Design and Testing of Thermal Ground Support Equipment for Calibration of HARP2

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Presented By
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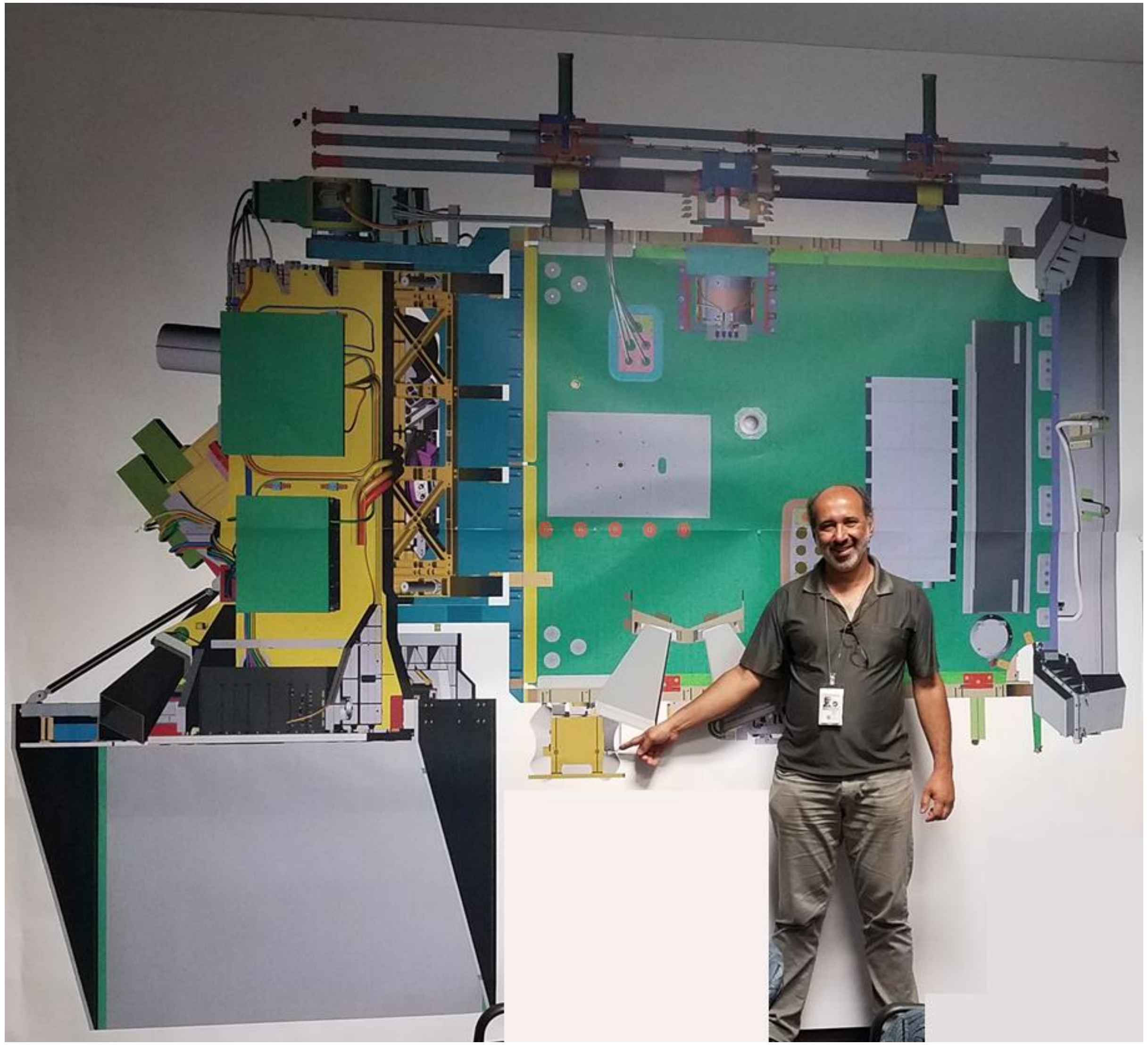
Agenda

- Intro to HARP2
  - Overview
  - Thermal design
- HARP2 Ground Calibration Campaign
  - Requirements
- Ground Cal Thermal GSE Design
- Ground Cal Thermal GSE Performance
- Conclusions and Lessons Learned

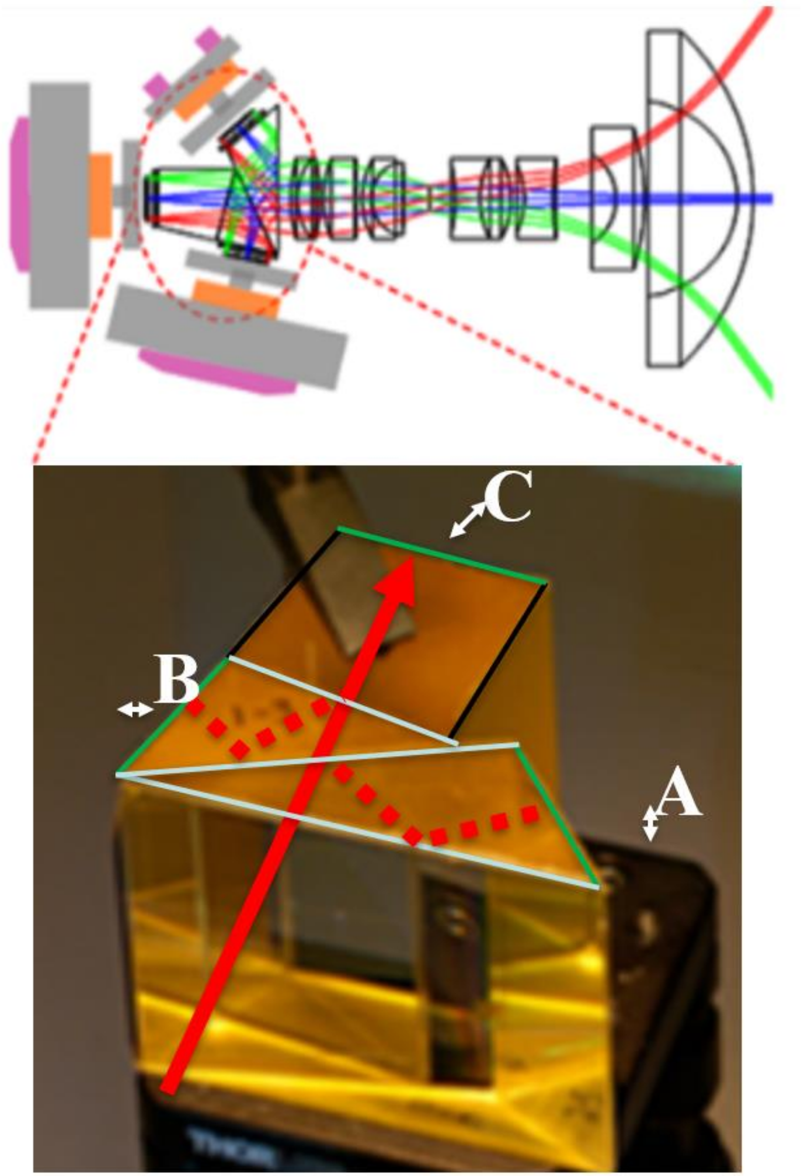
HARP2 Overview

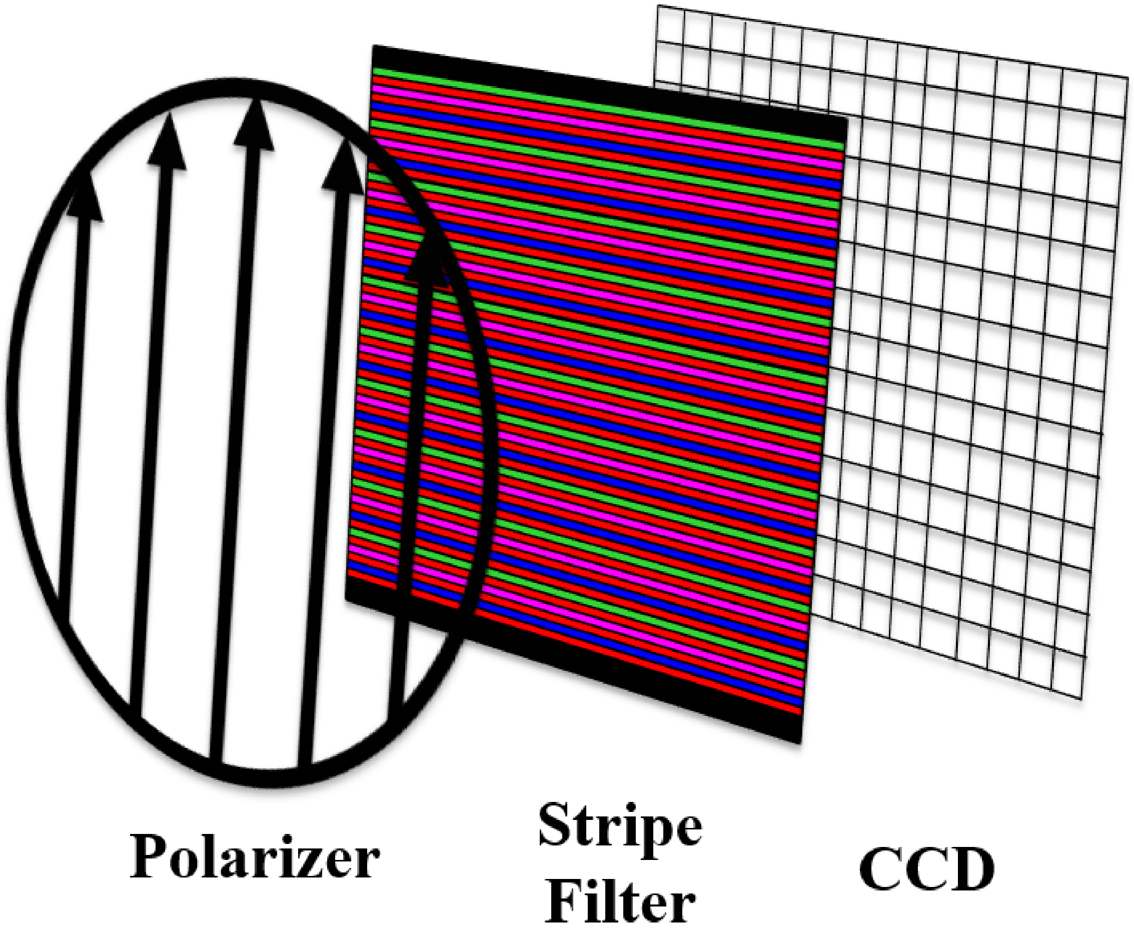
- *Hyper-Angular Rainbow Polarimeter 2* (HARP2) is a wide-field of view imaging polarimeter contributed to NASA's PACE mission by the University of Maryland, Baltimore County (UMBC)

HARP2 Overview



HARP2 Overview



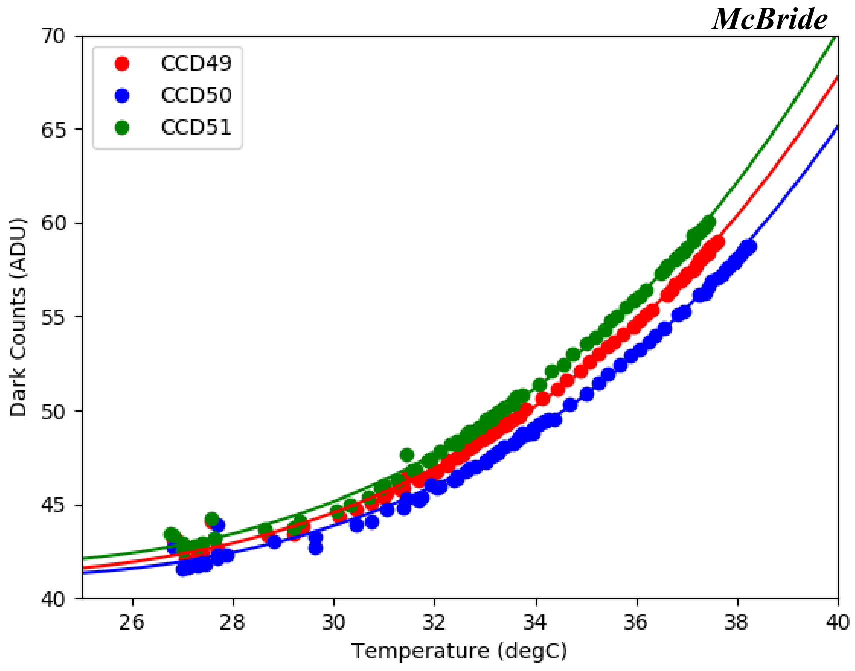


HARP2 Calibration

- HARP2 calibration needed to characterize
  - spectral response from 370nm to 900nm
  - radiometric response
  - polarimetric response
  - response over entire FoV
  - response at flight temperatures

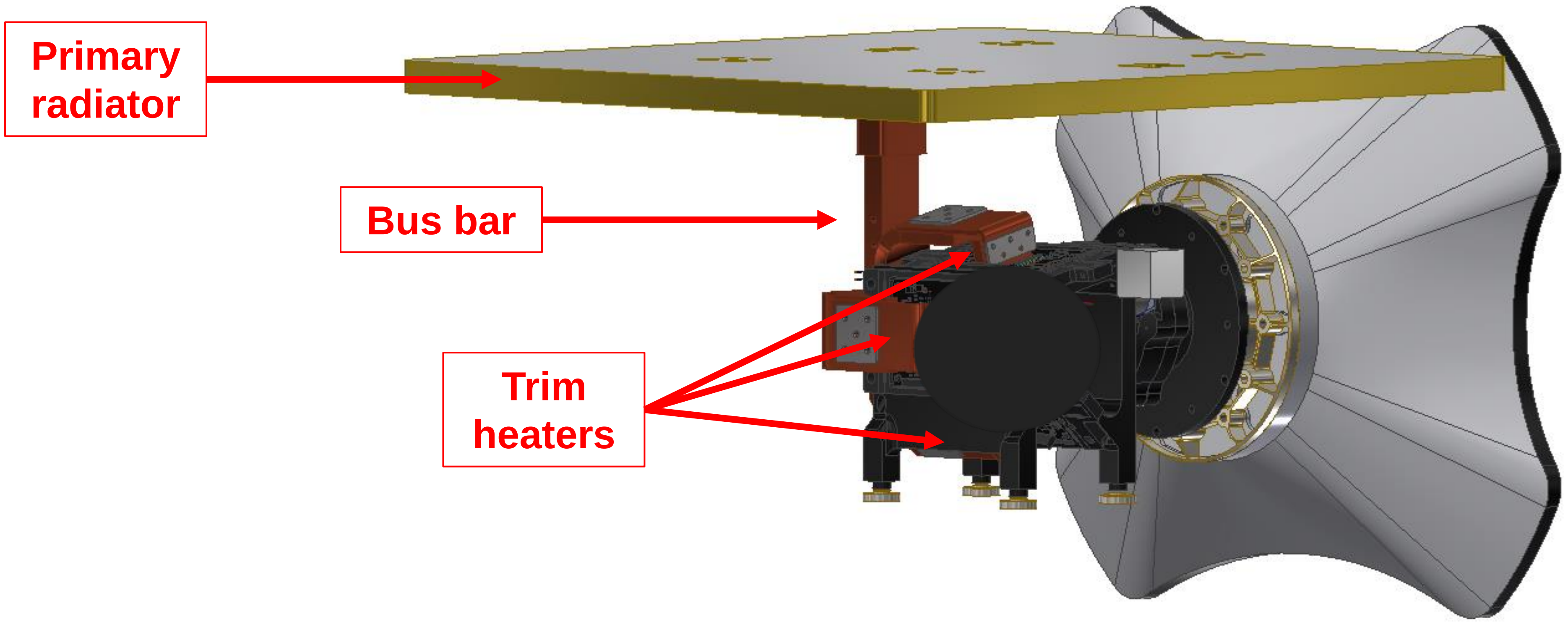
HARP2 Thermal Design

- Dark current is inherent noise in a detector that must be subtracted off
- Dark current is directly proportional to the temperature of the sensor
- To mitigate noise, HARP2 was designed to operate with a nominal on-orbit science CCD temperature of -13C



HARP2 Thermal Design

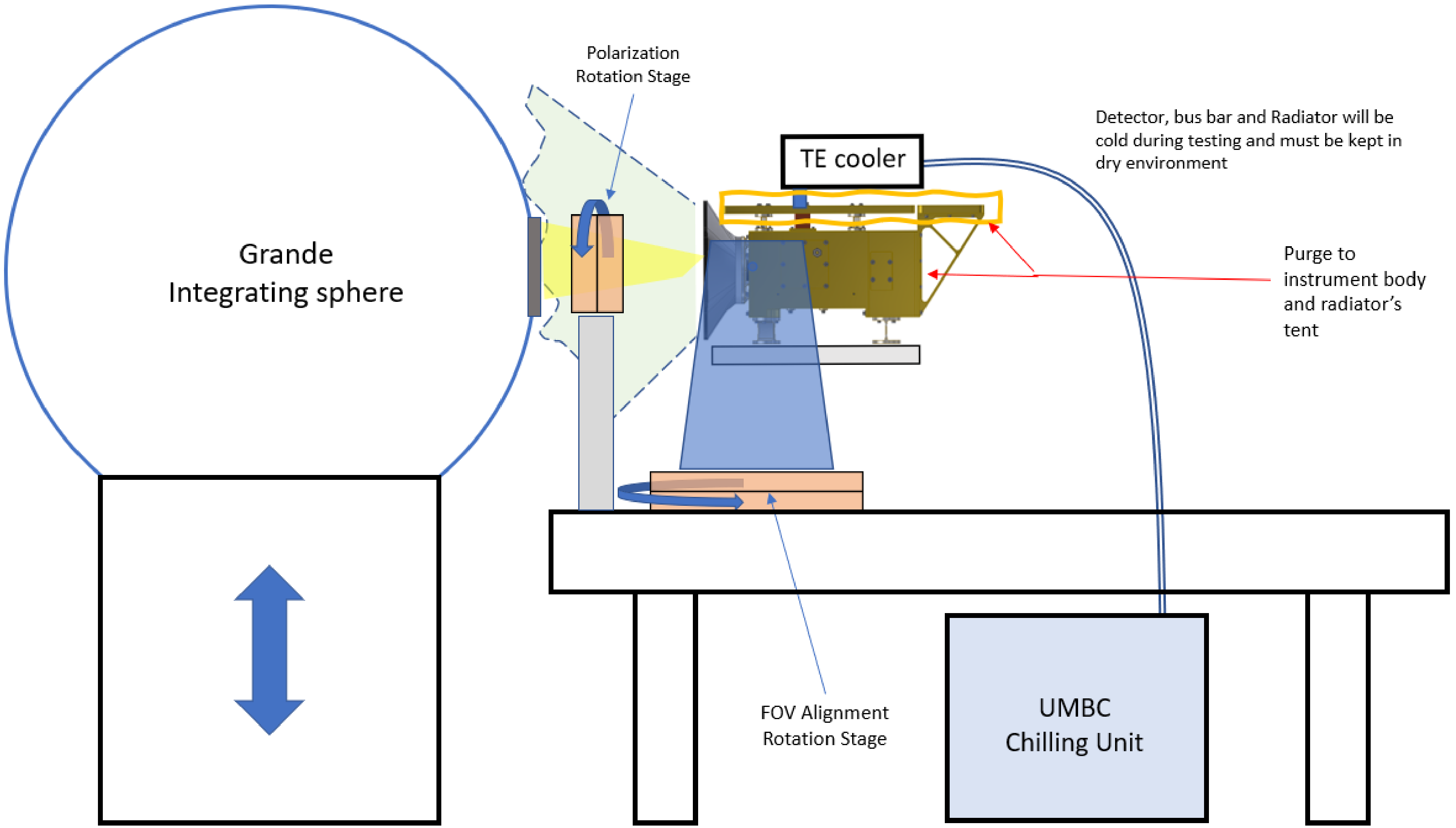
- HARP2's three detectors are cold biased using the primary radiator
- Trim heaters are used to stabilize the detectors within ±0.5C during acquisition



HARP2 Thermal Design

- The passive cooling scheme of HARP2 presented a challenge during ground calibration, which took place in ambient air in GSFC Bldg 33

Calibration GSE Design



Thermal GSE Design Constraints

- GSE needed to meet following requirements:
  - ✓ Actively cool three CCDs to flight temperature of -13C
  - ✓ Prevent vapor in the air from condensing on instrument
  - ✓ Allow for movement of the instrument, which is mounted on a pitch/yaw rotating stage
  - ✓ Allow for installation without disassembly / config change of the instrument

Thermal GSE Design Constraints

- GSE needed to meet following requirements:
  - ✓ Actively cool three CCDs to flight temperature of -13C

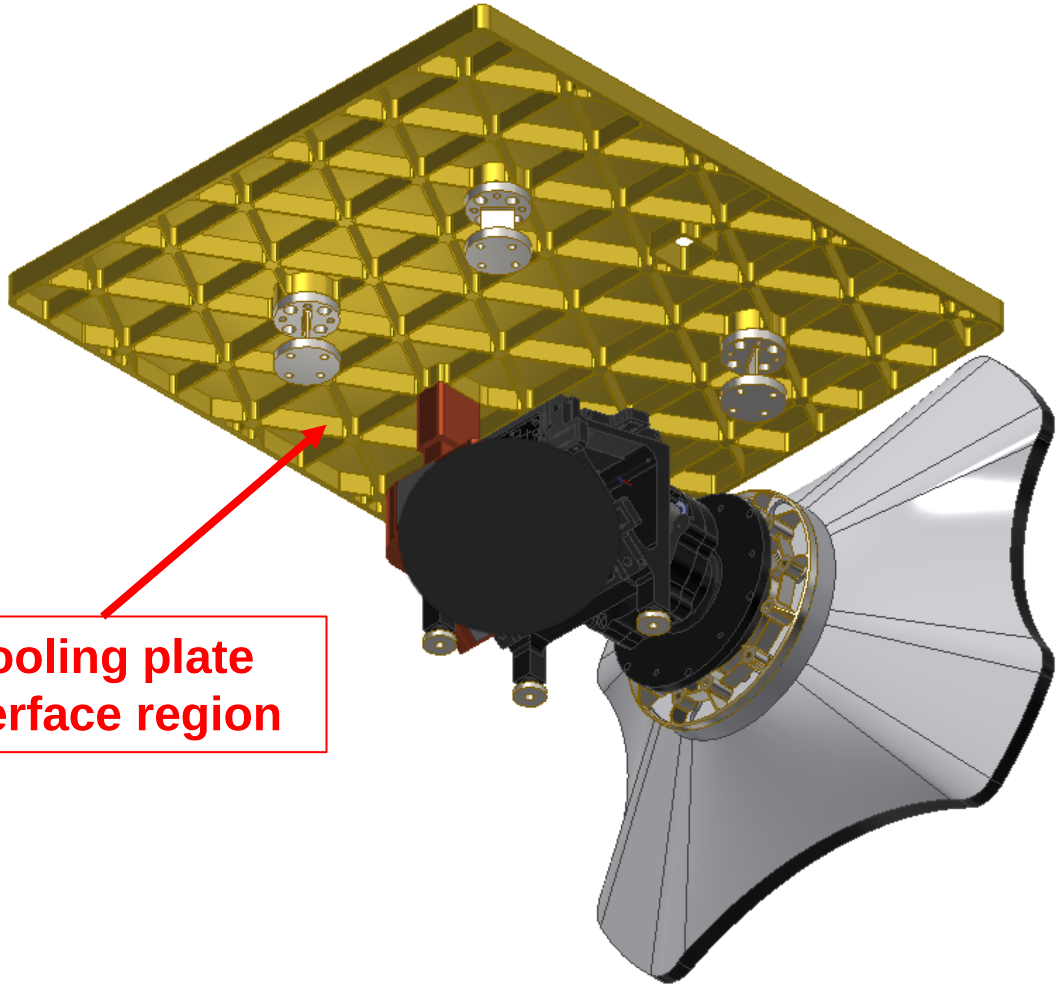
    Solution: Actively cool the radiator at an accessible place using a Peltier-cooled cold plate sunk to a refrigeration loop
  - ✓ Prevent vapor in the air from condensing on instrument

    Solution: bag the radiator with an insulative tent and purge both the instrument and the tent with nitrogen
  - ✓ Allow for movement of the instrument, which is mounted on a pitch/yaw rotating stage

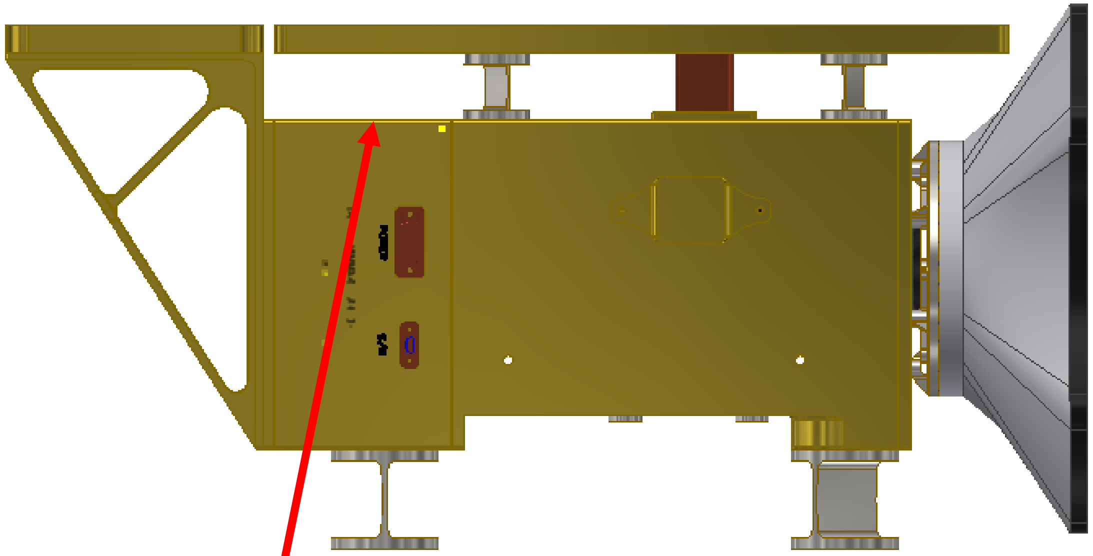
    Solution: connect the refrigeration lines to the cold plate using flexible, insulated tubing
  - ✓ Allow for installation without disassembly / config change of the instrument

    Solution: design radiator interface plate that can slide under the radiator and then be jacked into place

Thermal GSE Design

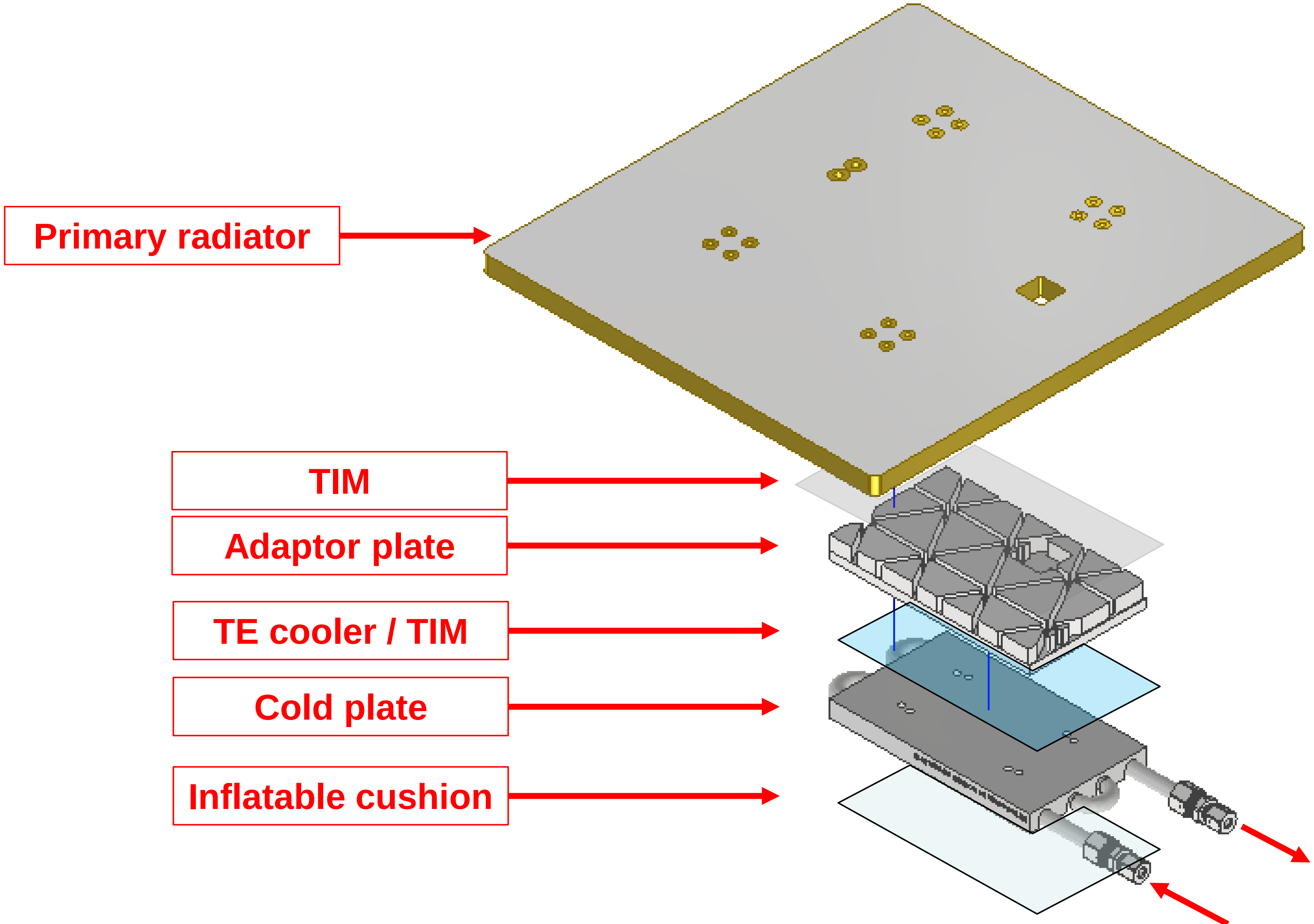


Cooling plate interface region

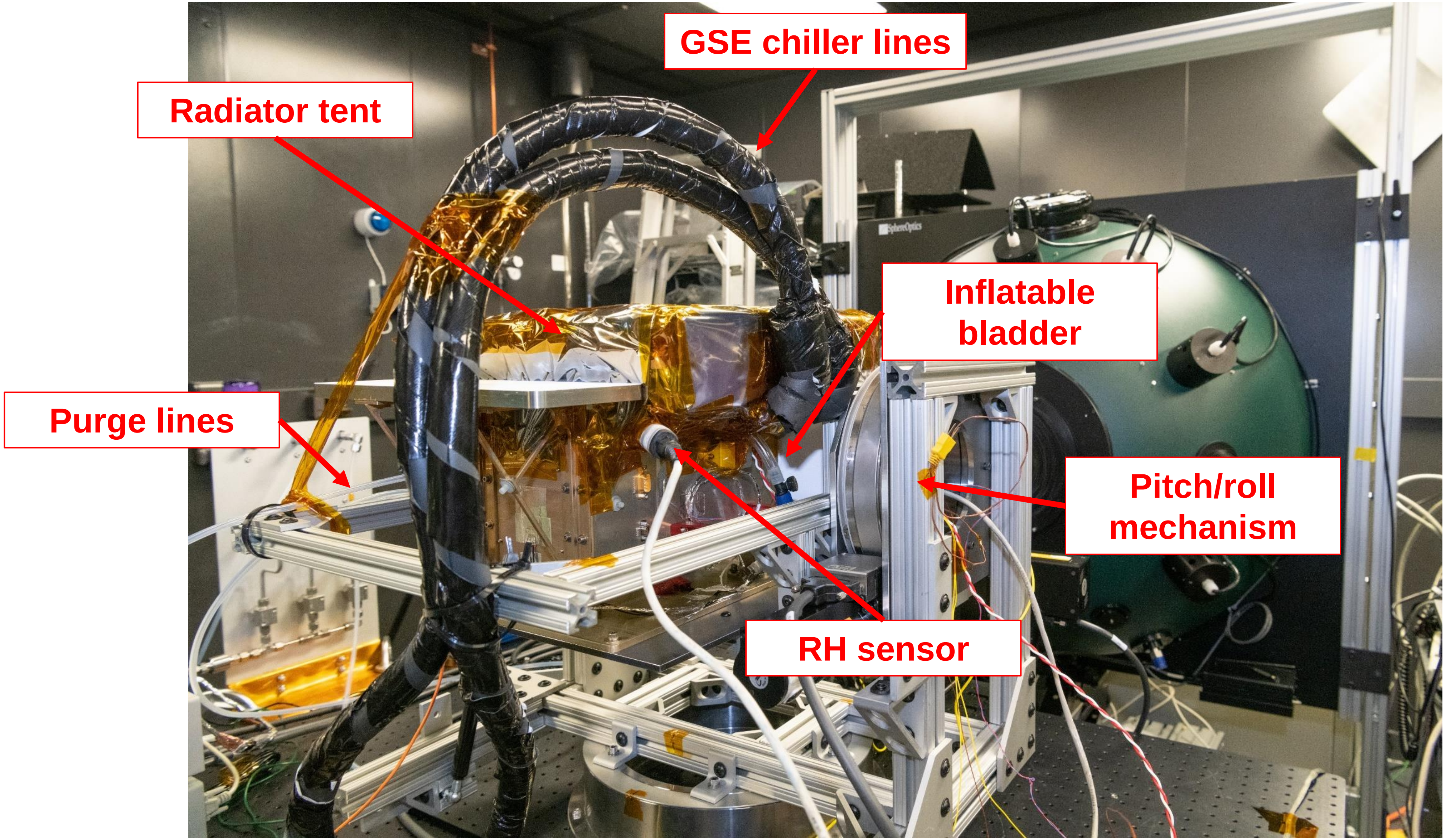


Low-clearance region to integrate cooling GSE

Thermal GSE Design

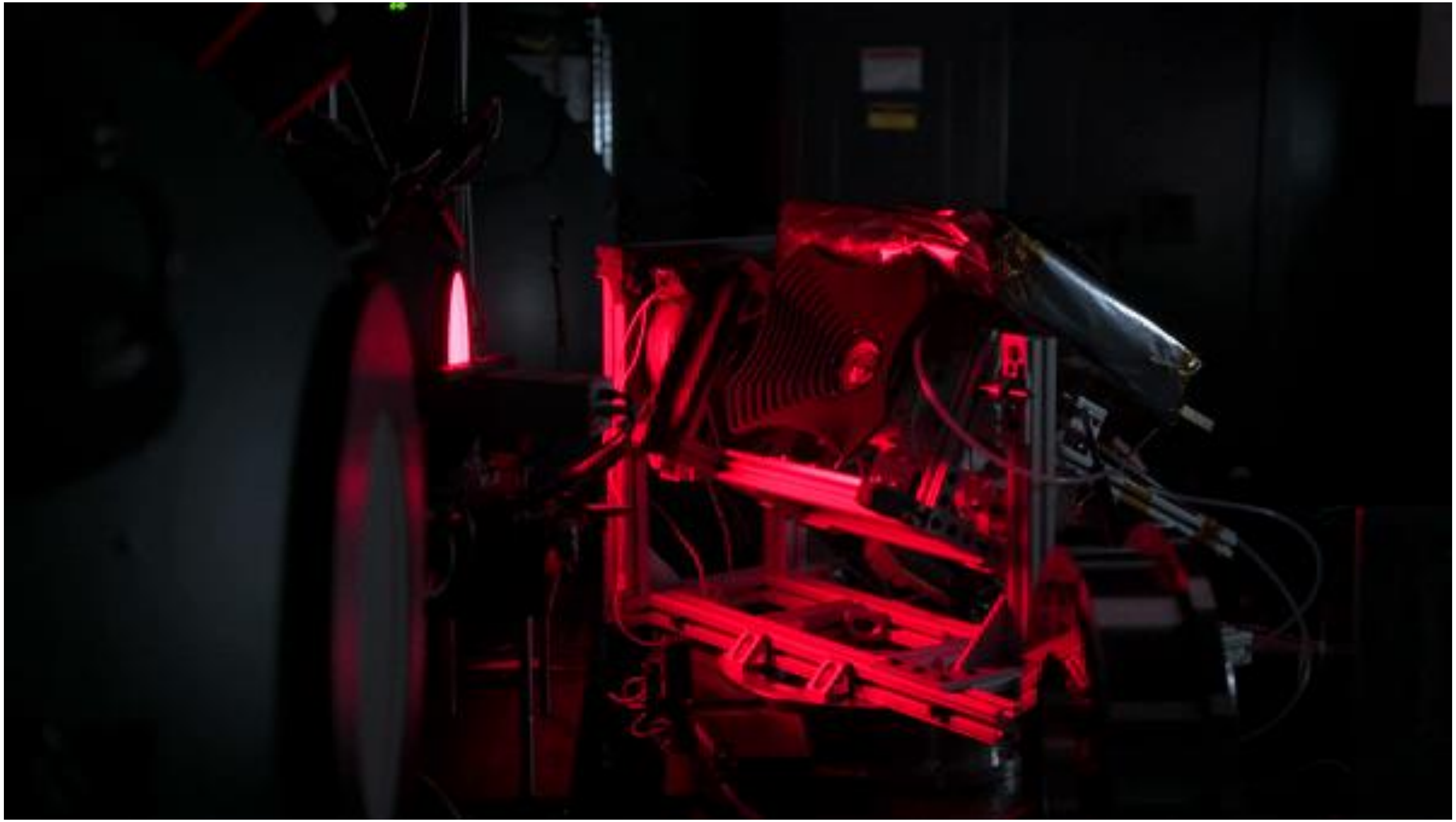


Thermal GSE Design

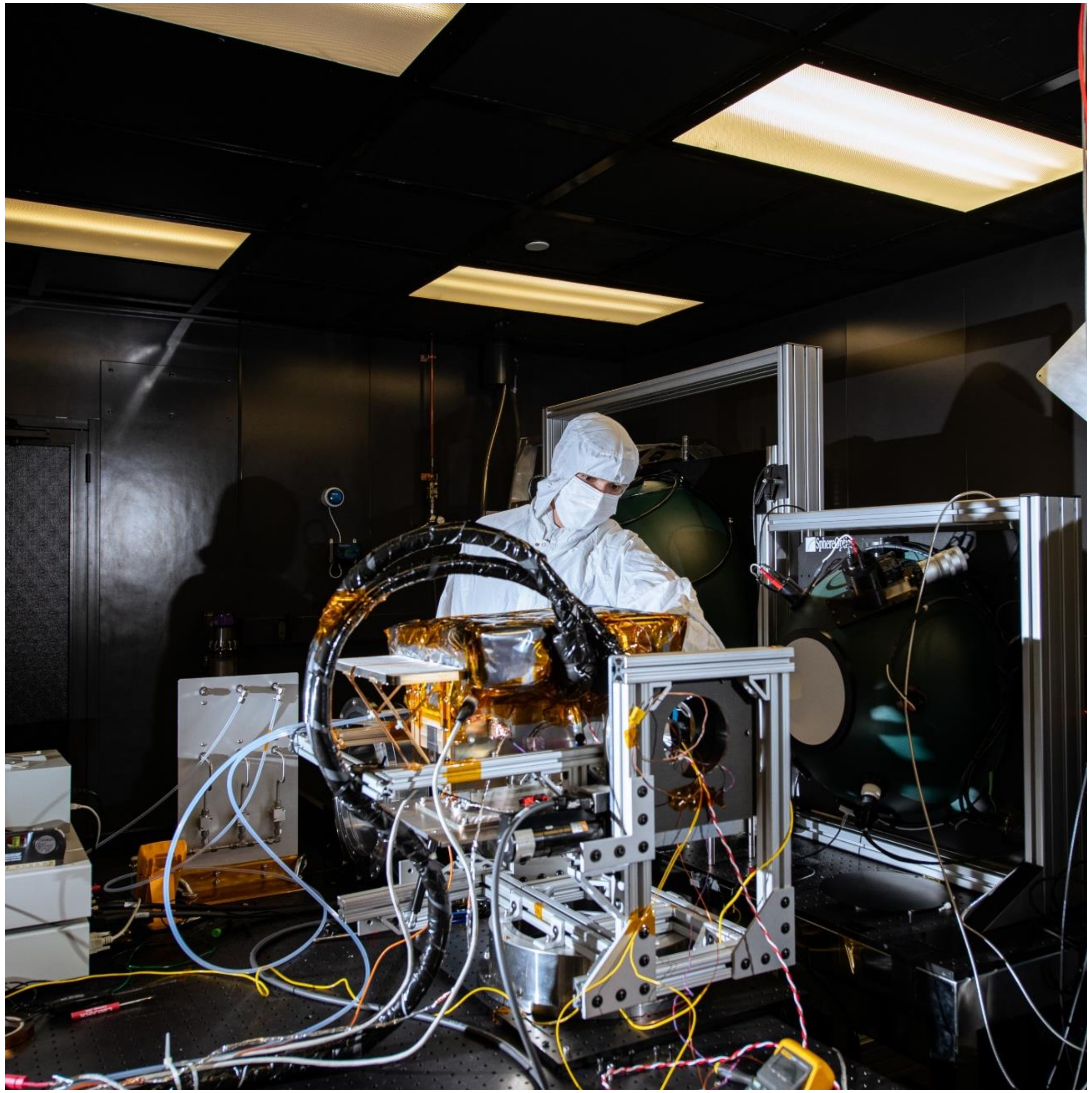


Thermal GSE Performance

Thermal GSE Performance



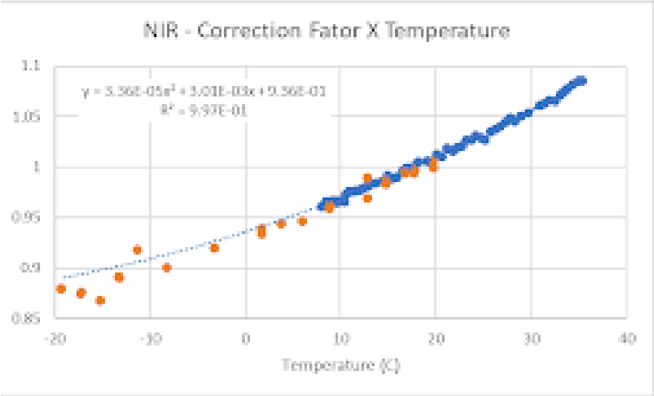
HARP2 Thermal Design

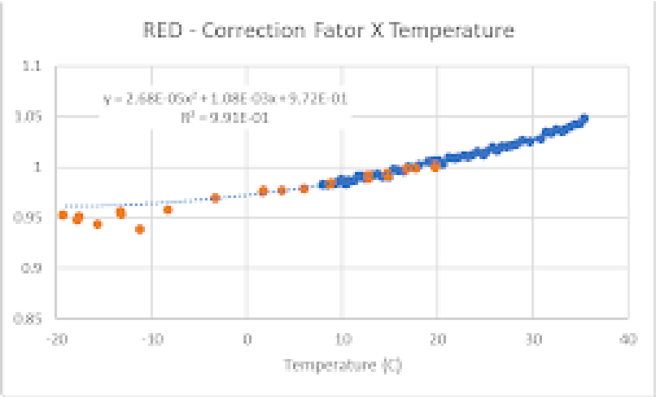


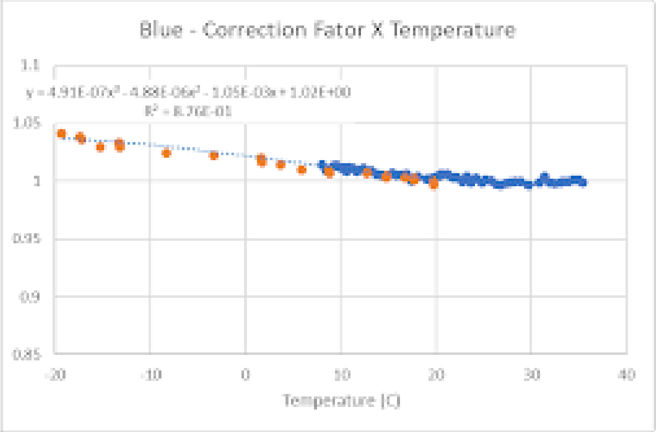
- While the TGSE succeeded in allowing for range of motion, serviceability, and condensation mitigation, it did not meet temperature performance
- The CCDs reached a minimum temperature of 7C

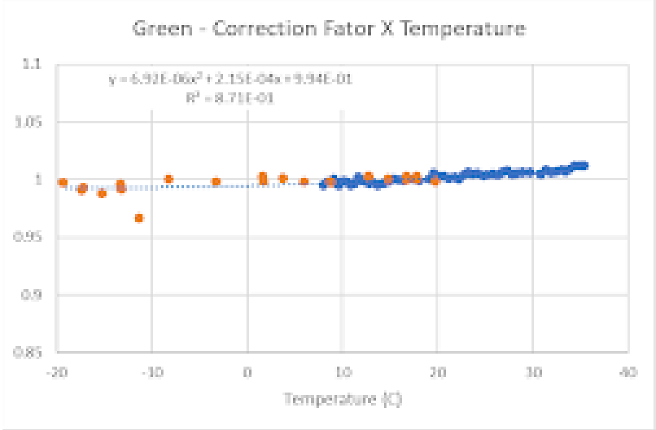
Conclusions

- Unable to calibrate at flight temperature
- Post calibrated during PACE Observatory TVAC
- Temperature dependent behavior obtained during obs TVAC will be applied to the calibration coefficients to produce high-quality on-orbit science









Lessons Learned

- Wherever possible, design passively-cooled instrument calibrations in vacuum environment
- Design flight components with GSE in mind

Thank you

- Questions?