Spectral and Radiometric Calibration using Tunable Lasers

Completed Technology Project (2012 - 2013)

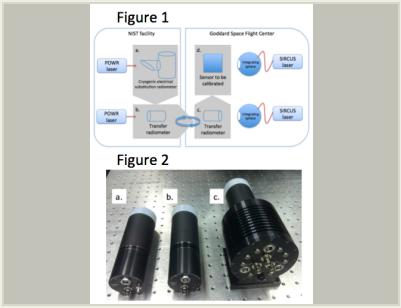
Project Introduction

The task is to develop Spectral Irradiance and Radiance Responsivity Calibrations using Uniform Sources (SIRCUS), thereby providing GSFC with capacity of state-of-the-art radiometric calibration, and validate this ability by providing absolute radiometric calibration and spectral characterization for three GSFC-based sensors. This task will develop the calibration light source (SIRCUS), a system for maintaining NIST-traceability via transfer radiometers, and a demonstration of this capability by calibrating and intercomparing three, passive optical sensors developed at GSFC: ORCA, SOLARIS, and G-LiHT.

SIRCUS-based calibration relies on a set of monitoring radiometers and tunable laser sources to provide an absolute radiometric calibration that can approach uncertainties <0.3%. The output of the sources is determined via detector standards characterized against the Primary Optical Watt Radiometer (POWR). The source is monochromatic in nature allowing the absolute spectral response of the sensor under study to be determined. Bringing this capability to GSFC requires two critical parts that are proposed here: 1) the light source (SIRCUS) and 2) a system to maintain the NIST-traceability of the transfer radiometers. Once these are established, measurement protocols and readiness to calibrate future sensors will be demonstrated by providing absolute radiometric calibration to ORCA, SOLARIS, and G-LiHT. For background Figure 1 illustrates the traceability of a SIRCUS, in which the transfer radiometer is the linchpin of the entire system. Absolute calibration of the transfer radiometer allows SIRCUS to achieve accurate absolute radiometric calibration of other sensors. This process is illustrated in the left side of the figure, all of which takes place at NIST. Briefly, the transfer radiometer is calibrated using the POWR laser. Traceability of the POWR laser calibration is through the helium-cooled substitution radiometer (Fig. 1a) that determines the amount of electric power needed to match the amount of optical power from the laser. The end result is that the transfer radiometer is absolutely calibrated with an uncertainty <0.09% (3σ). A periodic calibration of the transfer radiometer at NIST facilities or a certified substitution radiometer is performed to maintain this level of accuracy. SIRCUS is the light source enabling the transfer of calibration of the transfer radiometers to the sensor to be calibrated (Fig. 1c to Fig. 1d). These efforts make use of a recently obtained traveling SIRCUS that resides at GSFC's Optical Characterization Laboratory (OCL) in Building 5. This task will supply the necessary funding to develop the technical expertise and obtain the optical components to properly operate SIRCUS.

Anticipated Benefits

Once a SIRCUS facility and associated system for transfer radiometer calibration is developed at GSFC, it will be available for use by NASA's current and future multispectral imagers and imaging spectrometers. This task will make possible 0.3% absolute radiometric calibration with small cost and



Project Image ROE 94 ES Spectral and Radiometric Calibration using Tunable Lasers

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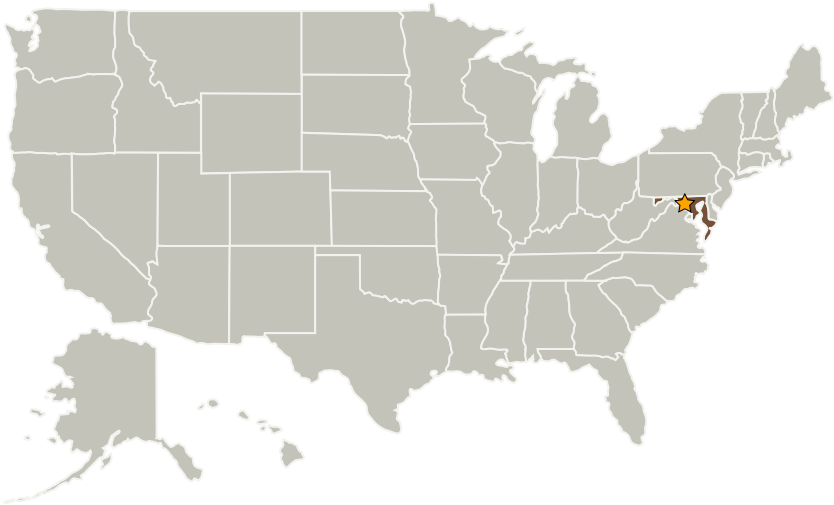
schedule impact to missions such as JPSS2-VIIRS, ACE, CLARREO, HyspIRI, and eMAS.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Co-Funding Partners	Type	Location
National Institute of Standards and Technology(NIST)	US Government	Boulder, Colorado

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

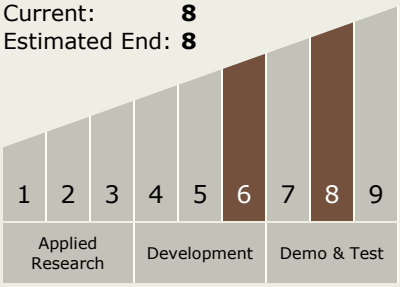
Matthew J Mcgill

Principal Investigator:

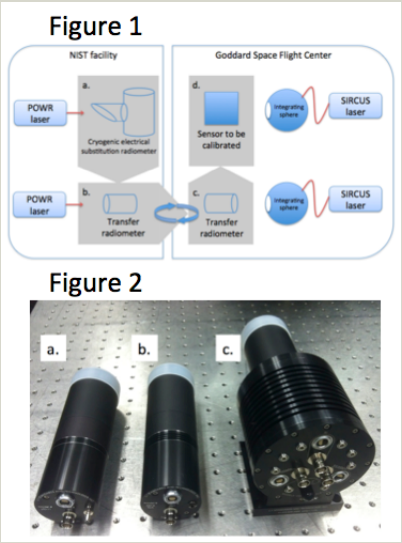
Joel T Mccorkel

Technology Maturity (TRL)

Start: **6**
Current: **8**
Estimated End: **8**



Images



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Project Image ROE 94 ES Spectral and Radiometric Calibration using Tunable Lasers
(https://techport.nasa.gov/image/1884)

Project Website:

http://sciences.gsfc.nasa.gov/sed/

Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.1 Remote Sensing Instruments/Sensors