

The Operational Land Imager: Overview and Performance

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Abstract



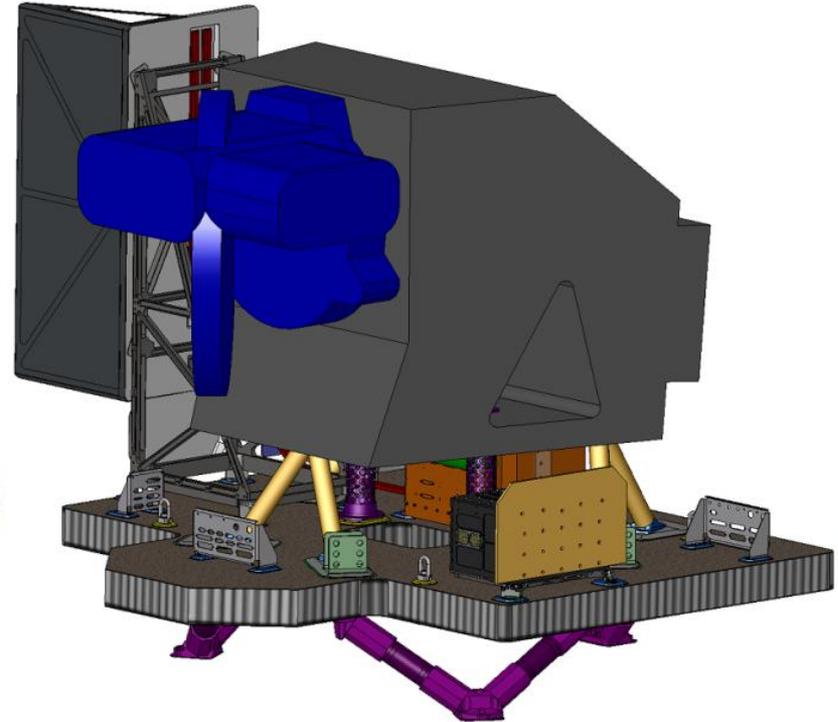
- **The Operational Land Imager (OLI) will be the main instrument on Landsat-8 when it launches in 2012. OLI represents a generational change from heritage Landsat instruments in its design but must maintain data continuity with the 30+ year Landsat data archive. As a result, OLI has undergone a stringent calibration and characterization campaign to ensure its characteristics are understood and consistent with past instruments. This paper presents an overview of the OLI design, its major differences from previous Landsat instruments, and a summary of its expected performance.**



The Operational Land Imager (OLI) represents a generational change in Landsat technology



- 1 - Mainframe
- 2 - Aperture Sunshade
- 3 - Scan Mirror
- 4 - Primary Mirror
- 5 - Secondary Mirror
- 6 - Prime Focal Plane
- 7 - Hybrid Preamplifiers
- 8 - Calibration Shutter
- 9 - Black Body
- 10 - Relay Optics Assembly
- 11 - Radiative Cooler
- 12 - Circuit Card Assemblies
- 13 - Earth Shield
- 14 - Electronics Module
- 15 - Power Supplies
- 16 - Thermal Control Louvers
- 17 - Full Aperture Calibrator Assembly



- Whiskbroom imager
- Obscured telescope
- 1020 cm² aperture
- 8 bits transmitted to ground
- VIS/SWIR and IR

- Pushbroom Imager
- Unobscured telescope
- 143 cm² aperture
- 12 bits transmitted to ground
- OLI is VIS/SWIR only (TIRS does IR)

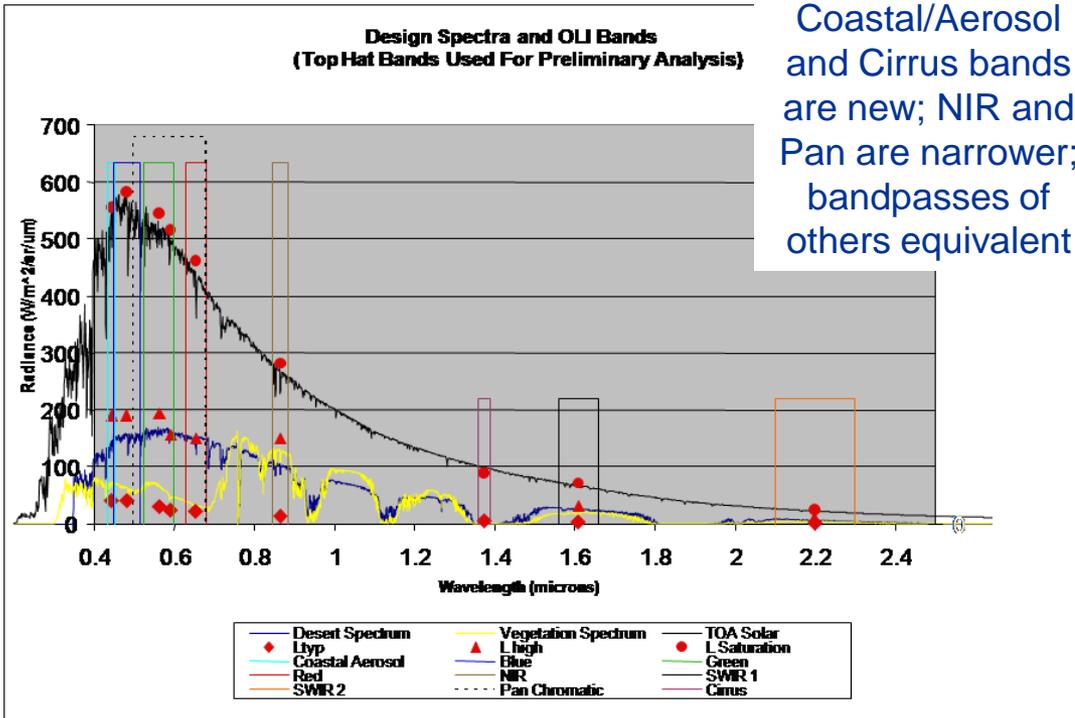


OLI Maintains Landsat Legacy



- Landsat Continuity Mission demands
 - Accurate spectral and spatial information
 - Frequent synoptic earth views
 - NIST calibrated over time
 - Precise geo-referenced data

- Key instrument parameters
 - Cross-track FOV 185 km
 - S/C altitude 705 km
 - Geodetic accuracy*
 - ❖ Absolute 65 m
 - ❖ Relative 25 m
 - Geometric accuracy**
 - ❖ Absolute 12 m



Band Name	CW (nm)	Bandwidth (nm)	GSD (m)	SNR
Coastal/Aerosol	443	20	30	130
Blue	482	65	30	130
Green	562	75	30	100
Red	655	50	30	90
NIR	865	40	30	90
SWIR 1	1610	100	30	100
SWIR 2	2200	200	30	100
PAN	590	180	15	80
Cirrus	1375	30	30	50

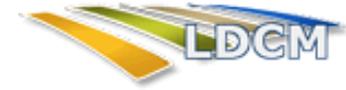
Visible/NIR SWIR

*No terrain compensation
**w/ terrain compensation

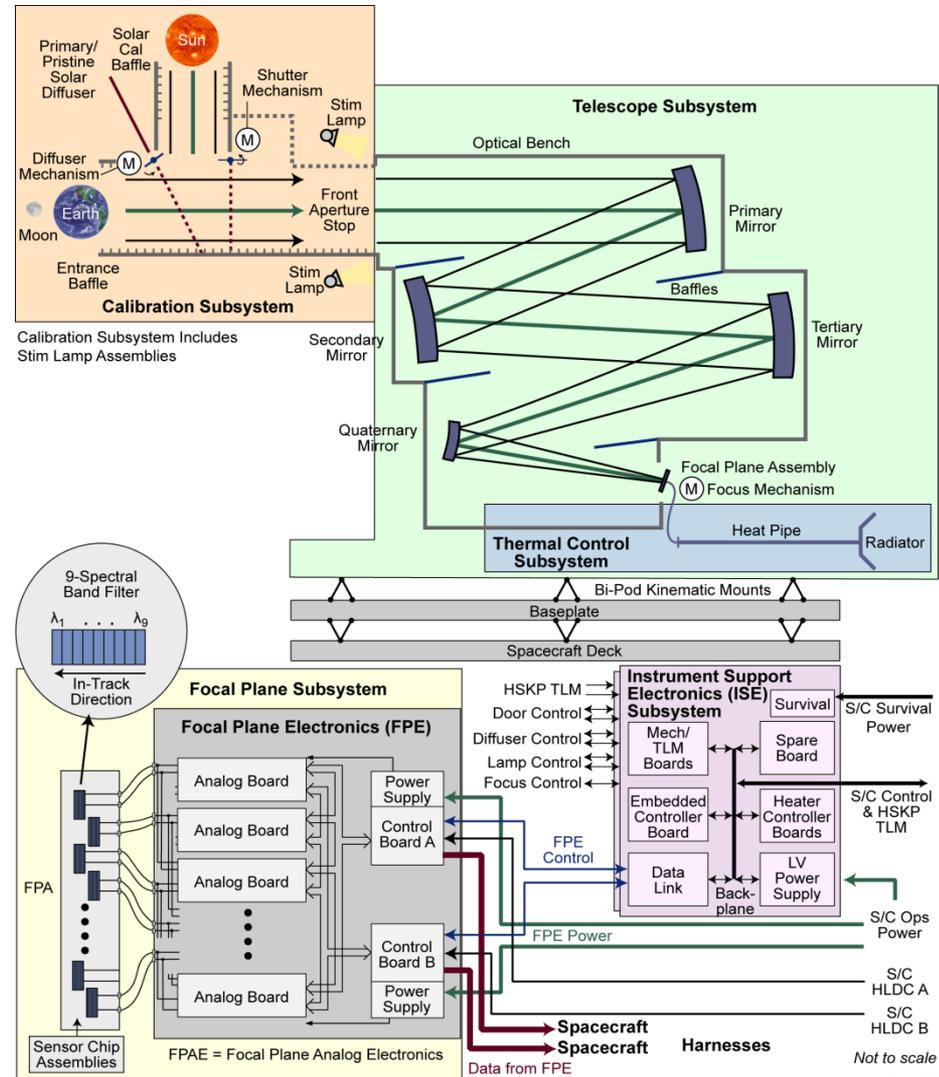
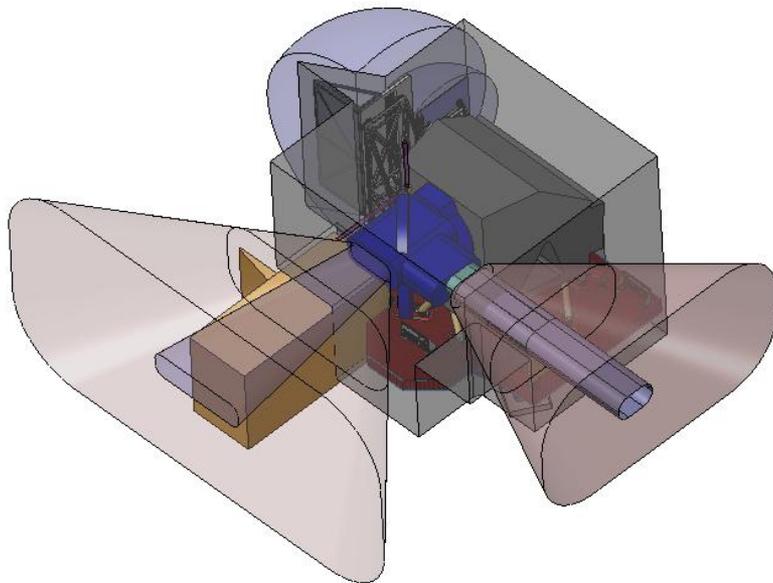
Note: Geometric reqts are tighter for OLI



OLI is a fairly simple instrument



- Pushbroom VIS/SWIR sensor
- Four-mirror telescope with front aperture stop
- FPA consisting of 14 sensor chip assemblies, passively cooled
- On-board calibration with both lamps and full aperture diffusers

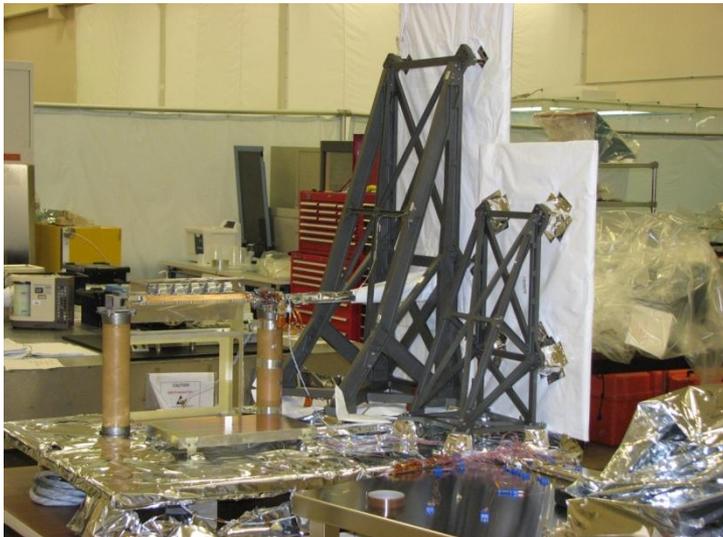




OLI Is Complete and in Final Environmental Testing

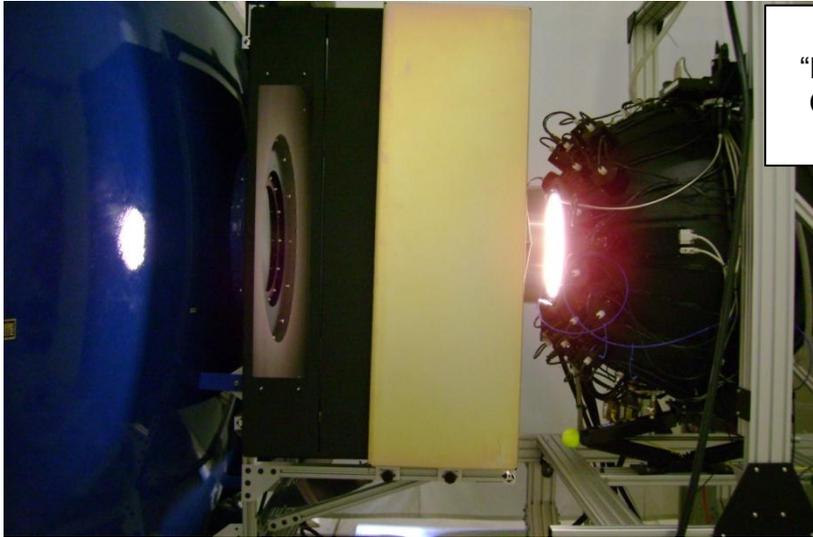


- OLI Telescope (right) and Thermal Control (below) have been mounted to Baseplate (lower right)





Radiometric and Spectral Tests Completed with traditional spheres and monochromators



Aligning
"Death Star"
Calibration
Sphere

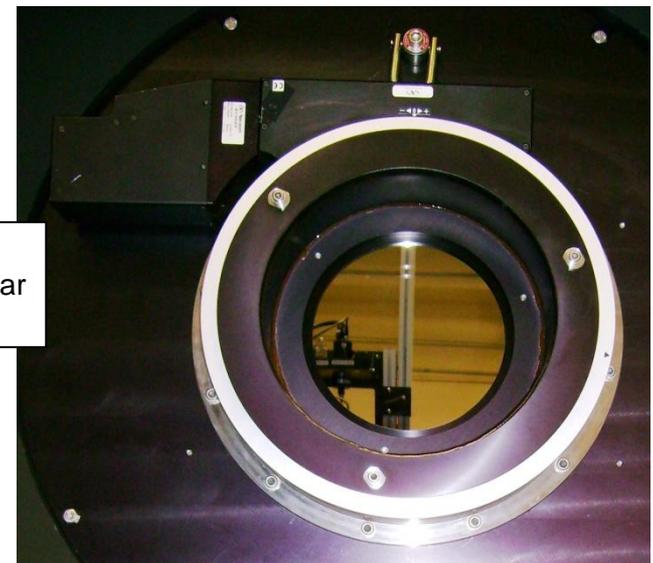


Inspecting
heliostat
alignment

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Spectral
Measurement
Assembly



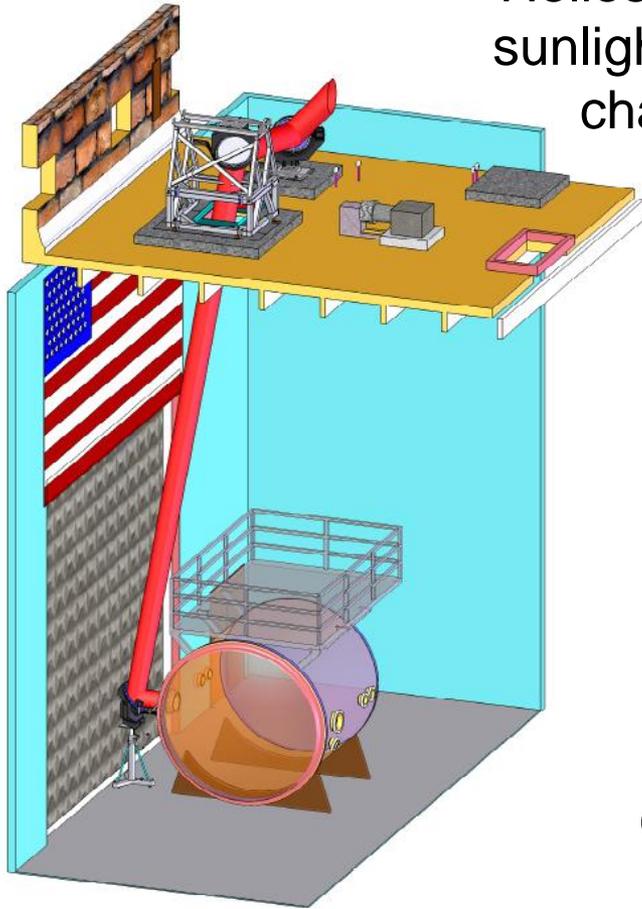
Large
aperture linear
polarizer



HelioStat Calibration provides transfer of calibration to orbit

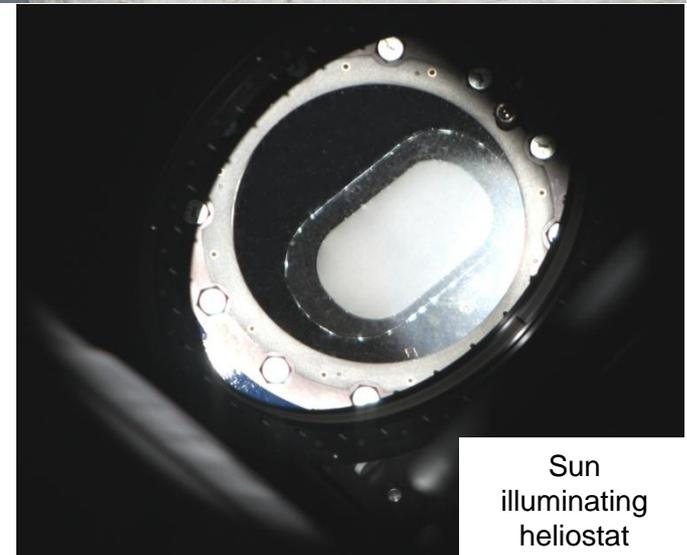


HelioStat steers sunlight into T/V chamber



Measuring HelioStat Transmission

Atmospheric transmittance characterized by University of Arizona



Sun illuminating heliostat

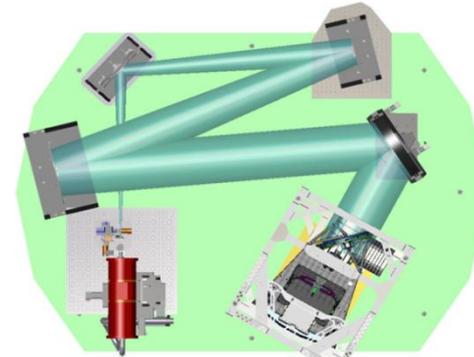
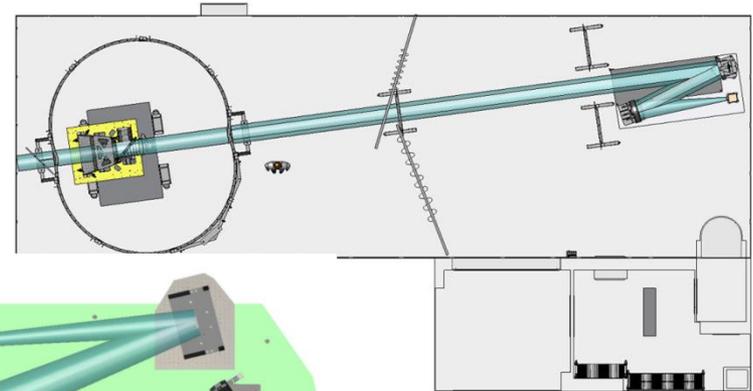


Extensive Spatial Characterization Successful



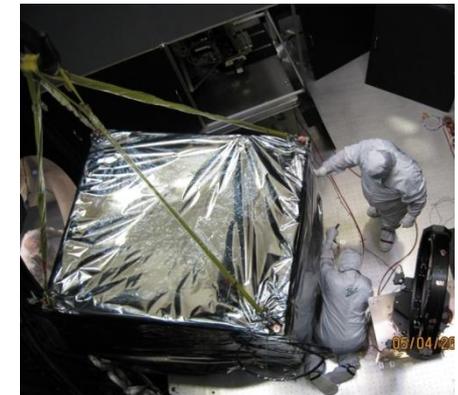
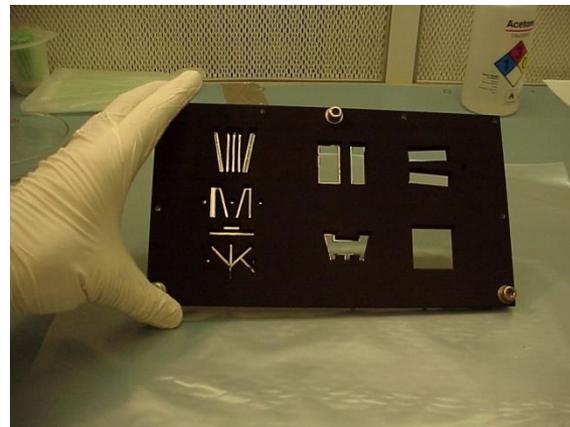
- Conducted stray light characterizations in state of art facility
- Other Spatial Characterizations with BATC's Horizontal Collimator Assembly (HCA)
 - Collimator and instrument in Vacuum
 - Various spatial targets used to conduct characterizations of edge response, ghosting, bright target recovery, pointing

Stray light facility



HCA

Spatial targets used for testing



OLI being lowered into chamber for spatial testing



Radiometric Performance looks excellent

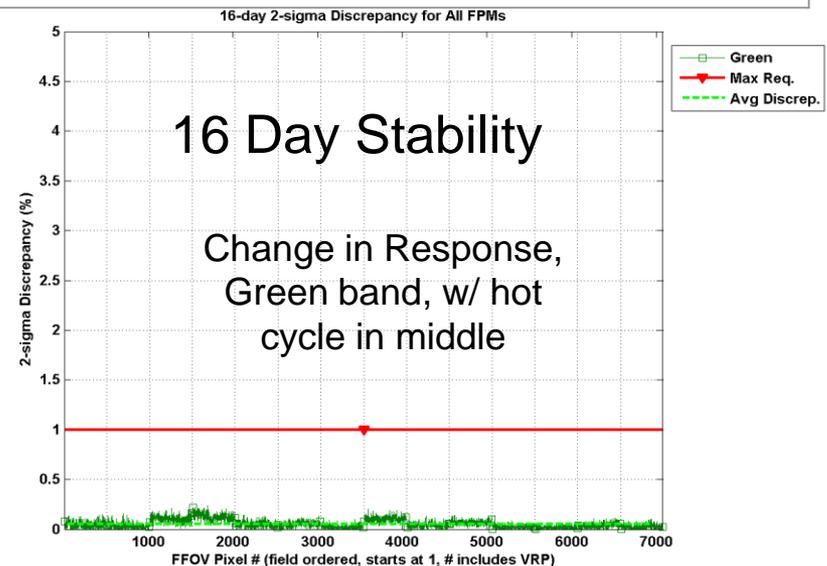
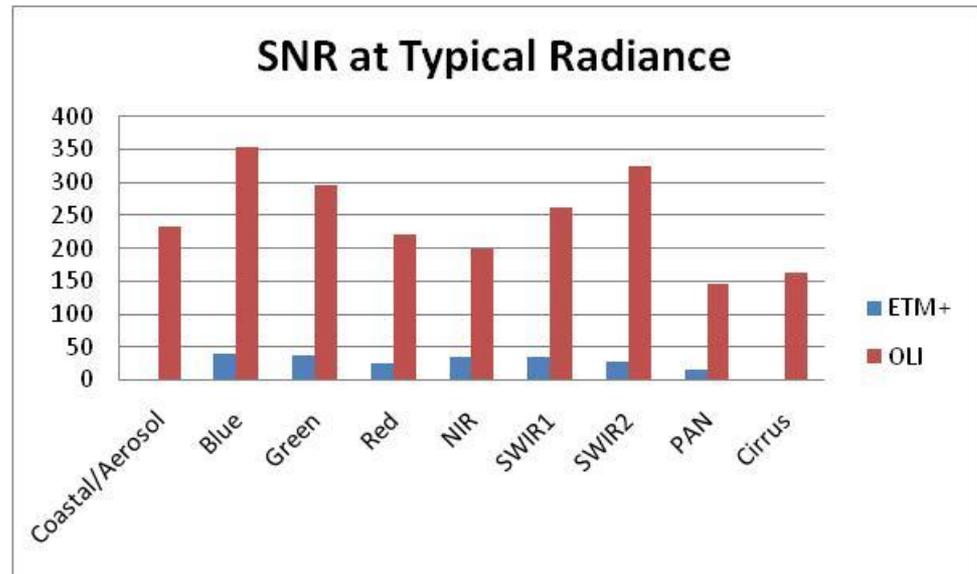


■ SNR

- SNR significantly exceeds requirements and heritage

■ Calibration

- Absolute uncertainty ~4%
 - ❖ Extensive round robin for NIST traceability
 - ❖ Transfer-to-Orbit uncertainties measured
- Since Landsat measures change, stability of response is critical
 - ❖ Stability over 60 seconds (2 standard scenes) is excellent
 - <0.02% 2σ
 - ❖ Stability over 16 days (time between Solar Diffuser Cals) is excellent
 - <0.54% 2σ for all but Cirrus Band which is <1.19%





Spectral and Polarization Performance looks excellent

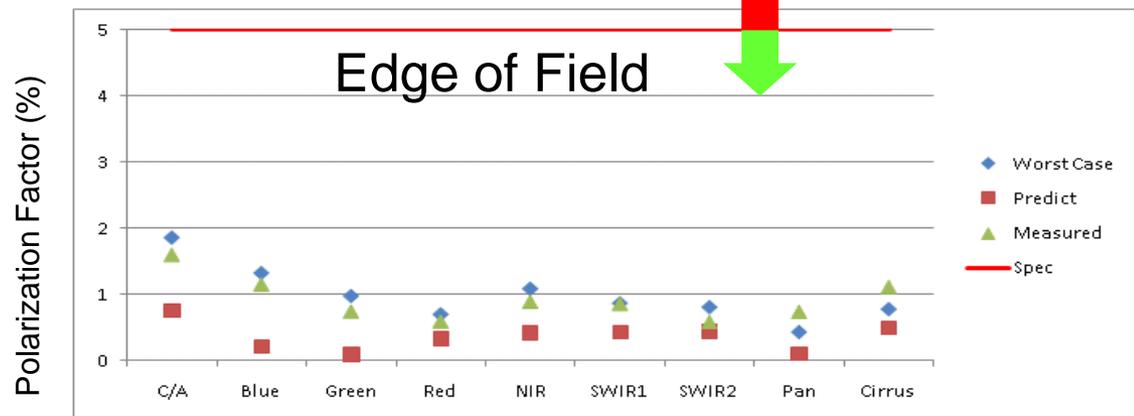
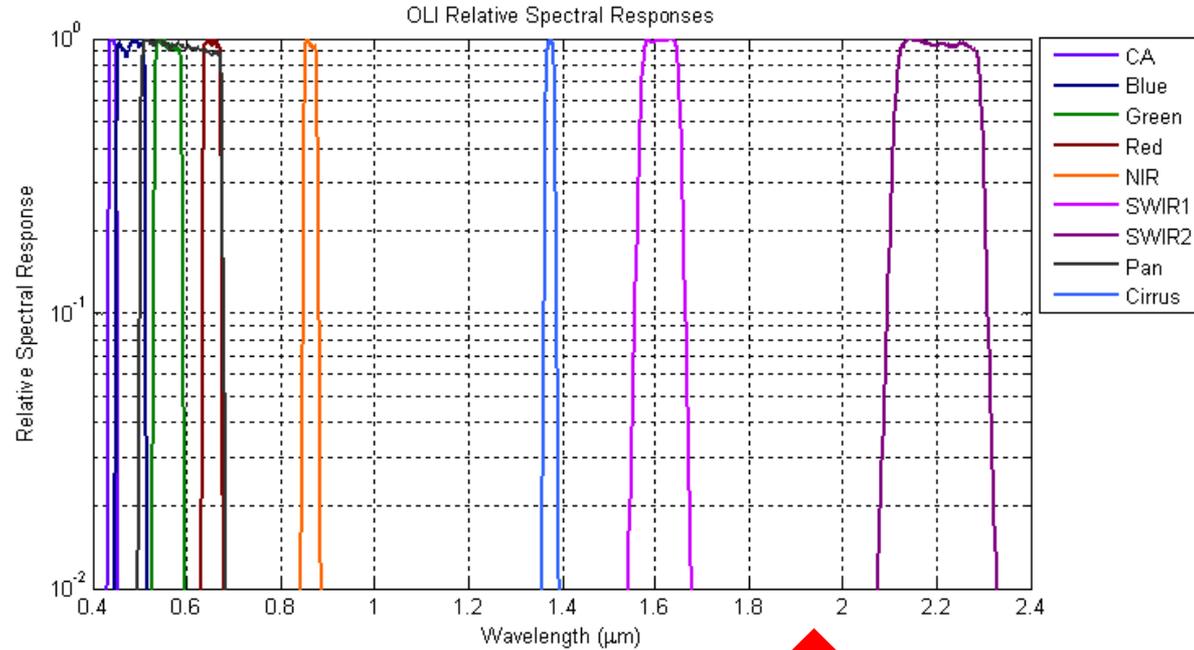


■ Spectral Performance

- Relative Spectral Responses have desired sharp bandpasses
- Out-of-Band Response typically below 10^{-4}

■ Polarization

- Polarization Sensitivity well below 2%
- Will not alter measured signal from highly polarized scenes such as canopies and water





Spatial Performance looks excellent

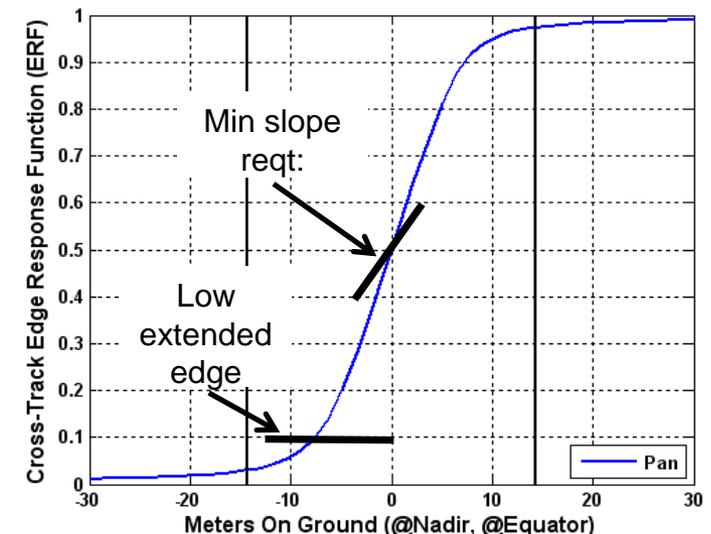
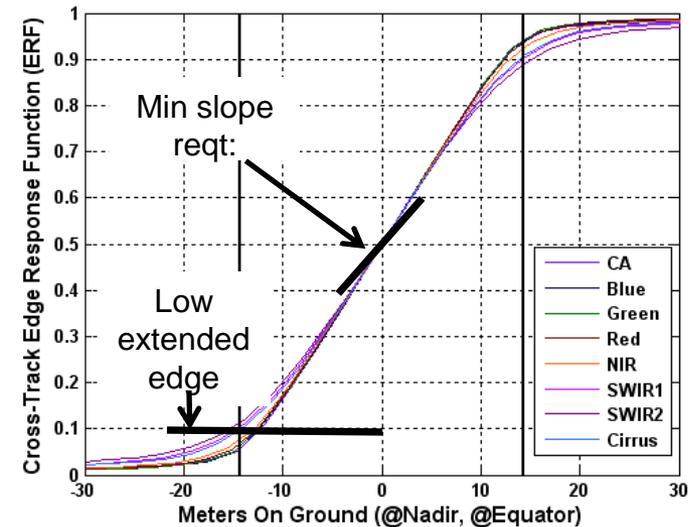


■ Spatial Performance

- Want sharp edges for change detection
- Measured spatial response has:
 - ❖ Steep slope (exceeding reqts)
 - ❖ Low extended edge (good half edge extent)
 - ❖ No ripple/overshoot

■ Geolocation

- Want good pointing knowledge, again for change detection
- Performance depends on both instrument and spacecraft; final measurements made during initial on-orbit checkout
- Pre-launch instrument measurements mapped line of sight of all detectors to reference pixel/boresight to $\sim 1/10^{\text{th}}$ of a pixel
- On target to have absolute geometric accuracy of $< 1/2$ pixel





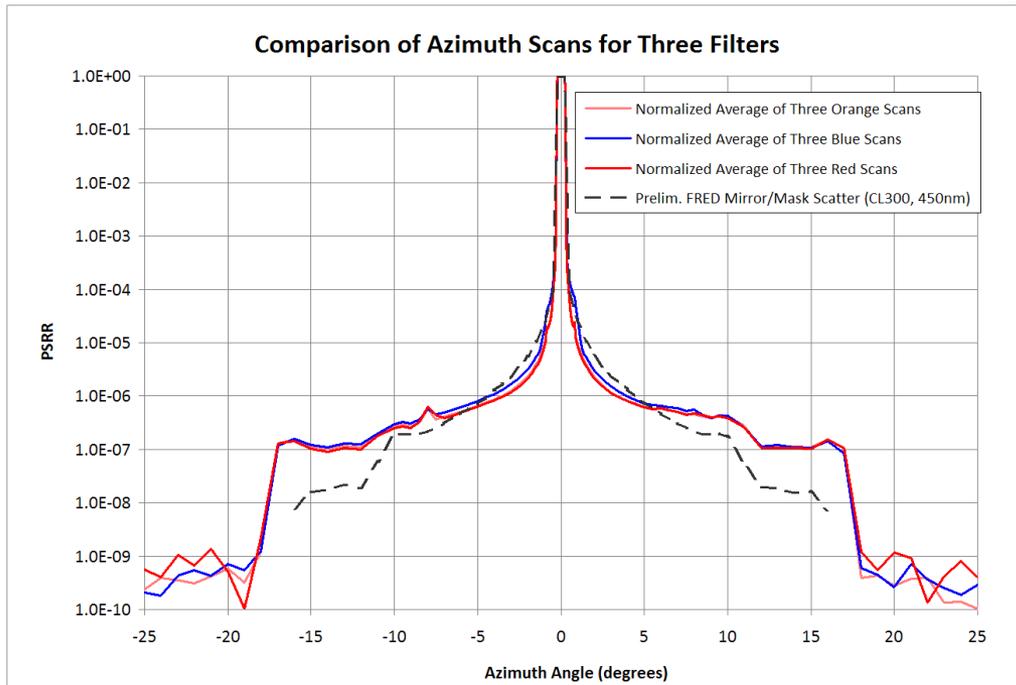
OLI Stray Light Testing Complete



- Tests using BATC state of art stray light facility; had tremendous results
 - Background light from facility undetectable (detector noise dominated)
 - Reference point: 9 orders of magnitude is difference between 10:30 am sun and $\frac{1}{4}$ moonlight



Stray Light Ninjas





Summary



- **OLI represents a generational change from ETM+ , but must preserve data continuity and therefore maintain solid calibration.**
- **Instrument design focuses on simplicity**
 - Pushbroom vs. whiskbroom instrument
- **Thorough pre-launch calibration and characterization complete**
 - With unique BATC calibration facilities
 - Final data analysis underway
- **Performance meeting user needs**