

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OAI
No. 286
Week 11
17.03.08
Routine Phase

Prepared by: M.J.H. Walker (OPS-OAI) and INTEGRAL FCT

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1 General

The Flight Control Team at MOC has compiled this report with some input provided by the Flight Dynamics Team, ISOC and ISDC.

It addresses the activities from 08.03.08 until 14.03.08 (both dates inclusive) and covers the revolutions 660 and 661.

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 two hexagonal dithers of the Galactic Bulge region (RA 17:45:36.00, DEC -28:56:00.0), a raster dither of the Galactic Plane Region 1 (RA 18:04:41.75, DEC -05:04:48.4), a hexagonal dither of the Gamma Ray Source 1915+105 (RA 19:15:11.50, DEC +10:56:44.0), and a raster dither of the Galactic Centre (RA 17:45:40.00, DEC -29:00:29.0).

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.

Two slews were missed from TL, during the observation period, due to problems on FDS and DSS-27 station.

The fuel consumption over the period between 07/03/2008 and 13/03/2008 was 0.1821 Kg. The remaining propellant is in the order of 141.8244 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.

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 Allocation was over-subscribed by 3 packets to SPI for 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

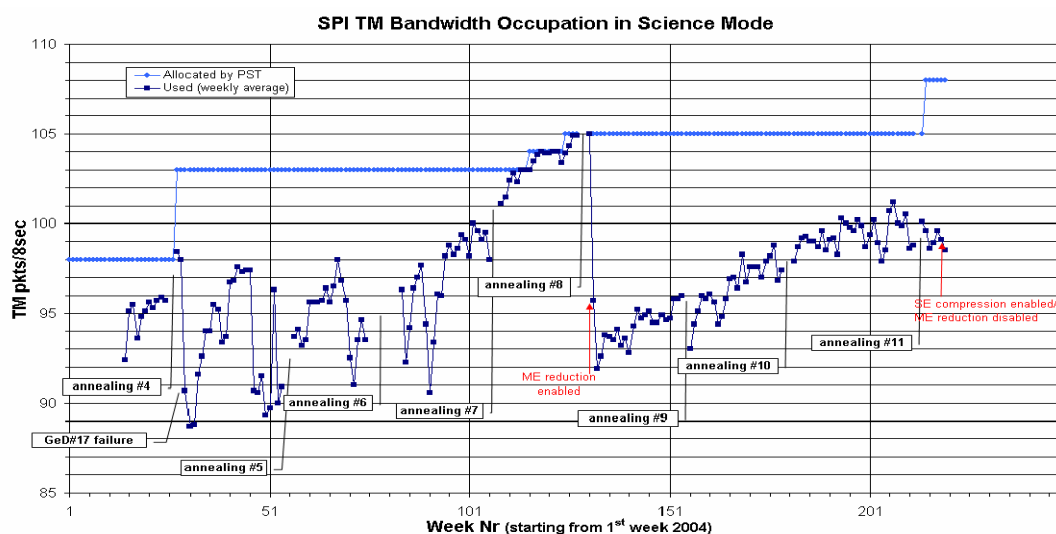
3.2.1 SPI

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 105 packets/cycle however the over-allocated PST with 108 packets/cycle for SPI was loaded. The average telemetry occupation in the science window was 98.5 packets/cycle.

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



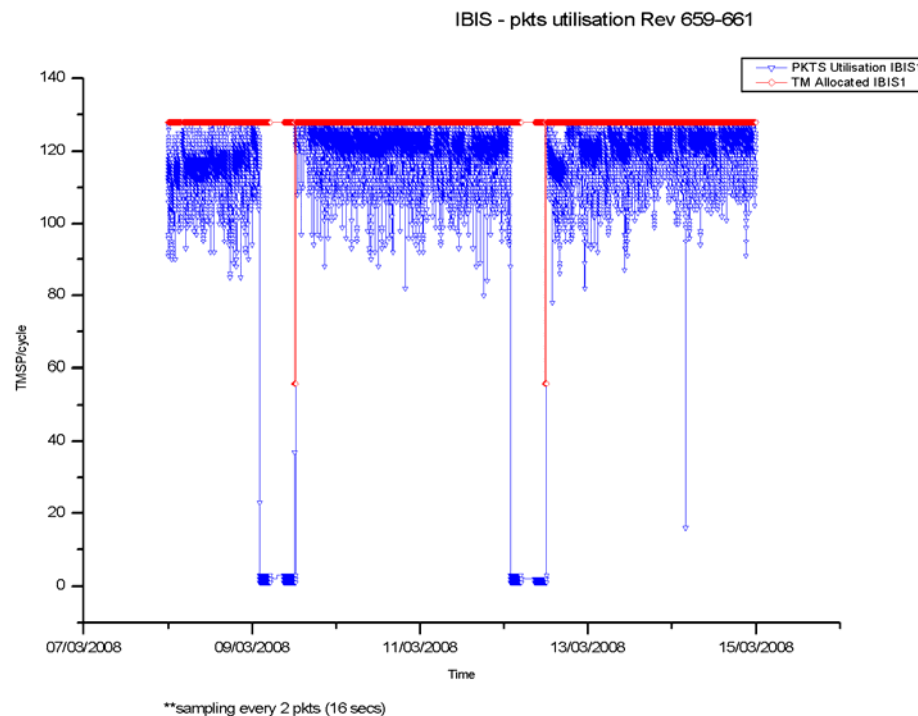
Note: Some more information concerning the SPI operations is provided in the Appendix.

3.2.2 IBIS

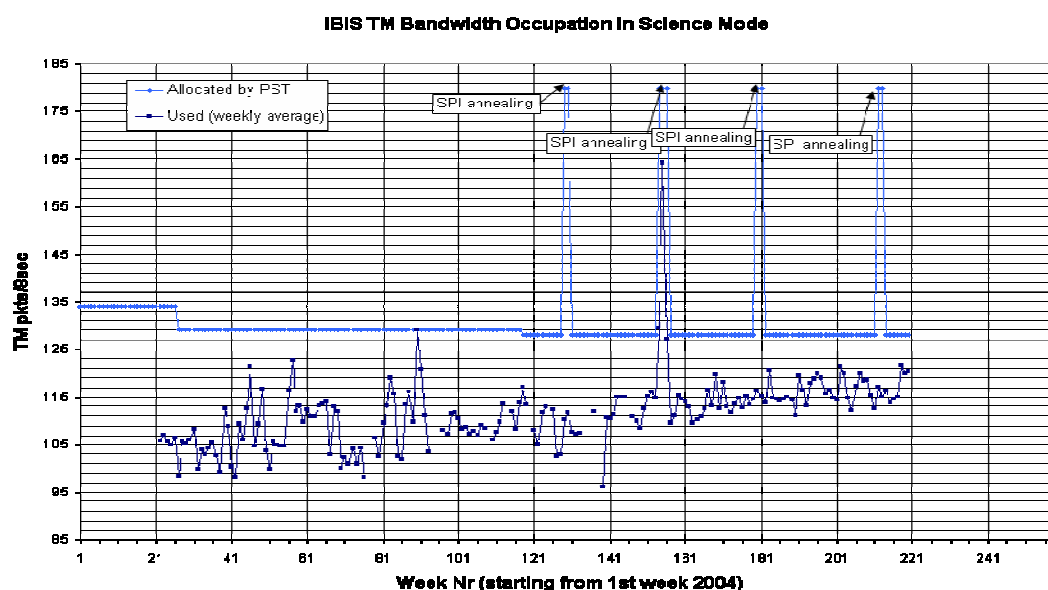
The overall status of the unit is nominal.

During the reporting period, the PST allocation to IBIS above the radiation belts was 128 packets/cycle and the IBIS mean bandwidth utilisation during the observation period (when IBIS was in Science mode) was 120.27 packets/cycle, up 0.46 on last week.

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



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, 148 of the 150 planned science pointings were executed nominally, 2 were lost.

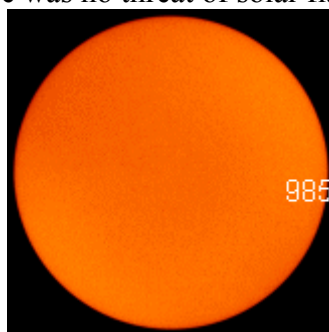
Note: Some more information concerning the OMC operations is provided in the Appendix.

3.2.5 IREM

The overall status of the unit is nominal.

Solar Activity

The observation period was characterised by low solar activity. A new sun spot (#985) emerged briefly in the evening of 10th March, and disappeared over the Sun's western limb a day later. There was no threat of solar flares.



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. 3 Pointings were lost to ground problems, although 1 of these was performed manually at the nominal time. The overall performance was well over the 95% requirement.

4.1 Mission Operations Centre

The performance of the MOC was good this week. There were two occasions where the TPF updates failed to arrive in time, one occasion a manual recovery was performed at the nominal time, and the other occasion had no impact at all.

4.2 Ground Stations & Network

The performance of the ground stations and Network was good this week. There were, however, one occasion where bad frames were received from Redu, and four occasions of TM drops from DSS27, two of which led to the loss of a pointing. There was an occasion where the data link with ISDC, and another where the voice loop with ISDC dropped.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

New PSFs have been received for revolution 668 and 669.

Revolution 664 was re-planned to optimize the Long Term Planning and to match better the Crab calibrations in revolutions 665 and 666. Observations have been planned and approved up to revolution 667. Further planning is waiting approval.

No new TSFs have been received.

2. Observation status

New ECSs have been received and processed for revolutions 653 to 655.

3. ISOC Science Data Archive

No news.

4. ISOC system

Version 18.1 has been released on Monday 10 March. Another minor release 18.2, only affecting the Web application, was installed on 12 March.

5. Problems

None.

4.3.2 ISDC

Status of ISDC observation processing on 17/03/2008:

- Latest Standard Analysis completed: observation 05200010013 (Galactic Bulge region, Revolutions 655) on 17/03/2008.

- Latest products archived: observation 05200010013 (Galactic Bulge region, Revolutions 655) on 17/03/2008.

- Latest observation products sent to the observer: observation 05200260003 (mid-latitude 1 (part 1), Revolution 653-654) on 17/03/2008.

5 Special Events

6 Anomalies

The following problems were reported this week that impacted operations.

- On DoY 068, at 04:01:57, a TM drop from DSS-27, forced the suspension of the Timeline. The TM briefly returned at 14:13, but failed again a minute later. At 04:18, the TM was back, and a recovery begun. The Timeline was rejoined at 04:32. The impact was the loss of pointing 06590045.
- On DoY 070, the FDS system failed to generate the update for CSL 06600034. A manual recovery was performed at the nominal time, replacing the slew with an OSL. There was no impact on science return.
- On DoY 071, at 07:41, the DSS-27 antenna stopped tracking, forcing the suspension of the Timeline. Data was flowing again at 07:57, and a manual recovery was performed. The Timeline was rejoined at 08:31. The impact was the loss of pointing 06600047.

There were no new anomaly reports were entered into the ARTS system this week.

7 Future Milestones

The following activities are foreseen in the next few weeks.

- The next Crab calibration will take place from during revolution 665 and 666.
- The Spring eclipse season starts on the 30th March 2008, at the end of revolution 666, and continues until the last eclipse on 26th April.

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 660

The observations in revolution 660 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 the Galactic Plane Region 1 (RA 18:04:41.75, DEC -05:04:48.4), lasting ~53.7 hours, until the end of the revolution.

Revolution 661

The observations in revolution 661 began with a hexagonal dither of the Gamma Ray Source 1915+105 (RA 19:15:11.50, DEC +10:56:44.0), lasting ~5.6 hours. They continued with a hexagonal dither of the Galactic Bulge region (RA 17:45:36.00, DEC -28:56:00.0), lasting ~3.5 hours. Finally, a raster dither of the Galactic Centre (RA 17:45:40.00, DEC -29:00:29.0), lasting ~46.7 hours, was performed, 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

2008-02-23T10:49:50.000Z	142.1498	F	Automatic TM processing.
2008-02-24T20:29:30.000Z	142.1305	F	Automatic TM processing.
2008-02-26T10:38:31.000Z	142.1154	F	Automatic TM processing.
2008-02-27T20:36:34.000Z	142.1089	F	Automatic TM processing.
2008-02-29T10:24:46.000Z	142.0932	F	Automatic TM processing.
2008-03-01T19:58:42.000Z	142.0799	F	Automatic TM processing.
2008-03-03T10:14:30.000Z	142.0758	F	Automatic TM processing.
2008-03-04T19:55:22.000Z	142.0530	F	Automatic TM processing.
2008-03-06T10:00:46.000Z	142.0425	F	Automatic TM processing.
2008-03-06T16:48:30.000Z	142.0065	F	Automatic TM processing.
2008-03-09T02:26:21.000Z	141.9295	F	Automatic TM processing.
2008-03-09T09:49:57.000Z	141.9267	F	Automatic TM processing.
2008-03-10T19:31:29.000Z	141.8568	F	Automatic TM processing.
2008-03-12T09:37:33.000Z	141.8451	F	Automatic TM processing.
2008-03-13T18:59:45.000Z	141.8244	F	Automatic TM processing.

This report was generated Fri Mar 14 08:00:23 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, 08/03/2008 – 14/03/2008

The AOCS operations were executed from the Automatic Timeline.

During this period, 84 Open Loop Slews, 77 Closed Loop Slews and 5 Momentum Biases were executed (as reported by ACC).

2 slews were missed from TL, during the observation period due to problem on FDS and on the antenna (tracking stopped) at DSS-27 station.

This is equivalent to $\sim 1.2\%$ of the total number of slews planned (161).

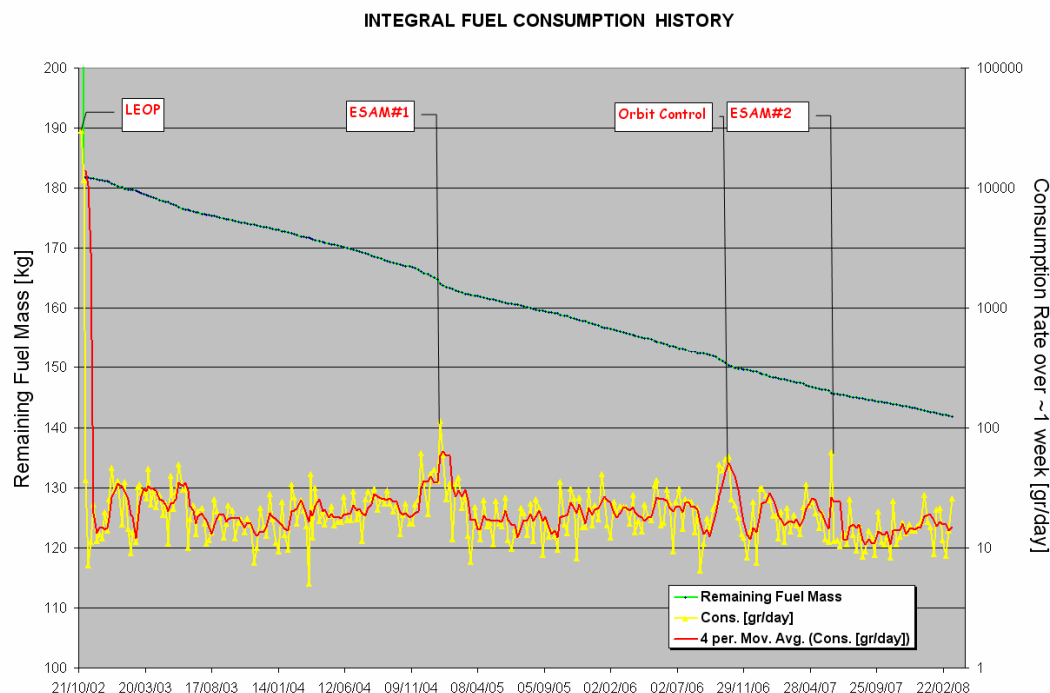
The OTF was not reached during PID 06600046 and PID 06610025, due to loss of guide star and consequent IMU ON.

Orbit Control

No update

Fuel consumption

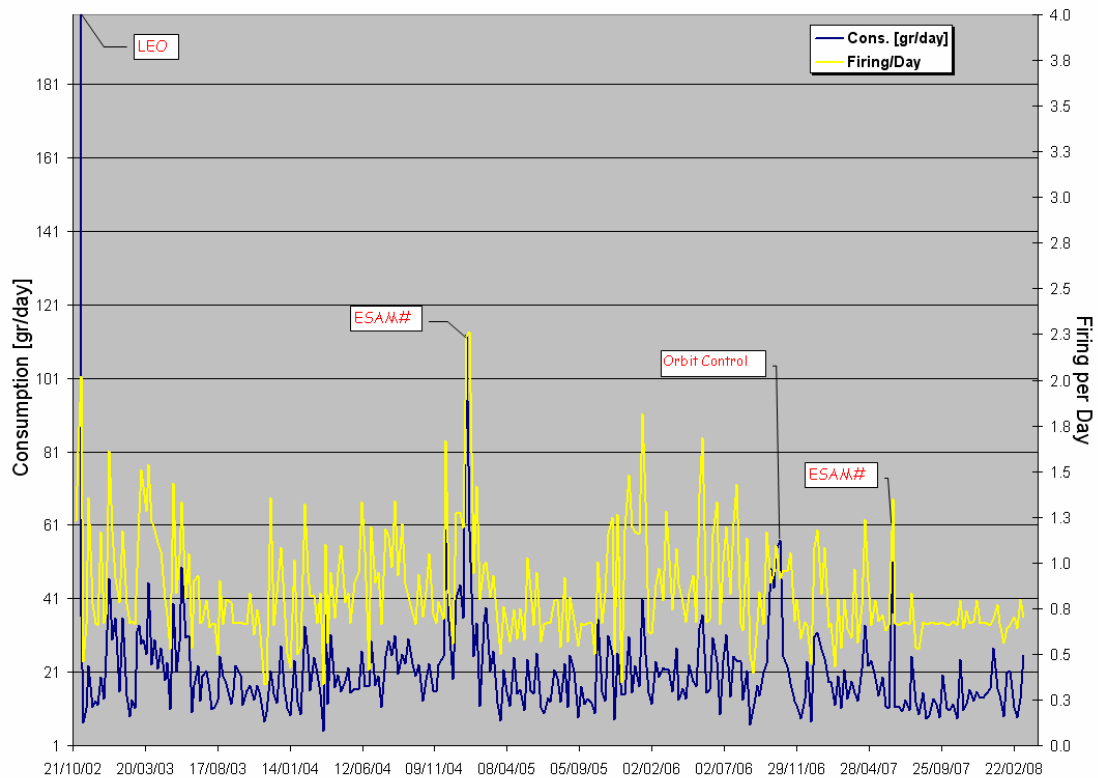
The fuel consumption (total, grams per day) over the period between 01/11/2002 and 13/03/2008 is reported in the plot below.



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 13/03/2008 is reported in the plot below.

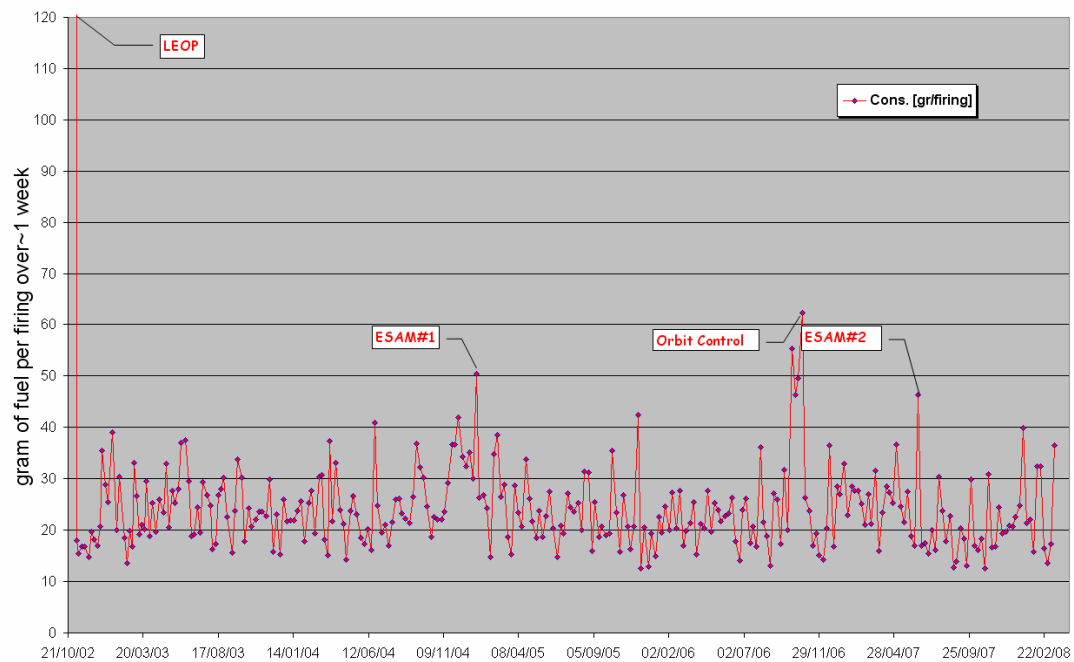
INTEGRAL FIRING PER DAY HISTORY



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

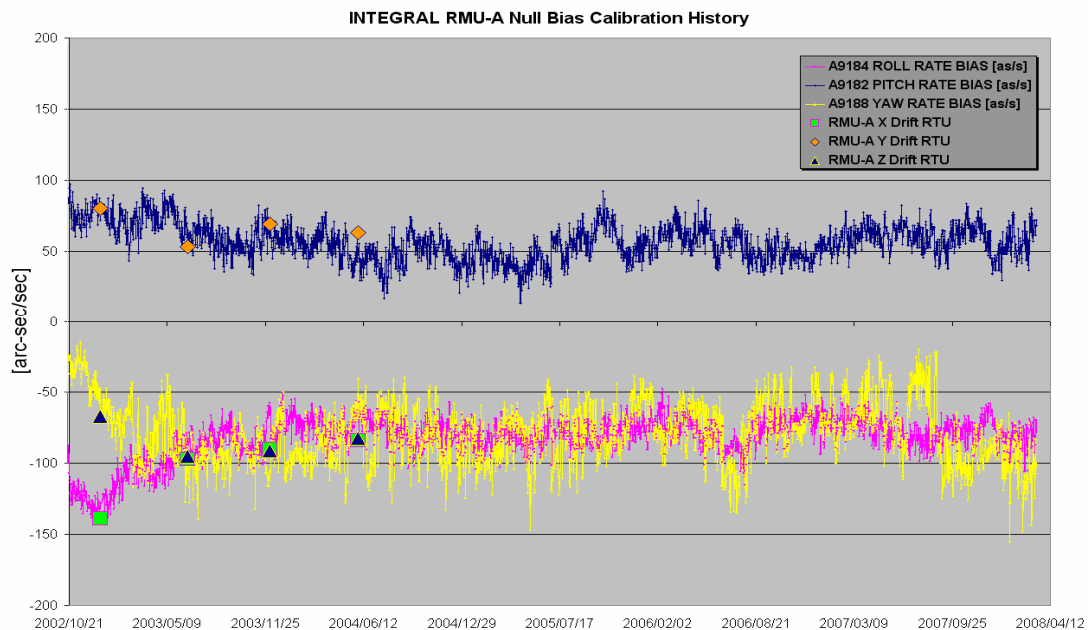
The fuel per firing over the period between 01/11/2002 and 13/03/2008 is shown in the plot below.

INTEGRAL FUEL MASS PER FIRING HISTORY



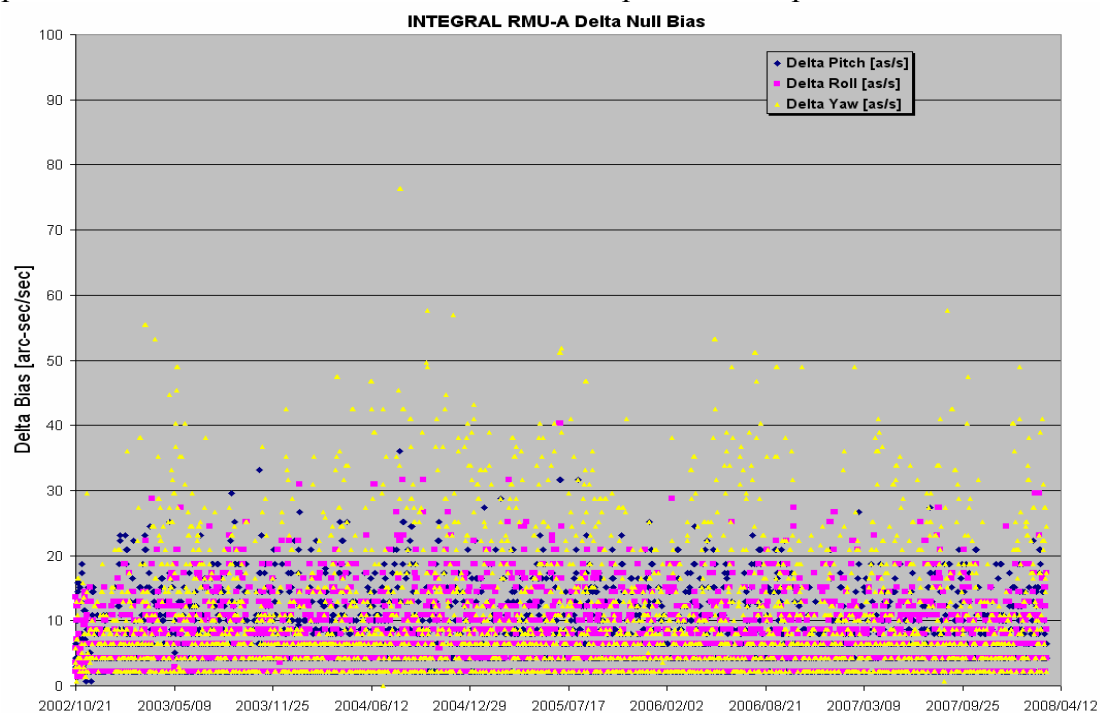
The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 14/03/2008 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 14/03/2008 is reported in the plot below.



08/03/2008 (Day of Year 068, Revolution 659)

Nothing to report.

09/03/2008 (Day of Year 069, Revolution 659-660)

Nothing to report.

10/03/2008 (Day of Year 070, Revolution 660)

Problem on FDS: at 16:22z a problem on the attitude determination process on the FDS caused the update for slew ID 06600034 to fail. The number of valid stars in the STR FoV was below the requested threshold (≥ 3) and no slew update was generated.

A manual recovery was performed from the attitude of PID 06600033 to the attitude of PID 06600034 (by OSL) and the slew ID 06600035 was updated in TL at 17:30z. The AOCS s/s was enabled in TL at 17:32z.

The following slew was missed in TL: 06600034(CSL)

11/03/2008 (Day of Year 071, Revolution 660)

Loss of guide star: at 07:34:31z a loss of the selected guide star occurred during PID 06600046. The origin of the event is not clear, likely due to SEU affecting the STR.

As foreseen by the IPS logic, the ACC switched ON the IMU 1, a new automatic mapping was commanded and a new guide star picked.

The OTF was not reached during the last part of PID 06600046.

Problem on DSS station: at 07:41z a problem on the antenna (stopped tracking) on DSS-27 station caused the slew 06600047 to fail release.

A manual recovery was performed from attitude of PID 06600046 to the attitude of PID 06600047 and the slew ID 06600048 manually updated in TL.

At 08:31z the AOCS s/s was enabled in TL.

The following slew was missed in TL: 06600047 (CSL)

12/03/2008 (Day of Year 072, Revolution 660-661)

Loss of guide star: at 05:18:46z a loss of the selected guide star occurred during PP of rev 0661. The origin of the event is not clear, likely due to SEU affecting the STR inside the Proton Belts.

As foreseen by the IPS logic, the ACC switched ON the IMU 1, a new automatic mapping was commanded and a new guide star picked.

No impact.

Loss of guide star: at 08:56:57z a loss of the selected guide star occurred at the beginning of rev 661. The origin of the event is not clear, likely due to SEU affecting the STR when still inside the radiation Belts.

As foreseen by the IPS logic, the ACC switched ON the IMU 1, a new automatic mapping was commanded and a new guide star picked.

No impact.

13/03/2008 (Day of Year 073, Revolution 661)

Loss of guide star: at 06:12:34z a loss of the selected guide star occurred during PID 06610025. The origin of the event is not clear, likely due to SEU affecting the STR.

As foreseen by the IPS logic, the ACC switched ON the IMU 1, a new automatic mapping was commanded and a new guide star picked. The next slew 06610026 was manually updated in TL.

The OTF was not reached during the last part of PID 06610025.

Problem on FDS: at 10:00z a problem on the FDS configuration caused the update for slew ID 06610030 to fail. An incorrect wheel check limit (due to on-going maintenance of FDS) caused the update to fail, requesting the execution of a RWB. The problem was corrected by FD on-call support, no RWB was requested and the Recovery Schedule Tool used to re-join the TL.

A manual recovery was performed and the slew ID 06610030 was updated in TL at 10:11z. The AOCS s/s was enabled in TL at 10:20z.

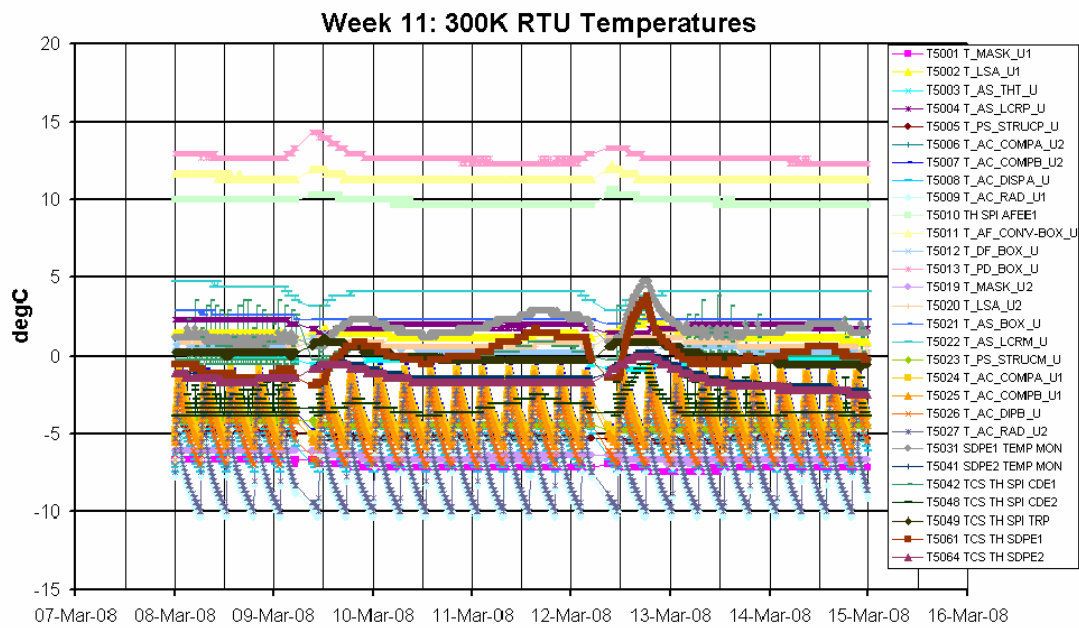
No impact on TL.

14/03/2008 (Day of Year 074, Revolution 661)

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.

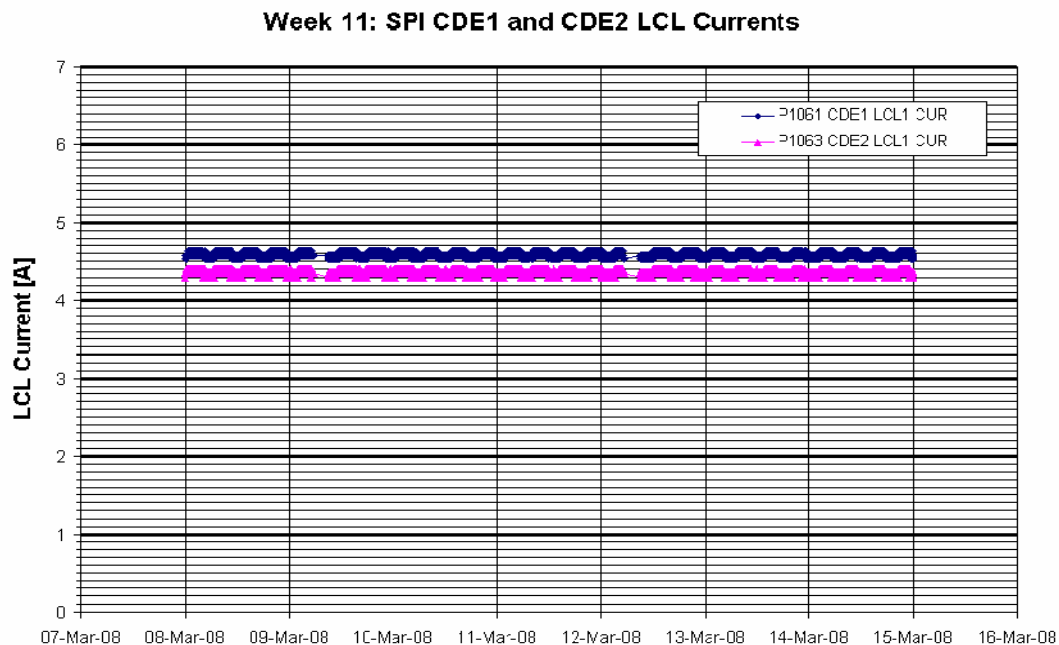


Stirling Compressors and Cryostat: The performance of the compressors is nominal. The cold plate temperature was maintained in the range 80K +/-1K with a positive drift of 0.053K/day.

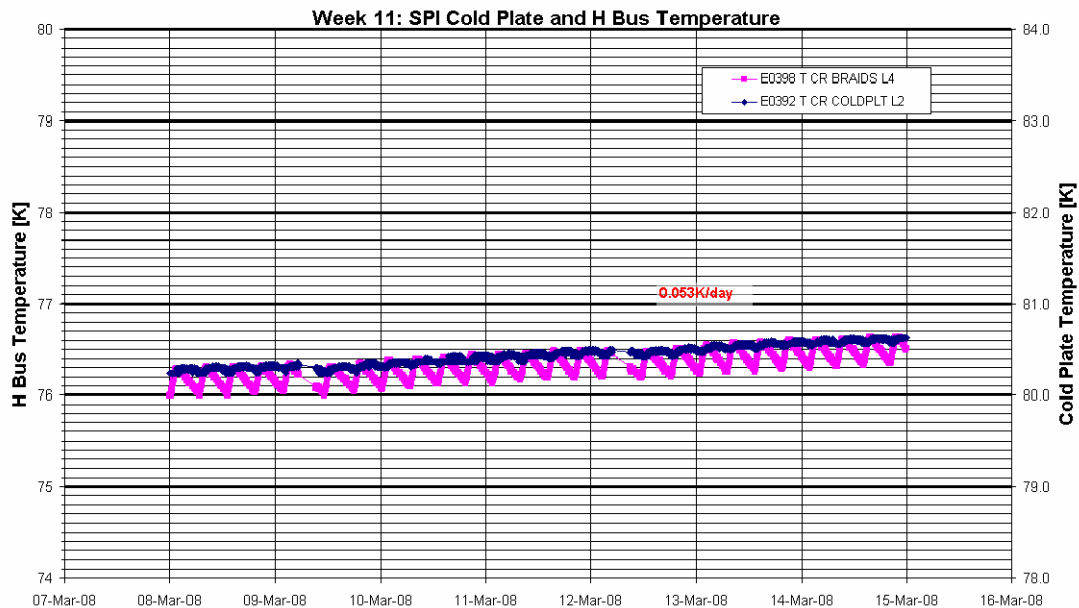
The stroke of all four compressors was set to 39 throughout the week. The average CDE LCL currents were as follows:

- CDE1 LCL Current = 4.58A
- CDE2 LCL Current = 4.36A

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 bar temperatures during the reporting period.

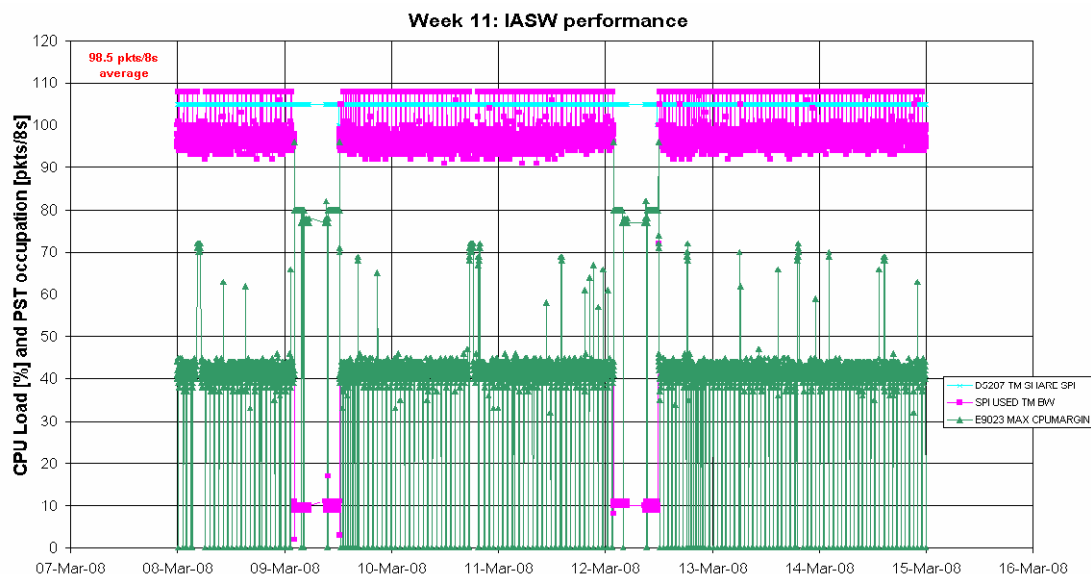


DPE & IASW: The DPE health and IASW performance is nominal.

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

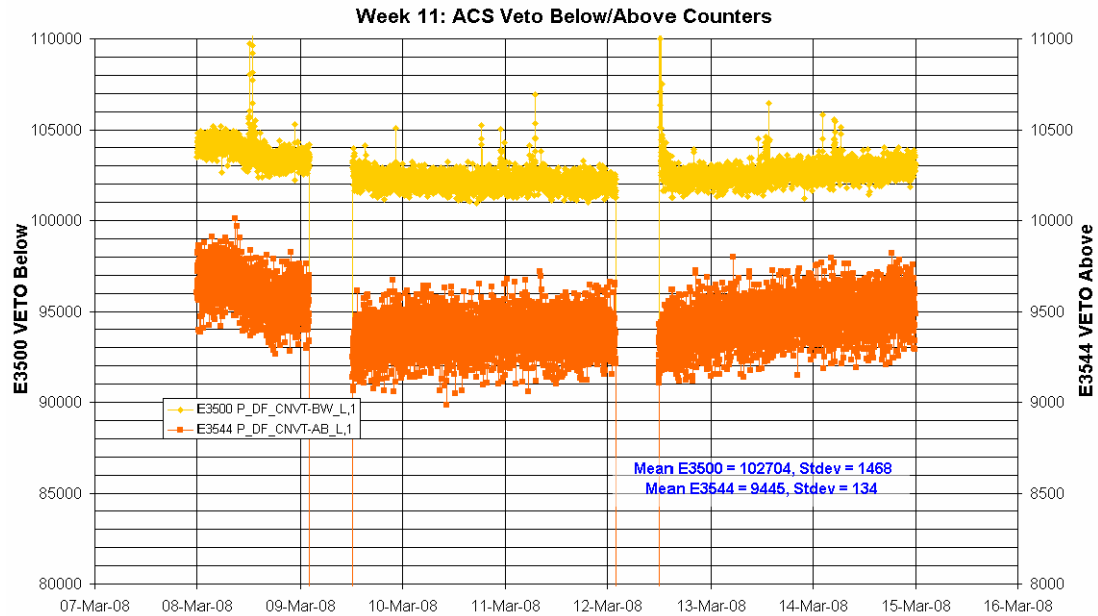
The average TM bandwidth occupation of SPI was 98.5 packets/cycle over the science window. The TM allocation in the science window was 105 packets/cycle, however the over-allocated PST with 108 packets/cycle for SPI was used (see plot below). Note that the Broadcast Packet TM allocation was not updated. This did not cause any problems and SPI used the additional TM bandwidth during spectra transmission.

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

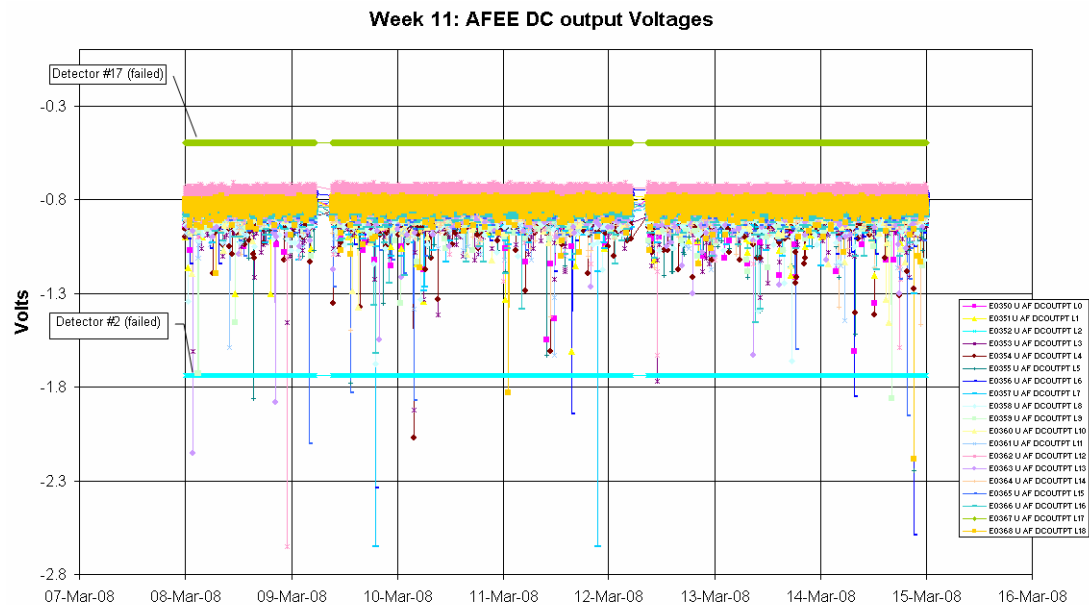


ACS: The performance of the ACS is nominal, except for FEE #81 which remains nominally switched off since the anomaly on 29/10/2006 (INT_SC-162) and FEE #57 which is nominally OFF due to the anomaly on 5/8/2003 (INT_SC-61).

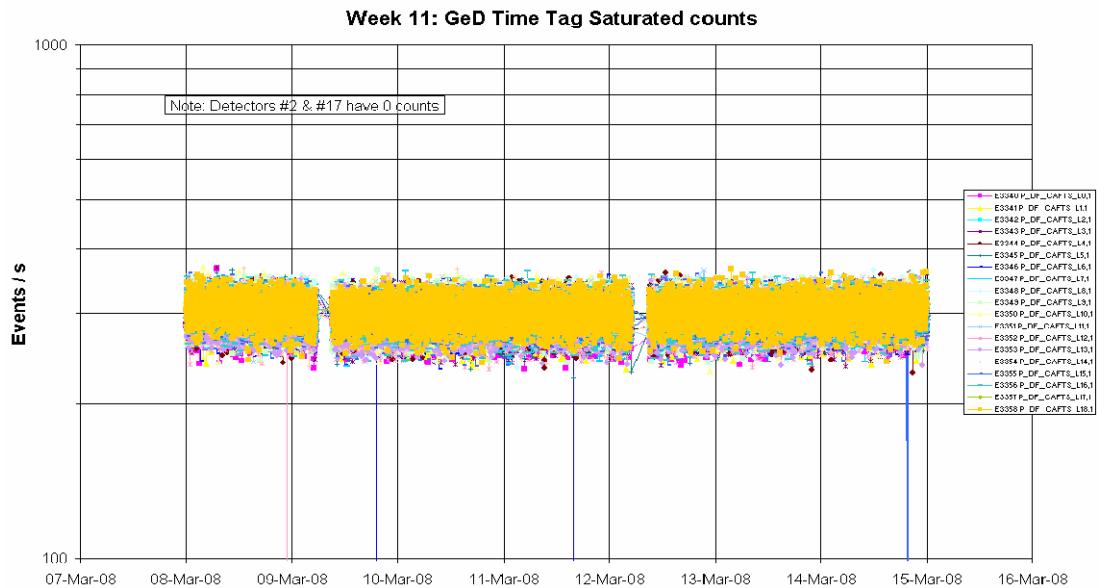
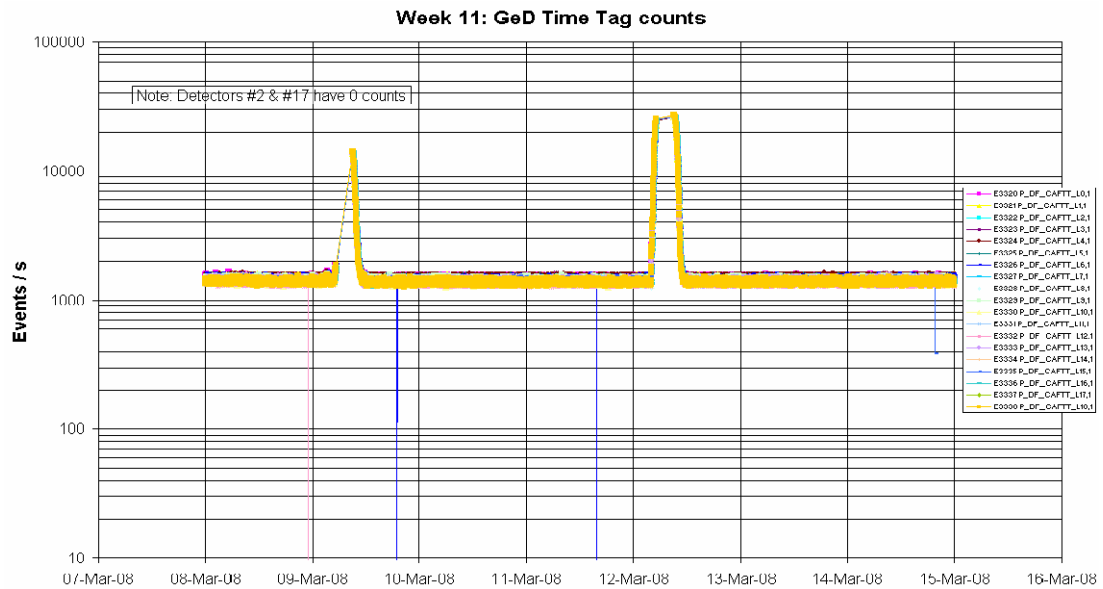
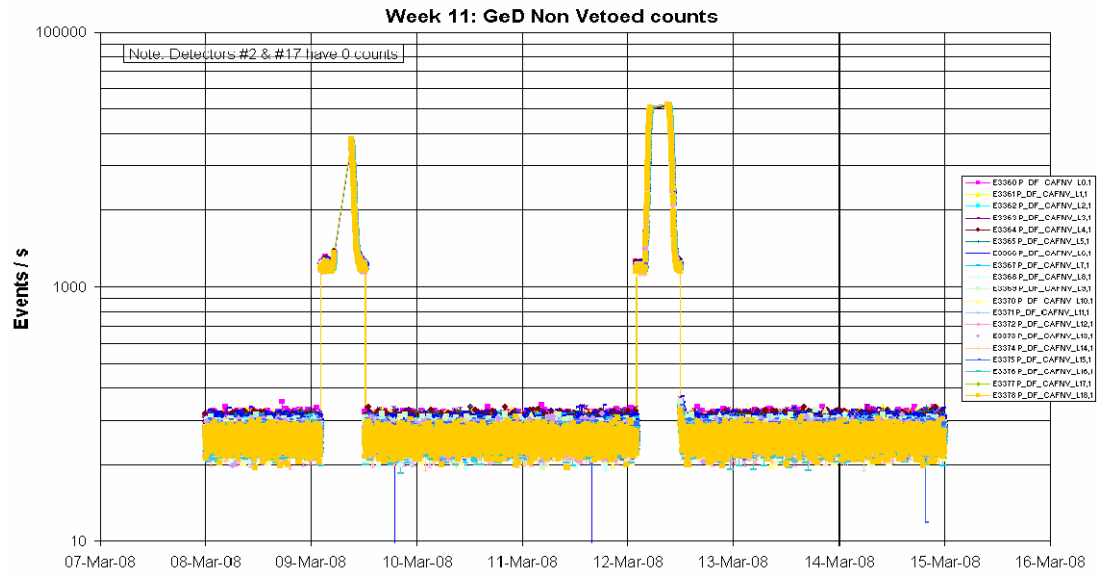
The following plot shows the ACS overall count rate evolution during the reporting period:



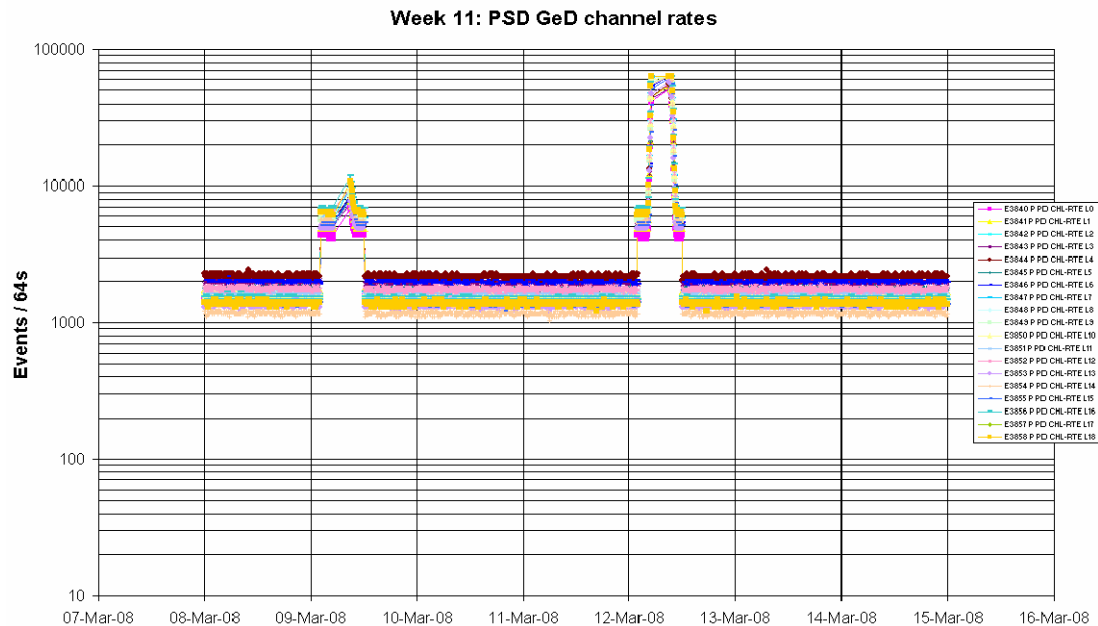
AFEE: The health of the AFEE is nominal. The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06/12/2003 and detector #17 is failed since 17/07/2004.



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:

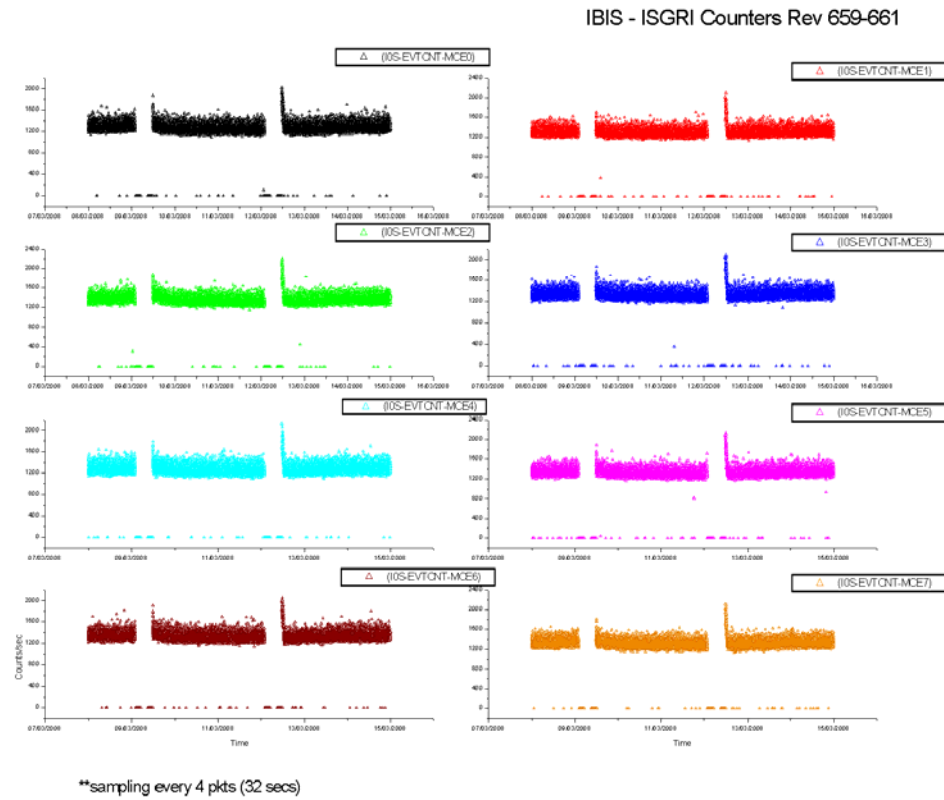
The following non-nominal events occurred on SPI over the reporting period:

- On 2008-03-09 at 05:05:37Z OEM APID 1024 ID 1 EXCEPTION SPI1 FIXED POINT OVERFLOW was received. This was during the LOS_CHK window of revolution 659, when the time verification TC was sent. This OEM is sometimes received when this TC is sent and no action was taken.
- On 2008-03-12 at 12:08:33Z, due to continuing high radiation after the expected radiation belt exit of revolution 661, the TM parameter E3500 (ACS CntVetoBelow) went OOL High. As it returned within limits at 12:19:05Z, no action was taken.
- On 2008-03-14 at 12:58:20Z TM parameters E1296 (ACS ISB response parity error) and E1297 (ACS FEE Configuration error) went OOL (value = ERROR STATE). As they returned within limits at the next TM cycle, no action was taken.
- The TM parameter E2115 for the Plastic Scintillator temperature toggled OOL Warning Low several times throughout the week. The lower soft limits will be modified from -15degC to -17degC in the next IODB release.

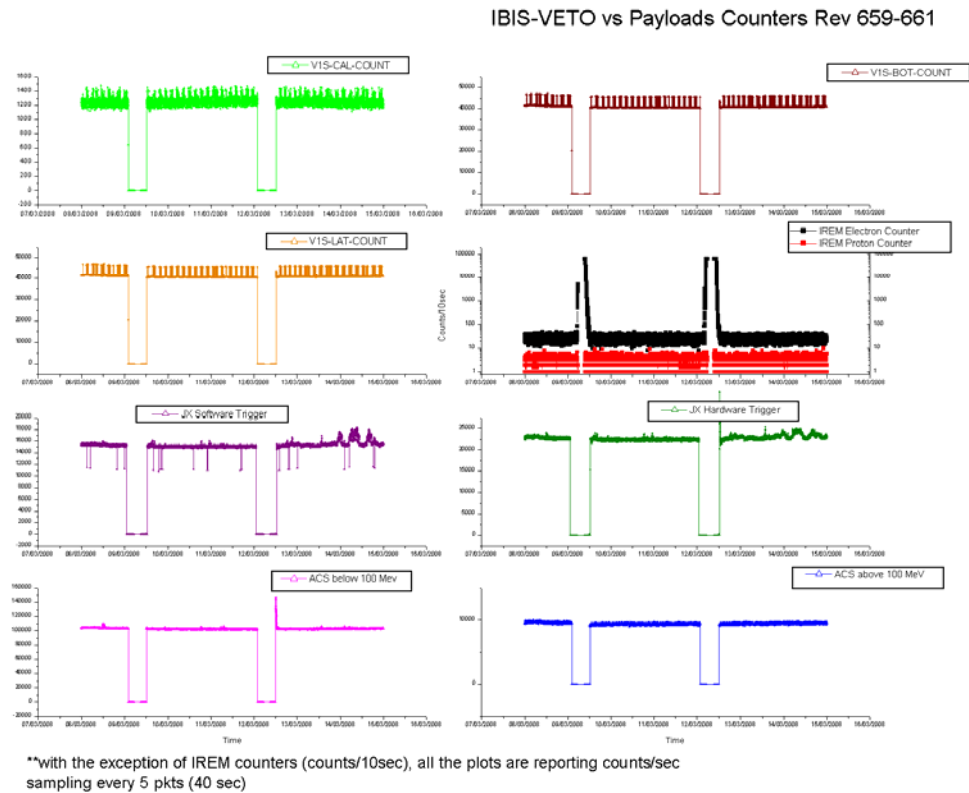
8.3.3 IBIS Operations

IBIS Event Counters Plots

ISGRI Counters:

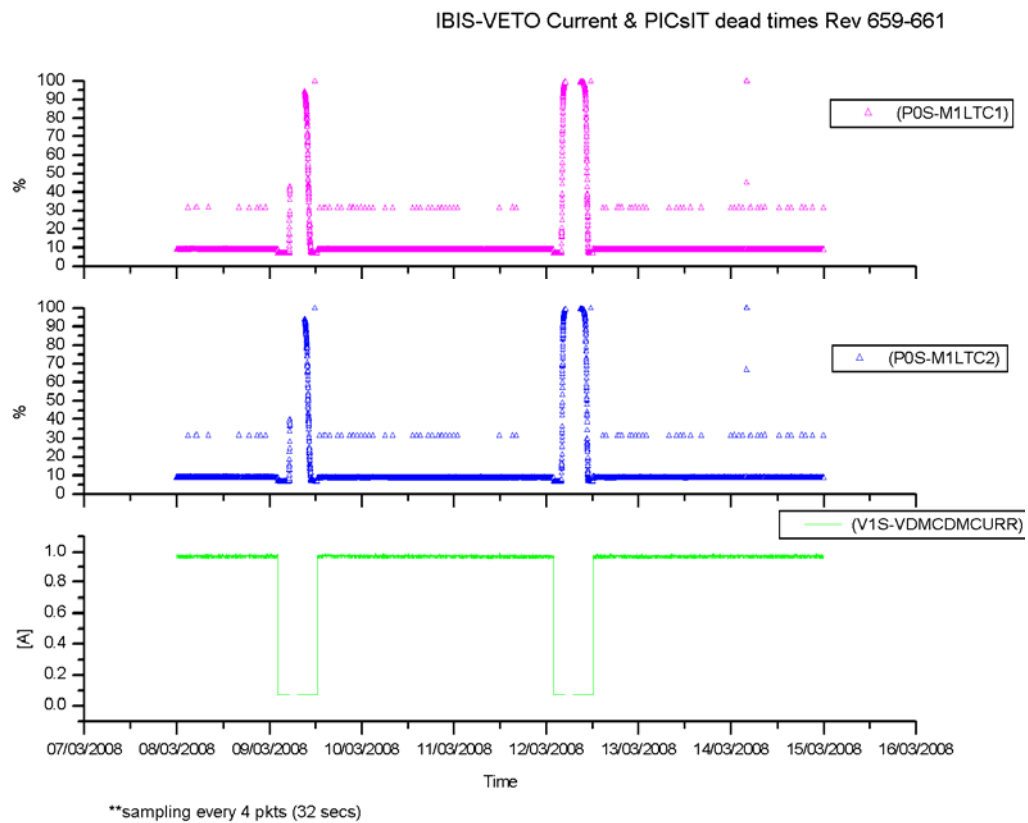


VETO vs Payload Counters:

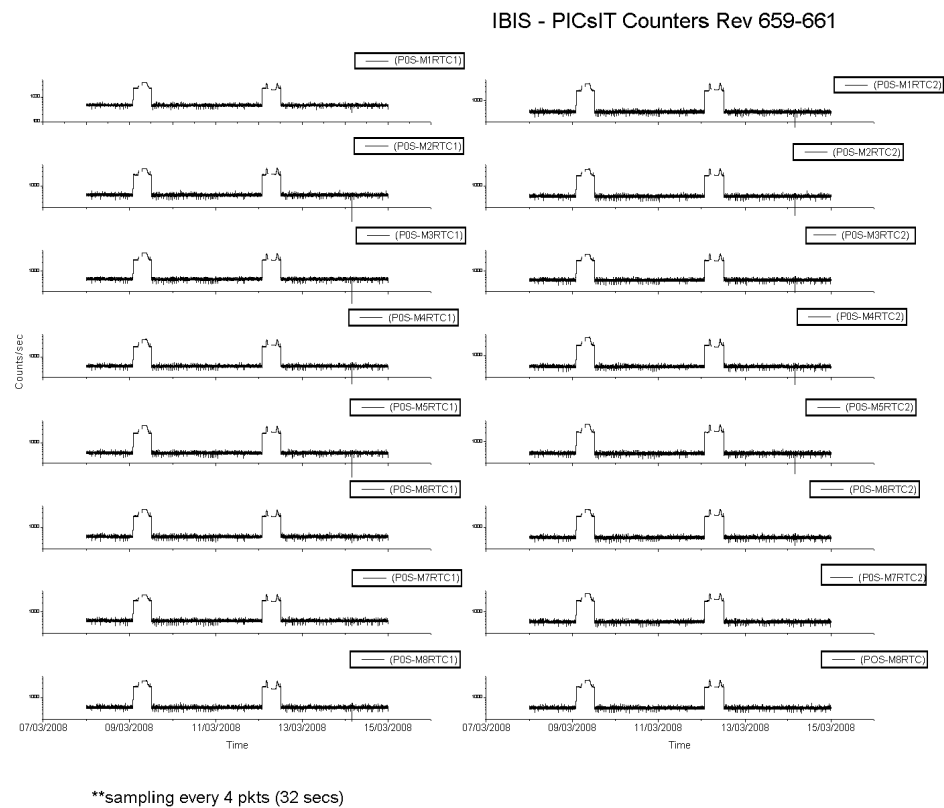


The week was characterised by low radiation as reported by the payload.

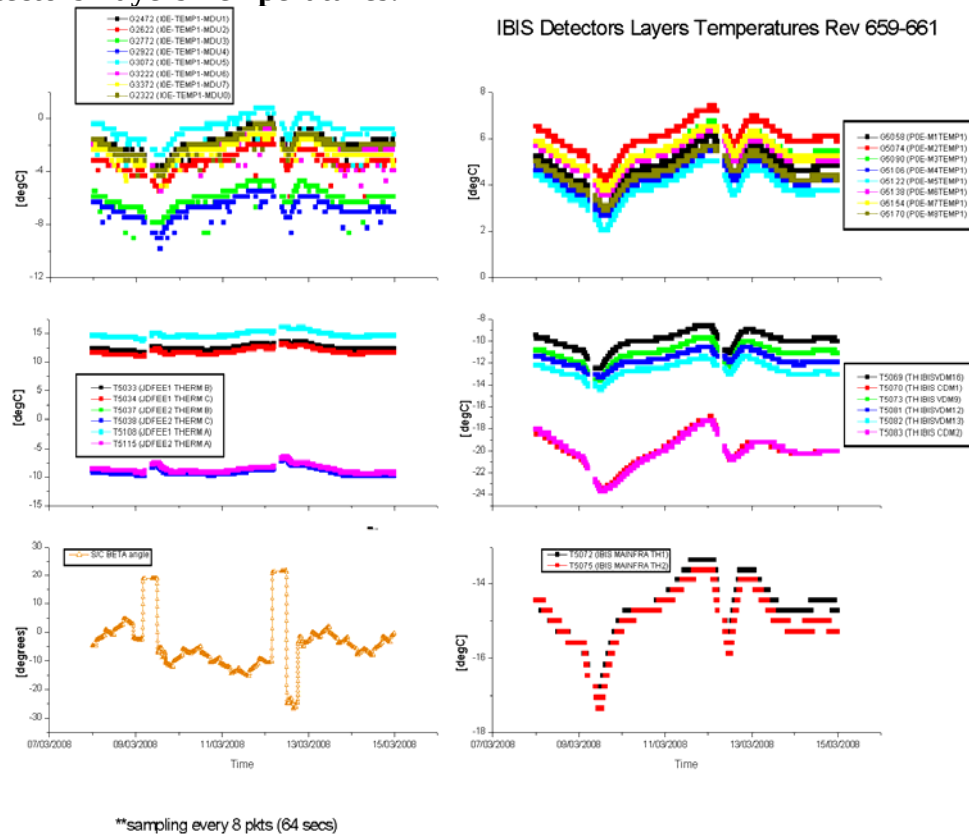
VETO Current:



PICsIT Counters:



IBIS Detectors Layers Temperatures:



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.

2008-03-08 (DOY 068, Rev 659) to 2008-03-13 (DOY 073, Rev 661)

IBIS operations executed nominally.

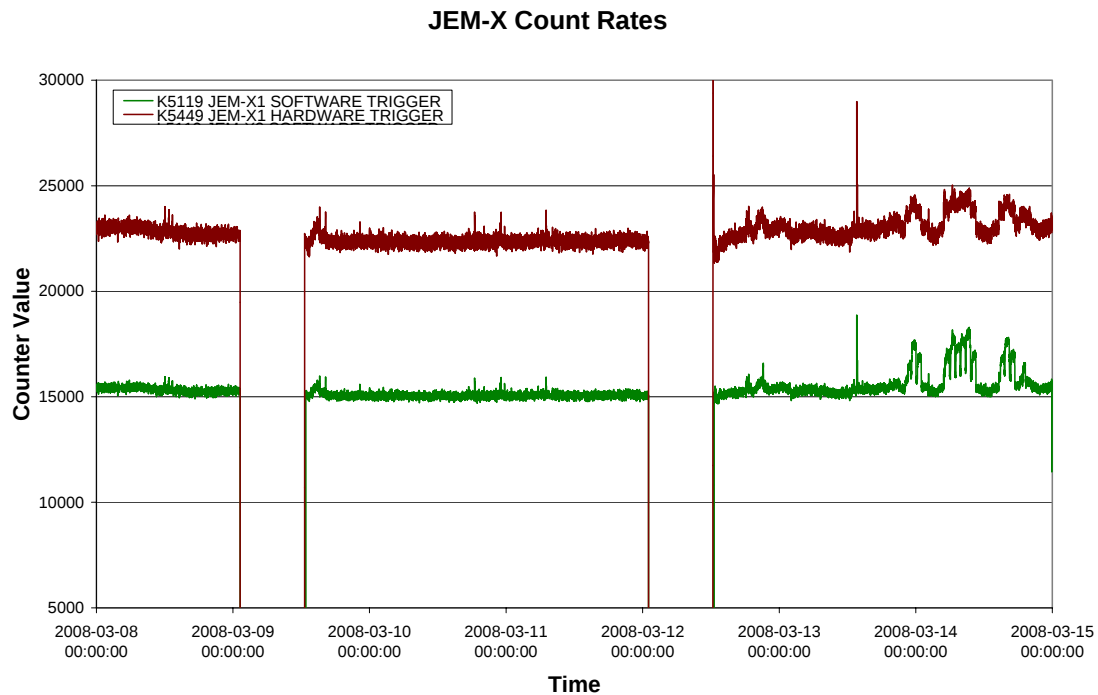
2008-03-14 (DOY 074, Rev 661)

At 04:04:33Z the TM parameters families G5068 and G5072 failed status consistency check (value = TRUE). These are the PDM semi-module FIFO error flags. At 04:04:52Z the TM parameter families G5002 and G5003 for the PDM semi-module counters started going OOL Low. As these were followed at 04:08:00Z 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 graph¹.



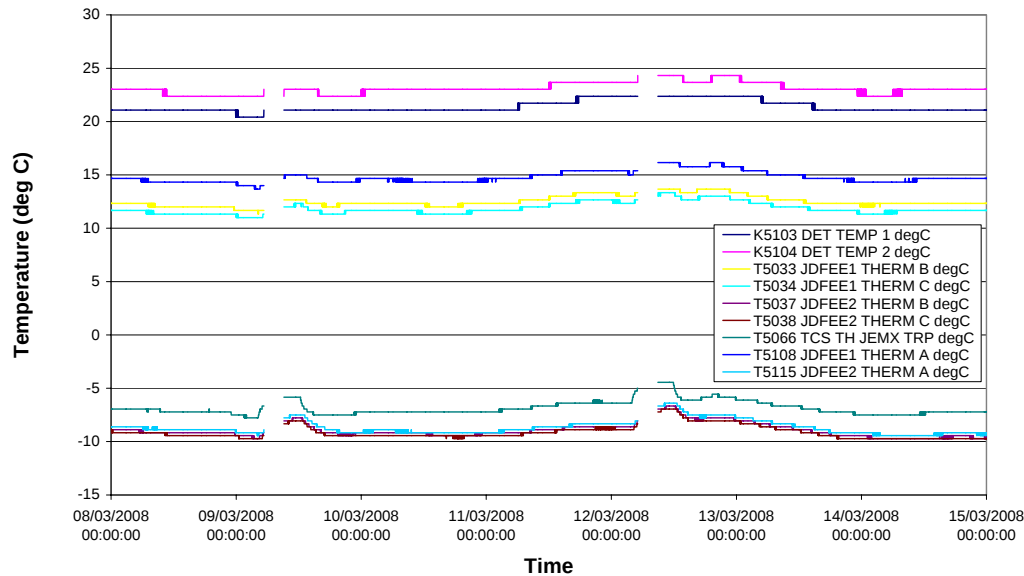
JEM-X Temperatures

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.

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)

JEMX Detector & DFEE Temperatures



JEM-X Daily Report

2008-03-08 (DoY 068, Rev 659)

JEM-X1 operations executed nominally.

2008-03-09 (DoY 069, Rev 659-660)

At 01:16:46, TC KU0014 terminated with status 'AFFECTED', and at 01:16:54, the same command terminated with status 'UNVERIFIED'. On both occasions, no action was taken and there was no impact.

2008-03-10 (DoY 070, Rev 660) to 2008-03-11 (DoY 071, Rev 660)

JEM-X1 operations executed nominally.

2008-03-12 (DoY 072, Rev 660-661)

At 11:45:36, and 11:52:39, TM parameter K5317 exceeded hard limits. At 12:22:14, TM parameter K5449 exceeded its soft limits. On each occasion, no action was taken and there was no impact.

2008-03-13 (DoY 073, Rev 661) to 2008-03-14 (DoY 074, Rev 661)

JEM-X1 operations executed nominally.

8.3.5 OMC Operations

2008-03-08 (DoY 068, Rev 659)

At 04:01:57, a TM drop from DSS-27 caused the slew commands to fail. A manual recovery was performed, and the Timeline rejoined at 04:32. The impact was the loss of pointing 06590045.

2008-03-09 (DoY 069, Rev 659-660) to 2008-03-10 (DoY 070, Rev 660)

Nothing to Report.

2008-03-11 (DoY 071, Rev 660)

At 07:41, a 16 minute drop in the TC & TM from Goldstone forced the suspension of the Timeline. After the spacecraft was re-acquired, a manual recovery was performed. The Timeline was rejoined at 08:31. The impact was the loss of pointing 06600047.

2008-03-12 (DoY 072, Rev 660-661) to 2008-03-14 (DoY 074, Rev 661)

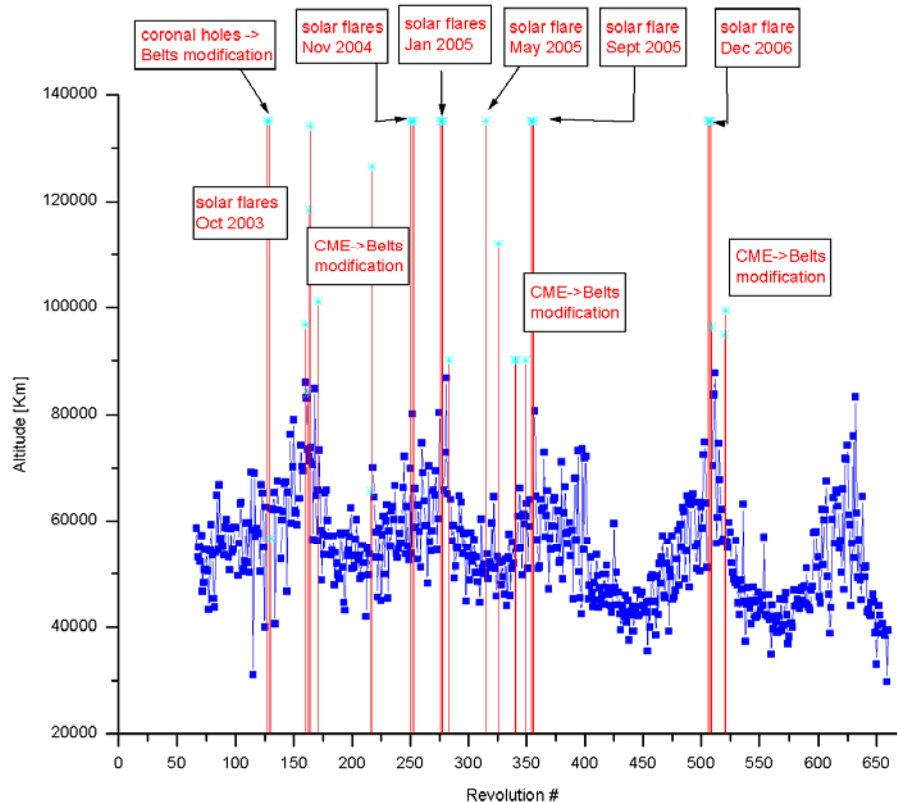
Nothing to Report.

On DoY 069 at 02:10:22 and DoY 072 at 01:55:50 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

Nothing to report.

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]
659	RAD_ENTR R 2008-03-09T02:10:19Z	09/03/2008 05:07:57	29723.0	09-Mar-2008 03:38:22	43169.31
660	RAD_EXIT R 2008-03-09T12:14:26Z	09/03/2008 11:49:57	>>33217.5	09-Mar-2008 11:18:22	45206.89
660	RAD_ENTR R 2008-03-12T01:55:45Z	12/03/2008 03:51:09	39389.5	12-Mar-2008 03:28:43	42508.68
661	RAD_EXIT R 2008-03-12T11:59:56Z	12/03/2008 11:53:25	52148.0	12-Mar-2008 11:08:43	45864.29

Reference

High radiation

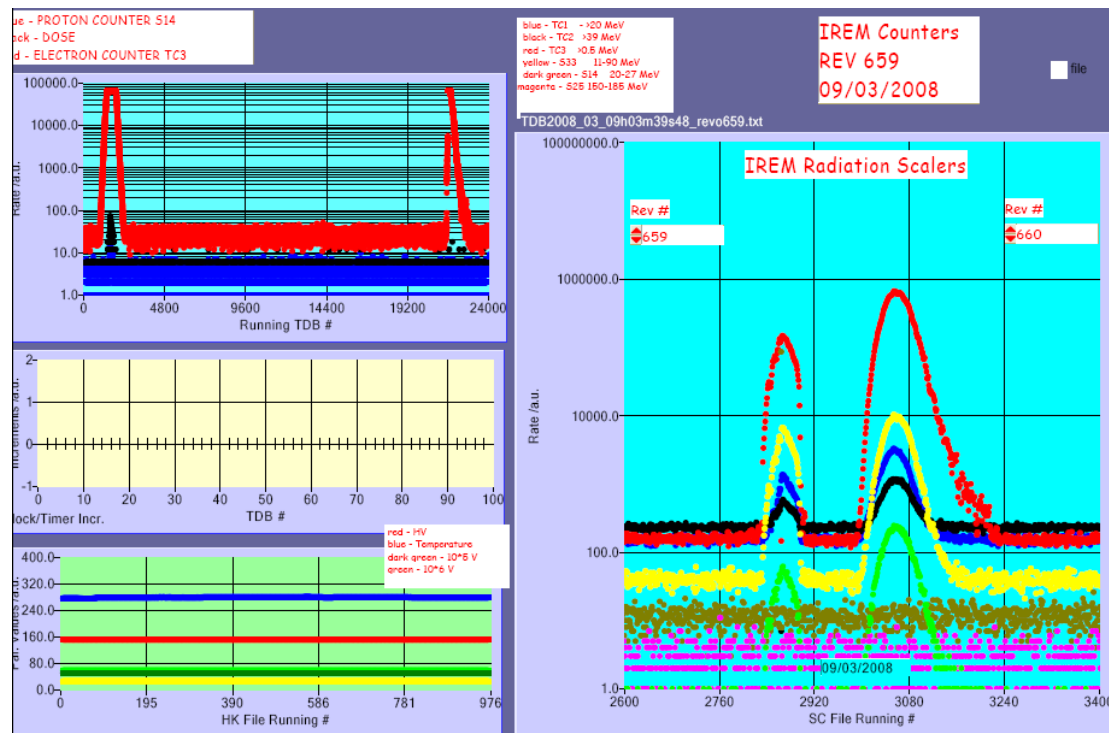
Very small error vs reference (less than 10 minutes)

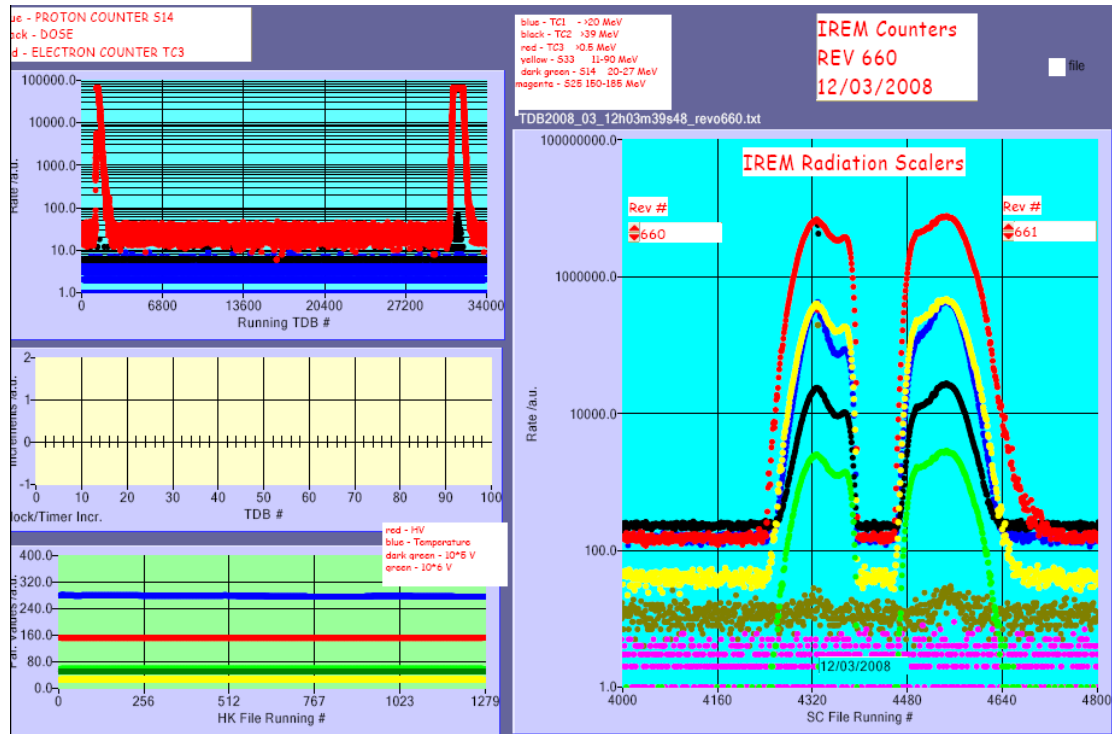
Small error vs reference (between 10 and 30 minutes)

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.

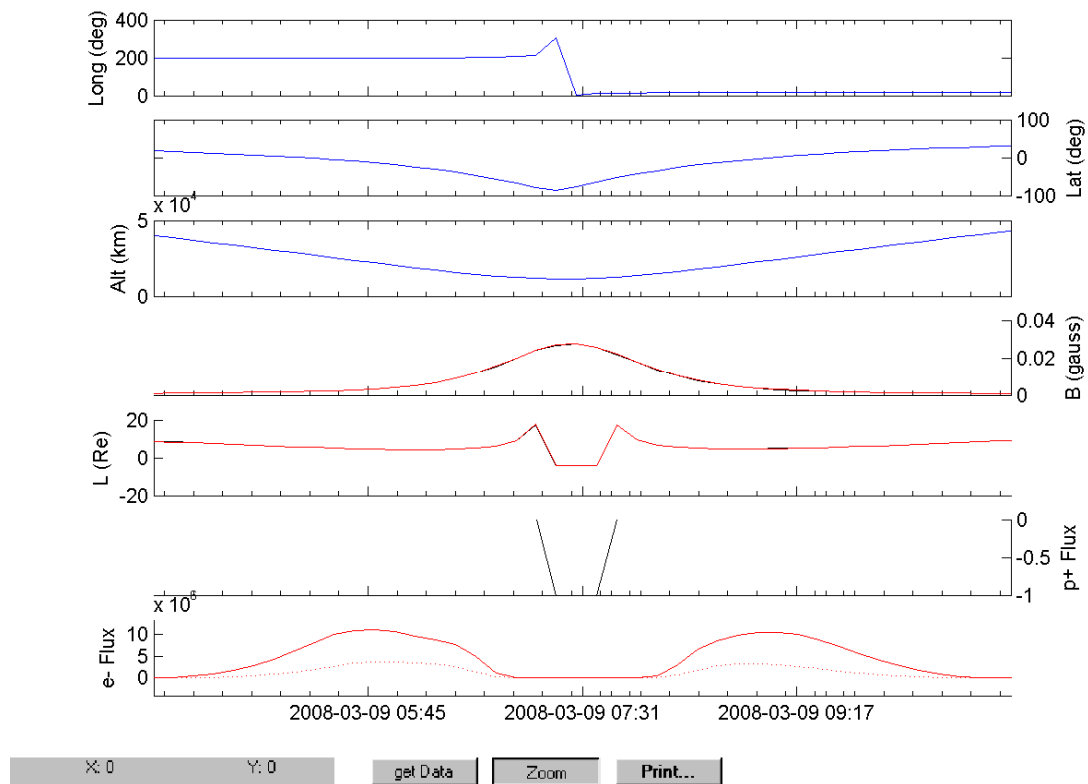
IREM radiation counters:



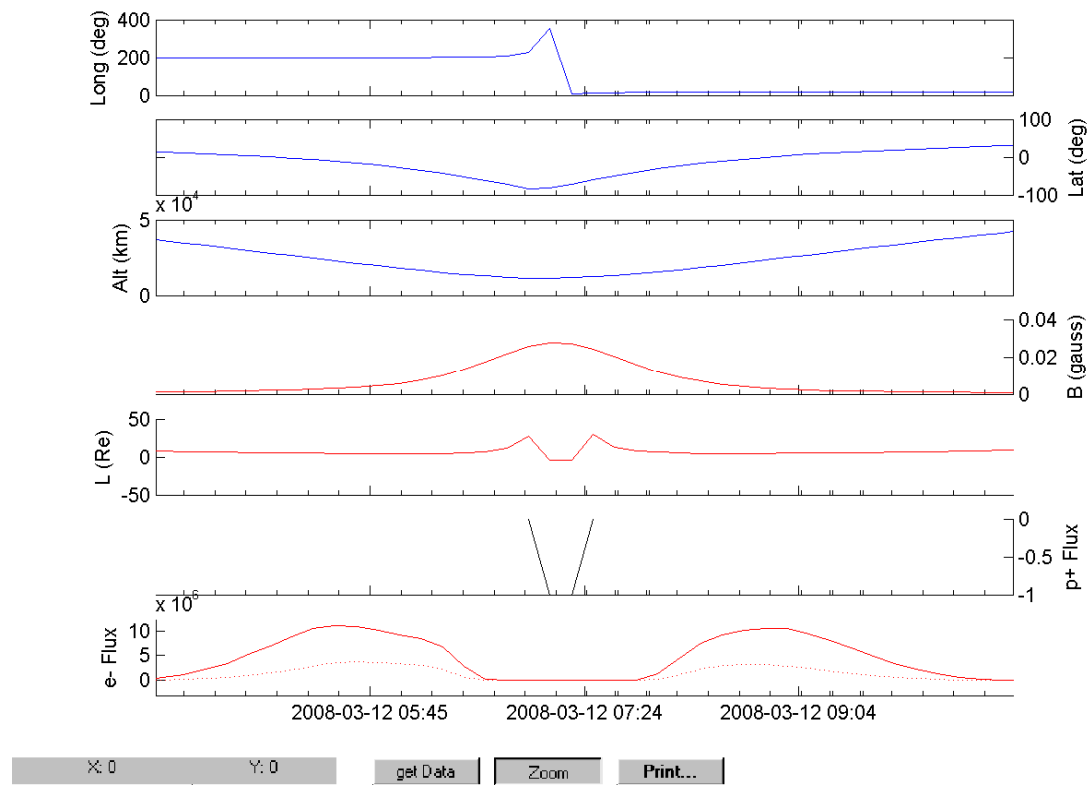


IREM Predicted Radiation Belt Passages

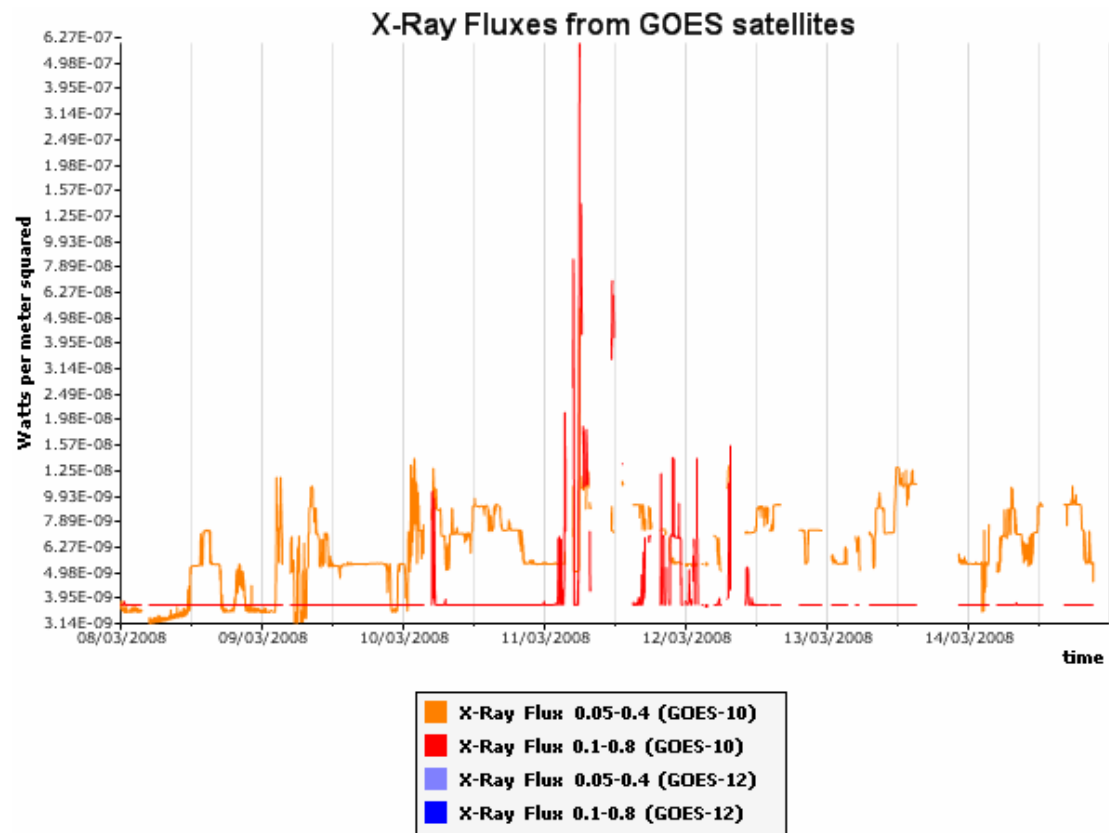
Rev 659



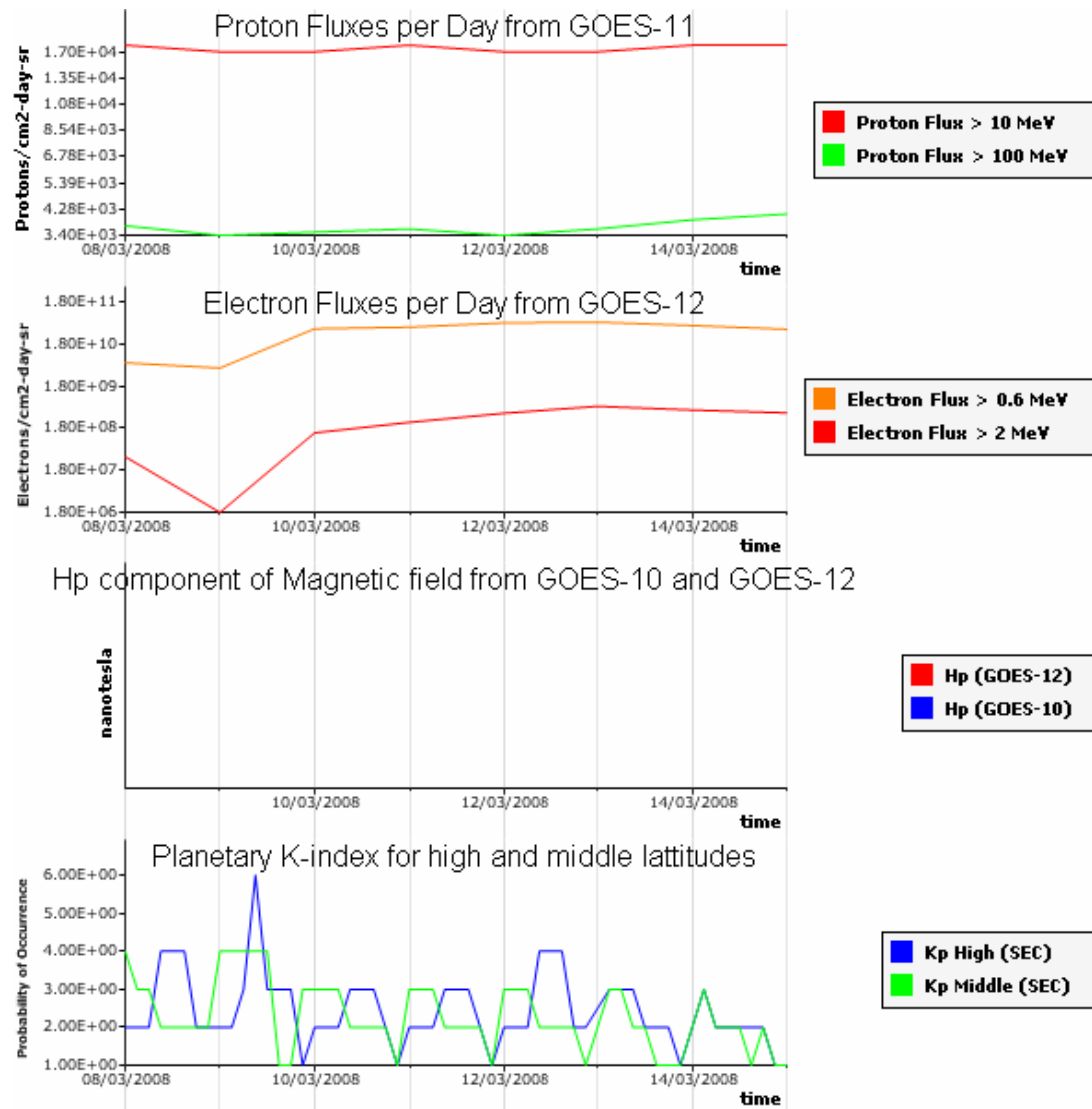
Rev 660



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



X-Ray fluxes start to be significant over 10^{-5} W/m² (corresponding to M-class flares). Above 10^{-4} W /m², 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.