







Development status of the Second-generation Global Imager (SGLI) on GCOM-C1

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Global Change Observation Mission Global Change Observation Mission Global Change Observation Mission

Global observation satellite system as JAXA's GEOSS contribution.

- 2 satellite series for 5 years, total 13 years observation.
 - <u>GCOM-W</u>Microwave radiometer observation for <u>WATER CYCLE</u> using AMSR2 (AMSR-E follow on)
 - <u>GCOM-C</u> Optical multi-channel observation for <u>RADIATION</u> <u>BUDGET</u> and <u>CARBON CYCLE</u> using SGLI (GLI follow on)





GCOM Mission









SGLI Specification



• The SGLI features are <u>250m (VNI) and 500m (T)</u> <u>spatial resolution</u> and <u>polarization/along-track slant view</u> channels (P), which will improve land, coastal, and aerosol observations. <u>250m over the Land or coastal</u> area, and 1km over offshore

								1	
GCOM-C SGLI	characteristics				S	GLI cha	annels		
	Sun-synchronous			λ	Δλ	L _{std}	L	SNR at Lstd	IFOV
GCOM-C SGLI characteristicsSun-synchronous (descending local time: 10:3 Altitude 798km, InclinationMission Life5 years (3 satellites; total 13) Push-broom electric scan (V Wisk-broom mechanical scar 1150km cross track (VNR: VN 1400km cross track (IRS: SW)Scan width1150km cross track (IRS: SW) 1400km cross track (IRS: SW)Digitalization12bit PolarizationPolarization3 polarization angles for P Along track directionVN: Solar diffuser, LED, Lun- maneuvers, and dark curr	(descending local time: 10:30)	СН	СН	VN, P, SW: nm		VN, P:		VN, P, SW:	
OIDIT	Altitude 708km Inclination 08 6deg		CH			W/m²/sr/µm		SNR	m
	Artitude 790km, inclination 90.00eg			1.1	um	T: k	Kelvin	Τ: ΝΕΔΤ	\mathbf{V}
MISSION LITE	5 years (3 satellites; total 13 years)		VN1	380	10	60	210	250	250
Scan	Push-broom electric scan (VNR)		VN2	412	10	75	250	400	250
Juli	Wisk-broom mechanical scan (IRS)		VN3	443	10	64	400	SNR at Lstd VN, P, SW: SNR T: NE Δ T 250 400 300 400 250 400 250 1200 400 250 1200 250 1200 250 1200 500 250 250 500 150 57 211 0.2 0.2	250
	1150km cross track (VNR: VN & P)		VN4	490	10	53	120	SNR at Lstd VN, P, SW: SNR T: NE Δ T 250 400 250 400 250 400 250 1200 400 250 1200 400 250 1200 250 1200 500 250 500 150 57 211 0.2 0.2	250
Scan width	1400km cross track (IRS: SW & T)		VN5	530	20	41	350	250	250
Digitalization	12hit		VN6	565	20	33	90	400	250
Delerization	2 polorization angles for D Multi-angle	,	VN7	673.5	20	23	62	400	250
Polarization	3 polarization angles for obs. for	\rightarrow	VN8	673.5	20	25	210	250	250
Along track	Nadir for VN, SW and T, 674nm and		VN9	763	8	40	350	1200	250/100
direction	+45 deg and -45 deg for P	r!	VN10	868.5	20	8	30	400	250
	VN: Solar diffuser, LED, Lunar cal	\mapsto	VN11	868.5	20	30	300	200	250
	maneuvers and dark current by		P1	673.5	20	25	250	250	1000
	marked nivels and nighttime obs		P2	868.5	20	30	300	250	1000
On-board	SW: Solar diffusor LED Lupar and dark		SW1	1050	20	57	248	500	1000
calibration	SW. SUITUSEI, LED, LUITAI, AITU UAIK		SW2	443106440030025049010531204002505302041350250250565203390400250673.5202362400250673.520252102502507638403501200250/100868.520830400250868.52030300200250673.520252501000868.52030300200250673.520252502501000868.520303002501000105020572485001000138020810315010001630200350572502210501.920211100010.80.73003400.2250					
calibration	current by deep space window		SW3	1630	200	3	50	57	250
	I: Black body and dark current by deep		SW4	2210	50	1.9	20	211	1000
	space window		T1	10.8	0.7	300	340	0.2	250/500
			T2	12.0	0.7	300	340	0.2	250/500

Development status of SGLI at SPIE Europe, Berlin 2009

option

Bread Board Model (BBM) Activity







BBM test results of VNR Dynamic Range



- VNR dynamic range requirement is set based on careful study of target characteristics.
- VNR uses CCD. Integration time can be easily changed by command.
- This means dynamic range adjustment is possible.
 - Difference between design and manufacturing results such as transmittance of optics can be adjusted
 - Dynamic range modification can be changed even after launch
 Calibration technique using different integration time.





PD

CCD

BBM test results of VNR CCD Integration Time



Previous GLI design









Integration Time ratio to Nominal Time



BBM test results of VNR Linearity



- Linearity is very important for radiometer because it leads to accuracy dependencies to input radiance level.
- Also, the test methodology using integration time above mentioned uses the assumption that sensor is very linear.
- VNR BBM linearity is checked for both input radiance dependencies and integration time dependencies.
- Test result is very good and further detailed analysis is conducted to find the major non-linear element to improve.

4% 3% 1% -2% test result -3% linearity req -4% 0 10 20 30 40 input radiance $[W/m^2/str/\mu m]$ 10 9 8 🔶 Odeg +12deg linearity error [%] 6 ← -12deg 5 req 4 3 2 ٥ VN1 VN2 VN3 VN4 VN5 VN6 VN7 VN8 VN9 VN10VN11

test result of VN10 non-polarized observing telescope



BBM test results of VNR Noise



- SGLI noise performance is required as Signal to Noise Ratio (SNR) at standard signal observation radiance (Lstd) for each observation channel.
- Both integration time dependence and input radiance for SNR was checked.
- The all channels noise level met the sensor specification.





BBM test results of VNR George Deservation George Deservation



As the result of BBM test, approximately 4% polarization observation accuracy ($\Delta P/Pstd$) and 1.3deg polarization direction error is confirmed for the 670nm polarization observing telescope with standard 5% polarized light (Pstd).

Polarization





Development status of SGLI at SPIE Europe, Berlin 2009



BBM test results of IRS Scanning Performance



Because very stable rotating speed is important for sensor observation geometry, the centroid position error and product of inertia should be minimized.
Manufacturing error and assembly process were carefully studied and confirmed. The friction learning technique in the rotation speed control loop is also applied.
The selection of the bearing unit is another key issue for the IRS 5years operation requirement. The bearing lifetime test under the vacuum condition was successfully completed for required 2.7 x 10^8 revolution operation and still under the test for the further design margin.







BBM test results of IRS **GCON** SWI Radiometric Performance

SNR performance

- high transmittance of telescope and filters
- ✓ detector sensitivity
- ✓ dark current of 2.2 µ m channel at operating -30deg C
- ✓ System SNR performance
- Dynamic Range
 - adjustment at analog signal processor (ASP)
- EMC allowance limit
 - Trans Impedance Amplifier (TIA) for detector readout.
 - EMC test in the shield room for both RF radiation and conductive noise allowance







BBM test results of IRS TIR Radiometric Performance

- Detector temperature & performance
 - \rightarrow special dewar for 55K
 - \rightarrow spectral characteristics at 55K
 - \rightarrow detector linearity
- Effects of sensor temperature around optical path
 - \rightarrow dynamic range design considering sensor temperature range
 - \rightarrow Thermal vacuum test to confirm

- Dynamic range adjustment methodology
 - \rightarrow integrating capacity at ROIC
 - \rightarrow integration time
 - \rightarrow post amplifier gain (fixed)
- TIR system level test meets the noise requirement (NEdT). (previous page)







SGLI Current Status

- Based on the BBM successful test result the sensor Engineering Model (EM) design is on going.
- The manufacturing of EM starts soon. EM test will be conducted in next year, and sensor PFM manufacturing starts.
- The target launch of GCOM-C1 is JAN 2014.

Japanese Fiscal Year	FY2006	FY2007	FY2008	FY20	009	FY2010	FY2011	FY2012	FY2013
Milestone	2	▲ GCOM-W1	Project start	M-C1 P	Project	C t start	GCOM-W1 A		GCOM-C1 A Launch A (TBD)
GCOM-W1		SDR	PDR Phase C		CDR	Phase D			
	Thase-A	T Hase-D	Thase-c			T Hase-D			
GCOM-C1						▲ PDR		 R	
	Pre-Phase-A	Phas	se-A	Phas	se-B	Phase	-C	Phase-D	







GCOM is JAXA's GEOSS contribution of global observation for water cycle, radiation budget and carbon cycle.

SGLI is the optical sensor on GCOM-C1 satellite.

Bread Board Model (BBM) design and test activity has successfully completed last year.

The Engineering Model (EM) design is currently conducted.

The EM testing including environmental test and I/F test with satellite system is planned in next year.