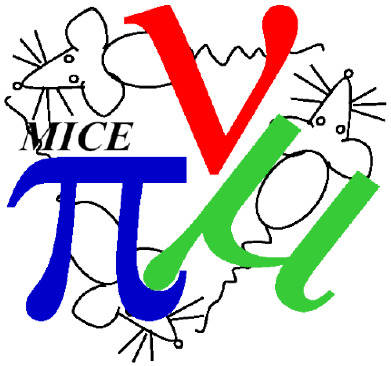
FC alignment studies



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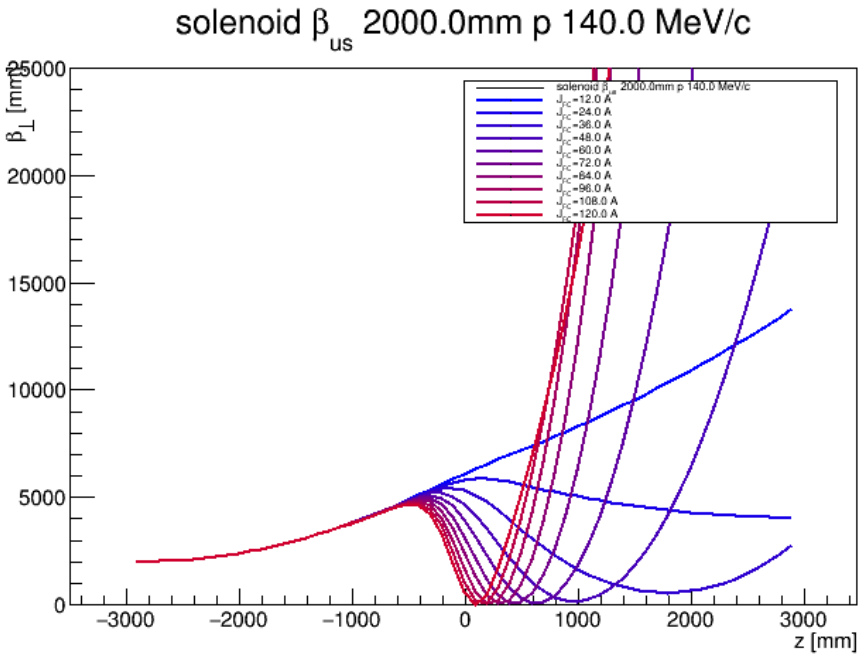
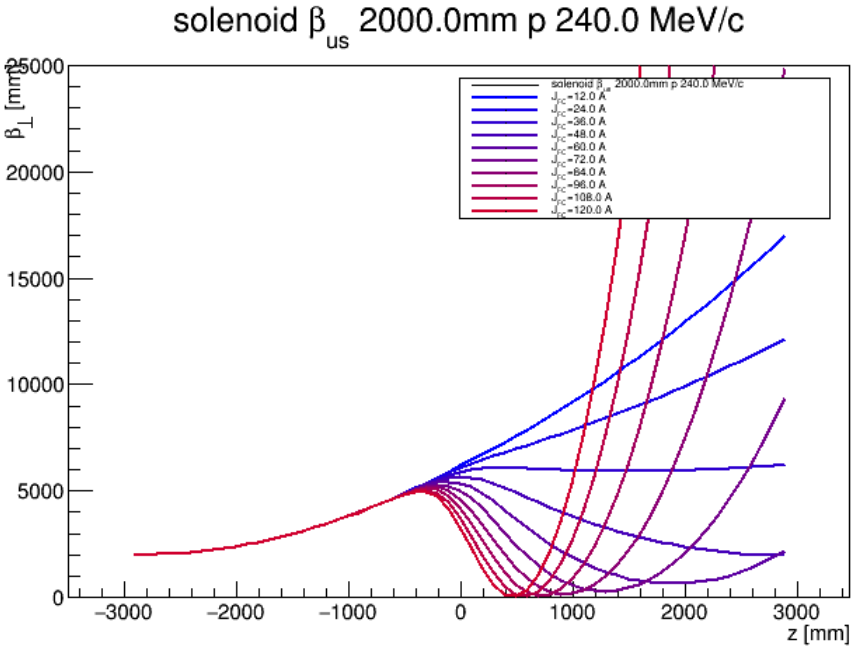
ASTeC

FC alignment studies

- Hopefully we will be able to measure the FC alignment in December
- Aim is to
  - Slice the input distribution by TOF12 (pz)
  - Look at x-x' and y-y' dependence on pz
- Can we get a good transmission?
- Can we get a good transverse kick (in the case of a misalignment)?
  - Offset focus coil will kick the beam transversely
- Can we measure the transverse kick?
  - Errors arise due to scattering in windows
  - Errors arise due to tracker resolution
- Use transfer matrix with
  - $u_{out} = m_0 + M\, u_{in}$
  - m_0 terms are “movement of beam centroid”
  - M terms are “focusing”

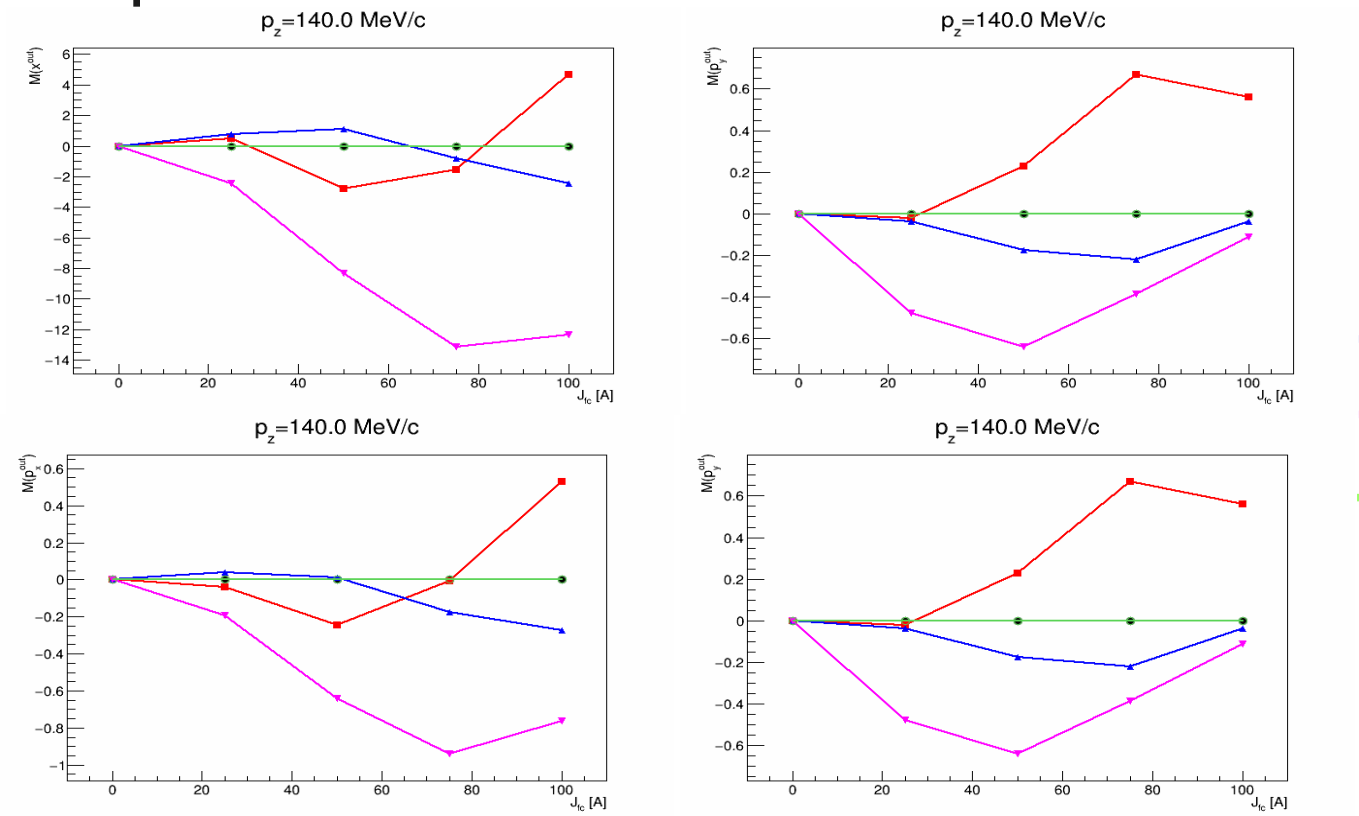
Optics (solenoid)





- In solenoid mode, we no longer have the “2pi” option at 140 MeV/c

Transfer matrix (solenoid, 140)



Perfect alignment

Map 2015-06-24

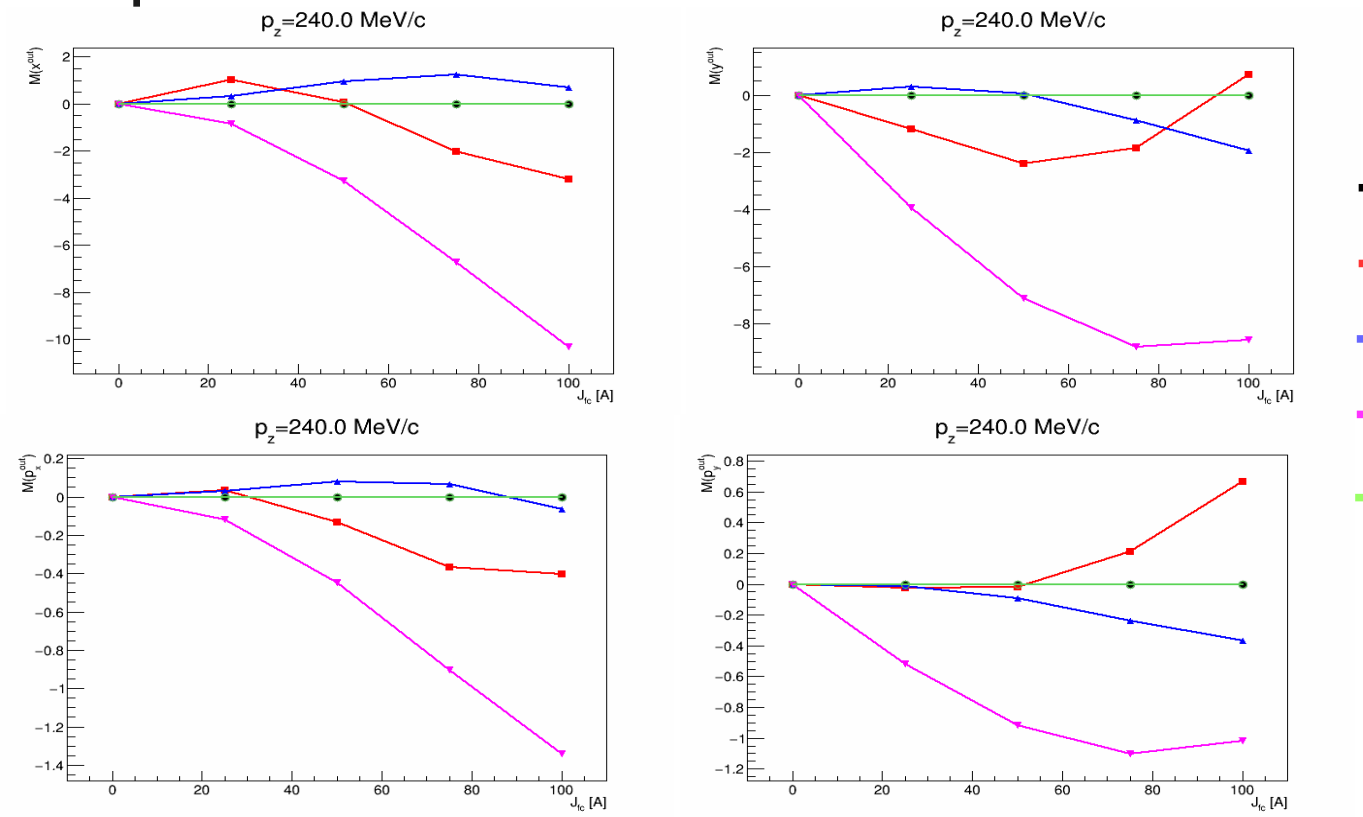
1 mm x displacement

5 mrad rotation about y

10 mm z displacement

- "Map 2015-06-24" is JHC/VB misalignments presented at CM42
- $M(x^{out})$ is "x position of beam centroid" downstream for perfectly aligned beam upstream in x
- No sensitivity to z misalignment

Transfer matrix (solenoid, 240)



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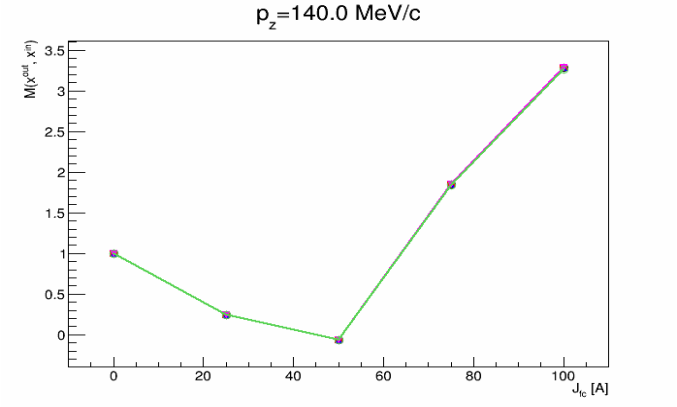
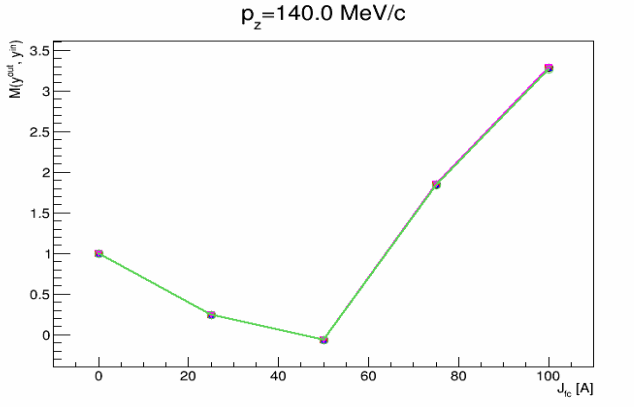
Transfer matrix (solenoid, 140)





Perfect alignment

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1 mm x displacement

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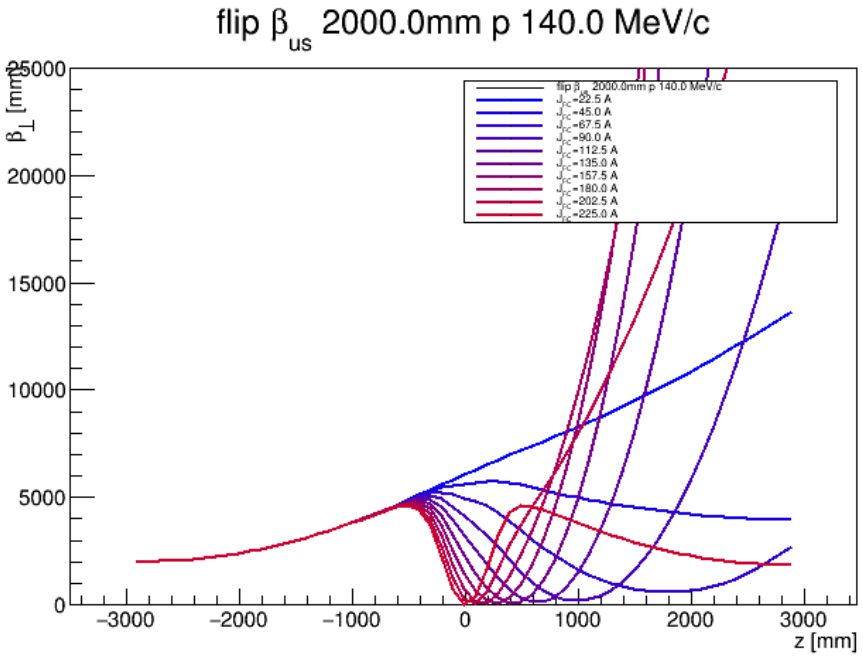
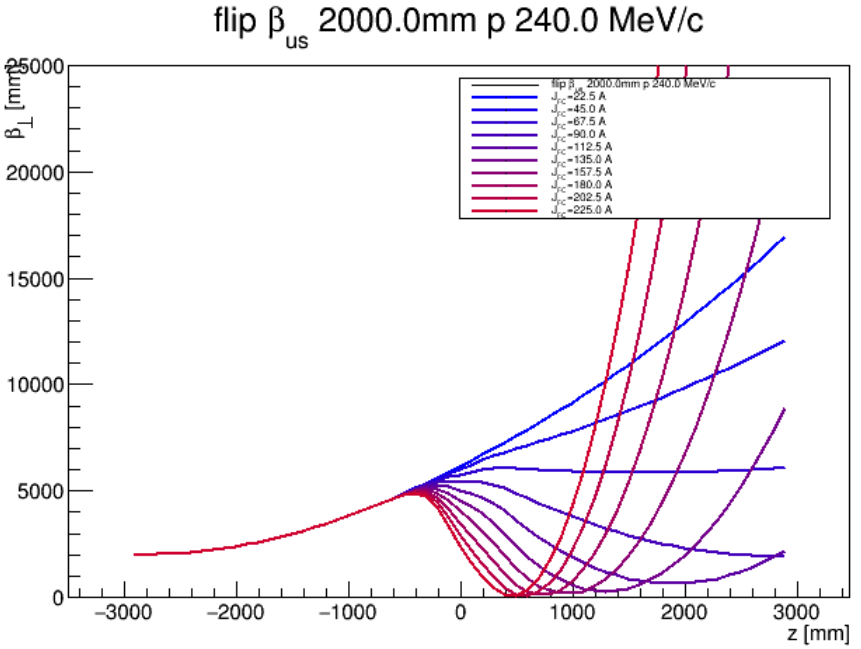
10 mm z displacement

- Focussing terms –
  - x_{out}/x_{in}
  - y_{out}/y_{in}
- Focussing terms don't really notice the misalignment
  - Mispowering (j “misalignment”) are likely to be measurable here

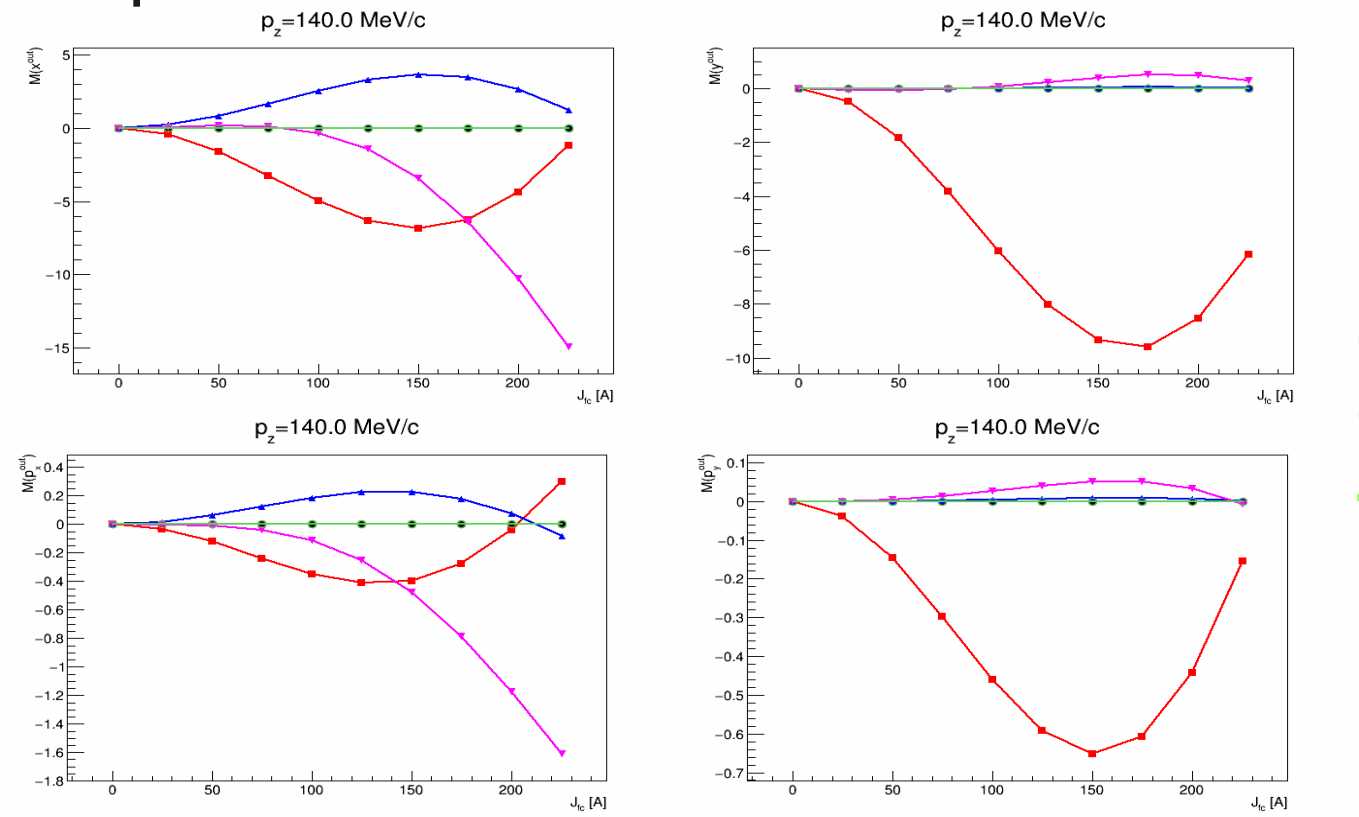
Optics (flip)





- Can we develop a reasonable optics?
  - 140 MeV/c – we can get a “pi” phase advance option and a “2pi” phase advance option
    - 45 A and 225 A options
  - 240 MeV/c – we can get a “pi” phase advance option only
    - 90 A
- I assume flip mode and beta start 2000 mm
  - I have plots for other options of beta start, solenoid mode, etc

Transfer matrix (flip, 140)



Perfect alignment

Map 2015-06-24

1 mm x displacement

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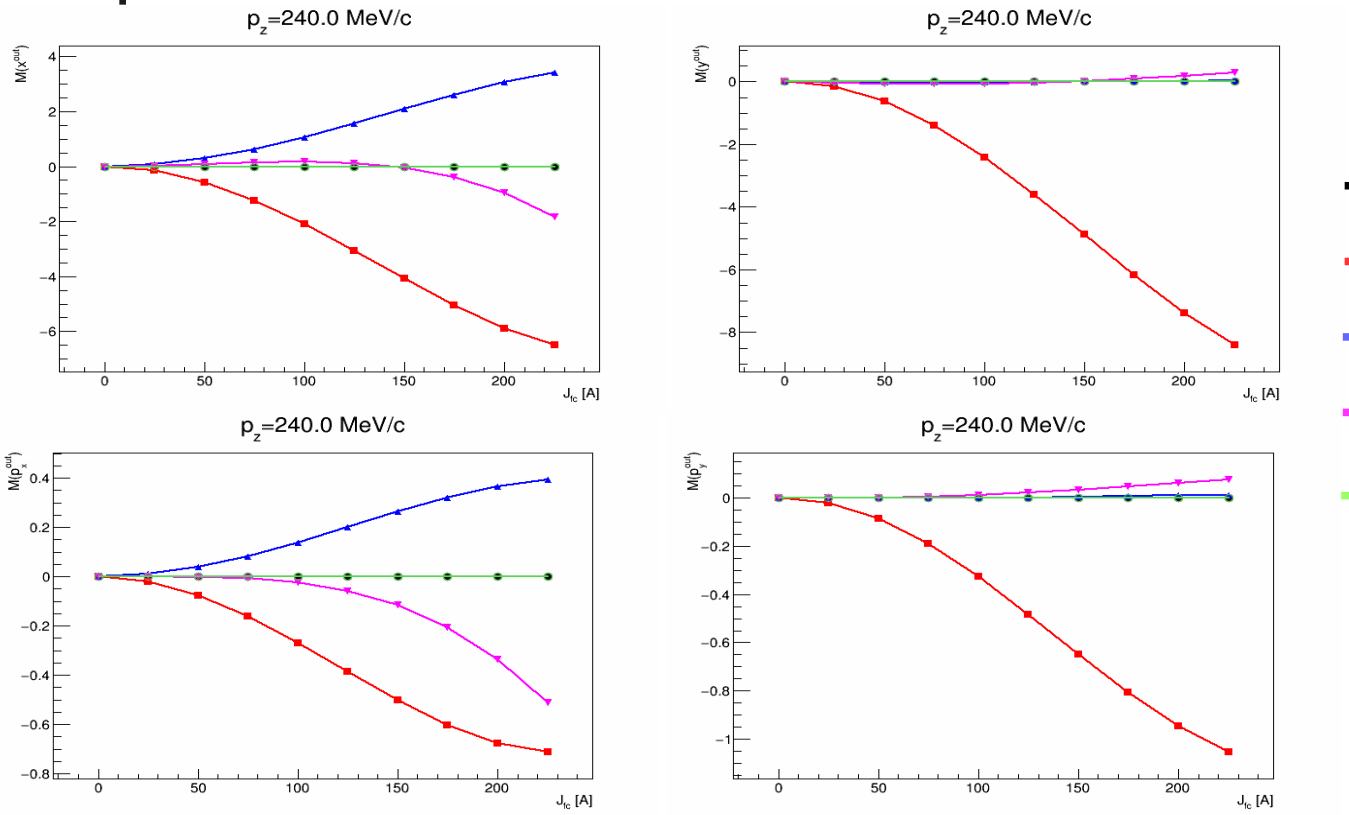
10 mm z displacement

- Flip mode looks more sensitive to displacement
- Insensitive to tilt

Transfer matrix (flip, 240)



Perfect alignment

Map 2015-06-24

1 mm x displacement

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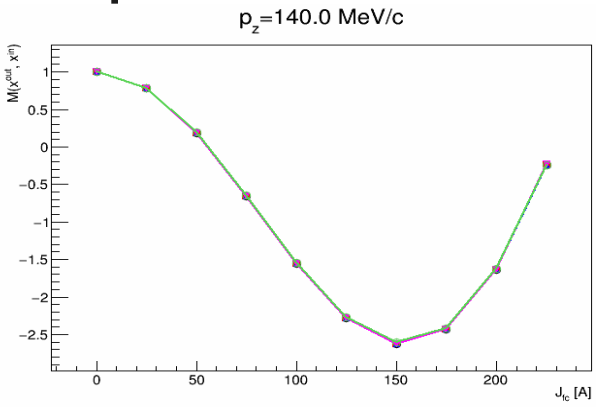
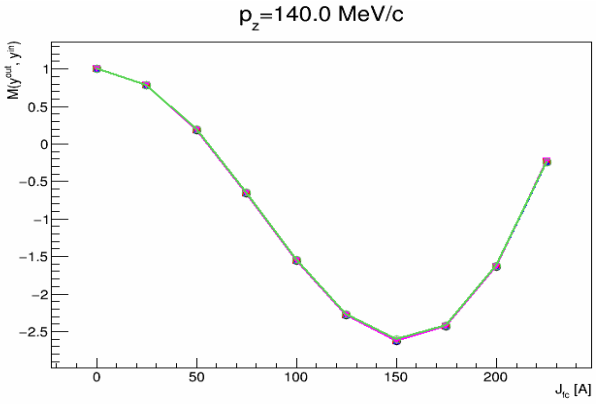
10 mm z displacement

Transfer matrix (flip, 140)





Perfect alignment

Map 2015-06-24

1 mm x displacement

5 mrad rotation about y

10 mm z displacement

- Focussing terms –
  - x_{out}/x_{in}
  - y_{out}/y_{in}
- Focussing terms don't really notice the misalignment
  - Mispowering (j “misalignment”) are likely to be measurable here
  - Z-misalignment is not measurable

Comments

- Looks like transverse kick moves smoothly as a function of FC current
  - Misalignment kick looks quite measurable ~ few mm
  - Tension between size of the misalignment kick and transmission
  - Resolution on movement of beam centre is likely to be worse for very divergent beam
  - Propose two run settings
  - Is there any reason to run in muon mode – or is pion mode preferable?

Statistics

- Full study including detector effects and materials is in progress (Sophie Middleton)
  - This will tell us what statistics are required
- In the meantime, statistics guess:
  - Width of x residuals in absence of focussing (straight tracks) ~ 25 mm
  - Say we want to get x mean with < 1 mm errors => 1000 muons
  - To get a good measurement of transfer matrix, we take a tight fiducial cut, say 50 % efficiency
  - We run with pion beam, which is half of the beam, so another 50 % cut
  - Say 4000 TOF2 triggers, round up to 10000 TOF2 triggers to be safe?
    - May want to take high stats at 0 and “optimal setting” e.g. 70 – 100 A flip, 50 A or so in solenoid
  - Or one hour data taking, whichever comes sooner
    - May get poor stats for the overfocussed settings
  - Plus 20 minutes per setting to ramp the magnets

Settings

- Settings
  - Take 240 MeV/c beam, and 140 MeV/c beam in flip mode and solenoid mode
  - Take 15 A steps in solenoid mode, up to 120 A
    - Don't want to quench the magnet
    - ~ Three shifts
  - One day to flip the field
  - Take 20 A steps in flip mode, up to 160 A
    - Don't want to quench the magnet
    - ~ Three shifts
- Operational procedures
  - Always ramp magnets from below? TBD with consultation from ops
  - Try to start or end a shift with a field-off reference beam
  - If time is limiting, prefer to increase the current step size or loose the highest current settings
  - Anything else?