MUSIC Solenoid

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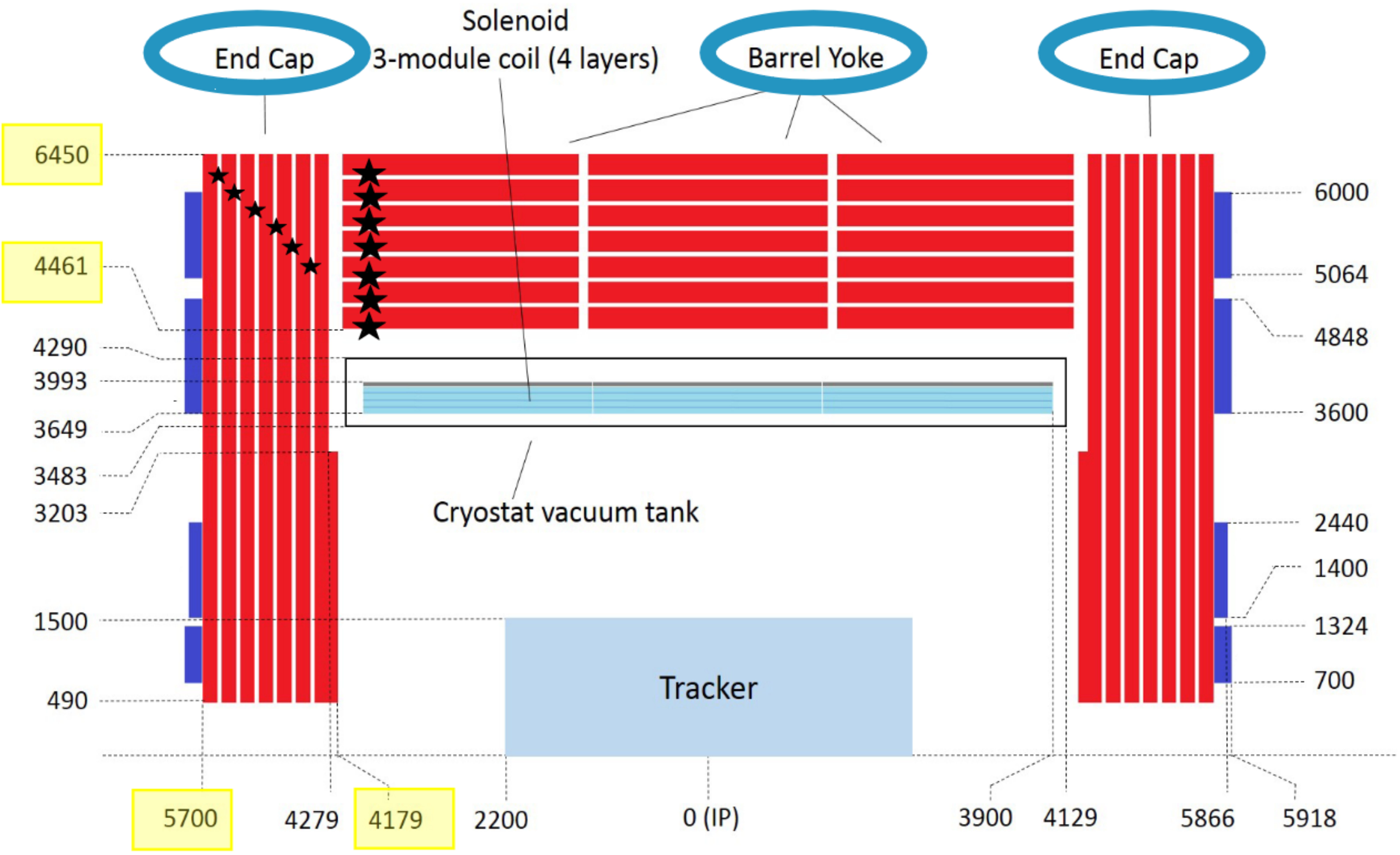
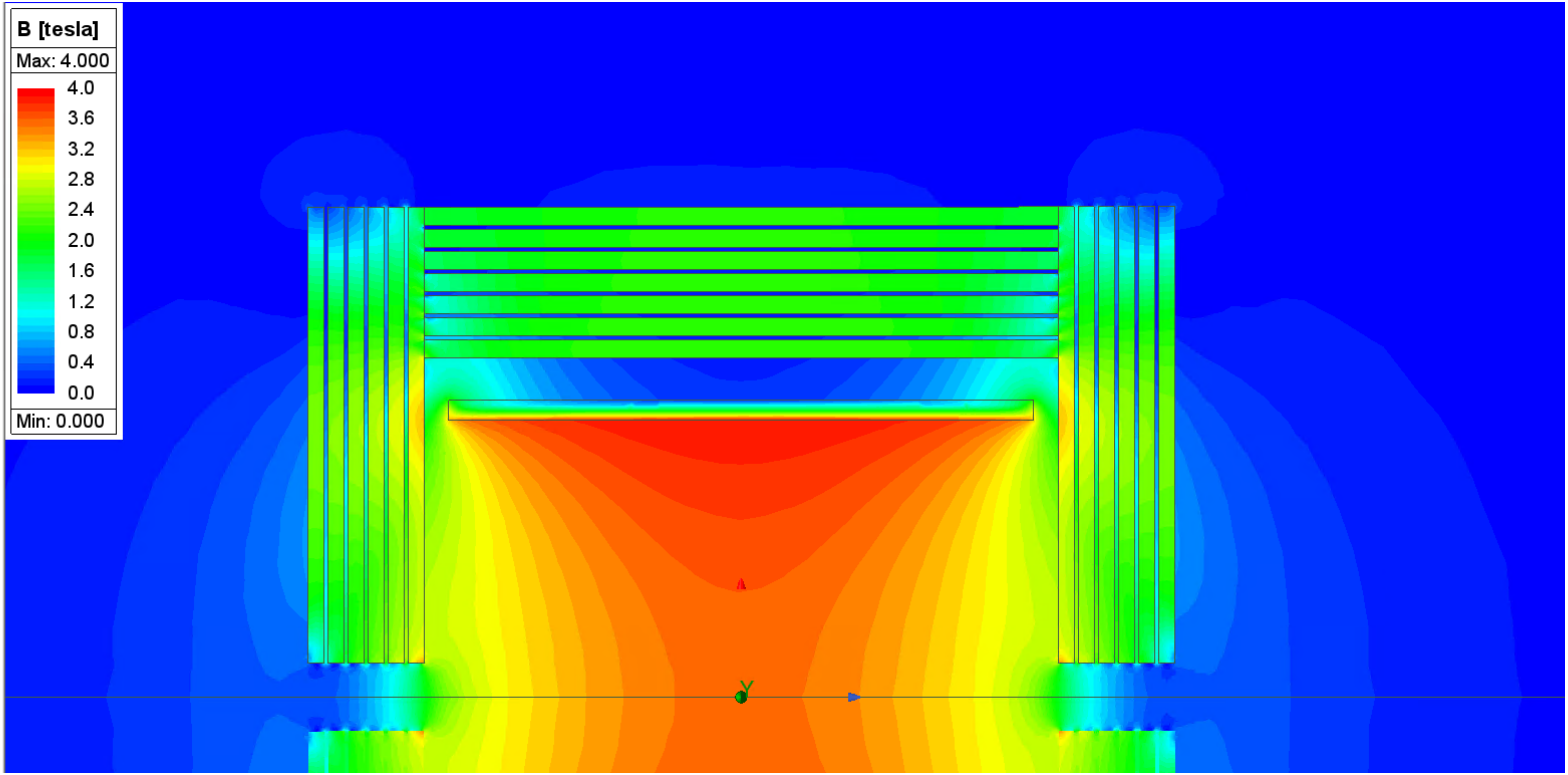
Old tentative design

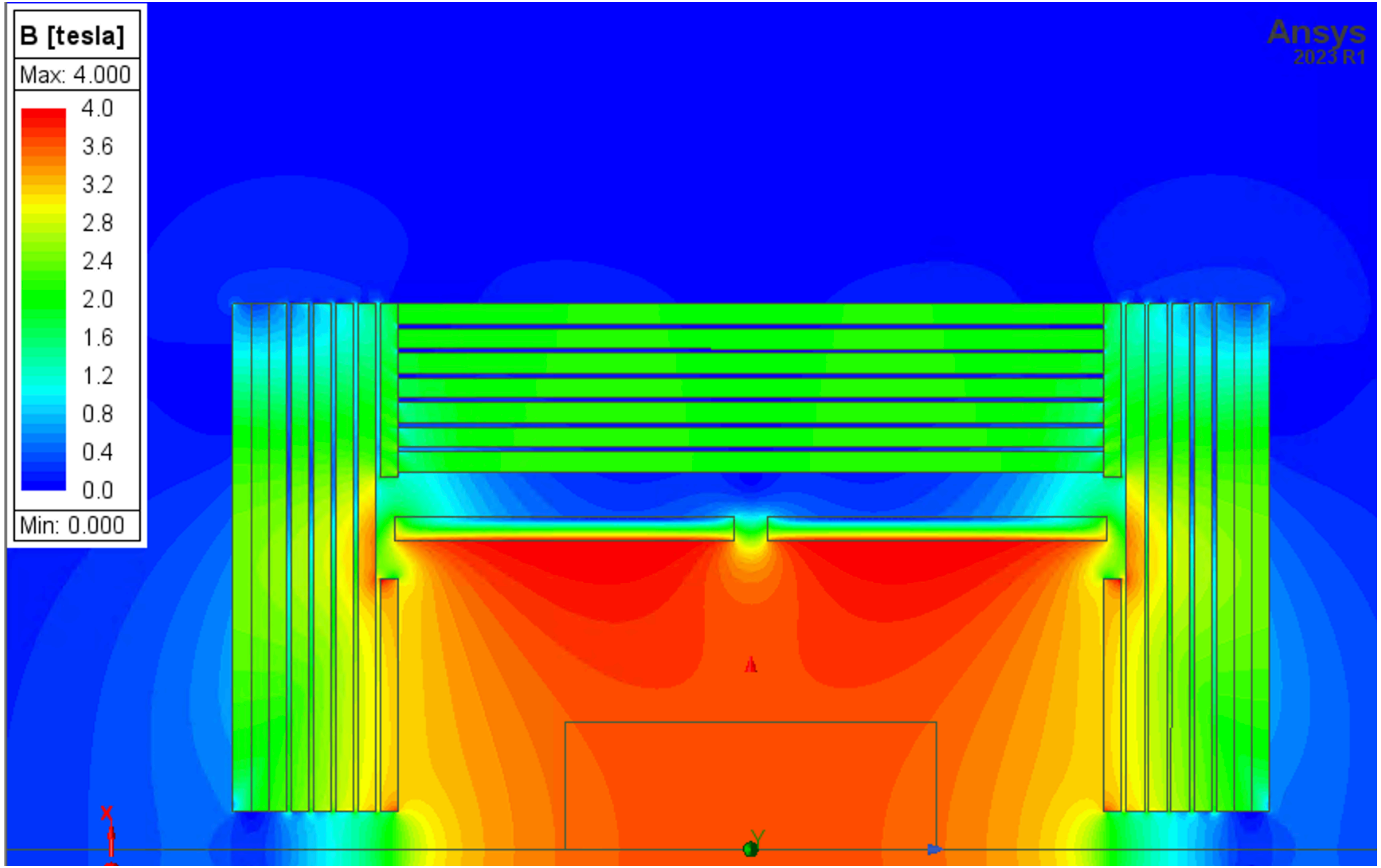
- To start, I took parameters from CLIC-based design
- I assumed a ~ 50 mm gap for muon chambers between iron layers (magnet design not so sensitive to this, at this level)
- 6 layers in the end-caps, 7 layers in the barrel
- Total coil length 7.8 meters, diameter 7.3 meters
- Field at centre 3.75 T
- Very similar calculations in M. Mentink slides



Non optimised design



March 2024 design



4 or 6 layers

- Central field: 3.66 T
- Stored energy: 2.25 GJ
- Current density: 12.3 MA/m^2
- Total coil thickness: 288 mm
- 6 layers:
  - Current: 17.7 kA
  - Cable size: 48 x 30 mm^2
  - Inductance: 14.4 H
- 4 layers:
  - Current: 19.5 kA
  - Cable size: 72 x 22 mm^2
  - Inductance: 11.85 H

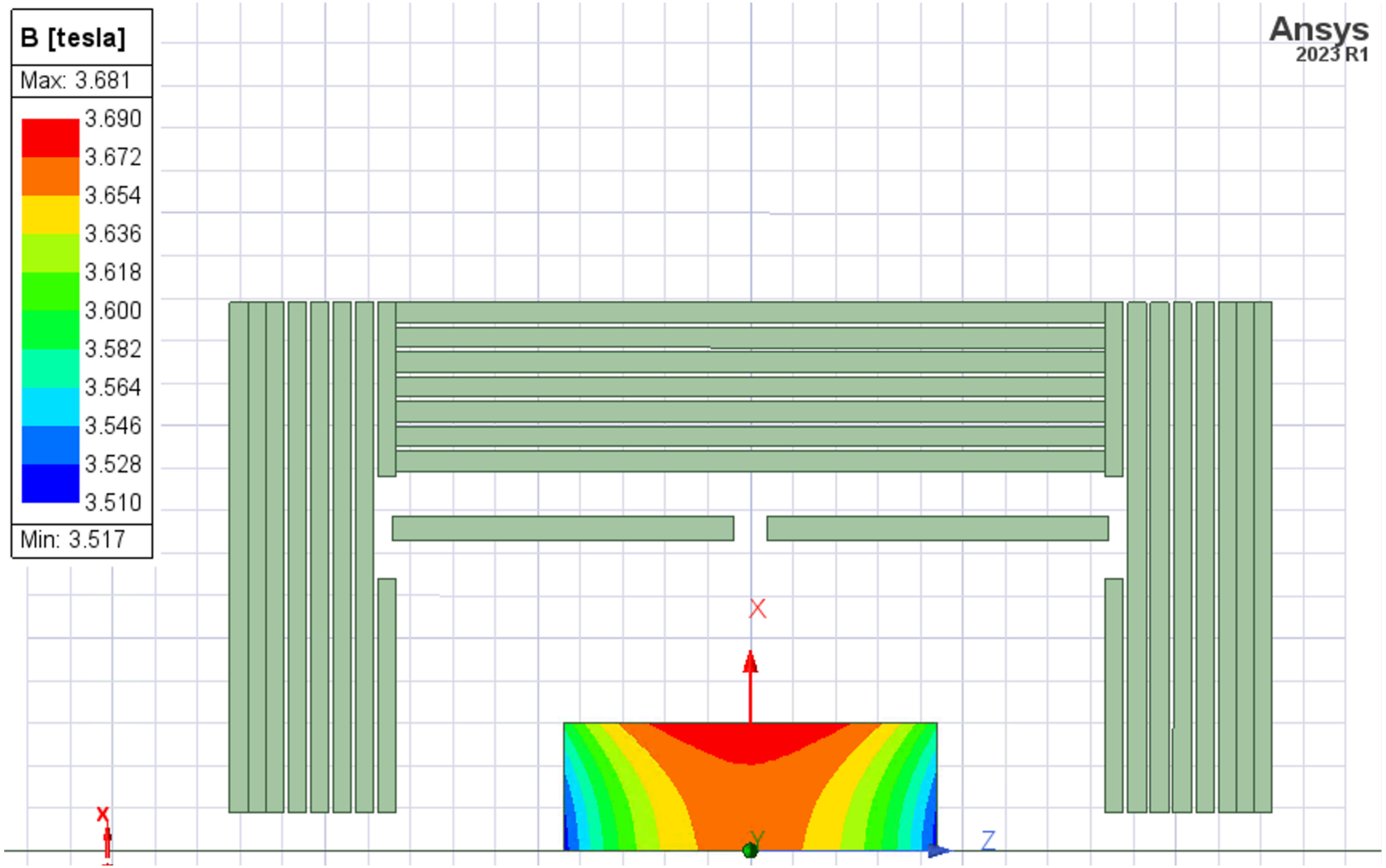
To be noticed:
Forces are non trivially contained
No optimisation on longitudinal stress at today
Some more clever splitting in sub-coils will be needed
This is a challenging design, overall
Stray field is still high
Magnetic properties of tungsten alloy are unclear
Interaction with collider magnets to be investigated

- No big difference, slight improvement
- A cable to be completely designed for both options (and a supplier must be found)

Some remarks on field quality

- Tracker region: -2200 < z < 2200, 0 < r < 1500
- B at IP: 3.66 T
- B = 3.60 ± 0.08 T
- Field uniformity: ±2.3%
- (Almost no optimisation)
- Max Br = 0.12 T

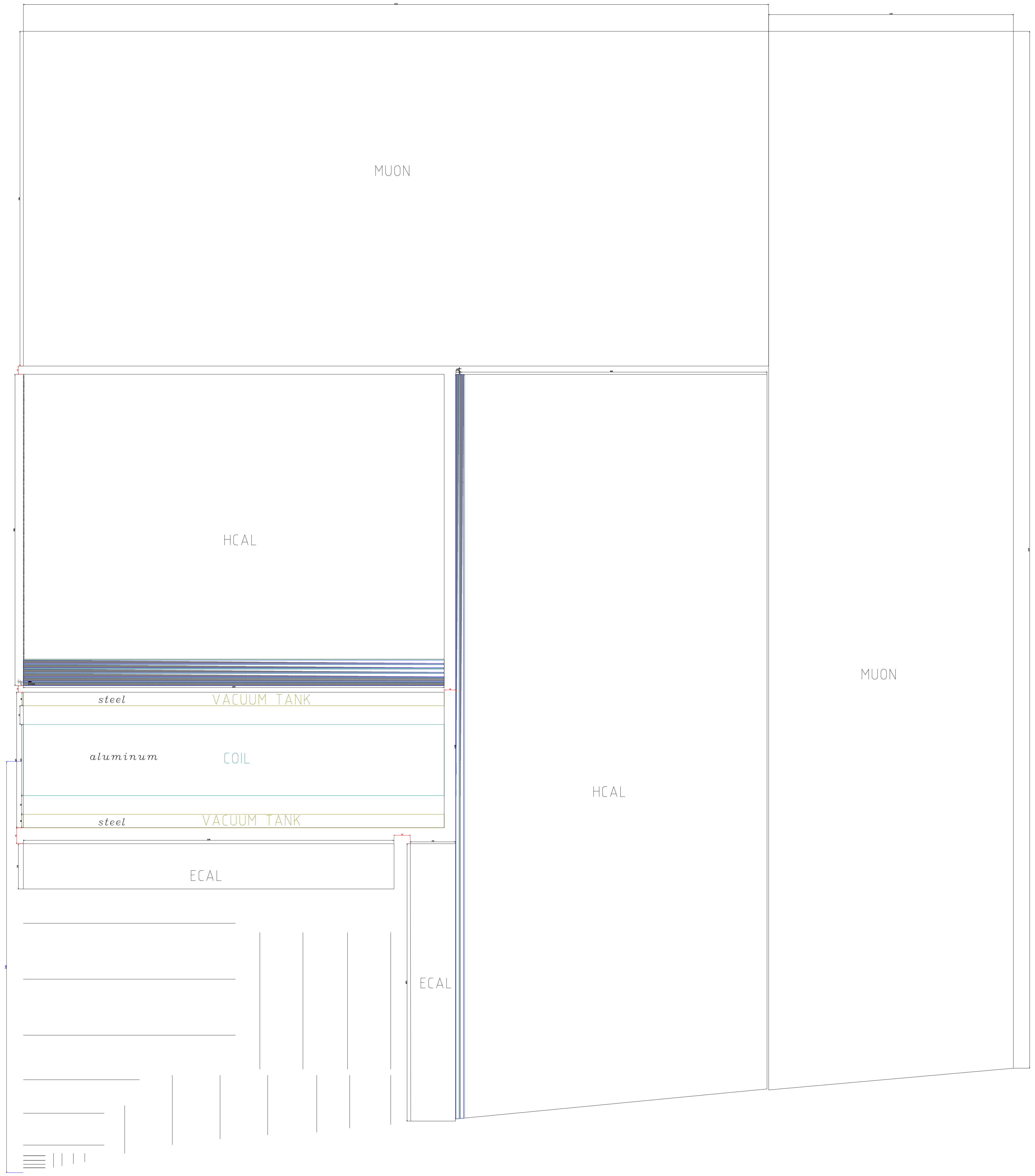
- Non optimised values
- B at IP: 3.75 T
- B = 3.63 ± 0.2 T
- Field uniformity: ±5.5%
- (No optimisation)
- Max Br = 0.2 T

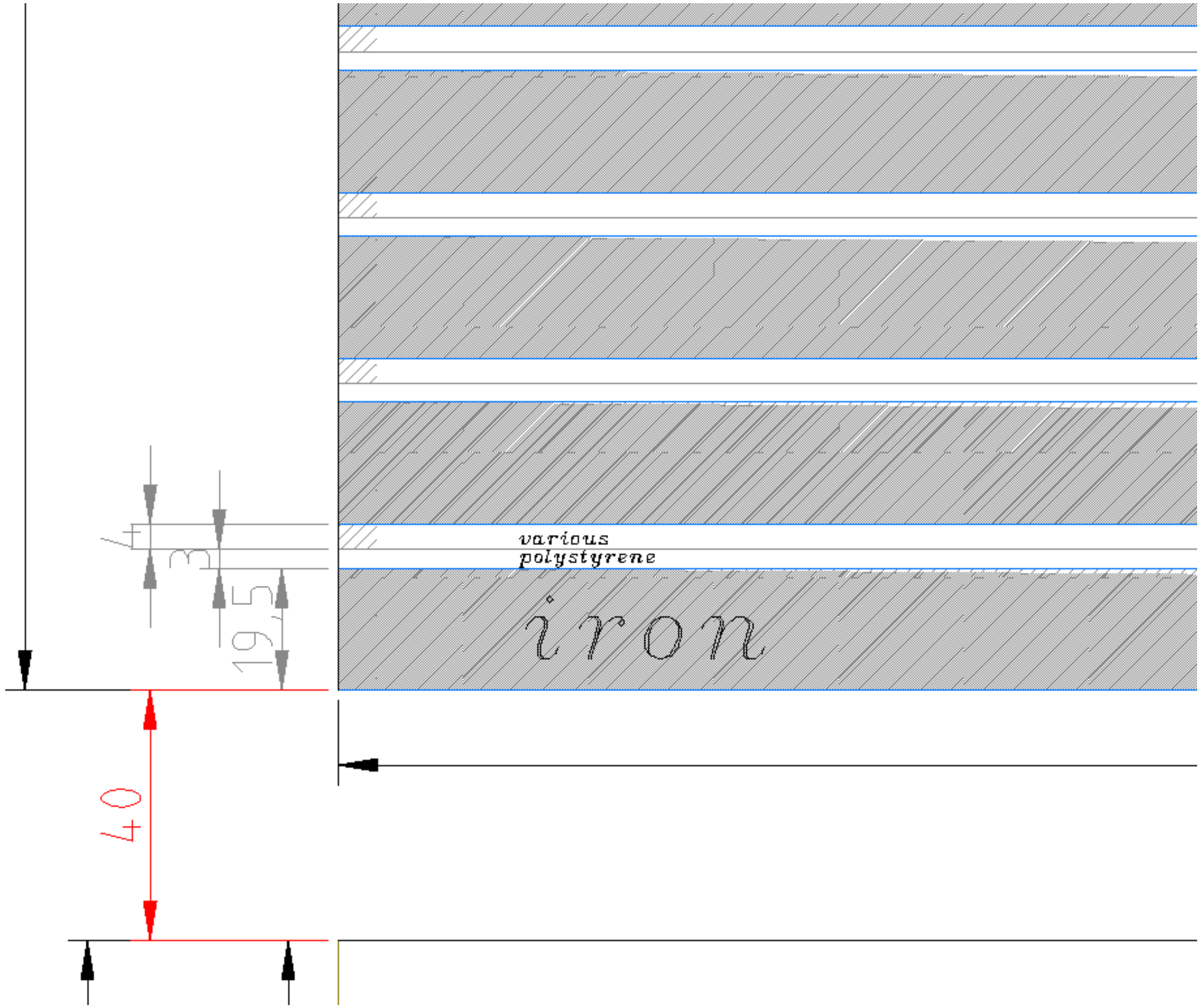


Some technicalities

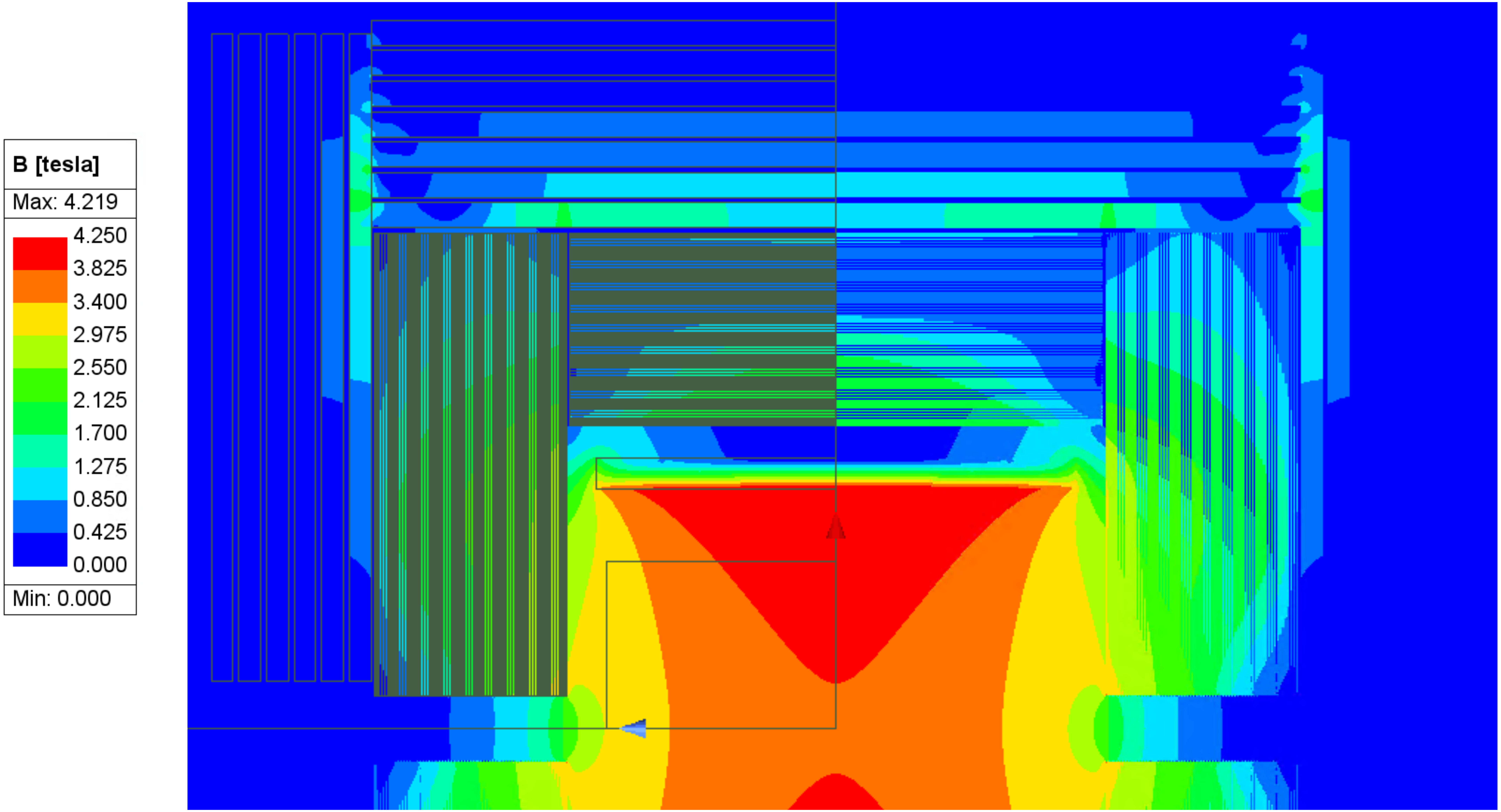
- Maximum field on conductor: 4.05 T
  - NbTi stabilised in aluminium can work properly
  - CMS cable seems very promising as a starting point for the development
  - No company is producing this cable
  - No trivial alternative is available IMHO
- Forces on the coil are HUGE (super preliminary results - no sense to give numbers at this stage)
  - Hoop stress is possibly not terrible
  - Compressive forces are really large
  - Stress management via sub-coils with mechanical supports, reduction of Br and other tricks can be attempted
- No optimisation at all has been performed
  - Some interface with the detectors can possibly be defined

Autumn iteration





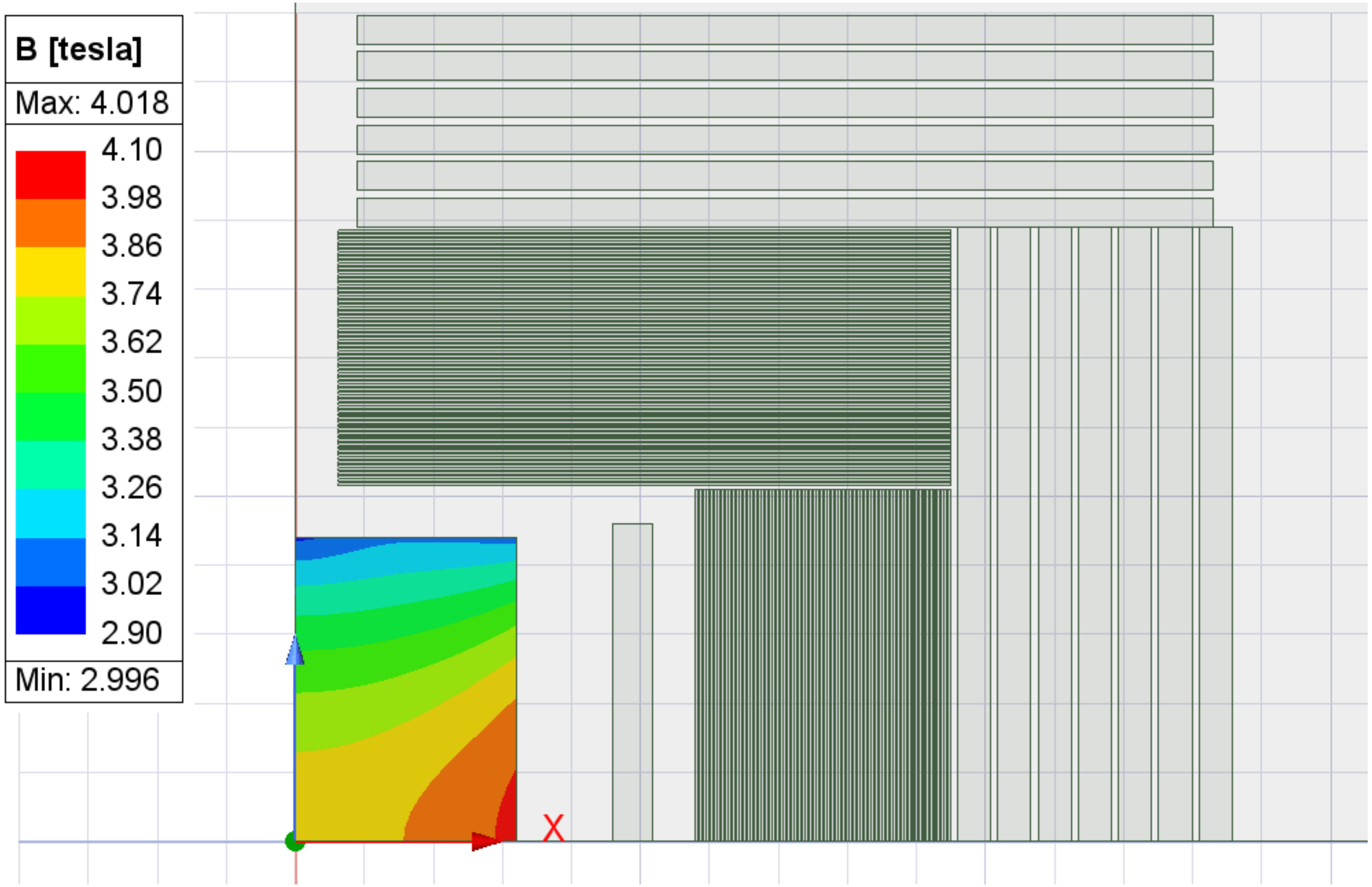
Outer HCAL design



New design parameters

- Tracker region: -2200 < z < 2200, 0 < r < 1500
- B at IP: 3.66 T
- B = 3.60 ± 0.08 T
- Field uniformity: ±2.3%
- (Almost no optimisation)
- Max Br = 0.12 T

- Outer HCAL design
- B at IP: 3.8 T
- B = 3.5 ± 0.5 T
- Field uniformity: ±14.2%
- (No optimisation)
- Max Br = 0.55 T



Conclusion and outlook

- To achieve a feasible, reliable and satisfactory magnet model a deeper integration between magnet and detector design would be desirable

- Presently, manpower is insufficient

- The solenoid can be placed both inside or outside the HCAL
  - different optimisation will be required
  - presently, field uniformity is way better with a large solenoid

- No technical show stopper is evident at this stage
  - but the cable, which is being investigated by CERN and KEK