VIIRS Performance Status Summary

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NPP VIIRS Calibration and Characterization (NVCC)
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Objective - General Comments

- **Objective: Present NASA data processing results based on the VIIRS FU1 Ambient testing, and share our assessments with NASA at-large Subject Matter Experts (SMEs) for SDRs and EDRs.**

- **These results are not meant to represent VIIRS sensor performance sell-off:**
  - NASA NPP L1 Team is still participating in the on-going VIIRS Program Ambient Test Data Reviews (NASA, IPO, NGST and SBRS)
  - End of Life performance still needed
  - Some specifications sell-off will be determined after TV testing

- **Raytheon SBRS has been leading the VIIRS testing program for NGST prime contractor, but program has now transitioned to Raytheon El-Segundo for all forthcoming testing**

- **NASA Science interaction with VIIRS sensor team facilitated through IPO Government teams and NGST/SBRS team**

VIIRS FU-1 Testing Schedule

- FU-1 Ambient Testing Complete:
  - Phase I testing: 06/20/07 – 08/29/07
  - Phase II testing: 08/29/07 – 11/30/07
  - Phase III testing: 01/28/08 – 04/18/08

- FU-1 Thermal Vacuum (TV) Schedule:
  - Pre-TV testing: 08/01/08 – 08/17/08
  - TV testing: 08/20/08 – 12/03/08

FU-1 testing complete and Ready to Ship: 02-24-09

Schedule current as of April 23rd

VIIRS Bands and Products

VIIRS 22 Bands:

16 M_ Band, 5 I_Band and 1 DNB

VIIRS Band	Spectral Range (um)	Nadir HSR (m)	MODIS Band(s)	Range	HSR
DNB	0.500 - 0.900				
○ M1	0.402 - 0.422	750	8	0.405 - 0.420	1000
○ M2	0.436 - 0.454	750	9	0.438 - 0.448	1000
○ M3	0.478 - 0.498	750	3 10	0.459 - 0.479 0.483 - 0.493	500 1000
○ M4	0.545 - 0.565	750	4 or 12	0.545 - 0.565 0.546 - 0.556	500 1000
I1	0.600 - 0.680	375	1	0.620 - 0.670	250
○ M5	0.662 - 0.682	750	13 or 14	0.662 - 0.672 0.673 - 0.683	1000 1000
M6	0.739 - 0.754	750	15	0.743 - 0.753	1000
I2	0.846 - 0.885	375	2	0.841 - 0.876	250
○ M7	0.846 - 0.885	750	16 or 2	0.862 - 0.877 0.841 - 0.876	1000 250
M8	1.230 - 1.250	750	5	SAME	500
M9	1.371 - 1.386	750	26	1.360 - 1.390	1000
I3	1.580 - 1.640	375	6	1.628 - 1.652	500
M10	1.580 - 1.640	750	6	1.628 - 1.652	500
M11	2.225 - 2.275	750	7	2.105 - 2.155	500
I4	3.550 - 3.930	375	20	3.660 - 3.840	1000
M12	3.660 - 3.840	750	20	SAME	1000
○ M13	3.973 - 4.128	750	21 or 22	3.929 - 3.989 3.929 - 3.989	1000 1000
M14	8.400 - 8.700	750	29	SAME	1000
M15	10.263 - 11.263	750	31	10.780 - 11.280	1000
I5	10.500 - 12.400	375	31 or 32	10.780 - 11.280 11.770 - 12.270	1000 1000
M16	11.538 - 12.488	750	32	11.770 - 12.270	1000

○ **Dual gain band**

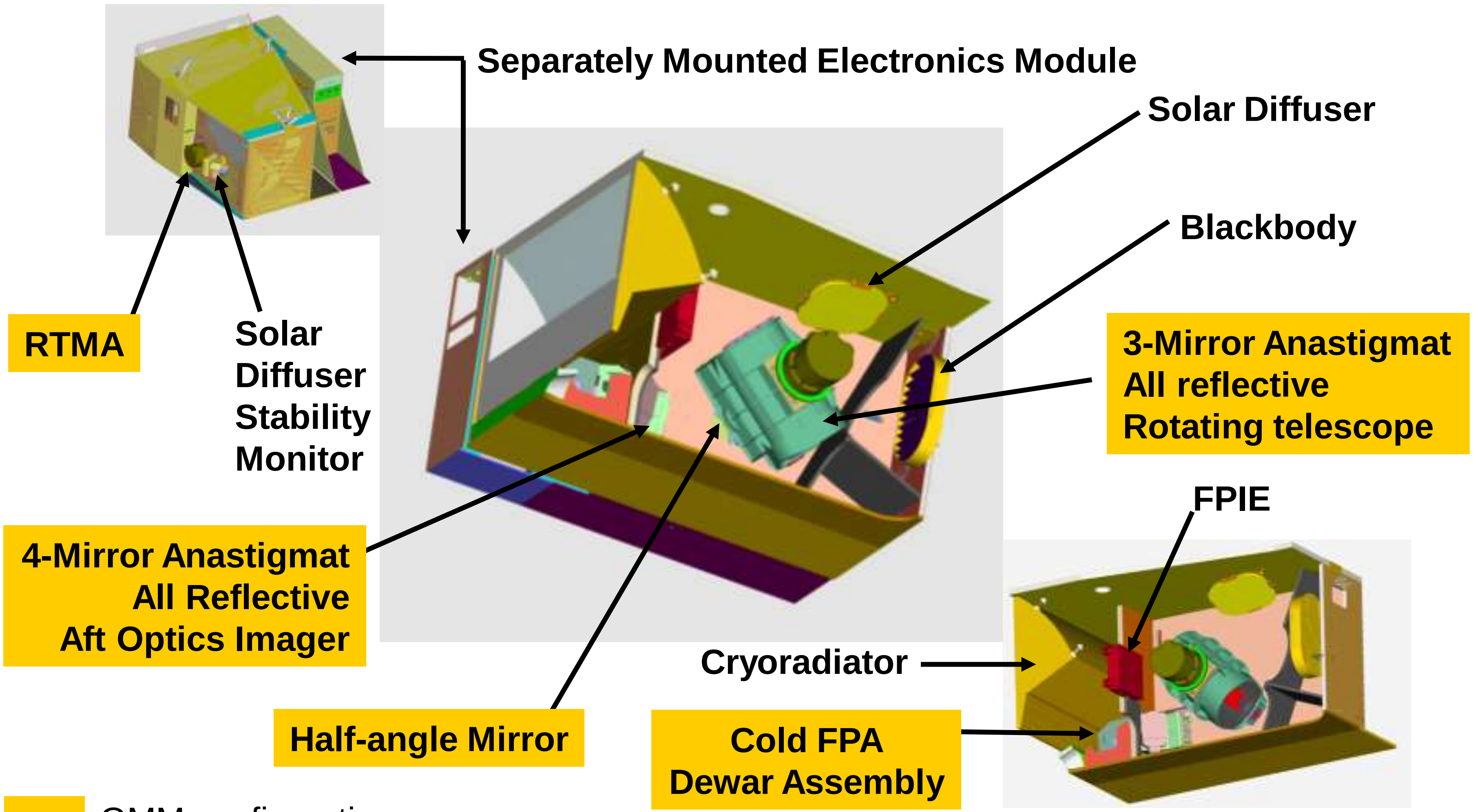
VIIRS 24 EDRs

Land, Ocean, Atmosphere, Snow

Name of Product	Group	Type
Imagery *	Imagery	EDR
Precipitable Water	Atmosphere	EDR
Suspended Matter	Atmosphere	EDR
Aerosol Optical Thickness	Aerosol	EDR
Aerosol Particle Size	Aerosol	EDR
Cloud Base Height	Cloud	EDR
Cloud Cover/Layers	Cloud	EDR
Cloud Effective Particle Size	Cloud	EDR
Cloud Optical Thickness/Transmittance	Cloud	EDR
Cloud Top Height	Cloud	EDR
Cloud Top Pressure	Cloud	EDR
Cloud Top Temperature	Cloud	EDR
Active Fires	Land	Application
Albedo (Surface)	Land	EDR
Land Surface Temperature	Land	EDR
Soil Moisture	Land	EDR
Surface Type	Land	EDR
Vegetation Index	Land	EDR
Sea Surface Temperature *	Ocean	EDR
Ocean Color and Chlorophyll	Ocean	EDR
Net Heat Flux	Ocean	EDR
Sea Ice Characterization	Snow and Ice	EDR
Ice Surface Temperature	Snow and Ice	EDR
Snow Cover and Depth	Snow and Ice	EDR

* Product has a Key Performance attribute

VIIRS Incorporates Modular Sensor Approach



OMM configuration

VIIRS Performance Summary

Radiometric Response:

Dynamic Range, Gain Transition and SNR/NeDT

- **All VIIRS bands meet SNR/NeDL/NeDT specifications**
- **All of VIIRS bands meet the Dynamic range and Transition requirements, except:**
  - M1 High Gain transition:

Band	Wavelength	L_max	L_transition	Ratio
M1	0.412	135	121	0.9

  - M1 and M2 Low Gain early saturation:

Band	Wavelength	L_max	L_sat	Ratio
M1-LG	0.412	615	529	0.86
M2-LG	0.445	687	680	0.99

  - M8 early saturation:

Band	Wavelength	L_max	L_sat	Ratio
M8	1.24	164.9	132	0.80

  - I1, I2, I3, I4 meet dynamic range, but margin is less than 1%. Need TV testing to determine compliance.

Response Vs. Scan (RVS)

- **Reflective bands RVS:**
  - **All bands RVS meet uncertainty spec:**
    - RSB RVS Spec: 0.3 %
    - Uncertainty for fit residual: <0.06 %
    - Uncertainty for fit residual + measurement: <0.22 %
  - Correction of the illumination response drift led to RVS compliance.
  - M9 water absorption correction was applied, improving the RVS uncertainty to meet spec
    - Government approach: Uncertainty < 0.1 %
    - SBRS approach: Uncertainty < 0.18 %
- **Thermal Emissive bands RVS:**
  - **All bands RVS meet uncertainty spec:**
    - TEB RVS Spec: 0.2 % (M14: 0.6 %)
    - Fit residuals <0.07%
    - Measurement repeatability <0.15%

Stray Light Rejection (SLR)

- **Multiple studio lamp positions (33) were used to simulate Earth radiance for stray light contamination**
  - Spec: 1% of Ltyp
  - Spec only for reflective bands (M1-M11, I1-I3)
  - View angle range: 4 – 28degrees
- **SLR testing was performed in 3 telescope positions**
  - Nadir, End of Scan, and Space View
- **SLR analysis results are showing non compliance for 4 bands: M5-M7 and M11**
- **A waiver is proposed to relax the SLR requirements leading to spec compliance at the end-of-life.**
- **EDR impact assessments is needed using MODIS and/or synthetic data**
  - **Need to integrate between lamp positions to reflect Cloud surfaces**

Near Field Response (NFR)

- **Near Field response requirement limit the amount of scattered light into a detector from a bright target.**
- **FU1 NFR analysis has shown non compliance for many bands: M1-M5, M7-M8, M11-M12, I1**
- **A waiver was proposed limiting the radiance values for bright targets, and deletion of I1-I3 bands NFR spec.**
  - Simulations based on new proposed spec, and the sensor model calculation have shown **margin improvements.**
  - NFR non compliance still observed for many bands: M4,M5, M7, M8, M11, M12, M13.
- **Ghosting is observed for many SMWIR and LWIR bands. Impact on EDRs is ongoing (EFR3326).**

Polarization Sensitivity

- **VIIRS Polarization analysis using the polarized sheet is still ongoing.**
  - Preliminary results are good and promising, showing compliance for polarization factor.
  - Still need to verify compliance for polarization characterization (0.5%)
  - Test data analysis has shown detector dependency of VIIRS polarization, not supported by the current model.
- **Some light leak issues related to the use of SIS source with polarized sheet are being investigated to determine correction factors (e.g M1).**

Spatial Characterization

- **Band to Band Registration (BBR):**
  - All VIIRS band-pairs meet BBR specification for intra M-bands and intra I-bands
  - Very low margin for 3 band pairs: I5-I1, I5-I2 and I5-I4
- **IFOV/DFOV Characterization**
  - Scan DFOV Spec is not met for majority of detectors
  - Track IFOV is met for all detectors except 3 detectors.
  - Thermal Vac. testing is expected to improve margins for Track IFOV.
- **MTF/LSF Characterization**
  - Scan MTF Spec is met for majority of M-band detectors
  - Track MTF meets spec for all M-bands.
- **Pointing characterization:**
  - FU1 meets specifications

Dynamic Crosstalk

- **Dynamic crosstalk (VisNIR):**
  - No spec for dynamic crosstalk
  - General agreement to the expected low dynamic crosstalk level (FU1 bond wire fix).
  - Most sender/receiver band pairs have coefficients much smaller than 0.001
  - Some band pairs are showing few detectors with crosstalk coefficients little larger than 0.001
  - Crosstalk coefficients are showing some detector dependency, especially for most affected band pairs.
  - Fixed low gain is showing lower crosstalk coefficients than HG
  - Dynamic crosstalk linearity was observed for many VisNIR bands.

Based on EDU crosstalk analysis, crosstalk specifications are being reviewed to make them consistent, realistic and specific to each crosstalk type.

Static Electric Crosstalk

– VisNIR

- Stringent crosstalk specification (0.2%Ltyp) are not met for all VIIRS bands
- The electric crosstalk levels are much smaller than those observed in optical crosstalk
- Crosstalk map is showing high sender detectors (e.g. det 3, 8 and 13 for M-bands and 6, 16, 26 for I-bands)
- High crosstalk at -/+N detector from the sender, and dependency on the sub-sample for I-bands are shown
- Low gain crosstalk coefficients are higher than those from high gain

– SMWIR

- Specification not met for all bands, but small crosstalk coefficients. No high sender detectors.
- Low gain is showing M1, M2 and M3 as very high senders into most SMWIR bands and detectors.
- In-band crosstalk is very high for M13 band in fixed low gain

– LWIR

- Specification not met, but very small electrical crosstalk. No high sender detectors.

Based on EDU crosstalk analysis, crosstalk specifications are being reviewed to make them consistent, realistic and specific to each crosstalk type.

VisNIR Optical Crosstalk

- Stringent optical crosstalk specification (0.2%Ltyp or 0.5NedL) is not met for any VIIRS band (STR406 and STR443)
- Based on ambient test results, FU-1 optical crosstalk is significant for many VisNIR bands.
- Uncertainties associated with test artifacts, the current optical/electronic de-convolution approach, and application to SDR/EDRs (Filter Spread Function) limit our understanding of final crosstalk impacts.
- Current EDR assessments have shown large impact on Ocean Color and high risk for Aerosol products
- Baseline testing of FU1 optical crosstalk is planned in Pre-TV (e.g FP-15, FP16)
- Further EDR impact assessments based on the combined future optical xtalk maps, as well as electric and dynamic crosstalk still to be finalized between NASA, NGST and IPO.

Based on EDU crosstalk analysis, crosstalk specifications are being reviewed to make them consistent, realistic and specific to each crosstalk type.

Four Major VIIRS Issues (EFRs)

1- Thermal Emissive Calibration (EFR2386)

- EDU Emissive bands calibration spec is not met for 3 bands (M12, M13 and M14)
- Large quadratic fit residuals and inconsistency between BCS and OBB calibration.
- FU1 TV does now include additional testing to investigate this EFR

2- Reflective Band Uniformity (EFR2384)

- EDU bands uniformity has shown non compliance for many bands (M4-M5, M7-M11, and I1-I3)
- NGST team recently provided a new data processing approach currently being reviewed by the government team.
- Verification of this approach is needed for FU1 TV

3- Ghosting in FU1 Emissive Bands (EFR3326)

- Root cause identified and characterization is ongoing based on ambient data
- Impact on FU1 EDRs is still to be completed.

4- Transition Noise and Linearity (EFR2129)

- EDU data have shown large noise increase (4X) at gain transition for dual gain bands.
- Noise is affecting a limited area of the radiance located at ~10% below HG Lmax
- Non-linearity increase (1%) is leading to non-compliance for calibration
- Need to complete characterization of this artifact for FU1 and assess impact on EDRs
- Land, Aerosol and Cloud pixels will have high probability to be affected

Other VIIRS Science Issues

(Joint Government List)

In addition to the four EFRs in the previous slide, NASA team is also tracking and updating 10 other FU-1 Risk Items

1)	VisNIR IFA Optical Crosstalk	Pre-TV
2)	VisNIR ROIC Static Electronic Crosstalk	Amb
3)	VisNIR Dynamic Crosstalk	Amb
4)	Stray Light Contamination	Amb
5)	Relative Spectral Response (RSR) Measurements	Pre-TV
6)	End-to-End Calibration (SD-SAS-SDSM)	Amb
7)	Sensor Stability (Temperature, SC voltage, EMI/EMC)	TV
8)	Response Versus Scan (RVS) Angle Verification	Amb
9)	Polarization Sensitivity characterization	Amb
10)	Ambient to T/V to On-orbit Spatial Performance	TV

Items not yet in priority order

Backup Slides

FU1 Sensor Test Flow

◇ = Consent to Break/Proceed

Opto-Mech Module CTI

Electronics Module CTI

OMM Mechanical Integration

FU1 TRR

Safe-to-Mate Tests
SI1, SI-7 Isolation and Continuity

Ambient Phase I Tests
SI-4 Commands and Telemetry
SI-2 Electronics Throughput
FP-5 Pointing Knowledge
SI-5 Electronics Self Test
SI-6 Noise Test
RC-1 Dynamic Range
FP-1 BB Functional and DC Restore
FP-4 Spectral Band Registration
FP-6 MTF and HSR

Ambient Phase II Tests
FP-11 Polarization Insensitivity
FP-14 Near Field Response
FP-10 Response vs. Scan Angle
FP-9 Operational Modes
FP-8 Power Profile
FP-12 Stray Light Rejection
FP-7 Mechanical Functions
FP-2 SD Operation SDSM Functional
FP-5 Pointing Knowledge

EMI Tests in El Segundo

Vibe Tests in El Segundo

Post Vibe/Pre TV Tests
SI1, SI-7 Isolation and Continuity
SI-4 Commands and Telemetry
SI-5 Electronics Self Test
SI-6 Noise Test
FP-2 SD Operation and SDSM Functional
FP-5 Pointing Knowledge
FP-7 Mechanical Functions
FP-6 MTF and HSR Warm FPAs
FP-3 Crosstalk Warm FPAs
FP-15 Relative Spectral Resp Warm FPAs
FP-16 Out-of-Band Spectral Resp Warm FPAs

TV Test
SI-4 Commands and Telemetry
SI-5 Electronics Self Test
SI-6 Noise Test
FP-3 Crosstalk CFPAs
FP-4 Spectral Band Registration
FP-6 MTF and HSR
FP-7 Mechanical Functions
FP-9 Operational Modes
FP-15 Relative Spectral Response CFPAs
FP-16 Out-of-Band Spectral Resp CFPAs
RC-2 Reflective Calibration
RC-3 Radiometric Stability
RC-5 Emissive Calibration
Thermal Cycling, Thermal Balance

Post TV Tests
FP-7 Mechanical Functions
FP-5 Pointing Knowledge
FP-17 Mass Properties
Bench Acceptance Tests (BAT)

PSR

NPP VIIRS Sensor

- **<u>Purpose:</u>** Global observations of land, ocean, & atmosphere parameters at high temporal resolution (~ daily)
- **<u>Predecessor Instruments:</u>** AVHRR, OLS, MODIS, SeaWiFS
- **<u>Management</u>:** IPO
- **<u>Status</u>:** Phase C/D (Raytheon)
- **<u>Approach:</u>** Multi-spectral scanning radiometer (22 bands between 0.4 µm and 12 µm) 12-bit quantization
- **<u>Swath width:</u>** 3000 km

Orbit: 1:30 pm
Altitude: 833 km
Polar Sun-Synch
Launch: 06/2010

Dimension: 134x141x85 cm
Mass: 275 kg
Power: 200 W
Data Rate: 10.5 peak/8 Mbps

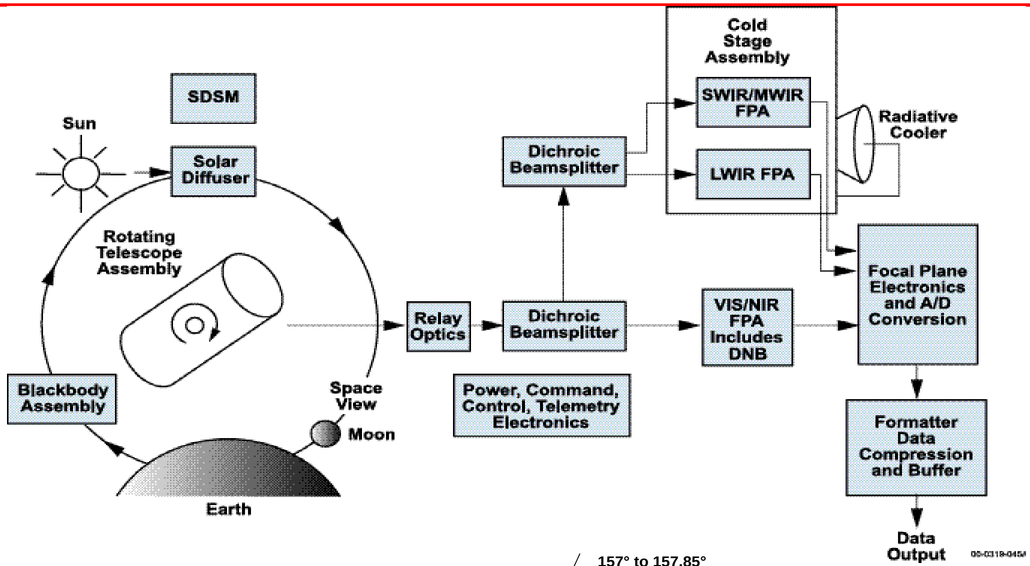
Calibration Requirements

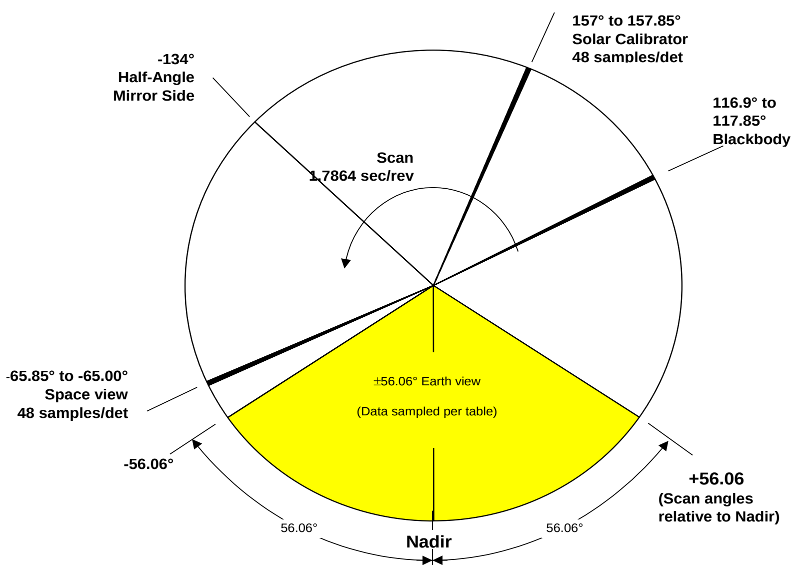
- RSB Calibration: < 2% Uniform scenes
- TEB Calibration: See Table #1 in Back up
- Non-linearity: 1%
- Stability: 0.3%
- Stray Light: <1% Ltyp
- Polarization: M2-6: <2.5% ; M1,M7: <3%
- RVS: Vis/NIR: 0.3% ; SWIR: 0.2%
- Crosstalk: 0.002 Ltyp or 0.5NEDL

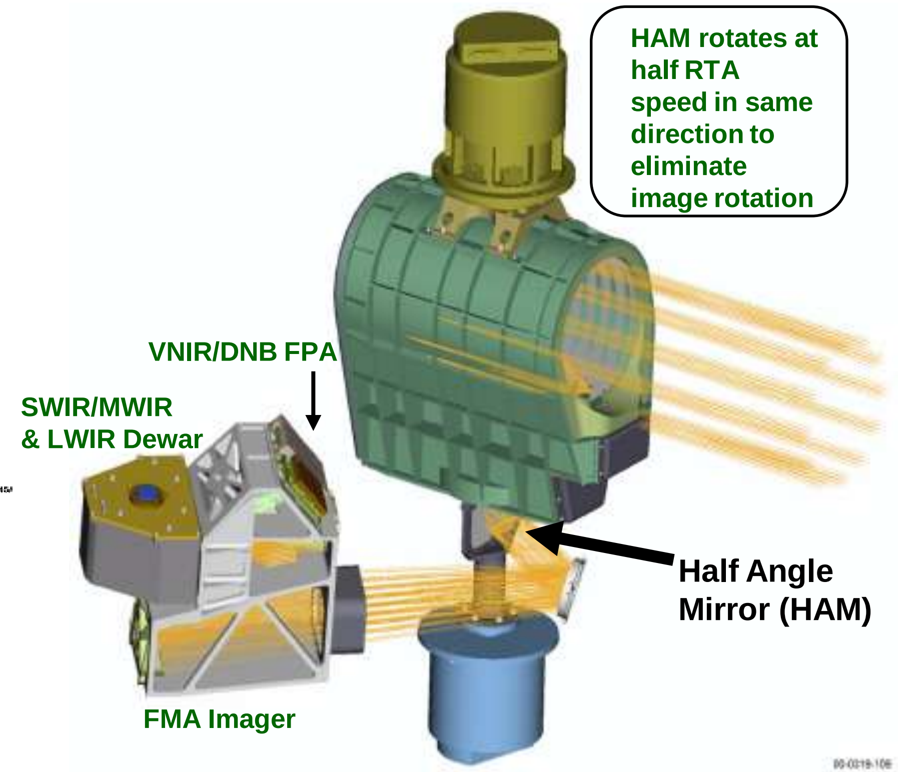
Full Requirement list in the Sensor Spec Document

- **Environmental Data Records (EDRs) are Similar to CEOS/NASA Level 2**
- **NPP will provide 25 of 55 NPOESS EDRs**

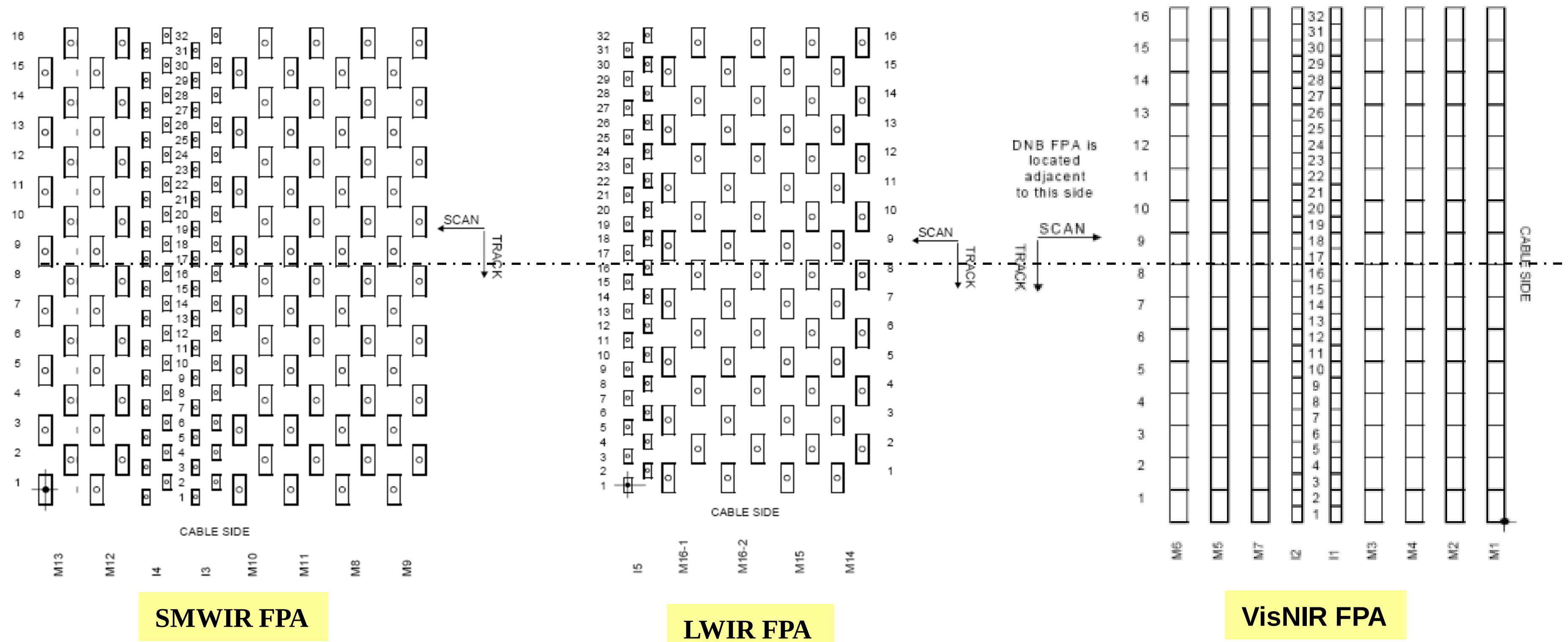
VIIRS Sensor Photons to DN Out







VIIRS Band/Detector Physical Layout



NASA L1 Science Team

Name	Org	Test Interest	Test Assignment	email	Phone
			NASA Team		
Barnes, Robert	*SAIC*	Spectral Test	FP15, FP16, FP11	rbarnes@seawifs.gsfc.nasa.gov	301-286-0501
Butler, James	*GSFC*	BB and SD functional	FP1	James.J.Butler@nasa.gov	301-614-5942
Che, Nianzeng	*SSAI*	*Crosstalk, Spectral, Calibration*	FP13, XTALK STRs, FP14, FP15, FP16, RC1	nianzeng_che@ssaihq.com	301-867-6298
Chiang, Vincent	*SSAI*	*Radiometry*	XTALK STRs, RC1	vincent_chiang@ssaihq.com	301-867-6335
Dorman, Tomothy	*SSAI*			timothy_dorman@ssaihq.com	
Eplee, Gene	*SAIC*	*Vis/Nir radiometry/Polariz.*	FP1	eplee@seawifs.gsfc.nasa.gov	*301-286-0953*
Esaias, Wayne	*GSFC*	Vis/Nir radiometry/Polariz.	FP12	Wayne.E.Esaias@nasa.gov	301-614-5709
Guenther, Bruce	*UMBC*	Vis/Nir/Swir radiometry	RC1	guenther@ltpmail.gsfc.nasa.gov	301-286-7486
Lin, Gary	*Innovim*			Gary.Lin@nasa.gov	
Liu, Arthur	*SSAI*			arthur_liu@ssaihq.com	
LaPorte, Dan	*U of Wis*	IR radiometry	FP15, FP16	dlaporte@facstaff.wisc.edu	805-967-8058
McCintire, Jeffrey	*SAIC*			jeffrey.w.mcintire@saic.com	
Meister, Gerhardt	*Futuretech*	Spectral Test	FP11	meister@simbios.gsfc.nasa.gov	301-286-0758
Moeller, Christopher	*U of Wis*	*IR radiometry*	FP15, FP16	chrism@ssec.wisc.edu	608-263-7494
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Oudrari, Hassan	*SSAI*	Crosstalk, thermal calibration	XTALK STRs, RC1	hassan.oudrari@gsfc.nasa.gov	301-614-6600
Pan, Chunhui	*SSAI*	Crosstalk, spectral, spatial, radiom	Crosstalk, FP10, RC1, FP4	chunhui_pan@ssaihq.com	301-867-6334
Patt, Fred	*SAIC*	Geolocation, Spatial	FP4, FP5, FP6	fred@seawifs.gsfc.nasa.gov	301-286-5723
Schwarting, Thomas	*SSAI*	Crosstalk, Spectral, Radiometry	FP13, FP14, FP15, FP16, SI6	thomas_schwarting@ssaihq.com	301-867-6336
Sun, Junqiang	*SSAI*	*Radiometry, Calibration*	FP6, FP14, FP12, FP6, SI5	junqiang_sun@ssaihq.com	301-867-6342
Turpie, Kevin	*SAIC*	Vis/Nir/Swir/TIR radiometry	ALL	turpie@gsfc.nasa.gov	301-286-9996
Waluschka, Gene	*GSFC*	Polarization	FP11	Eugene.Waluschka@nasa.gov	301-286-2616
Wolfe, Robert	*GSFC*	Spatial testing	FP4, FP5, FP6	robert.e.wolfe.1@gsfc.nasa.gov	301-614-5508
Xiong, Jack	*GSFC*	Science team	ALL	jxiong@ltpmail.gsfc.nasa.gov	301-614-5957
Xiong, Sam	*SSAI*	Vis/Nir/Swir/TIR radiometry	RC10, FP11, RC1	sanxiong_xiong@ssaihq.com	301-867-6343

Table # 17/18 Emissive Bands Radiometric Calibration Accuracy Requirements

		Scene Temperature				
Band	λ_c (μm)	190K	230K	270K	310K	340K
M12	3.7	N.A.	7.0%	0.7%	0.7%	0.7%
M13	4.05	N.A.	5.7%	0.7%	0.7%	0.7%
M14	8.55	12.3%	2.4%	0.6%	0.4%	0.5%
M15	10.763	2.1%	0.6%	0.4%	0.4%	0.4%
M16	12.013	1.6%	0.6%	0.4%	0.4%	0.4%

Band	Center Wavelength (nm)	Calibration Uncertainty
I4	3740	5.0%
I5	11450	2.5%

Equivalent or Better Performance Was Achieved on MODIS

TABLE 5. VIIRS Spectral band optical requirements

Band	Center Wavelength (nm)	Tolerance on Center Wavelength (± nm)	Bandwidth (nm)	Tolerance on Bandwidth (± nm)	OOB Integration Limits (lower, upper) (nm)	Maximum Integrated OOB Response (%)	Character-ization Uncertainty (nm)
M1	412	2	20	2	≥376, ≤444	1.0	1
M2	445	3	18	2	≥417, ≤473	1.0	1
M3	488	4	20	3	≥455, ≤521	0.7	1
M4	555	4	20	3	≥523, ≤589	0.7	1
M5	672	5	20	3	≥638,≤706	0.7	1
M6	746	2	15	2	≥721, ≤771	0.8	1
M7	865	8	39	5	≥801, ≤929	0.7	1.3
M8	1240	5	20	4	≥1205, ≤1275	0.8	1
M9	1378	4	15	3	≥1351, ≤1405	1.0	1
M10	1610	14	60	9	≥1509, ≤1709	0.7	2.3
M11	2250	13	50	6	≥2167, ≤2333	1.0	1.9
M12	3700	32	180	20	≥3410, ≤3990	1.1	3.7
M13	4050	34	155	20	≥3790, ≤4310	1.3	3
M14	8550	70	300	40	≥8050, ≤9050	0.9	11
M15	10763	113	1000	100	≥9700, ≤11740	0.4	10.8
M16	12013	88	950	50	≥11060, ≤13050	0.4	6
DNB	700	14	400	20	≥470, ≤960	0.1	1
I1	640	6	80	6	≥565, ≤715	0.5	1
I2	865	8	39	5	≥802, ≤928	0.7	1.3
I3	1610	14	60	9	≥1509, ≤1709	0.7	2.3
I4	3740	40	380	30	≥3340, ≤4140	0.5	3.7
I5	11450	125	1900	100	≥9900, ≤12900	0.4	20

[1] The values given under "OOB Integration Limits" are the specified limits on the 1% relative response points.
[2] The OOB integration limits will be the 1% response points determined during sensor characterization.

TABLE 12. Dynamic range requirements for VIIRS Sensor reflective bands

Band	Center Wavelength (nm)	Gain Type	Single Gain Lmin	Single Gain Lmax	Dual Gain High Gain Lmin	Dual Gain High Gain Lmax	Dual Gain Low Gain Lmin	Dual Gain Low Gain Lmax
M1	412	Dual	-	-	30	135	135	615
M2	445	Dual	-	-	26	127	127	687
M3	488	Dual	-	-	22	107	107	702
M4	555	Dual	-	-	12	78	78	667
M5	672	Dual	-	-	8.6	59	59	651
M6	746	Single	5.3	41.0	-	-	-	-
M7	865	Dual	-	-	3.4	29	29	349
M8	1240	Single	3.5	164.9	-	-	-	-
M9	1378	Single	0.6	77.1	-	-	-	-
M10	1610	Single	1.2	71.2	-	-	-	-
M11	2250	Single	0.12	31.8	-	-	-	-
I1	640	Single	5	718	-	-	-	-
I2	865	Single	10.3	349	-	-	-	-
I3	1610	Single	1.2	72.5	-	-	-	-

Spectral radiance (Lmin and Lmax) has units of watt m-2 sr-1 mm-1.

TABLE 13. Dynamic range requirements VIIRS Sensor emissive bands

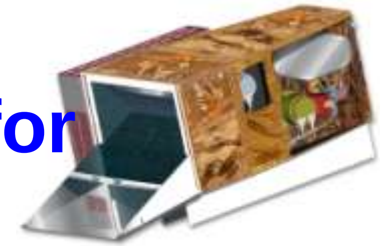
			Single Gain		Dual Gain			
					High Gain		Low Gain	
Band	**Center Wavelength (nm)**	**Gain Type**	**Tmin**	**Tmax**	**Tmin**	**Tmax**	**Tmin**	**Tmax**
M12	3700	Single	230	353	-	-	-	-
M13	4050	Dual	-	-	230	343	343	634
M14	8550	Single	190	336	-	-	-	-
M15	10763	Single	190	343	-	-	-	-
M16	12013	Single	190	340	-	-	-	-
I4	3740	Single	210	353	-	-	-	-
I5	11450	Single	190	340	-	-	-	-

TABLE 14. Sensitivity requirements for VIIRS Sensor reflective bands

			Single Gain		Dual Gain			
					High Gain		Low Gain	
Band	Center Wavelength (nm)	Gain Type	Ltyp	SNR	Ltyp	SNR	Ltyp	SNR
M1	412	Dual	-	-	44.9	352	155	316
M2	445	Dual	-	-	40	380	146	409
M3	488	Dual	-	-	32	416	123	414
M4	555	Dual	-	-	21	362	90	315
M5	672	Dual	-	-	10	242	68	360
M6	746	Single	9.6	199	-	-	-	-
M7	865	Dual	-	-	6.4	215	33.4	340
M8	1240	Single	5.4	74	-	-	-	-
M9	1378	Single	6	83	-	-	-	-
M10	1610	Single	7.3	342	-	-	-	-
M11	2250	Single	0.12	10	-	-	-	-
I1	640	Single	22	119	-	-	-	-
I2	865	Single	25	150	-	-	-	-
I3	1610	Single	7.3	6	-	-	-	-

Notes:
The units of spectral radiance for Ltyp are watt m-2 sr-1 mm-1.
The SNR column shows the minimum required (worst-case) SNR that applies at the end-of-scan.

TABLE 15. Sensitivity requirements for VIIRS Sensor emissive bands



			Single Gain		Dual Gain			
					High Gain		Low Gain	
Band	**Center Wavelength (nm)**	**Gain Type**	**Ttyp**	**NEdT**	**Ttyp**	**NEdT**	**Ttyp**	**NEdT**
M12	3700	Single	270	0.396	-	-	-	-
M13	4050	Dual	-	-	300	0.107	380	0.423
M14	8550	Single	270	0.091	-	-	-	-
M15	10763	Single	300	0.070	-	-	-	-
M16	12013	Single	300	0.072	-	-	-	-
I4	3740	Single	270	2.500	-	-	-	-
I5	11450	Single	210	1.500	-	-	-	-