Week 6: Centering and Axial Shield Effects

August 20, 2014

current data analysis steps

1. subtract backgrounds
2. correct for probe mis-centering along x axis
3. correct for B_x, B_y, B_z probe separations
4. estimate probe tilt angle and correct B_z
5. normalize simulated maps to B_z at magnet center

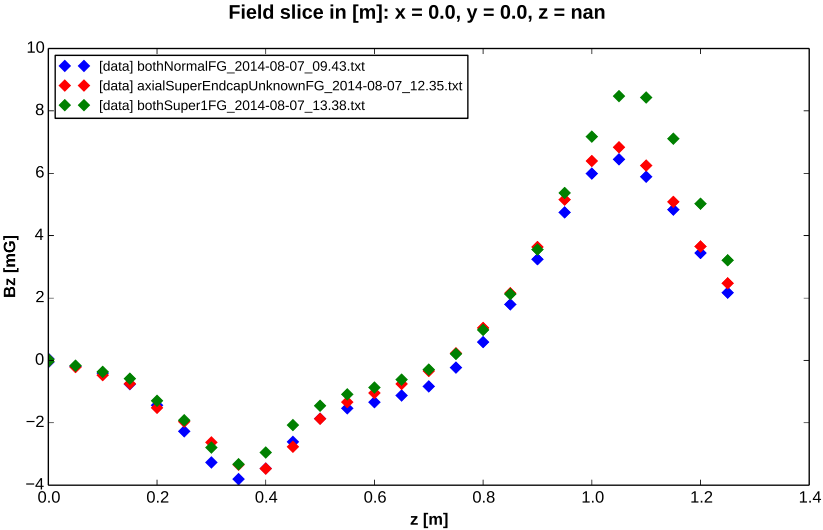
- step 2 (x centering) will be done differently
- steps 3 & 4 are new this week

correction 2: x centering

1. plot B_z v. z along $x = 0, y = 0$
   - if probe is perfectly centered, curve will be flat
   - height of actual curve peak suggests how far off-center we are
2. guess x offsets
3. plot B_z v. z along extremities $x = \pm 0.1$ m, $y = 0$

- doing step 1 for three maps:
  - axial shield normal, endcap normal (9:43/9:27)
  - axial shield SC, endcap unknown (12:35/12:20)
  - axial shield SC, endcap SC (13:38/13:24)

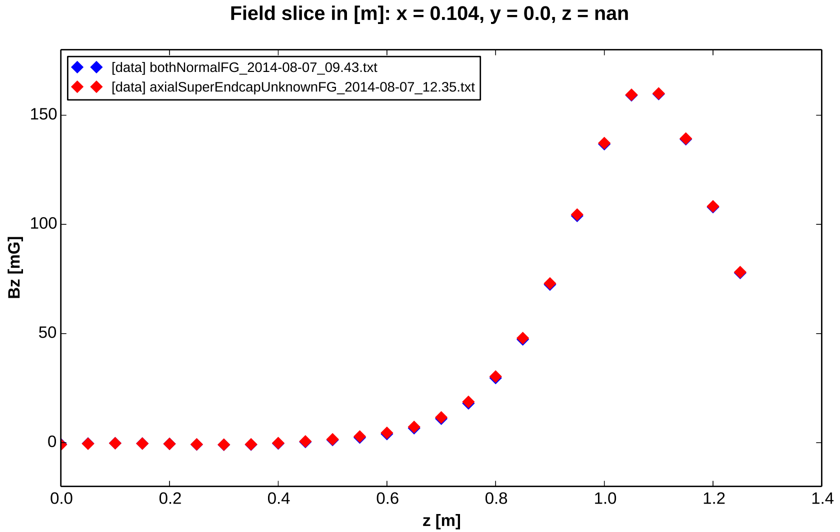
B_z v. z along $x = 0, y = 0$ for three maps



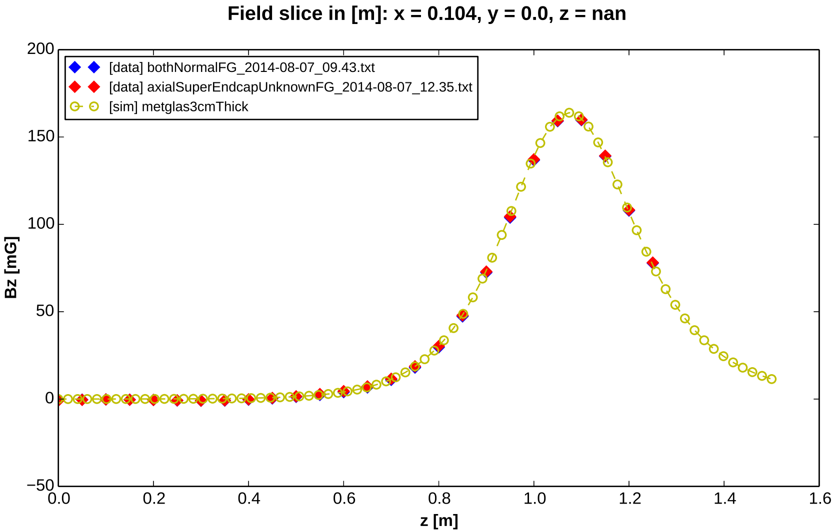
correction 2: x centering (cont.)

- peak heights are substantially different
- two possibilities:
  - we are seeing a small-scale version of the effect of the endcap
  - or, probe became further offset in x between 12:35 and 13:38
- probably a mix of both
- best to use 4mm x offset for all three maps - assuming that the probe became further offset between the normal and SC measurements would probably be confirmation bias

(axial normal, endcap normal) and (axial SC, endcap unknown) agree



both agree with Metglas-only simulation (no axial, no endcap)

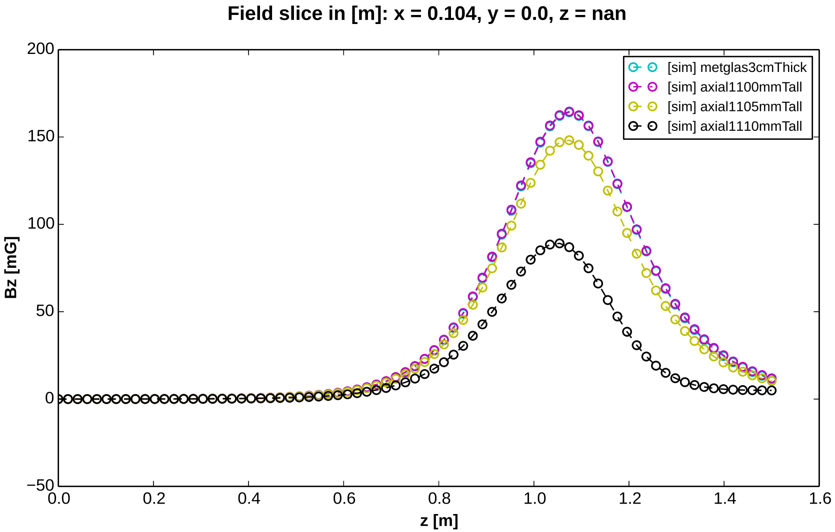


(axial normal, endcap normal) and (axial SC, endcap unknown)

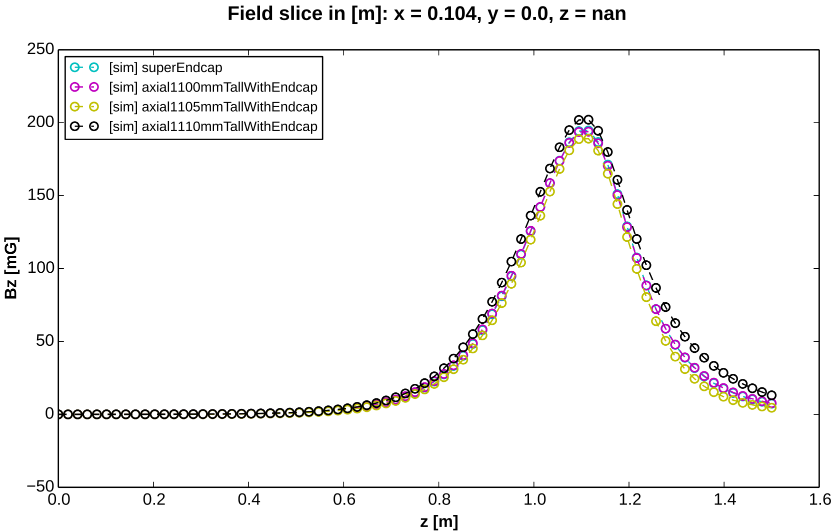
- agrees with Simon's plots
- when endcap state was unknown, it was likely not SC
- effect of the axial shield alone going SC seems to be minimal (as expected by design)

- but simulation predicts stronger effect from axial shield!
- this effect is highly dependent on axial shield length

simulations: axial shield not present, and present with lengths 1100, 1105, 1110 mm



simulations: same, but with SC endcap at $z = 1.128$ m in all four cases

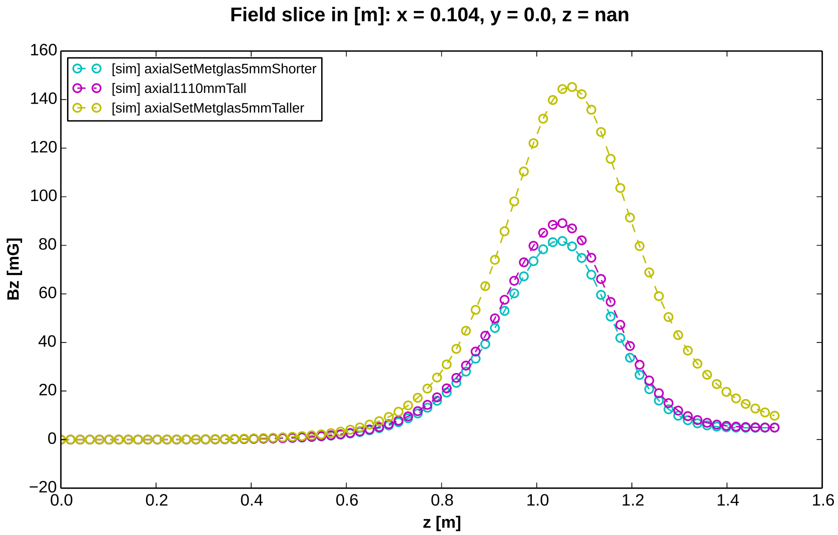


axial shield effects

- we expect axial shield effect to be negligible
- effect is indeed negligible when axial shield is 1100 mm tall
- but taller axial shields have a substantial B_z suppression effect
- presence of SC endcap hides this suppression effect

- 1100 mm is closest to Metglas height (1080 mm)
- perhaps what really matters is the height difference between the Metglas and axial shields?
- next: simulations with axial shield height fixed at 1110 mm, metglas height varying ± 5 mm

axial shield and Metglas height difference



thoughts

- axial shield's B_z suppression effect correlated with axial-Metglas height difference:
  the further the axial shield extends above the Metglas, the more it suppresses B_z (lower peak height)
- SC endcap hides this suppression effect
  - suppression effect desirable?
  - simulate extending the axial shield in lieu of the endcap to create better field uniformity?

thoughts (cont.)

- how do we explain the agreement between (axial normal, endcap normal) and (axial SC, endcap unknown) in the data?

1. maybe the real axial-Metglas height difference is smaller than measured?
   - we measured the heights of the axial and Metglas shields individually
   - perhaps reinforce this by measuring the height difference and gap - z centering may be off
   - if the gap is very small, then the axial shield suppression effect will be negligible (as shown in the simulation with axial shield height at 1100 mm)
2. maybe the endcap was partially SC, somehow enough to hide an axial shield suppression effect, but not enough to match the (axial SC, endcap SC) simulation? (very unlikely)