DSG NPS Collaborators' Meeting Update

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Detector Support Group
09/30/2021

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  - 0 W
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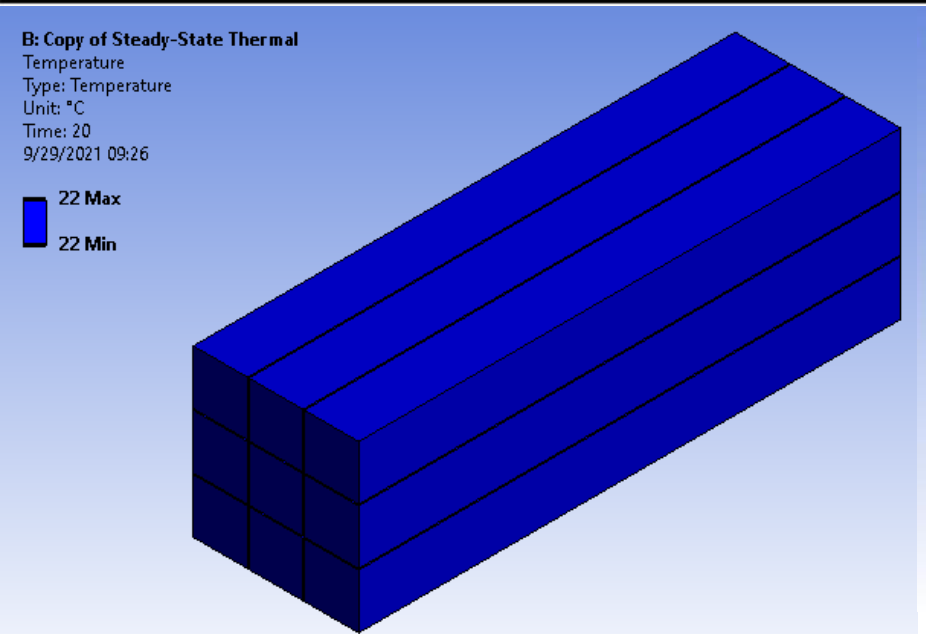
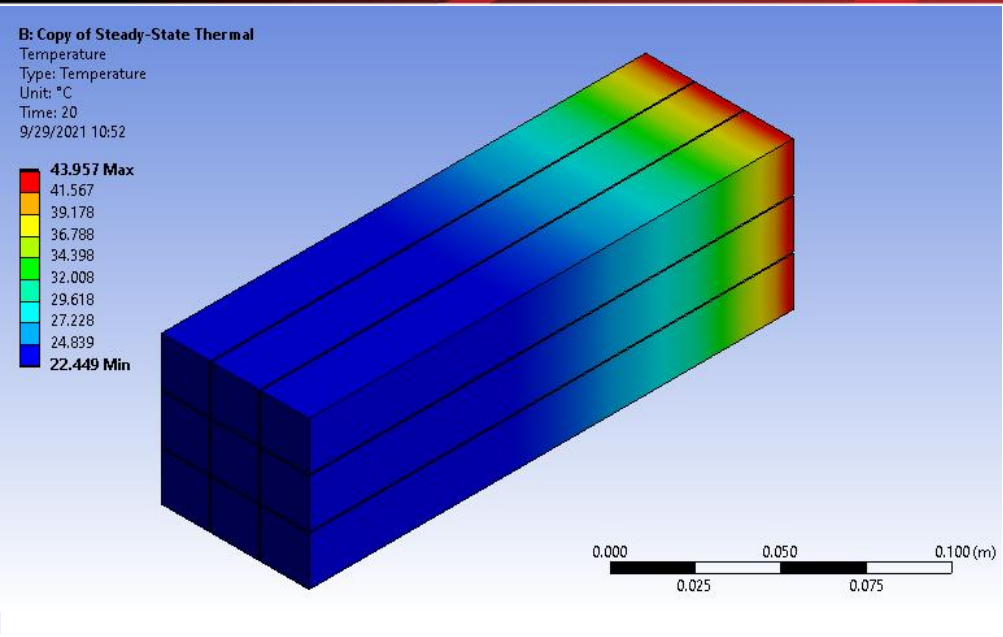
Materials Used in Simulation

- $PbWO_4$ crystals
  - Thermal conductivity (orthotropic): 2.4 W/m·K (*x* and *y* directions), 2.0 W/m·K (*z*)
  - Source: Journal of Chemical & Engineering Data
- Carbon fiber dividers
  - Thermal conductivity (isotropic): 0.5523 W/m·°C
  - Source: Granta Design Typical Materials (Ansys)
- Mu metal dividers
  - Thermal conductivity (isotropic): 19 W/m·K
  - Source: https://mumetal.co.uk/?p=101
- Copper shell
  - Thermal conductivity (isotropic): 396.7 W/m·°C
  - Source: Granta Design Typical Materials (Ansys)

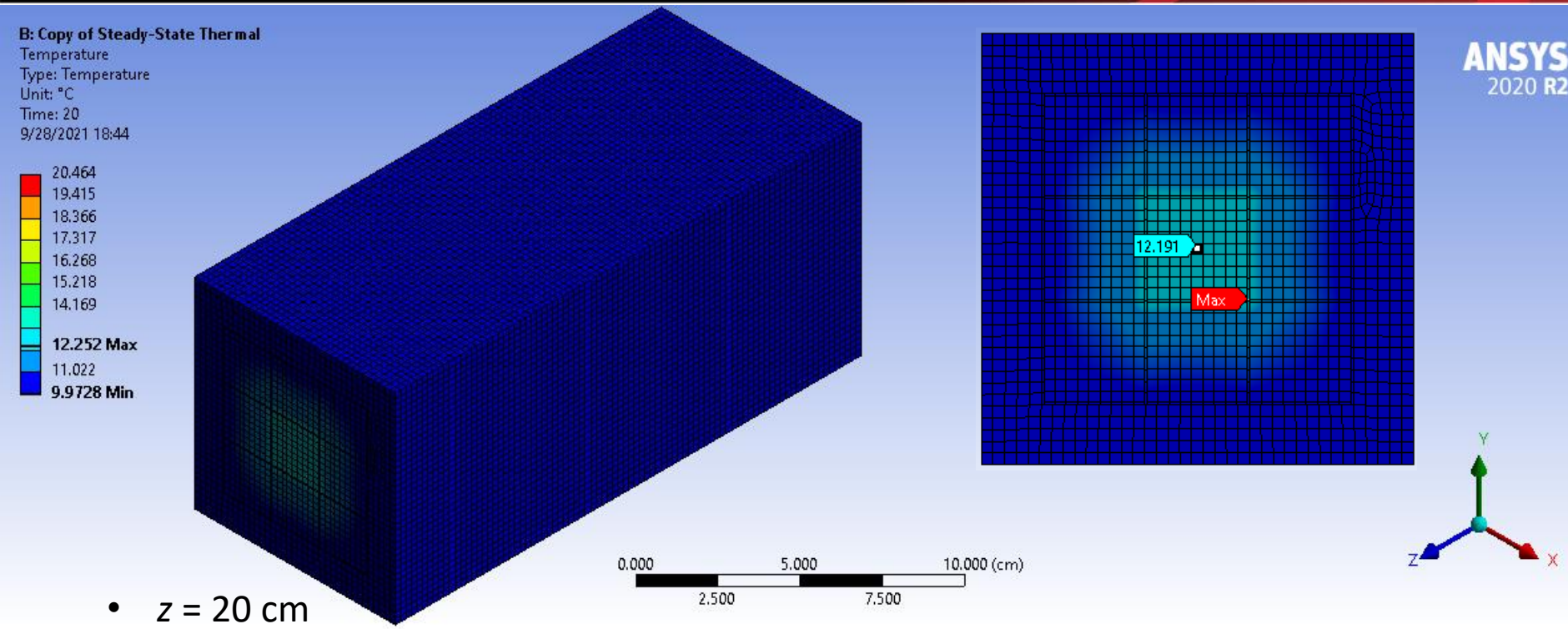
Baseline Simulations – 0 W and 3.5 W





- Q = 0 W (left) and Q = 3.5 W (right)
- Ambient temp. = 22°C
- Film Coefficient (convection) = 5 $W/m^2 \cdot °C$ for all bodies
- No Cu shell
- No carbon fiber dividers
- No mu metal dividers

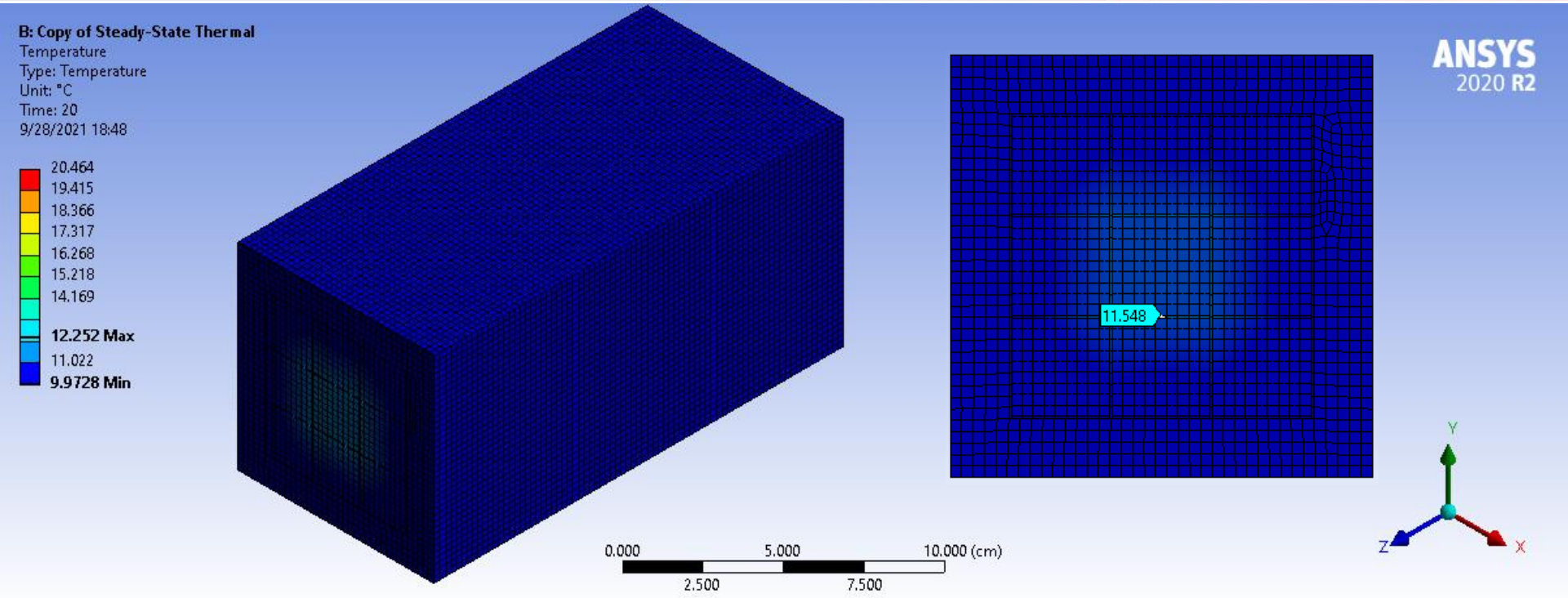
Full-length Crystal Simulation (0 W)



- z = 20 cm

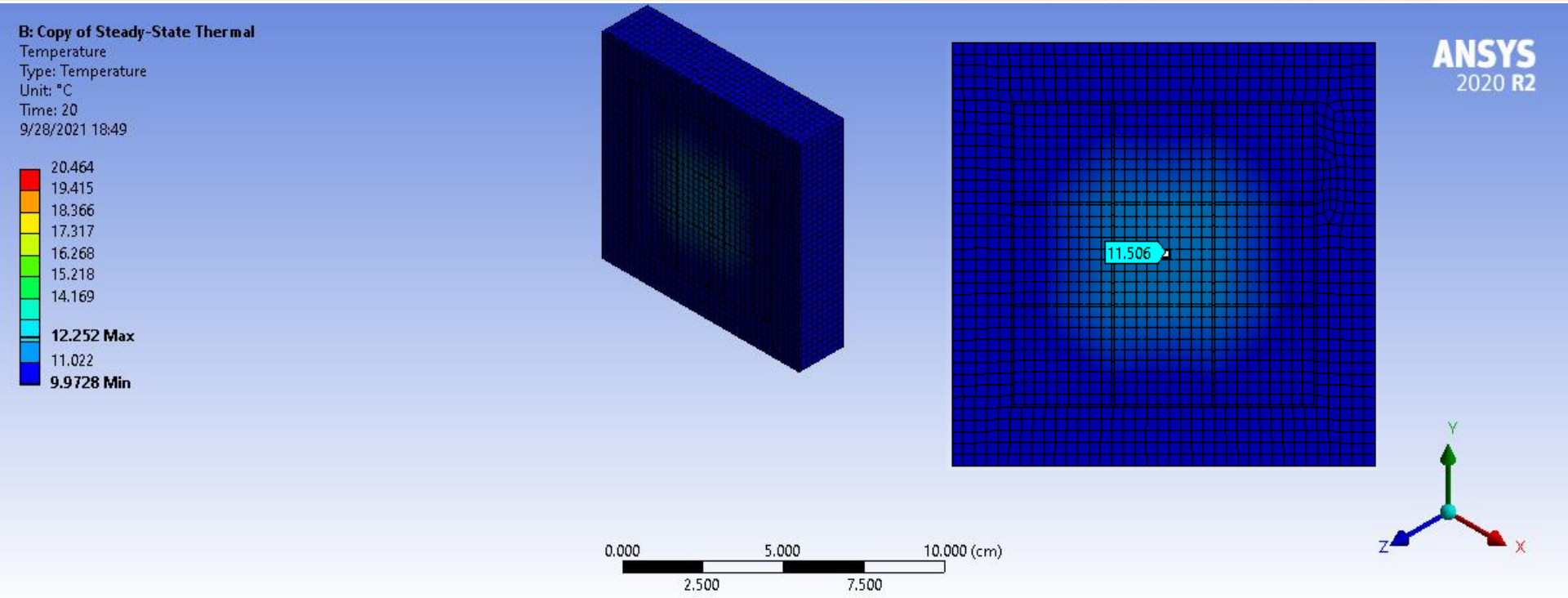
- Q = 0
- Ambient temp. = 22°C
- Film coefficient (convection) = 5 W/m^2 ·°C
- Cu shell temp. = 10°C
- Max. temp. = 12.252°C
- Start of carbon fiber cladding (2 cm)

Full-length Crystal Simulation (0 W)



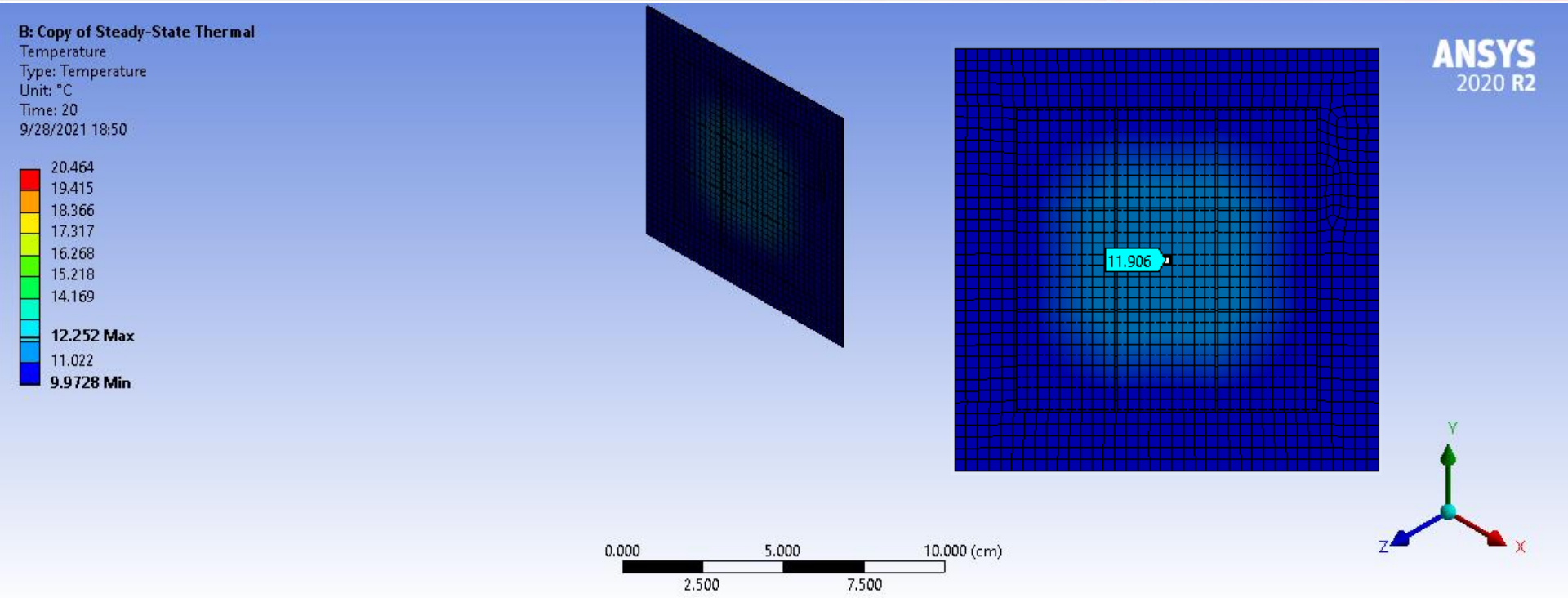
- z = 18 cm
- End of carbon fiber cladding (2 cm)

Full-length Crystal Simulation (0 W)



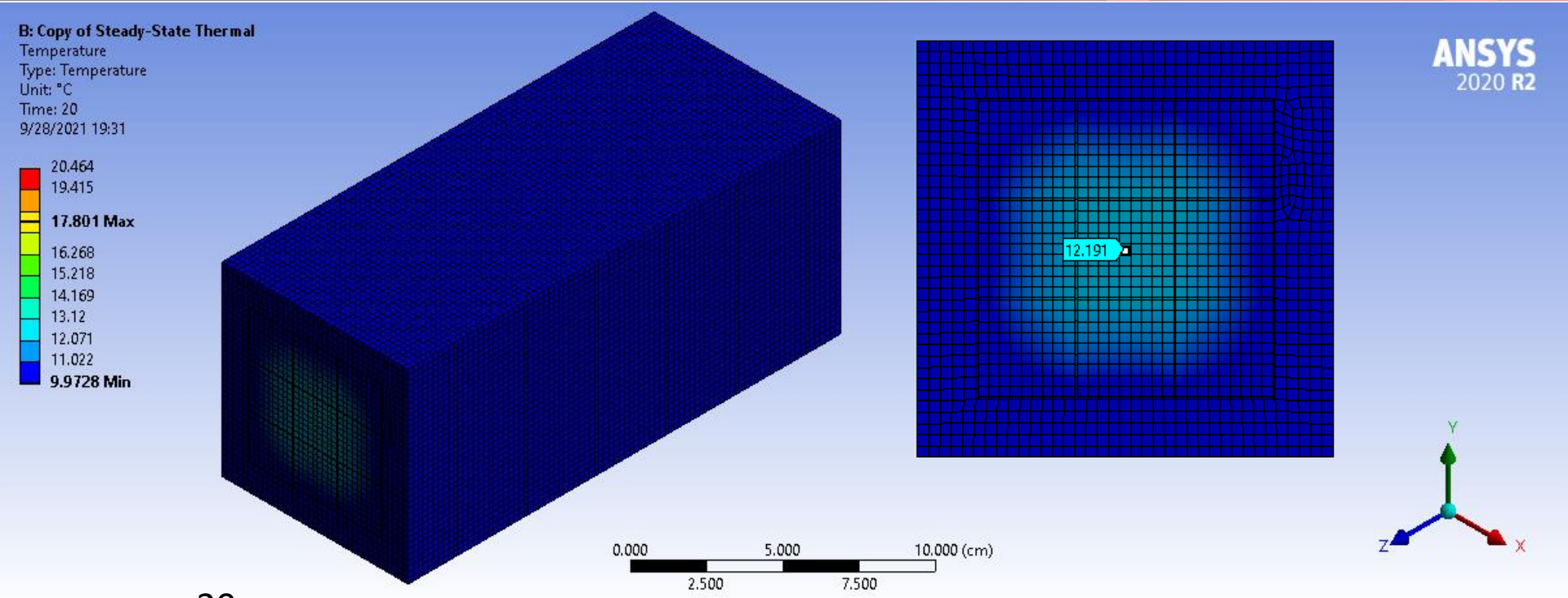
- z = 2 cm
- Start of mu metal cladding (2 cm)

Full-length Crystal Simulation (0 W)



- z = 0.1 cm
- End of mu metal cladding

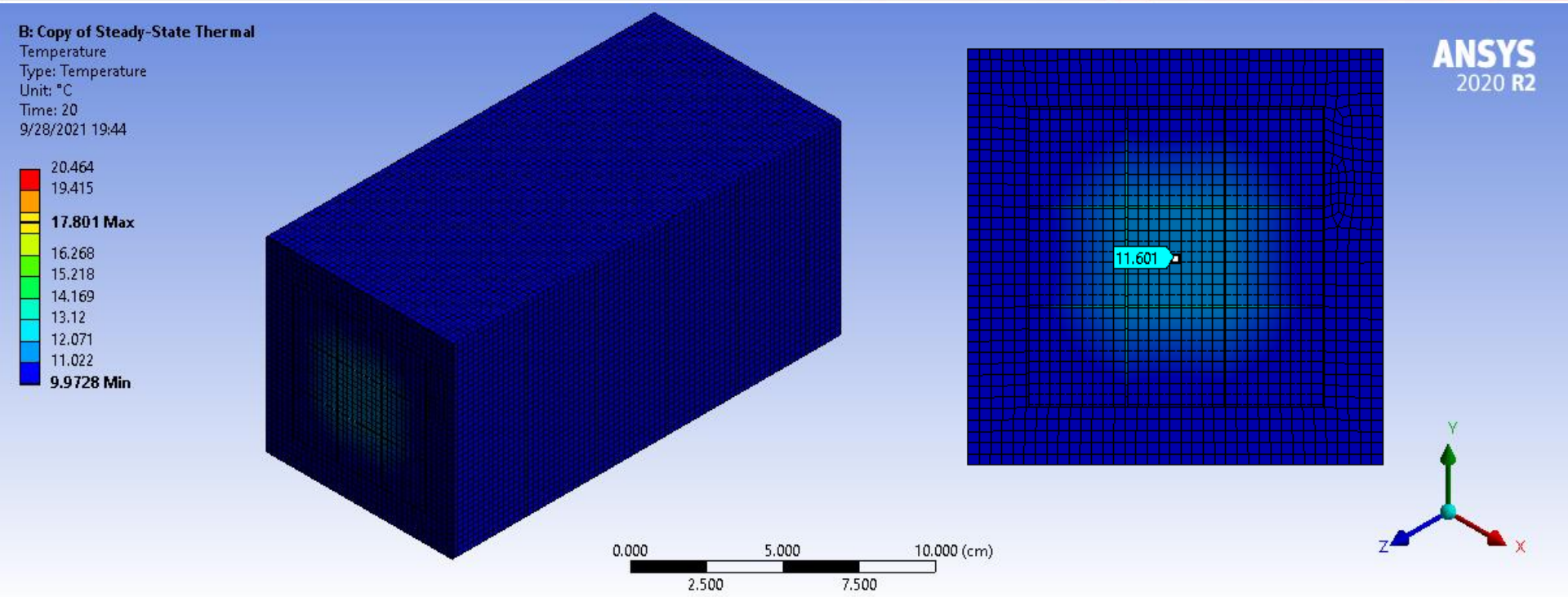
Full-length Crystal Simulation (3.5 W)



- z = 20 cm

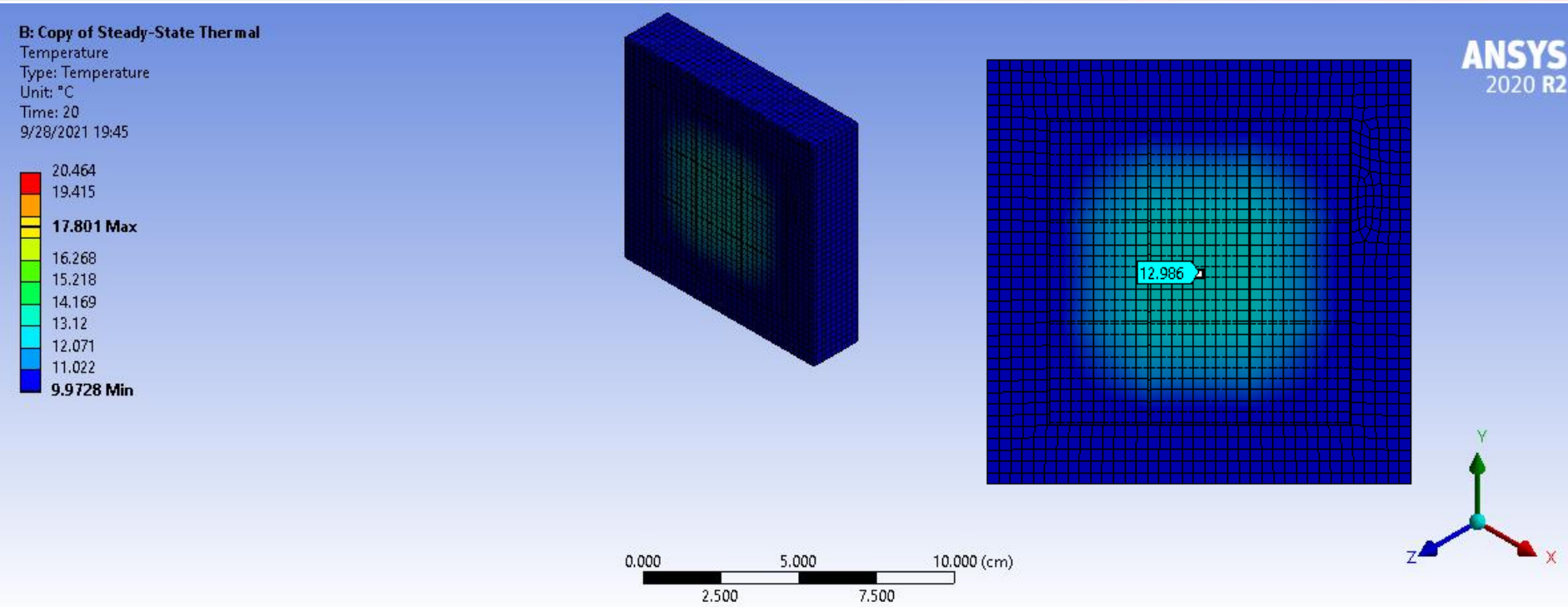
- Q = 3.5 W
- Ambient temp. = 22°C
- Film coefficient (convection) = 5 W/m^2 ·°C
- Cu shell temp. = 10°C
- Max. temp. = 17.801°C
- Start of carbon fiber cladding (2 cm)

Full-length Crystal Simulation (3.5 W)



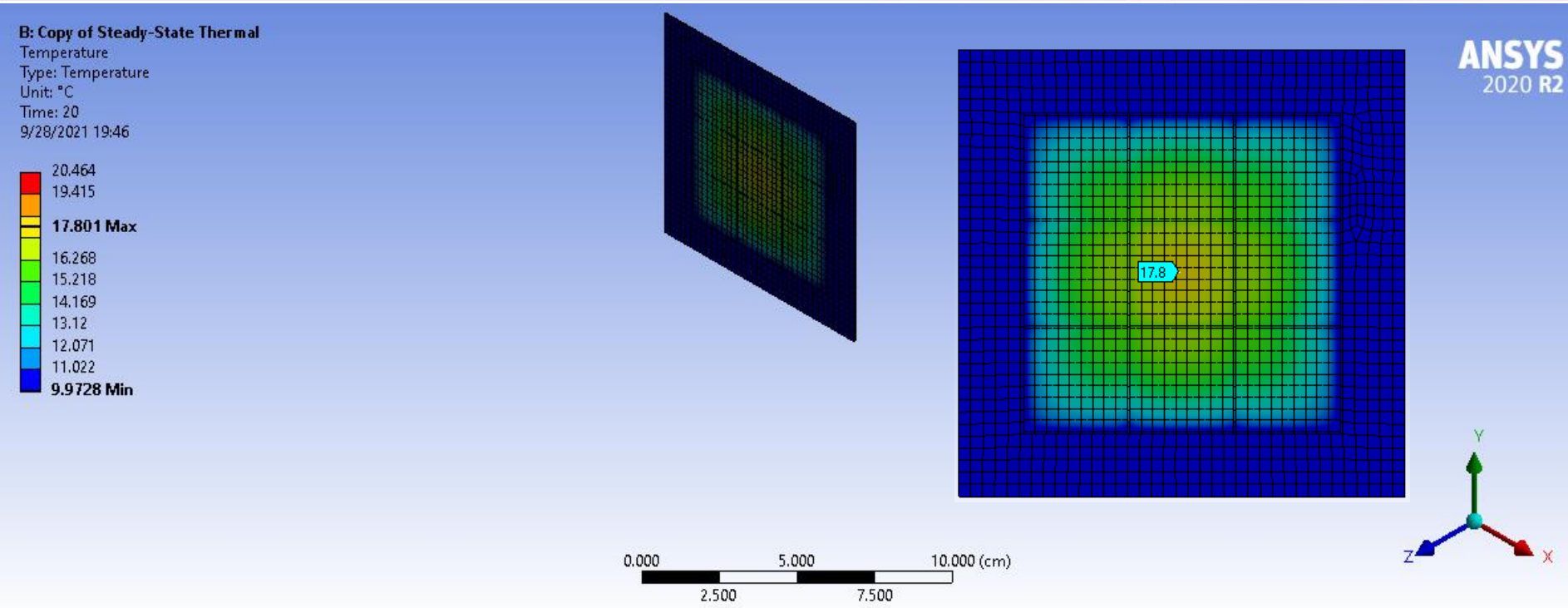
- z =18 cm
- End of carbon fiber cladding (2 cm)

Full-length Crystal Simulation (3.5 W)



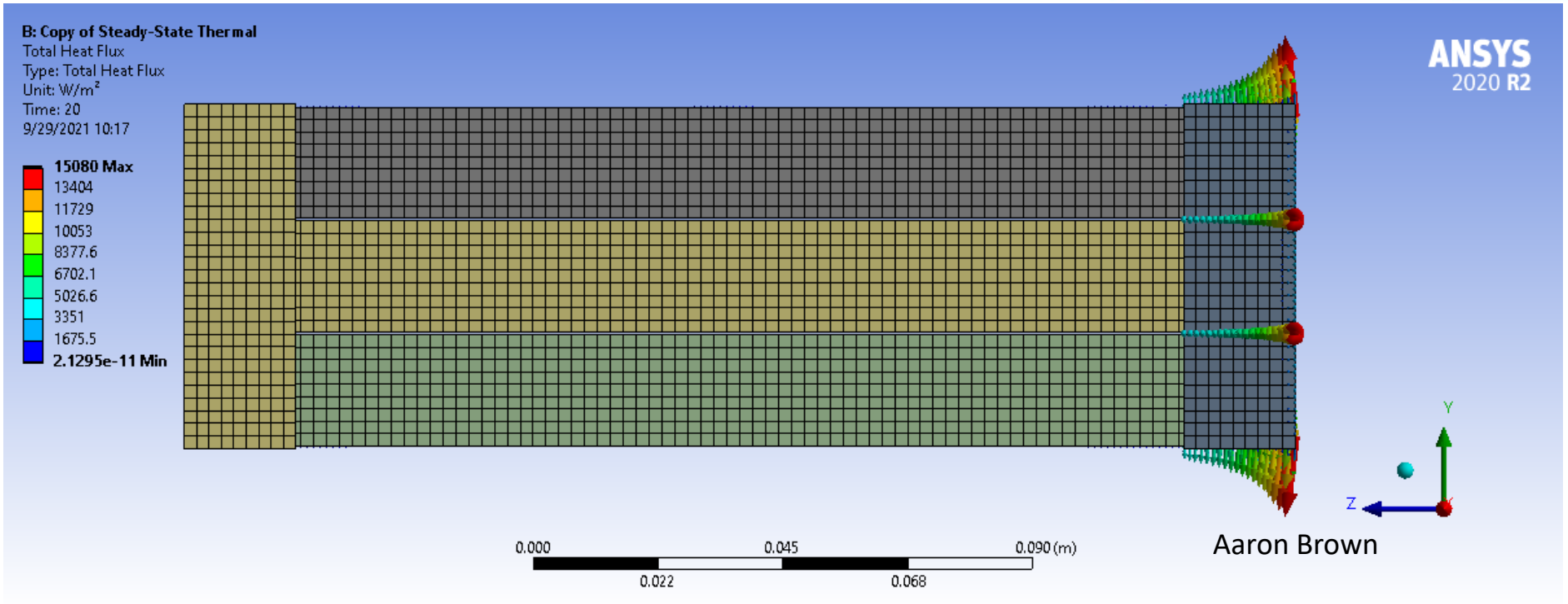
- z = 2 cm
- Start of mu metal cladding (2 cm)

Full-length Crystal Simulation (3.5 W)



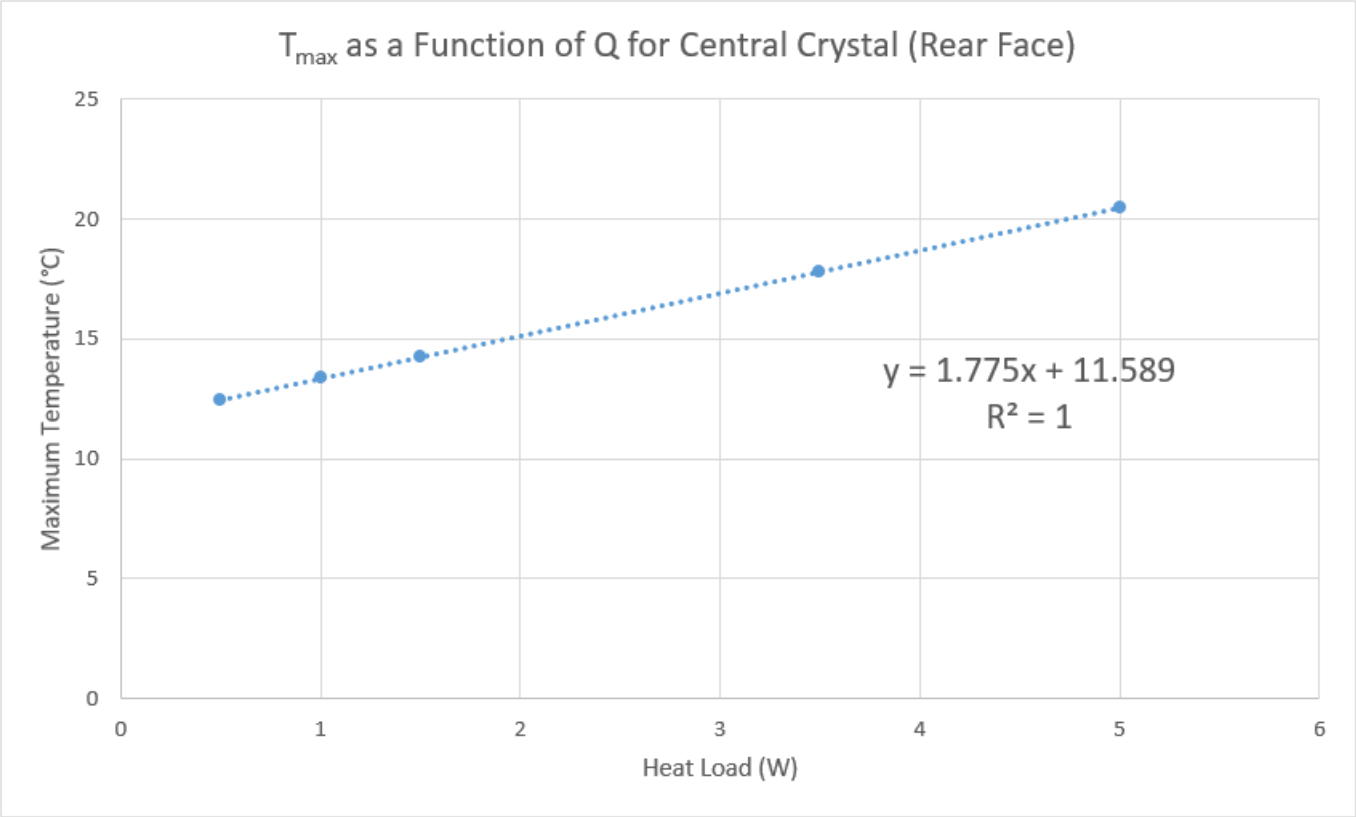
- z = 0.1 cm
- At 3.5 W central crystal is ~18°C
- End of mu metal cladding

Total Heat Flux (3.5 W)



- Heat load = 3.5 W
- Majority of heat is dissipated within the first 2 cm

Plot of T_{max} vs. Q



- For all values of Q:
  Cu shell temperature fixed at 10°C
  Model included carbon fiber and mu metal dividers
  Heat applied directly to the rear face of each crystal

Conclusion

- Conducting thermal analysis of a 3x3 $PbWO_4$ crystal array to determine temperature profile
  - 3.5-W heat load leads to a maximum temperature of ~18°C for the central crystal

- Heat conduction to the Cu shell is more at the mu metal end due to better conductivity of mu metal compared to carbon fiber

- Need to know thermal properties for carbon fiber

- Plan to scale up to full 36x30 model

Thank You!