JPSS-2 VIIRS
Prelaunch Geometric Performance and Characterization

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June 17 2019

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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

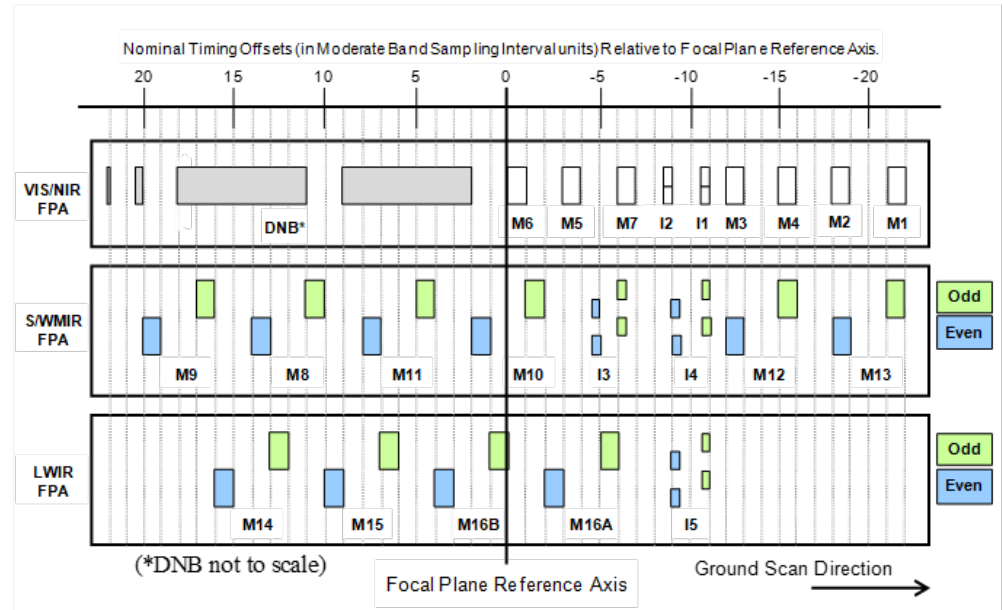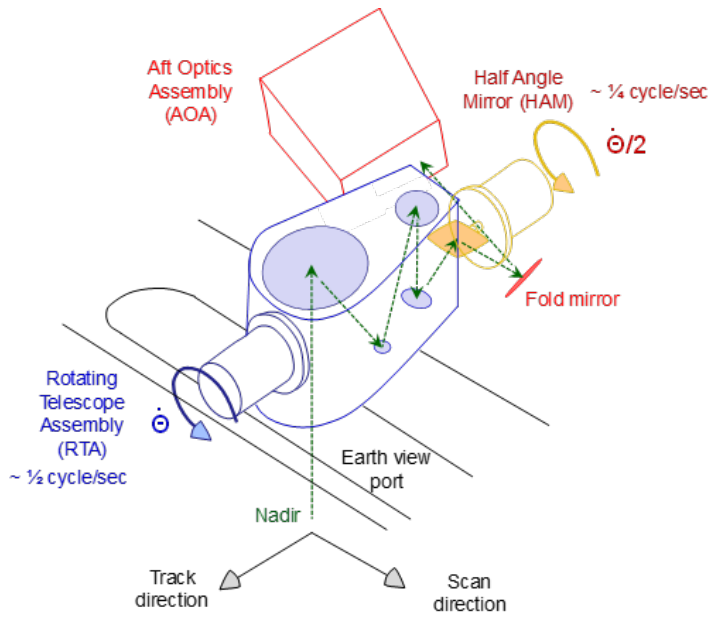date acquired
December 13, 2017

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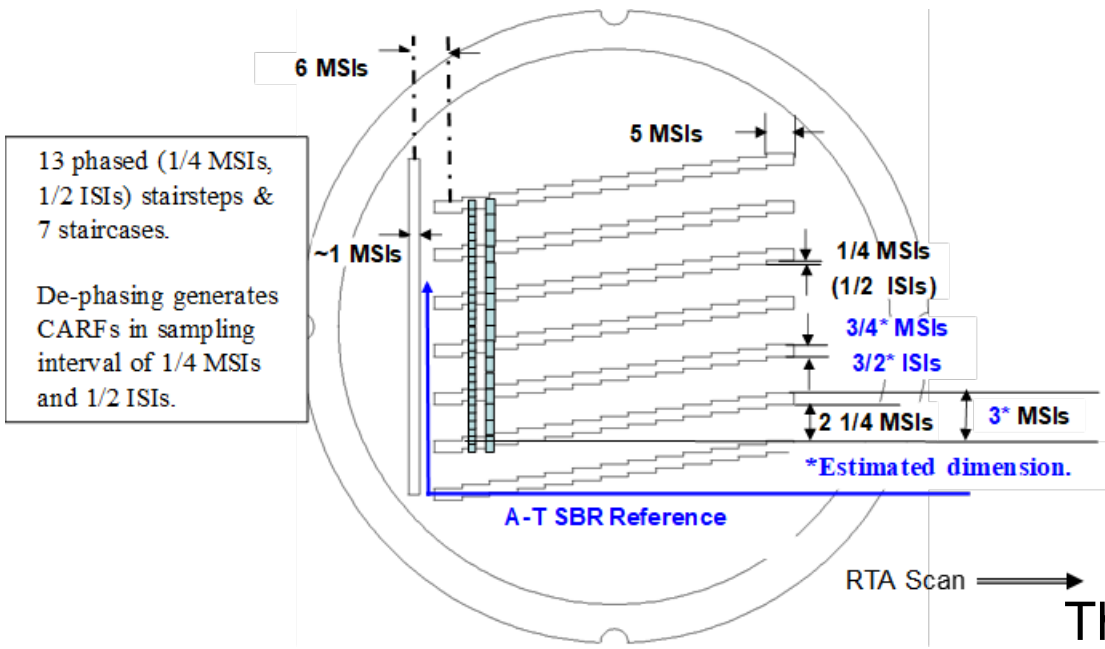
Visible and near infrared (VisNIR) focal plane assembly (FPA)

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

  - DN Range

  - Aggregation mode and Gains

  - Detectors

- DNB simulations with LSF anomaly use NPP data

13 phased (1/4 MSIs, 1/2 ISIs) stairsteps & 7 staircases.

De-phasing generates CARFs in sampling interval of 1/4 MSIs and 1/2 ISIs.

6 MSIs

5 MSIs

~1 MSIs

1/4 MSIs (1/2 ISIs)

3/4* MSIs
3/2* ISIs

2 1/4 MSIs   3* MSIs

*Estimated dimension.

A-T SBR Reference

RTA Scan →

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
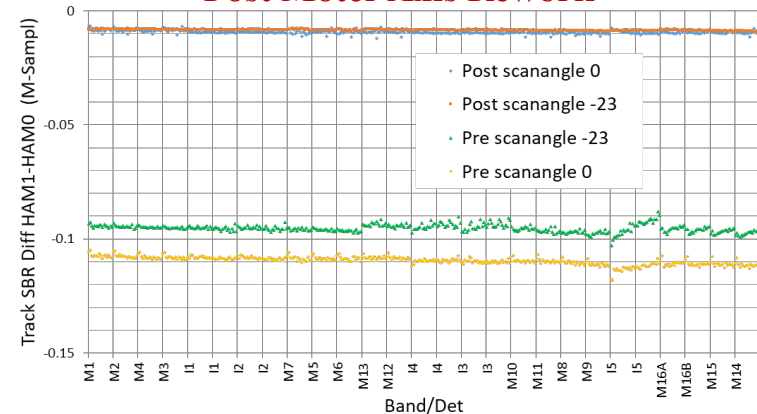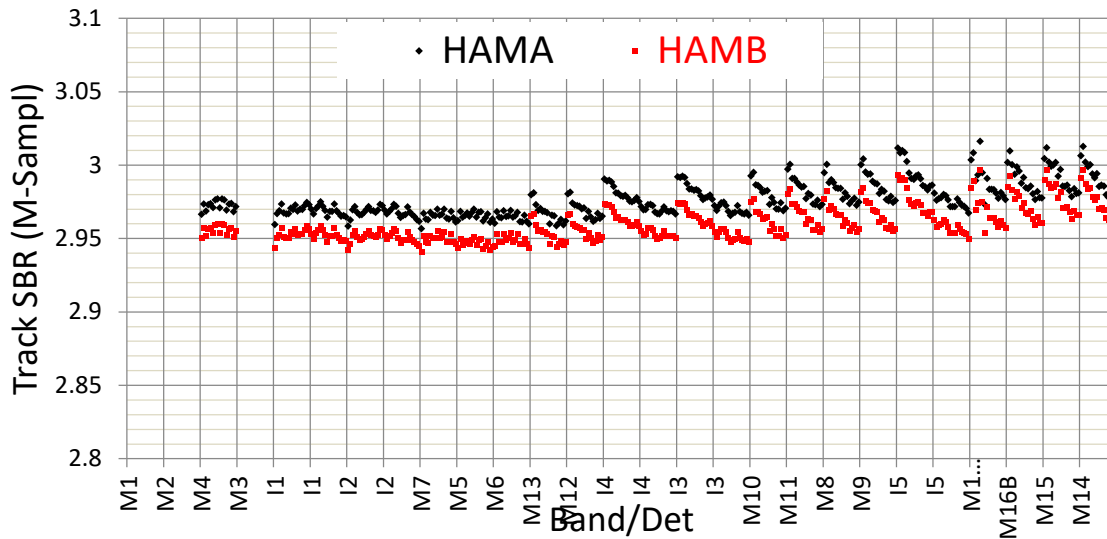
JPSS2 Spectral Band Registration

Pre Moter Axis Rework
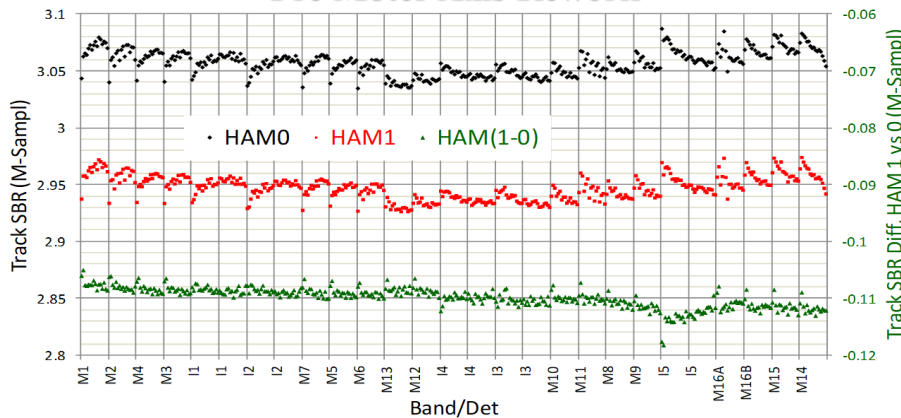
Post Moter Axis Rework

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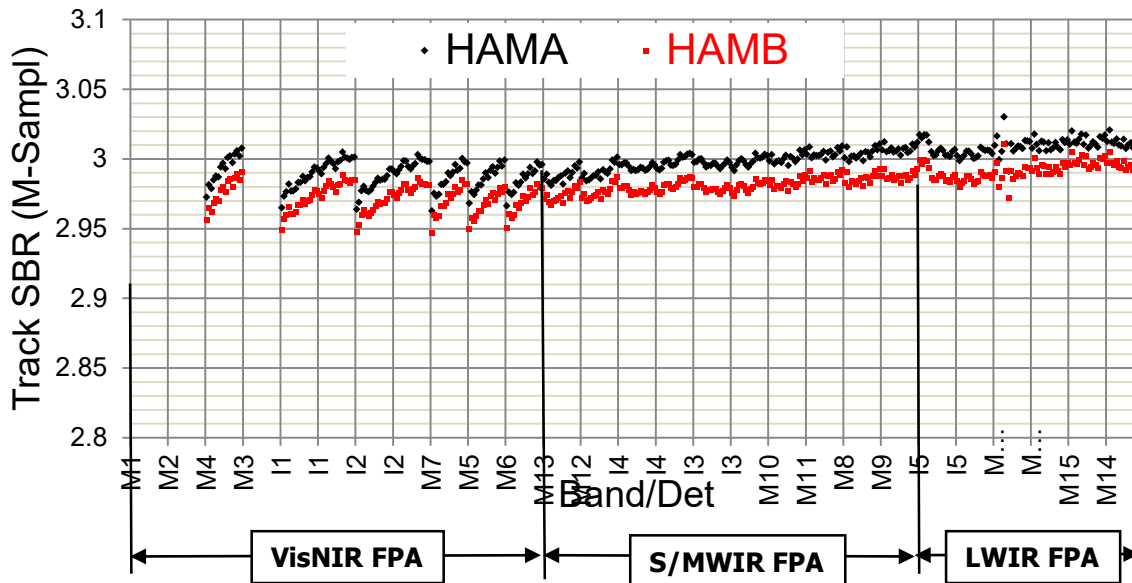
- TV Hot Track SBR with -7° scan angle
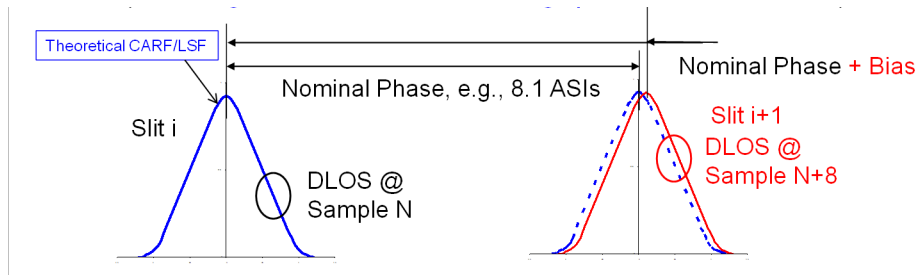- Slit spacing 3.008 M-samples for S/MWIR and LWIR FPA~ 0.27% longer EFL

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# JPSS2 Band-to-Band co-Registration (BBR)
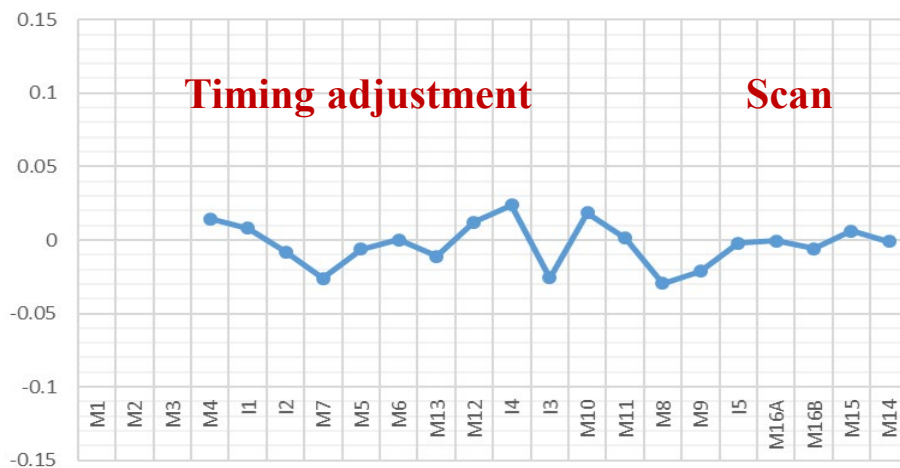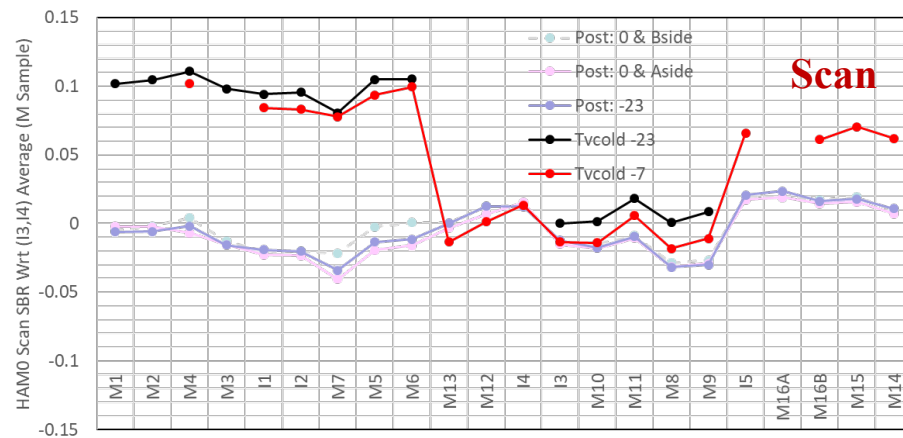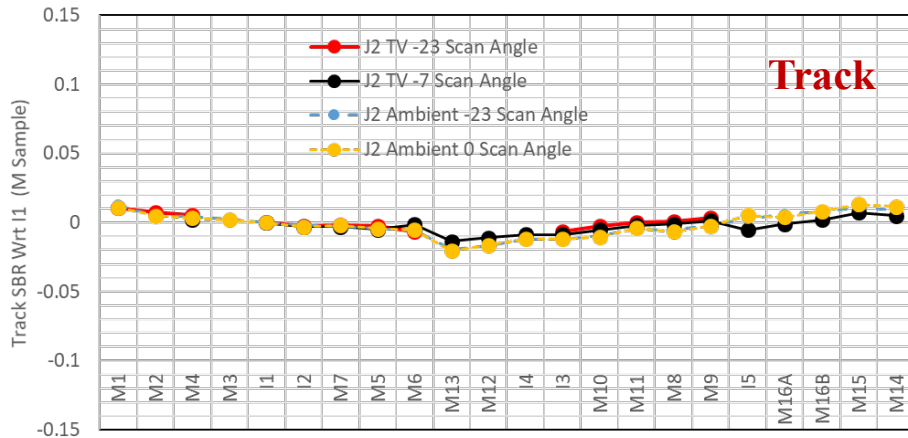
- **J2 VIIRS track/scan direction SBR compared to band I1/I2 average.**
- **Track variations within each FPA is less than 0.02 M sample**
- **Using timing adjustments, scan SBR errors in VISNIR and LWIR reduced to within in +/-0.03 M sample**

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JPSS2 Scan Dynamic LSF
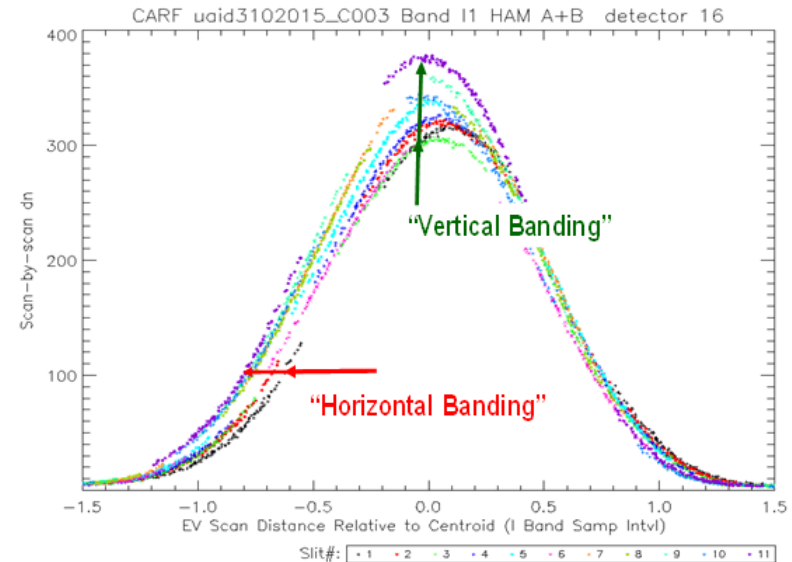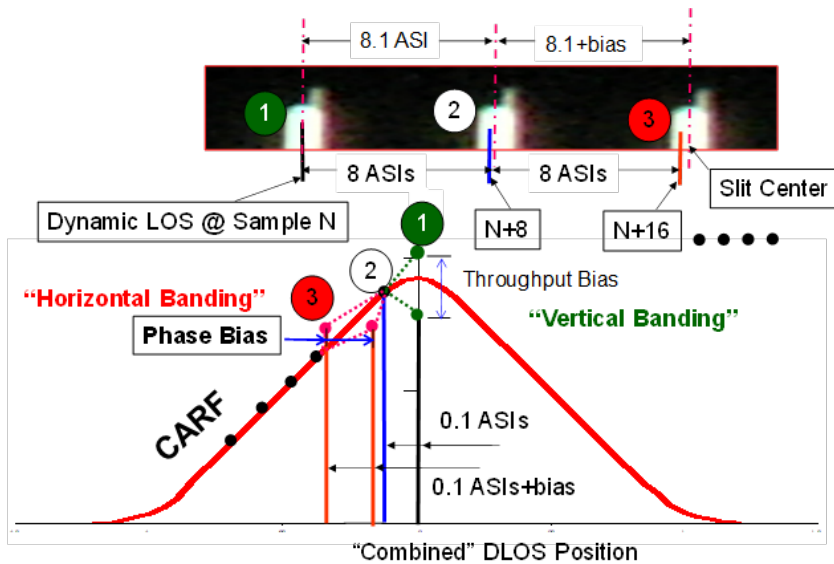
- The construction of LSF in scan direction is affected by time (RTA rotation angular speed)
- The variation of the spacing (phase) and opening (throughput) of the slits will have effects on the scan LSF construction

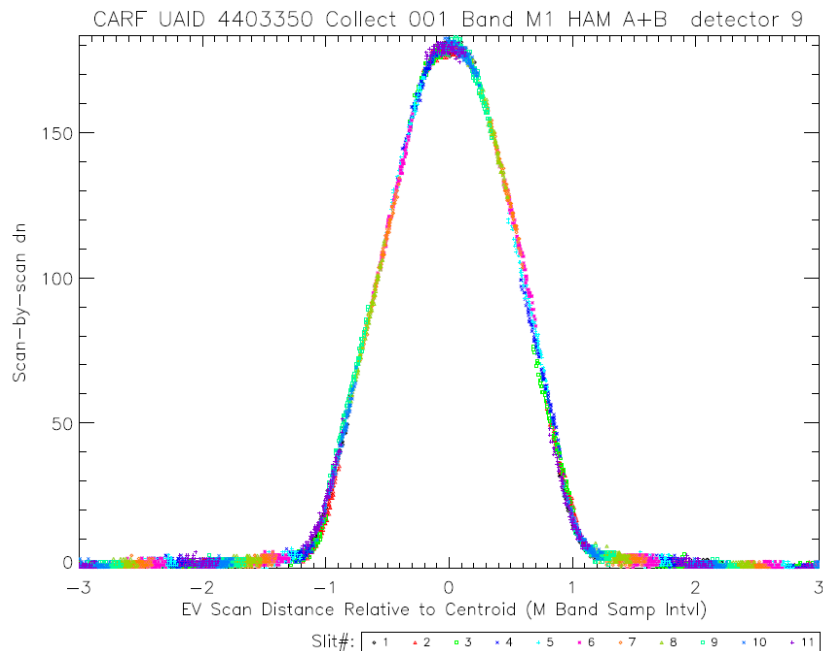# JPSS 2 VIIRS Scan Line Spread Function (LSF)

Phase Correction
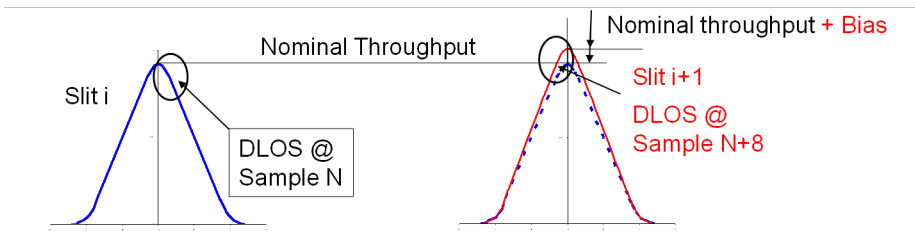
Throughput Correction

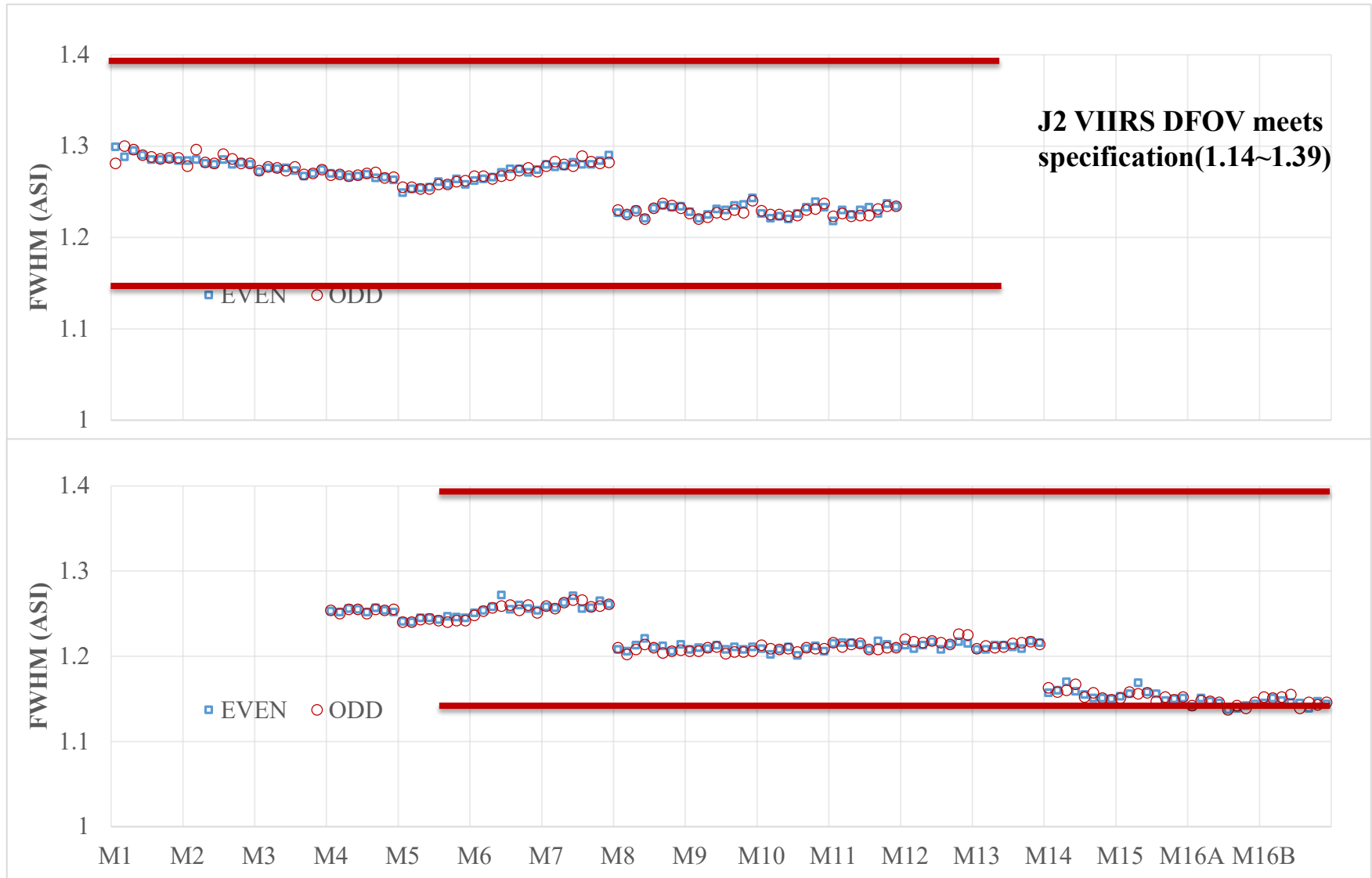To properly handle the horizontal banding and vertical banding challenges, we developed a method to correct phase bias and throughput bias
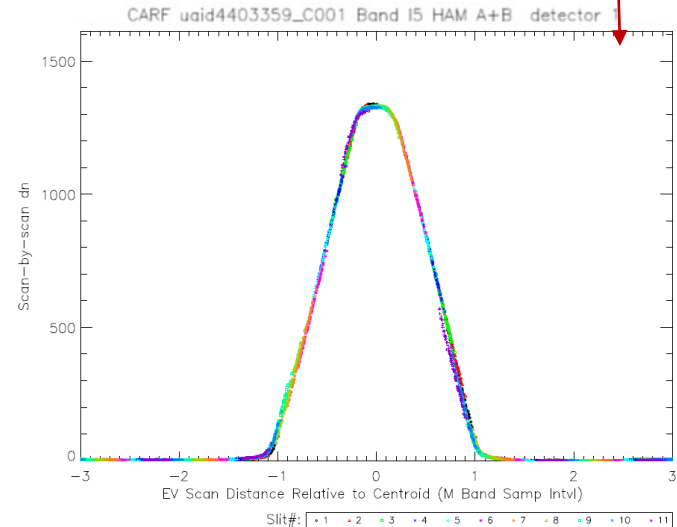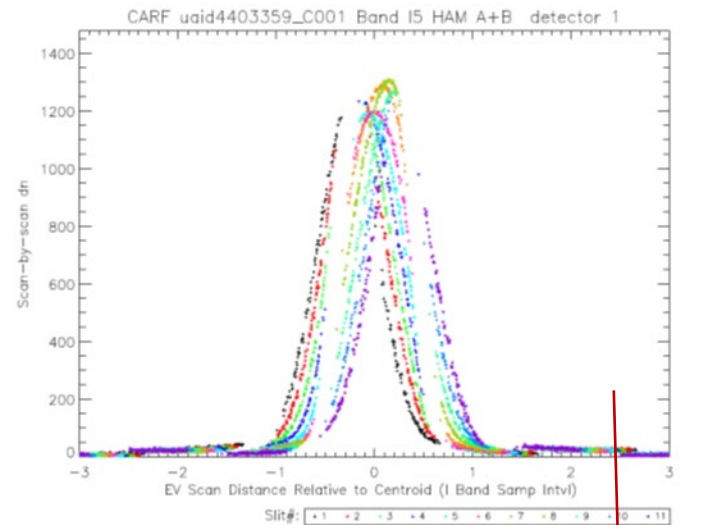
JPSS 2 VIIRS M band LSF
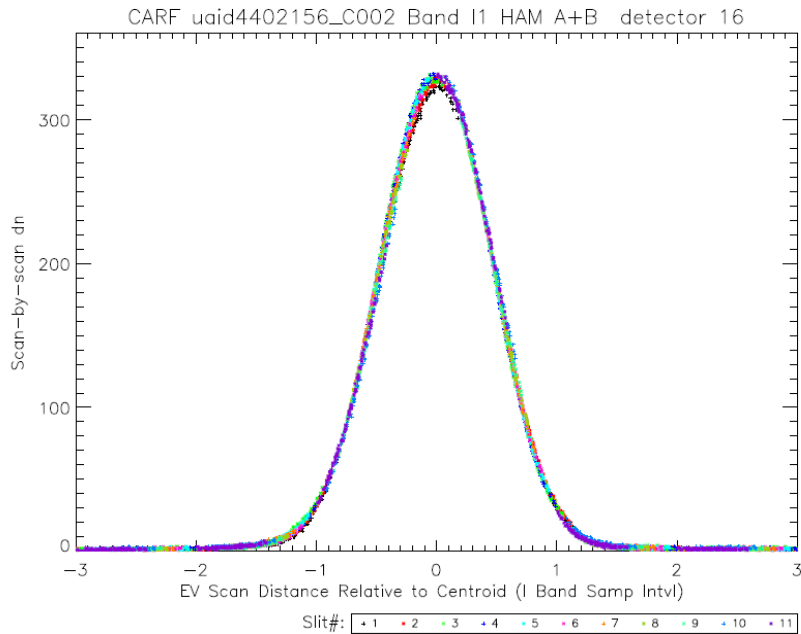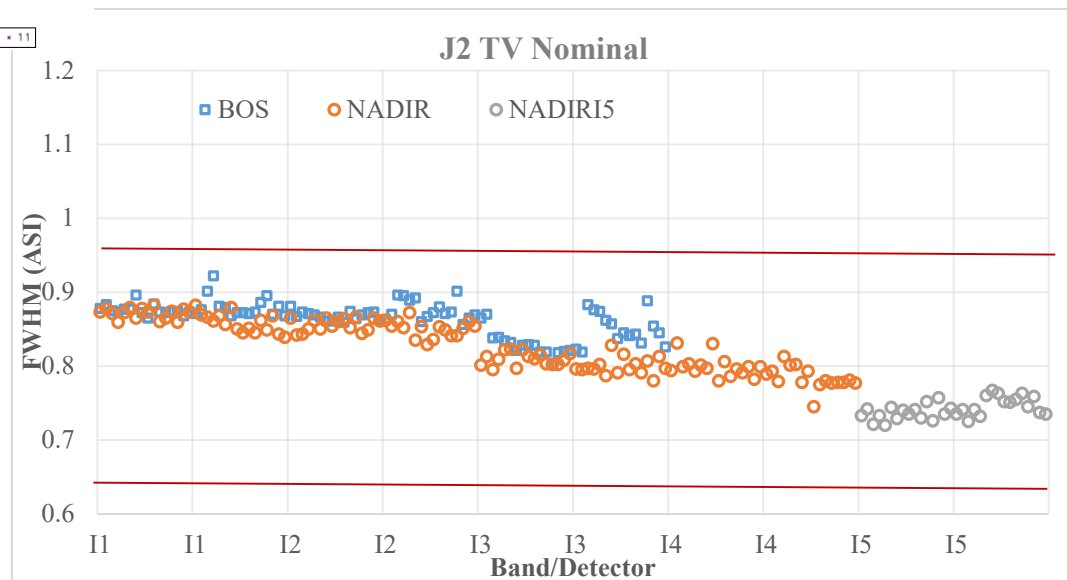
JPSS 2 VIIRS M band DFOV
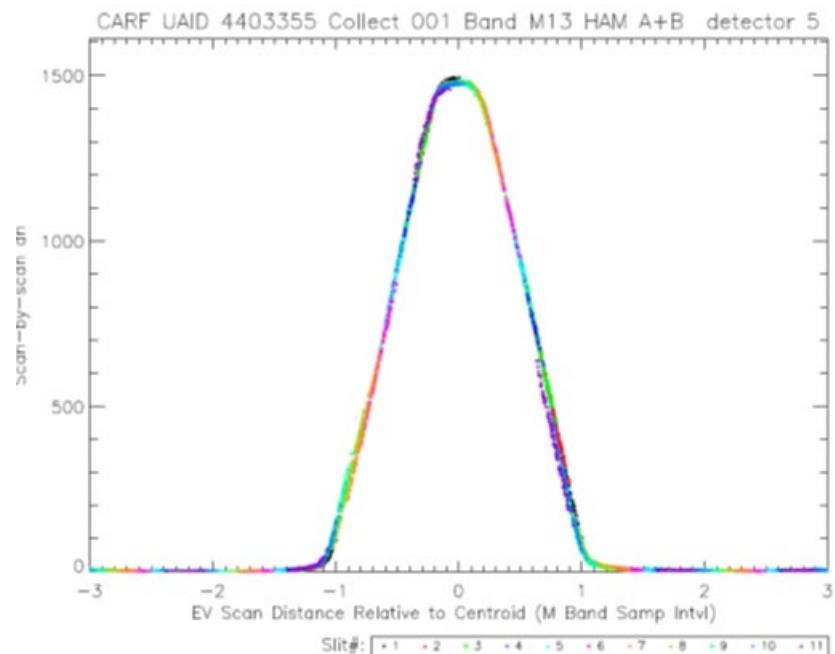
J2 VIIRS DFOV meets specification(1.14~1.39)

JPSS 2 VIIRS MTF Results

J2 VIIRS MTF
meets specification
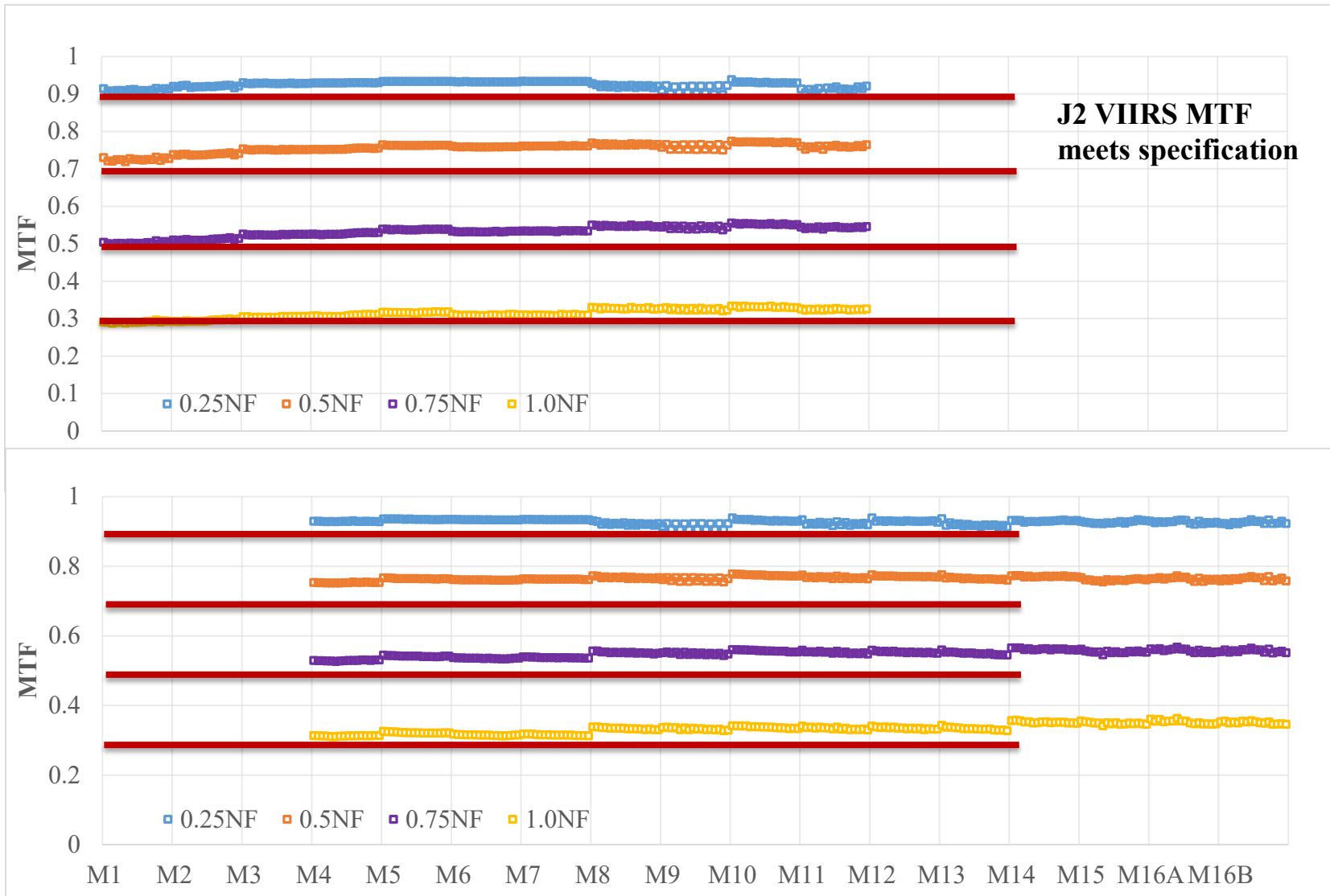
JPSS 2 VIIRS I band LSF and DFOV

CARF uaid4402156_C002 Band I1 HAM A+B detector 16

J2 VIIRS I band DFOV meets specification

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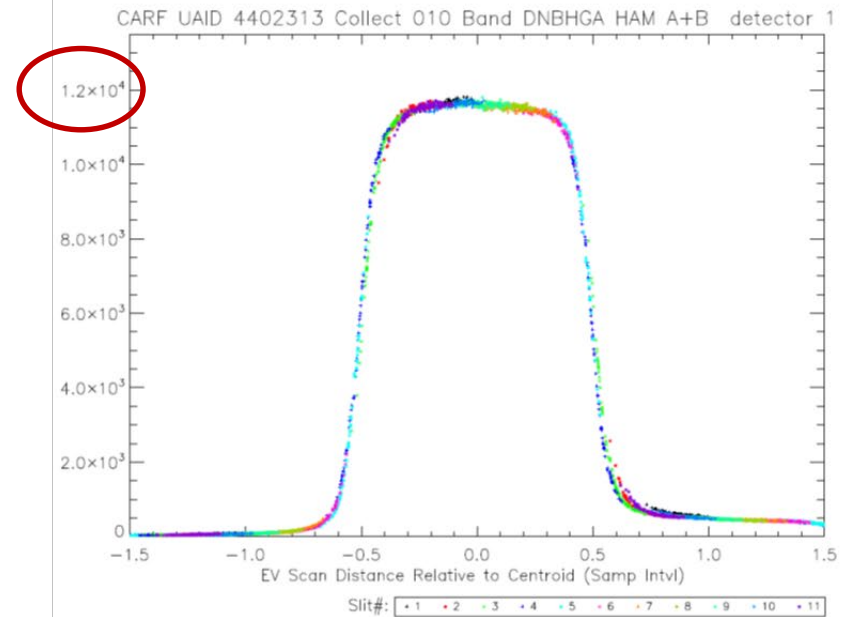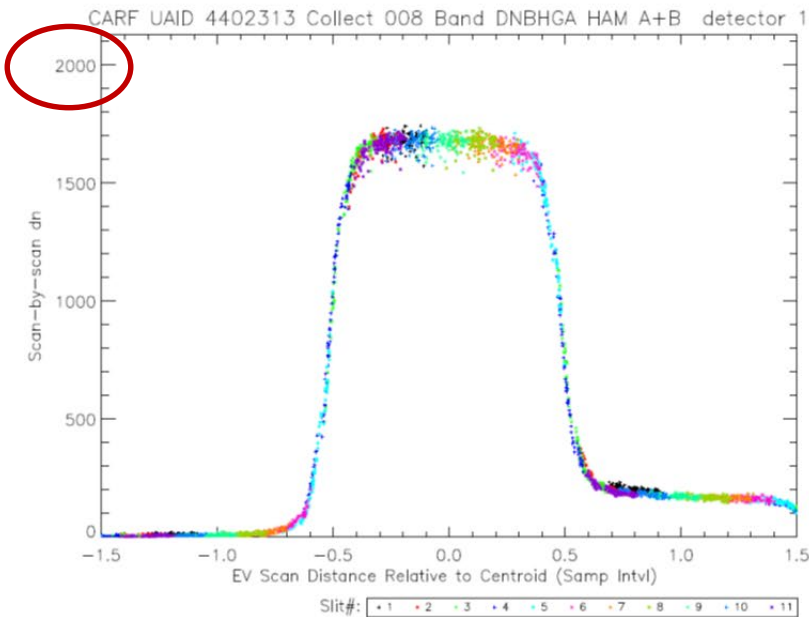- DNB simulations with LSF anomaly use NPP data
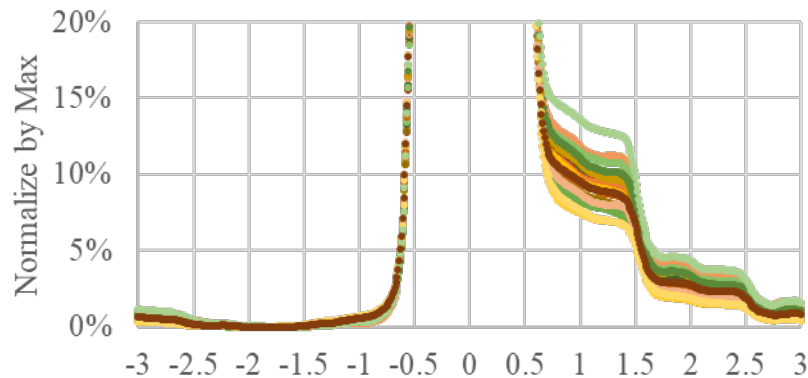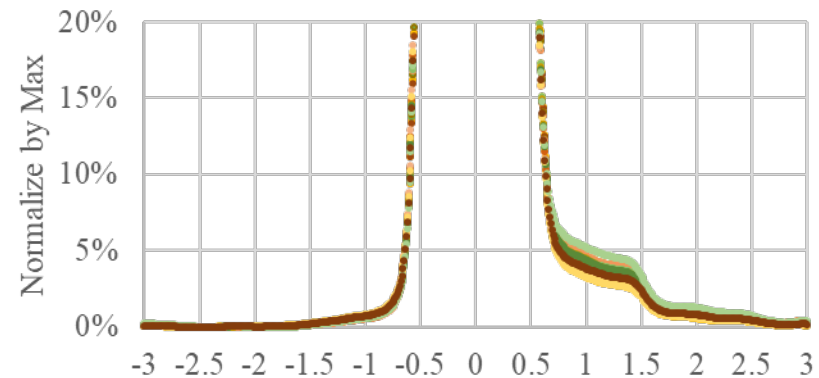
JPSS2 DNB LSF Anomaly
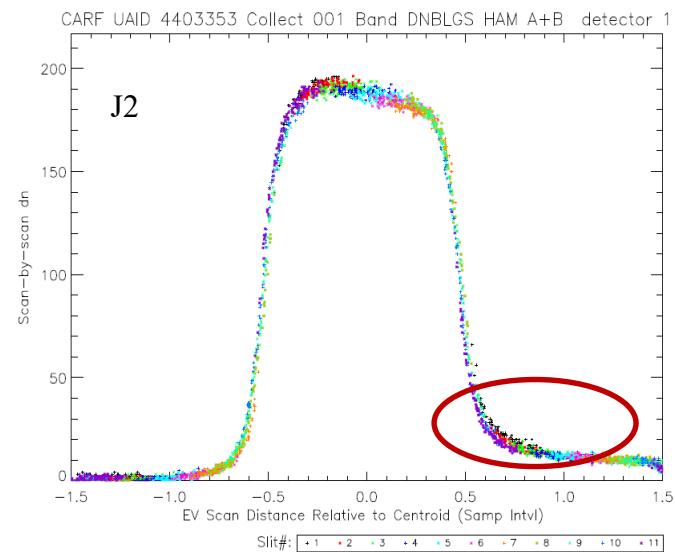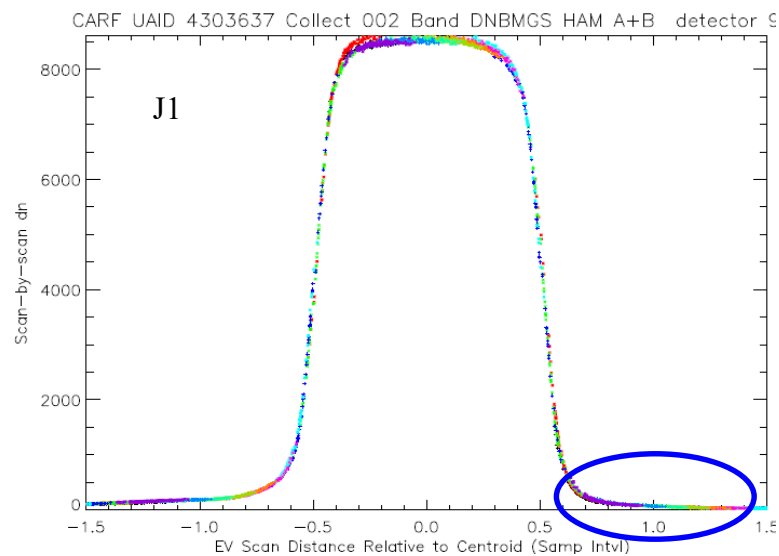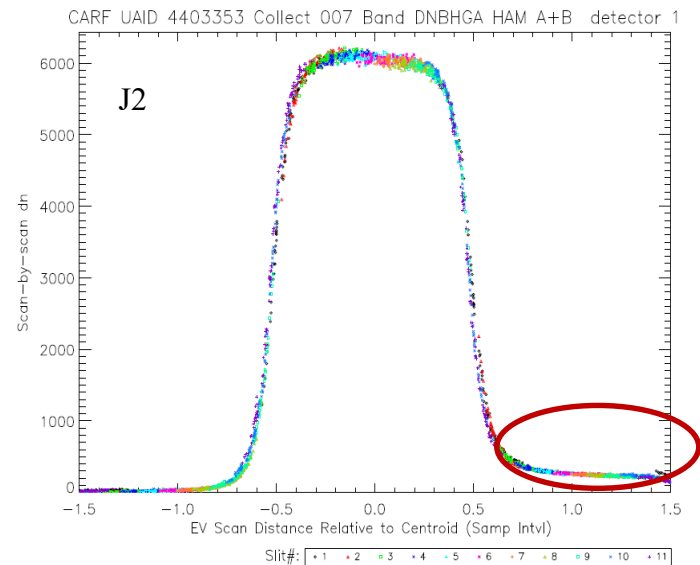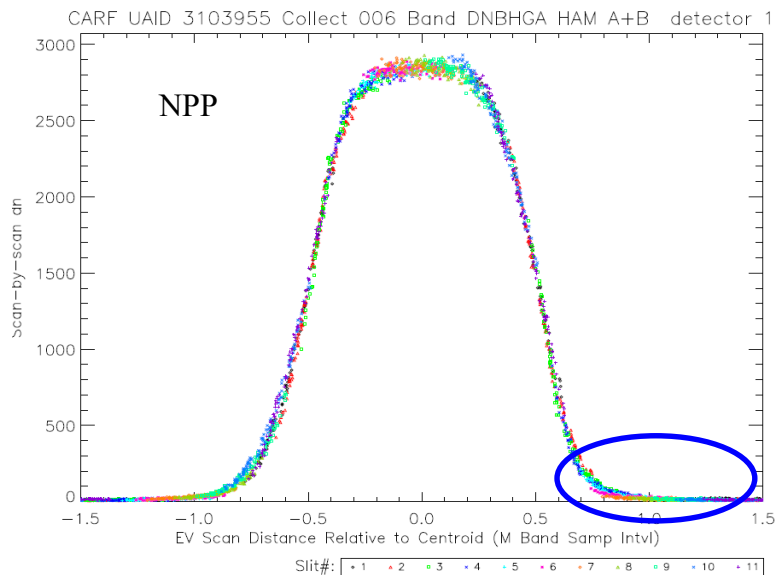
JPSS2 DNB LSF Anomaly vs DN Ranges
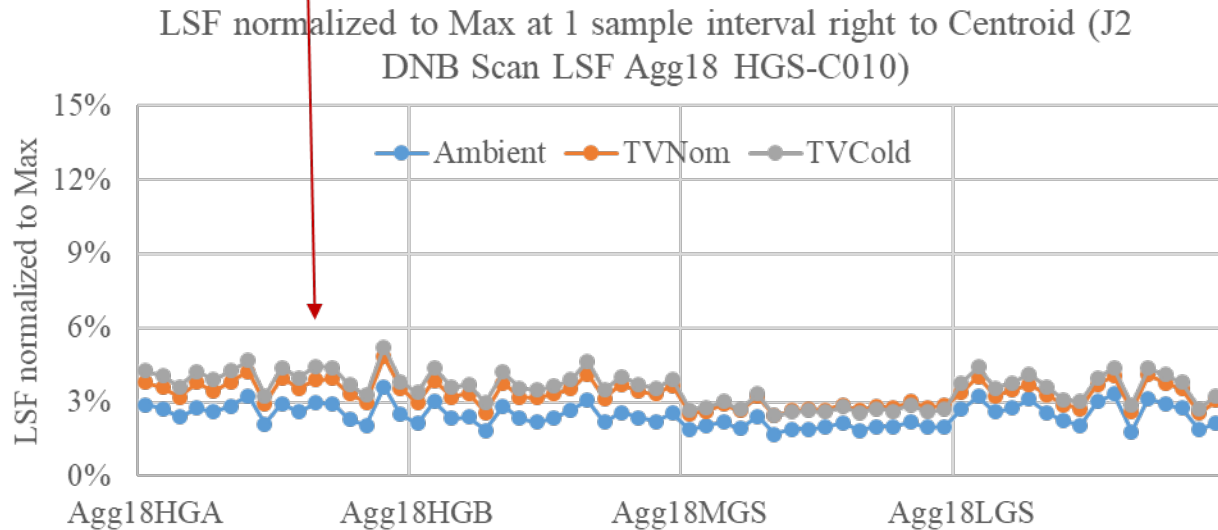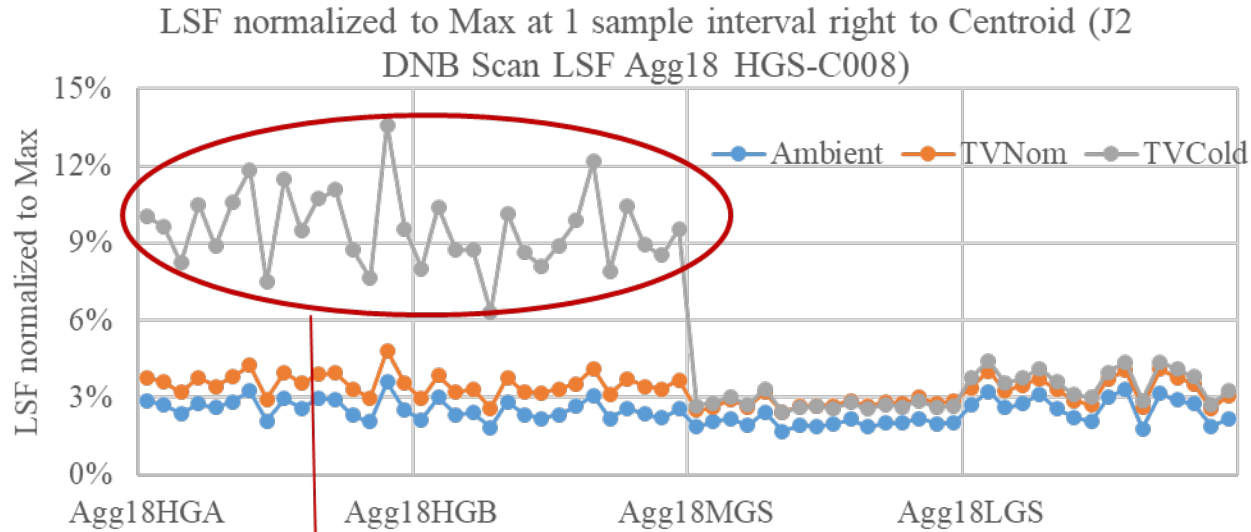
LSF normalized to Max at 1 sample interval right to Centroid (J2 DNB Scan LSF Agg18 HGS-C008)

LSF normalized to Max at 1 sample interval right to Centroid (J2 DNB Scan LSF Agg18 HGS-C010)

LSF normlized to Max at 1 sample interval right to Centroid (J2 DNB Scan LSF Agg18)
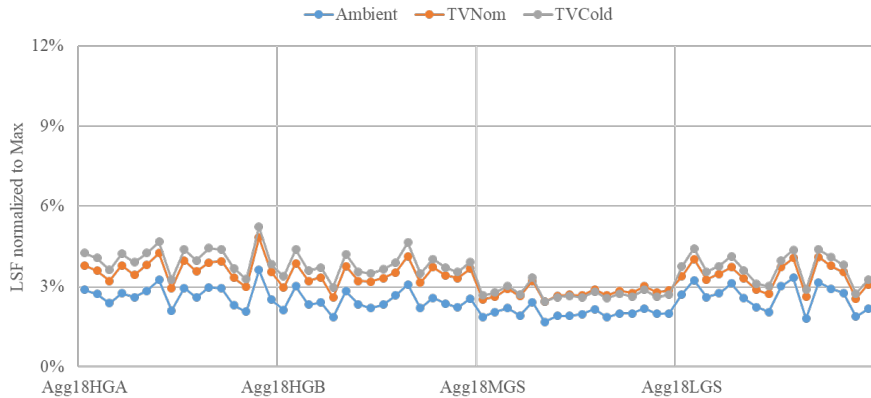
LSF normlized to Max at 1 sample interval right to Centroid (J2 DNB Scan LSF Agg22)
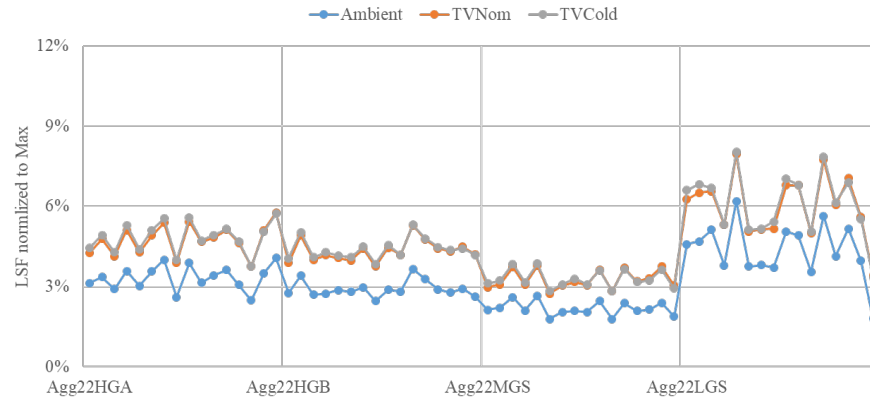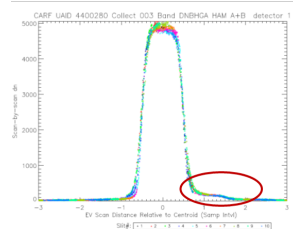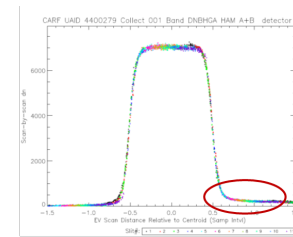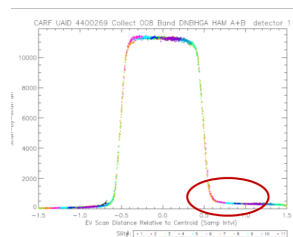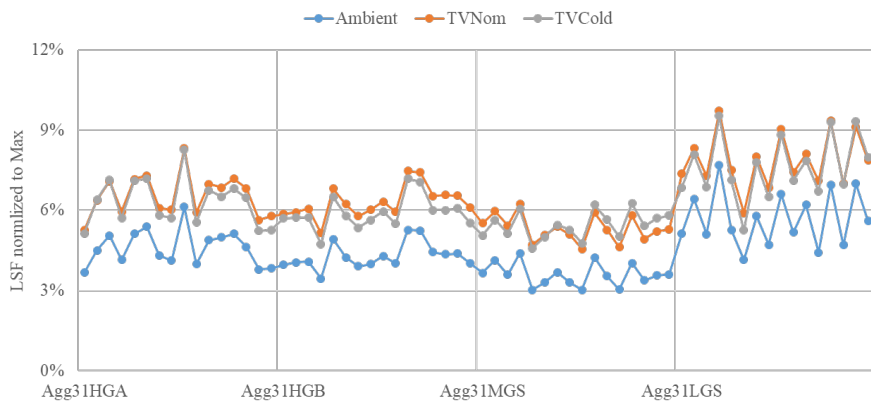

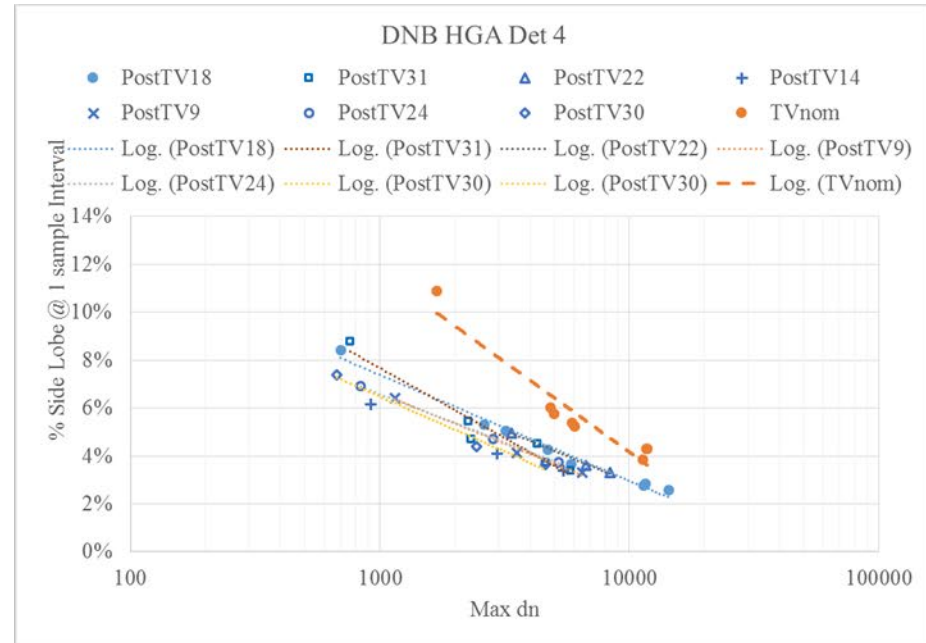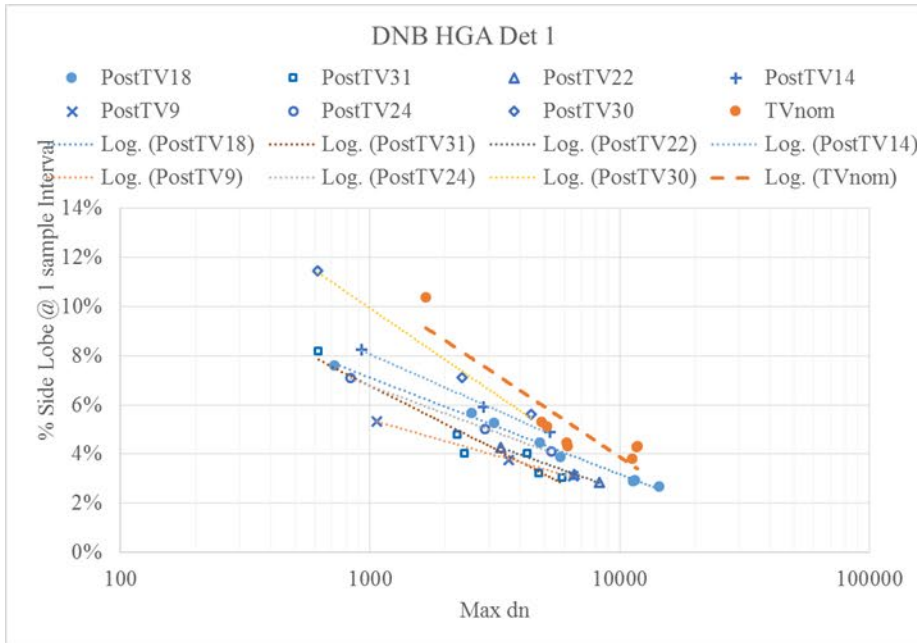LSF normlized to Max at 1 sample interval right to Centroid (J2 DNB Scan LSF Agg31)

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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  - DN Range

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  - Detectors
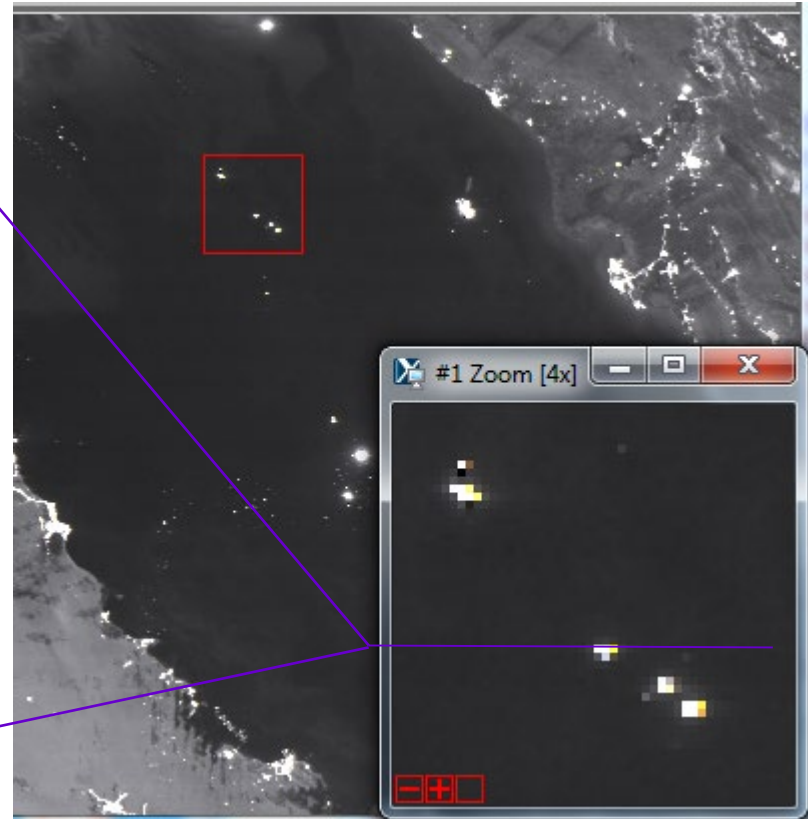
- DNB simulations with LSF anomaly use NPP data

NPP DNB night radiance

Simulated DNB night radiance with side lobe
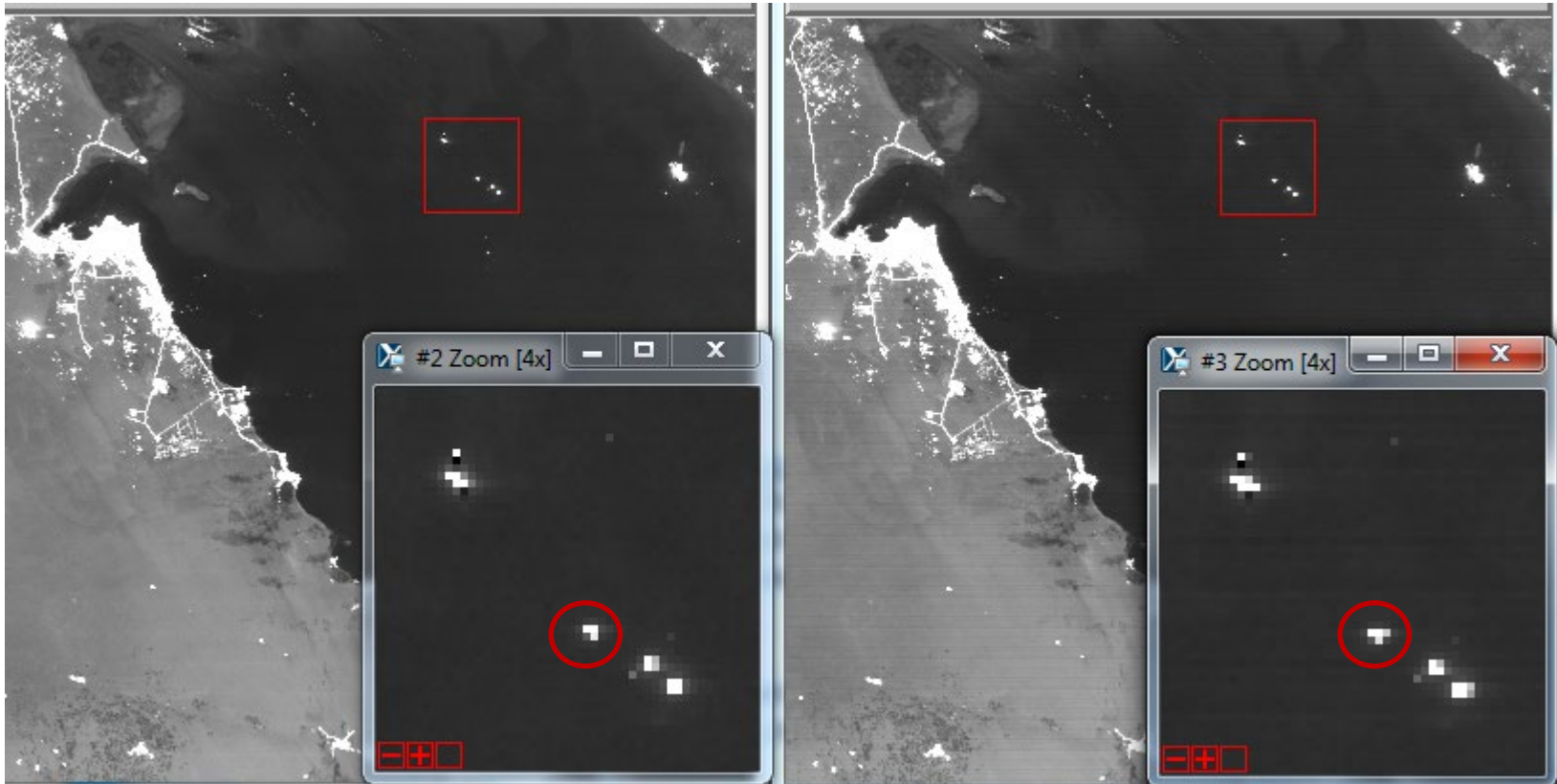
$$R'[i,j] = R[i,j] - \left(Slope \times \ln\left(\frac{R[i,j]}{rad2dn}\right) + Intercept \right) \times R[i,j]$$

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

Examples (2018002.2212)

R: Simulated DNB night radiance TV
G: Simulated DNB night radiance Ambient
B: NPP DNB night radiance
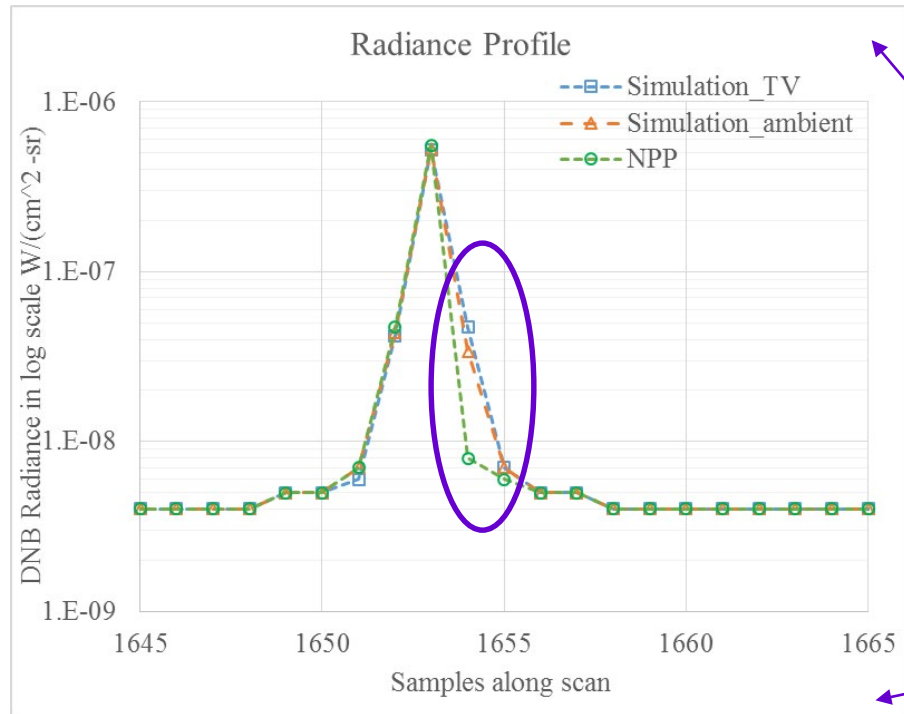
Red color indicates the effects of side lobe
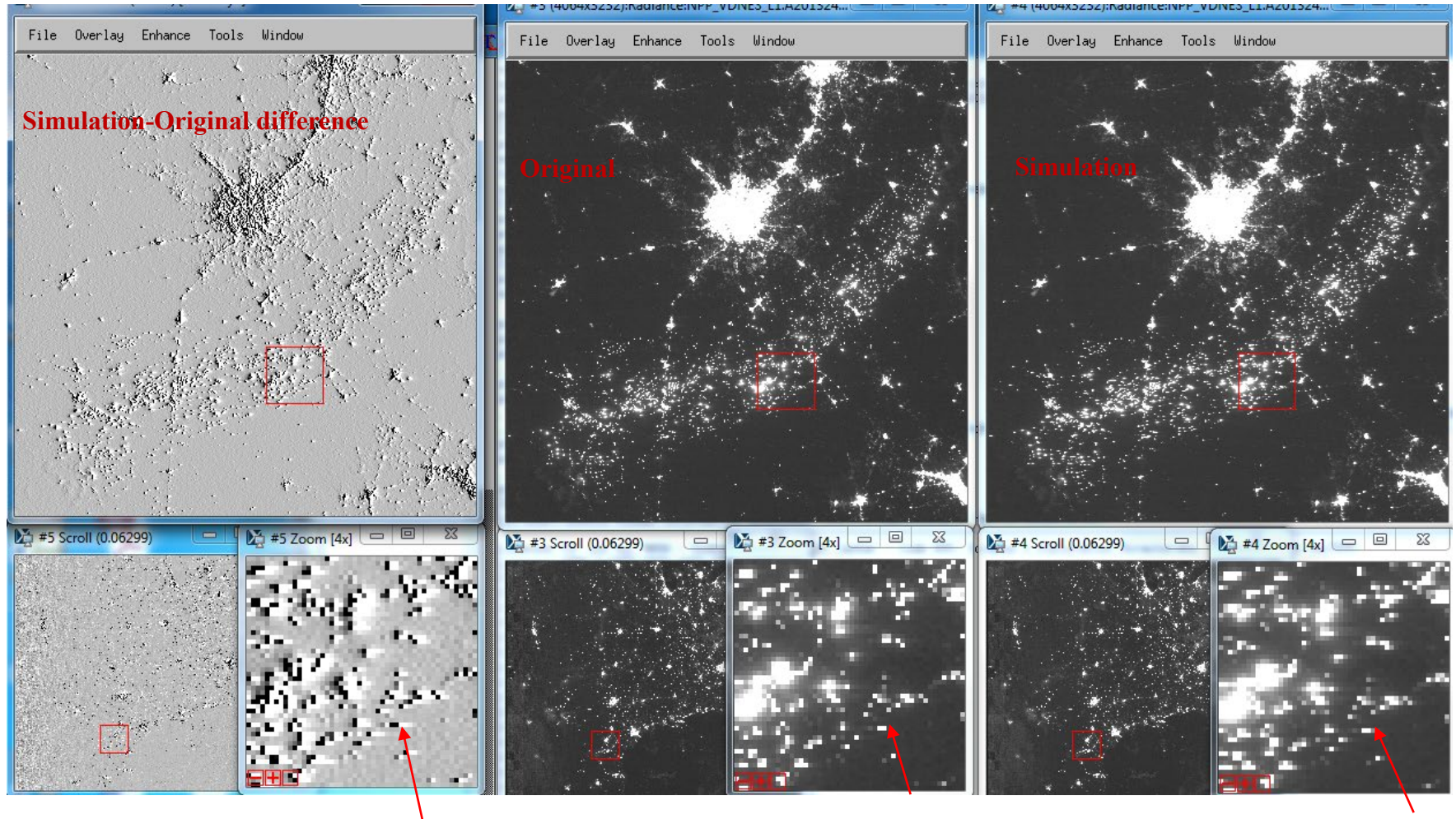
J2VIIRS DNB simulation with cumulative effect

Simulation-Original difference

Original

Simulation

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