OLI Overview and Status

Landsat Science Team Meeting

6/23/09

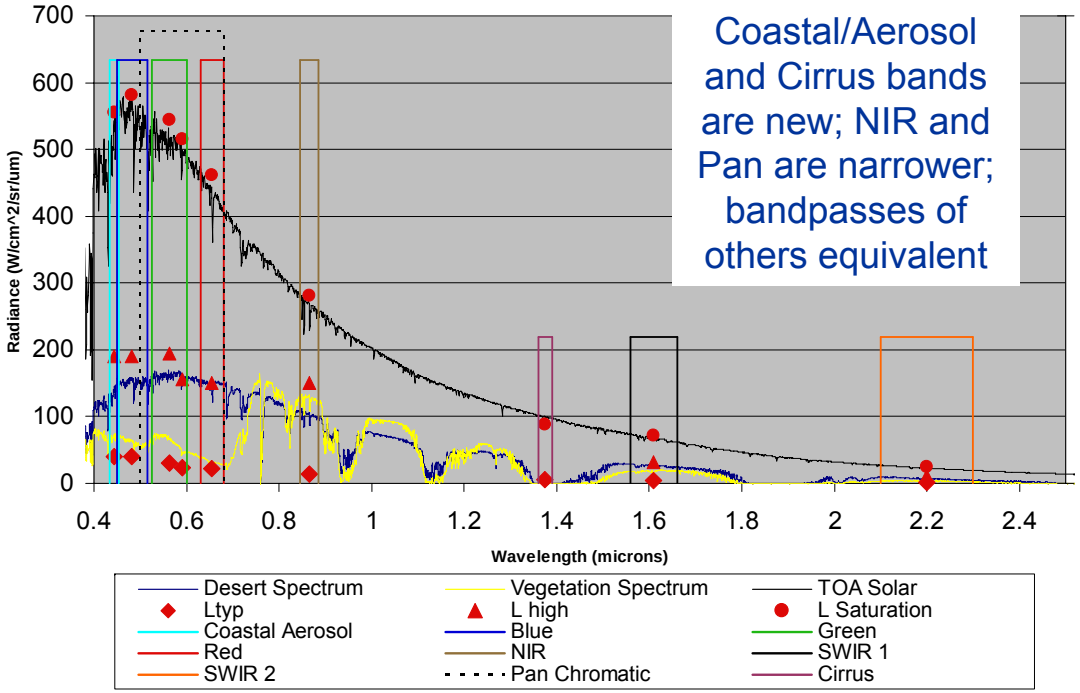
Outline

- Instrument Overview
- Subsystem Status
- Preliminary Data and Performance Predictions
- Conclusion

Instrument Overview

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



Coastal/Aerosol and Cirrus bands are new; NIR and Pan are narrower; bandpasses of others equivalent

- 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

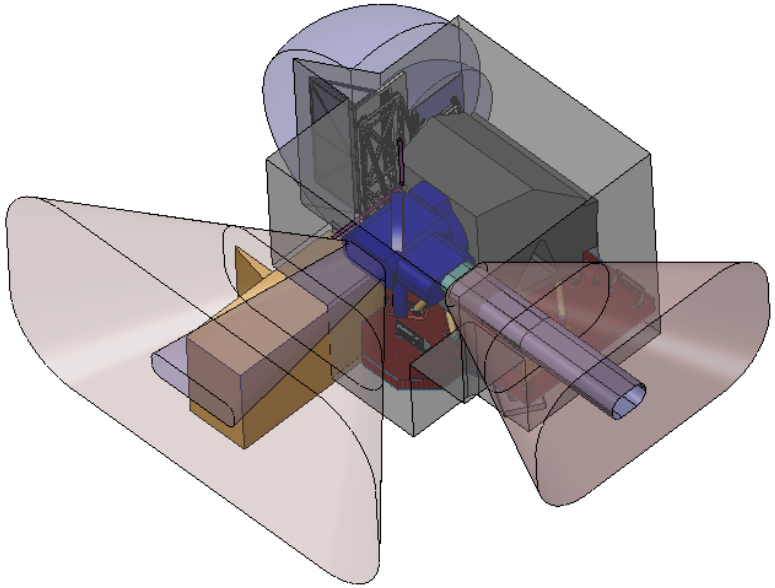
Visible/NIR SWIR

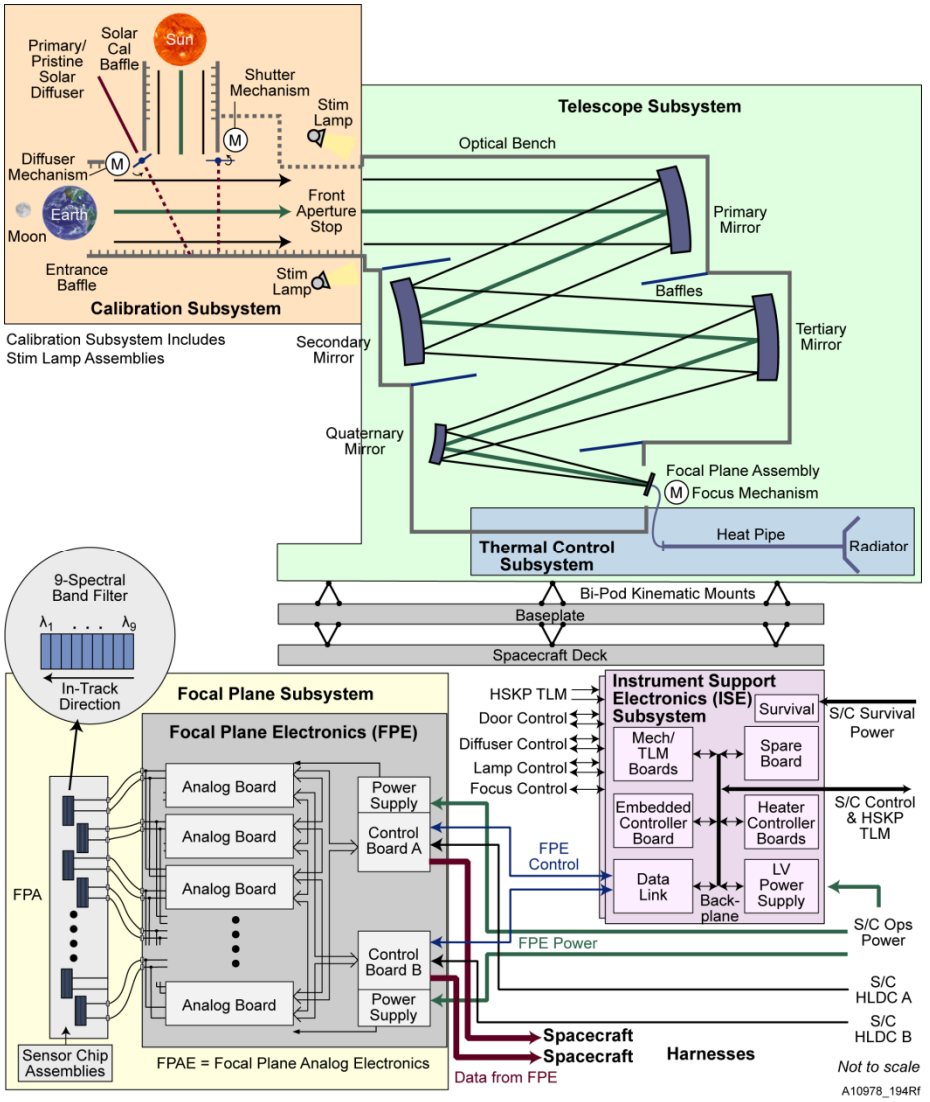
*No terrain compensation
**w/ terrain compensation

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 diffusers and lamps





Major Changes since last Science Team Meeting

- Locked down final thermal design
  - Small changes to heaters, thermistors, blankets, radiators from ICDR design
- Silicon Detector Anomaly resolved
  - Problem with stability over time identified; new detectors in work
- Built up most of telescope
  - Mirrors installed and aligned (TBR)
- Stim Lamp Assemblies complete and ready for installation
- Kinematic Mounts complete and ready for installation
- Light Baffles complete
  - Changed internal coating to reduce stray light

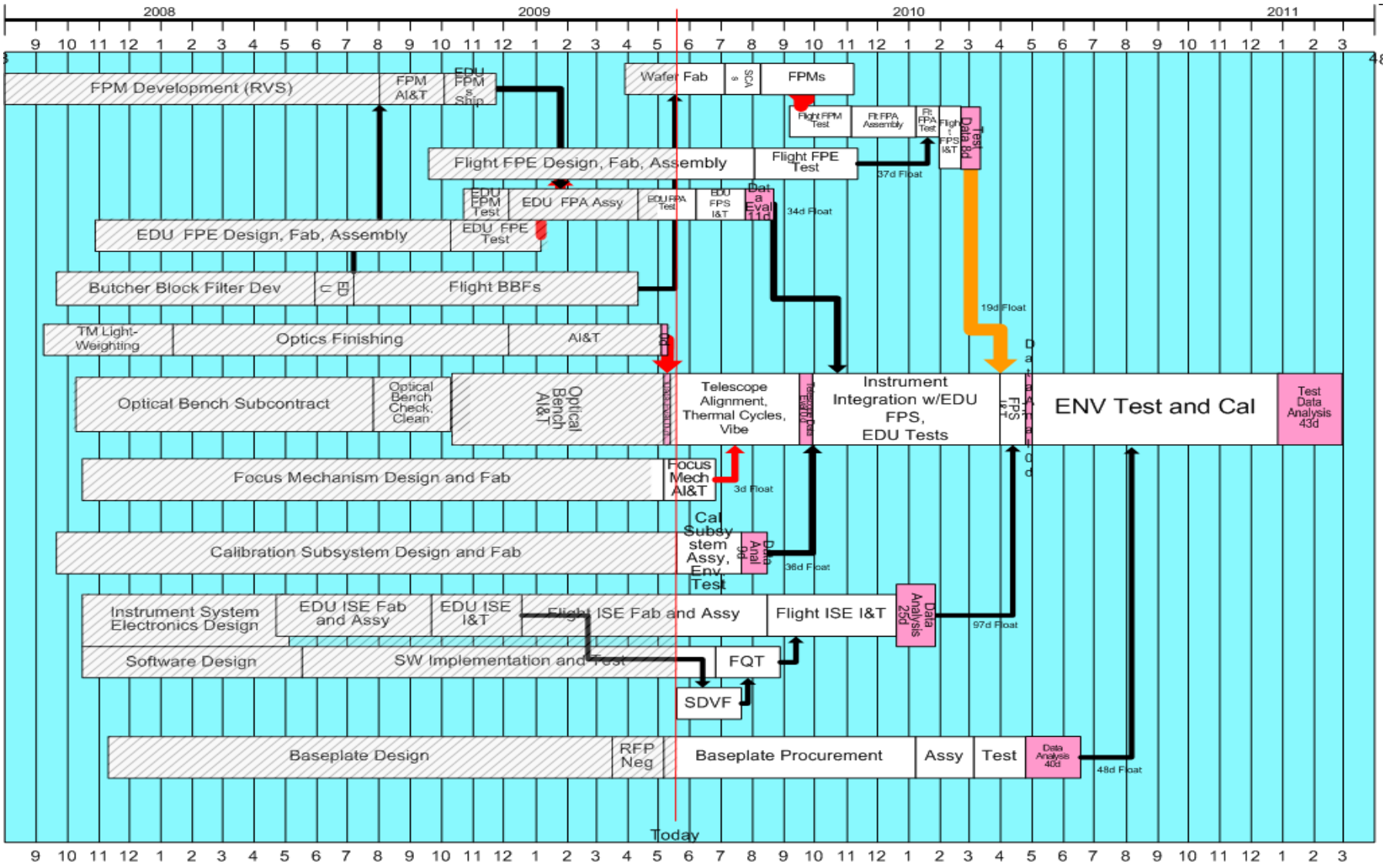
Key Technical Parameter (KTP) Performance Summary

- Meeting all key requirements with margin
- Changes since last Science Team
  - Finalization of Baseplate Design and impacts on Power and Mass
    - Steps to improve power margin are underway; not expected to be an issue
  - Performance predictions now incorporate actual optics measurements
    - Very close to original models

KTP	Reqt	1/09 Sci Team	6/09 Sci Team	Margin (%)	Units	Comments
Mass	375.0	374.8, 424.5	417.8/442.9	7.7,1.6	kg	CBE, Mature Mass
Peak Power	375	318.8, 330.6	396.1,407	,-5.3-7.9	W	CBE, Mature Power CAL MODE
Average Power	200	170.1, 181.1	189.4,200.3	5.6,-0.2	W	CBE, Mature Power
Data Rate	265	260.92	260.92	1.6	Mbps	Reqt. is NTE
SNR	130	72	71	-	%	Worst case margin at Ltyp (C/A band)
Edge Response Slope	0.027/m	5.5	5.5	-	%	Worst case margin (BLUE AT)
Abs. Rad. Accuracy	5.0	3.9	3.9	28	%	
Radiometric Stability	1.00	0.65	0.65	572	%	Worst band (SWIR2)
Pixel-to-Pixel Uniform.	0.25	0.14	0.14	46%	%	Banding C/A Band
Absolute Geodetic Accuracy	65	51.18	51.28	26.8	m	
Band-to-Band Reg. Accuracy	4.5	2.97/3.92	2.86/3.50	28.6	m	AT/XT

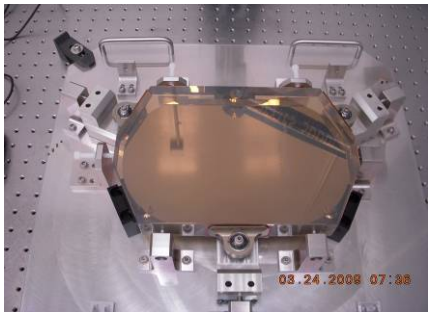
- Mass and power are reported for both current best estimate (CBE) and “mature” values, which include Ball Aerospace growth factors
  - “Current Best Estimate” is the designer’s estimate
  - Mature mass / mature power reflects historical growth. i.e., it’s contingency

OLI One-Page Schedule

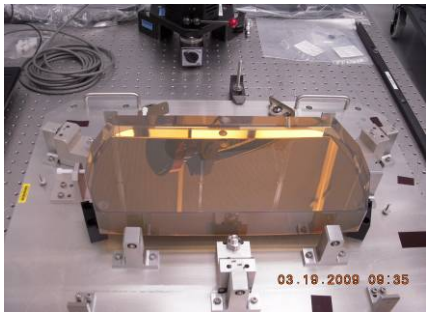


Subsystem Status

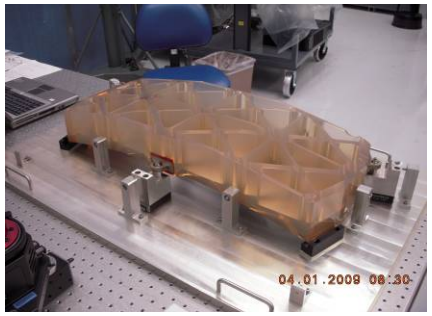
Optical Mirrors Complete



Primary

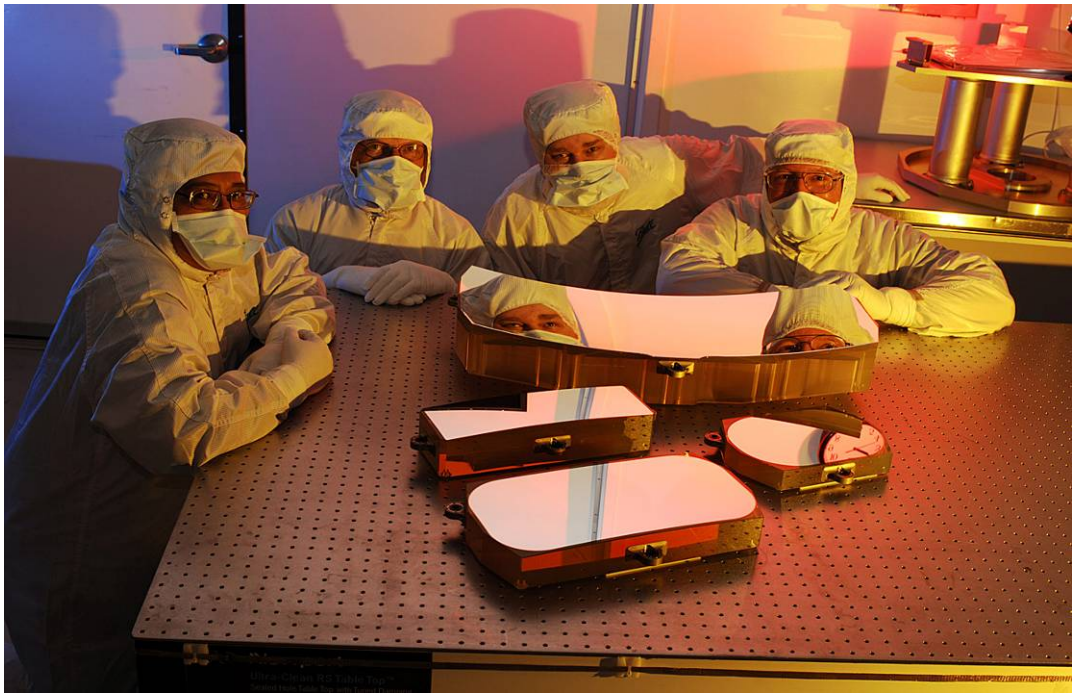


Secondary

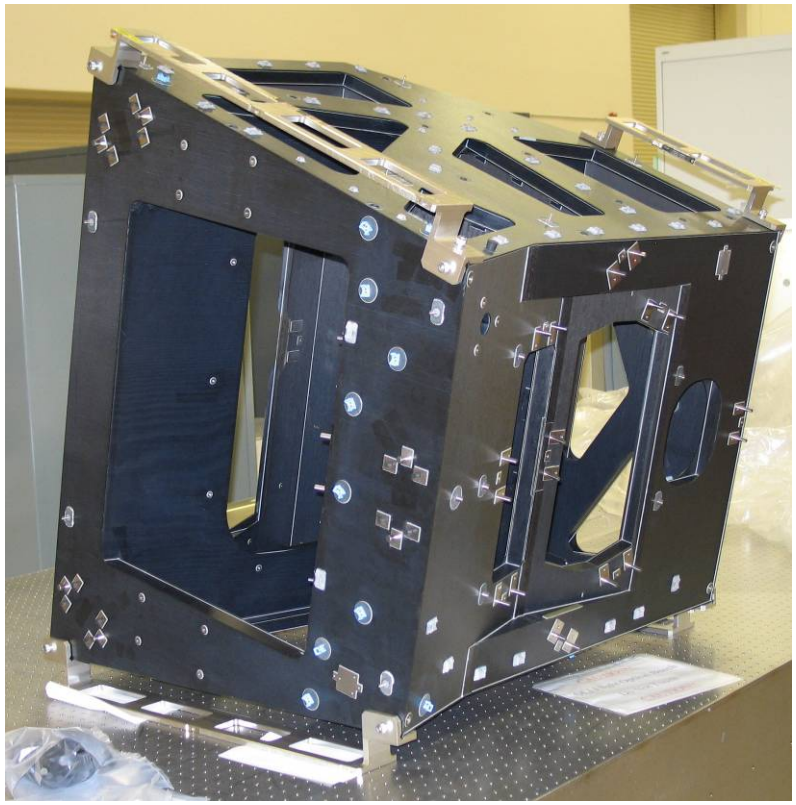


Tertiary

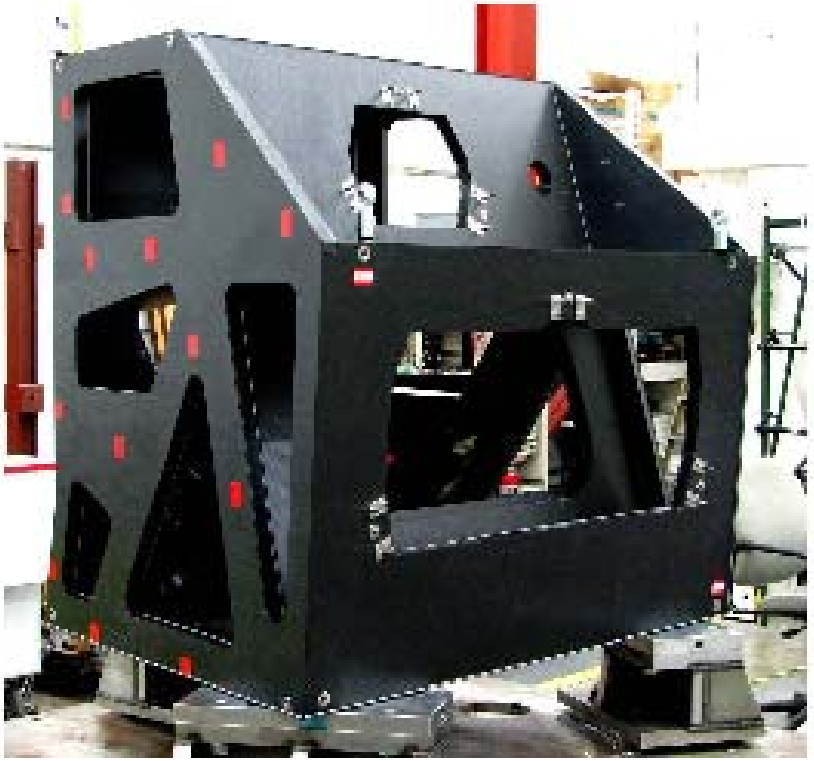
Quaternary



Main Bench Assembly Completed

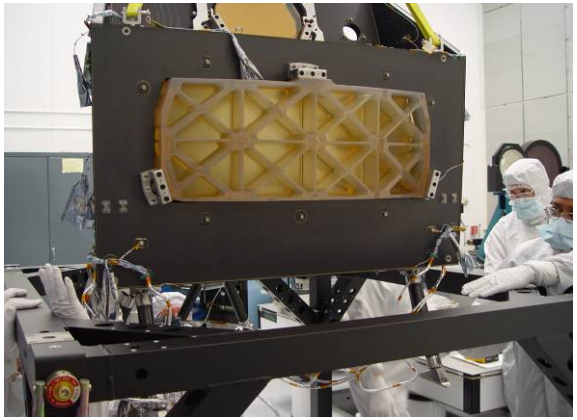


Side View of Bench

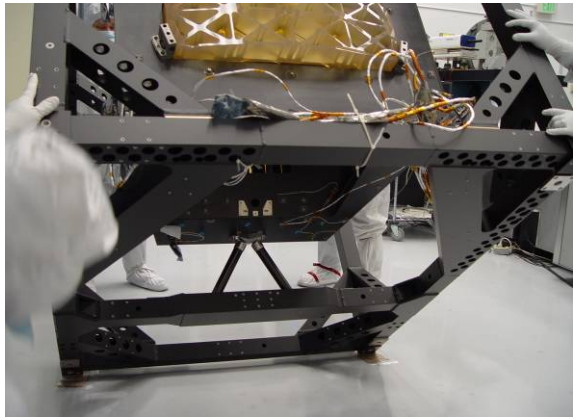


Back View of Bench

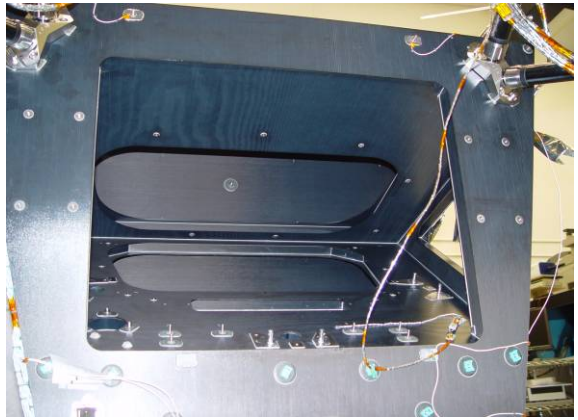
Telescope Build



Telescope install in
Universal Test Fixture (UTF)

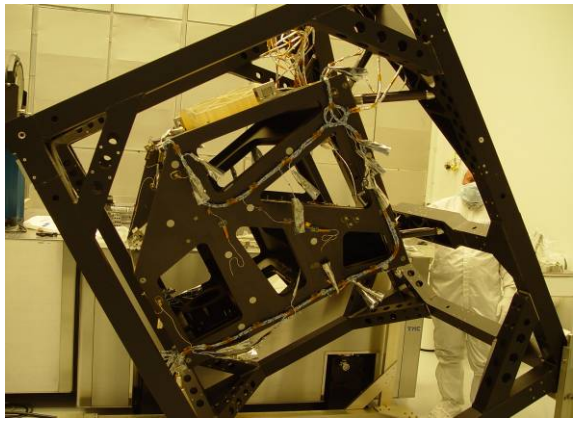


Telescope roll in UTF



FPA Mounting in Telescope

UTF Install into Wedge Assy

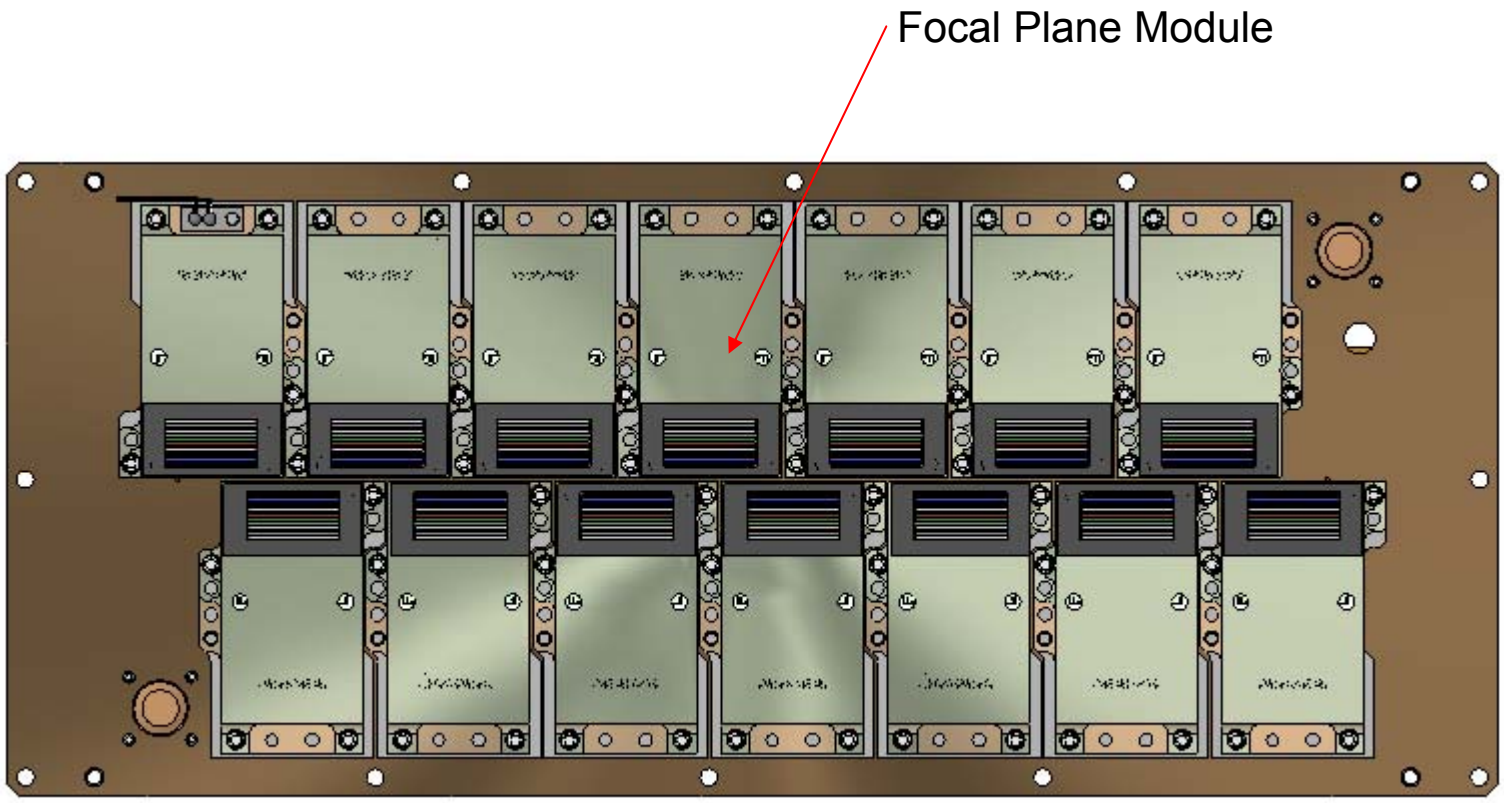


Tele in UTF

First “look” through telescope

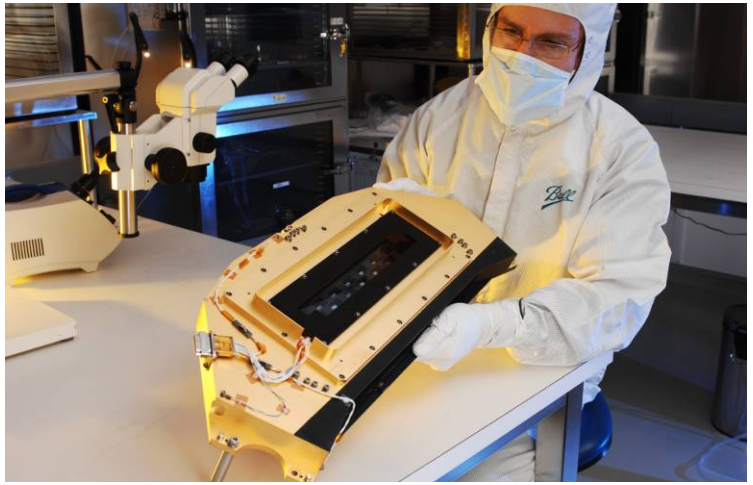
Focal Plane Consists of 14 Modules

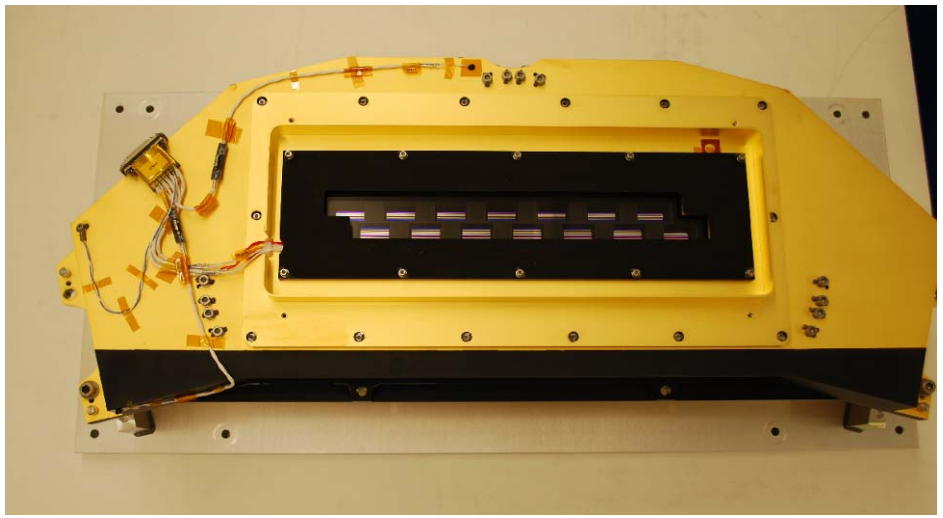
- Each Module contains Silicon and HgCdTe detectors mounted on a single readout chip (ROIC)
  - Spectral Filters above the detectors provide separation into bands



Engineering Development Unit FPA complete

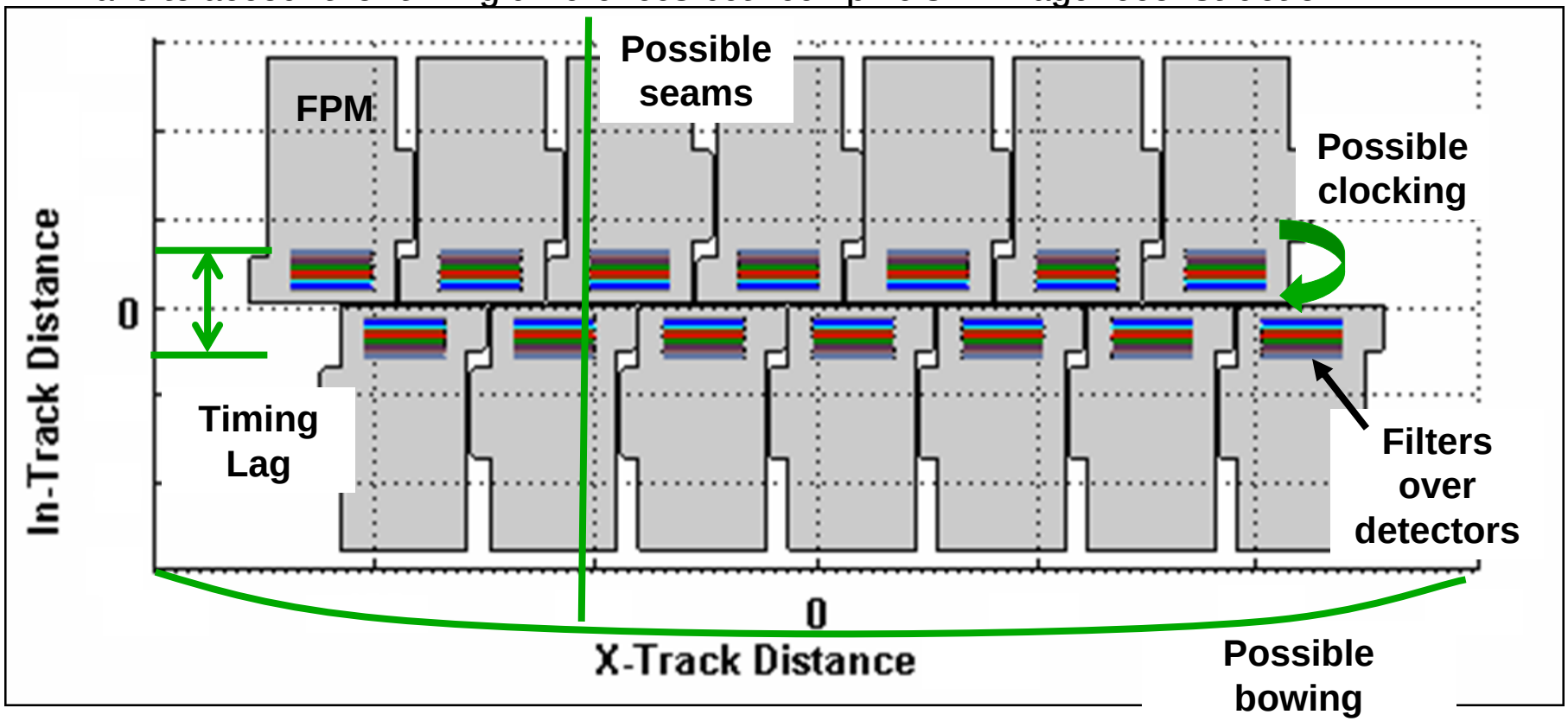
- Will retrofight a “flight” quality window later this summer
  - Will reduce ghosting
- Flight FPA parts proceeding on schedule
  - Will be waiting for the flight detectors



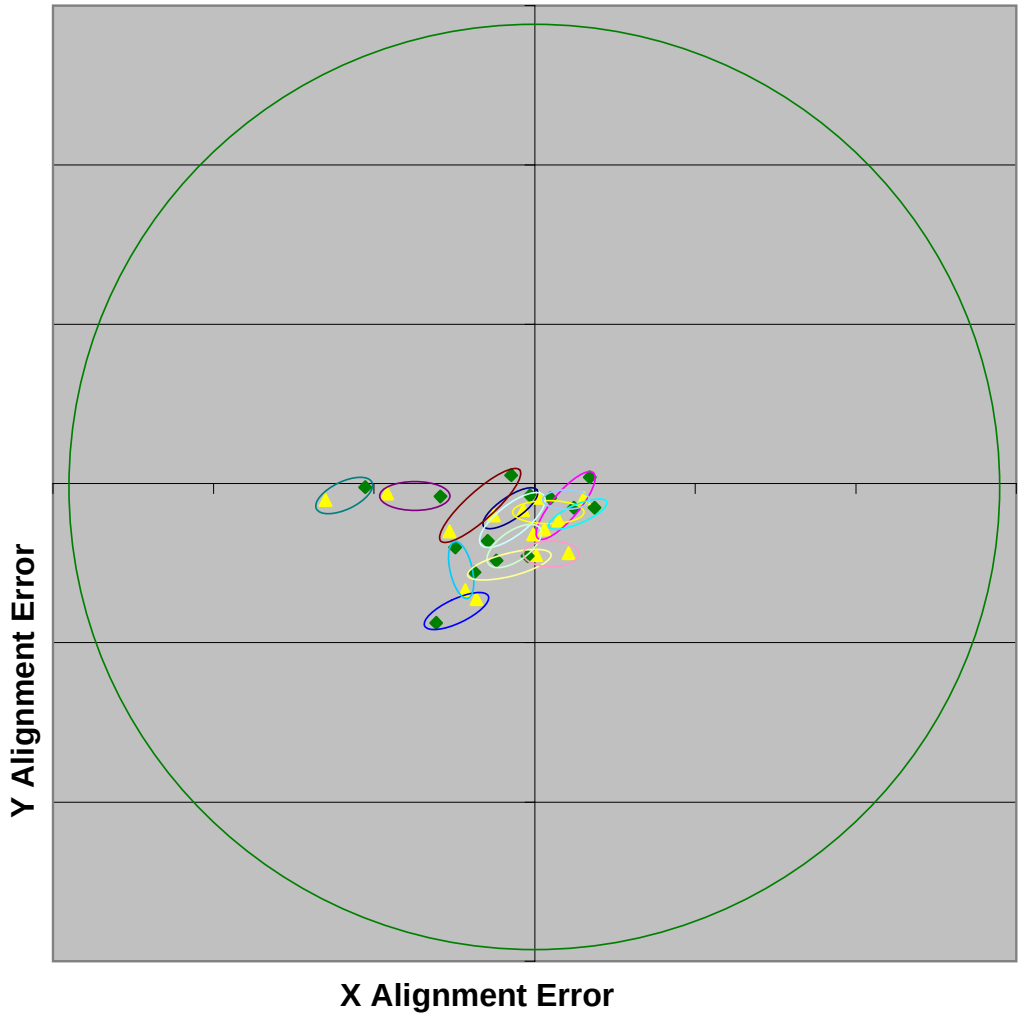


OLI image quality will depend on focal plane module uniformity

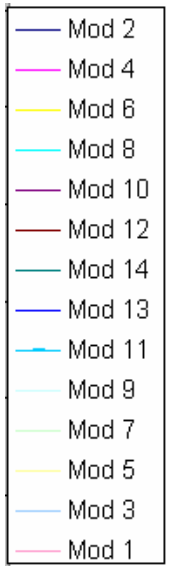
- Need filters and detector responses to be 'the same' (<0.5%) for all 14 FPMs
- Need precise alignment to eliminate clocking or other errors (will be known prelaunch)
  - Eliminate seams and bowing effects
- Have to account for timing differences between pixels in image reconstruction



EDU Preliminary X-Y Alignment Results



Well within requirement (green circle)



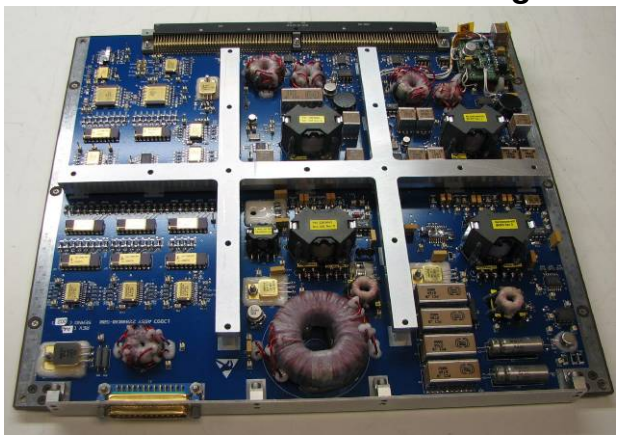
Silicon Detector Anomaly identified and resolved

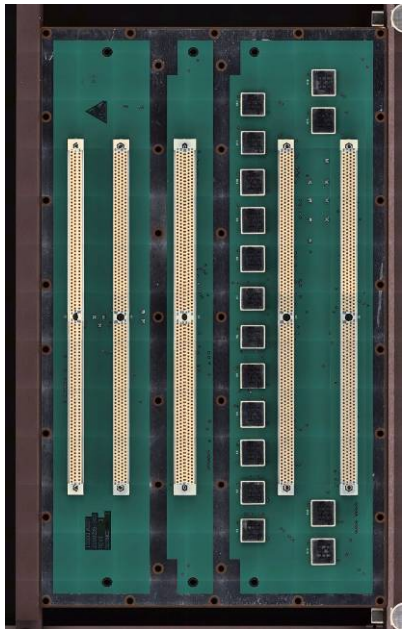
- Post-delivery measurements identified a degradation in some silicon detectors
  - Charge was diffusing into neighboring regions around pixels—no longer acting like a "detector"
  - Degradation was very slow (months)
- Aggressive technical team (Goddard, BATC, Raytheon) worked through data and identified root cause
  - Not discussed here for ITAR reasons
- Decision was to make new detectors for flight
  - Initial material manufactured; looks very good

Focal Plane Electronics Status

- Modified biases to accommodate new silicon flight detector design
  - Part of eliminating the anomaly conditions
- Most flight boards near completion
  - Examples below

EDU Board with Bias Change



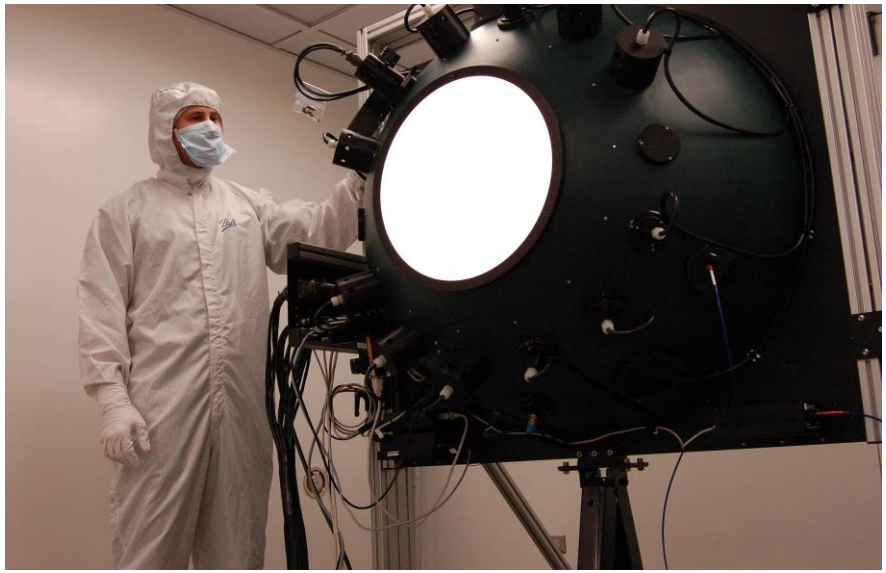


EDU FPE

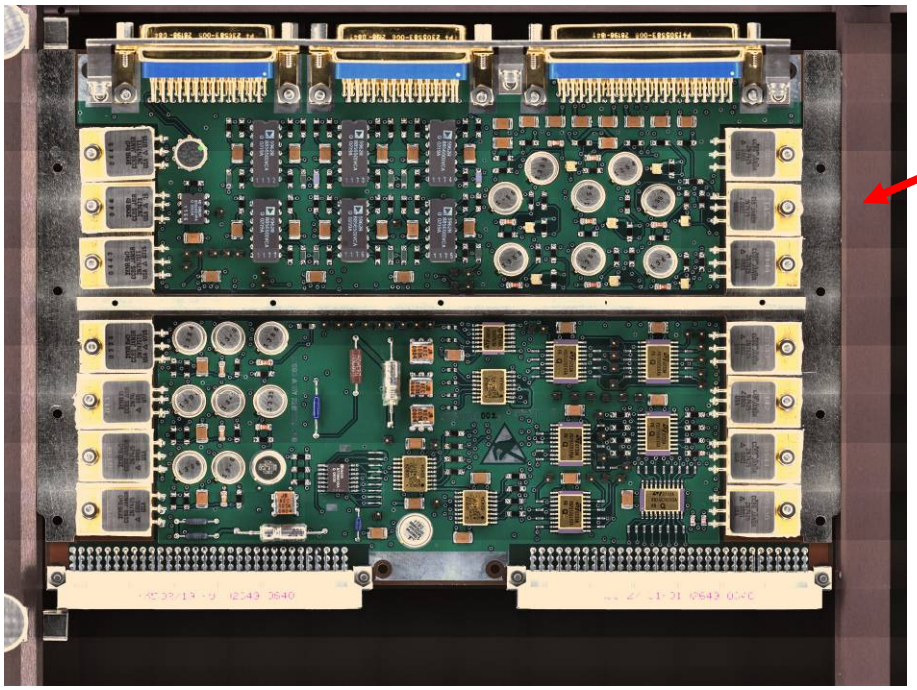
Focal Plane Testing

- Have completed testing on Engineering Model Focal Plane Modules
  - Conducted radiometric, spectral, spatial, ghosting tests
    - Select results toward the end
- Now testing at Focal Plane Subsystem level with Engineering Model
  - More Radiometric and Spatial Testing
  - Will also look at Stability and first “Image”

New, very bright integrating sphere for radiometric testing

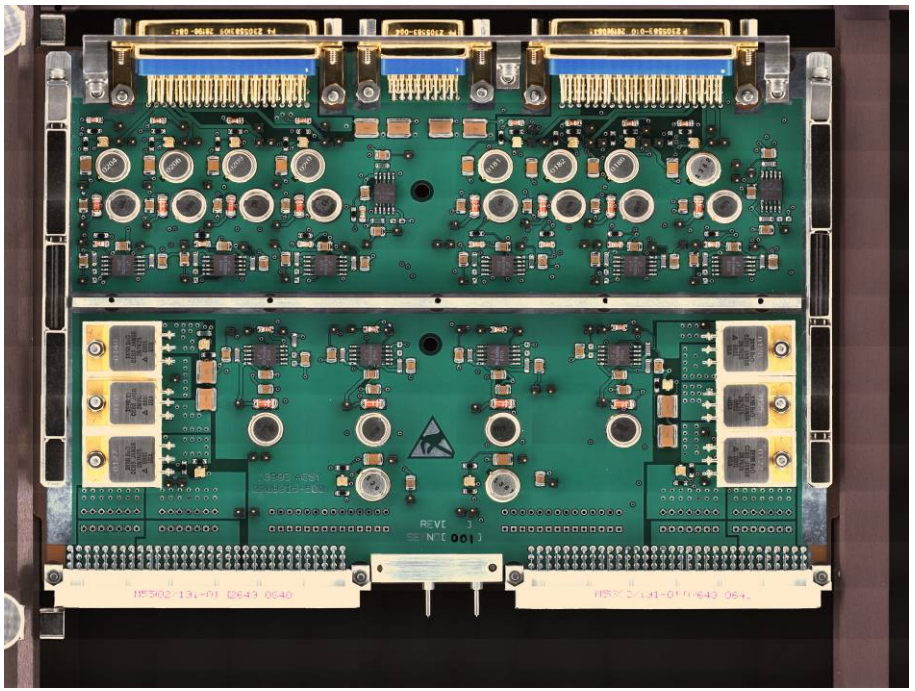


Flight Electronics Boards being completed

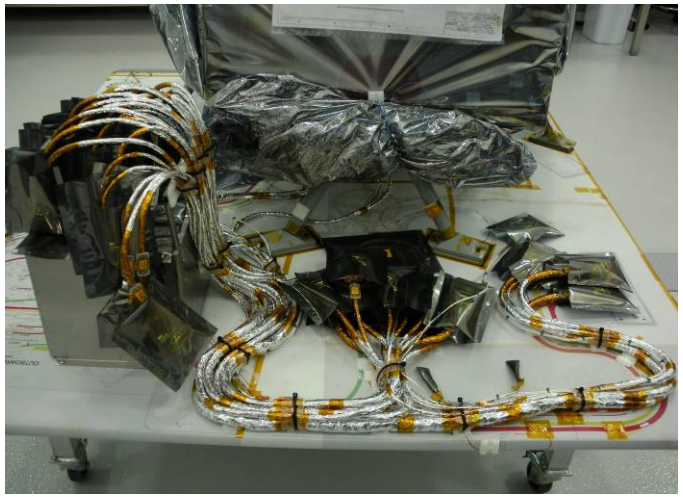


GHC board #1

SHC board

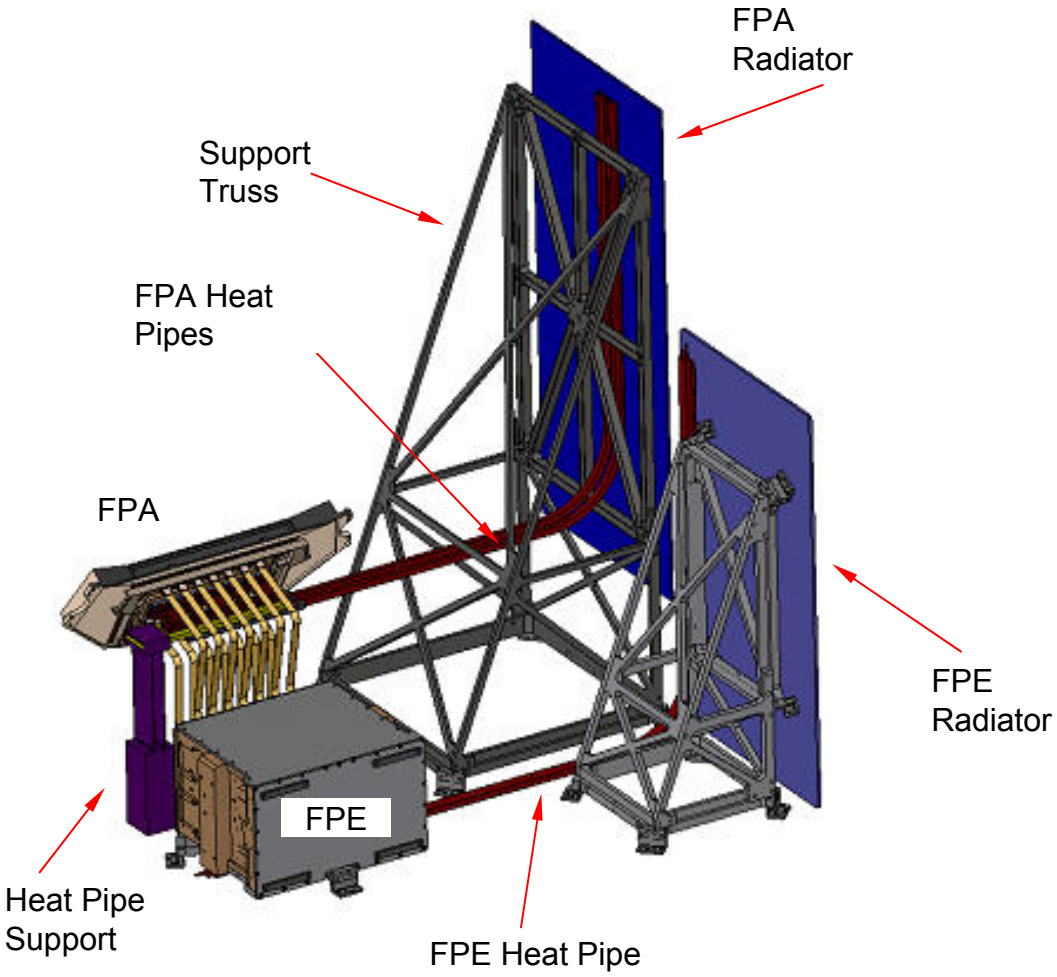


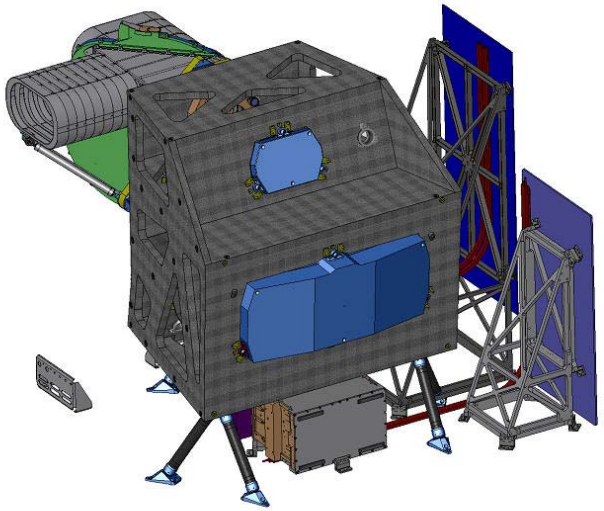
Harnesses near completion



Thermal Control Design Unchanged

+X UP ORIENTATION

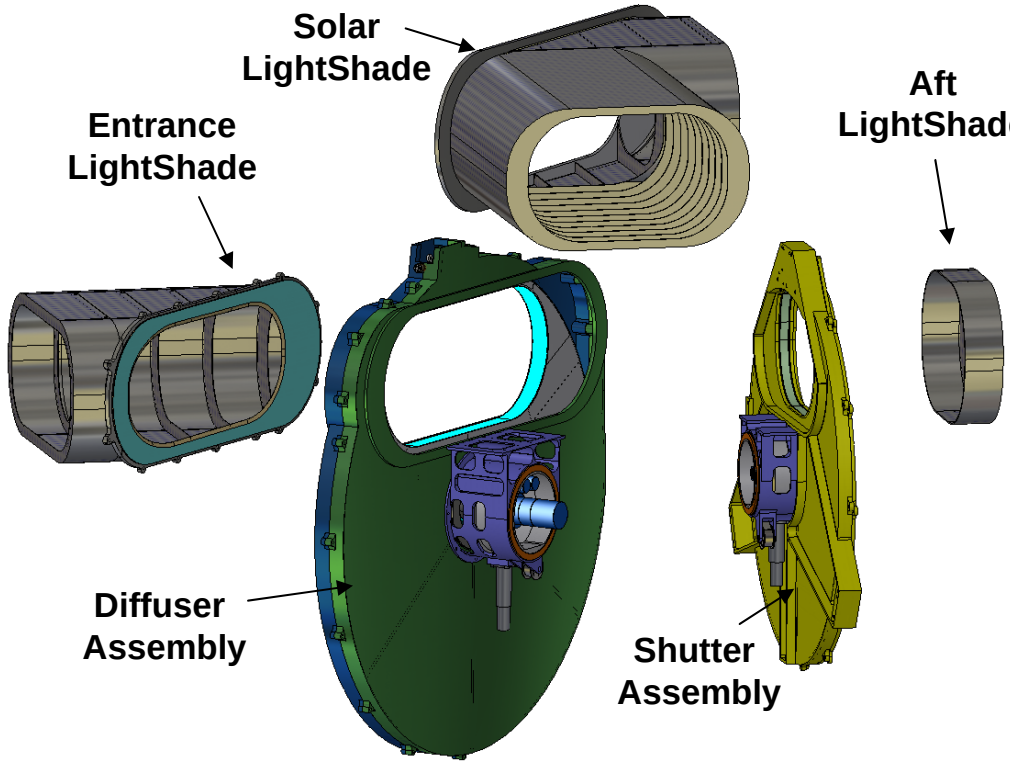




Design integrated onto instrument

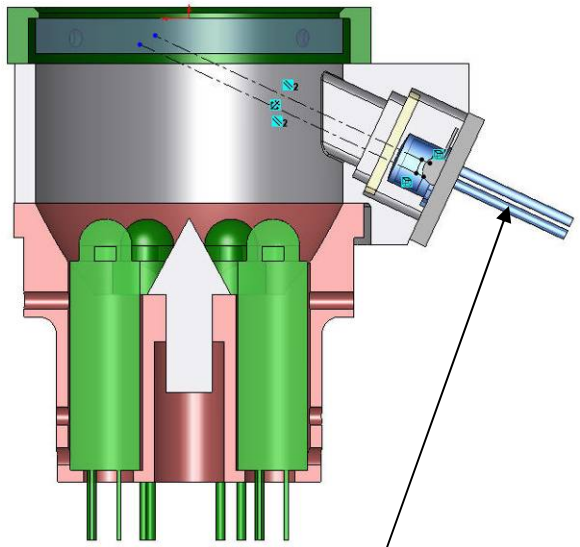
Calibration Subsystems in Manufacture

- Calibration Subassembly Consists of Five Subassemblies
  - 3 LightShade Assemblies
  - 1 Diffuser Assembly
  - 1 Shutter Assembly



Exploded View of Calibration Subassembly

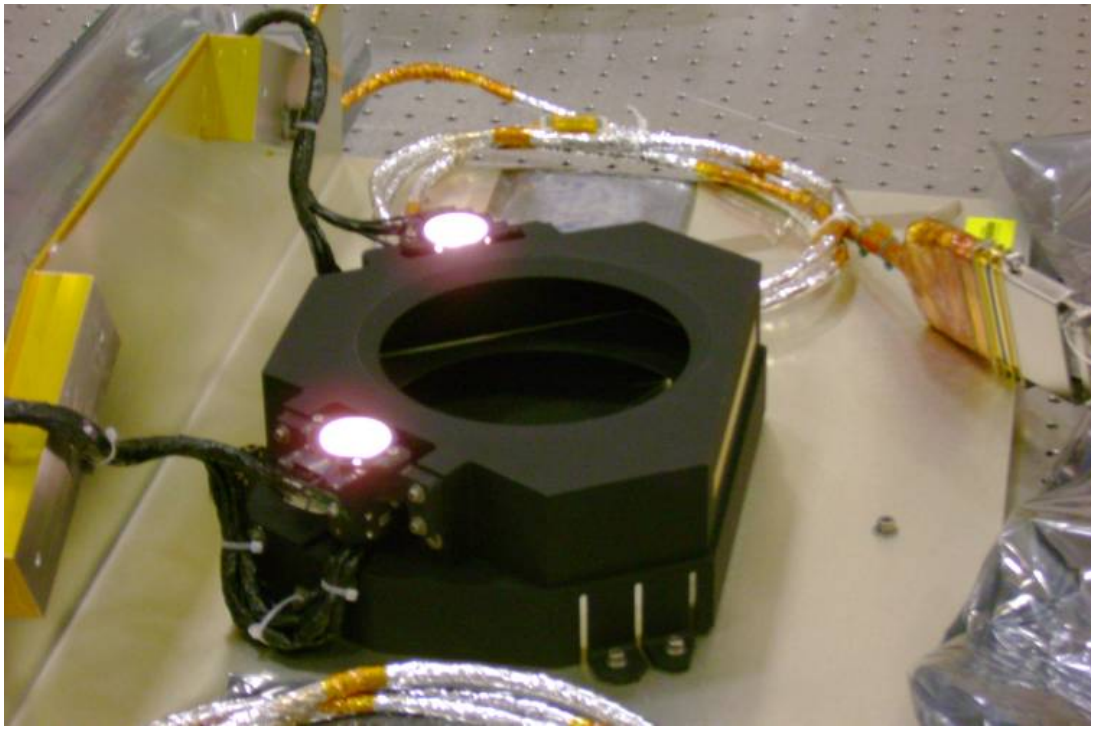
- Stim Lamp Assemblies redesigned to increase emitted light and optimize monitoring diode position



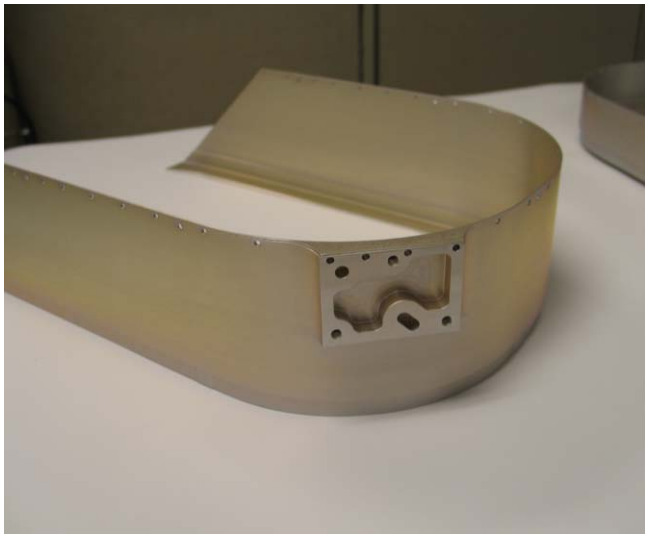
Diodes view diffuser instead of housing wall
No direct view of any lamps

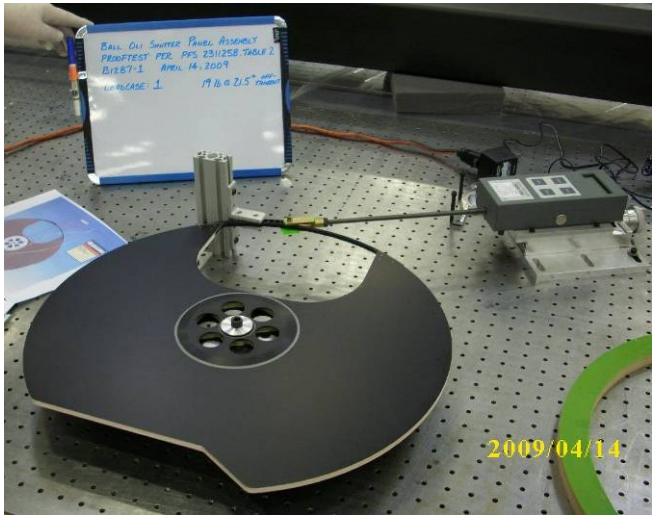
Stim Lamp Assemblies Complete and in Test

- Have been attached to aperture
- Completed radiometric testing
  - Signals good
- Completed Environmental Testing
- Ready for integration into telescope

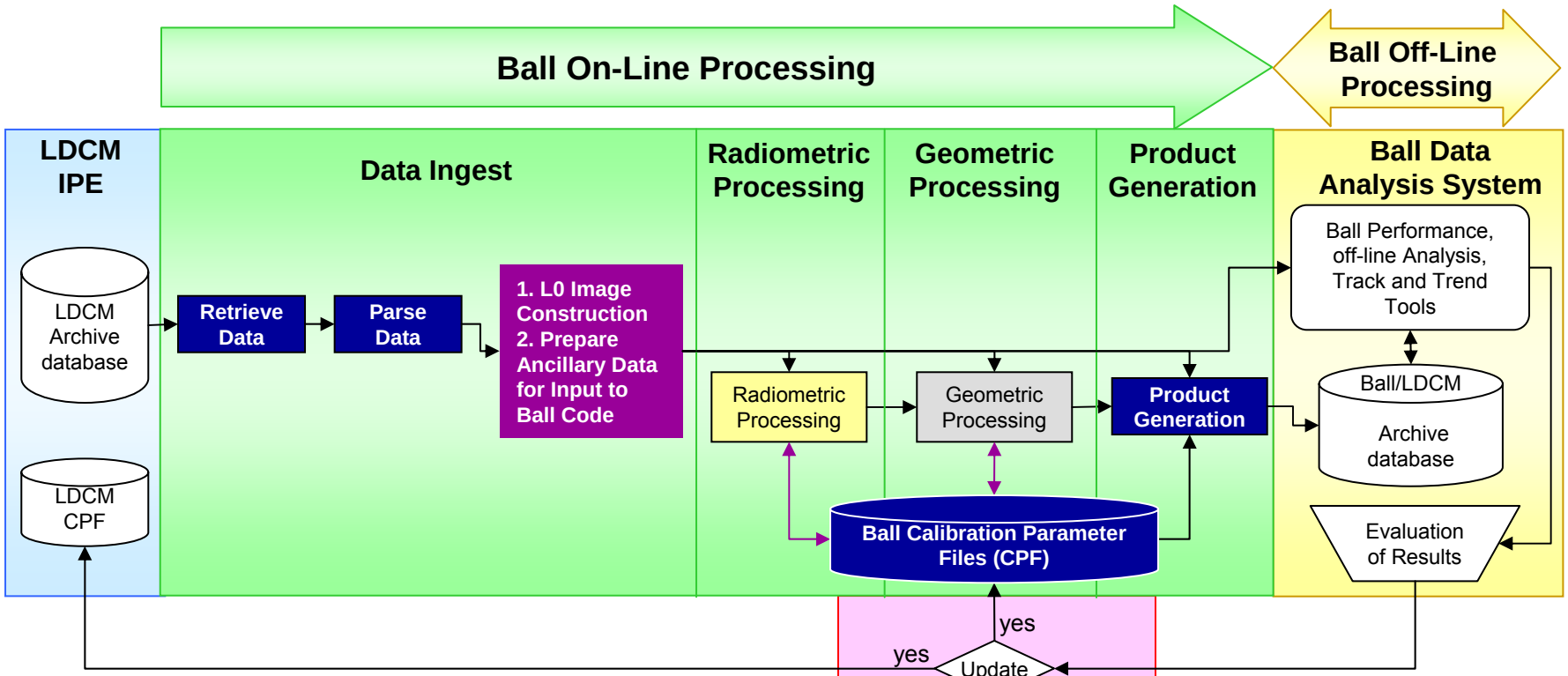


Shutter Wheel Has Been Delivered





Coding of Ball Aerospace Algorithms Into Continues—Next "drop" expected later this year



Processing Algorithm

Radiometric Algorithms

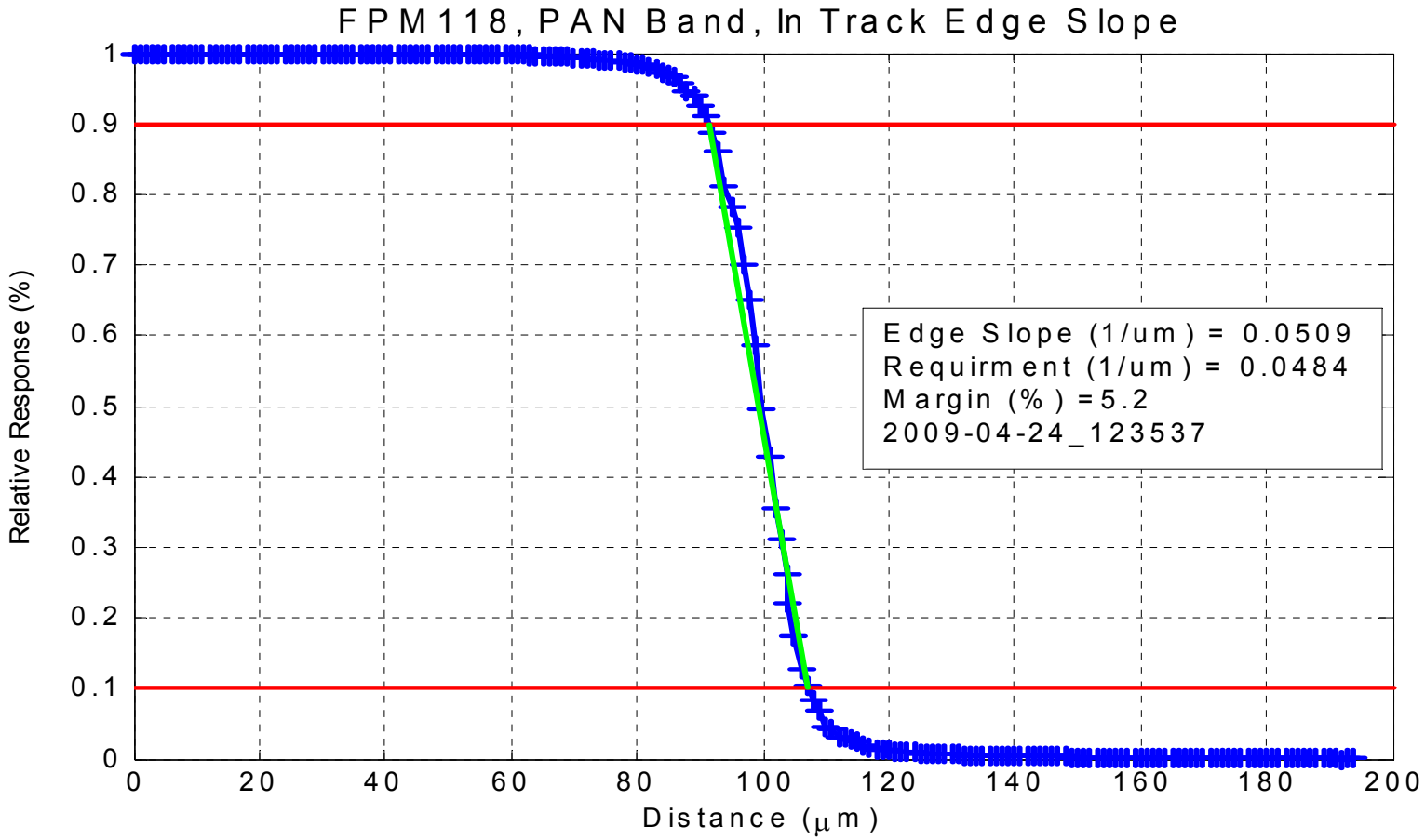
Geometric Algorithms

Changes Since last meeting

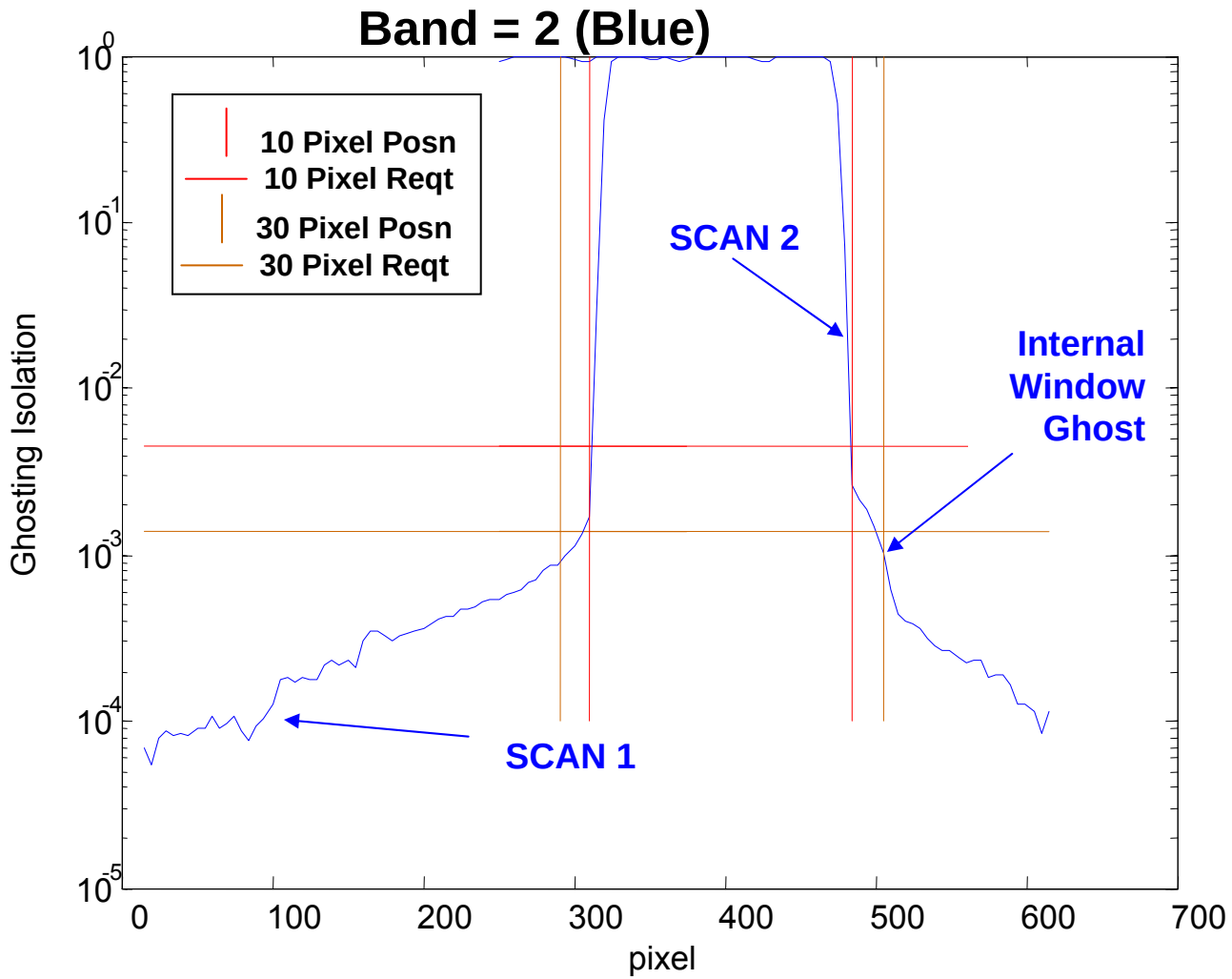
- **Grouping of modules in data ingest**
- **On-line cal algorithms append Ball CPFs**

Preliminary Data

FPM Spatial Response measurements look good

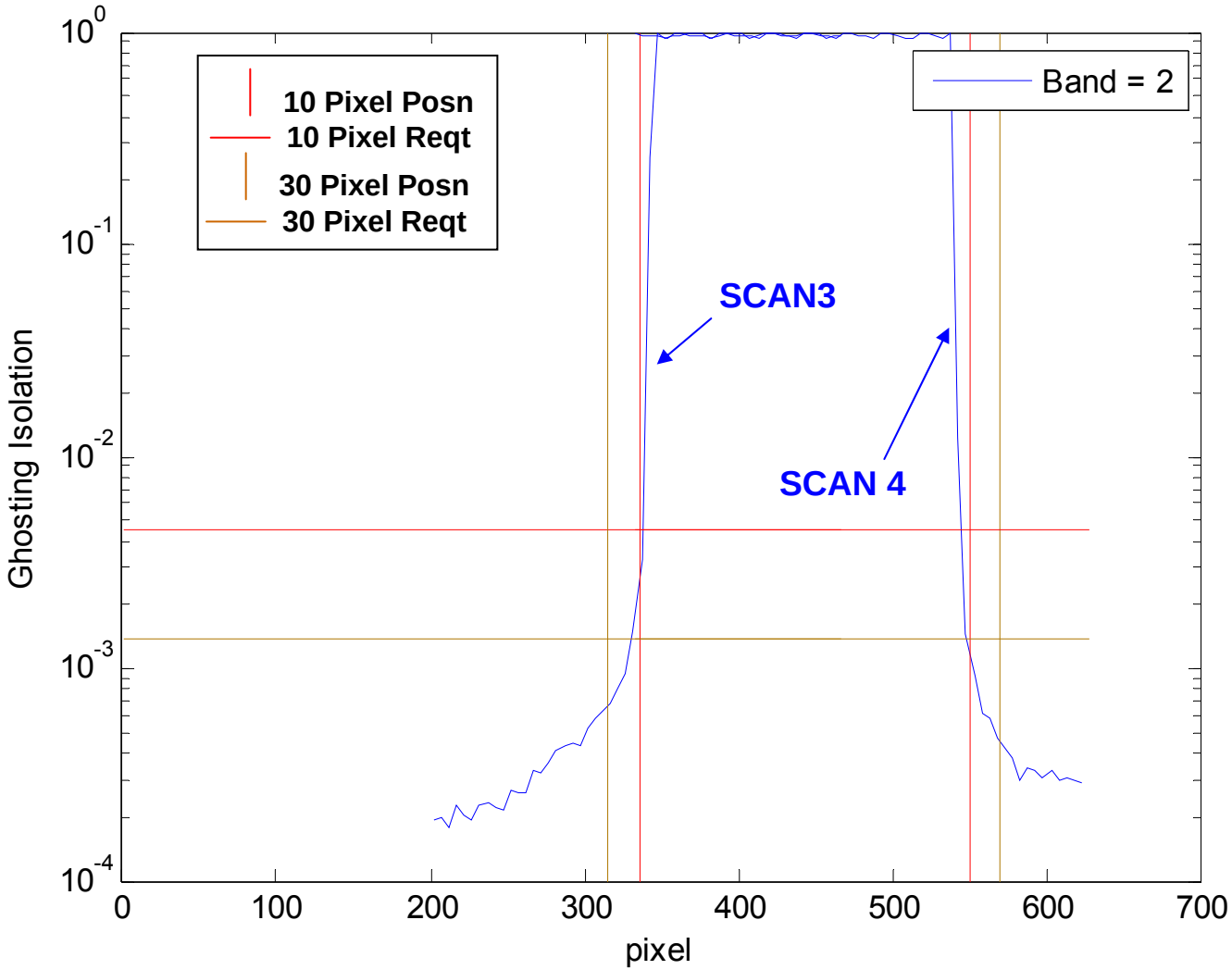


Ghosting looks good: Only Expected Internal Window Ghost Present – Along Track Scans -



*** Results plotted for single pixel in middle of array; all pixels consistent**

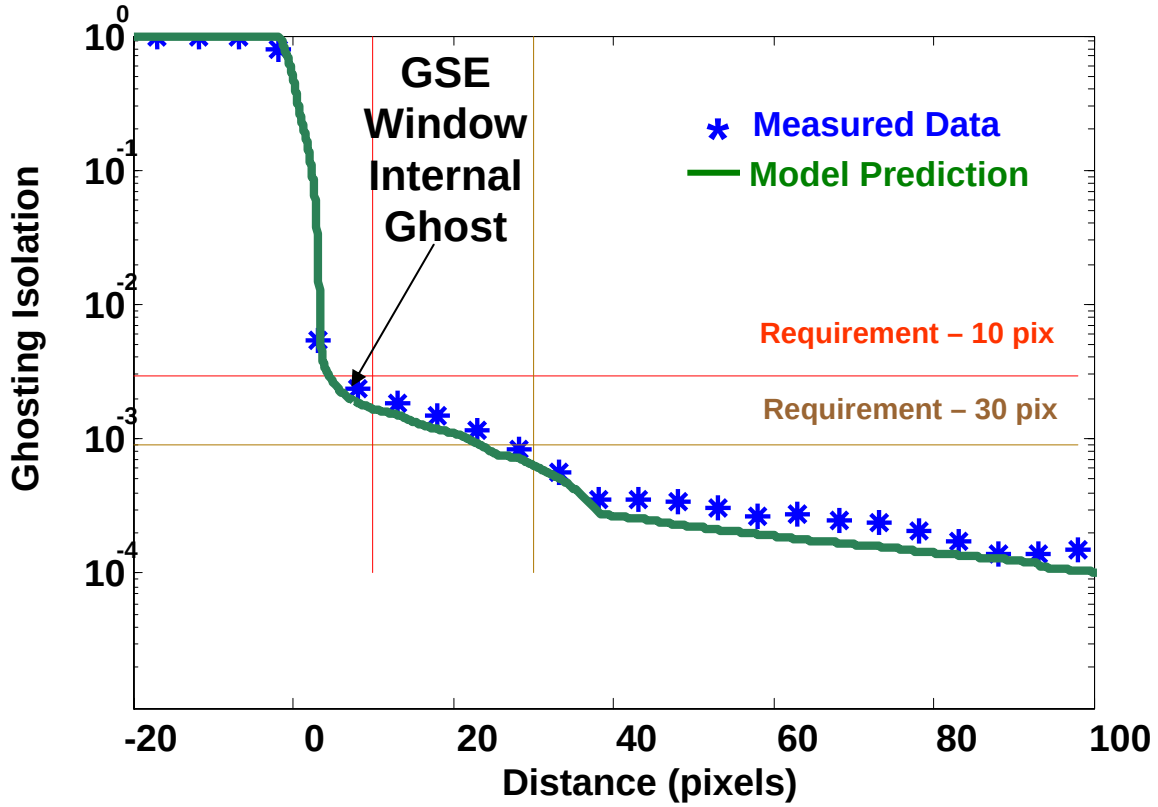
Cross-Track Scan Results – Blue Compliant, no Ghost



- No Ghost near requirements
  - Potential broadening, but still meets reqts

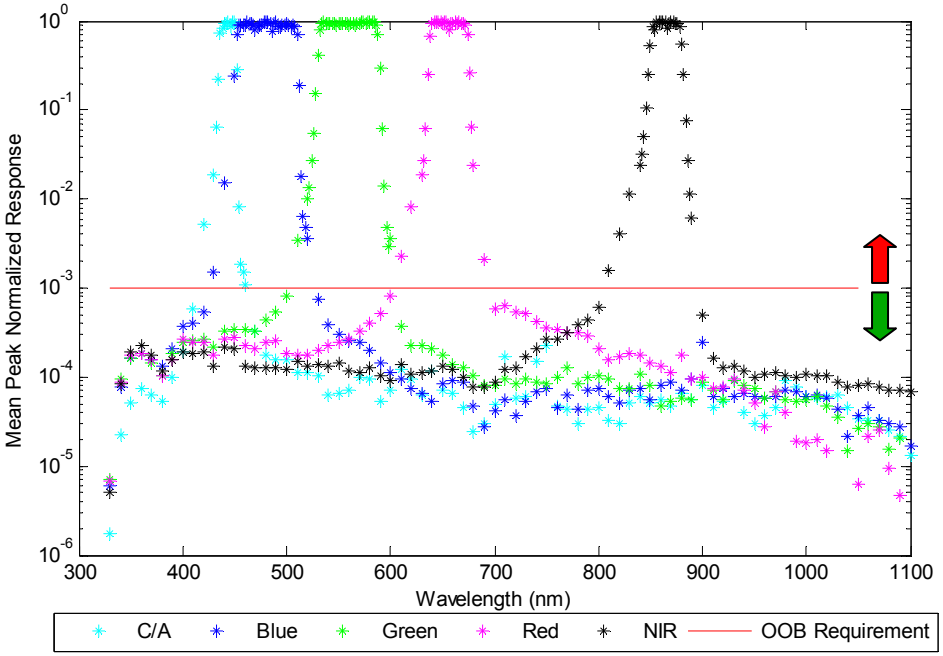
FPM Ghosting Data Shows Good Correlation with Stray Light Model - PAN

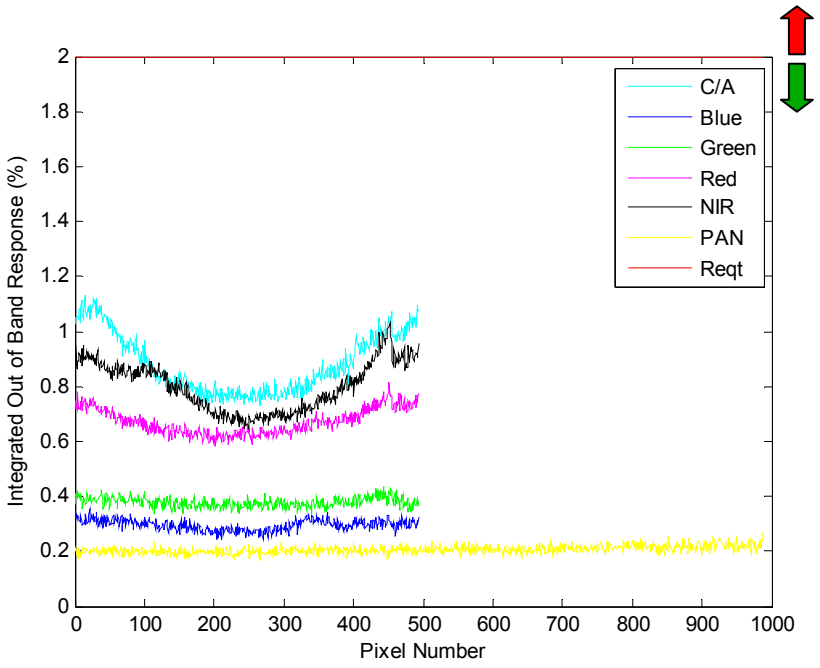
- Ghost Measurements
  - AT Scan
  - PAN Band
  - 1.5° Source (diagonal)
    - 1.2 x 0.8° Source



Spectral Response for VNIR Bands looks good

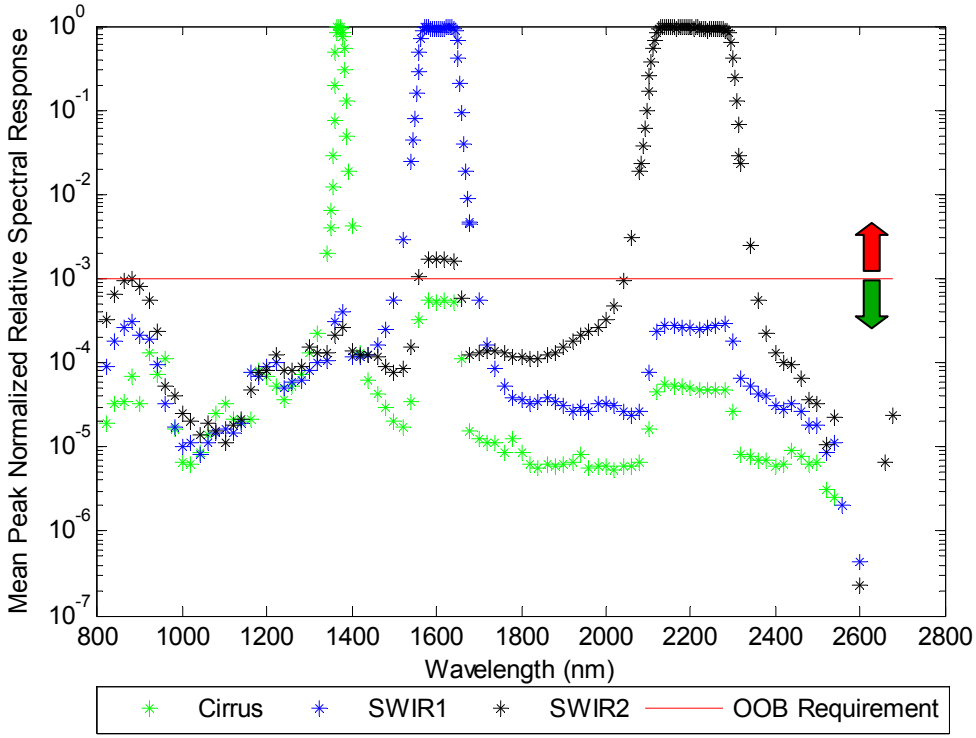
- In general, VNIR results are meeting requirements with margin
  - The VNIR bands meet non-integrated and integrated OOB response





Crosstalk was detected in some SWIR out-of-band response measurements—being mitigated

- Some EDU FPMs have OOB response that does not meet the non-integrated OOB requirement
  - Plot to left shows how SWIR2 was responding to SWIR1 light
- Was not present on all FPMs
- Was not present for all detectors
- Proved it was not a filter problem
  - Swapped filters between a 'good' and 'bad' FPM—crosstalk remained with detectors
- Established a very strong correlation with quantum efficiency
  - Those detectors that had poor QE also have crosstalk
- Which led to a screening test
  - Screen detectors for QE (already being done); reject those that do not meet new threshold requirement
  - No meaningful impact on schedule or performance expected



Summary

Ball
Ball Aerospace
& Technologies Corp.
Agility to innovate,
Strength to deliver

Summary

- Hardware is starting to roll in
- Artifacts have been identified, caught, and are being corrected for flight
- Performance predictions look good