OPTICAL TECHNOLOGY DIVISION

NIST

CEOS WGCV 30th Meeting
NIST Agency Report

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SUMMARY STATEMENT

The NIST Optical Technology Division supports and/or partners with weather & climate related satellite programs. It maintains and improves radiometric tools, facilities and the capabilities to do so.

HIGHLIGHTED ISSUES

- NISTstars: SI traceability of exoatmospheric irradiance of stars
- NIST Multi-year Climate Initiative
- NASA, NOAA collaborations
- Reflectance, radiance, and temperature scales for the solar reflected region
- Total Solar Irradiance & Thermal Infrared Transfer Radiometer (TXR)
- Flat plate illuminator for sensor testing at spacecraft integration
- Hyperspectral Imaging Projection (HIP)

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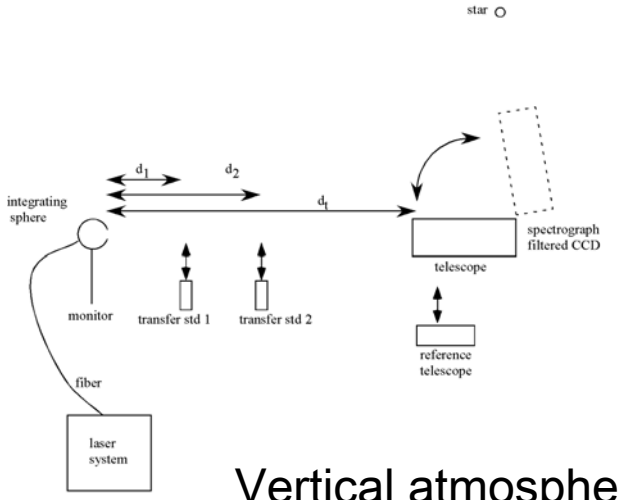
Absolute Flux of Standard Stars

Current: 2% to 5%
Objective: 1% to 0.5%

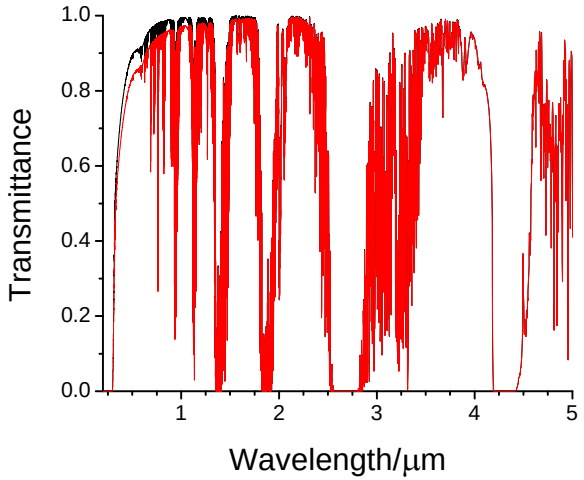


Calibration approach: "SIRCUS on a mountaintop"

- NIST/SIRCUS detectors calibrated for irradiance responsivity
- Laser (or SC in SLE) -illuminated sphere for irradiance standard (fixed point blackbody in 1970s work)
  - Si PDs w/ apertures at distances z; or
  - Portable telescope as transfer radiometer
- Horizontal atmospheric extinction is determined

Vertical atmospheric extinction

- Atmospheric correction – avoid known features, select site carefully; requires complete characterization (e.g. LIDAR for aerosols) for lowest uncertainty; or
- Utilize existing stellar standards to determine atmospheric correction *in situ* during actual observations from the Absolute Color Calibration Experiment for Standard Stars (ACCESS)



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NIST Stars Accomplishments

Workshop at Harvard, May 2009

Three projects at Mt. Hopkins:

-NISTStars approach to calibrating the Tillinghast 1.5m telescope; UNM partner for atmospheric correction, reference source located at MMT;

-Wavelength calibration and spectral responsivity characterization of echelle spectrograph at MMT

-Near field telescope calibration using flat panel; will compare near field to far field

One project at PanSTARRS, Haleakala, Maui; close collaboration established with Chris Stubbs, Harvard University: a Harvard-designed near field fiber-optic fed large area source was used with different illumination sources (lasers, supercontinuum (SC) with monochromator) to determine the relative instrument response for the GRISY bands;

One project at JPL, Traveling SIRCUS deployment for calibration of the Narrow Band Imager (high resolution spectrograph at 850nm) and two broadband imagers (H and I bands) that are part of the Cosmic Infrared Background Experiment (CIBER) mission.

Continued expansion of capabilities via purchase of additional laser systems for Traveling SIRCUS, including an automated laser system.

New Climate Initiative

NIST-wide (Physics, Chemistry, Electronics and Electrical Engineering Laboratories)

Focus Elements

- Accurate Radiometric Scales for in-flight sensors (e.g., total solar irradiance or lunar radiometry)
- New instrument design strategies
- Aerosol optical and physical properties
- Database of critically evaluated aerosol properties
- Scale and artifact development for free-space microwave radiometry

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NASA Collaborations

Decadal Survey Missions. NIST and NASA/GSFC have developed a white paper on program goals, modeled after the successful EOS cal/val program. Stay tuned.

CLARREO (Climate Absolute Radiance and Refractivity Observatory). NIST in discussion with NASA/LARC on cal/val program; NIST attended the Solar Science Team Meeting (Jan 2009) and the full Science Team meeting (May 2009). NIST is working on sub elements of CLARREO through the IIP program, collaborating with LASP, University of Wisconsin, Harvard, and LARC.

ACE/ORCA (Aerosols, Clouds and Ecosystems/Ocean Radiometer for Carbon Assessment). NIST is a member of the ORCA team in the role of cal/val and sensor characterization

OLI (Operational Land Imager). NIST is working with NASA/GSFC on cal/val efforts. Most recently, four ASD full range instruments were characterized for stray light on SIRCUS.

NOAA Collaborations

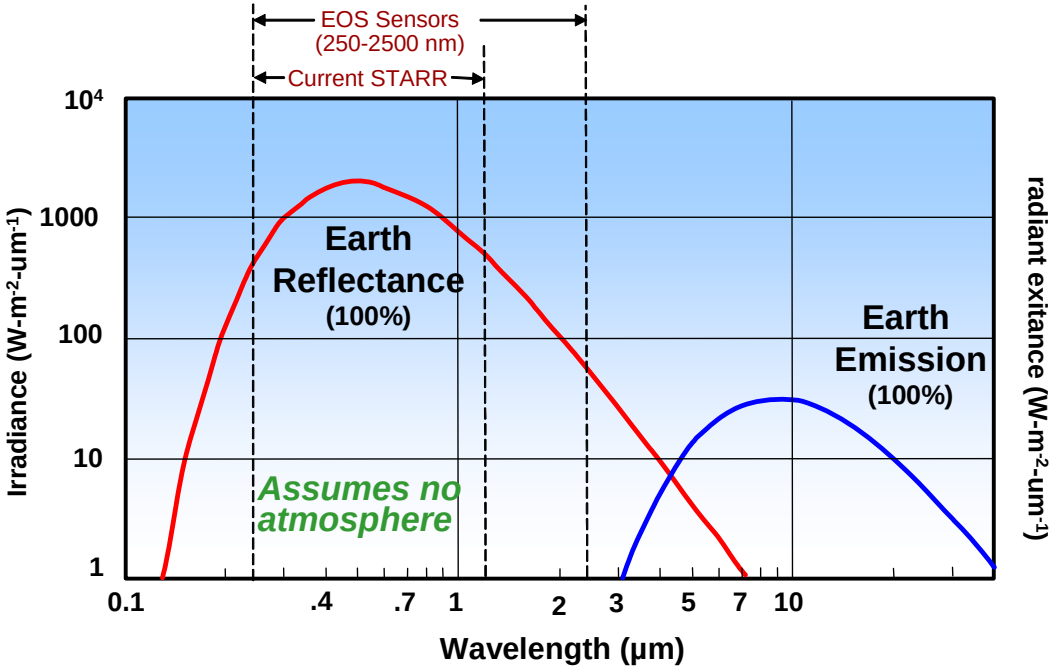
GOES-R ABI (Advanced Baseline Imager). NIST and NOAA have a cal/val plan in place; primary efforts will be validation of the radiometric scales of the ground support reference standards using the VXR, the NIST ASD, and the TXR.

NPOESS (National Polar-orbiting Operational Environmental Satellite System), and NPP (NPOESS Preparatory Project). NIST supports VIIRS characterization efforts; TXR deployed to ITT for CrIS blackbody validation.

MOBY (Marine Optical BuoY). The spectrographs were characterized for stray light at the NIST SIRCUS facility, updating the earlier and incomplete work done in Honolulu.

BRDF

Diffuse Reflectance Standards – fundamental artifact



- On-orbit solar – illuminated diffusers are the standard for reflectance values
- Lamp illuminated diffusers are a radiance standard

STARR (Spectral Tri-function Automated Reference Reflectometer) provides BRDF values for reflected solar region – the extension beyond 1100 nm is recent and comparisons of 0°/45° to 8°/hemispherical continue.

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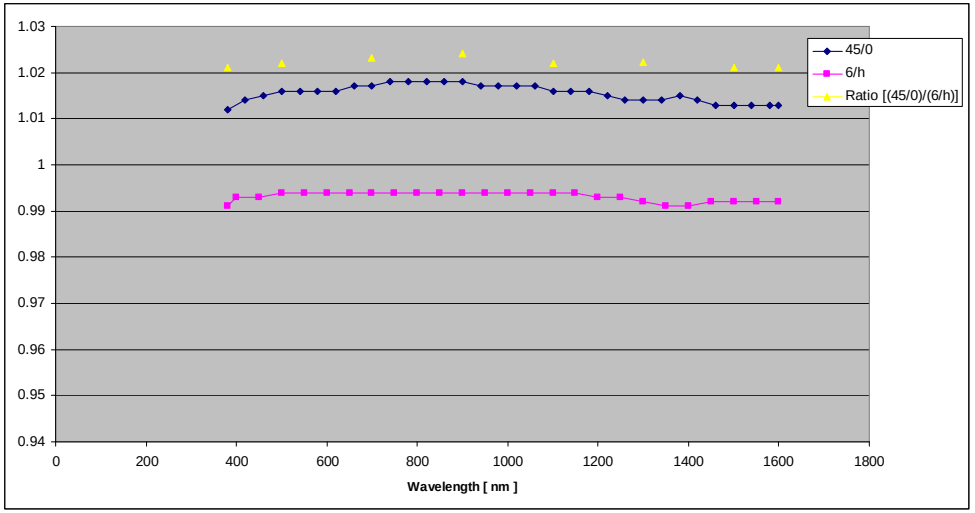
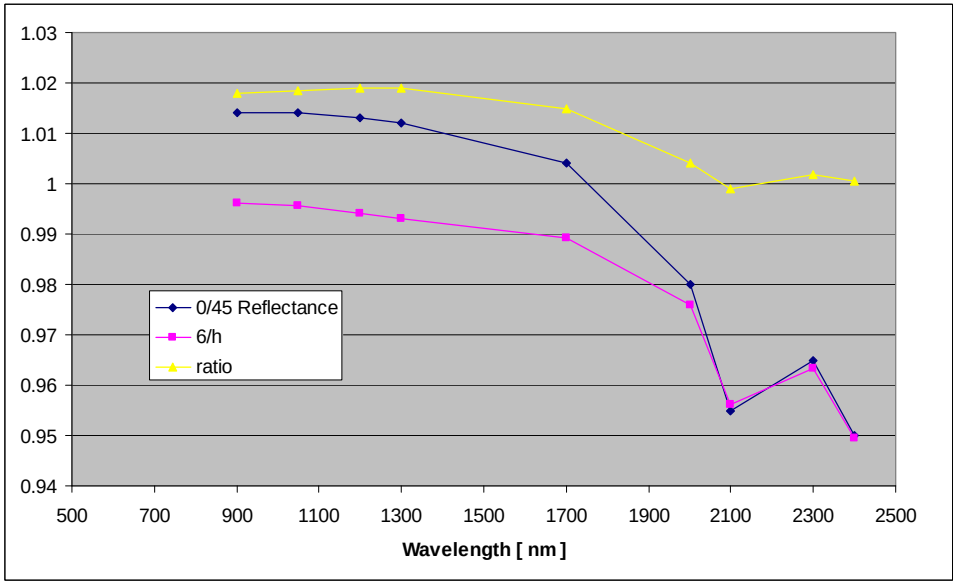
BRDF

A common assumption is the ratio of bi-directional to directional-hemispherical is a constant for Spectralon



The recent efforts establish that this is not the case, and extrapolations under this assumption are questionable.

MODIS' scale was based on this assumption!



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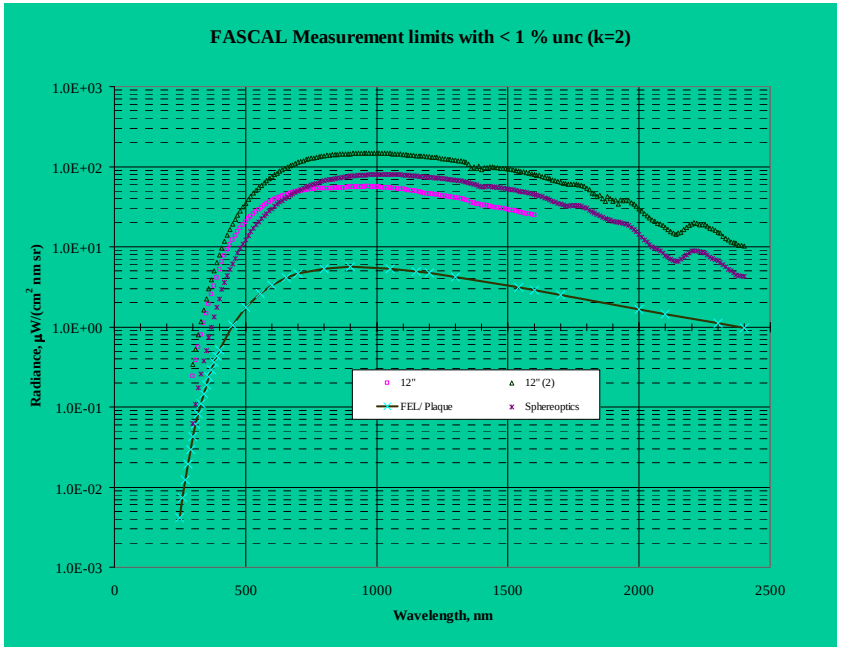
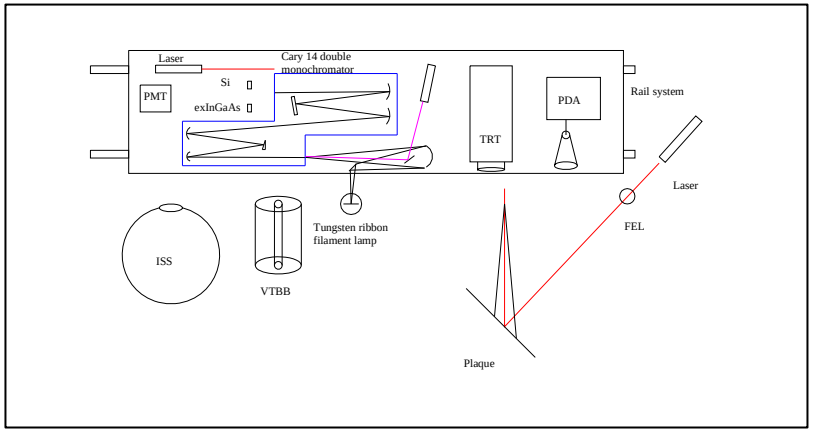
Radiance Scales

Improvements in FASCAL (Facility for Automated Spectroradiometric Calibrations). The Cary-14 has been reconfigured in the SWIR, reducing the measurement uncertainties and extending the range to 2500nm





R2T Facility. Will combine radiation thermometry (optical pyrometry) with spectral radiance scale determinations and include realizations for diffuse reflectance standards.

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Total Solar Irradiance

Flux comparison of cryogenic radiometry between NIST POWR and LASP's L-1 instrument was done at NIST prior to the LASP irradiance calibration of the GLORY TIM using the LASP cryogenic radiometer.

Two papers are in preparation.

This work was done in vacuum at solar power levels; previous work with VIRGO and NPL was in air at lower power levels.

The LASP L-1 cryogenic radiometer is available for future labatory comparisons (Greg Kopp, contact).

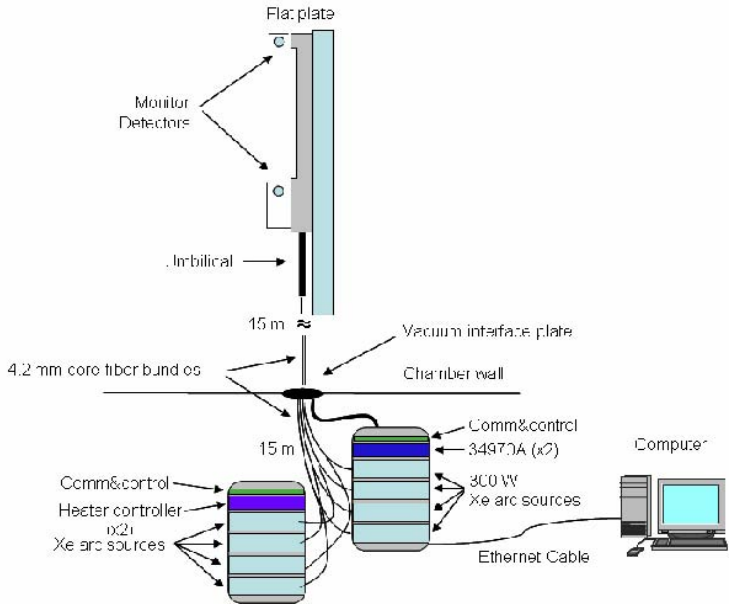
TSIS is now back on NPOESS (e.g, the TIM and the SIM)

The TXR and the NIST Water Bath Black body were deployed to Miami for the third thermal IR laboratory comparison; international participation.

Flat Plate Illuminator

- Vacuum compatible source to test for sensor repeatability from sensor-level testing to spacecraft-level testing
  - Identify changes in VIIRS sensitivity from sensor build to S/C integration w/in 10%
- Joint project with IPO for VIIRS
- Thermal vacuum testing performed; current efforts are focused on increasing the SWIR flux

- Recent decision made to perform system level testing of VIIRS / NPP at Ball using the FP and also Traveling SIRCUS



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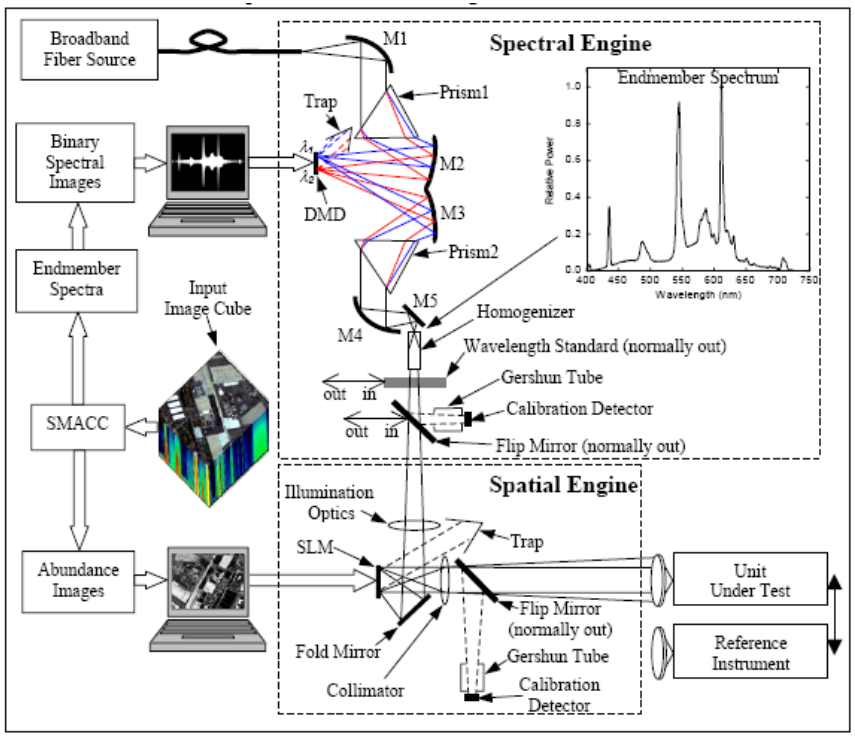
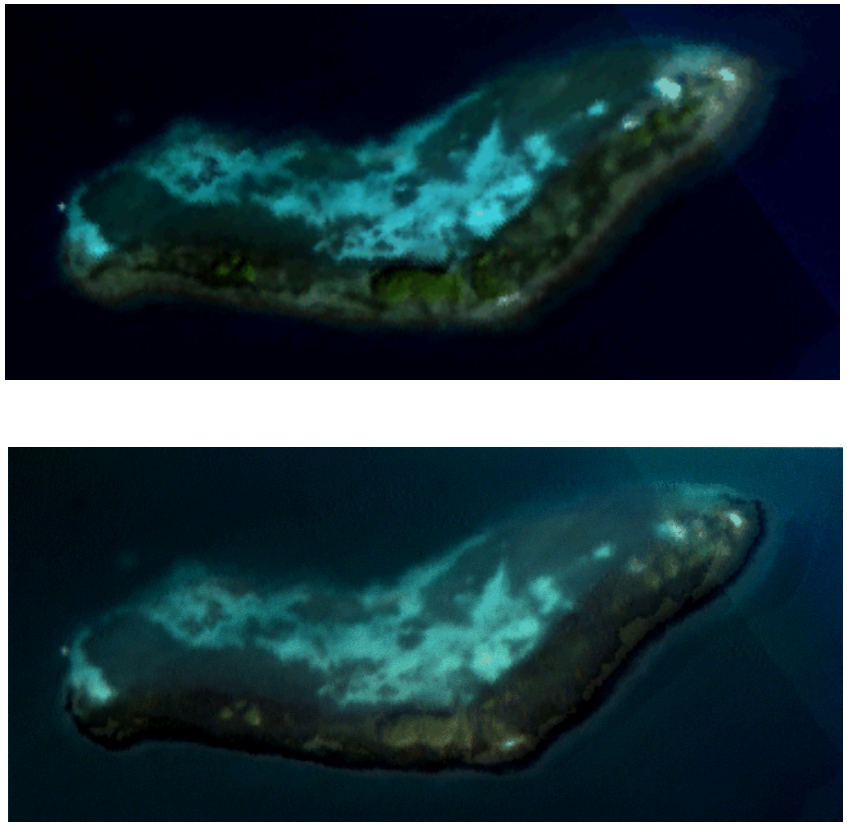
Hyperspectral Image Projector HIP



The HIP concept produces digitally controlled spectral and spatial scenes; there are many potential applications in radiometry, e.g. pre flight instrument characterization with realistic and complex reference sources.



Original (top) and the HIP image (bottom) as recollected using an imaging spectrometer. The images are a composite using 650 nm, 550 nm, and 460 nm for red, green and blue, respectively. David Allen et al., Proc. SPIE

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