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

INTEGRAL
Mission Report

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

No. 312
Week 37

15.09.08

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 06.09.08 until 12.09.08 (both dates inclusive) and covers the revolutions 721 and 722.

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 Perseus Arm region (RA 04:46:58.46, DEC +45:14:46.4), two hexagonal dithers of the Galactic Bulge region (RA 17:45:36.00, DEC -28:56:00.0) and a raster dither of SS433 (RA 19:11:49.56, DEC +04:58:57.6).

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 06/09/2008 and 12/09/2008 was 0.0838 Kg. The remaining propellant is in the order of 138.5874 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.
Battery 2 reconditioning started on 2/9/2008.

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

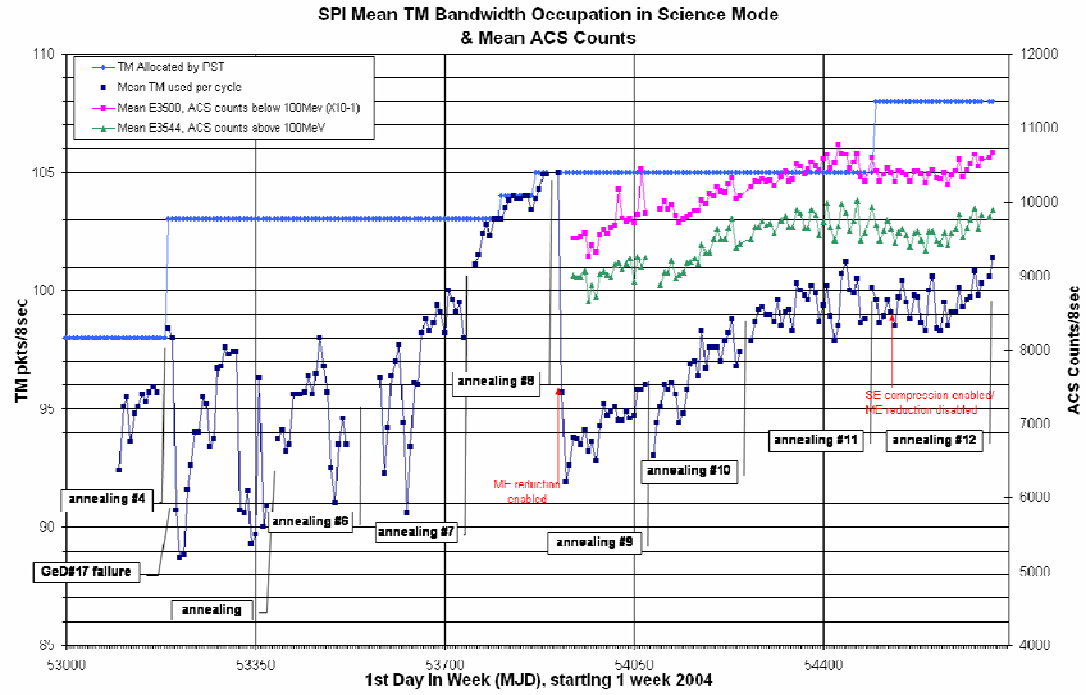
3.2.1 SPI

Following the 12th annealing, ended on 04/09/2008 at 23:50Z, the overall status of the gamma-ray spectrometer is nominal, except for detector #2 (failed since 06/12/2003) and detector #17 (failed since 17/07/2004). The energy resolution of the previously degraded GeD#12 has improved following this annealing and the bias of this detector is now set to 4kV as for the other detectors.

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

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 and the average telemetry occupation was 101.4 packets/cycle.

The following plot shows the evolution of the assigned and the average occupation of the SPI TM bandwidth along with the mean ACS count rate evolution (since July 2006). As can be seen, there is a strong correlation between the evolution of the background as measured by the ACS and the overall TM bandwidth usage.



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

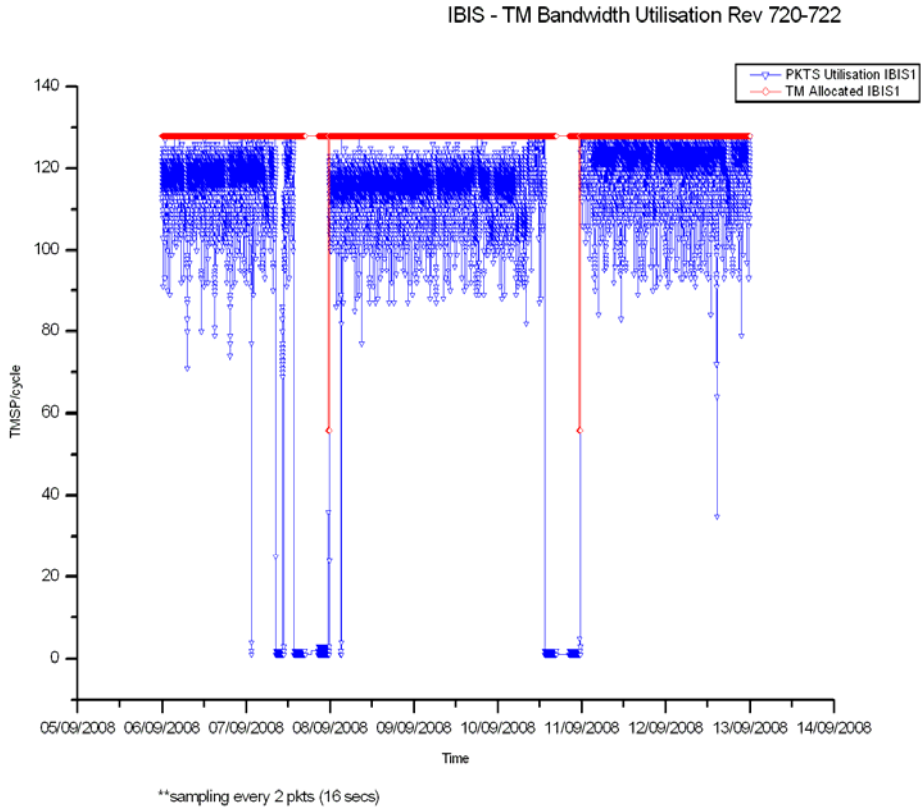
3.2.2 IBIS

The overall status of the unit is nominal.

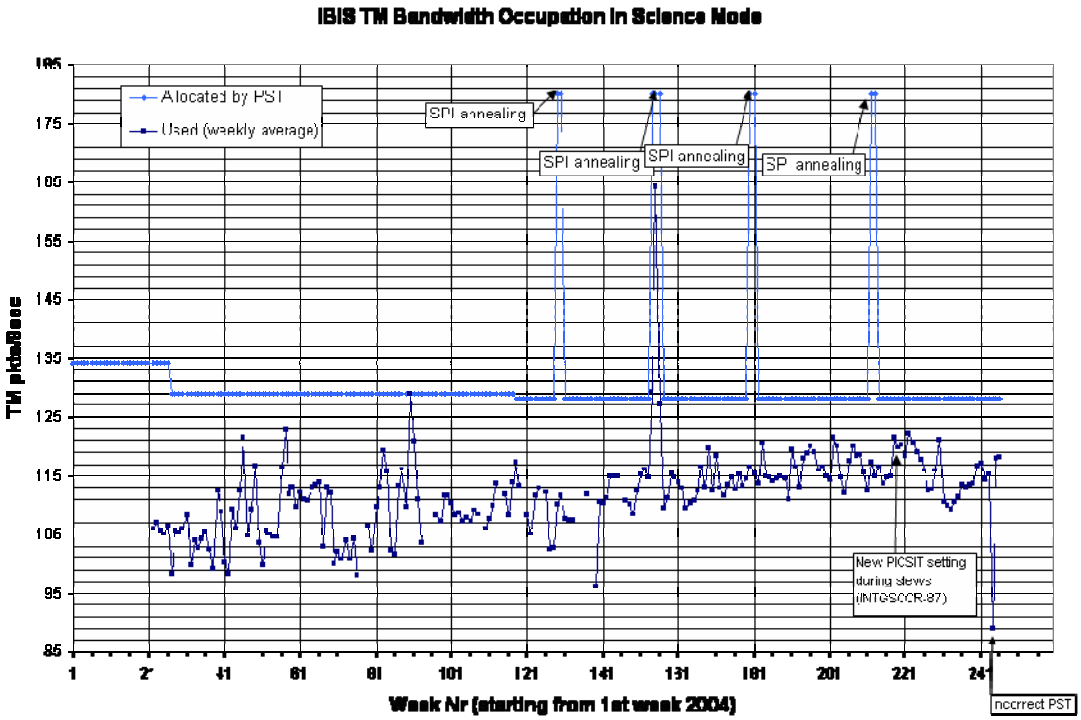
During the reporting period, the TM bandwidth statistics were as follows:

- PST allocation to IBIS above radiation belts: 128 packets/cycle
- IBIS mean bandwidth utilisation in science mode:118.14 packets/cycle (up 0.11 on previous week)
- Percentage of TM cycles in which full bandwidth was used: 7.86%

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



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.

During this reporting period, 227 of the 231 planned science pointings were executed nominally, 3 were lost, and one cut short by an IREM SEU.

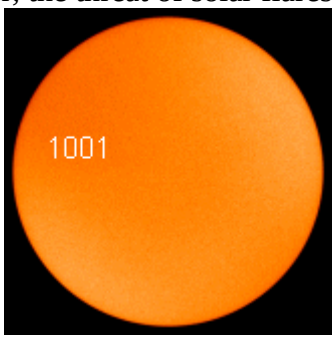
Note: Some more information concerning the OMC operations is provided in the Appendix.

3.2.5 IREM

The overall status of the unit is nominal.

Solar Activity

The observation period was characterised by low solar activity. A new small sun-spot emerged on the 12th September, the threat 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 good this week. One pointing was lost to ground problems. The overall performance was well above the 95% requirement.

4.1 Mission Operations Centre

The performance of the MOC was good this week. A command verifier crash caused the loss of a pointing.

4.2 Ground Stations & Network

The performance of the ground stations and Network was very good this week. There was one link drop reported from Redu, and one drop in the link to the isds, neither had any impact.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

A new PSF has been received for revolution 730.

Revolution 726 has been planned. Further planning is awaiting clarification of the upcoming Crab calibrations (727+728).

New TSFs have been received for revolutions 721 and 722.

2. Observation status

An ECS file for revolution 714 was received and processed.

3. ISOC Science Data Archive

Data has been transferred from ISDC up to revolution 715. Ingestion is ongoing.

4. ISOC system

ISOC system V19.4 has been released on Tuesday 9 Dec, including also the latest Flight Dynamics software and a tool for external users to query exposure map information.

5. Problems

The dwell times were set wrongly for some observations in the database. This is being fixed.

4.3.2 ISDC

Status of ISDC observation processing on 15/09/2008:

- Latest Standard Analysis completed: observation 05297000004 (Perseus OB2 Cloud, Revolutions 706-710) on 11/09/2008.

- Latest products archived: observation 05297000004 (Perseus OB2 Cloud, Revolutions 706-710) on 12/09/2008.

- Latest observation products sent to the observer: observation 05297000004 (Perseus OB2 Cloud, Revolutions 706-710) on 13/09/2008.

5 Special Events

6 Anomalies

The following problems were reported this week that impacted operations.

- On DoY 250, at 22:08, the imaging commands for OMC failed on-board acceptance, subsequently, the FD TPF updates failed to arrive. The impact was the loss of pointing 07200071.
- On DoY 251, at 08:31, an IREM SEU caused IBIS and OMC to go to Safe mode. A recovery was performed, and the instruments returned to science mode at 10:14. The impact was pointing 07200086 was cut short after 537 from a planned 2250 seconds, and pointings 07200087 and 07200088 were lost
- At 23:55, the Command Verifier crashed, which interrupted the KEHVAC01 ED. This had to be manually resent after restarting the crashed task. The impact was a 40 minute delay in the activation of JEMX-1.

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

AR id	Date Created	Subject	Segment	Status

AR id	Date Created	Subject	Segment	Status
INT-3025	2008-09-09	DSS-27 data gap (2mins) due to comms problem	NASA Station	Pending
INT_SC-235	2008-09-17	IREM Anomaly: Reset of IREM_CSCI S/W #66, 07/09/2008	Payload	Pending

7 Future Milestones

- The next eclipse season will begin on the 22nd September during revolution 725.
- The next crab calibration is due to start on the 25th September 2008, during revolution 727.

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 721

The observations in revolution 721 began with a raster dither of the Perseus Arm region (RA 04:46:58.46, DEC +45:14:46.4), lasting ~50.0 hours. This was followed by a dummy pointing at attitude (RA 22:00:00.00, DEC +70:00:00.0) for ~15 minutes. Finally a hexagonal dither of the Galactic Bulge region (RA 17:45:36.00, DEC -28:56:00.0), lasting ~3.5 hours was executed, until the end of the revolution.

Revolution 722

The observations in revolution 722 began with a hexagonal dither of the Galactic Bulge region (RA 17:45:36.00, DEC -28:56:00.0), lasting ~3.5 hours. They continued with a raster dither of SS433 (RA 19:11:49.56, DEC +04:58:57.6), lasting ~52.0 hours, until the end of the revolution.

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.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

```
2008-08-25T07:36:04.000Z     138.8999    F   Automatic TM processing.
2008-08-26T22:07:44.000Z     138.8864    F   Automatic TM processing.
2008-08-28T07:26:53.000Z     138.8669    F   Automatic TM processing.
2008-08-29T21:55:53.000Z     138.8519    F   Automatic TM processing.
2008-08-30T04:17:37.000Z     138.8274    F   Automatic TM processing.
2008-09-01T07:47:59.000Z     138.7863    F   Automatic TM processing.
2008-09-01T21:41:44.000Z     138.7720    F   Automatic TM processing.
2008-09-02T04:02:57.000Z     138.7597    F   Automatic TM processing.
2008-09-03T05:41:32.000Z     138.7258    F   Automatic TM processing.
2008-09-04T21:28:32.000Z     138.7128    F   Automatic TM processing.
2008-09-05T03:51:44.000Z     138.6712    F   Automatic TM processing.
2008-09-07T21:18:31.000Z     138.6576    F   Automatic TM processing.
2008-09-09T06:51:31.000Z     138.6108    F   Automatic TM processing.
2008-09-10T21:08:31.000Z     138.6016    F   Automatic TM processing.
2008-09-12T06:38:11.000Z     138.5874    F   Automatic TM processing.

This report was generated  Fri Sep 12 08:00:21 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, 06/09/2008 – 12/09/2008

The AOCS operations were executed from the Automatic Timeline.

During this period, 125 Open Loop Slews, 116 Closed Loop Slews and 4 Momentum Biases were executed (as reported by ACC).

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

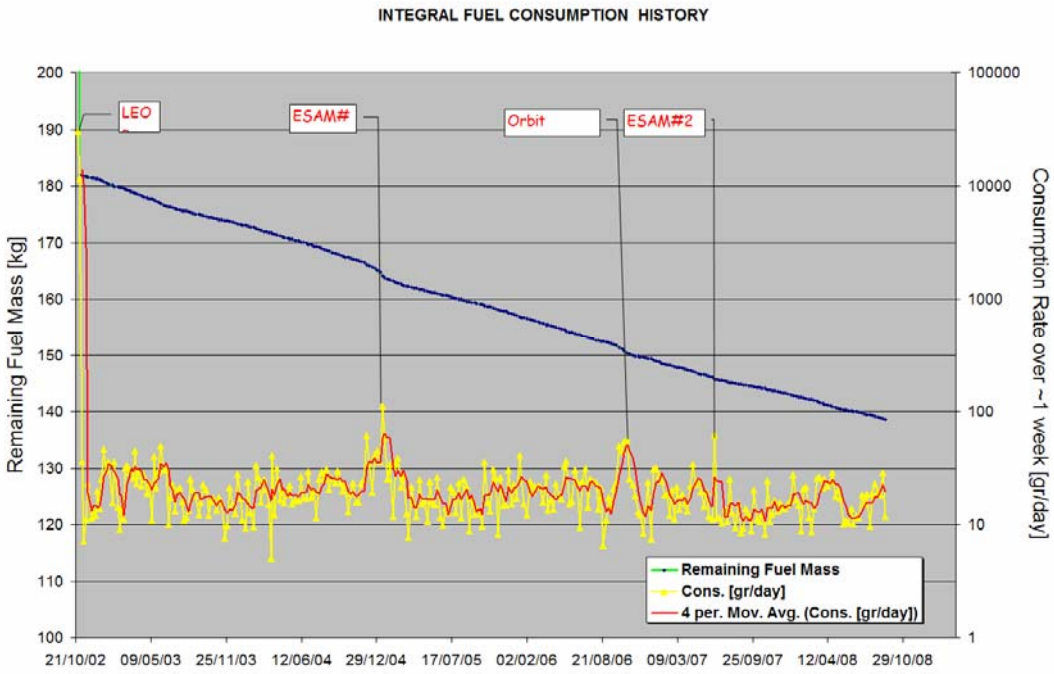
The OTF was not reached during PIDs 07200071-07210065-07220041.

Orbit Control

No update

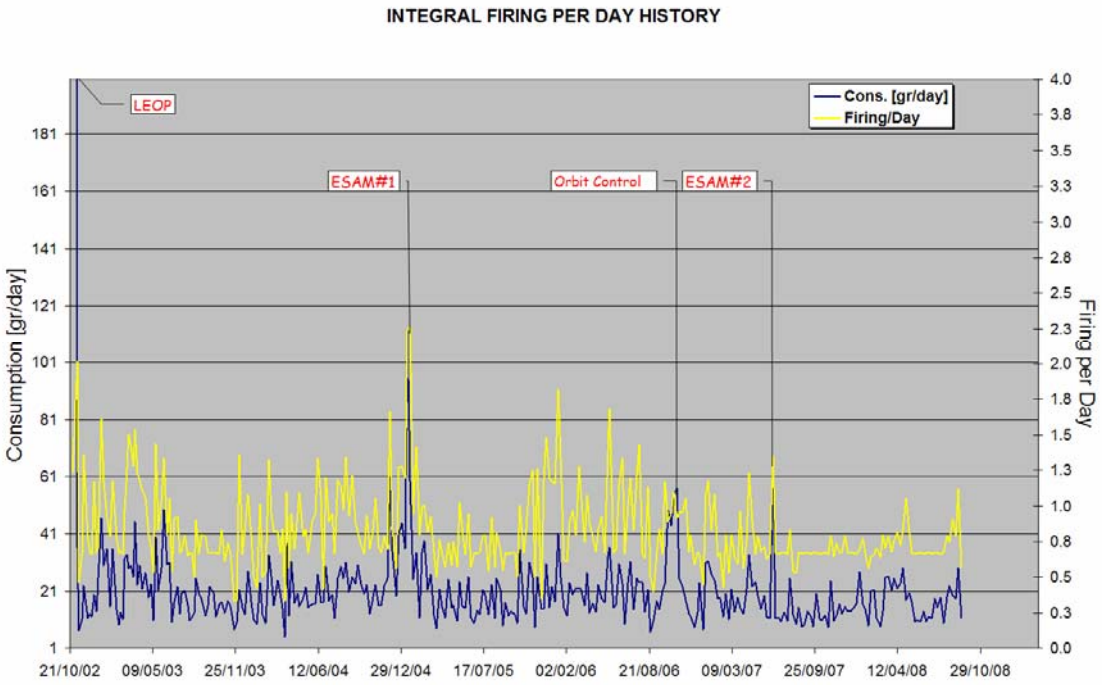
Fuel consumption

The fuel consumption (total, grams per day) over the period between 01/11/2002 and 12/09/2008 is reported in the plot below.



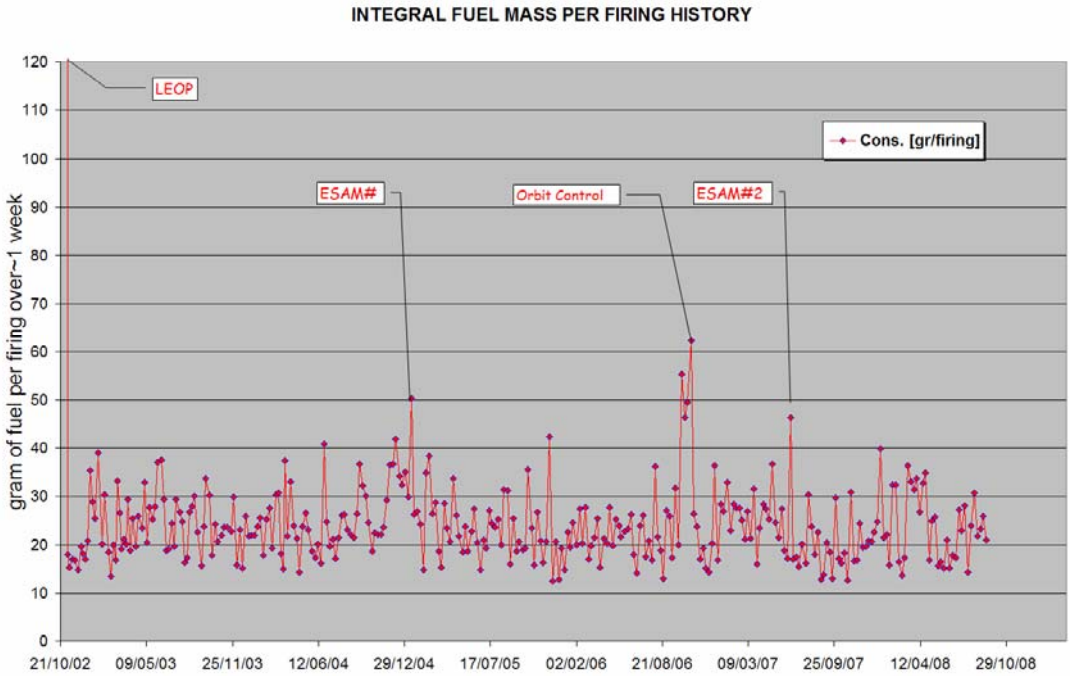
The above plot considers the ESAM fuel consumption spread over period of ~1 week.

The firing per day over the period between 01/11/2002 and 12/09/2008 is reported in the plot below.



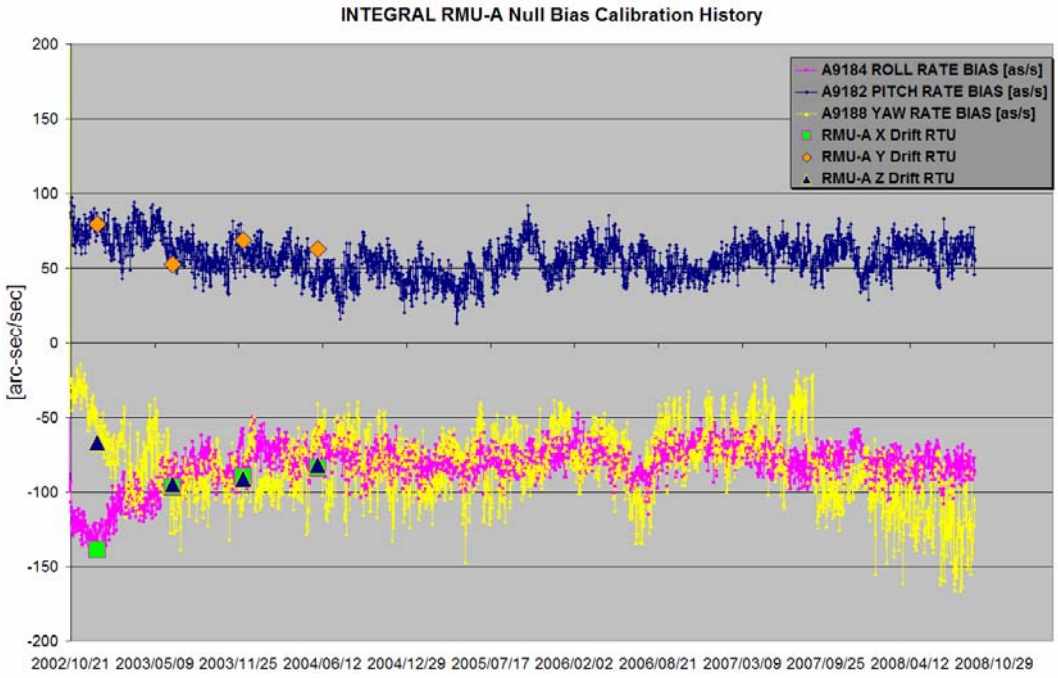
The above plot considers the ESAM fuel consumption spread over period of ~1 week.

The fuel per firing over the period between 01/11/2002 and 12/09/2008 is shown in the plot below.

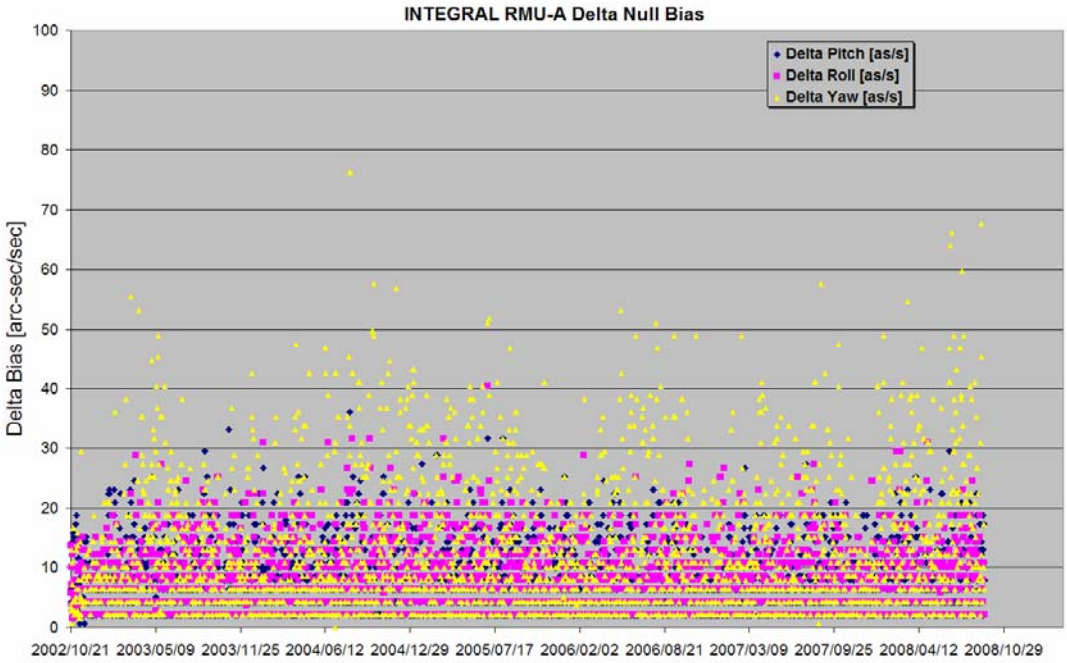


The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 12/09/2008 is reported in the plot below.
The evolution of the drift on yaw channel is under constant monitoring but the values are still well within the specs. 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 12/09/2008 is reported in the plot below.



06/08/2008 (Day of Year 250, Revolution 720)

IMCS CMD verification problem: at 22:18:00z due to a problem on the IMCS-A the TC verification failed and the TC service terminated. This caused the sequence for the STR mapping, after the end of slew execution, to fail release.

After recycling the TC service from CLTU to packet mode and back, the TC status reported a correct initialisation.

A manual mapping was performed and the next slew ID 07200072 in TL was manually updated in TL.

No impact on TL.
The pointing for PID 07200071 was correctly performed by the AOCS but the OTF was not reached for the payloads due to the missed release of the BCPKT from TL.

07/08/2008 (Day of Year 251, Revolution 720-721)

IMCS CMD Verifier task problem: at 23:50:00z due to a problem on the IMCS-A task CMD Verifier (application crash), the sequence for the STR mapping , at the end of slew execution, was not uplinked from TL.

A manual mapping was performed and the next slew in TL was manually updated in TL.

No impact on TL.

08/09/2008 (Day of Year 252, Revolution 721)

Nothing to report.

09/09/2008 (Day of Year 253, Revolution 721)

STR loss of guide star: at 18:46:23z after the end of slew ID 07210065 a loss of guide star occurred on the STR. The IMU did not switch ON being the event occurring in the first minute after the <<slew end>> OEM. An automatic mapping was commanded by the ACC and a new guide star tracked. As consequence the OTF was not reached and the FDS update for PID 07210066 failed.

A manual mapping was performed and the next slew 07210066 was manually updated in TL.

No impact on TL.
The OTF was not reached during PID 07210065.

10/09/2008 (Day of Year 254, Revolution 721-722)

Nothing to report.

11/09/2008 (Day of Year 255, Revolution 722)

STR loss of guide star: at 20:26:00z the IMU1 went ON during PID 07220041, due to loss of guide star from the STR caused by a false event.

A manual mapping was performed and the next slew 07220042 was manually updated in TL.

No impact on TL.

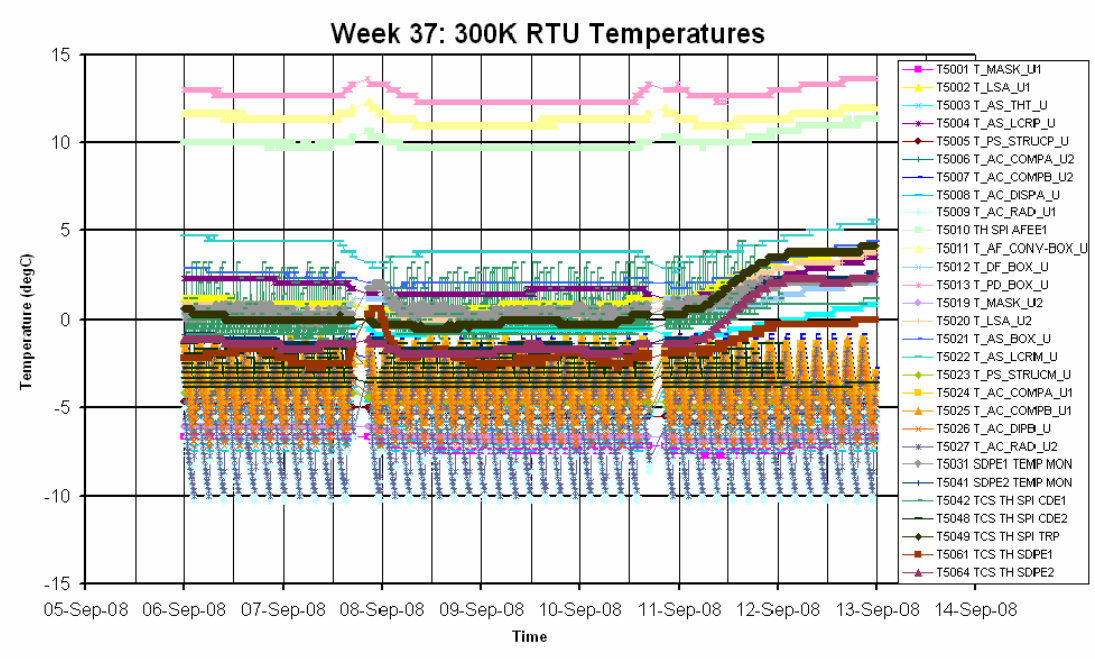
The OTF was not reached during PID 07220041.

12/09/2008 (Day of Year 256, Revolution 722)

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.

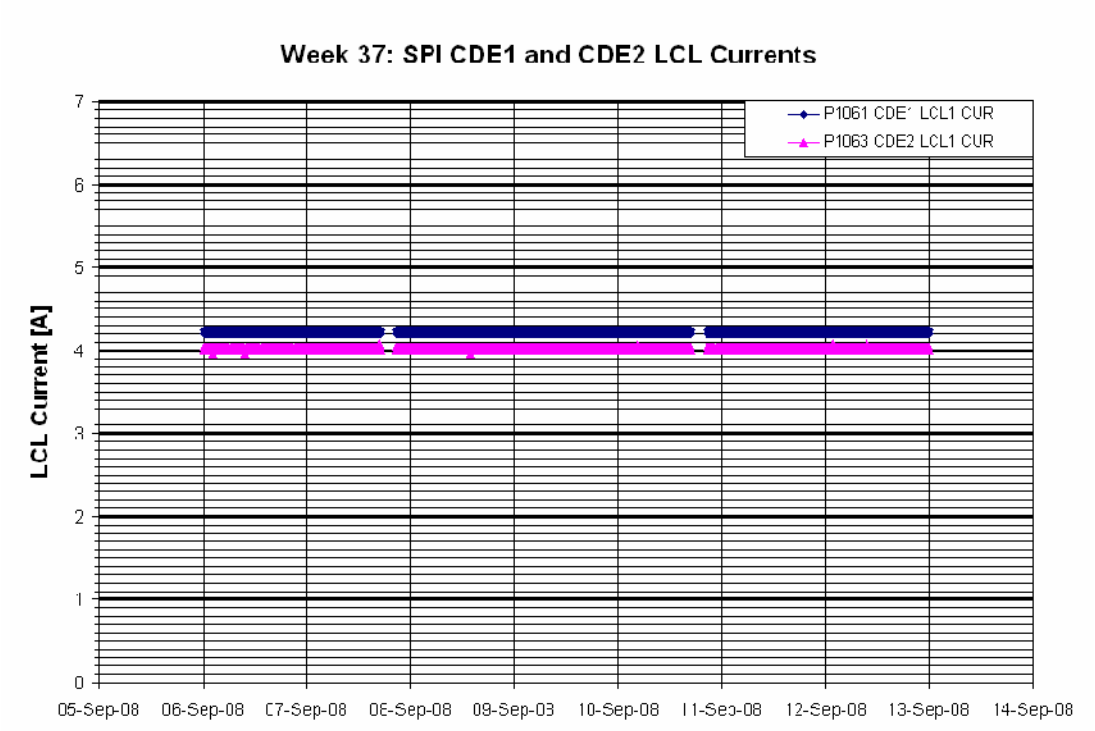


Stirling Compressors and Cryostat: The performance of the compressors is nominal. The cold plate temperature was maintained in the range 80K +/-1K.

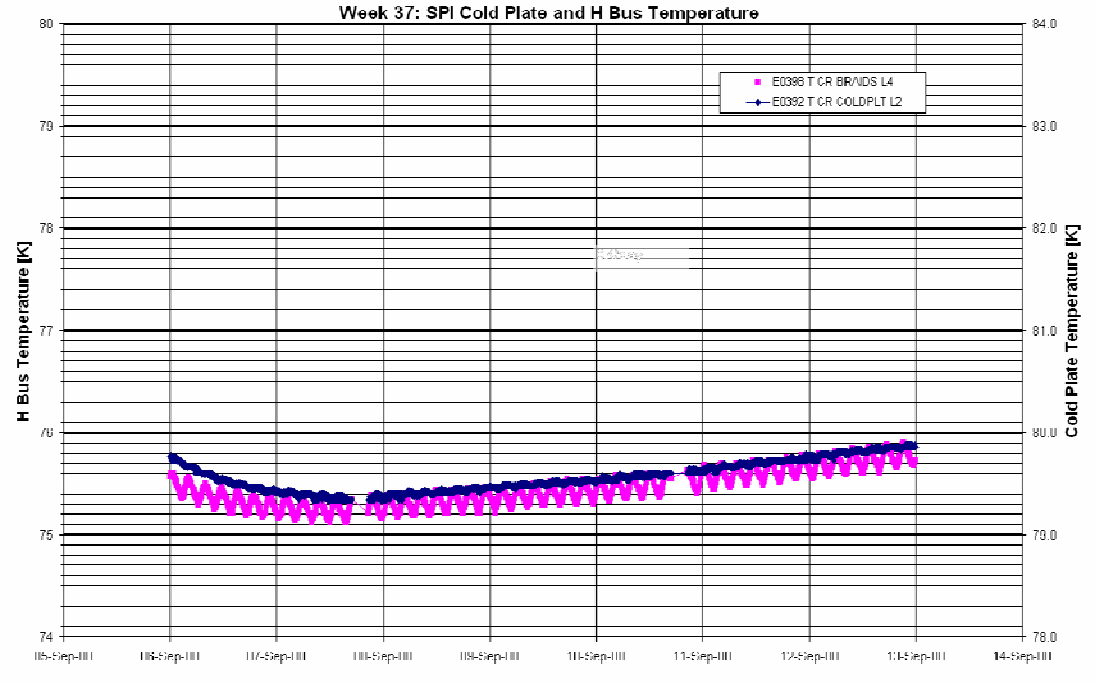
The stroke of all four compressors was set to 37 throughout the week. The average CDE LCL currents were as follows:

- CDE1 LCL Current = 4.22A
- CDE2 LCL Current = 4.02A

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



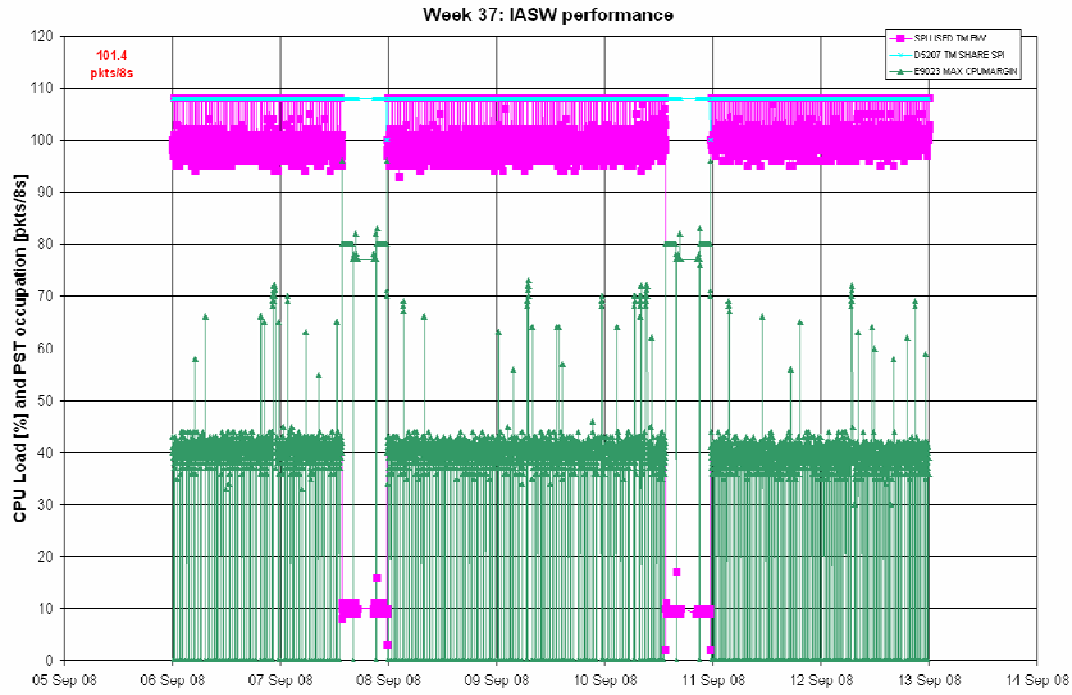
The following plot shows the evolution of the cold plate and H bus temperatures during the reporting period.



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

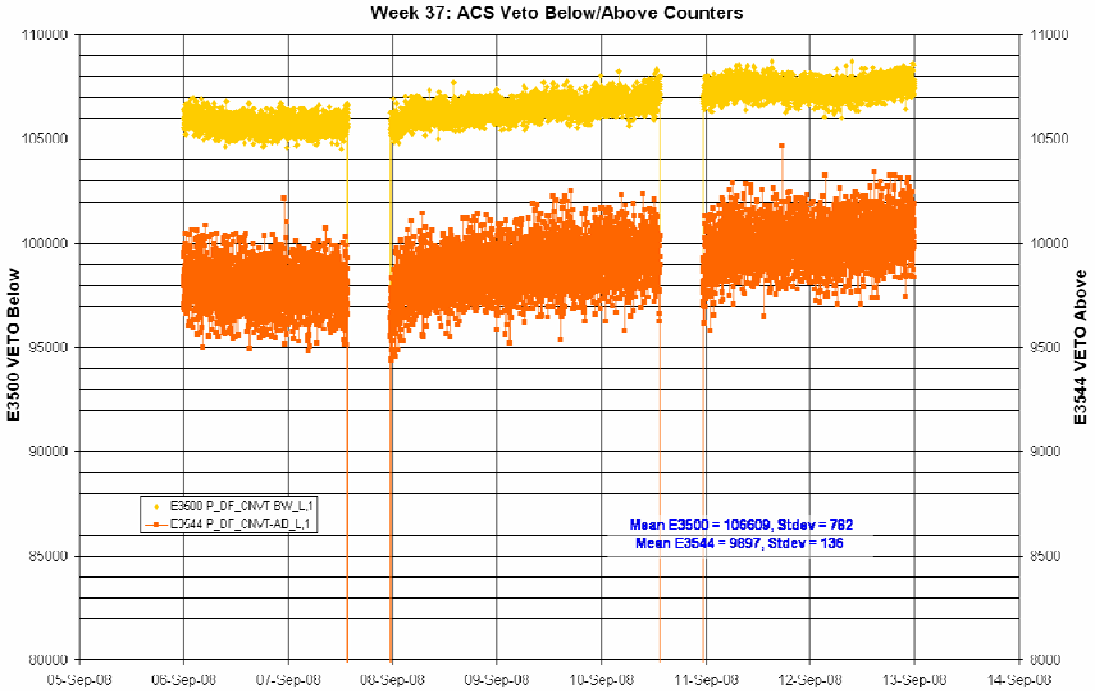
The IASW version installed is v4.3.4 with SE compression only enabled and the spectra scaling factor set to 8/19 SE.
The average TM bandwidth occupation of SPI was 101.4 packets/cycle over the science window when the TM allocation was 108 packets/cycle.

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

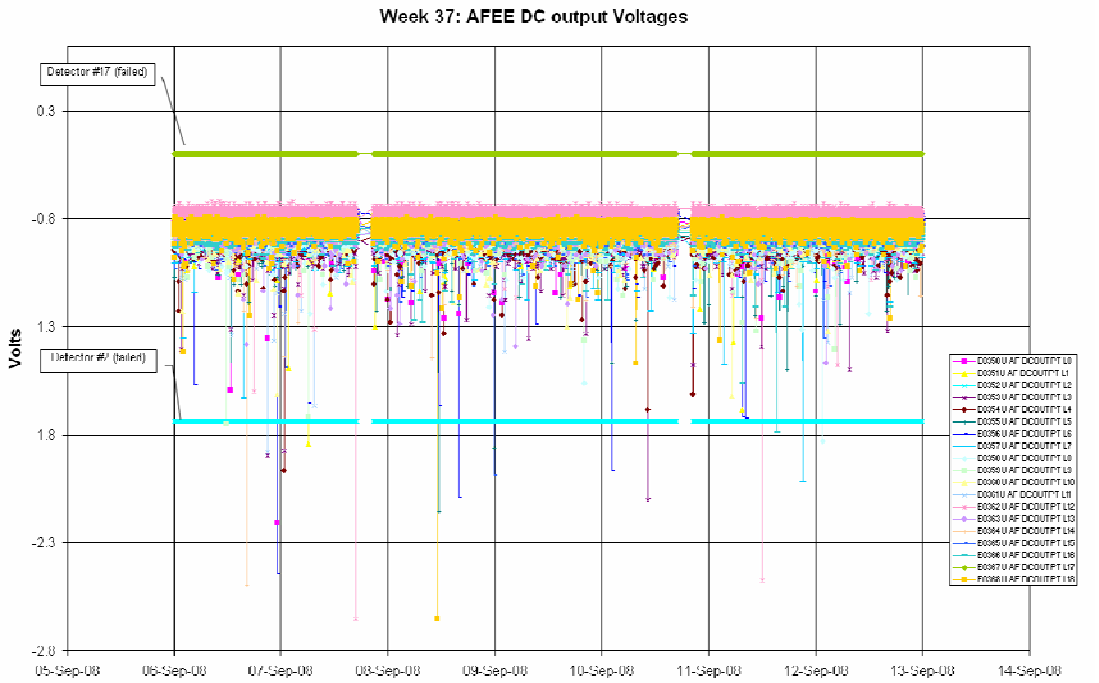


ACS: The performance of the ACS is nominal, except for FEE #81 which remains nominally switched off since the anomaly on 29/10/2006 (INT_SC-162) and FEE #57 which is nominally OFF due to the anomaly on 5/8/2003 (INT_SC-61).

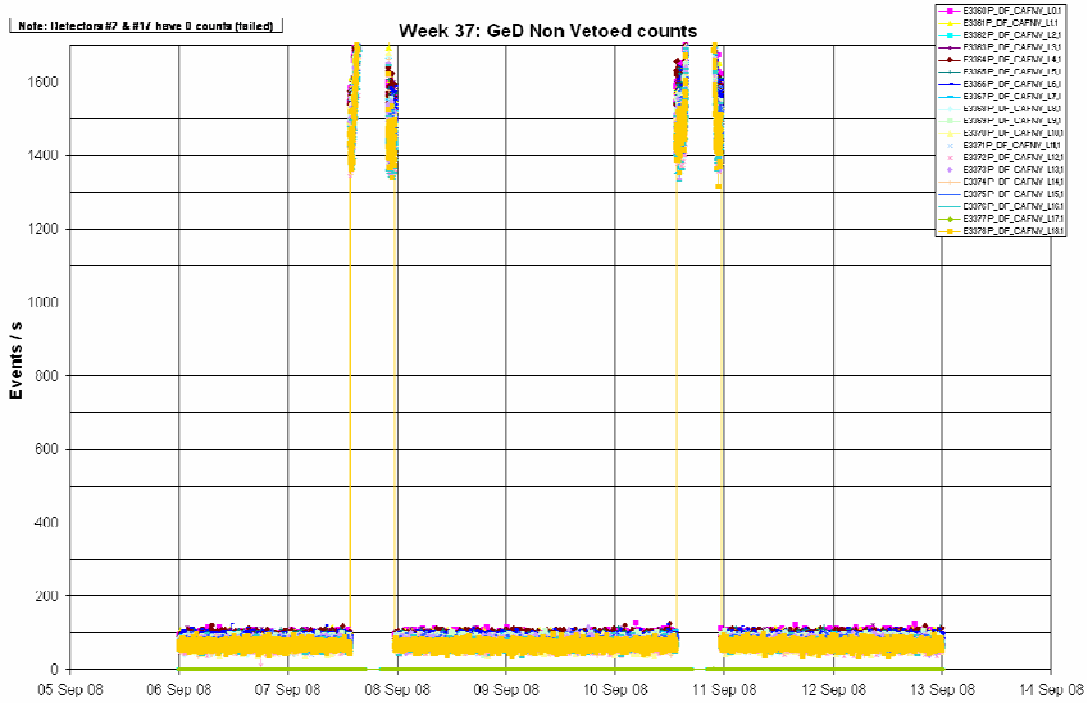
The following plot shows the ACS overall count rate evolution during the reporting period:

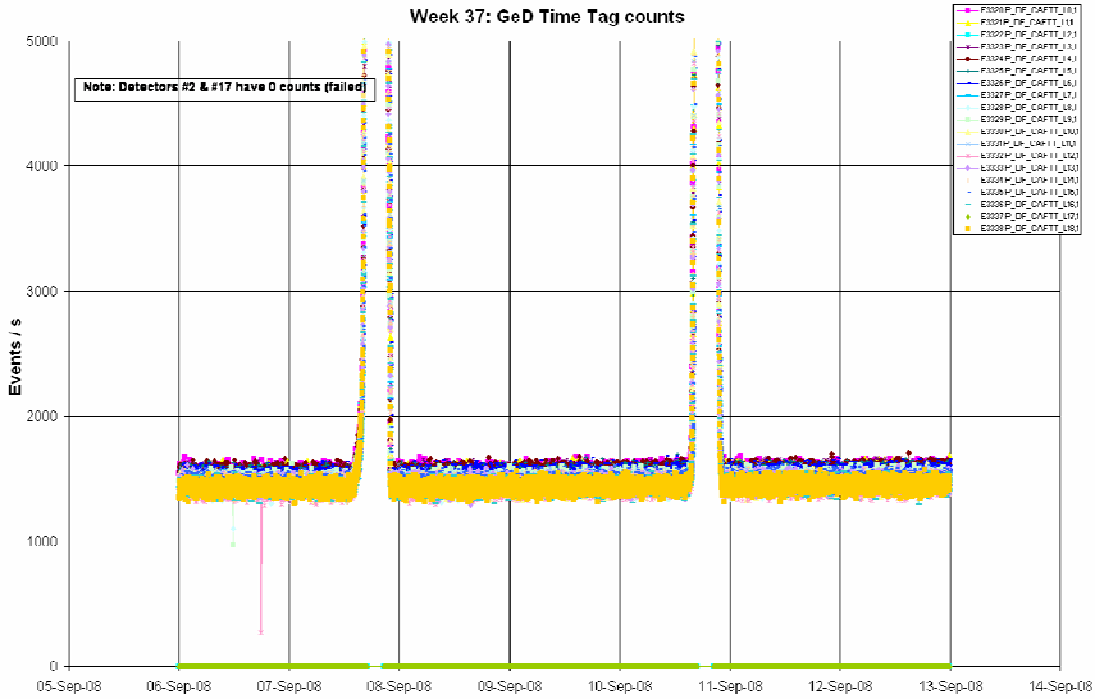


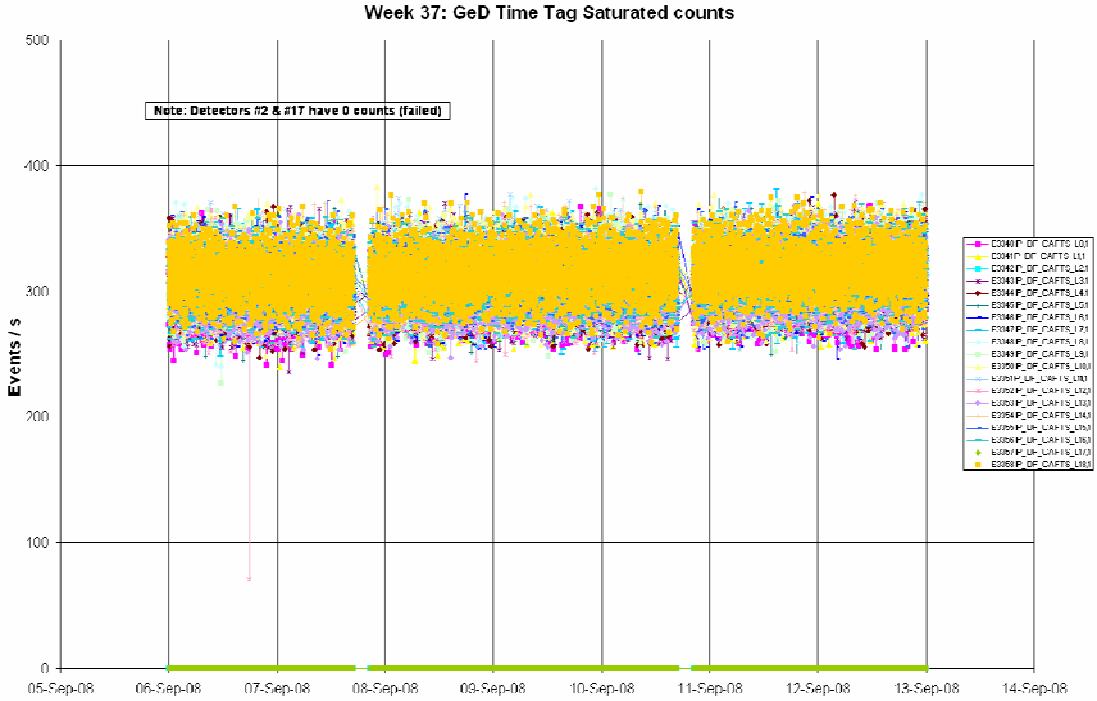
AFEE: The health of the AFEE is nominal. The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06/12/2003 and detector #17 is failed since 17/07/2004.



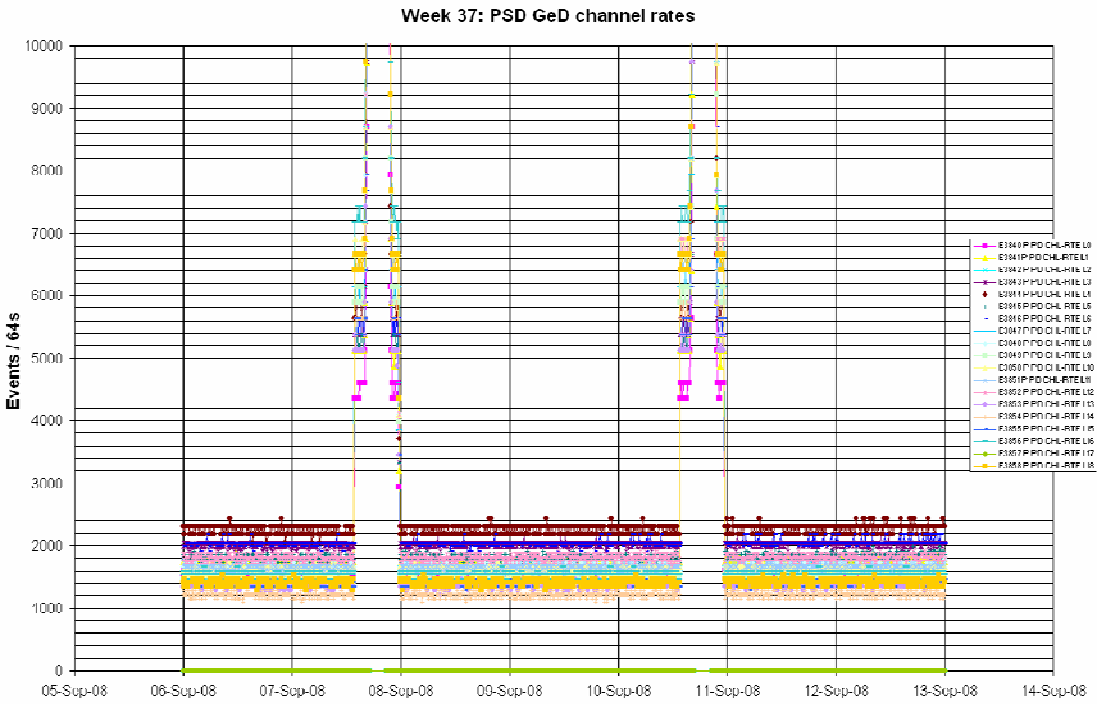
DFEE: The performance of the unit is nominal. The following plots show the Non Vetoed, Time Tag and Time Tag Saturated Event count rates during the reporting period.







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



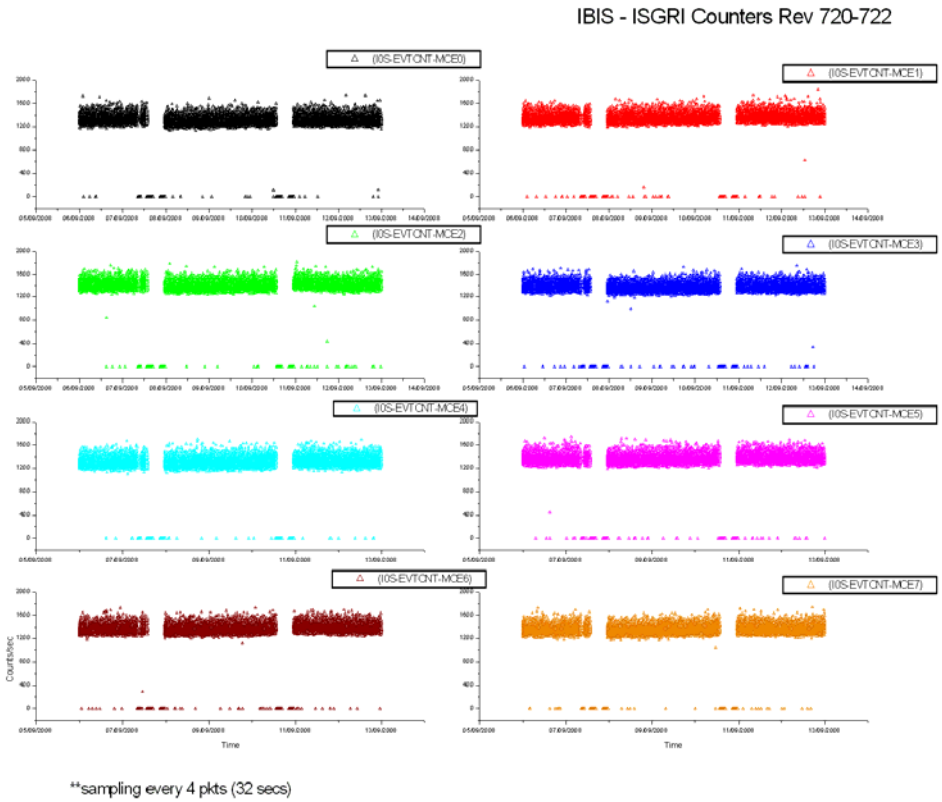
Event Log:

The following non-nominal events occurred on SPI over the reporting period:
On 2008-09-07 at 10:27:36Z OEM APID 1024 ID 229 EXCEPTION SPI1 PARTIAL FLAG OVERFLOW with parameter E9783 (SUBBLOCK ID) = SP7 was received. As this was a single occurrence, no action was taken.

8.3.3 IBIS Operations

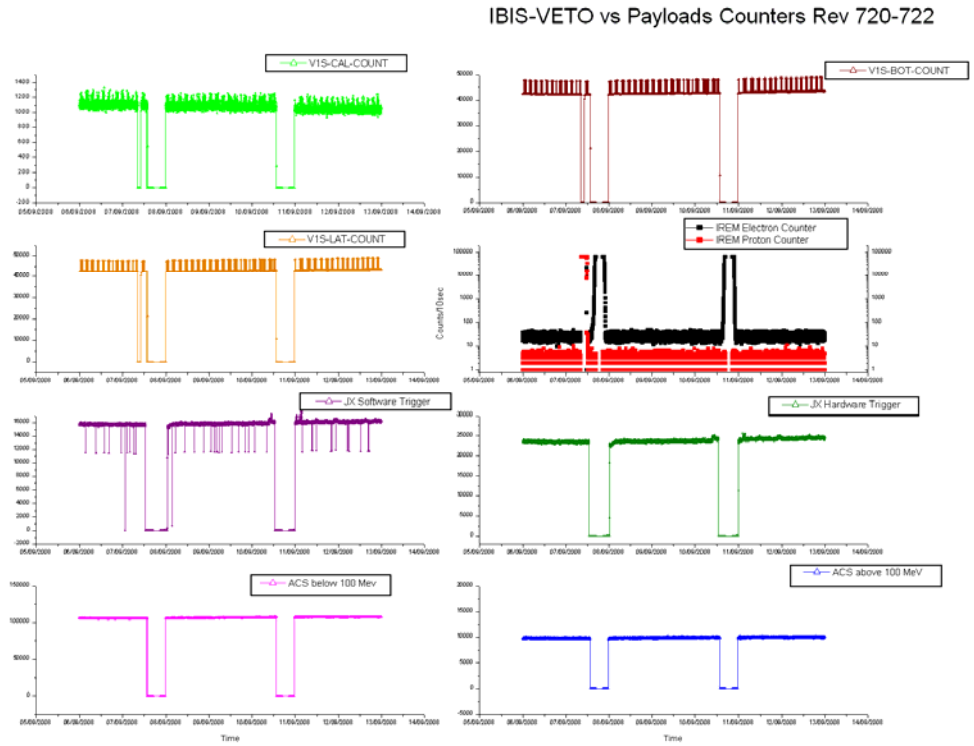
IBIS Event Counters Plots

ISGRI Counters:



**sampling every 4 pkts (32 secs)

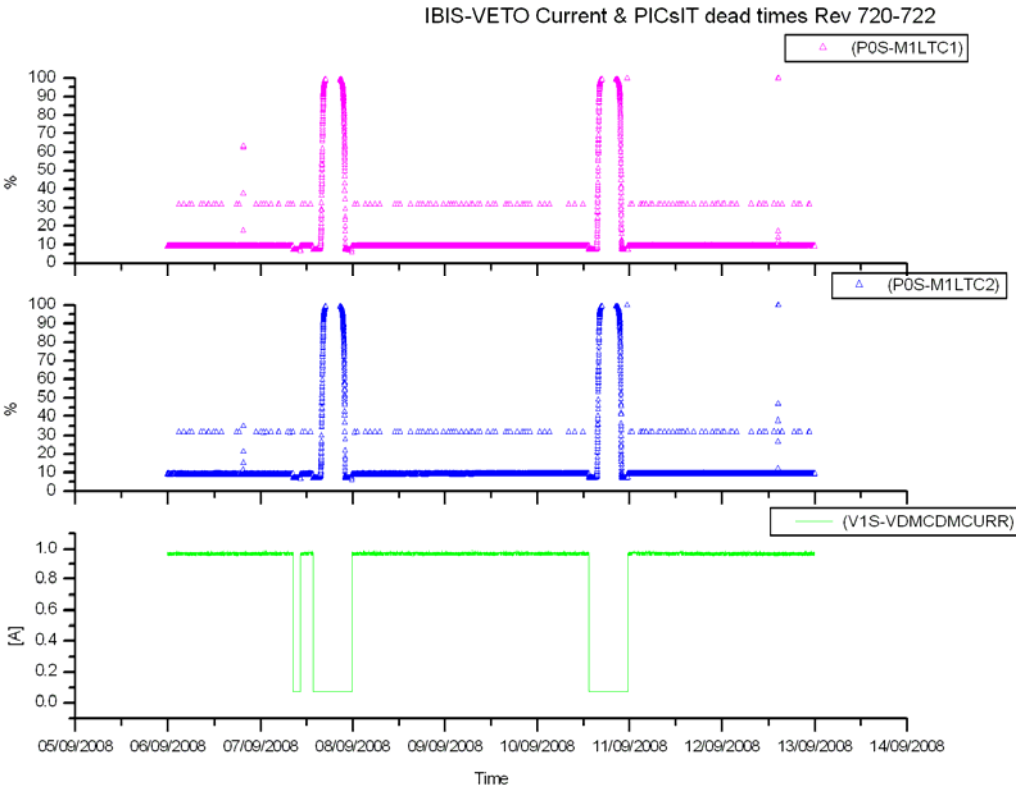
VETO vs Payload Counters:



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

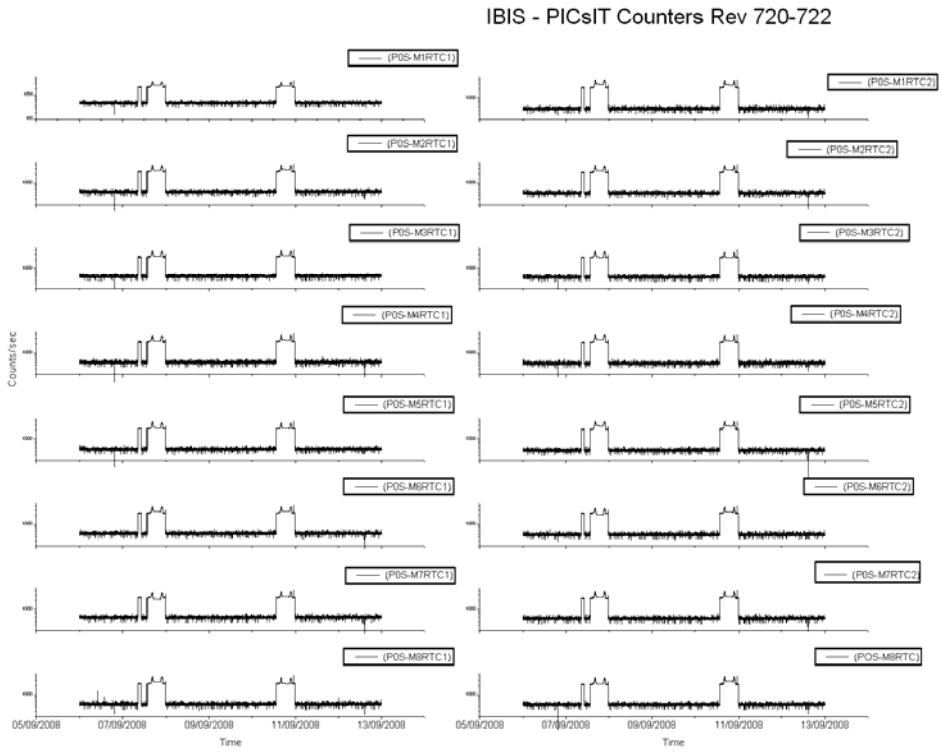
The week was characterised by low radiation as reported by the payload.

VETO Current:



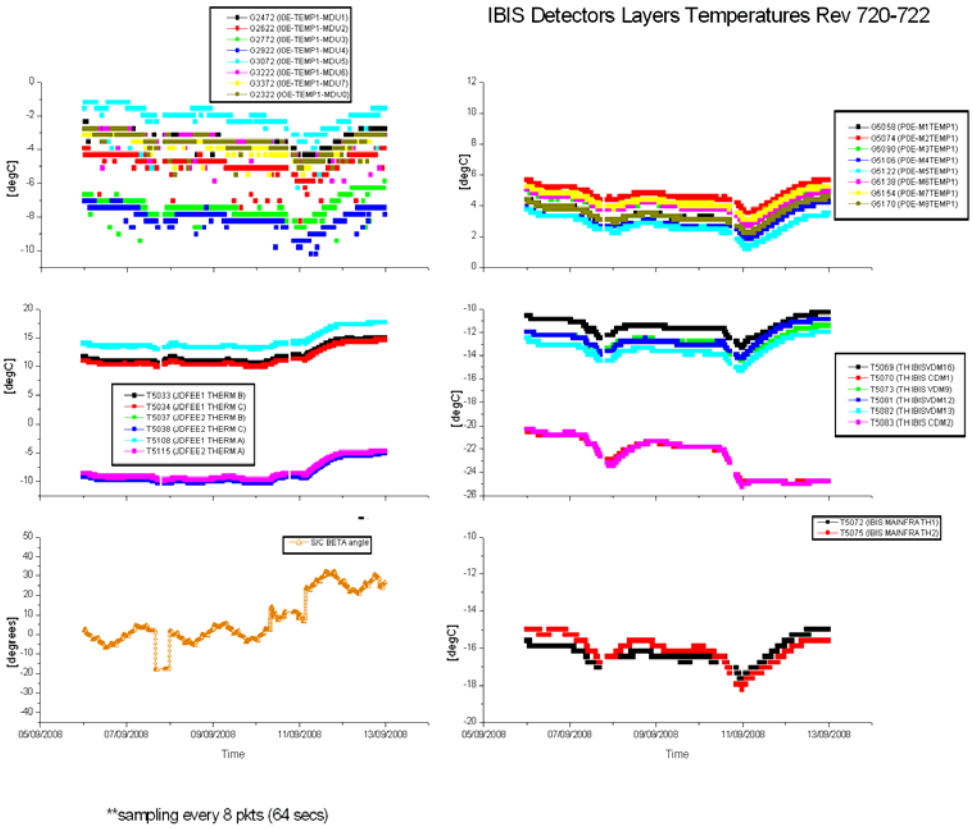
**sampling every 4 pkts (32 secs)

PICsIT Counters:



**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 (P0S-Mi_RTC1) and G5003 (P0S-Mi_RTC2) families and G2000 family (I0E-OVFWPXADD-Mi) were received during the radiation belt passages.

2008-09-06 (DOY 250, Rev 720)

At 19:31:07Z the TM parameters families G5068 and G5072 failed status consistency check (value = TRUE). These are the PDM semi-module FIFO error flags. As they had all returned within limits of their own accord by 19:32:11Z, no action was taken.

2008-09-07 (DOY 251, Rev 720-721)

Due to an IREM SEU, IBIS transitioned autonomously to Safe configuration at 08:31:38Z. It was recovered as follows:
- At 10:14:27Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE
- At 10:52:22Z ED GESTAN02 uplinked with the planned observation parameters and commanding to IBIS from the Timeline re-enabled.

IBIS operations continued nominally.

Due to a crash of the verifier task of the IMCS, the ED GESTAN02 scheduled at 23:50:25Z partially failed verification, although the commands were all released and actually executed onboard. When the system was recovered, CCCFs were enabled to

ensure the correct configuration of the instruments and therefore the CCCF_ED GESTAN02 was uplinked from the Timeline on 2008-09-08 at 03:14:27Z.

2008-09-08 (DOY 252, Rev 721) to 2008-09-11 (DOY 255, Rev 722)

IBIS operations executed nominally.

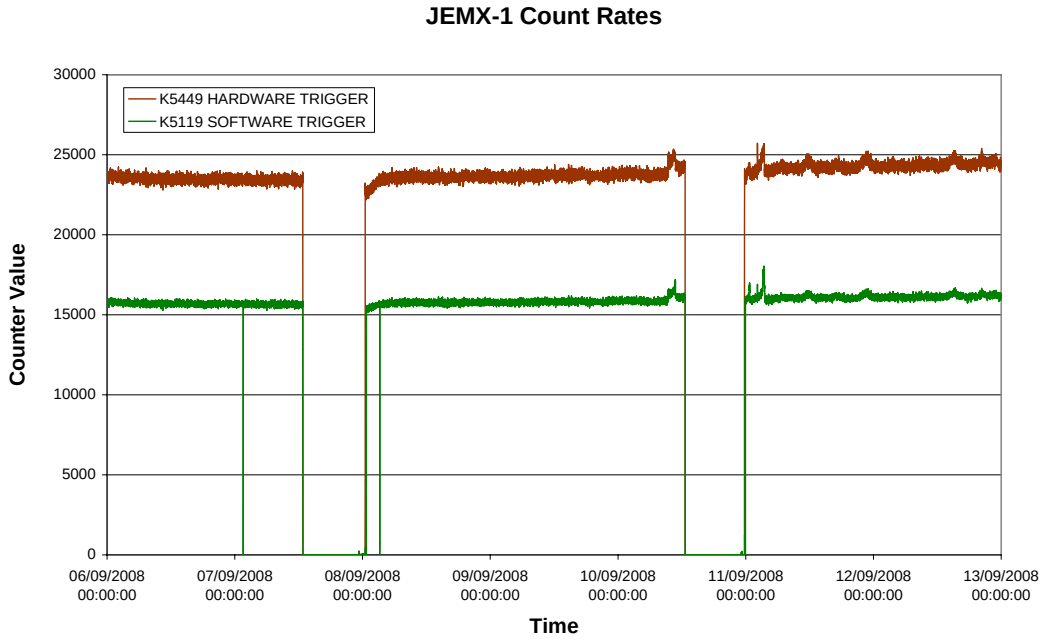
2008-09-12 (DOY 256, Rev 722)

At 14:30:51Z the TM parameters families G5068 and G5072 failed status consistency check (value = TRUE). These are the PDM semi-module FIFO error flags. At 14:32:06Z the TM parameter families G5002 and G5003 for the PDM semi-module counters started going OOL Low. As these were followed at 14:35:38Z by OEM APID 1280 ID 132 EVENT IBIS1 IASW HEPI RESYNCHRONIZED, indicating that HEPI resynchronised autonomously, by which time all the above parameters had returned within limits, no action was taken.

8.3.4 JEM-X Operations

JEM-X Count Rates

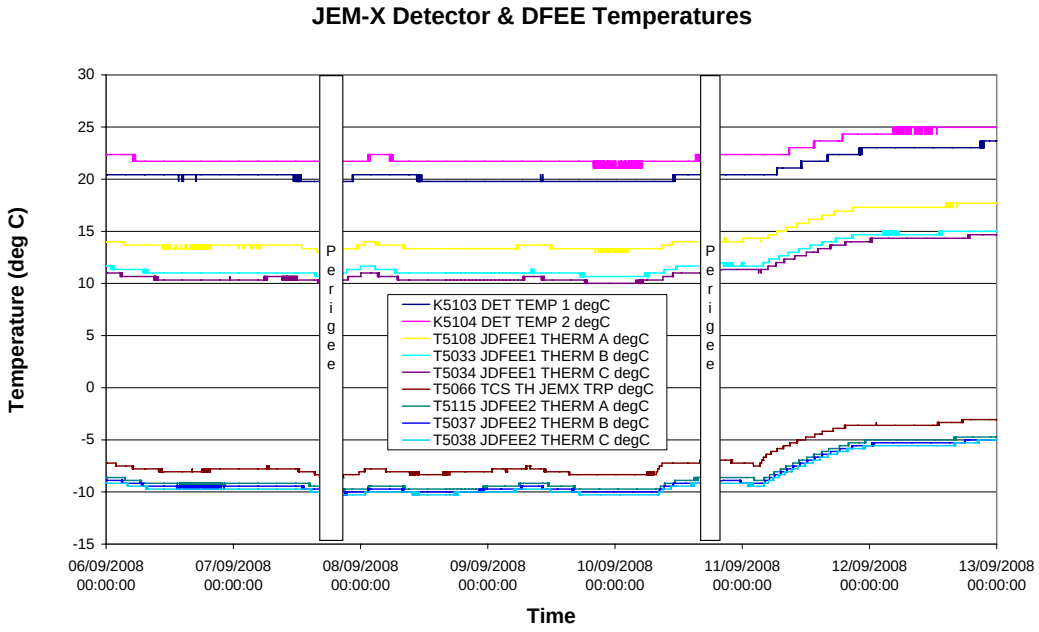
JEM-X count rates over the reporting period are displayed in the following graph[1].



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 graph[2].

[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-X Daily Report

2008-09-06 (DoY 250, Rev 720)

JEM-X 1&2 operations executed nominally.

2008-09-07 (DoY 251, Rev 720)

At 08:32:08 JEMX parameters K5315, K5316 & K5317 went Out-of-Limits due to an IREM SEU (#66). There was no impact as the reaction has been disabled.

At 23:50, a crash of the Command Verifier task interrupted the execution of the KEHVAC01 ED. The recovery took place the following day, see below:

2008-09-08 (DoY 252, Rev 721)

As part of the recovery from the Command Verifier crash, the following was executed:
00:13 FCP_JEM1_0040 JEMX-1 transition to Safe.
00:14 FCP_JEM1_0041 JEMX-1 transition to Setup.
00:25 re-uplinked KEHVAC01 taken from the Command History
00:42 re-uplinked KEDATA02 also taken from the Command History.
00:43 re-enabled in T/L, also enabled the CCCFs according to INT_OPS_337.

2008-09-09 (DoY 253, Rev 721) to 2008-09-12 (DoY 256, Rev 722)

JEM-X 1 operations executed nominally.

8.3.5 OMC Operations

2008-09-06 (DoY 250, Rev 720)

At 22:08, the imaging commands failed on-board acceptance. Subsequently, at 22:22, a slew update TPF failed to arrive, causing a suspension of operations. A recovery was performed and the Timeline rejoined at 22:48. The impact was the loss of pointing 07200021.

2008-09-07 (DoY 251, Rev 720)

At 08:31:28, OMC was sent to SAFE mode by an IREM SEU (#66). A recovery was performed, and the instrument returned to Stand-by at 09:56:07. The impact was pointing 07200086 was cut short after 537 from a planned 2250 seconds, and pointings 07200087 and 07200088 were lost.

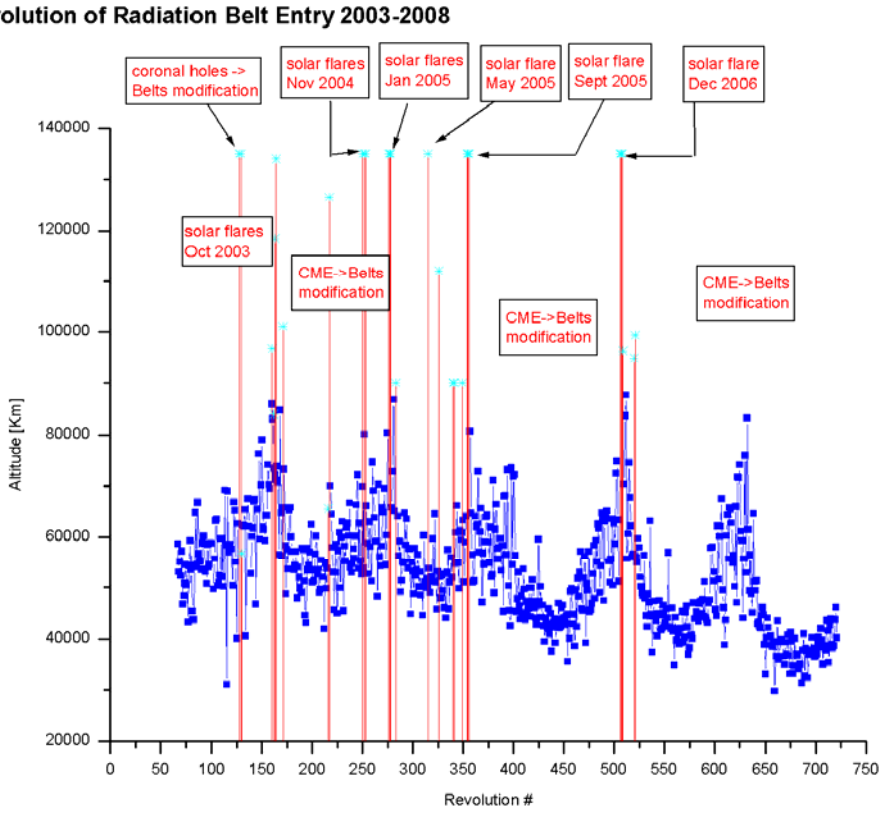
2008-09-08 (DoY 252, Rev 721) to 2008-09-12 (DoY 256, Rev 722)

Nothing to report.

On DoY 251 at 13:40:24 and DoY 254 at 13:29:52 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



IREM daily report

DoY 2008.251 (07/09/2008):

At 08.31:27Z, a local reset of the IREM CSCI S/W (SEU #66) occurred. The status of the unit, before the local reset of the IREM CSCI S/W, was nominal, here is a summary:

1) The temperatures were nominal;
2) The LCL current was nominal;
3) The last HK before the anomaly showed HV, 5V and 6V voltages inside limits;
4) The anomaly occurred at 2008.251.08.31:27Z (90690.4 km). The unit had performed an automatic transition to Standard Mode (ie. no block counter increasing, all the TM words= FFFF hex); just before the anomaly, radiation counters reported nominal values considering the position of the S/C along the orbit;
5) The recovery of the unit started immediately using procedure CRP_SYS_2570. The first dump of the status word after the anomaly reported a value of BCC0 HEX = 48320 DEC = 1011110011000000, i.e the Checksum Failure Flag ON. The unit was still reporting the status as if it was in Integral mode with counting ON and accumulation ON. This value of the status word is assumed to be an old one written by the S/W at the moment of the anomaly.
6) The patch was performed successfully with the correct re-starting of the S/W following procedure FCP_RM_0081. The operation was completed at 12:48Z.

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 09:56:07Z and IBIS at 10:14Z.

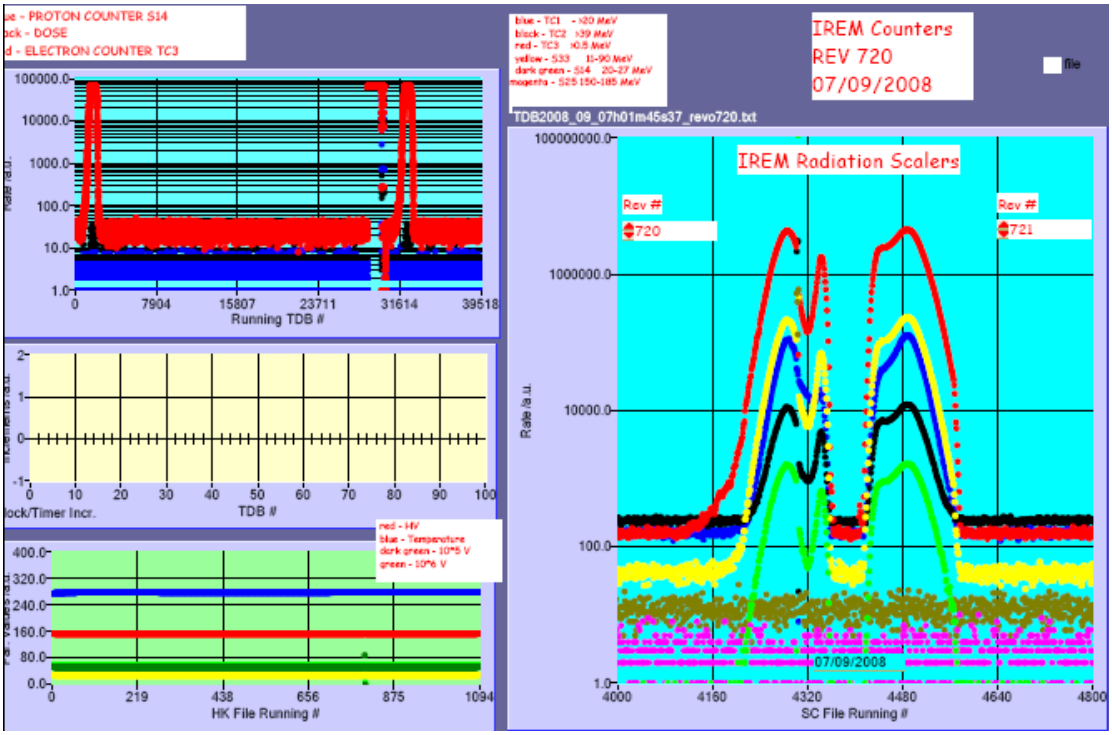
The cause of these S/W resets is apparently due to the unit's memory device that is sensitive to high energy radiation, as proved during test campaign on-ground.

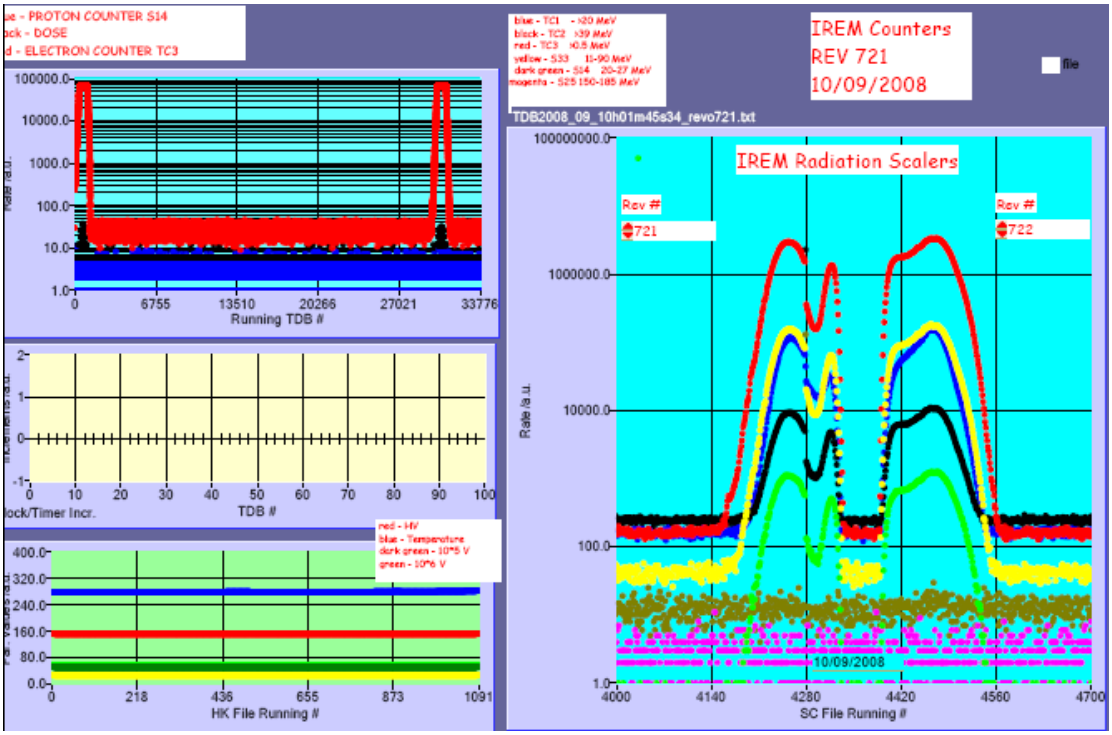
Electron Belts

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]
720	RAD_ENTR R 2008-09-07T13:40:22Z	07/09/2008 14:54:15	46113.8	07-Sep-2008 15:38:47	38990.8
721	RAD_EXIT R 2008-09-07T23:33:17Z	07/09/2008 22:07:35	>>33564.5	07-Sep-2008 22:48:47	45958.6
721	RAD_ENTR R 2008-09-10T13:29:45Z	10/09/2008 15:15:59	40196.2	10-Sep-2008 15:37:08	37792.12
722	RAD_EXIT R 2008-09-10T23:22:39Z	10/09/2008 22:07:59	>>33565.6	10-Sep-2008 22:37:08	45525.88

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.

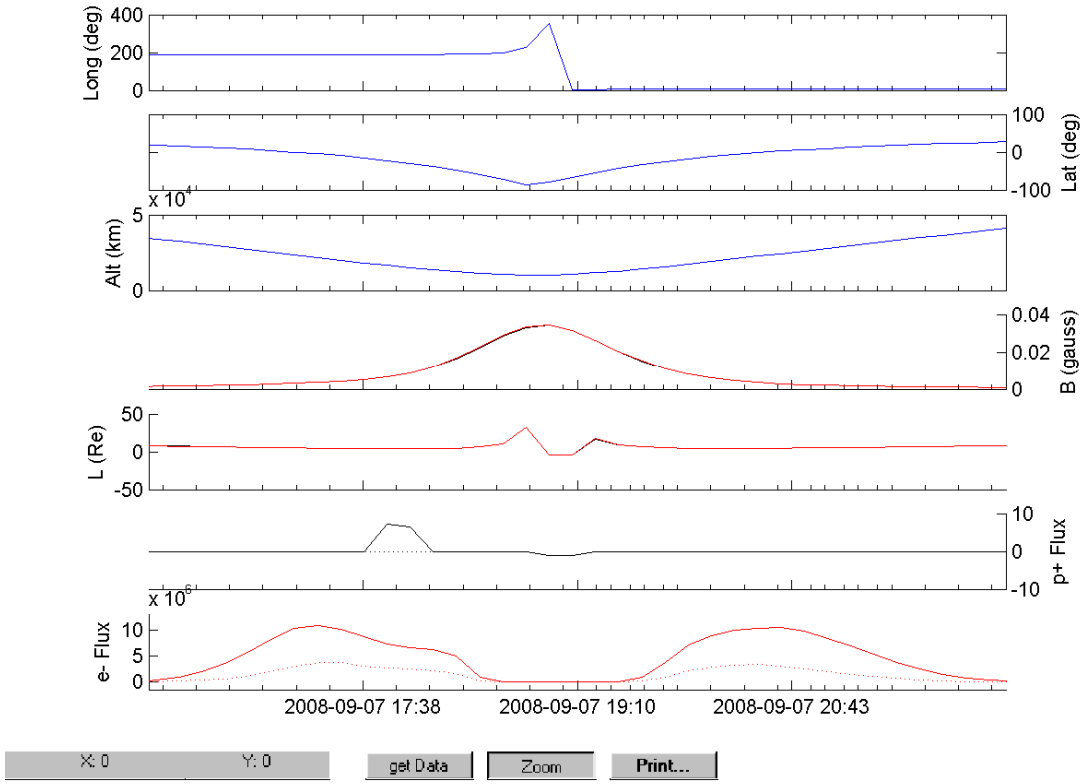
IREM radiation counters:



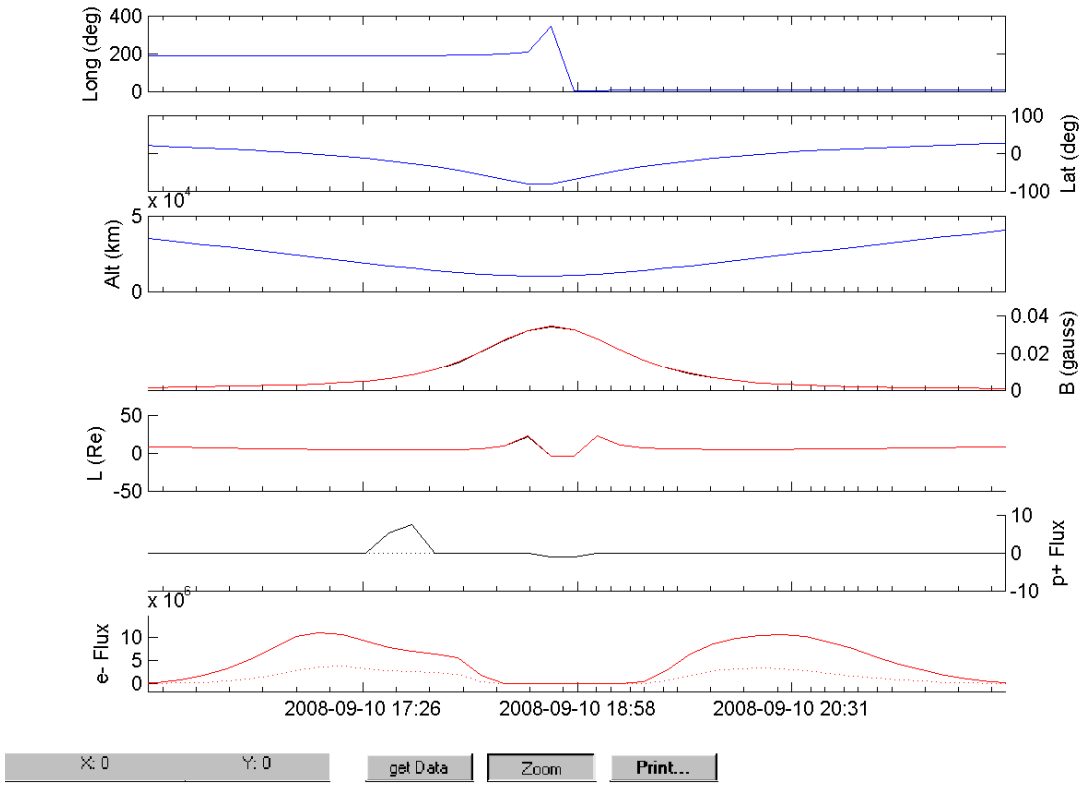


IREM Predicted Radiation Belt Passages

Rev 720



Rev 721



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

Due to a problem on the SEISDM server, no data are available this week. However, the week was very quiet and no radiation was reported.