

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OF
No. 112
Week 46
15.11.04
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.

It addresses the activities from 06.11.04 until 12.11.04 (both dates inclusive) and covers the revolutions 253 & 254.

2 Summary of Activities

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

The targets of these revolutions were the Galactic Plane; Cygnus X (RA 20:33:10.00; DEC +41:12:00.0) and NGC 7172 (RA 22:02:1.70; DEC -31:52:18.0), amalgamated with an observation of PKS 2155-304 (RA 21:55:58.40; DEC -30:13:32.1). The activities consisted of GPS and raster dithering observations.

Note: Some further information concerning the activities is provided in the Appendix.

3 Satellite Status

3.1 Platform

The performance of the platform was good. No new unexpected behaviour / malfunction was identified.

3.1.1 AOCS

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

1 Closed Loop Slew was missed from the Timeline due to a late bit-lock after a ground station handover.

The fuel consumption over the period between 06/11/2004 and 12/11/2004 was 0.094 kg. The remaining propellant is in the order of 166.8379 Kg.

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

3.1.2 Power

The EPS is working nominally, available power from the arrays is of the order of 2100W.

On DOY 316 (11/11/2004) at AOS (04.33z) after perigee passage the BCR2 status (P3005) in telemetry had changed from ON to OFF, the battery 2 (trickle) charge current was 0.0A. No other statuses were affected. The BCR was successfully switched back on at 07.25z, after switch on the correct Trickle charge current value was verified. The Spacecraft was experiencing high Proton radiation at the time, due to a Solar flare.

An identical event occurred on 3/11/2003 (INT_SC_68).

A similar event affecting P3001 "BDR2 ON/OFF STAT" / P3004 "BCR1 ON/OFF STAT" / P3016 "BAT1 RECO K09" / P3040 "BCE2 PROT ENA M" occurred on 30/7/2004 (INT_SC_89).

3.1.3 Thermal

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

3.1.4 OBDH

The OBDH subsystem is working flawlessly. No on-board communications problem was identified.

3.1.5 RFS

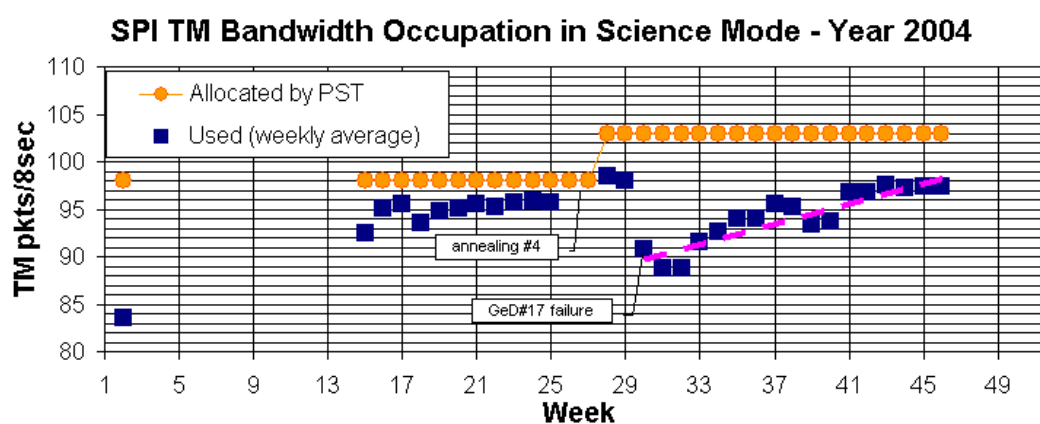
The RF subsystem is working properly. The link margin is sufficient to ensure proper TM reception and execution of commands with the ranging channel enabled.

3.2 Payload

3.2.1 SPI

The overall status of the instrument in this week is nominal, though the PSD (Pulse Shape Discriminator) still continues to randomly reproduce the malfunction of channels blocking and the abnormal solar activity was the cause of a few other alarms on the ACS (Anti-Coincidence System).

The instrument was kept in photon-by-photon mode for the whole period, with spectra TM enabled, an assigned TM bandwidth in the science observation windows of 103 pkts/cycle and an actual occupation of 97.4 pkts/cycle average. The following plot shows the occupied bandwidth, since beginning of 2004.



The cryo-cooler is working well, maintaining the temperature within 85+/-1K.

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

3.2.2 IBIS

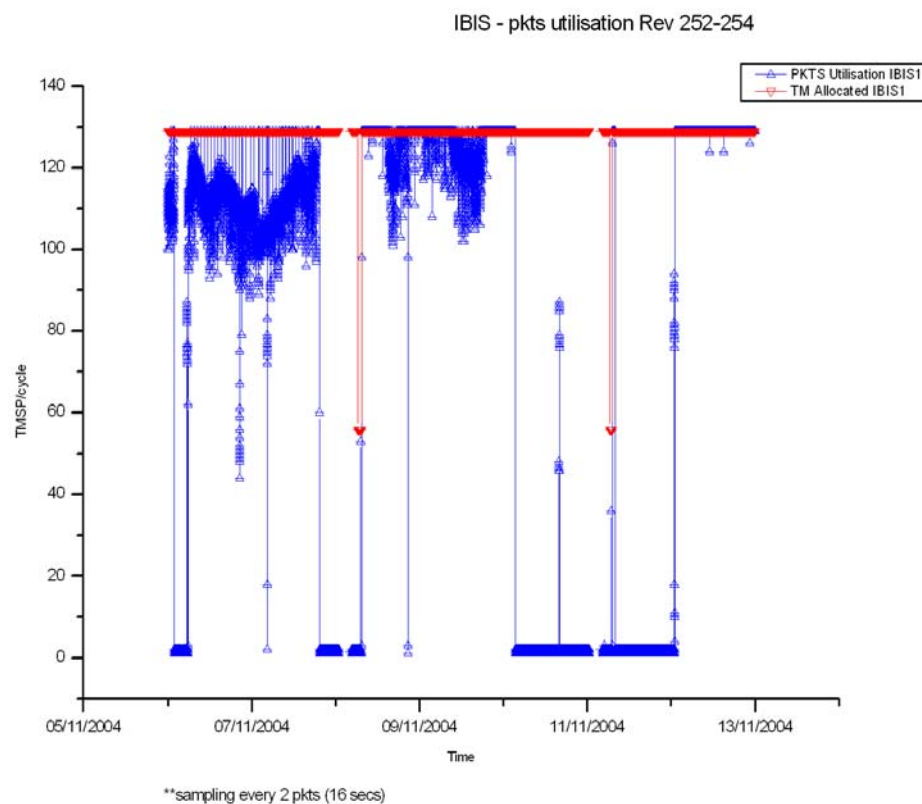
The overall status of the unit is Nominal.

The week was characterised by high solar activity and the unit remained part of the observation time in Safe configuration.

On DoY 311 an automatic reset of the IREM SW (#16) forced the transition of the unit to Stand-By with the VETO High Voltages and ISGRI Biases OFF.

During the reporting period the PST allocation to IBIS was 129 TMPS/cycle. The IBIS mean bandwidth utilisation during the observation period was 121.4 TMPS/cycle, up 9.0 on last week.

A plot of the IBIS TM utilisation during the observation period is shown below:



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

3.2.3 JEM-X

The status of both JEM-X units is nominal.

JEM-X operations were performed by the automatic Timeline.

JEM-X1 was operated in Data Taking mode during science observations, with a TM allocation of 8 packets/cycle. JEM-X2 remained dormant (DFEE OFF) with a TM allocation of 1 packet/cycle.

On 2004-11-06 at 02:33:41Z, an anomaly occurred on the JEM-X1 DPE (AR INT_SC-97). The anomaly consisted of a spontaneous reset of the JDPE1 CPU. In order to ensure the safety of JEM-X1 and to recover the unit, an unconditioned switch-off of the JDPE1 was performed, followed by a full power cycle of the JEM-X1 DPE and DFEE, including the reloading of all the S/W patches. Following the recovery operations, JEM-X1 was returned to Data Taking mode at 2004-11-06T10:18:43Z. However, due to the ongoing IREM recovery operations following the IREM S/W reset, which had occurred at 2004-11-06T01:49:57Z, JEM-X1 was operated without IREM protection until 2004-11-06T12:02:35Z, when the JEM-X1 reactions to the Broadcast Packet RMC flags were re-enabled. Following the JDPE1 anomaly, it was decided to keep all the JEM-X RMC flags ENABLED for the time being (contrary to OCR-183).

Due to high background radiation conditions as a result of a solar flare, JEM-X1 spent the majority of the reporting period in Safe mode. Specifically, JEM-X1 operations were interrupted from 2004-11-07T19:15Z to the end of the reporting period.

Further information on the JEM-X operations can be found in the Appendix Section 8.3.4.

3.2.4 OMC

The status of OMC is nominal.

During the reporting period OMC operations were performed by the automatic timeline, with the TM allocation to OMC of 5 packets/cycle.

The reporting period was heavily impacted with high radiation, during which the spacecraft was in SAFE mode.

There were 47 OMC pointings executed nominally, 6 were interrupted, and 82 were lost.

Note: Some more information concerning the OMC operations is provided in the Appendix Section 8.3.5.

3.2.5 IREM

The overall status of the unit is nominal.

On DoY 311, at 01:50z an automatic reset of IREM S/W (SEU#16) that impacted the instruments, forcing them to Safe Configuration occurred.

After the Payloads reconfiguration (OMC and IBIS), the unit was successfully recovered and currently no degradation of the performance is noted.

Solar Activity

The observation period was characterised by high solar activity.

On the 6th and 7th of November 2004, sunspot 696 unleashed a M7-class and a X1-class solar flare respectively. Consequently, on the 8th of November 2004, the IREM

counters (proton & electron) reported high values corresponding to the Coronal Mass Ejection hurled by these explosions. The major event reported was:

SUMMARY: Proton Event 10MeV Integral Flux exceeded 100pfu
Begin Time: 2004 Nov 07 1910 UTC
Maximum Time: 2004 Nov 08 0115 UTC
End Time: 2004 Nov 08 1000 UTC
Maximum 10MeV Flux: 495 pfu
NOAA Scale: S2 - Moderate

Sunspot 696 remained active the whole week. It unleashed a M8-class and a X2-class solar flare on the 9th and 10th of November 2004 respectively. The major event reported was:

SUMMARY: Proton Event 100MeV Integral Flux exceeded 1pfu
Begin Time: 2004 Nov 10 0320 UTC
Maximum Time: 2004 Nov 10 0330 UTC
End Time: 2004 Nov 10 1255 UTC
Maximum 100MeV Flux: 2 pfu

Hence, during the whole week, high radiations were reported. From the 8th to the 12th, IREM counters reported solar flare radiation levels.

Note: Some more information concerning the IREM operations is provided in the Appendix Section 8.3.6.

4 Ground Facilities

The performance of the Operational ground facilities was very good this week, well above the system performance requirements, 1 pointing was lost due ground station problems.

4.1 Mission Operations Centre

The performance of the MOC was in general good in the reporting period, although there were problems with resource consumption on some machines.

4.2 Ground Stations & Network

The performance of the ground stations and Network was in general good this week. A pointing was lost due to a late bit-lock after a handover to DSS-16, but 3 of the instruments were off anyway due to the radiation, there was also some lost packets from Redu. The overall performance though was well above the 95% requirement.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

PSF's up to rev 260 received. All these revolutions have been planned. TSF's received up to rev 255. Revolution 257 is re-planned to change some IBIS parameter settings in a special observation. This special test observation will test a further modification to the 5 x 5 dither pattern. This modification is designed to improve IBIS sensitivity. No ToO request received.

3. Observation status

No new ECS's this week

4. ISOC science data archive

Nothing to report

5. ISOC system

Version 10.6.2 is still in use. No problem detected.

6. Problems

none

7. Move to ESAC / Vilspa

Some detailed planning for the period December to February established. This is a critical period with activities both in ESTEC and ESAC that need to be well coordinated.

4.3.2 ISDC

Status of ISDC observation processing on 15/11/2004:

- Latest Standard Analysis completed: observation 02200890003 (SN 2004dj, Revolution 221-222) on 15/11/2004
- Latest products archived: observation 02200100003 (SGR1806-20, Revolution 225) on 05/11/2004
- Latest observation products sent to the observer: observation 02200100003 (SGR1806-20, Revolutions 225) on 09/11/2004

5 Special Events

6 Anomalies

There were a number of problems that impacted the operations:

- On DoY 311, at 00:29, the nctrs-b event log was consuming 78% of the available cpu.
- Later, at 01:50, an IREM SEU caused IBIS, JEMX-1 and OMC to switch to SAFE mode, see IREM report for details.
- At 02:33, JEMX-1 crashed, necessitating a full reboot (including load the S/W patches) of the unit. See JEMX report for details.
- At 16:45, the MMI launcher on imca had to be restarted owing to high cpu load (>12%) and low swap space (238MB).
- At 17:08, the following error appeared on idda EV>Error – HFACTMrecord::store. Error writing TM-record on archive 31104/store of packet failed.

- On DoY 314, at 20:23, there was a data gap on the VC0 TM-link from Redu. At the same time there were bad frames received. GFCC report Reed-Solomon alarms.
- On DoY 315, at 18:23, the timeline was stopped after a late bit-lock from DSS-16 during a handover from Redu. The impact was slew 02530070 was missed, subsequently sun122 froze, so the first attempt at recovery failed, but the attitude was recovery for pointing 02530071.
- On DOY 316, at 04.33 after perigee passage the BCR2 status (P3005) in telemetry had changed from ON to OFF, the battery 2 (trickle) charge current was 0.0A. No other statuses were affected. The BCR was successfully switched back on at 07.25z, after switch on the correct Trickle charge current value was verified. The Spacecraft was experiencing high Proton radiation at the time, due to a Solar flare.
- On DoY 316, at 22:32, there was a brief drop in the TM from Redu, there was no impact.

The following new anomaly reports were entered into the ARTS system.

AR id	Date Created	Subject	Segment	Status
INT_SC-98	08/11/2004	IREM Anomaly: Reset of IREM_CSCI S/W #16	Payload	Open
INT_SC-99	11/10/2004	BCR2 Spurious Switch-off #2.	Spacecraft	Pending
INT-2671	15/10/2004	Late Bitlock at DSS-16	NASA Station	Pending
INT-2672	15/10/2004	ManStk locked up	IMCS	Pending

7 Future Milestones

The Next eclipse season starts on the 23rd November 2004, and continues until the 17th December 2004. There will be a total of 9 eclipses, with a maximum duration of 57 minutes 41 seconds on 8th December 2004.

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 253

The observations in revolution 253 consisted of a GPS lasting ~12 hours, followed by a raster dithering observation of Cygnus X (RA 20:33:10.00; DEC +41:12:00.0), performed for the remaining ~48 hours of observation time.

Revolution 254

In revolution 254 a raster dithering observation of NGC 7172 (RA 22:02:1.70; DEC -31:52:18.0), amalgamated with an observation of PKS 2155-304 (RA 21:55:58.40; DEC -30:13:32.1), was performed throughout the available observation time (~62 hours).

Throughout these observations all instruments were planned to be in their nominal science modes, except JEM-X2 for which the DFEE remained off, and the TM allocation was IBIS 129; SPI 103; JEM-X1 8; JEM-X2 1; OMC 5.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

2004-10-24T19:23:59.000Z	167.1656	F	Automatic TM processing.
2004-10-25T17:00:41.000Z	167.1399	F	Automatic TM processing.
2004-10-27T06:15:17.000Z	167.1296	F	Automatic TM processing.
2004-10-27T15:07:26.000Z	167.1141	F	Automatic TM processing.
2004-10-27T22:16:39.000Z	167.0645	F	Automatic TM processing.
2004-10-30T06:05:56.000Z	167.0501	F	Automatic TM processing.
2004-10-30T14:58:21.000Z	167.0200	F	Automatic TM processing.
2004-10-31T16:27:12.000Z	166.9899	F	Automatic TM processing.
2004-11-02T05:51:32.000Z	166.9730	F	Automatic TM processing.
2004-11-03T16:21:19.000Z	166.9442	F	Automatic TM processing.
2004-11-05T05:39:15.000Z	166.9323	F	Automatic TM processing.
2004-11-06T16:17:03.000Z	166.8958	F	Automatic TM processing.
2004-11-08T05:27:40.000Z	166.8846	F	Automatic TM processing.
2004-11-08T14:16:45.000Z	166.8589	F	Automatic TM processing.
2004-11-11T05:13:55.000Z	166.8379	F	Automatic TM processing.

This report was generated Fri Nov 12 08:00:19 GMT 2004

8.3 Detailed Satellite Information

This section contains some detailed information concerning the various subsystems of the satellite and instruments.

8.3.1 AOCS Summary Operations Report 06/11/2004-12/11/2004

AOCS operations were executed from the Automatic Timeline.

During this period, 50 Open Loop Slews, 112 Closed Loop Slews and 5 Momentum Biases were executed. 1 slew was missed, with another executed manually. This is equivalent to a 0.62 % loss.

06/11/04 (Day of Year 311, Revolution 252)

Nothing to report.

07/11/04 (Day of Year 312, Revolution 252)

Nothing to report.

08/11/04 (Day of Year 313, Revolution 252-253)

Nothing to report.

09/11/04 (Day of Year 314, Revolution 253)

Nothing to report.

10/11/04 (Day of Year 315, Revolution 253)

Slew missed due to late bit-lock: At 18:23, the timeline was stopped after a late bit-lock from DSS-16 after a handover from Redu. The first attempt at recovery failed, as sun122 had frozen, but the attitude was recovered in time for pointing 02530071.

11/11/04 (Day of Year 316, Revolution 253-254)

Loss of Guide star: At 04:17:26, the guide star at location [-11207, -6976], magnitude 6.25 was released, probably due to the SEU threshold being exceeded, this caused the OEM 'ACC STR THR EX' to be sent. At 04:17:26, the IMU switched on, and remained on for 19 minutes until 04:36:40. A new guide star was selected at location [17014, -6489] magnitude 5.40. There was no impact.

12/11/04 (Day of Year 317, Revolution 254)

Nothing to report.

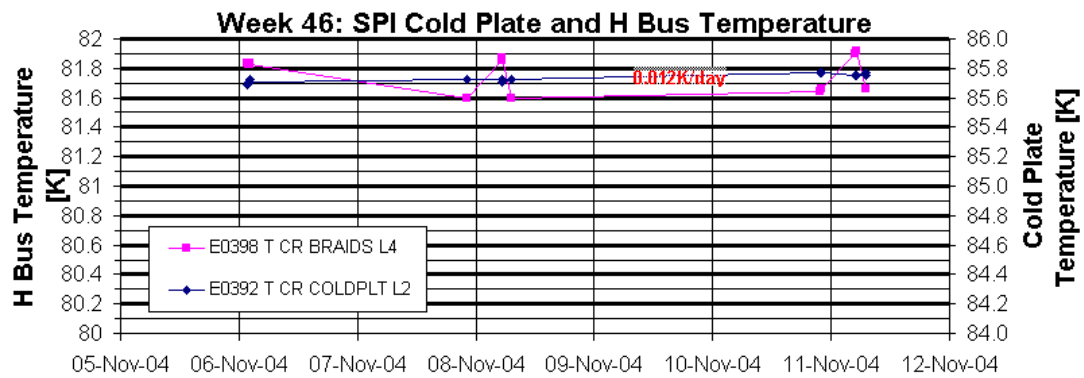
8.3.2 SPI Operations

Cryo-cooler / Detector Cold-Plate:

The performance of the cryo-cooler is nominal.

The cold plate temperature was maintained at 85K $\pm$ 1K showing the expected small positive drift.

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

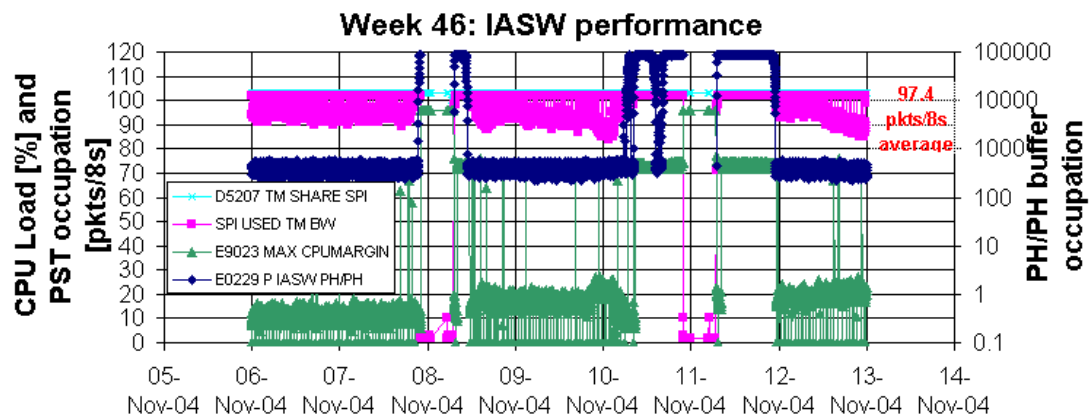


IASW/DPE:

The performance of the IASW/DPE is nominal.

The following diagram shows the IASW performance in terms of TM bandwidth, event buffer occupation and DPE CPU load during the reporting period.

Note: The photon buffer saturation peaks are the consequence of the increased radiation environment due to solar activity.

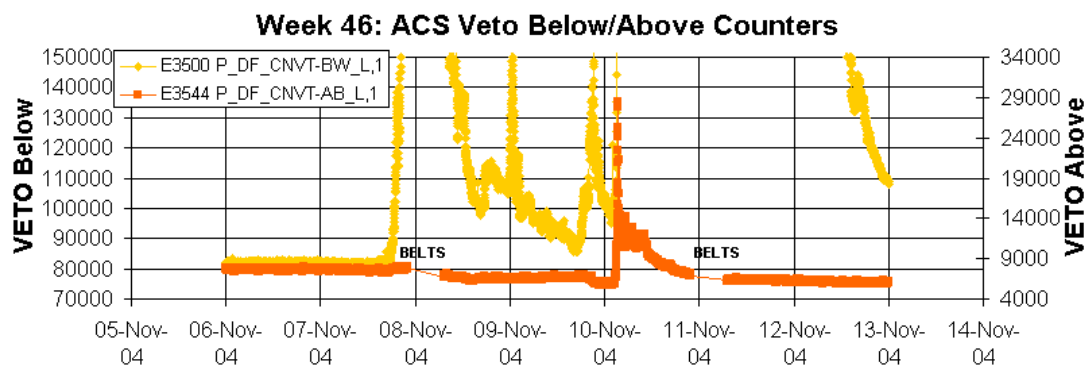


ACS:

The performance of the ACS is nominal.

The following plot shows the ACS overall count rate evolution during the reporting period.

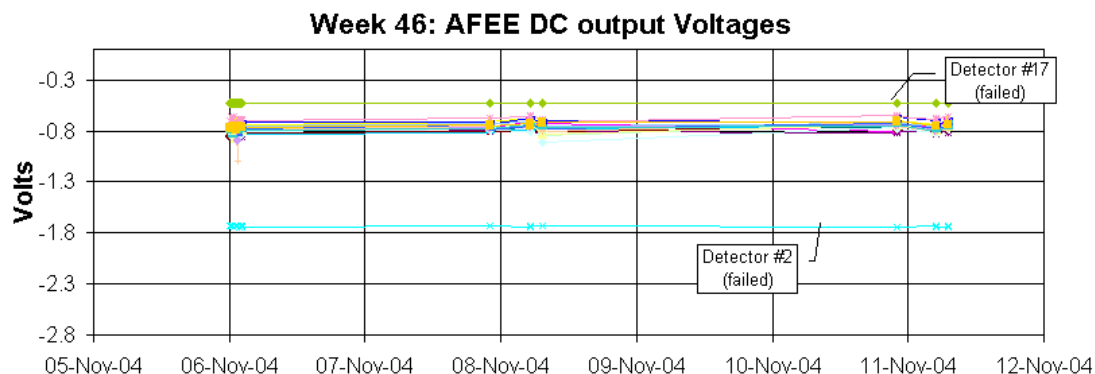
Note: The peaks outside the belts are the consequences of the increased radiation environment due to solar activity.



AFEE:

The performance of the detectors is nominal except for the detector #2, failed since 06.12.2003, and detector #17, failed since 17.07.2004.

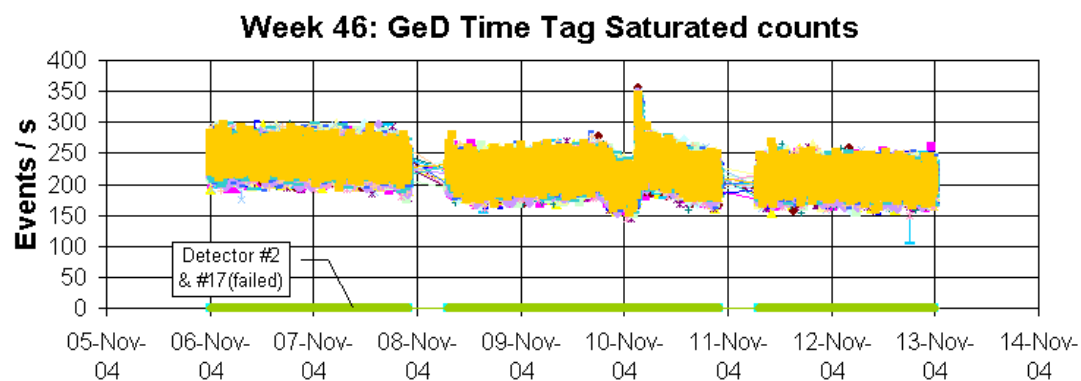
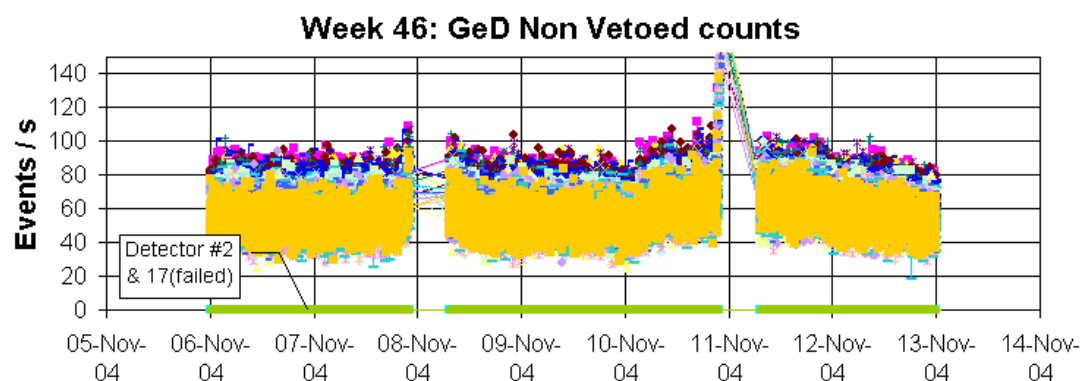
The following plot shows the AFEE dc output signals during the reporting period.



DFEE:

The performance of the unit is nominal.

The following plot shows the Non Vetoed event rates, processed by the DFEE during the reporting period. The count rate of each detector is within the expected range, except for the failed detector #2 and #17.

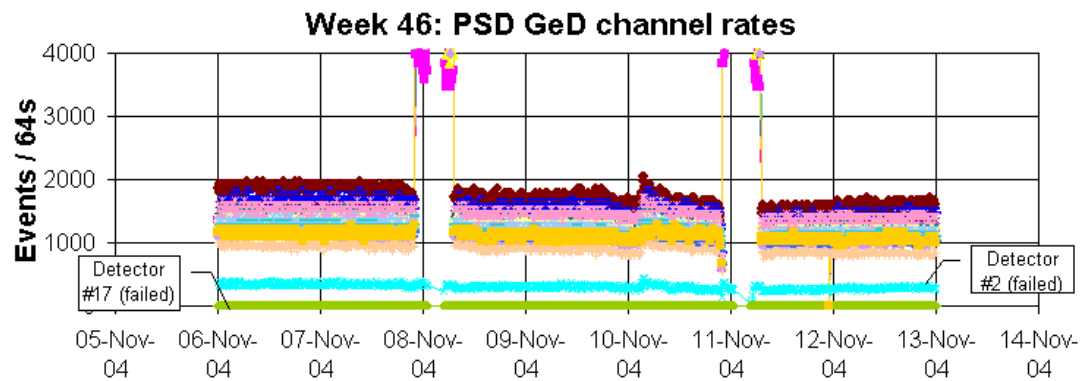


PSD:

The performance of the unit is nominal, though the malfunction of the channel rates blanking reproduced itself also this week (see AR INT_SC-90 for a detailed description of the anomaly).

An IASW patch is under final acceptance testing at Cessr to enable the Sci HK TM downlink inside the radiation belts. This would allow the deletion of the Out-Of-Limit currently defined for the PSD channel rates, thus removing the false alarms associated to the malfunction.

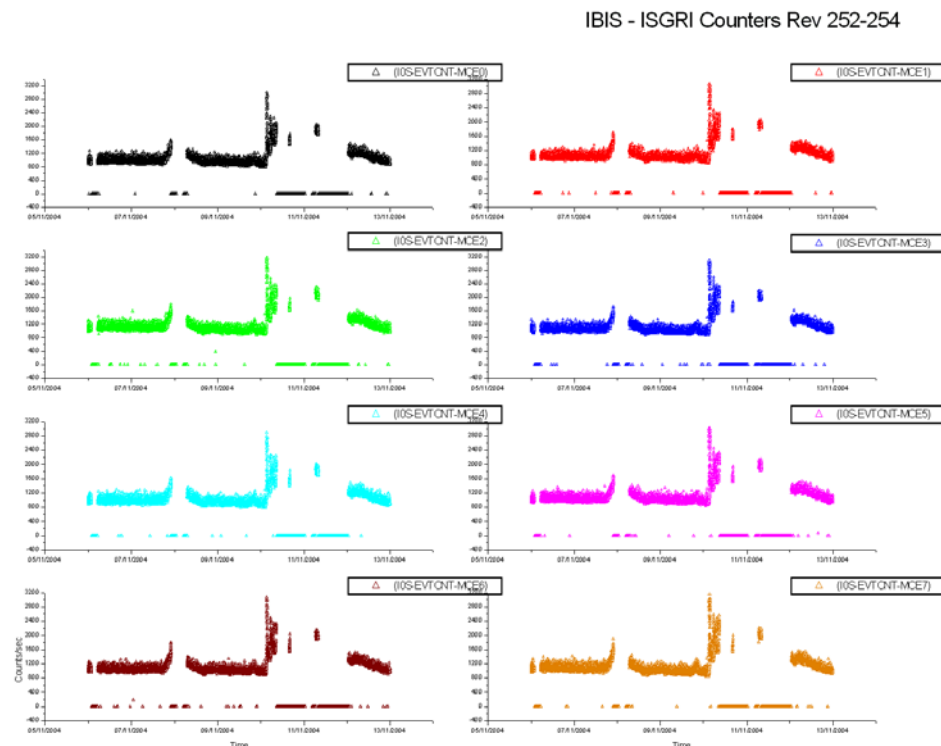
The following plot shows the PSD channel rates during the reporting period.



8.3.3 IBIS Operations

IBIS Event Counters Plots.

ISGRI Counters:

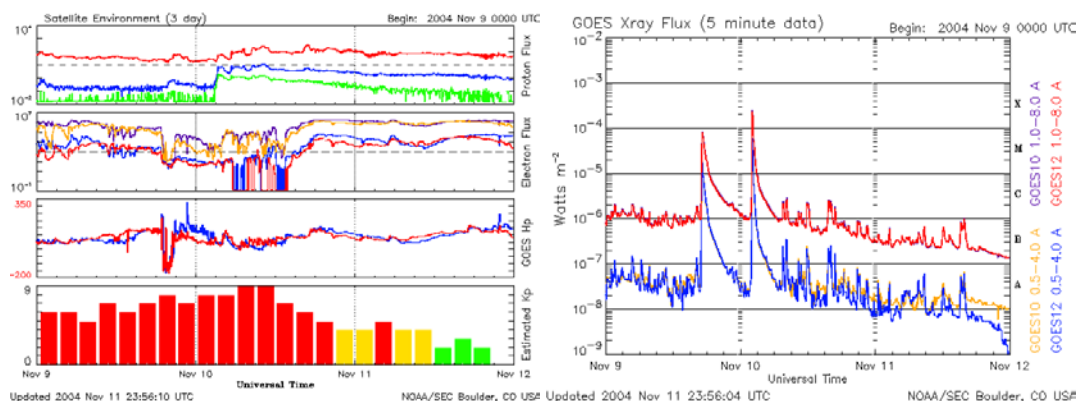
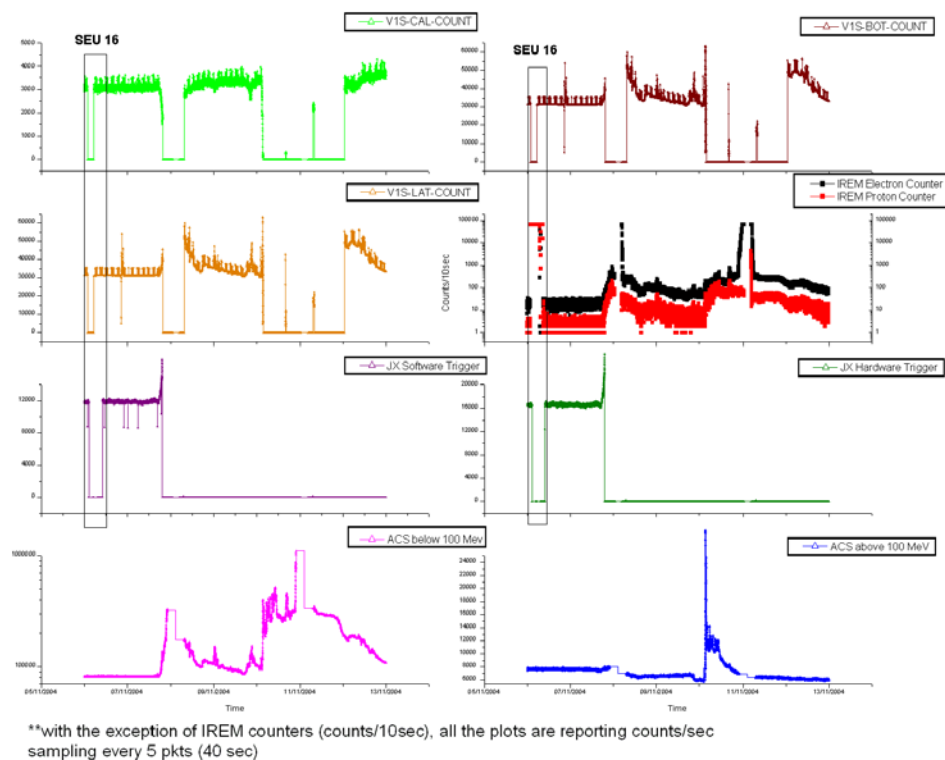


**sampling every 4 pkts (32 secs)

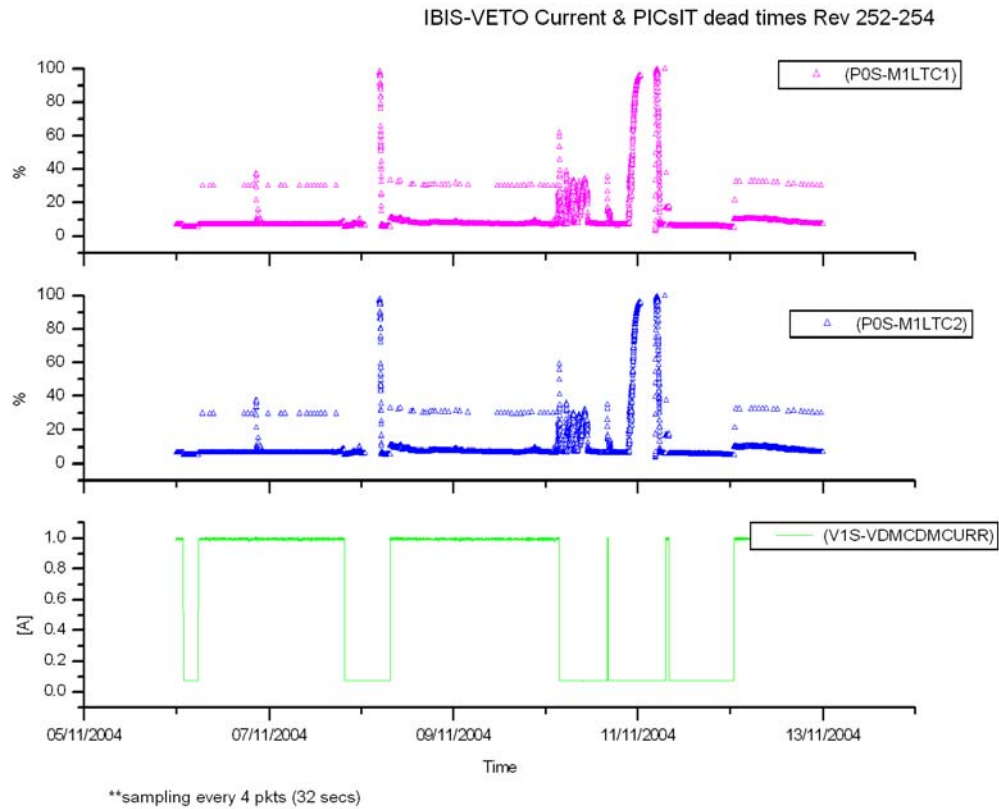
VETO vs Payloads Counters

The week was characterised by high solar activity. From the 8th of November 2004 until the 12th, the IREM counters (proton & electron) reported high radiation, which at some points exceeded the IBIS radiation thresholds switching the instrument to Safe Mode. An automatic reset of the IREM SW (SEU #16) occurred on DoY 311.01.49.58z, which impacted the instruments, also forcing them to Safe Configuration. The Spike on the ACS above 100 MeV is related to the proton-flux step that can be seen in the NASA Goes plots. The energy of this event is slightly different from the earlier one, being hard (above 100 MeV) as opposed to soft radiation (above 10 MeV).

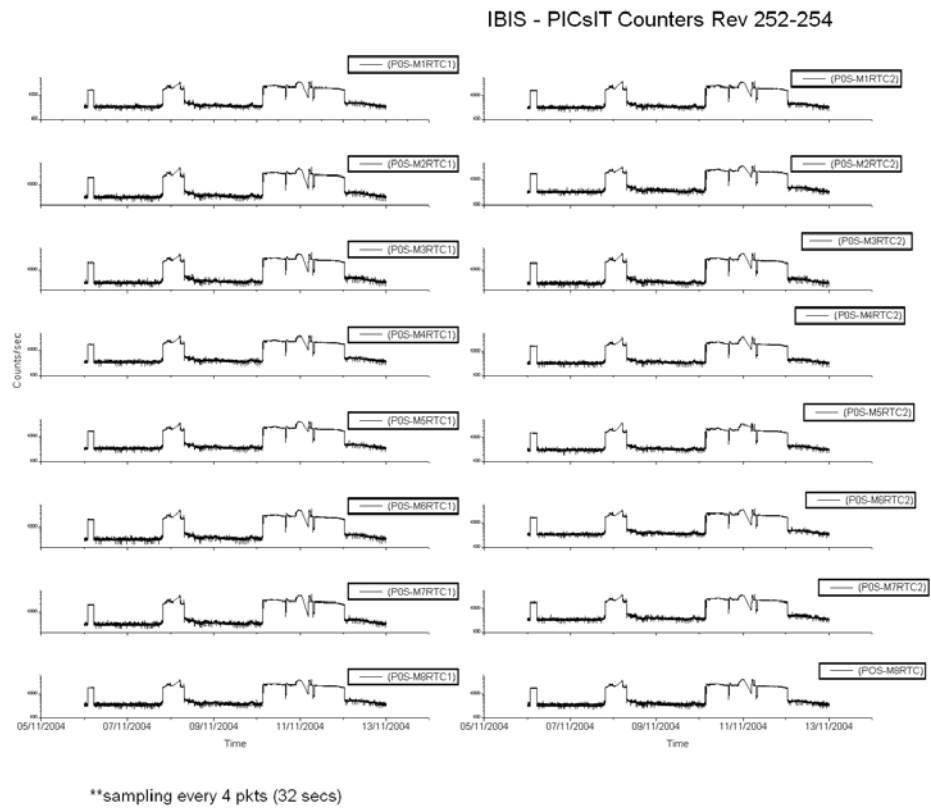
IBIS-VETO vs Payloads Counters Rev 252-254



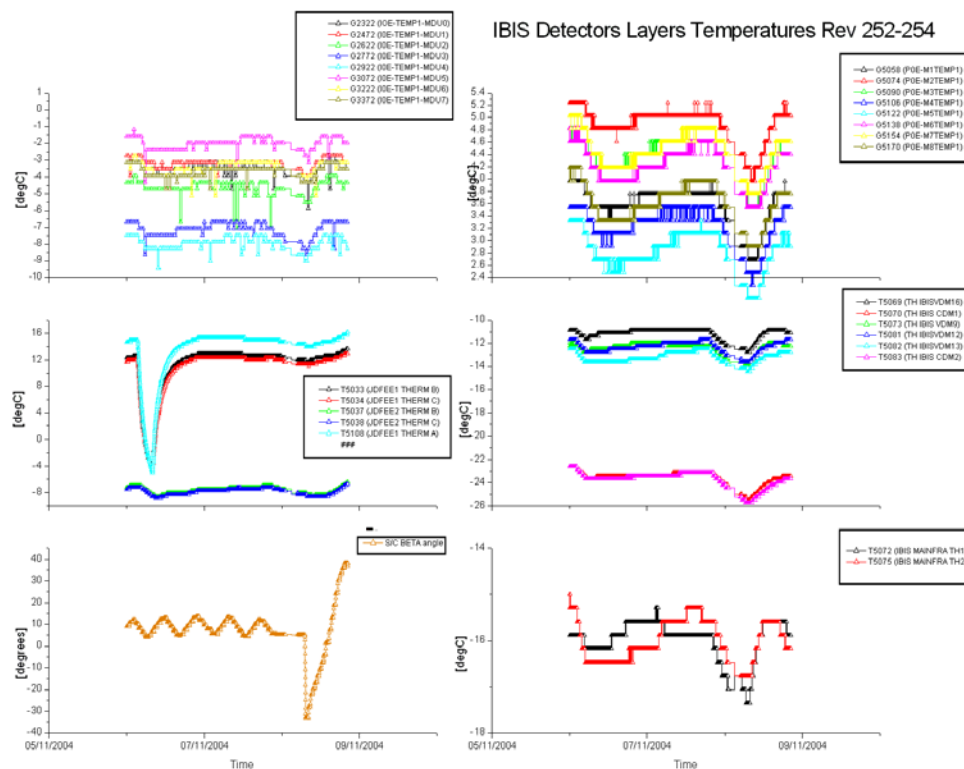
Veto Current:



Picsit Counters:



IBIS Detectors Layers Temperatures



**sampling every 8 pkts (64 secs)

IBIS daily report

DoY 2004.311 (06/11/2004)

At 01:50Z an IREM automatic transition to Standard Mode (reset of the CSCI S/W, SEU number 16) occurred. The anomaly affected the instrument status via the BCPKT forcing the automatic transition of IBIS to Stand-By with the VETO High Voltages and ISGRI Biases OFF. The recovery of the unit started at 05:22Z with FCP_IBIS1_0803, and was completed at 05:50Z when the unit was re-enabled in the automatic scheduling system (see IREM report for details).

DoY 2004.312 (07/11/2004)

At 04:17Z, the PICsIT histograms downloading stopped, the recovery defined by INT_OR_109 was applied. At 04:34Z the unit returned to Scientific Mode.

At 18:40Z TM G6061 (VIS_CAL_COUNT) went 'hard-low' OOL and back. It kept on toggling in and out of limits during about 4 minutes due to the increasing radiation level. At 18:56Z it turned to 'hard-low' OOL again.

At 19:31Z, according to the Payload Recovery document, the IBIS IASW was set into Stand-by (FCP_IBIS1_313) and VETO into Stand-by (FCP_IBIS1_203) by applying the reaction V-CAL. The unit was left in Stand-By until the end of the revolution 252, few hours later.

DoY 2004.313 (08/11/2004)

Nothing to report. (Status of IBIS nominal).

DoY 2004.314 (09/11/2004)

Nothing to report. (Status of IBIS nominal).

DoY 2004.315 (10/11/2004)

Due to the increasing of radiation background level, several IBIS parameters went OOL.

At 02:58Z TM G6061 (V1S_CAL_COUNT) went 'hard-low'. At 03:10Z TM G6062 and G6063 (V1S_LAT_COUNT and V1S_BOT_COUNT) went 'high' OOL.

At 03:30Z, according to reaction V-CAL, IBIS\ IASW was set to Stand by (FCP_IBIS1_0313), and 3 minutes later, IBIS\VETO was also set to Stand-by (FCP_IBIS1_0203).

At 03:36Z the parameter families G5002, G5003 and G2013, returned within limits.

At 04:00Z IBIS Sub-system was disabled in the Timeline and the unit maintained under constant monitoring.

At 04:58Z, the VETO 28V PMT set by IASW (G8015) toggled in/out of limit (warning high) several times, for few TM cycles. The same behaviour was observed at 06:00Z.

It was the first time this event has been observed outside the Radiation Belts and was likely to be connected to high radiation (reference AR INT_SC-101). During the same period the VETO HVs remained OFF.

From 05:23Z to 08:32Z, the ISGRI event counter MCE parameters (G2027, G2041, G2055, G2083, G2097 and G2111) toggled several times in/out of limit (warning high), for few TM cycles.

At 08:41Z, the unit performed an automatic transition to Safe configuration triggered by the high count-rates reported by IREM counters.

At 15:54Z the IBIS recovery started with FCP_IBIS1_0803 and IBIS exited Safe Mode.

Due to Radiation Spikes the on-board automatism forced a re-configuration to Safe mode at 16:15Z. The unit remained in this state until the end of the revolution 253.

DoY 2004.316 (11/11/2004)

At 05:50Z, the VETO 28V PMT set by IASW (G8015) toggled between nominal and warning high. According to the Payload Recovery document, as this happened inside Radiation Belts, no further action was taken. Investigations are on going at IBIS team in order to understand the origin of the mis-behaviour (reference AR INT_SC-101).

At 06:39Z TM G2028 (ISGRI Overflow of the noisy pixel address buffer in MCE2) and G2029 (ISGRI Overflow of the On-event message buffer in MCE2) went OOL. No action was taken according to the Payload FDIR document.

At 08:07Z, the unit performed an automatic transition to Safe configuration triggered by the high count-rates reported by IREM counters.

Due to high radiation, at 08:09Z IBIS was disabled in the timeline.

DoY 2004.317 (12/11/2004)

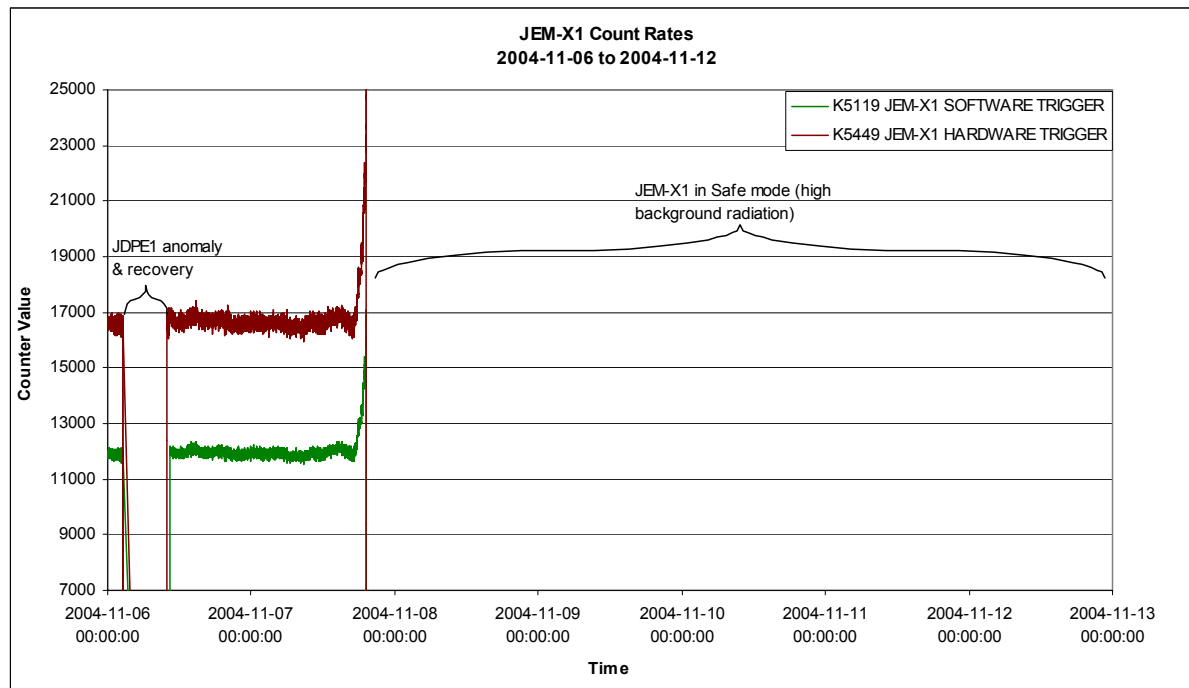
At 00:53Z FCP_IBIS1_0803 was applied and IBIS recovered from Safe configuration. Following OR_0180, IBIS was set into Scientific Standard Mode at 01:12Z, and enabled in timeline at 01:16Z.

At 02:29Z, G8080 went OOL high and back (at 02:32Z). This TM parameter features the rate of valid event on HBRA interface, and was triggered by the high radiation context.

8.3.4 JEM-X Operations

8.3.4.1 JEM-X Count Rates

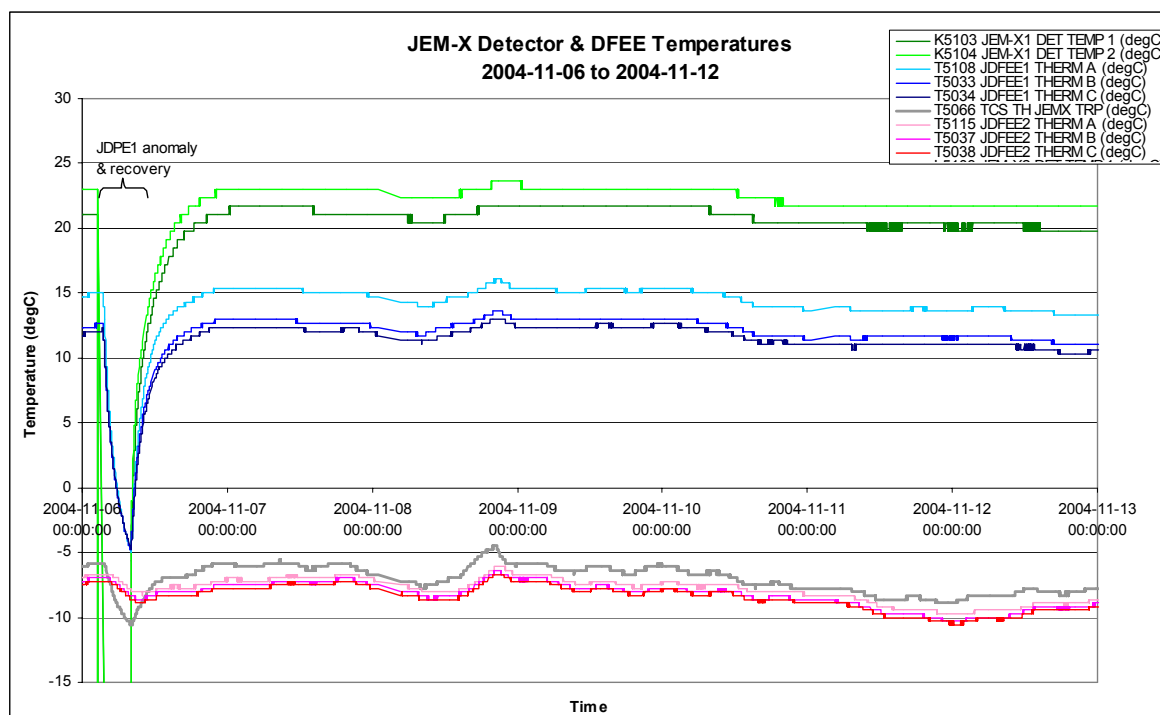
JEM-X count rates over the reporting period are displayed in the following graph¹.



8.3.4.2 JEM-X Temperatures

¹ Data sampled (1 frame in 4) and smoothed to remove spikes in S/W Trigger due to flushing of buffer after slews.

JEM-X Detector and DFEE temperatures over the reporting period are displayed in the following graph, along with the temperature on the detector bench between the two units².



8.3.4.3 JEM-X Daily Report

2004-11-06 (DOY 311, Rev 252)

At 02:33:41Z, an anomaly occurred on the JEM-X1 DPE. The details of this anomaly and recovery actions given below are also reported in AR INT_SC-97.

The anomaly occurred after an IREM S/W reset had occurred (at 01:49:57Z). JEM-X1 had not been affected by the IREM S/W reset as the JEM-X1 overrides for the RMC counters had been set to DISABLED on 2004-11-05 in line with OCR-183. Following the IREM S/W reset, JEM-X1 had continued to operate in Data Taking mode, with all HK parameters nominal, and the nominal OEMs being issued (e.g. OEM 235 JEM-X1-AUTO EVENT 5 issued at 01:53:42Z at the end of slew ID 02520020).

The **symptoms** of the anomaly were as follows:

1) The following OEMs were received:

```
2004.311.02.34.11.216 2004.311.02.33.58.531      129  Real Time Exception 82
EX OBIH TM ST11 WRONG RBI STATUS
      FIX6=0  D0006=1,NON-FATAL  ANOM  D0008=82,82EX  RBIST  ILL  FIX8=0
D0009=24,JEMX1BUSADDR D0077=1,RESET D0078=0,NOT WAIT D0079=0,DMA NOT BUSY
D0080=0,NOT RUNNING D0081=0,NO ERROR D0082=0,VALID LITTON FIX1=0 D0083=0,NO
ERROR D0084=0,NO REQUEST D0085=0,NO ANOMALY D0086=0,NOT READY
D0087=8,TBDBYACC/ICU
```

² Data sampled (1 frame in 8)

Doc. Title : INTEGRAL Mission Report #112
Doc. Ref. : INT-MOC-SYS-RP-1001-OPS-OF
Date : 15/11/04

Issue : 1
Rev. : 0
Page : 21

```
2004.311.02.34.11.281 2004.311.02.33.58.792      129  Real Time Exception 91
EX OBIH TC ST9 WRONG RBI STATUS 2
      D0079=0,DMA NOT BUSY D0080=0,NOT RUNNING D0083=0,NO ERROR D0085=0,NO
ANOMALY D0086=0,NOT READY D0006=1,NON-FATAL ANOM D0008=91,91EX INV RBI 2
FIX5=0 D0089=1537 FIX2=0 D0096=8195
```

>> Both of these OEMs indicate that the RBI (Remote Bus Interface) protocol communication with the JEM-X1 DPE is correct but the DPE delivers an RBI status which is not correct with respect to the checks performed by the RBI S/W, in this case that the JEM-X1 DPE is not in RUNNING mode and is not ready for receipt of a TC source packet.

```
2004.311.02.34.12.051 2004.142.14.41.07.435      1536  Real Time Event      0
JEM-X1 CAUSE OF CPU RESET
      K9072=1,POWER SAVING K9079=0 K9080=0 FIX16=0 FIX16=0
```

>> Indicating that the JDPE1 CPU has reset

```
2004.311.02.35.23.333 2004.142.14.42.14.435      1536  Real Time Anomaly      4
JEM-X1 CSSW INT ER BUF OVER
      FIX6=0 K9079=2 K9080=4 K9074=14 K9077=1,IASW TC
```

>> Indicating a JDPE1 CSSW internal error - buffer overflow

```
2004.311.02.35.23.374 2004.142.14.42.14.435      1536  Real Time Rejection 3
JEM-X1 TC REP TC SBFULL
      FIX6=0 K9079=3 K9080=3 FIX8=0 K9068=1 FIX2=0 K9069=8195
```

>> Indicating a rejected/failed TC report due to the JDPE1 TC sub-buffer being full

These last two OEMs ("JEM-X1 CSSW INT ER BUF OVER" and "JEM-X1 TC REP TC SBFULL") then continued to be received every TM cycle (8 seconds).

2) All the HK TM parameters from the JEM-X1 DPE which were inspected were reporting values corresponding to 0 RAW. In particular, the DFEE State was reported as DFEE OFF although the JEM-X1 DFEE LCL A (TM parameter P2106) was closed, and the LCL current parameter P2004 was reporting a nominal value of ~1.1A. This indicated that probably no data was being received from the JEM-X1 DPE.

Indeed, in performing TM retrievals later, the quality of these data is reported as 'Bad' and the contents of the first packet received after the anomaly shows the majority of the packet contents, in fact all except the CSSW parameters, being 0:

Header :

```
SC: 70825      STID: 65535      SCID: 121      TPSD: -1
Filing Time: 2004-11-06T02:33:41.429563      Create Time: 2004-11-
06T02:34:10.749641
APID: 1536      PSSC: 0      SPTYPE: 1      SPSUBTYPE: 8      SPID: 84502
```

Dump :

```
0000:8E00C000 01B11800 00050000 00000000 00000000 00000000 00000000 00000000
0020:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0040:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0060:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0080:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00A0:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00C0:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00E0:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0100:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0120:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0140:00000000 63630000 084AD0A0 C8C2C8CA CA74000F A1E0F155 10180001 10010000
0160:05AF0400 00000000 FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF
0180:FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF
```

01A0:FFFFFFFF FFFFFFFF FFFFFFFF FFFF0000 00000000 00006543

The Source Sequence Counter was also reset to zero, as was the DPE Local On-board Time. The latter had the effect that the correlated packet time was the time of the last LOBT wraparound (2004.142.14.41Z). This is reflected in the reported creation time of the OEMs from the DPE reported in point 1) above, as well as the filing time of the TM packets. These, being calculated as earlier than the previously archived (good) packet from before the JDPE1 anomaly, are assigned the filing time of the previous packet plus 1 microsecond (this is the same time as associated to the TM parameters in these packets when performing retrievals).

N.B. The above 2 sets of symptoms are consistent with a reset of the JEM-X1 DPE, in which the CSSW is initialised but the IASW is not initialised. Thus all TM parameters values supplied by the IASW are zero, and the DPE buffer overflows due to the received broadcast packet TCs which are not executed due to the IASW not being started (hence the OEMs "JEM-X1 CSSW INT ER BUF OVER" and "JEM-X1 TC REP TC SBFULL" being generated every TM cycle).

Recovery actions:

Commanding to JEM-X1 from the Autostack was disabled at 02:37:23Z.

Based on the observation that the HK data from the JDPE1 was not reliable, a switch off of the JEM-X1 DFEE was first performed in order to ensure that the instrument was in a safe state, as follows:

03.26.02Z FCP_JEM1_9010 JEM-X1 DFEE SWITCH OFF attempted. However, TC K0008 STATE SAFE (1st TC of sequence KS9010), failed on-board acceptance, with an associated set of OEMs "JEM-X1 CSSW INT ER BUF OVER" and "JEM-X1 TC REP TC SBFULL" being issued. Thus this procedure could not be performed.

03.28.15Z CRP_JEM1_9010 JEMX1 UNCONDITIONED DFEE SWITCH OFF executed successfully.

As part of the instruments' recovery procedure following an IREM S/W reset, CRP_SYS_2570, the broadcast packet DRMC flag was set to DISREGARD via FCP_DHS_1301 at 03:45:51Z.

Following the recovery actions suggested for repeated occurrences of the OEM "CSSW INT ER BUF OVER" in the Integral User Manual (Section 5.8.8.2.2.3.1.1), a full power cycle of the DPE and DFEE, including the reloading of all the DPE and DFEE patches, was then performed according to CRP_JEM1_5020. Step 2 of this procedure had already been done via CRP_JEM1_9010 (as above). Therefore, this procedure was started at Step 3. The operations were performed as follows:

04.09.28Z FCP_JEM1_9001 JEMX1 DISABLE BCP DISTRIBUTION. The Broadcast Packet Distribution to JEM-X1 was stopped at 09:10:52Z, after which the OEMs ("JEM-X1 CSSW INT ER BUF OVER" and "JEM-X1 TC REP TC SBFULL") stopped.

04.24.09Z FCP_JEM1_9000 JEMX1 DPE SWITCH OFF started and JDPE1 switched off. OEM Real Time Exception 81 EXCE OBIH TM 1 9 INVALID OR NOT RECEIVED RBI RESPONSE received from the CDMU as expected.

04.33.47Z FCP_JEM1_0010 JEMX1 DPE AND CSSW ACTIVATION started. At 04.35.12Z the JPDE1 was switched on and the following OEMs were received as expected:

04.35.21Z APID 129 Real Time Exception 82 EX OBIH TM ST11 WRONG RBI STATUS
04.35.46Z APID 1536 Real Time Event 0 JEM-X1 CAUSE OF CPU RESET, with parameter K9072=0,POWER UP.

Step 10 of this procedure (Enable the DPE Substitution Heater A) was postponed as the value of T5059 TCS TH JDPE1 was not above the required value stated in the procedure of - 1.94degC.

As part of this procedure, the following was then performed:

05.26.29Z FCP_JEM1_9810 JEMX1 LOAD NEW SW VERSION, to load the DPE image IIMG_P_JM1_0129_00006_F_X_000_000_2.INT. The following OEMs were generated as expected during this procedure:

05.26.30Z APID 129 Real Time Exception 82 EX OBIH TM ST11 WRONG RBI STATUS (with D0078=1,WAIT and D0080=0,NOT RUNNING) received when the JDPE1 was commanded to WAIT state by TC D7503;

07.06.09Z APID 129 Real Time Exception 81 EXCE OBIH TM 1 9 INVALID OR NOT RECEIVED RBI RESPONSE, when the JDPE1 RELAY0 (TM K9801) was commanded OFF to restart the DPE CSSW after the patch as per step 11;

07.06.51Z APID 1536 Real Time Event 0 JEM-X1 CAUSE OF CPU RESET with parameter K9072=1,POWER SAVING, when the JDPE1 RELAY0 was commanded back ON.

(N.B. Two occurrences of the OEM APID 129 Real Time Rejection 31 ME LOADPT EXEC STILL IN PROGRESS were received during the patch process, at 06.04.19Z and 05.33.39Z, due to two patch TCs failing as the previous patch TC was still being executed. In both cases, the failed TC was then re-uplinked later.)

07.32.28Z FCP_JEM1_0011 JEMX1 IASW DPE PATCH FOR BCP PID INTERPRETATION

07.41.01Z FCP_JEM1_0015 JEMX1 IASW ACTIVATION. Once the IASW was started, OEM 231 JEM-X1 AUTO EVENT 1 with K5419=0,NORMAL and K5420=80,LV OFF was received at 07.41.08Z. This was correct and indicated that upon activation the IASW registered that the shutdown level should be LV OFF (as the DFEE was off) instead of its initial value of NORMAL [0 RAW].

07.52:57Z FCP_JEM1_0016 JEMX1 ENABLE BCP DISTRIBUTION

07.58.56Z FCP_JEM1_0017 JEMX1 IASW EXTENDED TM CHECK

08.04.21Z FCP_JEM1_0020 JEMX1 DFEE 1st ACTIVATION AFTER DPE SWITCH-ON. OEM APID 1536 Real Time Event 233 JEM-X1 AUTO EVENT 3 with K5419=80,LV OFF and K5420=0,NORMAL was correctly received at 08.04.28Z, when the DFEE was switched on and JEM-X1 autonomously transitioned to Safe mode. (As the DFEE has been switched off unconditionally via CRP_JEM1_9010, the Auto-recovery Level, TM parameter K5458 AUTO RECOV INFO, was still DFEE CONTEXT, rather than being set to NO RECOVERY as during the nominal DFEE switch off procedure FCP_JEM1_9010.)

As part of this procedure, the following procedures were executed:

08.27.51Z FCP_JEM1_0025 JEMX1 DFEE SW PATCH SEQUENCE (ver 4.0 to 5.3)

09.15.42Z FCP_JEM1_0060 JEMX1 UPDATE ENERGY LINEARISATION TABLE

09.48.59Z FCP_JEM1_1010 JEMX1 CONFIGURATION SETTING FOR SCIENCE OPS. JEM-X1 was activated with the current nominal micro-strip gas gain voltage (dV) of 79 RAW.

10.18.43Z FCP_JEM1_0044 JEMX1 DATA TAKING

JEM-X1 commanding from the automatic Timeline was then re-enabled at 10:20:46Z.

In response to this anomaly, it had been decided in consultation with the PI to re-enable all the JEM-X reactions to the IREM count rates. Thus, at 10:12:13Z FCP_JEM2_0120 was performed to set the JEM-X2 Broadcast Packet overrides for the RMC parameters back to ENABLED.

However, as the IREM recovery was still ongoing, the JEM-X1 RMC flags were first set back to DISABLED via FCP_JEM1_0120 at 10:22:30Z. Once the stability of the IREM count rates had been monitored for ~2 hours, FCP_DHS_1301 was executed to set the DRMC flag back to REGARD at 11:35Z. At 12:02:35Z FCP_JEM1_0120 was executed to set the JEM-X1 Broadcast Packet overrides for the RMC parameters back to ENABLED.

At 12:34:31Z TC T5556 TSW JDPE1 HTA ON (the postponed step 10 of FCP_JEM1_0010) was sent. This was despite the fact that the value of TM T5059 TCS TH JDPE1 was still not above the limit indicated in the procedure (it was -3.6degC, which was ~0.3degC lower than at the time of the JDPE1 switch on), as it was verified that it was in fact within its usual range of values during normal operations.

Following the switch-on of the JEM-X1 DFEE at 08:04:28Z, Out of Limits were received on the JEM-X1 Detector pressure as follows:

- At 08:19:25Z K5102 DET PRESSURE 2 went OOL Warning Low (value = 134020), returning within limits at 12:30:05Z and then toggling in and out of limits until 12:51:01Z.
- At 08:29:09Z K5101 DET PRESSURE 1 went OOL Warning Low (value = 133950), toggling in and out of limits until 08:30:37Z, when it went out of limits again and remained so until 10:41:25Z, after which it toggled in and out of limits until 10:49:49Z.

2004-11-07 (DOY 312, Rev 252)

At 19:12Z the parameter K5317 RAD MONITOR 3 went out of limits (value = 65) but then returned within limits at the next TM cycle.

At 19:15Z K5317 RAD MONITOR 3 went out of limits again (value = 70) and, after remaining out of limits for 2 TM cycles, caused JEM-X1 to transition to Safe mode autonomously (issuing OEM 231 JEM-X1 AUTO EVENT 1). This was ~1.5 hours before JEM-X1 was due to be commanded to Safe mode by the ED KESAFE01 in the Timeline (scheduled at 20:43:55Z) before radiation belt entry of revolution 252. The ED KESAFE01 was then also allowed to execute from the Timeline, at which time another OEM 231 JEM-X1 AUTO EVENT 1 was received.

2004-11-08 (DOY 313, Rev 252-253)

At the start of revolution 253, the anode calibration sequence KEACAL01, scheduled at 06:59:58Z, was executed nominally from the automatic Timeline. However, at radiation belt exit of revolution 253 JEM-X1 remained in Safe mode due to the high background radiation conditions as reported by IREM (TM parameters K5315 RAD MONITOR 1 and K5317 RAD MONITOR 3 were both above their safe thresholds for JEM-X1). Therefore the HV activation sequence KEACT_03 (scheduled at 07:30:57Z) failed release due to PTV failure and commanding to JEM-X1 from the Autostack was disabled at 07:31:18Z.

JEM-X1 remained in Safe mode for the rest of this day.

2004-11-09 (DOY 314, Rev 253) to 2004-11-10 (DOY 315, Rev 253)

JEM-X1 remained in Safe mode due to high background radiation conditions.

2004-11-11 (DOY 316, Rev 253-254)

The JEM-X1 anode calibration (sequence KEACAL01, scheduled at 06:46:44Z) was interrupted at the start of revolution 254 due to the operator erroneously disabling commanding to JEM-X1 from the automatic Timeline at 06:47:56Z. JEM-X1 was thus left in a non-nominal configuration (remaining in Setup mode as the JEM-X1 Broadcast Packet overrides for the RMC flags were still DISABLED, and with only Anode Setting#1 ENABLED) from this time until 07:09:46Z, when the full KEACAL01 sequence was then re-uplinked manually.

Due to continuing high background radiation conditions, commanding to JEM-X1 from the Autostack was left disabled and JEM-X1 remained in Safe mode for the rest of this day.

2004-11-12 (DOY 317, Rev 254)

JEM-X1 remained in Safe mode due to high background radiation conditions.

8.3.5 OMC Operations

On DoY 311 at 01:50:12, the OMC autonomously switched to SAFE mode due to an IREM SEU. At 04:01:06, the unit was returned to stand-by, and continued with science operations. The impact was pointings 02520020 to 02520022 were lost.

On DoY 312 at 19:12:52, the OMC again switched to SAFE mode due to the high levels of radiation being experienced. The spacecraft entered perigee in this state, with the radiation still high after AOS. It was after this time that the following commands were rejected:

```
2004.313.07.31.47.029 2004.313.07.31.35.021 1792 Real Time Rejection 131
REJECTED TC1
      FIX2=0 M5010=2,SAFE M9079=3 M9080=131 M5001=60,IM A M9068=1 FIX2=0 M9069=1366
2004.313.07.31.39.396 2004.313.07.31.28.021 1792 Real Time Rejection 131
REJECTED TC1
      FIX2=0 M5010=2,SAFE M9079=3 M9080=131 M5001=130,RESET IM M9068=1 FIX2=0
M9069=1365
2004.312.19.37.14.219 2004.312.19.37.03.122 1792 Real Time Rejection 131
REJECTED TC1
      FIX2=0 M5010=2,SAFE M9079=3 M9080=131 M5001=60,IM A M9068=1 FIX2=0 M9069=1364
2004.312.19.37.07.855 2004.312.19.36.56.747 1792 Real Time Rejection 131
REJECTED TC1
      FIX2=0 M5010=2,SAFE M9079=3 M9080=131 M5001=130,RESET IM M9068=1 FIX2=0
M9069=1363
```

These commands correspond to the M1130 RESET IM, and MU1310 IMAGING A commands for the pointings 02530004 & 02530005. After this the commanding was disabled. The impact of the radiation was that pointing 02520061 was interrupted and pointings 02520062 & 02520063, then after perigee, pointings 02530004 through to 02530014 were lost. The unit was returned to stand-by at 15:06:44, and was in science mode at 15:19:30, in time to complete pointing 02530015.

On DoY 313 at 15:56:19, the unit again tripped to SAFE mode due to the radiation. It was at this time that the following commands were rejected:

```
2004.313.15.56.35.660 2004.313.15.56.29.037 1792 Real Time Rejection 131
REJECTED TC1
FIX2=0 M5010=2,SAFE M9079=3 M9080=131 M5001=60,IM A M9068=1 FIX2=0 M9069=1375
2004.313.15.56.35.583 2004.313.15.56.23.037 1792 Real Time Rejection 131
REJECTED TC1
FIX2=0 M5010=2,SAFE M9079=3 M9080=131 M5001=130,RESET IM M9068=1 FIX2=0
M9069=1374
```

These commands correspond to the M1130 RESET IM, and MU1310 IMAGING A commands for the pointing 02530016. The unit was returned to standby at 16:14:20, the impact being only pointing 02530016 was lost

On DoY 313 at 17:37:15, once again the unit switched to SAFE mode. It was recovered to stand by the following day at 11:15:56. The impact was pointing 02530018 was interrupted, and pointings 02530019 through to 02530038 were lost.

On DoY 314 at 12:50:04, the unit was again in SAFE mode. It was recovered shortly after at 12:59:32. The impact was pointing 02530040, which should have lasted 3303 seconds was interrupted after 1737.

Later, at 14:59:08, another SAFE mode until 15:24:52, this time pointing 02530042, which should also have had a duration of 3303 seconds, was cut short to 2633 seconds. Also on this occasion pointing 02530043, which should have started around 15:10, did not begin until 16:01:47, so will also have been lost.

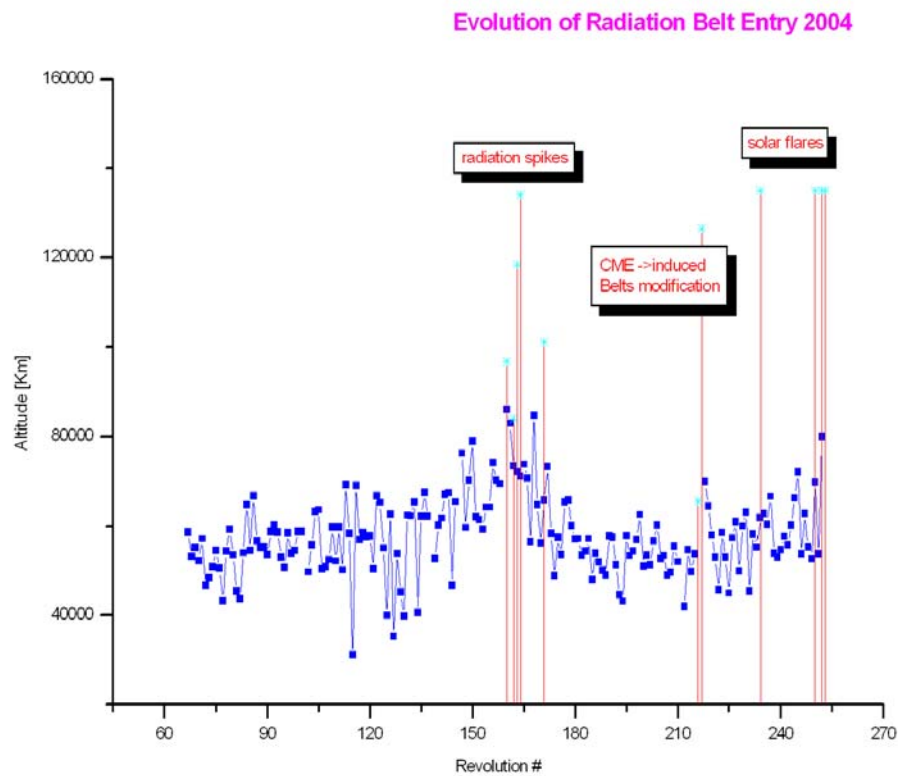
Later, at 20:12:28, OMC in SAFE again, until 23:15:16, this time pointing 02530047 was interrupted, and pointings 02530048 to 02530050 were lost.

Later, at 23:37:17, until 00:23:23 the following day, another SAFE mode. It was briefly recovered, then slipped again into SAFE mode, this time pointings 02530051 until the end of the orbit were lost (02530072). In the subsequent revolution, the unit remained in SAFE mode, pointings 02540002 to 02540043 were lost.

8.3.6 IREM Operations

Radiation Belts Entry

Due to high radiation background, the IREM electron counter does not report the electron cut-off featuring the entry and exit of radiation belts. Only times simulated with RadMon and estimation in the timeline are available.



Electron Belts

REV	S/C BCPKT (electron)	Electron CUT-OFF Observed Entry/Exit	Observed Entry/Exit Altitude [Km]	Electron CUT-OFF Predicted Entry/Exit	Predicted Entry/Exit Altitude [Km]
252	RAD_ENTR R 2004-11-07T22:06:36Z	2004-11-07 19:12:39	80077.7	2004-11-07 22:52:59	53643.5
253	RAD_EXIT R 2004-11-08T07:15:48Z	-	-	2004-11-08 06:02:59	28593.6
253	RAD_ENTR R 2004-11-10T21:53:22Z	-	-	2004-11-10 22:41:11	53465.98
254	RAD_EXIT R 2004-11-11T07:03:11Z	-	-	2004-11-11 05:51:11	28698.88

Reference

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)

Radiation Spike

Proton Belts

REV	Proton CUT-OFF Predicted Entry/Exit	ALT[Km] predicted
252	PROTON_RAD_ENTR	Not available in RadMon
253	PROTON_RAD_EXT	Not available in RadMon
253	PROTON_RAD_ENTR	Not available in RadMon
254	PROTON_RAD_EXT	Not available in RadMon

IREM daily report

DoY 2004.311 (06/11/04)

At 01:50Z a local reset of the IREM CSCI S/W (SEU #16): as previously (see anomalies on 16/12/02, 01/01/03, 03/06/03, 11/07/03, 19/07/03, 05/08/03, 24/08/03, 26/12/03, 13/05/04, 16/05/04, 09/06/04, 12/06/04, 10/09/04, 14/09/04, 28/10/04) the status of the unit, before the occurrence of the anomaly, was nominal, here is a summary:

- 1) Temperatures nominal
- 2) LCL current nominal
- 3) The last HK before the anomaly HV, 5V and 6V voltages inside limits
- 4) The anomaly occurred at 2004.311.01.50z at 133791km. The unit 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 at 02:21z using procedure CRP_SYS_2570. The first dump of the status word after the anomaly shown a value of BCC0 HEX = 48320 DEC = 1011110011000000, ie. the unit was still reporting the status as if it was in Integral mode with counting ON, accumulation ON and checksum failure flag 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) dumping all registers bank give a status word BC80 HEX = 48256 DEC = 1011110010000000, ie. the unit is still reporting the status as if it was in Integral mode but the checksum failure flag is now OFF and the checksum counter in the register number 3 incremented of 1 unit.
- 7) The patch was performed successfully with the correct re-starting of the S/W. The operation was completed at 09:32Z.

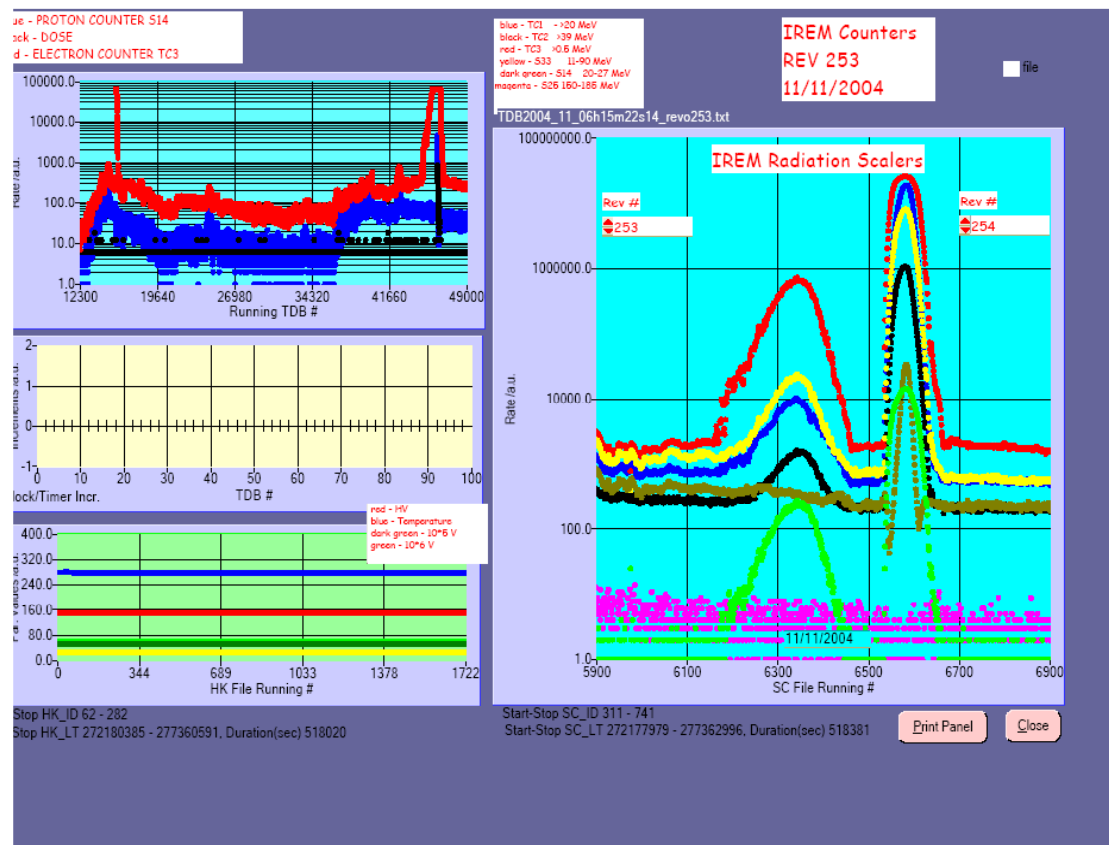
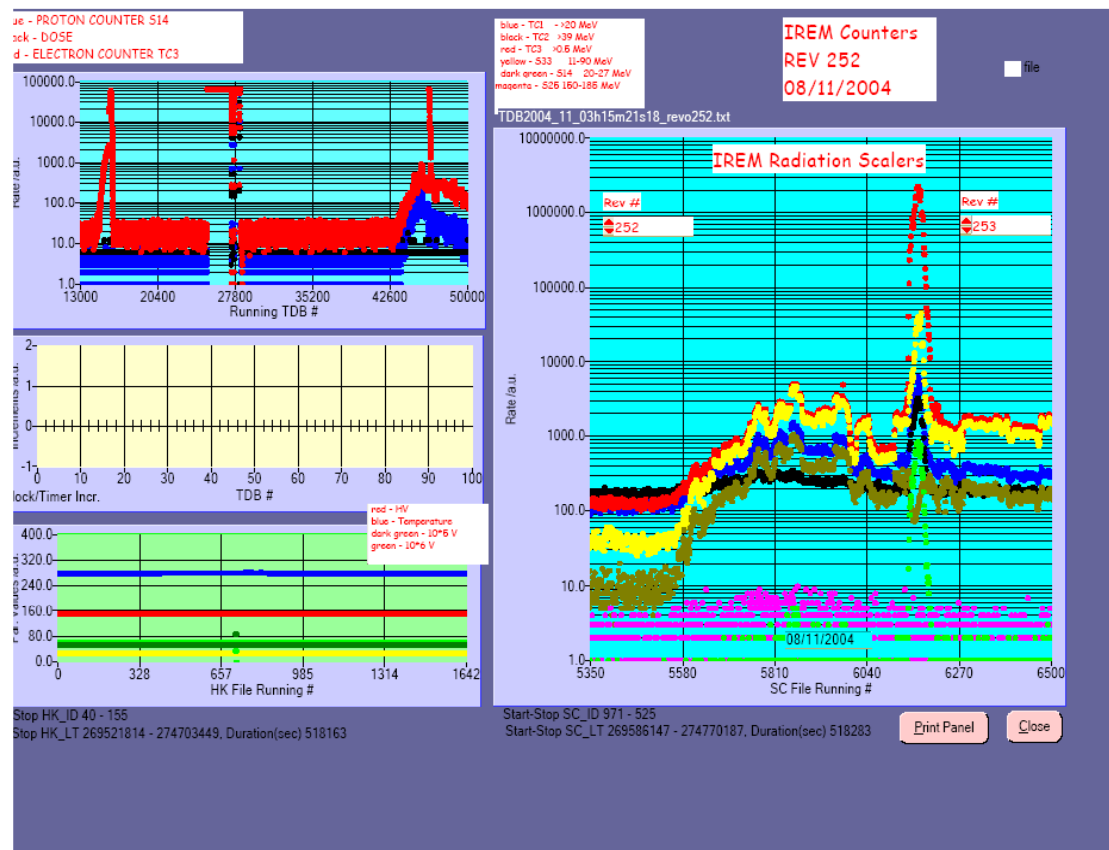
The IREM automatic transition to Standard Mode affected the instruments as it forced them to automatically enter Safe configuration, except for SPI and JEM-X whose automatism are disabled according to PIs request.

The recovery of the payloads was performed as follows:

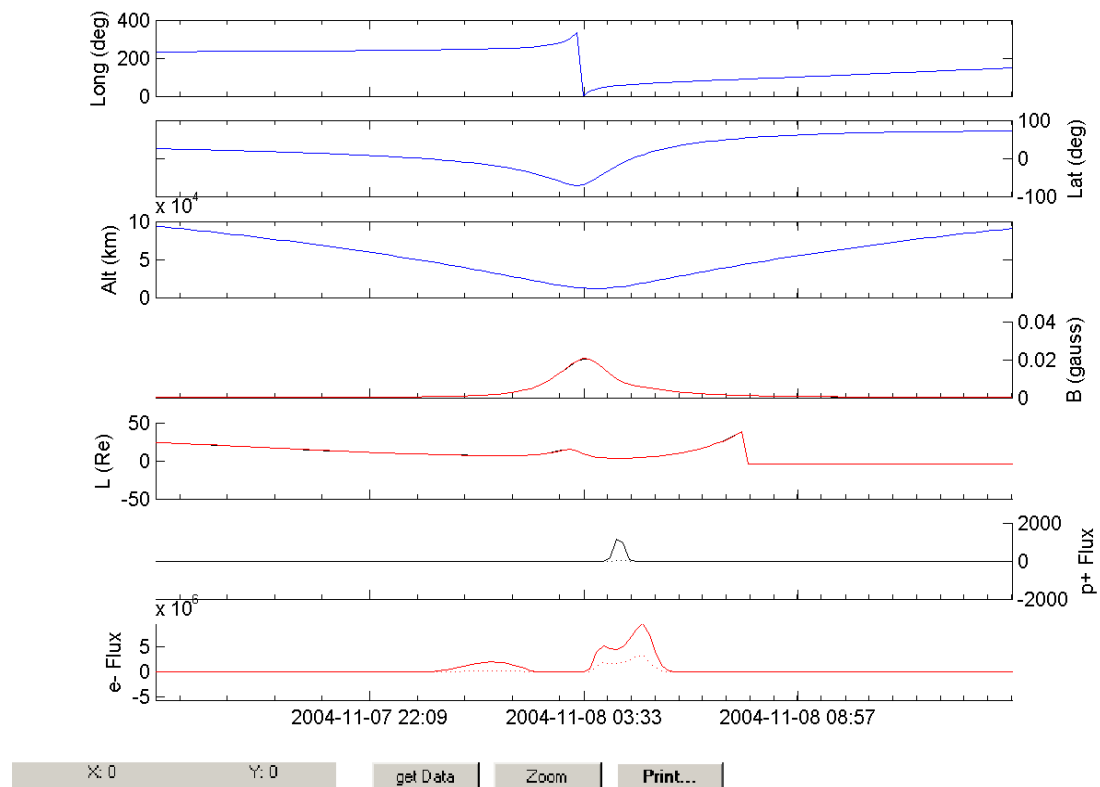
- IBIS re-enabled at 05:50Z
- OMC re-enabled in the automatic scheduling system at 04:01Z

The cause of this S/W reset is still under investigation, but it is apparently due to the unit's memory device, which is sensitive to ionising radiation.

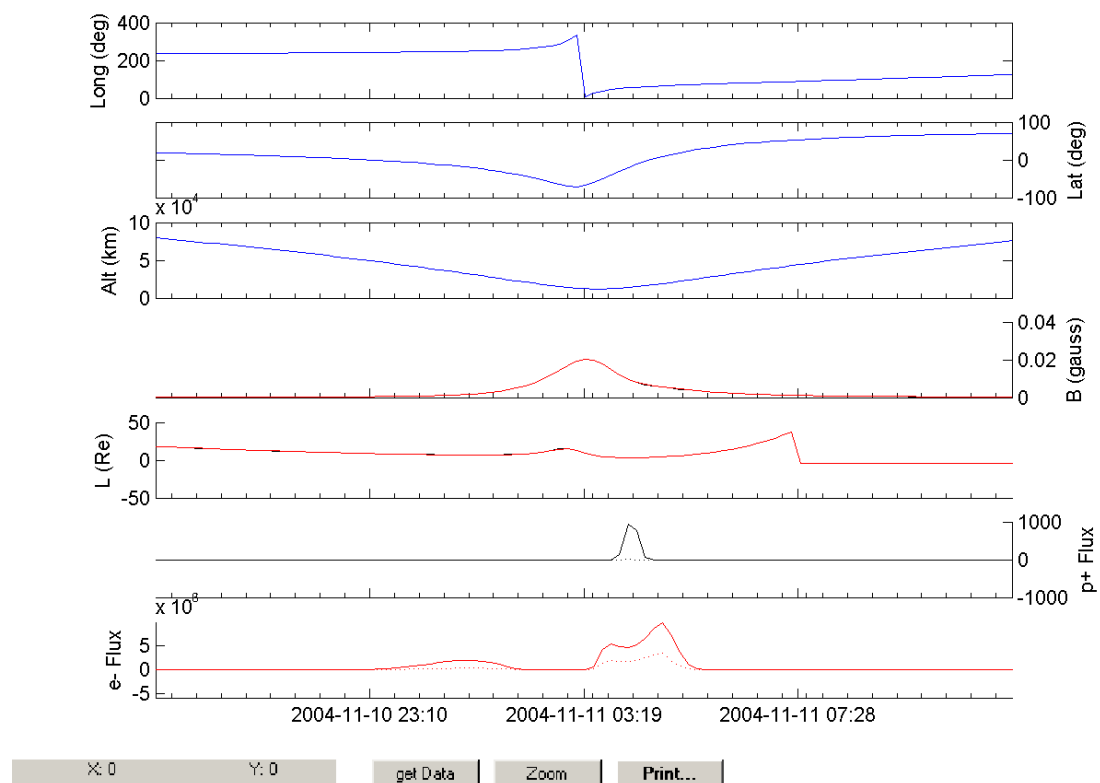
IREM radiation counters



IREM Predicted Radiation Belt Passages. Rev 252



Rev 253



SEC-GOES Observed Particles Fluxes.

