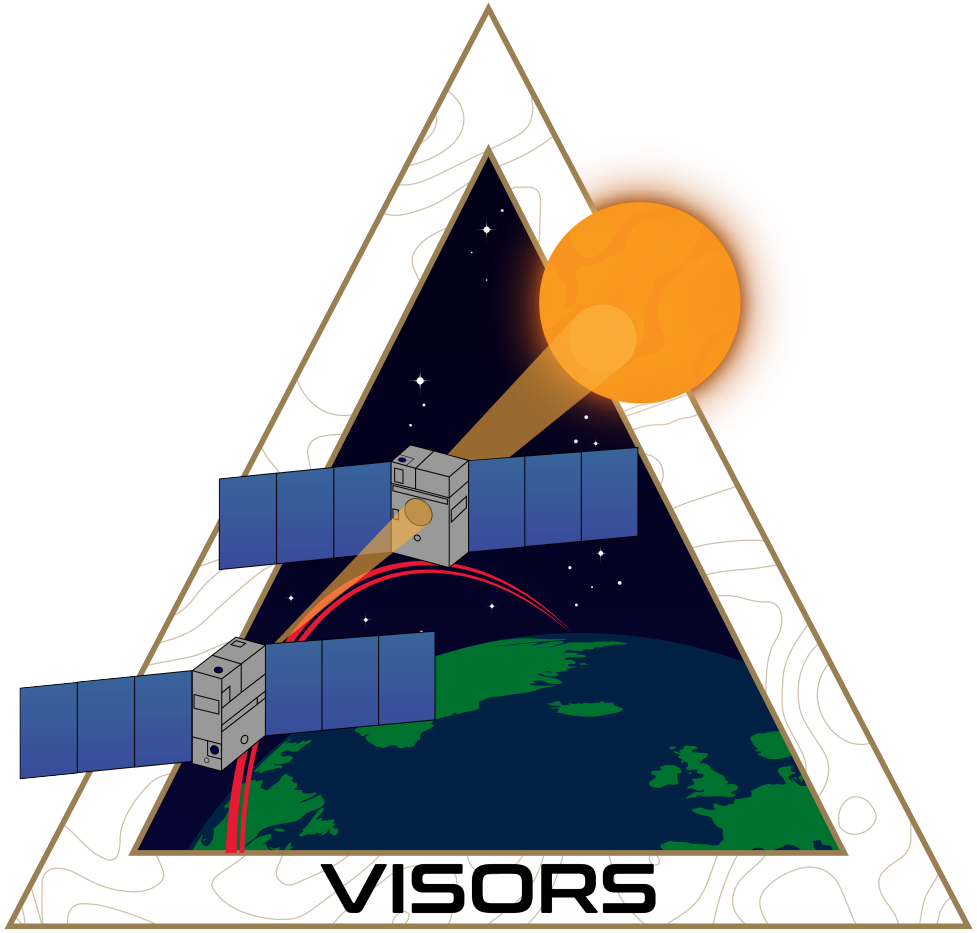


Thermal Analysis and Design for VISORS CubeSat Formation

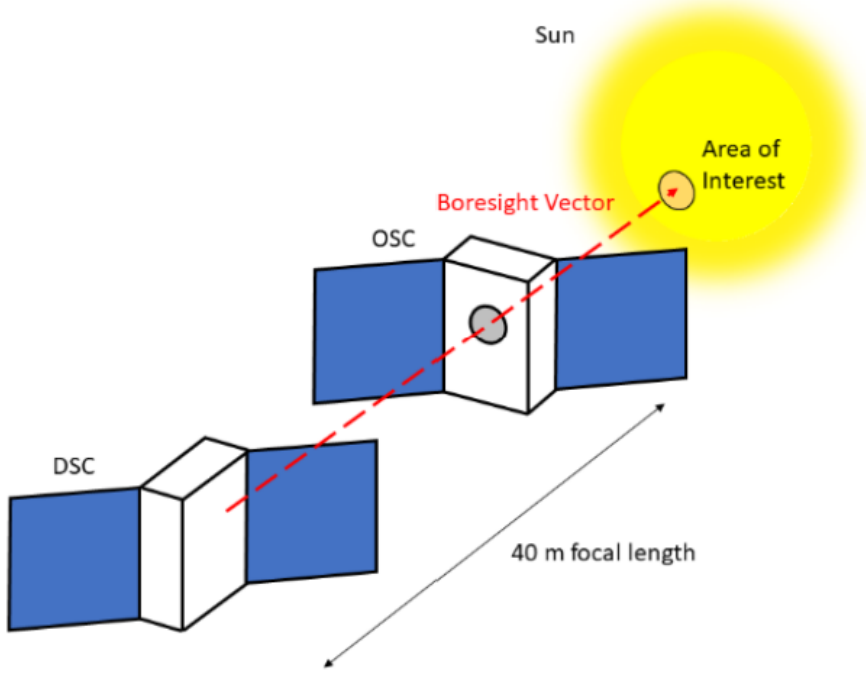
Erik Zabalegui Lopez
Rishikesh Gadre
Hasnain Daudi
Dr. Petr Kazarin

Faculty Advisor:
Alina Alexeenko

Purpose of the VISORS mission

To investigate the processes in the solar corona and observe and study the heat release regions with a resolution of 0.2 arcseconds.

To achieve this, a 40 m focal length is required, which is too large for a spacecraft, **making a distributed telescope of two 6U CubeSats the best solution.**



Orbits

Case	Orientation	Heat loads on Components On/ Off	Beta Angle (in degrees)
Hot	Primary: GNSS to Zenith Secondary: Solar Panels to Sun	On	69.14
Hot-Standby	Primary: Solar Panels to Sun	On	90
Cold	Primary: GNSS to Zenith Secondary: Solar Panels to Sun	On	9.86
Cold-Standby	Primary: Solar Panels to Sun	Off	0
Cold-Survival	Tumbling	Off	9.86

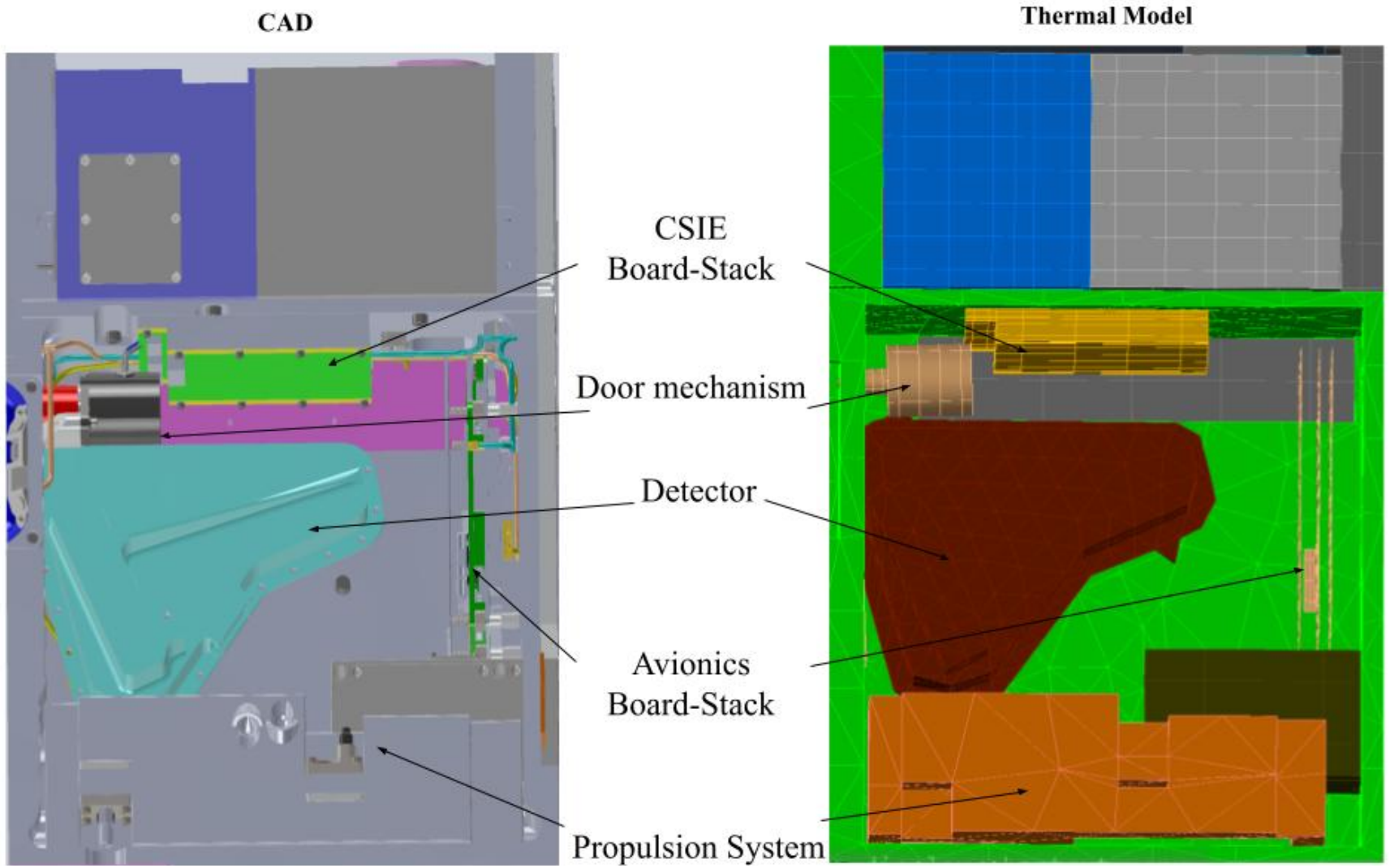
Heat Sinks, Sources, and Pathways

Heat Sources	Comments
The Sun	The Sun is the biggest heat source with an intensity of approximately 1350 W/m2.
Internal Heat Generation	Sunlight reflected from Earth affects the temperature of the Nadir side of the satellite.
Earth's IR emissivity	The earth is constantly radiating heat into space at temperature of 255K.

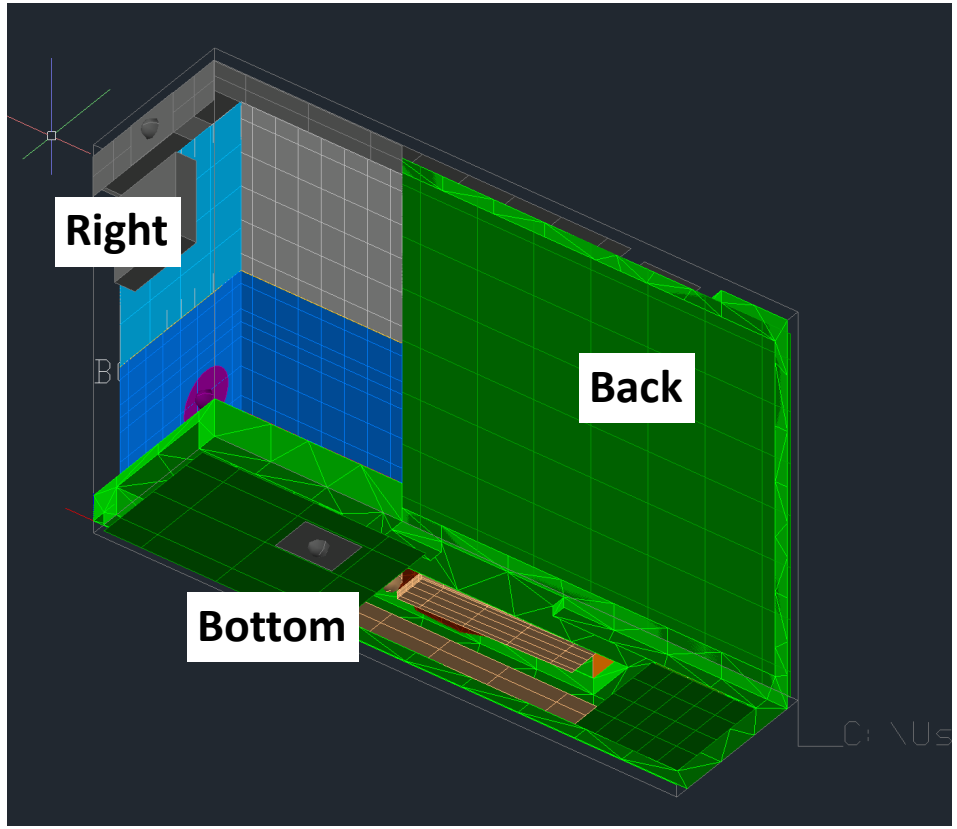
Heat Sinks	Comments
Radiation into space	The average temperature of empty space is 3K, and heat from the satellite is constantly radiating into space.

Pathways	Comments
Conduction	The satellite is largely made of aluminium and conducts heat to other parts of the satellite very well.
Radiation	If a component does not have a high conduction pathway, it will still emit heat to other parts of the satellite via radiation.

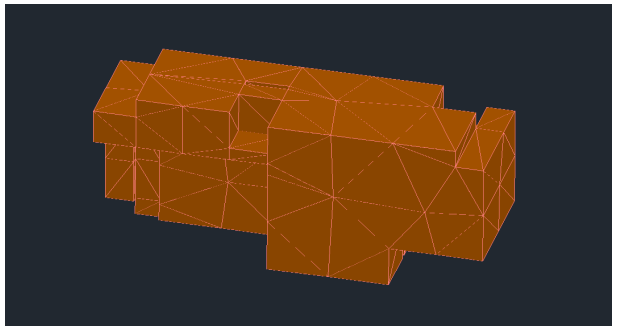
DSC Thermal Development



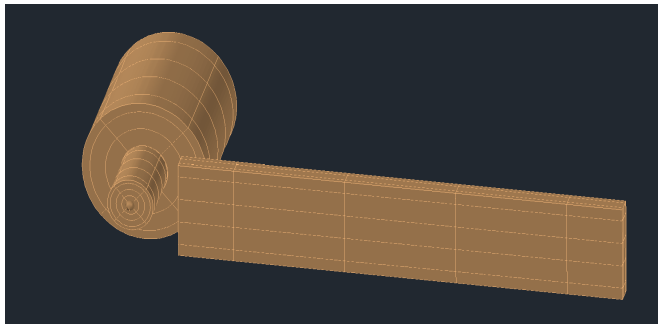
DSC Faces and Components



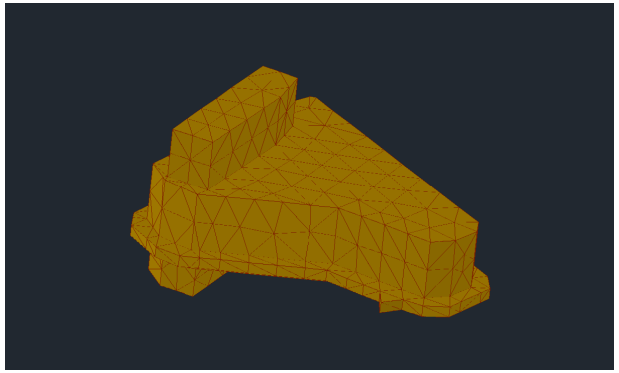
Propulsion System



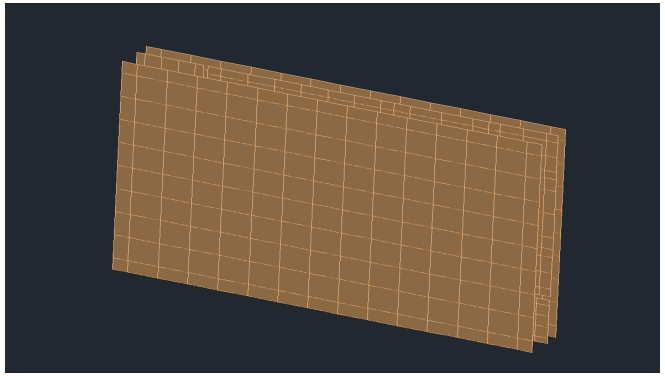
Door Mechanism



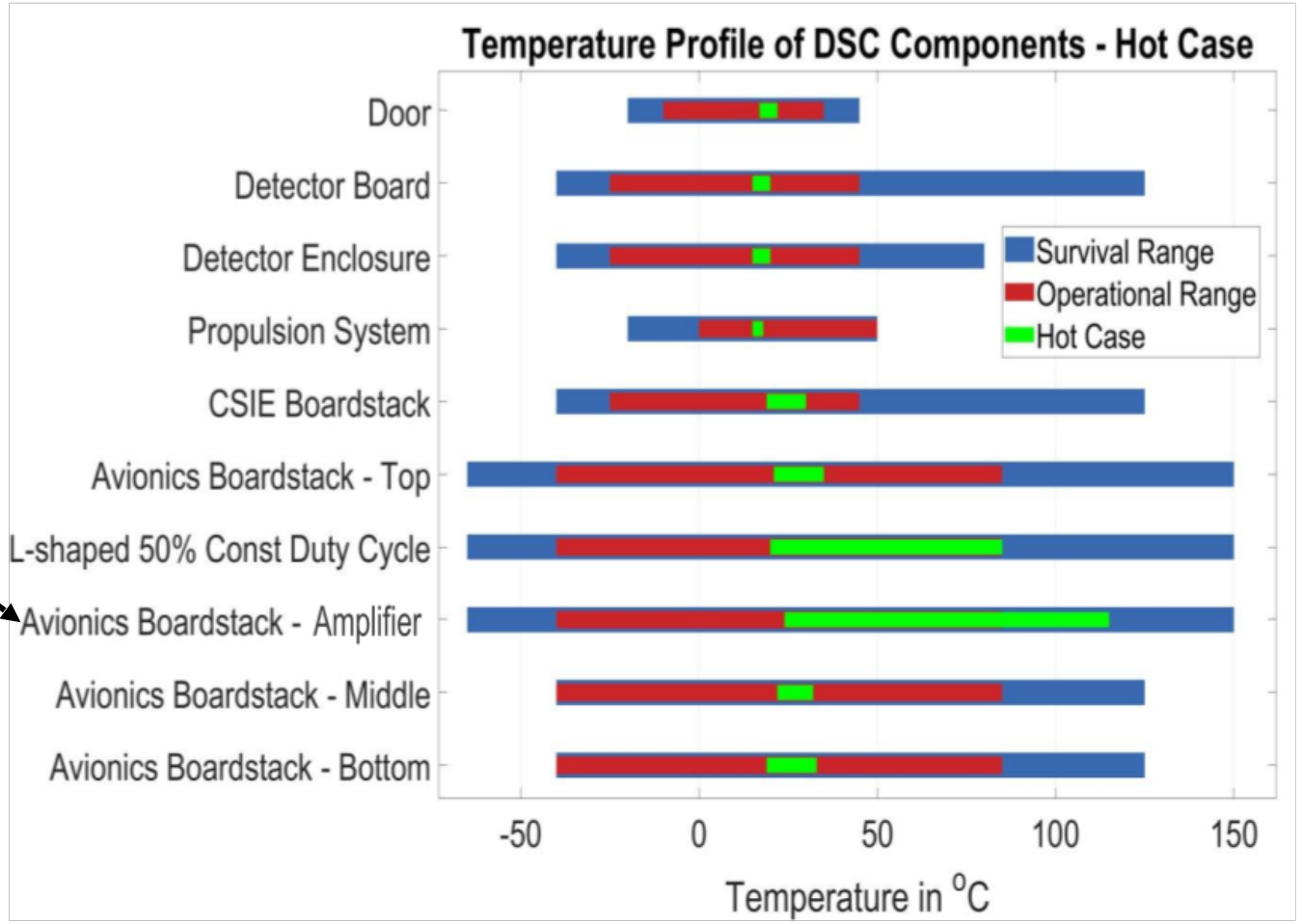
Detector



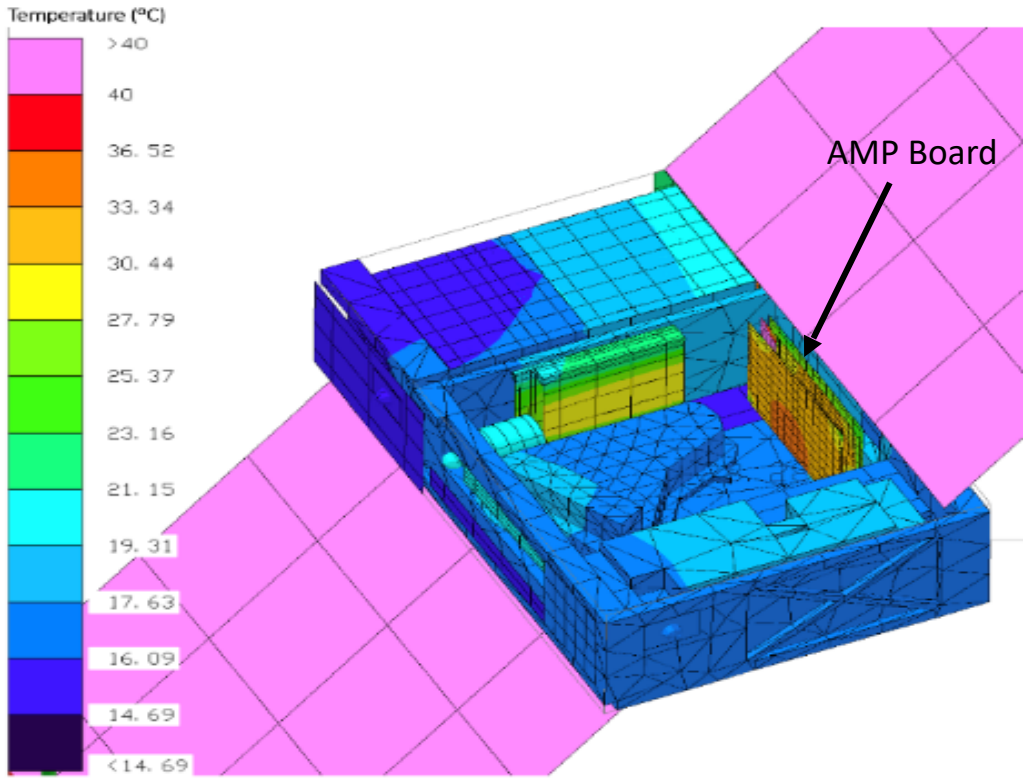
Avionics Board-stack



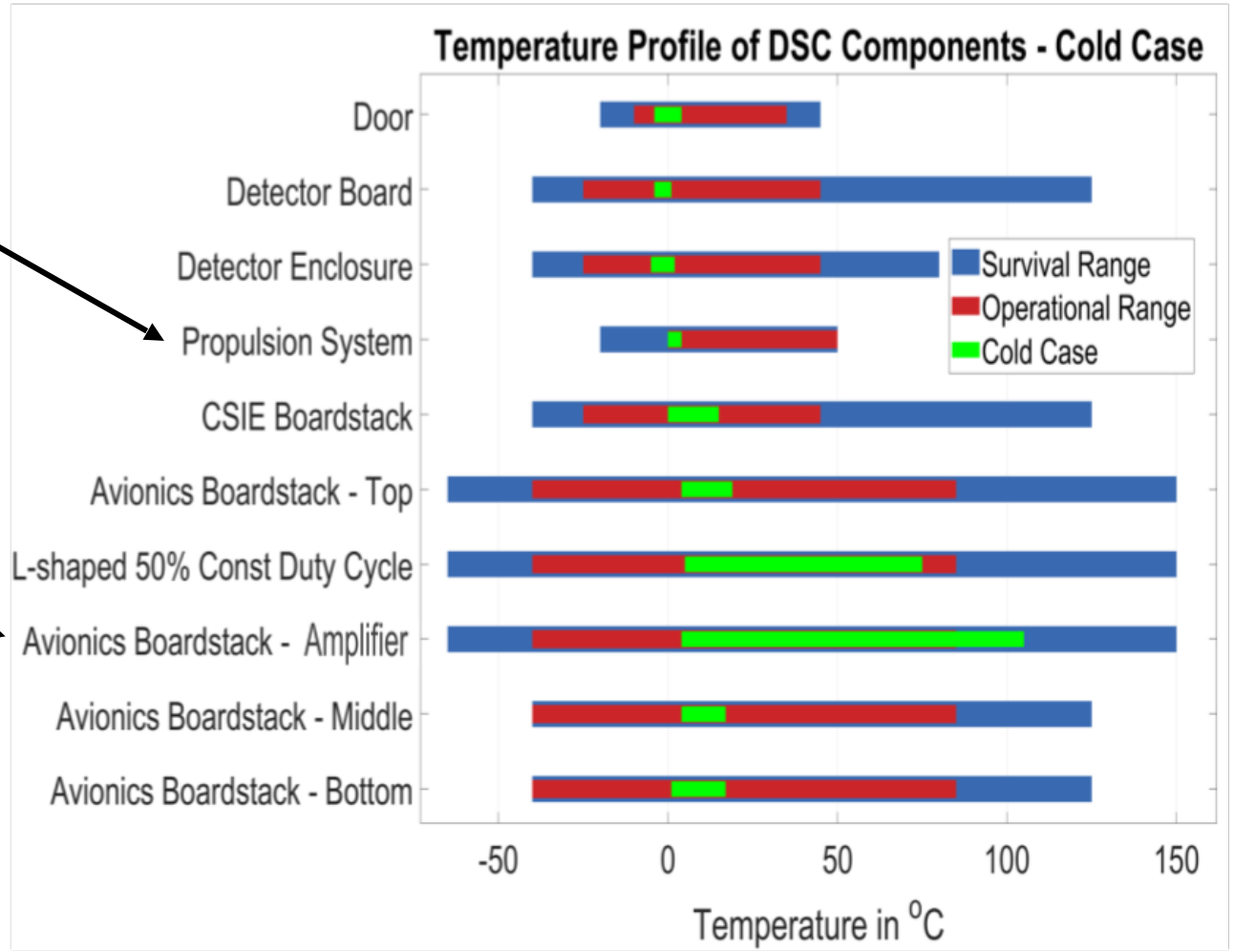
Hot Case



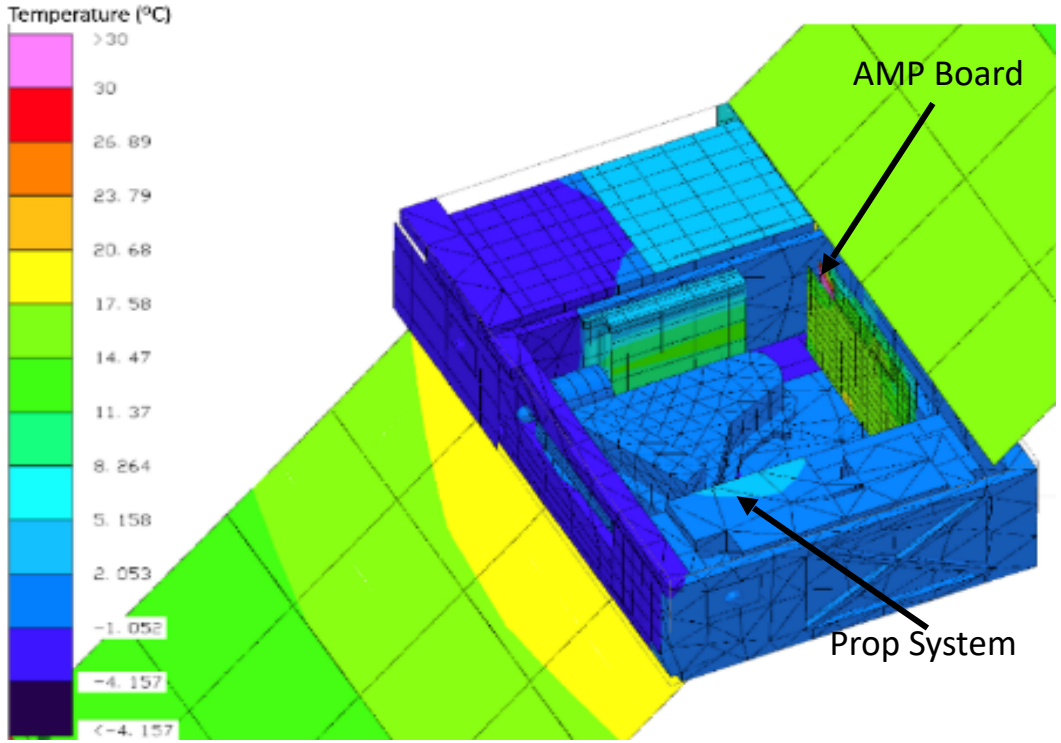
- Amplifier Board is out of operational range due to heat load at the amplifier chips



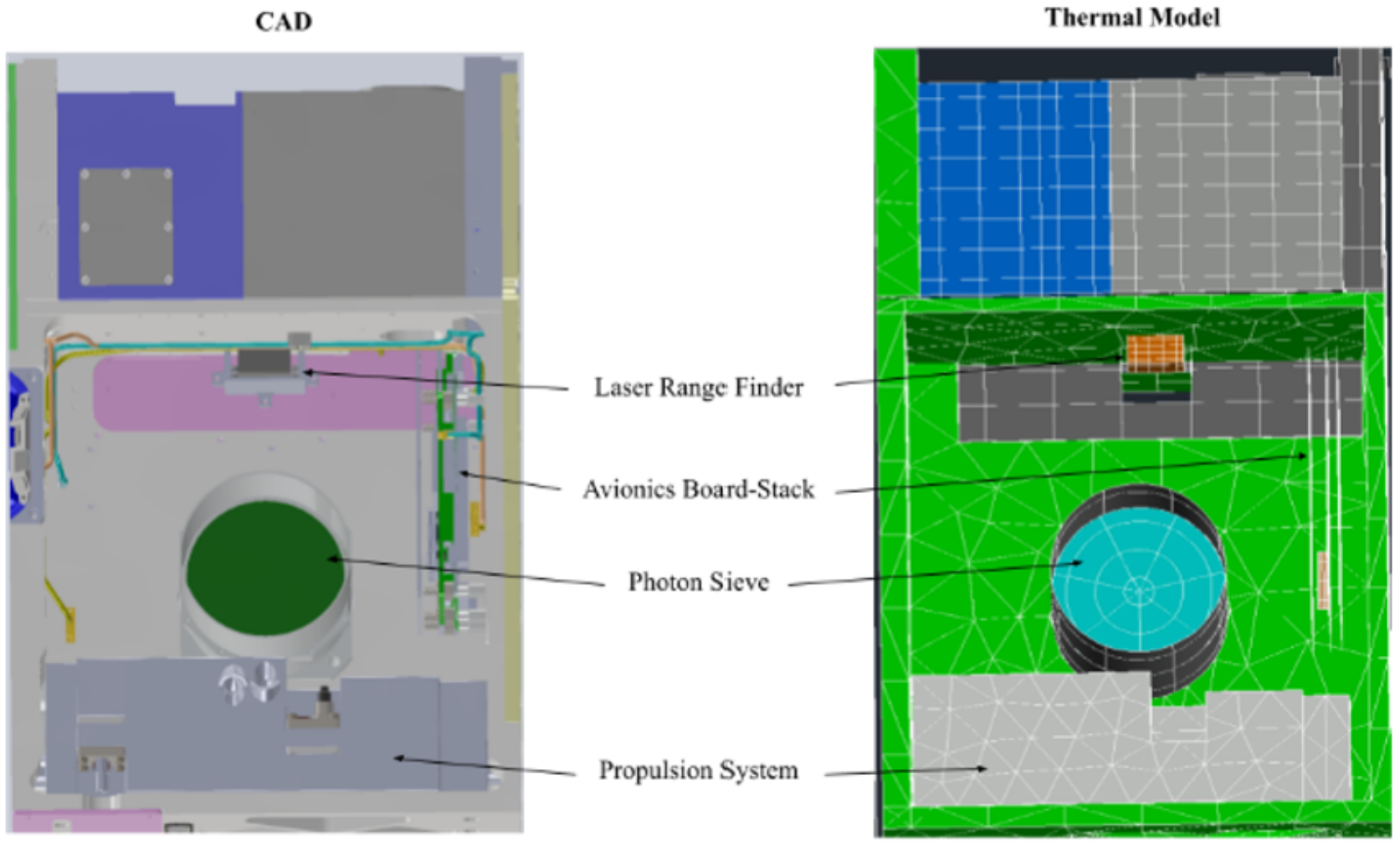
Cold Case



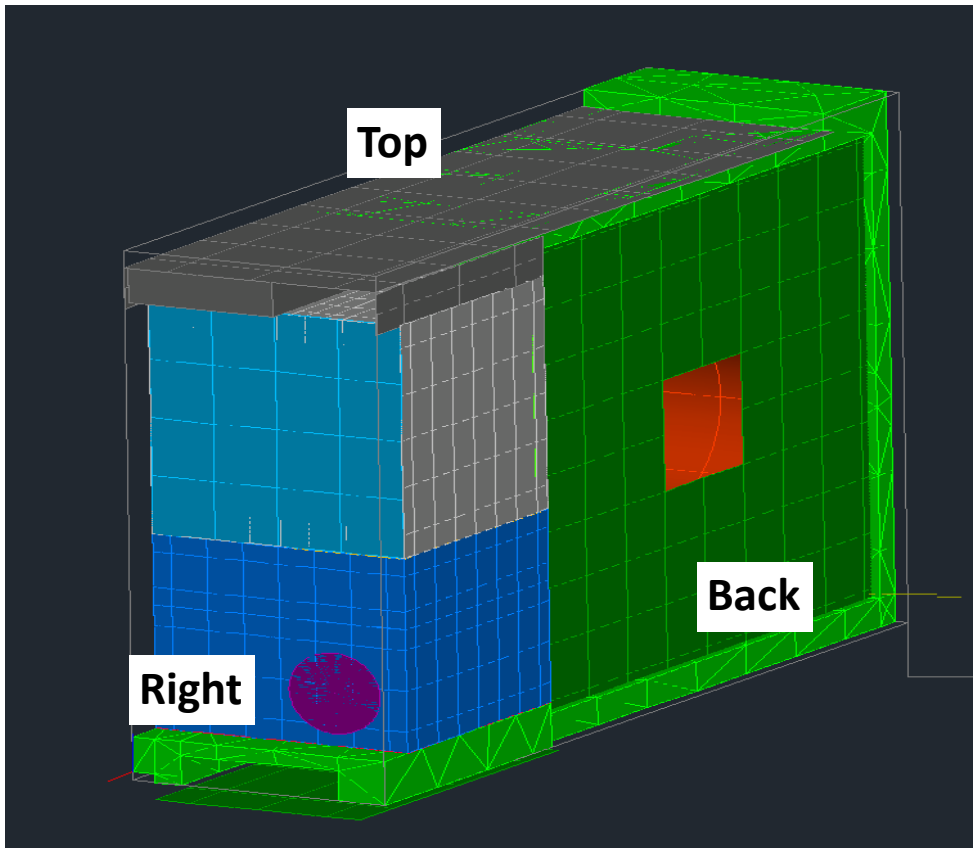
- Amplifier Board in the Avionics Board-Stack is out of operational range due to heat load at amp chips
- Propulsion system is out of operational range but within survival range



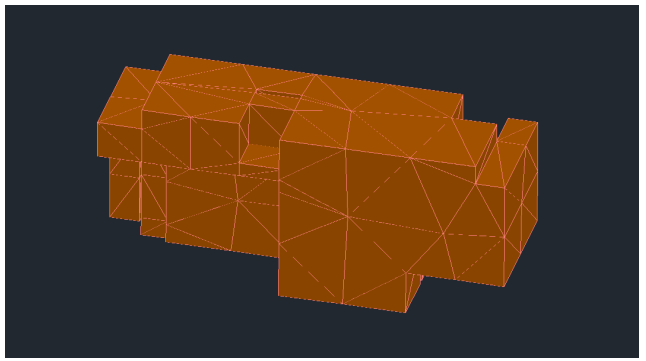
OSC Thermal Development



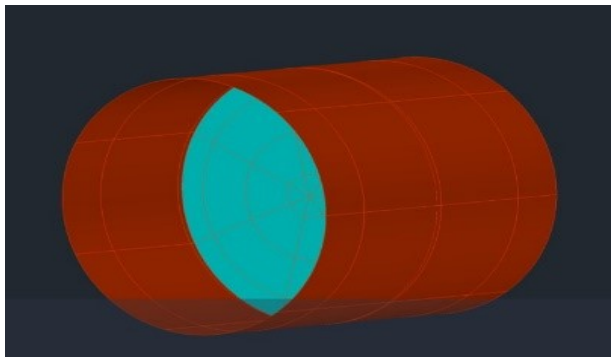
OSC Faces and Components



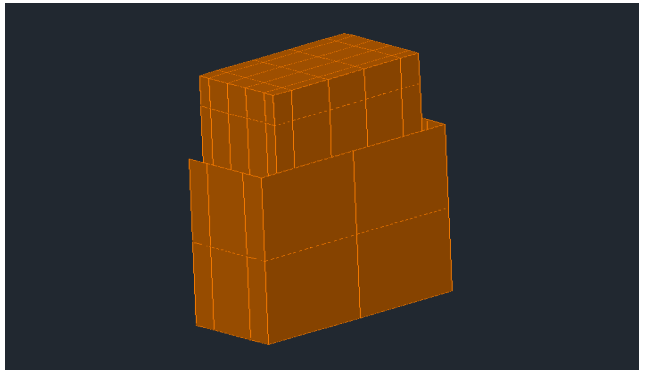
Propulsion System



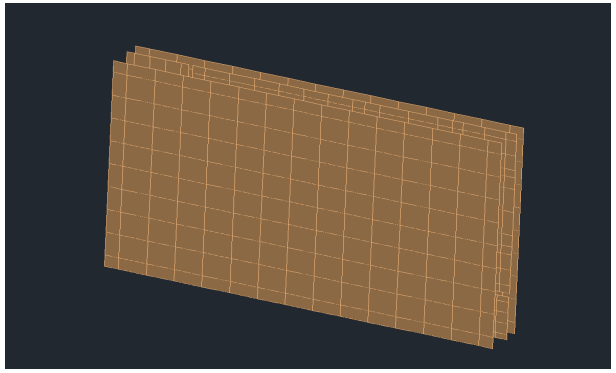
Photon Sieve



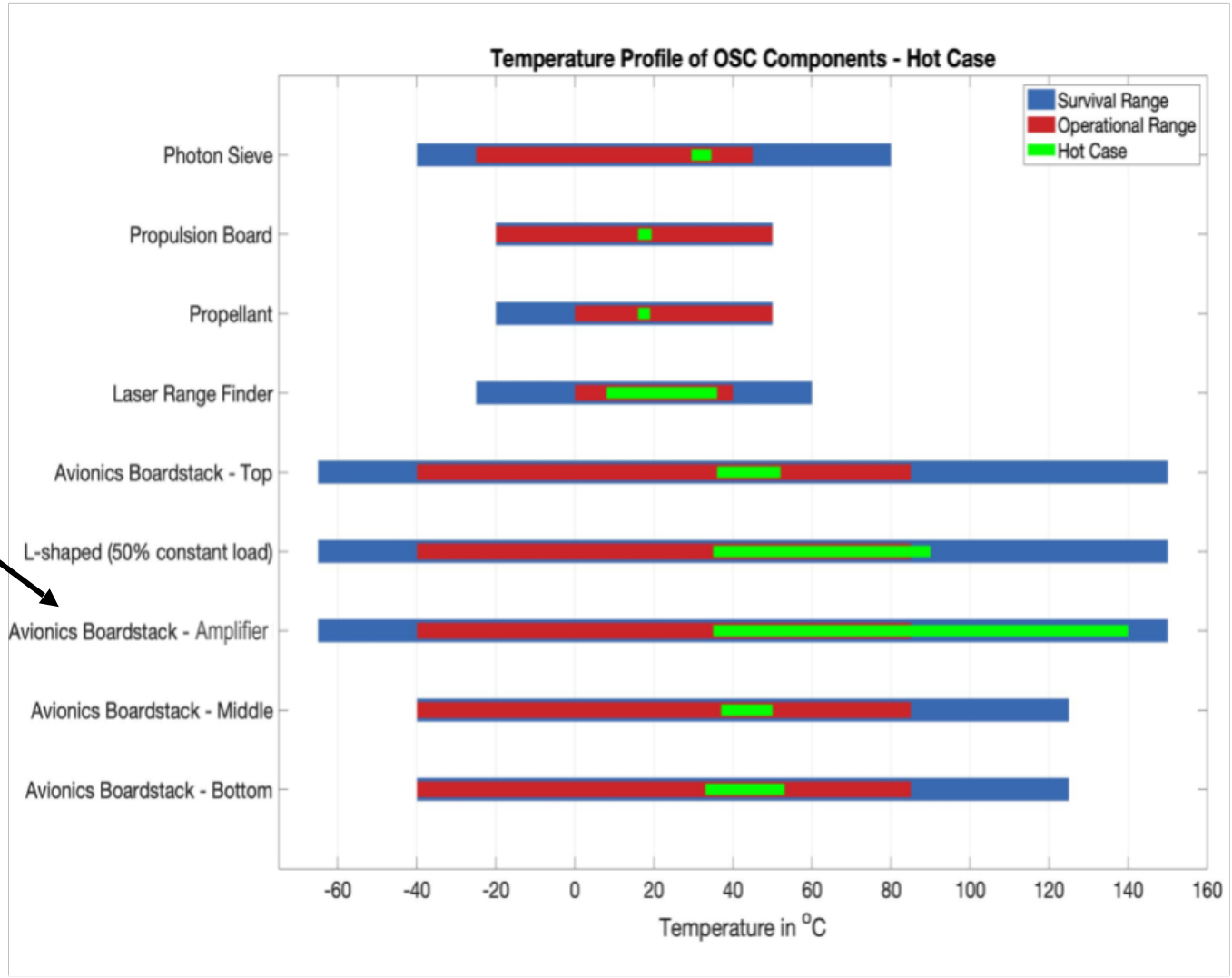
Laser Range Finder



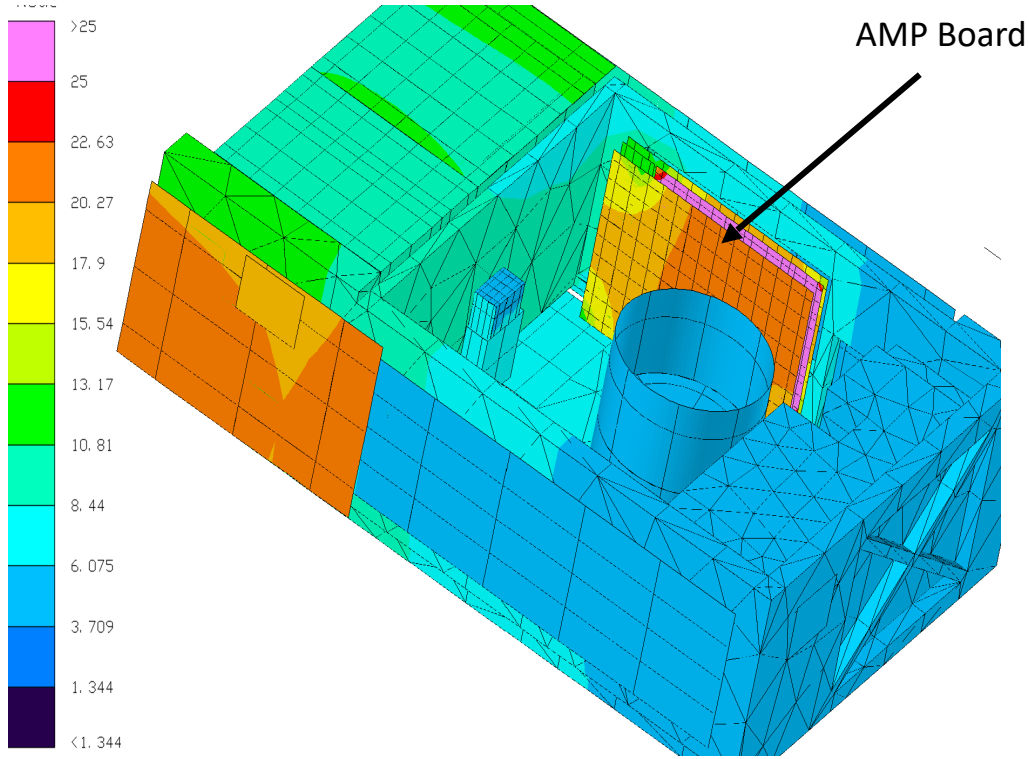
Avionics Board-stack



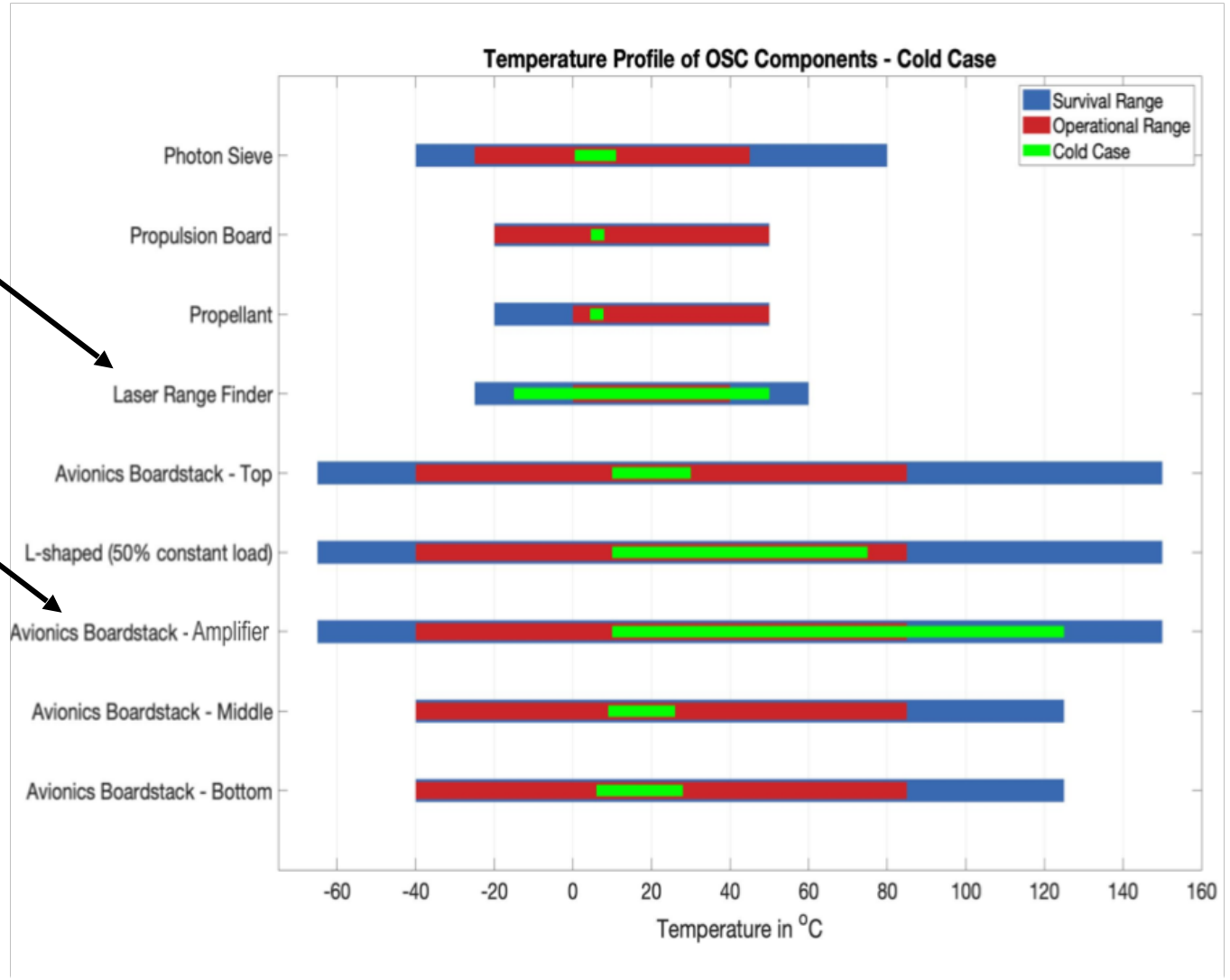
Hot Case



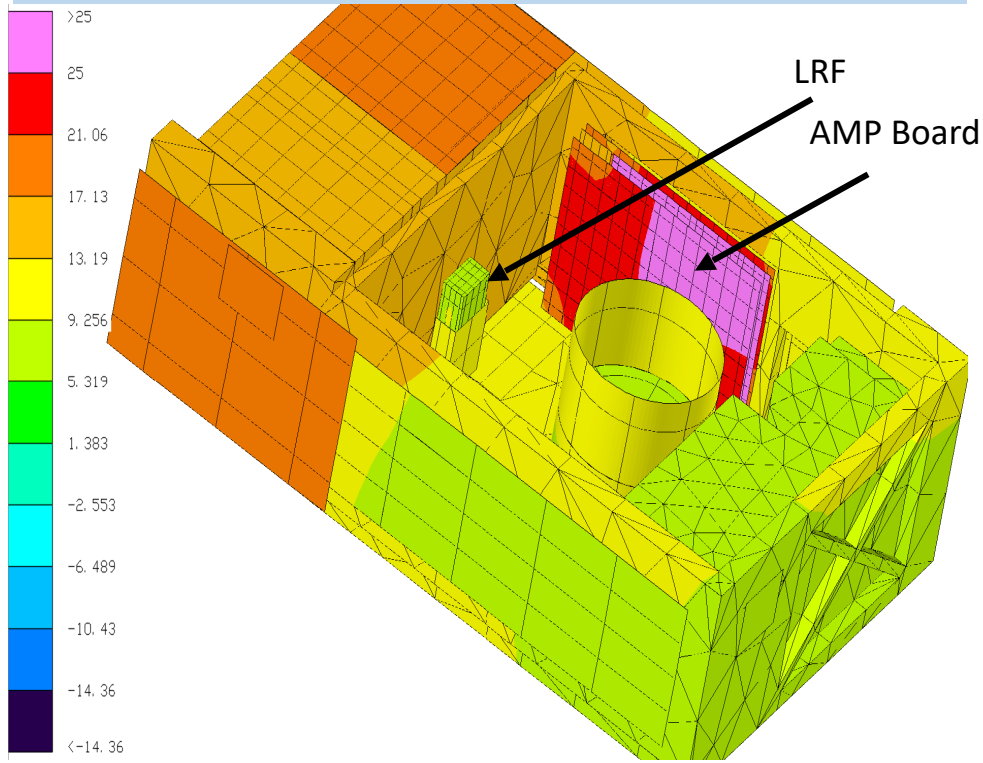
- The Amplifier Board in the Avionics Board-stack is out of its operational temperature range due to the heat load distribution of amplifier chips



Cold Case

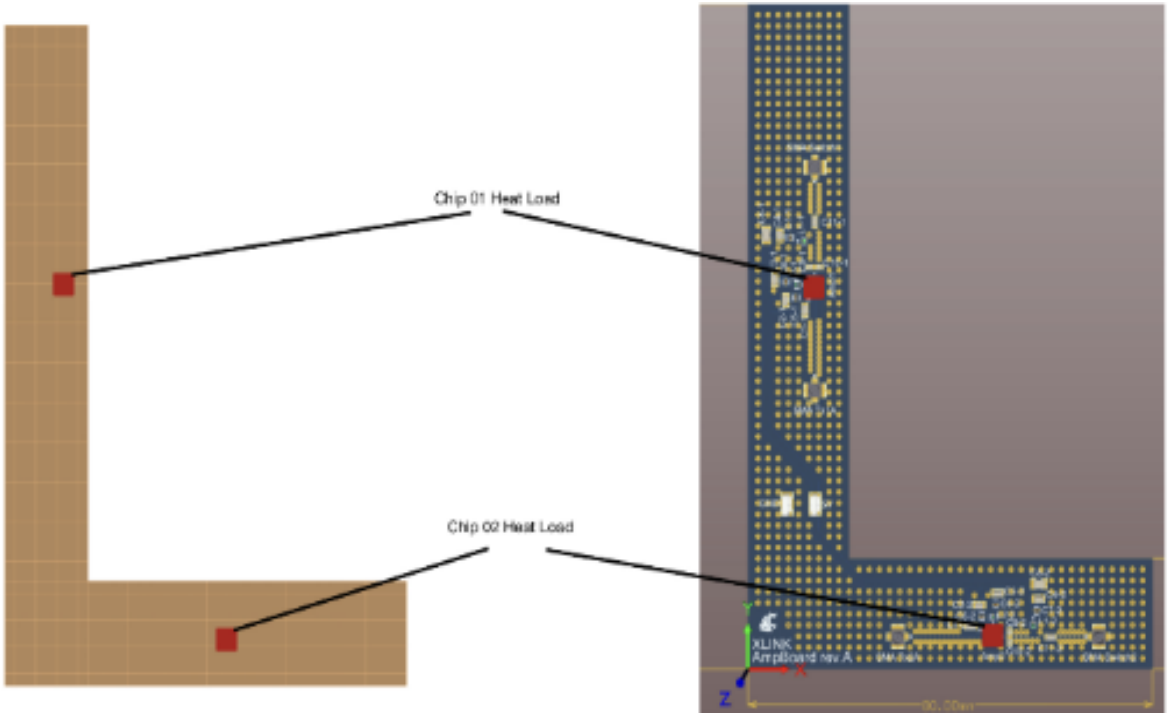


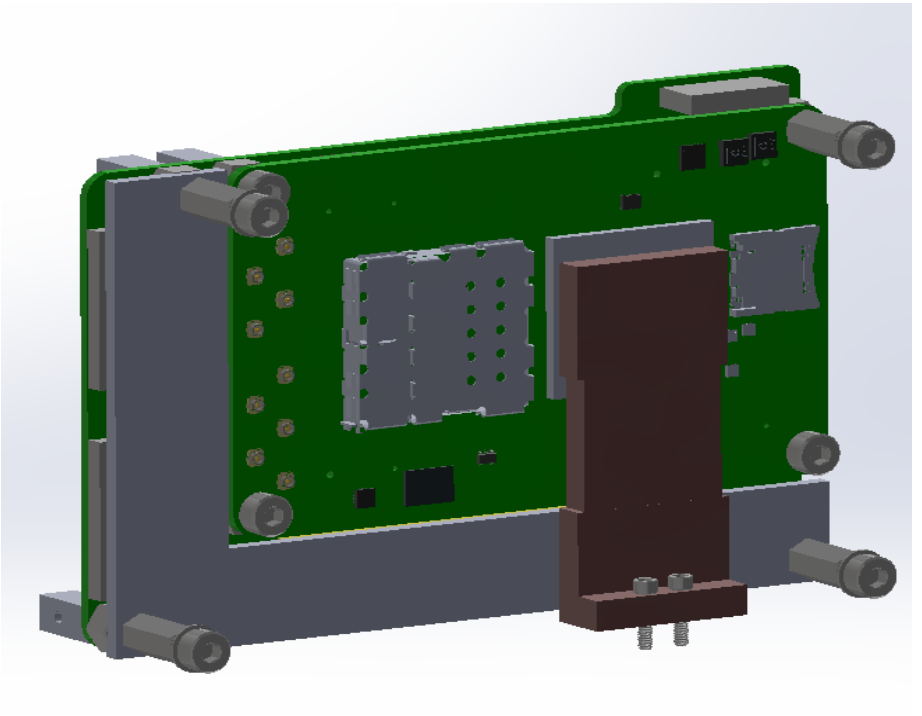
- The Amplifier board in the avionics board-stack and the LRF are out of their operational temperature range, but inside survival range.



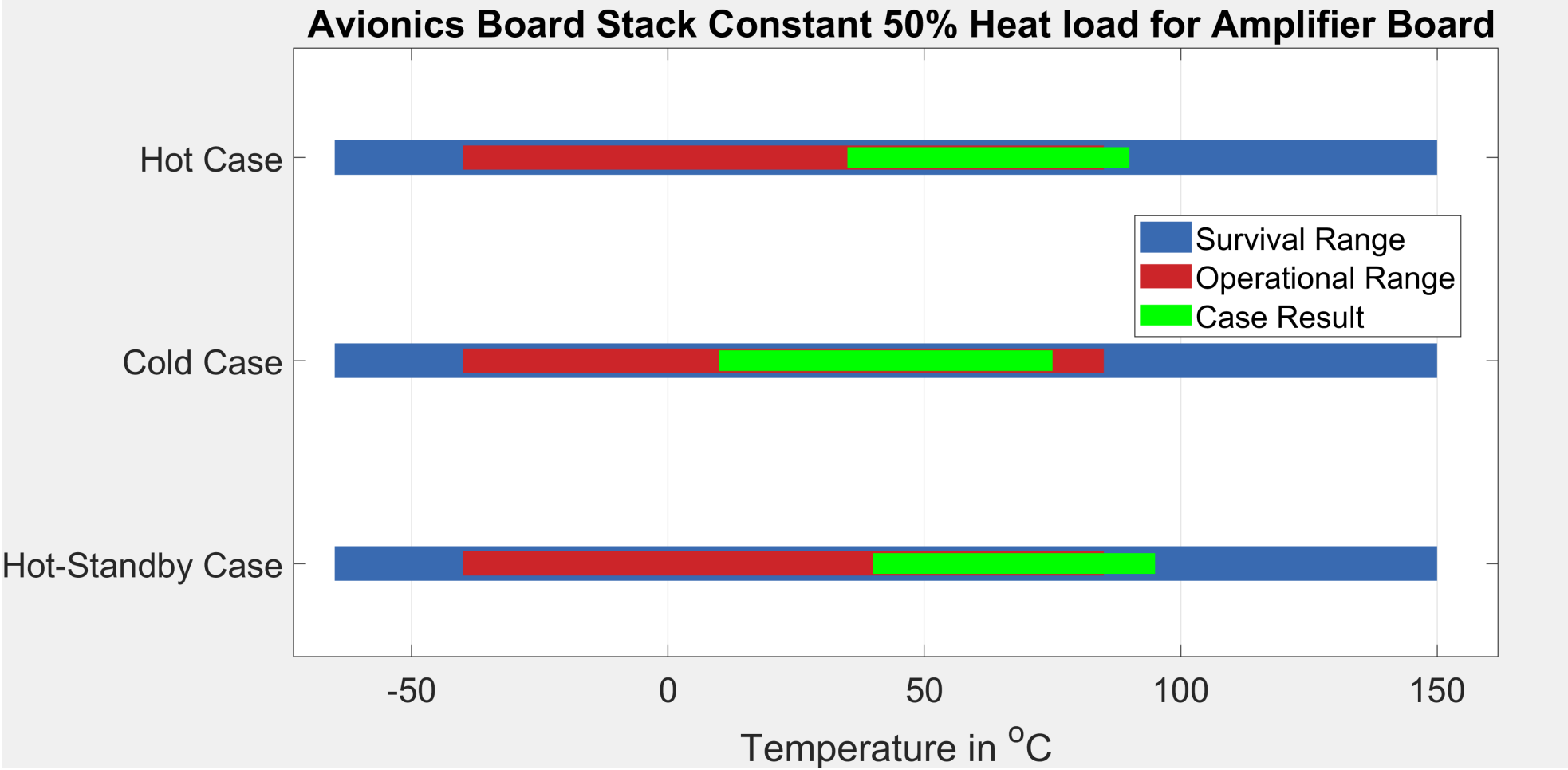
Challenges/Solutions

- Avionics Board Stack – Amplifier Board
  - Two Amp Chips - heat load had an alternating 0.5 second on/off duty cycle
  - Tried to utilize 5 second on/off duty cycle
  - 50% heat load was applied to the entire board
  - 0.2" thick copper bracket added to Avionics Board stack



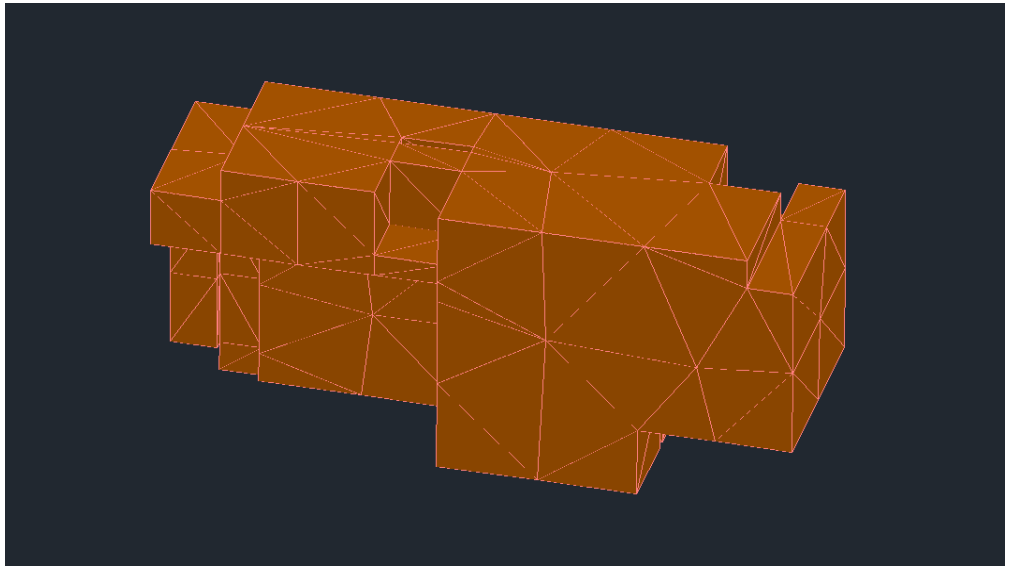


Avionics Board Stack – Amplifier Board – 50% Heat Load Results



Challenges/Solutions

- Propulsion System
  - The Simplified Model brings up questions of the accuracy of the values
- Current Trials
  - Utilizing a Conductor instead of a node
  - Solid Box Approach

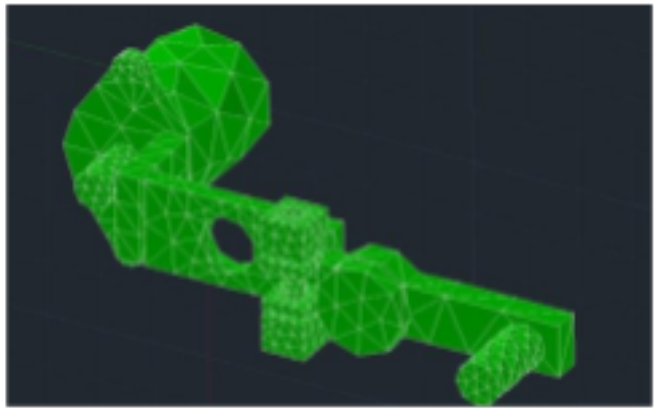


Conclusions

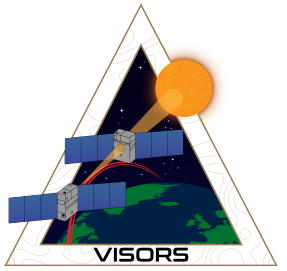
- Next Steps
  - Comprehensive Analysis of Laser Range Finder to develop more accurate results
  - Continued Modifications on Propulsion System
  - Currently remodelling door mechanism to improve the fidelity of the model
  - Test satellites in vacuum chamber to determine if simulations are accurate

Closed Door Model

Open Door Model



Acknowledgements



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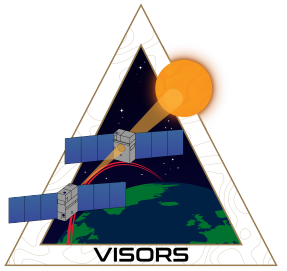

Questions?