DFX – Meeting 37

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06 December 2019

DFX vertical section – Essential topics drawn from actions list (02-12-2019)

Action list for SOTON

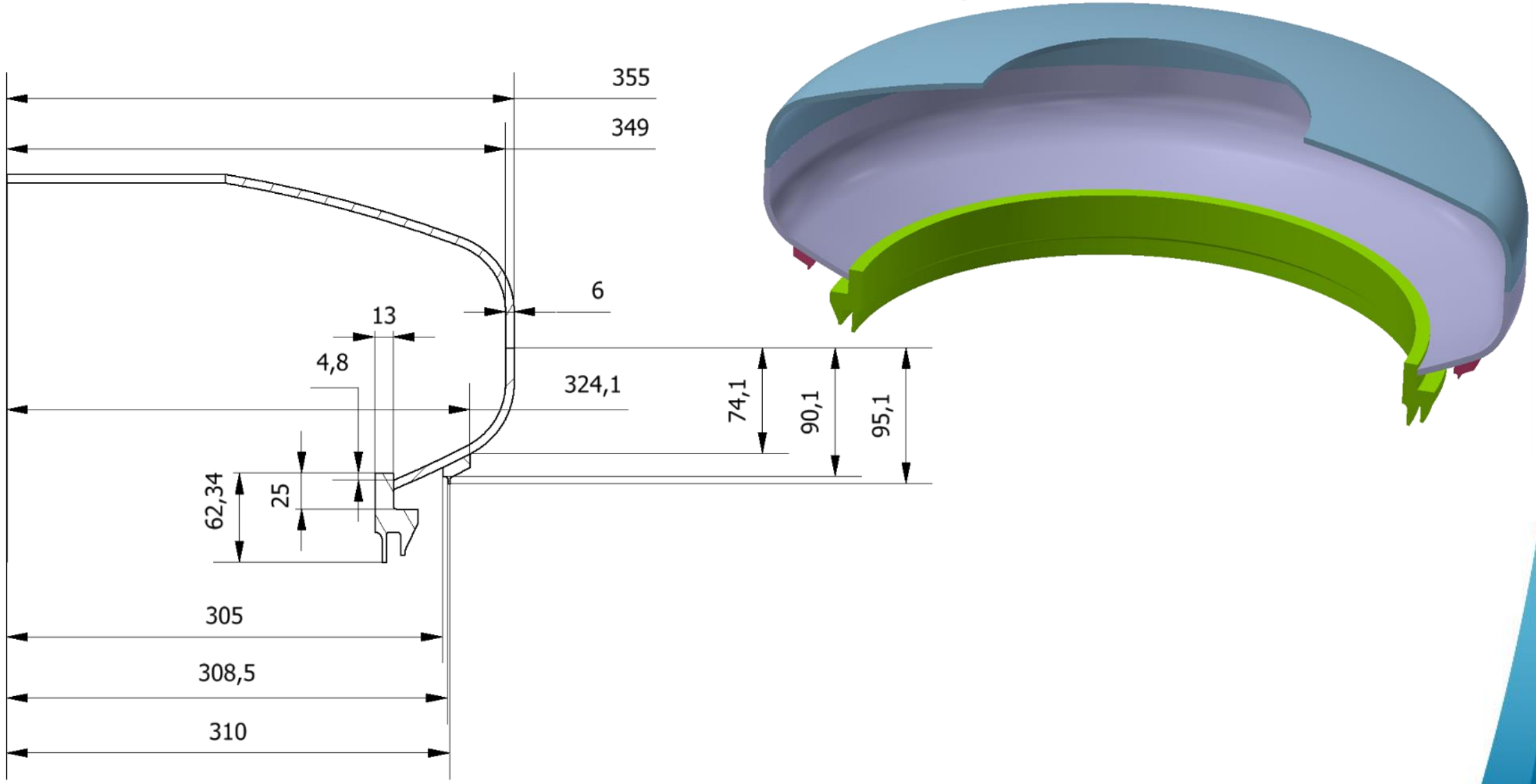
1. Compile list of dimensions taken from the CERN 3-D model and check coherence with the SOTON stress analysis models
   Full list compiled and circulated amongst the teams and differences between two models being addressed sequentially. Phonecall between WB and DO on Tuesday to discuss version 2 of list
   Further dimensional changes implemented by SOTON to reduce localised stress concentration over the last two days to be discussed today
2. SOTON to complete design report of vertical part and send by Friday 13 Dec.
   Compilation of design report in progress
3. CERN to send SOTON a list of ST numbers and equipment names
   TXT. file containing the a list of ST numbers and the part name/identifier supplied
4. SOTON and CERN to clarify bellows parameters (horizontal and vac. barrier) and contact Kompaflex
   Tighter specification for custom design of vacuum barrier membrane bellows sent to Kompaflex
   First iteration of offer by Kompaflex to be discussed today

DFX Vertical section – Addressing current actions

Domes

a. General strengthening required for particular load cases achieved by increasing the thickness domes from 5 mm to 6 mm. (Note: This change in dimensions already implemented by CERN in CATIA 3-D model)
b. Further reduction of the localised stresses identified in welding ring attached to the bottom of the dome under a few load cases achieved by increasing of thickness from 8 mm to 13 mm (STP now available for CERN)
c. Increasing the width of the mounting ring used for attaching the cage to the bottom dome add both local reinforcement to the bottom dome and help dissipate stresses developing at the top of cage structure. (STP now available for CERN)

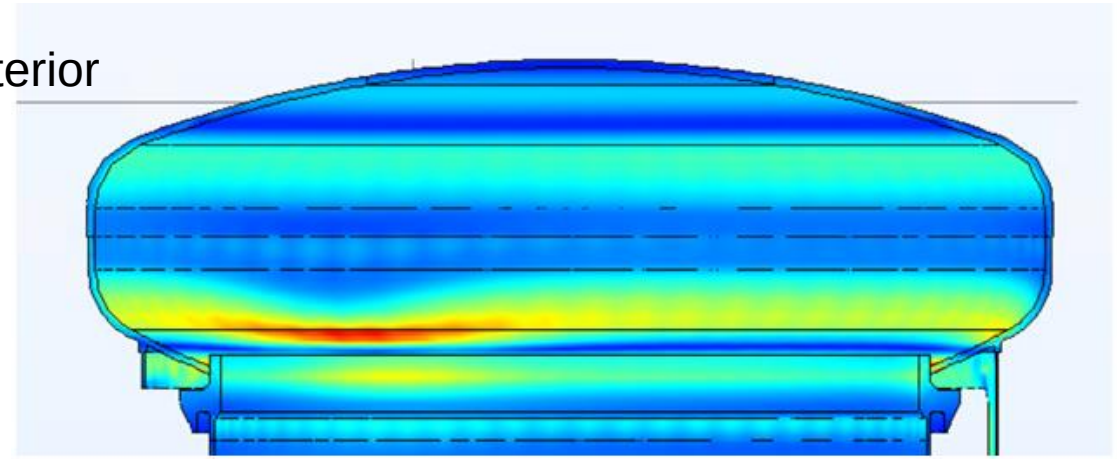
DFX Vertical section – Addressing current actions

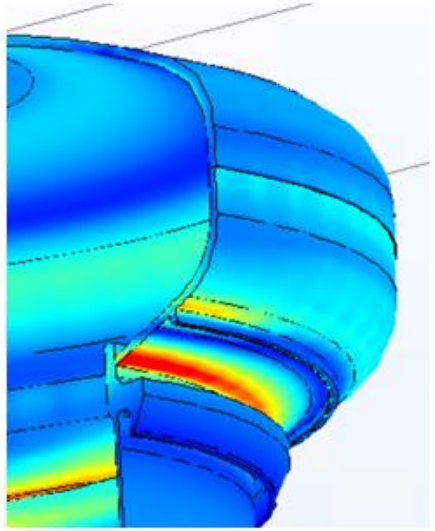


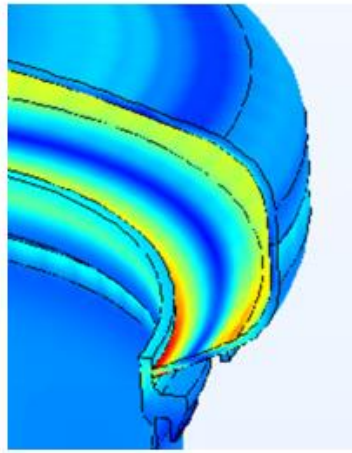
DFX Vertical section – Addressing current actions

BEFORE implementing change a) – c)

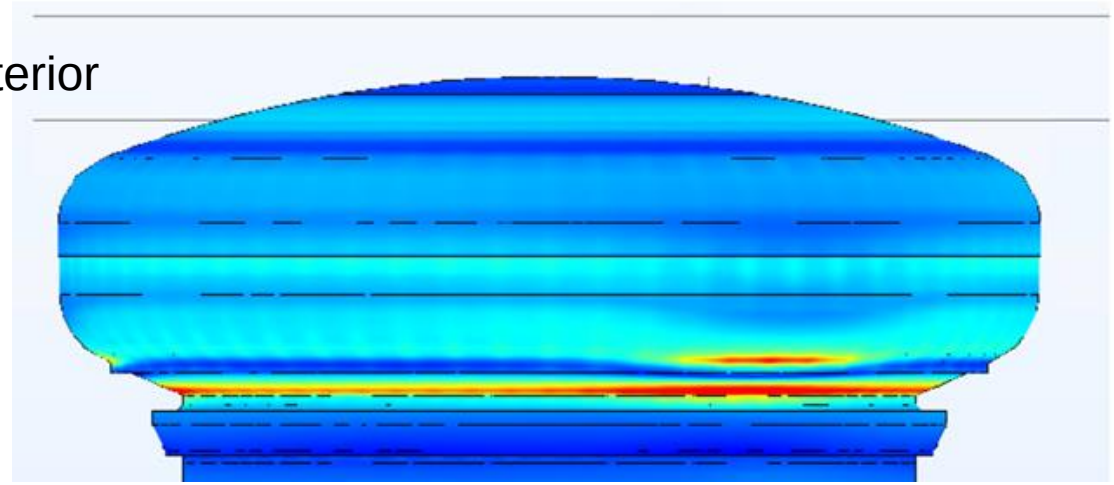
Interior







Exterior



DFX Vertical section – Addressing current actions

AFTER implementing change a) – c)

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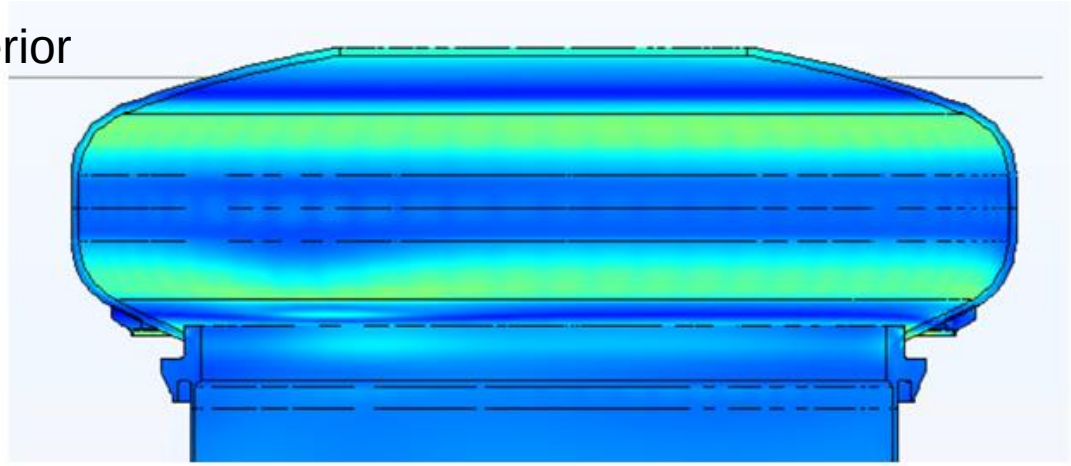

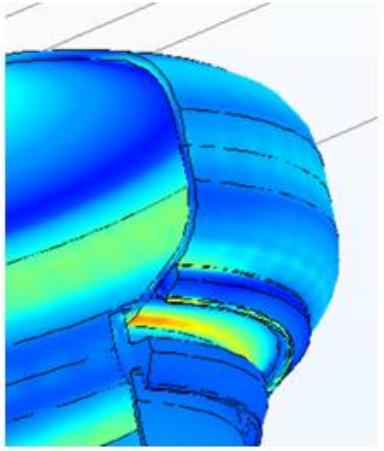

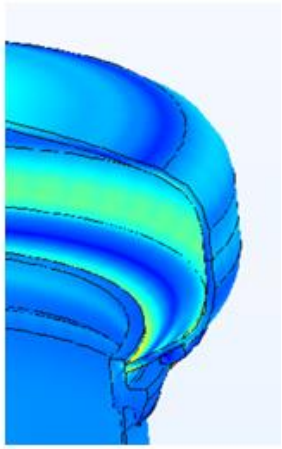

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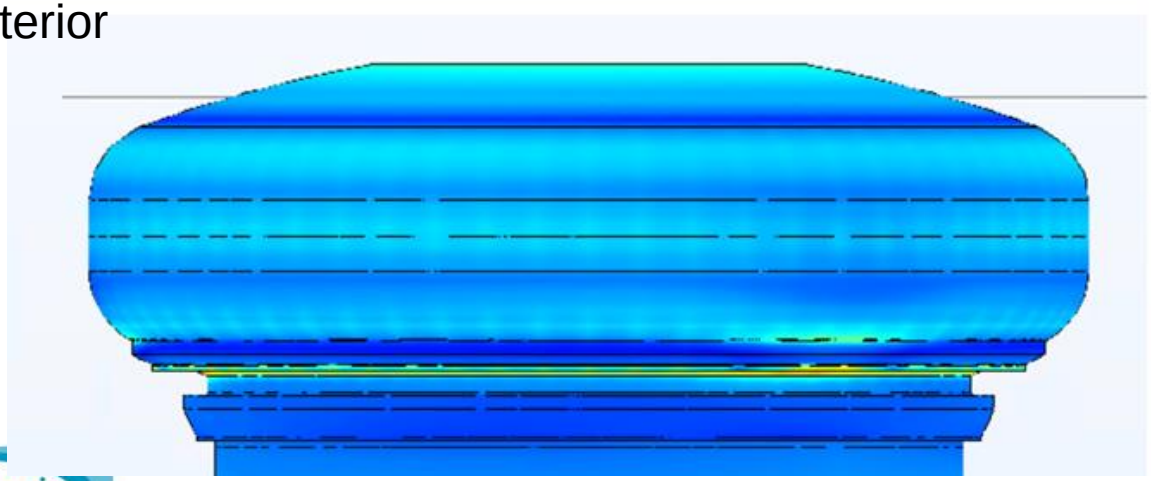
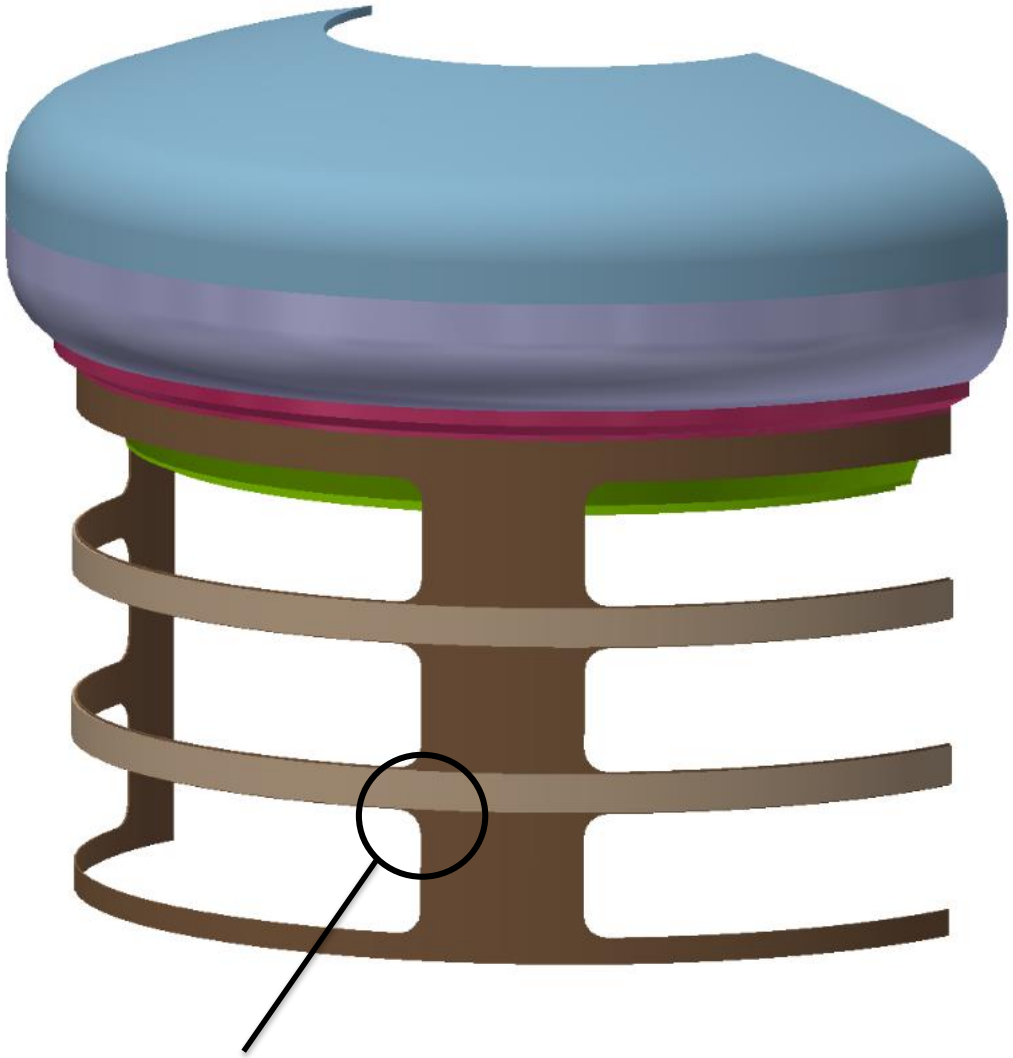


DFX Vertical section – Addressing current actions

Cage

d. Position of cage changed to converge with current position in CATIA 3-D model (i.e. ID = 617, OD = 624. This shift therefore enables 12 mm MLI blankets to be located on the outside of cage and inside the vacuum wall (650 ID).
e. Profile of cut-out in cage adapted to alleviate stress concentration. (STP now available for CERN)



e) Smaller radius works better

DFX Vertical section – Addressing current actions

Vacuum barrier membrane

f. Indicative proposal supplied by SOTON to Kompaflex

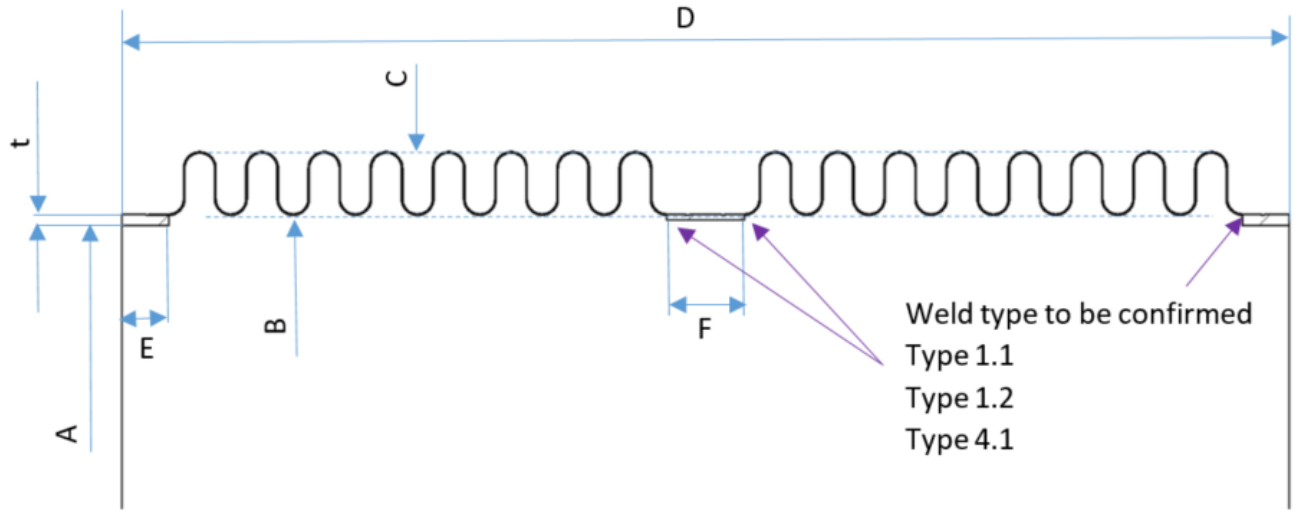


Figure 1 – Double bellows arrangement proposed for vacuum barrier membrane

Table 1 provides the technical requirements for the design

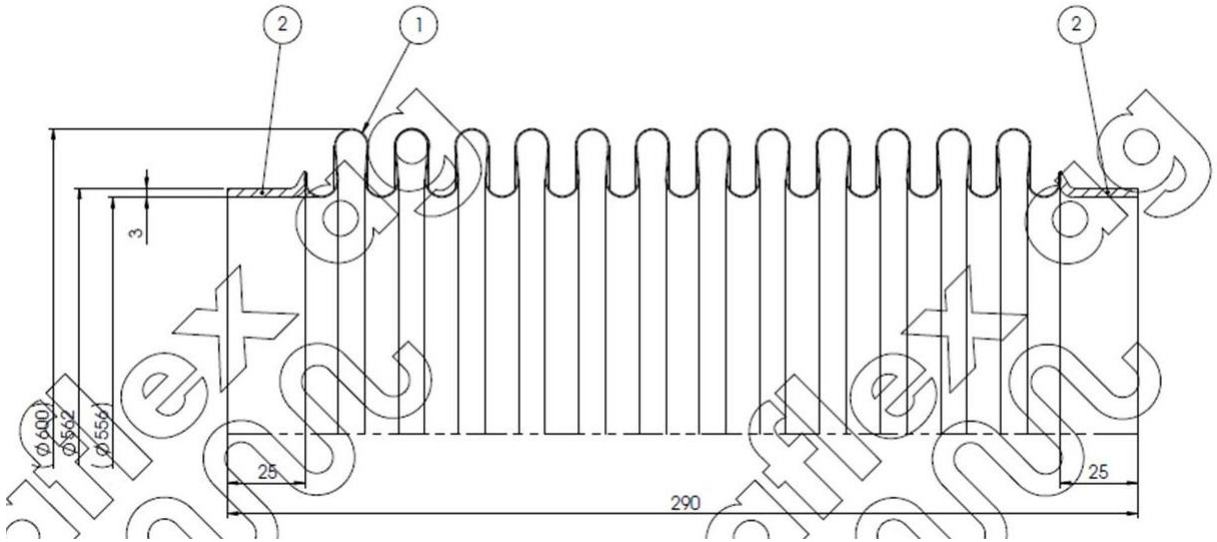
	Parameters	Value
	Design temperature	**-269 °C**
	Working fluid	**Helium (liquid and gas)**
Ps_{int}	Relative internal pressure	**1.5 bar**
Ps_{ext}	Relative external pressure	**1.5 bar**
	PED Category	**Category I**
	Convolution material*	**EN 1.4404 or EN1.4435**
	Bellow end material*	**EN 1.4404 or EN1.4435**
Δx	Axial movement	**+/- 5 mm**
$Nb_{\Delta x}$	Axial cycles	**500**
Δy	Lateral movement	**5 mm**
$Nb_{\Delta y}$	Lateral cycles	**10**
$\Delta\Theta$	Angular movement	**2.5 degrees**
$Nb_{\Delta\Theta}$	Angular cycles	**10**
B	Minimum convolution diameter	**556 mm**
C	Maximum convolution diameter	**600 mm**
A	Tube end inner diameter	**556 mm**
t	Tube end thickness	**3 mm**
D	Overall assembly length	**290 mm**
E	Straight end length	**>20 mm**
F	Inter bellow length	**>30 mm**
Kx	Max. axial elastic spring rate	**200 N/mm**
Ky	Max. lateral elastic spring rate	**100 N/mm**
K_Θ	Max. angular elastic spring rate	**N/A**
np	Number of plies	**Single ply (requested)**
ep	Ply thickness	**As thin as possible**
w	Convolution height	**As tall as can be tolerated**
q	Convolution pitch	**To be defined**

DFX Vertical section – Addressing current actions

Vacuum barrier membrane

Changed to 592

g. First design iteration supplied from Kompaflex to SOTON



- Single bellows with Omega profile
- Single ply (ply thickness = 0.4 mm)
- Welding ends = 25 mm sections (as shown) in material 1.4429 to guarantee Cobalt content
- Weld type = Edge weld (Type 4.1 as per EN 14917).
- X-ray content: 25 % of bellows longitudinal seam and longitudinal seams of welded ends

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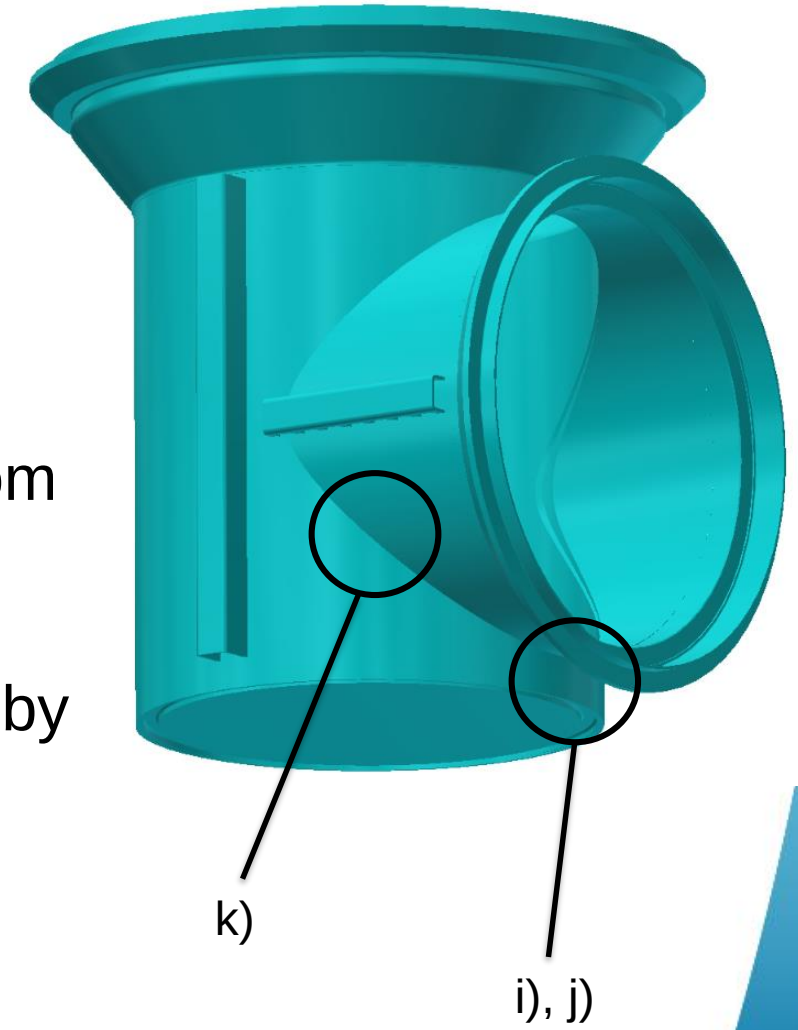
q	Convolution pitch	**To be defined**

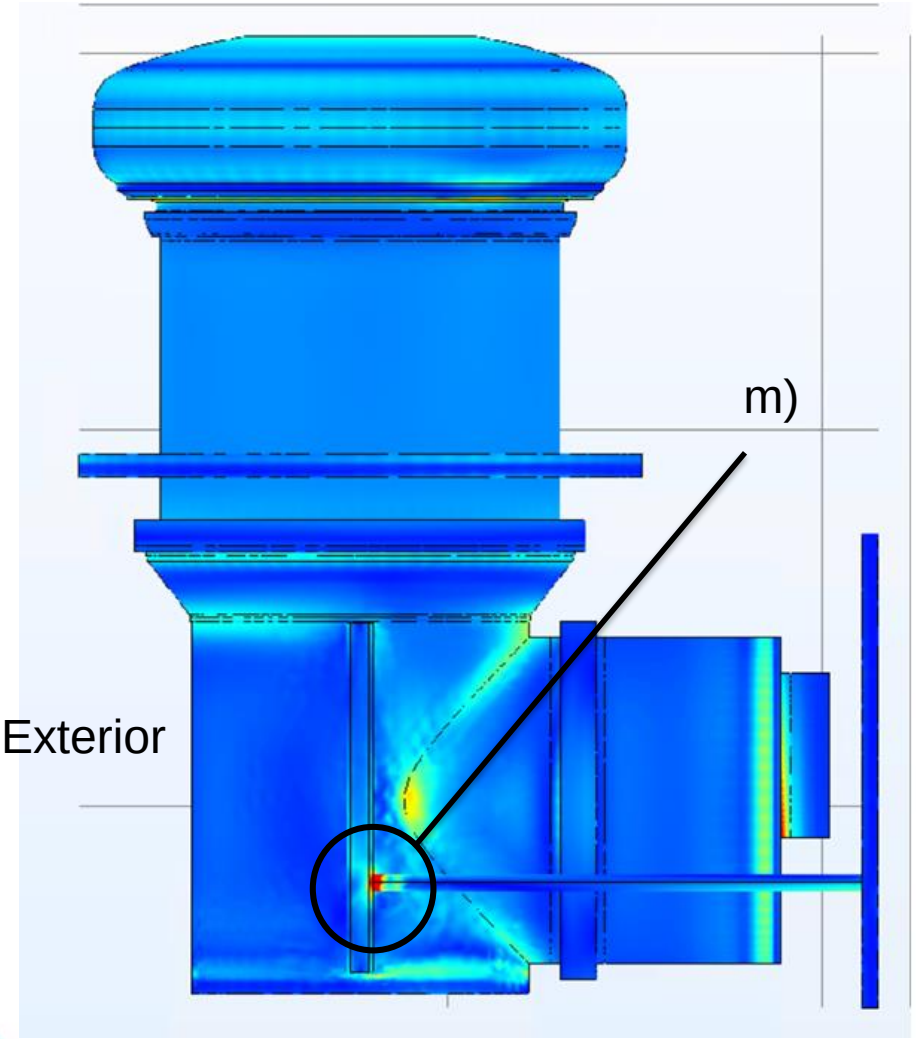
DFX Vertical section – Addressing current actions

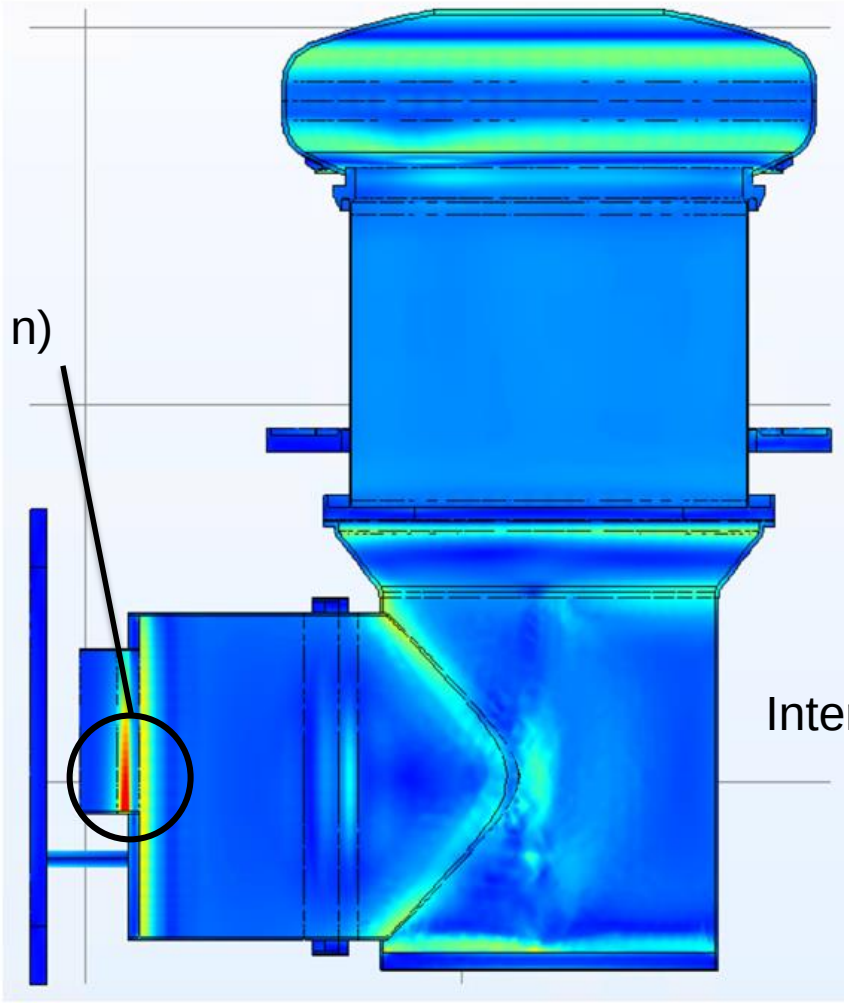
Elbow

i. Increasing the thickness of the bottom flange from 15 mm to 20 mm has reduced the high stress concentration appearing in the bottom of the vertical-horizontal intersection
j. Removing the horizontal stiffeners further reduced stress in same location even after increasing bottom flange thickness.
k. Reducing the stresses appearing circumferentially along the vertical-horizontal intersection achieved by increasing the wall thickness of both tubes from 3 mm to 4 mm. (New STP now available for CERN)



DFX Vertical section – Addressing current actions





DFX System – New actions

1. High stresses in **point m)** to be resolved by adapting the feature for fixing the horizontal restrain (INVAR) bar to the elbow. We are also experimenting and trying to optimise its vertical position
2. High stress in **point n)** to be resolved by increasing the wall thickness and flange thickness in this reducer section