HiLumi WP4 – Crab Cavities

Pre-tuner design – update

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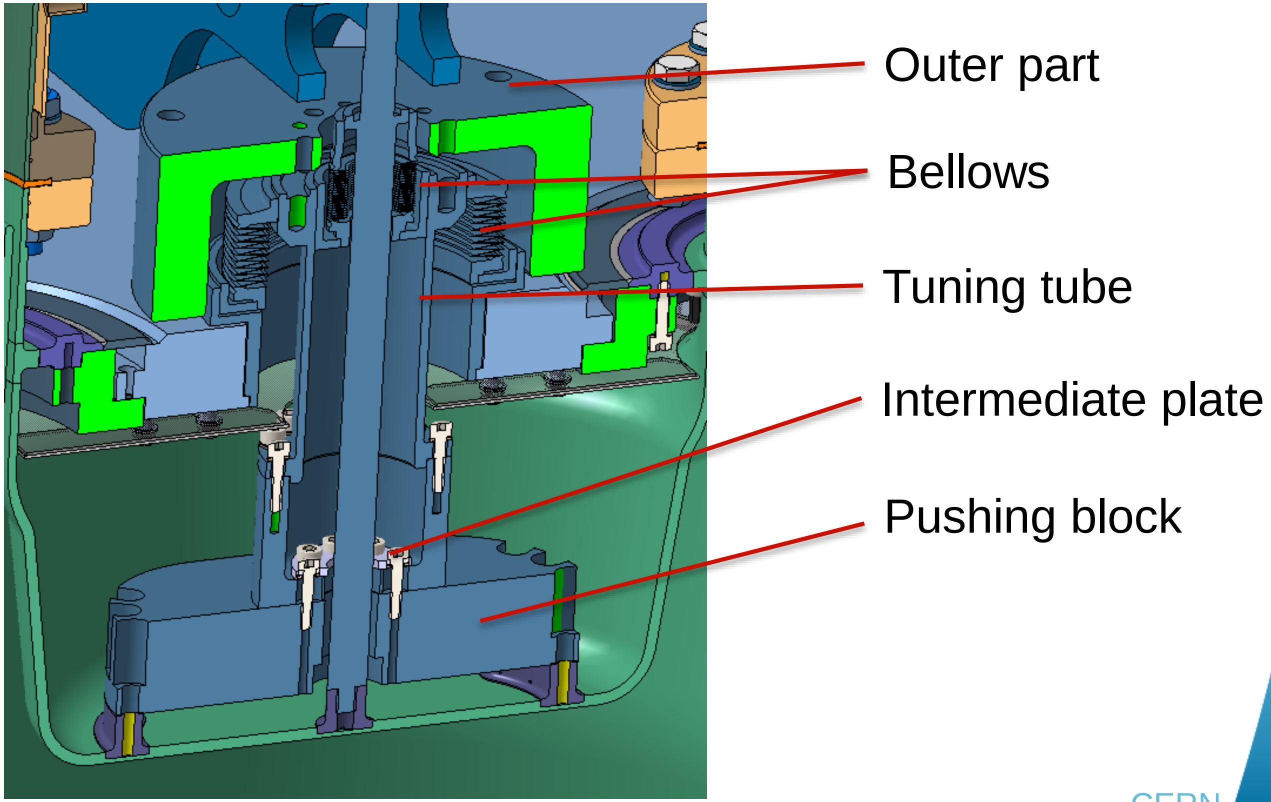
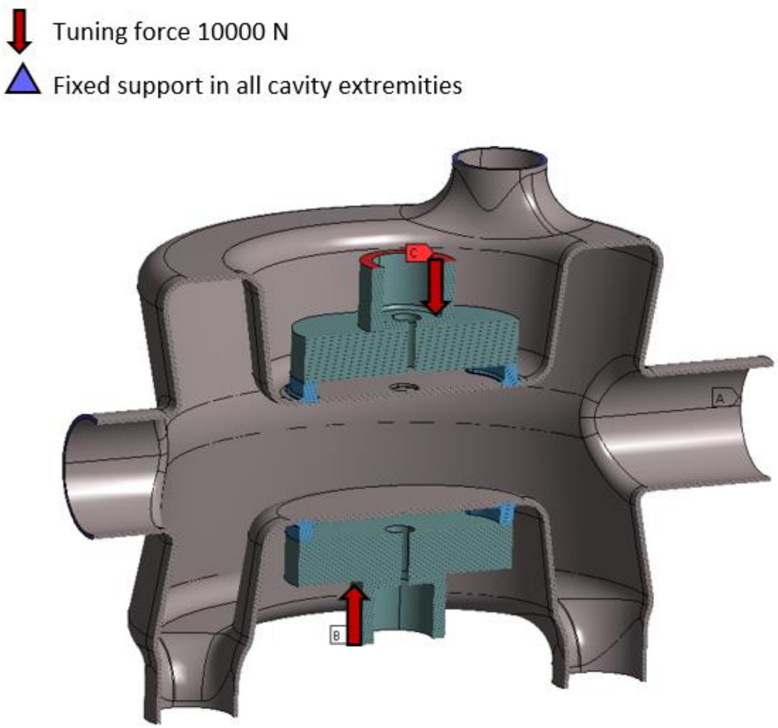
27.10.2016

Purpose

- Improvements of the pre-tuner design
- Approval of the new design
- Analysing separately the critical parts
- Elasto-plastic analysis of whole assembly

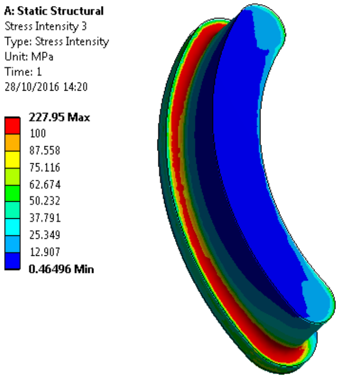


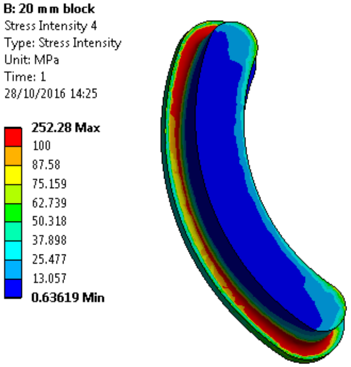
Pushing block

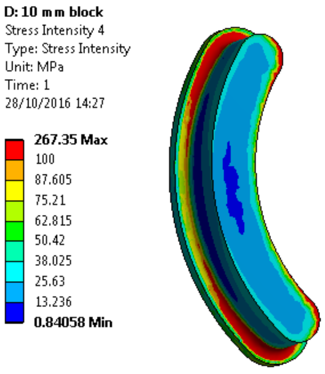


- Investigation of the stresses in bean shapes
- Decreasing pushing block thickness
- Elastic model (stresses values correct just for comparison purpose)

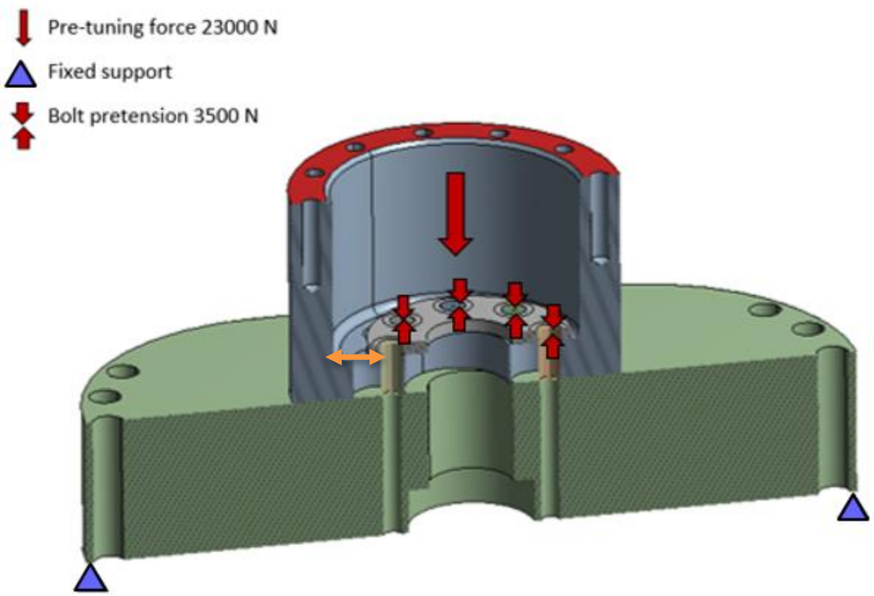
Thickness [mm]	Stress intensity in bean shape part [MPa]
33 (current)	228
20	252
10	267



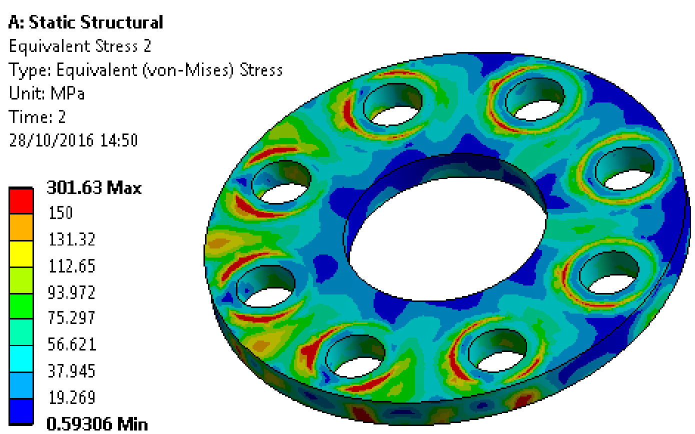


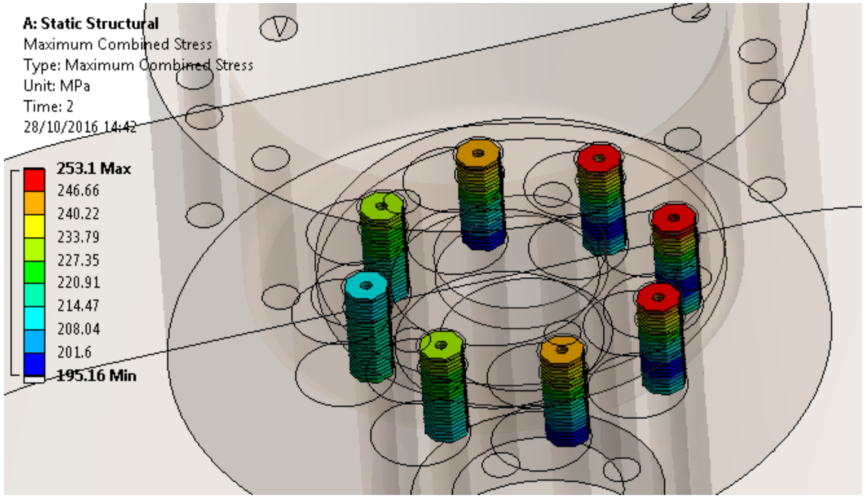


Intermediate plate

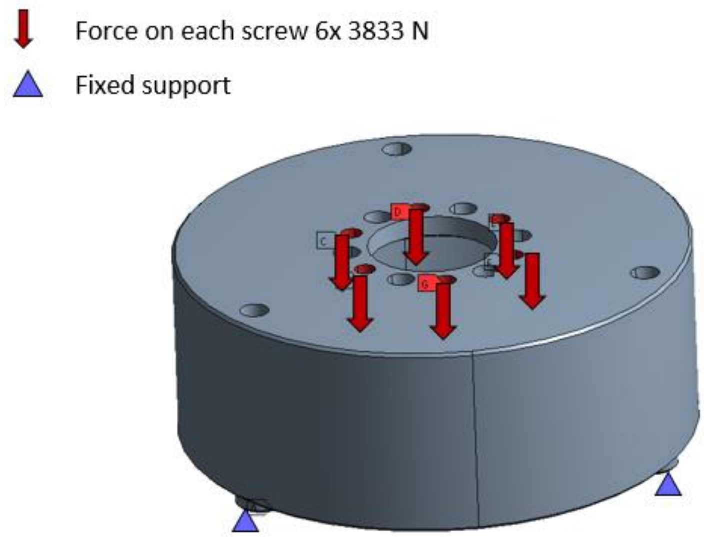


- Additional intermediate plate
- Allowing for 2 mm of offset in case of misalignment
- Check of the stresses in the intermediate plate and in the screws

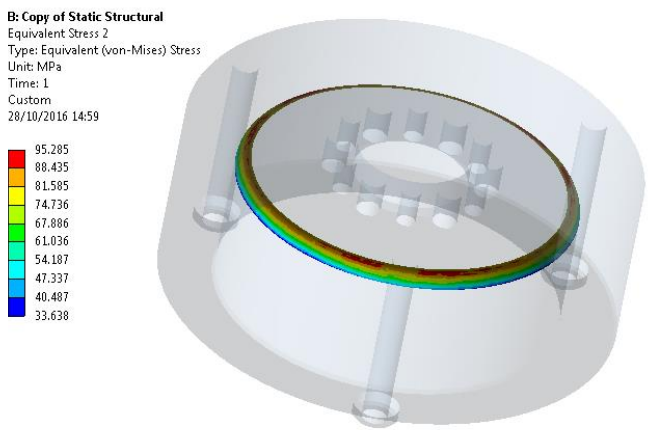




Outer part



- Possibility to increase tuning resolution by decreasing part thickness (to give more flexibility)
- Parametric model to compare stresses for different thickness cases



Thickness [mm]	Total Deformation Maximum [mm]	Equivalent Stress 2 Maximum [MPa]
12 (current)	0.11057	95.285
10	0.16319	128.41
8	0.27433	193.42
6	0.56577	329.35

- Screws connecting outer part with helium tank: 3x M8

Tension:

$$\sigma_z = \frac{F_s}{A_s}, \qquad F_s = 7666\ N$$

$$\sigma_z = 220\ MPa$$

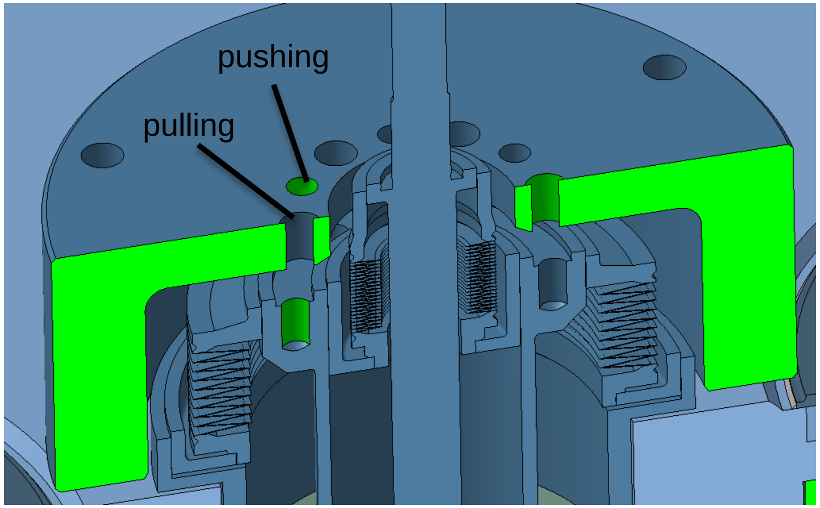
Bending stress:

$$\sigma_b = \frac{M \cdot \frac{d_1}{2}}{I_x}, \qquad \mathrm{M} = 3678\ \mathrm{Nmm}$$

$$\sigma_b = 127\ MPa$$

Applying tuning force

- 6 screws for pushing
- 6 screws for pulling
- Maximum tuning force: 23kN (3833 N per screw)



M6 screw:

$d_1 = 4.917\ mm$

$d_2 = 5.350$ mm

$p = 1\ mm$

Tension:

$$\sigma_z = \frac{F_s}{A_s}$$

$$\sigma_z = 202\ MPa$$

Torsional stress:

$$\tau = \frac{F_v \cdot d_2 \cdot \tan(\varphi^\circ + \rho^\circ)}{2 \cdot W_p}$$

$\mathrm{K} = \tan(\varphi + \rho) = 0.577$

$$\tau = \frac{F_v \cdot d_2 \cdot \mathrm{K}}{2 \cdot W_p} = 253.261\ MPa$$

Combined stress:

$$\sigma_V = \sqrt{\sigma_z^2 + 3 \cdot \tau^2} = \mathbf{482.6\ MPa}$$

M8 screw:

$d_1 = 6.647\ mm$

$d_2 = 7.188$ mm

$p = 1.25\ mm$

Tension:

$$\sigma_z = \frac{F_s}{A_s}$$

$$\sigma_z = 110\ MPa$$

Torsional stress:

$$\tau = \frac{F_v \cdot d_2 \cdot \tan(\varphi^\circ + \rho^\circ)}{2 \cdot W_p}$$

$\mathrm{K} = \tan(\varphi + \rho) = 0.571$

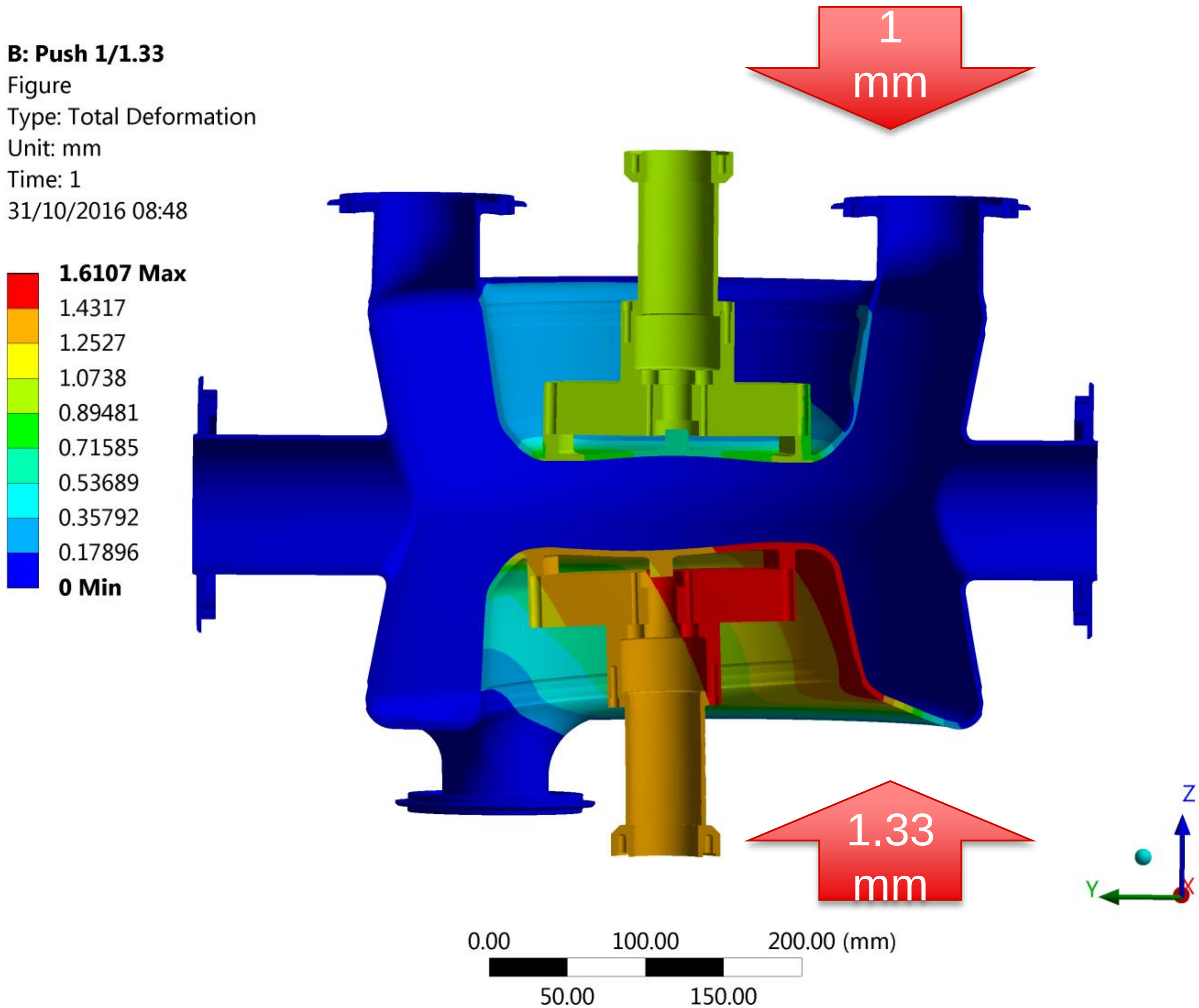
$$\tau = \frac{F_v \cdot d_2 \cdot \mathrm{K}}{2 \cdot W_p} = 136\ MPa$$

Combined stress:

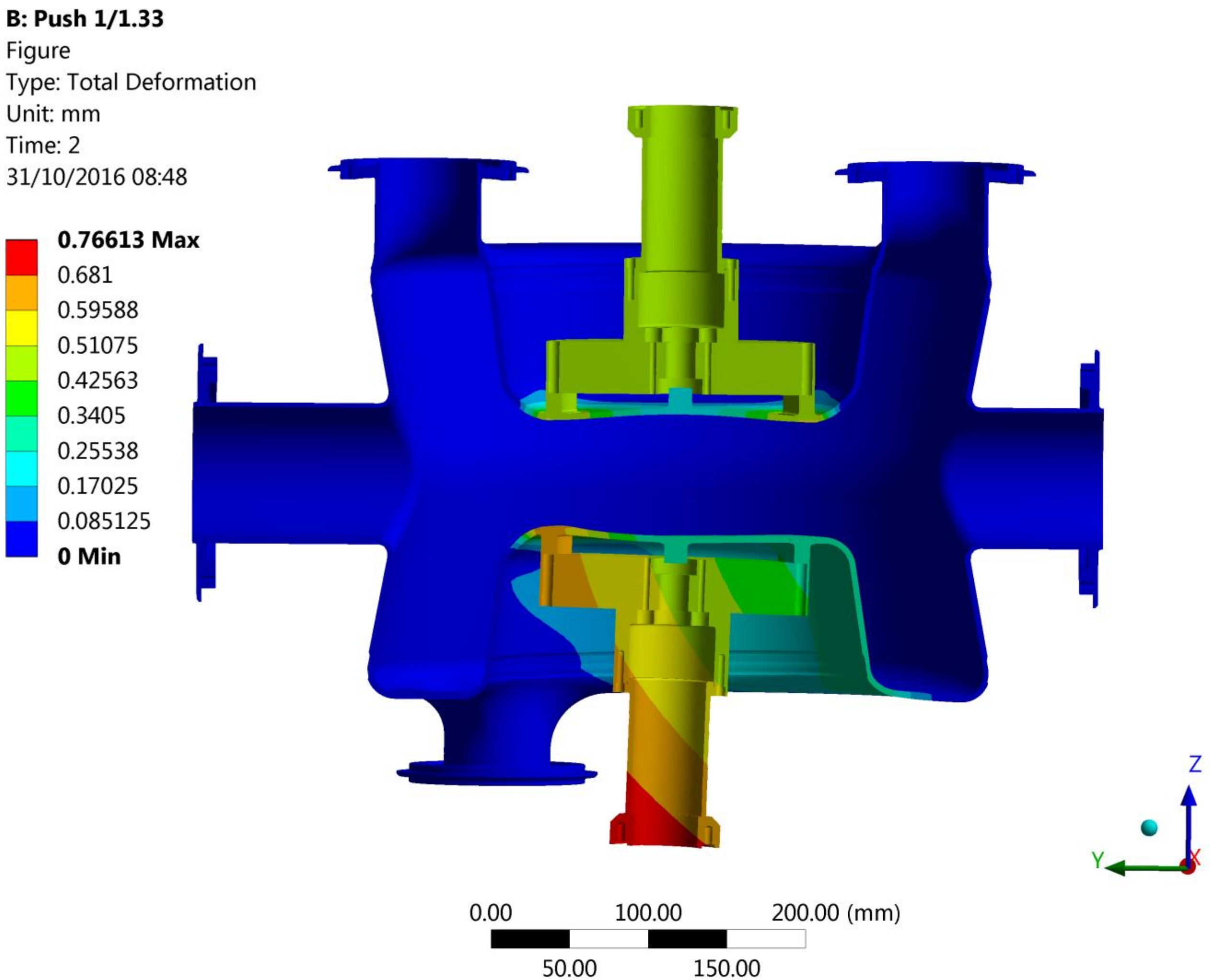
$$\sigma_V = \sqrt{\sigma_z^2 + 3 \cdot \tau^2} = \mathbf{261\ MPa}$$

Bigger safety factor

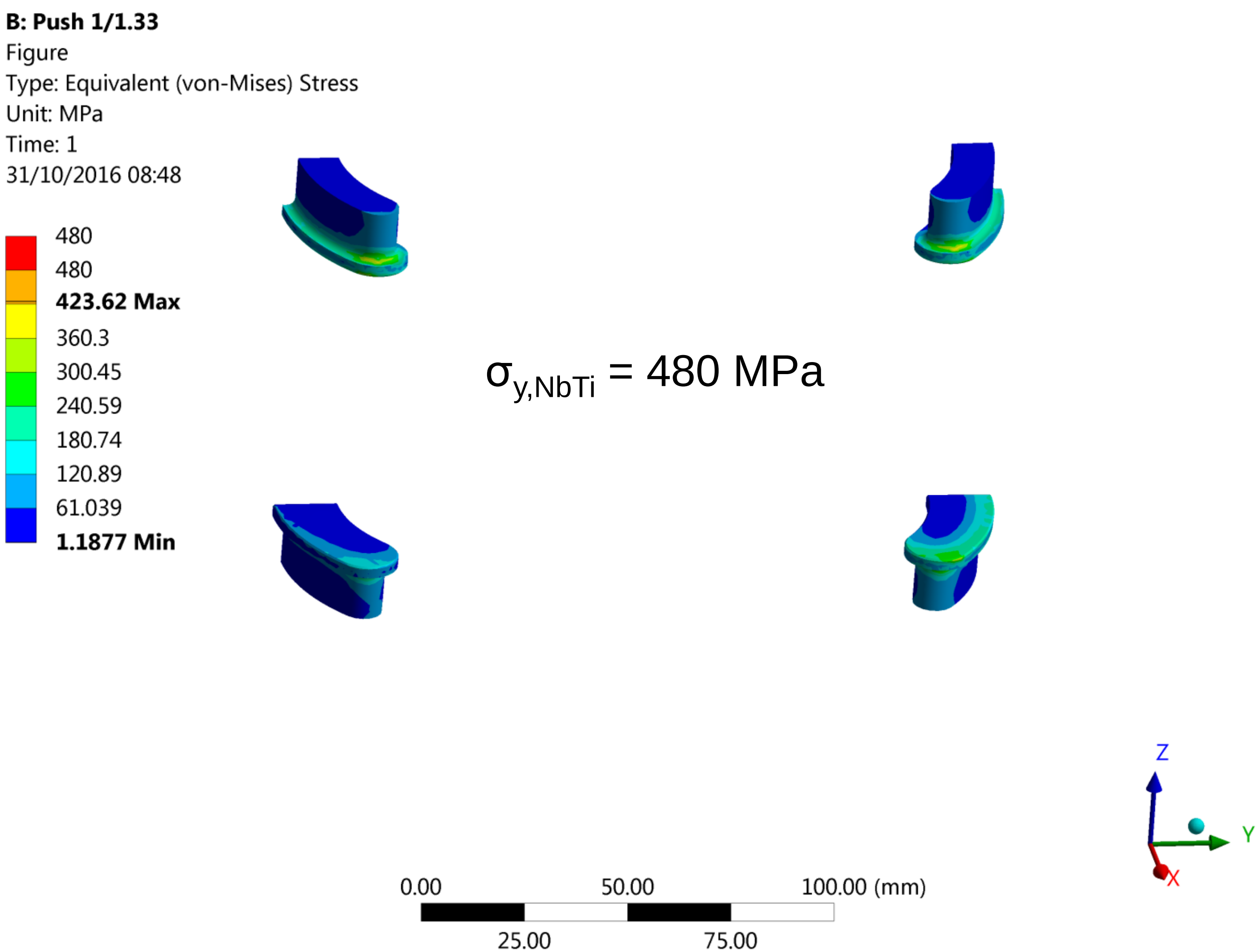
Elasto-plastic load: applied deformation



Elasto-plastic load: residual deformation



Elasto-plastic load: critical stress



$\sigma_{y,NbTi}$ = 480 MPa

Conclusions

- Elasto-plastic model approves pre-tuner improved design.
- Reducing pushing block thickness do not decrease stresses in the beam shapes, thick pre-tuner block was chosen.
- Improved design with intermediate plate allowing for assembly offset was approved.
- M8 screws guarantee bigger safety factor when applying the tuning force.
- To increase resolution, outer part connecting pre-tuner with helium tank could be more flexible.
- Francois Morel prepares 3D models and 2D drawings **ST0805441_01**

Thank you for your attention!