

Panda TS Aluminium Cryostat

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Material Properties

Structural Aluminium (Ansys)

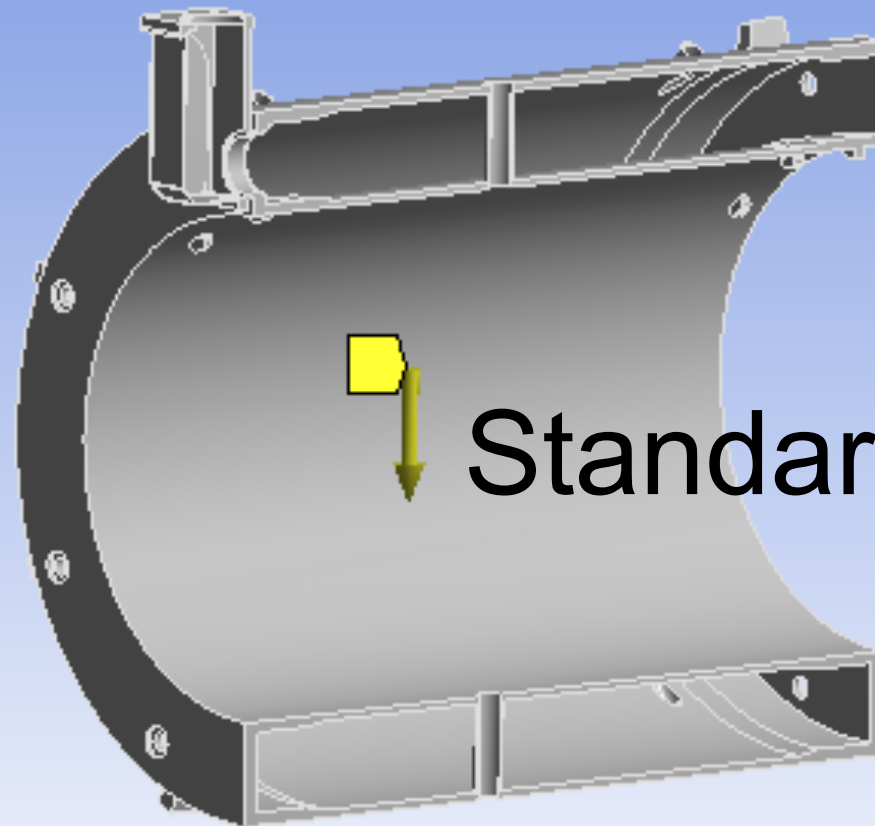
Density	2.77E+03	kg m ⁻³
Young's Modulus	7.10E+10	Pa
Poisson's Ratio	3.30E-01	
Bulk Modulus	6.96E+10	Pa
Shear Modulus	2.67E+10	Pa
Tensile Yield Strength	2.80E+08	Pa
Compressive Yield Strength	2.80E+08	Pa
Tensile Ultimate Strength	3.10E+08	Pa

Boundary Conditions

A: Static Structural
Standard Earth Gravity
Time: 1. s
30/08/2011 16.30



■ Standard Earth Gravity: 9.8066 m/s²
Components: -0., -0., -9.8066 m/s²



Standard Gravity

0.000 2.000 (m)
1.000



Supports

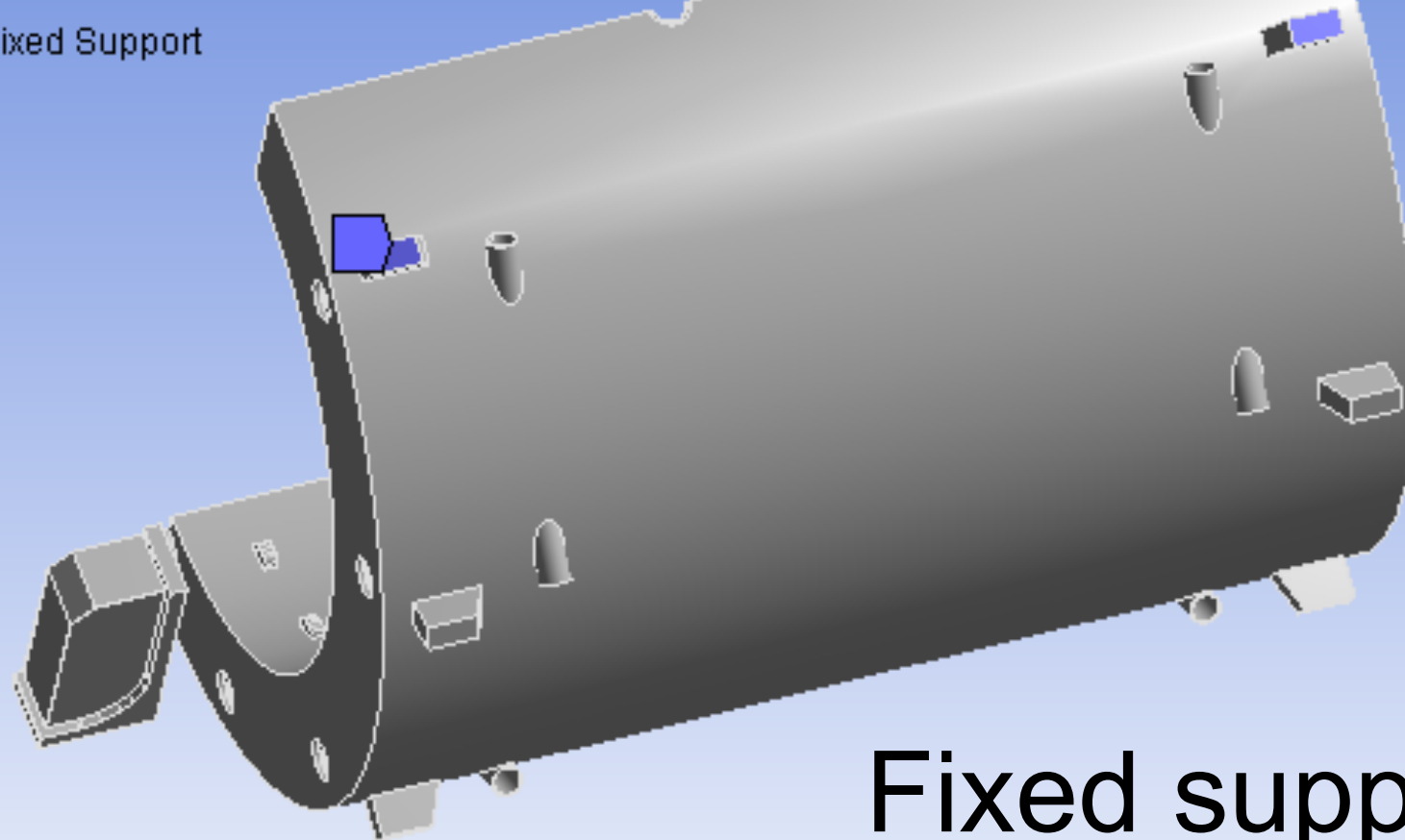
A: Static Structural

Fixed Support

Time: 1. s

30/08/2011 16.36

■ Fixed Support



Fixed support

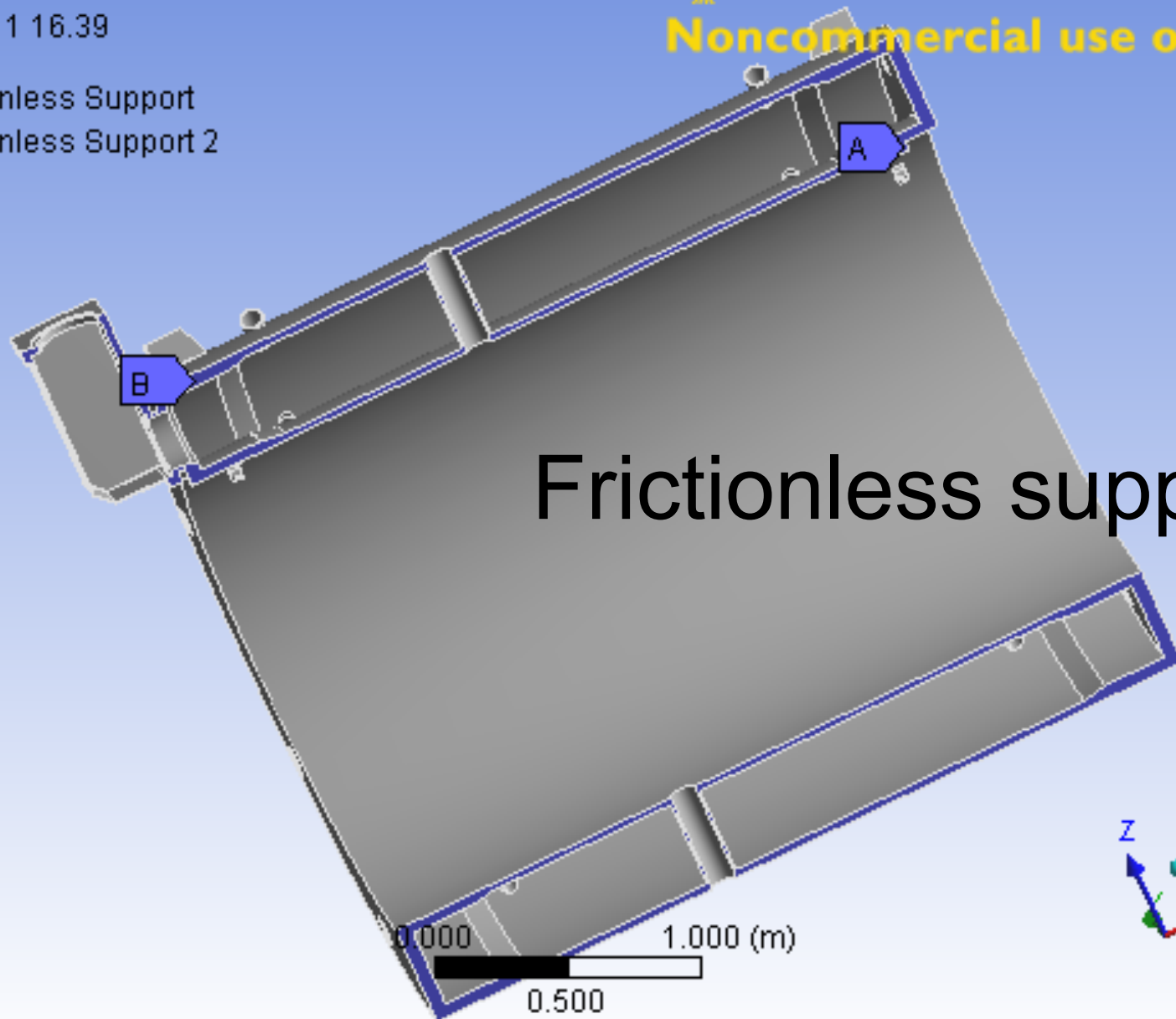
0.000 1.000 (m)
0.500



A: Static Structural
Frictionless Support 2
Time: 1. s
30/08/2011 16.39



- A** Frictionless Support
- B** Frictionless Support 2



Frictionless support

Imposed displacements

1. 1.5 mm displacement² in Z upper support
2. 1mm displacement³ in Y at the middle upper support.
3. 0.5 mm displacement⁴ in Y at the middle lower support.

A: Static Structural

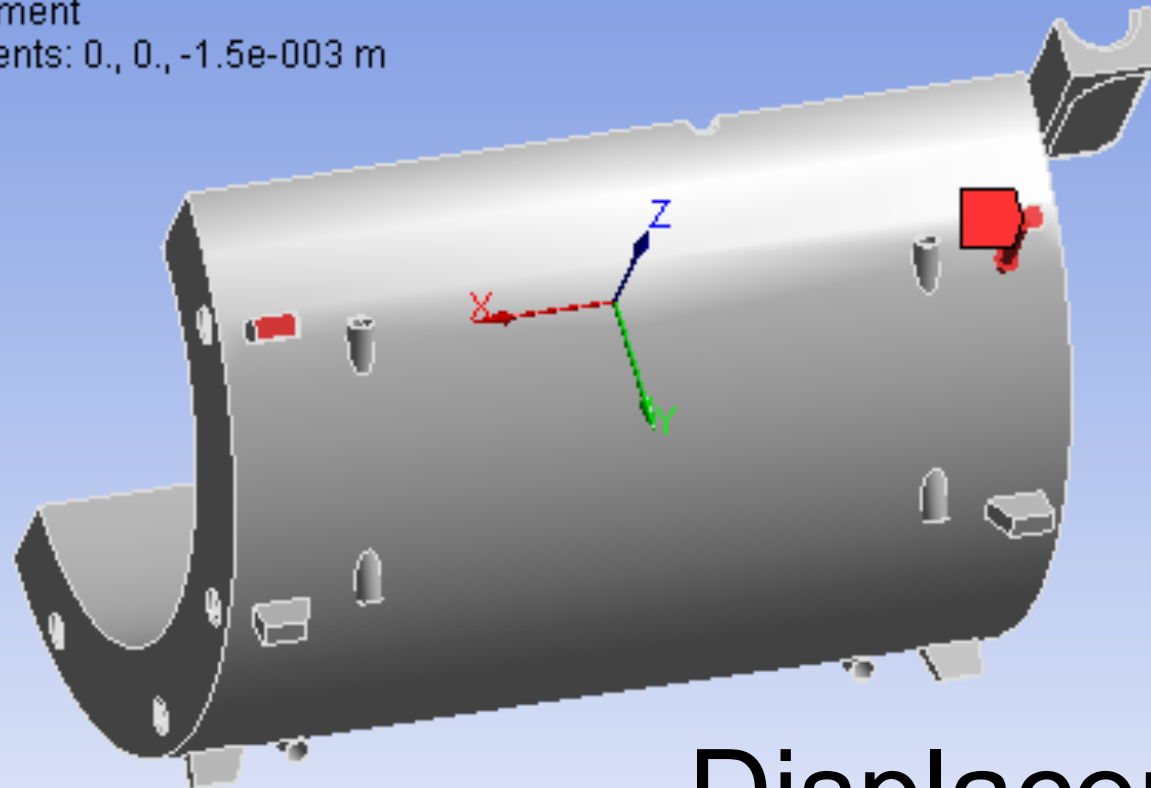
Displacement

Time: 1. s

30/08/2011 16.44

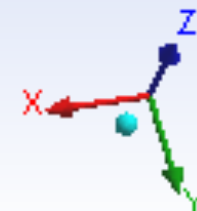


■ Displacement
Components: 0., 0., -1.5e-003 m



Displacement

0.000 2.000 (m)
1.000



A: Static Structural

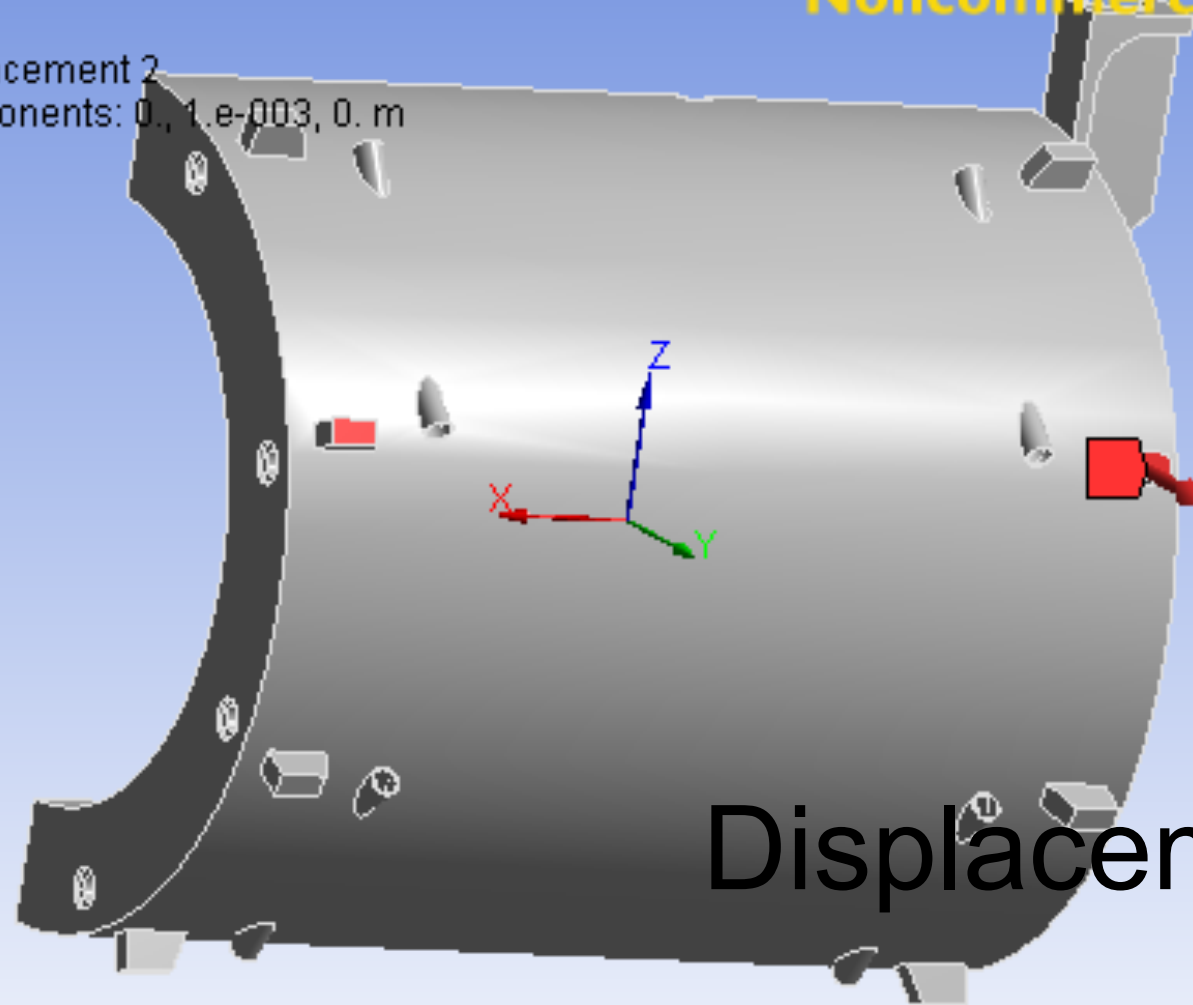
Displacement 2

Time: 1. s

30/08/2011 16.45

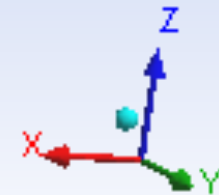


■ Displacement 2
Components: 0., 1.e-003, 0. m



Displacement2

0.000 1.000 (m)
0.500



A: Static Structural

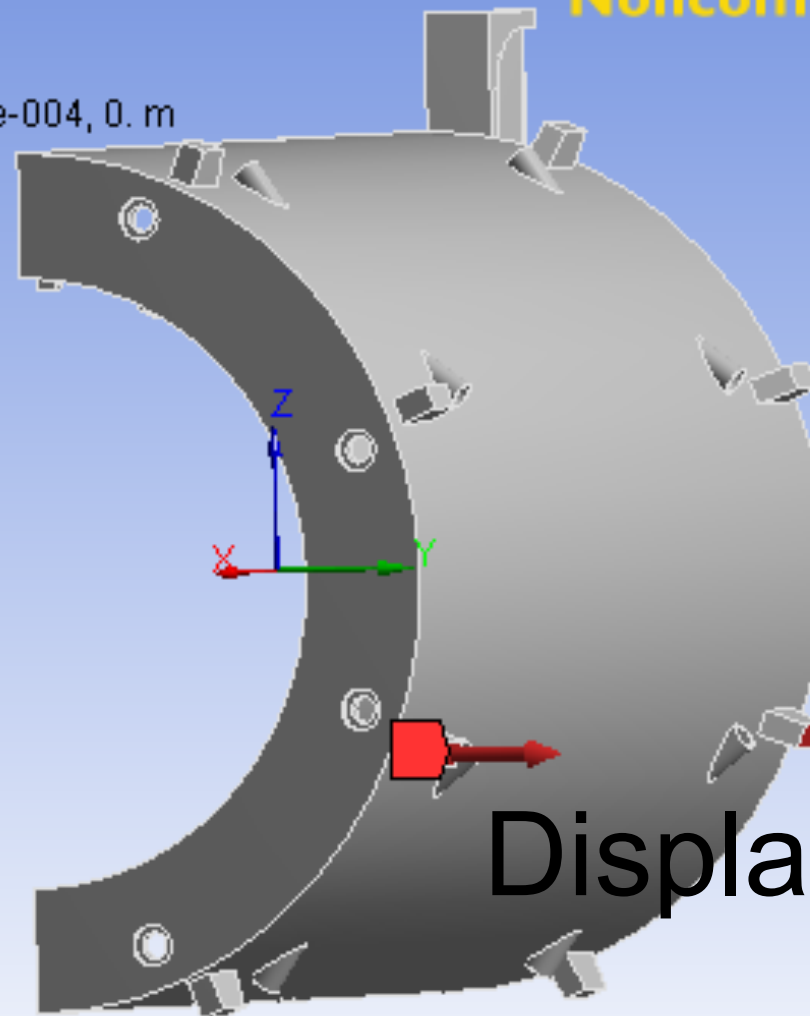
Displacement 3

Time: 1. s

30/08/2011 16.46

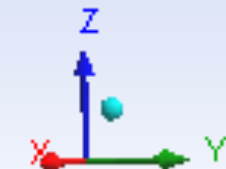


■ Displacement 3
Components: 0., 5.e-004, 0. m



Displacement3

0.000 1.000 (m)
0.500



Loads

1. Force4 axial Magnetic Load (20 T total)
2. Force5 Cryo Chimney (500 Kg)
3. Force6+7 Inner detector nominal (21 T)
4. Pressure .1 MPa from outside
5. Coil Load (4 T)

A: Static Structural

Force 4

Time: 1. s

30/08/2011 16:55

A Force: 25000 N

B Force 2: 25000 N

C Force 3: 25000 N

D Force 4: 25000 N



Magnetic Load

0.000 1.000 (m)

0.500

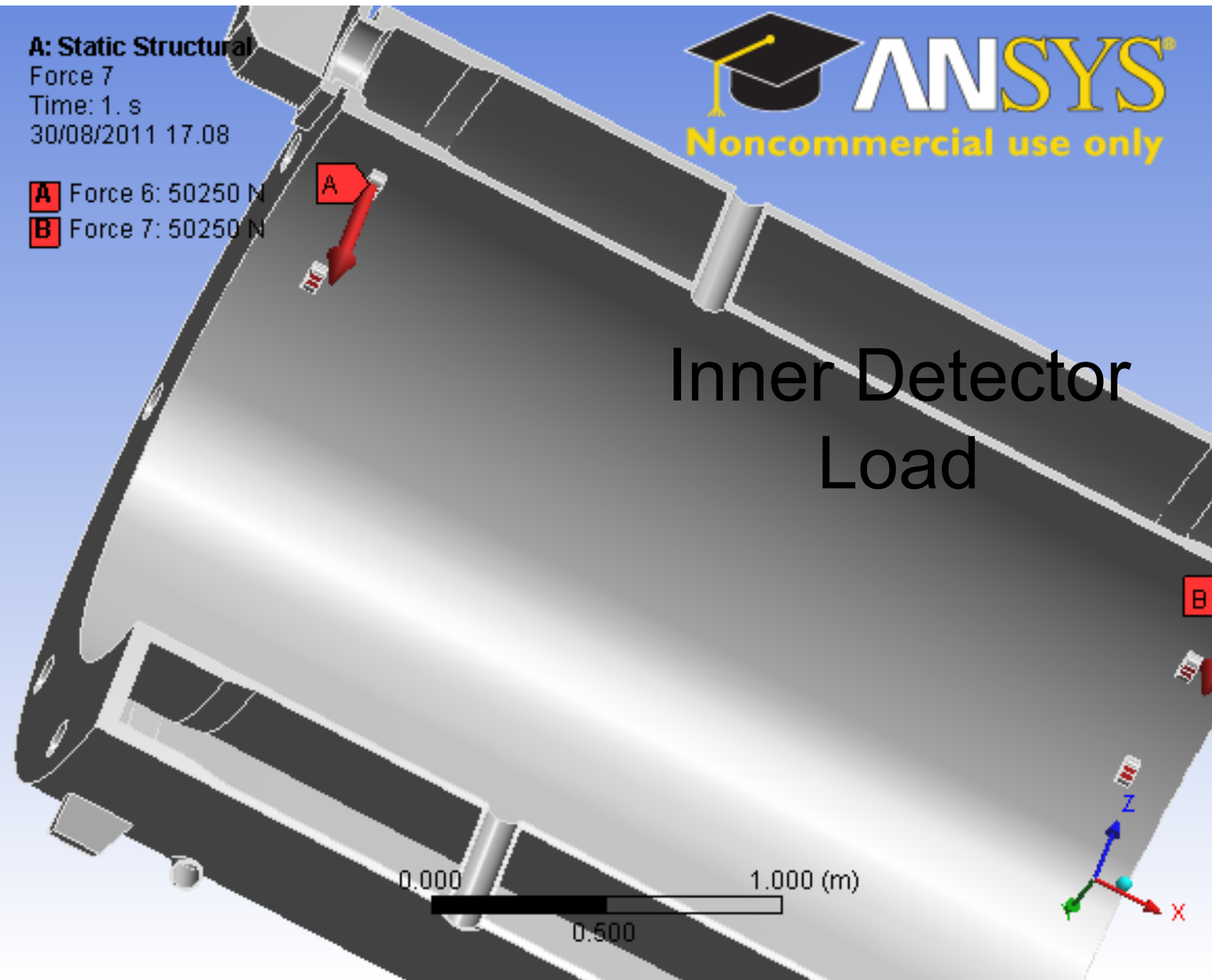


A: Static Structural
Force 7
Time: 1. s
30/08/2011 17.08



A Force 6: 50250 N
B Force 7: 50250 N

Inner Detector
Load



A: Static Structural

Force 8

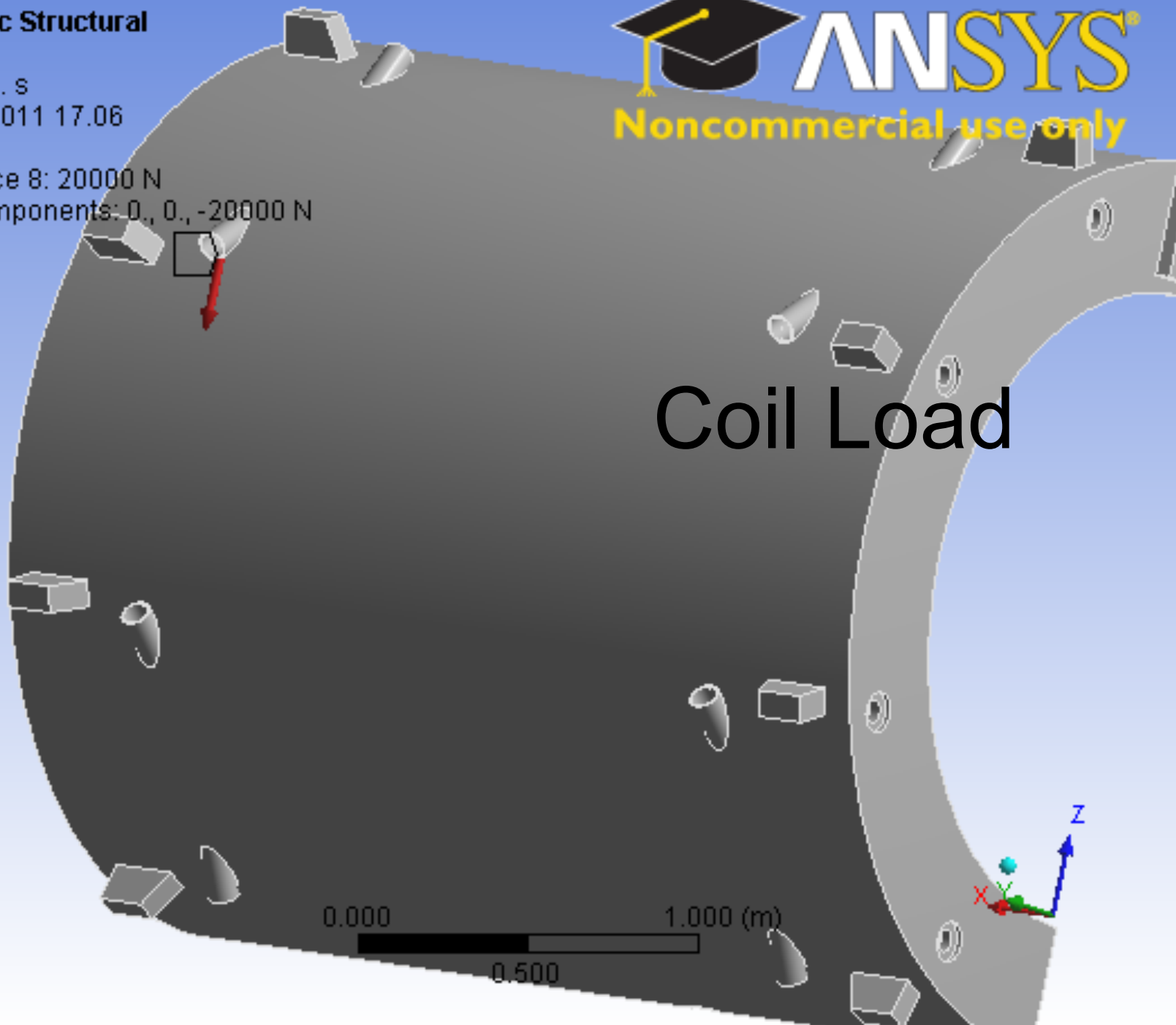
Time: 1. s

30/08/2011 17.06



Force 8: 20000 N
Components: 0., 0., -20000 N

Coil Load

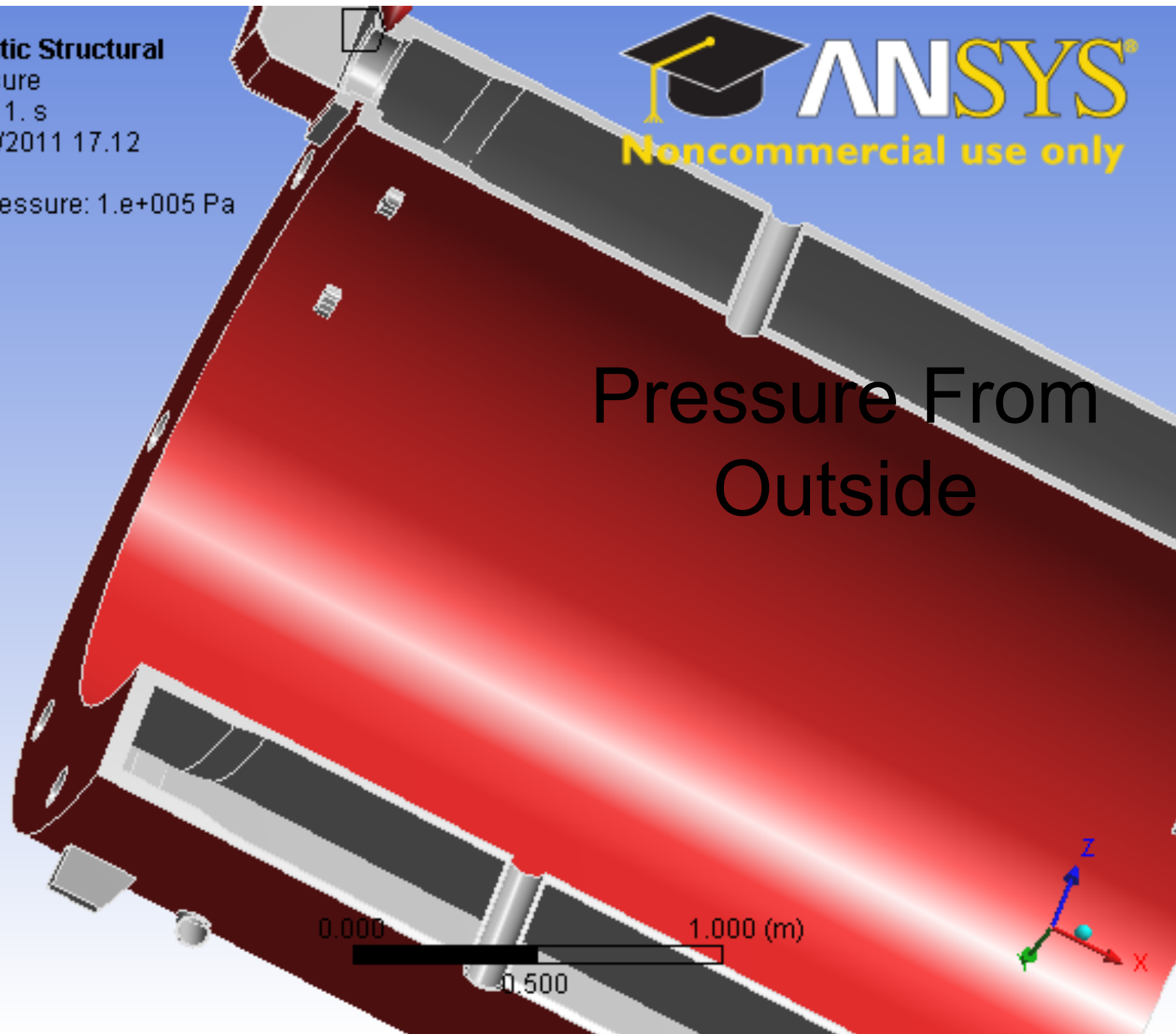


A: Static Structural
Pressure
Time: 1. s
30/08/2011 17.12

■ Pressure: 1.e+005 Pa



Pressure From
Outside



Deformations

A: Static Structural

Total Deformation

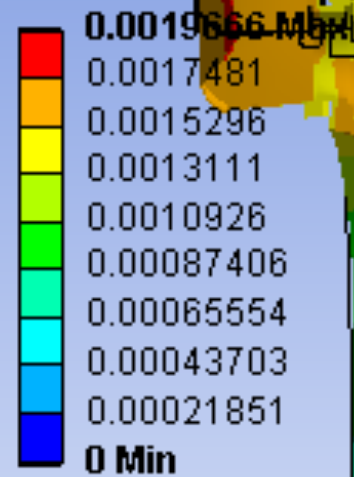
Type: Total Deformation

Unit: m

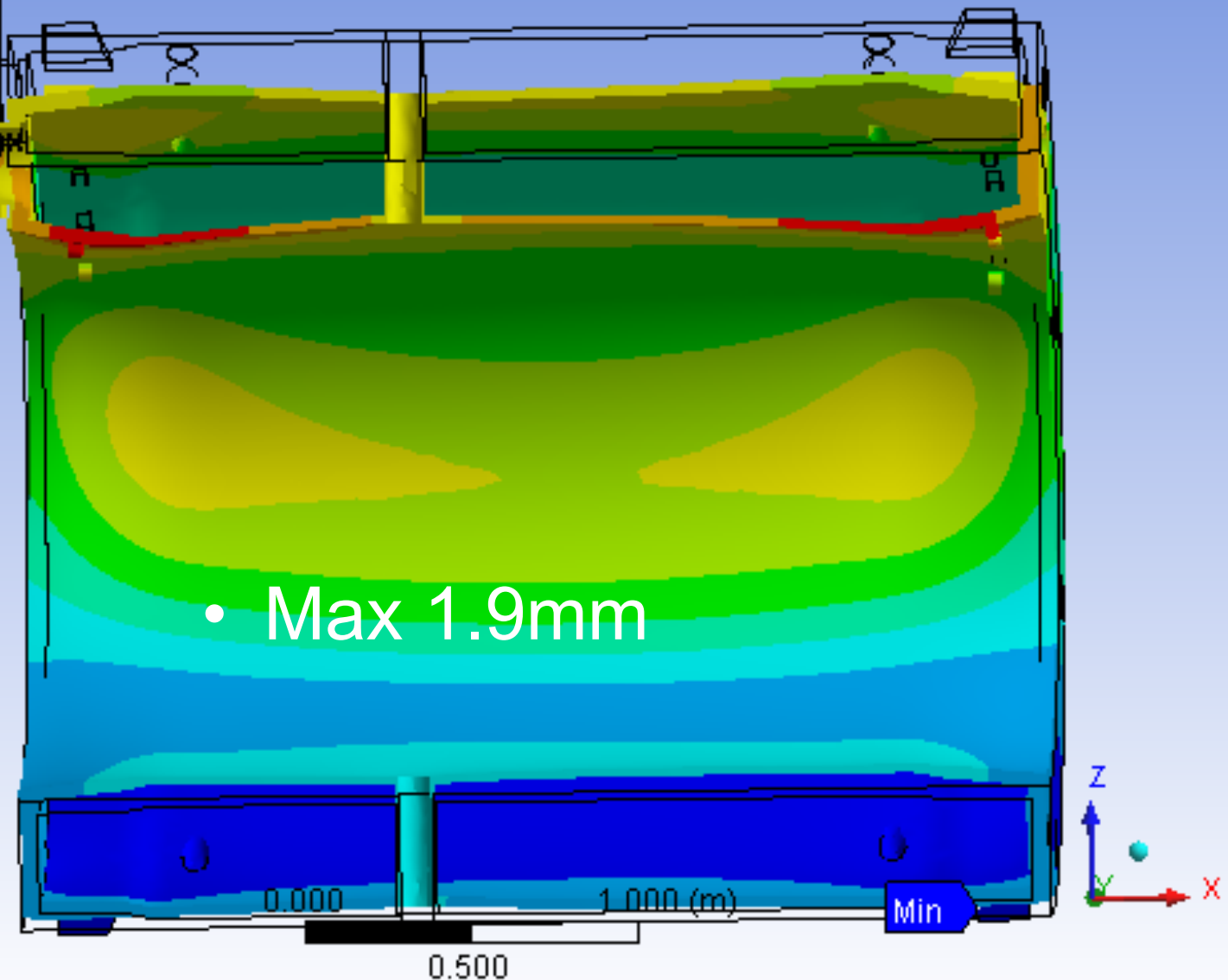
Max

Custom

08/07/201 14.41



• Max 1.9mm



A: Static Structural

Safety Factor

Type: Safety Factor

Time: 1

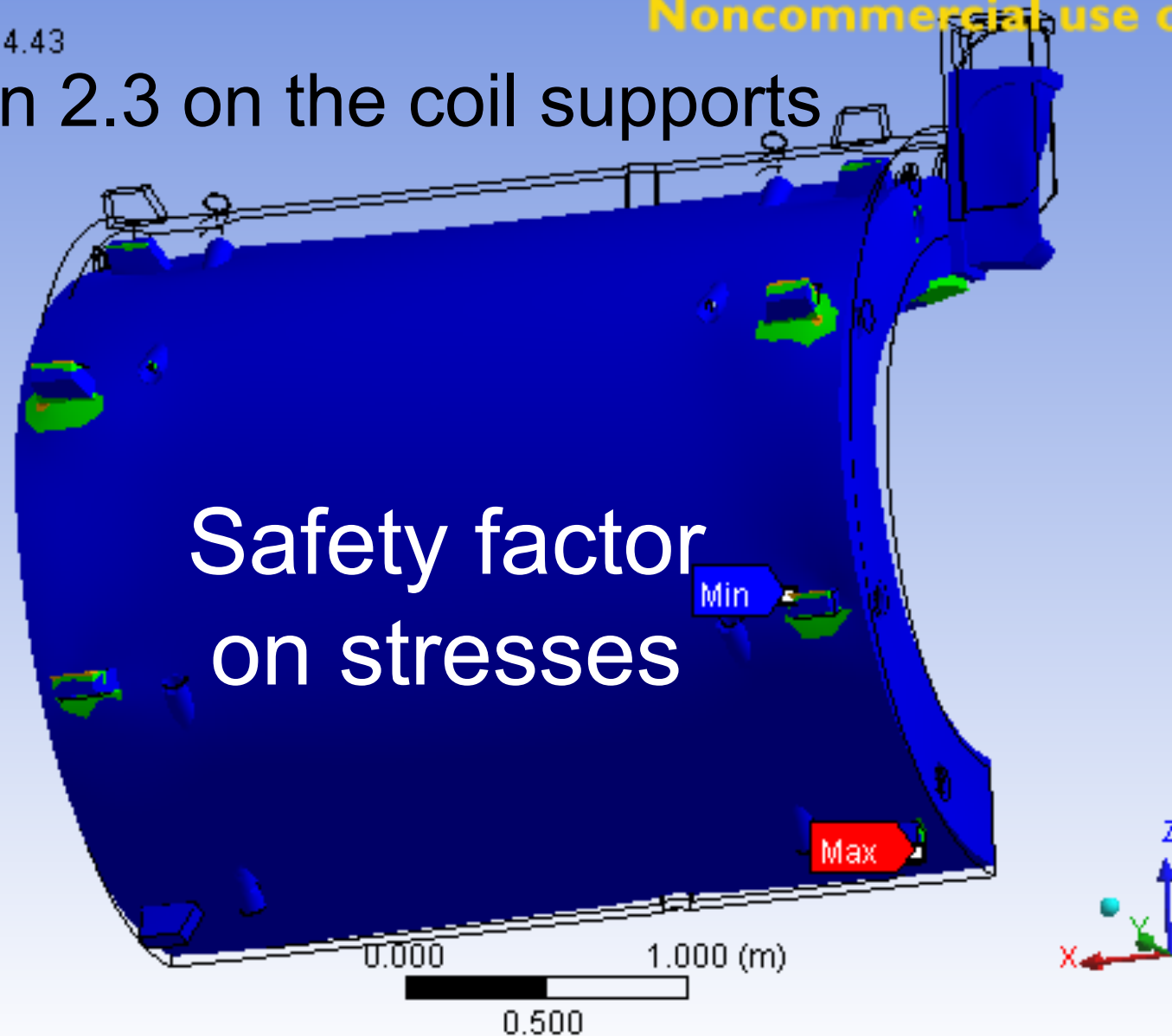
08/07/2011 14.43



Min 2.3 on the coil supports



Safety factor
on stresses



B: Linear Buckling

Total Deformation

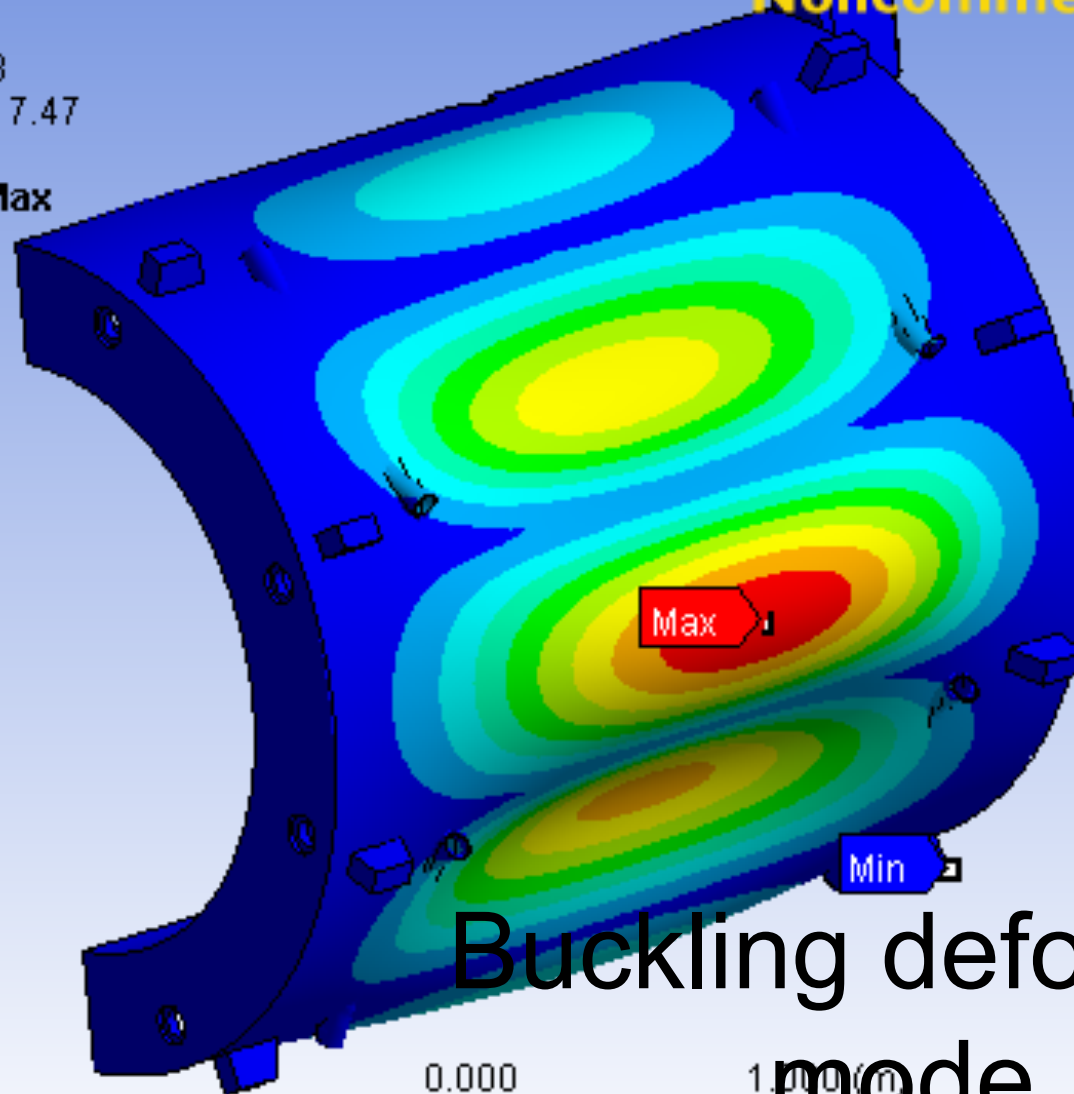
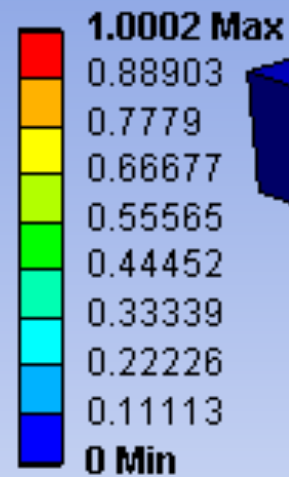
Type: Total Deformation

Load Multiplier: 34.953

Unit: m

Time: 34.953

30/08/2011 17.47



Buckling deformation
mode 1



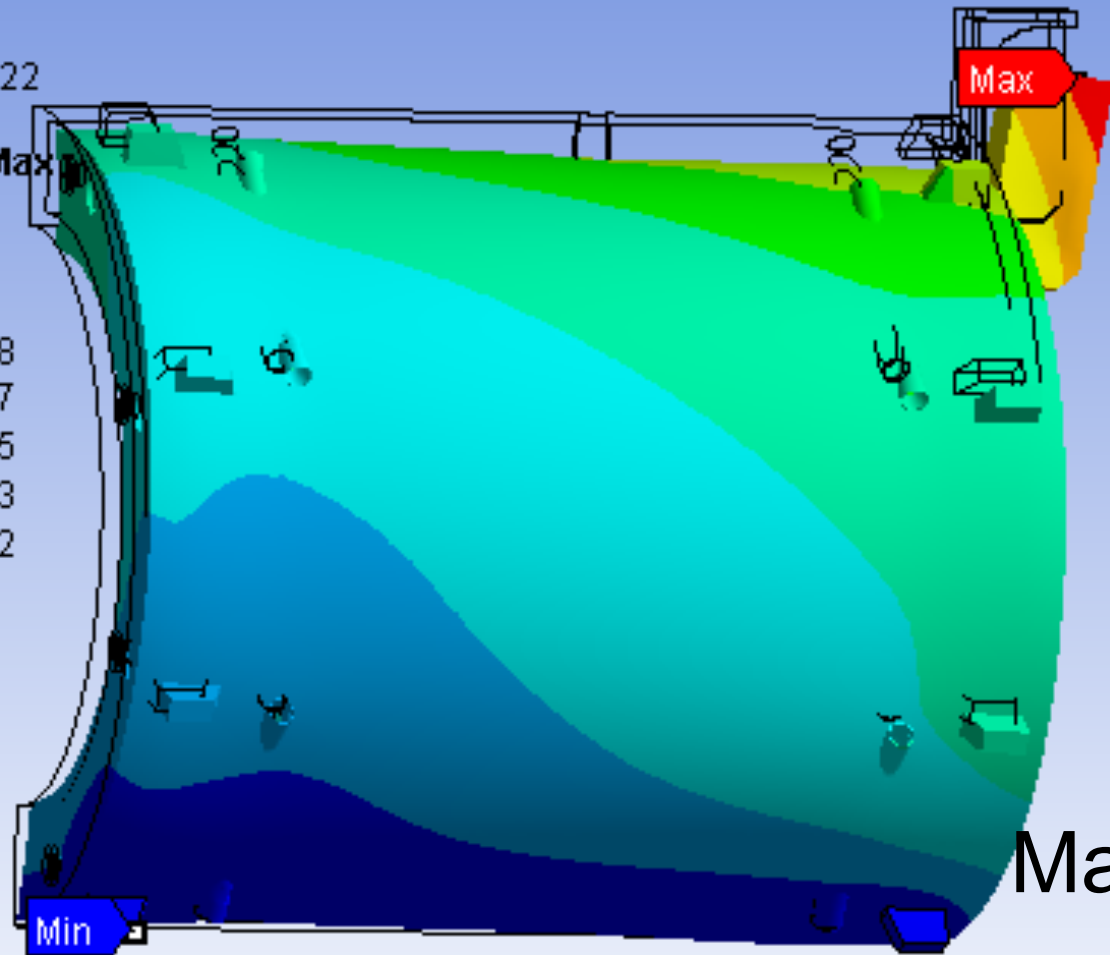
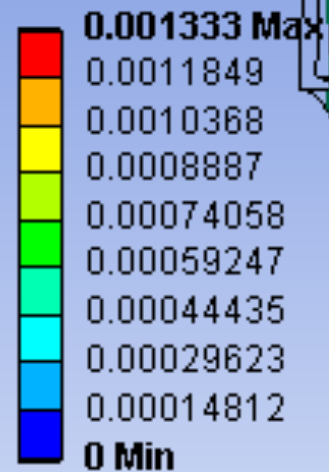
Buckling load multiplier

Mode1.	34.95
Mode2.	35.819
Mode3.	42.924
Mode4.	46.404
Mode5.	57.186

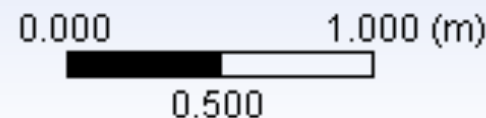
Free Cryostat
Resting On 4 Feet

Deformations

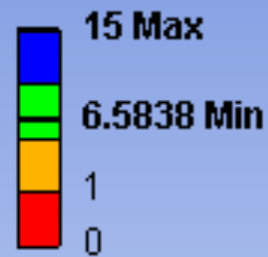
A: Static Structural
Total Deformation
Type: Total Deformation
Unit: m
Time: 1
Custom
31/08/2011 11.22



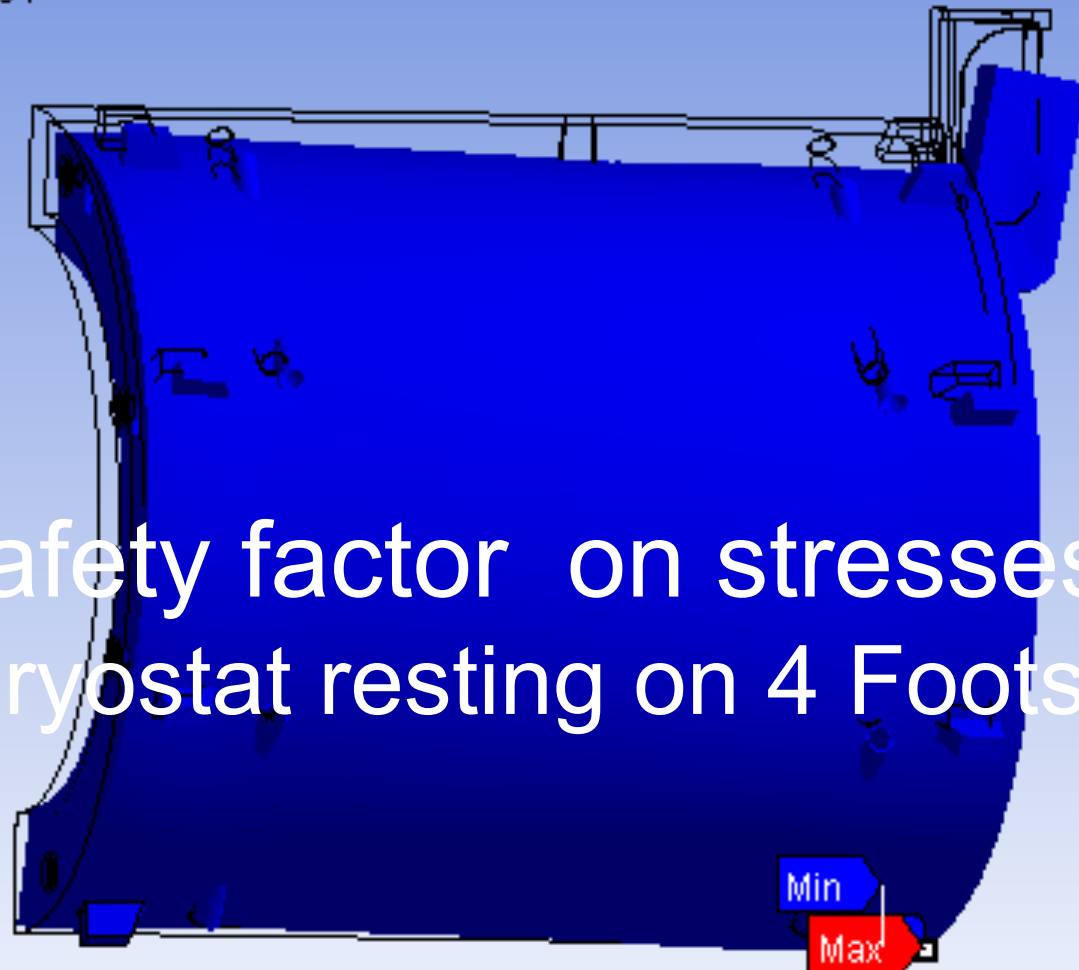
Max 1.3mm



A: Static Structural
Safety Factor
Type: Safety Factor
Time: 1
31/08/2011 10.54



Safety factor on stresses
(Cryostat resting on 4 Feet)



- Min 6.58 on the coil feet
- 0.000 0.500 1.000 (m)

Buckling load multiplier

(no imposed displacement)

- Mode 1. 32.187
- Mode 2. 33.85
- Mode 3. 42.072
- Mode 4. 45.513
- Mode 5. 56.988

Free Cryostat comparison

- Leaving the Cryostat resting On 4 Fools (no imposed displacement)
- The maximum deformation deformation goes to 1.3mm
- The safety factor goes to 6.5
- The buckling changes by a whisker

Cost estimate 5083 vs Aisi 304L

- Aluminium 5083 H111

$$4\text{€/kg} \times 2700\text{kg/m}^3 \sim 11000\text{€/m}^3$$

- 304L Stainless Steel

$$3\text{€/Kg} \times 8000\text{ kg/m}^3 \sim 24000\text{€/m}^3$$

- Ball-park figures for the cost of manufacturing are:

Total Cost ~ 3 x Material cost

- The aluminium solution is possibly less expensive, (to be carefully Checked)