Radiometric Uncertainty Analysis of the CHISI Instrument for a Constellation of LEO Infrared Sounding Satellites

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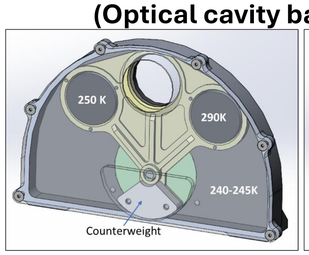
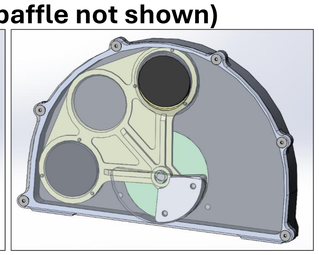
Introduction

- CHISI (Compact Hyperspectral Infrared Sounding Interferometer) is a field-widened hyperspectral imager. When deployed in a constellation of ~24 satellites, it enables generation of atmospheric temperature & moisture profiles with global updates <1 hour.
- Low radiometric uncertainty (RU) allows measurements from the constellation to be treated as if coming from a single instrument.
- Specification: RU <0.15% of 287 K blackbody radiance; places RU below the instrument noise floor.
- 2-point calibration via hot & cold Internal Calibration Target (ICT).
- ICT prototyped and RU modeled to determine feasibility.

Dual-Temperature Calibration Target
(Optical cavity baffle not shown)

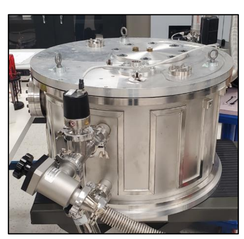


Clear Aperture Position



Calibration Position

Prototype Assembly

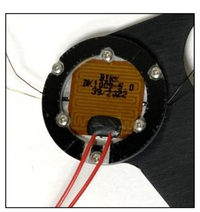


Thermal Vacuum Testing

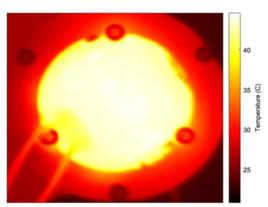
High-ε Carbon Nanotube Coating

Coated Puck

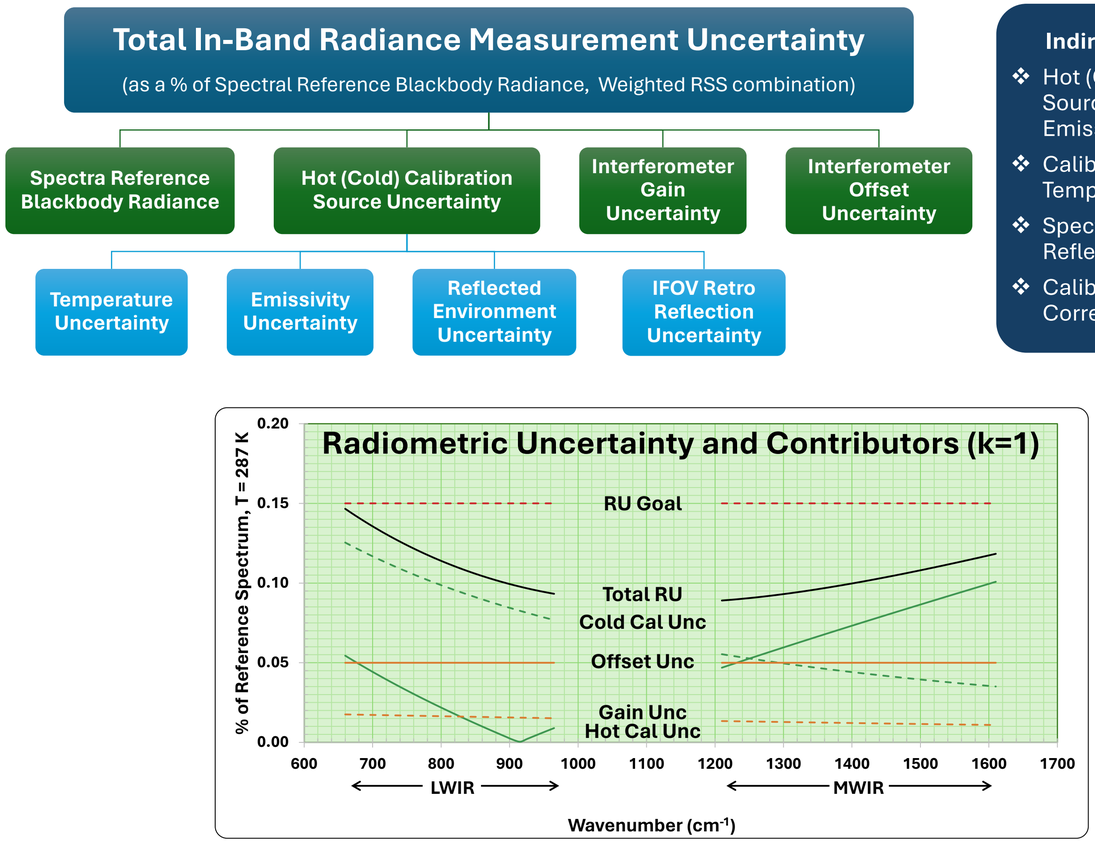
Puck Back Face



Resistive Heater



Thermal Image



Conclusions

- Dual calibration target eliminates need for deep space views.
- Carbon nanotube coated flat pucks, thermally stable baffle, housing, and ICT reflection models enable desired radiometric knowledge.
- Analytical model shows that calibration specification can be achieved.
- System-level design considerations:
  - Thermal management of cold blackbody housing and baffle.
  - Minimization of puck thermal gradients.

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