

The ILD - Barrel, End Cap and Cryostat integration - current design with 8 meters beam height -

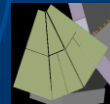
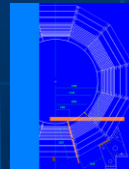
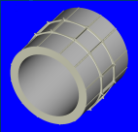
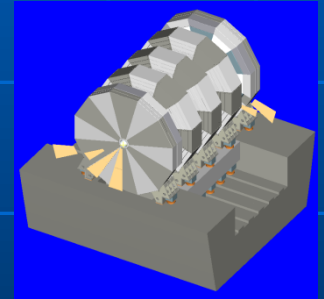
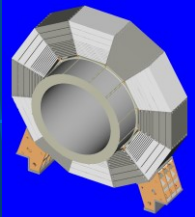
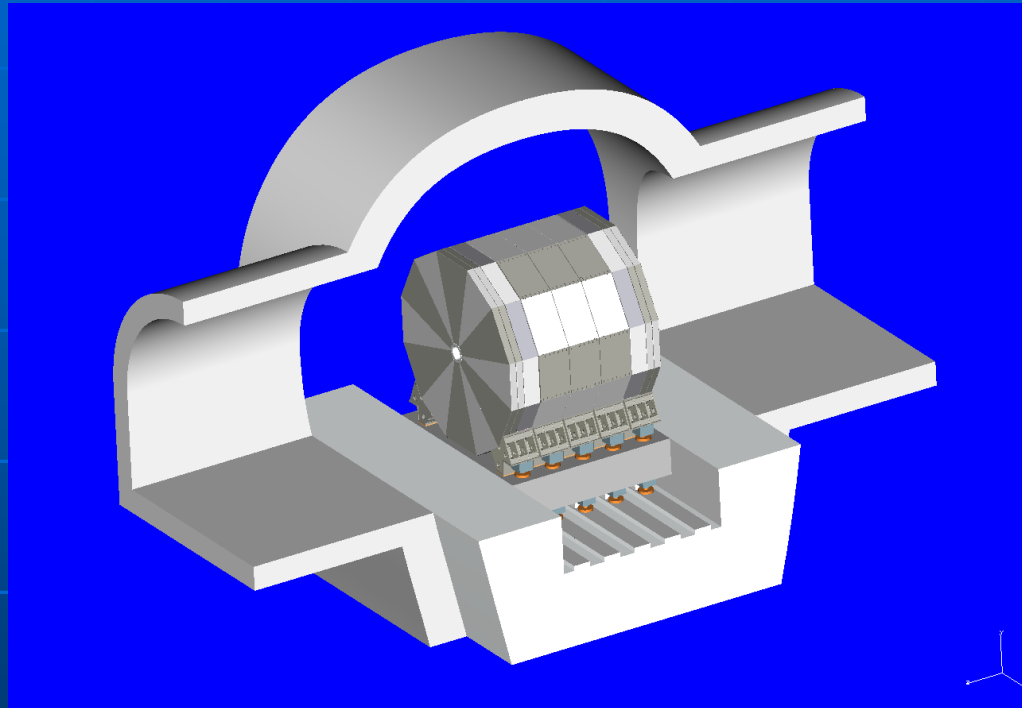
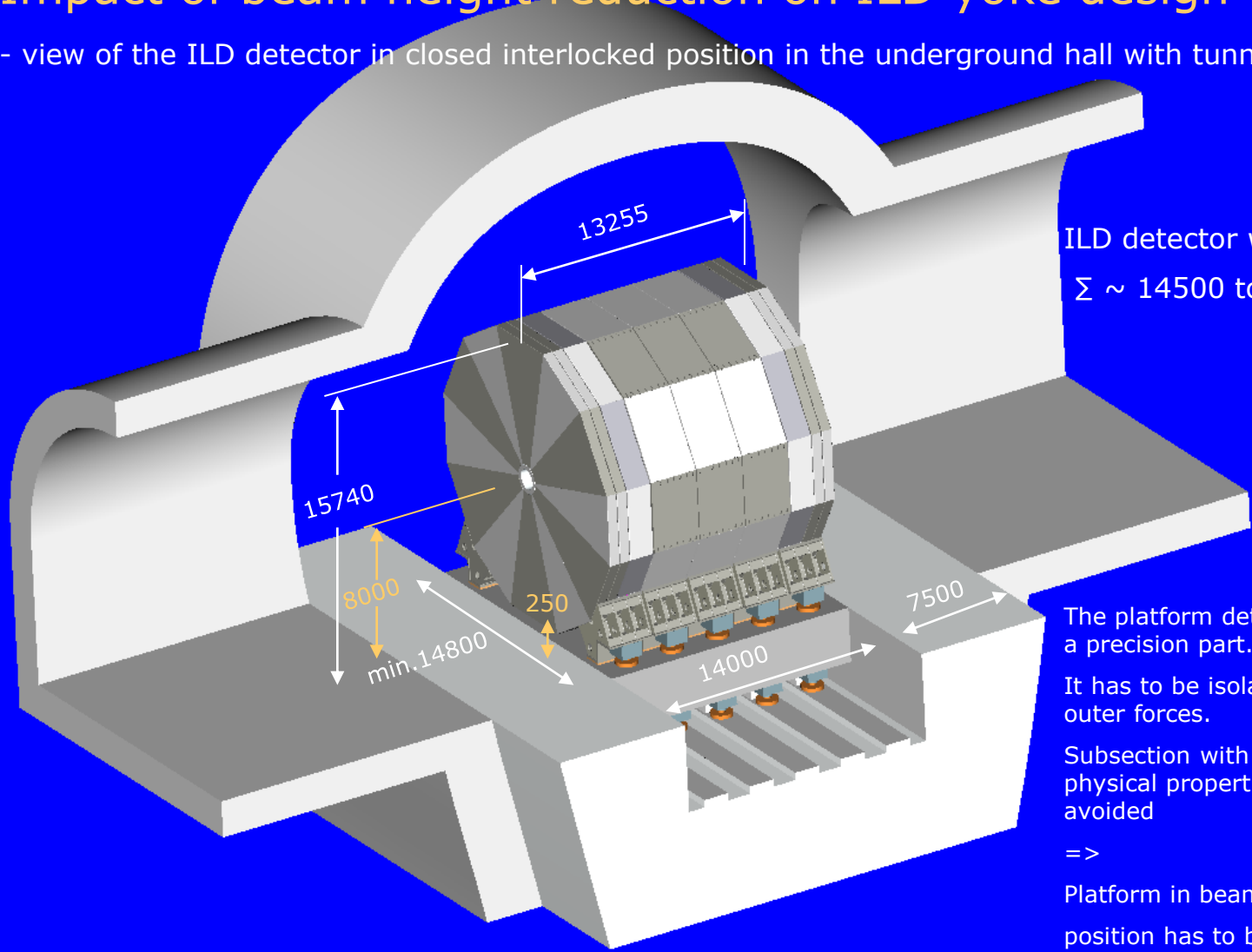


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Impact of beam height reduction on ILD yoke design

- view of the ILD detector in closed interlocked position in the underground hall with tunnel



ILD detector weight
 $\Sigma \sim 14500$ tons

The platform detector unit is a precision part.

It has to be isolated from outer forces.

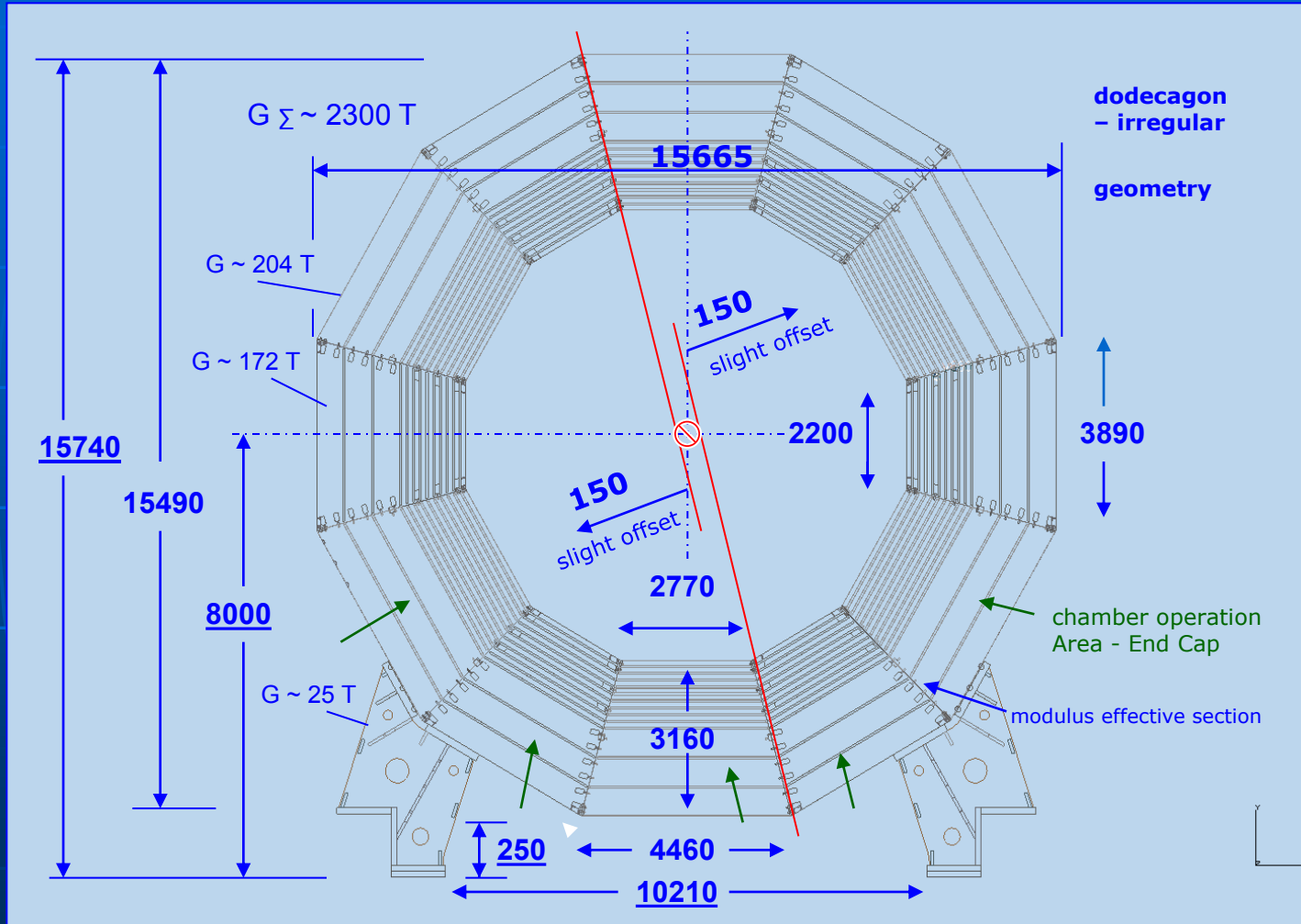
Subsection with different physical properties are to be avoided

=>

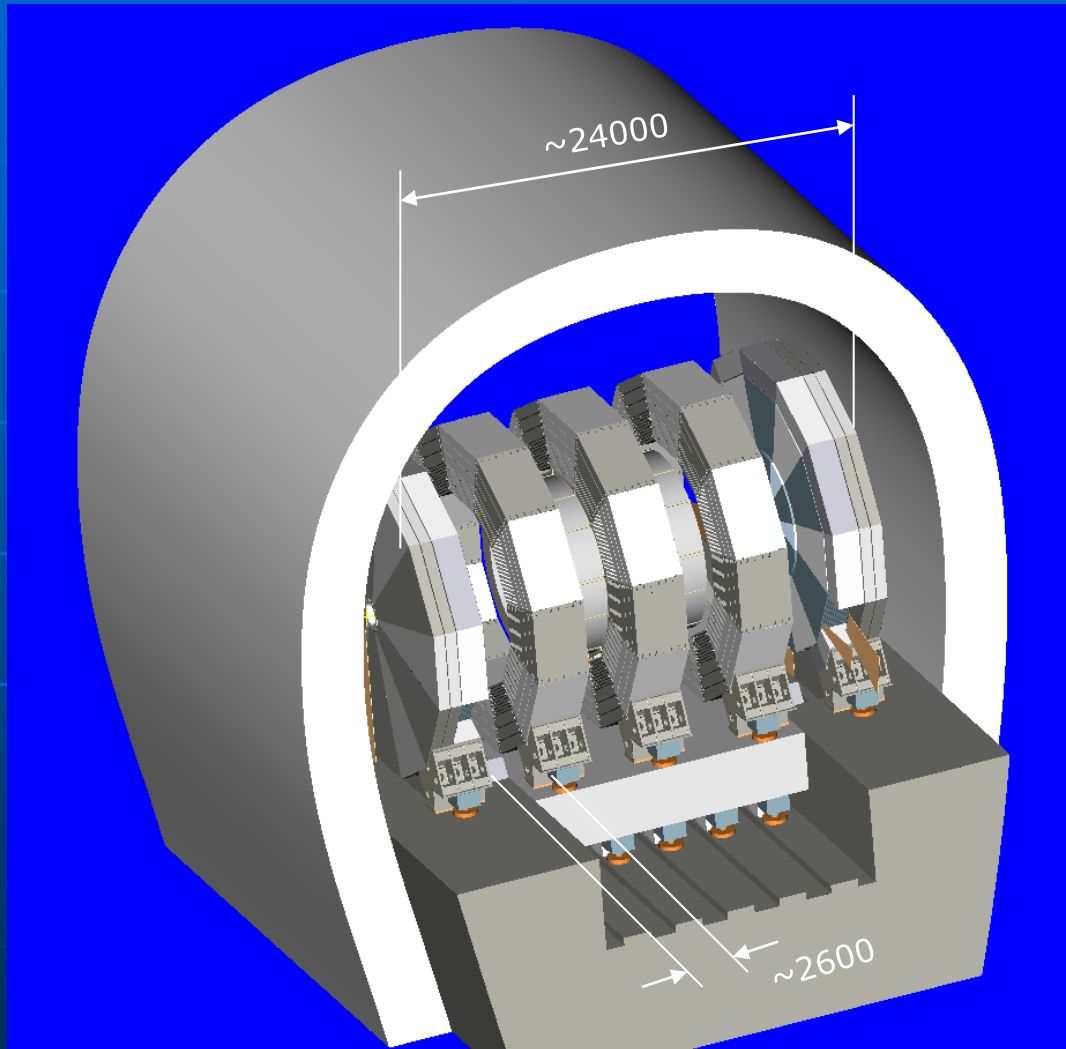
Platform in beam position has to be locked.



barrel geometry / dodecagon have irregularly geometry -
slight offset 150 mm



Overview of the detector / shut-down time



Required hall for detector and acquirment estimate area:

- escape route
- service operation
- scaffolding
- ladder
- cables
- cooling and gas system
- crane and movable device
- distance to crane working safety area
- operation tunnel for the chamber
- platform position locking safety system
- radiation shielding wall
- interlock set system
- general safety system (smoke-, gas detectors, fire fighting service...)
- light and more...

structural force / static

F_C centre of gravity = 11250 kN

F_C cryostat = 12000 kN / 2 = 6000 kN

F_A = 4300 kN

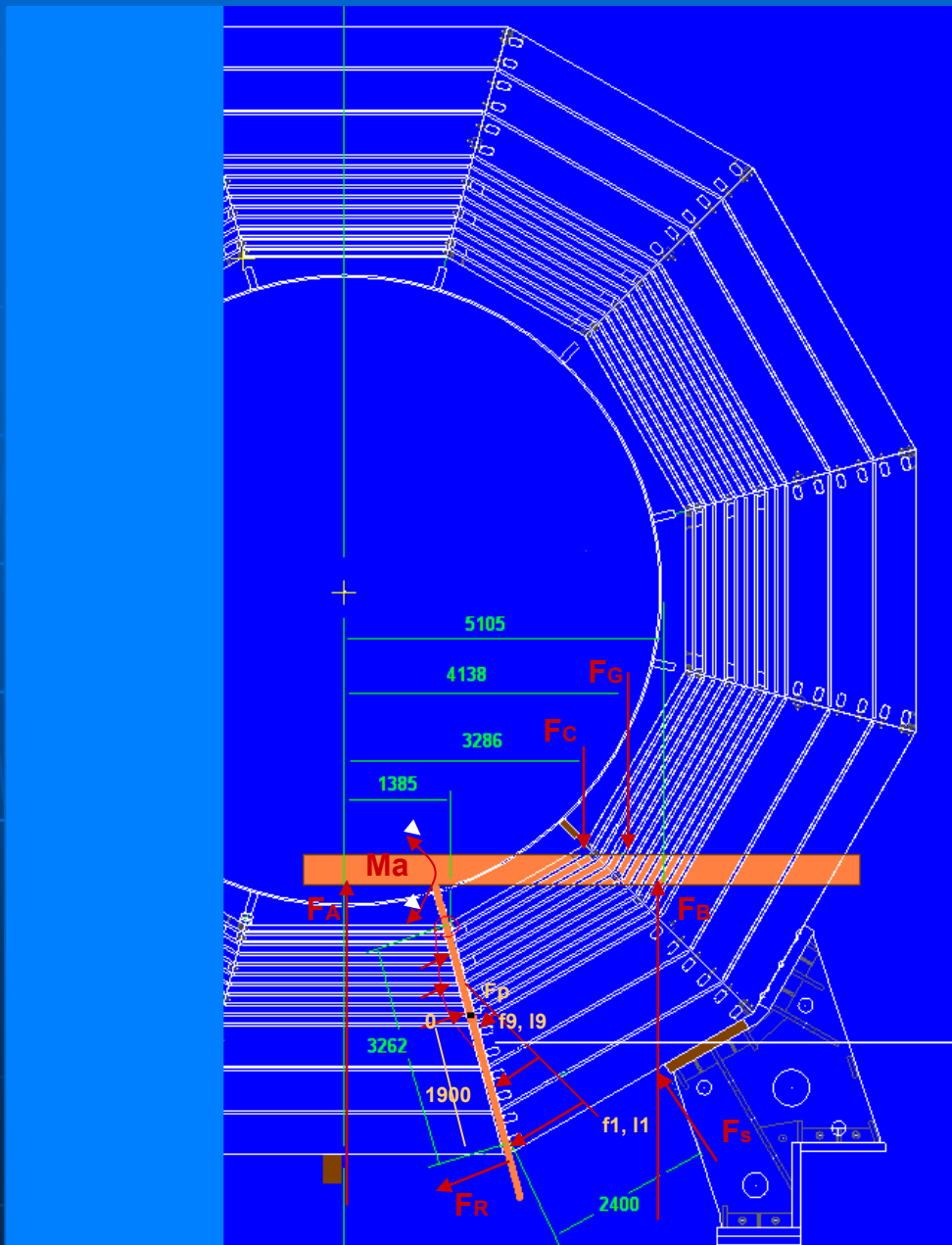
F_B = 13000 kN

M_a moment = 6000 kNm

F_S = 12000 kN

F_R resulting force = 17000 kN

F_P fictitious pressure point (Roloff / Matek Kap.8.4.5)



F_R = 16300 kN

F_2 = 15700 kN

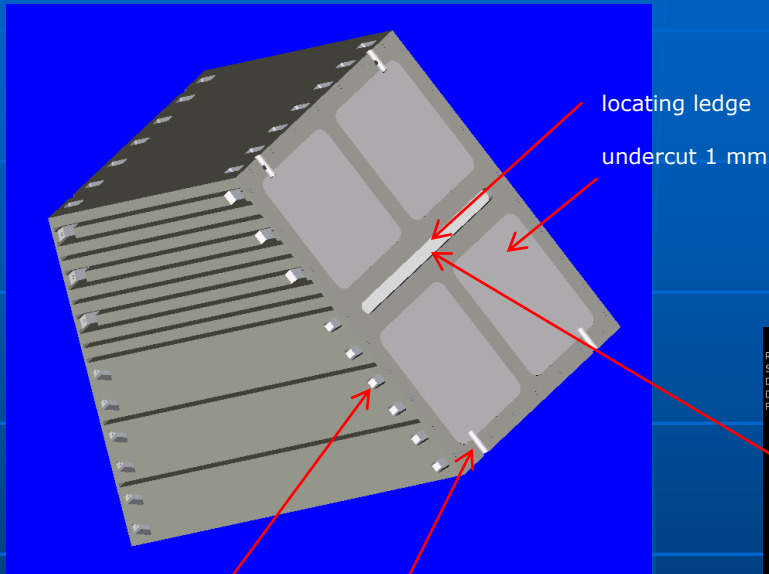
F_3 = 4200 kN

Parallel key



Barrel Segment after machining

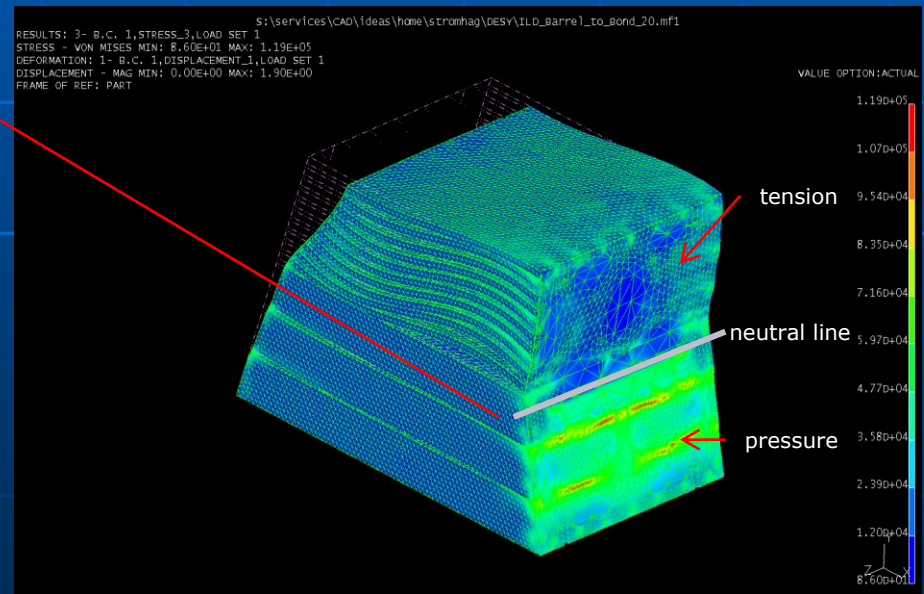
All machined surfaces can be delivered within a tolerance better than 0.6mm
(or better than 0.2mm according to MAN Deggendorf/Germany)



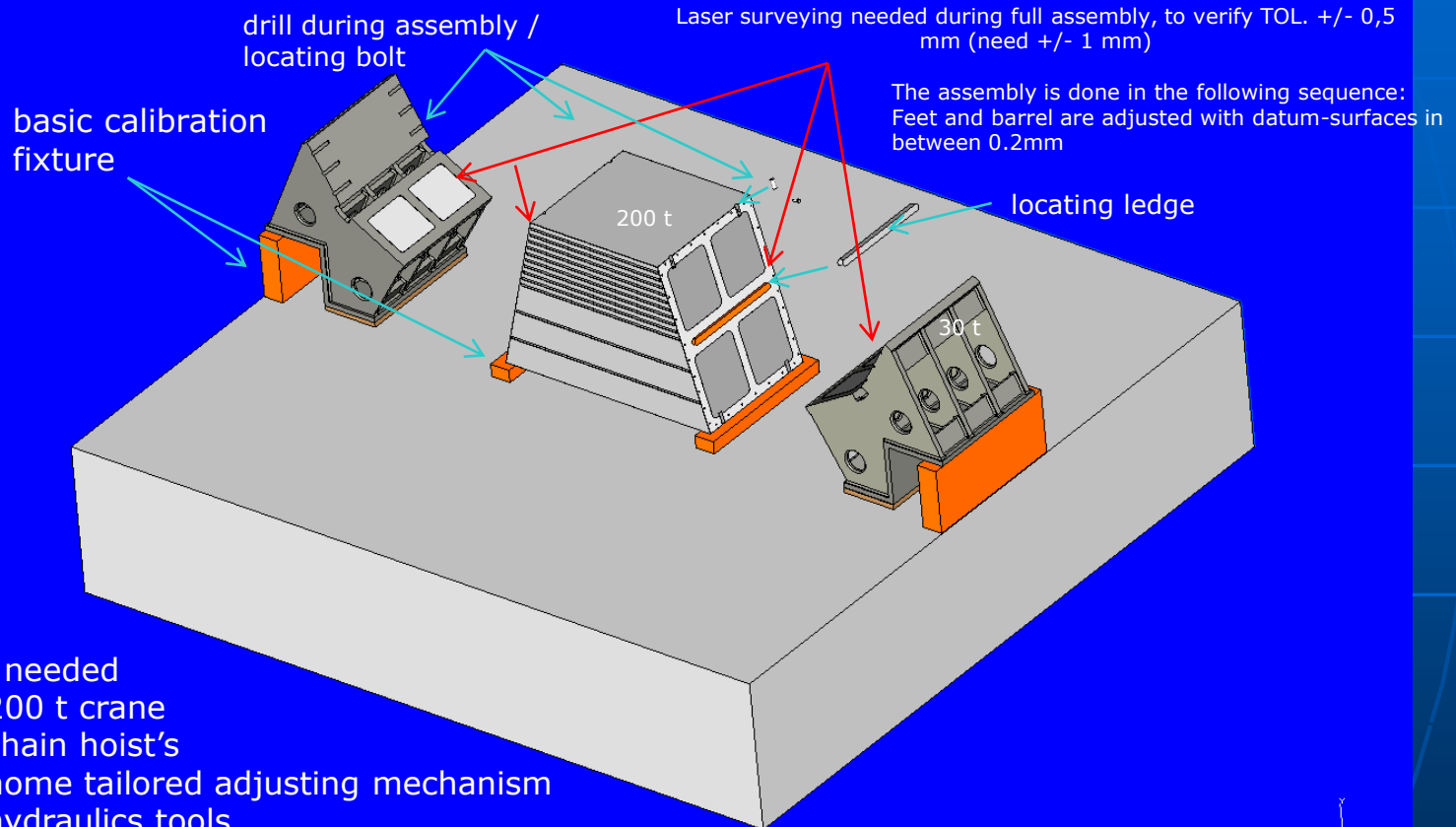
max. deformation and stress during assembly
2 mm / 115 N/mm²

Screw DIN ISO 4014 - M
36 x 125 (50)

bore during assembly /
locating bold (4x)



Basic Adjustment of Barrel / Plinth

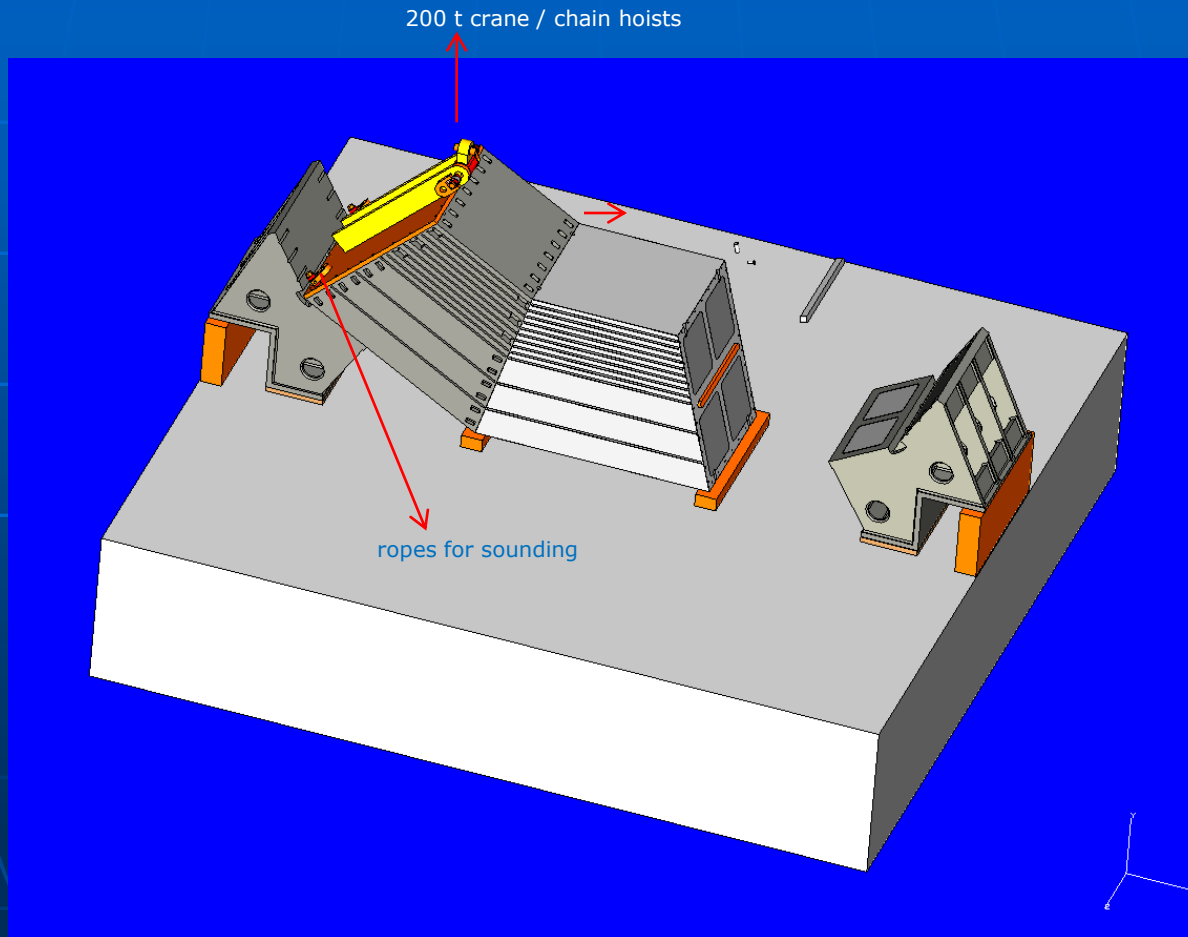


- Tools needed
- 200 t crane
 - chain hoist's
 - home tailored adjusting mechanism
 - hydraulics tools
 - surveyors

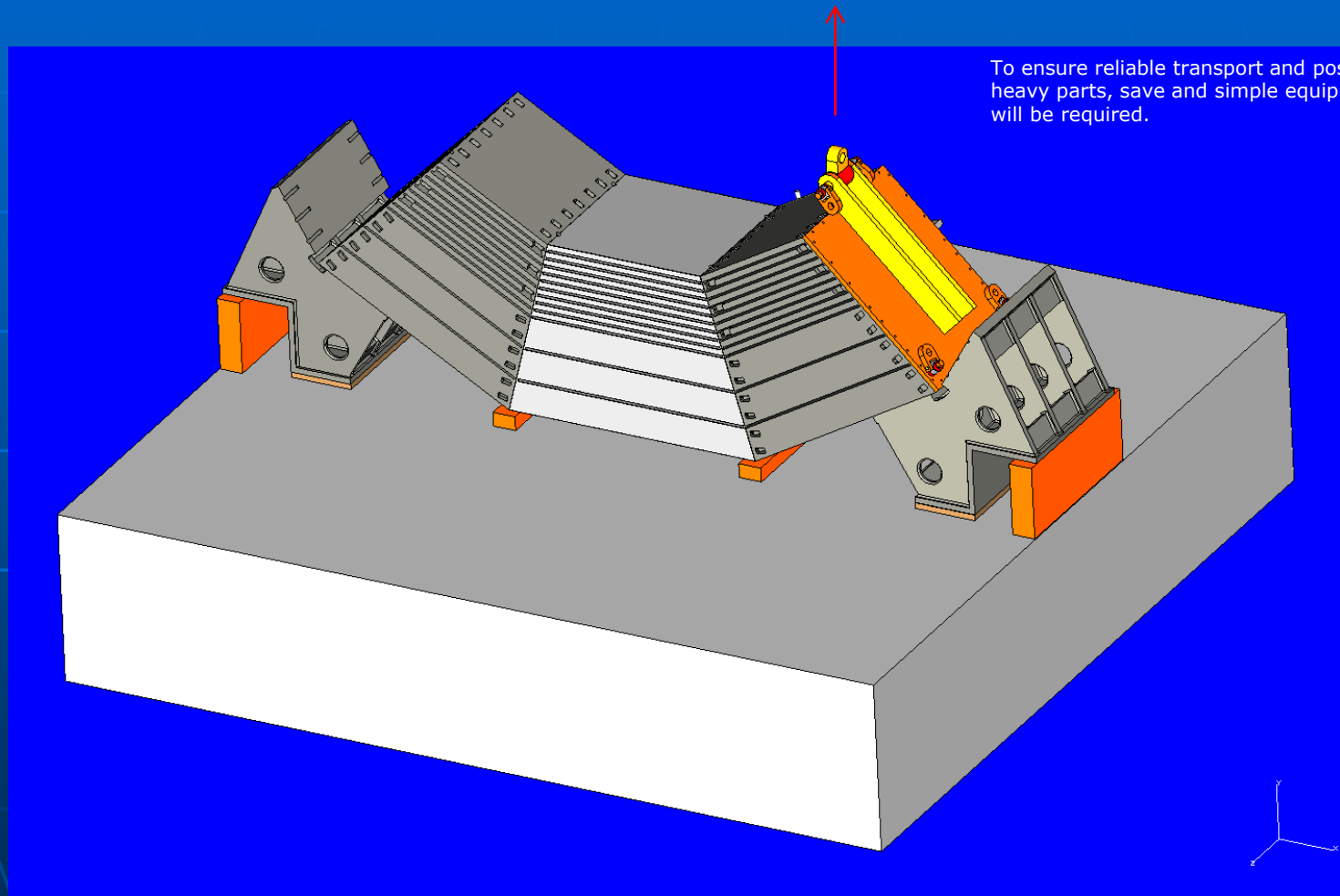


Barrel Assembly Step 1

Utilizing a jig that allows for adjusting the centre of gravity, the next barrels are brought into position, constrained via key inside the inner ring and screwed on hydraulic gear, (50 off M36 x120mm, ISO 4014 – 10.9).

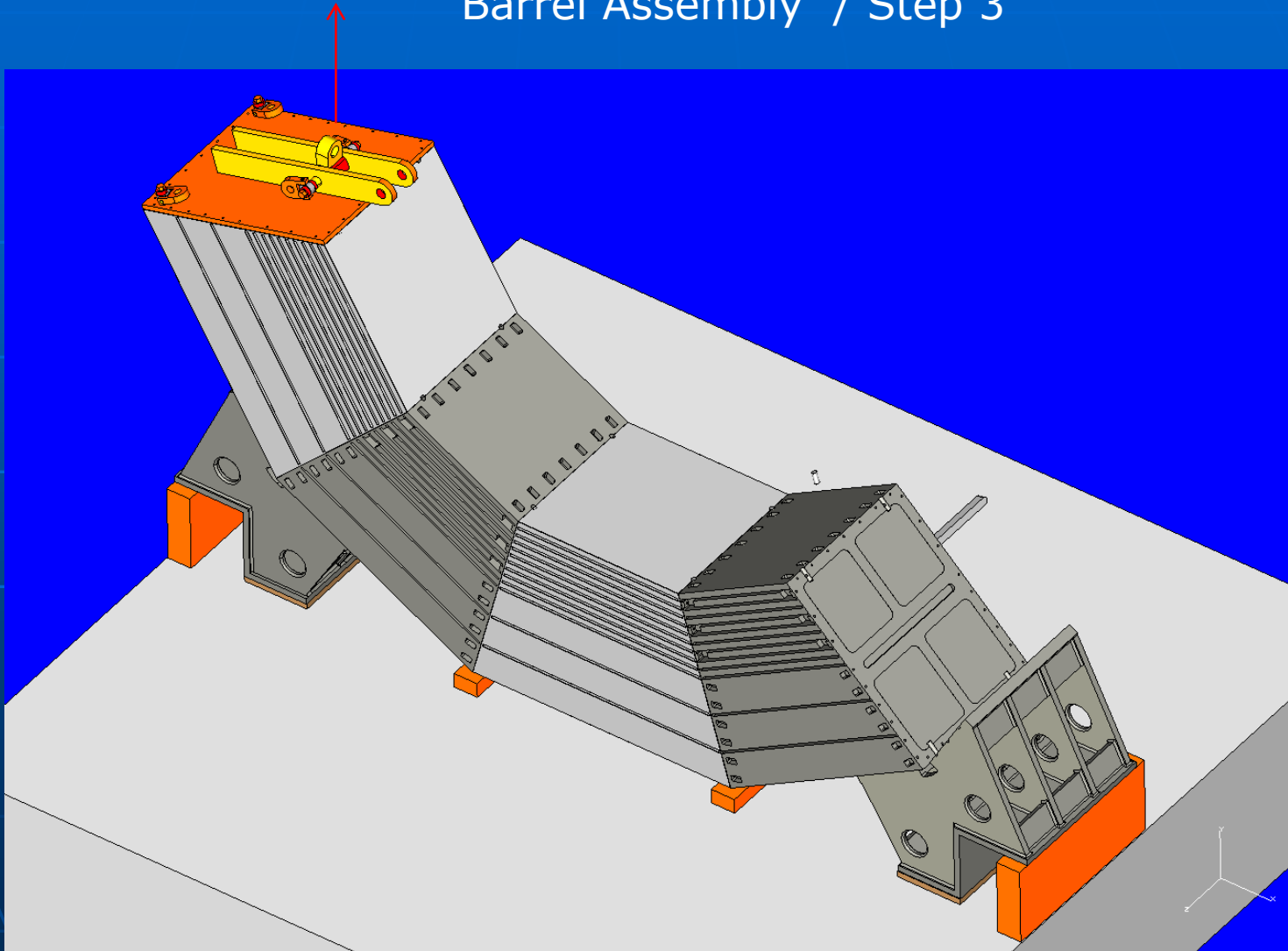


Barrel Assembly / Step 2

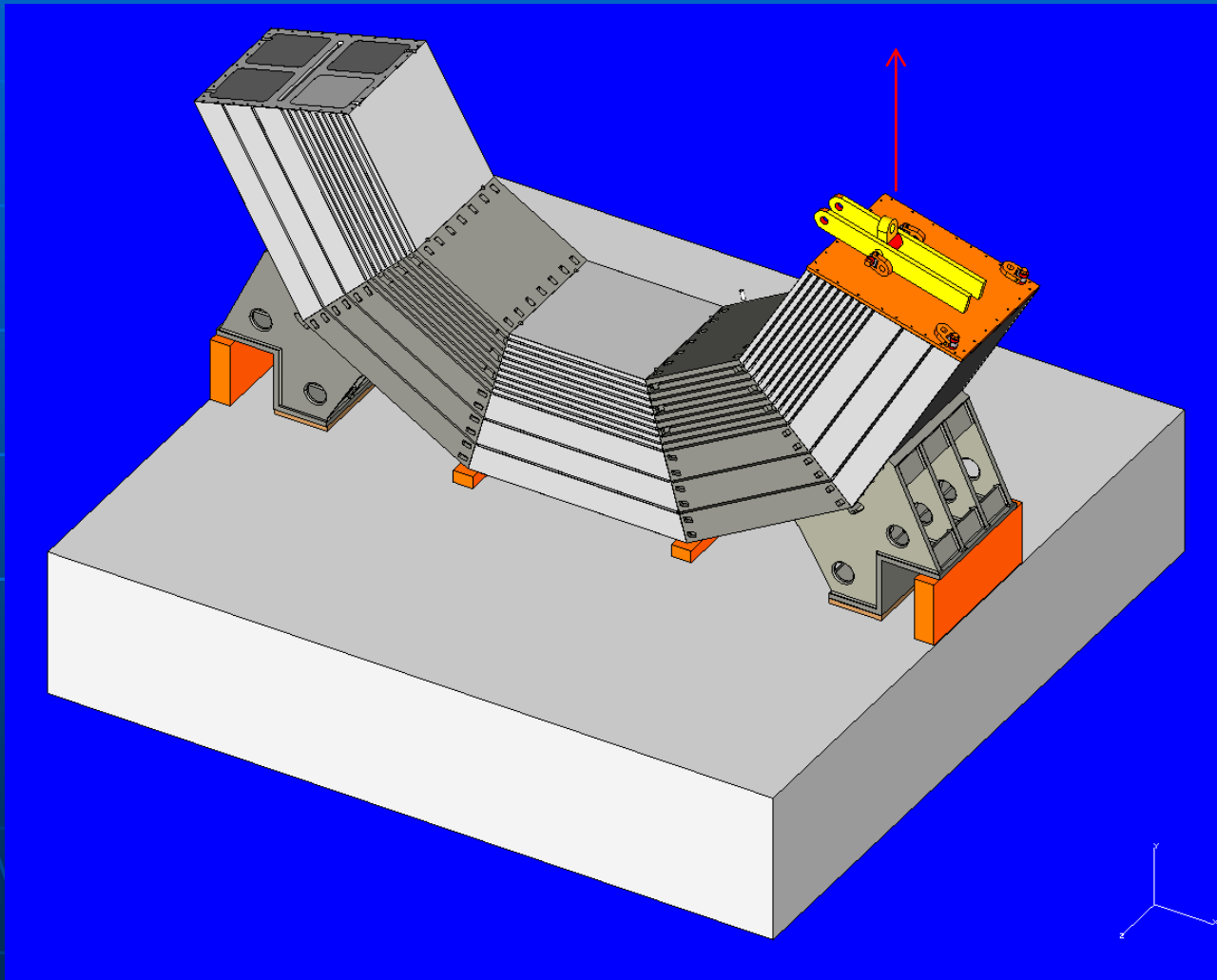


To ensure reliable transport and positioning of these heavy parts, save and simple equipment will be required.

Barrel Assembly / Step 3

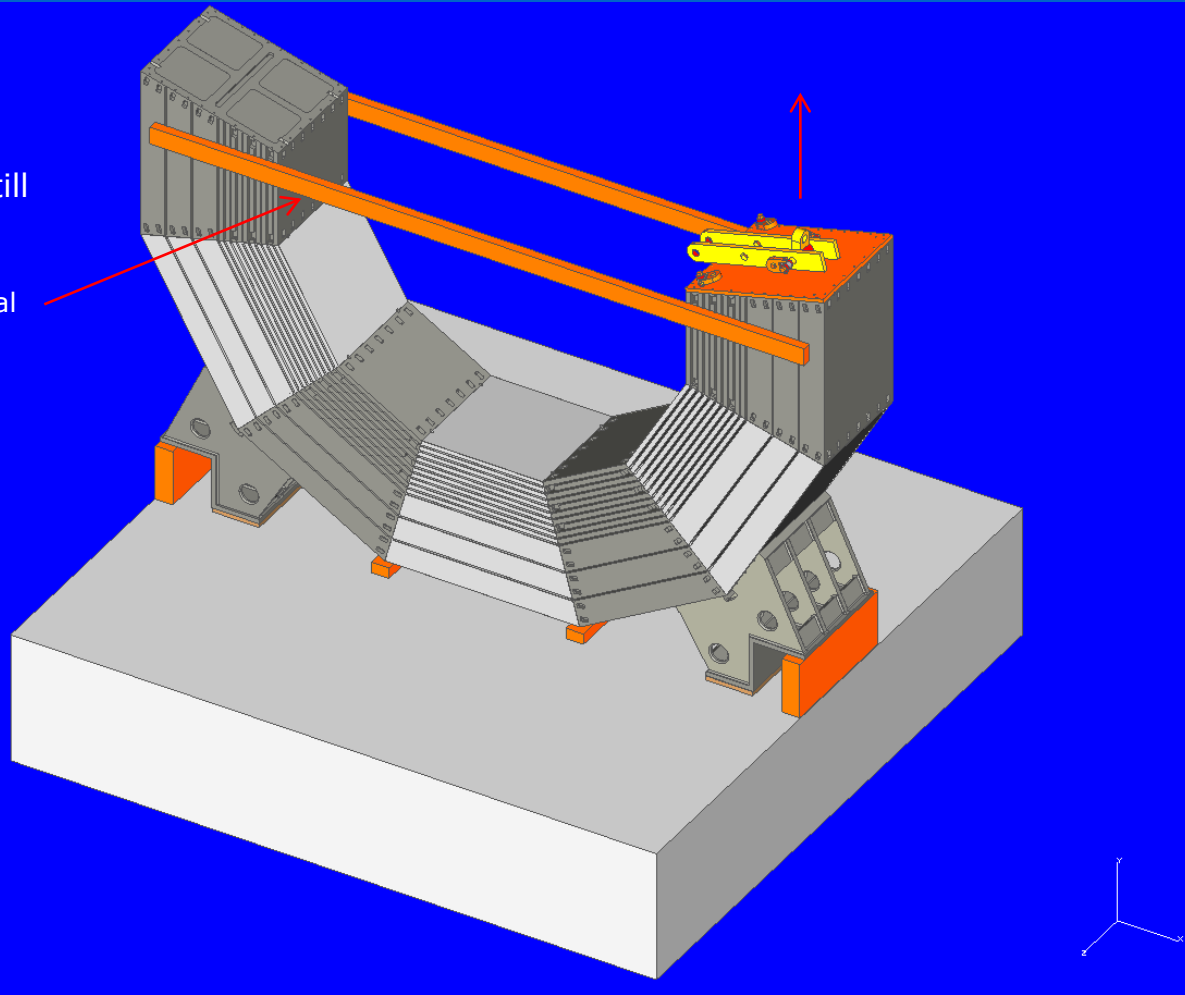


Barrel Assembly / Step 4

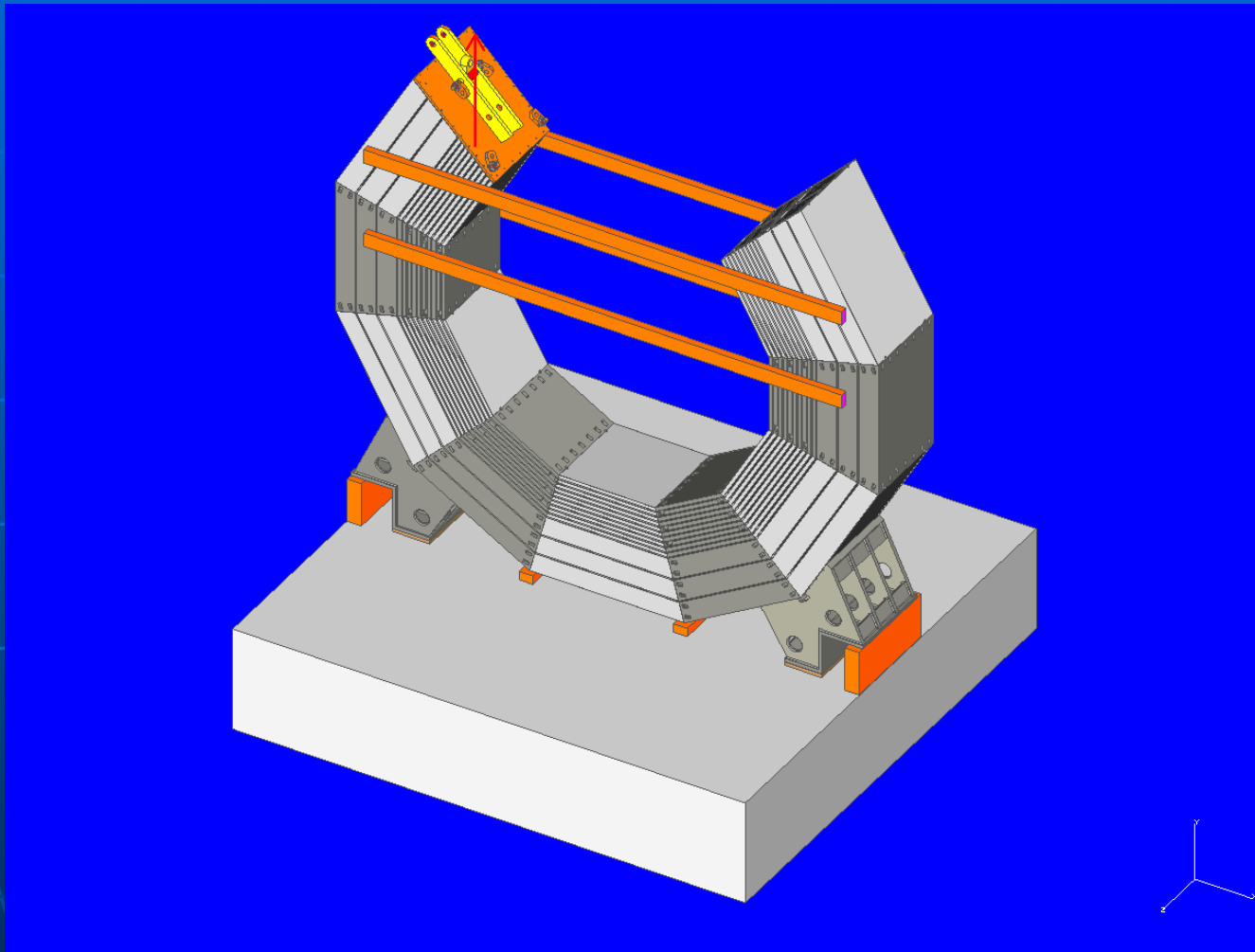


Barrel Assembly / Step 6 and 7

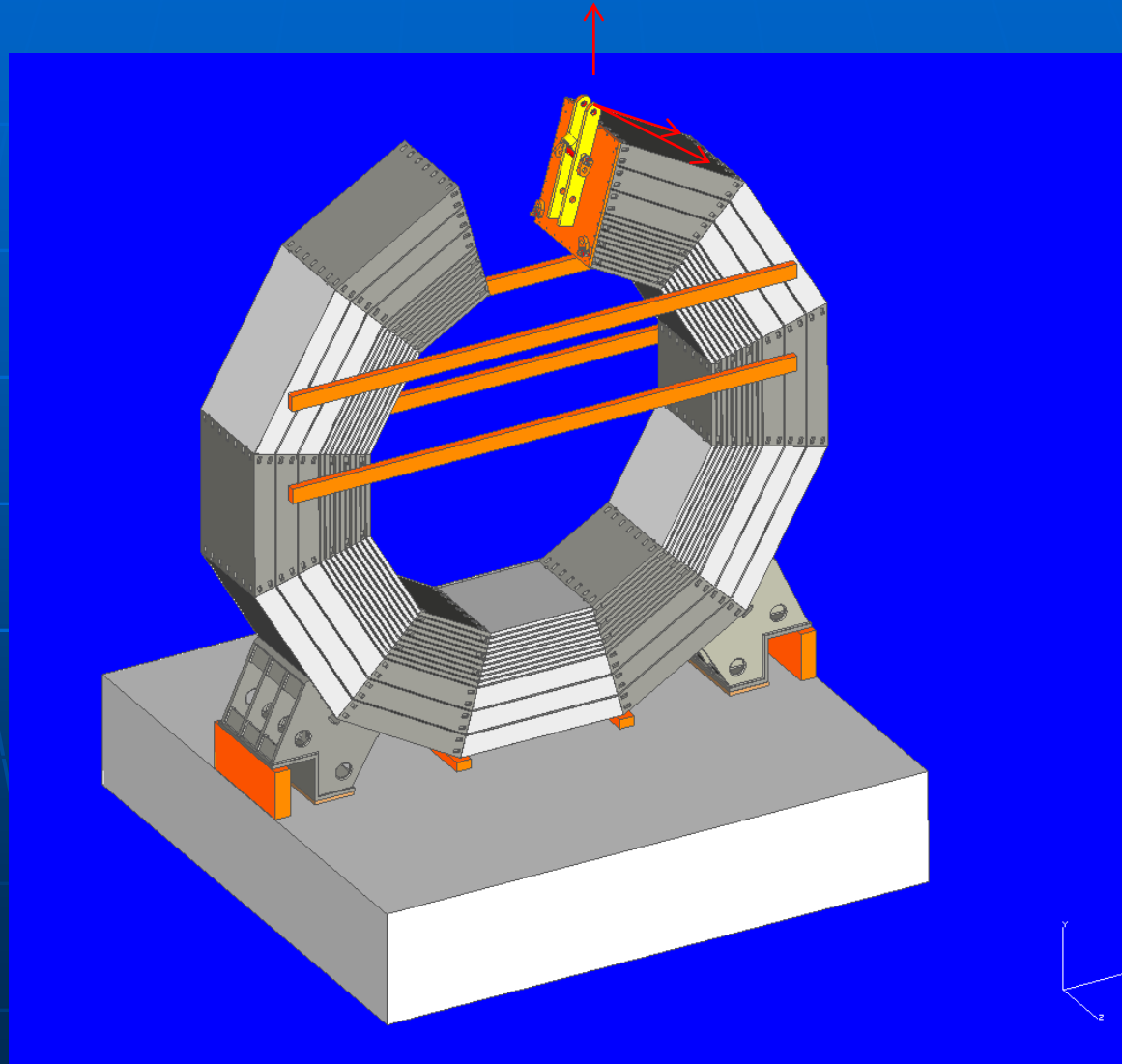
Tooling requirements still
to be investigation
Symmetrical erection is
required to ensure structural
integrity.
Scaffolding will be required



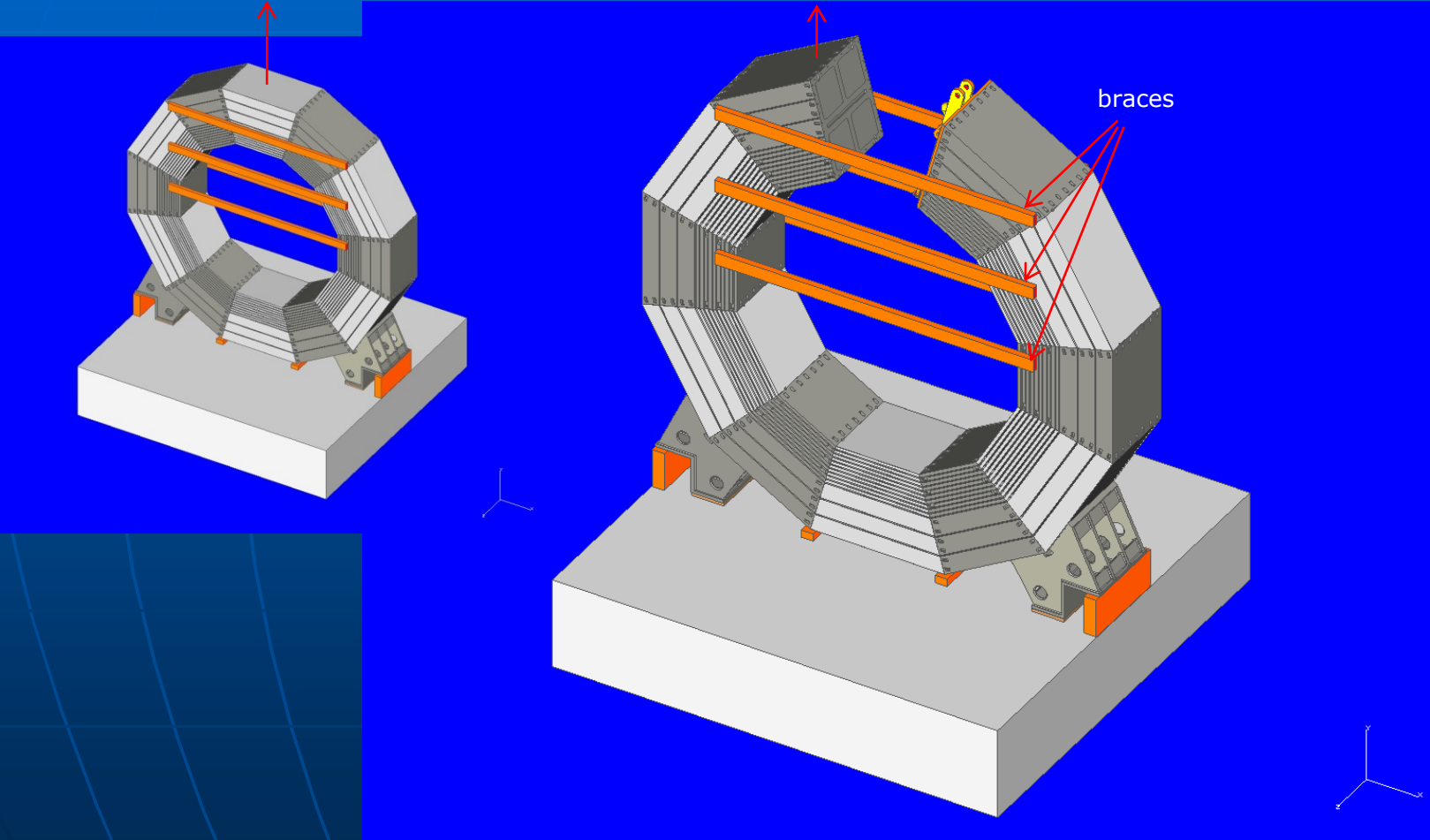
Barrel Assembly / Step 8 and 9



Barrel Assembly / Step 10 / 11



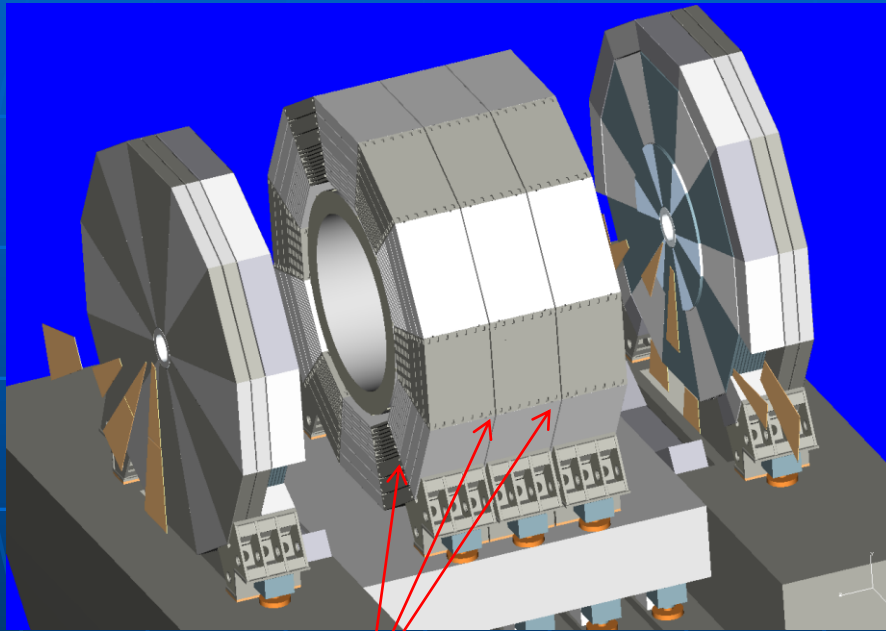
Barrel Assembly Step 12 / 13 / 14



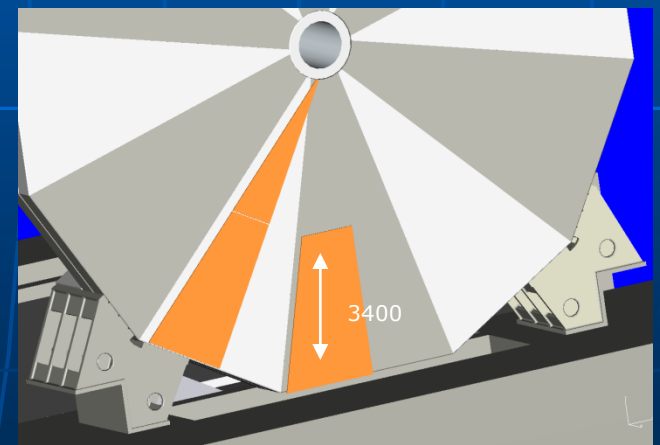
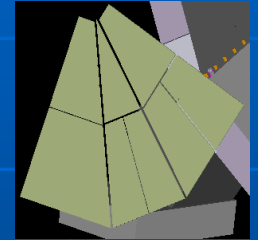
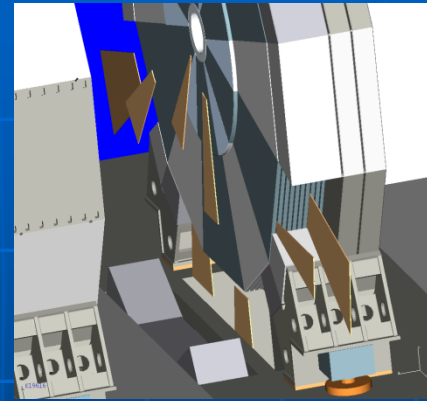
Chamber Pre Assembly in to End Cap

chamber assembly practical only for 2 or 3 segments

Geometry: $\sim 3400 \times \sim 2200 \times$ thickness between $25 \sim 30$ [mm]

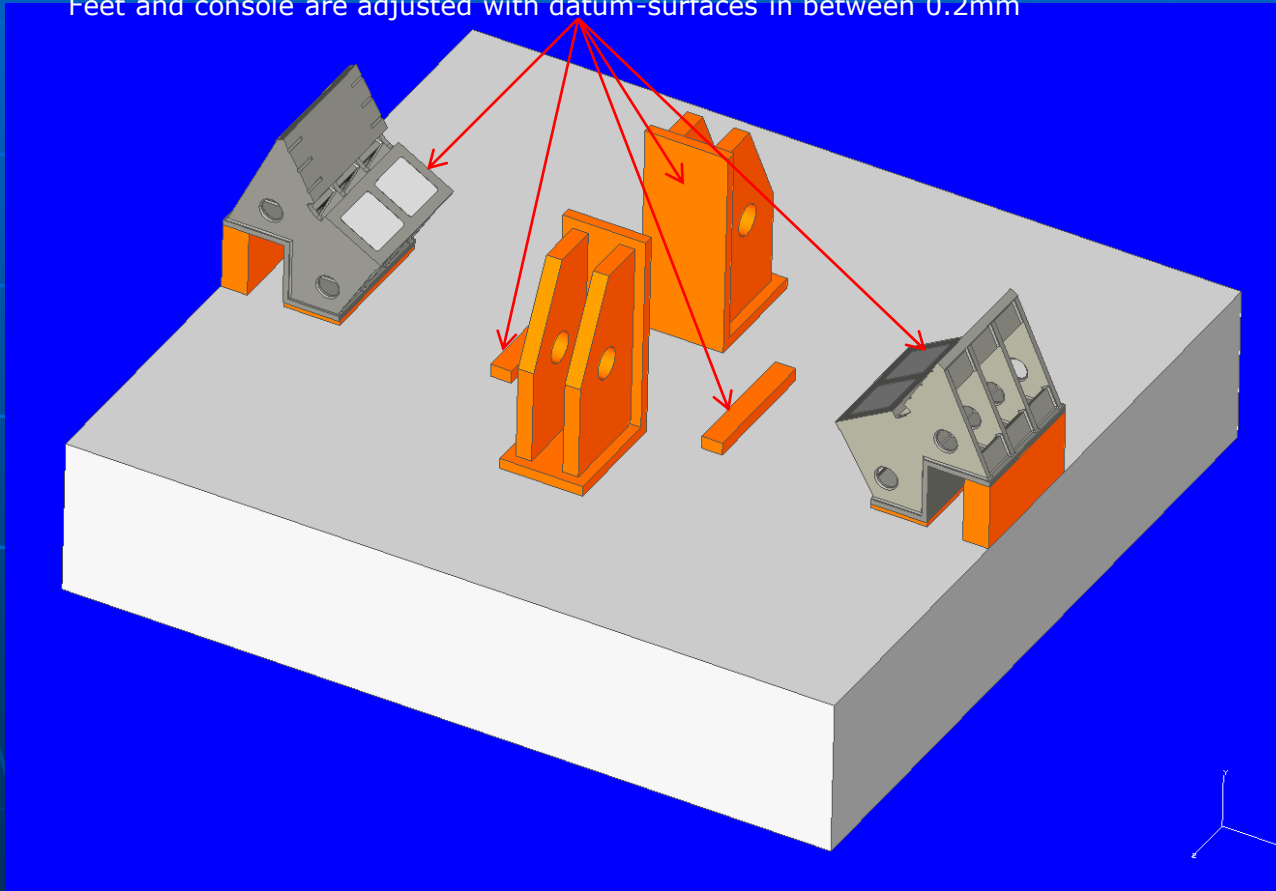


All irregularities between barrel rings and end cap will be individually compensated via spacer-bars after final assembly of the detector. These bars are manufactured from high density steel and measure 25mm on each part for a gap of 50mm.

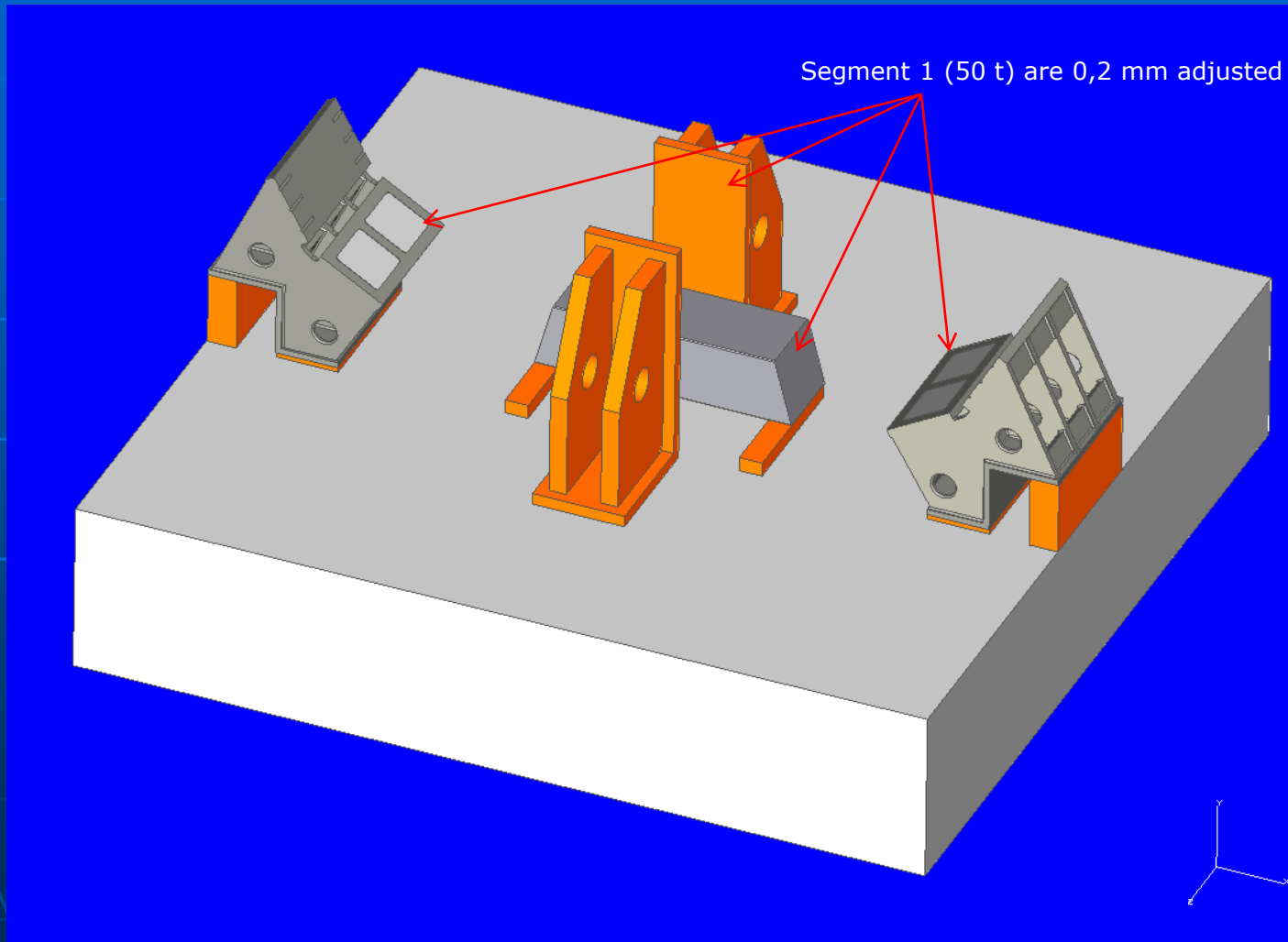


Basic Adjustment of End-Cap / Plinth

All parts will be aligned and adjusted with a laser-system during assembly,
(minimum space requirement will be 2m to datum-surface).
The assembly is done in the following sequence:
Feet and console are adjusted with datum-surfaces in between 0.2mm



End-Cap Assembly / Step 1

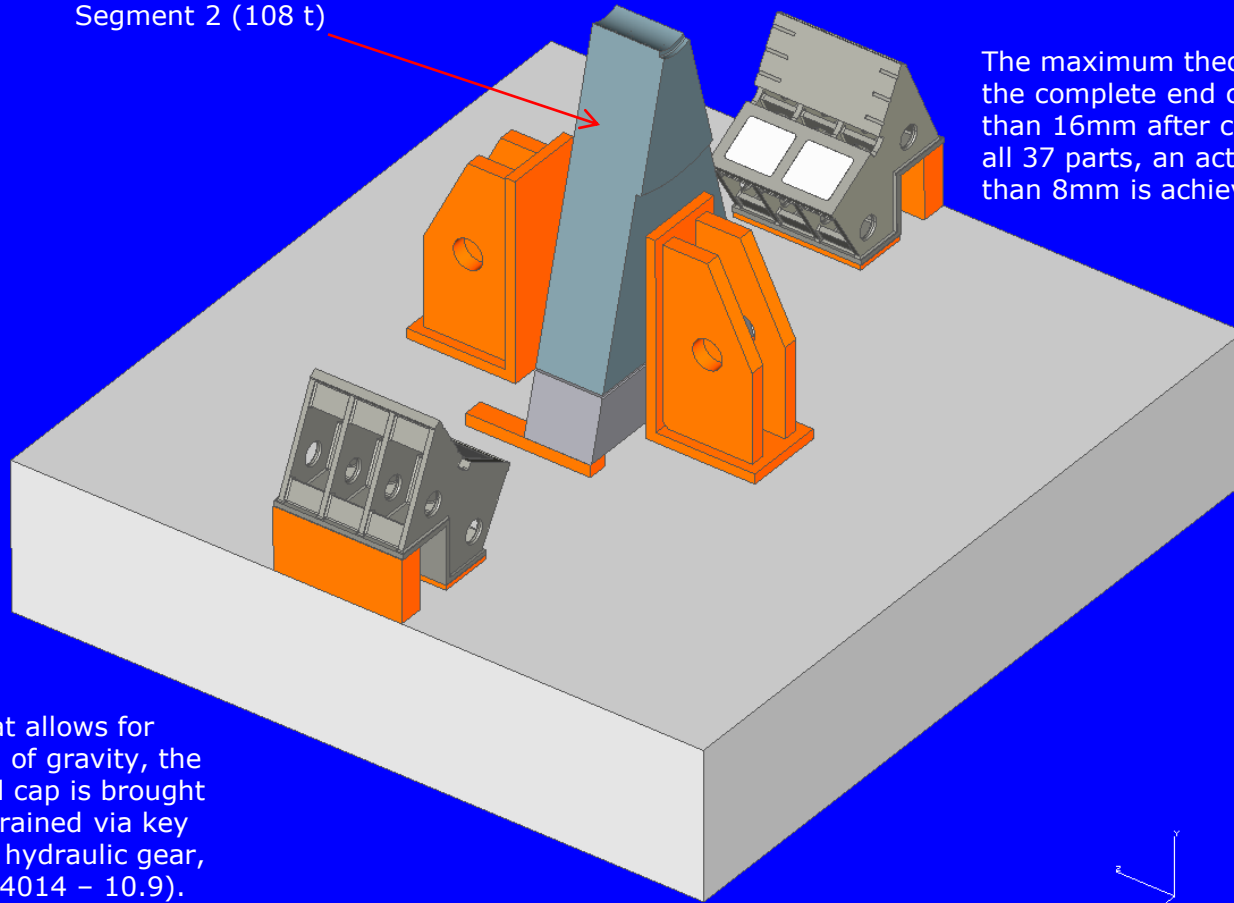


End-Cap Assembly / Step 2

All machined surfaces can be delivered within a tolerance better than 0.6mm
(or better than 0.2mm according to MAN Deggendorf/Germany)

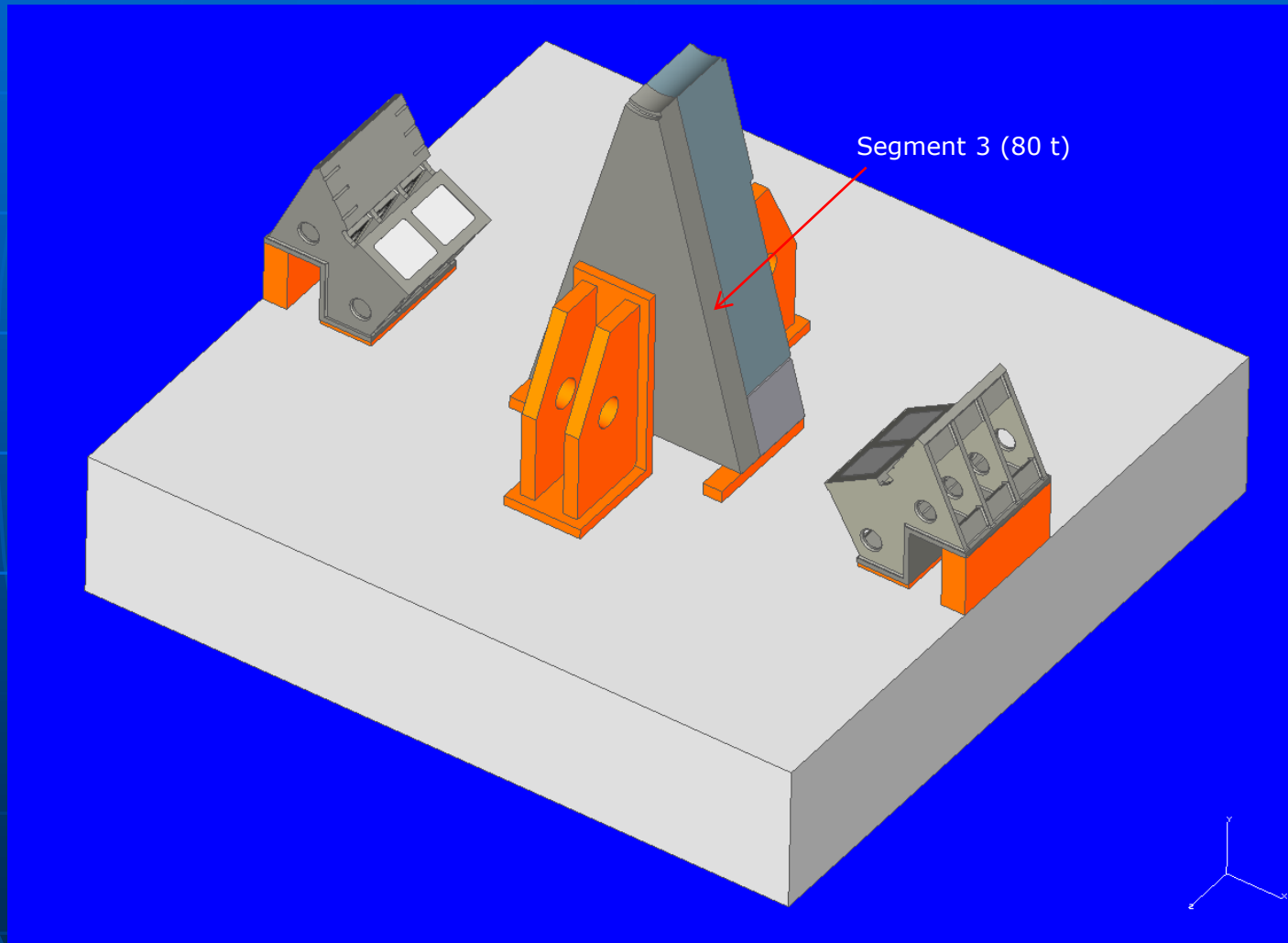
Segment 2 (108 t)

The maximum theoretical deviation – for the complete end cap – could be better than 16mm after complete assembly of all 37 parts, an actual tolerance better than 8mm is achievable.

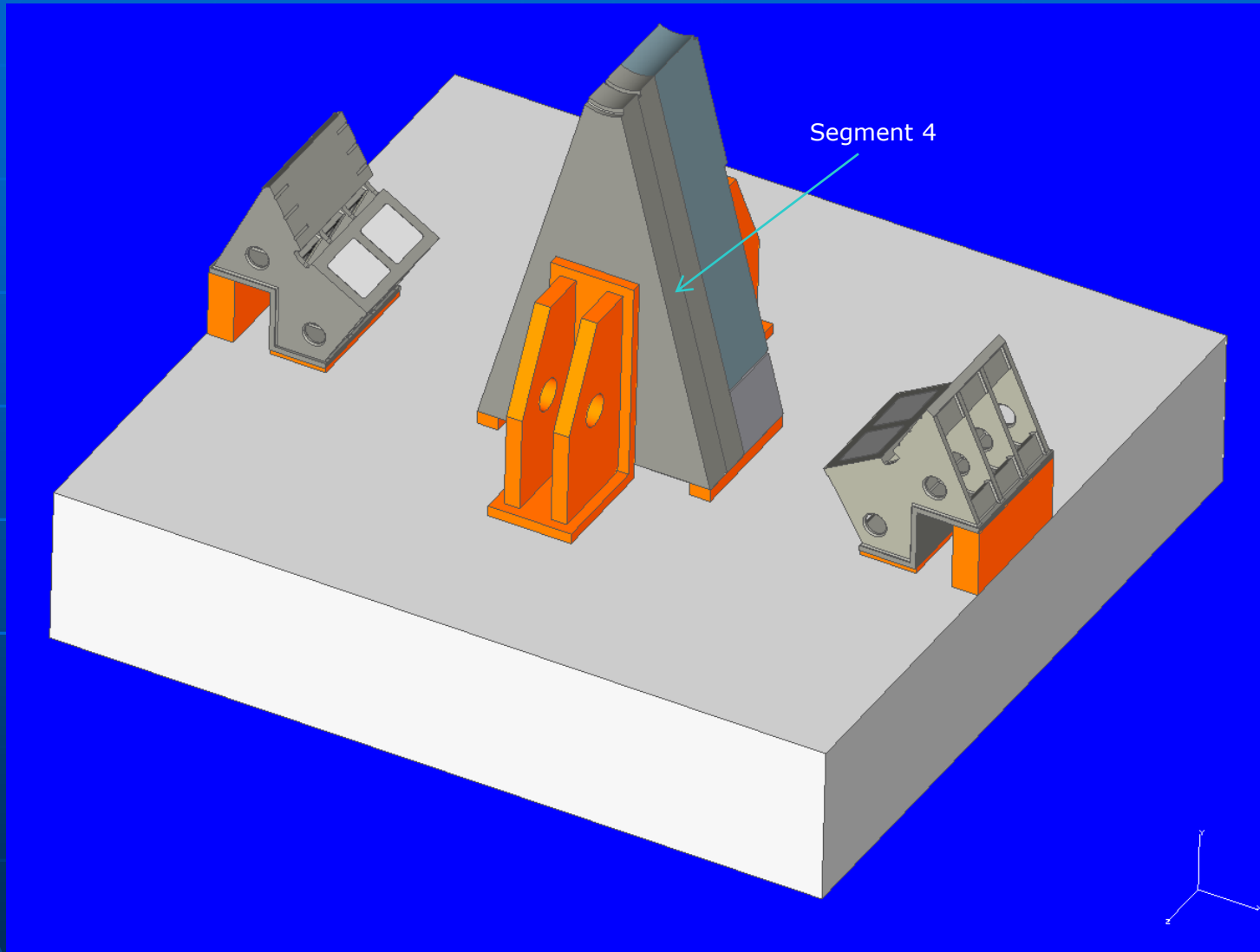


Utilizing a jig that allows for adjusting the centre of gravity, the next segment of end cap is brought into position, constrained via key and screwed on via hydraulic gear, (50 off M36 , ISO 4014 – 10.9).

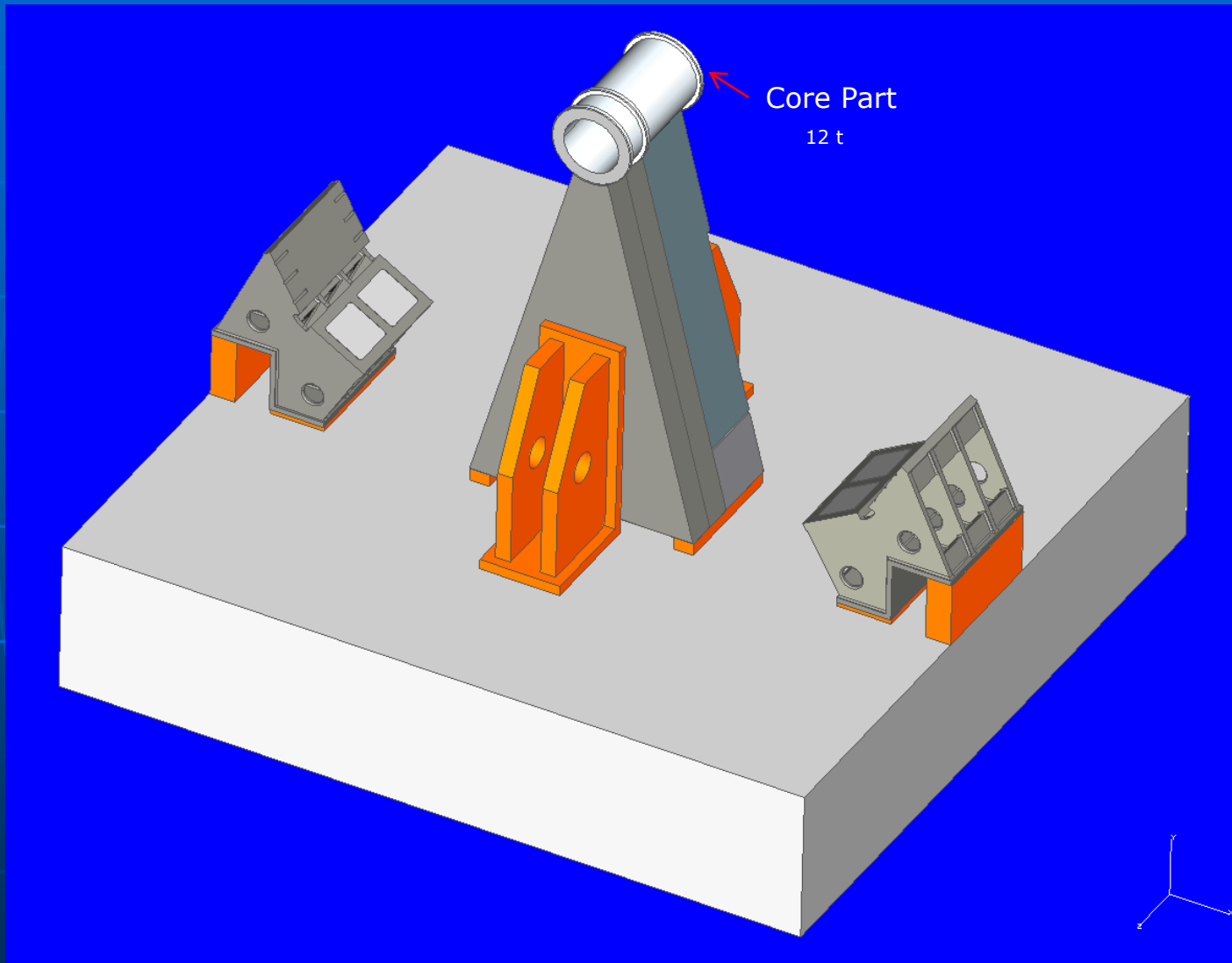
Endcap Assembly / Step 3



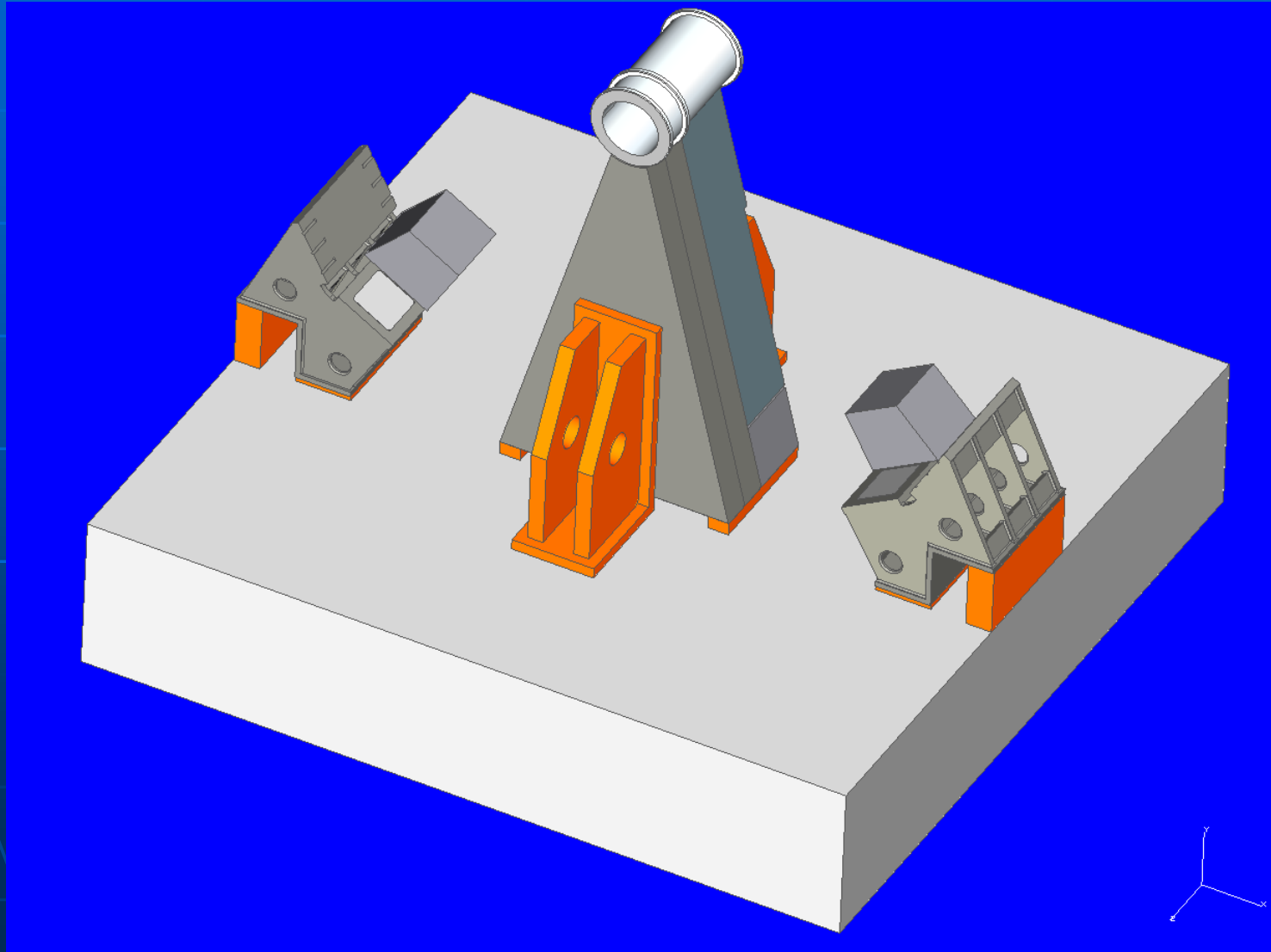
End Cap Assembly / Step 4



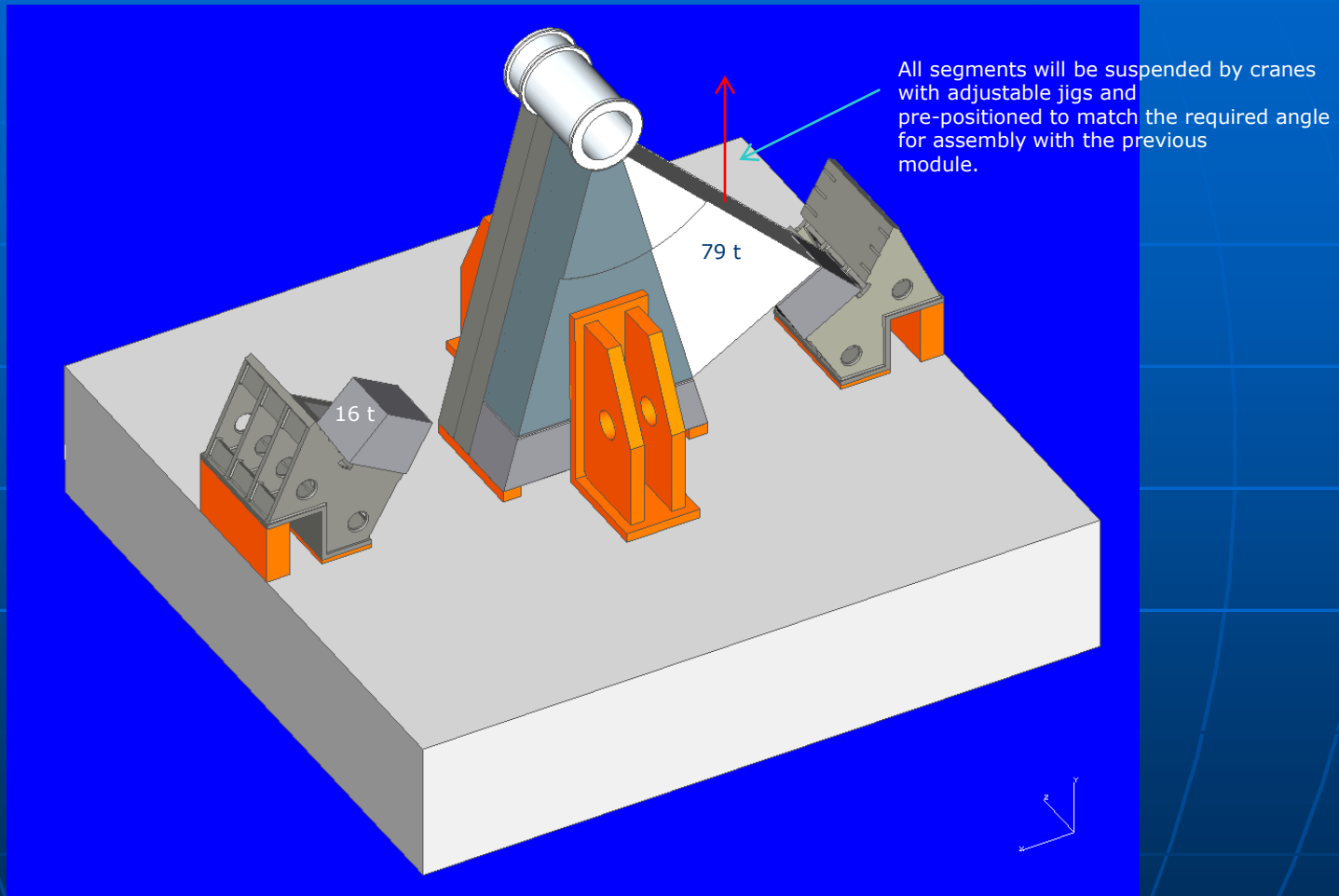
End Cap Assembly / Step 5



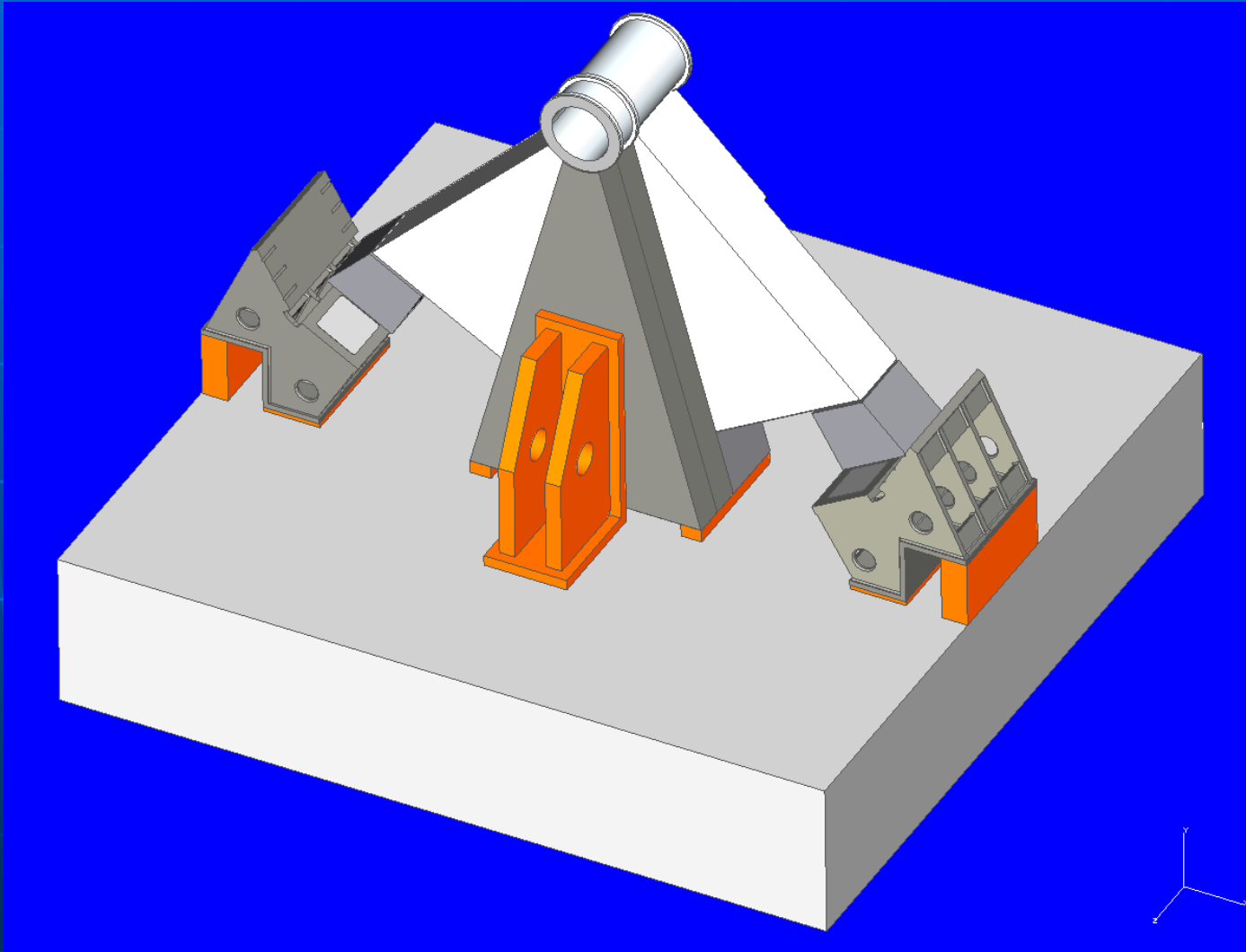
End Cap Assembly / Step 6; 7; 8



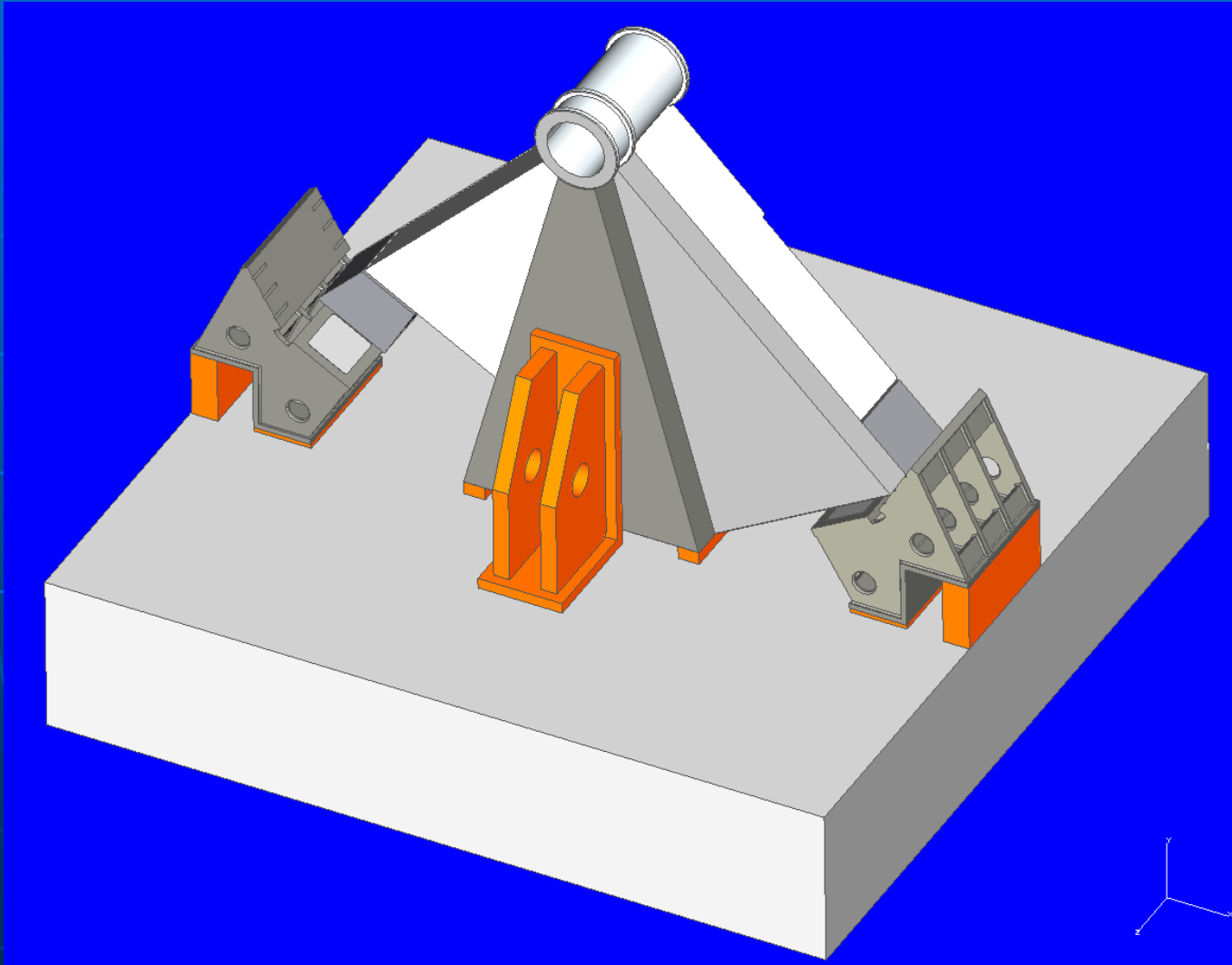
Endcap Assembly / Step 6; 7; 8



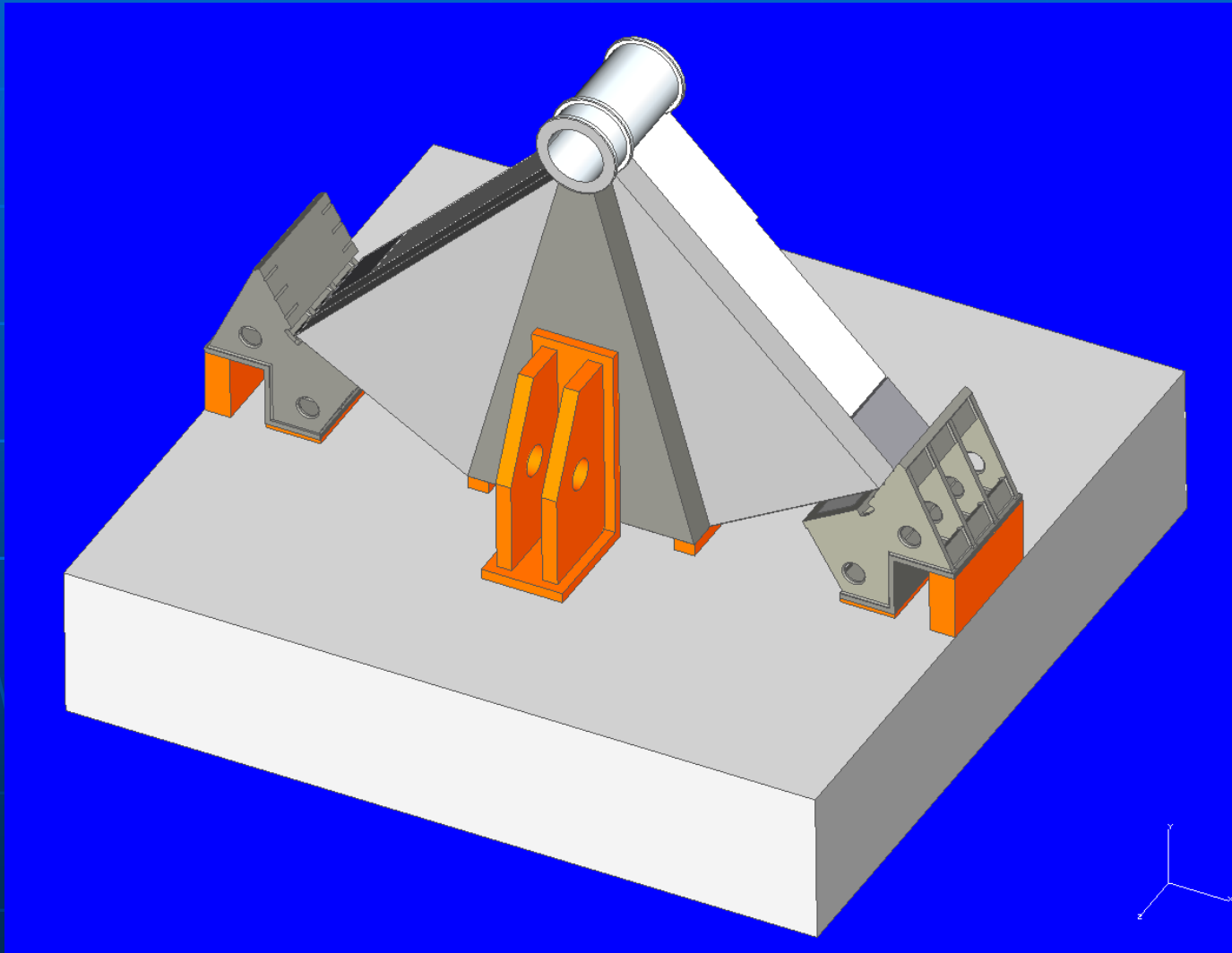
End Cap Assembly / Step 9; 10



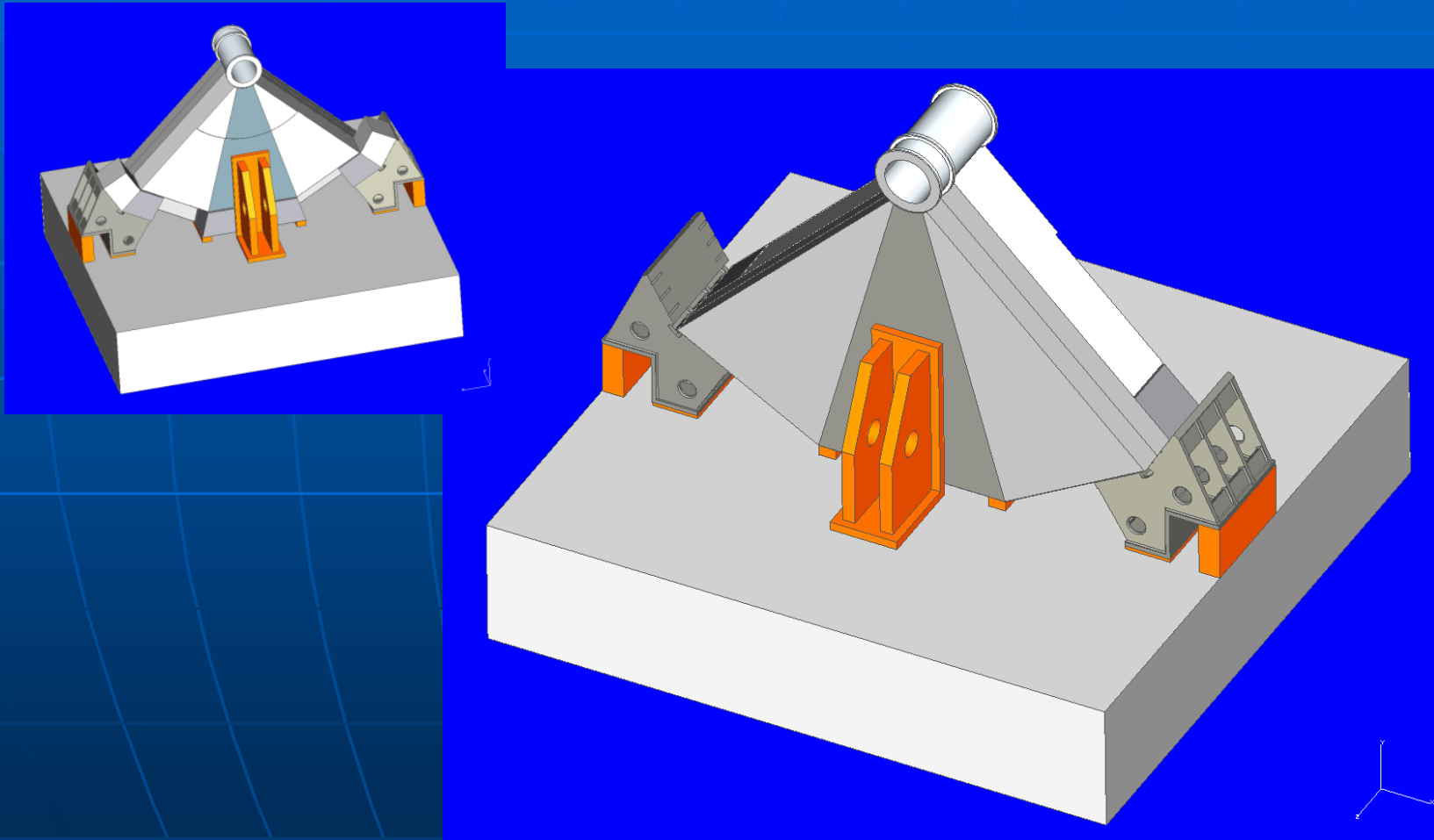
End cap Assembly / Step 9 / 10



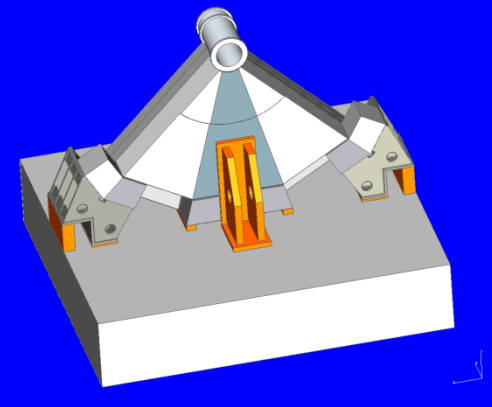
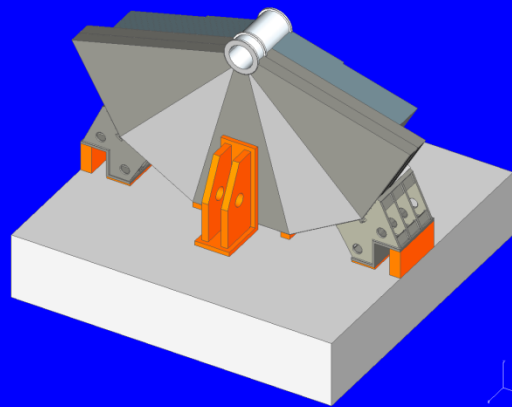
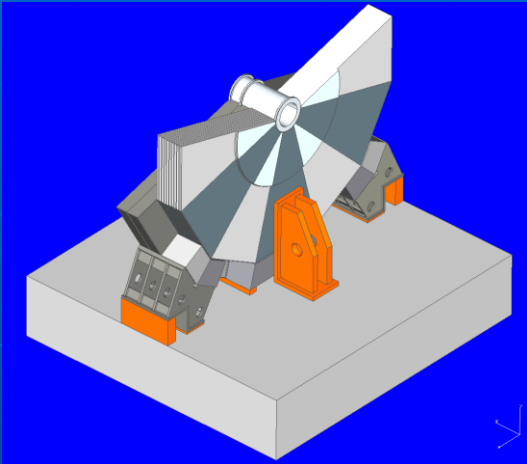
End Cap Assembly / Step 11; 12; 13



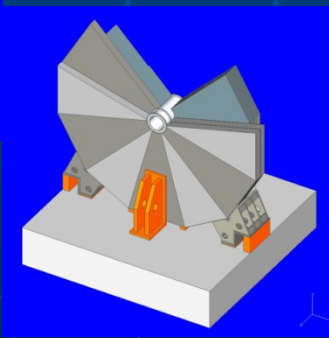
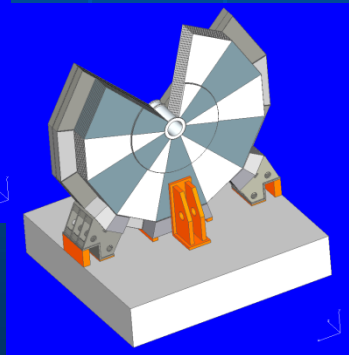
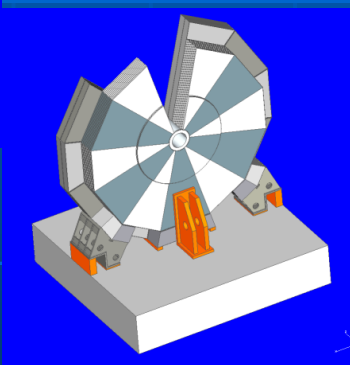
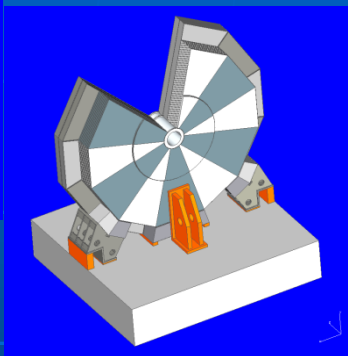
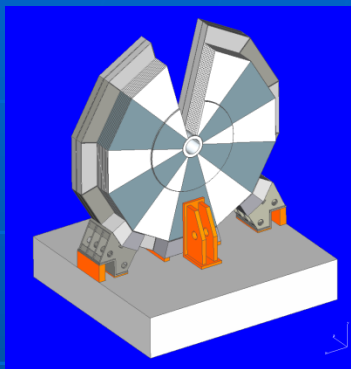
End cap Assembly / Step 11; 12;13



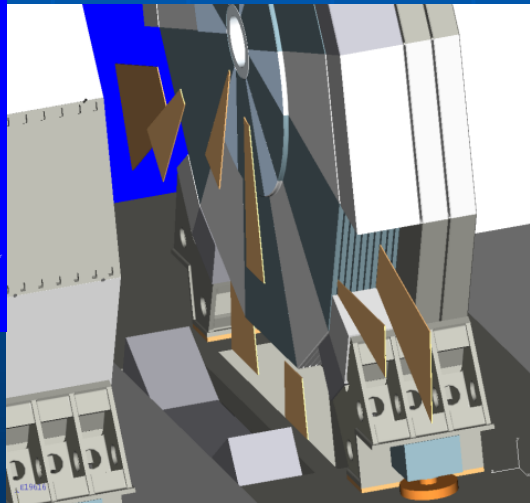
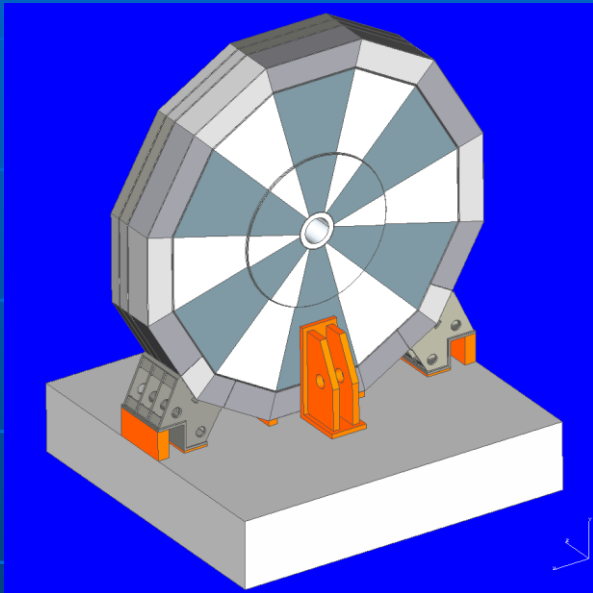
End cap Assembly / Step 14 to 22



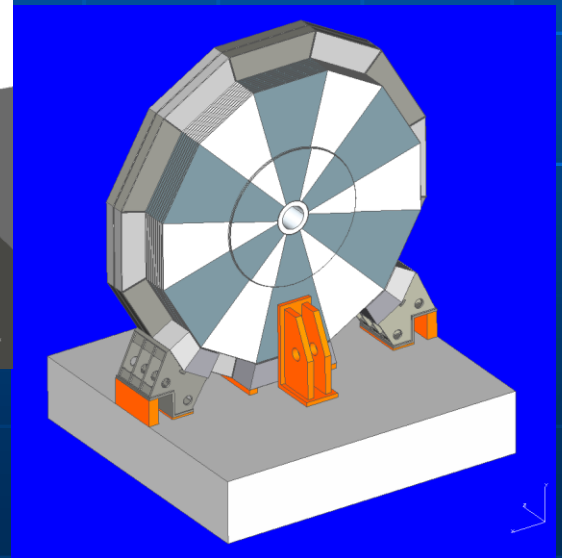
End cap Assembly / Step 23 to 36



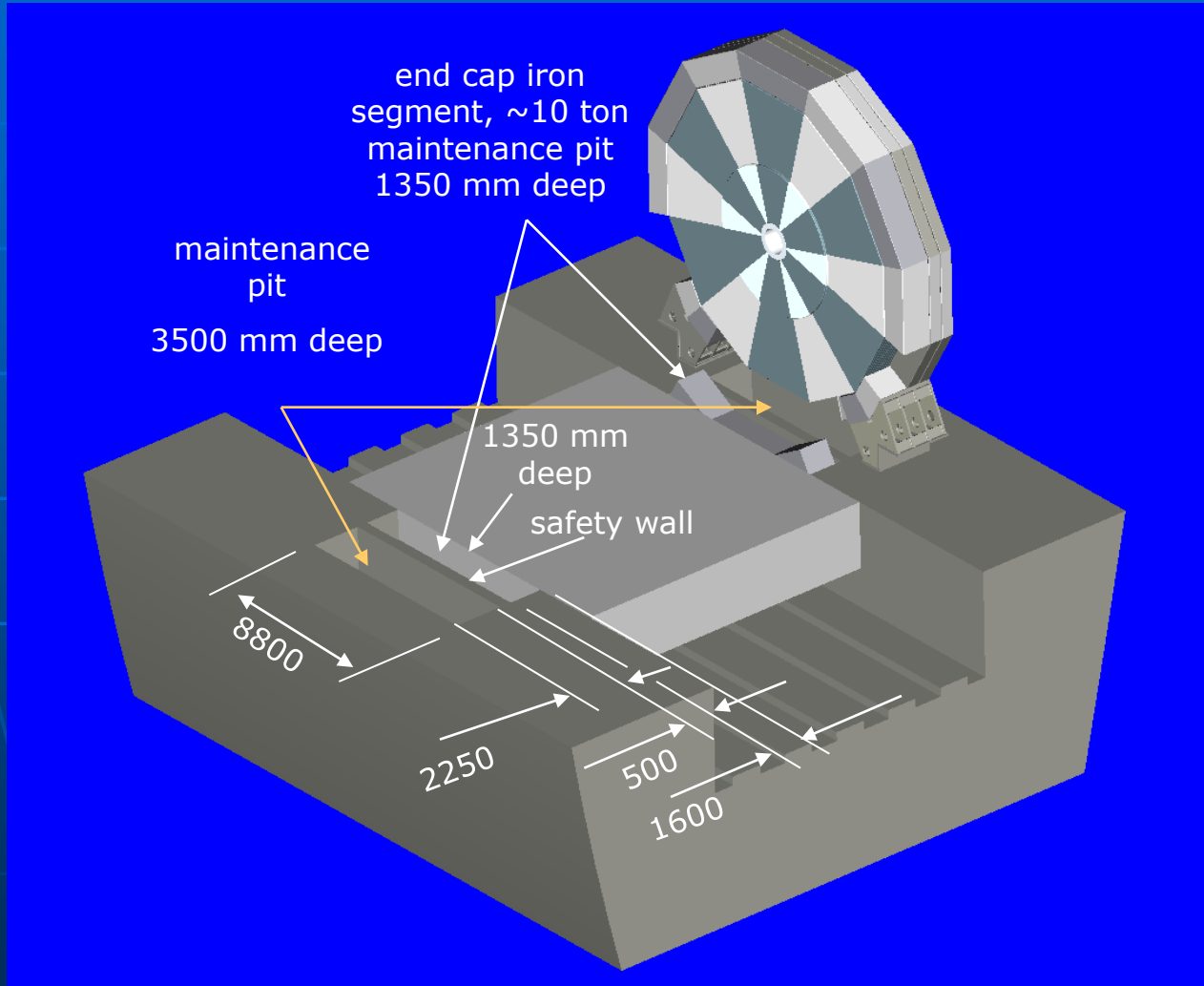
End cap Assembly / Step 36 to 50



Chamber omitted for clarity



ILD platform and foundation in hall



End cape iron segment in low-angle shot:

automation operating by hydraulic cylinder, electric motor or lifting jack

All other segments positioning with hall crane

chamber pit:
with scaffolding and ladder

Platform is positioned and safety lock is applied

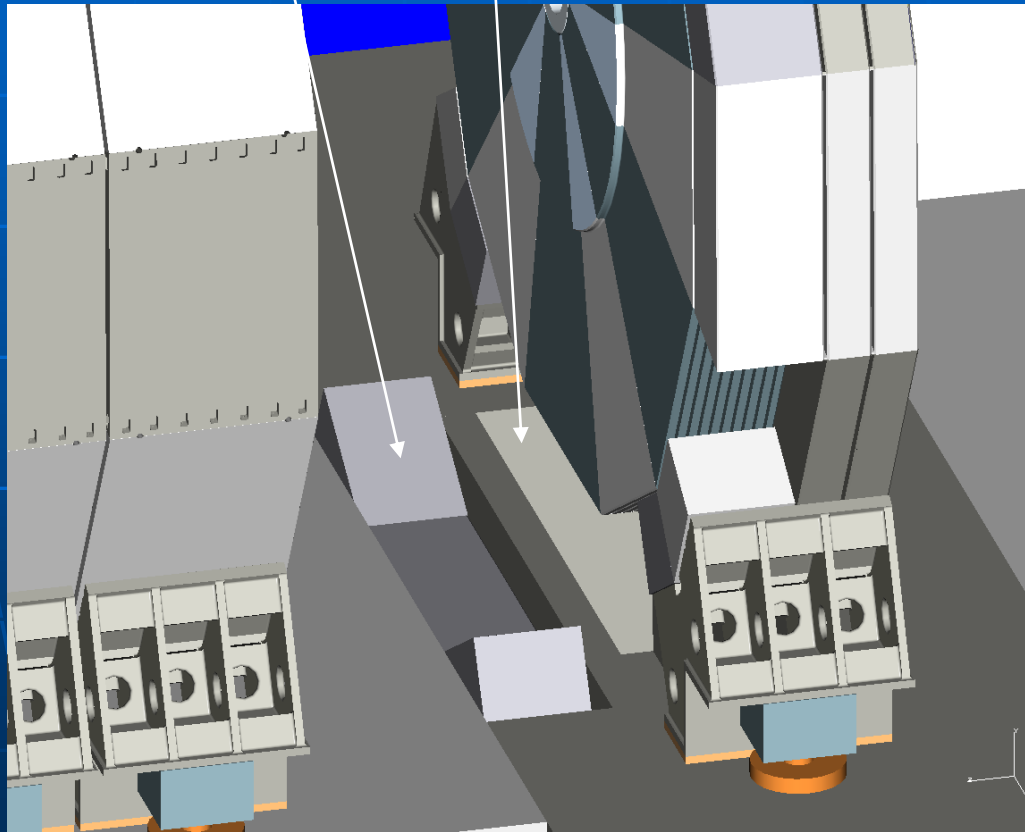
Chamber dismantling at shut down

Step 1: remove end cap over maintenance pit 1

lower iron (automatic with stroke jig)

Step 2: remove end cap over maintenance pit 2

change chamber (lifting jig and manual)



Conclusion

- The Barrel with End Caps and integrated Cryostat make up a self contained.
- The maximum theoretical deviation – for the complete barrel – could be better than 16mm after complete assembly of all 14 parts, an actual tolerance better than 8mm is achievable.
- To ensure reliable transport and positioning of these heavy parts, save and simple equipment will be required.
All segments will be suspended by cranes with adjustable jigs and pre-positioned to match the required angle for assembly with the previous module.

The maximum tolerance at final assembly, considering all influences like manufacturing methods and elastic deformation, may be achieved better than 12mm.
- Platform with detector has to be isolated against radiation with a protective wall.
It also has to be protected against vibration and earth quakes.
- The platform also has to have an additional locking mechanism also interlock access system, for safety reasons during operation.
- Sufficient access has to be provided for, scaffolding, cranes, ladders etc. so that tools and equipment may be easily employed during maintenance.
- In case of technical problems, external access to air-pads, sensors, cables and connectors has to be quick and easy.
- Safety issues have to be considered from the outset of the design and enough space has to be reserved for escape routes, fire alarm and fire extinguish devices.