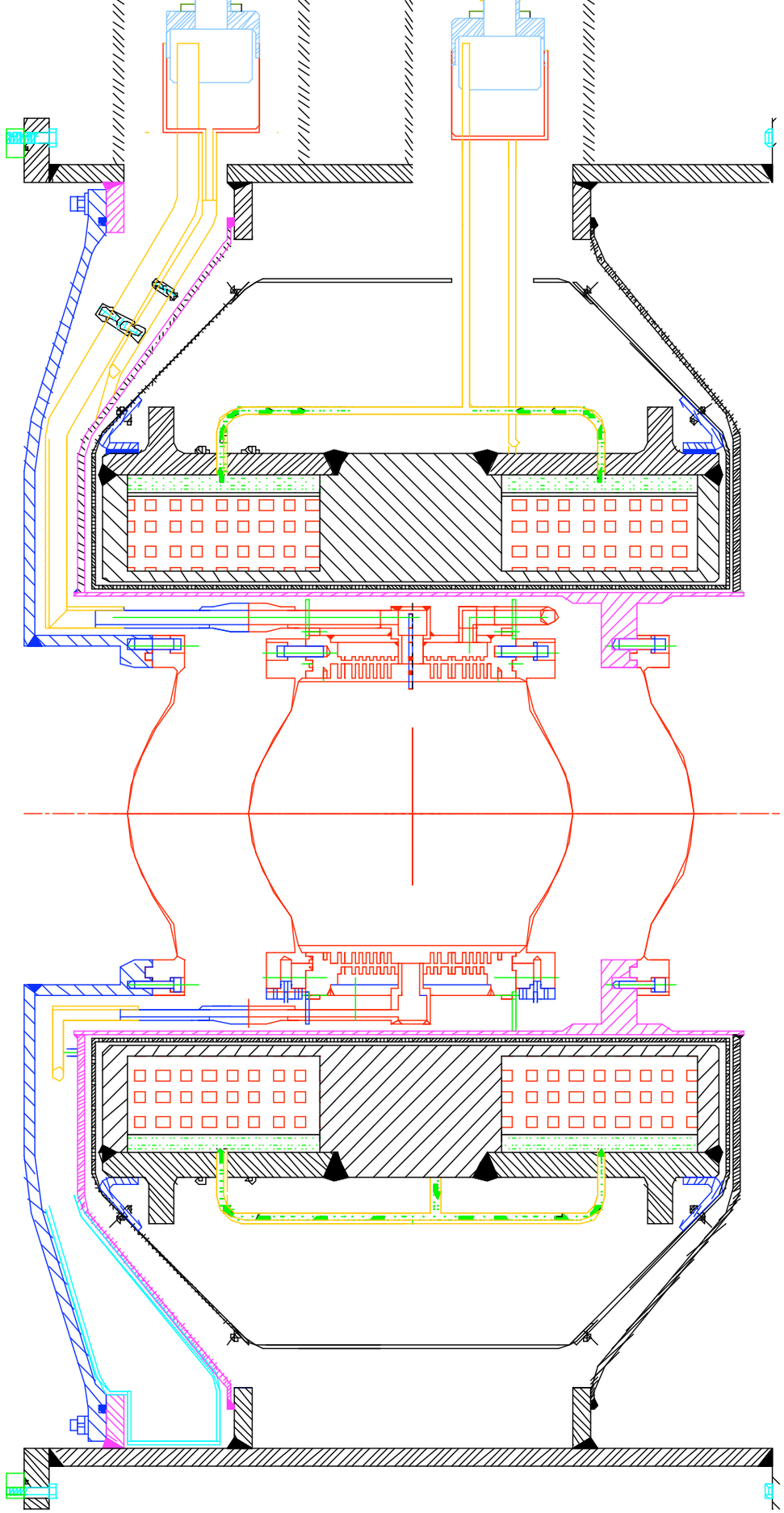
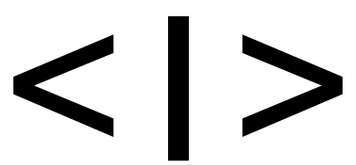


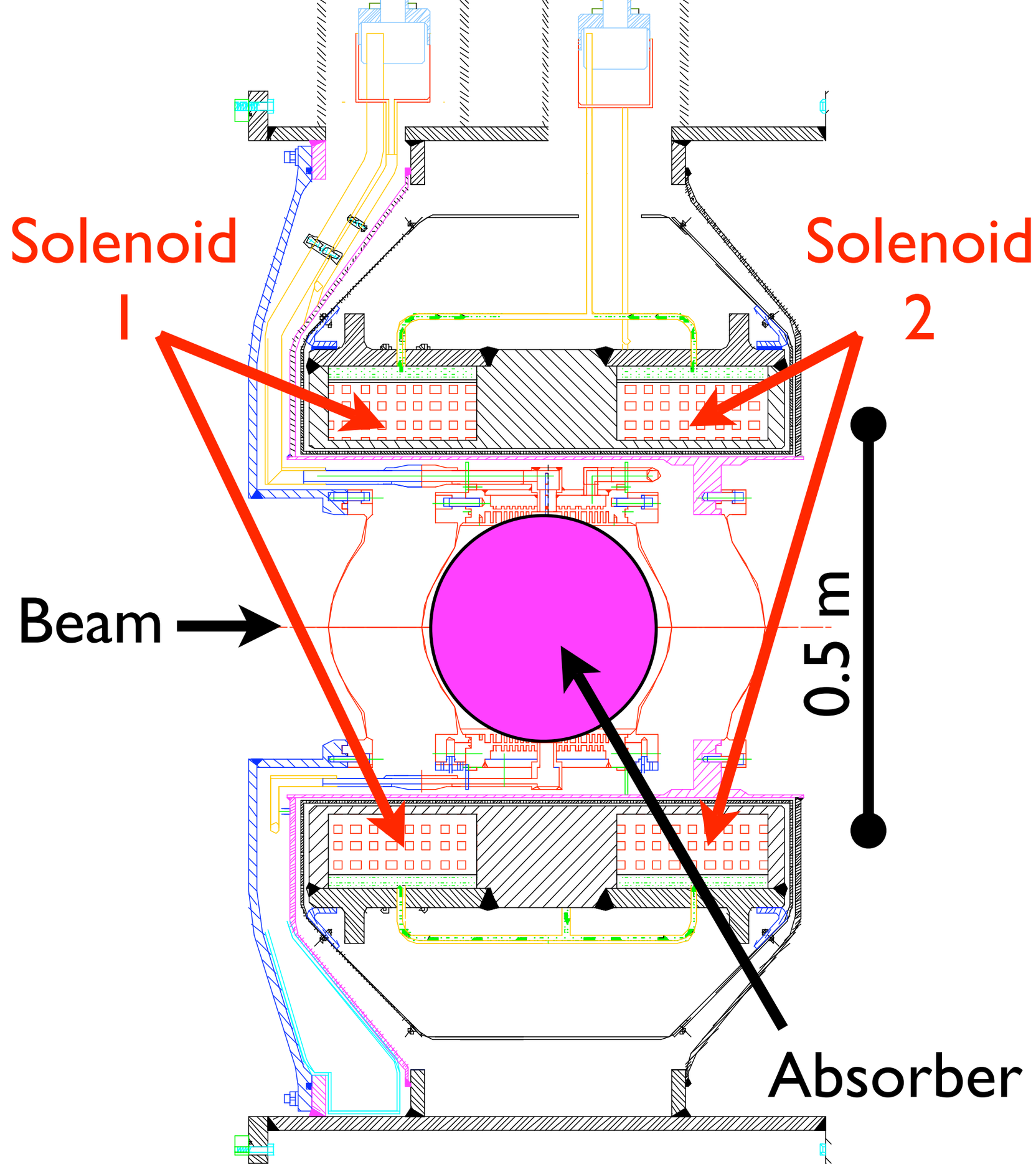
FC Magnet Tolerances

Chris Tunnell
JAI @ Oxford

3-part Question

1. What are our manufacturing tolerances
2. and what needs measuring post-production
3. that a hall probe can measure.





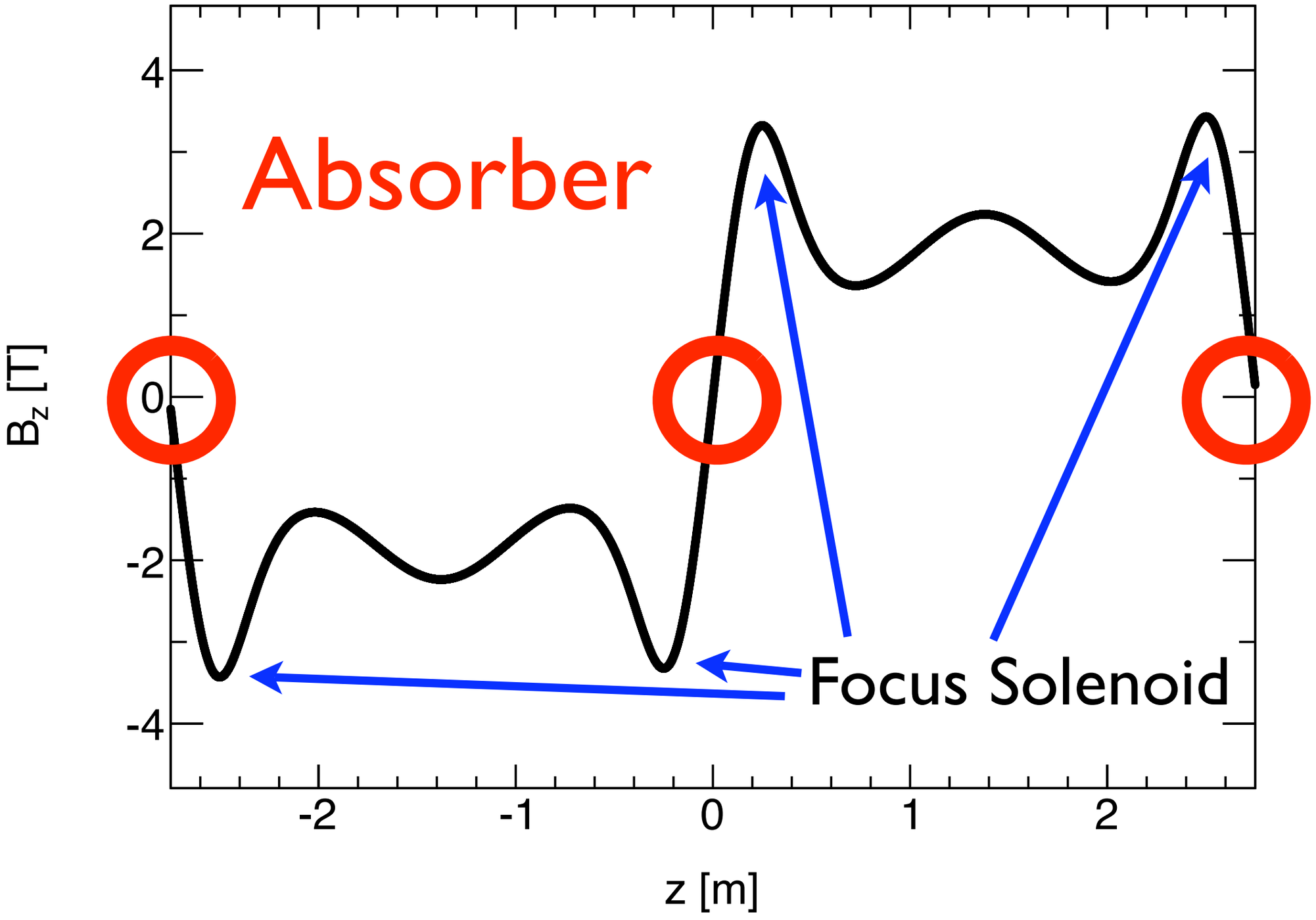
3.9 T

Want β small
at absorber


Thickness most
likely to vary
whilst wrapping

1. What are our manufacturing tolerances

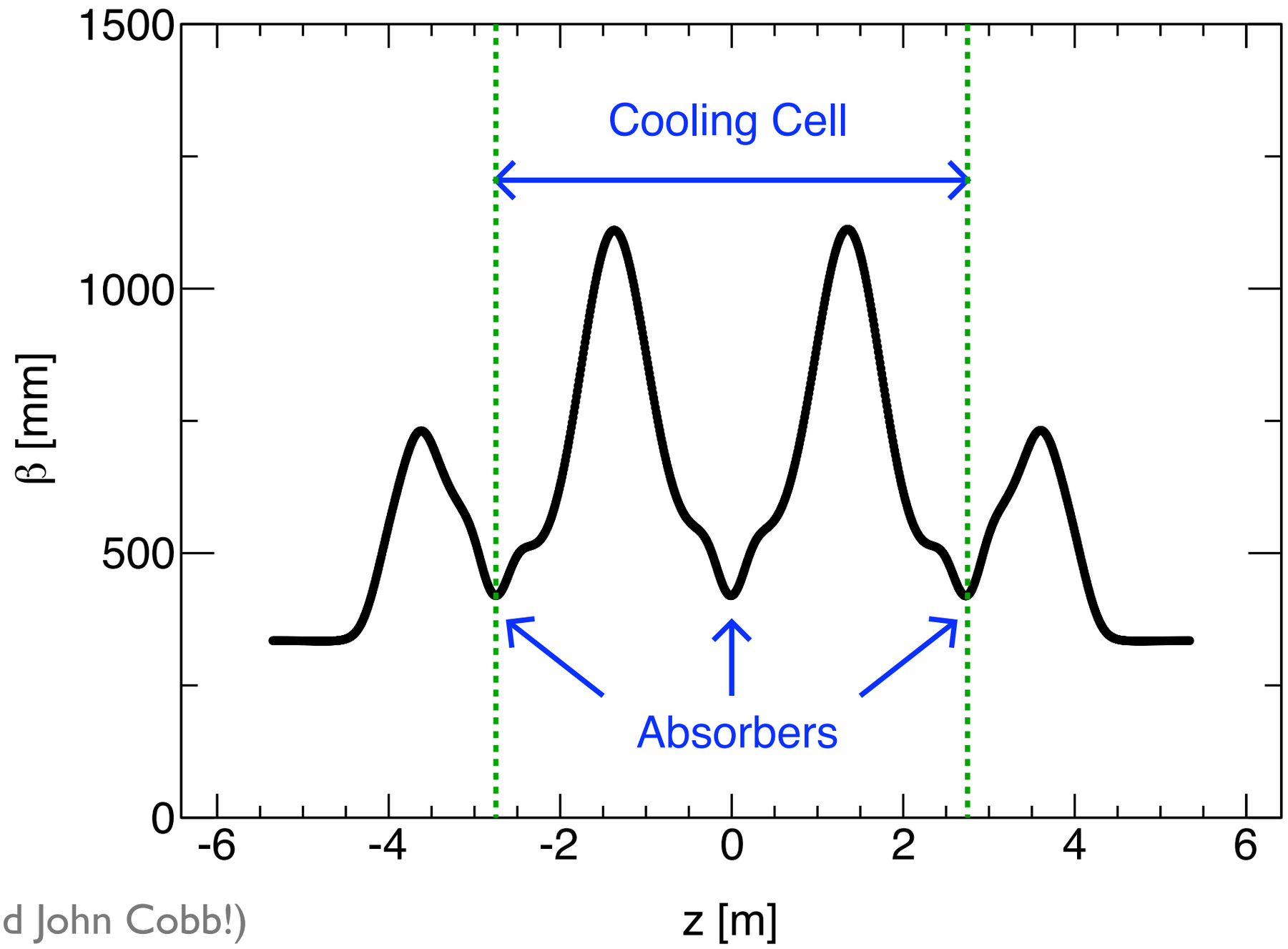
- According to manufacturer, they *may* be ~mm errors in FC thickness
- How does thickness smearing of all FC affect MICE performance?
- Criterion: β does not vary more than 1% in second spectrometer solenoid (ie. have periodic lattice)


Absorber
Focus Solenoid
B_z [T]
z [m]
4
2
0
-2
-4
-2
-1
0
1
2

Evolve β

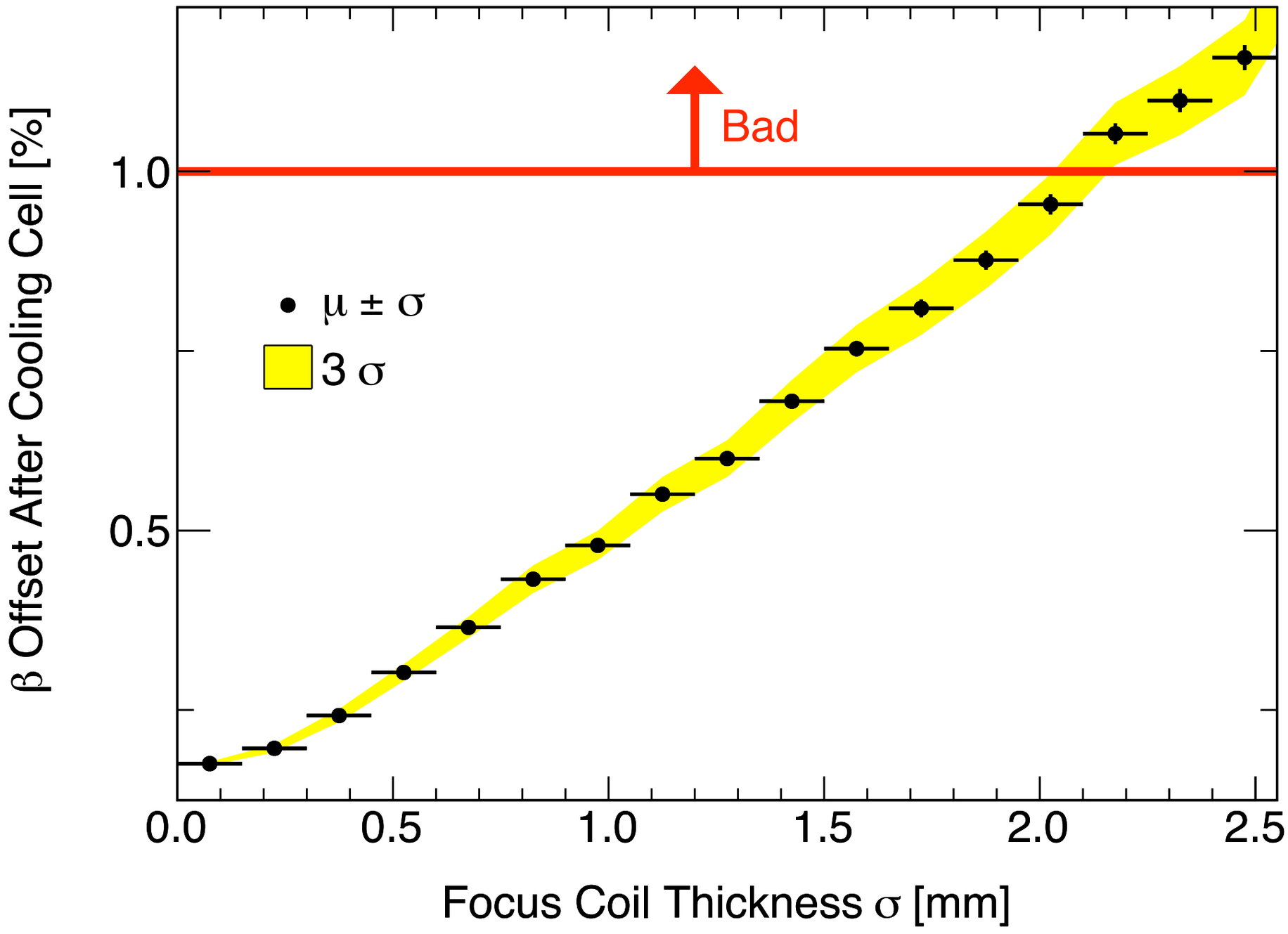
quick finite-difference method, tracking too slow

$$2\beta_T\beta_T'' - (\beta_T')^2 + 4\beta_T^2\kappa^2 - 4 = 0$$



(Thanks Tim Carlisle and John Cobb!)

Varying all 6 FC thicknesses



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2. and what needs measuring post-production

1. Alignment (previously studied)
2. Lattice tuning
3. Heating
4. Other?(track reconstruction uncertainties? winding non-linearities despite large aperture?)

Computing Field

- Field at any point near solenoid
- Opera3D, quick G4MICE, and my numerical integrator agree
- G4MICE equation deviation requires elliptic integral tables and has long history

Derivation of Off-axis Field of Thin-sheet Solenoid or:
How I Learned to Stop Worrying and Trust the G4MICE

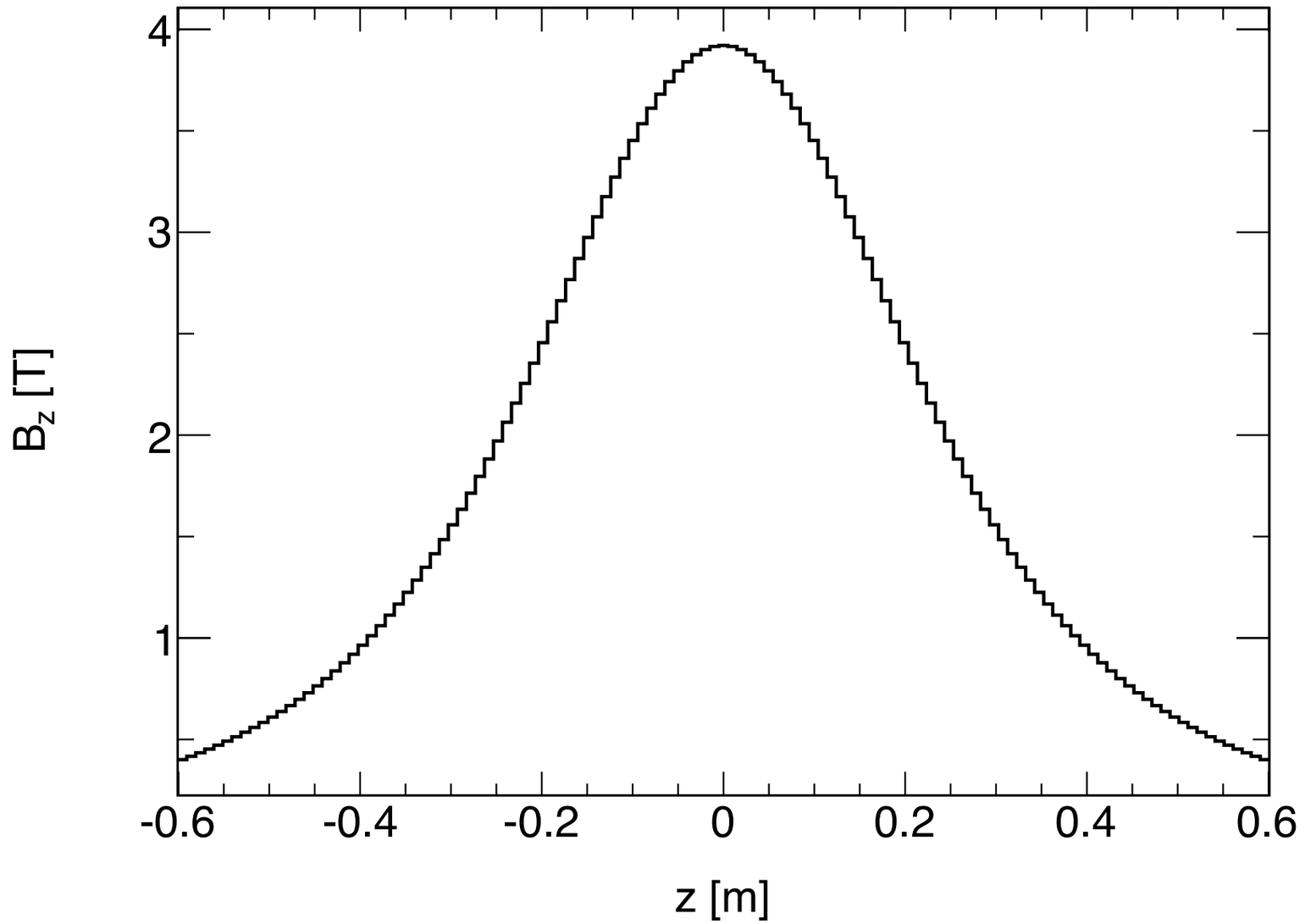
(note coming *soon*)

Focus Strength Single Coil

thin-lens approx. for focal length f:

$$\frac{1}{f} = \frac{q^2}{4p^2} \int B^2 \, \mathrm{d}\, z$$

focus strength related to both heating and lattice



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3. that a hall probe can measure.

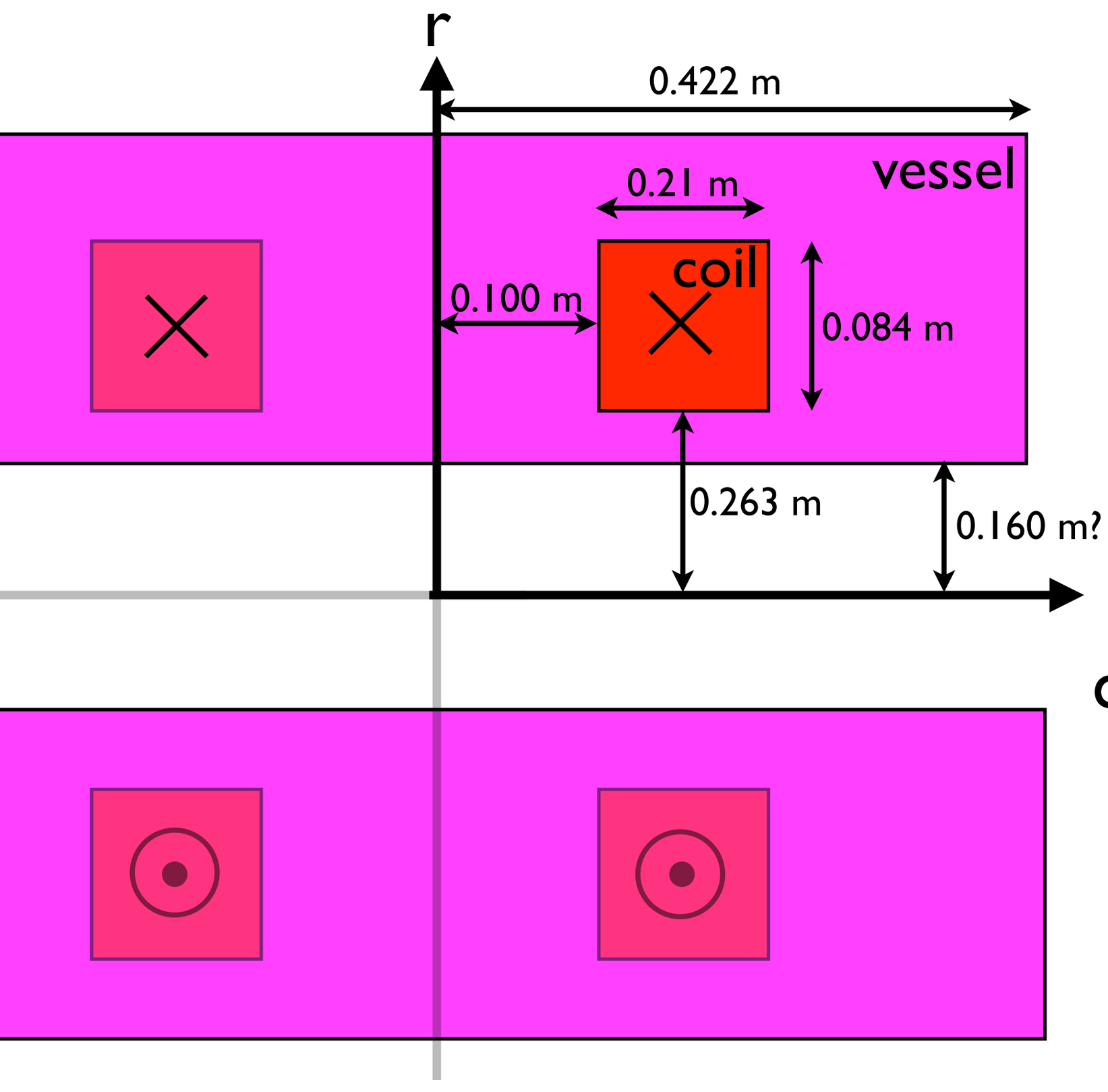
Modern Hall Bench used at DL for insertion magnets.

Hall Probe	MPT-141-3m	(Group 3);
Teslameter	DTM-141-DG	"
Longitudinal Range	1400	mm
Horizontal Range	200	mm
Vertical Range	100	mm
Longitudinal Resolution (z)	1	μm
Horizontal Resolution (x)	0.5	μm
Vertical Resolution (y)	0.5	μm
Nominal Longitudinal Velocity	1	mm/s
Maximum Calibrated Field	2.2	T
Hall Probe Precision	± 0.01 %	
Hall Probe Resolution	0.05	mT
Temperature Stability	± 10	ppm/°C

bad?

good?

FC Parameters can fit



global: Δr, Δx, φ, θ

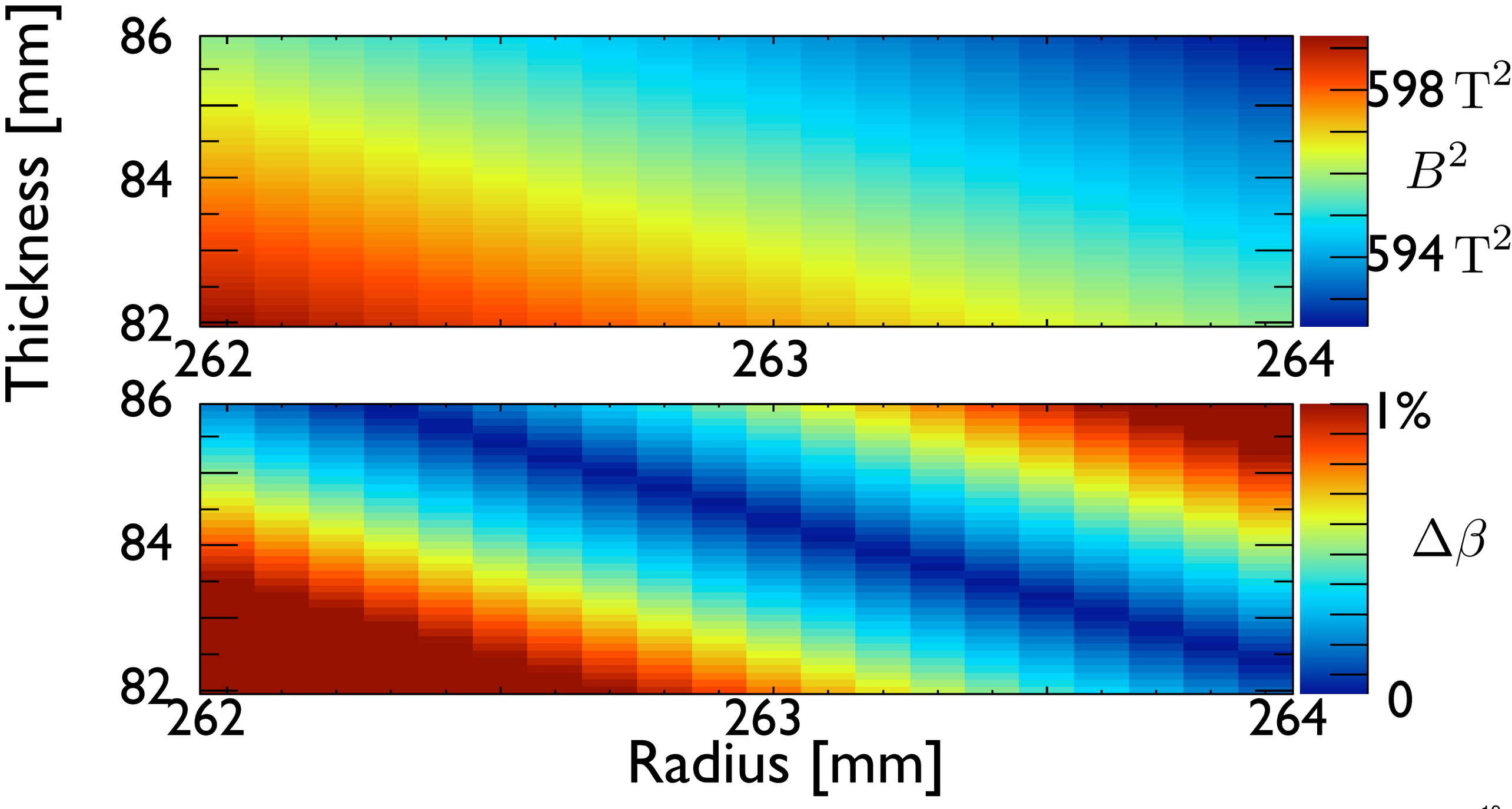
Symmetric about z = 0 and r=0

current: $113.9\ \mathrm{A/mm^2}$

overkill?

B^2 ~ tuned lattice

$$\frac{1}{f} = \frac{q^2}{4p^2} \int B^2 \, \mathrm{d}\, z$$



Thickness [mm]

86
84
82
262
263
264

3.94 T
B
3.92 T

86
84
82
262
263
264

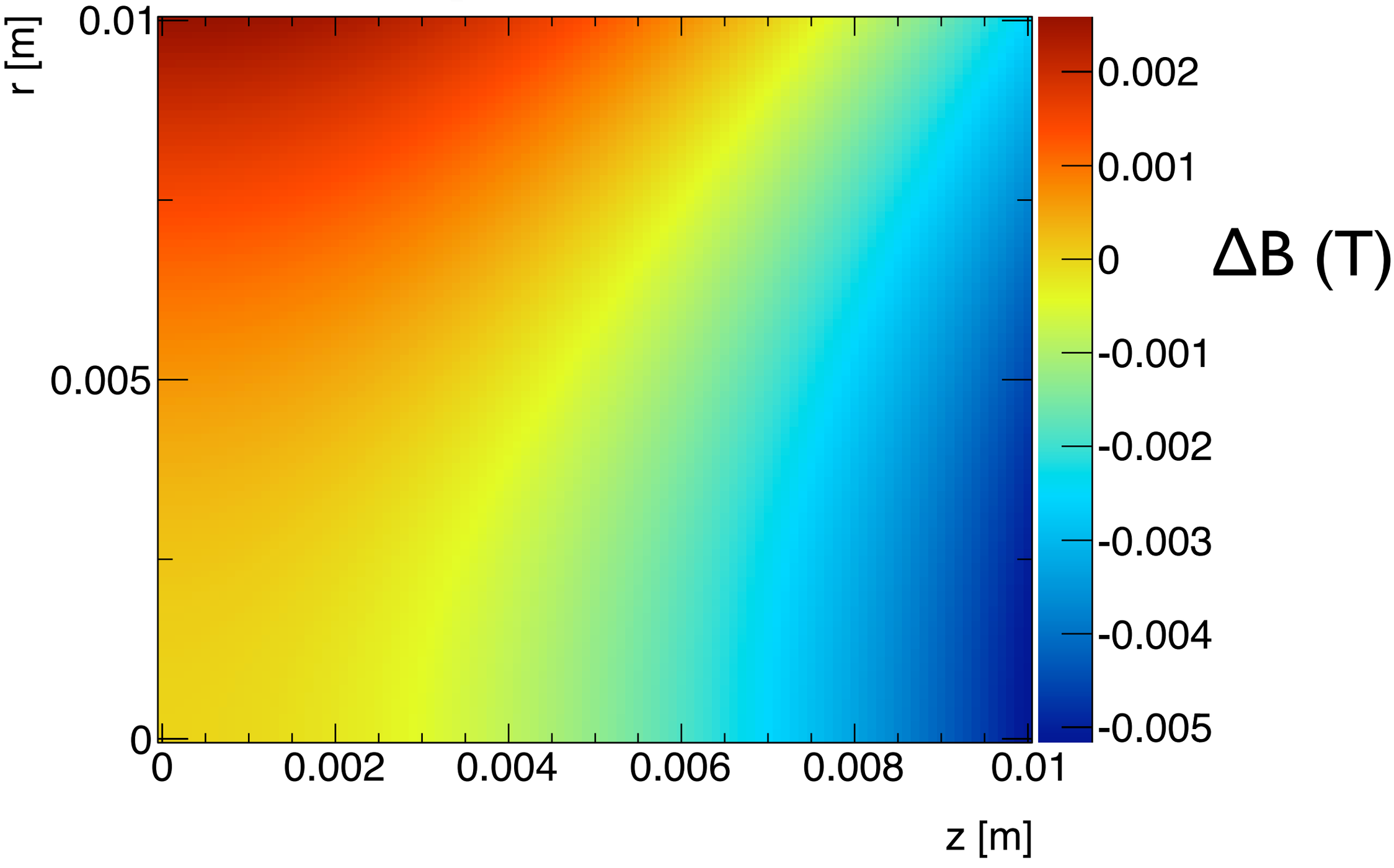
598 T^2
B^2
594 T^2

86
84
82
262
263
264

1%
$\Delta\beta$
0

Radius [mm]

Weak probe position dependence



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Conclusions

- Coil thickness should be built within 2 mm
- Preliminary constraints on FC post-construction are easy to measure
- TODO: what other constraints are there?
- TODO: where can we find a hall probe?