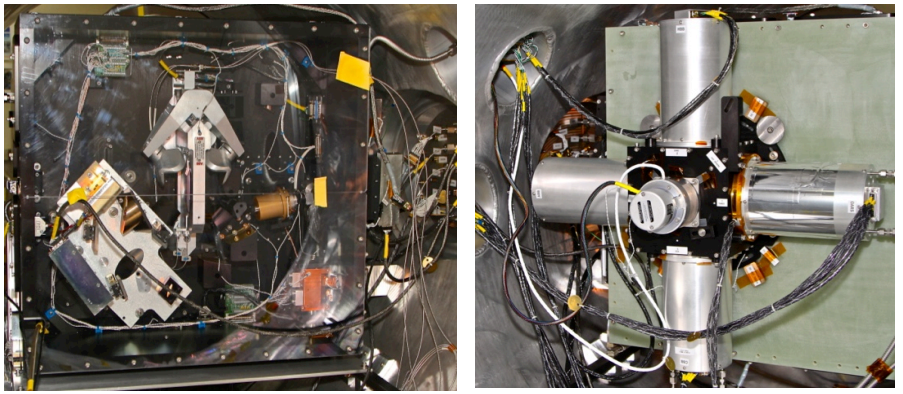
A New Class of Advanced Accuracy Satellite Instrumentation (AASI) for the CLARREO Mission

PI: Hank Revercomb, University of Wisconsin, SSEC

Objective

- Develop and demonstrate key technologies necessary to measure IR spectrally resolved radiances with ultra-high accuracy brightness temperature (<0.1 K, 3 sigma at scene temperature) for crucial climate benchmark missions. Technologies include:
  - On-orbit Absolute Radiance Standard (OARS) including Miniature Phase Change Cells (MPCC)
  - On-orbit Cavity Emissivity Module (OCEM) using quantum cascade laser (QCL) and heated halo (HH) reflection
  - On-orbit Spectral Response Module (OSRM) using QCL
  - Absolute Radiance Interferometer (ARI), giving spectral coverage from 200-2600 cm^{-1} (3.9-50μm) using 2 output ports



Absolute Radiance Interferometer (ARI) and On-Orbit Verification and Test System (OVTS) Prototype integrated into Vacuum Chamber

Accomplishments

- Developed Miniature Phase Change Cells (MPCC) and demonstrated:
  - full simulated on-orbit lifecycle performance after exposure to deep temperature cycling, elevated temperature soaks, and vibration
  - 5 mK absolute calibration performance using melts of Ga, H_2O, Hg, and Ga-Sn, to provide temperature calibration from -40 to +40°C
  - 5 mK absolute calibration performance after integration into a blackbody cavity with multiple thermistor sensors
  - Developed the broadband OCEM-HH with <0.0006 measurement uncertainty
  - Developed the (OARS with integrated MPCC and OCEM-HH technologies and demonstrated brightness temperature uncertainty of <45 mK for both laboratory and on-orbit applications
- Developed packaging for and characterized performance of a QCL in vacuum for use in measuring blackbody emissivity (OCEM-QCL), and for measuring instrument spectral response on-orbit (OSRM)
- Demonstrated monochromatic emissivity measurement uncertainty of <0.0002 with the (OCEM-QCL)
- Demonstrated instrument line-shape measurement capability of the OSRM by comparison with CO_2 laser results
- Developed the prototype Absolute Radiance Interferometer laboratory instrument integrated with the OARS, and demonstrated critical
- radiometric performance in the laboratory with scene temperatures from -40 to +40 °C consistent with better than 0.1 K measurement accuracy on-orbit. Tests were conducted using expected instrument orbital temperature variations
- Performed thermal/vacuum chamber optical and validation system testing. (1.2 X 10^{-6}Torr)

Co-Is/Partners: Fred Best, John Perepezko, Univ. of Wisconsin; John Dykema, Harvard Univ.

TRL_{in} = 3 **TRL_{out} = 6**