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INTEGRAL

Mission report

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

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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 January and covers the revolutions 1003 untill 1013 (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.

8 slews were missed from the Timeline.

The fuel consumption over the reporting period was 0.9145 Kg. The remaining propellant is in the order of 123.2 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 The average telemetry occupation when the allocation was 99 packets/cycle was 79.78 packets/cycle.

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

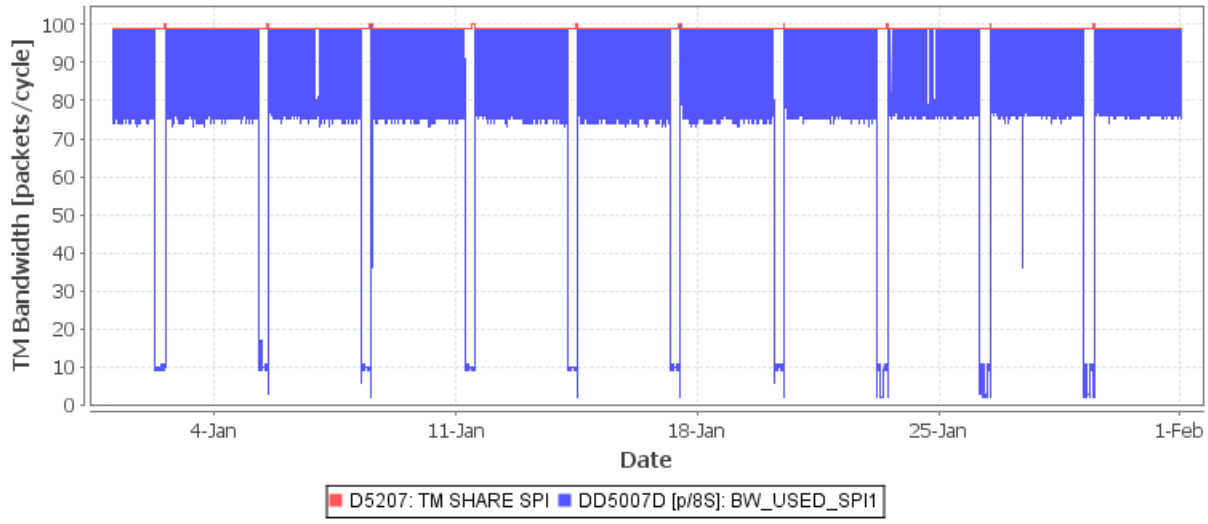


Figure 1: SPI TM bandwidth utilisation

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

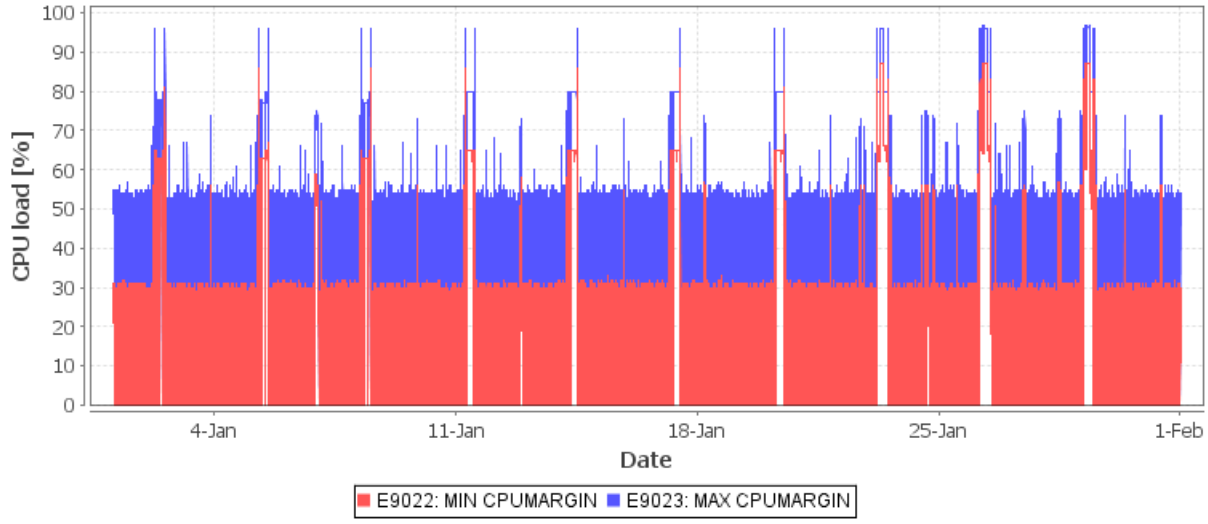


Figure 2: SPI IASW Performance

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

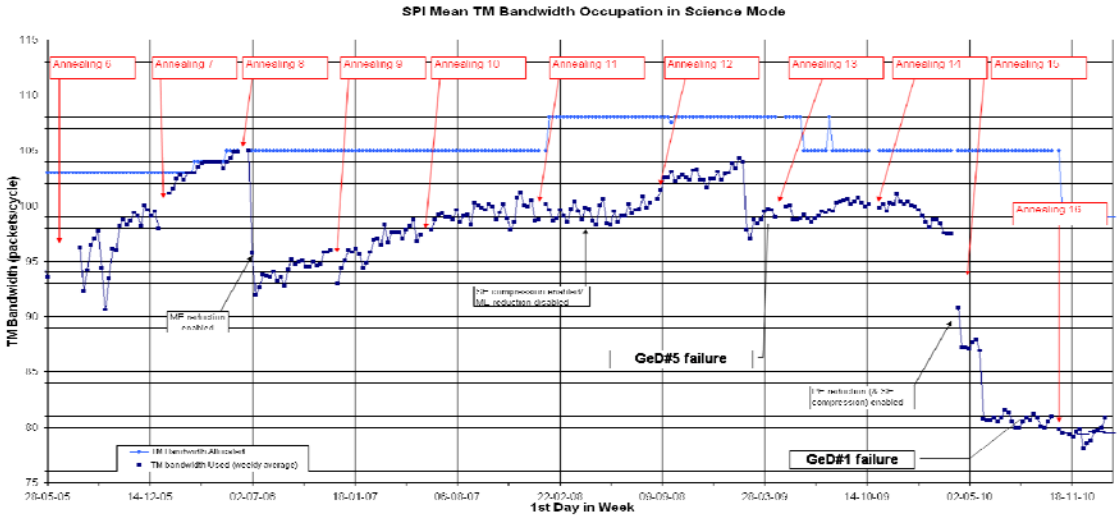


Figure 3: SPI TM bandwidth usage evolution since May 2005

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
- IBIS mean bandwidth utilisation in science mode: 111.07 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:

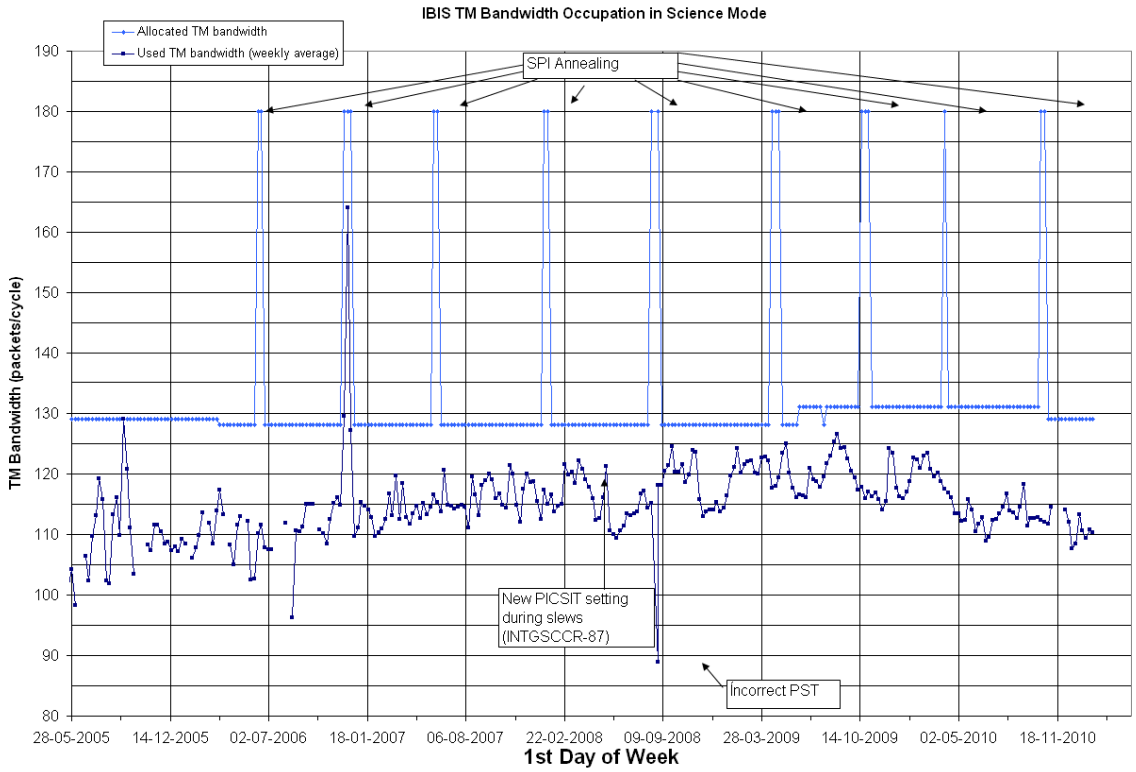


Figure 5: IBIS TM bandwidth usage evolution since May 2005

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:

- JEM-X1 & 2 was operated in Data Taking mode with a TM allocation of 8 packets/cycle.

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.

During this reporting period, 751 of the 759 planned science pointings were executed nominally. Four pointings were lost to FD problems, one was lost and two interrupted to the effects of IREM crashes, and one was not executed for reasons unknown. No Flat-field calibrations were performed this month.

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

2.2.5 IREM

The status of IREM is nominal.

On DoY 006 (06/01/2011), the 101st IREM SEU occurred.

On DoY 026 (26/01/2011), the 102nd IREM SEU occurred.

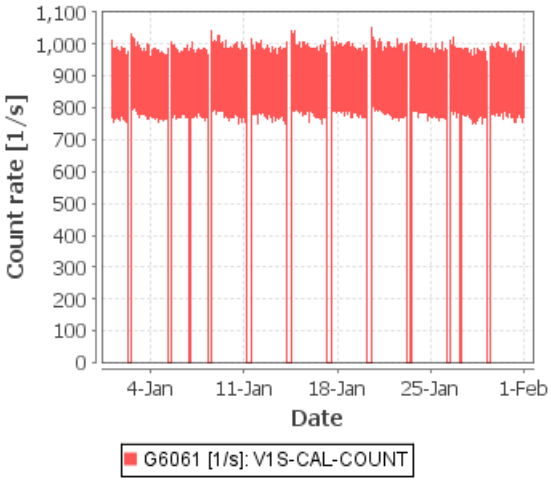
On DoY 027 (27/01/2011), the 103rd IREM SEU occurred.

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

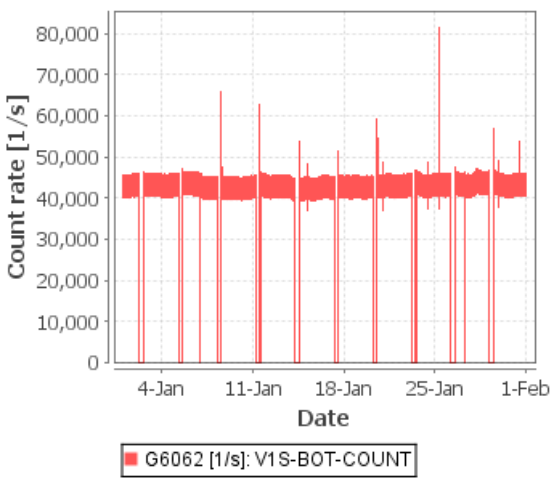
Radiation background

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:

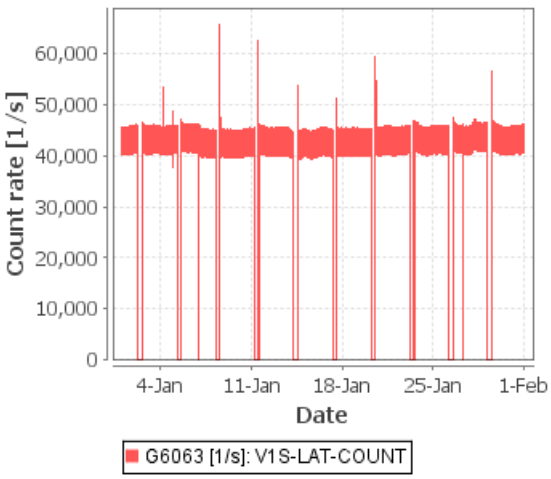
VETO Calibration Source Count Rate



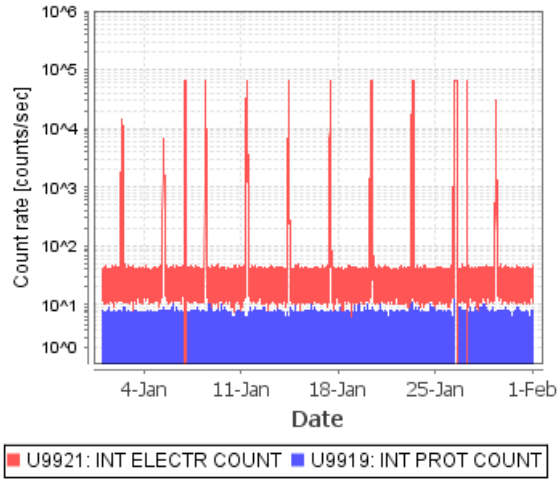
VETO Bottom Count Rate



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.

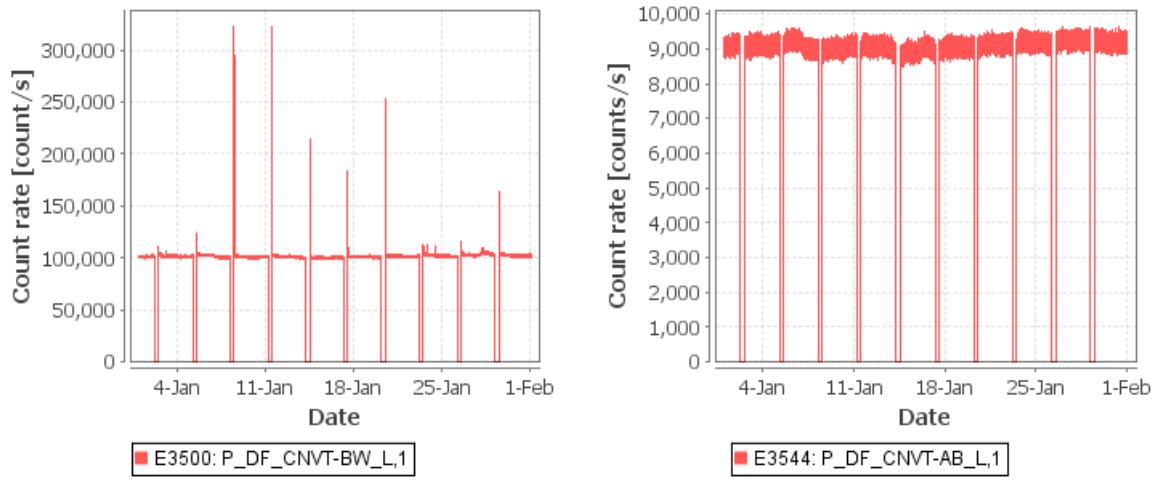


Figure 6: Instrument Count Rates

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

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

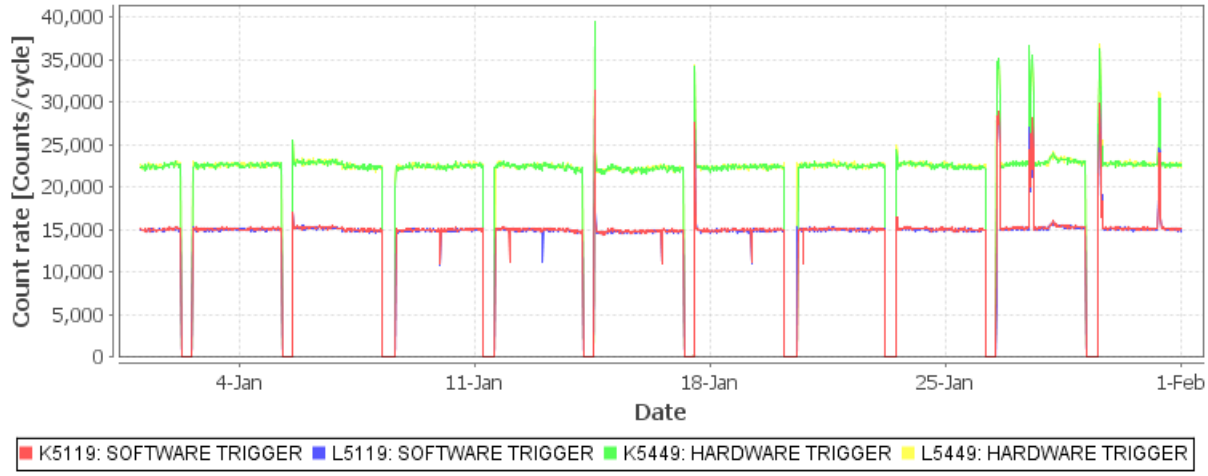


Figure 7: JEM-X Count rates. The smaller downward spikes in the figure are due to the slews of the spacecraft

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.

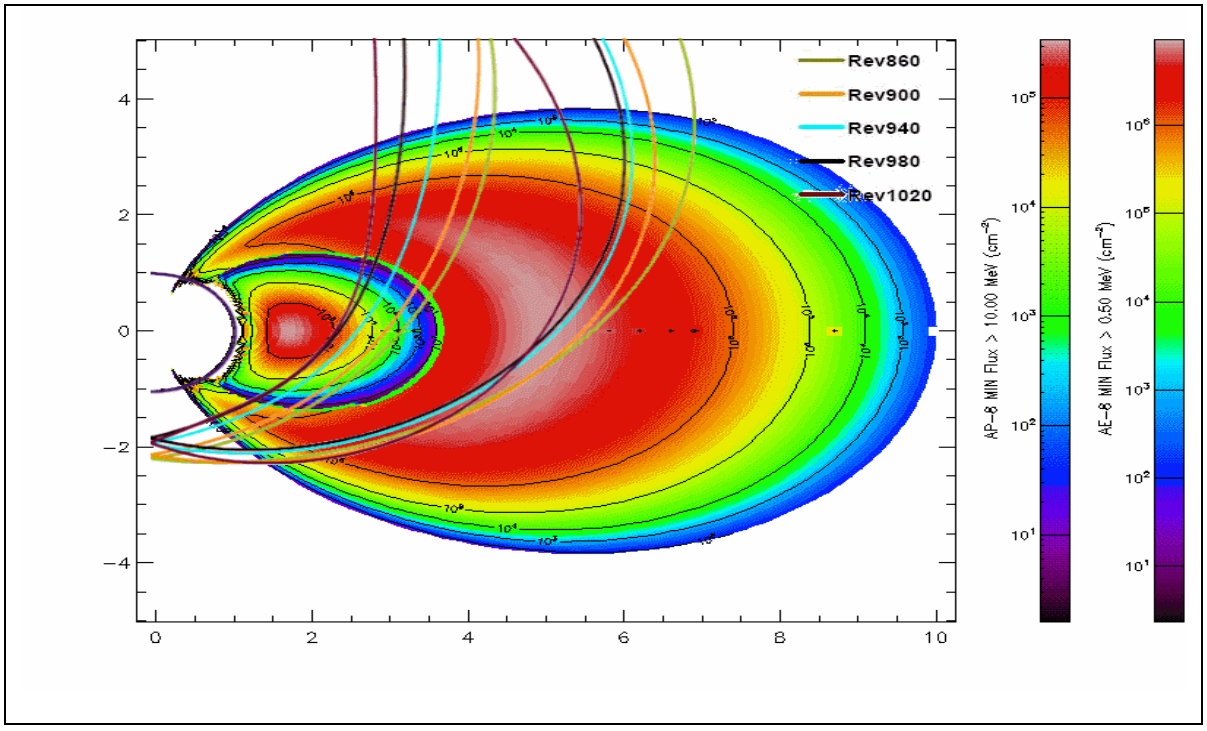


Figure 8: The predicted evolution of the orbit of Integral through the radiation belts

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.

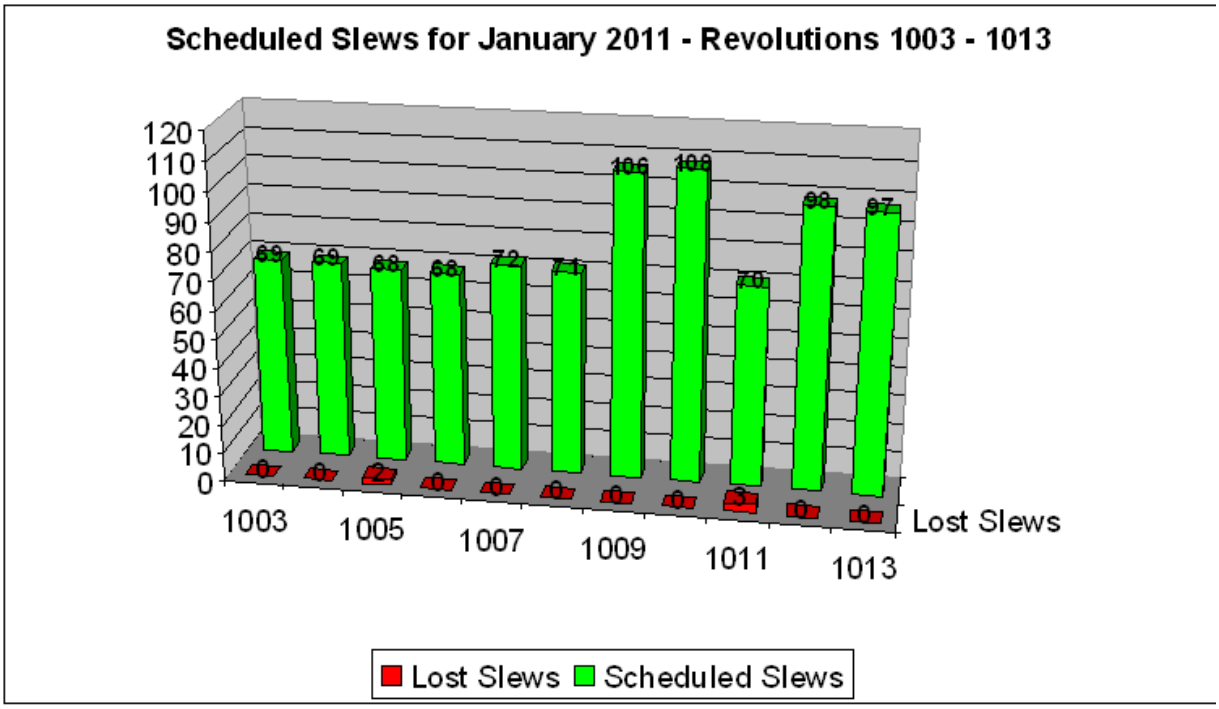


Figure 9: The number of slews scheduled compared to the number of slews lost

3.1 Mission Control System

On DOY 005 the OMCH and Multiplexer tasks crashed on imca and needed to be restarted
On DOY 013 the soft threshold for the /consolidator disk-space was reached on idda and iddb - this was traced back to a problem with the disk-tidy script not deleting files for Year 2011.
On DOY 020 the TCO server was restarted to apply new ground-station delay settings.
On DOY 023 the OBQM crashed and had to be restarted.
On DOY 024 all clients disconnected from the MISC as a new orbit file arrived – the complete a-chain was restarted to clear the problem
On DOY 025 RMCS software support configured sun120, sun127 and sun204 as backup clients for ROS/MEX/VEX
The ISDS and IFRD tasks on isdsa needed to be restarted on 6 occasions.

3.2 Ground Stations and Network

REDU

Five data gaps were identified and bad frames were received from REDU on 11 occasions which were due to RFI.

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.

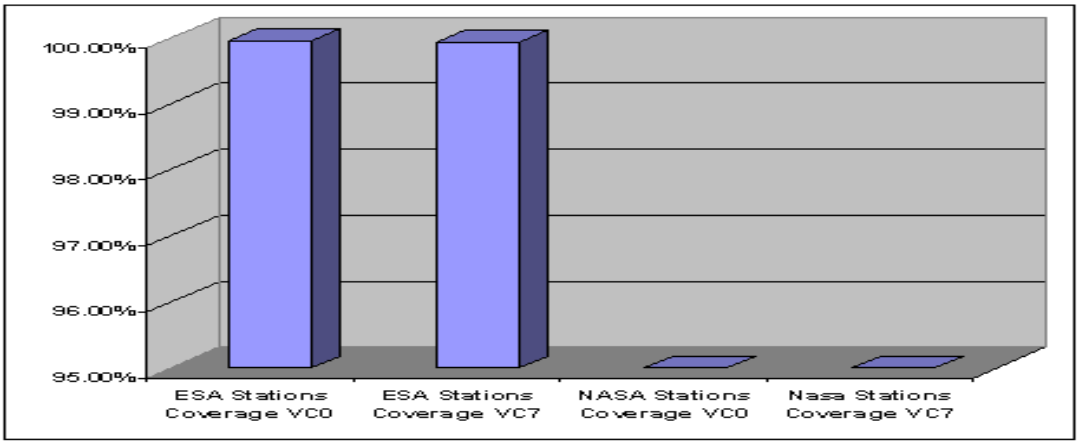


Figure 10: The usage of ESA ground stations compared to the usage of DSN ground stations

3.3 ISOC

3.3.1 Mission Planning

New or updated PSFs have been received for revolutions 1010 to 1019, corresponding to the time range 20 January to 19 February.

New observations have been planned for revolutions 1010 (20-23 January) to 1015 (4-7 February). For revolution 1013 multiple attempts were required before a valid wheel profile could be found by MOC.

TSFs have been received for revolutions 1008 to 1014.

3.3.2 Observation Status

New ECS files have been received for revolutions 988 to 997 (up to 15 December).

3.3.3 ISOC Science Data Archive

Scw data has been ingested up to revolution 995.

Raw telemetry copied from MOC is available up to 10 January with some gaps remaining.

New disks have been set up and syncing of rev_3 data is starting.

3.3.4 ISOC System

V27.2 released for testing on 14 January. This includes the appropriate delay for the first slew after GSHO.

V28 with AO-9 software is in preparation.

3.3.5 Problems

The scheduling problems in revolution 1013 are the main topic of MOC/ISOC videocon on 3 February.

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-3131	2011-01-11	IBIS response to high radiation	Payload	Closed
INT-3132	2011-01-26	MCS - OMCH task crashed at AOS	IMCS	Pending
INT-3133	2011-01-26	MPS - EPOS validation failed	IMCS	Pending
INT-3134	2011-01-29	MCS - Interlock failed on AOCS instead of SPI	IMCS	Pending
INT-3135	2011-01-27	Planning problems encountered during preparations for rev. 1013	ISOC	Open
INT_SC-312	2011-01-06	IREM Anomaly: Reset of IREM_CSCI S/W #101, 06/01/2011	Payload	Testing
INT_SC-313	2011-01-27	IREM Anomaly: Reset of IREM_CSCI S/W #103, 27/01/2011	Payload	Pending
INT_SC-314	2011-01-26	IREM Anomaly: Reset of IREM_CSCI S/W #102, 26/01/2011	Payload	Pending

5 Special Events & Future Milestones

Crab Calibration planned for 16th to 19th February 2011(Revolution 1019)
SPI annealing planned for May 2011
ISDC Communications Upgrade is an ongoing activity
Analysis for possible Earth observations in 2012

6 Appendix

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

6.1 AOCS operations

During this period, 466 Open Loop Slews, 385 Closed Loop Slews and 31 Momentum Biases were executed (as reported by ACC OEM).

8 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 01/02/2011 is reported in the following plot:

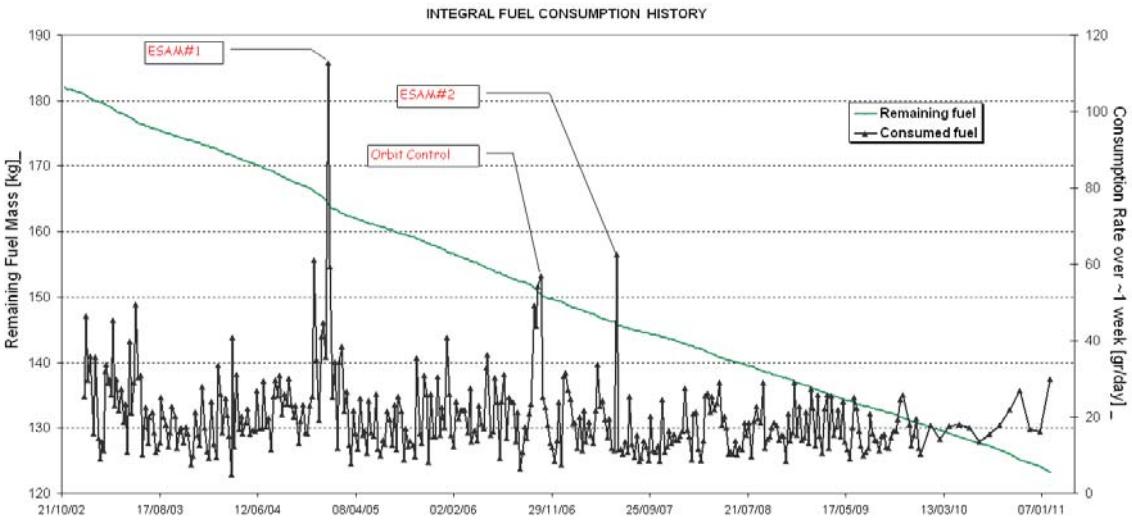


Figure 11: Fuel consumption. Note: ESAM fuel consumption is spread over period of ~1 week.

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.

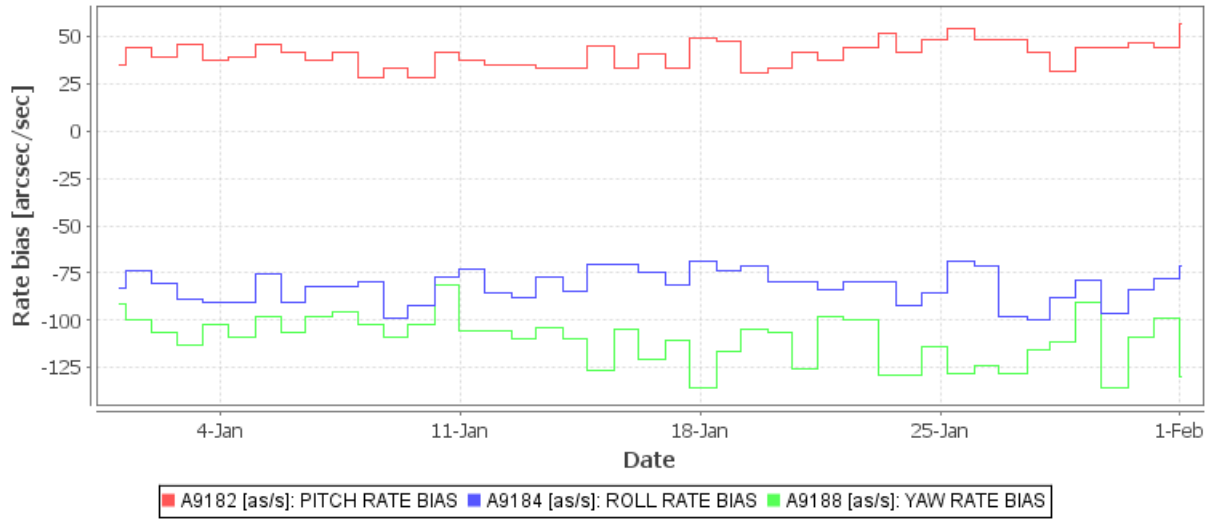


Figure 12: RMU pitch, roll and yaw. Historic data is available on request

6.1.3 Event log

Start of "summer eclipse season".

06/01/2011 (Day of Year 6, Revolution 1005)

FDS TPF update failed for the CGS prior to a RWB (20:08:00Z).The AOCS was suspended in the Timeline and FD was called in. Then a manual mapping was commanded and the TPF 1005_0500_M.CGS was generated and uplinked.

The subsequent RWB was performed manually via 1005_0500_M.RWB.

After the manual RWB was completed, a mapping was commanded an a manual slew was performed from attitude 10050034 to attitude 10050036.

After the manual slew was completed, the parameters for slew 10050036 were manually updated (spacontool).

Slews 10050035 and 10050036 were missed from the Timeline.

OTF was not reached for PIDs 10050035 and 10050036.

22/01/2011 (Day of Year 22, Revolution 1010)

FDS TPF update failed for slew 10100087 (19:50:00Z).The AOCS was suspended in the Timeline , then a manual mapping was commanded and a slew was manually generated from attitude 10100086 to attitude 10100087.

After the manual slew was completed, the parameters for slew 10100088 were manually updated (spacontool).

Slew 10100087 was missed from the Timeline. The OTF was not reached for its PID.

23/01/2011 (Day of Year 23, Revolution 1010 to 1011)

Autostack commanding for slew 10110006 (14:29:00Z) failed release. The AOCS was suspended in the Timeline , then a manual mapping was commanded and a slew was manually generated from attitude 10110005 to attitude 10110006.

After the manual slew was completed, the parameters for slew 10110007 were manually updated (spacontool).

Slew 10110006 was missed from the Timeline. The OTF was not reached for its PID.

24/01/2011 (Day of Year 24, Revolution 1011)

FDS TPF update failed for slew 10110031 (14:28:00Z).The AOCS was suspended in the Timeline , then a manual mapping was commanded and a slew was manually generated from attitude 10110030 to attitude 10110032.

After the manual slew was completed, the parameters for slew 10110033 were manually updated (spacontool).

Slews 10110031 and 10110032 were missed from the Timeline. The OTF was not reached for PIDs 10110031 and 10110032.

25/01/2011 (Day of Year 25, Revolution 1011)

FDS TPF update failed for slew 10110052 (11:00:00Z) due to FTS problems.The AOCS was suspended in the Timeline , then a manual mapping was commanded and a slew was manually generated from attitude 10110051 to attitude 10110052.

After the manual slew was completed, the parameters for slew 10110053 were manually updated (spacontool).

Slew 10110052 was missed from the Timeline. The OTF was not reached for its PID.

30/01/2011 (Day of Year 30, Revolution 1013)

IMU1 switched ON during the stable pointing of PID 10130036 (08:54:00Z). After the IMU switched back OFF, a manual slew was performed to go to attitude 10130037.

Then a mapping was commanded and the parameters for slew 10130038 were manually updated (spacontool).

OTF was not reached for PIDs 10130036 and 10130037.

Slew 10130037 was missed from the Timeline.

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

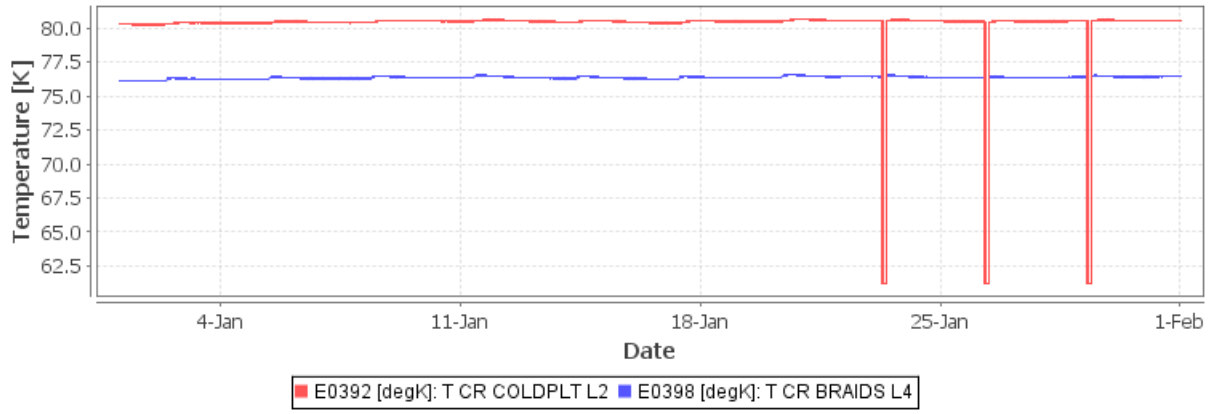


Figure 13: SPI Cold plate and H-bus temperature

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

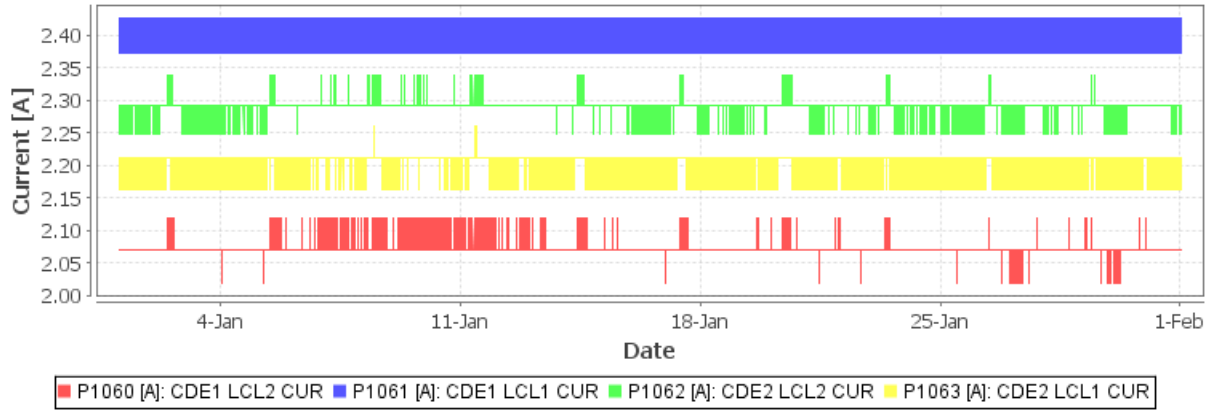


Figure 14: SPI CDE LCL curent

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.

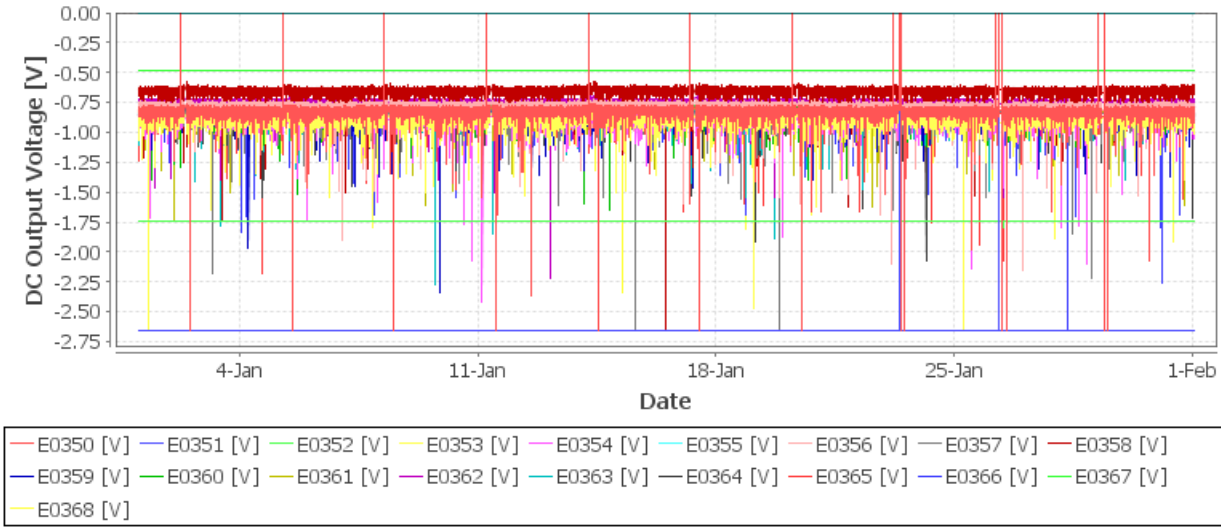


Figure 15: AFEE DC Output Voltages. Note that the data is sampled every 8th packet (64sec)

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

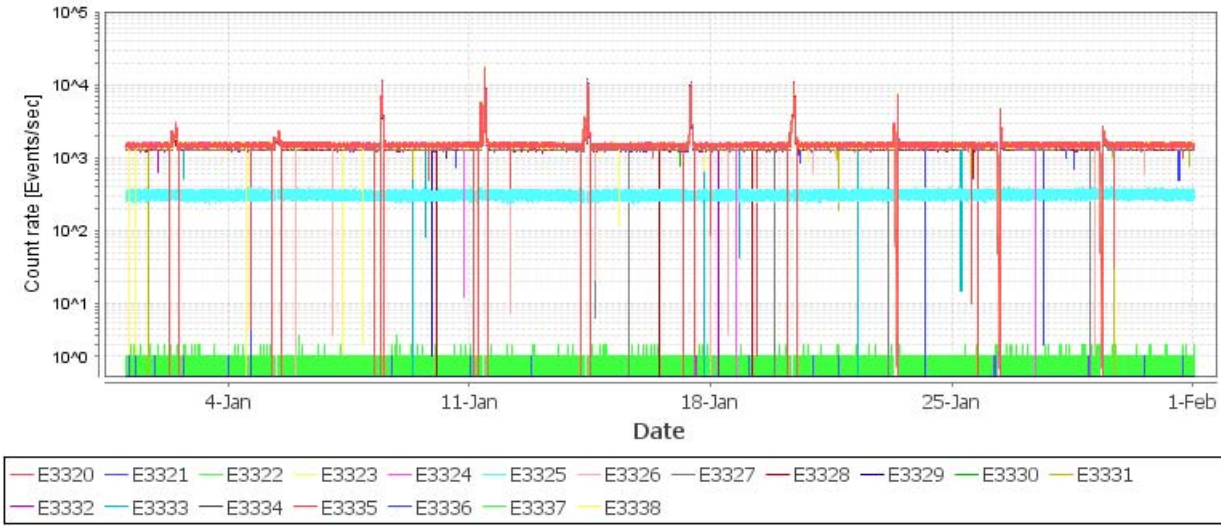


Figure 17: SPI GeD Time Tagged count rates. Note that the scale used for plotting is logarithmic

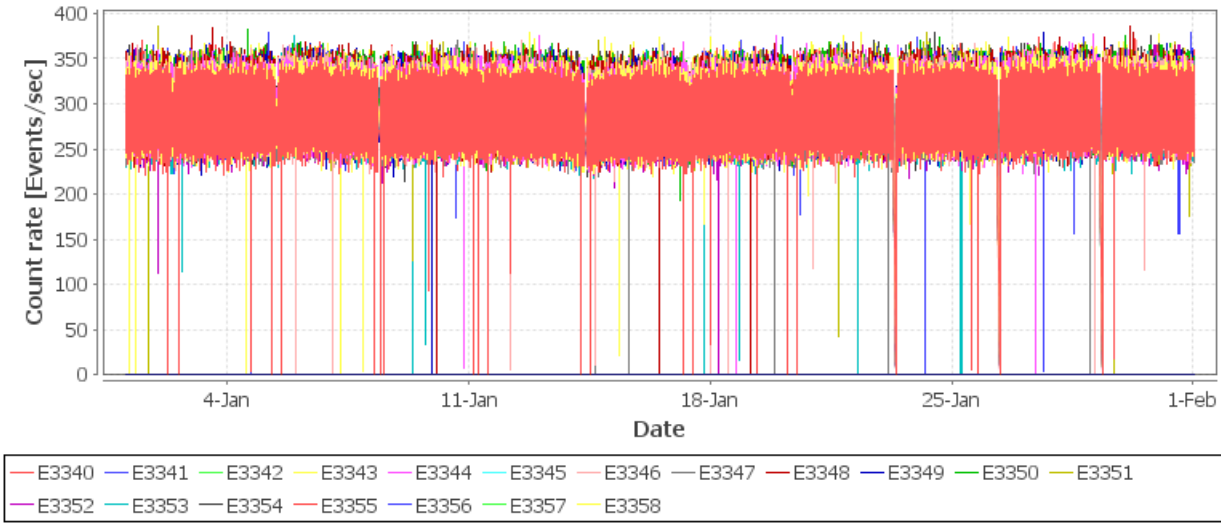


Figure 18: SPI GeD Time Tagged Saturated count rates

PSD

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

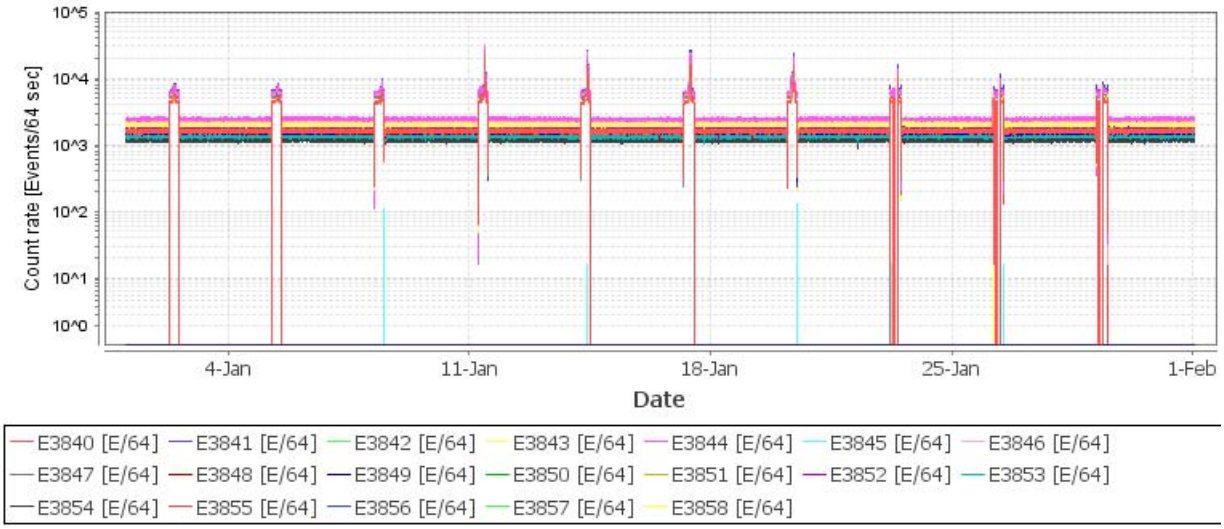


Figure 19: SPI PSD GeD Channel rates

6.2.2 Event Log

Due to continuing high background radiation after the expected radiation belt exit of revolutions 1006, 1007, 1008, 1009 and 1010, TM parameter E3500 (ACS Counts Below 100MeV) was OOL from 2011.008.13.13.41Z - 2011.008.13.046.02Z, 2011.011.12.59.46Z - 2011.011.13.22.28Z, 2011.014.12.46.29Z - 2011.014.13.18.28Z, 2011.017.12.32.05Z - 2011.017.12.43.56Z and 2011.020.12.37.33Z - 2011.020.13.34.52Z. As in each case it returned within limits of its own accord as the background radiation level decreased, no action was taken.

06-01-2011 (Day of Year 006, Revolution 1005)

At 13:28:36z TM parameter E2295 went OOL with value = PARAM < SPEC. It returned within limits when the next packet was received, no action was taken.

08-01-2011 (Day of Year 008, Revolution 1006)

At 18:59:12z TM parameter E3174 went OOL with value = PARAM < SPEC. It returned within limits when the next packet was received at 19:09:54Z, no action was taken.

17-01-2011 (Day of Year 017, Revolution 1009)

At 12:24:32z TM parameter E2350 and E3164 went OOL with value = PARAM < SPEC. They returned within limits of their own accord at 12:26:54Z, no action was taken.

23-01-2011 (Day of Year 023, Revolution 1011)

At 12:00:25Z the TC EU0102D from the sequence EEXIT03 failed release from the Timeline. The sequence was re-uplinked successfully according to the cross reference at 12:10:57Z. No further Action was taken. It is still unclear why the command failed release. Investigations are still ongoing.

25-01-2011 (Day of Year 025, Revolution 1011)

At 11:52:33z TM parameter E3274 went OOL with value = PARAM < SPEC. It returned within limits after the report command was send at 11:59:24Z, no action was taken.

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:

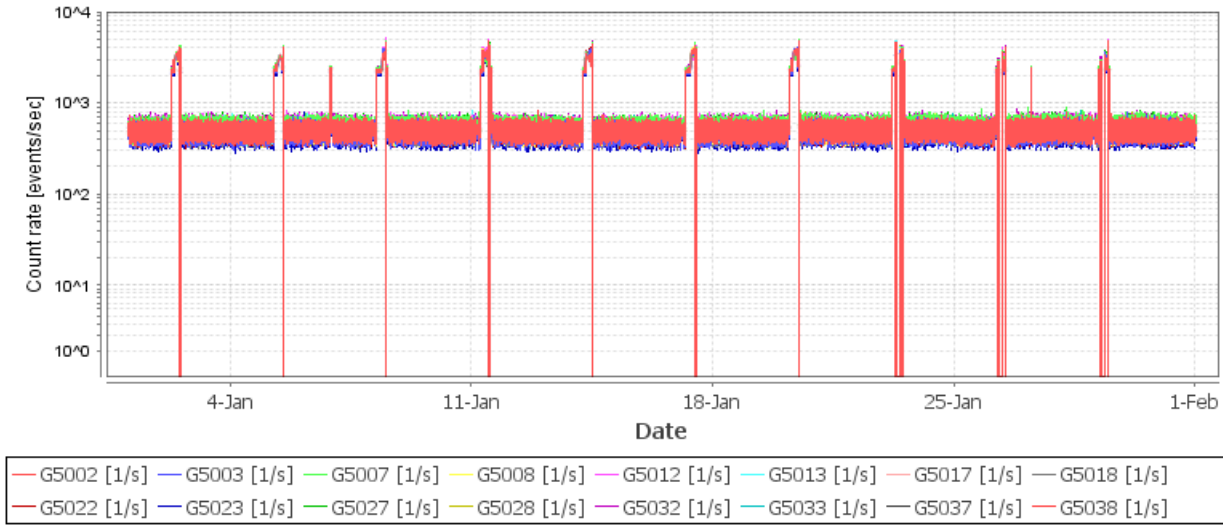


Figure 21: PICsIT semi-module counters. Note that the scale used for plotting is logarithmic

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

Start of the “Summer” eclipse season.

06/01/2011 (Day of Year 6, Revolution 1005)

Due to an IREM SEU, IBIS transitioned autonomously to Safe configuration at 2011.006.06.22.00Z. It was recovered as follows:

- At 2011.006.06.23.00Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE
- At 2011.006.06.22.00Z ED GESTAN02 uplinked with the planned observation parameters and commanding to IBIS from the Timeline re-enabled.

IBIS operations continued nominally.

11/01/2011 (Day of Year 11, Revolution 1006 to 1007)

At 2011-01-11T12:32Z, in the IBIS_CAL window as part of GEISCL03 ED, the ISGRI MCEs are switch to nominal and, because of high radiation, the G2013-G2083 family goes OOL with HIGH counters (NOTE: The same phenomena occurred on 2011-01-08T12:43Z). The radiation belt exit event was at 2011-01-11T12:50:59Z

X7955 was already OOL showing high radiation.

At 2011-01-11T12:55Z IBIS responded to the high radiation protection automatism. 3 OEMs were received:

2011-01-11T12:54:53Z IBIS1 IASW VETO SWITCH OFF PERFORMED DUE TO AUTOMATISM

2011-01-11T12:55:09Z IBIS1 IASW VETO SWITCH OFF PERFORMED DUE TO AUTOMATISM

2011-01-11T13:07:25Z IBIS1 IASW VETO SWITCH OFF PERFORMED DUE TO AUTOMATISM

The third one occurred coinciding with the commanding of GESTAN02 ED from the timeline (the subsystem had not been disabled).

After radiation decreased, the recovery was performed by executing:

- 14:18:00Z FCP_IBIS1_0803 “IBIS Exit from safe mode”
- 14:50:00Z Re uplink latest GESTAN02 ED

Later that day at 14:47:41Z parameter X7500 “IBIS HIST DWN LD” went out of limit FALSE.

SPACON performed the following procedure FCP_IBIS1_0312 and executed G0129 afterwards, but this didn’t cure the problem.

At the next pointing start, the problem cured itself.

23/01/2011 (Day of Year 23, Revolution 1010 to 1011)

After ED GEBEXT01 was executed (2011-01-23T12:27:10Z), the VETO parameters G6108 to G6227 became OOL, having all of them have raw value = 0

The following recovery was performed as per G6117 entry in the cross-reference:

G0125 TC-Y-550 2011.023.12.41.23

G0601 TC-V-STANDBY 2011.023.12.41.57

G0634 TC-V-MAINT 2011.023.12.44.41

followed by commands G0601, G0600 and then G0129 back to science.

Unfortunately, because of an operator mistake, the following was commanded:

G0601 TC-V-STANDBY 2011.023.13.40.03

G0129 TC-Y-554 2011.023.13.43.03

G0125 TC-Y-550 2011.023.13.52.06

G0600 TC-V-NOMINAL 2011.023.13.58.39

G0129 TC-Y-554 2011.023.14.00.28

After this point, science was resumed.

27/01/2011 (Day of Year 27, Revolution 1012)

Due to an IREM SEU, IBIS transitioned autonomously to Safe configuration at 2011.027.05.33.00Z. It was recovered as follows:

- At 2011.027.05.55.00Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE
- At 2011.027.06.05.00Z ED GESTAN02 uplinked with the planned observation parameters and commanding to IBIS from the Timeline re-enabled.

IBIS operations continued nominally.

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.

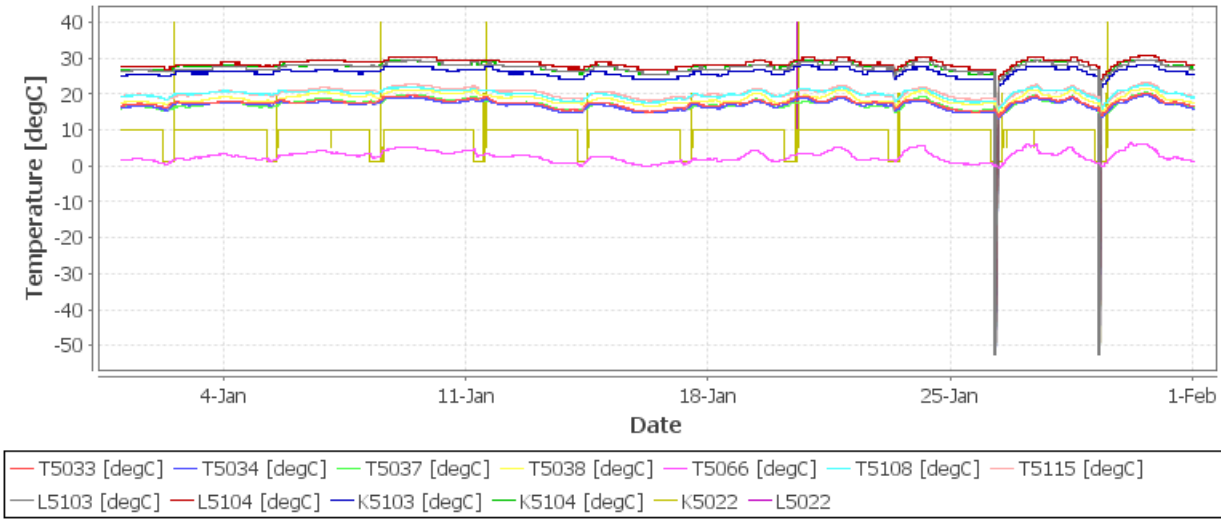


Figure 22: JEMX Detector and DFEE Temperatures

6.4.2 Event Log

02-01-2011 (Day of Year 002, Revolution 1004)

At 06:06:00, TC L0021, LU0014 failed completion (false indicator), no action was taken.

06-01-2011 (Day of Year 006, Revolution 1005)

At 22:00:30 JEMX-1 & 2 parameters K5315, K5316, K5317, L5315, L5316 & L5317 went Out-of-Limits due to an IREM SEU (#101). There was no impact as the reaction has been disabled.

08-01-2011 (Day of Year 008, Revolution 1006)

At 13:05:00, the TM parameters K/L5317 OOL High/High due to high radiation. This forced a delay in their activation after perigee.

At 13:36, the instruments were manually put to SAFE mode.

14:45, JEMX-1 was manually activated, and at 15:27 JEMX-2.

11-01-2011 (Day of Year 011, Revolution 1007)

At 13:12:00, the JEMX high voltage activation sequences K/LEHVAC01 sequences both fail due to high radiation.

At 14:17 JEMX-1 was manually activated, and at 14:36, JEMX-2.

14-01-2011 (Day of Year 014, Revolution 1008)

At 12:24:00, the K/L5317 parameters, which echo the IREM output were out-of-limits high, however, the reaction has been disabled

At 13:04:00, parameters KD 5020D and LD 5020D went briefly out of limit, no action was taken.

20-01-2011 (Day of Year 020, Revolution 1010)

At 12:49:00, the K/LEHVAC01 sequences both failed due to high radiation. A manual recovery was initiated, and at 13:26, JEMX 1 was back in data taking, however 3 minutes later, during the JEMX-2 recovery, a radiation spike forced it back to Safe mode.

Finally JEMX-2 was recovered at 13:50, and JEMX-1 at 14:21.

23-01-2011 (Day of Year 023, Revolution 1011)

At 22:16:00, TC L0021, SWREAD INT uncertain failed, although it happened at 12.56.35.

27-01-2011 (Day of Year 027, Revolution 1012)

At 05:34:0 JEMX-1 & 2 parameters K5315, K5316, K5317, L5315, L5316 & L5317 went Out-of-Limits due to an IREM SEU (#103). There was no impact as the reaction has been disabled.

At 12:04:00 & 12:58:00, parameters K/L5136 (Buffer Loss) went OOL high for a few seconds.

29-01-2011 (Day of Year 029, Revolution 1013)

At 12:15:00 the K/LEHVAC01 sequences both failed due to high radiation. A manual recovery was initiated, and at 12:46, both instruments were back in Data-taking.

6.5 OMC

6.5.1 Operations

The status and performance of OMC is nominal.

6.5.2 Event Log

06-01-2011 (Day of Year 006, Revolution 1005)

At 20:08, a FD problem, with a Change of guide Star forced an interruption to the Timeline. Before the recovery was complete, and IREM SEU caused OMC to switch to SAFE mode. A recovery was finally completed at 22:58:27. The impact was the loss of pointings 10050035 & 10050036. At 22:54, the command M1500 (To standby) was erroneously sent instead of TC1511 (Safe off), the command was rejected.

```
2011.006.21.30.25.521   2011.006.21.30.30.662   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2011.006.21.30.31.271   2011.006.21.30.42.308   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2011.006.22.31.10.899   2011.006.22.31.18.609   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2011.006.22.31.17.774   2011.006.22.31.30.280   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2011.006.22.54.28.775   2011.006.22.54.30.911   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, plus the rejected TC M1500.

22-01-2011 (Day of Year 022, Revolution 1010)

At 19:50, a FD problem forced an interruption. A recovery was performed, and the timeline rejoined at 20:25:01, The impact was the loss of pointing 10100087. It was at this time that the following pair of commands was rejected:

```
2011.022.20.09.20.683   2011.022.20.09.30.745   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR     N      E   E

2011.022.20.09.26.808   2011.022.20.09.37.078   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

24-01-2011 (Day of Year 024, Revolution 1011)

At 11:40, for unknown reasons pointing 10110028 was not performed.

At 14:08, after a swap from the A-chain to the b-chain, the FD update for the next slew failed. A recovery was performed, and the timeline rejoined at 15:17. The impact was the loss of pointing 10110031. It was at this time that the following pair of commands was rejected:

```
2011.024.14.32.38.904   2011.024.14.32.48.343   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR     N      E   E

2011.024.14.32.45.029   2011.024.14.32.48.366   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.

25-01-2011 (Day of Year 025, Revolution 1011)

At 10:27, a problem with the FTS prevented a slew update from arriving. A recovery was subsequently performed, and the timeline rejoined at 11:36. The impact was the loss of pointing 10110052. It was at this time that the following pair of commands was rejected:

```
2011.025.11.06.45.825   2011.025.11.06.47.384   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR     N      E   E

2011.025.11.06.51.950   2011.025.11.06.59.276   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.

27-01-2011 (Day of Year 027, Revolution 1012)

At 05:33:28, an IREM SEU (#103) forced OMC to SAFE mode, a recovery was performed, and the unit returned to standby at 05:46:56. The impact was pointing 10120030 was shortened from a planned

2083 to 1177 seconds. At 10:13:03, when the CCCFs were sent OMC switched to STAND-BY. The pointing commands were manually resent at 10:35:03. The impact was pointing 10120038 was cut short from a planned 2083 to 456 seconds.

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.

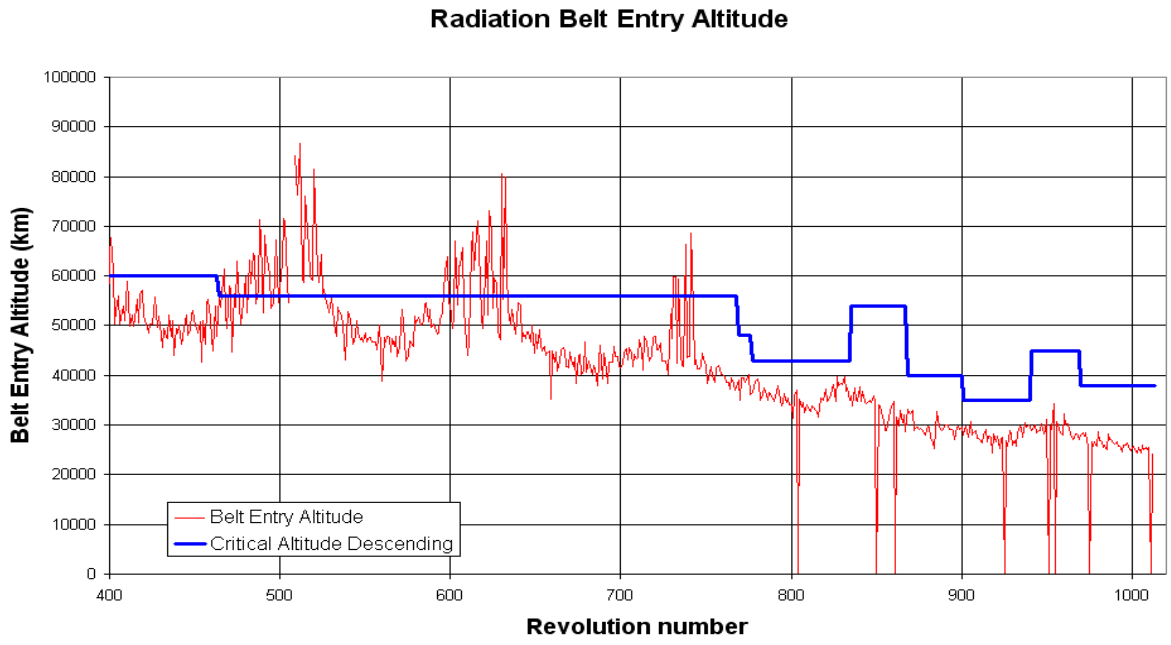


Figure 23: Radiation belt entry

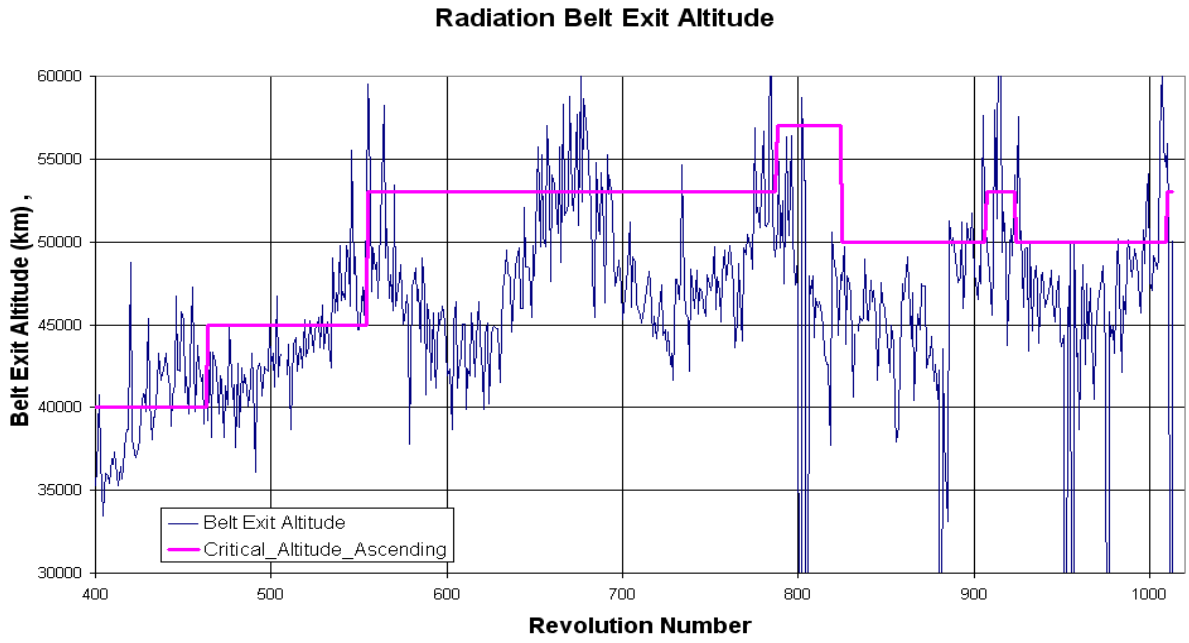


Figure 24: Radiation belt exit

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
1003	RAD_ENTR R 2011-01-02T06:45:23 Z	02/01/2011 08:18:53	19880.0	02-Jan-2011 08:14:06	19353.45	02-Jan-2011 08:54:06	9854.451
1004	RAD_EXIT R 2011-01-02T13:31:04 Z	02/01/2011 12:49:49	43053.0	02-Jan-2011 13:14:06	47437.14	02-Jan-2011 09:34:06	3947.111
1004	RAD_ENTR R 2011-01-05T06:32:37 Z	05/01/2011 08:00:45	20103.5	05-Jan-2011 07:58:29	20482.18	05-Jan-2011 08:48:29	8755.848
1005	RAD_EXIT R 2011-01-05T13:19:02 Z	05/01/2011 12:44:21	44306.8	05-Jan-2011 13:08:29	48163.86	05-Jan-2011 09:18:29	4090.76

1005	RAD_ENTR R 2011-01-08T06:17:59 Z	N/A	N/A	08-Jan-2011 07:50:53	18898.00	08-Jan-2011 08:30:53	9480.294
1006	RAD_EXIT R 2011-01-08T13:04:50 Z	08/01/2011 13:37:01	54708.0	08-Jan-2011 12:50:53	47619.01	08-Jan-2011 09:00:53	4291.099
1006	RAD_ENTR R 2011-01-11T06:04:19 Z	11/01/2011 07:31:58	20357.6	11-Jan-2011 07:34:22	19239.69	11-Jan-2011 08:14:22	9791.313
1007	RAD_EXIT R 2011-01-11T12:50:59 Z	11/01/2011 13:26:06	55930.5	11-Jan-2011 12:34:22	47427.43	11-Jan-2011 08:54:22	4060.85
1007	RAD_ENTR R 2011-01-14T05:51:14 Z	14/01/2011 07:23:18	18040.8	14-Jan-2011 07:17:31	19978.49	14-Jan-2011 07:57:31	10526.13
1008	RAD_EXIT R 2011-01-14T12:37:41 Z	14/01/2011 13:01:50	54437.8	14-Jan-2011 12:27:31	48575.54	14-Jan-2011 08:37:31	3986.534
1008	RAD_ENTR R 2011-01-17T05:36:19 Z	17/01/2011 07:08:22	18220.4	17-Jan-2011 07:03:59	19919.08	17-Jan-2011 07:43:59	10509.58
1009	RAD_EXIT R 2011-01-17T12:23:11 Z	17/01/2011 12:37:42	52042.1	17-Jan-2011 12:13:59	48531.09	17-Jan-2011 08:23:59	4078.796
1009	RAD_ENTR R 2011-01-20T05:22:27 Z	20/01/2011 06:53:42	19521.4	20-Jan-2011 06:45:42	21032.66	20-Jan-2011 07:35:42	9349.09
1010	RAD_EXIT R 2011-01-20T12:28:41 Z	20/01/2011 13:29:02	61738.5	20-Jan-2011 11:55:42	47700.32	20-Jan-2011 08:05:42	4277.065
1010	RAD_ENTR R 2011-01-23T05:09:45 Z	23/01/2011 06:39:58	20662.7	23-Jan-2011 06:33:14	20602.03	23-Jan-2011 07:23:14	8845.731

1011	RAD_EXIT R 2011-01-23T12:15:22 Z	23/01/2011 11:33:10	>>38288.3	23-Jan-2011 11:43:14	48118.67	23-Jan-2011 07:53:14	4061.405
1011	RAD_ENTR R 2011-01-26T04:59:29 Z	26/01/2011 06:32:54	19330.5	26-Jan-2011 06:22:32	20616.83	26-Jan-2011 07:12:32	8816.827
1012	RAD_EXIT R 2011-01-26T12:04:35 Z	N/A	N/A	26-Jan-2011 11:32:32	48173.27	26-Jan-2011 07:42:32	3991.818
1012	RAD_ENTR R 2011-01-29T04:49:35 Z	29/01/2011 06:24:07	17623.5	29-Jan-2011 06:14:24	20012.94	29-Jan-2011 06:54:24	10561.03
1013	RAD_EXIT R 2011-01-29T11:54:51 Z	29/01/2011 11:35:43	49905.4	29-Jan-2011 11:24:24	48551.29	29-Jan-2011 07:34:24	3986.151

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

05-01-2011 (Day of Year 005, Revolution 1004)

At 07:42:00 the TC: U4921 INT GND LINK OFF (part of the sequence UEGROF01) failed its CEV. The TM parameter U9903 SR INT GND LINK was OFF. No action was taken, and there was no impact.

06-01-2011 (Day of Year 006, Revolution 1005)

At 21:59:49Z, a local reset of the IREM CSCI S/W (SEU #101) was observed. 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 2011.006.21:59:49Z (158615.1 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.

At 00:55:00 the TC: U4920 INT GND LINK ON failed its CEV. The TM parameter U9903 SR INT GND LINK was ON. No further action was taken, and there was no impact.

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 01:26:00Z.

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 22:58:00Z and IBIS at 23:30:00Z.

08-01-2011 (Day of Year 008, Revolution 1005)

At 07:26:00 the TC: U4921 INT GND LINK OFF (part of the sequence UEGROF01) failed its CEV. The TM parameter U9903 SR INT GND LINK was OFF. No action was taken, and there was no impact.

14-01-2011 (Day of Year 014, Revolution 1007)

At 06:59:00 the TC: U4921 INT GND LINK OFF (part of the sequence UEGROF01) failed its CEV. The TM parameter U9903 SR INT GND LINK was OFF. No action was taken, and there was no impact.

20-01-2011 (Day of Year 020, Revolution 1009)

At 09:57:00 the TC: U4920 INT GND LINK ON failed its CEV. The TM parameter U9903 SR INT GND LINK was ON. No further action was taken, and there was no impact.

23-01-2011 (Day of Year 023, Revolution 1010)

At 09:45:00 the TC: U4920 INT GND LINK ON failed its CEV. The TM parameter U9903 SR INT GND LINK was ON. No further action was taken, and there was no impact.

26-01-2011 (Day of Year 026, Revolution 1011-1012)

At 09:03:02Z, after AOS, it was observed that a local reset of the IREM CSCI S/W (SEU #102) had occurred during the perigee passage. 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 between 2011.026.06:36:22 and 2011.026.09:03:02Z (<17511.9 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 A000 HEX = 40960 DEC = 1010000000000000, i.e counting mode off, Standard mode, command validity off, and HV off. 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 15:27:00Z.

The IREM automatic transition to Standard Mode did not affect the instruments this time, as it occurred inside the belts, when the instruments are in safe mode anyway.

27-01-2011 (Day of Year 027, Revolution 1012)

At 05:33:26Z, a local reset of the IREM CSCI S/W (SEU #103) was observed. 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 2011.027.05:33:26Z (141502.6 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 08:15:00Z.

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 05:47:00Z and IBIS at 06:07:00Z