Goddard Laser for Absolute Measurement of Radiance for Instrument Calibration in the Ultraviolet to Short Wave Infrared

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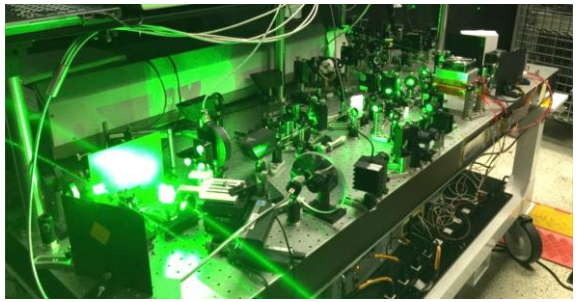
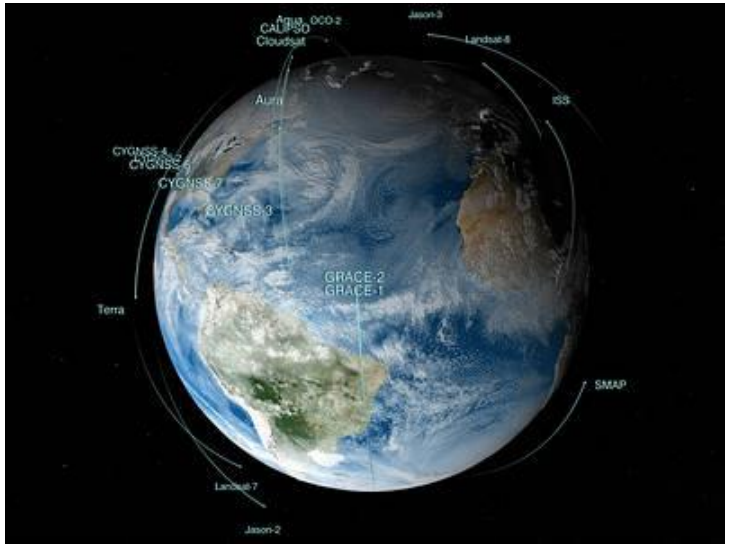
Introduction

- Purpose
- Absolute radiometric scale
- Calibration scheme
- Narrow linewidth tunable sources

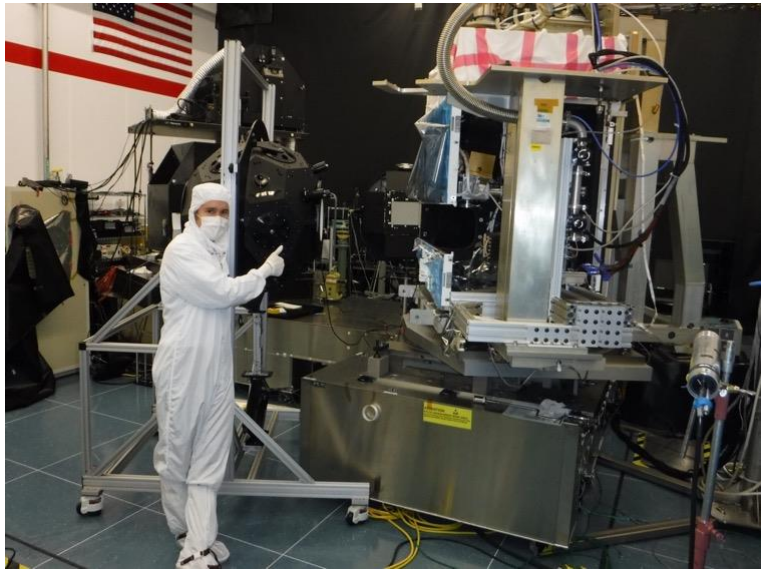




Light source → radiometry → prelaunch calibration for instruments

Purpose

- Narrow linewidth, high spectral bandwidth sources provide higher signal and dynamic range, improved wavelength and radiance accuracy over broadband lamp based techniques
- More straightforward measurement and data interpretation – flat field, full signal level
- Enables more science, reduced mission lifetimes & cost



Absolute radiometric scale

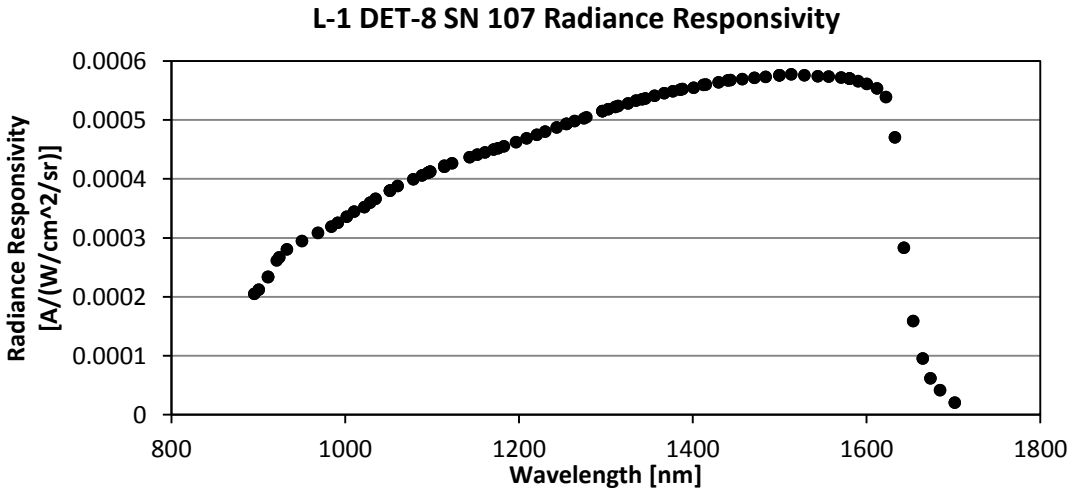
Radiance: power per unit area per unit solid angle $L = \frac{P}{A*\Omega}$

Spectral radiance: radiance per unit wavelength $L_\lambda = L/\Delta\lambda$

Greatest uncertainty is in optical power P

Area and solid angle are both traceable to meters

Optical power measured with electrical substitution radiometer and traceable to electrical units of measure

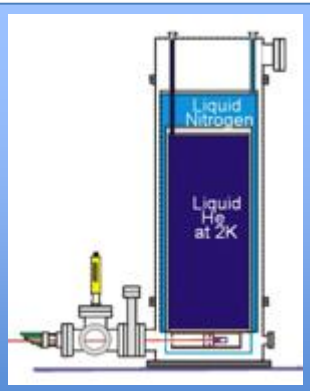


Integrating sphere with transfer radiometers

Narrow linewidth source eliminates error due to convolution of source spectrum with radiometer responsivity

Traceability path

NIST Facility



POWR

Primary Optical Watt Radiometer

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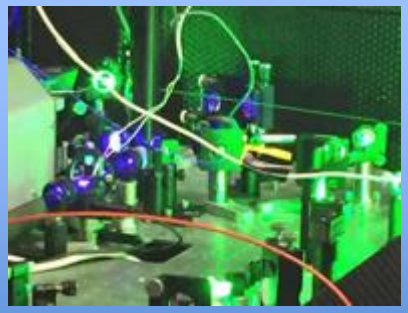

Stabilized laser source is used to transfer radiometric scale from POWR to portable transfer radiometer via another standard radiometer

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LTD-11 #107

transfer radiometer

Sensor vendor facility

LTD-11 #107

transfer radiometer

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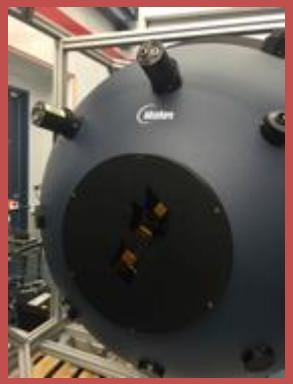

Sphere Monitor

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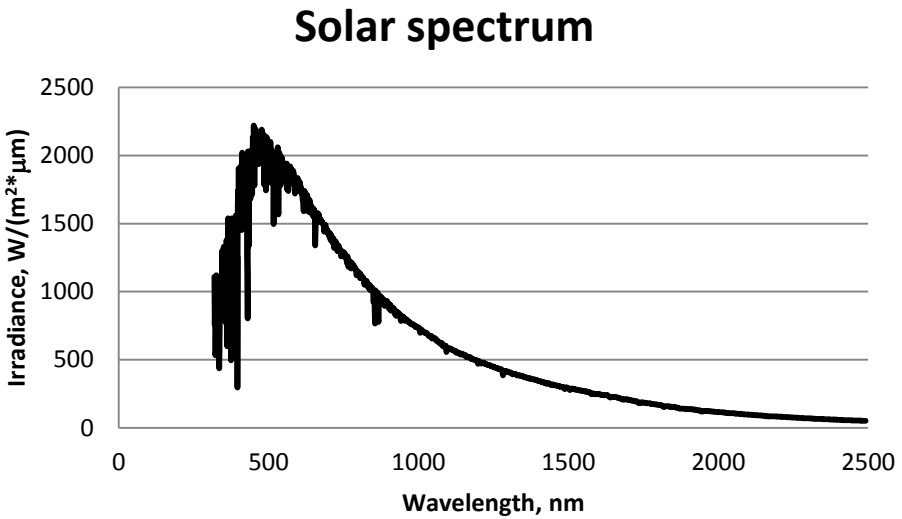
Satellite/airborne sensor

Tunable sources

Desired properties:

- **Radiometrically stable**
- Wavelength range covering the solar spectrum, 300 to 2500 nm
- Signal level comparable to maximum reflected solar radiance (snow and cloud cover at high sun angles)
- Linewidth << instrument under test
- Portability, minimal setup and facility infrastructure requirements
- Time efficiency: automated wavelength tuning, synchronized tuning with shutter cycling, instrument data collects
- Reliability: critical path operations



Lamp/monochromator
Titanium sapphire
Dye
Tunable diode
Optical parametric oscillator

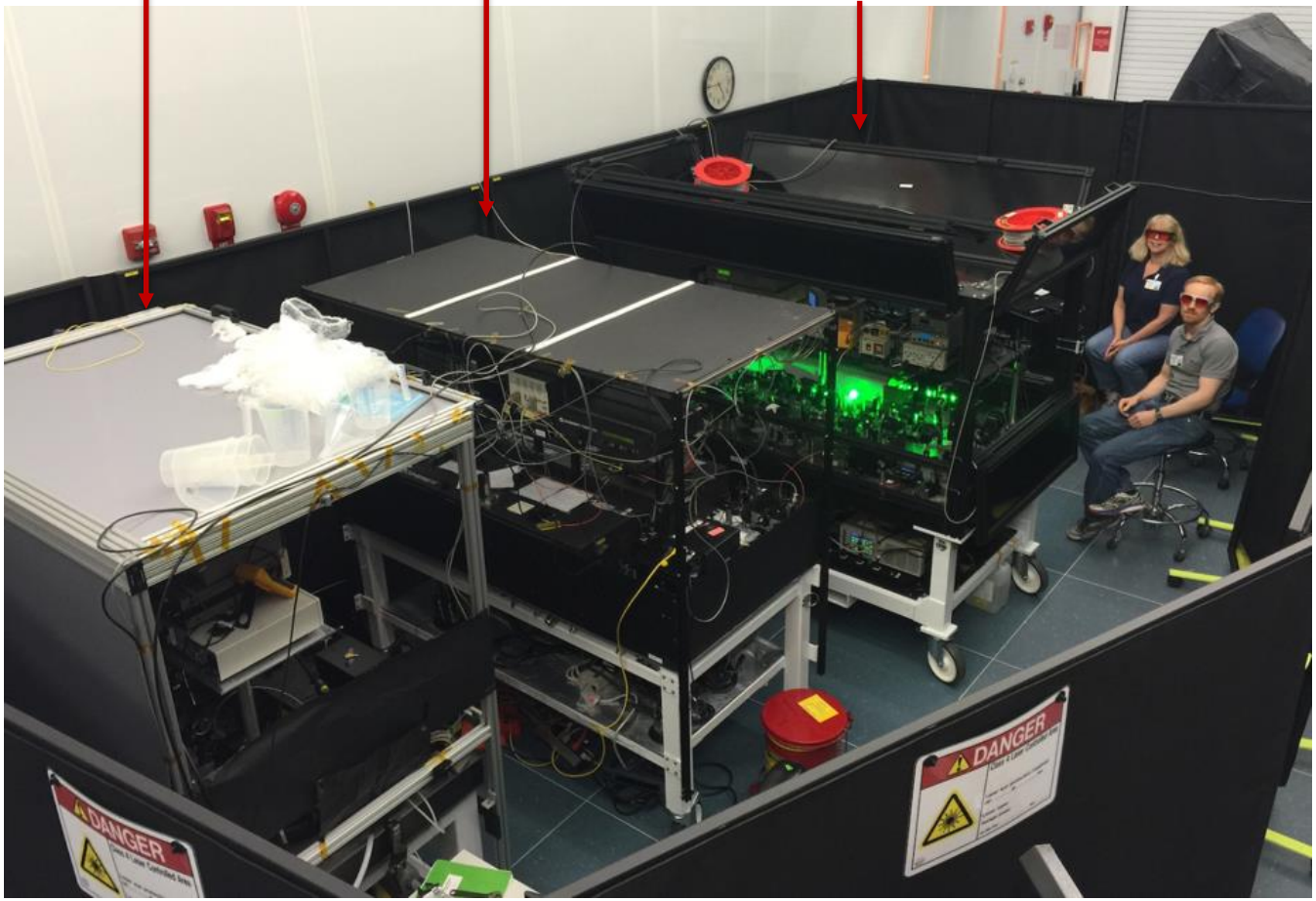
Sources setup for JPSS-2

Dye
570 to 680 nm

Ti:sapphire
680 to 1000 nm

OPO
Second harmonic: 360 to 570 nm
Signal and idler: 720 to 2000 nm

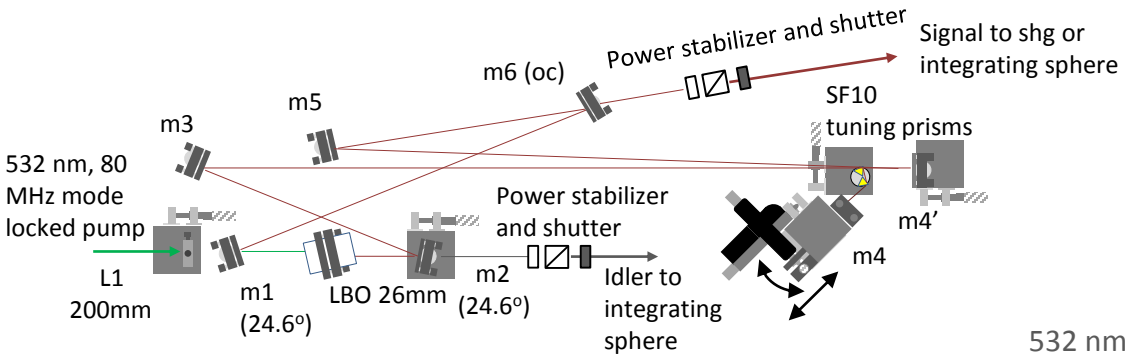
Joint Polar Satellite System 2
Visible and Infrared Imaging
Radiometer Suite calibration



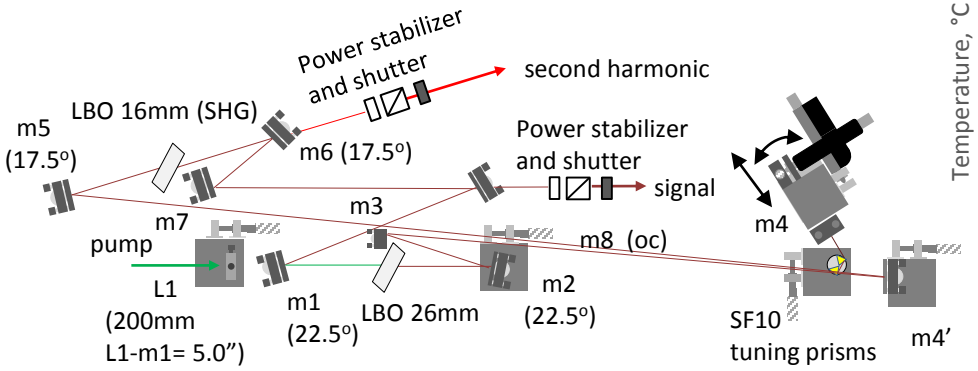
Combination of tunable sources covering 360 to 2000 nm

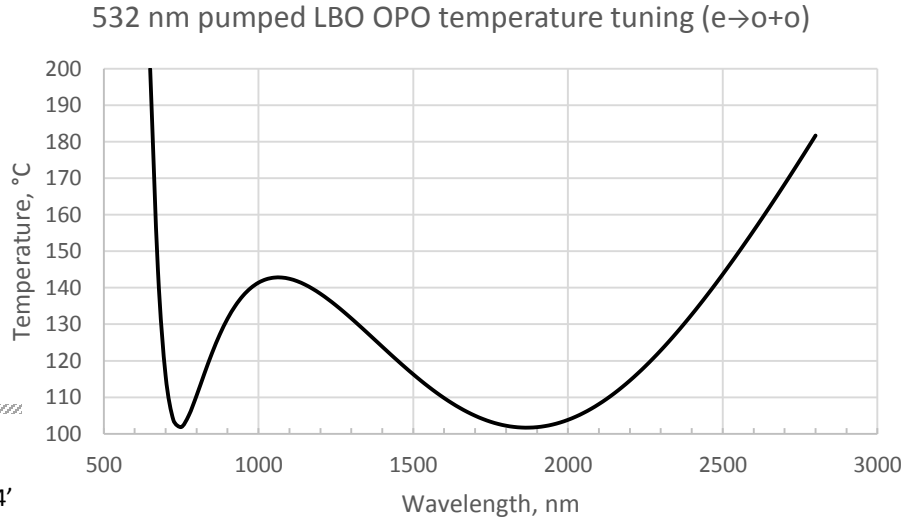
Custom LBO OPO

NIR-OPO 680-1100 nm + 1200-2200 nm



SWIR-OPO 1080-1400 nm + 540-700 nm





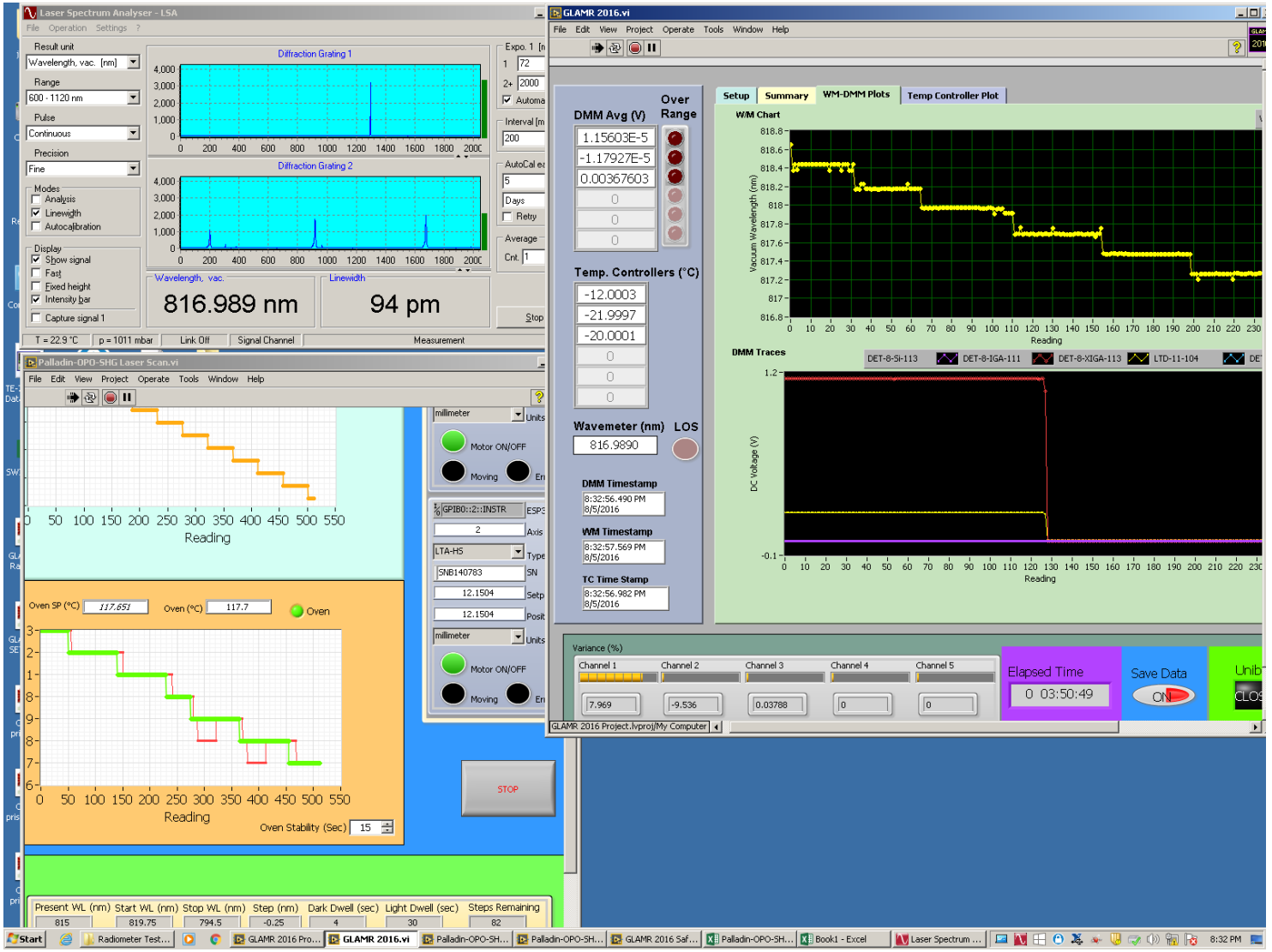
Automation

Real time display + recording of wavelength, radiance, shutter state, and OPO parameters

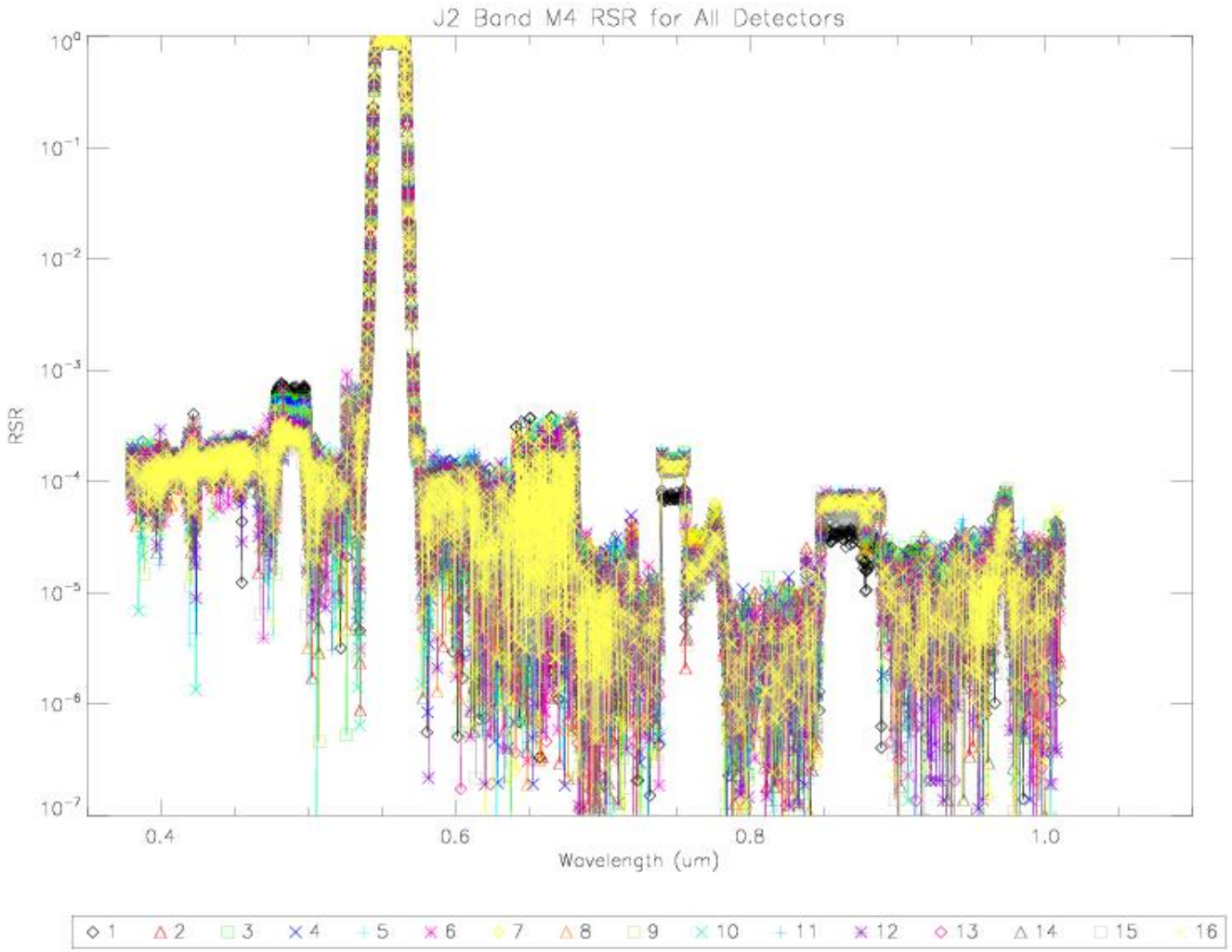
Light and dark dwell time

Scan wavelength interval

Automated tuning via parameter look up table



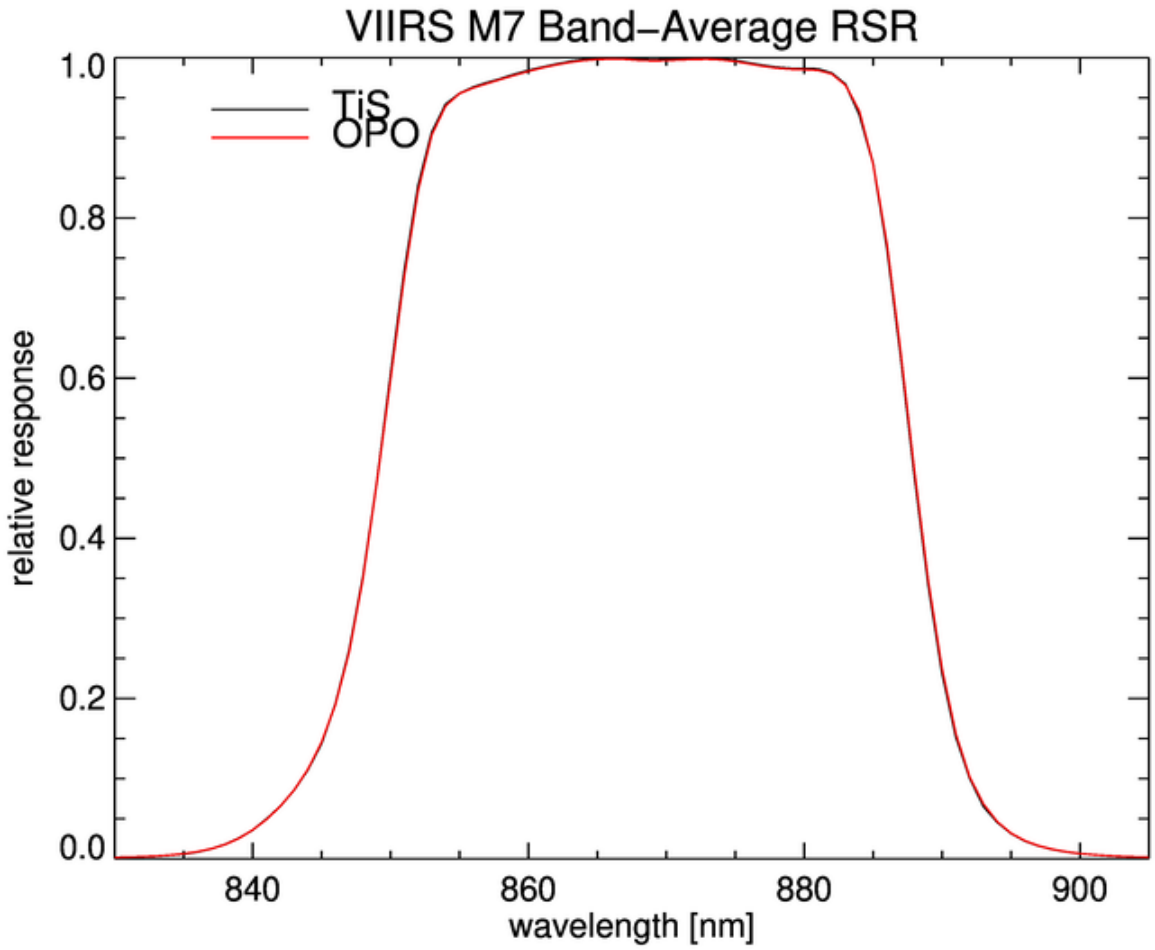
Example calibration data



VIIRS band M2 showing electronic crosstalk with other bands

Quasi-CW & CW sources

Integrating sphere provides temporal as well as spatial averaging with characteristic time on the order of nanoseconds



Comparison of 80 MHz prf OPO and continuous wave Ti:sapphire laser used as sources for VIIRS band M7 calibration

Future work

- Deeper UV coverage
- Improved operation near degeneracy and water vapor absorption lines
- More repeatable wavelength steps, order of 0.1 nm
- Long term stability and decreased operator intervention during scans
- More power

Summary, acknowledgements

Broad band optical parametric oscillator developed covering 360 to 2000 nm
Automated scanning
Demonstrated portability without realignment
Ability to support critical path instrument calibration

<u>Technical Support</u>
Based on design work and built with assistance from the late Keith Lykke, NIST

<u>Support</u>

GOES-R

NPP

SAGE III – ISS

Landsat

PACE Ocean Color Instrument

CLARREO Pathfinder

Joint Polar Satellite System