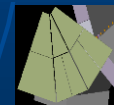
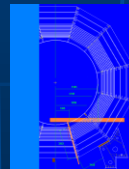
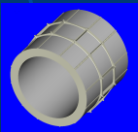
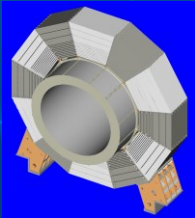
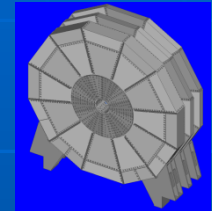
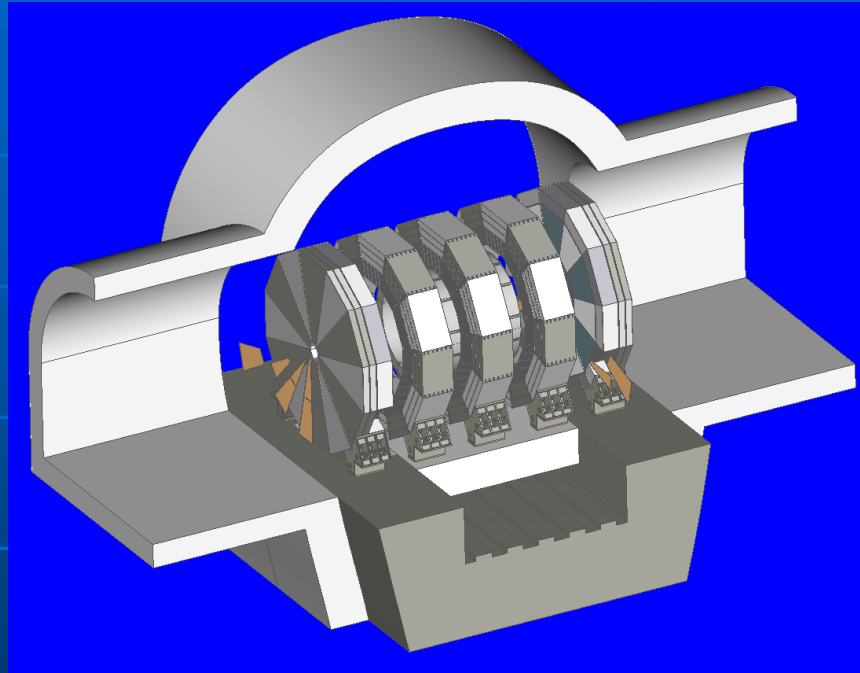
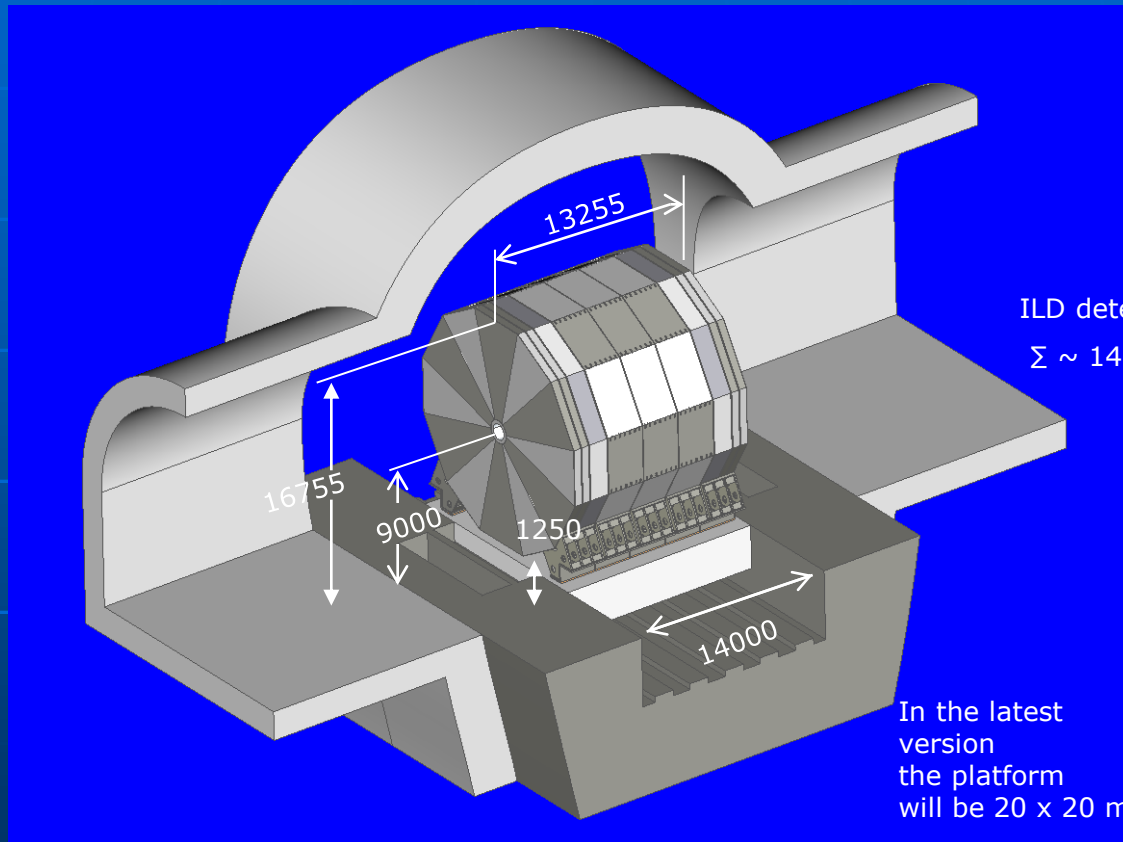


ILD - Barrel, End Cap integration

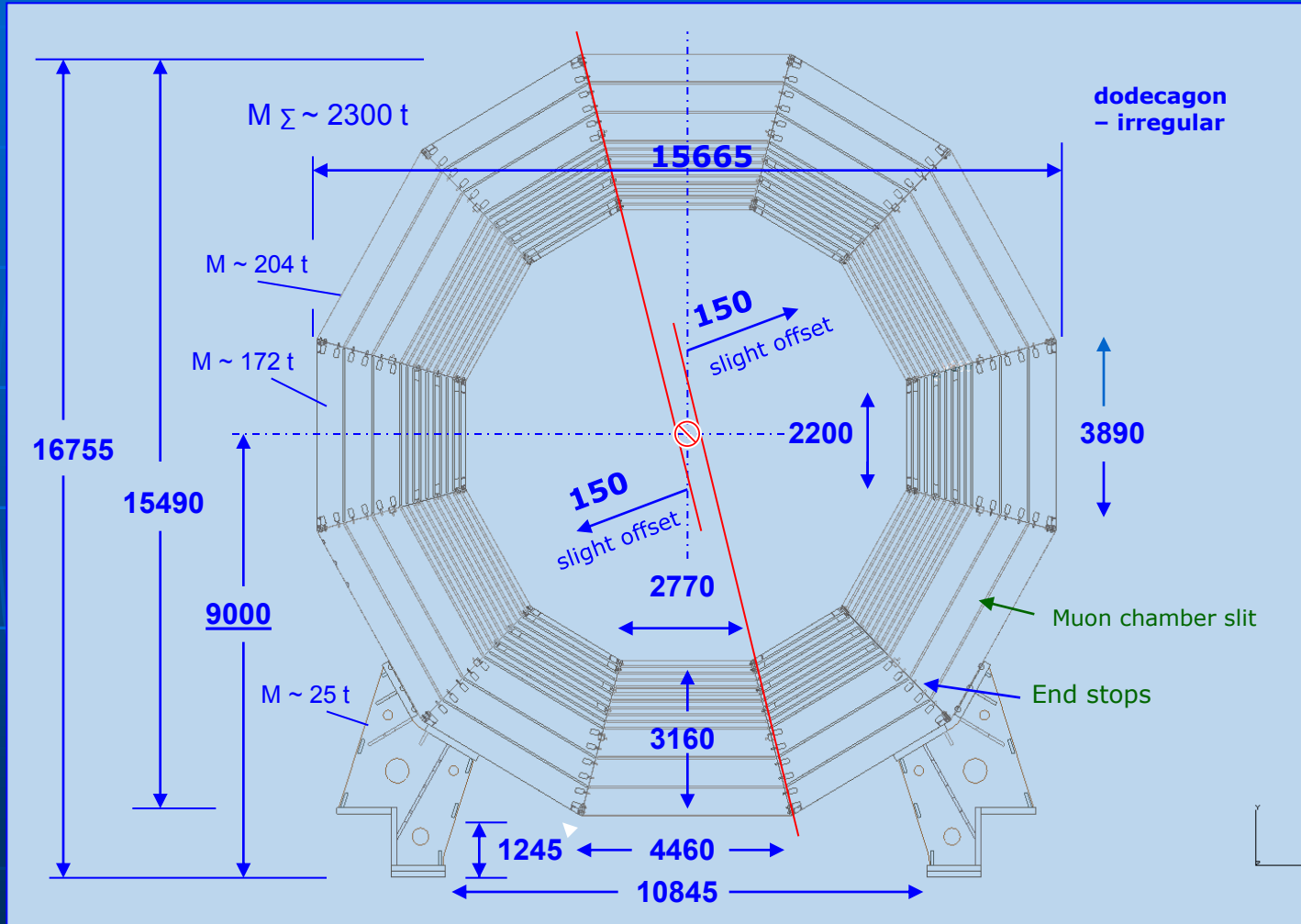
- current design with beam height 9 meter -



ILD detector in closed position

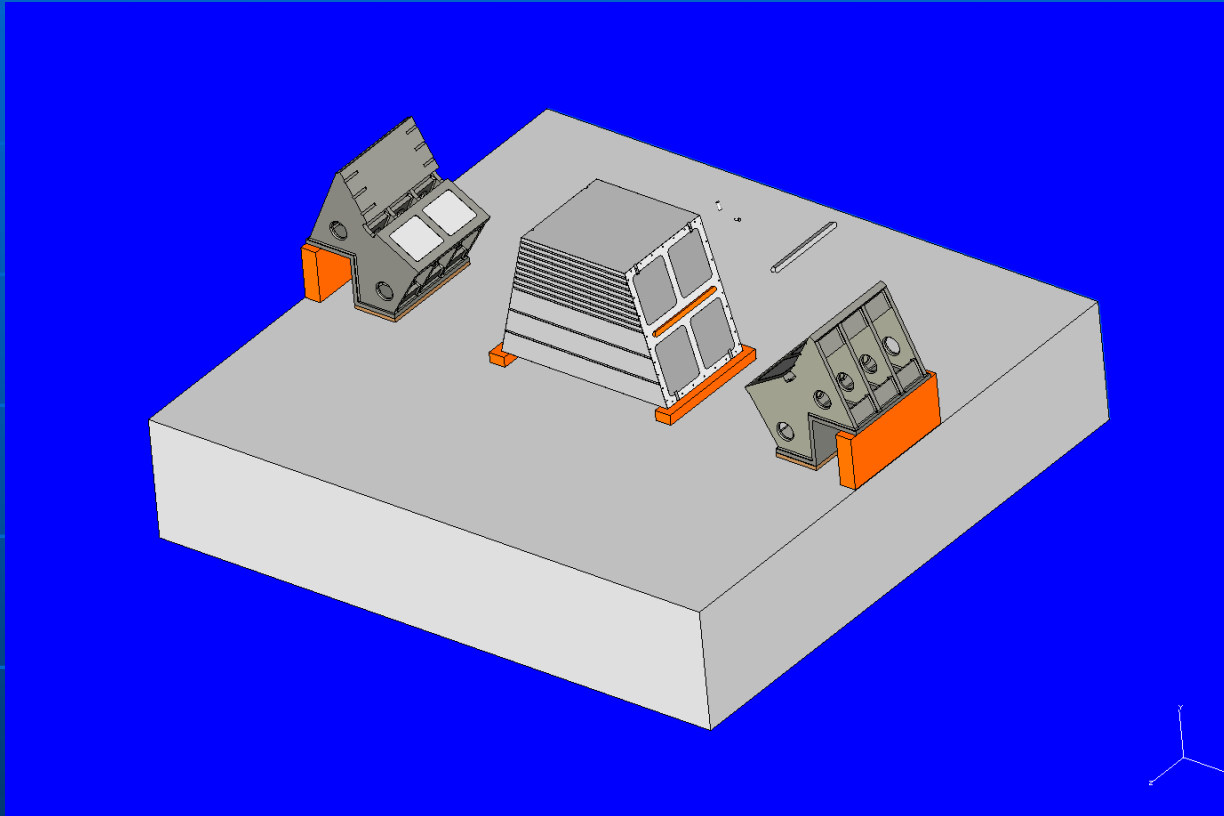


Barrel geometry / dodecagon - slight offset 150 mm



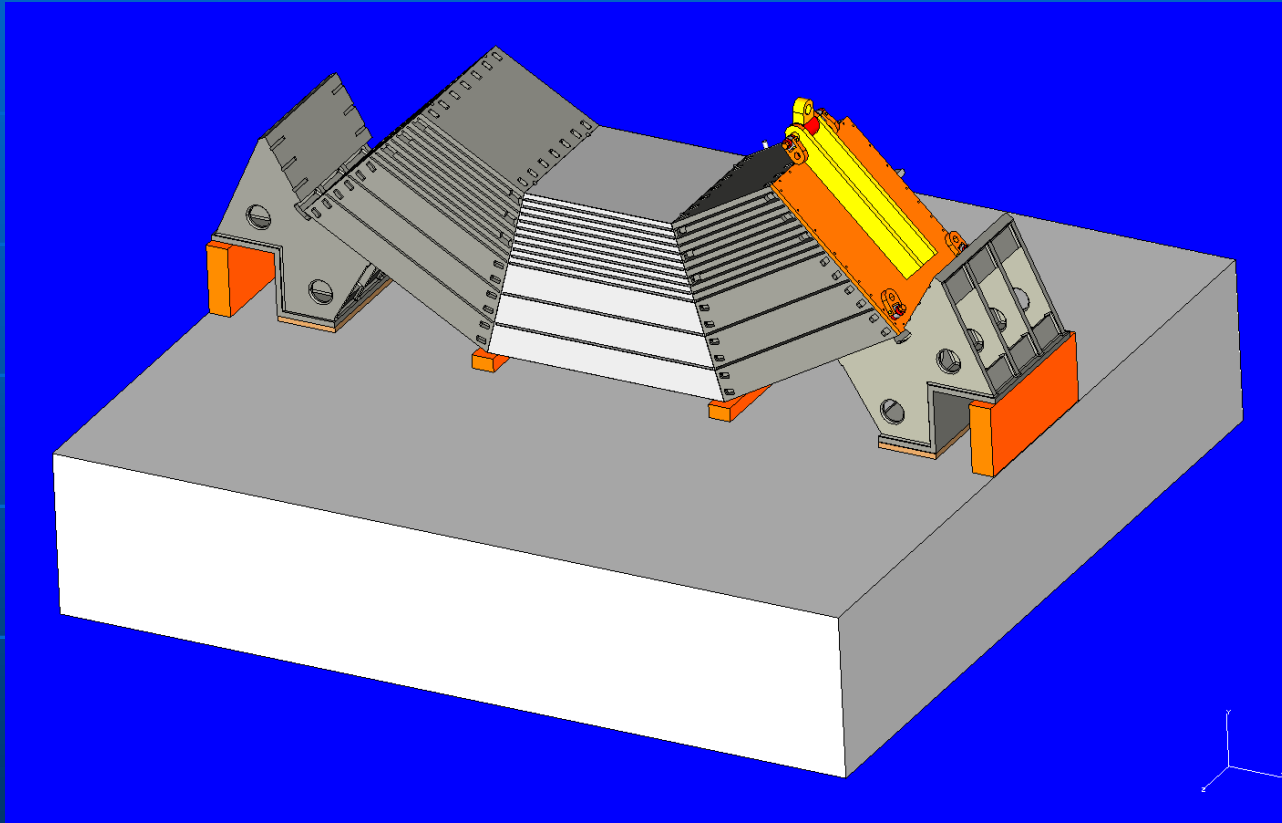
Preparations for the Final Assembly

support gear coloured orange



During the entire assembly procedure the position of the Yoke segments are continuously monitored, the tolerance has to be less than 1.6 mm.

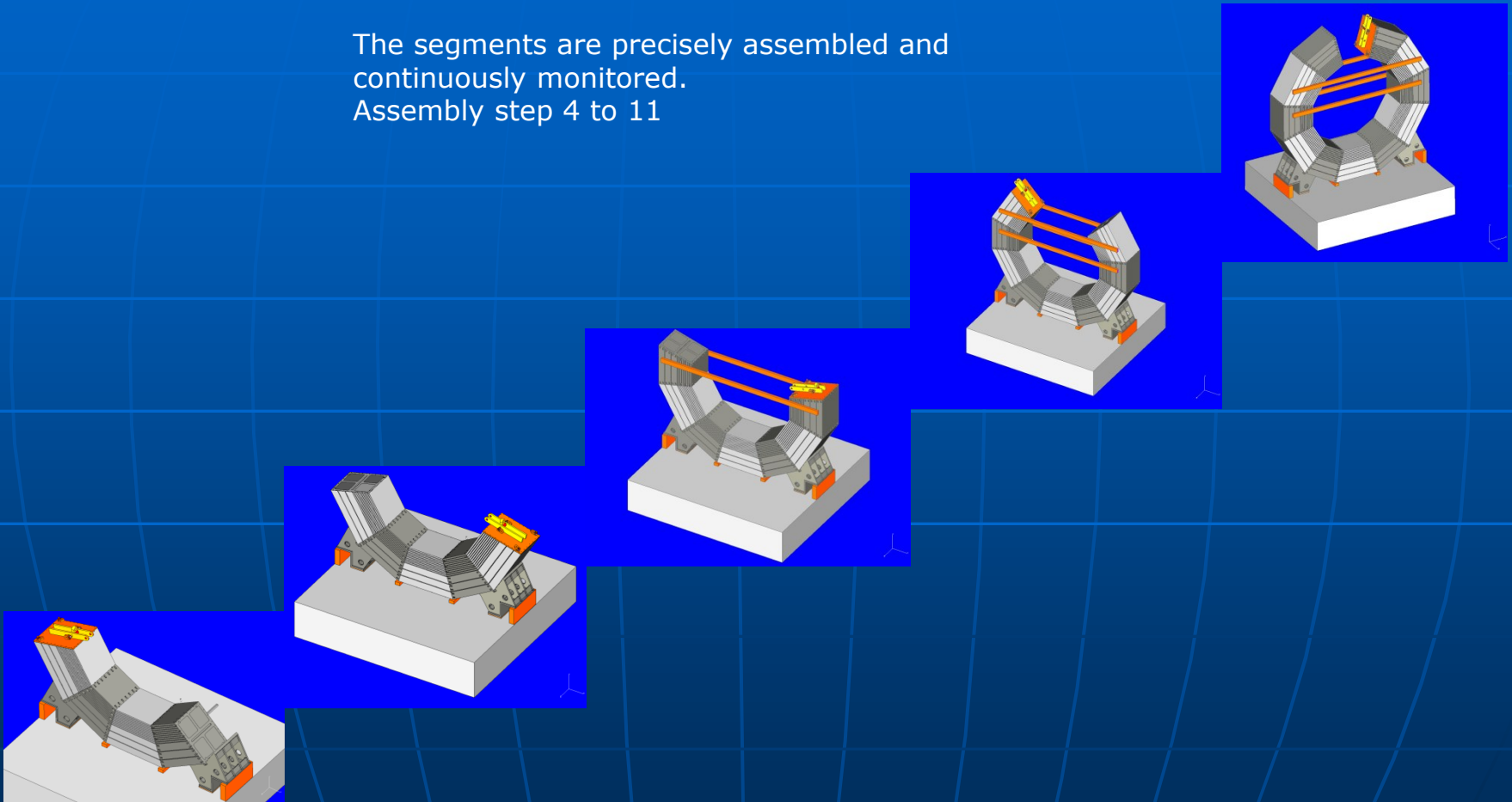
No. 3 segment assembly



The barrel segments are handled with special equipment and suspended at precisely the correct angle with an adjustable jig.

Yoke Ring Assembly (tooling indicated by orange bars)

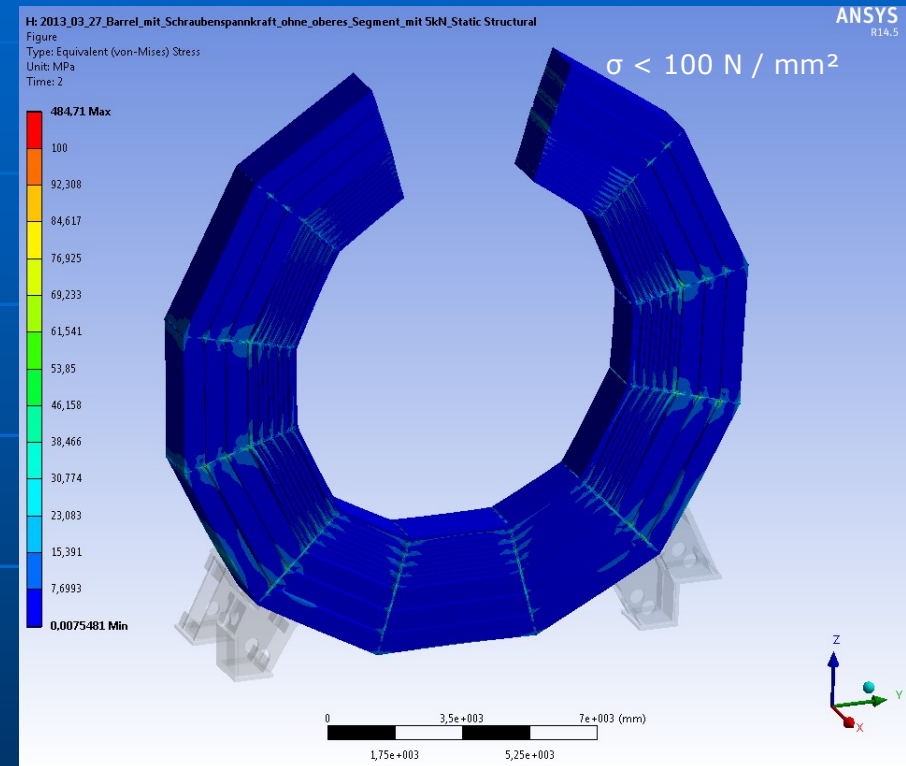
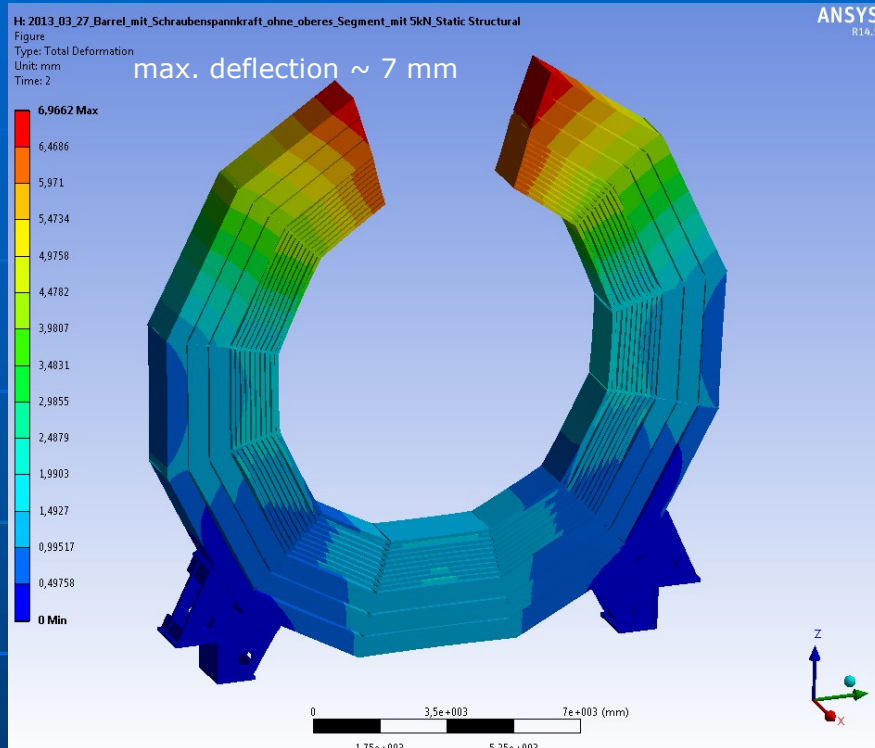
The segments are precisely assembled and continuously monitored.
Assembly step 4 to 11



Barrel Ring Deformation and Stress / top Segment not installed

FEM with bolted connection

FEM by Martin Lemke / ZM1

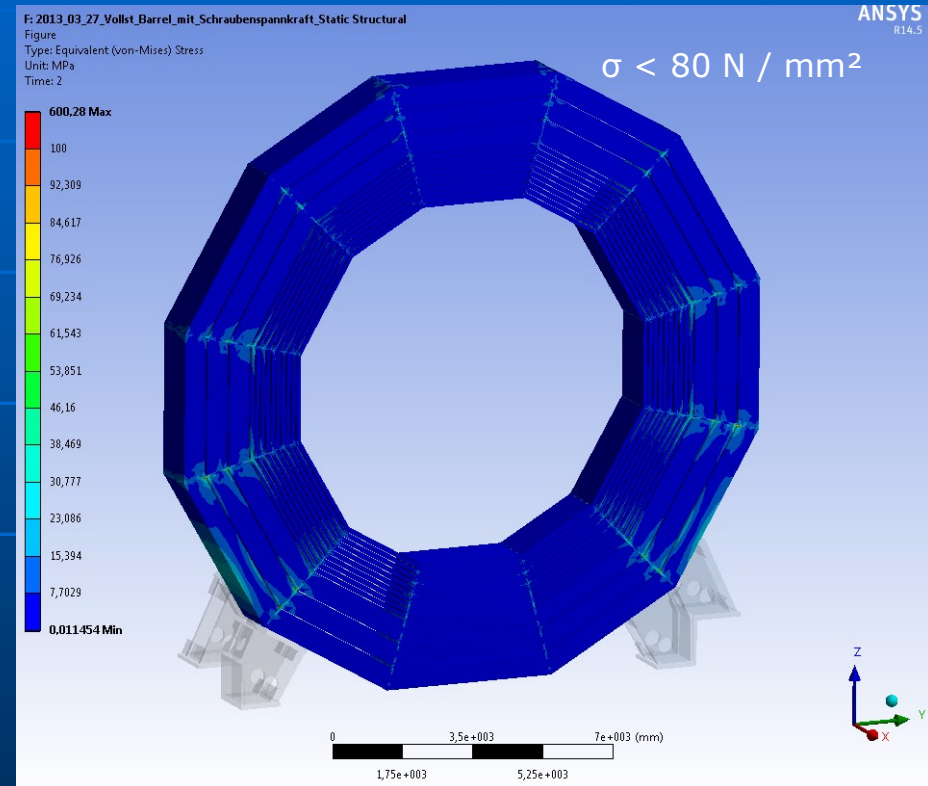
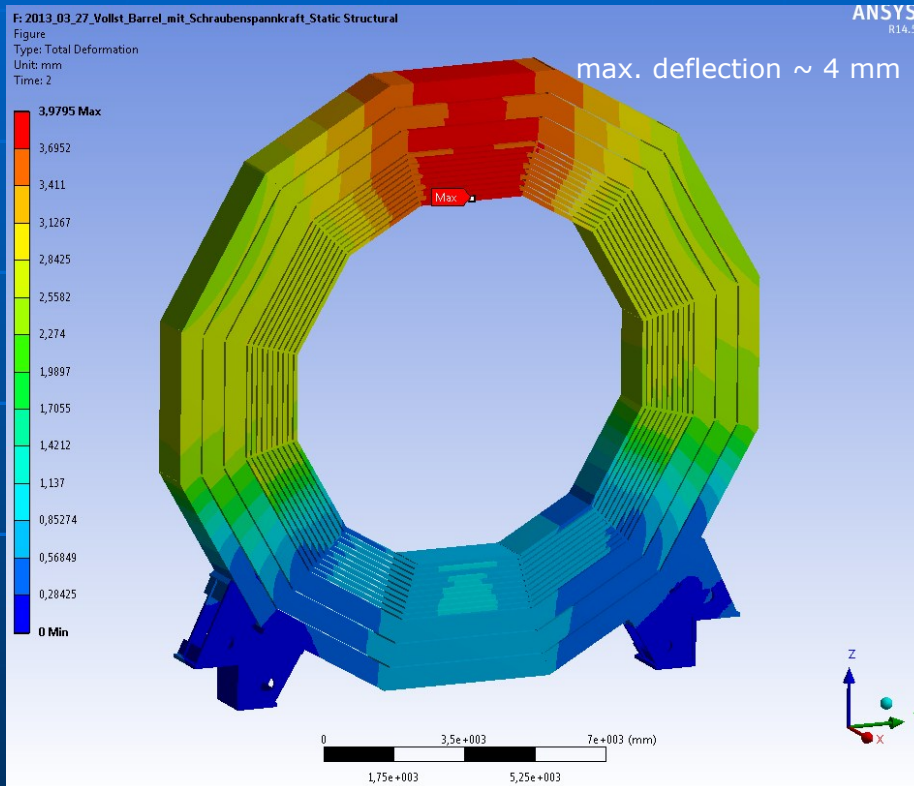


calculation made without any supporting structure

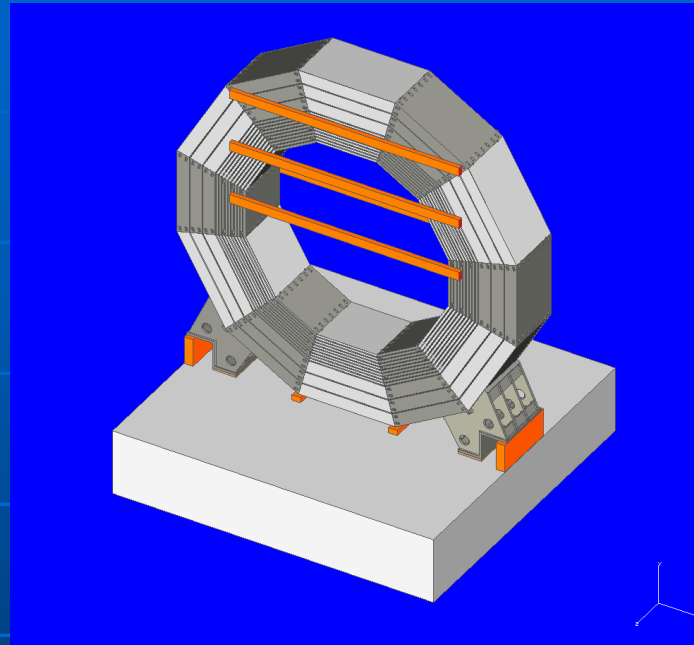
Barrel Deformation and Stress / top Segment installed

FEM with bolted connection

FEM by Martin Lemke / ZM1



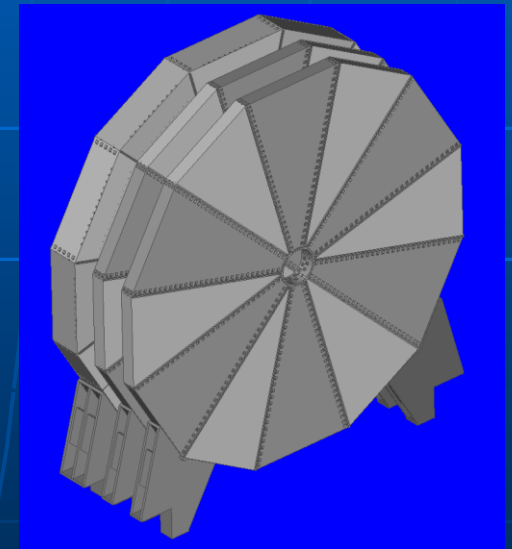
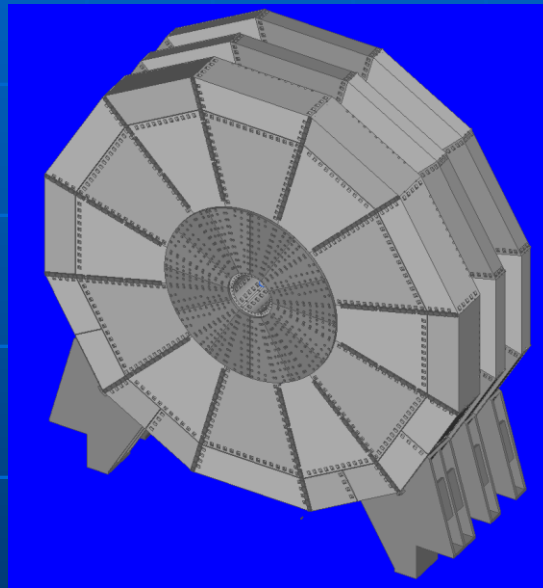
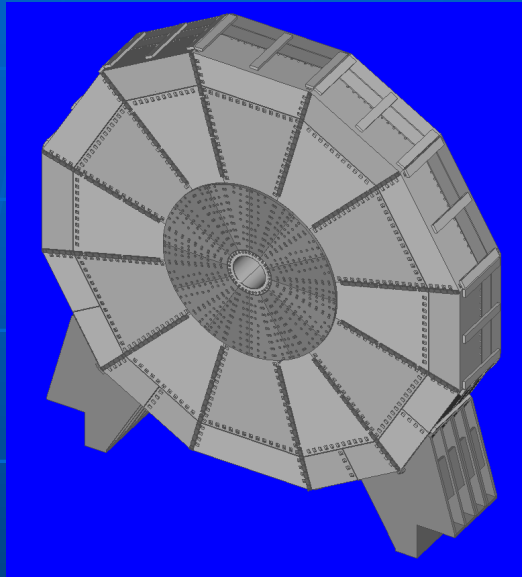
Insertion of the top closing Segment



The positioning of the top element requires special attention. Individually machined or adjusted with shims, options depend on the Yoke manufacturer's expertise.

ILD End Cap

End Cap consisting of three disc in the closed and open position

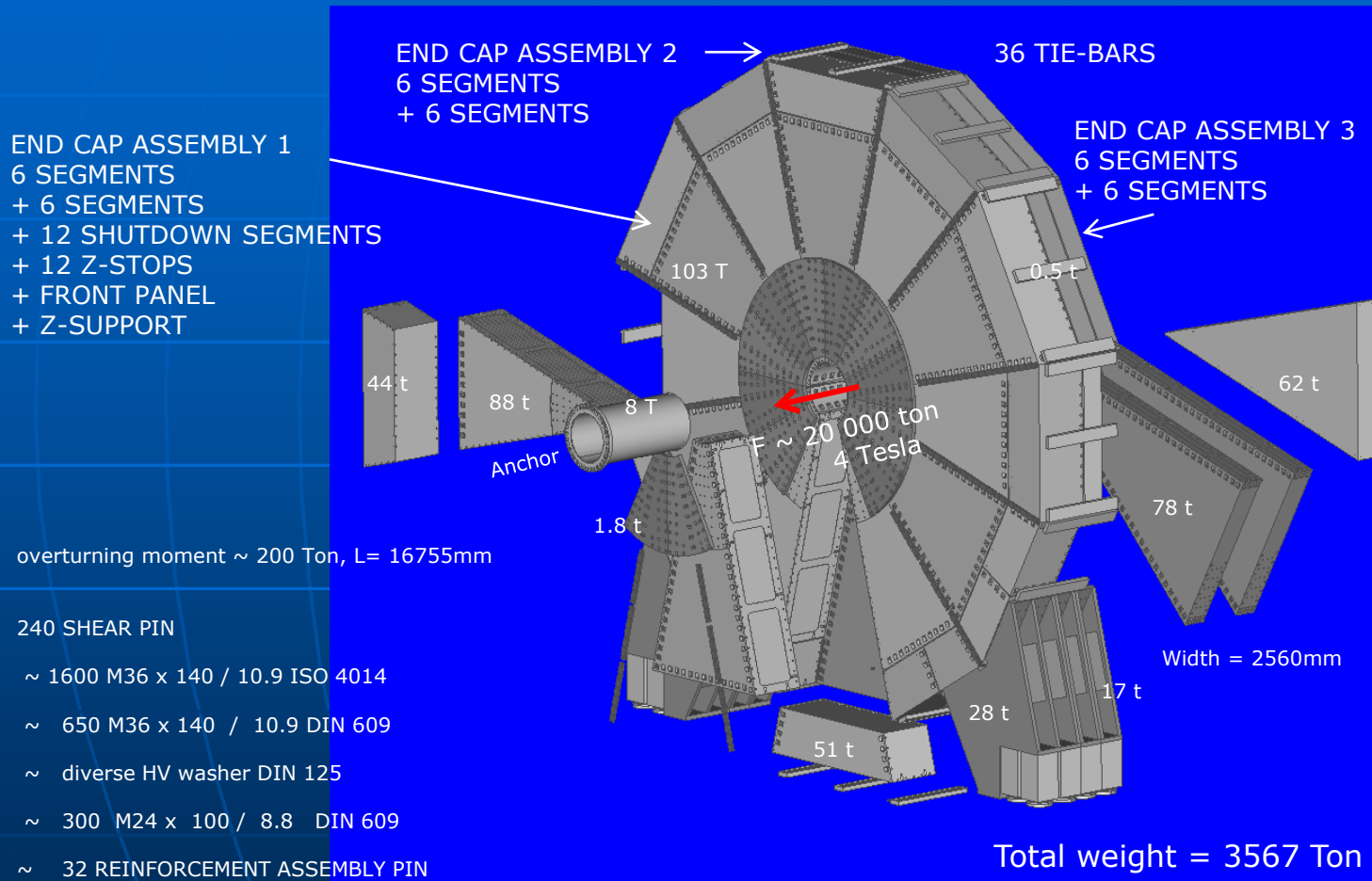


back view

End Cap is positioned via hydraulics, guide rails and transport beams during assembly.
The distance between the individual parts is 1000 mm.
It is possible to place scaffoldings and safety structures in between them.

End Cap Assembly Parts

The segments can be manufactured with a geometric positional tolerance of +/- 1.0 mm and 0.3 mm plan.
Complete assembly at the manufacturers site.



overturning moment $\sim 200\text{ Ton}$, $L = 16755\text{mm}$

240 SHEAR PIN

$\sim 1600\text{ M36} \times 140 / 10.9\text{ ISO 4014}$

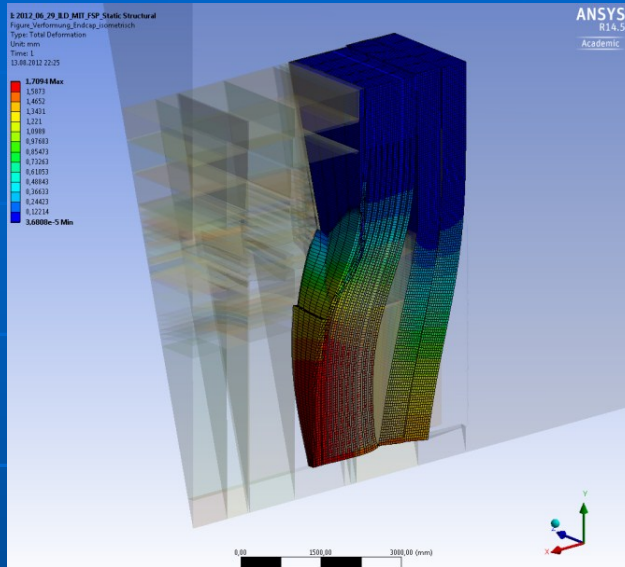
$\sim 650\text{ M36} \times 140 / 10.9\text{ DIN 609}$

\sim diverse HV washer DIN 125

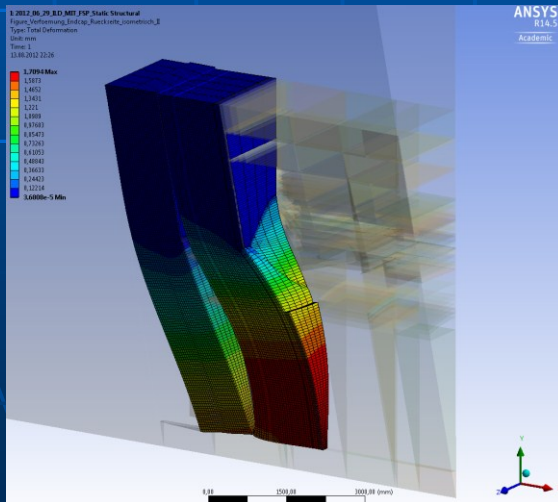
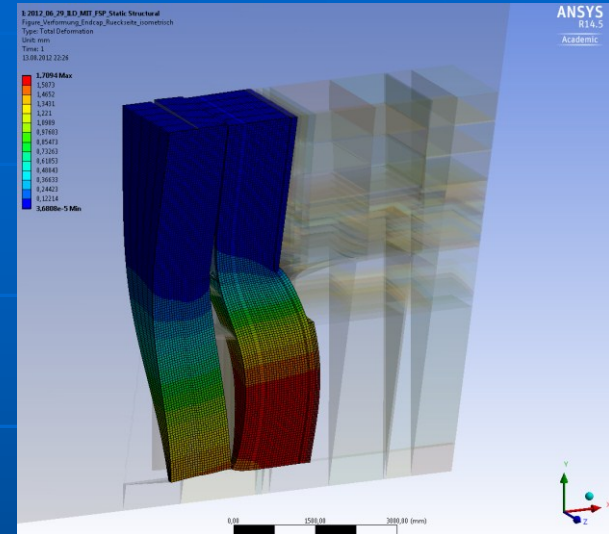
$\sim 300\text{ M24} \times 100 / 8.8\text{ DIN 609}$

$\sim 32\text{ REINFORCEMENT ASSEMBLY PIN}$

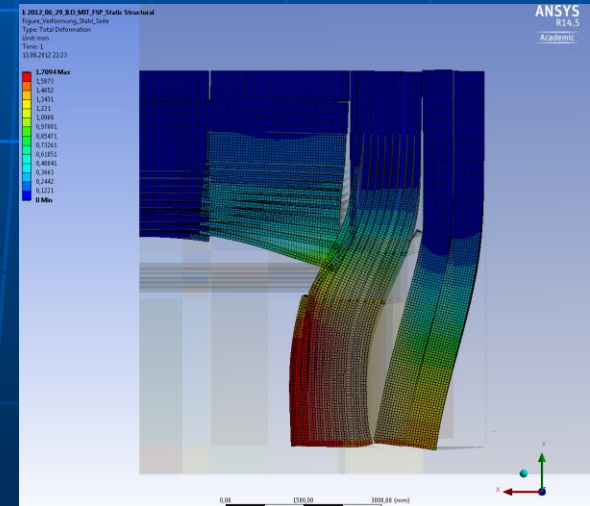
End Cap Deformation / fixed with Tension Anchor



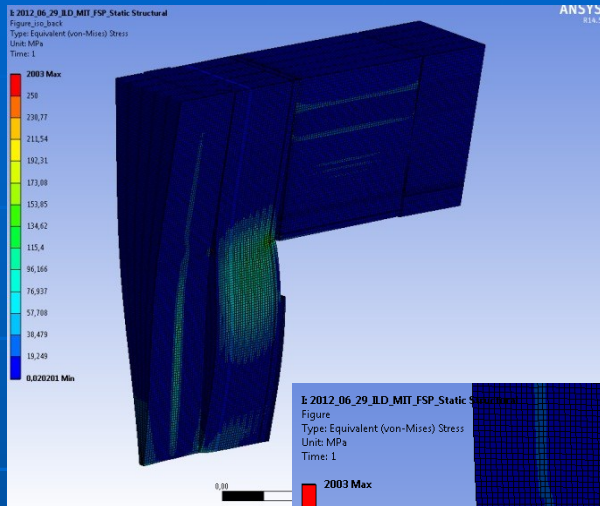
FEM by Martin Lemke / ZM1



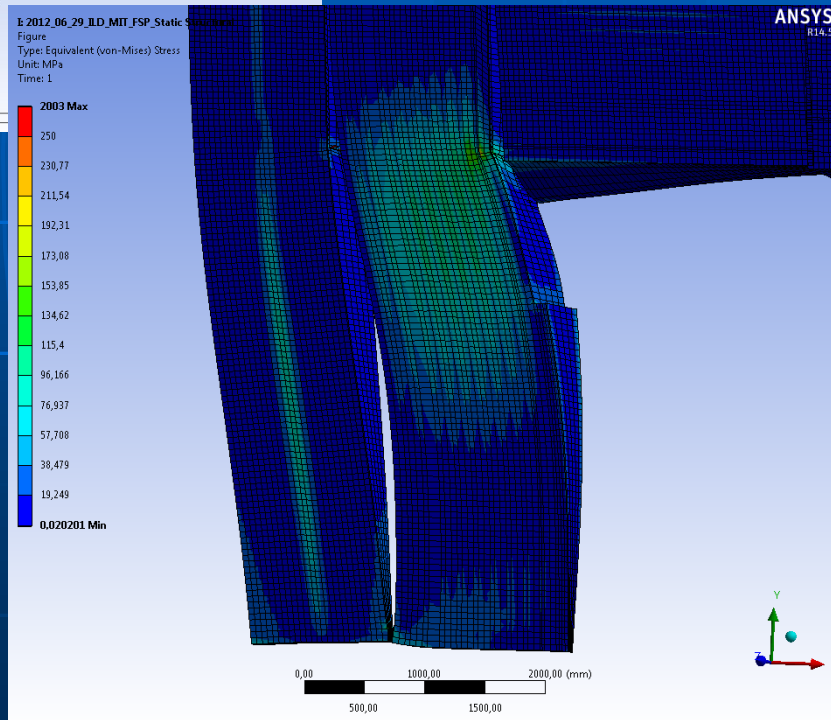
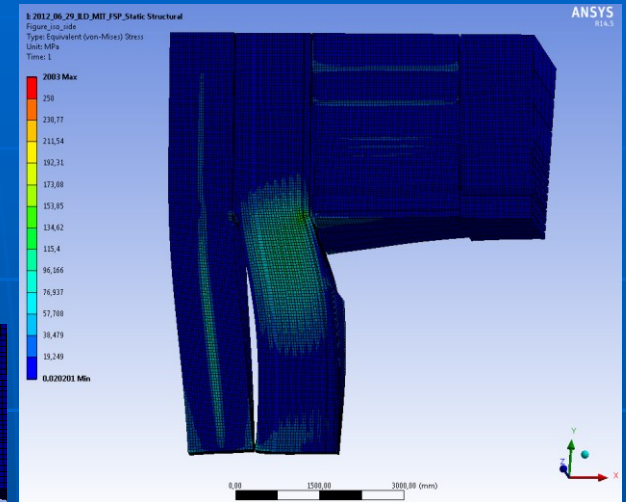
max. deflection ~ 2 mm



End Cap Stress / fixed with Tension Anchor



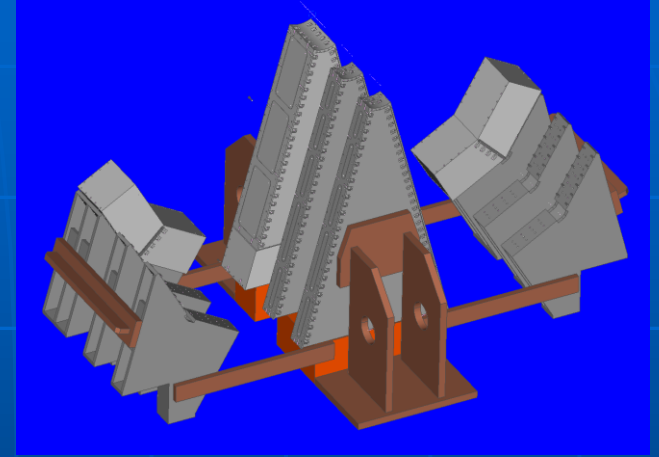
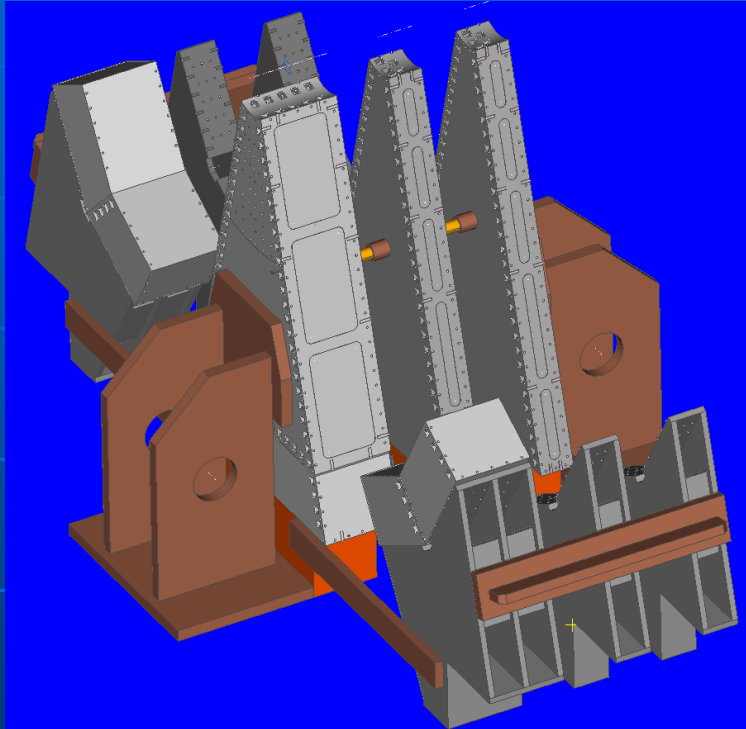
FEM by Martin Lemke / ZM1



$$\sigma < 200 \text{ N} / \text{mm}^2$$

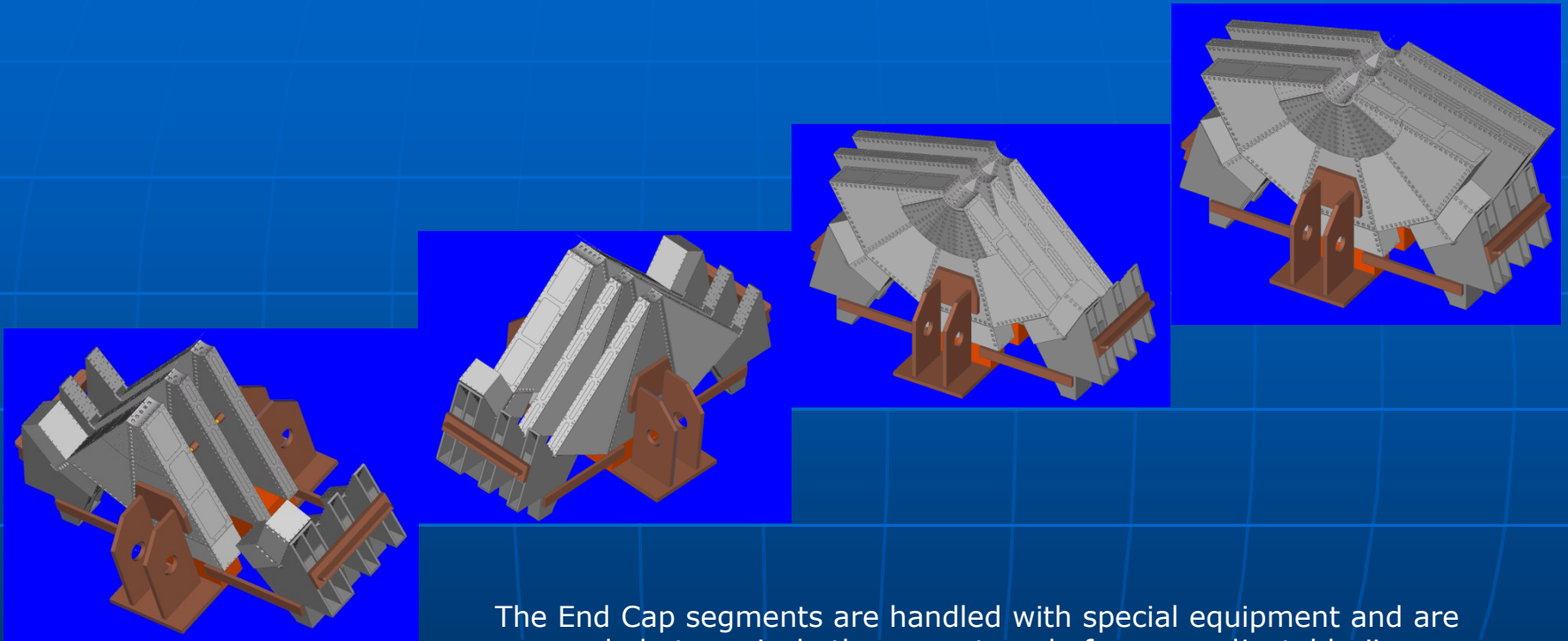
End Cap Assembly

support gear coloured brown and orange



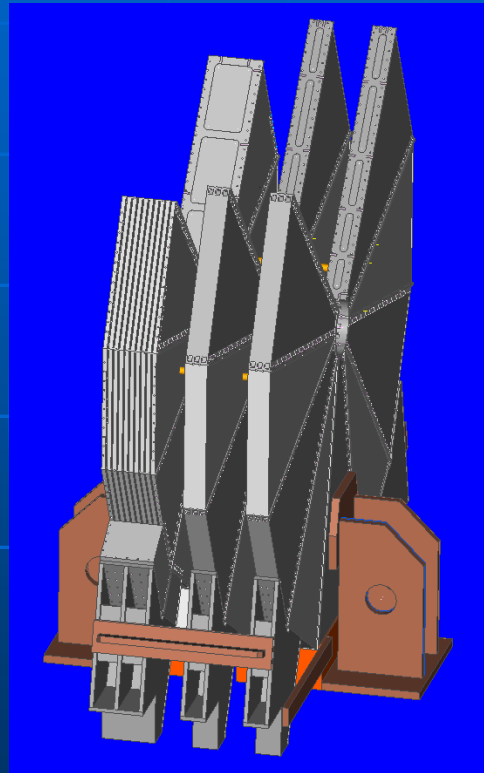
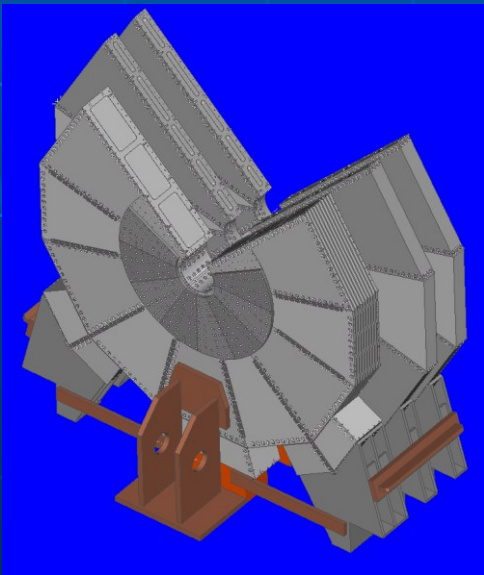
During the entire assembly procedure the position of the End Cap Yoke segments are continuously monitored, the tolerance has to be less than 1.6 mm.

End Cap Segment Assembly, next Steps

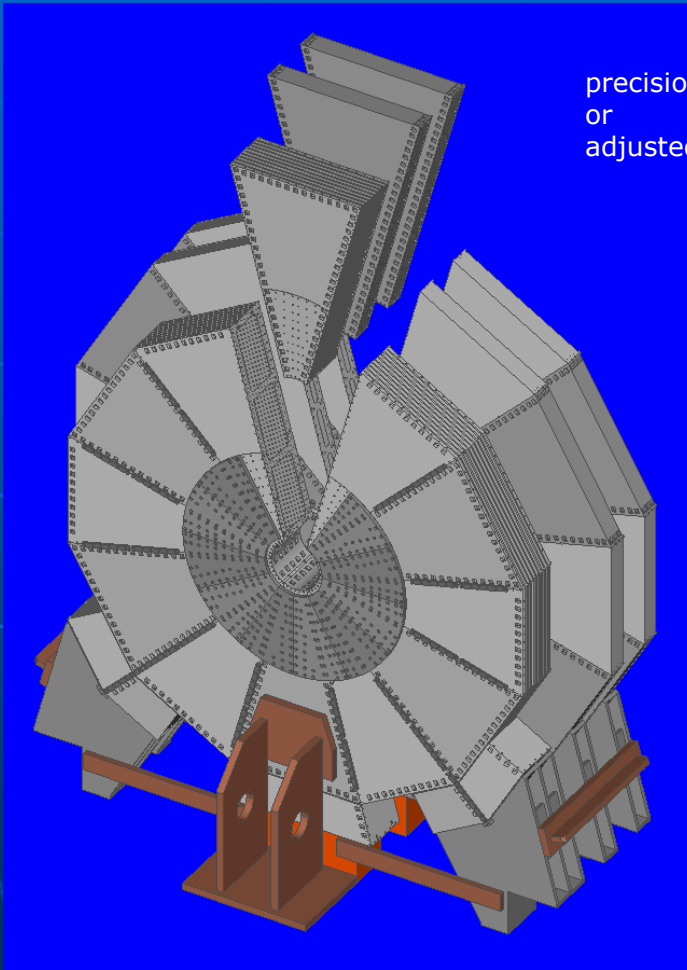


The End Cap segments are handled with special equipment and are suspended at precisely the correct angle from an adjustable jig. During the entire operation the position is continuously checked.

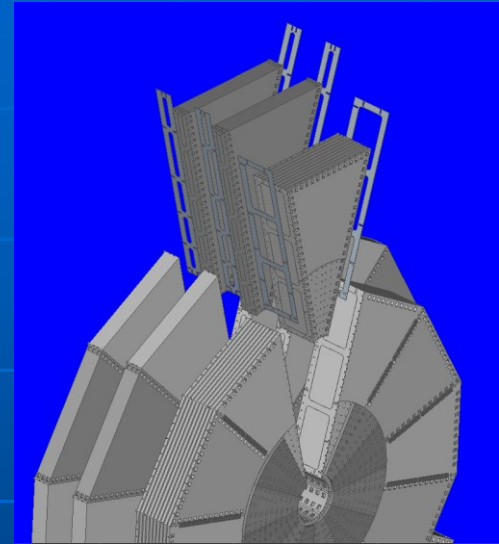
End Cap Segment Assembly next Steps



Positioning of the final segments

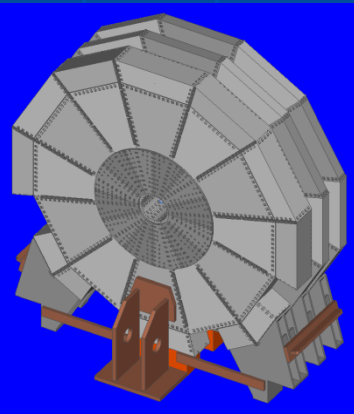
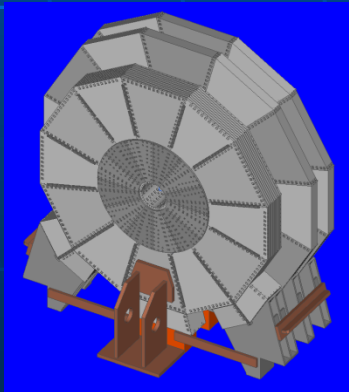


precision machined
or
adjusted with shims

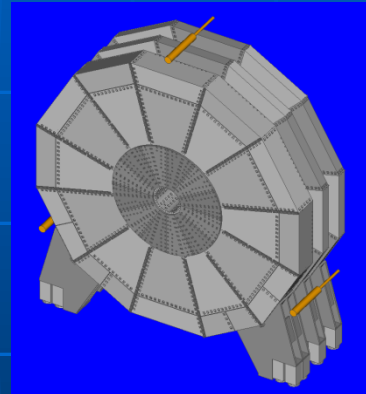


Closing of End Cap Disks

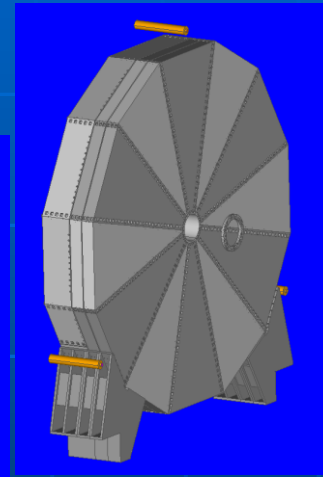
with hydraulics tools



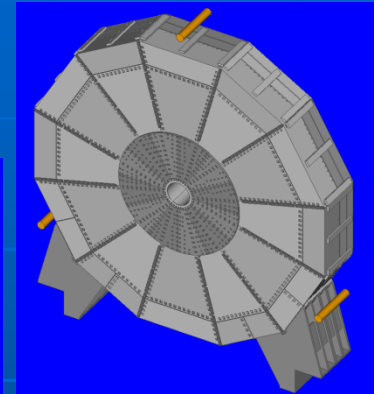
starting position
for chamber assembly



close with hydraulics

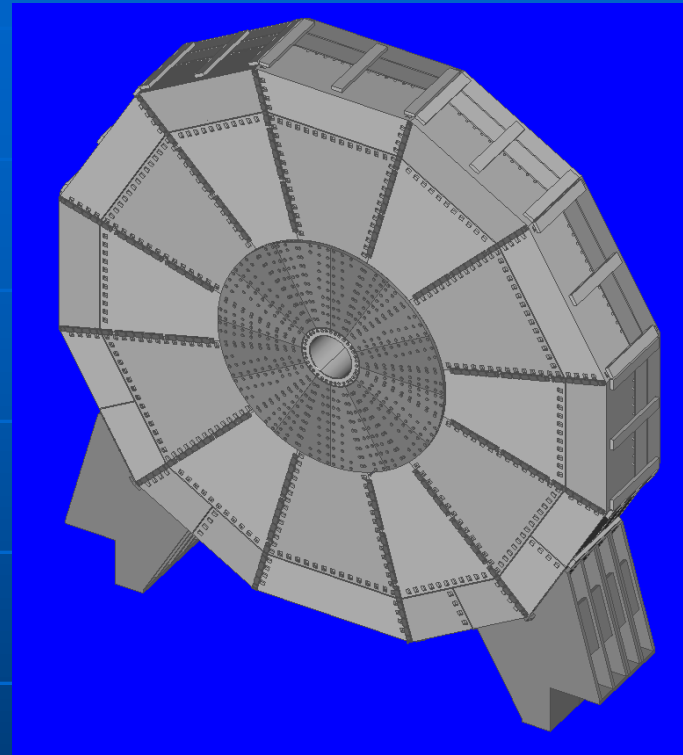
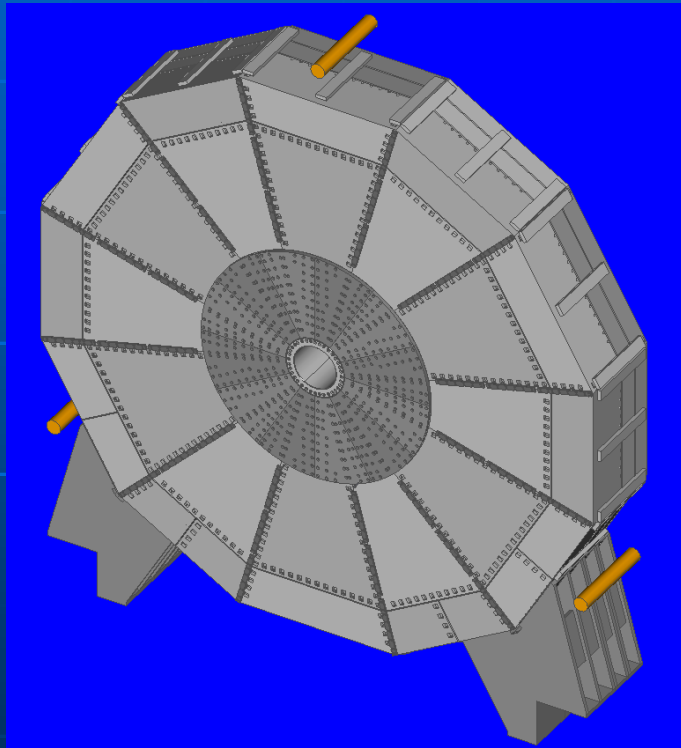


insert central piece



all tie bars

End Cap Connection

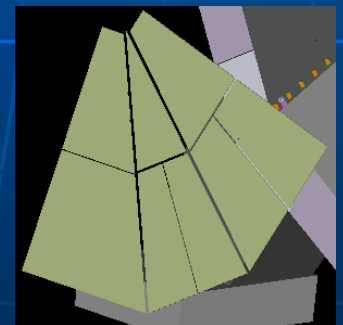
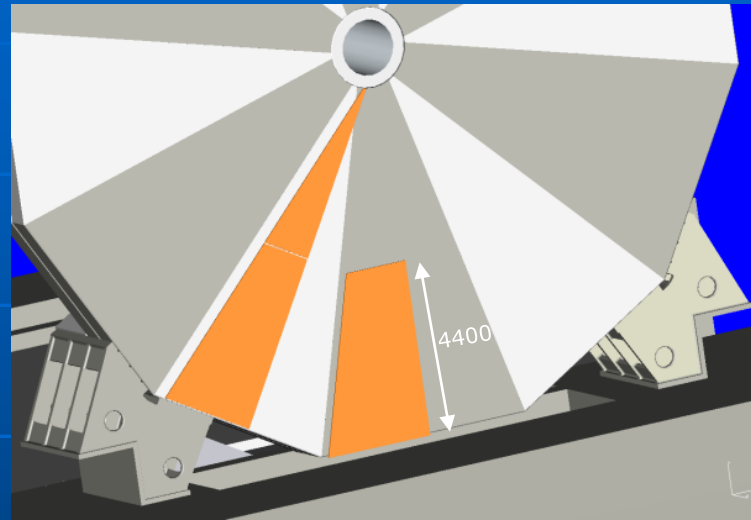
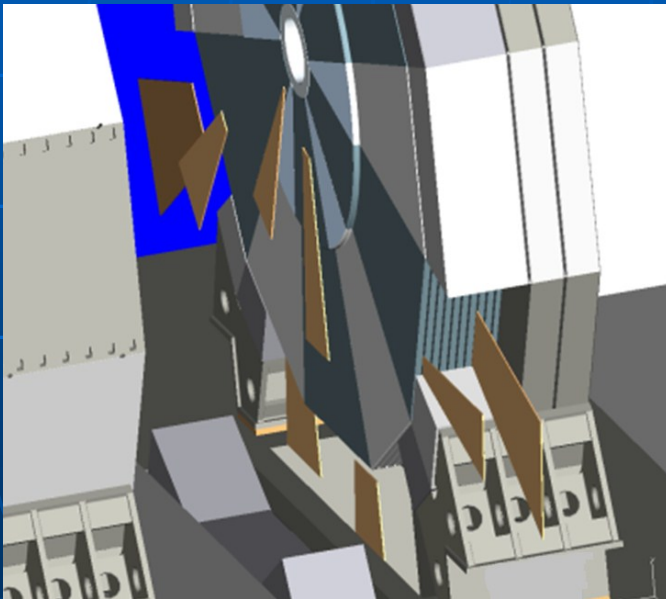


Assemble all tie bars
Assemble central part

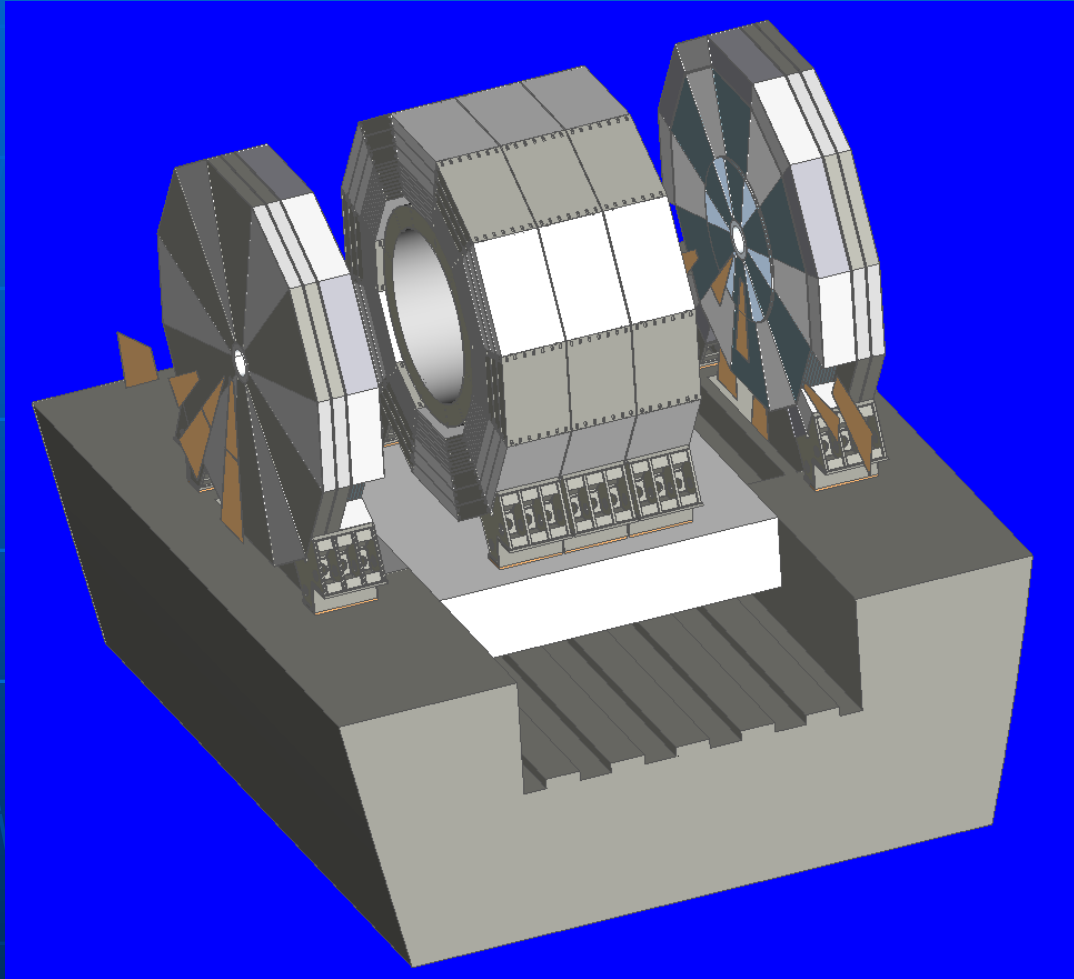
End Cap Chamber Assembly

chamber assembly example

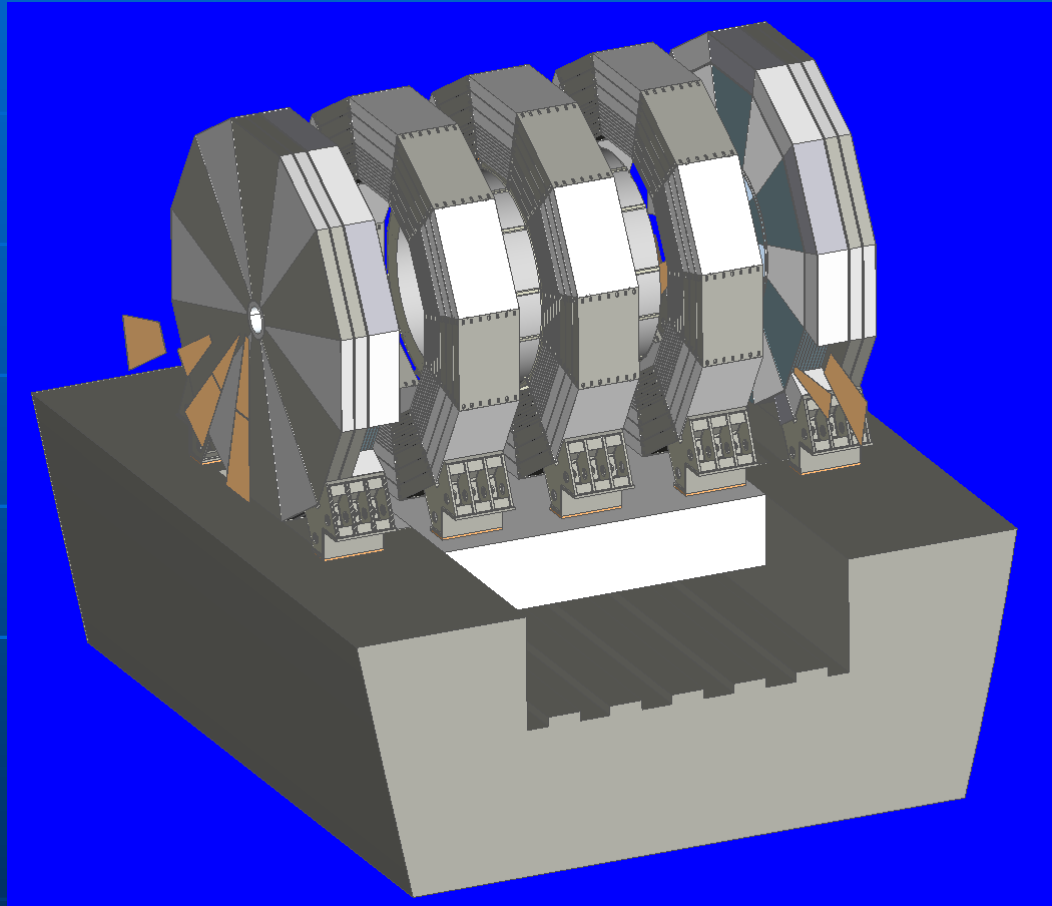
(old beam height 8 m, instead of 9 m)



End Cap removed



Detector Open for Maintenance



Conclusion

- The geometry of the ILD Detector Yoke satisfies the Physics requirements.
- More calculations and further detailed design work are needed for the ILD Detector Yoke.
- All transport and tooling equipment have to be designed according to the final design of the Yoke.
- A complete assembly of the Yoke at the manufactures site is mandatory.