NORTHROP GRUMMAN

Syracuse University College of Engineering & Computer Science

Generate an Empirical Database to Characterize Critical Oscillating Heat Pipe Parameters such as Channel Geometry and Fill Ratio

Project Description:

Northrop Grumman is looking for solutions to determine the best way to integrate Oscillating Heat Pipes (OHPs) into their design for heat sinks. These heat sinks will be incorporated onto spacecraft to dissipate excess heat produced from electronic components into space. To accomplish this, Northrop Grumman has approached us with the challenge of determining the most efficient OHP heat sink design. Our goals are to create a design matrix, build and simulate computer models, fabricate the best designs, and test them to determine the most efficient prototypes. The project is research centered, thus the team is encouraged to use creativity in our design to make our final prototypes as efficient as possible.

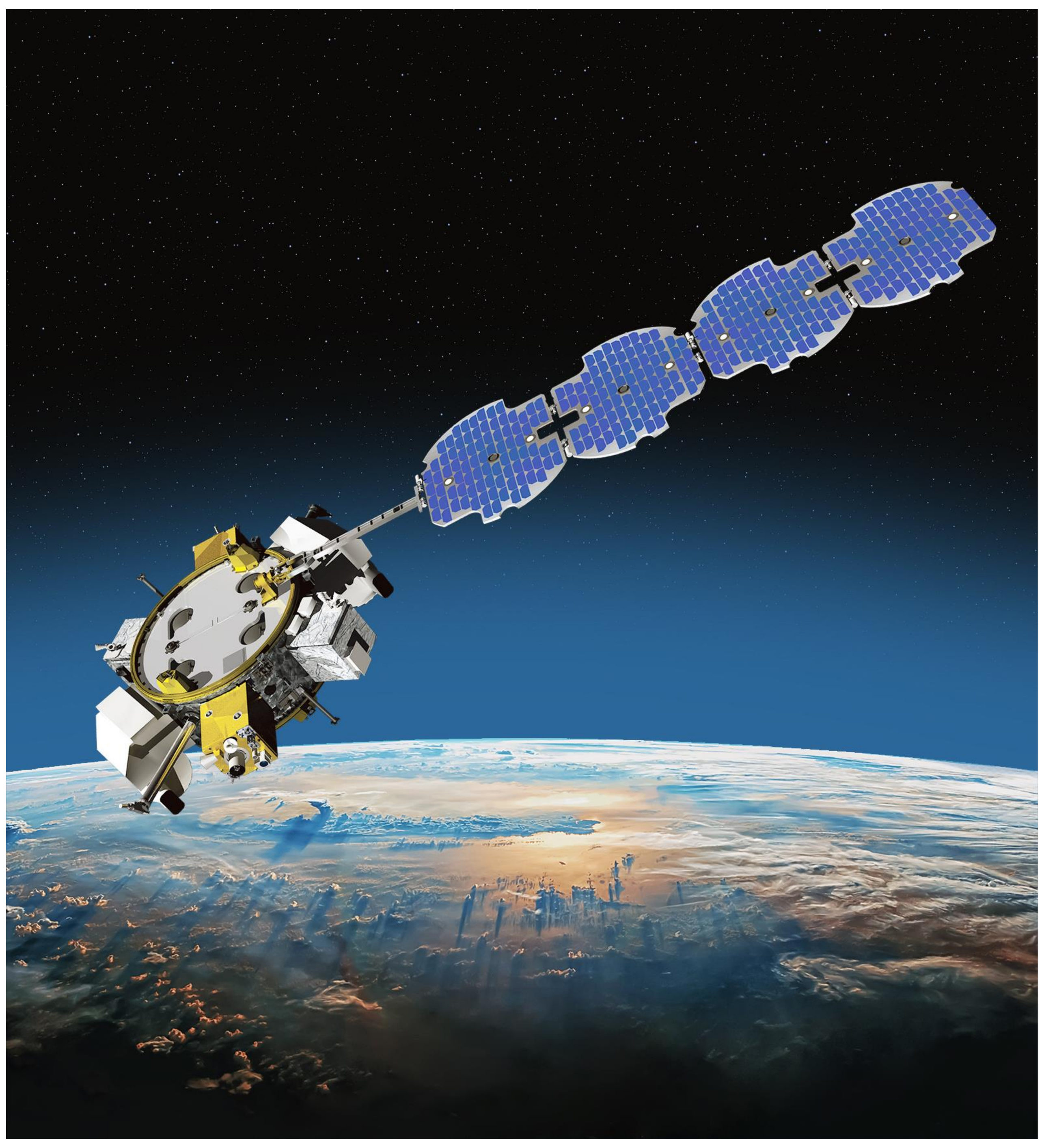

Figure 1: Northrop Grumman Satellite

Design Options:

Based on standardized hardware:
- 6U 220mm VPX

Changing parameters of OHPs to vary outcomes:
- Swept Length
- Pipe Diameter
- Fill Ratio

Ammonia is the chosen filling fluid for all configurations.
All designs are Aluminum based.
Due to the geometry involved in construction, Additive Manufacturing (3D Metal Printing) will be used to create all prototypes

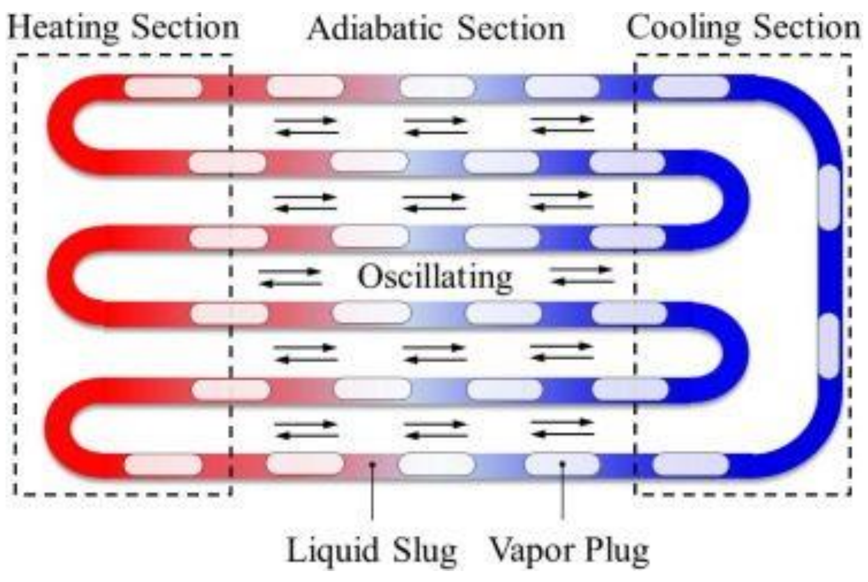

Figure 2: Oscillating Heat Pipe (OHP)

Figure 3: Generic Heat sink case for VPX Tray

CAD models and ANSYS Test Simulations:

- Default models will be created
- From there, we will make minor changes based on our design matrix
  - Example: Making a distinct model for each diameter choice [1, 2, 3, 4, 5, 6] mm
- Designs will be simulated in ANSYS Multiphysics software to determine most efficient designs for maximum heat dissipation
  - Best results/designs will be chosen to be physically prototyped in the future
- Currently, initial drafts have been created

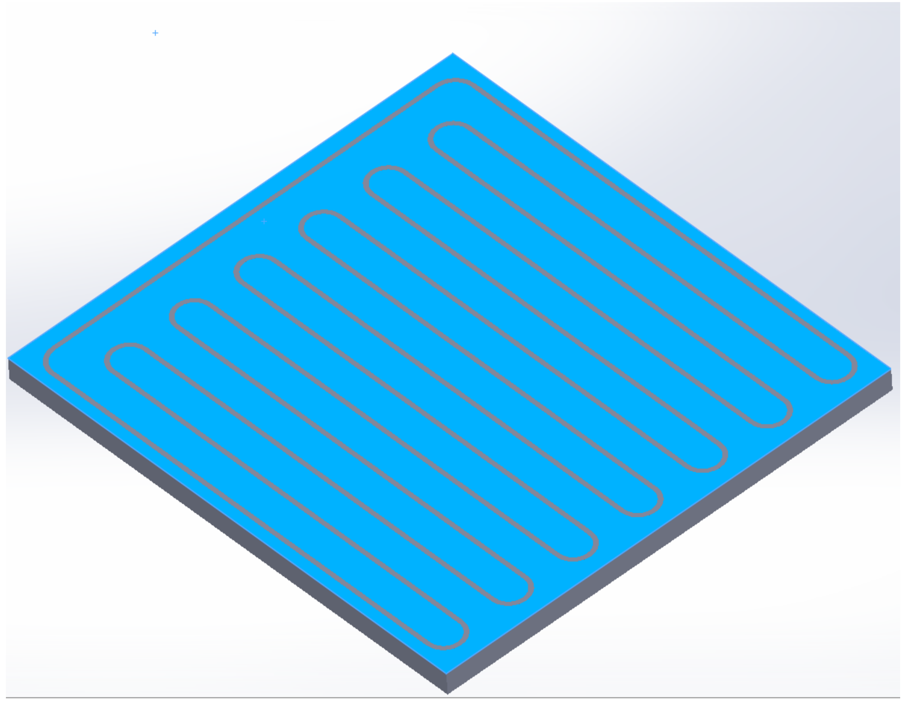

Figure 4: CAD Model of OHP (gray) in Tray (blue)

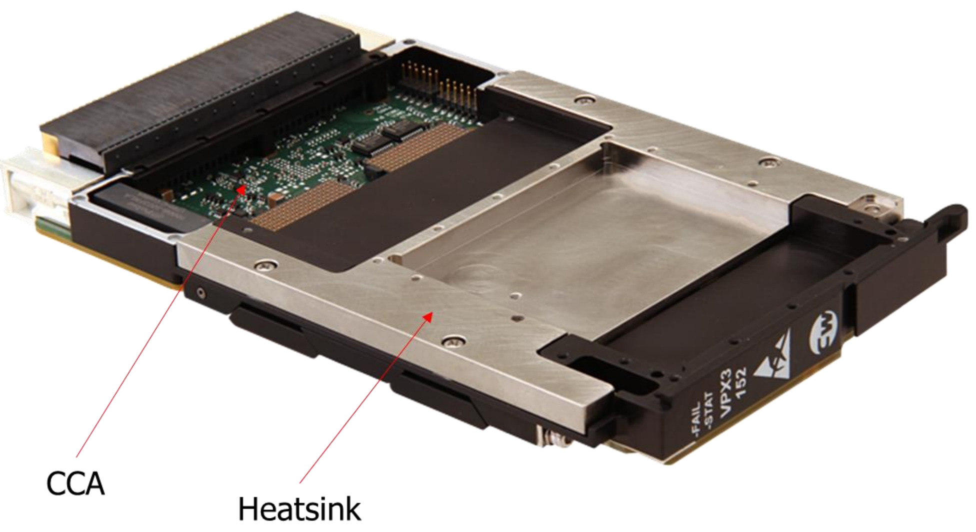

Figure 5: Generic VPX Tray for OHP Heatsink

Possible Solutions:

- 3D Modeling Software will be used to build multiple iterations of the OHPs. Varying the design parameters. It is estimated that 25-30 models will be needed
- Each model prototype will be simulated, the data captured, then evaluated; with special attention to the start-up time, dry-out, and its characteristic thermal gradient
- Simulations displaying the best performance will be selected to be additively manufactured
- Prototypes (test coupons) will be lab tested and the results validated against the collected simulation data

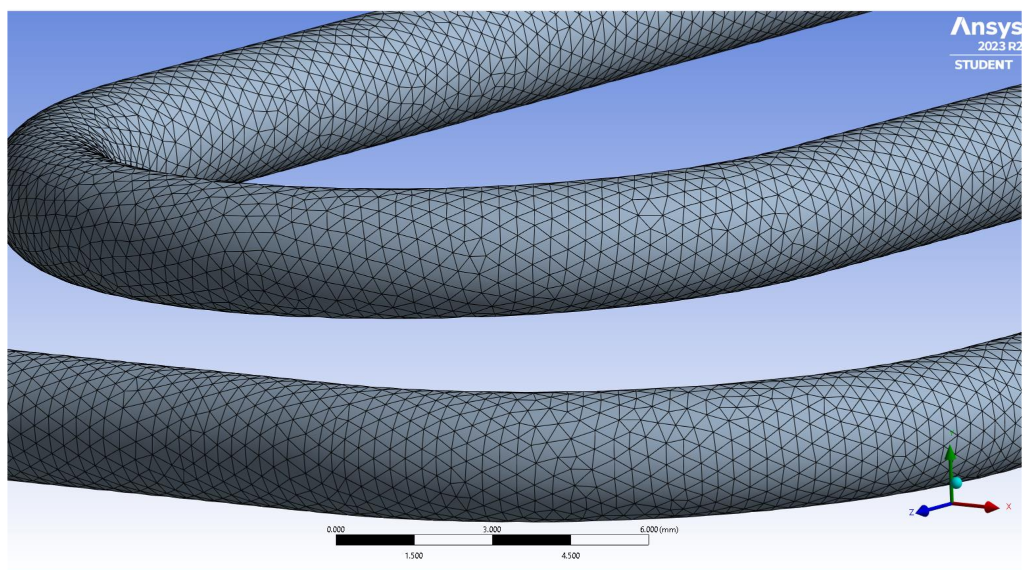

Figure 6: OHP in Ansys with Mesh Overlay

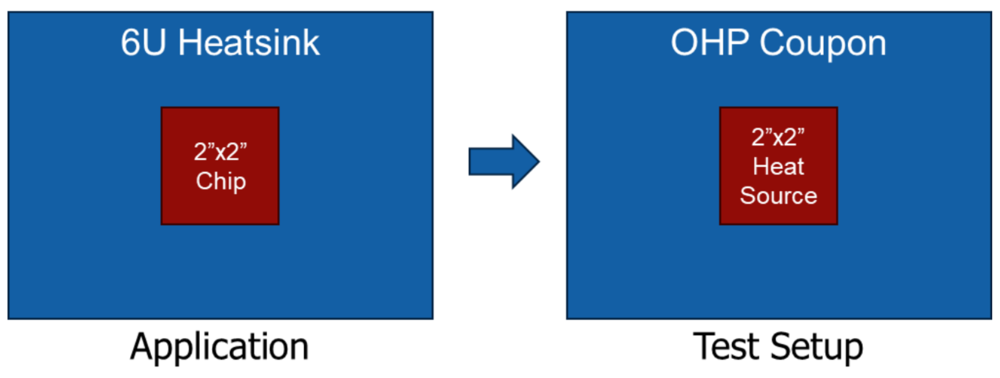

Figure 7: Development Path

Deliverables:

1. Develop test matrix of design parameters that will be varied to understand impact of OHP performance.
2. Design and simulate sample OHP's that are representative of an edge cooled 6U 220mm VPX heatsink and can transport up to 150W of power dissipation on a 2" x 2" square area, centered on the heatsink.
3. Procure and deliver sample OHP's and corresponding data to Northrop Grumman

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