International Ocean Colour Science Meeting 2019

# Status of JPSS-2 VIIRS Pre-launch Calibration and Characterization

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# Outline

- Status of J2 VIIRS Pre-launch Testing
- J2 VIIRS Pre-launch Performance
  - Radiometric , spectral, spatial, and other performance parameters, such as polarization, stray light, …
- Summary
  - Lessons and future work

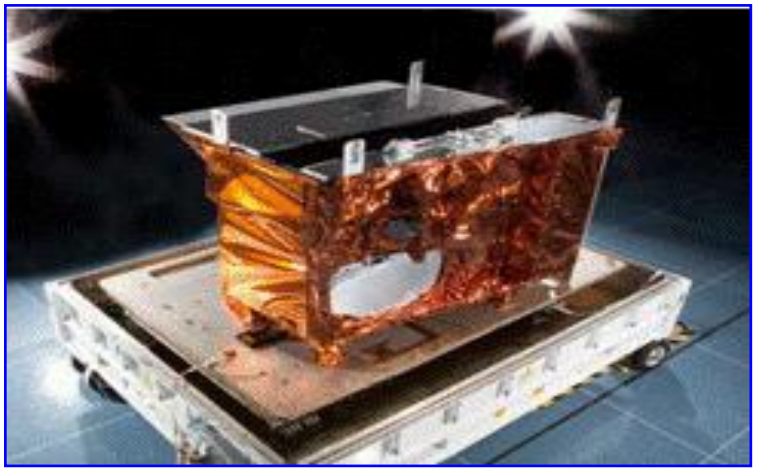
# VIIRS on S-NPP and JPSS-1/2/3/4

**22 bands (16 M-band, 5 I-band and 1 DNB)**

| | Band | λc(nm) | Δλ(nm) | Spatial Resolution (m) | MODIS Equivalent Band |
|---|---|---|---|---|---|
| VisNIR | DNB | 700 | 400 | 750 | |
| | M1 | 412 | 20 | 750 | B8 |
| | M2 | 445 | 18 | 750 | B9 |
| | M3 | 488 | 20 | 750 | B3-B10 |
| | M4 | 555 | 20 | 750 | B4-B12 |
| | M5 | 672 | 20 | 750 | B1 |
| | I1 | 640 | 80 | 375 | B1 |
| | M6 | 746 | 15 | 750 | B15 |
| | M7 | 865 | 39 | 750 | B2 |
| | I2 | 865 | 39 | 375 | B2 |
| SMWIR | M8 | 1240 | 20 | 750 | B5 |
| | M9 | 1378 | 15 | 750 | B26 |
| | M10 | 1610 | 60 | 750 | B6 |
| | I3 | 1610 | 60 | 375 | B6 |
| | M11 | 2250 | 50 | 750 | B7 |
| | I4 | 3740 | 380 | 375 | B20 |
| | M12 | 3700 | 180 | 750 | B20 |
| | M13 | 4050 | 155 | 750 | B21-B22-B23 |
| LWIR | M14 | 8550 | 300 | 750 | B29 |
| | M15 | 10763 | 1000 | 750 | B31 |
| | I5 | 11450 | 1900 | 375 | B31-B32 |
| | M16 | 12013 | 950 | 750 | B32 |

- 7 dual gain bands: M1-M5, M7, and M13
- 22 EDRs (research/operational applications)

- S-NPP: launched in Oct 2011
- JPSS-1: launched in Nov 2017
- **JPSS-2: launch in March 2022**
- JPSS-3/4: launch in 2026/2031



**Status JPSS-2 VIIRS PL Testing**

- Ambient: April - Aug 2016
- Pre-TVAC: March - May 2017
- TVAC: June - Oct 2017
- Post-TVAC: Nov - Dec 2017
- S/C Testing: 2020
- Launch: March 2022

# JPSS VIIRS Pre-launch Test Program

**Program developed with lessons from S-NPP VIIRS and MODIS**

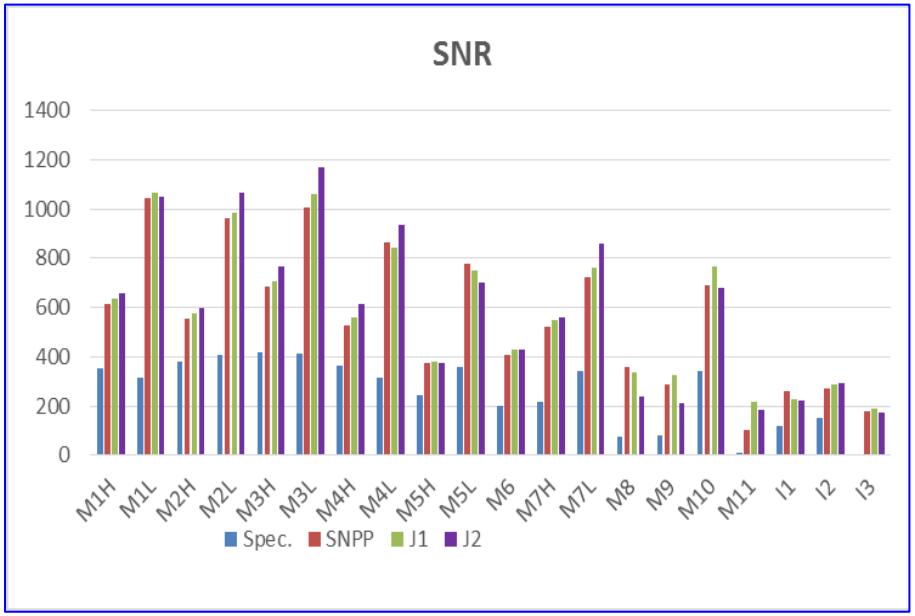
Objectives:

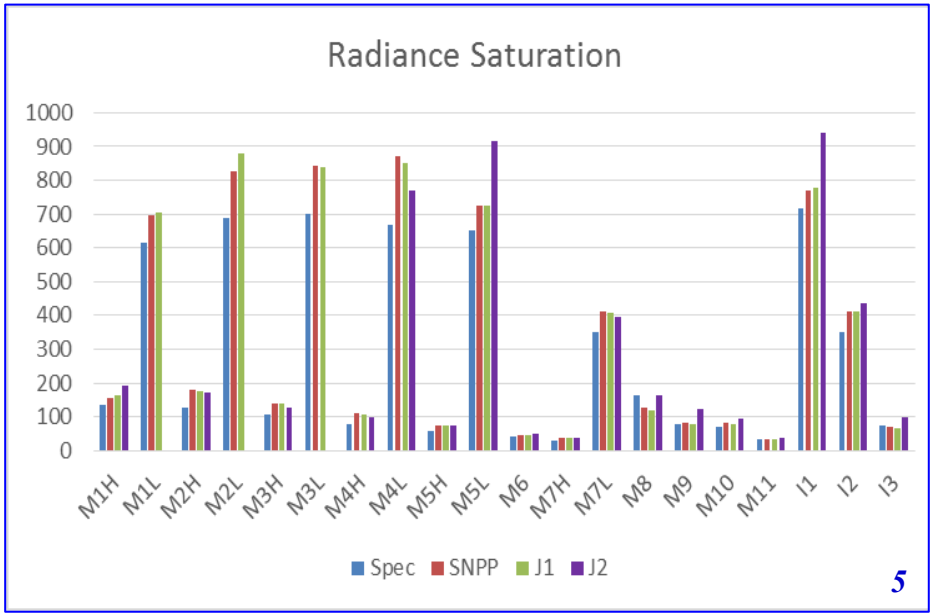
- Characterize sensor performance
  - Radiometric (SNR/NEdT, detector gain, and dynamic range, …)
  - Spectral (IB and OOB RSR, …)
  - Spatial and geometric (BBR, MTF, …)
  - Others (polarization, RVS, stray light, crosstalk, …)
- Ensure that **sensor performance** meets its design requirements and that **data quality** is adequate to achieve overall science objectives
- Collect and analyze testing data (**independently** by instrument vendor and government teams) to help derive and verify key sensor parameters for its on-orbit operation and calibration
- Develop and support implementation of mitigation strategies to address potential non-compliances

# RSB Radiometric Performance

- **Reflective solar bands (RSB): meeting nearly all requirements for dynamic range, gain transition and SNR (as good as J1)**
  - Minor non-compliances
    - M8 (96% of dynamic range) – improved over J1
  - Issues requiring special attention
    - **J1 nonlinearity issues corrected in J2 (SWIR and DNB)**

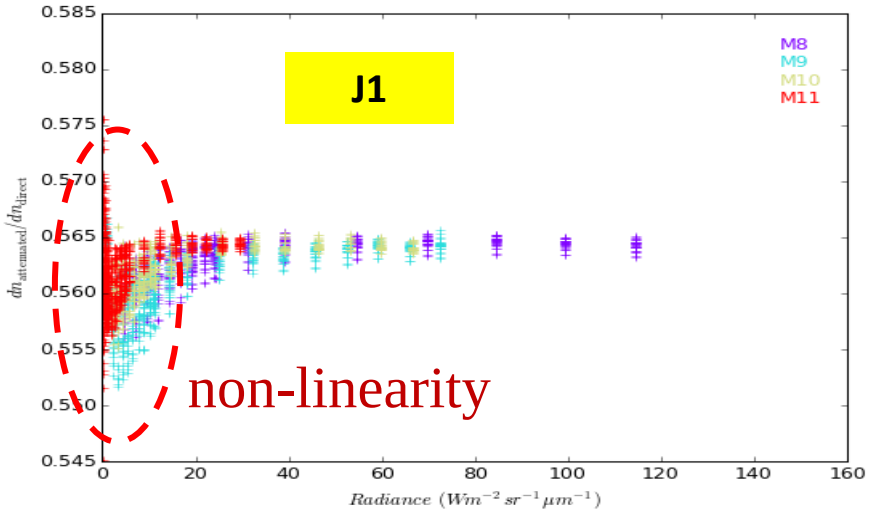
SIS-100

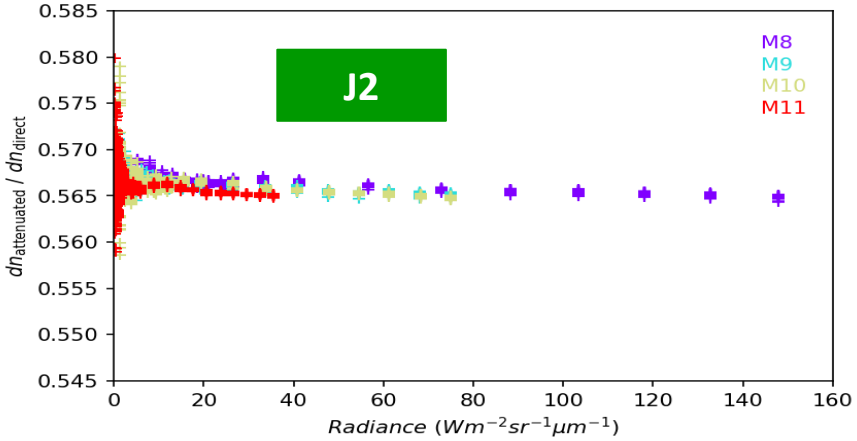


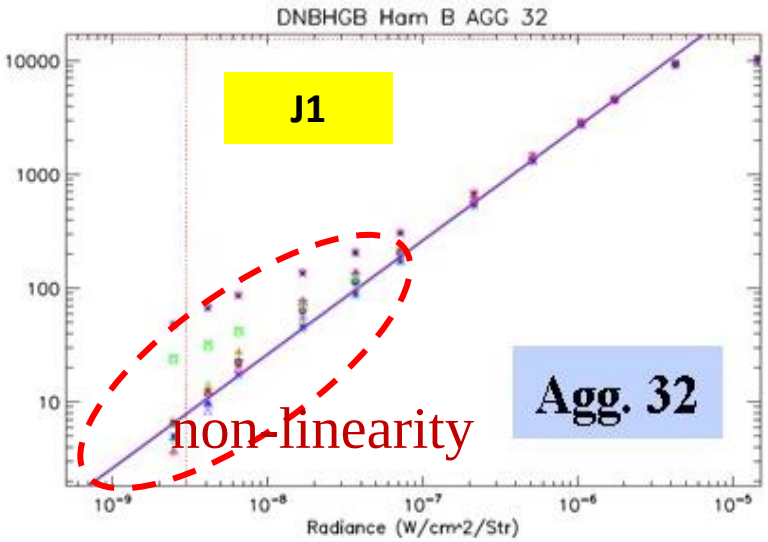
# RSB Radiometric Performance (examples)

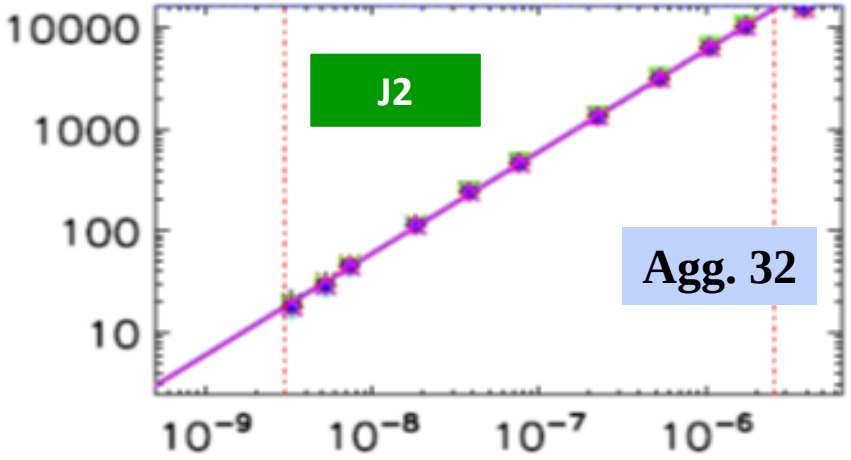
SWIR response (attenuated/direct)




DNB response (dn vs input radiance)

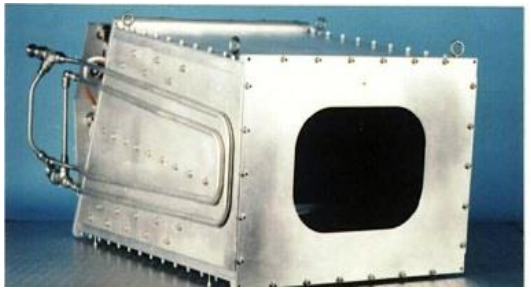


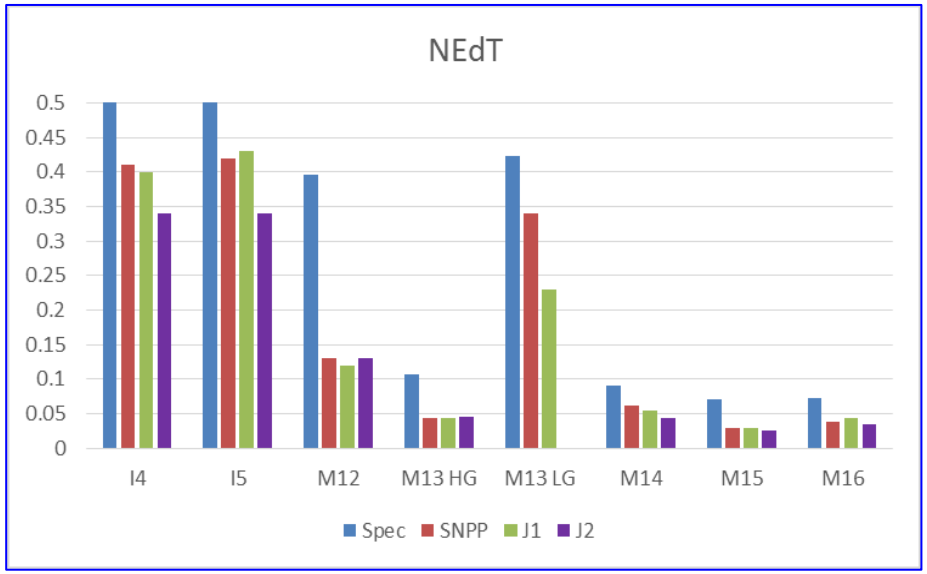



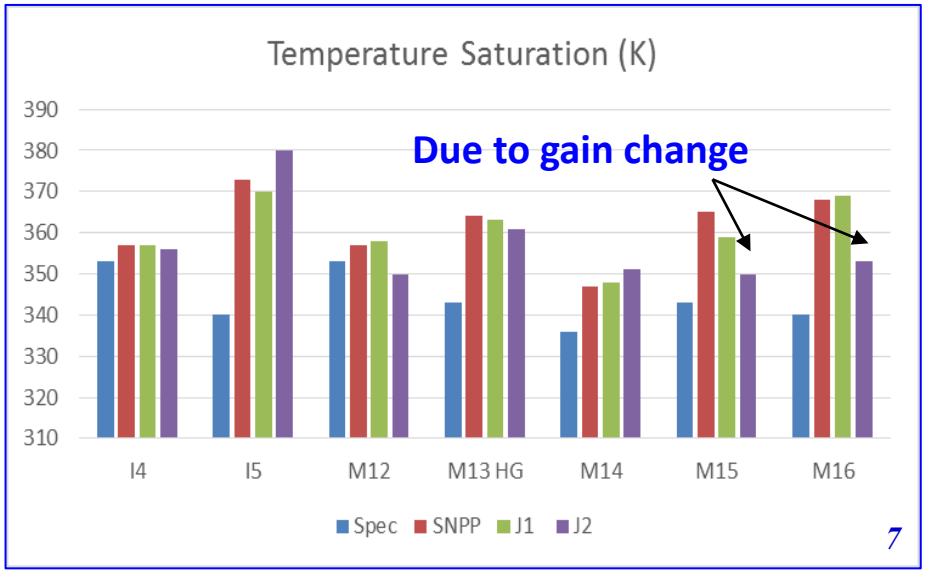
# TEB Radiometric Performance

- **Thermal emissive bands (TEB): meeting nearly all requirements for dynamic range, non-linearity, NEdT, uncertainty, and uniformity (comparable across all sensors)**
  - Minor non-compliances
    - Small OBC BB non-uniformity observed in TV (up to 50 mK vs 30 mK spec)
    - Cryo-cooler margin led to decision to set CFPA temperature at 82 K (some impact on NEdT and gains)

BCS





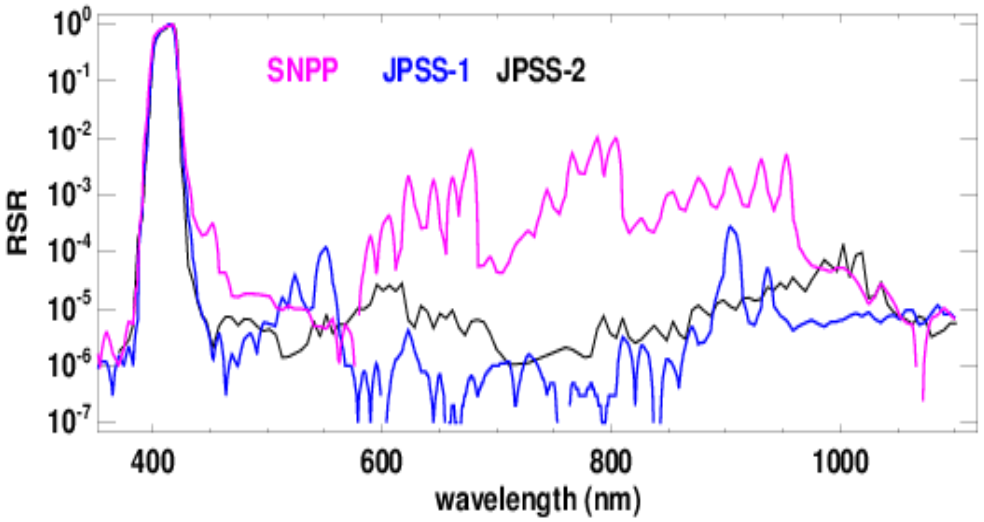
# TEB Radiometric Performance (examples)

| ARD Performance (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temp (K) | I4 | I5 | M12 | M13 | M14 | M15 | M16A | M16B |
| 190 | ~ | ~ | ~ | ~ | 0.68 | 0.29 | 0.17 | 0.25 |
| 230 | ~ | ~ | 7.60 | 2.95 | 0.11 | 0.07 | 0.08 | 0.04 |
| 267 | 0.48 | 0.10 | ~ | ~ | ~ | ~ | ~ | ~ |
| 270 | ~ | ~ | 0.24 | 0.15 | 0.08 | 0.05 | 0.04 | 0.04 |
| 310 | ~ | ~ | 0.25 | 0.17 | 0.11 | 0.06 | 0.03 | 0.04 |
| 340 | ~ | ~ | 0.27 | 0.18 | 0.09 | 0.05 | 0.03 | 0.03 |
| **ARD Specification (%)** | | | | | | | | |
| Temp (K) | I4 | I5 | M12 | M13 | M14 | M15 | M16A | M16B |
| 190 | ~ | ~ | ~ | ~ | 12.30 | 2.10 | 1.60 | 1.60 |
| 230 | ~ | ~ | 7.00 | 5.70 | 2.40 | 0.60 | 0.60 | 0.60 |
| 267 | 5.00 | 2.50 | ~ | ~ | ~ | ~ | ~ | ~ |
| 270 | ~ | ~ | 0.70 | 0.70 | 0.60 | 0.40 | 0.40 | 0.40 |
| 310 | ~ | ~ | 0.70 | 0.70 | 0.40 | 0.40 | 0.40 | 0.40 |
| 340 | ~ | ~ | 0.70 | 0.70 | 0.50 | 0.40 | 0.40 | 0.40 |

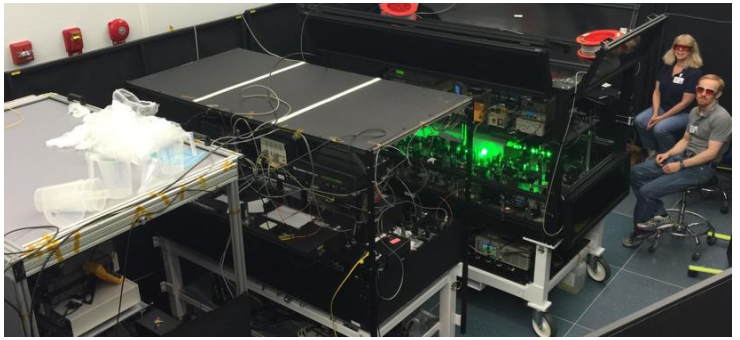
**Similar absolute radiometric uncertainty (ARD) performance for J1 and J2 VIIRS TEB**

# Spectral Performance

- **J2 VIIRS spectral performance - as good as J1**
  - Successful measurements with NASA GLAMR (same system to be used for future JPSS/VIIRS, Landsat/OLI, and PACE/OCI testing)
  - **Official RSRs**
    - V1: released in August 2018 (SpMA data)
    - V2: to be released in June, 2019 (SpMA + GLAMR measurements)
  - Minor non-compliances for DNB CW and M14 and I5 BW

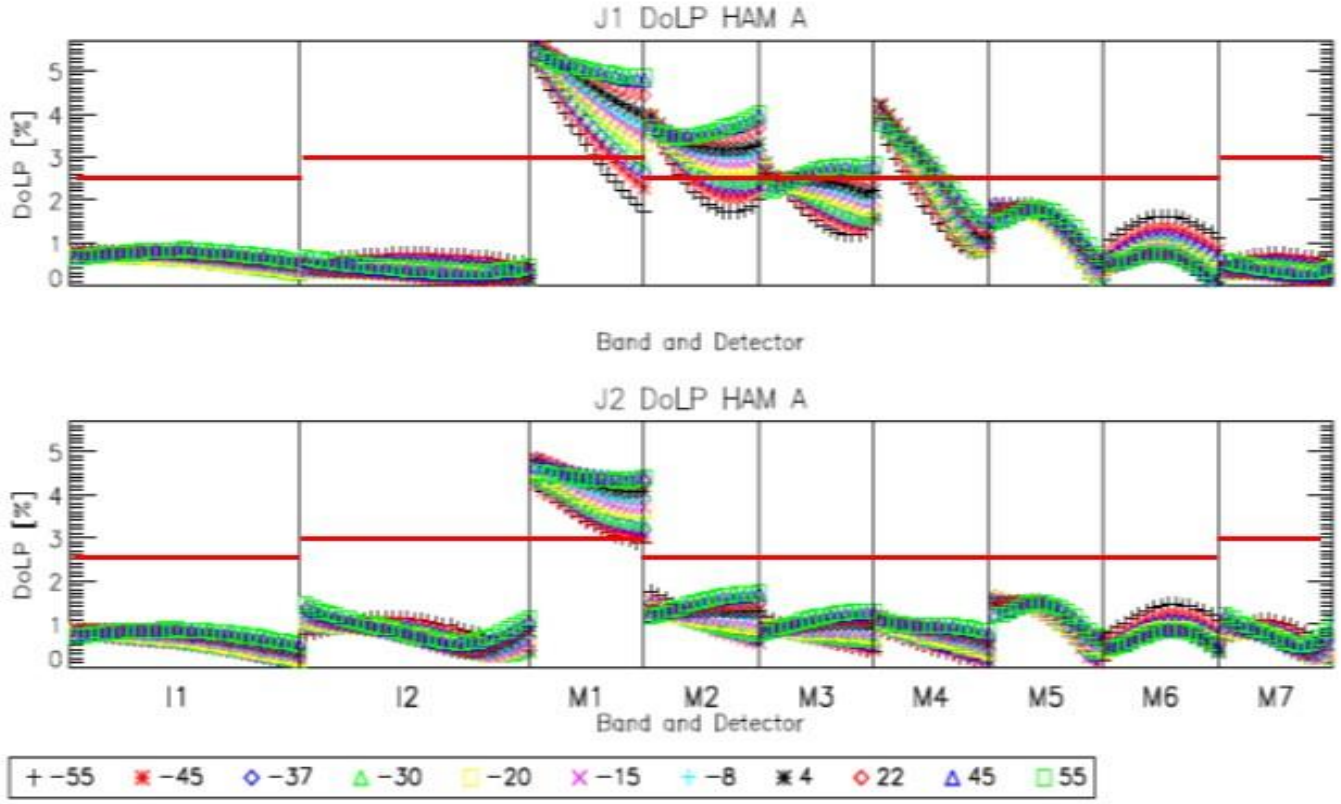



**SIRCUS:** Spectral irradiance and Radiance Calibrations with Uniform Sources
**GLAMR:** Goddard Laser for Absolute Measurement of Radiance



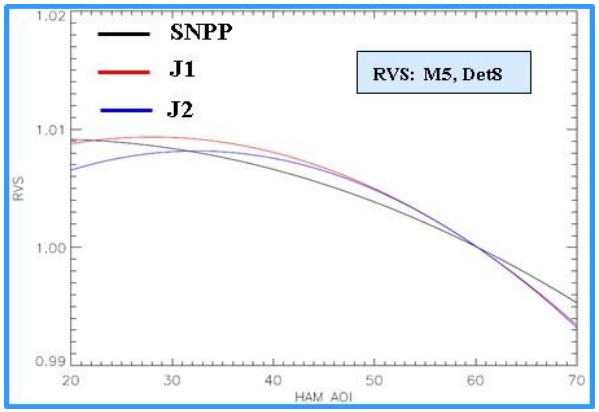
# Polarization Characterization

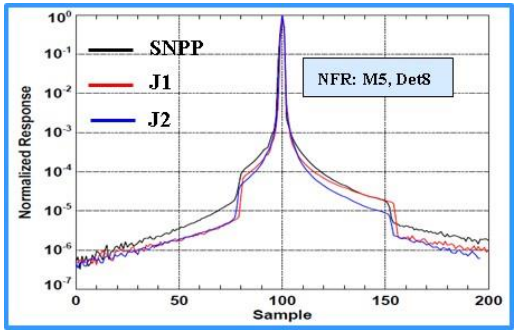
- Improved polarization performance with lessons from J1 and redesigned filters
- Non-compliance: M1 DoLP up to 5% (J1: M1-M4 failed to meet the spec)

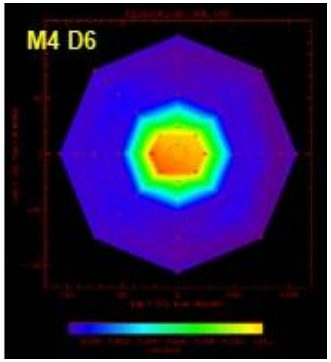


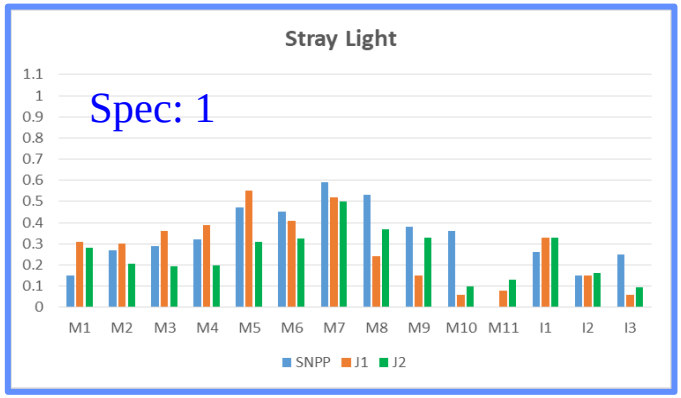
# Other Key Performance Parameters

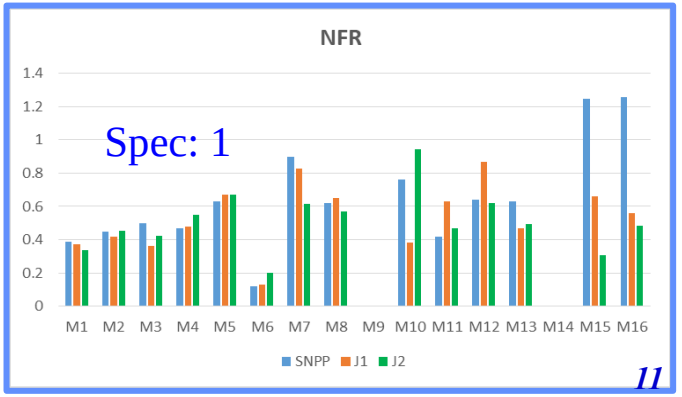
- Response Versus Scan-angle (RVS)
  - Uncertainty is under 0.06% for all RSB bands (vendor UC budget allocation: 0.3%) and under 0.15 % for all TEB bands except 0.6% for M14 (UC budget allocation: 0.2%)
  - Less HAM side differences than J1
- Stray Light
  - Near Field Response (NFR) and Stray Light Rejection are comparable to SNPP and J1
    - Meet SLR specification at BOL
    - M5 and M7 are predicted to fail the SLR requirements at the EOL



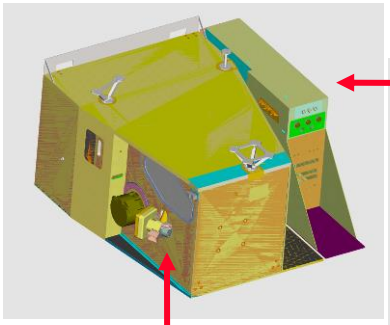
# Summary

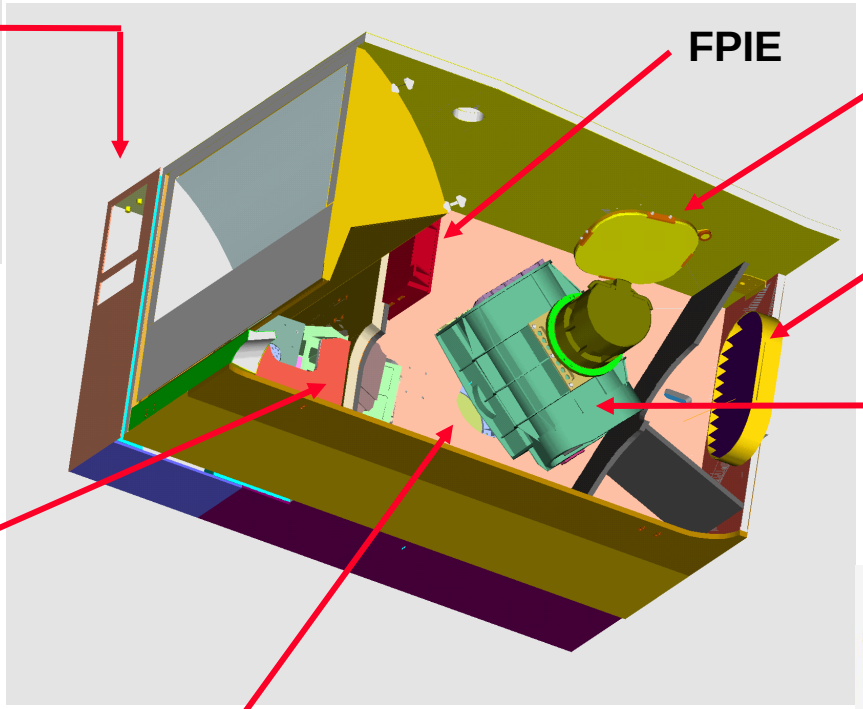
- **J2 VIIRS pre-launch test program executed as planned**
  - Overall performance is good and as expected based on the results derived from sensor TVAC testing
  - A number of improvements made to address issues identified in J1 VIIRS
  - A few non-compliances (less than J1) identified and reviewed with impacts assessed and mitigation strategies implemented
  - Lessons from S-NPP/J1/J2 to be applied for J3/J4 VIIRS (in I&T/develop phase)
  - Ready for spacecraft I&T (regular checkouts during storage)
  - Additional work on DNB stray light reduction proposed based on lessons from S-NPP and N-20 DNB performance (NASA code 300 review on April 4, 2019)

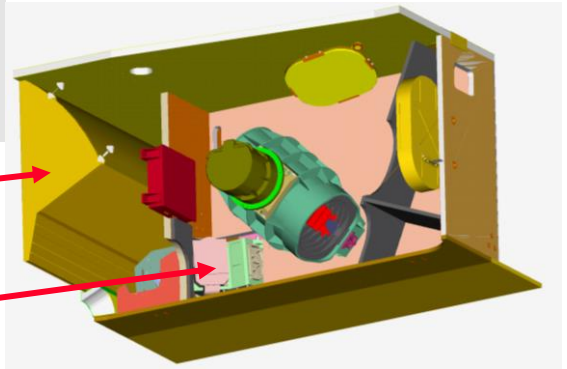
# *Backup Slides*

# VIIRS Instrument and On-board Calibrators

**Strong MODIS Heritage (Raytheon)**







Solar Diffuser

FPIE

Blackbody

Solar Diffuser
Stability Monitor

3-Mirror Anastigmat
All reflective
Rotating telescope

4-Mirror Anastigmat
All Reflective
Aft Optics Imager

Half-angle Mirror

Cryoradiator

Cold FPA
Dewar Assembly

Sensors with Comprehensive On-orbit Calibration Capability
→ Extensive Pre-launch Tests