



J1 VIIRS

Geometric Calibration and Performance & On-Orbit Expectations

NASA VIIRS Characterization Support Team (VCST)
Geometric Calibration Group

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Acknowledgements

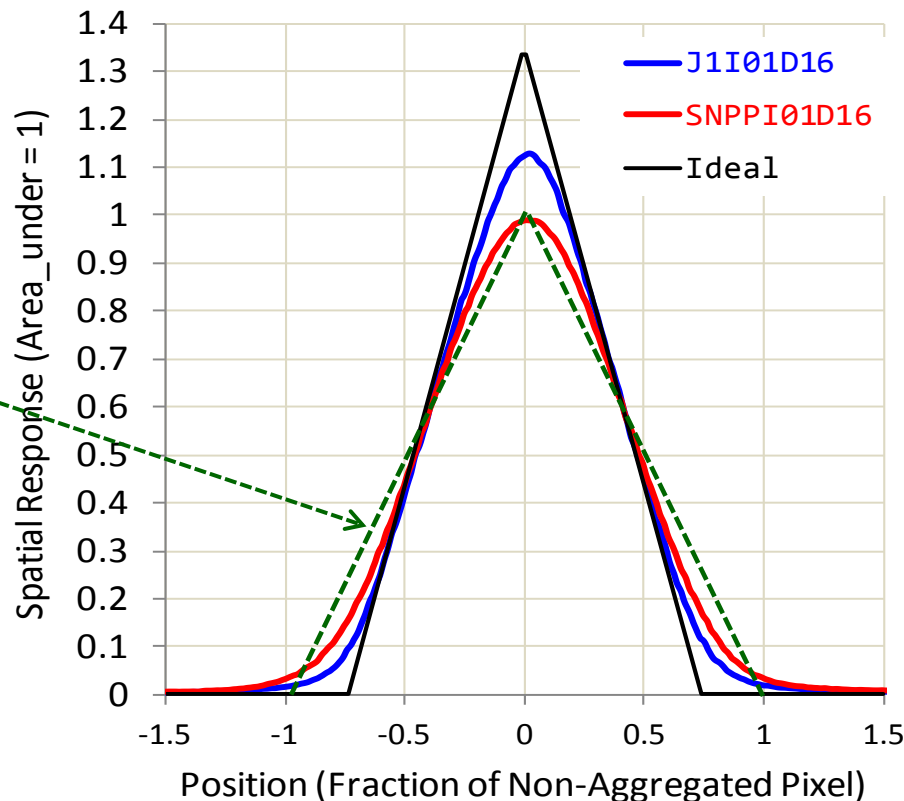
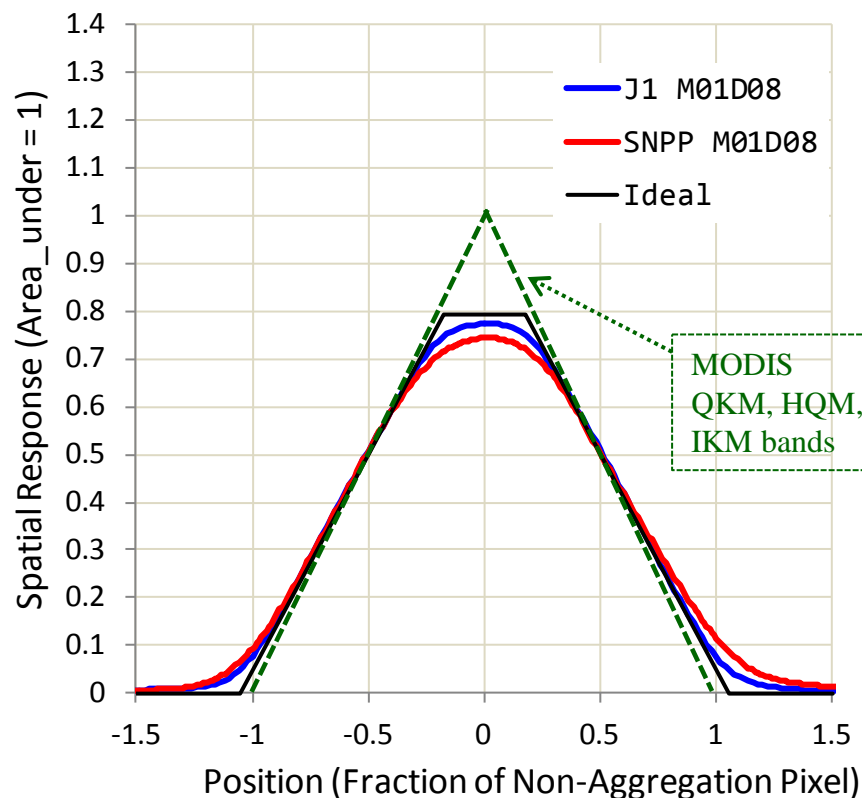
- Thanks the NASA instrument team led by Phil Driggers for the efforts in improving the J1 VIIRS optical system.
- Thanks the Raytheon VIIRS instrument test team for the efforts in addressing many concerns, including BBR related ones.
- Thanks the NOAA STAR team, NASA JPSS Project Science Office, NASA VCST Radiometric Calibration Team, UW spectral calibration team, Aerospace team, instrument on-site team & SC I&T on-site team for cooperation and assistance.
- Thanks Bin Tan, Zhangshi Yin and John Dellomo of the VCST Geo Group for data handling and processing.



Outline

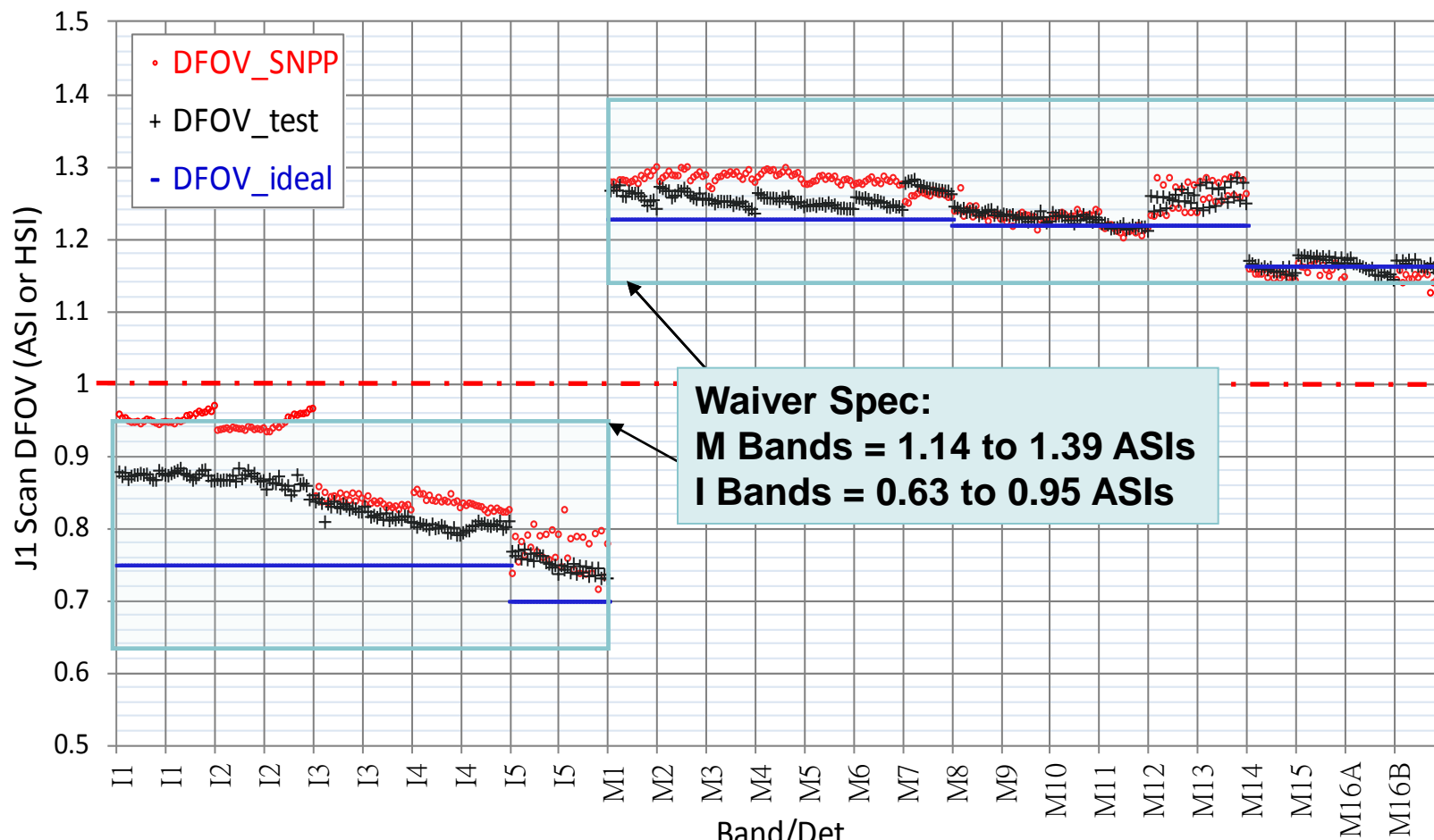
- Spatial Responses, LSF, DFOV, MTF
- Band-to-Band Co-registration (BBR)
- Pointing (for on-orbit geolocation)
- DNB Geometric Performance
- Concluding Remarks

Improved optical system



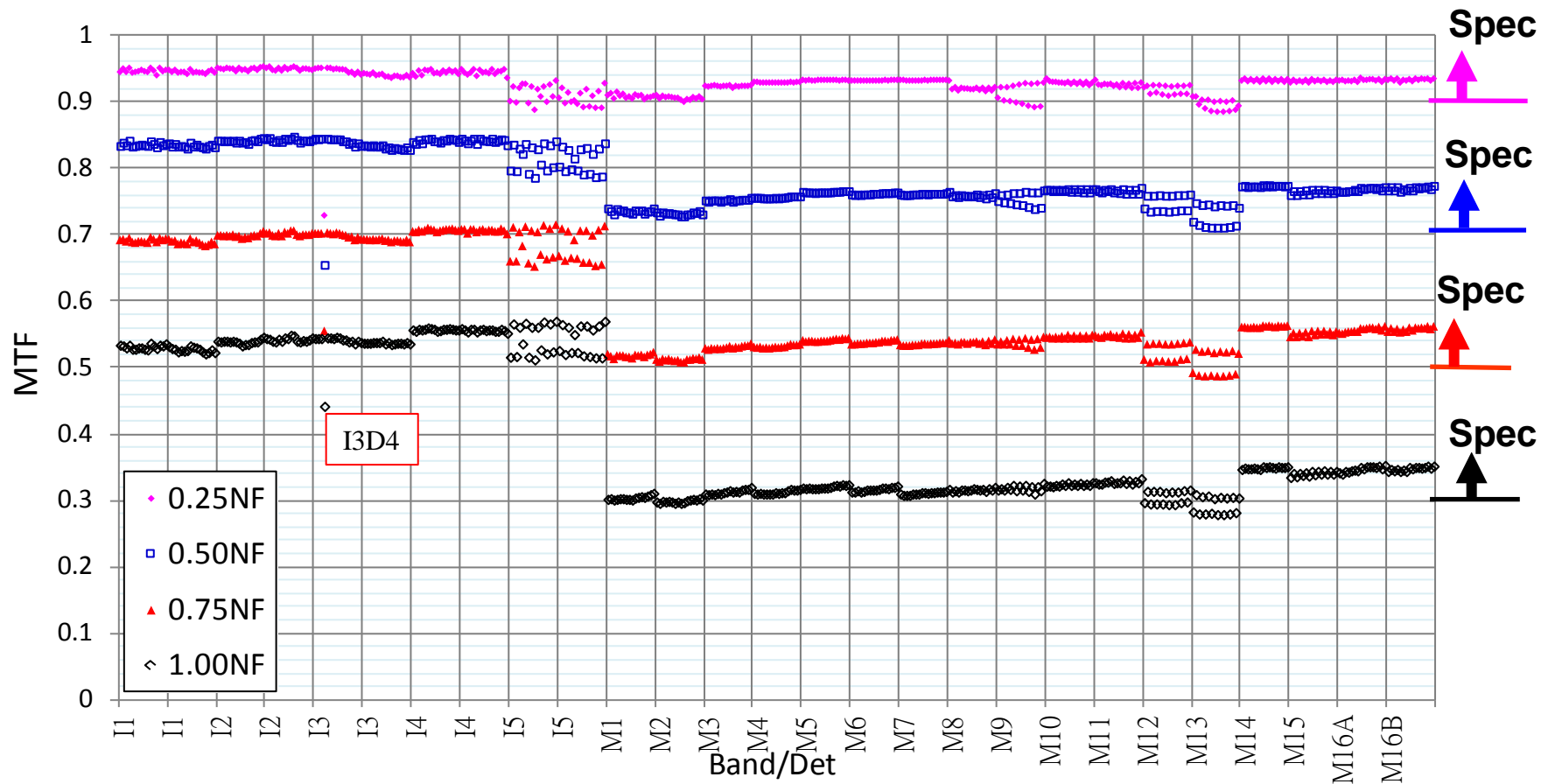
- J1 VIIRS scan direction line spread function is closer to ideal (non-defocus, non-optical scattering, non-test artifacts, etc) system spatial response than the SNPP VIIRS.
- Scan LSF side-lobes for M1&M2 are reduced, and for M11 have disappeared, as compared to those in SNPP VIIRS.

Scan LSF \rightarrow DFOV



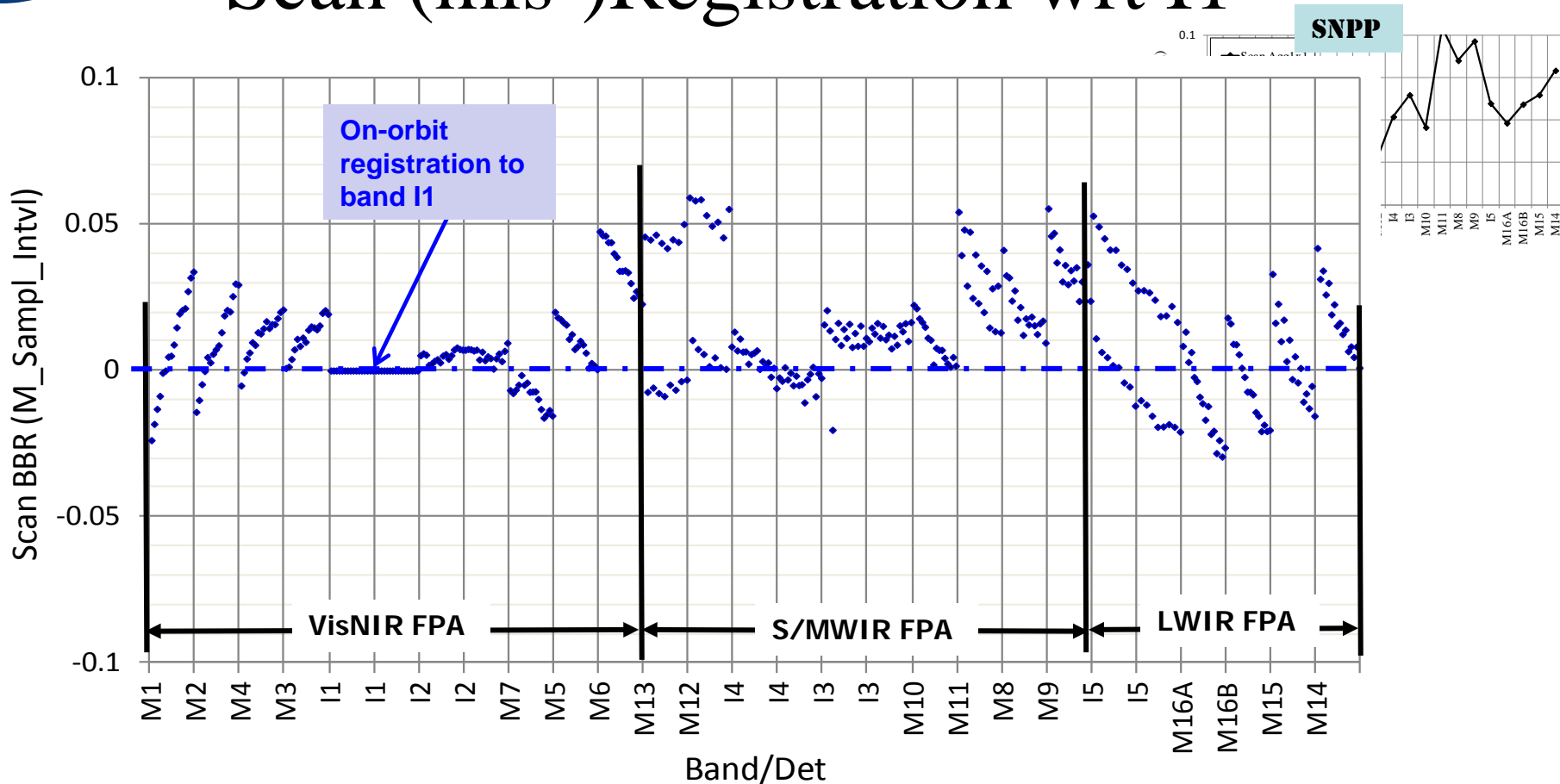
- J1 F2 optical performance is good (better than SNPP F1).
- M-Bands over-sample the earth, in the un-aggregated zones.
- I-bands under-sample the earth (TOA), mostly in the un-aggregated zones.
- Track direction LSFs are nearly square, IFOV \approx 1.0 ASI (or HSI on the ground).

Scan LSF \rightarrow MTF



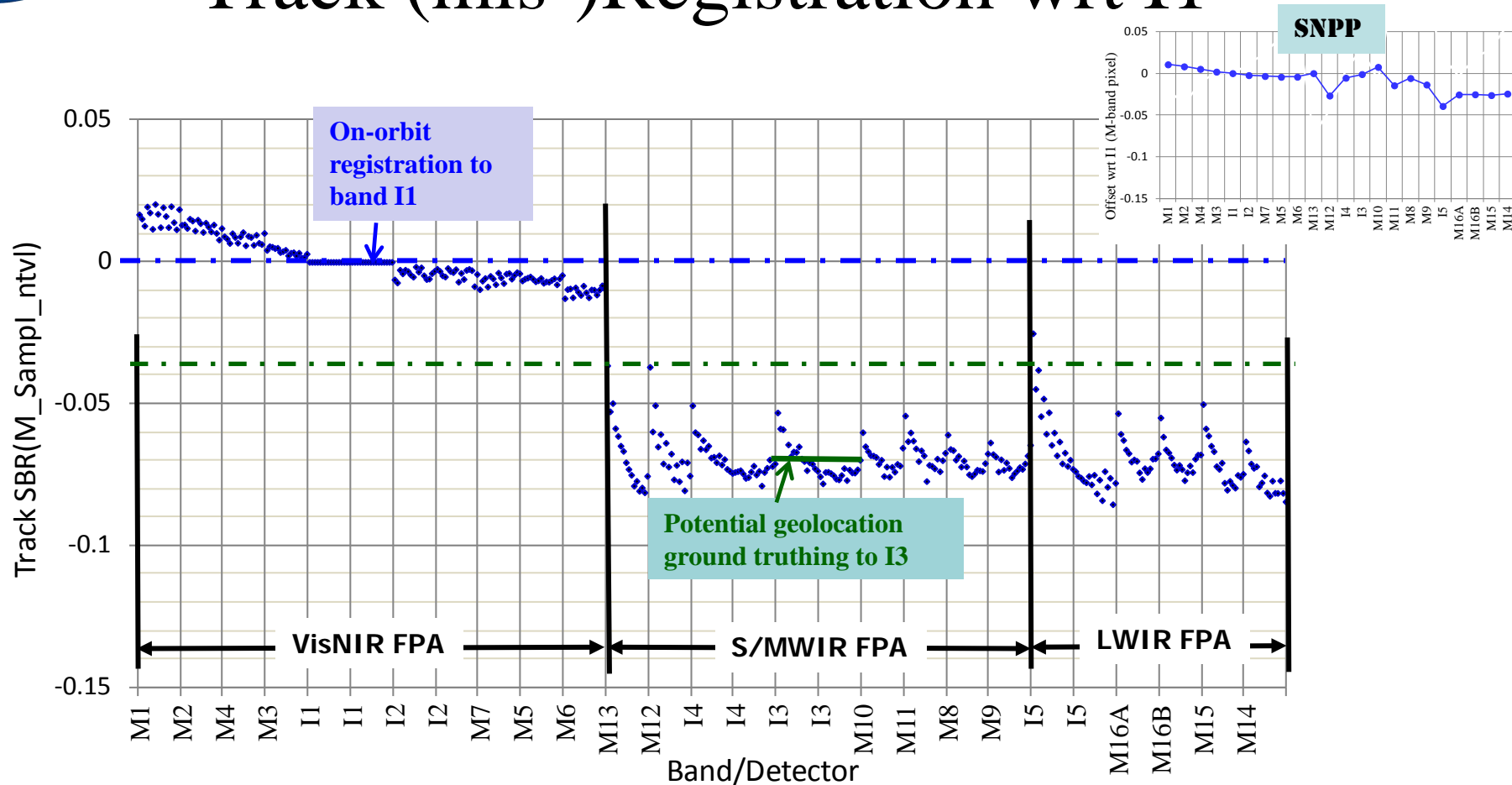
- MTF for M-bands mostly meets specification.
- I-bands images are very sharp, at least at TOA (I3D4 under-performs but is still good in MTF).
- Track direction LSFs are nearly square, MTF \approx 0.63 at 1.00NF (Nyquist Frequency).

Scan (mis-)Registration wrt I1



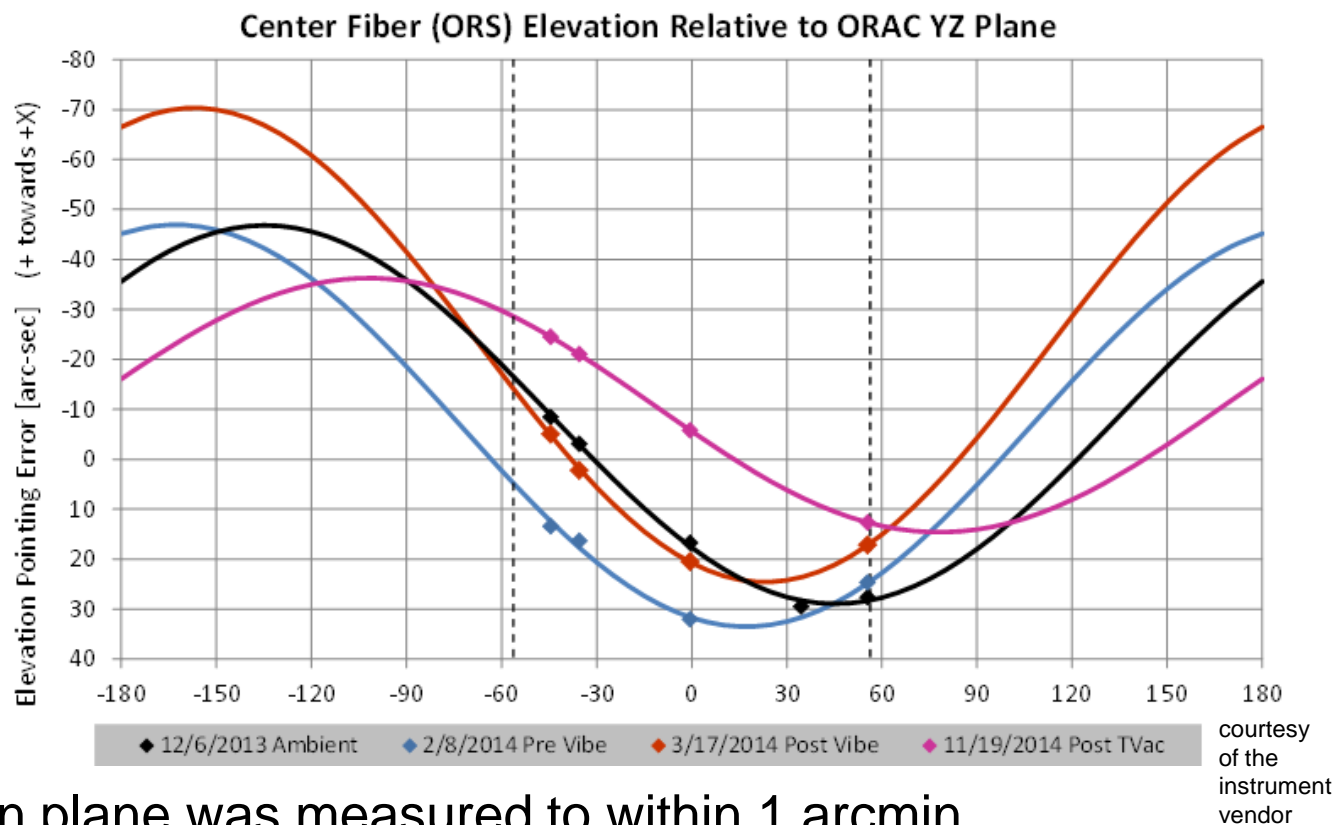
- The scan rate is nominal @1.786 sec/scan or 3.517 rad/sec (0.4% slower than SNPP).
- Mis-reg is < ~5% for M-band and < ~10% for I-bands in the un-agg zones.
- Data shows for un-agg zones. Mis-reg in Agg2x1 and 3x1 zones is 1/2 and 1/3 of those in the un-agg zones.

Track (mis-)Registration wrt I1



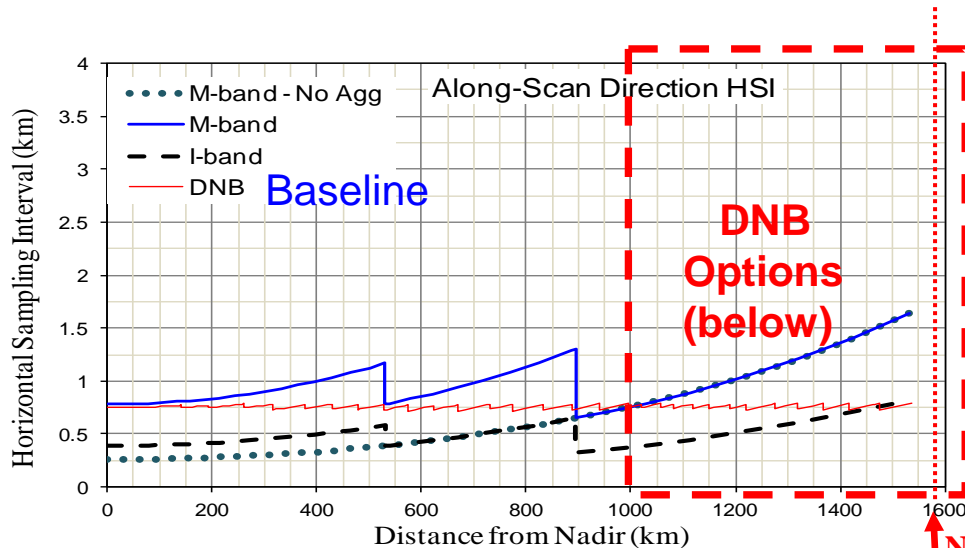
- Track direction bands co-register well within each FPA.
- Bands on SWMWIR and LWIR FPAs shifted from bands on VisNIR FPA, $\sim 7\%$ for M-bands and $\sim 14\%$ for I-bands. Mapping uncertainties are also affected, $RMSE = \sqrt{\sigma^2 + \mu^2}$.
- On-orbit ground truthing for geolocation is to I1. Thermal bands offsets are temperature dependent and a monitoring method is under development.

Pointing (for geolocation)



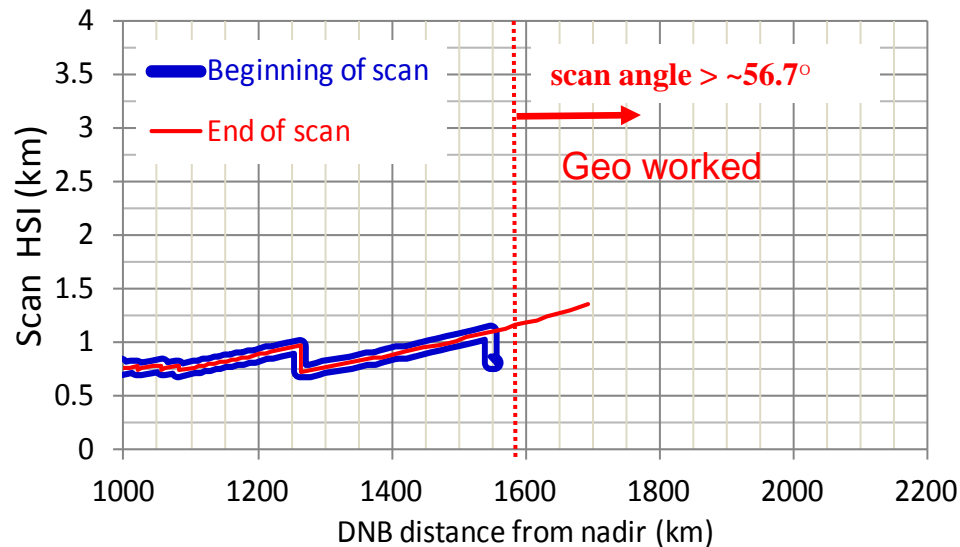
- Scan plane was measured to within 1 arcmin.
- Instrument mounting, launch will add to the variation.
- On-orbit geolocation CalVal will remove biases and sub-pixel accuracy is expected for M- & I-bands.

DNB Geometric Performance

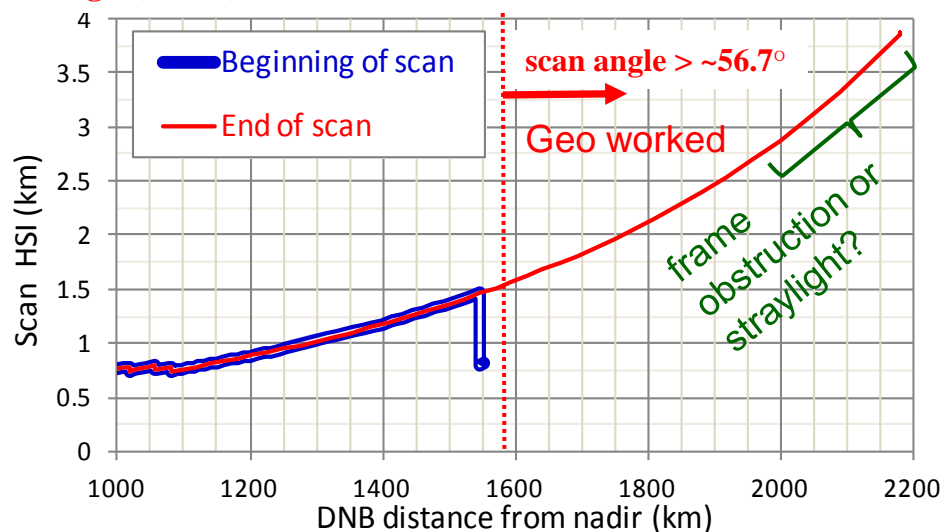


- DNB LSFs are nearly square.
- Baseline HSI is ~ 750 m.
- “Option21-26” has HSI max of 1.1 km within 56.7° (up to 1.4 km @ 57.6°).
- “Option21” has HSI max of 1.6 km within 56.7° (up to 3.9 km @ 60.5°).
- Geolocation worked beyond 56.7° .

Nominal maximum scan angle ($\sim 56.7^\circ$)

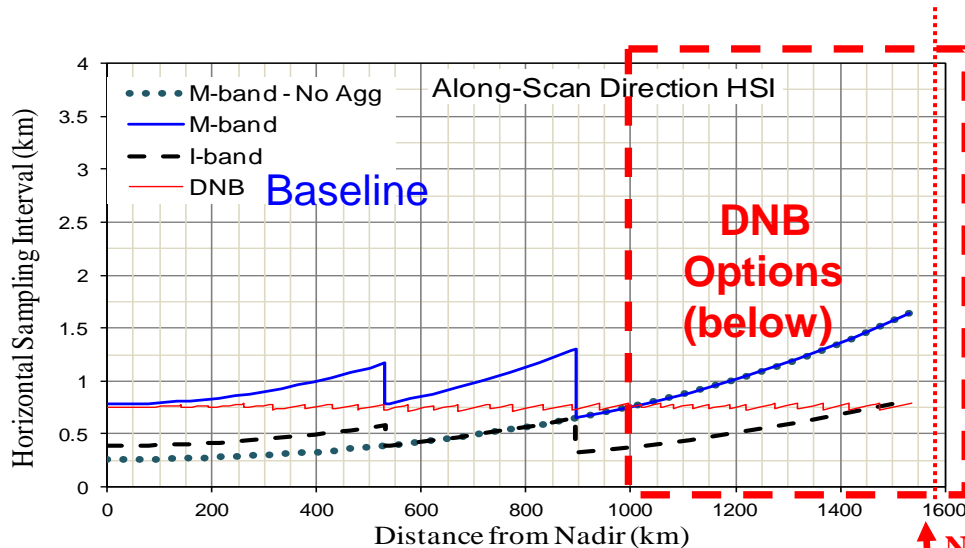


“Option21-26”

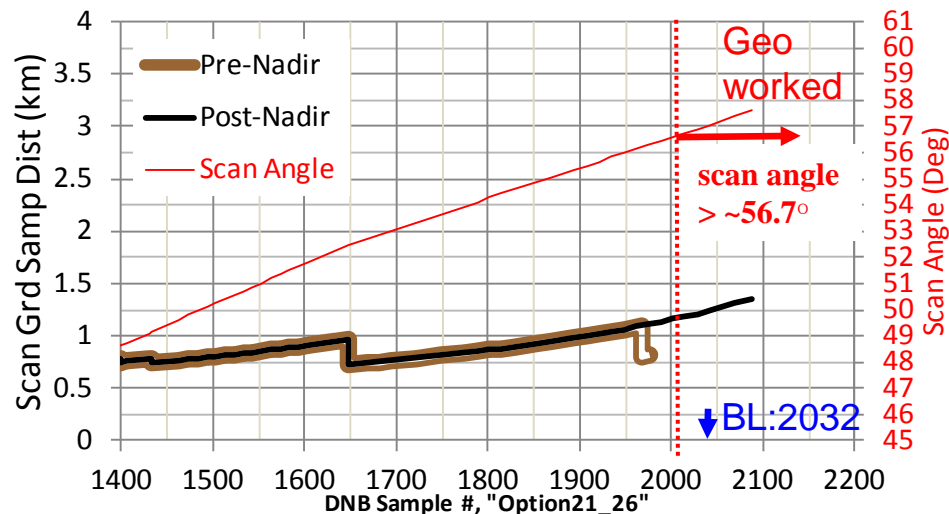


“Option21”

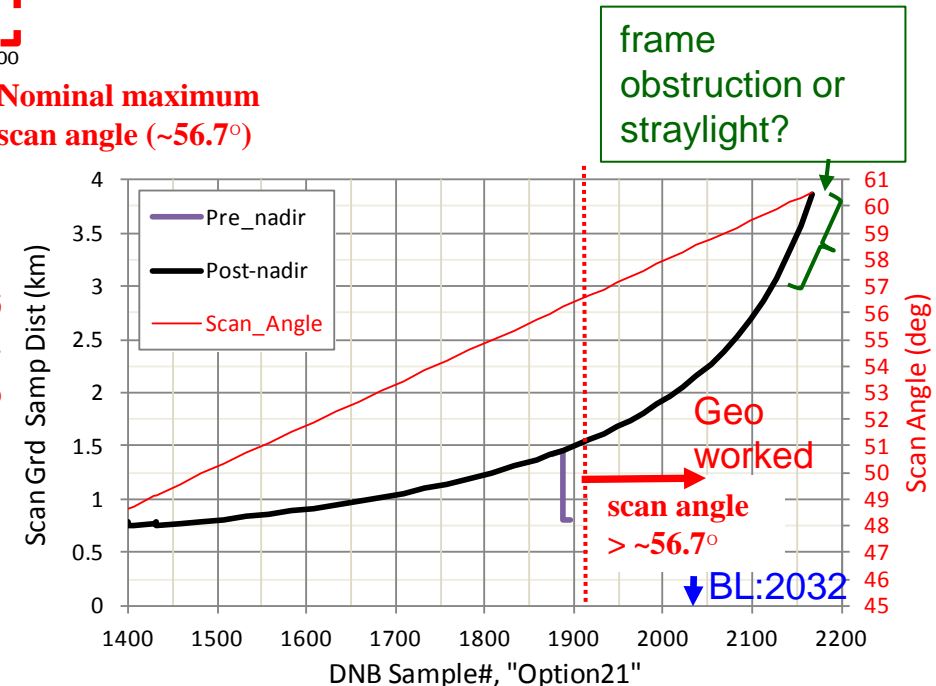
DNB Geometric Performance



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“Option21-26”



“Option21”

frame
obstruction or
straylight?



Concluding Remarks

- J1 VIIRS has good optical performance (better than SNPP).
- J1 VIIRS scan rate is nominal @ 1.786 sec/scan or 3.517 rad/sec (SNPP VIIRS is @ 1.779 sec/scan or 3.531 rad/sec).
- J1 VIIRS BBR aligns well in scan direction.
 - However, in the track direction, bands (**I3-5, M8-16**) on the CFPAs are shifted from bands (**I1-2, M1-7**) on VisNIR FPA, ~ 7% for M-bands and ~ 14% for I-bands. Mapping uncertainties will be affected.
- Pointing was measured. On-orbit geolocation CalVal will remove biases and sub-pixel accuracy is expected for M- & I-bands.
- J1 DNB geometry is TBD (1 baseline, 2 options).
 - NOAA STAR will assess J1 DNB on-orbit geolocation accuracy.



Backup

1. Summary of geometric calibration and performance
2. Image Resolution Specifications – FOVs



Summary

- J1 VIIRS optical system was re-worked and has better optical performance than SNPP → satisfactory DFOV and MTF.
- J1 VIIRS scan rate is nominal @ 1.786 sec/scan or 3.517 rad/sec (SNPP VIIRS is @ 1.779 sec/scan or 3.531 rad/sec).
- J1 VIIRS BBR aligns well in scan direction.
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- Pointing was measured. On-orbit geolocation CalVal will remove biases and sub-pixel accuracy is expected for M- & I-bands.
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Image Resolution Specifications – FOVs

- Scan Dynamic Field of View (DFOV), including integration drag
 - = Full Width Half Maximum (FWHM) of Line Spread Function (LSF)
 - I-bands, original Spec (actual dominated by integration_drag & EFL)
 - I1, I2: 114 (116) μrad
 - I3: 108 (116) μrad
 - I4: 109 (116) μrad
 - I5: 102 (109) μrad

$\pm 10\%$ for spec
 - M-bands: original Spec (actual dominated by detector_size & EFL)
 - M1 to M11: 382 (381) μrad
 - M12, M13: 379 (378) μrad
 - M14, M15: 362 (361) μrad
 - M16: 364 (361) μrad

$\pm 5\%$ for spec
- Track IFOV, without integration drag
 - Given by FWHM of LSF curve, nearly square
 - I-bands: IFOV = 445.5 μrad $\pm 5\%$
 - M-bands: IFOV = 891 μrad $\pm 5\%$
- Note: angular sampling interval (ASI) (and horizontal samplInterval (HSI)) at nadir w/ avg Alt=838.8 km
 - I-bands scan ASI = 155.21 μrad (130 m @ nadir) \rightarrow 3 ASIs = 465.6 μrad (391 m @ nadir)
 - I-bands track ASI = 445.5 μrad (381 m @ nadir)
 - M-bands scan ASI = 310.42 μrad (260 m @ nadir) \rightarrow 3 ASIs = 931.3 μrad (790 m @ nadir)
 - M-bands track ASI = 891 μrad (762 m @ nadir)