# VIIRS Sensor Radiometric Performance Overview

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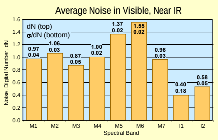
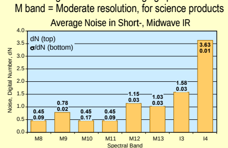
**Northrop Grumman Space Technology:** David Lewis, Steve Mills, Jim McCarthy, Justin Diehl, Mau Song Chou, Gary Grimm, Jackie Jaron, Rush Patel

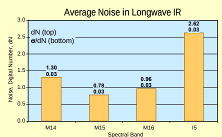
**Raytheon Space and Airborne Systems:** Brendan Robinson


## VIIRS Radiometric Noise Performance Characterized

- Radiometric performance noise data from VIIRS Flight Unit 1 Ambient Phase 1, 2 testing
- Noise data is in Digital Number, dN
  - Data is 12 bits, saturation dN level is 212 = 4096
  - Noise values are averaged over all detectors
    - Multiple scan average
  - Noise data taken in diagnostic mode data with no aggregation- Noise in Agg zones 3 and 2 is lower
  - Band designation: I band = Imaging spatial resolution, M band = Moderate resolution, for science products




***VIIRS radiometric noise performance supports required SNRs***

## VIIRS Signal to Noise Ratio Performance Exceeds Requirements

| | | Band | Wave-length (µm) | Driving EDRs | Gain Range | Lmax or Tmax | Ltyp or Ttyp | FU w/ MIB Fix, F/: 6.20 — SNR @ Ltyp or NEDT(K) @ Ttyp: Required | Performance | SNR Margin (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| VIS/NIR FPA | Silicon PIN Diodes | M1 | 0.412 | Ocean Color | High | 135.0 | 44.9 | 352 | 741 | 110.4 |
| | | | | Aerosols | Low | 615.0 | 155.0 | 316 | 1251 | 295.6 |
| | | M2 | 0.445 | Ocean Color | High | 127.0 | 40.0 | 380 | 459 | 20.7 |
| | | | | Aerosols | Low | 687.0 | 146.0 | 409 | 941 | 130.1 |
| | | M3 | 0.488 | Ocean Color | High | 107.0 | 32.0 | 416 | 589 | 41.6 |
| | | | | Aerosols | Low | 702.0 | 123.0 | 414 | 916 | 121.2 |
| | | M4 | 0.555 | Ocean Color | High | 78.0 | 21.0 | 362 | 517 | 42.8 |
| | | | | Aerosols | Low | 667.0 | 90.0 | 315 | 782 | 148.0 |
| | | I1 | 0.640 | Imagery | Single | 718.0 | 22.0 | 119 | 192 | 61.6 |
| | | M5 | 0.672 | Ocean Color | High | 59.0 | 10.0 | 242 | 357 | 47.4 |
| | | | | Aerosols | Low | 651.0 | 68.0 | 360 | 644 | 78.8 |
| | | M6 | 0.746 | Atmospheric Corr'n | Single | 41.0 | 9.6 | 199 | 356 | 78.9 |
| | | I2 | 0.865 | NDVI | Single | 349.0 | 25.0 | 150 | 274 | 82.4 |
| | | M7 | 0.865 | Ocean Color | High | 29.0 | 6.4 | 215 | 448 | 108.5 |
| | | | | Aerosols | Low | 349.0 | 33.4 | 340 | 583 | 71.3 |
| | CCD | DNB | 0.700 | Imagery | Variable | 500.0 | 6.67E-05 | 5.0 | 5.7 | 14.0 |
| S/MWIR | PV HgCdTe (HCT) | M8 | 1.240 | Cloud Partical Size | Single | 164.9 | 5.4 | 74 | 235 | 216.9 |
| | | M9 | 1.378 | Cirrus/Cloud Cover | Single | 77.1 | 6.0 | 83 | 207 | 150.3 |
| | | I3 | 1.610 | Binary Snow Map | Single | 72.5 | 7.3 | 6 | 164 | 2639.2 |
| | | M10 | 1.610 | Snow Fraction | Single | 71.2 | 7.3 | 342 | 600 | 75.2 |
| | | M11 | 2.250 | Clouds | Single | 31.80 | 0.12 | 10 | 25 | 150.2 |
| | | M12 | 3.700 | SST | Single | 353 | 270 | 0.396 | 0.163 | 143.3 |
| | | I4 | 3.740 | Imagery Clouds | Single | 353 | 270 | 2.500 | 0.503 | 396.8 |
| | | M13 | 4.050 | SST | High | 343 | 300 | 0.107 | 0.050 | 112.1 |
| | | | | Fires | Low | 634 | 380 | 0.423 | 0.263 | 60.6 |
| LWIR | PV HCT | M14 | 8.550 | Cloud Top Properties | Single | 336 | 270 | 0.091 | 0.062 | 46.5 |
| | | M15 | 10.763 | SST | Single | 343 | 300 | 0.070 | 0.028 | 146.7 |
| | | I5 | 11.450 | Cloud Imagery | Single | 340 | 210 | 1.500 | 0.348 | 330.7 |
| | | M16 | 12.013 | SST | Single | 340 | 300 | 0.072 | 0.040 | 77.8 |

← Lowest margin above spec: 20.7% for M2

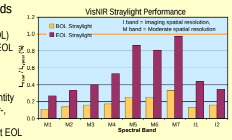
← Lowest margin above spec: 14% for Day Night Band

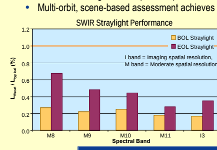
Update: November 2008

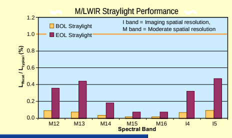
***VIIRS SNR performance meets requirements with margin***
***Based on Flight Unit and Engineering Development Unit test data and analysis***

## VIIRS Far-Field Straylight Performance Expected to Meet Spec

- Straylight characterized for VisNIR S/M/LWIR bands
  - Far-field Straylight Performance for VIIRS Flight Unit 1
    - VisNIR is Ambient Test data scaled to End of Life (EOL)
    - S/M/LWIR performances is calculated and scaled to EOL
    - Requirement is 1% at EOL
  - Spec performance is scenario dependent due to $L_{ffscat}$ and $L_{typical}$
    - $L_{typical}$ is "typical" scene spectral radiance, a spec quantity
  - Credible scene-based scenarios identified for Visible, Near-, Short-, Mid- and Longwave IR spec compliance
    - Multi-orbit, scene-based assessment achieves spec at EOL



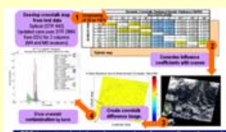



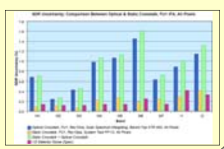

***VIIRS Far-field Straylight performance <1% at EOL***

## The Impact of Optical Crosstalk on Flight 1 Sensor Data Record (SDR) and Environmental Data Records (EDRs) Has Been Characterized

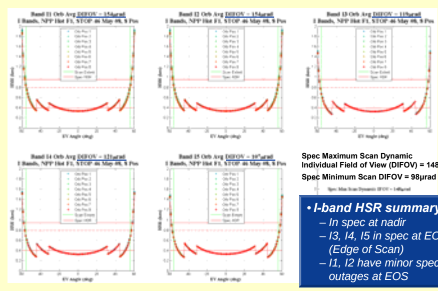
- Optical Crosstalk in VisNIR FPA
  - Optical crosstalk dominates over static and dynamic electric crosstalk on F1
  - Crosstalk source is scattering in Integrated Filter Assembly- Corrected by new hardware installed for Flight 2+
  - Characterized through extensive testing and analysis
  - Impact on SDR/EDR data products quantified through working group meetings
    - Methodology summarized at right
    - Uses MODIS proxy data and Global Synthetic Data
    - Relative Spectral Response (RSRs) measured during F1 testing
- SDR Impact of Optical Crosstalk characterized
  - SDR impact results summarized at right
- EDR Impact of optical crosstalk characterized
  - No significant impact on VIIRS Cloud Mask, Aerosols, and Land Products
  - Ocean Color precision errors mitigated byRSRs used in Atmospheric Correction algorithm



*EDR impact analysis based on mapping of crosstalk senders and receivers superimposed on proxy scene data*



## I-bands NPP FU1 Hot Orbit Scan Direction Horizontal Spatial Resolution (HSR)

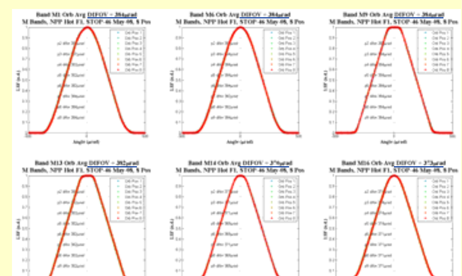


**Spec Maximum Scan Dynamic Individual Field of View (DIFOV) = 148µrad**

**Spec Minimum Scan DIFOV = 98µrad**

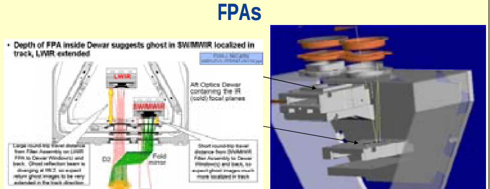
- ***I-band HSR summary***
  - *In spec at nadir*
  - *I3, I4, I5 in spec at EOS (Edge of Scan)*
  - *I1, I2 have minor spec outages at EOS*

## M-band Flight Unit 1 Scan Direction Dynamic Individual Fields of View (DIFOVs)



***M-band DIFOVs meet spec = 393µrad***

## Radiometric Artifacts Caused by Reflections from Dewar Windows onto Short-, Mid- and Longwave IR FPAs

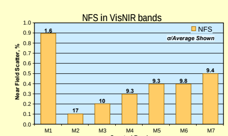


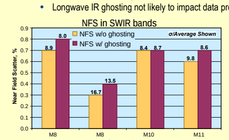

- **Ghosting identified as reflection of Out of Band (OOB) light off Short-, Mid- and Longwave IR Integrated Filter Assembly (IFR) surfaces and reflected back by dewar windows to adjacent bands and detectors on Focal Plane Arrays (FPAs)**
- **Larger spread angle expected for LWIR due to a larger separation between IFA and dewar windows**
  - As observed in the analysis
  - See drawing above
- **Two Independent analysis methods used to quantify "Ghosting" radiometric artifact**
  - Ray trace analysis performed by Raytheon-used for Short-, Mid- and Longwave IR bands
  - Semi-empirical spatial crosstalk formalism developed by NGST and analysis independently

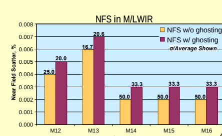
***"Ghosting" radiometric artifact is small compared to Near Field Scattering***

## VIIRS Near-Field Scattering (NFS) Quantified

- VIIRS Near-Field Scatter measured during Ambient Phase 1, 2 Testing
  - Optical ghosting from dewar window reflections noted in S/M/LWIR bands (EFR 3326)
  - NFS and ghosting analyzed by multiple teams
- Status of NFS and Ghosting Impact Analysis
  - Initial Sensor Data Record (SDR), and SST data product impact assessments performed
    - Recent SDR impact results presented here
      - Based on 2 orbits, 422 granules of proxy data
    - Impacts on science algorithm chain underway
    - Longwave IR ghosting not likely to impact data products

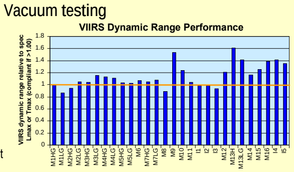



## VIIRS Dynamic Range Capability Spans the Range of Observed On-orbit Radiances

- VIIRS Dynamic Range capability established during Thermal Vacuum testing
  - Current performance summary at right
    - Data from Flight Unit and Engineering Development Unit
    - 16 bands meet or exceed spec
    - 6 bands show ≥85% capability against spec
      - M1HG, M2HG no signficant impact for Ocean Color
  - Several bands have Lmax values that exceed credible scene maximum limits
    - M1LG
    - M8
    - I1, I2, I3




***VIIRS Dynamic Range capability meets the range of observed earth scene radiances***