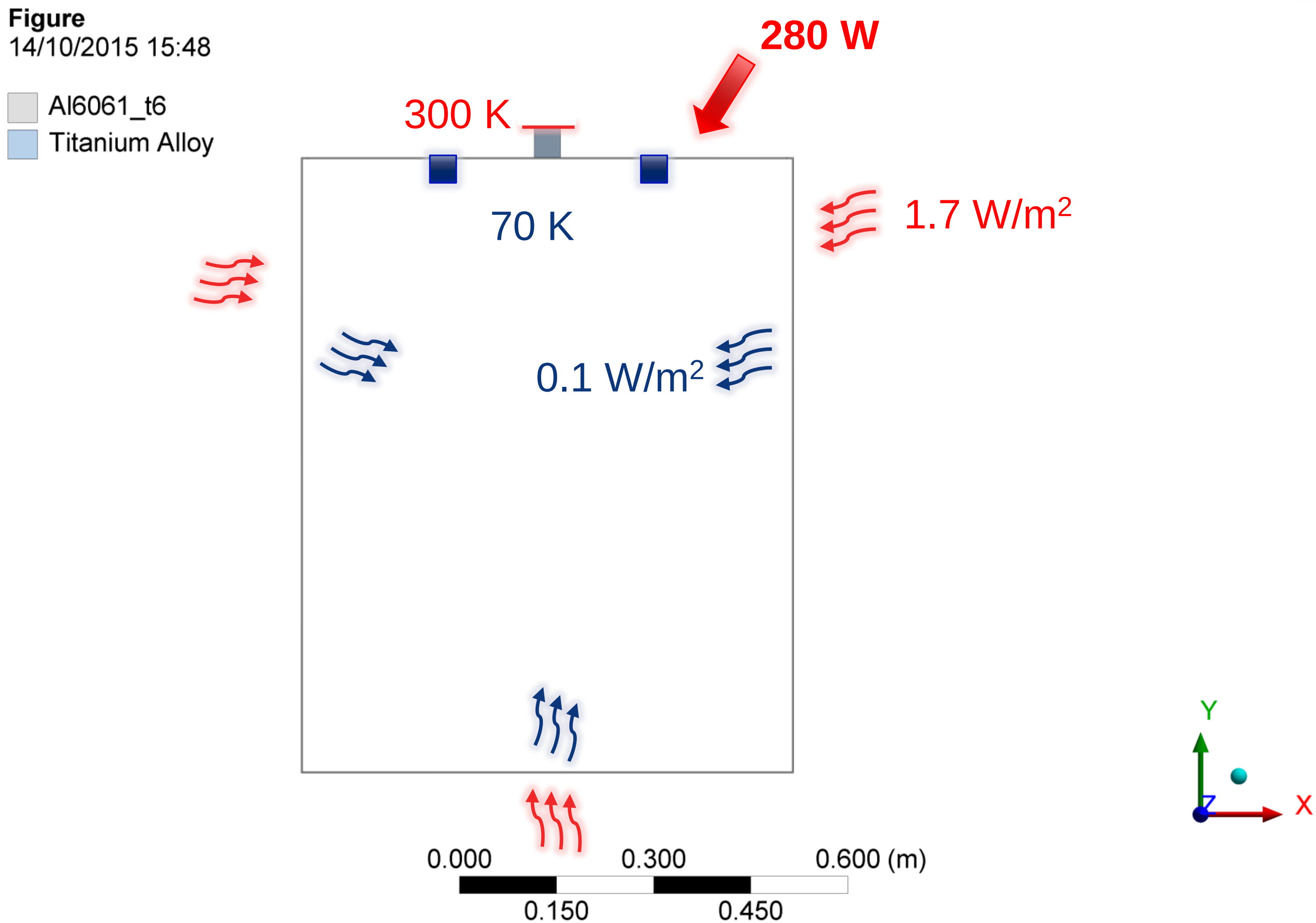
Preliminary 3D calculation of the Thermal Shield

Carlo Zanoni

ENGINEERING DEPARTMENT

Loads and Boundary Conditions



Loads and Boundary Conditions

	DQW		RFD	
	2K	80K	2K	80K
Static				
Radiation	~~3~~	~~35*~~	~~3~~	~~35*~~
CWT	0.2	2	0.2	2
Supports	0.8	30	0.8	30
FPC	4	100	4	100
Instrumentation	1	0	1	0
HOM/Pickup	2.5	10	1.7	10
Tuner	0.3	10	0.3	10
Total static	11.8	187	11	187
Dynamic				
Cavity	6	0	6	0
FPC	5.6	10	5.6	20
HOM/Pickup	7.2	120	5.5	80
Beam	0.5	0	0.5	0
Total Dynamic	19.3	130	17.6	100
TOTAL	28.2	282	25.6	252

*see MLI

Loads and Boundary Conditions

- 300 K external (support edge)
- 77 K at the intercepts locations (real T between 50 and 70 K)
- 280 W to shield from HOM, pickup etc…*
- 0.1 W/m^2 radiative heat to the tank *
- 1.7 W/m^2 radiative heat through the MLI (1.5x factor from **)
- 250 W/m^2K thermal conductance (i.e. localized thermal resistance at contact location) ***

*from Fede's table
G:\Departments\EN\Projects\MME_MechanicalEngineering\Federico.Carra\CrabCavities\

**MLI (also implemented with an Ansys macro as T dependent, but it's a secondary effect):

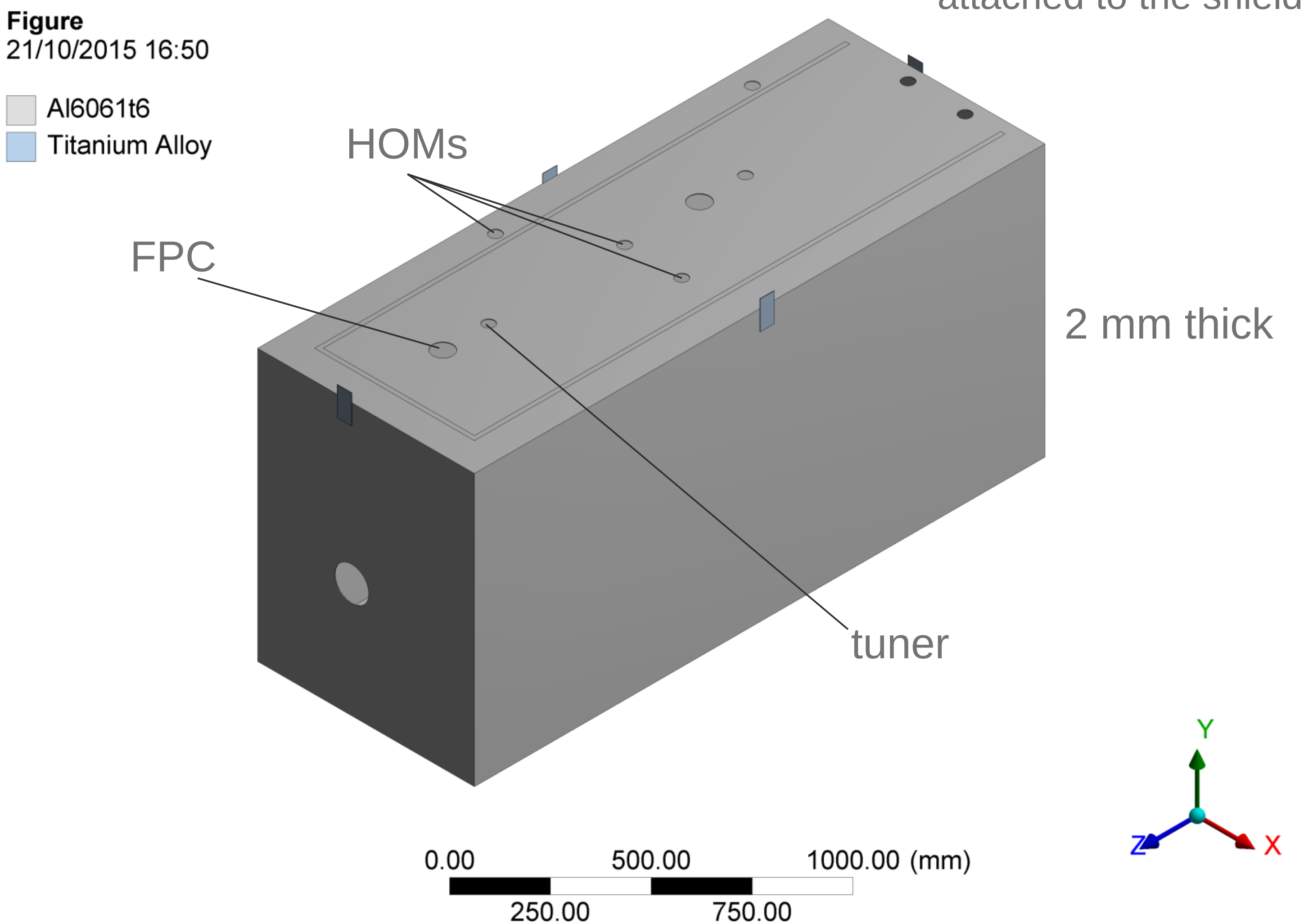
http://arxiv.org/ftp/arxiv/papers/1501/1501.07154.pdf

***not implemented for now

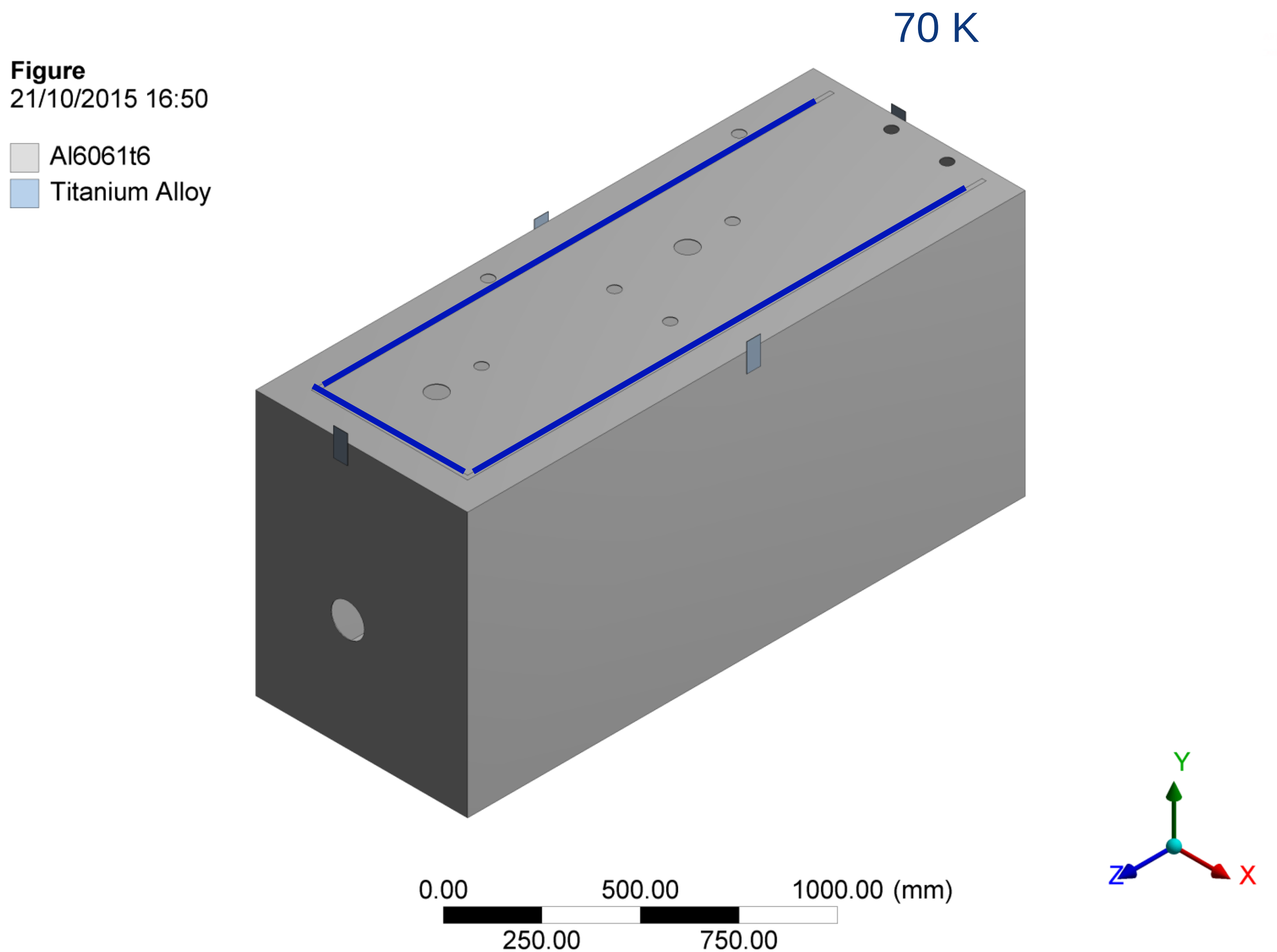
Simple U pipe – Al 6061

Geometry

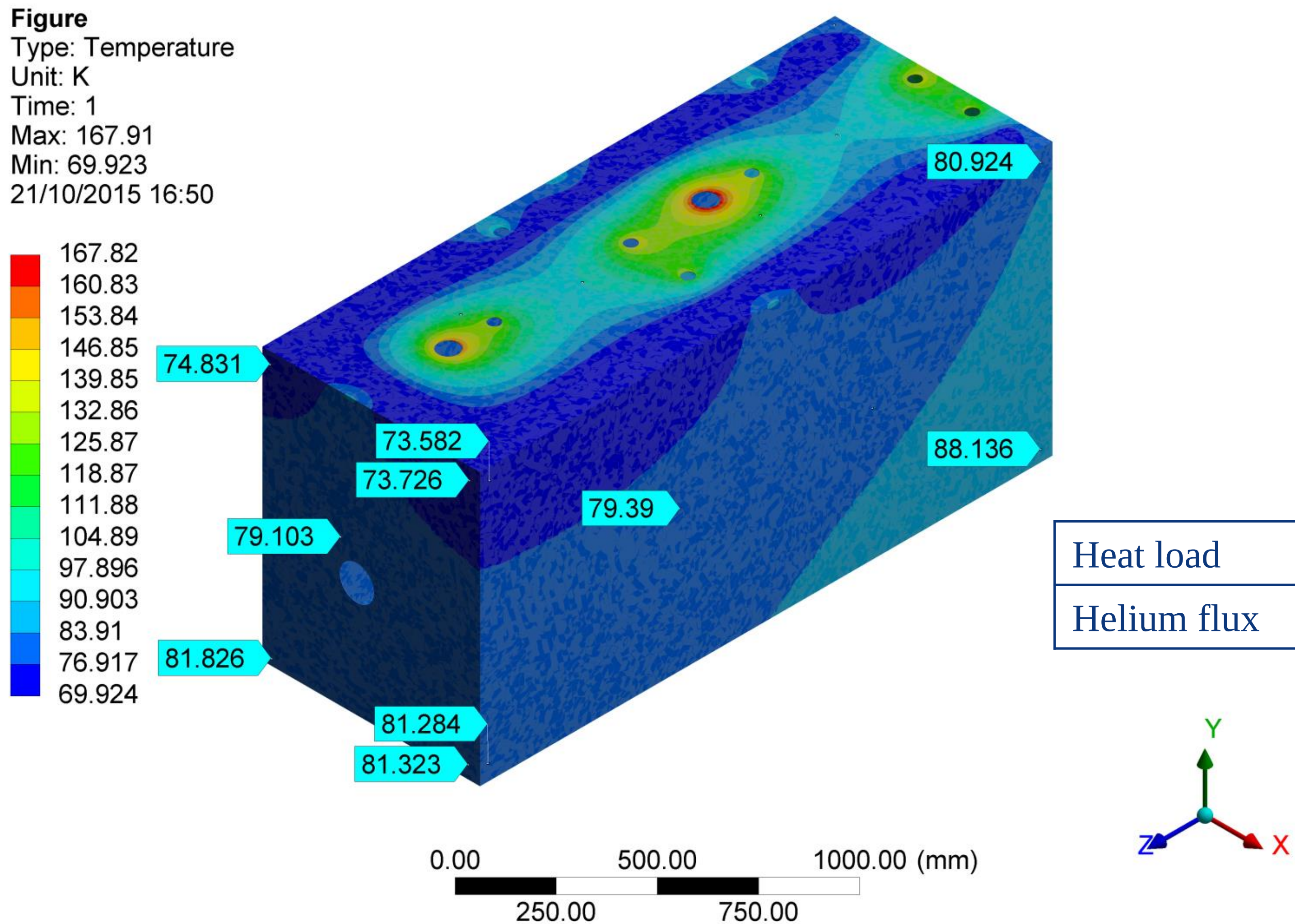
The support is made through 100mm long Ti blades, attached to the shield sides



Geometry

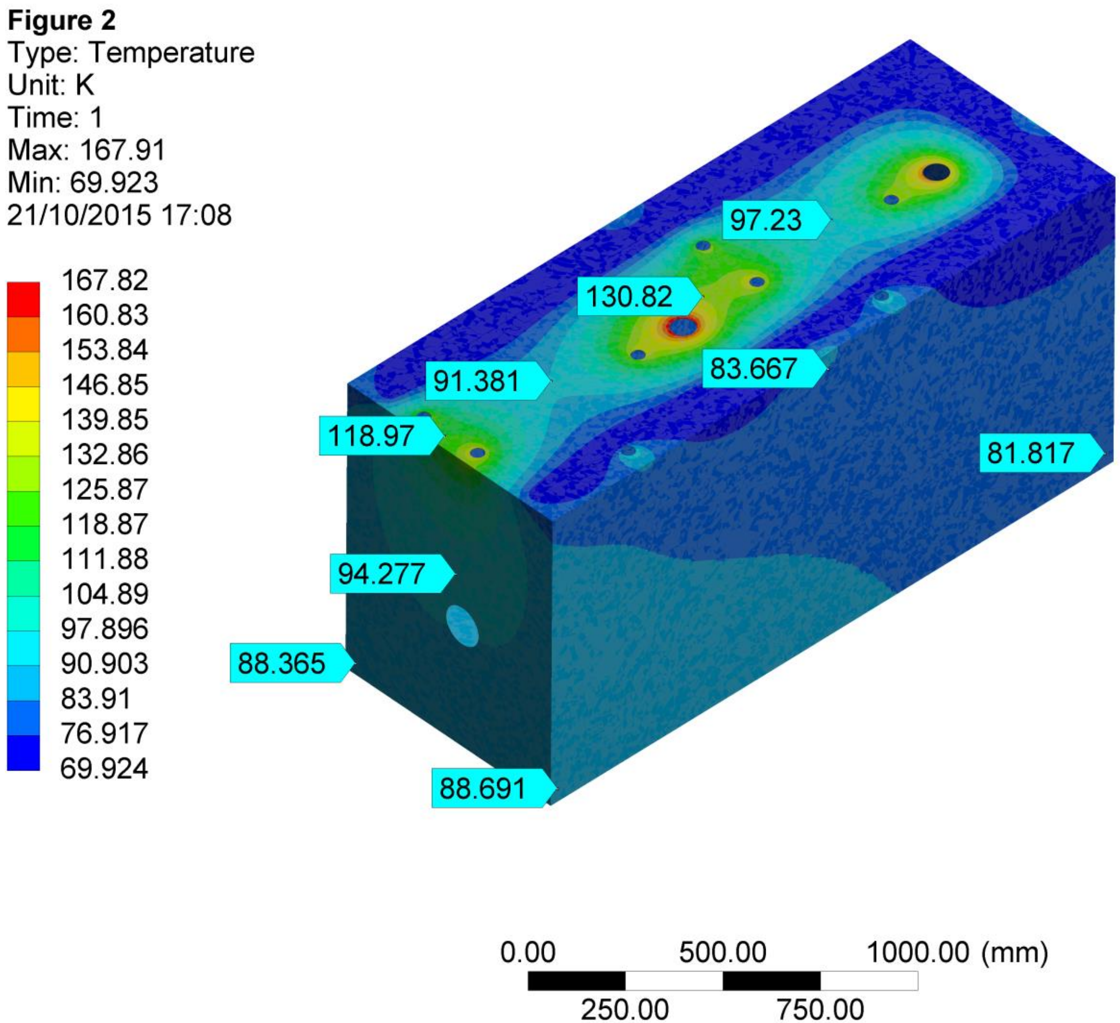

70 K
Figure
21/10/2015 16:50
Al6061t6
Titanium Alloy
0.00
500.00
1000.00 (mm)
250.00
750.00
Y
Z
X

Temperature Distribution

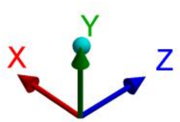


Heat load	315 W
Helium flux	3 g/s

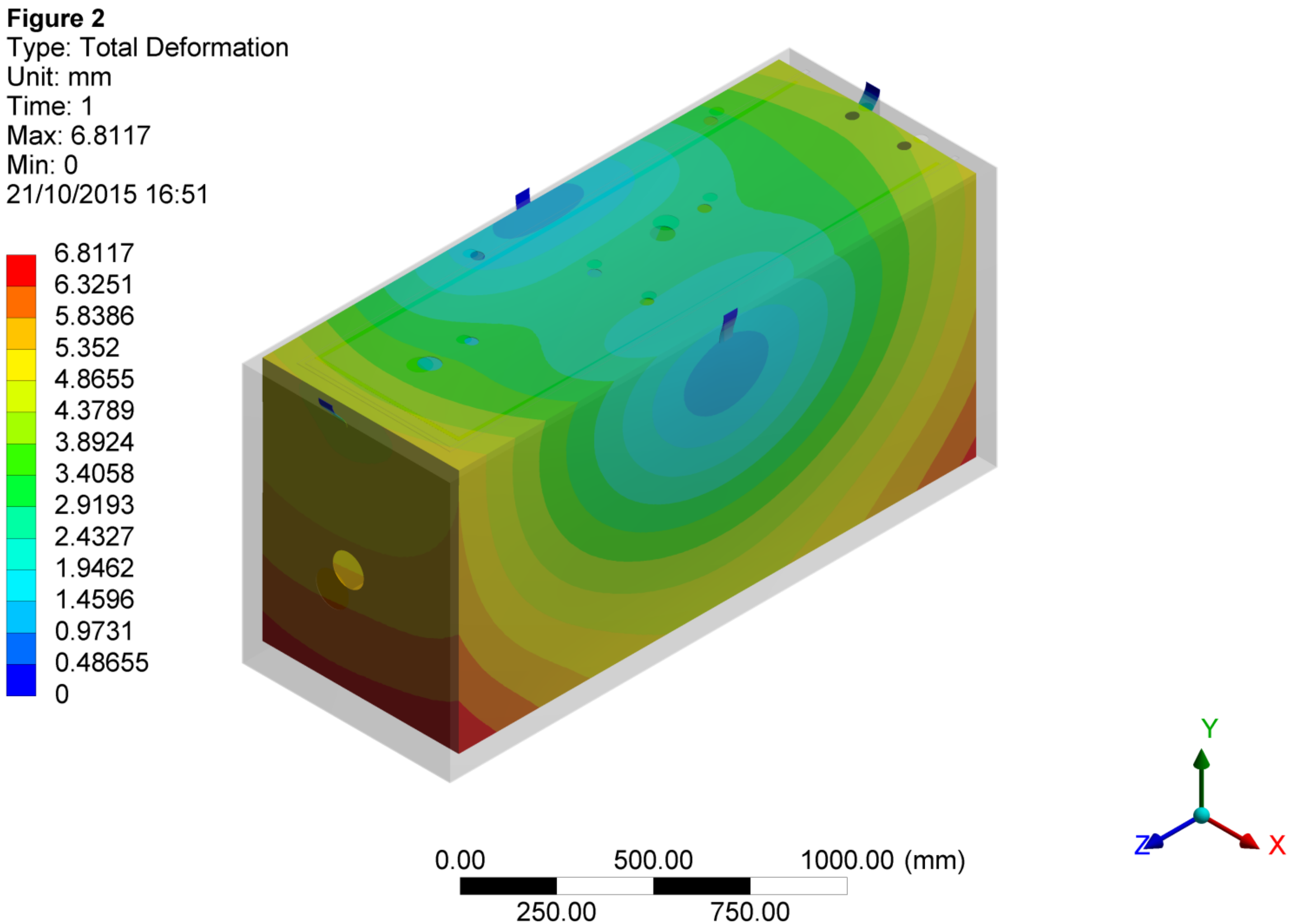
Temperature Distribution



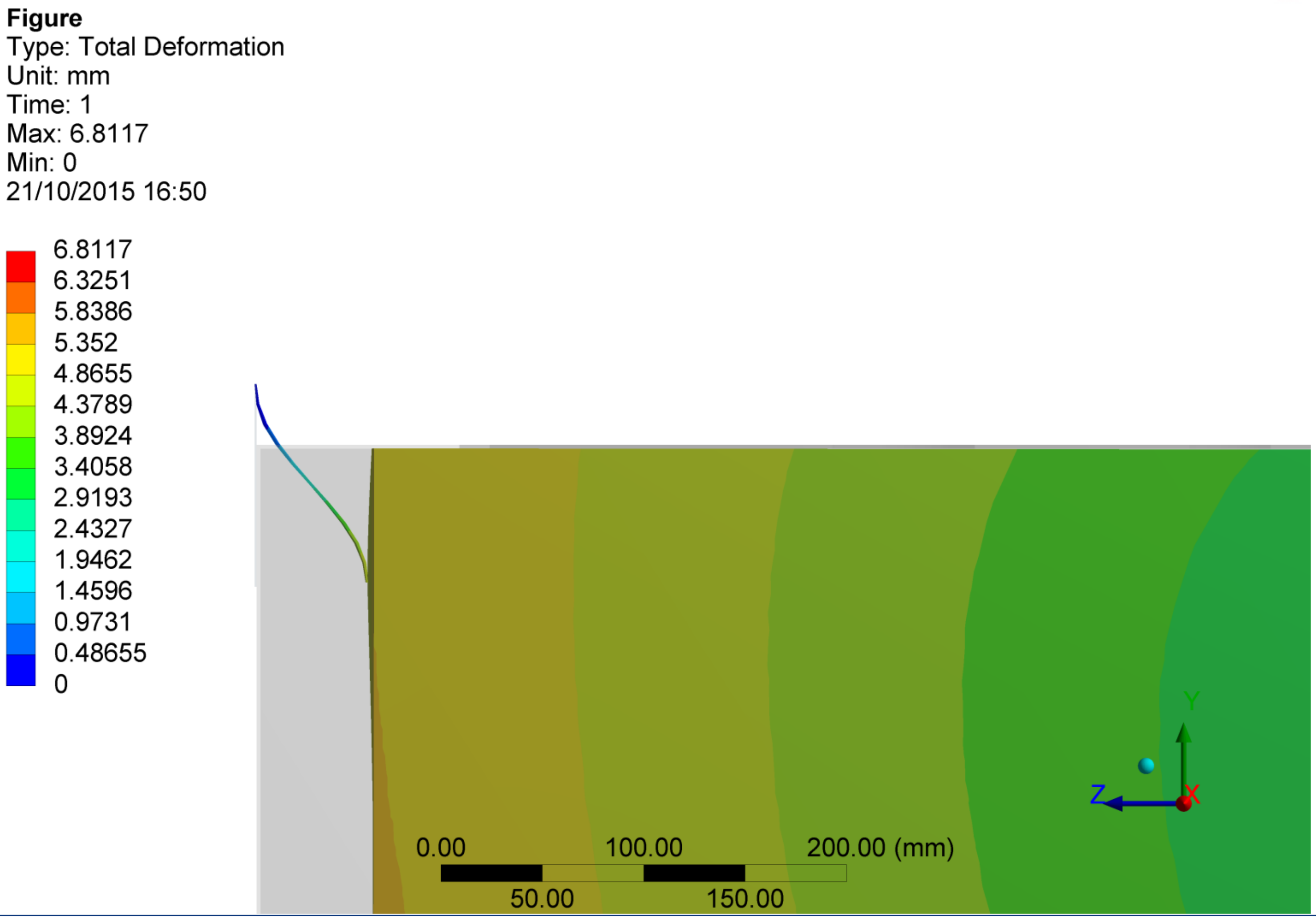
Heat load	315 W
Helium flux	3 g/s



Deformation



Deformation



Stress

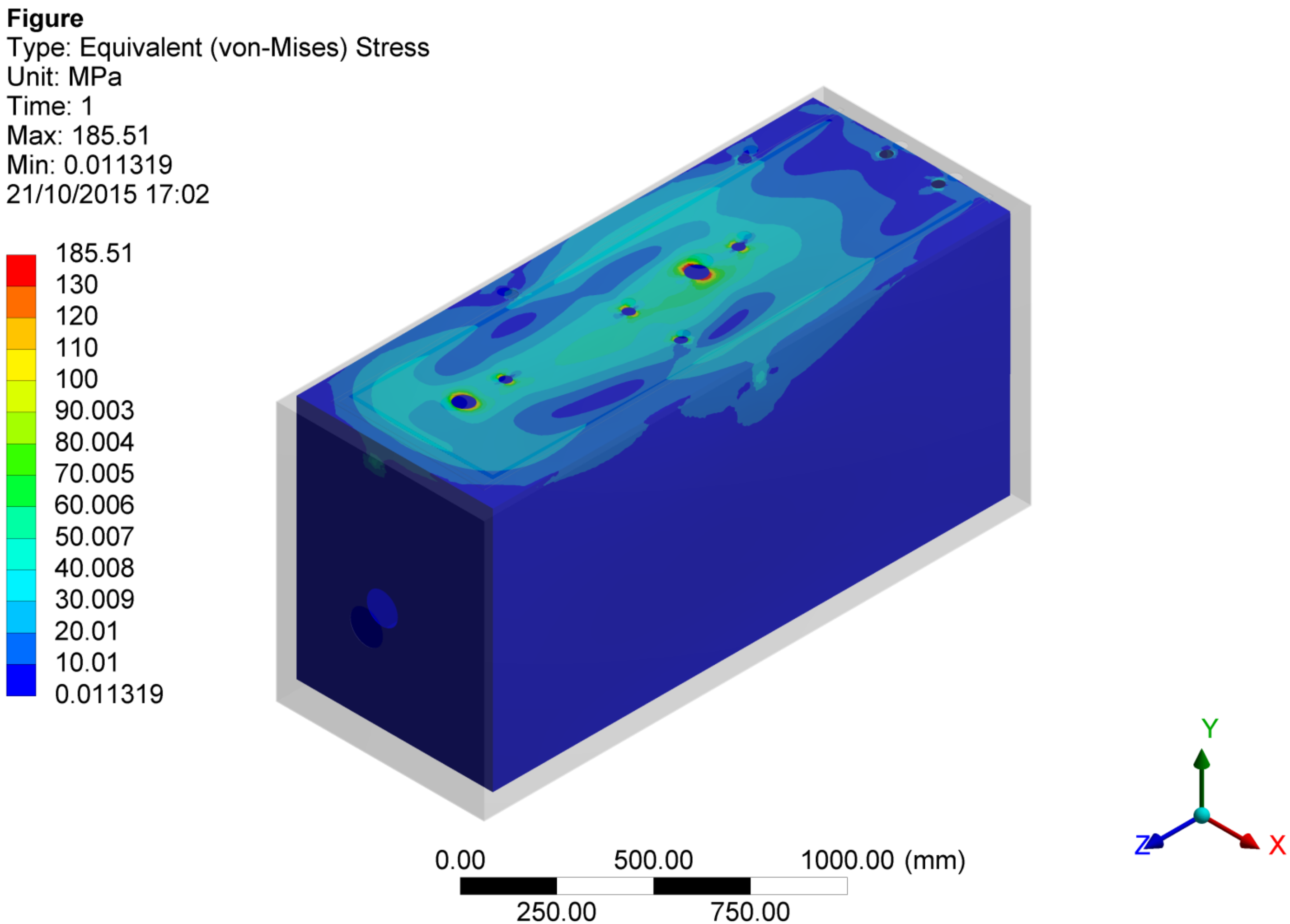
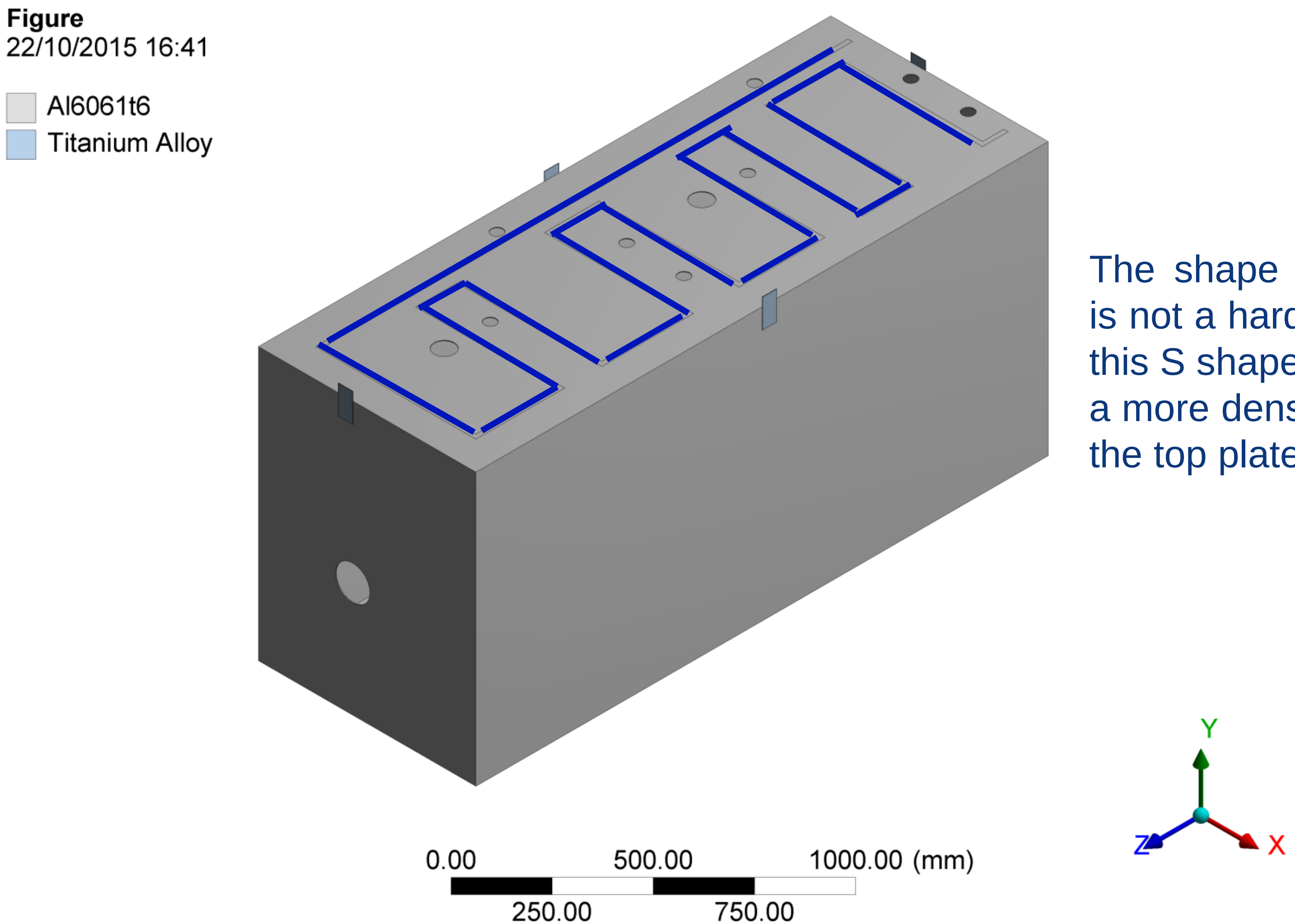


Figure
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1
Max: 185.51
Min: 0.011319
21/10/2015 17:02
185.51
130
120
110
100
90.003
80.004
70.005
60.006
50.007
40.008
30.009
20.01
10.01
0.011319
0.00
500.00
1000.00 (mm)
250.00
750.00
Y
Z
X

S pipe – Al 6061

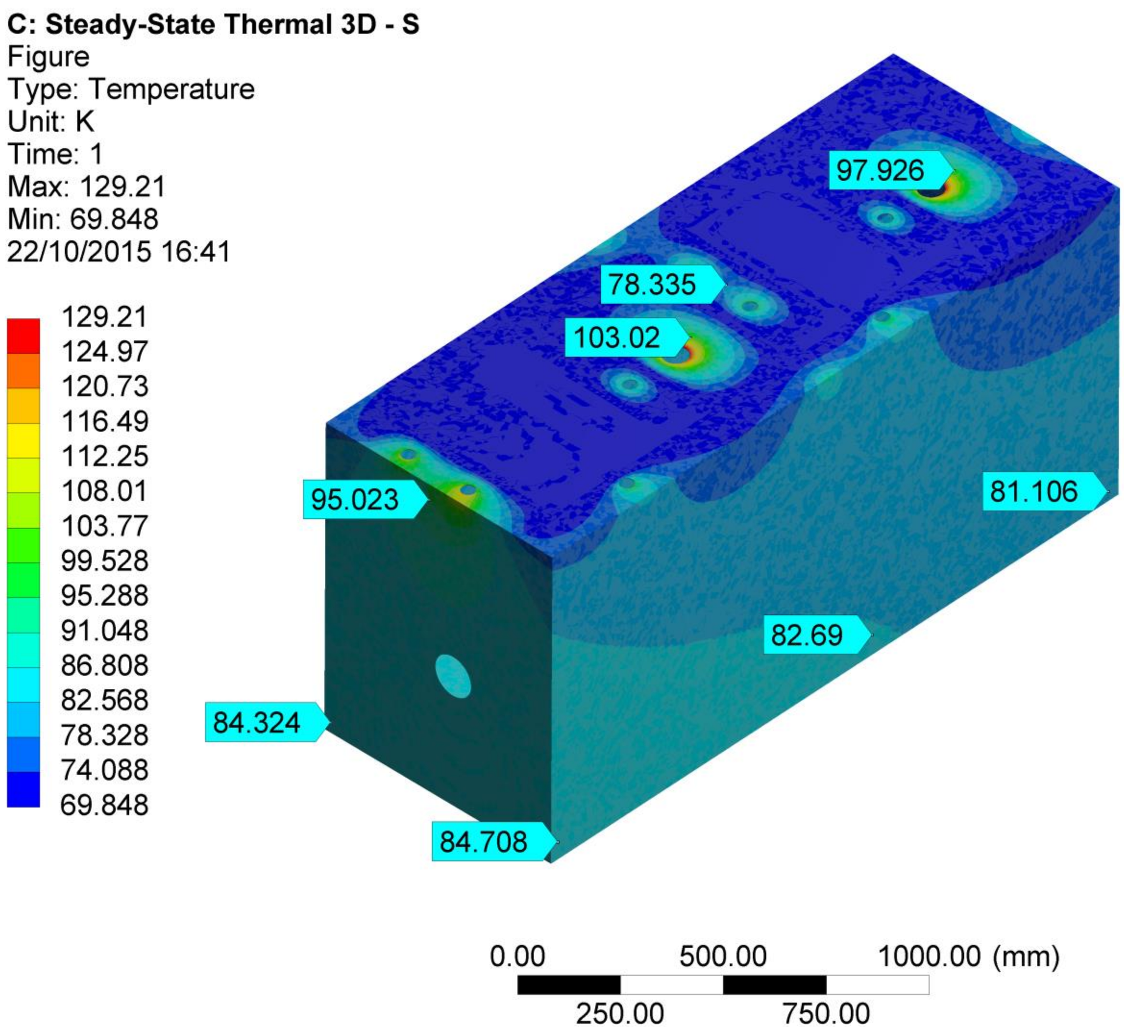
Geometry

70 K



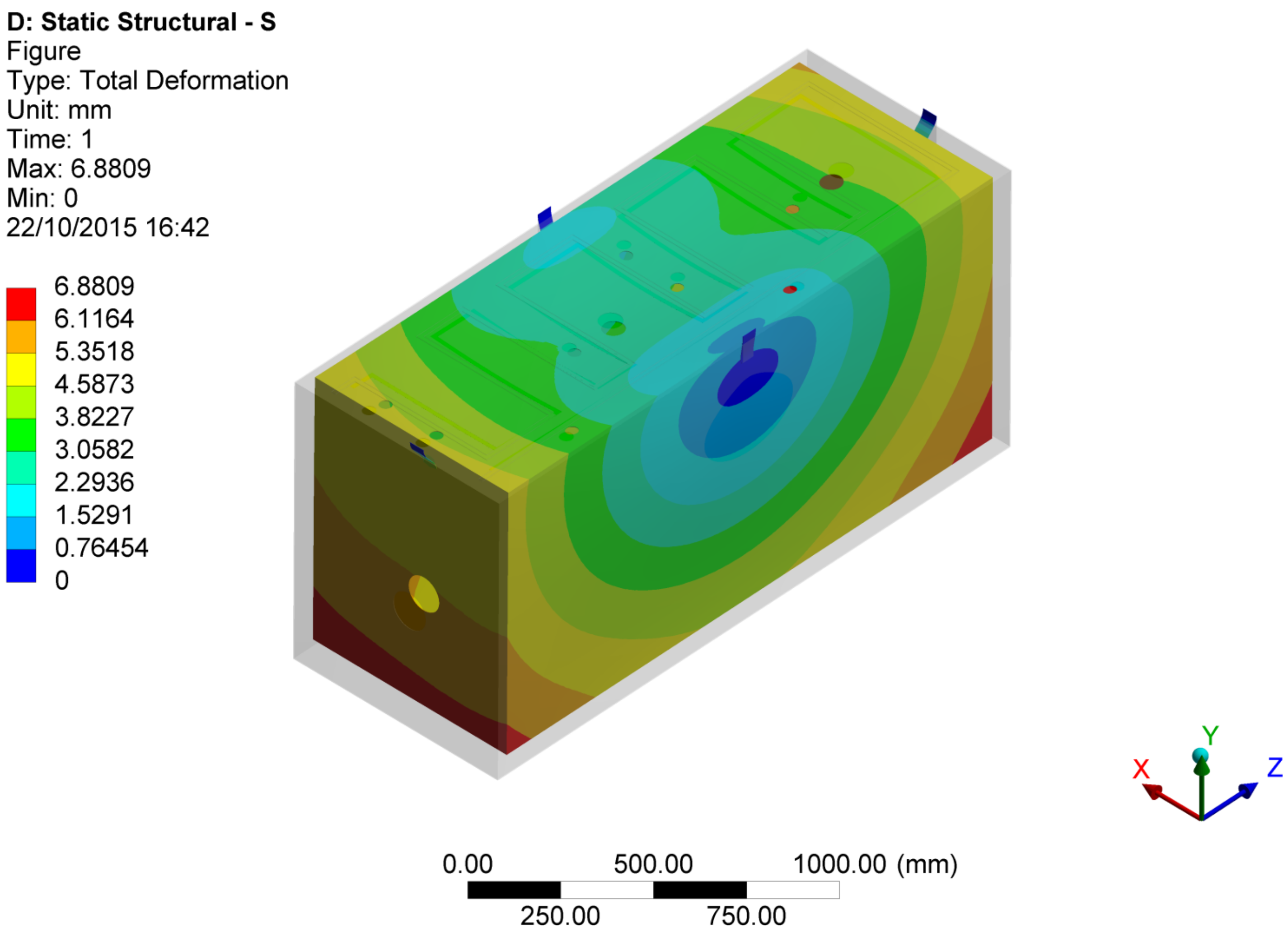
The shape of the pipe is not a hard constraint, this S shape represents a more dense piping on the top plate

Temperature Distribution

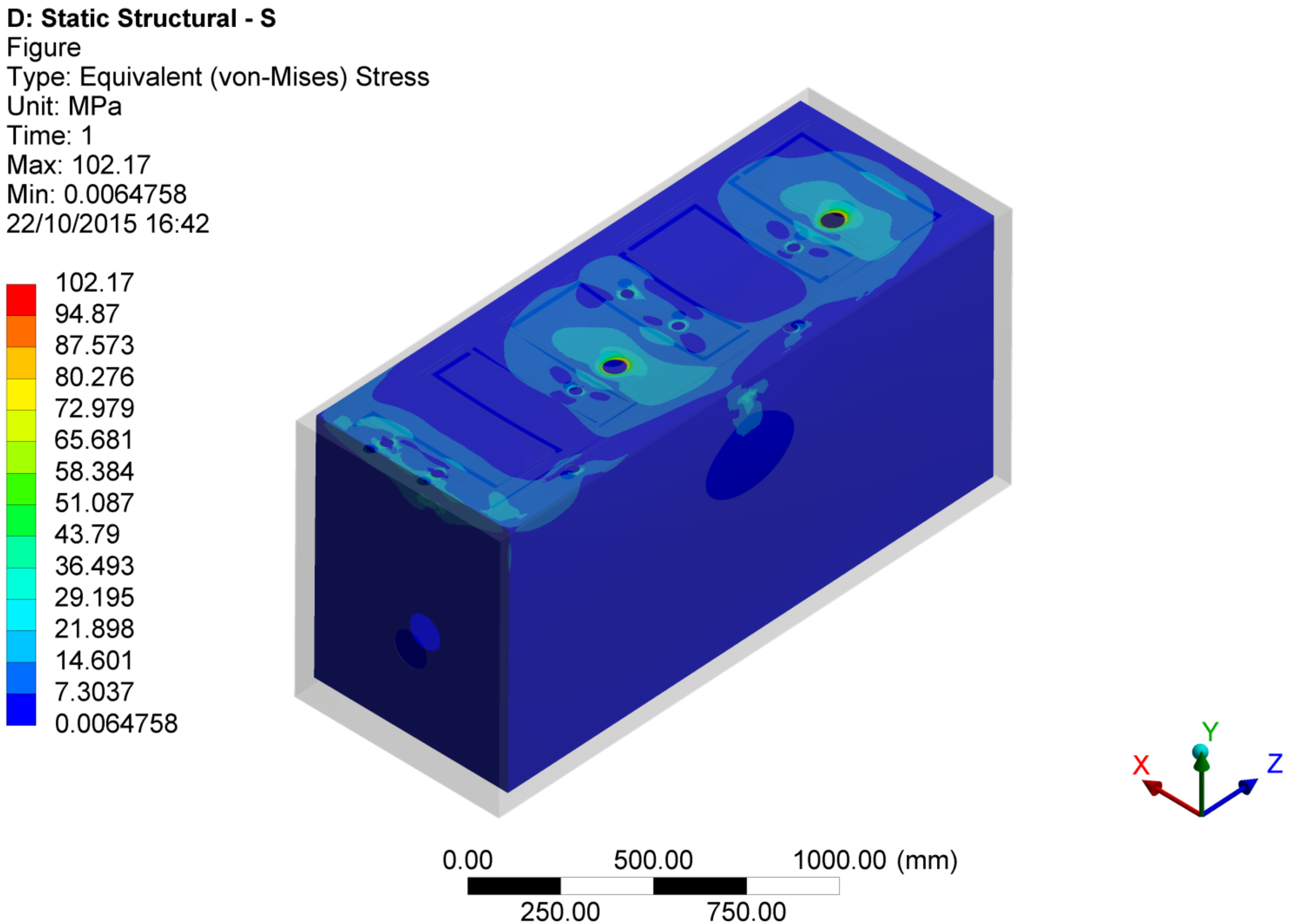


Heat load	326 W
Helium flux	3.13 g/s

Deformation

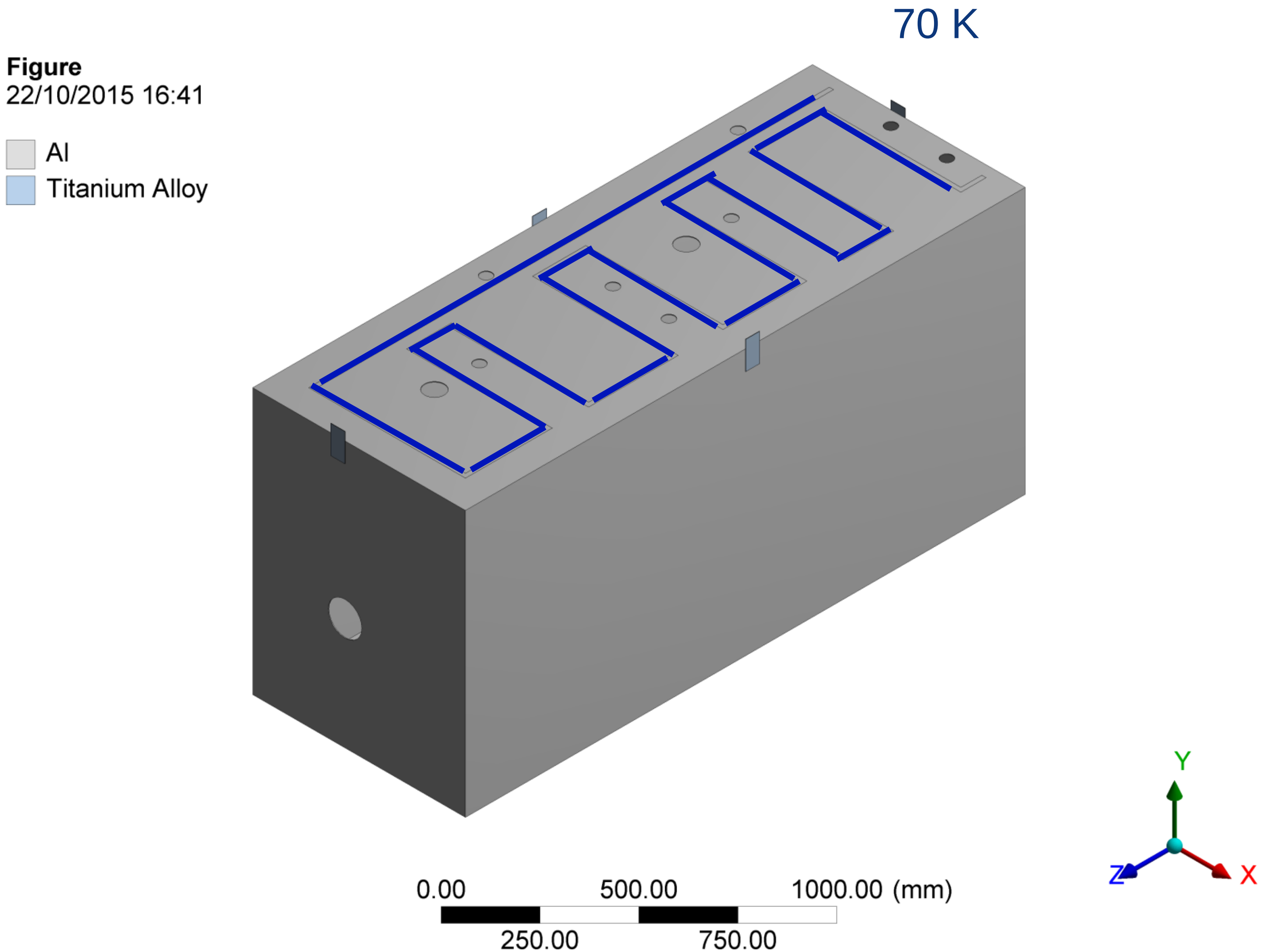


Stress

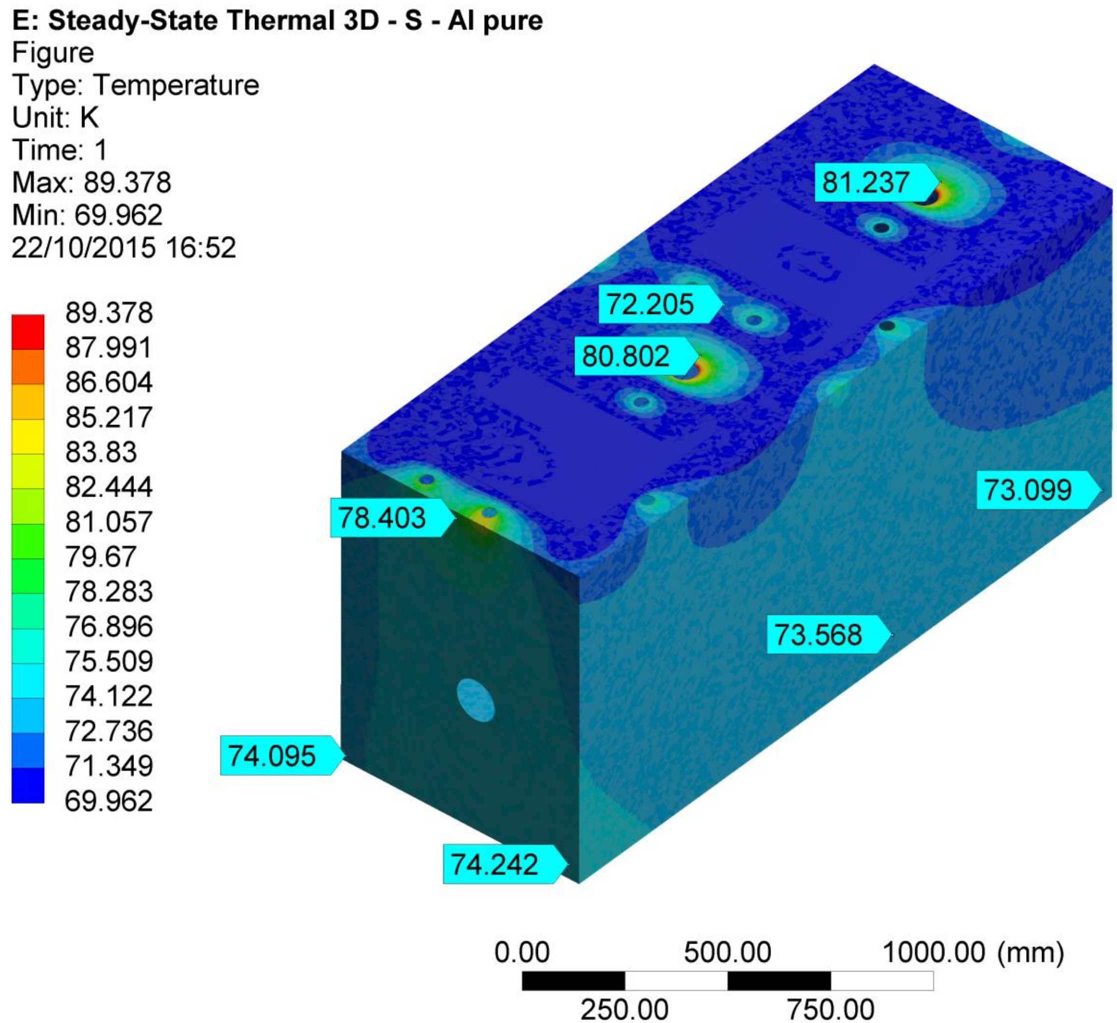

D: Static Structural - S
Figure
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1
Max: 102.17
Min: 0.0064758
22/10/2015 16:42
102.17
94.87
87.573
80.276
72.979
65.681
58.384
51.087
43.79
36.493
29.195
21.898
14.601
7.3037
0.0064758
Y
X
Z
0.00
500.00
1000.00 (mm)
250.00
750.00

S pipe – Al 1060

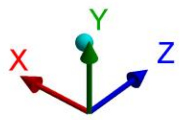
Geometry


70 K
Figure
22/10/2015 16:41
Al
Titanium Alloy
0.00
500.00
1000.00 (mm)
250.00
750.00
Y
Z
X

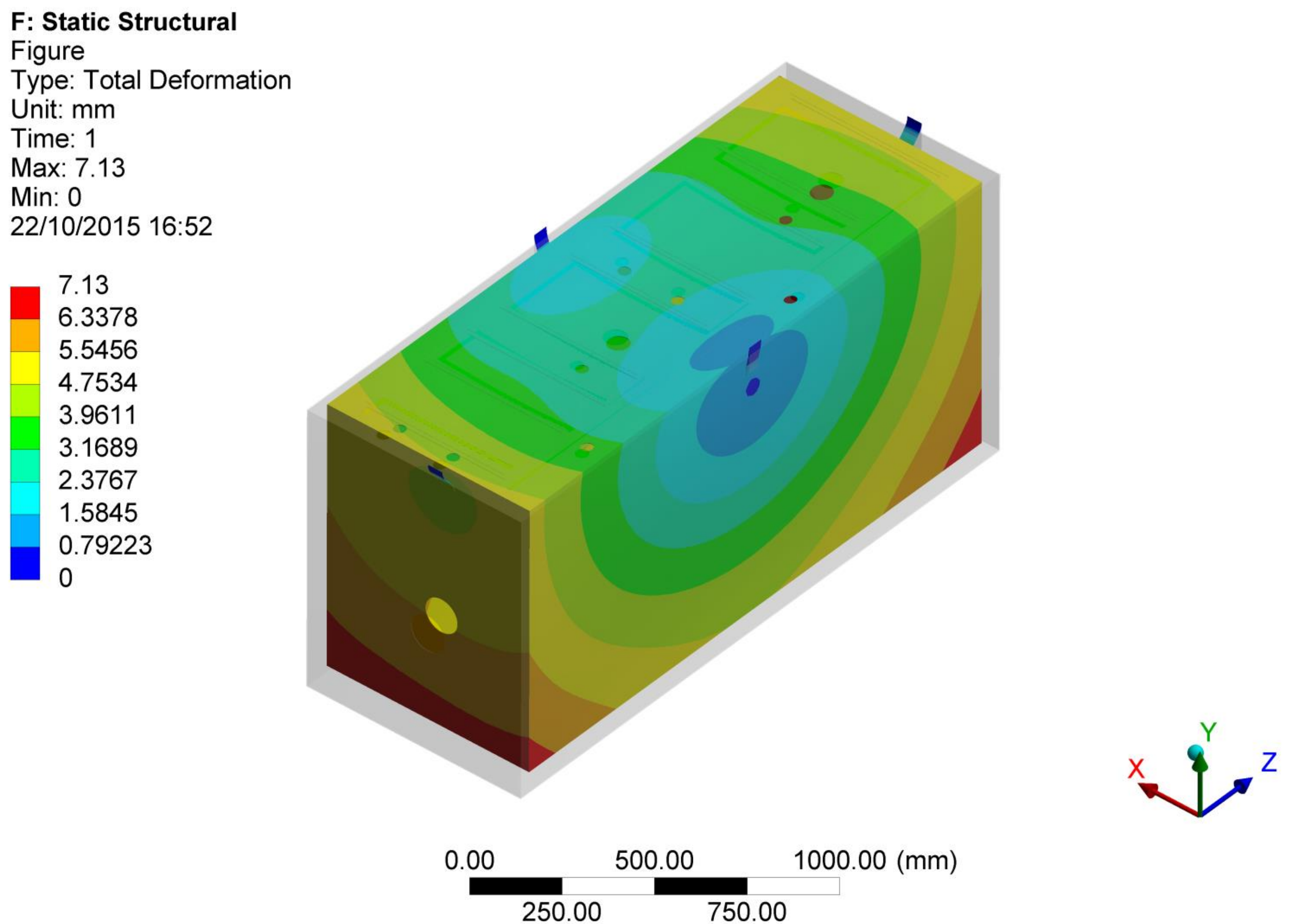
Temperature Distribution



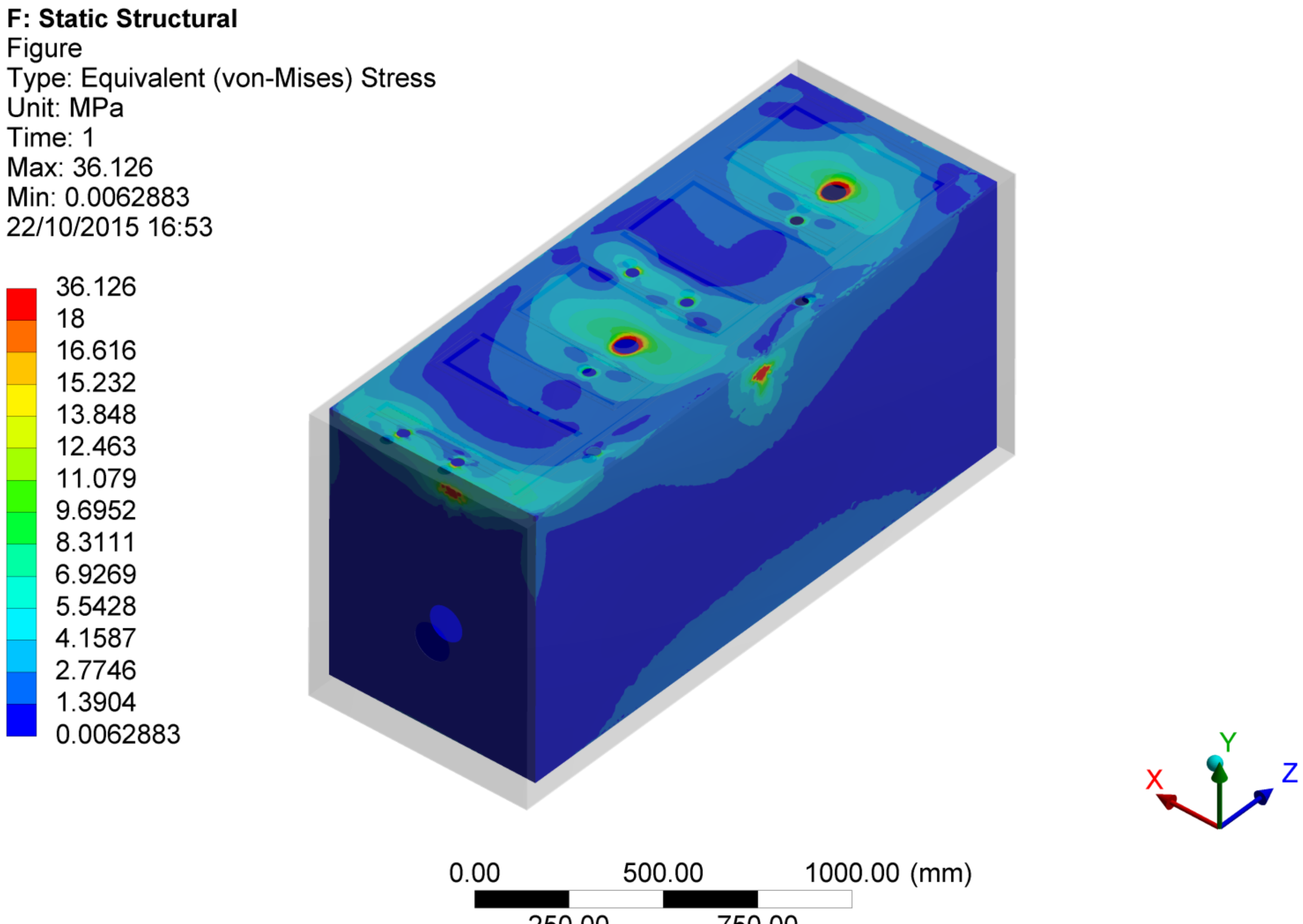
Heat load	331 W
Helium flux	3.18 g/s



Deformation

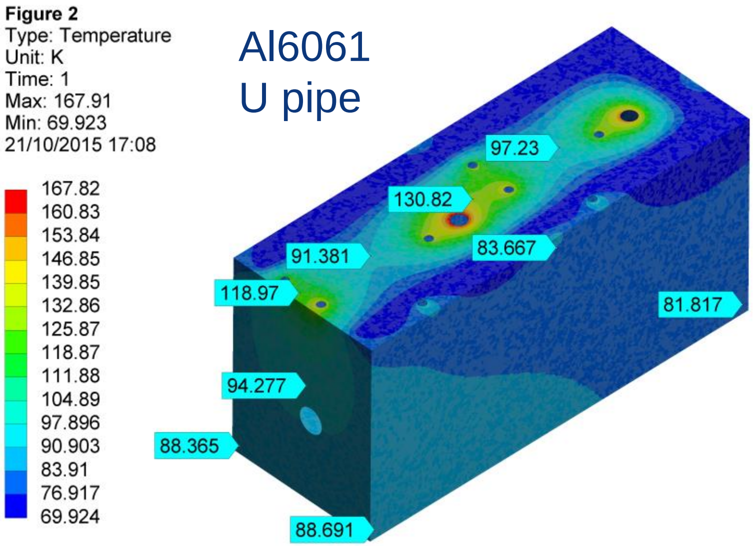


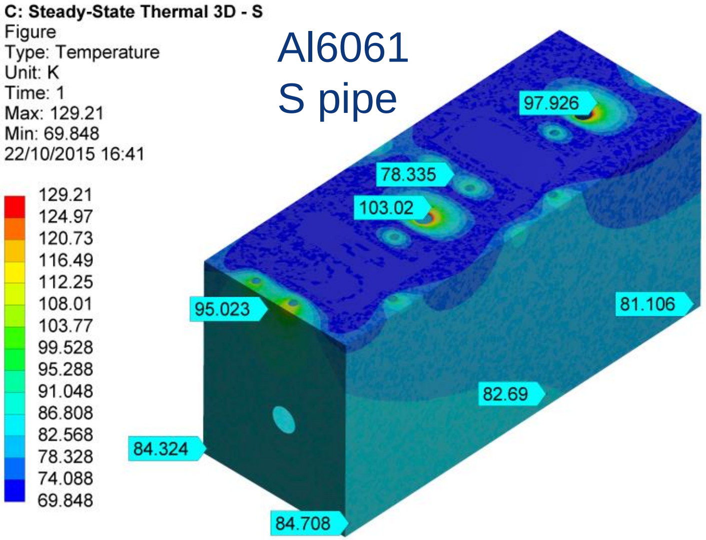
Stress

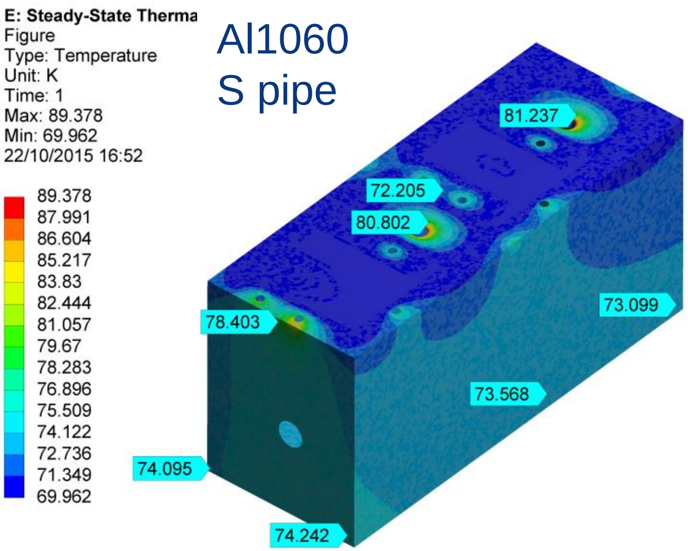

F: Static Structural
Figure
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1
Max: 36.126
Min: 0.0062883
22/10/2015 16:53
36.126
18
16.616
15.232
13.848
12.463
11.079
9.6952
8.3111
6.9269
5.5428
4.1587
2.7746
1.3904
0.0062883
Y
X
Z
0.00
500.00
1000.00 (mm)
250.00
750.00

Comparison

Temperature

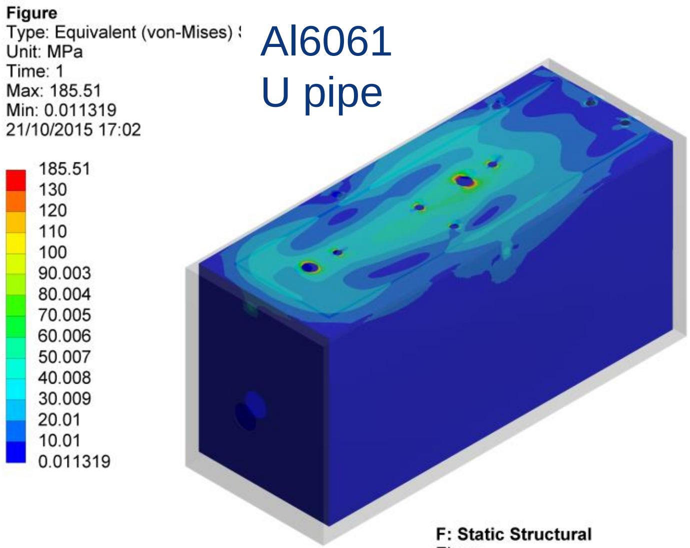




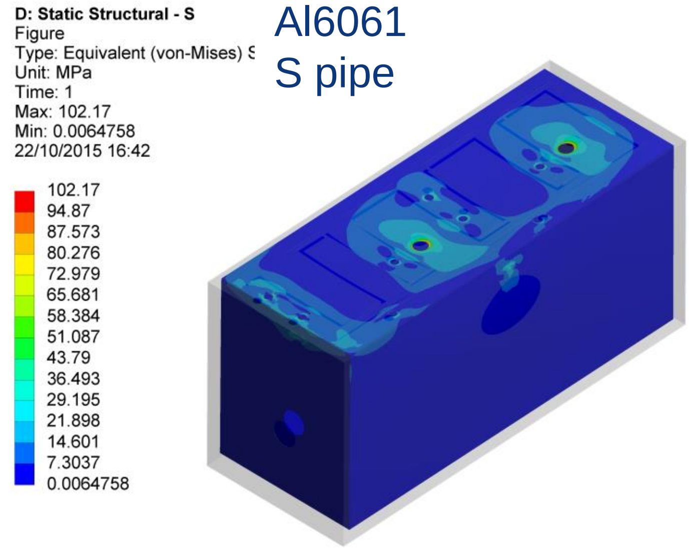


Stress

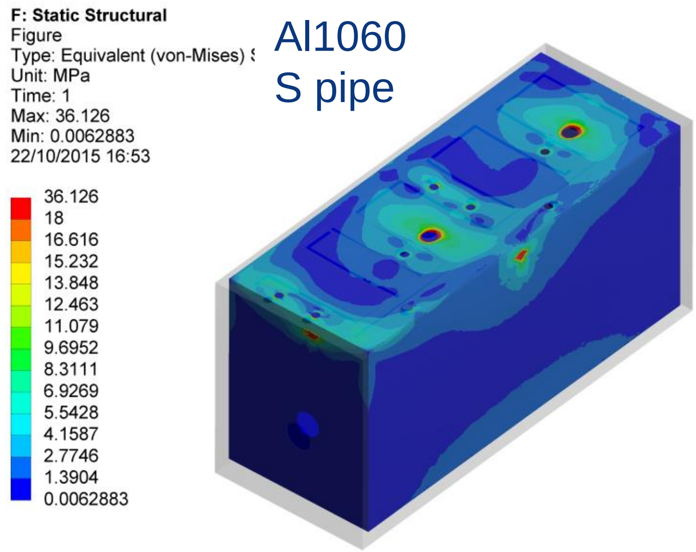
Al6061
U pipe



Al6061
S pipe



Al1060
S pipe



Comments

- The use of a more complex pipe greatly enhances the performance (i.e. smaller T gradient and lower stress)
- Pure Al (1060) has 5x* conductivity of 6061. The result is a further improvement of T and stress
- Al 1060 has low yield and all my researches point towards thermal shields in Al 6061. The Al series 6 is easily weldable.
- Best choice?

*the Al 1060 conductivity may be overestimated