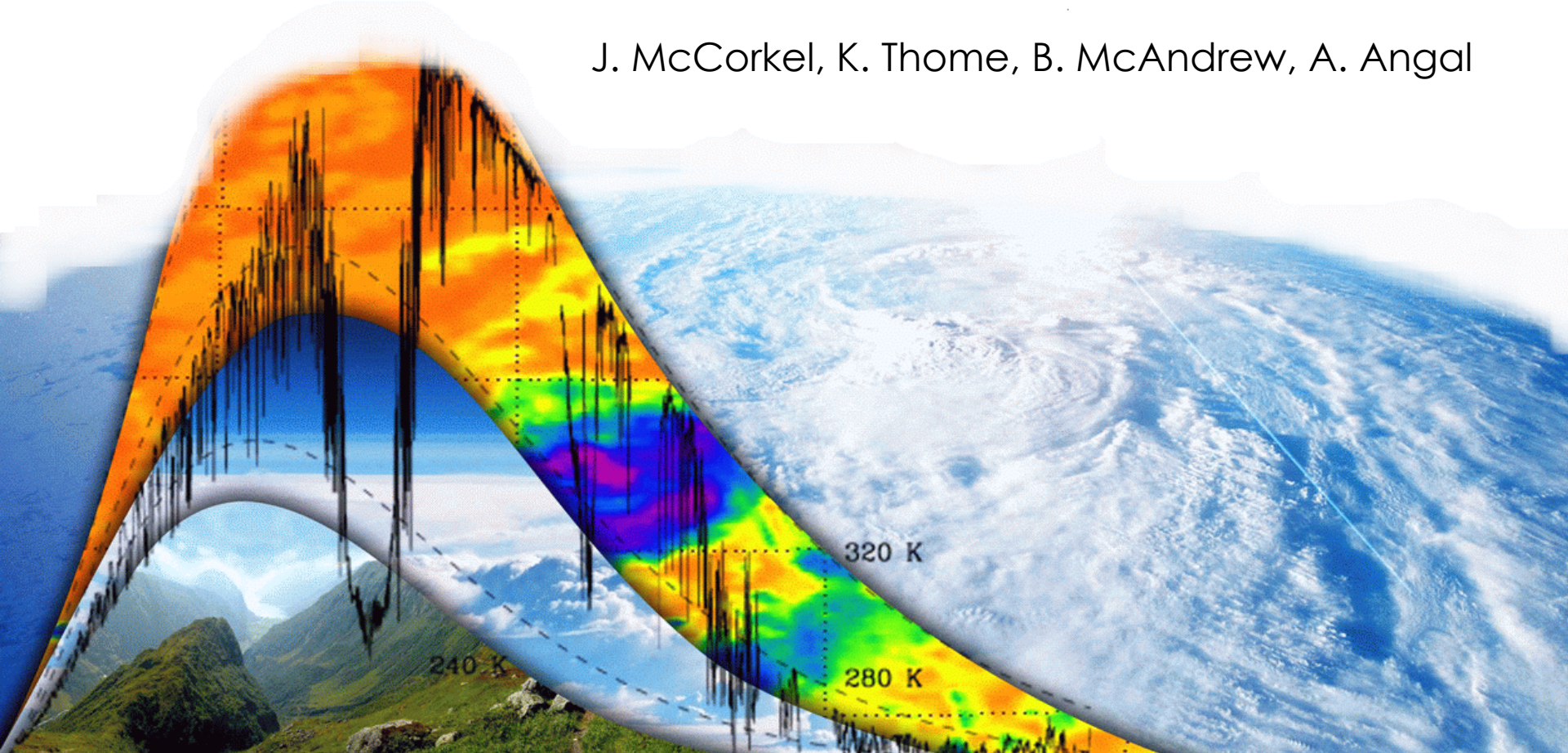
National Aeronautics and Space Administration
Goddard Space Flight Center

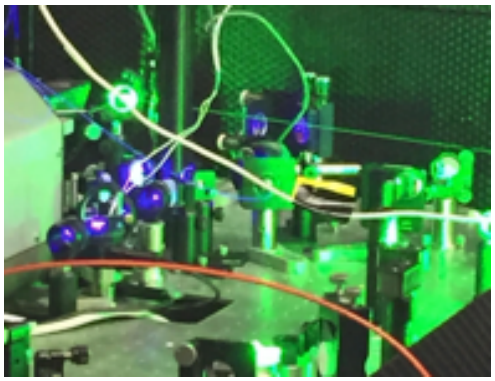
RS CDS activities

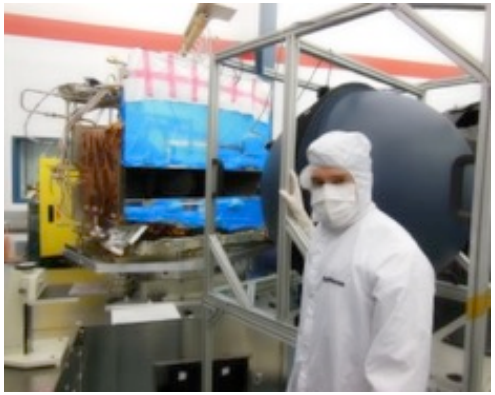
J. McCorkel, K. Thome, B. McAndrew, A. Angal



CLARREO RS GSFC Overview

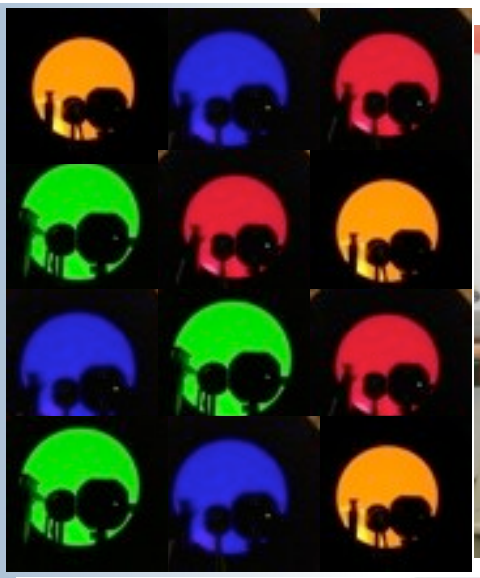
- Past seven months since last meeting has seen work on GLAMR calibration facility, Calibration Demonstration System (CDS) as well as Pathfinder activities
- Coordinating and collaborated with other projects to optimize resources
  - Collaboration with JPSS, team also leading laser-based characterization of J2 VIIRS
  - NIST involvement
- Improvements to laboratory calibration system
  - Automation and robustness
  - Demonstration of SWIR source and radiometers

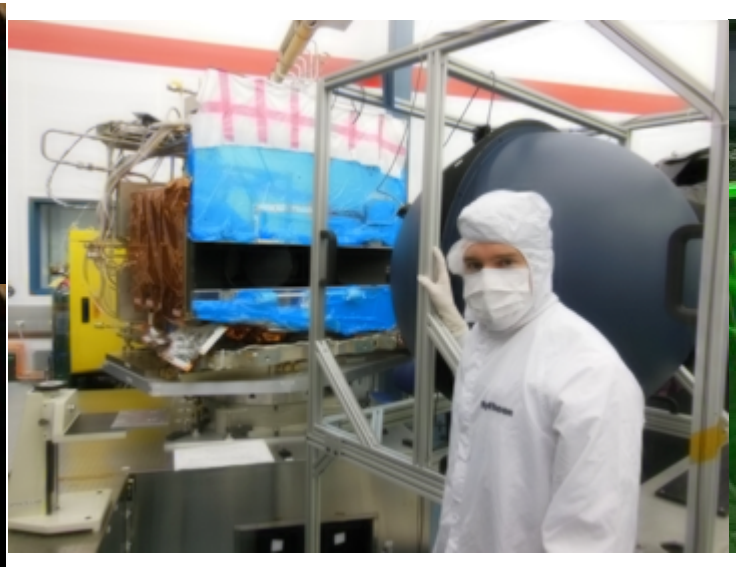


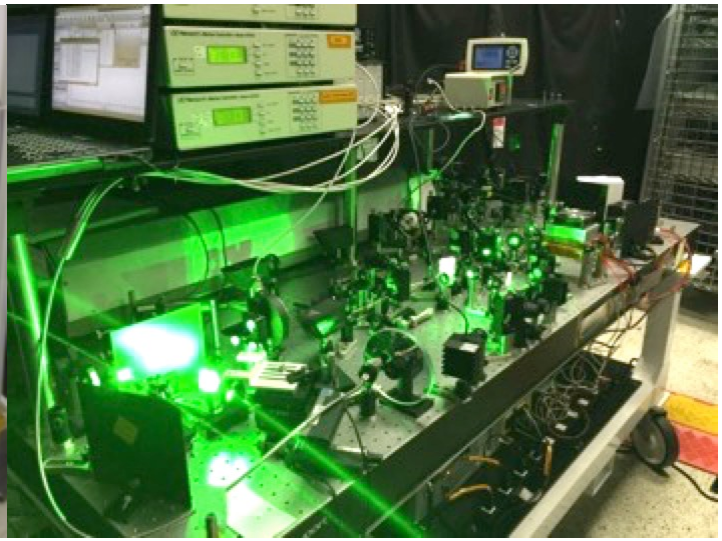


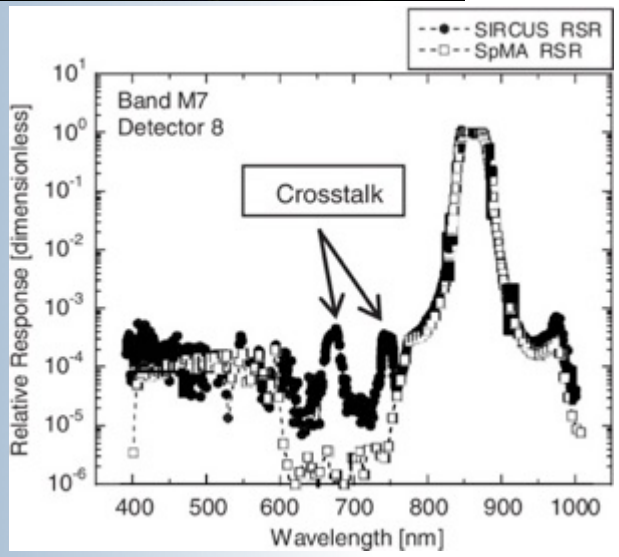
GLAMR

Goddard Laser for Absolute Measurement of Radiance









GLAMR is required for improving instrument model parameterization

- Spectral/radiometric response
- Linearity
- Crosstalk
- Detector-to-detector differences
- Stray/scattered light

JPSS-2,3,4

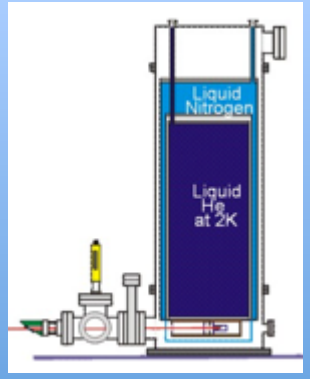
PACE

Landsat 9

PATHFINDER

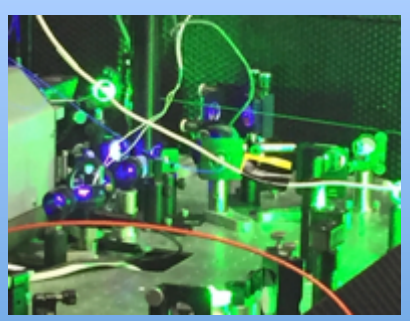
GLAMR Traceability Path

NIST Facility



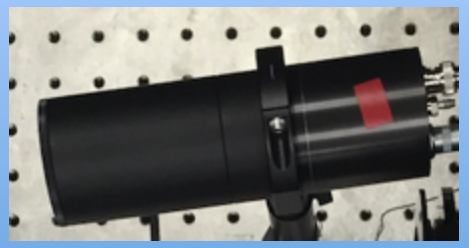
POWR
Primary Optical Watt Radiometer

→



Stabilized laser source is used to transfer radiometric scale from POWR to portable transfer radiometer via another standard radiometer

→

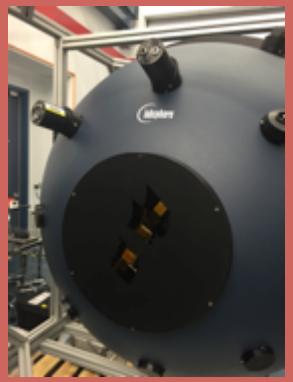


LTD-11 #107
transfer radiometer

Sensor vendor facility

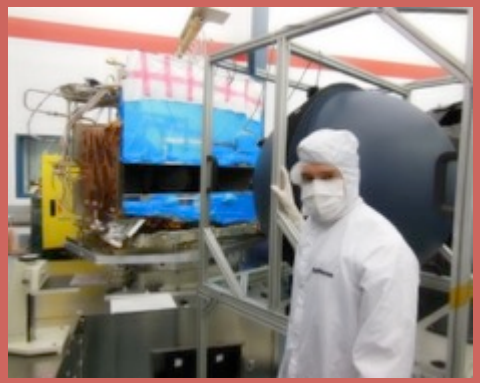
LTD-11 #107
transfer radiometer

→



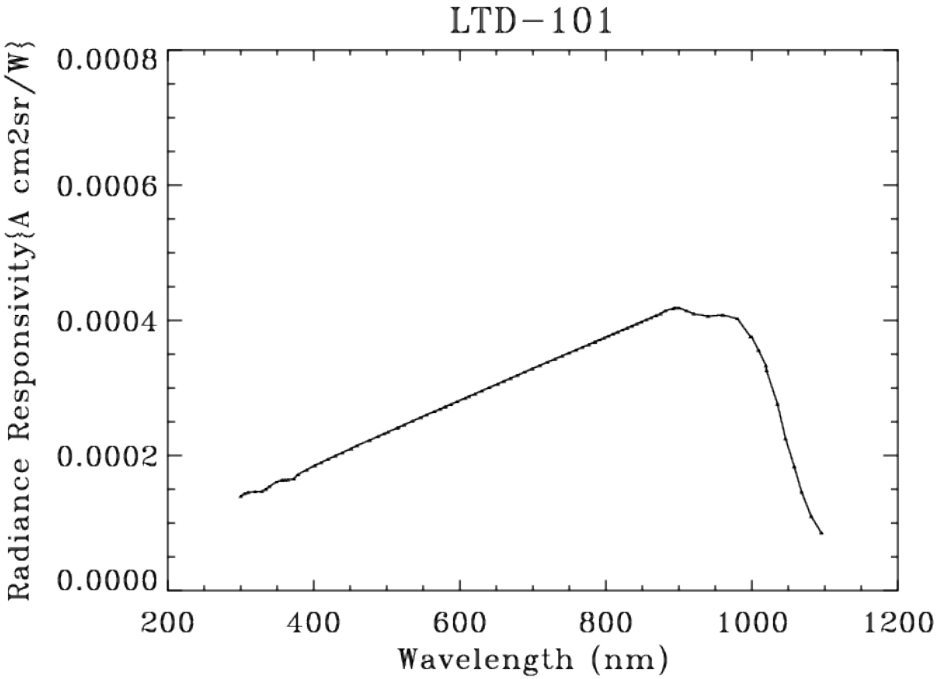
Sphere Monitor

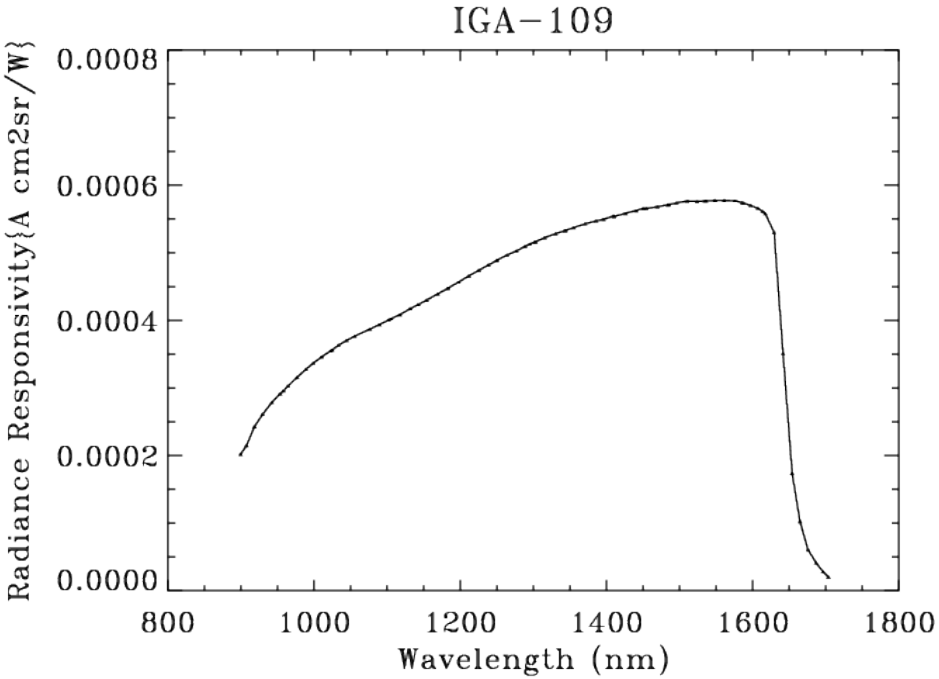
→



Satellite/airborne sensor

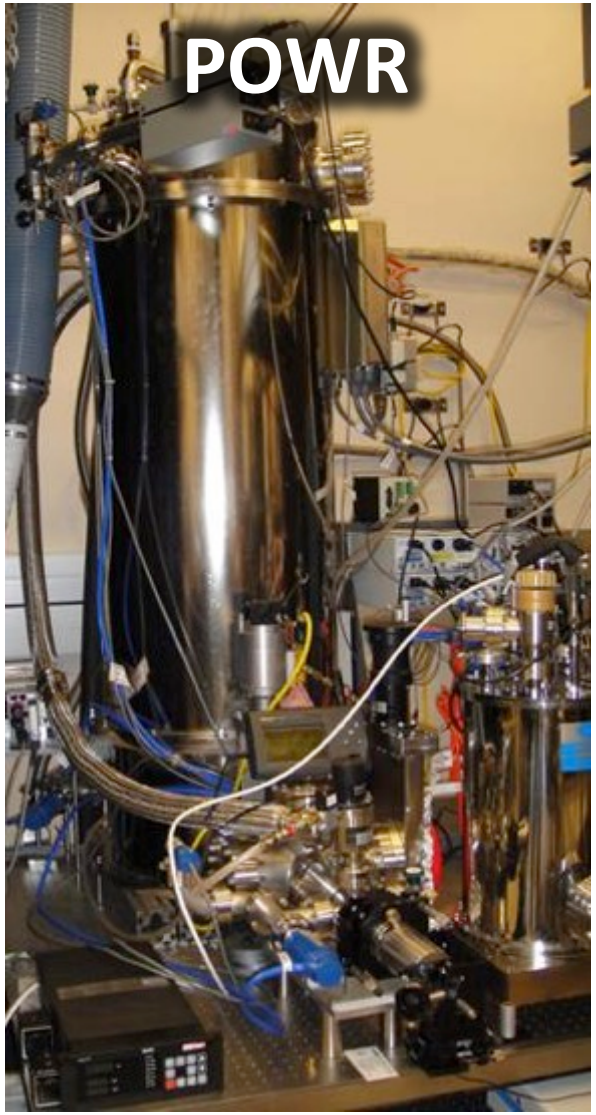
Traceability From NASA's NIST-Calibrated Transfer Radiometers

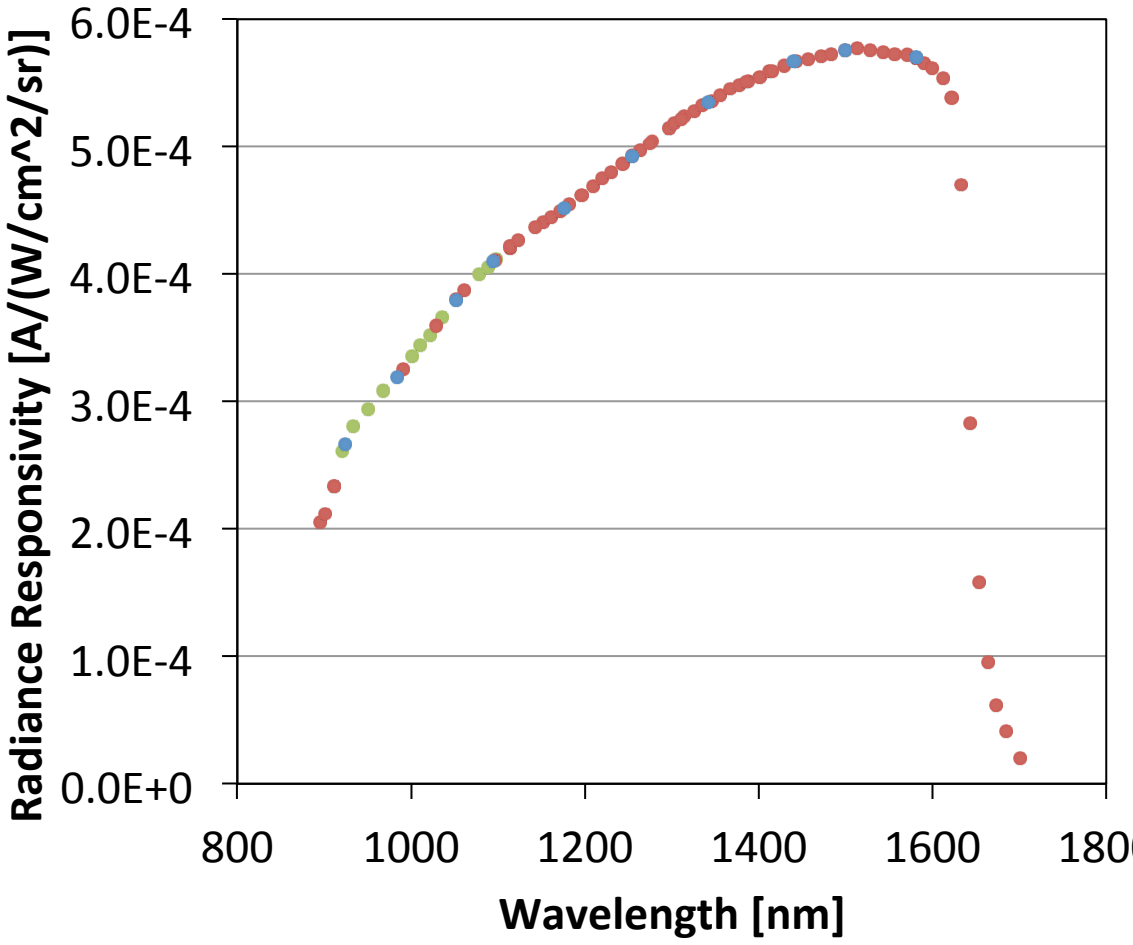




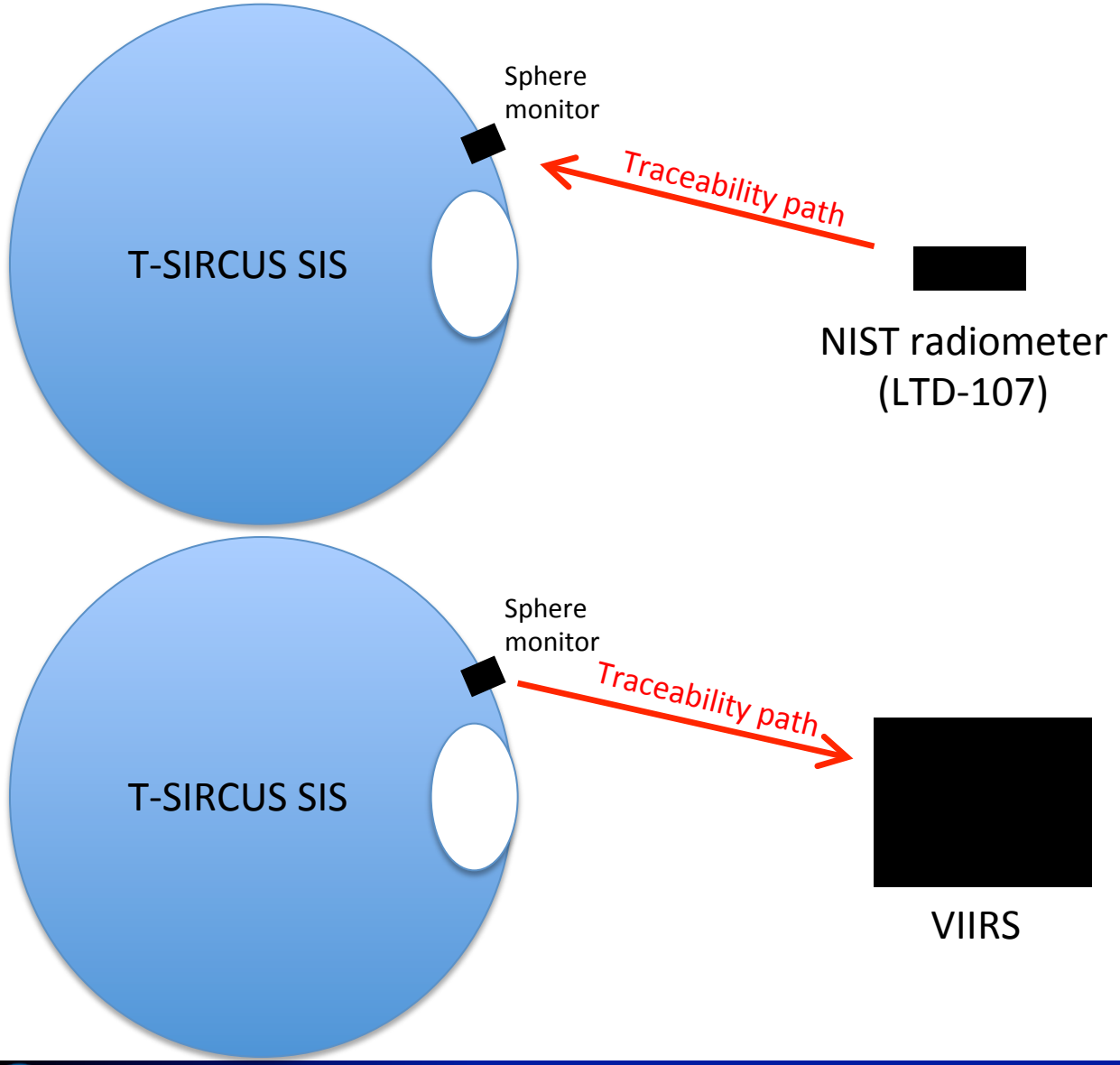
*NIST is currently finalizing calibration of Si, IGA, and Extended IGA transfer radiometers that will be used for J-2 VIIRS

NIST radiometric characterization of NASA transfer radiometer





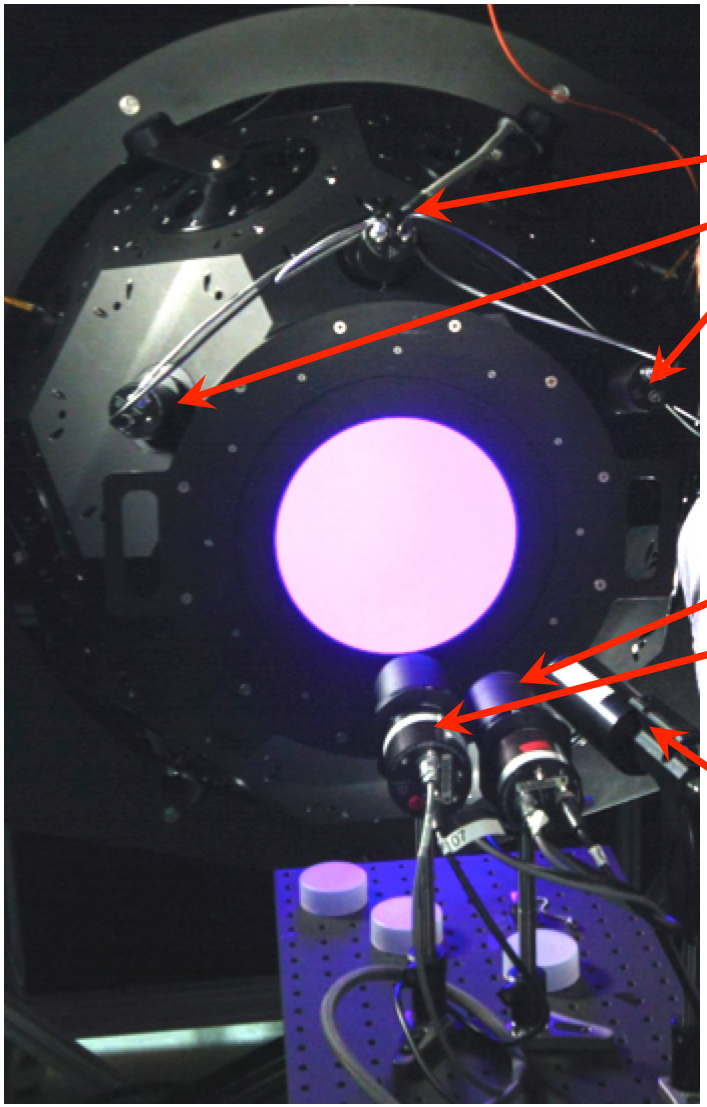
Measurements For Radiometric Traceability



Traceability is transferred from a NIST transfer radiometer to the Sphere monitor during a laser sweep prior to VIIRS calibration.

Traceability is transferred from the Sphere to VIIRS during the spectral responsivity testing.

Sphere calibration



Sphere monitors

- Silicon
- InGaAs
- Extended InGaAs

Transfer radiometers

- Silicon (LTD-11 #101)
- InGaAs (DET-8 IGA #109)
- ASD spectroradiometer

Sphere calibration transfers NIST traceability from transfer radiometers to sphere monitors that have fixed and permanent view of rear of sphere.

Sphere then placed in front of sensor to provide traceable, monochromatic extended source.

Concerns of this transfer include

- Sphere loading
- View geometry effects
- Uniformity

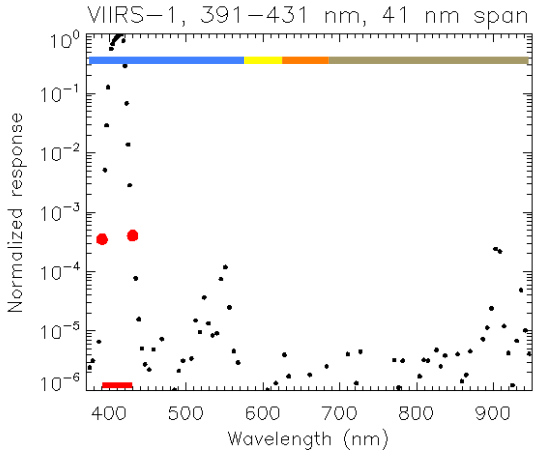
Uncertainty from NIST radiometric characterization of transfer radiometers

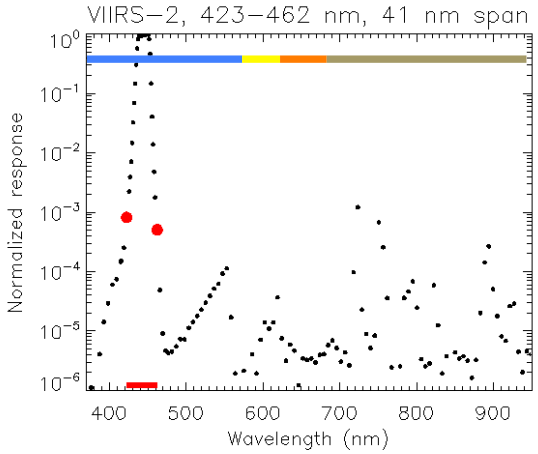
Uncertainty source (%)	300-400 nm	470-870 nm	895-991 nm	1001-1543 nm	1556-1643 nm
Source-radiometer distance	-	-	0.05	0.05	0.05
Geometry alignment	-	-	0.05	0.05	0.05
Amplifier gain	-	-	0.10	0.10	0.10
Reference irradiance cal	-	-	0.50	0.30	0.50
aperture	-	-	0.02	0.02	0.02
Wavelength	-	-	0.01	0.01	0.01
E to L conversion	-	-	0.07	0.07	0.07
Total (k=2)	**0.55**	**0.11**	**1.04**	**0.66**	**1.04**

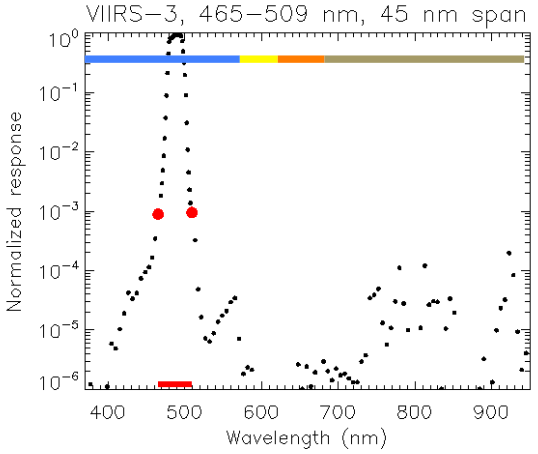
JPSS-2 VIIRS example

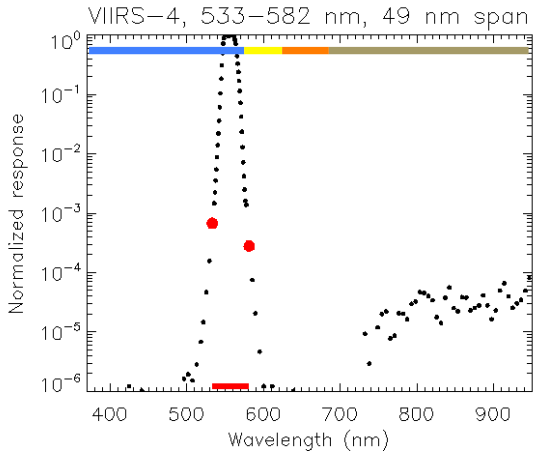
- JPSS-2 VIIRS laser-based characterization will take place summer 2016
  - Vendor site in southern California
  - NASA lasers primary
  - NIST system provides redundancy
  - Traceability relies on transfer radiometers characterized by NIST

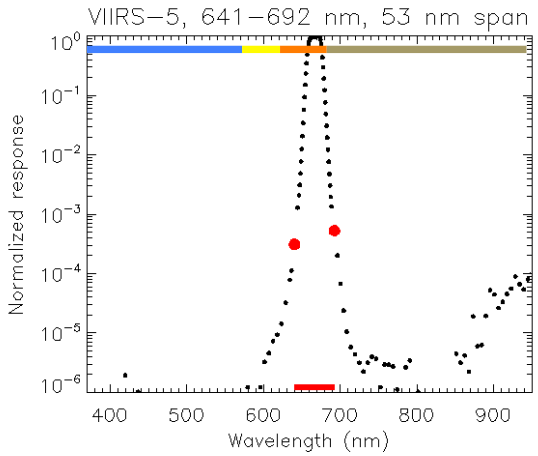
VIIRS VNIR Channels, Red Dots Are 0.1% Points

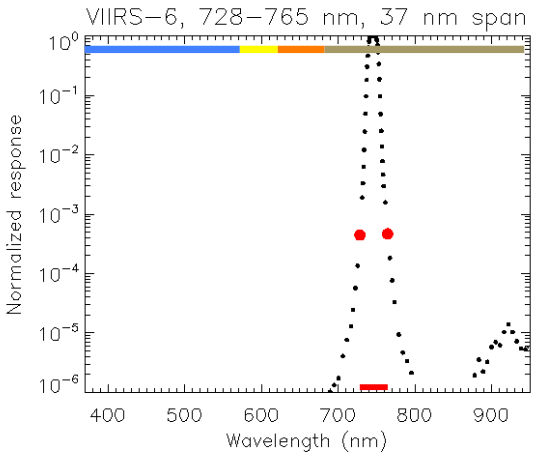


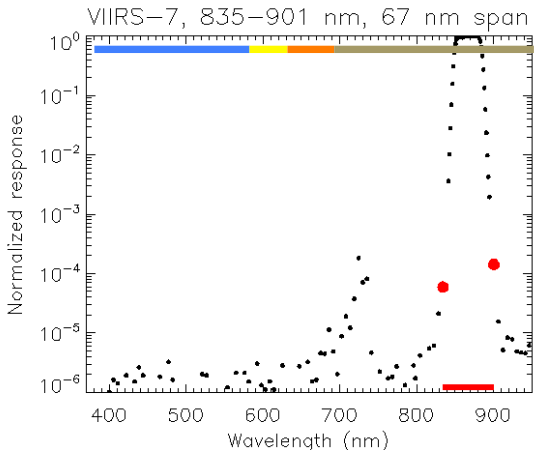












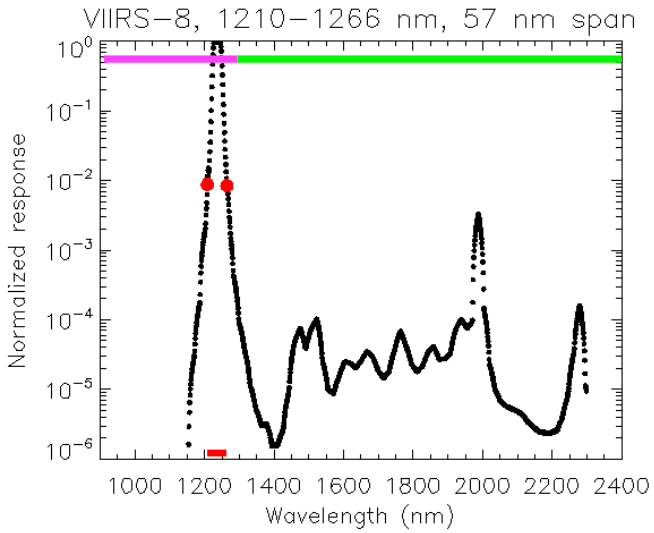
0.001 points (J1 VIIRS *prelim*)

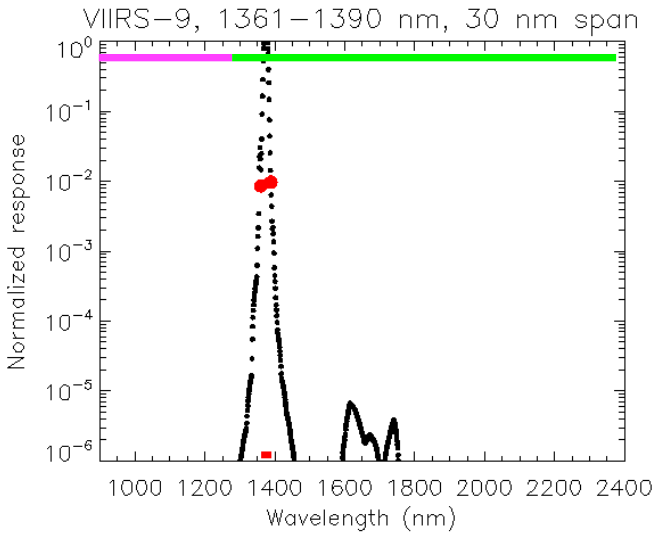
M1	391	431
M2	423	463
M3	466	510
M4	534	582
M5	641	693
M6	729	765
M7	835	901

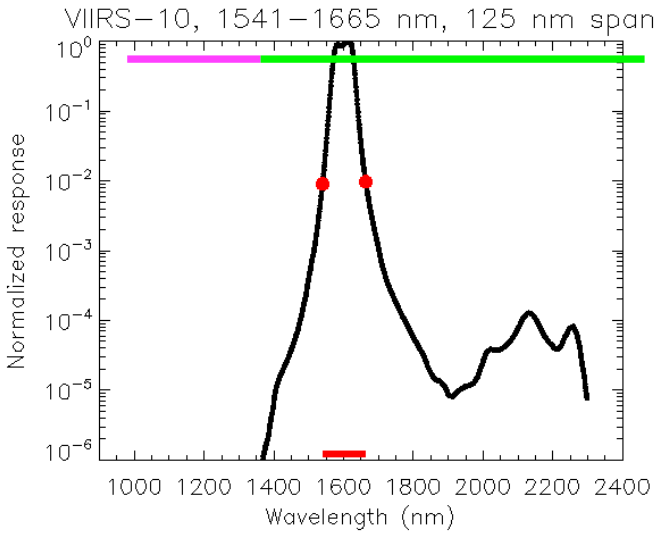
Laser key:

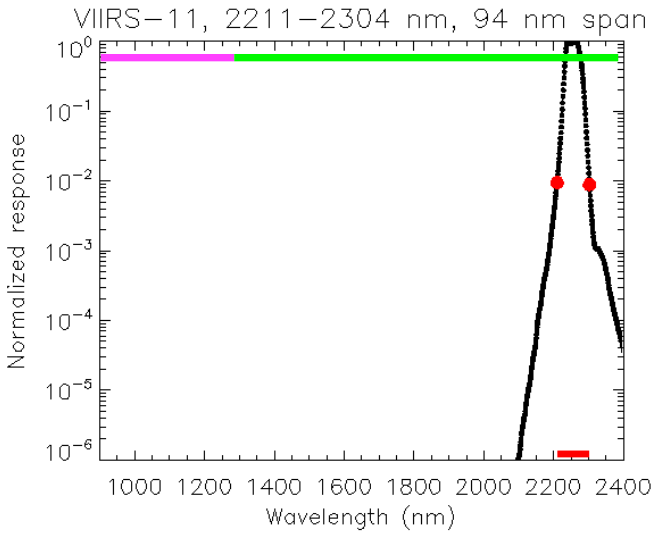
- OPO-NIR-SHG — Backup: NIST
- Dye R6G
- Dye DCM — Backup: OPO-SWIR-SHG; 2nd Backup: Ti:S OPO
- TI:Sapphire — Backup: dye table

VIIRS SWIR Channels, Red Dots Are 0.1% Points









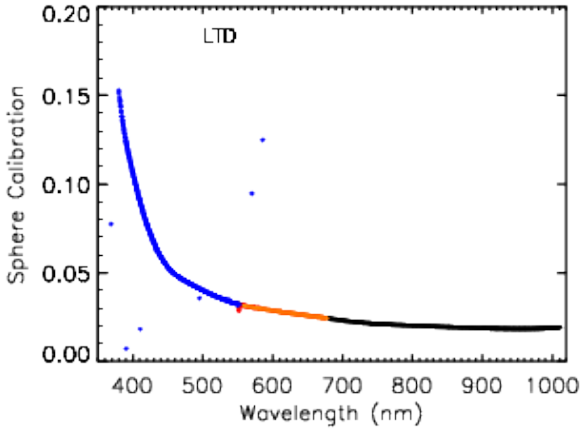
0.001 points (J1 VIIRS *prelim*)

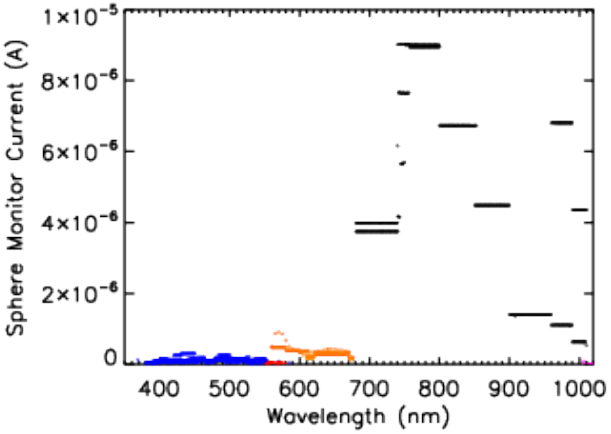
M8	1210	1266
M9	1361	1390
M10	1541	1665
M11	2211	2304

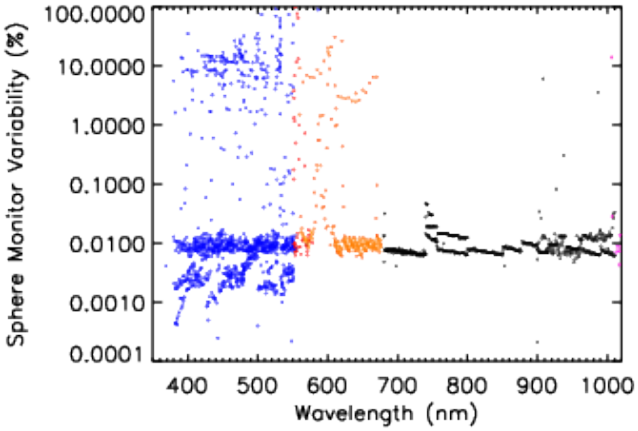
Laser key:

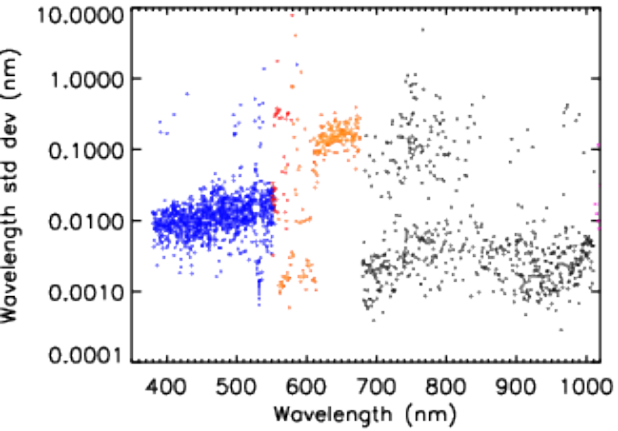
- OPO-SWIR-Idler
- OPO-NIR-Idler

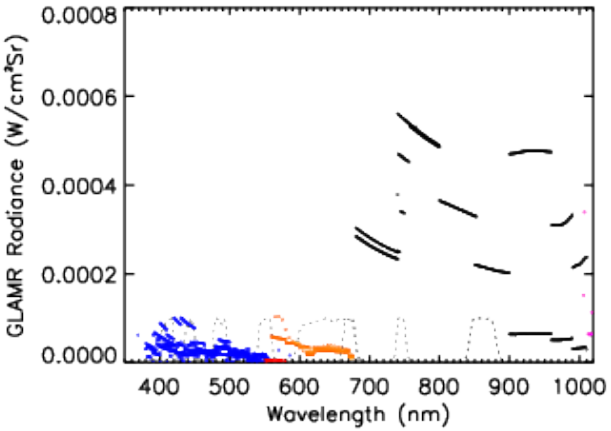
VNIR Performance

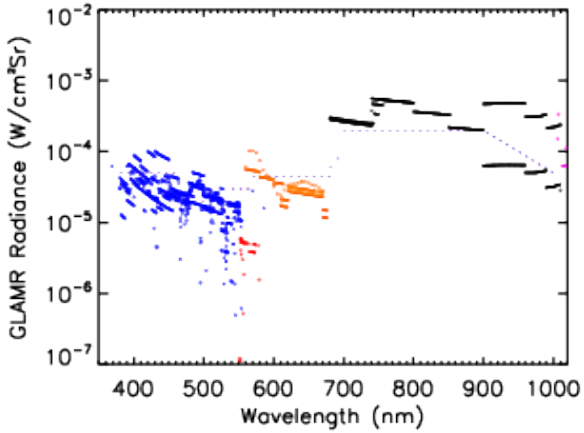










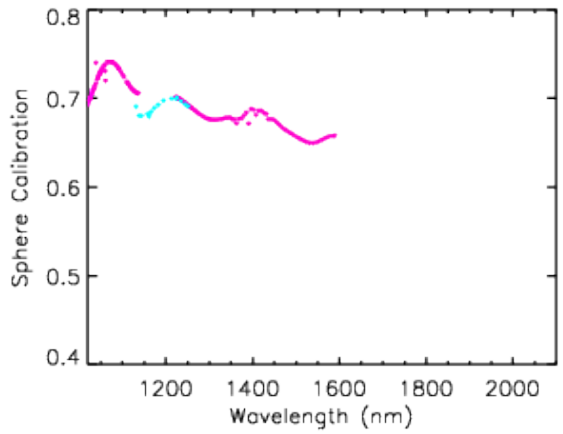


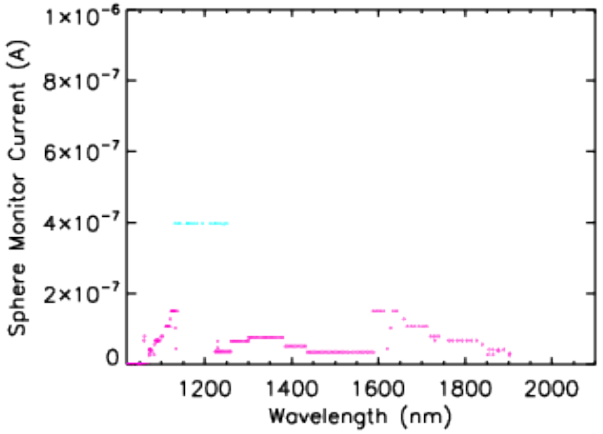
Ti:Sapphire OPO-NIR SHG OPO-SWIR-SHG OPO-NIR-Idler Ti:Sapphire OPO

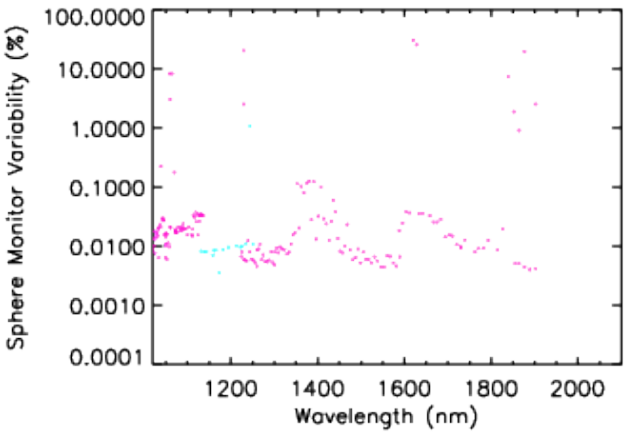
Dye Lasers OPO-SWIR

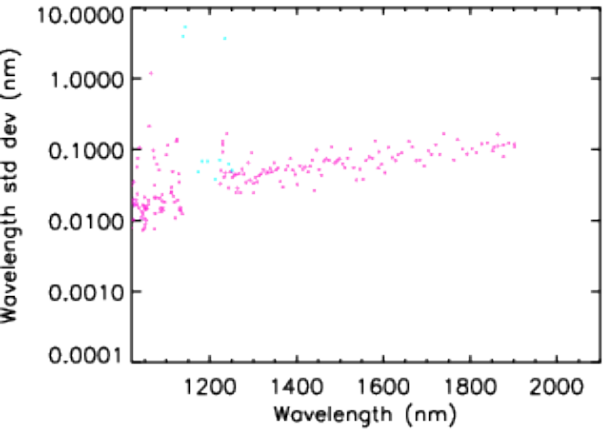
Measurements with new Sphere

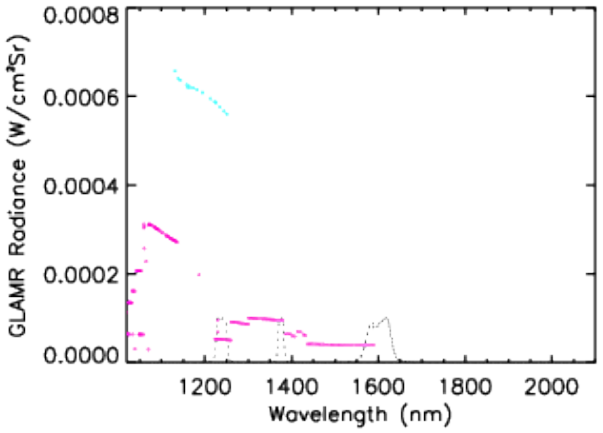
SWIR Performance

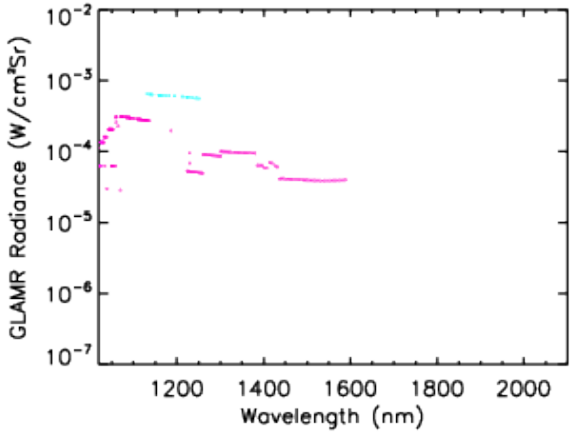










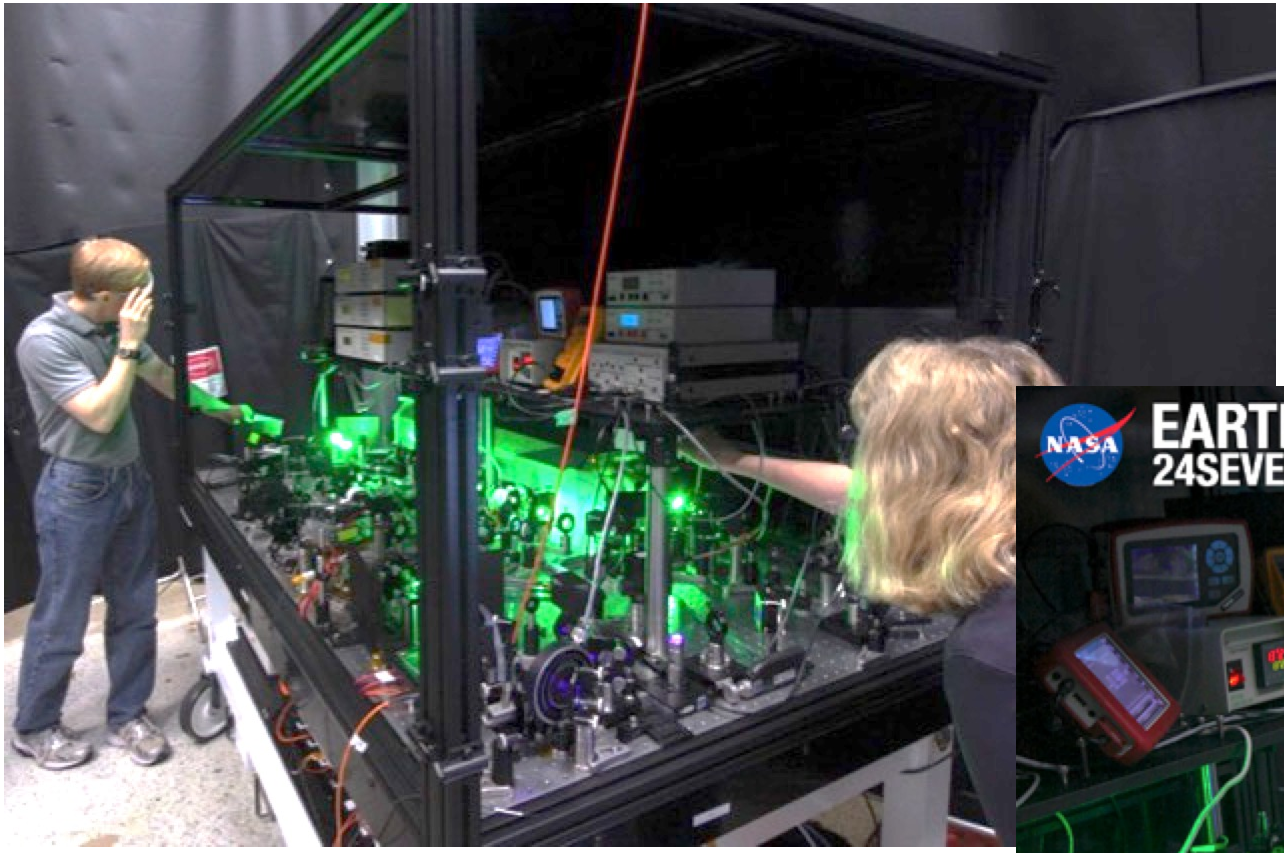


Ti:Sapphire OPO-NIR SHG OPO-SWIR-SHG OPO-NIR-Idler Ti:Sapphire OPO

Dye Lasers OPO-SWIR

Measurements with new Sphere

Table 1 (OPOs)



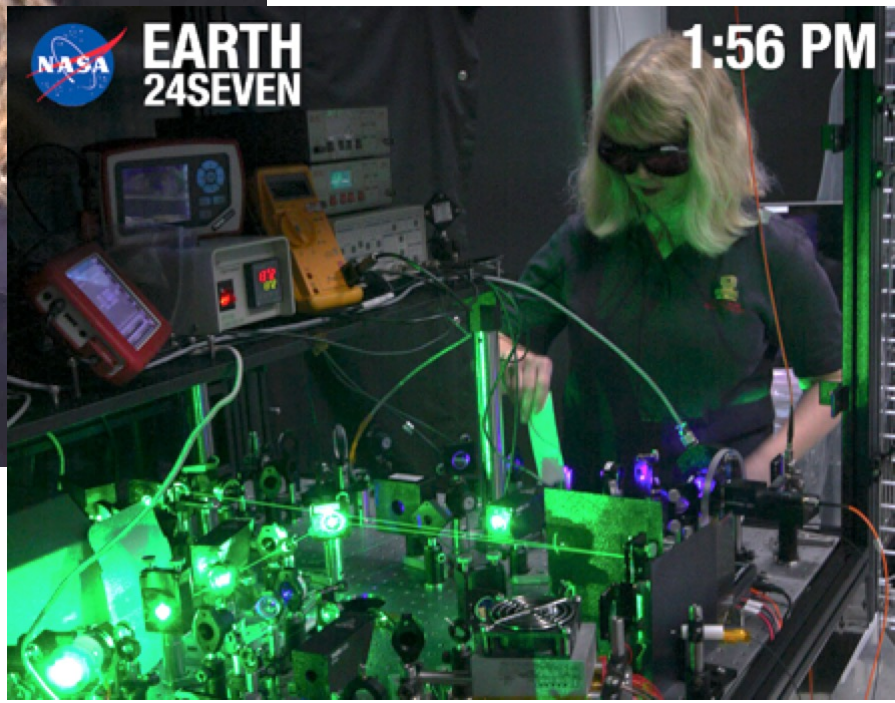


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Table 2 – Dye Lasers (DCM & R6G)

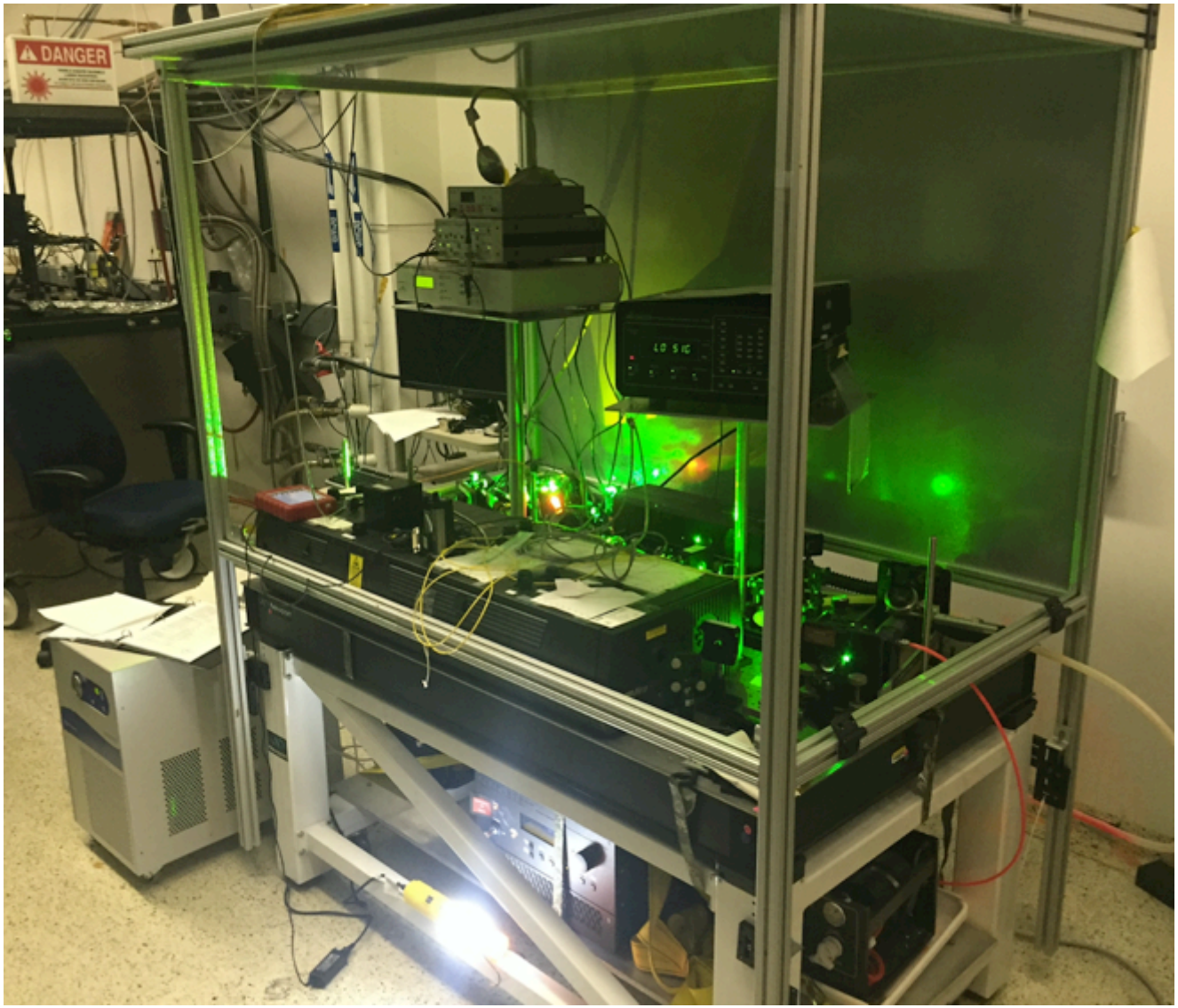
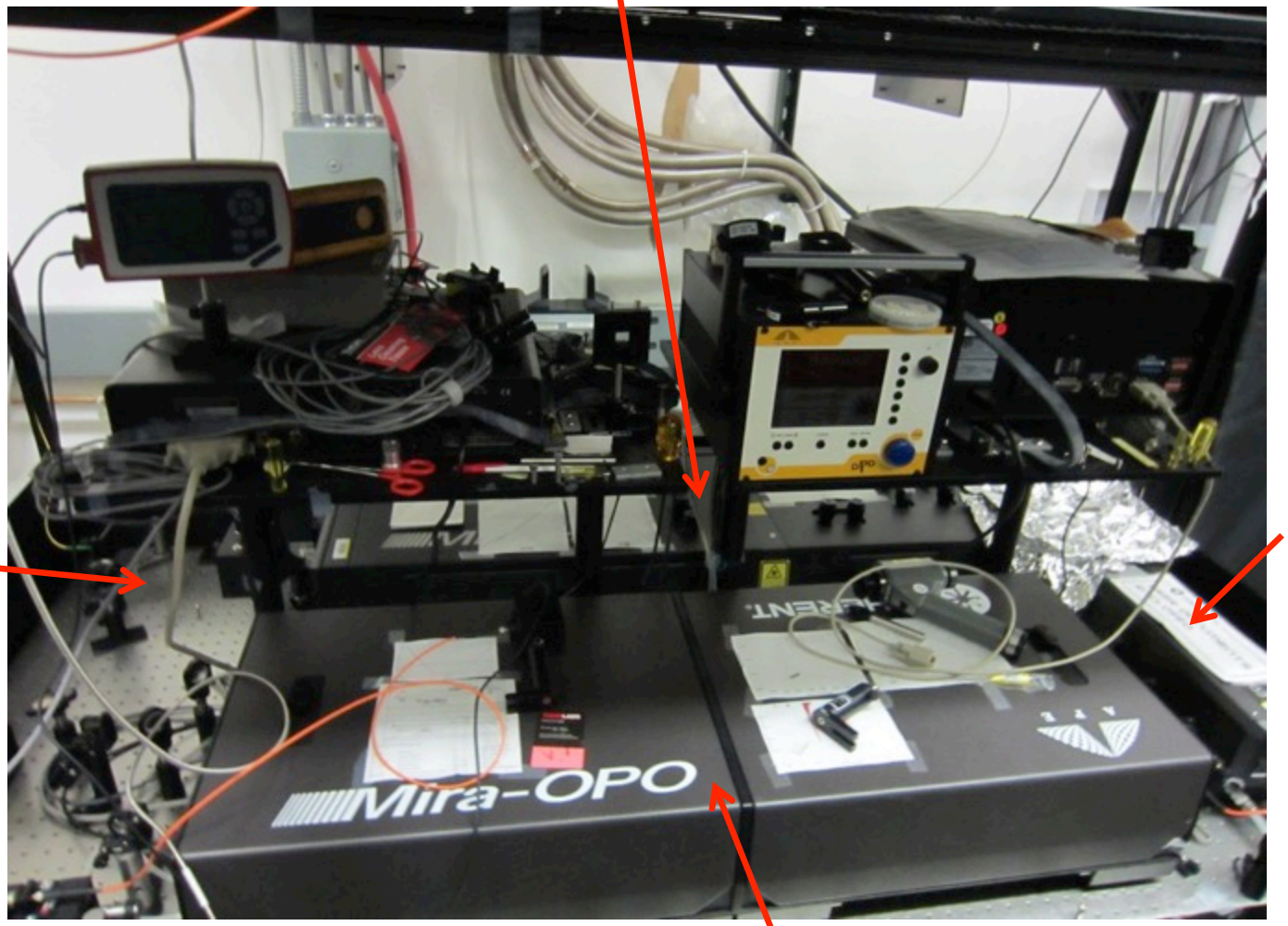


Table 3 (Ti:Sapphire)

MIRA Ti:Sapphire

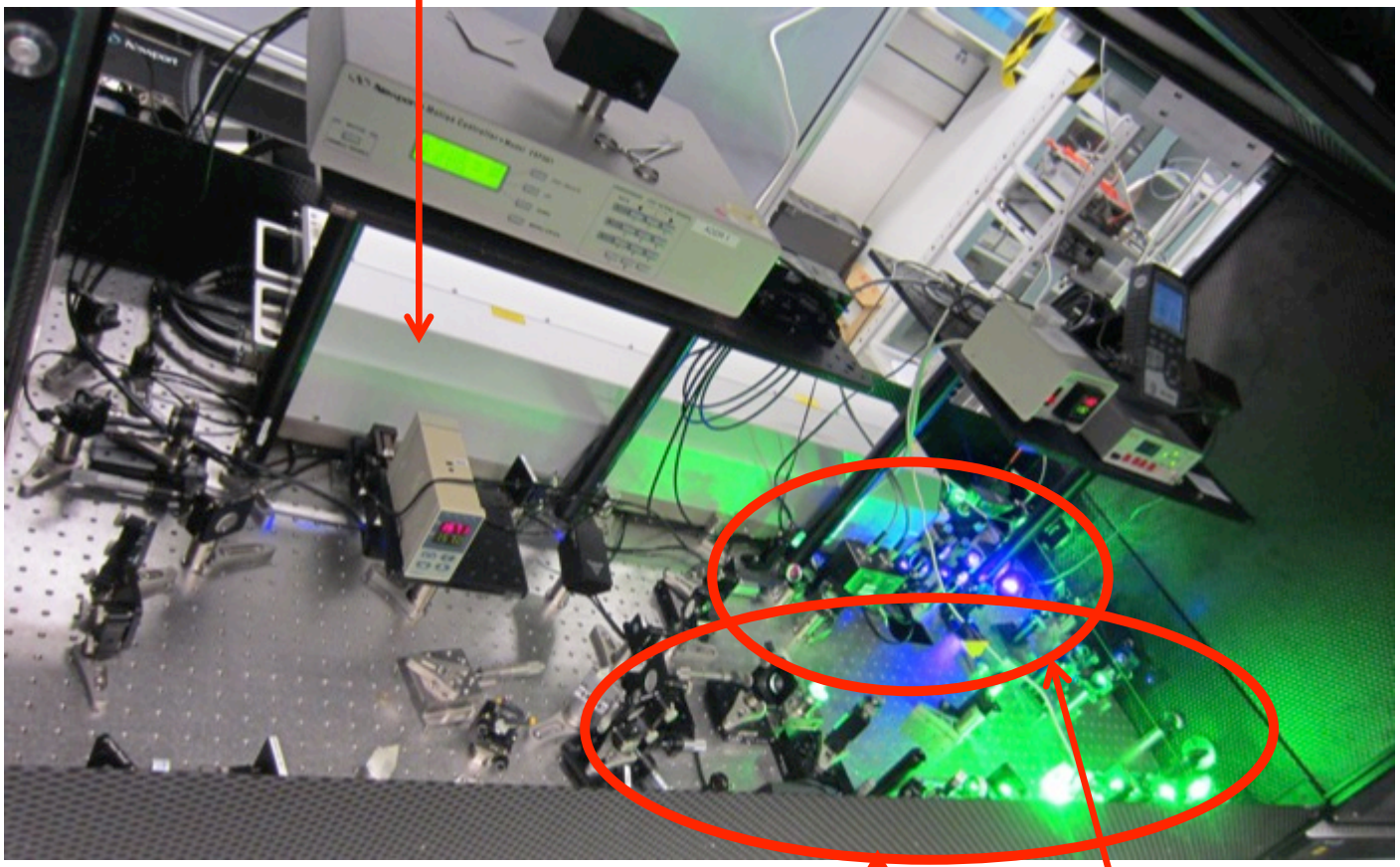


Doubler goes here but is on the table to the right out of the photo

Coherent Verdi 18 pump

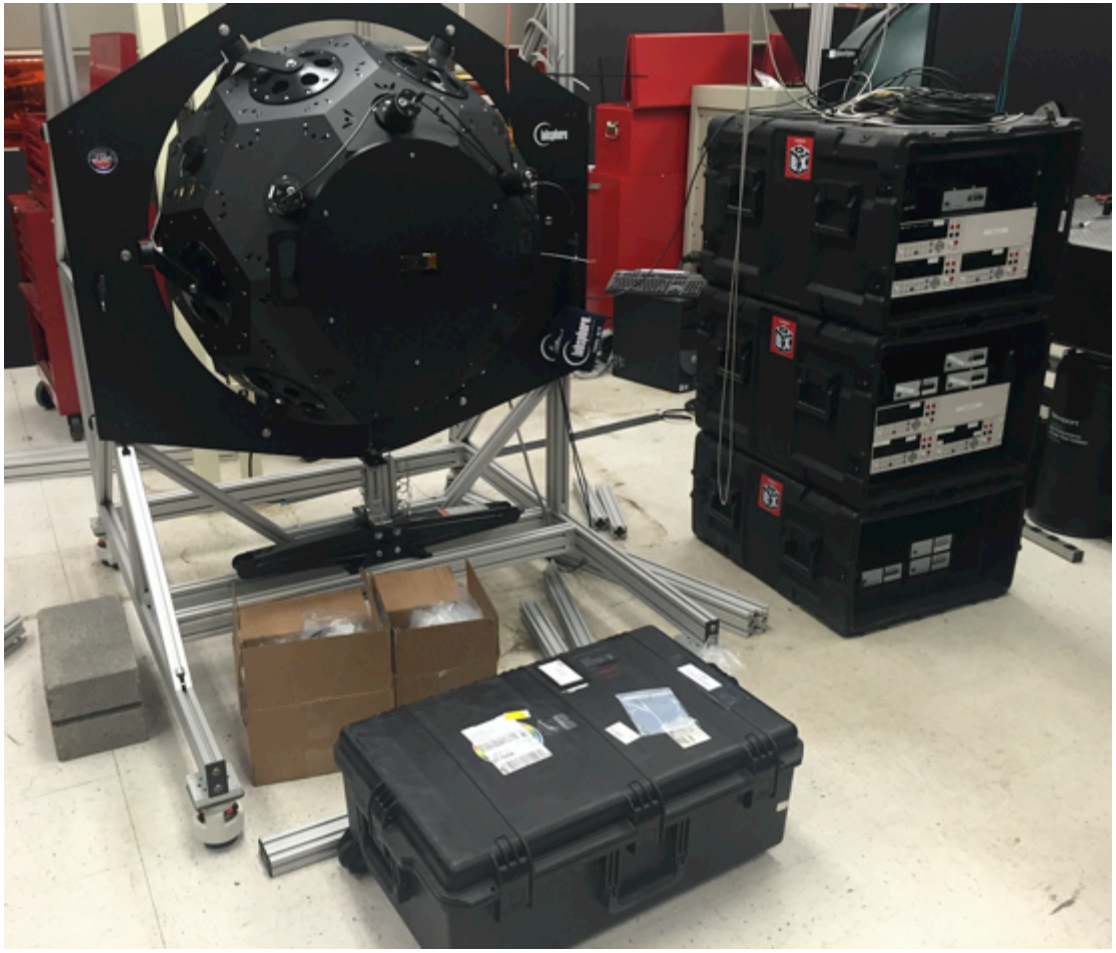
OPO

Table 4 (NIST's OPO Backup)

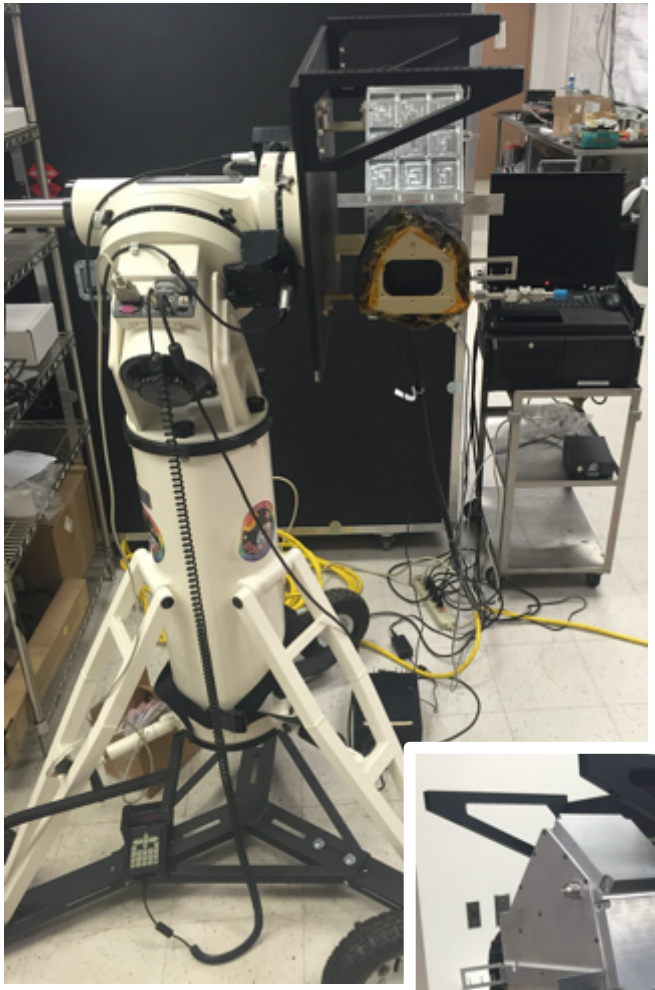


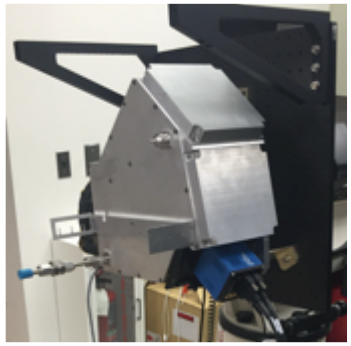
All packed for J2 VIIRS

Successful Pre-ship Review held on 5 May 2016 with laser team, sensor vendor team, JPSS project, and NIST



Suitcase SOLARIS-2 (SS-2)





The Washington Post

Capital Weather Gang

Record rain streak hits 15 days in D.C. and threatens to stretch into next week

By Jason Samenow May 11 at 12:50 PM

SS-2 scan of CLARREO team before PPBE meeting

First scan with SS-2

FY17 Plans

- RS Instrument model development based on SS2
- Document laboratory calibration uncertainty below 1% (k=2) to 2.3 micrometers
- Absolute reflectance retrieval comparison to NIST standards to evaluate uncertainties
- Further measurements of solar and lunar irradiance in addition to field deployments
  - Repeatability of lunar retrievals
  - Absolute measurement of solar irradiance
- NIST-calibrated transfer radiometer data acquisition system completed to 2.3 micrometers
  - New SWIR laser on order (>4W 1.85-2.5 microns)
- Implementation of extended InGaAs transfer radiometers (characterization currently in progress at NIST with GSFC radiometers)