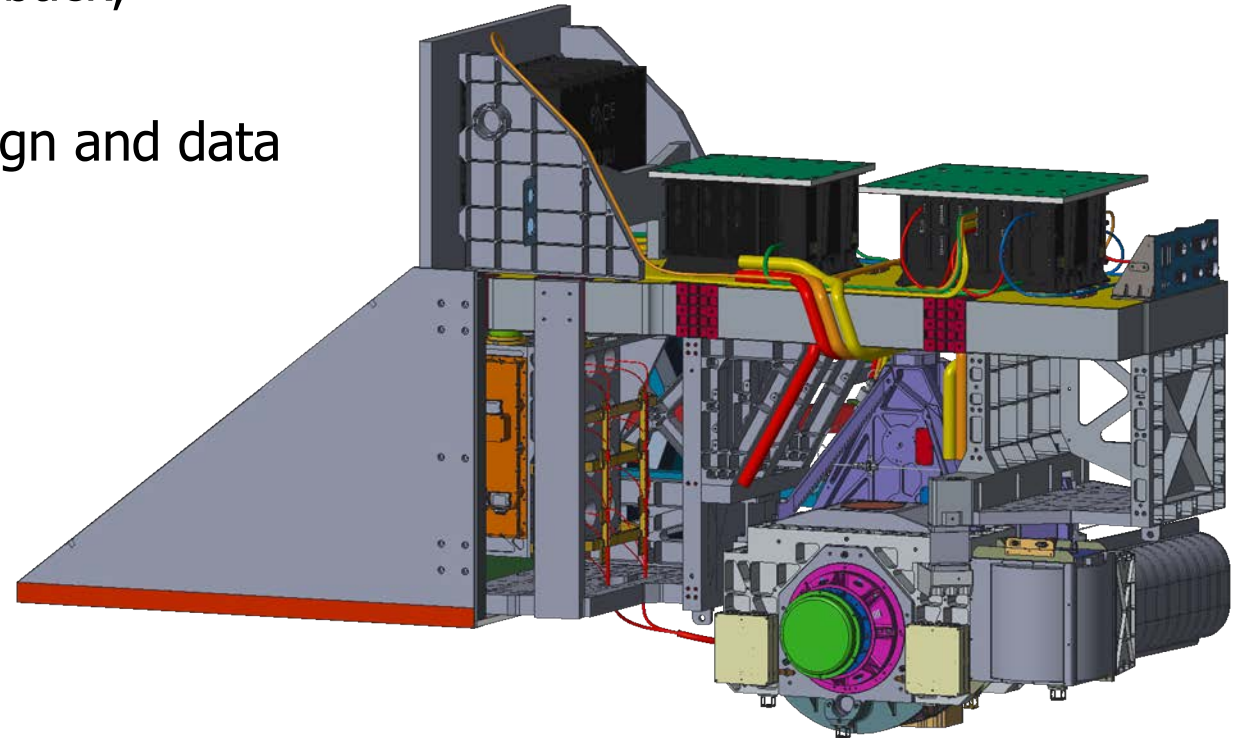

OCI ETU Calibration and Characterization

**Shihyan Lee
and
OCI Calibration Team**

**Feb 4, 2022
IOCCG Calibration Working Group**

Summary

- OCI ETU calibration/characterization testing campaign:
 - Performance verification (requirements)
 - Characterization, potential new capability, issues and limitation.
 - Aid instrument development R&D (Feed back, components test, modeling)
- OCI complexity poses challenges in test design and data analysis
- ETU Tests & results



OCI Calibration Challenges

- 3 focal planes:
- Blue/red CCD: 340 – 890 nm
 - Hyperspectral, 0.625 – 5 nm bands
 - time delay integration (TDI)
 - Variable spectral/spatial aggregation modes
- SWIR: 940 – 2260 nm
 - 9 multi-spectral bands
 - No TDI or spectral/spatial aggregation
- Rotating Telescope Assembly (RTA)
- Solar-cal: diffusor, port angle not in EV

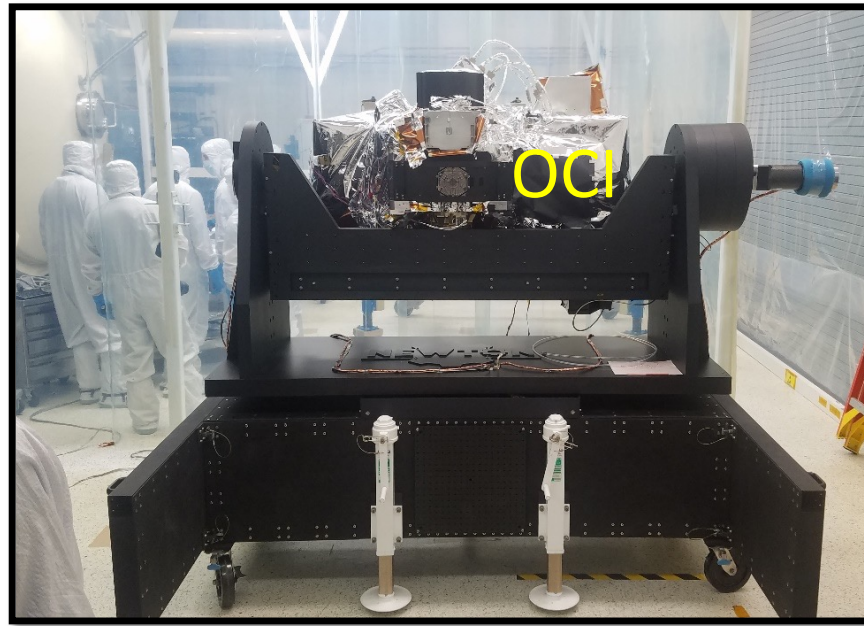
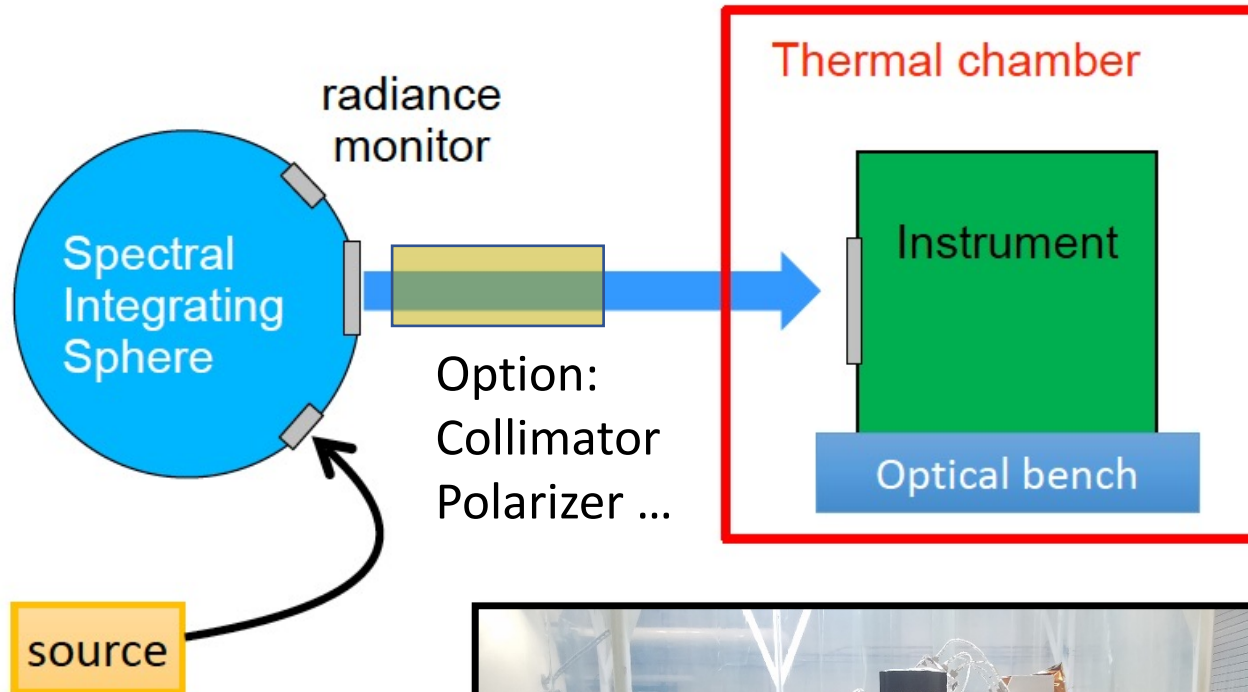
- Challenges:

- Hyper and multi-spectral bands + RTA design
- Very high sensitivity and requirement
- Multiple data collection configurations
- Ever evolving test configuration and data formats
- High data volume and complexity (128-1024 CCD bands + 9 (32) SWIR bands)

- **ETU:**

- **Red FPA only (no blue FPA)**
- **only 10 SWIR detectors (vs 32 in flight)**
- **no solar diffuser**

Test setup



- Source:
 - Integrating sphere
 - Monochromatic: GLAMR
 - Flood: Tungsten, or others
- Optional adaptor
 - Collimator, slit (LSF)
 - polarizer
- OCI
 - GAToR (spatial position)

XINA (Test) Marker

- A web based, searchable interface
- Record each test's configuration and associated GSE data
- Greatly facilitated data analysis

12 intervals found (1 - 12)

Int ID Contains ▼

Between

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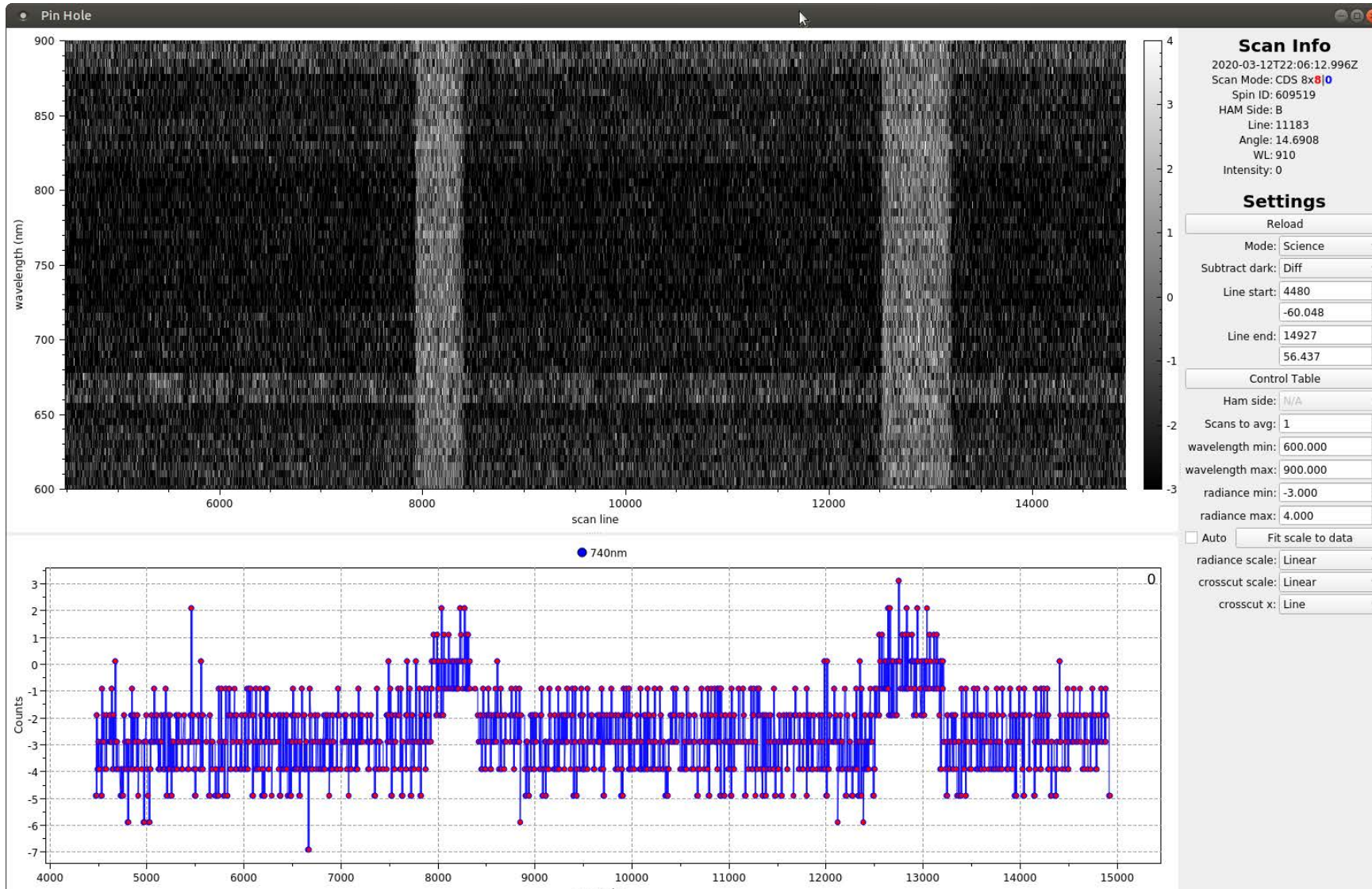
Label / Meta Contains ▼

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Q

Start	End	DOY	Duration	Pri ID	Sec ID	Label / Meta	
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2022-01-13T13:36:14.544	2022-01-13T13:43:49.317	013	00:07:34.773	6110	0	1x1 DEBUG = NO	
2022-01-13T12:09:45.141	2022-01-13T12:18:25.291	013	00:08:40.15	6111	1	1x1_LiOp0_At100_n1Secs_1x1_RED_SsmY DEBUG = NO	
2022-01-13T12:09:13.994	2022-01-13T12:18:26.372	013	00:09:12.378	6110	0	1x1 DEBUG = NO	

Real-time Quick-look Tool

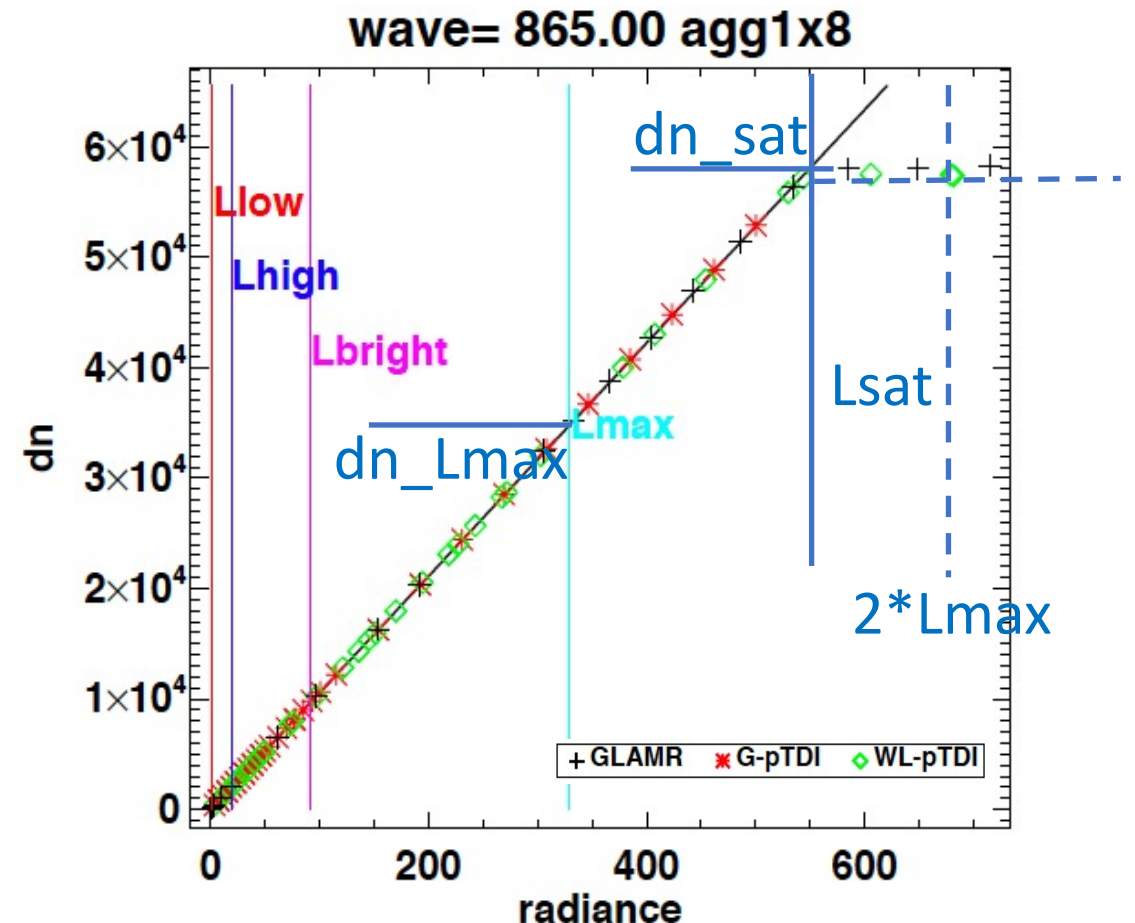
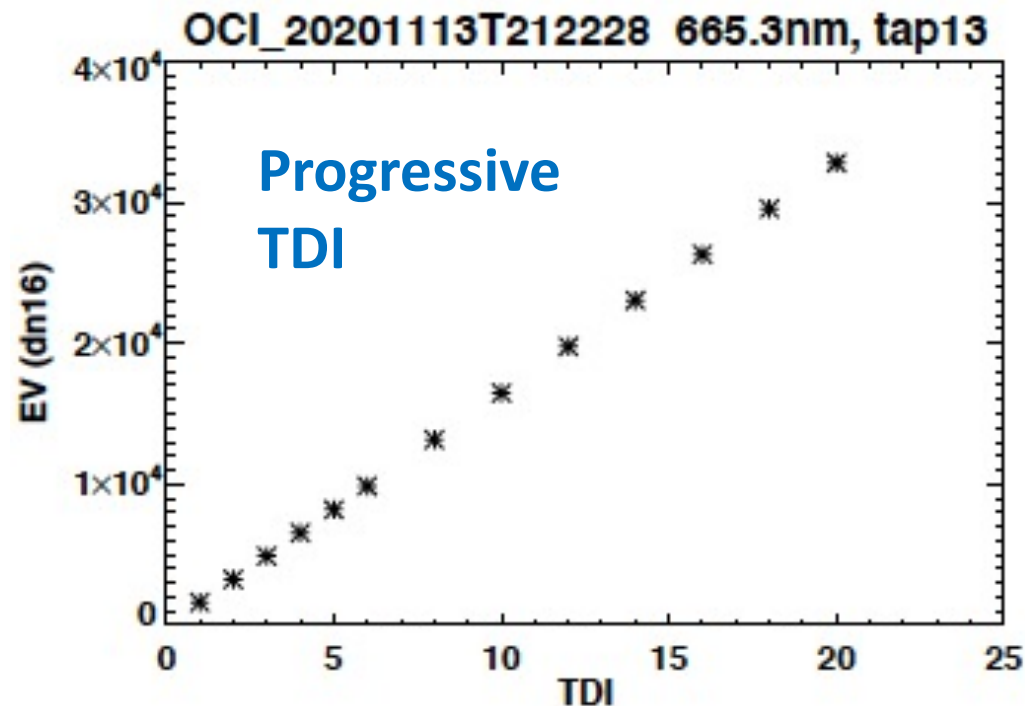


- A real-time quick-look tool to facilitate QA and trouble shooting prior to taking data
- Spotter for issues for further analysis
- Example show CCD dark pulses

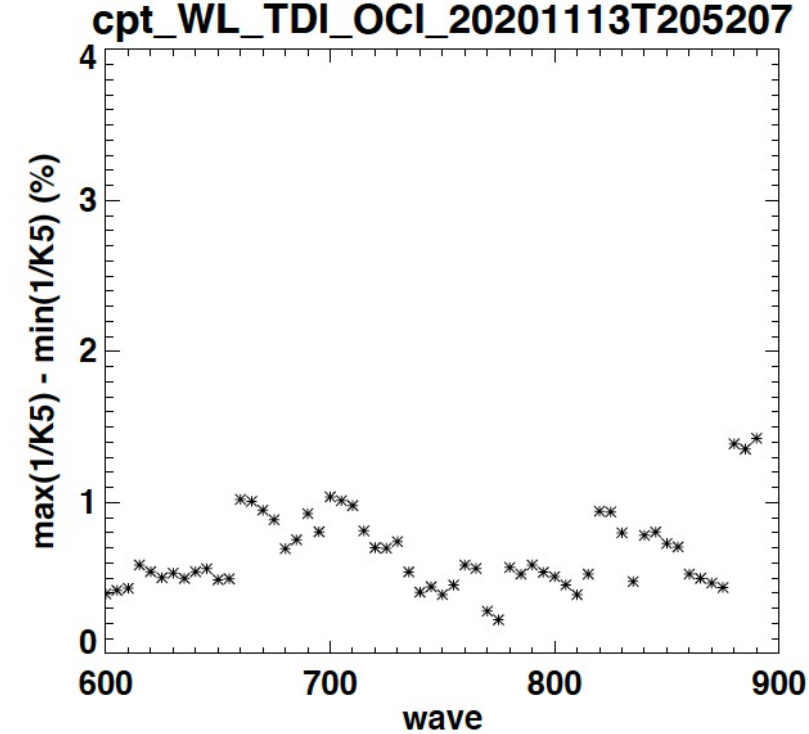
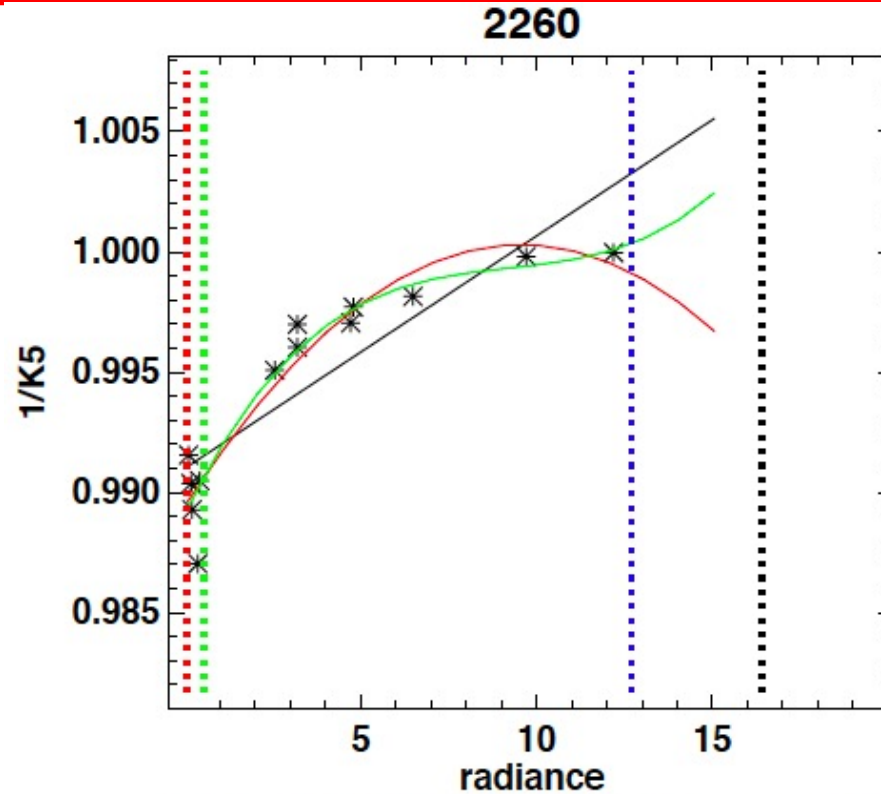
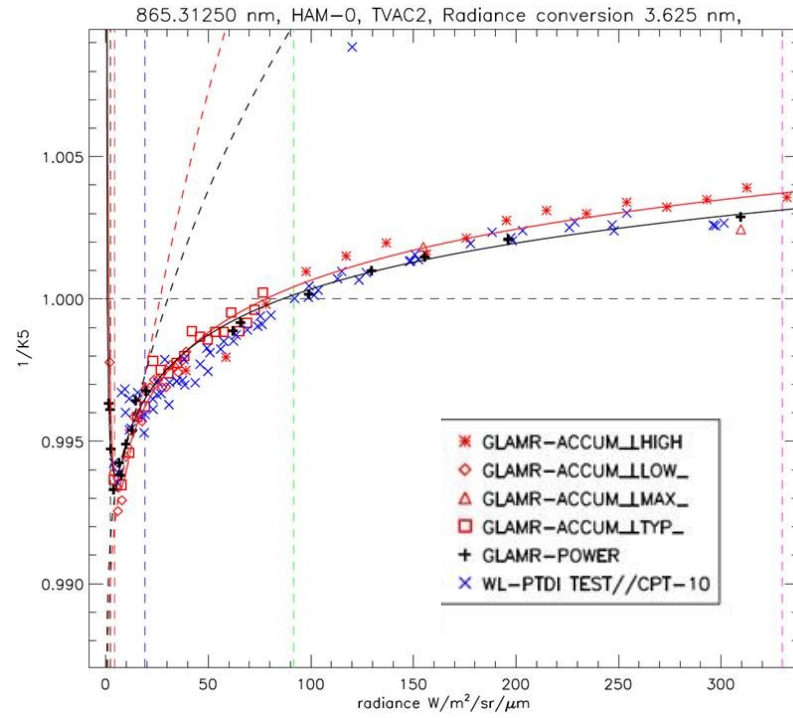
Response vs. source intensity

- Power stepping
 - Monochromatic: GLAMR
 - Flood: Tungsten, or others
- Progressive TDI (hyperspectral bands only)

- Results: Gain, SNR, saturation, linearity
- GLAMR power stepping vs. pTDI

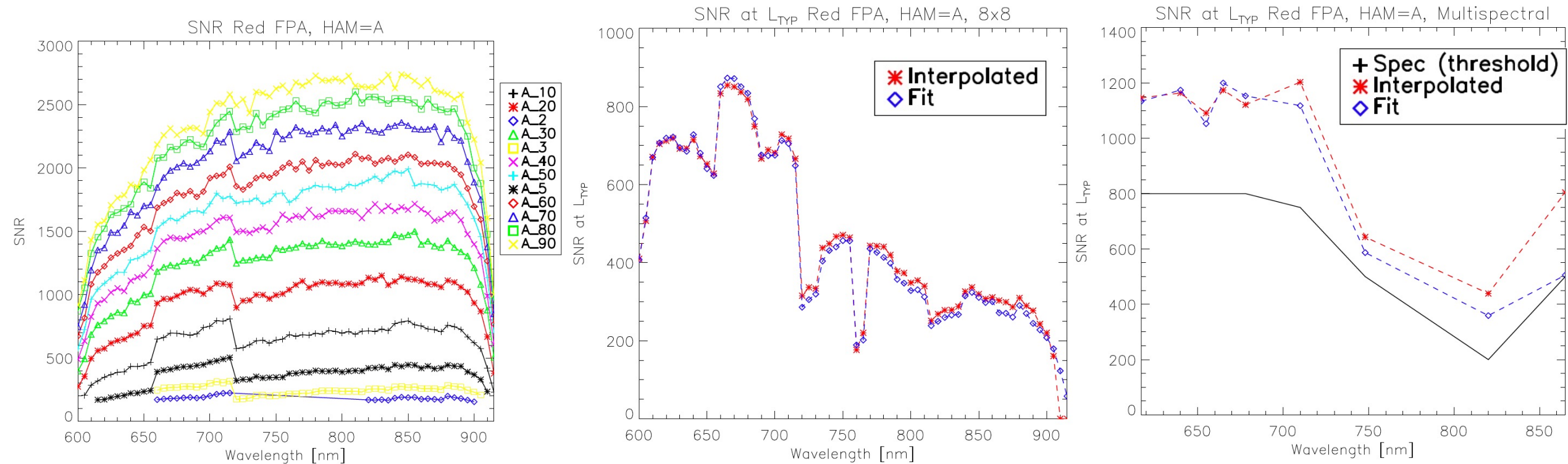


Linearity



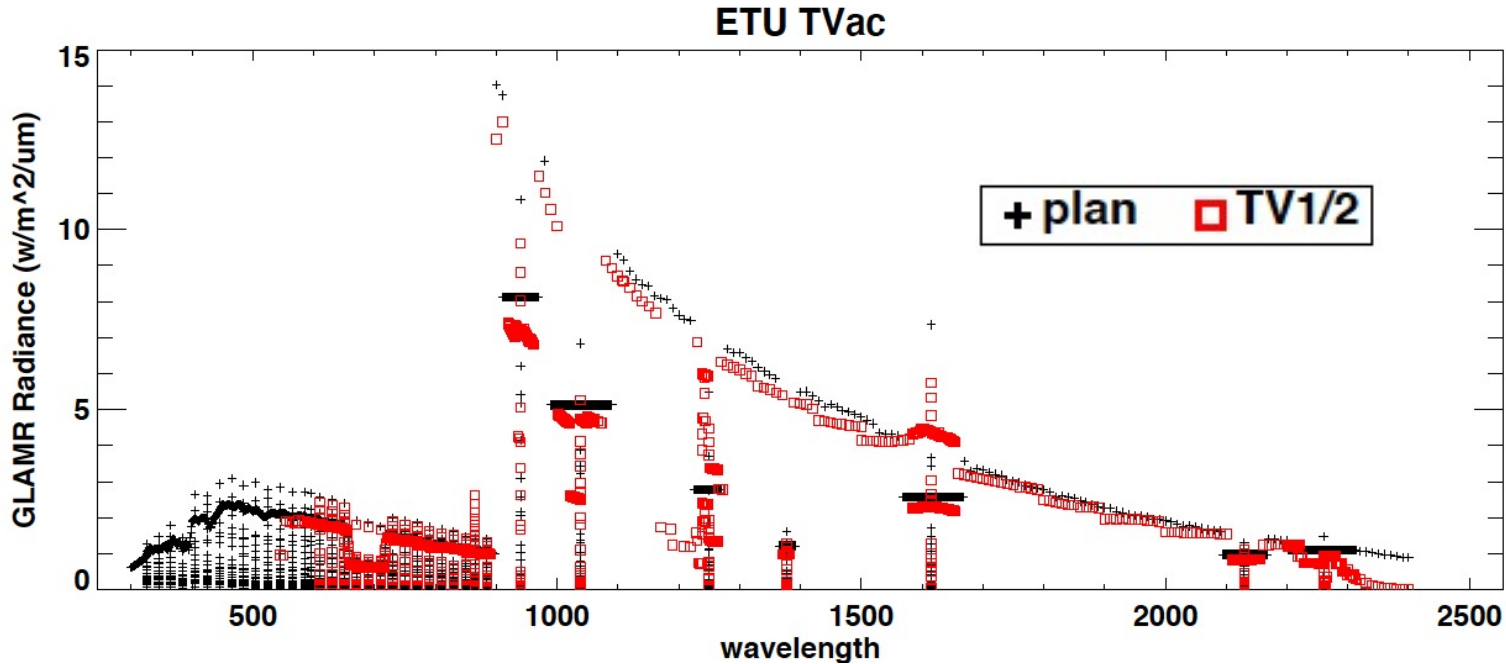
- GLAMR power stepping performed one band per tap (20 nm) and all SWIR bands.
- pTDI performed for all CCD bands
- (Left) Verify linearity for pTDI matches GLAMR power stepping.
- Linearity characterization: CCD bands - pTDI, SWIR bands - GLAMR

SNR

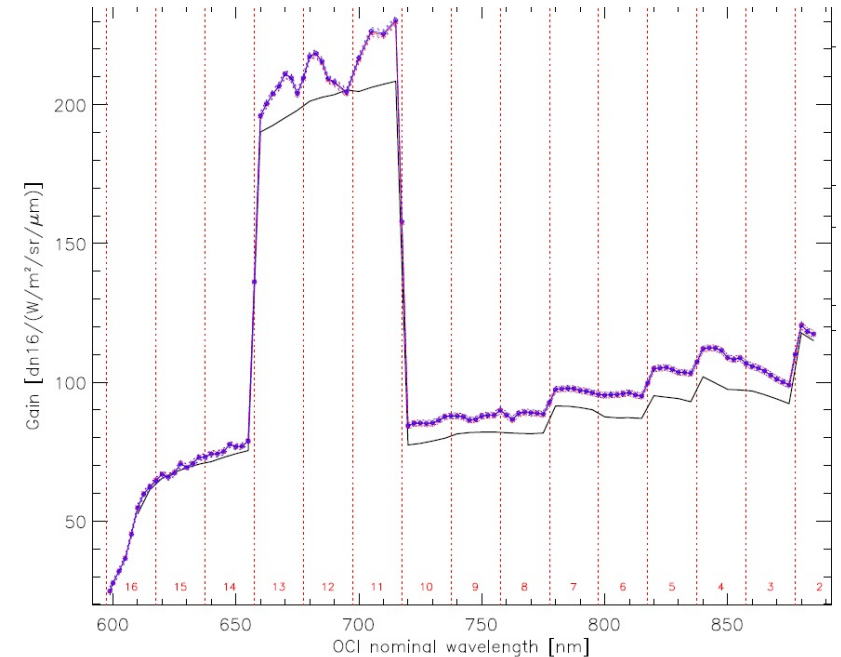
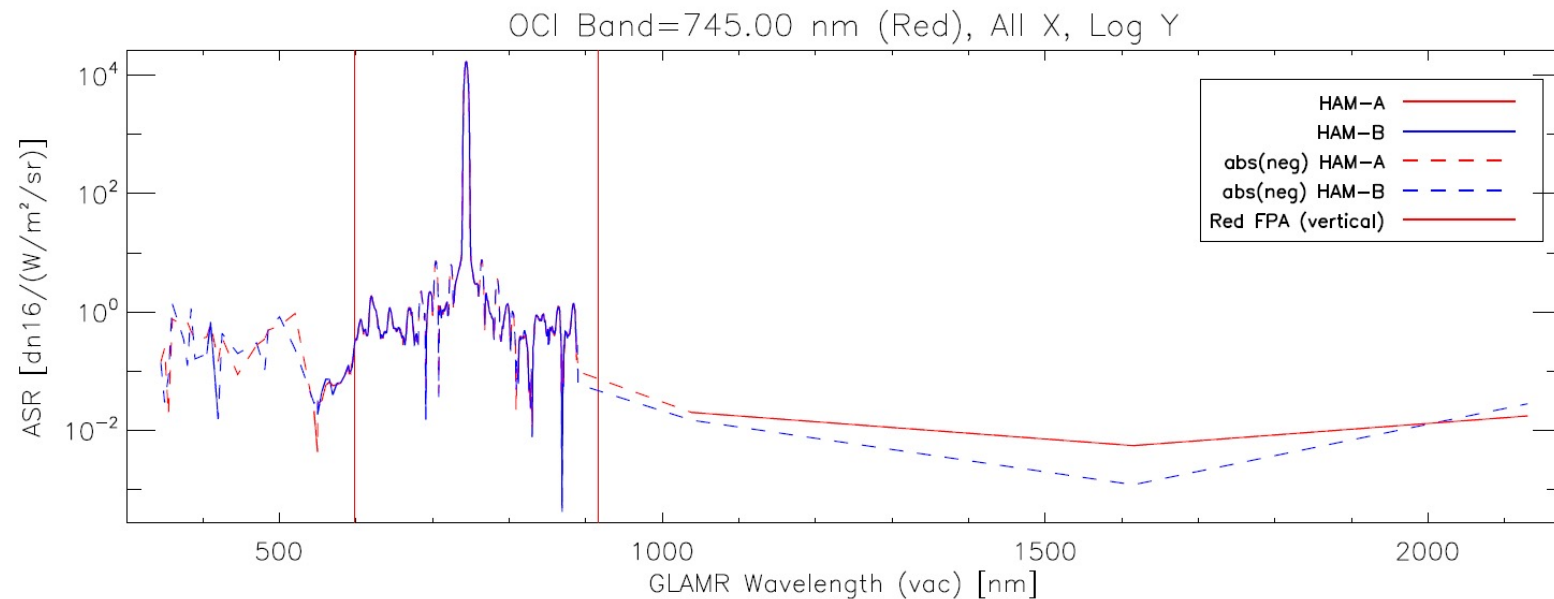


- Left: SNR vs. power level, red CCD
- Mid: 5nm band SNR@Ltyp
- Right: multi-spectral band SNR@Ltyp. (heritage sensor)

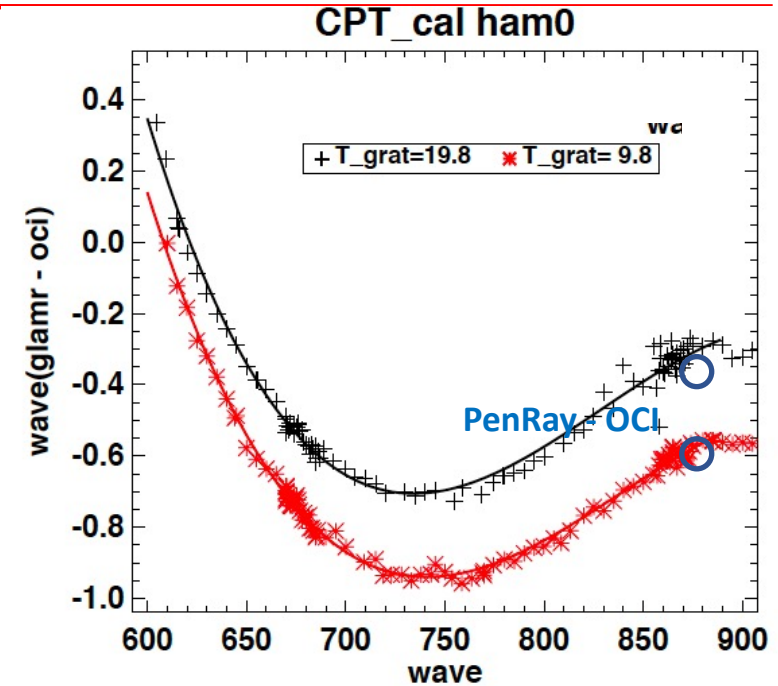
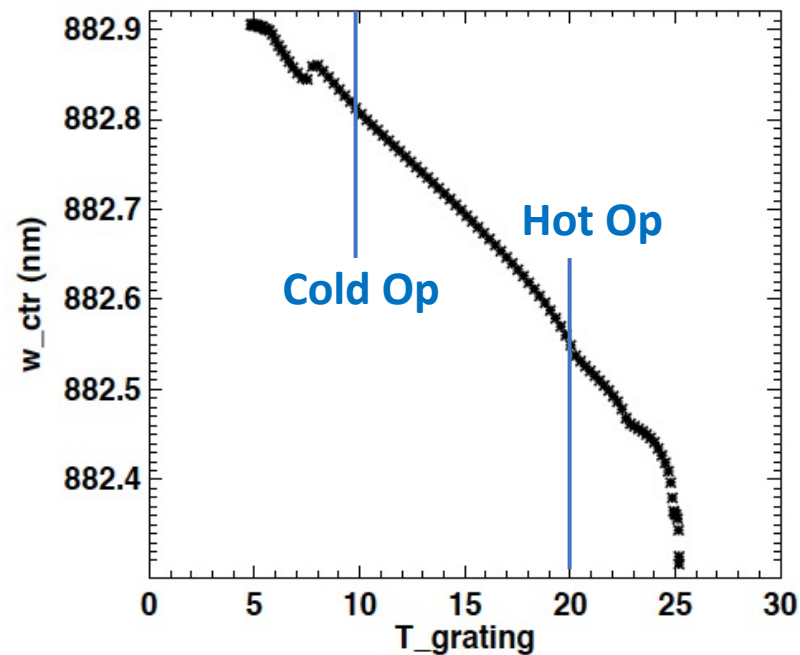
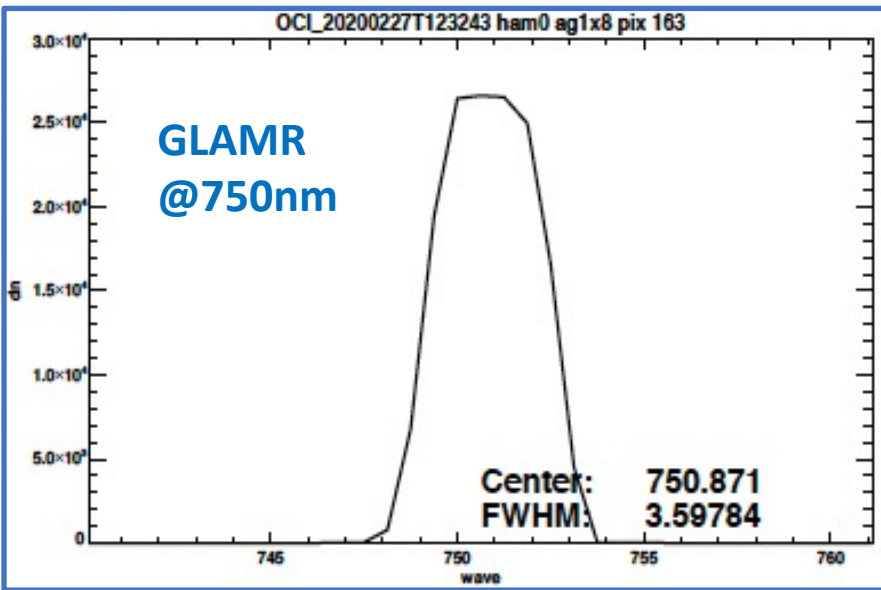
Spectral Response



- Source: GLAMR spectral scans
- Absolute spectral response (ASR), RSR
- Gain, OOB, band center, bandpass.



Spectral response vs. Temperature



- Track spectral shift due to temperature change use OCI hyperspectral band response
- Left: OCI response to GLAMR
- Right: GLAMR: hot/cold plateaus at all wavelengths
- Pen-Ray: few selected wavelengths to track OCI spectral shift during temperatures transition

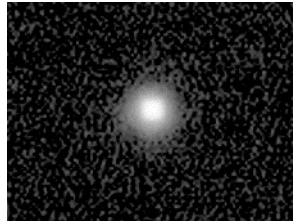
LSF Bench

Scene Masks

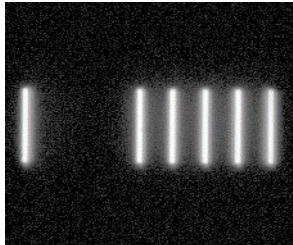
“1-SP” 1-Science Pixel Masks
(1km x 1km equiv.)



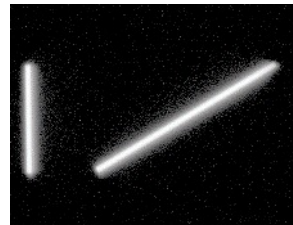
“1-PYP” 1-Physical Pixel Mask



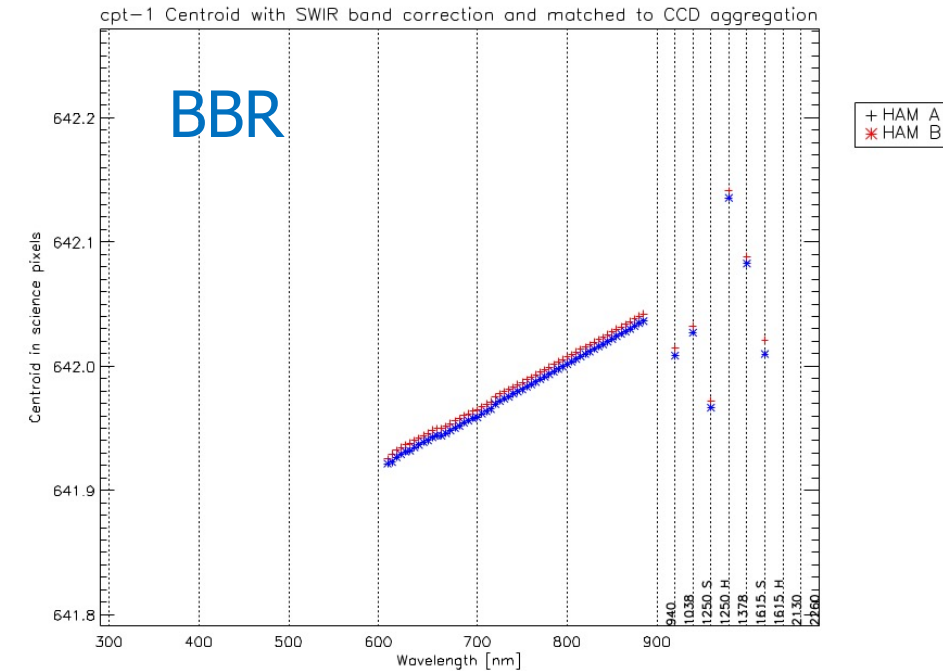
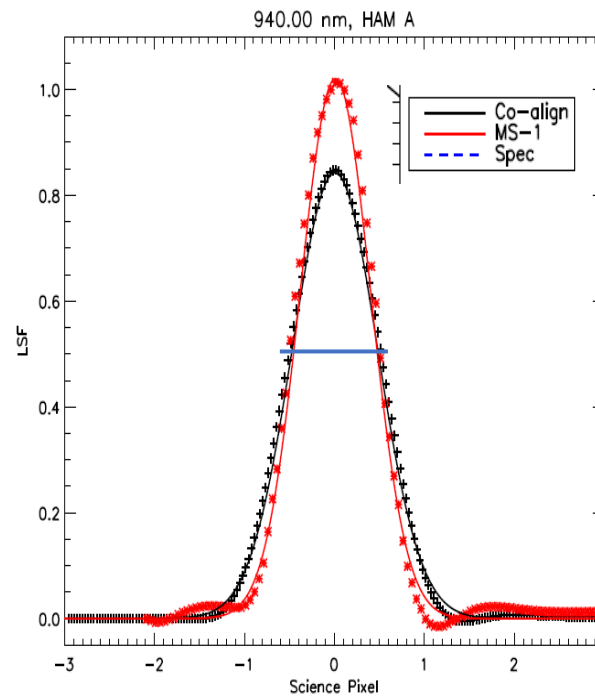
“MS-1” Multi-Slot Mask for Higher
Detail LSF Measurement



“J-1” Jitter, Along-Track iFOV, LSF etc.

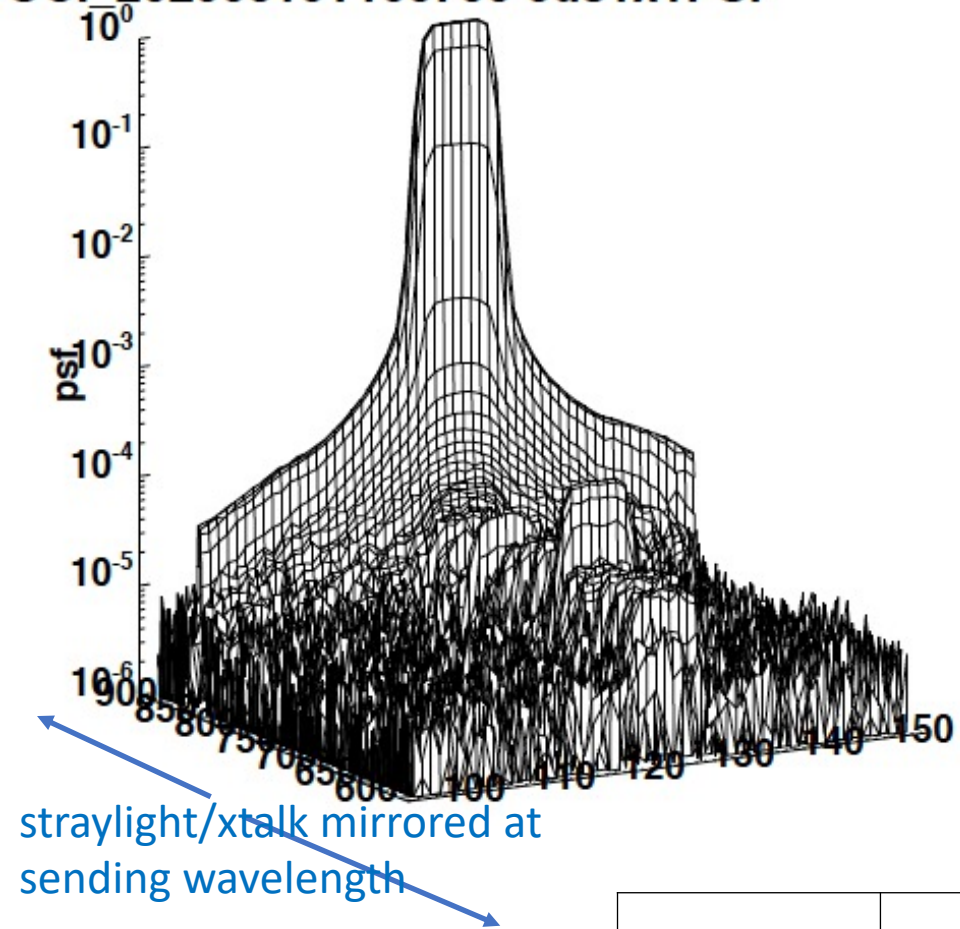


- Line Spread Function (LSF), BBR (band-to-Band Registration), GSD (Ground sample distance), IFOV, MTF



Straylight / Crosstalk

OCI_20200310T105750 cds1x1PSF

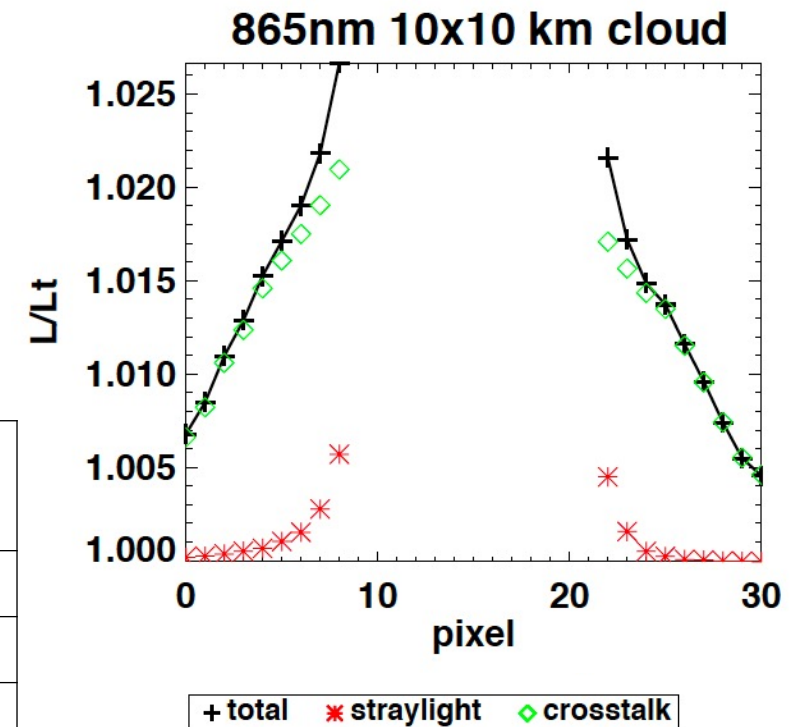


Stress vs. Science scene impact

- spatial dimension (track/scan), spectral (xtalk)
- Build a straylight/xtalk model base on GLAMR data.
- Estimate science impact in 1-day MODIS data.

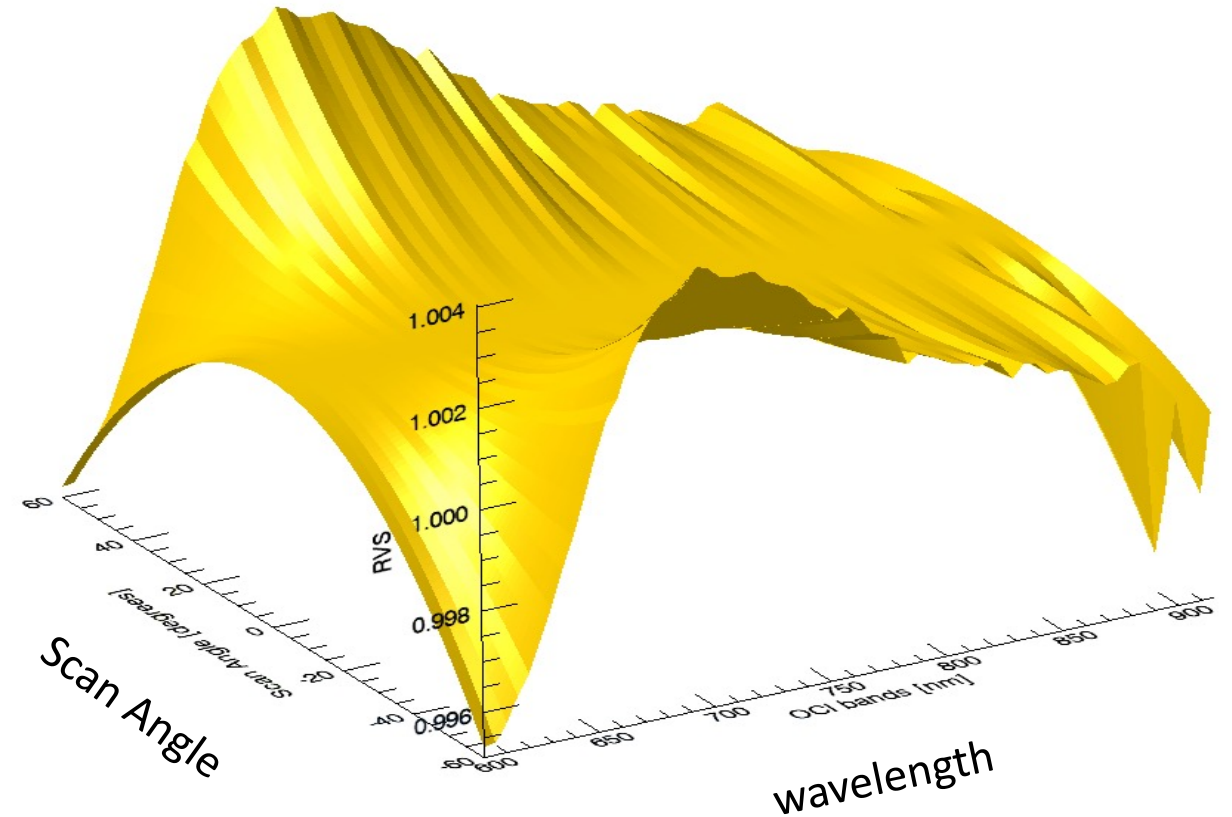
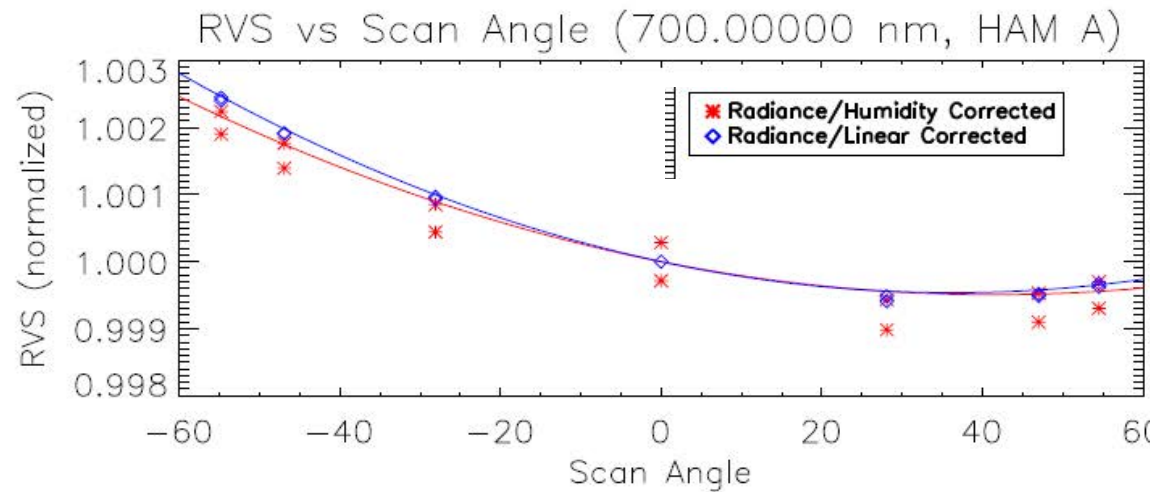
ETU Cross-Track only

wave (nm)	straylight (%)	crosstalk (%)	total (%)
678	0.002	0.017	0.019
748	0.003	0.03	0.033
869	0.005	0.068	0.073



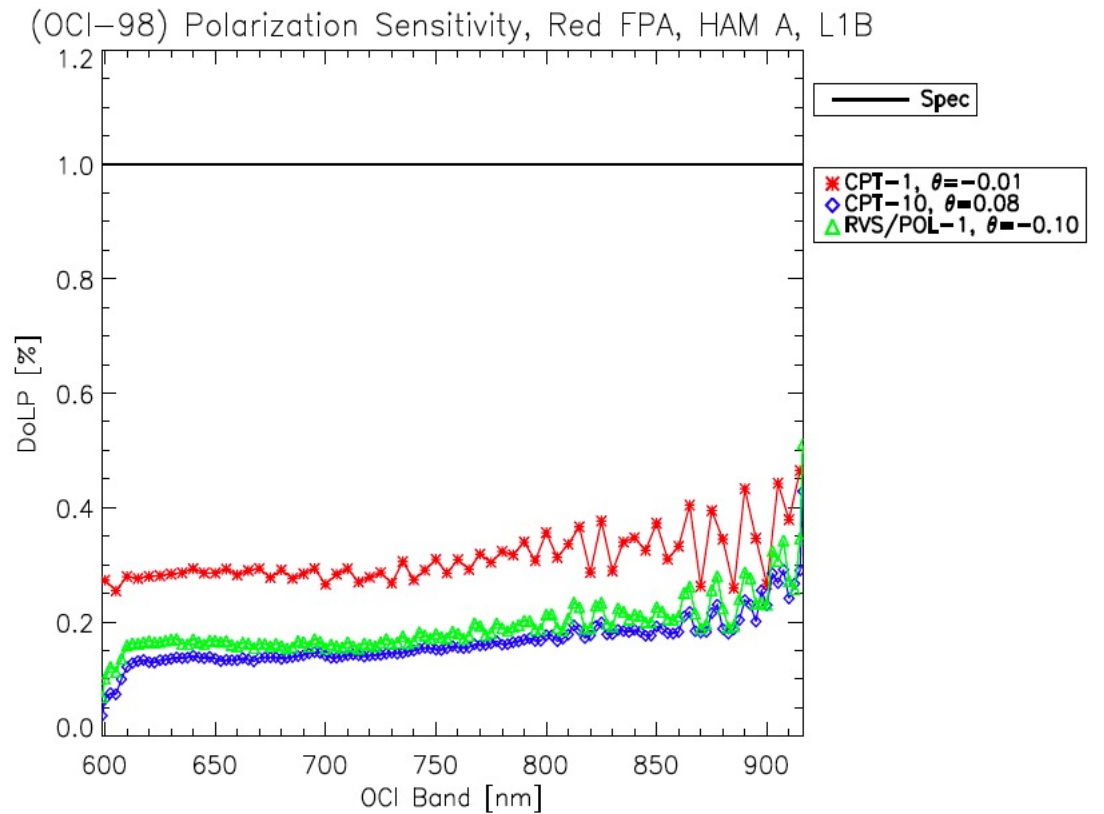
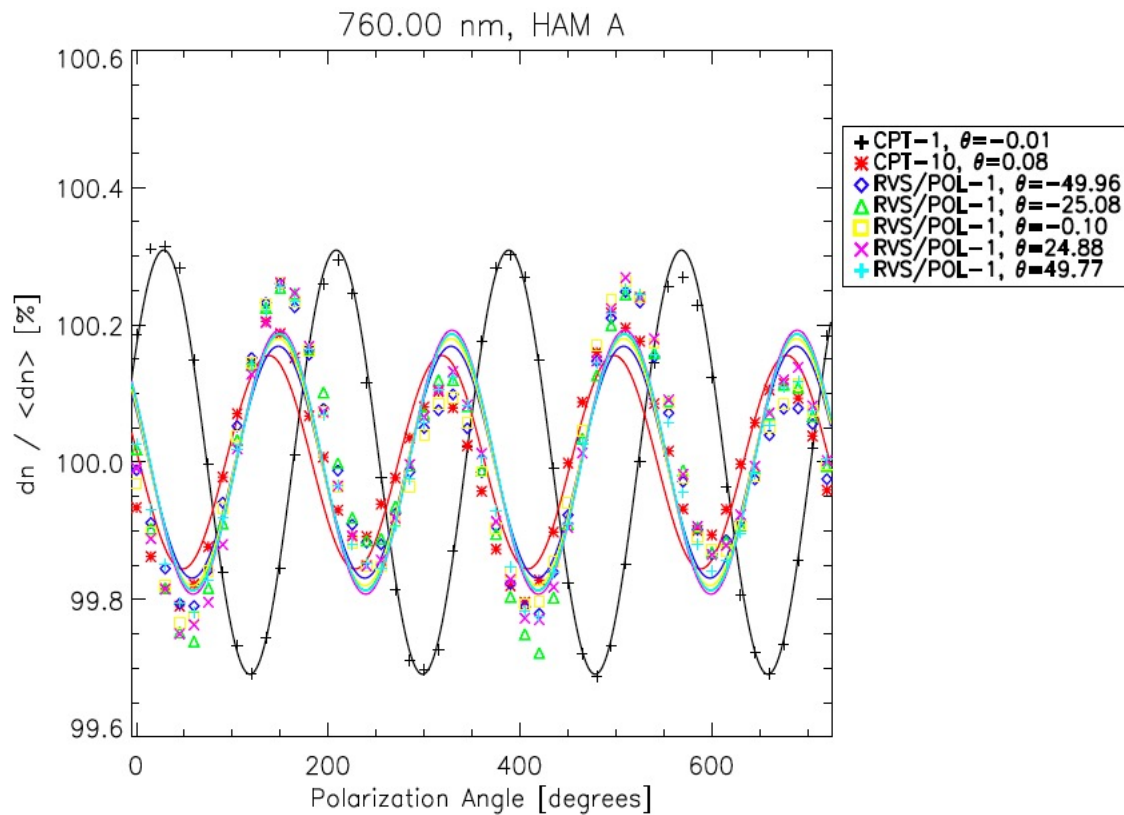
Response vs. view angle: RVS

- Change OCI view angle to the source
- OCI response vs. scan angle



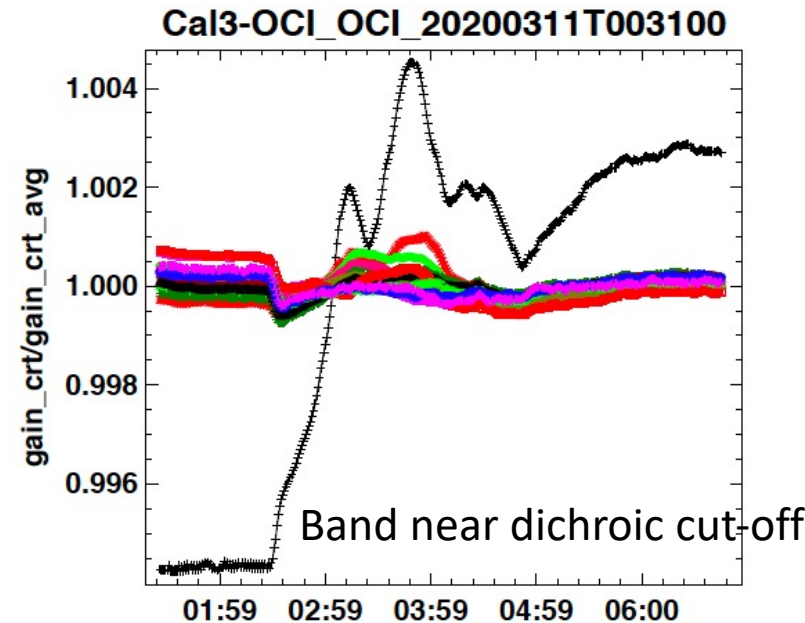
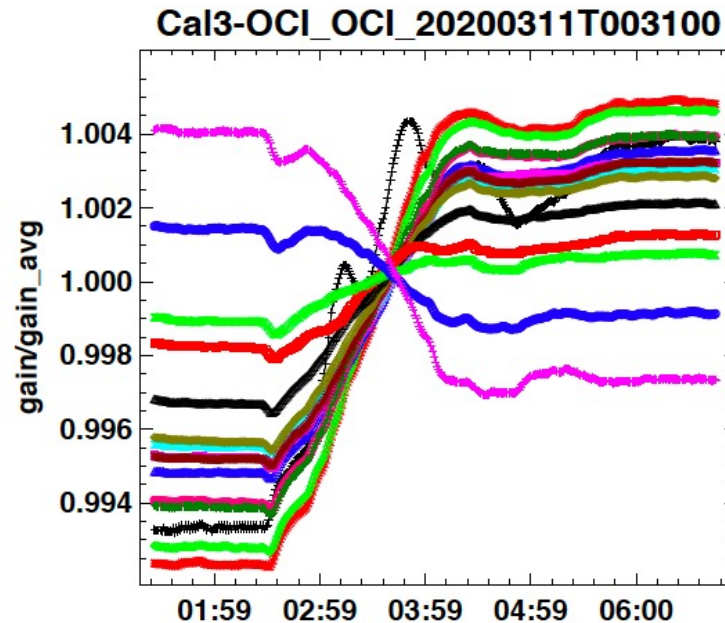
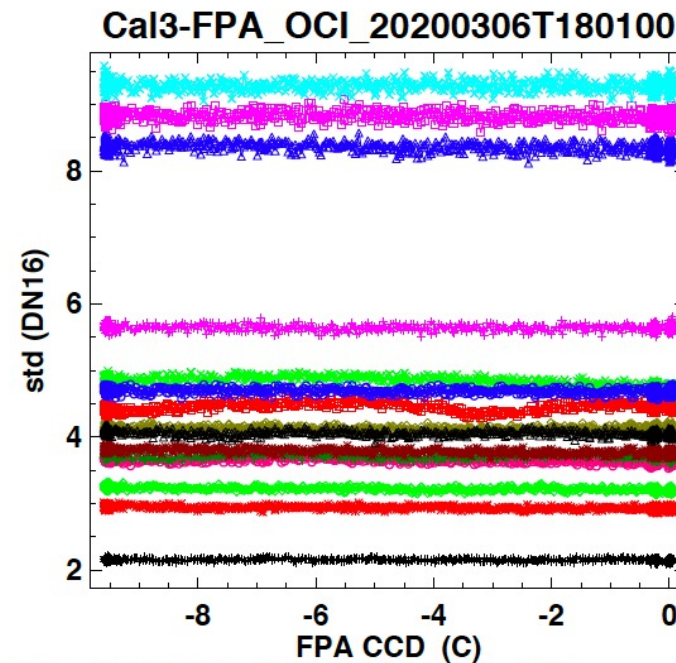
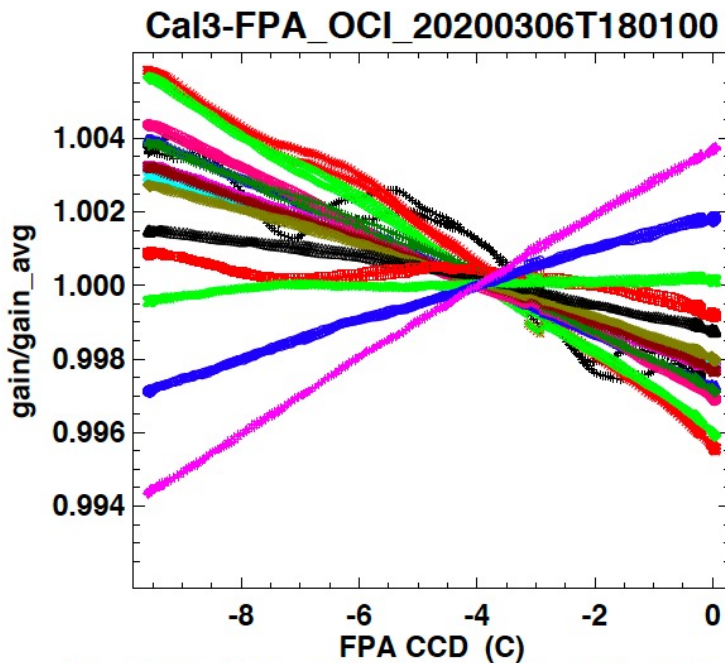
Polarization Sensitivity

- OCI response vs. polarizer angle
 - CPT1 has a different setup, results not comparable with the rest CPTs.



Response vs. Temp

- OCI sensitivity is most sensitive to FPA temperature. Slightly sensitive to MOB temperature
- Top: OCI response vs. FPA CCD temperature
- Bottom: OCI gain before and after temperature correction



+ 605 * 625 ◇ 645 △ 665 □ 685 × 705 ○ 725 + 745 * 765 ◇ 785 △ 805 □ 825 × 845 ○ 865 + 885 × 905

+ 605 * 625 ◇ 645 △ 665 □ 685 × 705 ○ 725 + 745 * 765 ◇ 785 △ 805 □ 825 × 845 ○ 865 + 885 × 905

Additional Tests

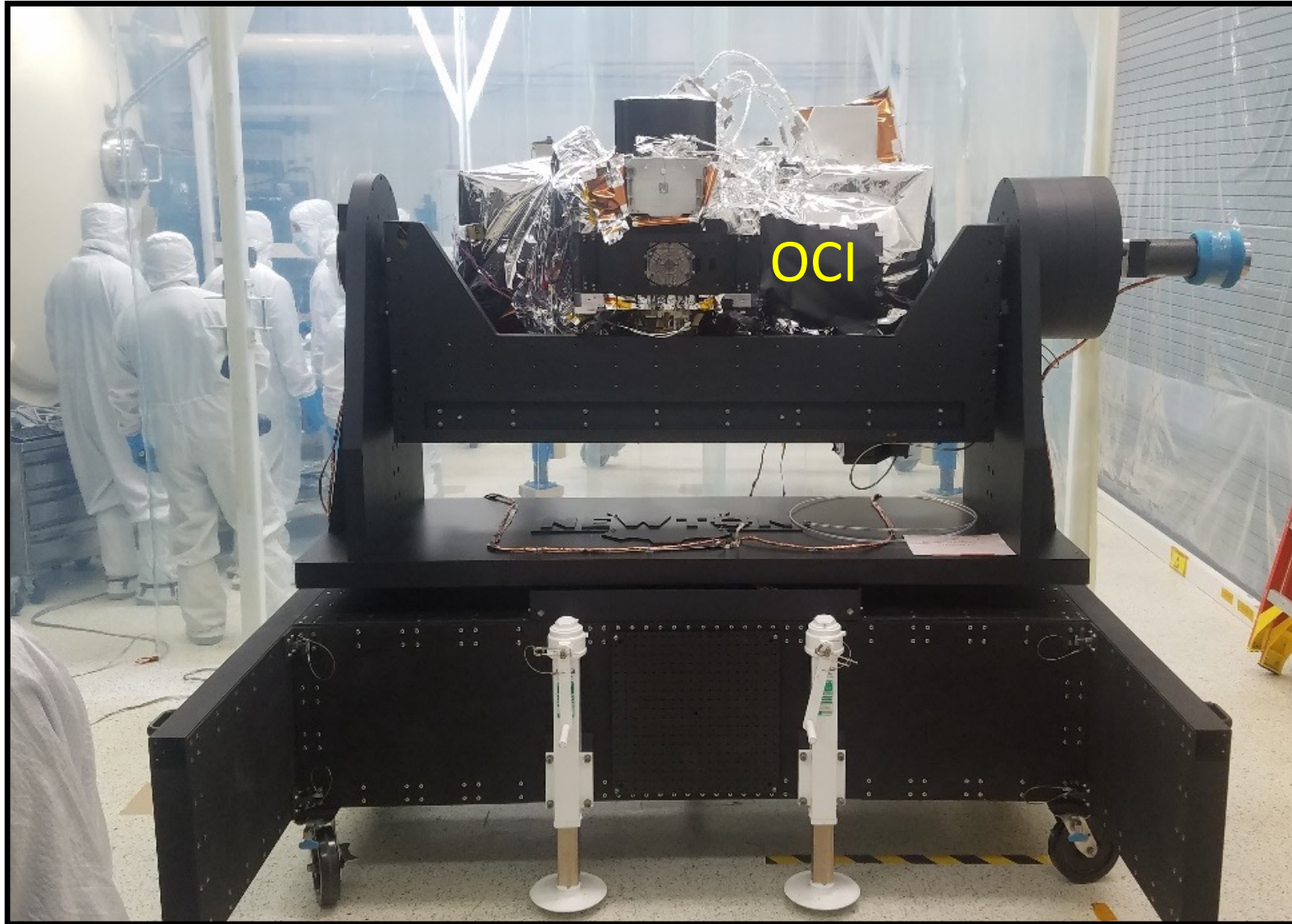
- Cal2: gain/SNR/offset stability test
- EMI/EMC test: radiation susceptibility test
- Repeat tests to track instrument performance over time
 - CPT: comprehensive performance trending
 - LPT: limited performance trending

Going Forward

- OCI Flight Unit (FU) testing
- New hardware and tuning
 - Both blue/red CCD + complete SWIR band assembly
- Test program updates based on lesson learned
 - GLAMR radiance sweeps
 - LSF slits, timing delay
 - pTDI steps

Backup

GSE: GAToR



Key GAToR specs demonstrated with OCI mass and CG:

- Rotation: $\pm 100^\circ$ Az, $+90^\circ, -30^\circ$ El.
- Step Precision: sub-physical pixel equivalent. stepping (< 40 arcsec)