Magnet Studies in OPERA

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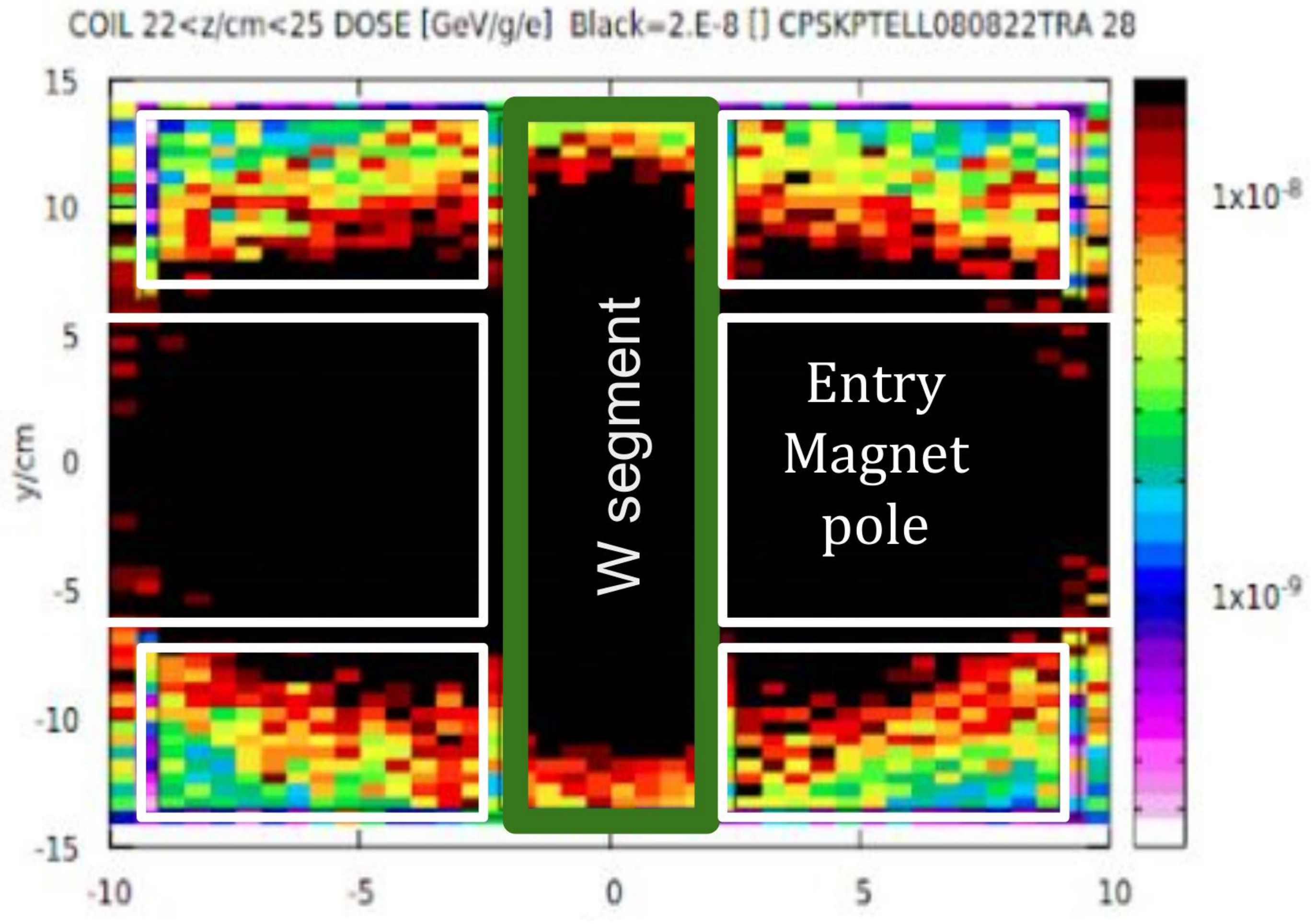
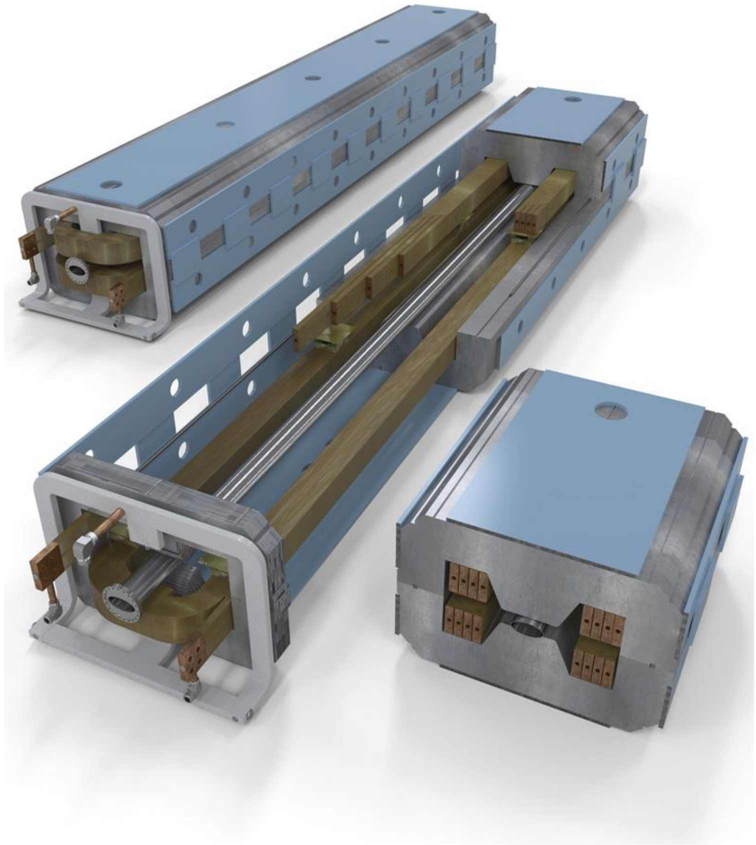
Motivation

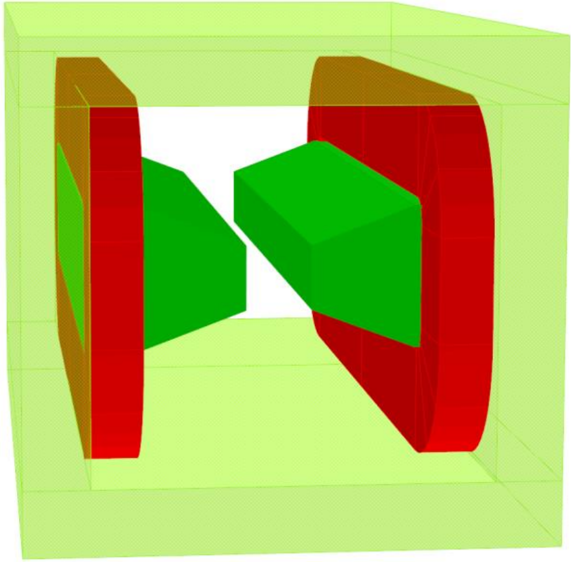


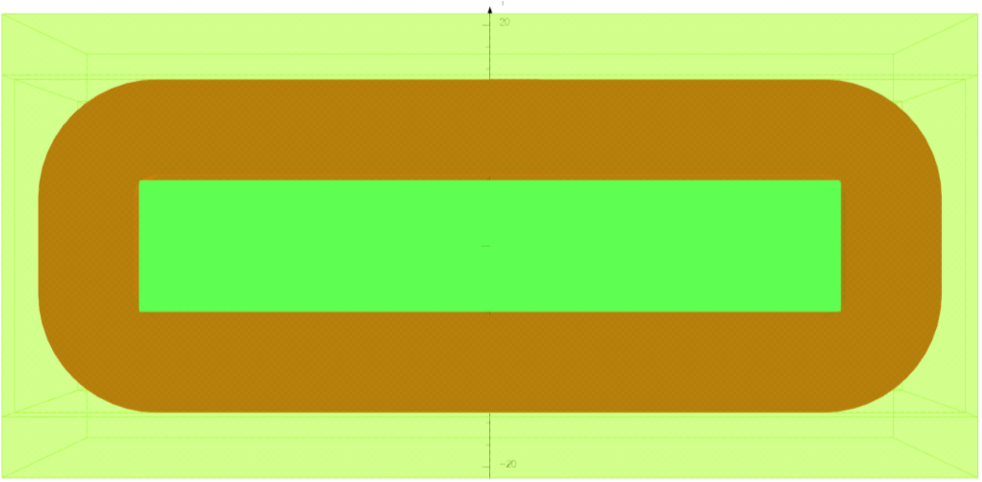


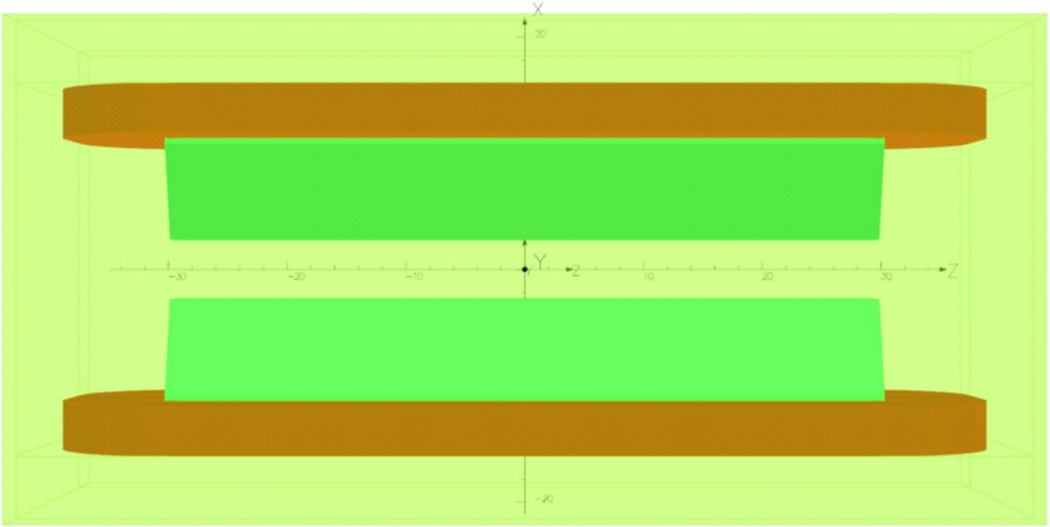
- Vitaly's studies show that there is s large radiation dose rate near the beamline where the magnet coils are.
- Some parts of the coils in the conceptual design seem to be in a high radiation area.
- It is better to move coils some distance (10cm) away from the beamline.
- May or may not be able to do it with Fermilab magnet.
- Do a generic study with OPERA to have more convincing arguments for the Readiness review.
  - Criteria is to have 2x magnetic field (2xB=0.5T) to fit the existing conceptual model.

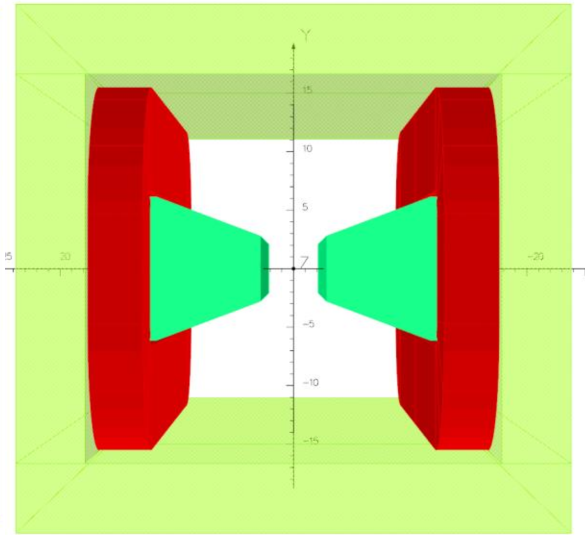
OPERA Model

- The outer dimensions of the magnet are such that it fits in 40x40cm^2 tungsten block.
  - Important to minimize tungsten costs.
  - May still be too large in the x-direction.
- The inner part between the coils allows to put a copper insert 27x4.4cm^2.
  - Use 2" gap as it is in the Fermilab magnet.
- The innermost part of the coil package is 10 cm away from the center plane x=0.
  - In y-direction the inner part is still ~6cm away from y=0 plane.
- The yoke and poles are iron.
- Iron yoke of 5cm for sufficient shielding and for 2x field required by Vitaly's design.
  - Fermilab magnet seems to have ~6cm of iron.
- Coils of 8x4cm^2 in cross section
  - Current density in the coils is 500 A/cm^2
  - For coils with 16 turns this would correspond to 1000 A current from the power supply.
- Not much effort spent to optimize the field strength.
  - Professionals from the NPD magnet group should be able to improve the magnetic field strength by optimizing the coil and the yoke shape.



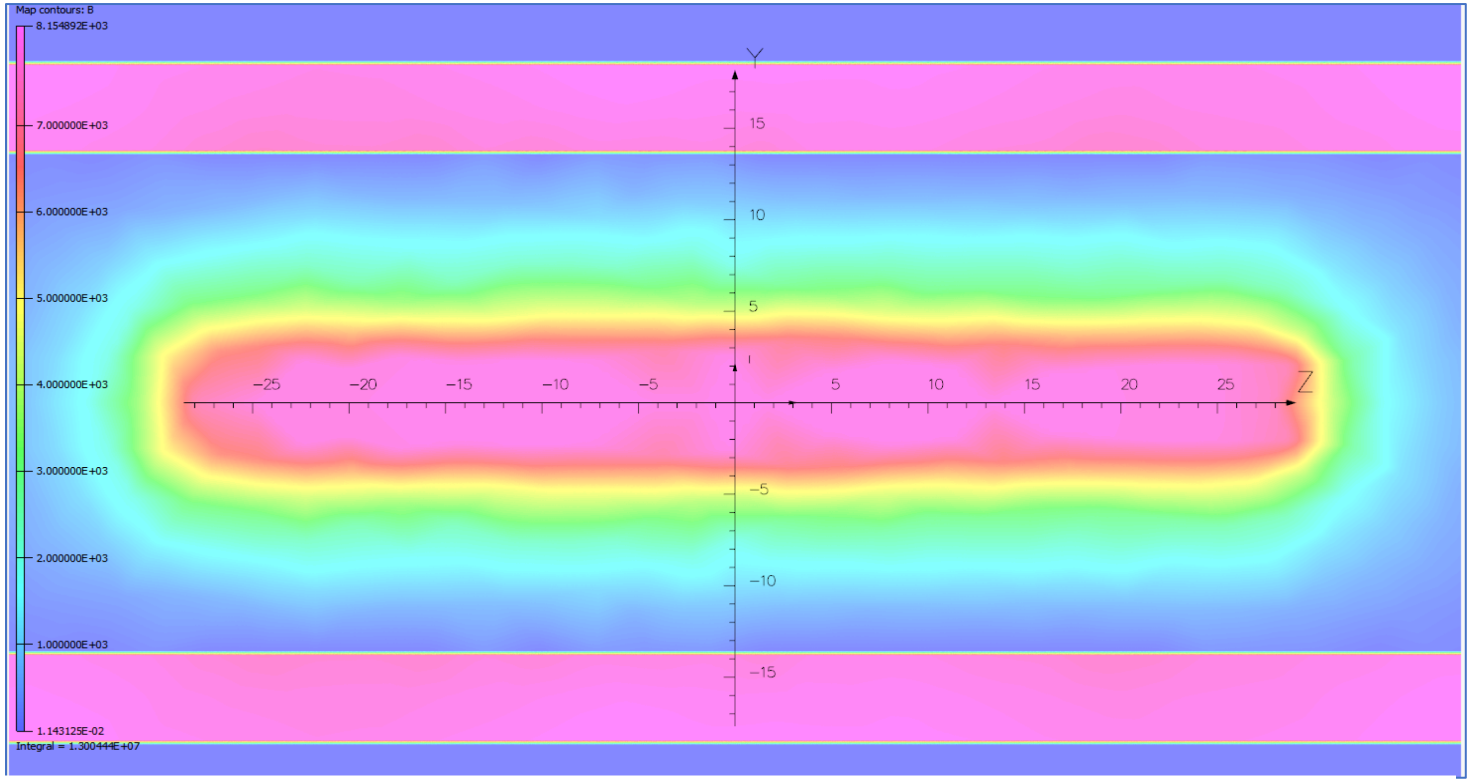


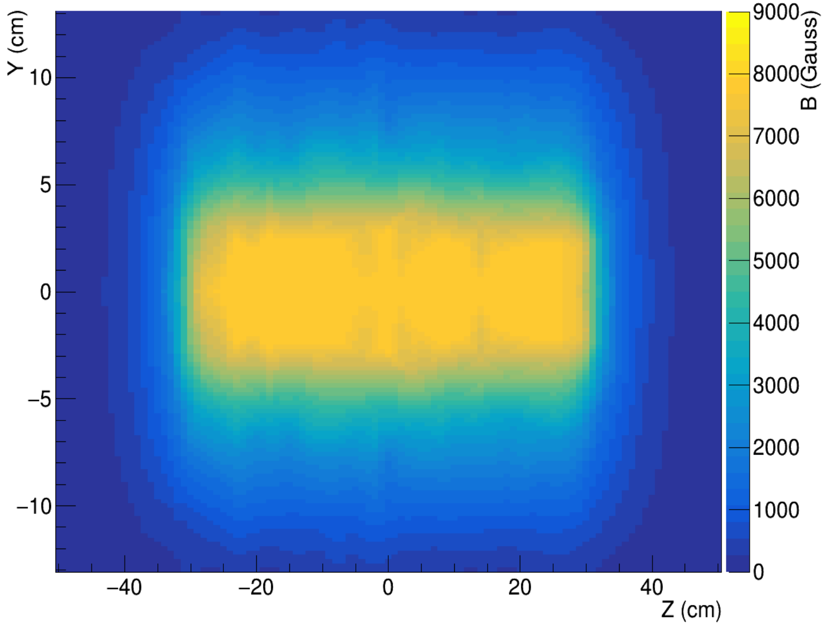


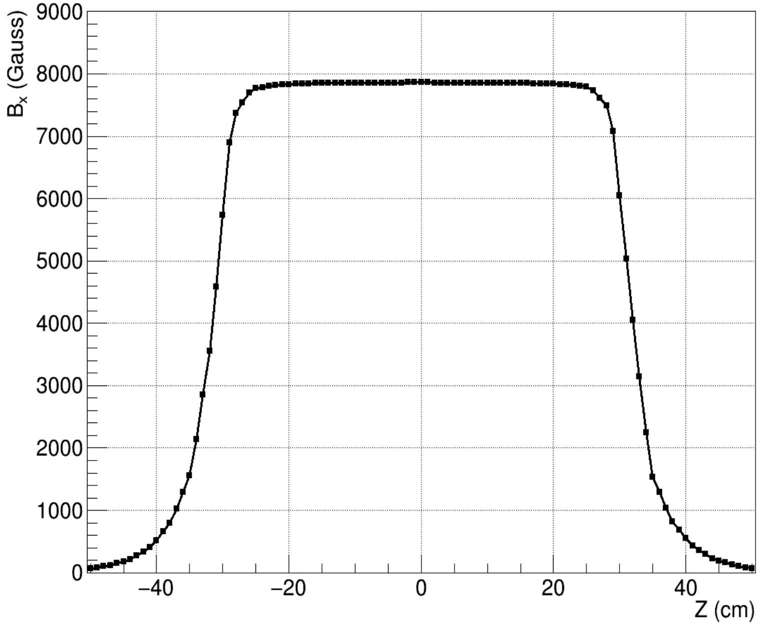


Resulting Fields

- The maximum field between the poles is about 0.786 T.
  - > 3x required B-field
- The field is quite uniform in Z.
  - It is easy to make the magnetic field longer.
- The iron yoke is still not saturated.
  - Can increase the total current.
    - Need to watch the current density.







Conclusions

- With this configuration we can get at least 3x times the field in the model.
  - I suspect this magnet model is a little big in the x-direction.
  - Shift the coils in y-direction and reduce the x-shift.
- Can try reducing the cross section of the coil package to make the x-size smaller and reduce the field strength.
  - An optimized magnet design by a professional would probably provide 20% larger field that what a rookie gets.
- If we do not need 10cm distance from the beam center, we need to define the distance looking at the Vitaly's simulation for dose rates
  - I need Vitaly's FLUKA ".bnn"-file for the radiation dose of coils.
    - I would like to remake the figures in the note using ROOT, probable adding some projection plots .
  - We probably need to fix the lifetime safety statement to just the fiberglass coil insulation.
  - Define the criteria for coil lifetime : 5x PAC days or 10x PAC days.