MICE Shielding

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MICE Single Shielding Option

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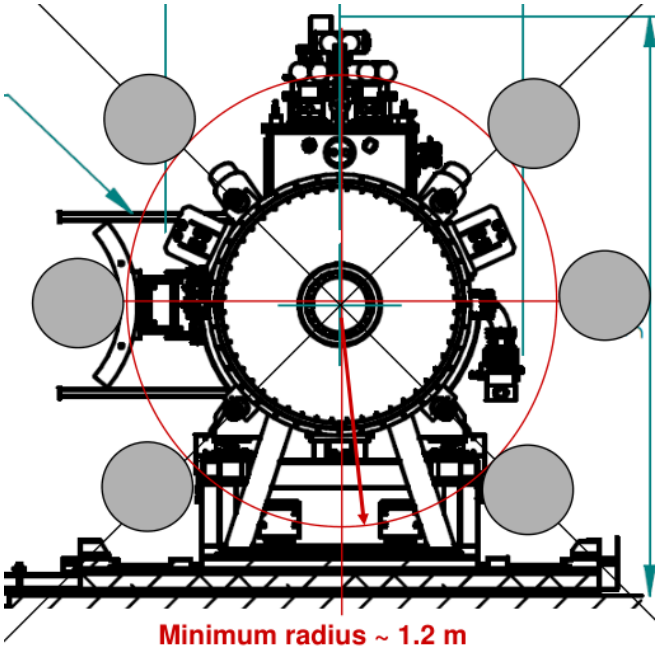
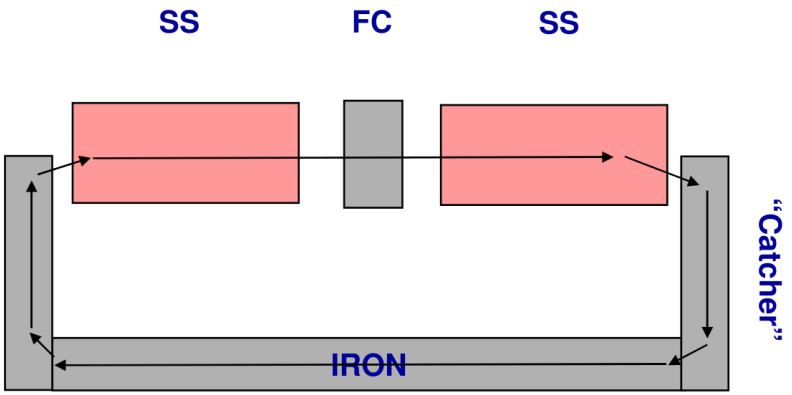
- Aim: identify single shield solution
  - one iron shield which makes shielding of individual components unnecessary
  - Initially only for Stage IV, but should also work for Stage VI (or upgradable)
- Explore shielding options
  - shield geometry probably does not fit
  - important: general principles
  - also means: need engineering effort for integration
- What has been done so far?
  - initial studies studying effectiveness of different shielding approaches (multiple bars, flux catchers, cylinders, …)
  - effect of shielding on field of MICE
  - effect on Q9 and TOF cage

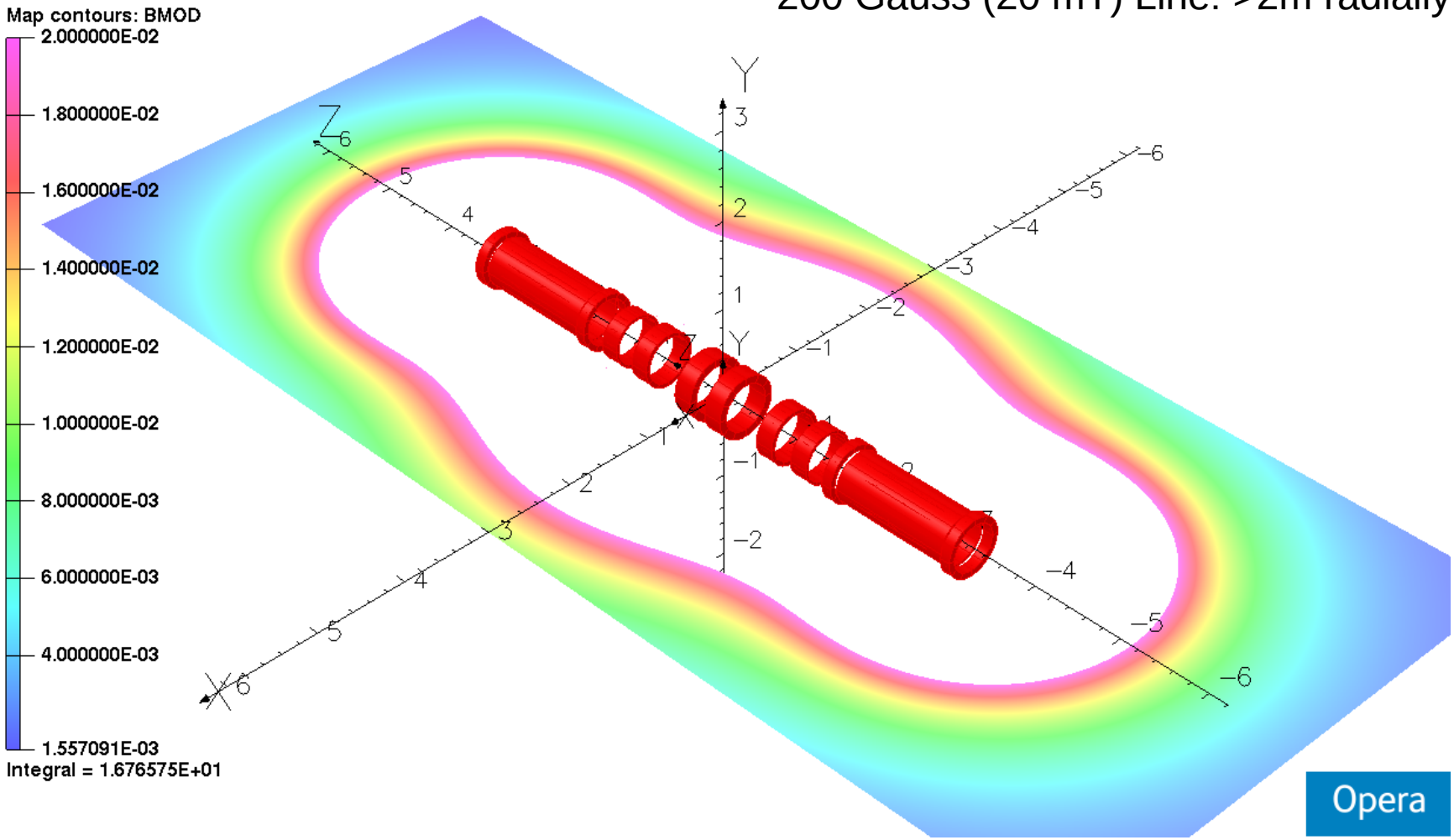
Things which don't work

- Flux return path with multiple iron bars (4/6/8/…)
  - poor shielding performance (~2)
  - reason: large gaps between bars allows flux to escape
  - gets slightly better with increase in diameter and number of bars
- Flux catchers / end caps (in combination with bars)
  - catch only (some) flux from spectrometer



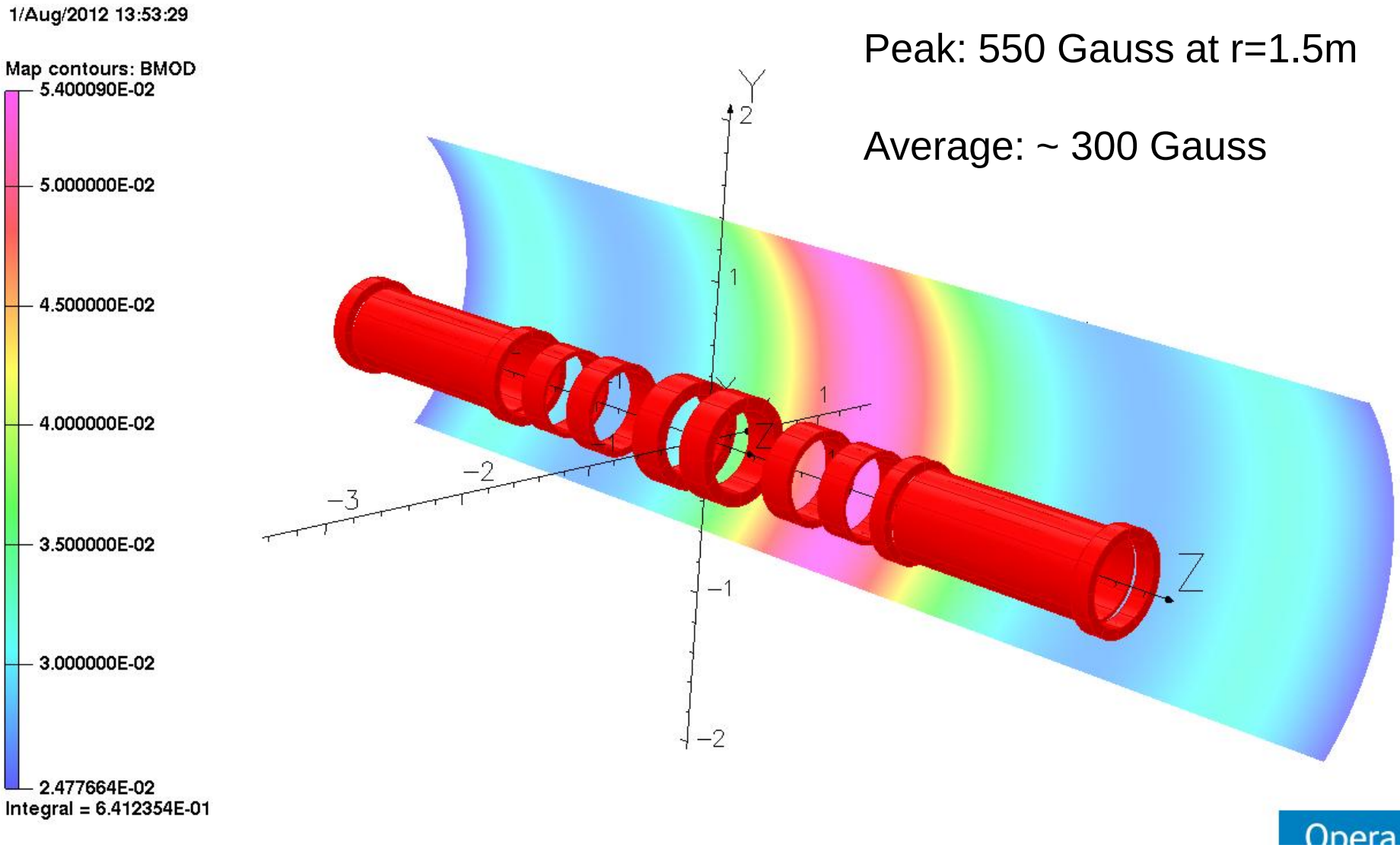


Initial Fields



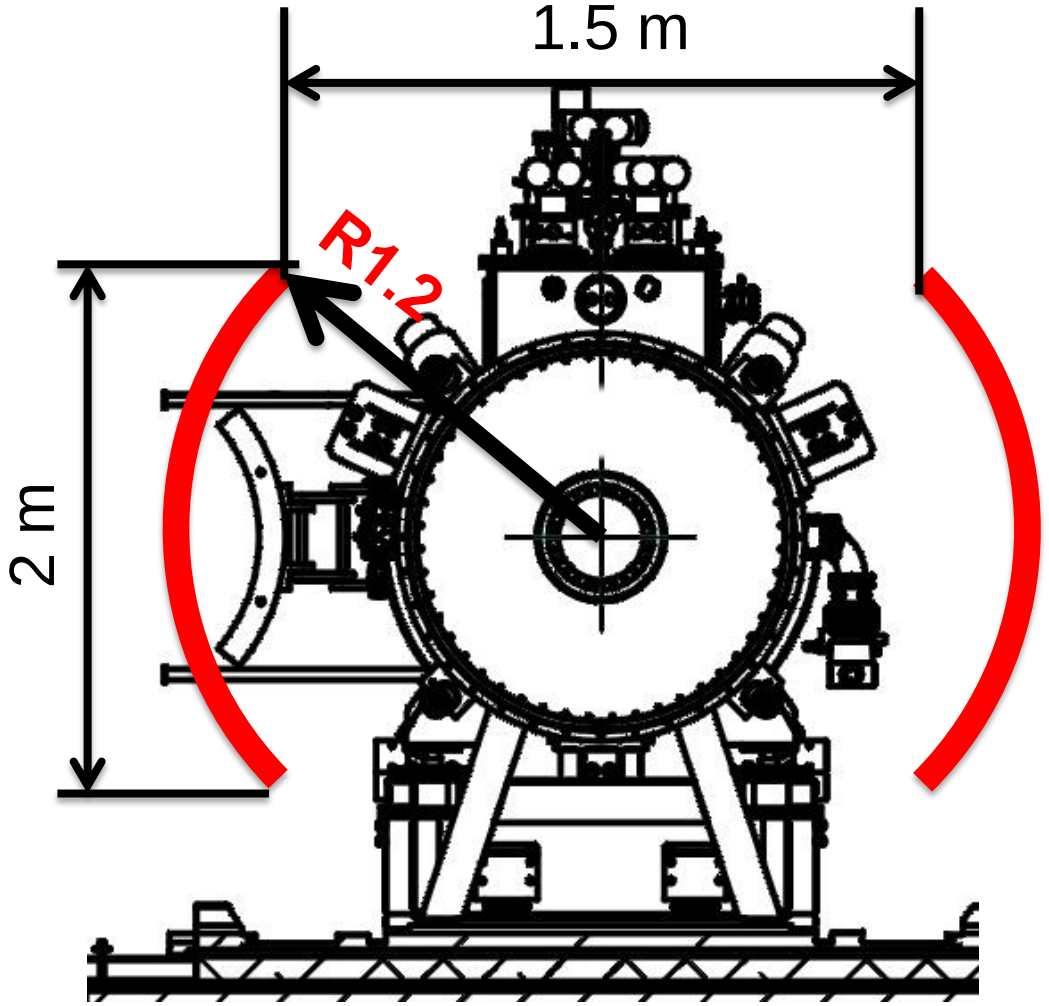
Simulation: Stage IV, 200 MeV flip, no iron

Initial Fields

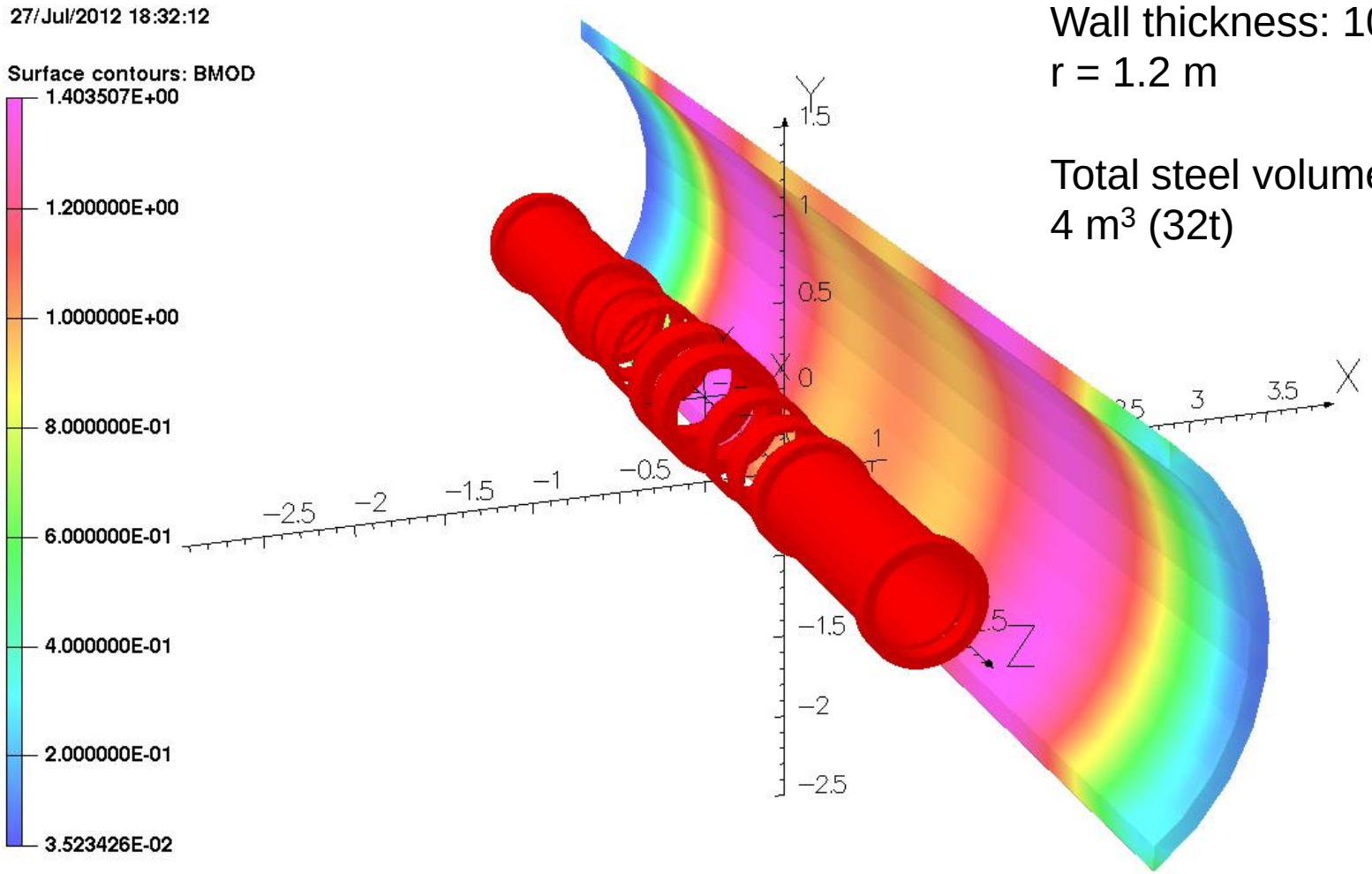


Quarter Tubes

- (Note: not to scale)
- To get good shielding horizontally: need continuous steel in azimuthal direction
- Geometry
  - Tube of radius 1.2 m
  - wall thickness 10 cm
  - hor. cut-out of 1.5 m
  - Length: 9 m
- breaks symmetry, will come back to this later



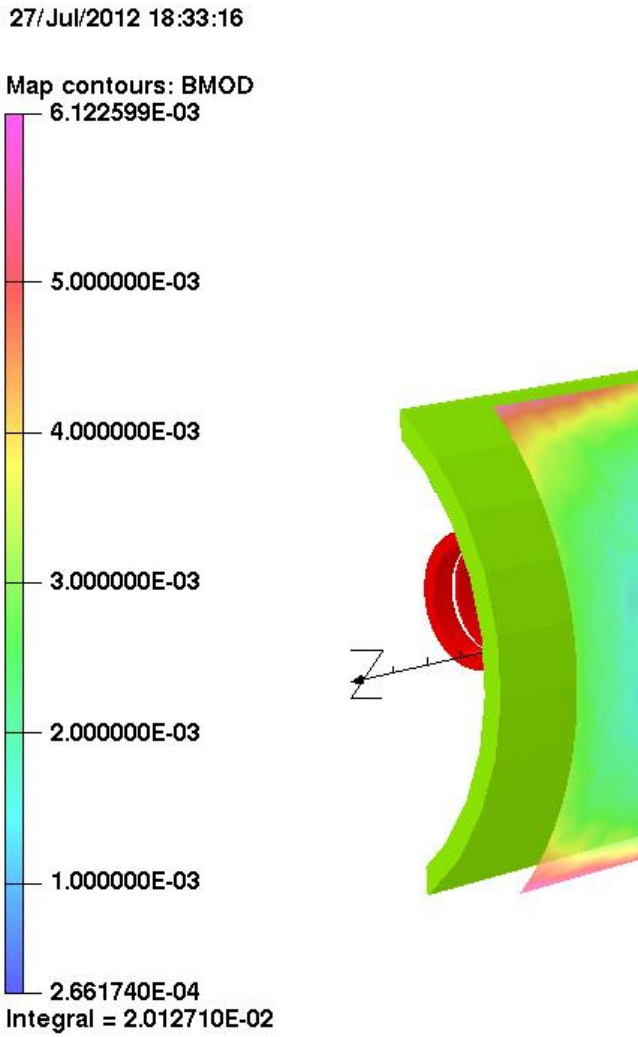
Magnetization

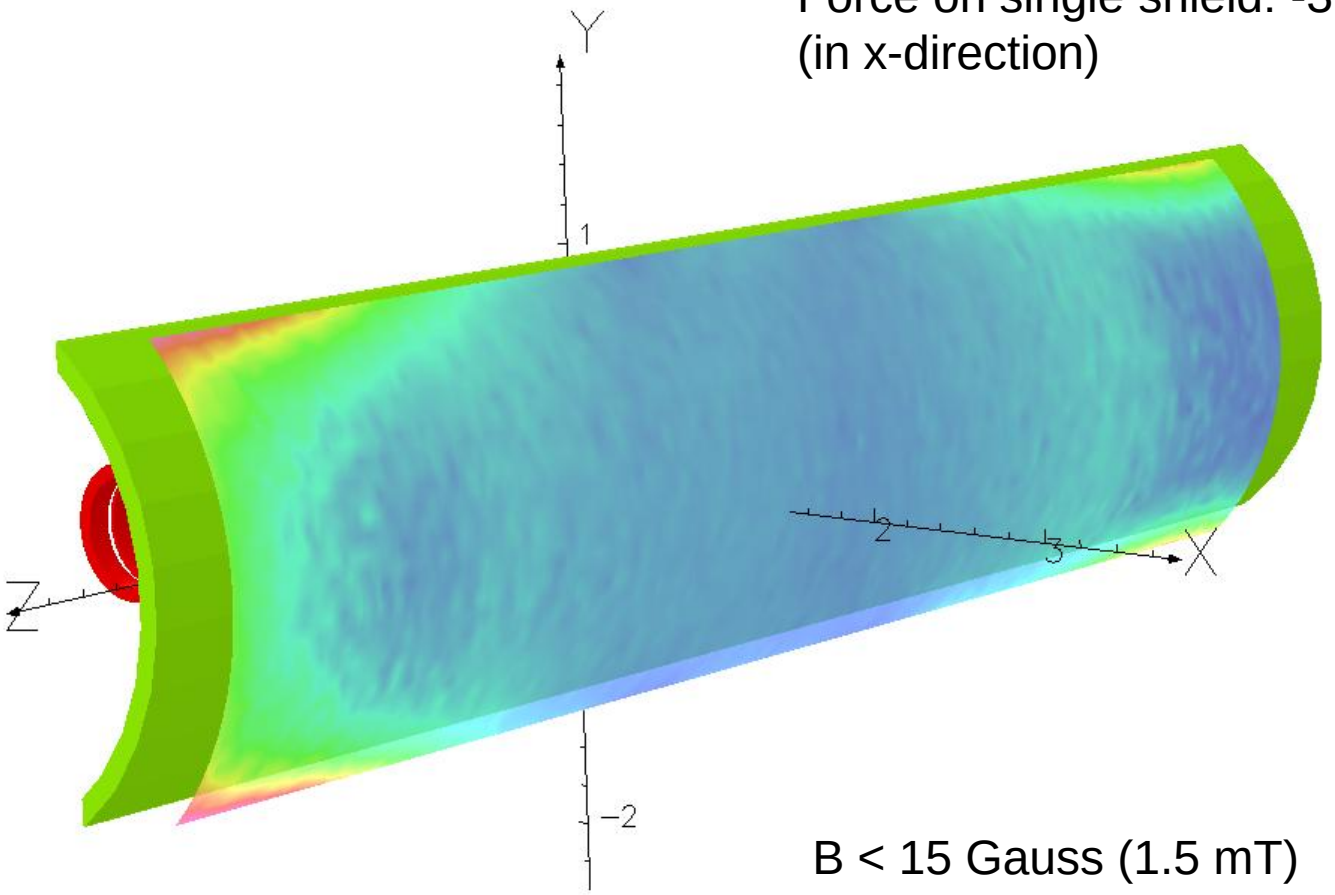


Wall thickness: 10 cm
r = 1.2 m

Total steel volume:
4 m^3 (32t)

Step IV, 240 MeV, Flip



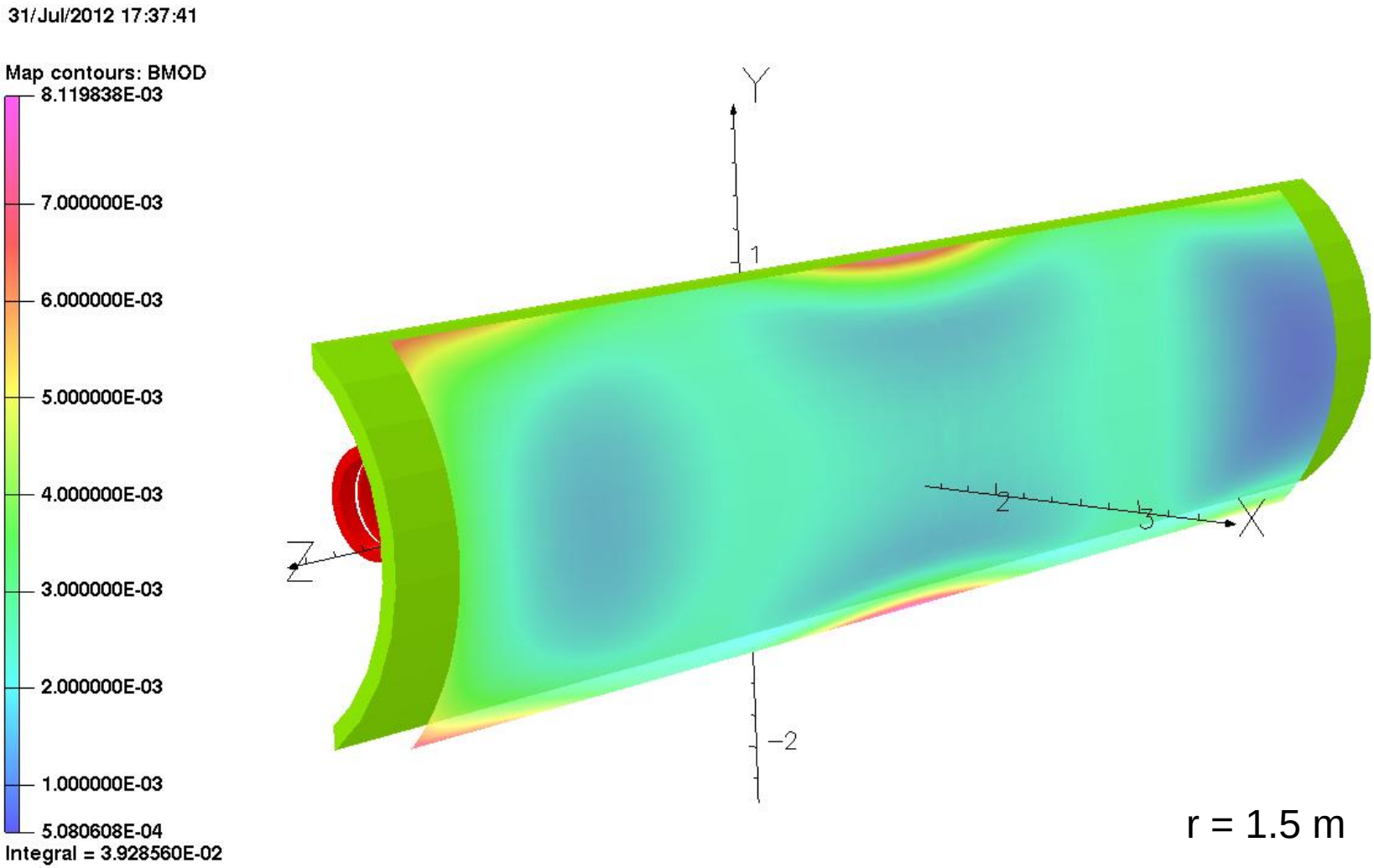


Force on single shield: -36 kN (in x-direction)

B < 15 Gauss (1.5 mT)

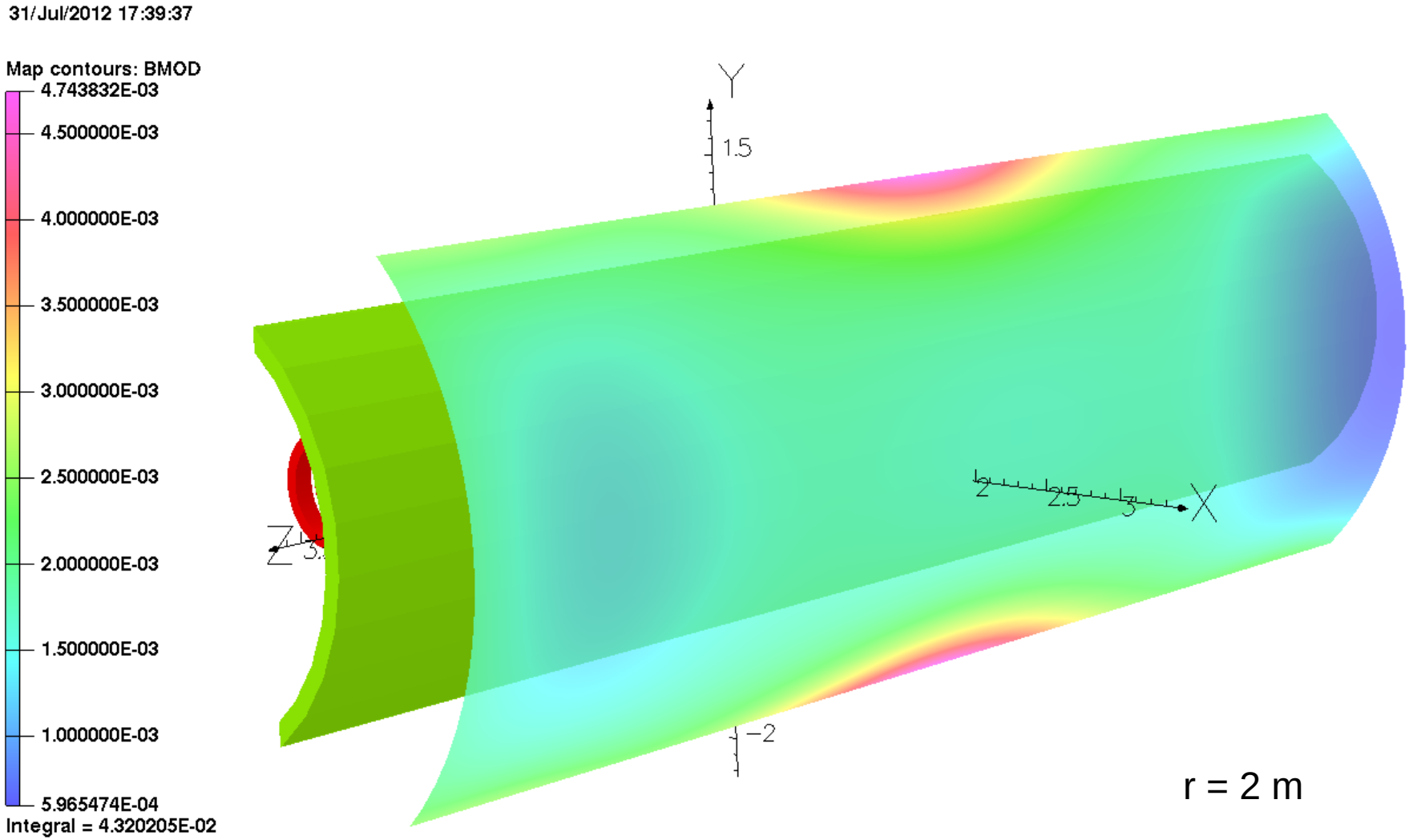
240 MeV/c

Development of Fringe Field

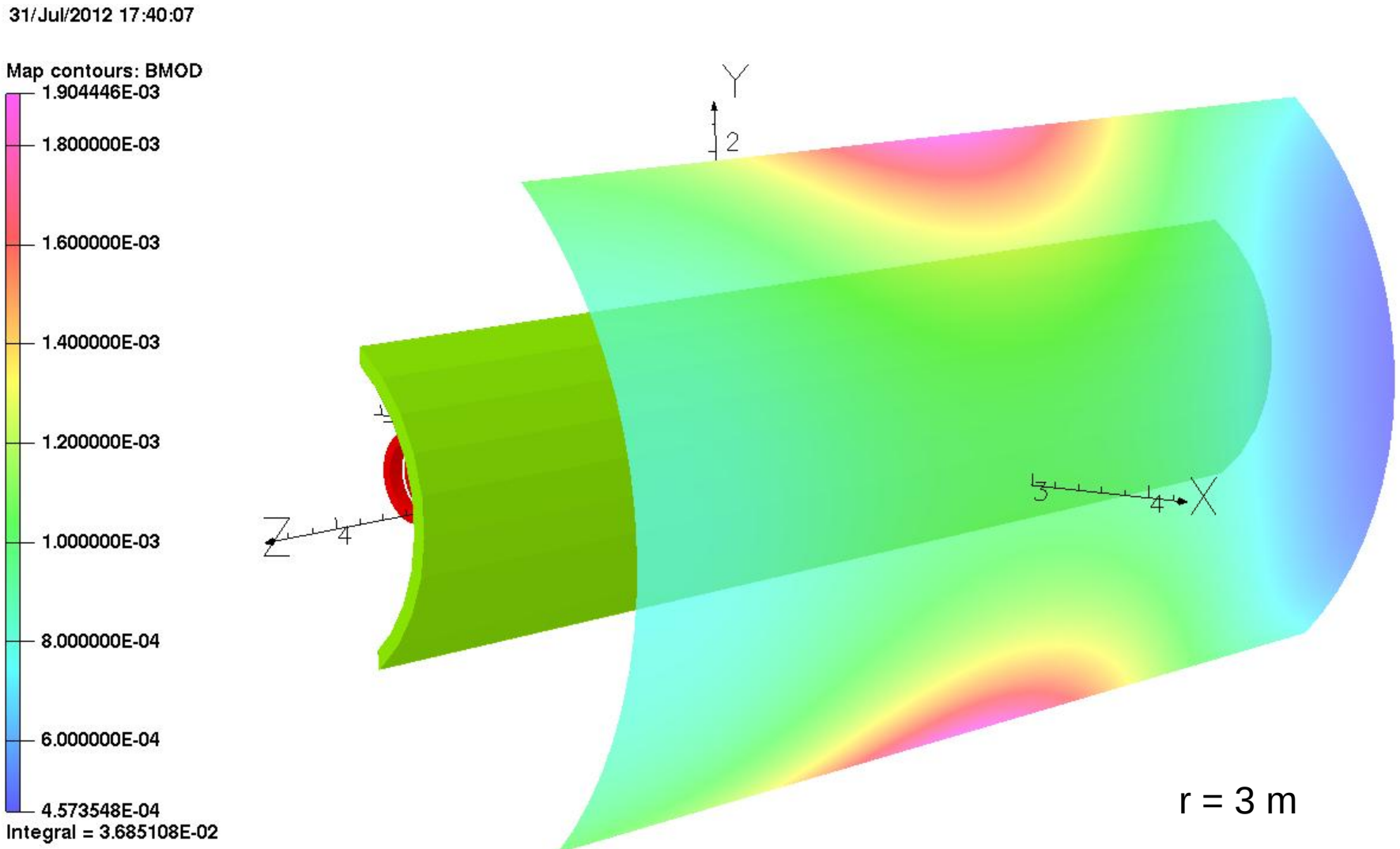


r = 1.5 m

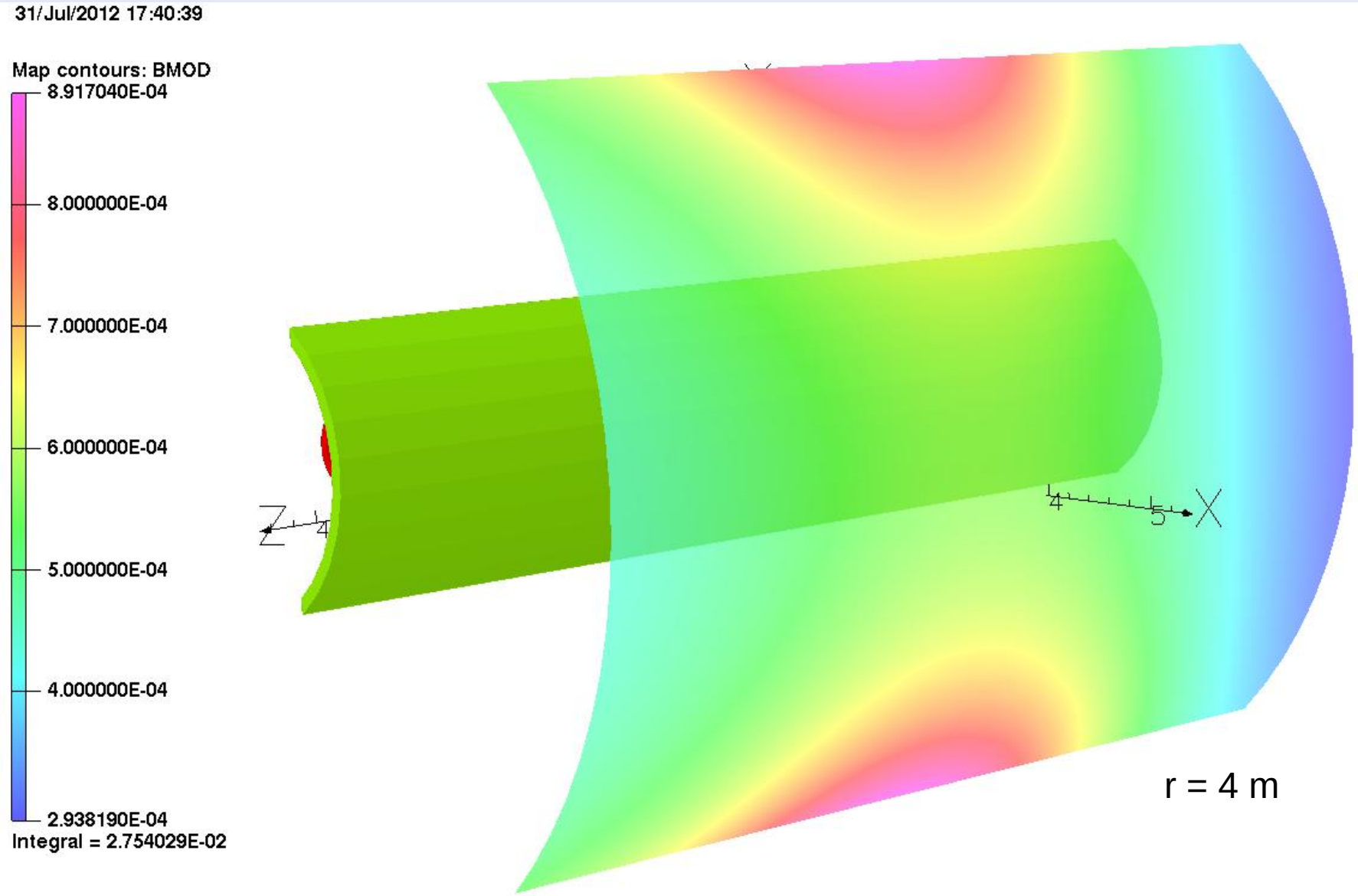
Development of Fringe Field



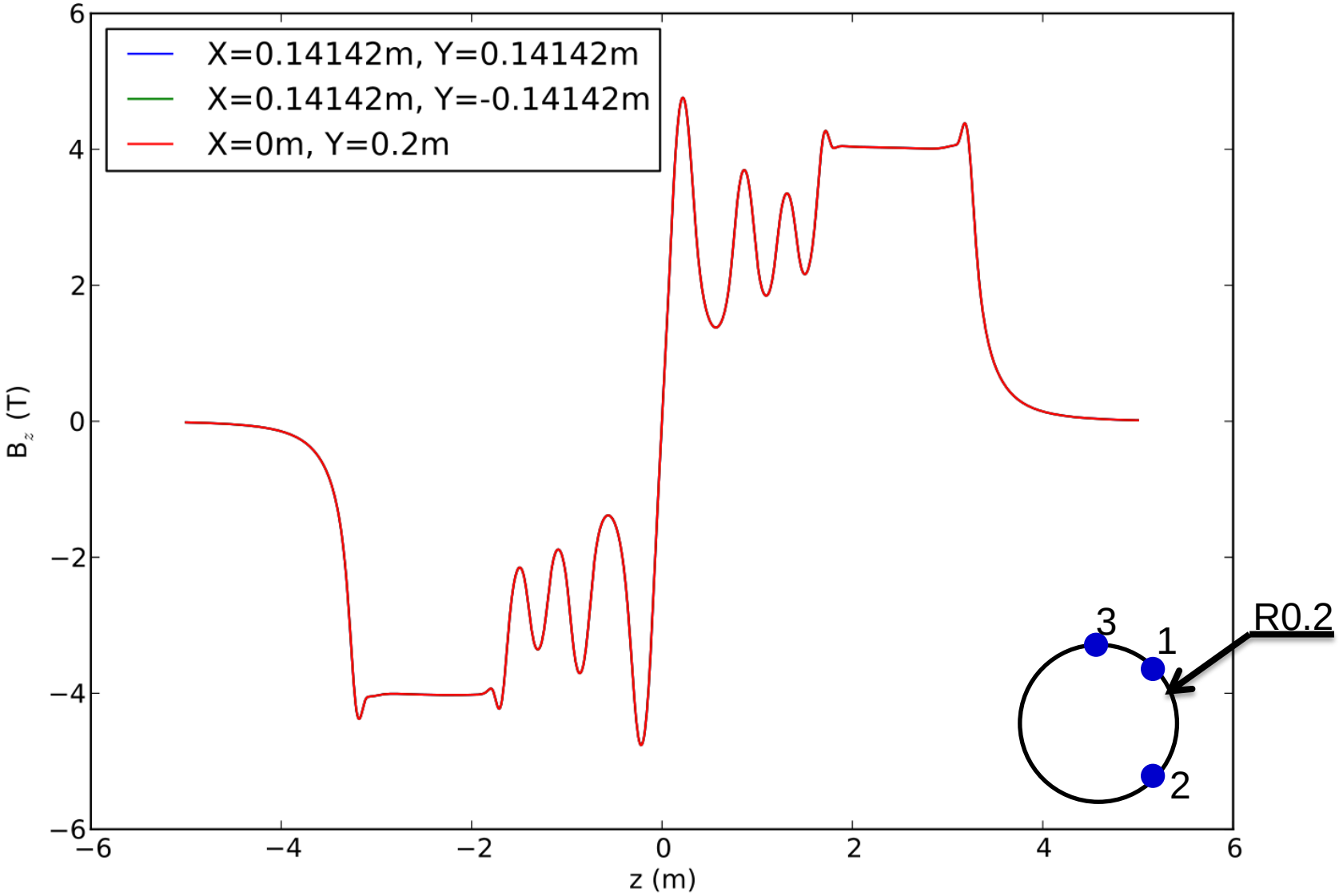
Development of Fringe Field



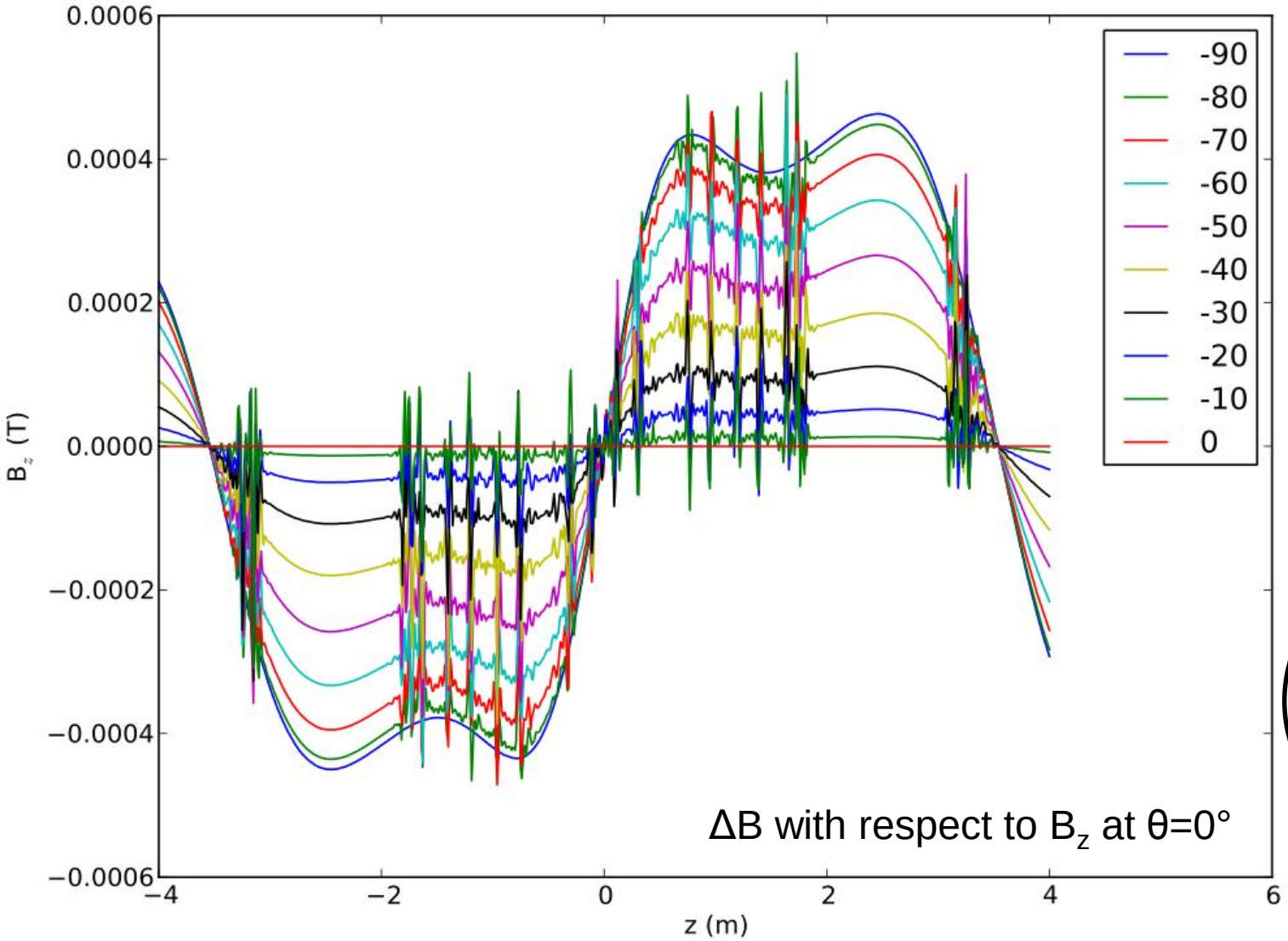
Development of Fringe Field

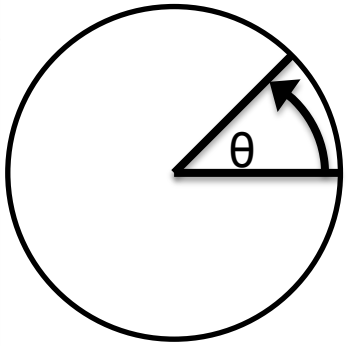


Effect on Field in Channel

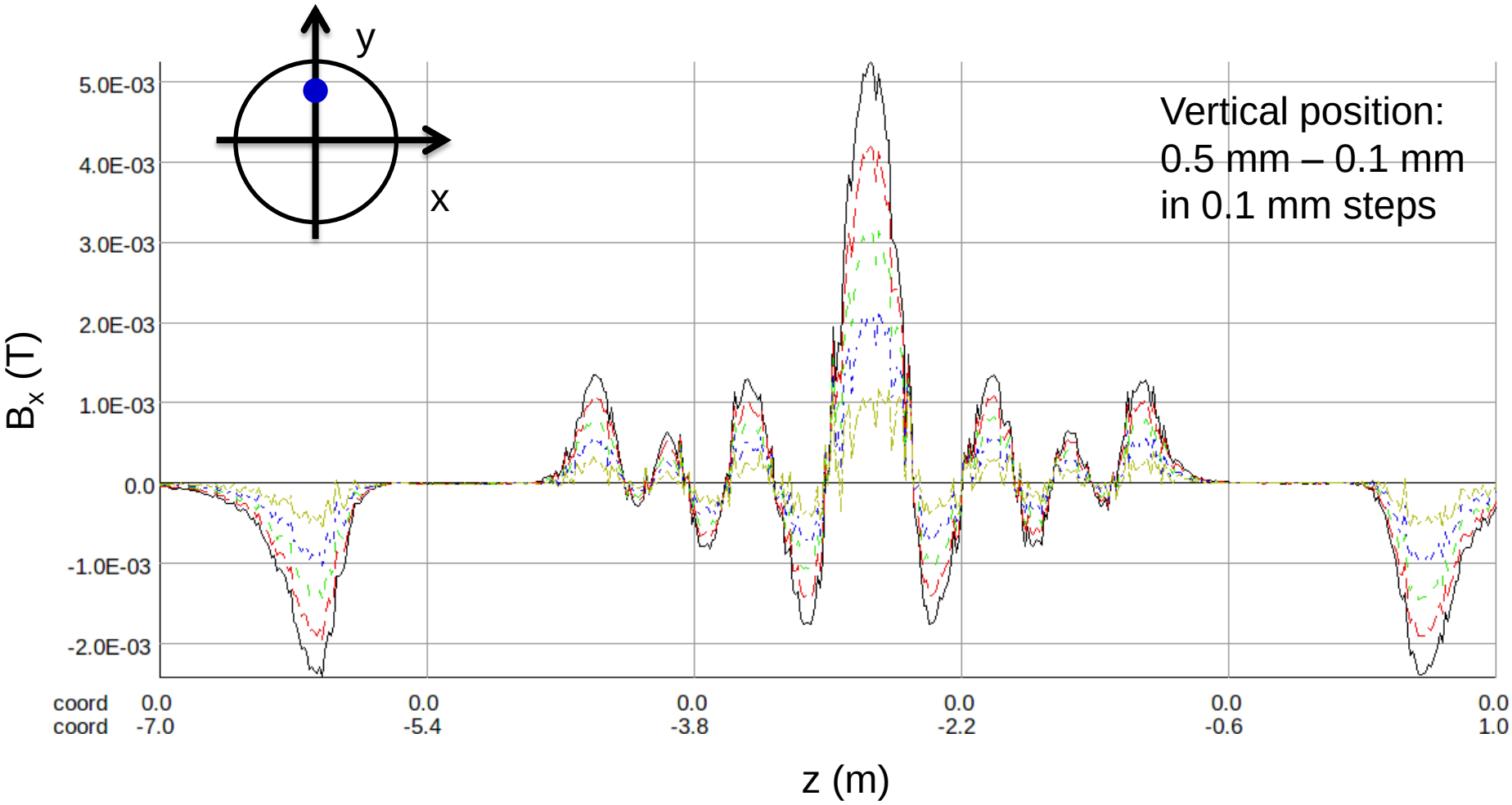


Effect on Field in Channel



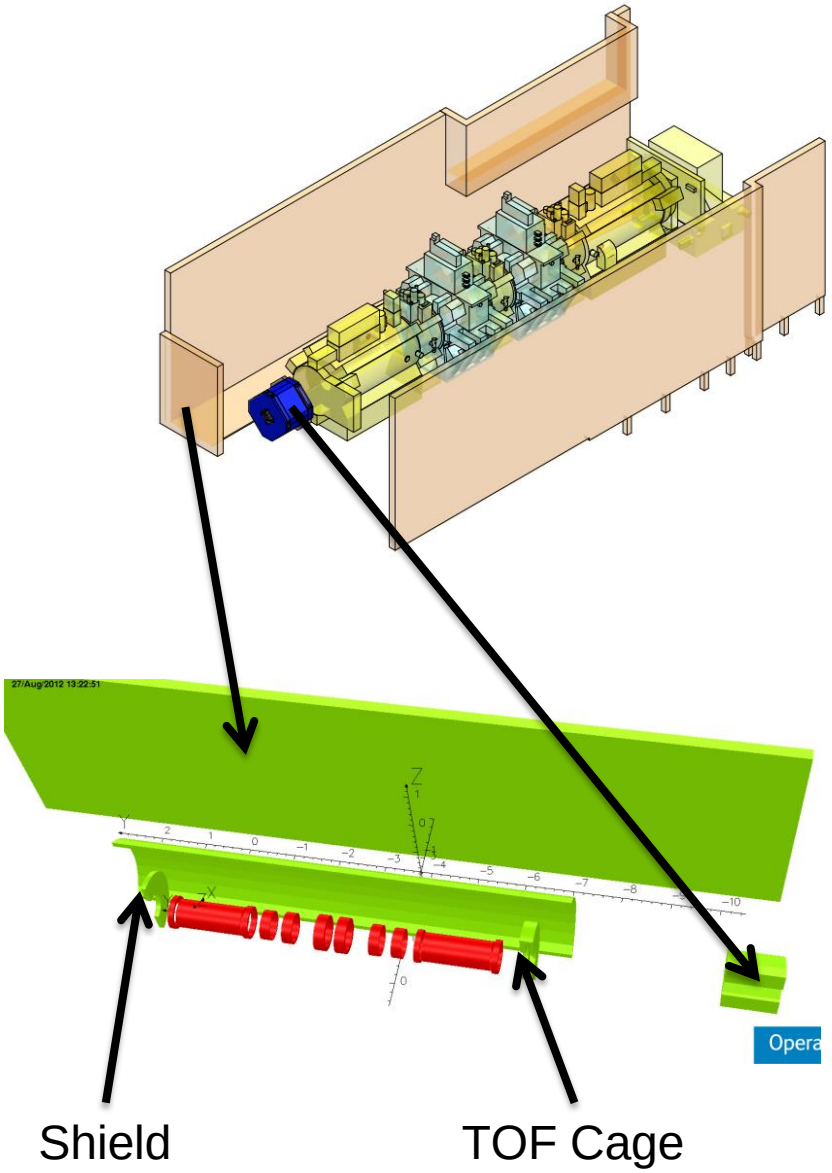


Effect of Shield on Field



Additional Iron Structures

- Additions:
  - ‘Virostek’ shields
  - TOF cage
  - Quad Q9
- Geometry: SAT file from Jason Tarrant
- Geometry simplifications
  - Q9: ignore pole faces
  - walls: simple plates hor. 4m away on either side



Quad Q9

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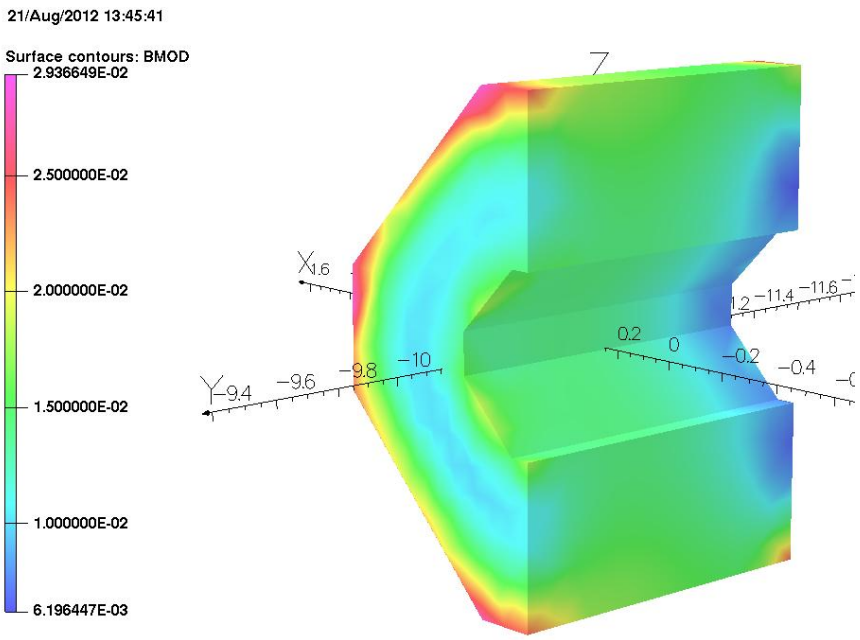
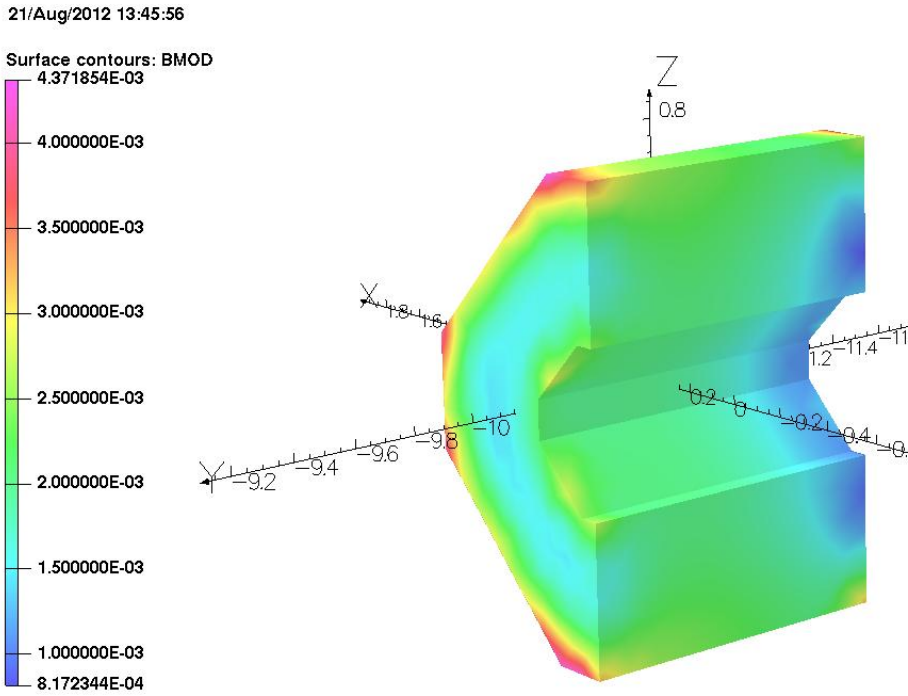
No Shield: 15mT



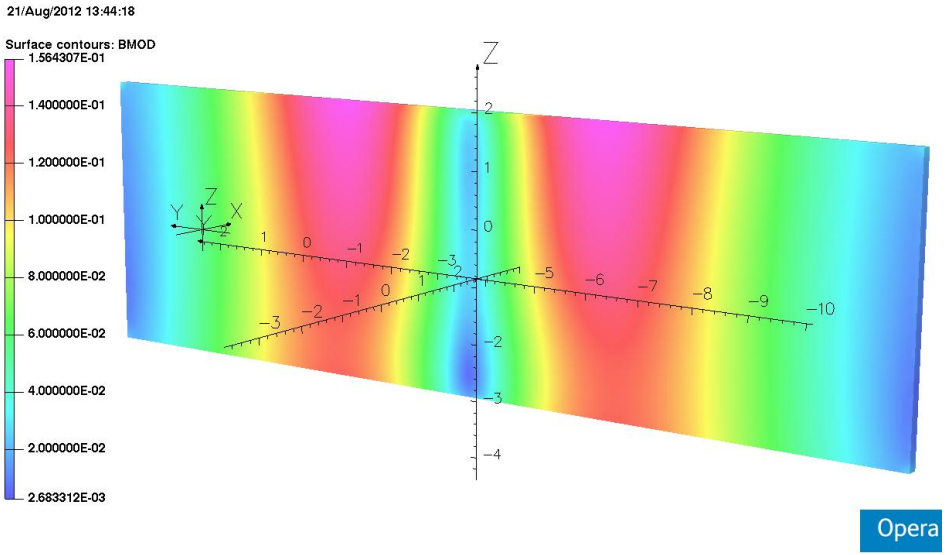
Shield: 2.5 mT



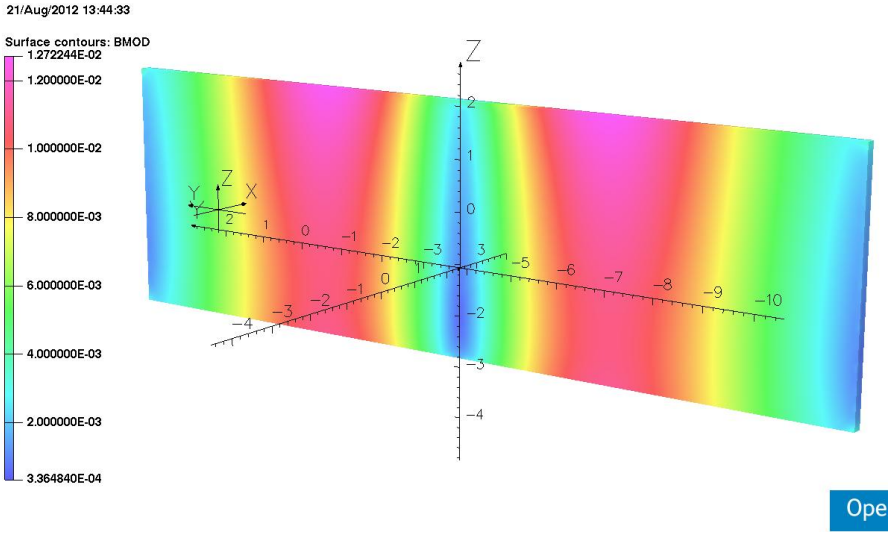
Reduction of factor 7

Walls

No Shield: 150 mT (peak)

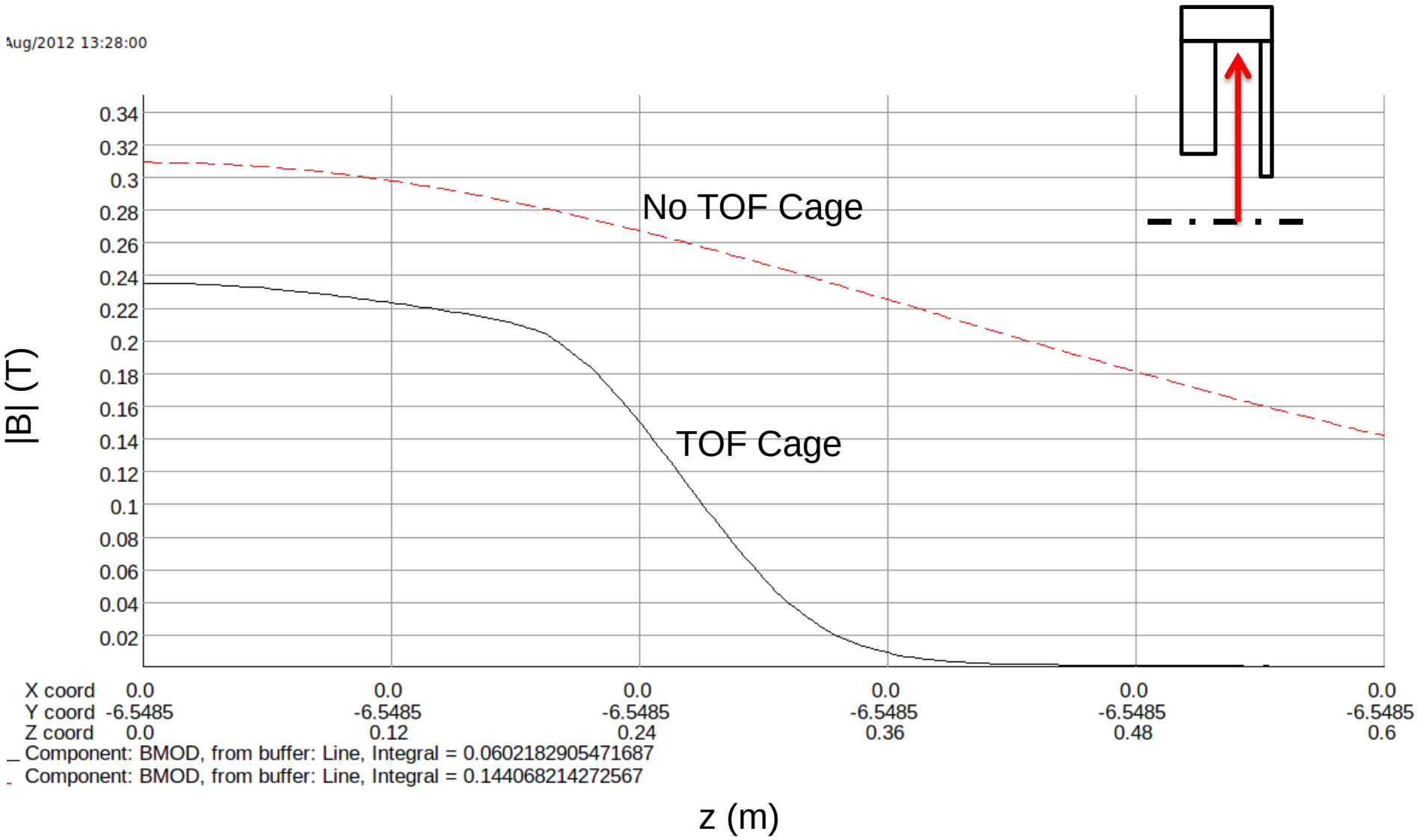


Shield: 12 mT (peak)



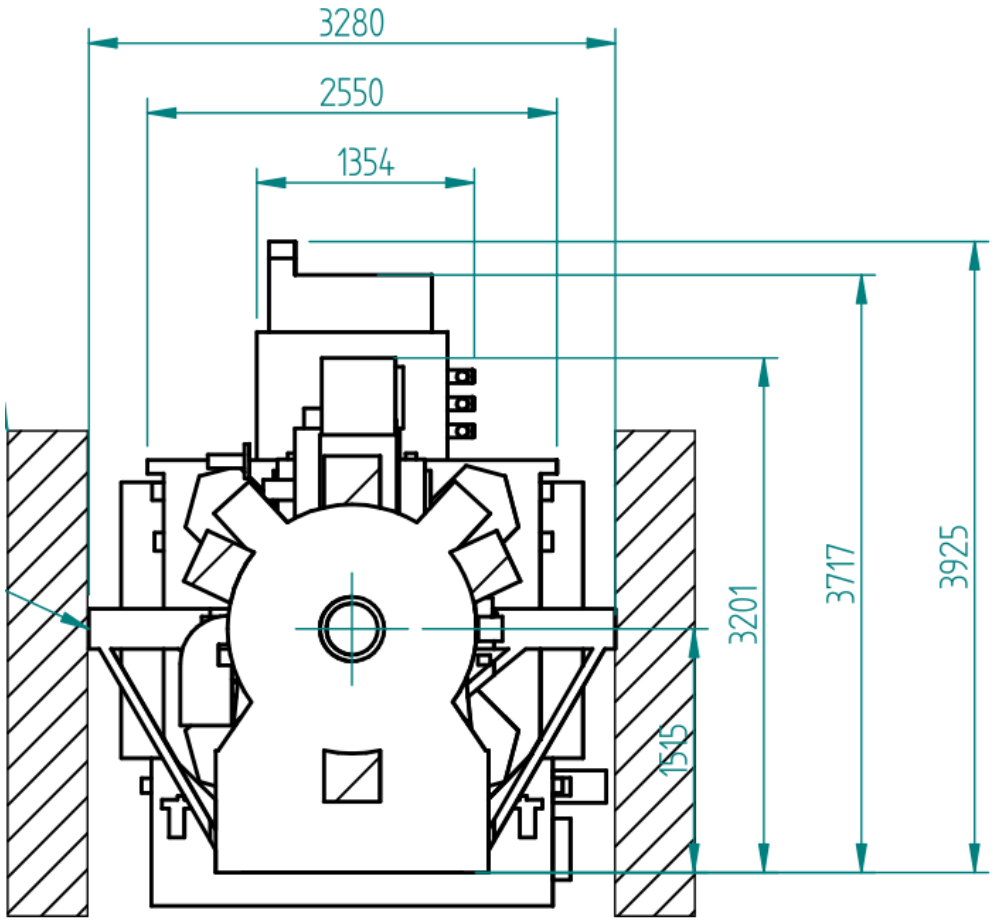
Reduction of factor 10+

Field in TOF Cage



Options for Extension MICE Stage VI

- MICE stage VI: significantly larger in diameter
  - Coupling coils
  - RF waveguides
- Adaption of scheme possible?
- Ideally:
  - single scheme for both scenarios
  - Or: possibility of modification



MICE Stage VI

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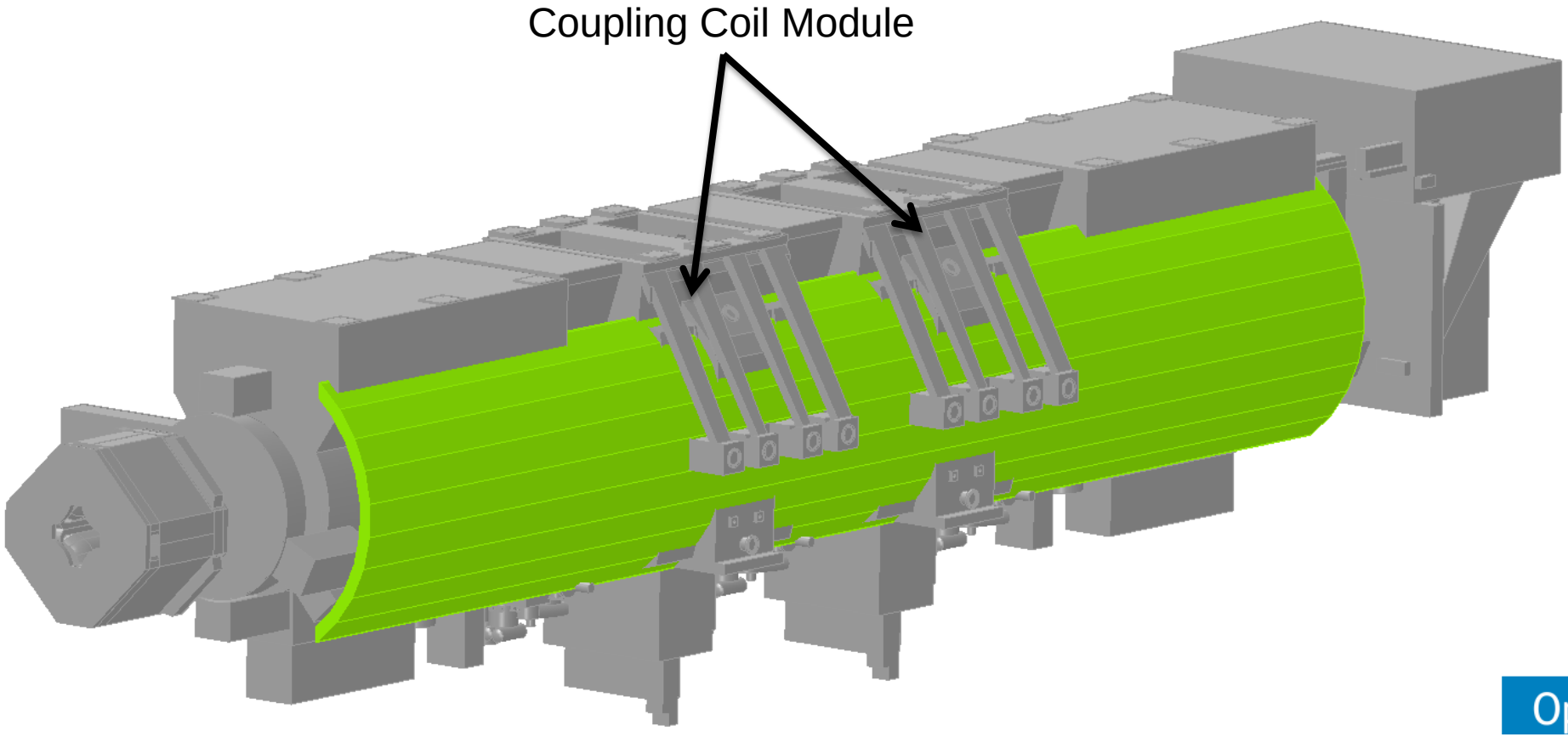

MICE Stage VI CAD file provided by Jason Tarrant

MICE Stage VI – Option 1

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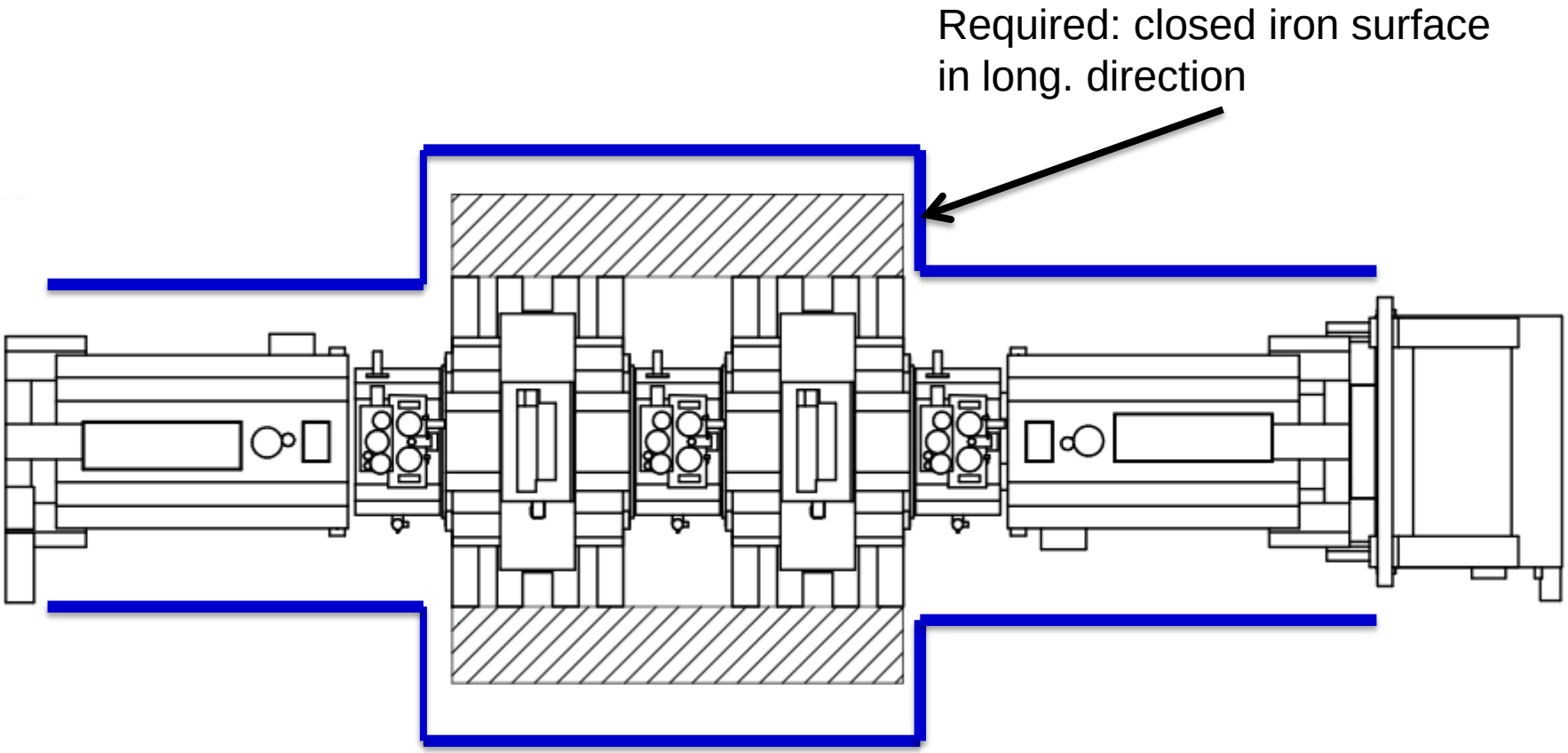

MICE Stage VI – Option 1

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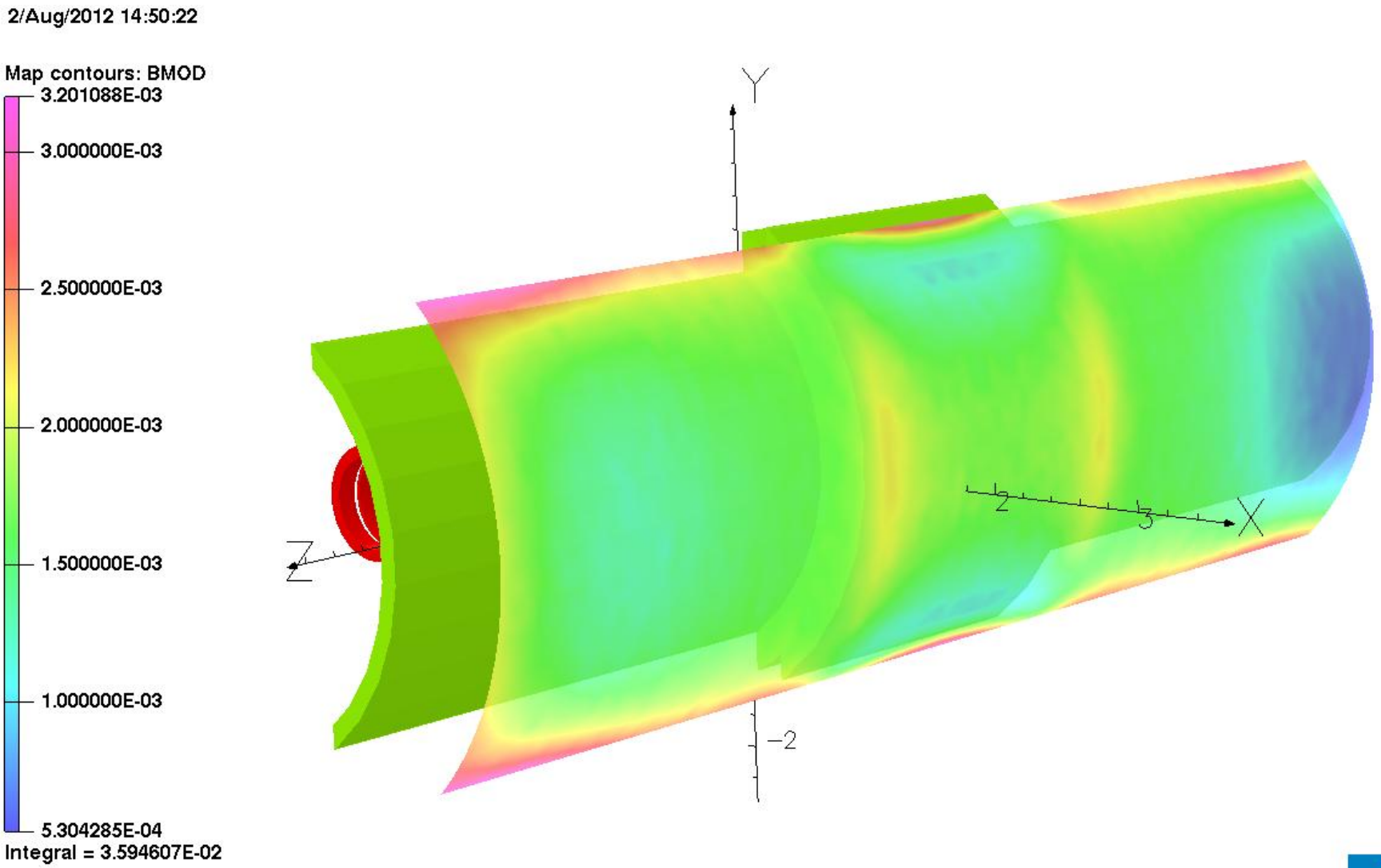

r=1.5m

MICE Stage VI – Option 2

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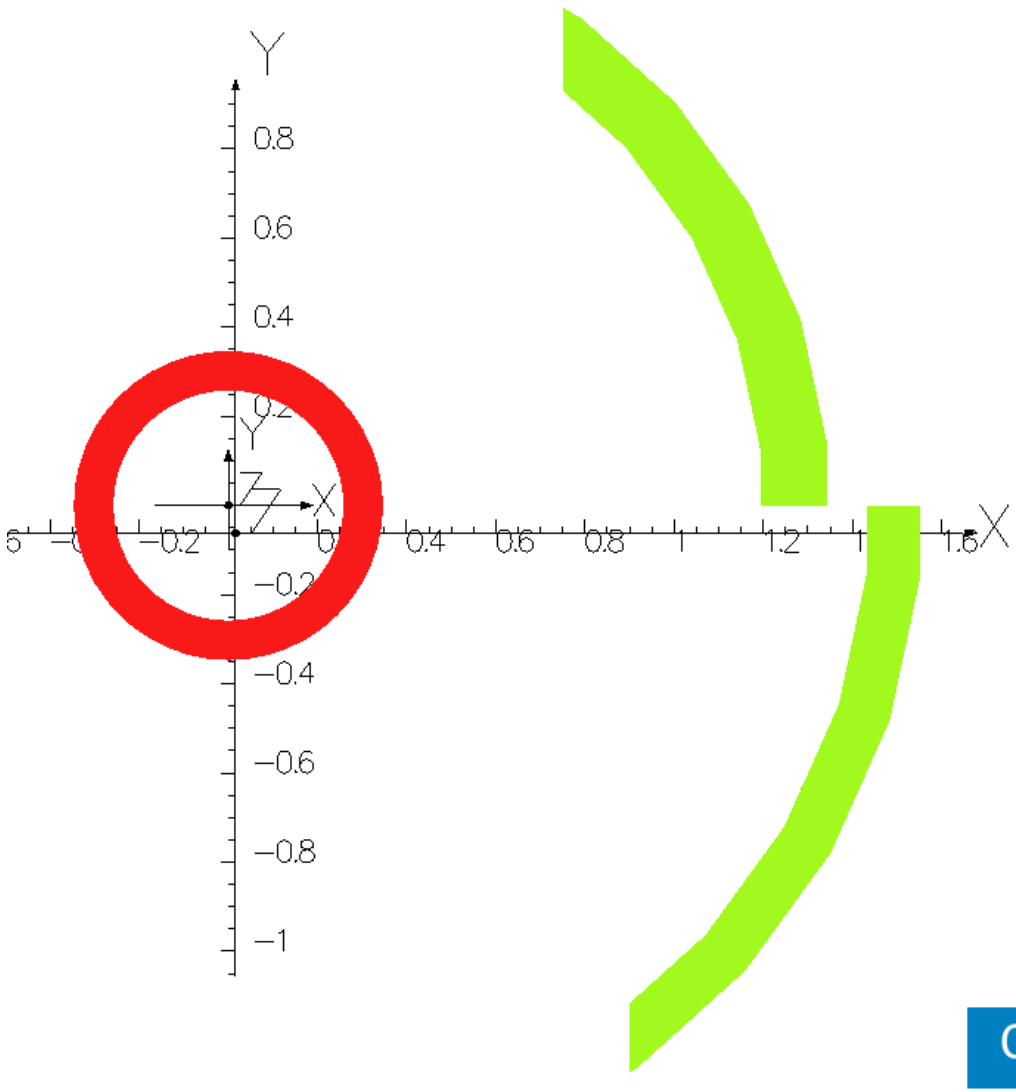
- Gap in radial direction
  - still continuous flux return path in longitudinal direction
- Nesting of tubes of different diameter
  - azimuthal angles must match
  - overlap seems not necessary
- Allows feed-in/out of tracker wiring?



MICE Stage VI – Option 2

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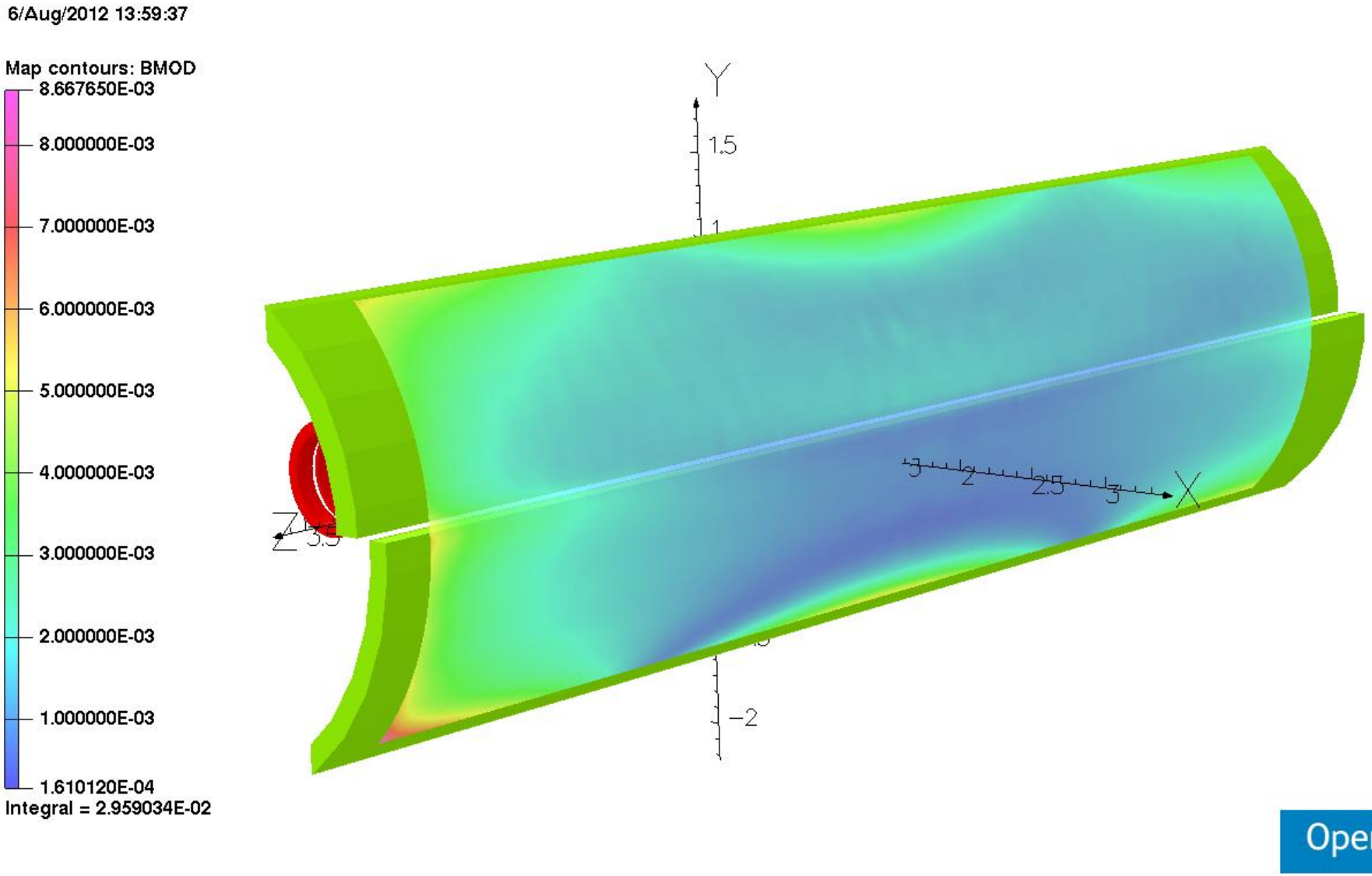

Conclusion

- Things which don't work:
  - several iron bars around MICE
  - flux catchers
- Quarter tubes covering ±50° look promising
  - for all cases of Stage IV, not only 200 MeV flip mode
  - B less than 15 Gauss (shielding factor 30)
  - forces manageable?
  - effect on central field small (small enough?)
- Stage VI: options for possible modification of scheme
  - provide continuous longitudinal flux path
  - cover all azimuthal angles (jumps in radial direction seem ok)