



JPSS-2 VIIRS

Prelaunch Geometric Performance and Characterization

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CALCON
Logan, UT
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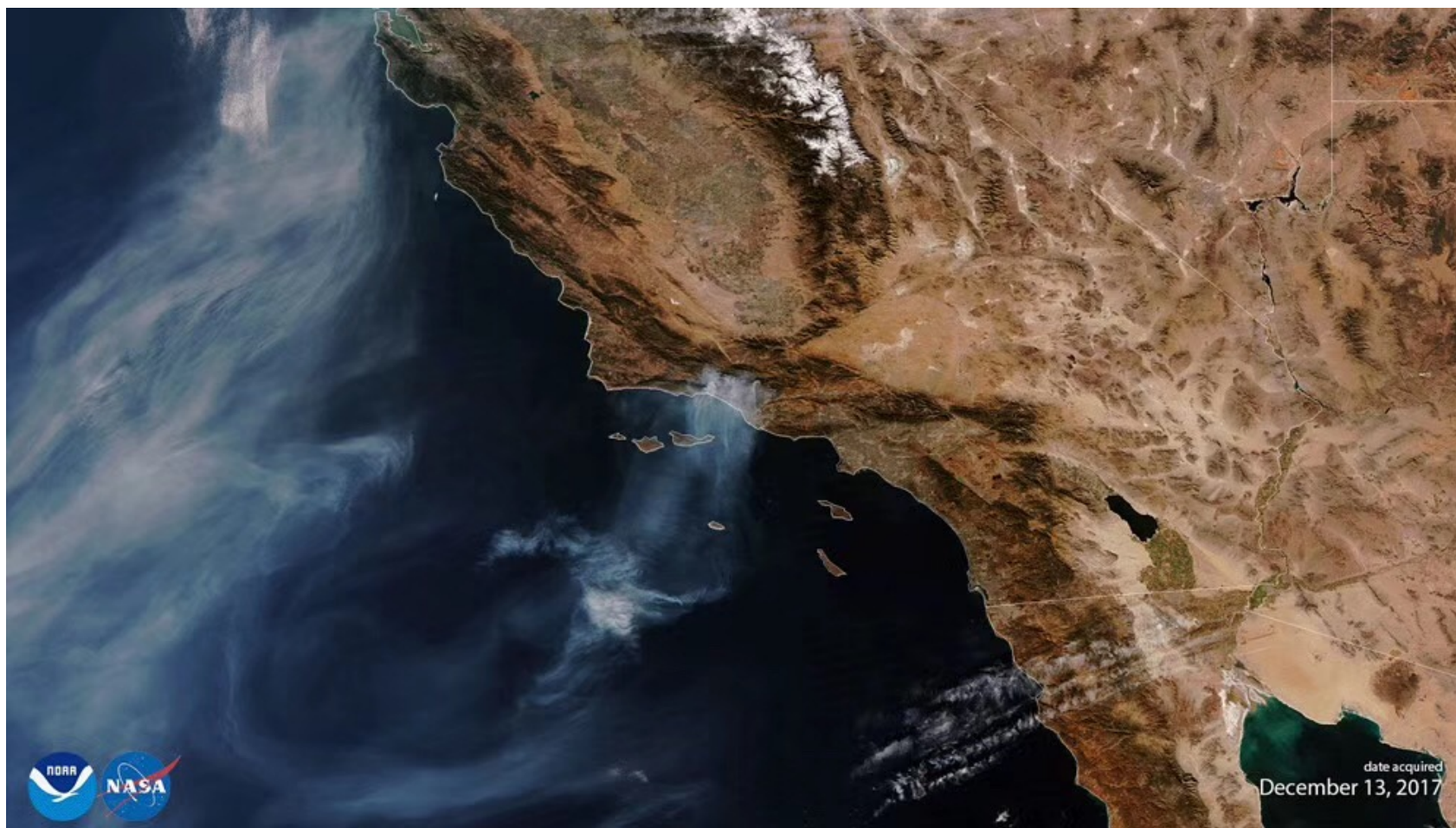


NASA/NOAA VIIRS

- The NASA/NOAA **Visible Infrared Imaging Radiometer Suite (VIIRS)** is one key instrument onboard JPSS missions (SNPP and J1-4).
- Provide long-term measurements of geophysical variables, as well as operational weather forecasting and disaster relief and other applications.
- Spectral coverage from 0.4 to 12.5 microns
- Nadir resolution at ~375 m and ~750 m
- Afternoon orbit with 16 days repeat cycle



VIIRS Image

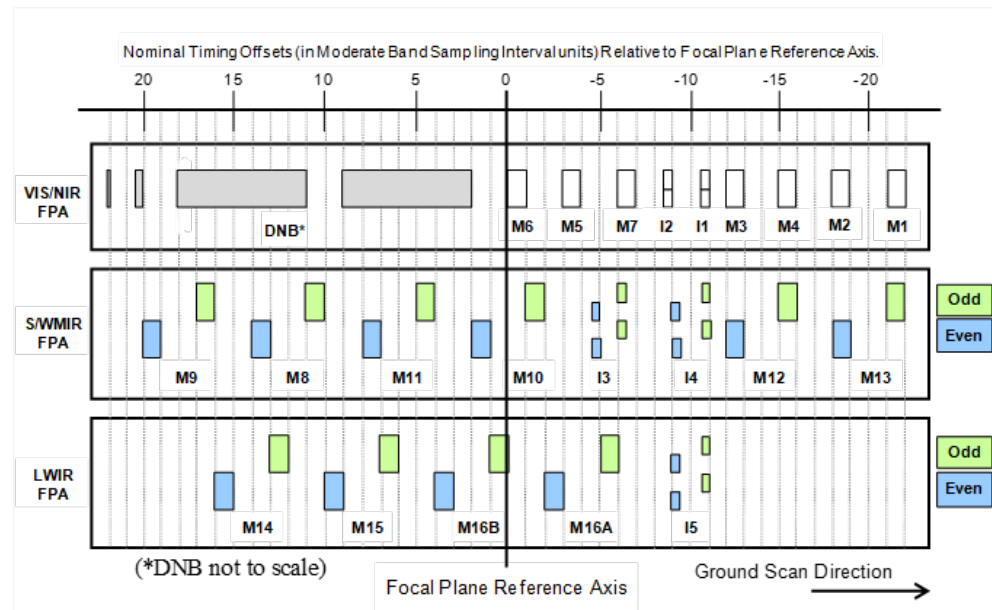
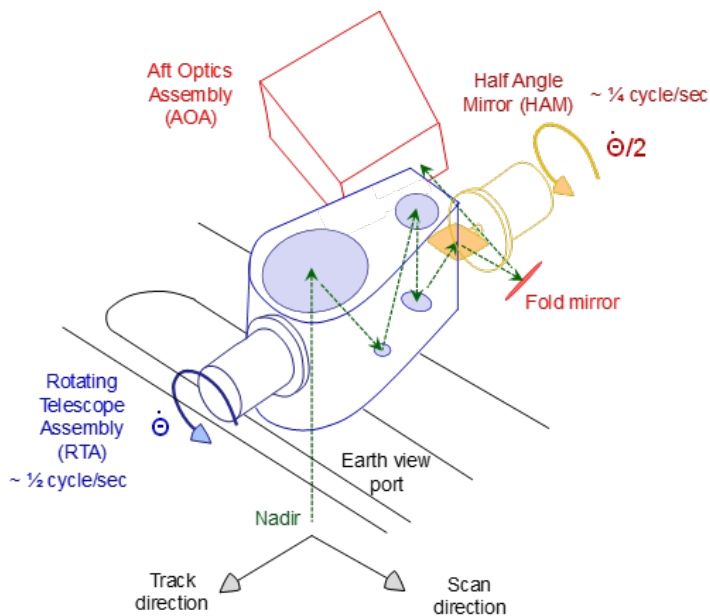


VIIRS Image



DNB image of Spain showing lights in urban centers and clouds over the Atlantic Ocean. Image courtesy of NASA's Direct Readout Laboratory.

JPSS2 VIIRS Scanning Mechanism and Optical Path



Wiskbroom imaging system with a rotating telescope assembly (RTA)

A half angle mirror (HAM) de-rotates the incoming rays from the RTA into a fixed aft-optics assembly (AOA)

Visible and near infrared (VisNIR) focal plane assembly (FPA)

Short- and mid-wave infrared (SWMWIR) FPA

Long-wave infrared (LWIR) FPA

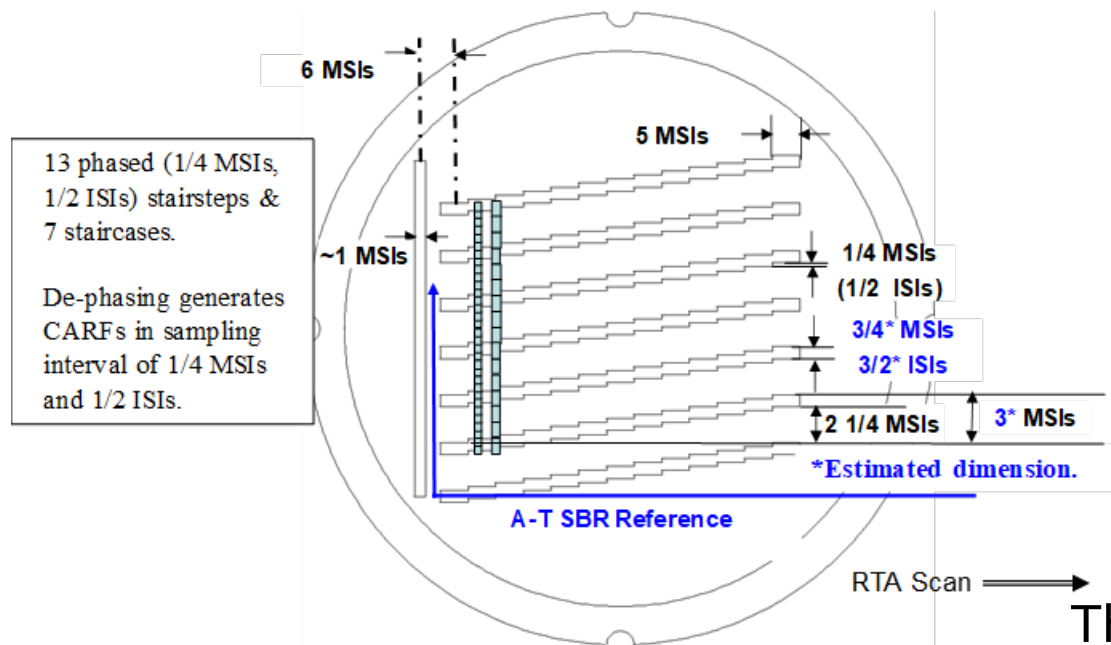
Day-night band (DNB) FPA



Outline

- JPSS-2 VIIRS prelaunch geometric performance assessment focuses on the **sensor's spatial response** and **band-to-band co-registration**
- Spectral Band registration
- Band-to-band co-registration
- Scan Line Spread Function
- Factors affect the JPSS-2 VIIRS DNB LSF anomaly
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 - Aggregation mode and Gains
 - Detectors
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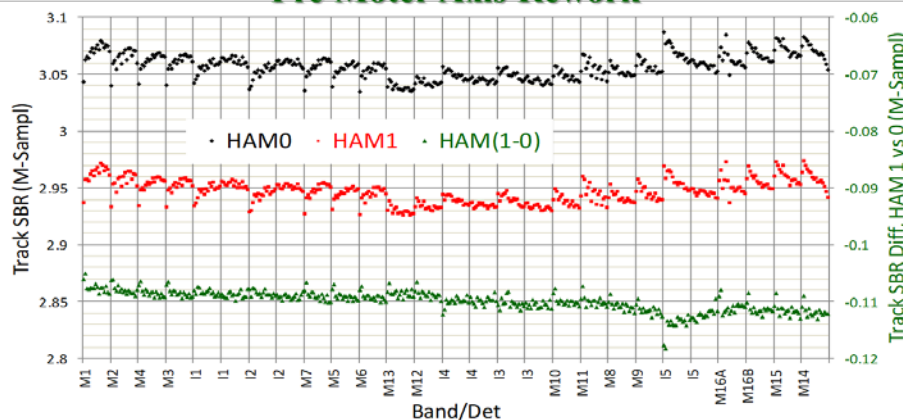
JPSS 2 Spectral Band Registration in Track Direction



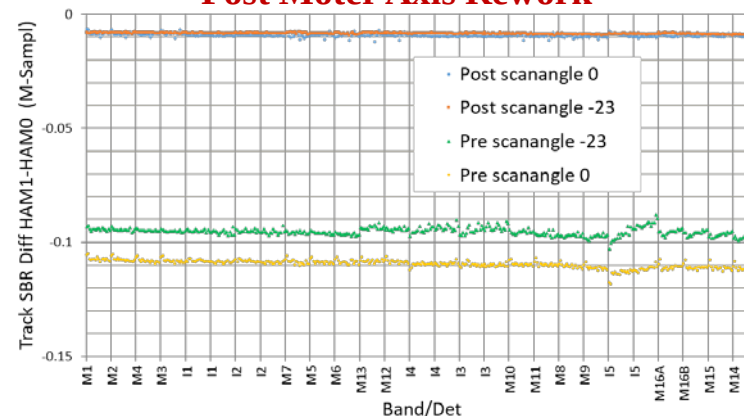
The SBR difference between HAM side A and B can be caused by misalignment of the mirror plane of symmetry to the HAM motor axis

JPSS2 Spectral Band Registration

Pre Motor Axis Rework

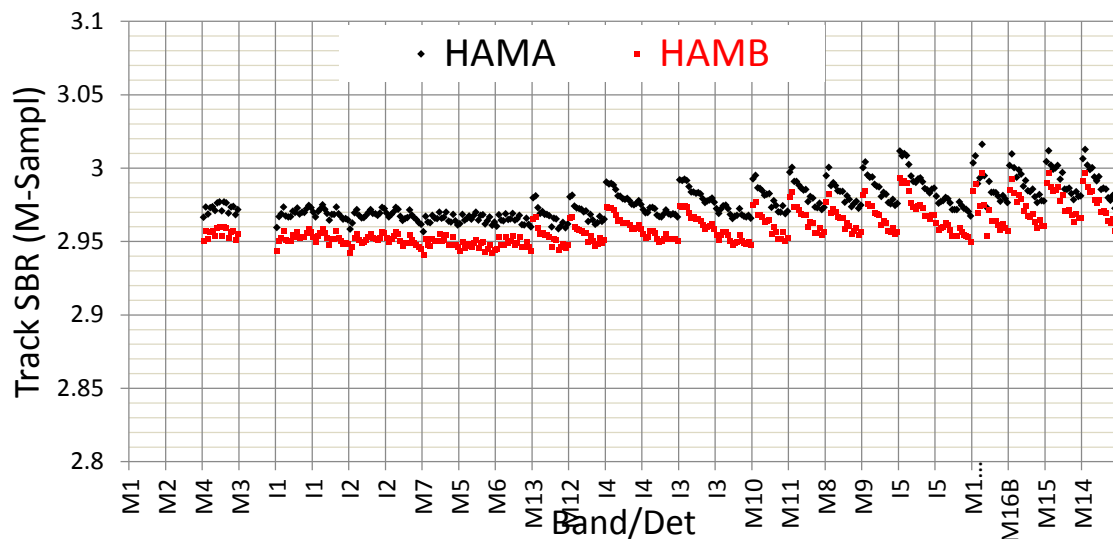


Post Motor Axis Rework

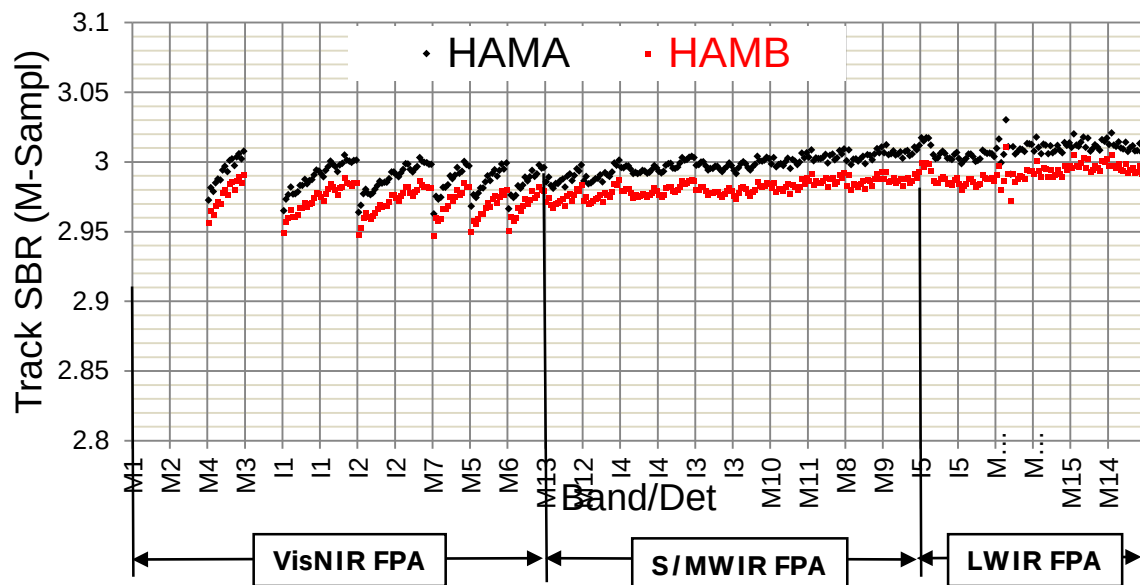


- On average, about 10% of M-band sample (20 arc sec) difference is found between HAM 1 and HAM 0 Pre J2 motor axis rework.
- Post Motor Axis rework, track direction SBR difference between two HAM side reduced to 0.01 M-band sample at both 0 and 23 degree scan angle.

J2 VIIRS focal length variation



- TV Hot Track SBR with -7° scan angle
- Slit spacing 3.002 M-samples for VisNIR FPA~ 0.017% longer EFL

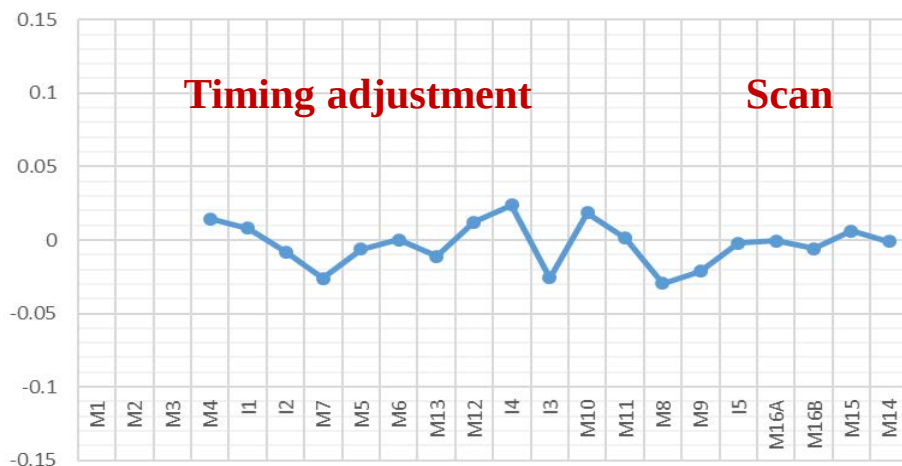
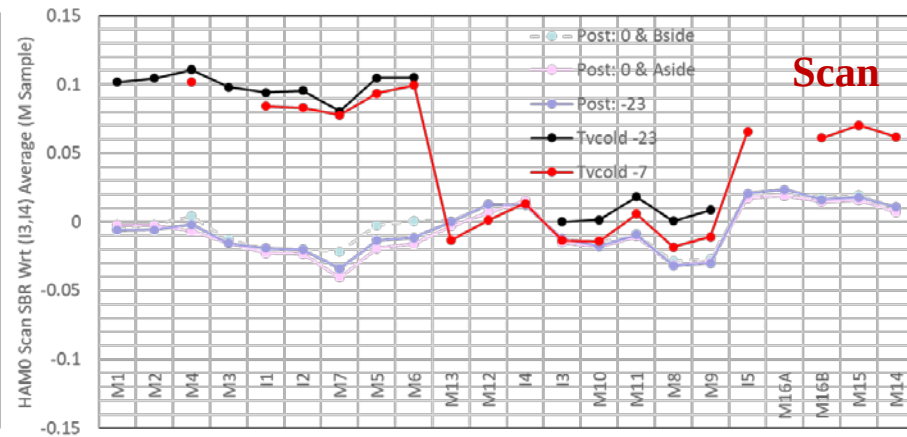
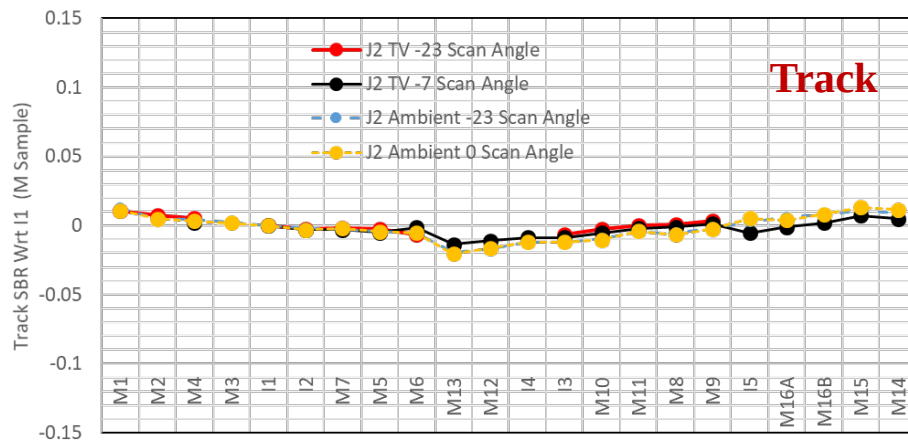


- TV Hot Track SBR with -7° scan angle
- Slit spacing 3.008 M-samples for S/MWIR and LWIR FPA~ 0.27% longer EFL



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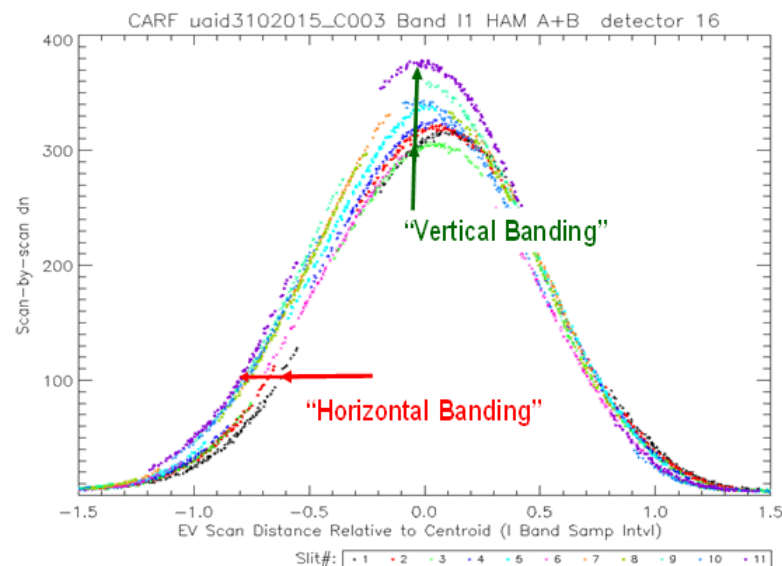
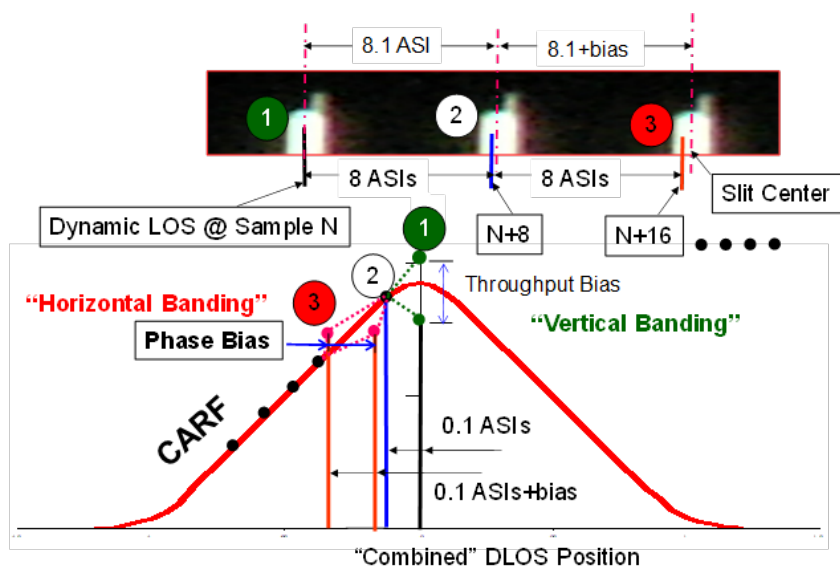
- J2 VIIRS track/scan direction SBR compared to band I1/I2 average.
- Track variations within each FPA is less than 0.02 M sample
- Using timing adjustments, scan SBR errors in VISNIR and LWIR reduced to within in +/-0.03 M sample



Outline

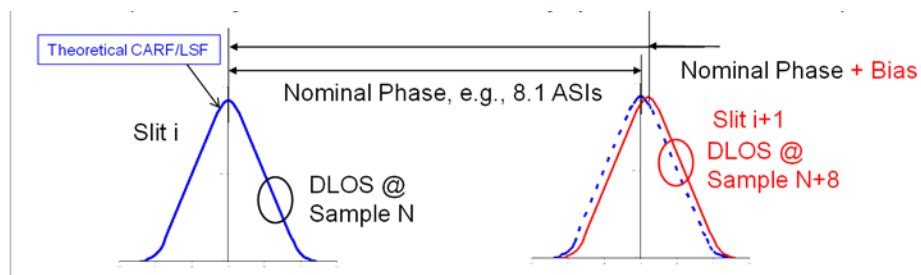
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JPSS2 Scan Dynamic LSF

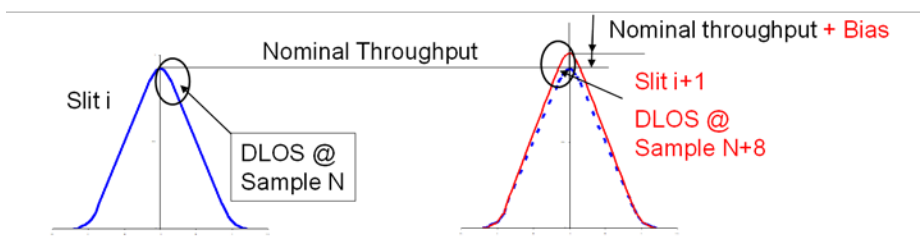


- The construction of LSF in scan direction is affected by time (RTA rotation angular speed)
- The variation of the spacing (phase) and opening (throughput) of the slits will have effects on the scan LSF construction

JPSS 2 VIIRS Scan Line Spread Function (LSF)

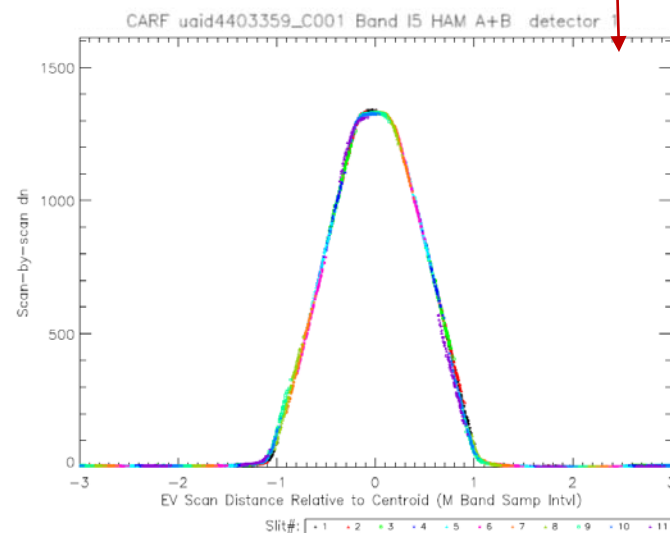
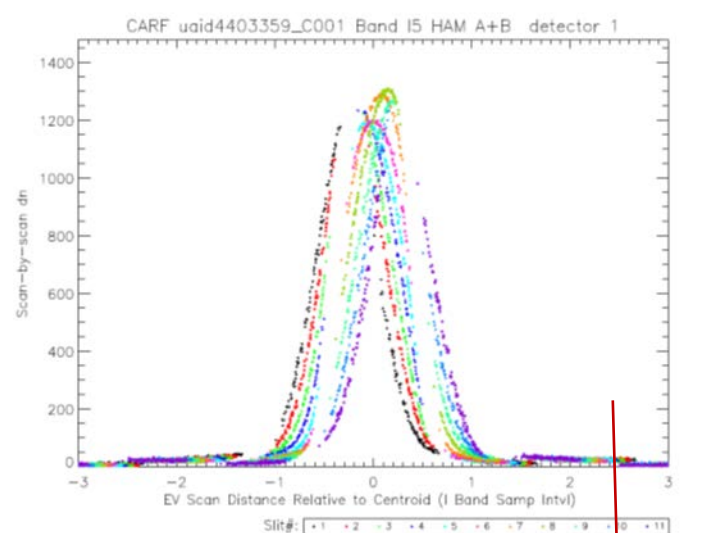


Phase Correction

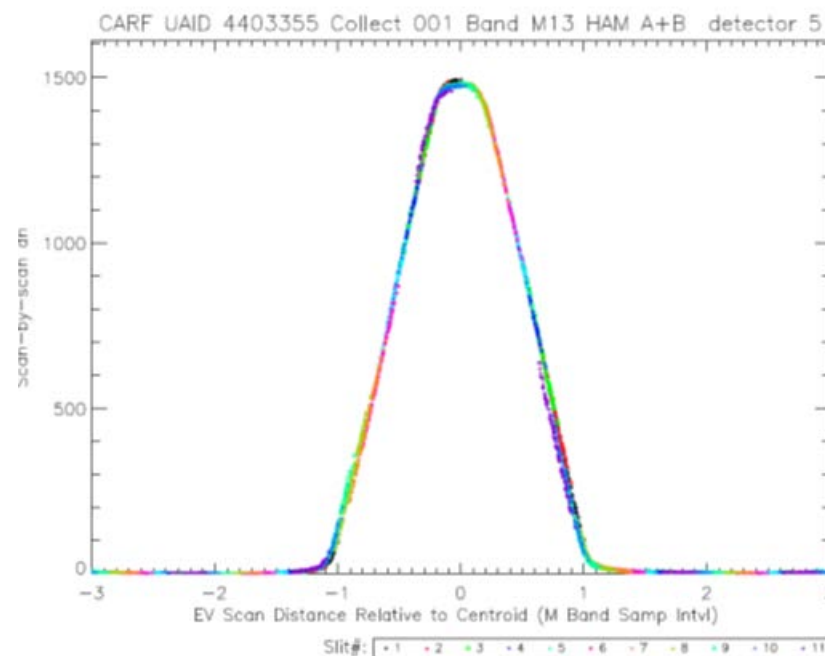
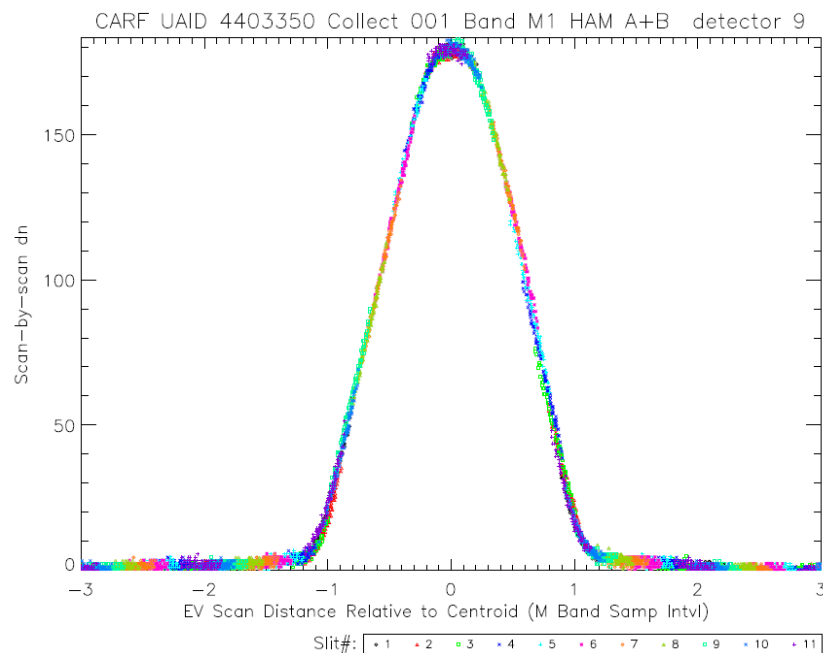


Throughput Correction

To properly handle the horizontal banding and vertical banding challenges, we developed a method to correct phase bias and throughput bias

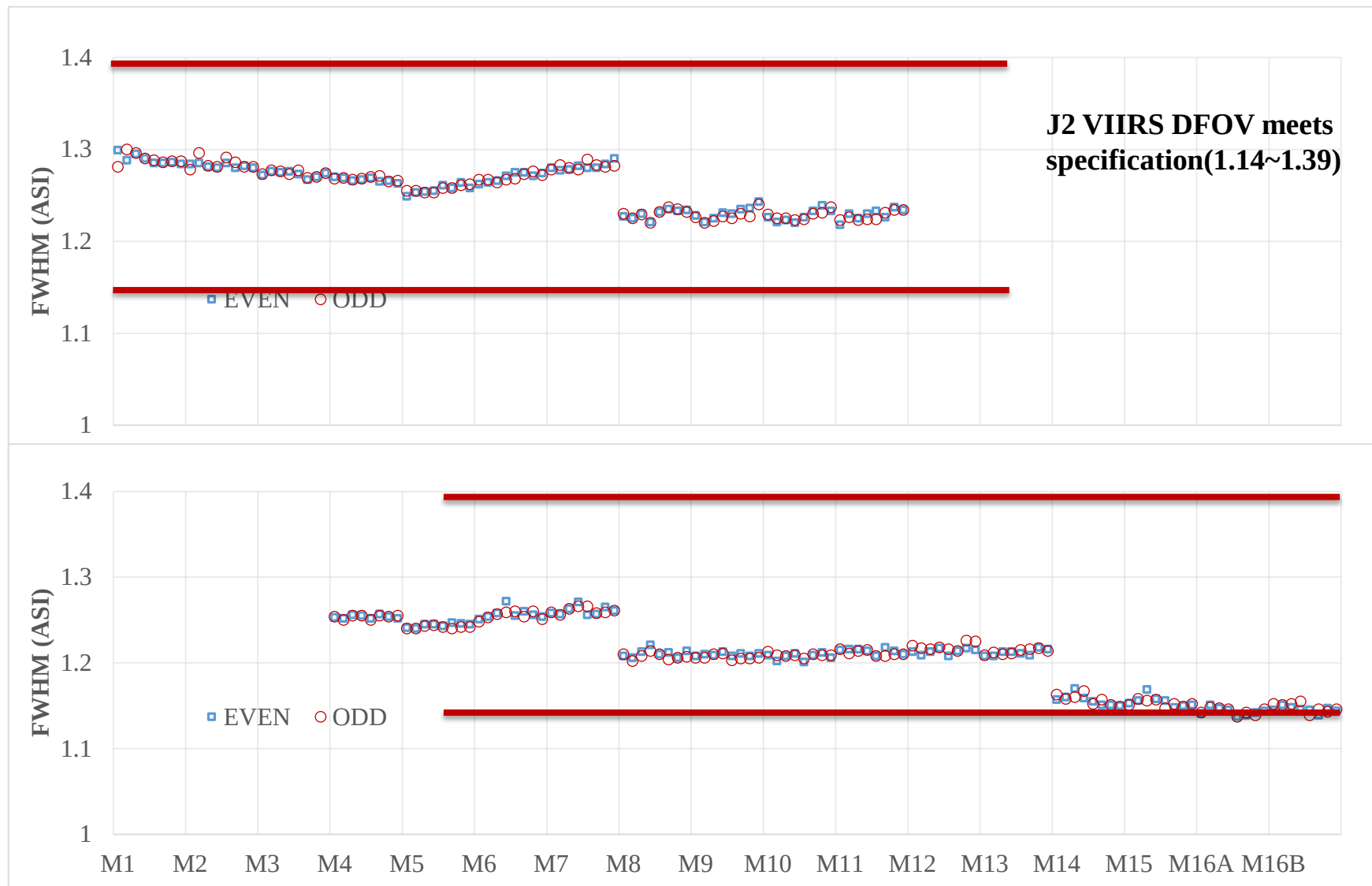


JPSS 2 VIIRS M band LSF



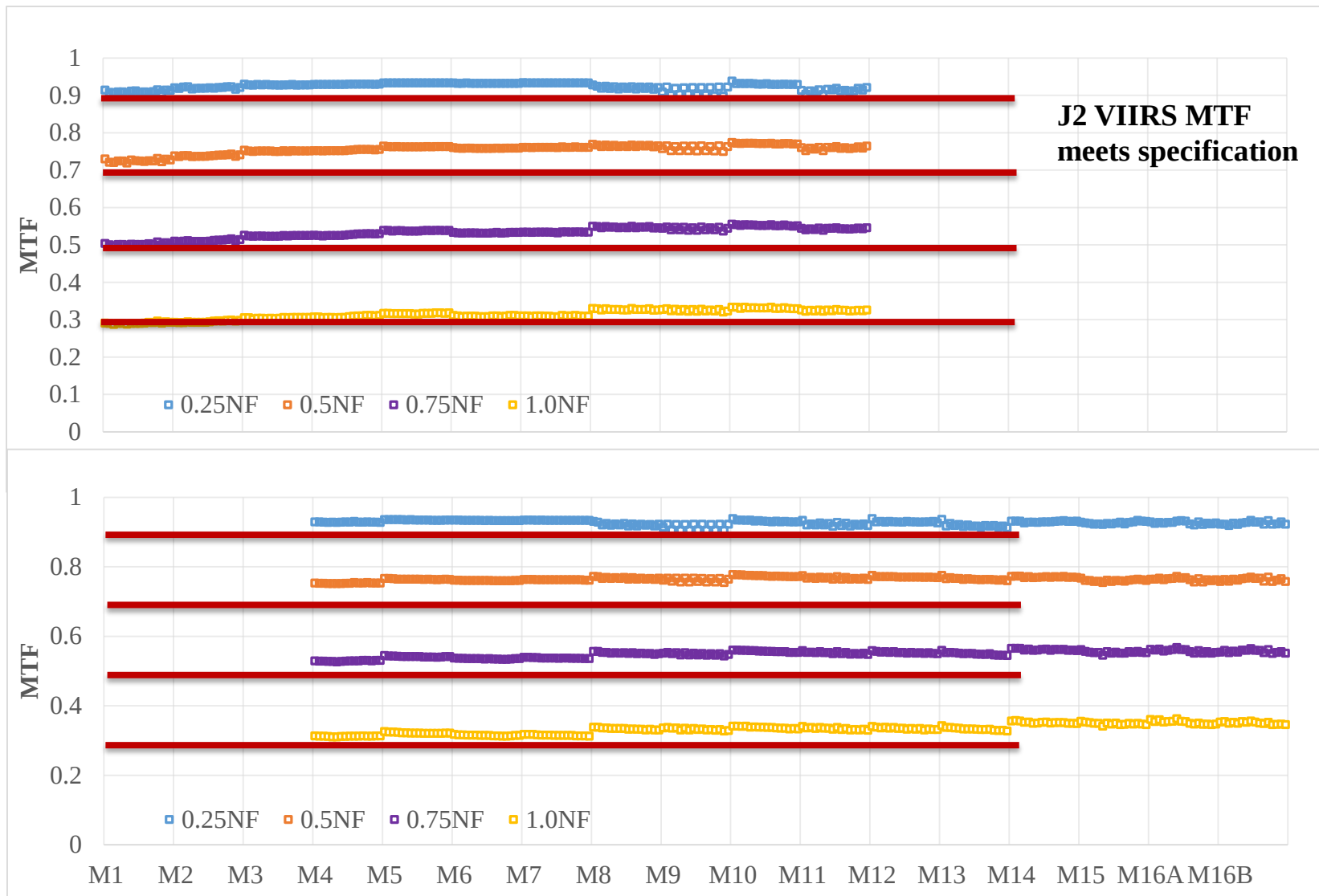


JPSS 2 VIIRS M band DFOV



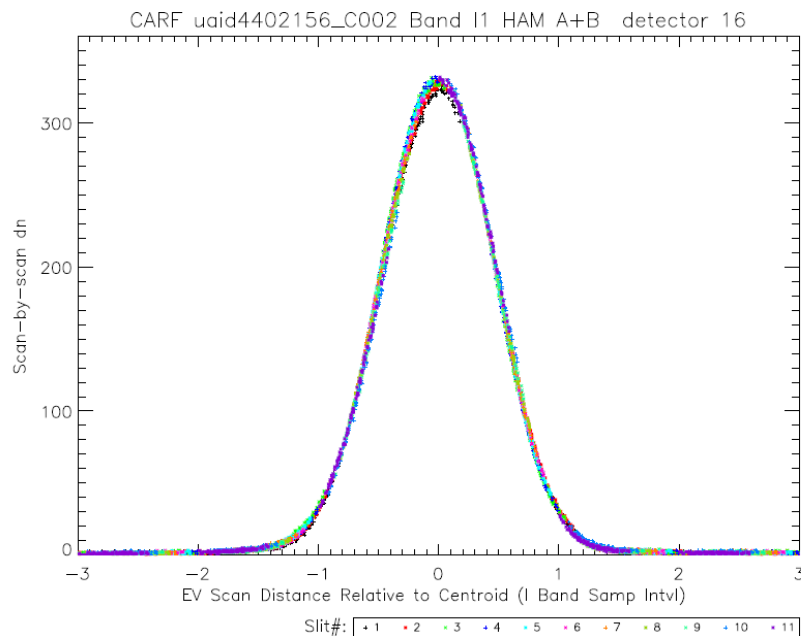


JPSS 2 VIIRS MTF Results

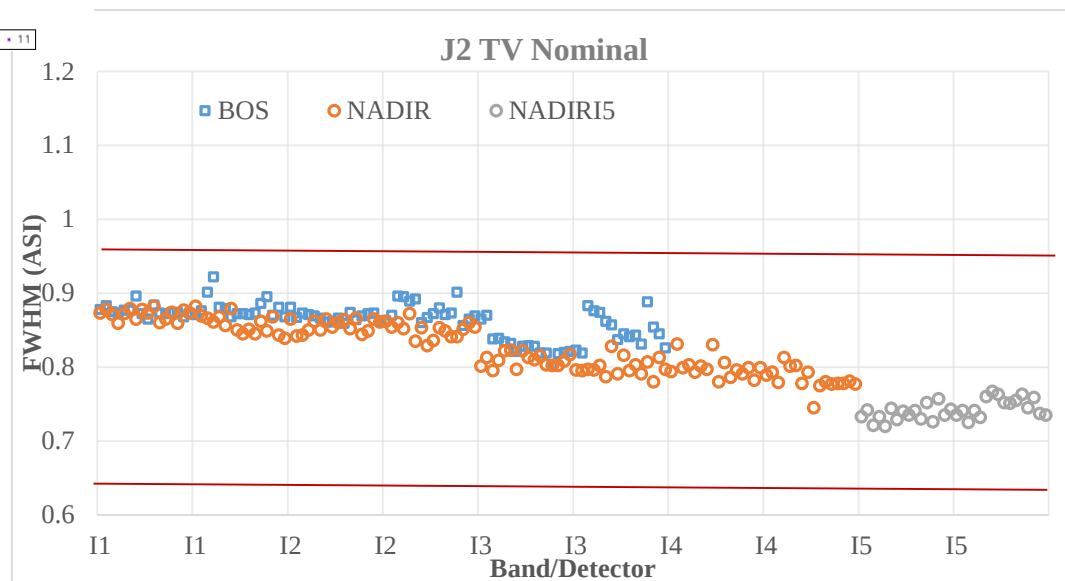




JPSS 2 VIIRS I band LSF and DFOV



**J2 VIIRS I band DFOV
meets specification**



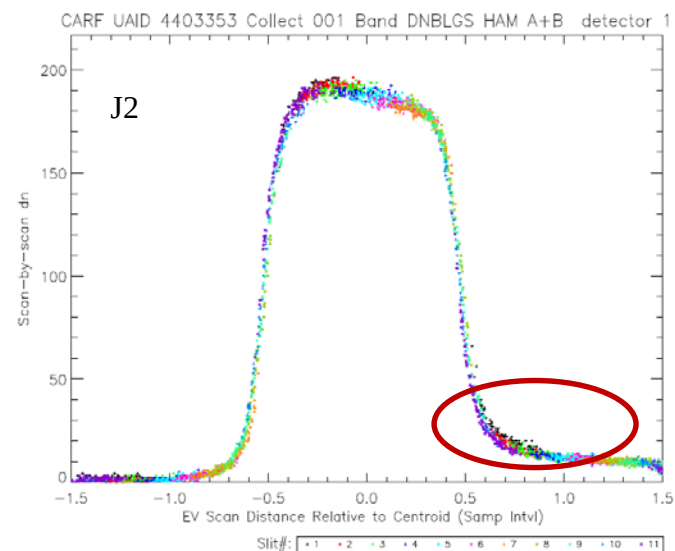
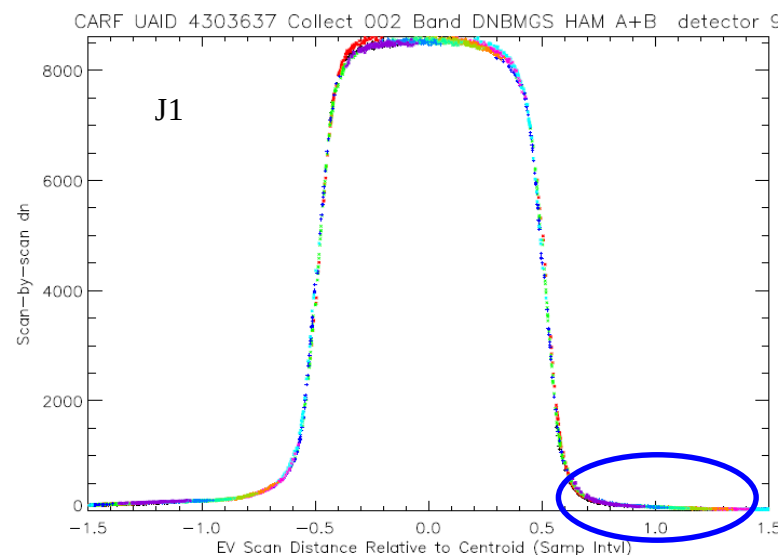
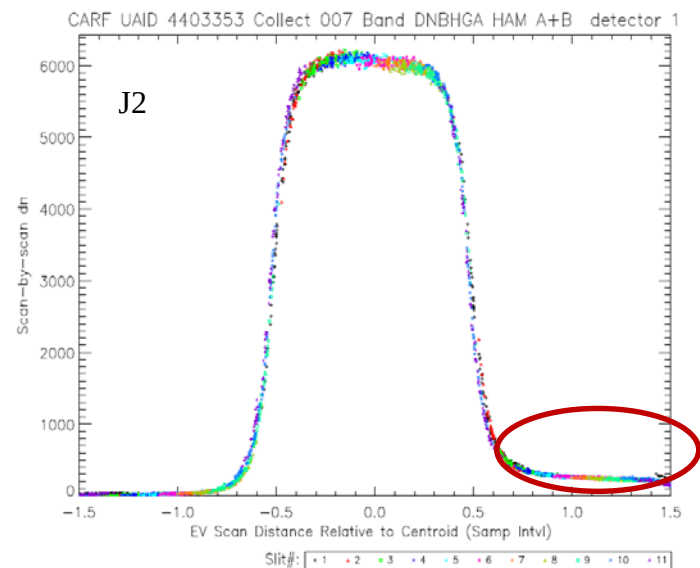
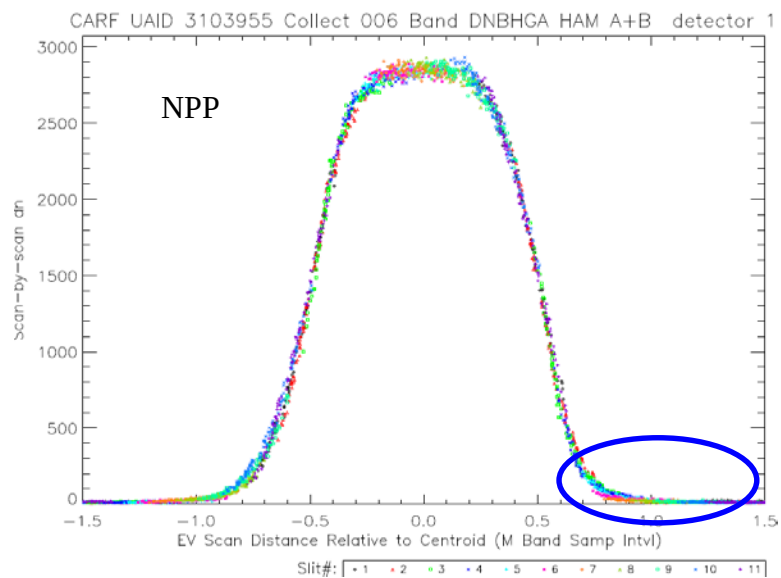


Outline

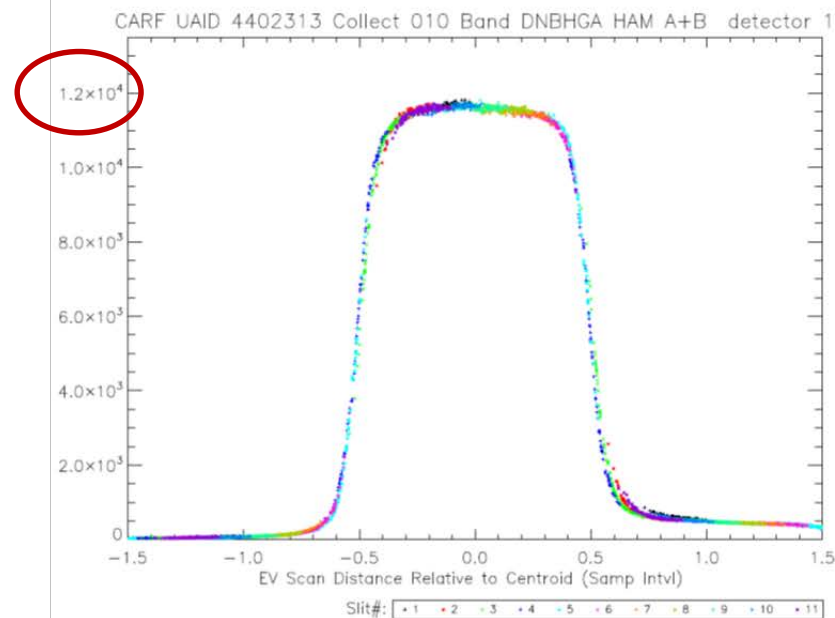
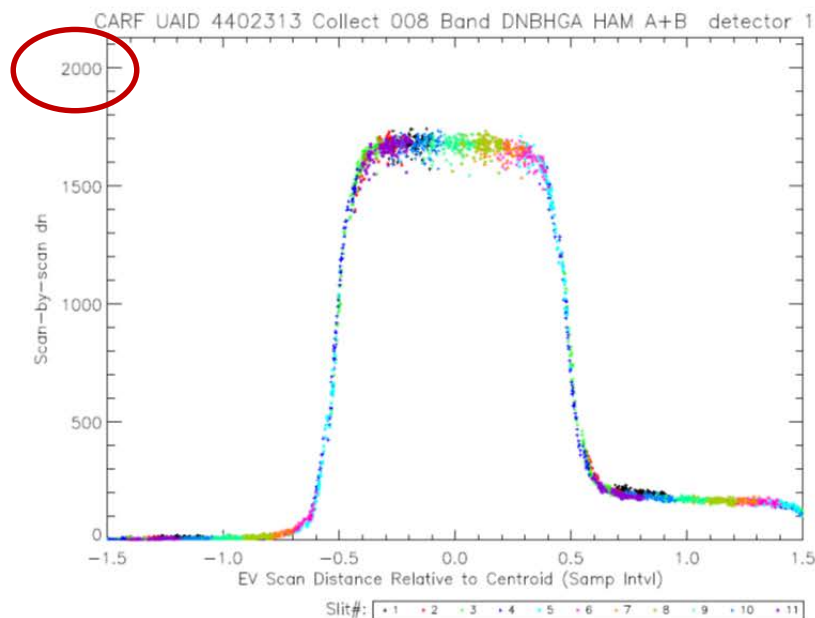
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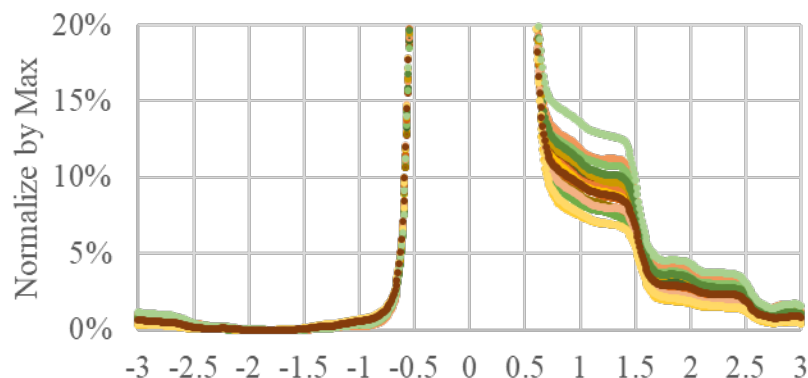
JPSS2 DNB LSF Anomaly



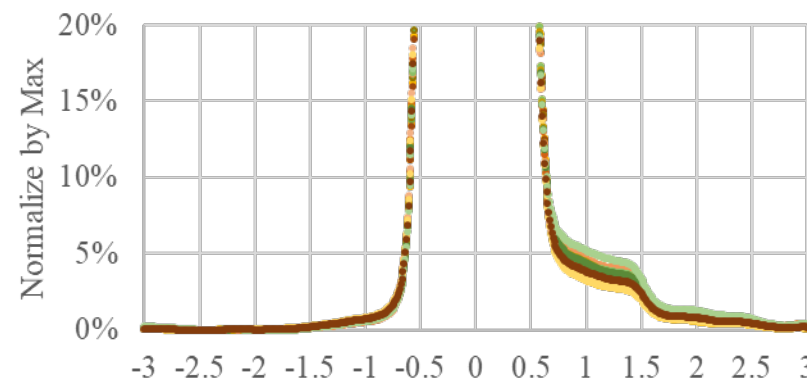
JPSS2 DNB LSF Anomaly vs DN Ranges



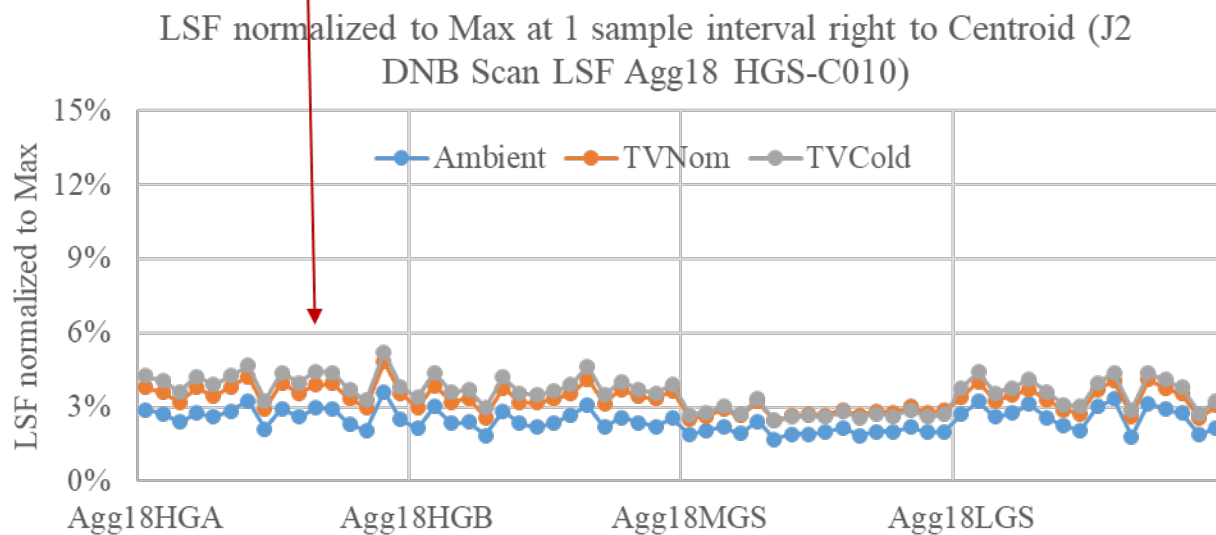
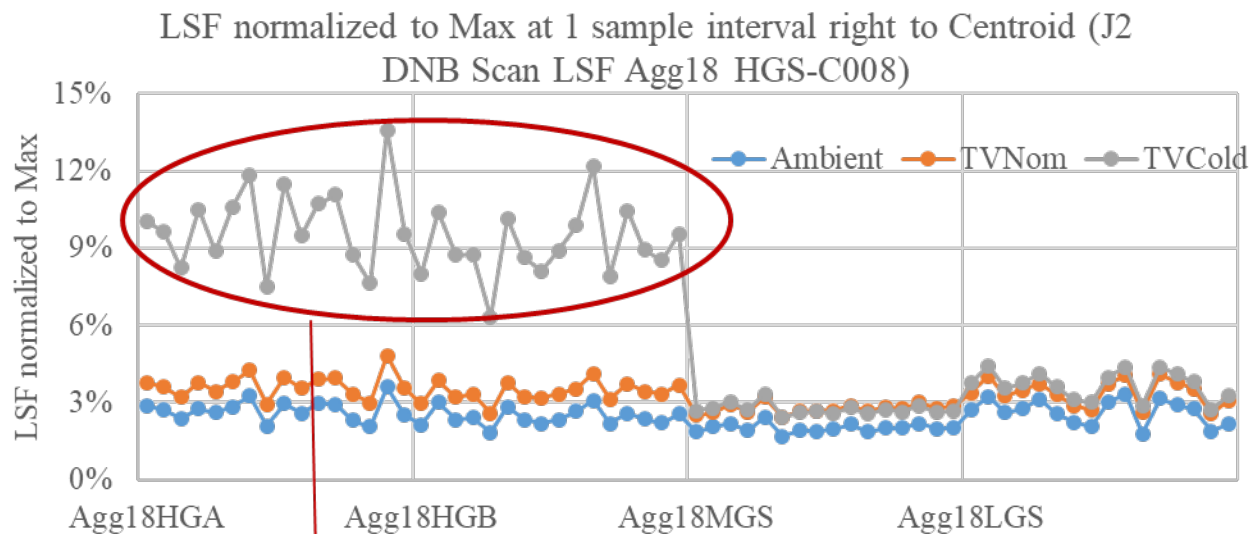
AGG18 HGA C8



AGG18 HGA C10

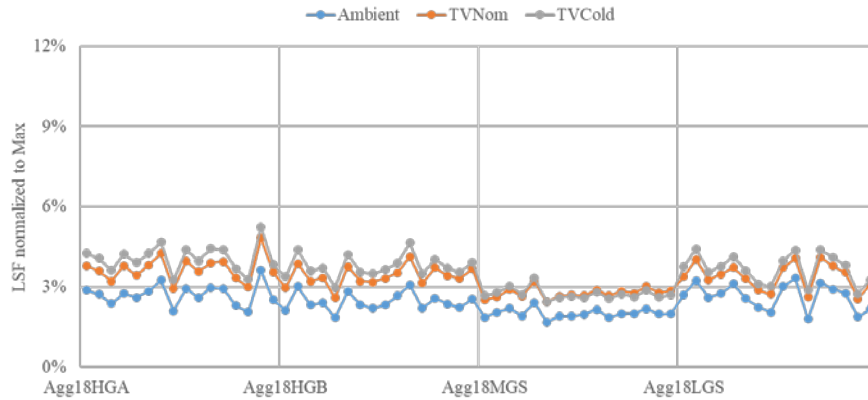


JPSS2 DNB LSF Anomaly vs DN Ranges

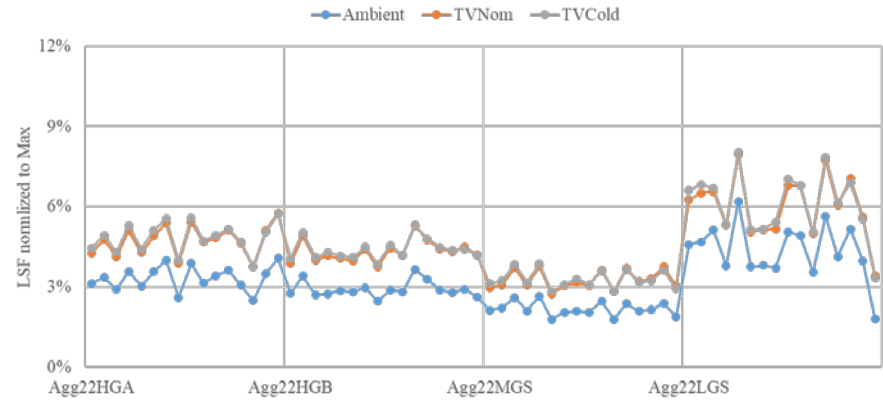


JPSS2 DNB LSF Anomaly vs Agg Mode/Gain

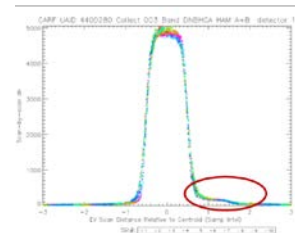
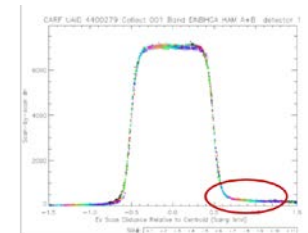
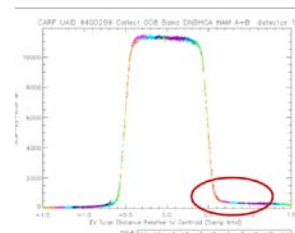
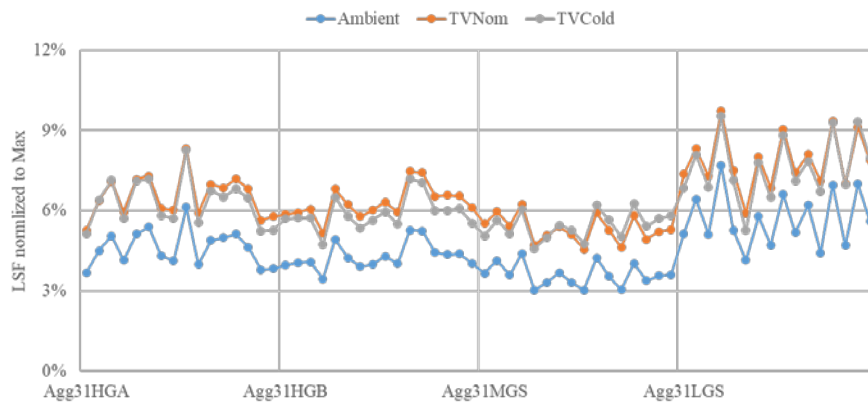
LSF normalized to Max at 1 sample interval right to Centroid (J2 DNB Scan LSF Agg18)



LSF normalized to Max at 1 sample interval right to Centroid (J2 DNB Scan LSF Agg22)



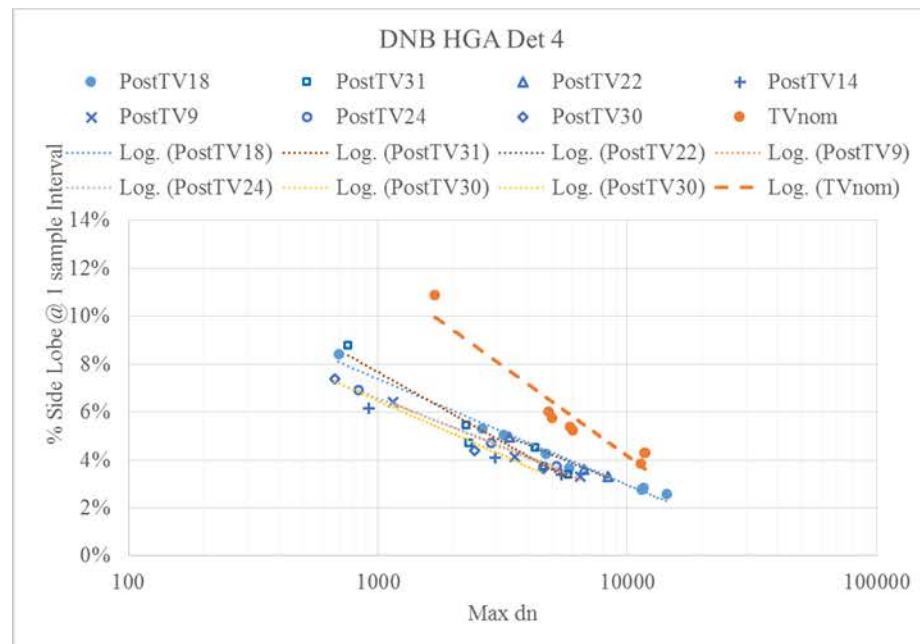
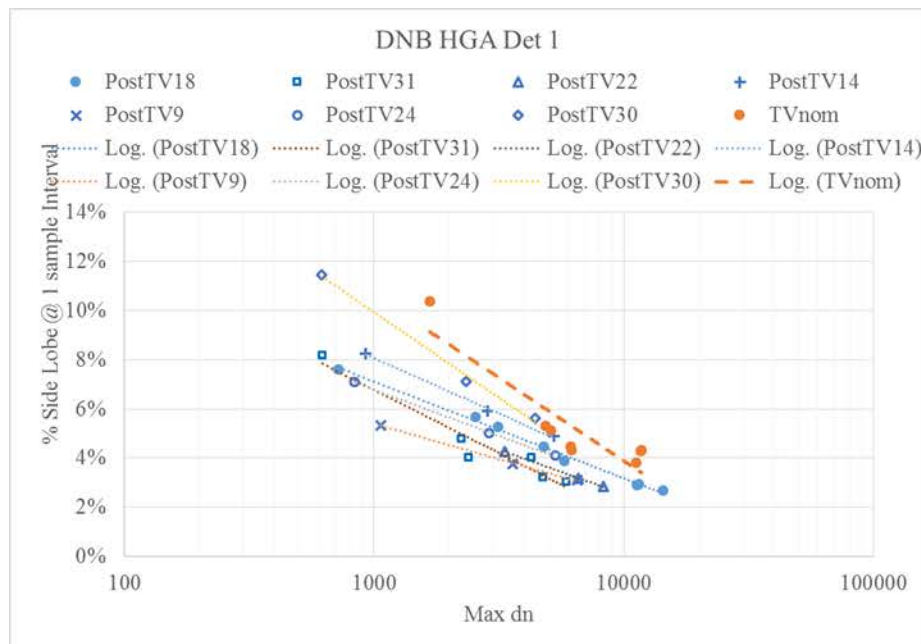
LSF normalized to Max at 1 sample interval right to Centroid (J2 DNB Scan LSF Agg31)



JPSS2 DNB LSF Anomaly vs Detectors

Logarithm fit between Max dn and side lobe @ 1 sample interval

Intercept indicate the maximum % Side lobe when max dn=1



$$SideLobe = Slope \times \ln(maxdn) + Intercept$$



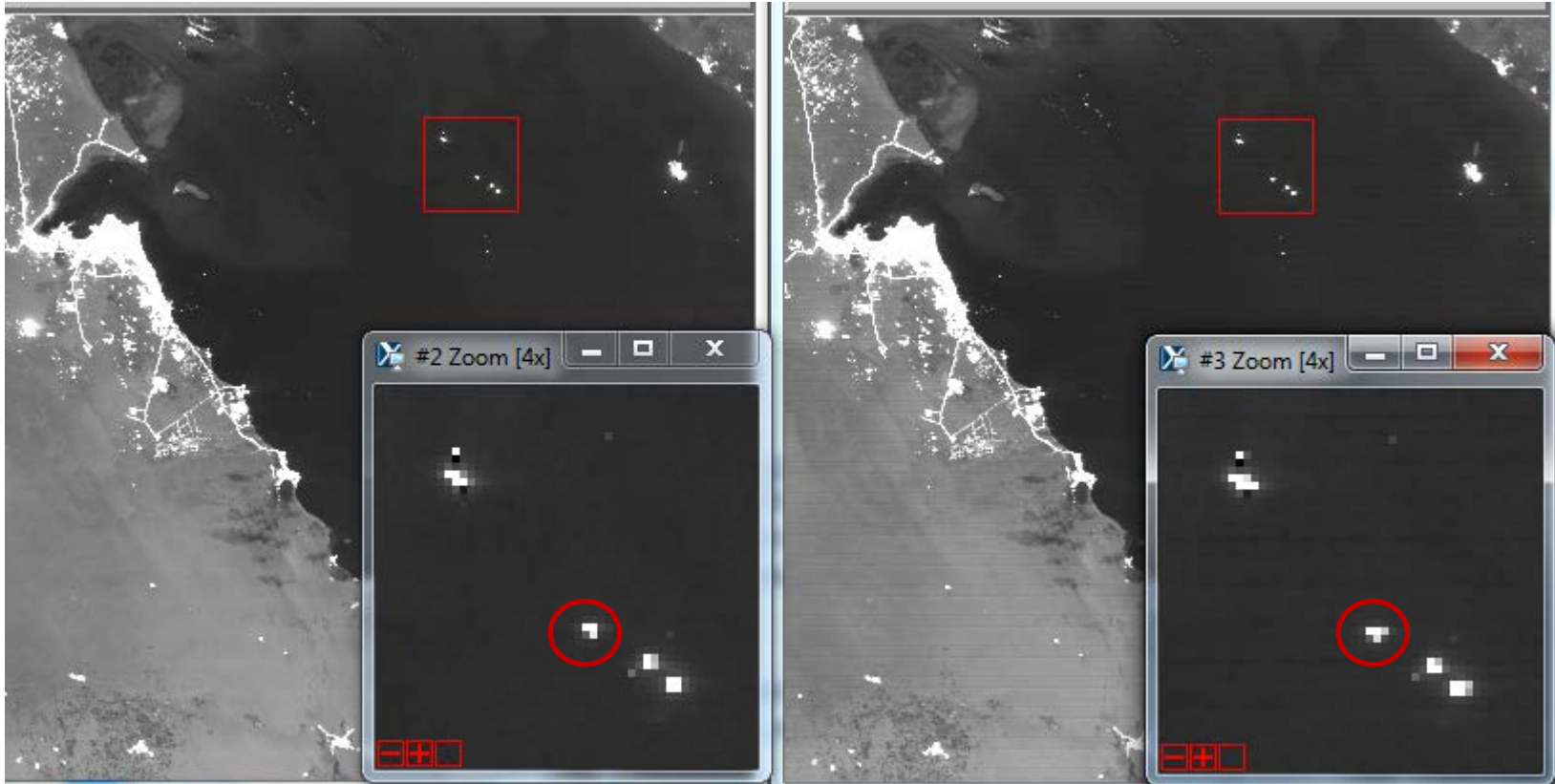
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Simulated DNB night radiance with side lobe effect from previous pixel

NPP DNB night radiance

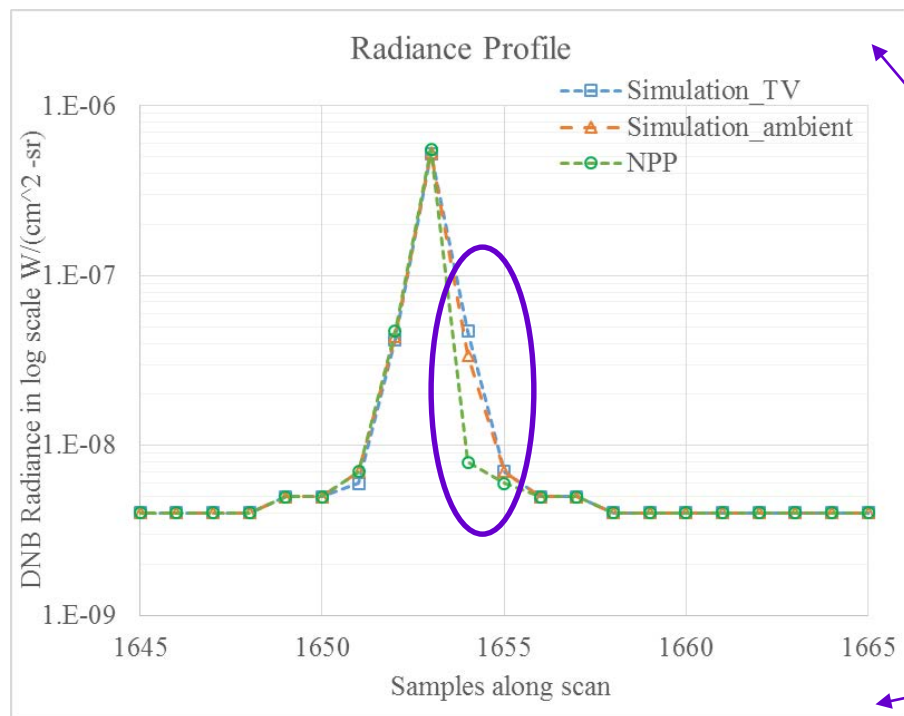
Simulated DNB night radiance with side lobe



$$R'[i,j] = R[i,j] - \left(Slope \times \ln \left(\frac{R[i,j]}{rad2dn} \right) + Intercept \right) \times R[i,j] \\ + \left(Slope \times \ln \left(\frac{R[i,j-1]}{rad2dn} \right) + Intercept \right) \times R[i,j-1]$$

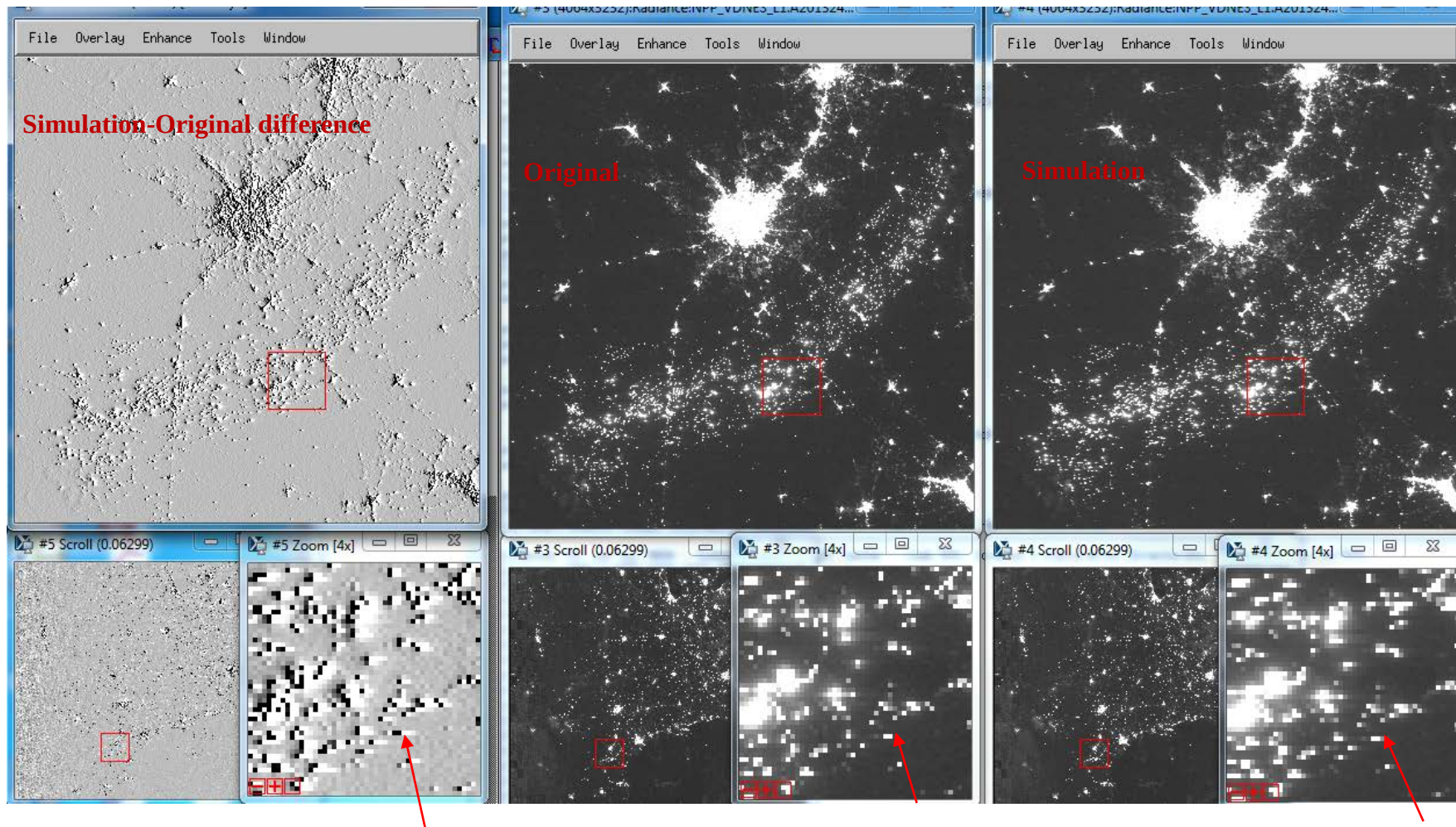
Examples (2018002.2212)

R: Simulated DNB night radiance TV
 G: Simulated DNB night radiance Ambient
 B: NPP DNB night radiance



Red color indicates the effects of side lobe

J2VIIRS DNB simulation with cumulative effect



2013241.0754

$$R'[i,j] = R[i,j] - \left(Slope \times \ln \left(\frac{R[i,j]}{rad2dn} \right) + Intercept \right) \times R[i,j] \\ + \left(Slope \times \ln \left(\frac{R'[i,j-1]}{rad2dn} \right) + Intercept \right) \times R[i,j-1]$$



Conclusion

- In general, JPSS-2 VIIRS' prelaunch geometric performance is **good**.
- Axis rework reduced JPSS-2 VIIRS half-angle mirror (HAM) side difference from **10%** (about 20 arcsec) mis-registration of an M-band sample to **1%**
- Using timing adjustments, the initial band-to-band co-registration errors between VisNIR and LWIR bands in the scan direction had been **corrected to within +/-0.03 M sample**.
- M-band and I-band DFOV/MTF **meet** specification
- Electronics anomaly caused Day Night Band (DNB) scan-direction Line Spread Function (LSF) anomaly.
 - Incorrect voltage setting causes the charge in the current sample to remain behind in the transfer gate and be deferred into the next sample in the scan direction
 - Impact is **mild**