CLARREO IR Calibration Demonstration System (CDS) Status Update

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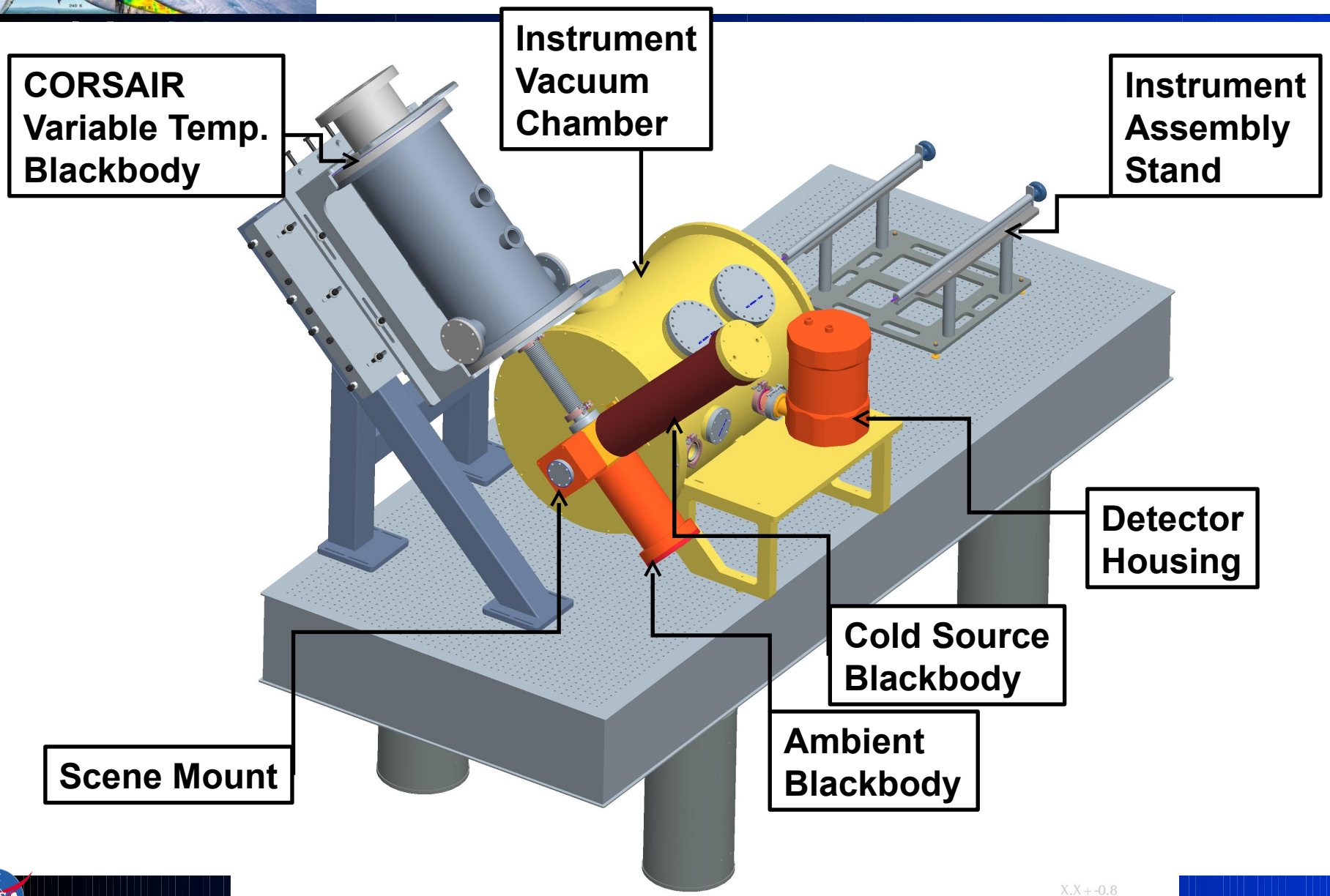
CDS Goal and Requirements

- Goal:
  - Learn how to measure brightness temperature to 0.1 K (k=3) for scene temperatures of 200-320 K from 200 to 2000 cm^{-1} .
- General Design Requirements:
  - Design spectrometer and calibration sources with sufficient diagnostic sensors and operational flexibility to diagnose sources of bias.
  - Include observations of a variable temperature blackbody source to quantify measurement bias over a range of scene temperatures.
- In addition:
  - Use flexible system architecture to enable easy addition of improvements that result from lessons learned.

Key CDS design features

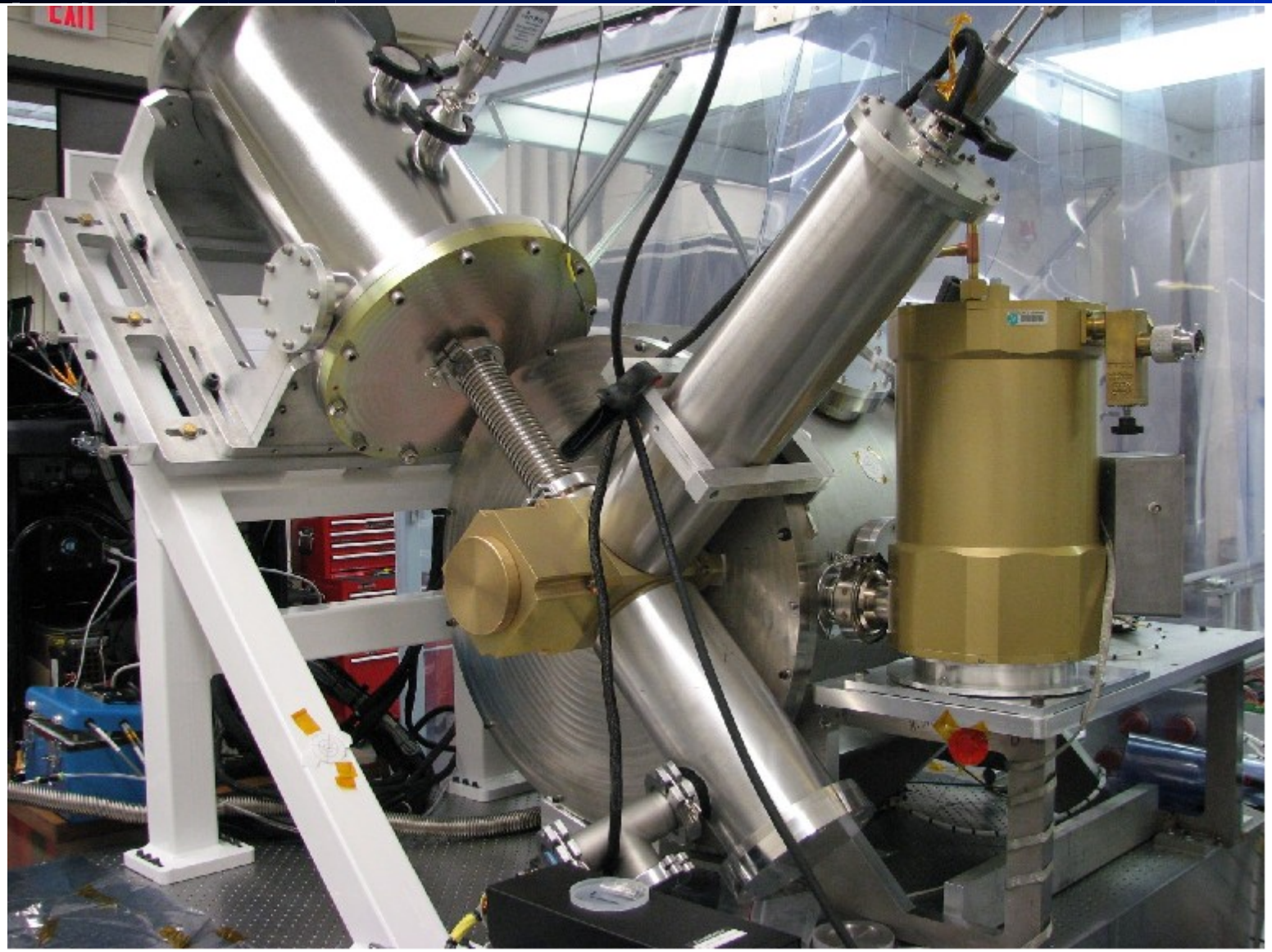
- 4-port Fourier transform spectrometer (FTS; 2 inputs, 2 outputs).
- Input pupil at calibration blackbody aperture, intermediate pupil at FTS cube corner, exit pupil at FTS output.
- FTS operated in vacuum housing for thermal and acoustic isolation, elimination of atmospheric absorption, and protection of hygroscopic CsI beamsplitter.
- Use fold mirror and stepper motor to switch between ambient and LN_2-cooled blackbody calibration sources and test source.
- No windows on FTS input.

Instrument Overview

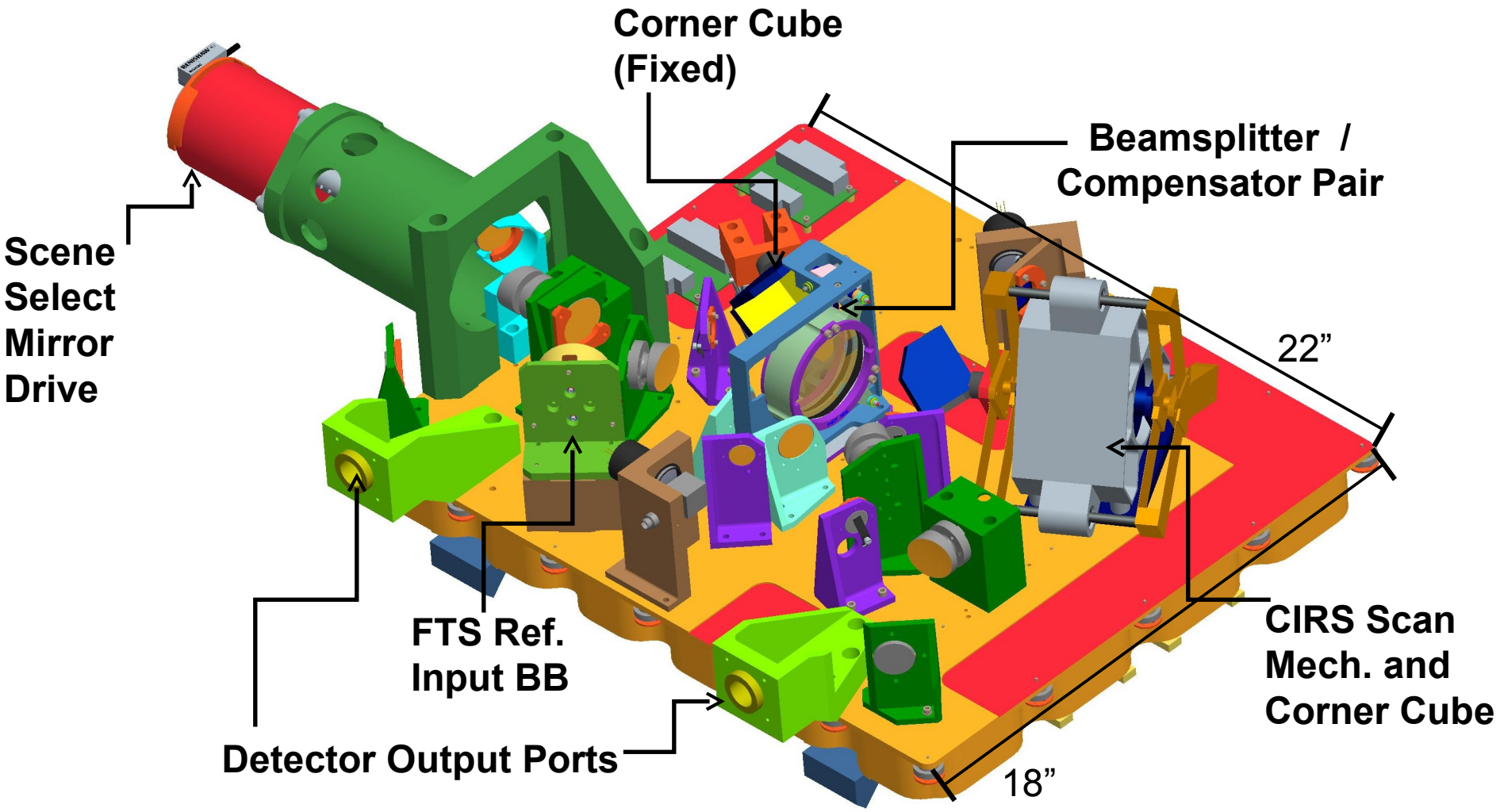


X.X+-0.8

View from Blackbodies



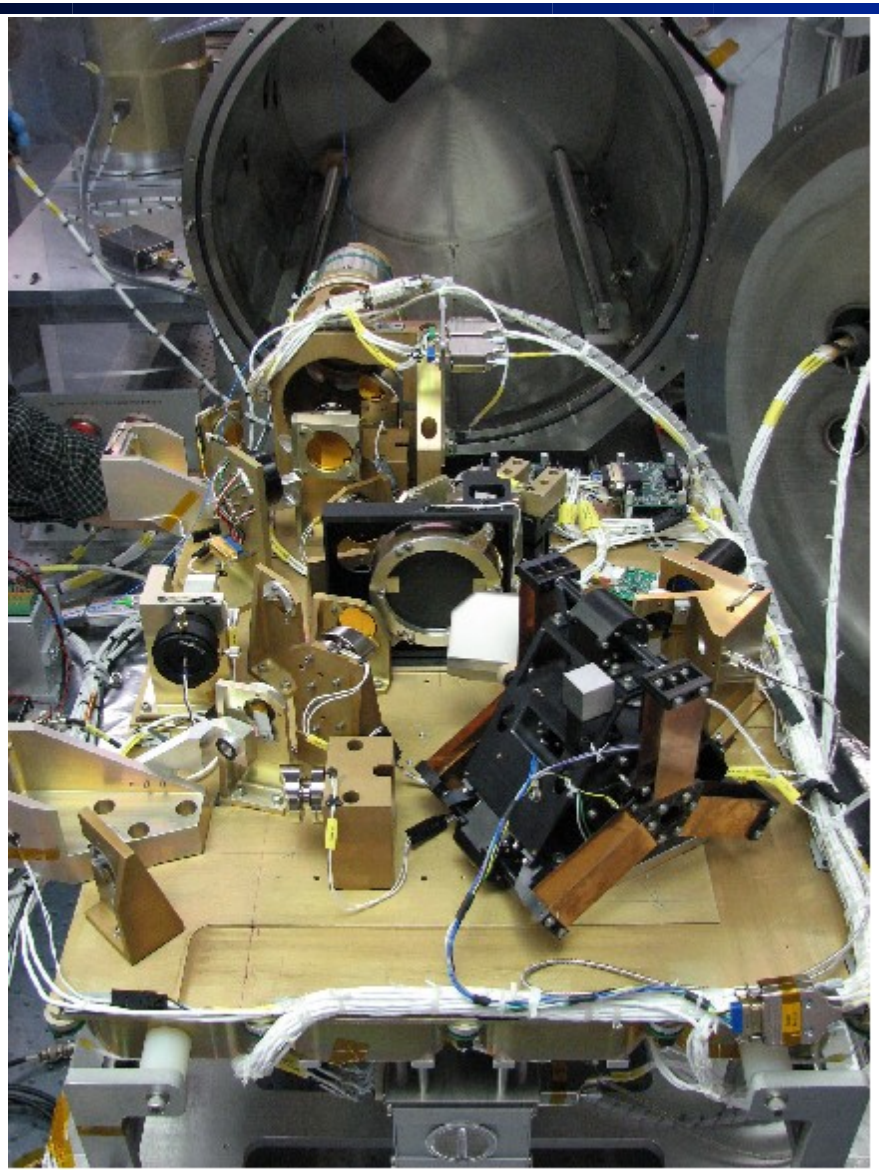
Optical Bench



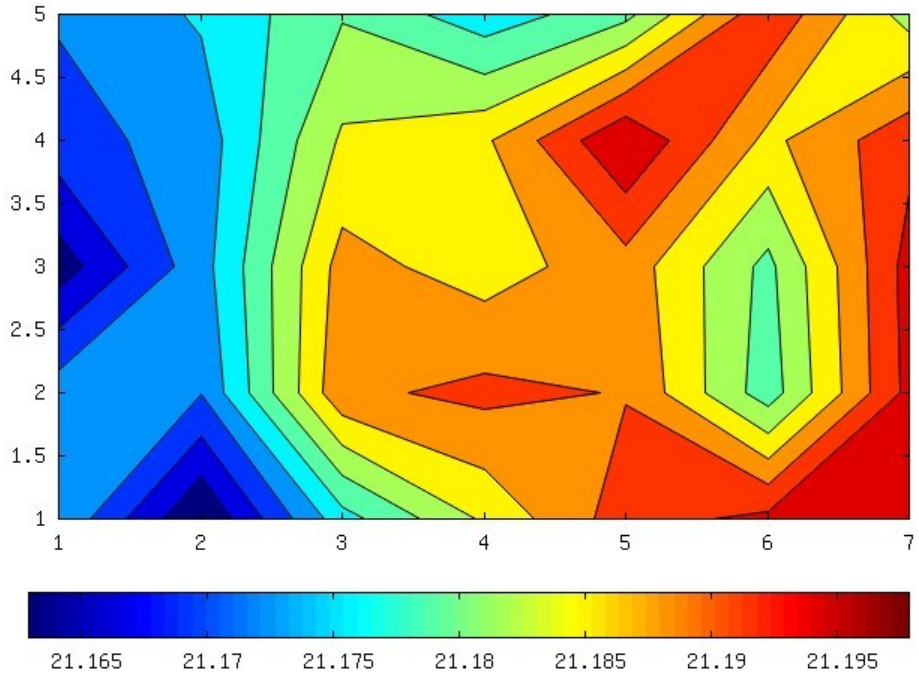
Completed Optical Bench:

View Rotated From Previous Slide

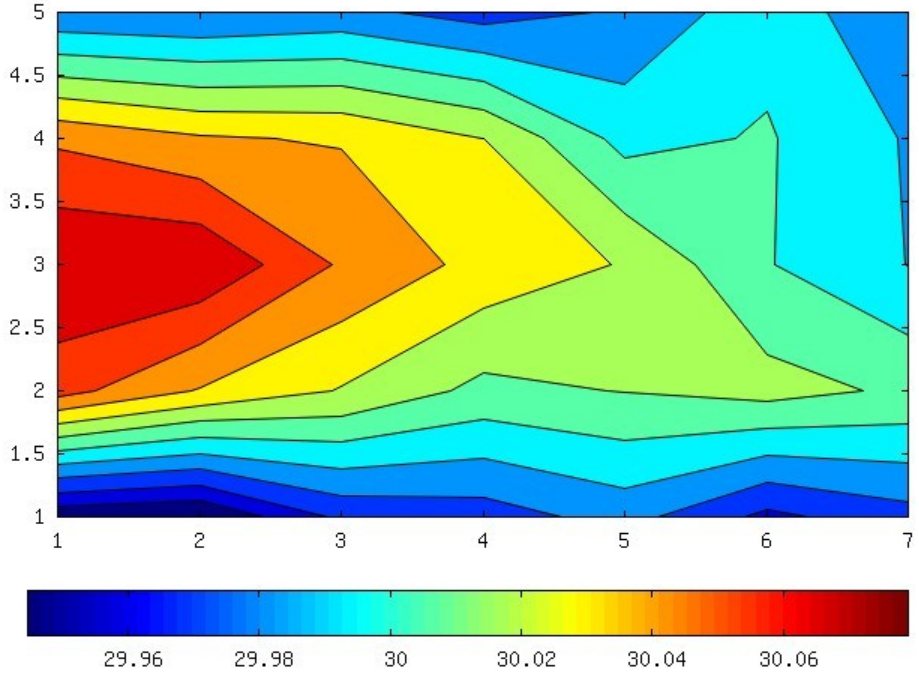
View from Chamber Door



Temperature Control: Spatial Gradients

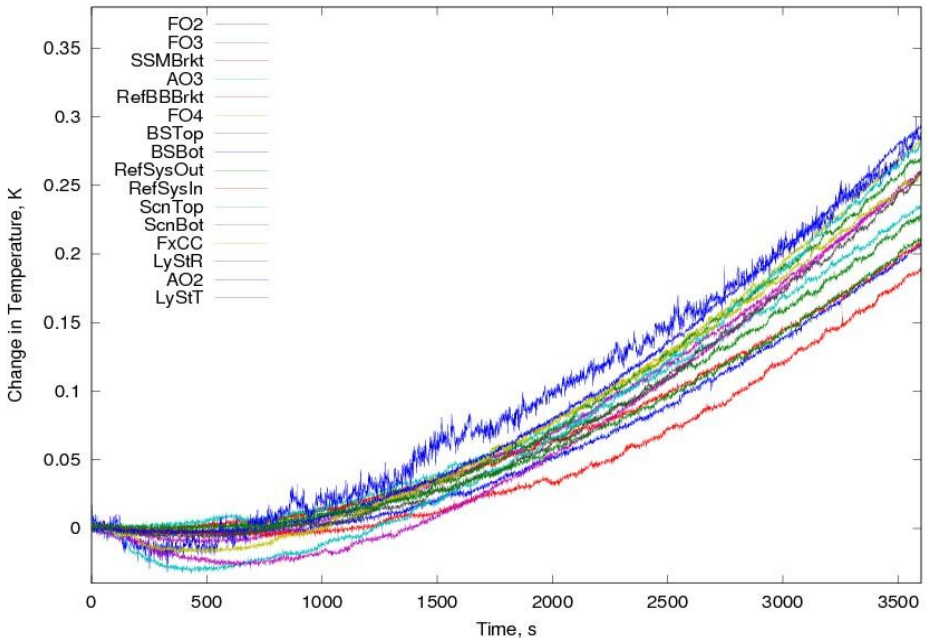


Heaters Off

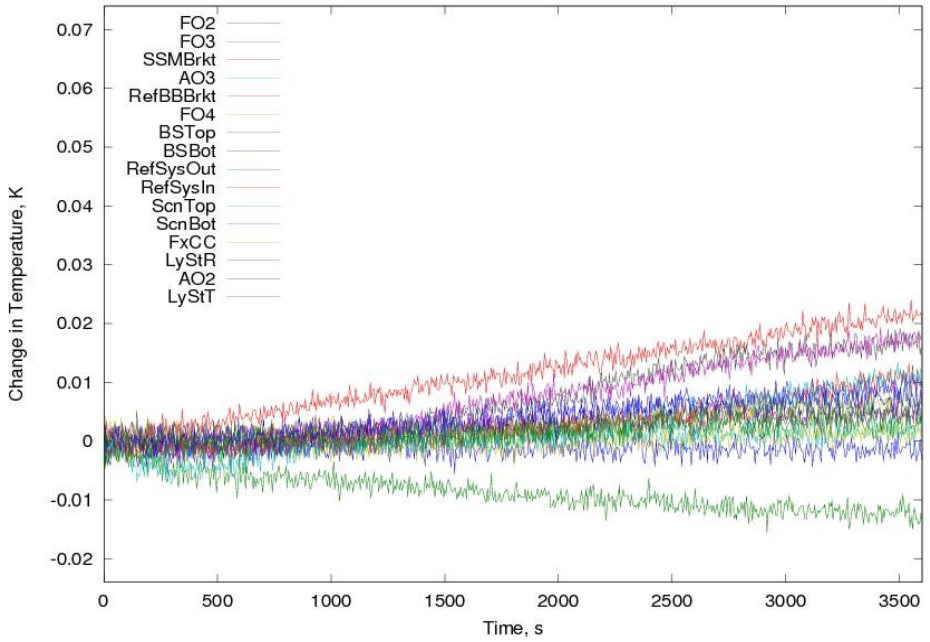


Heaters On

Temperature Control: Stability



Optical mount temperature drift with active control off



Optical mount temperature drift with active control on

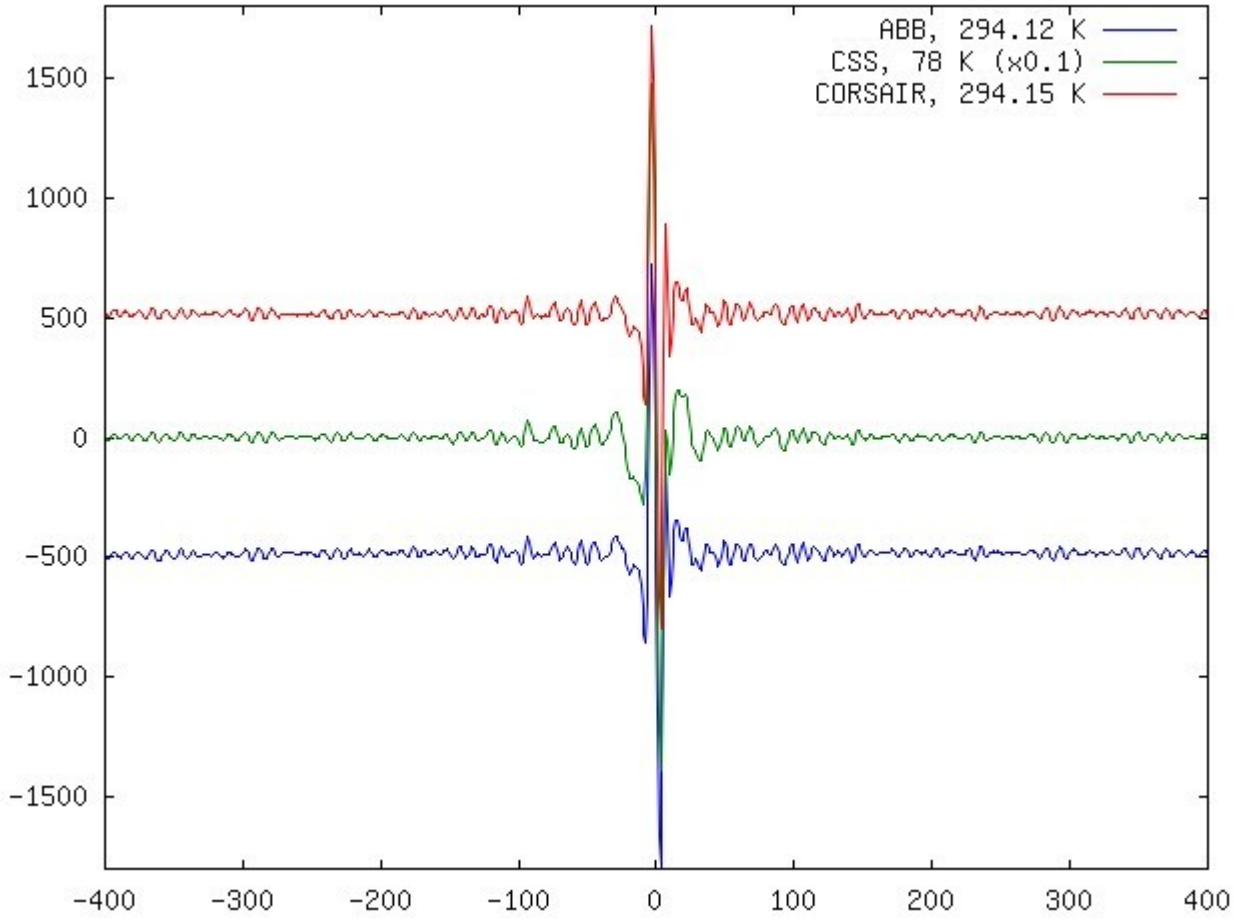
Interferograms from First Detector Cooldown: 9/25/12

Internal reference ~303 K.

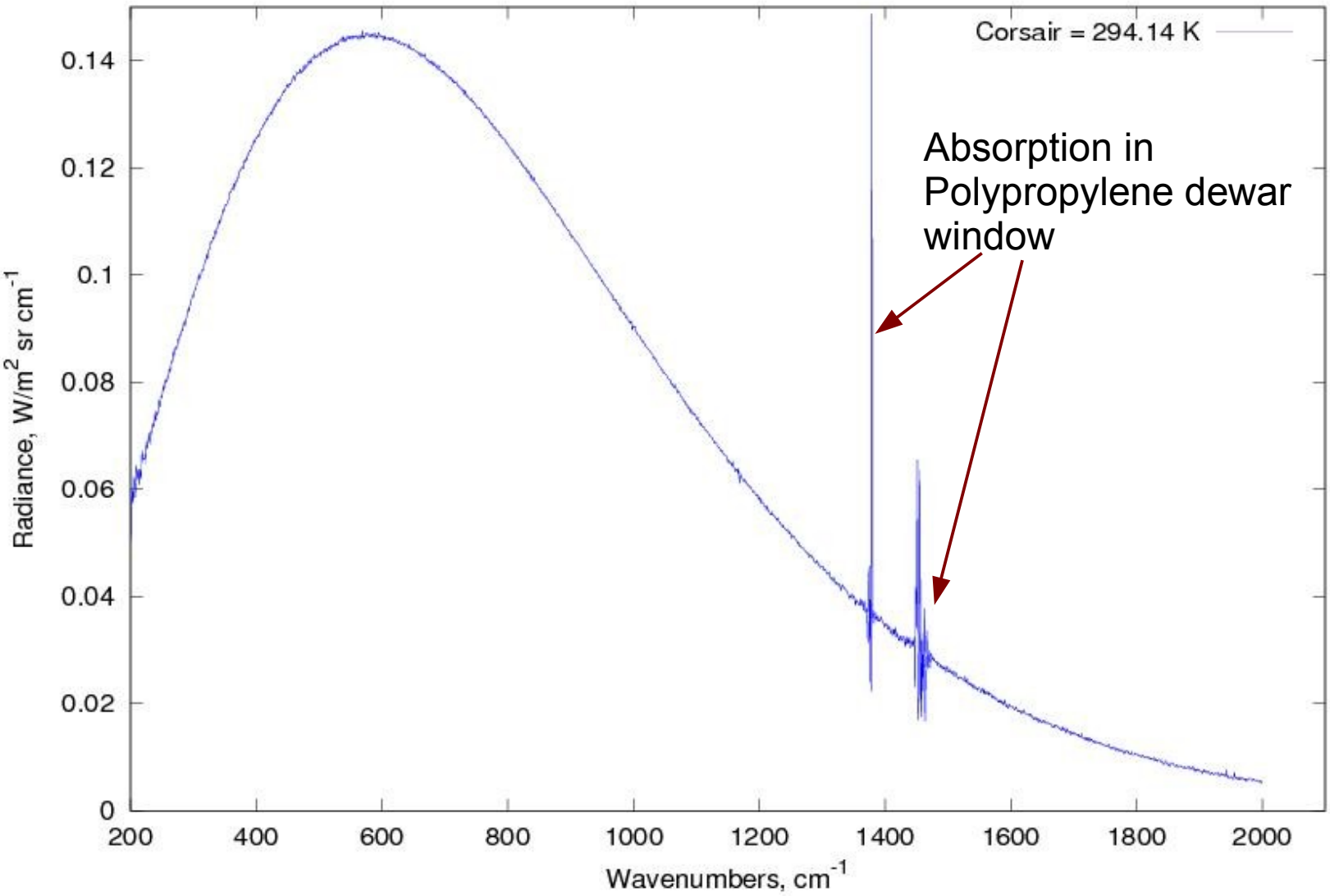
CSS interferogram divided by 10 to fit on same scale.

Individual interferograms offset by 500 for clarity.

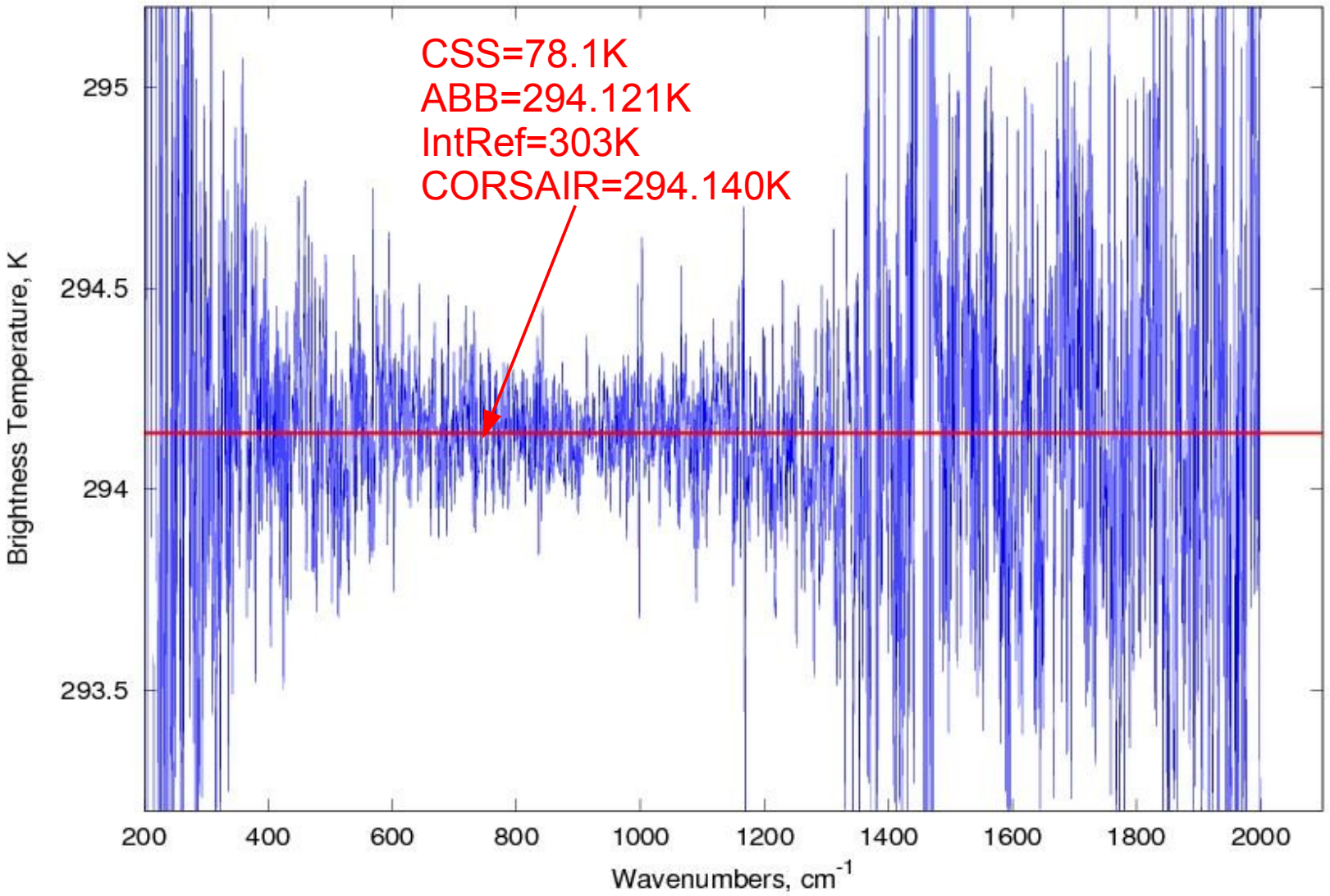
Only the central region is shown.



Preliminary Radiometric Cal



Brightness Temp from 15s of Data



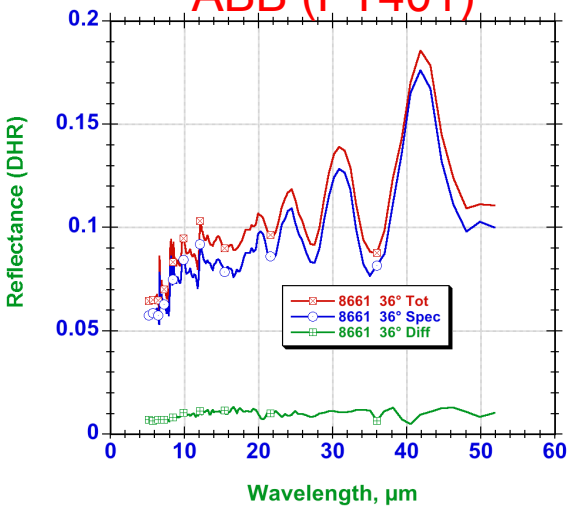
Blackbody Emissivity

- Thanks to NIST (Leonard Hanssen and Joe Rice), we now have measurements of:
  - Specular and diffuse reflectance for PT-401 ABB paint coupon, Z302 CSS paint coupon, and Z302 CORSAIR point coupon from 5-50 μm from Surface Optics Corporation (SOC);
  - Specular and diffuse reflectance for PT-401 ABB paint coupon, Z302 CSS paint coupon, and Z302 CORSAIR point coupon from 2-19 μm from NIST;
  - CHILR measurements of ABB reflectance at 10.6 μm and 4 μm
  - CHILR measurements of CSS reflectance at 10.6 μm and 4 μm
- Work underway to reconcile the SOC and NIST diffuse reflectance measurements
- Will also compare CHILR results with model calculations

Paint Sample Measurements

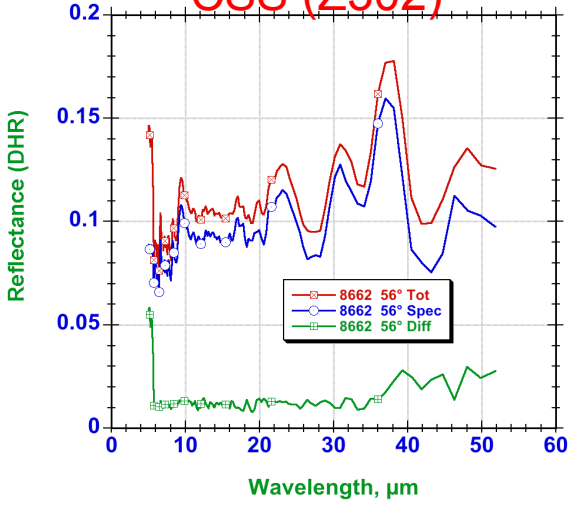
SOC 8661 Results

ABB (PT401)



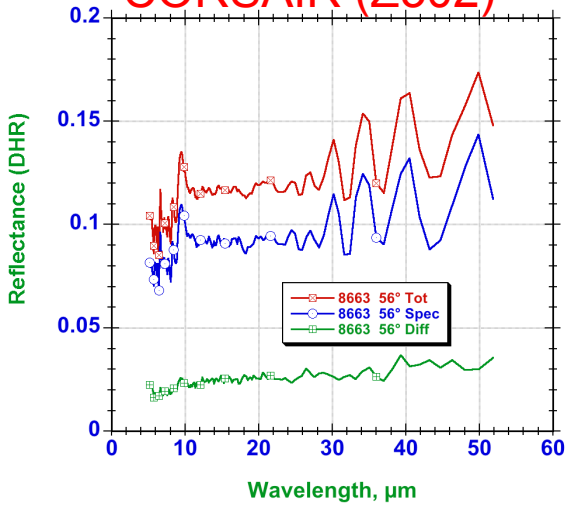
SOC 8662 Results

CSS (Z302)

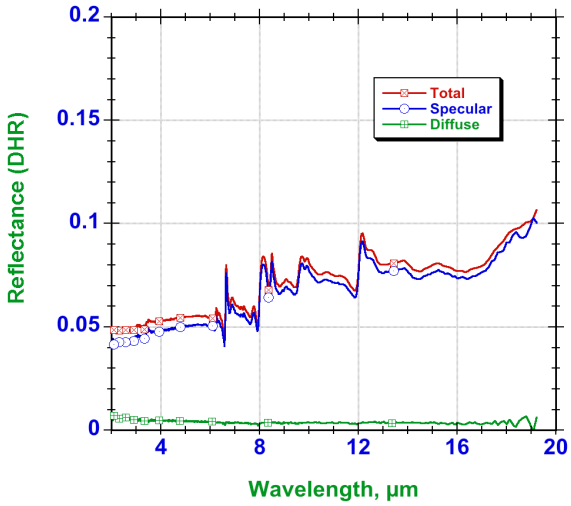


SOC 8663 Results

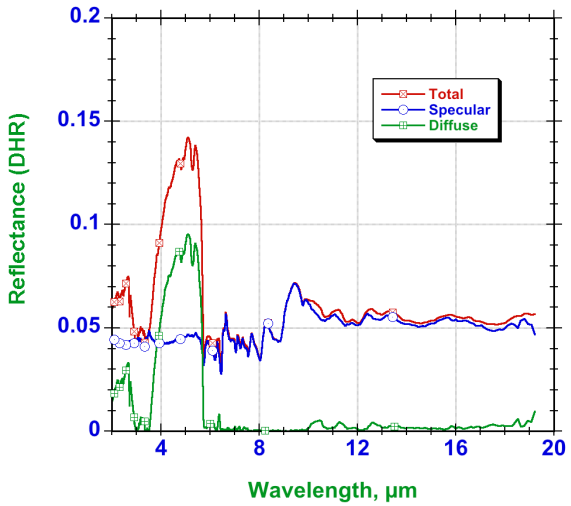
CORSAIR (Z302)



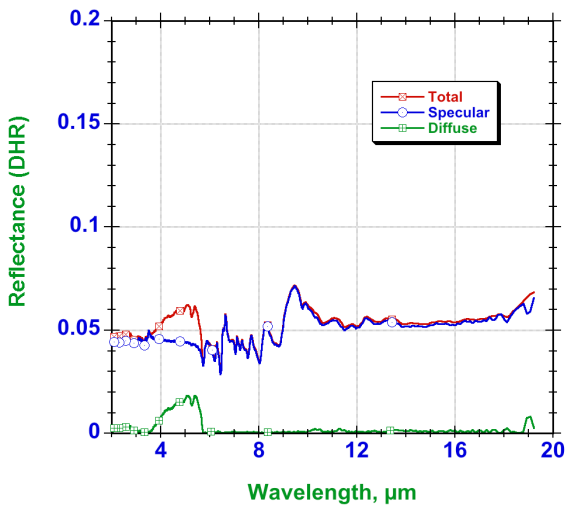
NIST 8661 Results



NIST 8662 Results



NIST 8663 Results

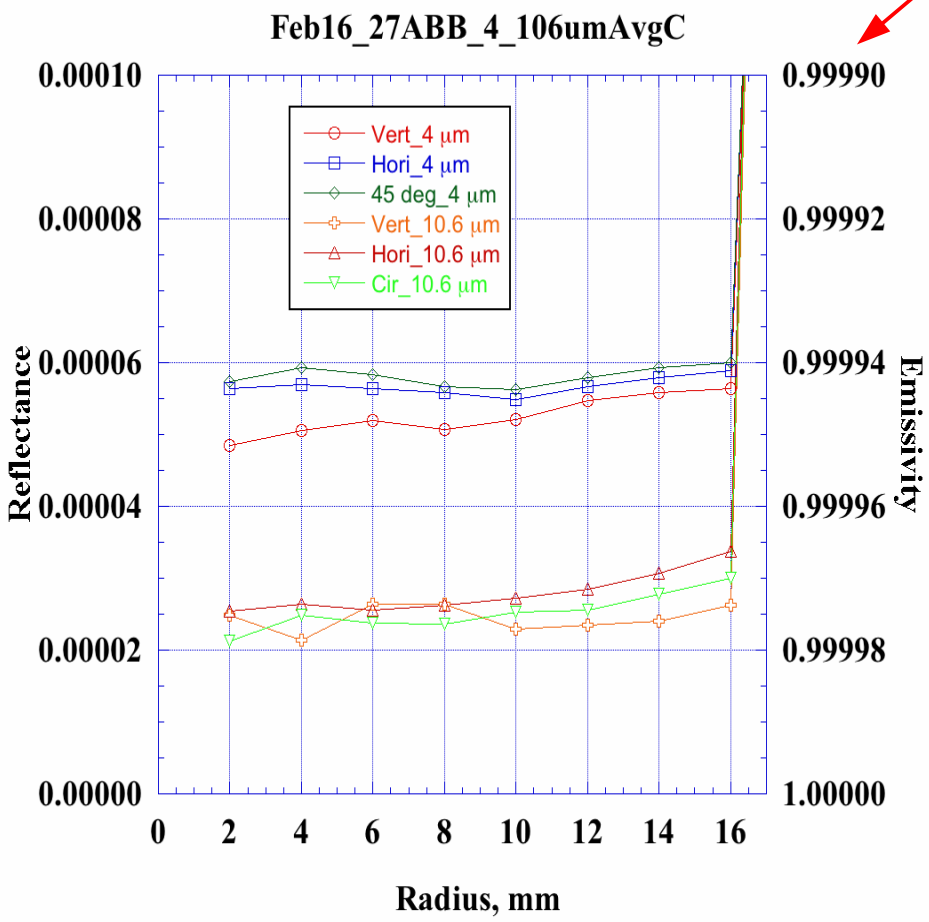


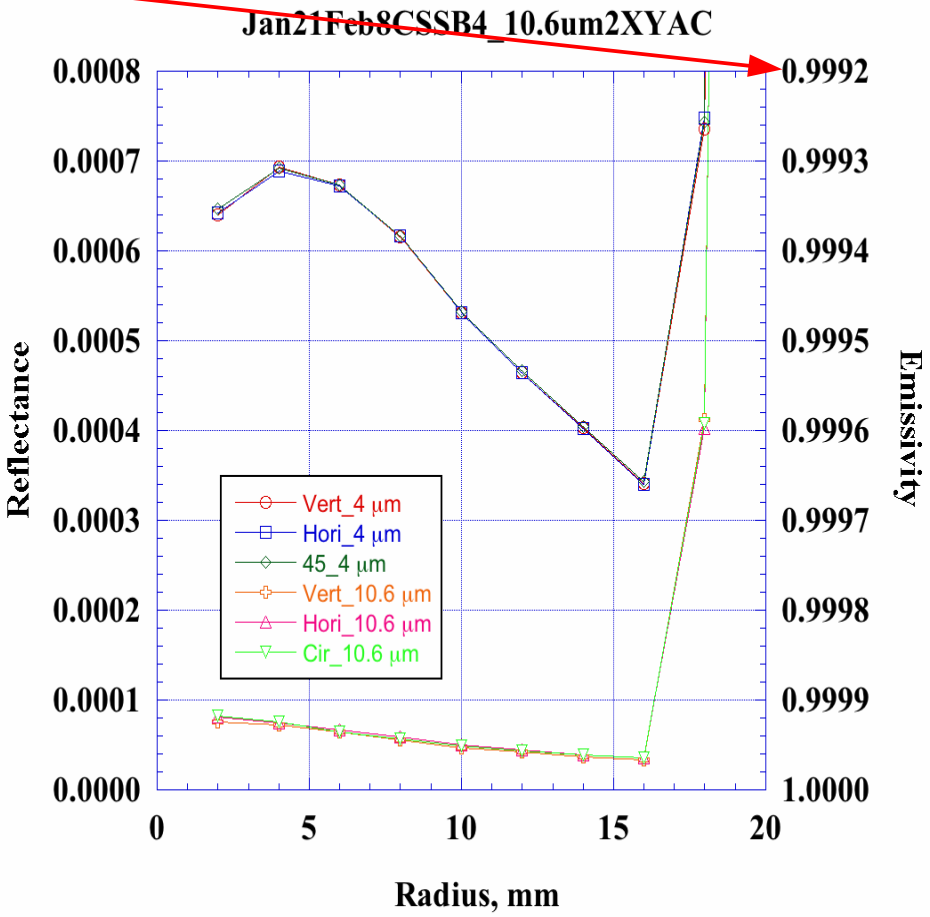
Cavity Reflectance

ABB

Note scale change

CSS





Next Steps

- Analyze data in hand and evaluate subsystem performance
- Optimize optical alignment
- Collect additional data sets while stepping CORSAIR over operational temperature range
- Complete error analysis
- Complete blackbody emissivity modeling with paint coupon data
- Integrate and test Pyroelectric channel
- Develop minimum (relaxed) instrument specifications:
  - Temperature stability
  - Active or passive internal reference
  - Others?