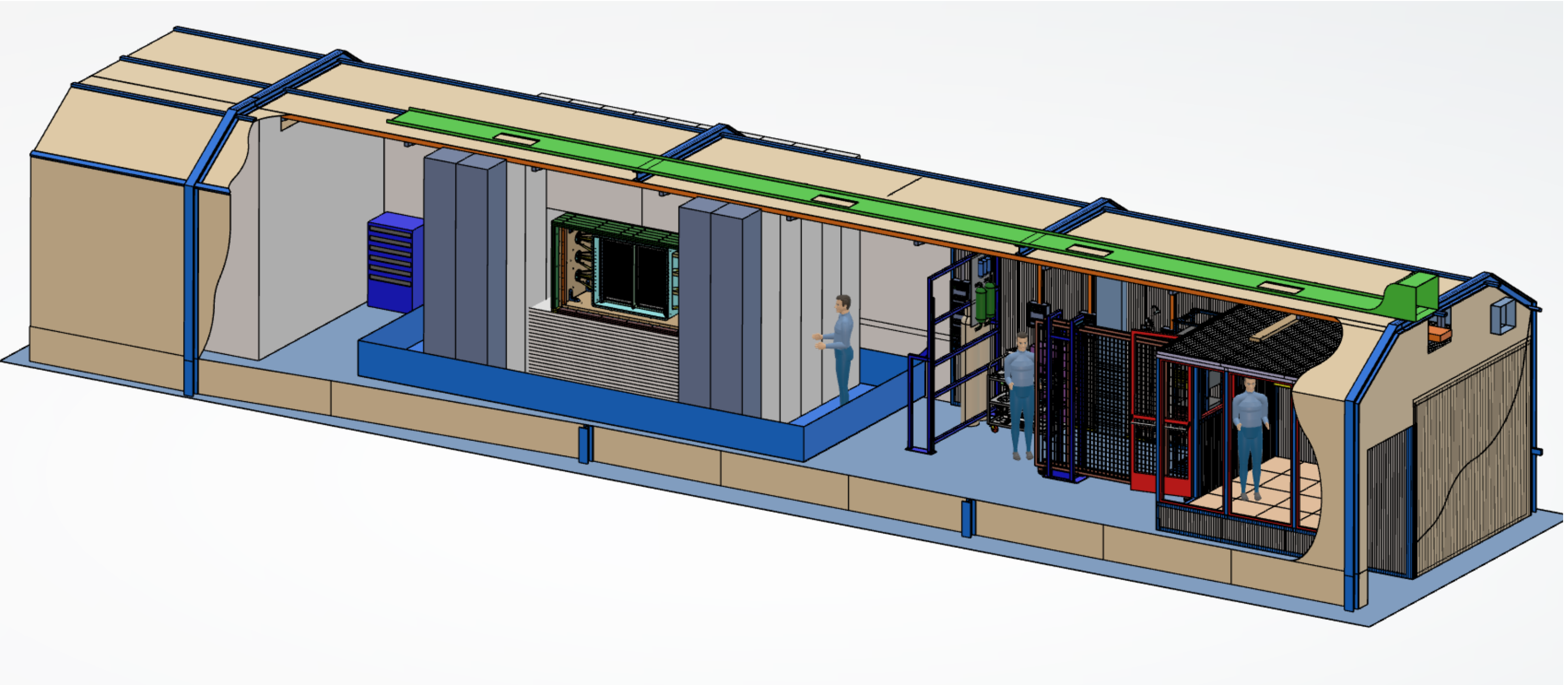
CYGNO
Engineering aspects
Mechanics-Integration-Maintenance



Technical Review Meeting

Frascati

July 22nd 2024

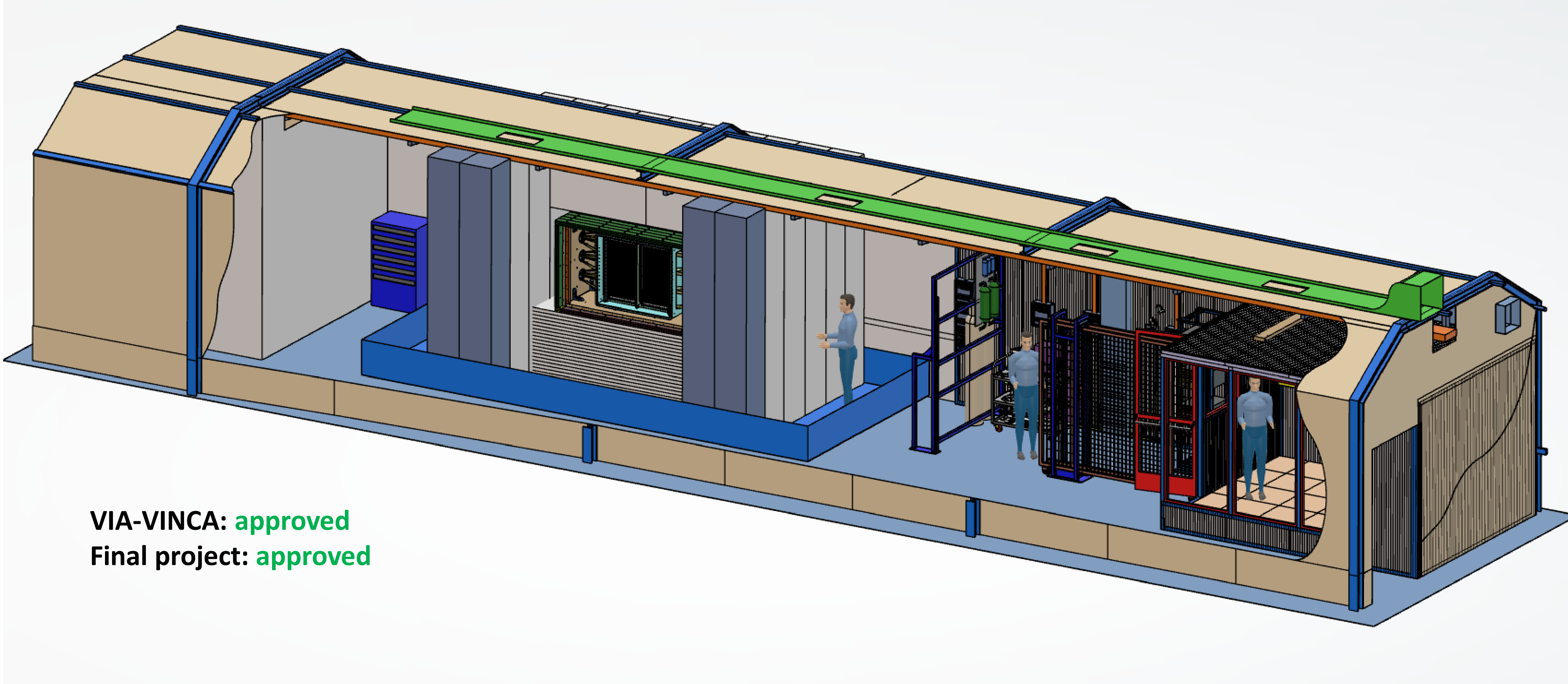
S. Tomassini

I would like to thank all the people who helped me preparing this report

Outline

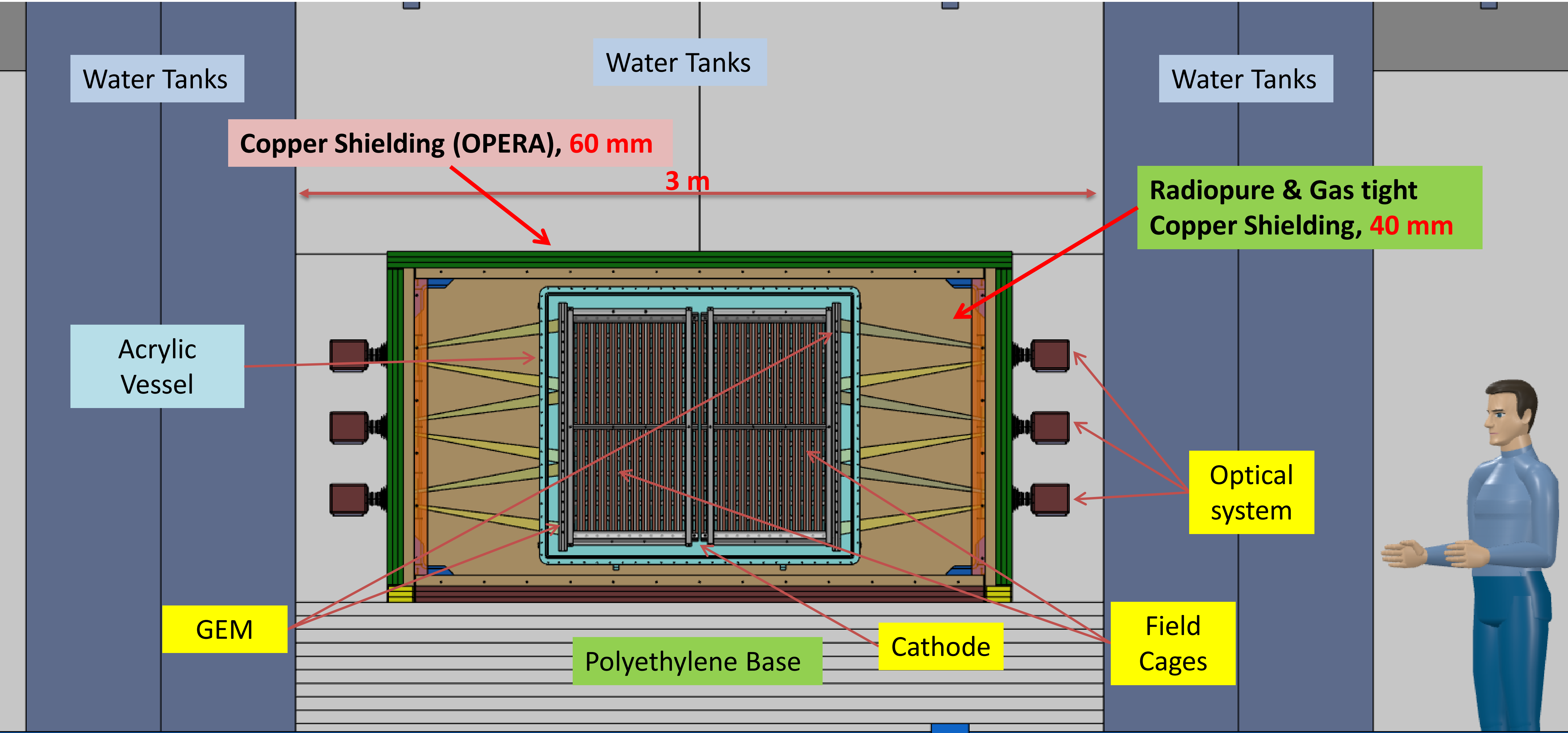
- Cygno general layout
- Gamma shielding Integration
- Neutron shielding integration
- Maintenance sequence
- Field cage design (Engineering aspects)
- FC small prototype for GIN
- Conclusions

CYGNO @ LNGS Hall F

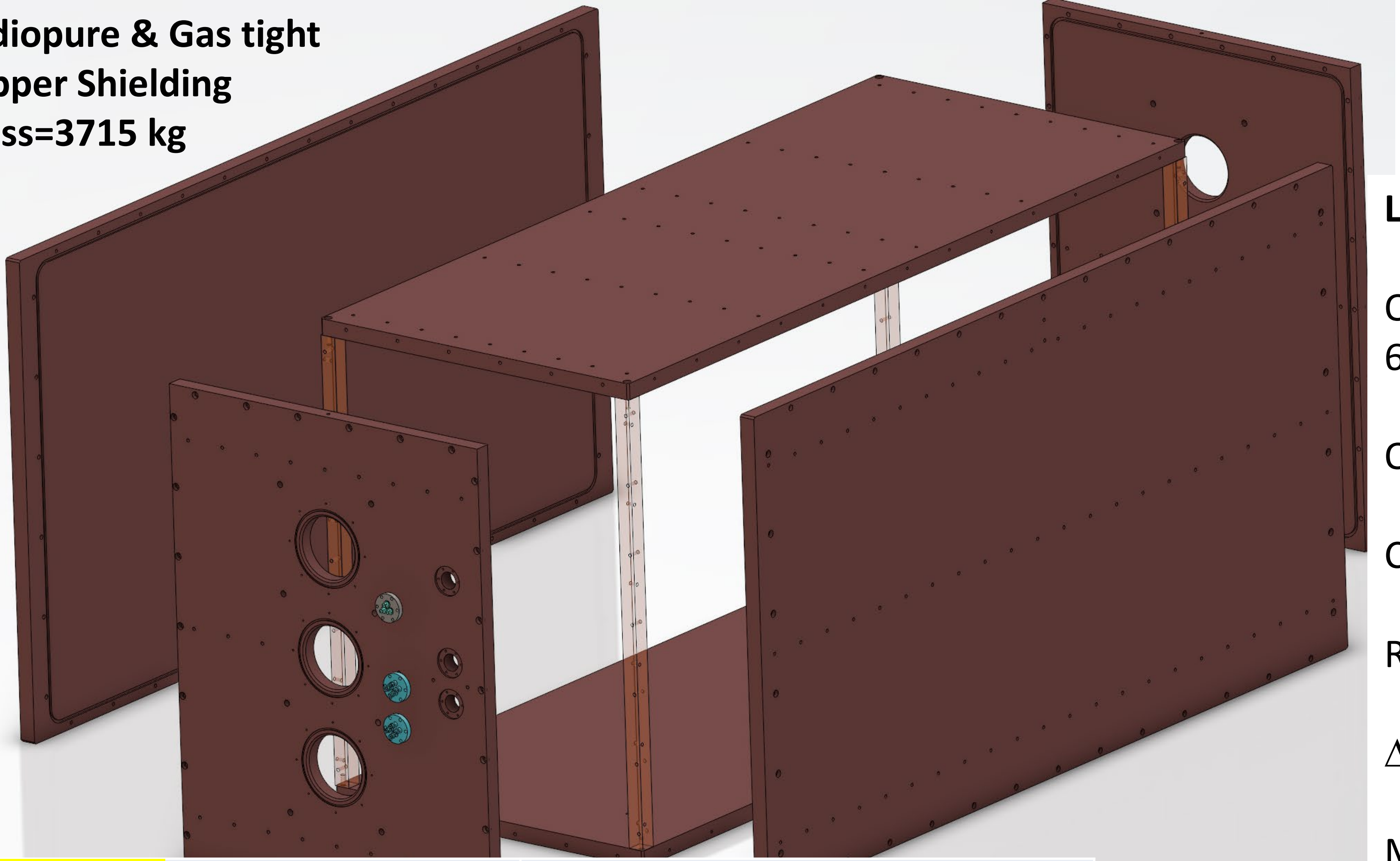


VIA-VINCA: approved
Final project: approved

Mechanical Layout



Radiopure & Gas tight
Copper Shielding
Mass=3715 kg



Leak rate

Leak rate spec: **1 sccm = 0.0168 mbar*l/s**

O-ring length=
6.3*2+4*2+0.57*6+0.050*16+.2*6=**26m**

O-ring diam= 6.3 mm

Compression= 30%

Roughness = 0.8 micron

Δp= +0.5 mbar

Mixture = helium

NOT A VACCUM CHAMBER!

L = 0.7 F D P Q (1-S)2

Where:

L = Approximate leak rate of the seal, std. cc/sec.

F = Permeability rate of the gas through the o-ring elastomer at the expected operating temperature, (std. cc cm/cm2 sec bar) x 10-8

D = contact length of the O-ring, inches (rectangular or square type).

P = Pressure differential across the o-ring seal, lb/in2

Q = Factor based on the percent squeeze and whether the O-ring is lubricated or dry.

S = Percent squeeze on the O-ring cross section expressed as a decimal. (i.e., for a 20% squeeze, S = .20)

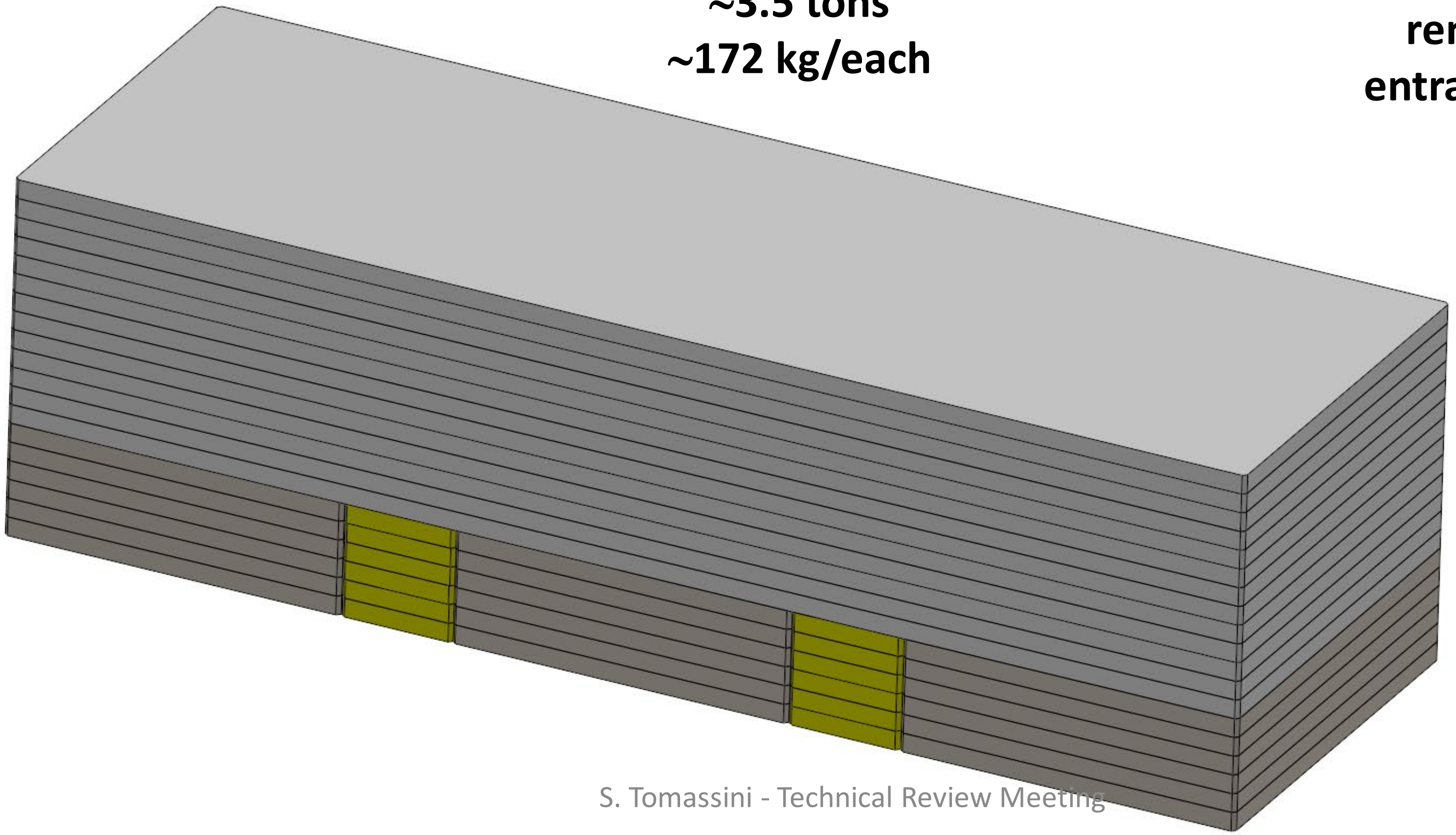
2.81E-06	mbar *l/s
	with safety fact=10

INTEGRATION

Polyethylene Base

~3.5 tons
~172 kg/each

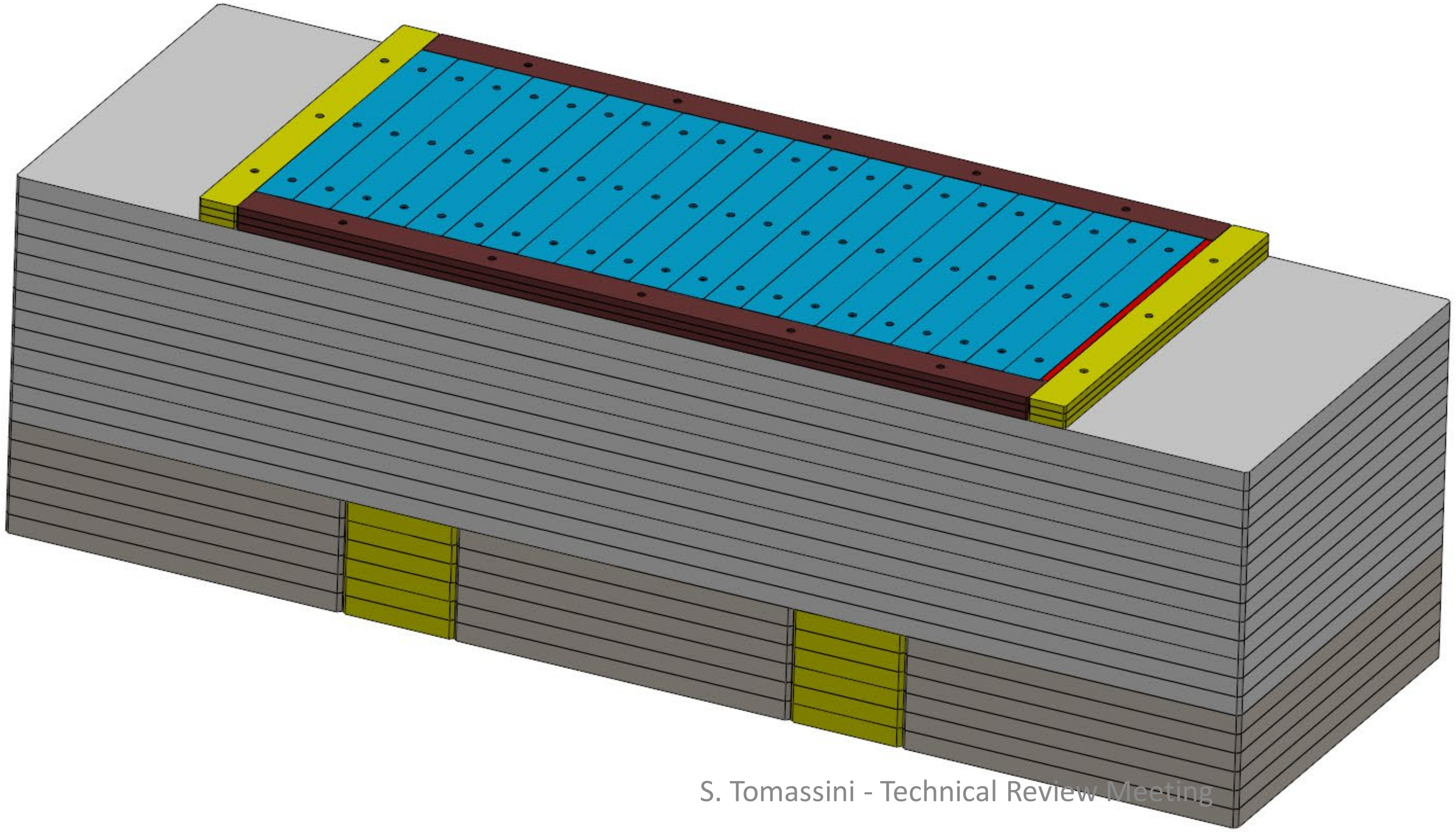
The yellow slots can be removed to allow the entrance of lifting devices



INTEGRATION

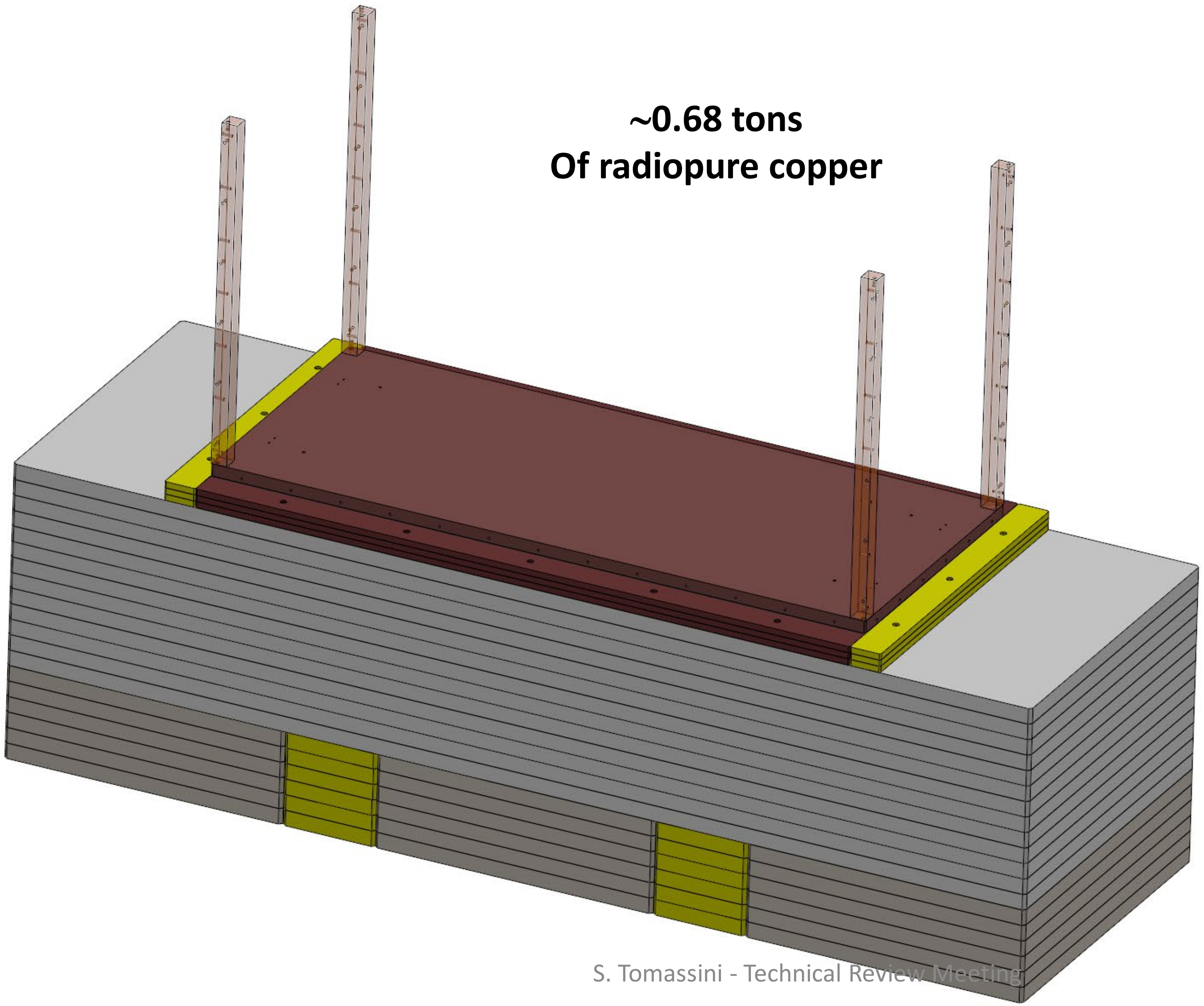
Copper slabs from the OPERA detector at LNGS are recovered to build the external shielding

~1.36 tons

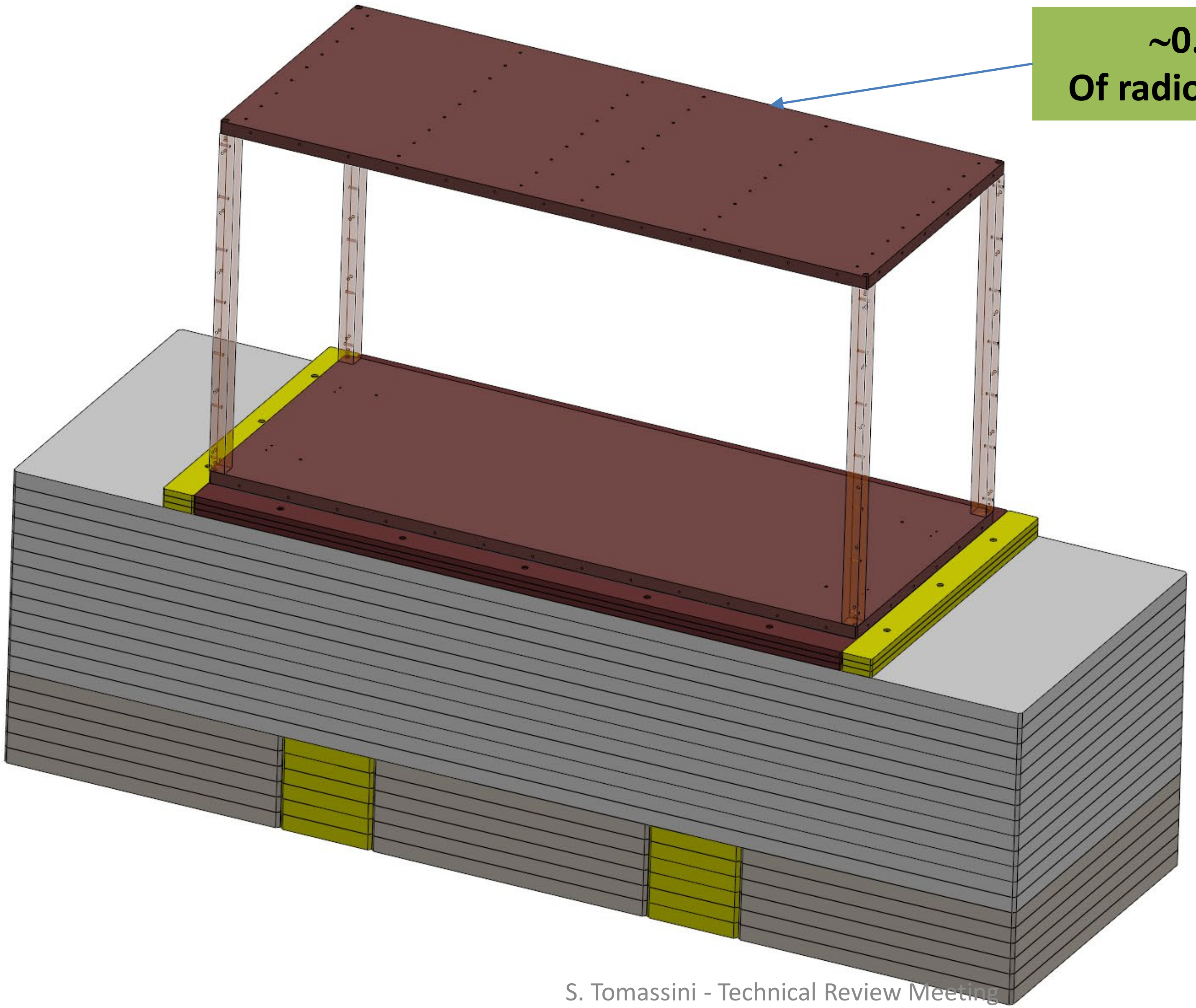


INTEGRATION

~0.68 tons
Of radiopure copper



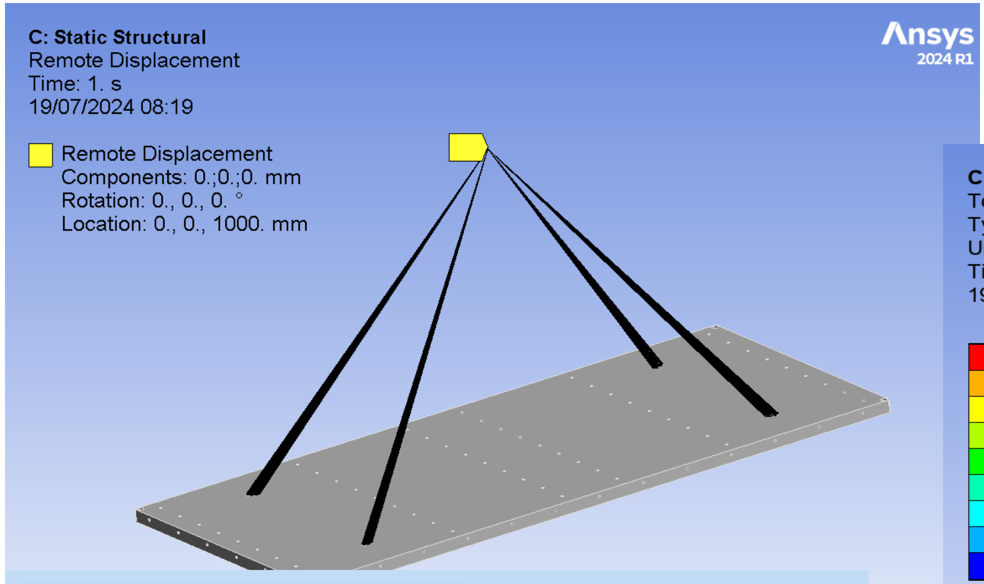
INTEGRATION

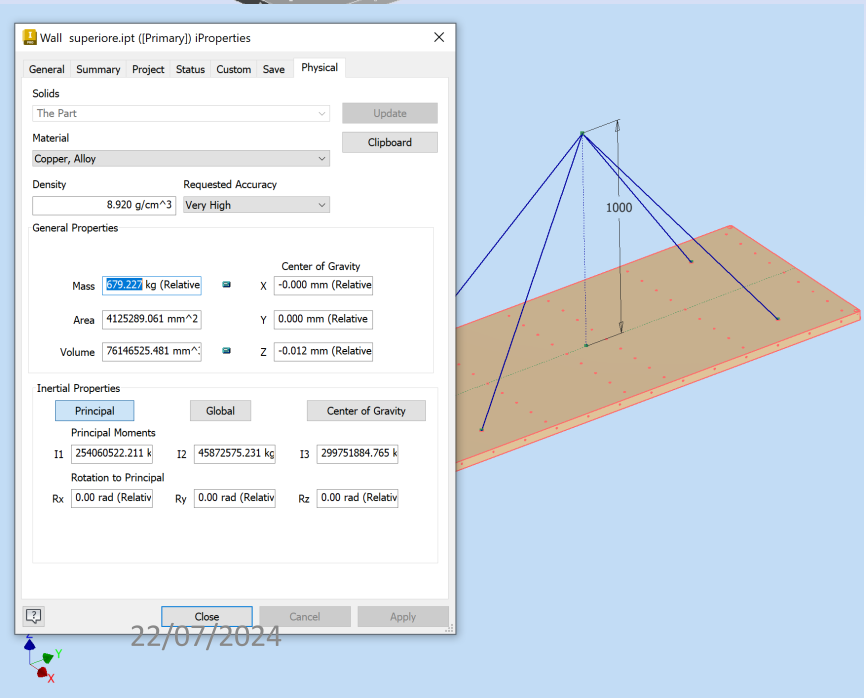


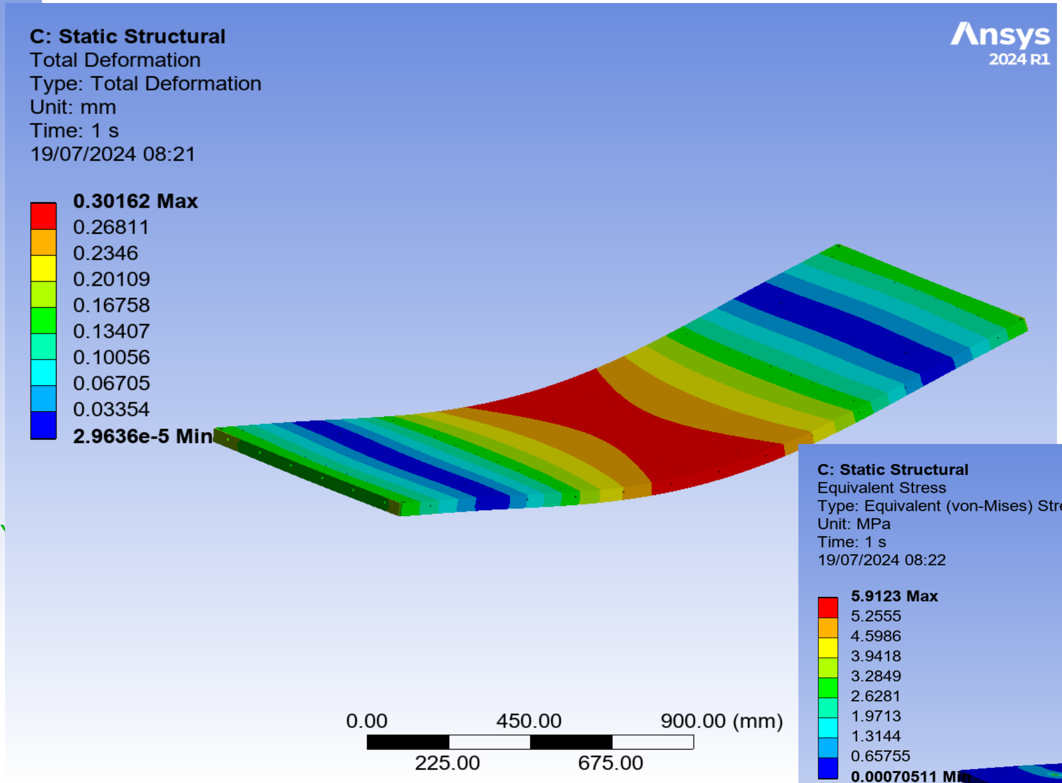
~0.67 tons
Of radiopure copper

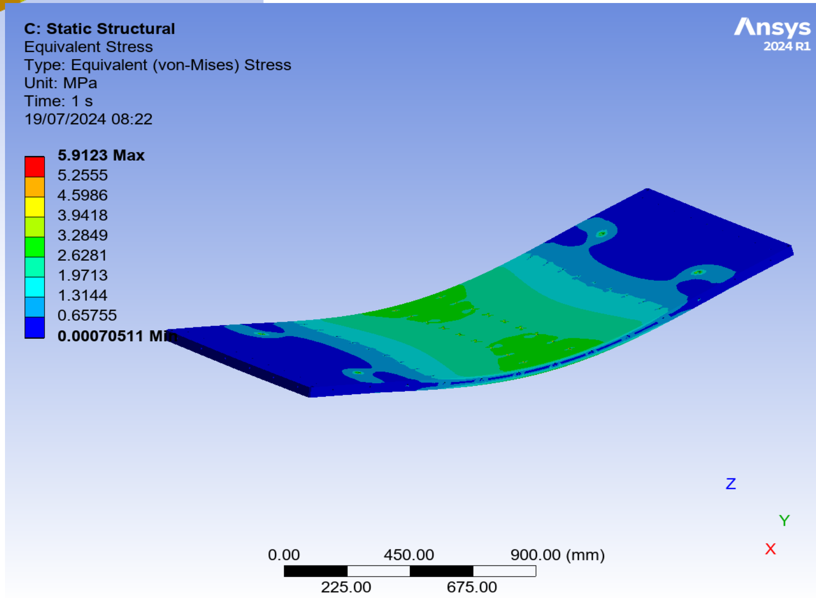
Copper Plate handling

The copper plate can be safely handled with four straps and a lifting device (crane or equivalent). Four Swivel eye-bolts M20 are required.

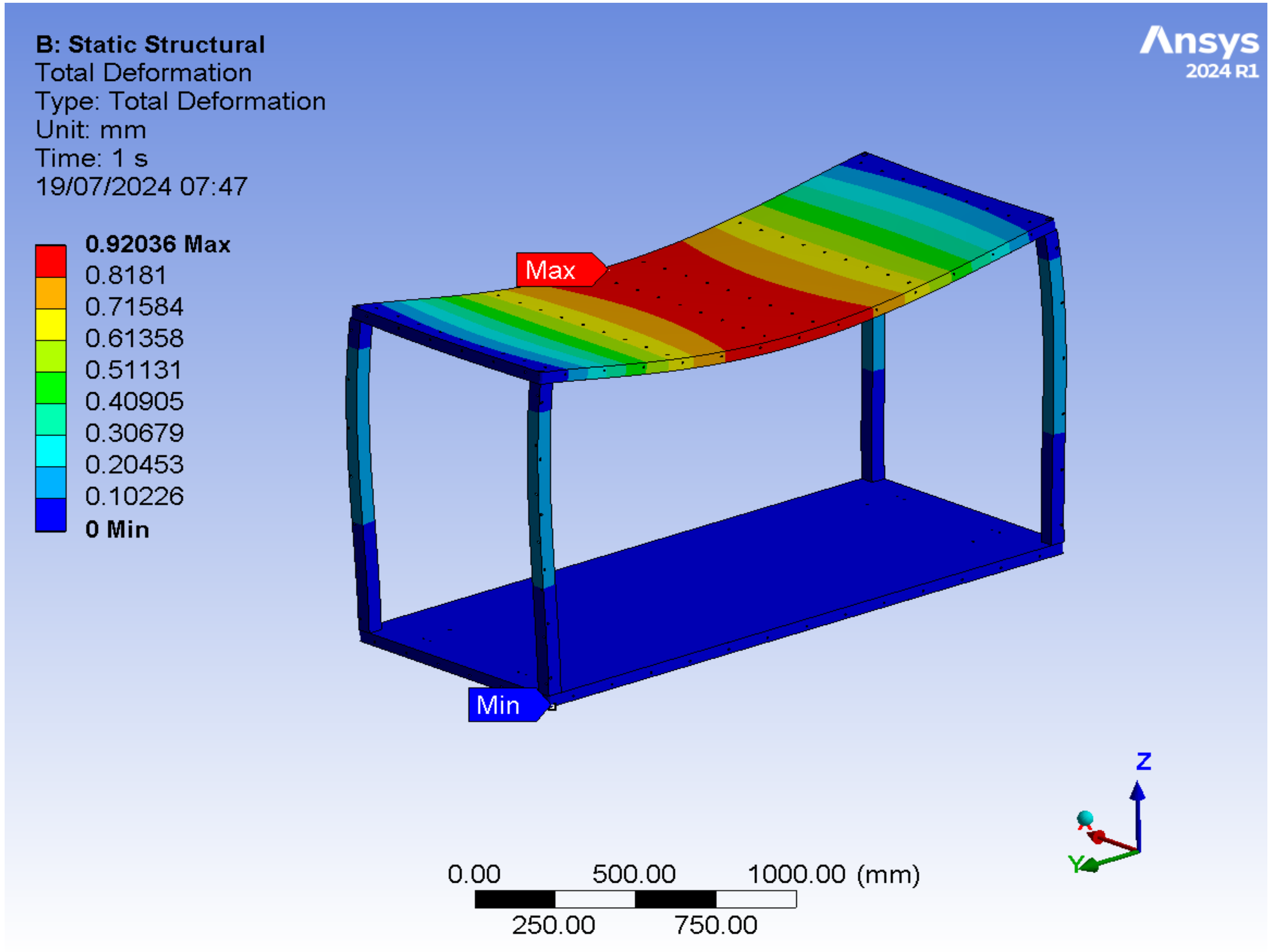




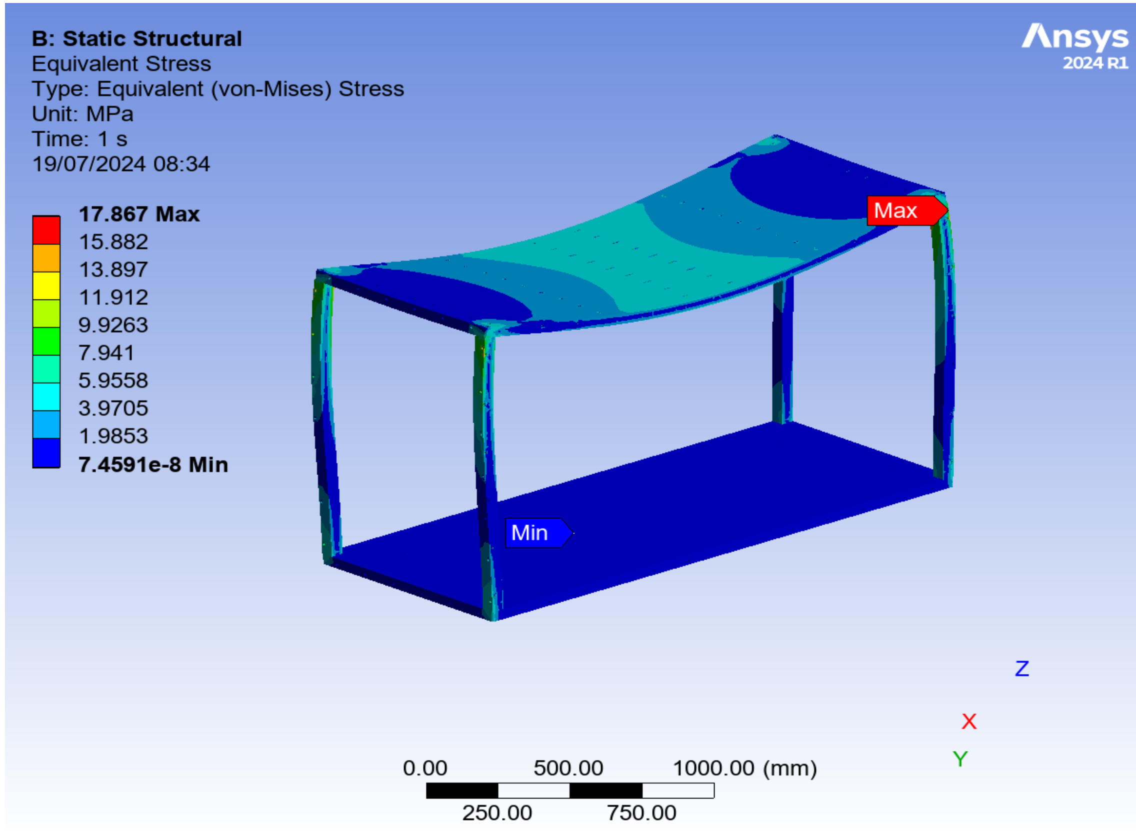




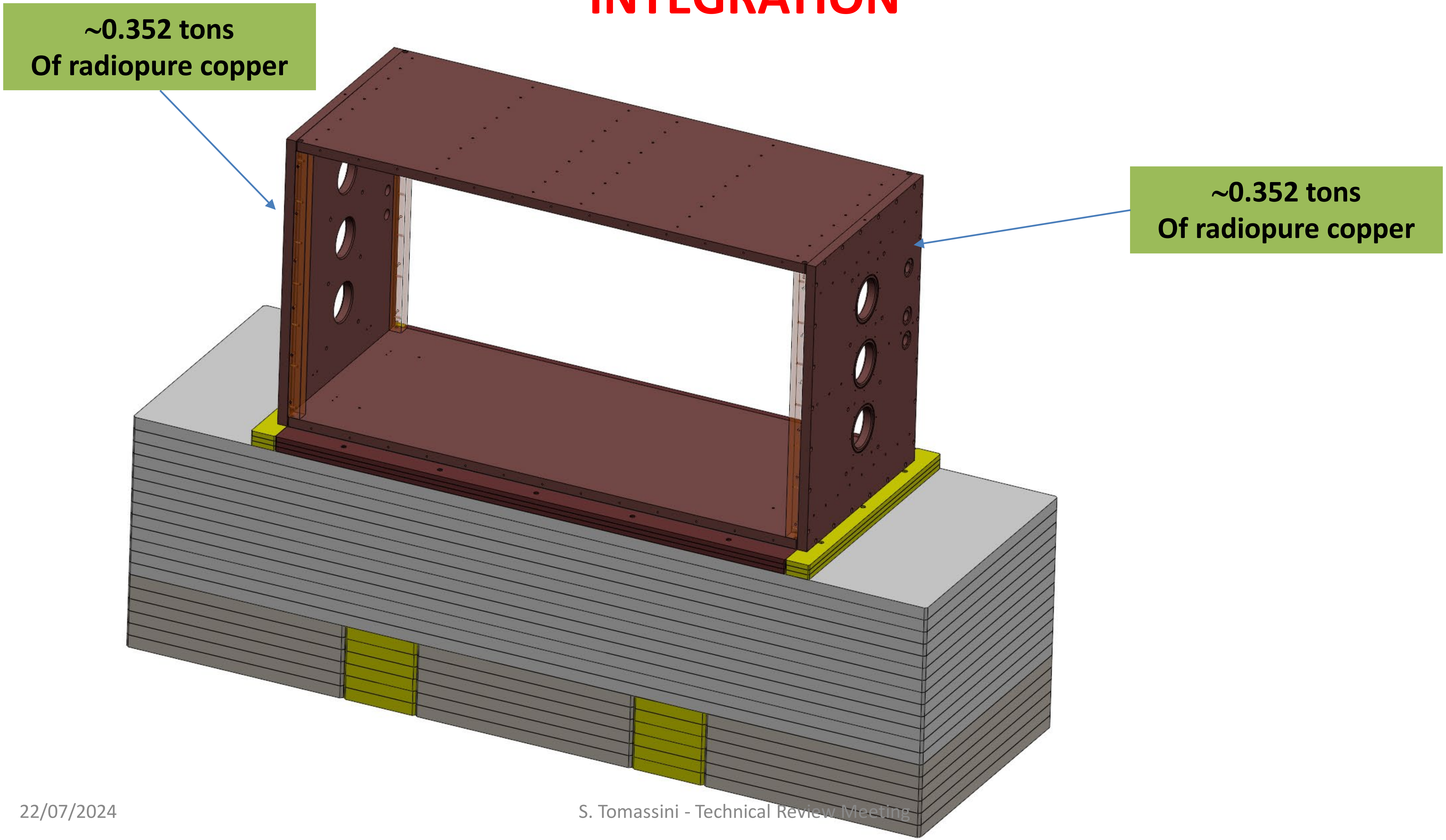
Copper box Integration



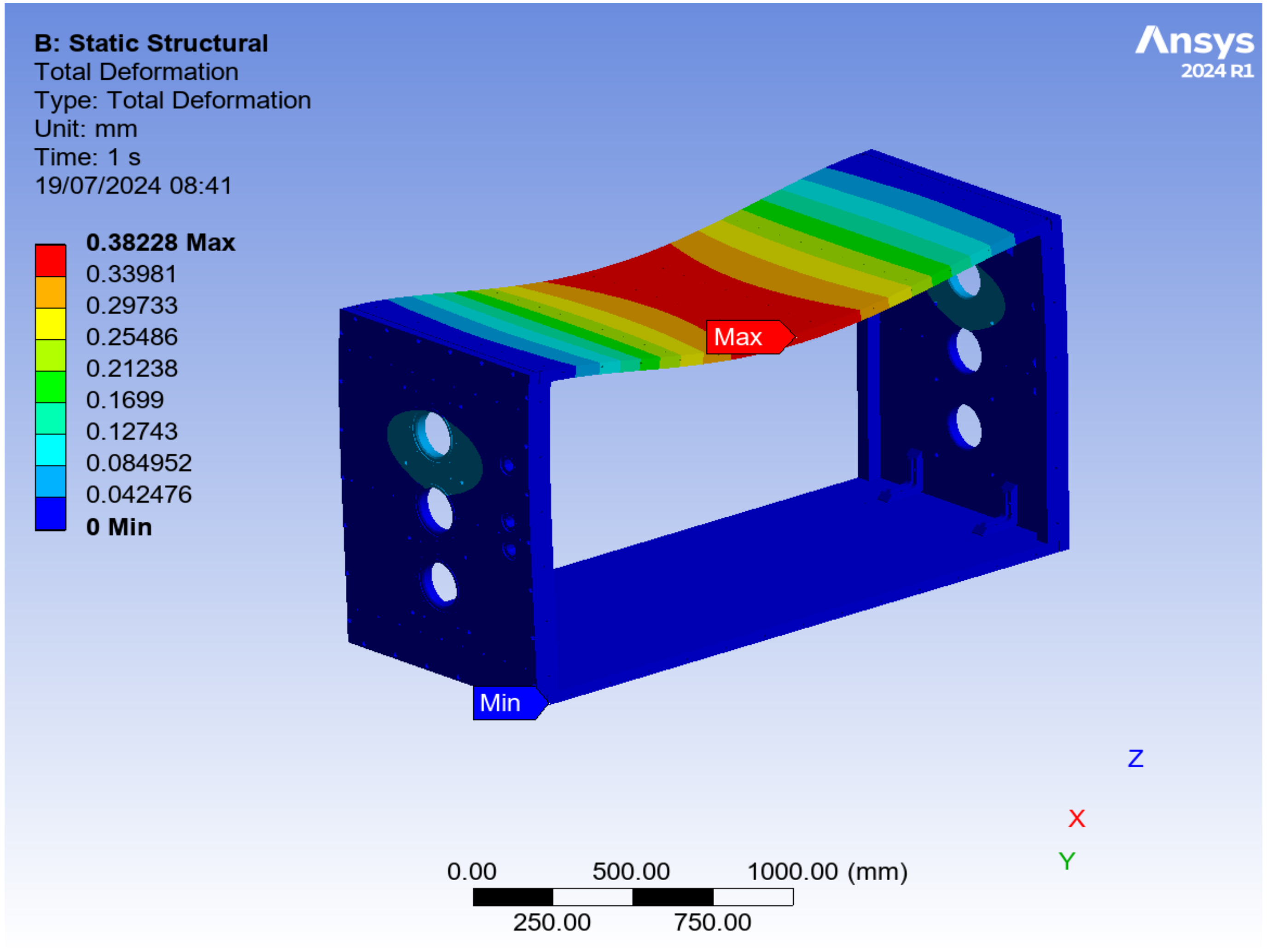
Since large deformations of the top panel occur during integration, for this phases a strong-back is recommended to stiffen the panel. No problem for the stress level.



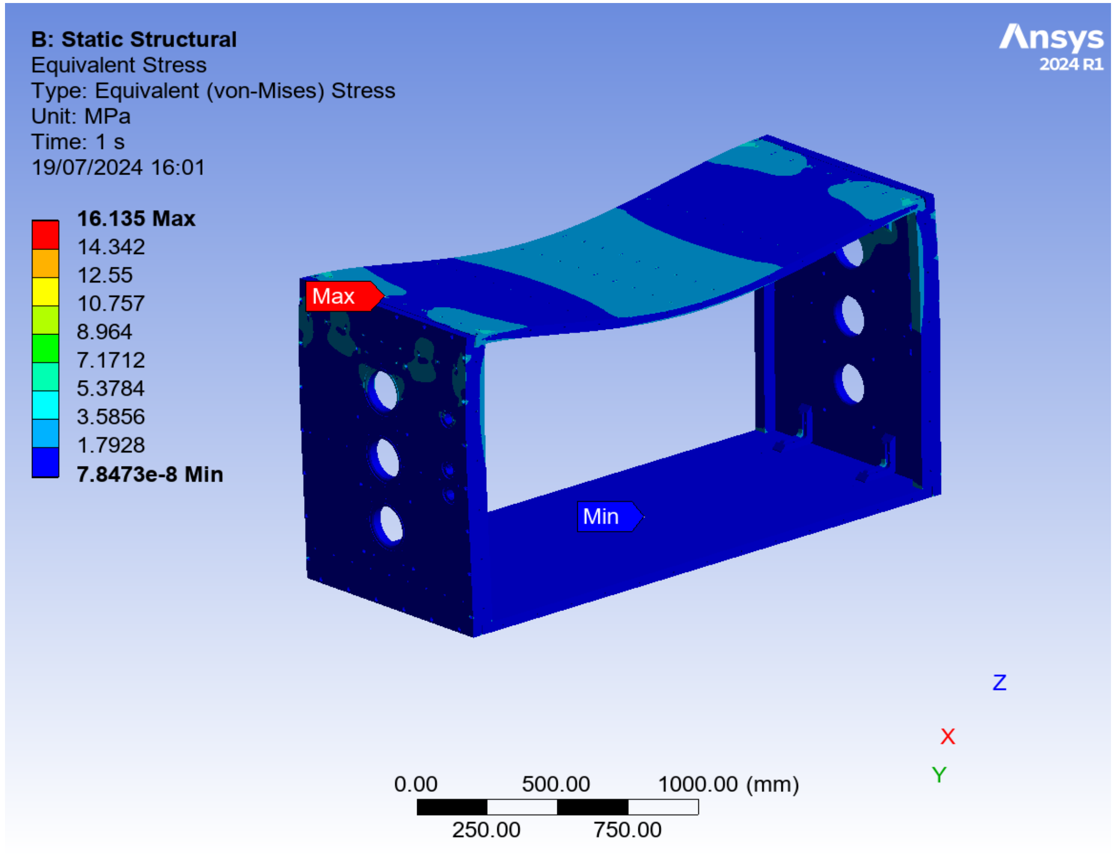
INTEGRATION



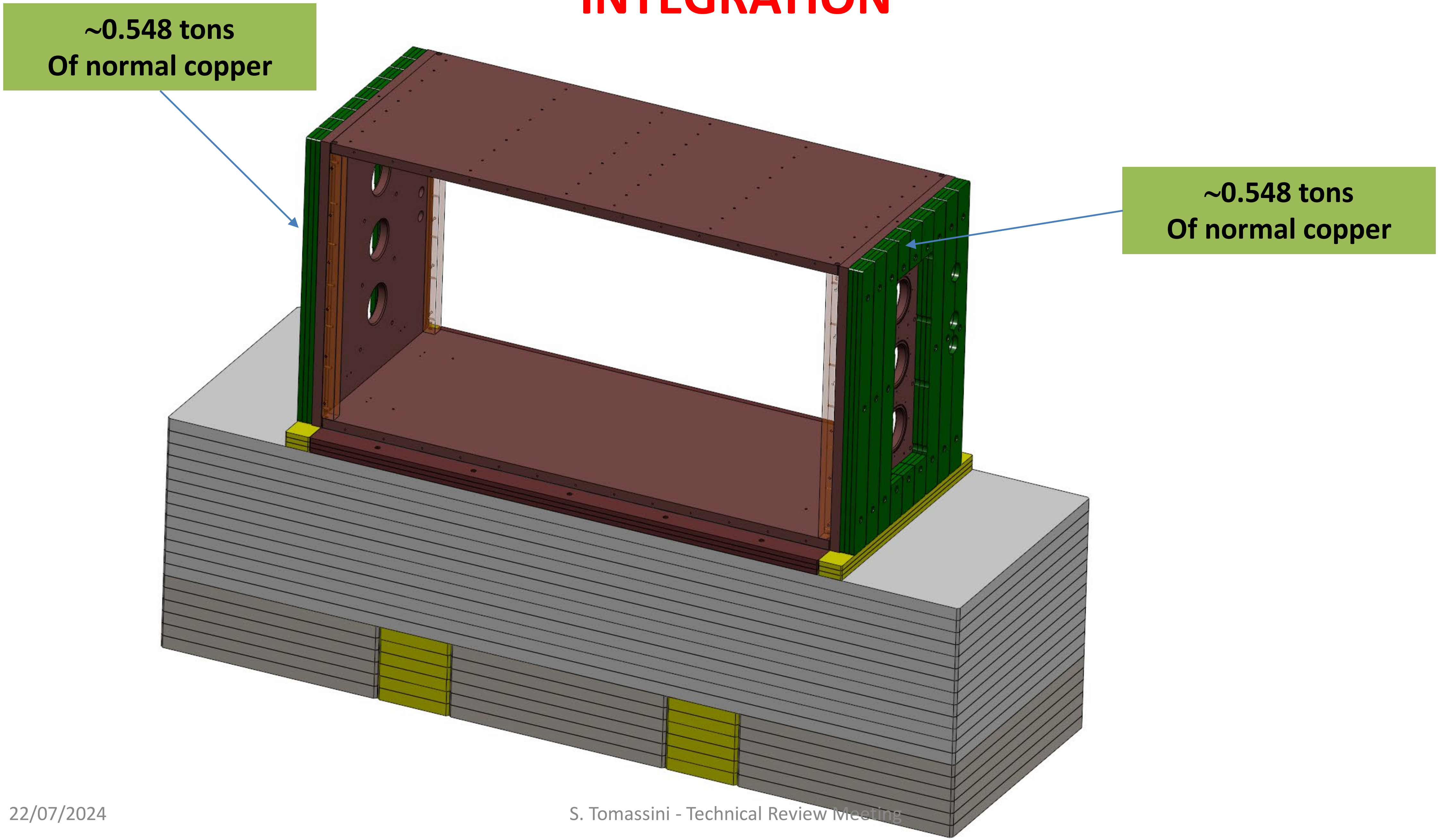
Copper box Integration cont'



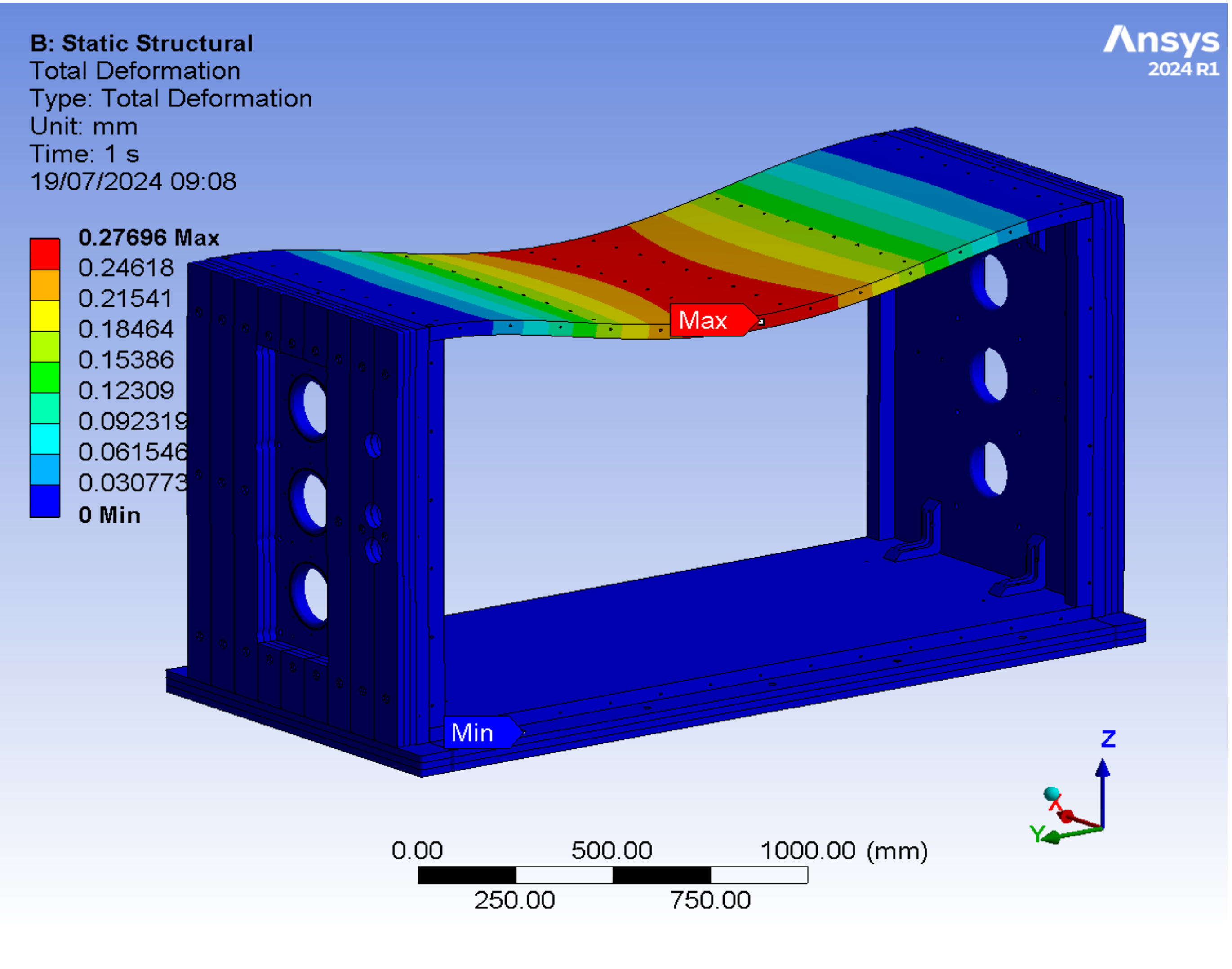
Since deformations of the top panel occur during integration, for this phase a strong-back is still required to stiffen the panel and allow the integration of the copper slabs on the external layer.



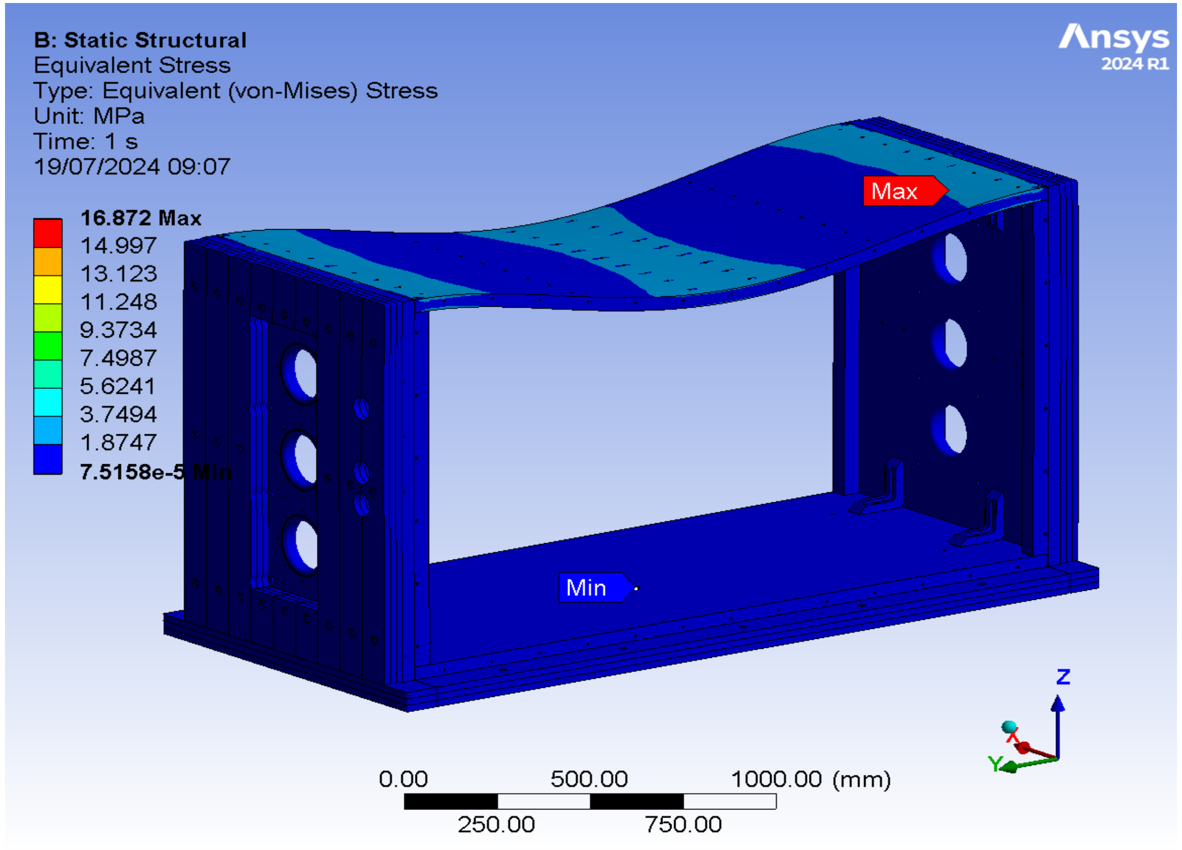
INTEGRATION



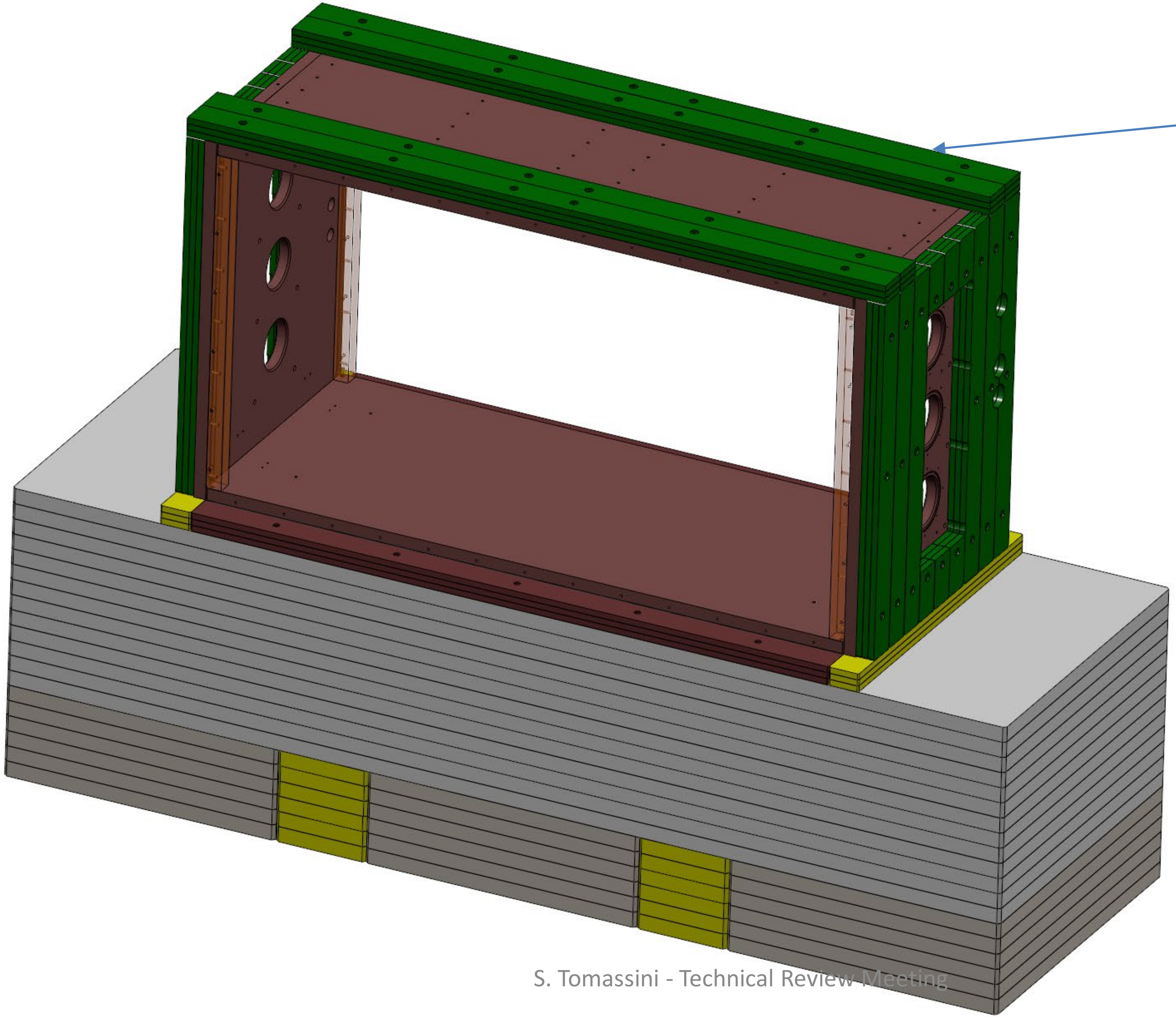
Copper box Integration cont'



In this phase a strong-back is still required to stiffen the panel and allow the integration of the copper slabs on the external layer.

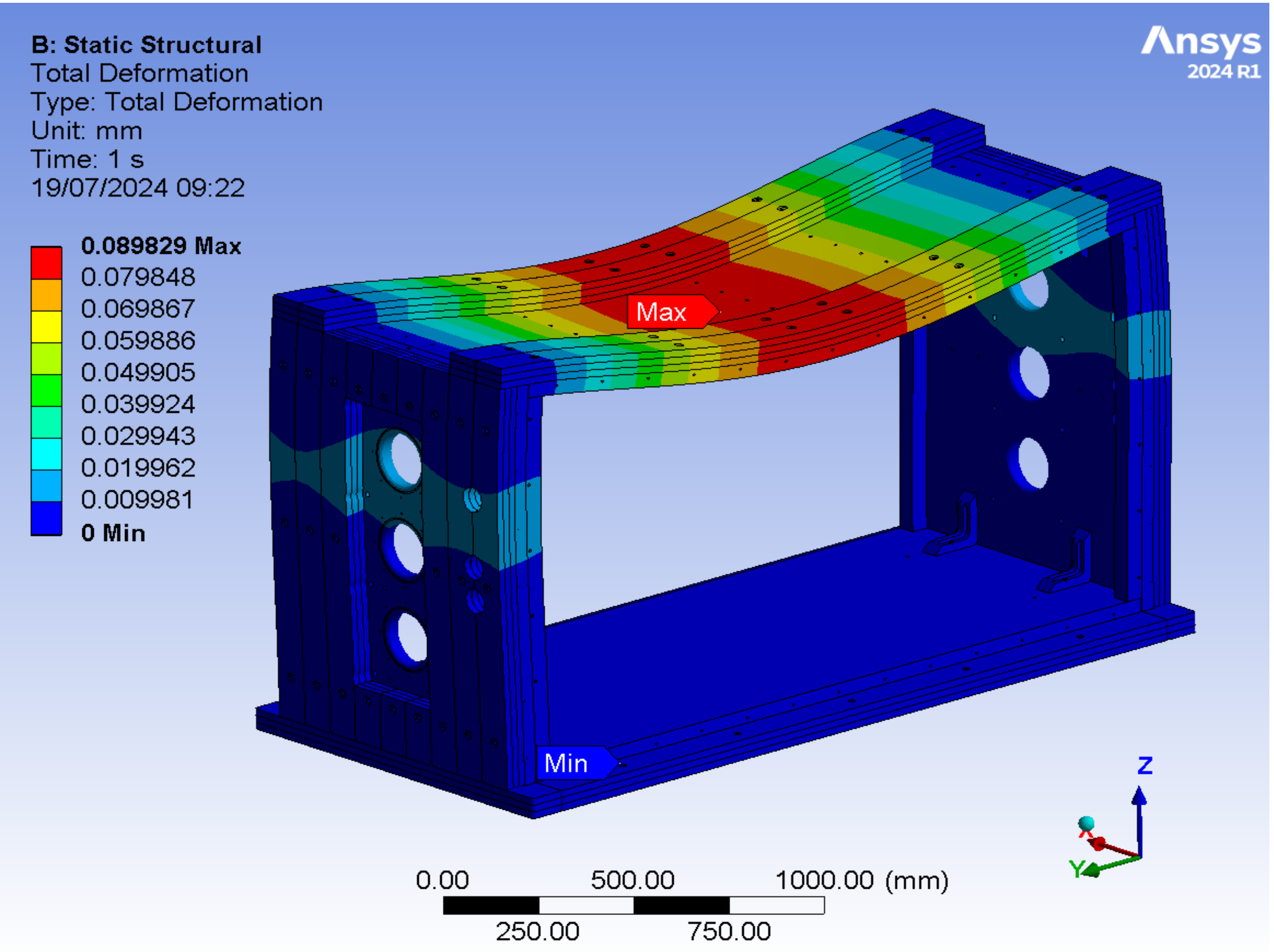


INTEGRATION

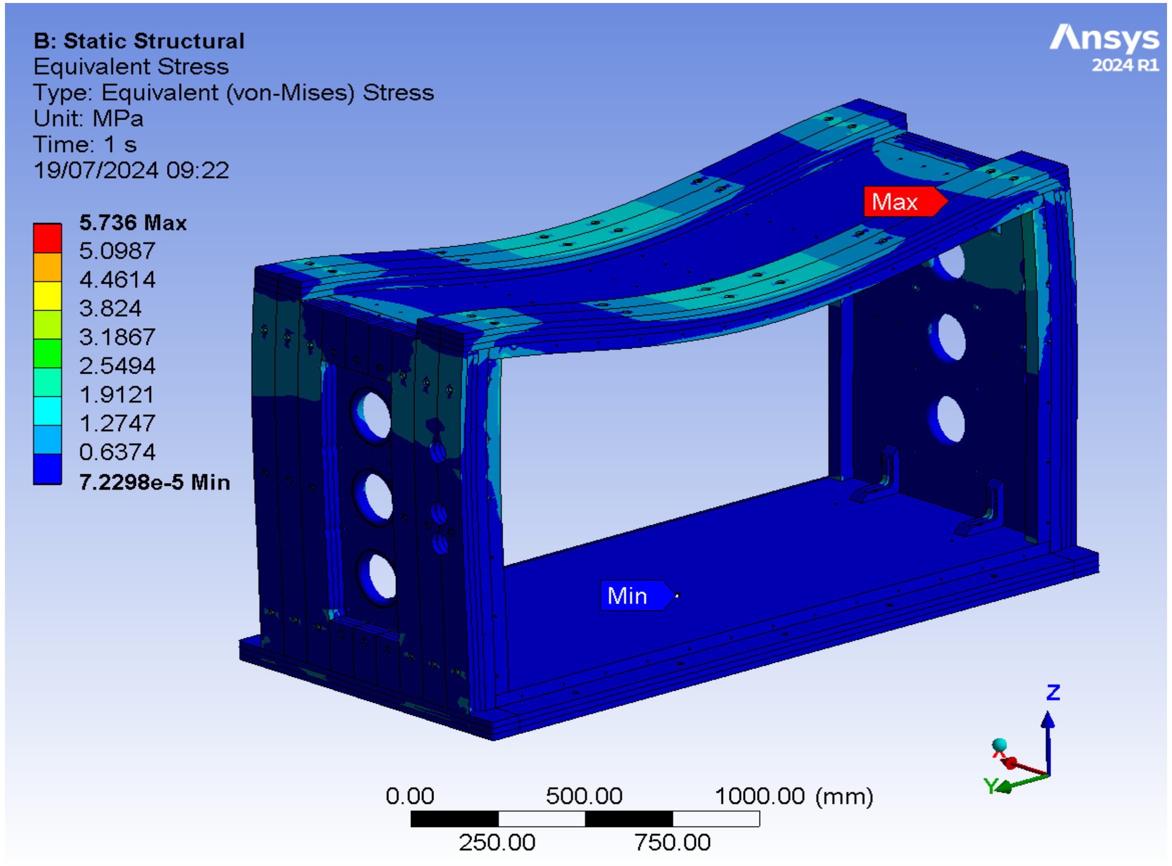


~0.496 tons
Of normal copper

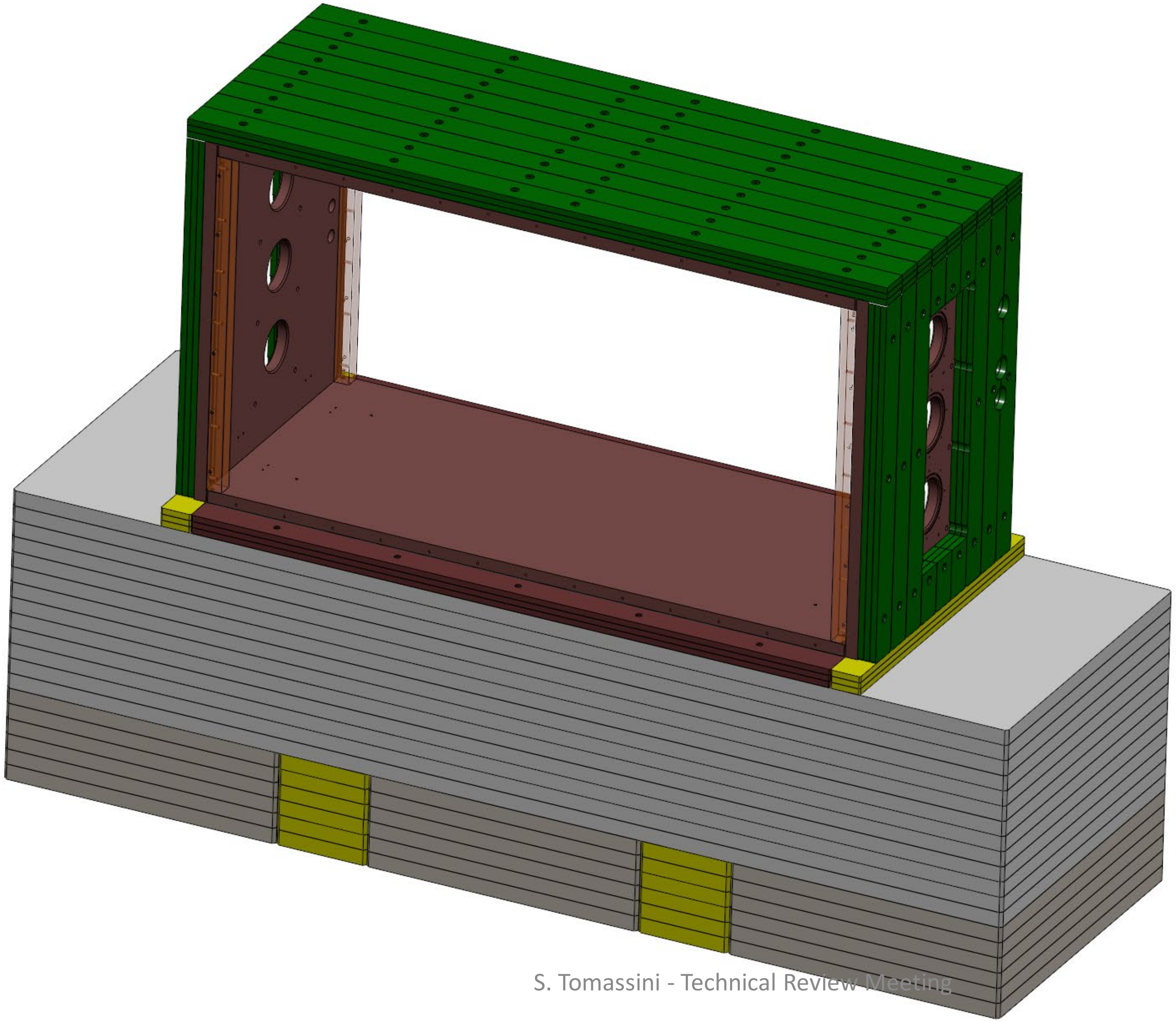
Copper box Integration cont'



In this phases, after the integration and the tightening of 12 slabs on the top panel, the strong-back can be removed since the deformation of the top plate itself is below 0.1 mm

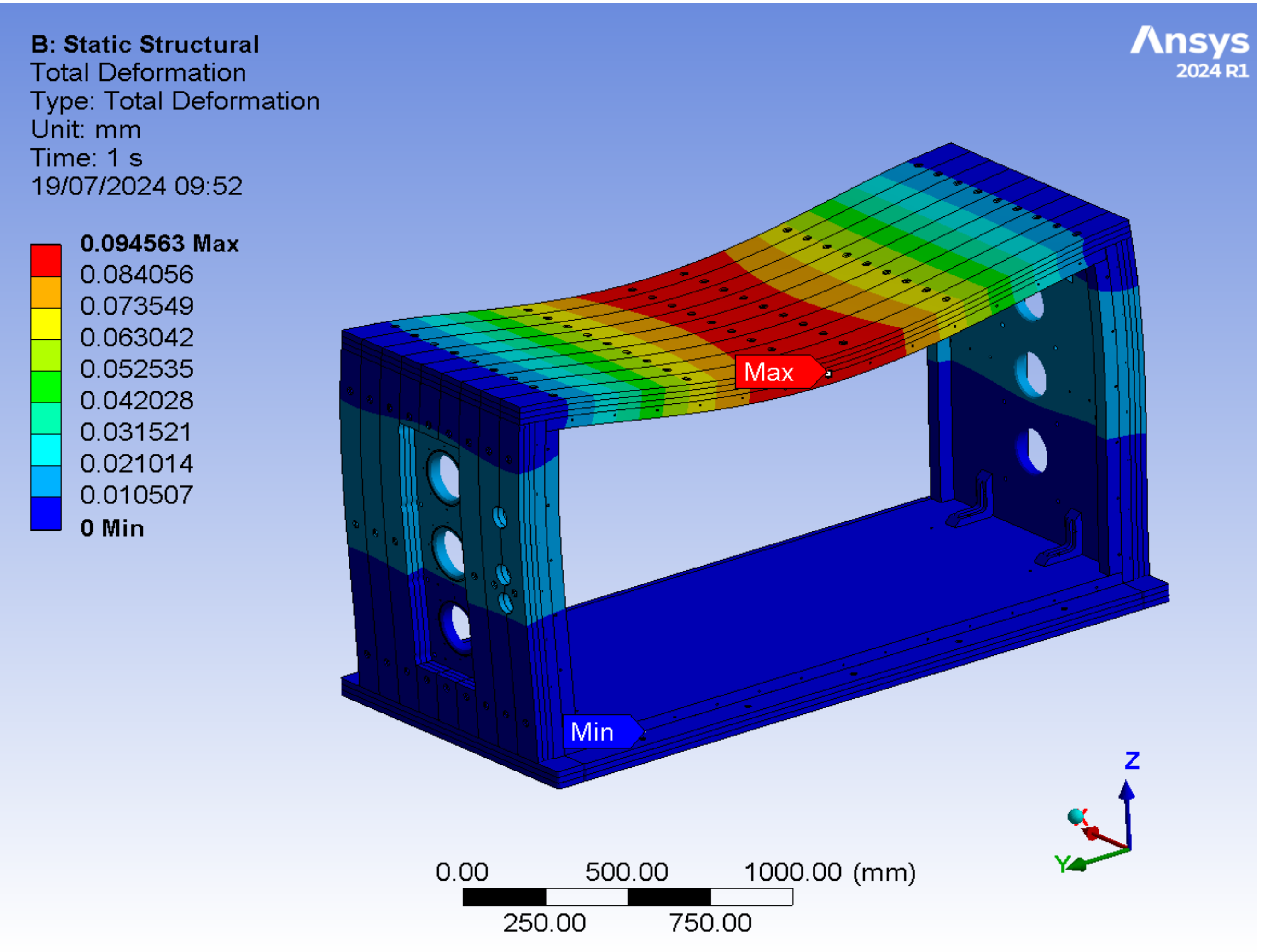


INTEGRATION

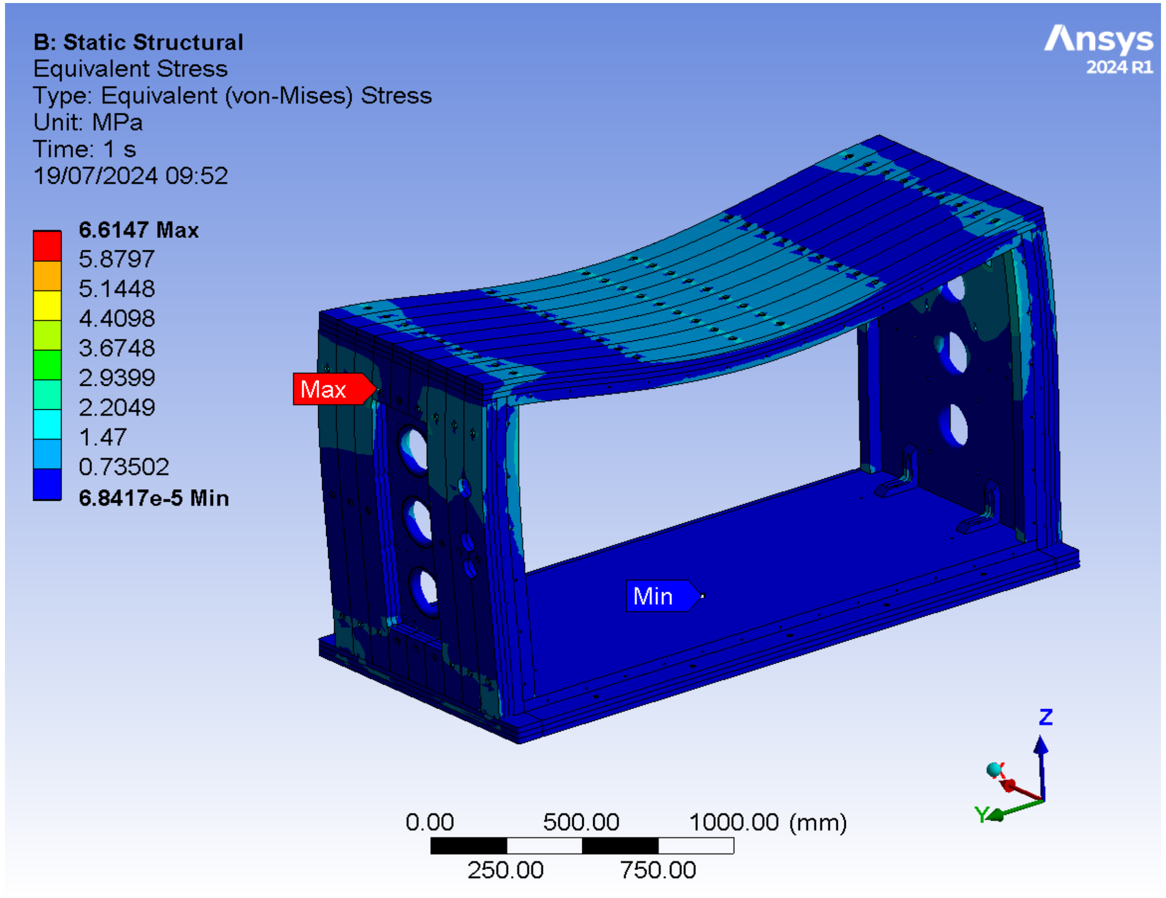


Completion of TOP part

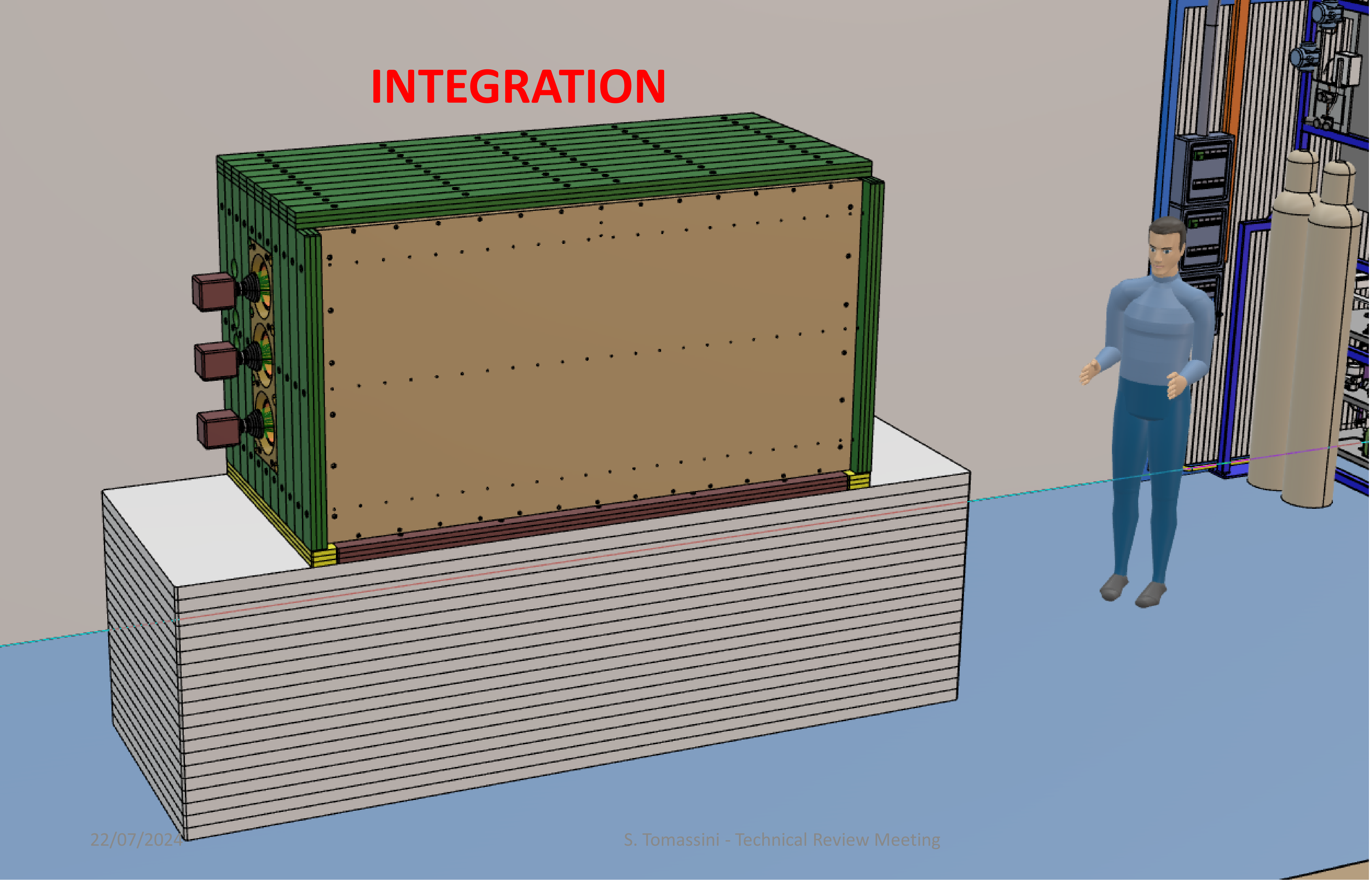
Copper box Integration cont'



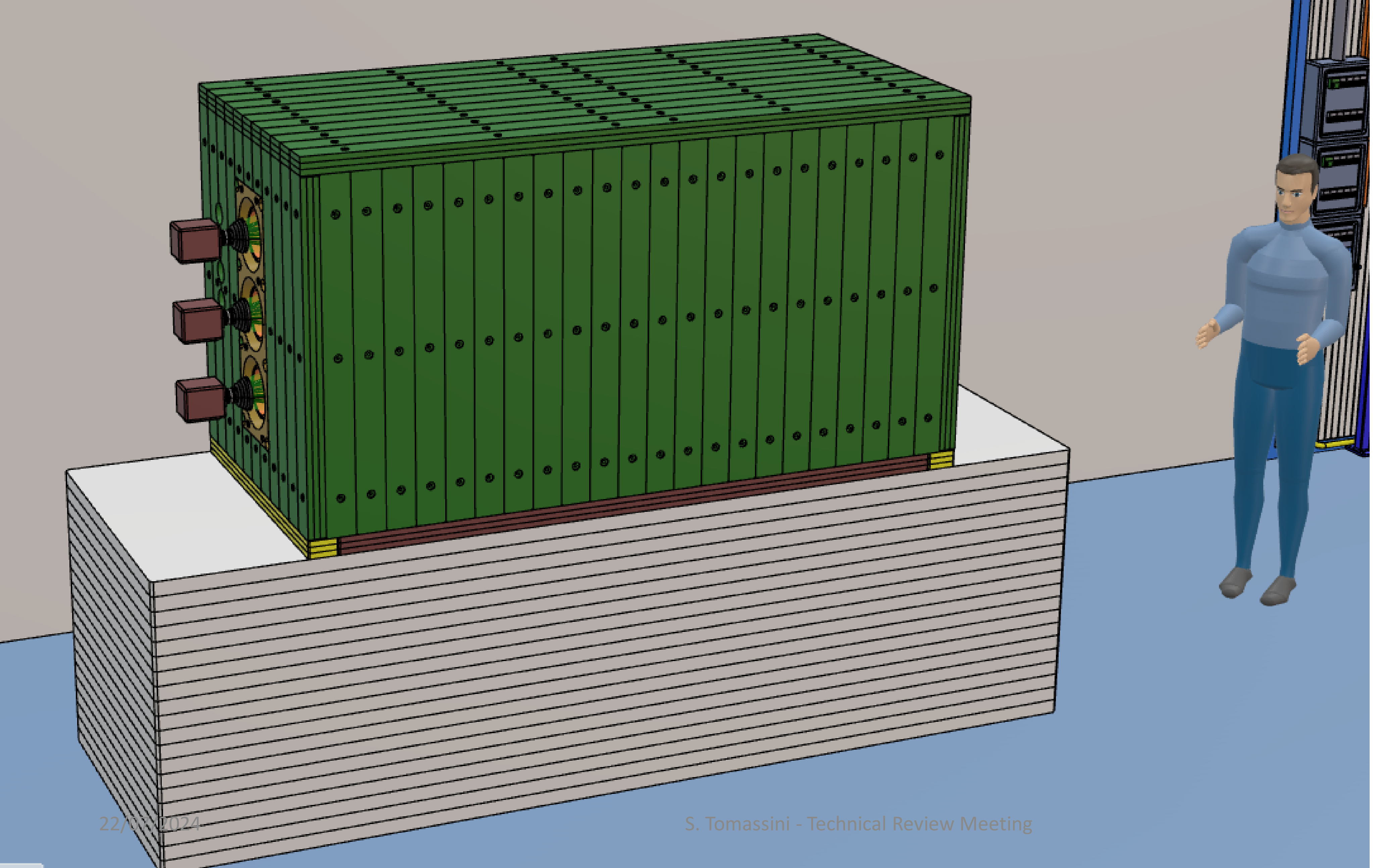
In this phases, after the integration and the tightening of all slabs on the top panel, the deformation of the top plate itself remains below 0.1 mm



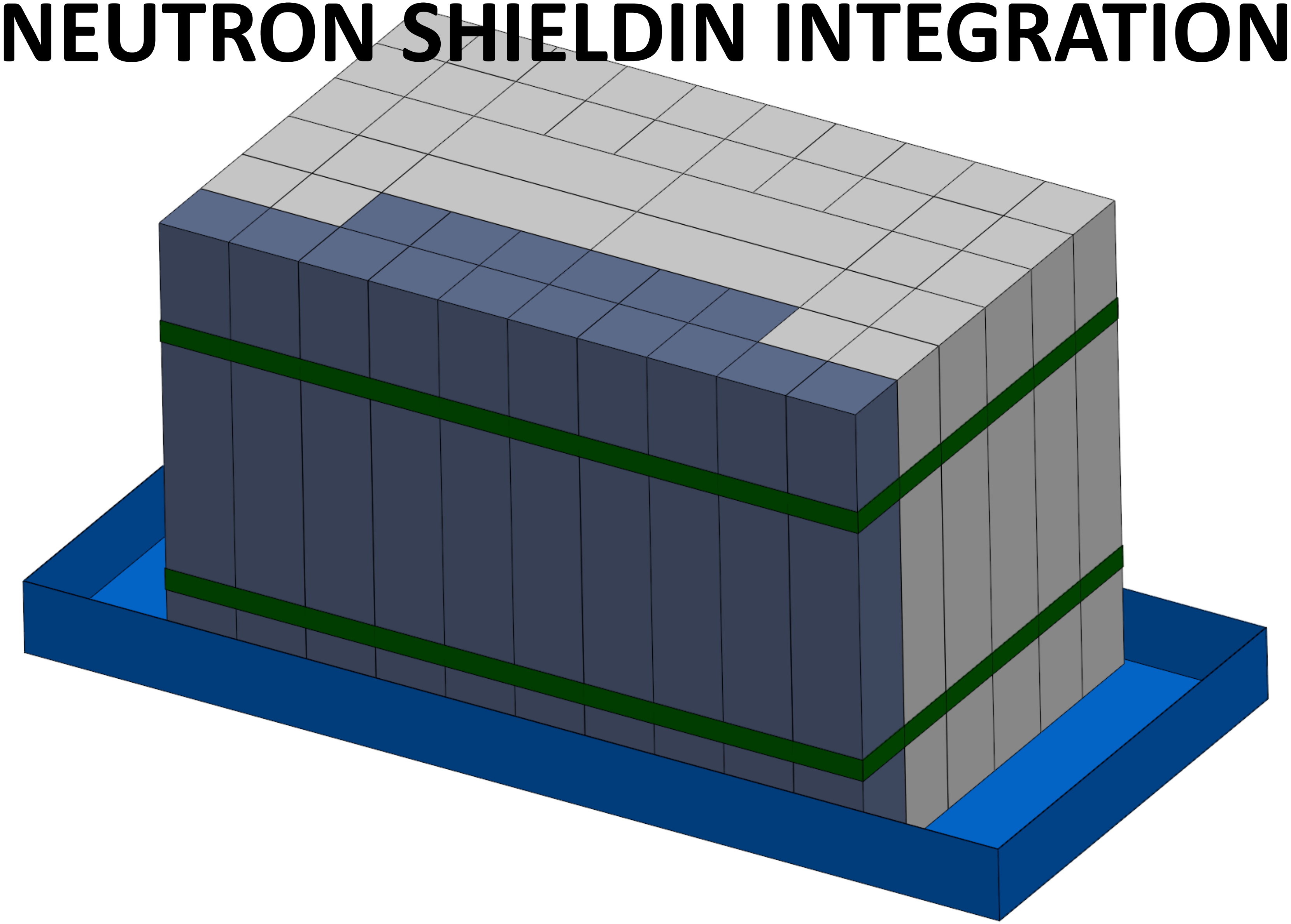
INTEGRATION



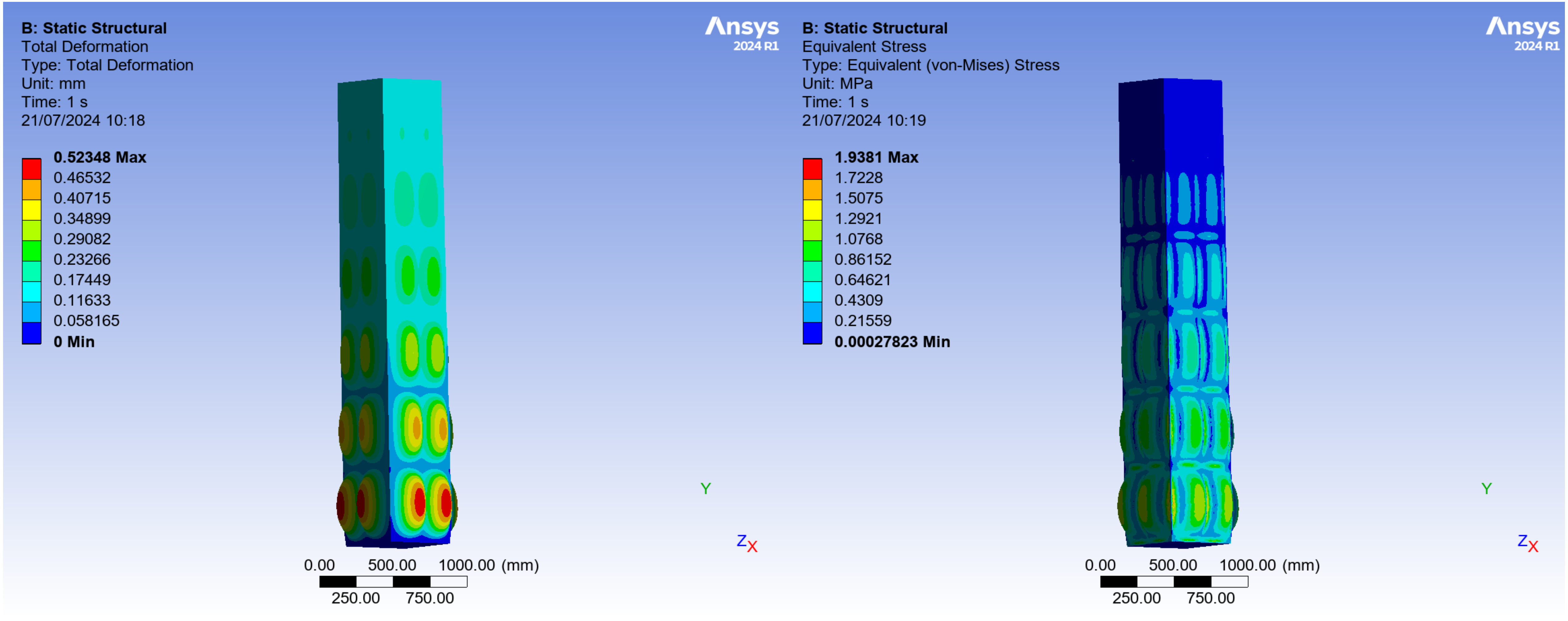
Copper Shielding INTEGRATION Completion



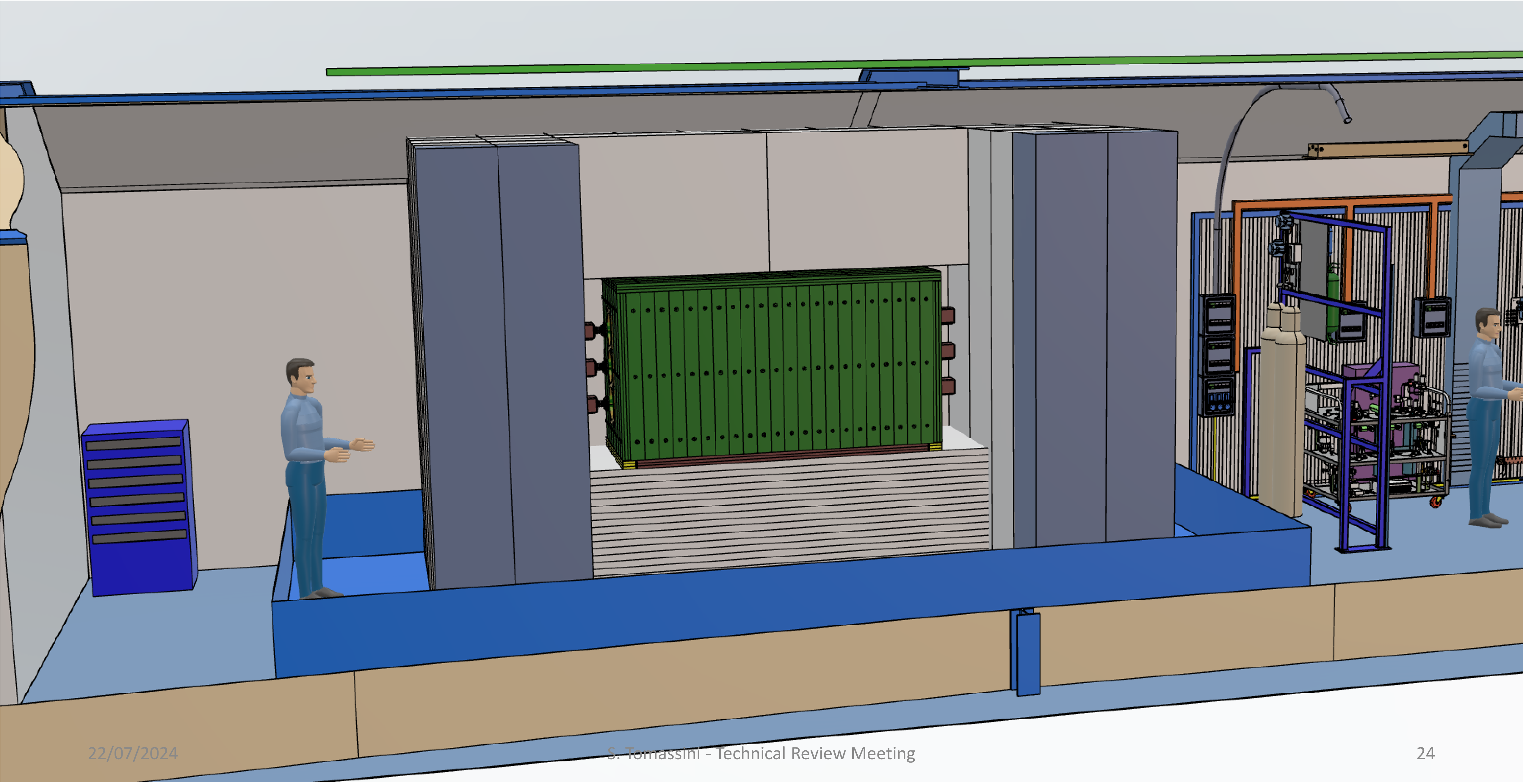
NEUTRON SHIELDIN INTEGRATION



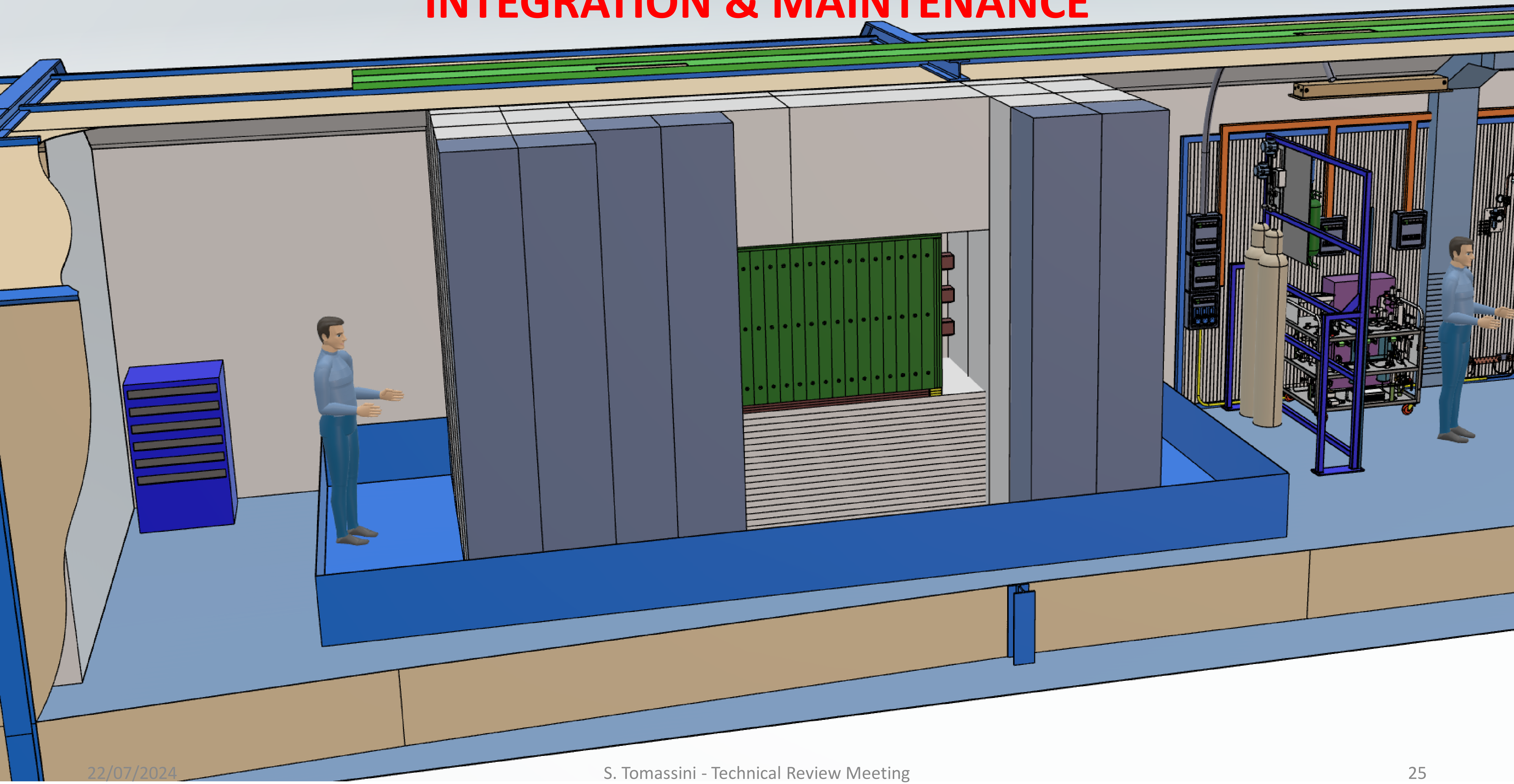
PE tanks


B: Static Structural
Total Deformation
Type: Total Deformation
Unit: mm
Time: 1 s
21/07/2024 10:18
0.52348 Max
0.46532
0.40715
0.34899
0.29082
0.23266
0.17449
0.11633
0.058165
0 Min
Ansys
2024 R1
Y
Z
X
0.00
500.00
1000.00 (mm)
250.00
750.00
B: Static Structural
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
21/07/2024 10:19
1.9381 Max
1.7228
1.5075
1.2921
1.0768
0.86152
0.64621
0.4309
0.21559
0.00027823 Min
Ansys
2024 R1
Y
Z
X
0.00
500.00
1000.00 (mm)
250.00
750.00

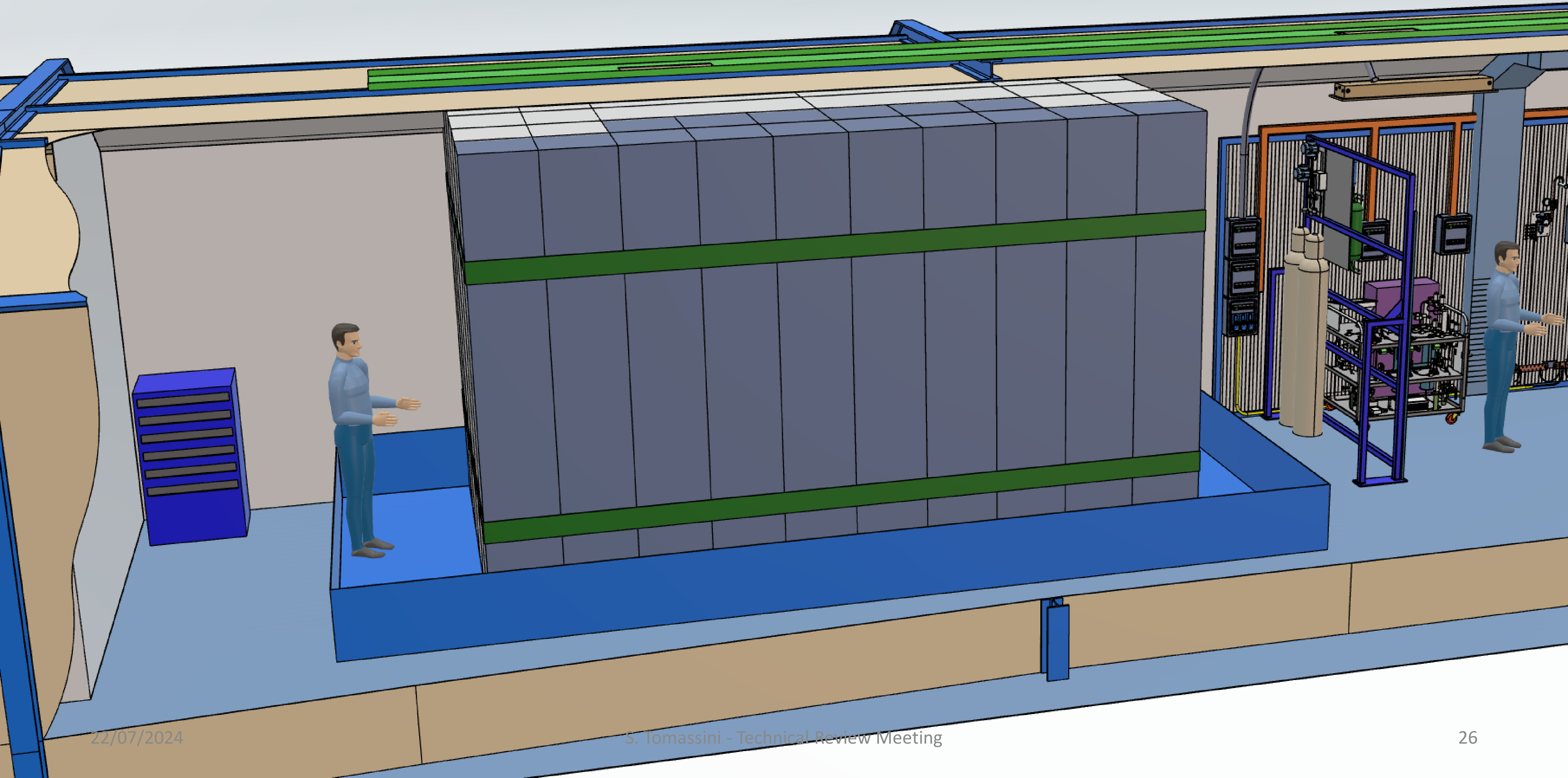
INTEGRATION & MAINTENANCE



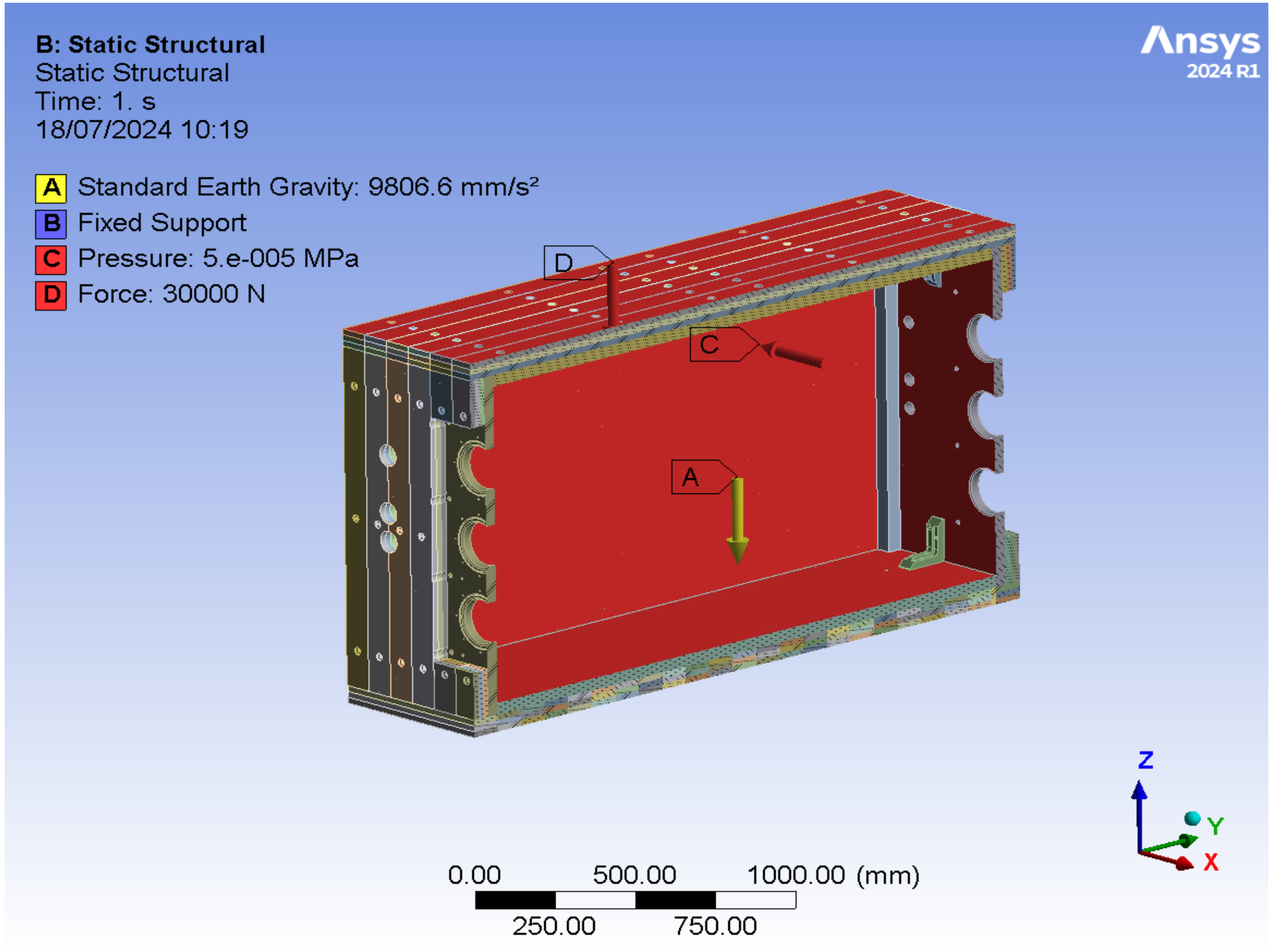
INTEGRATION & MAINTENANCE



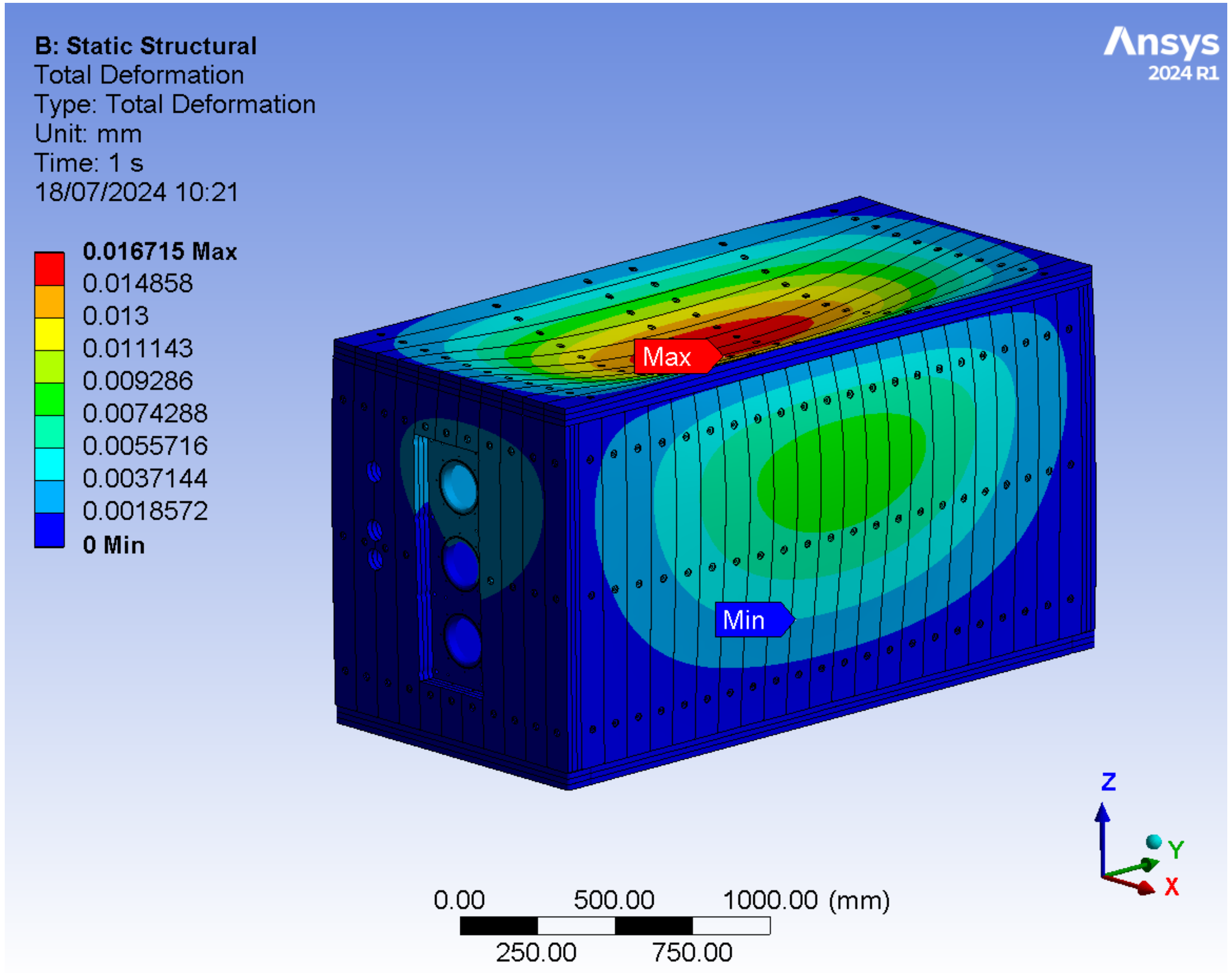
INTEGRATION

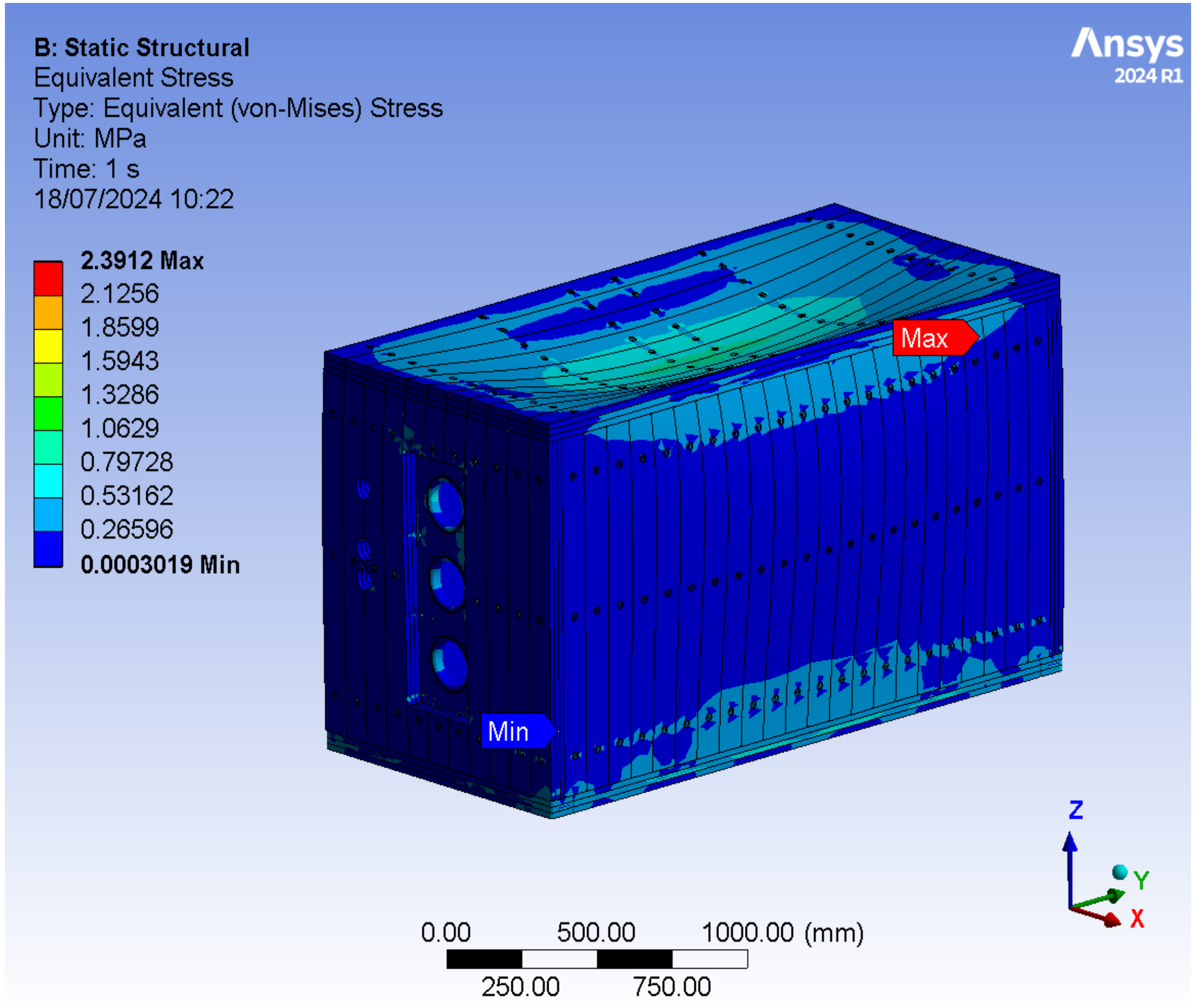


STATIC STRUCTURAL LOADS: DATA TAKING

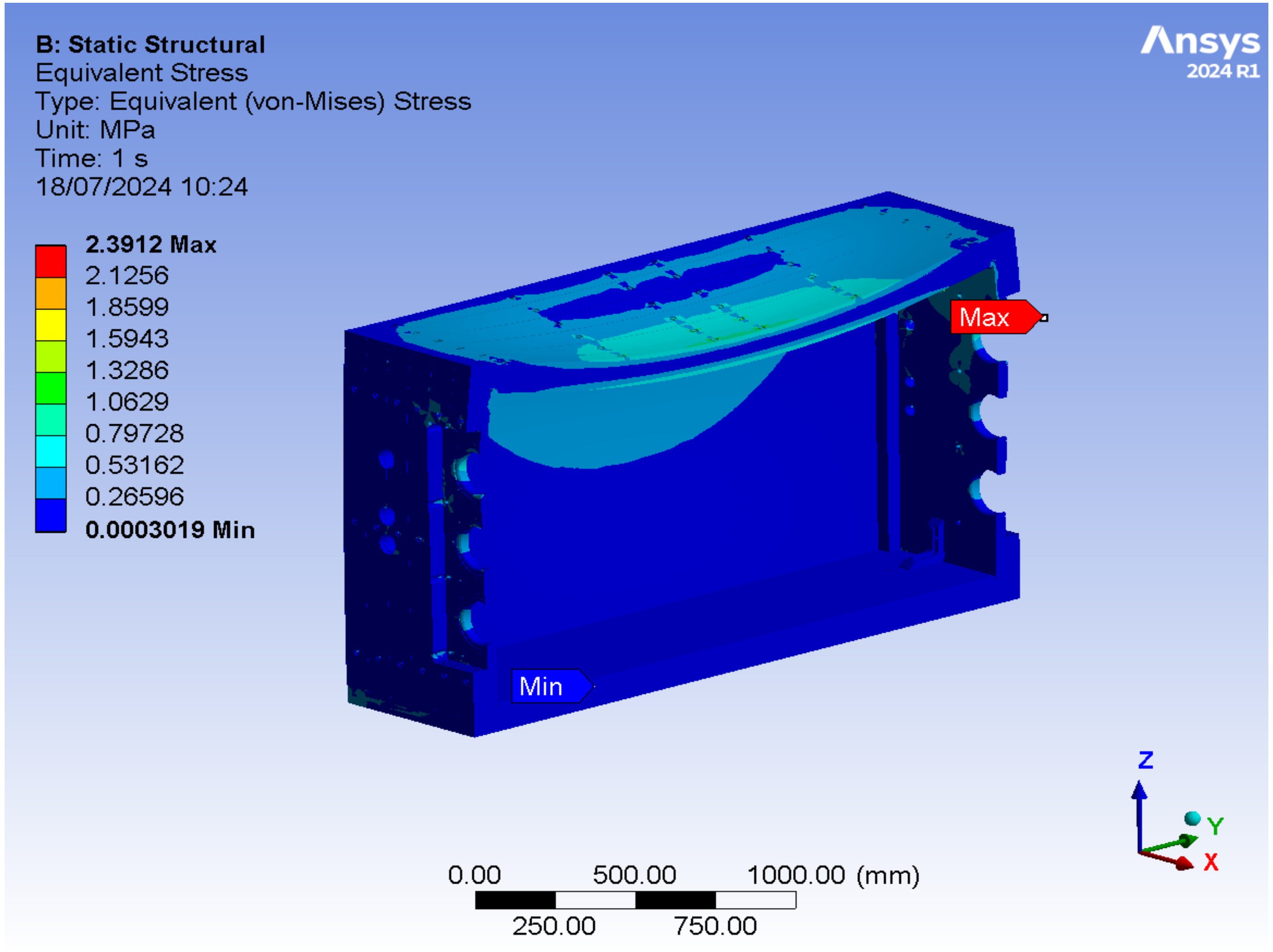


STATIC STRUCTURAL: DATA TAKING

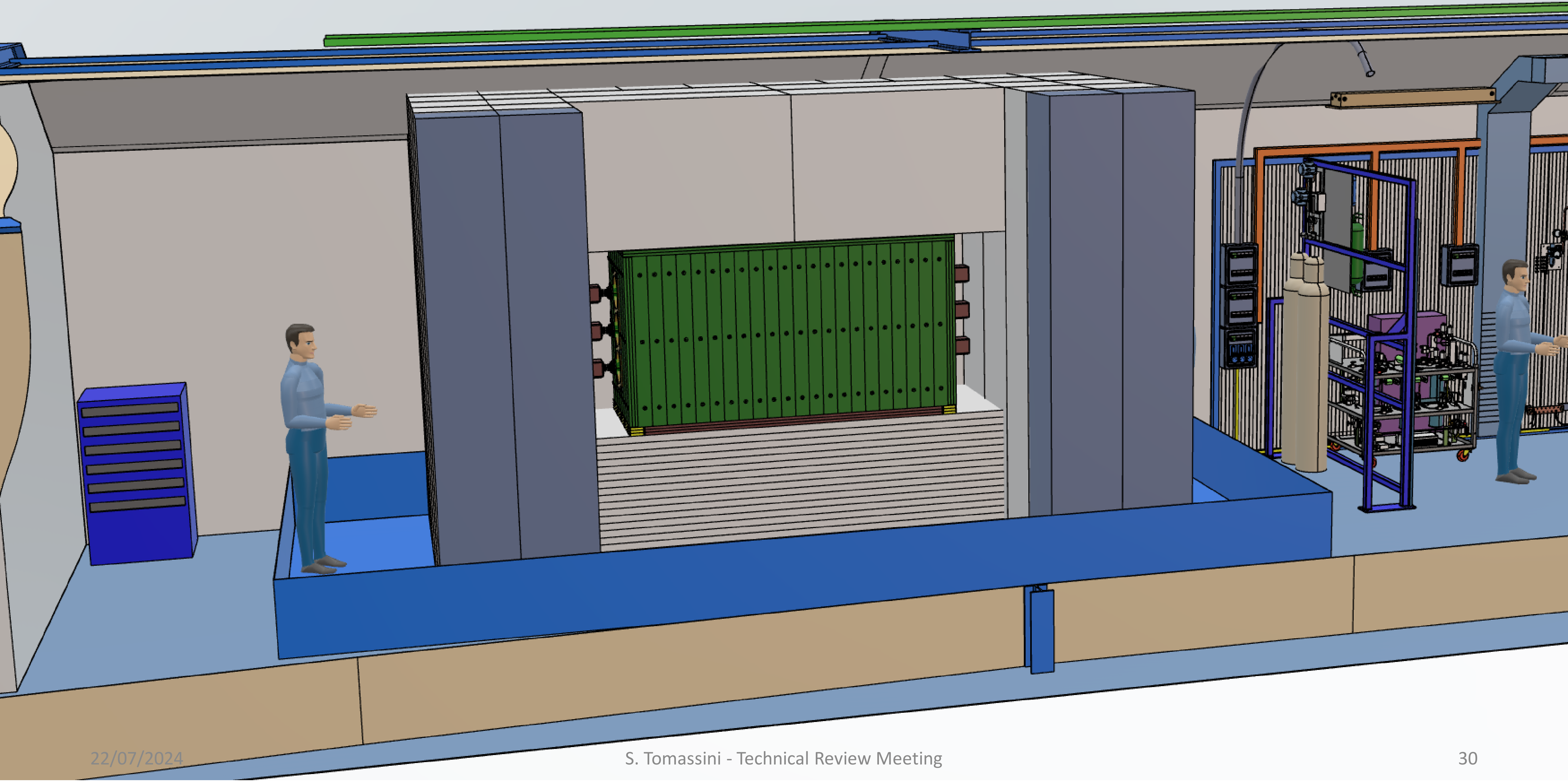




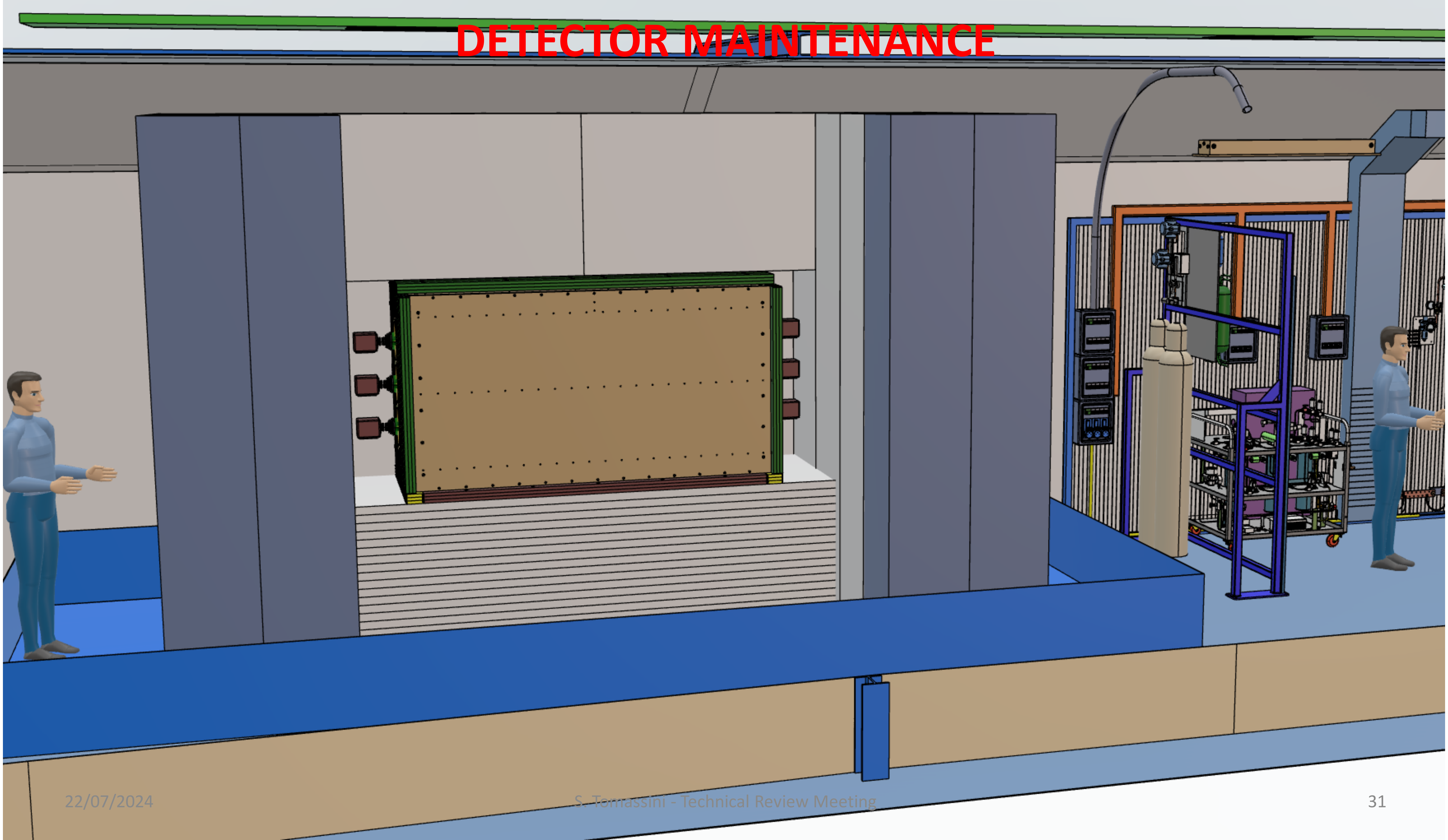
STATIC STRUCTURAL: DATA TAKING



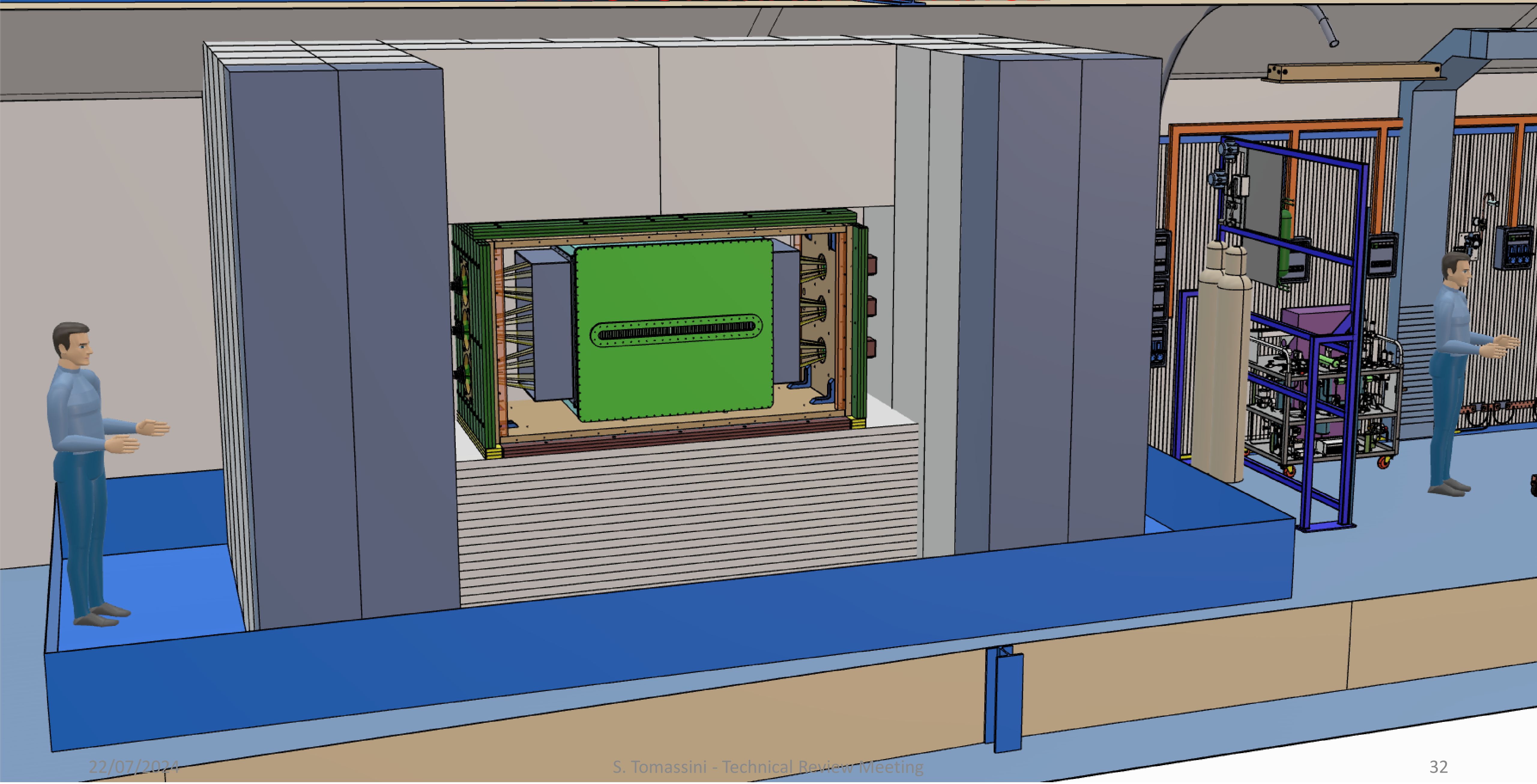
DETECTOR MAINTENANCE



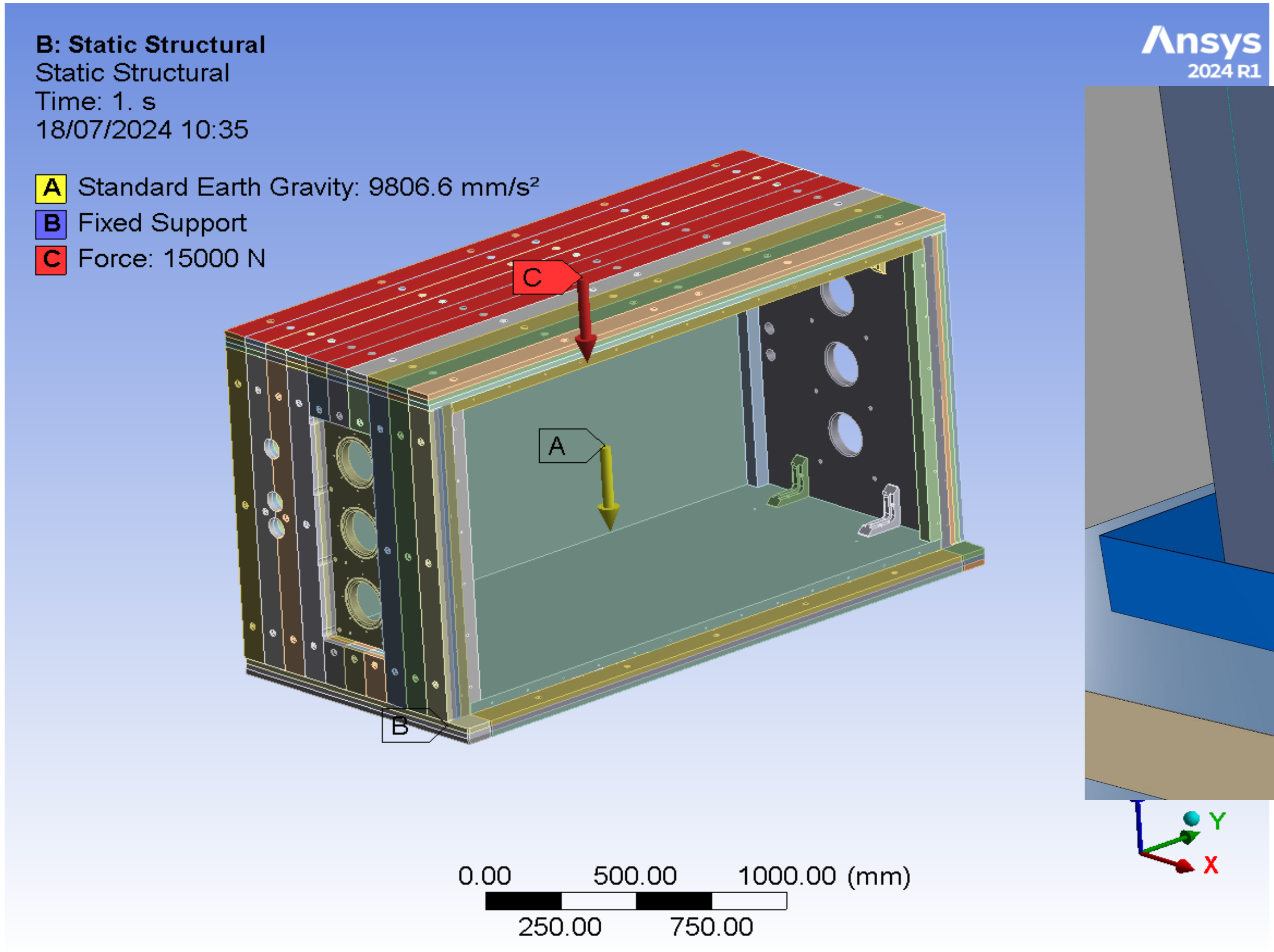
DETECTOR MAINTENANCE

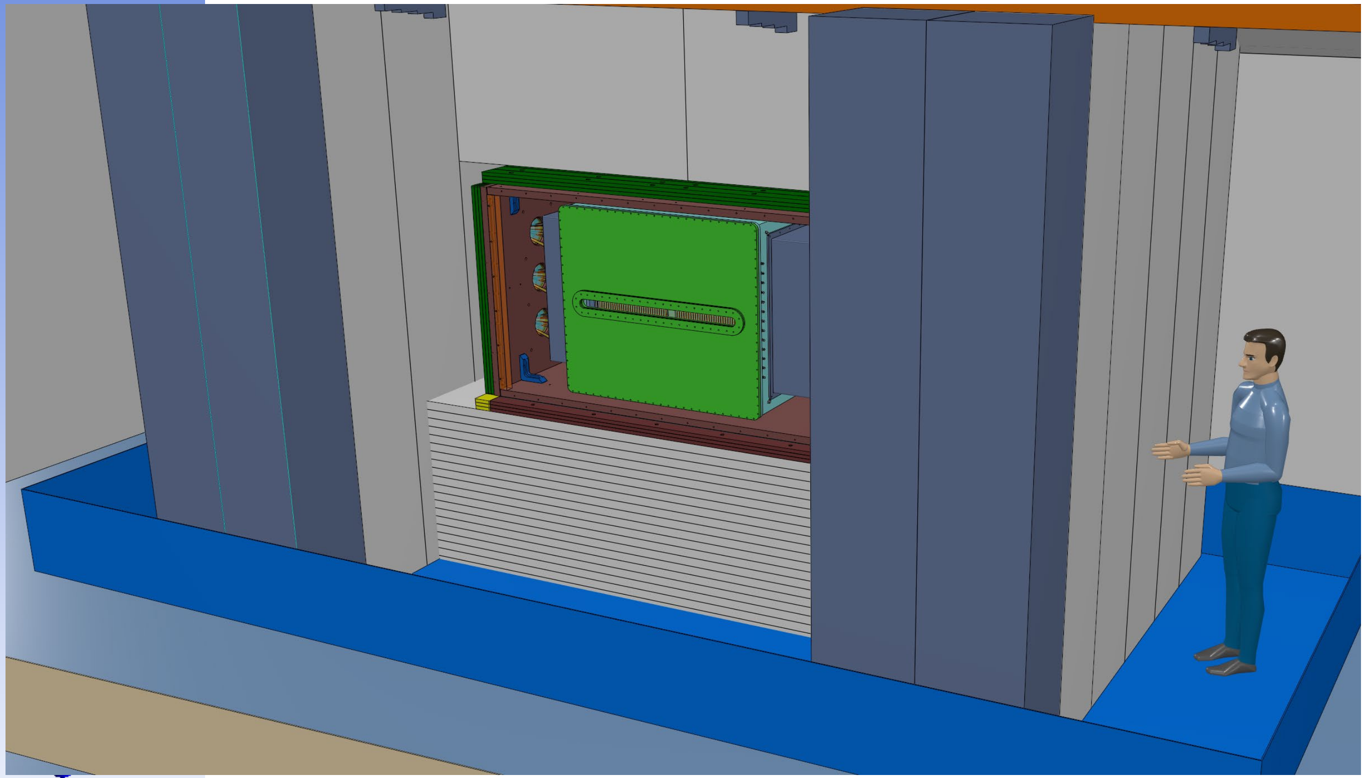


DETECTOR MAINTENANCE

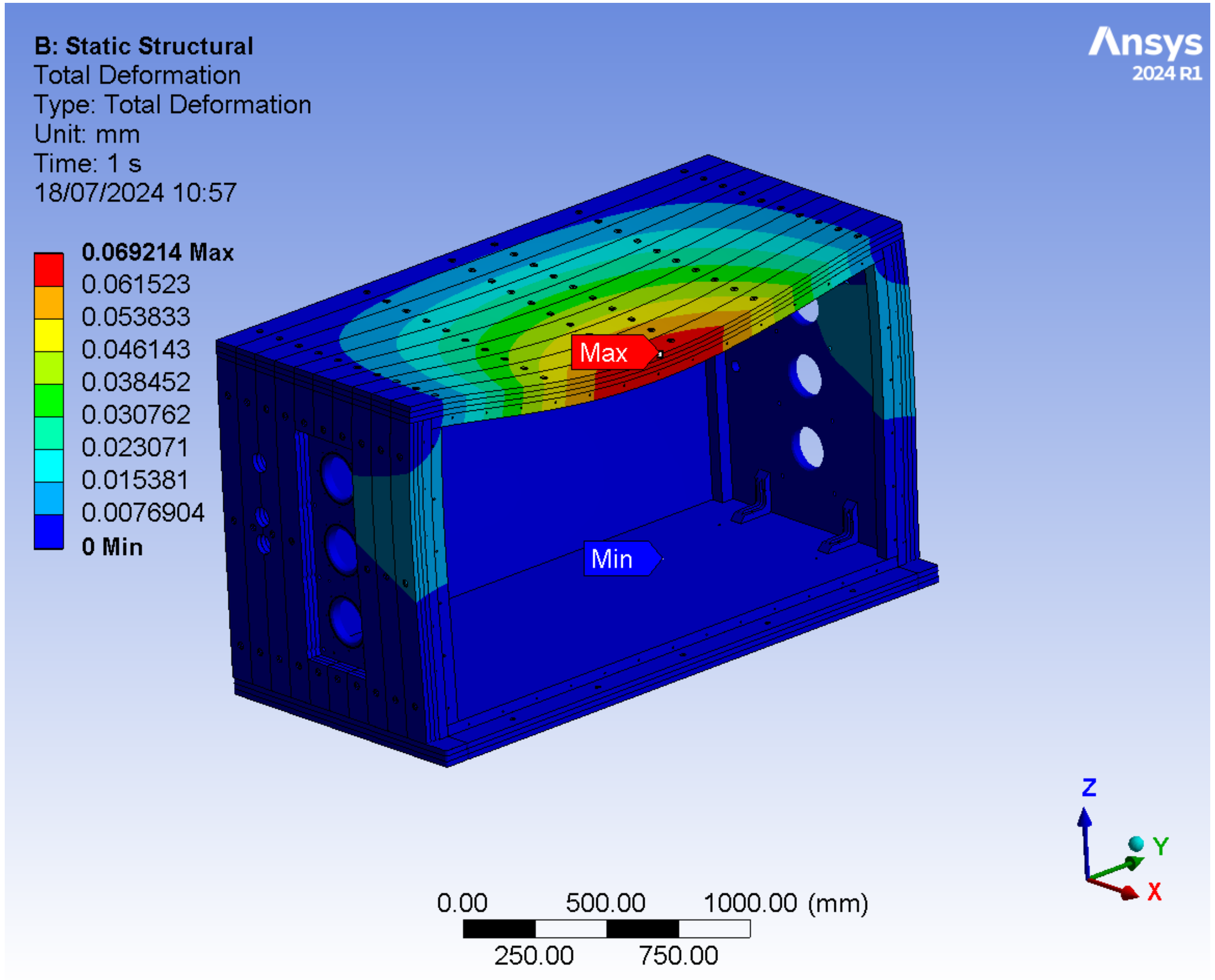


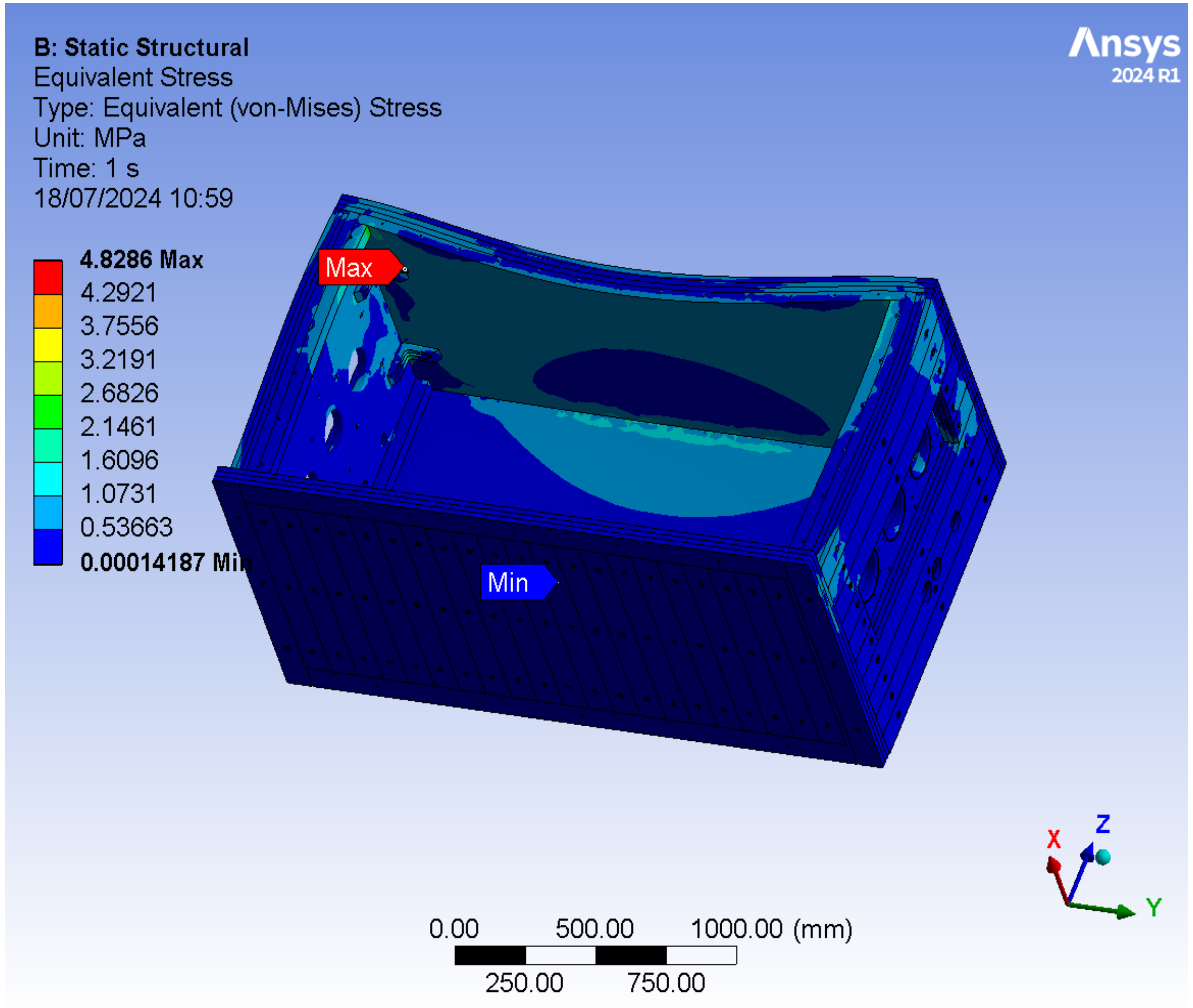
STATIC STRUCTURAL: DETECTOR MAINTENANCE



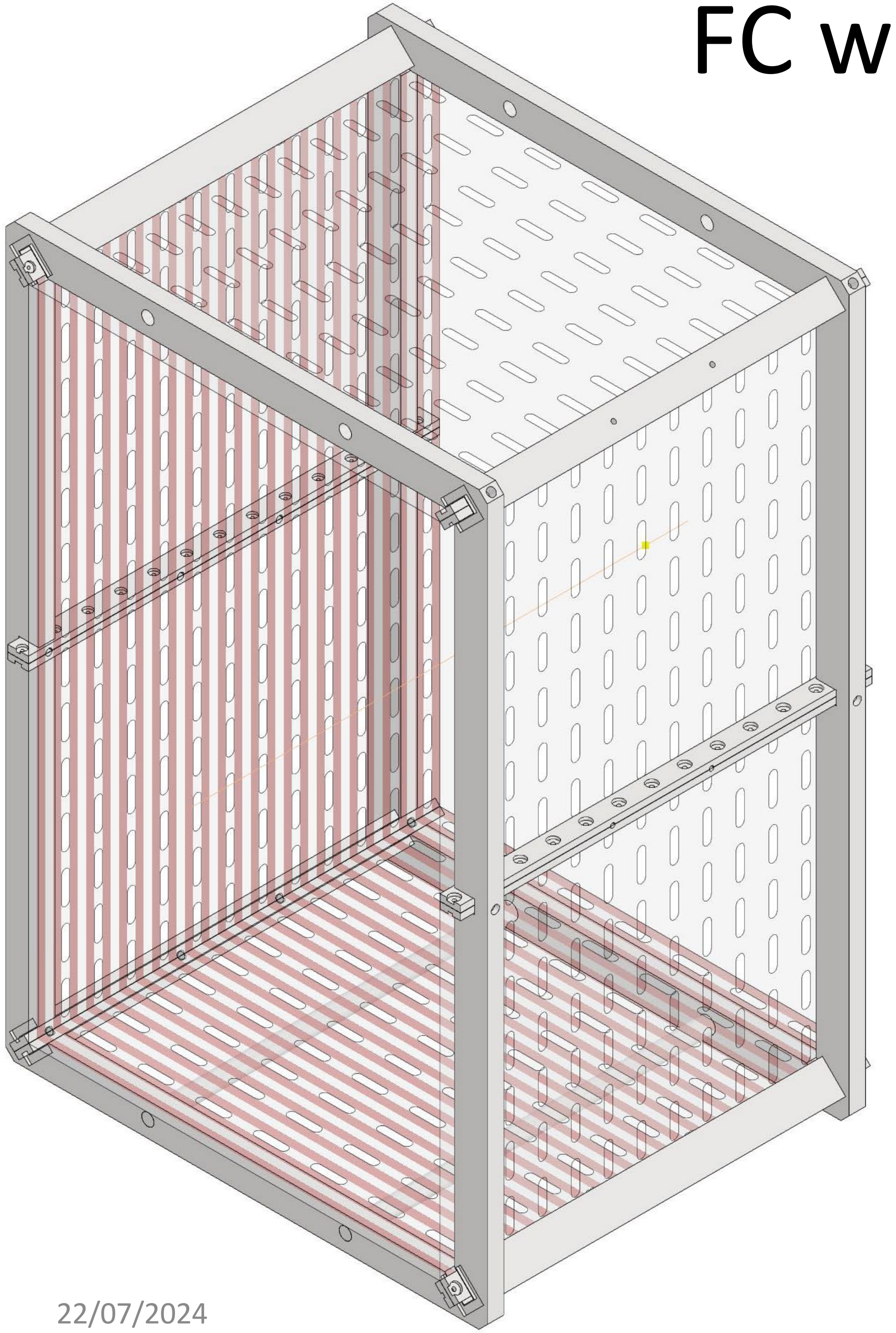


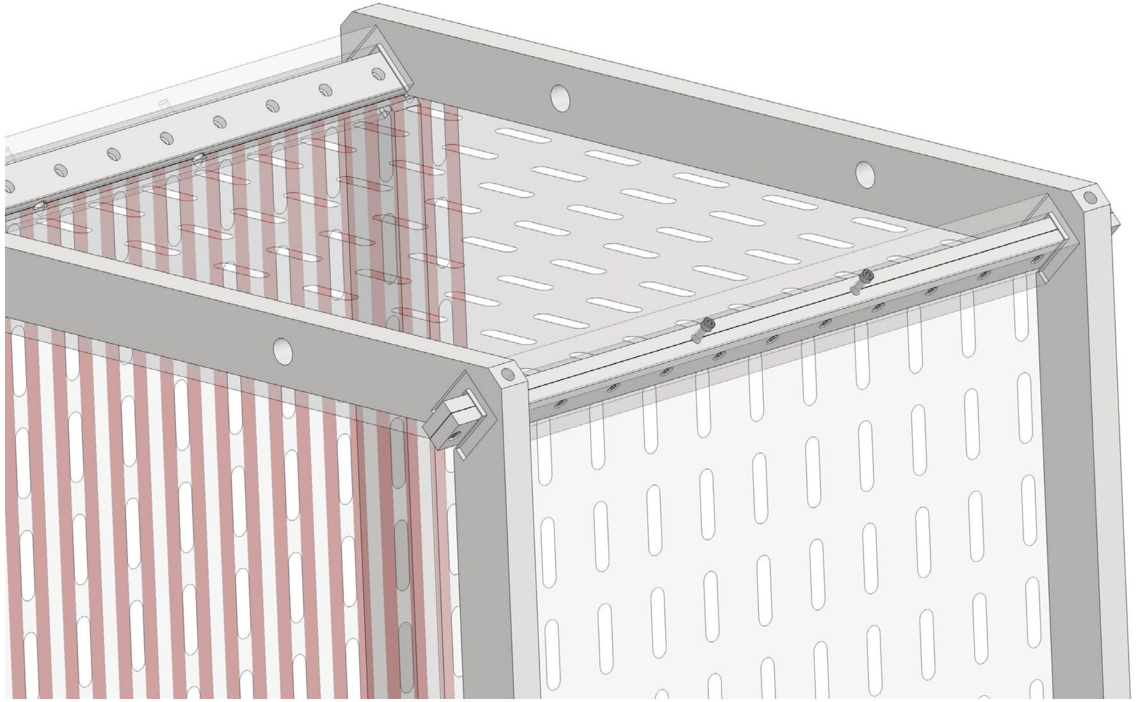
STATIC STRUCTURAL: DETECTOR MAINTENANCE



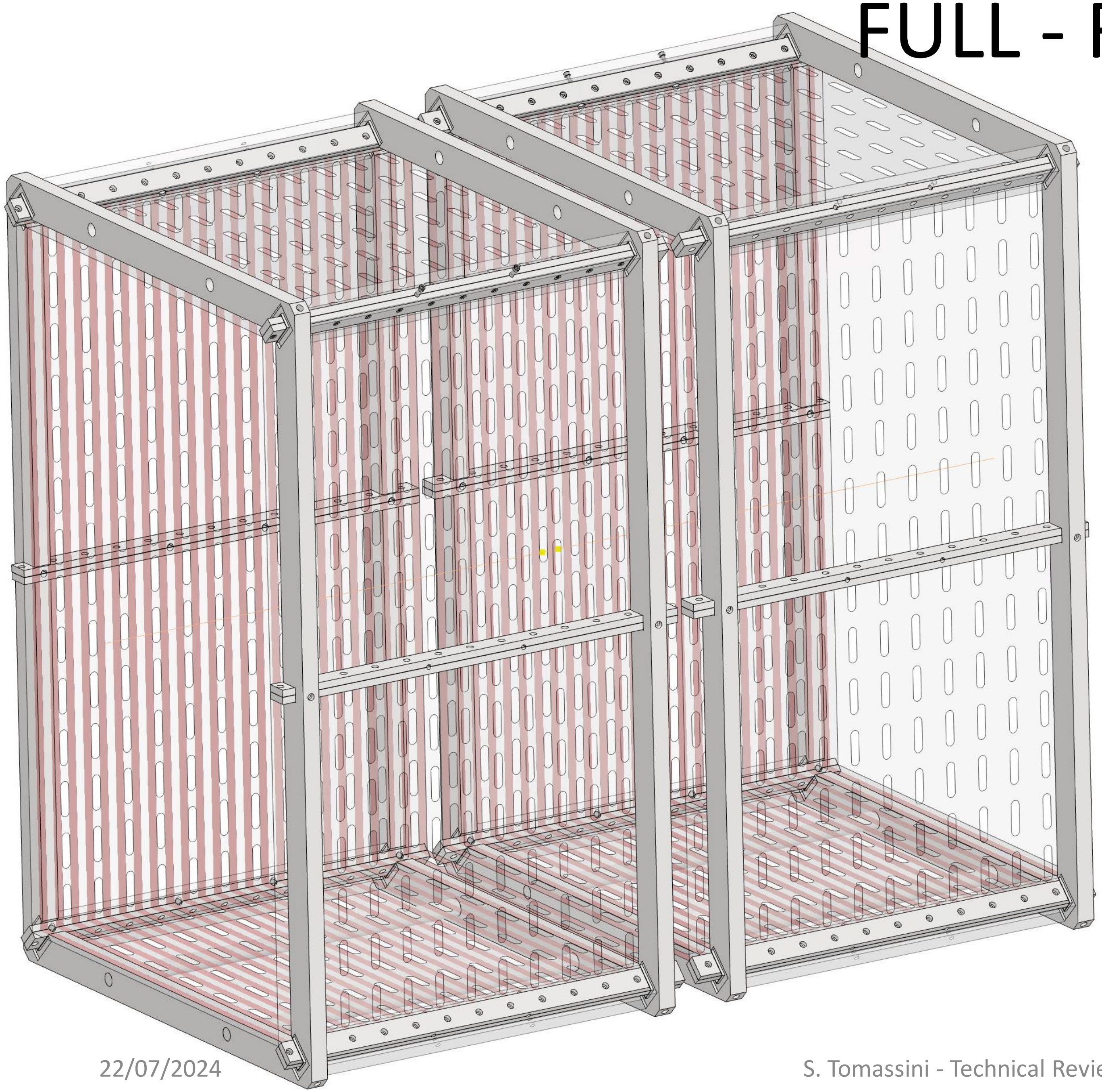


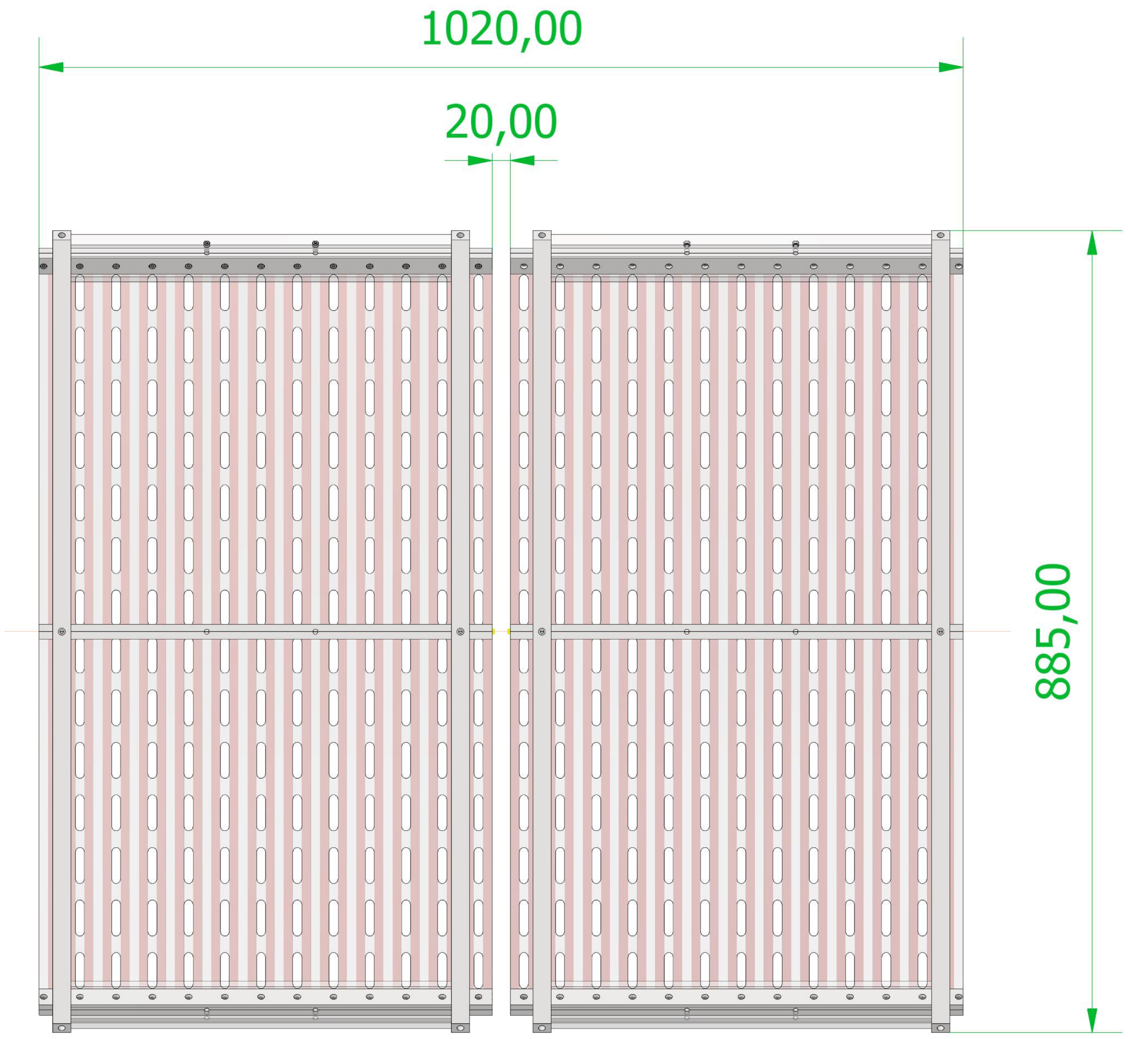
FC with tension system



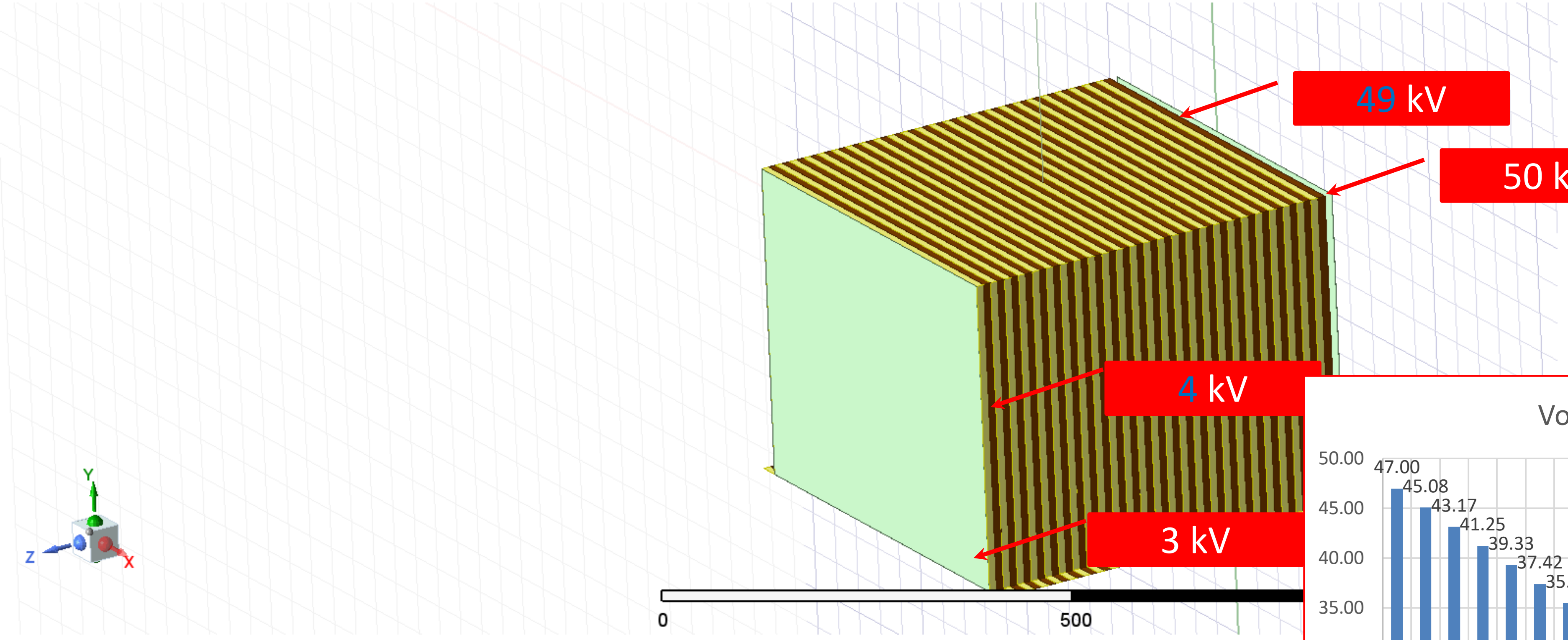


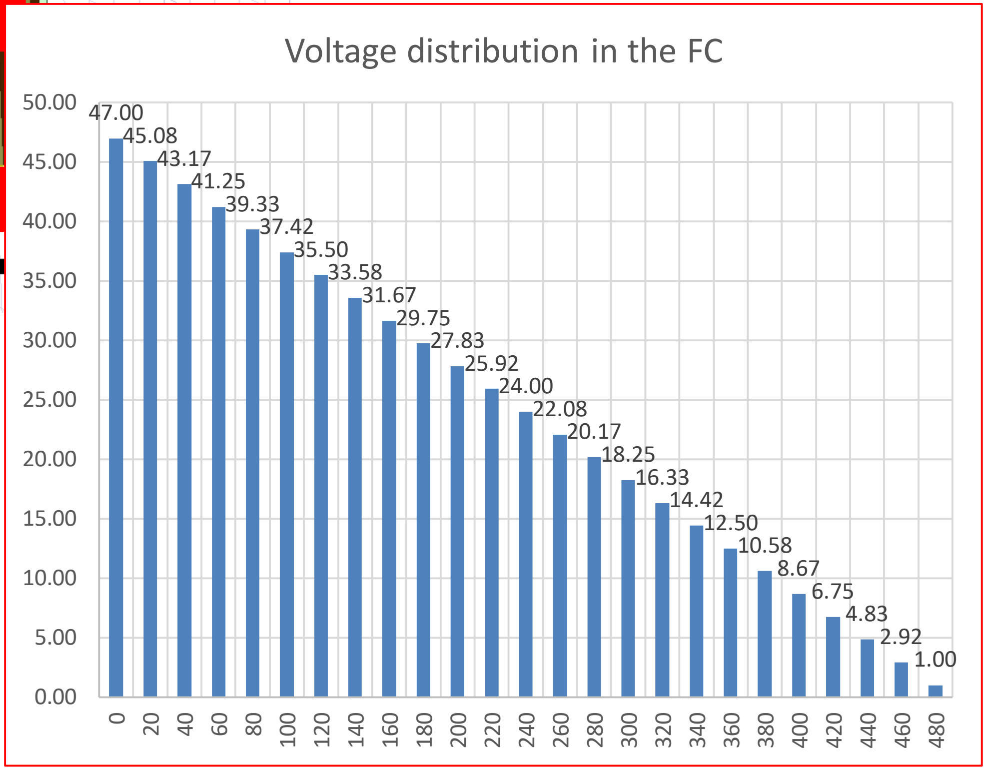
FULL - FC





FC: 47 kV to 1 kV





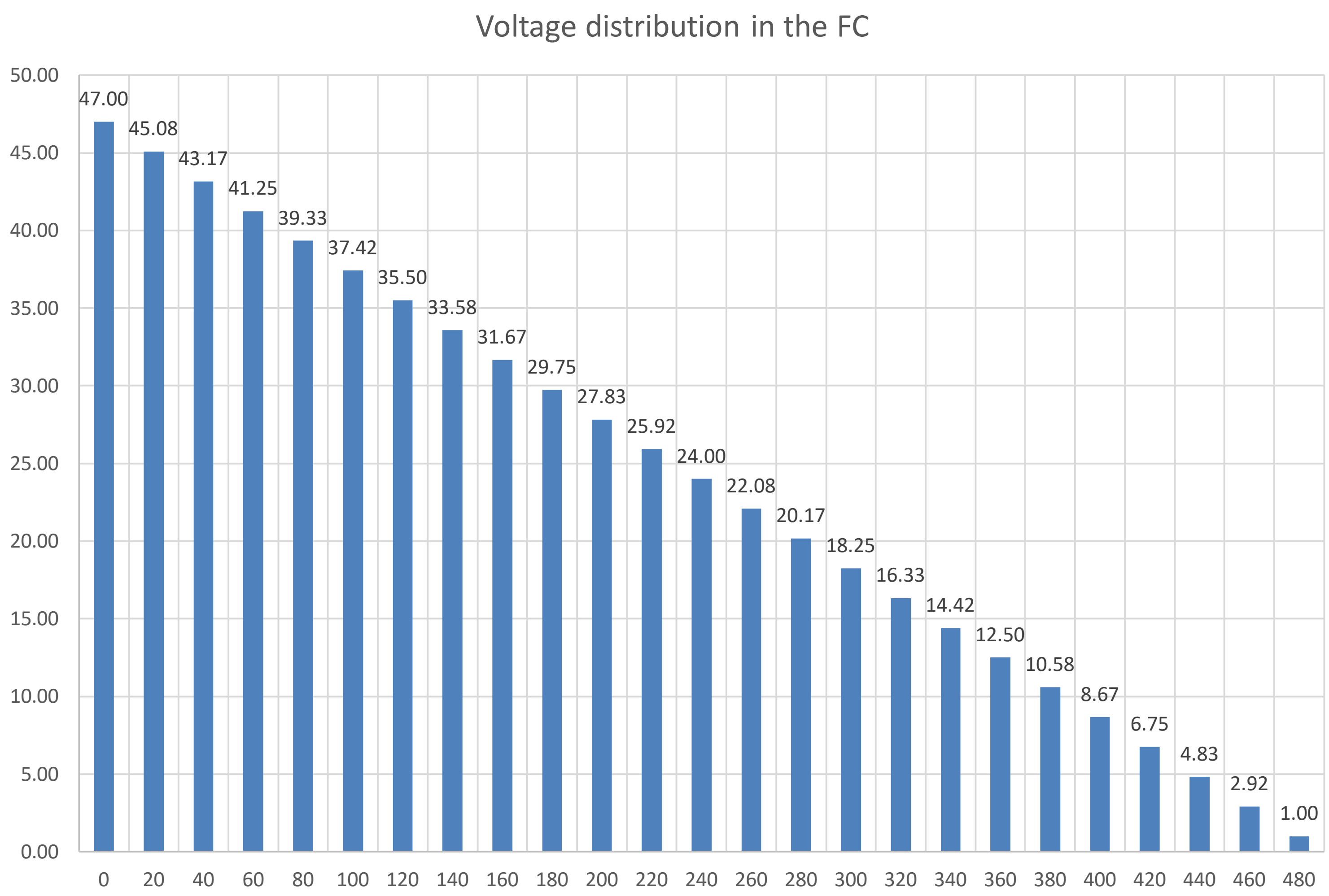
Voltage distribution in the FC

The first turn close to the Cathode is at **10 mm**

The last turn distance from the GEM is **10 mm**

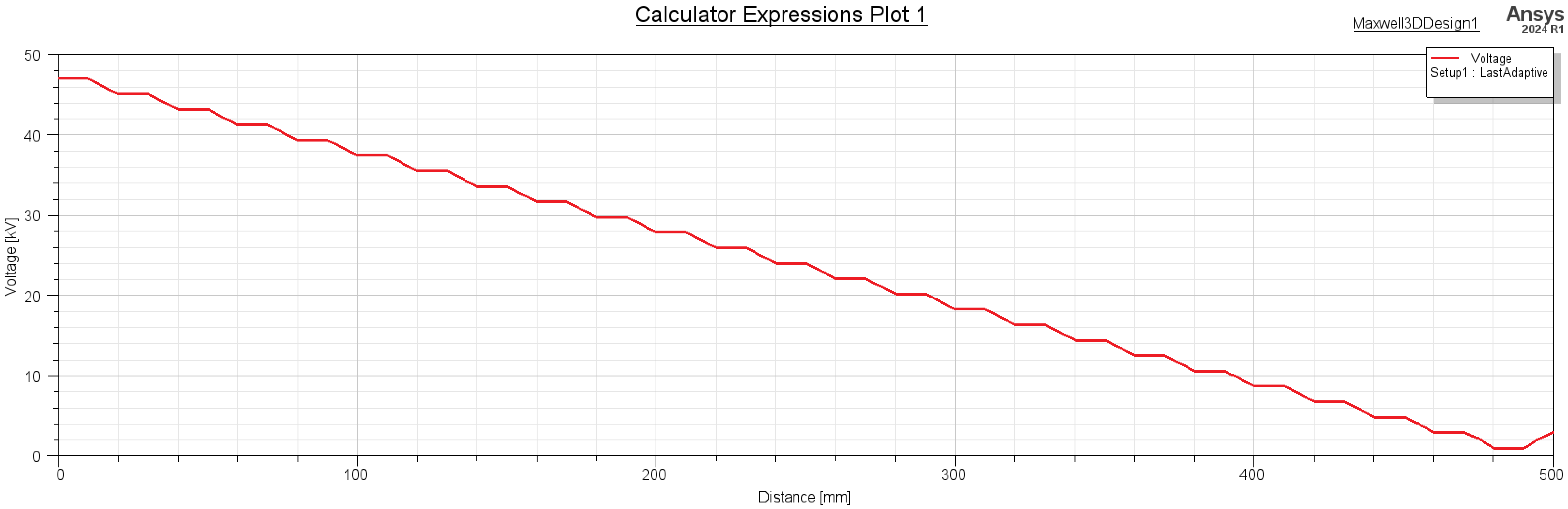
The cathode is at 50 kV

The GEM is at 3 kV

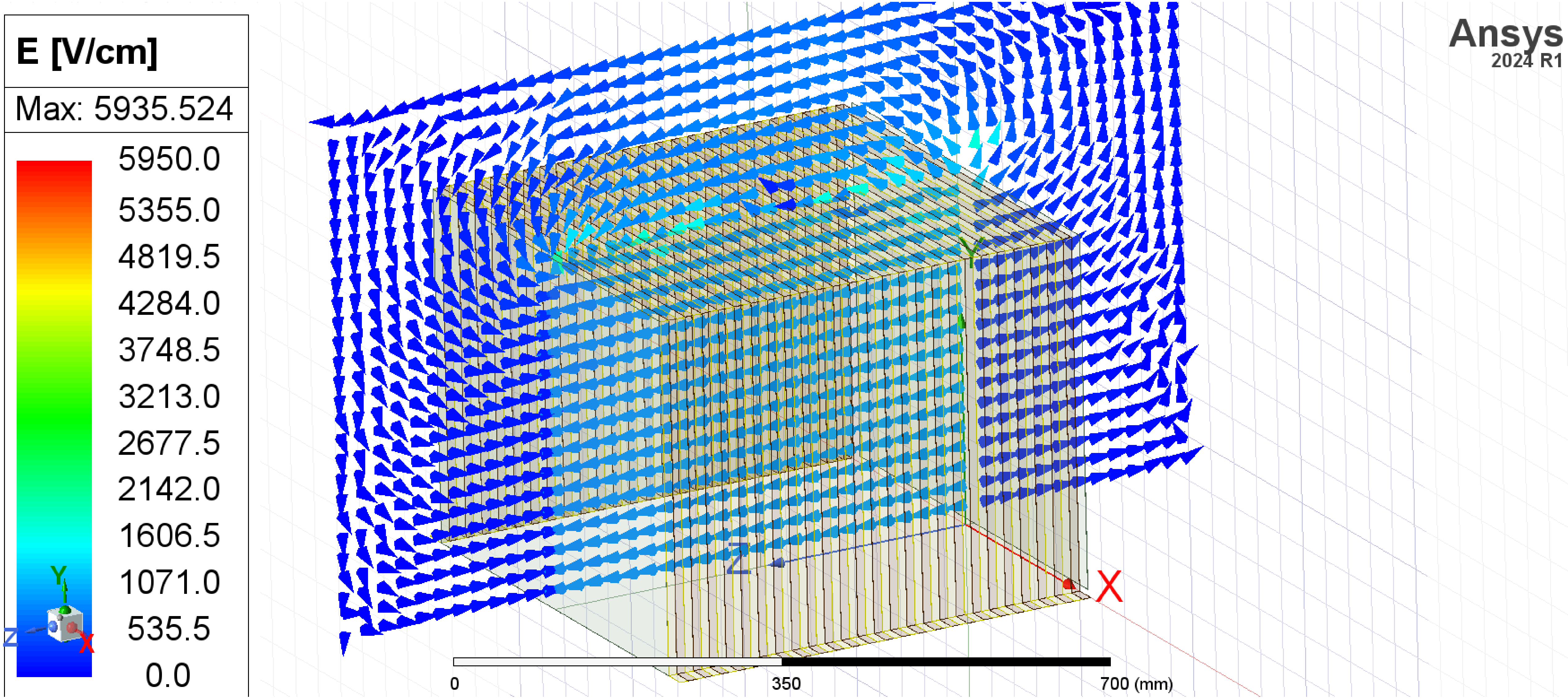


Voltage distribution applied to the FC

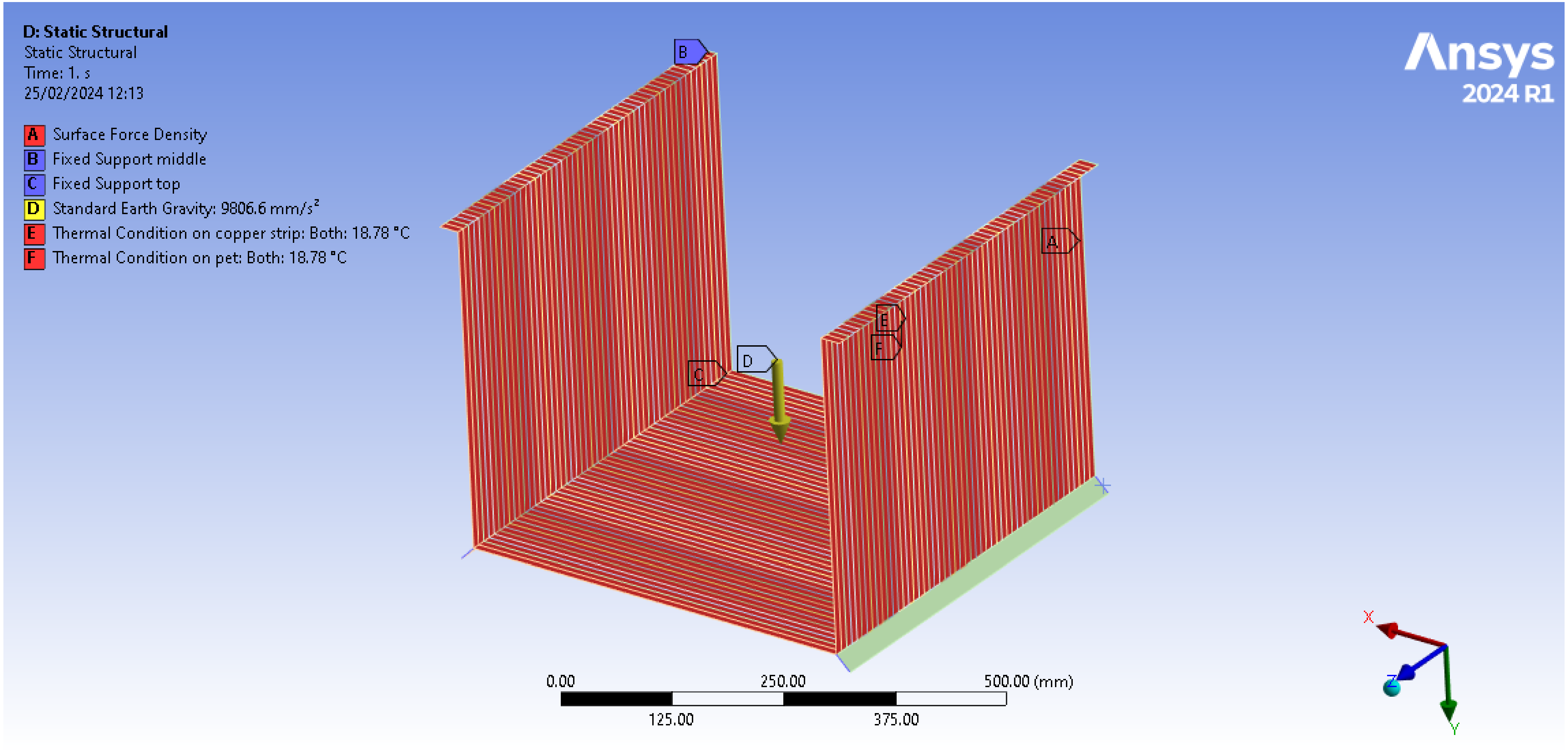
- The first turn close to the Cathode is at **10 mm**
- The last turn distance from the GEM is **10 mm**
- **The cathode is at 50 kV**
- **The GEM is at 3 kV**



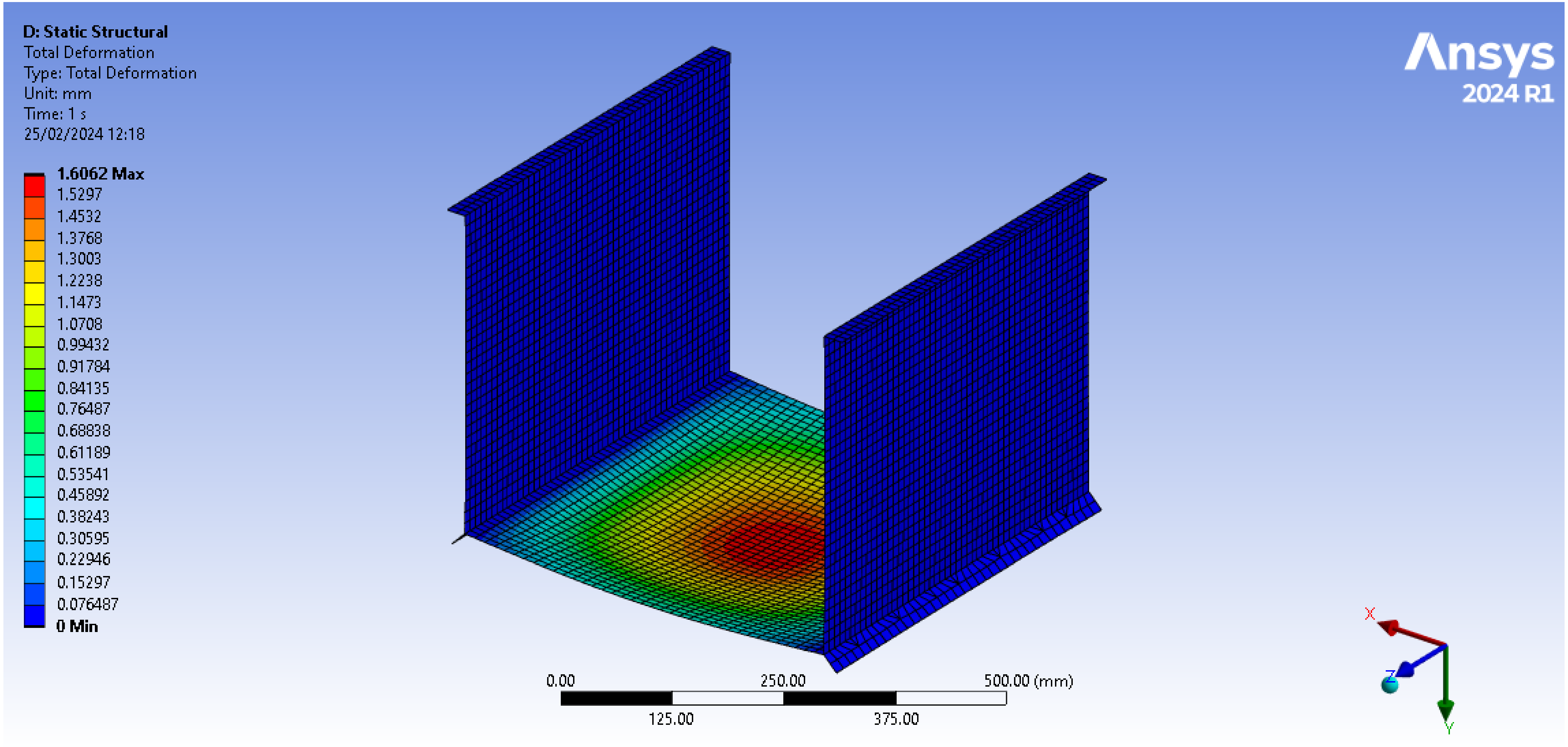
FC: 47 kV to 1 kV



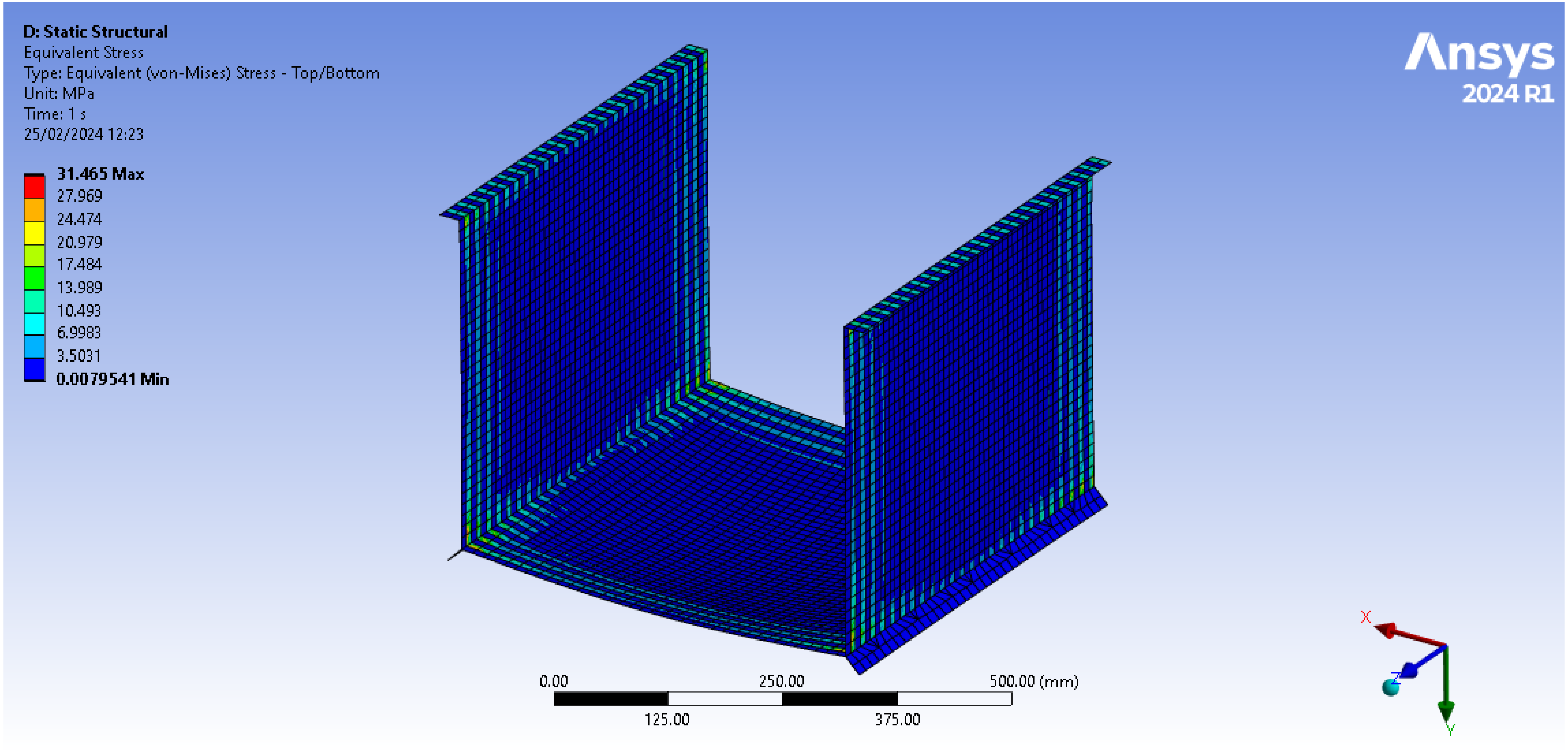
Bottom: Loads with 30 N Stretching Force



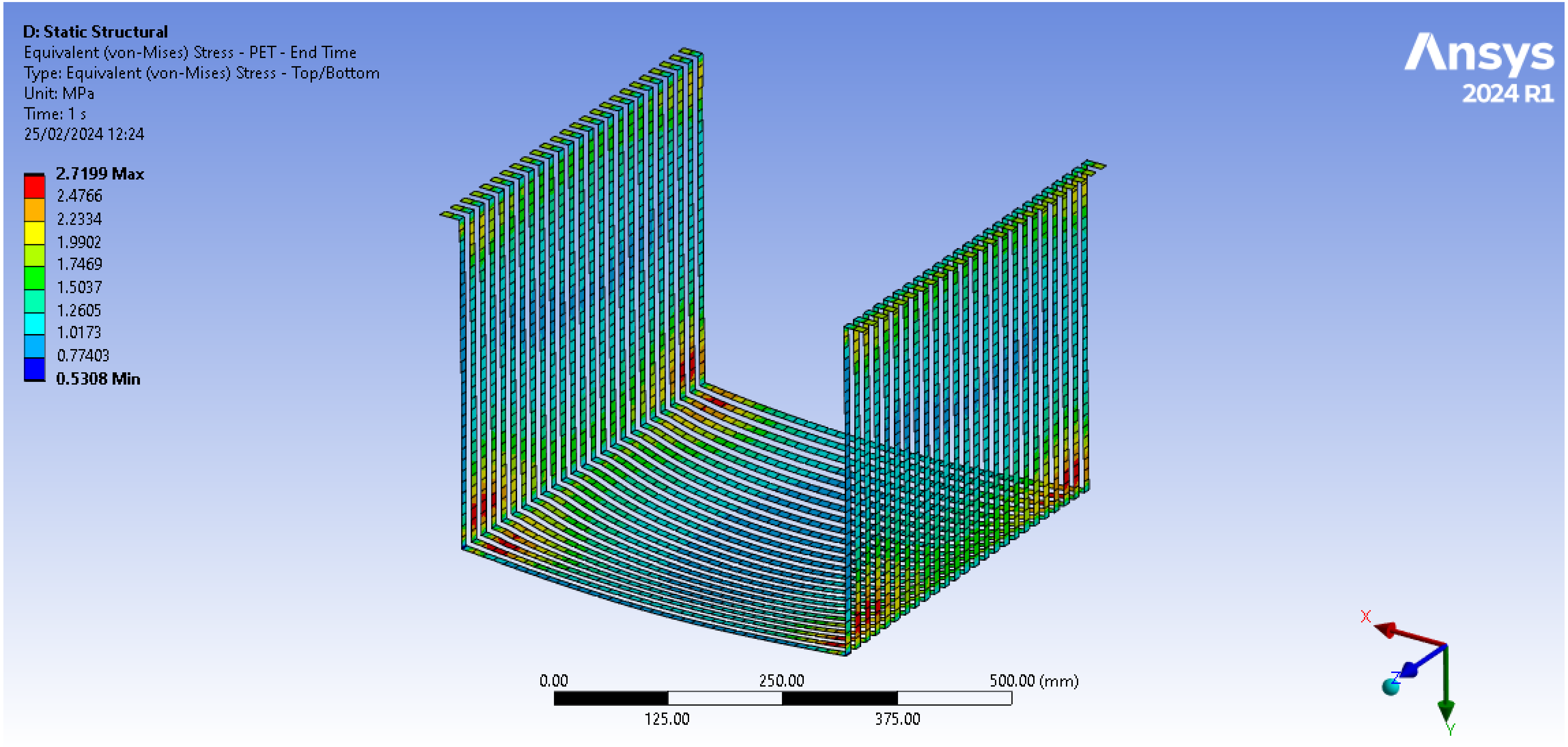
Bottom: Total deformation with 30 N Stretching Force



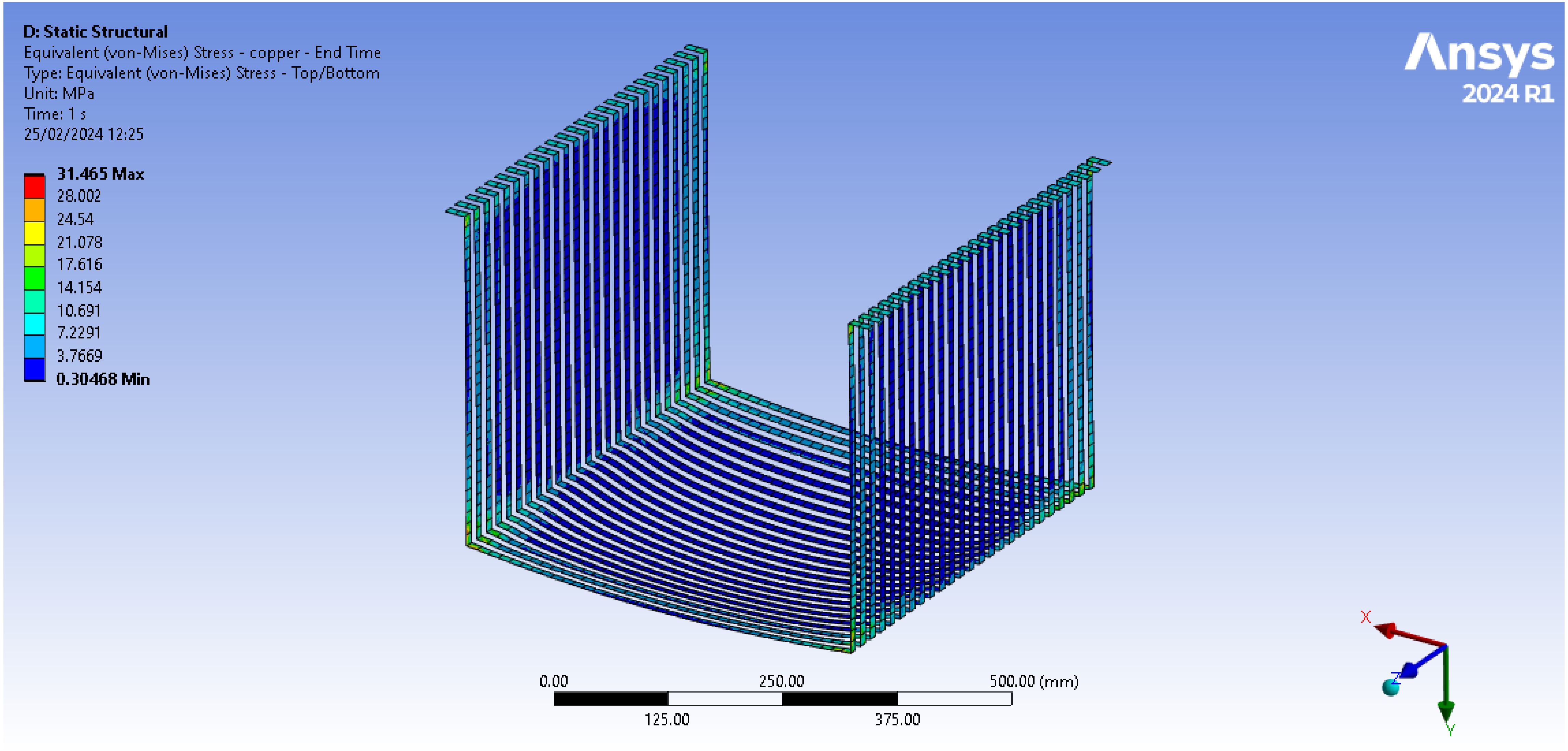
Bottom: Von Mises with 30 N Stretching Force



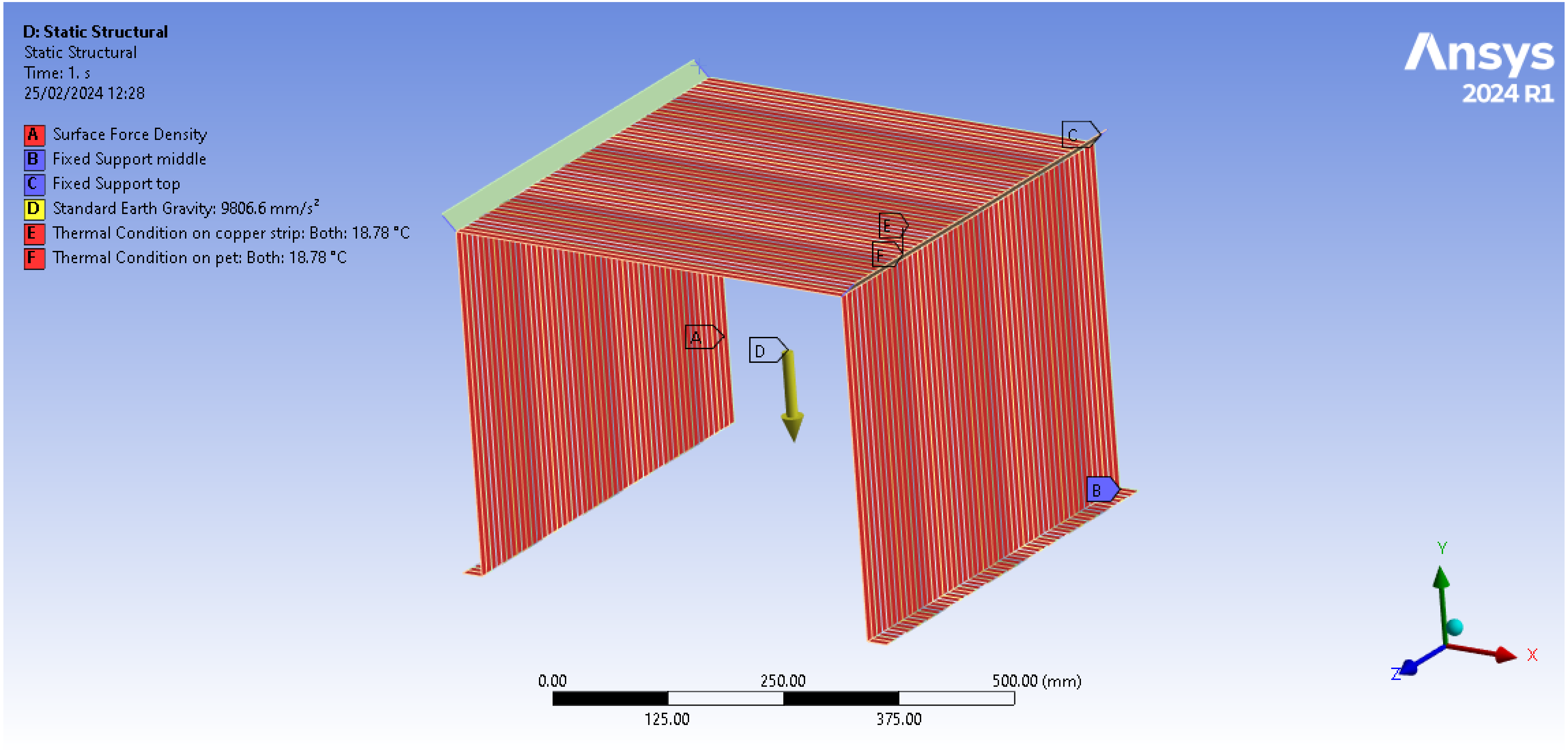
Bottom: Von Mises with 30 N Stretching Force (PET)



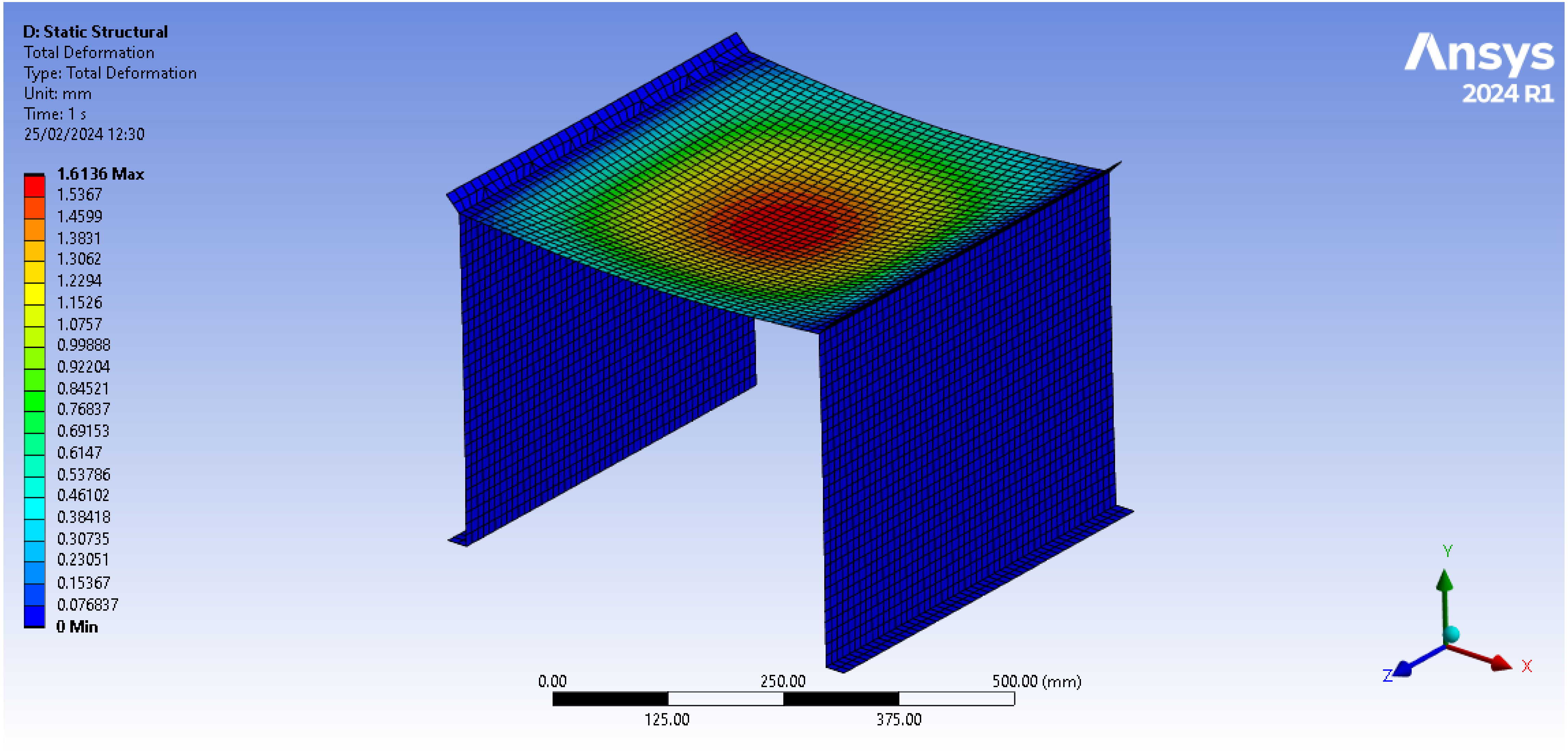
Bottom: Von Mises with 30 N Stretching Force (Cu)



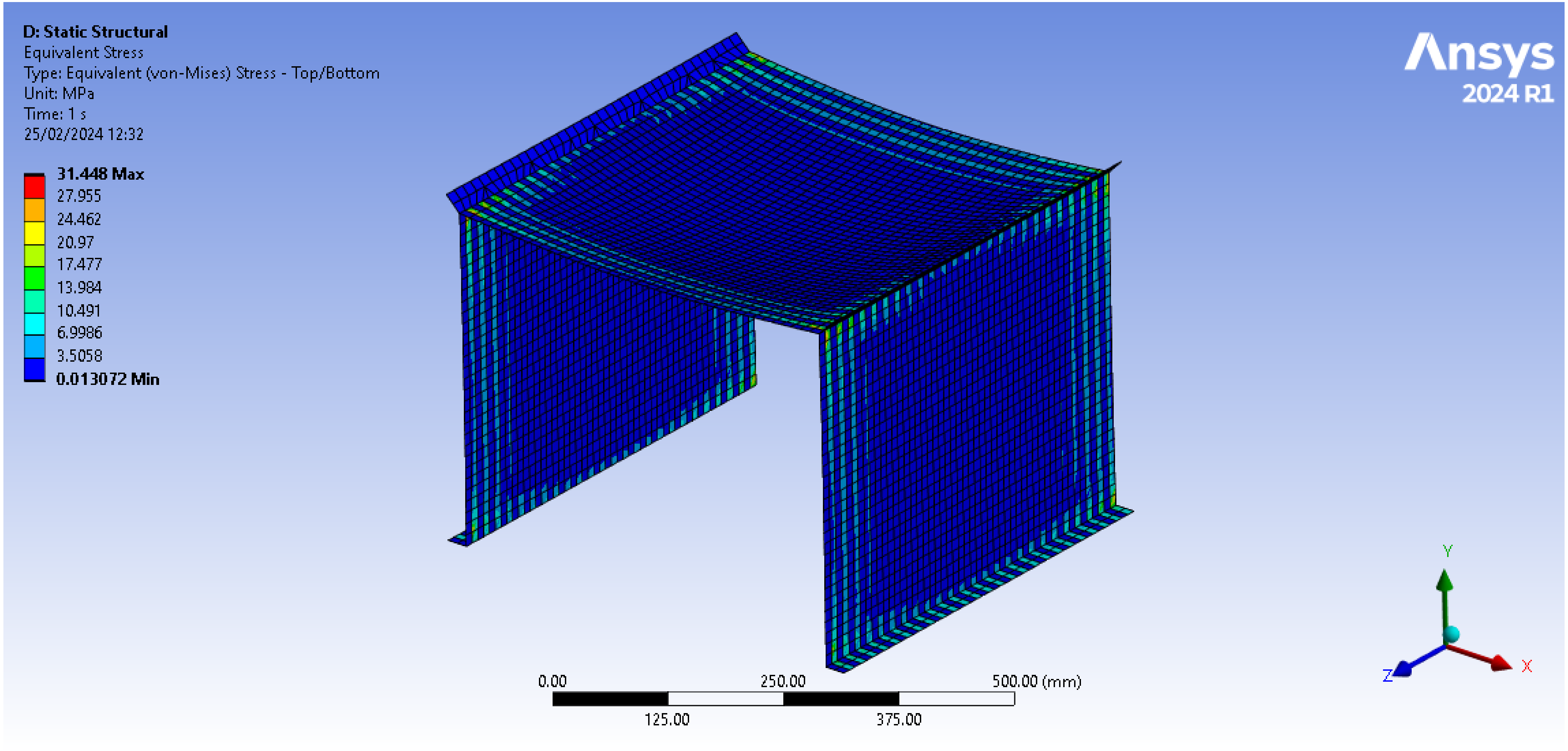
TOP: Loads with 30 N Stretching Force



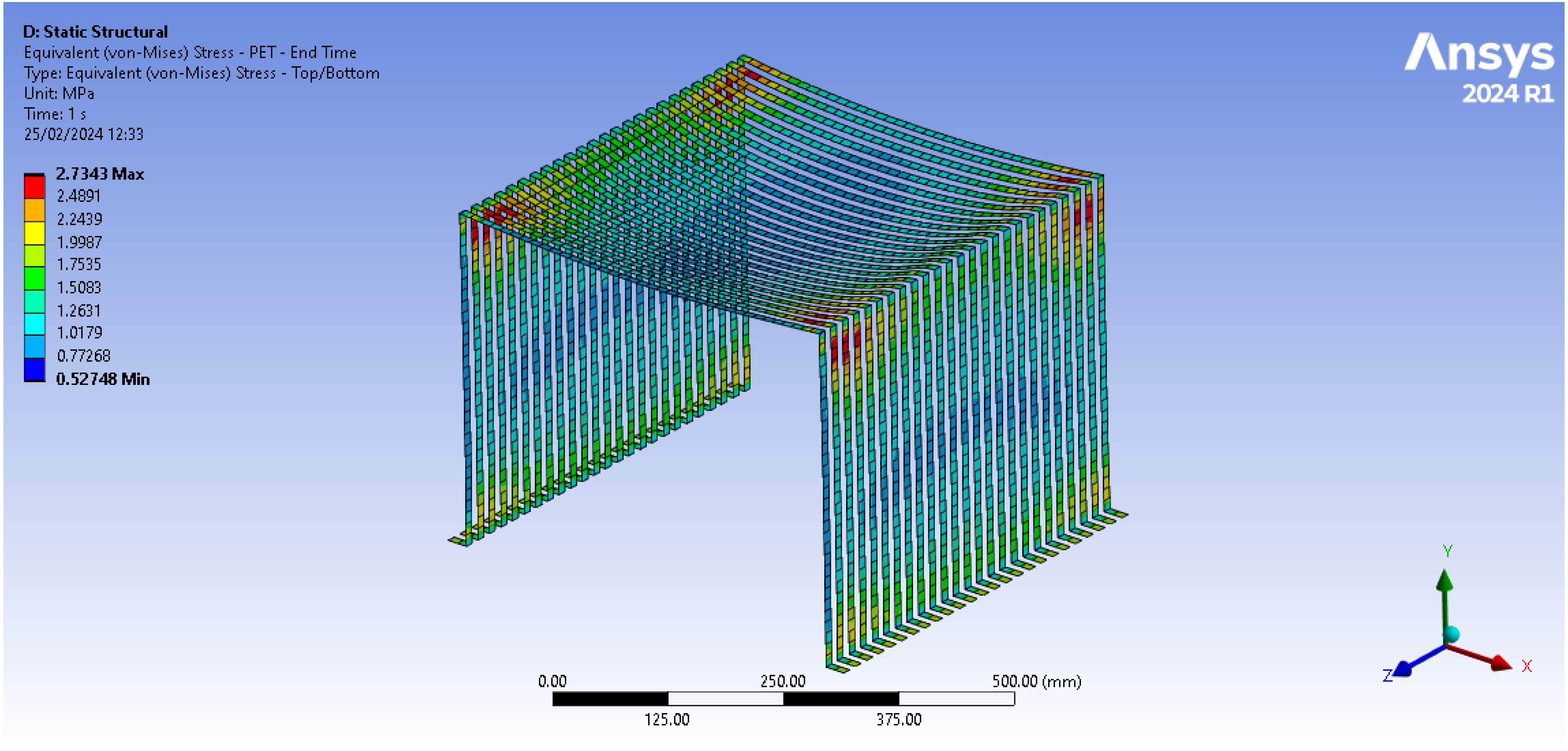
Top: Total deformation with 30 N Stretching Force



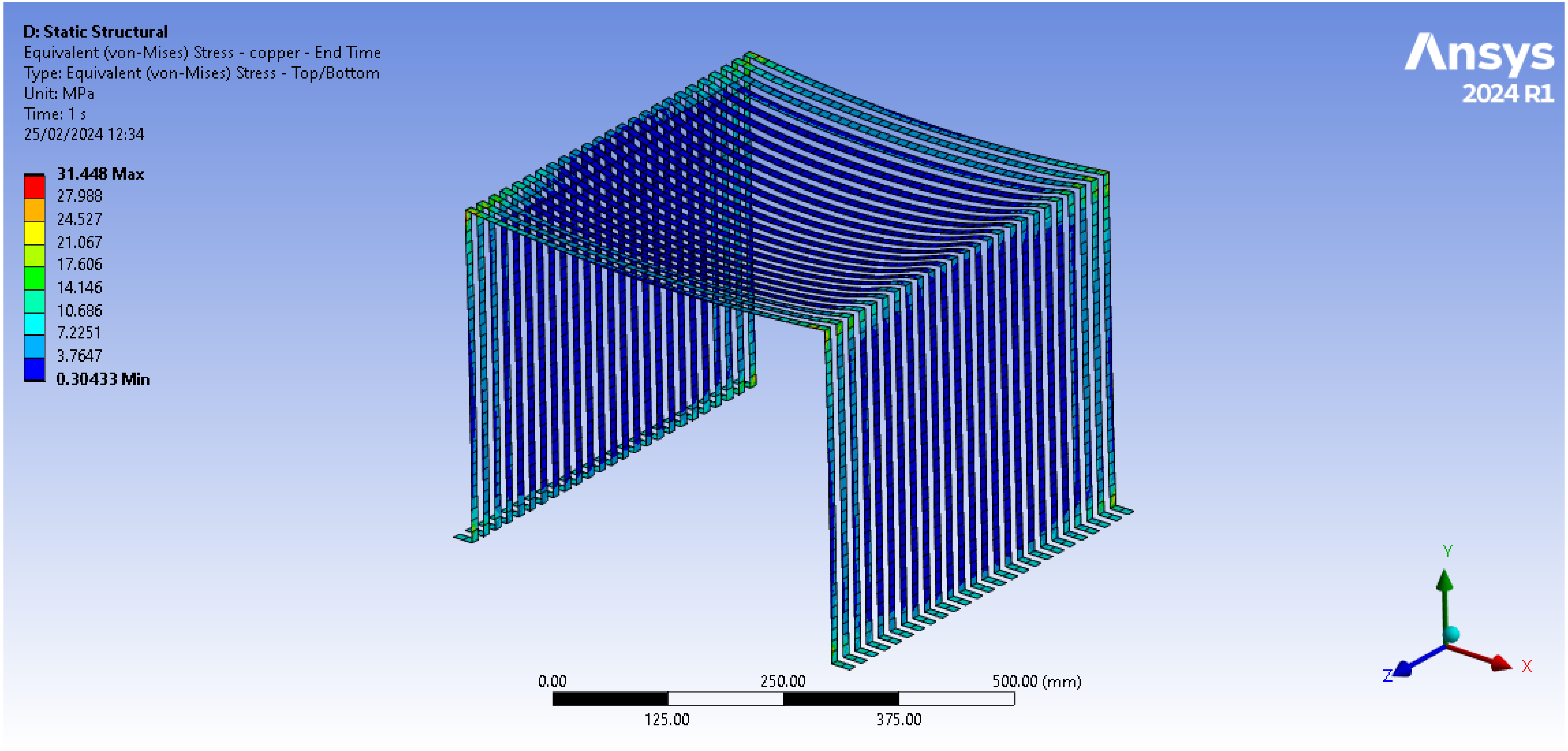
Top: Von Mises with 30 N Stretching Force



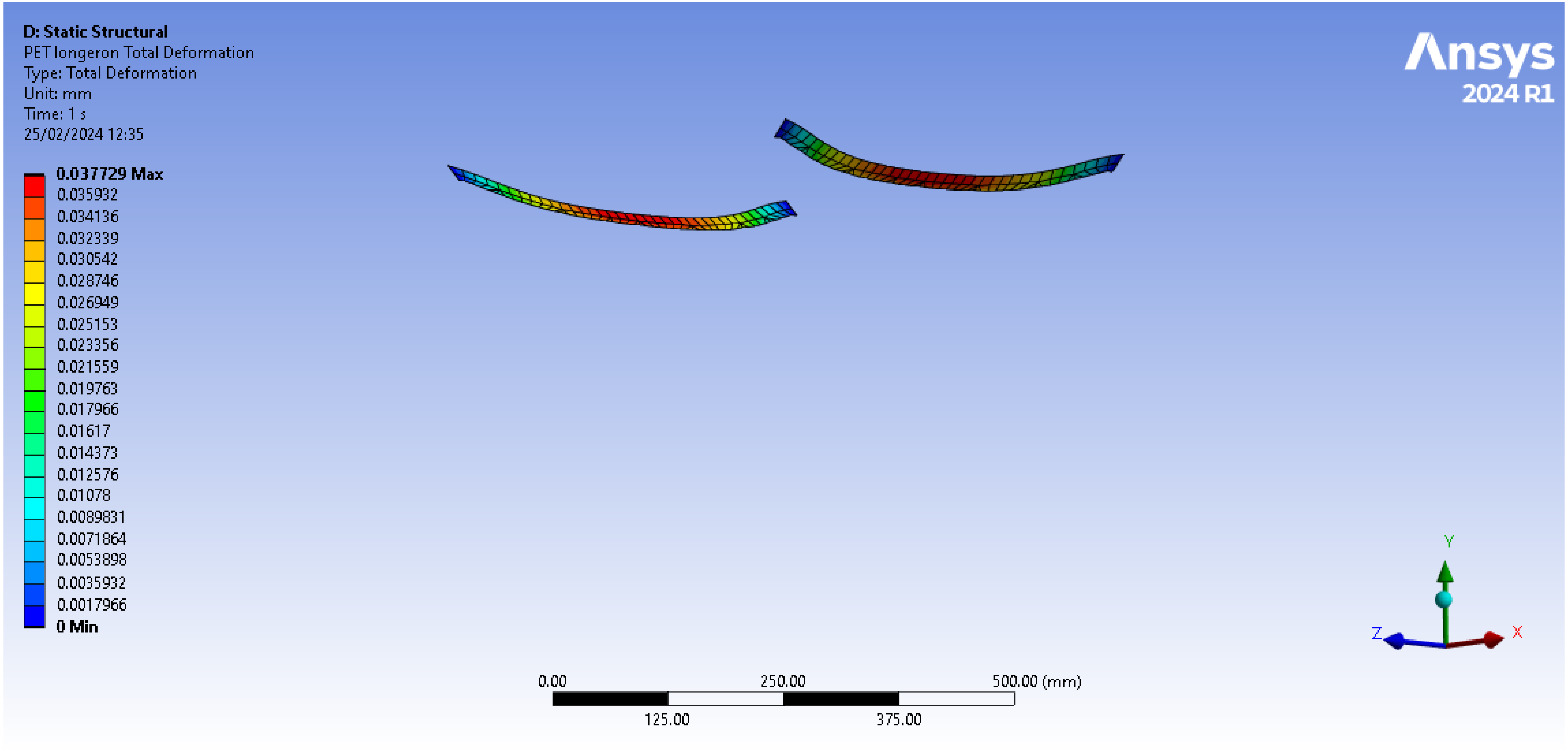
Top: Von Mises with 30 N Stretching Force (PET)



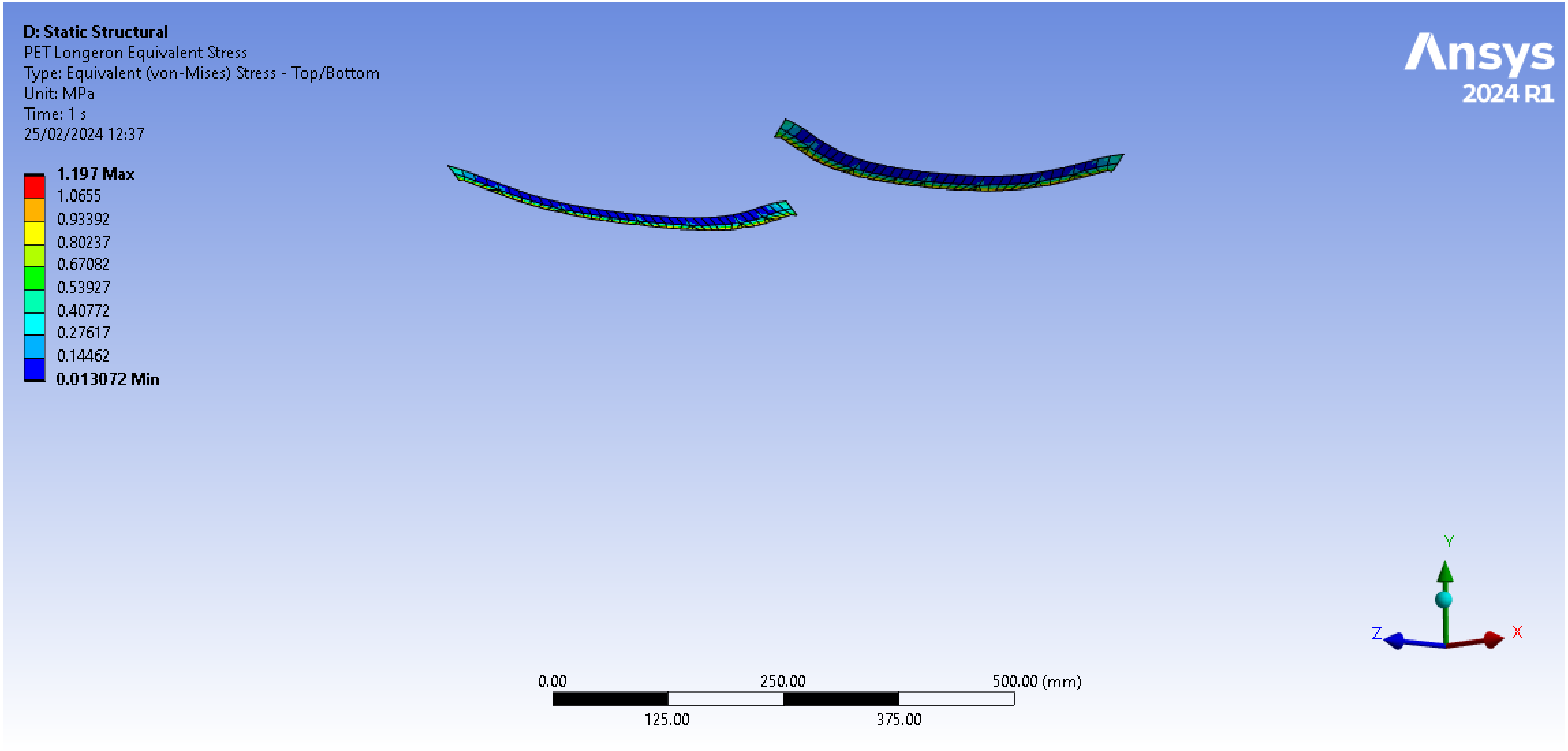
Top: Von Mises with 30 N Stretching Force (Cu)



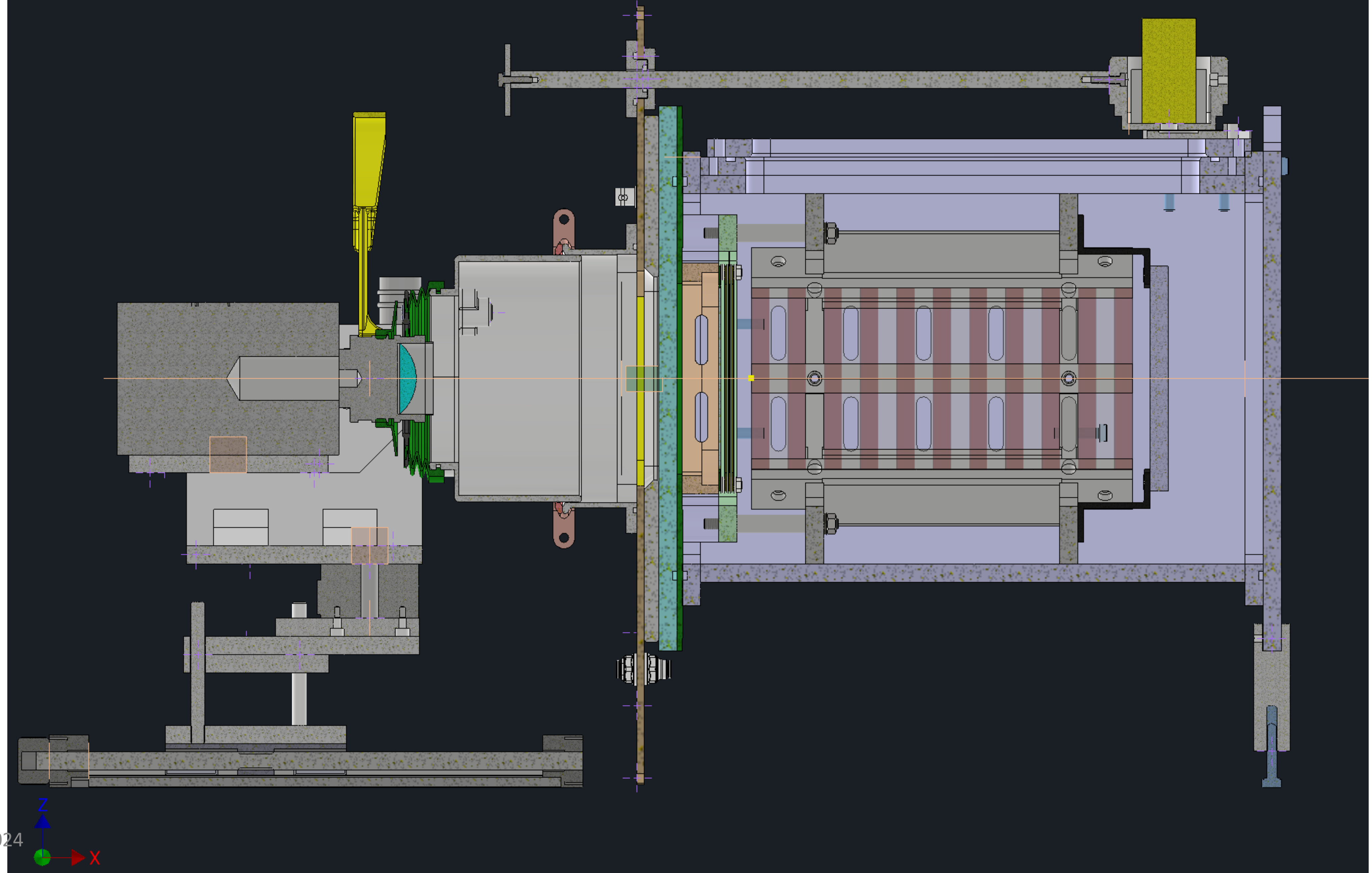
Top: Total deformation with 30 N Stretching Force (Longeron)

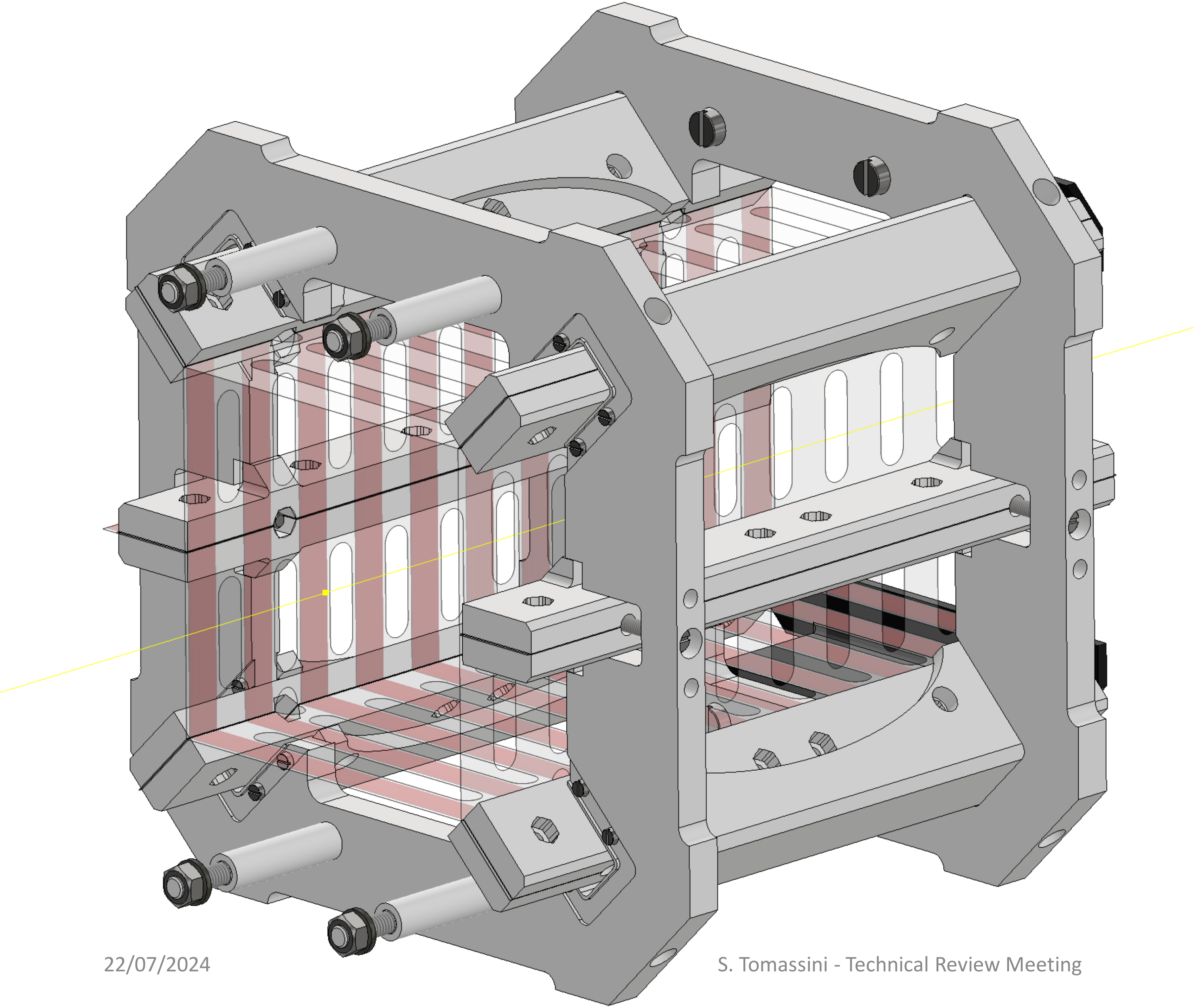


Top: Von Mises with 30 N Stretching Force (Longeron)

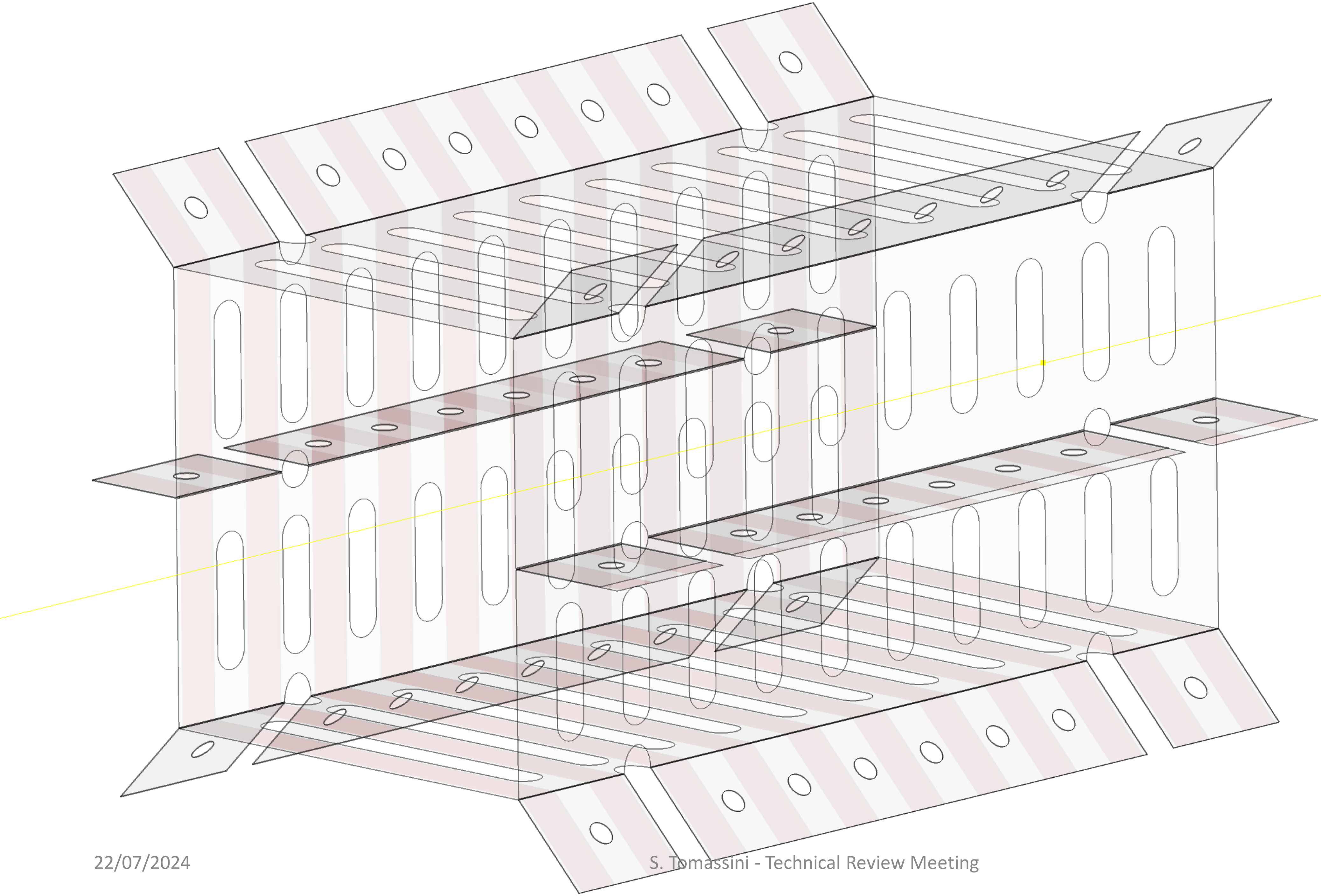


GIN: with the new FC



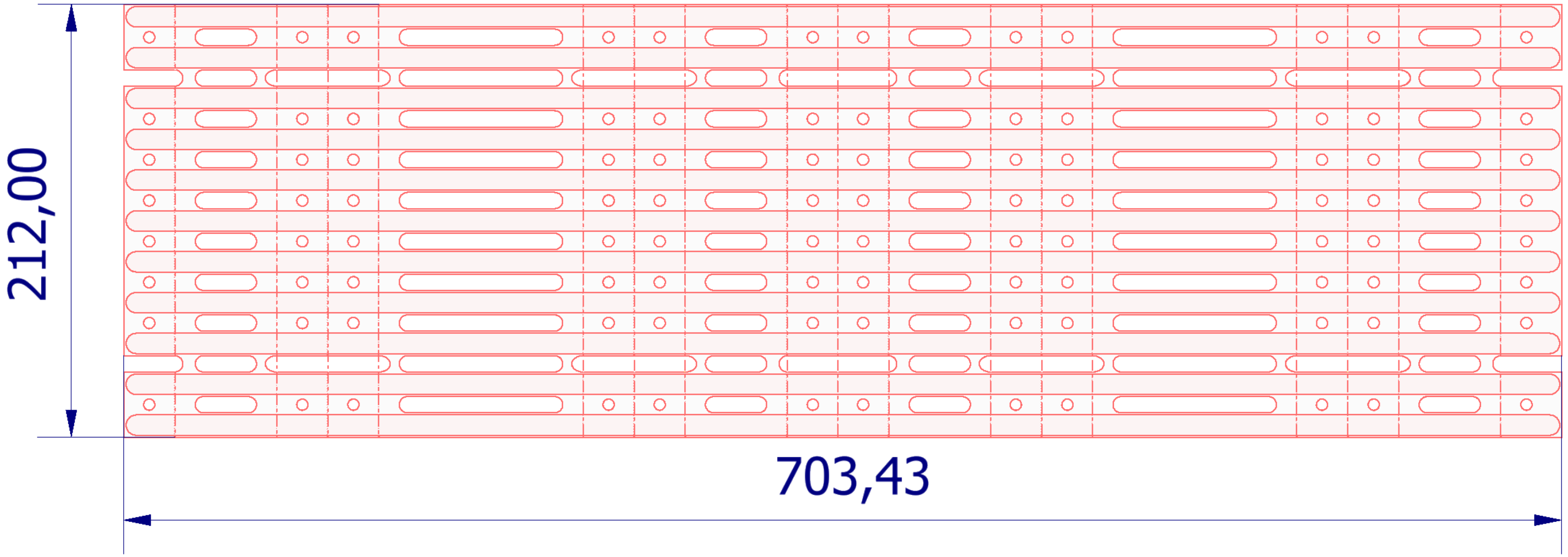


FC OPTIMIZED FOR THE GIN SETUP. All the components can be machined as acrylic material

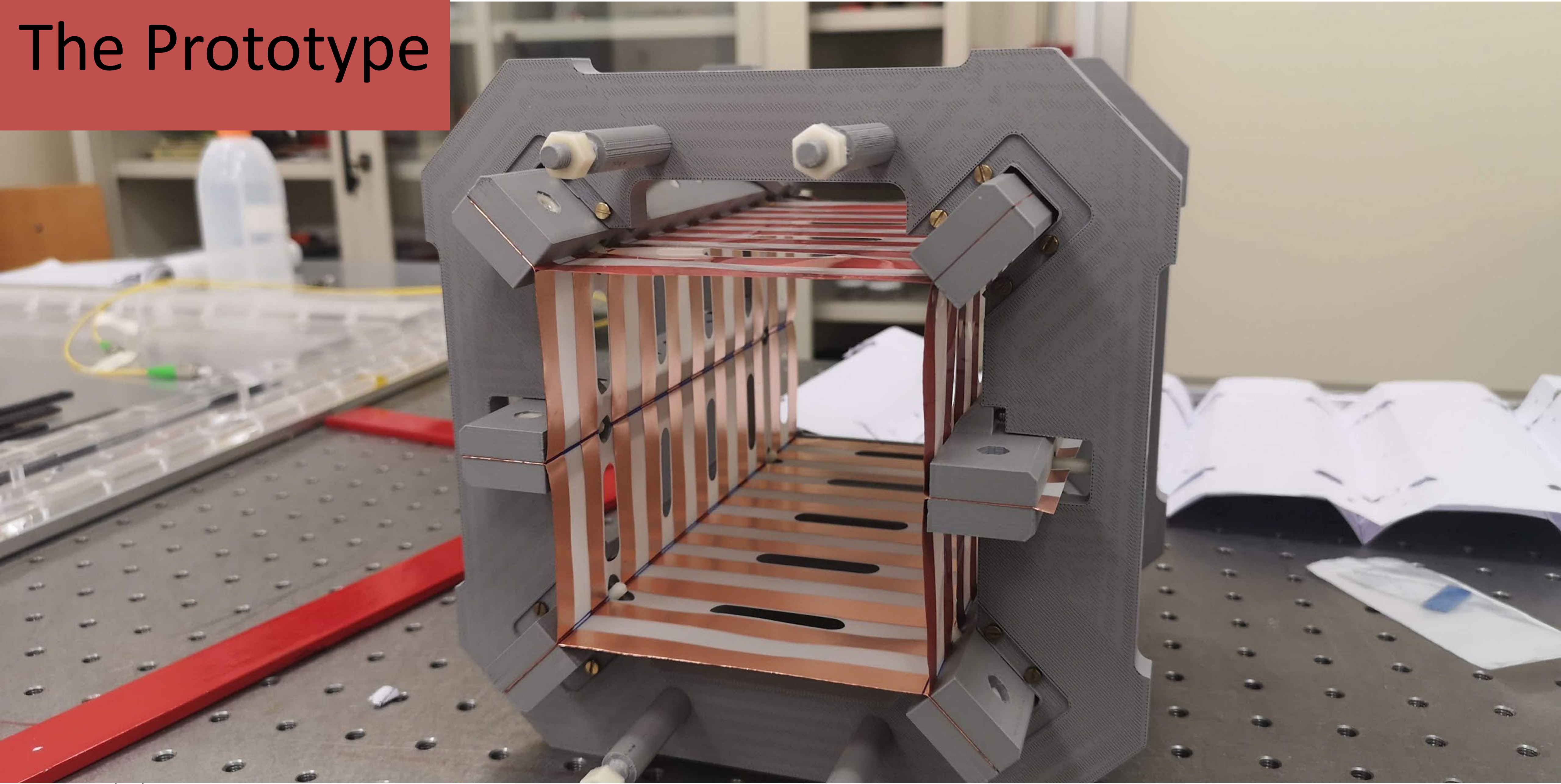


FC foil using PET or Kapton support

FLAT PATTERN WITH BENDING LINES



The Prototype



CONCLUSIONS

The service project at LNGS was prepared by an external professional and approved by the LAB. The services installation start is foreseen by beginning of September 2024.

The gamma shielding design is well advanced and completed for the next steps: procurement of radiopure raw copper plate. We expect a green light from the review panel to go. The lead time for the copper plate delivery is 18 months. For that we need to start the procurement ASAP.

The recovery of copper slabs from OPERA is well understood.

The Neutron shielding design is ongoing. A smaller shielding has been built and installed for the LIME detector. Some other work must be done in the coming months.

The design of the field cage is well advanced. A small FC prototype has been built for the GIN detector. Results are expected soon. More optimizations must be considered for the FC after the first tests.

The acrylic vessel design is ongoing provided the limit of 135 kg mass. Not presented in this review.