

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OAI
No. 299
Week 24
16.06.08
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 07.06.08 until 13.06.08 (both dates inclusive) and covers the revolutions 690, 691 and 692.

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 consisted of a raster dither of the North Ecliptic Pole (RA 18:00:00.00, DEC +66:33:39.0), an OMC Flat-Field calibration at attitude (RA 17:05:12.00, DEC +50:48:00.0), and three raster dithers of Loop I-Loop IV Super (RA 13:57:10.00, DEC +07:34:37.0).

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.

No slews were missed from TL, during the observation period.

The fuel consumption over the period between 06/06/2008 and 13/06/2008 was 0.1044 Kg. The remaining propellant is in the order of 140.0926 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.

From the EPS point of view the eclipse passage was entirely nominal.

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 has been identified.

The PST was over-subscribed by 3 packets, which were allocated to SPI during the Instrument window for the entire reporting period.

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

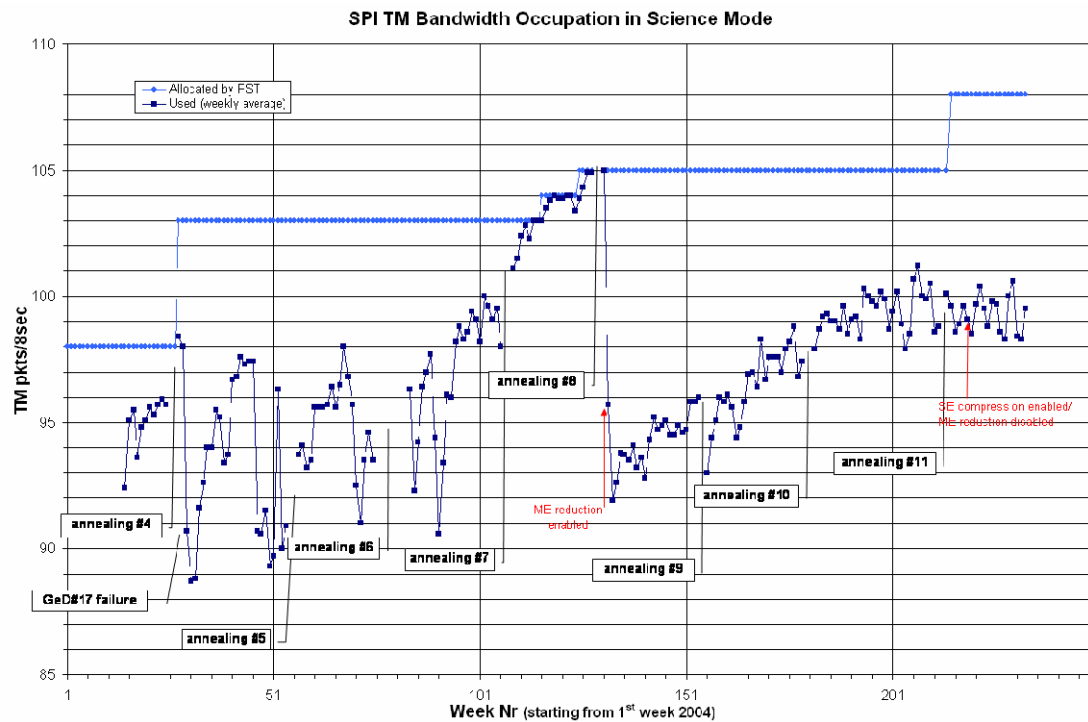
3.2.1 SPI

Following the 11th annealing, which ended on 30th January, the overall status of the gamma-ray spectrometer is nominal, except for the Ge detector #12 which, although its energy resolution improved since the previous annealing, is still showing a slightly degraded energy resolution compared to the other detectors and is therefore operating at a lower HV setting of 3.5kV (instead of 4kV). Detector #2 is failed since 06/12/2003 and detector #17 since 17/07/2004.

The Stirling compressors are working nominally, maintaining the Germanium detectors at 80 +/-1K.

During science operations, the instrument was kept in photon-by-photon mode with spectra TM enabled. The assigned TM bandwidth in the science observation windows was 108 packets/cycle except from 2008-06-07T22:19:05Z to 2008-06-08T05:07:01Z when the TM allocation was 88 packets/cycle due to an OMC Flat Field Calibration. The over-allocated PST with an additional 3 packets/cycle for SPI was used however the Broadcast Packet TM allocation was not updated until revolution 691 onwards. The average telemetry occupation in the science window was 99.5 packets/cycle.

The following plot shows the assigned and the average occupation of the SPI TM bandwidth.



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

3.2.2 IBIS

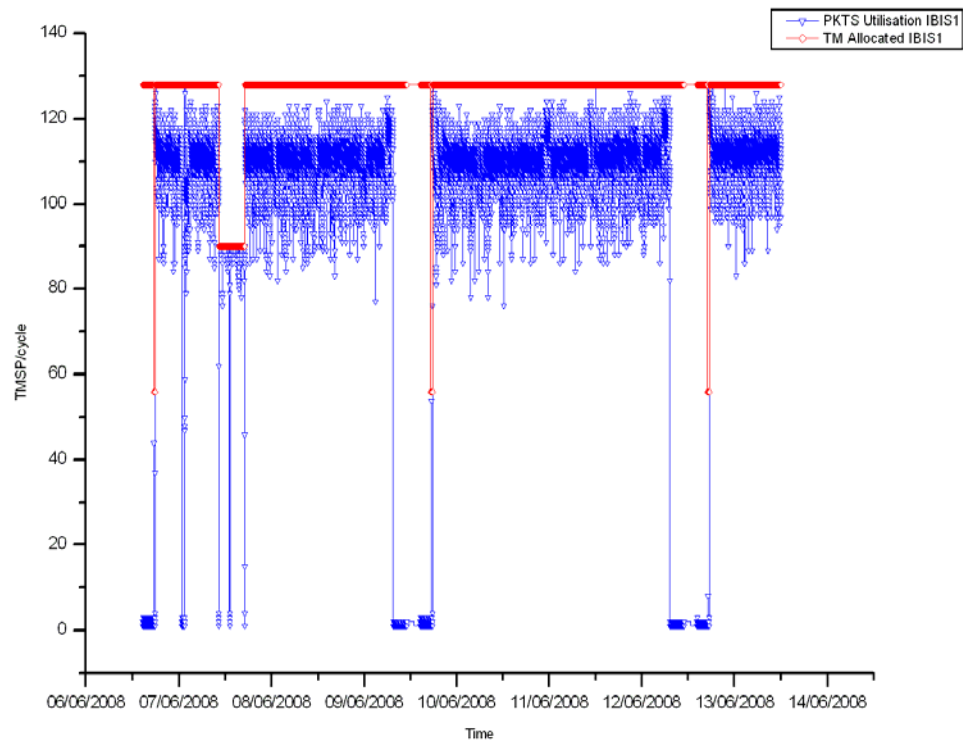
The overall status of the unit is nominal.

During the reporting period, the TM bandwidth statistics were as follows:

- PST allocation to IBIS above radiation belts: 128 packets/cycle except from 2008-06-07T22:19:05Z to 2008-06-08T05:07:01Z when the TM allocation was 90 packets/cycle due to an OMC Flat Field Calibration.
- IBIS mean bandwidth utilisation in science mode: 109.36 packets/cycle (down 0.54 on last week)
- Percentage of TM cycles in which full bandwidth was used: 0.26%

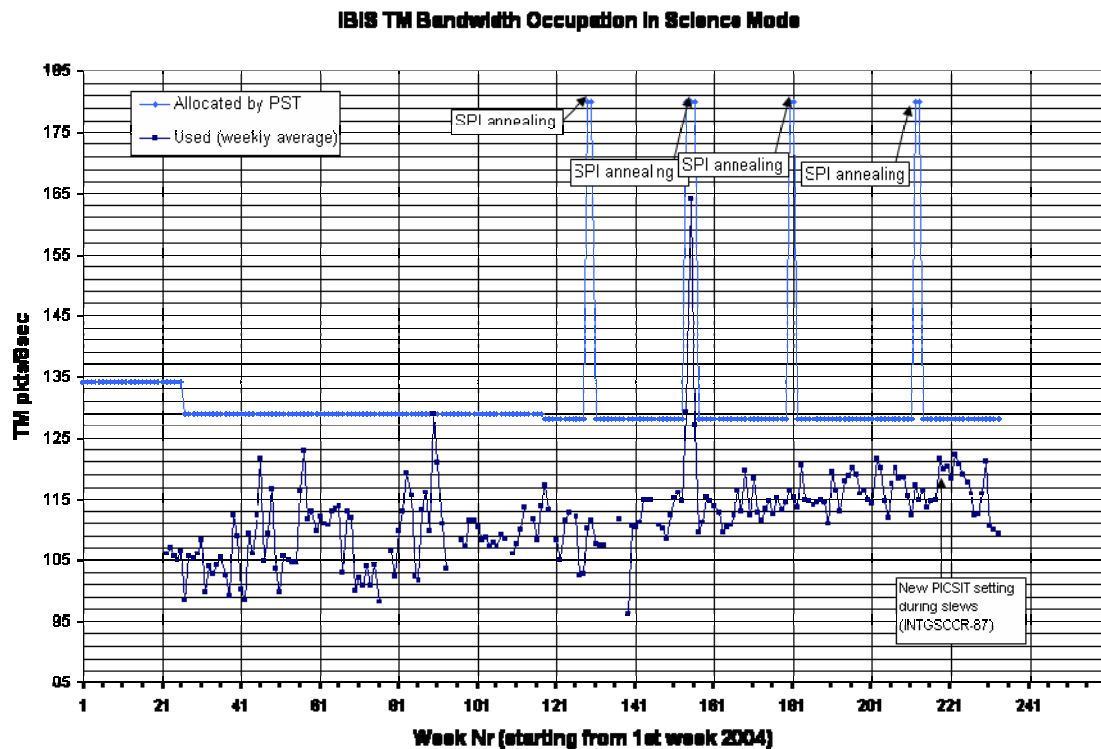
The plot below shows the IBIS TM utilisation during the observation period.

IBIS - pkts utilisation Rev 690-692



**sampling every 2 pkts (16 secs)

A plot of the IBIS weekly bandwidth utilisation since 2004 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 with a TM allocation of 8 packets/cycle. JEM-X2 was dormant (DPE OFF) with no TM slots allocated.

Note: Some more information concerning the JEM-X operations is provided in the Appendix.

3.2.4 OMC

The status of OMC is nominal.

OMC operations were performed by the automatic Timeline. OMC was operated in Science Normal mode during science observations, with a TM allocation of 5 packets/cycle, except at the start of revolution 691 from 05:17:21 to 08:09 on 10/06/2008, when it was mistakenly set to 2 packets/cycle.

During this reporting period, 125 of the 129 planned science pointings were executed nominally, 1 pointing was shortened and 3 were lost.

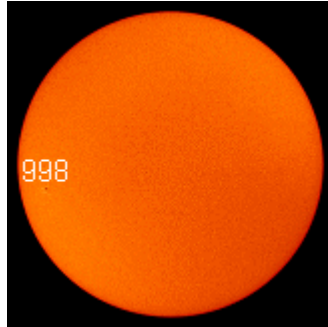
Note: Some more information concerning the OMC operations is provided in the Appendix.

3.2.5 IREM

The overall status of the unit is nominal.

Solar Activity

The observation period was characterised by low solar activity. Sun-spot #998 emerged on the 10th June, and remained until the end of the week. The risk of solar flares was very low.



Reference: www.spaceweather.com

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

4 Ground Facilities

The Operational ground facilities performance was very good this week. No pointings were lost to ground problems. The overall performance was well over the 95% requirement.

4.1 Mission Operations Centre

The performance of the MOC was very good this week. The TCOServer task crashed once, there was no impact.

4.2 Ground Stations & Network

The performance of the ground stations and Network was good this week. There was however 5 occasions where the TM dropped from Redu and the links to ISDC dropped once, there was no impact on any occasion.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

A new PSF has been received for revolution 698.

Observations have been planned for revolutions 695 and 696.

For revolutions 692 to 694 the planning files had to be regenerated in order to set the SPI TM settings correctly.

New TSFs have been received for revolutions 692 and 693.

2. Observation status

New ECS files have been received for revolution 681 to 683.

3. ISOC Science Data Archive

Data has been ingested up to revolution 670. An ISDA status was held on 13 June.

4. ISOC system

Work is ongoing on ISOC system V19.3

5. Problems

None.

4.3.2 ISDC

Status of ISDC observation processing on 16/06/2008:

- Latest Standard Analysis completed: observation 05200260004 (mid-latitude 2, Revolutions 680 & 681) on 16/06/2008.
- Latest products archived: observation 05200510008 (Mrk 421, Revolutions 679) on 14/06/2008.
- Latest observation products sent to the observer: observation 05200510009 (Mrk 421, Revolutions 679) on 16/06/2008.

5 Special Events

6 Anomalies

The following problems were reported this week that impacted operations.

- On DoY 159 at 12:44:59, an IREM SEU (#64) caused the OMC, and IBIS units to switch to SAFE mode. The units were recovered, promptly, see the relevant section in the Appendix for details.
- On DoY 162 at 05:17:21, it was noticed that the PST allocation in the POS for revolution 691 was incorrect. 3 packets had been added to the variable part of the PST instead of to the fixed part. This resulted in 3 packets too many allocated to SPI, and 3 too few to OMC. The problem was manually corrected at 08:09:00, and subsequent POSes updated. The impact was the loss of OMC data for pointings 06910002 and 06910003.

The following anomaly reports were entered into the ARTS system this week.

AR id	Date Created	Subject	Segment	Status
INT_SC-228	2008-06-18	IREM Anomaly: Reset of IREM_CSCI S/W #64, 07/06/2008	Payload	Pending
INT-3003	2008-06-10	Incorrect PST TM Allocation in Mission Planning Files Rev 691	ISOC	Pending

7 Future Milestones

Nothing to report.

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 690

The observations in revolution 690 began with a raster dither of the North Ecliptic Pole (RA 18:00:00.00, DEC +66:33:39.0), lasting ~15.5 hours. They continued with an OMC Flat-Field calibration at attitude (RA 17:05:12.00, DEC +50:48:00.0), lasting ~3.4 hours. Finally a raster dither of Loop I-Loop IV Super (RA 13:57:10.00, DEC +07:34:37.0), lasting ~34.8 hours, was performed until the end of the revolution.

Revolution 691

The observations in revolution 691 consisted entirely of a raster dither of Loop I-Loop IV Super (RA 13:57:10.00, DEC +07:34:37.0), lasting ~56.1 hours.

Revolution 692

The observations in revolution 692 consisted entirely of a raster dither of Loop I-Loop IV Super (RA 13:57:10.00, DEC +07:34:37.0), lasting ~58.0 hours.

Throughout these observations, all instruments were in their nominal science modes, except JEM-X2, which is switched off. The TM allocation was IBIS 128; SPI 108; JEM-X1 8; JEM-X2 0; OMC 5, except from 2008-06-07T22:19:48Z to 2008-06-08T05:07:44Z during the OMC Flat-Field calibration, when it was IBIS 90; SPI 85; JEM-X1 8; JEM-X2 0; OMC 63.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

2008-05-23T04:28:08.000Z	140.3383	F	Automatic TM processing.
2008-05-24T14:17:39.000Z	140.3210	F	Automatic TM processing.
2008-05-26T05:41:52.000Z	140.3097	F	Automatic TM processing.
2008-05-27T13:54:11.000Z	140.2861	F	Automatic TM processing.
2008-05-29T04:07:12.000Z	140.2729	F	Automatic TM processing.
2008-05-30T13:42:28.000Z	140.2506	F	Automatic TM processing.
2008-06-01T03:53:52.000Z	140.2439	F	Automatic TM processing.
2008-06-02T13:32:27.000Z	140.2257	F	Automatic TM processing.
2008-06-04T03:41:03.000Z	140.2180	F	Automatic TM processing.
2008-06-05T13:17:55.000Z	140.1970	F	Automatic TM processing.
2008-06-07T03:29:11.000Z	140.1850	F	Automatic TM processing.
2008-06-08T04:13:45.000Z	140.1610	F	Automatic TM processing.
2008-06-10T03:15:19.000Z	140.1206	F	Automatic TM processing.
2008-06-11T12:24:18.000Z	140.1081	F	Automatic TM processing.
2008-06-13T03:03:10.000Z	140.0926	F	Automatic TM processing.

This report was generated Fri Jun 13 08:00:33 GMT 2008

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, 07/06/2008 – 13/06/2008

The AOCS operations were executed from the Automatic Timeline.

During this period, 78 Open Loop Slews, 62 Closed Loop Slews and 5 Momentum Biases were executed (as reported by ACC).

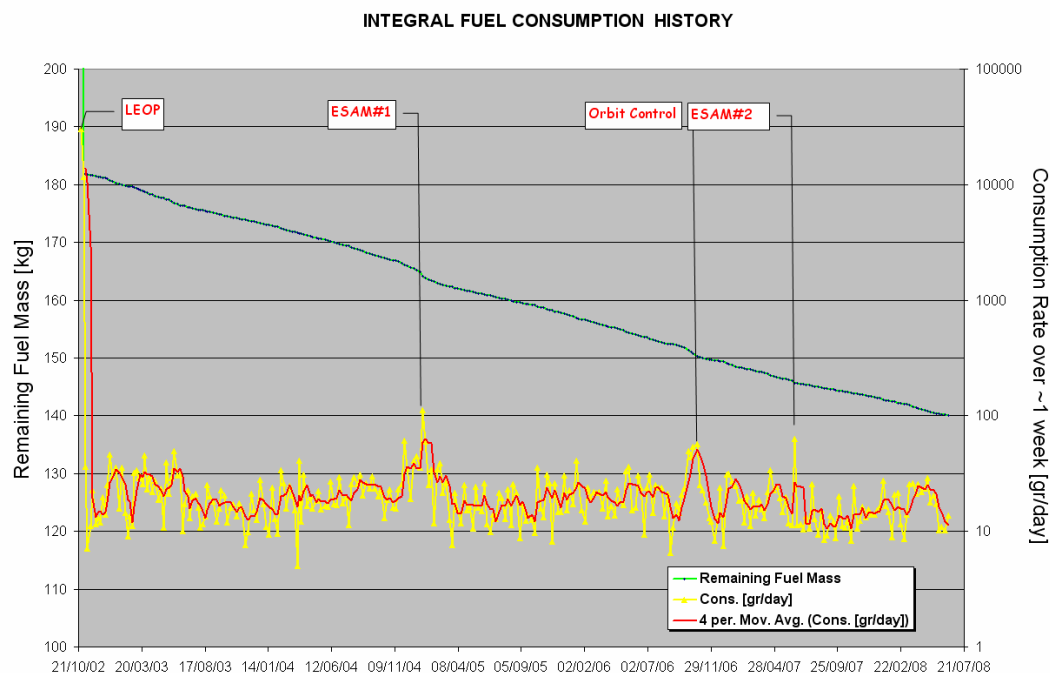
No slew was missed from TL, during the observation period.

Orbit Control

No update

Fuel consumption

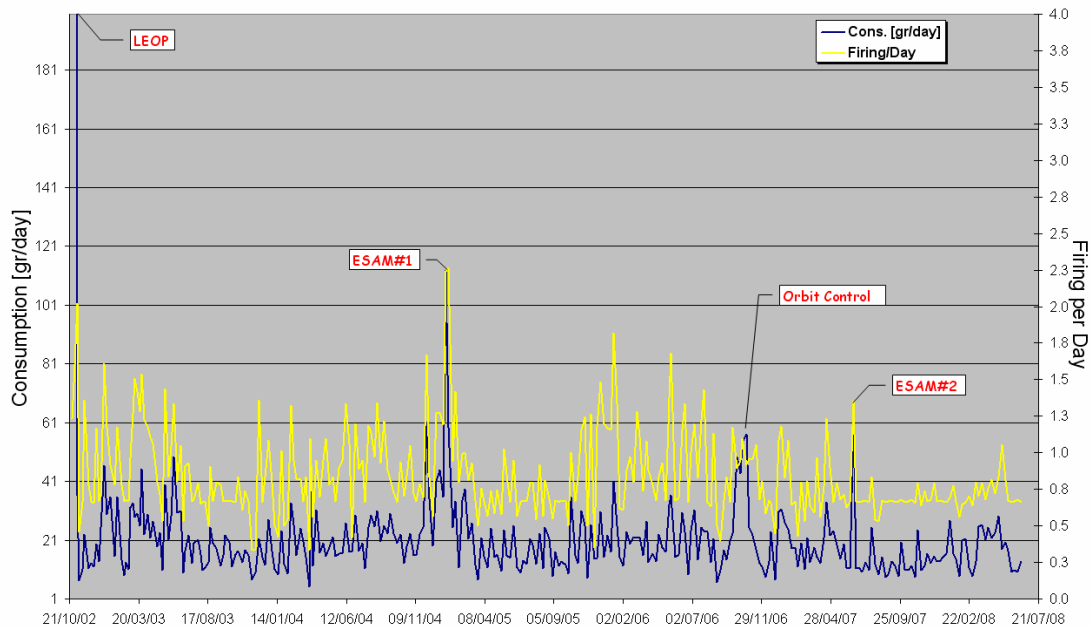
The fuel consumption (total, grams per day) over the period between 01/11/2002 and 13/06/2008 is reported in the plot below.



The above plot considers the ESAM fuel consumption spread over period of ~1 week.

The firing per day over the period between 01/11/2002 and 13/06/2008 is reported in the plot below.

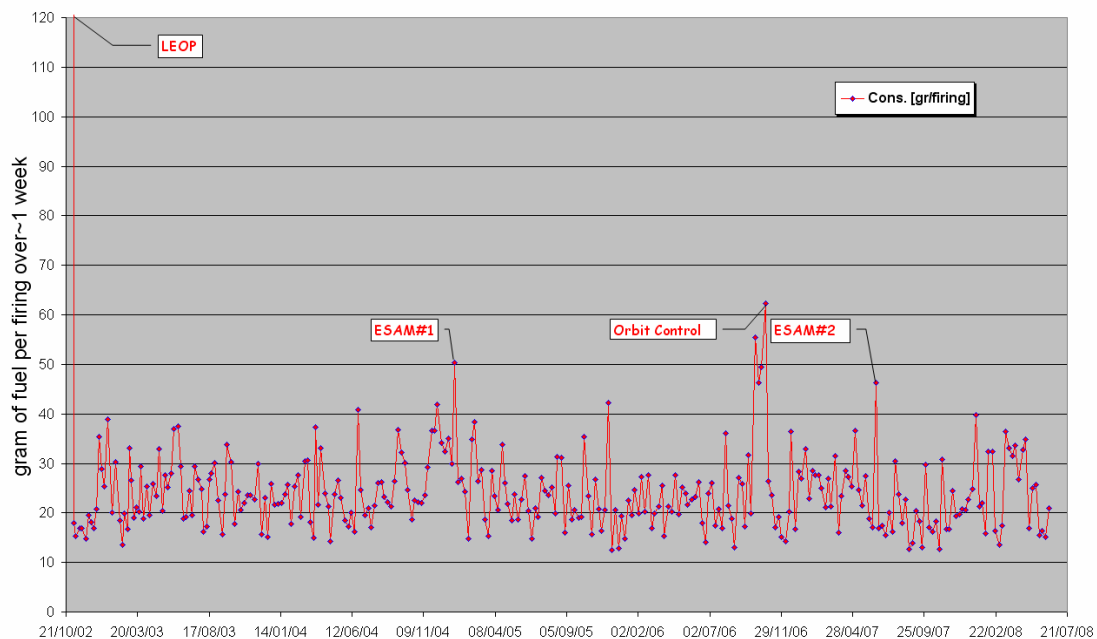
INTEGRAL FIRING PER DAY HISTORY



The above plot considers the ESAM fuel consumption spread over period of ~1 week.

The fuel per firing over the period between 01/11/2002 and 13/06/2008 is shown in the plot below.

INTEGRAL FUEL MASS PER FIRING HISTORY

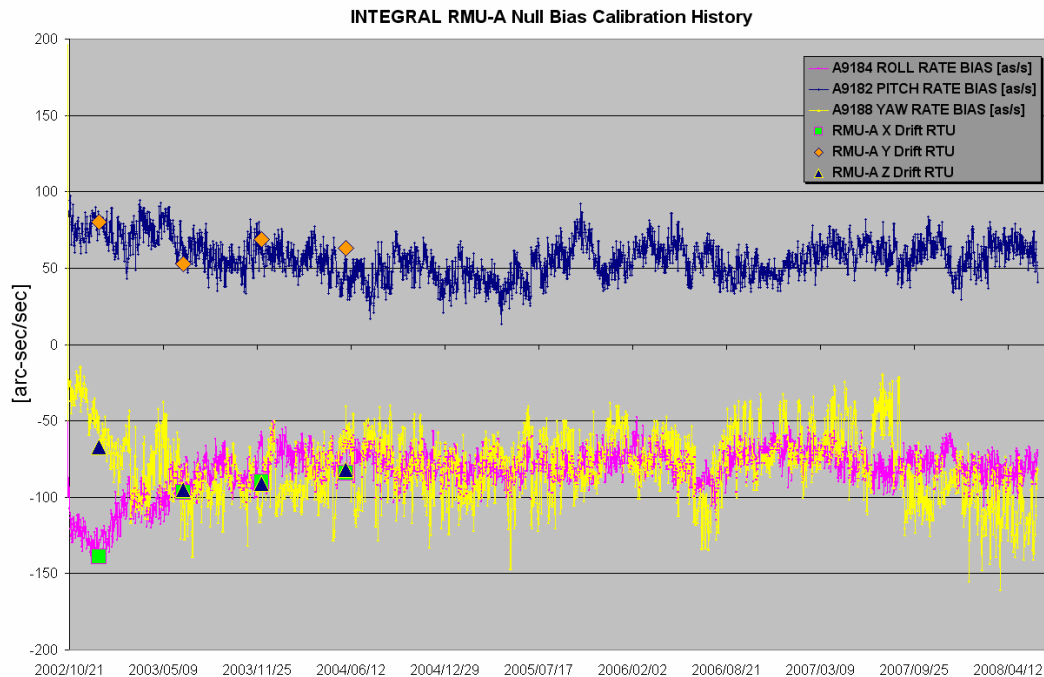


The RMU-A null bias calibration

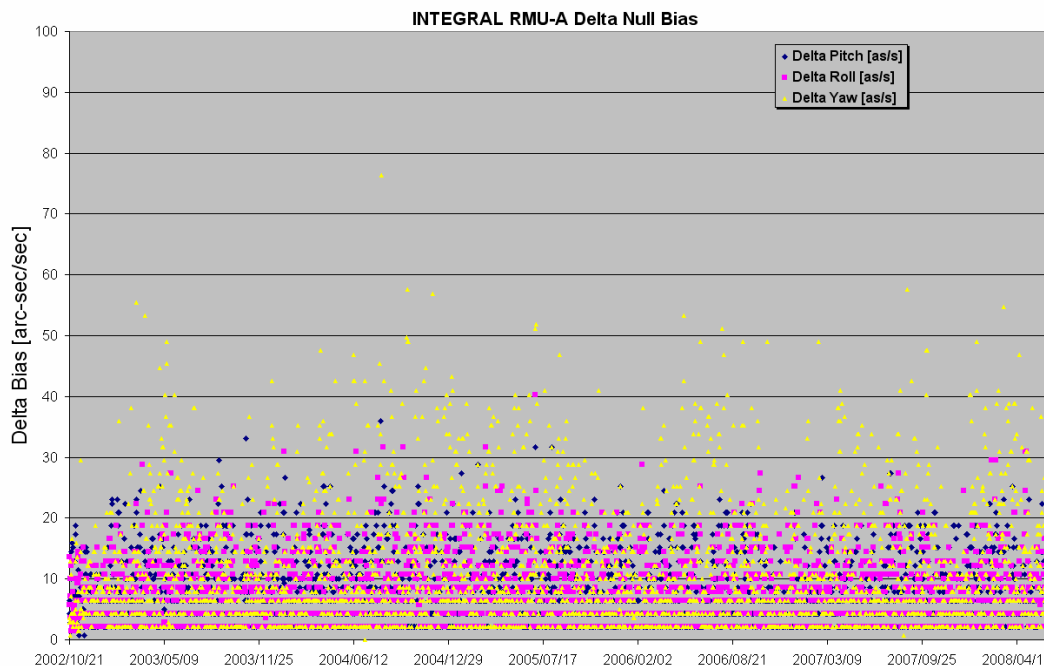
The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 13/06/2008 is reported in the plot below.

Problems have been reported during the last period on FDS when generating the drift update for the RMU-A Yaw channel: the limits set on FDS have been violated few times. The evolution of the drift on yaw channel is under constant monitoring but the

values are still well within the specs. At moment the current constraints (for drift update generation) on the FDS have been relaxed to cope with the current situation.



The RMU-A delta null bias calibration history, on pitch, roll and yaw channel over period between 01/11/2002 and 13/06/2008 is reported in the plot below.



07/06/2008 (Day of Year 159, Revolution 689-690)

Nothing to report.

08/06/2008 (Day of Year 160, Revolution 690)

Nothing to report.

09/06/2008 (Day of Year 161, Revolution 690)

Nothing to report.

10/06/2008 (Day of Year 162, Revolution 690-691)

Nothing to report.

11/06/2008 (Day of Year 163, Revolution 691)

Nothing to report.

12/06/2008 (Day of Year 164, Revolution 691)

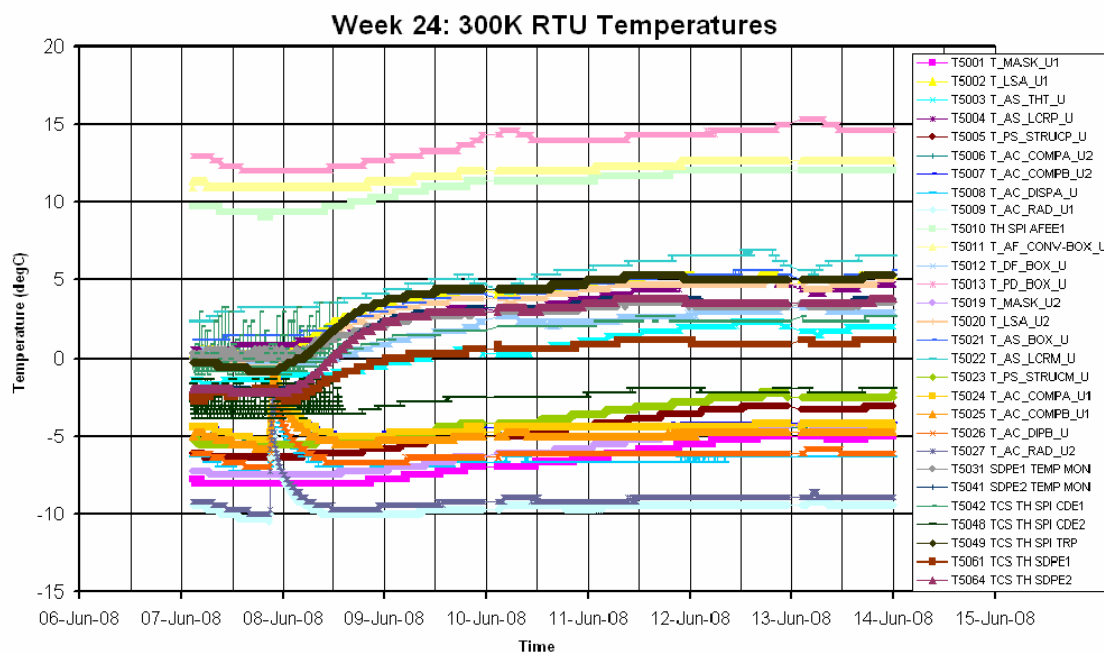
Nothing to report.

13/06/2008 (Day of Year 165, Revolution 691-692)

Nothing to report.

8.3.2 SPI Operations

Unit Temperatures: All the equipment temperatures are inside the operational limits. The following plot shows their evolution during the reporting period.

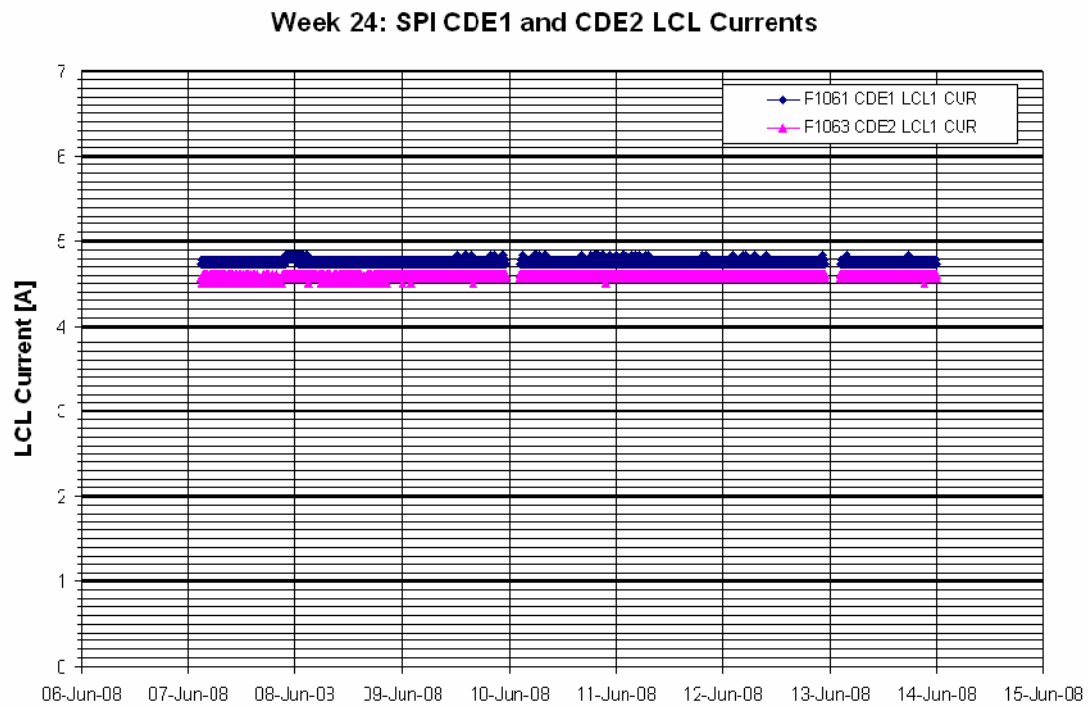


Stirling Compressors and Cryostat: The performance of the compressors is nominal. The cold plate temperature was maintained in the range 80K +/-1K.

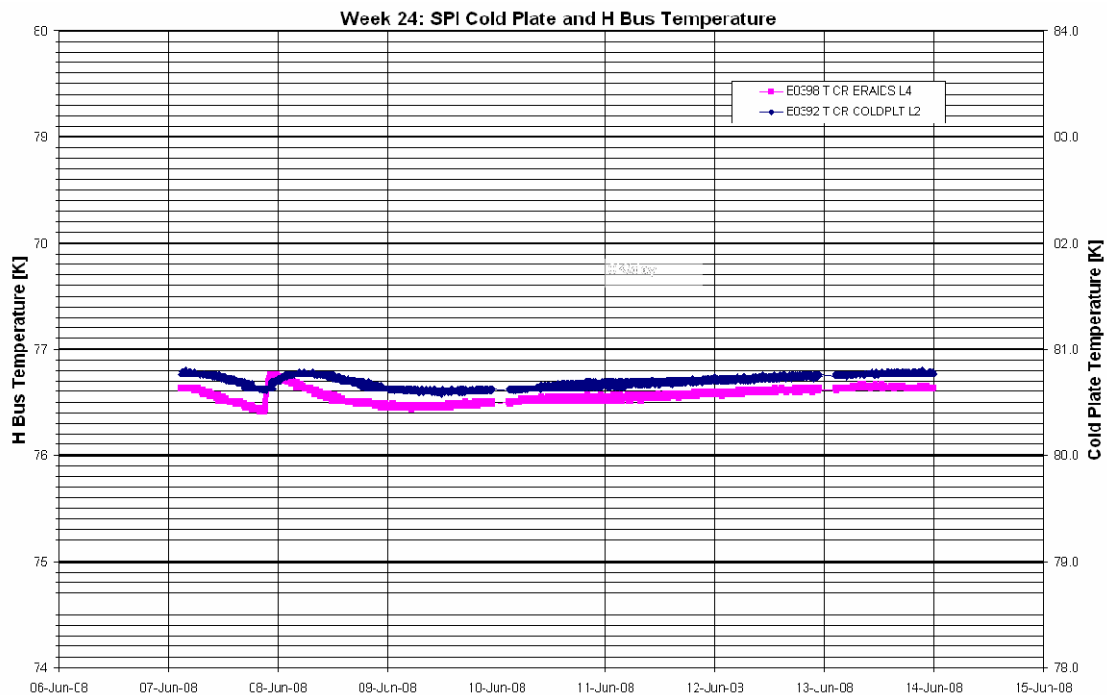
The stroke of all four compressors was set to 40 throughout the week. The average CDE LCL currents were as follows:

- CDE1 LCL Current = 4.77A
- CDE2 LCL Current = 4.57A

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



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

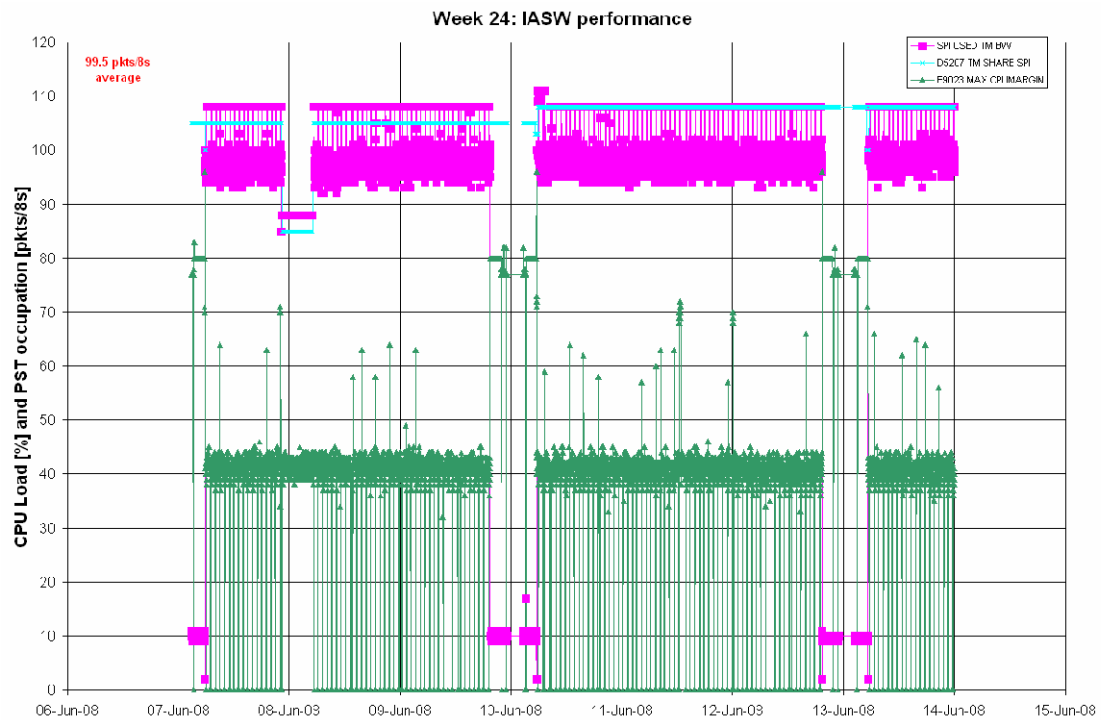


DPE & IASW: The DPE health and IASW performance is nominal.

The IASW version installed is v4.3.4 with SE compression only enabled and the spectra scaling factor set to 8/19 SE.

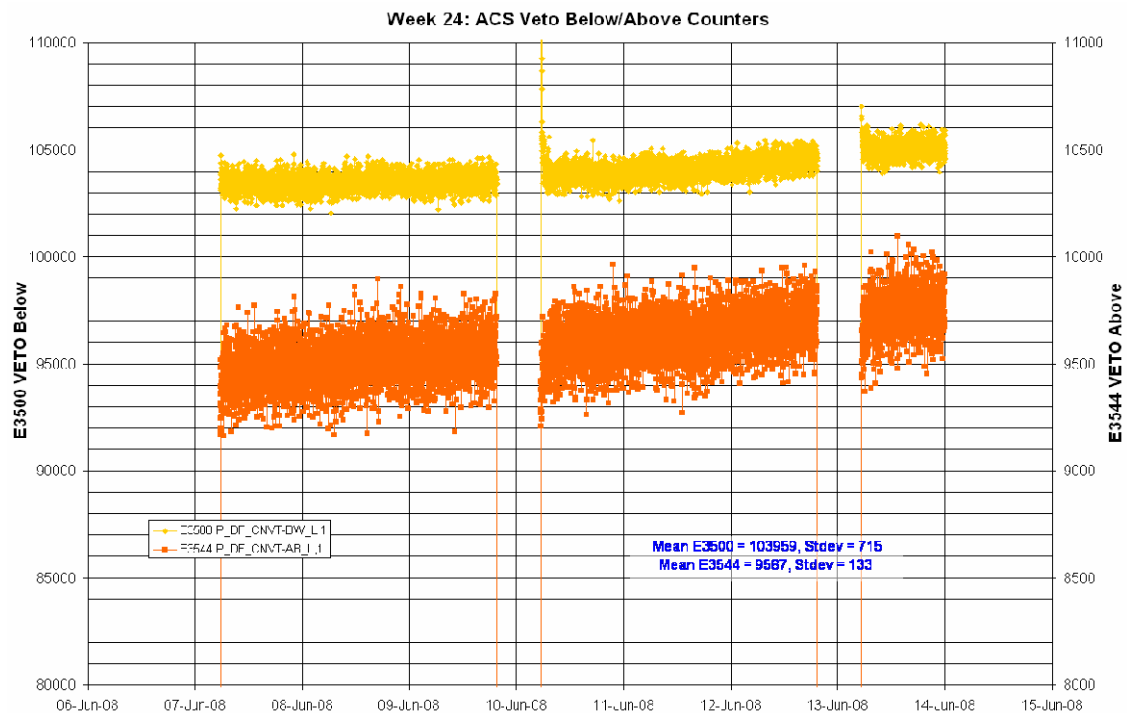
The average TM bandwidth occupation of SPI was 99.5 packets/cycle over the science window. The TM allocation in the science window was 108 packets/cycle except from 2008-06-07T22:19:05Z to 2008-06-08T05:07:01Z when the TM allocation was 88 packets/cycle due to an OMC Flat Field Calibration. This allocation is considering that the over-allocated PST with the additional 3 packets/cycle for SPI was being used, however the Broadcast Packet TM allocation was not updated until revolution 691. (N.B. The allocation set in the POS for revolution 691 was in fact incorrect, with a total of 111 packets/cycle being allocated to SPI, see AR INT-3003. This was noticed soon after radiation belt exit and the correct PST was loaded manually.)

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

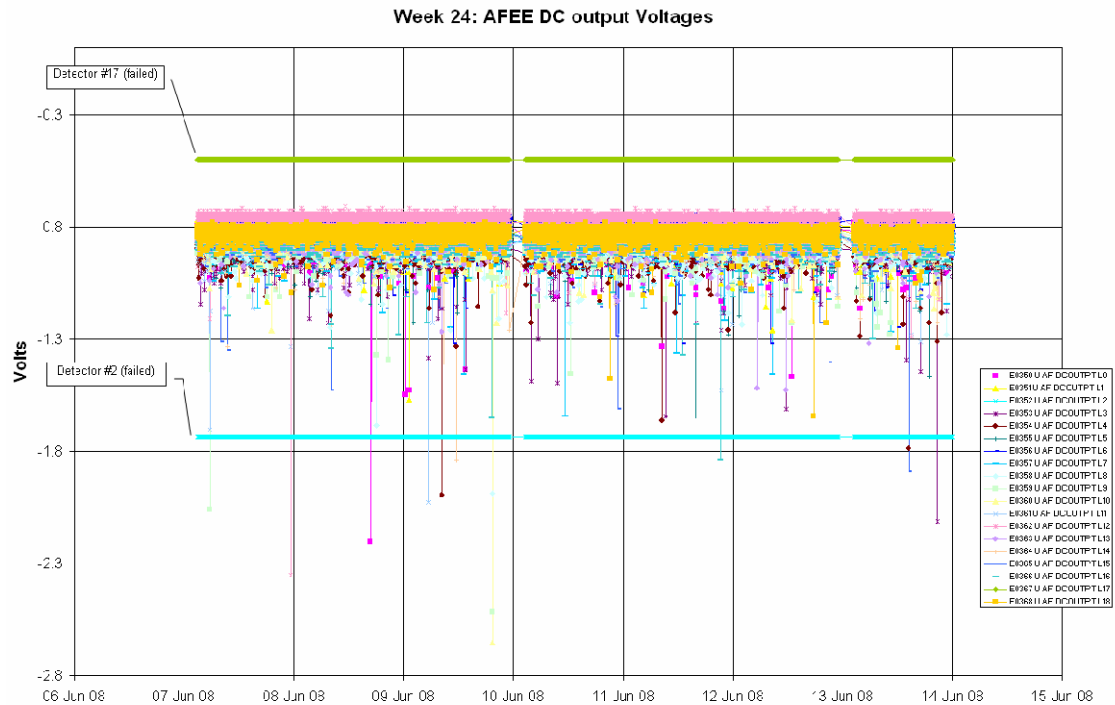


ACS: The performance of the ACS is nominal, except for FEE #81 which remains nominally switched off since the anomaly on 29/10/2006 (INT_SC-162) and FEE #57 which is nominally OFF due to the anomaly on 5/8/2003 (INT_SC-61).

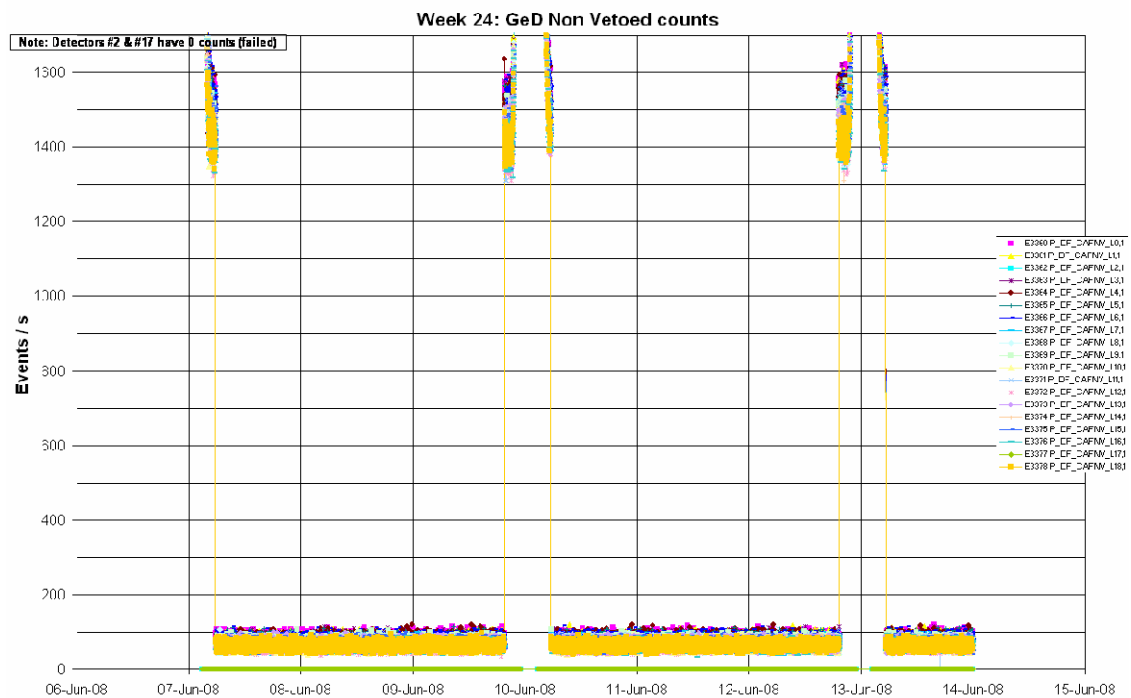
The following plot shows the ACS overall count rate evolution during the reporting period:

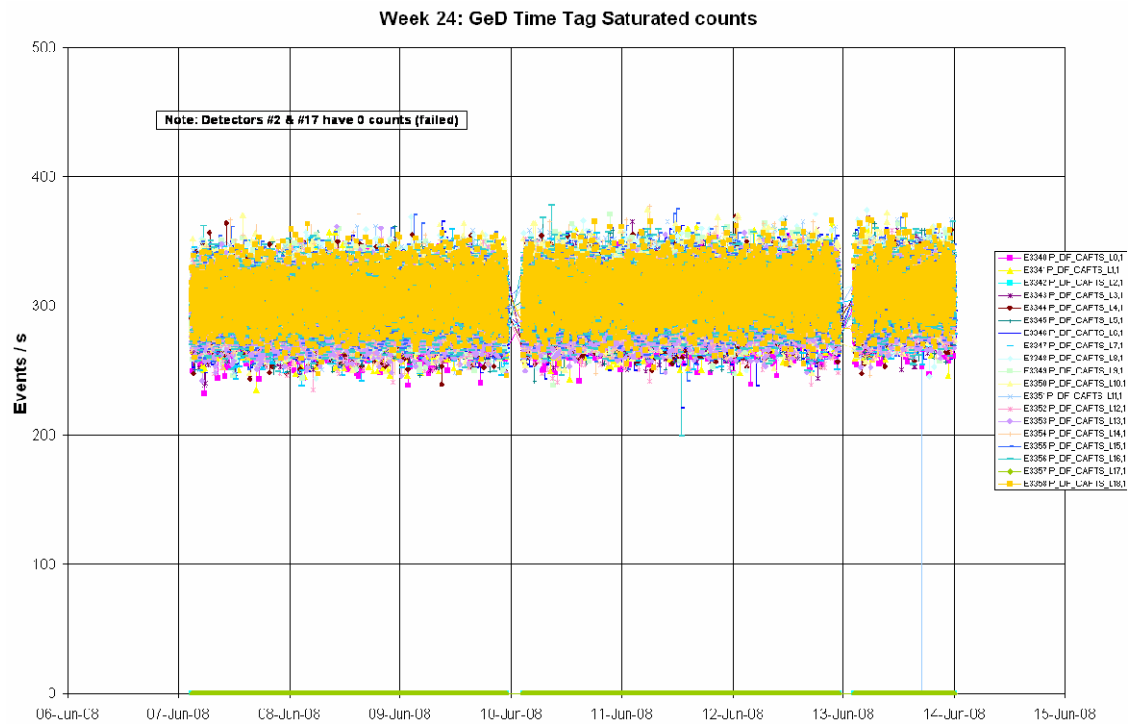
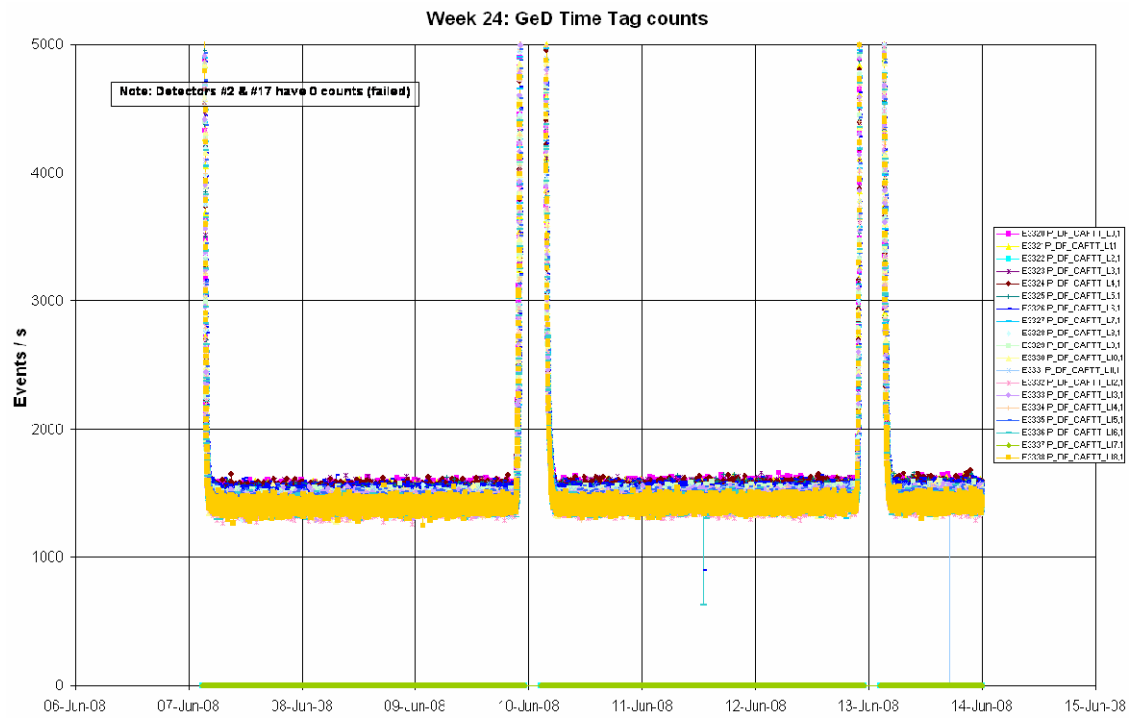


AFEE: The health of the AFEE is nominal. The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06/12/2003 and detector #17 is failed since 17/07/2004.

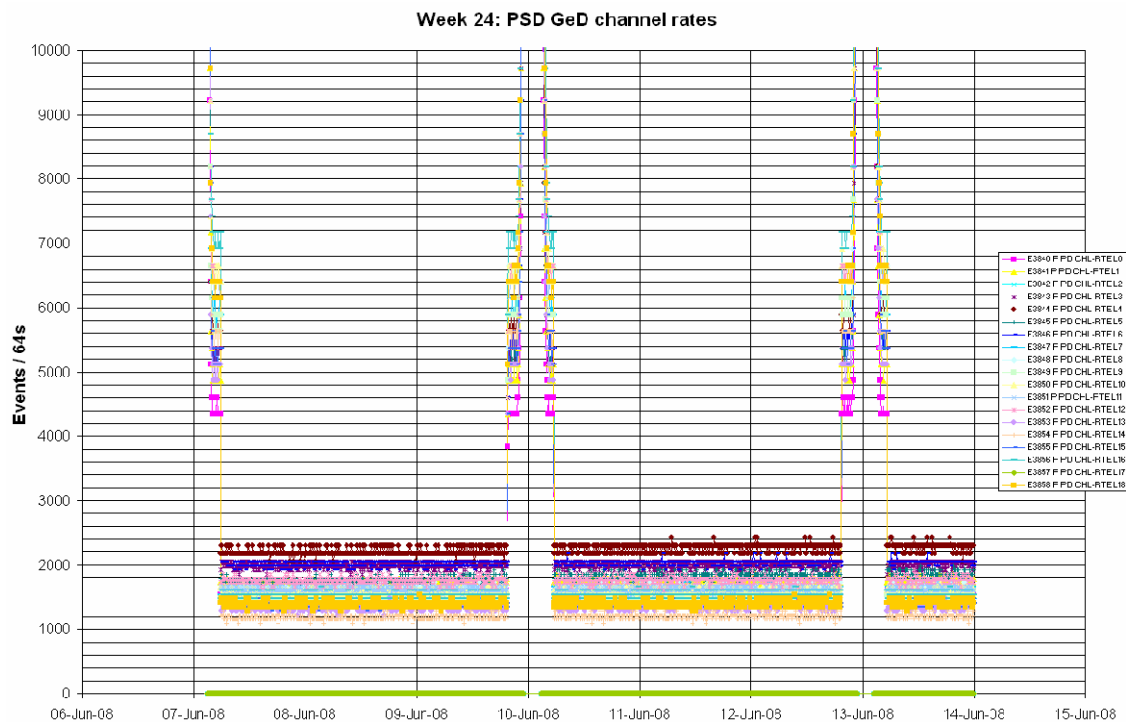


DFEE: The performance of the unit is nominal. The following plots show the Non Vetoes, Time Tag and Time Tag Saturated Event count rates during the reporting period.





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



Event Log:

The following non-nominal events occurred on SPI over the reporting period:

- On 2008-06-08 from 05:19:25Z to 05:20:27Z 17 occurrences of the following pair of OEMs were received:

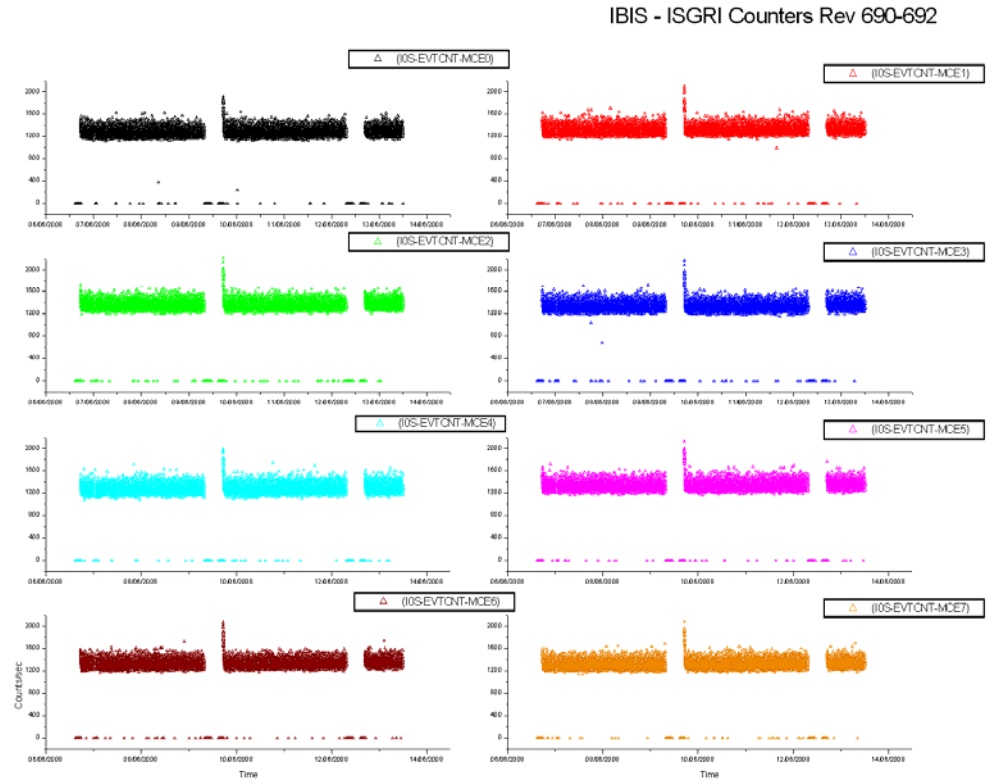
APID	1024	ID	224	EXCEPTION	SPI1	SW	ERROR
				FIX6			0
				E9079			1
				E9080			224
				E9777			3
				FIX16			0
APID	1024	ID	7	EXCEPTION	SPI1	CONSTRAINT	DPE CULPR
				E9073			IASW
				E9079			1
				E9080			7
				E9076			4097
				E9067			11637

This was about 10 minutes after the TM allocation reverted back to the nominal 108 packets/cycle following the reduced allocation during the OMC Flat Field Calibration. As they stopped of their own accord and no further alarms were received, no action was taken.

8.3.3 IBIS Operations

IBIS Event Counters Plots

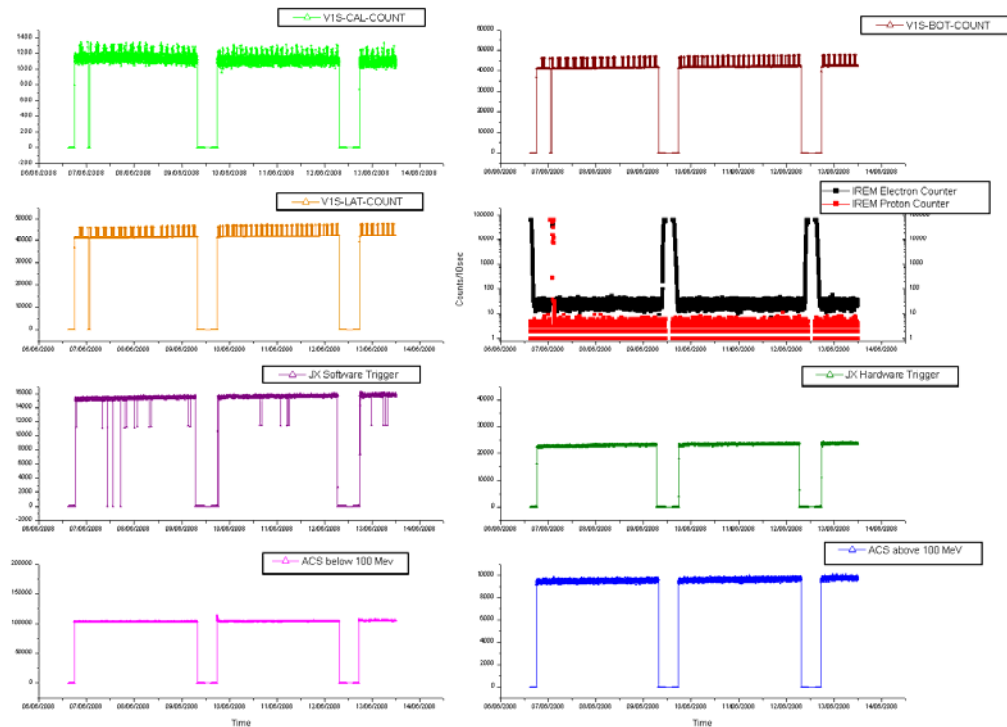
ISGRI Counters:



**sampling every 4 pkts (32 secs)

VETO vs Payload Counters:

IBIS-VETO vs Payloads Counters Rev 690-692

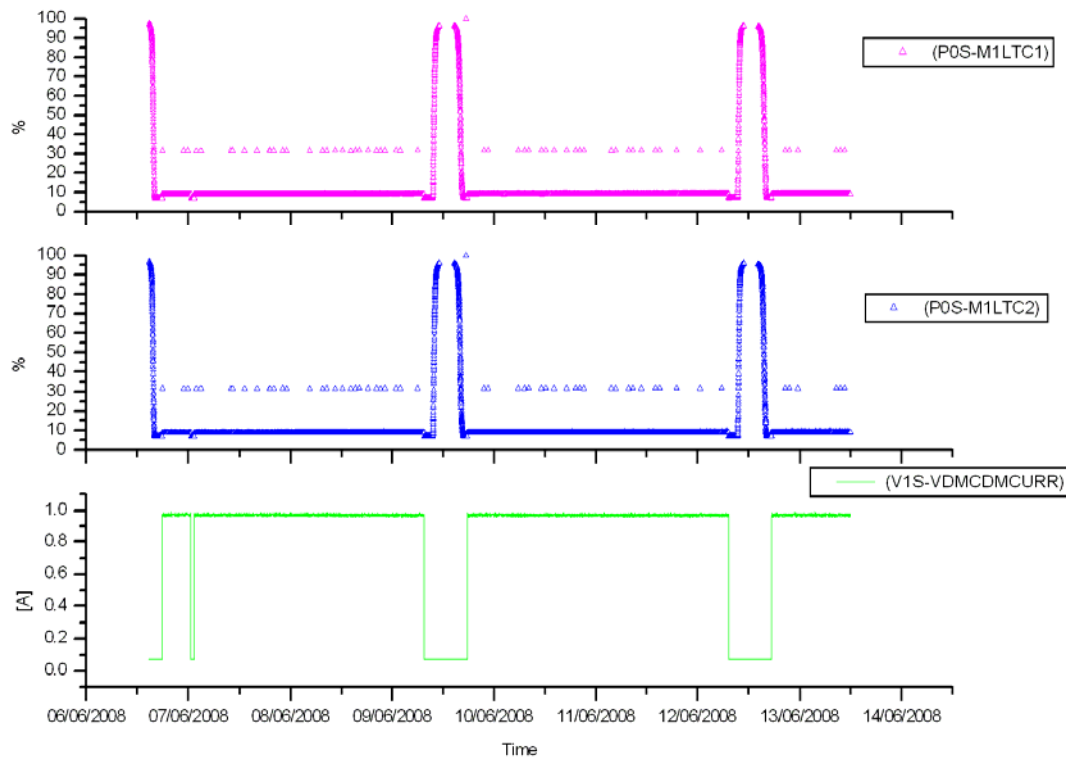


**with the exception of IREM counters (counts/10sec), all the plots are reporting counts/sec sampling every 5 pkts (40 sec)

The week was characterised by low radiation as reported by the payload.

VETO Current:

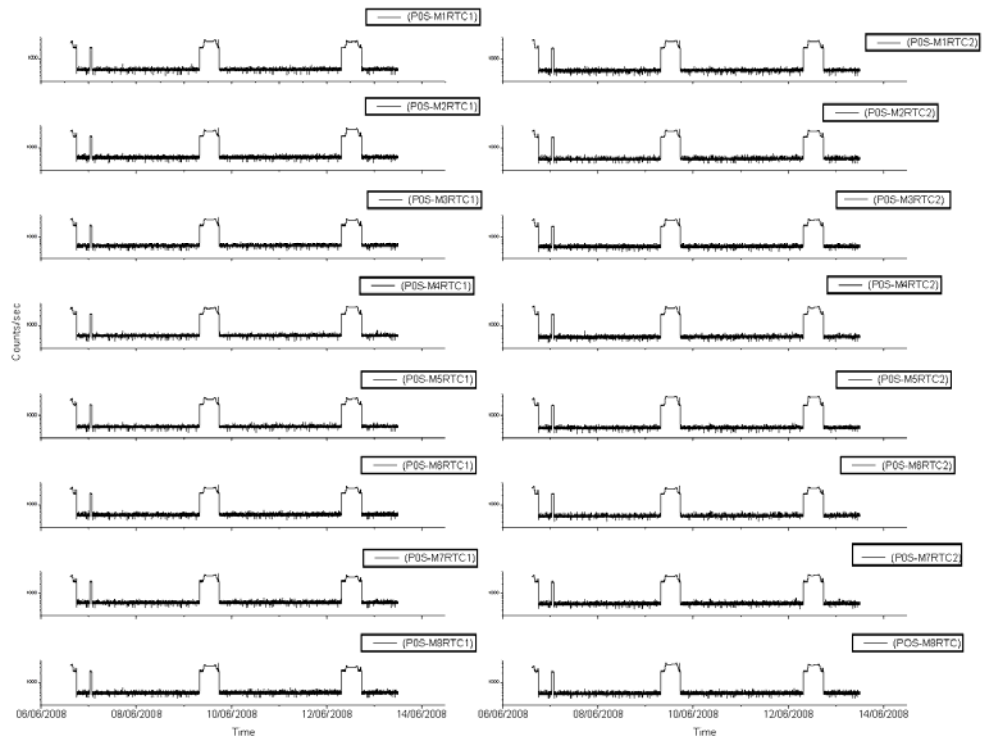
IBIS-VETO Current & PICsIT dead times Rev 690-692



**sampling every 4 pkts (32 secs)

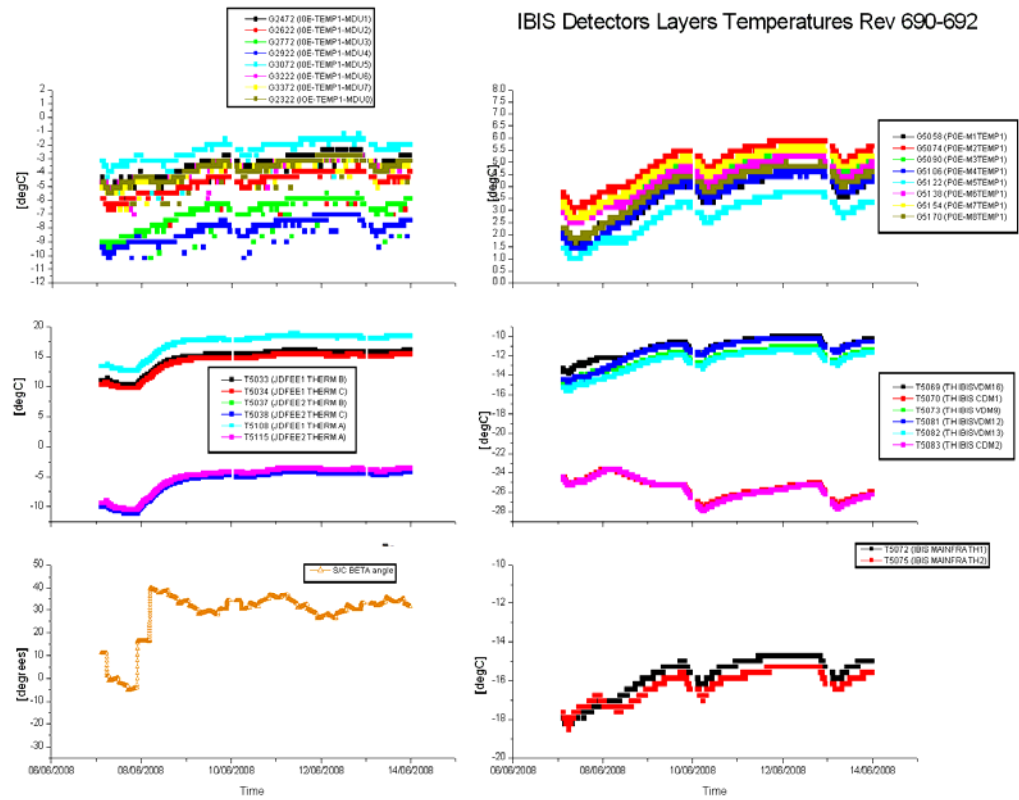
PICsIT Counters:

IBIS - PICsIT Counters Rev 690-692



**sampling every 4 pkts (32 secs)

IBIS Detectors Layers Temperatures:



**sampling every 8 pkts (64 secs)

IBIS daily report:

The usual Out Of Limits on TM parameter G8015 (S1E-A2_PMT_V), G5002 (POS-Mi_RTC1) and G5003 (POS-Mi_RTC2) families and G2000 family (IOE-OVFWPXADD-Mi) were received during the radiation belt passages.

2008-06-07 (DOY 159, Rev 689-690)

Due to an IREM SEU, IBIS transitioned autonomously to Safe configuration at 12:45:10Z. It was recovered as follows:

- At 13:22:31Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE
- At 13:33:14Z ED GESTAN02 uplinked with the planned observation parameters and commanding to IBIS from the Timeline re-enabled.

IBIS operations continued nominally.

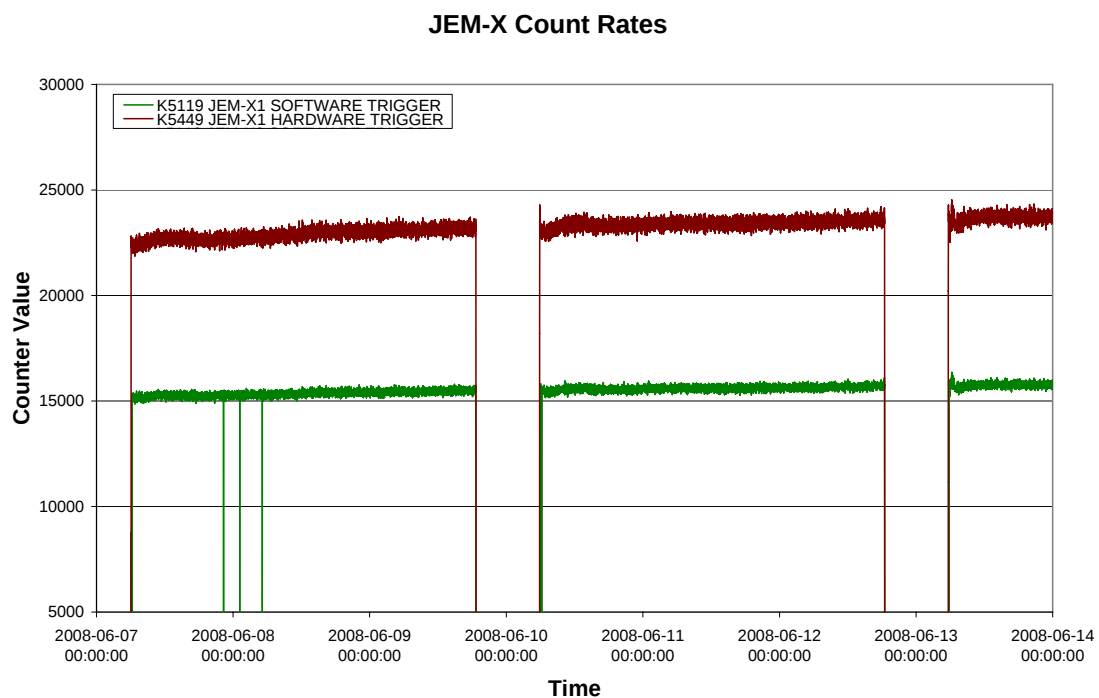
2008-06-08 (DOY 160, Rev 690) to 2008-06-13 (DOY 165, Rev 691-692)

IBIS operations executed nominally.

8.3.4 JEM-X Operations

JEM-X Count Rates

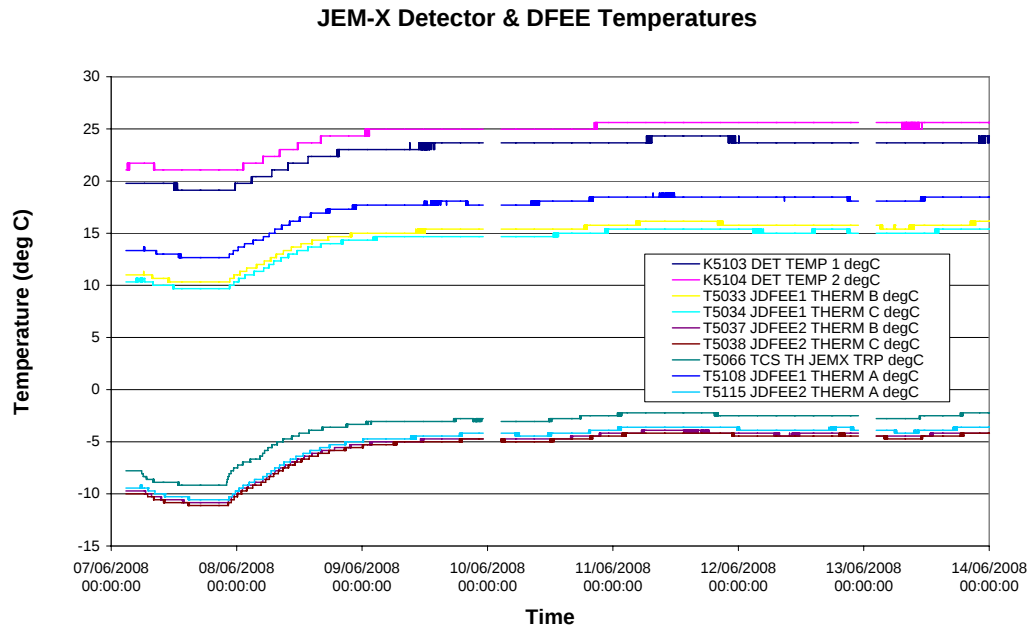
JEM-X count rates over the reporting period are displayed in the following graph¹.



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 Temperatures

JEM-X Detector and DFEE temperatures, along with the temperature on the detector bench between the two units, over the reporting period are displayed in the following graph².



JEM-X Daily Report

2008-06-07 (DoY 159, Rev 690)

At 06:14:55, TCs K0021 & KU0014 terminated with status unknown, and at 06:15:13, TC K0021 terminated with status unknown_failed. No action was taken, and there was no impact.

At 12:45:39 JEMX parameters K5315, K5316 & K5317 went Out-of-Limits due to an IREM SEU (#64). There was no impact as the reaction has been disabled.

2008-06-08 (DoY 160, Rev 690) to 2008-06-13 (DoY 165, Rev 692)

JEM-X1 operations executed nominally.

8.3.5 OMC Operations

2008-06-07 (DoY 159, Rev 690)

At 12:44:59, OMC was sent to SAFE mode by an IREM SEU (#64). A recovery was performed, and the instrument returned to Stand-by at 13:19:19. The impact was pointing 06900008 was cut short after 2688 from a planned 3479 seconds, and pointing 06900009 was lost.

² Data sampled (1 frame in 8)

2008-06-08 (DoY 160, Rev 690) to 2008-06-09 (DoY 161, Rev 690)

Nothing to report.

2008-06-10 (DoY 162, Rev 691)

Due to a problem with the mission planning, the PST allocation to SPI for revolution 691 was set three packets too high, this reduced the allocation for OMC to 2 packets per cycle. This was manually corrected in real-time at 08:09:00. The impact was pointing 06910002 and most of 06910003, will not have telemetred completely to ground.

2008-06-11 (DoY 163, Rev 691) to 2008-06-13 (DoY 165, Rev 692)

Nothing to report.

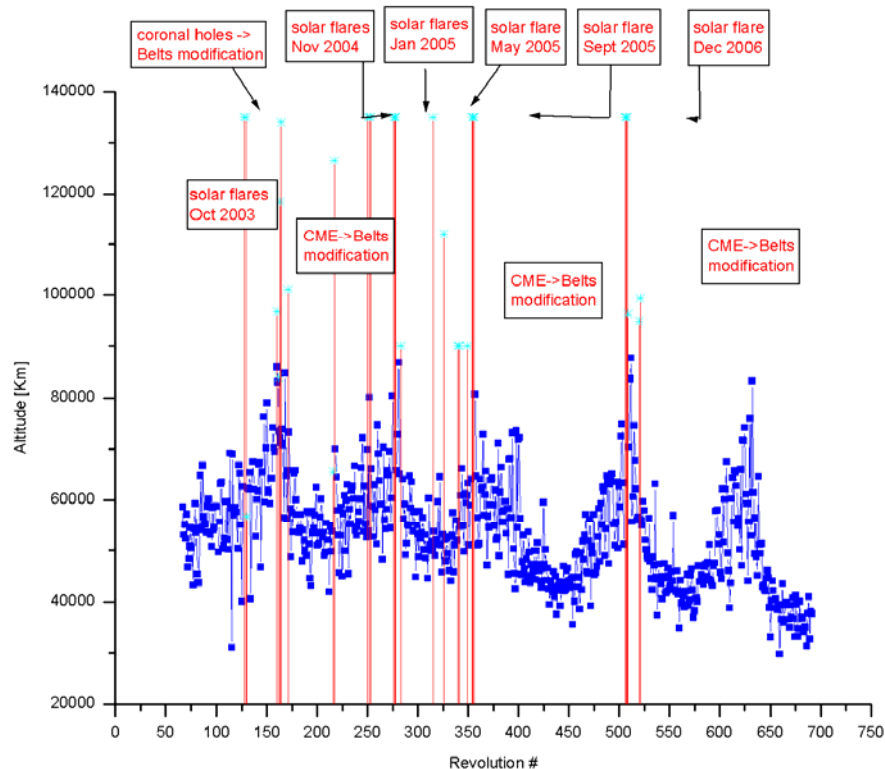
Throughout the reporting period the OMC lens temperature (T5106) dipped frequently briefly below the soft limit of -10 deg C. No action was taken.

On DoY 161 at 19:33:39 and DoY 164 at 19:21:55 OMC went to SAFE mode nominally, at the radiation belt entry time as set in the Broadcast Packet.

8.3.6 IREM Operations

Radiation Belts Entry

Evolution of Radiation Belt Entry 2003-2008



IREM daily report

DoY 2008.159 (07/06/2008):

At 12:44:59Z, a local reset of the IREM CSCI S/W (SEU #64) was observed. The status of the unit, before the local reset of the IREM CSCI S/W, was nominal, here is a summary:

- 1) The temperatures were nominal;
- 2) The LCL current was nominal;
- 3) The last HK before the anomaly showed HV, 5V and 6V voltages inside limits;
- 4) The anomaly occurred at 2008.159.12:44:59Z at 98261.6 km. The unit had performed an automatic transition to Standard Mode (ie. no block counter increasing, all the TM words= FFFF hex); just before the anomaly, radiation counters reported nominal values considering the position of the S/C along the orbit;
- 5) The recovery of the unit started at 12:45:01Z using procedure CRP_SYS_2570. The first dump of the status word after the anomaly reported a value of BCC0 HEX = 48320 DEC = 1011110011000000, i.e the Checksum Failure Flag ON. The unit was still reporting the status as if it was in Integral mode with counting ON and accumulation ON. This value of the status word is assumed to be an old one written by the S/W at the moment of the anomaly.
- 6) The patch was performed successfully with the correct re-starting of the S/W following procedure FCP_RM_0081. The operation was completed at 14:06Z.

The IREM automatic transition to Standard Mode affected the instruments by forcing them to automatically enter Safe configuration, except for SPI and JEM-X whose automatisms are disabled according to the PIs request. OMC was recovered at 13:19:19Z and IBIS at 13:33Z.

The cause of these S/W resets is apparently due to the unit's memory device that is sensitive to high energy radiation, as proved during test campaign on-ground.

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]
690	RAD_EXIT R 2008-06-07T05:42:58Z	07/06/2008 04:22:34	>>35126.1	07-Jun-2008 04:56:34	46448.01
690	RAD_ENTR R 2008-06-09T19:33:36Z	09/06/2008 21:34:10	38153.9	09-Jun-2008 21:19:17	40562.1
691	RAD_EXIT R 2008-06-10T05:29:49Z	10/06/2008 05:07:30	>>33454.1	10-Jun-2008 04:39:17	45605.94
691	RAD_ENTR R 2008-06-12T19:21:48Z	12/06/2008 21:26:02	37661.3	12-Jun-2008 21:09:17	40477.17
692	RAD_EXIT R 2008-06-13T05:17:30Z	13/06/2008 04:35:30	>>33471.1	13-Jun-2008 04:29:17	45743.54

Reference

High radiation

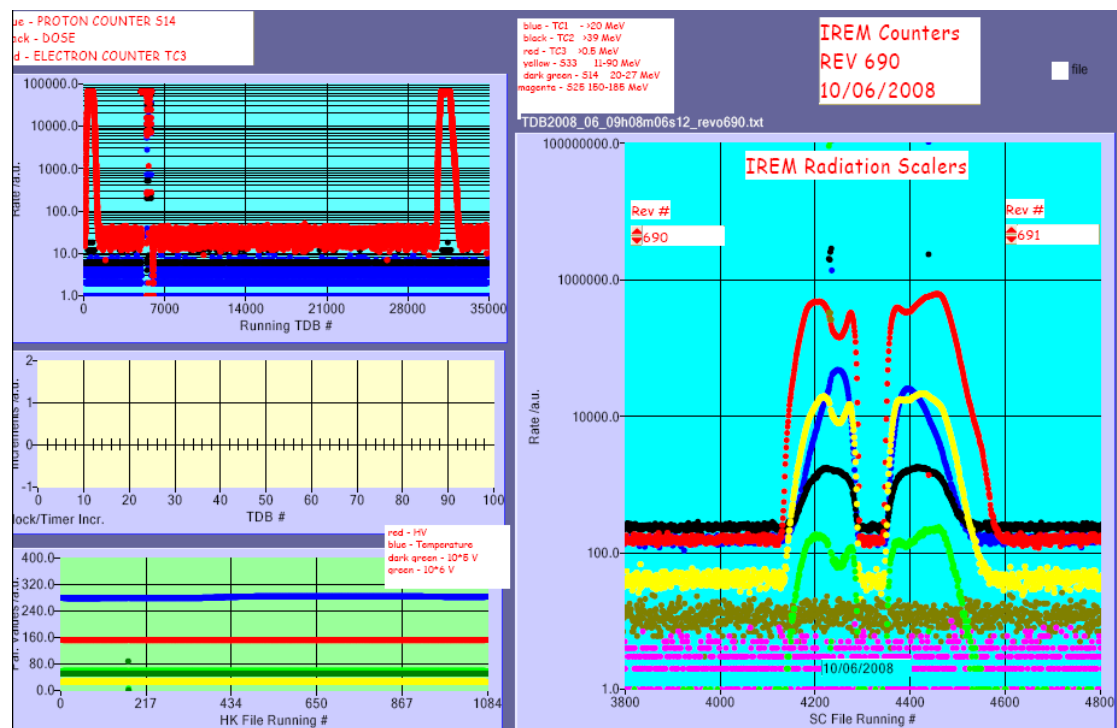
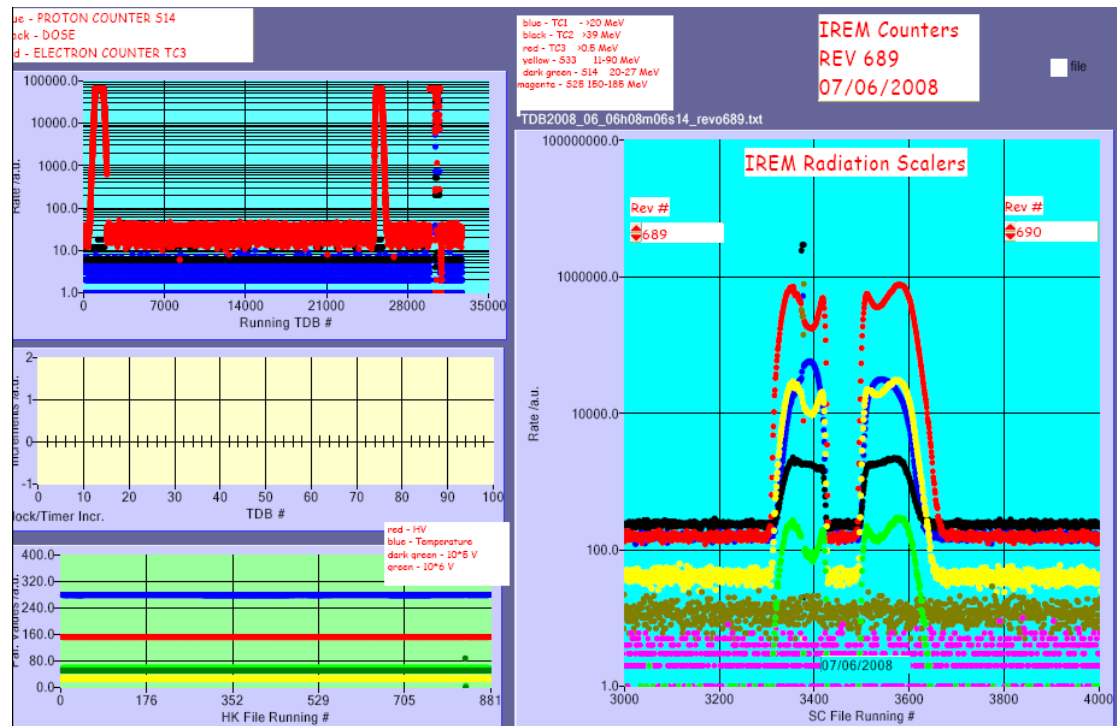
Very small error vs reference (less than 10 minutes)

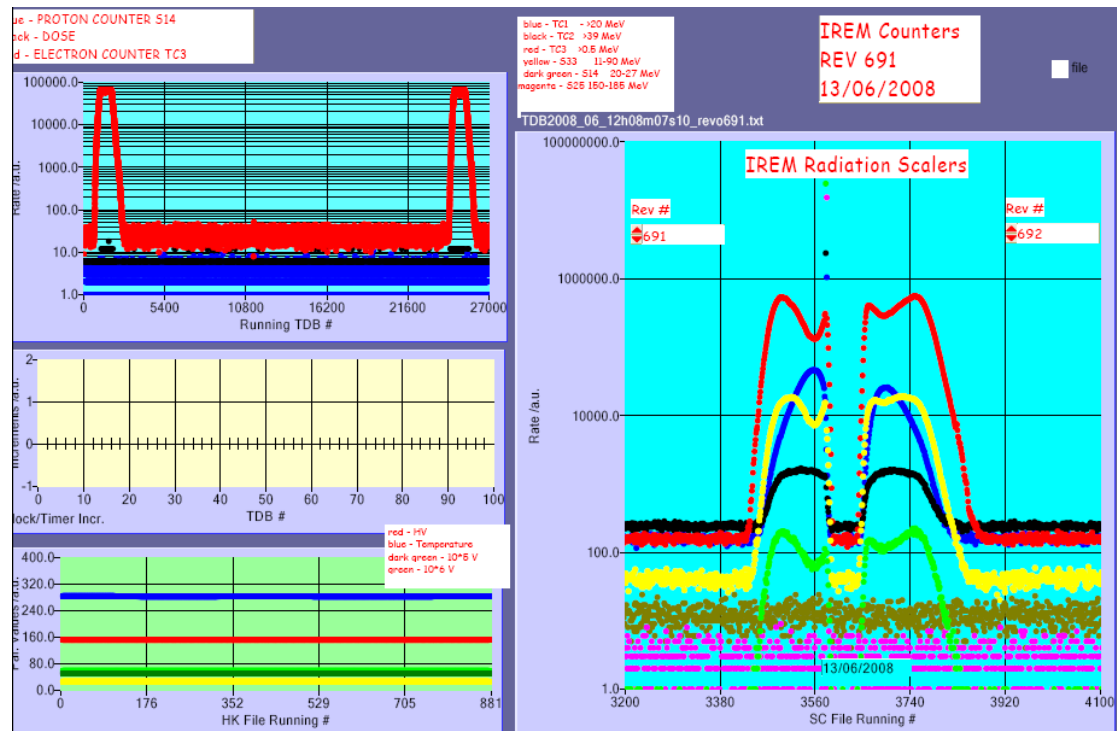
Small error vs reference (between 10 and 30 minutes)

Large error vs reference (more than 30 minutes)

* Rad belt entry time ignoring previous threshold crossings where a gap of more than 30 minutes is present.

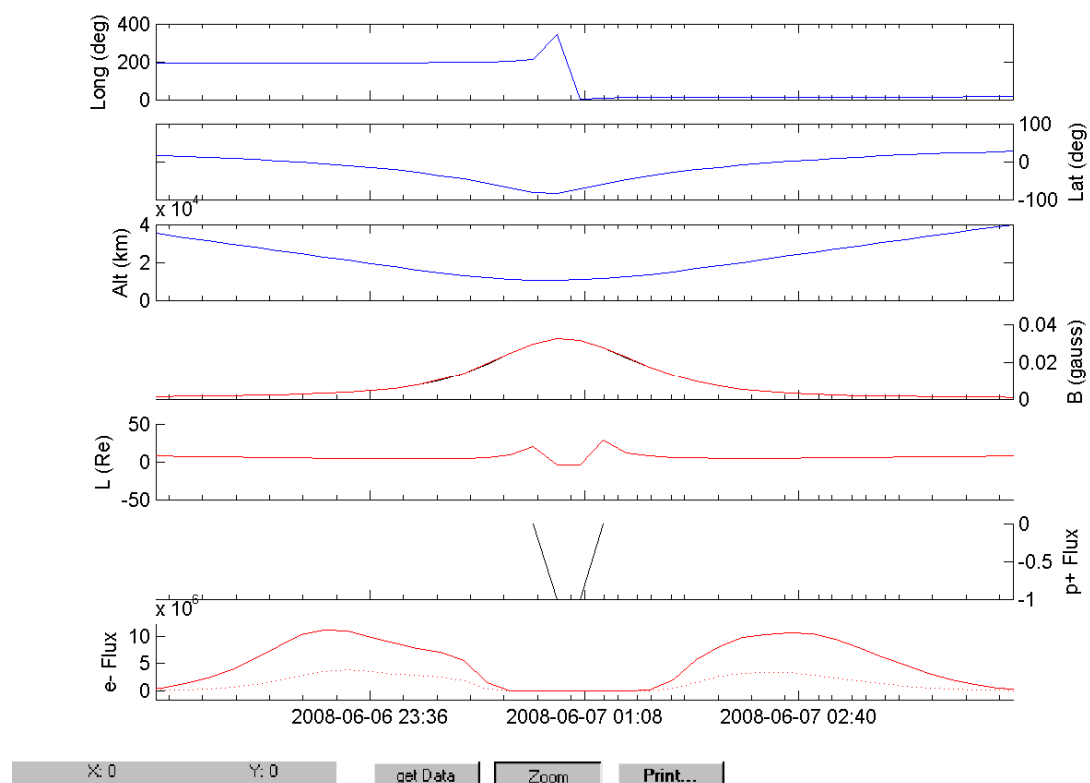
IREM radiation counters:



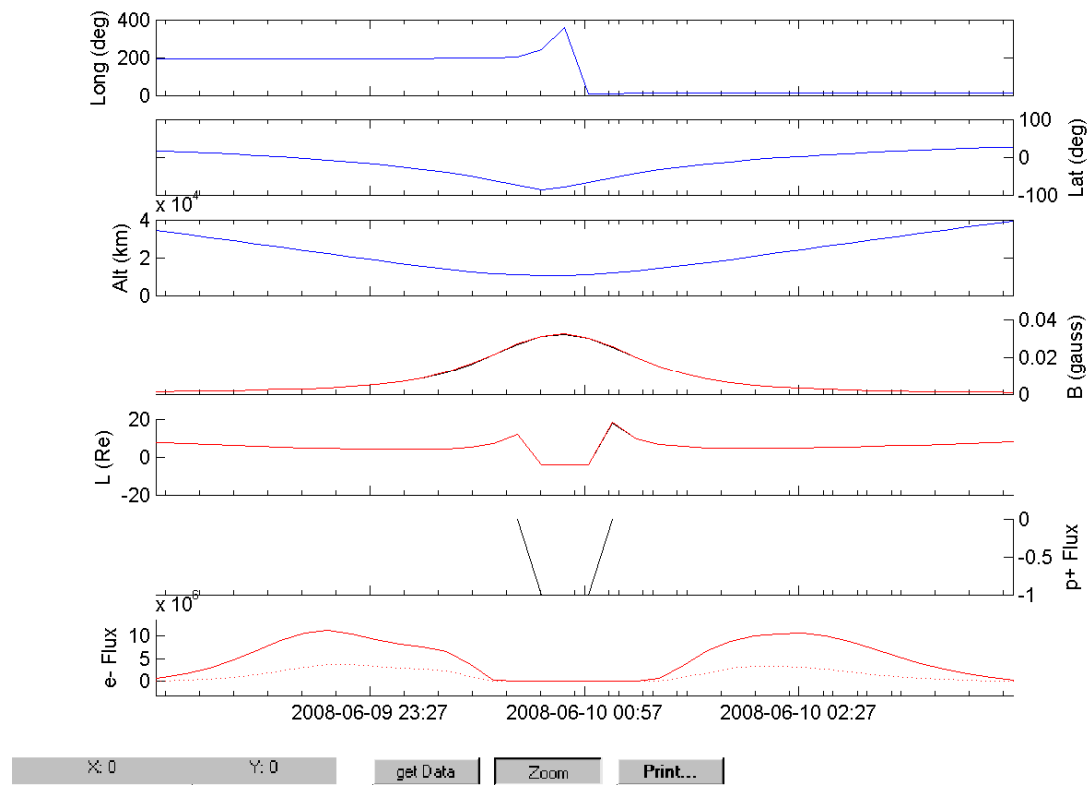


IREM Predicted Radiation Belt Passages

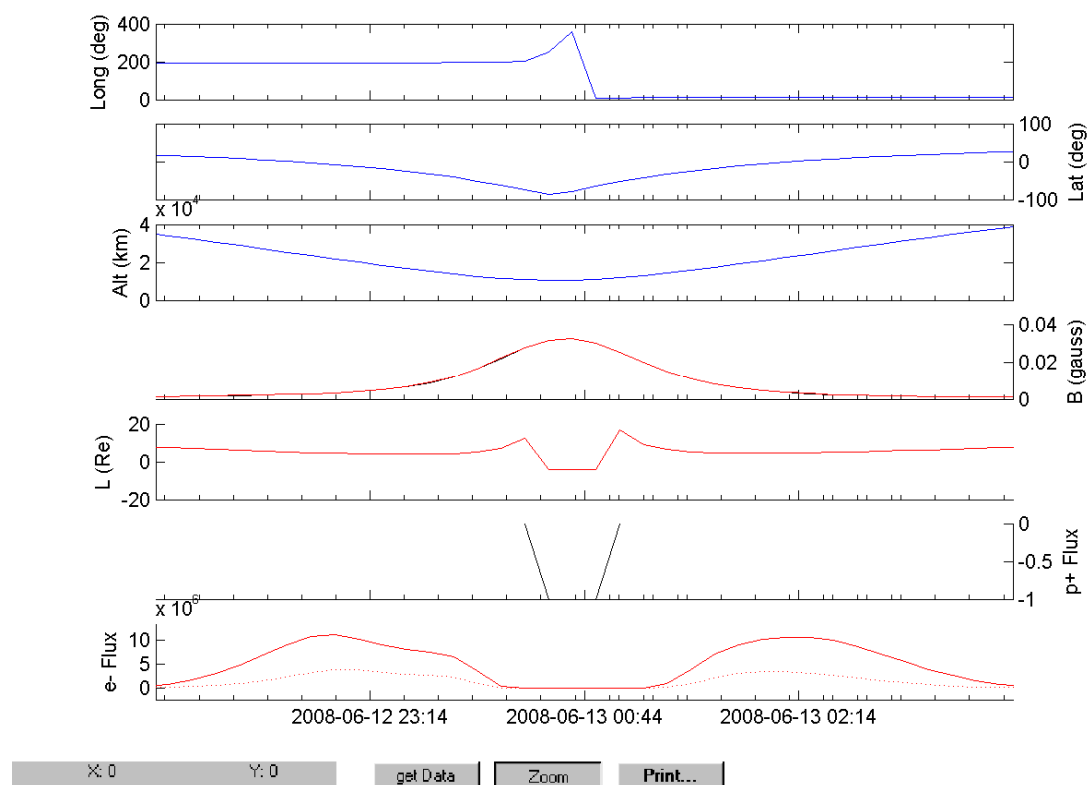
Rev 689



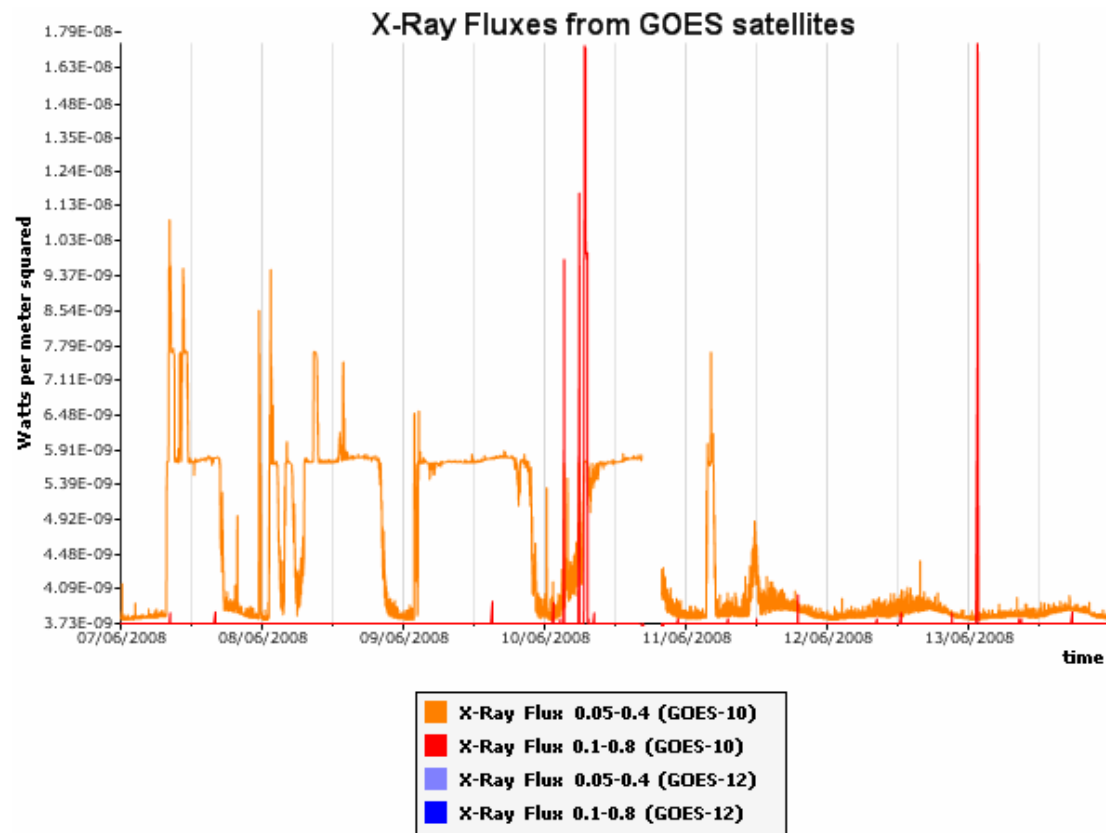
Rev 690



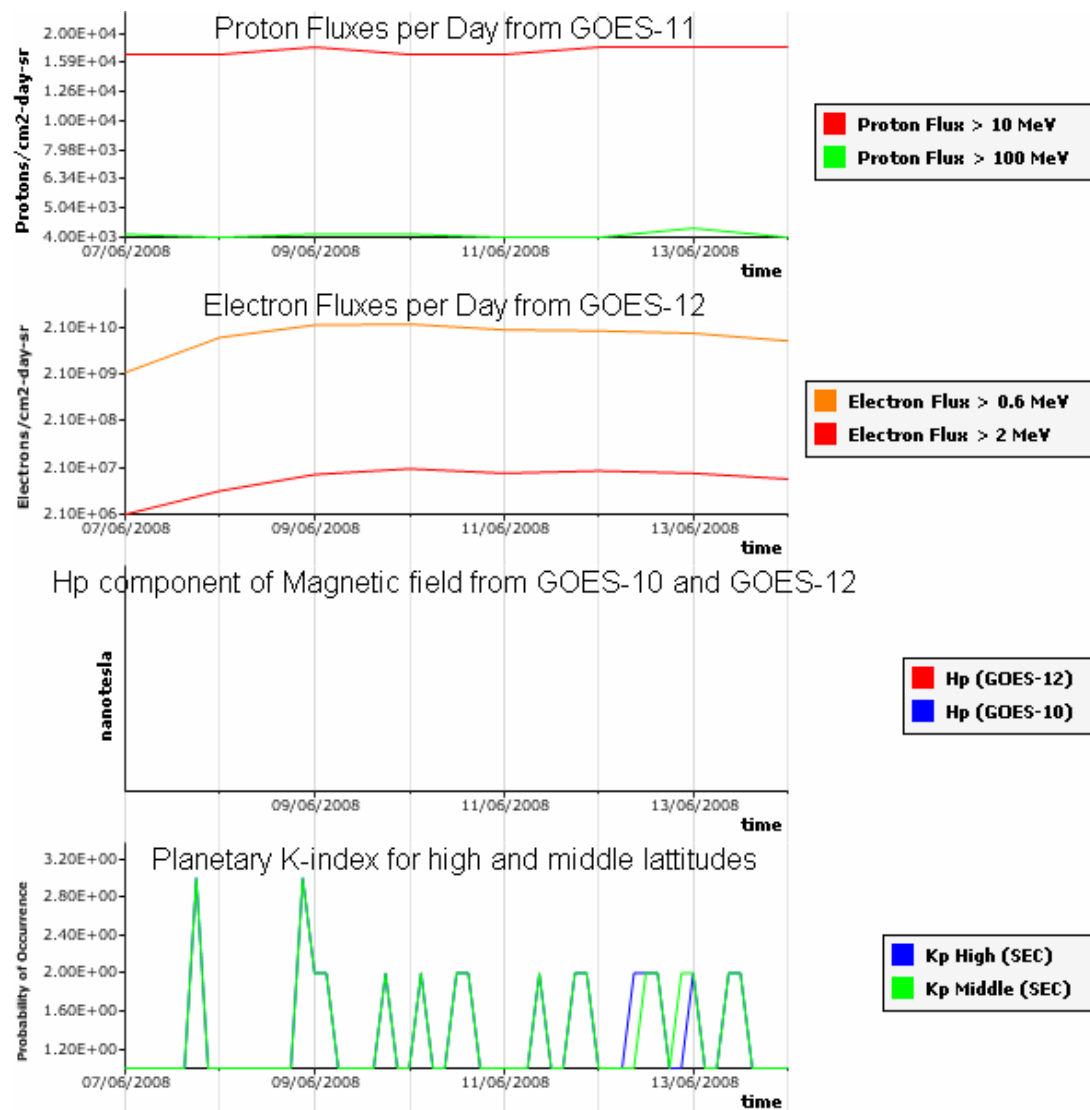
Rev 691



SEC-GOES Observed Particles Fluxes (using SEIS/RAT tool):



X-Ray fluxes start to be significant over 10^{-5} W/m^2 (corresponding to M-class flares). Above 10^{-4} W/m^2 , they correspond to strong X-class flares.



Proton and electron flux report low radiation background.

Hp component of the Geomagnetic Field is essentially parallel to the Earth's rotation axis. A drop near 0 nT is associated with a significant variation in the magnetic field. Kp index is based on ground magnetometers. Kp ≥ 5 features storm-level geomagnetic activity.