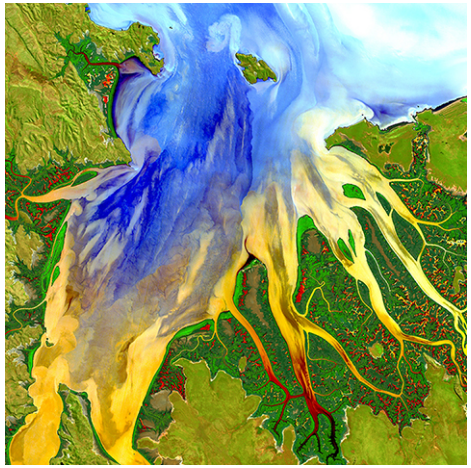
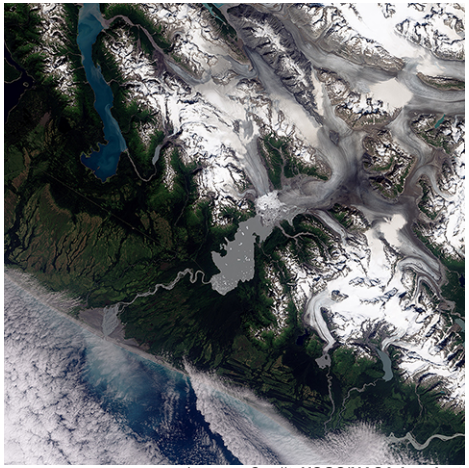
Overview of the Operational Land Imager (OLI-2) Pre-Launch Characterization and Calibration





Imagery Credit: **USGS/NASA Landsat**

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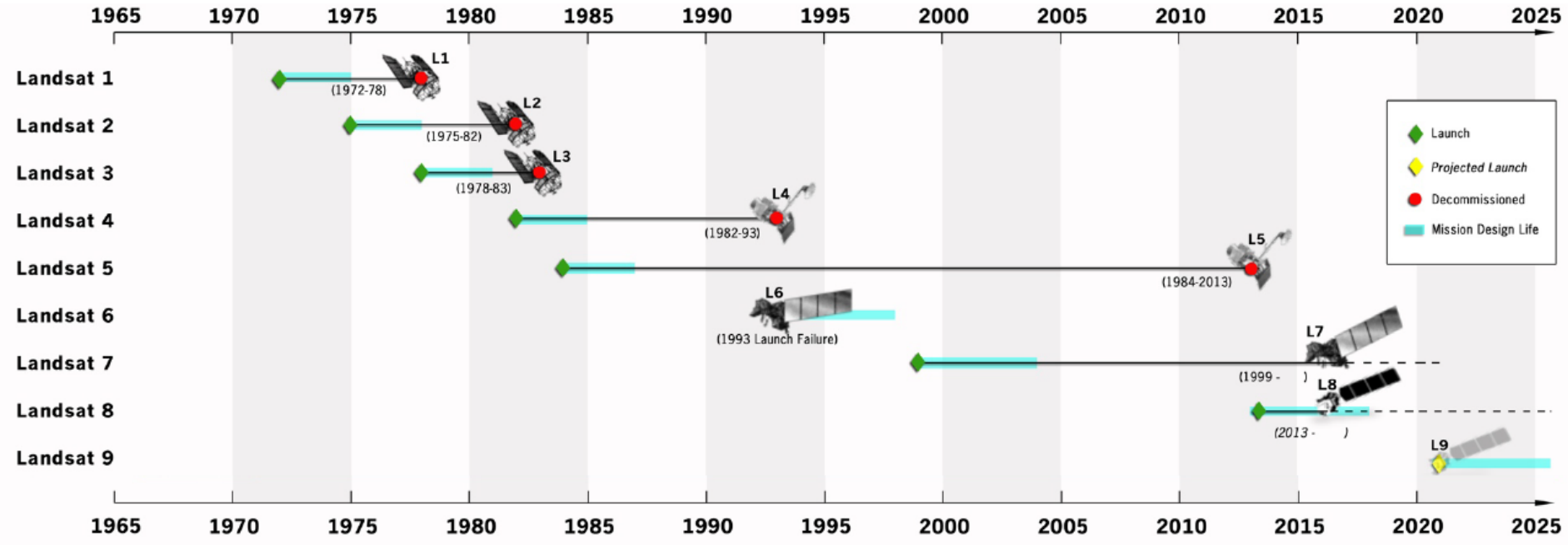
Abstract

The Operational Land Imager 2 (OLI-2), slated to fly as part of the Landsat-9 mission, is a nine band VIS-SWIR imaging radiometer that is nearly identical to the Operational Land Imagers (OLI) flying on Landsat-8. OLI-2 has recently completed extensive pre-launch characterization and calibration that shows it will have comparable or superior performance to its predecessor. This presentation gives an overview of the testing and results.

The Operational Land Imager 2 (OLI-2) continues the Landsat legacy



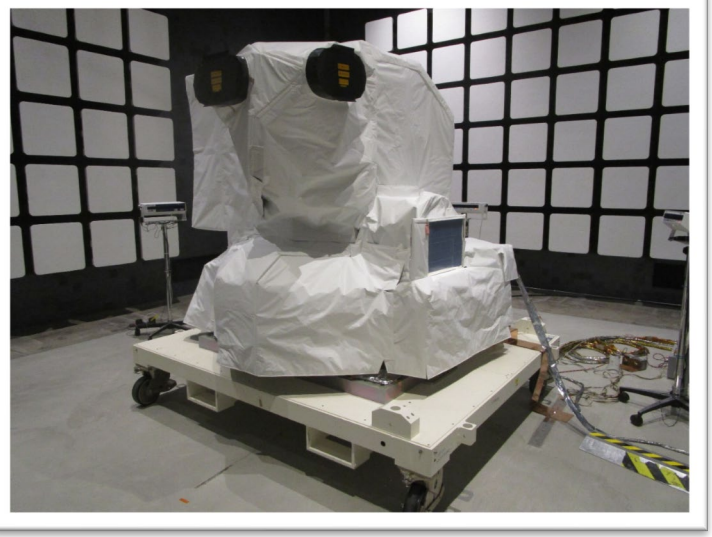
- **Landsat focuses on having good calibration in order to preserve the data continuity over the decades**
- **OLI-2 will fly on Landsat 9, currently slated for launch in December 2020**

OLI-2 Complete and Fully Tested

- **OLI-2 design was strictly controlled to minimize differences from OLI**
  - **Only <u>two</u> significant changes**
    - **Modified the cables between the Focal Plane Array and Focal Plane Electronics to be less fragile**
    - **Added more blanketing for micrometeroid/orbital debris protection**
- **Calibration and Characterization Tests completed Fall 2018**
- **Environmental Tests completed Spring 2019**

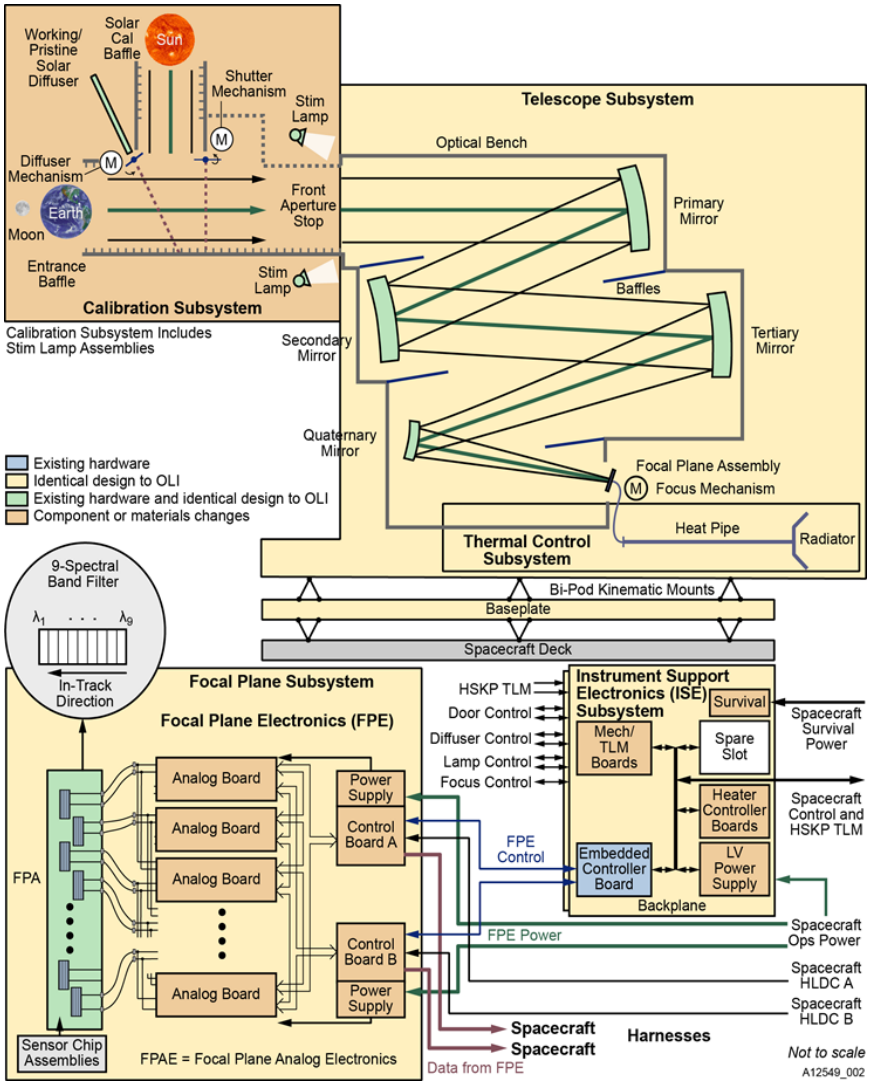
OLI-2 without blankets (but with aperture covers) in clean room

OLI-2 with blankets and aperture covers in EMI/EMC Chamber



OLI-2 Design Almost Unchanged Since OLI

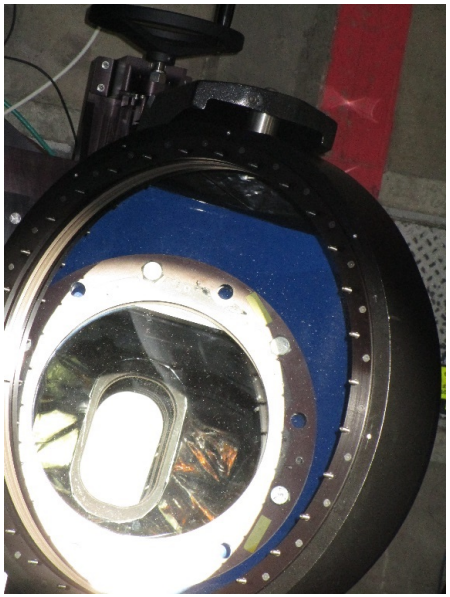
- Pushbroom VIS/SWIR sensor
- Four-mirror telescope with front aperture stop
- FPA consisting of 14 sensor chip assemblies, passively cooled
- On-board calibration with:
  - Two Diffusers
  - A Set of Lamps with 3 pairs of bulbs
  - Shutter that can be closed for Dark Calibration
- Only significant changes:
  - New design for cables between FPA and electronics to address fragility issues
  - More Micrometeroid / Orbital Debris protection added to thermal blankets



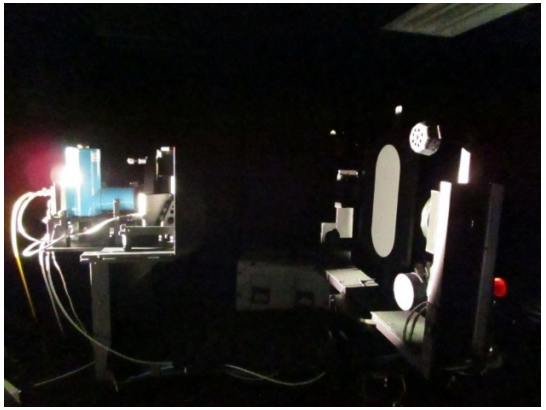
OLI-2's Primary Calibration is 2 Spectralon™ Diffusers

- Two panels of Spacegrade Spectralon™
  - One measured frequently, the other kept pristine (measured every six months)
- Characterized pre-launch at the University of Arizona
  - Reflectance traced to NIST via calibrated panel

Diffuser in Lab



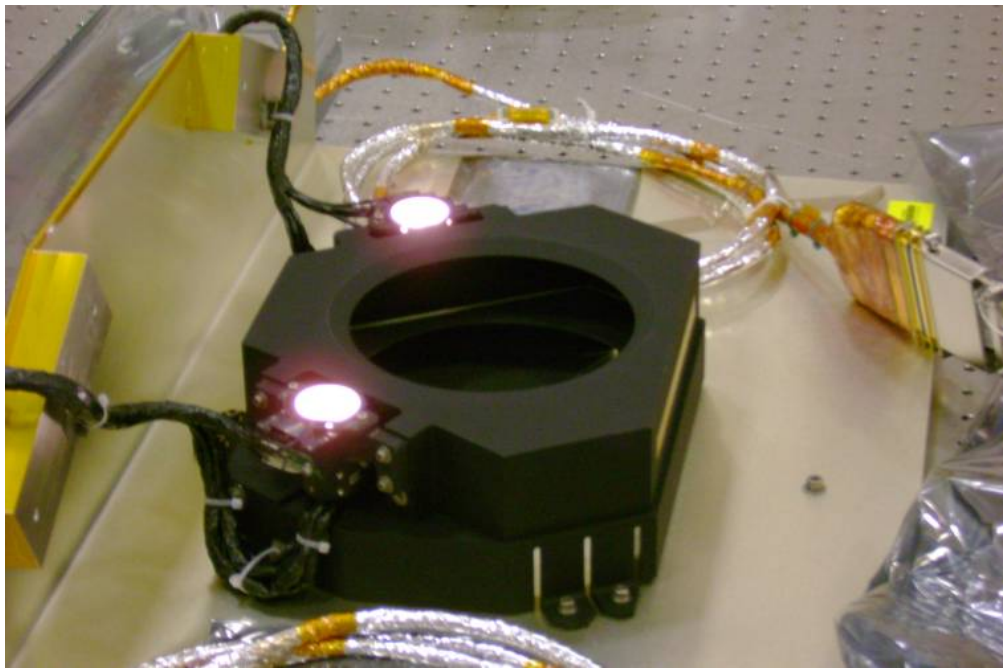
Installed diffuser as viewed from heliostat



Diffuser BRDF characterization at University of Arizona

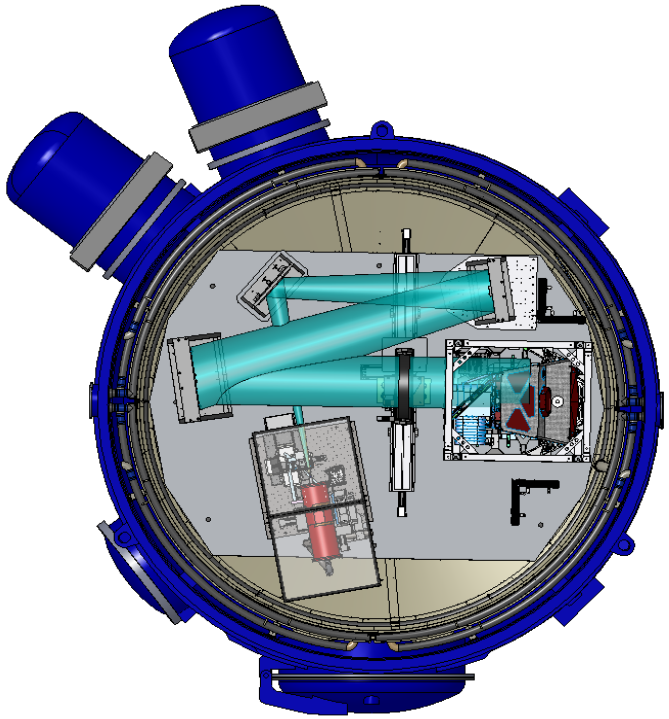
Stim Lamps used for trending

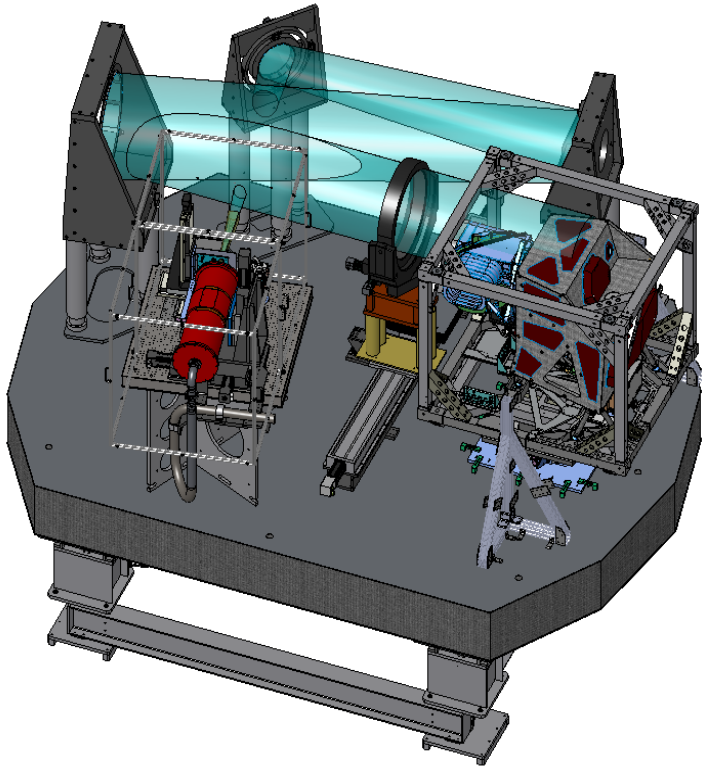
- **Three pairs of lamps mounted in two assemblies on either side of the aperture**
  - **Fully redundant, so six pairs total**
- **Bulbs from same lot as OLI**
  - **Used frequently pre-launch to track performance, then daily on-orbit as a secondary standard**



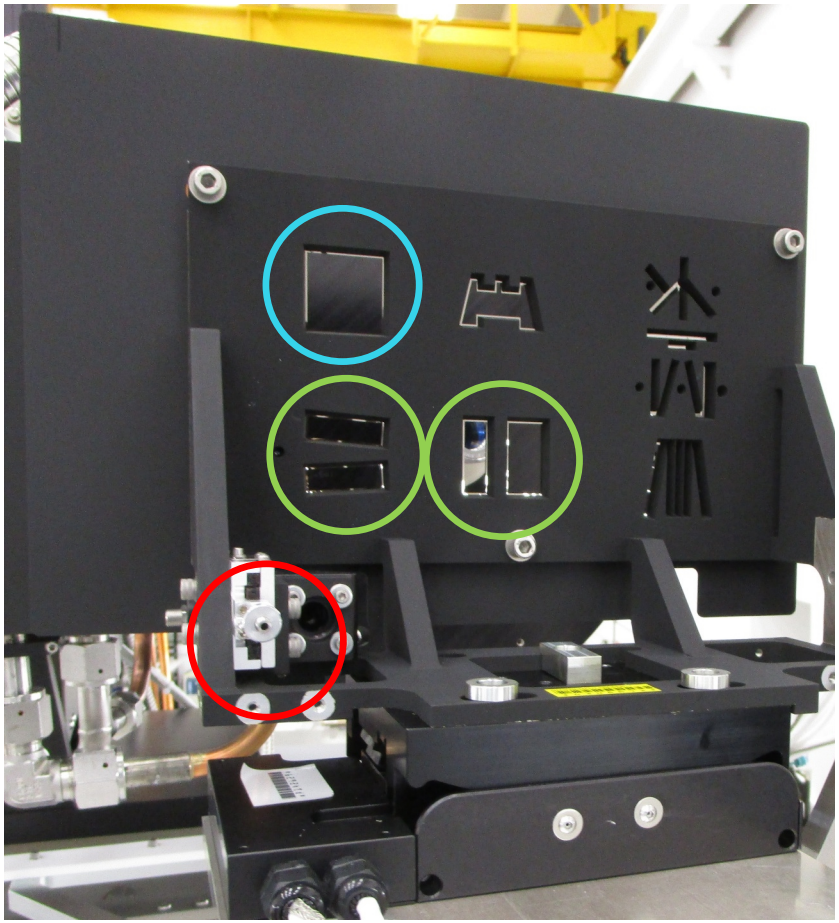
Spatial Characterization Done in Vacuum with proven Ball Test Set

- **Spatial Test Station (SPATS) expands and collimates a beam that fills the aperture.**
  - **A stage allows multiple targets to be moved into the optical path**



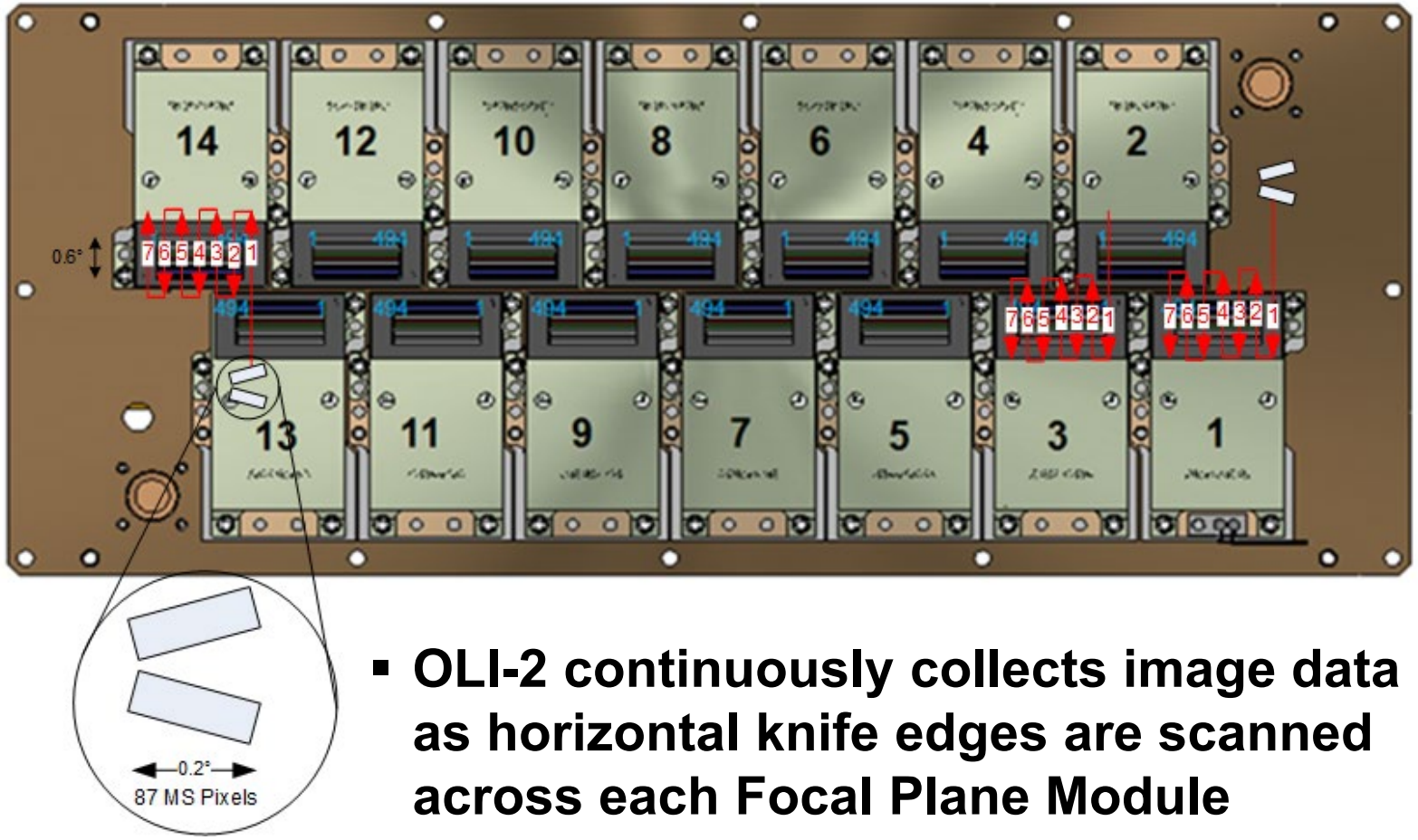


Multiple Spatial Targets Used



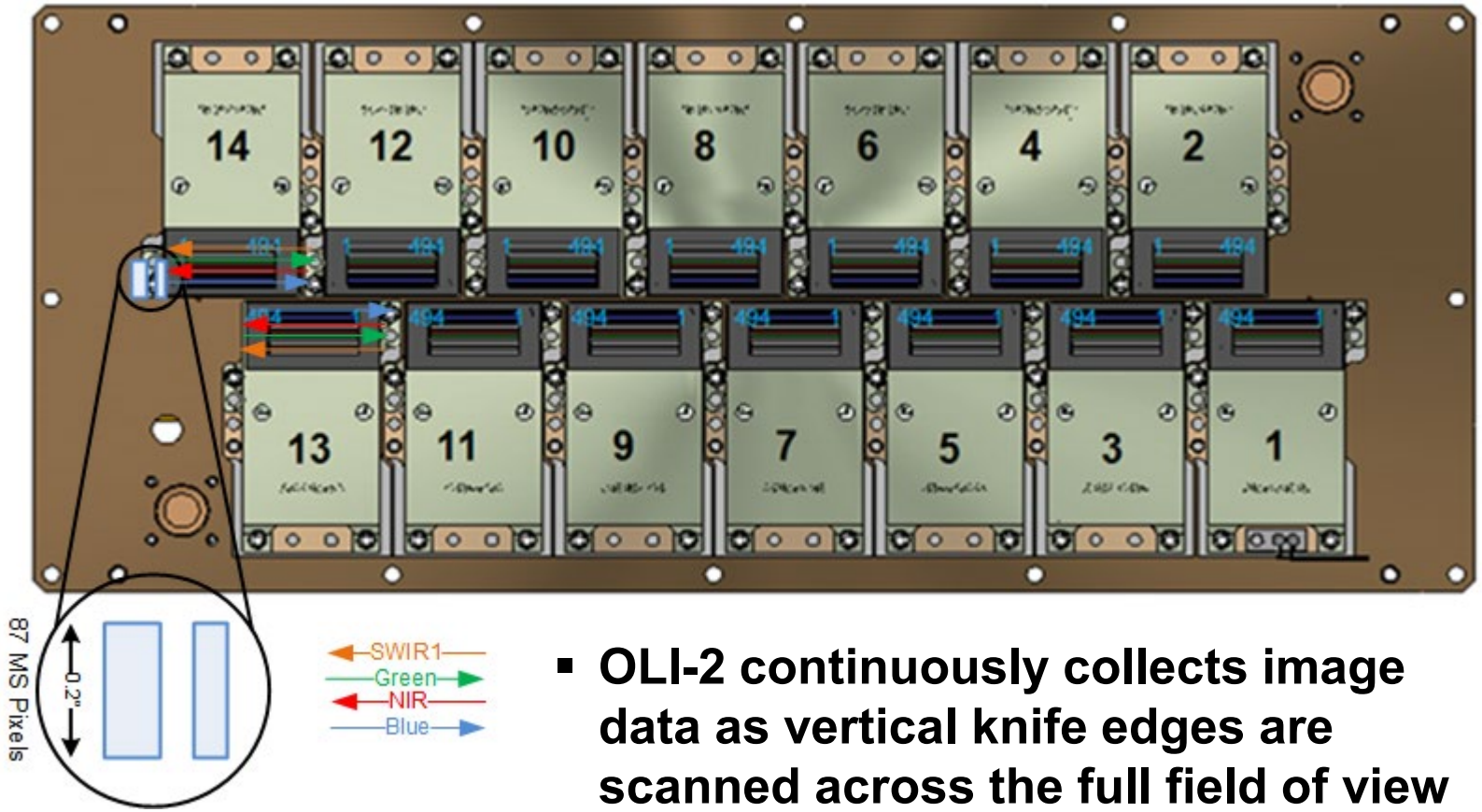
- Knife edge targets circled in green
- Ghosting Target circled in blue
- Bright target recovery laser circled in red
- Other targets used for various alignments or had historical uses and weren't re-used on OLI-2

Example of In-Track Scanning



- **OLI-2 continuously collects image data as horizontal knife edges are scanned across each Focal Plane Module**

Example of Cross-Track Scanning



- **OLI-2 continuously collects image data as vertical knife edges are scanned across the full field of view**

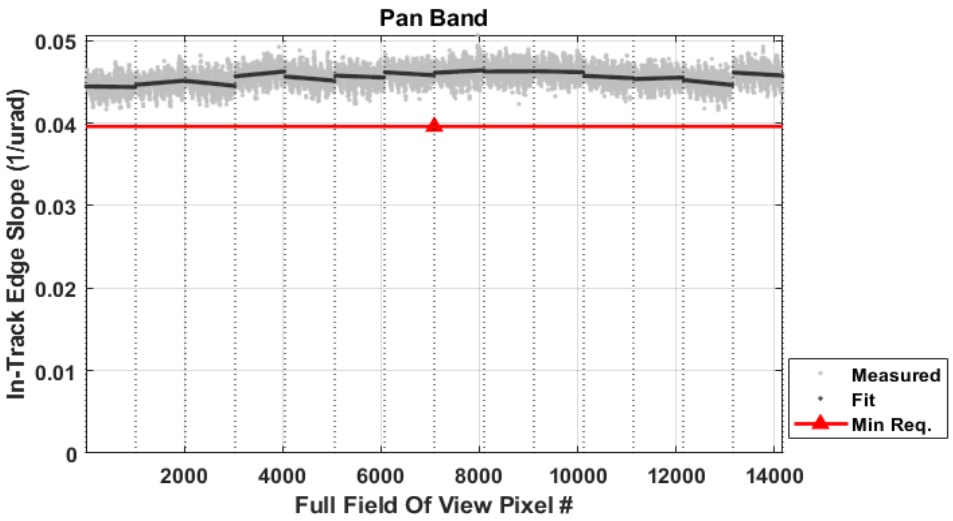
Spatial Performance Summary

- **OLI-2 has excellent spatial performance**
  - **Sharp Edge Response**
  - **Good coregistration**
  - **Minimal image artifacts (ghosting, etc.)**

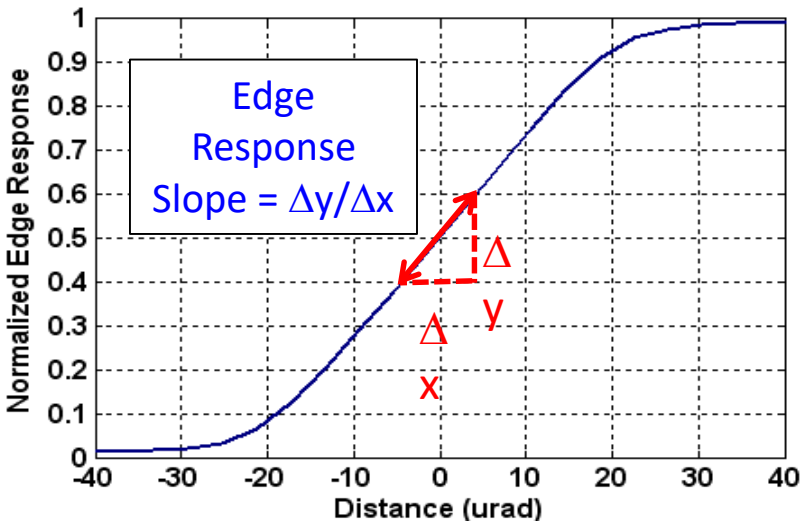
Edge Slope Reqts determine how sharp the image is

Edge Response Slope Level 4 Requirements (1/µrad)		
Band	**In-track**	**X-track**
C/A	0.0215	0.0195
Blue	0.0215	0.0195
Green	0.0219	0.0195
Red	0.0218	0.0195
NIR	0.0221	0.0195
SWIR1	0.0228	0.0195
SWIR2	0.0230	0.0195
PAN	0.0396	0.0391
Cirrus	0.0228	0.0195

* No smear, No Jitter

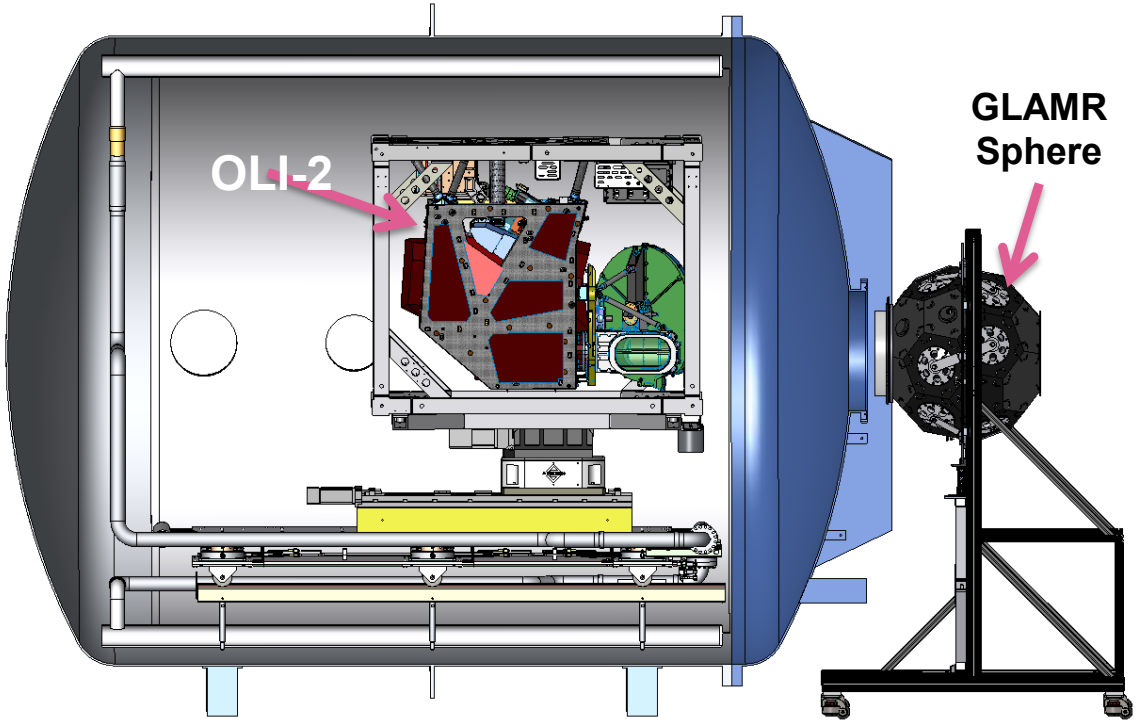


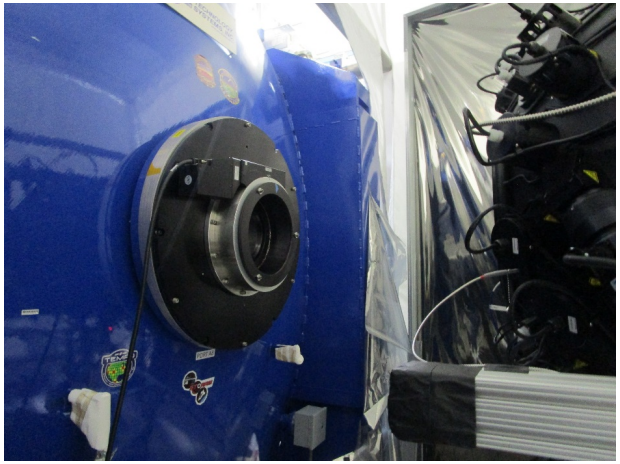
Worst Case Band (Pan) shows good performance for all detectors



Radiometric, Spectral, and Spatial Characterization done together

- **The Calibration Test Station (CATS) put the instrument inside a vacuum chamber with sources outside the window**
  - **Large integrating sphere (radiometric characterization/calibration)**
  - **Integrating Sphere with large sheet polarizer (polarization)**
  - **NASA provided GLAMR source (tunable lasers pumping a sphere)**



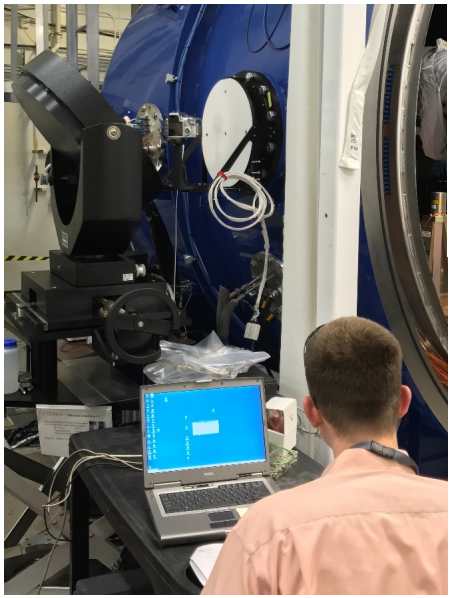


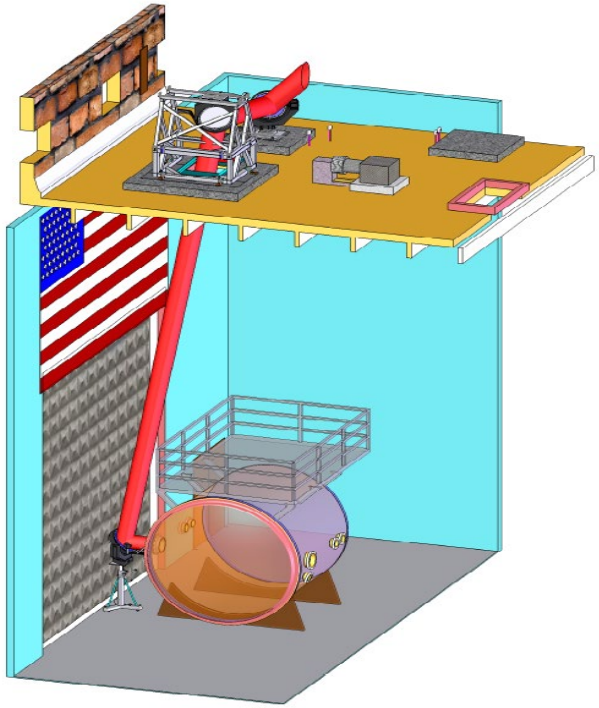
Rotating
Polarizer in front
of window

Heliostat Brings Sunlight into the same Thermal Vacuum Chamber

- **The Heliostat is a Three Mirror Relay**
  - **First Mirror is on a rotation stage programmed to track the sun**
  - **Second Mirror angles the beam through the roof**
  - **Third Mirror directs the beam into the Ball 10 chamber**
  - **Second and Third Mirrors are aligned so that the beam is perpendicular to the chamber window**

Tracking Mirror on roof

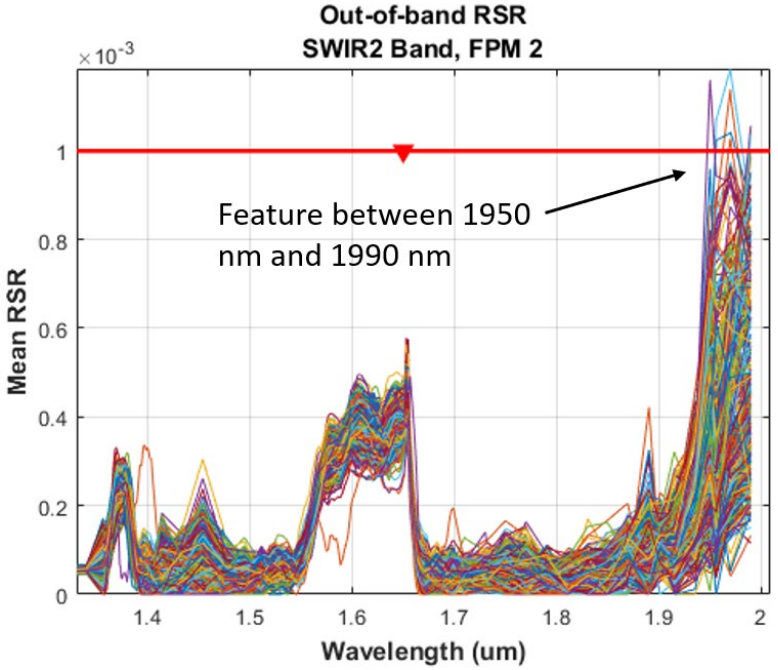




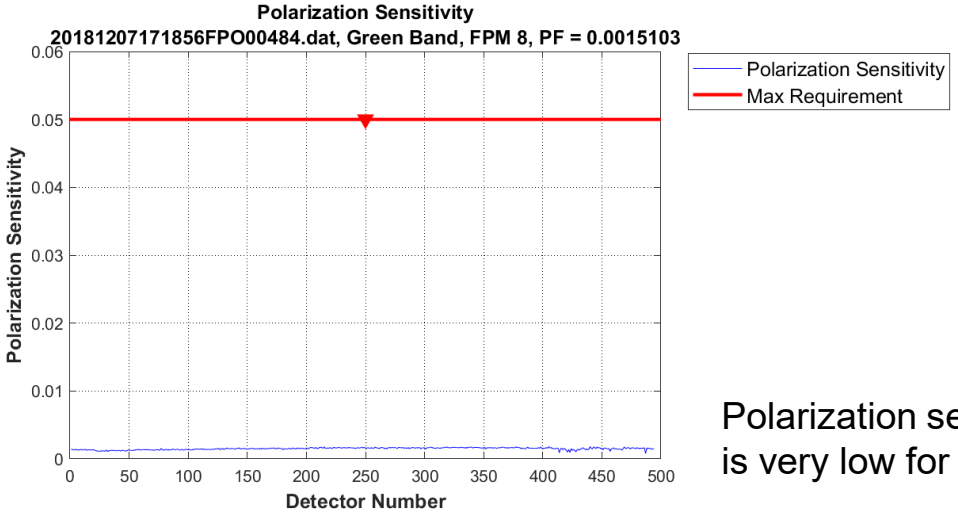
Third mirror outside of chamber and closed chamber port

CATS Performance Summary: Spectral and Polarization

- **The spectral characterization data collected with GLAMR measured every detector across its entire spectral response region to ~1-2 nm in-band and 10-20nm out-of-band**
- **Polarization characterized to better than 0.005**



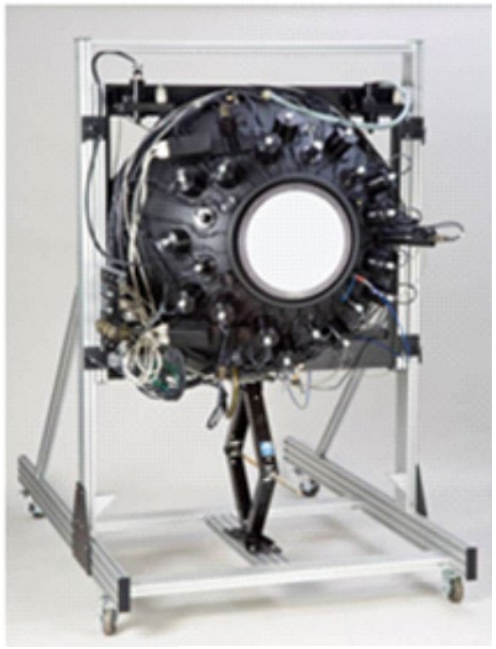
We got good out-of-band measurements <0.001 of peak response. Plot shows all 494 SWIR2 band detectors on Focal Plane Module 2.



Polarization sensitivity is very low for OLI-2

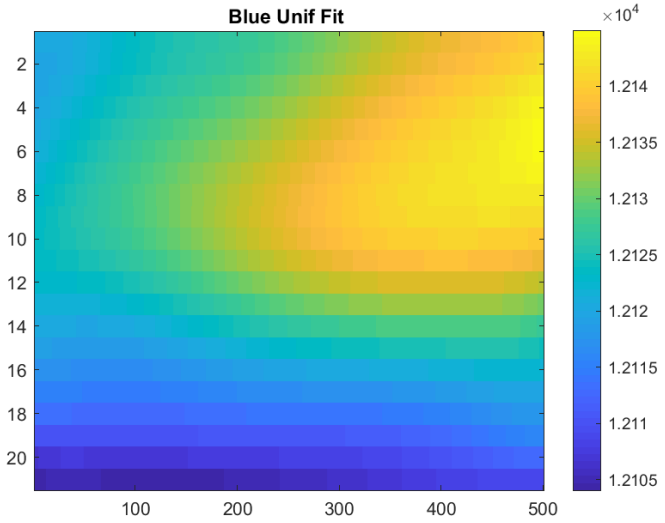
CATS Performance Summary: Radiometric

- **Used external large Integrating Sphere as radiometric standard for multiple measurements**
  - **Signal to Noise Ratio**
  - **Linearity**
  - **Uniformity**
  - **Repeatability**
  - **Stability**
  - **Absolute Radiometric Calibration**



Large Integrating Sphere

Map of sphere uniformity in the Blue Band: Counts as a function of position



Summary

- **OLI-2 is complete; on schedule for December 2020 launch**
  - **Minimal changes from OLI**
  - **Maintained strong emphasis on calibration and characterization**
- **Characterization and Calibration testing is complete**
  - **Results are comparable or better to OLI**
    - **Spectral and spatial characterizations more complete**
    - **Linearity measured more precisely**
  - **Following presentations will discuss results in more detail**