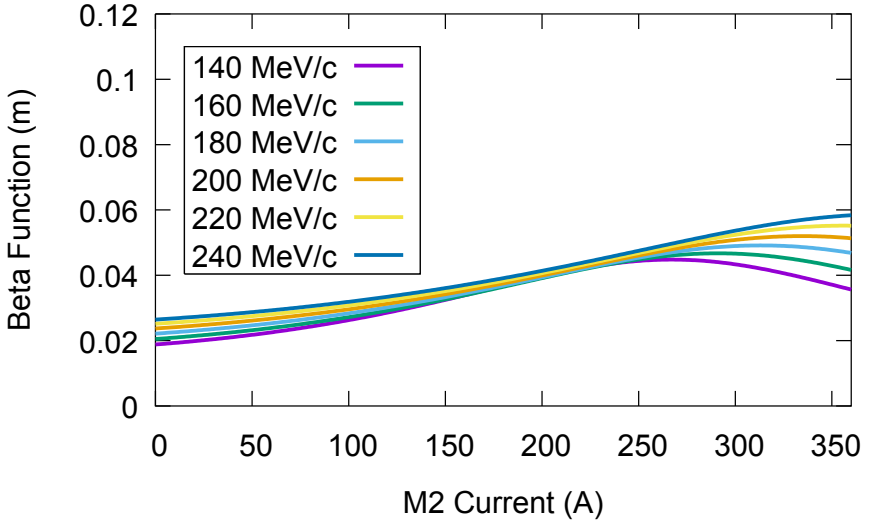


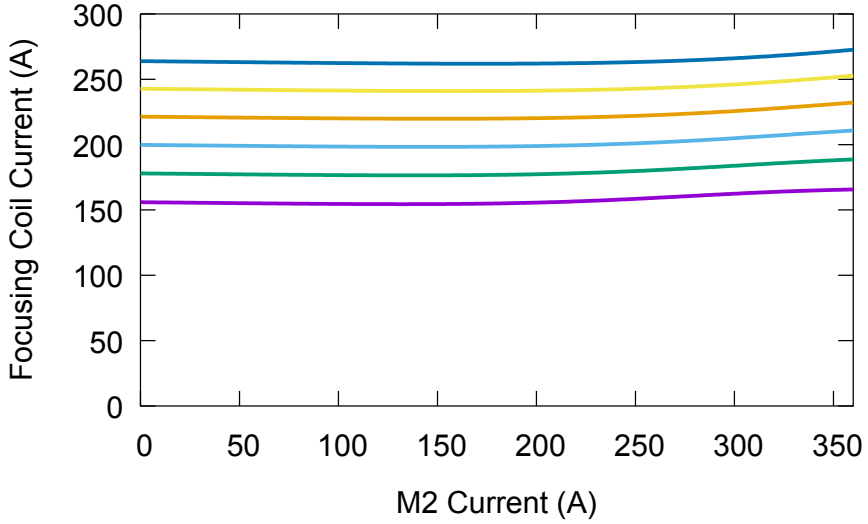


Solenoid, Spectrometer 2.0 T

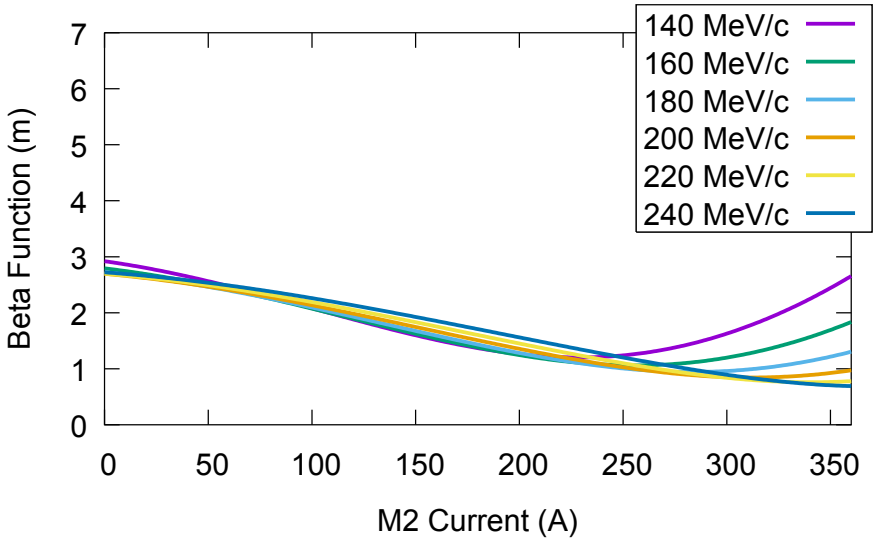


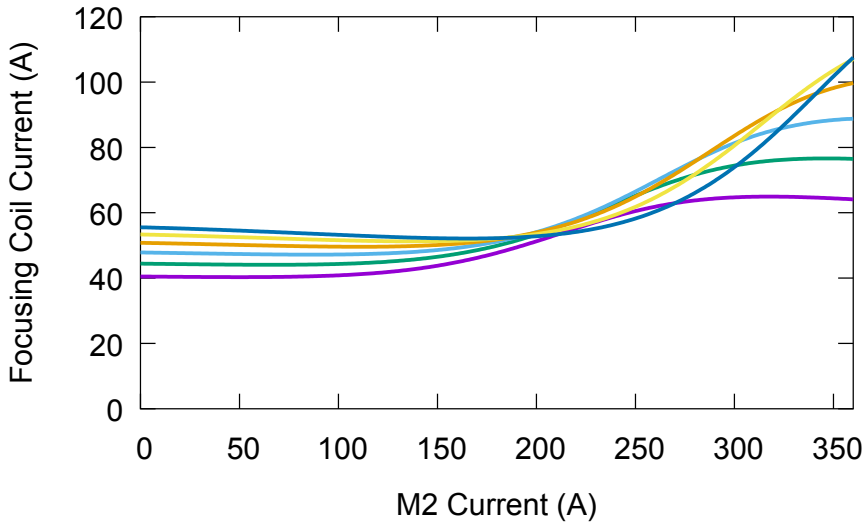


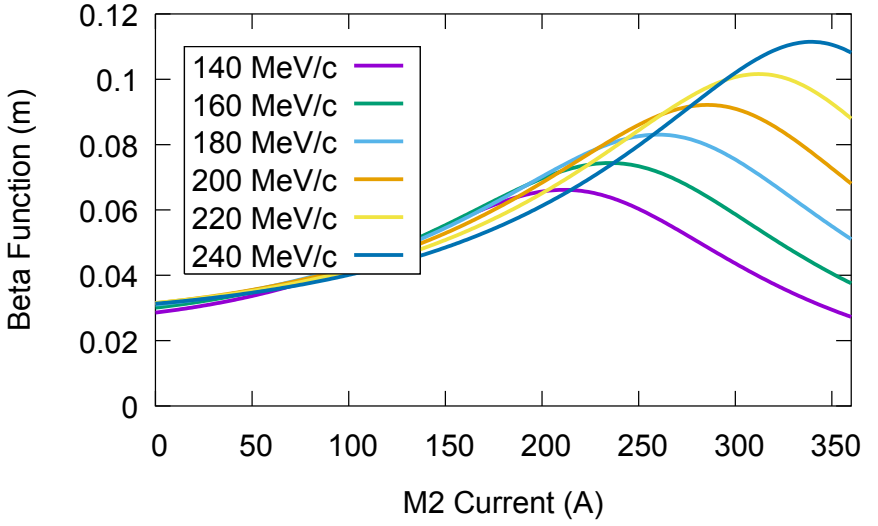


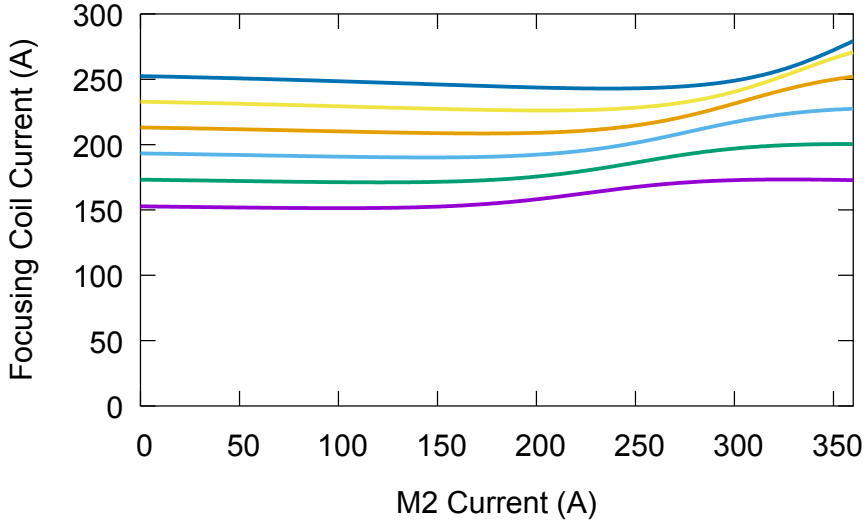


Solenoid, Spectrometer 1.0 T









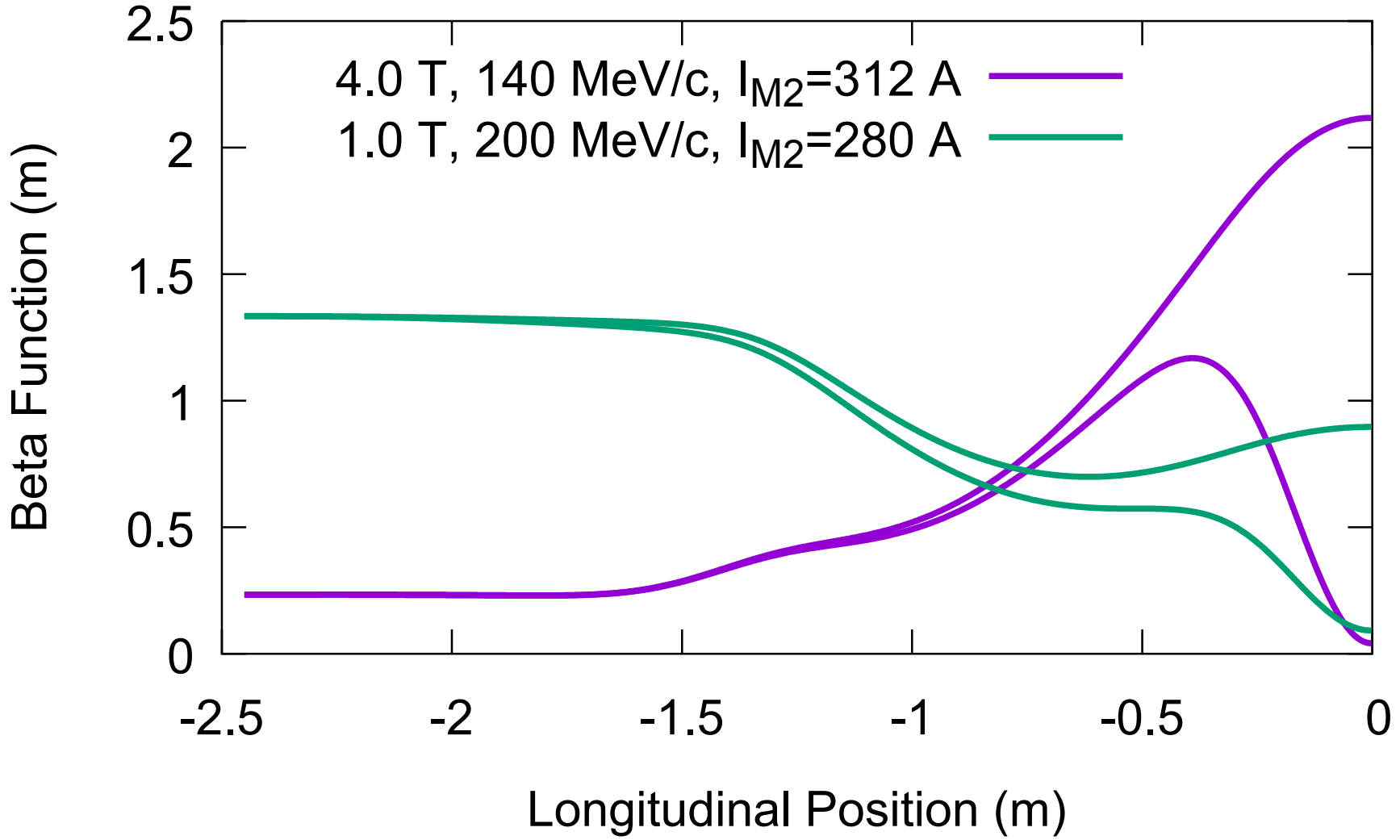
Vary M2 and Spectrometer Field

- Low I_{FC} solution has large beta functions, high I_{FC} solution has tiny beta functions
  - Tiny beta functions will have acceptance issues (later)
- High I_{M2} gives better beta functions (low for high I_{FC}, high for low I_{FC})
- I_{FC} nearly independent of I_{M2}, but do depend strongly on reference momentum
- Better beta functions for small spectrometer field, improving significantly from 2 to 1 T.

Beta Functions along Beamline

- Look at β vs. longitudinal position
- Showing both solutions: differ only in I_{FC}
- Showing low and high spectrometer field
  - And different momenta since 4 T case looks worse at high momenta
- Low spectrometer field:
  - Spectrometer becomes limiting aperture
  - Relative effect of downstream coils greater
- Second solution has best physical aperture to equilibrium ratio

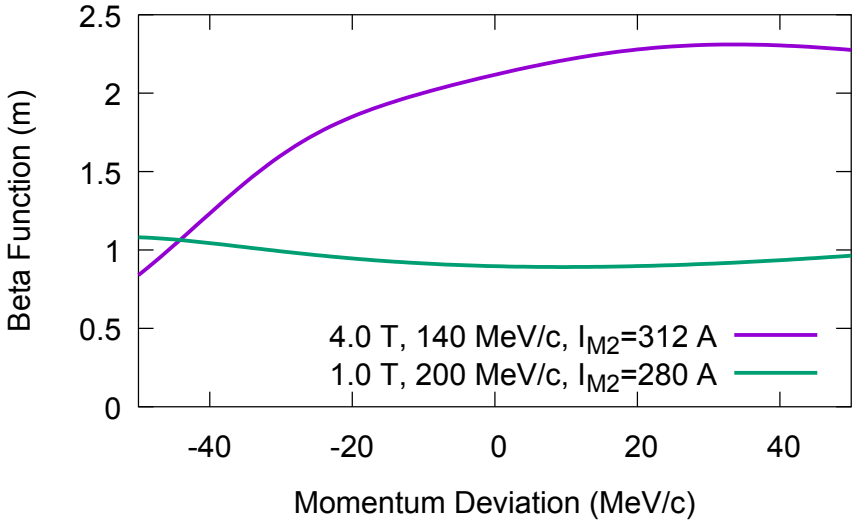
Beta Functions along Beamline

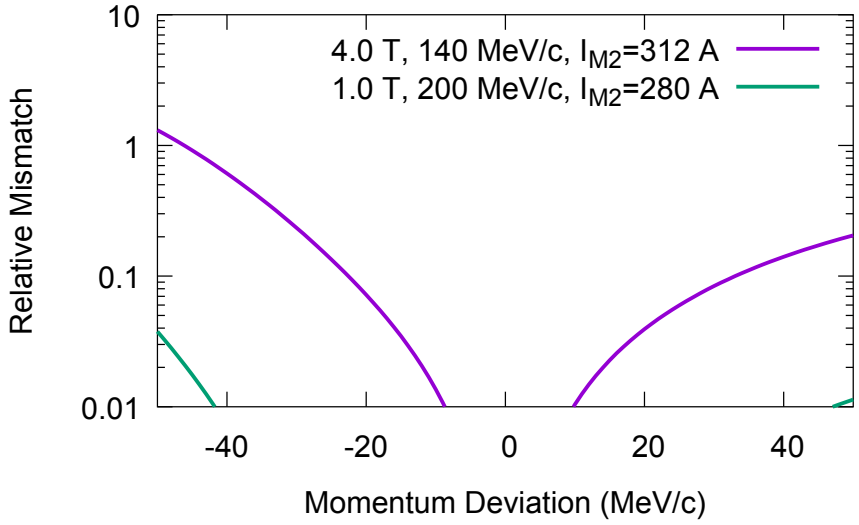


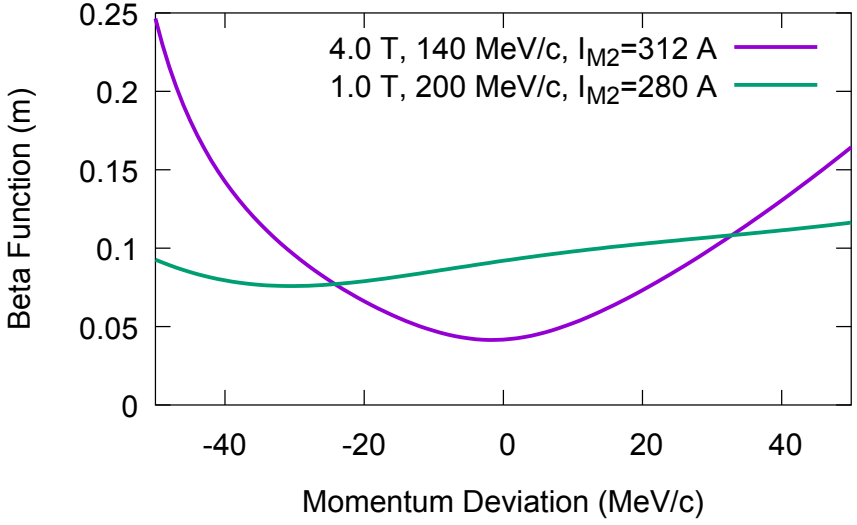
Momentum Acceptance

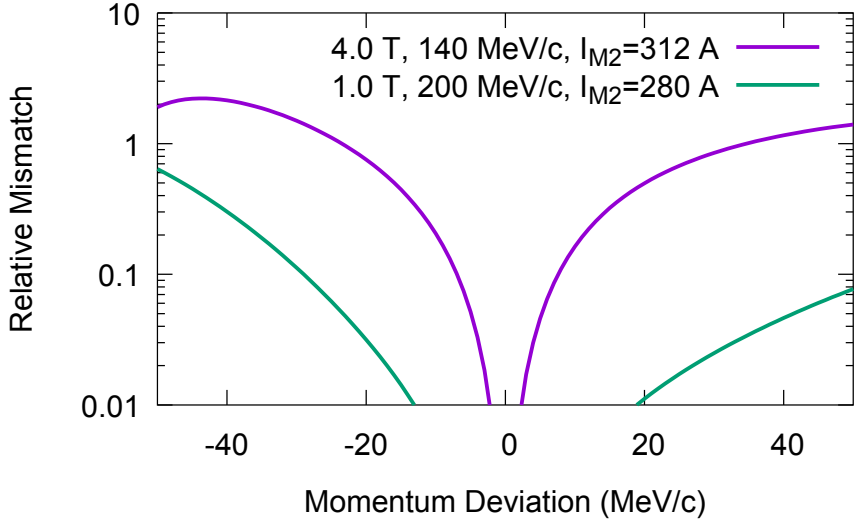
- Variation of two quantities with respect to momentum
  - Beta function at absorber
  - Relative emittance mismatch at spectrometer solenoid
- Semi-bogus computation that gets the right idea:
  - Start with $\alpha = 0$, $\beta = \beta_{\mathrm{abs}}$ at absorber
  - Track to center of spectrometer solenoid, and compute mismatch there
  - Choose β_{abs} that minimizes mismatch
  - "Semi-bogus" becuase I start at absorber
- Low I_{FC} on top, high I_{FC} on bottom
- β_{abs} to left, relative emittance mismatch to right

Momentum Acceptance









Momentum Acceptance

- Low spectrometer field has very flat beta functions vs. momentum, and low mismatch off-momentum, even for high I_{FC} solution
- High spectrometer field, high I_{FC} has poor momentum acceptance
- High spectrometer field, low I_{FC} has OK momentum acceptance, but low spectometer, high I_{FC} looks better

Adding Upstream M1

- Just thoughts at this point
- With both M1, the two solutions are continuously connected in the FC-M1-M2 current space
  - Can reach the intermediate beta functions
  - Multiple solutions with the same beta function: can vary parameters for performance
- Adding upstream M1 will expand range of beta functions, maybe give better performance with given beta functions
  - Not sure whether only upstream M1 is sufficient to close the range between the two $I_{\mathrm{M1}} = 0$ solutions

Adding Upstream M1

- Basic issue is that matching solenoids are further away than before
  - Upstream M1 is closer, but still missing downstream M1
  - Effectively can (sort of) get minimum closer to solenoids by adding M1, but shift minimum downstream, leading to higher beta at absorber
- Almost certainly worthwhile to add upstream M1, but may not help much

Final Thoughts

- Work in progress, will continue if there is interest
  - Flip case
  - Adding upstream M1
  - Tracking good looking cases
- Low spectometer field, high I_{FC} solution looks good
  - Hitting I_{FC} limits?
  - 1 T, maybe a bit higher, but probably not 2 T
  - But I haven't tracked it yet
  - Main problem: reconstructing helix in spectrometer!
- My gut feeling: get a decent high-I_{FC} solution with as high a spectrometer field as possible, add upstream M1 to give you some help