EUROPEAN SPACE AGENCY

DIRECTORATE OF TECHNICAL & OPERATIONAL SUPPORT

MISSION OPERATIONS DEPARTMENT

INTEGRAL

Mission report

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

No. 383

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Routine Phase

Prepared by: L.Spiteri (OPS-OAI) and INTEGRAL FCT

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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 March and covers the revolutions 901 untill 911. 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.

10 slews were missed from the Timeline.

The fuel consumption over the reporting period was 0.5288 Kg. The remaining propellant is in the order of 129.1918 Kg.

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

2.1.2 Power

The performance of the EPS was good during the eclipse season. No unexpected behaviour / malfunction were identified.

30/03/2010

Following the end of the eclipse season the following changes were made to the On-board configuration:

- Select Full charge rate C/26 for both batteries.
- FCP_EPS_1273: Select Full Charge Rate (C/13), BCR1
- FCP_EPS_1274: Select Full Charge Rate (C/13), BCR2
- Load the On-board monitoring list for use outside of the eclipse season.
- FCP_DHS_1231: Load OBM Entries for Non-eclipse Season.

Table 1: Eclipse times

Date	Penumbra Entry	Umbra Entry	Umbra Exit	Penumbra Exit	MIN ANG	Total Eclipse Penumbra Duration	Umbra duration Only
16/02/2010	06:47:57			06:52:17	16.421	0:04:20	0:00:00
19/02/2010	06:23:02	06:24:47	06:52:34	06:53:53	13.6621	0:30:51	0:27:47
22/02/2010	06:07:38	06:08:55	06:47:22	06:48:15	10.6963	0:40:37	0:38:27
25/02/2010	05:53:18	05:54:24	06:38:18	06:39:01	7.733	0:45:43	0:43:54
28/02/2010	05:40:07	05:41:07	06:27:25	06:28:03	5.0234	0:47:56	0:46:18
03/03/2010	05:31:08	05:32:04	06:18:58	06:19:32	2.2704	0:48:24	0:46:54
06/03/2010	05:24:39	05:25:32	06:11:45	06:12:18	0.6496	0:47:39	0:46:13
09/03/2010	05:18:04	05:18:55	06:03:25	06:03:56	3.5977	0:45:52	0:44:30
12/03/2010	05:10:24	05:11:15	05:53:07	05:53:39	6.4386	0:43:15	0:41:52
15/03/2010	05:02:10	05:03:01	05:41:28	05:42:01	9.1666	0:39:51	0:38:27
18/03/2010	04:54:32	04:55:24	05:29:39	05:30:14	11.8987	0:35:42	0:34:15
21/03/2010	04:48:26	04:49:20	05:18:22	05:19:01	14.8232	0:30:35	0:29:02
24/03/2010	04:41:49	04:42:52	05:05:15	05:06:03	17.7452	0:24:14	0:22:23
27/03/2010	04:34:32	04:35:56	04:50:08	04:51:17	20.4164	0:16:45	0:14:12
30/03/2010	04:32:03			04:36:17	23.0829	0:04:14	0:00:00

Table 2: Eclipse recharge parameters

Date	Expected DOD	Observed DOD 1	Observed DOD 2	Expected Recharge Capacity	Expected Recharge Time	EOC Time Battery 1	EOC Time Battery 2	Recharge Duration Battery 1	Recharge Duration Battery 2	Calculated MRU Timer Threshold (h)	Calculated MRU Timer Threshold (s)	Threshold in TC	Ratio Recharge to Discharge time
16/02/2010	0.00	0.00	0.00	0.00	0:00:00					0	0	0.000	
19/02/2010	2.69	2.89	2.86	2.89	1:36:14	08:36:59	08:35:55	1:43:06	1:42:02	1.44357569	5196.8725	18.000	3.71085783
22/02/2010	3.72	3.98	3.94	4.00	2:13:11	09:10:43	09:09:23	2:22:28	2:21:08	1.99779792	7192.0725	25.000	3.70524491
25/02/2010	4.24	4.58	4.53	4.56	2:32:04	09:23:15	09:21:39	2:44:14	2:42:38	2.28097083	8211.495	28.000	3.74107821
28/02/2010	4.48	4.82	4.77	4.81	2:40:23	09:20:43	09:19:07	2:52:40	2:51:04	2.40567083	8660.415	30.000	3.72930166
03/03/2010	4.53	4.97	4.91	4.87	2:42:27	09:17:39	09:15:55	2:58:07	2:56:23	2.43684583	8772.645	30.000	3.79779673
06/03/2010	4.47	4.85	4.79	4.80	2:40:05	09:06:19	09:04:35	2:54:01	2:52:17	2.40134097	8644.8275	30.000	3.76523621
09/03/2010	4.30	4.59	4.54	4.62	2:34:09	08:48:35	08:46:51	2:44:39	2:42:55	2.31214583	8323.725	29.000	3.7
12/03/2010	4.05	4.38	4.34	4.35	2:25:01	08:30:44	08:29:24	2:37:05	2:35:45	2.17532222	7831.16	27.000	3.75199045
15/03/2010	3.72	4.04	4.00	4.00	2:13:11	08:07:08	08:05:56	2:25:07	2:23:55	1.99779792	7192.0725	25.000	3.77416558
18/03/2010	3.31	3.53	3.49	3.56	1:58:38	07:36:52	07:35:32	2:06:38	2:05:18	1.77957292	6406.4625	22.000	3.6973236
21/03/2010	2.81	3.00	2.97	3.02	1:40:34	07:06:44	07:05:48	1:47:43	1:46:47	1.50852361	5430.685	19.000	3.71010333
24/03/2010	2.16	2.34	2.31	2.33	1:17:32	06:29:32	06:28:44	1:23:29	1:22:41	1.16300069	4186.8025	14.000	3.72970961
27/03/2010	1.37	1.53	1.52	1.48	0:49:11	05:45:32	05:45:08	0:54:15	0:53:51	0.73780833	2656.11	9.000	3.82042254
30/03/2010	0.00	1.53	1.52	0.00	0:00:00					0	0	0.000	

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.

Test of Transmitter 2 Functionality and Transmitter 1 and 2 switching procedure via LCLs.

Due to the evolving perigee height Integral will violate ITU regulations starting in mid 2010 until early 2013 if the transmitter remains on at perigee. Therefore starting from mid May the Transmitter will be switched off below 5000km, as these periods are entirely outside station coverage switching will be done by time-tagged command.

Before switching off Transmitter 1 for the first time in more than 7 years it was decided to verify the functionality of Transmitter 2 and then verify the LCL switching of Transmitter 1, again for the first time in 7 years. The tests were carried out on 23/3/2010, the behaviour of both Transmitters appears to be absolutely nominal in all respects. The frequency offset of the 2 transponders was sufficient for the REDU ground Station to be able to process 2 clean TM streams during the periods when both Transmitters were transmitting, this meant that there was no interruption to the ongoing science operations. In order to execute the tests we needed both on-board antennae to be visible from the supporting ground station, such a (very favourable) period was identified in revolution 908 under REDU coverage.

The sequence of events was:

- 13.35z TX-2 LCL ON via prime TC
- 13.29z TX-2 LCL OFF via prime TC (time-tagged)
- 13.56z TX-2 LCL ON via Redundant TC
- 13.58z TX-1 LCL OFF via prime TC
- 13.59z TX-1 LCL ON via prime TC
- 14.01z TX-1 LCL OFF via redundant TC (execution of nominal Timeline activities, including slew, Instrument commanding and RF switch movement with TX-2 in use)
- 14.28z TX-1 LCL ON via redundant TC
- 14.35z TX-2 LCL OFF via Redundant TC

The power consumption of TX-2 was slightly higher than TX-1 (0.9A vs. 0.85A), this is still well within limits (Soft 0 - 1.5A) and may have been temperature related as the LCL current seemed to reduce slightly as the transmitter warmed up. The Converter output voltages were also stable and well within limits:

As a result of these tests we have very high confidence that the switch-off of TX-1 at perigee will execute smoothly and that TX-2 is available in case of problems

2.2 Payload

2.2.1 SPI

Following the 14th SPI annealing, which ended on 06/11/2009, the overall status of the gamma-ray spectrometer is nominal, except for detector #2 (failed since 06/12/2003); detector #17 (failed since 17/07/2004) and detector #5 (failed since 19/02/2009). The 15th SPI annealing started on 30/03/2010. Annealing operations are progressing nominally.

The Germanium detectors' temperature was kept in the range 80K+/-1K until the start of annealing operations.

Eclipse season was ongoing during this reporting period, with the last eclipse occurring on 27/03/2010. Eclipse operations for SPI were executed nominally.

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 105 packets/cycle, except from 2010-03-03T11:17:28Z to 2010-03-03T17:08:44Z (Crab Calibration), when it was 85 packets/cycle; 2010-03-17T20:45:48Z to 2010-03-18T00:33:00Z (OMC Flat Field Calibration), when it was 88 packets/cycle and from revolution 911 onwards (starting 30/03/2010), when it was 30 packets/cycle due to the annealing. The average telemetry occupation when the allocation was 105 packets/cycle was 97.9 packets/cycle.

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

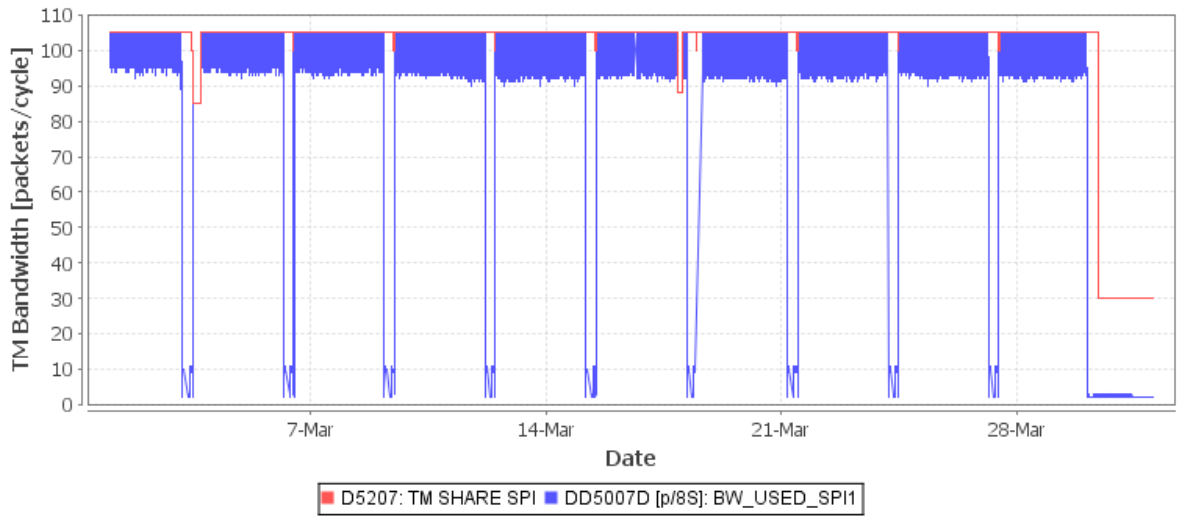


Figure 1: SPI TM bandwidth utilisation

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

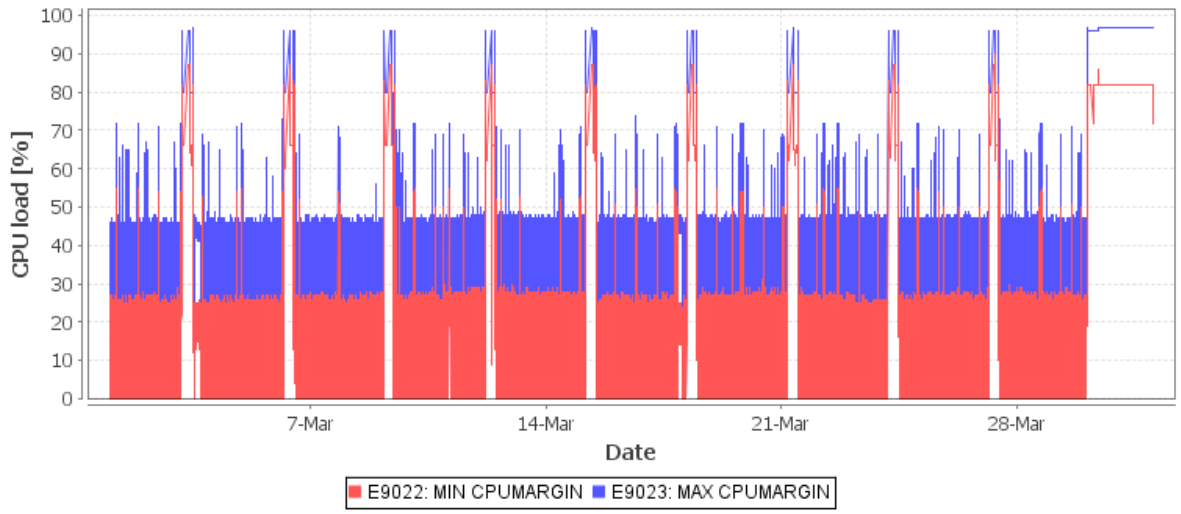


Figure 2: SPI IASW Performance

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

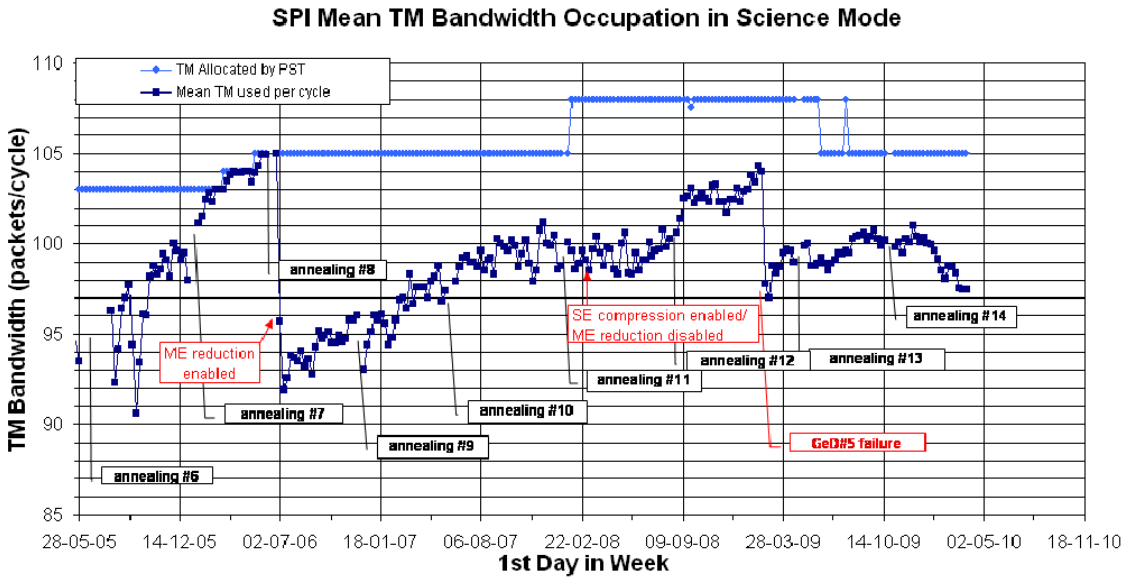


Figure 3: SPI TM bandwidth usage evolution since May 2005

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.

Eclipse season was ongoing during this reporting period, with the last eclipse occurring on 27/03/2010. Eclipse operations for IBIS were executed nominally.

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: 131 packets/cycle, except:
  - in revolution 902 and 903 (Crab Calibration), when it was 129 packets/cycle;
  - 2010-03-17T20:45:48Z to 2010-03-18T00:33:00Z (OMC Flat Field Calibration), when it was 90 packets/cycle;
  - from revolution 911 onwards (starting 30/03/2010), when it was 180 packets/cycle due to the SPI annealing.
- IBIS mean bandwidth utilisation in science mode: 120.5 packets/cycle.

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

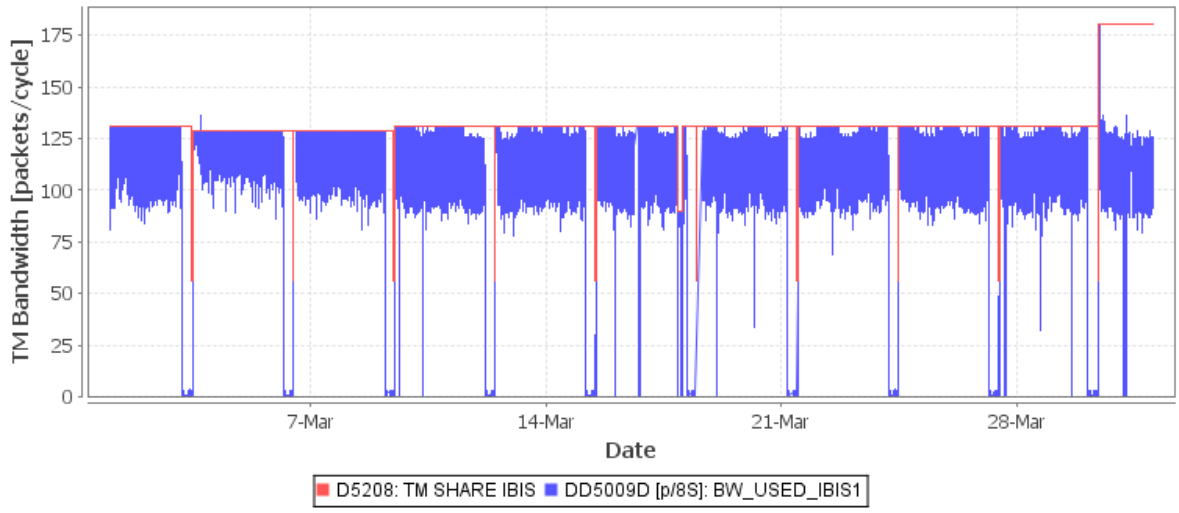


Figure 4: IBIS TM bandwidth utilisation

A plot of the IBIS weekly bandwidth utilisation since May 2005 is shown on the next page:

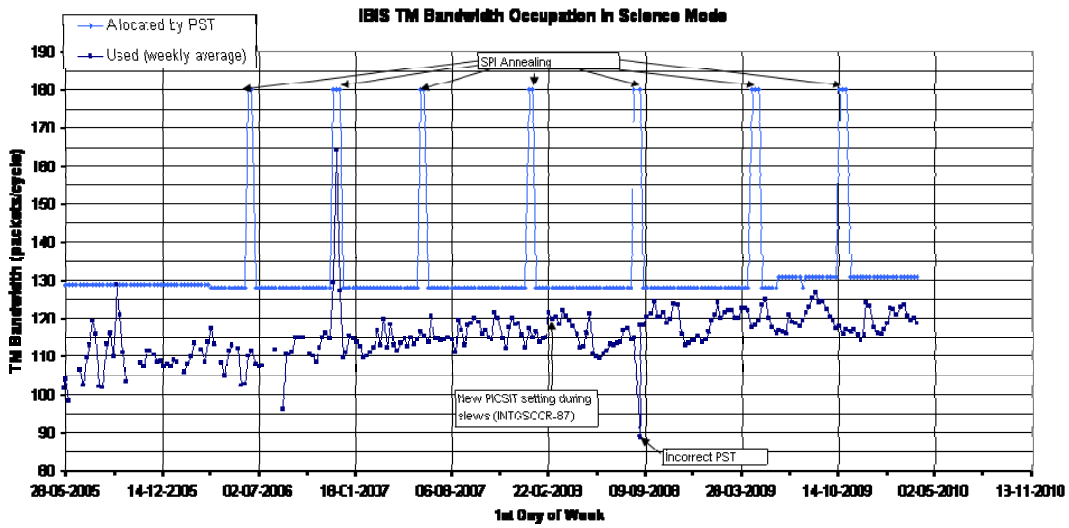


Figure 5: IBIS TM bandwidth usage evolution since May 2005

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

Except from 2010-03-03T11:17:28Z to 2010-03-03T17:08:44Z during the Crab-calibration when both instruments were operating with 15 packets per instrument allocated. For the remainder of revolutions 902 & 903 5 packets were allocated. At the end of the month from 2010-03-30T09:51:07Z onwards, during the SPI annealing, both instruments were again operating, with 15 packets per instrument allocated.

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 2010-03-17T20:45:48Z to 2010-03-18T00:33:00Z during the Flat-Field calibration, when it was 63 packets/cycle, and from 2010-03-30T09:51:07Z to the end of the month, during the SPI annealing, when it was 9 packets/cycle.

During this reporting period, 1068 of the 1076 planned science pointings were executed nominally, 4 pointings were lost to ground station problems, 2 to AOCS problems, and 1 pointing was interrupted and another lost to an IREM SEU. There was also a Flat-field calibration, which was performed nominally.

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

2.2.5 IREM

The status of IREM is nominal.

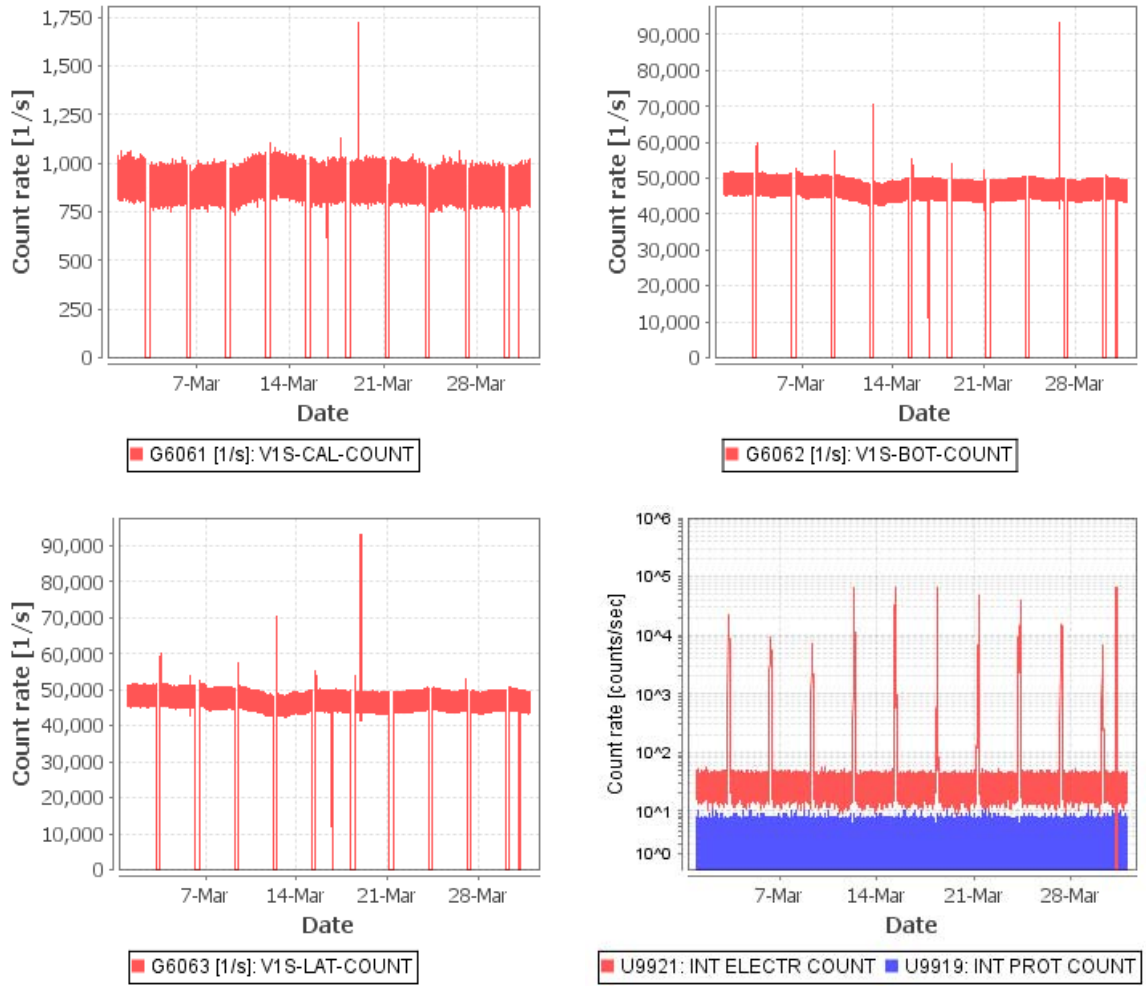
The solar activity is hotting up, with the number of sun spots increasing. However, Integral has not yet experienced any high radiation.

On DoY 090 (31/03/2010), the 87th IREM SEU occurred, details in Appendix 6.6.

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

Radiation background

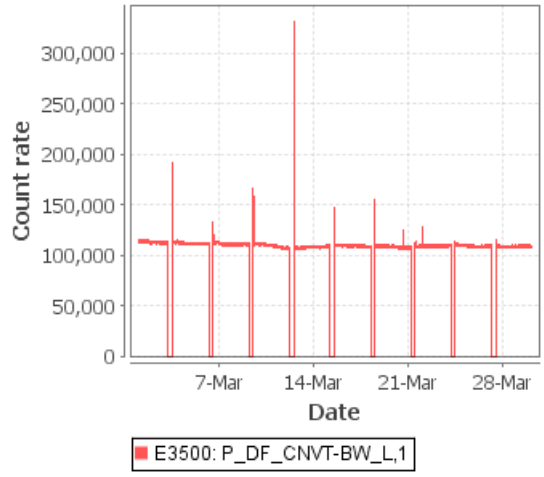
The background radiation level as measured by the instrument counters was low during the reporting period. The following plots show the SPI ACS, IBIS VETO, JEM-X Triggers and IREM count rates over the reporting period:



IREM proton & electron counters[1]

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

ACS below 100MeV



ACS above 100MeV

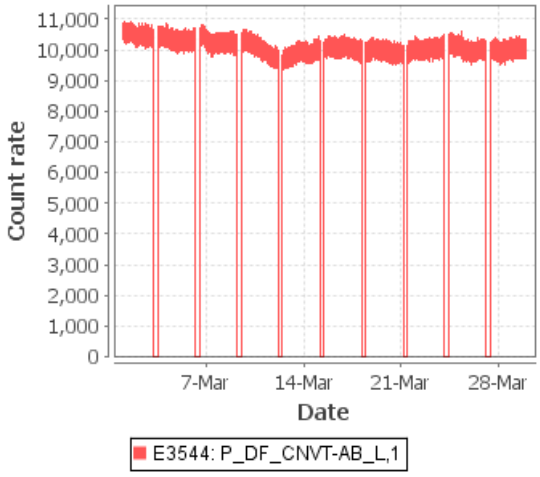


Figure 6: Instrument Count Rates

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

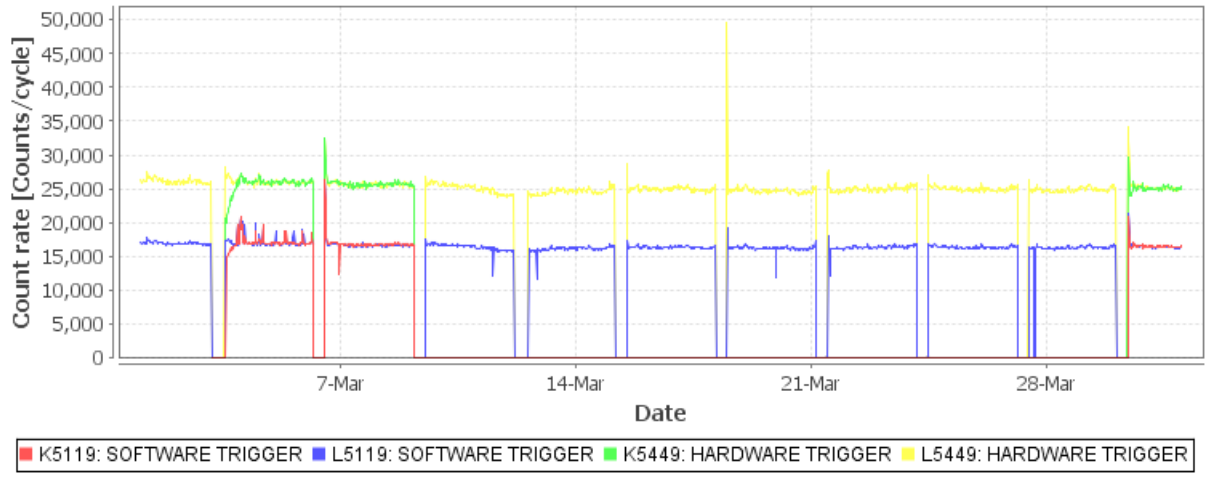


Figure 7: JEM-X Count rates. The smaller downward spikes in the figure are due to the slews of the spacecraft

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.

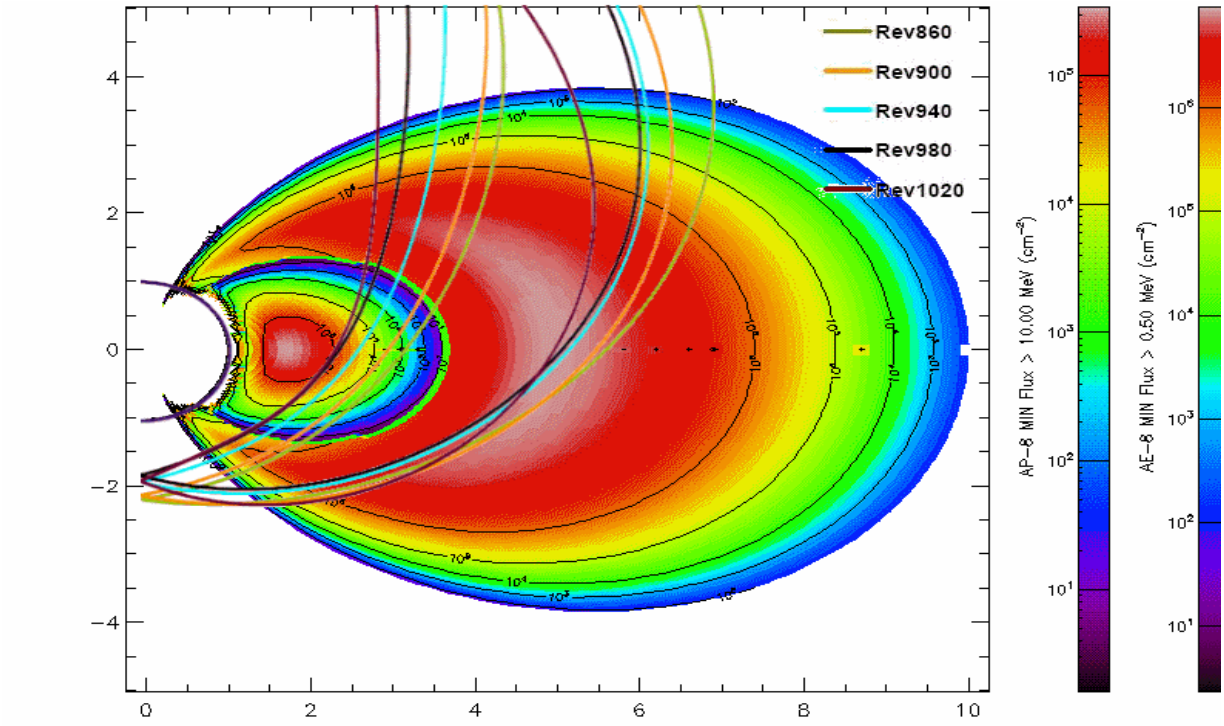


Figure 8: The predicted evolution of the orbit of Integral through the radiation belts

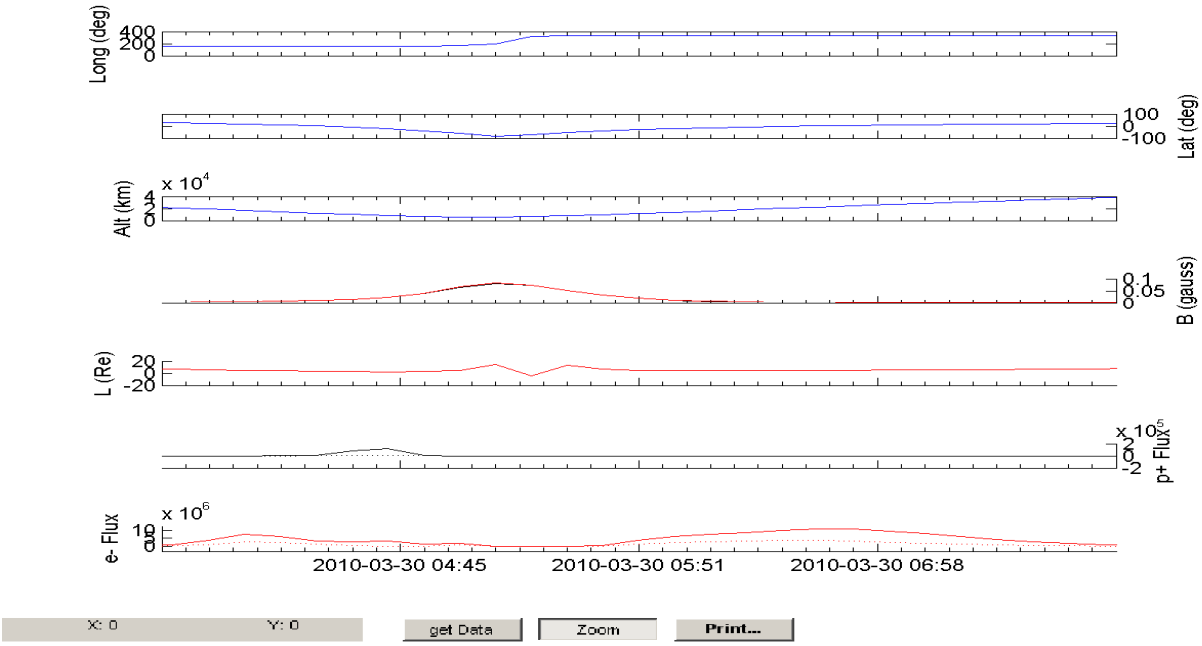


Figure 9: Predicted radiation belt passages

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.

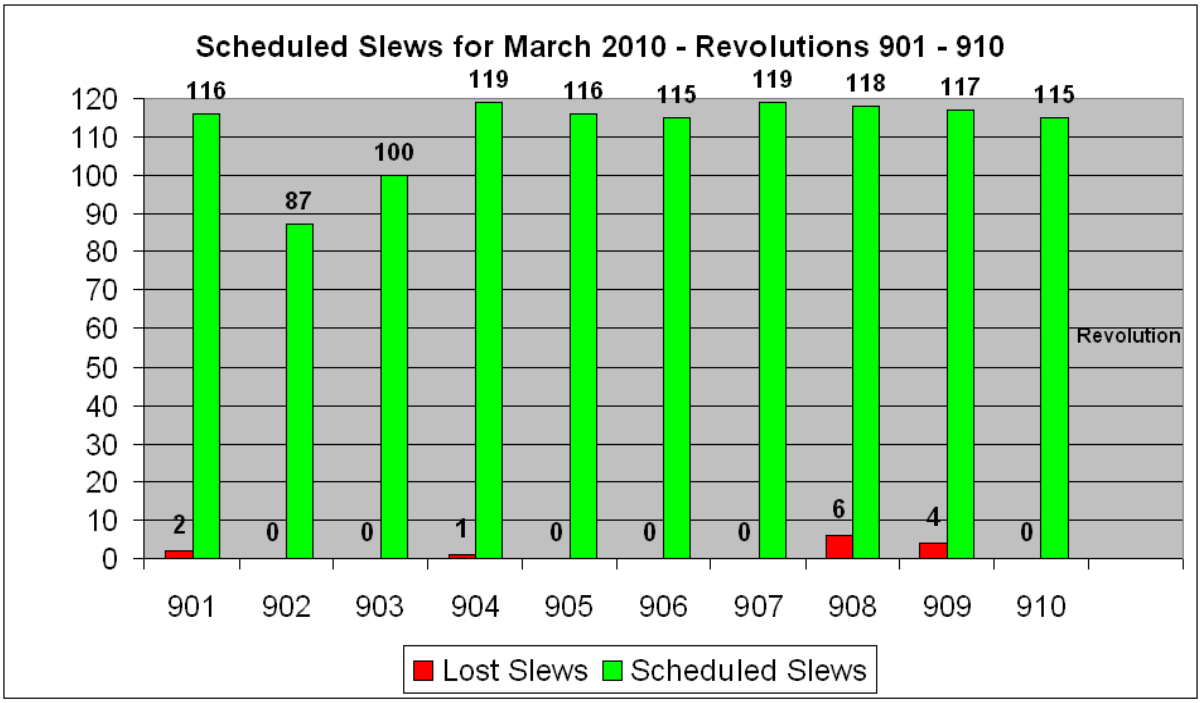


Figure 10: The number of slews scheduled compared to the number of slews lost

3.1 Mission Control System

This month the HFA_TM task was restarted eleven times on iddb (due to MUST retrievals) and two times on idda. The DDS on isdsc and iddb was restarted one time due to MUST testing. There were three messages that CD production failed.

On DOY068 the connection to the TM CPD CMDH verifier was lost, the limit checker was not connected and there were no TCO packets generated. Software support was in and restarted the TM CPD task. On DOY082 the error message "Lost Connection to TM CPD, will try to re-establish connection" was received and followed by the next message one minute later: "Reconnected to RT TM cache". No further action taken afterwards.

3.2 Ground Stations and Network

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

REDU

There were drops on VC-0 and VC-7 on DOYs 070 and 071 due to a hit on the line. The drops in telemetry during Redu-1 support on DOYs 073, 074, 078 and 079 seem to be due to RFI from an unidentified source, as previously experienced on a number of occasions. They do not correspond with the times of predicted Formosat RFI. On DOY084 there were data gaps in VC-0 and VC-7 combined with bad frames, on DOY085 there was a drop in VC-0 and VC-7 for 6 minutes. Network reported that the line to REDU was down. On DOY089 bad frames from REDU were received.

DSS27

On DOY063 and DOY079 there was a drop in VC-0 for a couple of minutes. TM flow was re-established after recycling of the link. On DOY069 the receiver lost lock for one minute, there was no impact.

On DOY81 there was a drop in VC-0 and VC-7, JPL reports that the ground station has lost power. REDU was requested for support until DSS27 was back. After moving back to DSS27, the link remained unstable. REDU supported Integral as from 05:46:00. At 09:18:00 an unscheduled ground station handover from REDU to VIL2 was done, because ONN needed REDU for maintenance. VIL2 was unavailable from as from 10:59:00; ground station handover to DSS27 was done. Because of earlier instability of the link from DSS27, REDU was requested back from maintenance earlier (11:28:00) and a handover was done. On DOY090 the ground station handover from REDU to DSS27 was cancelled, DSS27 was declared RED.

On DOY064 a Maspalomas A-chain test was done successfully.

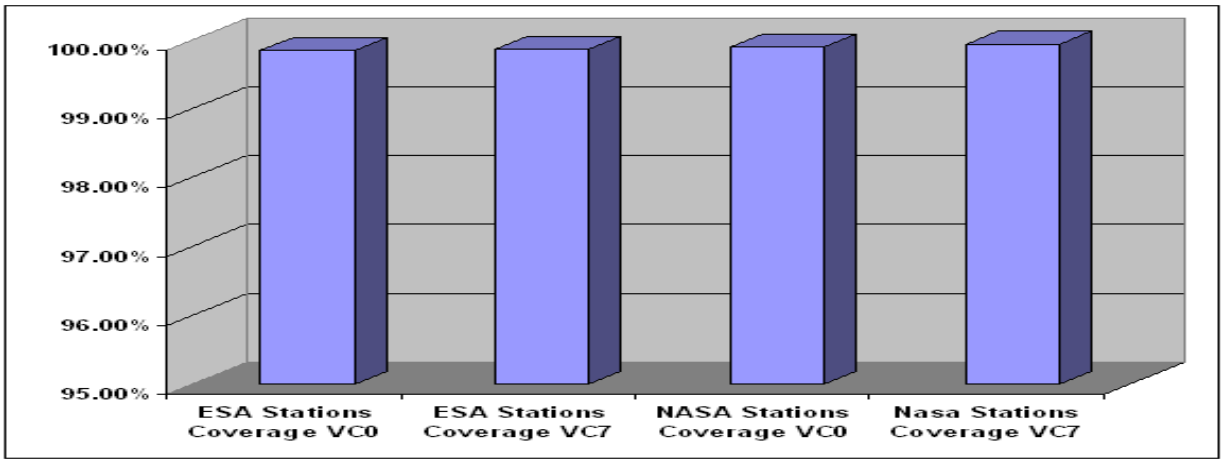


Figure 11: The usage of ESA ground stations compared to the usage of DSN ground stations

3.3 ISOC

3.3.1 Mission Planning

New or updated PSFs have been received for revolutions 907 to 916 during March, corresponding to the time range 18 March to 17 April. SPI annealing began in revolution 911.

The PSFs for revolutions 907 and 908 had to be manually edited at ISOC to change a DUMMY window parameter not accepted by the ISOC software. This will be fixed by ISOC software V25 (April).

Observations have been planned up for revolutions 904 (9-12 March) to 915 (11-14 April). An urgent TOO request for the transient X-ray pulsar A 0535+26 was received and approved on 31 March leading to reshuffling of revolutions 912ff.

TSFs have been received for revolutions 902 to 914.

3.3.2 Observation Status

New ECS files have been received for revolutions 889-895 and 899 (22-25 February), but were missing for 896-898.

3.3.3 ISOC Science Data Archive

Intense work is ongoing on the next ISDA release, but various further problems have been encountered to set up the test environment for the next release. The next ISDA release date will probably have to be delayed.

Raw TM data are routinely transferred from MOC. Several gaps have been filled, but a few still remain.

Mobile disks have been sent to Toulouse to capture the historical raw telemetry data.

A trainee student has begun a project to link from the scheduling pages to the Archive.

3.3.4 ISOC System

The proposal handling system for AO-8 is working smoothly. ISOC V25 to support the TAC and fixing various issues has been scheduled for testing in early April.

3.3.5 Problems

No new problems.

4 Anomalies

Table 3 contains the anomalies that occurred in the reporting period:

Table 3: Anomalies reported

AR id	Date of occurrence	Subject	Segment	Status
INT-3100	22/03/2010	DSS27 - Power outage to full complex (DOY 080)	NASA Station	Pending
INT_SC-287	16/03/2010	PICsIT High Count Rates due to VETO counters drop	IBIS	Open
INT-3099	17/03/2010	Recover-schedule advice to generate a corrective CSL	FDS	Pending
INT-3098	04/03/2010	Empty FoV on target 09020047	FDS	Pending
INT-3097	15/03/2010	High Radiation at Belts exit causing ISGRI calibration problems		Open
INT_SC-280	31/03/2010	IREM Watchdog Time out	Payload	Pending
INT_SC-279	20/03/2010	PPDU HLCL 5B1 Opened Unexpectedly	Payload	Pending

5 Special Events & Future Milestones

SPI Annealing started March 30, 2010.
DCA move and renovation planned, starting in May 2010.

6 Appendix

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

6.1 AOCS operations

During this period, 730 Open Loop Slews, 415 Closed Loop Slews and 21 Momentum Biases were executed (as reported by ACC OEM).

Ten 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 01/04/2010 is reported in the following plot:

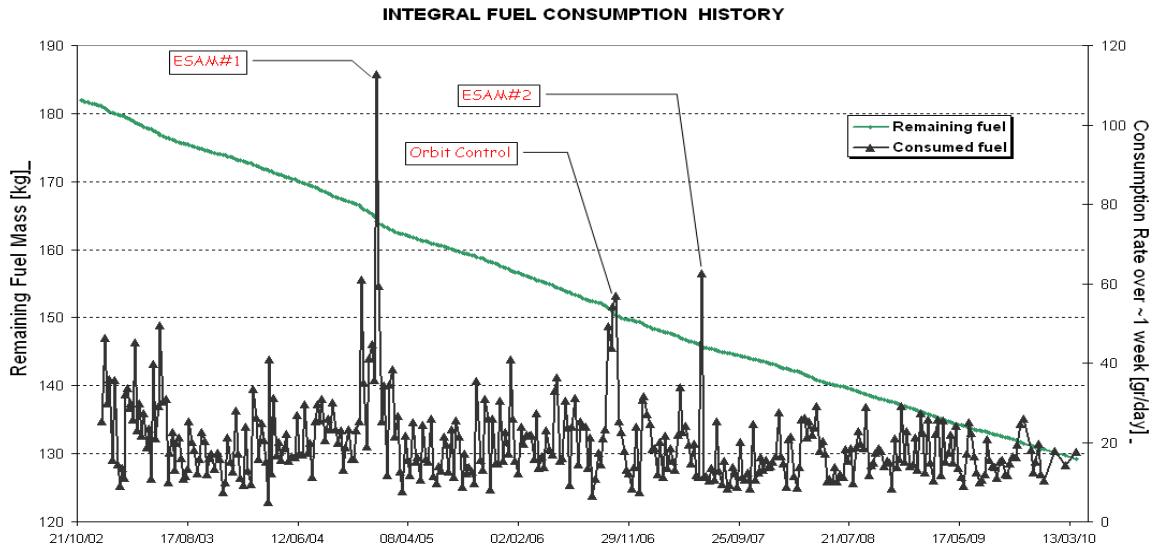


Figure 12: Fuel consumption. Note: ESAM fuel consumption is spread over period of ~1 week.

6.1.2 The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel as from December 2009 up to date are reported in the plot below. Historic data is not available at the moment, but present in the archives. The evolution of the drift on yaw channel is under constant monitoring but the values are still well within the specs.

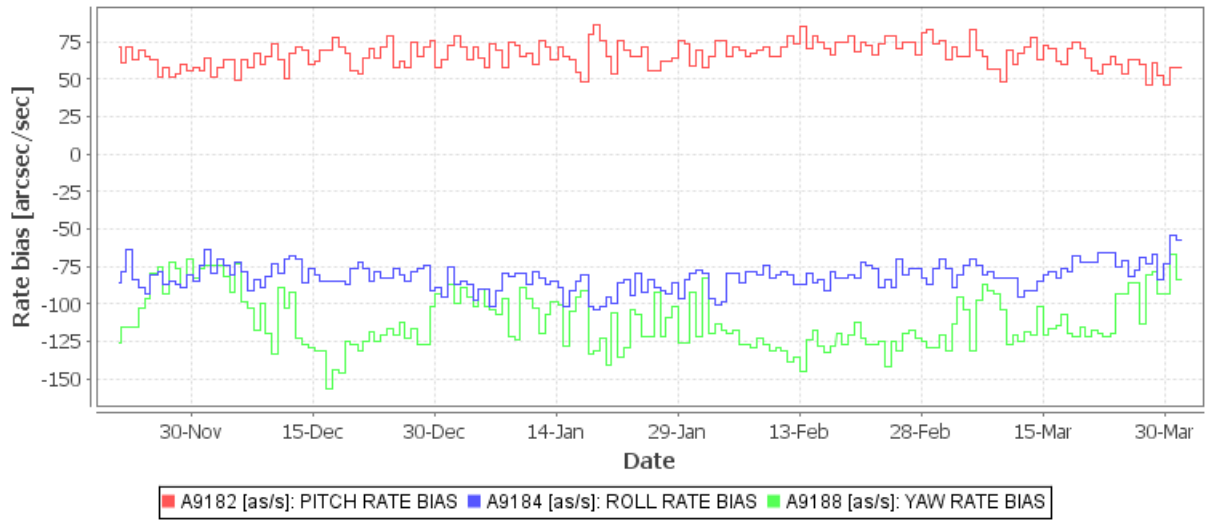


Figure 13: RMU pitch, roll and yaw. Historic data is available on request

6.1.3 Eclipse season

The summer eclipse season is summarized in Table 4:

Table 4: Summary of eclipse season

AOCS Eclipse Times															Summer 2010
Date	LOS	AOS	ACC Eclipse Imminent	Eclipse Start						Eclipse End					Eclipse Duration
				ACC	FDE	FCE	Penumbra	FSS Sun Out	Umbra	Umbra	FSS Sun In	Penumbra	FDE/FCE	ACC	
2010-02-16	06:37:28	09:18:57	05:48:24	06:30:20	06:41:20	06:42:03	06:48:04	penumbra only	00:00:00	00:00:00	penumbra only	06:52:23	06:58:23	07:02:01	0:04:19
2010-02-19	08:25:28	09:06:25	05:23:20	06:05:23	06:16:23	06:17:06	06:23:00	06:24:21	06:24:45	06:52:32	06:52:58	06:53:51	06:59:50	07:03:37	0:30:51
2010-02-22	06:13:52	08:54:34	05:07:56	05:49:50	06:00:50	06:01:33	06:07:36	06:08:36	06:08:53	06:47:20	06:47:36	06:48:13	06:53:49	06:57:49	0:40:37
2010-02-25	06:01:37	08:42:23	04:53:36	05:35:32	05:46:31	05:47:16	05:53:16	05:54:08	05:54:23	06:38:16	06:38:30	06:38:59	06:45:24	06:48:37	0:45:43
2010-02-28	05:48:44	08:28:39	04:40:25	05:22:18	05:33:18	05:34:01	05:40:05	05:40:51	05:41:05	06:27:23	06:27:37	06:28:01	06:33:37	06:37:37	0:47:56
2010-03-03	05:37:15	08:16:27	04:31:21	05:13:17	05:24:17	05:25:00	05:31:01	05:31:50	05:31:57	06:18:51	06:19:07	06:19:25	06:25:20	06:29:03	0:48:24
2010-03-06	05:27:25	08:05:57	04:25:00	05:06:56	05:17:56	05:18:39	05:24:40	05:25:20	05:25:33	06:11:46	06:11:54	06:12:19	06:18:15	06:21:57	0:47:39
2010-03-09	05:17:05	07:55:38	04:18:26	05:00:22	05:11:22	05:12:05	05:18:06	05:18:41	05:18:57	06:03:27	06:03:34	06:03:59	06:10:13	06:13:37	0:45:53
2010-03-12	05:05:33	07:45:35	04:10:45	04:52:42	05:03:42	05:04:25	05:10:25	05:11:01	05:11:15	05:53:07	05:53:16	05:53:39	05:59:37	06:03:19	0:43:14
2010-03-15	04:53:21	07:39:55	04:02:23	04:44:19	04:55:19	04:56:02	05:02:03	05:02:48	05:02:54	05:41:20	05:41:37	05:41:53	05:47:34	05:51:31	0:39:50
2010-03-18	04:41:22	07:19:56	03:54:52	04:36:33	04:47:33	04:48:16	04:54:32	04:55:10	04:55:23	05:30:14	05:29:49	05:29:39	05:36:08	05:39:37	0:35:07
2010-03-21	04:30:00	07:07:27	03:48:46	04:30:21	04:41:21	04:42:04	04:48:26	04:49:06	04:49:20	05:18:22	05:18:33	05:19:00	05:24:48	05:28:17	0:30:34
2010-03-24	04:17:30	06:55:14	03:42:09	04:24:06	04:35:06	04:35:49	04:41:49	04:42:34	04:42:51	05:05:15	05:05:30	05:06:03	05:11:57	05:15:42	0:24:14
2010-03-27	04:04:30	06:41:41	03:34:52	04:16:51	04:27:51	04:28:34	04:34:32	04:35:30	04:35:56	04:51:17	04:50:29	04:50:08	04:57:22	05:00:58	0:15:36
2010-03-30	03:53:23	06:29:34	03:32:23	04:14:17	04:25:17	04:26:00	04:32:03	penumbra only	00:00:00	00:00:00	penumbra only	04:36:17	04:42:20	04:45:53	0:04:14

Table 5 shows a summary of the IMU-1 drifts and time consumption during the eclipse season:

Table 5: Summary of IMU drift and times

IMU Usage during Eclipse Season						Summer 2010
IMU On	IMU Off	From Health Check		From Auto Calibration	On Time	Accumulated On Time
		Noise Roll [as/s]	Drift Roll [as/s]	Drift Roll [as/s]		
						0:00:00
2010-02-16 03:35:48	2010-02-16 07:04:22	0.1719	0.2977	0.2983	3:28:34	3:28:34
2010-02-19 02:55:00	2010-02-19 07:05:59	0.3176	0.2767	0.2983	4:10:59	7:39:33
2010-02-22 02:53:30	2010-02-22 07:00:10	0.1710	0.2933	0.3357	4:06:40	11:46:13
2010-02-25 02:53:48	2010-02-25 06:50:59	0.2073	0.2183	0.2527	3:57:11	15:43:24
2010-02-28 02:31:22	2010-02-28 06:39:59	0.2133	0.2852	0.3397	4:08:37	19:52:01
2010-03-03 02:18:04	2010-03-03 06:31:25	0.2498	0.1683	0.2112	4:13:21	24:05:22
2010-03-06 02:08:35	2010-03-06 06:24:18	0.3321	0.1417	0.2024	4:15:43	28:21:05
2010-03-09 02:07:41	2010-03-09 06:15:58	0.2212	0.3076	0.3415	4:08:17	32:29:22
2010-03-12 01:50:00	2010-03-12 06:05:41	0.2245	0.1974	0.2332	4:15:41	36:45:03
2010-03-15 01:42:39	2010-03-15 05:53:53	0.2855	0.1417	0.2275	4:11:14	40:56:17
2010-03-18 01:18:09	2010-03-18 05:41:59	0.1578	0.3158	0.3447	4:23:50	45:20:07
2010-03-21 01:34:45	2010-03-21 05:30:39	0.4184	0.2850	0.3025	3:55:54	49:16:01
2010-03-24 01:10:45	2010-03-24 05:18:03	0.2842	0.2500	0.2740	4:07:18	53:23:19
2010-03-27 00:43:47	2010-03-27 05:03:19	0.3980	0.3083	0.3437	4:19:32	57:42:51
2010-03-30 00:11:15	2010-03-30 04:48:14	0.2965	0.2800	0.3080	4:36:59	62:19:50

6.1.4 Event log

- **01/03/2010 (Day of Year 60, Revolution 901)**

IMU1 switched ON during the stable pointing of PID 09010061 (21:21:00Z). A manual mapping was commanded after the IMU switched OFF.

A manual slew was performed from attitude 09010061 to attitude 09010062 and the parameters for slew 09010063 were afterwards manually updated (spacontool).

Slew 09010062 was missed from the Timeline.

OTF was not reached for PID 09010061 and 09010062.

- **04/03/2010 (Day of Year 63, Revolution 902)**

- IMU1 switched ON during the stable pointing of PID 09020046 (15:56:31Z). A manual mapping was commanded and the parameters for slew 09020047 were afterwards manually updated (spacontool).

OTF was not reached for PID 09020046.

- FDS TPF update failed for slew 09020048 (16:29:00Z). FD advices to let next slew go without update.

- **11/03/2010 (Day of Year 70, Revolution 904)**

TM/TC link drop from Redu (00:57:00Z). As a consequence, slew 09040073 fails execution. After TM/TC link was recovered, a mapping was commanded and a manual slew was performed from attitude 09040072 to attitude 09040073.

The parameters for slew 09040075 were afterwards manually updated (spacontool).

Slew 09040073 was missed from the Timeline.

OTF was not reached for PID 09040073.

- **17/03/2010 (Day of Year 76, Revolution 906)**

IMU1 switched ON during the stable pointing of PID 09060103 (18:34:16Z). A manual mapping was commanded after the IMU switched OFF.

A manual slew was performed from attitude 09060103 to attitude 09060105. FD spacontool advised to perform a corrective CSL to the same attitude.

After the corrective CSL completed, the parameters for slew 09060106 were manually updated (spacontool).

Slews 09060104 and 09060105 were missed from the Timeline. OTF was not reached for PID 09060103, 09060104 and 09060105.

- **22/03/2010 (Day of Year 81, Revolution 908)**

- As a consequence of a TM/TC link drop (04:24:00Z), the execution of slews 09080035, 09080036 and 09080037 failed.

After TM/TC link was recovered, a mapping was commanded and a manual slew was performed from attitude 09080034 to attitude 09080037.

The parameters for slew 09080038 were afterwards manually updated (spacontool).

Slews 09080035, 09080036 and 09080037 were missed from the Timeline.

OTF was not reached for PID 09080034, 09080035, 09080036 and 09080037.

- PID 09080044 interrupted due to unexpected ground station handover (09:18:00Z).

- FDS TPF update failed for slew 09080054 (15:14:00Z). A mapping was commanded and a manual slew was performed from attitude 09080053 to attitude 09080055.

After the manual slew was completed, the parameters for slew 09080056 were manually updated (spacontool).

Slews 09080054 and 09080055 were missed from the Timeline.

OTF was not reached for PID 09080054.

- **23/03/2010 (Day of Year 82, Revolution 908)**

- FDS TPF update failed for slew 09080088 (10:04:00Z). A mapping was commanded and the parameters for slew 09080088 were manually updated (spacontool).

No impact on the Timeline.

- IMU1 switched ON during the stable pointing of PID 09080089 (10:51:31Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 09080090 were manually updated (spacontool).

OTF was not reached for PID 09080089.

- **24/03/2010 (Day of Year 83, Revolution 908 to 909)**

- IMU1 switched ON during the stable pointing of PID 09090006 (12:27:21Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 09090007 were manually updated (spacontool).

OTF was not reached for PID 09090006.

- **25/03/2010 (Day of Year 84, Revolution 909)**

- IMU1 switched ON during the stable pointing of PID 09090050 (12:55:00Z). A manual mapping was commanded after the IMU switched OFF.

A manual slew was performed from attitude 09090050 to attitude 09090051 and the parameters for slew 09090052 were afterwards manually updated (spacontool).

Slew 09090051 was missed from the Timeline.

OTF was not reached for PIDs 09090050 and 09090051.

- IMU1 switched ON during the stable pointing of PID 09090057 (17:43:21Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 09090058 were manually updated (spacontool).

OTF was not reached for PID 09090057.

- **26/03/2010 (Day of Year 85, Revolution 909)**

- IMU1 switched ON during the stable pointing of PID 09090101 (17:49:00Z). After the IMU switched back OFF, a manual mapping was commanded and the parameters for slew 09090102 were manually updated (spacontool).

OTF was not reached for PID 09090101.

6.2 SPI

6.2.1 Operations

Stirling Compressors and Cryostat

The performance of the compressors is nominal however their efficiency appears to be degraded following the CDE2 LCL trip-off which occurred on 04/11/2009 (AR INT_SC-273). This is thought to be due to contaminant evaporation and re-condensation during the period of the anomaly. However the Cold Plate temperature evolution in the reporting period was better than had been expected initially, following the last annealing.

The Cold Plate temperature was maintained in the 80K +/-1K range until the start of annealing on 30/10/2010. Until this time, the stroke of compressors A and B (CDE1) was set to 43 and that of compressors C and D (CDE2) was 45. The stroke of CDE2 was set to higher than that of CDE1 as the LCL current of CDE2 is lower than that of CDE1 for the same stroke. At these stroke settings (43 on CDE1 and 45 on CDE2) the LCL currents were:

- CDE1 LCL Current = 5.8A
- CDE2 LCL Current = 5.9A

At these stroke settings, the LCL currents were very stable and the drift of the Cold Plate temperature was negligible.

For the annealing operations, started on 30/03/2010, the cryocooler was in Standby mode.

Also on 30/03/2010, following the compressor switch-off, the CDE2 power supply configuration was changed in line with OCR 272 such that CDE2 is powered by 2 LCLs, one for each compressor. This involved moving the CDE2 internal relay from the “LCL1” position to the “LCL1+2” position. The command to move the CDE2 relay worked first time and the current of both LCLs was nominal following the change.

The following plot shows the evolution of the Cold Plate and thermal braids temperature until the start of annealing:

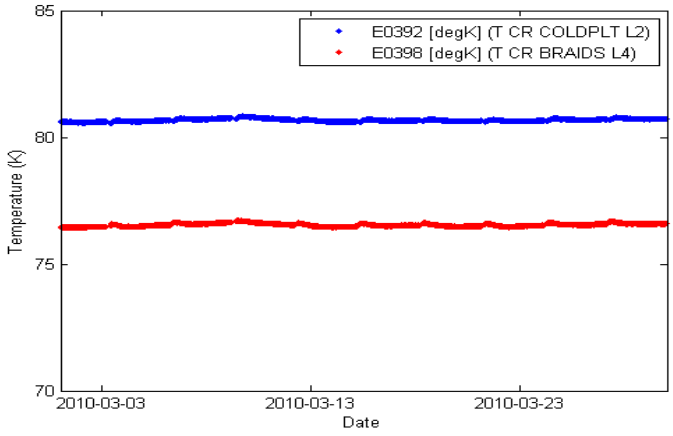


Figure 14: SPI Cold Plate and thermal braids temperature until start of annealing

The following plot shows the evolution of the Cold Plate, thermal braids and Cold Box temperatures since the start of annealing:

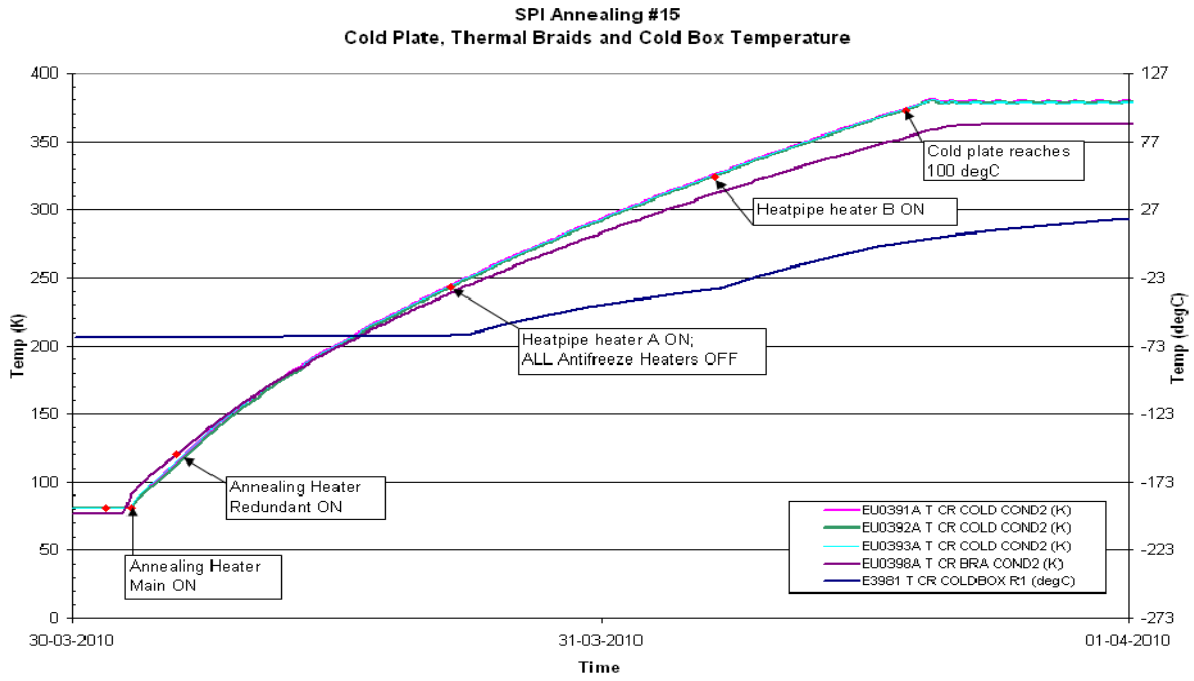


Figure 15: SPI Cold Plate, thermal braids and Cold Box temperature since start of annealing

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

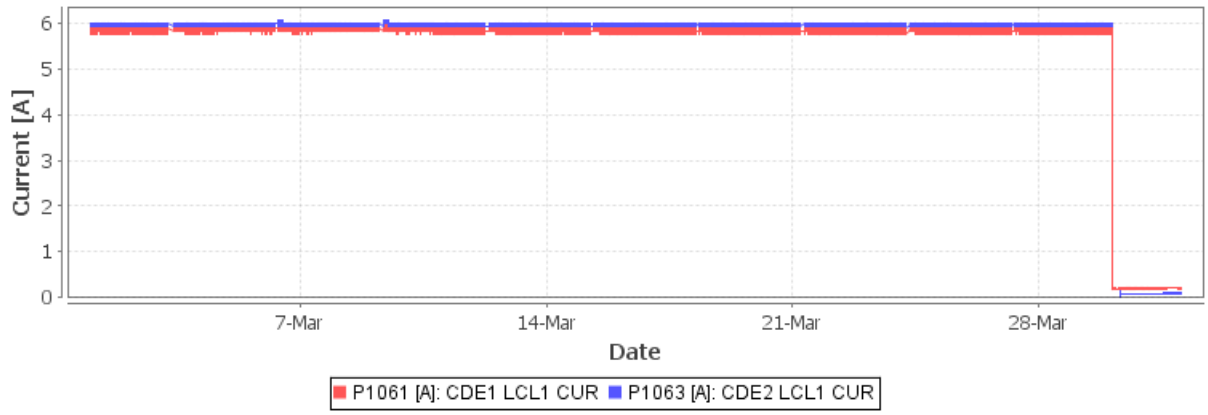


Figure 16: SPI CDE LCL curent

DPE & IASW

The DPE health and IASW performance are nominal. The IASW version installed is v4.3.5 with SE compression only enabled and the spectra scaling factor set to 7/19 SE. The DPE CPU usage was nominal during the reporting period (see Figure 1).

From revolution 911 onwards, SPI was in CONF mode with a TM allocation of 30 packets/cycle due to the annealing.

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.

For the 15th annealing operations, started on 30/03/2010, the ACS High Voltages were set to the minimum voltage (~980V) and the ACS was in CONF mode.

AFEE

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

For the 15th annealing operations, started on 30/03/2010, all detector HVPSs were switched off and only the LVPSs are left on and the AFEE was in CONF mode.

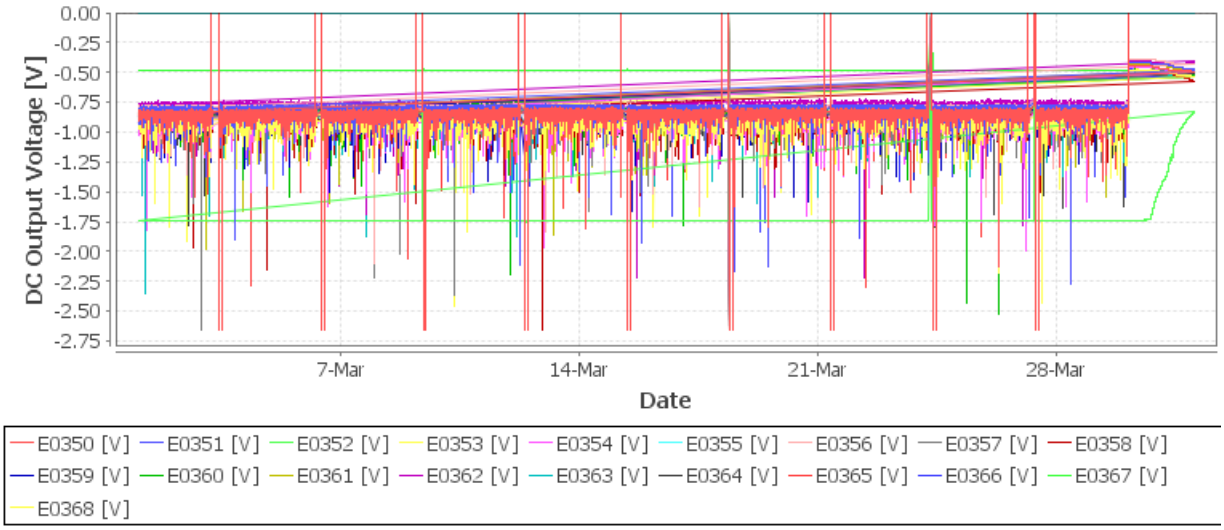


Figure 17: AFEE DC Output Voltages. Note that the data is sampled every 8th packet (64sec)

DFEE

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

For the 15th annealing operations, started on 30/03/2010, the DFEE was in CONF mode.

Figure 18: SPI GeD Non-Vetoed count rates. Note that the scale used for plotting is logarithmic

Figure 19: SPI GeD Time tag count rates

Figure 20: SPI GeD Time tag saturated count rates

PSD

The health of the PSD is nominal. For the 15th annealing operations, started on 30/03/2010, the PSD was in CONF mode.

The following plot shows the PSD channel rates over the reporting period:

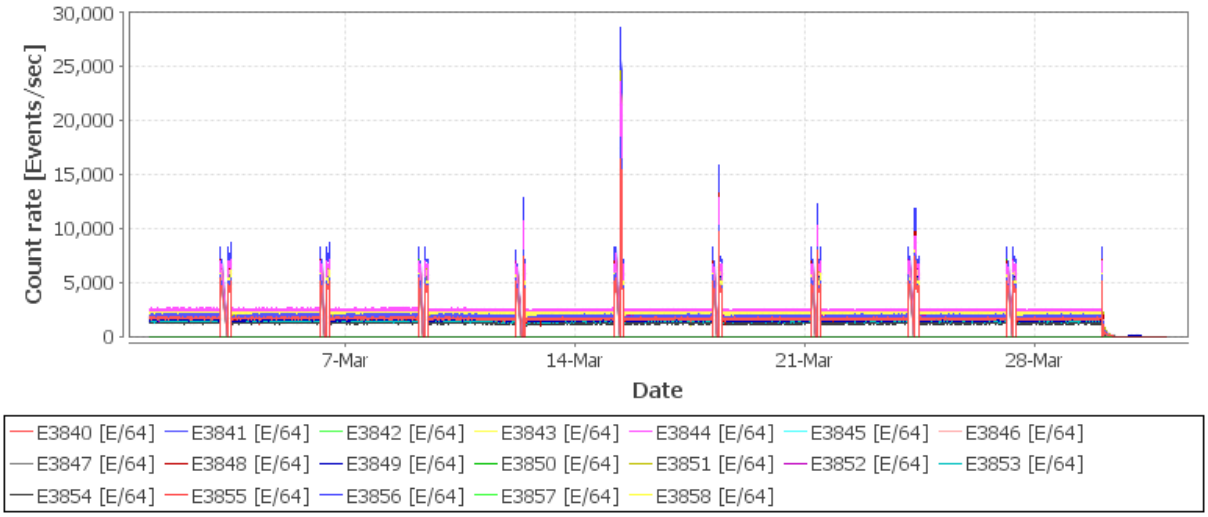


Figure 21: SPI PSD GeD Channel rates

6.2.2 Event Log

- Due to continuing high background radiation after the expected radiation belt exit of revolutions 902-907 TM parameter E3500 (ACS Counts Below 100MeV) was OOL between the times 2010.062.11.23.22Z - 2010.062.11.40.26Z, 2010.065.11.04.35Z - 2010.065.11.22.05Z, 2010.068.10.54.58Z - 2010.068.11.26.10Z, 2010.071.10.44.09Z - 2010.071.11.49.45Z, 2010.074.10.31.45Z - 2010.074.11.16.17Z and 2010.077.10.38.16Z - 2010.077.11.00.00Z. As in each case it returned within limits of its own accord as the background radiation level decreased, no action was taken. However, the radiation belt exit altitude was increased from 50000km to 53000km from revolution 907 onwards.

- 2 occurrences of OEM APID 1024 ID 243 EXCEPTION SPI1 SPECTRA BUILDING NOT COMPLETED were received during the reporting period (at 2010.061.02.57.17Z and 2010.083.22.41.20Z). As these were single occurrences and not frequent, no action was required.

- **30-03-2010 (Day of Year 089, Revolution 910-911)**

The start of the 15th annealing (OCR-275) was performed starting approximately one hour before radiation belt entry of revolution 910. Operations for this annealing are progressing nominally. The main activities are given in Table 6.

At the start of revolution 911, the operations to change the power supply configuration of the CDE2 were performed (OCR-272) such that CDE2 is powered by 2 LCLs. The operations performed were as follows:

- 06.56.03Z Initial test of LCL2 by commanding the CDE2 LCL2 to CLOSE (TC P3301), check TM P1162 CDE2 LCL2 STA = CLOSE and then open CDE2 LCL2 again (TC P3300)

- 07.09.01Z Switch CDE2 off: step 3.23 of FCP_SPI1_2520 SPICO: FROM STAND-BY TO OFF.
- 07.11.36Z Change the internal CDE relay position and reactivate CDE2 using both LCLs using FCP_SPI1_2570 SPICO 4 LCL CONFIG: FROM OFF TO STAND-BY (CDE1 Master), omitting the TCs for CDE1.

Table 6: Main activities SPI annealing

Date/Time	Activity
2010-03-30 01:29:09Z	Configure SPI for start of Annealing and stop SPI active cooling
2010-03-30 02:40:00Z	Annealing Heater Main ON
2010-03-30 04:40:00Z	Annealing Heater Redundant ON
2010-03-30 17:10:00Z	Heat Pipe Heater Main ON, All Antifreeze Heaters (1A; 2A; 1B; 2B) OFF
2010-03-31 05:10:20Z	Heat Pipe Heater Redundant ON
2010-03-31 13:50:00Z	Cold plate temperature reached 373K (100degC)

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:

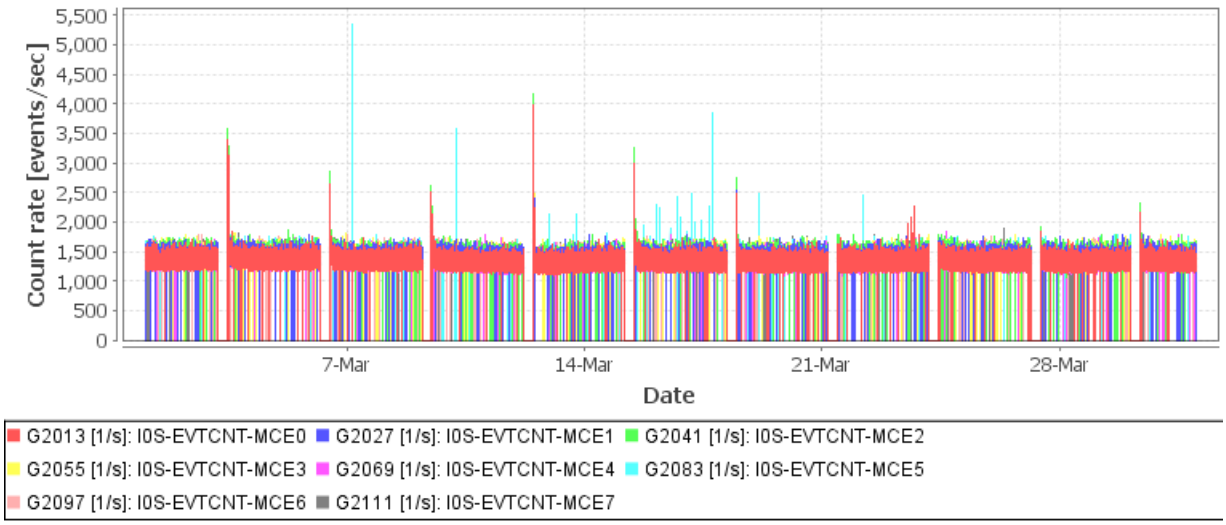


Figure 22: ISGRI MCE Counters

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

VETO

Other than the VETO count rate anomaly which occurred on 16-03-2010 (see below), the health and performance of VETO was nominal during the reporting period.

6.3.2 Event Log

- Due to continuing high radiation at radiation belt exit of revolutions 902-907, the ISGRI MCE counters (TM parameter family G2013) and the VETO count rates (TM parameters G6062 and G6063) toggled OOL for a while after the expected radiation belt exit of these revolutions (in the worst cases up to ~1 hour). As in each case they returned within limits of their own accord as the background radiation level decreased, no action was taken. However, the radiation belt exit altitude was increased from 50000km to 53000km from revolution 907 onwards.

- **06-03-2010 (Day of Year 065, Revolution 902-903)**

At 2010.065.12.06.13Z the following pair of OEMs was issued indicating a transfer error on the Low Speed Line:

- APID 1280 ID 131 ANOMALY IBIS1 IASW LSL TRANSFER FAIL REPORT FOR HIGH-LEVEL MODU

- APID 1280 ID 133 ANOMALY IBIS1 IASW LSL TRANSFER FAILED (LOW LEVEL) (TOGETHER WI 0

These were followed at 2010.065.12.06.23Z by OEM APID 1280 ID 246 TC REJECT IBIS1 MCE6 TIME OUT, indicating a timeout of an internal TC to MCE6, resulting from the LSL transfer error. This is a known problem which can occur and, as only one set of these OEMs was received and IBIS continued to operate nominally, no action was taken.

- **10-03-2010 (Day of Year 069, Revolution 904)**

At 06:24Z, following a ground station handover, TM parameter X7500 went OOL, indicating a problem with the histogram process. The following recovery procedure was then executed to force the histogram accumulation and download process to resume:

- 2010.069.07.00.57Z FCP_IBIS1_0312
- 2010.069.07.06.40Z TC G0129 uplinked to return IBIS to Science Standard mode.

IBIS operations continued nominally.

- **15-03-2010 (Day of Year 074, Revolution 905-906)**

At 23:46Z, following a ground station handover, TM parameter X7500 went OOL, indicating a problem with the histogram process. The following recovery procedure was then executed to force the histogram accumulation and download process to resume:

- 2010.074.23.50.23Z FCP_IBIS1_0312
- 2010.075.00.06.04Z TC G0129 uplinked to return IBIS to Science Standard mode.

IBIS operations continued nominally.

- **16-03-2010 (Day of Year 075, Revolution 906)**

At 2010.075.14.29.12Z the TM parameters families G5068 and G5072 failed status consistency check (value = TRUE). These are the PDM semi-module FIFO error flags. At 2010.075.14.29.55Z the TM parameter families G5002 and G5003 for the PDM semi-module counters started going OOL Low. As these were followed at 2010.075.14.32.49Z 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.

VETO Count Rate Anomaly

At 2010.075.15.49.55Z TM parameter families G5002 and G5003 (PDM semi-module counters) went OOL Soft High, with values ~2500counts/sec. Also around this time TM parameter G6061 (VETO Calibration source counter) started toggling OOL Soft Low. In addition, starting at 2010.075.15.59.10Z OEM APID 1280 ID 167 ANOMALY IBIS1 PICSIT NOISY SEMIMODULE SIGNALLING was regularly issued (8 occurrences between this time and when they stopped at 2010.075.17.37.18Z). No other OOLs for IBIS were received during this time. Initially a recovery was attempted by uplinking the ED GESTAN02 at 2010.075.17.11.15Z to make a mode transition to Standby and back to Science Standard mode. As this did not cure the problem, a further recovery was attempted as follows:

- 2010.075.17.45.10Z Set IBIS-IASW in Stand-By (TC G0125)
- 2010.075.17.45.28Z FCP_IBIS1_0228 PICsIT Context Restore

- 2010.075.17.48.23Z Set IBIS-IASW in Science Standard (TC G0129)

This also did not cure the problem and at this point it was observed that the VETO Bottom and Lateral counters (TM parameters G6062 and G6063) were reporting lower values than normal (~11000 instead of ~40000), although the values were not low enough to trigger an Out of Limit. At this point the following standard recovery for a VETO reduced count rates anomaly was performed:

- 2010.075.17.56.49Z Set IBIS-IASW in Stand-By (TC G0125)
- 2010.075.17.57.38Z Set IBIS-VETO in Stand-By (TC G0601)
- 2010.075.17.58.32Z Set IBIS-VETO in Nominal (TC G0600)
- 2010.075.17.59.24Z Set IBIS-IASW in Science Standard (TC G0129)

Following this the VETO count rates returned to nominal values and the PICsIT counters returned within limits. IBIS operations continued nominally. This is recorded as Anomaly Report INT_SC-287.

- **20-03-2010 (Day of Year 079, Revolution 907)**

At 2010.079.03.01.44Z the TM parameters families G5068 and G5072 failed status consistency check (value = TRUE). These are the PDM semi-module FIFO error flags. At 2010.079.03.02.59Z the TM parameter families G5002 and G5003 for the PDM semi-module counters started going OOL Low. As these were followed at 2010.079.03.06.01Z 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.

- **27-03-2010 (Day of Year 086, Revolution 909-910)**

Due to the upcoming wraparound of the DPE LOBT, IBIS was commanded to Standby Mode at 2010.086.14.07.32Z via FCP_IBIS1_0313. It was commanded back to Science Standard Mode via the CCCF_ED GESTAN02 in the Timeline at 2010.086.14.49.29Z.

- **28-03-2010 (Day of Year 087, Revolution 910)**

At 2010.087.16.20.41Z the TM parameters families G5068 and G5072 failed status consistency check (value = TRUE). These are the PDM semi-module FIFO error flags. At 2010.087.16.20.52Z the TM parameter families G5002 and G5003 for the PDM semi-module counters started going OOL Low. As these were followed at 2010.087.16.23.50Z by OEM APID 1280 ID 132 EVENT IBIS1 IASW HEPI RESYNCHRONIZED, indicating that HEPI resynchronised autonomously, by which time all the above parameters had returned within limits, no action was taken.

- **31-03-2010 (Day of Year 090, Revolution 911)**

Due to an IREM SEU, IBIS transitioned autonomously to Safe configuration at 2010.090.04.02.12Z. It was recovered as follows:

- At 2010.090.04.31.50Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE

- At 2010.090.04.49.06Z 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-2 is nominal. JEMX-1 is currently inactive. The following plot shows the JEMX and DFEE detector temperatures over the reporting period.

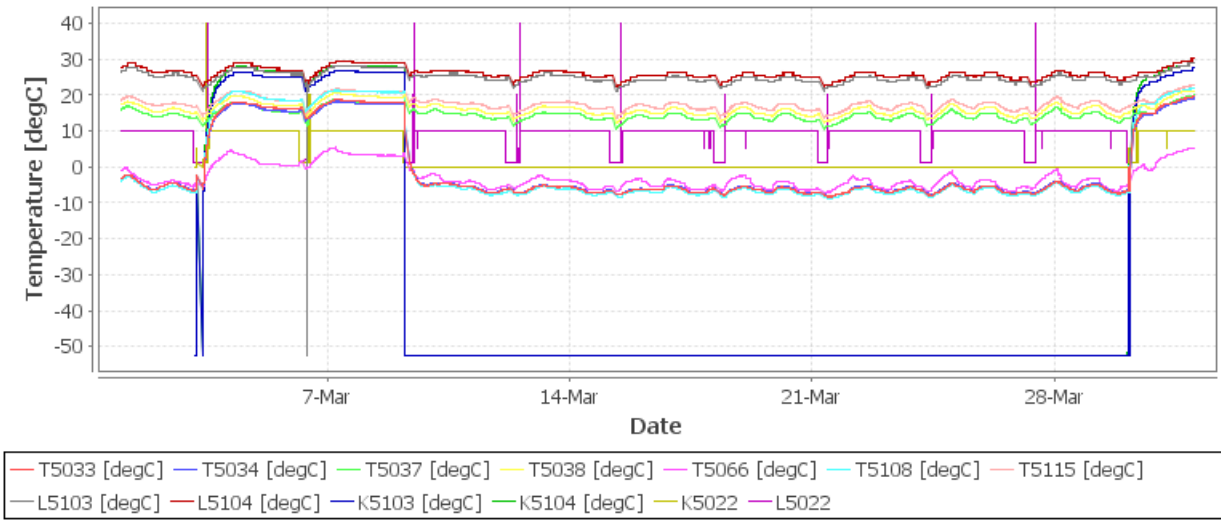


Figure 24: JEMX Detector and DFEE Temperatures

6.4.2 Event Log

- **03-03-2010 (Day of Year 062, Revolution 901 - 902)**

At 04:15, operations to activate JEMX-1 were commenced. At the indicated times, the following procedures were completed:

- 04:16:01 DEBWHI00 (Allocation of PST)
- 04:18:00 FCP_JEM1_0010 JEMX1 DPE AND CSSW ACTIVATION
- 04:51:00 FCP_JEM1_0015 JEMX1 IASW ACTIVATION
- 04:57:00 FCP_JEM1_0016 JEMX1 ENABLE BCP DISTRIBUTION
- 05:00:00 FCP_JEM1_0017 JEMX IASW EXTENDED TM CHECK
- 05:04:00 FCP_JEM1_0020 JEMX1 DFEE 1ST ACTIVATION AFTER DPE SWITCH

The transition to SAFE mode occurred automatically when the reaction to the broadcast packet was re-enabled.

The operations were completed before LOS at 05:05:00.

At 09:00, it was noted that there were 2 words that showed a discrepancy between the dumped DPE OBSM image and that supplied by the PI. This was hot-patched but afterwards no change was observed. It was then decided together with the PI to run with image as loaded, there was no impact.

At 09:07, the KECLEX01 ED was manually uplinked, as the time-tagged ED had not been loaded in the timeline.

At 11:26, the KEHVAC01 & LEHVAC01 EDs both failed release due to high radiation at belt exit. A recovery was performed, with JEMX-2 being recovered at 12:27, and JEMX-1 at 12:55.

- **06-03-2010 (Day of Year 065, Revolution 902 - 903)**

At 08:04:00, during the AOS checks, it was noticed that a JEM-X2, DFEE anomaly had occurred:

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.

2) 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.

In response to this, the following operations were performed:

1) At 09:14 a JEM-X2 DFEE power cycle was performed according to CRP_JEM2_5010 JEMX2 DFEE POWER CYCLE

2) At 09:39 the LECLXT01 ED was re-uplinked.

At 09:40Z JEM-X2 was re-enabled in T/L. (before the LEACAL01 ED at 10:35:47). The above recovery proceeded nominally and JEM-X2 operations then continued from the Timeline.

From 11:46 to 12:42 TM parameters K5449 & L5449 were intermittently soft high, no action was taken.

- **09-03-2010 (Day of Year 068, Revolution 903 - 904)**

At 04:01, manual operations were commenced to turn off JEMX-1.

These consisted of:

- 04:01:00 FCP_JEM1_9010 JEMX1 DFEE SWITCH OFF.
- 04:02:00 FCP_JEM1_0120 JEMX1 SET BCP OVERRIDES inhibiting reaction to belt entry.
- 04:12:00 FCP_JEM1_0120 JEMX1 SET BCP OVERRIDES enabling reaction to belt entry.

- 04:13:00 FCP_JEM1_9001 JEMX1 DISABLE BCP DISTRIBUTION
- 04:17:00 FCP_JEM1_9000 JEMX1 DPE SWITCH OFF

At 11:12, the TC L0013 (part of the LEHVAC01 ED) failed release due to high radiation at belt exit.

At 11:38, this was recovered by re-uplinking the failed LEHVAC01 ED, also the CCCFs were enabled for good measure.

- **12-03-2010 (Day of Year 071, Revolution 904 - 905)**

At 10:51:59, the TC L0003 (part of the LEHVAC01 ED) failed release due to high radiation at belt exit.

This was recovered by executing the following procedures:

- 11:00:00 FCP_JEM2_0040 (Go to SAFE)
- 12:30:00 FCP_JEM2_0041 (Go to SETUP)
- 12:32:00 Uplinking the LEHVAC01 ED (JEM-X2 High Voltage on)
- 12:48:00 Uplinking the LEDATA02 ED (JEM-X2 to Data-Taking)

- **15-03-2010 (Day of Year 074, Revolution 905 - 906)**

At 10:43:30, the OEM:JEMX2 PROB DFEE 9 was received, probably due to high radiation at belt exit.

This was recovered by executing the following procedures:

- 10:50:00 FCP_JEM2_0040 (Go to SAFE)
- 11:11:00 FCP_JEM2_0041 (Go to SETUP)
- 11:17:00 Uplinking the LEHVAC01 ED (JEM-X2 High Voltage on)
- 11:33:00 Uplinking the LEDATA02 ED (JEM-X2 to Data-Taking

- **18-03-2010 (Day of Year 077, Revolution 906 - 907)**

At the start of revolution 907, the CRITICAL_ALT_ASC was put back by about 20 minutes to reduce the incidence of problems associated with JEMX switch on.

- **30-03-2010 (Day of Year 089, Revolution 910 - 911)**

At 01:30, operations to activate JEMX-1 were commenced. The following procedures were completed:

- FCP_JEM1_0010 JEMX1 DPE AND CSSW ACTIVATION
- FCP_JEM1_0015 JEMX1 IASW ACTIVATION
- FCP_JEM1_0016 JEMX1 ENABLE BCP DISTRIBUTION

- FCP_JEM1_0017 JEMX IASW EXTENDED TM CHECK
- FCP_JEM1_0020 JEMX1 DFEE 1ST ACTIVATION AFTER DPE SWITCH

The operations were completed before LOS at 03:44:00.

- **31-03-2010 (Day of Year 090, Revolution 911)**

At 04:02:00 JEMX-1&2 parameters K5315, K5316, K5317, L5315, L5316 & L5317 went Out-of-Limits due to an IREM SEU (#87). 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

- **11-03-2010 (Day of Year 070, Revolution 904)**

At 00:57, a TM drop from Redu forced a suspension of operations. A recovery was performed, and the timeline rejoined at 01:23. The impact was the loss of pointing 09040073. It was at this time that the following pair of commands was rejected:

```
2010.070.01.00.06.922   2010.070.01.00.19.367   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2010.070.01.00.13.047   2010.070.01.00.26.738   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.

- **17-03-2010 (Day of Year 076, Revolution 906)**

At 18:34, an AOCS problem forced an interruption. A recovery was performed, and the timeline rejoined at 19:23. The impact was that pointing 09060104 was executed at the wrong attitude and pointing 09060105 was lost. It was at this time that the following pair of commands was rejected:

```
2010.076.19.17.57.663   2010.076.19.18.09.538   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N     E   E

2010.076.19.18.03.913   2010.076.19.18.09.590   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 09060105.

- **22-03-2010 (Day of Year 081, Revolution 908)**

At 04:20, missing packets caused an AOCS command to fail completion, which forced an interruption. A recovery was performed, and the timeline rejoined at 05:35. The impact was the loss of pointings 09080035, 09080036 & 09080037. It was at this time that the following pairs of commands were rejected:

```
2010.081.04.23.13.900   2010.081.04.23.18.967   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N      E   E

2010.081.04.23.20.150   2010.081.04.23.26.183   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N      E   E



2010.081.04.55.10.151   2010.081.04.55.22.116   1792   RealTime   131     TC REJECT   REJECTED
TC1                                             0       0    65535   PR    N      E   E

2010.081.04.55.16.276   2010.081.04.55.22.147   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 pointings 09080035 & 09080036.

At 15:13, an AOCS problem forced a suspension of operations. A recovery was performed, and the timeline rejoined at 15:46. The impact was the loss of pointing 09080054.

- **31-03-2010 (Day of Year 090, Revolution 911)**

At 04:01:59 an IREM SEU (#87) forced OMC to SAFE mode, a recovery was performed, and the unit returned to standby at 04:28:18. The impact was an interruption of pointing 09110026 after 2537 from a planned 2667 seconds, and the loss of pointing 09110027

6.6 IREM

6.6.1 Operations

Radiation belts entry and exit

The following plots show the Radiation Belt Entry (Figure 25, red line) and Exit times (Figure 26, blue line) obtained from the ISDC website, defined where the IREM TC3 (soft electrons) rate reads 600 counts. The blue line in Figure 25 and the magenta line in Figure 26 are the altitudes used by the MOC for planning purposes.

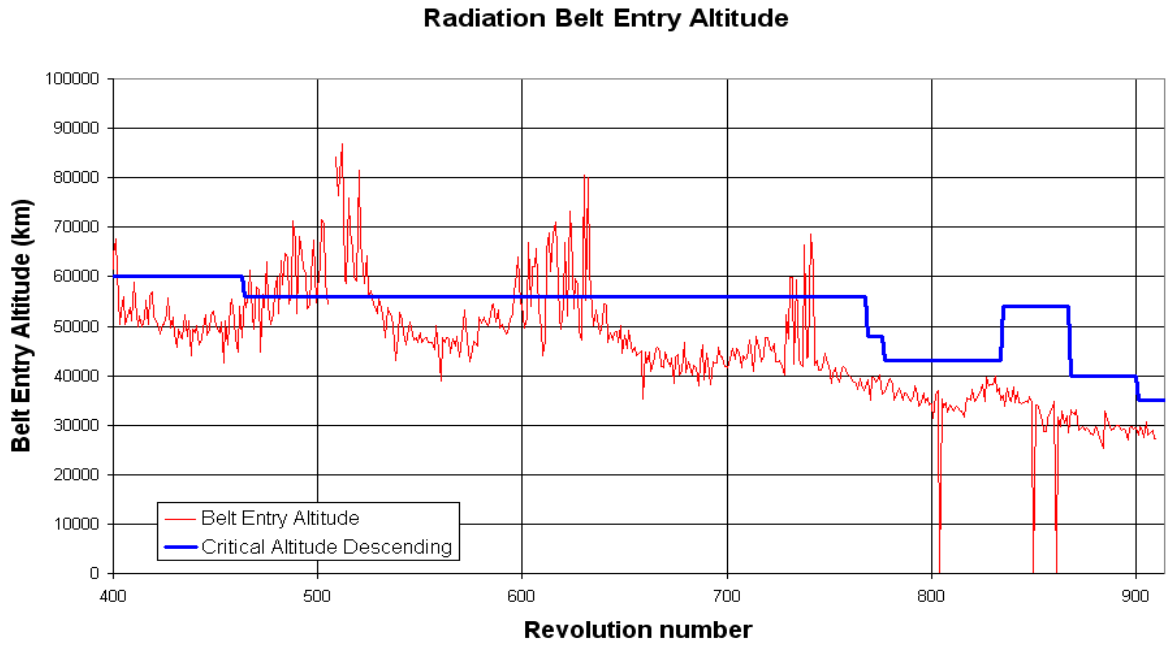


Figure 25: Radiation belt entry

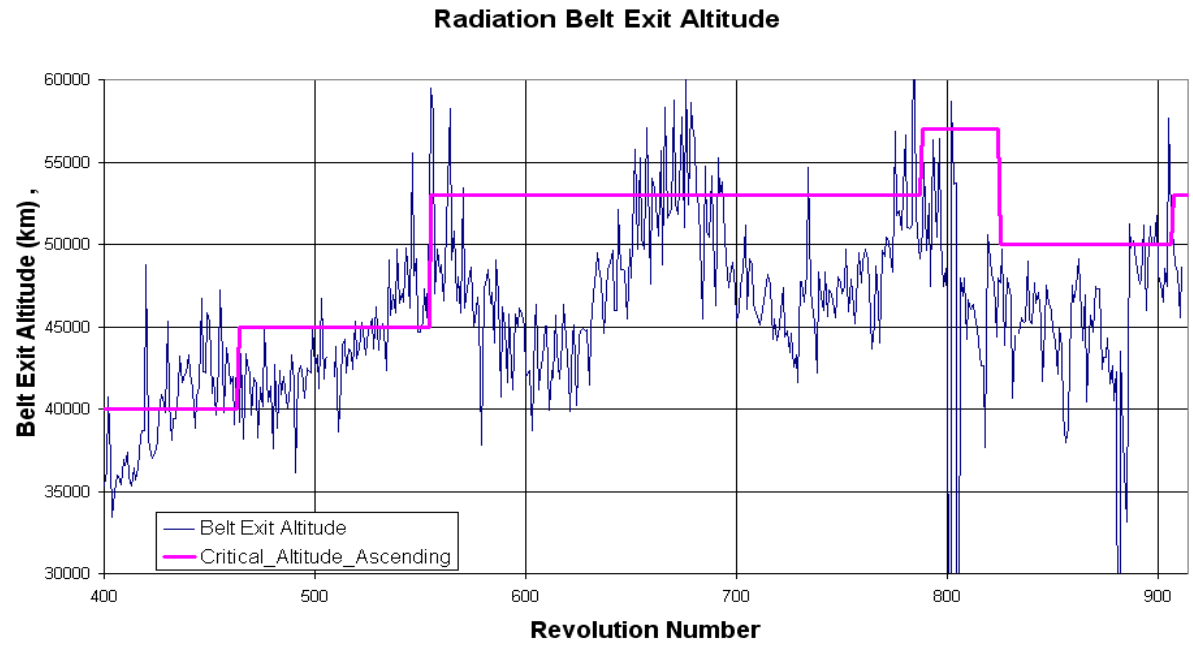


Figure 26: Radiation belt exit

Table 7: 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
901	RAD_ENTR R 2010-03-03T04:16:01Z	03/03/2010 05:19:56	23381.7	03-Mar-2010 05:04:11	25656.57	03-Mar-2010 06:04:11	12946.44
902	RAD_EXIT R 2010-03-03T11:01:32Z	03/03/2010 10:29:00	<46606.9	03-Mar-2010 10:44:11	47353.39	03-Mar-2010 06:44:11	6295.952
902	RAD_ENTR R 2010-03-06T04:07:03Z	06/03/2010 05:00:04	22893.8	06-Mar-2010 05:03:00	23759.97	06-Mar-2010 06:03:00	11018.3
903	RAD_EXIT R 2010-03-06T10:51:59Z	06/03/2010 10:11:48	<46214.7	06-Mar-2010 10:33:00	47260.61	06-Mar-2010 06:33:00	6325.609
903	RAD_ENTR R 2010-03-09T03:57:30Z	09/03/2010 04:57:16	24145.0	09-Mar-2010 04:53:54	23792.65	09-Mar-2010 05:53:54	11072.27
904	RAD_EXIT R 2010-03-09T10:42:25Z	09/03/2010 10:04:12	43940.3	09-Mar-2010 10:23:54	47205.88	09-Mar-2010 06:23:54	6375.357
904	RAD_ENTR R 2010-03-12T03:46:23Z	12/03/2010 04:54:04	21363.2	12-Mar-2010 04:36:43	24995.25	12-Mar-2010 05:36:43	12307.75
905	RAD_EXIT R 2010-03-12T10:31:34Z	12/03/2010 11:49:00	61473.3	12-Mar-2010 10:06:43	46203.5	12-Mar-2010 06:16:43	6160.516
905	RAD_ENTR R 2010-03-15T03:33:55Z	15/03/2010 04:25:25	24676.0	15-Mar-2010 04:28:26	24274.26	15-Mar-2010 05:28:26	11585.59
906	RAD_EXIT R 2010-03-15T10:19:10Z	15/03/2010 10:03:57	<49035.4	15-Mar-2010 09:58:26	46774.15	15-Mar-2010 05:58:26	6656.616
906	RAD_ENTR R 2010-03-18T03:21:23Z	18/03/2010 04:25:01	21559.4	18-Mar-2010 04:12:39	25156.02	18-Mar-2010 05:12:39	12404.59
907	RAD_EXIT R 2010-03-18T10:25:40Z	18/03/2010 09:41:33	>>37172.0	18-Mar-2010 09:42:39	46183.66	18-Mar-2010 05:52:39	6084.084
907	RAD_ENTR R 2010-03-21T03:09:48Z	21/03/2010 04:12:13	22450.0	21-Mar-2010 04:04:44	23992.56	21-Mar-2010 05:04:44	11166.92

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
908	RAD_EXIT R 2010-03-21T10:13:24Z	21/03/2010 09:13:33	>>37223.4	21-Mar-2010 09:34:44	47193.31	21-Mar-2010 05:34:44	6292.672
908	RAD_ENTR R 2010-03-24T02:57:47Z	24/03/2010 03:58:05	23428.9	24-Mar-2010 03:49:03	24803.67	24-Mar-2010 04:49:03	12004.02
909	RAD_EXIT R 2010-03-24T10:01:22Z	24/03/2010 09:03:57	>>37225.4	24-Mar-2010 09:19:03	46524.4	24-Mar-2010 05:29:03	5919.971
909	RAD_ENTR R 2010-03-27T02:44:15Z	27/03/2010 03:53:33	22082.6	27-Mar-2010 03:38:30	24551.66	27-Mar-2010 04:38:30	11729.37
910	RAD_EXIT R 2010-03-27T09:47:38Z	27/03/2010 08:30:45	>>37237.9	27-Mar-2010 09:08:30	46755.61	27-Mar-2010 05:08:30	6571.205
910	RAD_ENTR R 2010-03-30T02:32:44Z	30/03/2010 03:41:25	22277.4	30-Mar-2010 03:31:28	23068.66	30-Mar-2010 04:21:28	12243.77
911	RAD_EXIT R 2010-03-30T09:35:10Z	30/03/2010 08:37:25	>>35486.3	30-Mar-2010 08:51:28	46433.17	30-Mar-2010 05:01:28	5793.259

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

- **31-03-2010 (Day of Year 090, Revolution 911)**

At 04:01:58Z, a local reset of the IREM CSCI S/W (SEU #87) occurred. The status of the unit, before the local reset of the IREM CSCI S/W, was nominal, here is a summary:

1) The temperatures were nominal;
2) The LCL current was nominal;
3) The last HK before the anomaly showed HV, 5V and 6V voltages inside limits;

4) The anomaly occurred at 2010.090.04:01:58Z (142607.4 km). The unit had performed an automatic transition to Standard Mode (i.e. 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.

6) It was noted that the dump of the status word gave a value of BCA0 (48288), indicating the watchdog had elapsed, usually the status word shows BCC0 (48320). This value has been observed only once before with SEU number 37 at 2006.304.02.18.00Z.

7) The patch was performed successfully with the correct re-starting of the S/W following procedure FCP_RM_0081. The operation was completed at 10:28:00Z.

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 04.28.23Z and IBIS at 04:53:00Z.