IASI Conference 2010

Status of IASI instruments:
FM2 after 3 years in orbit
PFM-R and FM3 on ground

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Status of IASI instruments:
FM2 after 3 years in orbit
PFM-R and FM3 on ground

■ IASI FM2
  • More than 3 years in orbit
  • Very good instrument health
  • Very good instrument availability

■ IASI PFM-R and FM3
  • 2 next IASI flight models on Metop-B and Metop-C
  • Will be launched in 2012 and 2016
IASI FM2: instrument availability

- **Time spent in Normal Operation mode**
  - 97.1% over year 2008/2009
  - 94.1% over year 2007/2008

- **Time spent in External Calibration mode**
  - 1% over year 2008/2009
  - 1.1% over year 2007/2008
  - Routine External Calibrations: 2 orbits/month.
  - Moon pass in 1st Cold Space view: 2 or 3 occurrences/year
IASI FM2: instrument availability

Year 2008/2009 Main events

- 3 IASI anomalies
- External calibrations
  - Routine
  - 3 Moon passes (CS1)
- 1 TOP update
  - Reduced spectra
- 1 METOP OOP manoeuvre

Routine External Calibration

0 = Off (0.000%)
1 = Standby or Standby/Refuse (0.46%)
2 = Heater 1 (1.15%)
3 = Heater 2 or Heater/Refuse (0.22%)
4 = Auxiliary (0.05%)
5 = External Calibration (1.01%)
6 = Normal Operation (97.16%)
Since beginning of life, instrument outages are due to

- Anomalies
  - IASI anomalies: all related to radiative environment (SEU/MEU – Single/Multiple Event Upset, SET – Single Event Transient)
    Mainly 2 equipments are impacted: DPS (Data Processing Subsystem) and CCE (Cube Corner Electronics). SRAM memory parts used in these equipments are sensitive to SEU.
  - Metop anomalies (4 occurrences in 2007-2008)
- External events (Moon pass, satellite manœuvre)
- Monthly routine external calibrations
- Ice decontamination
  - Done in March 2008. The next one is expected before end 2010. 
    → needed to restore instrument radiometric performance @850cm-1
### IASI anomalies since end of SIOV

<table>
<thead>
<tr>
<th>date</th>
<th>anomaly</th>
</tr>
</thead>
<tbody>
<tr>
<td>15/05/2007</td>
<td>13:18:09 SEU laser</td>
</tr>
<tr>
<td>13/06/2007</td>
<td>10:23:03 SEU DMC</td>
</tr>
<tr>
<td>20/07/2007</td>
<td>14:30:47 SEU DPC 3A</td>
</tr>
<tr>
<td>01/11/2007</td>
<td>13:35:46 SEU DPC 4A</td>
</tr>
<tr>
<td>08/11/2007</td>
<td>11:02:57 SEU DMC</td>
</tr>
<tr>
<td>18/11/2007</td>
<td>01:31:32 SET DPS DMC Converter</td>
</tr>
<tr>
<td>04/02/2008</td>
<td>12:46:11 SEU CCM ALU</td>
</tr>
<tr>
<td>09/02/2008</td>
<td>10:37:06 SEU DPC 3B</td>
</tr>
<tr>
<td>21/07/2008</td>
<td>23:43:54 SEU DPC 1A</td>
</tr>
<tr>
<td>09/12/2008</td>
<td>20:28:10 SET DPS Main Converter</td>
</tr>
<tr>
<td>29/12/2008</td>
<td>22:50:19 EQSOL double EDAC</td>
</tr>
<tr>
<td>26/08/2009</td>
<td>11:08:59 SEU DMC</td>
</tr>
<tr>
<td>07/09/2009</td>
<td>18:17:20 SEU CCM ALU</td>
</tr>
<tr>
<td>30/10/2009</td>
<td>04:49:50 SEU CCM ALU</td>
</tr>
</tbody>
</table>

**IASI FM2: instrument availability**

IASI anomalies since end of SIOV.
IASI FM2: instrument availability

- Improvement of the availability over 3 years
  - Anomalies
    - Joint work with Eumetsat to improve anomaly recovery procedures: systematic procedures in case of SEU
      - Outage time was significantly reduced
        For a typical SEU anomaly: 1.5 day outage in 2007, 3 orbits max (5h) outage in 2009 with the « turbo » procedure.
    - A software patch developed by TAS was implemented onboard FM2 on September 2009. It allows an automatic reinitialisation in case of SEU anomaly on the DPS (Data Processing Subsystem).
      - The outage time will be reduced to almost zero for DPS SEU anomalies
  - Moon avoidance strategy
    - New strategy applied in 2009: switch to External Cal only during the part of orbit where the Moon appears in CS1 view
      - Reduced time in External Cal

⇒ Instrument availability is very good and is still improving!
Up to now, very good functional behaviour of IASI FM2

- No hardware anomaly
- No use of redundancy
- All functional anomalies have SEU or SET origin
IASI FM2 : functional status

- Very good health of all subsystems
  - Interferometer
    - Optical Bench
    - Reference Laser
    - Cube Corner Mechanism
  - Scan Subsystem
  - Hot Blackbody
  - Integrated Imager
  - Cold Box subsystem
  - Instrument Management Subsystem & Data Processing Subsystem
  - Active Thermal Control
  - Equipments power consumption
IASI FM2 : functional status

- Optical bench (OBU)
  - Thermal status
    - OBU perfectly regulated
  - Alignment stability
    - Low drift of CC offset
    - Stability of interferometric contrast
  ➔ no impact on spectral performances

![Graph of OBU optical area (HK sensor)](image)

![Graph of OBU CCA area (HK sensor)](image)
IASI FM2 : functional status

- RPD system: Laser + RAU (Reference Acquisition Unit)
  - Amplitude of OPD reference signal received by RAU:
    - low variations of the RAU amplitude but large margin w.r.t. the minimum functioning value (<100 mW)
  - Very good stability of the functioning point of the laser control loop
IASI FM2 : functional status

- Cube Corner Mechanism (CCM)
  Position Data Diagnostic telemetry (CCFD only)
  No change in the speed profile during the period
  → very good health status of the CCFD
Scan Mechanism Subsystem

- Position Data Diagnostic allow to check the stability of the positioning control loop.

Across track pointing stability better than 30 µrad (25m on ground)
Along track compensation speed = 5.49 mrad/s (target = 5.56 mrd/s)
Along track compensation error < 30 µrad (25m on ground)

⇒ Perfect behaviour of the scan
IASI FM2: functional status

- Blackbody Subsystem
  - Stability of BB temperature measurement

- Integrated Imager
  - Focal plane temperature
    - Drift of 0.13 K/year observed in orbit
      Same drift observed for the models still on ground (while IIS OFF or ON)
      Root cause under investigation (detector or telemetry measurement)
    - Analysis is ongoing (a working group was set up). We expect no impact on imager performance.
IASI FM2 : functional status

Cold Box Subsystem

- 3rd stage ATC regulation line
  - CBS average ATC power regulation : around 5mW
- Nominal thermal behaviour. No need to change the regulation target.

CBS 3rd stage regulation power

CBS 3rd stage ATC line temperature
IASI FM2: functional status

- IMS & DPS
  - DPS converter temperature
    - $\approx +0.5 \text{ K/year}$
  - IMS temperature
    - $\approx +0.7 \text{ K/year}$
  - Evolution correlated with Metop panel temperature
  - Stability of DPS mean power consumption

Graphs showing temperature changes over time for DPS and IMS systems.
### IASI FM2 : functional status

- **Active Thermal Control**
  - 14 regulation lines (including CBS)
  - The 14 IASI ATC lines consumption is stable with margin on min and max power of each line
- **Nominal behaviour of IASI thermal control**

<table>
<thead>
<tr>
<th>PI line number</th>
<th>Reference</th>
<th>September 2008,01&amp;02</th>
<th>+1 year</th>
<th>September 2009,01&amp;02</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATC_1</td>
<td>USP (IIS area)</td>
<td>5.36 W + 0.37 W - 0.54 W</td>
<td>+ 0.05 W</td>
<td>5.41 W + 0.36 W - 0.52 W</td>
<td>OK</td>
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<tr>
<td>ATC_2</td>
<td>IIS objective</td>
<td>0.57 W + 0.20 W - 0.22 W</td>
<td>- 0.01 W</td>
<td>0.56 W + 0.19 W - 0.25 W</td>
<td>OK</td>
</tr>
<tr>
<td>ATC_3</td>
<td>ACW support</td>
<td>0.71 W + 0.01 W - 0.02 W</td>
<td>+ 0.00 W</td>
<td>0.71 W + 0.03 W - 0.03 W</td>
<td>OK</td>
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<tr>
<td>ATC_4</td>
<td>O.B.U. (optics area)</td>
<td>2.36 W + 0.17 W - 0.17 W</td>
<td>- 0.06 W</td>
<td>2.30 W + 0.19 W - 0.19 W</td>
<td>OK</td>
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<tr>
<td>ATC_5</td>
<td>MAS/CCE/SCU area</td>
<td>10.39 W + 2.14 W - 2.23 W</td>
<td>- 0.32 W</td>
<td>10.07 W + 2.35 W - 2.26 W</td>
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<tr>
<td>ATC_6</td>
<td>MAS/CCE/SCU area</td>
<td>10.39 W + 2.14 W - 2.23 W</td>
<td>- 0.32 W</td>
<td>10.07 W + 2.35 W - 2.26 W</td>
<td>OK</td>
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<tr>
<td>ATC_7</td>
<td>O.B.U. (CCA area)</td>
<td>5.06 W + 0.28 W - 0.29 W</td>
<td>- 0.07 W</td>
<td>4.99 W + 0.30 W - 0.33 W</td>
<td>OK</td>
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<tr>
<td>ATC_8</td>
<td>CD</td>
<td>0.67 W + 0.12 W - 0.09 W</td>
<td>- 0.03 W</td>
<td>0.64 W + 0.15 W - 0.11 W</td>
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<tr>
<td>ATC_9</td>
<td>LAU support</td>
<td>5.44 W + 0.91 W - 1.00 W</td>
<td>- 0.11 W</td>
<td>5.33 W + 1.00 W - 1.09 W</td>
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<tr>
<td>ATC_10</td>
<td>C.B.S.</td>
<td>6.44 mW + 3.59 mW - 2.15 mW</td>
<td>- 1.0 mW</td>
<td>5.43 mW + 1.33 mW - 3.30 mW</td>
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<tr>
<td>ATC_11</td>
<td>USP (MAS area)</td>
<td>3.72 W + 0.24 W - 0.24 W</td>
<td>- 0.08 W</td>
<td>3.63 W + 0.33 W - 0.32 W</td>
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<tr>
<td>ATC_12</td>
<td>USP (BBC area)</td>
<td>13.36 W + 0.79 W - 0.56 W</td>
<td>- 0.01 W</td>
<td>13.35 W + 0.80 W - 0.62 W</td>
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<tr>
<td>ATC_15</td>
<td>USP (CBS area)</td>
<td>8.48 W + 0.23 W - 0.27 W</td>
<td>- 0.01 W</td>
<td>8.47 W + 0.23 W - 0.27 W</td>
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<tr>
<td>ATC_16</td>
<td>-Y wall</td>
<td>4.75 W + 0.42 W - 0.42 W</td>
<td>- 0.03 W</td>
<td>4.71 W + 0.36 W - 0.43 W</td>
<td>OK</td>
</tr>
</tbody>
</table>
No significant evolution of Telemetry level change after a new switch on correspond to a different phasing of the telemetry sampling w.r.t. the functioning cycle of the subsystem.

→ good status for all units

**Equipments power consumption**

IASI FM2 : functional status

- IIS
- CCM
- SCAN
- MAS
IASI FM2 : functional status

- Conclusion

- All appears as nominal on IASI
- No symptom of degradation can be observed
- Ageing effects appear very low
IASI instruments on ground

Two other IASI flight models in storage phase, already integrated on satellite: IASI PFM-R on Metop-B and IASI FM3 on Metop-C

- **Metop-B** : de-storage activities have started…
  - December 2009: IASI IMS & DPS EEPROM update
  - February 2010: SFT test (System Functional Test) at Astrium (Friedrichshafen)
  - April-June 2010: Thermal Vacuum test at ESTEC (Noordwijk)
  - 2011: Metop PLM and SVM coupling, SSVT test
  - April 2012: launch from Baïkonour

- **Metop-C**
  - Annual health checks (AFT tests) until de-storage
  - 2016: launch
IASI instruments on ground

- Annual health checks overview
  - AFT (Abbreviated Functional Test)
  - Ambiant functional test, with detectors OFF and CCM locked
  - Objectives: check system integrity, electrical interfaces, heater lines activation (ATC, SMA and DEC), activation of scan mechanism
IASI FM3

- Anomalies on 2 thermistors (Fenwall thermistors): erratic behaviour of the measured temperature
  - 1 thermistor used for ATC line will be replaced
  - 1 thermistor used for monitoring will not be replaced (monitoring function will be addressed to another thermistor)
IASI instruments on ground

- Incoming Thermal Vacuum test with IASI PFM-R
  - Objective: verification of IASI spectral and radiometric performances
  - No evolution since last Optical Vacuum Test at TAS Cannes (2006)
  - No impact of perturbations coming from other instruments
Conclusions

■ IASI FM2
  • Nominal behaviour
  • Very good health of the instrument
  • Instrument availability is very good and still improving

■ IASI PFM-R and FM3
  • De-storage activities have started for PFM-R. Launch 2012.
  • FM3 in storage. Launch 2016.
  • No functional anomaly on PFM-R. Fenwall anomalies on FM3 will be treated before launch.

■ Thanks to all the IASI team at CNES, TAS & EUMETSAT !