Pandora Payload Near Infrared Detector Thermal Testing

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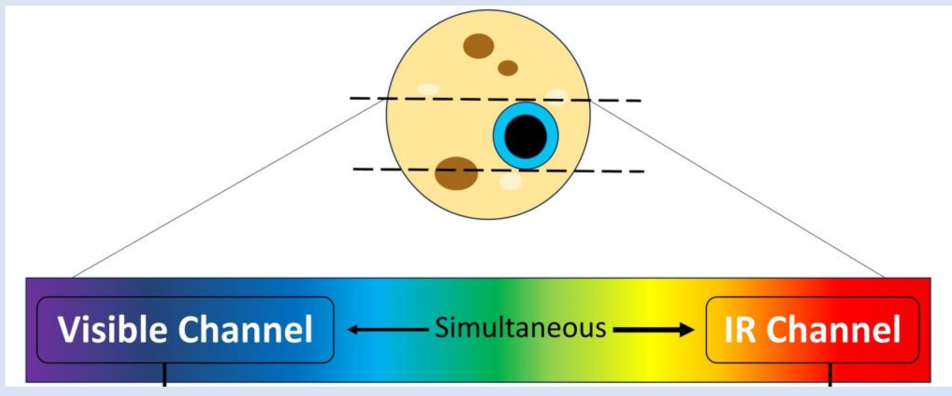
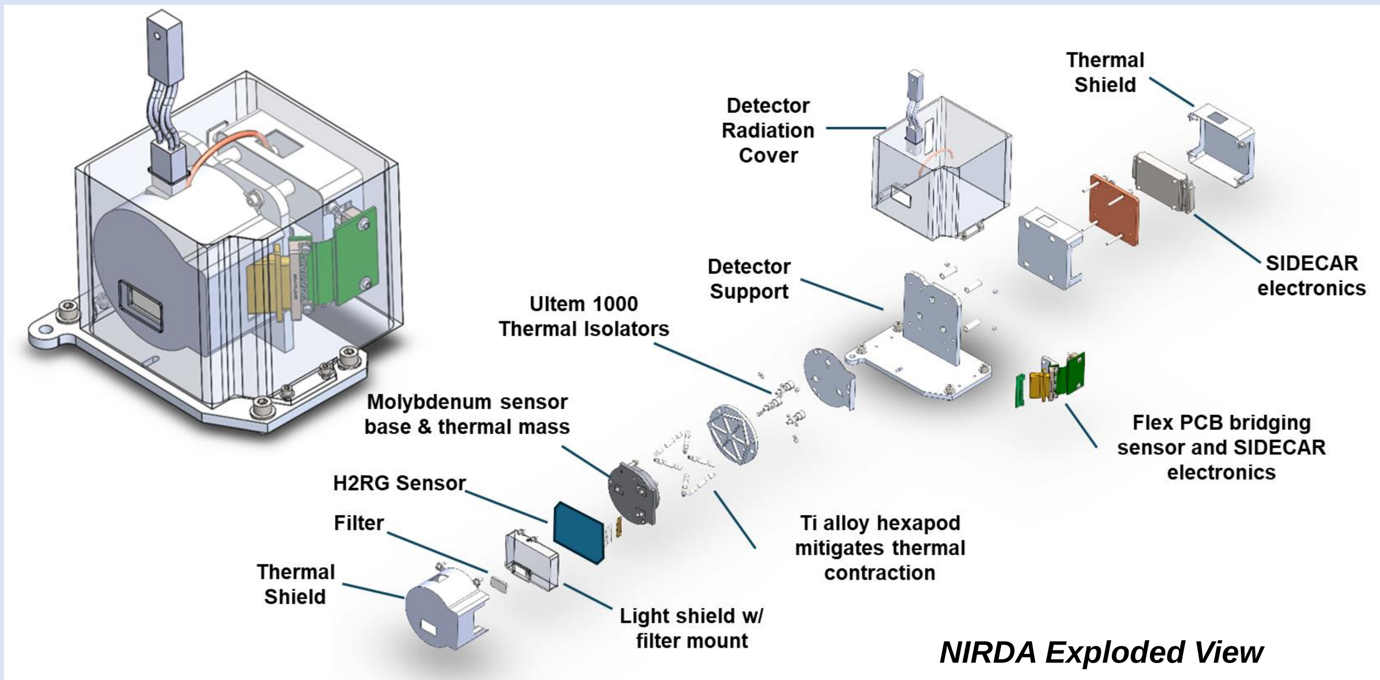
Overview

The Pandora mission introduces the Near-Infrared Detector Assembly (NIRDA) as an advancement in small satellite space-based infrared spectroscopy. This presentation emphasizes thermal stability, compact form factor, and ruggedized design. Developed by Lawrence Livermore National Laboratory (LLNL), with support from NASA Ames Research Center (ARC) and NASA Goddard Space Flight Center (GSFC), the NIRDA is designed as one of two detector assemblies on the Pandora mission. Pandora is a Pioneers class astrophysics mission that seeks to characterize exoplanets and the activity of their host stars. The following presents the testing results of the NIRDA engineering unit (EU) and a comparison with our finite element models. Key performance metrics are absolute temperature of the detector, sustained gradients at boundary conditions, and temperature stability.

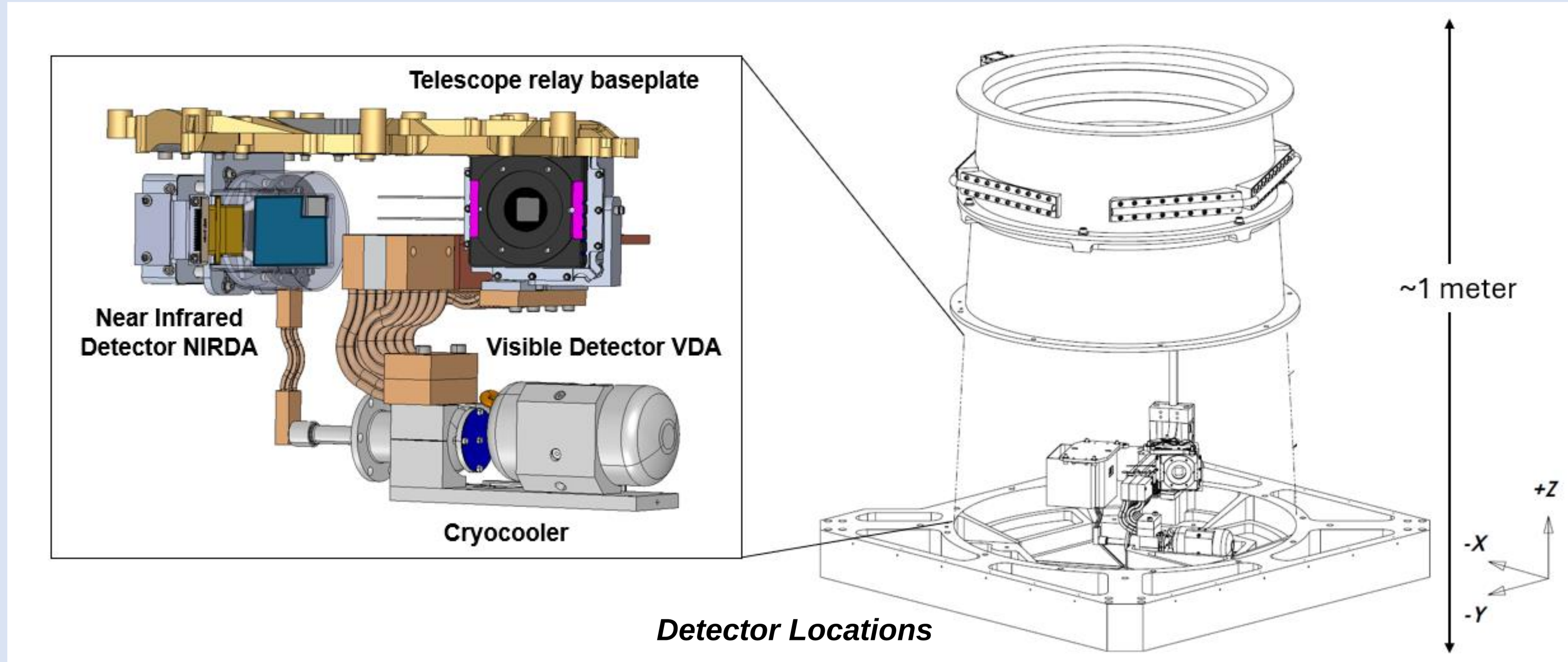


NIRDA Design

The near infrared detector is built around a Teledyne H2RG and provides structural and thermal isolation to prevent noise from jitter, strains on the focal plane array, and thermal instability. A heat strap to the mechanical cryocooler cold finger provides the necessary cooling. Multiple radiation shields and thermal isolators minimize parasitic heat loss. The detectors are positioned below the telescope to minimize distance to the relay optics.

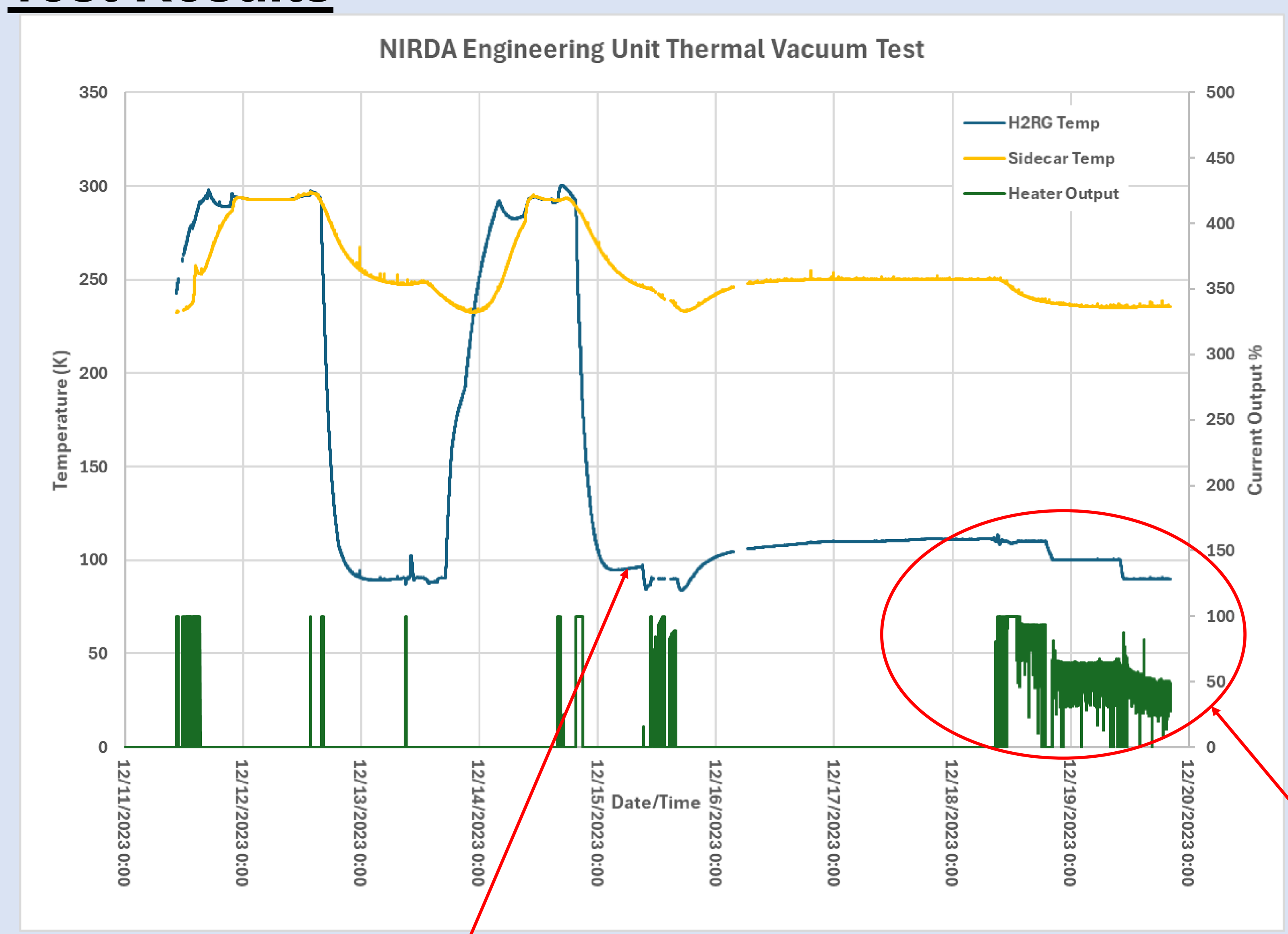


NIRDA Exploded View

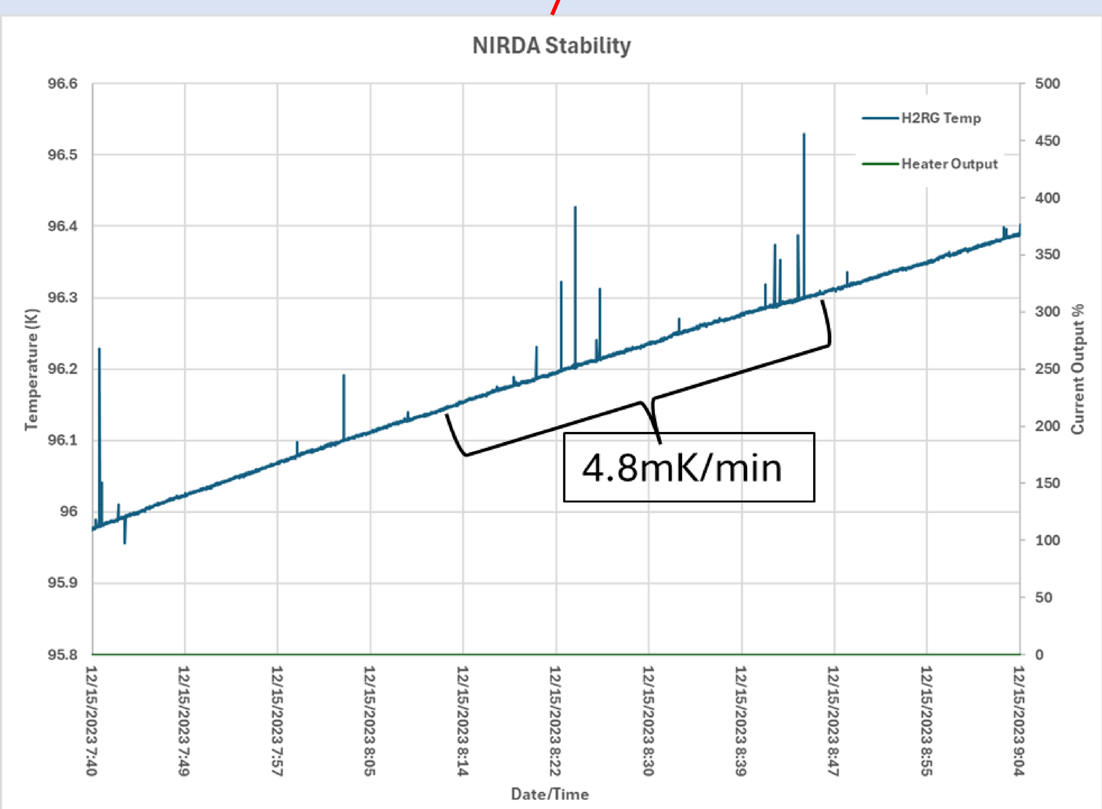


Detector Locations

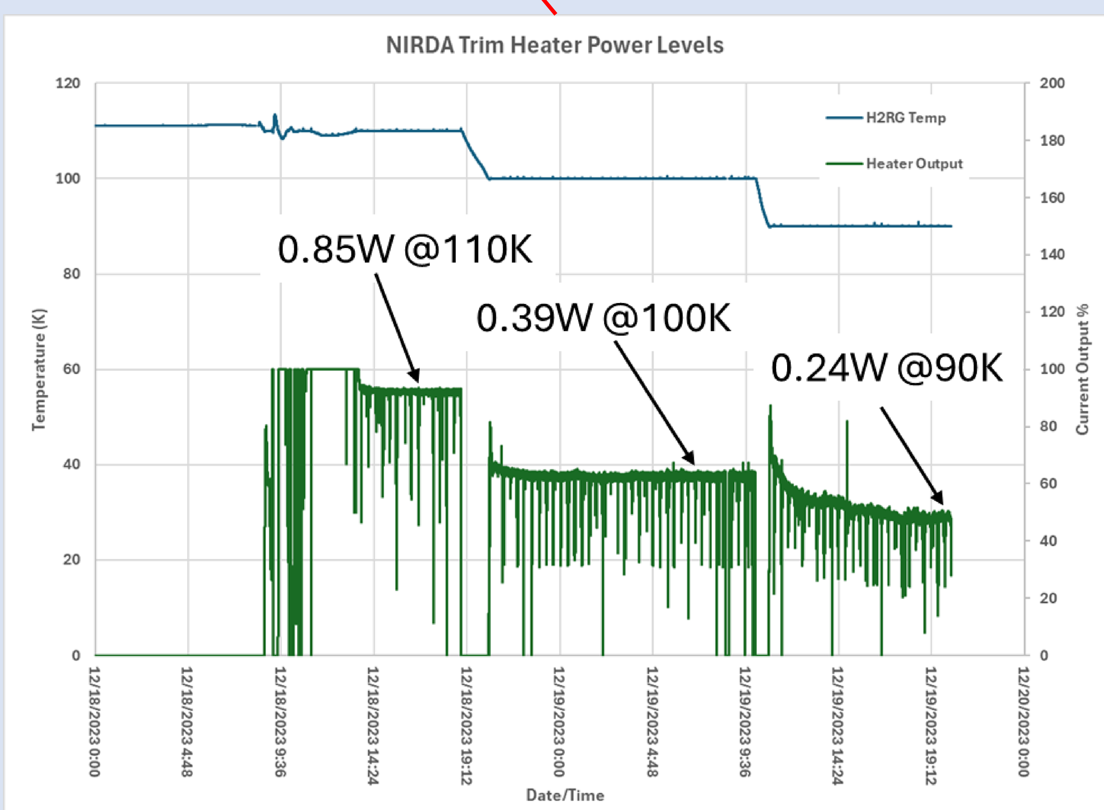
Test Results



- The NIRDA exceeded the design requirement of 110K and was cooled down to 85K
- The sensor was characterized at 110K, 100K, and 90K
- The SIDECAR heat strap was not connected and left uncooled to demonstrate SIDECAR performance at warmer temperatures
- Cool down and warmup of the detector was carefully monitored to slowly transition at <3°C/min for minimal thermal stress on the focal plane.

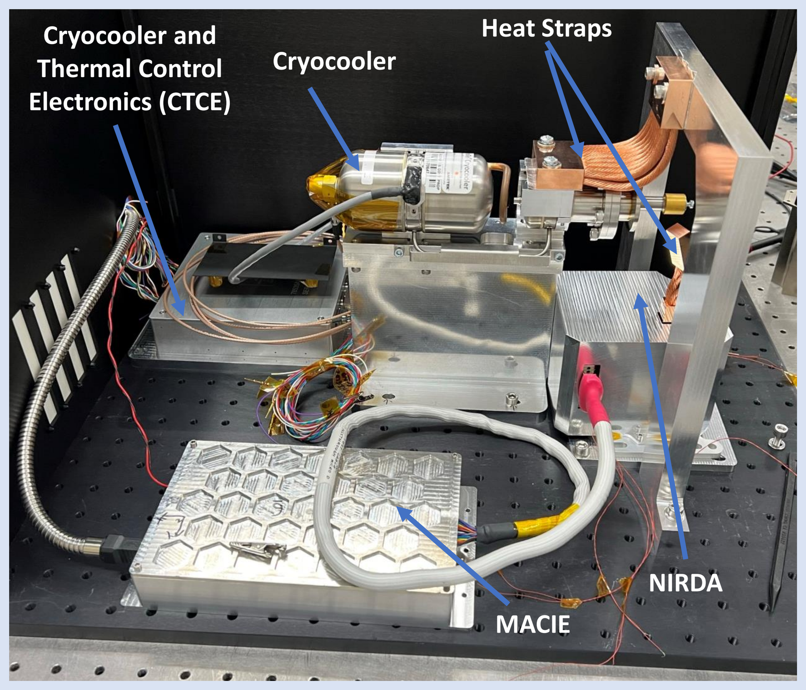


The cryocooler controller was set to manual open loop mode and the trim heater was disabled off to characterize thermal stability. The average drift during this assessment was 4.8 mK/min. Spikes in the data are noise from the silicon diode telemetry line.

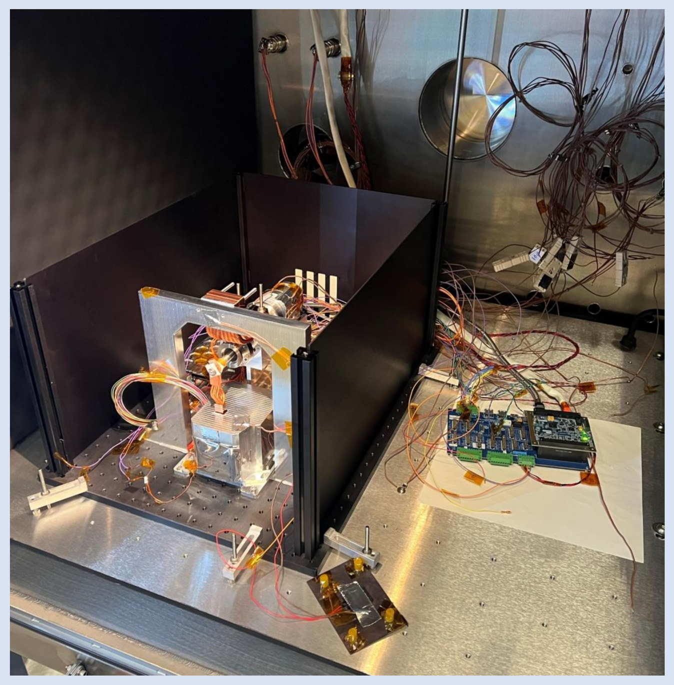


The cryocooler was operated in a backed off condition with a trim heater to maintain steady temperatures for detector characterization. The trim heater power at each temperature demonstrates the excess cryocooler lift available at each level.

Test Configuration



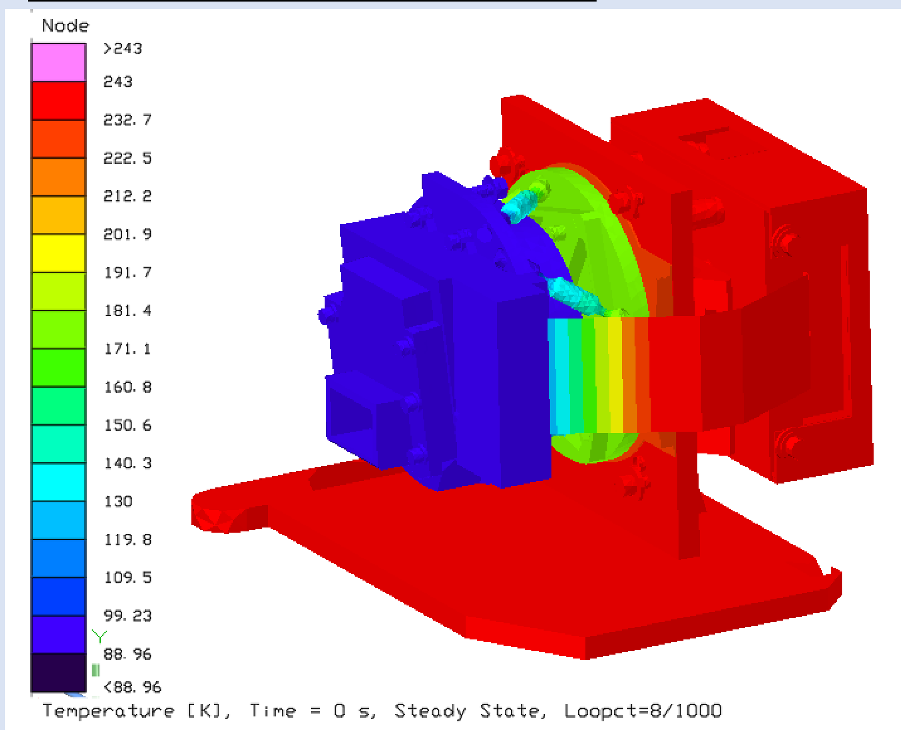
NIRDA Test Assembly Configuration



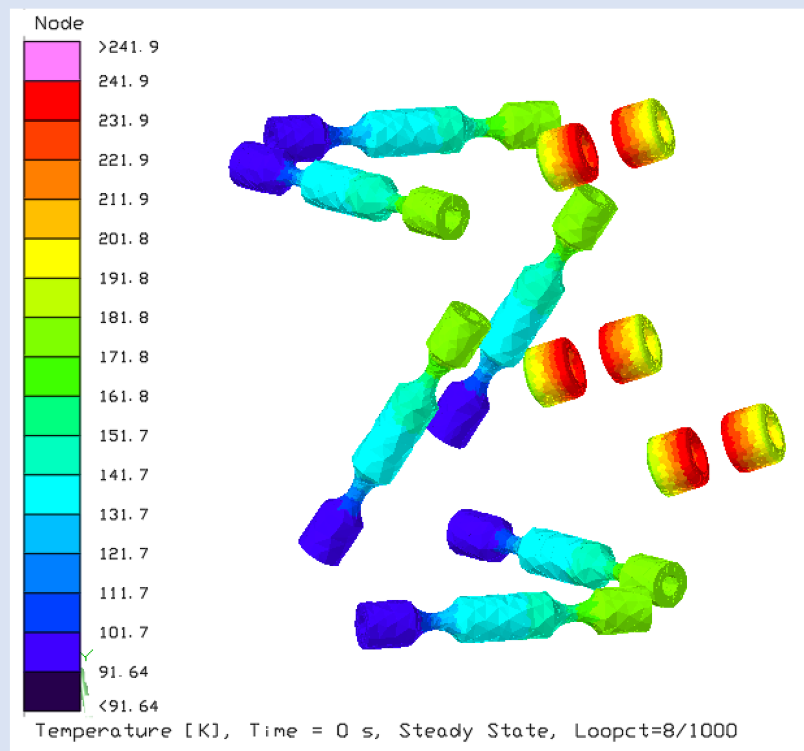
NIRDA Test Assembly in Chamber

The NIRDA was tested in the LLNL 40" thermal vacuum chamber over several weeks. Thermocouple data was recorded on a Keysight 34980A DAQ while RTD and silicon diode data was recorded on a Lakeshore Model 336 cryogenic temperature controller which also powered the NIRDA test trim heater in a PID control loop.

Thermal Analysis



NIRDA Thermal Model Results from 90K Case



NIRDA Thermal Model Gradients Across Isolators

The thermal model initially showed significantly less parasitic heat losses than the test data suggests. The emissivity of the radiation shields and conduction through the isolators were increased to correlate with the demonstrated heat leakages. For the 90K thermal case, the model predicts 1.26W of parasitic loss to balance the 0.24W trim heater power and estimated 1.5W of cryocooler lift.

Thank you to all our dedicated partners and our suppliers, especially Trevor Foote for executing this test

Blue Canyon Technologies | The University of Arizona | Corning | NASA Goddard Space Flight Center | Ames Research Center | Lawrence Livermore National Laboratory

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