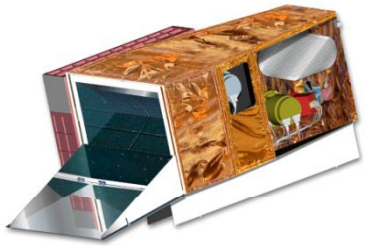


VIIRS F1 Performance Status Summary

NPOESS Preparatory Project (NPP)

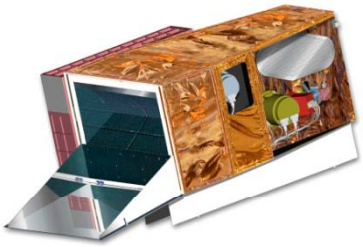
Project Science Office (PSO)

Presented by

Hassan Oudrari

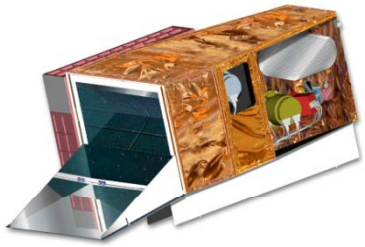
NPP VIIRS F1 Calibration and Characterization Workshop
January 25th, 2010
Lanham, MD

Content



- Objective and General Comments
- VIIRS F1 Testing Status
- VIIRS F1 Sensor and NPP Mission Overview
- VIIRS F1 TV Performance Summary

Acknowledgements



NASA

- NPP Instrument Characterization Support Team (NICST)
- NPP Instrument Calibration and Support Element (NICSE)
- MODIS Characterization Support Team (MCST)
- VIIRS Ocean Science Team (VOST)
- University of Wisconsin (UW)
- Project Science Office (PSO)

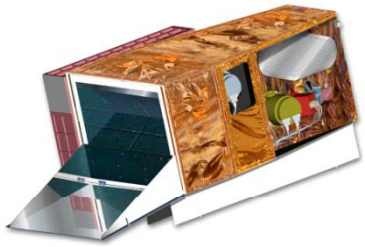
Integrted Program Office (IPO)

- Internal Government Studies (IGS)
- Aerospace Cooperation
- MIT/LL

Contractors

- Northrop Grumman
- Raytheon SBRS and El-Segundo

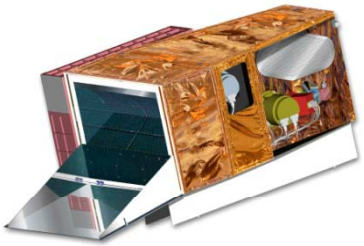
Objective - General Comments



- **Present NASA data processing results based on the VIIRS F1 Thermal Vacuum testing, and share our assessments with NASA at-large Subject Matter Experts (SMEs) for SDRs and EDRs.**
  - Present NASA F1 Beginning of Life (BOL) performance assessments at summary level. In some cases Raytheon and NGST results are also shown.
  - Identify issues and risks associated with completeness of test data or test data analysis, and areas of non compliances of interest to the NASA science objectives

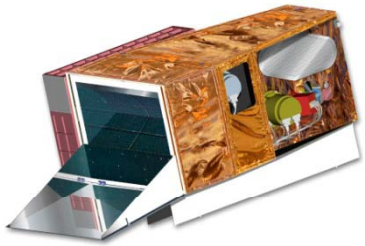
- **Raytheon has been leading the VIIRS testing program for NGST prime contractor**
  - Ambient testing at Raytheon SBRS
  - Remaining testing at Raytheon El-Segundo (Environmental, Vibration, Pre-TV, TV and Post-TV).

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



VIIRS TV Testing Summary

VIIRS F1 Testing Schedule



- **F1 Ambient Testing Complete:**
  - Phase I testing: 06/20/07 – 08/29/07
  - Phase II testing: 08/29/07 – 11/30/07

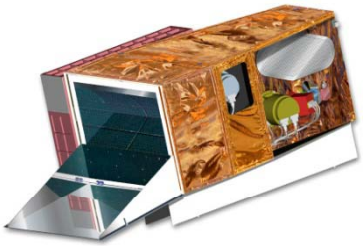
- **F1 Thermal Vacuum (TV) Complete:**
  - Pre-TV testing: 03/29/09 – 05/03/09
  - TV testing: 05/03/09 – 08/23/09
  - Post-TV: 08/24/09 – 09/23/09
  - **Sensor ready to ship: 10-28-09**

VIIRS F1 sensor is at Ball since **January 15th**.

Preparations to integrate to NPP Spacecraft are ongoing

(VIIRS Integration Readiness Review is being held this week at Ball)

VIIRS F1 Sensor Test Flow



◇ = Consent to Break/Proceed

Opto-Mech Module CTI

Electronics Module CTI

OMM Mechanical Integration

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

VIIRS F1 TRR June 2007

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

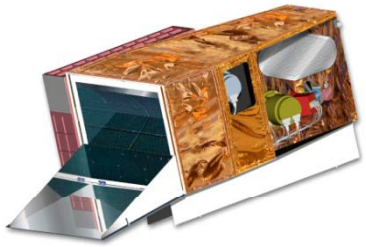
Post Vibe/Pre TV Tests
SI1, SI-7 Isolation and Continuity
SI-4 Commands and Telemetry
SI-5 Electronics Self Test
SI-6 Noise Test
FP-2 SD Operation and SDSM Functional
FP-5 Pointing Knowledge
FP-7 Mechanical Functions
FP-6 MTF and HSR Warm FPAs
ETPs

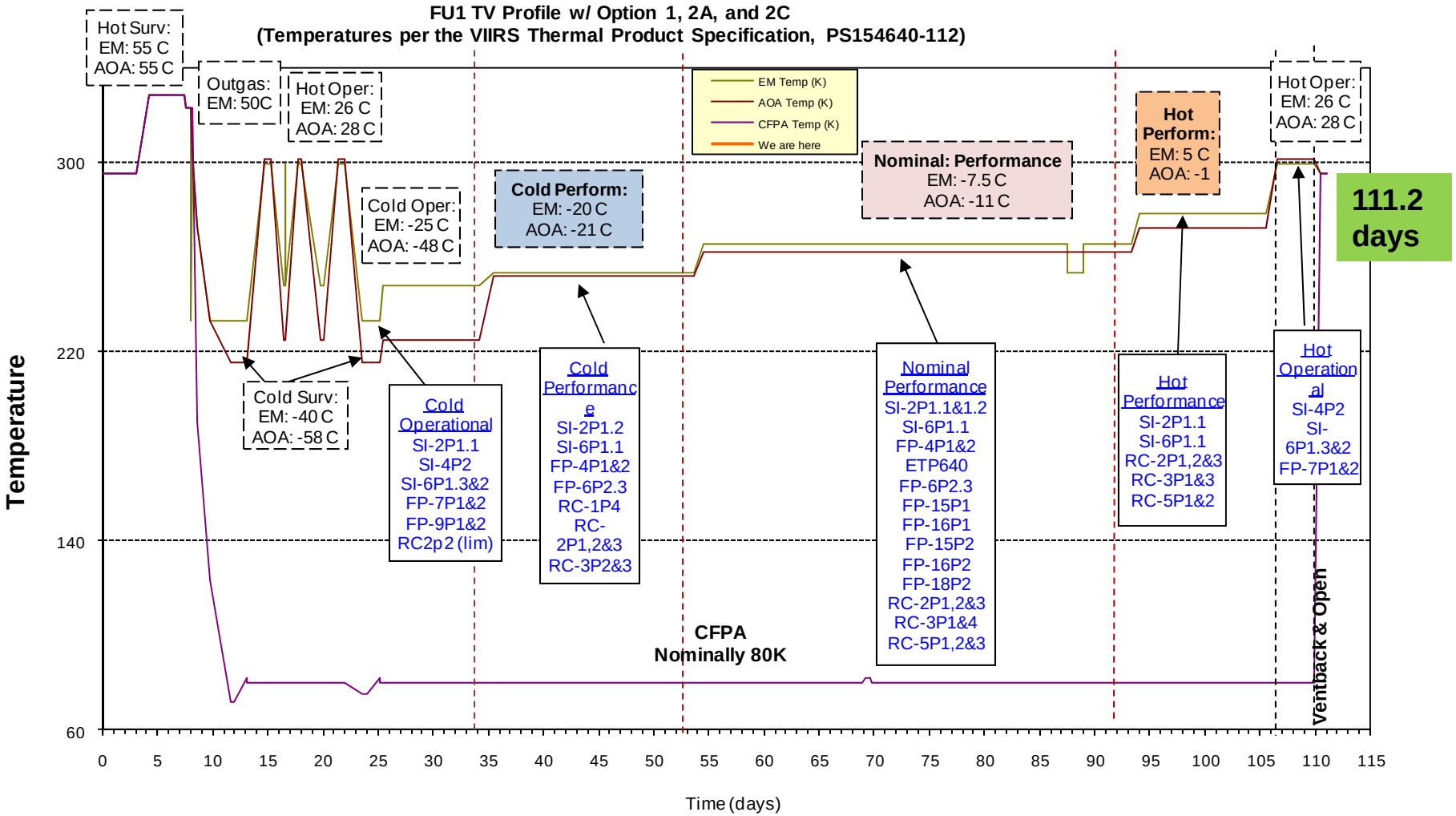
TV Test
SI-4 Commands and Telemetry
SI-5 Electronics Self Test
SI-6 Noise Test
FP-4 Spectral Band Registration
FP-6 MTF and HSR
FP-7 Mechanical Functions
FP-9 Operational Modes
FP-15 -16 Relative Spectral Response
FP-18 Day in The Life
RC-1 Radiometric characterization
RC-2 Reflective Calibration
RC-3 Radiometric Stability
RC-5 Emissive Calibration
Thermal Cycling, Thermal Balance
ETPs

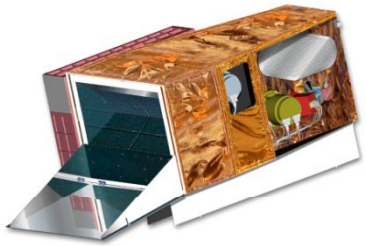
Post TV Tests
SI-4 Command and telemetry
SI-5 Electronic self test
SI-6 noise
FP-11 Polarization
EMI

PSR
12-16-2009

VIIRS F1 TVAC Test Profile

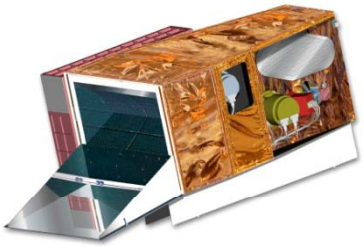






VIIRS and NPP Mission Overview

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	750			
○ 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**

Similar MODIS bands are shown for comparison

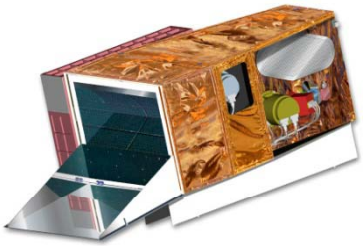
VIIRS 21 EDRs, 1 Application

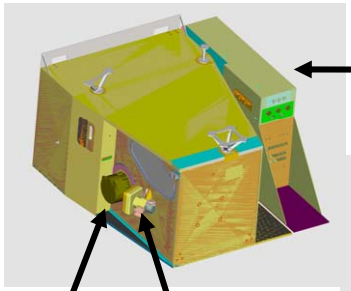
Land, Ocean, Atmosphere, Snow

Name of Product	Group	Type
Imagery *	Imagery	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
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

* 2 Key Performance Parameter (KPP) products: Imagery and SST

VIIRS Incorporates Modular Sensor Approach





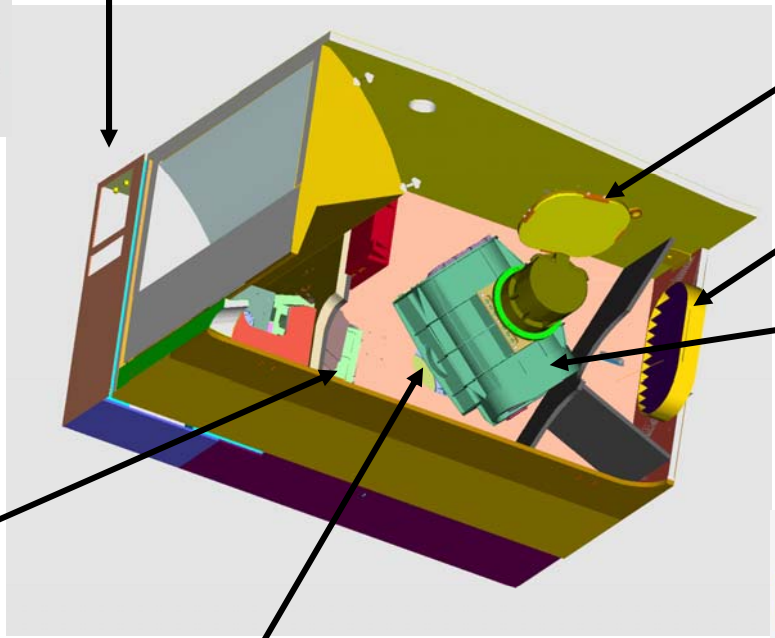
Separately Mounted Electronics Module

Solar Diffuser

Blackbody

RTMA

Solar Diffuser Stability Monitor

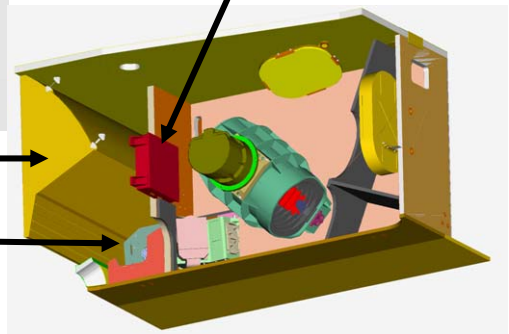


3-Mirror Anastigmat All reflective Rotating telescope

FPIE

4-Mirror Anastigmat All Reflective Aft Optics Imager

Cryoradiator

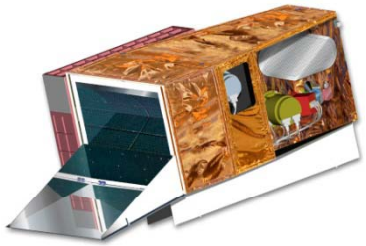


Half-angle Mirror

Cold FPA Dewar Assembly

OMM configuration

VIIRS F1 Sensor Block Diagram



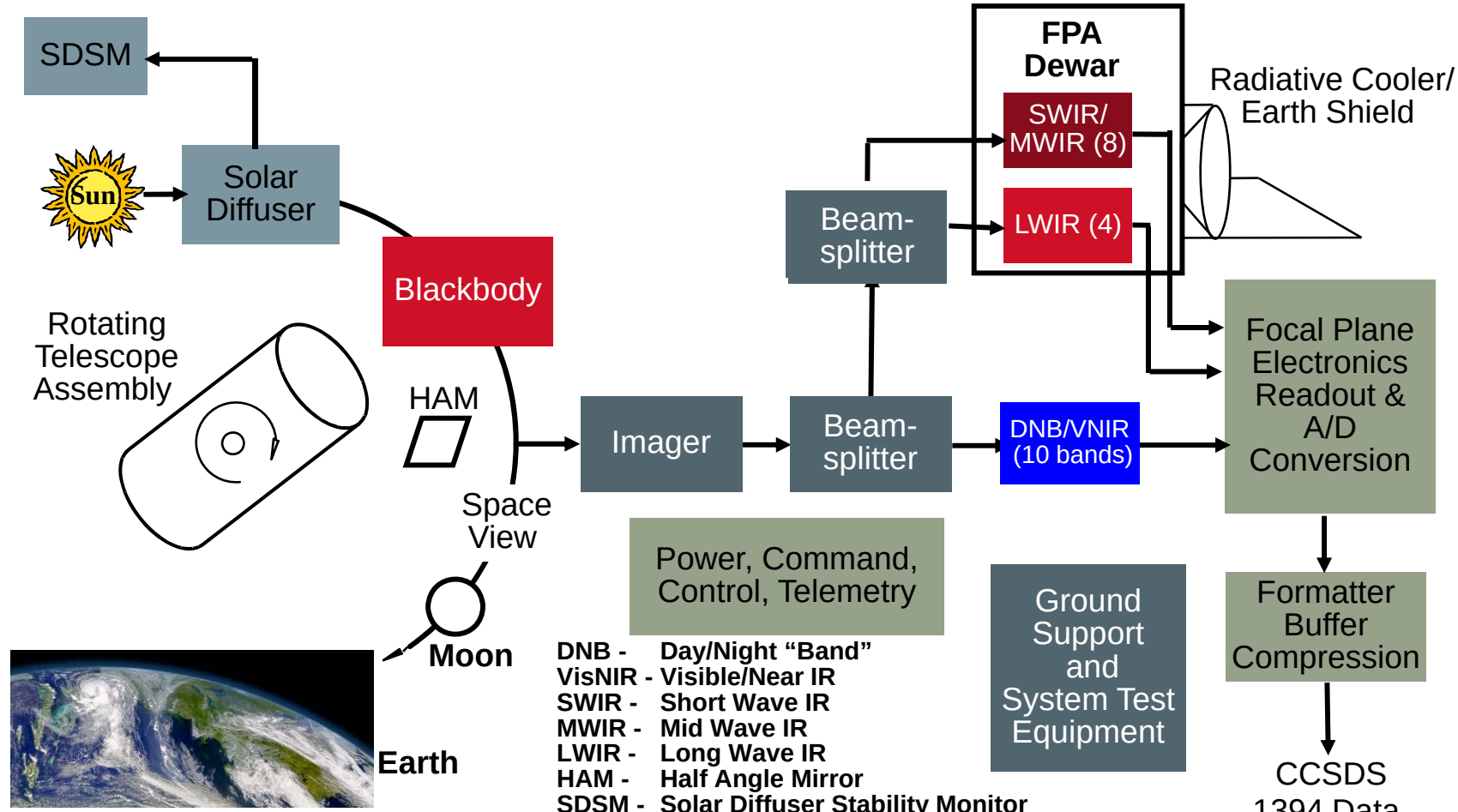
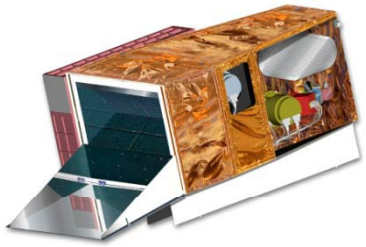
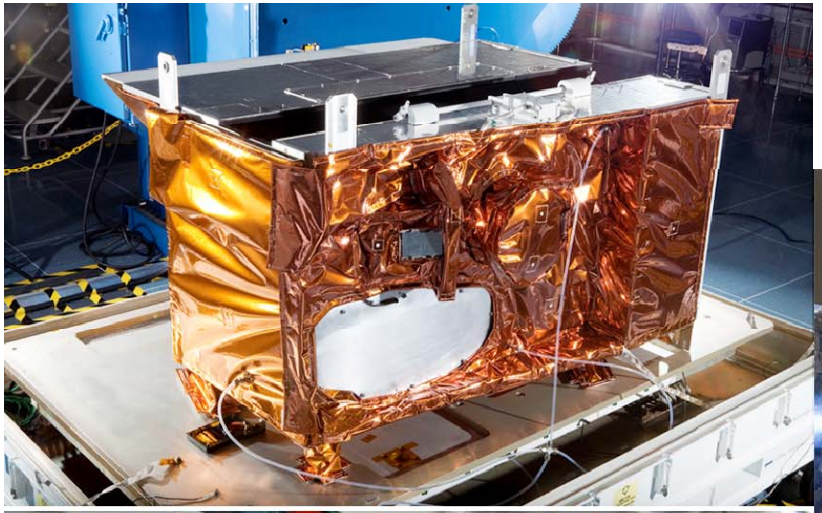


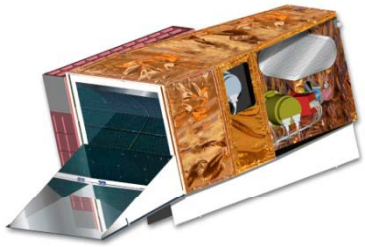
Image provided courtesy of NASA GSFC

VIIRS Opto-Mech Module





NPOESS Preparatory Project (NPP)



Objectives

– Provide NASA with continuity of global change parameters between the Earth Observing System and NPOESS programs

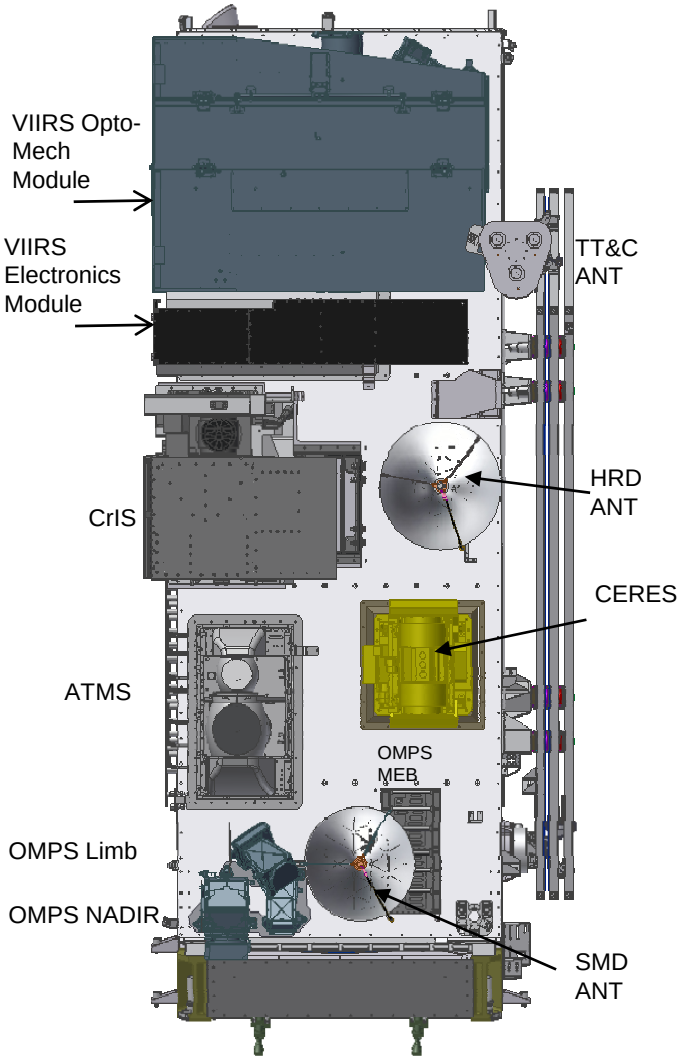
– Provide IPO with pre-operational risk reduction and validation for NPOESS instruments, algorithms, and ground processing

Key Characteristics

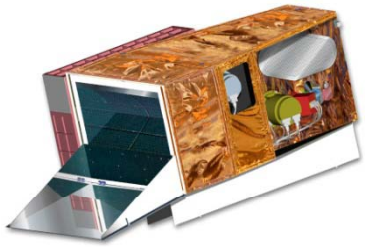
–**Lifetime:** 5yr
–**Orbit:** 824 km, sun-synch, 1:30 pm Ascending Node
–Support 5 instrument payload suite: VIIRS, CrIS, ATMS, CERES, OMPS

Status

–Spacecraft complete
–Completed extensive EDU risk reduction campaign
–ATMS, CERES, and OMPS instruments installed
– Launch expected Fall 2011

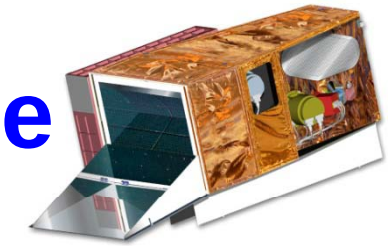


NPP Space Segment



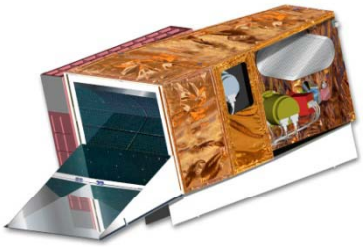
VIIRS TV Performance Summary

VIIRS F1 Sensor Performance



- **VIIRS F1 testing program is complete and has provided test data to support 141 performance requirements**
  - Based on Cold performance plateau, Program decided to use **side B** electronics as **Primary**. However, both A and B sides exhibit largely similar performance.
- **NASA team has completed extensive analysis of VIIRS test data**
  - Support to test planning and execution (e.g. Test procedure reviews, Special tests, etc.)
  - Support of sensor test data analysis, and requirement verification (e.g DAWG telecons, Raytheon daily quick-look briefings, etc.)
    - Release more than 130 reports and memos just for TV phase
    - eRoom link: https://collab2.st.northropgrumman.com/eRoom/PayloadSensors/VIIRS/0_2afa4
  - Support to EFR resolution and EDR impact analysis for use-as-is decisions
  - Support to Waiver evaluation, including SDR/EDR impact assessment
- **All performance waivers have been evaluated by NGST and reviewed by NASA team**
  - Most waivers have small to negligible EDR performance impacts
  - Some waivers indicate need for algorithm revisions and/or changes to Cal/Val
    - **Optical crosstalk and OOB is a significant performance impact to Ocean Color and to some extent Aerosol, and NG is working a mitigation plan for on-orbit EDR algorithms**

VIIRS Performance Waivers



Raytheon Waiver #	NG Waiver #	Title	Status
W053D	BER-179R2	DNB Stray Light	Approved
W047C W114	BER-W182R2 BER-W249	DFOV, MTF, I-Band HSR, DNB HSR, DNB HSI, DNB HRI	Approved
W051A	BER-W174R4	M8 Dynamic Range	Approved
W120	BER-W217R2	Swath Width	Approved
W043B	BER-W216	Gain Transition	Approved
W116	BER-W176R6 BER-W245	In-Band Spectral	Approved
W024B	BER-W230R2	Band to Band Registration	Approved
W049A	BER-W231 BER-W232R2 BER-W244	Integrated OOB Response	2 Pending
W112A	BER-W233R2 BER-W234R1	M-Band & DNB Near Field Response	1 Pending
W054A	BER-W237R2	Crosstalk	1 Pending
W128	BER-W241	Effective Focal Length	Approved
W113	BER-W228R1	M-Band Uniformity	Approved
	BER-W242	DNB Uniformity	Approved
W070B	BER-W246	Emissive Band Radiometric Characterization	Approved
W113	BER-W248	Reflective Band Characterization Uncertainty	Approved
W113	BER-W247	M11 Absolute Radiometric Calibration Uncertainty	Approved
W080A	BER-W221R1	One-Day Pointing	Approved

Raytheon and Northrop Grumman provided F1 performance waiver packages

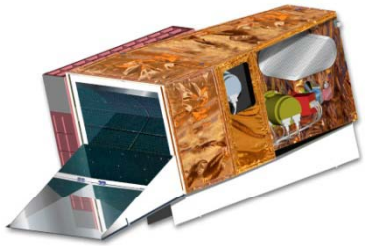
NG provided or will provide impact on SDR/EDRs of all non compliances in Sensor performance requirements

- Currently, NG's impact assessments on mission performance have been found to be acceptable in all cases

Most of F1 waiver packages have been approved through NG CCB and forwarded to SEWG for approval.

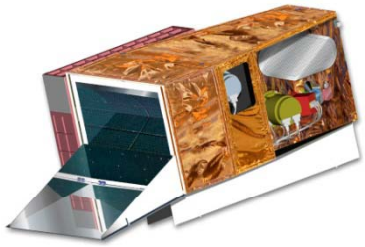
- **There are currently 4 waivers against sensor performance awaiting approval at SEWG**

Other VIIRS F1 TV Issues and Concerns



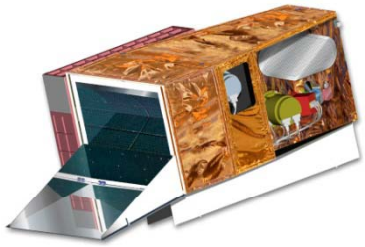
Issue	Description	Results and Impact
Spikes	Large sample spikes in the sensor signal observed for few bands during operational mode, only on A-side (Redundant) Electronics	NG is preparing mitigation plans to correct for the bit flip leading to spikes, and to Implement alternative geolocation algorithm (potential loss of RTA/HAM encoder timestamps).
Vignetting	Observed at FU1 TV Cold functional plateau, but goes away when sensor temperature warms up closer to TV Cold performance. Vignetting was not noticeable at any Performance plateau (Cold, Nominal, Hot).	Program has provided STOP model #6 that includes vignetting compoent. Need to verify that the model is validated, and can be used on orbit for any anomaly simulation and mitigation/correction approach.
VisNIR crosstalk / OOB	Spectral measurment using SpMA and spetial measurements using SpMA and Polarizer sheets are showing large optical OOB in some bands and optical crosstalk/leaks between bands.	Crosstalk coefficient maps are being used to assess impact on SDRs and EDRs. Uncertainty assessment still to be finalized, including contributions from the SpMa stability and characterization, the allignment, NFR, and electronics.
Gain bit crosstalk effect	Some bands calibration results are showing dependency on other bands gain status (High Gain vs Low Gain).	Need to consider this term in the final calibration error budget and impact assessments.
M1 and M11 tail and side lobe artifacts	LSF measurements have revealed side lobe features for M11 and M1. M11 side lobe might be attributed to field stop reflections, and M1 side lobe might be contributed to optical crosstalk.	Need further modeling, to determine impact since on orbit illumination will have broad spectrum. It is not known how this side lobe is going to be varying on orbit (Ghosting shift if coming from mechanical part).
Gain transition noise	Increase of radiance non linearity and noise for dual gain bands at approximately 10% below Lmax.	Analysis done only with ambient phase testing and have shown low impact on some EDRs. Need further assessments based on TV testing.
End-to-End Testing	VIIRS on-board RSB calibration (e.g. SD, SDSM) is not tested yet.	Preparations to get this testing implemented at the Spacecraft Level at Ball are ongoing, using laser sources.

VIIRS F1 Reflective Bands Radiometric Performance



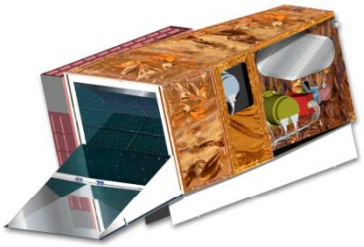
Reflective Solar Band (RSB) Performance			
Performance	**Requirement Verification**	**Comments**	**Expected Risk to EDRs**
SNR	All RSB bands meet SNR specifications with margin	All margins exceed 50%	**Low**
Dynamic Range	M1 and I2 slightly not compliant	M1 and I2 Dynamic Range is expected to be compliant after SIS100 red leak correction.	**Low**
	M8 not compliant	Margin is about -20% of Lmax	**Low**
Gain Transition	Only M1 is not compliant. Margin is about -10% of Lmax.	This only preliminary analysis. It is expected that the red leak will make M1 compliant, and M3, M4, M5, M7 slightly not compliant	**Low**
Linearity	All RSB bands meet Linearity specification with margin	Excellent linearity	**Low**
Uniformity	Most bands are not meeting uniformity requirement (1NeDL) at certain radiances, gain stage, or sensor temperature.	NGST is planning for an on-orbit mitigation approach to correct for uniformity effect (stripping)	**Medium**
Uncertainty	All bands are meeting specification	Reflective bands calibration is being finalized through Government and NGST cal/val actitivities	**Low**
Stability	All RSB bands meet Stability requirements with margin	Stability with sensor temperature and voltage has shown excellent performance.	**Low**

VIIRS F1 Emissive Bands Radiometric Performance



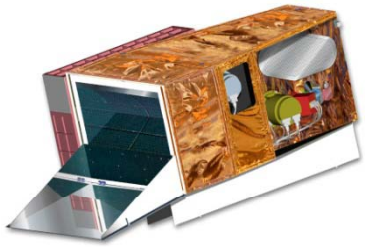
Thermal Emissive Band (TEB) Performance			
Performance	**Requirement Verification**	**Comments**	**Expected Risk to EDRs**
NEdT	All TEB bands meet NeDT specifications with margin	All margins exceed 30%	**Low**
Dynamic Range	All TEB bands compliant for Lmax.	I4 and M14 slightly not compliant for Lmin .	**Low**
Gain Transition	Only M13 is slightly not compliant.	It is expected that M13 will be compliant if sensor Vref is adjusted on orbit.	**Low**
Linearity	All TEB bands meet Linearity specification with margin	Excellent linearity	**Low**
Uniformity	All TEB bands meeting uniformity requirement (1NeDL), Except M12 Det #1.	Good uniformity performance (low risk for sensor stripping)	**Low**
Absolute Radiometric Difference	All TEB bands are meeting specification with significant margins	Emissive bands calibration is expected to be excellent, based on TV testing at 3 plateaus	**Low**
Stability	All TEB bands meet Stability requirements with margin	Stability with sensor temperature and voltage has shown excellent performance.	**Low**

VIIRS F1 Spectral Performance



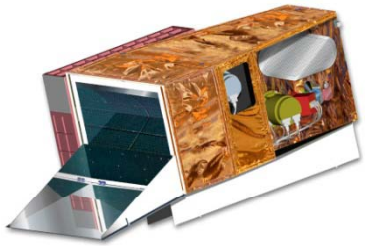
Spectral RSR Performance			
Performance	**Requirement Verification**	**Comments**	**Expected Risk to EDRs**
Spectral Band Center	Only M4 and M16 are slightly not meeting specification	Minimum impact is expected from these non compliances	**Low**
Spectral Bandwidth	Only M2, M8 and M14 slightly not compliant. M16A Detectors #5-7 also slightly not compliant	Minimum impact is expected from these non compliances. However, Impact assessment might be needed.	**Low**
Extended Bandwidth	Only I5 is slightly not compliant for the upper 1% limit	No major impact is expected.	**Low**
Integrated Out-Of-Band	Many VisNIR bands (M1, M3-M6, I2) and many LWIR bands (M15-16 and I5) are not compliant.	Assessment of performance and uncertaintie is not fully mature. Impact on EDRs is underway for many EDRs (Ocean color, Aerosol, NDVI and Clouds).	**Medium-High**
Band to Band Crosstalk	Sensor specifications not met as expected. Spectral test data collected at Nominal plateau will support performance assessment.	Crosstalk characterization and impact on EDRs are in progress. Currently, Most affected EDRs are expected to be Ocean Color, and Aerosol.	**Medium-High**

VIIRS F1 Spatial Performance

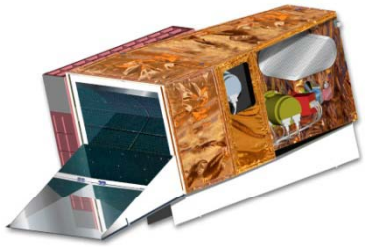


Spatial Performance			
Performance	**Requirement Verification**	**Comments**	**Expected Risk to EDRs**
Line Spread Function (LSF)	Scan DFOV is compliant for majority of M-bands and I-bands.	Slight non compliances. No signficant impact is expected.	**Low**
	Track IFOV is compliant for all M-Bands and I-bands, Except M12 Det #1.	Slight non compliances. No signficant impact is expected.	**Low**
	Scan MTF is compliant for majority of M-bands	Slight non compliances. No signficant impact is expected.	**Low**
	Track MTF is compliant for all M-Bands.	Excellent performance for A-track MTF	**Low**
	Scan HSR is compliant for majority of I-bands	Slight non compliances. No signficant impact is expected.	**Low**
	Track HSR iscompliant for all I-bands	Excellent performance for A-track HSR	**Low**
Band to Band Registration (BBR)	BBR is compliant for all band pairs, except few cases	Slight non compliances. No significant impact expected. Raytheon PVR is showing more non-compliances when spacecraft jitter is included.	**Low**
Pointing Stability	Pointing stability is compliant, except daily stability in track direction	Slight non-compliance (to the original Spec, Waiver accepted). Pointing variations will be corrected post-launch in IDPS	**Low**

VIIRS F1 TV Summary

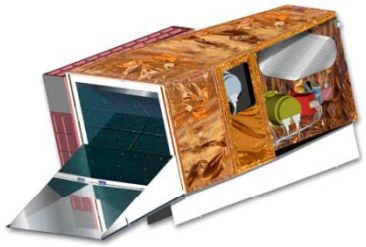


- **VIIRS F1 test program is complete and has provided good test data to assess sensor performance.**
- **Sensor performance exceeds requirements in most cases, and non compliances are addressed or being addressed in waiver packages and impact assessments**
- **NASA performance assessments are beginning of life (BOL). Modeling of EOL performances are available in Raytheon Performance Verification Reports (PVRs).**
- **Effort by both Government and Contractor is still ongoing to finalize VIIRS F1 Performance Assessments, and to generate on-orbit LUTs for SDR algorithm**
- **NASA team presentations and posters will provide detailed performance assessments, issues and recommendations for performance parameters.**



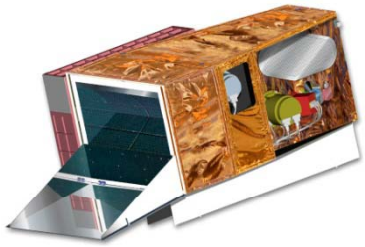
Backup Slides

Agenda



Introduction (Jim Butler)	1:30 PM
VIIRS Instrument and Calibration Background (Hassan Oudrari)	1:40 PM
Reflective Solar Bands Calibration (Junqiang Sun)	2:00 PM
Thermal Emissive Bands Calibration (Jeff McIntire)	2:35 PM
RSR Characterization (Chris Moeller)	3:10 PM
Break	3:35 PM
Spatial Characterization (Gary Lin)	**3:50 PM**
Cross-talk Characterization (Tom Schwarting)	**4:20 PM**
Polarization Characterization (Junqiang Sun/Gerhard Meister)	**4:50 PM**
Status of Stray Light, NFR, and RVS Characterization (Hassan Oudrari)	**5:10 PM**
Adjourn	**5:30 PM**

NASA Calibration Team



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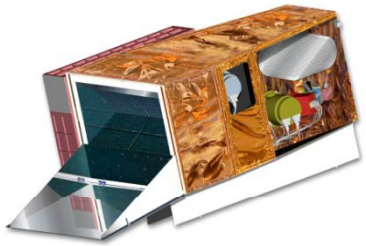
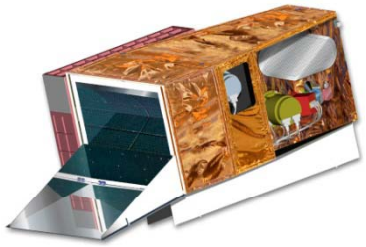
NICST: NPP Instrument Characterization Support Team	**NICSE**: NPP Instrument Calibration Support Element
VOST: VIIRS Ocean Science Team	**UW**: University of Wisconsin
PSG: Project Science Group	

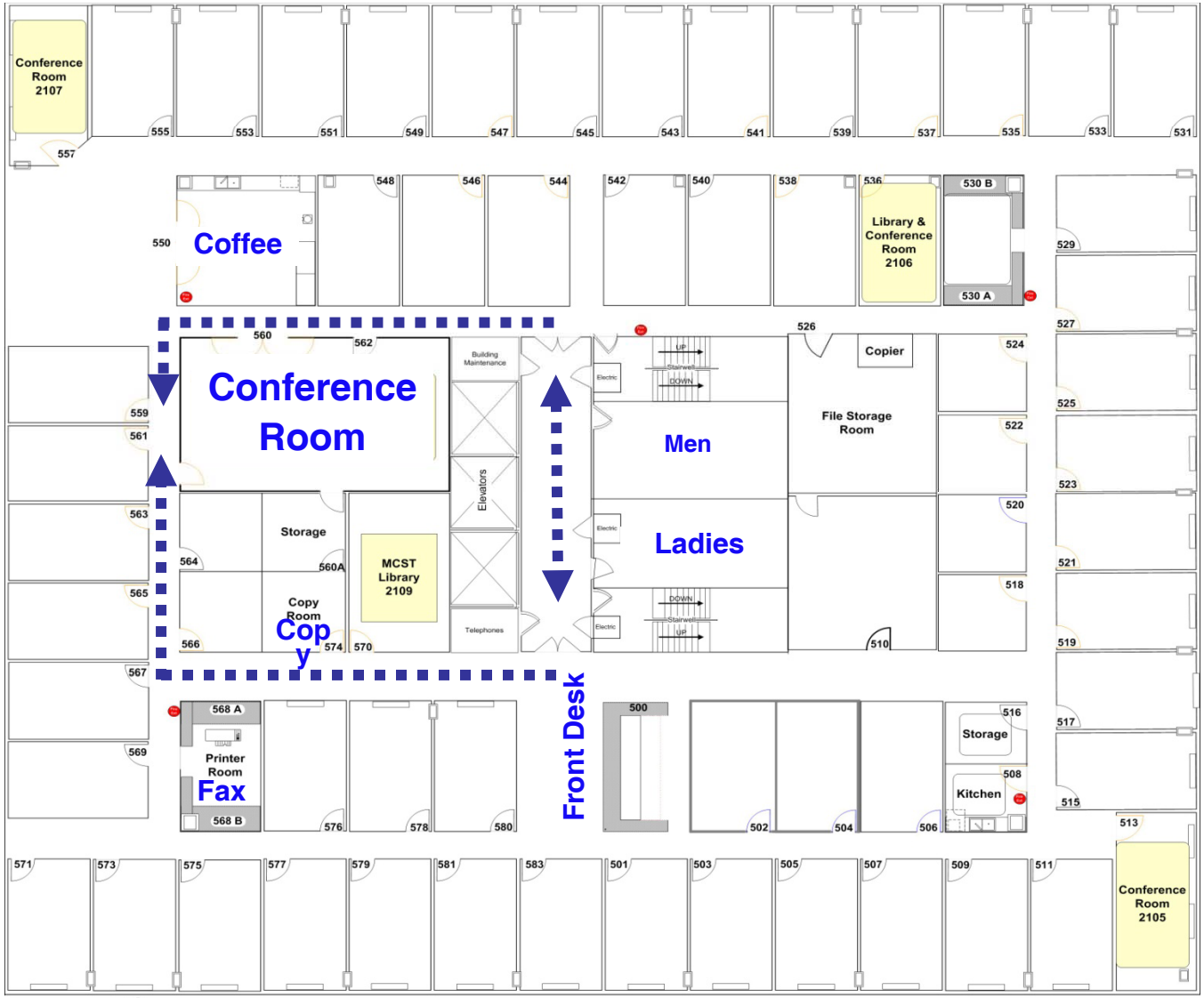
Logistics



- Badge (sign-in at front desk)
- Restroom (keys available at front desk)
- Breaks (lunch and coffee)
- Copy and Fax (available upon request)
- Wireless Internet
  - Login:
  - Password:

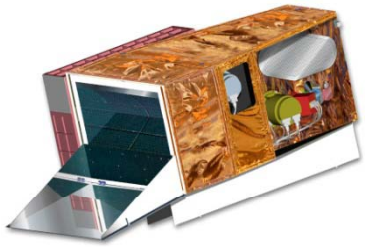
SSAI 5th Floor Layout





SSAI 5th Floor

VIIRS Bands and Products



VIIRS 22 Bands: 16 M-Band, 5 I-Band and 1 DNB
Dual Gain Bands: M1-M5, M7, M13

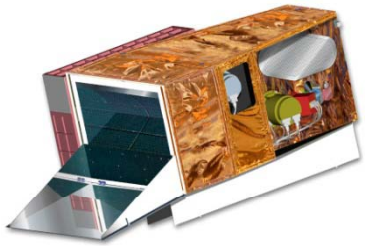
VIIRS 24 EDRs
Land, Ocean, Atmosphere, Snow

		DNB	M1	M2	M3	M4	I1	M5	M6	M7	I2	M8	M9	M10	I3	M11	M12	I4	M13	M14	M15	I5	M16
	Wavelength (um)	**0.7**	**0.412**	**0.445**	**0.488**	**0.555**	**0.64**	**0.672**	**0.746**	**0.865**	**0.865**	**1.24**	**1.378**	**1.61**	**1.61**	**2.25**	**3.7**	**3.74**	**4.05**	**8.55**	**10.76**	**11.45**	**12.01**
1	Imagery	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2	Sea Surface Temp																x				x		x
3	Soil Moisture		Uses VCM, VIIRS LST and several CMIS products, but no SDRs																				
4	Cloud Base Height							x				x		x			x		x	x	x		x
5	Cloud cover/Layers							x				x		x			x		x	x	x		x
6	Cloud Optical Part Size							x				x		x			x			x	x		x
7	Cloud Thickness							x				x		x			x			x	x		x
8	Cloud Top Height							x				x		x			x		x	x	x		x
9	Cloud Top Pressure							x				x		x			x		x	x	x		x
10	Cloud Top Temp							x				x		x			x		x	x	x		x
11	Land Surface Temp.																x		x		x		x
12	Active Fires							x		x						x			x		x		x
13	Vegetation Index				x		x				x												
14	Snow Cover (Binary)						x				x				x						x	x	x
15	Snow Cover (Fraction)		x		x	x				x		x		x		x							
16	Surface Type		x	x	x	x	x	x		x	x	x		x		x	x		x	x	x		x
17	Surface Albedo		x	x	x	x		x		x		x		x		x							
18	Ice Surface Temp.																				x		x
19	Net Heat Flux		Uses VCM and other VIIRS EDRs, but no SDRs																				
20	Surface Temperature (IP)																				x	x	x
21	Ocean Color / Chloro		x	x	x	x		x	x	x													
22	Sea Ice Age						x				x										x	x	x
23	Aer Opt Thick (Ocean)					x		x	x	x		x	x	x		x	x				x		
24	Aer Opt Thick (Land)		x	x	x	x		x					x			x	x				x		
25	Aer Part Size (Ocean)		Uses AOT, but no SDRs																				
26	Aer Part Size (Land)		Uses AOT, but no SDRs																				
27	Suspended Matter																			x	x		x
28	Total Prec Water																x		x	x	x		x
29	Cloud Mask (IP)		x				x	x		x	x		x	x		x	x	x	x	x	x	x	x
30	Ice Location/Conc. (IP)		Imagery Application is not re				x				x										x	x	x
31	Sfc Reflectance (IP)		x	x	x	x	x	x		x	x	x		x	x	x							

Ocean
Land
Aerosol
Clouds
Ice and Snow

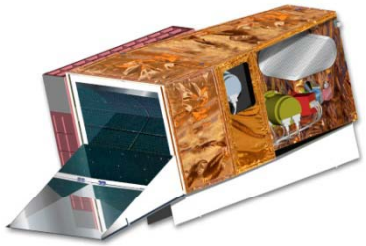
VIS	NIR	SWIR	MWIR	LWIR

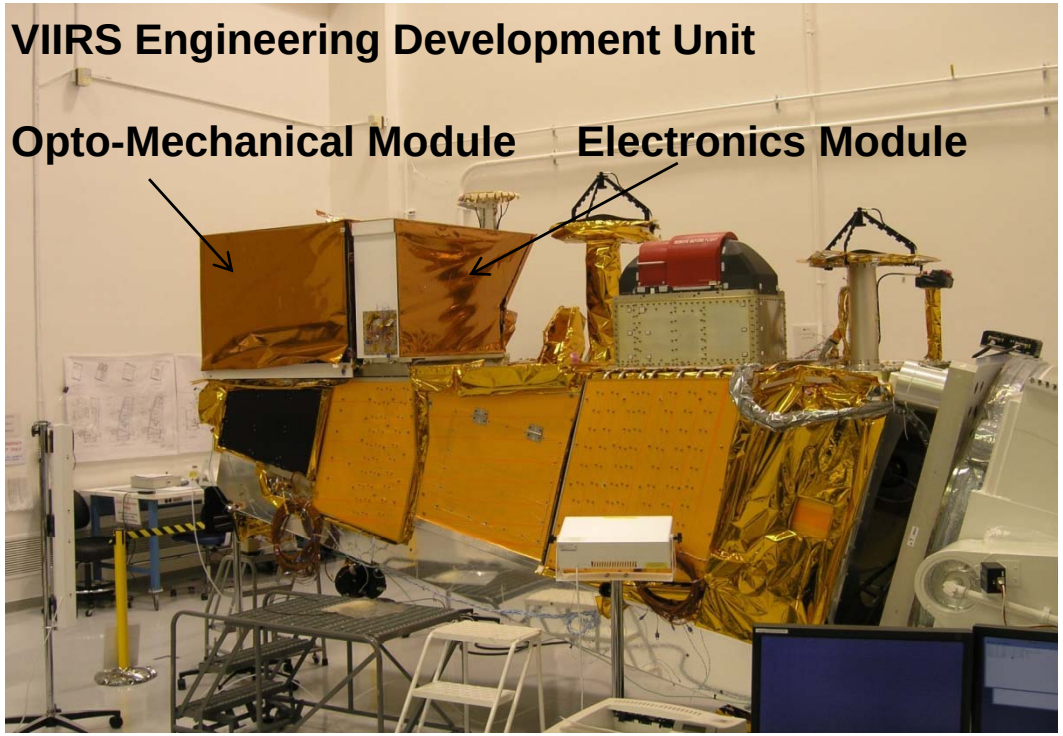
VIIRS vs. Heritage Sensors Bands



		VIIRS			MODIS Equivalent			AVHRR-3 Equivalent			OLS Equivalent		
		Band	Range (um)	HSR (m)	Band	Range	HSR	Band	Range	HSR	Band	Range	HSR
Reflective	VisNIR	DNB	0.500 - 0.900								HRD PMT	0.580 - 0.910 0.510 - 0.860	550 2700
		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 12	0.545 - 0.565 0.546 - 0.556	500 1000						
		I1	0.600 - 0.680	375	1	0.620 - 0.670	250	1	0.572 - 0.703	1100			
		M5	0.662 - 0.682	750	13 14	0.662 - 0.672 0.673 - 0.683	1000 1000	1	0.572 - 0.703	1100			
		M6	0.739 - 0.754	750	15	0.743 - 0.753	1000						
		I2	0.846 - 0.885	375	2	0.841 - 0.876	250	2	0.720 - 1.000	1100			
		M7	0.846 - 0.885	750	16	0.862 - 0.877	1000	2	0.720 - 1.000	1100			
	SMWIR	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	3a	SAME	1100			
		M11	2.225 - 2.275	750	7	2.105 - 2.155	500						
Emissive		I4	3.550 - 3.930	375	20	3.660 - 3.840	1000	3b	SAME	1100			
		M12	3.660 - 3.840	750	20	SAME	1000	3b	3.550 - 3.930	1100			
		M13	3.973 - 4.128	750	21 22 23	3.929 - 3.989 3.929 - 3.989 4.020 - 4.080	1000 1000 1000						
	LWIR	M14	8.400 - 8.700	750	29	SAME	1000						
		M15	10.263 - 11.263	750	31	10.780 - 11.280	1000	4	0.300 - 11.30	1100			
		I5	10.500 - 12.400	375	31 32	10.780 - 11.280 11.770 - 12.270	1000 1000	4 5	10.300 - 11.300	1100 1100	HRD	10.300 - 12.900	550
		M16	11.538 - 12.488	750	32	11.770 - 12.270	1000	5	1.500 - 12.50	1100			

NPP Spacecraft with VIIRS EDU





VIIRS

- **Purpose:** Global observations of land, ocean, & atmosphere parameters at high temporal resolution (~ daily)
- **Swath width:** 3000 km
- **Scan Range:** ±56º
- **Orbit:** 1:30 pm, Polar Sun-Synch
- **Altitude:** 824 km
- **Launch:** Fall 2011

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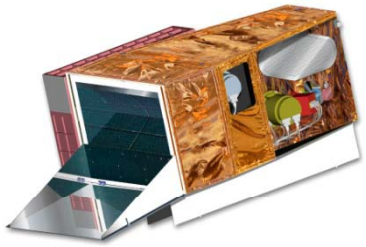
VIIRS Scan Geometry: Image Character Nadir vs. Edge?



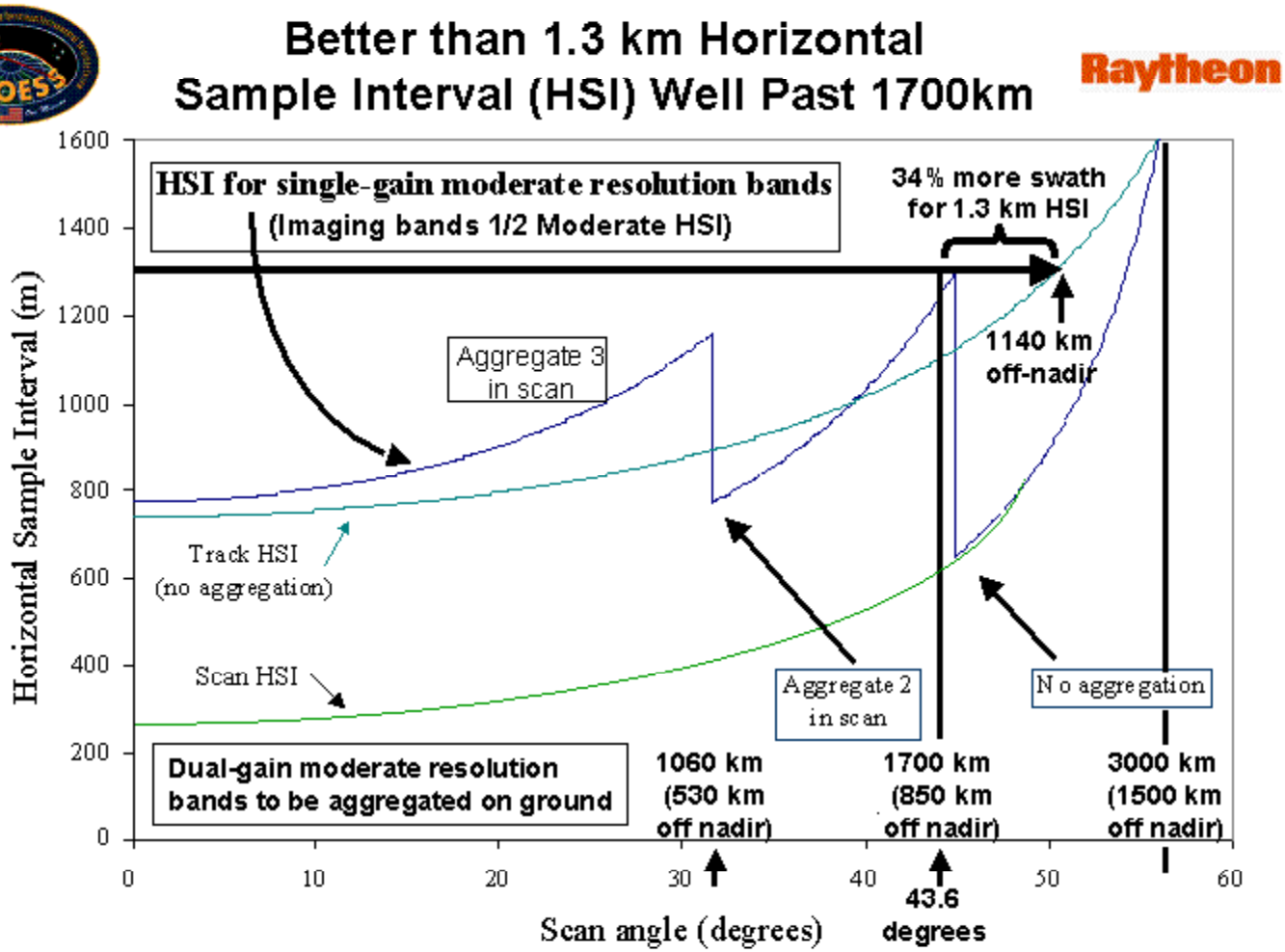
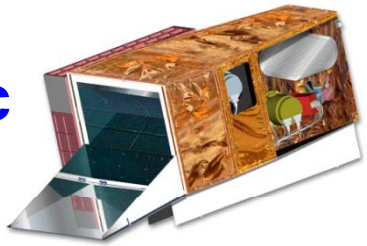


Table # 17/18: Emissive Bands Radiometric Calibration Accuracy Requirements

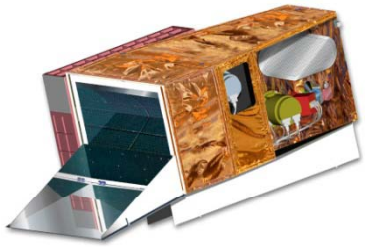


		Scene Temperature				
Band	λ_c (μm)	190K	230K	270K	310K	340K
M12	3.7	N.A.	7.0%	0.7%	0.7%	0.7%
M13	4.05	N.A.	5.7%	0.7%	0.7%	0.7%
M14	8.55	12.3%	2.4%	0.6%	0.4%	0.5%
M15	10.763	2.1%	0.6%	0.4%	0.4%	0.4%
M16	12.013	1.6%	0.6%	0.4%	0.4%	0.4%

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

Equivalent or Better Performance Was Achieved on MODIS

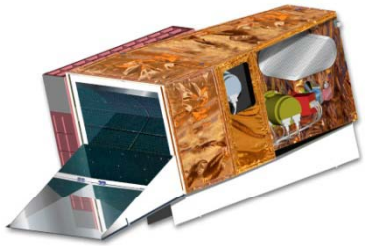
TABLE 5. VIIRS Spectral band optical requirements



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.

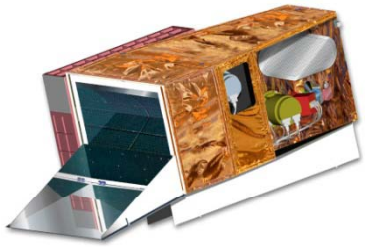
TABLE 12. Dynamic range requirements for VIIRS Sensor reflective bands



			Single Gain		Dual Gain			
					High Gain		Low Gain	
Band	Center Wavelength (nm)	Gain Type	Lmin	Lmax	Lmin	Lmax	Lmin	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	-	-	-	-

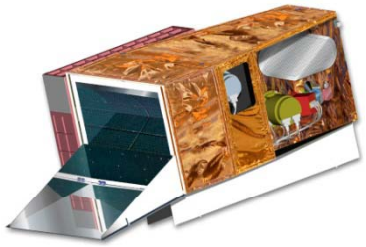
Spectral radiance (Lmin and Lmax) has units of watt m-2 sr-1 μm-1.

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	-	-	-	-

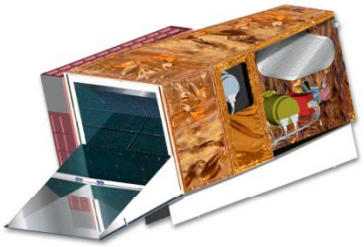
TABLE 14: Sensitivity requirements for VIIRS Sensor reflective bands



			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 μm-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	-	-	-	-