Engineering Model testing for SGLI IRS especially TIR radiometric data
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Tamiki HOSOKAWA*a, Kazuhiro Tanaka*b, Yoshihiko Okamura*b, Takahiro Amanoa, Masaru Hiramatsua

a NEC TOSHIBA Space Systems Ltd.
b Japan Aerospace Exploration Agency (JAXA)

http://suzaku.eorc.jaxa.jp/GCOM_C/index_j.html
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 radiometer 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 (WATER)**
- Advanced Microwave Radiometer 2 (AMSR2)
  - Passive Microwave Observation
  - Water vapor, soil moisture etc

**GCOM-C (CLIMATE)**
- Second Generation Global Imager (SGLI)
  - Optical Observation 380nm – 12 micron
  - Cloud, Aerosol, Vegetation, Chrolophl etc
SGLI on GCOM-C1 satellite

- **SGLI IRS**
- **ELU**
- **SGLI VNR**
- **SRU**

**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
Second Generation Global Imager

Visible and Near Infrared Radiometer (SGLI-VNR)

Infrared Scanning Radiometer (SGLI-IRS)

Sensor Unit | features
-------------|---------------------------------------------------------------
SGLI VNR     | Non Polarized Observation (11ch), IFOV 250m, Swath 1150km
             | Polarized Observation (2ch), IFOV 1km, Swath 1150km
SGLI IRS     | Shortwave Infrared (SWI 4ch), IFOV 250m/1km, Swath 1400km
             | Thermal Infrared (TIR:2ch), IFOV 500m, Swath 1400km
SGLI IRS

SGLI Infrared Scanning Radiometer

All optical components are mounted on the strain free CFRP optical bench:

SWI-DET and TIR-DET are optically arranged onto telescope bore sight using folding dichroic mirror without using the additional relay optics.
SGLI Specification

- The SGLI features are 250m (VNR-NP & SW3) and 500m (TIR) spatial resolution and polarization/along-track slant view channels (VNR-PL), which will improve land, coastal, and aerosol observations.

### GCOM-C SGLI characteristics

<table>
<thead>
<tr>
<th>Orbit</th>
<th>Sun-synchronous (descending local time: 10:30) Altitude 798km, Inclination 98.6deg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Life</td>
<td>5 years (3 satellites; total 13 years)</td>
</tr>
<tr>
<td>Scan</td>
<td>Push-broom electric scan (VNR) Wisk-broom mechanical scan (IRS)</td>
</tr>
<tr>
<td>Scan width</td>
<td>1150km cross track (VNR: VN &amp; P) 1400km cross track (IRS: SW &amp; T)</td>
</tr>
<tr>
<td>Digitalization</td>
<td>12bit</td>
</tr>
<tr>
<td>Polarization</td>
<td>3 polarization angles for P</td>
</tr>
<tr>
<td>Along track direction</td>
<td>Nadir for VN, SW and T, +45 deg and -45 deg for P</td>
</tr>
</tbody>
</table>

#### SGLI channels

<table>
<thead>
<tr>
<th>CH</th>
<th>λ (VN, P, SW: nm)</th>
<th>Δλ (T: µm)</th>
<th>Lstd (VN, P: W/m²/sr/µm)</th>
<th>Lmax</th>
<th>SNR at Lstd</th>
<th>IFOV (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VN1</td>
<td>380</td>
<td>10</td>
<td>60</td>
<td>210</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>VN2</td>
<td>412</td>
<td>10</td>
<td>75</td>
<td>250</td>
<td>400</td>
<td>250</td>
</tr>
<tr>
<td>VN3</td>
<td>443</td>
<td>10</td>
<td>64</td>
<td>400</td>
<td>300</td>
<td>250</td>
</tr>
<tr>
<td>VN4</td>
<td>490</td>
<td>10</td>
<td>53</td>
<td>120</td>
<td>400</td>
<td>250</td>
</tr>
<tr>
<td>VN5</td>
<td>530</td>
<td>10</td>
<td>53</td>
<td>350</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>VN6</td>
<td>565</td>
<td>10</td>
<td>33</td>
<td>90</td>
<td>400</td>
<td>250</td>
</tr>
<tr>
<td>VN7</td>
<td>673.5</td>
<td>20</td>
<td>23</td>
<td>62</td>
<td>400</td>
<td>250</td>
</tr>
<tr>
<td>VN8</td>
<td>673.5</td>
<td>20</td>
<td>25</td>
<td>210</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>VN9</td>
<td>763</td>
<td>12</td>
<td>40</td>
<td>350</td>
<td>1200</td>
<td>250/1000</td>
</tr>
<tr>
<td>VN10</td>
<td>868.5</td>
<td>20</td>
<td>8</td>
<td>30</td>
<td>400</td>
<td>250</td>
</tr>
<tr>
<td>VN11</td>
<td>868.5</td>
<td>20</td>
<td>8</td>
<td>30</td>
<td>200</td>
<td>250</td>
</tr>
<tr>
<td>P1</td>
<td>673.5</td>
<td>20</td>
<td>25</td>
<td>250</td>
<td>250</td>
<td>1000</td>
</tr>
<tr>
<td>P2</td>
<td>868.5</td>
<td>20</td>
<td>25</td>
<td>250</td>
<td>250</td>
<td>1000</td>
</tr>
<tr>
<td>SW1</td>
<td>1050</td>
<td>20</td>
<td>57</td>
<td>248</td>
<td>500</td>
<td>1000</td>
</tr>
<tr>
<td>SW2</td>
<td>1380</td>
<td>20</td>
<td>8</td>
<td>103</td>
<td>150</td>
<td>1000</td>
</tr>
<tr>
<td>SW3</td>
<td>1630</td>
<td>200</td>
<td>3</td>
<td>50</td>
<td>57</td>
<td>250</td>
</tr>
<tr>
<td>SW4</td>
<td>2210</td>
<td>50</td>
<td>1.9</td>
<td>20</td>
<td>211</td>
<td>1000</td>
</tr>
<tr>
<td>T1</td>
<td>10.8</td>
<td>0.7</td>
<td>300</td>
<td>340</td>
<td>0.2</td>
<td>250/500</td>
</tr>
<tr>
<td>T2</td>
<td>12.0</td>
<td>0.7</td>
<td>300</td>
<td>340</td>
<td>0.2</td>
<td>250/500</td>
</tr>
</tbody>
</table>

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

- Multi-angle obs. for 674nm and 869nm

- On-board calibration: VN: Solar diffuser, LED, Lunar cal maneuvers, and dark current by masked pixels and nighttime obs. SW: Solar diffuser, LED, Lunar, and dark current by deep space window T: Black body and dark current by deep space window
Infrared Scanning Radiometer
SGLI-IRS


- Observation light through Ritchey Chretien type telescope is divided for two wavelength region.
  - Shortwave Infrared detector (SWI-DET)
  - Thermal Infrared detector (TIR-DET).

- SWI-DET uses InGaAs type detectors at -30deg C using peltier cooler.

- TIR-DET uses PV-MCT type detectors at 55K using mechanical stirling cooler.
IRS SWI Radiometric Test Result

1mφ Integration Sphere (Light Source)  IRS SRU (EM)

- IRS EM radiometric Test was performed using high stability Integration-sphere for SWI (1 to 2.2 micron) light source.

<table>
<thead>
<tr>
<th></th>
<th>CH</th>
<th>S[DN]</th>
<th>N[DN]</th>
<th>SNR RESULT</th>
<th>SNR REQUEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW1</td>
<td>1196.37</td>
<td>1.12</td>
<td>1068.19</td>
<td>≥500</td>
<td></td>
</tr>
<tr>
<td>SW2</td>
<td>371.24</td>
<td>0.99</td>
<td>374.99</td>
<td>≥150</td>
<td></td>
</tr>
<tr>
<td>SW3</td>
<td>244.93</td>
<td>2.55</td>
<td>96.05</td>
<td>≥57</td>
<td></td>
</tr>
<tr>
<td>SW4</td>
<td>423.68</td>
<td>1.64</td>
<td>258.34</td>
<td>≥211</td>
<td></td>
</tr>
</tbody>
</table>

SWI SNR Test Result meets the Requirement!
IRS SWI Radiometric Test Result (Linearity)

SWI 4bands linearity test result obtains good linearity within 1% tolerance!!
IRS TIR Radiometric Test Configuration (Thermal Vacuum Test)
IRS TIR Radiometric Test Configuration (Thermal Vacuum Test)

Temperature-adjustable Black Body (Temperature Range: 180[K] to 340[K])

Temperature-fixed Black Body (Temperature Range: ≤100[K])

IRS TIR Radiometric Test (10 to 12 micron) was performed using high stability Temperature-adjustable Black-body.
Temperature-adjustable Black-body

Test Result

<table>
<thead>
<tr>
<th>Black-body Radiation Factor</th>
<th>0.97 (@&lt; 10.2 μ m) over 0.98(@≧10.2 μ m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Control Range</td>
<td>180[K]～340[K]</td>
</tr>
<tr>
<td>Temperature Stability</td>
<td>less than ±0.3[K]</td>
</tr>
<tr>
<td>Temperature Distribution</td>
<td>-0.100[K] @ -96 deg C</td>
</tr>
<tr>
<td></td>
<td>-0.079[K] @ -56 deg C</td>
</tr>
<tr>
<td></td>
<td>-0.049[K] @ -16deg C</td>
</tr>
<tr>
<td></td>
<td>+0.043[K] @ +23 deg C</td>
</tr>
<tr>
<td></td>
<td>+0.129[K] @ +70 deg C</td>
</tr>
</tbody>
</table>
IRS TIR Radiometric Test Result
(NEdT @ TDI 500m Resolution)

- TIR1 NEdT: TDI (TimeDelay Integration) 500m Resolution
- TIR2 NEdT: TDI (TimeDelay Integration) 500m Resolution

NEdT Test Result meets the Requirement!
(≤ 0.2@ TDI 500m)
IRS TIR Radiometric Test Result
(NEdT@250m Resolution)

TIR1-a NEdT @ 250m Resolution

TIR1-b NEdT @ 250m Resolution

TIR2-a NEdT @ 250m Resolution

TIR2-b NEdT @ 250m Resolution

Legend:
- Hot Case
- Nominal Case
- Cold Case
IRS TIR Radiometric Test Result (Linearity)
(Nominal Temperature Case)

IRS TIR Radiometric Test (10 to 12 micron) was performed using high stability Temperature-adjustable Black-body.

It obtains very good linearity and linearity error is less than 2% !!!
IRS TIR Radiometric Test Result (Stability)
(Nominal Temperature Case)

TIR Output Stability meets the requirement ($\leq \pm 0.6\%$).
Conclusion

- SGLI is the optical sensor on GCOM-C1 satellite.

- SGLI Engineering Model (EM) test is under the last test phase now.

- SGLI SWI (1.1 to 2.2 micron) radiometric test result obtains good linearity within 1% tolerance!

- SGLI TIR (10 to 12 micron) radiometric test was performed using high stability Temperature-adjustable Black-Body. It obtains very good linearity and linearity error is less than 2%!!