EUROPEAN SPACE AGENCY
DIRECTORATE OF TECHNICAL & OPERATIONAL SUPPORT
MISSION OPERATIONS DEPARTMENT

INTEGRAL
Mission Report

INT-MOC-SYS-RP-1001-OPS-OAI

No. 351
Week 24

15.06.09

Routine Phase

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1 General

The Flight Control Team at MOC has compiled this report with some input provided by the Flight Dynamics Team, ISOC and ISDC.

It addresses the activities from 06.06.09 until 12.06.09 (both dates inclusive) and covers the revolutions 811, 812 and 813.

2 Summary of Activities

The operations were performed according to the planning inputs from ISOC combined with some manual commanding by MOC.

The targets of these revolutions consisted of a raster dither of NGC 4151 (RA 12:10:32.00, DEC +39:24:19.0), a raster dither of the North Ecliptic Pole (RA 18:00:00.00, DEC +66:33:39.0), a raster dither of 47 Tuc and SMC (RA 00:53:55.20, DEC -72:26:42.0), a raster dither of Loop I-Loop IV Super (RA 13:57:10.00, +07:34:37.0) and a raster dither of the Virgo Cluster (RA 12:26:32.10, +12:43:24.0).

Note: Some further information concerning the activities is provided in the Appendix.

3 Satellite Status

3.1 Platform

The performance of the platform was good. No new unexpected behaviour / malfunction was identified.

3.1.1 AOCS

The AOCS operations were executed from the Automatic Timeline.

During this period, 105 Open Loop Slews, 47 Closed Loop Slews and 5 Momentum Biases were executed (as reported by ACC OEM).

No slew was missed from the TL

The OTF was not reached during part of PID 08140062.

Note: Some more information concerning the AOCS operations is provided in the Appendix.

3.1.2 Power

All the other units of EPS are working nominally; available power from the arrays is of the order of 2100W.

3.1.3 Thermal

The thermal control of the satellite is working well. The temperatures are currently all within the specified operational limits.

3.1.4 OBDH

The OBDH subsystem is working flawlessly. No on-board communications problem has been identified.

The PST was over-subscribed by 3 packets, which were allocated to SPI during the Instrument window for the entire reporting period.

3.1.5 RFS

The RF subsystem is working properly. The link margin is sufficient to ensure proper TM reception and execution of commands with the ranging channel enabled.

3.2 Payload

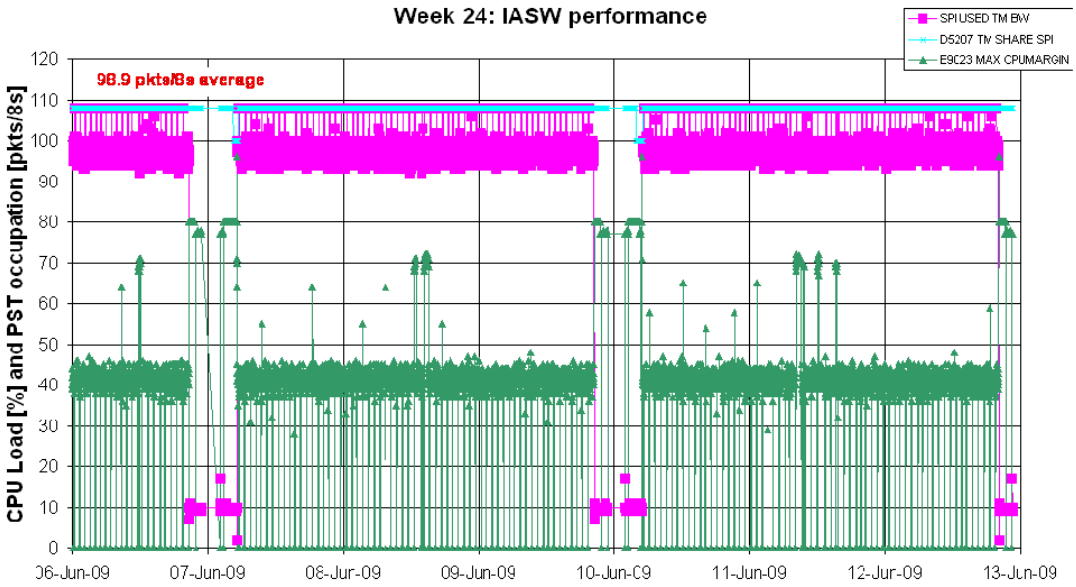
3.2.1 SPI

Following the 13th SPI annealing, which ended on 11/05/2009, the overall status of the gamma-ray spectrometer is nominal, except for detector #2 (failed since 06/12/2003); detector #17 (failed since 17/07/2004) and detector #5 (failed since 19/02/2009).

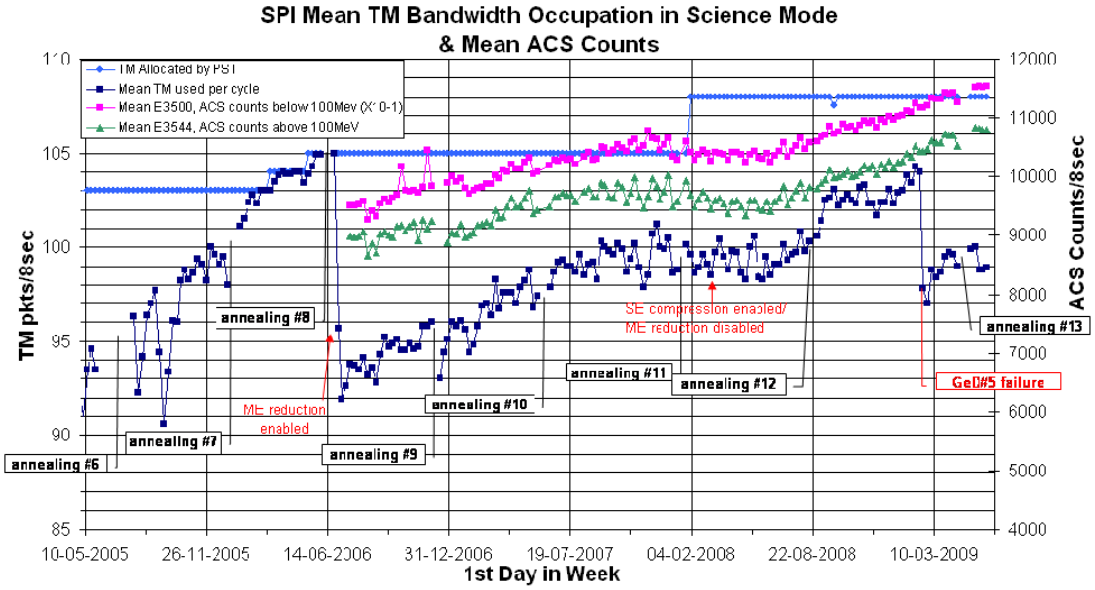
The Stirling compressors are working nominally. The Germanium detectors' temperature was kept in the range 80K+/-1K.

SPI was operated in photon-by-photon mode with spectra TM enabled during science observations. The assigned TM bandwidth in the science observation windows was 108 and the average telemetry occupation was 98.9 packets/cycle.

The following plot shows the TM bandwidth allocation, occupation and DPE CPU load during the reporting period:



The following plot shows the evolution of the assigned and the average occupation of the SPI TM bandwidth since May 2005 along with the mean ACS count rate evolution (since July 2006). As can be seen, there is a strong correlation between the evolution of the background as measured by the ACS and the overall TM bandwidth usage.



Note: Some more information concerning the SPI operations is provided in the Appendix 8.3.2.

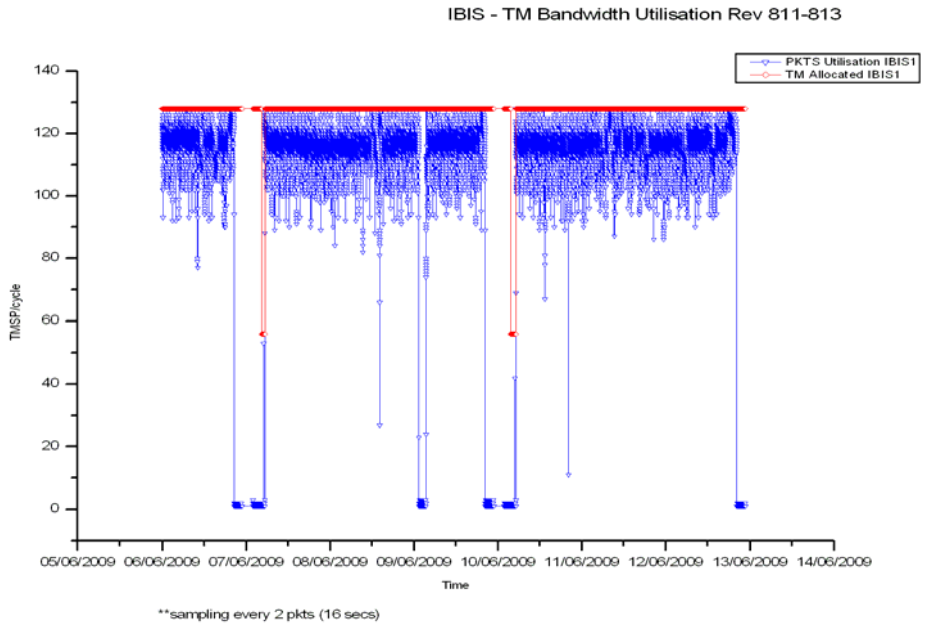
3.2.2 IBIS

The overall status of IBIS is nominal.

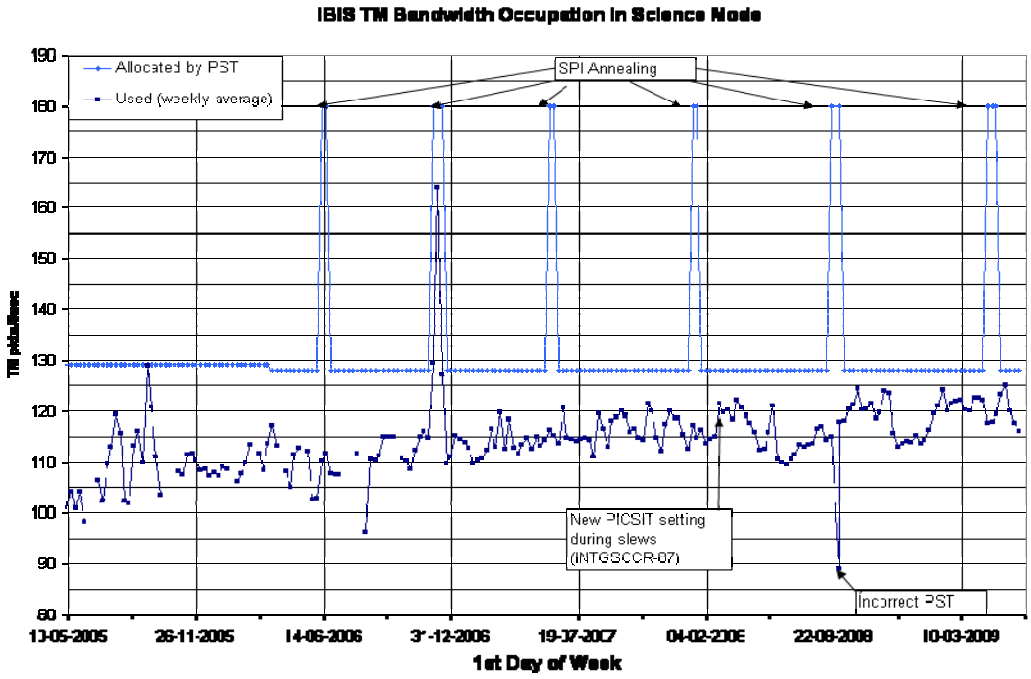
During the reporting period, IBIS was operated in Science Standard mode during science observations. The TM bandwidth statistics were as follows:

- PST allocation to IBIS above radiation belts: 128 packets/cycle
- IBIS mean bandwidth utilisation in science mode: 116.11 packets/cycle (down 1.51 on previous week)
- Percentage of TM cycles for which bandwidth usage was 128 packets/cycle: 1.99%

The plot below shows the IBIS TM utilisation during the reporting period.



A plot of the IBIS weekly bandwidth utilisation since May 2005 is shown below:



Note: Some more information concerning the IBIS operations is provided in the Appendix.

3.2.3 JEM-X

The status of both JEM-X units is nominal.

JEM-X operations were performed by the automatic Timeline.

JEM-X1 was operated in Data Taking mode with a TM allocation of 8 packets/cycle. JEM-X2 was dormant (DPE OFF) with no TM slots allocated.

Note: Some more information concerning the JEM-X operations is provided in the Appendix Section 8.3.4.

3.2.4 OMC

The status of OMC is nominal.

OMC operations were performed by the automatic Timeline. OMC was operated in Science Normal mode during science observations, with a TM allocation of 5 packets/cycle.

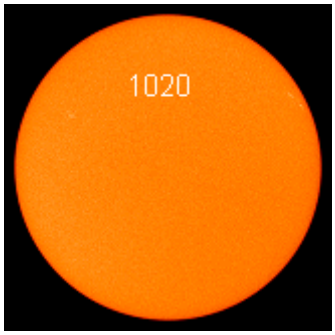
During this reporting period, 134 of the 136 planned science pointings were executed nominally, 1 was interrupted, and 1 lost.

Note: Some more information concerning the OMC operations is provided in the Appendix.

3.2.5 IREM

The overall status of the unit is nominal.

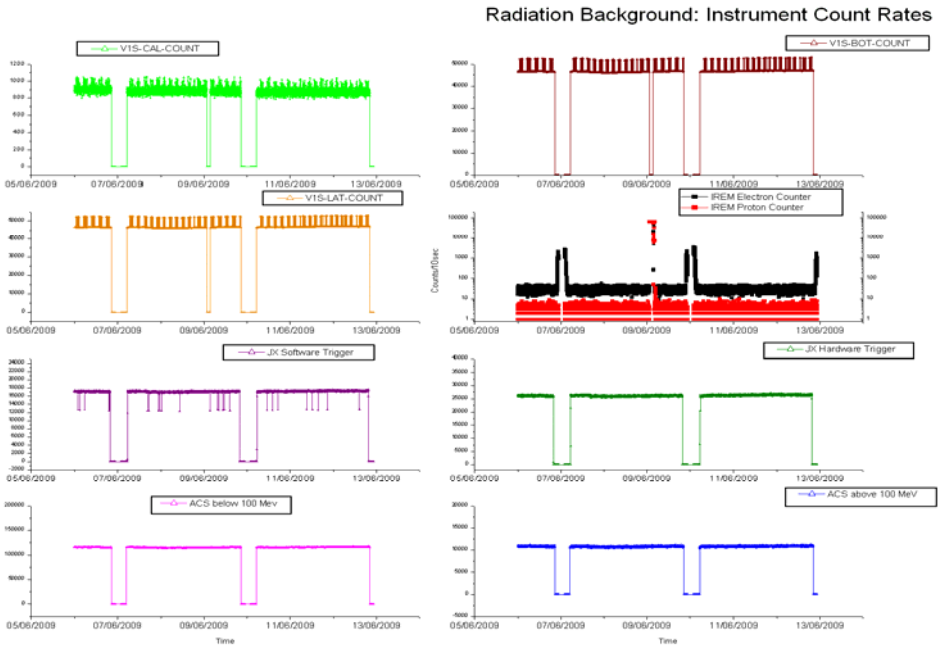
Solar Activity
The observation period was characterised by low solar activity. A small sun-spot emerged on the 10th June, but had disappeared by the following day. For the rest of the week the sun was blank. The risk of solar flares was very low.



Note: Some more information concerning the IREM operations is provided in the Appendix Section 8.3.6.

3.2.6 Radiation Backround

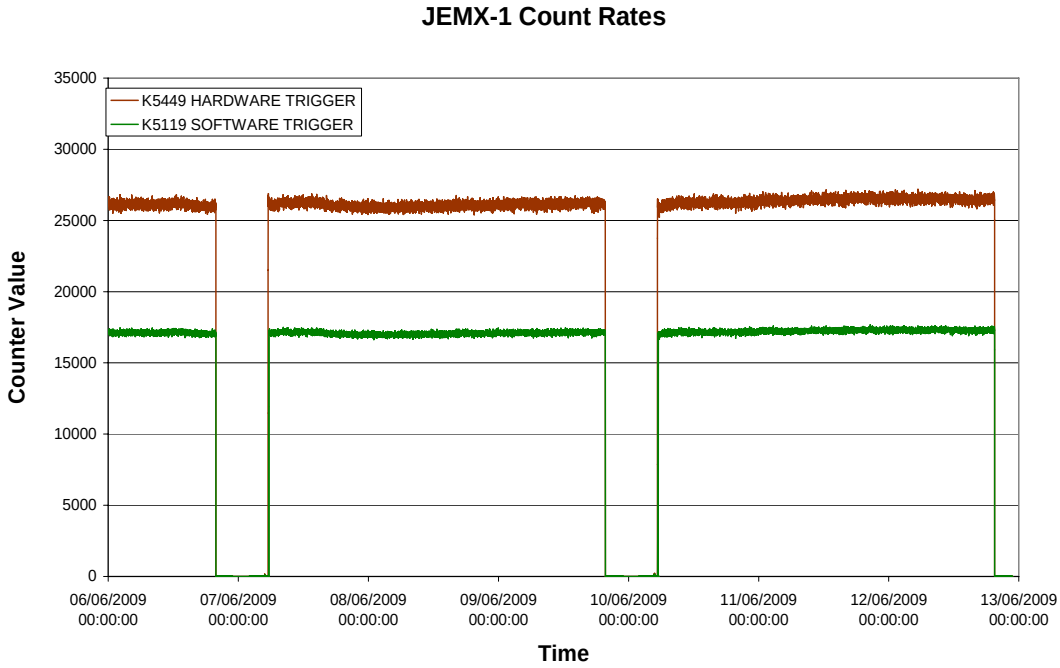
The background radiation level as measured by the instrument counters was low during the reporting period. The following plots show the SPI ACS, IBIS VETO, JEM-X Triggers and IREM count rates over the week:



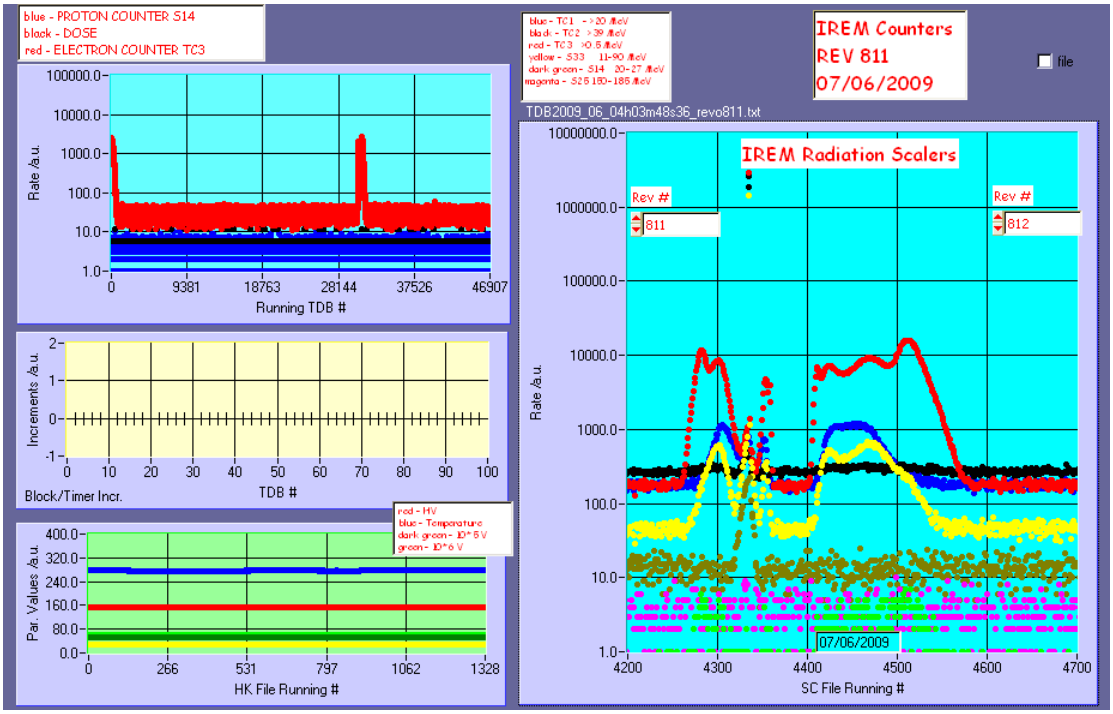
**with the exception of IREM counters (counts/10sec), all the plots are reporting counts/sec sampling every 5 pkts (40 sec)

JEM-X Count Rates

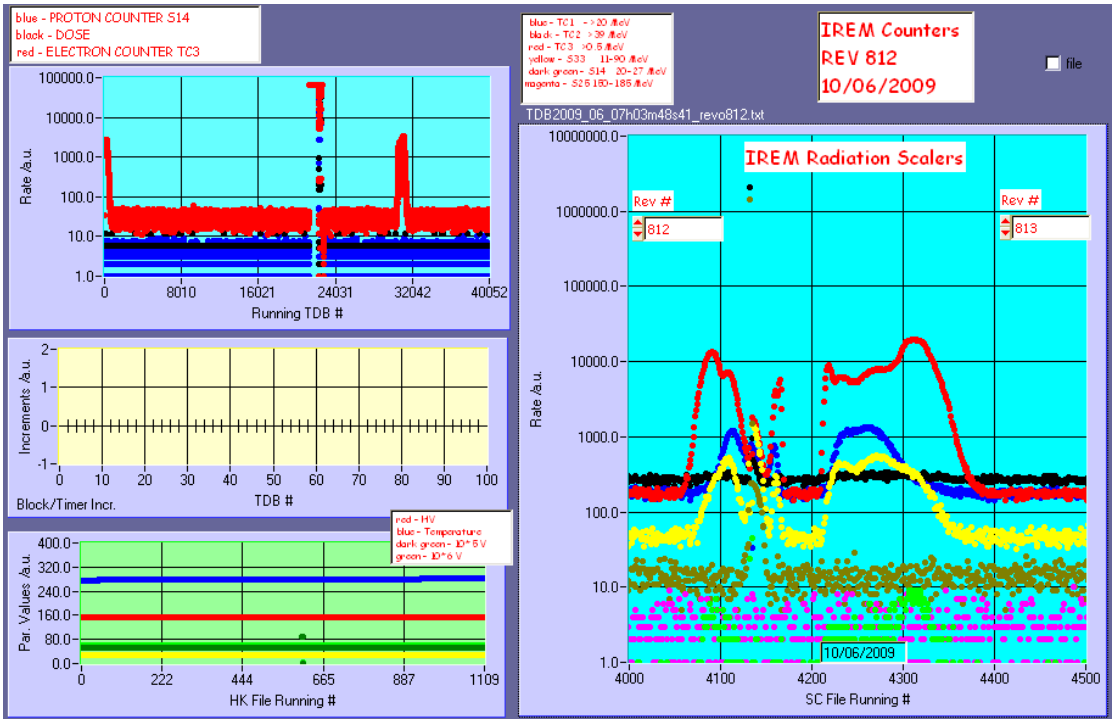
JEM-X count rates over the reporting period are displayed in the following graph[1].

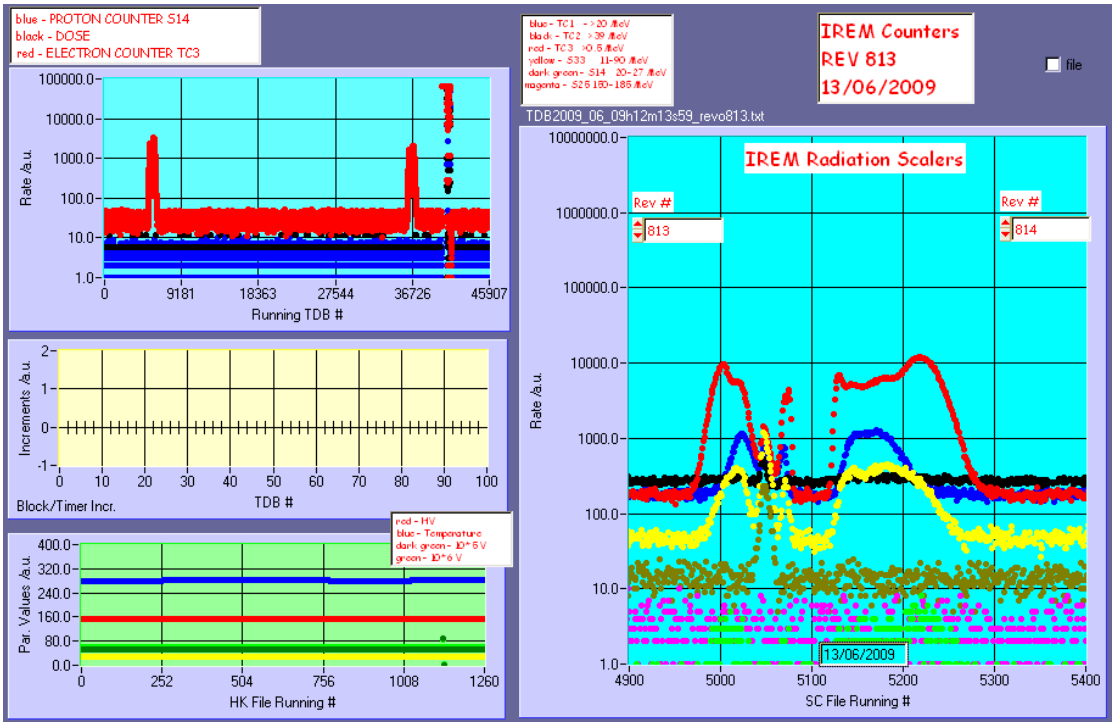


IREM radiation counters:



[1] Data sampled (1 frame in 4) and smoothed to remove spikes in S/W Trigger due to flushing of buffer after slews.





4 Ground Facilities

The Operational ground facilities performance was good this week. The overall performance was over the 95% requirement.

4.1 Mission Operations Centre

The performance of the MOC was very good this week. Nothing to report.

4.2 Ground Stations & Network

The performance of the ground stations and Network was good this week, there were two occasions of bad frames from Redu and one from VIL2 with no impact.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

An updated PSF has been received for revolution 816. Replanning of this and the subsequent revolutions was held to clarify if further changed PSFs were expected.

No new PSFs were received and thus no new observations have been planned.

New TSFs have been received for revolutions 813 and 814.

2. Observation status

New ECS files have been received for revolutions 795, 796 and 800.

3. ISOC Science Data Archive

Testing of the beta release of ISDA 3.0 is ongoing. A Status Meeting and a CCB have been held, as well as detailed technical discussions on several issues.

4. ISOC system

No news.

5. Problems

No new problems.

5 Special Events

6 Anomalies

The following anomaly report was entered into the ARTS system this week.

AR id	Date Created	Subject	Segment	Status
INT_SC-258	2009-06-09	IREM Anomaly: Reset of IREM_CSCI S/W #77, 01/06/2009	Payload	Pending

7 Future Milestones

8 Appendix

The appendix includes various detailed information.

8.1 Consumables

8.2 Detailed Satellite Information

This section contains some detailed information concerning the various subsystems of the satellite and instruments.

8.2.1 AOCS SUMMARY OPERATIONS REPORT, 06/06/2009 – 12/06/2009

The AOCS operations were executed from the Automatic Timeline.

During this period, 105 Open Loop Slews, 47 Closed Loop Slews and 5 Momentum Biases were executed (as reported by ACC OEM).

No slew was missed from the TL.

The OTF was not reached during part of PID 08140062.

Orbit Control

No update.

Fuel consumption

No update

The RMU-A null bias calibration

No update

06/06/2009 (Day of Year 157, Revolution 811)

Nothing to report

07/06/2009 (Day of Year 158, Revolution 811 to 812)

Nothing to report

08/06/2009 (Day of Year 159, Revolution 812)

Nothing to report

09/06/2009 (Day of Year 160 , Revolution 812)

FD Job scheduler crashed. Slews 08120059 and 08120060 were up-linked without the real time update. After this was noticed the scheduler was re-started and the parameters for slew 08120061 were updated via SPACON tool.

No impact on the Timeline.

10/06/2009 (Day of Year 161, Revolution 812 to 813)

Nothing to report

11/06/2009 (Day of Year 162, Revolution 813)

Nothing to report

12/06/2009 (Day of Year 163, Revolution 813)

IMU switched ON during the stable pointing of PREQ 08140062 (18:03:00Z). A mapping was commanded and the parameter for the next slew updated.

No impact on the Timeline

8.2.2 SPI Operations

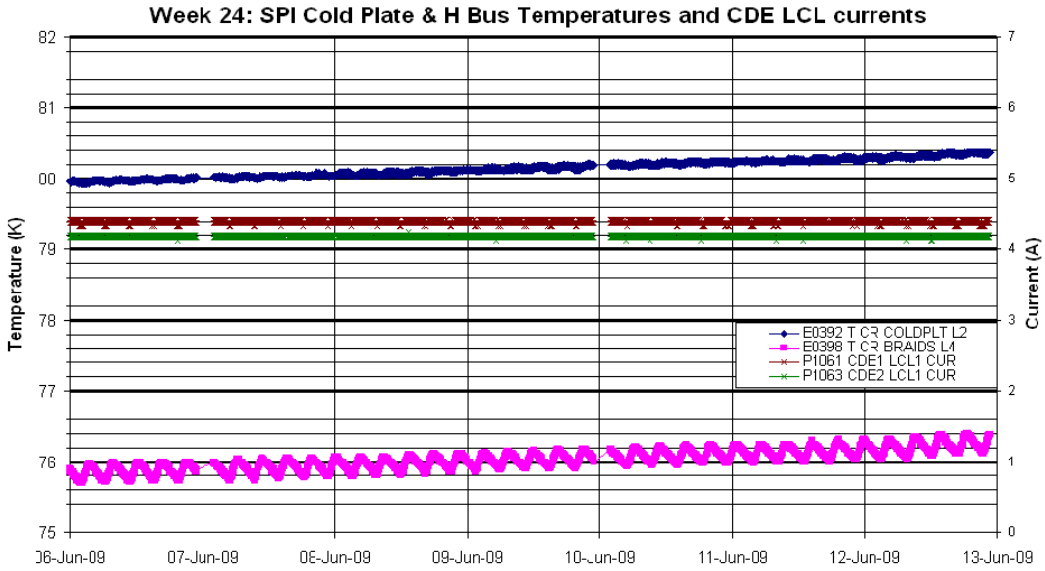
Unit Temperatures: All the equipment temperatures are inside the operational limits.

Stirling Compressors and Cryostat: The performance of the compressors is nominal. The cold plate temperature was maintained in the range 80K +/-1K.

The stroke of all four compressors was set to 38 throughout the week and the average CDE LCL currents were as follows:

- CDE1 LCL Current = 4.39A
- CDE2 LCL Current = 4.18A

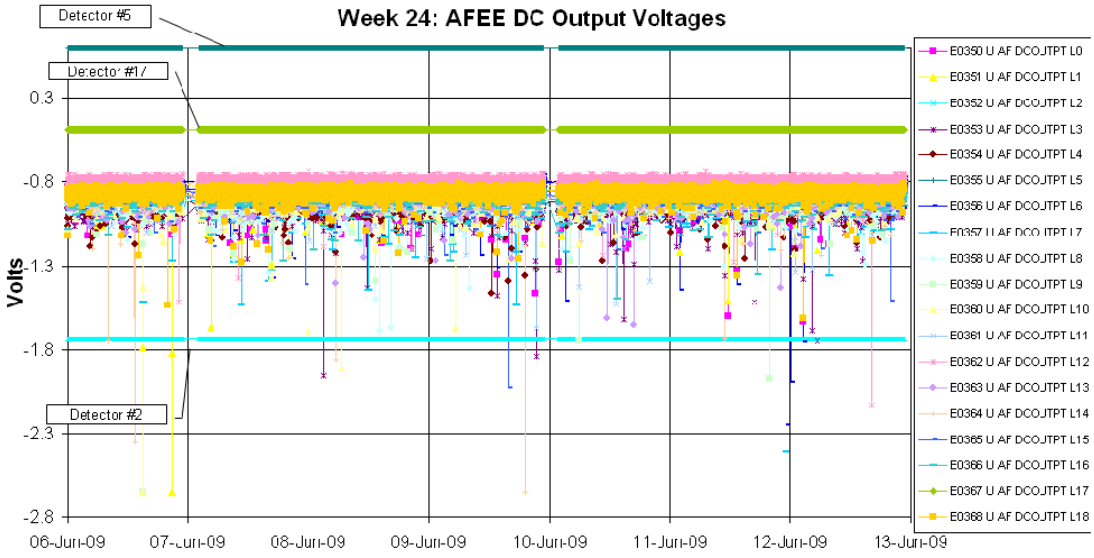
The following plot shows the evolution of the cold plate and H bus temperature as well as the CDE LCL currents during the reporting period:



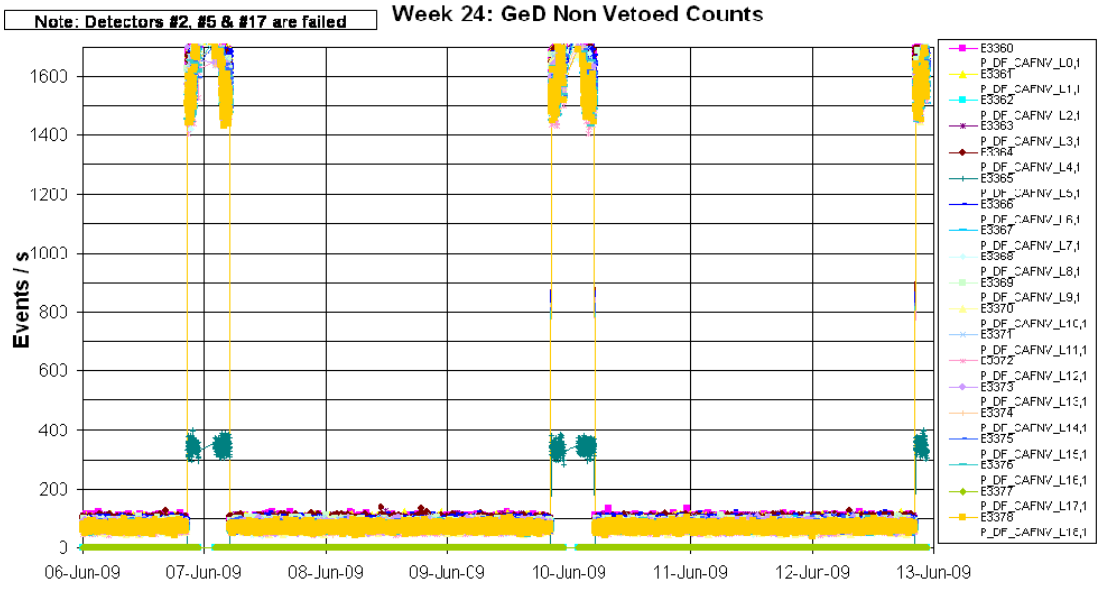
DPE & IASW: The DPE health and IASW performance are nominal. The IASW version installed is v4.3.4 with SE compression only enabled and the spectra scaling factor set to 8/19 SE. The DPE CPU usage was nominal during the reporting period (see plot in Section 3.2.1).

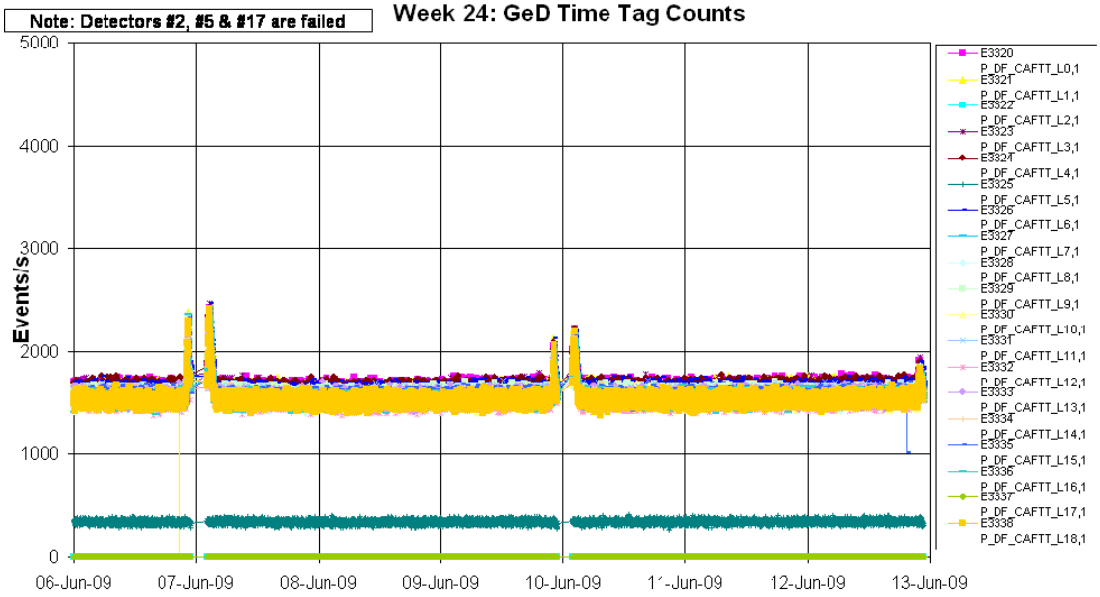
ACS: The performance of the ACS is nominal, except for FEE #81 which remains nominally switched off since the anomaly on 29/10/2006 (INT_SC-162) and FEE #57 which is nominally OFF due to the anomaly on 5/8/2003 (INT_SC-61). A plot of the ACS counts is given in Section 3.2.6.

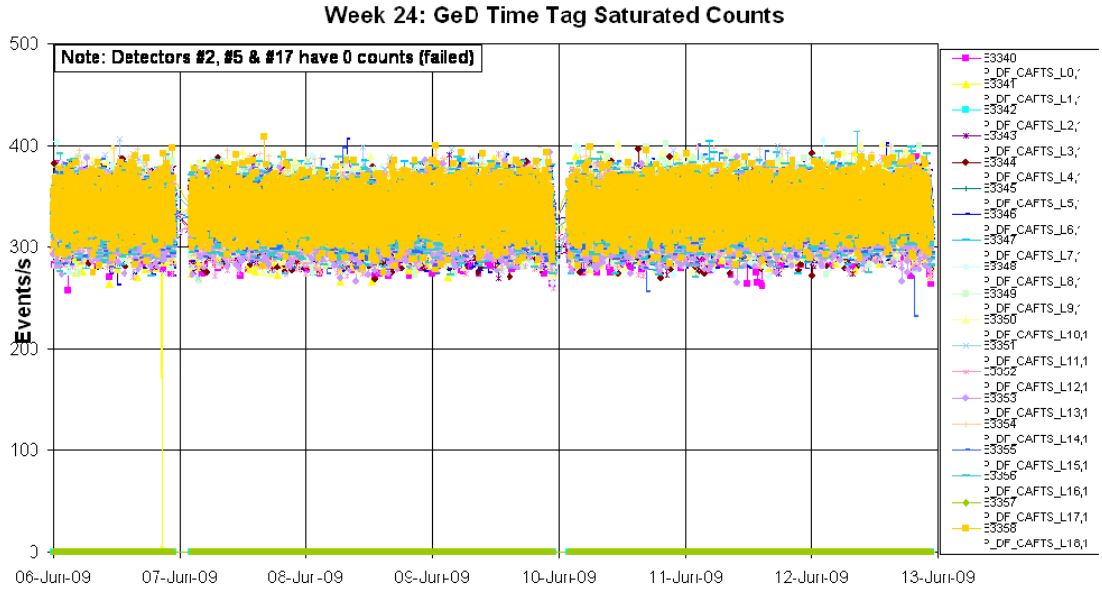
AFEE: The health of the AFEE is nominal. The following plot shows the dc output voltage of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06/12/2003; detector #17 is failed since 17/07/2004 and detector #5 is failed since 19/02/2009. The HV of the failed detectors are nominally set to 0.5kV.



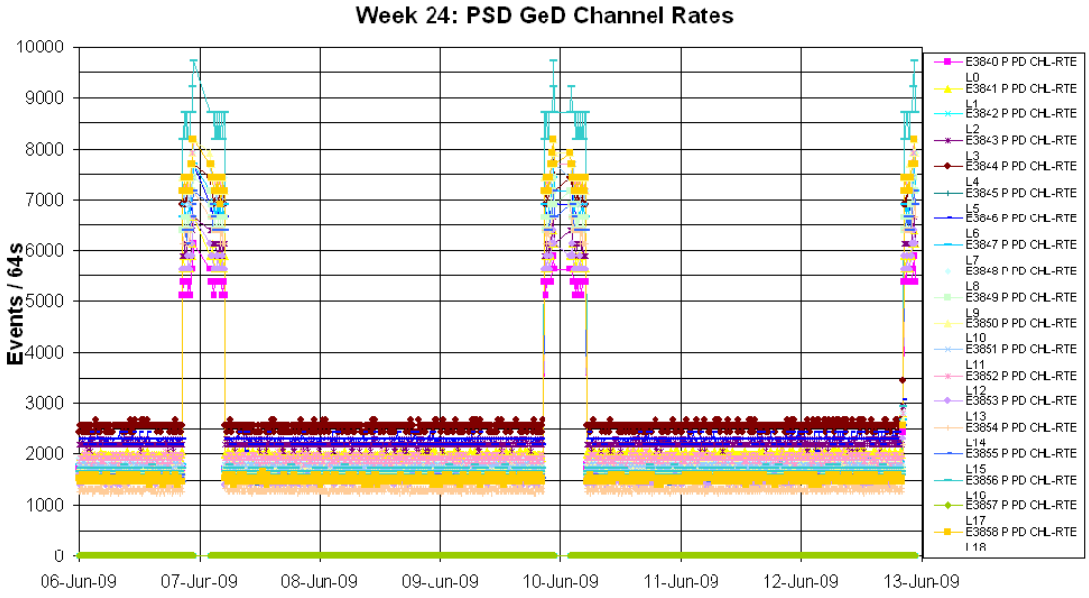
DFEE: The health of the unit is nominal. The following plots show the Non Vetoed, Time Tag and Time Tag Saturated Event count rates during the reporting period.







PSD: The health of the unit is nominal. The following plot shows the PSD channel rates over the reporting period.



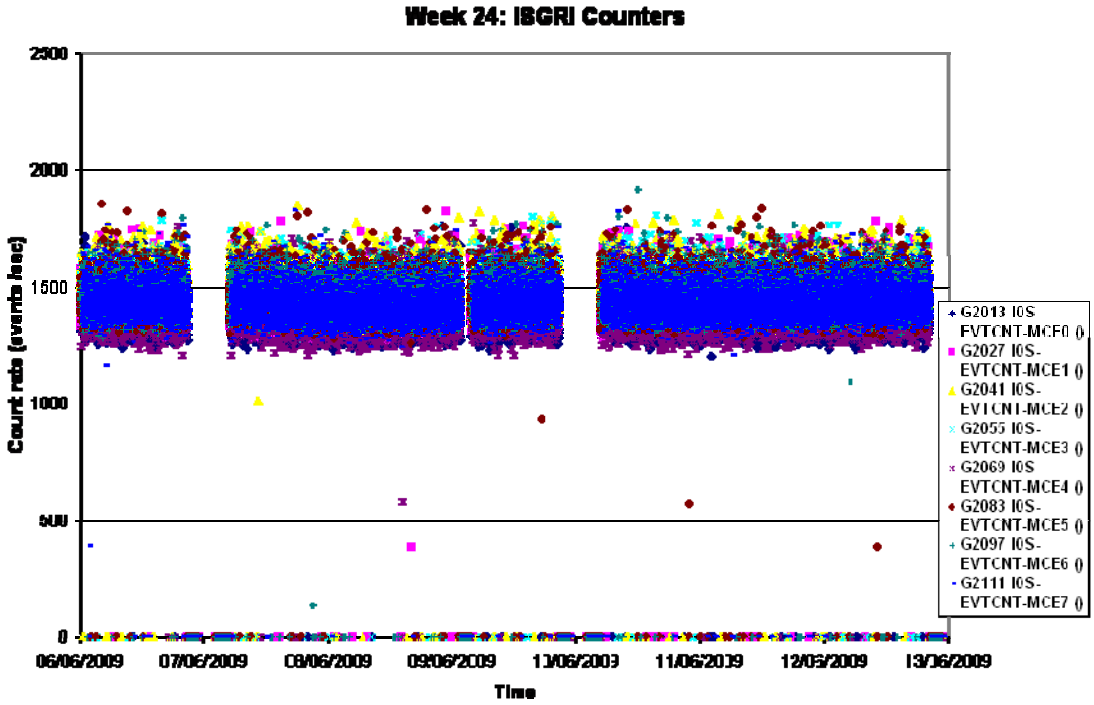
Event Log:

- No non-nominal events occurred with SPI over the reporting period.

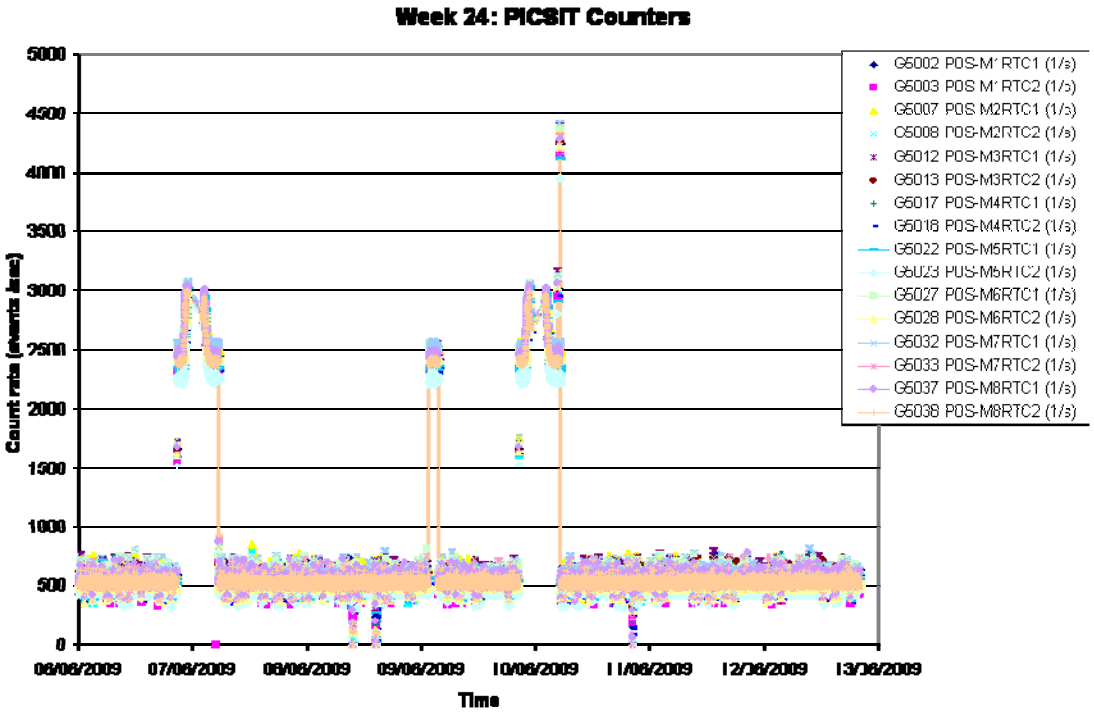
8.2.3 IBIS Operations

Unit Temperatures: All the equipment temperatures were inside the operational limits throughout the week.

ISGRI
The health and performance of ISGRI was nominal during the reporting period. The following plot shows the ISGRI MCE counters during the week:

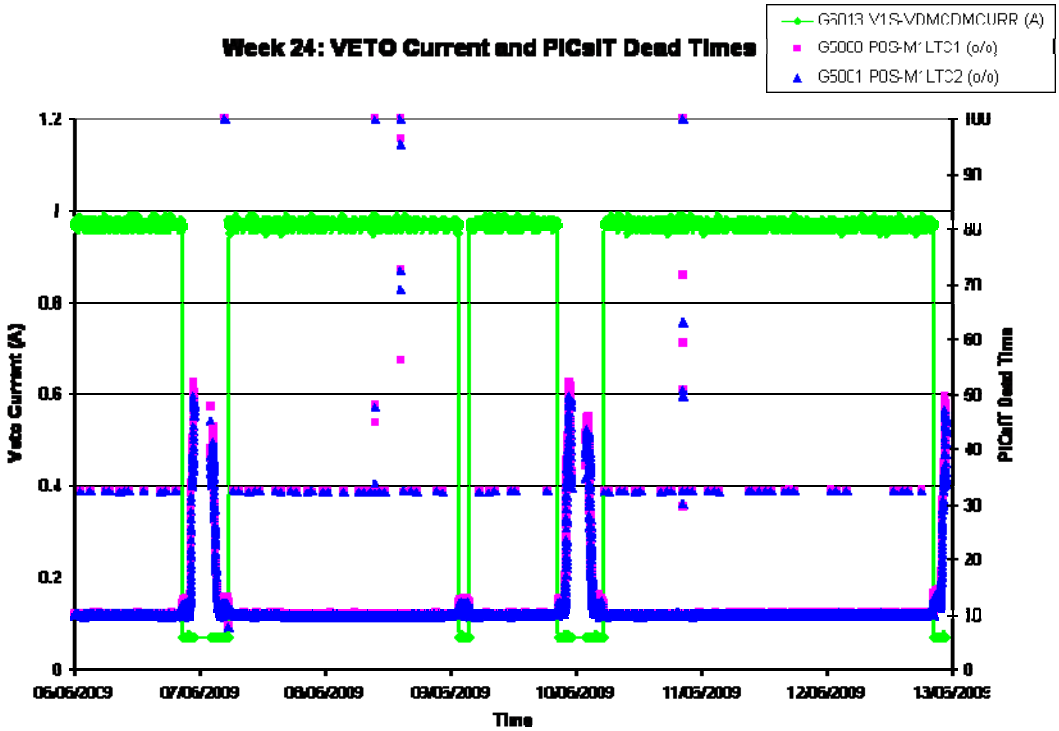


PICsIT
The health and performance of PICsIT was nominal during the reporting period. The following plot shows the PICsIT semi-module counters during the week:



VETO

The health and performance of VETO was nominal during the reporting period. The following plot shows the VETO current and PICsIT dead-times during the week:



IBIS Daily Report

The usual Out Of Limits on TM parameter G8015 (S1E-A2_PMT_V), G5002 (P0S-Mi_RTC1) and G5003 (P0S-Mi_RTC2) families and G2000 family (I0E-OVFWPXADD-Mi) were received during the radiation belt passages.

TM parameter G6061 went OOL Warning Low several times during the week. This is the VETO calibration counter. As in each case it shortly returned within limits of its own accord, no action was taken. These frequent OOLs are due to a reduction in calibration counts as a result of the natural decay of the radioactive calibration source. The lower limit for this parameter will therefore be updated in the next database release.

2009-06-06 (DOY 157, Rev 811)

IBIS operations executed nominally.

2009-06-07 (DOY 158, Rev 811-812)

At 05:20:27Z TM parameters G6062, G6063 (VETO bottom and lateral counters respectively) went OOL Warning High. As they returned within limits of their own accord at the next TM cycle, no action was taken.

2009-06-08 (DOY 159, Rev 812)

At 09:25:16Z the TM parameter families G5002 and G5003 for the PDM semi-module counters went OOL Low. As they returned within limits of their own accord at 09:25:40Z, no action was taken.

At 14:14:33Z the TM parameters families G5068 and G5072 failed status consistency check (value = TRUE). These are the PDM semi-module FIFO error flags. At 14:15:24Z the TM parameter families G5002 and G5003 for the PDM semi-module counters started going OOL Low. As these were followed at 14:18:50Z by OEM APID 1280 ID 132 EVENT IBIS1 IASW HEPI RESYNCHRONIZED, indicating that HEPI resynchronised autonomously, by which time all the above parameters had returned within limits, no action was taken.

2009-06-09 (DOY 160, Rev 812-813)

Due to an IREM SEU, IBIS transitioned autonomously to Safe configuration at 01:29:21Z. It was recovered as follows:
- At 03:20:56Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE
- At 03:34:39Z ED GESTAN02 uplinked with the planned observation parameters and commanding to IBIS from the Timeline re-enabled.

IBIS operations continued nominally.

2009-06-10 (DOY 161, Rev 813)

At 20:14:33Z the TM parameters families G5068 and G5072 failed status consistency check (value = TRUE). These are the PDM semi-module FIFO error flags. At 20:16:20Z the TM parameter families G5002 and G5003 for the PDM semi-module counters started going OOL Low. As these were followed at 20:19:46Z by OEM APID 1280 ID 132 EVENT IBIS1 IASW HEPI RESYNCHRONIZED, indicating that HEPI resynchronised autonomously, by which time all the above parameters had returned within limits, no action was taken.

2009-06-11 (DOY 162, Rev 813)

At 18:25:24Z TM parameters G6062, G6063 (VETO bottom and lateral counters respectively) went OOL Warning High. As they returned within limits of their own accord at the next TM cycle, no action was taken.

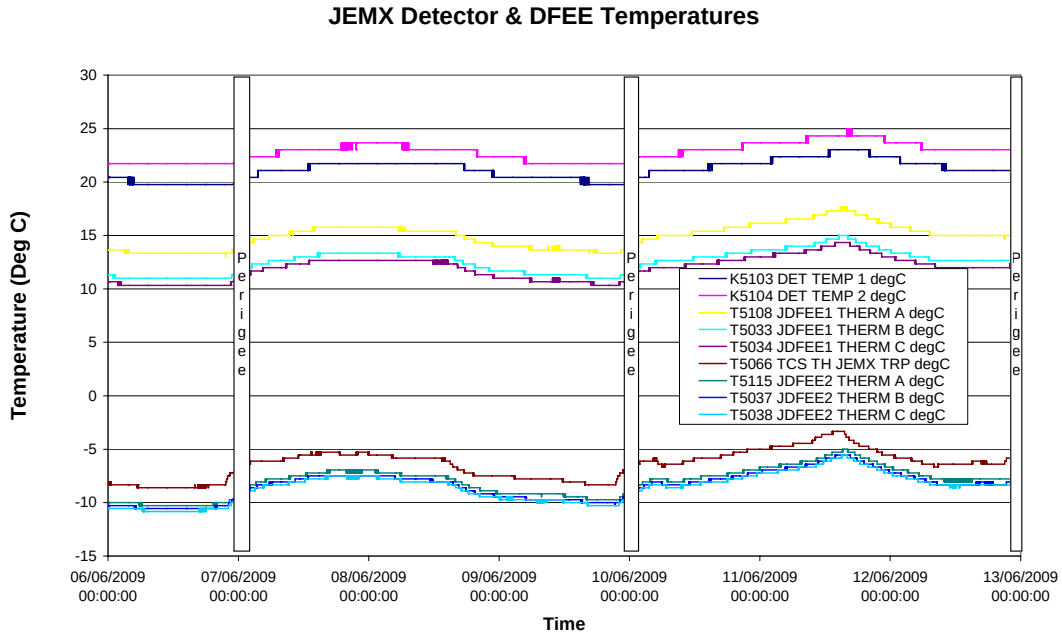
2009-06-12 (DOY 163, Rev 813-814)

IBIS operations executed nominally.

8.2.4 JEM-X Operations

JEM-X Temperatures

JEM-X Detector and DFEE temperatures, along with the temperature on the detector bench between the two units, over the reporting period are displayed in the following graph[2].



[2] Data sampled (1 frame in 8)

JEM-X Daily Report

2009-06-06 (DoY 157 Rev 811) to 2009-06-08 (DoY 159 Rev 812)

JEM-X 1 operations executed nominally.

2009-06-09 (DoY 160 Rev 812)

At 01:29:09 JEMX parameters K5315, K5316 & K5317 went Out-of-Limits due to an IREM SEU (#78). There was no impact as the reaction has been disabled.

2009-06-10 (DoY 161 Rev 813) to 2009-06-11 (DoY 162 Rev 813)

JEM-X 1 operations executed nominally.

2009-06-12 (DoY 163 Rev 813)

At the indicated times, the following OEMs were received:

```
2009.163.17.47.55.281   2009.163.17.48.00.106   1536   RealTime   5        EXCEPTION
JEM-X1 EXC IACS INTERF EXID                              0       0    65535   PR    N
E   E
    FIX6                                          0
    K9079          MESS CLASS                     1
    K9080          MESS ID                        5
    K9065          CSSW OPERAT ID                 START
    K9066          TASK ID 8                      IASW
    K9067          LOGICAL ADDRESS                4989
2009.163.17.47.55.281   2009.163.17.48.00.170   1536   RealTime   6        EXCEPTION
JEM-X1 EXC IACS INTERF CULP                              0       0    65535   PR    N
E   E
    FIX6                                          0
    K9079          MESS CLASS                     1
    K9080          MESS ID                        6
    K9065          CSSW OPERAT ID                 START
    K9066          TASK ID 8                      IASW
    K9067          LOGICAL ADDRESS                19726
```

No action was taken, and there was no impact.

8.2.5 OMC Operations

2009-06-06 (DoY 157, Rev 811) to 2009-06-08 (DoY 159, Rev 812)

Nothing to report.

2009-06-09 (DoY 160, Rev 812)

At 01:29:10, an IREM SEU (#78) forced OMC to SAFE mode, a recovery was performed, and the unit returned to standby at 03:12:58. The impact was the interruption after 424 from a planned 3479 seconds of pointing 08120045, and the loss of pointing 08120046

It was at this time the following OEMs were received:

```
2009.160.02.20.21.501   2009.160.02.20.36.040   1792   RealTime   131      TC REJECT
REJECTED TC1                                             0       0    65535   PR    N
E   E
2009.160.02.20.27.063   2009.160.02.20.36.073   1792   RealTime   131      TC REJECT
REJECTED TC1                                             0       0    65535   PR    N
E   E
```

These correspond to the M1130 (RESET IM) and MU1310 (IMAGING-A) commands for pointing 08120046.

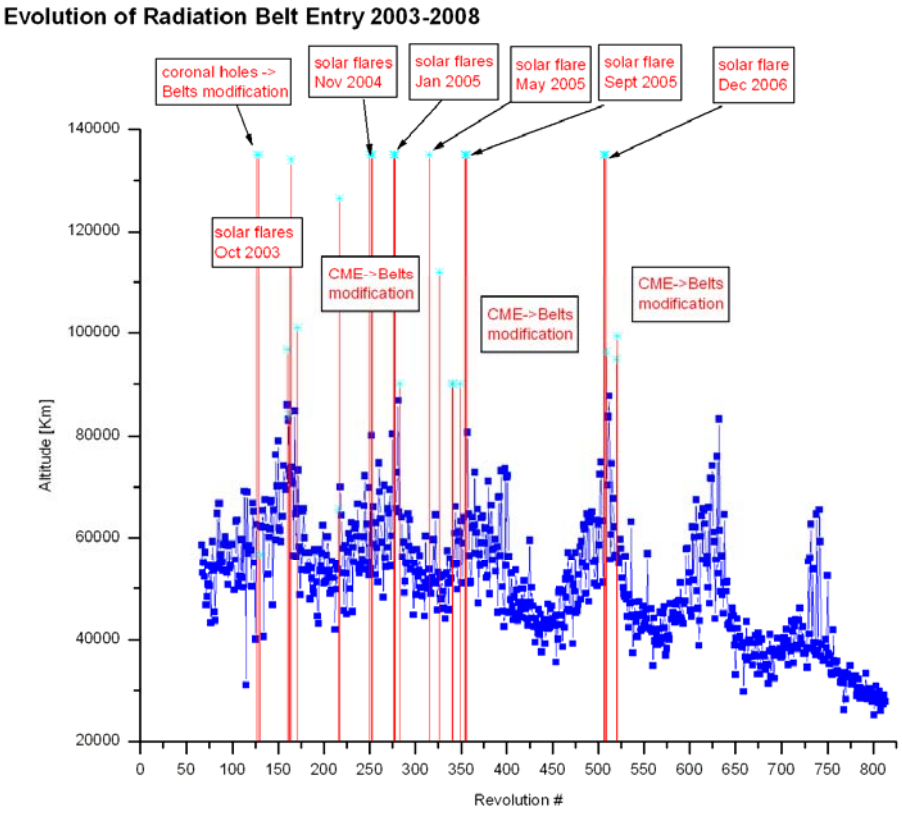
2009-06-10 (DoY 161, Rev 813) to 2009-06-12 (DoY 163, Rev 813)

Nothing to report.

On DoY 157 at 20:36:22, DoY 160 at 20:26:38 and DoY 163 at 20:15:34 OMC went to SAFE mode nominally, at the radiation belt entry time as set in the Broadcast Packet.

8.2.6 IREM Operations

Radiation Belts Entry



IREM daily report

DoY 2009.160 (09/06/2009):

At 01:29:09Z, a local reset of the IREM CSCI S/W (SEU #78) occurred. The status of the unit, before the local reset of the IREM CSCI S/W, was nominal, here is a summary:

1) The temperatures were nominal;
2) The LCL current was nominal;
3) The last HK before the anomaly showed HV, 5V and 6V voltages inside limits;
4) The anomaly occurred at 2009.160.01.29:09Z (139548.5 km). The unit had performed an automatic transition to Standard Mode (ie. no block counter increasing,

all the TM words= FFFF hex); just before the anomaly, radiation counters reported nominal values considering the position of the S/C along the orbit;
5) The recovery of the unit started immediately using procedure CRP_SYS_2570. The first dump of the status word after the anomaly reported a value of BCC0 HEX = 48320 DEC = 1011110011000000, i.e the Checksum Failure Flag ON. The unit was still reporting the status as if it was in Integral mode with counting ON and accumulation ON. This value of the status word is assumed to be an old one written by the S/W at the moment of the anomaly.
6) The patch was performed successfully with the correct re-starting of the S/W following procedure FCP_RM_0081. The operation was completed at 05:10:00Z.

The IREM automatic transition to Standard Mode affected the instruments by forcing them to automatically enter Safe configuration, except for SPI and JEM-X whose automatisms are disabled according to the PIs request. OMC was recovered at 03:12:58Z and IBIS at 03:36:30Z.

Electron Belts

REV	S/C BCPKT (electron)	Electron CUT-OFF Observed Entry/Exit	Observed Entry/Exit Altitude [Km]	Electron CUT-OFF Predicted Entry/Exit	Predicted Entry/Exit Altitude [Km]
811	RAD_ENTR R 2009-06-06T20:36:17Z	06/06/2009 22:07:49	27236.1	06-Jun-2009 21:41:06	31536.07
812	RAD_EXIT R 2009-06-07T05:07:38Z	07/06/2009 03:23:57	>>36316.0	07-Jun-2009 04:01:06	47355.64
812	RAD_ENTR R 2009-06-09T20:26:32Z	09/06/2009 21:51:33	29106.7	09-Jun-2009 21:32:05	31309.79
813	RAD_EXIT R 2009-06-10T04:57:46Z	10/06/2009 03:10:05	>>36322.4	10-Jun-2009 03:52:05	47543.37
813	RAD_ENTR R 2009-06-12T20:15:32Z	12/06/2009 21:41:01	27858.6	12-Jun-2009 21:22:05	30850.0

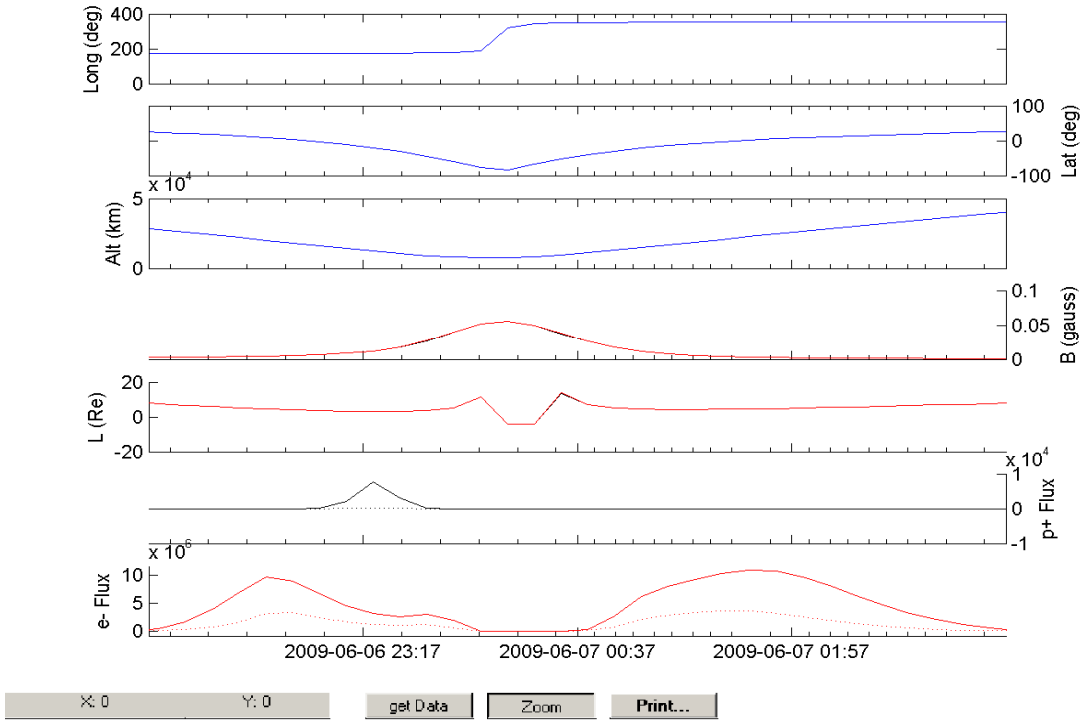
Reference
High radiation
Very small error vs reference (less than 10 minutes)
Small error vs reference (between 10 and 30 minutes)
Large error vs reference (more than 30 minutes)
* Rad belt entry time ignoring previous threshold crossings where a gap of more than 30 minutes is present.

IREM radiation counters:

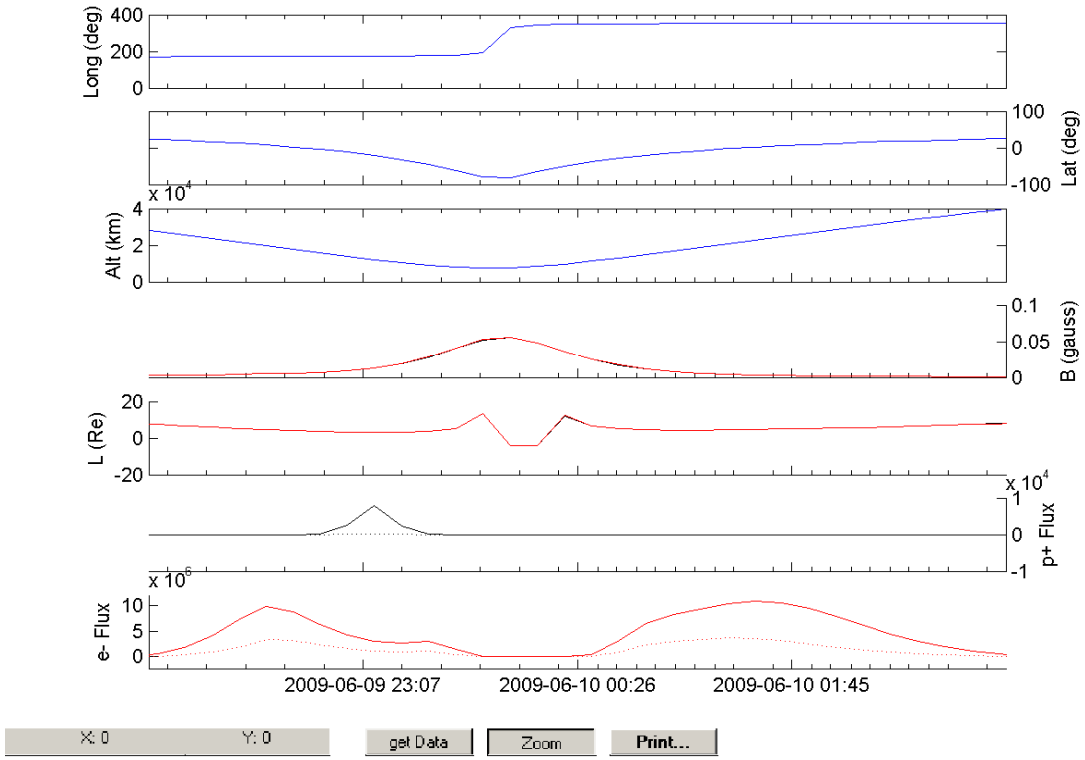
The IREM radiation counter plots are not available this week.

IREM Predicted Radiation Belt Passages

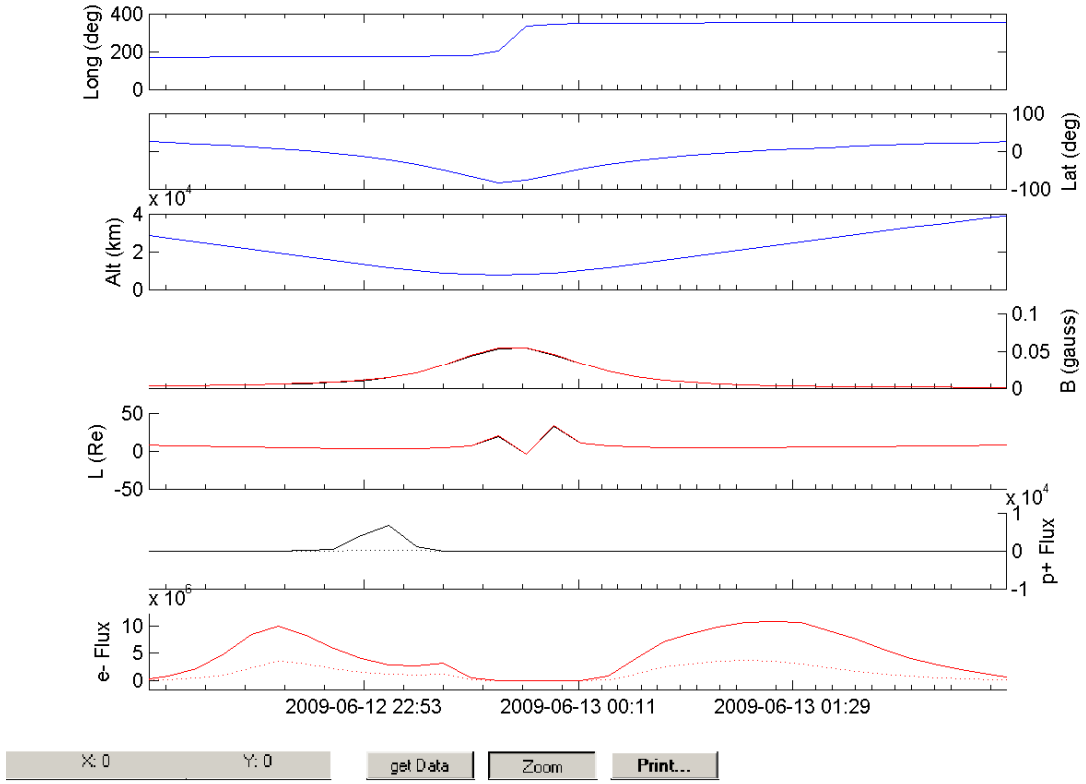
Rev 811



Rev 812



Rev 813


Long (deg)
400
200
0
100
0
-100
Lat (deg)
x 10^4
Alt (km)
4
2
0
0.1
0.05
0
B (gauss)
L (Re)
50
0
-50
x 10^4
1
0
-1
p+ Flux
x 10^6
e- Flux
10
5
0
2009-06-12 22:53
2009-06-13 00:11
2009-06-13 01:29
X: 0
Y: 0
get Data
Zoom
Print...