CLICdp Collaboration Meeting

Engineering aspects of the old/new detector concepts

F. Duarte Ramos

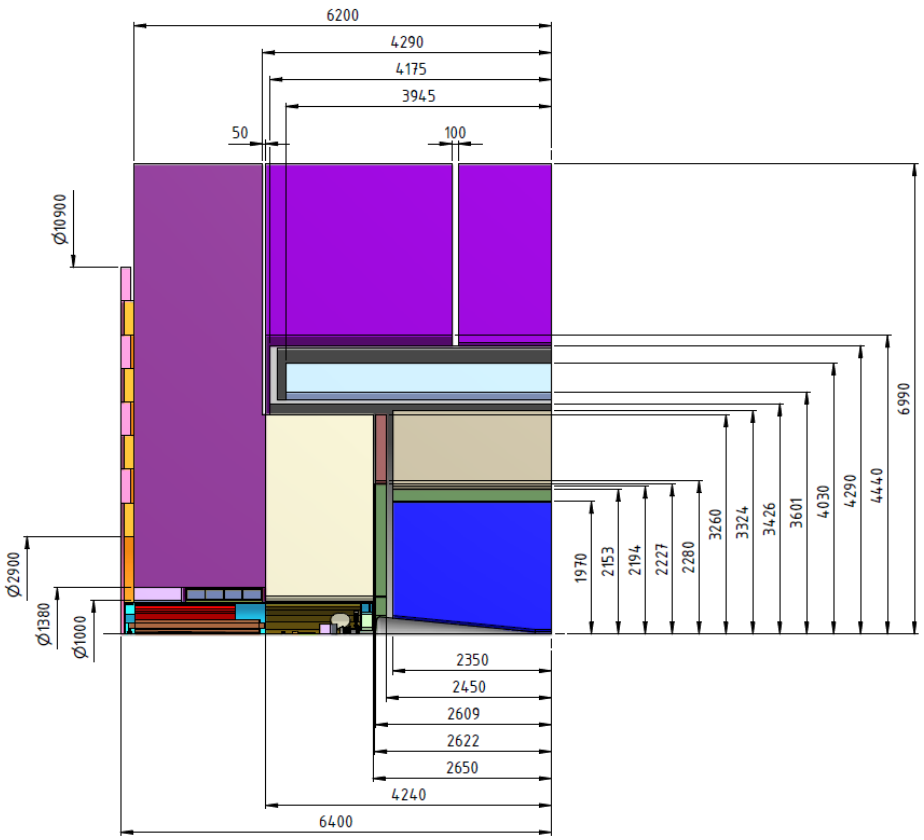
June 10, 2014

Previous work

H. Gerwig, N. Siegrist

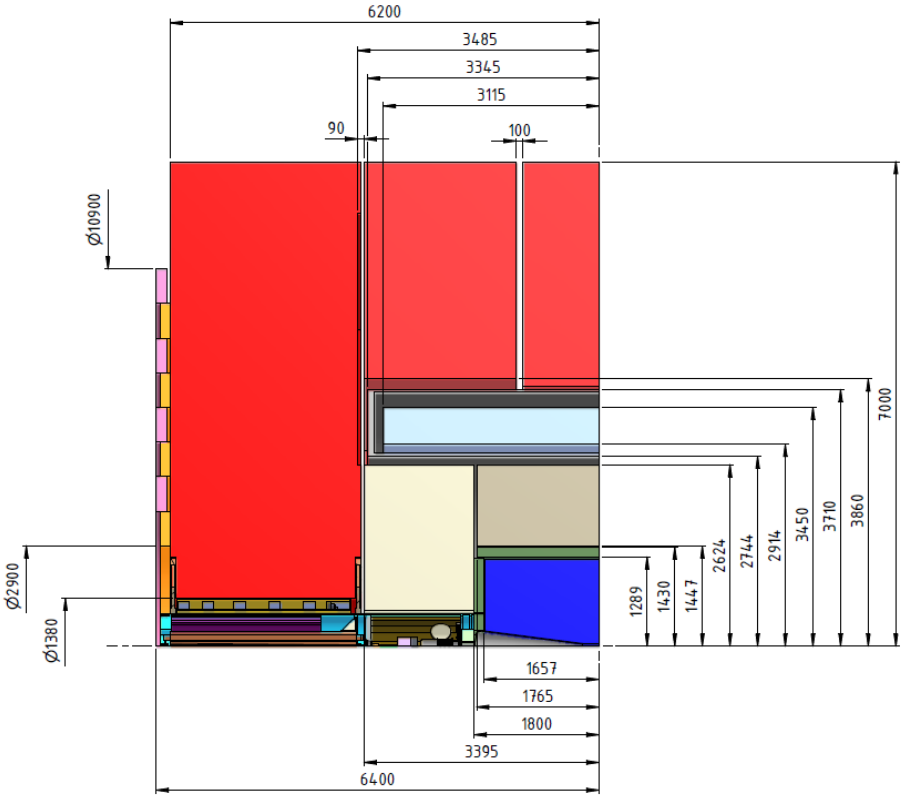
CLIC_ILD

4T



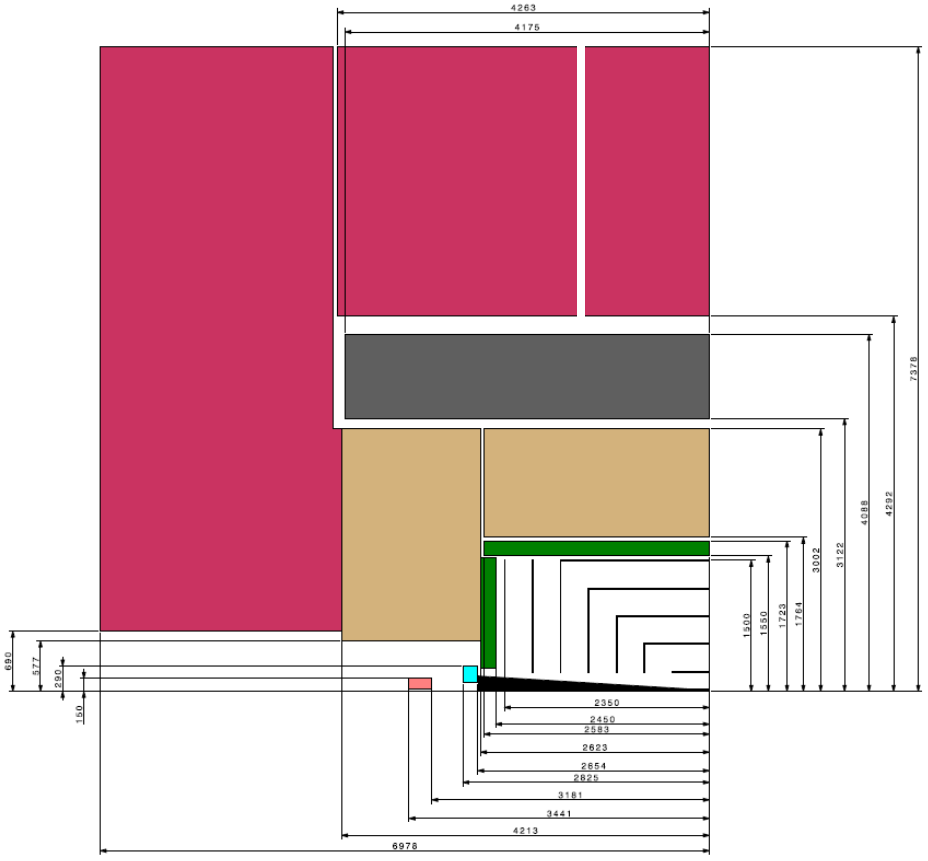
CLIC_SiD

5T



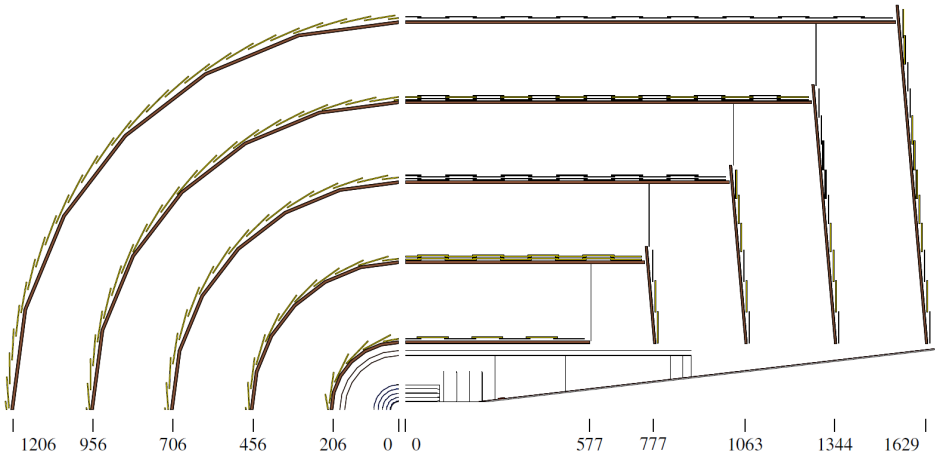
New detector

CLIC_ILD+CLIC_SiD?



- Beampipe radius and opening angle?
- Vertex layout (single vs. double layers)?
- Tracker: R=1500 mm; L=4600-4700 mm
  - Number of layers?
  - Barrel to endcap transition?
  - Expected heat dissipation?
- ECAL thickness: 171 mm vs. 139 mm?
- HCAL:
  - Current thickness: Barrel=1238 mm; Endcap=1590 mm;
  - Steel vs. Tungsten?
  - Endcap angular coverage/W-PE shield?
- QD0 location:
  - L*?
  - Inside or outside of detector?
- B-Field:
  - 4.5 T;
  - Yoke thickness? (see talk of B. Cure next)
  - Field homogeneity inside the tracker?
- Gaps for services (power, signal, cooling and gas) routing?
- Space for electronic cards and mechanical supports?
- Opening scenario?

CLIC_SiD tracker
as used in the GEANT4 model

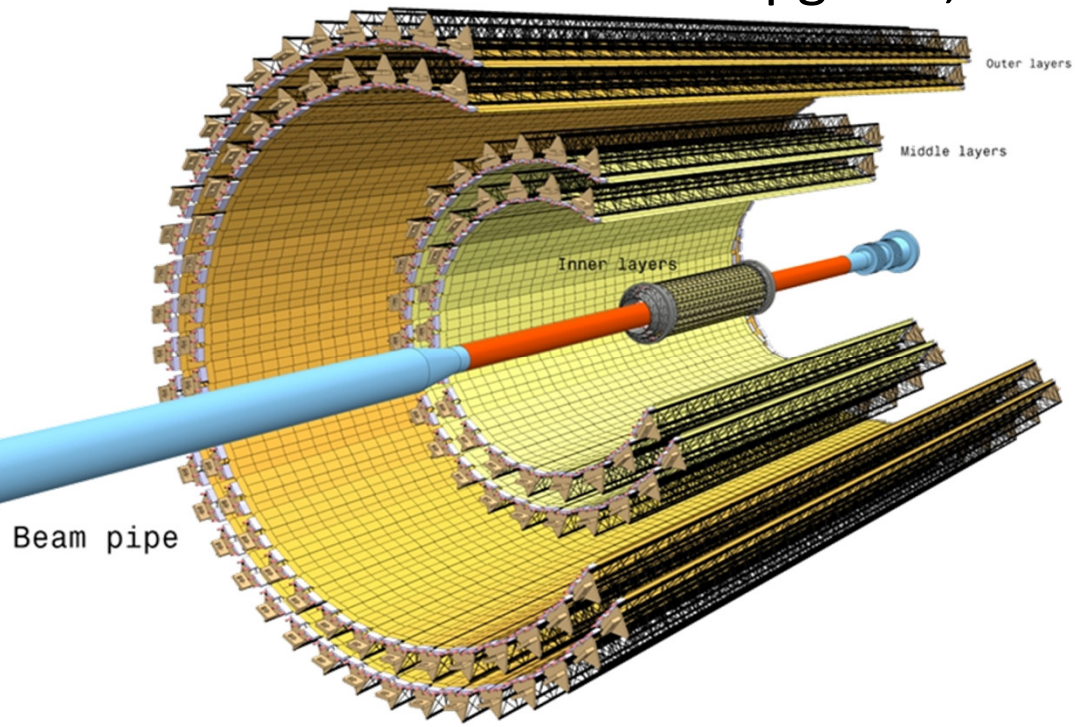


C. Grefe, A. Münnich, "The CLIC_SiD_CDR Detector Model for the CLIC CDR Monte Carlo Mass Production", LCD-Note-2011-009

- 9 mm thick barrel support cylinders (sandwich 8 mm Rohacell + 2x0.5 mm CFRP) with 0.48% X_0 per layer;
- 4.5 mm thick endcap cones (sandwich 3.5 mm Rohacell + 2x0.5 mm CFRP) with 0.5% X_0 per layer;
- 97.8x97.8 mm^2 modules for the barrel;
- Trapezoidal modules (89.8/100.1 mm radial extent) for the endcaps;
- No mention of cooling.

Alternative tracker designs

ALICE ITS upgrade, C. Gargiulo PH/DT



Inner Barrel (IB): 3 layers pixels

<Radius> (mm): 22,31,39

Length in z (mm): 270

Nr. of staves: 12, 16, 20

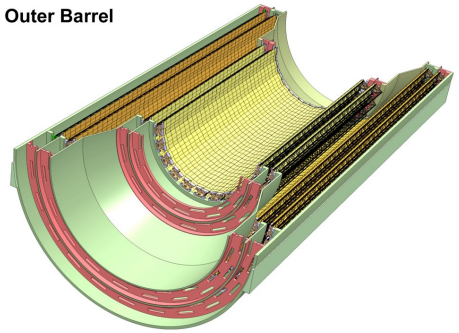
Nr. of chips/stave: 9

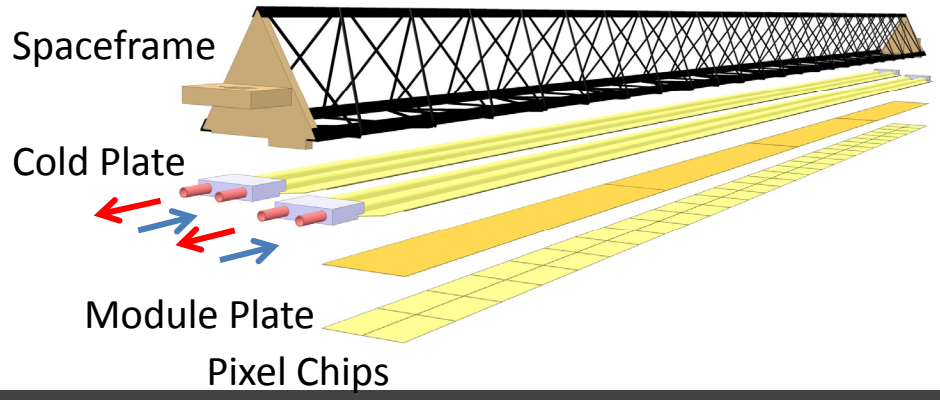
Nr. of chips/layer: 108, 144, 180

Material thickness: ~ 0.3% X_0

Power density: < 300 mW/cm^2

Throughput (@100kHz):
< 500 Mbit / sec x cm^2





Outer Barrel (OB)

<radius> (mm): 194, 247, 353, 405

Length (mm): 843 (ML), 1475 (OL)

Nr. staves: 22, 28, 40, 46

Nr. modules/stave: 4 (ML), 7 (OL)

Nr. chips/module: 14

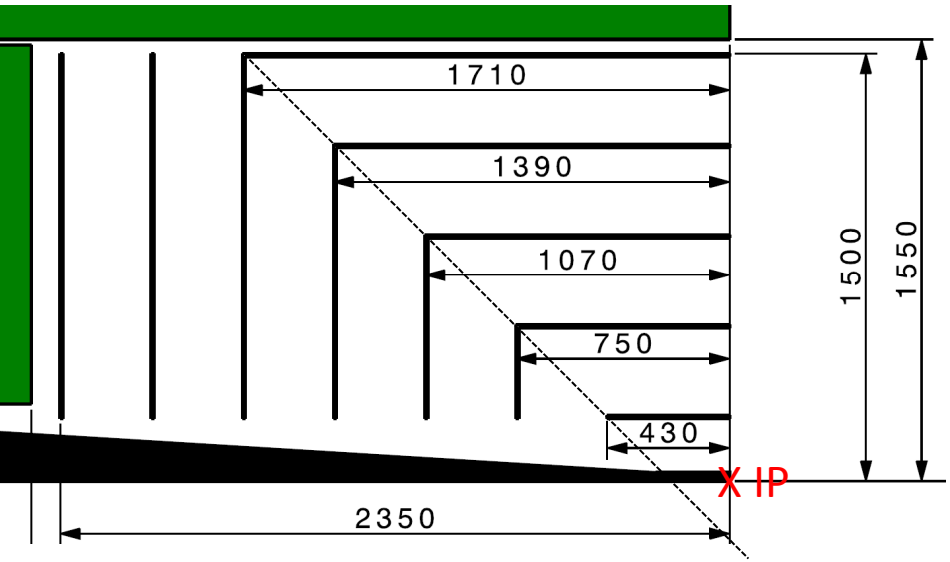
Material thickness: ~ 0.8% X_0

Throughput (@ 100 kHz):

< 12 Mbit / sec x cm^2

Tracker designs

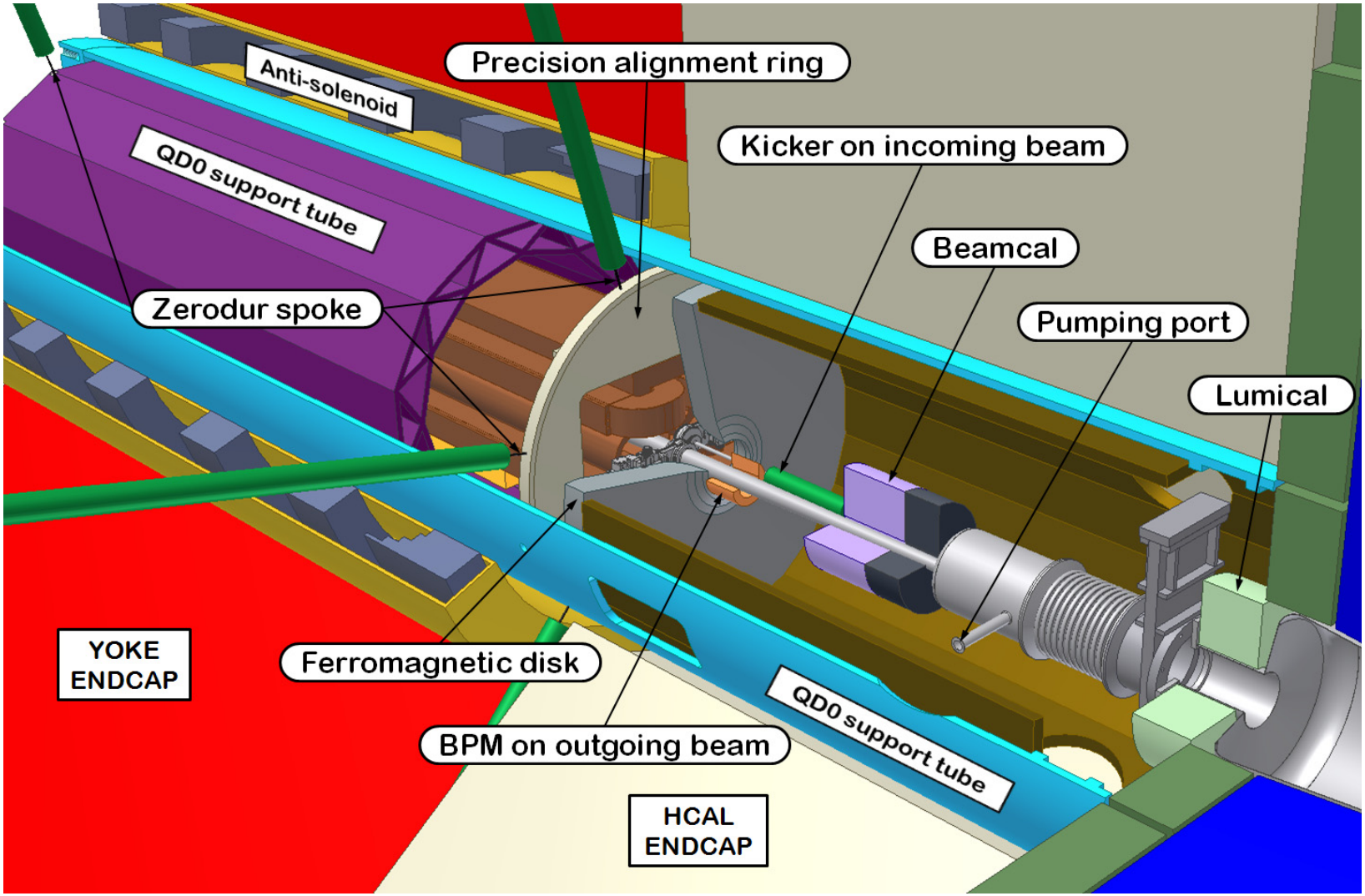
1st layout proposal (not at all optimized!)



- 2 innermost barrel layers within ALICE ITS OB dimensions (cooling+support = 0.28% X_0);
- Use less material than objective (1% X_0) in “short” inner layers and more in “long” outer layers;
- Barrel/endcap transitions not pointing to IP but aligned between each other (a problem?);
- Air cooling seems unlikely (unless very low heat dissipation allows natural convection) due to volume between layers (but needs to be verified once heat dissipation estimates are available);
- ALICE ITS upgrade OB staves include leakless water based cooling (0.2% X_0) in the 0.8% X_0 total for 100 mW/cm^2.

Forward region

H. Gerwig, N. Siegrist



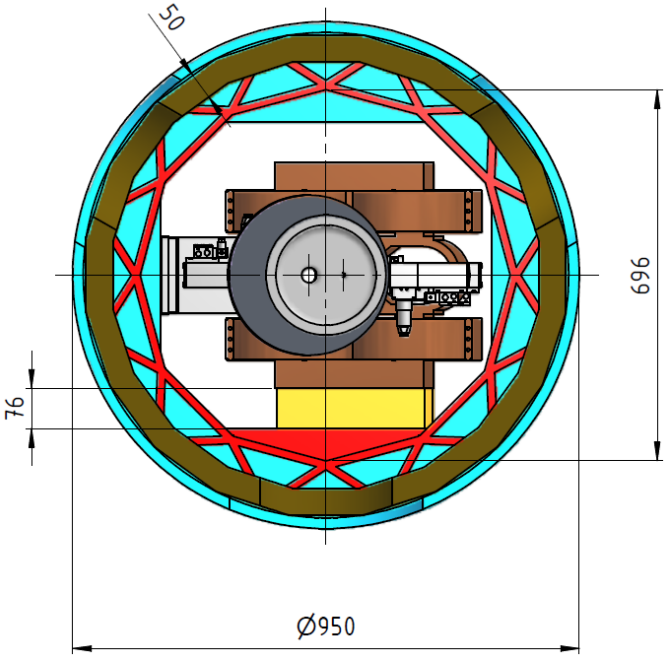
Forward region

In the CDR designs, the diameter of the endcap bore is driven by the QD0 support tube (R=500mm);

For the new detector proposal:

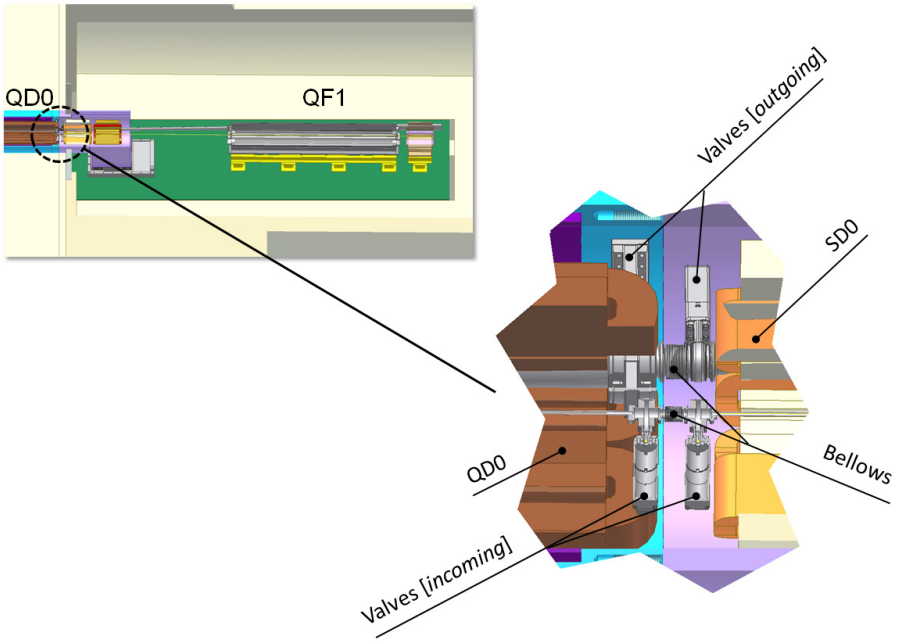
- Is QD0 still inside the detector? (in view of the yoke endcap thickness reduction studies);
- If not, does the anti-solenoid need to be redesigned? (its functions are to shield the permanent magnets of QD0 and minimize luminosity losses due to 10mrad crossing angle);

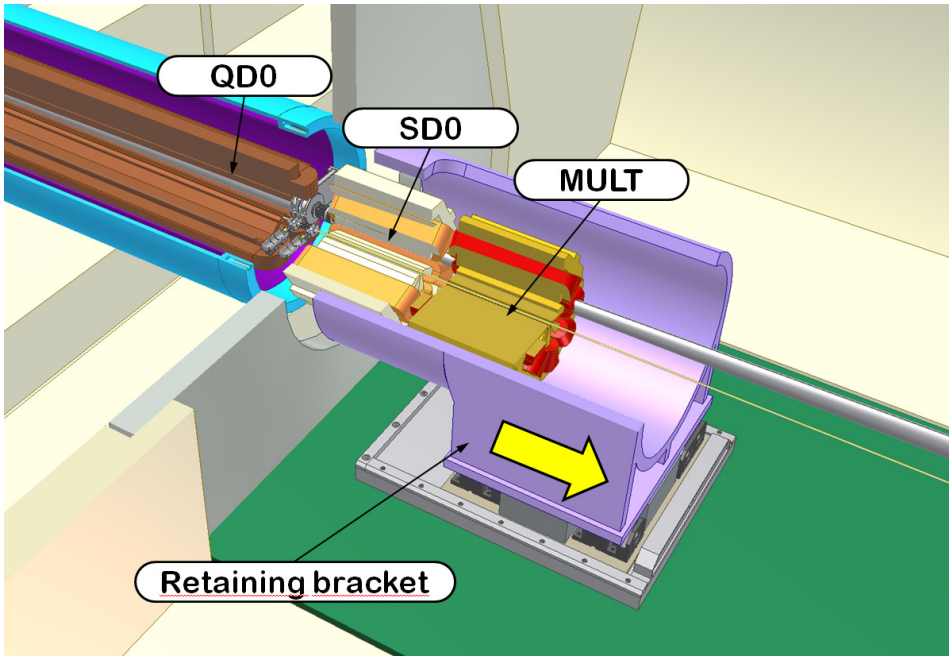
A redesign of the forward region would likely result in a new detector opening scenario.



Current opening scenario

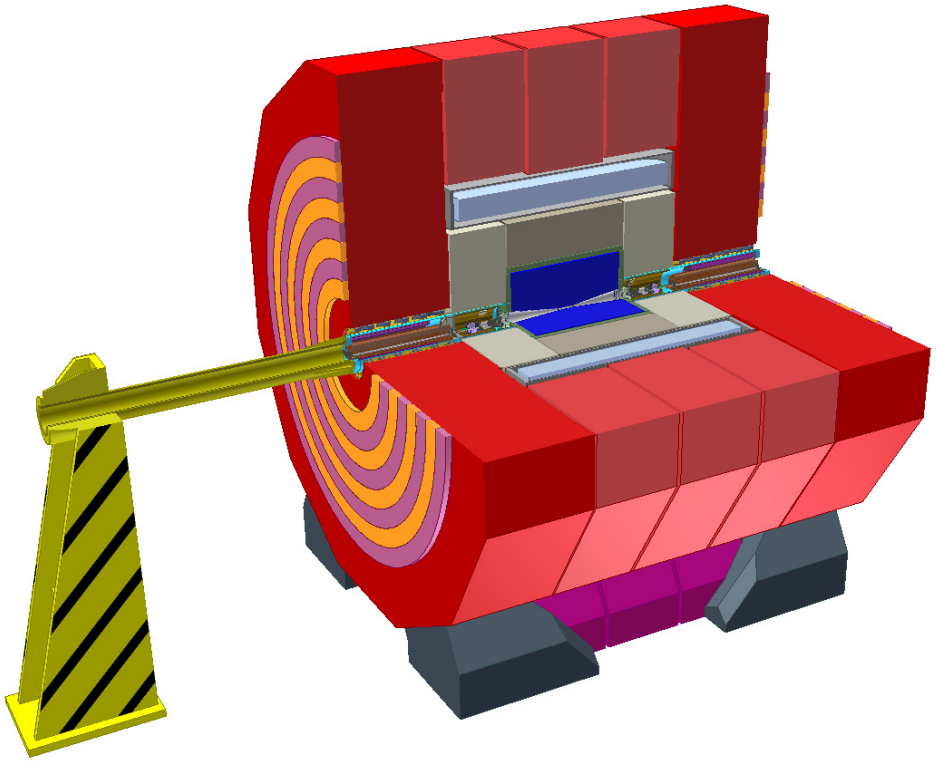
H. Gerwig, N. Siegrist

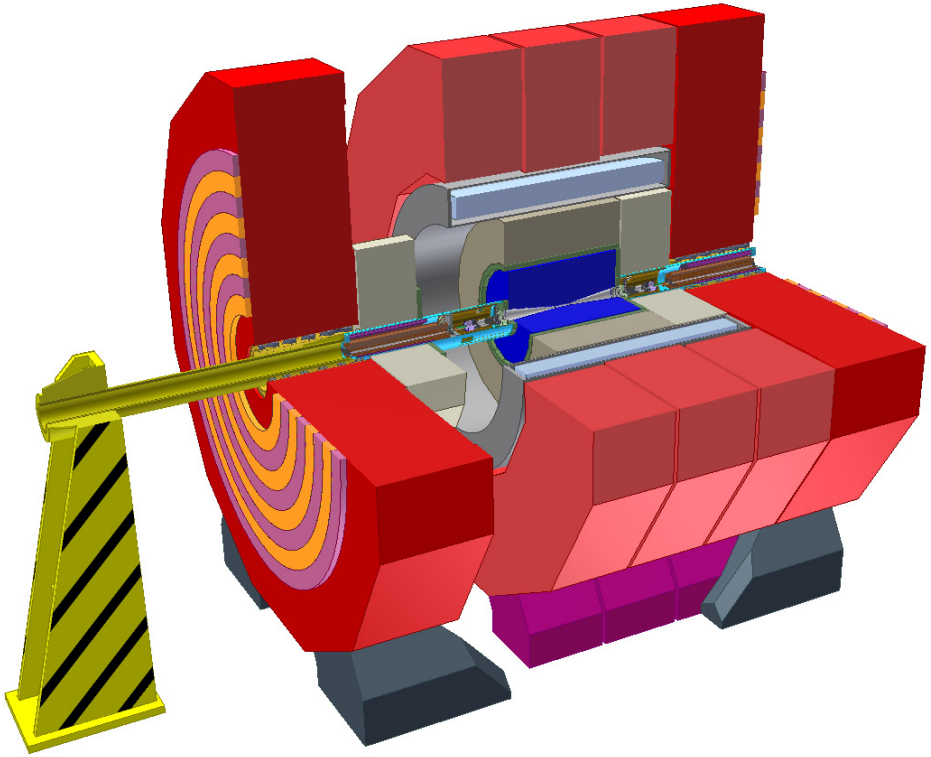




Current opening scenario

H. Gerwig, N. Siegrist





Current opening scenario

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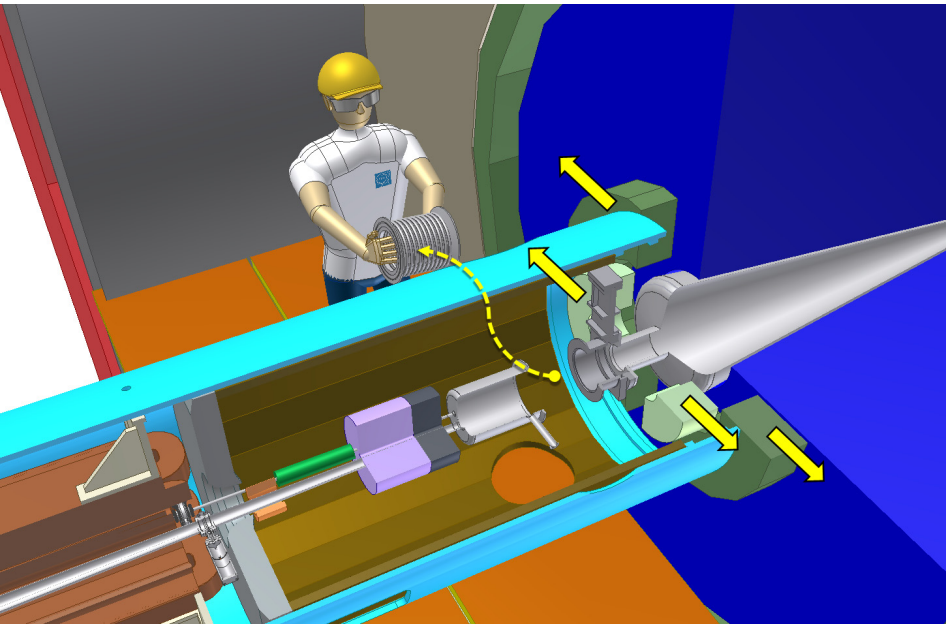

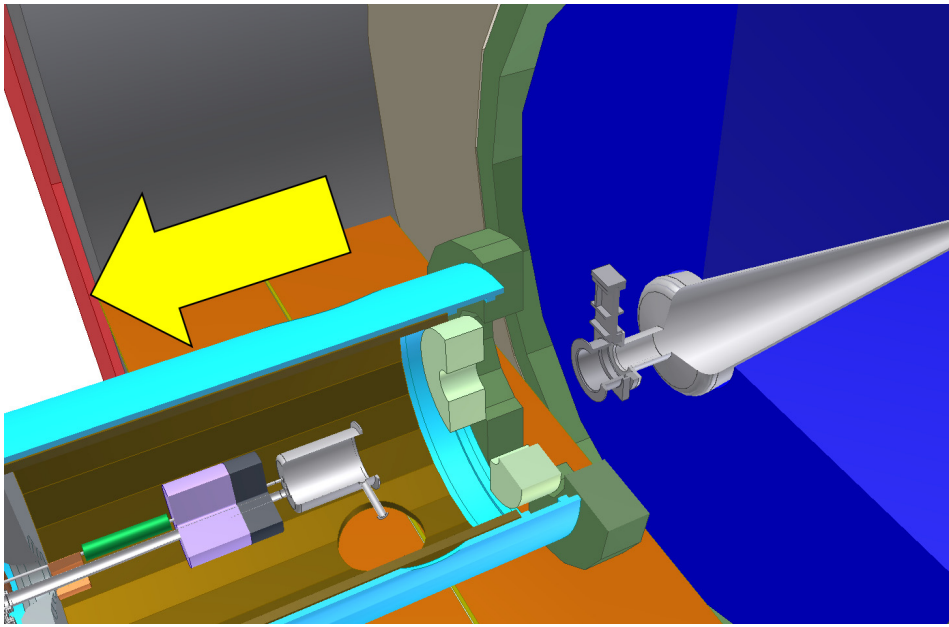

Current opening scenario

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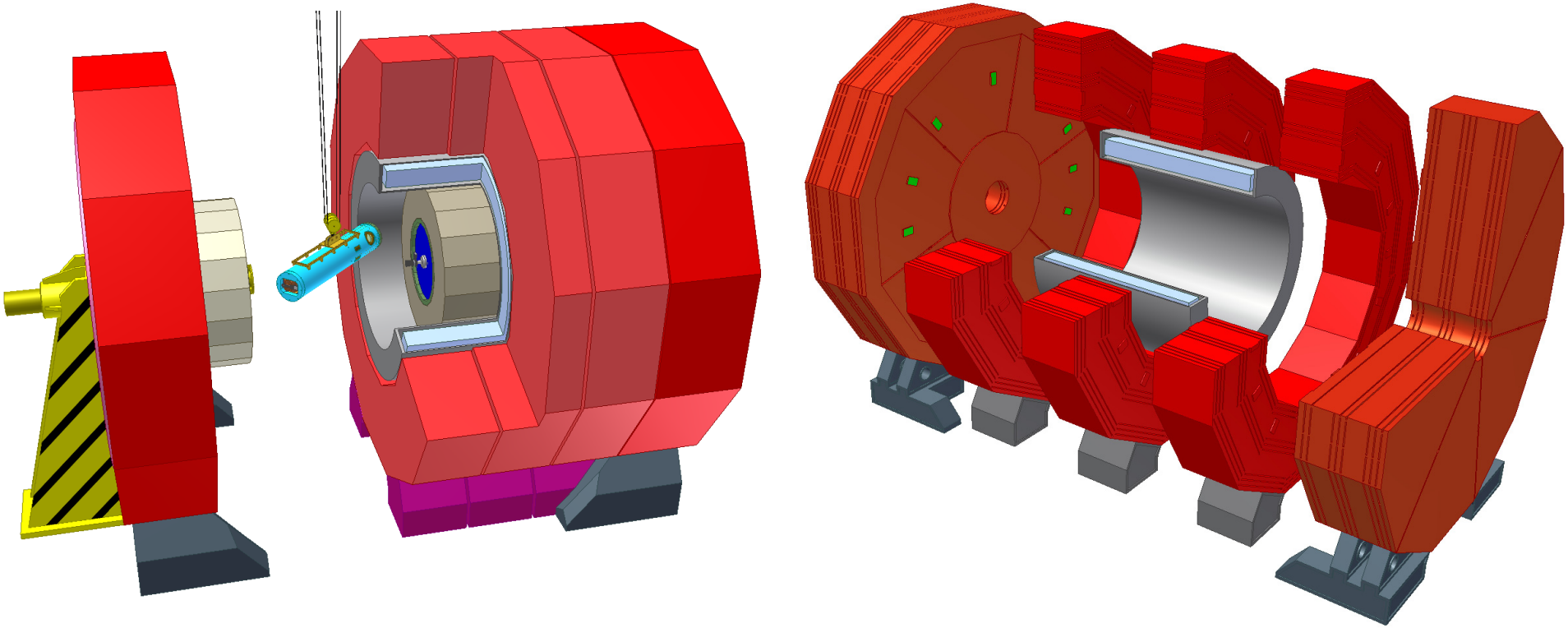
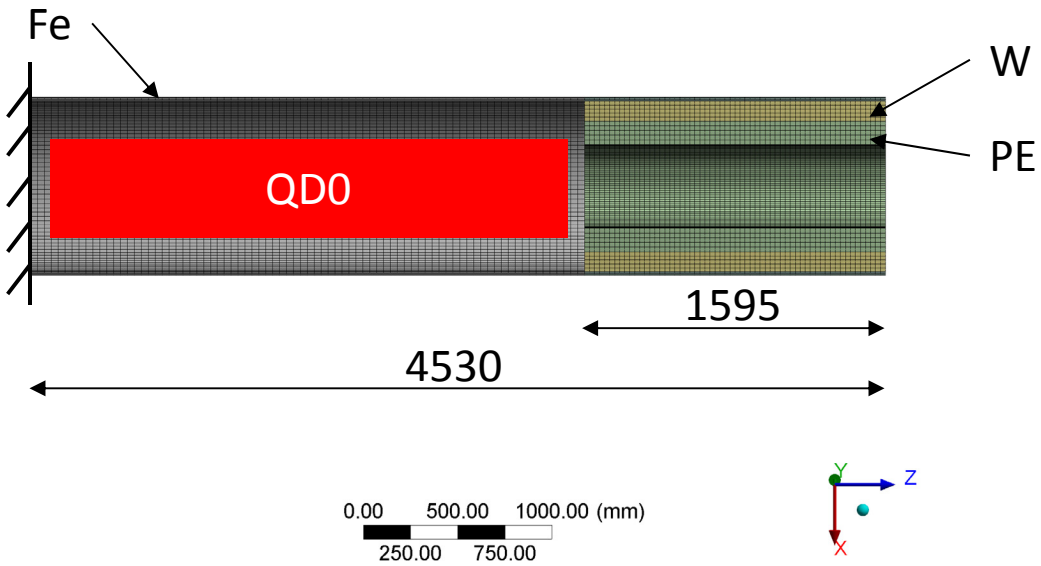
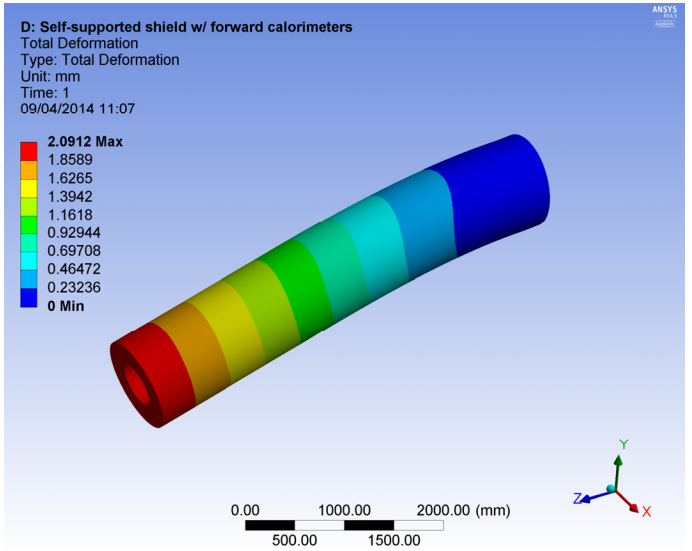


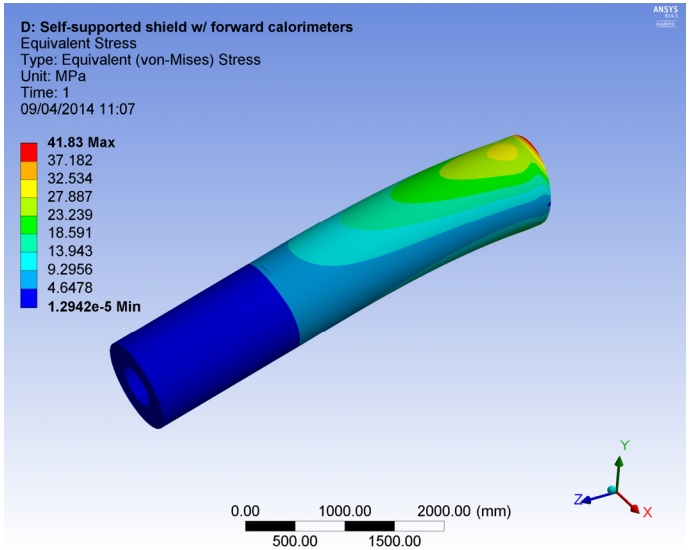
Forward region with W-PE shield

Proposal of S. Van Dam to reduce occupancy due to incoherent pairs in the HCAL endcap

PE: R_{in}=225 mm; R_{out}=350 mm; M=0.38 tonne
W: R_{in}=350 mm; R_{out}=475 mm; M=9.97 tonne

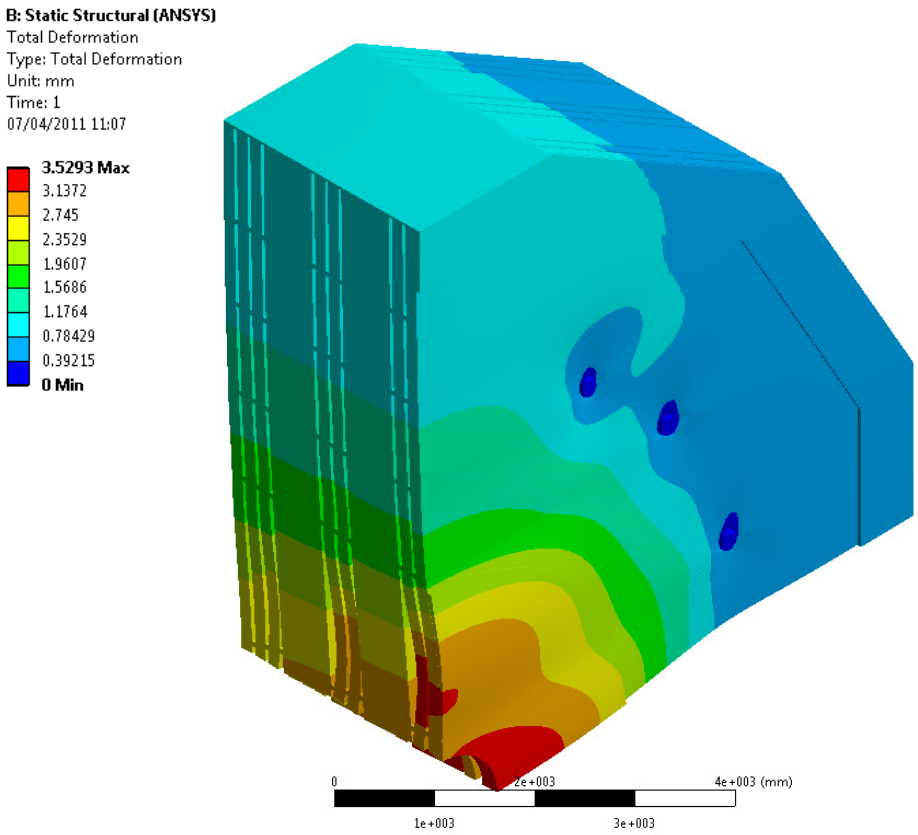






Lower mass if instead the HCAL endcap is extended to this region (~6 tonne)

Yoke thickness



(Deformation due to magnetic forces at 5T)

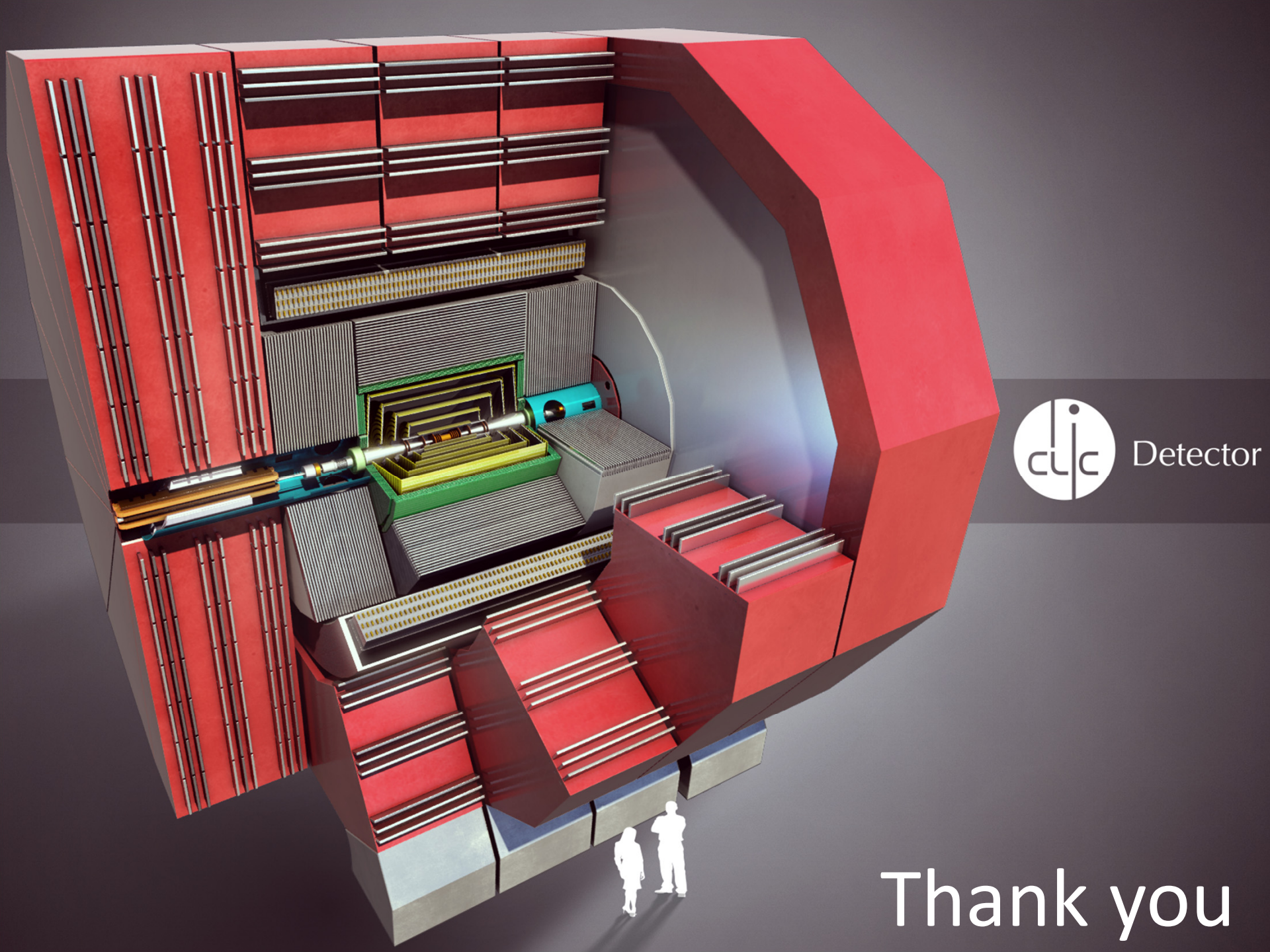
Defined by (CDR requirements):

- Magnetic field quality ($\int \frac{B_r}{B_z} dz < 10mm$ over the tracking volume);
- Fringe field limitations (less than 50 Gauss @ 15m);
- Radiation self-shielding in case of accidental beam loss;
- Withstand magnetic forces (18000 tonnes @ 5T for the endcap);

Some of these requirements may be removed if we only have one detector?

Summary

- Many engineering studies were performed at CERN in order to write the CDR (e.g. HCAL design, main solenoid, yoke layout, forward region and QD0 stabilization, push-pull and cavern layout, etc.);
- Some aspects were studied in detail (e.g. forward region) while others only superficially (e.g. tracker);
- For the new detector, some of the ideas may be reused, if the requirements are maintained;
- But before that, the requirements need to be reviewed.


clic
Detector
Thank you