

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OF
No. 096
Week 30
26.07.04
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 17.07.04 until 23.07.04 (both dates inclusive) and covers the revolutions 215, 216 & 217.

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 Cygnus X (RA 20:33:10.00; DEC +41:12:00.0), the galactic plane and PSR B1509-58 (RA 15:13:55.62; DEC -59:08:09.0). 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.

As part of the periodic AOCS calibrations, all the mappings of revolutions 205 to 207 were processed for possible bad (lit-blemish or noisy) pixels. 4 new pixels were identified in this process. These pixels are added to the FDS blemish pixel table, to prevent planning of close-loop slews with start and end guide-star locations near the blemishes. Since the problem that we have so far encountered with bad pixels can be avoided at mission planning level, using the FDS blemish pixel table, it has been decided not to update the onboard blemish pixel table at this stage.

The new SAS thresholds that were obtained from the SAS calibration pointings, performed on 30/06/2004, were loaded on-board.

Three slews were lost during this period. In one case the FDS-selected Guide Star was very close to one of the identified blemish pixels and the STR failed to pick the star in the search cycle. The other two cases were due to problems with the links to the ground station.

There were three cases of flickering of the Pointing-Bit, probably caused by undetected False Events on the STR. None of them were seen at BCP level, no pointing was therefore affected.

The fuel consumption over the period between 16/07/2004 and 23/07/2004 was 0.068 kg. The remaining propellant is in the order of 169.362 Kg on the 23rd of July.

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.

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

During the reporting period the instrument was affected by an anomaly in the detector plane: one of the 19 high purity Germanium detectors (GeD#17) failed. A few recovery and troubleshooting procedures were attempted without success. The instrument was therefore reconfigured to work without GeD#17 in photon-by-photon mode with spectra TM enabled, an assigned TM bandwidth in the science windows of 103 pkts/cycle. The actual average occupation was of 90.7 pkts/cycle for the period. During troubleshooting, the instrument also suffered a DPE software anomaly, which required a complete instrument power reset to recover nominal operations.

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.

During revolution 214 the calibration of the VETO CDM01 (calibration unit) in parallel with the deactivation of the JEM-X2 DFEE was performed. This activity was executed inside the window for the OMC FF Calibration.

During the reporting period the PST Allocation to IBIS was 129 TMSP / Cycle (except during the OMC FFC/DCC where the TM allocation was set to 90 TMSP/Cycle). The mean IBIS Bandwidth usage was 106.05 TMSP / Cycle, up 0.75 TMSP on last week.

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 science 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 and JEM-X2 was dormant with a TM allocation of 1 packet/cycle.

In line with INTGSCCR-58, a test of the thermal impact on IBIS of a switch-off of the JEM-X2 DFEE was performed, starting at the beginning of the OMC Flat Field Calibration in Revolution 214. The JEM-X2 DFEE was off between 2004-07-17T03:04Z and 2004-07-17T15:26Z.

Due to high levels of background radiation JEM-X1 made an autonomous transition to Safe mode towards the end of revolution 216 and spent the following period of time in Safe mode: 2004-07-22T18:25Z to 2004-07-22T23:56Z.

On 2004-07-23 out of limits were observed on the parameters K5136 Buffer Loss and K5119 Software Trigger.

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.

There were 130 OMC pointings executed nominally, 1 was delayed by 18 minutes, and 3 were lost. A Flat-Field and Dark Current calibration was performed at the beginning of the week.

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.

Solar Activity

The observation period was characterised by moderate to high solar activity. A new sunspot # 652 emerged over the sun's eastern limb. With the emergence of sunspot 652, two active regions on the sun could be possible originators of the strong solar flares.

Magnetic fields above the giant sunspot 652 erupted on 20/07/04 at 12:30Z, sparking an M8-class solar flare. The explosion also hurled a coronal mass ejection (CME) into space.

On 22/07/04 the coronal mass ejection (CME) swept past Earth at 10:00Z. The effect of the CME was recorded by both the IREM electron and proton counters around 19:00Z. No degradation of the unit is currently reported.

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, 3 pointings were lost, and one delayed.

4.1 Mission Operations Centre

The performance of the MOC was in general good in the reporting period, there were some minor problems with the link to ISDC, and some test data was inadvertently filed, but apart from that, a quiet week.

4.2 Ground Stations & Network

The performance of the ground stations and Network was in general good this week. There was a minor problem with a handover to from Redu to DSS-16 and several problems with the lines to both stations, on one occasion a pointing was lost, and another caused an 18 minute delay. The overall performance though was well above the 95% requirement.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

PSFs: new files received for revolutions 223, 224, 225.

POS and POD: generated for revolutions 223 and 224.

TSFs: received up to revolution 218.

No ToO request received.

2. Observation status

ECSs received for revolutions 202, 204, 206; corresponding OCSs will be generated next week. Not yet received 201, 203 or 205.

3. ISOC science archive

Two new tapes were received from ISDC but have not yet been ingested into ISOC Science Data Archive.

4. ISOC system

The ISOC system version 10.4 patch 5 is still in use.

5. Problems

No new problems.

4.3.2 ISDC

Status of ISDC observation processing on 26/07/2004:

- Latest Standard Analysis completed: amalgamated observations 02200210001,02201030001,02297000004 (Carina, Revolution 192-196) on 25/07/2004
- Latest products archived: observation 01202520005 (GRS 1915+105, Revolution 193) on 19/07/2004
- Latest observation products sent to the observer: observation 02201040001 (Sgr arm tangent, Revolution 176-187) on 20/07/2004

5 Special Events

6 Anomalies

There were a number of problems related to the ground segment that impacted the operations:

- On DoY 199, at 02:28, there was no bit-lock after a handover to DSS-16, this caused a delay in the handover, there was no impact.
- At 04:52, the TC link to DSS-16 became 'not valid', and the AD service dropped. The impact was the loss of a pointing in the OMC Flat-Field calibration.
- At 07:45 ISDC reported they were not receiving any AUX files, the IFTS-MOC, IFTS-IMC and finally the IFTS_SDS were all started in the idda, which cured the problem. At 14:30 ISDC again were not receiving the AUX files. ISDS-A was rebooted, curing the problem.
- At 18:10 it was noted that SPI detector #17 had problems after switching to photon-mode, see appendix for further details.
- On DoY 200 at 20:38, an AOCS command to start the slew failed release, due to the guide star not being recognised, the impact was loss of pointings 02150031 and 02150032.
- On DoY 201 at 05:53, there was a handover failure from Redu to DSS-16, the problem was a failure to get bit-lock. At 06:04, the handover was completed. The impact was the broadcast packet commands had to be sent manually, but apart from that no impact. The corresponding DR# is G104610.
- At 14:03, due to problems with the TC link to Redu, slew 02150046 was missed.
- Between 14:47 and 14:49, the links were disconnected while the nctrs-a was restarted after a change in configuration.

- On DoY 202 from 09:16:12.052 to 09:18:26.418, test VC0 TM, and from 09:16:22.065 to 09:18:20.470 test VC7 TM were inadvertently filed.
- On DoY 204, there was an error sending data to ISDC, at 09:58, the data to ISDC was flowing Ok, but the IFRD showed that it was disconnected. At 10:01, CCC stopped and restarted IFRD, at 10:03, all links were returned to the nominal state.
- At 11.25, there were some strange messages concerning the TMDSmain routine on the idda, there were unix errors and software errors etc, but the links seemed to be unaffected.
- On DoY 205, at 08:35, there was a brief drop in the ISDN line carrying TLM from DSS-16, probably caused by on-going testing on the primary line.
- At 16:07, the TM & TC links from Redu dropped, caused by a 'hit on the line', the impact was a delay of 18 minutes in the start of pointing 2170005.

The following new anomaly report was entered into the ARTS system.

AR id	Date Occurrence	Subject	Segment	Status
INT_SC-87	18/07/2004	SPI anomaly on GeD #17	Payload	Pending

7 Future Milestones

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 215

In revolution 215 an amalgamated raster dithering observation of Cygnus X (RA 20:33:10.00; DEC +41:12:00.0) was performed throughout the available observation time (~61.5 hours).

During this observation IBIS, JEM-X1 and OMC were in their nominal science modes and JEM-X2 was in Safe mode. SPI was in Photon-by-Photon mode except for during the periods in which investigation and recovery actions were being performed following the GeD#17 anomaly. The TM allocation during this observation was IBIS 129; SPI 103; JEM-X1 8; JEM-X2 1; OMC 5.

Revolution 216

In revolution 216 an amalgamated raster dithering observation of Cygnus X (RA 20:33:10.00; DEC +41:12:00.0) was performed throughout the available observation time (~61.5 hours).

During this observation all instruments were in their nominal science modes, except for JEM-X2, which was in Safe mode, and the TM allocation was IBIS 129; SPI 103; JEM-X1 8; JEM-X2 1; OMC 5.

Revolution 217

The observations in revolution 217 consisted of 16 pointings of a GPS lasting ~11 hours followed by an amalgamated raster dithering observation of PSR B1509-58 (RA 15:13:55.62; DEC -59:08:09.0), performed for the remaining ~50 hours of observation time.

During these observations all instruments were planned to be in their nominal science modes, except for JEM-X2, which was to remain in Safe mode. However, due to high levels of background radiation JEM-X1 went to Safe mode ~12 hours earlier than planned and then OMC went to Safe mode ~10 hours before radiation belt entry. The TM allocation throughout these observations was IBIS 129; SPI 103; JEM-X1 8; JEM-X2 1; OMC 5.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

2004-07-04T01:33:05.000Z	169.6237	F	Automatic TM processing.
2004-07-05T09:22:52.000Z	169.5980	F	Automatic TM processing.
2004-07-07T00:41:36.000Z	169.5929	F	Automatic TM processing.
2004-07-08T14:26:20.000Z	169.5773	F	Automatic TM processing.
2004-07-10T00:30:24.000Z	169.5563	F	Automatic TM processing.
2004-07-11T14:17:48.000Z	169.5321	F	Automatic TM processing.
2004-07-11T23:03:09.000Z	169.5189	F	Automatic TM processing.

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2004-07-12T03:30:54.000Z	169.4823	F	Automatic TM processing.
2004-07-13T00:22:48.000Z	169.4737	F	Automatic TM processing.
2004-07-14T14:53:56.000Z	169.4535	F	Automatic TM processing.
2004-07-16T00:05:27.000Z	169.4302	F	Automatic TM processing.
2004-07-17T13:48:03.000Z	169.4113	F	Automatic TM processing.
2004-07-19T00:46:39.000Z	169.3948	F	Automatic TM processing.
2004-07-20T13:30:19.000Z	169.3825	F	Automatic TM processing.
2004-07-22T00:32:31.000Z	169.3621	F	Automatic TM processing.

This report was generated Fri Jul 23 08:00:15 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 17/07/2004-23/07/2004

AOCS operations were executed from the Automatic Timeline.

During this period, 47 Open Loop Slews, 95 Closed Loop Slews and 6 Momentum Bias were executed. 3 slews were missed or executed manually. This is equivalent to a 2.1%.

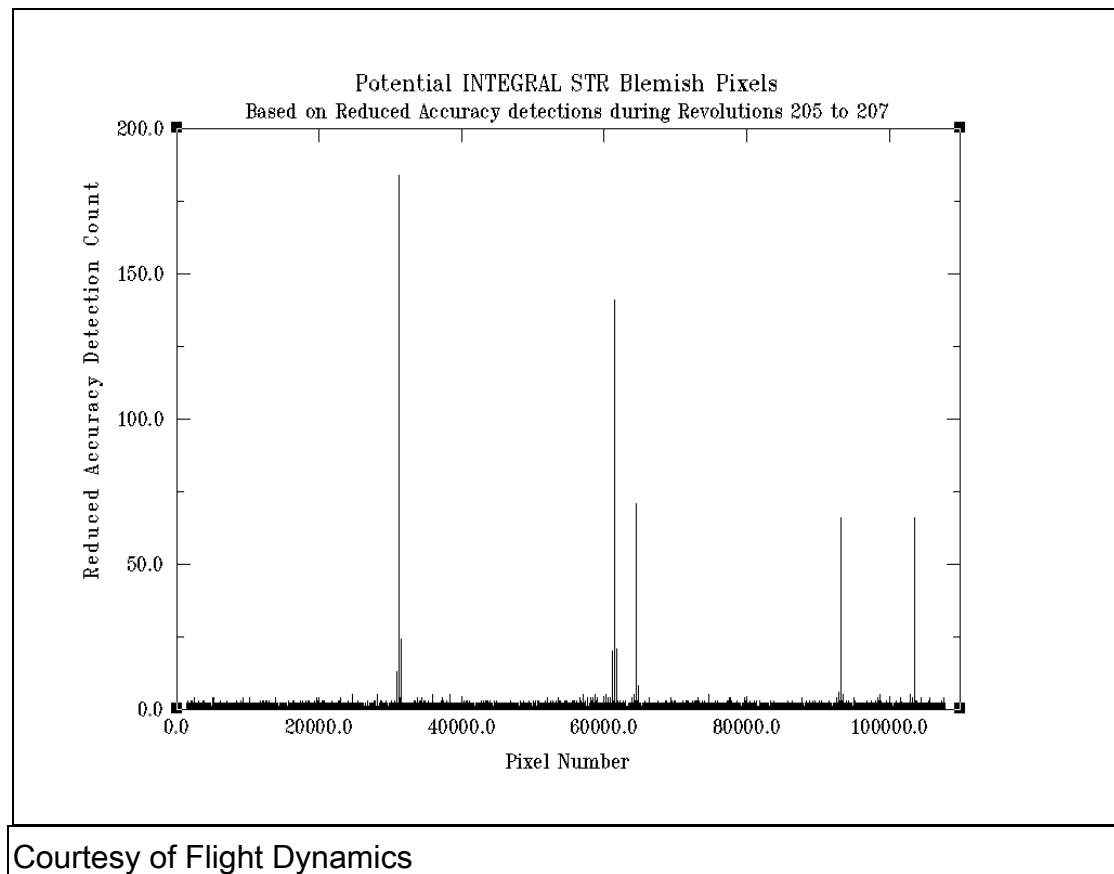
17/07/04 (Day of Year 199, Revolution 214-215)

Nothing to report.

18/07/04 (Day of Year 200, Revolution 215)

Execution of Close-Loop Slew failed because the STR could not pick the commanded star: Close loop slew 02150031 failed execution because the STR could not pick the commanded guide star in the search-and-track. The star is 3170-00189 with A0 spectral type and 8.0Mi. The star was also not reported in TM in either of the mappings that were done at this attitude. The star image was expected at CCD location [13826, -18977] or pixel (106, 26), very close to a later identified bad pixel. Another effort to manually perform the missed slew also failed because of the same reason: The Timeline recovery tool selected the same star for the slew and the STR failed to pick it in the search cycle. At the end a manual close-loop slew was commanded to the attitude of PID 02150032. Pointing 02150031 was lost.

Update of the Blemish Pixel table in the FDS: As part of the periodic AOCS calibrations, FD processed all the mappings of revolutions 205 to 207, inclusive, to identify the pixels which have an exceptionally high count of reduced-accuracy detections. These are suspect of being lit blemish or noisy pixels. The reduced-accuracy counts of all the pixels from the mentioned mappings are shown in the following plot:



The abscissa is the linear transformation of the pixel array: X=1 corresponds to pixel (1, 1) and X=109252 corresponds to pixel (382, 286).

From the results, the following five pixels are identified as bad pixels:

Yp	Zp
110	29
216	19
226	202
326	274
363	70

It should be noted that the same pixels were identified from the mappings of revolutions 139 to 142. The noisy pixel that was originally identified by Alenia is also in this list.

Pixel (110, 29) is very close to the image position of the guide star selected for close-loop slew 02150031, which the STR failed to pick in the search cycle.

These five pixels are added to the STR Blemish Pixel Table in the FDS. The system determines the trace of the pixels that the guide-star crosses during a close-loop slew. The trace - including the start and end positions - is then checked for known blemishes. No blemish should be within 15 pixels either side of the start and end

positions. Moreover no blemish should be within 5 pixels either side of the slew path. If these conditions are not met, the system tries to find another star to perform the close-loop slew. If no suitable star is found, the slew needs to be manually converted to an open-loop slew. This is done at EPOS generation level, since the ISOC software currently does not have this feature.

The currently used thresholds in the FDS are very conservative. With only five entries in the blemish pixel table, the available STR area for planning close-loop slews is reduced by more than 4%. The figures need to be re-evaluated and optimized, especially when more pixels are added to the blemish table.

19/07/04 (Day of Year 201, Revolution 215)

Slew missed from the Timeline due to problem with TC link to Redu: Slew 02150046 failed execution from the Timeline due to a TC link problem with the Redu ground-station. After the link was re-established, a manual Close Loop Slew was performed to the attitude of PID 02150046. Pointing 2150046 was affected. The next slew executed from the Timeline after being manually updated.

Flickering of the Pointing-Bit due to Yaw error: At 16:01:32, an undetected False Event on the STR caused a jump in the position of the guide-star. The change in the Z position was more than the OTF threshold for Yaw and caused the flickering of the Pointing-Bit. The 8.3Mi Guide-Star (Cat. Nr: 3152 1125), which was picked by the ACC after and open-loop slew, was located on CCD location [6172, 18954]. This was at an altitude of about 129000 km. The event was not seen at BCP level.

20/07/04 (Day of Year 202, Revolution 215-216)

Nothing to report.

21/07/04 (Day of Year 203, Revolution 216)

Flickering of the Pointing-Bit due to Yaw error: At 13:02:33, an undetected False Event on the STR caused a jump in the position of the guide-star. The change in the Z position was more than the OTF threshold for Yaw and caused the flickering of the Pointing-Bit. The 8.45Mi Guide-Star (Cat. Nr: 3152 701), which was picked by the ACC after and open-loop slew, was located on CCD location [-917, -18834]. This was at an altitude of about 141000 km. The event was not seen at BCP level.

22/07/04 (Day of Year 204, Revolution 216)

Update of the SAS Thresholds: The SAS window thresholds were updated.

The old thresholds were:

SAS-X Threshold = 3.744 mA

SAS-Y Threshold = 3.744 mA

The new thresholds are:

SAS-X Threshold = 3.432 mA

SAS-Y Threshold = 3.354 mA

These values are based on the SAS scale factors (gains) obtained on 30/06/2004, normalised to the sun-earth distance on that day, and the original SAS thresholds of 3.76 mA.

Flickering of the Pointing-Bit due to Yaw error: At 09:02:22, an undetected False Event on the STR caused a jump in the position of the guide-star. The change in the Z position was more than the OTF threshold for Yaw and caused the flickering of the Pointing-Bit. The 8.5Mi Guide-Star (Cat. Nr: 3156 420), which was picked by the ACC after an open-loop slew, was located on CCD location [4593, -718]. This was at an altitude of about 143900 km. The event was not seen at BCP level.

23/07/04 (Day of Year 205, Revolution 216-217)

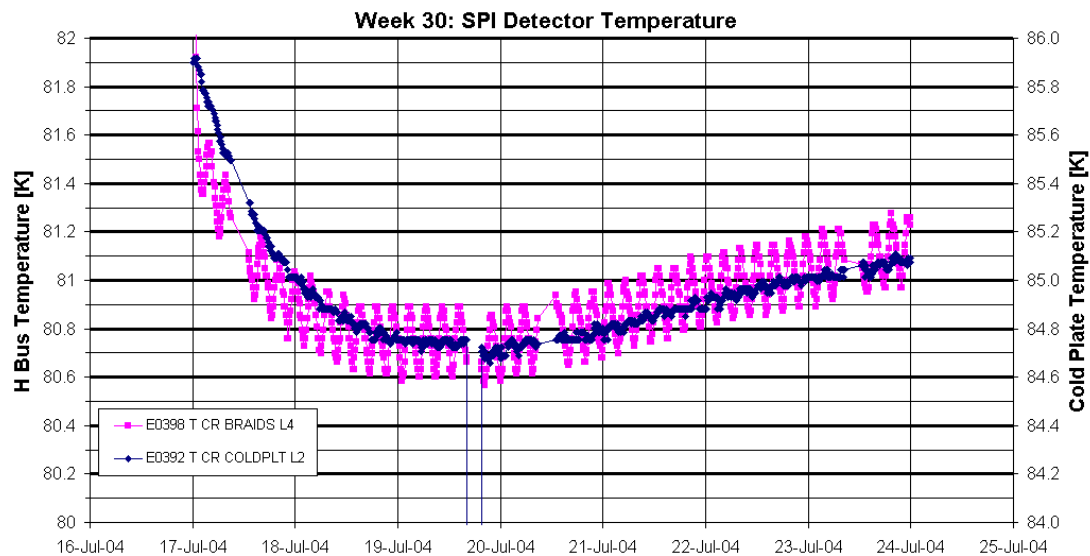
Slew missed from the Timeline due to drop in links from Redu: At 16:07, both TM and TC links from Redu dropped (the problem is described as “hit on the line”) and execution of slew 02170005 from the Timeline failed. After re-establishment of the links, a manual open-loop slew was performed to the attitude of PID 02170005. Pointing 02170005 was affected and the next slew was executed from the Timeline after being manually updated.

8.3.2 SPI Operations

Cryo-cooler / Detector Cold-Plate:

The performance of the cryo-cooler is nominal.

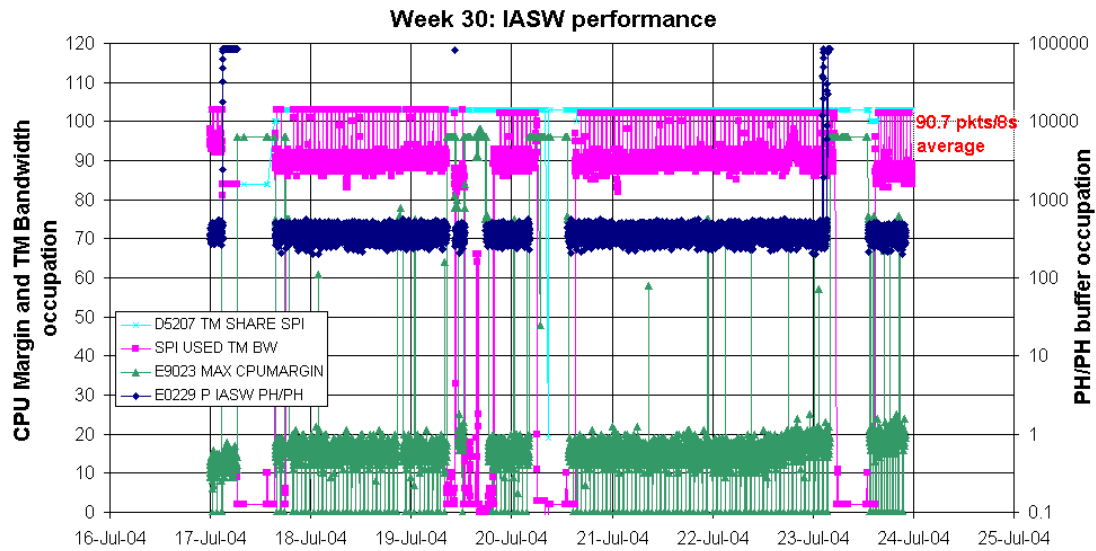
The cold plate temperature is leveled off and maintained at 85K $\pm$ 1K. The stroke amplitude was adjusted from 4x36dec to 4x37dec.



IASW/DPE:

The performance of the IASW/DPE was nominal until the GeD#17 anomaly troubleshooting was attempted: a known IASW bug, first detected on 20th November 2003 (see AR INT_SC-70), was unexpectedly reproduced. The recovery consisted in a complete power cycle of the instrument (see anomaly report here after)

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



Germanium Detector #17 Anomaly Report

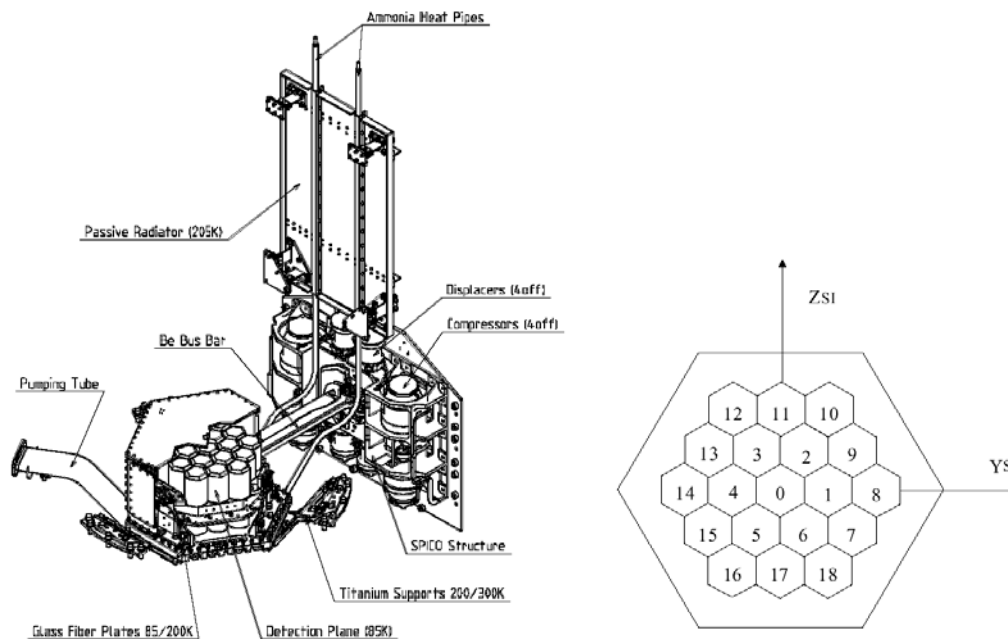
A summary of the events that followed the SPI Germanium Detector #17 (GeD#17) failure on 17th July 2004 follows.

This anomaly follows a similar one, on GeD #2, which failed on 6th December 2003 (logged in ESOC as AR INT_SC-72 and discussed by CESR GeD#2 Failure Report SPI-RE-4211-4296-CESR).

GeD#17 Location

The Germanium detector #17 is part of the SPI detection plane made up of 19 encapsulated hexagonal high purity Germanium detectors. They are mounted as close as possible to each other on the cold plate 1 (CP1), cooled at 85+/-1K. The CP1 supports also 19 printed boards with proximity electronics (PA1). The preamplifiers (PA2) are mounted on the cold plate 2 (CP2) at 210 K.

The location of the GeD#17 is showed in the following figures (from SPI UM):



Status before the anomaly

No indication from the available telemetry parameters pointed to an imminent failure in the detector plane. The instrument completed the 4th annealing cycle, on 30th June 2004, and since then resumed nominal operations and was working flawlessly.

Analysis of the telemetry shows that, before the failure, the SPI configuration and the housekeeping parameters were all nominal. An excerpt of the significant HK parameters have been plotted and included in the following telemetry data plots covering 16-18th July period.

In particular:

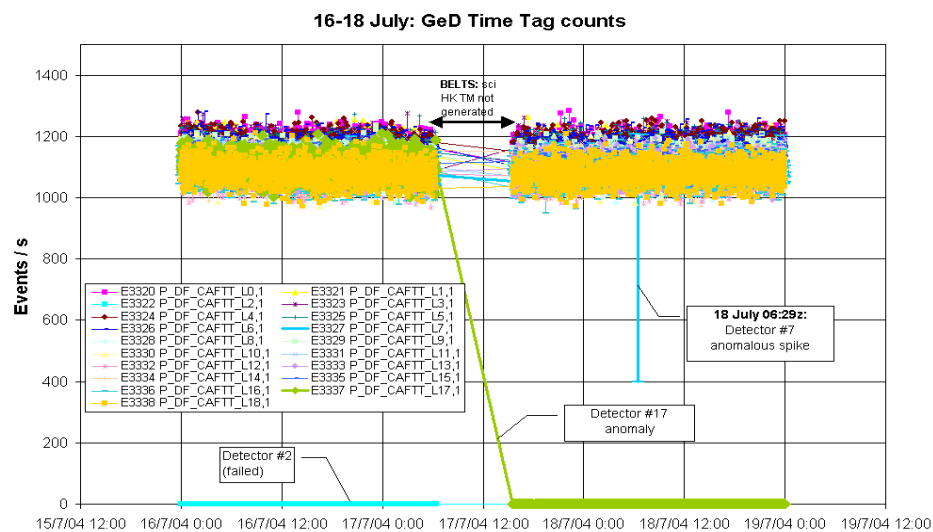
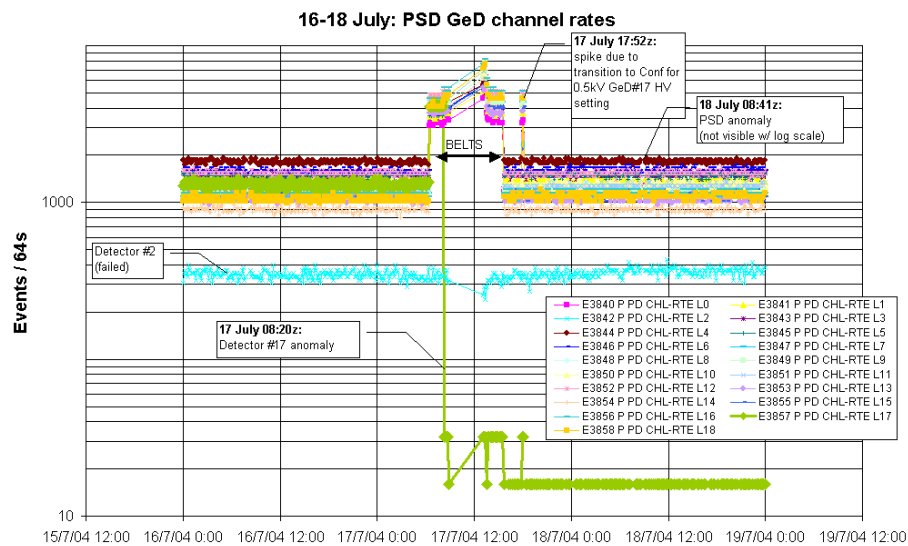
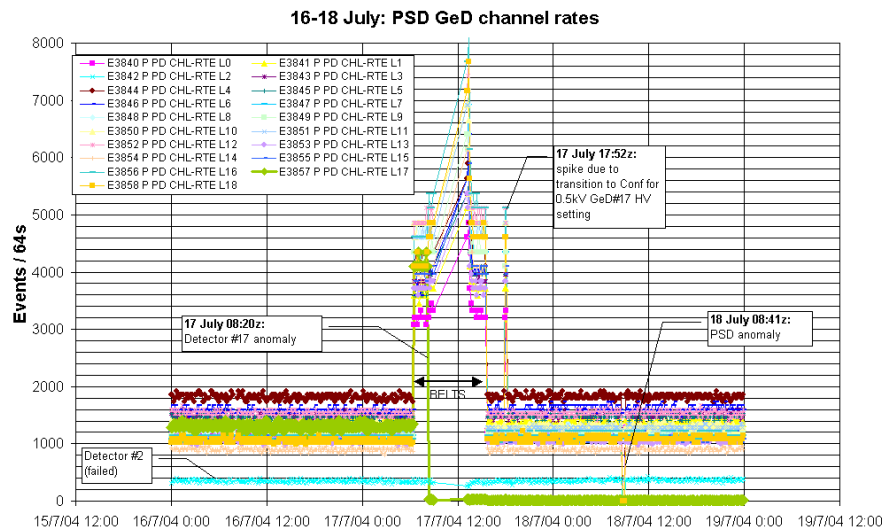
- The detector high voltage power supply (HVPS) parameters were in range for 4kV operations.
- The cold plate temperature was at 85.5K, decreasing, following a compressor stroke increase commanded 8 hours before: from the plots, the well known response to this increase is clearly recognisable and nominal.
- The dc output voltage, measuring the PA2 signal dc offset, was in the expected range. Before the anomaly a few spikes can be seen on the DC output voltage of a few detectors. Such spikes are due to high-energy particles hitting the detectors and temporarily altering its electrical charge. They can be noted however all along the orbit, every orbit, and is a characteristic of these parameters observed since launch.
- The AFEE (Analog Front End Electronics of the detectors) power consumption was nominal.
- The low voltage power supply (LVPS) was delivering power to the pre-amplifiers with nominal parameters.
- The pre-amplifier PA2 temperature was in the expected range.
- Since the reactivation after the annealing, the background radiation level has been compatible with what observed in previous revolutions, though slightly increasing, and no particular solar activity had been affecting operations.

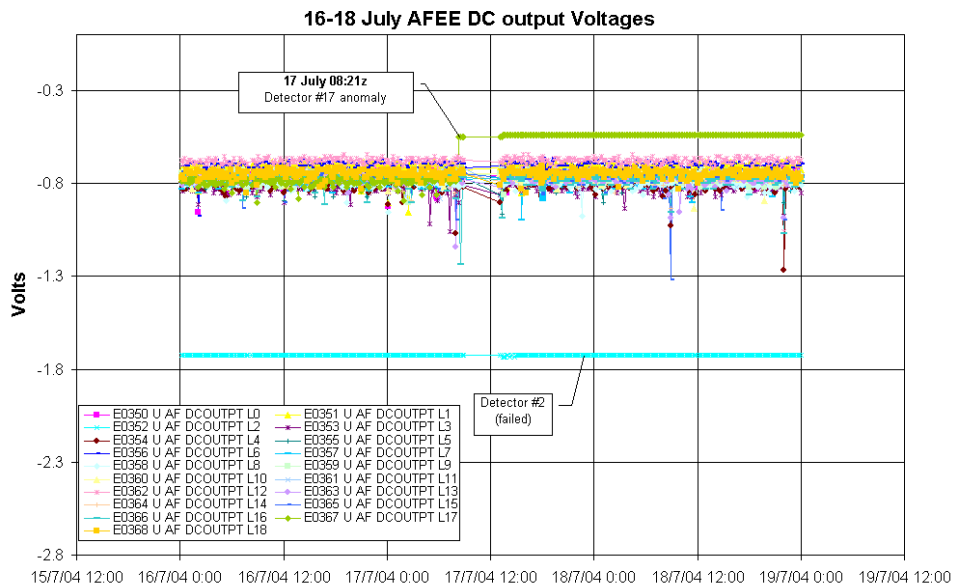
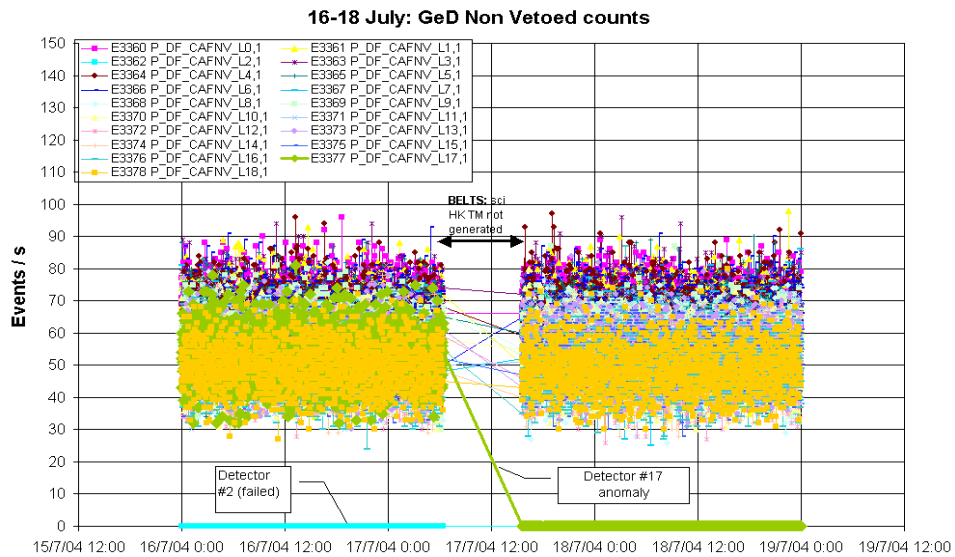
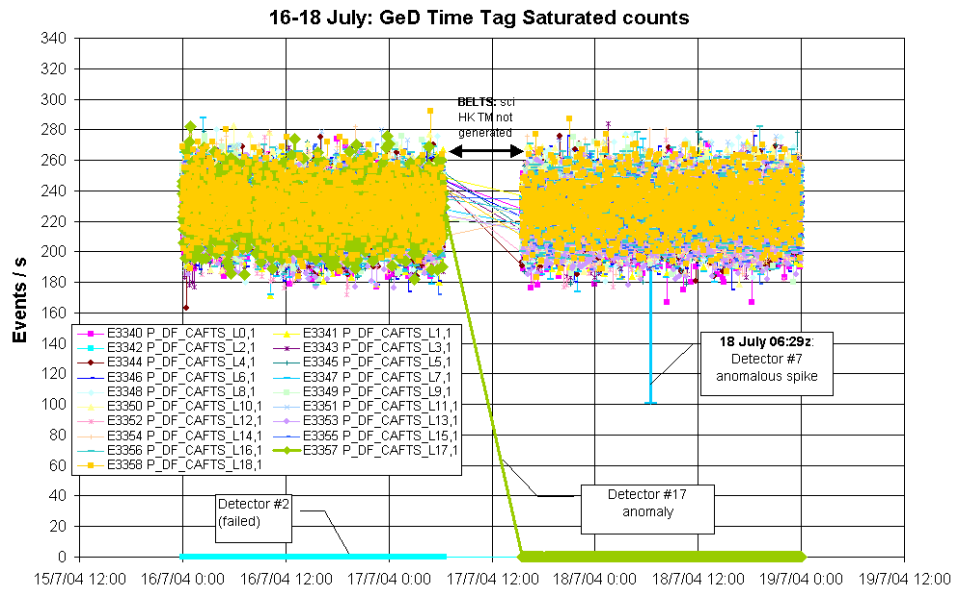
Doc. Title : INTEGRAL Mission Report # 96
Doc. Ref. : INT-MOC-SYS-RP-1001-OPS-OF
Date : 26/07/04

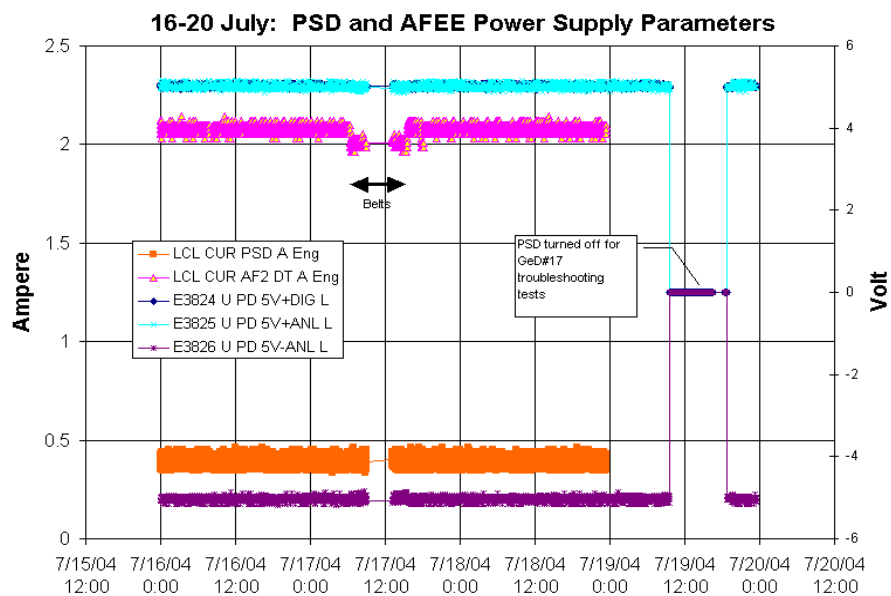
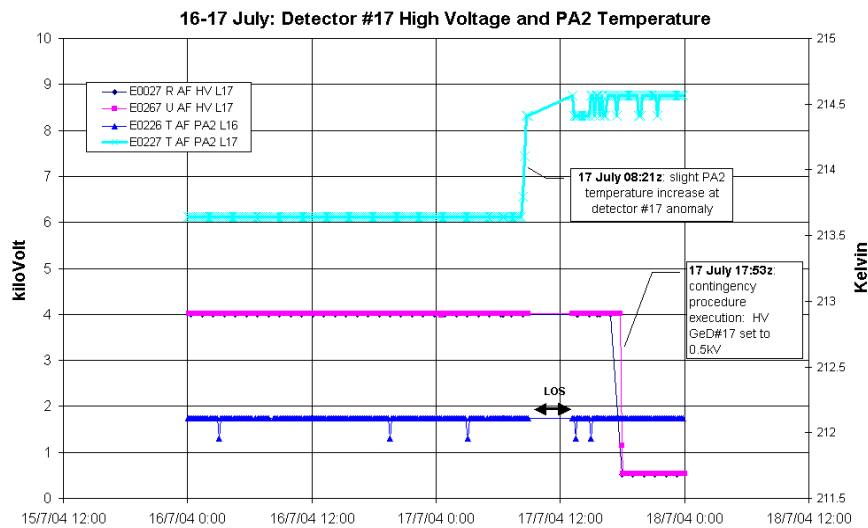
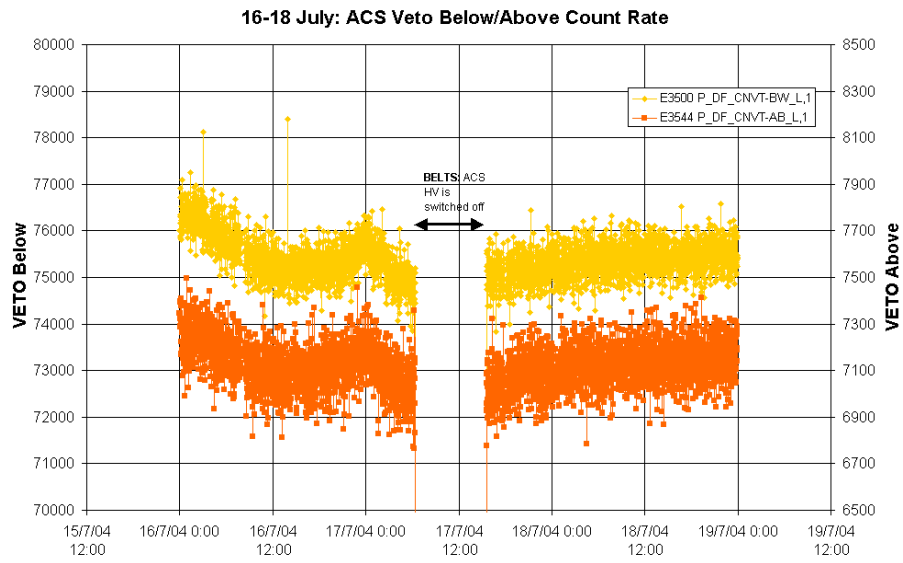
Issue : 1
Rev. : 0
Page : 16

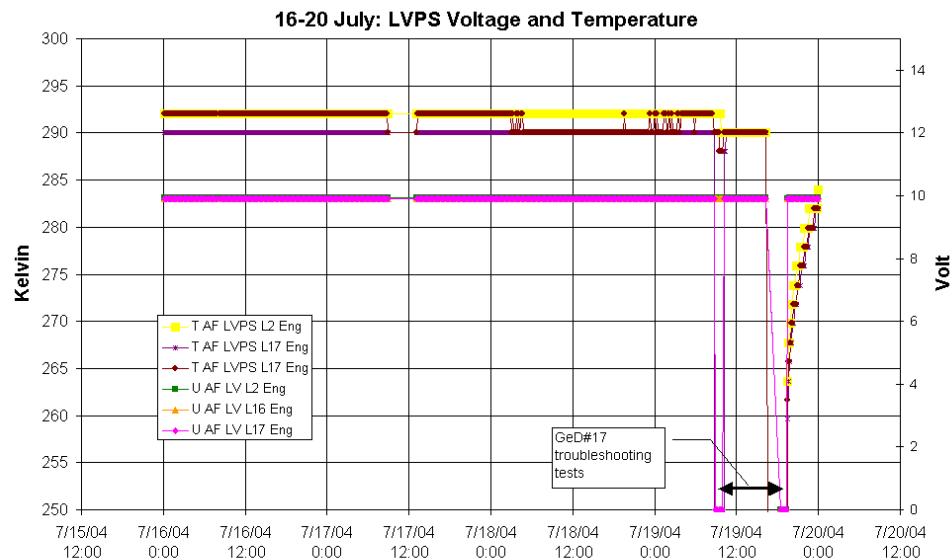
- The failure occurred inside a belts passage: a preliminary analysis of the IREM measurements indicates that the electron/proton radiation level was nominal, within the limits observed in previous passages.

SPI GeD#17 Anomaly: Telemetry data plots (16th to 18th July) :









Events following the anomaly (17-18th July)

The following events occurred after the GeD #17 failure:

1. **17th July (Saturday) 08.20z, anomaly first detected:** It occurred inside the radiation belts, in proximity to the perigee passage of rev.215. The anomaly was first detected thanks to limit monitoring of the PSD channel rates (TM E3840-E3858, down-linked every 64s) performed by the Mission Control System. TM E3857 showed a low-low out of limit (alarm) of GeD#17 count rate, below 50 counts (see also plots).
Note: Such PSD parameters are not exactly the real count rate of the detectors, as affected by a strong noise component. However they are the closest measurement available while SPI is in protected mode inside the belts. In this mode SPI is in fact not producing the science HK telemetry packets, containing the actual count rates.
2. **17th July 08:54z, LOS:** The anomaly first detection happened just half an hour before the perigee LOS, therefore nothing could be done for about 4 hours to verify the actual failure condition of the GeD#17.
3. **17th July 13:07z, AOS:** At AOS, the parameter E3857 was still showing the same out of limit, however as SPI was in protected mode inside the belts and as no special action was associated to this out of limit, another two hours had to pass till belt exit.
4. **17th July 17:53z, execution of the contingency procedure:** At belts exit, SPI automatically resumes the Photon science mode, thus producing also the science hk telemetry packets. At this point another alarm was detected on TM E3337 (DFEE Time Tag events count rate of GeD#17) showing zero counts. The alarm triggered eventually the execution of the contingency procedure defined by the Operational Request OR-INT-150, consisting of:
 - transition of SPI to CONFIGURATION mode by using FCP_SPI1_0160 procedure;

- setting the GeD#2 and #17 high voltage to 0.5 kV, by using FCP_SPI1_1713 procedure. All other detectors remained set to 4 kV;
- resuming PHOTON mode, by procedure FCP_SPI1_0130.

The objective of the contingency procedure is to put the malfunctioning detector into a safe status, while possible recovery/troubleshooting actions are devised.

5. **17th July ~18:30z, SPI PI contacted:** The PI was consulted and it was agreed to leave the instrument in this safe state until 19th July (Monday), before deciding on any recovery attempt.
6. **18th July 06:29:25z, anomalous spike on Germanium detector #7:** Offline analysis of the Time Tag and Time Tag Saturating event count rates revealed at this time, for GeD#7, an anomalous spike, down to 1/3 of the nominal counts (see also plots).

It must be noted that such a spike is not reported by the non-vetoed counts of GeD #7, hence it might have occurred inside a veto window. The DC output voltage of GeD#7 showed a nominal pattern during this time.

Such a kind of spikes have however already been observed before, during nominal operations at 85K, though they are rare. A possible link with the GeD#17 failure is at the moment not found.

7. **18th July 08:41z, low alarm on all PSD channel rates:** All the PSD channel rates suddenly and unexpectedly showed zero counts for about half an hour. The anomaly apparently affected only the PSD locally as the count rates down-linked via the science HK telemetry packets were still nominal. Also the DC output voltage showed a nominal pattern during the anomaly. This anomalous hang-up was never observed before 18th July. Apparently it was already observed during ground tests. A possible link with the GeD#17 failure is not excluded.

Recovery and troubleshooting attempts on 19th July

On suggestion of the PI (see email on 19/07/2004 by J.P.Roques), the following recovery plan was attempted, starting at 08:34z, ending at 10:23z :

1. goto conf mode
2. GeD#17 HV = 0 and off with dc output voltage monitoring
3. GeD#17 LVPS off
4. goto stand-by mode
5. on/off sub-assemblies configuration change : PSD OFF
6. electrical switch off of the PSD
7. goto conf mode
8. send all configuration parameters
9. GeD#17 LVPS switch on
10. monitoring of HK parameters (on-request cmd)
11. GeD#17 HV on and HV=500V with DC output voltage monitoring
12. GeD#17 HV=4kV with DC output voltage monitoring
13. goto photon mode

➔ No counts were however produced by GeD#17

The following steps were subsequently agreed by tele-conference, while discussing the results of the first attempt. The recovery actions/troubleshooting were attempted starting at 10:27z, ending at 14:21z:

1. apply a detection threshold of 0keV on AFEE
2. goto photon mode
- ➔ GeD#17 counts goes to > 20000/s, showing healthy status of the signal detection electronics
3. goto conf mode
4. restore 20 keV threshold (nominal)
5. goto photon mode
- ➔ No counts produced by GeD#17
6. goto conf mode
7. GeD#17 HV=5kV (maximum possible) with DC output voltage monitoring
8. goto photon mode
- ➔ No counts produced by GeD#17
9. goto conf mode
10. Analysis of the HV transient response: step change of the HV with DC output voltage monitoring
 - a. first go to 0 Volt on GeD#2, #16 (taken as reference) and #17
 - b. step change to 4kV on GeD#2, #16 and #17
 - c. step change to 0 Volt on GeD#2, #16 and #17
- ➔ The results of the analysis are not yet available: the objective is to analyse the decay of the HV, in order to deduce the time constant of the HV circuit, which is very long at switch off (expected ~59s). As the time constant depends on the capacitor and resistance connected downstream the HVPS output, it should theoretically be possible to establish the integrity of the connections of the circuit.

After these troubleshooting tests, the OR TM packets generation function of the SPI IASW crashed (due to a known bug which occurs when requesting OR TM packets at high rate).

The recovery, which took about 4.5hrs, consisted of:

1. A full DPE RAM memory dump (for future investigations of IASW anomaly)
2. A full deactivation of the instrument (down to subassembly switch off)
3. Power cycle of the DPE
4. Re-uplink of IASW 4.30 and memory dump for verification
5. A full re-activation of the instrument, keeping GeD#2 and #17 off (0.5kV)
- ➔ SPI was finally put back in photon mode following POS observations at 19:55z on 19th July (without GeD#2 and #17).

On request, a detailed history of the up-linked commands can be provided for the period.

Events on 21st July

1. **01:24z, low alarm on all PSD channel rates:** All the PSD channel rates suddenly dropped to zero counts for about 9 minutes. The anomaly has the same symptoms as the one appeared on 17th July at 08:41z and, again, it affected only the PSD as the detector count rates, measured via the DFEE, were still nominal.

Preliminary failure analysis

From the observed symptoms and preliminary evaluation of the data gathered during the first recovery/troubleshooting attempts, the following observations can be made:

1. Dc output voltage of GeD#17 nominal for HV off:

Following the anomaly on the count rate, the dc output voltage shifted immediately from a mean value of -0.7947V with standard deviation of 0.0222V to a fixed value of -0.5408V (see plots). During the subsequent recovery attempts, the parameter was observed staying constant also after a change in the high voltage bias to the detector. This is considered as an anomalous behaviour, as usually the DC output voltage shows a very well defined characteristic as a response to a high voltage step change. The value -0.5408V stays in fact unchanged whatever the GeD#17 HV is set; the value itself is compatible with a zero high voltage setting, thus suggesting a broken connection to the detector.

The value is also different from the -1.7V being showed by the faulty GeD#2, which is behaving in the same way anyway, i.e. no reaction to HV changes.

2. A few counts per minute still observed from GeD#17:

It must be noted that since the GeD#17 failure occurrence, a few events are still produced by the detector chain (a few counts per minute) and down-linked to ground. This suggests that the signal link between AFEE and the detector should still be present. A test performed on 19th July during the recovery attempts, by lowering to zero the GeD#17 energy threshold in the AFEE, showed a very high count rate (>20000/s), thus at least indicating the good health status of the AFEE electronics.

3. Small increase of the GeD#17 PA2 temperature:

Just at the same time of the anomaly, the PA2 temperature shifted one degree higher (from about 213.5K to 214.5K, see plots). Usually this temperature is very stable and this shift is therefore suspicious. Ground tests showed that this measurement can be affected by an error proportional to the applied high voltage, thus suggesting that something has happen in this area. However the temperature sensor itself is close to the interface electronics between PA2 and PSD, thus also suggesting that the shift could be related to an anomalous status of this interface, also in view of the anomalous PSD behaviour, observed on 18th July at 08:41z.

4. GeD#17 high voltage still nominal:

The detector high voltage reading still shows the correct voltage setting. The voltage sensing is however not directly on the detector but rather located at the output of the HVPS, in the feedback circuit. A special test was performed on 19th July during the recovery attempts in order to understand whether the connection to the detector is still nominal (results not yet available).

5. Different GeD#17 PSD rates, compared to the faulty GeD#2:

PSD channel rate for GeD#17 is very low if compared to the faulty GeD#2:

- a few counts / 64s for GeD#17
- 380 counts / 64s for GeD#2
- 1050 counts / 64s for the others

Future troubleshooting tests

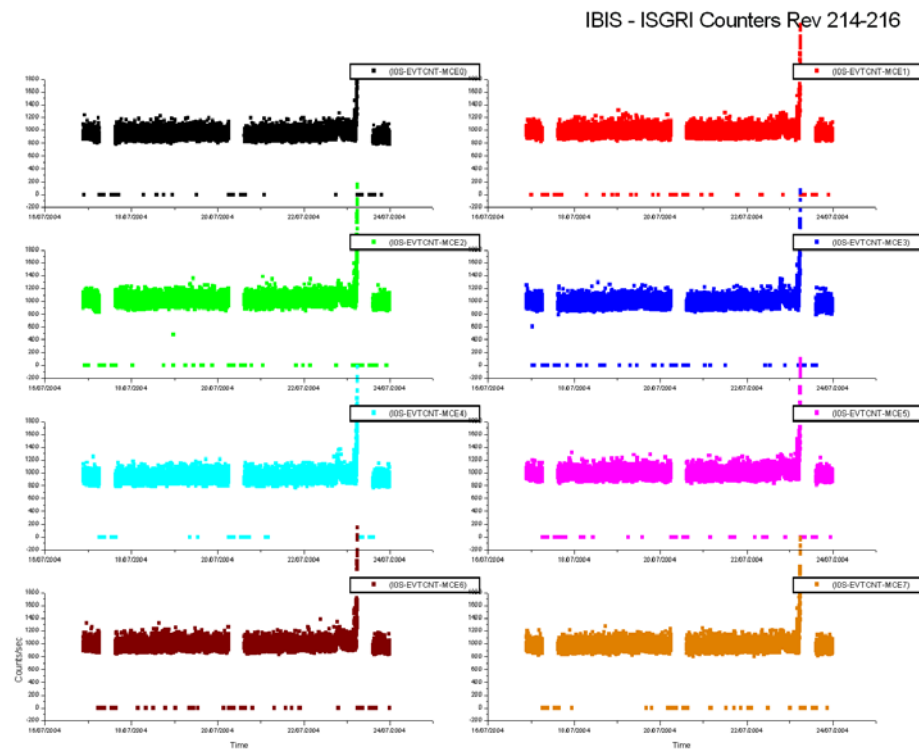
- Tests at different energy thresholds to investigate the electrical connection between AFEE and PA2.
- Tests on ground to characterise the PA2 response to voltage changes repetition of the same test on-board.

To be further developed.

8.3.3 IBIS Operations

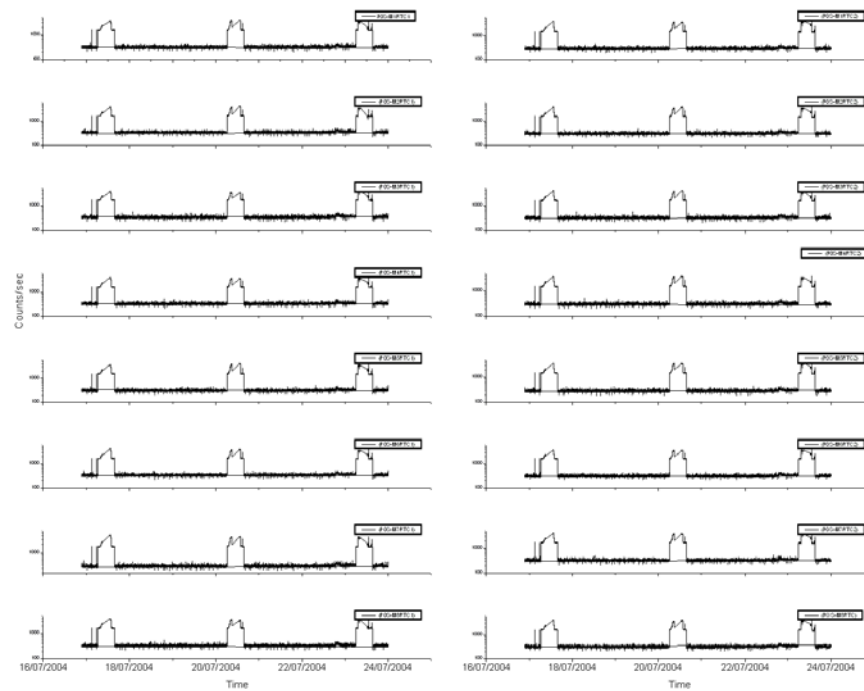
IBIS Event Counters Plots.

ISGRI Counters:



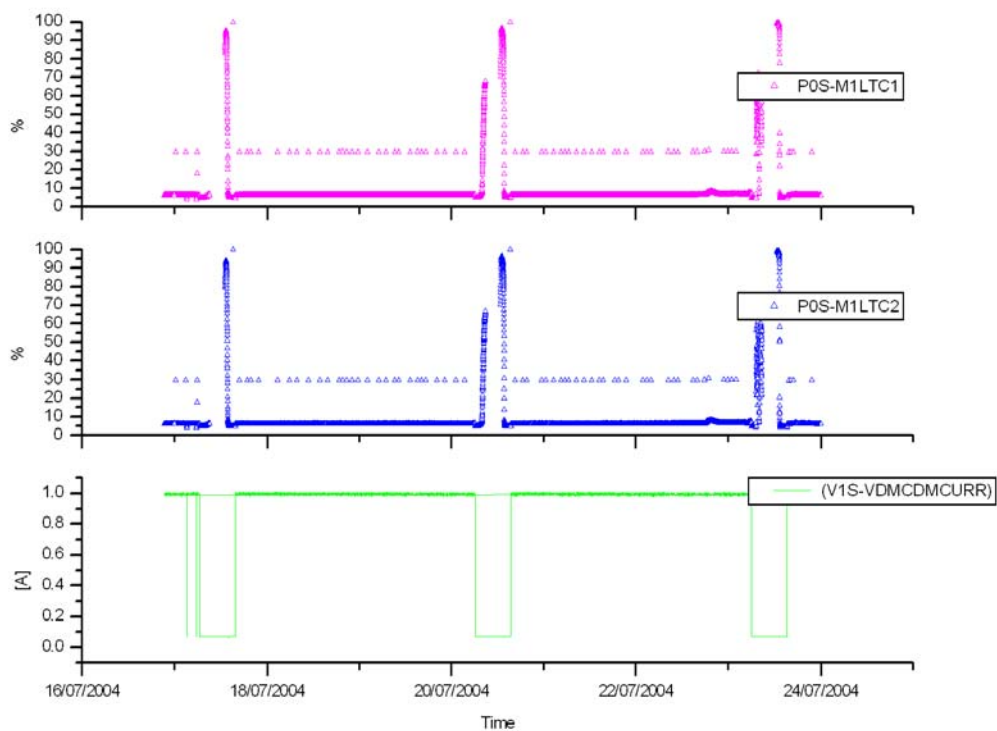
Picsit Counters:

IBIS - PICsIT Counters Rev 214-216



Veto Current:

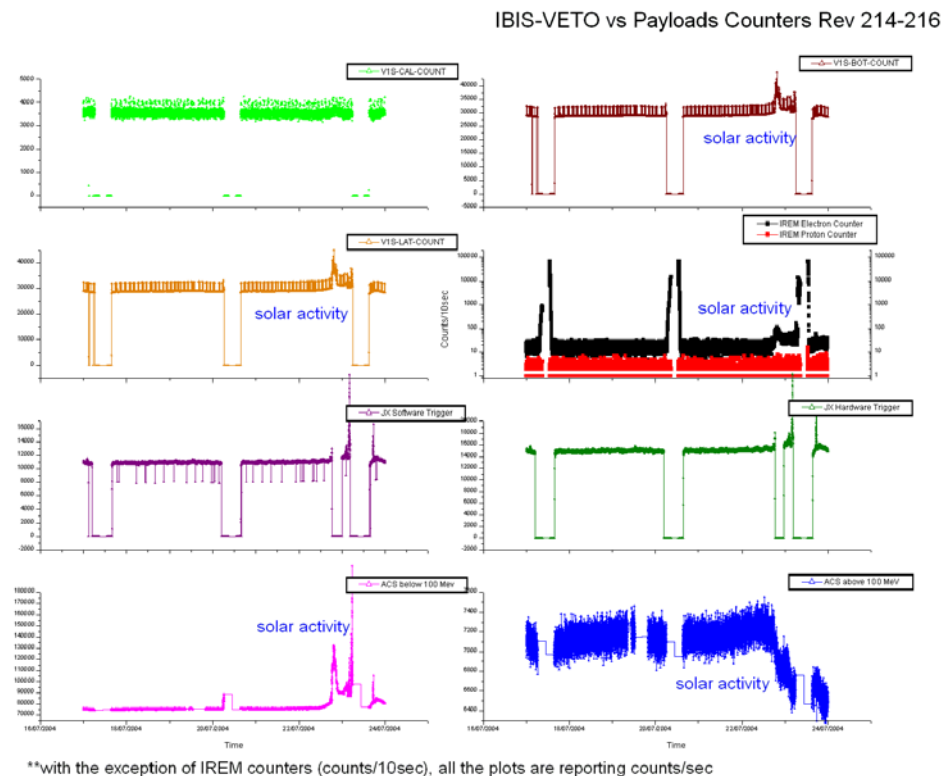
IBIS-VETO Current & PICsIT dead times Rev 214-216



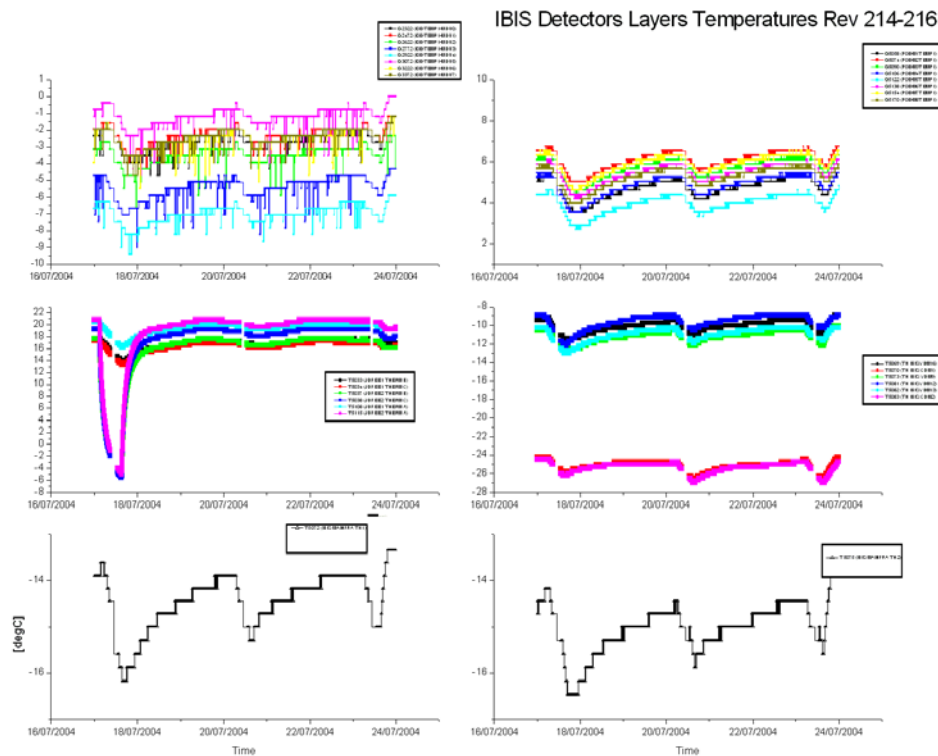
VETO vs Payloads Counters

The comparison between the count-rates reported by VETO, the SPI-ACS, the IREM counters and JEM-X hardware/software triggers, gives in general an indication of stabilization of the background (protons and heavy ions) across the rev 214-215: this is shown by the following plot, in which all the on-board sources mentioned are considered.

During rev 216 a new sunspot (# 652) emerged over the sun's eastern limb. The coronal mass ejection (CME) hurled by, swept past Earth at 10:00Z on 22/07/04. The effect of the CME has been observed on most of the on-board anticoincidence system and radiation monitors as high proton and electron count-rates.



IBIS Detectors Layers Temperatures



IBIS daily report

DOY 2004.199 (17/07/04)

At 03:15Z the VETO CDM01 High Voltage Calibration (OR 162) in parallel with the JEM-X2 DFEE deactivation (OR 161) was performed, a summary of the activity is given below:

1) The deactivation of the JEM-X2 DFEE started at 02:59Z and was completed successfully at 03:04Z.

The temperatures (before the switch OFF) for the JEM-X2 DFEE were

T5115 (DFEE A) = 20.83 degC

T5037 (DFEE B) = 17.69

T5038 (DFEE C) = 19.23

The ISGRI temperature 1 (lateral thermistor), before the DFEE OFF, reported almost constant values

G2322 = -1.965 degC

G2472 = -1.965

G2622 = -3.141

G2772 = -5.101

G2922 = -6.277

G3072 = - 0.789

G3222 = -1.965

G3372 = -1.965

2) the VETO CDM1 calibration started at 03:15Z and was completed at 05:38Z (lasting more than 2 hours due to a problem with the TC link at 4:53Z with the station DSS16). The calibration was performed successfully and IBIS continued his activity as per timeline.

During all the execution of the calibration, for the remaining part of rev 214 and for the beginning of 215 the detectors temperatures were monitored (see plot above referring to the IBIS and JEM-X2 DFEE temperatures)

IBIS/ISGRI (see plot below) presented a clear decreasing of the temperatures, in some cases well over the limit of 2 degC defined by IBIS PIs and not reaching, during the deactivation period, any sort of temperature plateau.

Considering the information gathered during the thermal test/calibration campaign, a dependency of the detector gain from the temperature of~ 0.4% for degC, would produce a variation of gain >1% .

The VETO (BGO temp and external VDM temp) reported a change in temperature of ~ 4degC for the lateral modules while the PICsIT modules (temp 1 & 3) reported globally a change of ~2 degC.

3) At 15:26Z just few minutes before the Radiation Belts Exit, JEM-X2 DFEE was re-activated in order to re-establish the nominal (pre-DFEE OFF) thermal condition in the IBIS detectors layers.

DOY 2004.200 (18/07/04)

Nothing to report.

DOY 2004.201 (19/07/04)

Nothing to report.

DoY 2004.202 (20/07/04)

There were a few reports during the Belt passage the OEM APID 1280 ID 167 Class 2 <<IBIS1 PICsIT NOISY SEMIMODULE SIGNALLING>> due to the PICsIT detectors being ON without the VETO anticoincidence system, as required by the PIs.

DoY 2004.203 (21/07/04)

Nothing to report.

DoY 2004.204 (22/07/04)

At 18:25Z high electron count-rate, due to the geomagnetic storm activated by the CME, that forced JEM-X1 unit in Safe Mode. Consequently, the parameter family G5004 (PICsIT VETO strobes) went OOL (Alarm low) for few TM cycles at the following times: 18:37Z, 19:01; 19:09, 20:22, 20:38. No further action was taken.

At 20:29Z the parameter G2070 failed the SCC (OOL). The parameter reported an overflow of the number of the noisy pixels for the MDU 5. The parameter returned within limits after one TM cycle. No further action was taken.

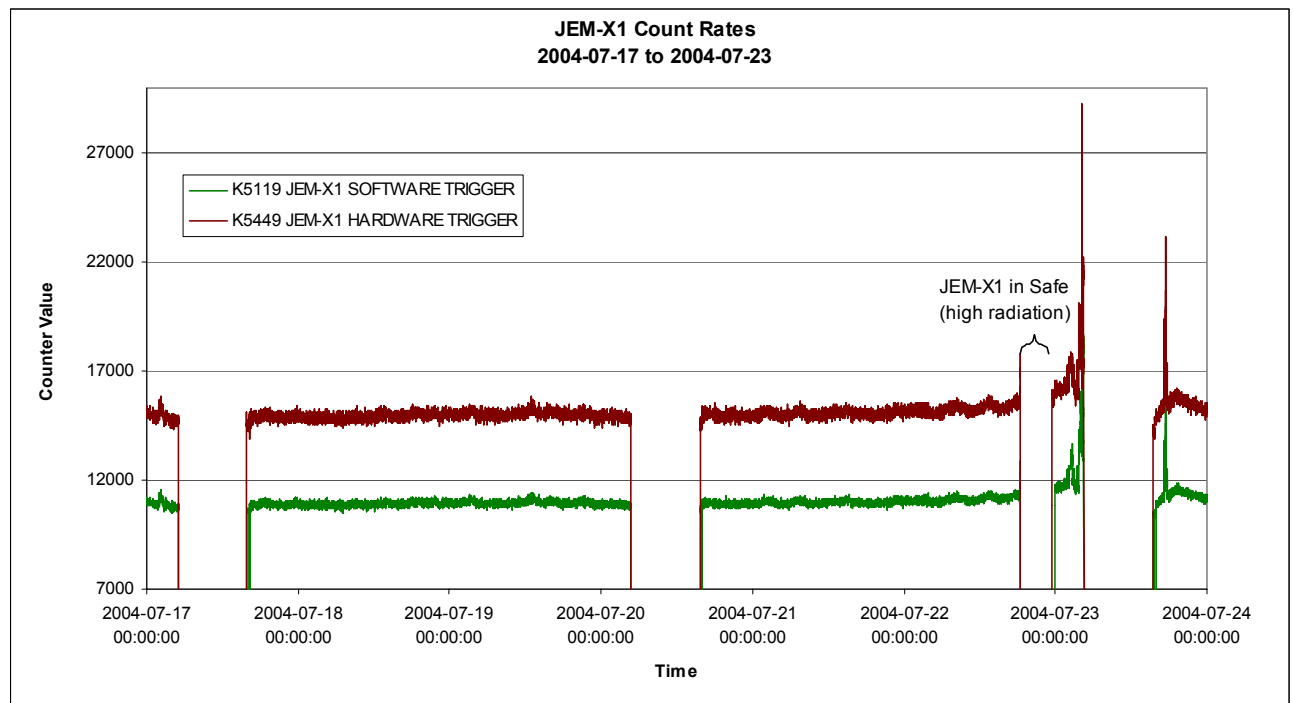
DoY 2004.205 (23/07/04)

There were a few reports during the Belt passage the OEM APID 1280 ID 167 Class 2 <<IBIS1 PICsIT NOISY SEMIMODULE SIGNALLING>> due to the PICsIT detectors being ON without the VETO anticoincidence system, as required by the PIs.

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

The JEM-X1 and JEM-X2 detector temperatures over the reporting period are displayed in the following graph, along with the temperatures at a selection of DFEE locations and on the detector bench between the two units².

The effect of switching off the JEM-X2 DFEE on 2004-07-17 on the temperatures of both units can be clearly seen. Over the ~12 hour period during which the JEM-X2 DFEE was off:

- JEM-X1 Detector temperature dropped by ~3degC;
- JEM-X1 DFEE temperatures dropped by ~4degC;

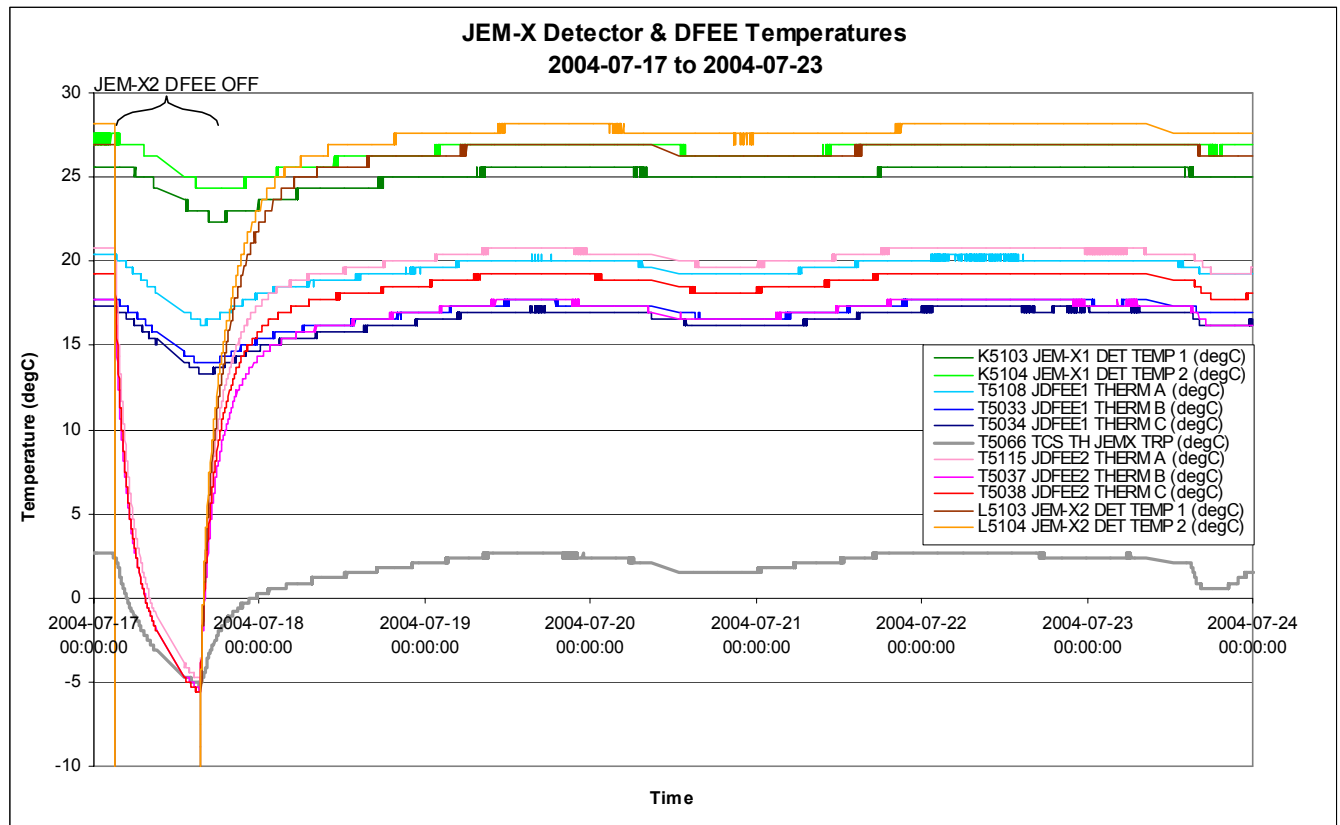
¹ Data sampled (1 frame in 4) and smoothed to remove spikes in S/W Trigger due to flushing of buffer after slews.

² Data sampled (1 frame in 8)

- JEM-X2 Detector temperatures dropped by $\sim 35\text{degC}$;
- JEM-X2 DFEE temperatures dropped by $\sim 24\text{degC}$,

although changes in the Solar Aspect Angle over this period would also have had an impact on these temperature decreases.

Details of the JEM-X2 DFEE switch-off operations are provided in Section 8.3.4.3.



8.3.4.3 JEM-X Daily Report

2004-07-17 (DOY 199, Rev 214-215)

In line with INTGSCCR-58, a test of the thermal impact on IBIS of a JEM-X2 DFEE Switch-off was performed towards the end of revolution 214 until the start of revolution 215. The JEM-X2 DFEE was switched off at the beginning of the OMC Flat Field Calibration in revolution 214. The operations were performed according to INT_OR_0161, with key stages of the operations as follows:

02:59Z Procedure FCP_JEM2_9010 JEM-X2 DFEE Switch Off started
 03:04Z JEM-X2 DFEE switched off

The evolution of the IBIS temperatures was then monitored. At the start of revolution 215 it was considered that the temperature decrease of IBIS was such that the JEM-X2 DFEE should be switched back on (see IBIS section of this report for plot of temperature evolution of IBIS and Section 8.3.4.2 above for plot of JEM-X temperatures).

At 15:26Z procedure FCP_JEM2_0021 JEMX2 DFEE Activation was started and the JEM-X2 DFEE was switched on.

Due to the fact that the activation was performed while still inside the radiation belts, without the broadcast packet radiation belt protections being disabled for JEM-X2³, as well as the fact that the Autorecovery Level had been set to 'NO RECOVERY' (part of the manual DFEE switch off), the following complications arose in the execution of the rest of procedure FCP_JEM2_0021:

- At 15:30:04Z the TC L0009 STATE SETUP (step 4.5) failed with the issuing of OEM 136 (TC rejected due to shutdown in progress). This was due to the fact that the Shutdown Levels were still RAD BELTS.
- At broadcast packet radiation belt exit (15:32:07Z), the Wanted Shutdown Level changed to NORMAL, but the Active Shutdown Level remained RAD BELTS due to the fact that the Autorecovery Level was still set to 'NO RECOVERY'. Thus, at 15:34:03Z an attempt to resend TC L0009 STATE SETUP failed again with OEM 136 (TC rejected due to shutdown in progress).

At 16:07:21Z the JEM-X2 broadcast packet overrides for radiation belt entry/exit times and IREM counters were set to DISABLED in an attempt to bring the Active Shutdown Level to NORMAL. However this had no effect on the Active Shutdown Level (as Autorecovery Level was 'NO RECOVERY') and the BCP overrides were re-enabled at 16:33:04Z.

At 16:34:04Z JEM-X2 was commanded to Safe mode in order to reset the Active Shutdown Level to NORMAL, which successfully occurred, and the rest of procedure FCP_JEM2_0021 was performed.

However, the report of the SW Integer and Float parameters (steps 4.8.1 and 4.8.2) could not be verified in telemetry due to the fact that JEM-X2 had an allocation of 1 packet/cycle at this time. In order to verify these parameters, these steps were repeated at the start of revolution 216 (see report for 2004-07-20).

Following the reactivation of the JEM-X2 DFEE some out of limits were received on the JEM-X2 Detector pressures as follows:

- L5101 DET PRESSURE 1 went Soft Low out of limits (value=132650) at 15:35:59Z and returned within limits at 18:17:51Z, then continuing to fluctuate in and out of limits until 18:25:11Z.
- L5102 DET PRESSURE 2 went Soft Low out of limits (value=135200) at 15:31:59Z and returned within limits at 19:36:55Z, then continuing to fluctuate in and out of limits until 19:47:43Z.

This drop in the JEM-X2 Detector pressure is related to the temperature decrease of the JEM-X2 Detector due to the JEM-X2 DFEE switch off and is also occasionally observed during eclipse season, when the DFEE is reactivated following an eclipse.

³ JEM-X DFEE Switch off and activation procedures will be updated to include condition that if performed inside radiation belts, or non-nominal conditions, broadcast packet distribution to JEM-X should be disabled for duration of procedure.

2004-07-18 (DOY 200, Rev 215) to 2004-07-19 (DOY 201, Rev 215)

Nothing to report.

2004-07-20 (DOY 202, Rev 215-216)

Just after radiation belt exit of revolution 216, during the ~10 minutes in which JEM-X2 still had a TM allocation of 9 packets/cycle, a report of the JEM-X2 DFEE S/W Integer and Float parameters was performed. This was the final part of the JEM-X2 DFEE reactivation performed on 2004-07-17 (as part of INT_OR_0161), which could not be verified in telemetry due to the TM allocation of 1 packet/cycle to JEM-X2 at that time. The operations performed were as follows:

- 15:17:54Z JEM-X2 commanded to Setup mode via TC L0009 STATE SETUP (step 4.5 of procedure FCP_JEM2_0021 JEMX2 DFEE Activation).
- 15:18:19Z Report of SW Integer Parameters (TC L0021 SW READ INT, step 4.8.1 of procedure FCP_JEM2_0021).
- 15:20:12Z Report of SW Float Parameters (TC L0022 SW READ FLOAT, step 4.8.2 of procedure FCP_JEM2_0021).
- 15:21:30Z JEM-X2 commanded back to Safe mode via FCP_JEM2_0040 JEM-X2 Transition to Safe.

The JEM-X2 S/W Integer and Float parameters were verified as being correct.

2004-07-21 (DOY 203, Rev 216)

Nothing to report.

2004-07-22 (DOY 204, Rev 216)

At 18:25Z the following radiation monitoring parameters from IREM went Out of Limits:

K5317 RAD MONITOR 3 (Dose Counter), value = 72,
causing JEM-X1 to transition to Safe mode autonomously (issuing OEM 231 JEM-X1 AUTO EVENT 1).

At 22:51Z JEM-X1 performed an autonomous recovery to Setup mode (issuing OEM 233 JEM-X1 AUTO EVENT 3) after the IREM RMCR values had remained below the JEM-X1 thresholds for exiting from Safe mode for more than 10 minutes. At 23:21Z the procedure FCP_JEM1_1010 (JEM-X1 Configuration Setting for Science Ops) was executed and at 23:56Z JEM-X1 was then commanded back to Data Taking mode by the procedure FCP_JEM1_0044 and JEM-X1 operations continued nominally.

2004-07-23 (DOY 205, Rev 216-217)

At 04:12:16Z the TM parameter K5136 Buffer Loss went out of limits (value = 143), reaching a maximum of 955 at 04:12:56Z and returning within limits at 04:13:12Z.

At 04:14:00Z The TM parameter K5119 Software Trigger went soft out of limits (value = 20039) and then exceeded the hard limit at 04:15:28Z (value = 24399). It returned within soft limits at 04:15:52Z, and back within limits at 04:16:48Z. The counts were not high enough for JEM-X1 to transition to Safe mode (threshold = 25000). At 04:17:36Z the parameter K5119 Software Trigger went soft out of limits again (value = 20327) but returned within limits at 04:18:24Z.

8.3.5 OMC Operations

On DoY 199, between 05:08:04 and 05:08:04, a Flat Field calibration and subsequently between 05:50:07 and 06:05:07, a Dark Current calibration, were performed. At 04:52, the TC link, slipped into a strange 'not valid' state causing the loss of a pointing in the Flat-Field calibration.

On DoY 200, at 20:42:14, due to the STR inability to pick-up the commanded guide star, a slew was lost, the impact was the loss of pointing 02150031, it was at this time that the following pair of commands were rejected:

```
2004.200.20.42.21.731 2004.200.20.42.11.475 1792 Real Time Rejection 131
REJECTED TC1
FIX2=0 M5010=6,NORMAL M9079=3 M9080=131 M5001=60,IM A M9068=1 FIX2=0 M9069=412
2004.200.20.42.14.859 2004.200.20.42.05.225 1792 Real Time Rejection 131
REJECTED TC1
FIX2=0 M5010=6,NORMAL M9079=3 M9080=131 M5001=130,RESET IM M9068=1 FIX2=0
M9069=411
```

These correspond to the M1130 (RESET IM) and MU1310 (IMAGING-A) commands for that pointing. Pointing 02150032 was also lost.

On DoY 201, at 14:03, due to problems with the TC link with Redu, pointing 02150046 was missed

On DoY 203, at 20:17:39, during the perigee passage from Rev 215 to 216, there was a non-critical SECL OEM, when temperature detected in the middle of the lens barrel (parameter T5016, OMC LENS TEMP1) went below the limit of -10°C. The autonomous on-board monitoring routine SECL turned on heater 39 (ref: OMC LNSA ON in SECL nominal heater table) to control the situation.

On DoY 205, at 16:14:29, due to a 'hit on the line' communications with Redu were lost, the impact was a delay of 18 minutes in the start of pointing 02170005, it was at this time that the following pair of commands were rejected:

```
2004.205.16.14.38.134 2004.205.16.14.28.506 1792 Real Time Rejection 131
REJECTED TC1
FIX2=0 M5010=6,NORMAL M9079=3 M9080=131 M5001=60,IM A M9068=1 FIX2=0 M9069=573
2004.205.16.14.29.691 2004.205.16.14.21.881 1792 Real Time Rejection 131
REJECTED TC1
FIX2=0 M5010=6,NORMAL M9079=3 M9080=131 M5001=130,RESET IM M9068=1 FIX2=0
M9069=572
```

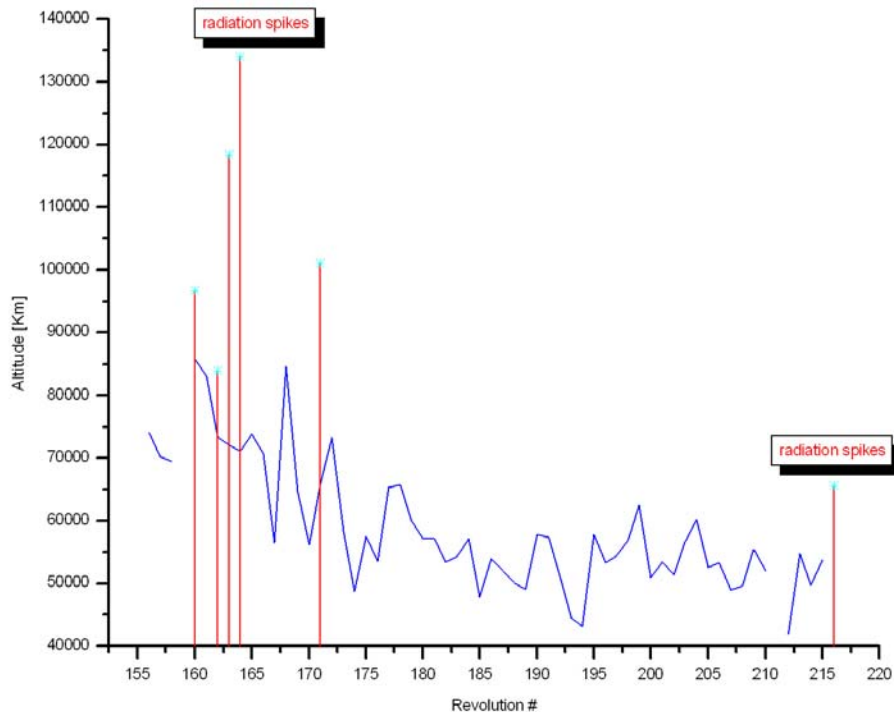
These correspond to the M1130 (RESET IM) and MU1310 (IMAGING-A) commands for that pointing.

On DoY 199 at 06:24:29, DoY 202 at 06:10:05 and DoY 205 at 05:56:49, OMC was switched by the Timeline to SAFE mode, at the nominal times.

8.3.6 IREM Operations

Radiation Belts Entry

Evolution of Radiation Belt Entry 2004



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]
214	RAD_ENTR R 2004-07-17T06:24:15Z	17/07/2004 07:43:29	49766	17-Jul-2004 07:05	54537
215	RAD_EXIT R 2004-07-17T15:32:05Z	17/07/2004 14:09:13	>24855	17-Jul-2004 14:15	27614
215	RAD_ENTR R 2004-07-20T06:09:53Z	20/07/2004 06:57:35	53751	20-Jul-2004 06:52	54392
216	RAD_EXIT R 2004-07-20T15:17:15Z	20/07/2004 13:56:49	>24852	20-Jul-2004 14:02	27880
216	RAD_ENTR R 2004-07-23T05:56:27Z	23/07/2004 05:13:53	65583	23-Jul-2004 06:42	54147
217	RAD_EXIT R 2004-07-23T15:03:36Z	23/07/2004 13:24:01	23173	23-Jul-2004 13:52	28208

Reference

Small error vs reference

Large error vs reference

Radiation Spike

Proton Belts

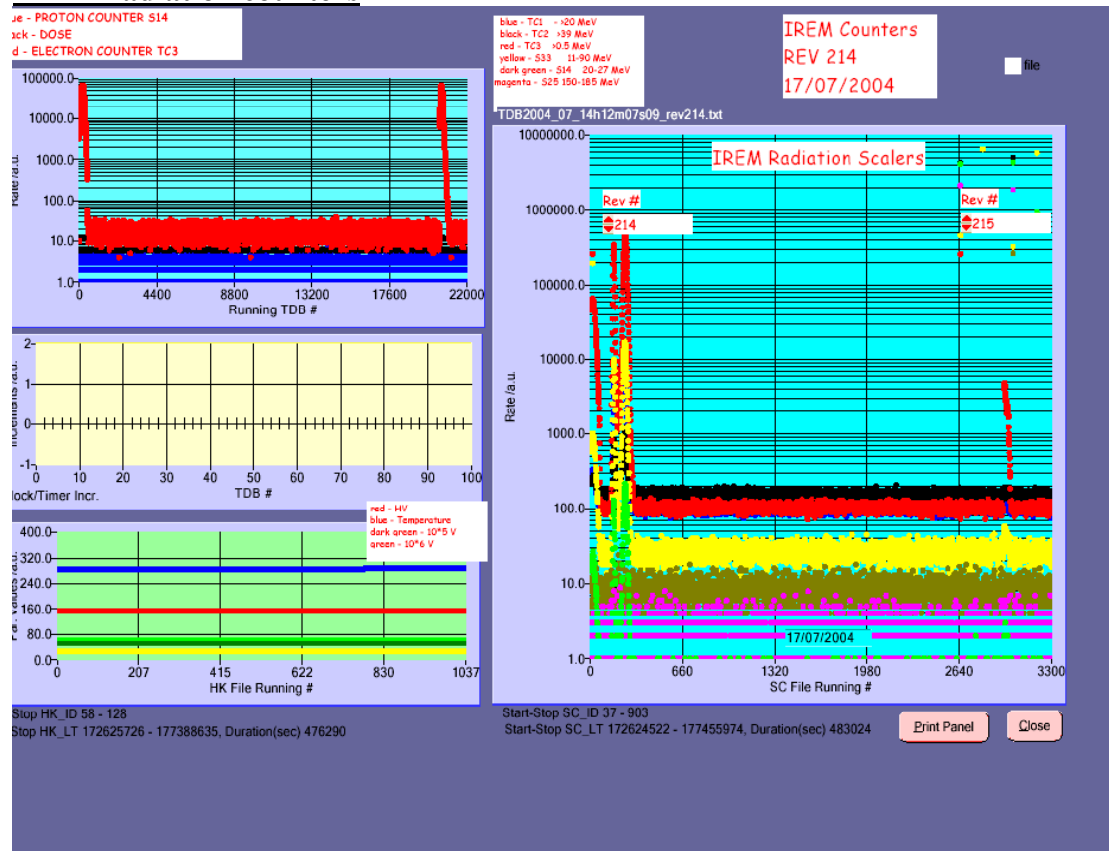
REV		Proton CUT-OFF Predicted Entry/Exit	ALT[Km] predicted
214	PROTON_RAD_ENTR	17-Jul-2004 12:45	13798
214	PROTON_RAD_EXIT	17-Jul-2004 12:55	14983
215	PROTON_RAD_ENTR	20-Jul-2004 12:22	12868
215	PROTON_RAD_EXIT	20-Jul-2004 12:42	15113
216	PROTON_RAD_ENTR	23-Jul-2004 12:12	13020
216	PROTON_RAD_ENTR	23-Jul-2004 12:32	15351

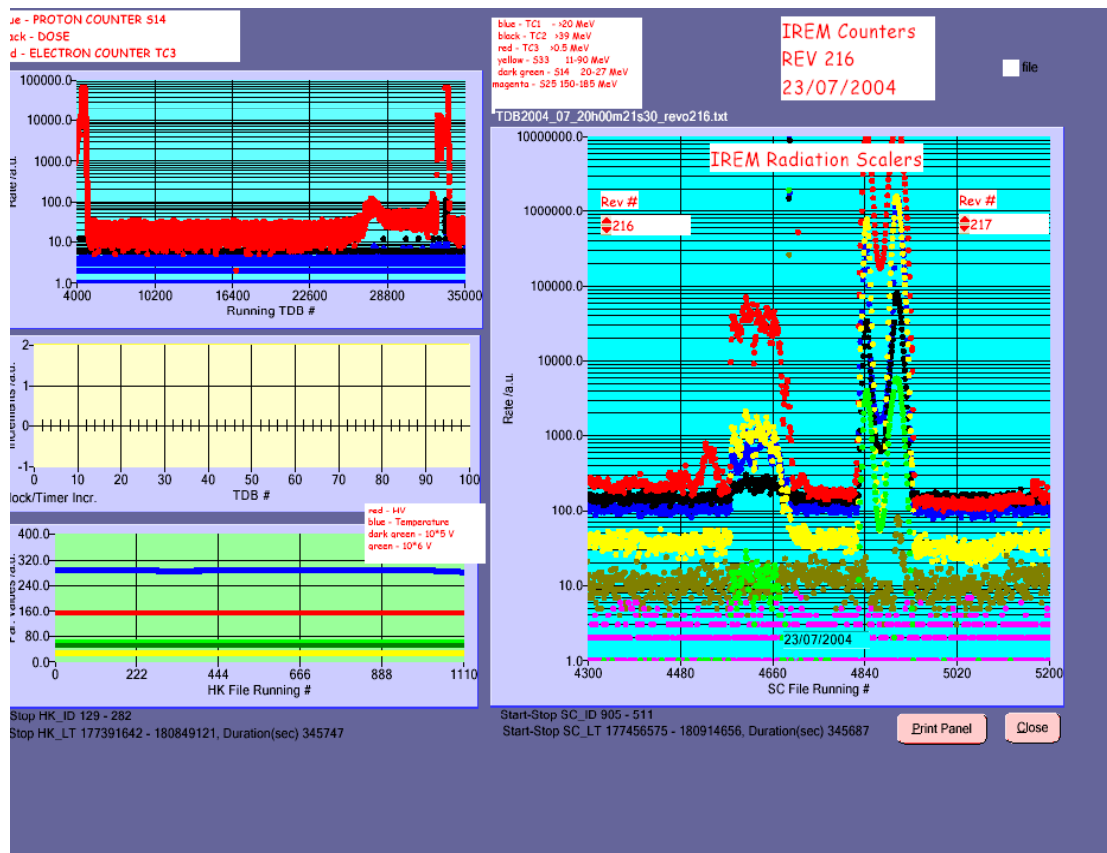
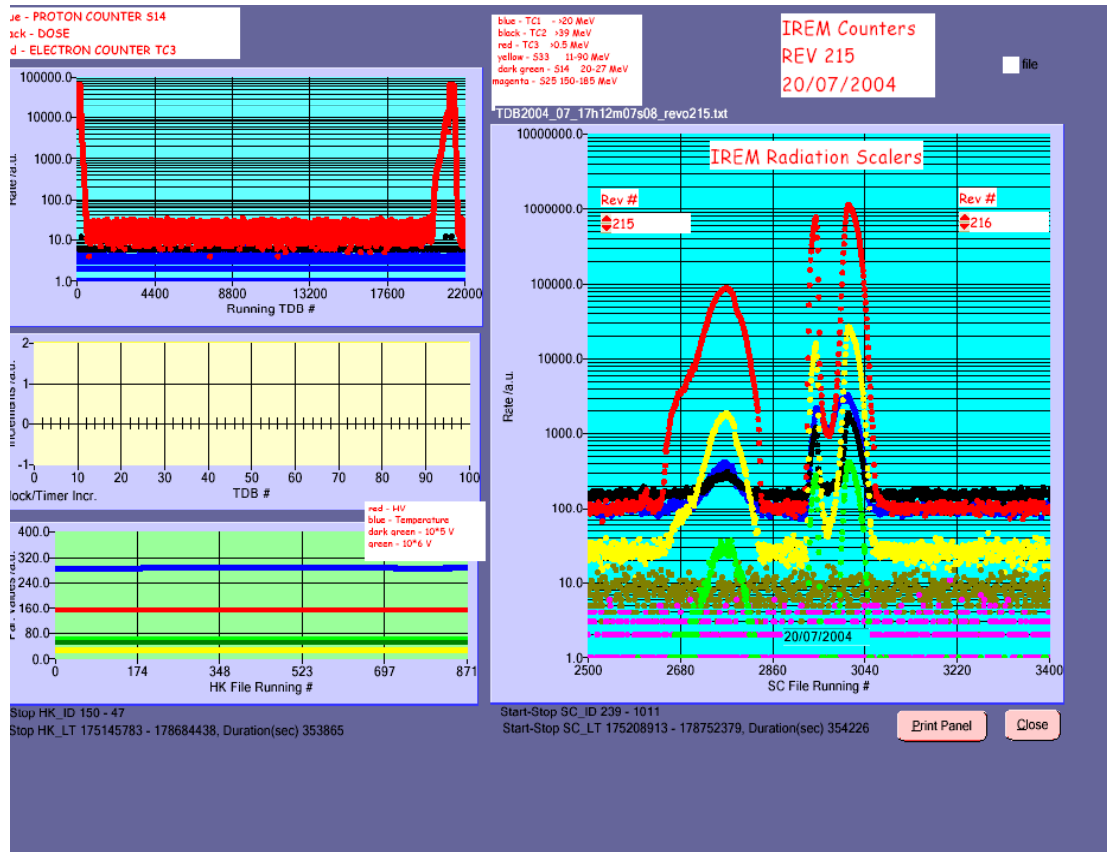
(Values for Rev 211 will be provided next week)

IREM daily report

Nothing to report.

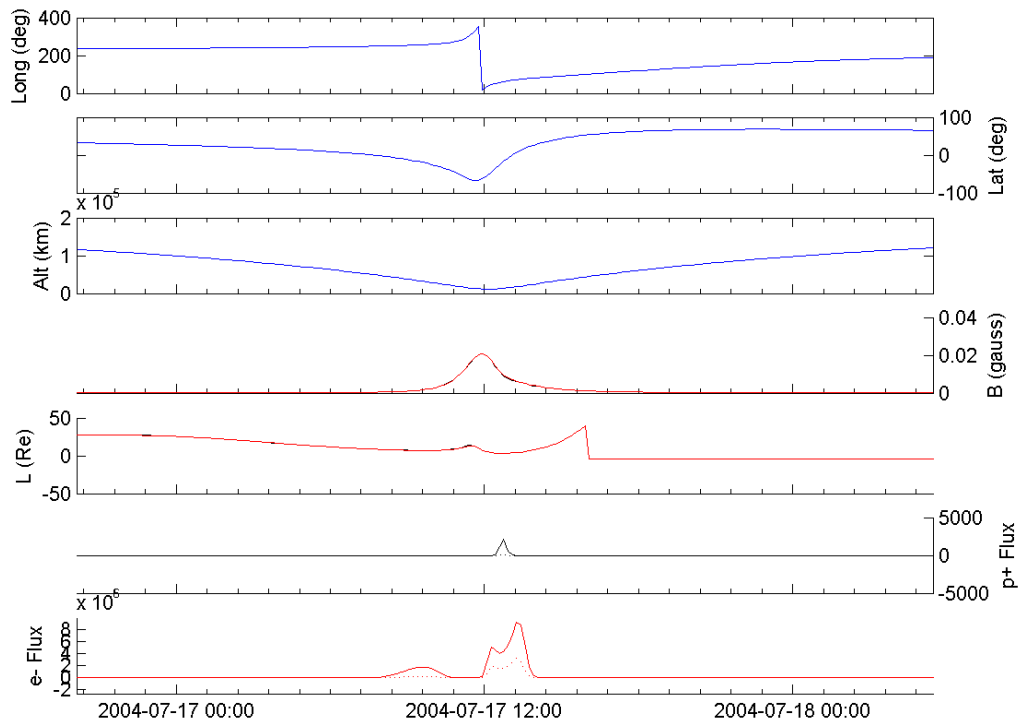
IREM radiation counters



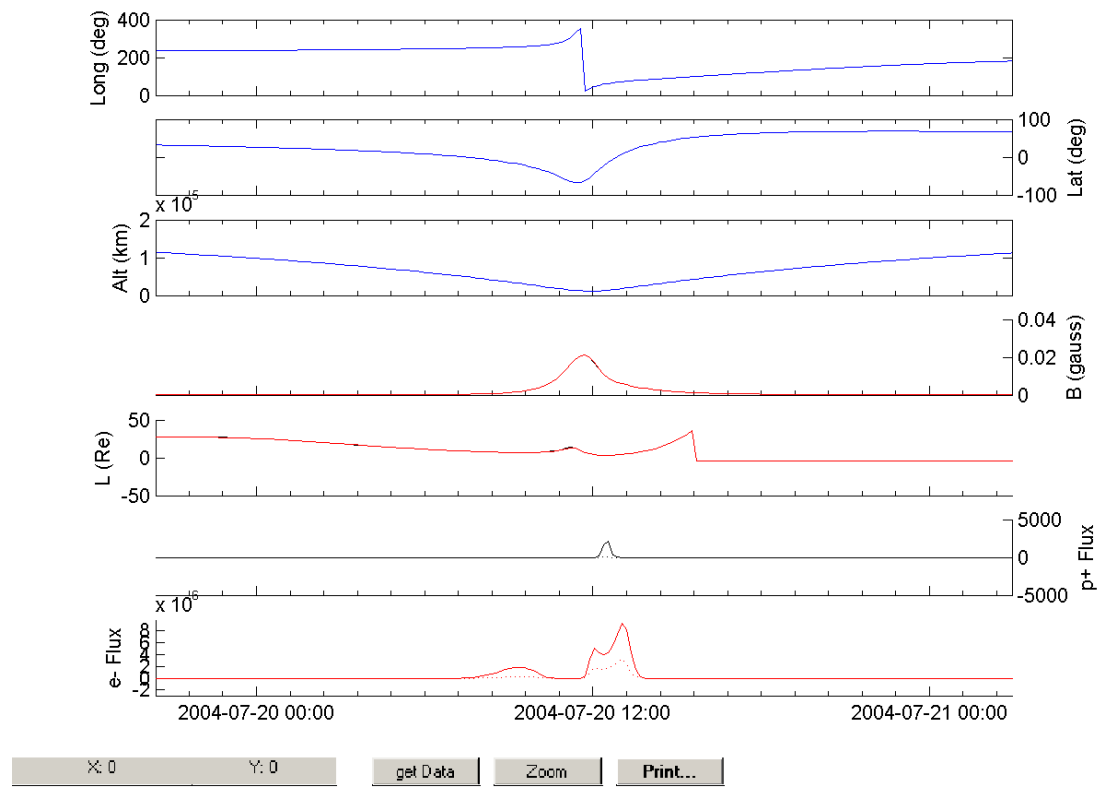


IREM Predicted Radiation Belt Passages.

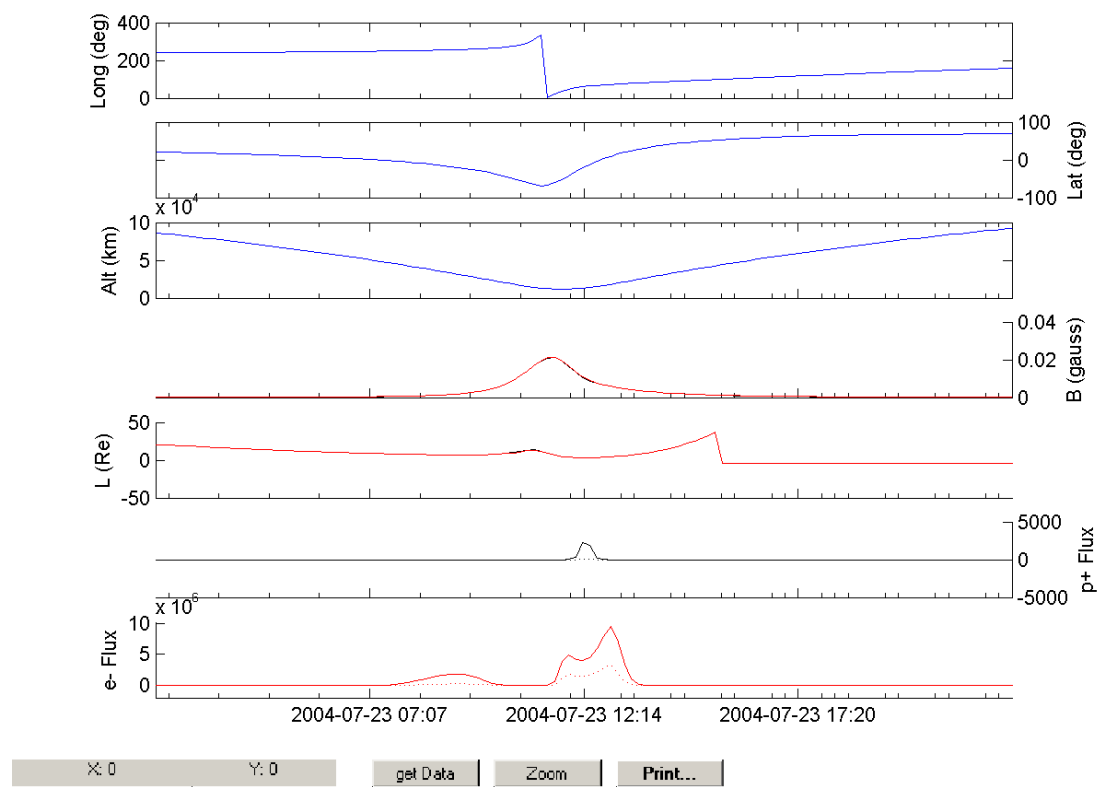
Rev 214



Rev215



Rev 216



SEC-GOES Observed Particles Fluxes.

