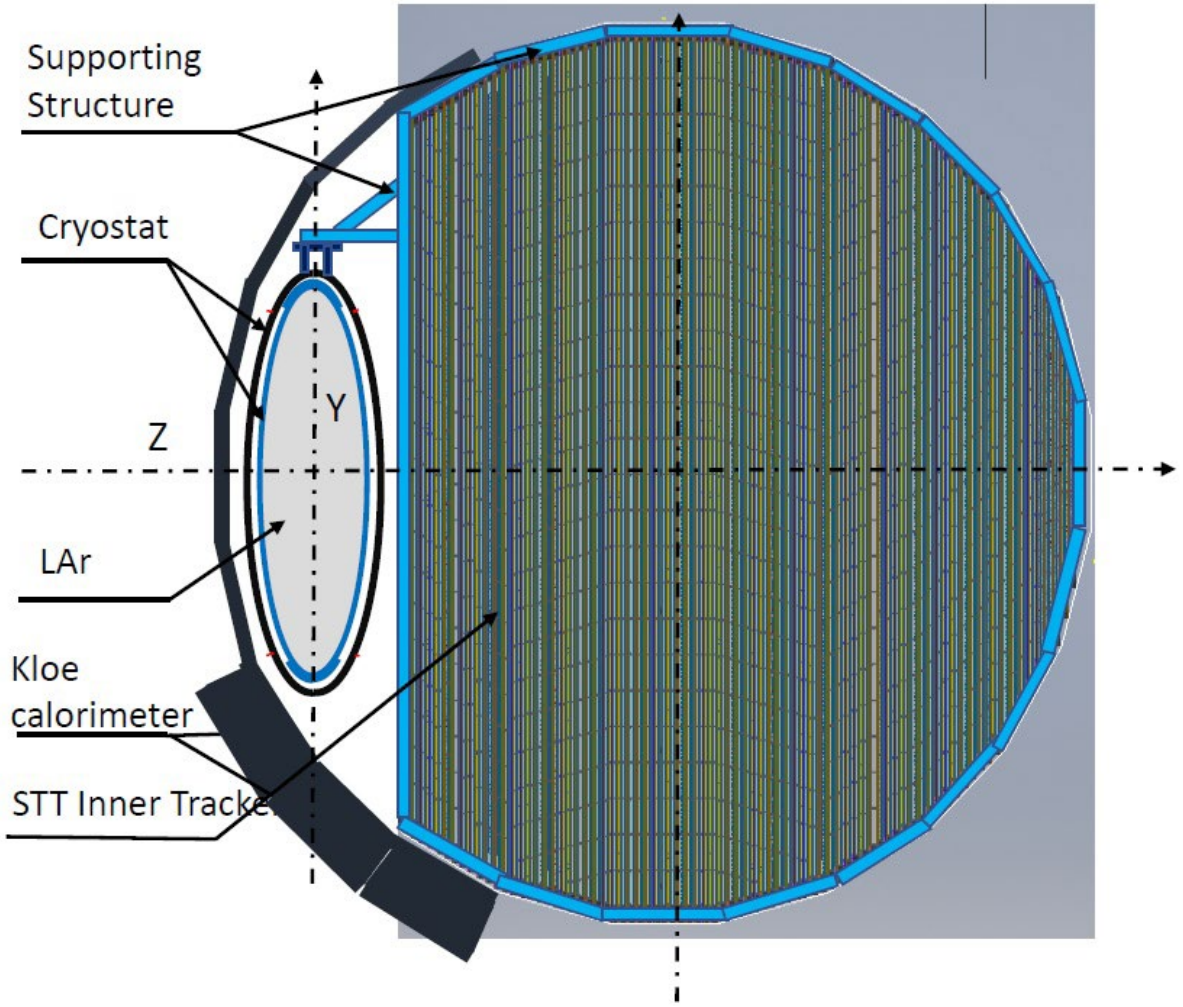
GRAIN: Mechanics

CSN1 review of SAND – Jul 11, 2024

Gianluigi Piazza

GRAIN inside SAND



In order to use all the available space inside SAND, the cryostat has an elliptical section.

The capacity is almost 1 ton of liquid argon

Inner vessel

Preliminary studies has been carried out, but the design has to be certified for EN13445 standards. An order for calculation has already been issued.

In the meantime, Technetics is conducting a study to validate the identified Helicoflex gasket in order to ensure a leak rate of 10^{-8} mbar·l/s

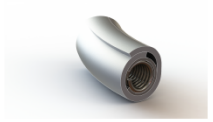
Technetics GROUP

Issued by	Atoboso	Design number	FT3383
Date	07-01-2021	Customer's name	ITALSEAL [18028]
Version	A	Asked by	

HELICOFLEX® HN230 - Cross section=5.60/6.10
Outer jacket made of Al
Ø984.90 x Ø996.10

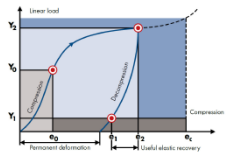
Working Conditions

Application	
Media to be sealed	Argon liquide
Pression de service [bar]	0.0
Température de service [°C]	-188.0
Media side	Internal



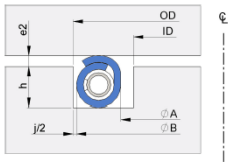
Seal Data

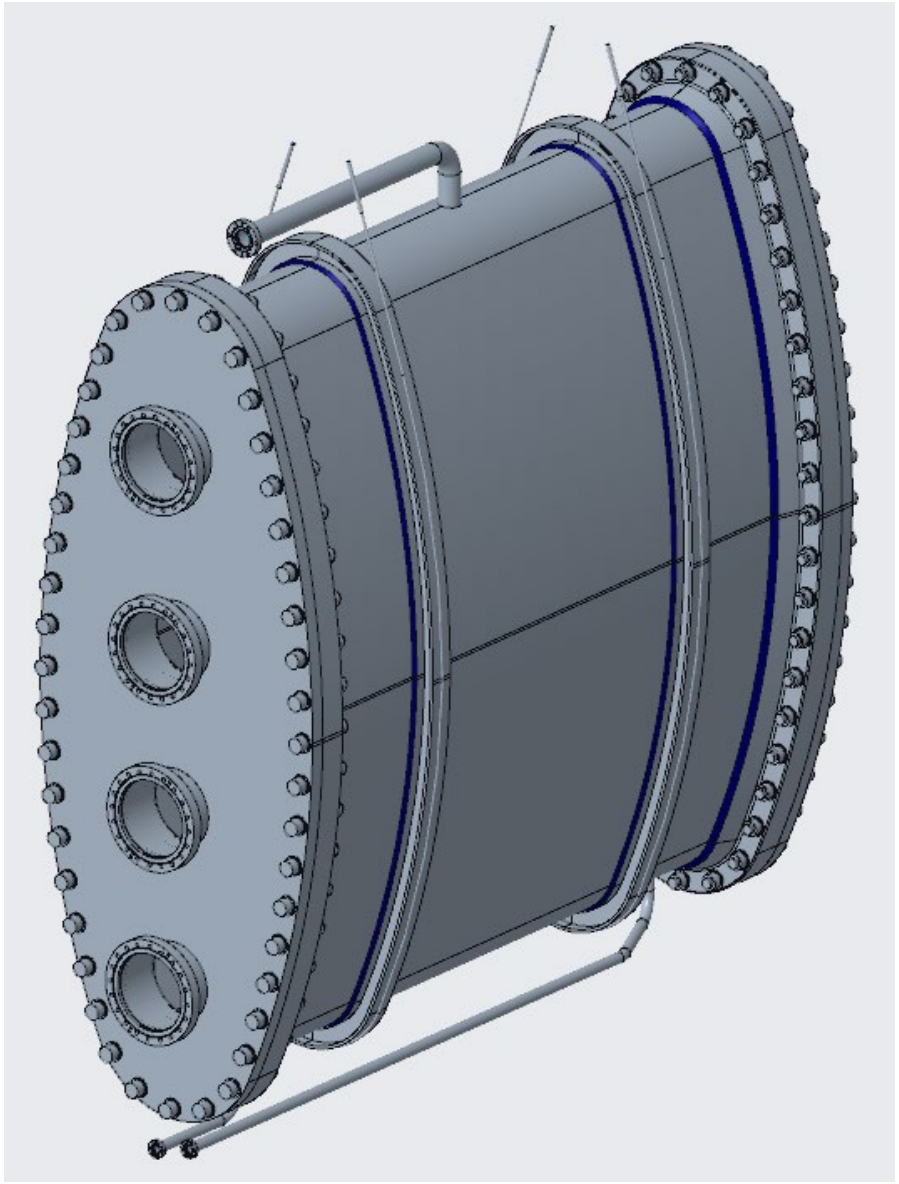
Seal style	HN230
Cross section [mm]	5.60
Diameter at seal load reaction (DJ) [mm]	990.50
Seal ID (A) [mm]	984.90
Seal OD (B) [mm]	996.10
Sealing material	Al
Plating	No
Inner material	Cu
Spring material	Nimonic 90
Internal limiter	No
Leak tightness	Helium
Compression load (Y2) [N/mm]	280 +10%



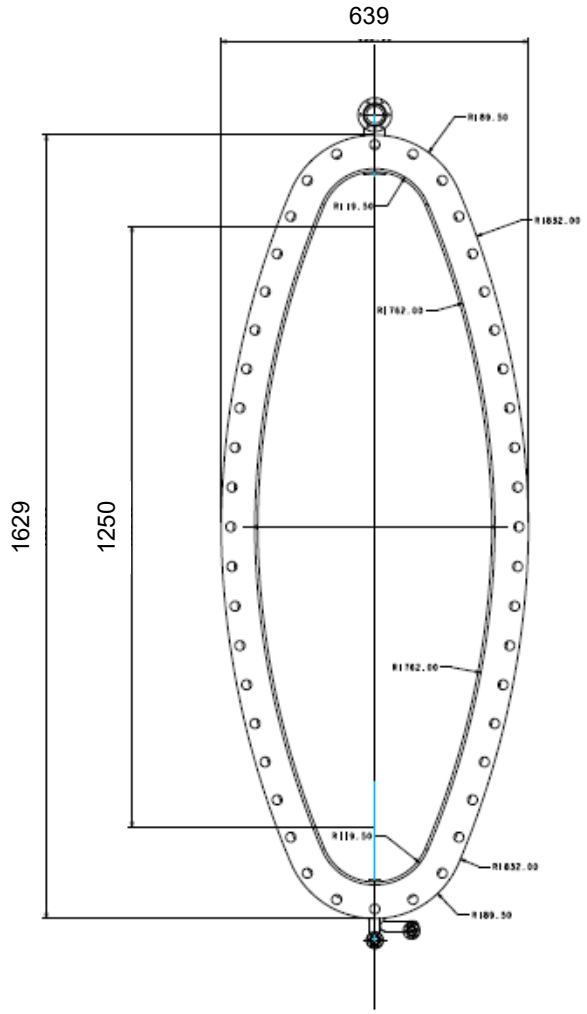
Groove Data

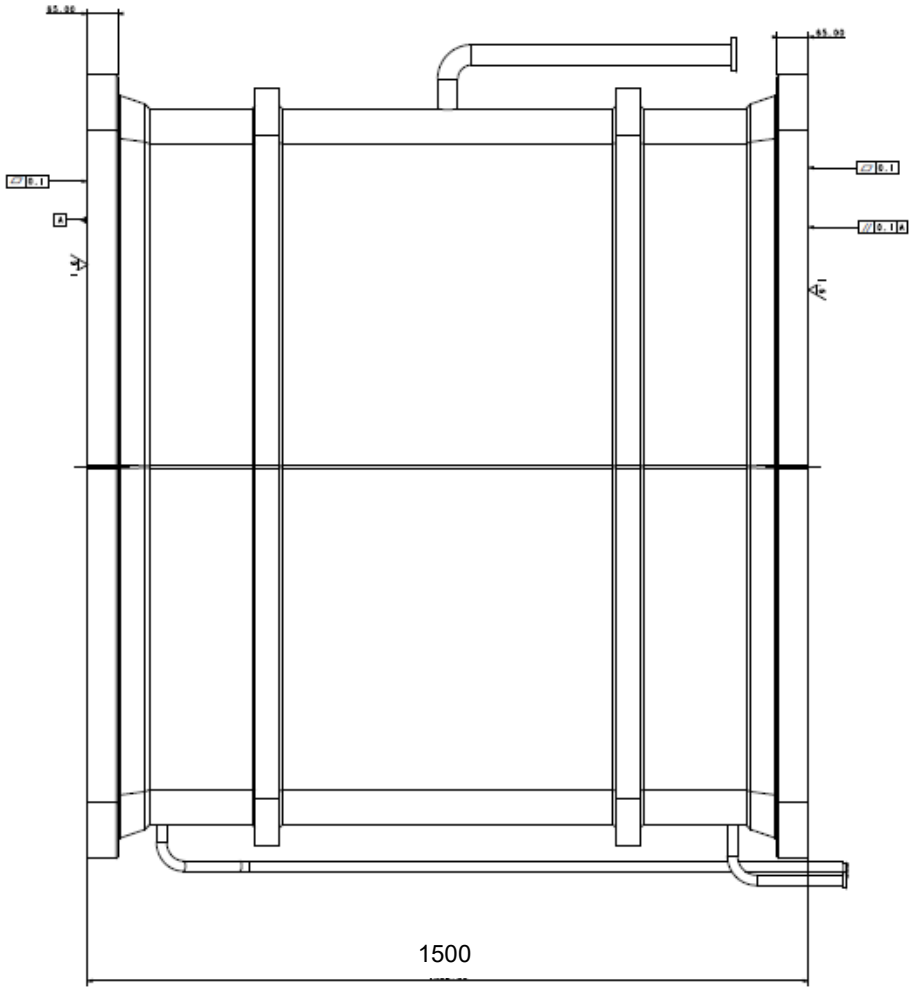
Groove ID [mm]	982.80 max
Groove OD [mm]	996.60 +0.100
Groove depth (h) [mm]	5.20 ±0.050
Compression value (e2) [mm]	0.90
Diametrical clearance (j) [mm]	0.50
Roughness obtained as per Technetics' specification	Ra1.6 - Ra3.2
Minimum hardness [HV]	
Minimum seating load (Fj) [N]	958418.2

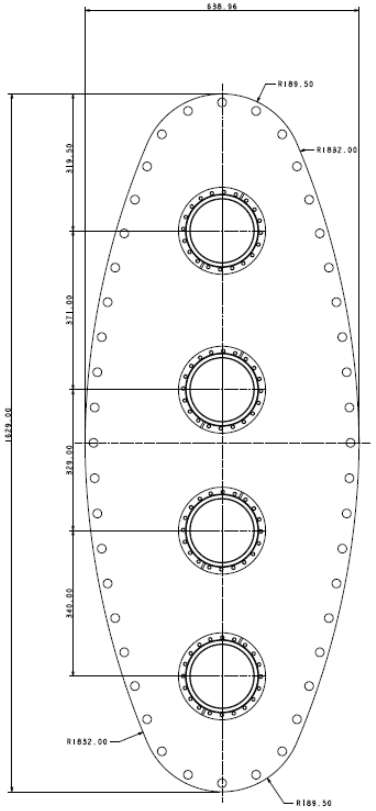


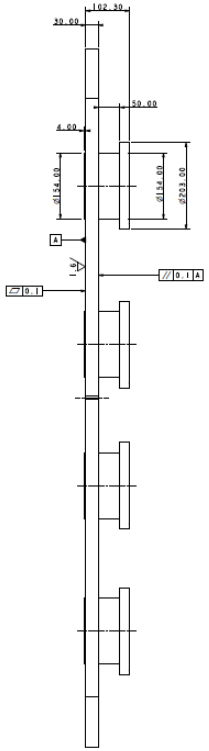


Inner vessel

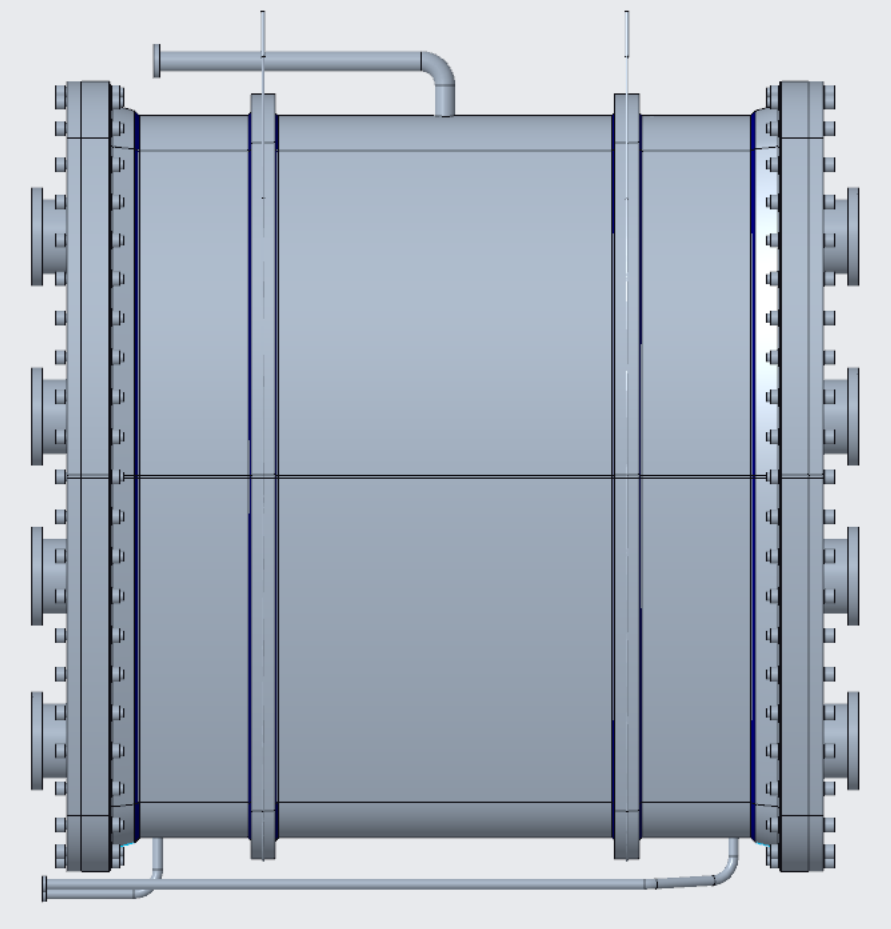








Internal vessel design

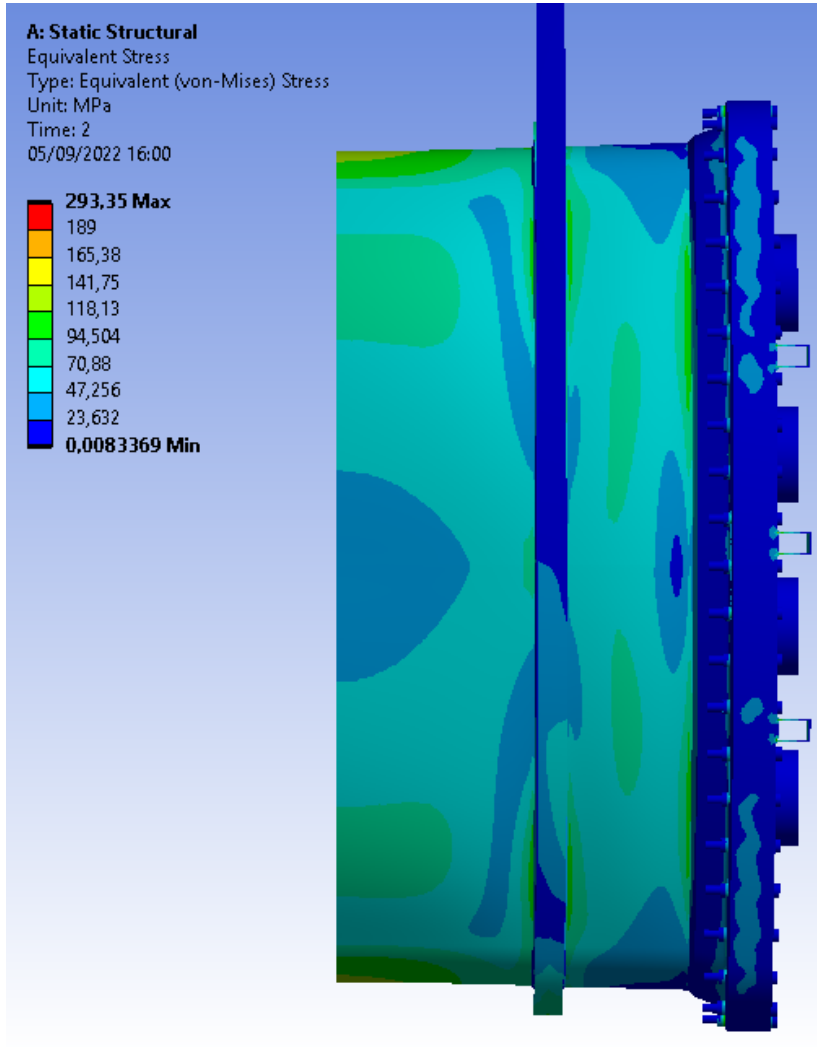


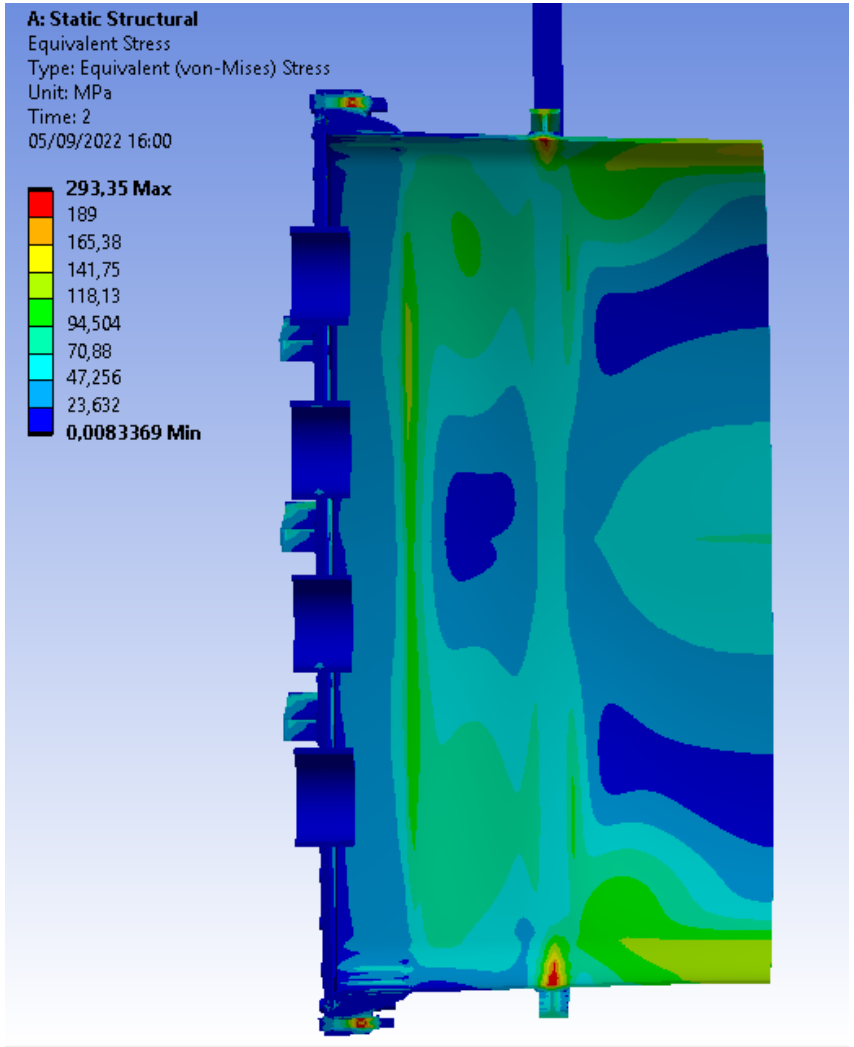
- Material: AISI 316 L
- Body wall thickness 6 mm
- Cover thickness 30 mm
- Internal pressure 1,5 bara

4 DN160 CF flanges per side, feedthrough to be defined.

Suspension is provided by 2 stainless steel wire ropes with a thickness of 5 mm

Internal vessel: FE analysis



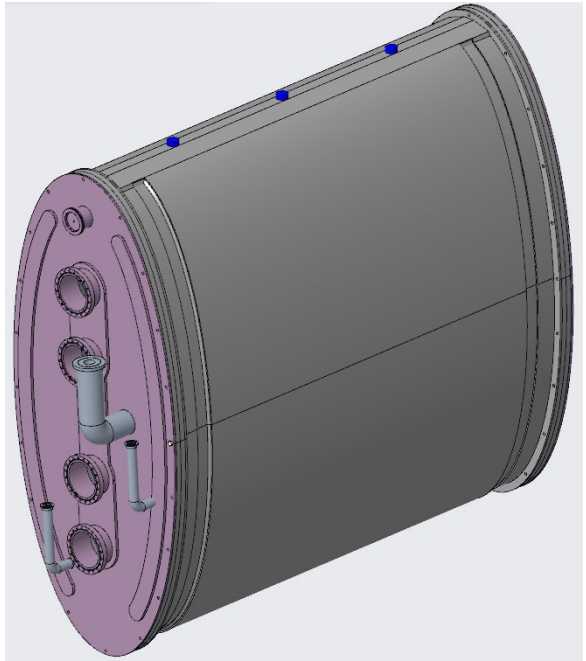


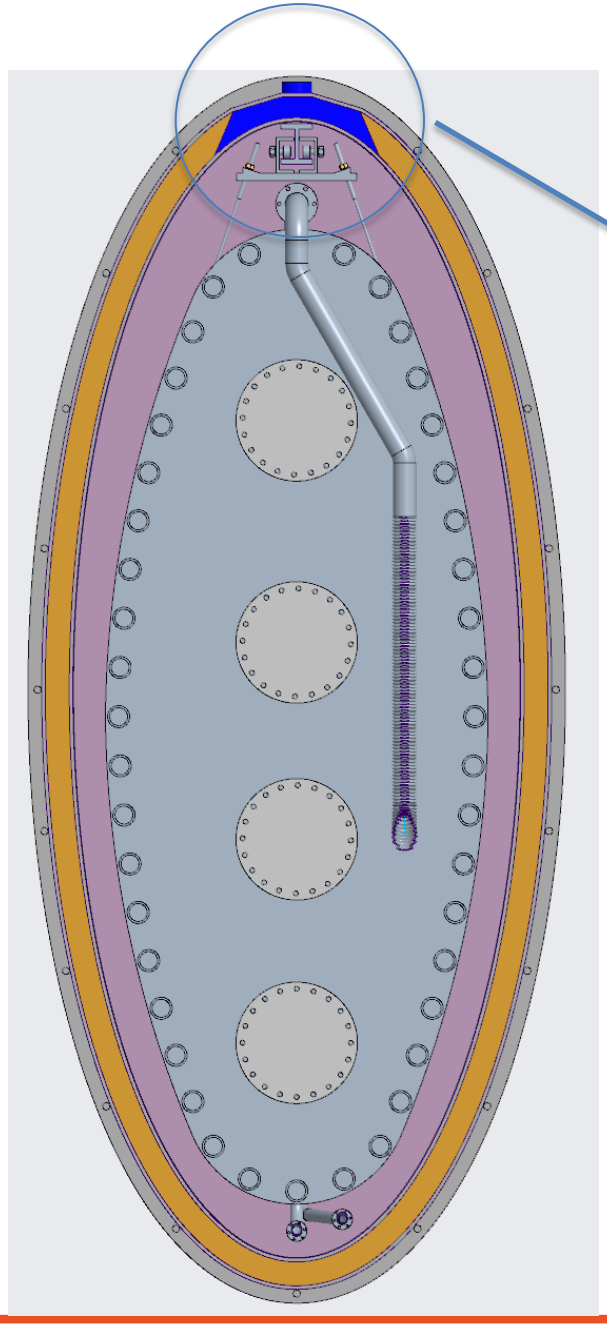
The design of the internal vessel is almost ready to be validated according to standards

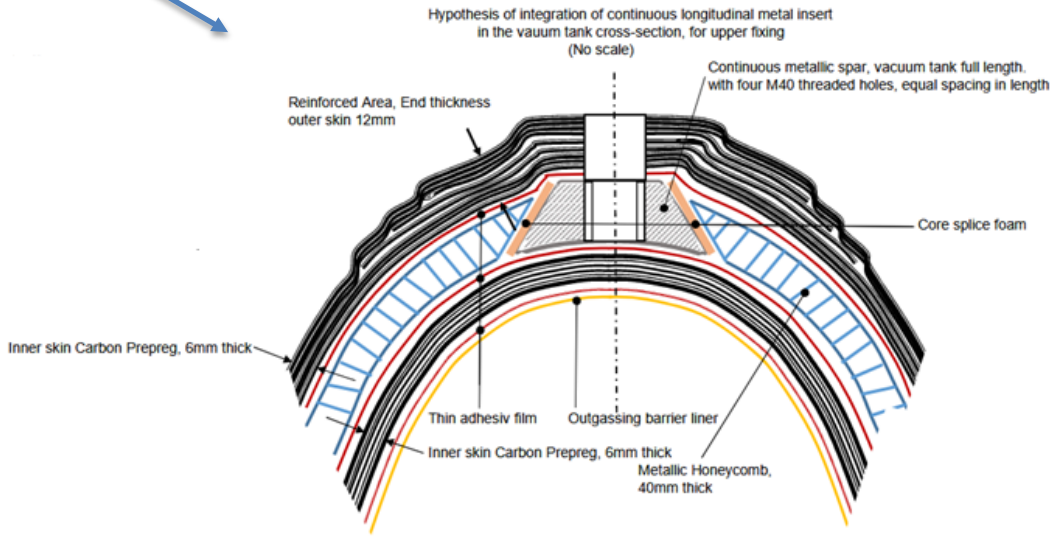
Vacuum tank

Design is still preliminar

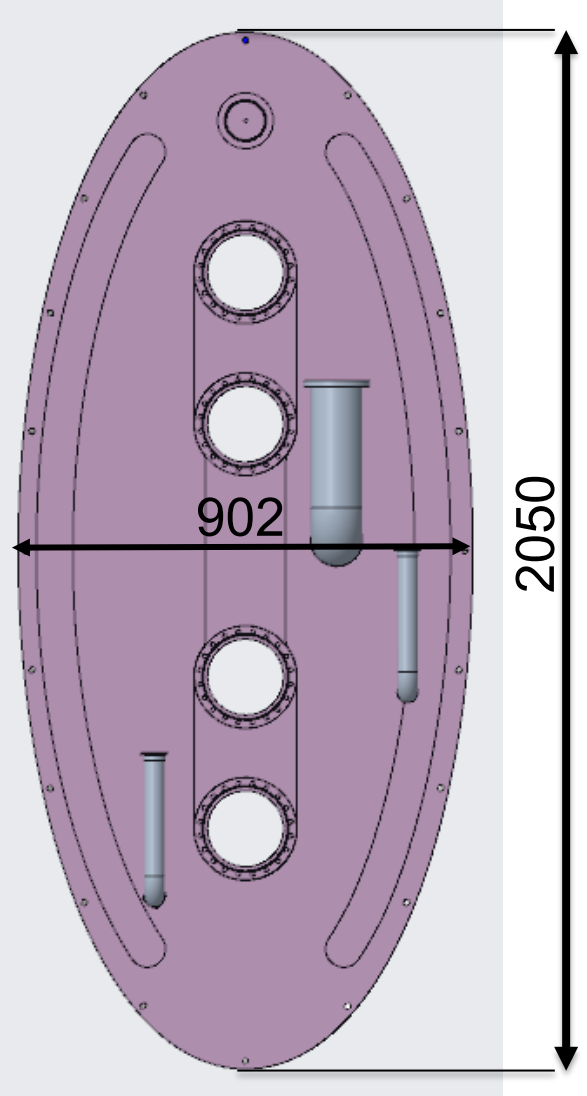
Made of composite material:
Carbon fiber
Aluminum honeycomb
Aluminum alloy and/or stainless steel

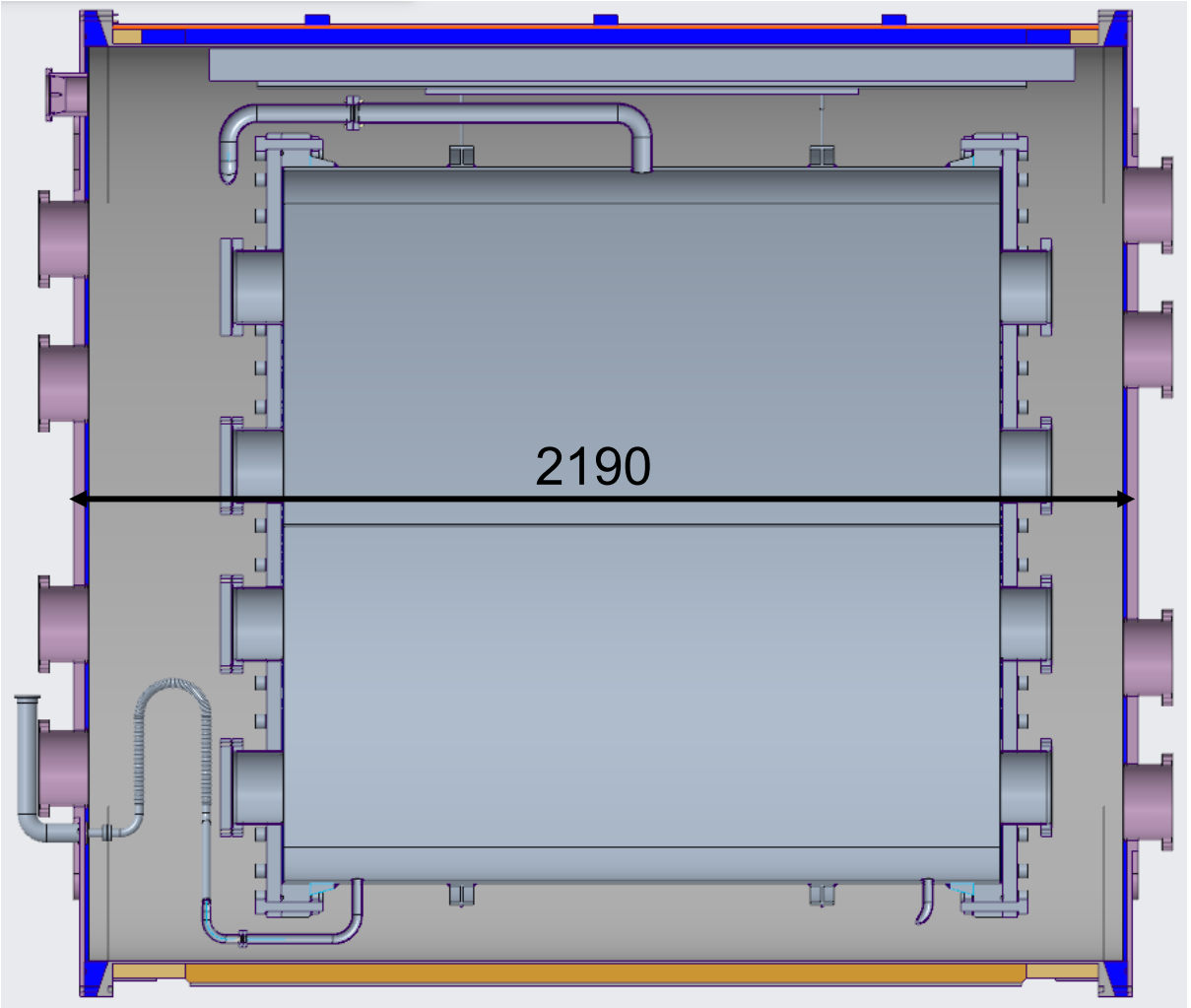






Vacuum tank





Vacuum tank: materials

Prepreg Toray T300 3K

COMPOSITE PROPERTIES

PROPERTY	ENGLISH	METRIC	METHOD
Tensile Strength*	264 ksi	1,820 MPa	ASTM D-3039
Tensile Modulus*	20 Msi	140 GPa	ASTM D-3039
Tensile Strain		1.26%	ASTM D-3039
Compressive Strength*	213 ksi	1,470 MPa	SACMASRM1R-94
Flexural Strength*	260 ksi	1,790 MPa	ASTM D-790
Flexural Modulus*	18 Msi	123 GPa	ASTM D-790
ILSS	14 ksi	94.1 MPa	SACMASRM1R-94
In Plain Shear Strength	14 ksi	95 MPa	ASTM D-3518
90° Tensile Strength	11 ksi	76 MPa	ASTM D-3039

*Normalized to 60% fiber volume. Cured with #2500 epoxy at 130 °C.

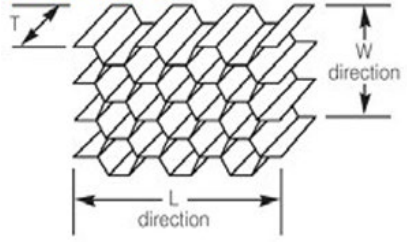
Honeycomb:

Nomex Overexpanded Toray ANC-4.8-48

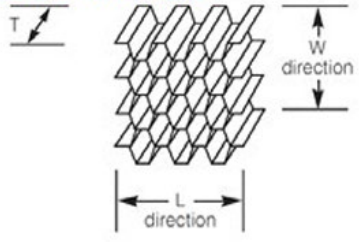
MECHANICAL PROPERTIES

Property	Stabilized Compression		Plate Shear			
	Strength (MPa)	Modulus (MPa)	Strength "L Direction" (MPa)	Modulus "L Direction" (MPa)	Strength "W Direction" (MPa)	Modulus "W Direction" (MPa)
ANC-3.2–48	2.17	127	1.10	36	0.62	21
ANC-4.8–32	1.20	75	0.70	29	0.40	19
ANC-4.8–48	2.40	140	1.20	40	0.70	25
ANC-4.8–48(OX)	2.90	120	0.76	22	0.49	43

HEXAGONAL CELL

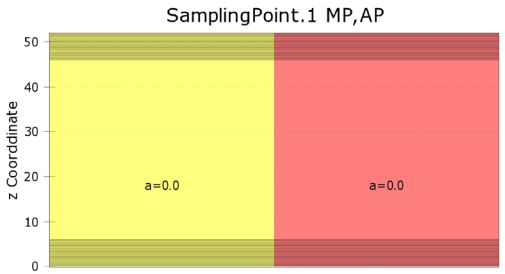


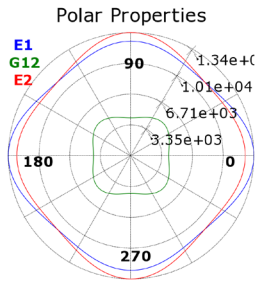
OVEREXPANDED CELL

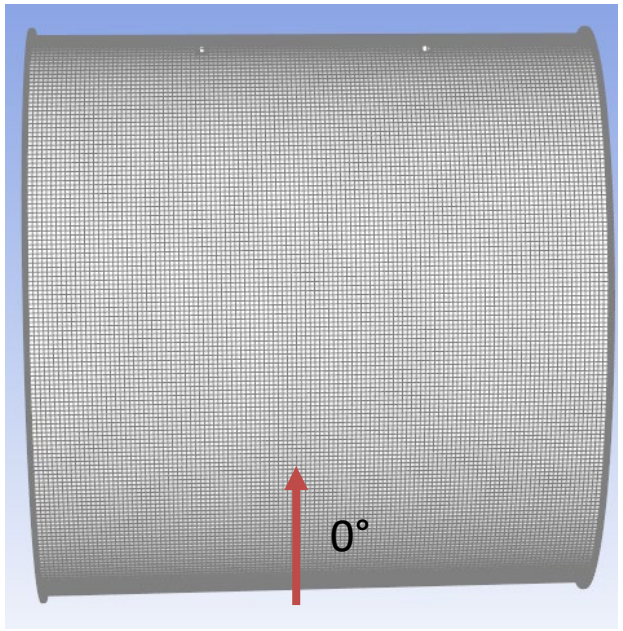


T = Thickness or cell depth L = Ribbon direction W = Direction perpendicular to the ribbon direction

Vacuum tank

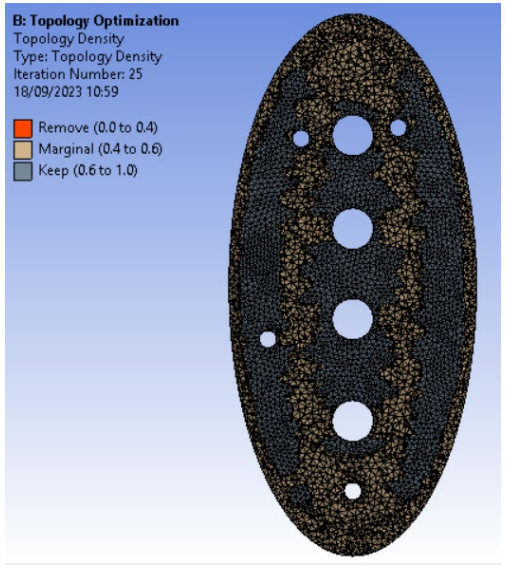


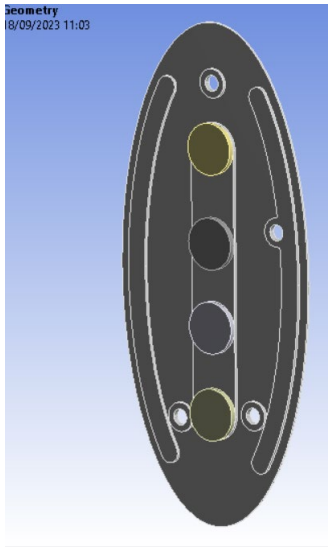




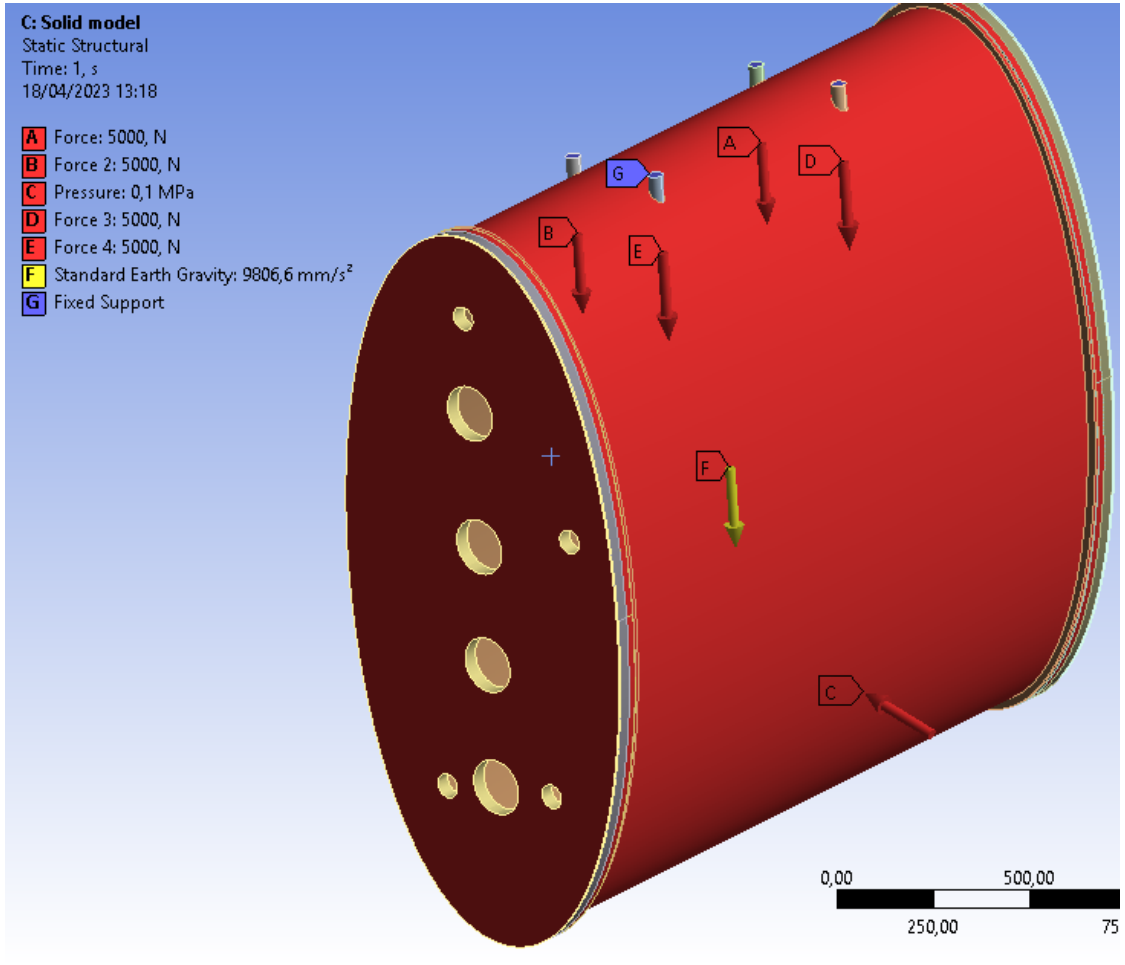
- Lay-up sequence main body:
  $[\ (45/0/45)_{10}\ ]$ + Core + $[\ (45/0/45)_{10}\ ]$
  Core thickness 40 mm

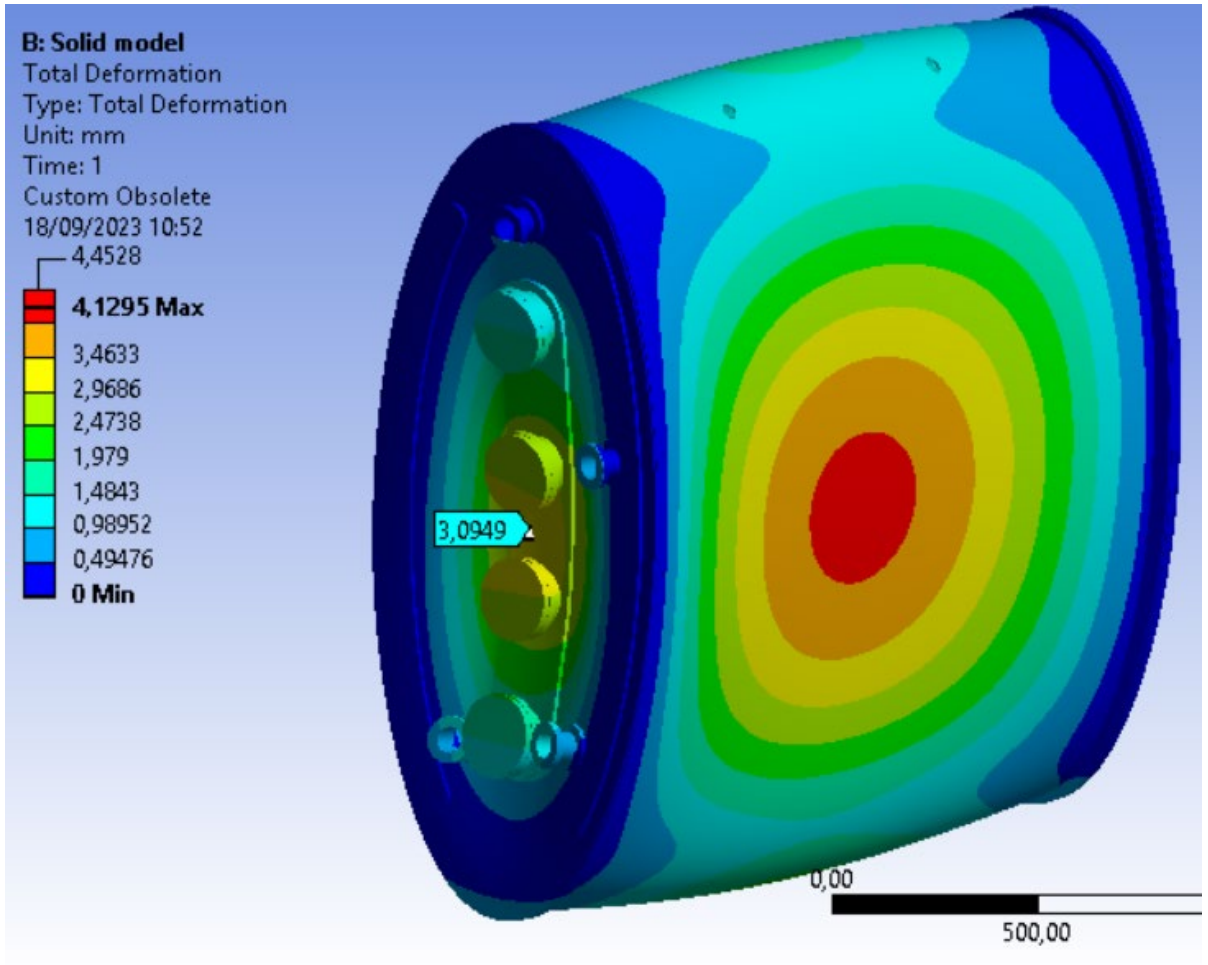
- Covers in aluminum alloy AA7075:
  Preliminary thickness optimization 12-24 mm





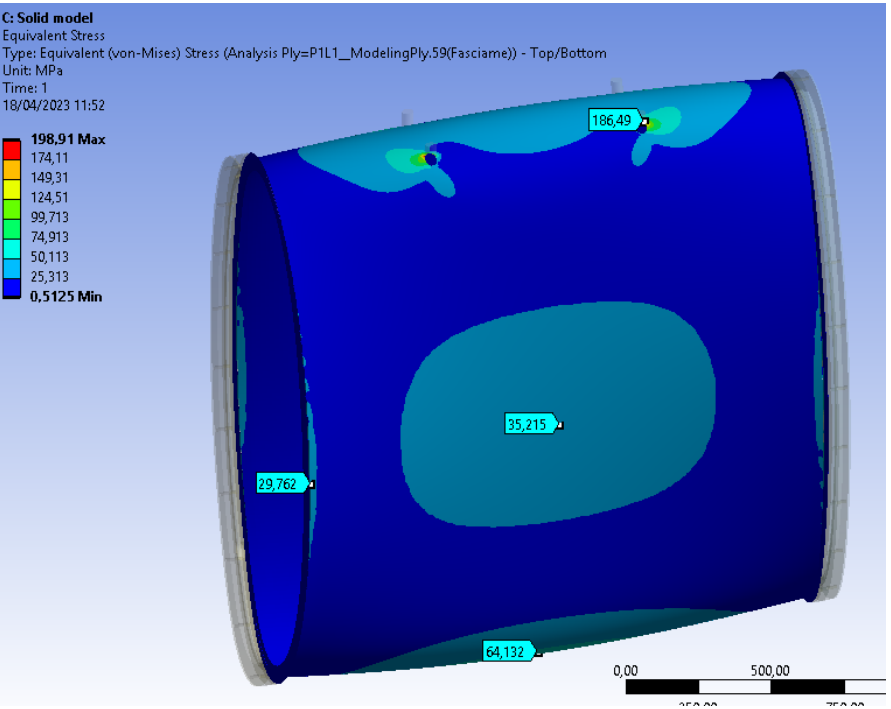
Vacuum tank: loads and deformation



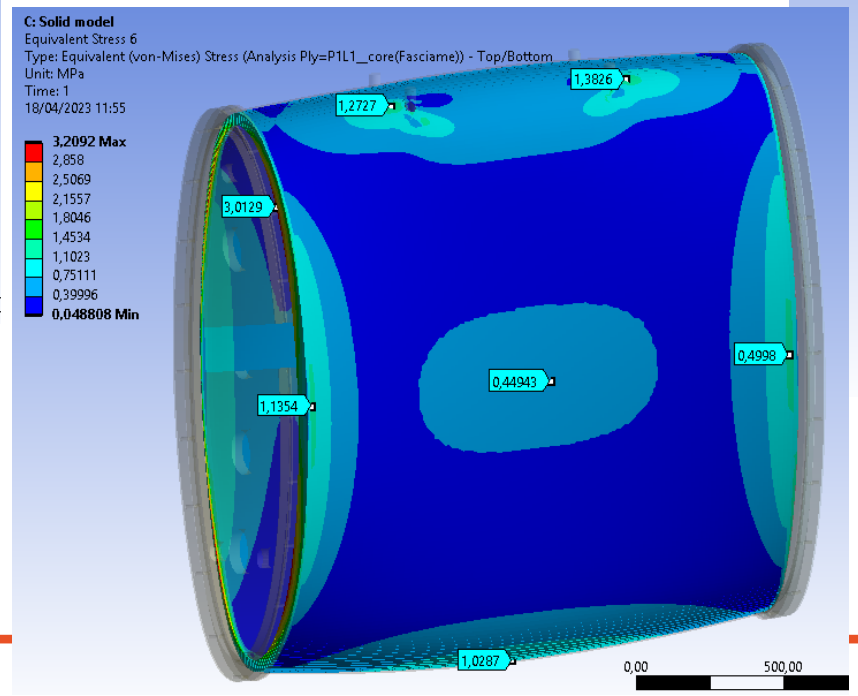


Vacuum tank: central body stress

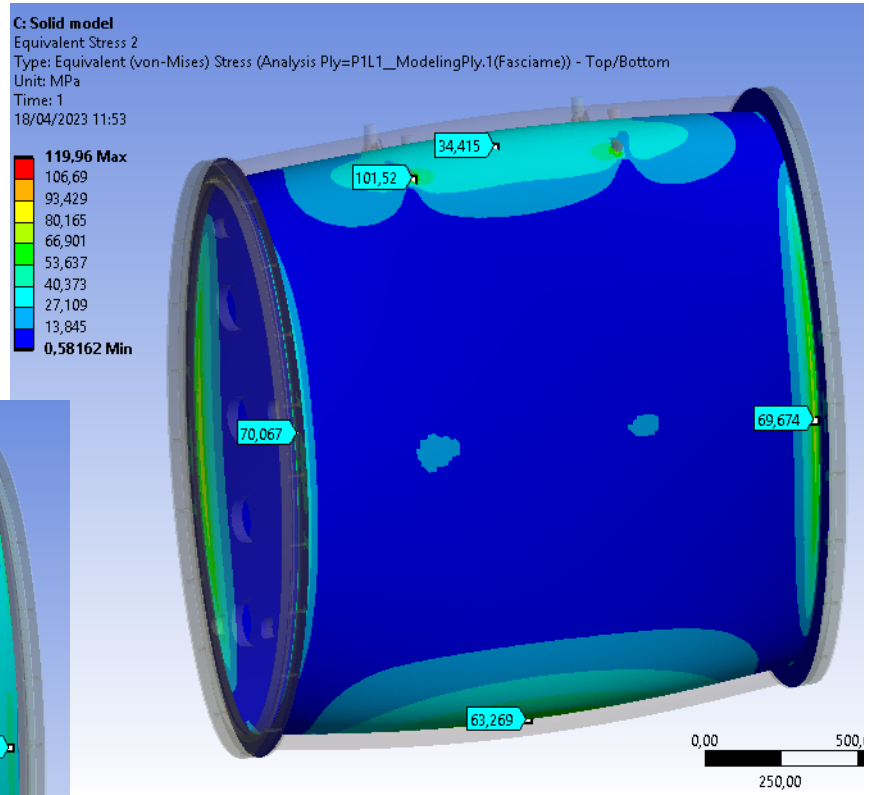
Outer ply



core



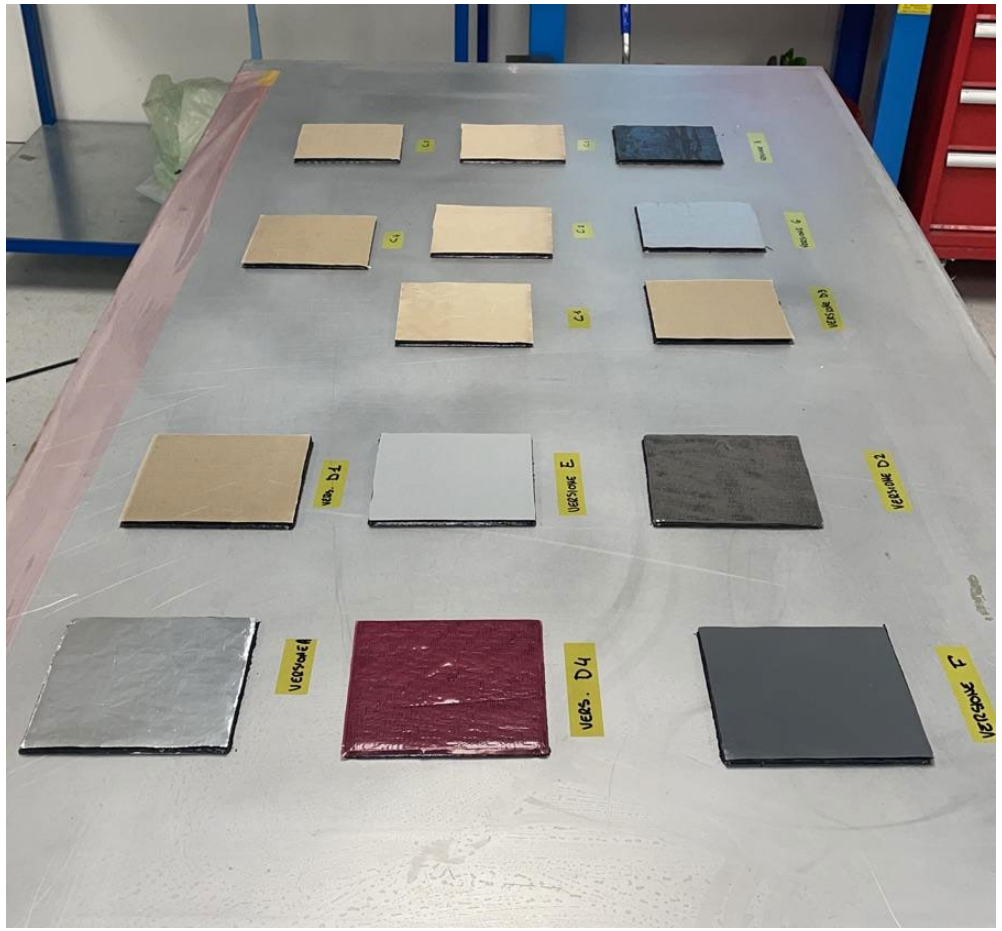
Inner ply



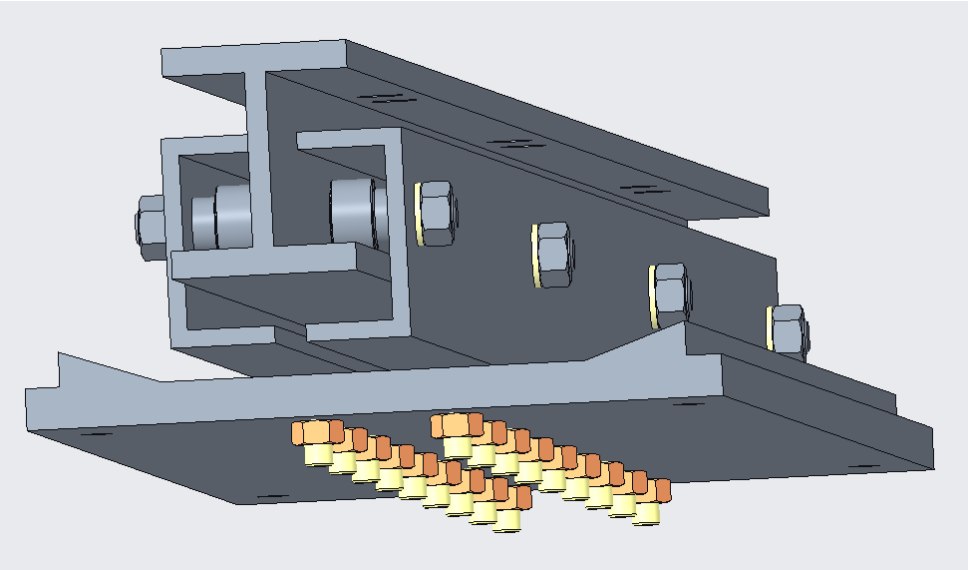
CFRP samples

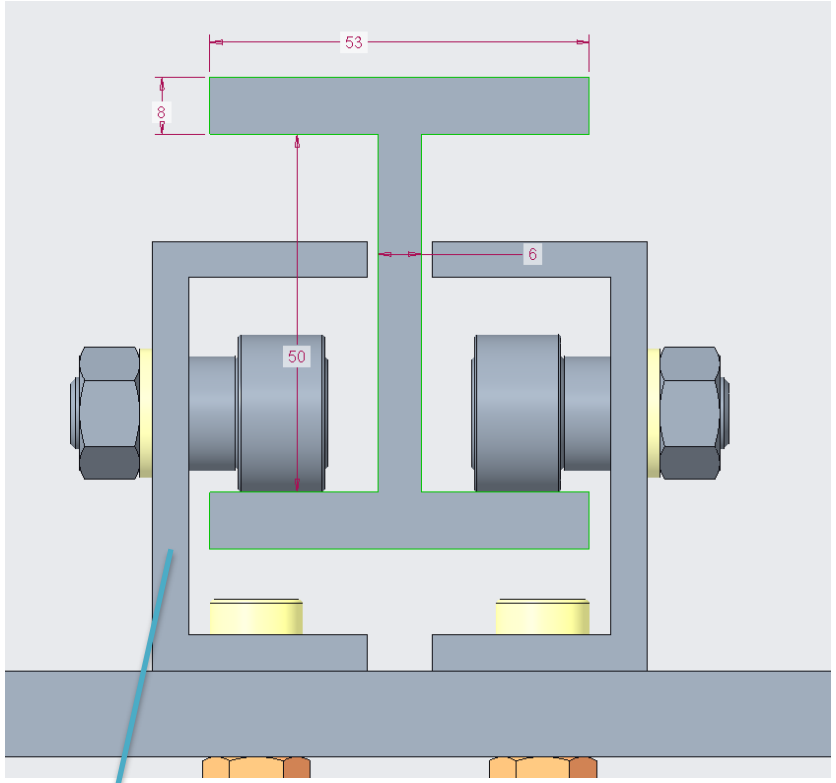
In order to understand feasibility of vacuum
and to choose the best solution for the future mock-up,
a campaign of outgassing test is currently underway in
LNF.

Different samples with different coatings (aluminum foil,
various resins) have been prepared by Refraschini
company and are ready to test.



Sliding system





IPE beam like:

h=66 mm
b=53 mm
tf=8 mm
tw=6 mm
L=1800 mm

C beam IPA hot rolled, dimensions: 60x30x5 mm, 1600 mm long

Montanstahl can produce laser welded customised profiles in 316L
1500 € for 3000 mm ca

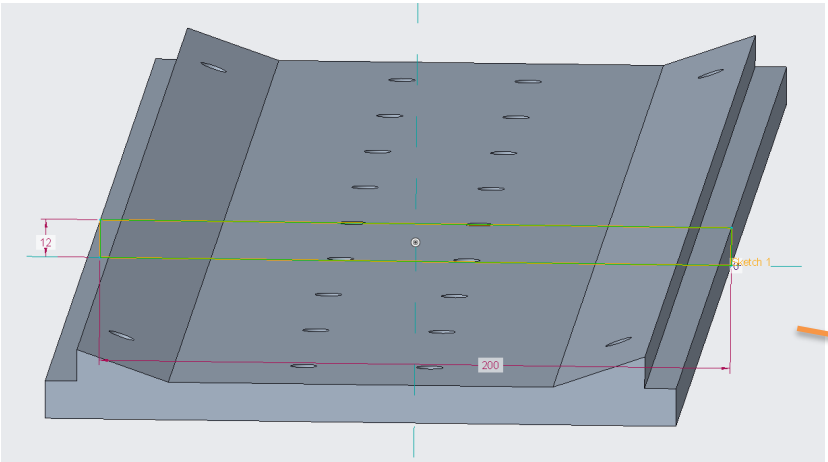
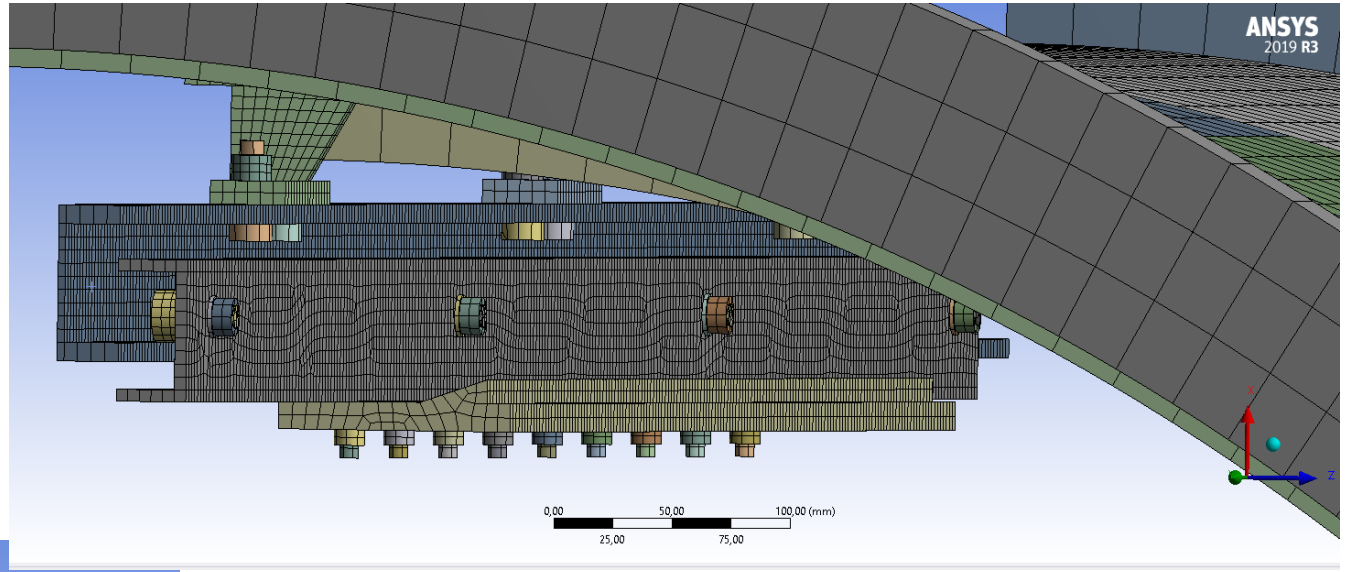
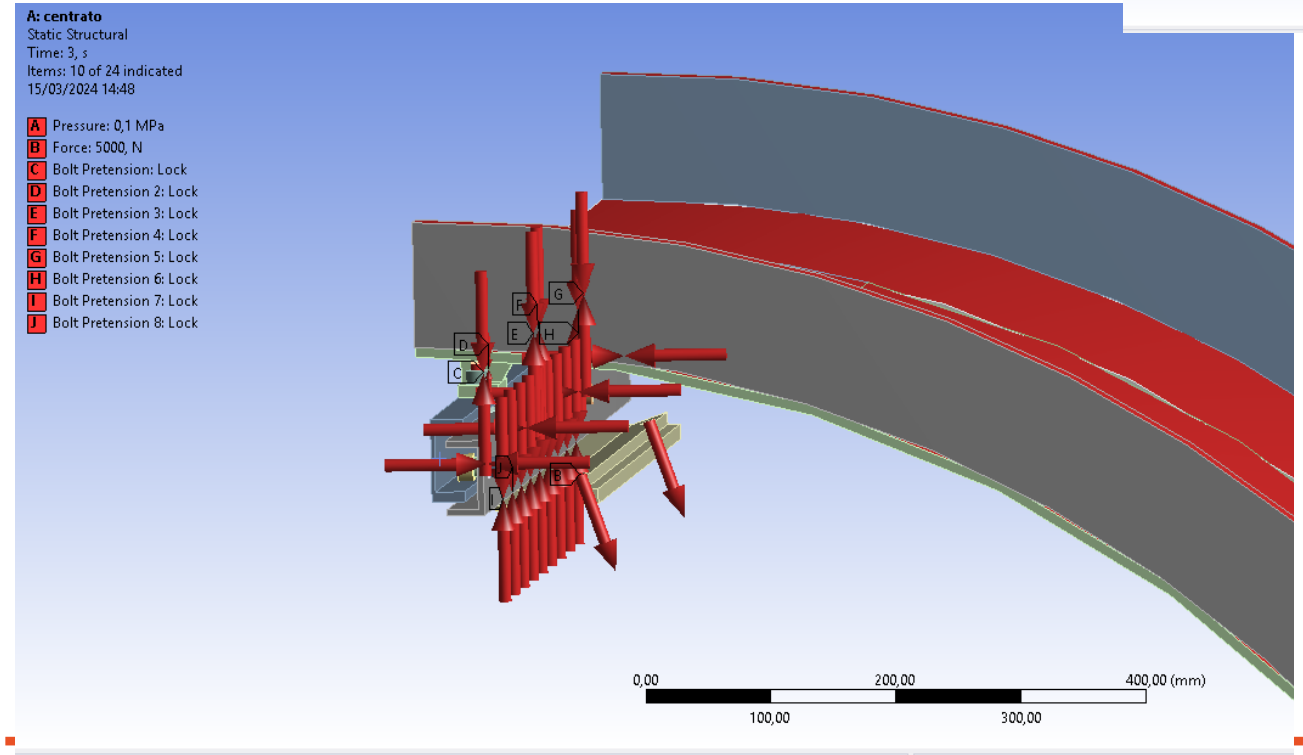


Plate 200x12x900 mm

FEM analysis

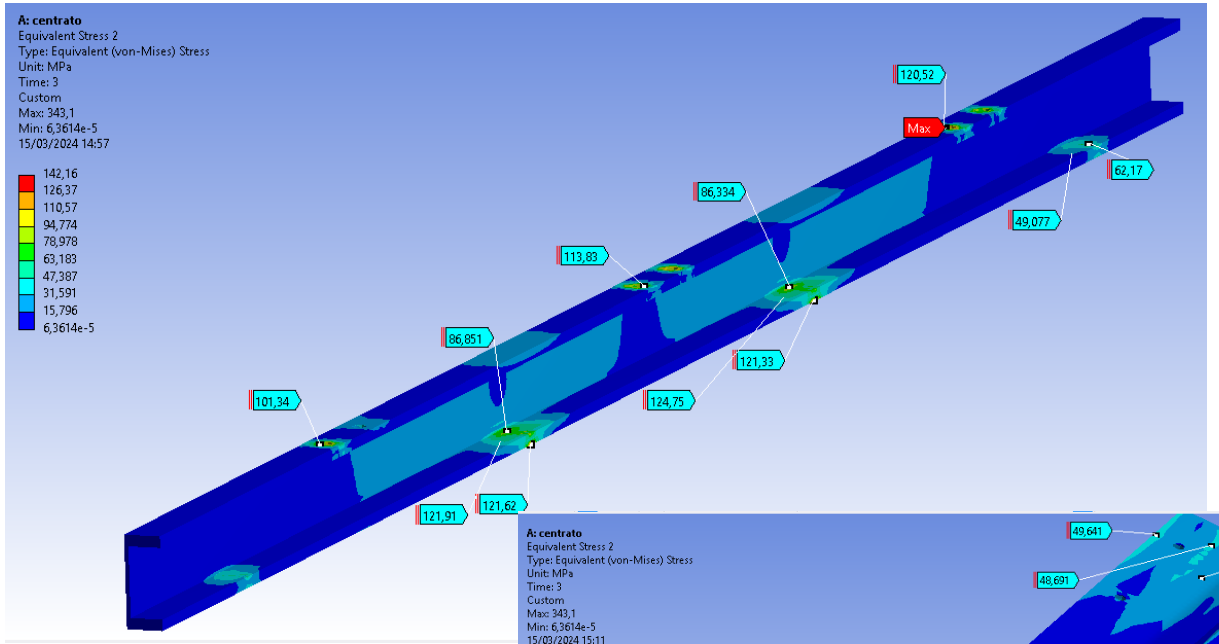


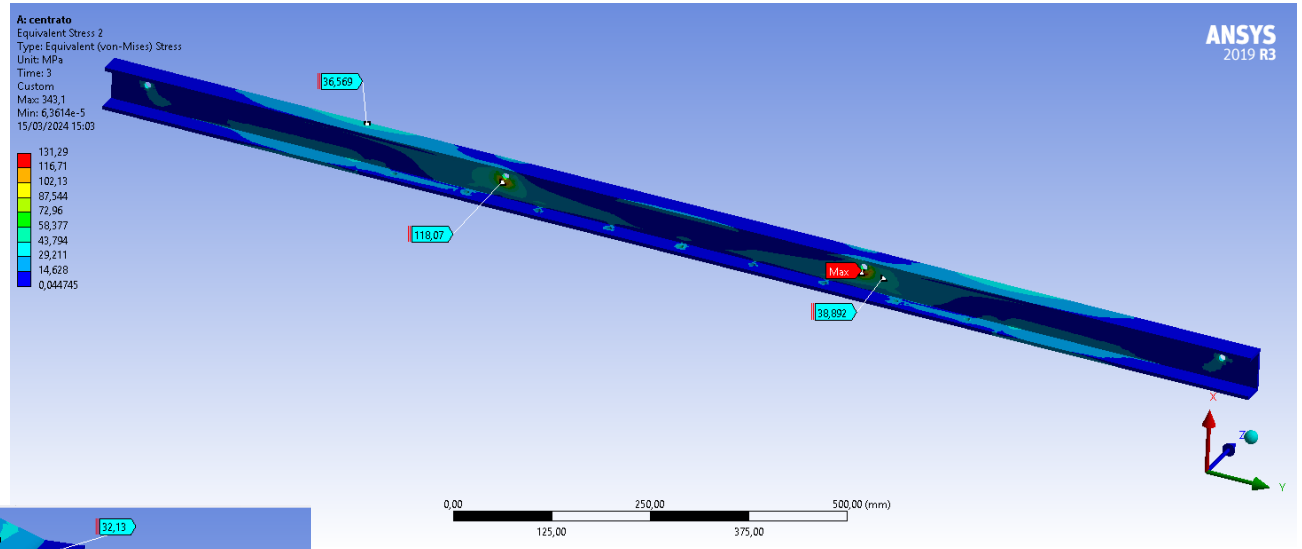


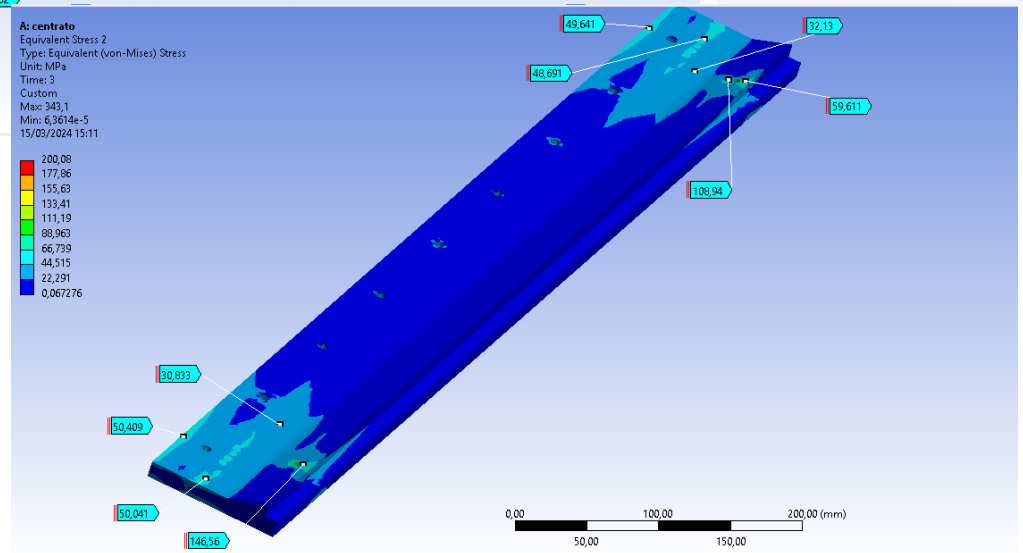
Mesh:
36490 elements
224121 nodes

4 steps:
1- bolts pretension
2- force: 1000 kg
3- external pressure 1 bar
4- force 2: 2000 kg (1 ton of LAr)

FEM analysis





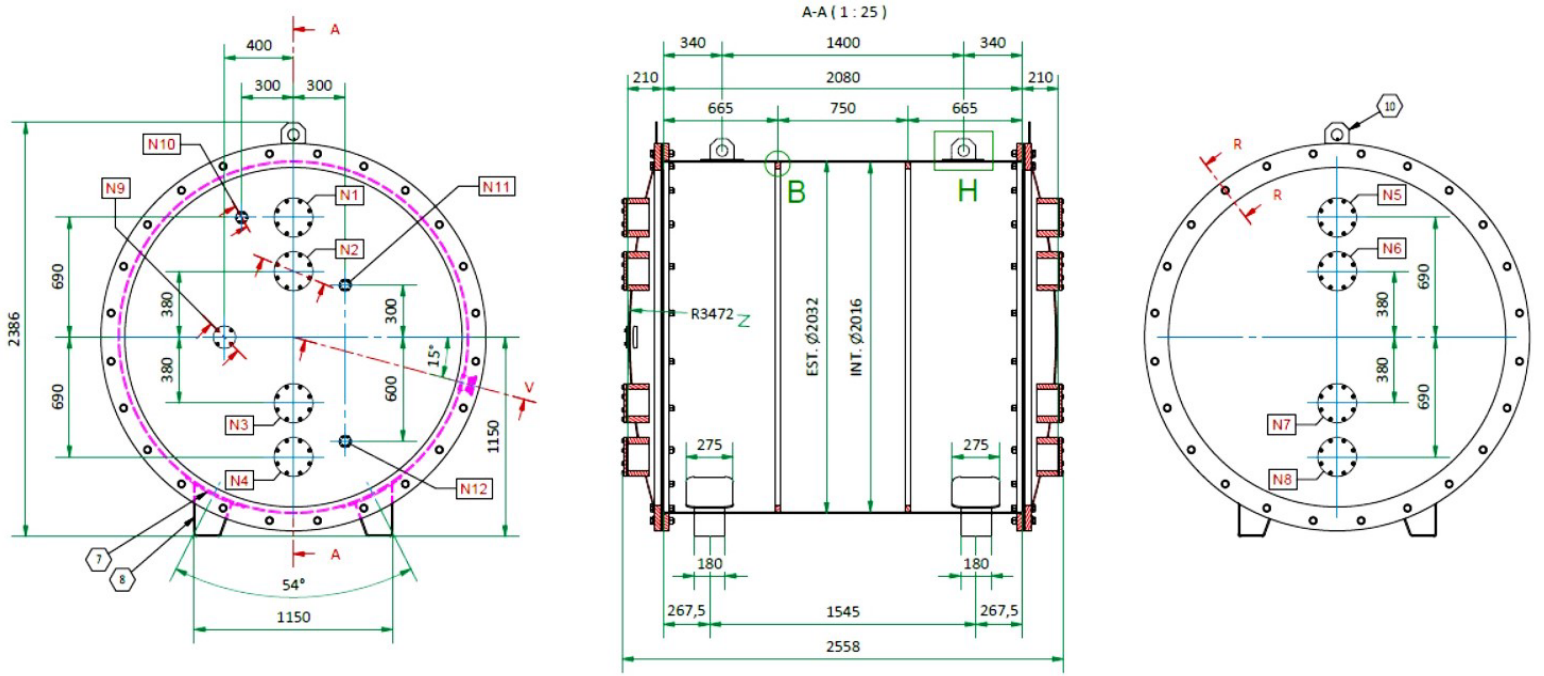


316L Rp0.2=220 MPa

first vacuum tank for LNL facility test

To test cryogenics in LNL,
it has been decided to use a temporary stainless steel vacuum tank

Almost all details have been discussed with the company CryoService
that is starting to manufacture. It will be ready in 6 months



Conclusion

- Inner vessel to be ordered by the end of the year
- First vacuum tank for LNL tests to be ready next winter
- Composite material vacuum tank: we plan to order a scaled mock-up next year