

CLIC X-BAND Corrector Cavity

Static structural analyses Tuning simulations

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ENGINEERING
DEPARTMENT

2022/10/07

EDMS n°2782224

Model configuration

- Material behaviour: elastic-plastic
- Contacts: perfectly bonded
- Boundaries:
 - lower face blocked vertically
 - 1 middle line blocked horizontally
- Loads (besides gravity):
 - Step 1: displacement for tuning
 - Step 2: removing displacement
 - Step 3:
 - P=6 bar in cooling circuits
 - vacuum in cavity (P_{atm} outside)

Loads

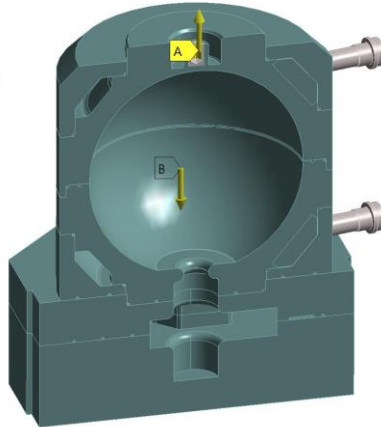
• Case 1: tuning up 0.8 mm

L: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-thread

Standard Earth Gravity
Time: 1. s
07/10/2022 10:26

- A** Displacement $z=0.8$
- B** Standard Earth Gravity: 9806.6 mm/s²

Step 1

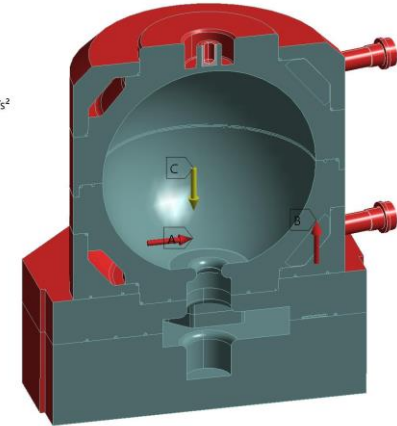


L: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-thread

Standard Earth Gravity
Time: 3. s
07/10/2022 10:27

- A** Patm: 0.1 MPa
- B** Pressure cooling circuit: 0.6 MPa
- C** Standard Earth Gravity: 9806.6 mm/s²

Step 3



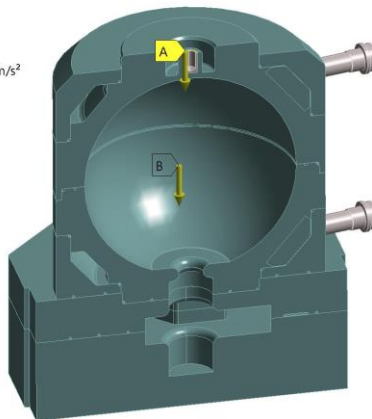
• Case 2: tuning down 1 mm

N: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1

Standard Earth Gravity
Time: 1. s
07/10/2022 10:30

- B** Standard Earth Gravity: 9806.6 mm/s²
- A** Displacement $z=-1$

Step 1

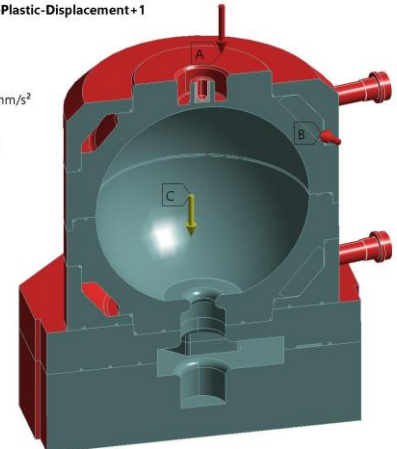


N: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1

Standard Earth Gravity
Time: 3. s
07/10/2022 10:31

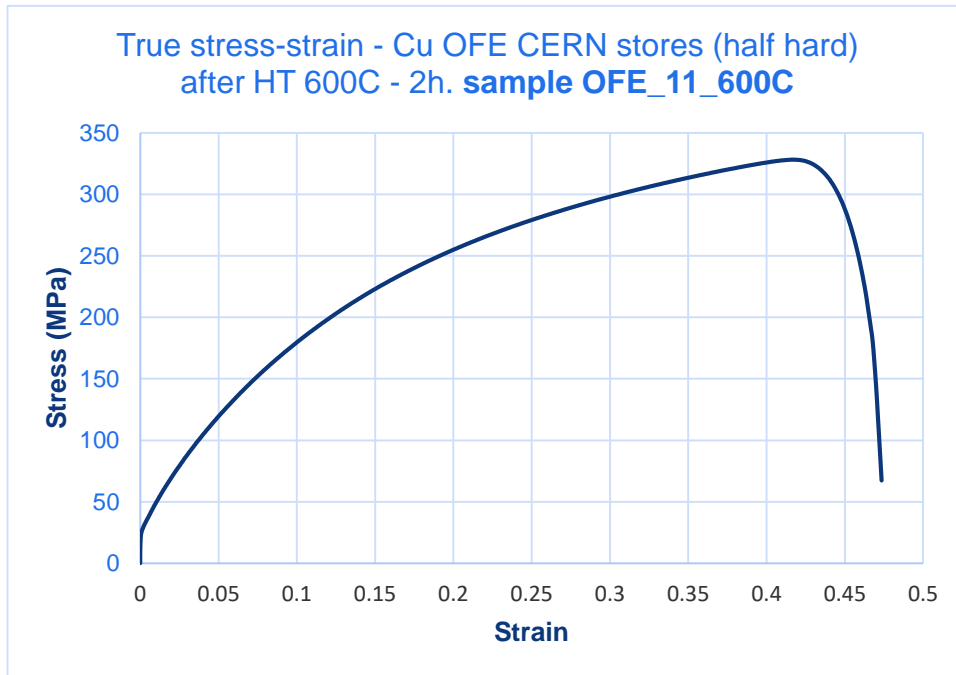
- C** Standard Earth Gravity: 9806.6 mm/s²
- A** Patm: 0.1 MPa
- B** Pressure cooling circuit: 0.6 MPa

Step 3



Cu OFE annealed properties

- Stress-strain curve



Obtained from tests at CERN

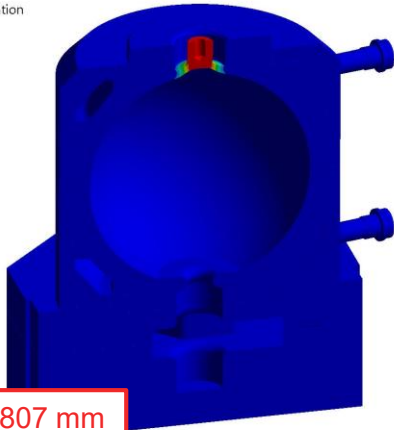
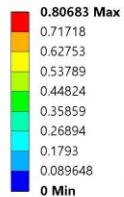
- OFE (UNS C10100) and OFS (UNS C10700) **3mm thick. sheet from CERN stores** (half-hard temper state)
- **Material certificates** available in EDMS 2436530.
- **Surfacing** RRR samples by machining (as per RF gaskets) + side cut by spark erosion
- **Mechanical engraving** of each sample individually (to avoid mixture)
- **Degreasing** before heat treatments (as per RF gaskets)
- Heat treatments in **MME brazing furnace** (as per RF gaskets), by F. Motschmann.
- **RRR measurements** by D. Richter (TE-MS), (**V and I contacts placed on the machined faces**)
- Sample sizes:
 - RRR: 1.9x1.9x122 mm
 - Tensile specimens: ASTM E8
 - Metallo: 25 x 20 x thickness mm

Case 1 (tuning up 0.8 mm): deformation

- Original design (Ø20mm, R0.5 mm)

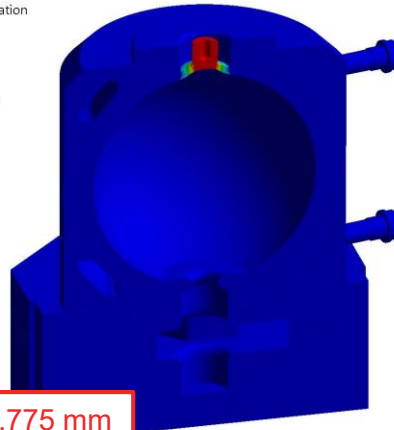
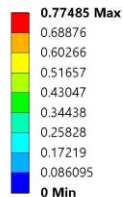
L: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-thread

Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
07/10/2022 10:40



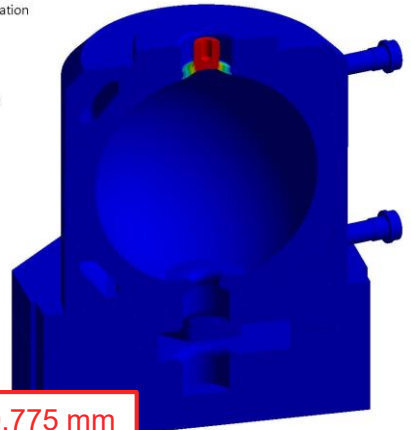
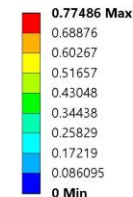
L: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-thread

Total Deformation 2
Type: Total Deformation
Unit: mm
Time: 2
07/10/2022 10:40



L: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-thread

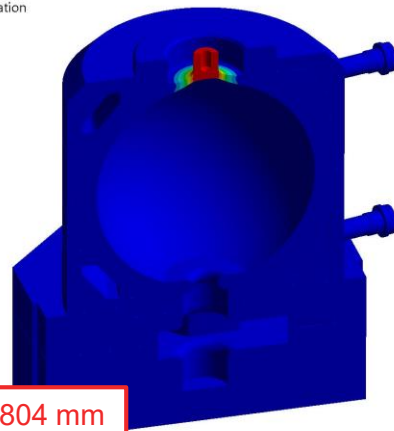
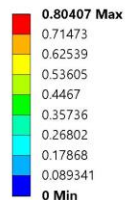
Total Deformation 3
Type: Total Deformation
Unit: mm
Time: 3
07/10/2022 10:40



- Modified design (Ø30mm, R2 mm)

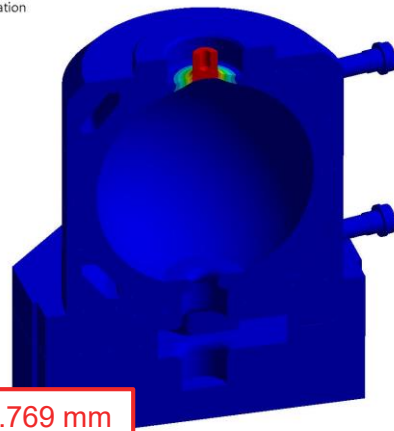
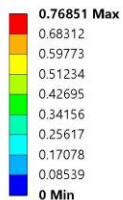
M: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-R+5mm-R2mm

Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
07/10/2022 10:53



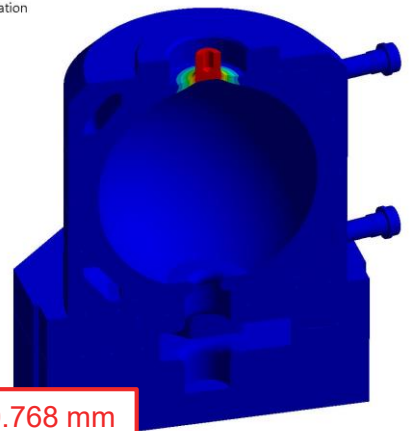
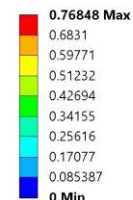
M: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-R+5mm-R2mm

Total Deformation 2
Type: Total Deformation
Unit: mm
Time: 2
07/10/2022 10:54



M: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-R+5mm-R2mm

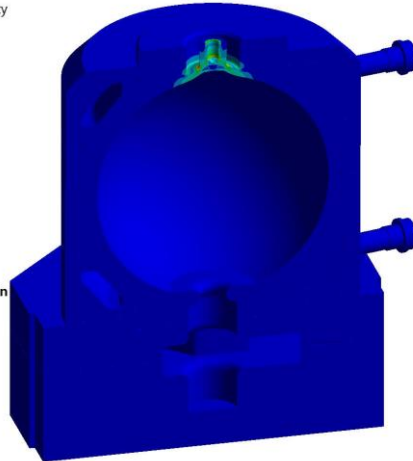
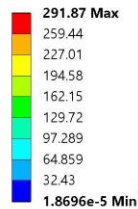
Total Deformation 3
Type: Total Deformation
Unit: mm
Time: 3
07/10/2022 10:54



Case 1 (tuning up 0.8 mm): stress & strain

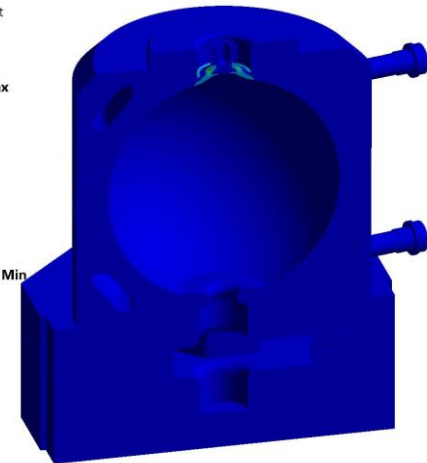
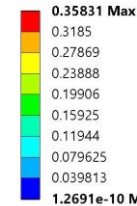
- Original design (Ø20mm, R0.5 mm)

L: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-thread
Stress Intensity
Type: Stress Intensity
Unit: MPa
Time: 1
07/10/2022 10:59



$\sigma_{\max} \approx 292 \text{ MPa}$

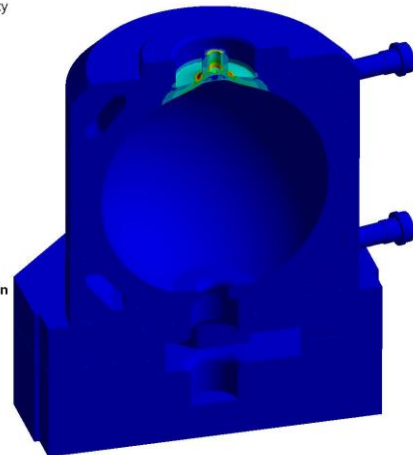
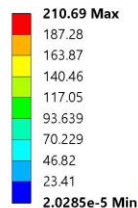
L: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-thread
Tresca Total strain
Expression: epttint
Time: 1
07/10/2022 10:41



$\epsilon_{\max} \approx 36 \%$

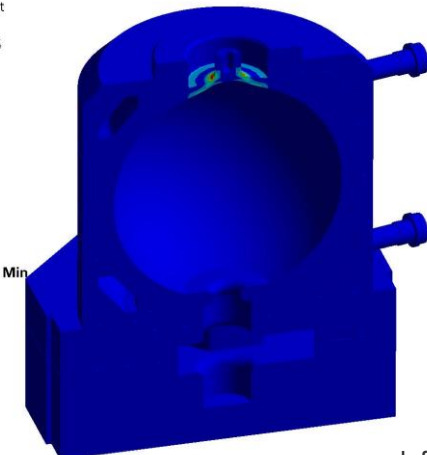
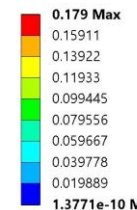
- Modified design (Ø30mm, R2 mm)

M: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-R+5mm-R2mm
Stress Intensity
Type: Stress Intensity
Unit: MPa
Time: 1
07/10/2022 10:59



$\sigma_{\max} \approx 211 \text{ MPa}$

M: Tuning+Vacuum+Water-ElastoPlastic-Displacement-0.8-R+5mm-R2mm
Tresca Total Strain
Expression: epttint
Time: 1
07/10/2022 10:55

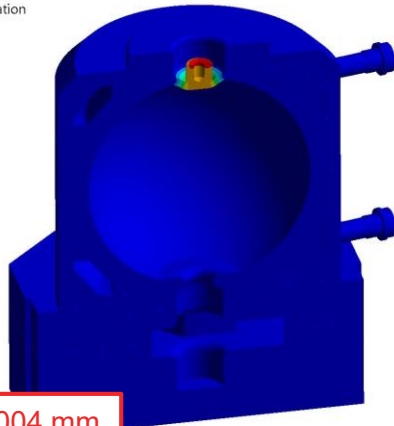
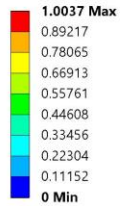


$\epsilon_{\max} \approx 18 \%$

Case 2 (tuning down 1 mm): deformation

- Original design ($\varnothing 20\text{mm}$, R0.5 mm)

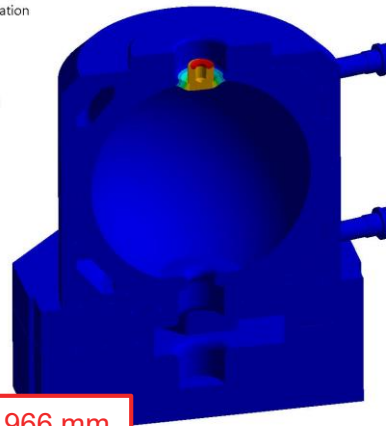
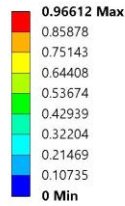
N: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1
Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
07/10/2022 11:31



Step 1

$\delta_{\max} \approx 1.004 \text{ mm}$

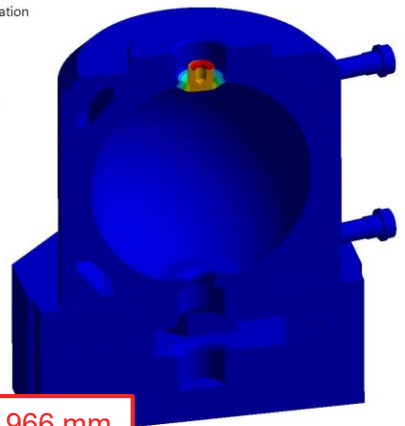
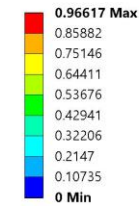
N: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1
Total Deformation 2
Type: Total Deformation
Unit: mm
Time: 2
07/10/2022 11:31



Step 2

$\delta_{\max} \approx 0.966 \text{ mm}$

N: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1
Total Deformation 3
Type: Total Deformation
Unit: mm
Time: 3
07/10/2022 11:31

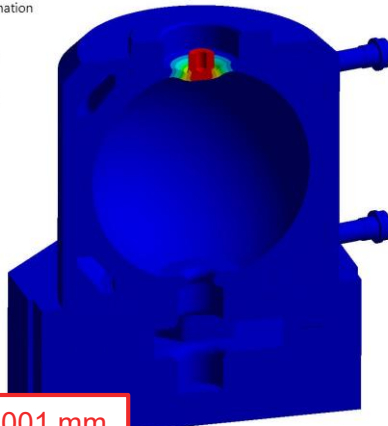
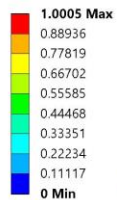


Step 3

$\delta_{\max} \approx 0.966 \text{ mm}$

- Modified design ($\varnothing 30\text{mm}$, R2 mm)

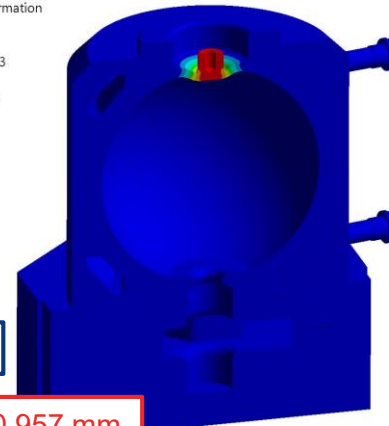
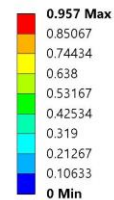
O: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1-R+5mm-R2mm
Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
07/10/2022 11:32



Step 1

$\delta_{\max} \approx 1.001 \text{ mm}$

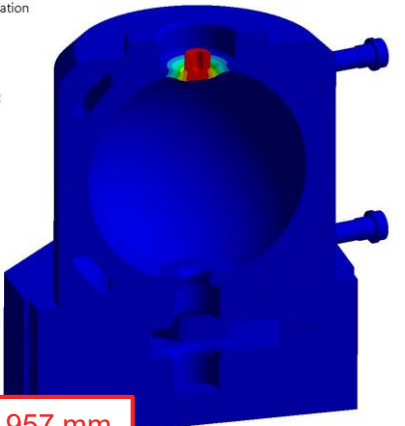
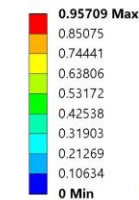
O: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1-R+5mm-R2mm
Total Deformation 2
Type: Total Deformation
Unit: mm
Time: 2
07/10/2022 11:33



Step 2

$\delta_{\max} \approx 0.957 \text{ mm}$

O: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1-R+5mm-R2mm
Total Deformation 3
Type: Total Deformation
Unit: mm
Time: 3
07/10/2022 11:33



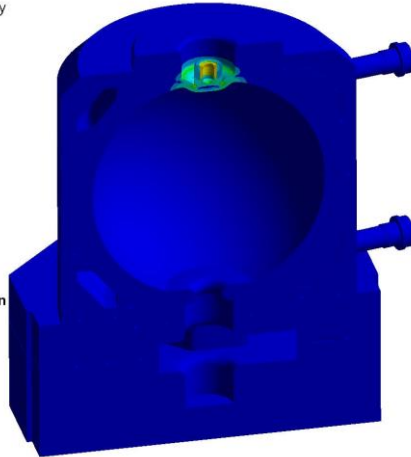
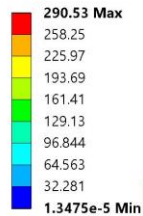
Step 3

$\delta_{\max} \approx 0.957 \text{ mm}$

Case 2 (tuning down 1 mm): stress & strain

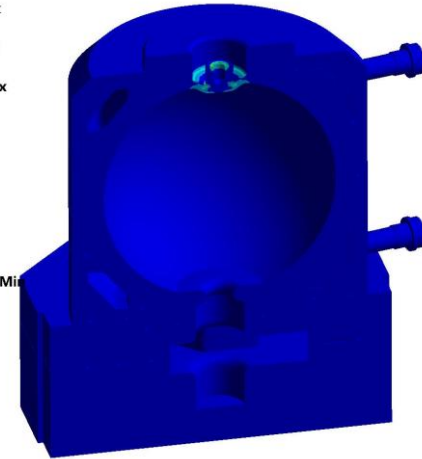
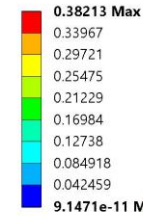
- Original design (Ø20mm, R0.5 mm)

N: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1
Stress Intensity
Type: Stress Intensity
Unit: MPa
Time: 1
07/10/2022 11:32



$\sigma_{\max} \approx 291 \text{ MPa}$

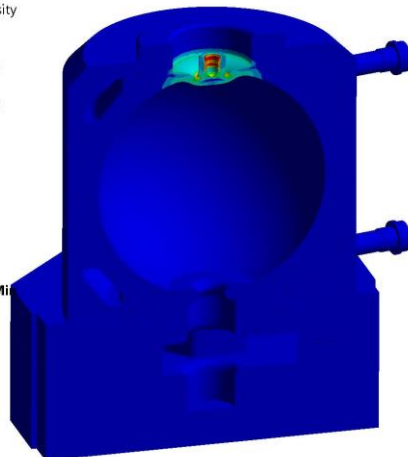
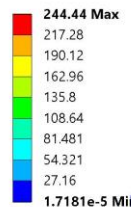
N: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1
Tresca Total strain
Expression: epttint
Time: 1
07/10/2022 11:32



$\epsilon_{\max} \approx 38 \%$

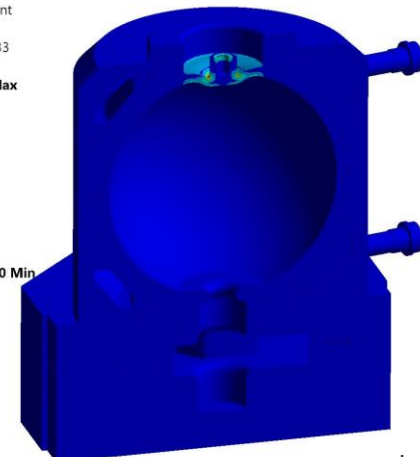
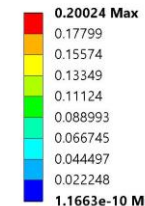
- Modified design (Ø30mm, R2 mm)

O: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1-R+5mm-R2mm
Stress Intensity
Type: Stress Intensity
Unit: MPa
Time: 1
07/10/2022 11:33



$\sigma_{\max} \approx 244 \text{ MPa}$

O: Tuning+Vacuum+Water-ElastoPlastic-Displacement+1-R+5mm-R2mm
Tresca Total Strain
Expression: epttint
Time: 1
07/10/2022 11:33



$\epsilon_{\max} \approx 20 \%$