JPSS-1 VIIRS Radiometric Performance Summary – Pre Launch Performance –

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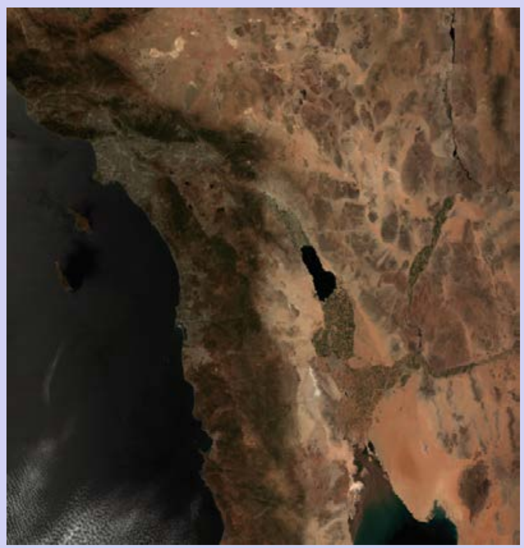
With Contributions from all VCST team members

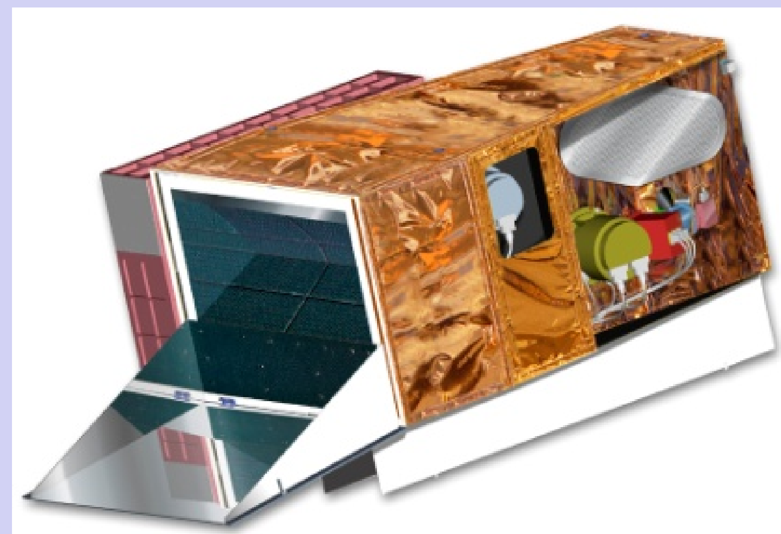
Acknowledgements:

DAWG, Raytheon, NASA VIIRS

On-site Instrument Team



Courtesy of NASA NPP LPEATE



NOAA/STAR Annual Meeting, College Park, (MD), Aug. 26, 2015

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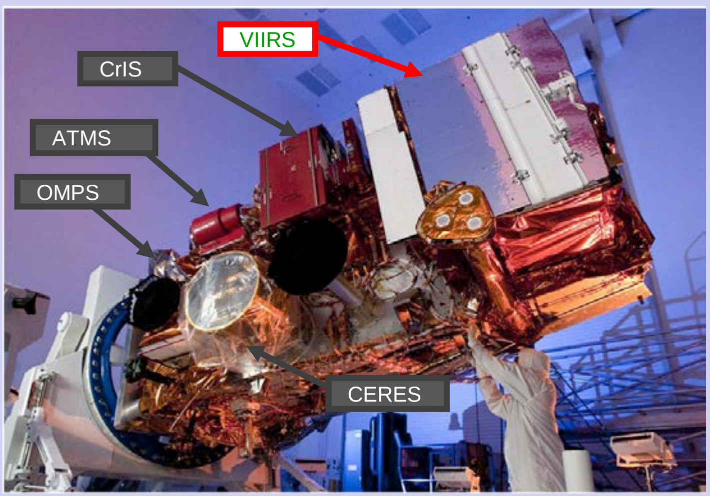
Latest J1 Instrument Status

Raytheon/NASA Team – Sensor Shipping from RTN

VIIRS J1 Leaving Raytheon in Route to Ball

VIIRS J1 installation on the Spacecraft



- J1 VIIRS is the follow on sensor after SNPP VIIRS
- J1 VIIRS completed successfully its sensor level testing program
- Sensor Shipped from Raytheon to Ball (spacecraft) on 2/6/15
- Sensor installed on spacecraft on 2/20/15
- J1 VIIRS completed its initial ambient testing on 03/17/2015.
- J1 VIIRS TV testing (as-you-fly), expected spring 2016.
- J1 VIIRS Launch December 2016

J1 VIIRS Sensor Integration to Spacecraft and Initial Performance Trending were Completed Successfully

VIIRS Bands and Products

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

Dual Gains

VIIRS 22 EDRs
Land, Ocean, Clouds, Aerosol

Land

1- Active Fires
2- Snow Cover
3- Land Surface Albedo
4- Vegetation Index
5- Land Surface Temperature
6- Surface Type
7- Ice Surface Temperature
8- Net Heat Flux
9- Snow Ice Characterization

Ocean

1- Sea Surface Temperature
2- Ocean Color/Chlorophyll

Imagery and Clouds

1- Imagery and low light imaging
2- Cloud Top Height
3- Cloud Optical Thickness
4- Cloud Top Temperature
5- Cloud Effective Particle Size
6- Cloud Base Height
7- Cloud Top Pressure
8- Cloud Cover/Layers

Aerosol

1- Aerosol Optical Thickness
2- Aerosol Particle Size
3- Suspended Matter

Data Analysis Working Group (DAWG) Activities

- **The Data Analysis Working Group (DAWG) team derived an independent verification of J1 instrument**
  - Successful DAWG activities due to collaborative and efficient effort between GVT teams and sensor vendor:
    - NASA, NOAA-STAR, Aerospace, U. of Wisconsin
  - Shared performance results and issues with Raytheon, NOAA-STAR and NASA science subject matter experts (SMEs)
  - Delivered a large set of J1 technical reports and memos, al available on JPSS eRoom
  - Derived a list of J1 performance and testing issues (~44), reviewed by science members and Raytheon.
    - Led to additional testing to complete investigation and to get better instrument characterization before breaking configuration
  - DAWG approval of J1 testing completion & success

RSB Radiometric Performance

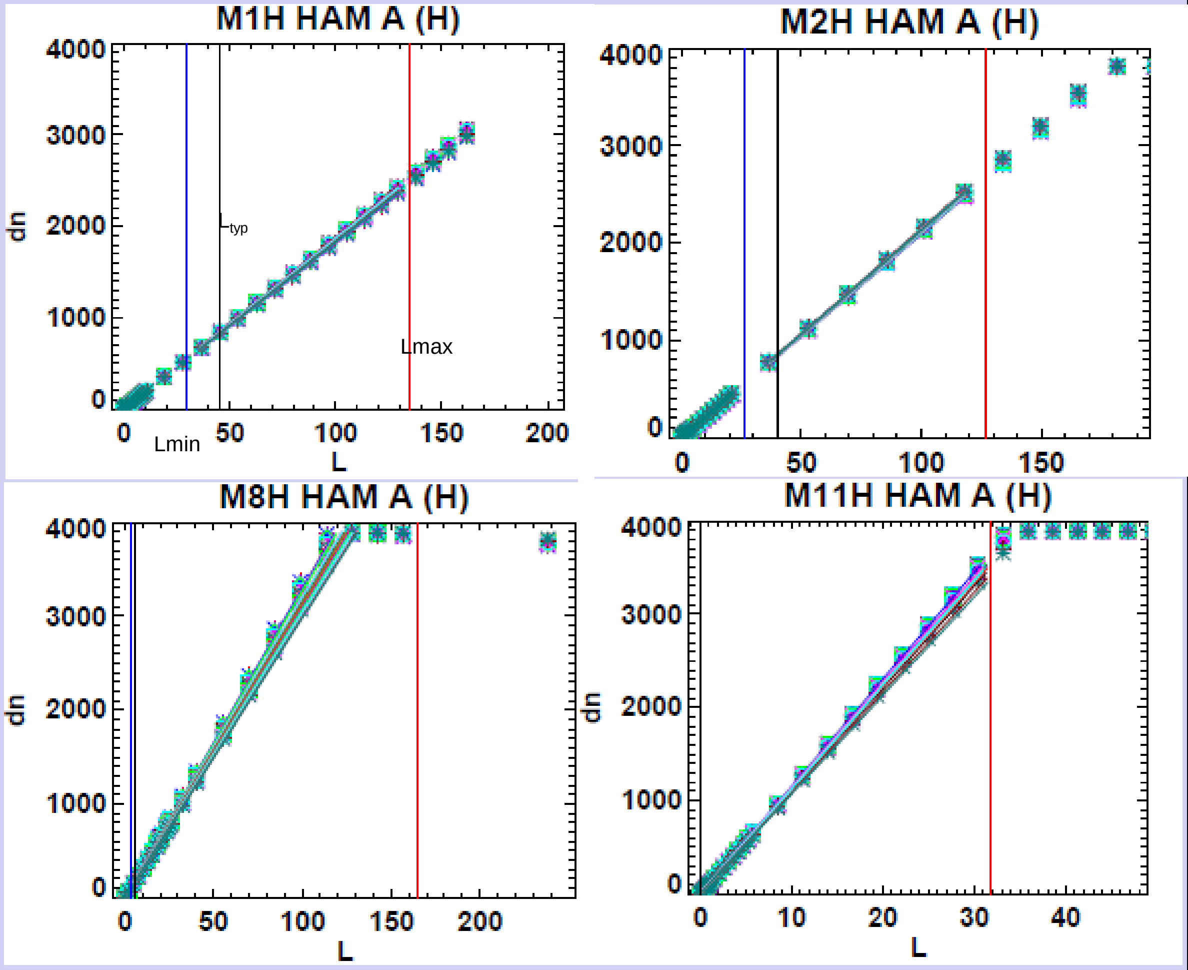
Dual-Gain bands Transition

Band	L_{MAX}	L_{MAX} + 50%	L_trans
M1	135	202.5	**154.4**
M2	127	190.5	**136.8**
M3	107	160.5	**113.3**
M4	78	117	**87.3**
M5	59	87.5	**61.3**
M7	29	43.5	**30.7**

Full Compliance of Gain Transition

- **Attenuator method used to generate Calibration Coefficients (c0, c1, c2)**
- **J1 Radiometric performance is quite similar to SNPP**
- **Higher than expected non-linearity seen in SWIR bands and DNB**

RSB Calibration

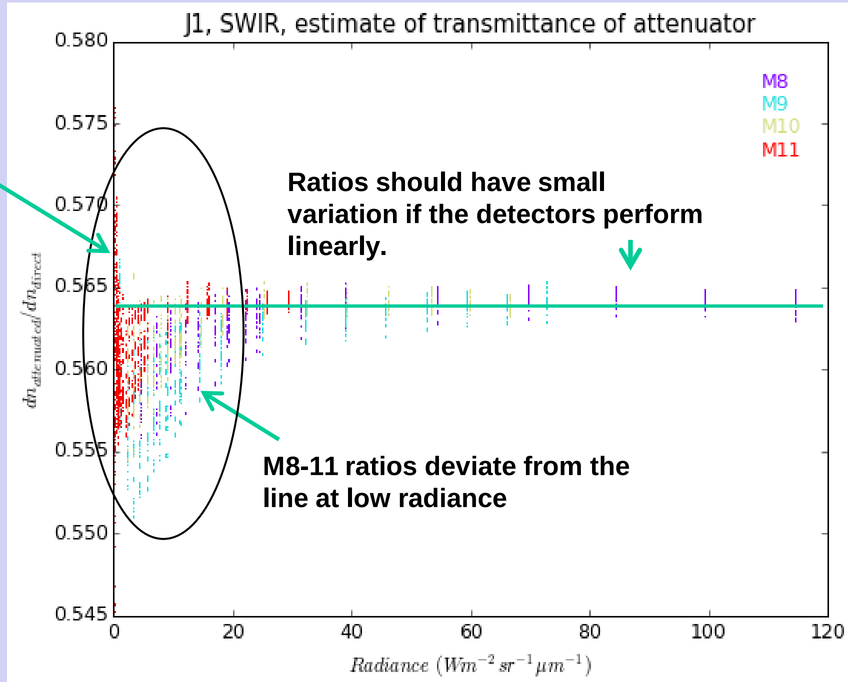


$$L = c_0 + c_1 dn + c_2 dn^2 + O(dn^3)$$
$$\tau \cdot L = c_0 + c_1 dn_a + c_2 dn_a^2 + O(dn_a^3)$$

SWIR Radiometric Performance

SWIR Non-Linearity Issue (Low Radiance)

Quantized data



$$L = c_0 + c_1 dn + c_2 dn^2 + O(dn^3)$$

$$\tau \cdot L = c_0 + c_1 dn_a + c_2 dn_a^2 + O(dn_a^3)$$

$$L = c_0 + c_1 dn + c_2 dn^2 + c_3 dn^3 + O(dn^4)$$

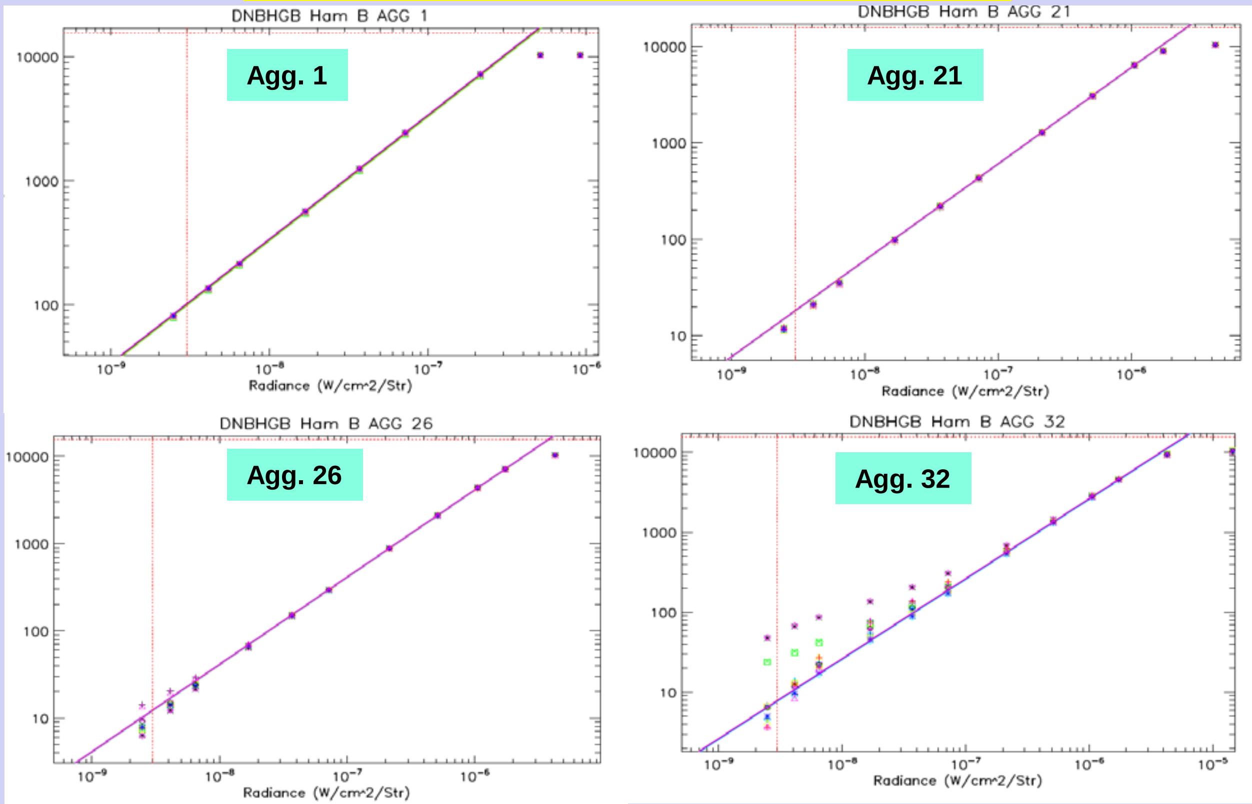
$$L = c_0 + c_1 dn + c_2 dn^2 + c_3 dn^3 + c_4 dn^4 + O(dn^5)$$

Increased enhancement

- SWIR Non-Linearity issue was observed at low radiances
- Issue characterized and root cause identified (ASP electronics bias, VR_Clamp)
- Quantized data are contribution to the non-linear behavior
- Mitigation plan is ready (if needed) for SDR software (3rd or 4th degree equation, two-piece calibration)

DNB Radiometric Performance

DNB HGS Non-Linearity Issue (Low Radiance)



- **Issue characterized and root cause identified (timing card setting)**
- **Limited to agg. modes at the end of scan (21-32)**
- **Mitigation plan was developed (Option agg. Mode 21), and is being tested**
  - **Better radiometric performance (e.g. uniformity, SNR, on-orbit cal.)**
  - **Loss of spatial resolution at the edge of scan (low risk)**

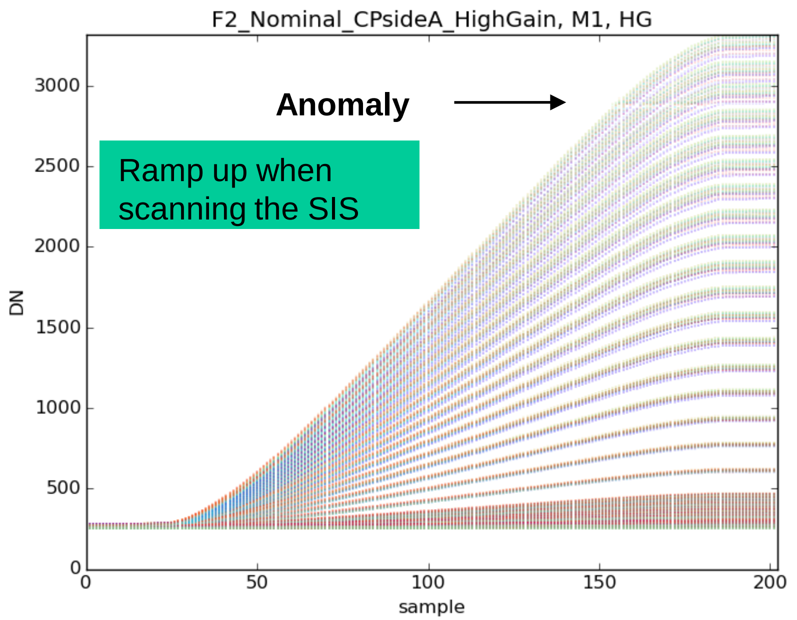
J1 RSB SNR and Lsat

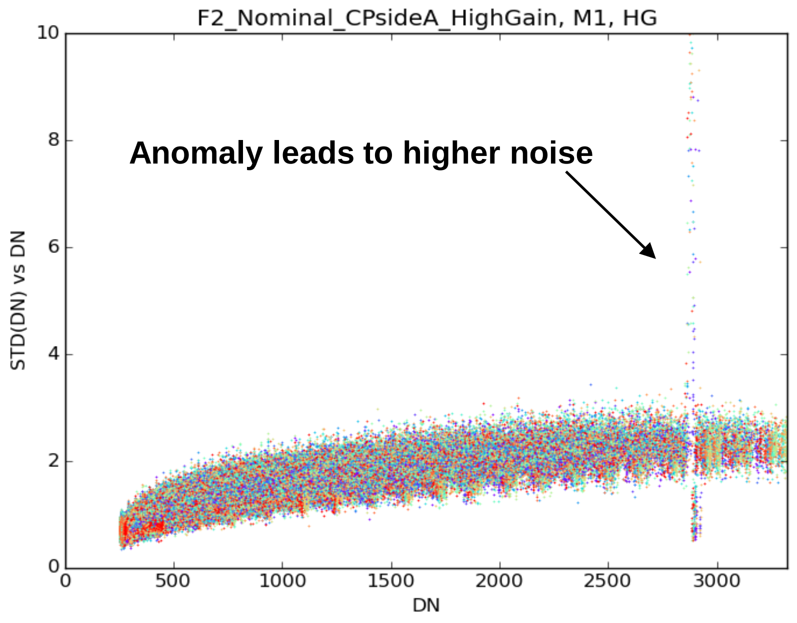
Band	Gain Stage	SNR (Spec)	Lmax (Spec)	SNPP SNR	J1 SNR	SNPP SNR/Spec	J1 SNR/Spec	SNPP L_sat/Lmax	J1 L_sat/Lmax
M1	High	352	135	613	636	1.74	1.81	1.16	1.21
M1	Low	316	615	1042	1066	3.30	3.37	1.13	1.10
M2	High	380	127	554	573	1.46	1.51	1.41	1.40
M2	Low	409	687	963	986	2.35	2.41	1.20	1.30
M3	High	416	107	683	706	1.64	1.70	1.29	1.31
M3	Low	414	702	1008	1063	2.44	2.57	1.20	1.20
M4	High	362	78	526	559	1.45	1.54	1.42	1.39
M4	Low	315	667	864	844	2.74	2.68	1.31	1.28
M5	High	242	59	373	380	1.54	1.57	1.24	1.25
M5	Low	360	651	776	751	2.16	2.09	1.12	1.11
M6	High	199	41	409	428	2.06	2.15	1.16	1.16
M7	High	215	29	524	549	2.44	2.55	1.28	1.26
M7	Low	340	349	721	760	2.12	2.23	1.19	1.17
M8	High	74	164.9	358	335	4.84	4.53	0.77	0.72
M9	High	83	77.1	290	325	3.49	3.91	1.09	1.04
M10	High	342	71.2	691	765	2.02	2.24	1.14	1.09
M11	High	10	31.8	105	216	10.49	21.57	1.09	1.10
I1	High	119	718	261	227	2.19	1.91	1.07	1.08
I2	High	150	349	273	287	1.82	1.91	1.18	1.17
I3	High	6	72.5	176	190	29.36	31.72	0.97	0.91

- **J1 SNR met requirement with significant margin.**
- **Dynamic range is not met for M8 and I3, M9 (D1-3)**
- **In general, very good linearity performance (<<1%)**

- **Similar to SNPP, non-compliances seen for characterization uncertainty and uniformity.**
- **Waivers released by Raytheon show low risk**

RSB Radiometric Performance





Dual Gain Anomaly (DGA)

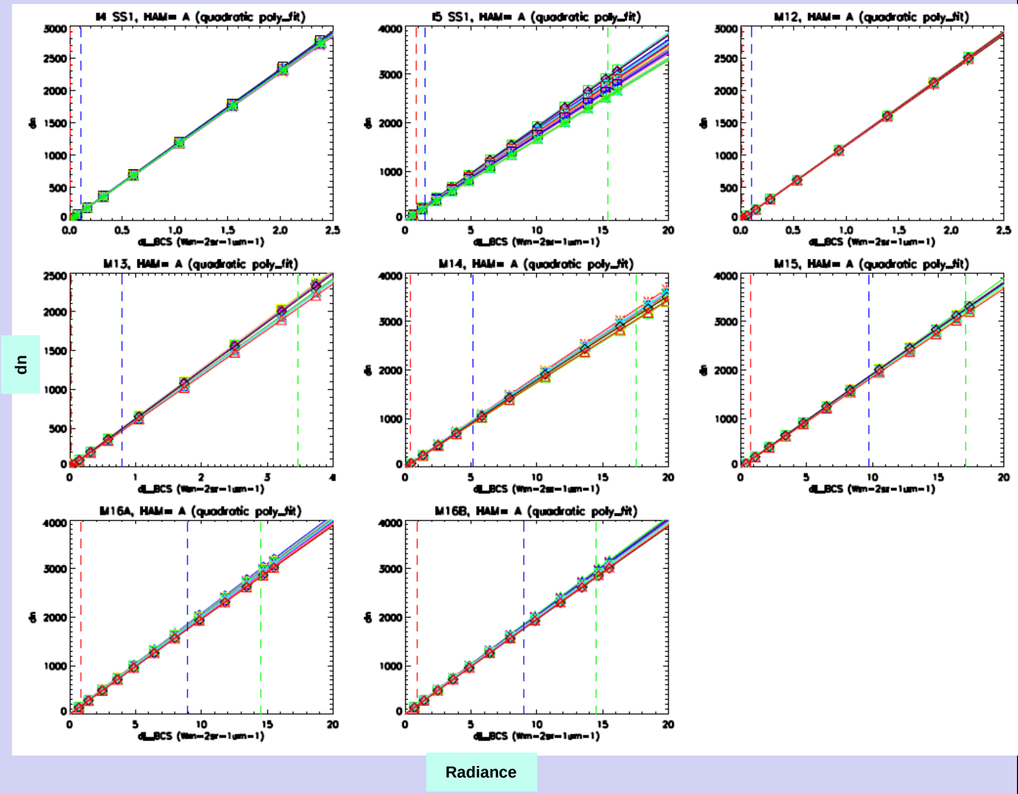
ramp up	M1		M2		M3		M4		M5		M7	
Detector	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
16	2846	2882	3186	3222	2984	3016	3195	3269	2987	3017	3117	3139
15	2849	2887	3182	3224	2979	3010	3172	3252	3034	3094	3101	3123
14	2849	2891	3207	3240	2975	3014	3157	3204	3017	3070	3100	3126
13	2862	2902	3227	3256	3022	3054	3201	3277	3006	3096	3123	3151
12	2884	2923	3215	3250	2989	3028	3206	3243	2986	3087	3053	3122
11	2849	2893	3194	3232	2977	3019	3187	3223	2972	3012	3055	3124
10	2855	2897	3216	3250	3016	3033	3191	3267	2959	3047	3111	3188
9	2842	2885	3212	3244	3004	3038	3183	3205	2988	3018	3120	3184
8	2851	2894	3196	3233	3004	3023	3156	3237	3028	3052	3125	3154
7	2851	2890	3202	3248	2995	3028	3162	3217	3008	3088	3106	3138
6	2851	2894	3192	3229	2989	3018	3160	3266	3015	3049	3100	3123
5	2853	2895	3196	3229	2977	3003	3174	3212	2995	3029	3095	3128
4	2855	2893	3192	3216	2972	3013	3190	3224	3060	3097	3085	3118
3	2856	2893	3206	3244	2981	3023	3165	3274	2993	3026	3069	3143
2	2884	2920	3202	3242	2988	3026	3195	3259	2957	3029	3108	3141
1	2867	2902	3218	3241	3015	3033	3181	3262	3012	3099	3085	3124

- **J1 DGA was expected and similar to SNPP**
- **Root-cause well understood based on SNPP testing**
- **Noise increase up to 4 times in DGA region**
- **J1 testing allowed DGA characterization for SDR flagging**
- **Low risk for on-orbit data products**

J1 TEB Performance: NEdT & Lsat

Band	NEdT at Ttyp				Lsat			
	Spec	SNPP	J1	J1/Spec	Spec	SNPP	J1	J1/spec
I4	2.5	0.41	0.42	0.17	353	357	357	1.01
I5	1.5	0.42	0.41	0.27	340	373	370	1.09
M12	0.396	0.13	0.12	0.30	353	357	358	1.01
M13 HG	0.107	0.044	0.043	0.40	343	364	363	1.06
M13 LG	0.423	0.34	0.304	0.72	634	--	--	--
M14	0.091	0.061	0.05	0.55	336	347	348	1.04
M15	0.07	0.03	0.026	0.37	343	365	359	1.05
M16	0.072	0.038	0.043	0.60	340	368	369	1.09

J1 VIIRS meets all NEdT and Lsat requirements with margins



- **J1 TEB calibration shows very good overall performance.**
- **Minor non-compliances observed: T_{MIN} for I4 and M14; M13 gain transition radiance, out of family detector noise for M15 (D4) and M16B (D5)**
  - ❑ **Impact to science is expected to be small.**

J1 TEB Radiometric Performance

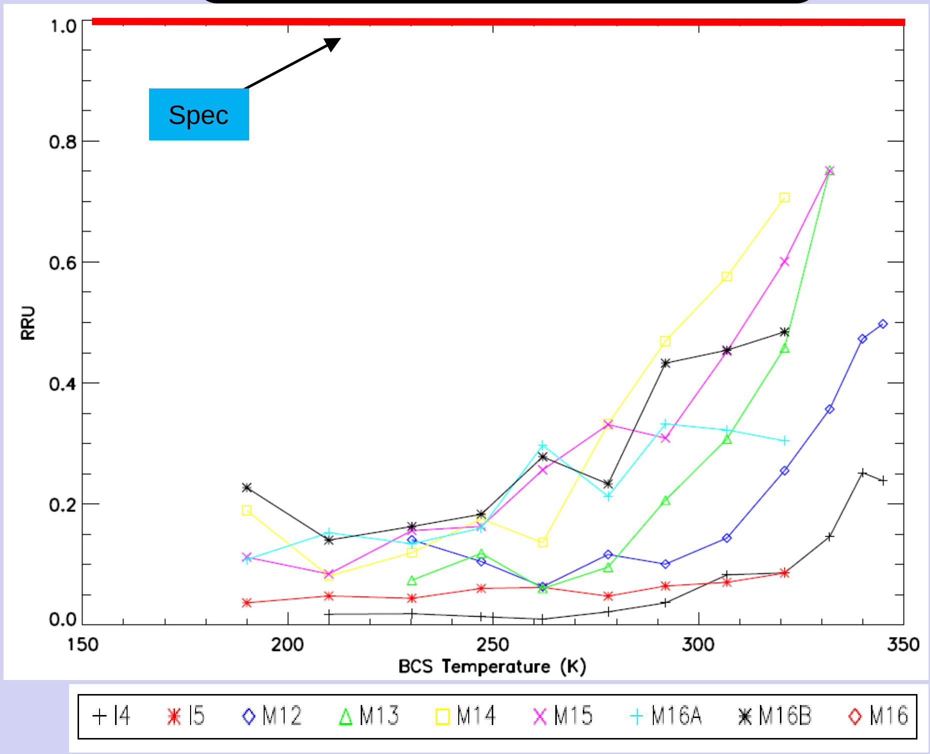
Absolute Radiometric Uncertainty (ARD): Nominal

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

J1 ARD requirements met with margins

Uniformity – Det. Striping Nominal



- **J1 TEB calibration shows very good performance for ARD and uniformity (striping).**
  - **ARD is below ~0.3 % except at low temperatures for the MWIR (as expected).**
  - **Detector-to-detector uniformity shows some small potential for striping at high temperatures in bands M12 – M14 (similar to SNPP).**

J1 VisNIR Polarization Sensitivity

- **DAWG data analysis showed that bands M1 – M4 were non-compliant with the polarization sensitivity requirements**
  - First reported on December 28, 2013 (Ambient phase)
  - Root-cause is the band spectral filters (Bandpass edges)

- **A series of telecons were held with NASA and NOAA SMEs**
  - NASA/NOAA-STAR identified SMEs for each discipline (01/29/2014)
  - Impact assessments were performed for Ocean, Land , Atmosphere
  - Correction methodologies were shown to enhance the EDR products

- **Additional testing was requested after TVAC**
  - Additional scan angles were measured using a broadband source
  - Limited narrowband measurements were performed with a laser source for model validation

Successful and comprehensive J1 polarization testing was completed

J1 Polarization Factor (%)

	Band	Sensor	Scan Angle												
			-55	-45	-37	-30	-22	-15	-8	4	20	45	55	Max Pol.	Spec
HAM A	I1	SNPP	1.5	1.24	~	~	0.93	~	0.85	~	0.7	0.64	0.62	**1.24**	2.5
		J1	0.81	0.74	0.75	0.73	0.73	0.79	0.76	0.8	0.82	0.85	0.85	**0.85**	2.5
	I2	SNPP	0.29	0.27	~	~	0.34	~	0.37	~	0.47	0.51	0.51	**0.51**	3
		J1	0.73	0.62	0.54	0.47	0.36	0.37	0.37	0.43	0.5	0.61	0.66	**0.62**	3
	M1	SNPP	2.99	2.63	~	~	1.95	~	1.79	~	1.42	1.21	1.4	**2.63**	3
		J1	5.13	5.26	5.35	5.52	5.54	5.56	5.65	5.7	5.66	5.51	5.37	**5.7**	3
	M2	SNPP	2.11	1.97	~	~	1.63	~	1.53	~	1.28	1.17	1.29	**1.97**	2.5
		J1	3.72	3.79	3.85	3.95	3.9	3.89	3.94	3.95	3.9	3.99	4.04	**3.99**	2.5
	M3	SNPP	1.2	1.14	~	~	0.9	~	0.82	~	0.61	0.7	0.8	**1.14**	2.5
		J1	2.89	2.85	2.83	2.85	2.73	2.69	2.68	2.63	2.62	2.8	2.84	**2.85**	2.5
	M4	SNPP	1.05	1.1	~	~	1.19	~	1.16	~	1	0.88	0.84	**1.19**	2.5
		J1	3.61	3.9	4.08	4.16	4.17	4.22	4.18	4.18	4.04	3.89	3.8	**4.22**	2.5
	M5	SNPP	1.19	1.02	~	~	0.85	~	0.84	~	0.76	0.73	0.69	**1.02**	2.5
		J1	1.9	1.86	1.9	1.86	1.82	1.85	1.79	1.83	1.81	1.8	1.8	**1.9**	2.5
	M6	SNPP	0.99	0.96	~	~	0.94	~	0.94	~	0.88	0.82	0.76	**0.96**	2.5
		J1	1.62	1.32	1.13	0.99	0.86	0.85	0.79	0.75	0.73	0.75	0.76	**1.32**	2.5
	M7	SNPP	0.17	0.19	~	~	0.25	~	0.28	~	0.38	0.42	0.41	**0.42**	3
		J1	0.73	0.62	0.54	0.46	0.36	0.36	0.32	0.39	0.45	0.55	0.6	**0.62**	3

J1 Polarization test data have very good quality for all bands

- **Broadband data analyzed and DoLP / phase determined for all VisNIR bands**
- **Uncertainty requirements met for all bands (max ~0.4 %)**
- **Very good testing repeatability (DoLP to within ~0.11 %)**
- **T-SIRCUS showed DoLP agreement to within ~0.5 %**

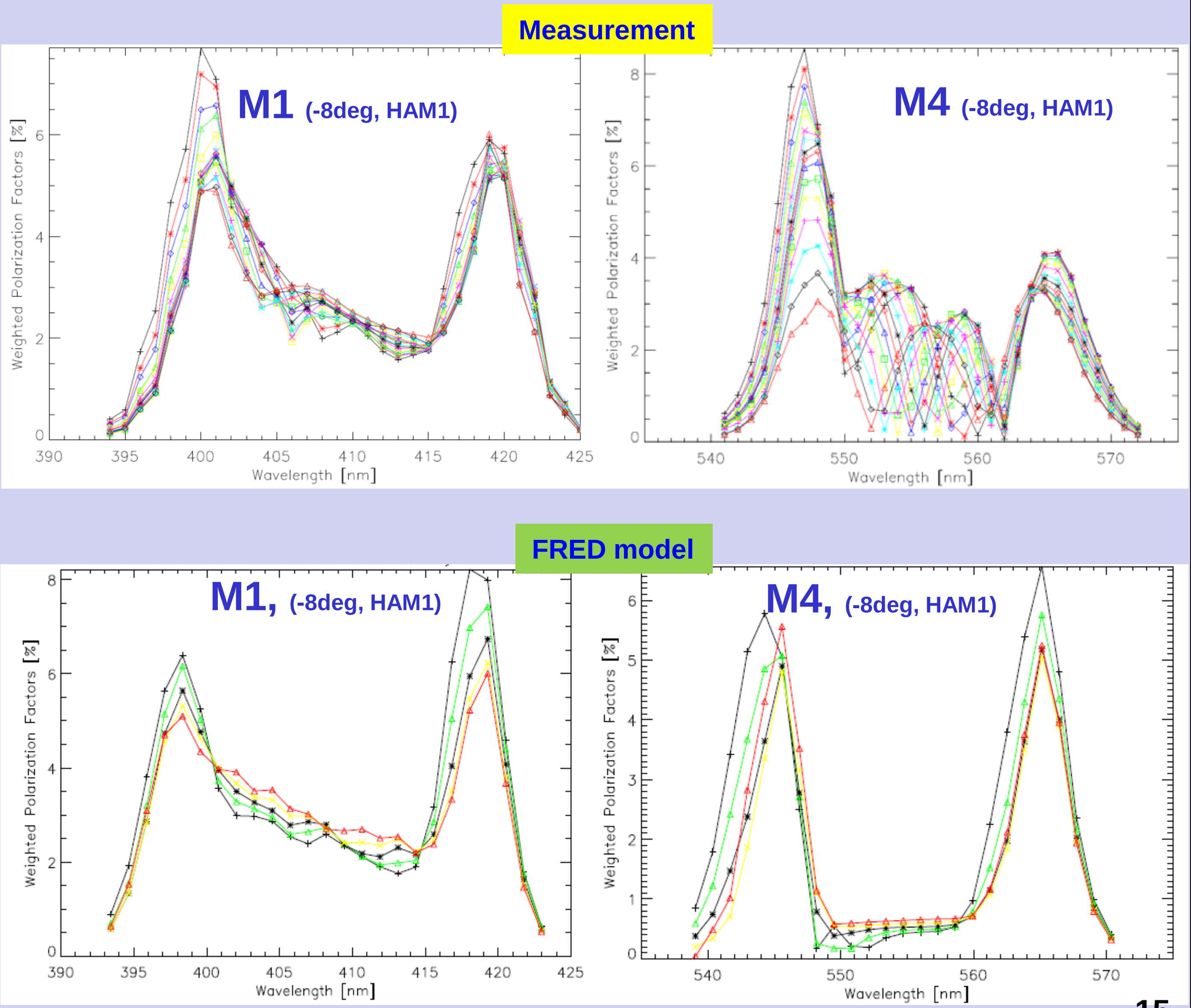
T-SIRCUS Polarization Measurements

T-SIRCUS polarization measurements were performed in December 2014 (M1 and M4).

Limited number of measurements made in terms of scan angle, HAM side, and wavelength.

FRED model data compared to measurement results:

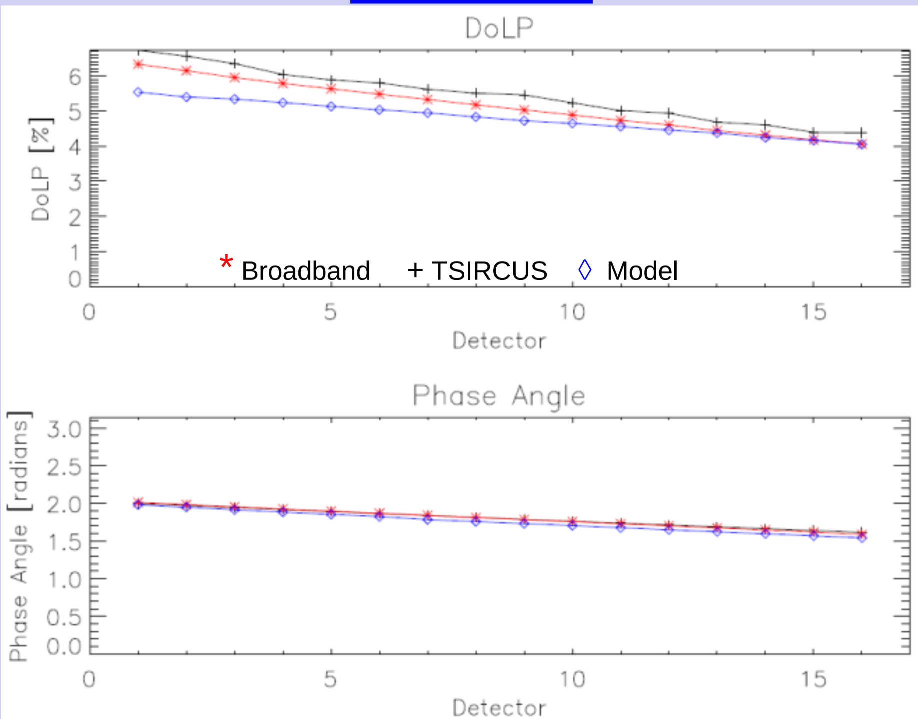
1) **Good agreement on general shape of wavelength dependence**
2) **Largest contribution comes from the edges of the filter bandpass**
3) **Phase shifts in the center of M4 bandpass not represented by model**



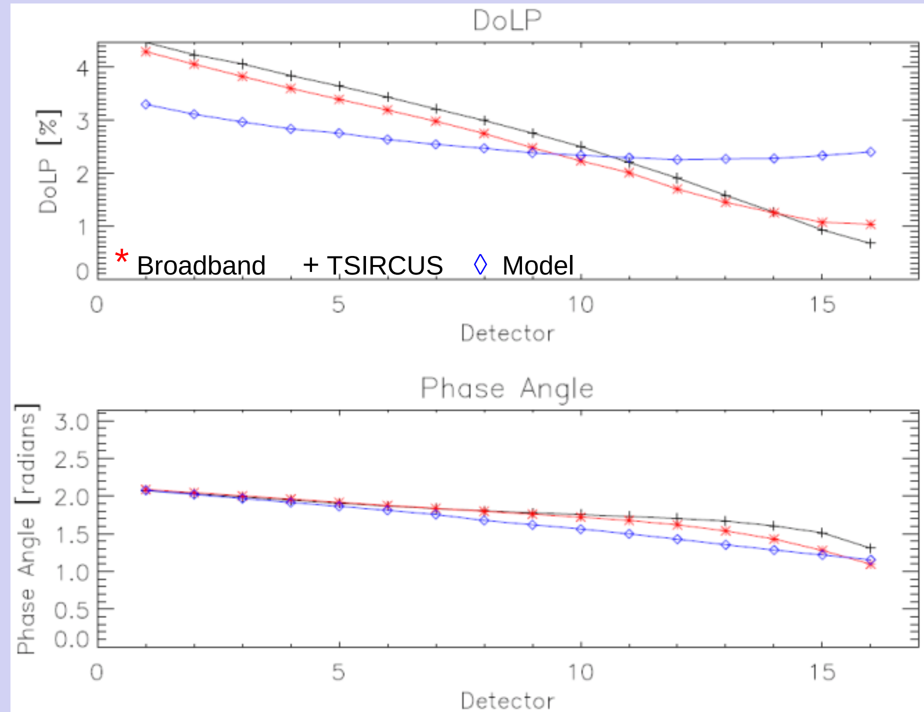
Polarization Sensitivity Comparison:

Broadband vs T-SIRCUS vs. Model

M1 (-8, HAM 1)



M4 (-8, HAM 1)



DAWG team concluded that J1 Polarization test data have good quality

- Uncertainty requirements met for all bands (max ~0.4 %)
- Broadband test data were consistent (DoLP to within ~0.11 %; phase to within ~4^0)

T-SIRCUS data analyzed and DoLP / phase determined for M1 and M4

- Agreement between SIRCUS and FP-11 / FP-11’ to within ~0.5 %
- FRED model needs enhancement to be consistent with J1 instrument

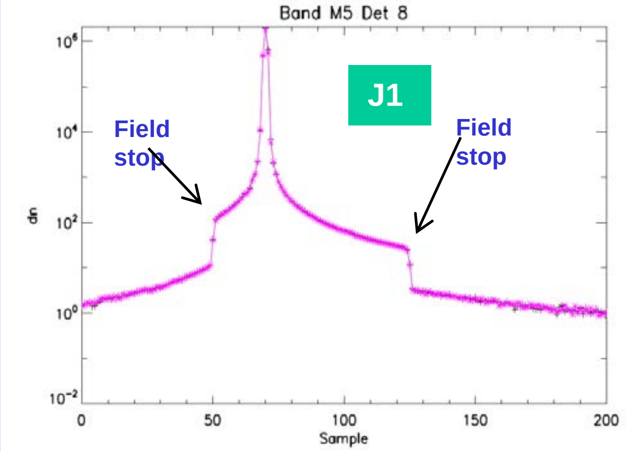
Near-Field Response (NFR) Performance

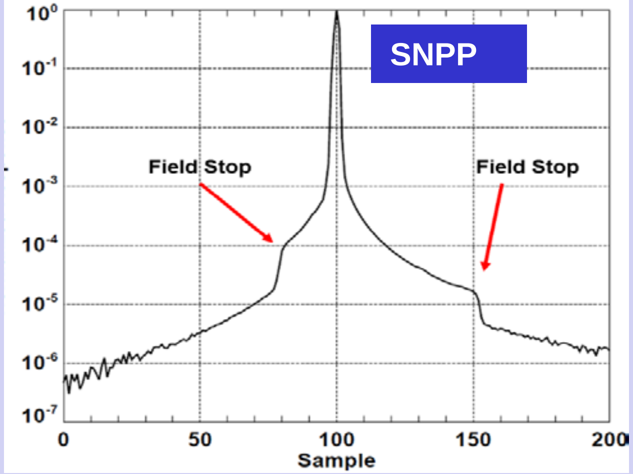
J1 NFR Performance at Beginning of Life (BOL)

Band	Center Wavelength (nm)	Angular Separation (mrad)	L_{bright}	L_{scat}	SNPP L_{scat} / L_{spec}	JPSS-1 L_{scat} / L_{spec}
M1	412	6	162	2.77E-03	0.39	0.37
M2	445	6	180	2.22E-03	0.45	0.42
M3	488	6	160	2.00E-03	0.5	0.36
M4	555	6	160	1.31E-03	0.47	0.48
M5	672	6	115	8.70E-04	0.63	0.60
M6	746	12	147	1.31E-03	0.12	0.13
M7	865	6	124	5.16E-04	0.90	0.83
M8	1240	6	57	9.47E-04	0.62	0.60
M9	1378	NA	NA	NA	NA	NA
M10	1610	6	86.1	8.48E-04	0.76	0.30
M11	2250	6	1.2	1.00E-03	0.42	0.63
M12	3700	3	0.3	1.67E-03	0.64	0.40
M13	4050	3	1.7	1.86E-03	0.63	0.32
M14	8550	NA	NA	NA	NA	NA
M15	10763	3	12.5	7.75E-04	1.25	0.01
M16	12013	3	11.3	7.92E-04	1.26	0.88
DNB	12013	3	NA	2.00E-03	NA	0.41

J1 NFR requirements are met for all bands at BOL

Measured near-field response for band M5 (672 nm) detector 8, as a function of samples. The figure also shows the location of the field stops

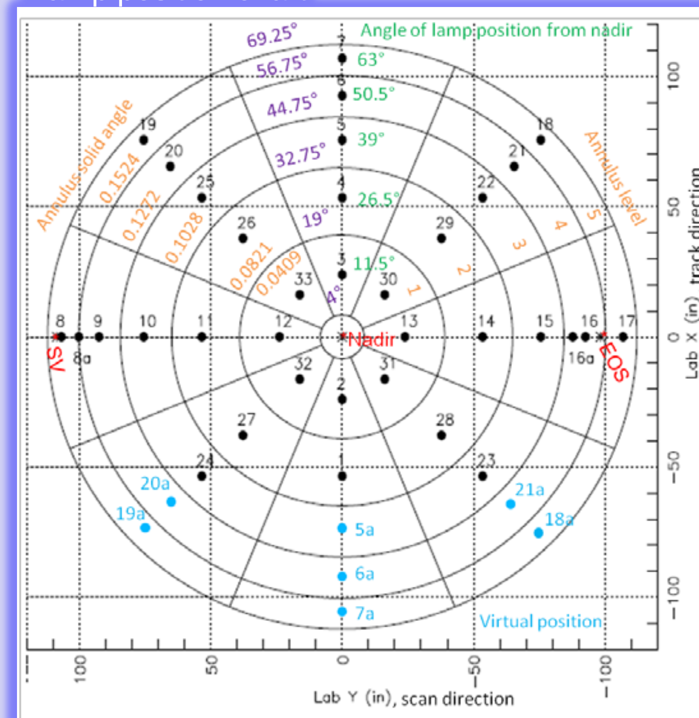


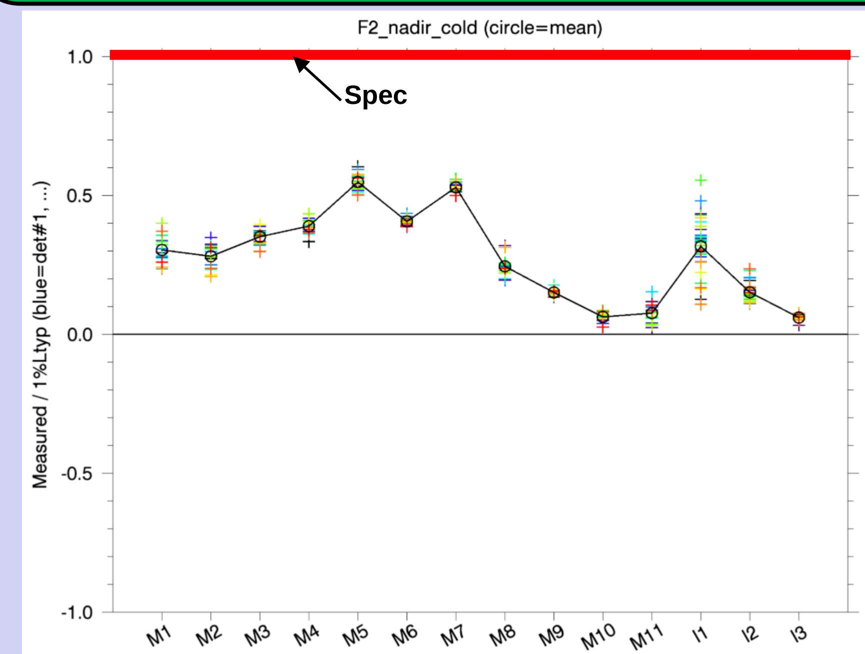


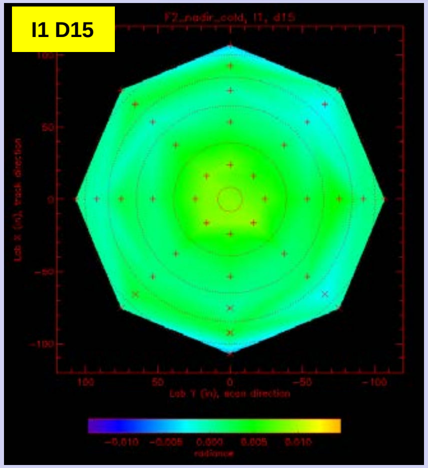
Stray-Light Response (SLR) Performance

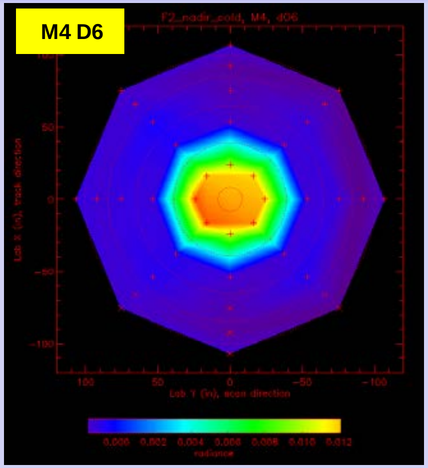
- J1 SLR performance is comparable to SNPP. The right hand side shows a couple of examples (out of 336) of simulated views from detectors.
- **All RSB detectors meet SLR specification at Beginning of Life (BOL) (plot below).**
- Bands M5 and M7 are predicted to fail Spec at the End of Life (EOL), while M6 will become marginal.

Lamp position chart



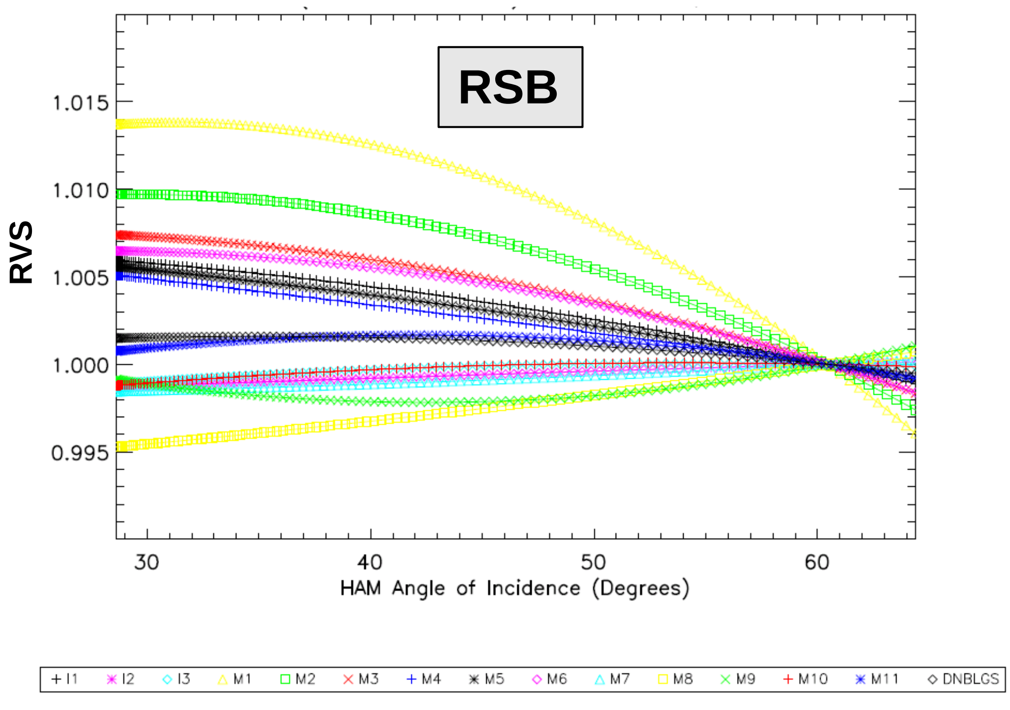


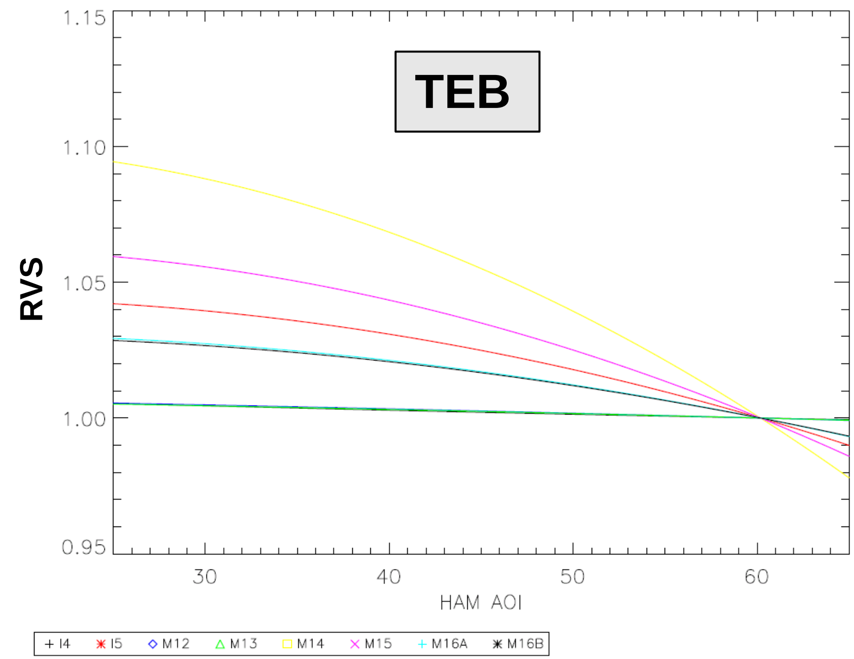




Response vs. Scan (RVS) Performance

RVS is the HAM reflectance as a function of HAM Angle of incidence (AOI)

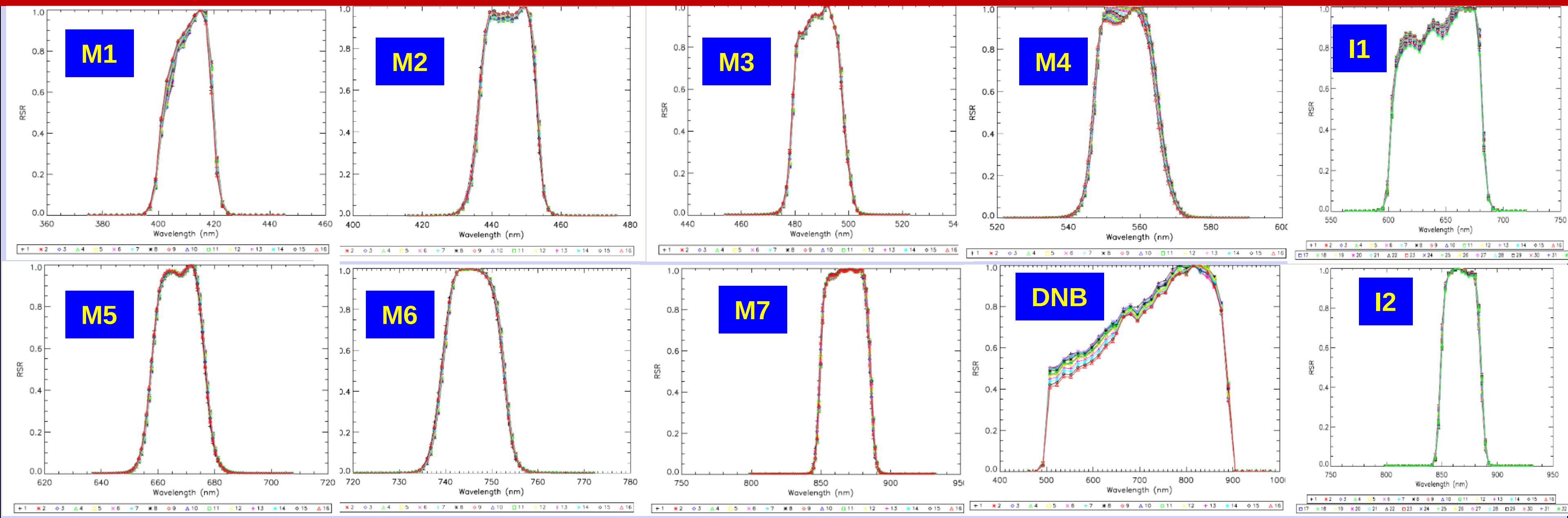


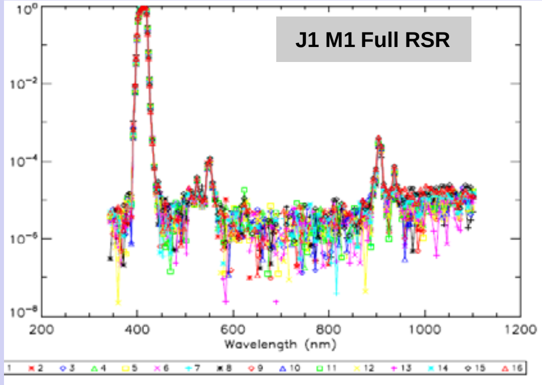


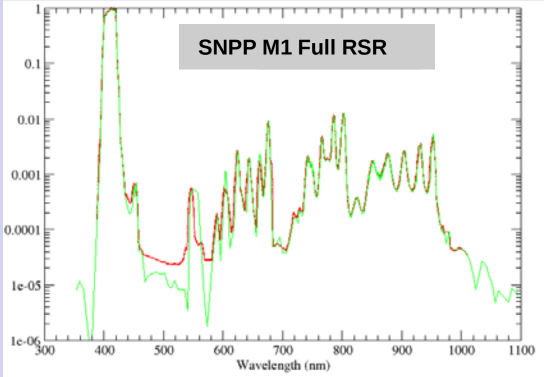
- **Uncertainty under 0.06% for all bands except I3 det4 and M9 (water vapor).**
- **Short wavelength bands M1 and M2 have the largest RVS.**

- **Uncertainty under 0.15 % for all bands.**
- **Largest RVS observed in LWIR (with M14 up to ~10 %) and the smallest in the MWIR (less than 1%).**

J1 Spectral Performance: VisNIR bands

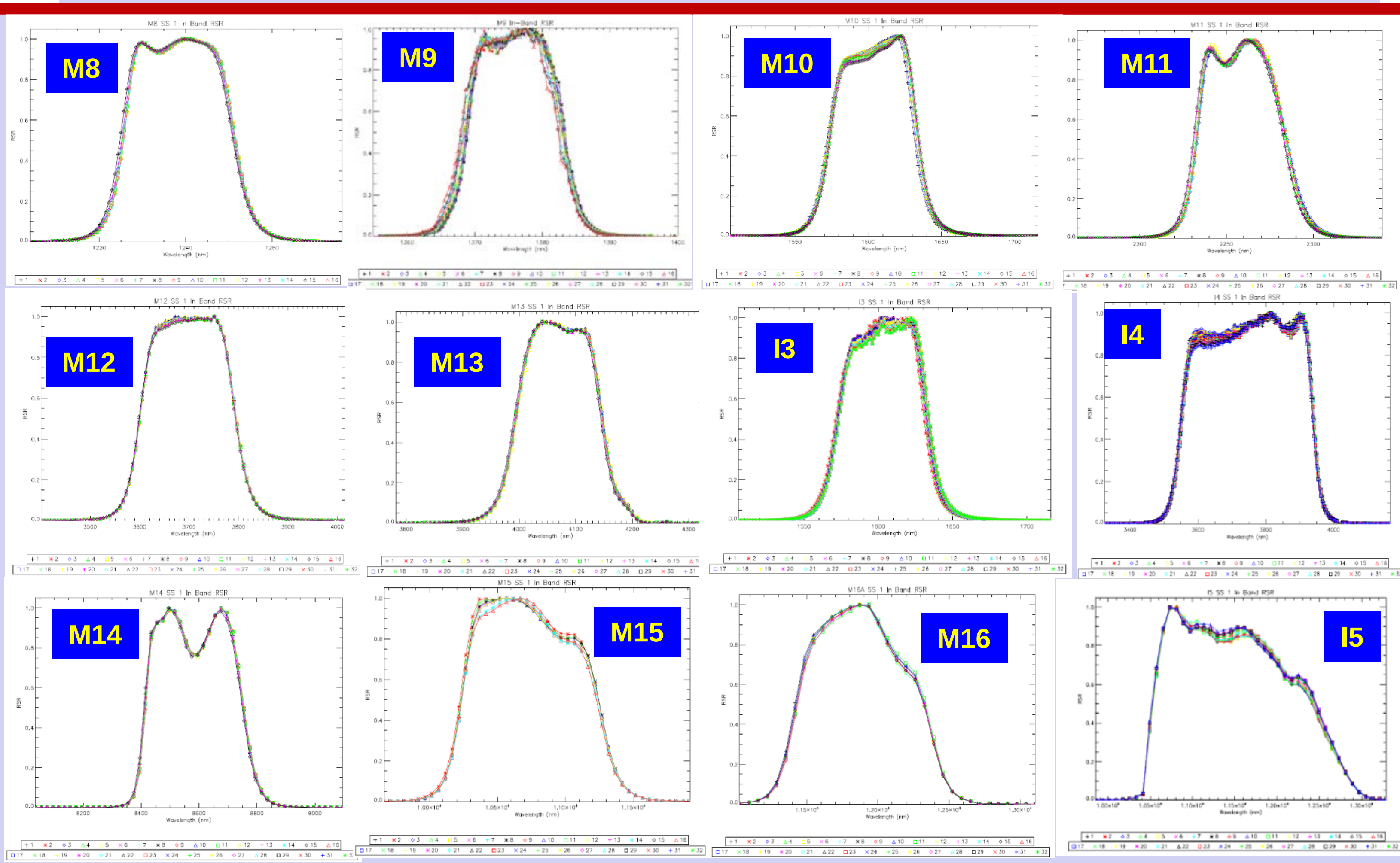






- VisNIR Relative Spectral Response (RSR) was completed successfully for all bands
- Good performance of J1 Crosstalk (optical/electric), as good as SNPP or better
- Laser test data (TSIRCUS) are being merged with the SpMA to refine J1 RSRs

J1 Spectral Performance:
SMWIR/LWIR



- **SWMIR/LWIR Relative Spectral Response (RSR) was completed successfully for all bands**
- **M9 RSR was corrected for water vapor leading to smoother RSR profile**

J1 Spectral Performance

SNPP

Band	Band center	Bandpass (FWHM)	Lower 1% point	Upper 1% point	MIOOB
'M1'	pass	pass	pass	pass	FAIL
'M2'	pass	FAIL	pass	pass	pass
'M3'	pass	pass	pass	pass	FAIL
'M4'	FAIL	pass	pass	pass	FAIL
'I1'	pass	pass	pass	pass	pass
'M5'	pass	pass	pass	pass	FAIL
'M6'	pass	pass	pass	pass	FAIL
'I2'	pass	pass	pass	pass	FAIL
'M7'	pass	pass	pass	pass	pass
'M8'	pass	FAIL	pass	pass	pass
'M9'	pass	pass	pass	pass	pass
'I3'	pass	pass	pass	pass	pass
'M10'	pass	pass	pass	pass	pass
'M11'	pass	pass	pass	pass	pass
'I4'	pass	pass	pass	pass	pass
'M12'	pass	pass	pass	pass	pass
'M13'	pass	pass	pass	pass	pass
'M14'	pass	FAIL	pass	pass	FAIL*
'M15'	pass	pass	pass	pass	FAIL*
'I5'	pass	pass	pass	FAIL	FAIL*
'M16A'	FAIL	pass	pass	pass	FAIL*
'M16B'	FAIL	pass	pass	pass	FAIL*
DNBLGS	pass	pass	pass	pass	pass

J1

Band	Band center	Bandpass (FWHM)	Lower 1% point	Upper 1% point	MIOOB
'M1'	pass	FAIL	pass	pass	pass
'M2'	pass	pass	pass	pass	pass
'M3'	pass	pass	pass	pass	pass
'M4'	pass	pass	pass	pass	pass
'I1'	pass	pass	Pass	pass	pass
'M5'	pass	pass	pass	pass	pass
'M6'	pass	pass	pass	pass	pass
'I2'	pass	pass	pass	pass	pass
'M7'	pass	pass	pass	pass	pass
'M8'	pass	FAIL	pass	pass	pass
'M9'	pass	pass	pass	pass	pass
'I3'	pass	pass	pass	pass	pass
'M10'	pass	pass	pass	pass	pass
'M11'	pass	pass	pass	pass	pass
'I4'	pass	pass	pass	pass	pass
'M12'	pass	pass	pass	pass	pass
'M13'	pass	pass	pass	pass	pass
'M14'	pass	FAIL	pass	pass	pass
'M15'	pass	pass	pass	pass	pass
'I5'	pass	pass	pass	FAIL	pass
'M16A'	FAIL	pass	pass	pass	pass
'M16B'	FAIL	pass	pass	pass	pass
DNBLGS	pass	pass	pass	pass	pass

- J1 RSR showing good performance as expected. Minor non-compliances are small risk
- J1 RSR version 1 (V1) was released to the science community in June, 2015
- J1 RSR data set (V1) is available from a secure web site.

*High noise floor in LWIR out-of-band response test

J1 Lesson Learned & Implementation into J2

- **A series of lessons learned discussions led to a list of 97 items.**
- **Most of these items will lead to no additional testing time, but expect the total testing time to be reduced**
  - 35 identified as “will do”
  - 26 identified as “task order” candidates
  - 3 identified as “already implemented”
  - 3 identified as “AOA risk reduction”
  - 6 identified as “open”
  - 24 rejected – acceptable risk not to implement

Summary & Conclusion

- **J1 VIIRS test program at the instrument level was completed successfully**

  - VIIRS testing provided an extensive amount of high quality data to enable the assessment of sensor performance
  - VIIRS performance exceeds requirements with few non-compliances
  - Non-compliances have been reviewed, impacts have been assessed, and mitigation plans are being prepared for on-orbit processing

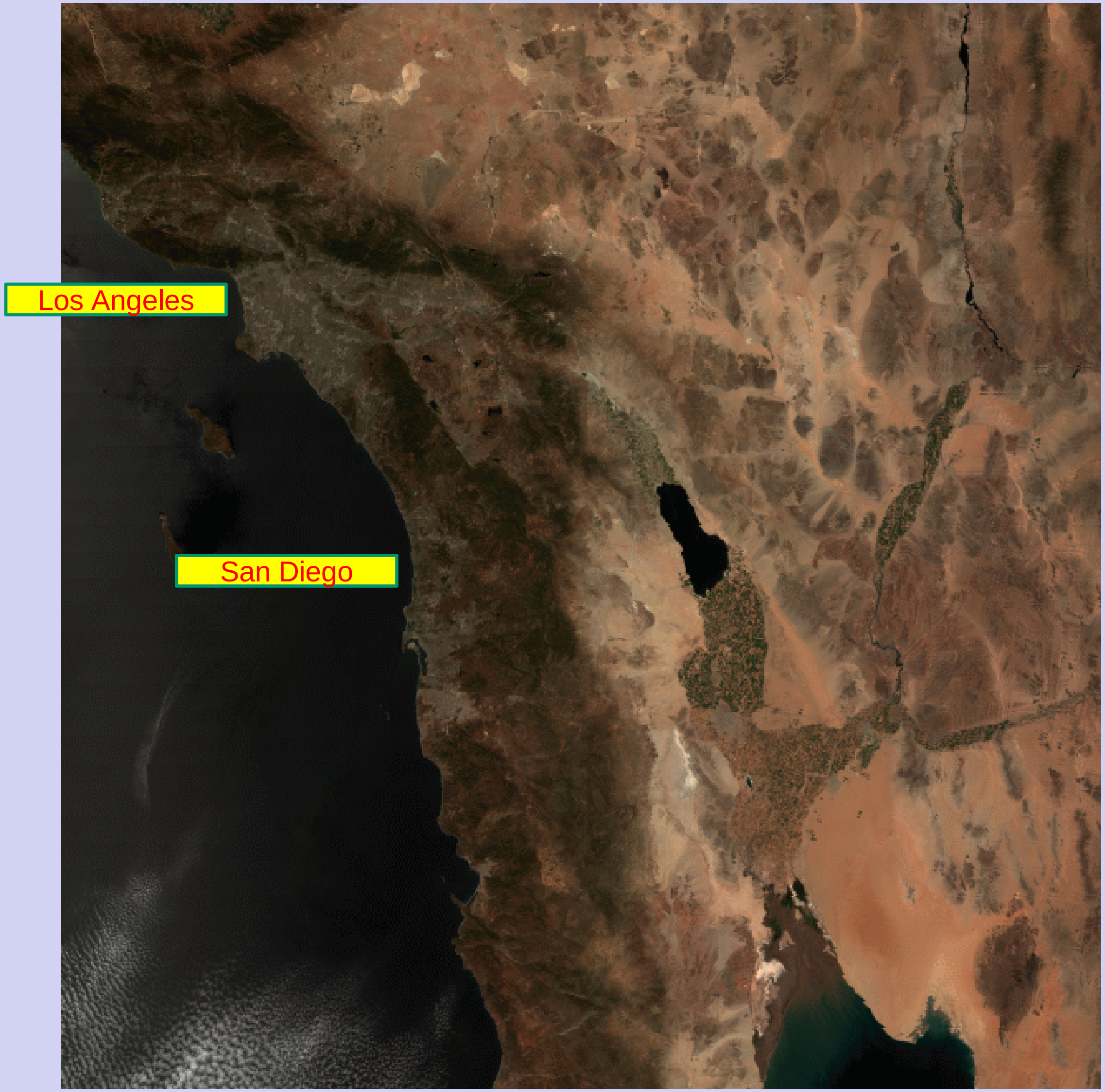
- **J1 VIIRS spacecraft testing is ongoing**

  - VIIRS instrument was integrated successfully onto the spacecraft, awaiting TV testing (April 2016)
  - Key TV testing includes the DNB testing and verification of the configurations planned to reduce non-linearity issue on orbit.

- **J1 LUTs development for SDR processing**

  - J1 SDR LUTs effort is ongoing based on pre-launch testing. Initial version released in July 2015
  - **J1 SDR effort is ongoing to mitigate performance issues (e.g. DNB and SWIR non linearity, polarization).**

SNPP VIIRS Imagery



Courtesy of NASA NPP LPEATE

RGB using M5, M4 and M3 SDR bands

J1 VIIRS is also expected to deliver high quality radiance and environmental data products

Thank You!

J1 VIIRS Performance Waivers

Raytheon Waiver #	Title	Status
RDW_148	J1 Relief against reflective band absolute radiometric calibration uncertainty requirements for bands M1-M3	Approved
RDW_149	J1 Relief against reflective band absolute radiometric calibration uncertainty requirements for band M11	Approved
RDW_150A	J1 Relief for DNB stray light in certain viewing geometries and related impacts on sensitivity and radiometric calibration	Approved
RDW_151	J1 relief against maximum radiance requirement for bands M8, I1 and possibly M1LG and I3.	Approved
RDW_166	J1 relief agains maximum polarization sensitivity requirement for bands M1 to M4.	Approved
RDW_153	J1 relief against electrical and optical crosstalk. Stringent requirements and testing artefacts are leading to non-compliances	Approved
RDW_150A	J1 relief against the sensor modulated transfer function (MTF)	Approved
RDW_161	J1 relief against the relative spectral response (RSR) requirements. Band center (M5, M16), Band width (M1,M8,M14,DNB), 1% limit (I5,DNB), IOOB (M16)	Approved
RDW_168	J1 relief against near field response (NFR). Non-compliance for (M7, M13, M16A and I3)	Approved
RDW_171	J1 relief from emissive relative radiometric reponse calibration uniformity (M12-M14 at high temp) and characterization uncertainty (I5 and M12).	Approved
RDW_172	J1 relief from reflective band characterization uncertainty (all bands non-compliant except M4HG and M5HG, and M7HG), and uniformity characterization (all bands non-compliant except M1-M7 high gain and M6)	Approved
RDW_173	J1 relief from band-to-band registration for I bands (non-compliance for I1-I3, I2-I3, I1-I4, I2-I4, I1-I5, I2-I5, I3-I5, I4-I5)	Approved
RDW_174	J1 relief from DNB SNR, uniformity and RCU.	Approved
RDW_175	J1 relief from spatial dynamic field of view (DFOV). All M bands and I5 not compliant	Approved
RDW_177	J1 DNB relief from dynamic range (LGS)	Approved

- **All 15 waivers were approved by NASA/NOAA review board**
- Completed a series of telecons (half-dozen) with NASA and NOAA SMEs to review each waiver
- Compliance is against end-of-life (EOL) performance
- All of non-compliances have mitigation plans, or will lead to acceptable impact.

J1 VIIRS Performance Based on Sensor Level Testing

- **RSB Radiometric Performance:**
  - **J1 VIIRS meets all requirements for Signal to Noise Ratio, Dynamic Range, Gain Transition,**
    - Successful J1 RSB radiometric calibration. Overall, as good as SNPP
    - Minor non-compliances for dynamic range: M8 (72%) and I3 (91%), while I3 Det4 is a bad detector (very noisy and lower responsivity).
    - Shortwave bands non-linearity: High residuals at low radiance. Issue can be mitigated using higher order calibration equation.
    - DNB HGS/MGS non-linearity: shown only at higher agg modes (22-32). Identified resolution plan (agg mode 21, agg mode 21-26).

J1 VIIRS Performance Based on Sensor Level Testing

- **TEB Radiometric Performance**
  - **J1 VIIRS meets all requirements for Noise (NEdT), Dynamic Range, and non-linearity**
    - TEB showed excellent calibration performance based on the TV testing; comparable to SNPP performance.
    - Minor non-compliances include M12 not meeting the absolute radiometric calibration (ARD) at low temperature, and similar to SNPP, J1 did not meet the characterization uncertainty for many bands.
    - Out of family detectors (higher noise) were identified, **M16B D5** and **M15 D4**, are considered as low risk, but could result into striping in products such as SST.
- **J1 VIIRS Bands Spectral Performance**
    - Successful spectral testing with minor non-compliance. J1 performance is in general better than SNPP.
    - J1 RSRs Version 0 (V0) was released on 02/26/2015 by DAWG team.
    - Work is ongoing to released enhanced J1 RSRs Version 1 (V1) by June 2015. Further releases (TSIRCUS) are planned.
    - Electrical and optical crosstalk generated from spectral testing is comparable to SNPP performance. SNPP did not show crosstalk on-orbit.

JPSS NASA Program Science Staff

JPSS Program Scientist: **Mitch Goldberg**
JPSS Project Scientist: **Jim Gleason**
Deputy JPSS Senior Project Scientist (Flight): **Jim Butler**

JPSS VIIRS Instrument Scientists:
Kurt Thome (NASA)

STAR VIIRS SDR Leads:
Changyong Cao (NOAA/STAR)

NASA VCST Lead:
Jack Xiong (NASA)

DAWG Lead:
Hassan Oudrari (NASA/SSAI)

- Each Instrument Scientist has the support and staffing they need to provide an independent verification of critical instrument performance requirements.

- **Coordinates with NOAA-STAR SDR Team to ensure test results get into data production system.**

VIIRS Sensor Block Diagram

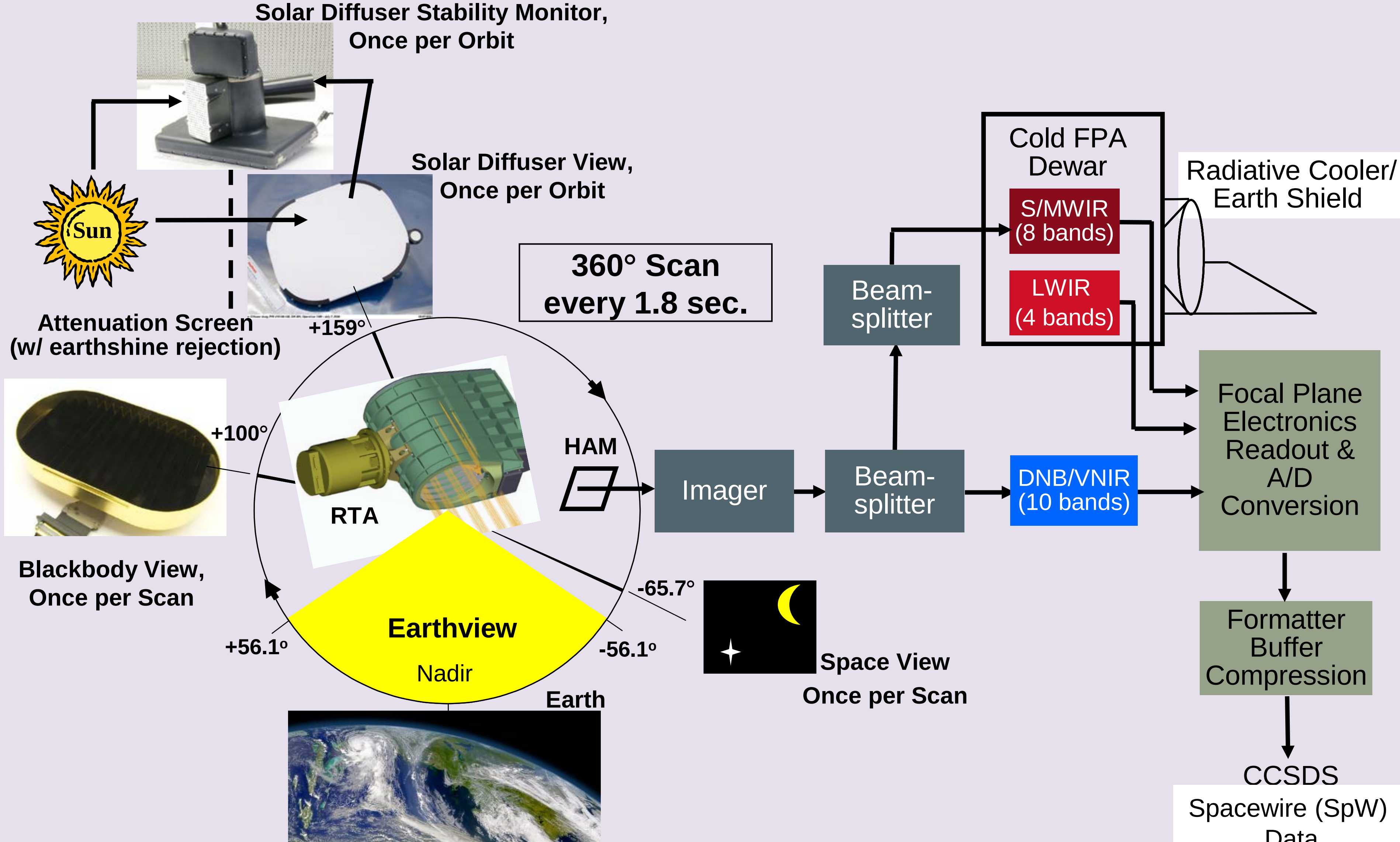


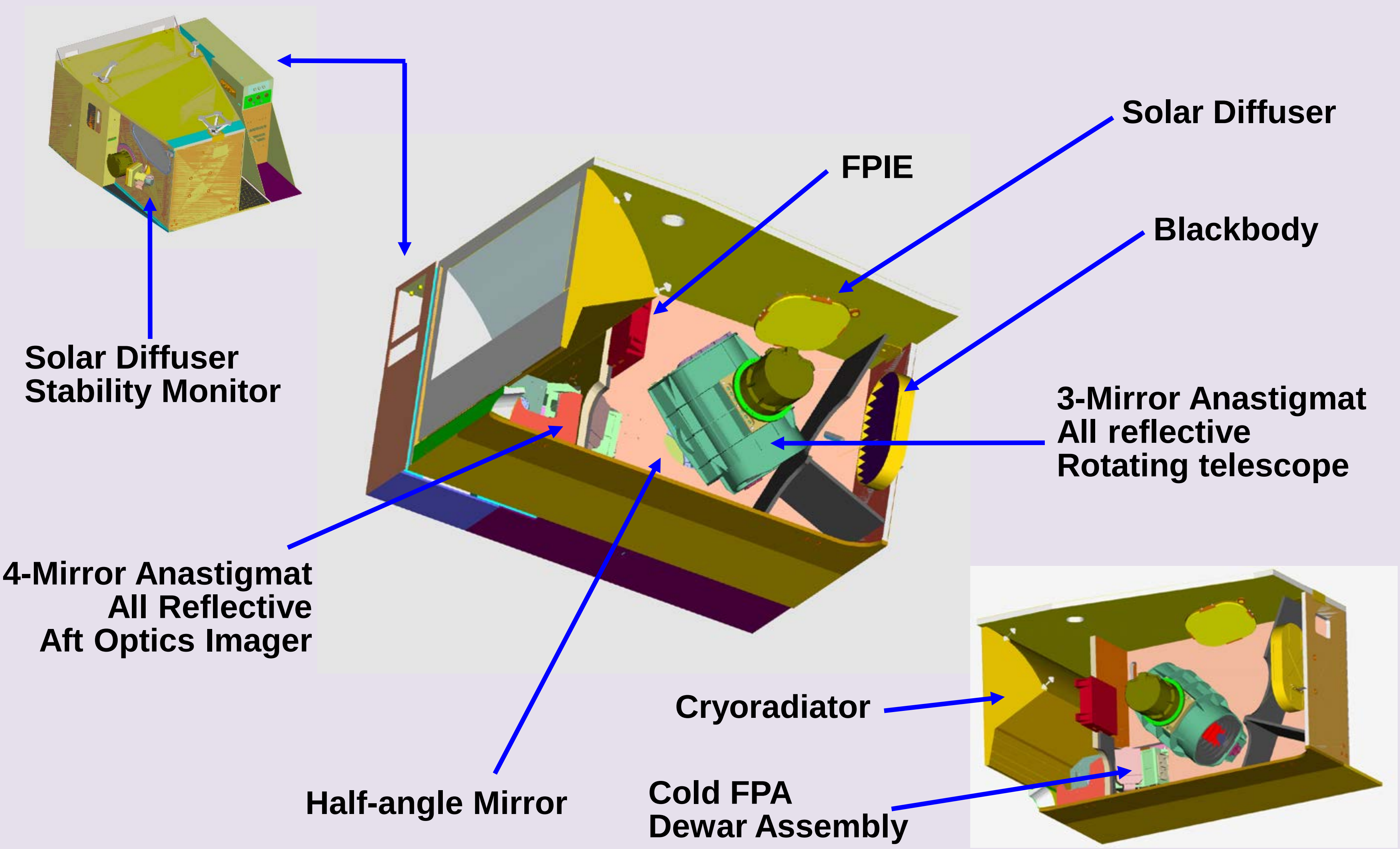
Image provided courtesy of NASA GSFC

DAWG List of J1 Testing/Performance Issues:

- **Sample of J1 VIIRS list of issues identified, understood, and resolved/accepted.**
  - 34 items from Ambient, and 42 from thermal vacuum.

Priority (L,M,H)	Issue #	Date	Authors	Test	Title	EFR #	Description	Status	DAWG Comments	DAWG Review (10-01-2014)	Tests requested
Closed	1	7/2/2014	Oudrari	FP15/FP16	SpMA bulb A failure		Raytheon reported lamp failure after testing M6 on Wednesday July 2nd. Testing was stopped, and resumed on Monday July 7th using Lamp B.	Closed	Lamp life expectancy was about 150 hrs based on F1 testing. Lamp failure occurred at less than 80 hrs. Lamb B was installed in the SpMA on July 7th. Lamp B also showed signs of impending failure after about 80 hrs. Lamp D was burned in for use on remaining VisNIR and DNB bands. Lamp C was planned to be burned in over the weekend (July 4-6th), but due to script error was burned in for 80 hrs instead of 11 hrs.	DAWG team agreed to close this issue. This list of issues contains other items addresing the RSO issue. This is expected to be included in the lessons learnd for J2+ testing.	None
Low	2	7/8/2014	McIntire	FP15	Noise due to dual gain anomaly		Some of the RSR data falls within the dual gain anomaly region, at or near peak response. The standard deviation of the spectral data has shown out of family values (high and low), and this standard deviation variability resembles the behavior in the dual gain anomaly region.	Open	VCST presented these findings on July 8, 2014 (report #14-036). Impact on the RSR still to be assessed.	DAWG team expects a small impact on the spectral performance assessment. Post-launch SIRCUS testing will provide validation of the SpMA derived RSRs. A note should be shared with NIST to avoide the Dual gain anomlay (DGA) region in their radiance settings.	Post-TV TSIRCUS: Avoid DGA in the radiance setting
Closed	3	7/8/2014	Schwarting	FP16/FP15	Wrong DNB band substitution table		VCST got unexpected results when analyzing DNB crosstalk data (FP16). This issue was reported on 7/9/2014 at the DAWG telecon.	Closed	(7/9/2014) VCST thinks that this issue affects DNB when all of the bands were illuminated, and might need to repeat FP16 crosstalk for many bands. The DNB table was updated only for two bands: M7 and DNB (the last 2 bands tested for FP15/FP16). RTN does not believe in cross-FPAs optical crosstalk, so RTN does not believe for the need to repeat FP15/FP16. DAWG will continue looking at the test data available to identify any concern for the DNB optical xtalk (e.g. FP13, etc.).	DAWG team agree to close this issue. FP13 and FP14 testing did not show obvious crosstalk between VisNIR and DNB focal planes. Team will continue to mitor DNB optical crosstalk.	None
Medium	4	7/9/2014	McIntire	FP16/FP15	Spectral non-compliance of bands M1, M5, and DNB		M1 bandpass was short for some detectors, M5 center wavelength was short (by a very small margin for one detector) and the DNB LGS bandwidth and center wavelength were short and long respectively.	Open	Issues with RSO collection may impact some these non-compliances. Spectral to be refined after all spectral testing is complete at the end of Nominal plateau.	DAWG team assigned medium priority level to this issue because it still needs re-analysis based on the final RSOs. Team also determined that post-launch SIRCUS testing will provide valuable validation data.	Post-TV TSIRCUS: Avoid DGA in the radiance setting
Medium	5	7/14/2014	McIntire/Moyer	FP15/FP16	Lamp D RSO issue - Spectral shift		Based on Moyer's presentation at the DAWG, RSR derived for DNB MGS showed a spike around 670nm, and higher RSR in the blue region when compared to RSR LGS. Using Lamp B RSO provides more consistent RSRs for the DNB.	Open	Investigation done by David Moyer has shown that a shift in the RSO could be the reason (7/15), and this was confirmed few days later by Raytheon. The lock-in amplifier used for the SiPD reference detector had a firmware issue, resulting in incorrect wavelength values being reported (wavelength shift). EFR3565 was created on July 16, 2014. FRB was held on 7/22, and path forward was defined. SpMA Merlin lock-in amplifier issue was fixed (8/9). Additional testing is planned (ETP 392, FP15 M4 and I1). Fix was implemented (fix details are not known). TSIRCUS. will help for M5 the highest impact. Need of RSO-c and RSO-a Post TV.	DAWG team assigned medium priority level to this issue because it still needs re-analysis based on the final RSOs. Team also determined that post-launch SIRCUS testing will provide valuable validation data, especially to validate most affected band (M5). Team also requested to perform RSOa and RSO-c in the post TV phase.	Post-TV TSIRCUS: Avoid DGA in the radiance setting. Team also requested to perform RSOa and RSO-c in the post TV phase.

Opto-Mechanical Module



Performance Differences between J1 and SNPP

- **RTA mirrors changed from Ni coated to VQ**
  - Performance Area Positively Impacted: Better Spatial Stability with Temperature
    - Eliminated the focus change issues over temperature
- **Dichroic 2 coatings redesigned**
  - Performance Area Positively Impacted: Spatial
    - Coating redesign improved focus between the SMWIR & LWIR
- **Throughput degradation due to Tungsten exposure eliminated**
  - Performance Area Positively Impacted: Radiometric Sensitivity
    - J1 performance will not be impacted by the silver coating tungsten exposure issue seen on SNPP
- **VisNIR Integrated Filter Coating change from SNPP**
  - Performance Areas Positively Impacted: Crosstalk, IOOB, and RSR
    - J1 crosstalk performance for the VisNIR bands is greatly improved with this redesign effort
  - Performance Area Negatively Impacted: Polarization, Bands M1 – M4
- **Changes to voltage (Vclamp) and DNB timing card**
  - Performance Area Negatively Impacted: non-linearity issue at low radiance for SWIR and DNB (Agg Modes 21 – 32)
    - DNB: Plan to modify aggregation tables as a mitigation to this issue
    - SWIR: Plan to use cubic equation to enhance radiometric performance.

J1 VIIRS Performance Based on Sensor Level Testing

- **Key decisions during J1 VIIRS Testing**
  - SpaceWire replaced the 1394 communication bus, and a new Single Board Computer was installed
  - A-side electronics was designated as the primary electronics (B-side is the redundant one)
  - The CFPA operation temperature was set to 80.5 K