# Landsat-8 Operational Land Imager (OLI) Initial On-Orbit Performance

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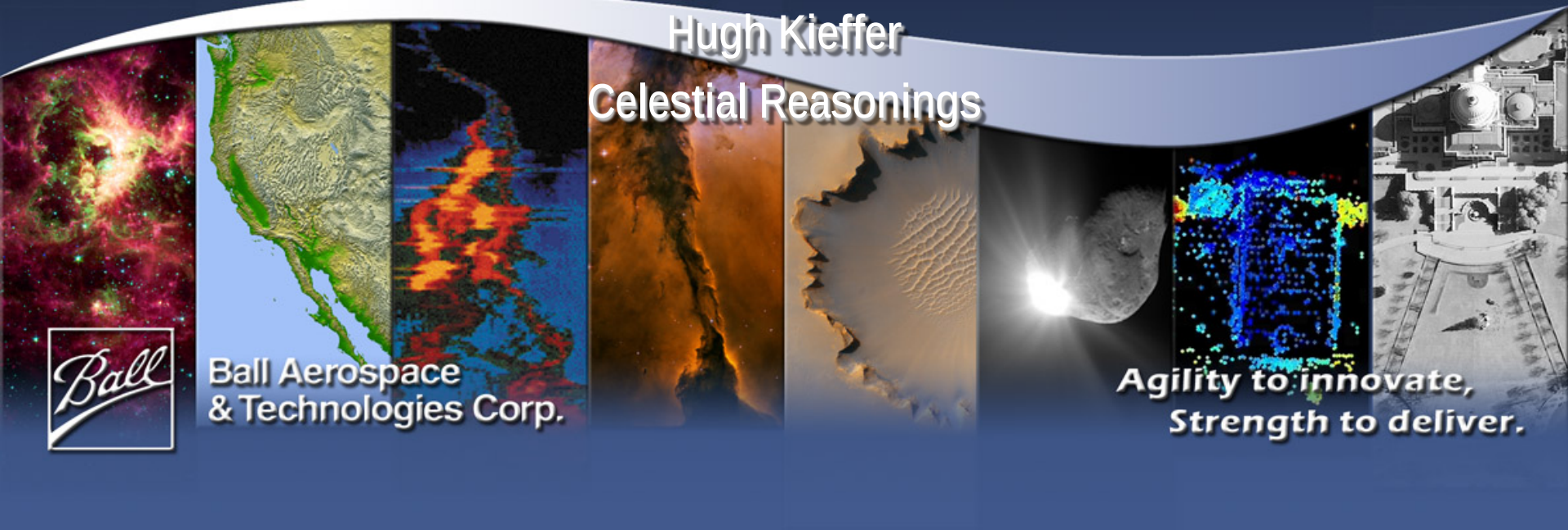
Celestial Reasonings

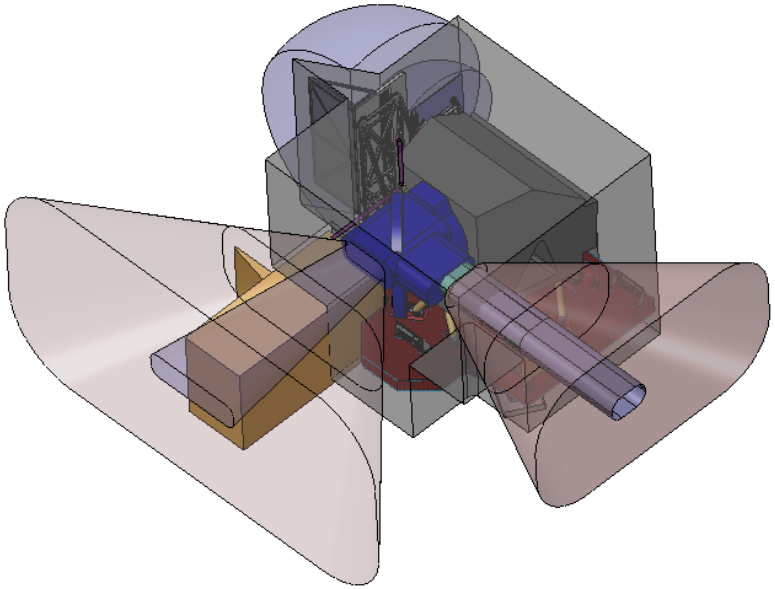


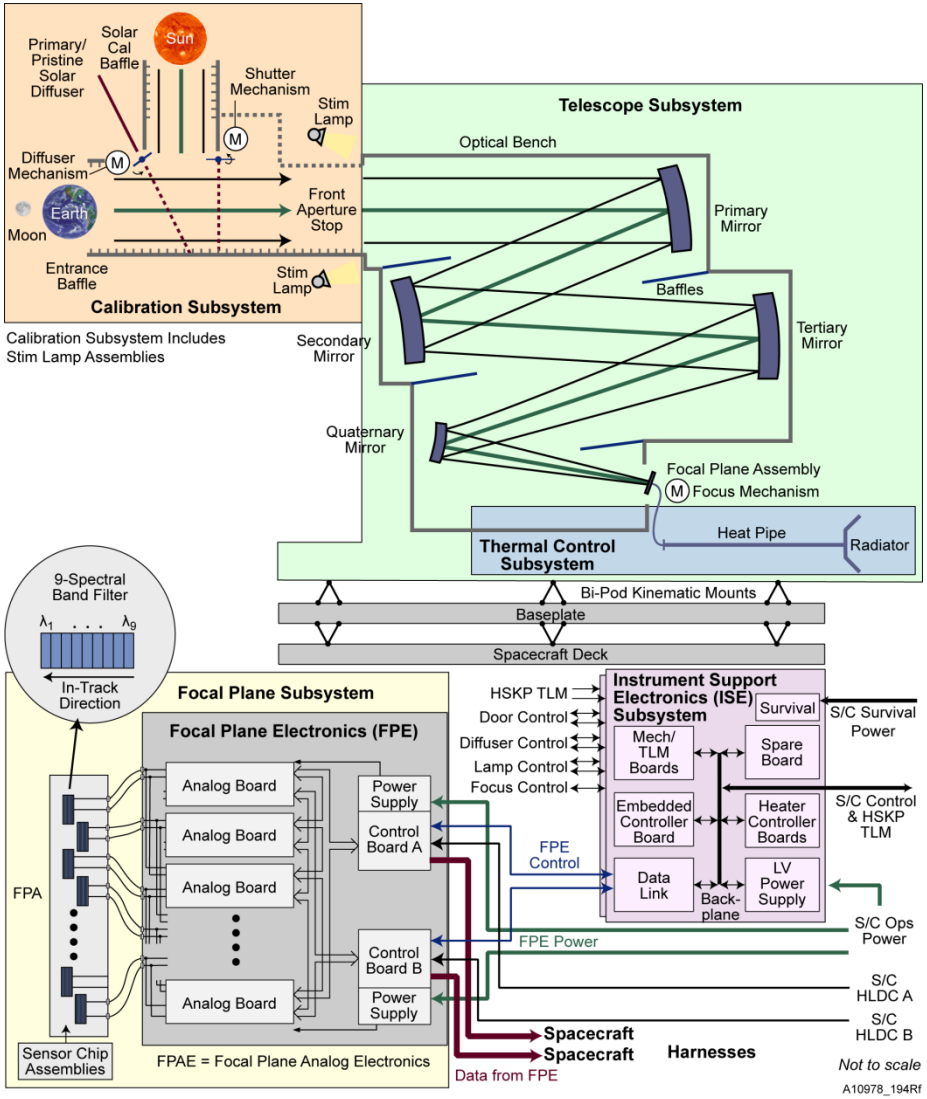
# Introduction

- Intent of talk is to review On Orbit Checkout (first 90 days on-orbit)
  - Emphasis was on health and welfare of OLI, exercising all observation modes and comparison with pre-launch test activities
- Overview of instrument and calibration operations
- Pre-launch to post-launch comparison by observation type
  - Shutter (dark)
  - Stim lamps
  - Diffusers
  - Variable Integration Time
- Celestial Targets
  - Moon
  - Stars
- Overview of performance vs. Key Performance Requirements
  - SNR
  - Stability
  - Uniformity

# OLI Instrument Overview

- 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 lamps and a shutter

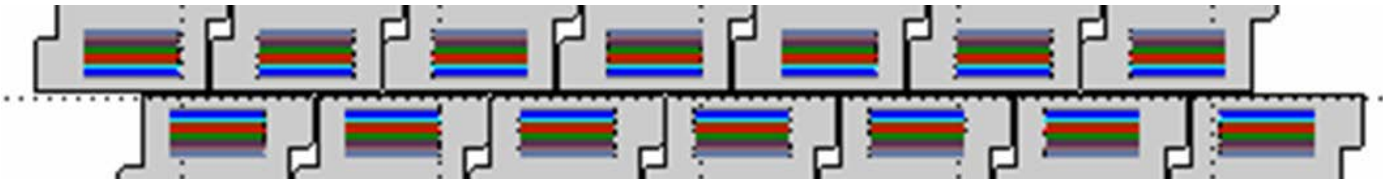


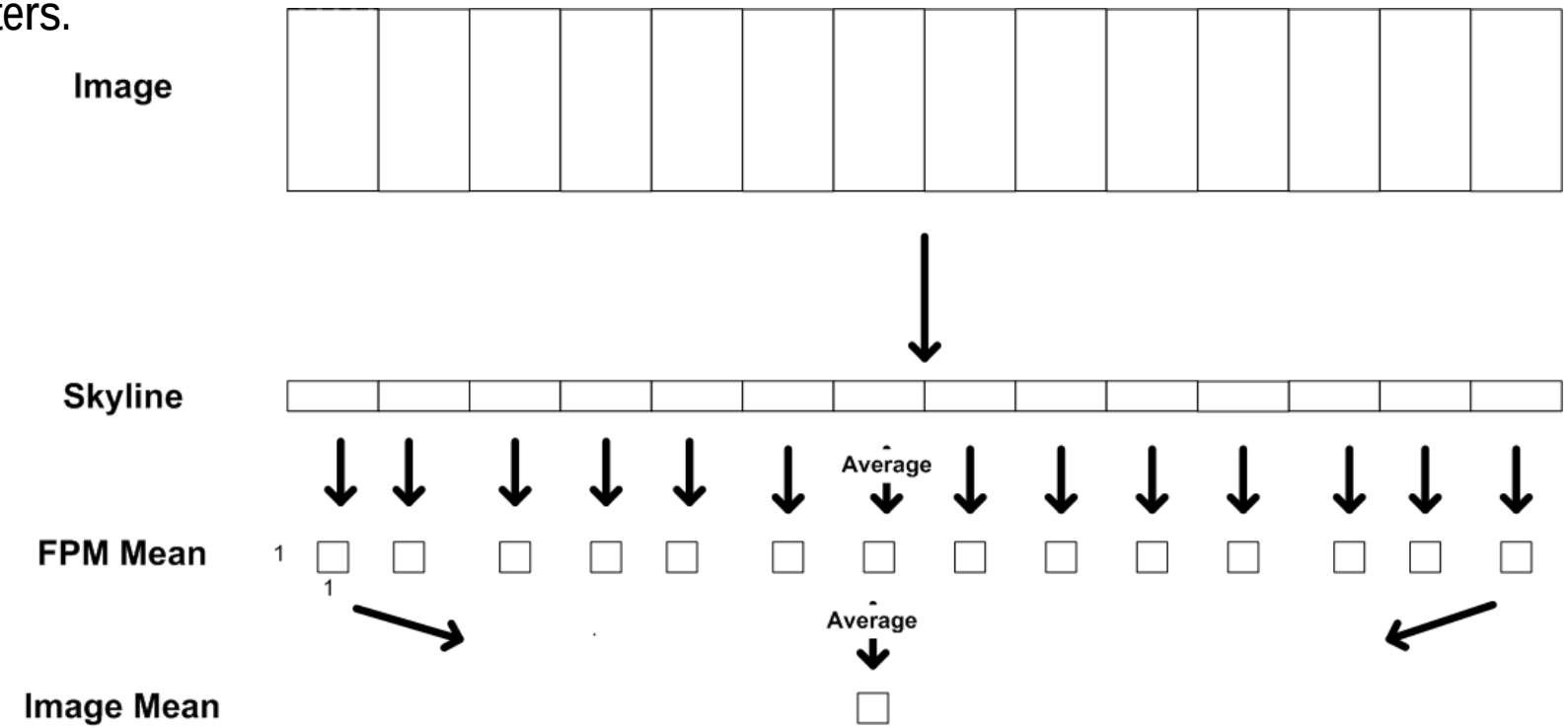


# OLI Focal Plane and Data Layout

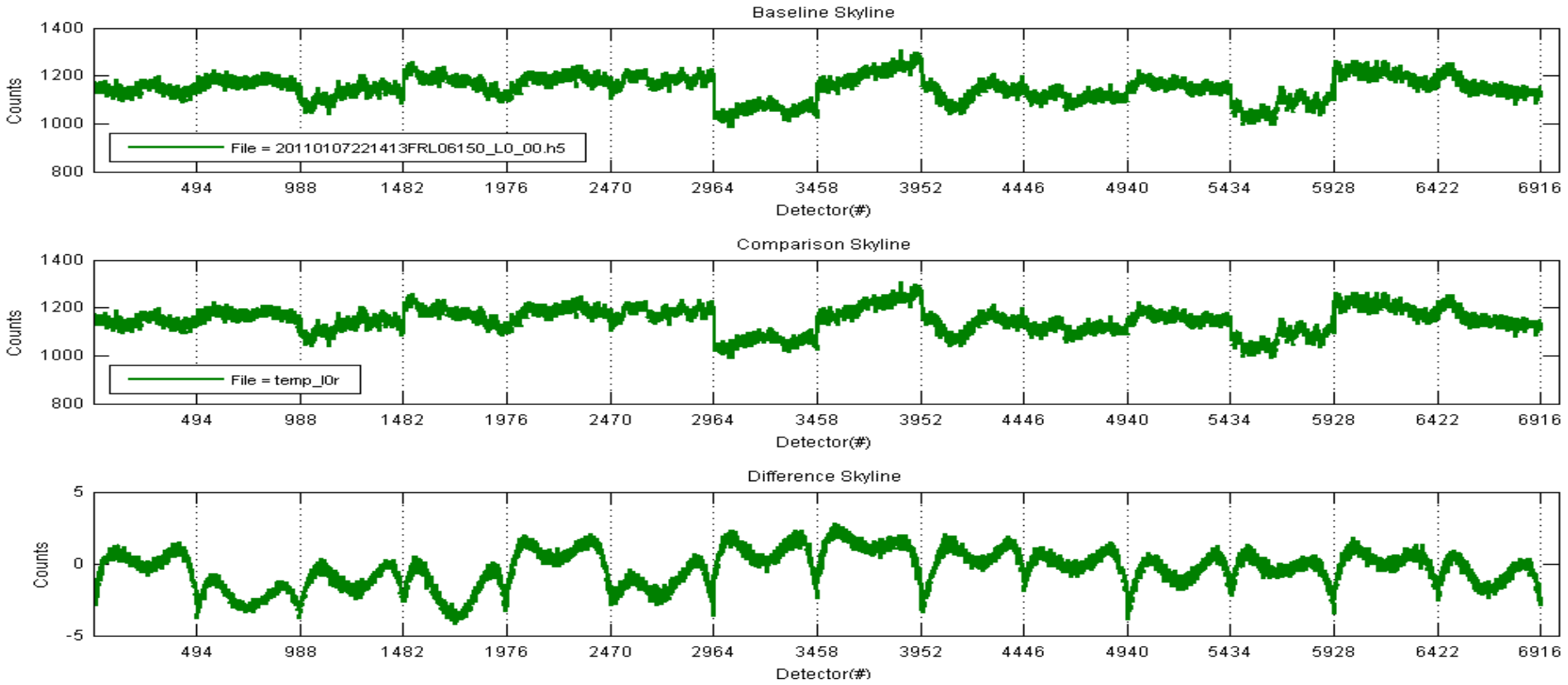
OLI has 9 bands, 6 Si and 3 HgCdTe on each of 14 FPMs

Spectral separation uses 9 “toothpick” interference filters.



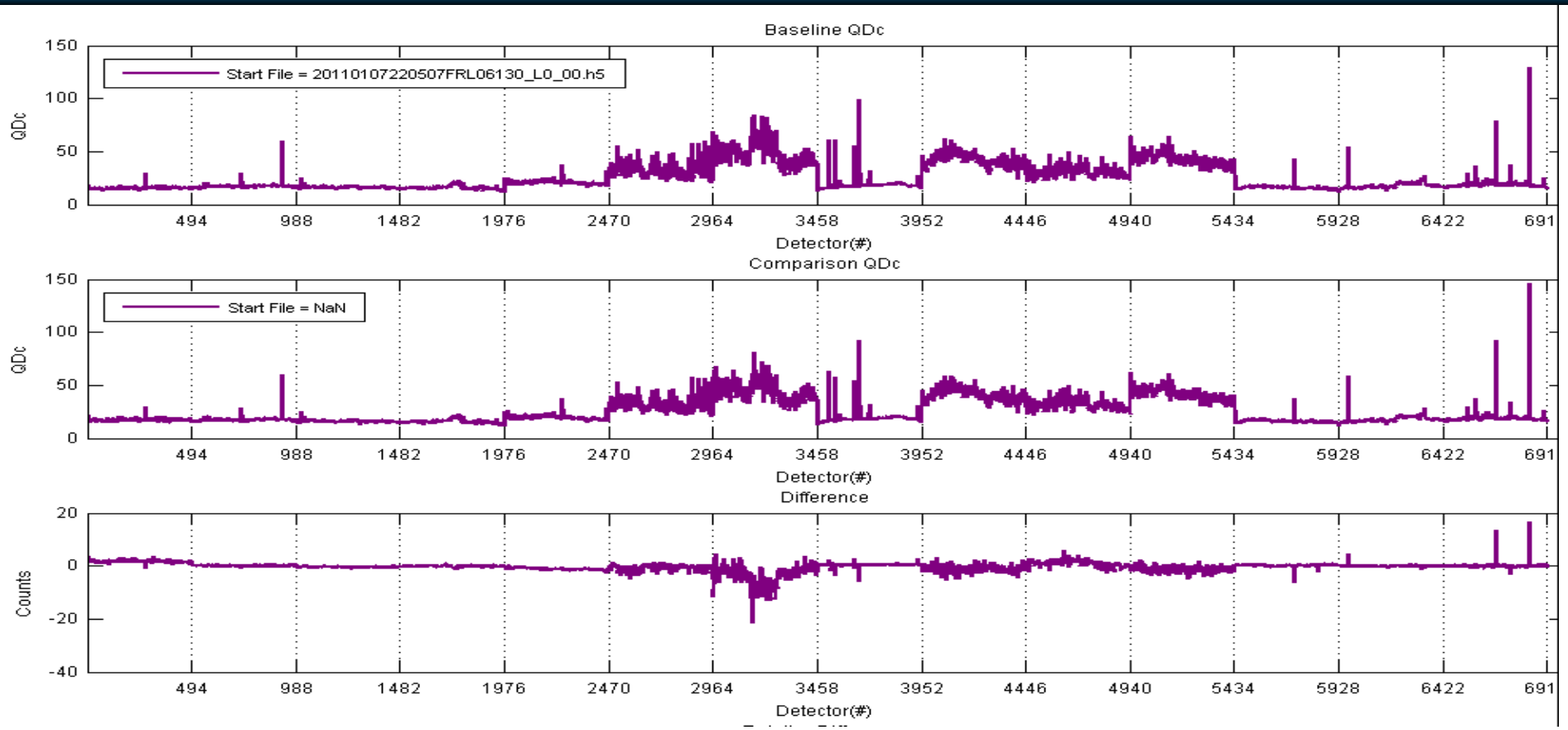


# Shutter Observations Pre-Launch To On-Orbit



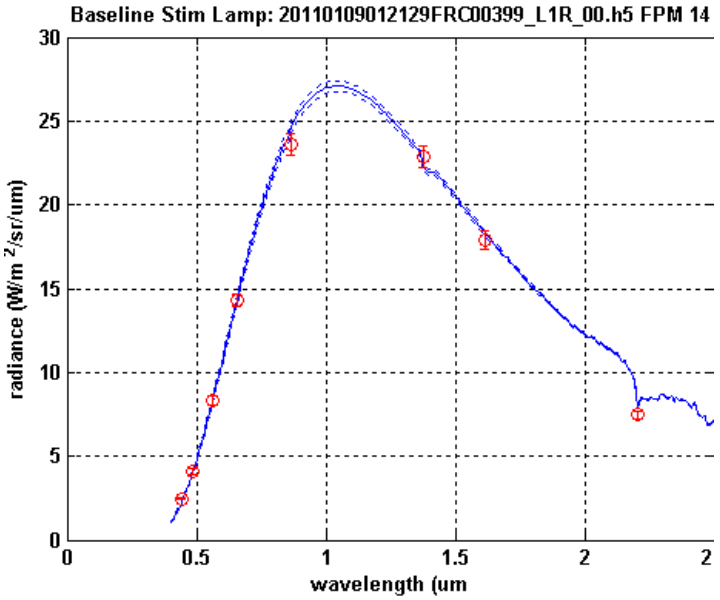

- Si band Shutter observations show a small bias shift common to all bands.

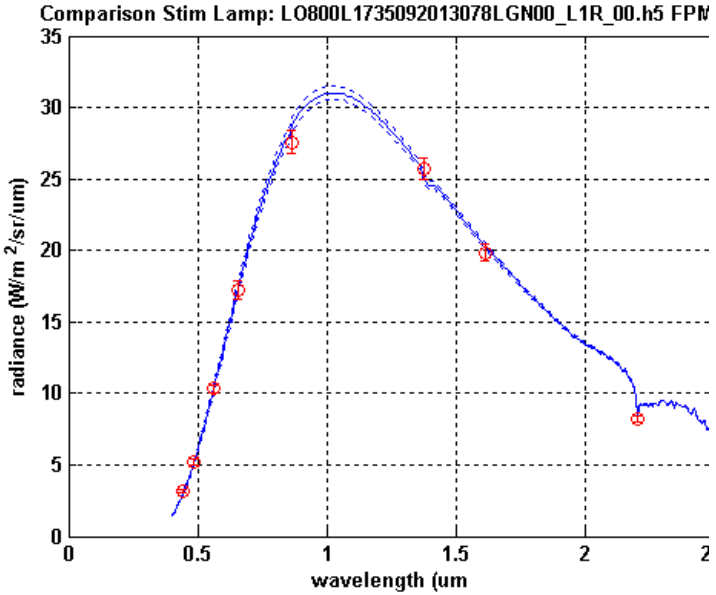
# Dark Current Measurement v/Variable Int. Time




- Variable integration time shutter observations allow OLI to track HgCdTe band dark current.
- The basic dark current pattern has remained, however not all detectors have changed identically.

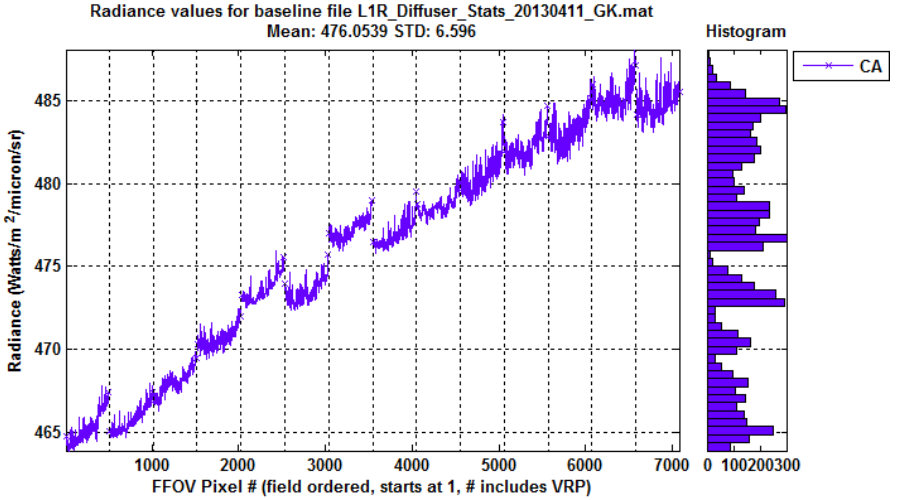
# On-Board Stim Lamps Allow a Second Set of Pre-Launch to On-Orbit Comparisons

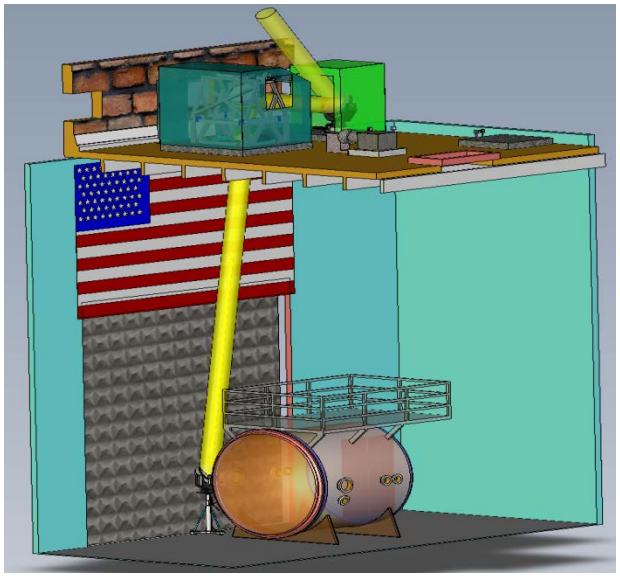


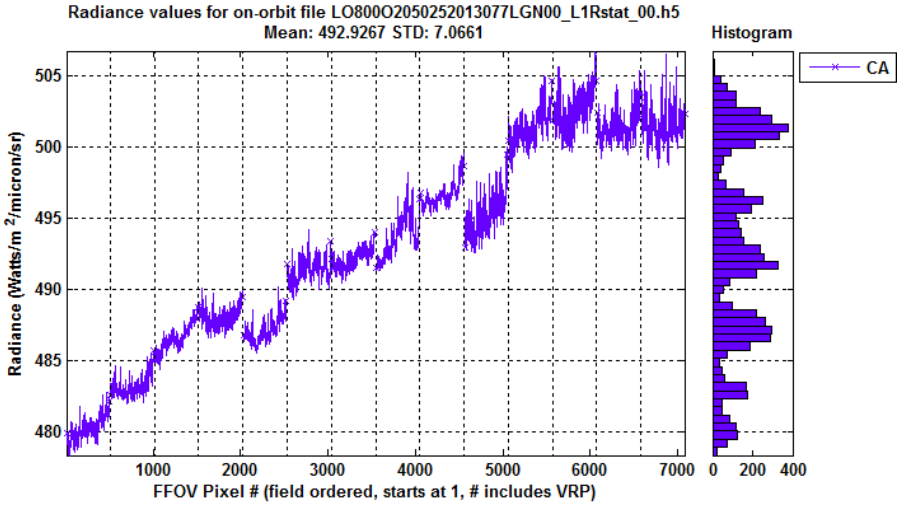




- A simple analytical model of the stim lamp output (Planck function + optics transmission) allows us to fit an effective temperature to the lamps.
- We observed an ~60K increase in effective temperature, consistent with our expectations for 0G effects.

# The Heliostat Was Used as the Basis for the Transfer to Orbit Experiment

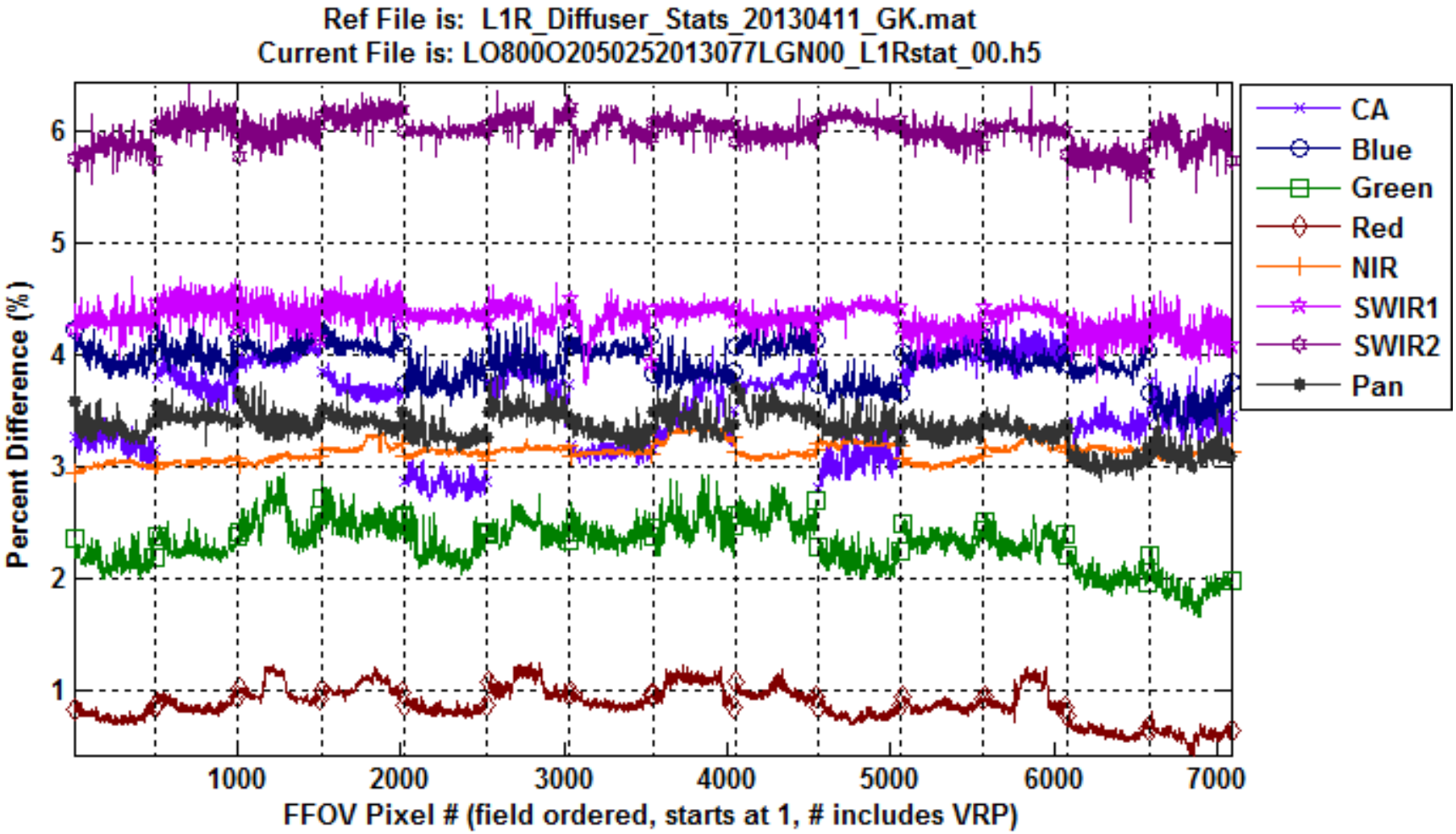




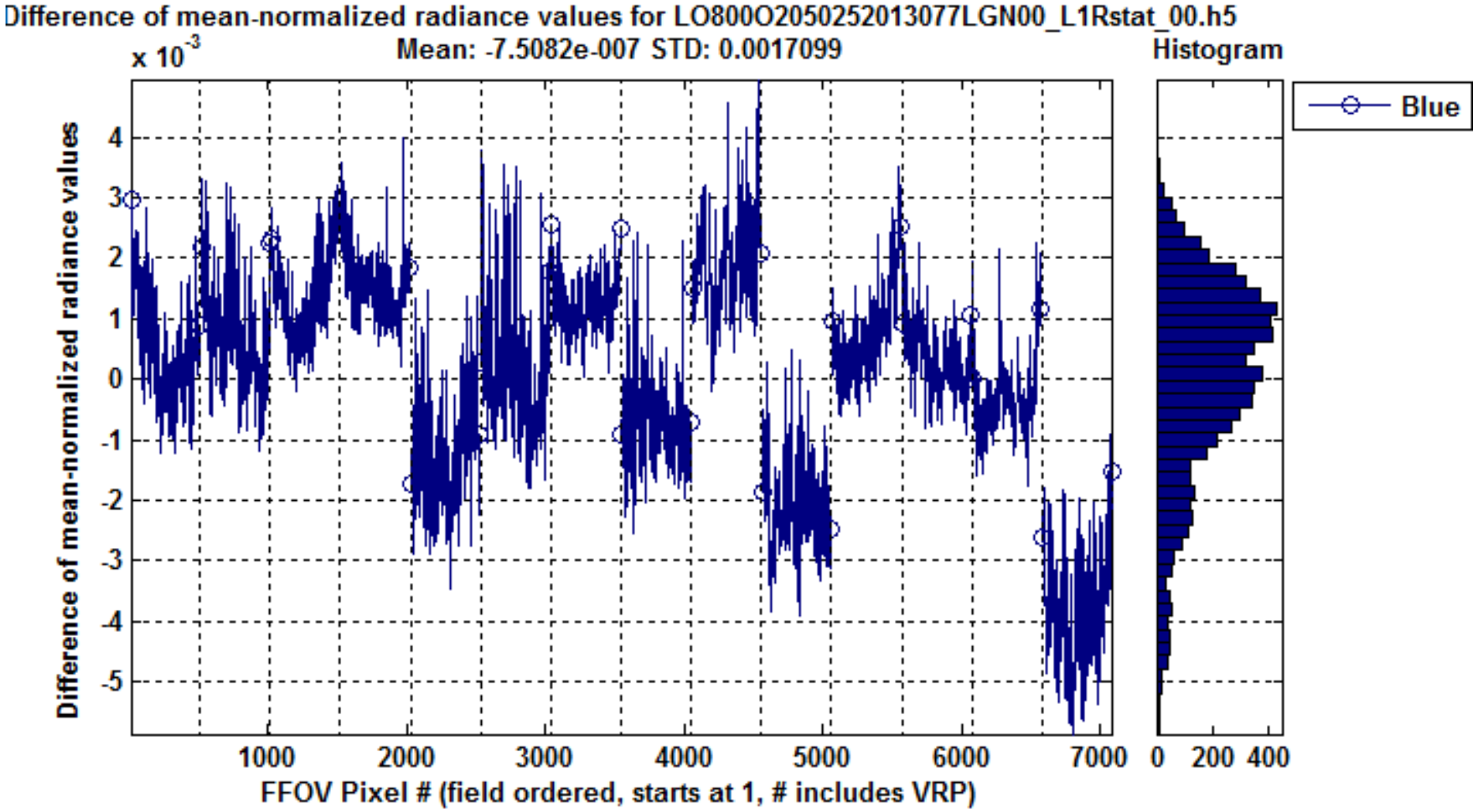

- Using the heliostat we illuminated the flight diffuser in a flight like manner and estimated the corresponding TOA radiances.
- The transfer to orbit experiment compares predicted diffuser TOA radiances to measured radiances.

# Summary of Transfer to Orbit



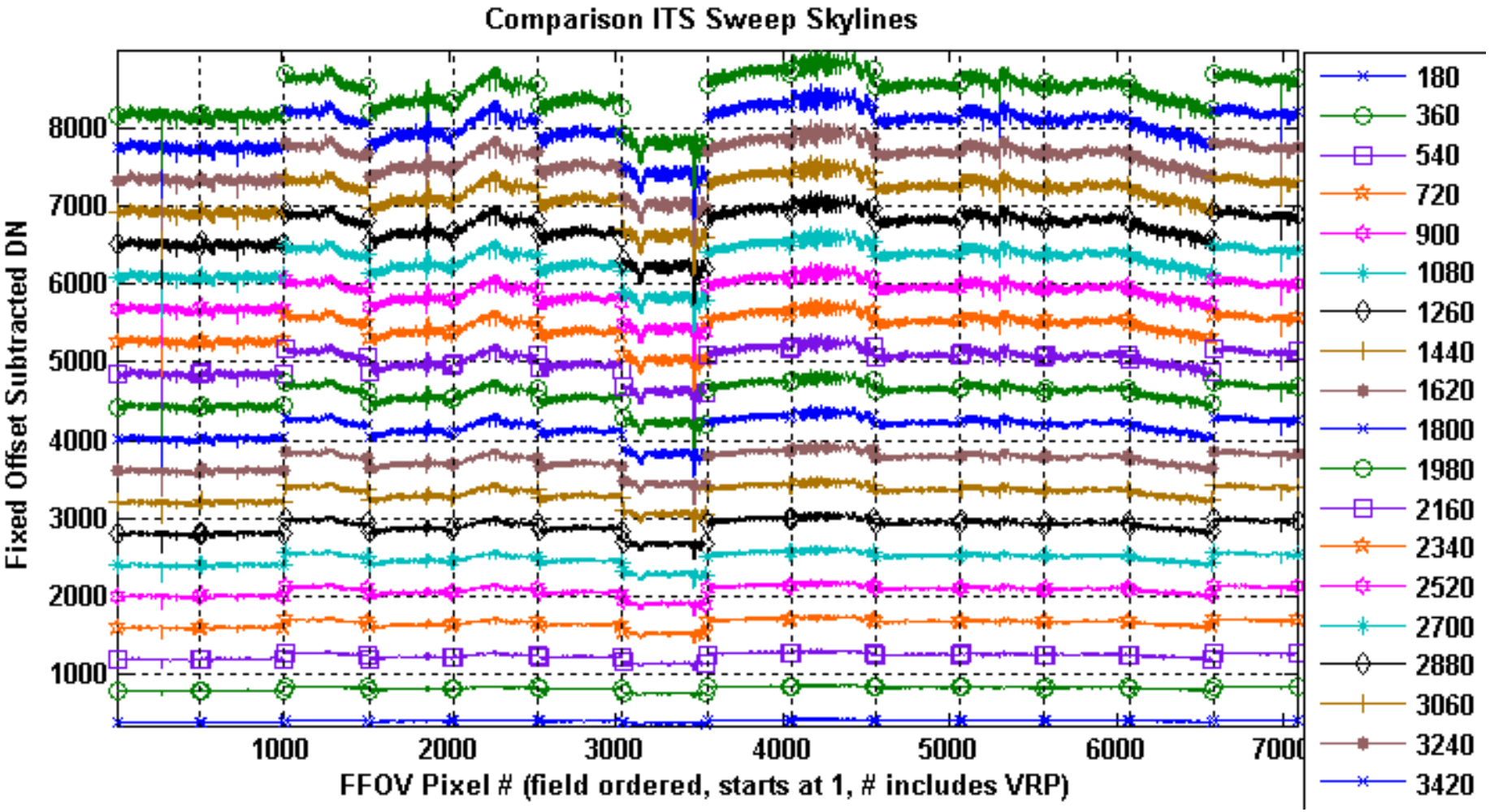

- We estimated ~2.5% uncertainty (1s) on this comparison.
- Positive bias in all bands is probably significant- i.e. there is likely an unaccounted for bias error

# Heliostat Allows Montioring Change in Diffuser Uniformity Pre-Launch to On-Orbit



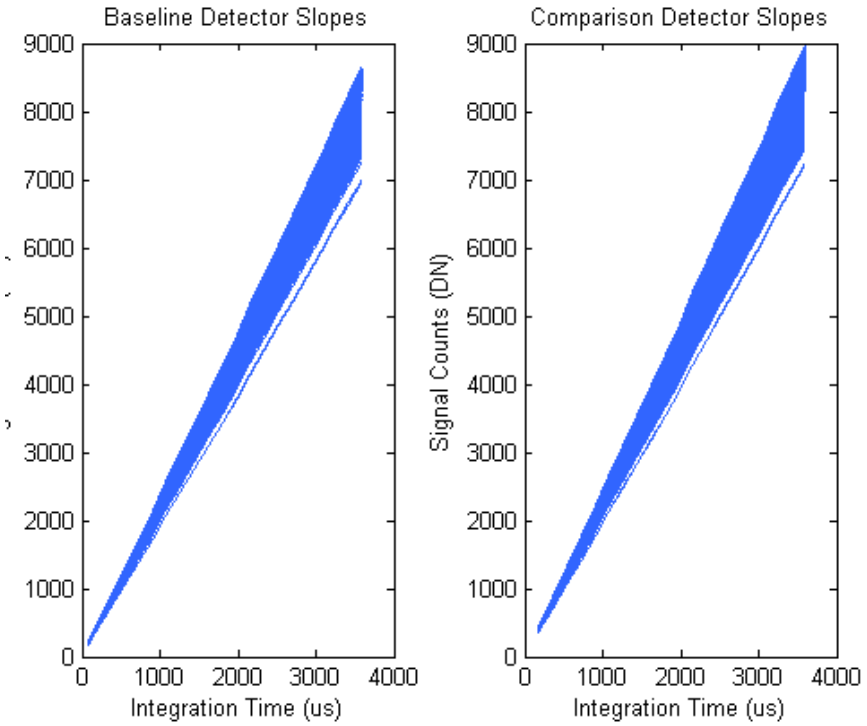

- Non-Uniformity of the heliostat agrees to about +/- 0.5% with On-Orbit observations

# Diffuser Variable Integration Time



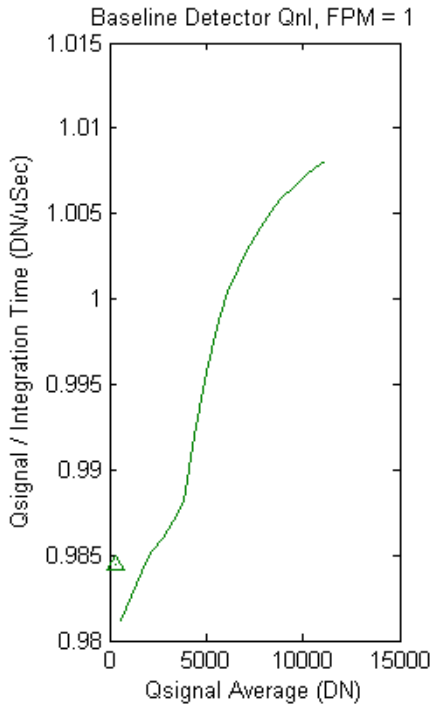

- Variable integration time observations of the diffuser allow linearity monitoring

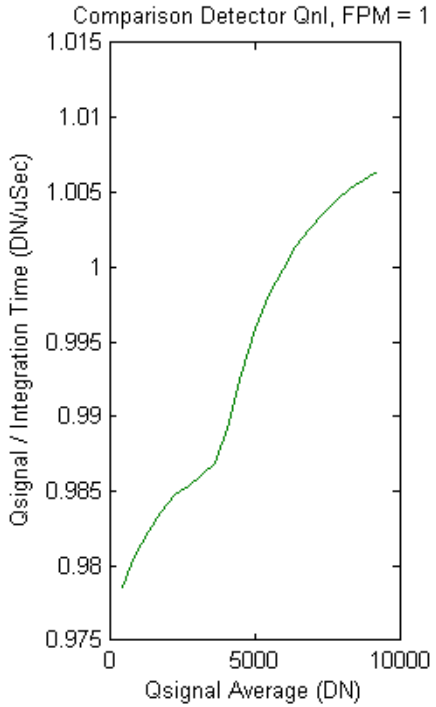
# Linearity vs Integration Time Pre-Launch to On-Orbit





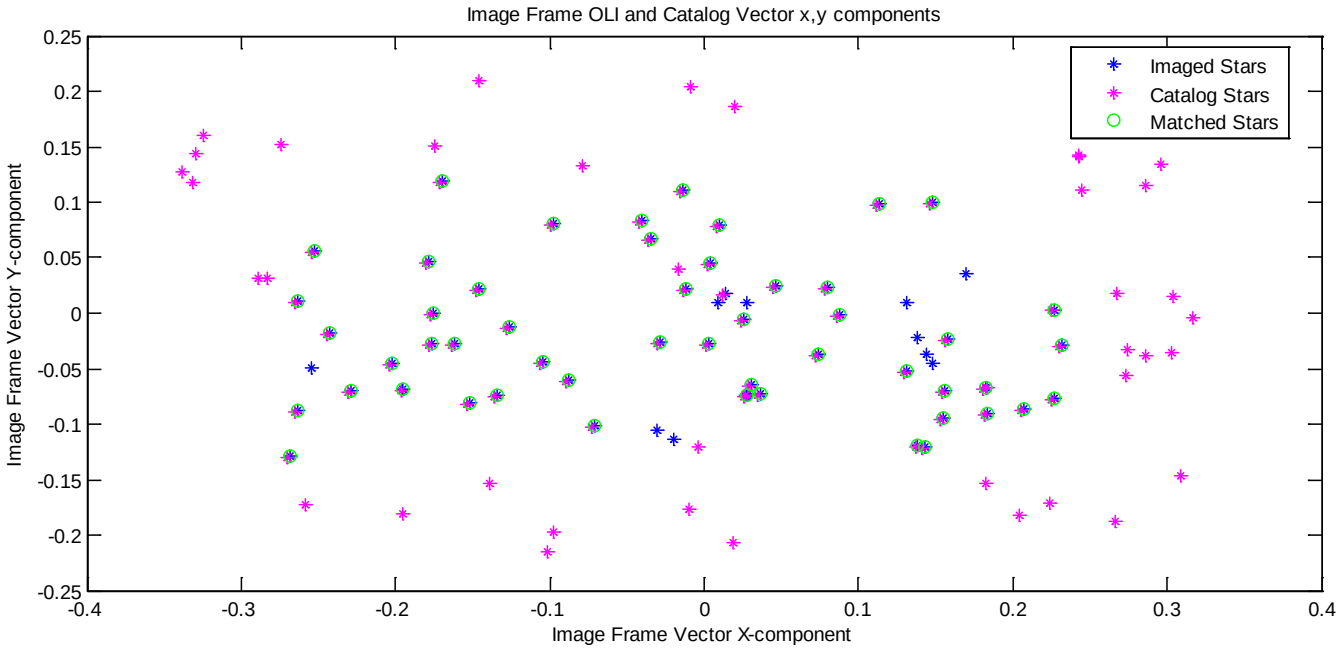




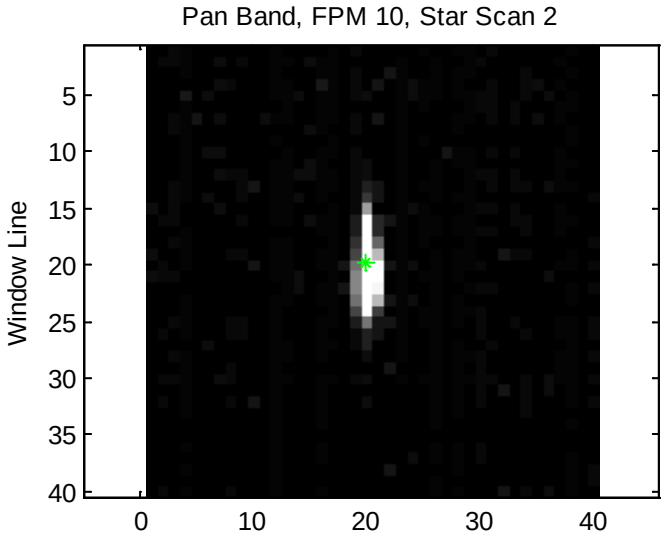



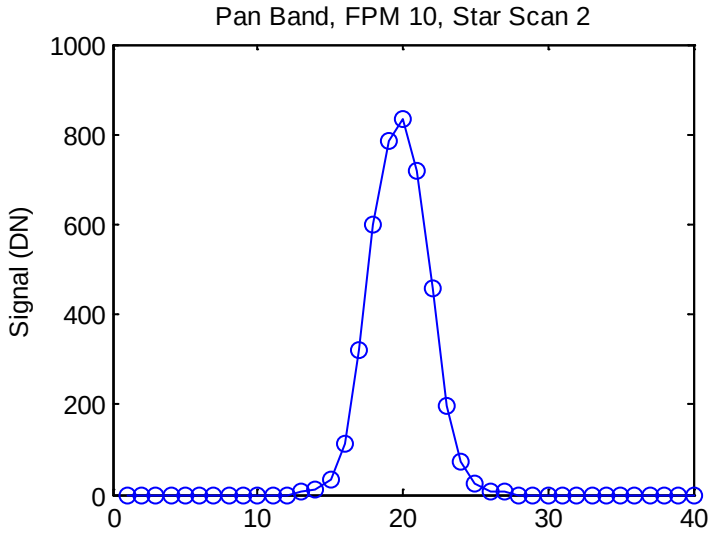

- FPM non-linearity observations agree well with pre-launch values.
- Pre-launch and post-launch variable integration time observations agree well for all detectors.

# Stellar Observations Were Used To Validate Pointing

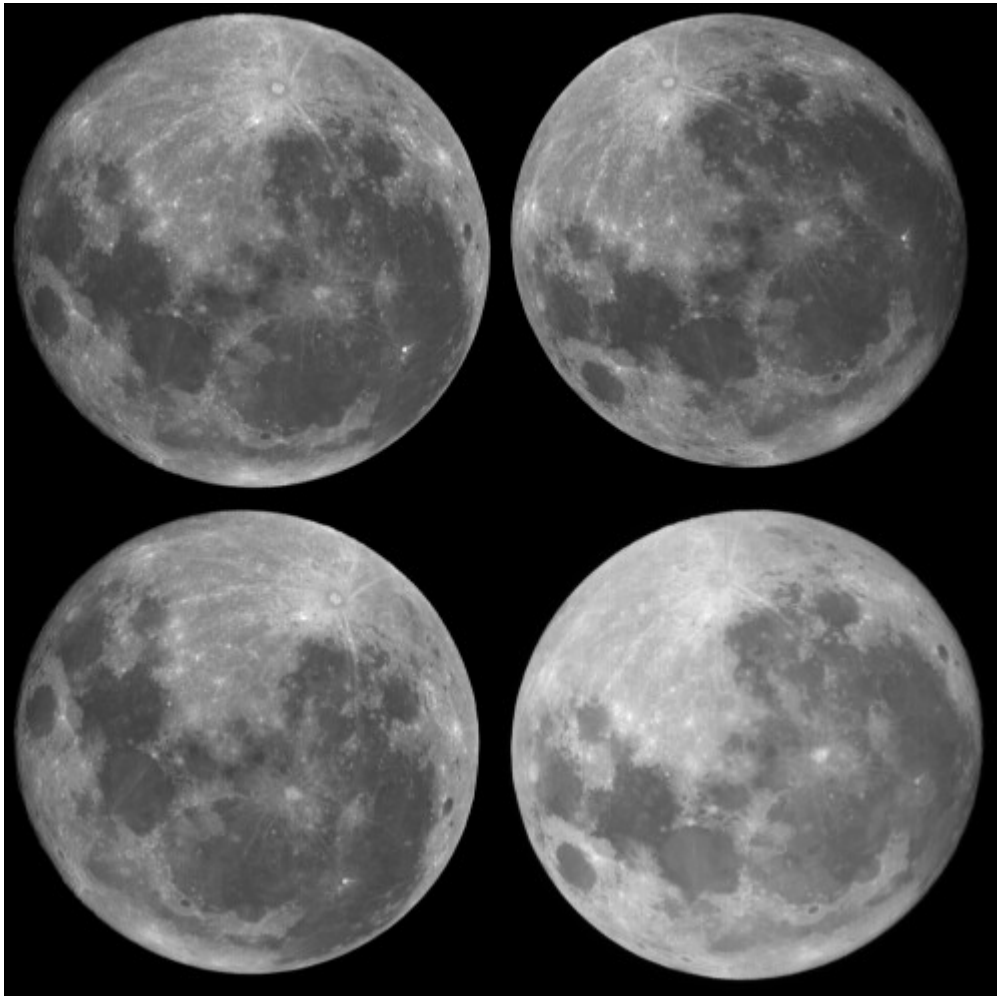



- With an observatory maneuver OLI was able to scan two star fields
- Mean errors of 2 m AT, 128 m XT
- Standard deviation of errors of < 4 m XT and AT



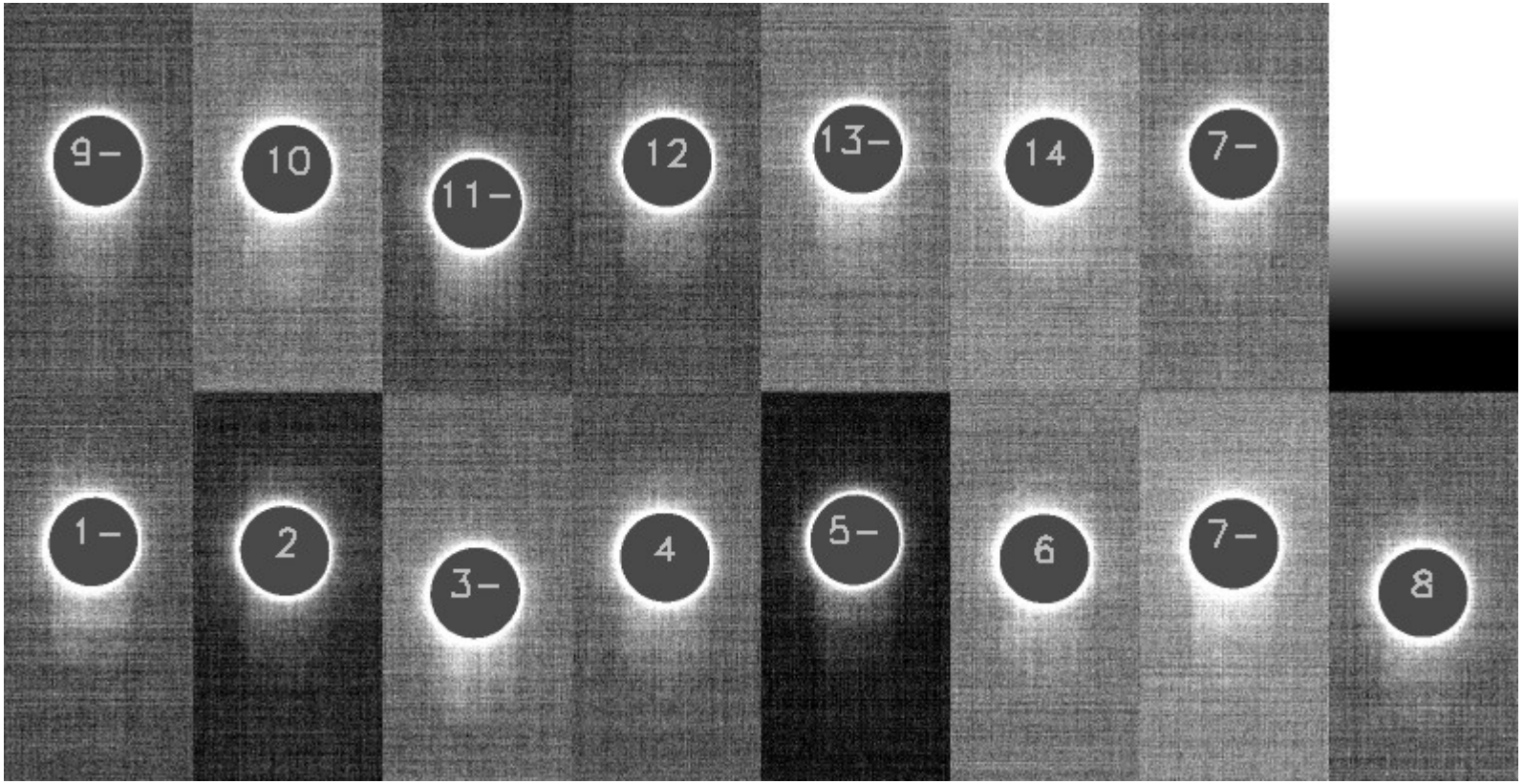



# Lunar Observations



- With an observatory maneuver OLI scans the full Moon every month in each spectral band.
- This requires 15 scans over 2 orbits.
- During On-Orbit Checkout, our focus was on the Moon as a stray light (not a radiometric) source.
- Artifacts are not visible to the naked eye.

# Lunar Observations Show that OLI Ghosting Meets its Requirements




Ghosting is small and well contained.

# SNR On-Orbit Agrees Well With Pre-Launch Measured Values

Pre-Launch

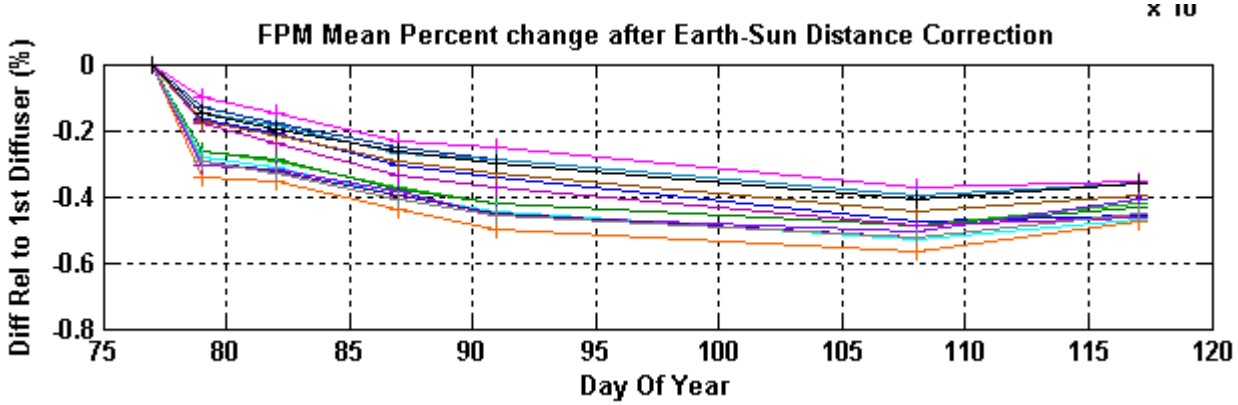
| Spec Value | C/A (1) | Blue (2) | Green (3) | Red (4) | NIR (5) | SWIR 1 (6) | SWIR 2 (7) | Pan (8) | Cirrus (9) |
|---|---|---|---|---|---|---|---|---|---|
| Req. at Ltyp | 130 | 130 | 100 | 90 | 90 | 100 | 100 | 80 | 50 |
| Value (12 bit) | 232 | 355 | 296 | 222 | 199 | 261 | 326 | 146 | 162 |
| Req. at Lhigh | 290 | 360 | 390 | 340 | 460 | 540 | 510 | 230 | NA |
| Value (12 bit) | 607 | 1127 | 1213 | 945 | 1009 | 1007 | 1030 | 440 | |

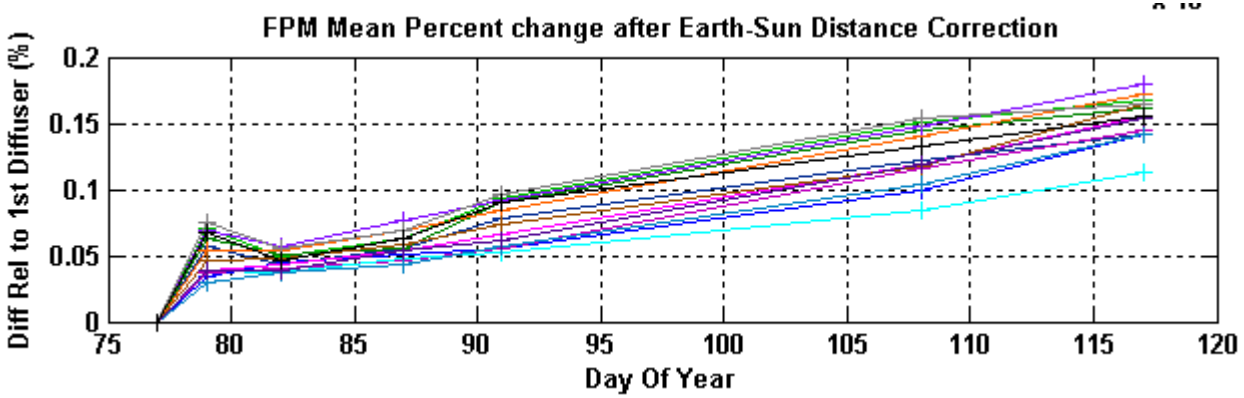
On-Orbit

| Spec Value | CA | Blue | Green | Red | NIR | SWIR1 | SWIR2 | Pan | Cirrus |
|---|---|---|---|---|---|---|---|---|---|
| string | # | # | # | # | # | # | # | # | # |
| Req. at Ltyp | 130 | 130 | 100 | 90 | 90 | 100 | 100 | 80 | 50 |
| Value | 233 | 361 | 298 | 224 | 198 | 263 | 334 | 150 | 168 |
| Req. at Lhigh | 290 | 360 | 390 | 340 | 460 | 540 | 510 | 230 | NA |
| Value | 623 | 1162 | 1236 | 969 | 1014 | 1016 | 1045 | 452 | |

- All bands meet spec.
- There are no out of spec detectors
- On-orbit values show good agreement with Pre-Launch

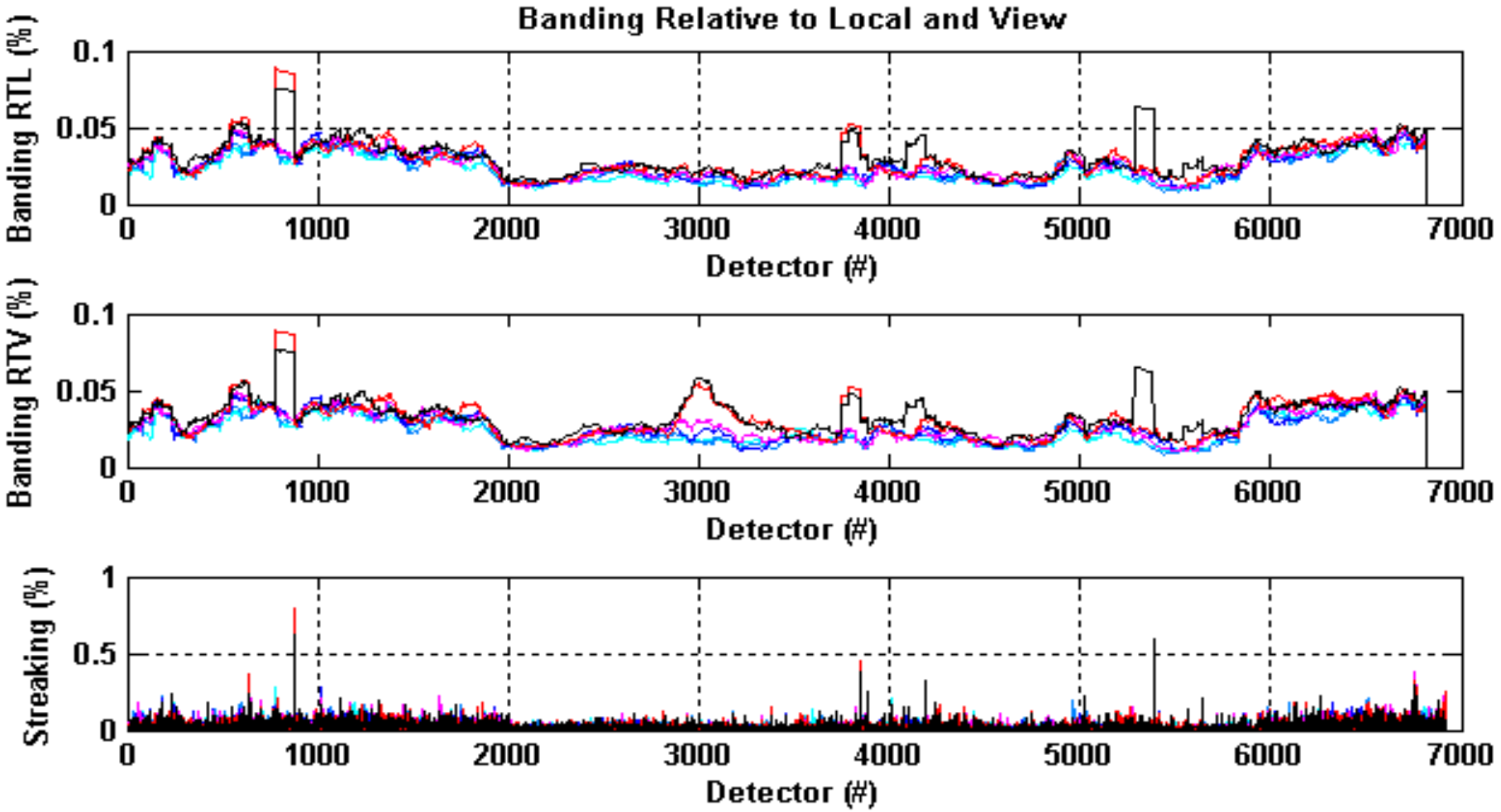
# Stability of Diffuser Observations is Used to Evaluate a KPR



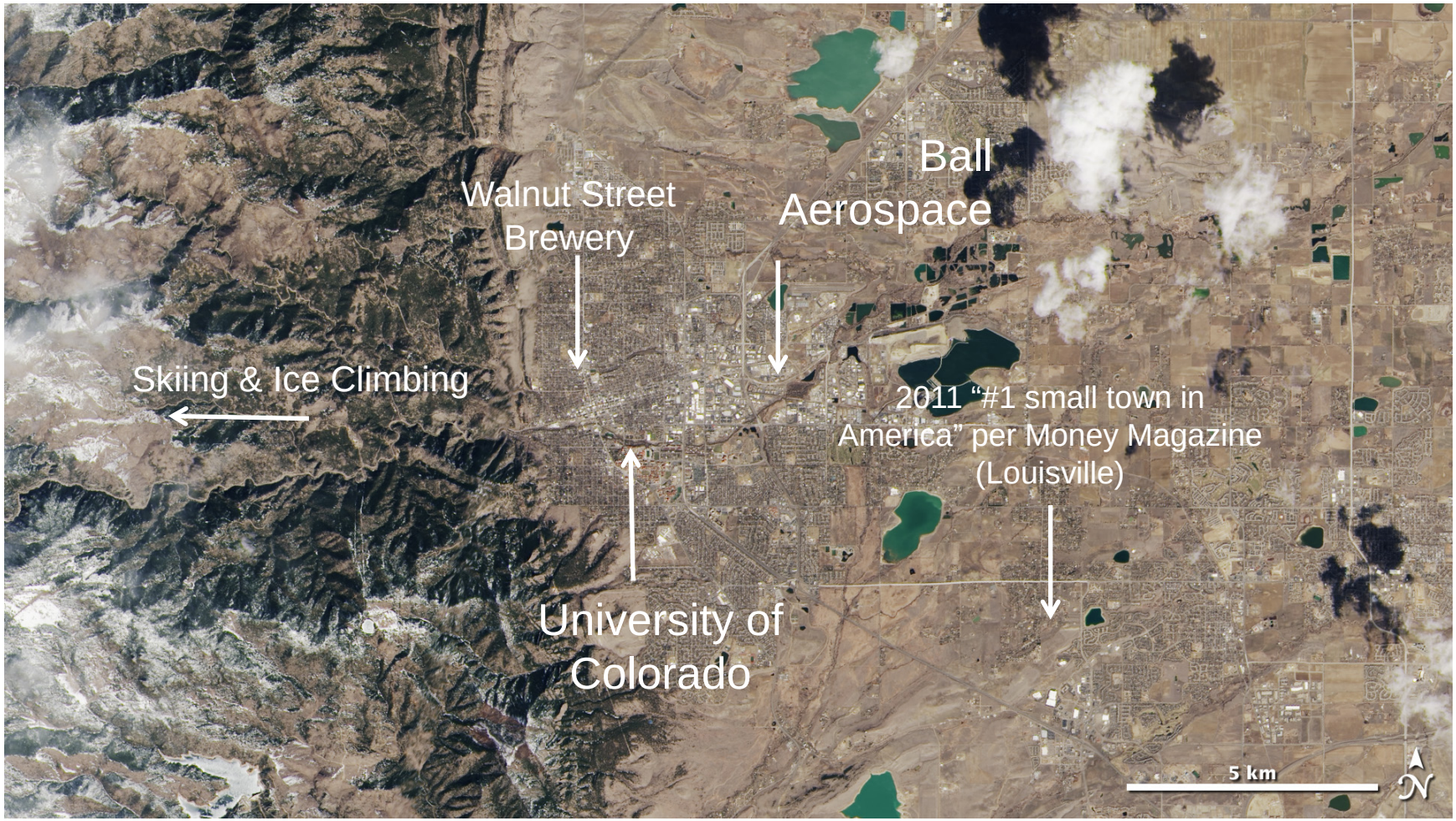

- The time series of diffuser observations shows:
- A small degradation in response in the Blue & CA bands
- A very small increase in all other bands

# Diffuser Observations are Used to Evaluate Uniformity KPR




- Repeatability of the diffuser uniformity on-orbit is good.
  - Banding likely contans information about local diffuser non-uniformity
  - Streaking is dominated by cosmic ray hits

# Earth Observations




EROS data center was able to generate high quality imagery using pre-launch calibration coefficients in a timely manner

# Summary

- OLI continues to operate successfully and meet its Key Performance Requirements
- The pre-launch calibration have been successfully transitioned on-orbit and provide a good baseline for characterizations over the mission life.