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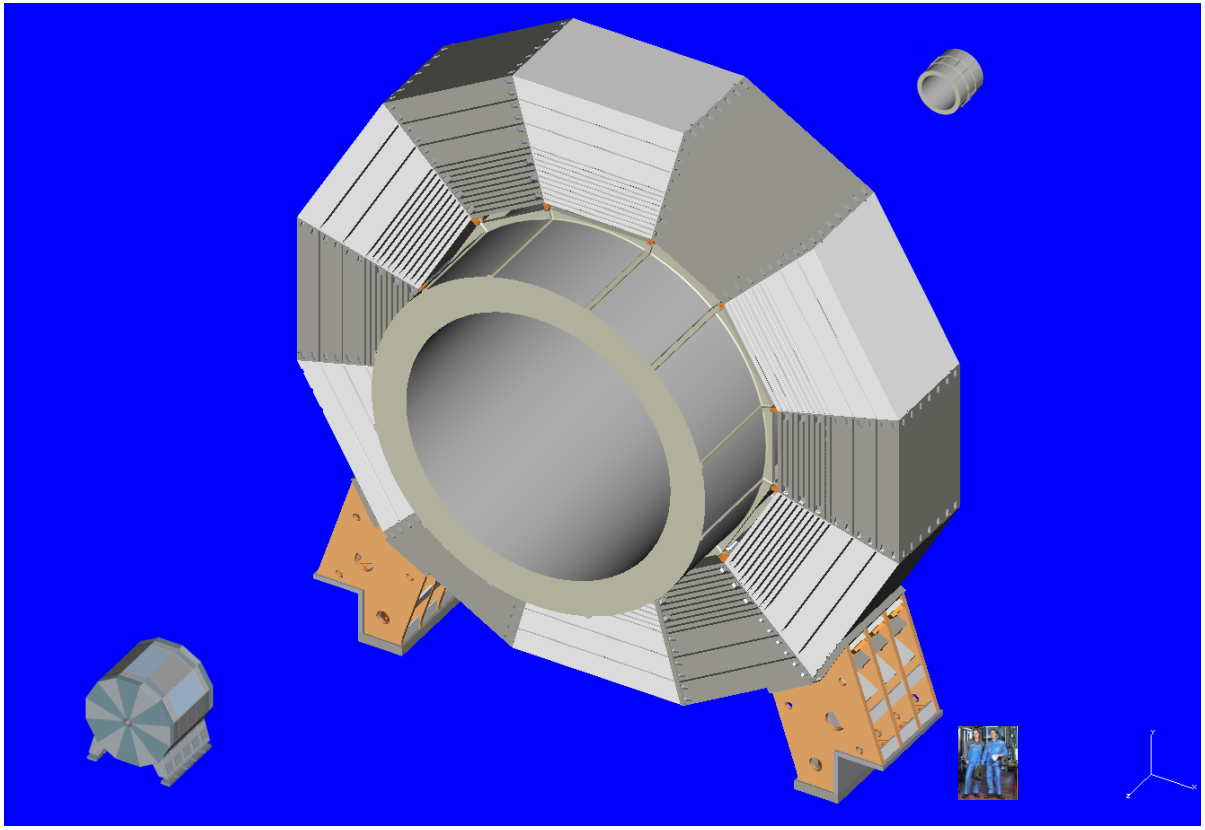
Cryostat Integration into ILD



CERN CMS Solenoid schematic

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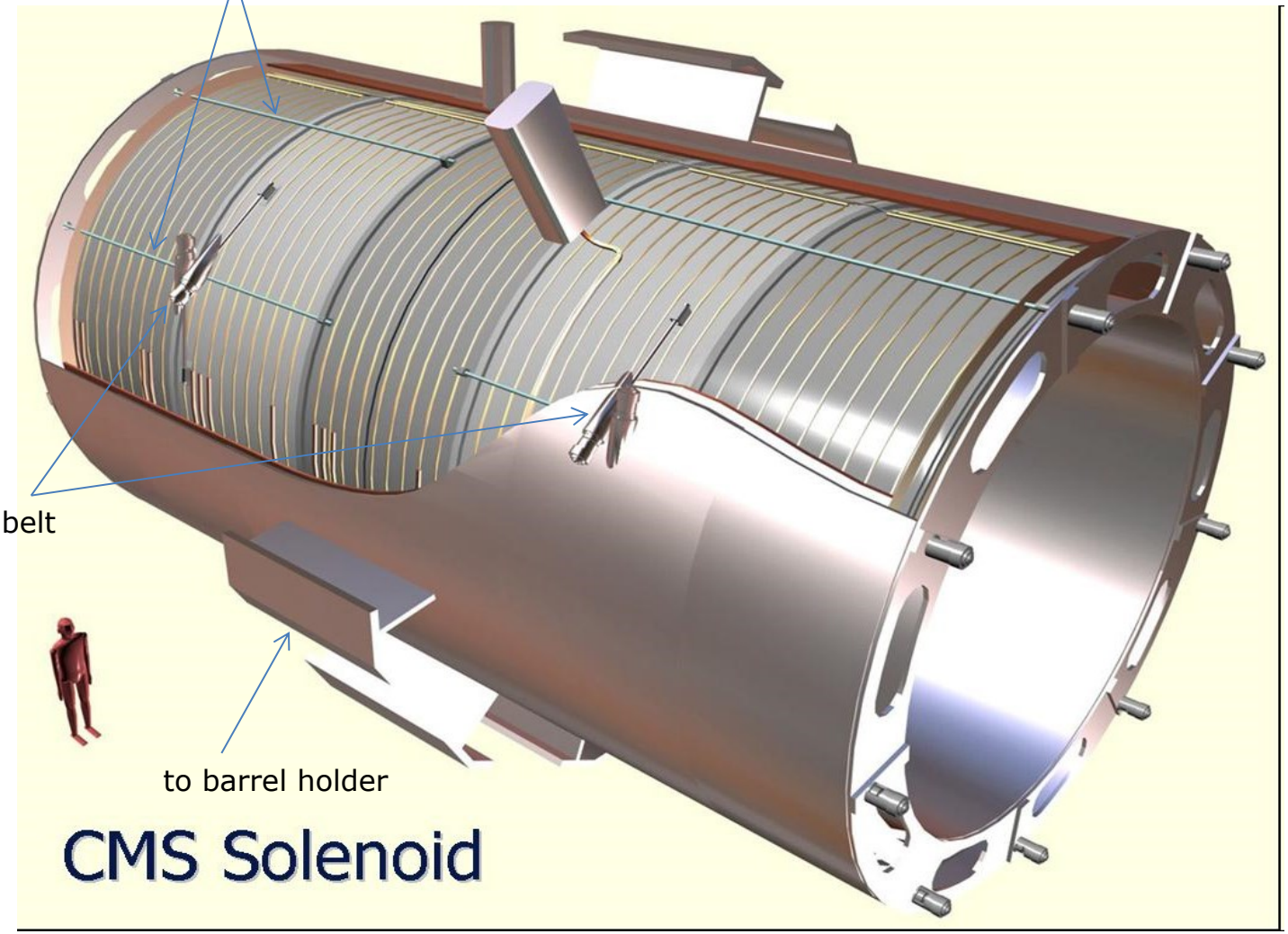
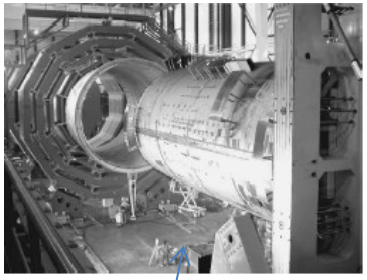


insertion of outer vac-tank / CMS



to need jig
and scaffolding
for on-site
installation

CMS Cryostat with inner-, outer vacuum vessel and end flange

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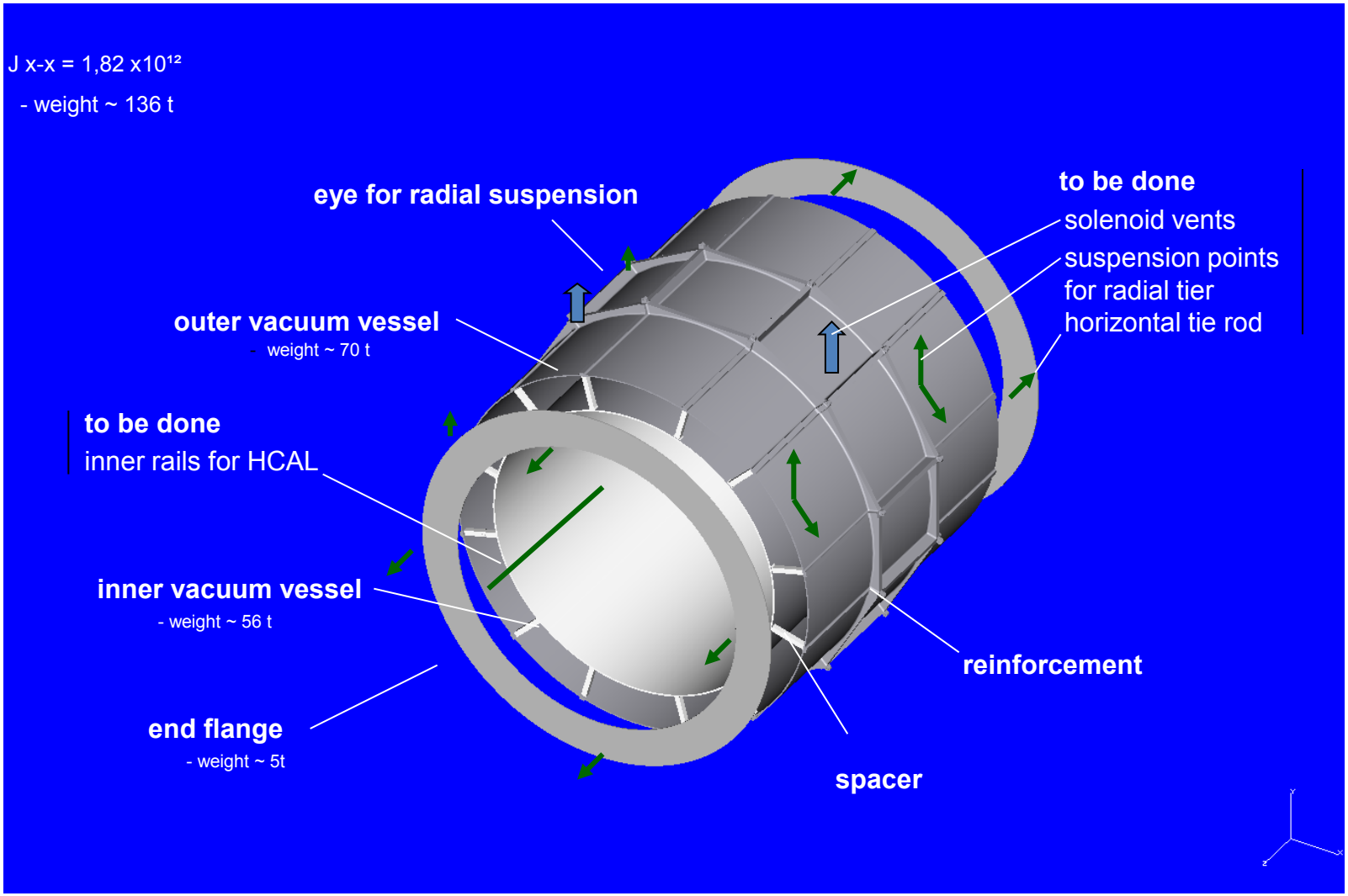
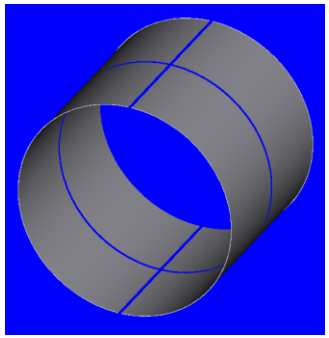
ILD cryostat structure proposal / all-welded

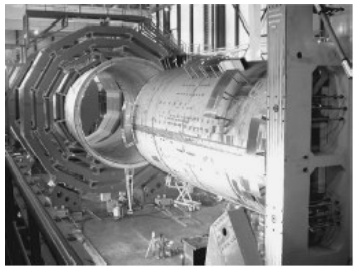


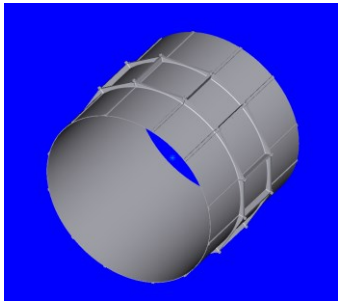
ILD cryostat production flow suggestion / assembly cryostat



Outer-, and inner- vacuum vessel

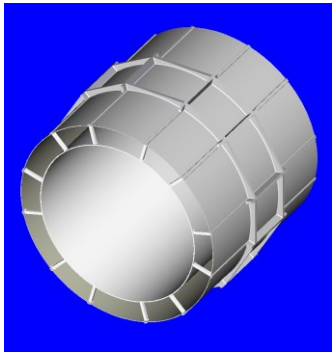
-sheet 4 or 8 (max. 13610 mm x 3905 mm, s= 30 mm)
segment rolled and welded





outer vacuum vessel

- prepared edge lined up and welded
- rotation symmetrical pilot hole diameter (ø 40 mm)
- outer reinforcements clamped to barrel and held in place by outer support
- aligned axis of ovv and barrel
- fixed ovv and welded brackets to the central barrel



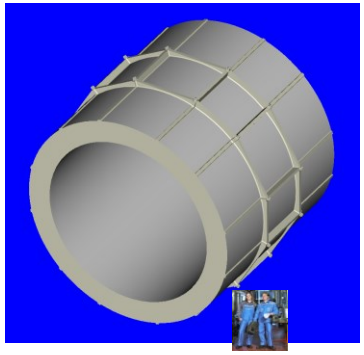
to be done

assembly cryostat to ovv

- solenoid completion and fixture

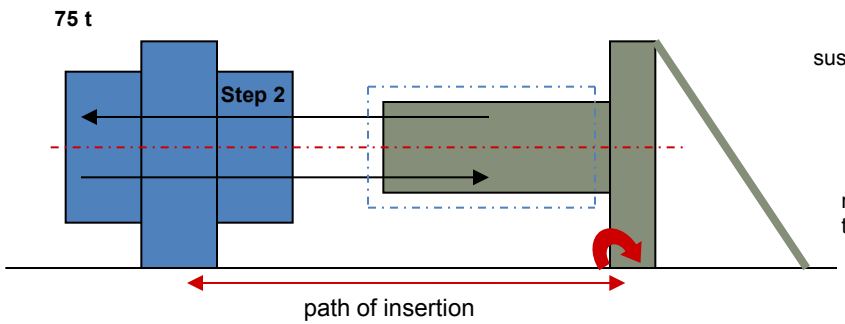
inner vacuum vessel

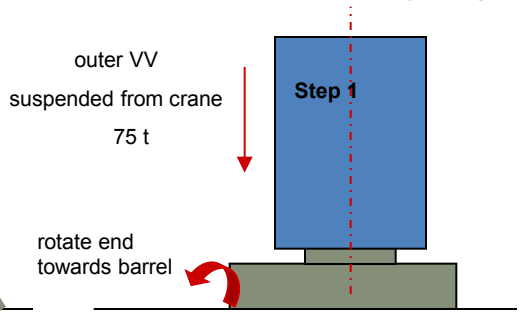
- sheet 4 or 8 rolled and outside scaffold
- aligned and welded
- lodge inner vv in outer vv, align rims and weld
- welding of end plate



assembly completion of solenoid and vacuum vessel (CMS)

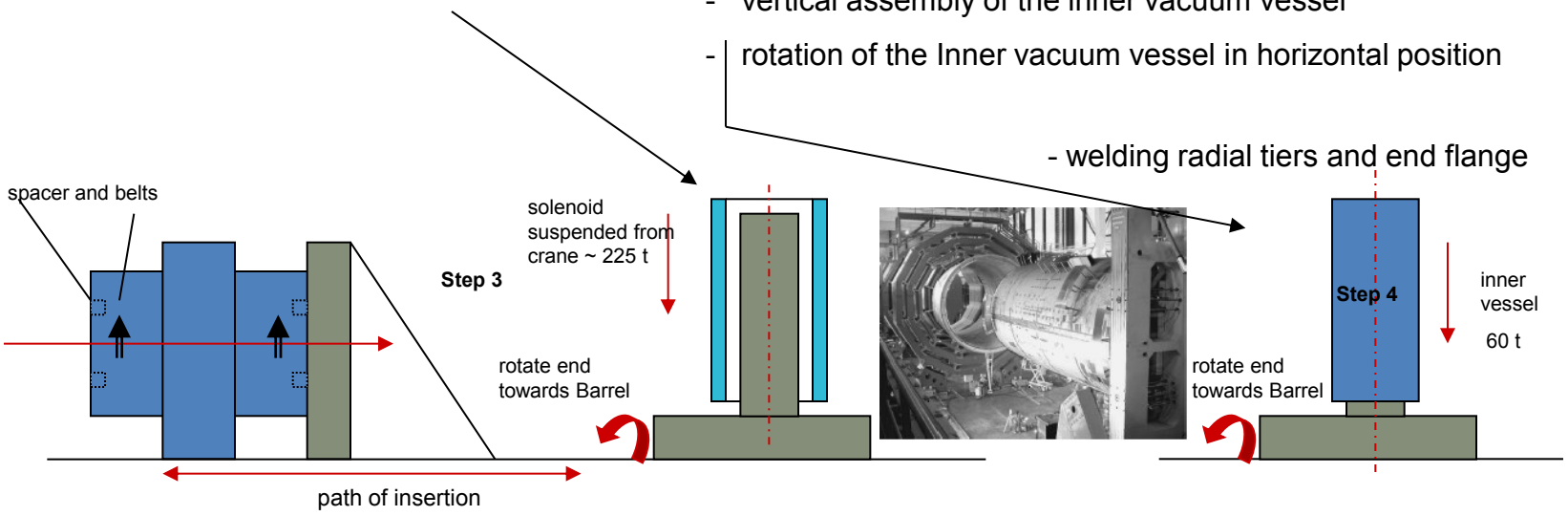
1. outer vacuum vessel (75 tons) with barrel after installation on turn table, primary alignment



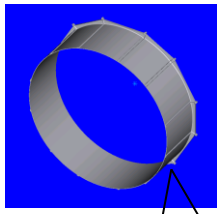


2. assembly and completion of the solenoid (~ 225 t)

- rotate inner vacuum vessel into horizontal position => weld radial tiers and end flange
  - vertical assembly of the inner vacuum vessel
  - rotation of the Inner vacuum vessel in horizontal position
  - welding radial tiers and end flange



ILD Cryostat: applied and resulting forces, deflection line



1. outer vacuum vessel (ovv)
   - weight ~ 70 t
   - section modulus J x-x = 9,57 x 10^{11}
2. outer + inner + end-flanges (oief)
   - weight ~ 136 t
   - section modulus J x-x = 1,82 x10^{12}
3. cryostat weight total ~ 360 t
4. HCAL, ECAL, TPC ~ 710 t

∑ **~ 1200 t**

outer ø 8680 / s = 30

inner ø 6880 / s = 40

(stainless steel)

7810

reaction force, resetting fixing

reaction force

reaction force, resetting fixing

F_L ~ 6000 kN

(active force)

f ovv ~ 0,5 mm

f oief ~ 0,3 mm

f oief ~ 0,03 mm

F ovv ~ 0,05 mm

F_R ~ 6000 kN

(active force)

f ovv ~ 0,5 mm

f oief ~ 0,3 mm

support

support

F_B ~ 6000 kN

(active force)

(active force)

F_A ~ 6000 kN

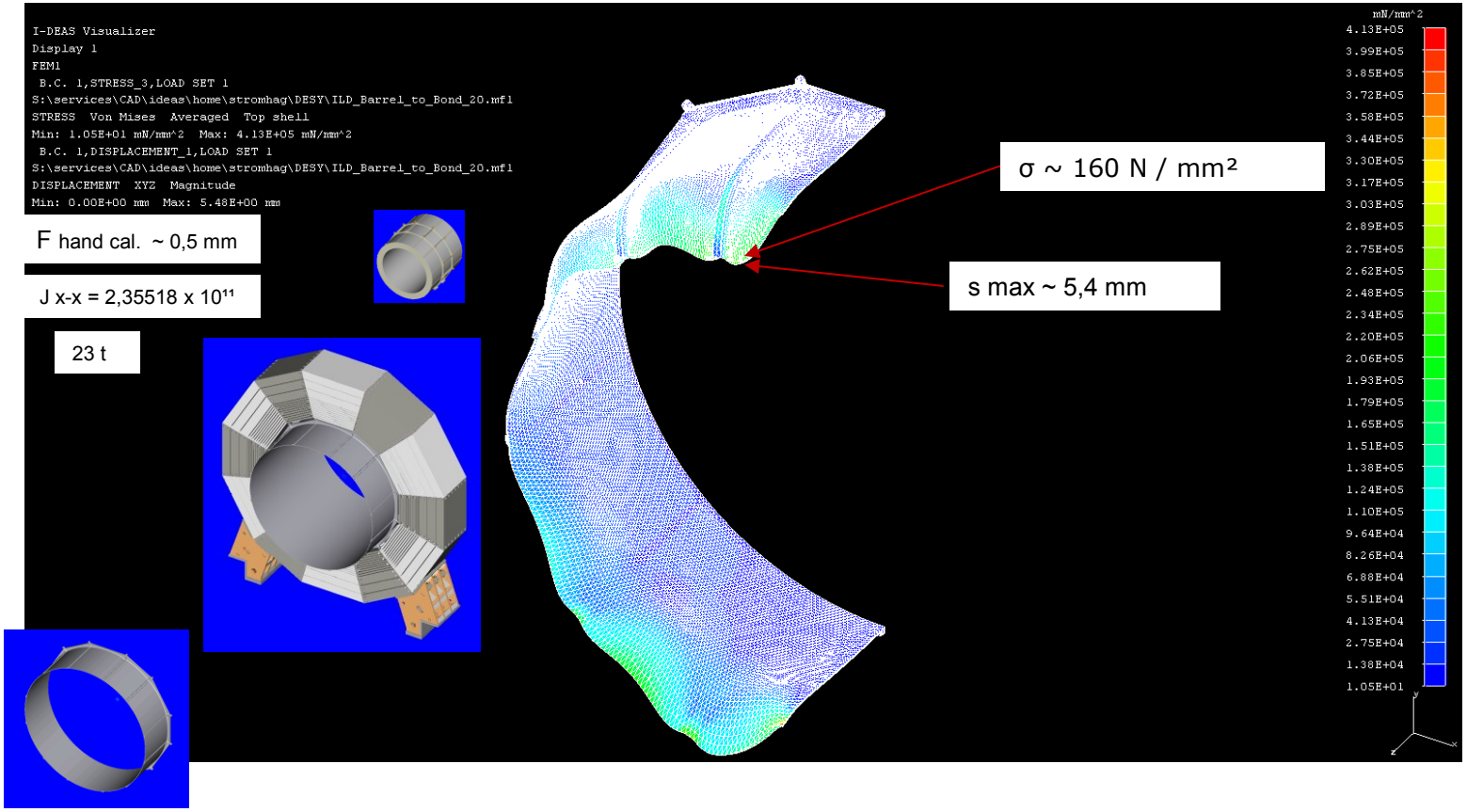
2868

2074

2868

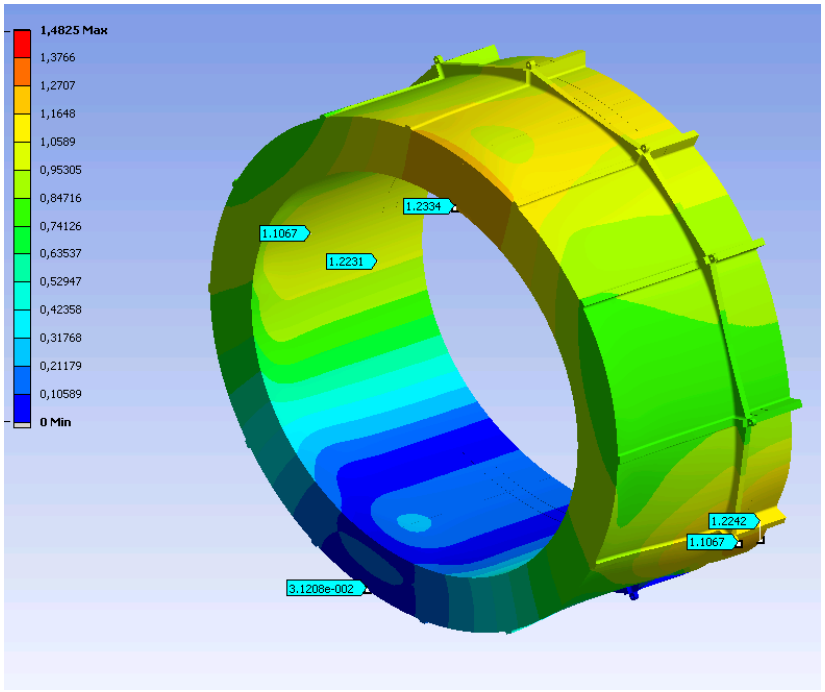
ILD cryostat FEM simulation

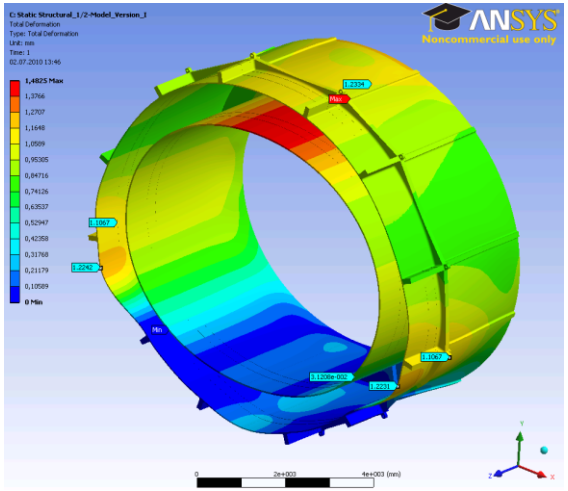
only end half part 2868 mm lg. / F = 3000 kN constant off-circumference

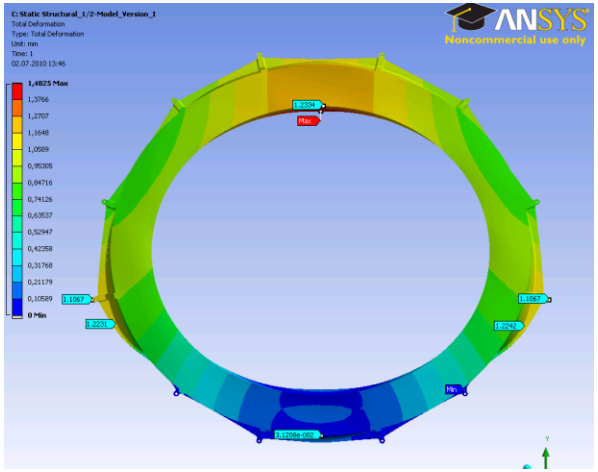


ILD Cryostat total deformation

max. ~ 2mm

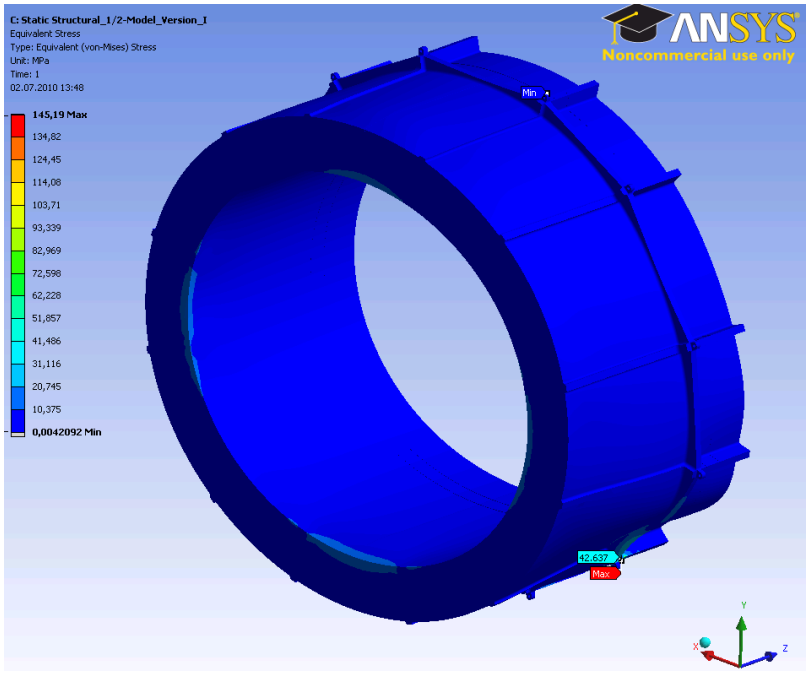




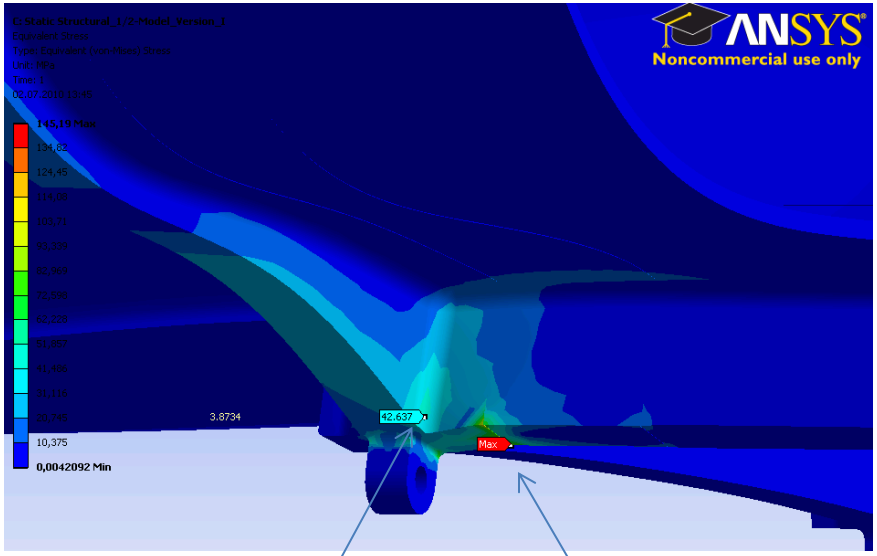


M. Lemke

ILD Cryostat total stress



M. Lemke



normal max. 43N/mm²

max. ~ 110 N/mm²
(as an exception)

Cryostat integration in central barrel ILD first step

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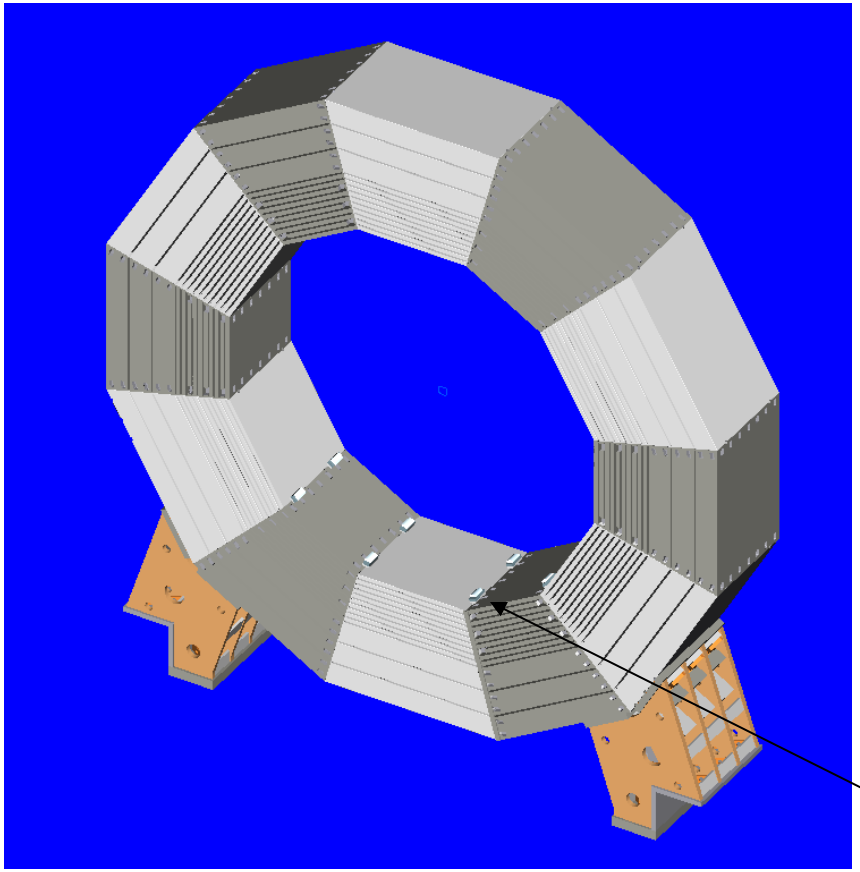
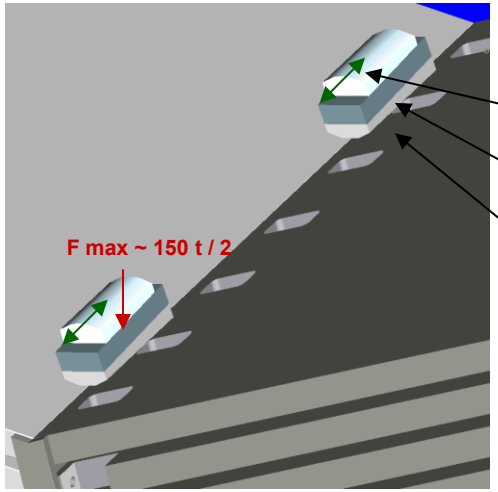




allowable pressure

S235JR (St37) R_{mN} ~ 360 N/mm²

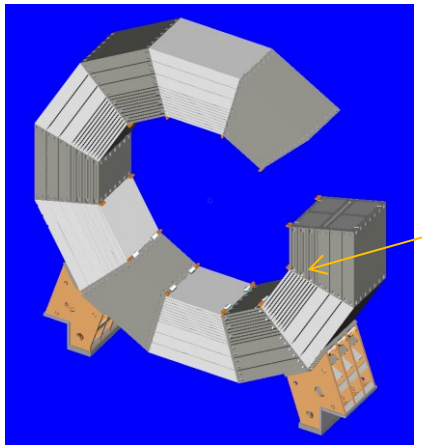
yield point $Rp_{0,2N}$ ~ 235 N/mm²

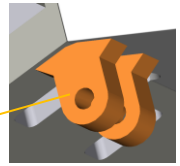
σ_{dB} ~ F / A ~ 75 000 0 N / 8 x 500 (mm) ~ 188 N/mm²

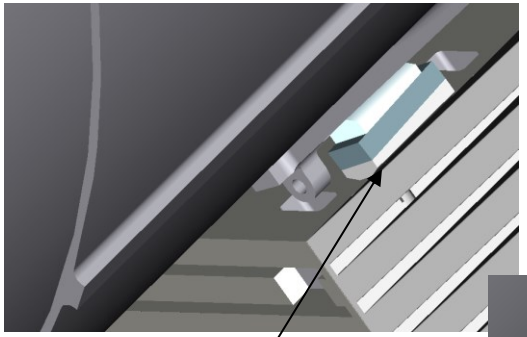
without preparatory work, full yield settling ~ 0,8 mm

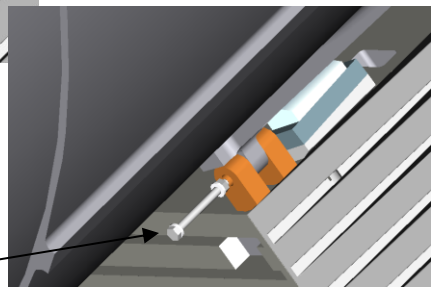
Installation of "jacking up to line" keys with hardened plate to primary alignment (integral key ~ 3deg), shown in position (8 units)

push the outer vacuum vessel to the central barrel ILD second step





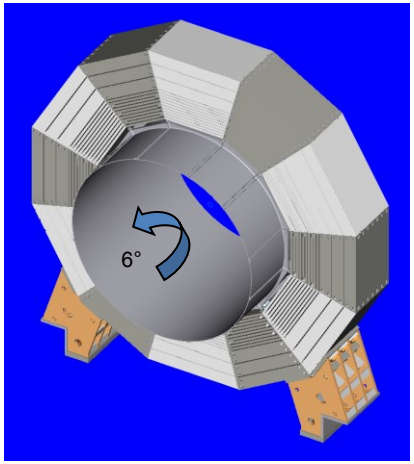




-after primary alignment

- tack weld each bracket to barrel individually,
- from point to point to fit and tack
- fit screw between barrel and ovv
- all bracket to barrel tack welding
- remove circular 6° ovv from barrel
- all bracket end welding

(alternative: welding without removal of ovv)



Cryostat integration in central barrel ild

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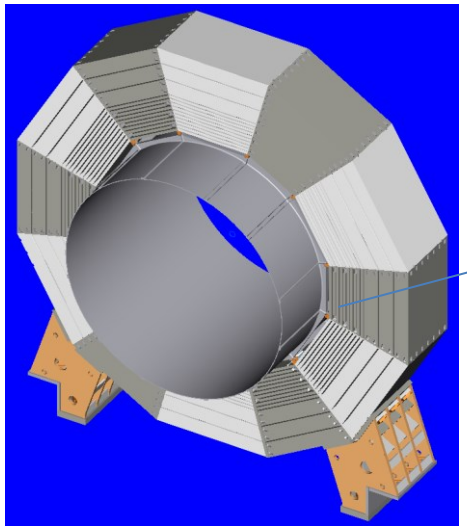
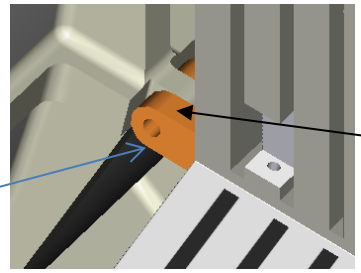
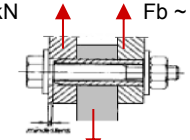




Assembly boring of ø 50H¹² mm
Bearing case in combination with Cryostat ear

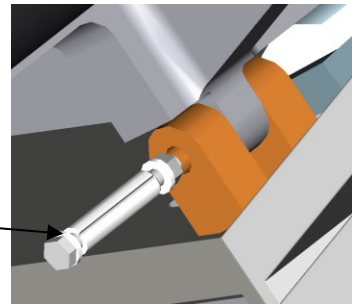
fix with friction bolt DIN 1481 - ø 50 x 240 lg.
hexagon head bolts with large head (HV)
DIN 6914 – M30 x 300 comply with washers and nuts

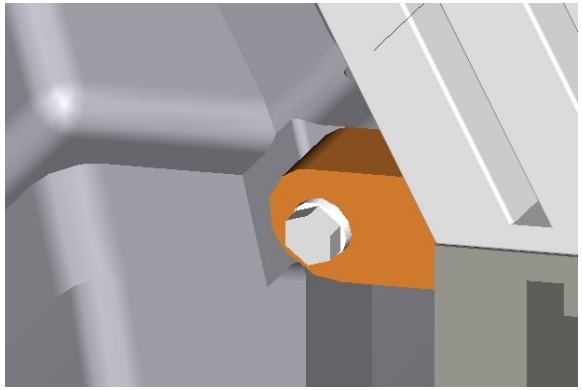
Fa ~ 300 kN



Fb ~ 300 k N

Fr theory ~ 600 kN
Fr applied under 600 kN!
Surface pressure 65 N/mm²





friction bold DIN 1481
shearing force max ~ 1685 kN
Account: 20 friction bold to lift 1200 t

shear stress factor ~ 2,5 (1,2 is ok)
surface pressure 125 N / mm²

S235JR ~ 235 N/mm² > 125 N/mm²

pressure factor ~ 1,8 (1,2 is ok)

tightening screw condition:
hydraulically operated in sequence for 24 bold
DIN 6914 – M30 x 300
M ~ 1650 Nm, Fv ~ 350 kN

cryostat integration in central barrel ild

welding bearing case

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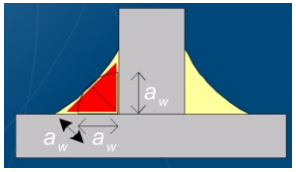
account to data sheet DVS 0705 / DIN 18800

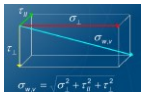
weld seam: aw ~ 35 mm,

l = 80 mm, Aw = 2800 mm²



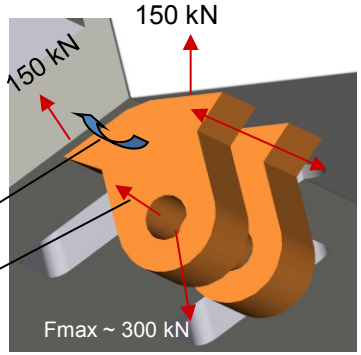
steel: S235JRG2
Rm ~ 360 N/mm²
Re ~ 215 N/mm²

σ_{II} ~ 18 N/mm²
$\sigma_{\perp}$ ~ 32 N/mm²
ζ_{II} ~ 32 N/mm²
$\zeta_{\perp}$ ~ 32 N/mm²



stress reference value

σ_{exist} ~ 48 N/mm² < σw ~ 207 N/mm² (St37)
(factor ~ 4)



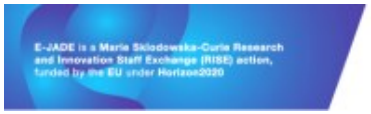
M bending moment ~ 19 kNm

F axial ~ 150 kN

σ normal stress ~ 152 N/mm² < $\sigma_{tol.}$ ~ 195 N/mm²

DVS 0705

conclusion



- A lot of studies need to be performed:
- design of cryostat supporting system
- - all geometrical parameters
- - finish cryostat constructions concept
- - cryostat quench scenarios
- - cabling concept
- - power supply connection design
- - cryostat safety instruction sheet
- - scaffolding
- - gas-, cables-, water-, power-connection
- - escape rotes
- - safety periphery and risk assessment analyse
- - collaboration with other international ild interacting groups