Iterated Design of 200 mm, 6 T Superconducting Solenoid for e-lens

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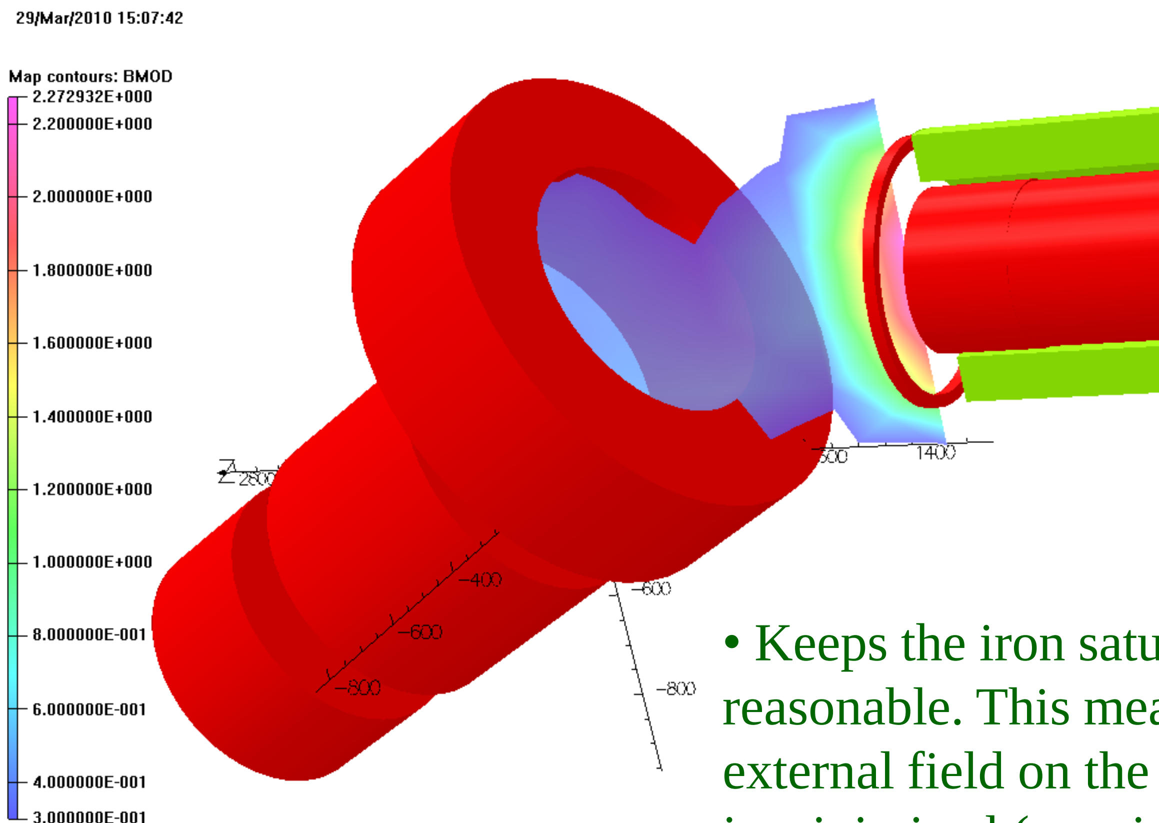
Small Superconducting Solenoid next to Main Solenoid
(fringe field coil may be part of the same coldmass)

Size of the small sc solenoid : A few cm X a few cm - likely to be made of small corrector wire to keep current low. (parameters are not yet optimized)

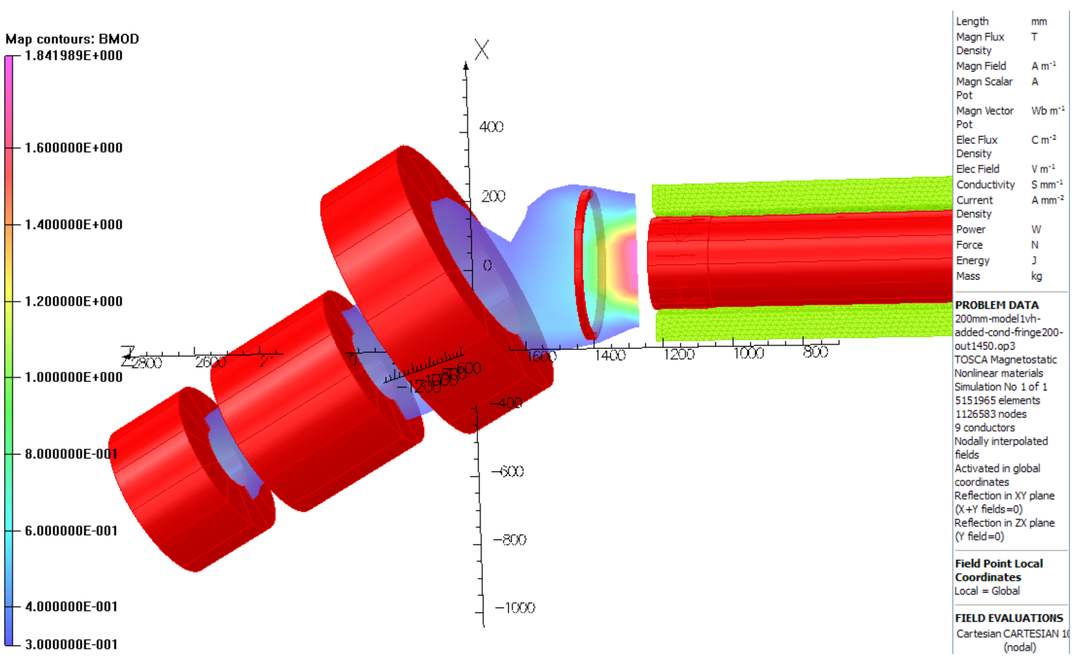


- There are several benefits of a separate solenoid to create field in the region between the superconducting and the copper solenoids.
- Provides an independent control (knob) to create the desired field, irrespective of what that desired field is, the field in the main solenoid and the field in the copper solenoid
- Keeps the iron saturation in the main solenoid reasonable. This means that the influence of the external field on the field inside the main solenoid is minimized (a major consideration in this design).

➢ **Another design: Fringe field coils further out where they are more effective**

Development since last presentation

- Request to increase power of fringe field (or exterior field coil).
- Exterior field coils can't be as out (axially) as previously thought.
- Finding it difficult to put all in 2.8 meter slot allocated
- Axial forces could cause significant design and protection issue.



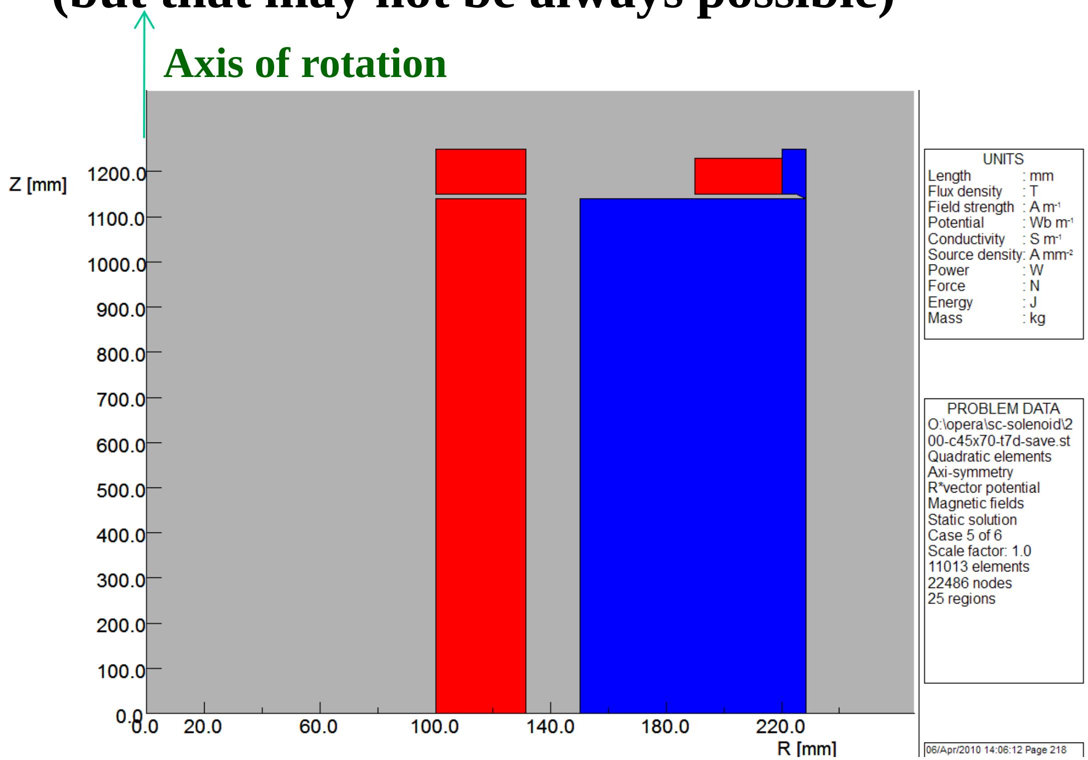
One of the design presented last week

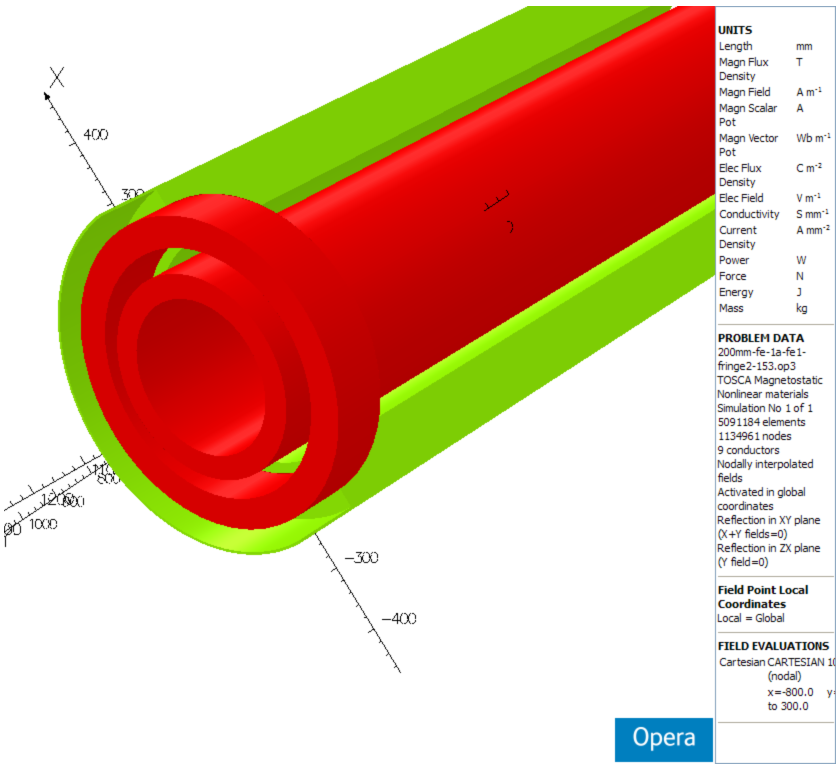
Note:

The following slides show the design work (design ideas) that are being investigated and is not the final design.

Iterated Design Concept

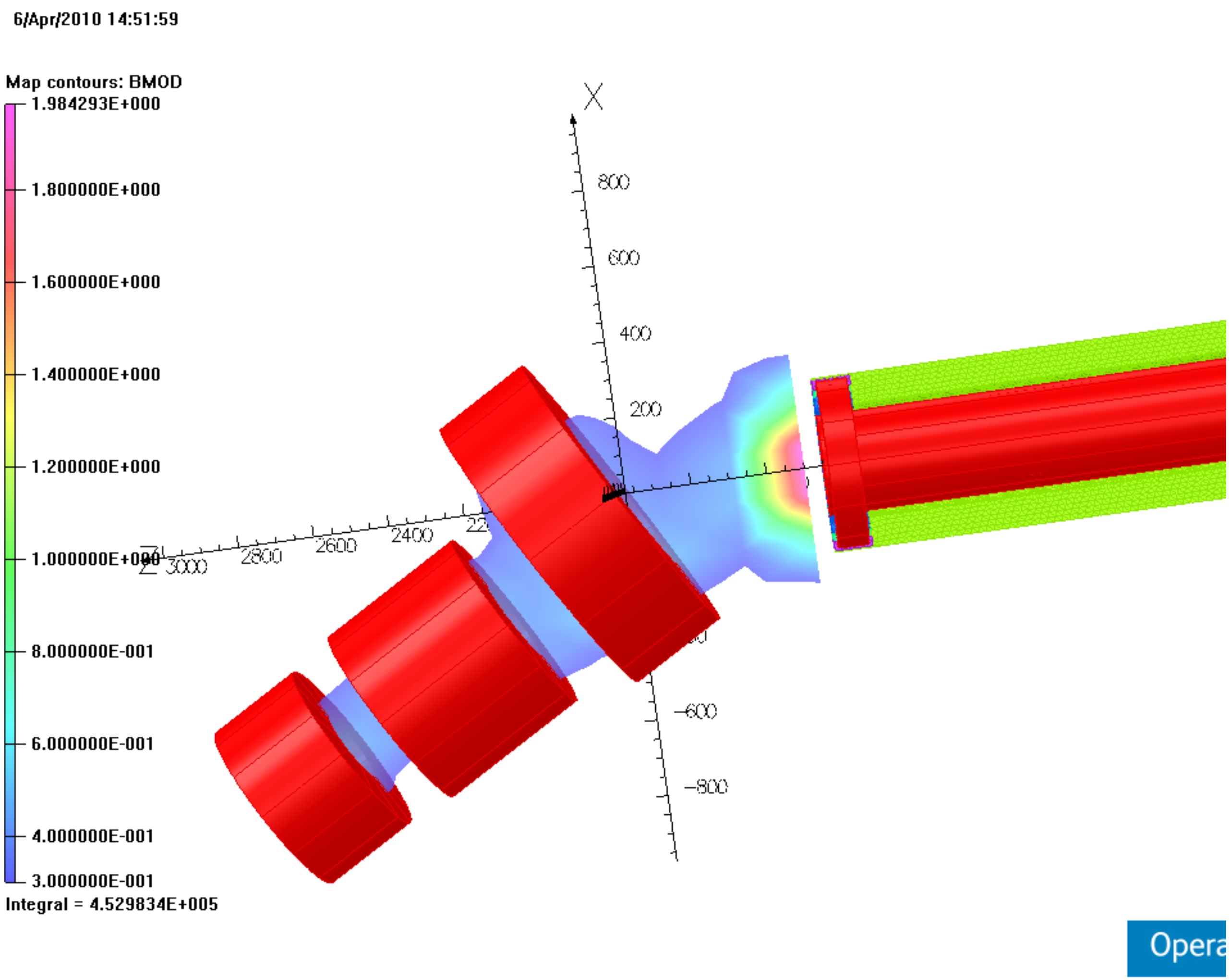
- Structure is introduced between the coil to take large axial Lorentz forces
- Exterior field (fringe field) coil is brought within 2500 mm yoke
- Exterior field coil is made with the same conductor as main coil and is connected in series to save on number of leads
- Strength of exterior field coil is increased for > 0.3 T in region of interest
- In this case trim coil in the end were avoided by iterating various parameters (but that may not be always possible)





Field in the intermediate region

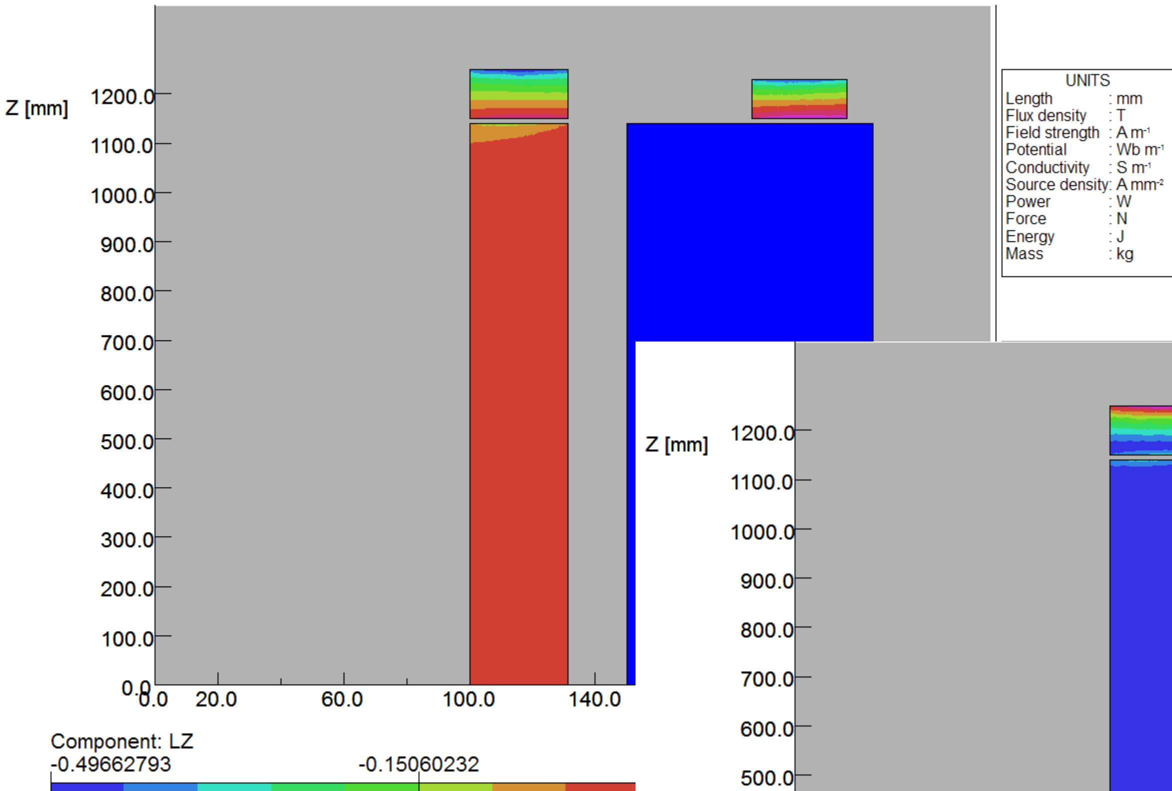
- **It is possible to obtain a field > 0.3 T in the region of interest.**



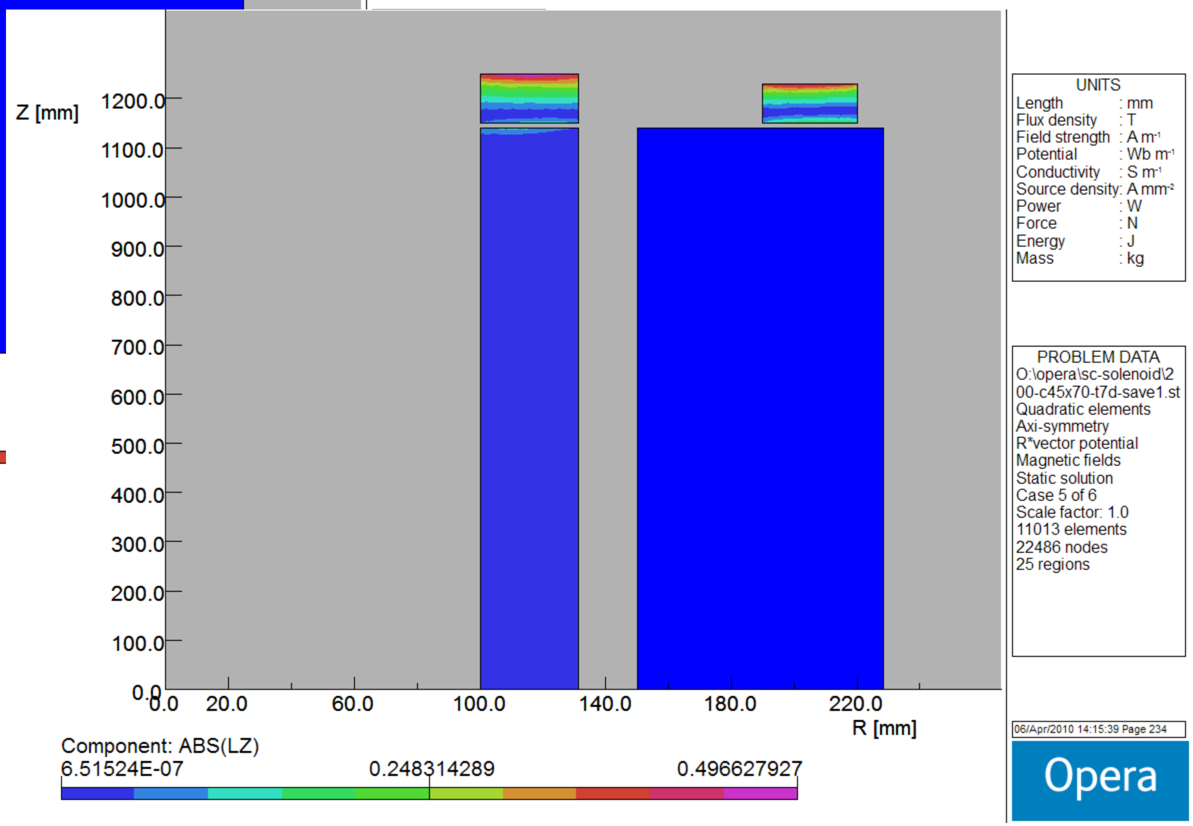
- However, it is @6T main field. If one wants >0.3 T independent of the main field, then the exterior field coils may have to be independently powered.

- This means the extra lead can't be eliminated.

Axial Forces



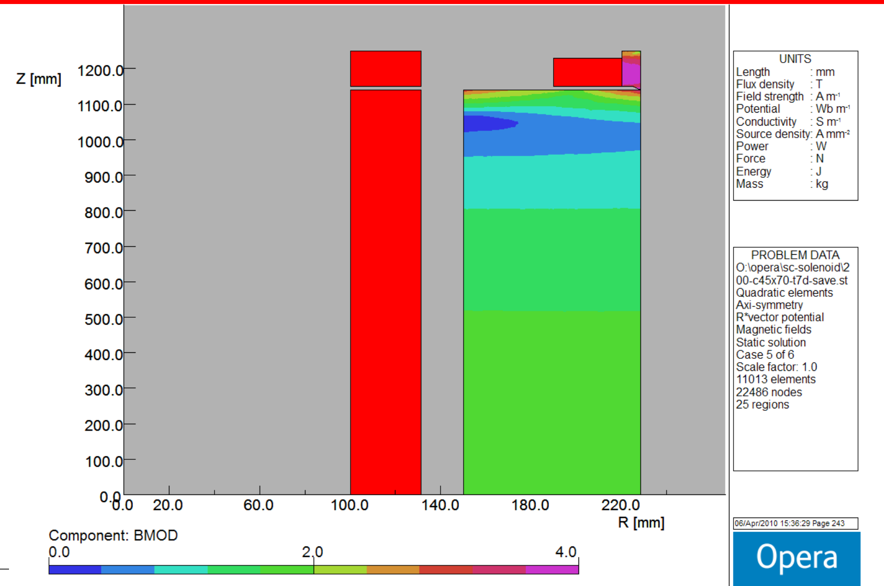
It is possible to segment the axial Lorentz forces

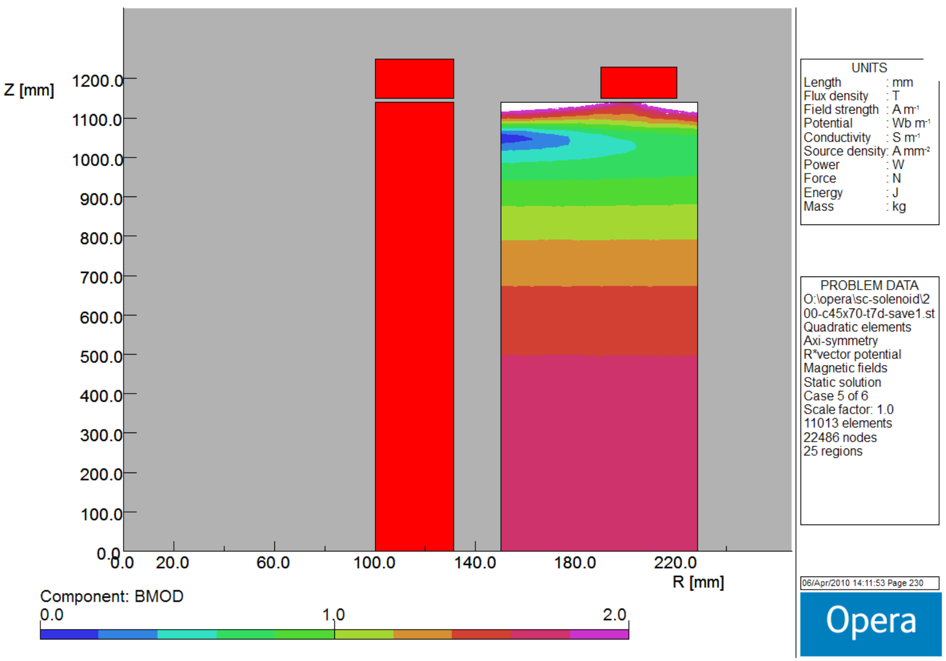


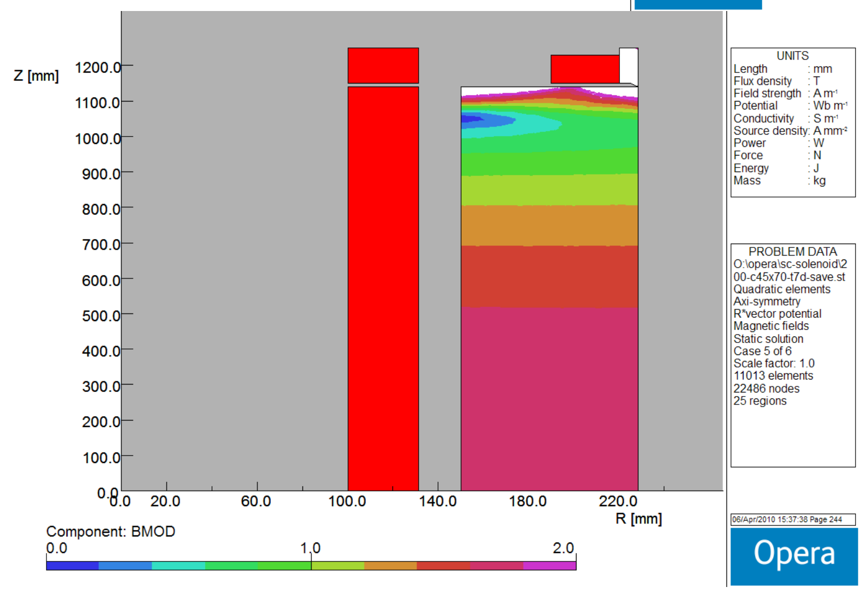
The layers of end coils should run in series to main coil to avoid uneven force distribution during quench

Field in the Iron Yoke

Field in yoke is primarily below 2T

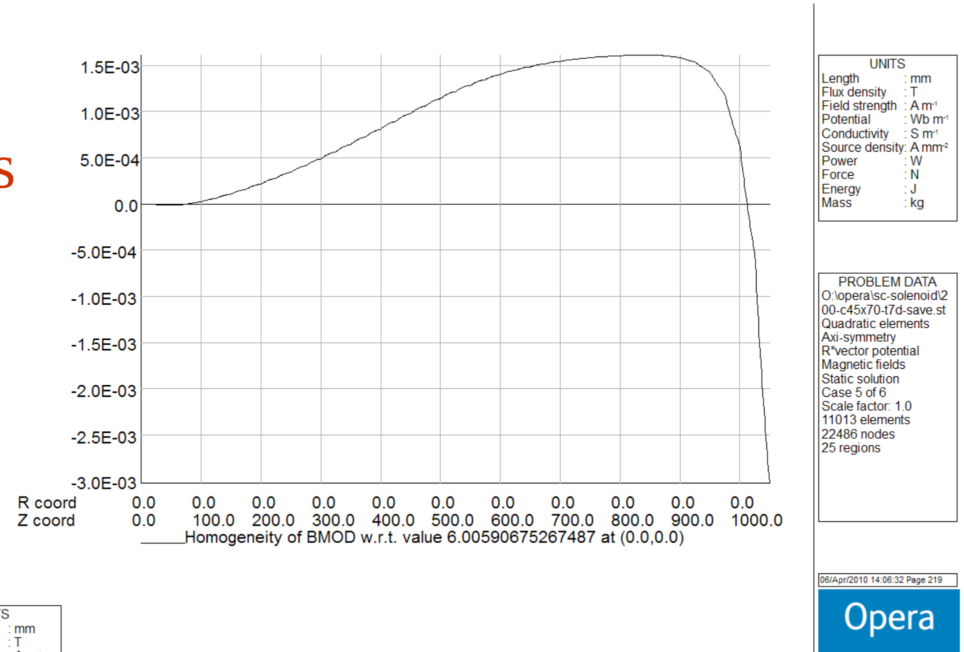


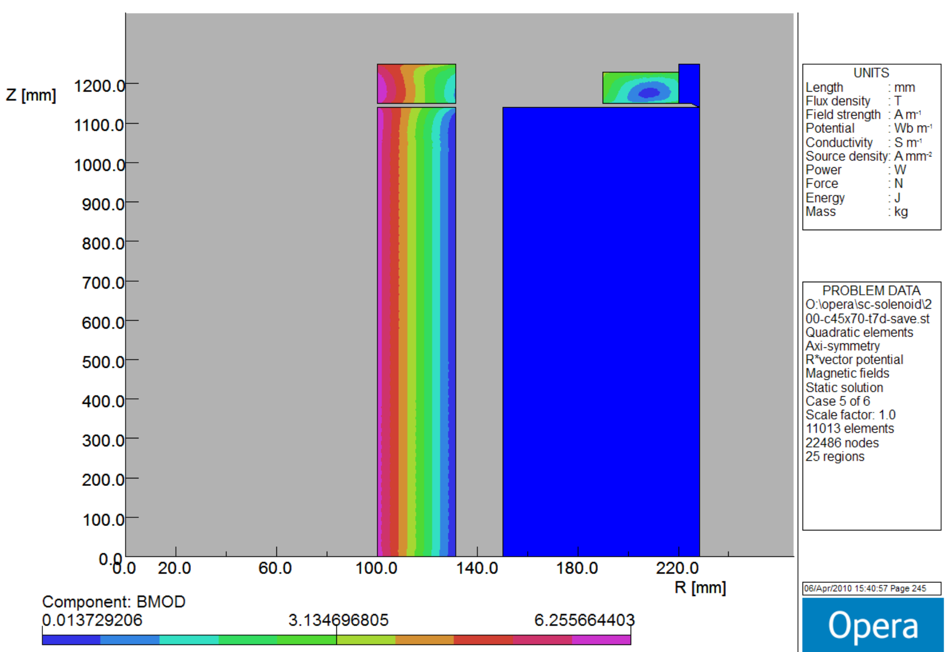




Field Quality

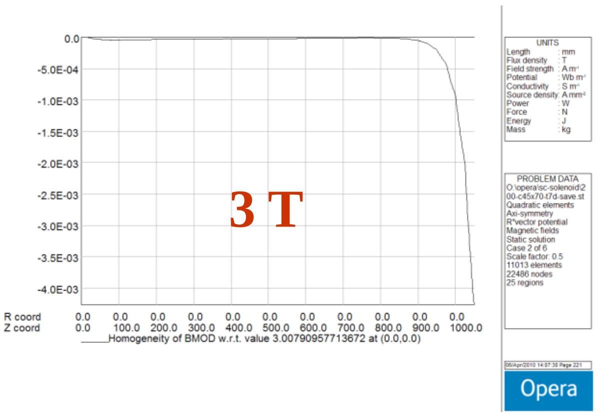
It is possible to obtain field errors $<5 \times 10^{-3}$ despite a little gap.

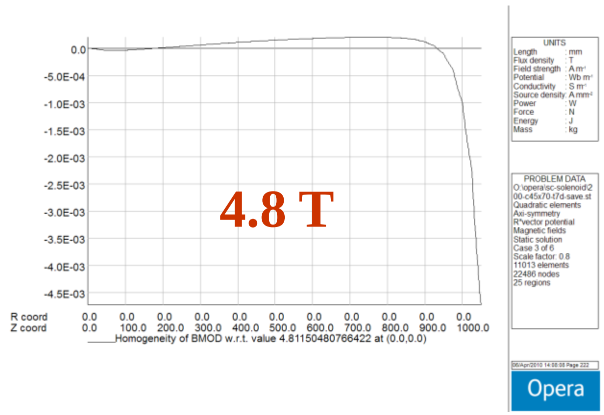


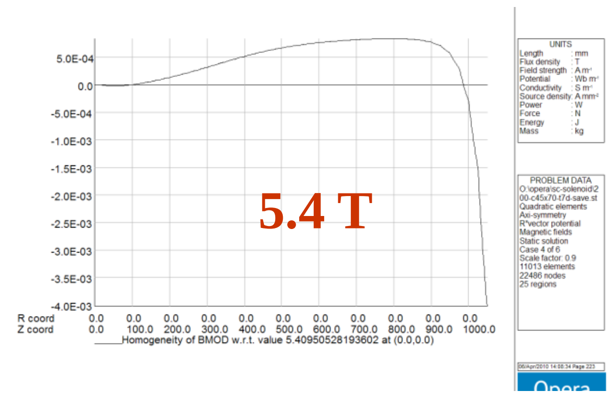


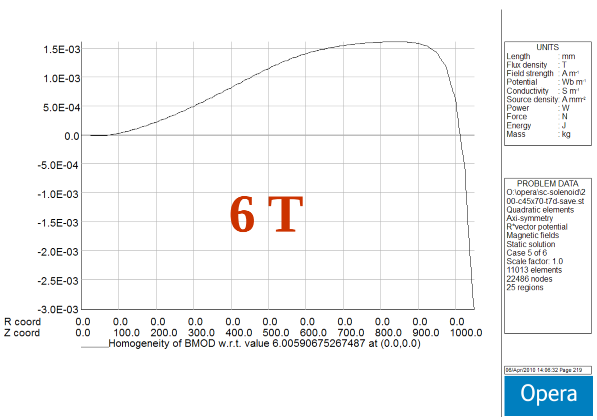
Field Errors at Different Fields

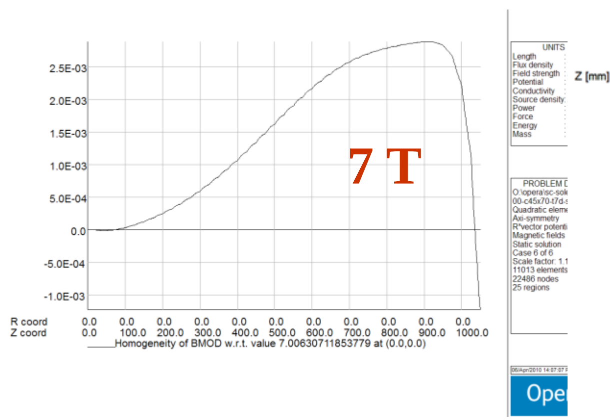
- Proof of principle design to show relative errors < 10^{-3}
- Relative field errors are plotted from center to 1050 mm axially

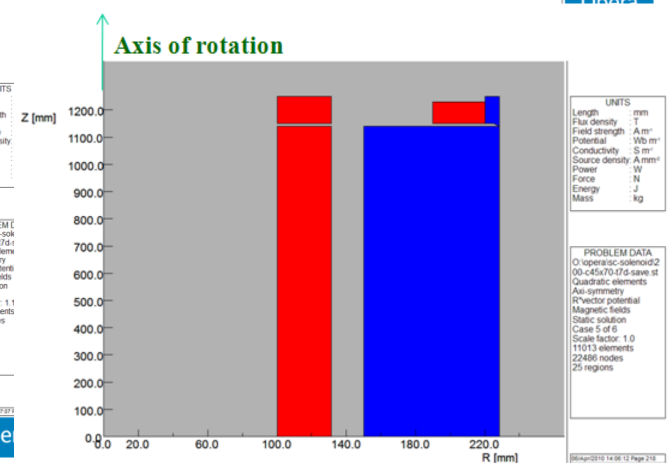












Summary

- Work in progress

- The design is in reasonable stage to move forward – no show stoppers

- It is possible to obtain >0.3 T field with superconducting coil inside the coldmass.