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

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

This report addresses the activities from March and covers the revolutions 1023 until 1033 (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-INTTEGRAL 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.

14 slews were missed from the Timeline.

The fuel consumption over the reporting period was 0.8425 Kg. The remaining propellant is in the order of 121.7095 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 16th SPI annealing, which ended on 28/10/2010, 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 \pm 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 2011-03-11T01:10:22Z to 2011-03-11T06:05:35Z (OMC Flat Field Calibration), when it was 88 packets/cycle. The average telemetry occupation when the allocation was 99 packets/cycle was 78.9 packets/cycle.

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

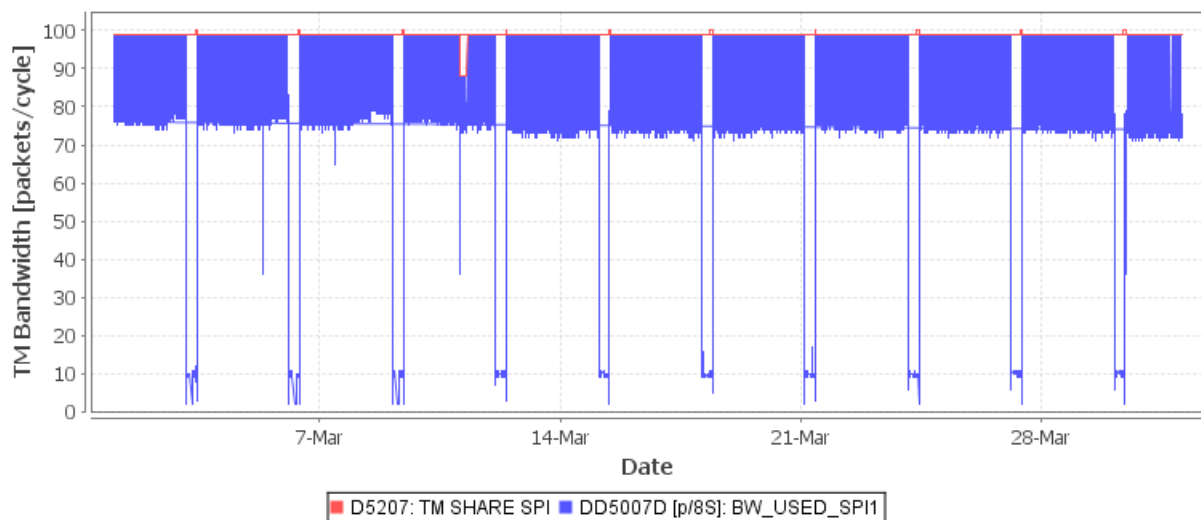


Figure 1: SPI TM bandwidth utilisation

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

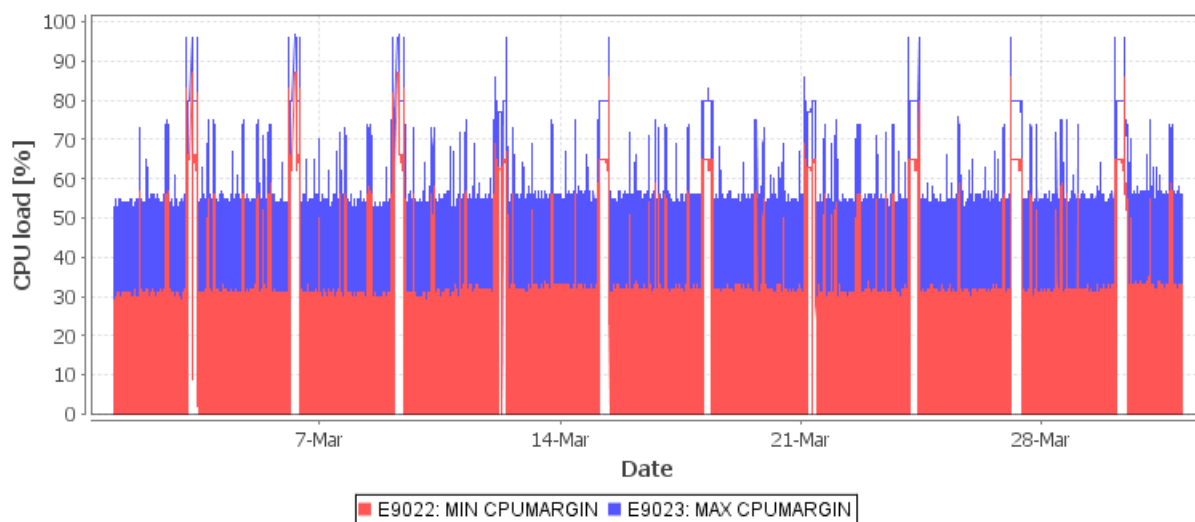


Figure 2: SPI IASW Performance

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

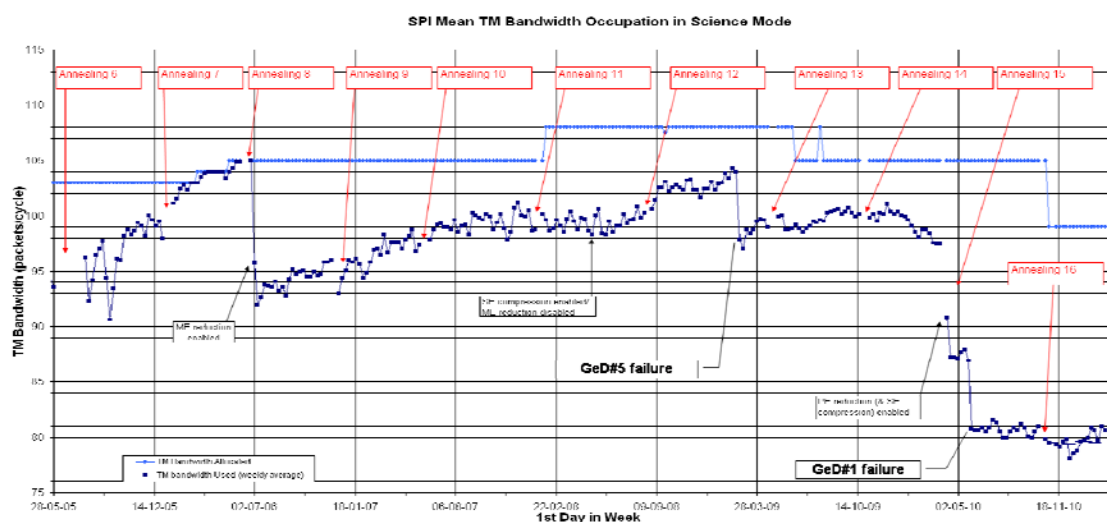


Figure 3: SPI TM bandwidth usage evolution since May 2005

Note: Some more information concerning the SPI operations is provided in Appendix 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 2011-03-11T01:10:22Z to 2011-03-11T06:05:35Z (OMC Flat Field Calibration), when it was 90 packets/cycle

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

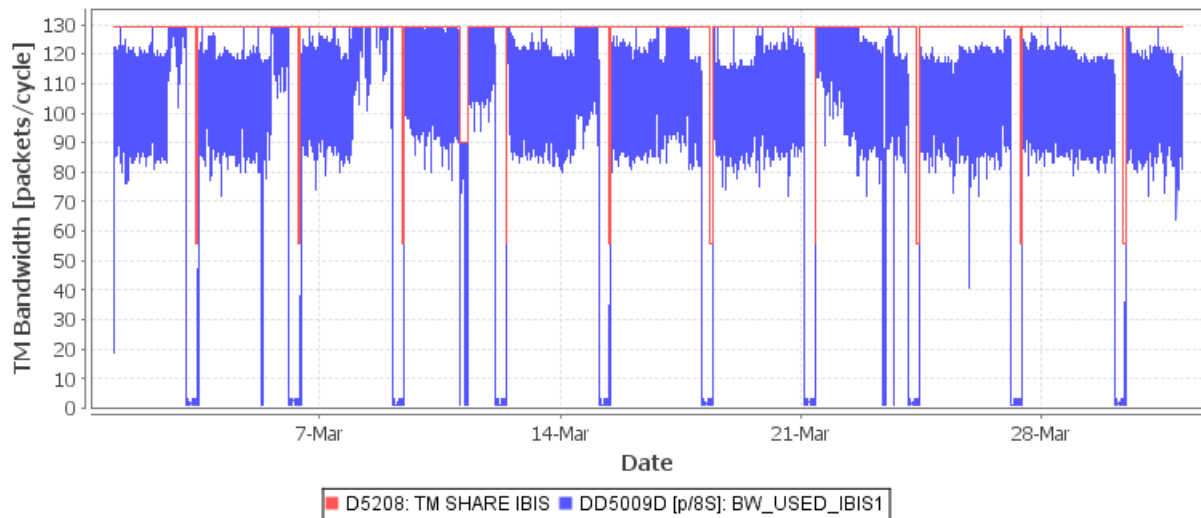


Figure 4: IBIS TM bandwidth utilisation

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 were 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 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 2011-03-11T01:10:22Z to 2011-03-11T06:05:35Z during the Flat-field calibration, when it was 63 packets/cycle.

During this reporting period, 900 of the 937 planned science pointings were executed nominally. Twenty pointings were lost and one shortened due high radiation, 10 were lost to AOCS problems, 3 pointings were lost and 2 interrupted by IREM SEUs. One was lost to RFI. In addition, one Flat-field calibration was 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 064 (05/03/2011), the 105th IREM SEU occurred

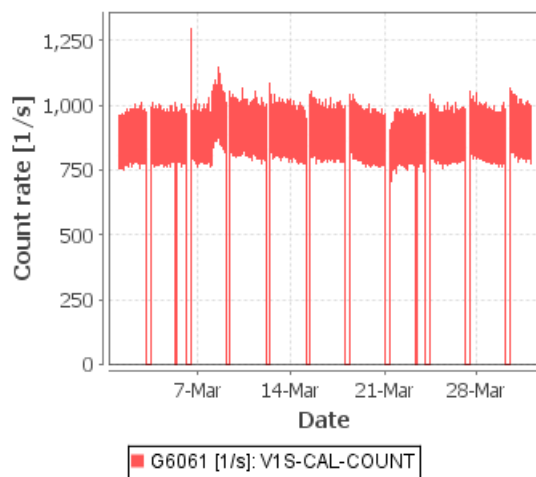
On DoY 082 (23/03/2011), the 106th IREM SEU occurred

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

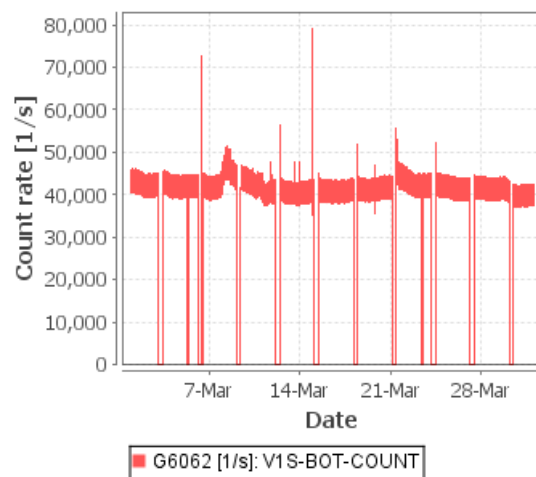
Radiation background

The background radiation level as measured by the instrument counters was low during the reporting period, except on the 8th March from 03:42 until the end of the revolution, when high radiation forced OMC to SAFE. The following plots show the SPI ACS, IBIS VETO, JEM-X Triggers and IREM count rates over the reporting period:

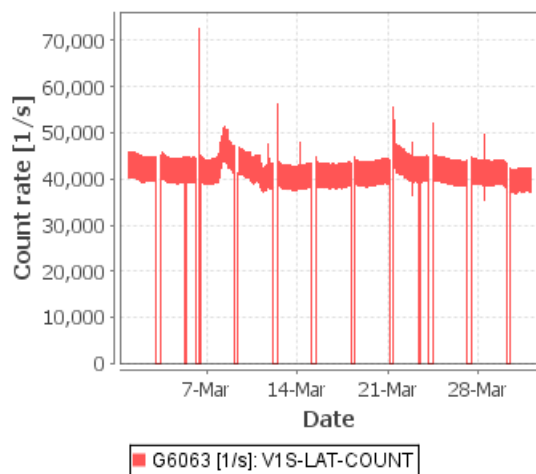
VETO Calibration Source Count Rate



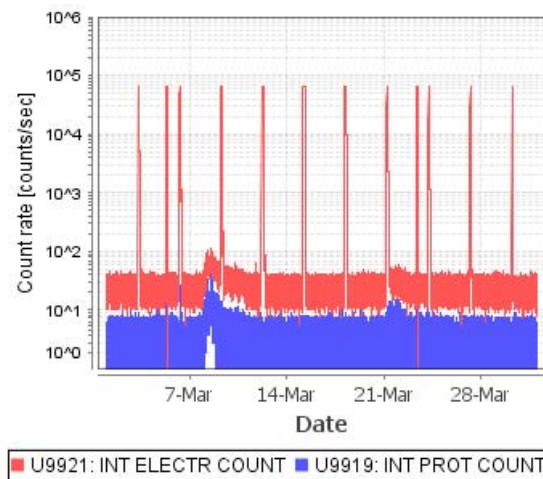
VETO Bottom Count Rate



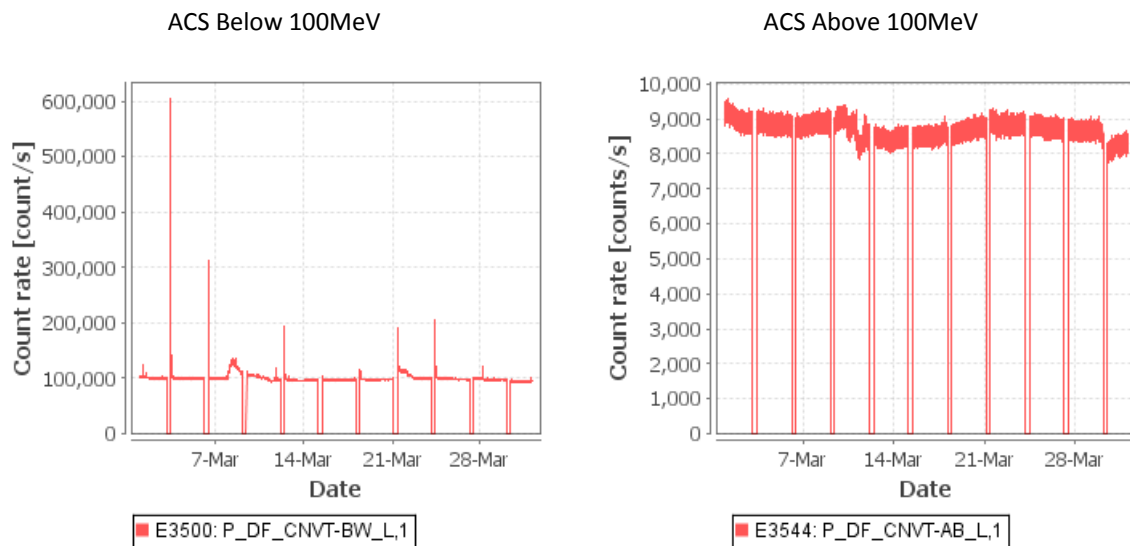
VETO Lateral Count Rate



IREM Proton & Electron Counters¹

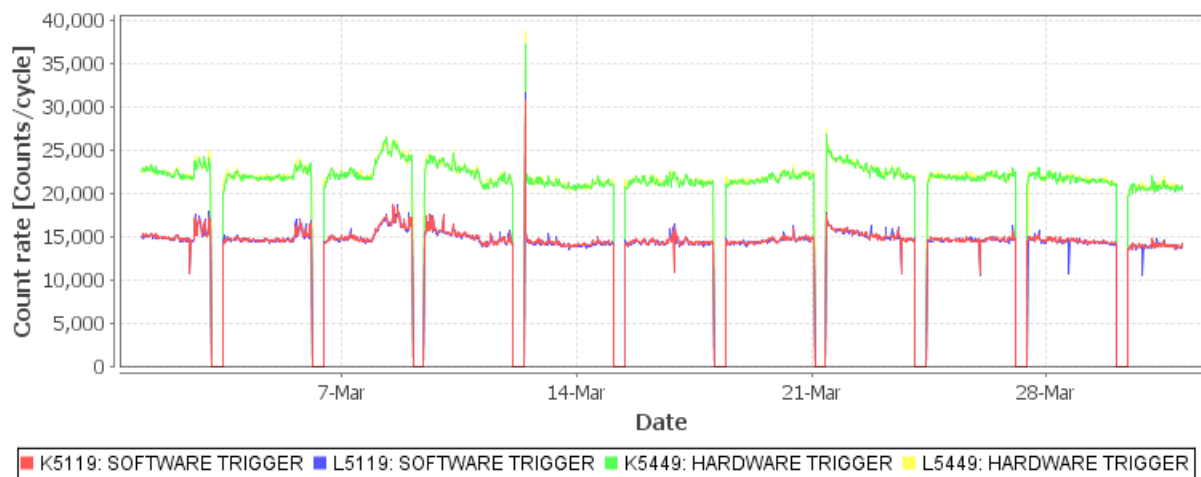


¹ Note that the scale used in this plot is logarithmic.

**Figure 5: 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 6: JEM-X Count rates. The smaller downward spikes in the figure are due to the slews of the spacecraft**

Radiation Belts

Figure 7 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.

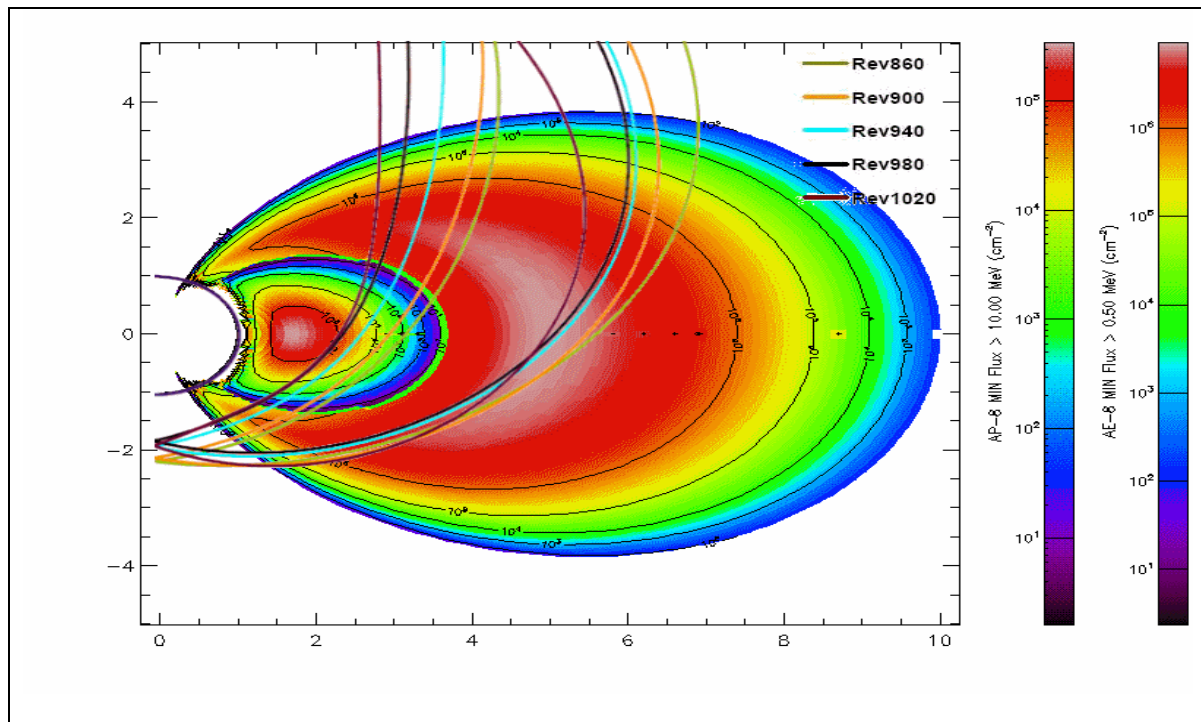


Figure 7: The predicted evolution of the orbit of Integral through the radiation belts

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.

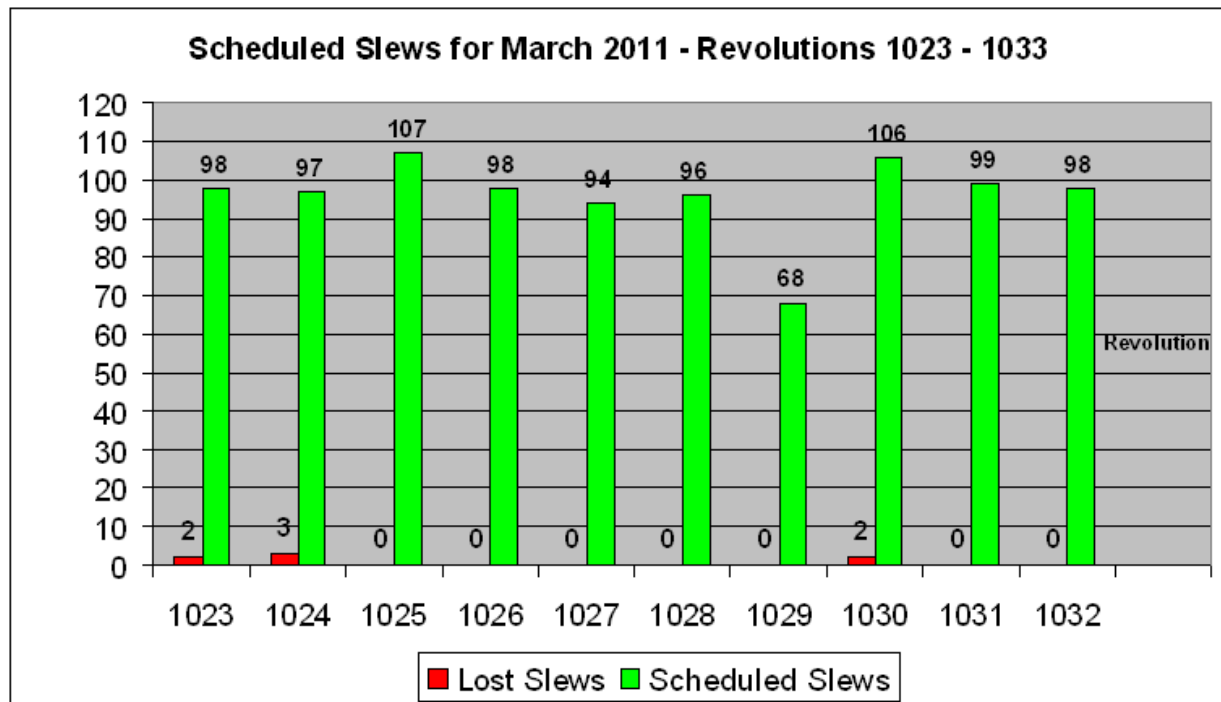


Figure 8: The number of slews scheduled compared to the number of slews lost

3.1 Mission Control System

Input not available this month.

3.2 Ground Stations and Network

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

REDU

There were many occasions of data gaps and bad frames, largely due to RFI from an unknown source.

Figure 9 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.

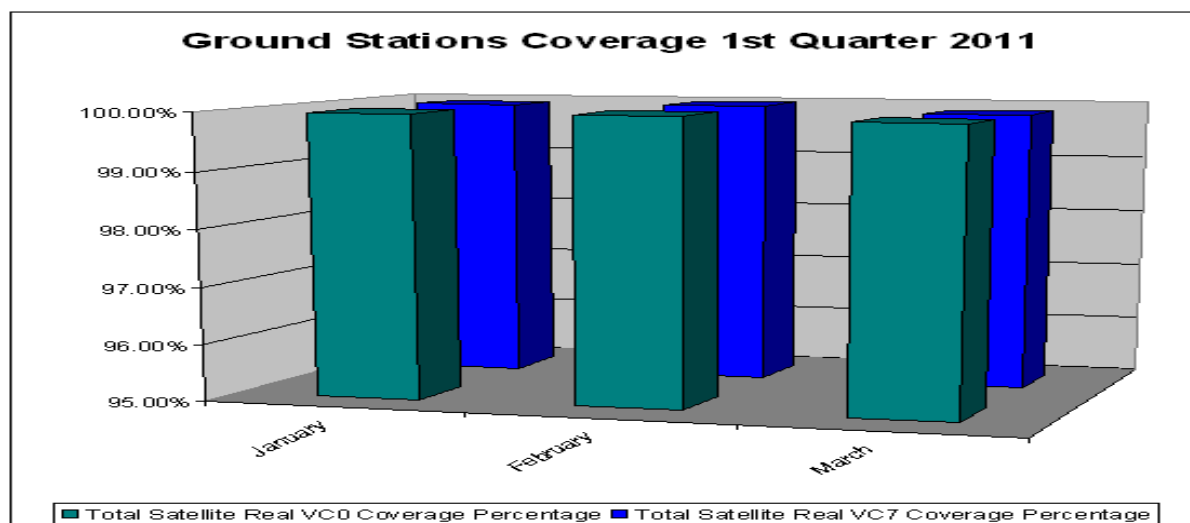


Figure 9: The usage of ESA ground stations compared to the usage of DSN ground stations

3.3 ISOC

3.3.1 Mission Planning

New or updated PSFs have been received for revolutions 1030 to 1041, corresponding to the time range 21 March to 25 April. New observations have been planned for revolutions 1025 (6-9 March) to 1037 (11-13 April). TOO observations of the Be X-ray binary A0535+26 were continued up to revolution 1028. Another TOO observation was done on SXP175 in revolution 1034.

TSFs have been received for revolutions 1024 to 1035.

3.3.2 Observation Status

No new ECS files have been received in March. The last available was for revolution 1009 (up to 20 January).

3.3.3 ISOC Science Data Archive

Scw data (rev_2) has been ingested up to revolution 1009. Syncing of rev_3 data is ongoing.

Raw telemetry copied from MOC is available up to 18 March with some gaps remaining.

3.3.4 ISOC System

V28 (AO9 call for proposals) released on 7 March for opening of AO.

3.3.5 Problems

A problem in updating the eAIMS (LTP tool) database with the operational database was found and solved.

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-3139	2011-03-02	Slews executed without update.		Pending
INT-3140	2011-03-03	IBIS response to high radiation	Payload	Closed
INT-3141	2011-03-17	Integral LCTF Red	IMCS	Testing
INT-3142	2011-03-18	IMCS - Double harddisk failure on same mirror set	IMCS	Closed
INT-3143	2011-03-18	Cross Reference Tables don't all contain date and issue number		Pending
INT-3144	2011-03-22	FTS problem transferring files to ISDC and / or idda aux area	IMCS	Pending
INT_SC-319	2011-03-03	JEM-X2 DFEE CRC Anomaly following eclipse on 2011-03-03	Payload	Testing
INT_SC-320	2011-03-05	IREM Anomaly: Reset of IREM_CSCI S/W #105, 05/03/2011	Payload	Closed
INT_SC-321	2011-03-23	IREM Anomaly: Reset of IREM_CSCI S/W #106, 23/03/2011	Payload	Testing

5 Special Events & Future Milestones

The 17th SPI Annealing will start on 25.04.2011

Battery 2 reconditioning will start on 6th May.

6 Appendix

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

6.1 AOCS operations

During this period, 489 Open Loop Slews, 549 Closed Loop Slews and 35 Momentum Biases were executed (as reported by ACC OEM).

14 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 01/04/2011 is reported in the following plot:

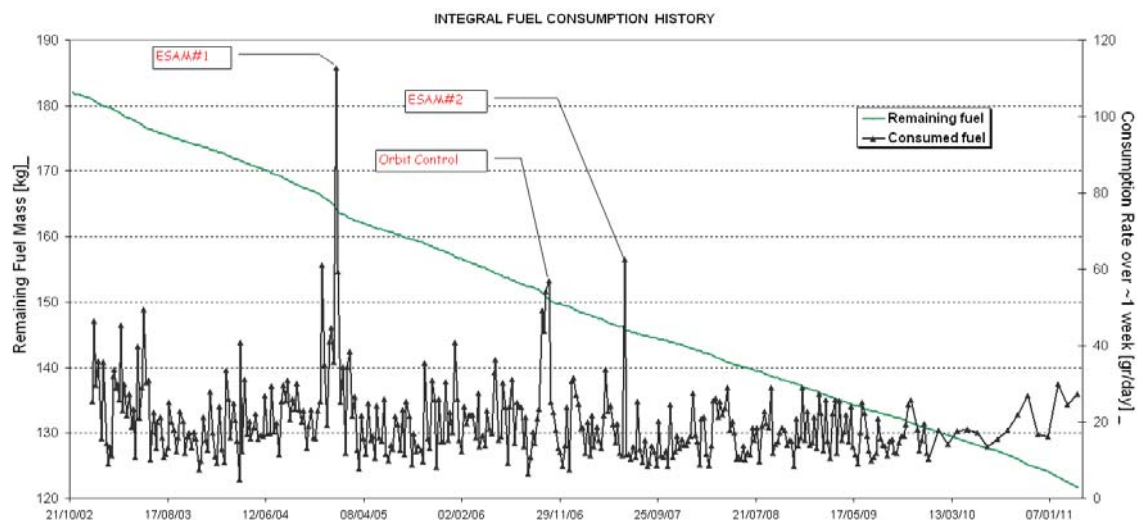


Figure 10: Fuel consumption. Note: ESAM fuel consumption is spread over period of ~1 week.

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.

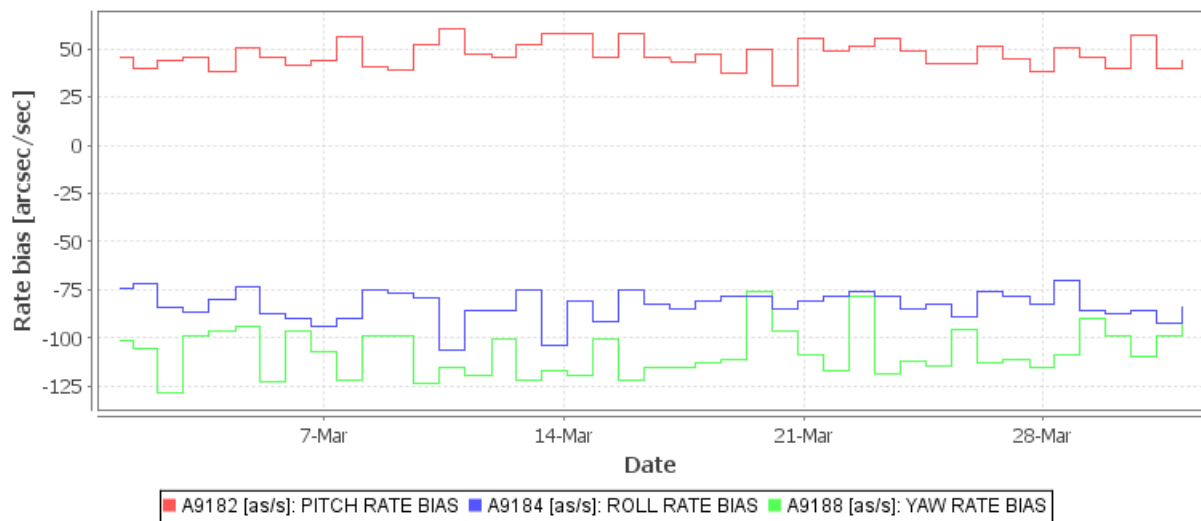


Figure 11: RMU pitch, roll and yaw. Historic data is available on request

6.1.3 Event log

02/03/2011 (Day of Year 61, Revolution 1023)

FDS TPF update failed for slew 10230084 (12:50:00Z). A manual 1023_0502_M.OSL TPF was generated with the spacontool from PID 10230083 to 10230084.

After completion of 1023_0502_M.OSL, another manual 1023_0503_M.OSL TPF was generated with the spacontool from PID 10230084 to 10230085.

Then a manual mapping was commanded in order to update the parameter for slew 10230086.

Slows 10230084 and 10230085 were missed from the Timeline. OTF was not reached for their corresponding PIDs.

03/03/2011 (Day of Year 62, Revolution 1023 to 1024)

IMU1 switched ON during the stable pointing of PID 10240016 (21:41:00Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 10240017 were manually updated (spacontool).

OTF was not reached for PID 10240016.

No slew was missed

04/03/2011 (Day of Year 63, Revolution 1024)

Due to parameter A5264 OOL (17:11:00Z) the timeline was disabled for AOCS subsystem and slows 10240049, 10240050 and 10240051 were missed.

Timeline was rejoined at 18:24:00Z

10/03/2011 (Day of Year 69, Revolution 1026)

Autostack commanding for slew 10260033 (04:23:00Z) failed release (TC A3189 "START GUIDE STAR"). The AOCS was suspended in the timeline, then a manual mapping was commanded and a slew was manually generated from attitude 10260032 to attitude 10260034.

After the manual slew was completed, the parameters for slew 10260035 were manually updated (spacontool).

Slews 10260033 and 10260034 were missed from the Timeline. The OTF was not reached for its PID.

16/03/2011 (Day of Year 75, Revolution 1028)

- IMU1 switched ON during the stable pointing of PID 10280035 (02:53:00Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 10280036 were manually updated (spacontool).

OTF was not reached for PID 10280035.

No slew was missed

- IMU1 switched ON during the stable pointing of PID 10280062 (17:29:41Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 10280063 were manually updated (spacontool).

OTF was not reached for PID 10280062.

No slew was missed

22/03/2011 (Day of Year 81, Revolution 1030)

Because of repeated problems with the IFTS, FDS TPF updates failed to arrive for slews 10300054 (13:01:00Z) and 10300055 (13:47:00Z).

The AOCS was suspended in the Timeline and FD was called in. Then a manual mapping was commanded and a slew was manually generated from attitude 10300054 to attitude 10300055.

Since the problem with the IFTS persisted, another manual slew was commanded from attitude 10300054 to attitude 10300056.

After the manual slew was completed, the parameters for slew 10300057 were manually updated (spacontool).

Slews 10300054, 10300055 and 10300056 were missed from the Timeline.

OTF was not reached for PIDs 10300054, 10300055 and 10300056.

28/03/2011 (Day of Year 87, Revolution 1032)

Autostack commanding for slew 10320051 (11:06:00Z) failed release (TC A3189 "START GUIDE STAR"). The AOCS was suspended in the timeline, then a manual mapping was commanded and a slew was manually generated from attitude 10320050 to attitude 10320052.

After the manual slew was completed, the parameters for slew 10320053 were manually updated (spacontool).

Slows 10320051 and 10320052 were missed from the Timeline. The OTF was not reached for its PID.

30/03/2011 (Day of Year 89, Revolution 1032 to 1033)

As a consequence of a problem on the FDS File Server at perigee exit (07:11:00Z) the AOCS subsystem was disabled in the Timeline.

Slows 10330002 to 10330005 were missed from the Timeline, which was rejoined at 09:03:00Z, to the attitude of PID 10330006.

Slows 10330002 to 10330005 were missed from the Timeline. The OTF was not reached for its PID.

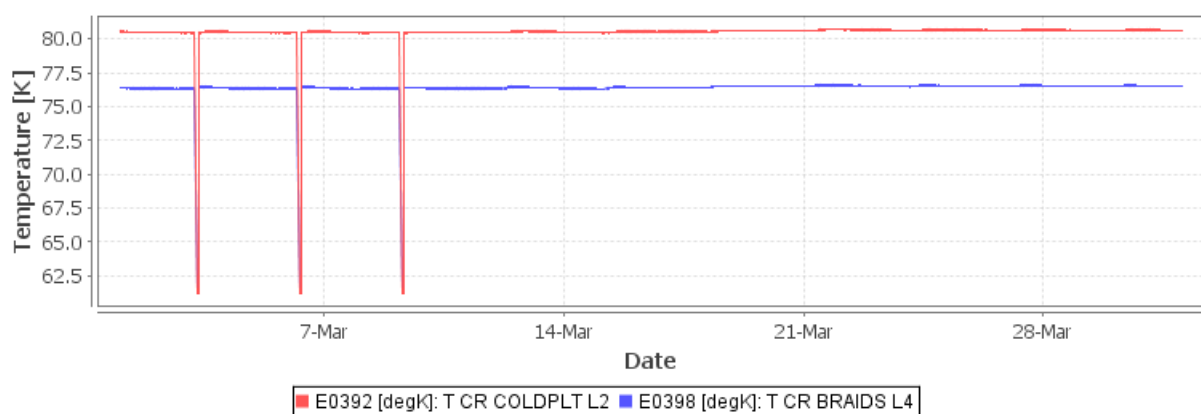
6.2 SPI

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 41 throughout the month. The CDE LCL currents for a given stroke setting are stable.

The following plot shows the evolution of the cold plate and H bus temperature during the reporting period. The downward spikes in the cold plate temperature should be disregarded as these are zero values acquired when the AFEE is OFF during eclipse.



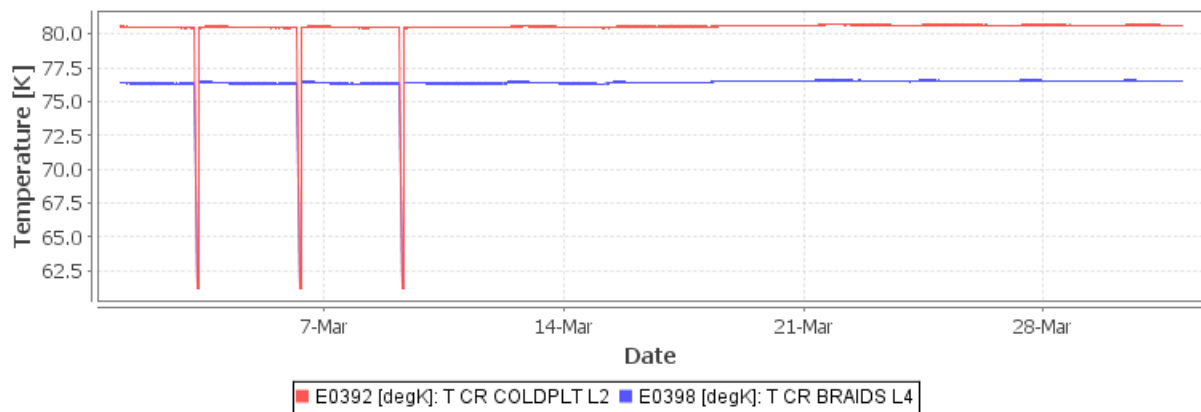


Figure 12: SPI Cold plate and H-bus temperature

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

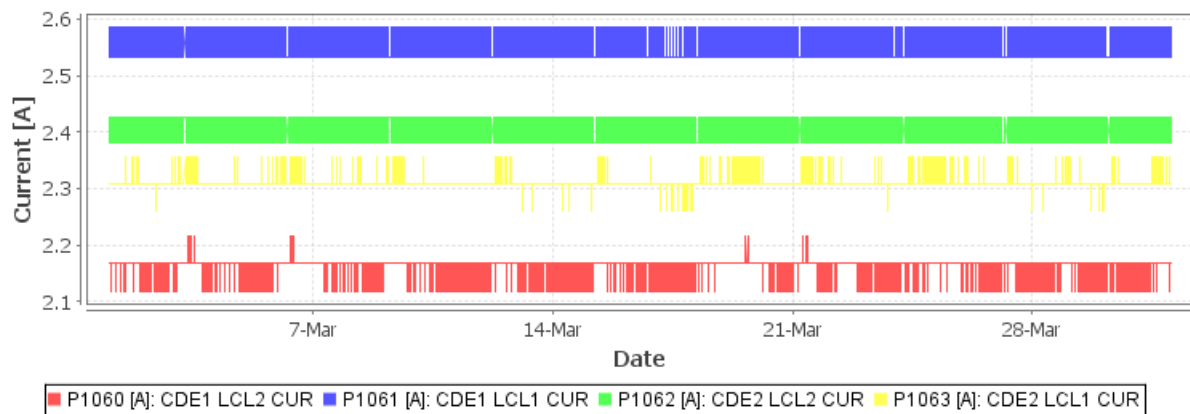


Figure 13: SPI CDE LCL current

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 5: 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.

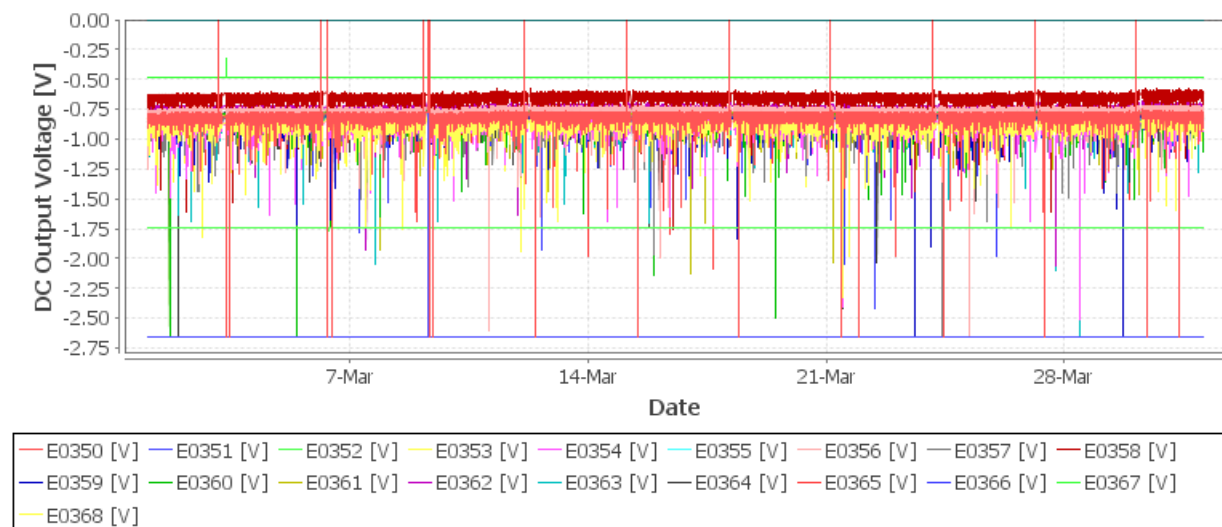


Figure 14: AFEE DC Output Voltages. Note that the data is sampled every 8th packet (64sec)

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



Figure 16: SPI GeD Time Tagged count rates. Note that the scale used for plotting is logarithmic



Figure 17: 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:

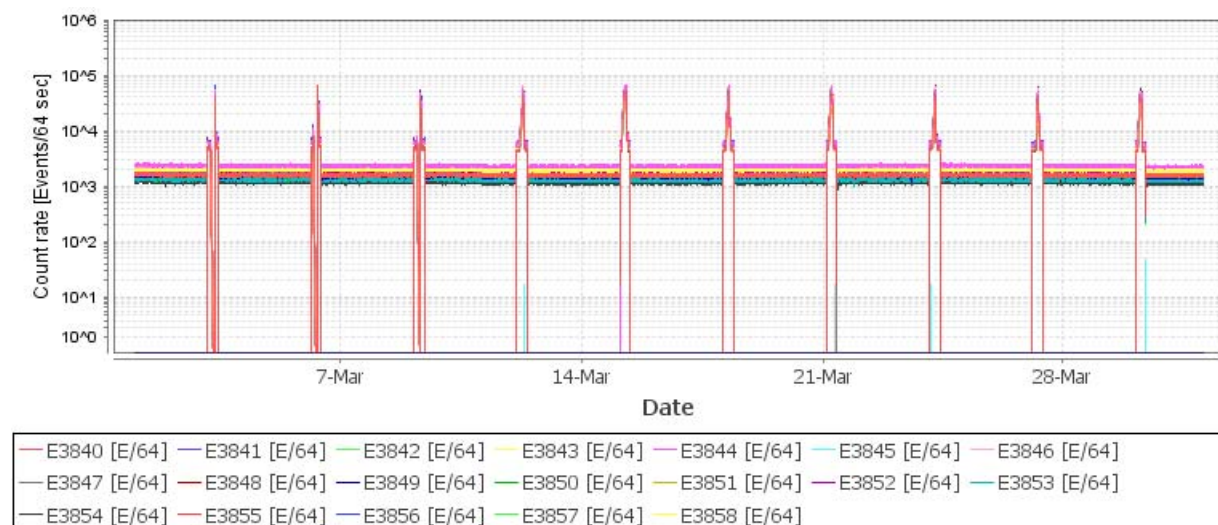


Figure 18: SPI PSD GeD Channel rates

6.2.2 Event Log

Due to continuing high background radiation after the expected radiation belt exit of revolutions 1024, 1025 and 1030, TM parameter E3500 (ACS Counts Below 100MeV) was OOL from 2011.062.10.13.28Z - 2011.062.10.27.15Z, 2011.065.09.59.37Z - 2011.065.10.05.19Z, and 2011.080.08.45.51Z - 2011.080.09.58.54Z. As in each case it returned within limits of its own accord as the background radiation level decreased, no action was taken.

28-02-2011 (Day of Year 059, Revolution 1022)

At 10.16.00z the sequence EEXIT-03 was manually uplinked. The timing interval between the report TC and the dynamic default TC has been increased to 30 seconds instead of 20 seconds. The sequence executed successfully. The sequence EEXIT-03 will be updated with next database release.

03-03-2011 (Day of Year 062, Revolution 1024)

At 07:01:38Z one occurrence of OEM APID 1024 ID 1 EXCEPTION SPI1 FIXED POINT OVERFLOW was received. As it was a single occurrence, no action was required.

04-03-2011 (Day of Year 063, Revolution 1024)

At 10:16:37Z TM parameter E2334 went OOL with value = PARAM < SPEC. It returned within limits when the next packet was received at 10:27:15Z, no action was taken.

06-03-2010 (Day of Year 067, Revolution 1025)

Due to continuing high background radiation during the revolution 1025, TM parameter E3500 (ACS Counts Below 100MeV) was OOL from 2011.067.04.12.54Z - 2011.067.14.56.13Z. As in each case it returned within limits of its own accord as the background radiation level decreased, no action was taken.

18-03-2011 (Day of Year 077, Revolution 1029)

At 07:01:38Z one occurrence of OEM APID 1024 ID 1 EXCEPTION SPI1 FIXED POINT OVERFLOW was received. As it was a single occurrence, no action was required.

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:

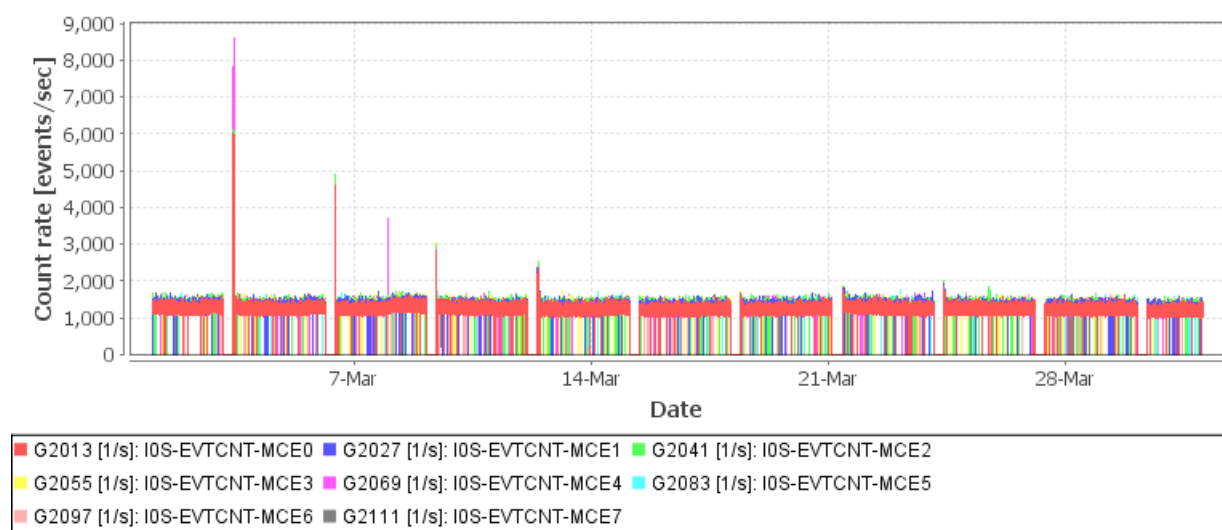


Figure 19: ISGRI MCE Counters

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:

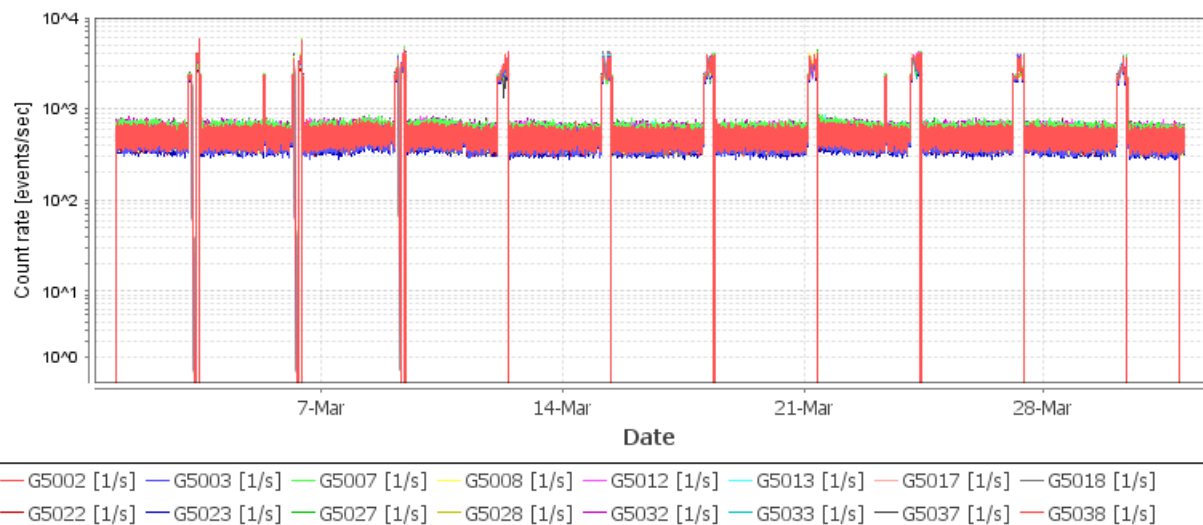


Figure 20: PICsIT semi-module counters. Note that the scale used for plotting is logarithmic

VETO

The health and performance of VETO was nominal during the reporting period. Plots of the VETO counters are given in Figure 5: Instrument Count Rates.

6.3.2 Event Log

01/03/2011 (Day of Year 60, Revolution 1023)

At 2011.060.00.13.27Z the TM parameters families G5068 and G5072 failed status consistency check (value = TRUE). These are the PDM semi-module FIFO error flags. At 2011.060.00.14.00Z the TM parameter families G5002 and G5003 for the PDM semi-module counters started going OOL Low. As these were followed at 2011.060.00.16.00Z 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.

03/03/2011 (Day of Year 62, Revolution 1023 to 1024)

Due to high radiation at belt exit time, IBIS transitioned autonomously to Safe configuration

2011-03-03T10:04:00Z IBIS1 IASW VETO SWITCH OFF PERFORMED DUE TO AUTOMATISM

It was recovered as follows:

- At 2011-03-03T10:55:00Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE
- At 2011-03-03T11:10:00Z ED GESTAN02 uplinked with the planned observation parameters and commanding to IBIS from the Timeline re-enabled.

IBIS operations continued nominally.

05/03/2011 (Day of Year 64, Revolution 1024)

Due to an IREM SEU, IBIS transitioned autonomously to Safe configuration at 2011.064.07.04.00Z. It was recovered as follows:

- 2011.064.07.50.00Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE
- 2011.064.08.04.00Z ED GESTAN02 uplinked with the planned observation parameters and commanding to IBIS from the Timeline re-enabled.

IBIS operations continued nominally.

06/03/2011 (Day of Year 65, Revolution 1024 to 1025)

Due to high radiation at belt exit time, IBIS transitioned autonomously to Safe configuration

2011-03-06T09:52:00Z IBIS1 IASW VETO SWITCH OFF PERFORMED DUE TO AUTOMATISM

It was recovered as follows:

- At 2011-03-06T10:42:00Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE
- At 2011-03-06T10:52:00Z ED GESTAN02 uplinked with the planned observation parameters and commanding to IBIS from the Timeline re-enabled.

IBIS operations continued nominally.

23/03/2011 (Day of Year 82, Revolution 1030)

Due to an IREM SEU, IBIS transitioned autonomously to Safe configuration at 2011.082.07.45.00Z. It was recovered as follows:

- 2011.082.08.22.00Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE
- 2011.082.08.59.00Z 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.

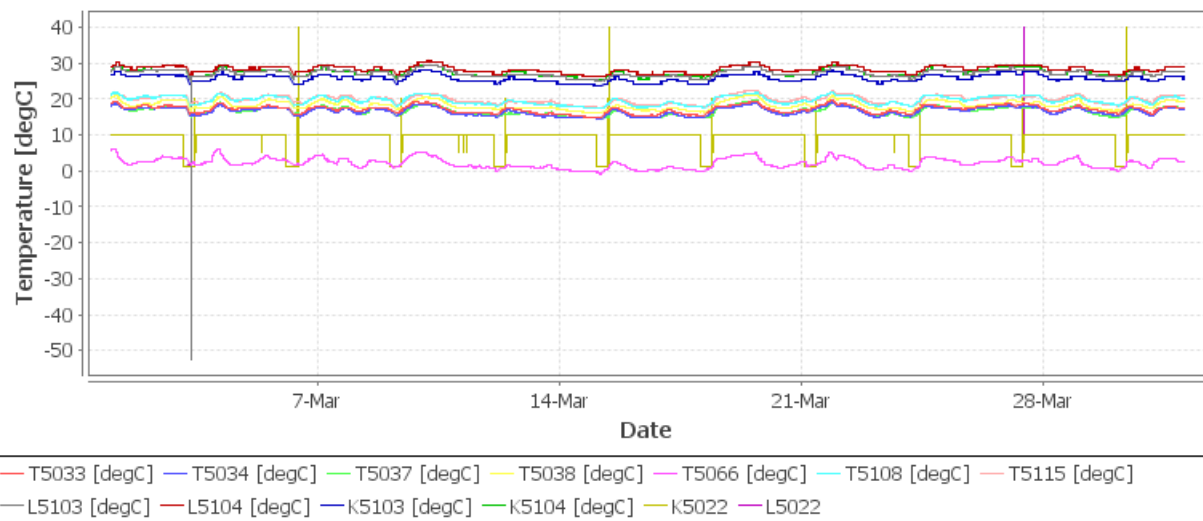


Figure 21: JEMX Detector and DFEE Temperatures

6.4.2 Event Log

03-03-2011 (Day of Year 062, Revolution 1024)

At 06:35:32, after AOS, it was observed that JEMX-2 had not switched-on correctly after the eclipse. The symptoms were as follows:

1) Following the execution of LECLXT01 ED, the JEM-X2 DFEE state (TM parameter L5022) remained MEMORY, instead of SAFE, and the Active Shutdown Level (TM parameter L5381) remained ECLIPSE instead of RAD. BELTS.

3) The DFEE CPU speed, TM parameter L5583 CPU MODE, remained at a value of 8 MHz WAIT (as at start-up) rather than the nominal value of 16MHz.

4) A dump was performed according to the XRef table, which gave results of:

Start Length CRC Value

B000 2000 F1B3

B000 1000 F074

C000 1000 CF9F

which are correct.

5) To recover JEM-X2, a DFEE power cycle was then performed at 07:38 according to CRP_JEM2_5010 JEMX2 DFEE POWER CYCLE, – 08:00Z JEMX2 re-enabled in T/L.

The above recovery proceeded nominally and JEM-X2 operations then continued from the Timeline. There was no impact.

03-03-2011 (Day of Year 062, Revolution 1024)

At 10:22:00 The JEMX1/JEMX2 PROB DFEE 9 was received. As the OEM Error off was received shortly afterwards, no action was taken. There was no impact.

05-03-2011 (Day of Year 064, Revolution 1024)

At 07:04:00 JEMX-1 & 2 parameters K5315, K5316, K5317, L5315, L5316 & L5317 went Out-of-Limits due to an IREM SEU (#105). There was no impact as the reaction has been disabled.

08-03-2011 (Day of Year 067, Revolution 1025)

At 04:32:00 JEMX-1 & 2 parameters K5317 & L5317 went Out-of-Limits due to high radiation. There was no impact as the reaction has been disabled.

09-03-2011 (Day of Year 068, Revolution 1026)

At 09:16:00 JEMX-1 & 2 parameters K5315 & L5317 went Out-of-Limits due to high radiation. There was no impact as the reaction has been disabled.

19-03-2011 (Day of Year 078, Revolution 1029)

At 15:10:00 JEMX-1 & 2 parameters K/L5136 BUFFER LOSS SH OOL for about 1min, no action was taken.

23-03-2011 (Day of Year 082, Revolution 1030)

At 07:34:01 JEMX-1 & 2 parameters K5315, K5316, K5317, L5315, L5316 & L5317 went Out-of-Limits due to an IREM SEU (#106). There was no impact as the reaction has been disabled.

6.5 OMC**6.5.1 Operations**

The status and performance of OMC is nominal.

6.5.2 Event Log**2011-03-03 (Day of Year 062, Revolution 1024)**

At 21:41, a lost guide star forced the interruption of operations. A recovery was performed, and the timeline rejoined at 22:00. The impact was pointing 10240016 was lost.

2011-03-04 (Day of Year 063, Revolution 1024)

At 17:11, due to a ping-pong filter flag inside a reaction wheel bias window, it was decided as a precaution to disable the AOCs. A recovery was subsequently performed, and the Timeline rejoined at 18:24. The impact was the loss of pointings 10240050 & 10250051. It was at this time that the following pair of commands was rejected:

2011.063.18.11.04.930	2011.063.18.11.14.474	1792	RealTime	131	TC REJECT	REJECTED
TC1		0	0	65535 PR	N E E	
2011.063.18.11.11.055	2011.063.18.11.14.520	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 10240051.

2011-03-05 (Day of Year 064, Revolution 1024)

At 03:42, due to RFI, pointing 10240068 was lost. Subsequently the TPF update for the next slew failed to arrive. At 04:02, a manual slew to the attitude for pointing 10240069 was executed, and at 04:24, the timeline was rejoined. The impact was the loss of pointings 10240068 and 10240069. It was at this time that the following pair of commands was rejected:

2011.064.04.17.05.952	2011.064.04.17.17.949	1792	RealTime	131	TC	REJECT	REJECTED
TC1		0	0	65535	PR	N	E
2011.064.04.17.11.952	2011.064.04.17.18.005	1792	RealTime	131	TC	REJECT	REJECTED
TC1		0	0	65535	PR	N	E

These correspond to the M1130 (RESET IM) and MU1310 (IMAGING-A) commands for pointing 10240069.

2011-03-05 (Day of Year 064, Revolution 1024)

At 07:04:18, an IREM SEU (#105) forced OMC to SAFE mode, a recovery was performed, and the unit returned to standby at 07:31:55, and re-enabled on the autostack at 07:44. The impact was pointing 10240073 was shortened from a planned 1955 to 1673 seconds, and pointings 10240074 & 10240075 were lost. It was at this time that the following pair of commands was rejected:

2011.064.07.09.24.833	2011.064.07.09.29.655	1792	RealTime	131	TC	REJECT	REJECTED
TC1		0	0	65535	PR	N	E
2011.064.07.09.30.958	2011.064.07.09.41.632	1792	RealTime	131	TC	REJECT	REJECTED
TC1		0	0	65535	PR	N	E

These correspond to the M1130 (RESET IM) and MU1310 (IMAGING-A) commands for pointing 10240074.

2011-03-08 (Day of Year 067, Revolution 1025)

At 03:20:42, high radiation forced OMC to SAFE mode. Repeated attempts were made to switch back to science operations, but new spikes caused OMC to go back to SAFE mode. A recovery was performed, and the timeline rejoined at 22:00. The impact was pointing 10250079 was cut short from a planned 1955 to 169 seconds, and pointings 10250080 to 10250086, 10250090 & 10250092 to 10250103 lost.

2011-03-10 (Day of Year 069, Revolution 1026)

At 04:23:00, the AOCS commands for slew 10260033 failed (possibly due to RFI), the timeline was suspended, and a recovery performed. Operations were resumed at 05:02:00, the impact was the loss of pointing 10260033.

2011.069.04.26.09.225	2011.069.04.26.18.704	1792	RealTime	131	TC	REJECT	REJECTED
TC1		0	0	65535	PR	N	E

2011.069.04.26.14.975	2011.069.04.26.18.720	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.

2011-03-16 (Day of Year 075, Revolution 1028)

At 18:50, the lack of a slew update forced an interruption. A recovery was performed, and the timeline rejoined at 19:24:42. The impact was the loss of pointing 10280064. It was at this time that the following pair of commands was rejected:

2011.075.19.01.31.825	2011.075.19.01.38.150	1792	RealTime	131	TC	REJECT	REJECTED
TC1		0	0	65535 PR	N	E	E

2011.075.19.01.37.950	2011.075.19.01.49.935	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.

2011-03-22 (Day of Year 081, Revolution 1030)

At 13:01, an FTS problem prevented the slew updates from getting through, this forced an interruption. A recovery was performed, and the timeline rejoined at 14:16. The impact was the loss of pointing 10300055. It was at this time that the following pair of commands was rejected:

2011.081.13.41.23.900	2011.081.13.41.32.434	1792	RealTime	131	TC	REJECT	REJECTED
TC1		0	0	65535 PR	N	E	E

2011.081.13.41.30.150	2011.081.13.41.38.476	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.

2011-03-23 (Day of Year 082, Revolution 1030)

At 07:34:03, an IREM SEU (#106) forced OMC to SAFE mode, a recovery was performed, and the unit returned to standby at 08:12:25. The impact was pointing 10300084 was shortened from a planned 2858 to 1201 seconds, and pointing 10300085 was lost.

2011-03-28 (Day of Year 087, Revolution 1032)

At 11:06:06, an AOCS command failed release, which forced a suspension of operations. A recovery was performed, and the timeline rejoined at 11:42. The impact was the loss of pointing 10320051.

2011-03-30 (Day of Year 089, Revolution 1033)

At 06:05, the FD server was restarted. Subsequently, the File Transfer System failed, which forced a suspension of operations. A recovery was performed, and the timeline rejoined at 09:03. The impact was the loss of pointings 10330004 & 10330005.

6.6 IREM

6.6.1 Operations

Radiation belts entry and exit

The following plots show the Radiation Belt Entry (Figure 22, red line) and Exit times (Figure 23, blue line) obtained from the ISDC website, defined where the IREM TC3 (soft electrons) rate reads 600 counts. The blue line in Figure 22 and the magenta line in Figure 23 are the altitudes used by the MOC for planning purposes.

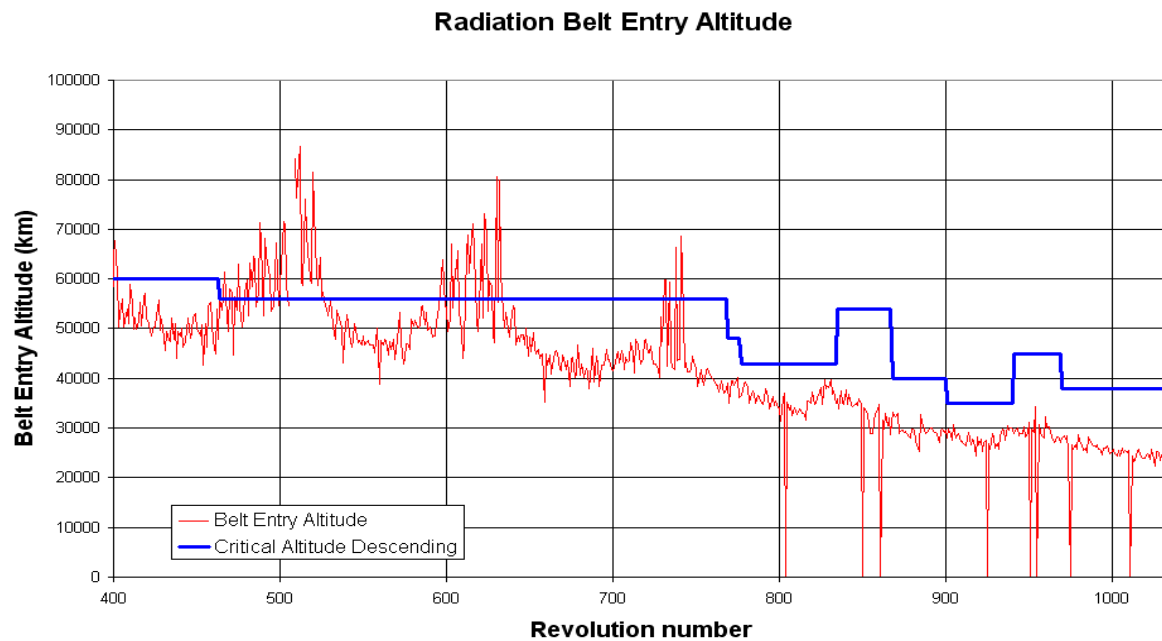
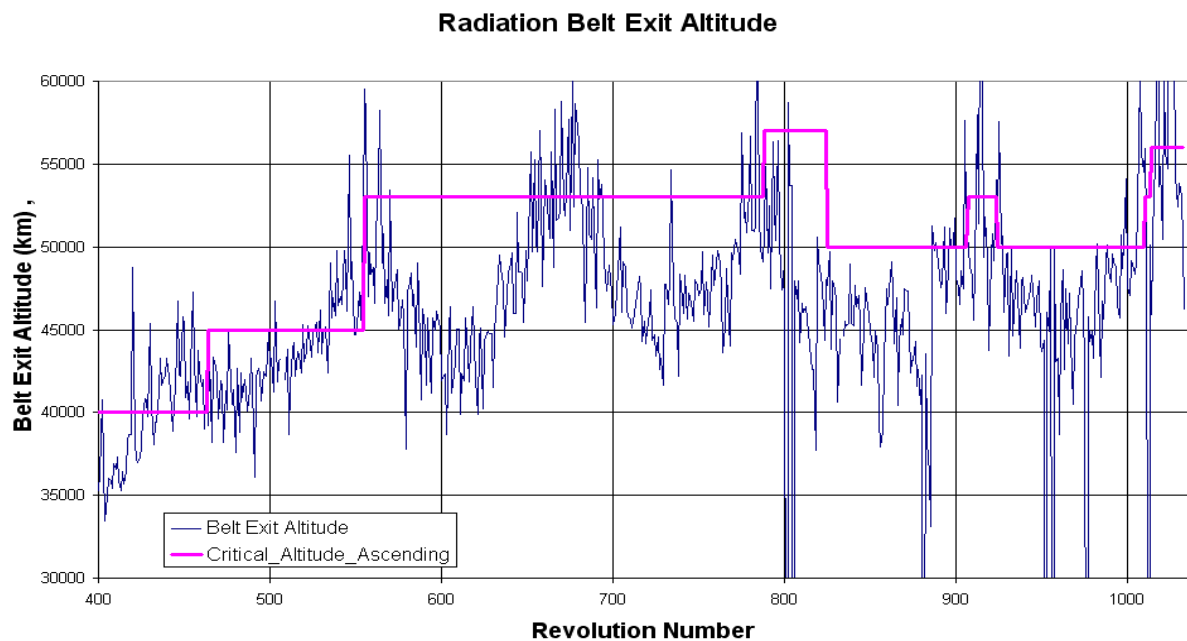


Figure 22: Radiation belt entry

**Figure 23: 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
1023	RAD_ENTR R 2011-03-03T02:33:48Z	N/A	N/A	03-Mar-2011 03:58:01	20079.03	03-Mar-2011 04:48:01	8243.69
1024	RAD_EXIT R 2011-03-03T09:57:39Z	03/03/2011 10:58:40	64264.5	03-Mar-2011 09:08:01	48619.63	03-Mar-2011 05:18:01	3870.093
1024	RAD_ENTR R 2011-03-06T02:20:22Z	06/03/2011 03:49:13	19997.4	06-Mar-2011 03:52:18	18547.41	06-Mar-2011 04:32:18	8961.602
1025	RAD_EXIT R 2011-03-06T09:43:40Z	06/03/2011 10:05:29	58486.6	06-Mar-2011 08:52:18	48156.65	06-Mar-2011 05:02:18	3870.972
1025	RAD_ENTR R 2011-03-09T02:07:50Z	08/03/2011 01:39:29	152590.0	09-Mar-2011 03:34:17	19707.35	09-Mar-2011 04:14:17	10089.31
1026	RAD_EXIT R 2011-03-09T09:30:26Z	09/03/2011 09:31:13	56150.6	09-Mar-2011 08:34:17	47428.91	09-Mar-2011 04:54:17	3667.357

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
1026	RAD_ENTR R 2011-03- 12T01:55:02Z	12/03/2011 03:38:33	16199.2	12-Mar-2011 03:22:49	19536.79	12-Mar-2011 04:02:49	9924.147
1027	RAD_EXIT R 2011-03- 12T09:17:30Z	12/03/2011 09:45:29	60151.7	12-Mar-2011 08:22:49	47530.42	12-Mar-2011 04:42:49	3702.478
1027	RAD_ENTR R 2011-03- 15T01:40:40Z	15/03/2011 03:11:05	18582.8	15-Mar-2011 03:13:16	18522.91	15-Mar-2011 03:53:16	8901.731
1028	RAD_EXIT R 2011-03- 15T09:03:10Z	15/03/2011 08:24:41	>>30754.3	15-Mar-2011 08:13:16	48235.15	15-Mar-2011 04:23:16	3798.265
1028	RAD_ENTR R 2011-03- 18T01:27:01Z	18/03/2011 02:56:57	18273.0	18-Mar-2011 02:56:26	19117.93	18-Mar-2011 03:36:26	9434.022
1029	RAD_EXIT R 2011-03- 18T08:48:45Z	18/03/2011 07:56:49	47731.5	18-Mar-2011 07:56:26	47938.04	18-Mar-2011 04:16:26	3650.976
1029	RAD_ENTR R 2011-03- 21T01:16:24Z	21/03/2011 02:53:37	18256.8	21-Mar-2011 02:46:47	18778.03	21-Mar-2011 03:26:47	9013.096
1030	RAD_EXIT R 2011-03- 21T08:37:04Z	21/03/2011 09:11:05	61516.9	21-Mar-2011 07:46:47	48308.55	21-Mar-2011 03:56:47	3573.497
1030	RAD_ENTR R 2011-03- 24T01:06:36Z	24/03/2011 02:38:41	18286.7	24-Mar-2011 02:39:22	18279.5	24-Mar-2011 03:19:22	8507.872
1031	RAD_EXIT R 2011-03- 24T08:26:57Z	24/03/2011 08:44:10	58633.7	24-Mar-2011 07:39:22	48657.37	24-Mar-2011 03:49:22	3470.689
1031	RAD_ENTR R 2011-03- 27T00:55:10Z	27/03/2011 02:24:26	18905.5	27-Mar-2011 02:31:46	17475.4	27-Mar-2011 03:01:46	10142.03
1032	RAD_EXIT R 2011-03- 27T08:15:47Z	27/03/2011 07:09:54	45489.8	27-Mar-2011 07:21:46	47499.45	27-Mar-2011 03:41:46	3495.619
1032	RAD_ENTR R 2011-03- 30T00:42:07Z	30/03/2011 02:23:14	16614.9	30-Mar-2011 02:11:32	19476.19	30-Mar-2011 02:51:32	9770.863
1033	RAD_EXIT R 2011-03-	30/03/2011 06:32:34	>>28803.5	30-Mar-2011	47749.39	30-Mar-2011	3534.862

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
	30T08:02:51Z			07:11:32		03:31:32	

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

03-03-2011 (Day of Year 062, Revolution 1023)

At 03:47, the TC U4921 showed a failed CEV but telemetry showed Ground Link is Off. No action was taken.

05-03-2011 (Day of Year 064, Revolution 1024)

At 07:04:16Z, a local reset of the IREM CSCI S/W (SEU #105) 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 2011.064.07:04:16Z (142295.5 km). The unit had performed an automatic transition to Standard Mode (ie. no block counter increasing, all the TM words= FFFF hex); just before the anomaly, radiation counters reported nominal values considering the position of the S/C along the orbit;
- 5) The recovery of the unit started immediately using procedure CRP_SYS_2570. The first dump of the status word after the anomaly reported a value of BCC0 HEX = 48320 DEC = 1011110011000000, i.e the Checksum Failure Flag ON. The unit was still reporting the status as if it was in Integral mode with counting ON and accumulation ON. This value of the status word is assumed to be an old one written by the S/W at the moment of the anomaly.
- 6) The patch was performed successfully with the correct re-starting of the S/W following procedure FCP_RM_0081. The operation was completed at 09:56:00Z.

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 Pls request. OMC was recovered at 07:44:00Z and IBIS at 08:09:00Z.

23-03-2011 (Day of Year 082, Revolution 1030)

At 07:34:01Z, a local reset of the IREM CSCI S/W (SEU #106) 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 2011.082.07:34:01Z (138101.4 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 11:51:00Z.

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 Pls request. OMC was recovered at 08:10:00Z and IBIS at 09:19:00Z.