EUROPEAN SPACE AGENCY

DIRECTORATE OF TECHNICAL & OPERATIONAL SUPPORT

MISSION OPERATIONS DEPARTMENT

INTEGRAL

Mission report

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

No. 392

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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. 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 December and covers the revolutions 993 untill 1003 (included). The targets of these revolutions can be found on the ISOC web: http://integral.esac.esa.int/isocweb/schedule.html?action=intro .

The previous weekly and monthly reports are available at the XMM-INTEGRAL website: http://xmm.esoc.esa.int/documentation/documentation.php3 .

2 Satellite status

2.1 Platform

2.1.1 AOCS

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

28 slews were missed from the Timeline.

The fuel consumption over the reporting period was 0.5074 Kg. The remaining propellant is in the order of 124.1563 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; available power from the arrays is of the order of 2100W.

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 15th SPI annealing, which ended on 16/04/2010, 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 99 packets/cycle, except from 2010-12-30T02:58:11Z to the end of the revolution 1002 (OMC Flat Field Calibration), when it was 88 packets/cycle. The average telemetry occupation when the allocation was 99 packets/cycle was 79.0 packets/cycle.

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

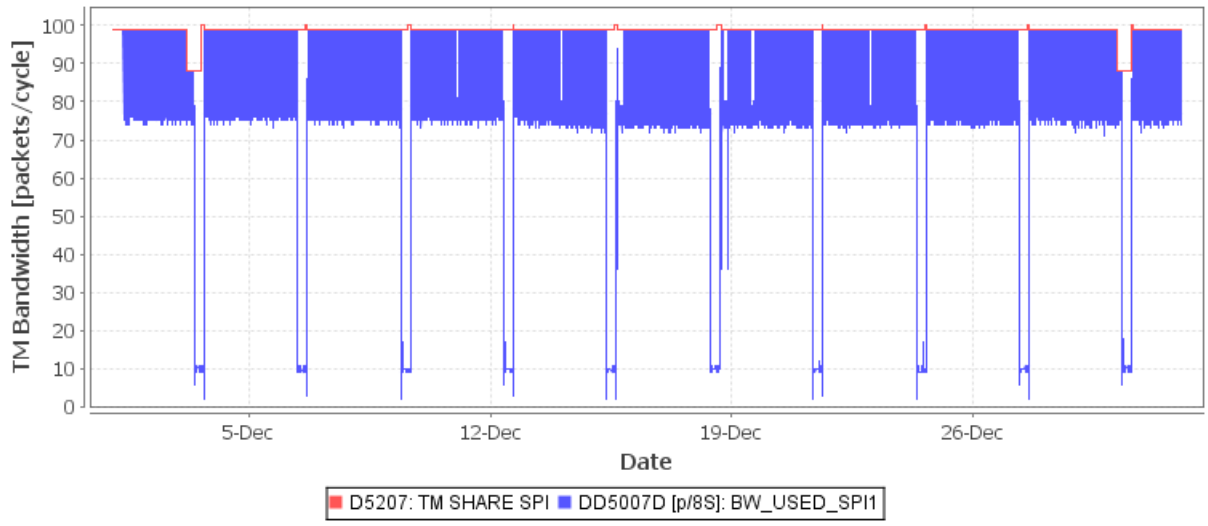


Figure 1: SPI TM bandwidth utilisation

The following plot shows the DPE CPU load during the reporting period:

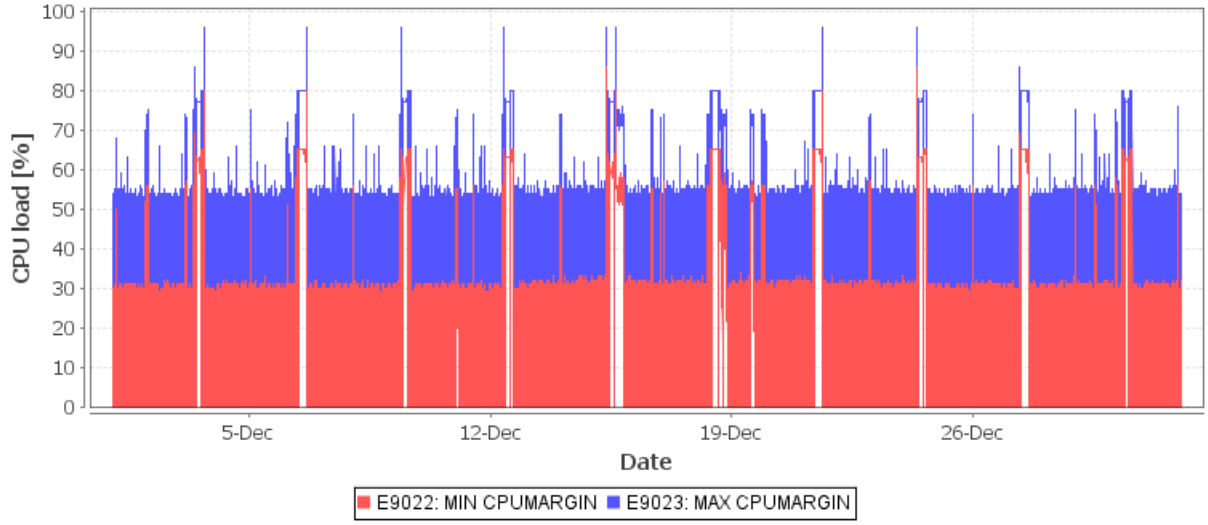


Figure 2: SPI IASW Performance

The following plot shows the evolution of the assigned and the average occupation of the SPI TM bandwidth since May 2005:

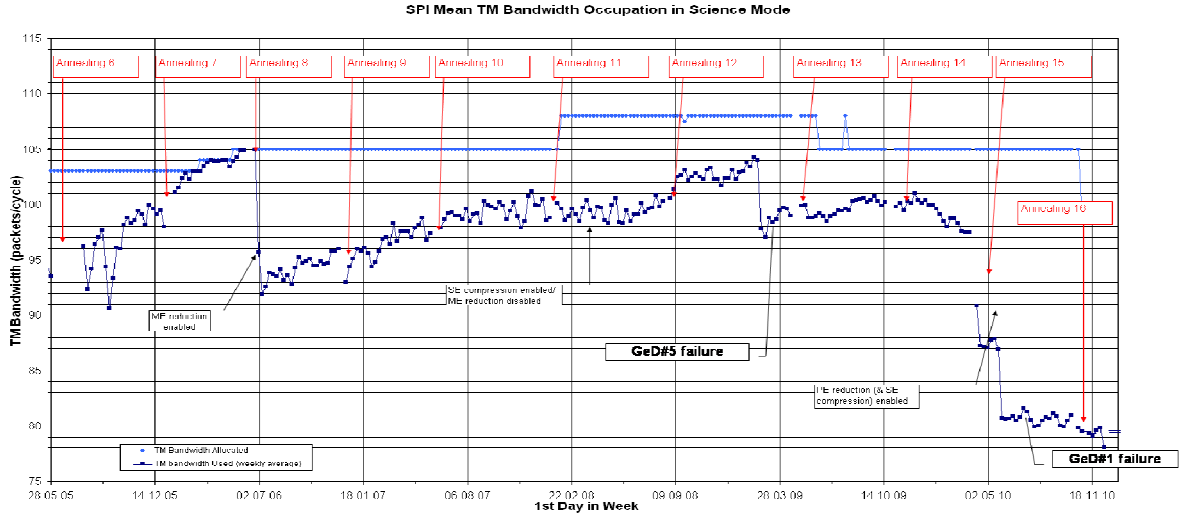


Figure 3: SPI TM bandwidth usage evolution since May 2005

Note: Some more information concerning the SPI operations is provided in Appendix 0.

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 2010-12-30T02:58:11Z to 2010-12-30T07:00:33Z (OMC Flat Field Calibration), when it was 90 packets/cycle

- IBIS mean bandwidth utilisation in science mode: 110.73 packets/cycle

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

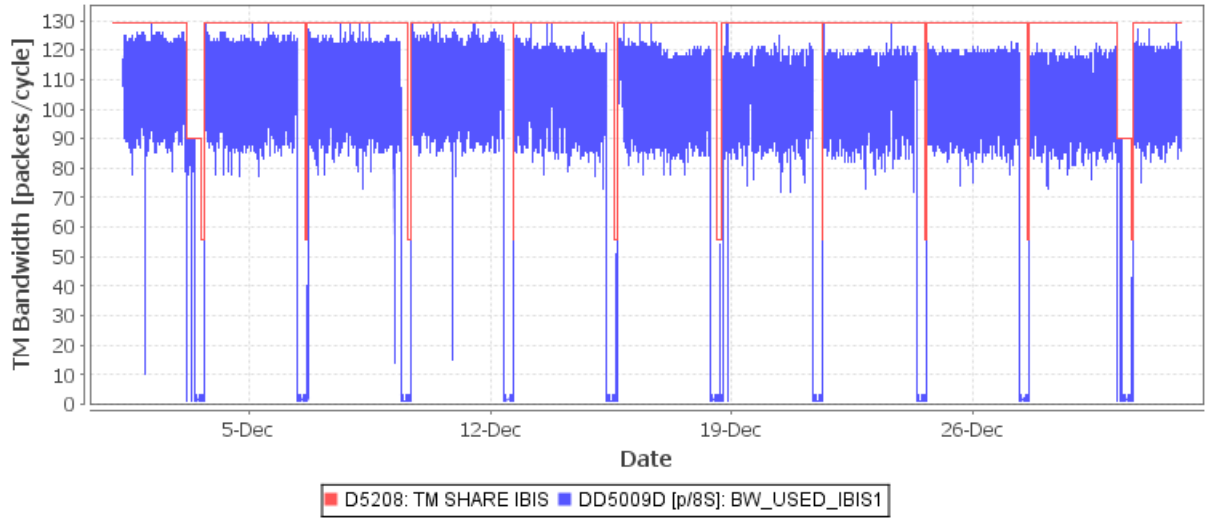


Figure 4: IBIS TM bandwidth utilisation

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

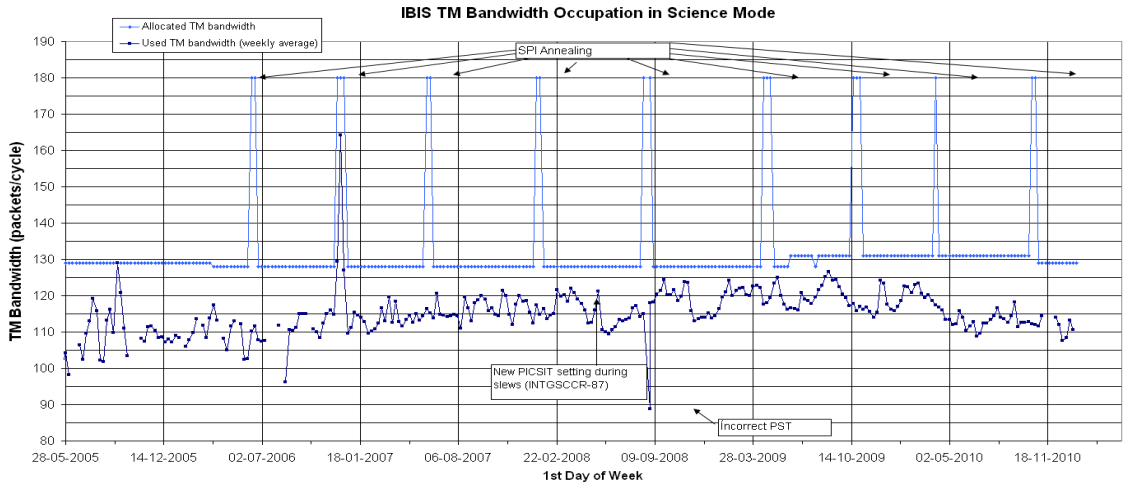


Figure 5: IBIS TM bandwidth usage evolution since May 2005

Note: Some more information concerning the IBIS operations is provided in Appendix 6.3.

2.2.3 JEM-X

The status of both JEM-X units is nominal:

JEMX-1 & 2 were operated in Data Taking mode with a TM allocation of 8 packets/cycle each, except from 2010-12-30T02:58:11Z to the end of the revolution 1002, during the OMC Flat-field calibration, when they were allocated 4 packets/cycle each.

Note: Some more information concerning the JEM-X operations is provided in Appendix 0*.*

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 2010-12-30T02:58:11Z to the end of the revolution 1002, during the Flat-field calibration, when it was 63 packets/cycle.

During this reporting period, 709 of the 728 planned science pointings were executed nominally. Two pointings were lost to ground station problems, and 17 to problems with the FDS. In addition 1 Flat-field calibration was performed this month (nominally).

Note: Some more information concerning the OMC operations is provided in Appendix 0.

2.2.5 IREM

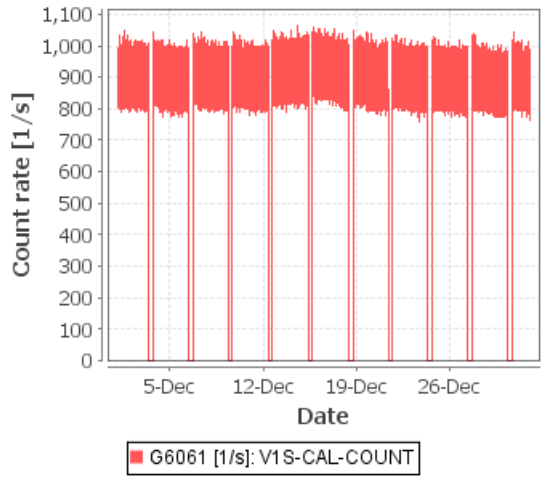
The status of IREM is nominal.

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

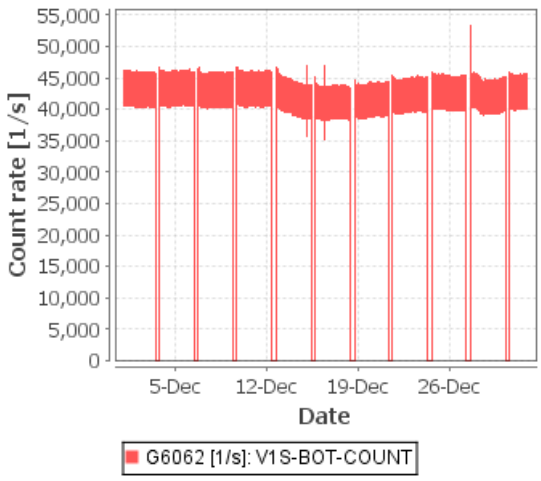
Radiation background

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



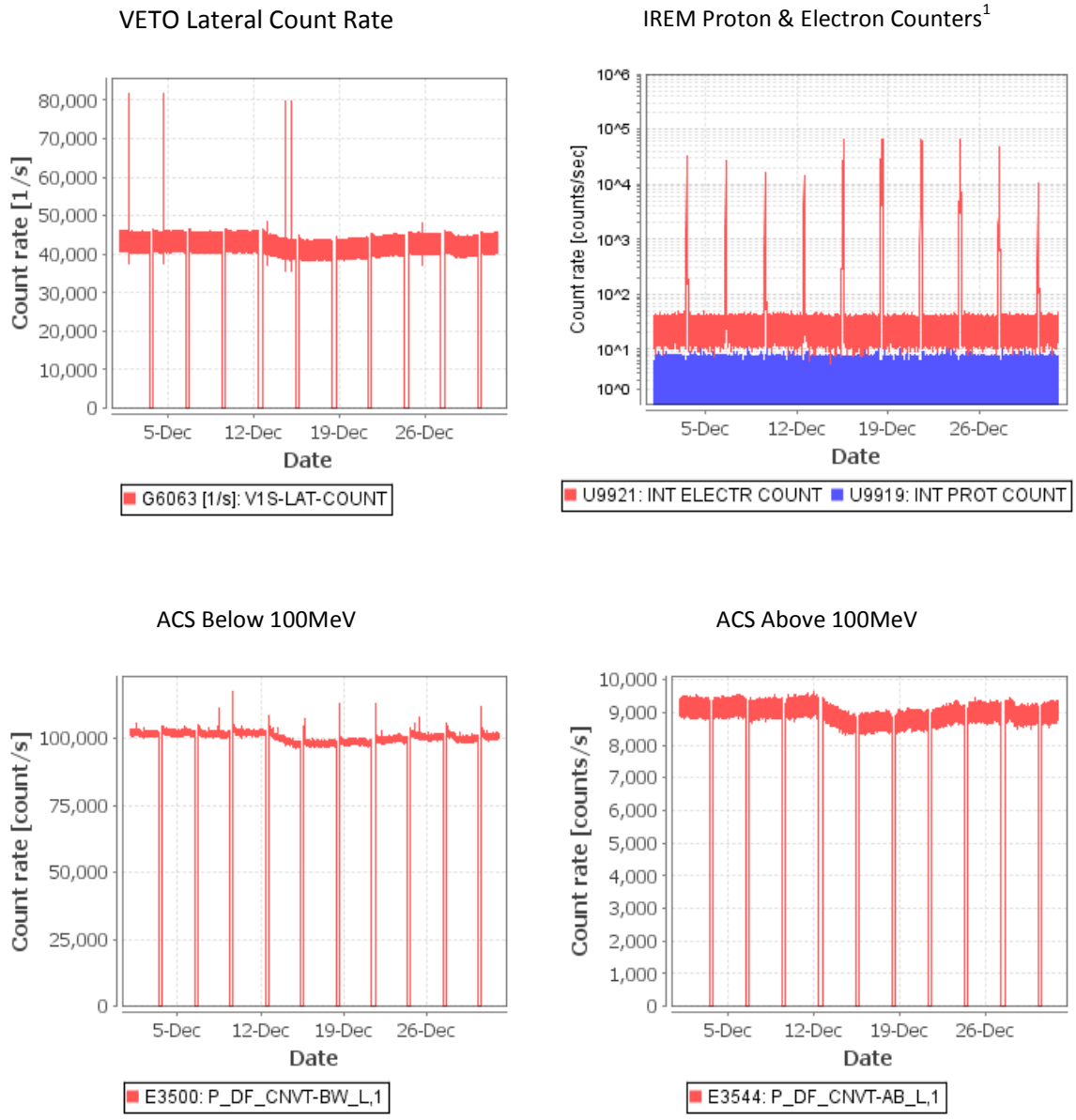


Figure 6: Instrument Count Rates

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

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

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

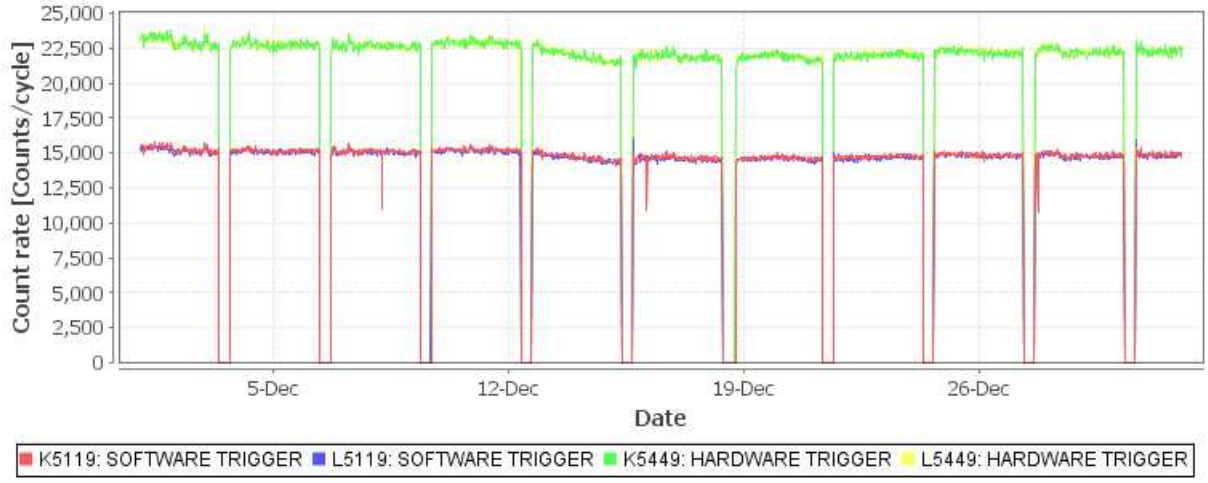


Figure 7: JEM-X Count rates. The smaller downward spikes in the figure are due to the slews of the spacecraft

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.

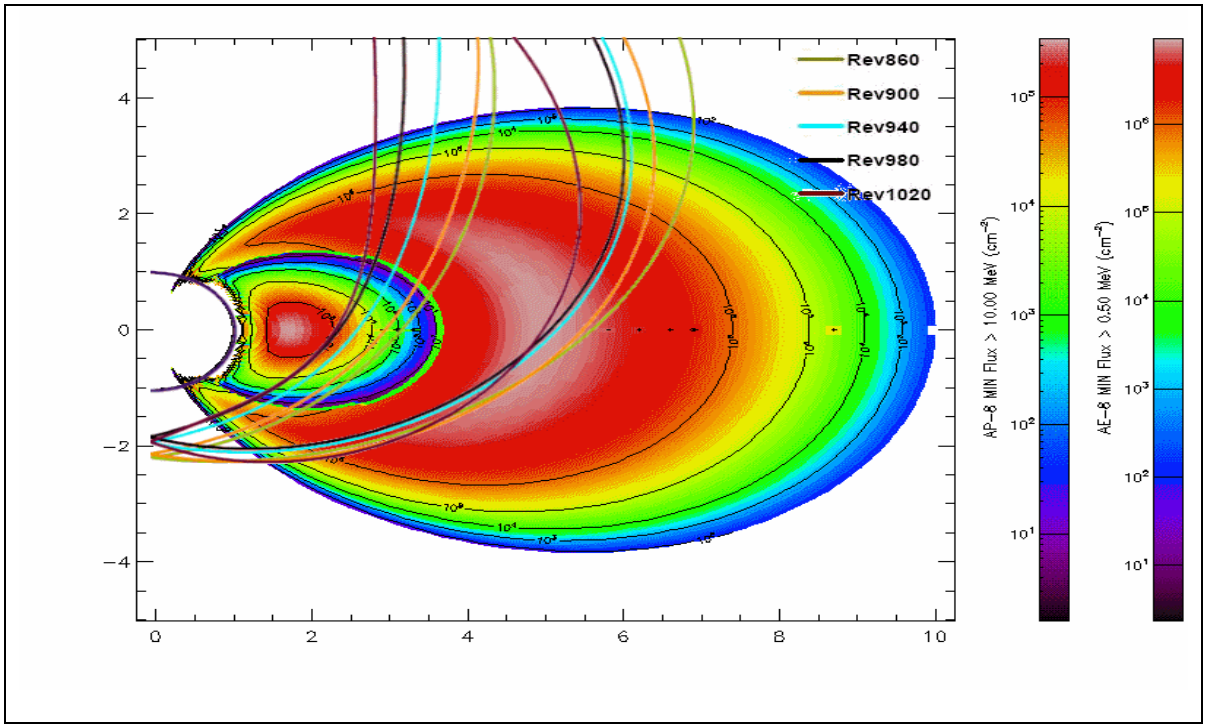


Figure 8: The predicted evolution of the orbit of Integral through the radiation belts

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.

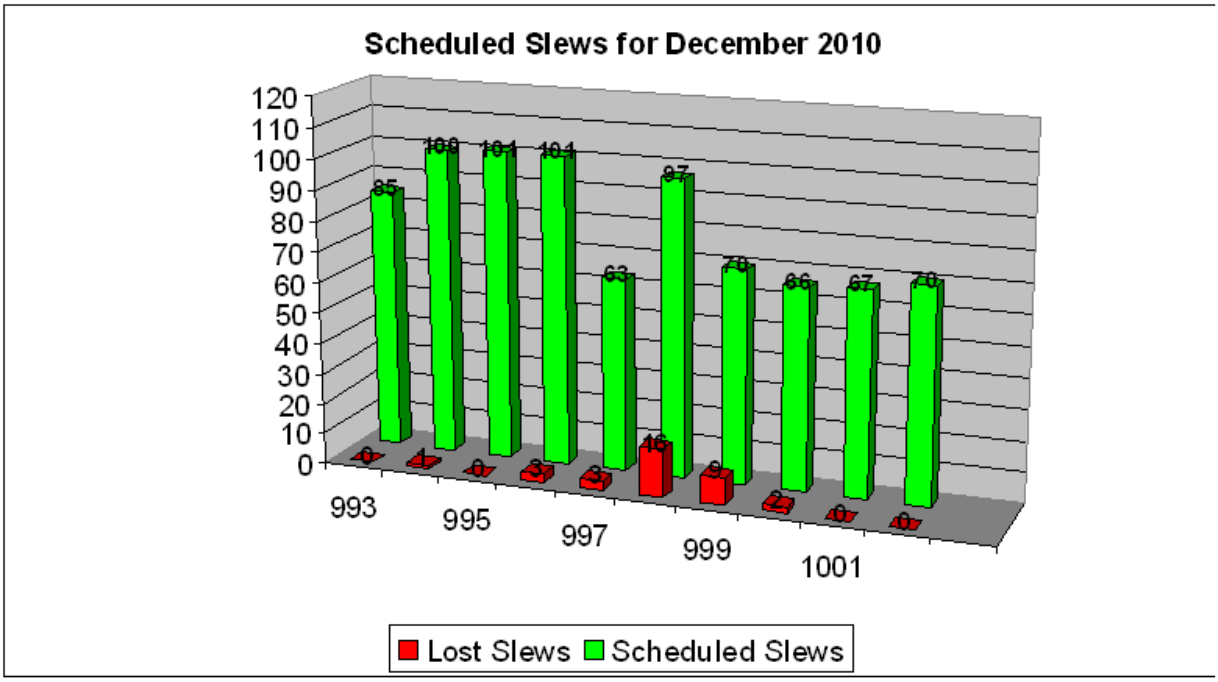


Figure 9: The number of slews scheduled compared to the number of slews lost

3.1 Mission Control System

On DOY 335 iddb had to be restarted as it had lost connection to the TM RT cache.
On DOY 346 the error message "Packet time in future ..." was received, this was cleared after an automatic reset of the Time Correlator
On DOY 346 only 3 of the 8 expected ISGRI CTX files arrived at MOC, this was caused by IFTS connection problems which were cleared after an IFTS restart.
On DOY 349 the new Database release "IODB_3.1_0065_2010_12_15" was successfully installed on the A- and B-chains
The OBQM task died and needed to be restarted on three occasions (DOYs 353, 354 & 355), the cause of this is currently under investigation.
On DOY 361 the automatic CD production failed, this was corrected by restarting the AUX and ARCH tasks.

3.2 Ground Stations and Network

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

REDU
On DoY336 at 23:29:00, drop VC-0 For a few seconds. On DoY343 at 18:18:00, bad Frames --> NETWORK reports possible RFI.

On DoY 344, at 11:34:00 ground station handover DSS24 --> Redu was performed too late by mistake, should have been at 11.04 Therefore PID # 0035 interrupted.

On DoY345, at 10:40:00 Carrier went down. Reason: Auto scheduling was running in background trying to reconfigure station for planned start of track at 11:15. Commanding for slew ID 09960069 failed.

On DoY 349, at 23:37:00: bad frames. On DoY350 at 01:28:00 Bad Frames.

On DoY 352, at 14:41:00 drop VC-0, Lots of bad frames due to low AGC level, we are on the wrong on-board antenna, TM lost. At 14:55:41, antenna swap in the blind, TLM back, PID 09990004 lost.

On DoY 353, at 11:47:00 bad frames, before TM started dropping out. AGC is slowly dropping as is the signal to noise ratio. Cause is snow on the antenna, move to VIL2. At 18:17:00, drop VC-0 & VC-7. AGC remained stable. At 19:02:00, TM drop. AGC is slowly dropping, TM dropped out completely, again due to snow on the antenna, move to VIL2. On DoY355, at 04:57:00, bad frames.

On DoY 356, at 04:20:00 bad frames, Network report a probable hit on the line.

On DoY362, at 19:11:01 data gaps on VC-0 & VC-7. At 19:11:02, bad frames (DUs 70).

On DoY 363, at 04:38:00, drop VC-0 & VC-7. Network report possible RFI.

VIL-2

On DoY 354, at 04:45:00 lots of Data Gaps VC-0 & VC-7. At 04:58:00 Groundstation handover VIL2 --> Redu.

DSS24
On DoY344 at 06:27:00 No VC-7. At 06:57:00 VC-7 TM from Redu. At 07:33:00 Intermittent bursts of VC-7, VC-7 from Redu for whole pass. (DR No. N106899). At 10:11:00 VC-7 Data reconnected after Ranging Cal at Redu.

DSS27
On DoY345 at 00:00:01 drops VC-7, 1 drop per minute, network asked to investigate. At 00:39:00 Ground station handover DSS27 --> Redu. SPACON decided to go back to Redu as no stable link with DSS27 possible. On DoY 347, at 06:27:00 drop VC-0 & VC-7, the antenna stopped tracking. At 06:42:0 TM/TC back. The DR number is G110852.

On DoY 350, at 16:39:00 drop VC-0 & VC-7. Station reports loss of power. DR G110860. At 16:52:00

TM+TC from Redu, in time for slew at 16.56. At 17:00:00 DSS27 report they are back on track but as the scheduled station handover is only 17 minutes away there is no point performing another handover - this was the last scheduled DSN pass.

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.

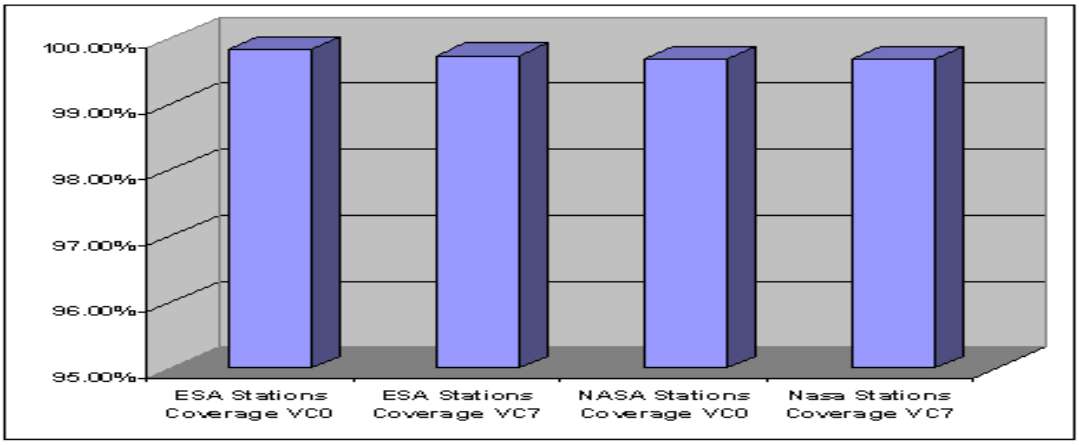


Figure 10: The usage of ESA ground stations compared to the usage of DSN ground stations

3.3 ISOC

3.3.1 Mission Planning

New or updated PSFs have been received for revolutions 1003 to 1010, corresponding to the time range 30 December to 23 January.

New observations have been planned for revolutions 997 (12-15 December) to 1010 (20-23 January).

TSFs have been received for revolutions 995 to 1007.

The requirement for a special perigee attitude occasionally implies the use of dummy pointings or rather long slews.

3.3.2 Observation Status

New ECS files have been received for revolutions 982 to 987 (up to 15 November).

3.3.3 ISOC Science Data Archive

Scw data has been ingested up to revolution 985.

Raw telemetry copied from MOC is available up to 29 November with some gaps.

Work has begun to define the reworked ISDA planned for 2011.

3.3.4 ISOC System

Working on V27.2 with various improvements to scheduling software and Web pages.

3.3.5 Problems

No new problems.

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-3126	2010-12-06	COMMS - data took 2 hours to arrive at printer	COMMS	Pending
INT-3127	2010-12-10	JPL: Instable VC7 TM delivery from DSS-24	NASA Station	Closed
INT-3128	2010-12-13	Flight Dynamics System Unstable since 13/12/2010	FDS	Closed
INT-3129	2010-12-22	Filter not working in TCHistory when history print is selected.	IMCS	Pending
INT-3130	2010-12-18	CGS prior to LOS followed by CGS after AOS (perigee)	FDS	Pending
INT_SC-311	2010-11-16	IBIS: VETO reset	Payload	Testing

5 Special Events & Future Milestones

- FSS/STR Misalignment Calibration to be planned
- Star tracker blemish pixel survey to be planned
- The transfer of NCTRS operations to the SPACONs to be planned
- DSN routine support was discontinued after 16.12.2010
- A new perigee passage strategy for SPI has been implemented from revolution 993 onwards (OCR-298).
- Analysis ongoing for possible Earth observations in 2011/2012
- New FOP release issued on 06.12.2010
- Installation of the INTEGRAL MCS on ROSSETTA clients will be done after E3.4 validation.

- ISDC communications upgrade ongoing

6 Appendix

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

6.1 AOCS operations

During this period, 475 Open Loop Slews, 352 Closed Loop Slews and 24 Momentum Biases were executed (as reported by ACC OEM).

28 slews were missed from the Timeline.

6.1.1 Fuel consumption

The fuel consumption (total, grams per day) over the period between 01/11/2002 and 01/01/2011 is reported in the following plot:

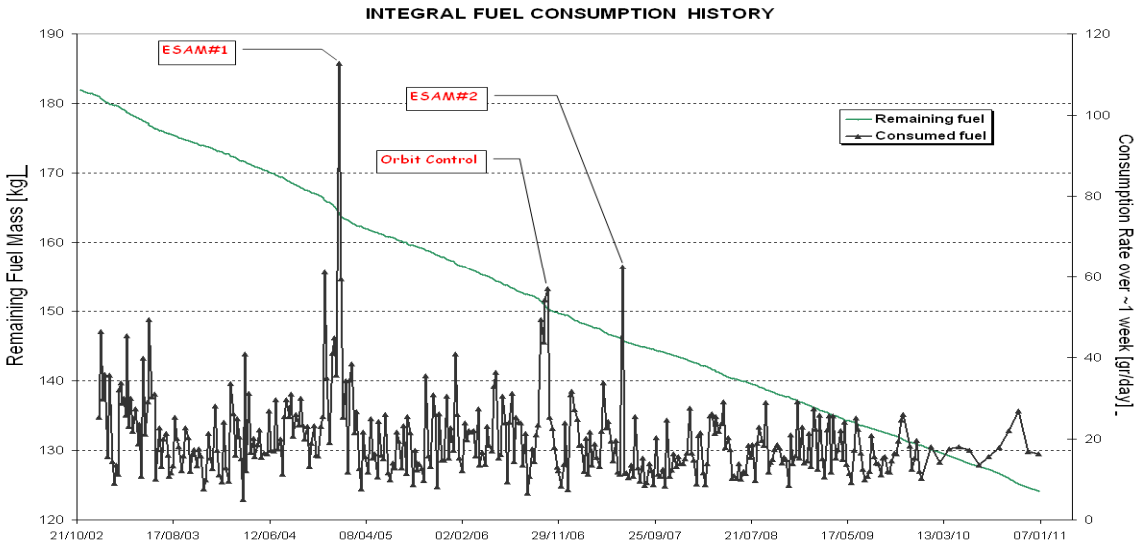


Figure 11: Fuel consumption. Note: ESAM fuel consumption is spread over period of ~1 week.

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.

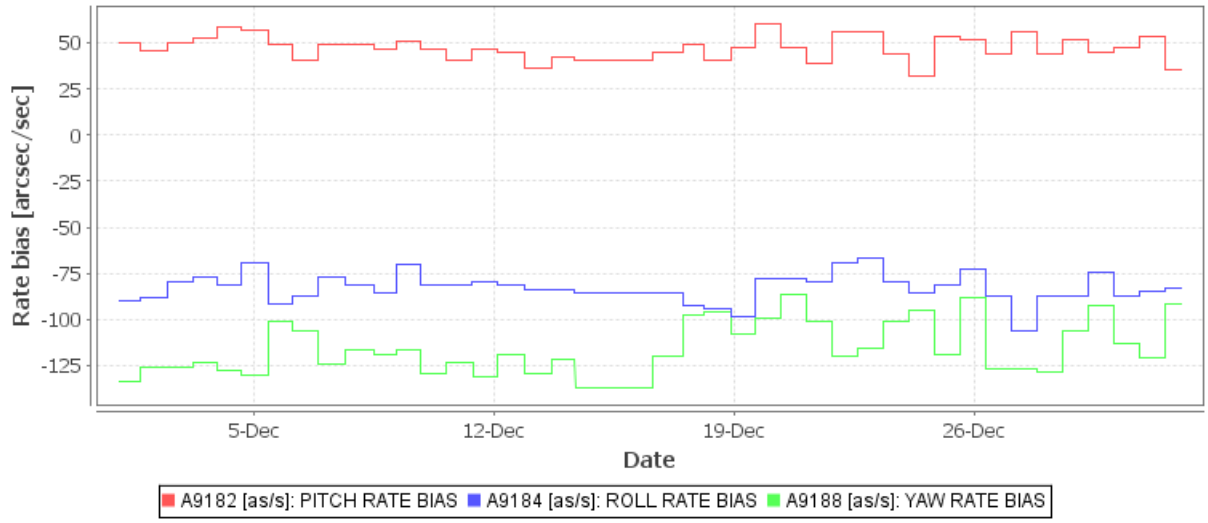


Figure 12: RMU pitch, roll and yaw. Historic data is available on request

6.1.3 Event log

Note: In the time period from the 13th and the 21st of December several instances of the so called "FDS File Server fail over" occurred, causing different levels of impact in operations. This "FDS File Server fail over" is described in detail in the anomaly report INT-3128 and its follow up in both ESOC_NCR-78 and ESOC_MRB-38. Only those instances which had an impact in operations will be reported in what follows.

05/12/2010 (Day of Year 339, Revolution 994)

IMU1 switched ON during the stable pointing of PID 09940052 (00:32:00Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 09940053 were manually updated (spacontool).

OTF was not reached for PID 09940052.

07/12/2010 (Day of Year 341, Revolution 995)

IMU1 switched ON during the stable pointing of PID 09950046 (20:46:00Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 09950047 were manually updated (spacontool).

OTF was not reached for PID 09950046.

11/12/2010 (Day of Year 345, Revolution 996)

As a consequence of Redu GS carrier drop, the commanding release for slew 09960069 failed (10:41:00Z). AOCS subsystem was disabled. Once GS TC link was recovered, a manual slew was performed from attitude 09960068 to attitude 09960069.

After the manual slew was completed, the parameters for slew 09960070 were manually updated by the Spacon.

OTF was not reached for PID 09960069.

Slew 09960069 was missed from the Timeline.

13/12/2010 (Day of Year 347, Revolution 997)

IMU1 switched ON during the stable pointing of PID 09970026 (16:40:00Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 09970027 were manually updated (spacontool).

OTF was not reached for PID 09970026.

14/12/2010 (Day of Year 348, Revolution 997)

As a consequence of a "FDS File Server fail over" at 08:09Z, the automatic update for slews 09970042 to 09970046 failed. However, the updates were performed manually by the SPACON.

No impact on the Timeline.

15/12/2010 (Day of Year 349, Revolution 997 to 998)

As a consequence of a "FDS File Server fail over" at 12:23Z the AOCS subsystem was disabled in the Timeline.

Slews 09980001 to 09980013 were missed from the Timeline, which was rejoined at 20:23Z, to the attitude of PID 09980013. 13 PIDs were missed.

16/12/2010 (Day of Year 350, Revolution 998)

As a consequence of a planned FDS restart, slews 09980048 to 09980050 were missed from the Timeline.

18/12/2010 (Day of Year 352, Revolution 998 to 999)

As a consequence of a "FDS File Server fail over" at 13:40Z the AOCS subsystem was disabled in the Timeline.

Slews 09990001 to 09990009 were missed from the Timeline, which was rejoined at 19:29Z, to the attitude of PID 09990009. 9 PIDs were missed.

19/12/2010 (Day of Year 353, Revolution 999)

As a consequence of Redu GS drop, the commanding release for slew 09990026 failed (12:00:00Z). Once GS TC link was recovered, a manual slew was performed from attitude 09990025 to attitude 09990027.

After the manual slew was completed, the parameters for slew 09990028 were manually updated (spacontool).

Slews 09990026 and 09990027 were missed from the Timeline, and OTF was not reached for their PIDs.

21/12/2010 (Day of Year 355, Revolution 999 to 1000)

As a consequence of a "FDS File Server fail over", the automatic update for slew 10000001 failed. However, the update was performed manually by the SPACON.

No impact on the Timeline.

23/12/2010 (Day of Year 357, Revolution 1000)

IMU1 switched ON during the stable pointing of PID 10000048 (13:13:00Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 10000049 were manually updated (spacontool).

OTF was not reached for PID 10000048.

24/12/2010 (Day of Year 358, Revolution 1000 to 1001)

IMU1 switched ON during the stable pointing of PID 10000064 (06:05:00Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 10000065 were manually updated (spacontool).

OTF was not reached for PID 10000064.

31/12/2010 (Day of Year 365, Revolution 1003)

IMU1 switched ON during the stable pointing of PID 10030033 (19:40:00Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 10030034 were manually updated (spacontool).

OTF was not reached for PID 10000064.

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 stroke of all four compressors was set to 40 throughout the month of December. From revolution 993 onwards the new perigee passage attitude has been chosen to reduce the temperature jump of the SPI cold plate temperature during the perigee passage.

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

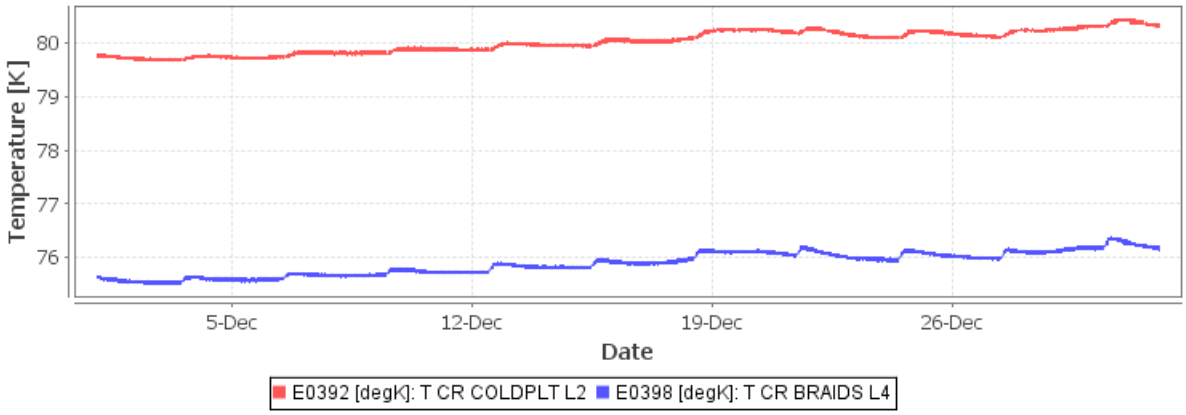


Figure 13: SPI Cold plate and H-bus temperature

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

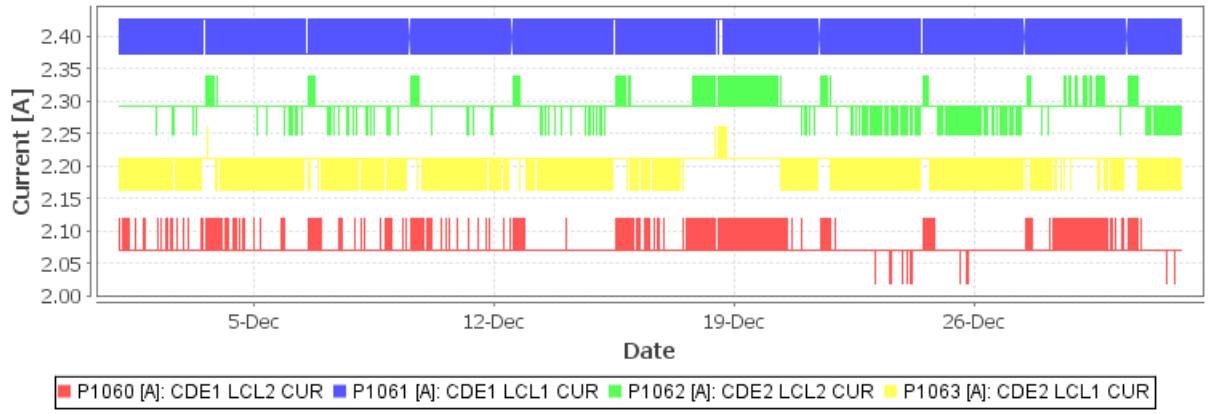


Figure 14: SPI CDE LCL curent

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.

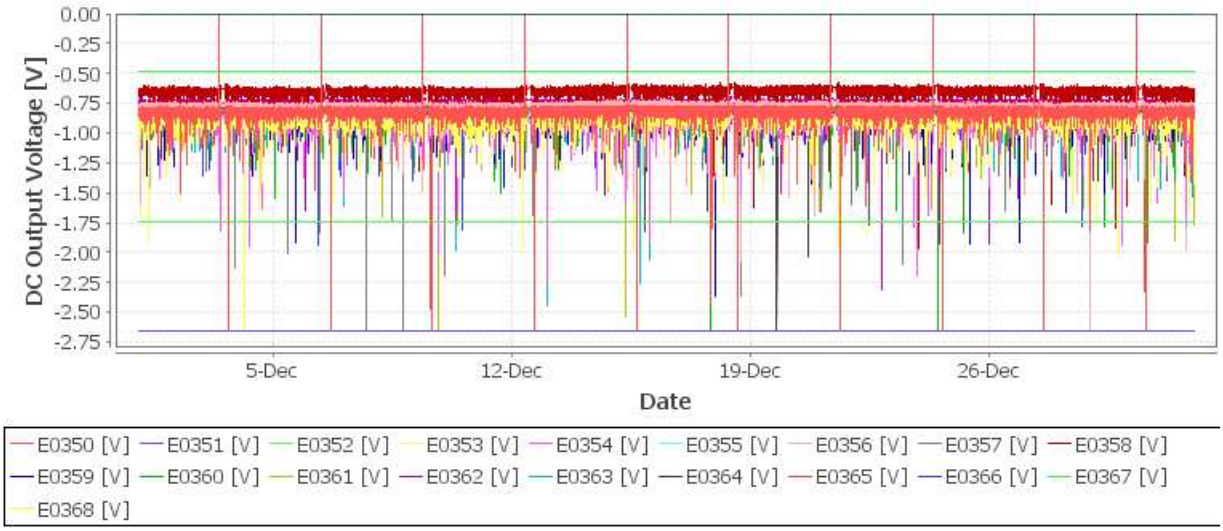


Figure 15: AFEE DC Output Voltages. Note that the data is sampled every 8th packet (64sec)

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:

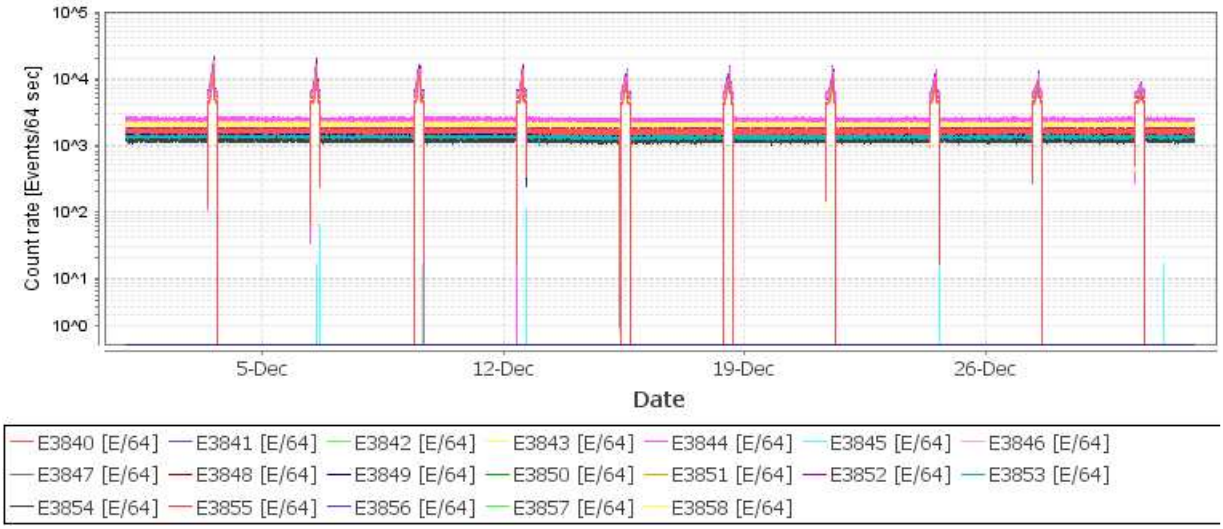


Figure 19: SPI PSD GeD Channel rates

6.2.2 Event Log

Nothing to report

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:

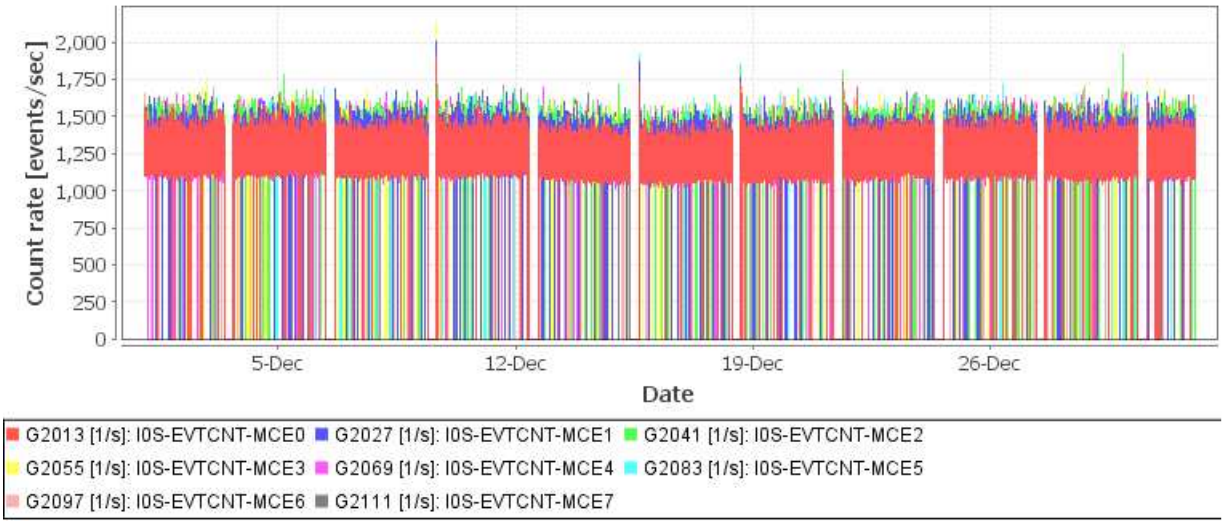


Figure 20: ISGRI MCE Counters

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:

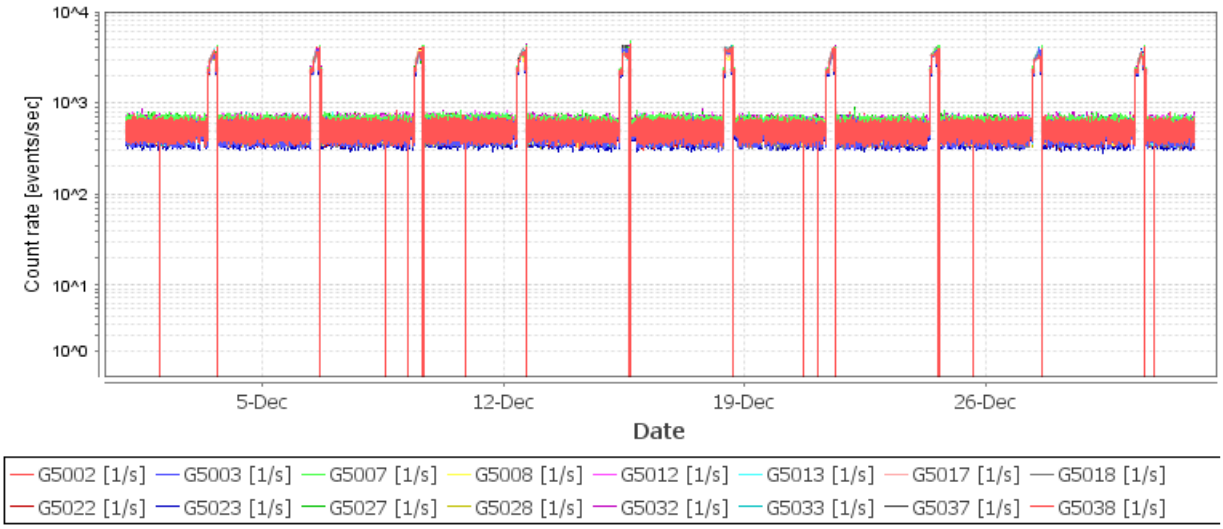


Figure 21: PICsIT semi-module counters. Note that the scale used for plotting is logarithmic

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

01/12/2010 (Day of Year 335, Revolution 993)

TM: G5002 and G5003 families OOL along with G5614 back in limits when HEPI RESYNCHRONISED OEM arrived (23.06.58Z).No further action taken

09/12/2010 (Day of Year 343, Revolution 995 to 996)

At 03:52:11Z the TM parameters families G5068 and G5072 failed status consistency check (value = TRUE). These are the PDM semi-module FIFO error flags. At 03:52:42Z the TM parameter families G5002 and G5003 for the PDM semi-module counters started going OOL Low. As these were followed at 03:55 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.

10/12/2010 (Day of Year 344, Revolution 996)

At 20:54:03Z the TM parameters families G5068 and G5072 failed status consistency check (value = TRUE). These are the PDM semi-module FIFO error flags. At 20:54:30Z the TM parameter families G5002 and G5003 for the PDM semi-module counters started going OOL Low. As these were followed at 20:57:46 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.

12/12/2010 (Day of Year 346, Revolution 996 to 997)

2010-12-12 12:50:00Z IBIS Context tables for MCEs 3 to 7 were not received. The context tables from revolution 995 were used instead.

18/12/2010 (Day of Year 352, Revolution 998 to 999)

At 2010-12-18 14:41:39Z sequence GEBENT02 failed release due to lack of TM. The instrument activation was performed manually, via resending the GEBENT02 sequence at 15:24:00Z and the sequence GEBEXT01 afterwards (16:09:00Z).

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.

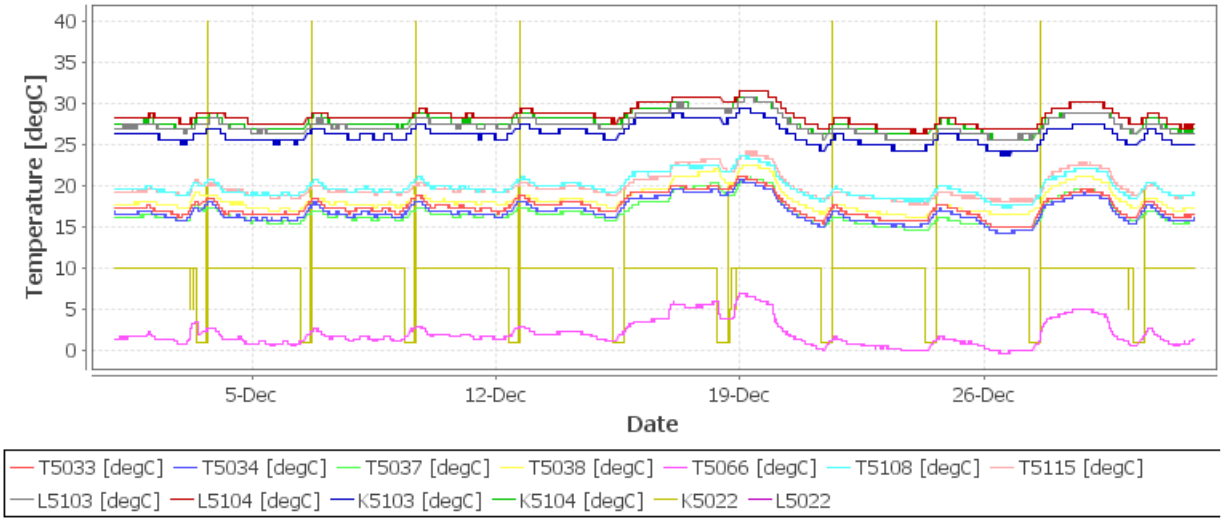


Figure 22: JEMX Detector and DFEE Temperatures

6.4.2 Event Log

18-12-2010 (Day of Year 352, Revolution 999)

At 14:21:47, 14:22:51 JEMX-1 & 2 parameters K5317 & L5317 respectively went Out-of-Limits (Hard), and then again at 14:25:47 both went Out-of-Limits. There was no impact as the reaction has been disabled.

At 15:00:50, the activation sequence for both units was missed, as the commanding had been disabled due to the ongoing problems with the FDS. They were later manually activated at 17:04.

6.5 OMC

6.5.1 Operations

The status and performance of OMC is nominal.

6.5.2 Event Log

2010-12-11 (DoY 345, Rev 996)

At 10:40, a ground station problem forced an interruption to operations. After resetting the uplink, a recovery was performed, and the timeline rejoined at 11:20. The impact was the loss of pointing 09960069. It was at this time that the following pair of commands were rejected:

```
2010.345.10.45.52.035   2010.345.10.45.58.912   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2010.345.10.45.58.035   2010.345.10.46.05.115   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 that pointing.

2010-12-15 (DoY 349, Rev 998)

At 12:29, after AOS, a dump of on-board OEMs showed there had been an IMU on during perigee passage. An attempt was made to manually recover the situation, however a problem with the FD system prevented this. The timeline was not recovered until 20:09. OMC did go to science mode at 19:24, however that attitude was incorrect. The overall impact was the loss of pointings 09980004 to 09980013. It was at this time that the following pair of commands were rejected:

```
2010.349.19.50.33.641   2010.349.19.50.38.903   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2010.349.19.50.39.766   2010.349.19.50.45.887   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 09980013.

2010-12-17 (DoY 351, Rev 998)

At 13:30, a planned reboot of the FD system failed, with the FTS not working, after resolving the issue, a recovery was performed, and the timeline rejoined at 15:44. The impact was the loss of pointings 09980048 and 09980049. It was at this time that the following pairs of commands were rejected:

```
2010.350.14.22.29.057   2010.350.14.22.40.820   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2010.350.14.22.35.307   2010.350.14.22.40.860   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2010.350.14.54.24.058   2010.350.14.54.31.634   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2010.350.14.54.30.308   2010.350.14.54.40.432   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 those pointings.

2010-12-18 (DoY 352, Rev 999)

At 13:40, the FD system crashed, difficulty finding out-of-hours support delayed the recovery which was not achieved until 19:29. The impact was the loss of pointings 09990004 to 09990008. It was at this time that the following pairs of commands were rejected:

```
2010.350.14.22.29.057   2010.350.14.22.40.820   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N      E   E

2010.350.14.22.35.307   2010.350.14.22.40.860   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N      E   E

2010.350.14.54.24.058   2010.350.14.54.31.634   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N      E   E

2010.350.14.54.30.308   2010.350.14.54.40.432   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 those pointings.

2010-12-19 (DoY 353, Rev 999)

At 11:47, problems at Redu (possibly snow on the antenna) caused bad frames to be sent, which stopped the timeline. Operations were switch to VIL2, and a recovery performed. The timeline was then rejoined at 13:05. The impact was the loss of pointing 09990026.

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.

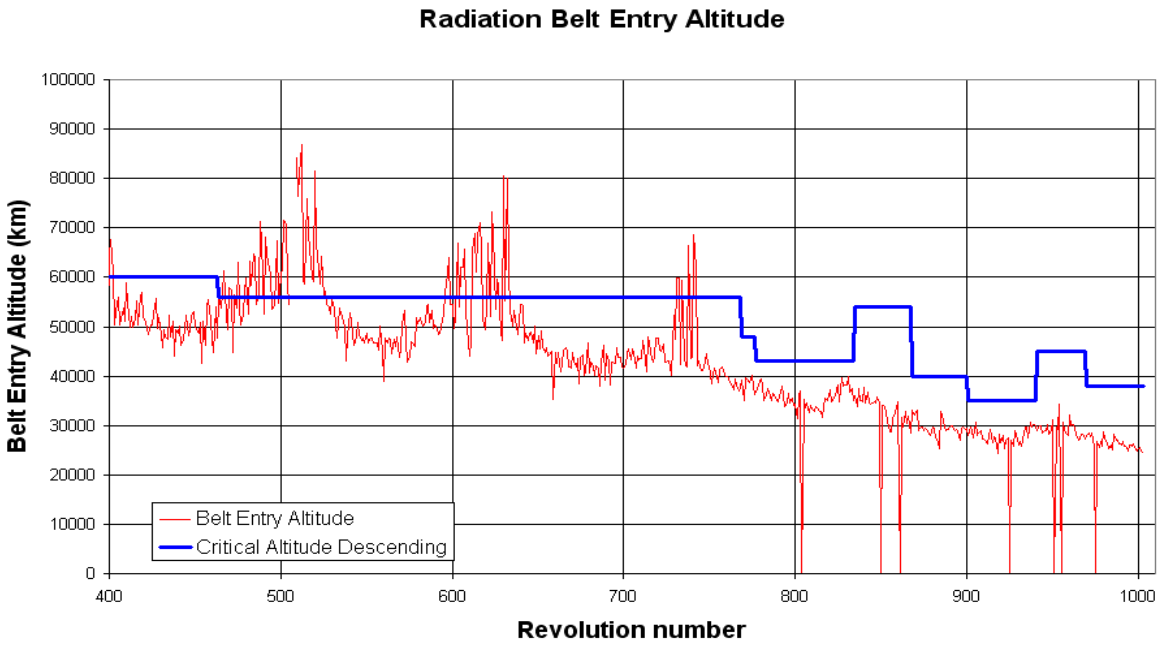


Figure 23: Radiation belt entry

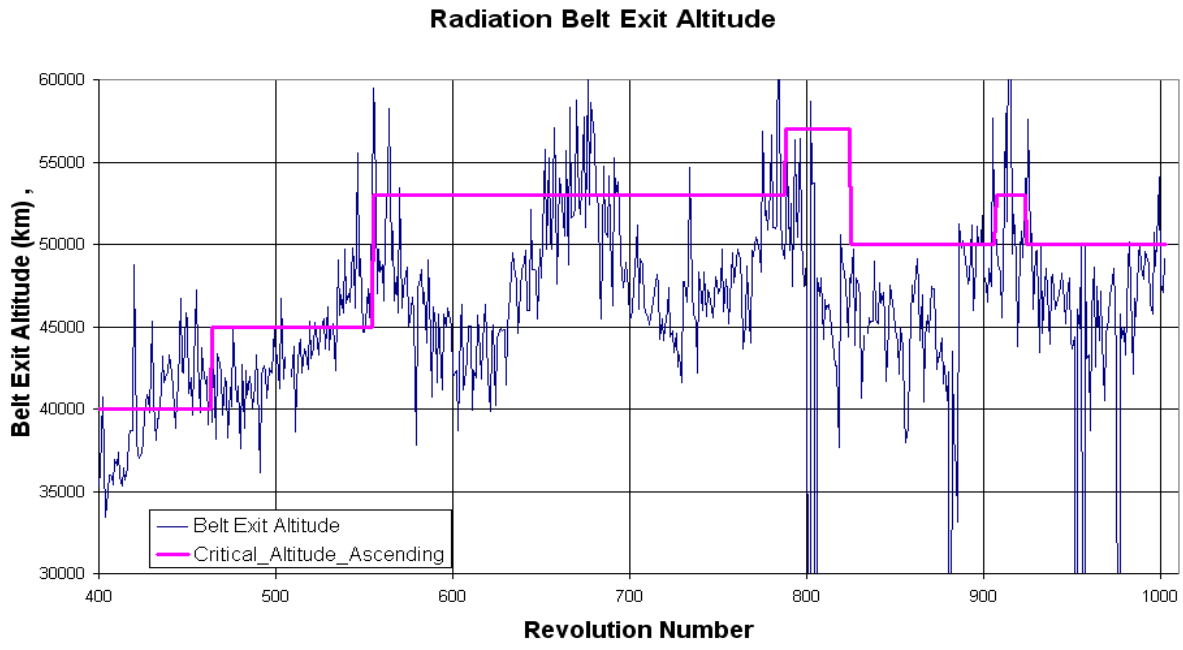


Figure 24: Radiation belt exit

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
993	RAD_ENTR R 2010-12-03T08:53:09Z	03/12/2010 10:21:07	19678.5	03-Dec-2010 10:17:29	20595.1	03-Dec-2010 11:07:29	8640.065
994	RAD_EXIT R 2010-12-03T15:37:26Z	03/12/2010 14:42:43	40761.7	03-Dec-2010 15:17:29	46766.26	03-Dec-2010 11:37:29	3733.653
994	RAD_ENTR R 2010-12-06T08:42:53Z	06/12/2010 10:15:00	19535.5	06-Dec-2010 10:06:36	20556.22	06-Dec-2010 10:56:36	8664.578
995	RAD_EXIT R 2010-12-06T15:27:30Z	06/12/2010 14:29:16	40152.8	06-Dec-2010 15:06:36	46700.04	06-Dec-2010 11:26:36	3832.637
995	RAD_ENTR R 2010-12-09T08:30:17Z	09/12/2010 09:55:48	19873.8	09-Dec-2010 10:00:29	19228.06	09-Dec-2010 10:40:29	9713.757
996	RAD_EXIT R 2010-12-09T15:15:34Z	09/12/2010 14:49:56	46290.2	09-Dec-2010 15:00:29	47556.34	09-Dec-2010 11:20:29	3939.451
996	RAD_ENTR R 2010-12-12T08:16:21Z	12/12/2010 09:42:36	21223.7	12-Dec-2010 09:43:14	19959.06	12-Dec-2010 10:23:14	10476.53
997	RAD_EXIT R 2010-12-12T15:01:59Z	12/12/2010 14:20:36	>>28591.9	12-Dec-2010 14:43:14	47002.77	12-Dec-2010 11:03:14	3924.723
997	RAD_ENTR R 2010-12-15T08:02:49Z	15/12/2010 09:25:16	21357.2	15-Dec-2010 09:28:07	20324.86	15-Dec-2010 10:18:07	8482.875
998	RAD_EXIT R 2010-12-15T14:48:15Z	15/12/2010 14:27:40	46791.0	15-Dec-2010 14:28:07	46796.36	15-Dec-2010 10:48:07	3883.274
998	RAD_ENTR R 2010-12-18T07:50:10Z	18/12/2010 09:17:32	19244.8	18-Dec-2010 09:12:01	20814.58	18-Dec-2010 10:02:01	8961.18
999	RAD_EXIT R 2010-12-18T14:35:27Z	18/12/2010 14:27:48	48812.3	18-Dec-2010 14:22:01	48115.64	18-Dec-2010 10:32:01	3938.09
999	RAD_ENTR R	21/12/2010 09:06:28	19254.3	21-Dec-2010	20247.03	21-Dec-2010	10786.92

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
	2010-12-21T07:35:28Z			09:01:07		09:41:07	
1000	RAD_EXIT R 2010-12-21T14:21:17Z	21/12/2010 13:35:08	>>28581.9	21-Dec-2010 14:01:07	46767.09	21-Dec-2010 10:21:07	3966.121
1000	RAD_ENTR R 2010-12-24T07:21:40Z	24/12/2010 08:49:49	19574.9	24-Dec-2010 08:52:23	19291.44	24-Dec-2010 09:32:23	9817.729
1001	RAD_EXIT R 2010-12-24T14:07:45Z	24/12/2010 13:15:41	>>30614.3	24-Dec-2010 13:52:23	47439.29	24-Dec-2010 10:12:23	4006.317
1001	RAD_ENTR R 2010-12-27T07:08:58Z	27/12/2010 08:34:53	19740.5	27-Dec-2010 08:41:48	18760.1	27-Dec-2010 09:21:48	9232.86
1002	RAD_EXIT R 2010-12-27T13:54:37Z	27/12/2010 13:19:01	43888.3	27-Dec-2010 13:41:48	47906.64	27-Dec-2010 09:51:48	4036.47
1002	RAD_ENTR R 2010-12-30T06:56:18Z	30/12/2010 08:29:01	19641.3	30-Dec-2010 08:24:05	20090.26	30-Dec-2010 09:04:05	10572.14
1003	RAD_EXIT R 2010-12-30T13:41:38Z	30/12/2010 13:13:49	44505.4	30-Dec-2010 13:24:05	46984.5	30-Dec-2010 09:44:05	3842.604

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