Preliminary thinking on magnet design: Italy

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Introduction

- Genova group started following this magnet development in the last weeks
- We have not yet studied in detail any technical solution
- We have followed the presentations given about the "Helmholtz coils with screens" solution designed by FNAL people
- We have tried to understand how this design cope with our experience
- We present here some preliminary, general considerations

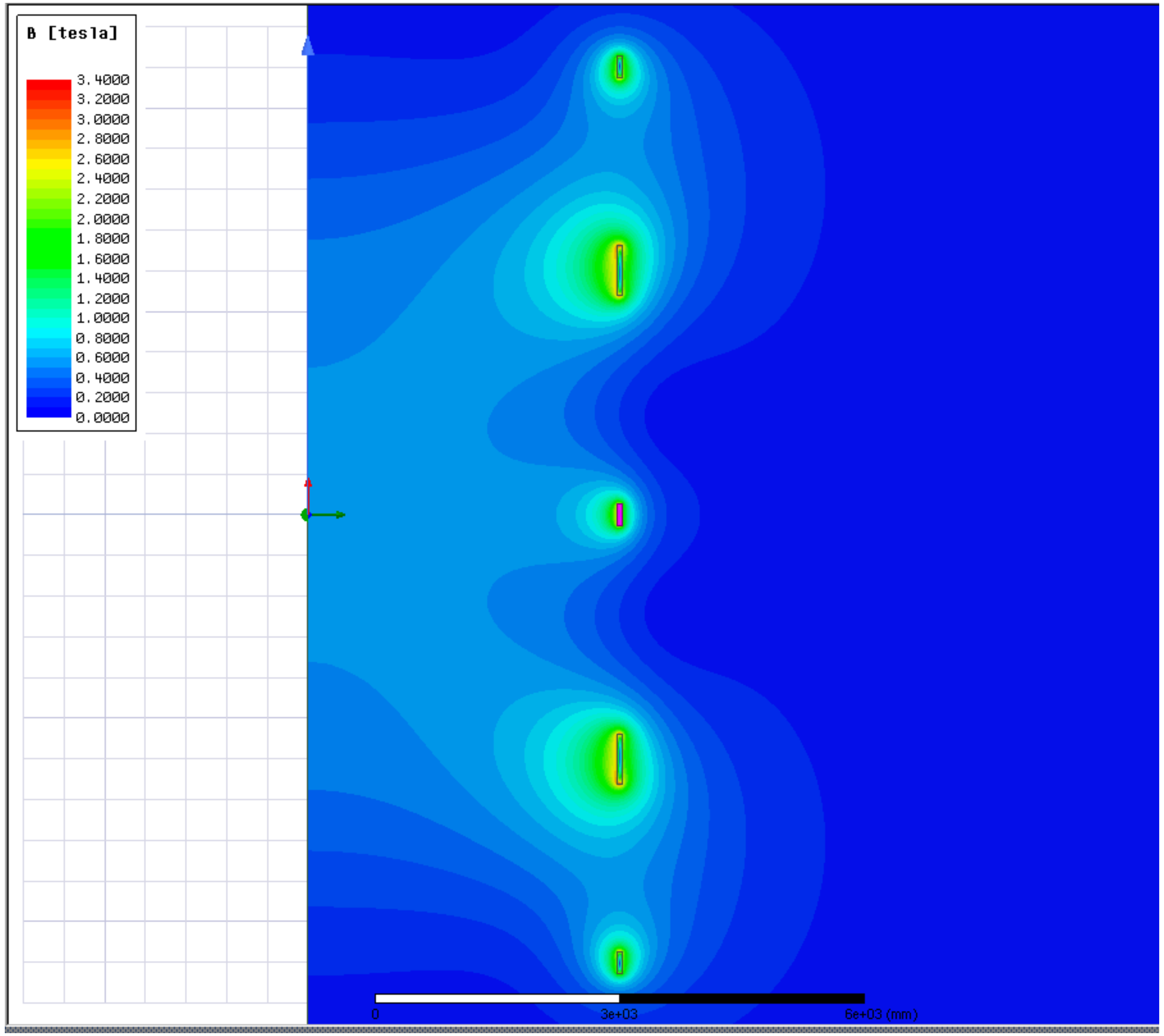
Magnet features

- Central field: 0.5T±20%
  - large tolerance, reducing it can be helpful?
- Warm bore: 7m diameter, ~10m length
  - should accomodate TPC (6m diameter) and calorimeter (+50cm on the radius)?
- Current and cable: 10kA in an aluminium stabilised NbTi Rutherford (proposal)

- Stray field constraints
- Detector & magnet will be movable (total size constraints)
- Assembly in the cavern (parts size and handling constraints)
- Material budget along the particle path (thickness – uniformity)

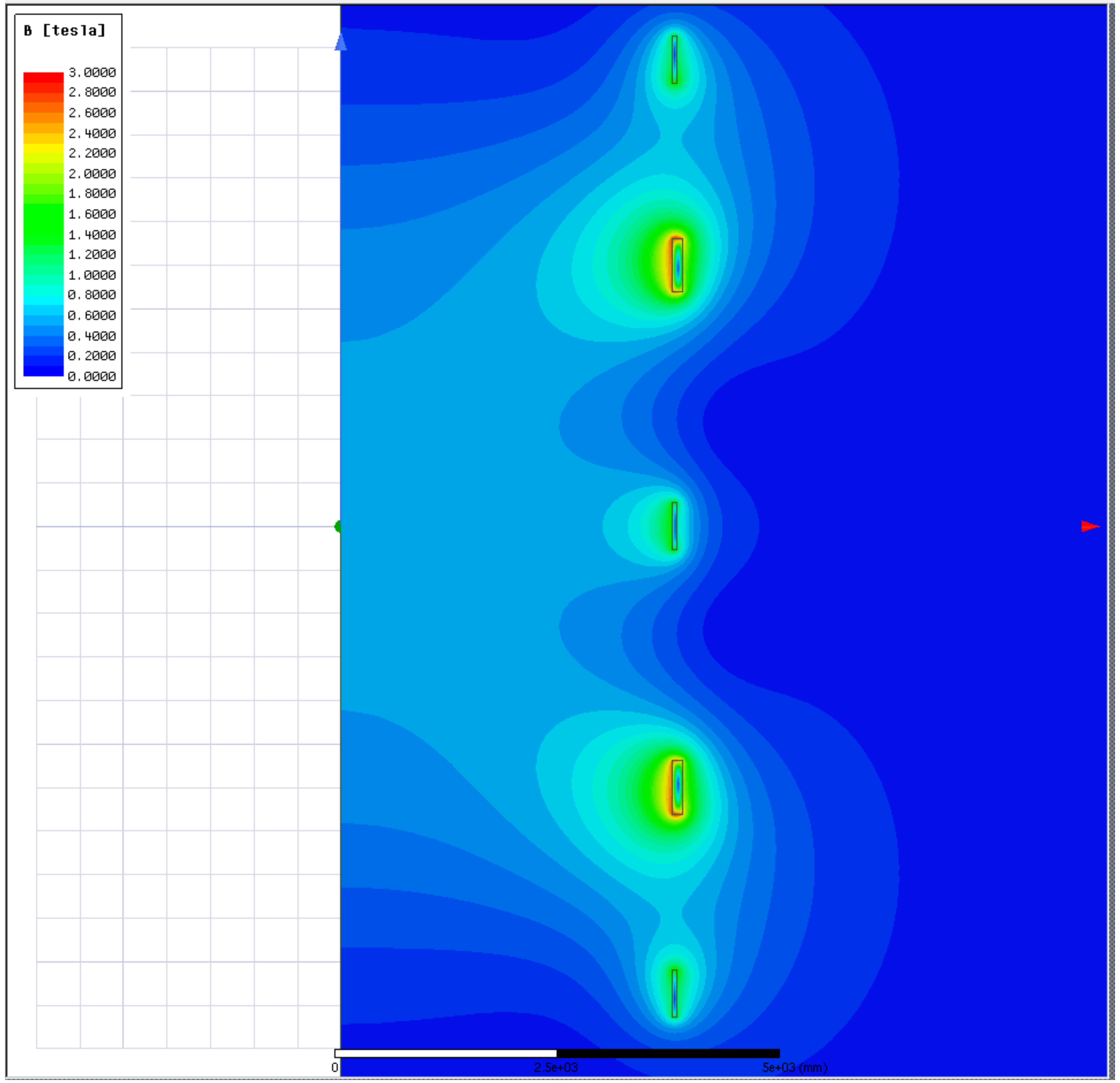
FNAL proposed magnet

- Brilliant design with no iron
- According to our model:
  - overall current density: 65 A/mm^2
  - stray field is non negligible
  - peak field on the conductor is 3.4 T
  - total inductance is 2.6 H
- With a 0.1 Ω dump resistor
  - max quench voltage: 1000 V
  - max estimated temperature: ~300 K (conservative)



Lower current density

- A first option is to decrease the current density enlarging the coils
- Here we show 33.5 A/mm²
  - more uniform material budget
  - lower stray field (marginally)
  - lower peak field (3.4 T -> 3 T)
  - quench temperature < 100 K
- "More" cable needed
  - mainly stabilisation aluminium
  - perhaps < 5% more length

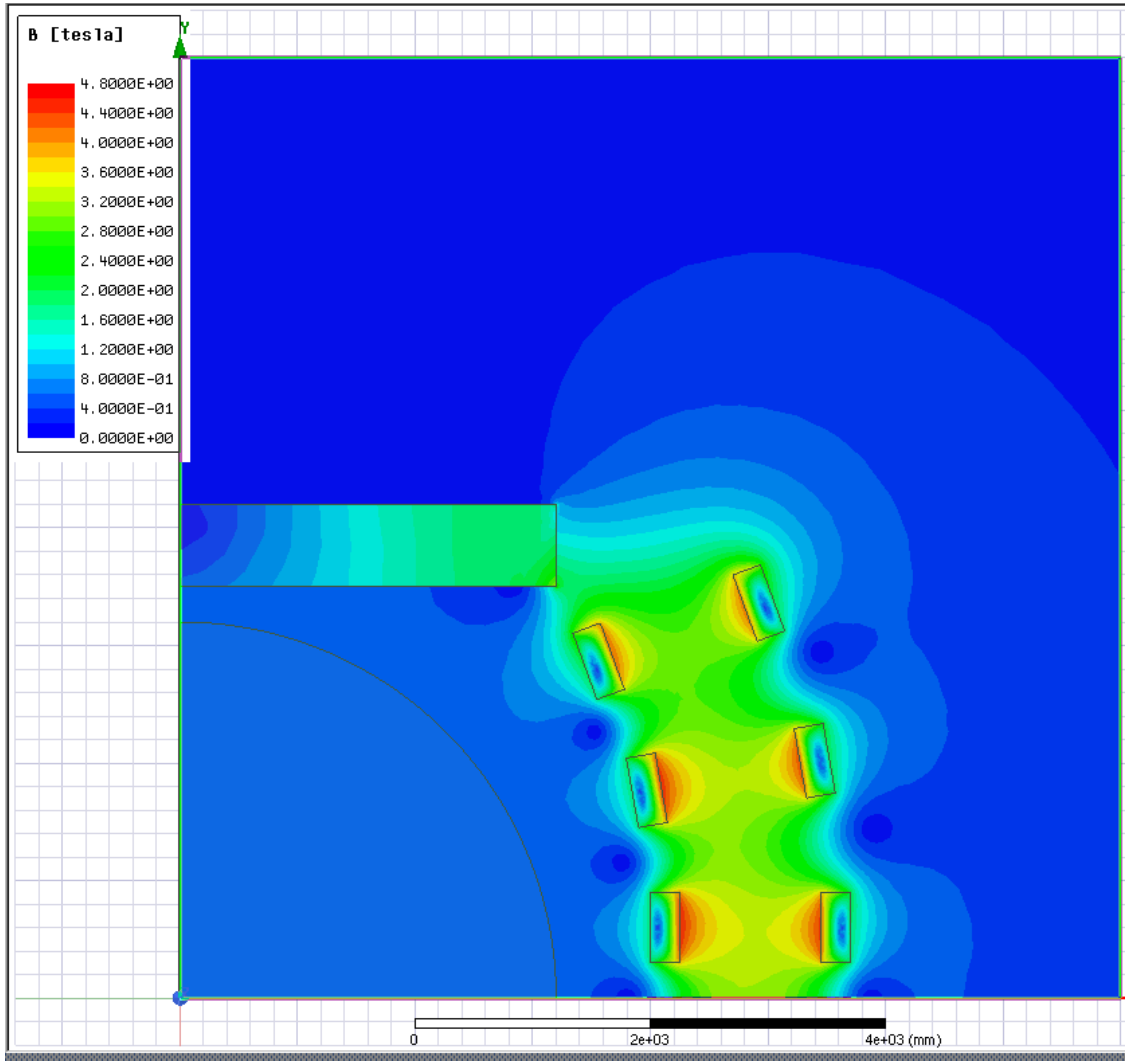


Mechanical considerations

- This kind of magnet can be easily wound in a proper external coil former
  - 5 separate ones, only external and side support needed
- Forces between coils are huge (4.5 and 8.6 MN)
  - proper support structure is being designed
  - misalignments, buckling have been taken into account?
- Parts are very large, yet reasonably movable
  - assembly "around" the detector should be studied in detail

A different (not optimised) approach

- Coils are on the sides of the detector
- 12 long and narrow racetracks
- Field is dipolar
- Some iron helps shaping the field
- Essentially, a "double dipole"

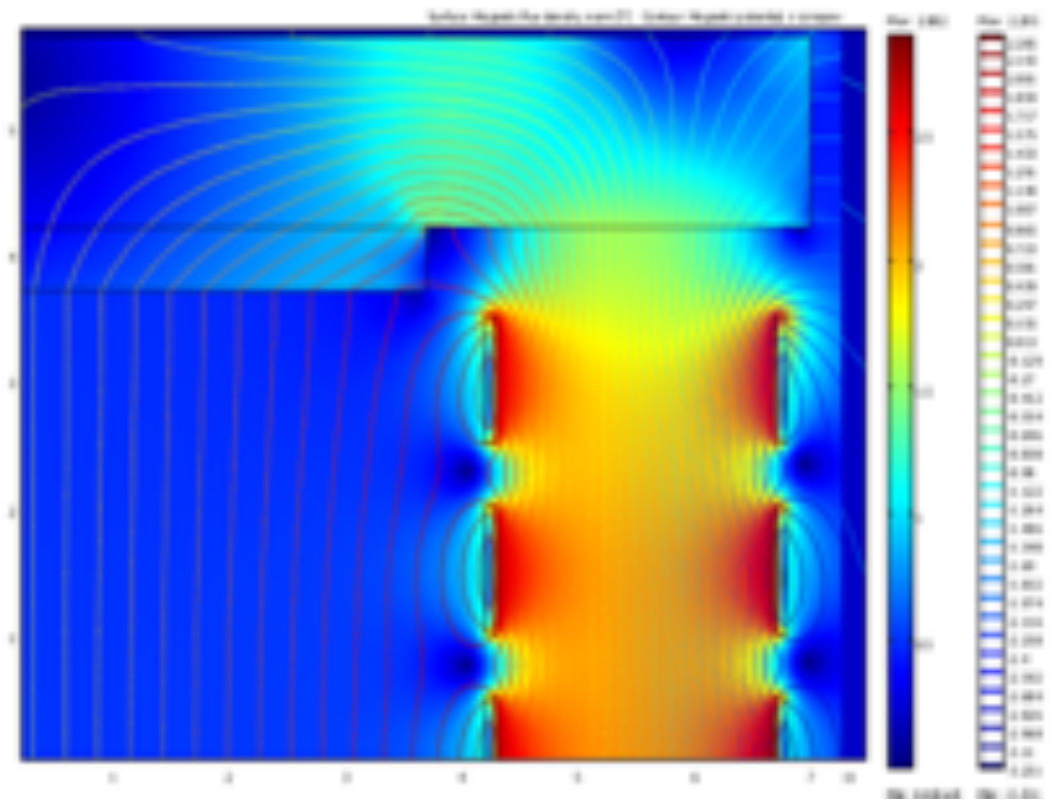


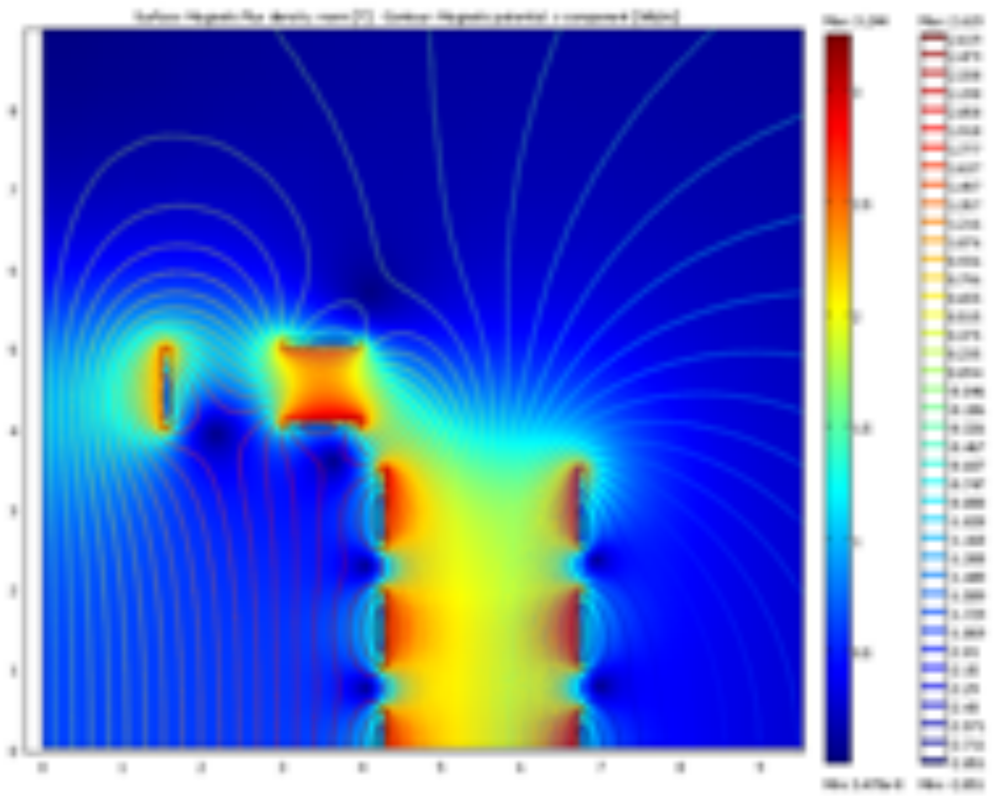
Advantages and disadvantages

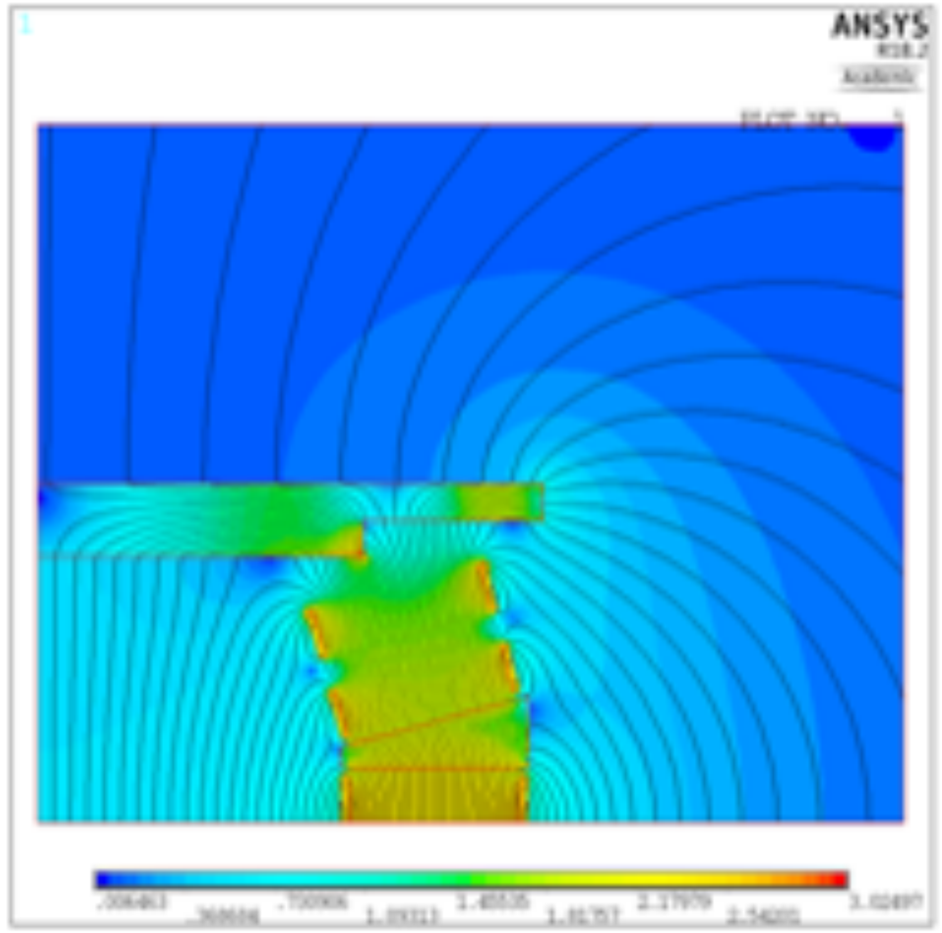
- Field quality is easily ±5%
- No dead material on the particles path
- Stray field is mainly on the sides
- (almost) No length constraints
- Parts are smaller
- Can be assembled in two halves
  - less interference with the detector

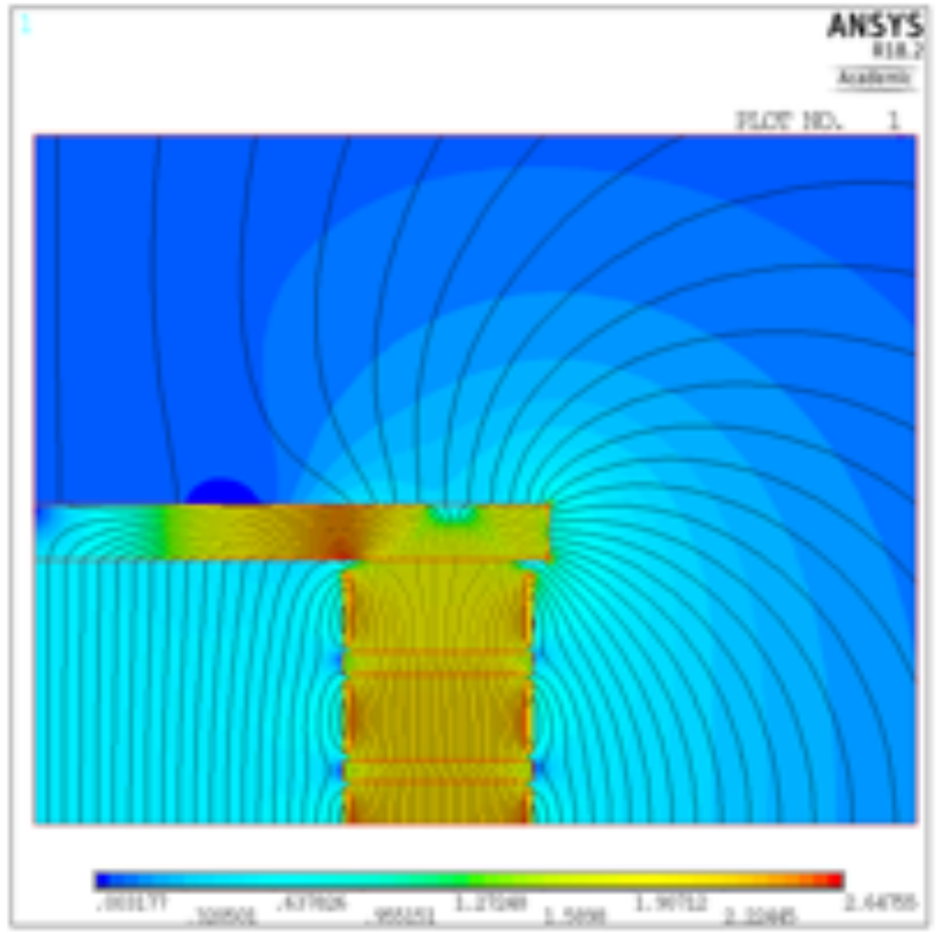
- More SC cable is needed
  - more expensive
- Some iron is needed
  - heavier
- Racetrack coils need compensation for hoop stress
- Lateral size is more constrained
  - indeed, can accomodate a 7m diameter vessel

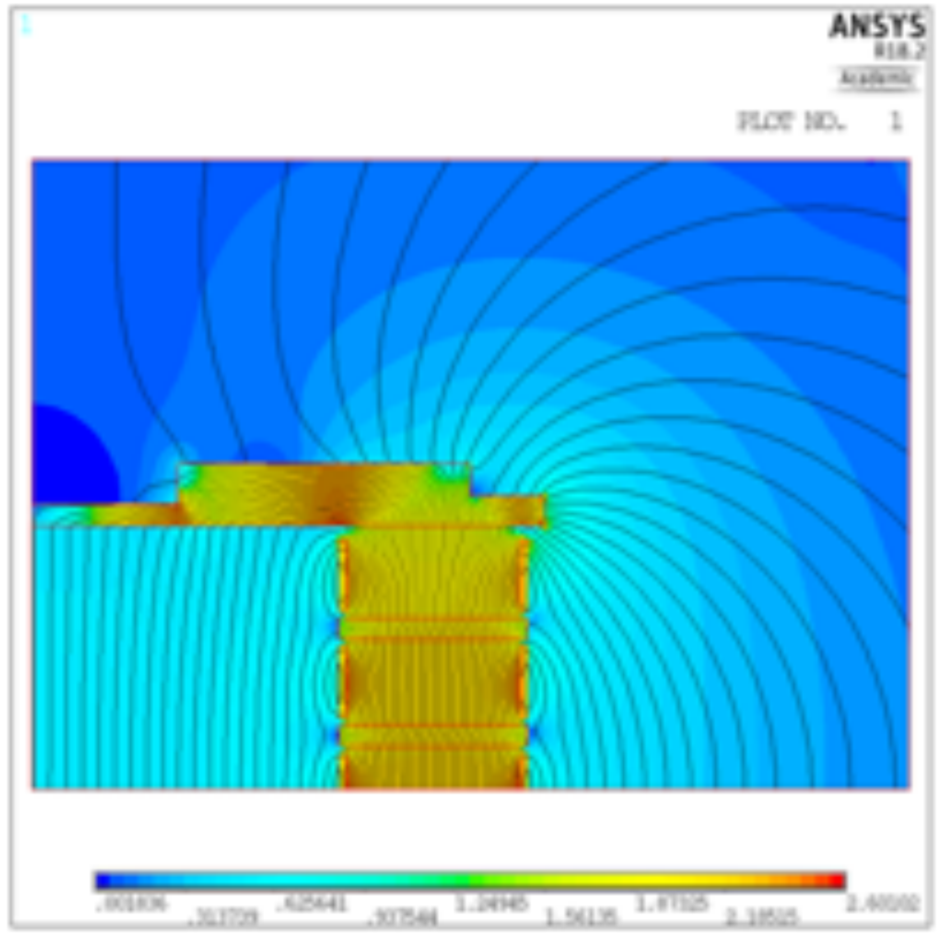
Double dipole variations











- Calculations by Pasquale Fabbricatore and Stefania Farinon

Other possible designs

- Adding iron to Helmholtz coils
  - "rings" on the ends and a beam on the bottom?
- Adding iron – changing coil geometry to the double dipole
  - reducing stray fields vs. lighter magnet
- Completely different designs
  - a "traditional" dipole
  - a continuous solenoid – with or without iron
- Different priorities in the requirements promote different solutions

Next steps for us

- A detailed review of FNAL design
  - a significant amount of work has been done
  - a deep comprehension is mandatory for us to become really useful
- A phase of study on the detector design and priorities
  - the following of this week will be a good starting point
- Definition of the possible role of INFN Genova magnet group in the Collaboration
- Discussion about the present FNAL design and possible variations
  - two months from now

Deep in the human unconscious is a pervasive need for a logical universe that makes sense. But the real universe is always one step beyond logic

Frank Herbert, Dune