RFD cavity stress assessment and tuning

Cavity of 5 mm thickness

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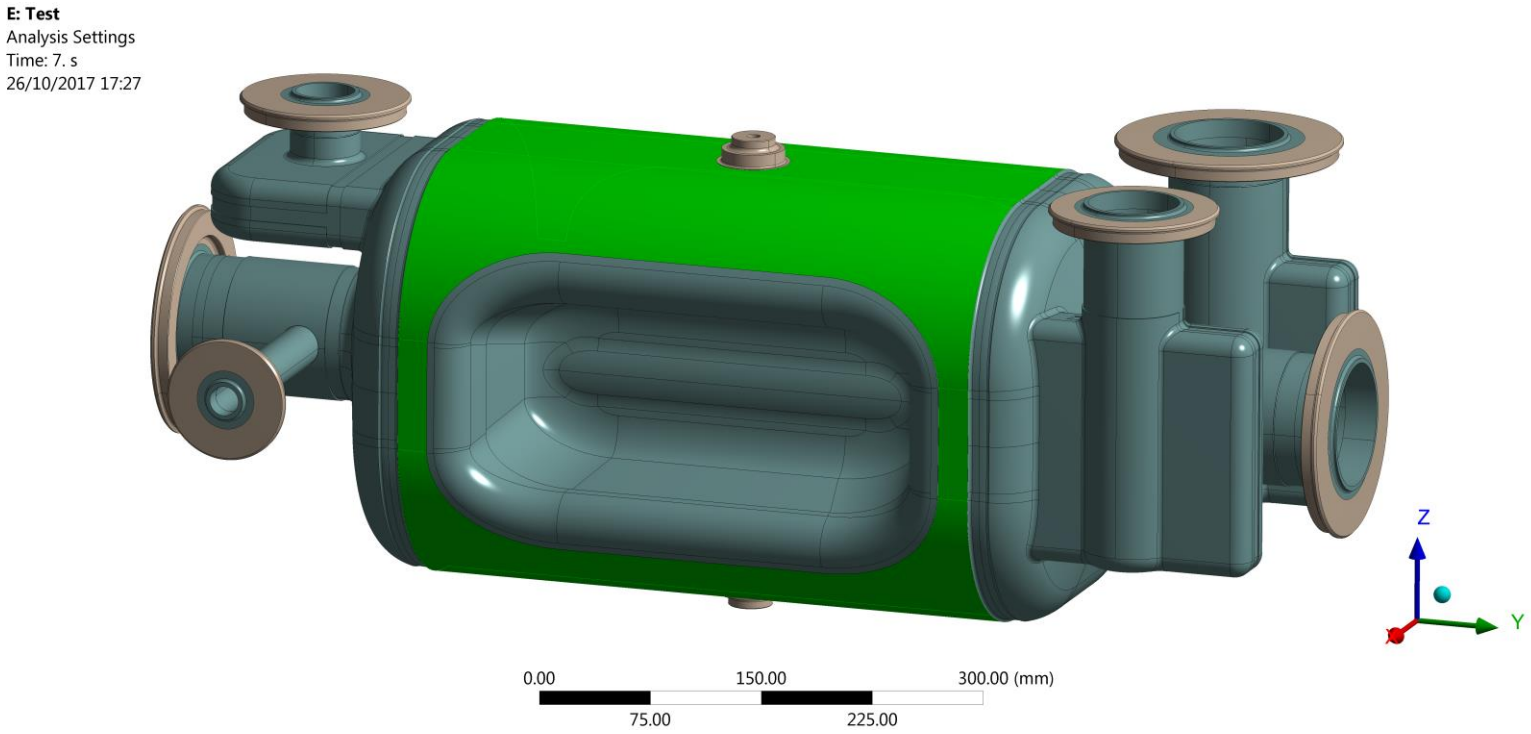
17/11/2017

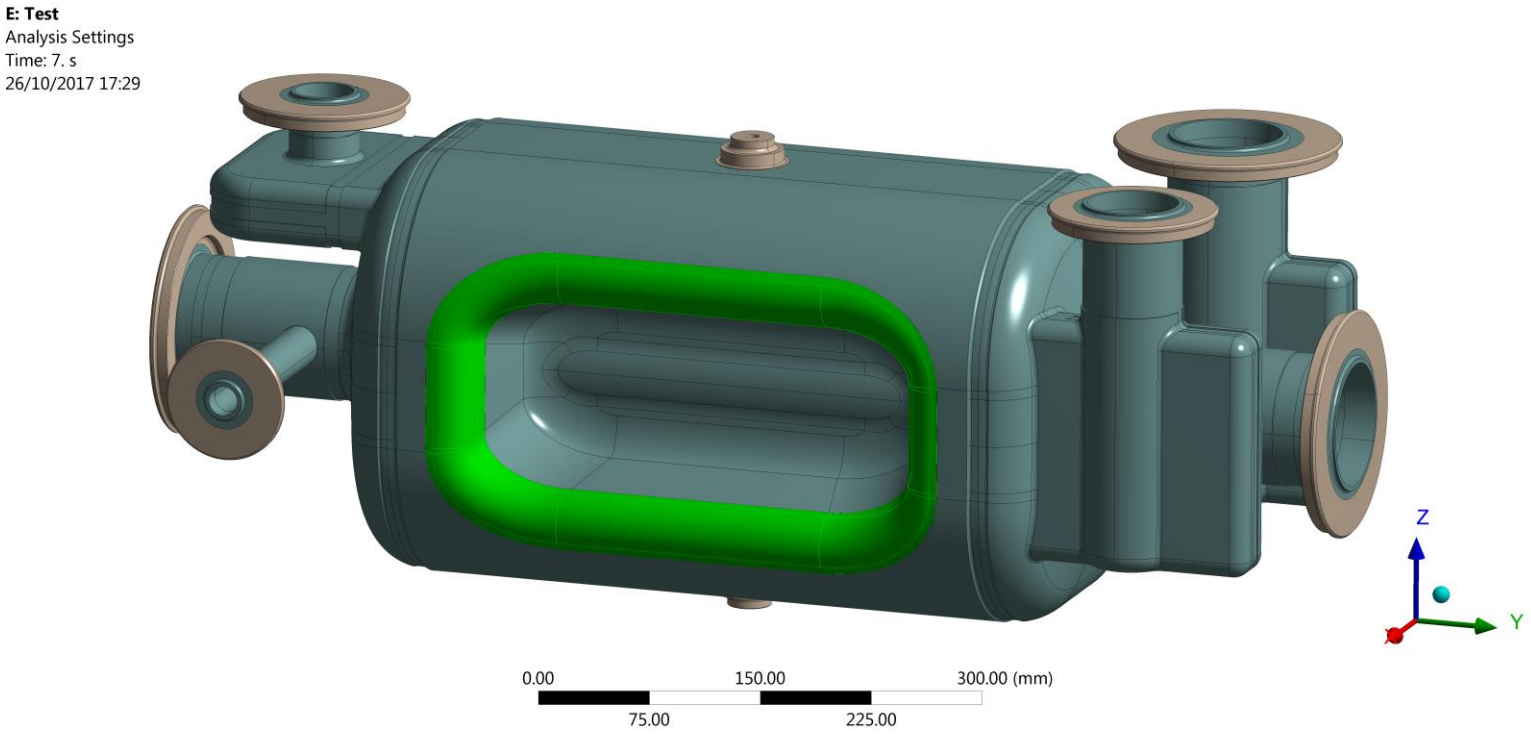
RFD stress intensity of a cavity of 5 mm thickness

The thickness of the cavity main body (green) has been increased to 5 mm.



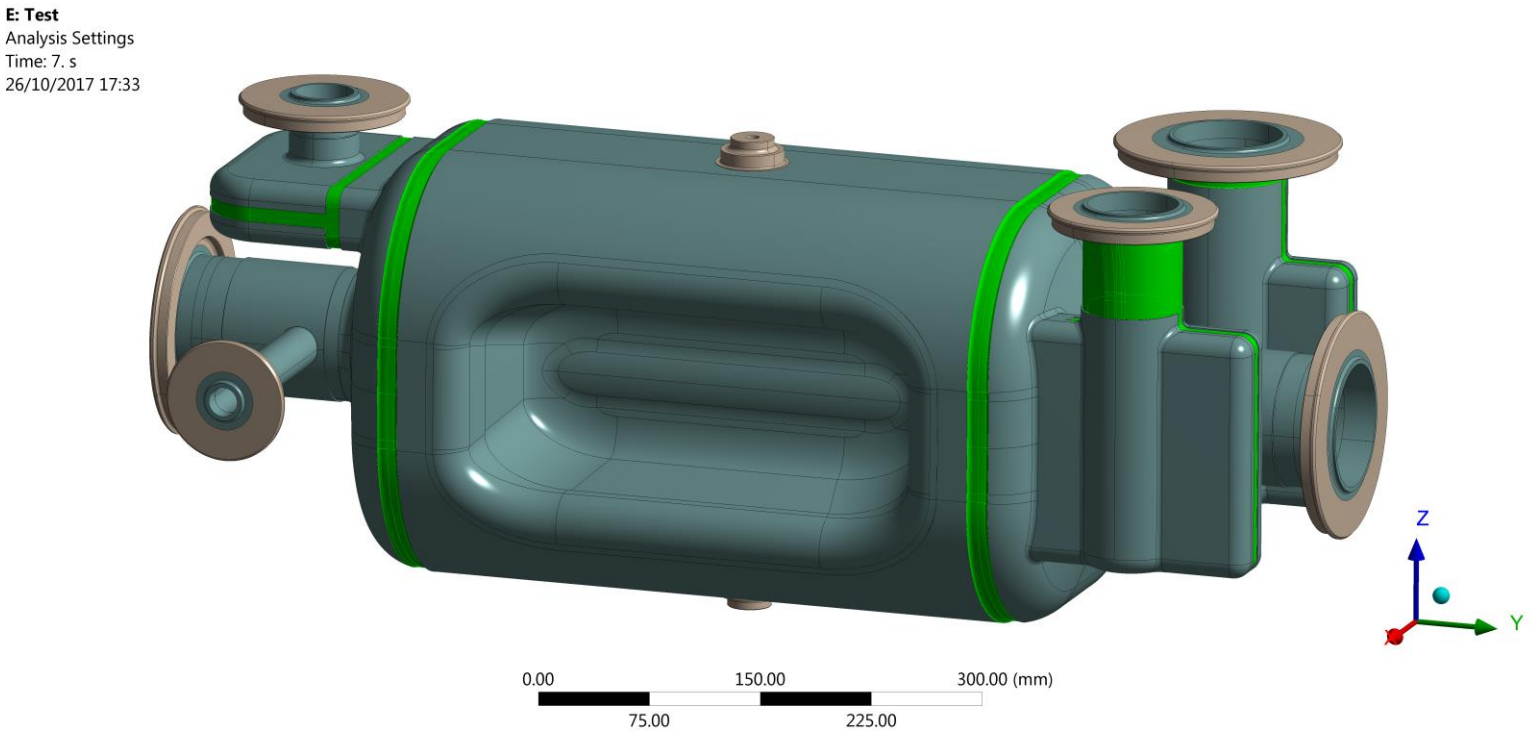
RFD stress intensity of a cavity of 5 mm thickness

The thickness of the cavity main body has been increased to 5 mm.
The curved region is 6.35 mm thick.



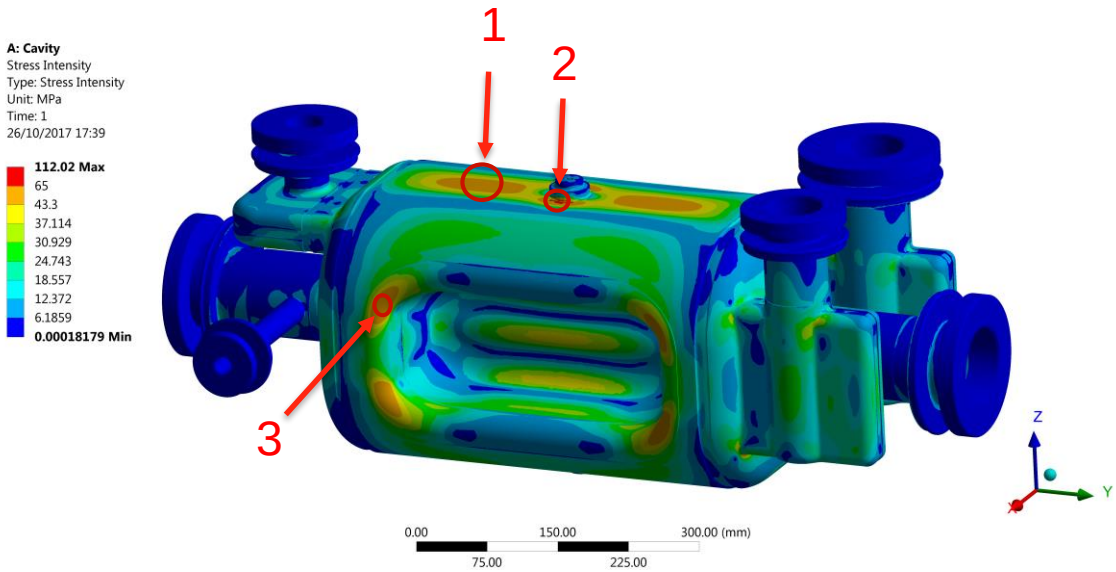
RFD stress intensity of a cavity of 5 mm thickness

The thickness of the cavity main body has been increased to 5 mm.
The curved region is 6.35 mm thick.
Transitions of 3 mm thickness.



5 mm cavity

- Tresca equivalent stress - High stress intensity regions



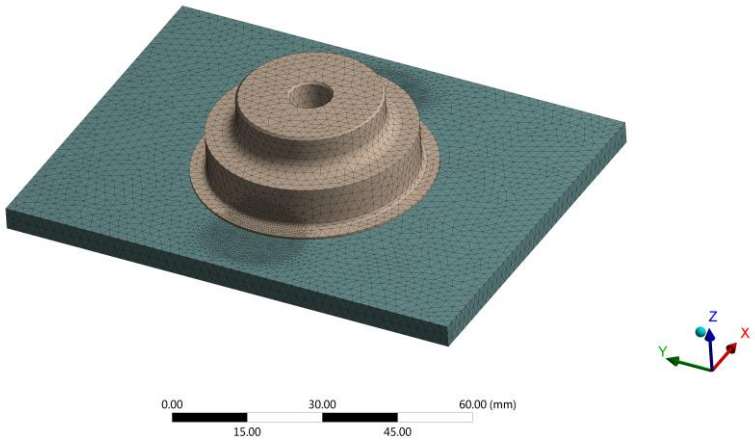
	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
1	7.5	50.9
2	15.7	69
3	34.1	60.8
Limit	43.3	65

The tuner regions still present high stresses → Submodel
All the other regions are below the limits

Submodel

Mesh of 2 mm in the tuner region and 0.5 mm in the critical regions

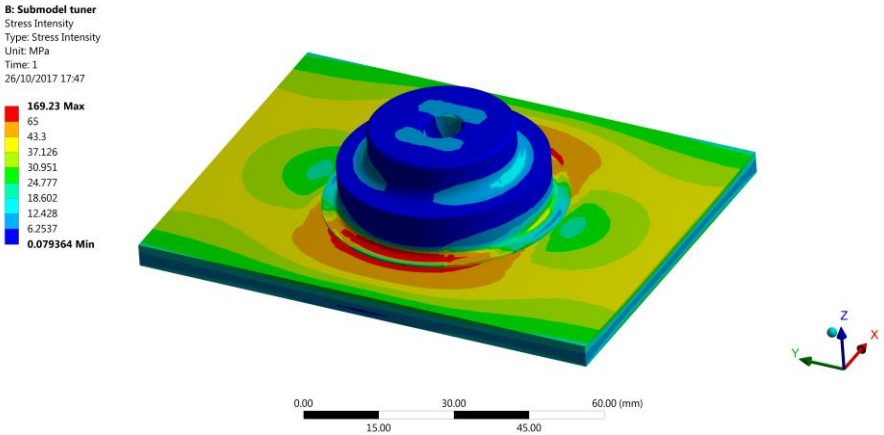
Without weld



Submodel

Mesh of 2 mm in the tuner region and 0.5 mm in the critical regions

Without weld

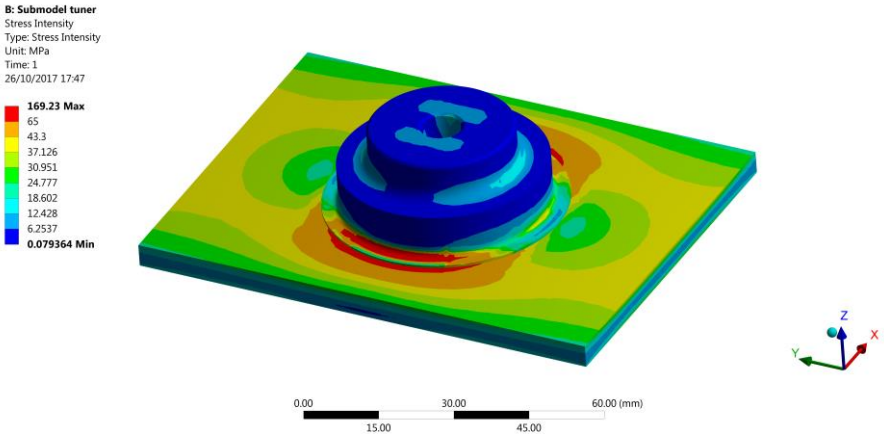


	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
	12.3	65.4
Limit	43.3	65

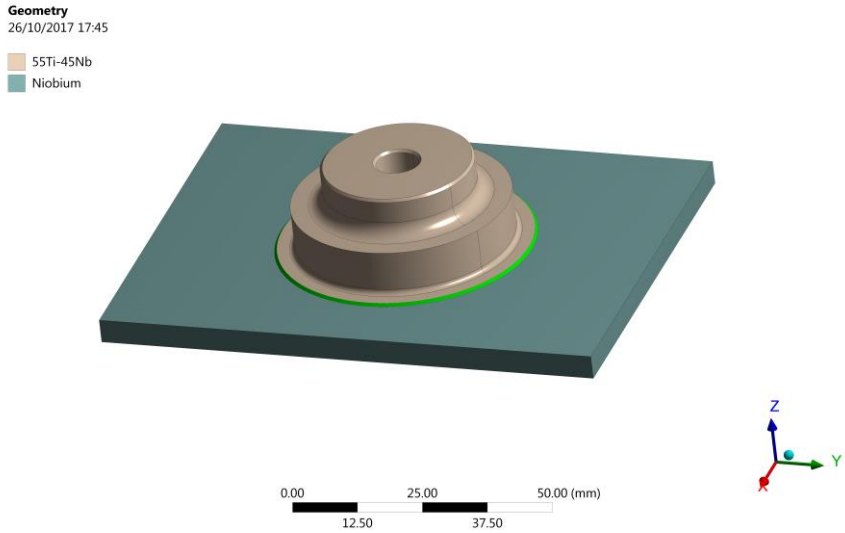
The linearized stress close to the tuner decreases but it is still above the limits

Submodel

Without weld



Welded

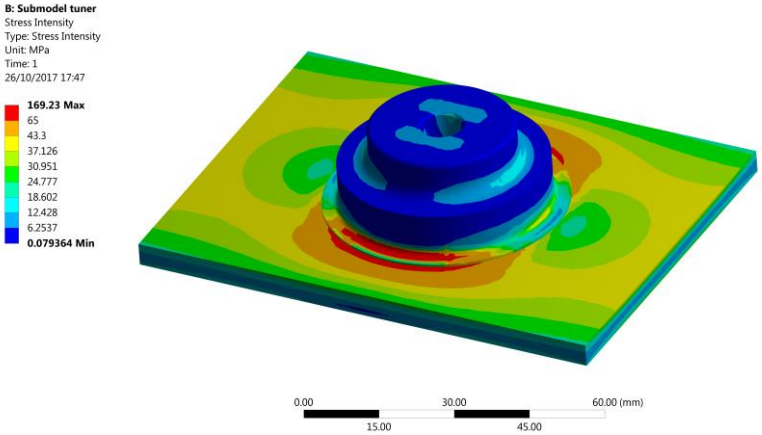


	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
	12.3	65.4
Limit	43.3	65

Generation of a volume around the tuner emulating the presence of the weld

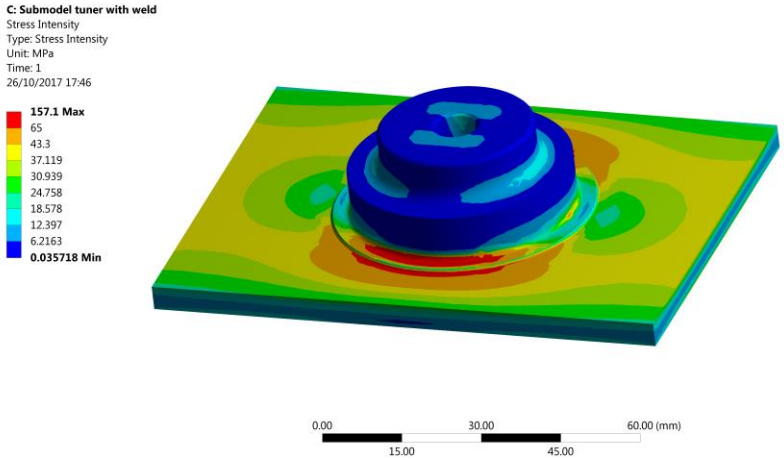
Submodel

Without weld



	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
	12.3	65.4
Limit	43.3	65

Welded

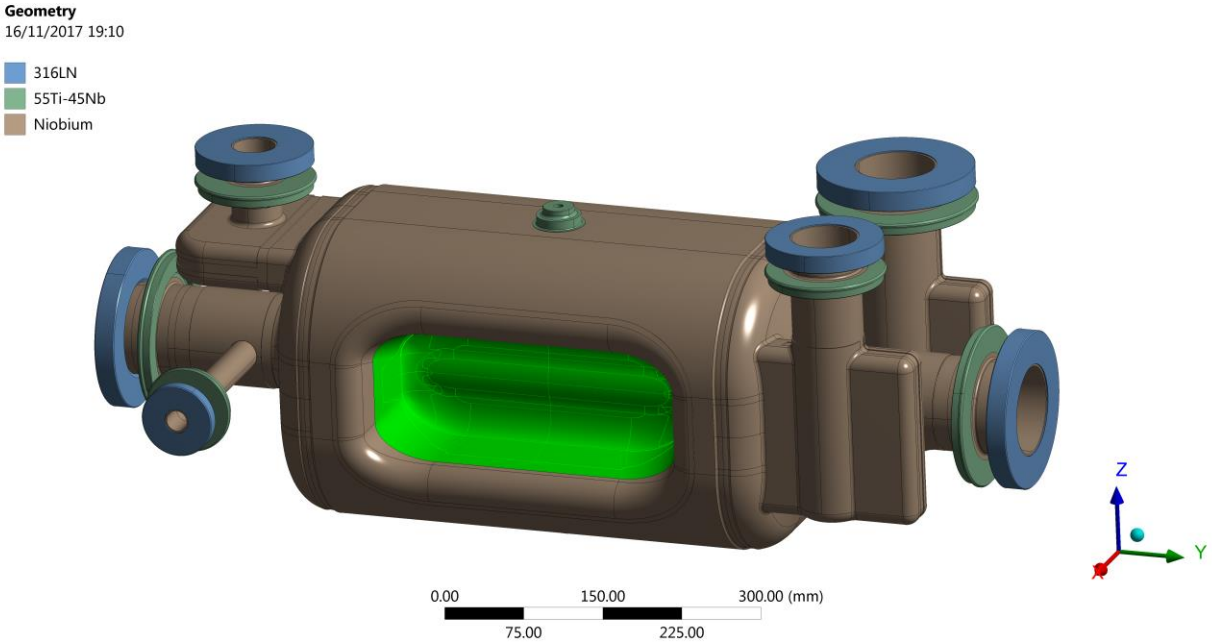


	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
	10.4	60.1
Limit	43.3	65

Using this approach the linearized stress is now below the limits. Special care has to be taken when modeling the tuner region

5 mm cavity – realistic thickness distribution in the bowl

- Thickness reduction in specific regions of the bowl during forming



5 mm cavity – realistic thickness distribution in the bowl

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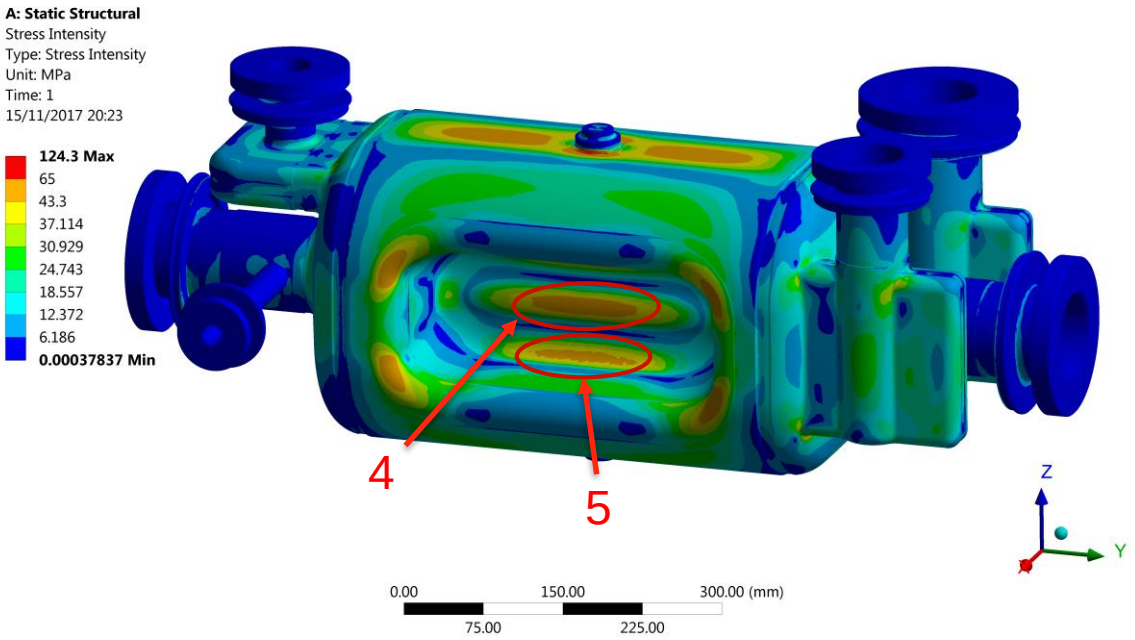


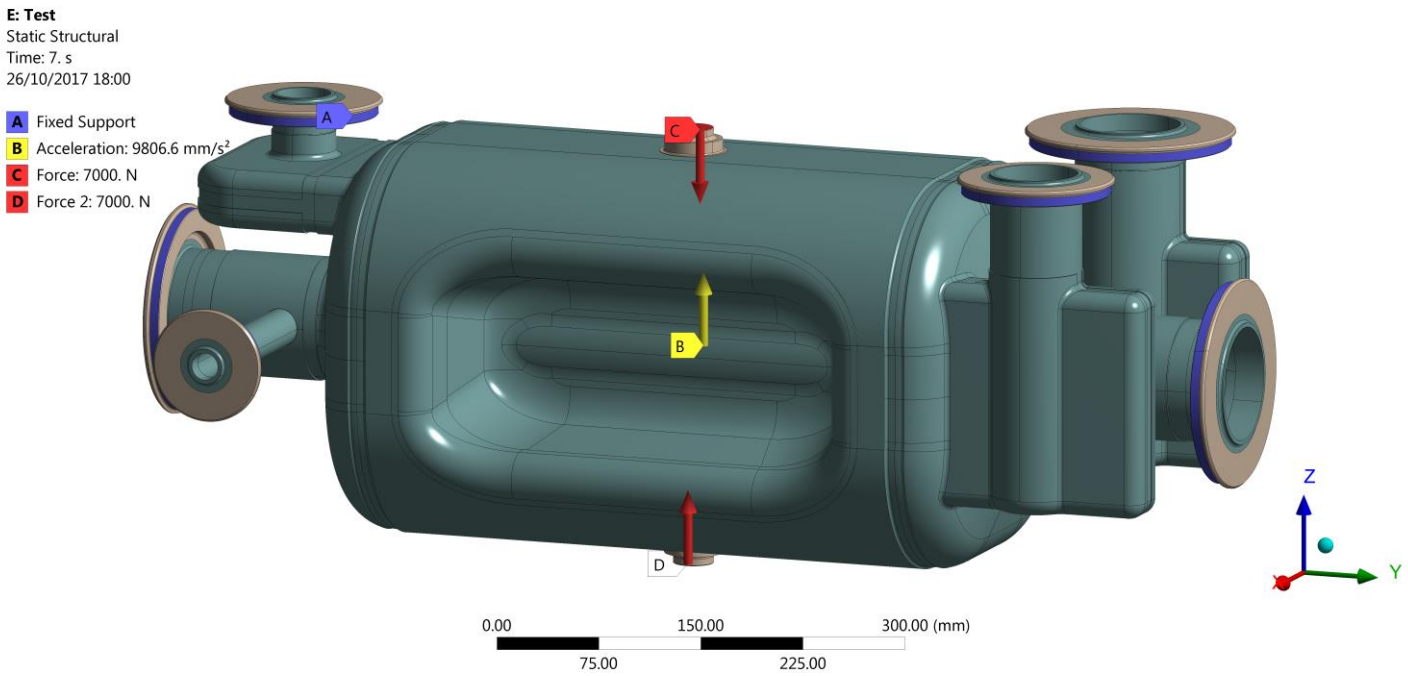
	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
4	5.6	49.1
5	7	45
Limit	43.3	65

Special care to be taken in the bowl central region
Nevertheless, the reduction of the bowl thickness during forming takes place in the corners

Tuning deformation

- Comparison of the 5 mm cavity and the 4 mm cavity with stiffeners

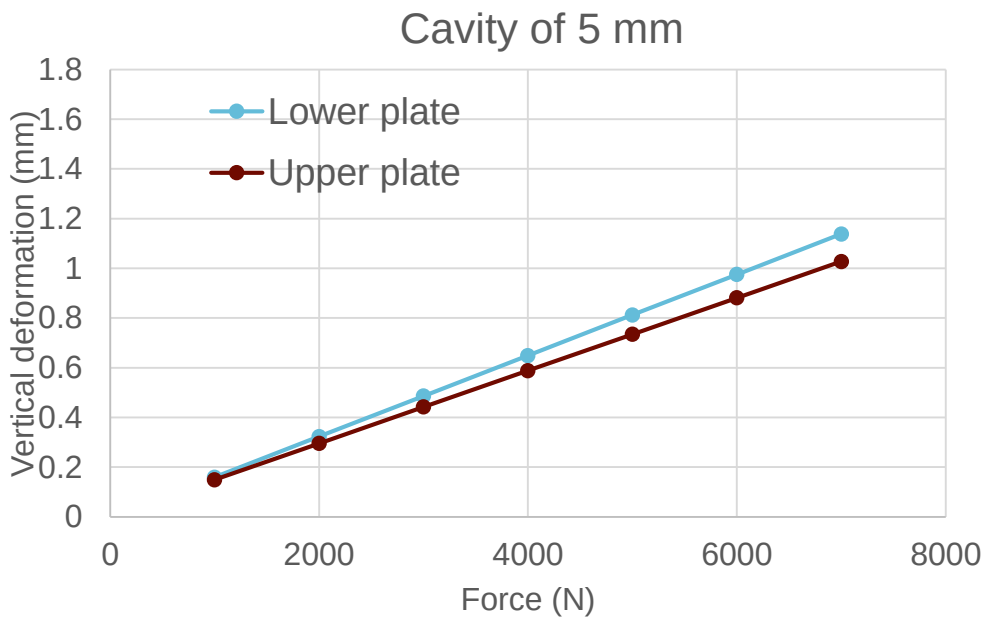
Vertical force applied to the tuner surfaces



Vertical deformation between plates

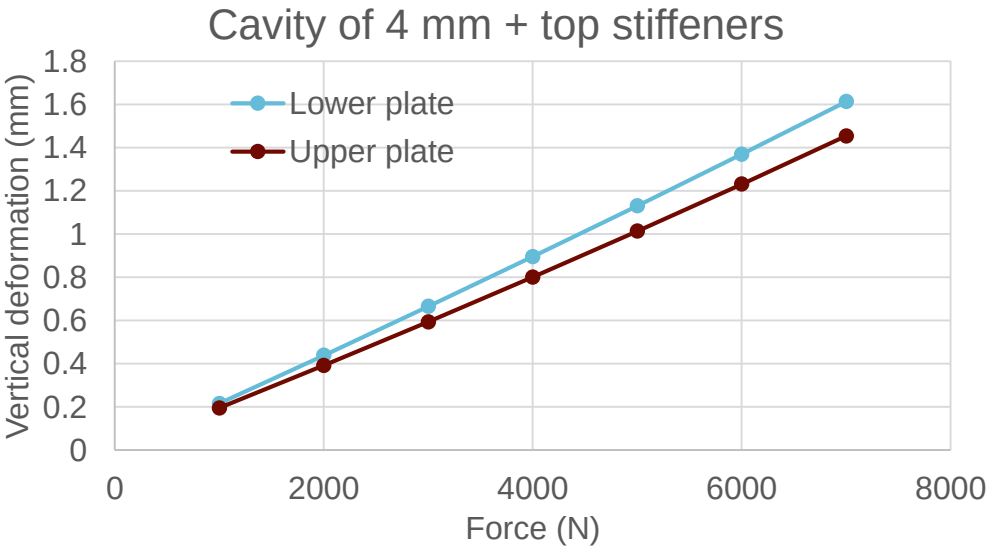
5 mm cavity

3232 N/mm
(between plates)



4 mm cavity + stiffeners

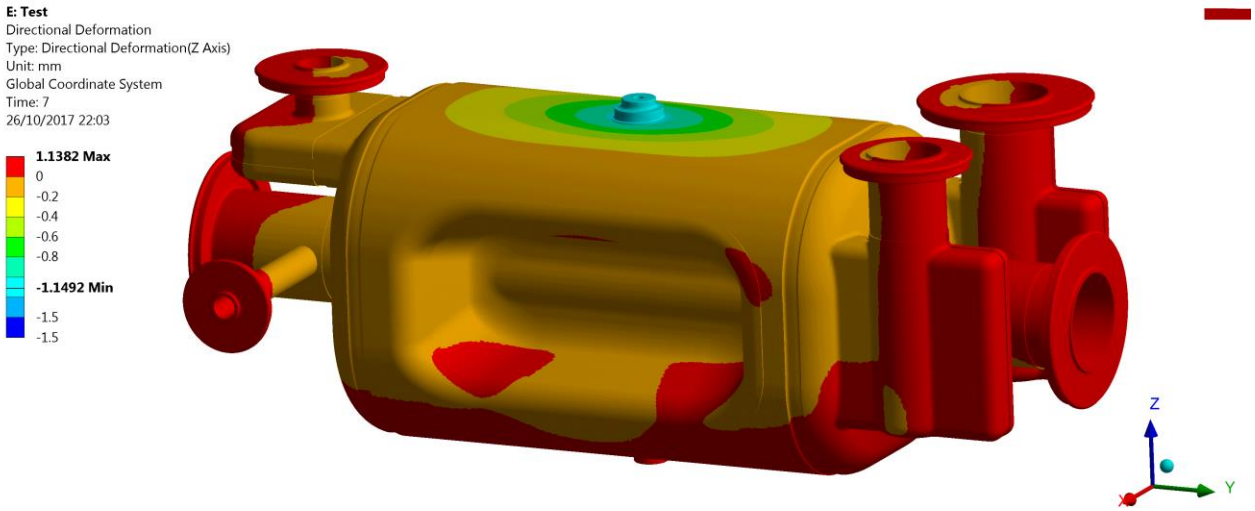
avg. 2358 N/mm
(between plates)



Vertical deformation 7 kN load

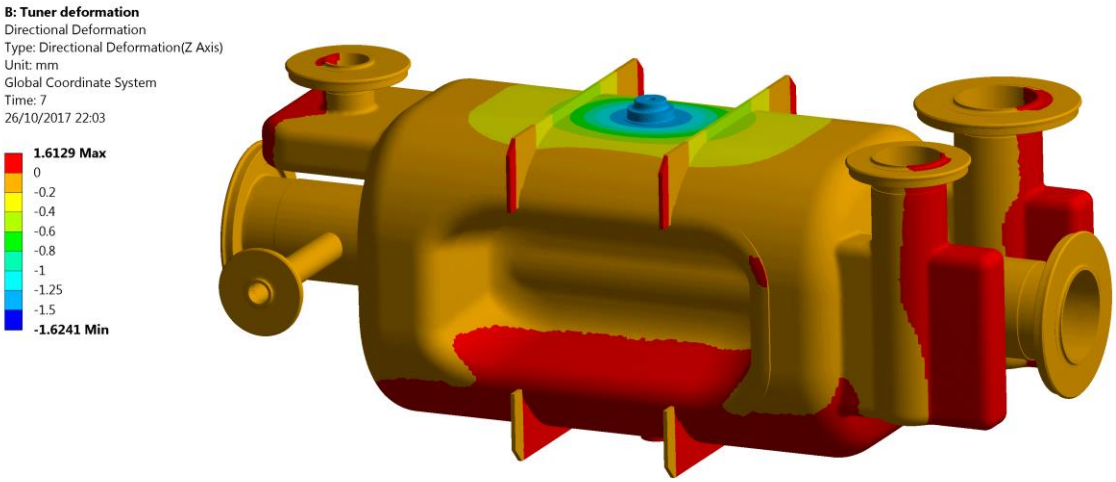
5 mm cavity

Large deformation covering a larger area



4 mm cavity + stiffeners

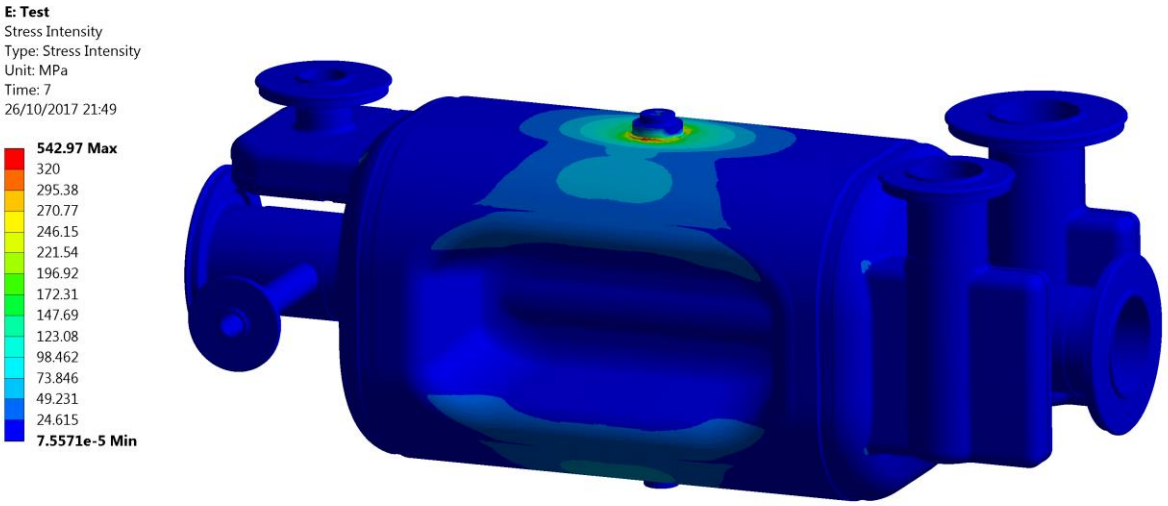
Large deformation concentrated between the stiffeners



Stress distribution 7 kN load

5 mm cavity

Large stress covering a larger area



4 mm cavity + stiffeners

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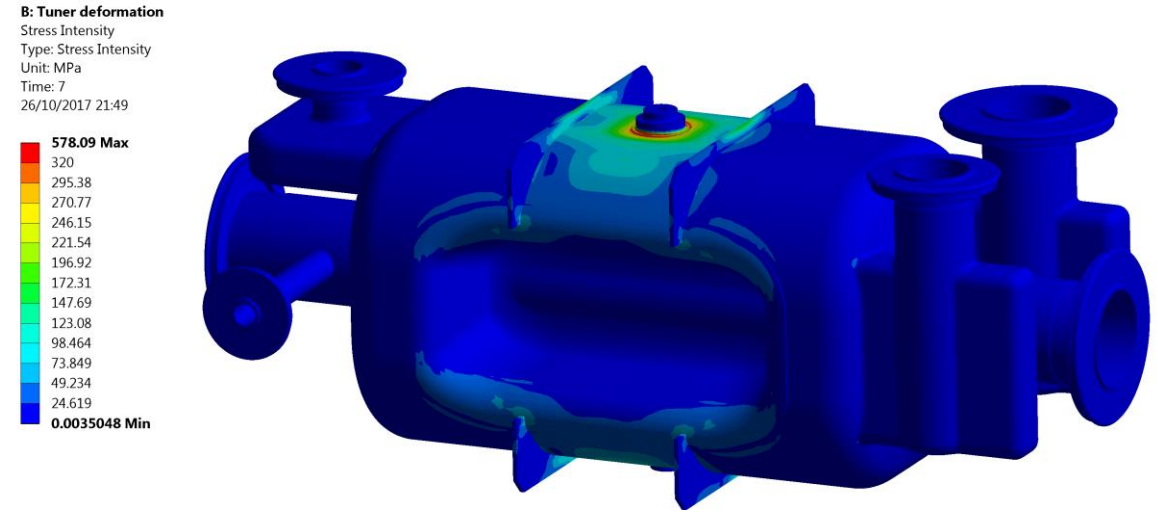

Design conclusions

- The stress of the 5 mm cavity is below the limits. Nevertheless, special attention has to be still paid to the tuner region.
- The force needed to deform the 5 mm cavity top and bottom plates for tuning is 3232 N/mm, larger than the force needed to deform the cavity of 4 mm + stiffeners.
- When applying the tuning force, the deformation and stress are more evenly distributed along the top and bottom plates of the 5 mm cavity.

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