Thermally induced deformations of the TCLPX jaw

Engineering actions HiColDEM Meeting #35

R. Key EN-MME-EDS

CERN | EN ENGINEERING DEPARTMENT

TCLPX JAW

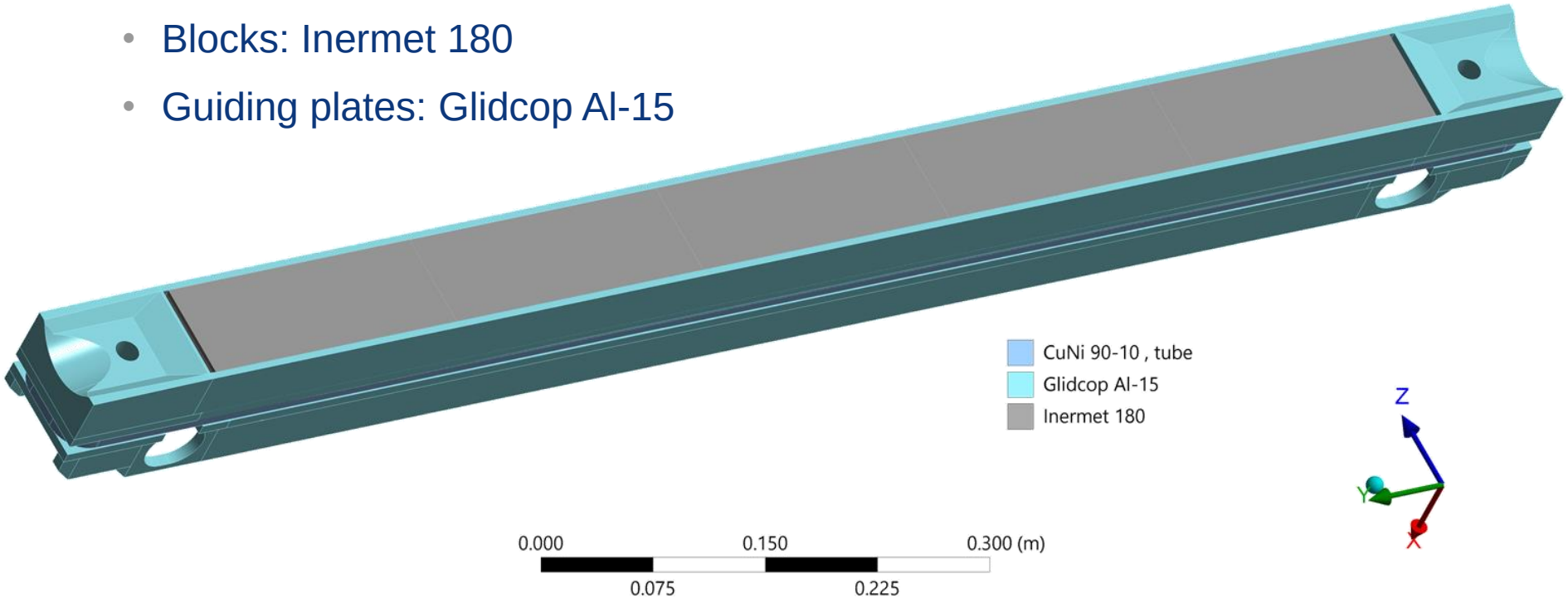
Request:

- Load on the jaw coming from collision debris
- Out-plane deformation at the JAW's active face under energy deposition in "Continuos flow" from Fluka maps

TCLPX JAW

Materials[1]:

- Housing: Glidcop Al-15
- Stiffener: Glidcop Al-15
- Pipes: CuNi 90-10
- Blocks: Inermet 180
- Guiding plates: Glidcop Al-15

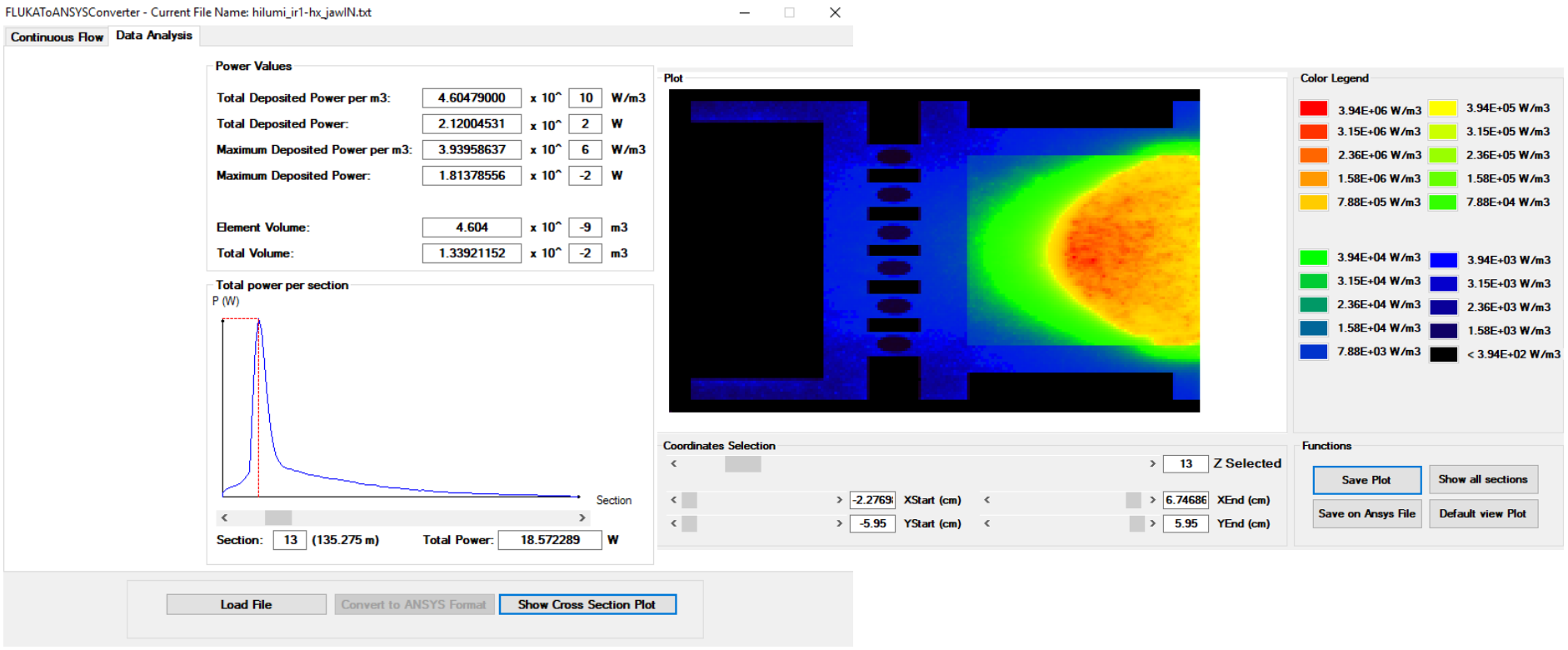


[1] [1] E. M. D. Office, Ansys Workbench material database

TCLPX JAW

Fluka map[2]

- Energy deposition: 212 W
- Type: Continuous flow

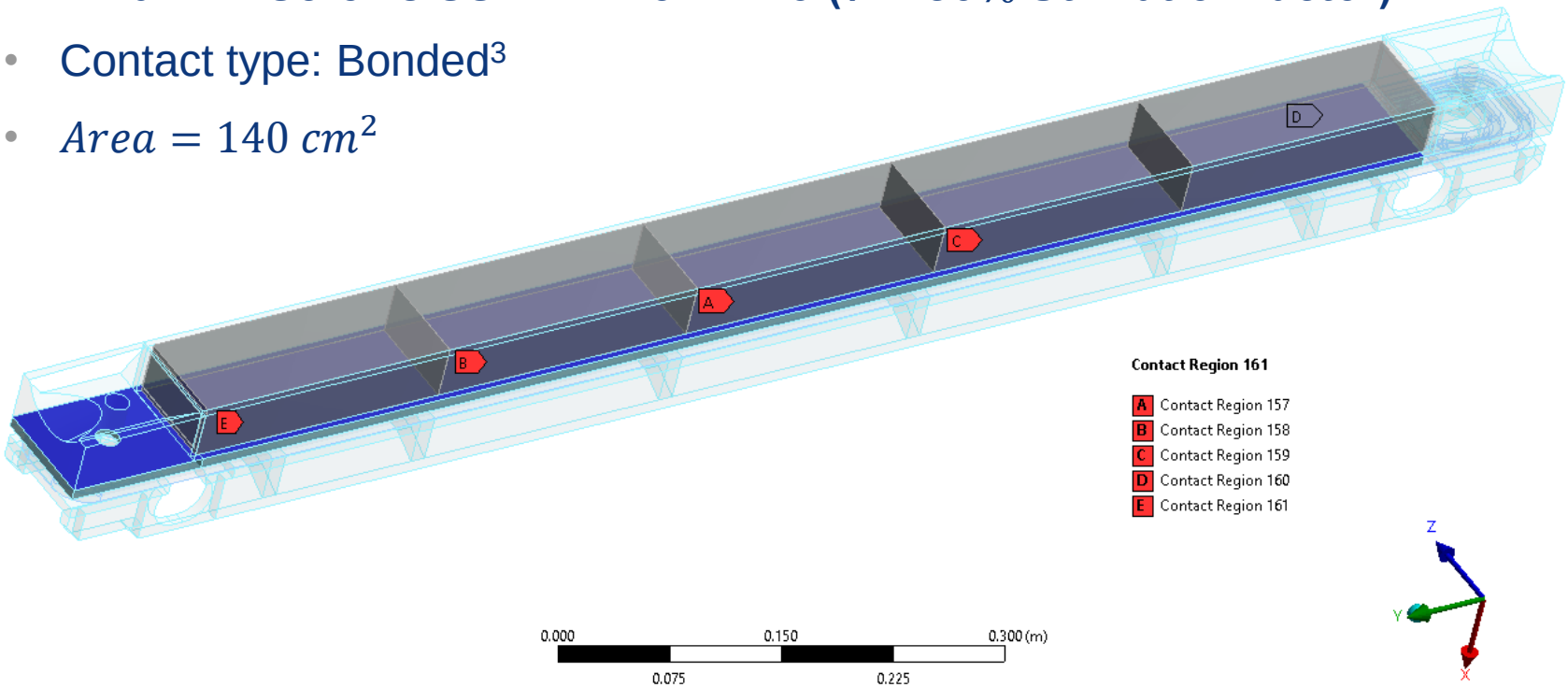


[2] Provided by Marta Sabate Gilarte

TCLPX JAW

Thermal contact resistance calculations:

- Brazing between CuNi pipes and Glidcop: $25000\ \frac{W}{m^2 \cdot K}$
- Contact (@~24bar) between Glidcop and Inermet 180 block: $7954\ \frac{W}{m^2 \cdot K}$
  - Effective Contact Pressure: $23.956\ bar\ \cong 24\ bar$
    - **20x M4 Screws SS Cr.Ni.18.12 Mo ($\nu = 60\%$ Utilization factor)**
  - Contact type: Bonded[3]
  - $Area = 140\ cm^2$

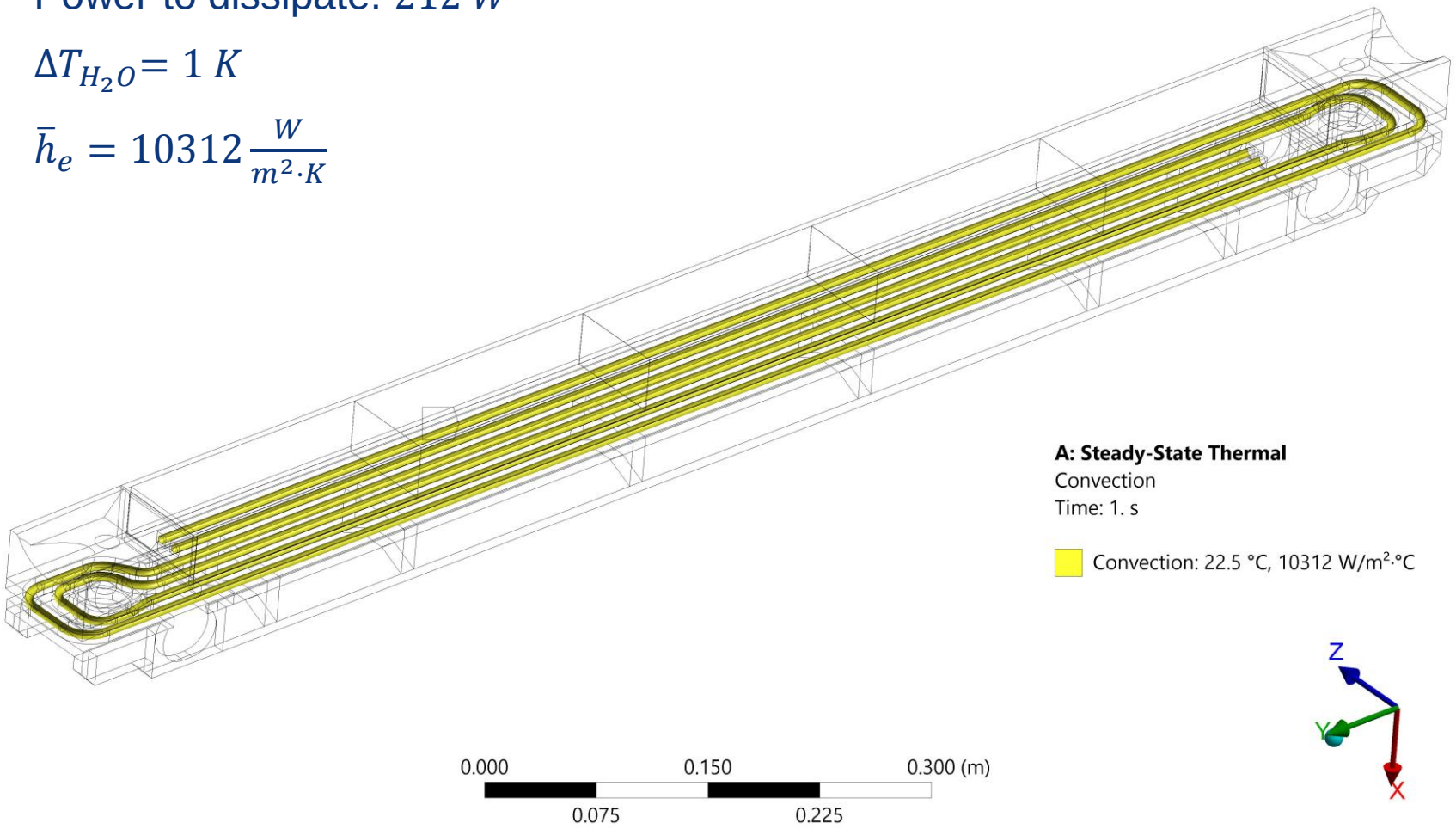


[3]Simplification procedure proofed to be equivalent for executed simulations on TCSP and TCTP calculations see: EDMS 1212639 & 1297290

TCLPX JAW

Film coefficient on cooling pipes calculations (Convection)

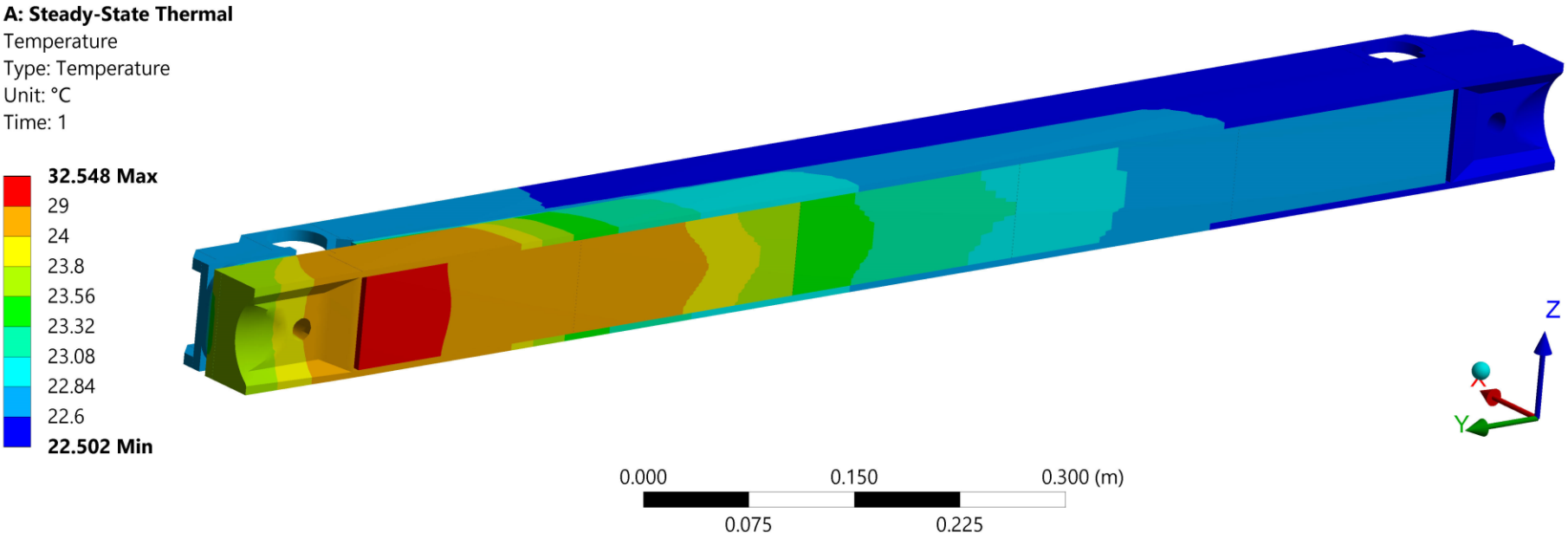
- Power to dissipate: 212 W
- $\Delta T_{H_2O} = 1\ K$
- $\bar{h}_e = 10312 \frac{W}{m^2 \cdot K}$



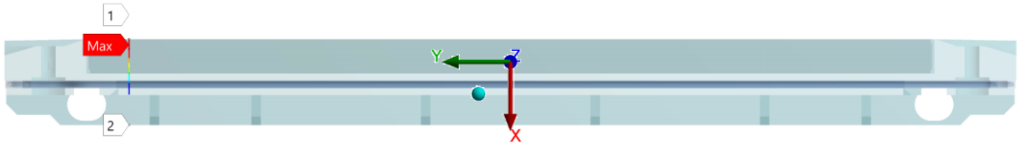
TCLPX JAW

Steady-State Thermal Results

- Nett power 204.85 W (3.37% Error)

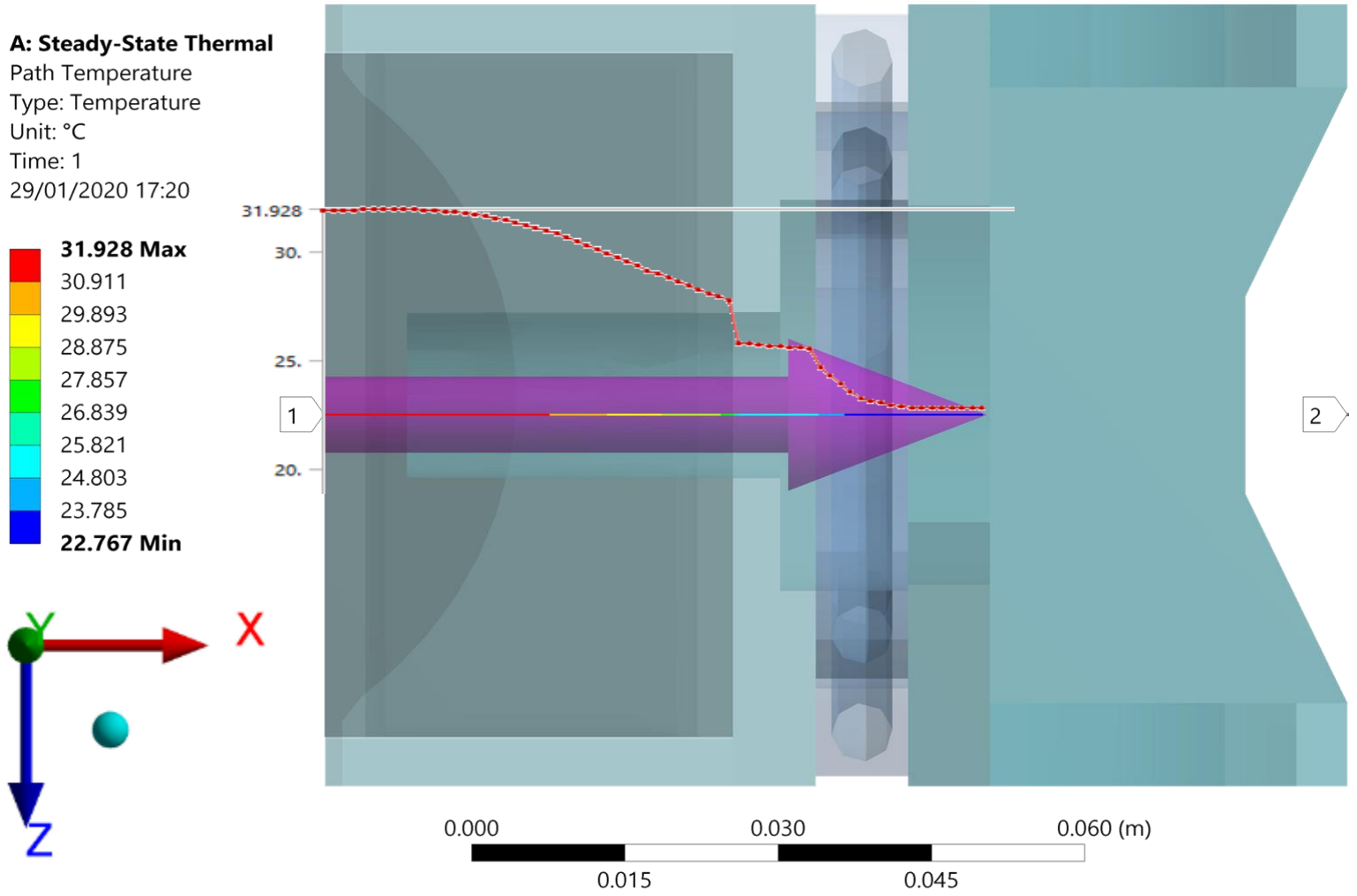


TCLPX JAW



Steady-State Thermal Results

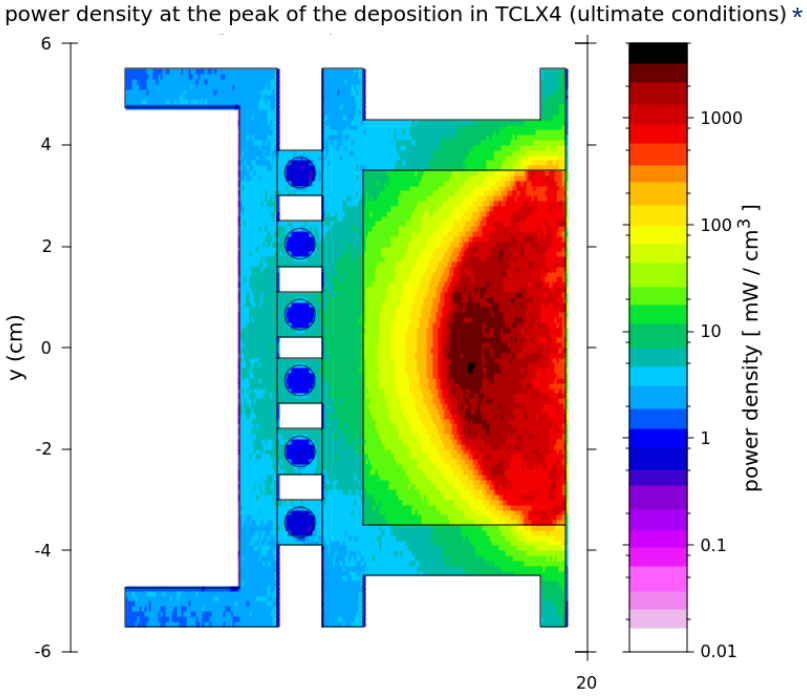
- Temperature through path – GCS (x,0.45,0.002) m



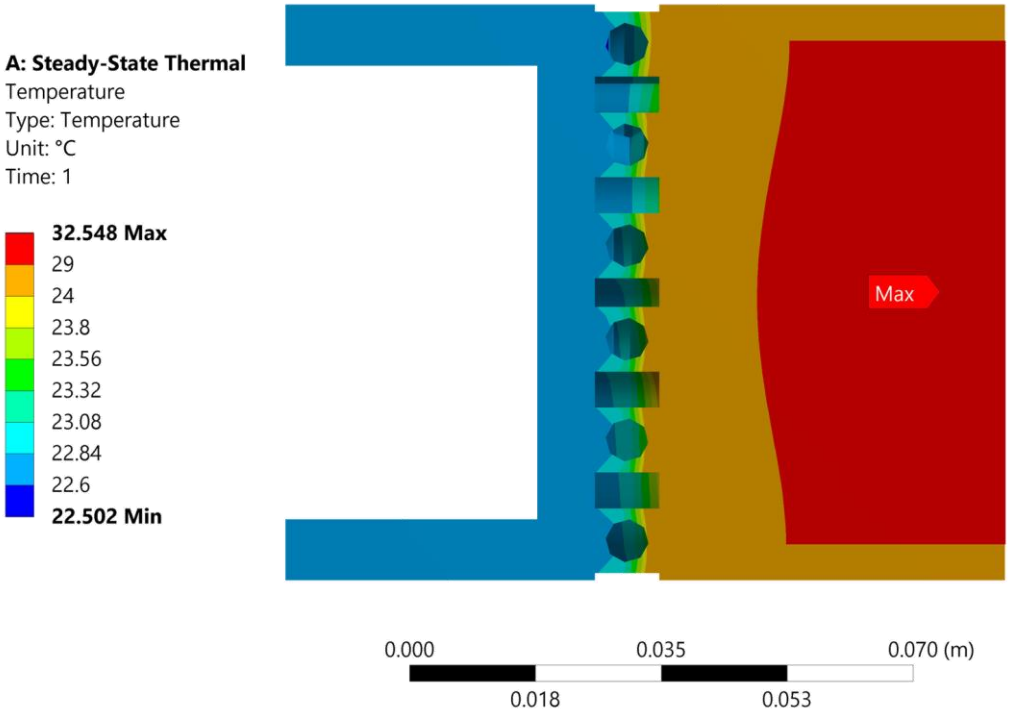
TCLPX JAW

Steady-State Thermal Results vs. power density FLUKA

INPUT POWER



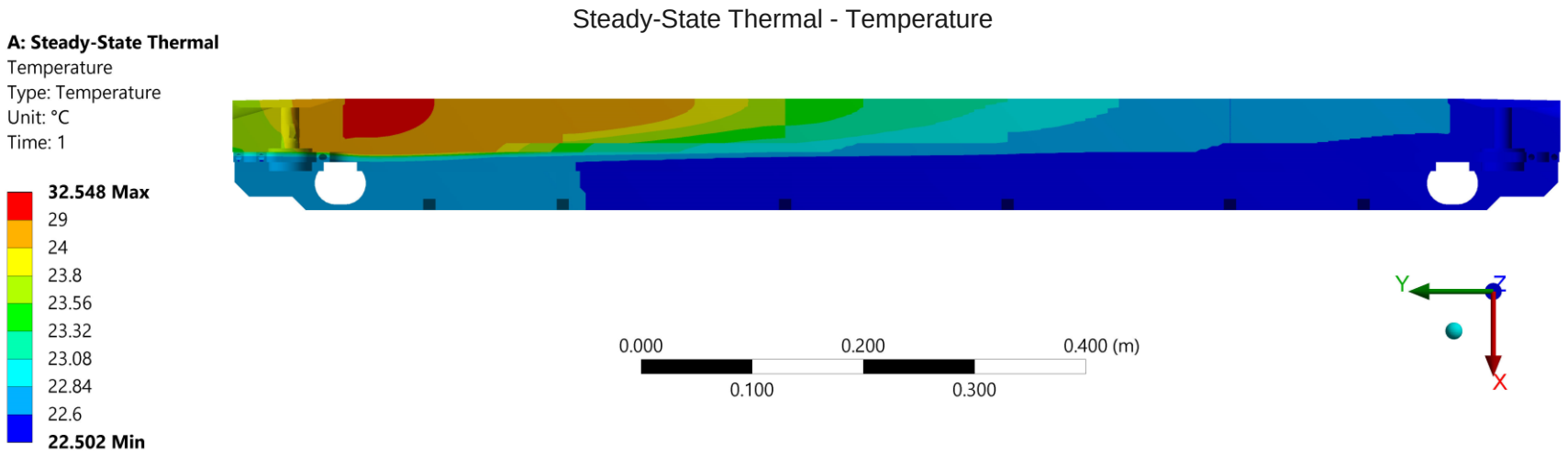
RESULTING TEMPERATURE

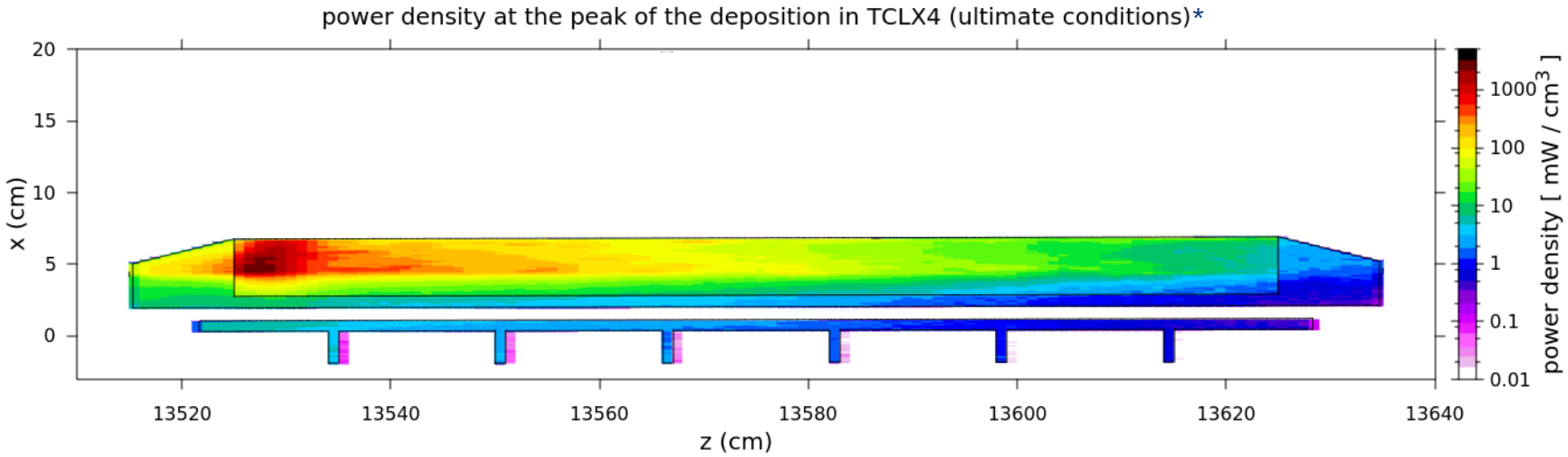


*Provided by Marta Sabate Gilarte

TCLPX JAW

Steady-State Thermal Results vs. power density FLUKA





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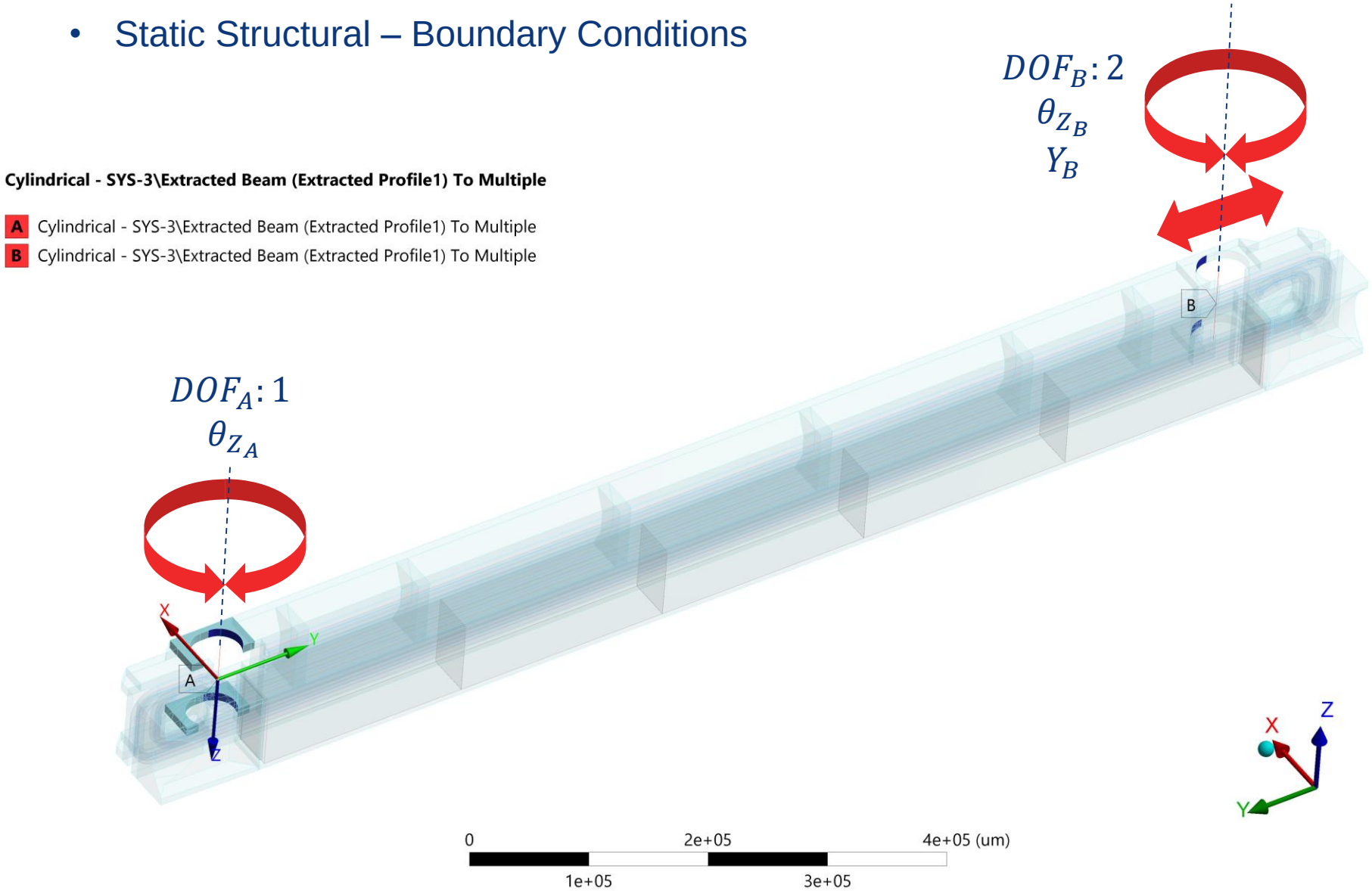
TCLPX JAW

- Static Structural – Boundary Conditions



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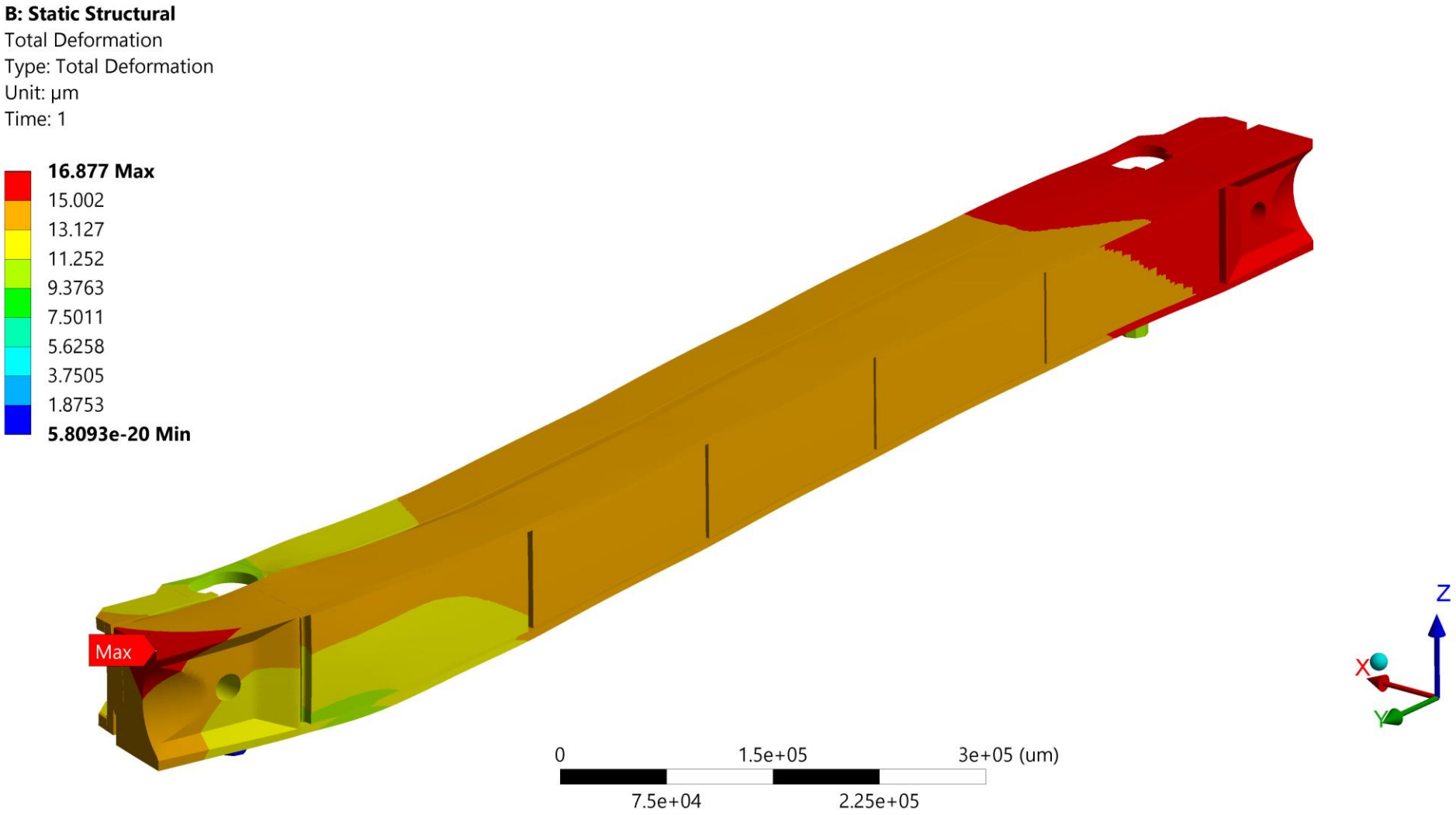
- Static Structural – Results

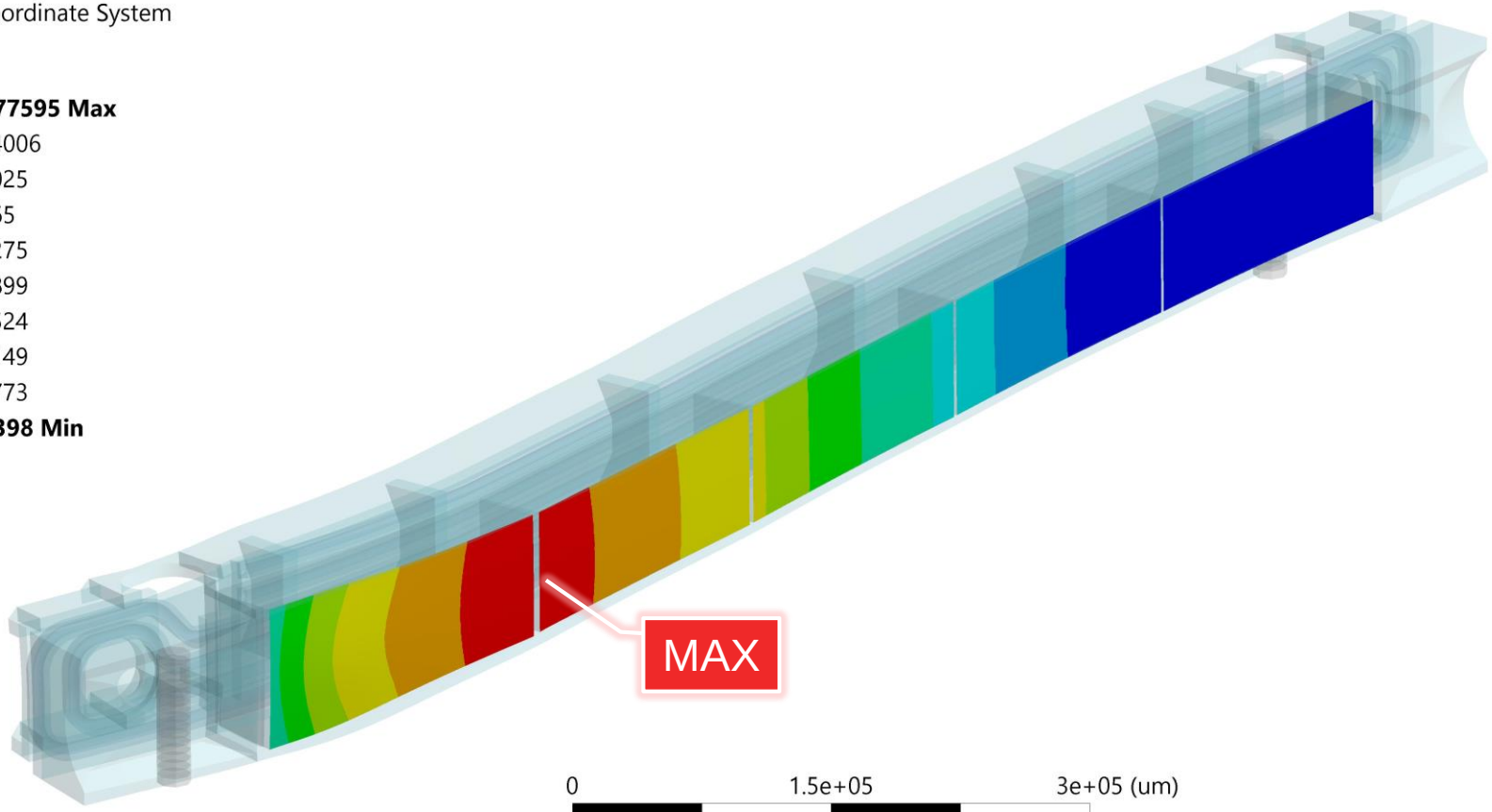


TCLPX JAW

- Static Structural Results

B: Static Structural
X Axis - Directional Deformation - Multiple - 1. s
Type: Directional Deformation(X Axis)
Unit: µm
Global Coordinate System
Time: 1

-0.077595 Max
-0.84006
-1.6025
-2.365
-3.1275
-3.8899
-4.6524
-5.4149
-6.1773
-6.9398 Min



Conclusions

- The specification for a collimator jaw is a maximum deformation in operation, in the beam direction, **of 100 µm**. In the worst possible case (errors summing up), the typical budget is:
  - 40 µm manufacturing tolerances
  - 30 µm self weight
  - 30 µm thermal deformations
- **We have in this case < 50 µm**
  - 40 µm manufacturing tolerances
  - 0 µm self weight (horizontal collimator)
  - 7 µm thermal deformations
- For the **TCLPX, we will thus be dominated by the manufacturing tolerances**.

Thank you!