



Early test results of proto-flight test of Second Generation Global Imager (SGLI), Infrared Scanning Radiometer (IRS)



Empowered by Innovation



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http://suzaku.eorc.jaxa.jp/GCOM_C/index_j.html



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Global Change Observation Mission (GCOM)



- Global observation satellite system as JAXA's GEOSS contribution.
- 2 satellite series for 5 years, total 13 years observation.
 - ✓ GCOM-W Microwave radiometric observation for WATER CYCLE using AMSR2 (AMSR-E follow on)
 - ✓ GCOM-C Optical multi-channel observation for RADIATION BUDGET and CARBON CYCLE using SGLI (GLI follow on)



GCOM-W "SHIZUKU" was launched on May 18, 2012.



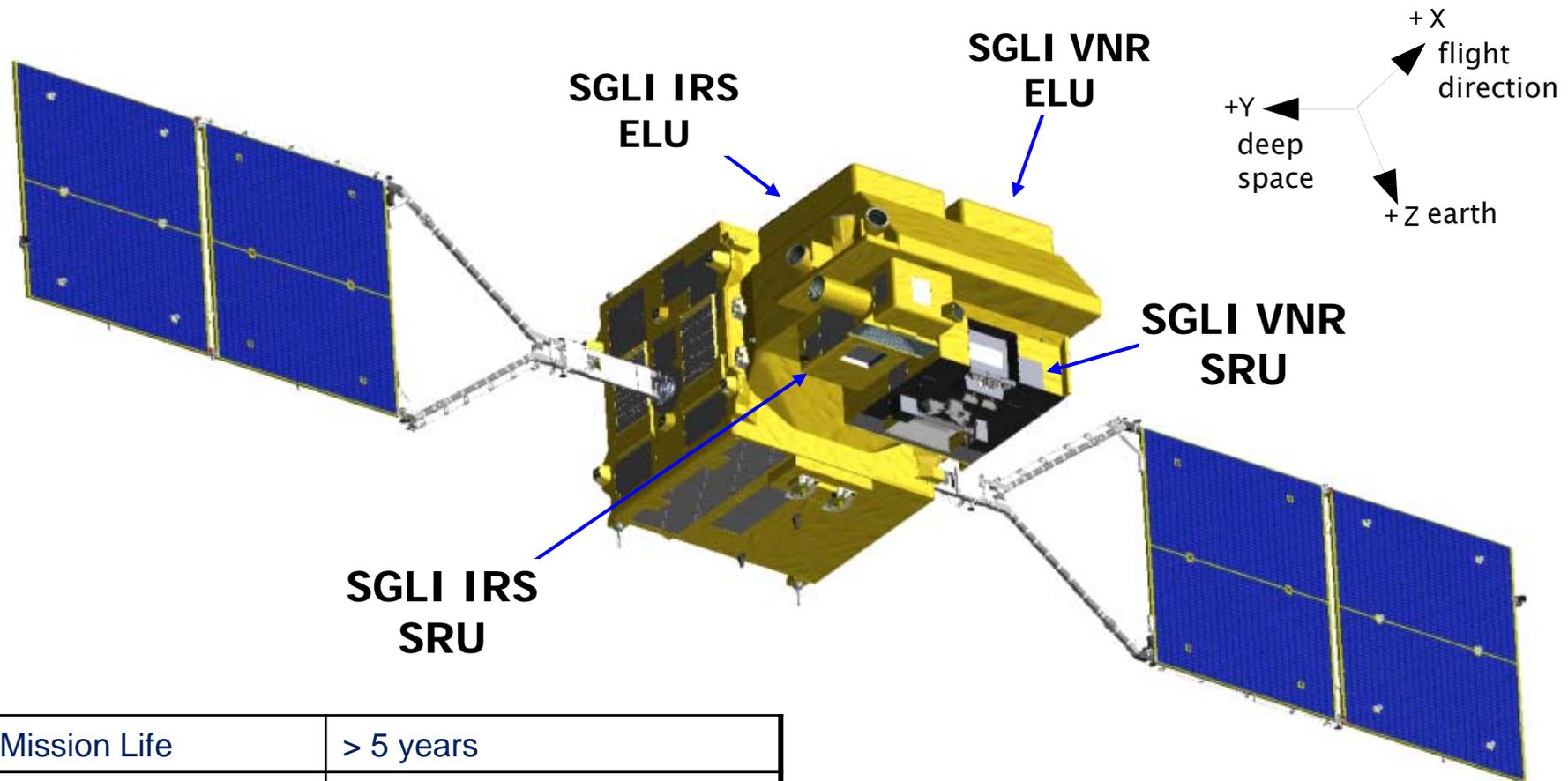
GCOM-C is scheduled for launch in 2017.

Sensor	Advanced Microwave Radiometer 2 (AMSR2) Passive Microwave Observation Water vapor, soil moisture etc
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Sensor	Second Generation Global Imager (SGLI) Optical Observation 380nm - 12 micron Cloud, Aerosol, Vegetation, Chlorophyll etc
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Second generation Global Imager (SGLI) on GCOM-C satellite



Mission Life	> 5 years
Solar Paddle	> 4000w (End of Life)
Mass	about 2,000kg

SGLI Second Generation Global Imager
VNR Visible and Near Infrared Radiometer
IRS Infrared Scanning Radiometer
SRU Scanning Radiometer Unit
ELU Electronic Unit

SGLI Specification

- The SGLI features are 250m spatial resolution (VNR-NP, SW3 & TIR) and polarization/along-track slant view channels (VNR-PL), which will improve land, coastal, and aerosol observations.

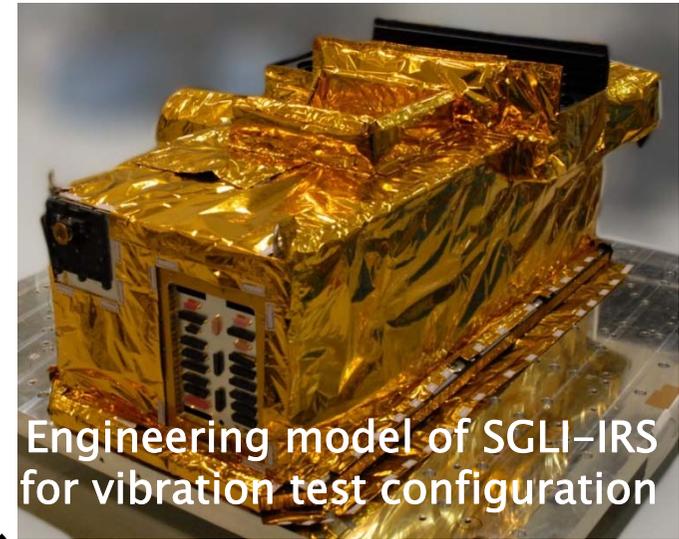
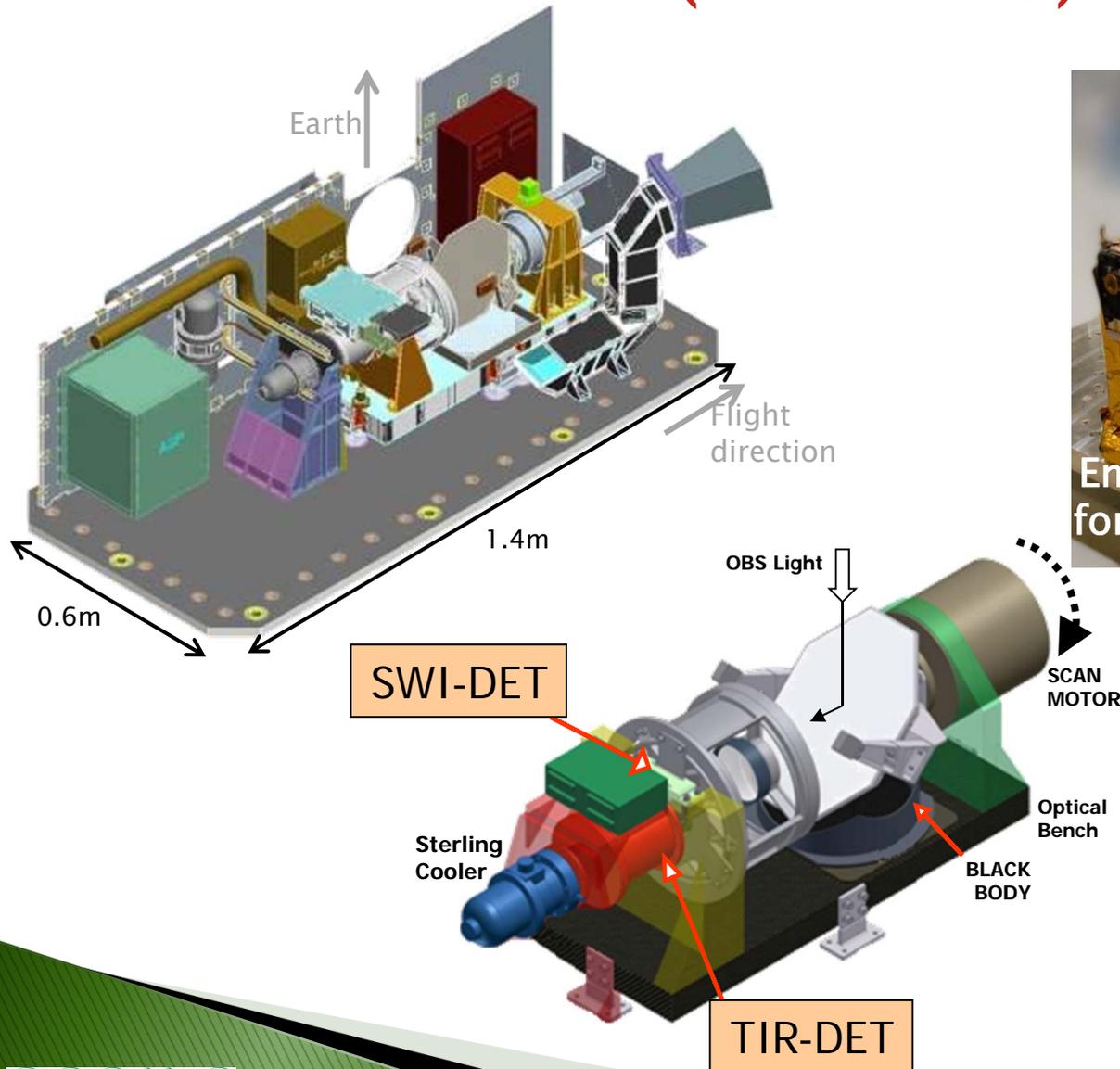
250m over the Land or coastal area, and 1km over offshore

GCOM-C SGLI characteristics	
Orbit	Sun-synchronous (descending local time: 10:30) Altitude 798km, Inclination 98.6deg
Mission Life	5 years (3 satellites; total 13 years)
Scan	Push-broom electric scan (VNR) Wisk-broom mechanical scan (IRS)
Scan width	1150km cross track (VNR: NP & PL) 1400km cross track (IRS: SWI & TIR)
Digitalization	12bits
Polarization	3 polarization angles for PL
Along track direction	Nadir for NP, SWI and TIR, +45 deg and -45 deg for PL
On-board calibration	VN: Solar diffuser, LED, Lunar cal maneuvers, and dark current by masked pixels and nighttime obs. SWI: Solar diffuser, LED, Lunar, and dark current by deep space window TIR: Black body and back ground by deep space window

Multi-angle obs. for 674nm and 869nm

SGLI channels						
CH	λ	$\Delta\lambda$	L_{std}	L_{max}	NP,PL,SWI: SNR at Lstd	IFOV
	NP, PL, SWI: nm TIR: μm		NP, PL, SWI: W/m ² /sr/ μm TIR: Kelvin		TIR: NE Δ T at 300K	m
VN1	380	10	60	210	250	250
VN2	412	10	75	250	400	250
VN3	443	10	64	400	300	250
VN4	490	10	53	120	400	250
VN5	530	20	41	350	250	250
VN6	565	20	33	90	400	250
VN7	673.5	20	23	62	400	250
VN8	673.5	20	25	210	250	250
VN9	763	12	40	350	1200	250/1000
VN10	868.5	20	8	30	400	250
VN11	868.5	20	30	300	200	250
PL1	673.5	20	25	250	250	1000
PL2	868.5	20	30	300	250	1000
SW1	1050	20	57	248	500	1000
SW2	1380	20	8	103	150	1000
SW3	1630	200	3	50	57	250/1000
SW4	2210	50	1.9	20	211	1000
T1	10.8	0.7	300	340	0.2	250/1000
T2	12.0	0.7	300	340	0.2	250/1000

Infrared Scanning Radiometer (SGLI-IRS)



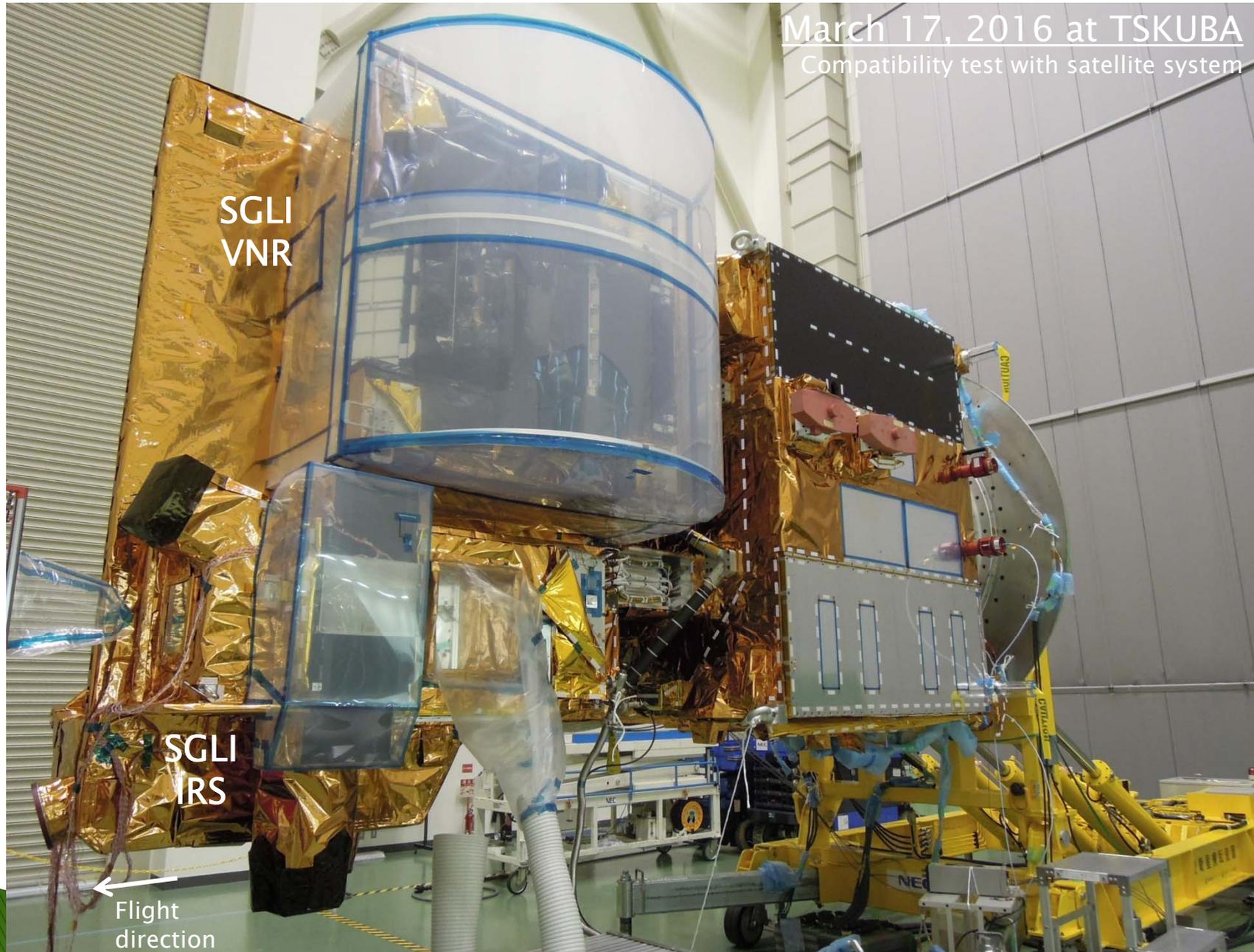
Engineering model of SGLI-IRS for vibration test configuration

Weight:
193kg
Power: 400W

Current Status

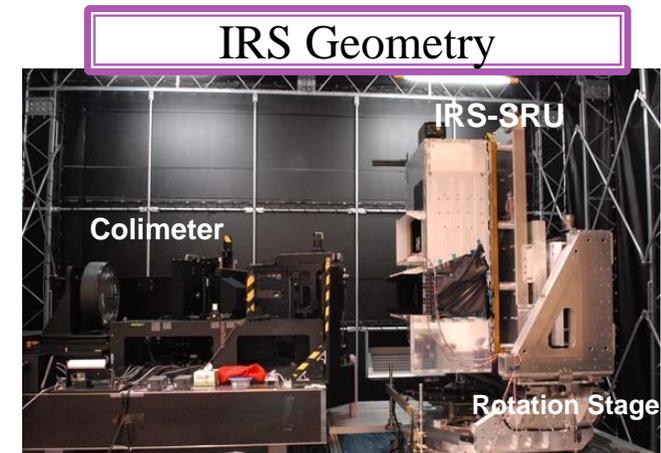
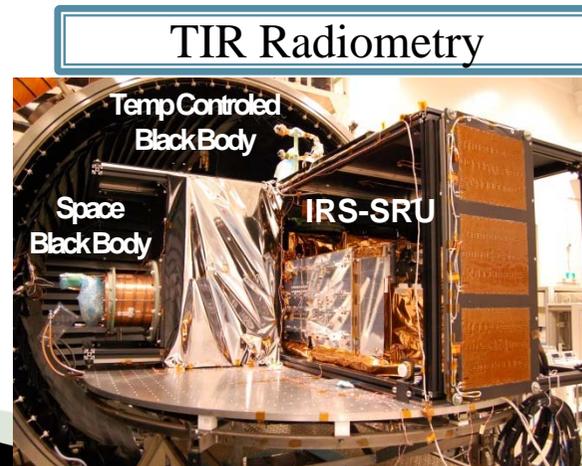
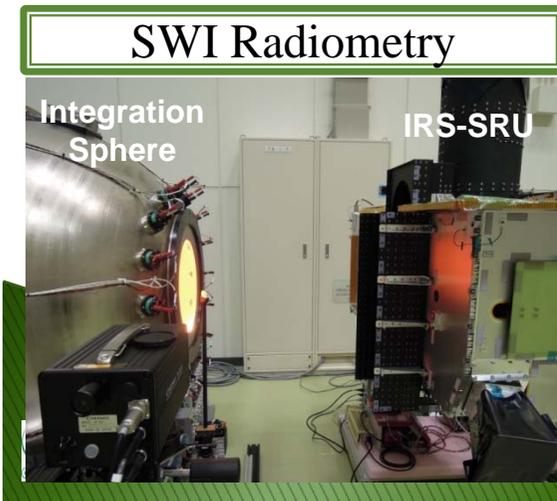
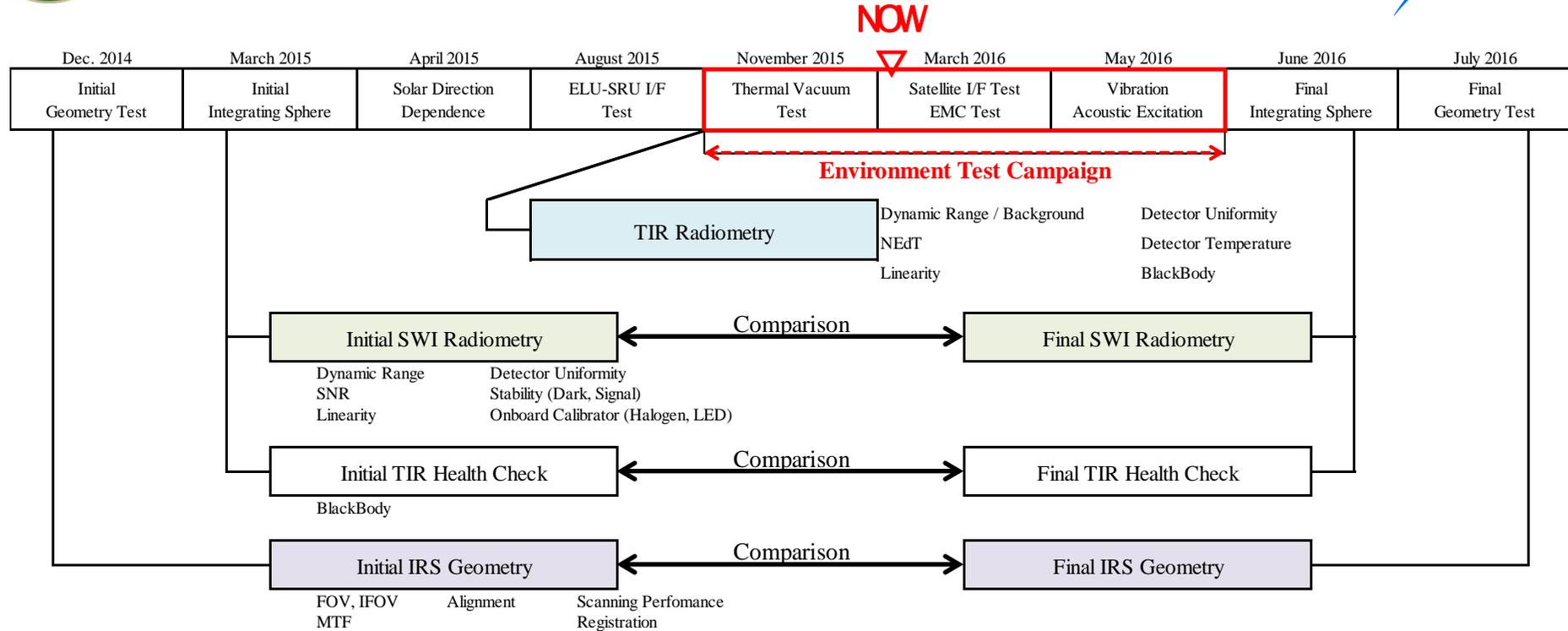
- ▶ SGLI consists of two sensors, SGLI–VNR and SGLI–IRS
- ▶ IRS sensor system manufacturing and integration were finished.
- ▶ The sensor level pre–flight tests started in December 2014.
- ▶ IRS test is in the final stage before the delivery to the satellite system.
- ▶ Satellite level test will start within 2016 and planned for launch in 2017.

March 17, 2016 at TSKUBA
Compatibility test with satellite system





Verification Flow of IRS-SRU PFT





Verification Matrix of IRS-SRU Proto Flight Test (PFT)



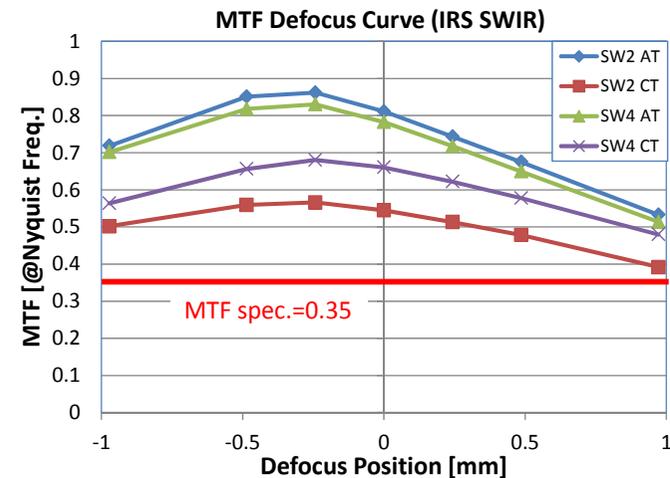
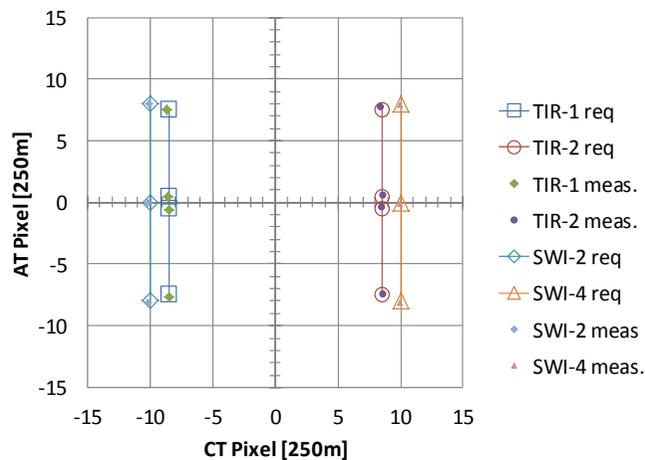
	Component Test & Integration	Initial Electric Performance Test (I-EPT)	Thermal Vacuum Test (TVT)	EMC Test	Vibration Acoustice Excitation	Final Electric Performance Test (F-EPT)
Geometry						
FOV, IFOV	Component	Rotation Table	-	-	-	Rotation Table
MTF	Component	Rotation Table	-	-	-	Rotation Table
Alignment	Integration	Rotation Table	Cube Mirror	-	Cube Mirror	Rotation Table
Scanning Performance	Component	Rotation Table	Resolver	Resolver	Resolver	Rotation Table
Registration	Component	Rotation Table	-	-	-	Rotation Table
SWI Radiometry						
Dynamic Range	Component	Integrating Sphere	-	-	-	Integrating Sphere
SNR	Component	Integrating Sphere	-	-	-	Integrating Sphere
Linearity	Component	Integrating Sphere	-	-	-	Integrating Sphere
Detector Uniformity	Component	Integrating Sphere	-	-	-	Integrating Sphere
Stability (Dark, Signal)	Component	Integrating Sphere	-	-	-	Integrating Sphere
Onboard Calibrator (Halogen)	Component	Calibrator Test	Calibrator Test	Calibrator Test	Calibrator Test	Calibrator Test
Onboard Calibrator (LED)	Component	Calibrator Test	Calibrator Test	Calibrator Test	Calibrator Test	Calibrator Test
Onboard Calibrator (Light Guide)	Component	Angle Dependence	-	-	-	-
TIR Radiometry						
Dynamic Range / Background	Component	-	TVT Test	-	-	-
NEdT	Component	Black Body	TVT Test	Black Body	Black Body	Black Body
Linearity	Component	-	TVT Test	-	-	-
Detector Uniformity	Component	Black Body	TVT Test	Black Body	Black Body	Black Body
Detector Temperature	Component	Ambient Test	TVT Test	Ambient Test	Ambient Test	Ambient Test
BlackBody (On-Board)	Component	Ambient Test	TVT Test	Ambient Test	Ambient Test	Ambient Test
BlackBody (Ambient)	Component	Ambient BBC / LN2	-	Ambient BBC	Ambient BBC	Ambient BBC
BlackBody (TVT)	-	-	TVT Test	-	-	-



Geometric Performance Test



- ▶ Objectives
 - to confirm that IRS was integrated mechanically as designed
 - to obtain the geometry data processing parameters after the launch
- ▶ detector position and alignment is measured
 - rotation stage (3 rotation axis, 2 linear translation)
 - collimator (halogen lamp for shortwave IR, black body for thermal IR)
- ▶ Test results :
 - MTF > 0.35 req.
 - detector position < 0.2 pixel (250m) accuracy





Radiometric Performance Test Shortwave Infrared (SWI) channels



- ▶ Objectives
 - to confirm that IRS/SWI was integrated radiometrically as designed
 - to obtain the gain parameter for the data processing
- ▶ Traceable to the Japanese national standard
 - Gold coated integrated sphere developed by JAXA's sensor group
 - Calibrated with fixed point black body
- ▶ Test results :
 - all requirements met.
 - Small offset non-linearity in high temperature ; under study
 - The humidity effects in 1.36micron channels ; under study.

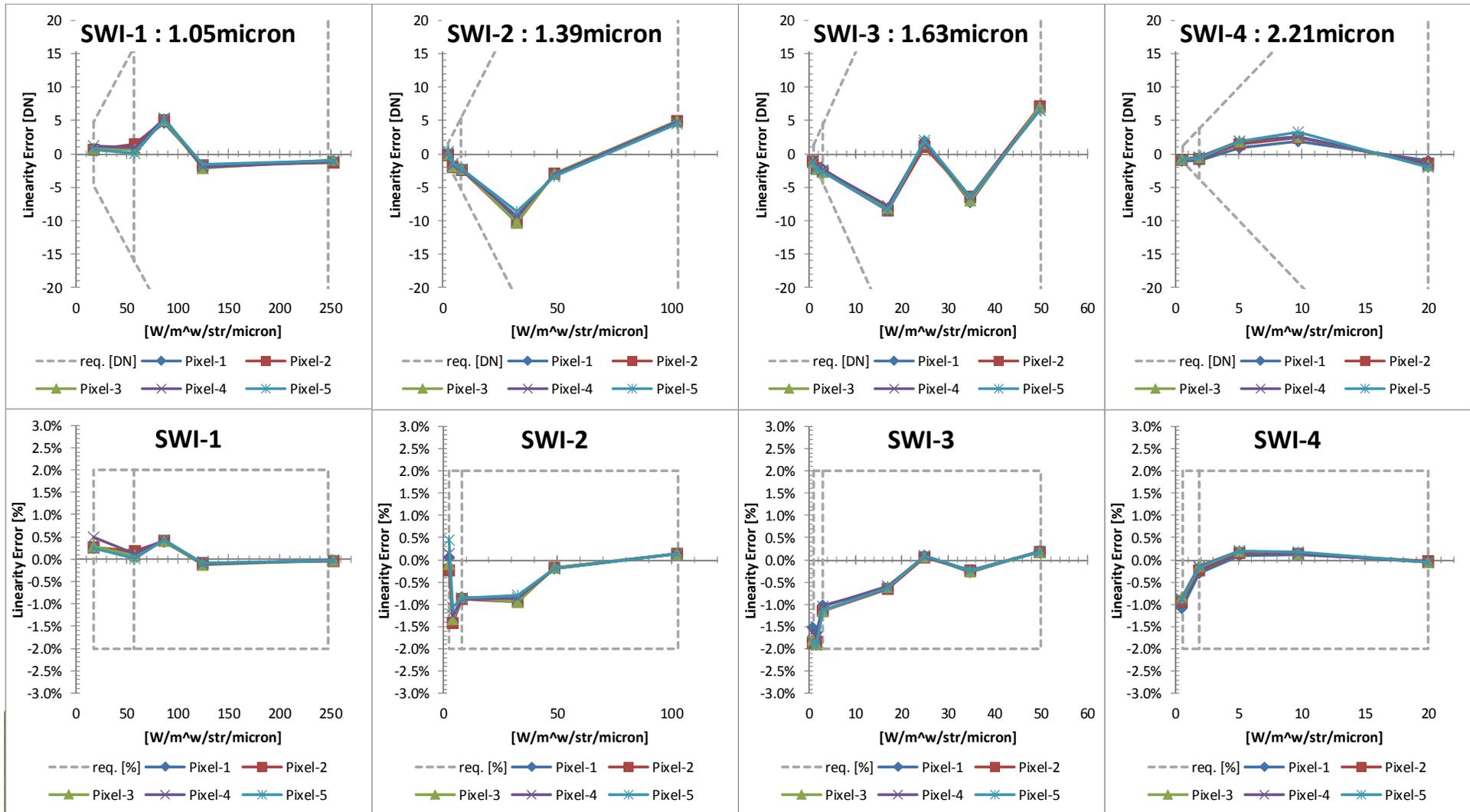
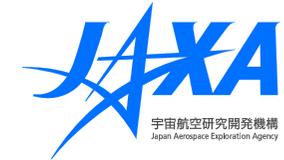
Ch	λ_c [micron]	Band Width [nm]	Signal Level (min)						Gain				Noise				
			Lmax		Lstd		Dark	Saturation (4095DN) [W*]	Gain (min) W*/DN	Linearity Error (max)		Sigma (max)			SNR		
			Radiance [W*]	Corrected [DN]	Radiance [W*]	Corrected [DN]				Lstd	Worst	Lmax	Lstd	Dark	Lstd	Spec.	
			[W*]	[DN]	[W*]	[DN]	[DN]	[%]	[DN]	[DN]	[DN]	(min)					
SWI-1	1.05	21.8	253.3	3529.0	58.2	811.5	102.1	282.3	0.0707	0.2%	5.1	1.5	0.9	0.8	942	500	
SWI-2	1.38	20.7	102.4	3385.4	8.3	270.3	99.8	118.6	0.0297	-0.9%	-8.6	4.1	0.8	0.8	329	150	
SWI-3	1.63	191.3	49.8	3723.6	3.0	220.0	93.2	50.5	0.0127	-1.1%	-7.7	3.8	2.2	2.0	100	57	
SWI-4	2.21	51.9	20.0	3668.5	1.9	342.8	97.0	21.4	0.0054	-0.1%	3.3	2.2	0.9	0.9	368	211	

[W*] = [W/m²/str/μm]



Shortwave Infrared (SWI) channels

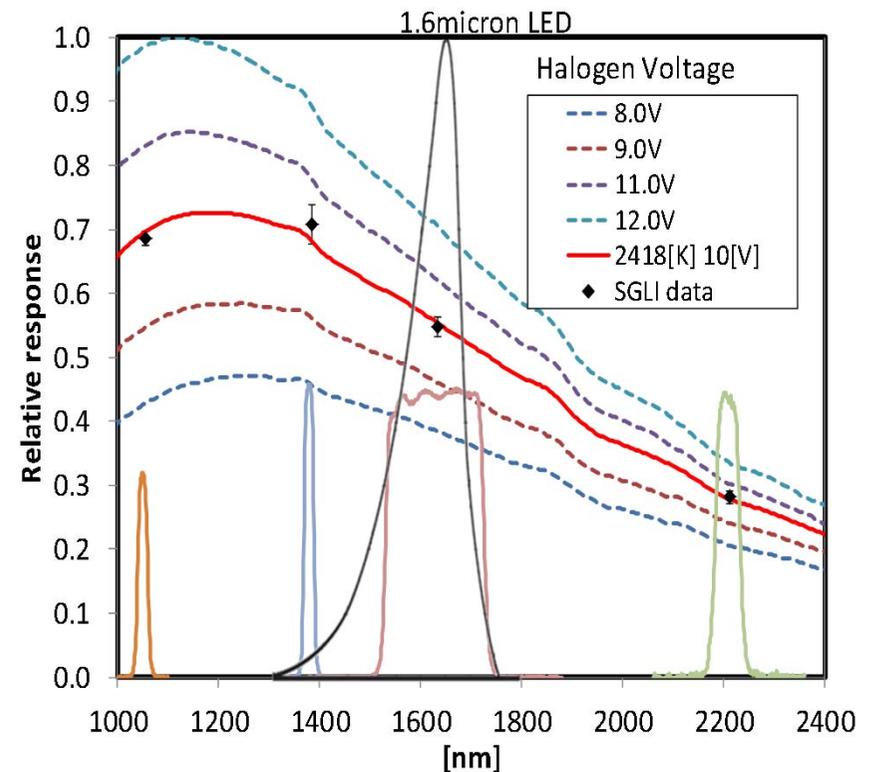
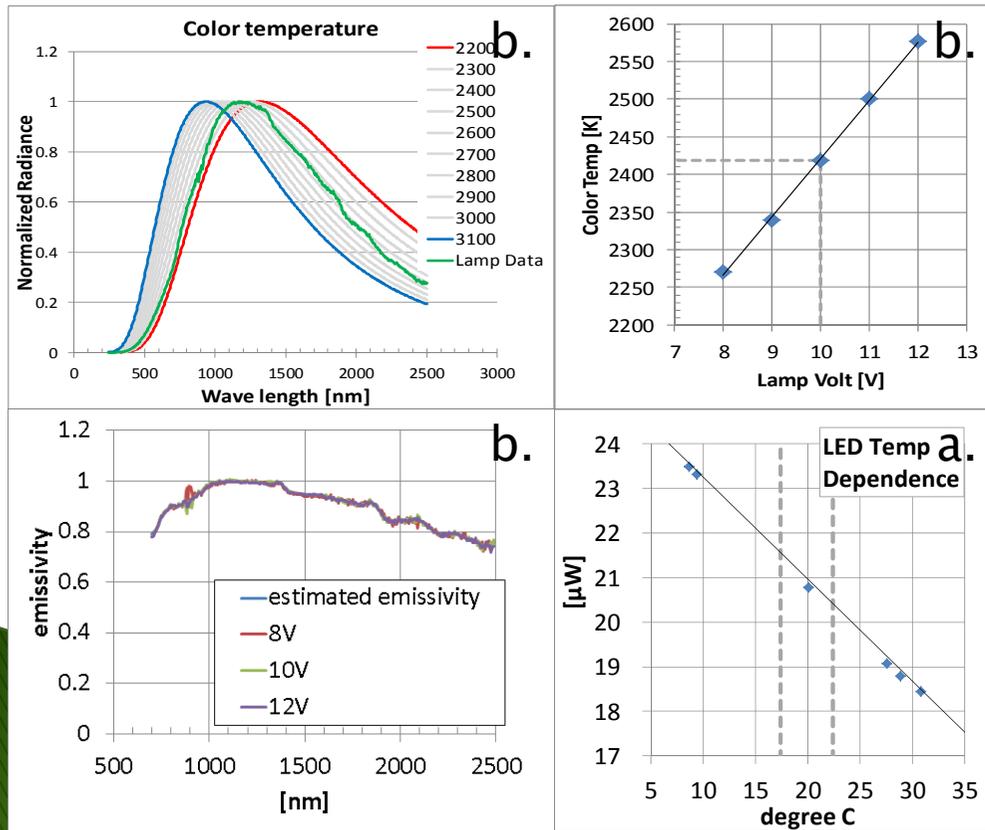
Linearity (preliminary)





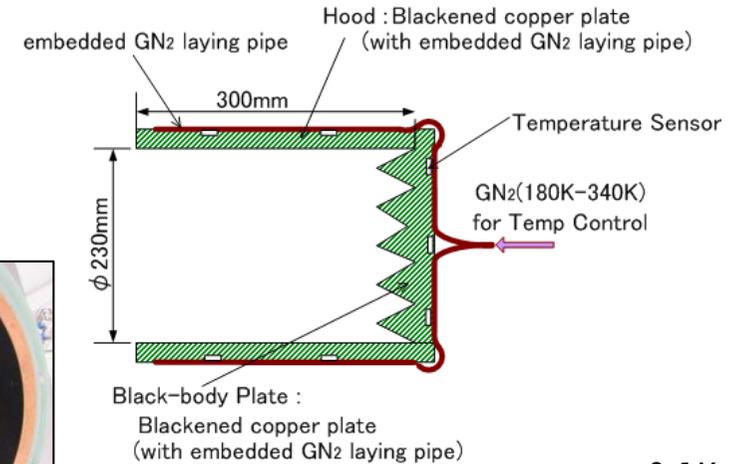
Halogen-LED hybrid calibration for Short wave Infrared (SWI) channels

- a. 1.6 μm LED with temperature correction for the absolute reference
- b. Halogen color temperature and emissivity estimation from the lab. data
- c. Relative and absolute calibration for all 4 channels
- d. Total calibration error is estimated as 1.6 to 4.3 % (1σ ; preliminary)



Radiometric Performance Test Thermal Infrared (TIR) channels

- ▶ Objectives
 - to confirm that IRS/TIR was integrated radiometrically as designed.
 - to obtain the gain parameter
- ▶ Specially designed black body for the thermal vacuum environment
- ▶ Test results :
under calculation



$$\sigma_{\text{temp}} < 0.1\text{K}$$

$$\text{Temp}_{\text{Stability}} < 0.01\text{K}$$

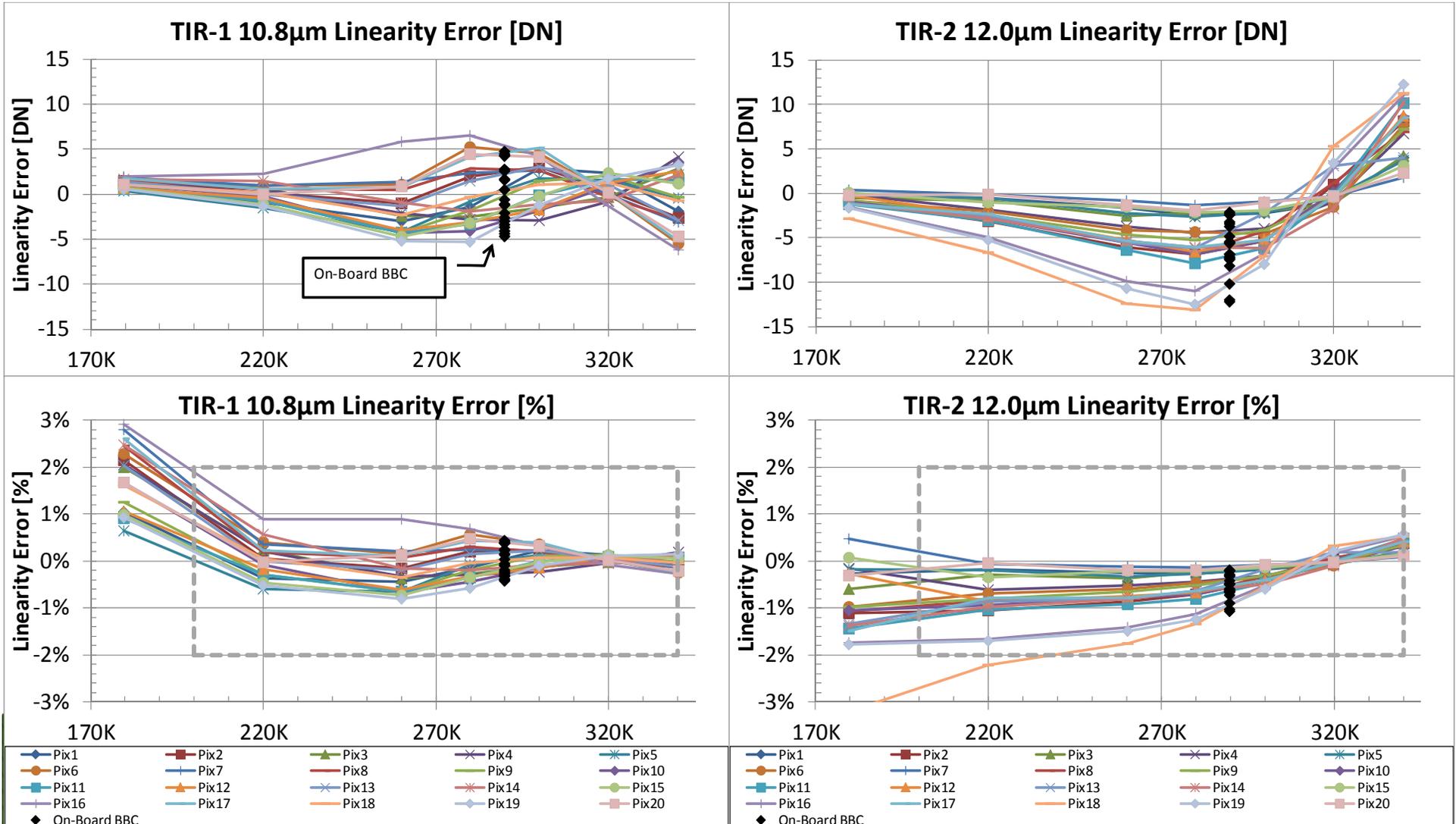
$$\epsilon_{\text{witness}} > 0.97$$

Ch	λ_c	Band Width	Signal Level (min)					Back Ground	Gain			Noise				
			Tmax		Tstd		Saturation		Gain 300K	Error (worst)		Sigma (max)			NEdT [K]	
			Radiance [K]	Corrected [DN]	Radiance [K]	Corrected [DN]				Tstd [%]	Worst [%]	Tmax [DN]	Tstd [DN]	Space [DN]	Tstd (max)	Spec. (500m)
TIR-1	10.78	0.74	340	2150.0	300	1263.4	158%	534.9	0.0528	0.35%	1.89%	1.3	1.2	1.1	0.06	0.2
				2146.0		1257.7	138%			986.8	0.0529	0.35%	-0.88%	1.4	1.3	1.3
TIR-2	11.97	0.77	340	2071.9	300	1261.0	159%	676.3	0.0579	-0.44%	-1.99%	1.6	1.5	1.5	0.09	0.2
				2056.1		1260.5	133%			1225.1	0.0579	-0.80%	-1.97%	1.8	1.8	1.7

250m resolution, TDI = YES, Upper = BOL(COLD) / Lower = EOL(HOT)

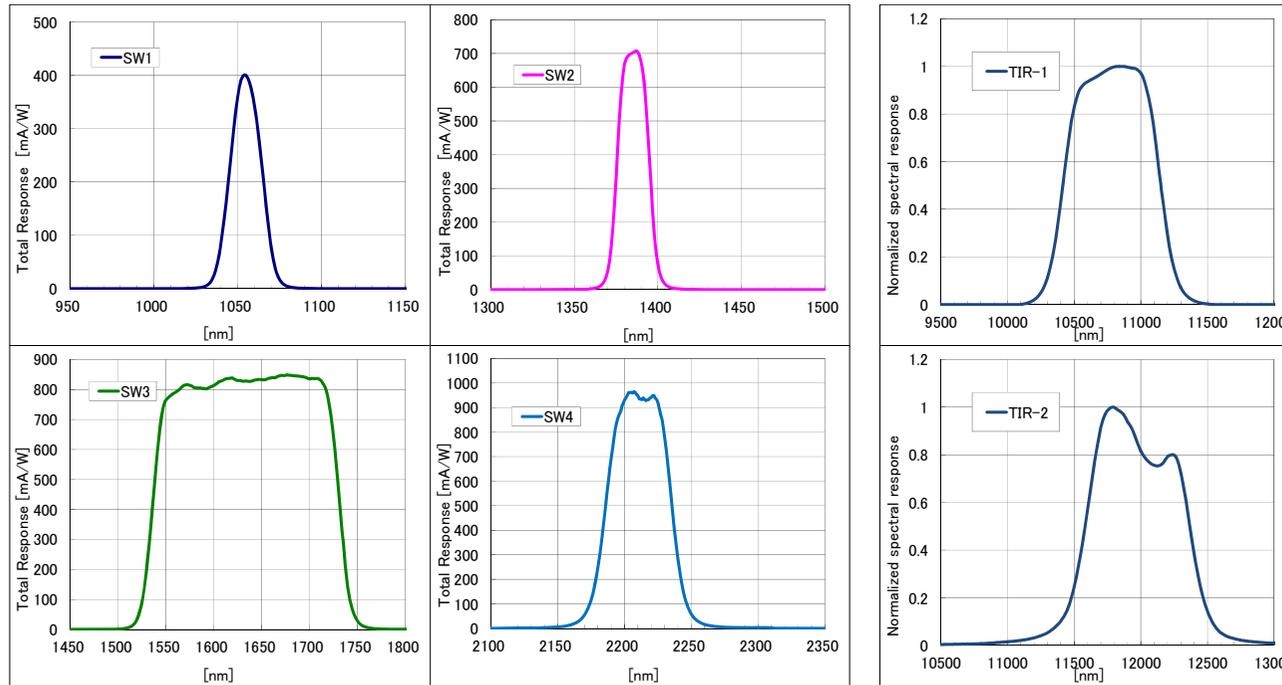


Thermal Infrared (TIR) channels Linearity (250m, TDI=YES) (preliminary)





Spectral Response (preliminary)



	FWHM Spectral Response [nm]				Weighted Spectral Response [nm]			
	Center Wavelength	Half Response		Band width	Center Wavelength	Half Response		Band width
		Lower Wavelength	Upper Wavelength			Lower Wavelength	Upper Wavelength	
SWI-1	1,054.93	1,044.40	1,065.45	21.05	1,054.86	1,043.90	1,065.69	21.78
SWI-2	1,385.31	1,375.25	1,395.37	20.12	1,385.34	1,375.01	1,395.66	20.65
SWI-3	1,633.70	1,536.20	1,731.20	195.00	1,634.65	1,539.36	1,730.62	191.26
SWI-4	2,210.62	2,185.43	2,235.81	50.38	2,210.91	2,184.73	2,236.59	51.86
TIR-1	10,782.67	10,414.98	11,150.35	735.37	10,787.18	10,420.94	11,156.63	735.69
TIR-2	11,974.75	11,581.97	12,367.53	785.56	11,952.36	11,557.59	12,327.17	769.58





Conclusion

- ▶ SGLI consists of two sensors, SGLI-VNR and SGLI-IRS
- ▶ IRS sensor system manufacturing and integration were finished.
- ▶ The sensor level pre-flight tests started in December 2014.
- ▶ IRS test is in the final stage before the delivery to the satellite system.
- ▶ Satellite level test will start in 2016 and planned for launch in 2017.