NIST Agency Report -- CEOS WGCV - 31

March 2-5, 2010
Bolger Center, Potomac, MD, USA

Presented by **Raju Datla**
Optical Technology Division, Physics Laboratory

Contributions from: Steven Brown, Raju Datla, Gerald Fraser, Patrick Heather, Carol Johnson, Simon Kaplan, Keith Lykke, Sergey Mekhontsev, Joe Rice, Bob Saunders, Eric Shirley, Allan Smith, Solomon Woods, Howard Yoon

Outline

(Highlights of Progress since WGCV-30 , May 2009)

- NOAA/NIST Collaborations
  - GOES R
  - NPP VIIRS, CrIS
- NASA/NIST Collaborations
- NIST Climate Initiative / OTD Strategic Plan
- Other Capabilities and Projects

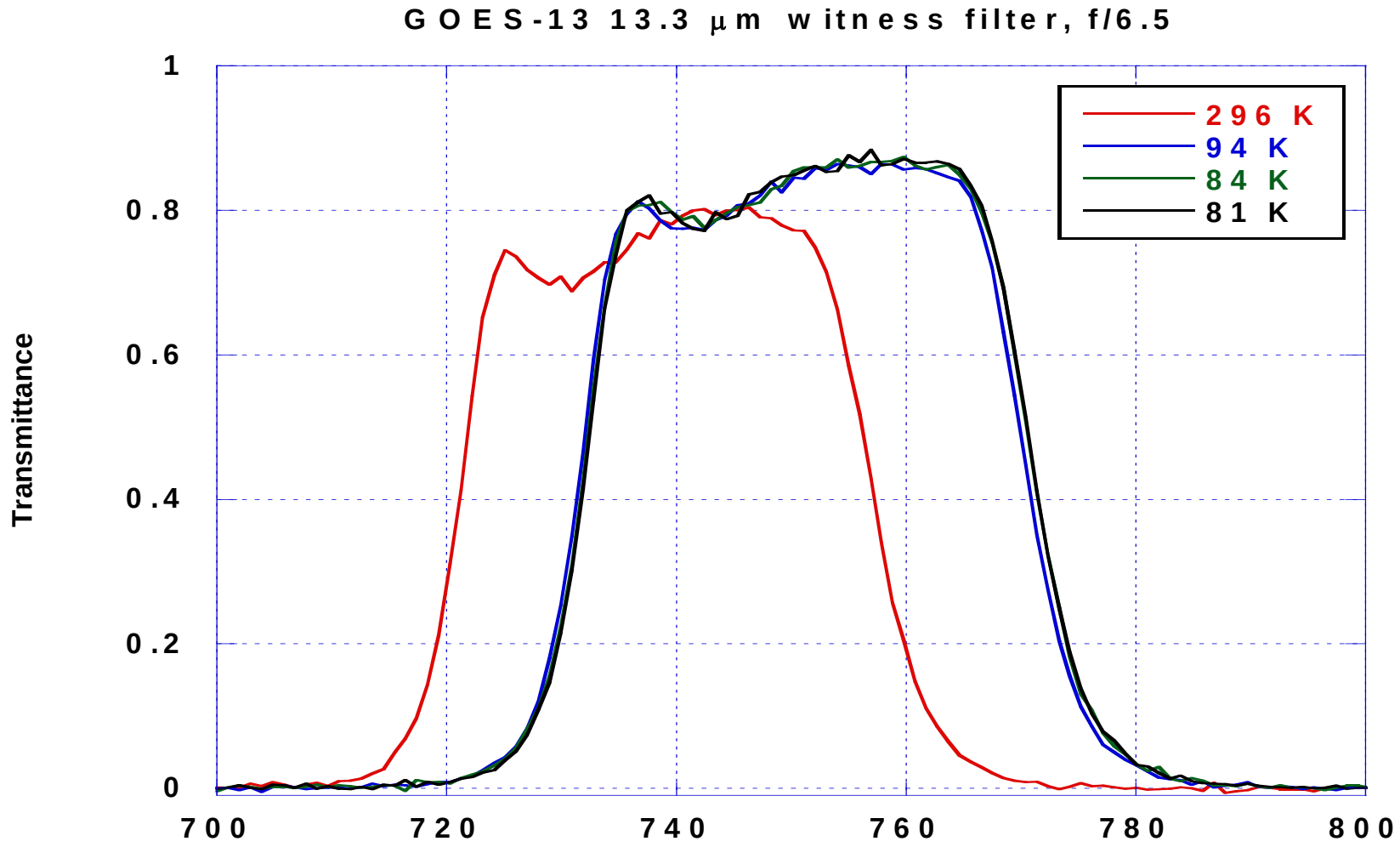
GOES-R / NIST Optical Technology Division (OTD)

NIST/NOAA MOU Completed

The NIST Optical Technology Division will provide oversight, as well as develop and implement methods and instrumentation to enable NOAA to verify and document the radiometric metrology developed and maintained by the instrument manufacturers or other scientific participants. To accomplish this, NIST will provide instrument calibration and characterization services including, but not limited to, the following:

a) Participate in the GOES-R CWG/AWG meetings, including review of written design and test plans, test procedures, and calibration plans by NIST staff.
b) Validate radiance scale of the ABI ECT, et al. vs NIST radiance scale from the reflected solar to the thermal infrared wavelength range at ITT for the ABI w/ transfer radiometers. The schedule will be coordinated w/ ITT thru proper channels.
c) Filter measurements.
d) Cal/characterization of the ABI PTM using the (traveling) SIRCUS Facility.
e) Other details of work for each year will be specified in the statement of work agreed upon by NIST & NOAA.
f) Periodic reporting to NOAA.

GOES-13 Filter SRF measurement

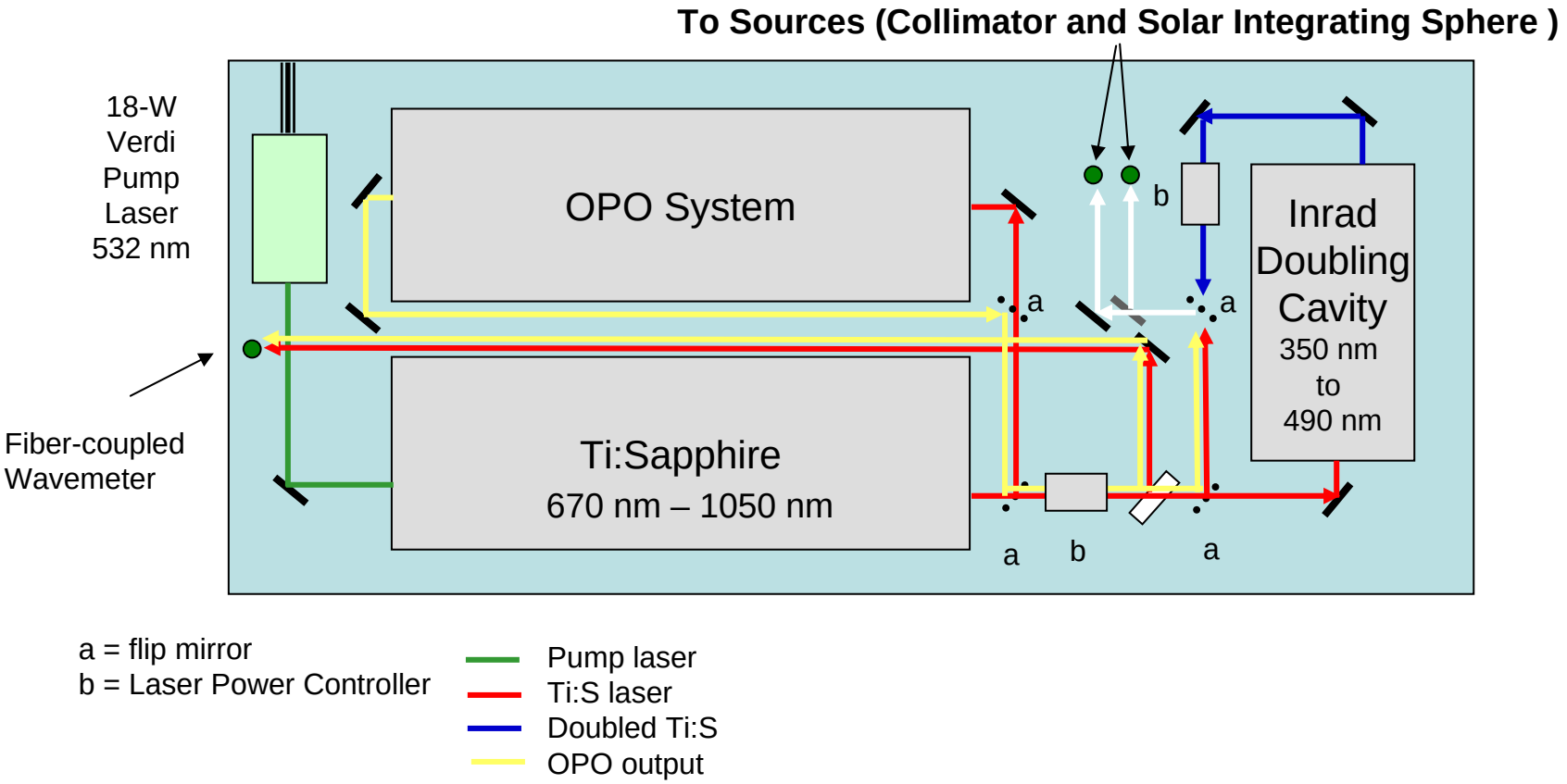


Ongoing Tasks

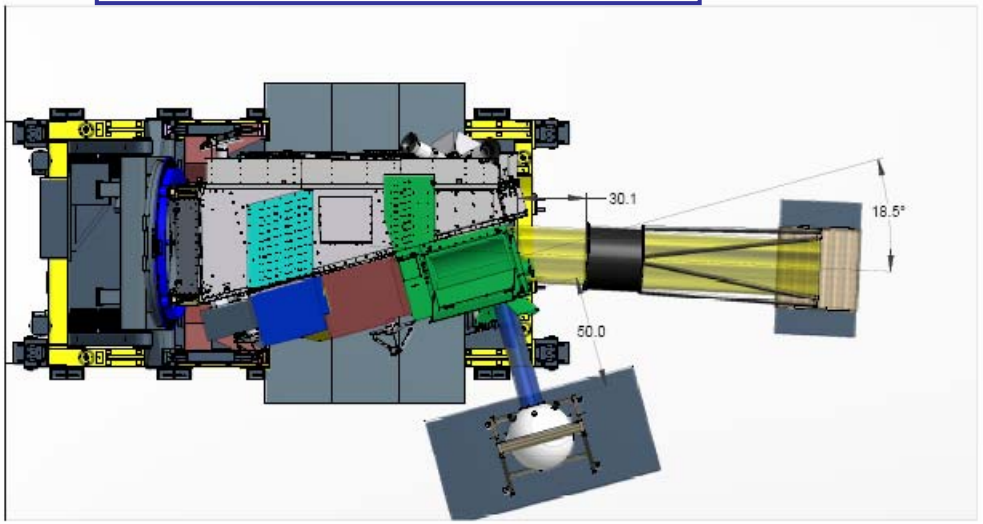
- The Visible Transfer Radiometer (VXR) has been recalibrated in SIRCUS for absolute radiance responsivity. It will be deployed to ITT for validation of External Laboratory Calibration Targets for GOES-R ABI.
- GOES-R External Calibration Target (ECT) radiance and possibly emissivity (via the measurement of reflectance) measurements will be done using NIST Thermal Infrared Radiometer (TXR).
- TXR deployment is also planned for similar measurements on the External Calibration Target (ECT) for NPOESS CrIS.

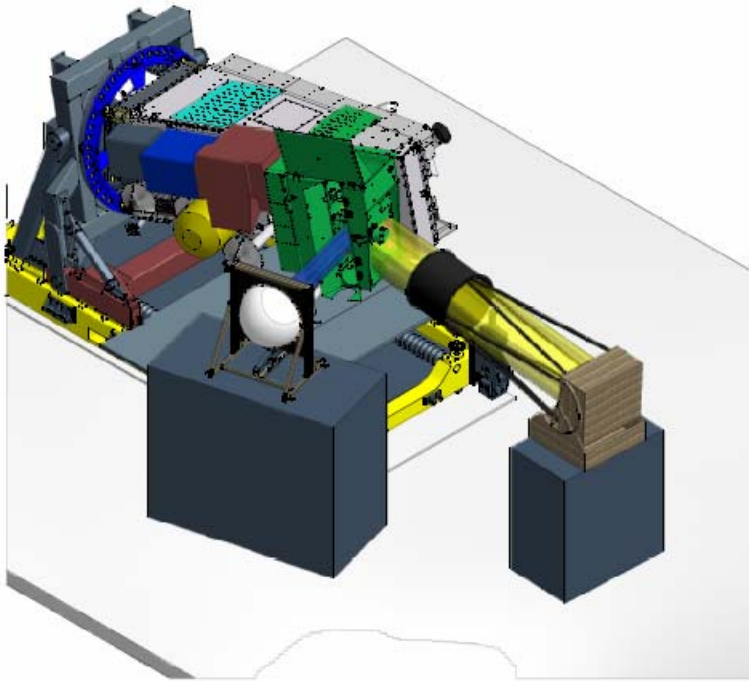
Traveling SIRCUS - NPP VIIRS End to End Calibration at Ball Aerospace

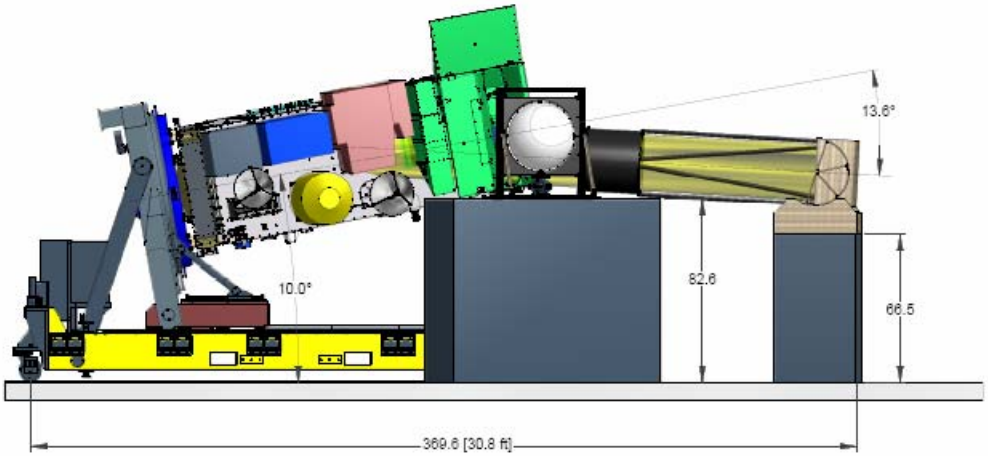
Table Dimensions: 3' x 7'



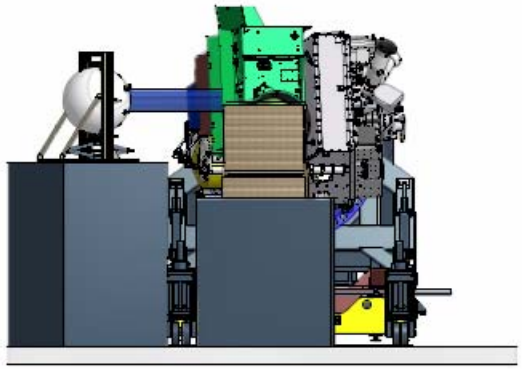
End To End Test With SIS
13.6° Az/18.5° El







NPP TILTED 10° FROM HORIZONTAL
COLLIMATOR @ 13.6° AZIMUTH/18.5° ELEVATION
WITH SOLAR INTEGRATING SPHERE



NPP ROTATED 2.71° CCW
TO MAINTAIN VIIRS BORESIGHT
PARALLEL TO FLOOR

Outline

(Highlights of Progress since WGCV-30 , May 2009)

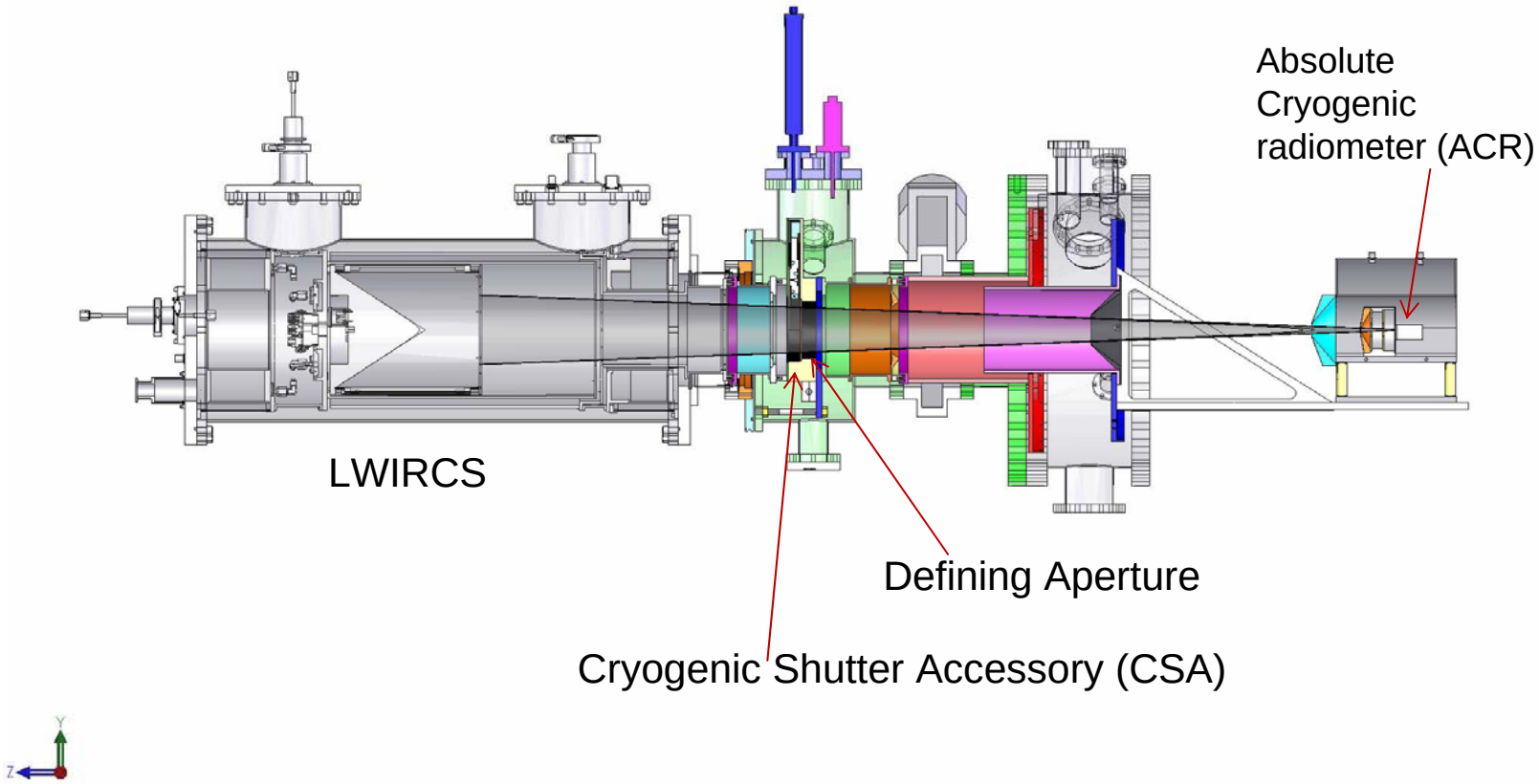
- NOAA/NIST Collaborations
- NASA/NIST Collaborations
  - OLI
  - CLARREO
  - CORSAIR BB - LWIRCS from SDL
- NIST Climate Initiative / OTD Strategic Plan
- Other Capabilities and Projects

NASA/NIST Collaborations

- The Landsat Data Continuity Mission (LDCM) Operational Land Imager (OLI) is the follow-on to Landsat-7. NIST is supporting on several fronts the calibration and validation activities of NASA GSFC and Ball Aerospace.
- MOU is signed for NIST to support the Climate Absolute Radiance and Refractivity Observatory (CLARREO) mission to achieve absolute, spectrally-resolved infrared radiance accuracy of 0.1 K 3-sigma and the solar reflectance accuracy of 0.2% for the 500 to 900 nm and 1% at other wavelengths.
- In this regard Space Dynamics laboratory built Long Wavelength Infrared Calibration Source, LWIRCS with phase transition cells and NIST LBIR facility just completed measurements and preliminary data indicates that such accuracies are achievable through cryogenic radiometry. (Supports TRUTHS concept)
- NIST is overseeing the building of a new sensor for **Marine Optical Buoy** (MOBY) for Ocean Color

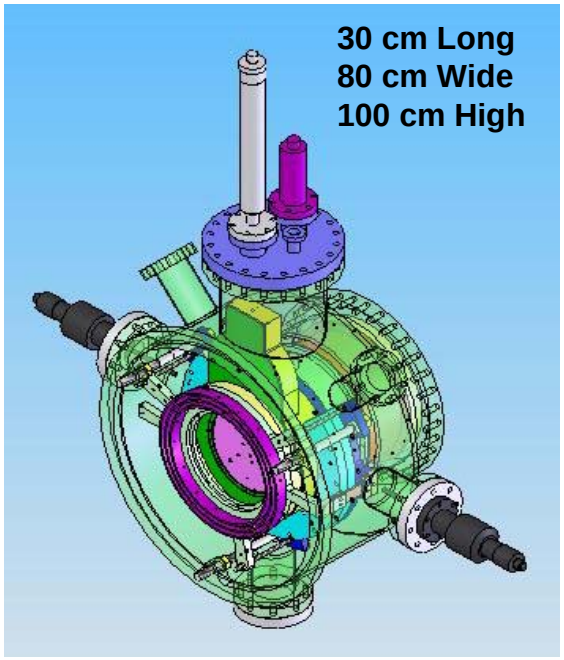
Schematic Layout of LWIRCS at LBIR

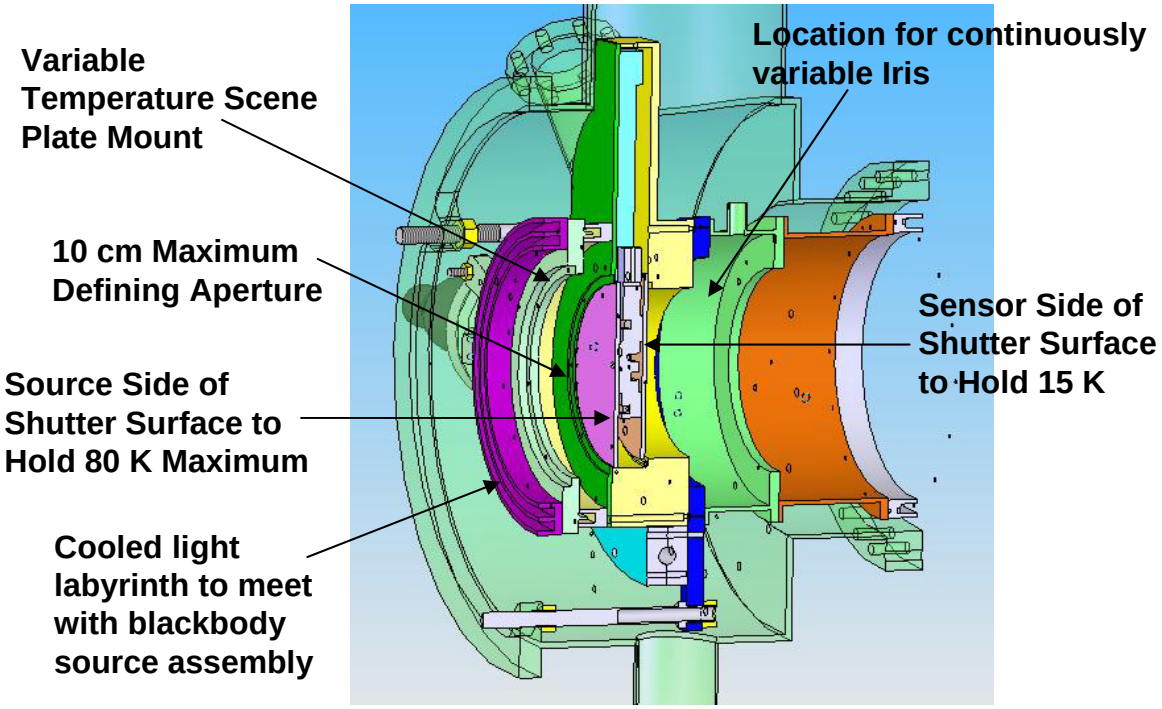
Defining Aperture: 101.6 mm diameter
ACR Aperture: 3 mm diameter
Distance from defining aperture to ACR: 1260 mm
Viewing cone half-angle: 2.2 deg; viewing ~ 90 % of LWIRCS aperture.
Series of 5 baffles to eliminate stray light.



Cryogenic Shutter Accessory

- Goal: Provide cryogenic shuttering for LWIRCS and LBIR Large Aperture Water Bath Blackbody, and other large aperture customer blackbodies.





- - Variable temperature scene plate for blackbody emissivity studies.
- - Shutter side facing sensor (ACR, BXR, MDXR or other) allowed low background shuttering for ACR.
- - Also contains continuously variable iris to study size of source effects for future applications.

Temperatures for LWIRCS calibration

°C (approx.)	K equivalent (approx.)	Note
80	353	Warmest operational temperature of LWIRCS
62	335	
50	323	
29	300	Gallium triple point
0	273.15	H_2O triple point
-39	234	Mercury triple point
-63	210	
-92	181	
-148	125	
-176	97	Coldest operational temperature of LWIRCS

Goal: Radiance temperature expanded uncertainty (k =2) +/- 0.1 K over this temperature range.

- includes uncertainties due to aperture areas, distance, diffraction, ACR power measurement, stray light.

Status: (1) LWIRCS was delivered to NIST.

(2) It was installed and aligned with the CSA and ACR in the LBIR Broadband Chamber

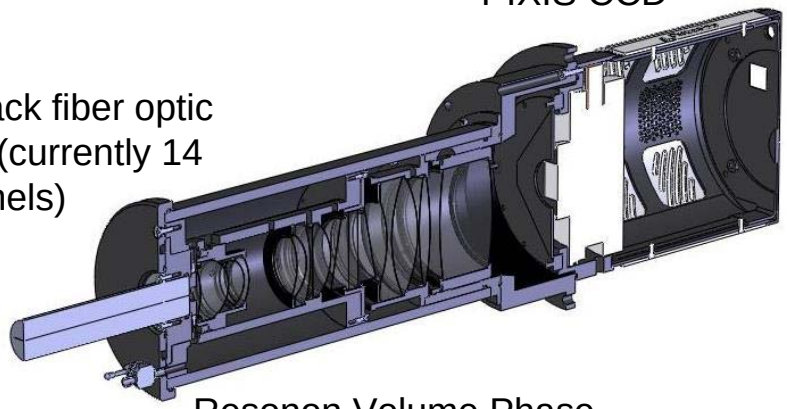
(3) Cryogenic shutter Accessory (CSA) performed well.

(4) Data collection is completed (3/3/10). Preliminary analysis shows that the goals of the test have been met.

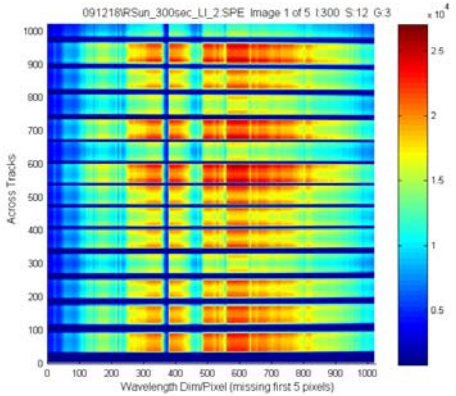
New Sensor for MOBY – Simultaneous Data Acquisition

Princeton Instrument PIXIS CCD

Romack fiber optic input (currently 14 channels)

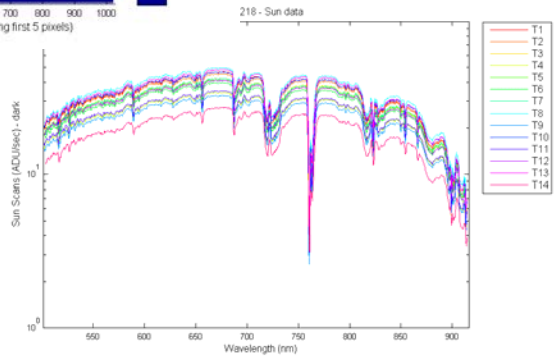


Resonon Volume Phase Holographic (VPH) in line spectrograph

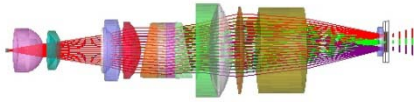


RILS image of diffuse solar flux

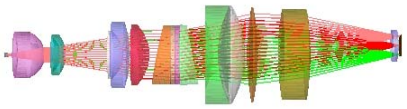
Average net ADU/sec for each channel



Blue In Line Spectrograph (BILS)



Red In Line Spectrograph (RILS)



The inputs to the optical fibers are at the desired locations. The fiber outputs are aligned vertically at the entrance slit. The prism-grating-prism in-line optical system (Resonon, Inc.) images the different input channels at the same time on the CCD camera), spaced along the slit direction.

Outline

(Highlights of Progress since WGCV-30 , May 2009)

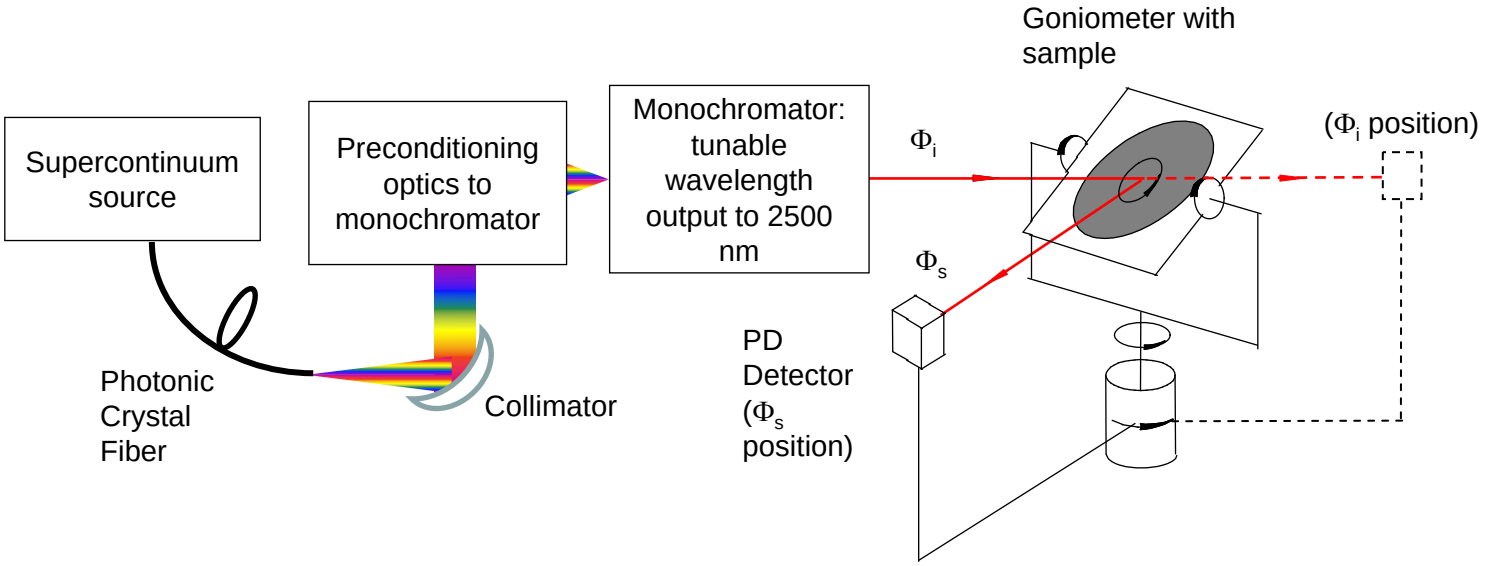
- NOAA/NIST Collaborations
- NASA/NIST Collaborations
- NIST/OTD Strategic Plan
  - Reflectance
  - CBS3
  - Workshop on Data Gaps – Dec 10, 2009
- Other Capabilities and Projects

NIST/OTD Strategic Plan - 2010

Key Milestones

- Develop and demonstrate system-level, end-to-end and spectral responsivity calibrations using Traveling SIRCUS.
- Build a new facility for the accurate and rapid measurement of the reflectance of materials from 200 nm to 2.5 mm as a function of all necessary variables to support measurement of the Earth's albedo and for the characterization of optical components used in satellite sensors.
- Establish the Controlled Background Spectroradiometry and Spectrophotometry System (CBS3) Facility for the primary realization of spectral radiance, radiance temperature, spectral hemispherical-directional reflectance, and spectral directional emittance in the far and mid infrared from 2.5 µm to 100 µm for the calibration and characterization of materials and blackbody sources in support of airborne and space borne sensors such as CLARREO.
- Realize a full infrared version of Traveling SIRCUS using near-infrared lasers and/or interferometers.
- Demonstrate the application of the Hyperspectral Image Projector to the calibration and characterization of Earth remote sensing instruments.
- Provide calibration support, optical component measurements, and transfer standards to NOAA, NASA, USGS, and DOD satellite programs.

New UV-SWIR Gonioreflectometer



- Angle-resolved reflectance over full 250-2500 nm range
- Improved 5-axis goniometer for arbitrary incident/viewing angles including new out-of-plane capabilities
- Supercontinuum-based light source projected to provide 1000x more power density in SWIR than current STARR lamp source (auxiliary source for UV, not shown)
- Facility under development

Recent Activities:

- Poster, "Spectroradiometer of a High Power, Broadband Supercontinuum Light Source for the Next Generation of Reference Gonoireflectometry at NIST", H.J. Patrick, C.J. Zarobila and J.P. Rice, presented at 2010 Art, Science and Applications of Reflectance Spectroscopy Symposium

- Participated in "Bridging Satellite Climate Data Gaps", held at NIST in December of 2009, and the "2009 Earth Observing Systems Conference"

Outline

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- NOAA/NIST Collaborations
- NASA/NIST Collaborations
- NIST Climate Initiative / OTD Strategic Plan
- Other Capabilities and Projects
  - RCSS – Radiometrically Calibrated Spectral Source for the calibration of NIRspec Instrument on the James Webb Telescope - Low photon fluxes measurements are a challenge and this task is accomplished at LBIR for Astrium/ European Space Agency.

LBIR Task is to measure the low flux levels accurately

Radiometry and calibration concept

For the NIRSpec calibration the RCSS has to deliver the following spectral photon fluxes within two operating modes in the wavelength region of 0.7 to 5 µm:

Multi-Object Spectroscopy (MOS) Mode:

[µm]	[photon/(µm*s)]	[photon/(µm*s)]
0.7 - 1.4	$6*10^5$	$6*10^6$
1.0 - 1.8	$7*10^5$	$6*10^6$
1.7 - 3.0	$4*10^5$	$4*10^6$
2.9 - 5.0	$4*10^5$	$4*10^6$
1.0 - 5.0	$3*10^4$	$2*10^6$

Integral Field Spectroscopy (IFS) Mode:

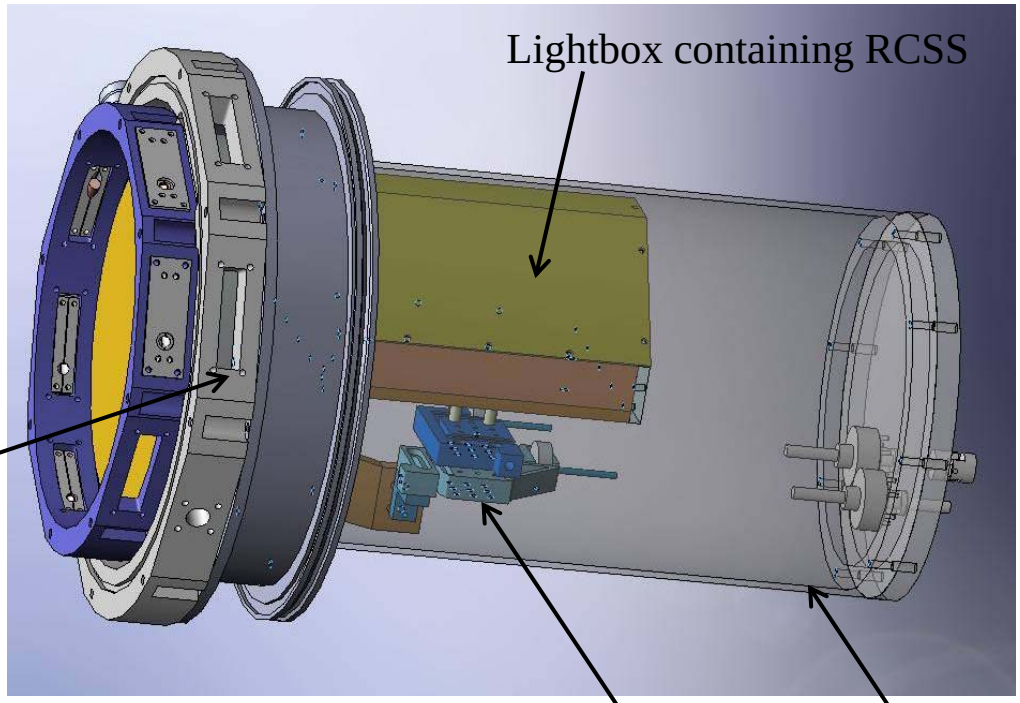
Wavelength range [µm]	Minimum flux [photon/(µm*s)]	Maximum flux [photon/(µm*s)]
1.0-1.8	$3*10^5$	$2.5*10^7$
1.7-3.0	$2*10^5$	$2.0*10^7$
2.9-5.0	$1.5*10^5$	$2.5*10^7$

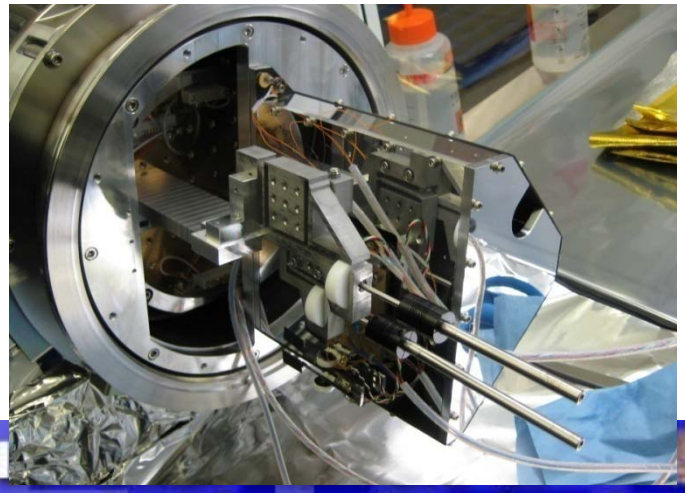
Purpose of NIST measurements

- Sampling the spectral curve from 0.7 to 5 µm for different apertures and lamp currents
- Detector current information within the 3 bands (Si, InGaAs, InSb)
- Rough information about the spectral shape of the emitted lamp broadband radiation

- Comparison to adopt the radiometric model for choosing the proper lamp current and aperture settings to fulfill the wavelength dependent spectral photon flux limits.

Measurement Configuration Within LBIR Cryostat





Measurement/Analysis Details

Measurement with 3 Detector/Filter Combinations at T=70-90 K

Si Detector: 0.75-1.2 µm
InGaAs Detector: 0.90-1.7 µm
InSb Detector: 3.0-5.0 µm

Measurement Procedure

- Find signal peak with translation stages to center beam on detector
- Measure all lamps at maximum lamp current (17 mA)
- Measure LiLS 6 at lamp currents from 7-17 mA

Data Presentation

- For each measurement configuration, provide detector current
- Use current, spectral detector responsivity, and spectral filter transmission to provide estimated photon flux density (photons/[s·µm])

Results from Final InGaAs Run II