EUROPEAN SPACE AGENCY

DIRECTORATE OF TECHNICAL & OPERATIONAL SUPPORT

MISSION OPERATIONS DEPARTMENT

INTEGRAL

Mission report

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

No. 413

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Routine Phase

Prepared by: M. Walker (OPS-OAI) and INTEGRAL FCT

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	A. Mantineo	C. Brysbaert (SPI)	M. M. Hesse (OMC)
INTEGRAL/XMM Flight Dynamics team			
INTEGRAL/XMM Flight Control team			

1 General

The Flight Control Team at MOC has compiled this report with some input provided by the Flight Dynamics Team, ISOC and ISDC. Nominal science operations were perfomed according to the planning inputs from ISOC combined with some manual commanding by MOC.

This report addresses the activities from September and covers the revolutions 1207 untill 1217 (included). The targets of these revolutions can be found on the ISOC web: http://integral.esac.esa.int/isocweb/schedule.html?action=intro .

Summary of the main activities during the reporting period

- Nominal science operations. During this reporting period, 878 of the 884 planned science pointings and a Flat Field calibration were executed nominally. 1 pointing was lost to a FD problem, 3 lost to lost guide stars, 1 lost to a ground station issue, and 1 lost during the post Earth observation activities.
- Earth Observations 2.4
- Battery 1 Reconditioning

Summary of the overall status and performance of S/C

- Nominal for platform and payload
- IBIS VETO VDM02 HV Breakdown

Summary of the overall status and performance of the ground segment

- Ongoing occasional RFI at Redu, some sources identified, filter installed for testing
- Ongoing occasional interruptions to ISDS-ISDC link
- Loss of FEC Remote Control at REDU interrupts operations
- No automatic switch over from INPUT to PROCESS for VC7 on B chain

The previous weekly and monthly reports are available at the XMM-INTEGRAL website: http://xmm.esoc.esa.int/documentation/documentation.php .

2 Satellite status

2.1 Platform

2.1.1 AOCS

The AOCS operations were performed from the timeline during this period.

2 slews were missed from the Timeline due to ground segment issues. For slews interrupted due to other issues (guide star problems, etc) please see the INTEGRAL weekly reports: http://10.33.199.49/documentation/wops.php

The fuel consumption over the reporting period was 0.5488 Kg. The remaining propellant is in the order of 109.9486 Kg.

Note: Some more information concerning the AOCS operations and the fuel budget is provided in the Appendix 6.1.

2.1.2 Power

All units of the EPS are working nominally.

From 11/09/2012 to 24/09/2012 Battery 1 was successfully reconditioned.

2.1.3 Thermal

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

2.1.4 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.

2.1.5 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.

2.2 Payload

2.2.1 SPI

Following the 18th SPI annealing, which ended on 09/12/2011, 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), detector #5 (failed since 19/02/2009) and detector #1 (failed since 27/05/2010).

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 89 packets/cycle, except from 2012-09-17T05:56:38Z to 2012-09-17T11:20:20Z (OMC Flat Field Calibration), when it was 88 packets/cycle and from 2012-09-27T16:54:13Z to 2012-09-28T07:48:04Z during the Earth observation when it was 85. The average telemetry occupation when the allocation was 89 packets/cycle was 72.4 packets/cycle.

The following plot shows the TM bandwidth allocation and occupation during the reporting period.

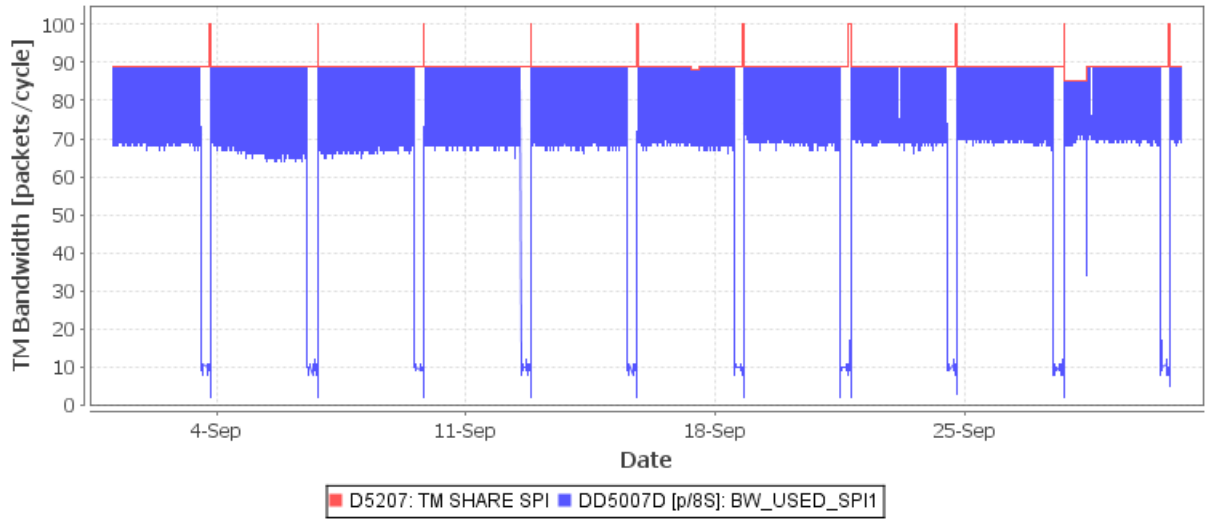


Figure 1: SPI TM bandwidth utilisation

The following plot illustrates the DPE CPU load during the reporting period.

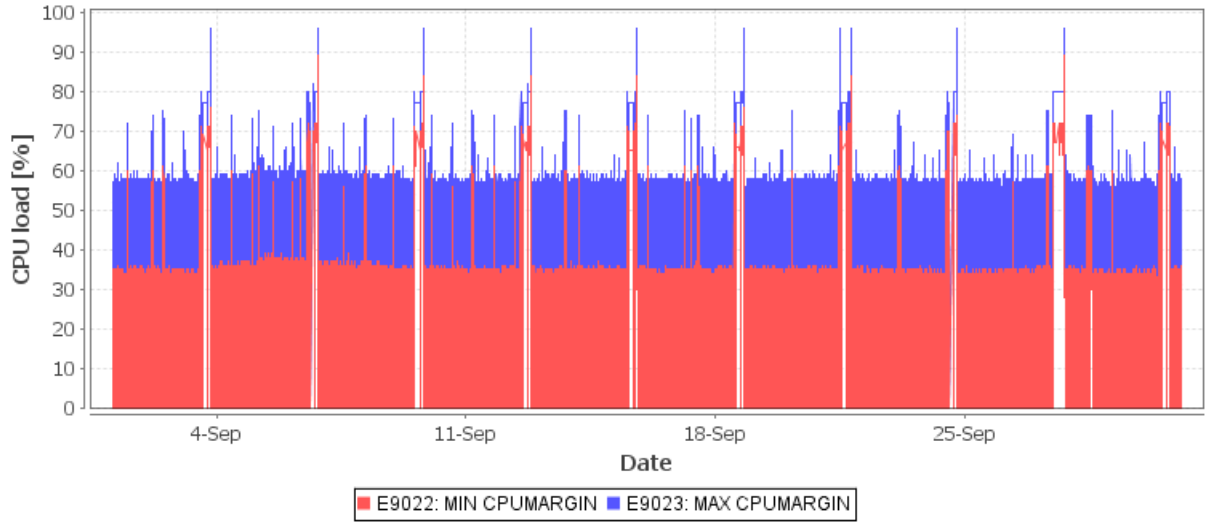


Figure 2: SPI IASW Performance

The following plot shows the evolution of the assigned and the average occupation of the SPI TM bandwidth since May 2010.

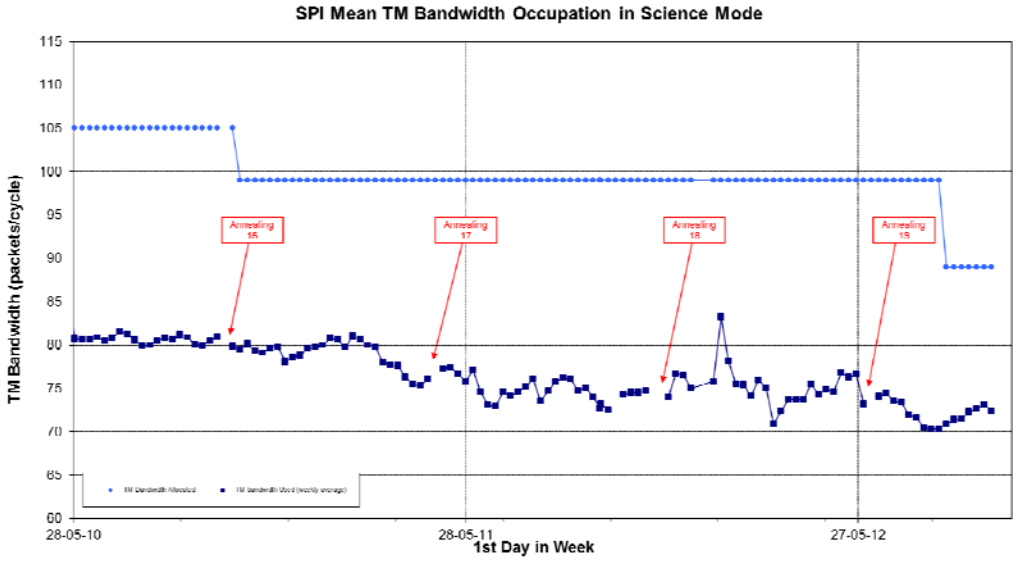


Figure 3: SPI TM bandwidth usage evolution since May 2010

Note: More information concerning the SPI operations is provided in Appendix 6.2.

2.2.2 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: 129 packets/cycle, except from 2012-09-17T05:56:38Z to 2012-09-17T11:20:20Z (OMC Flat Field Calibration), when it was 90 packets/cycle
- IBIS mean bandwidth utilisation in science mode: 107.7 packets/cycle

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

Figure 4: IBIS TM bandwidth utilisation

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

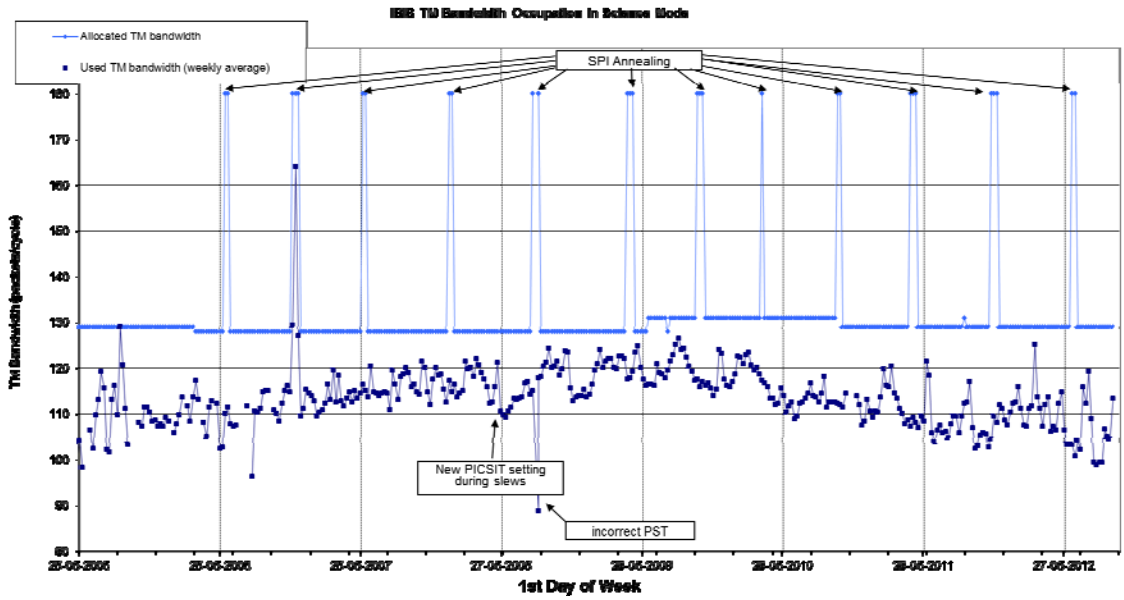


Figure 5: IBIS TM bandwidth usage evolution since May 2005

Note: More information concerning the IBIS operations is provided in Appendix 0.

2.2.3 JEM-X

The status of both JEM-X units is nominal:

- JEM-X1 & 2 were operated in Data Taking mode with a TM allocation of 13 packets/cycle, except from 2012-09-17T05:56:38Z to 2012-09-17T11:20:20Z, during the OMC Flat-Field calibration, when it was 4 packets/cycle each.

Note: Some more information concerning the JEM-X operations is provided in Appendix 6.4.

2.2.4 OMC

The status of OMC is nominal.

OMC was operated in Science Normal mode during science observations, with a TM allocation of 5 packets/cycle, except from 2012-09-17T05:56:38Z to 2012-09-17T11:20:20Z, during the Flat-Field calibration, when it was 63 packets/cycle, and from 2012-09-27T16:54:13Z to 2012-09-28T07:48:04Z during the Earth observation, when it was 9 packets/cycle.

During this reporting period, 878 of the 884 planned science pointings and a Flat Field calibration were executed nominally. 1 pointing was lost to a FD problem, 3 lost to lost guide stars, 1 lost to a ground station issue, and 1 lost during the post Earth observation activities.

Note: Some more information concerning the OMC operations is provided in Appendix 6.5.

2.2.5 IREM

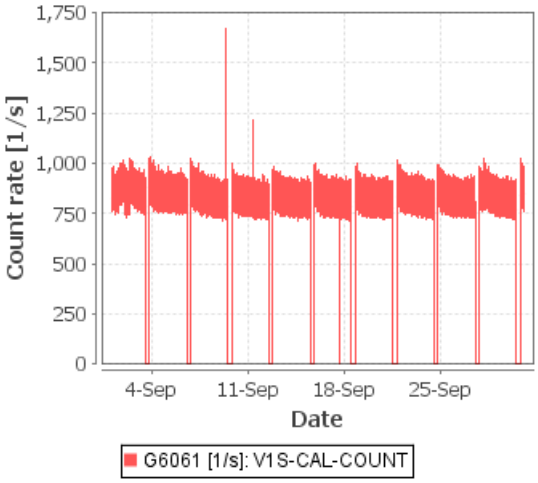
The status of IREM is nominal.

Note: Some more information concerning the IREM operations is provided in Appendix 6.6.

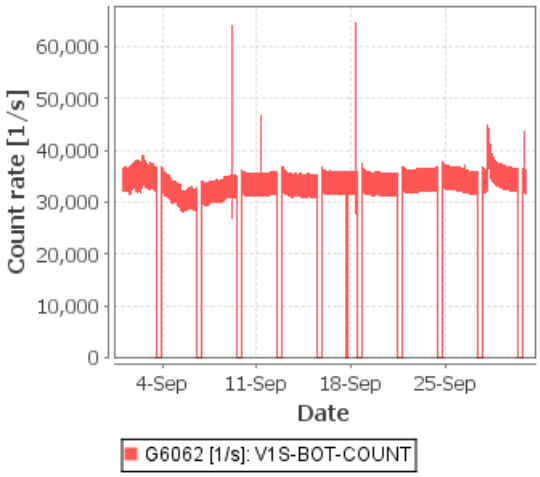
Radiation background

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 reporting period:

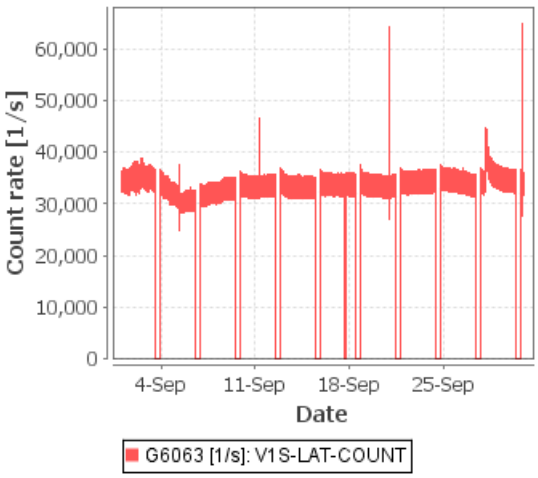
VETO Calibration Source Count Rate VETO Bottom Count Rate



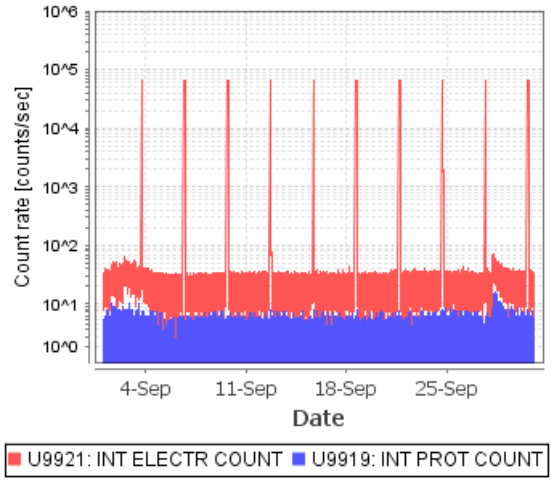
VETO Lateral Count Rate



IREM Proton & Electron Counters[1]



ACS Below 100MeV



ACS Above 100MeV

[1] Note that the scale used in this plot is logarithmic.

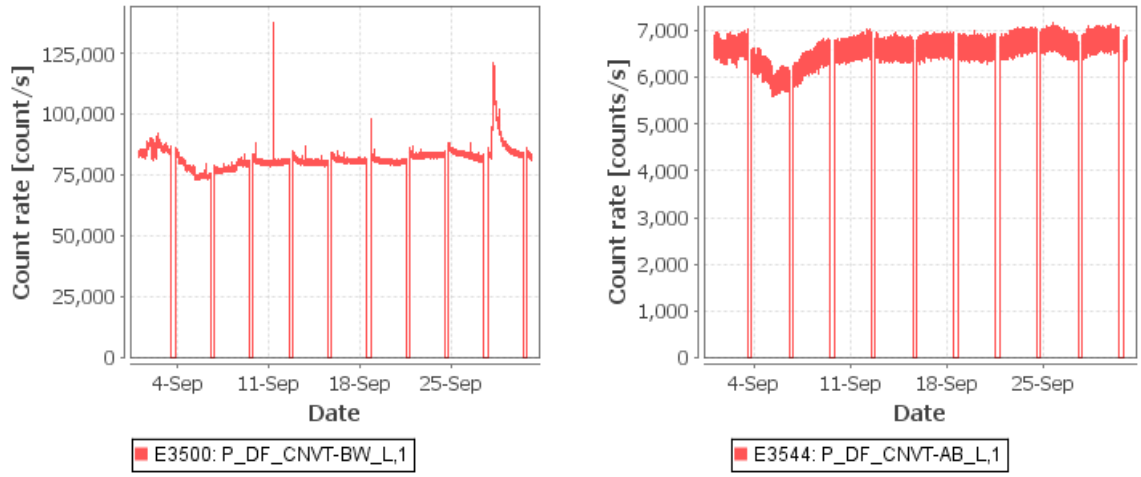


Figure 6: Instrument Count Rates

The JEM-X count rates are plotted for both JEM-X units, the data is sampled every 8th packet (64sec).

K5119/L5119 - JEM-X1/2 Software trigger, K5449/L5449 - JEM-X1/2 Hardware trigger

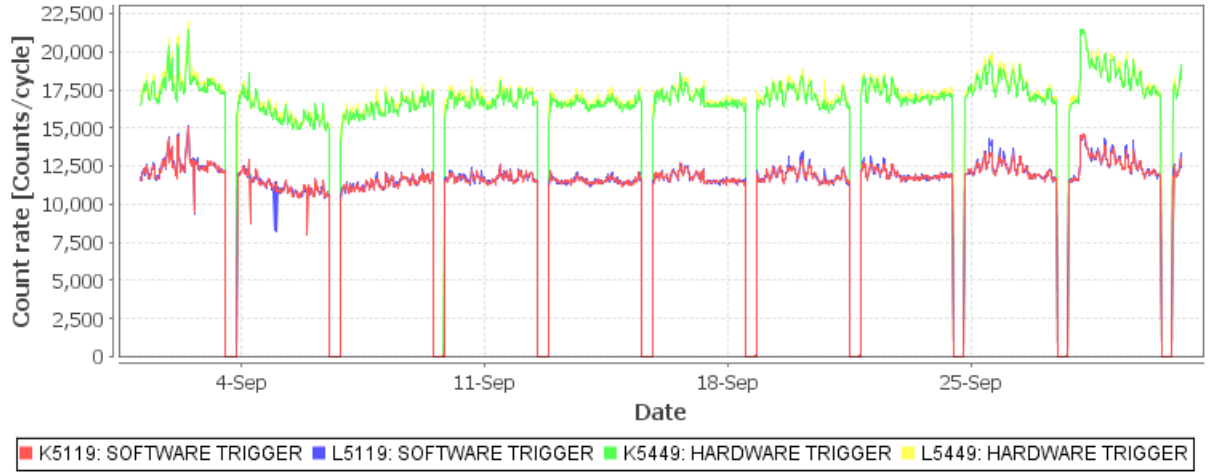


Figure 7: JEM-X Count rates. The smaller downward spikes in the figure are due to the slews of the spacecraft

Radiation Belts

Figure 8 gives a prediction of the trapped radiation environment sensed by the S/C when descending into perigee; the different areas crossed, the Radiation Belt entry/exit points, the shape of the Radiation Belt passage and a rough estimation of the trapped proton and electron fluxes.

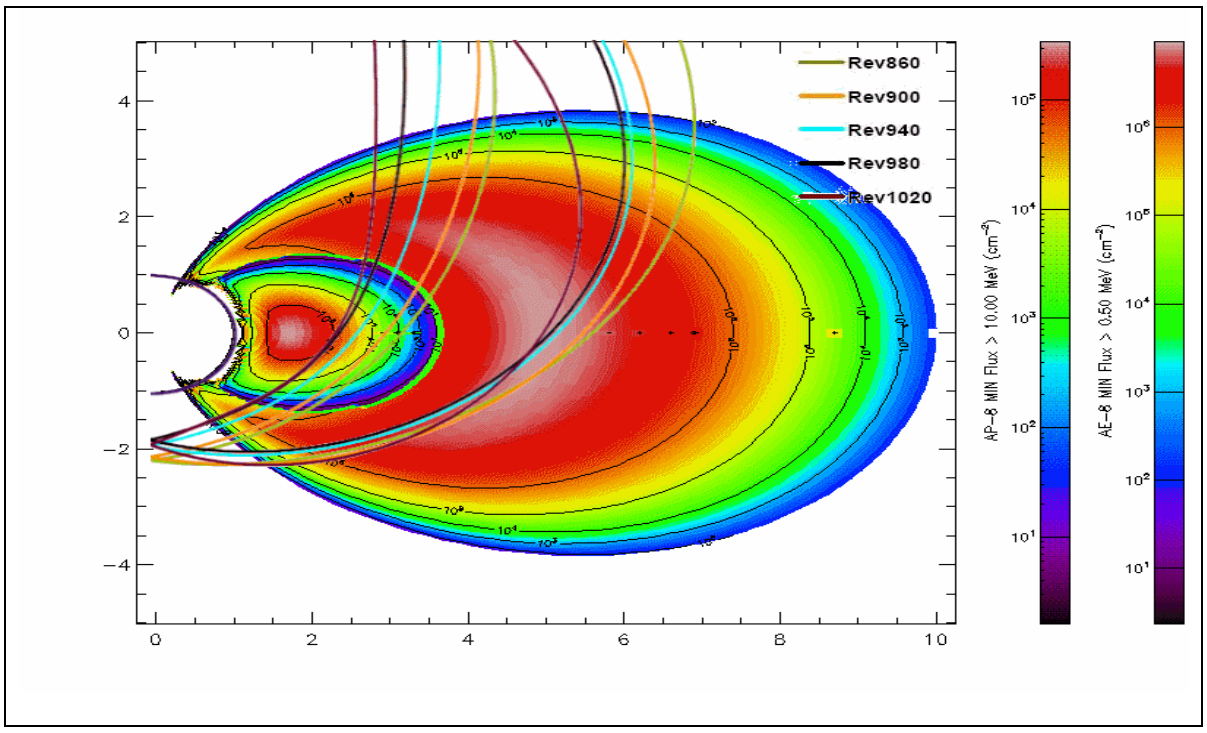


Figure 8: The predicted evolution of the orbit of Integral through the radiation belts

3 Ground Facilities

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

The following figure shows the number of slews executed and the number of slews missed per revolution. These numbers give a very good indication of the performance of the operational ground facilities, because it involves all the different elements of the ground facilities to complete all slews scheduled.

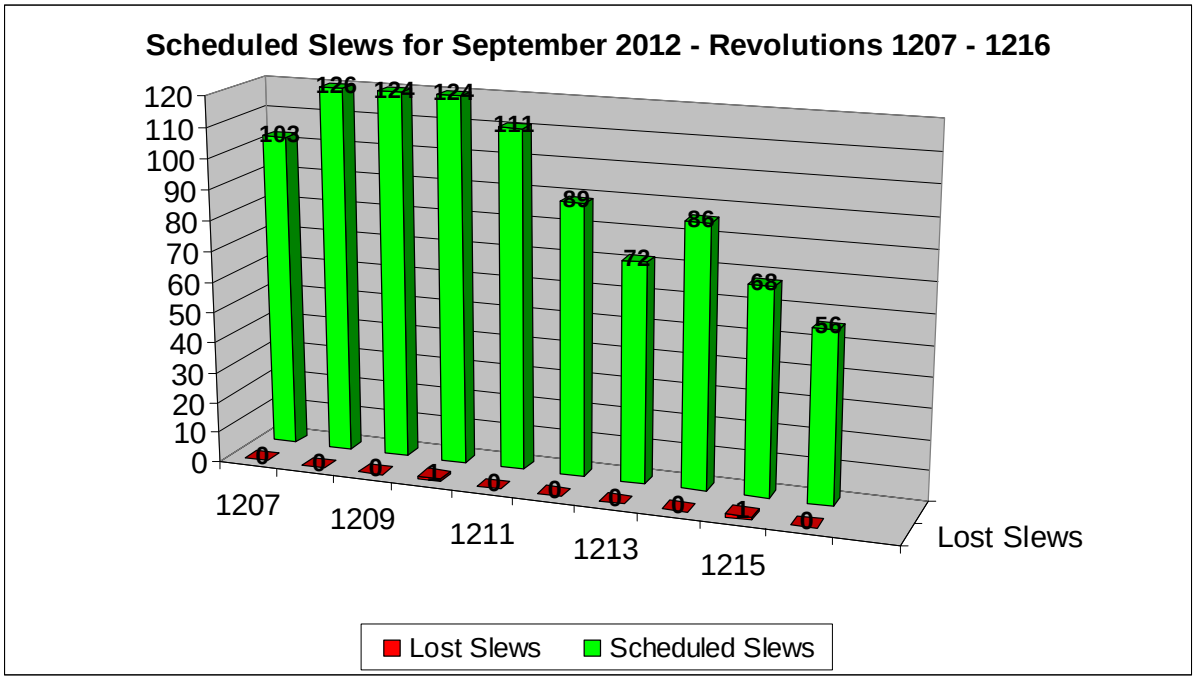


Figure 9: The number of slews scheduled compared to the number of slews lost

3.1 Mission Control System

On 18th September, a new Database Release was installed, but found to be faulty. This was then rolled back to the previous version 0072.

3.2 Ground Stations and Network

The performance of the ground stations and Network was good this month.

REDU

There were several occasions of RFI from an unknown source reported. On DOY289 bad frames were received and there was a data gap on VC-7. There was a problem with the FEC1 on DOY288 starting at 19:32:00, which was solved at 21:17:00 when commanding at REDU was resumed.

DSS24

On DOY287 there was a drop in TM on VC-0 and VC-7, possibly caused by RFI. See DR G110664.

DSS27

The supports with scheduled begin-of-track on DOY 281 at 06:35 and on DOY 281 at 23:15 were cancelled because the station was declared red. Instead support was provided from Redu-1. On DOY289 There was a problem with the transmitter (see G11066), hence a part of the scheduled pass was moved to REDU.

Figure 10 shows the quality of the ground station performance. The data received from the ground

stations is compared to the data that is expected to be received.

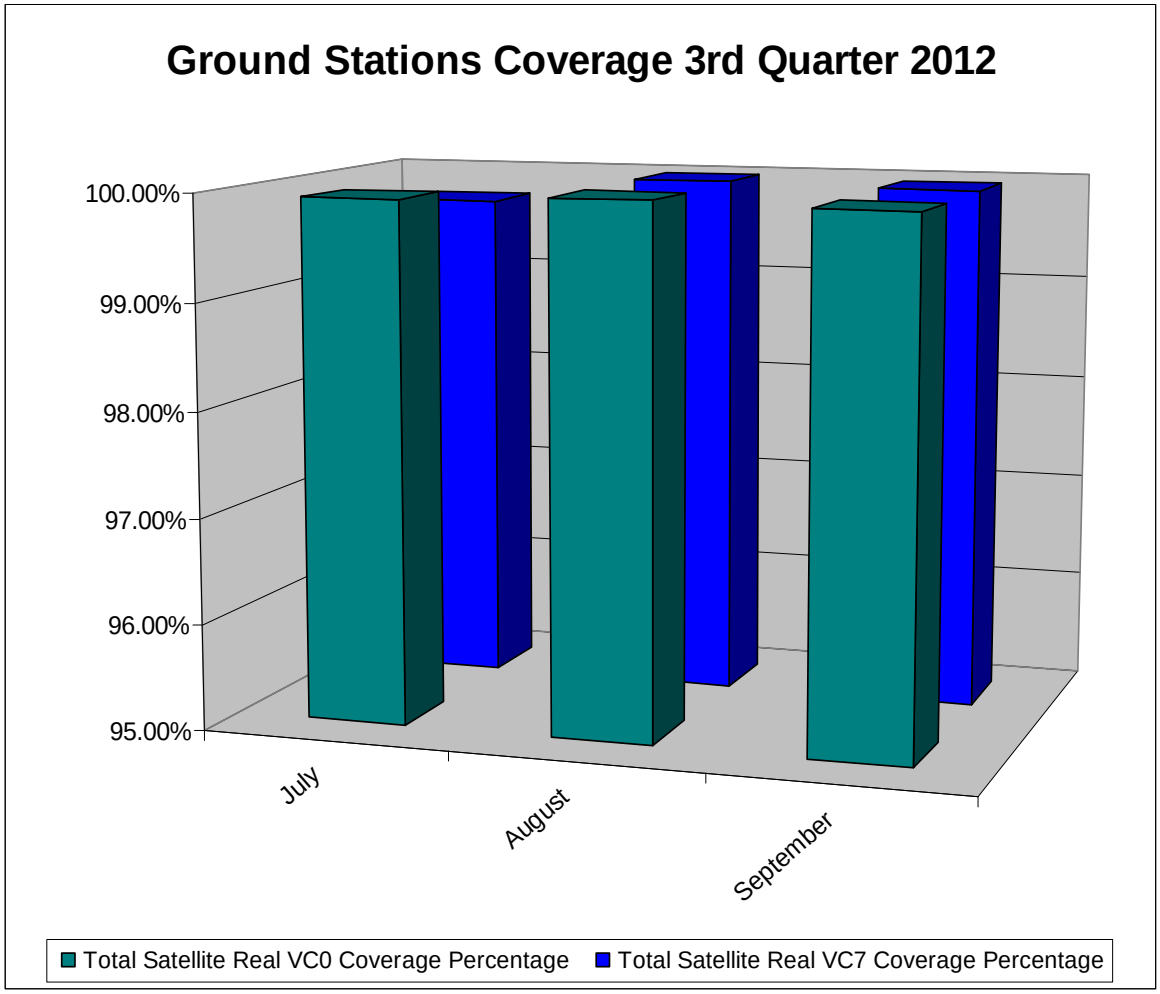


Figure 10: Comparison of VC0 to VC7 coverage

3.3 ISOC

3.3.1 Mission Planning

New or updated PSFs have been received for revolutions 1218 to 1223, corresponding to the time range 3-21 October.

New observations have been planned for revolutions 1213 (18-21 September) to 1218 (3-6 October), including further ToO observations of the new Black Hole candidate Sw J174510.8-262411 as well as Earth Observation 2.4.

TSFs have been received for revolutions 1211 to 1217.

3.3.2 Observation Status

New ECS files have been for revolutions 1190 to 1198, covering observations up to 7 August.

3.3.3 ISOC Science Data Archive

Some gaps in the telemetry data transferred from MOC are still to be filled in.

An ICD between the ESAC SAT team and ISDC is being set up.

3.3.4 ISOC System

No release in September.

3.3.5 Problems

During Earth Observations the position angle was found to be different than expected. The issue is under investigation.

4 Anomalies

Table 1 contains the anomalies that occurred in the reporting period:

Table 1: Anomalies reported

AR id	Date of occurrence	Subject	Segment	Status
INT-3301	2012-09-12	Lessons Learned from Earth occultation observations EO 2.1, 2.2 and 2.3		Pending
INT-3302	2012-09-24	Loss of FEC Remote Control at REDU interrupts operations	ESA Stations	Pending
INT-3303	2012-09-18	Sudden re-appearance of commands removed from DEBWHI00 in 2010	ODB	Pending
INT-3304	2012-09-28	No automatic switch over from INPUT to PROCESS for VC7 on B chain	NCTRS	Pending
INT_SC-408	2012-09-17	IBIS VETO VDM02 HV Breakdown	Payload	Pending

5 Special Events & Future Milestones

Virtualised Solaris environments
MCS development
Earth observation 2.5
Raising of radiation belt exit to 53000km on rev. 1226 and 56000km on rev. 1233
Rev. 1222: all slews as OSLs
Rev. 1224: STR-FSS misalignment and SAS calibration
Second STR blemish pixel survey: rev. 1227

6 Appendix

The appendix contains some detailed information concerning the AOCS subsystem and the instruments.

6.1 AOCS operations

During this period, 544 Open Loop Slews, 410 Closed Loop Slews and 23 Momentum Biases were executed (as reported by ACC OEM).

2 slews were missed from the Timeline due to ground segment issues. For slews interrupted due to other issues (guide star problems, etc) please see the INTEGRAL weekly reports: http://10.33.199.49/documentation/wops.php

6.1.1 Fuel consumption

The fuel consumption (total, grams per day) over the period between 01/11/2002 and 01/10/2012 is reported in the following plot:

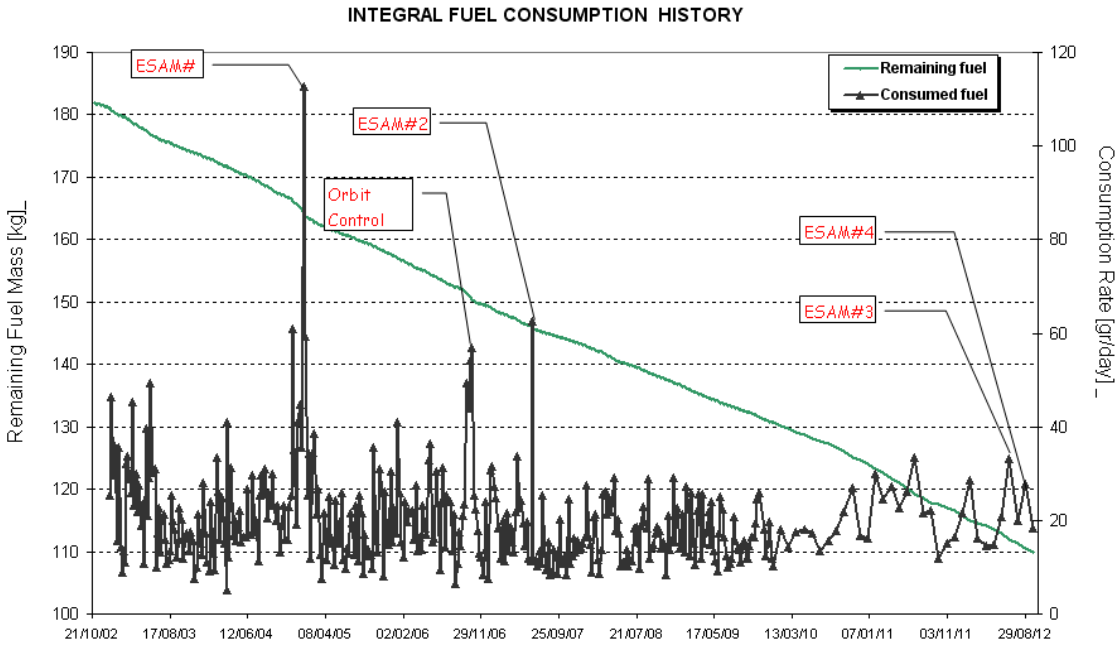


Figure 11: Fuel consumption. Note: ESAM fuel consumption is spread over period of ~1 week.

6.1.2 The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel over the last month are reported in the plot below. The evolution of the drift on yaw channel is under constant monitoring but the values are still well within the specs.

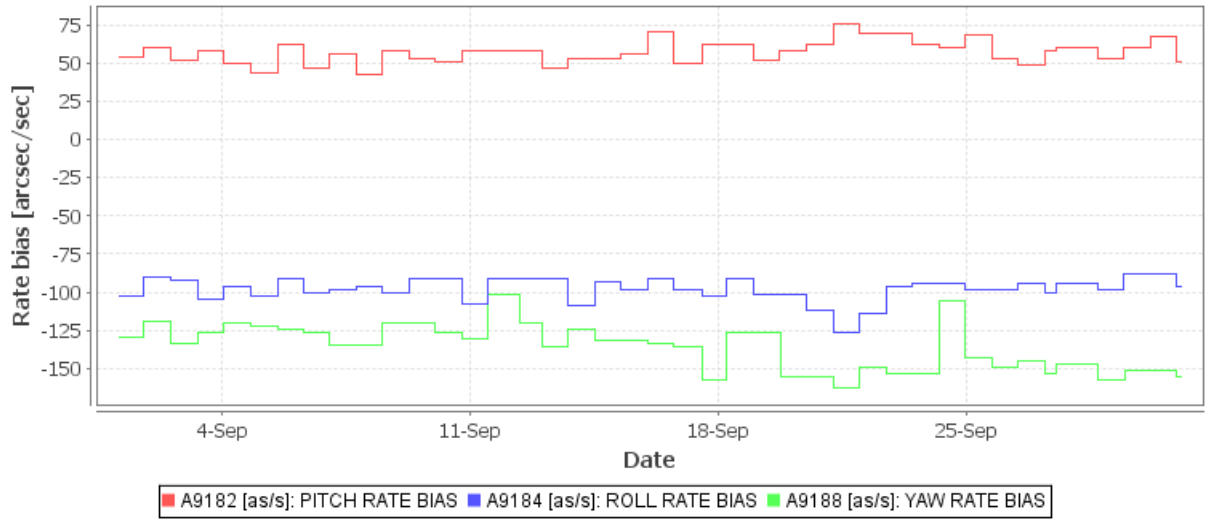


Figure 12: RMU pitch, roll and yaw. Historic data is available on request

6.1.3 Event log

Please refer to the INTEGRAL weekly reports for all AOCS issues not considered as anomaly (e.g., TPF update failures that forced an interruption to the timeline and have led to a loss of a slew , TC Start Sun Steer Law failed at CEV level completion, events where the IMU came on due to the loss of a guide star,..).

6.2 SPI

6.2.1 Operations

Stirling Compressors and Cryostat

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

The following plot shows the evolution of the cold plate and H bus temperature during the reporting period.

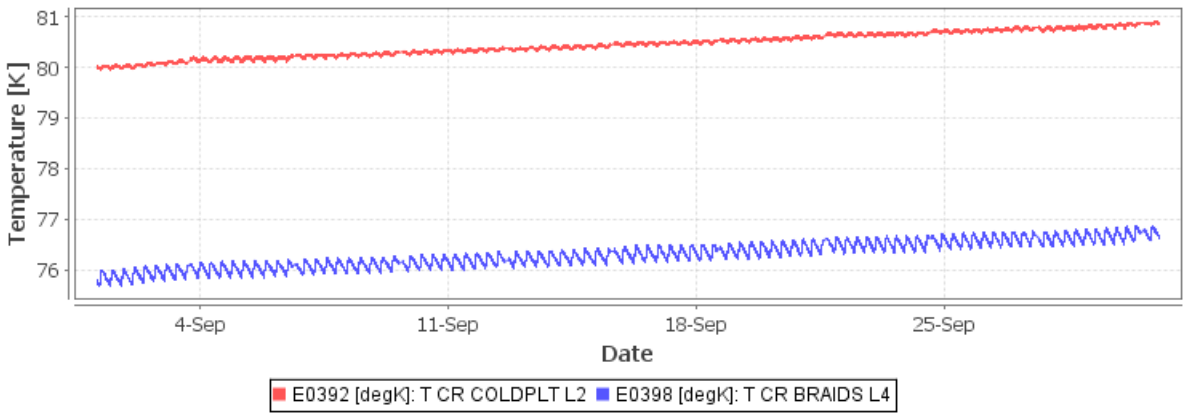


Figure 13: SPI Cold plate and H-bus temperature

The following plot shows the evolution of the CDE LCL currents during the reporting period.

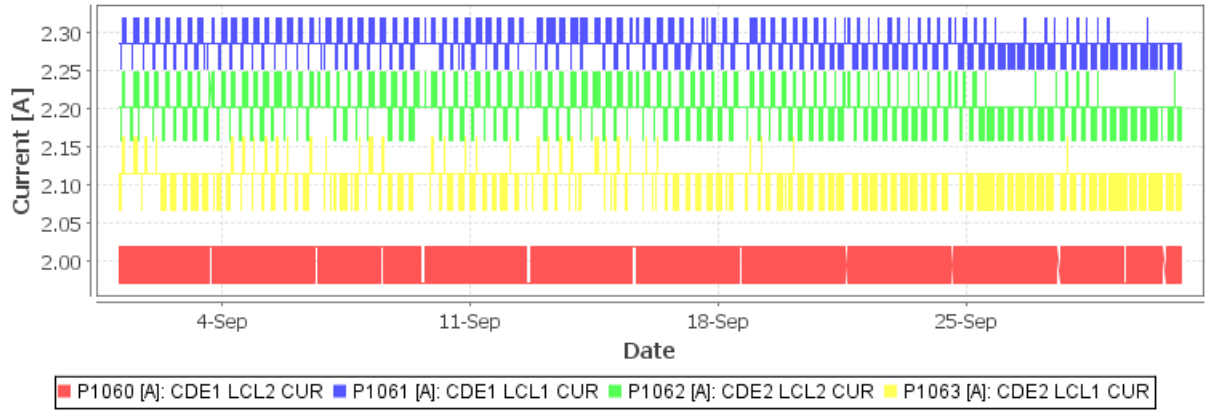


Figure 14: SPI CDE LCL current

DPE & IASW

The DPE health and IASW performance are nominal. The IASW version installed is v4.3.5 with both SE compression and PE reduction enabled and the spectra scaling factor set to 7/19 SE. The DPE CPU usage was nominal during the reporting period (see Figure 2).

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 Figure 6: Instrument Count Rates.

AFEE

The health of the AFEE is nominal. Detector #2 is failed since 06/12/2003, detector #17 is failed since 17/07/2004, detector #5 is failed since 19/02/2009 and detector #1 is failed since 27/05/2010. The HV of the failed detectors are nominally set to 0.5kV and events from these GeDs are disabled in the DFEE and PSD. The following plot shows the AFEE DC output voltages over the reporting period.

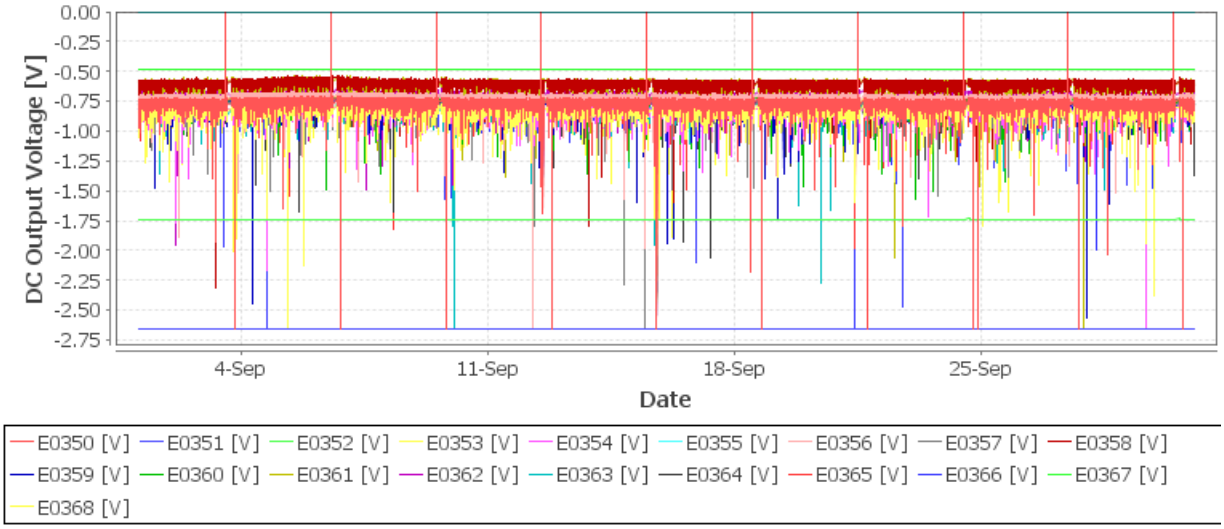


Figure 15: AFEE DC Output Voltages. Note that the data is sampled every 8th packet (64sec)

DFEE

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

Figure 16: SPI GeD Non-Vetoed count rates. Note that the scale used for plotting is logarithmic.

Figure 17: SPI GeD Time Tagged count rates. Note that the scale used for plotting is logarithmic.

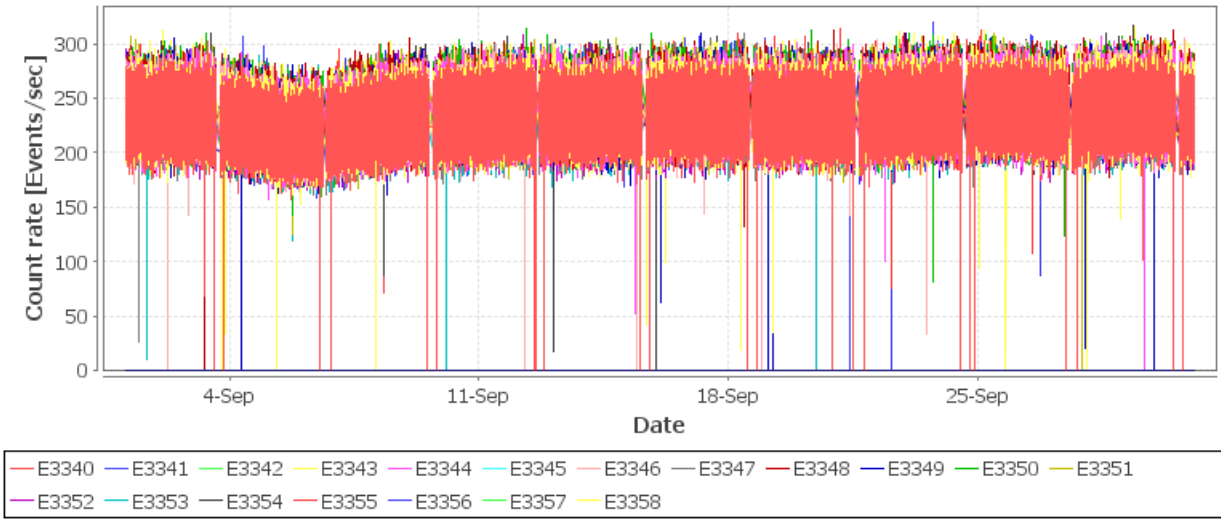


Figure 18: SPI GeD Time Tagged Saturated count rates

PSD

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

Figure 19: SPI PSD GeD Channel rates

6.2.2 Event Log

No SPI anomalies occurred in the reporting period.

6.3 IBIS

6.3.1 Operations

ISGRI

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

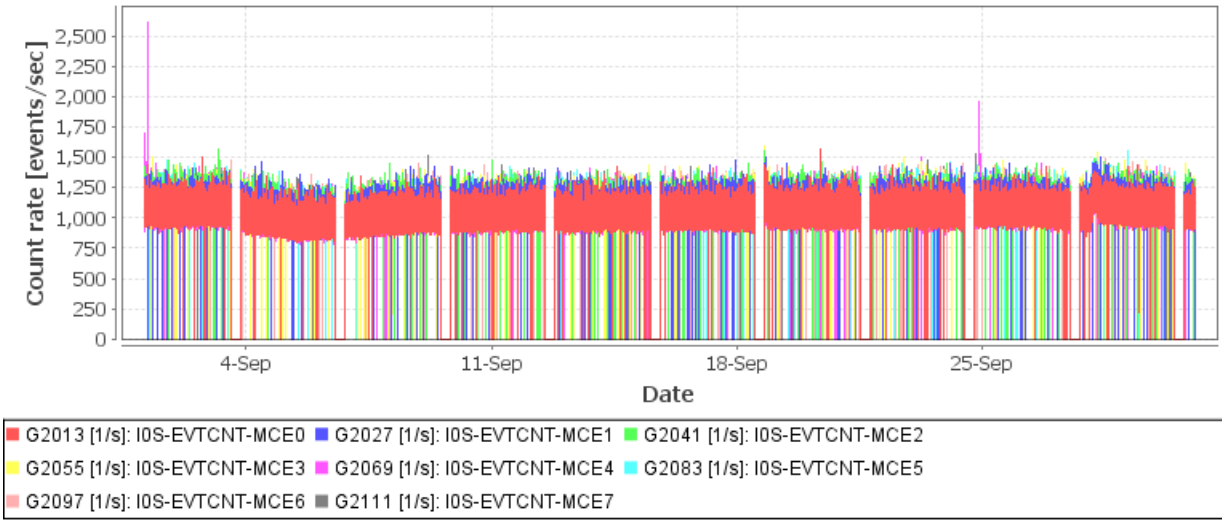


Figure 20: ISGRI MCE Counters

PICsIT

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

Figure 21: PICsIT semi-module counters. Note that the scale used for plotting is logarithmic.

VETO

The health and performance of VETO was nominal during the reporting period. Plots of the VETO counters are given in Figure 6: Instrument Count Rates.

6.3.2 Event Log

17-09-2012 (Day of Year 261, Revolution 1212)

IBIS VETO VDM02 high voltage breakdown: see ARTS report INT_SC-408

6.4 JEM-X

6.4.1 Operations

The Status of JEMX-1 & 2 is nominal. The following plot shows the JEMX DFEE and detector temperatures over the reporting period.

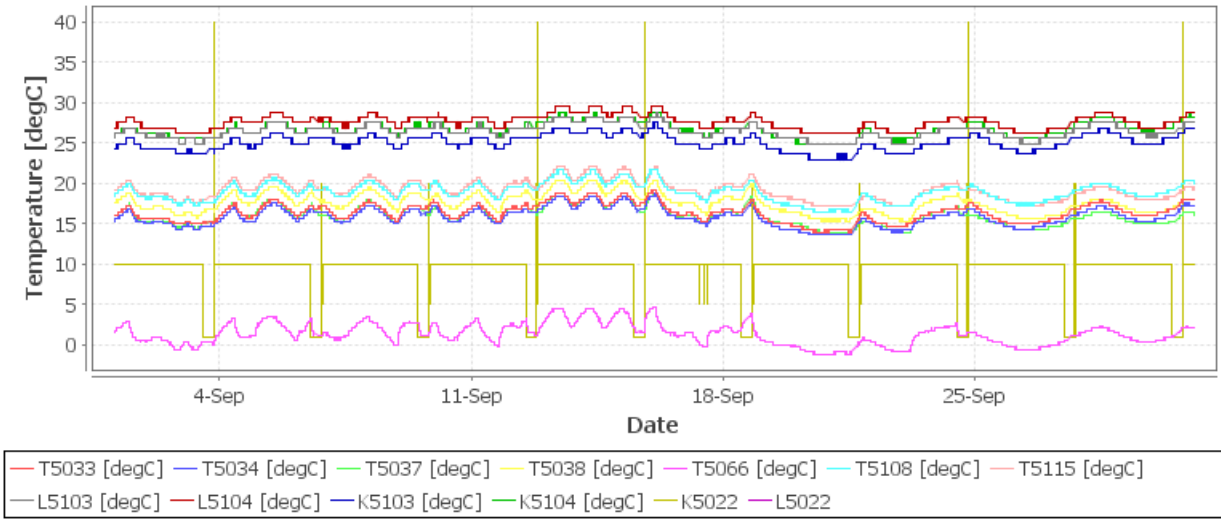


Figure 22: JEMX Detector and DFEE Temperatures

6.4.2 Event Log

Nothing to report.

6.5 OMC

6.5.1 Operations

The status and performance of OMC is nominal.

6.5.2 Event Log

12-09-2012 (Day of Year 256, Revolution 1210)

At 09:32, a FD problem forced an interruption to the timeline. A recovery was performed, and the timeline rejoined at 10:21. The impact was the loss of pointing 12010122. It was at this time the following OEMs were received:

```
2012.256.10.08.36.745   2012.256.10.08.43.421   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2012.256.10.08.42.745   2012.256.10.08.48.705   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E
```

These correspond to the rejected M1130 (RESET IM) and MU1310 (IMAGING-A) commands sent from the auto-stack for that pointing.

13-09-2012 (Day of Year 257, Revolution 1211)

At 15:45, a lost guide star forced an interruption to the timeline. A recovery was performed, and the timeline rejoined at 16:54. The impact was the loss of pointings 12110040 & 12110041. It was at this time the following OEMs were received:

```
2012.257.16.50.15.574   2012.257.16.50.28.061   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E
```

```
2012.257.16.50.21.074   2012.257.16.50.28.176   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0     65535   PR    N      E    E
```

These correspond to the rejected M1130 (RESET IM) and MU1310 (IMAGING-A) commands sent from the auto-stack for pointing 12110041.

24-09-2012 (Day of Year 268, Revolution 1215)

At 20:52, a ground station drop forced in interruption to the timeline. A recovery was performed, and the timeline rejoined at 21:41. The impact was the loss of pointing 12150008.

28-09-2012 (Day of Year 272, Revolution 1216)

At 07:58:56, the instrument was put to science mode, but owing to the on-going Earth observation activities, the attitude was not quite correct. The impact was pointing 12160005 was executed at the wrong time, and with an incorrect attitude.

At 10:27, a lost guide star forced an interruption to the timeline, a recovery was performed, and the timeline rejoined at 10:51, the impact was the loss of pointing 12160006.

6.6 IREM

6.6.1 Operations

Radiation belts entry and exit

The following plots show the Radiation Belt Entry (Figure 23, red line) and Exit times (Figure 24, blue line) obtained from the ISDC website, defined where the IREM TC3 (soft electrons) rate reads 600 counts. The blue line in Figure 23 and the magenta line in Figure 24 are the altitudes used by the MOC for planning purposes.

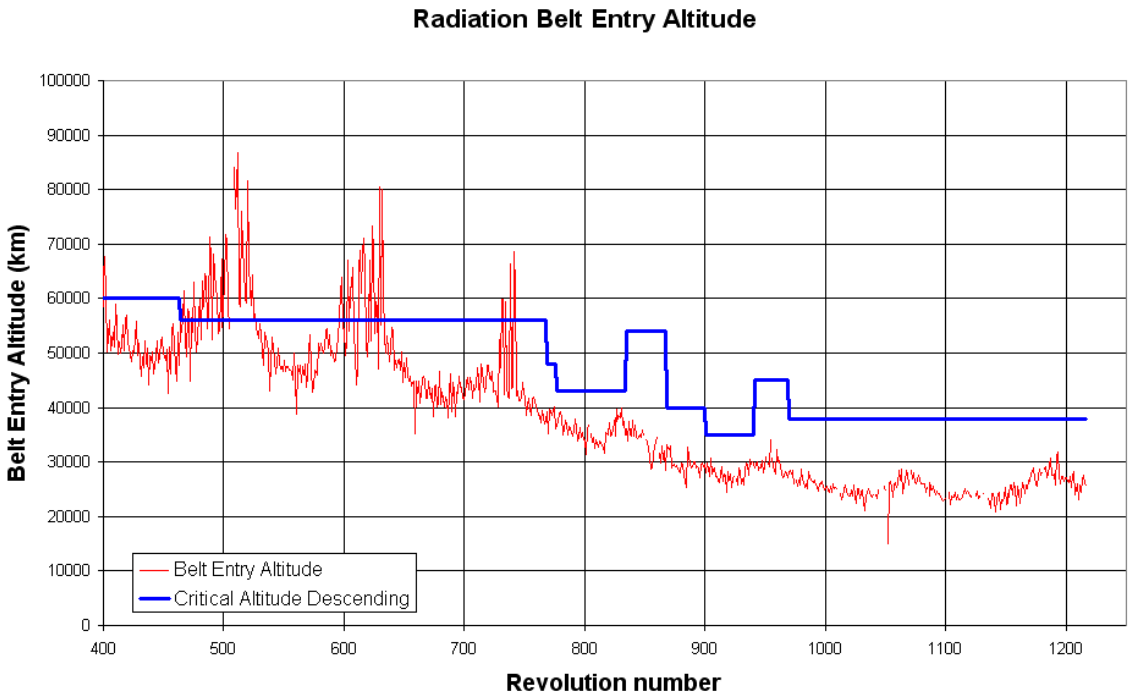


Figure 23: Radiation belt entry

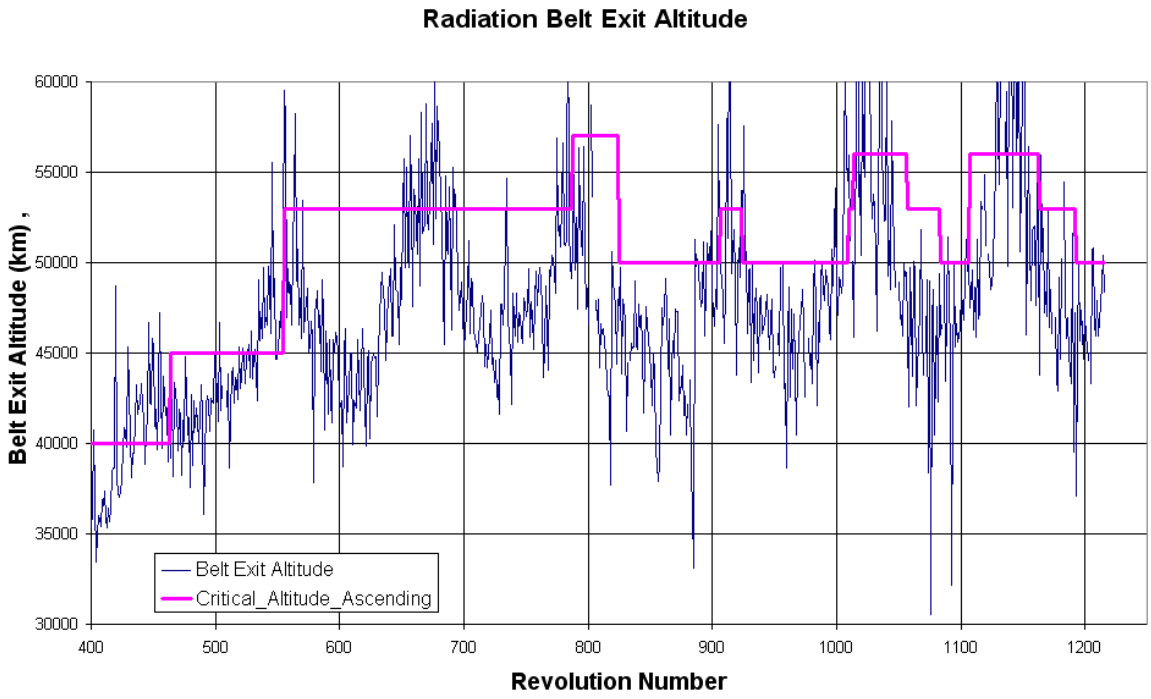


Figure 24: Radiation belt exit

Table 2: Radiation belts. Radiation belt entry crossings are ignored if there is a subsequent gap of at least 30 minutes of low radiation.

Revo number	Spacecraft BCPKT (electron)	Observed entry/exit time by Electron CUT-OFF	Observed entry/exit altitude [km] by Electron CUT-OFF	Predicted entry/exit time by Electron CUT-OFF	Predicted entry/exit altitude [km] by Electron CUT-OFF	Predicted entry/exit time by Proton CUT-OFF	Predicted entry/exit altitude [km] by Proton CUT-OFF
1207	RAD_ENTR R 2012-09-03T11:32:31Z	N/A	N/A	03-Sep-2012 13:01:31	19886.2	03-Sep-2012 13:41:31	10199.62
1208	RAD_EXIT R 2012-09-03T18:15:16Z	03/09/2012 17:22:39	46613	03-Sep-2012 18:11:31	49099.95	03-Sep-2012 14:21:31	3500.513
1208	RAD_ENTR R 2012-09-06T11:18:36Z	N/A	N/A	06-Sep-2012 12:51:36	19369.63	06-Sep-2012 13:31:36	9704.969
1209	RAD_EXIT R 2012-09-06T18:01:38Z	06/09/2012 17:05:59	45993	06-Sep-2012 18:01:36	49380.38	06-Sep-2012 14:11:36	3627.167
1209	RAD_ENTR R 2012-09-09T11:04:12Z	N/A	N/A	09-Sep-2012 12:30:54	21137.32	09-Sep-2012 13:20:54	9134.351
1210	RAD_EXIT R 2012-09-09T17:47:16Z	09/09/2012 17:04:47	48284	09-Sep-2012 17:50:54	49774.61	09-Sep-2012 14:00:54	3729.527
1210	RAD_ENTR R 2012-09-12T10:50:36Z	N/A	N/A	12-Sep-2012 12:24:01	19396.87	12-Sep-2012 13:04:01	9678.507
1211	RAD_EXIT R 2012-09-12T17:33:11Z	12/09/2012 16:51:03	48251	12-Sep-2012 17:34:01	49465.17	12-Sep-2012 13:44:01	3520.141
1211	RAD_ENTR R 2012-09-15T10:45:09Z	N/A	N/A	15-Sep-2012 12:13:39	19113.19	15-Sep-2012 12:53:39	9344.874
1212	RAD_EXIT R 2012-09-15T17:27:08Z	15/09/2012 16:35:11	47531	15-Sep-2012 17:23:39	49736.45	15-Sep-2012 13:33:39	3496.715
1212	RAD_ENTR R 2012-09-18T10:34:33Z	N/A	N/A	18-Sep-2012 12:00:48	19834.69	18-Sep-2012 12:40:48	10113.79
1213	RAD_EXIT R 2012-09-	18/09/2012 16:34:31	49247	18-Sep-2012	49202.08	18-Sep-2012	3437.63

Revo number	Spacecraft BCPKT (electron)	Observed entry/exit time by Electron CUT-OFF	Observed entry/exit altitude [km] by Electron CUT-OFF	Predicted entry/exit time by Electron CUT-OFF	Predicted entry/exit altitude [km] by Electron CUT-OFF	Predicted entry/exit time by Proton CUT-OFF	Predicted entry/exit altitude [km] by Proton CUT-OFF
	18T17:16:22Z			17:10:48		13:20:48	
1213	RAD_ENTR R 2012-09-21T10:22:57Z	N/A	N/A	21-Sep-2012 11:45:10	20494.96	21-Sep-2012 12:35:10	8456.369
1214	RAD_EXIT R 2012-09-21T17:05:35Z	21/09/2012 16:26:08	49752	21-Sep-2012 16:55:10	48621.79	21-Sep-2012 13:05:10	3582.579
1214	RAD_ENTR R 2012-09-24T10:08:58Z	N/A	N/A	24-Sep-2012 11:33:56	20175.44	24-Sep-2012 12:23:56	8161.701
1215	RAD_EXIT R 2012-09-24T16:52:01Z	24/09/2012 16:20:08	51089	24-Sep-2012 16:43:56	48809.86	24-Sep-2012 12:53:56	3598.293
1215	RAD_ENTR R 2012-09-27T09:54:30Z	N/A	N/A	27-Sep-2012 11:21:13	19830.94	27-Sep-2012 12:01:13	10153.18
1216	RAD_EXIT R 2012-09-27T16:37:19Z	27/09/2012 15:52:56	48901	27-Sep-2012 16:31:13	49119.28	27-Sep-2012 12:41:13	3526.428
1216	RAD_ENTR R 2012-09-30T09:41:16Z	N/A	N/A	30-Sep-2012 11:02:06	20919.8	30-Sep-2012 11:52:06	8869.41
1217	RAD_EXIT R 2012-09-30T16:23:58Z	30/09/2012 15:12:08	43923	30-Sep-2012 16:22:06	49987.96	30-Sep-2012 12:32:06	3737.627

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)

6.6.2 Event Log

Nothing to report.