

NIST Agency Report -- CEOS WGCV 26

October 31- November 2, 2006
Chiang Mai, Thailand
Raju Datla

Optical Technology Division
Physics Laboratory
National Institute of Standards and Technology
<http://physics.nist.gov/Divisions/Div844/div844.html>

Outline

- Earth Observing System (EOS)
- National Polar-orbiting Operational Environmental Satellite System (NPOESS) & NPOESS Preparatory Project (NPP)
- Geostationary Operational Environmental Satellite (GOES)
- Collaborations
- Recommendations to Plenary

NIST Activities for the EOS Program

- Aperture area comparison—at final set of measurement activities **Continuing** (with JPL/ACRIM)
- Preparations are underway for Laboratory comparison for Total Solar Irradiance (TSI) between NIST, TIM, ACRIM, DIARAD, PMO6V in irradiance mode.
- **Preliminary characterization of SIM Instrument at the SIRCUS Facility resolves most of the discrepancy between the SIM measurements and the Thullier/SOLSPEC measurements.**
- Limited comparison between NIST and TIM, and only in power mode is scheduled for November 17th, 2006.



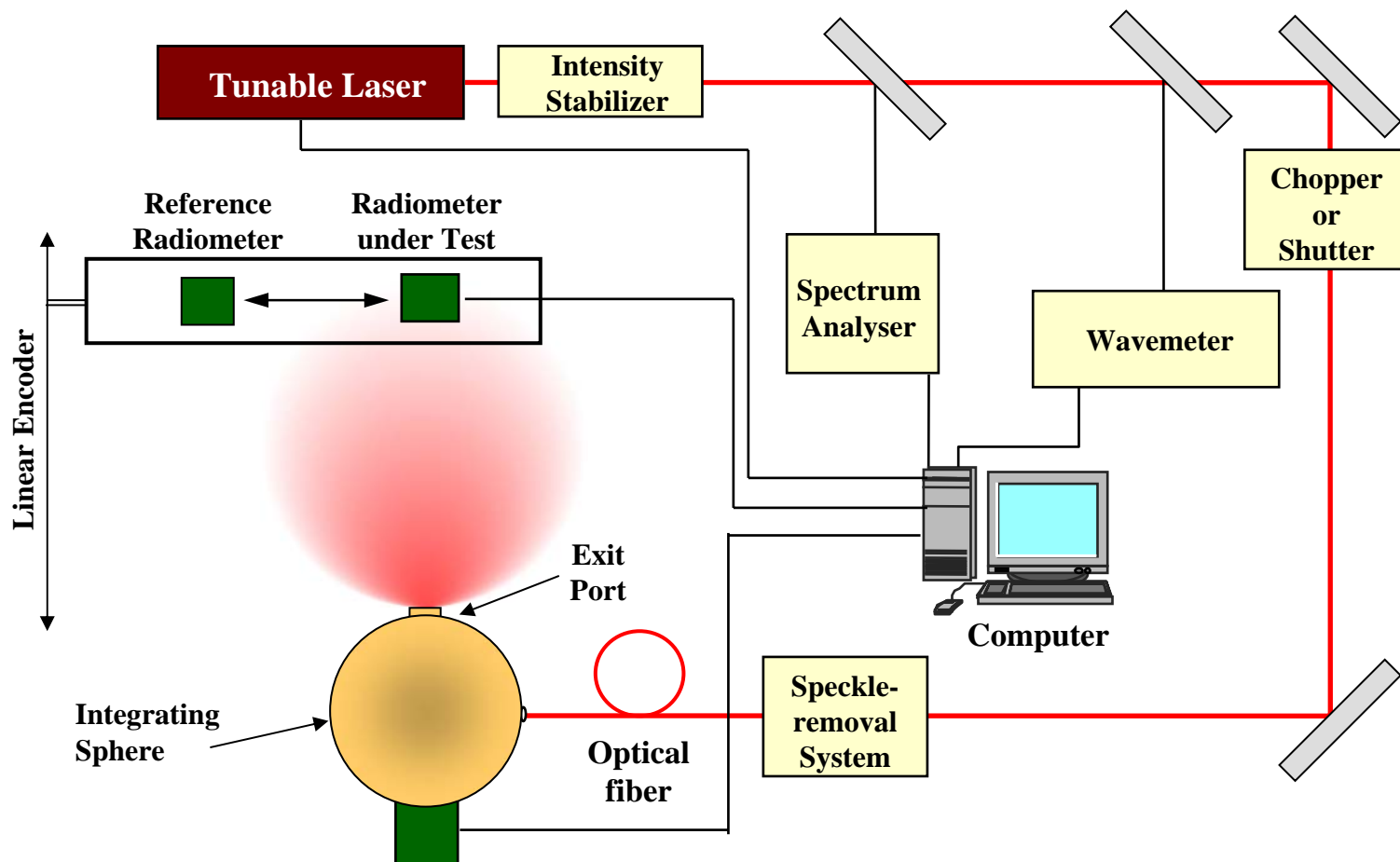
Characterization of SIM on SIRCUS

Characterization Team

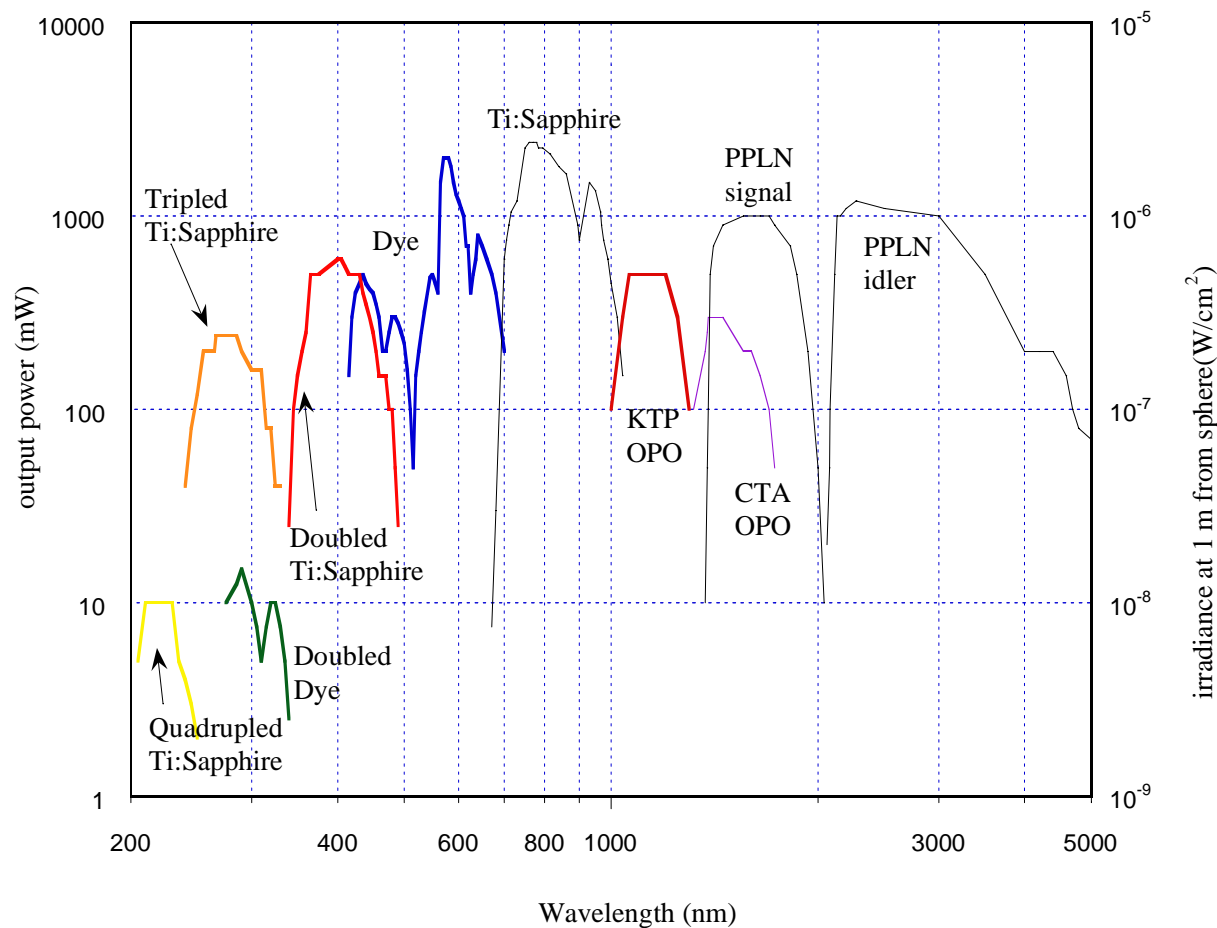
- LASP
 - Jerry Harder, Erik Richard, and Nate Miller
- NIST
 - Keith Lykke, Steve Brown, Robert Bousquet, and Joe O'Connell

SIRCUS Facility

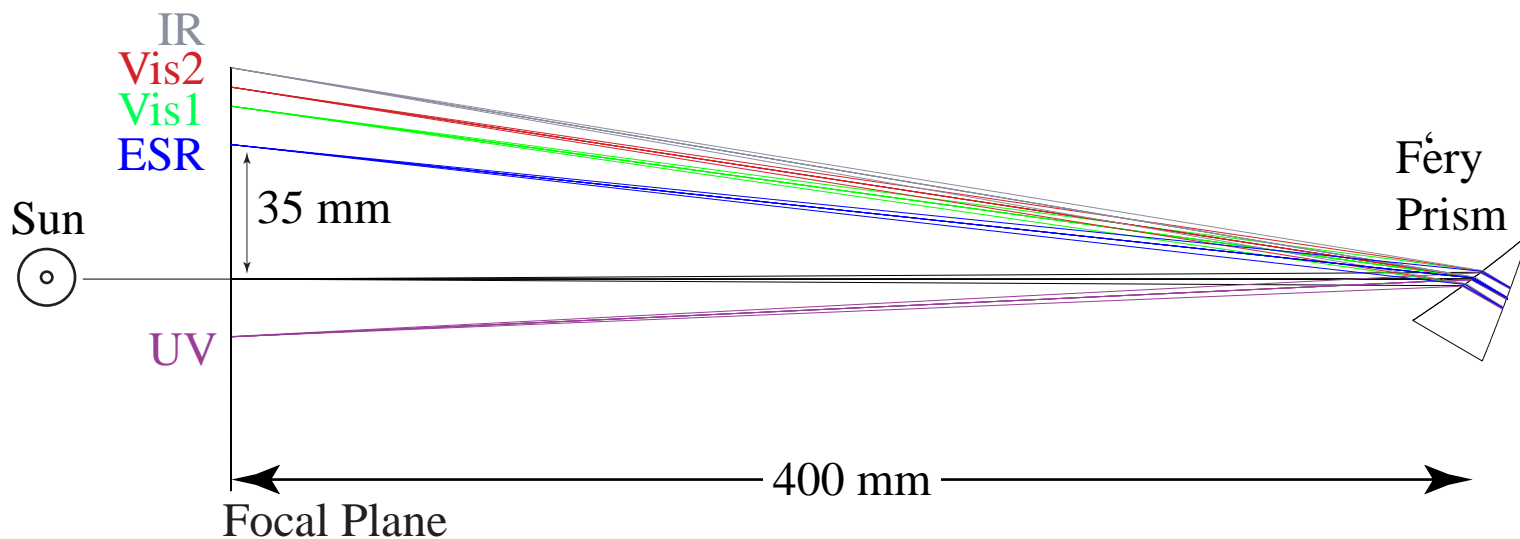
Spectral Irradiance and Radiance responsivity Calibrations using Uniform Sources



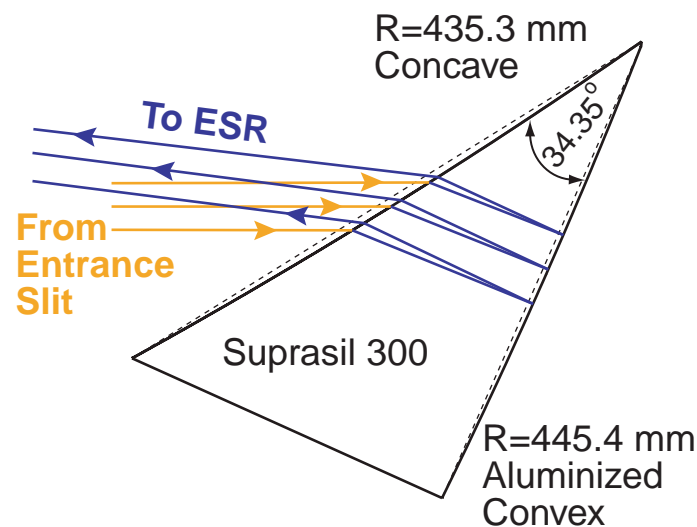
SIRCUS Lasers & Powers



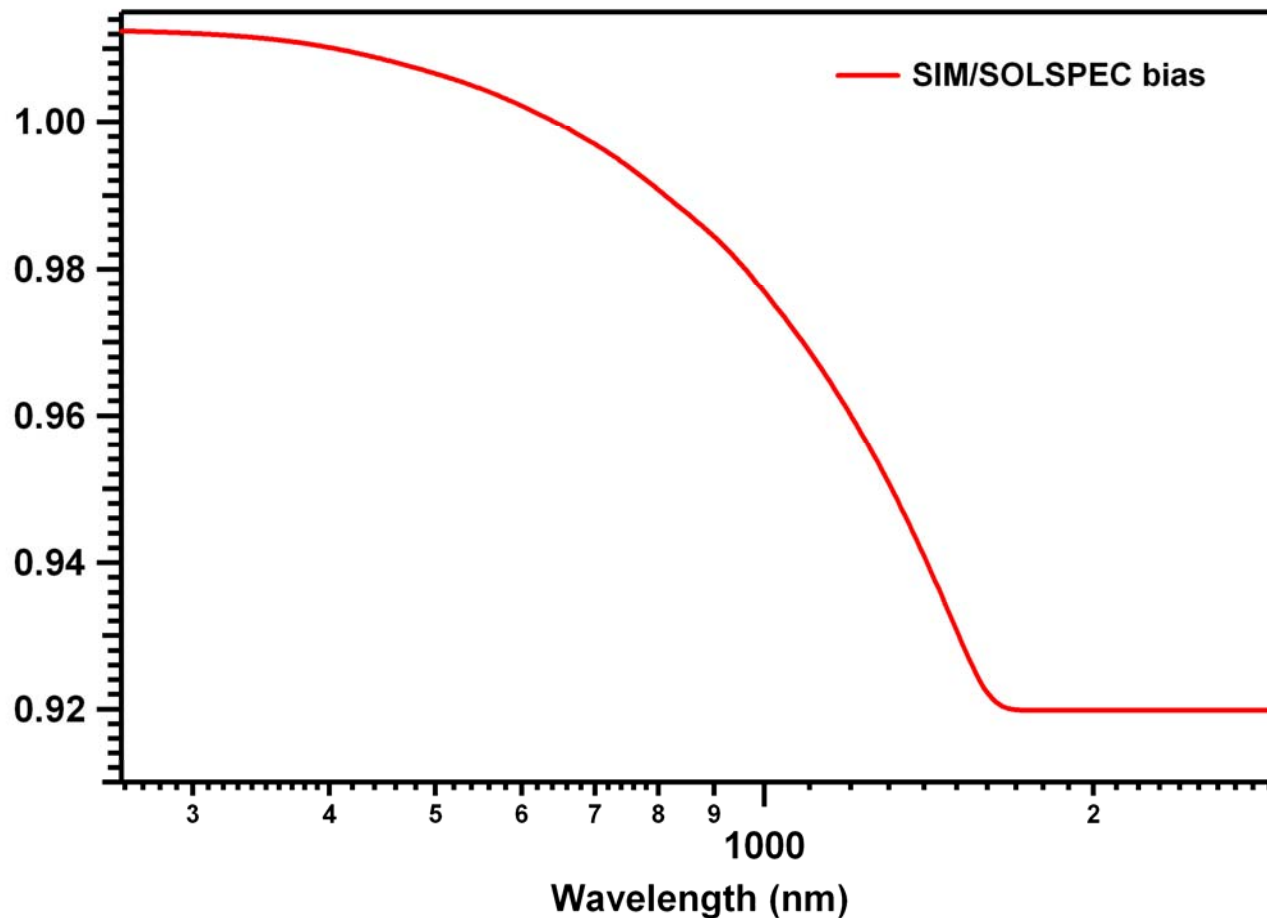
SIM Optical Properties Overview



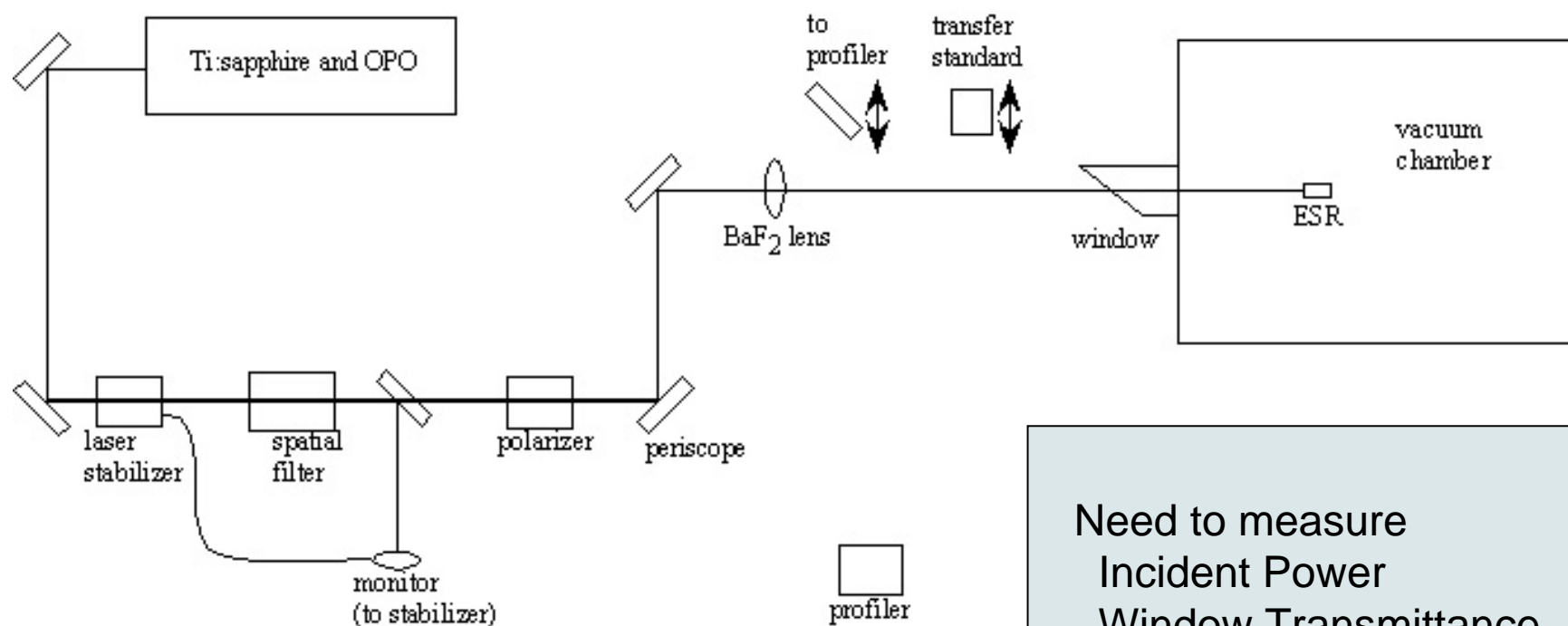
Optical Characteristics	Value
Resolution (nm)	0.25-34
Resolving Power	800-30
Spectrometer f/#	f/16
Solar f/#	f/115
Prism Aperture (mm)	25 × 18
Effective Focal Length (mm)	400
Slit Sizes (mm)	7 × 0.3
Scan Range in Focal Plane (mm)	70
Optical Aberrations at Exit Slit (μm)	5
Diffraction Correction (%)	0.3-2.2



The ESR Problem: SIM disagrees with SOLSPEC



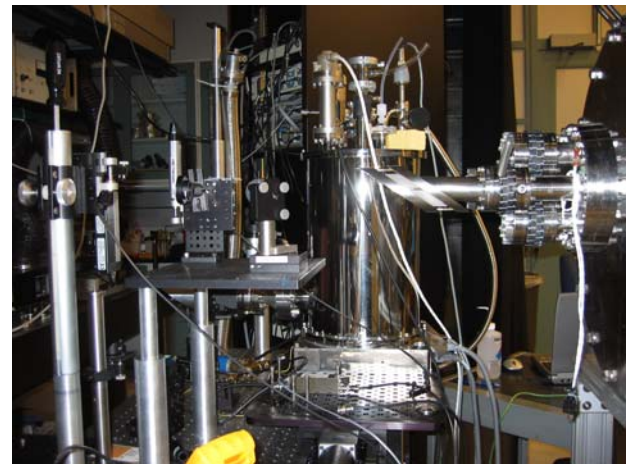
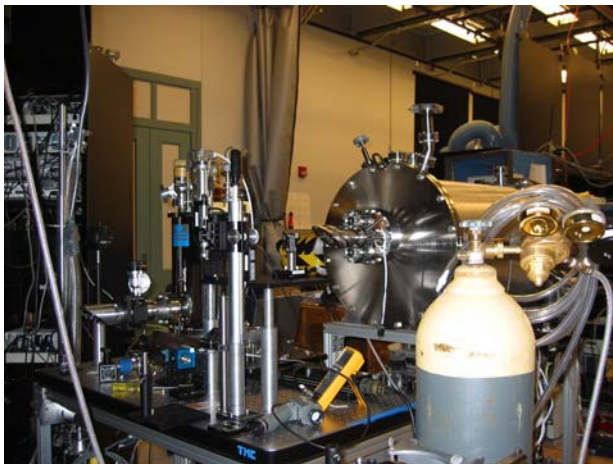
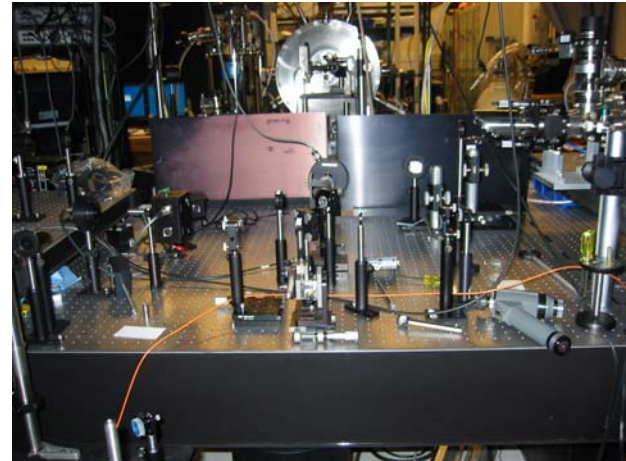
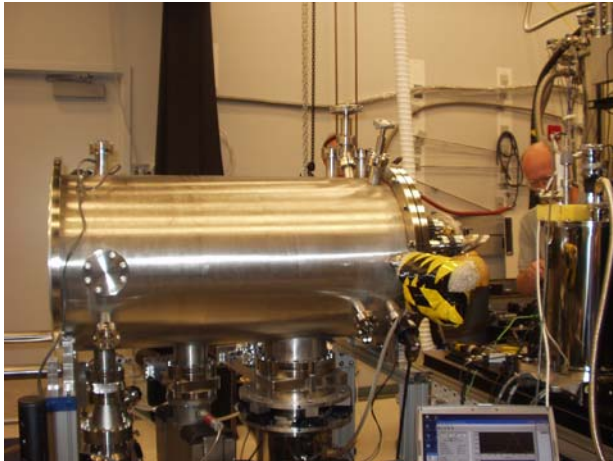
SIM ESR Responsivity: Setup



Keep track of laser spot size
and incident direction

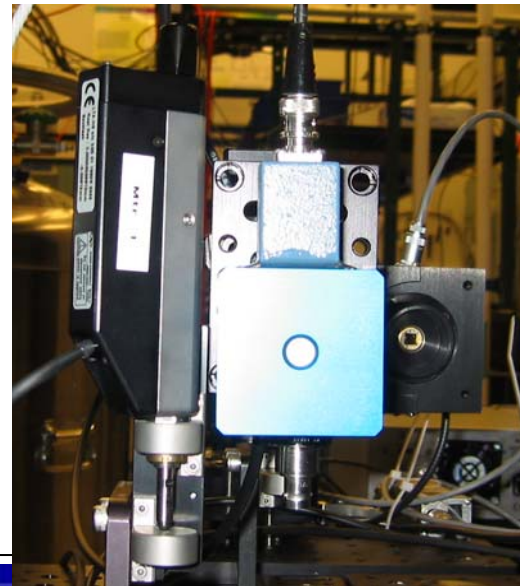
Need to measure
Incident Power
Window Transmittance
to get
Power on the ESR

SIM ESR Setup Pictures

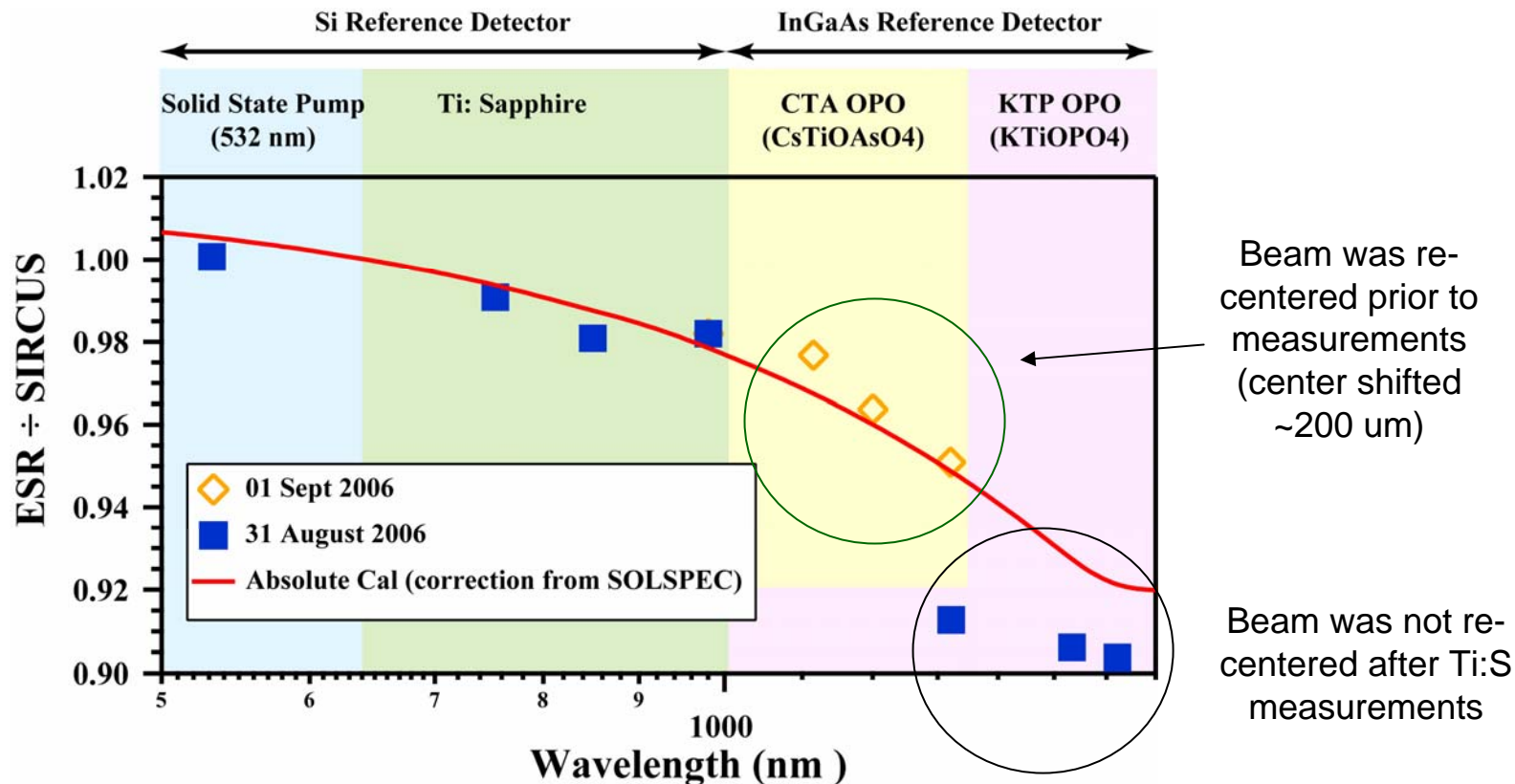


Incident Power

- Measured with integrating sphere receiver with Si and InGaAs photodiodes
- Calibrated directly against a cryogenic radiometer



Preliminary ESR Efficiency Results



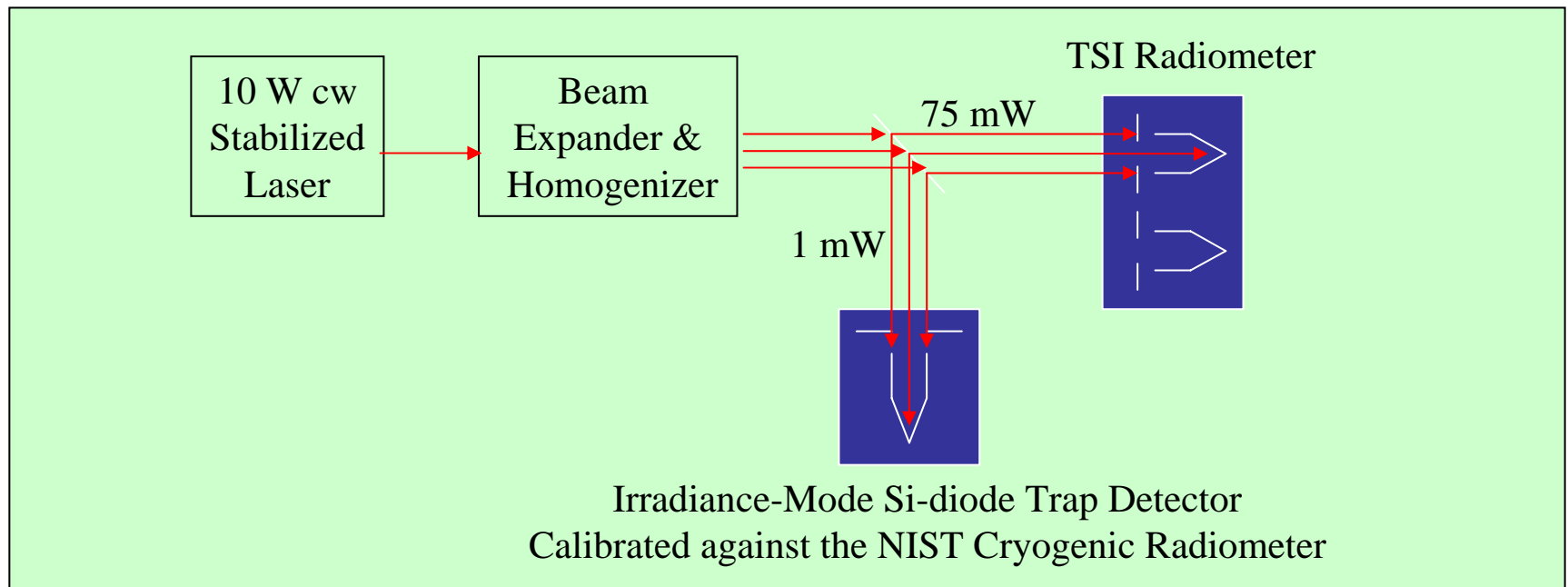
- Centering laser beam on bolometer critical (mapping); must be done with every laser change
- Brewster window improvements needed, transmittance should be measured prior to comparison w/ detector to save time with instrument
- Greater point density, extended coverage on both sides would be useful

Future Work on SIM

- Worthwhile repeating the measurements
 - SIM:
 - Extend slit scatter function measurements into the UV & IR
 - Look more closely at baseline scatter level
 - ESR:
 - Extend the spectral coverage to UV & IR
 - Establish the uncertainty in the measurements
- Timing for those measurements:
 - TBD, but currently planned for December 06-January 07

TSI Instrument Comparison at NIST

- Direct system-level comparison with representative TSI radiometer in a vacuum chamber.
- Beam expander for variable beam diameters up to 15 mm: both irradiance and power modes.
- Homogenizer produces a top-hat profile: simulates solar irradiance geometry.
- Beamsplitter ratio (transmittance/reflectance) measured in a separate step.

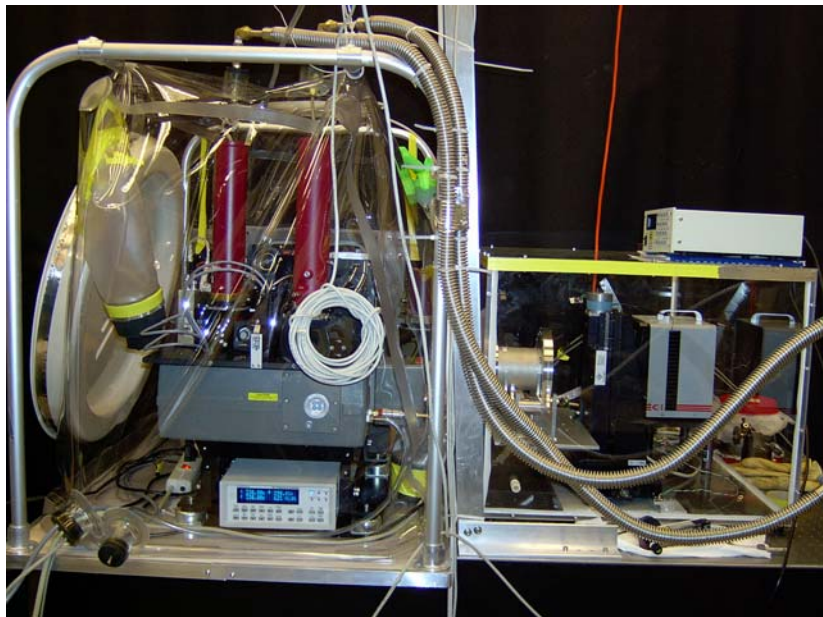


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Calibration Support for CrIS*

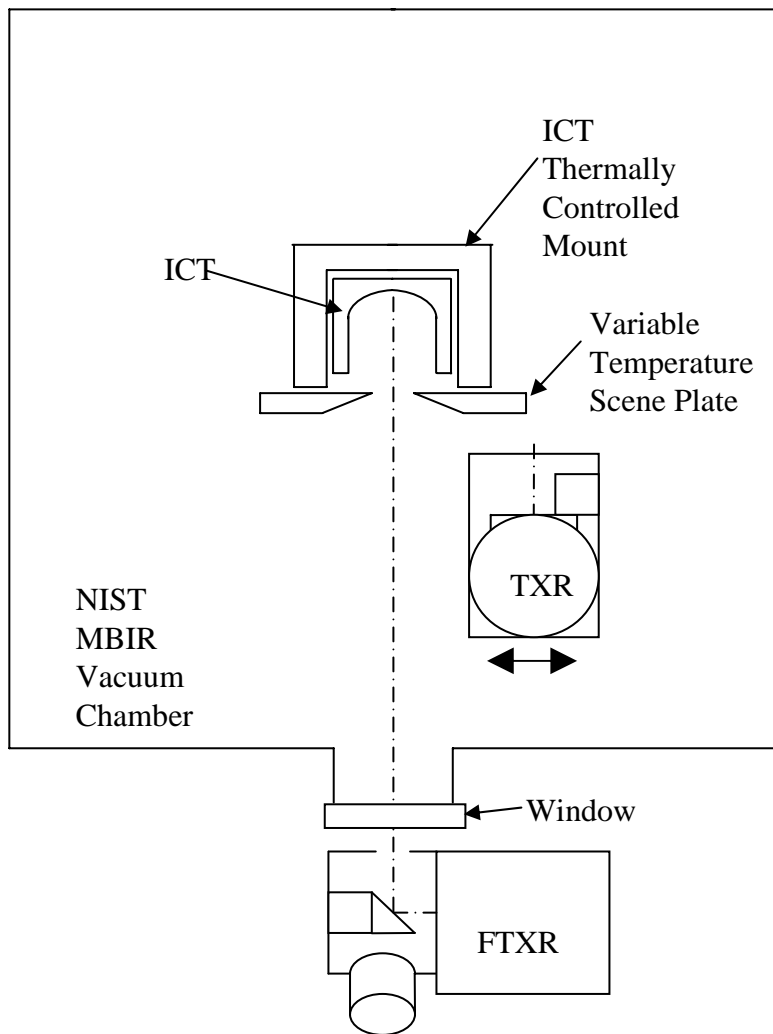
- NPP/NPOESS CrIS blackbody: Planned study at the NIST MBIR Facility.
 - A preparatory experiment **is completed** with NIST blackbody in the MBIR Facility **and the data is being analyzed**.
 - The CrIS ECT blackbody testing is expected to take place in FY07.
 - The CrIS ICT blackbody testing is planned for FY08



*Cross-track Infrared Sounder (CrIS)

The NIST FTXR

Test for NPOESS CrIS Calibration Blackbody (ICT)



- Purpose is to validate vendor's radiance scale.
- TXR is a filter radiometer.
- FTXR is an FTIR spectroradiometer.
- CrIS blackbody and TXR are in vacuum.
- FTXR views blackbody thru window.
- ICT controlled over its temperature range and radiometers measure emitted radiance.
- Separately, by widely varying temperature of the Scene Plate in front of the ICT, reflected radiance from the ICT is measured and used to infer ICT emissivity.

Characterization Support for VIIRS*

*Visible/Infrared Imager/Radiometer Suite (VIIRS)

- Half Angle Mirror: infrared reflectance scale comparison
 - NIST instrument **upgrade** with BIB detector **to cover the LWIR range is completed.**
- Bi-directional reflectance distribution function (BRDF)
 - Measurements of samples (UV, Vis, Near IR)
 - Consultation on reflectance scales **is continuing**
- System testing through the solar view aperture
 - “Apparent” BRDF of VIIRS solar diffuser target

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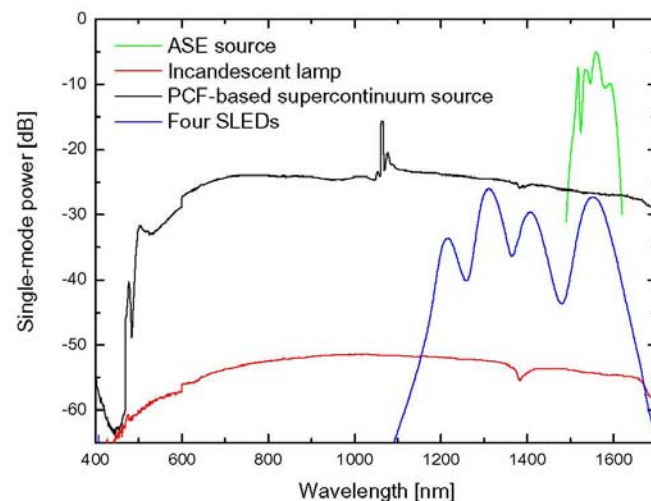
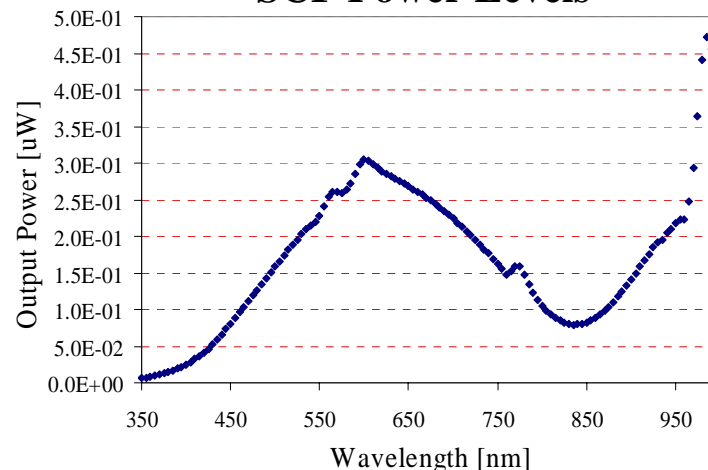
Novel Sources for GOES-R

Supercontinuum Sources for Metrology

Replace Lamps in lamp/monochromator systems

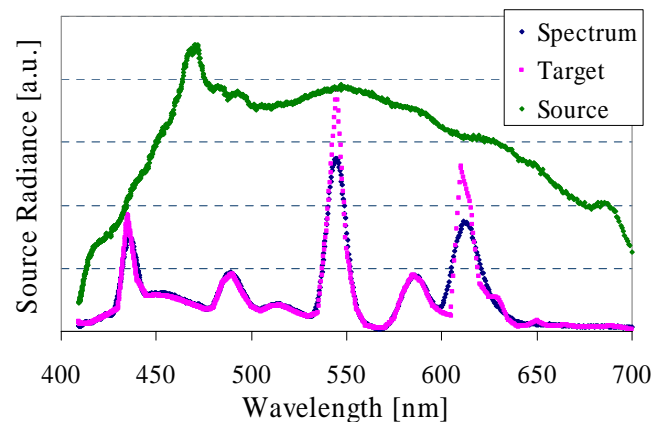
- **Power**
 - SCF < 1 $\mu\text{W}/4\text{ nm}$
 - SCS > 4 mW/1 nm
- **Stability**
 - ~ 0.1 % over several hours
- **Resolution determined by entrance/exit slit**
 - SCF: 1 mm
 - SCS – single mode fiber: 10 μm
- **Spectral range**
 - 450 nm to 2000 nm (commercial)
 - 380 nm to 3000 nm (demonstrated)
- **Emerging technology**
 - Originally developed for telecommunications industry
 - Expect specifications to improve while cost is reduced

SCF Power Levels

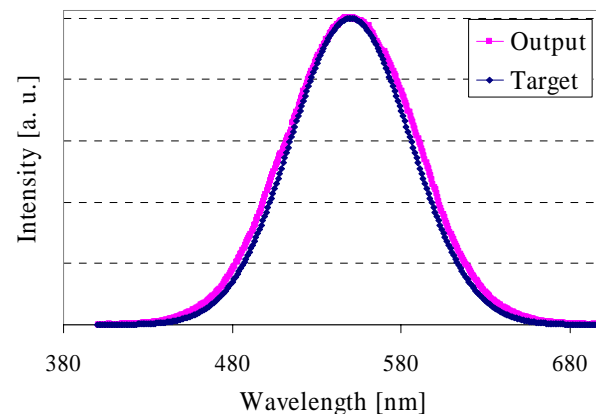


Application-Specific Sources – Digital Micromirror Device

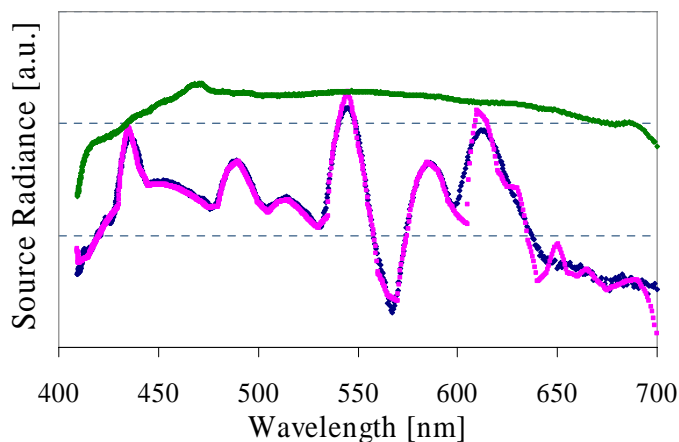
Tri-phosphor Lamp



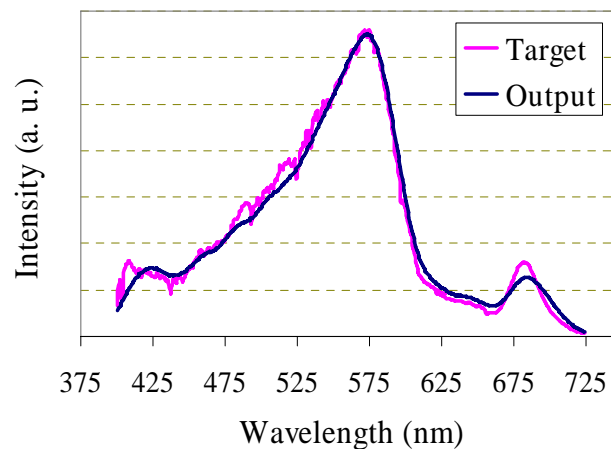
Gaussian



Log Scale



Ocean Color



Tidal Photonics, Inc.

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Collaborations

NIST and Space Dynamics Laboratory at USU started collaboration to work towards SI traceability for Space Based Sensors.

- Joint Proposal at the workshop on “Achieving Satellite Instrument Calibration for Climate Change” (ASIC3) (May 2006)
 - **LUSI** (Lunar Spectral Irradiance)
A New Program to Reduce the Uncertainty in the Absolute Lunar Spectral Irradiance

Project Summary

- NIST continues to collaborate with Earth observing programs to assess the accuracy of the radiometric characterization and calibration of flight sensors, as well as field equipment.

EOS

Jim Butler, NASA/GSFC cal/val lead

Primary efforts, FY07: TSI, TIM, SIM, stray light algorithms, prepare for lunar radiometry scale validation

NPOESS and NPP

Karen St. Germain and Steve Mango, IPO

Primary efforts, FY07: CrIS blackbody at NIST with TXR, VIIRS reflectance scale, publication of TXR verification of SBRs VIIRS blackbody radiance

Ocean Color (NOAA/NESDIS)

Menghua Wang, NOAA/NESDIS, Ken Voss, UM, Carol Johnson & Dennis Clark, NIST

Primary efforts, FY07: MOBY operations, Instrument development for vicarious calibration
NPP/NPOESS & GOES-R

GOES and GOES-R

Michael Weinreb, NOAA/NESDIS

Primary efforts, FY07: Plan for ABI calibration verification efforts; application of TXR measurements of the GOES Imager blackbody source; novel source development, Participate in GOES-R reviews

- Collaboration with NOAA for participating in the implementation of GSICS
- Collaboration with USU/SDL for SI traceable Space based Radiometry

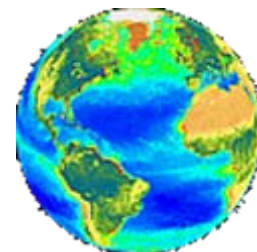
Recommendations to Plenary

Incorporate MOON irradiance measurements for VIS/NIR instruments in remote sensing space satellites for their calibration and stability monitoring.

Acknowledgements

NIST Optical Technology Division Collaborators

- Leaders of the NIST Calibration Effort
 - Carol Johnson
 - Joe Rice
 - Steve Brown
- Other NIST Collaborators
 - David Allen
 - Raju Datla
 - Charles Gibson
 - Toni Littorja
 - Keith Lykke
 - Al Parr (Division Chief)
 - Jim Proctor
 - Bob Saunders
 - Howard Yoon



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