

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OAI
No. 285
Week 10
10.03.08
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 01.03.08 until 07.03.08 (both dates inclusive) and covers the revolutions 658 and 659.

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 Orion OB1 (RA 05:17:00.30, DEC +01:47:17.7).

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.

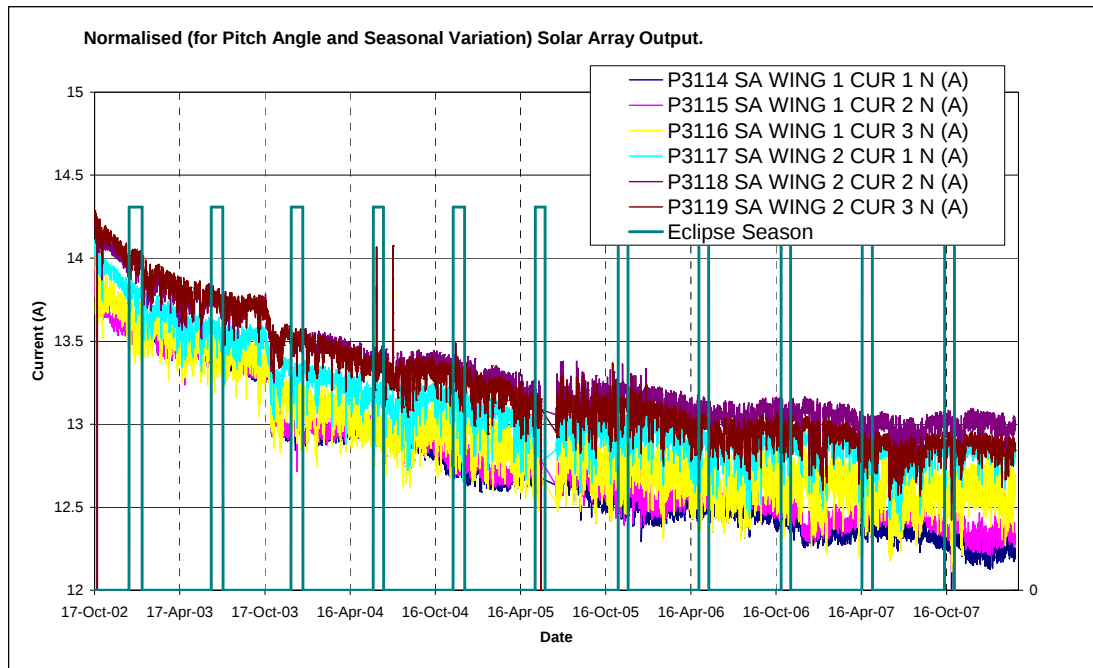
The fuel consumption over the period between 01/03/2008 and 06/03/2008 was 0.0867 Kg. The remaining propellant is in the order of 142.0065Kg.

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

3.1.2 Power

The Evolution of the Array Output Currents is shown in the plot below, the most indicative values of the actual output are P3114 and P3115 (the lowest values), as these are the 2 sections which are permanently supplying the main bus - under load the array output currents are somewhat lower than open circuit.

As expected the rate of degradation is decreasing, currently the arrays can produce a maximum of 2100W, this will fall to about 2000W in July due to seasonal effects. The power margin is still sufficient to power the Satellite without pitch angle constraints and is expected to remain so until the end of the nominal mission.



3.1.3 Thermal

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

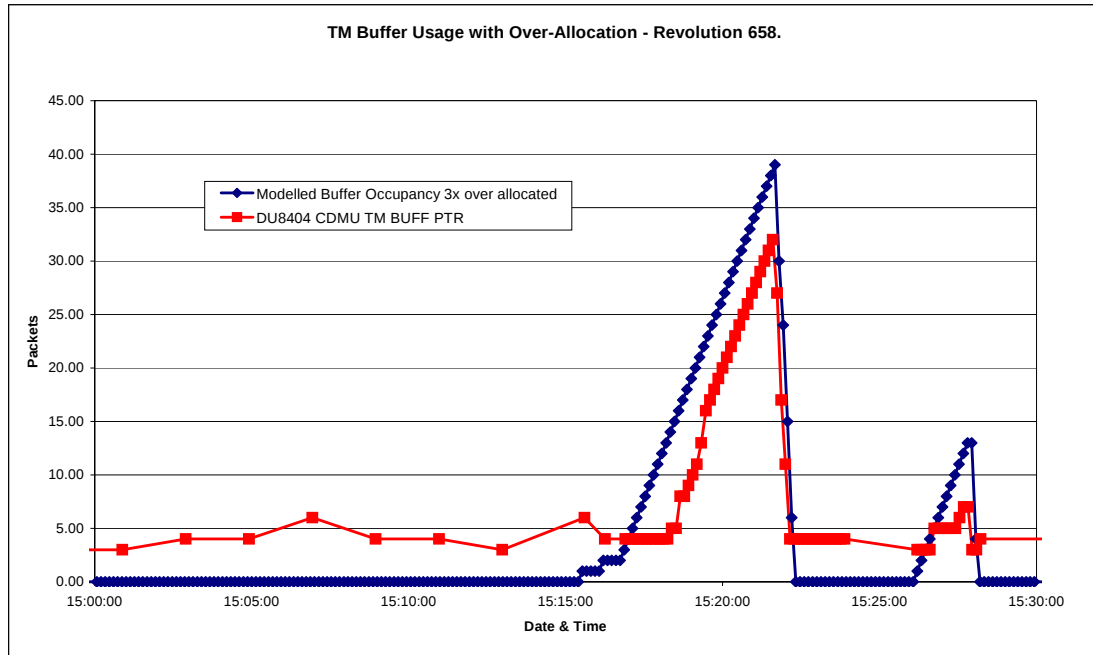
3.1.4 OBDH

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.

On 3/3/2008 all PTs were saturating their TM bandwidth for long periods of time, in order to verify the TM buffer modelling assumptions a memory dump was started in order to force the satellite to produce more TM than the available downlink bandwidth. The results are in the plot below which shows the modelled TM buffer usage and the actual buffer pointers contained in report telemetry, two things are obvious:

- At low buffer occupancy the model is inaccurate. Probably some temporary storage of packets is always necessary. However, we are not interested in low buffer occupancy, so this is not a problem.
- Once some TM build up occurs, the model actually over-estimates the actual buffer usage by about 6 packets. This just means that we would get any alarms slightly earlier than expected.



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

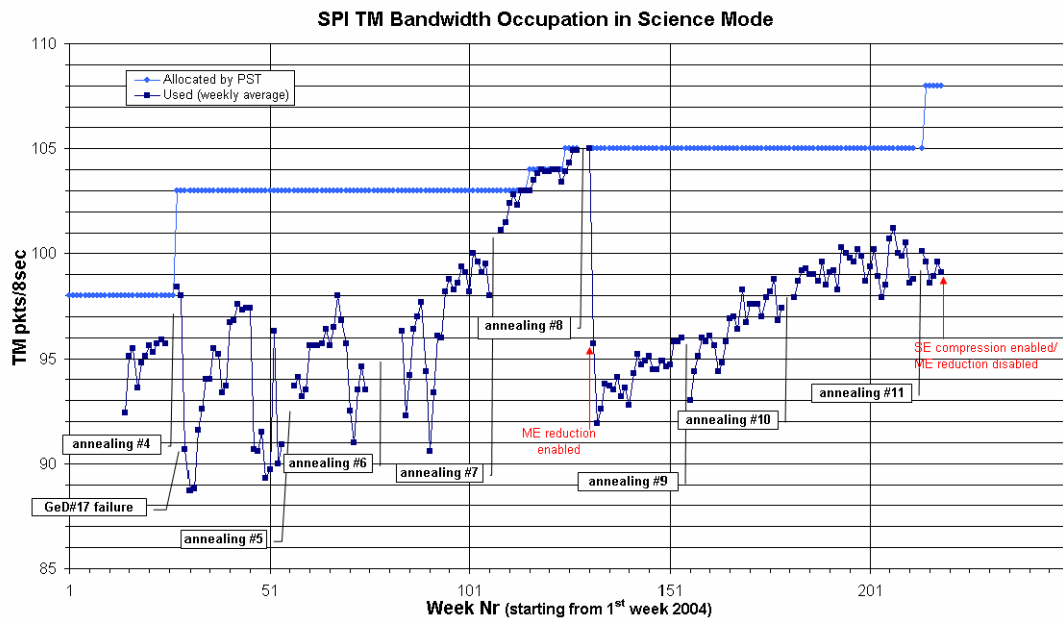
Following the 11th annealing, which ended on 30th January, the overall status of the gamma-ray spectrometer is nominal, except for the Ge detector #12 which, although its energy resolution improved since the previous annealing, is still showing a slightly degraded energy resolution compared to the other 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 99.1 packets/cycle.

On 2008-03-06, before radiation belt exit of revolution 659, the Single Event compression function was enabled and Multiple Event reduction was disabled in line with INTGSCCR-88.

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



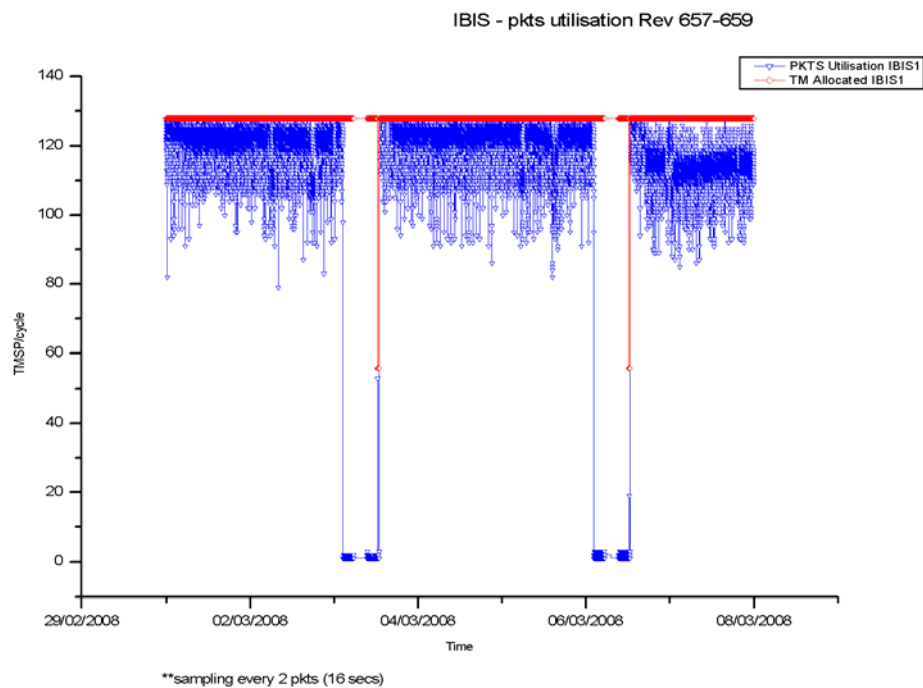
Note: Some more information concerning the SPI operations is provided in the Appendix.

3.2.2 IBIS

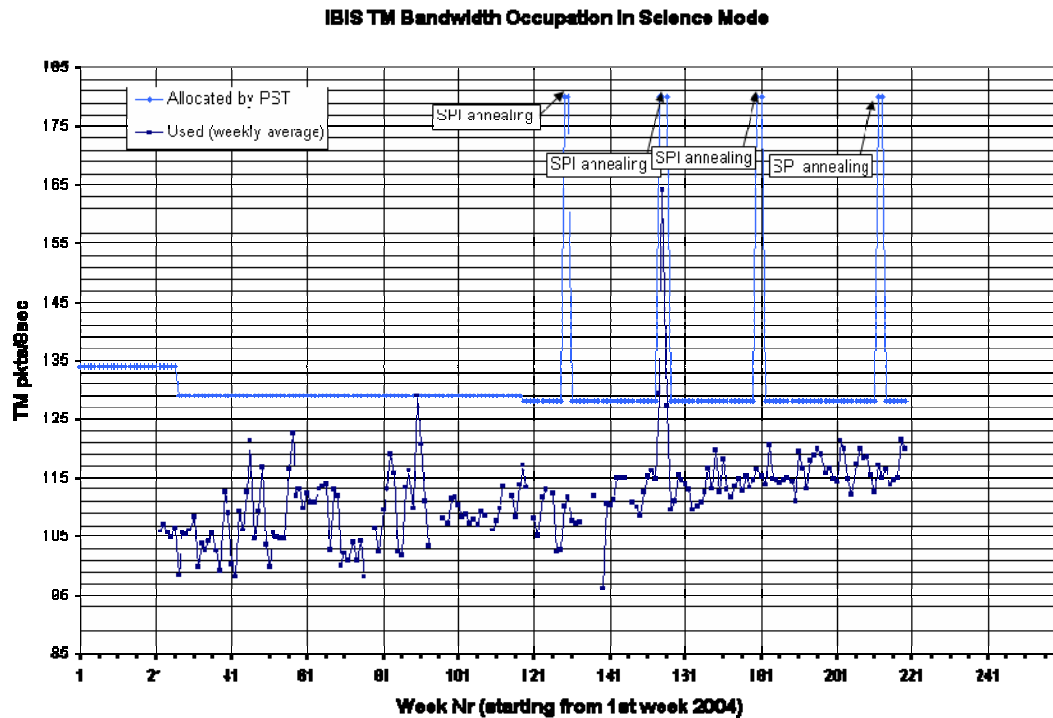
The overall status of the unit is nominal.

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 119.81 packets/cycle, down 1.7 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, all of the 143 planned science pointings were executed nominally.

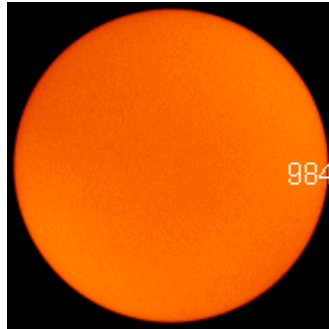
Note: Some more information concerning the OMC operations is provided in the Appendix.

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 emerged briefly on the 4th March, but disappeared the same day before it was categorised, and another bipolar sun spot appeared 7th March (#984) just before it disappeared over the Sun's western limb. 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 very good this week. No pointings were lost to ground problems. The overall performance was nearly 100%.

4.1 Mission Operations Centre

The performance of the MOC was very good this week. There was only one anomaly noted, a lost connection to the TM RT cache, which was immediately manually corrected without impact.

4.2 Ground Stations & Network

The performance of the ground stations and Network was very good this week. There were, however, two occasions where bad frames came from Redu, and one occasion where there were missing source packets from DSS24, there was no impact. Also the voice loop with ISDC dropped twice.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

A new PSF has been received for revolution 667.

No new observations have been planned yet, as the details of the next Crab calibration observations in revolutions 665 and 666 had to be settled first.

No new TSFs have been received.

2. Observation status

New ECSs have been received and processed for revolutions 651 and 652.

3. ISOC Science Data Archive

An ISDA status meeting was held on 4th March, settling the contents of the next releases. New disks have been made available. The ingestion, that had to be temporarily stopped, is now continuing normally.

4. ISOC system

Version 18.1 has been tested and will be installed after the AO release - it does not affect proposal submission.

ISOC is waiting for the outcome of the investigation at ESOC on problems using the latest Flight Dynamics software.

5. Problems

None.

4.3.2 ISDC

Status of ISDC observation processing on 10/03/2008:

- Latest Standard Analysis completed: observation 04200730054 (Galactic disk latitude scans, Revolutions 651) on 06/03/2008.
- Latest products archived: observation 04200730057 (Galactic disk latitude scans, Revolutions 651) on 06/03/2008.
- Latest observation products sent to the observer: observation 05200010018 (Galactic Bulge region, Revolution 651) on 07/03/2008.

5 Special Events

6 Anomalies

There were no problems reported this week that impacted operations.

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

AR id	Date Created	Subject	Segment	Status
INT-2982	2008-03-05	BAD Frame reception while Redu1 Tracking	ESA Stations	Pending

.

7 Future Milestones

The following activities are foreseen in the next few weeks.

Doc. Title : INTEGRAL Mission Report #285
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Date : 10/03/08

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Rev. : 0
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- 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 658

The observations in revolution 658 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 659

The observations in revolution 659 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 hexagonal dither of the Gamma Ray Source 1915+105 (RA 19:15:11.50, DEC +10:56:44.0), lasting ~5.6 hours. Finally, a raster dither of Orion OB1 (RA 05:17:00.30, DEC +01:47:17.7), lasting ~43.8 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 105; JEM-X1 8; JEM-X2 0; OMC 5.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

2008-02-15T20:46:11.000Z	142.2251	F	Automatic TM processing.
2008-02-17T11:15:59.000Z	142.2109	F	Automatic TM processing.
2008-02-18T17:49:46.000Z	142.1885	F	Automatic TM processing.
2008-02-20T11:03:59.000Z	142.1716	F	Automatic TM processing.
2008-02-21T14:25:54.000Z	142.1609	F	Automatic TM processing.
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.

This report was generated Fri Mar 7 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, 01/03/2008 – 07/03/2008

The AOCS operations were executed from the Automatic Timeline.

During this period, 68 Open Loop Slews, 86 Closed Loop Slews and 5 Momentum Biases were executed (as reported by ACC).

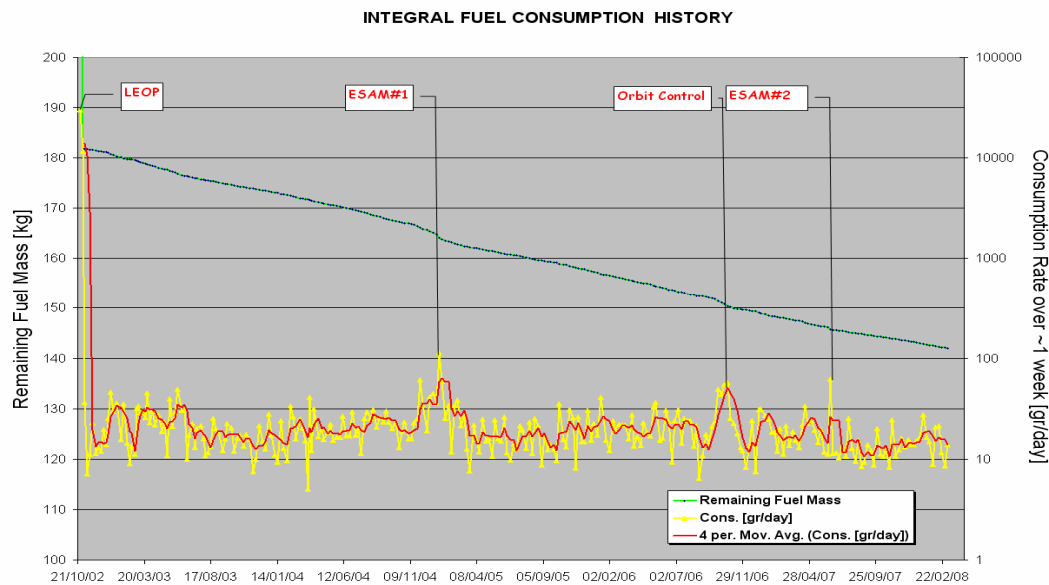
No slews were missed from TL, during the observation period.

Orbit Control

No update

Fuel consumption

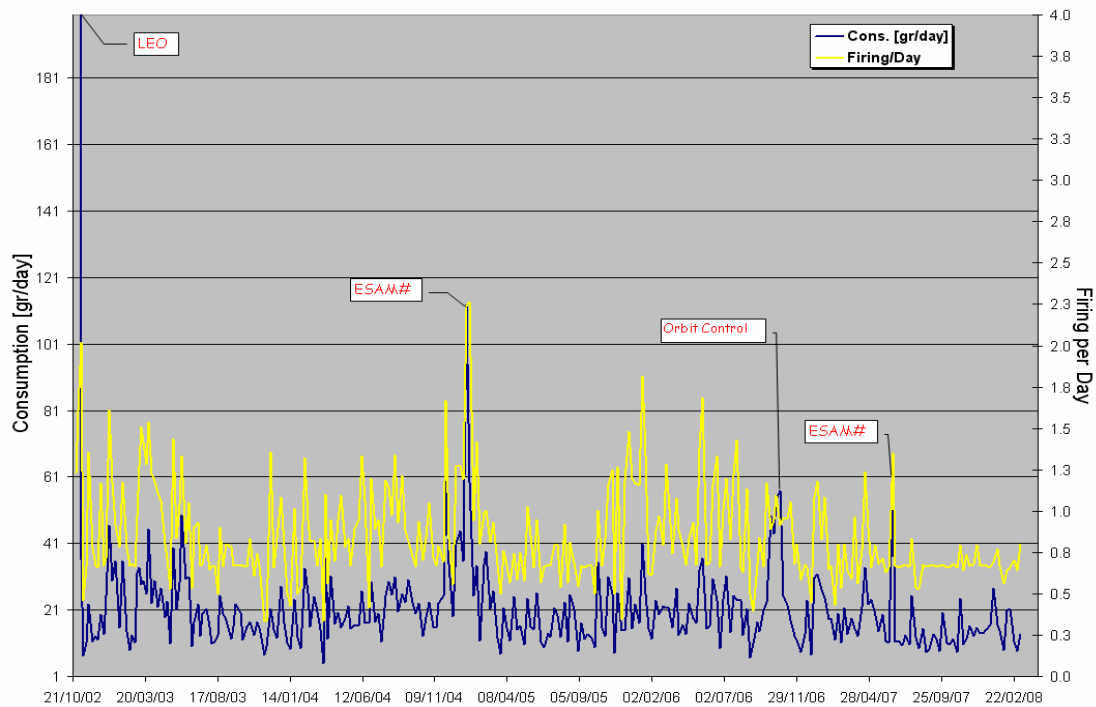
The fuel consumption (total, grams per day) over the period between 01/11/2002 and 06/03/2008 is reported in the plot below.



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 06/03/2008 is reported in the plot below.

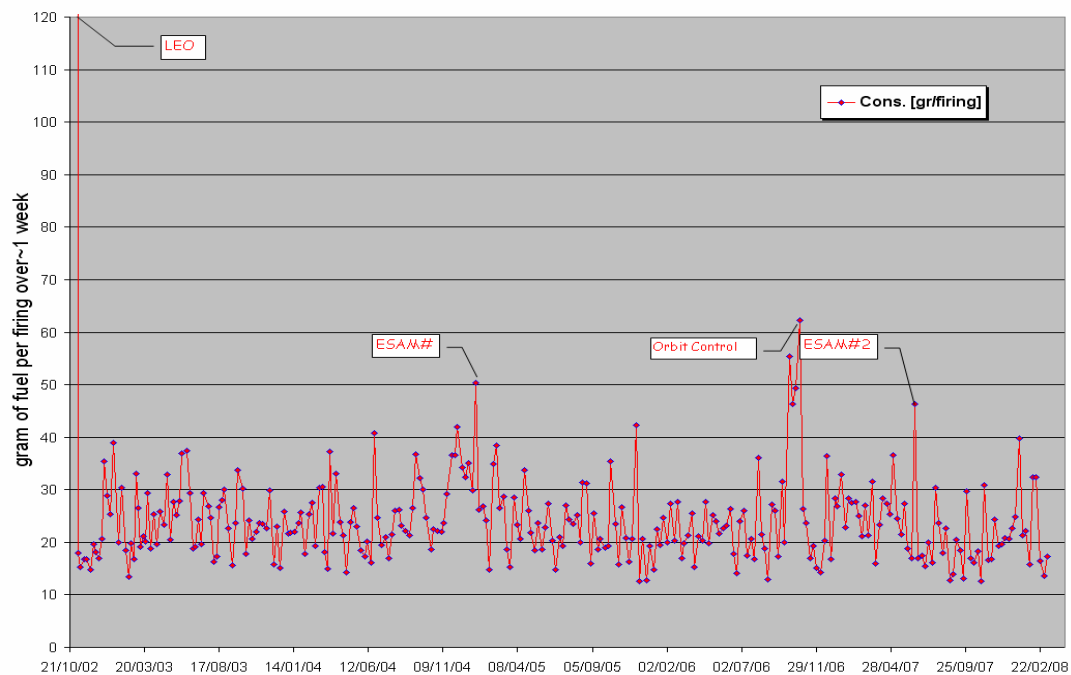
INTEGRAL FIRING PER DAY HISTORY



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

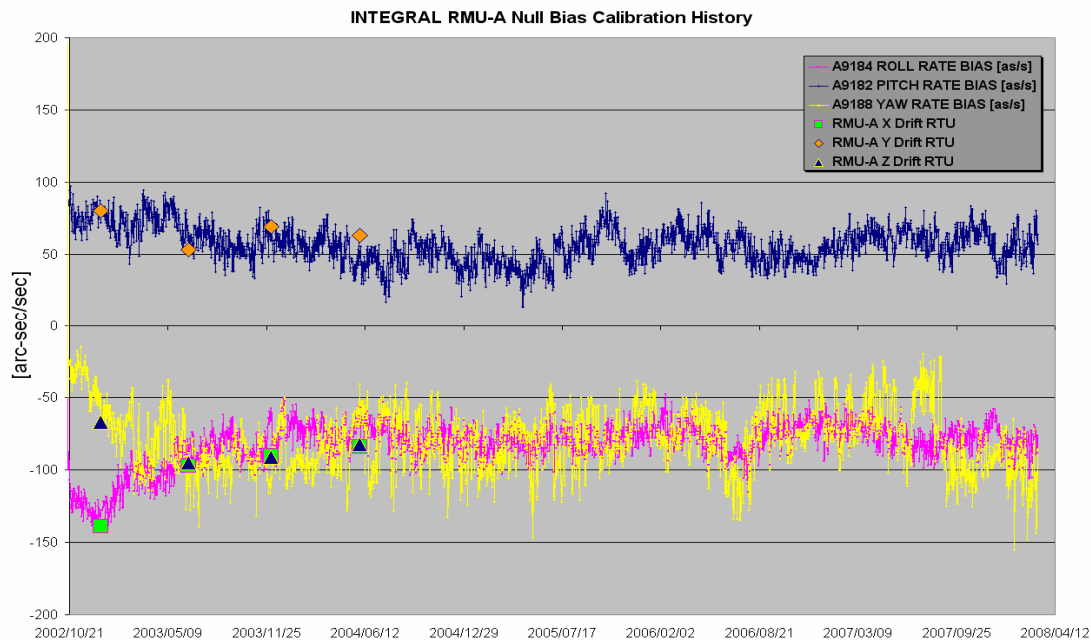
The fuel per firing over the period between 01/11/2002 and 06/03/2008 is shown in the plot below.

INTEGRAL FUEL MASS PER FIRING HISTORY



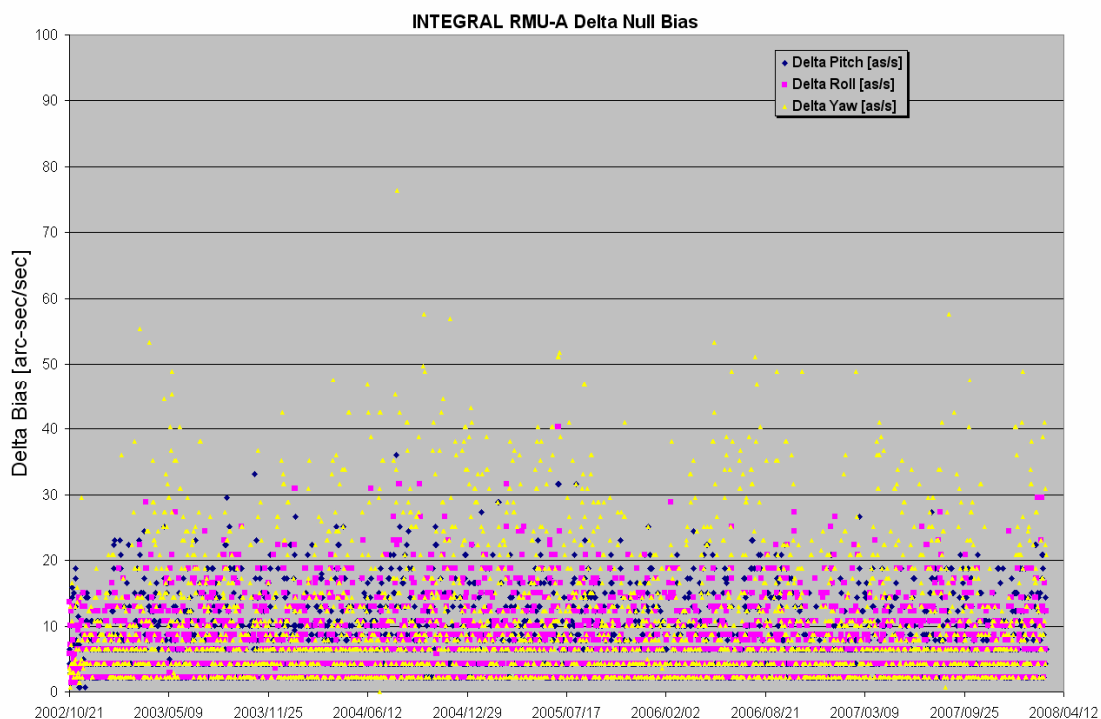
The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 07/03/2008 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 07/03/2008 is reported in the plot below.



01/03/2008 (Day of Year 061, Revolution 657)

Nothing to report.

02/03/2008 (Day of Year 062, Revolution 657)

Nothing to report.

03/03/2008 (Day of Year 063, Revolution 657-658)

Nothing to report.

04/03/2008 (Day of Year 064, Revolution 658)

Nothing to report.

05/03/2008 (Day of Year 065, Revolution 658)

Nothing to report.

06/03/2008 (Day of Year 066, Revolution 658-659)

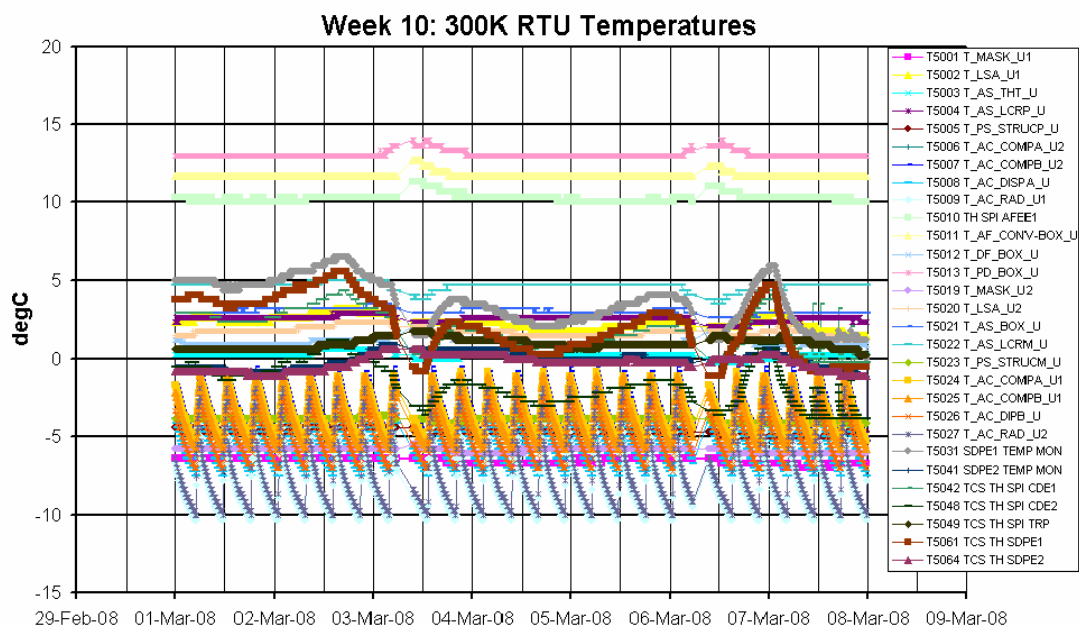
Nothing to report.

07/03/2008 (Day of Year 067, Revolution 659)

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.

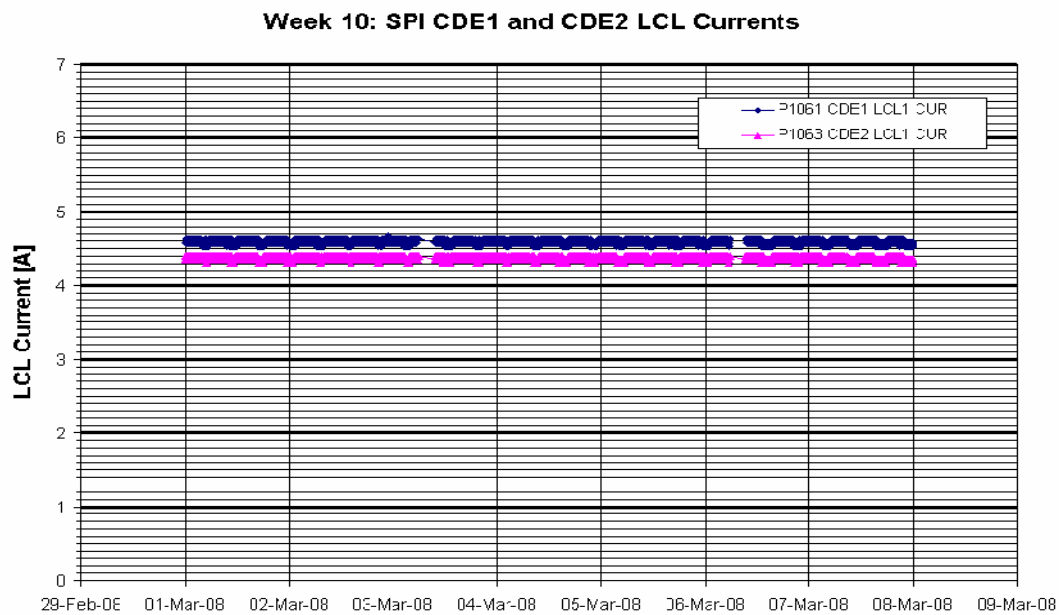


Stirling Compressors and Cryostat: The performance of the compressors is nominal. The cold plate temperature was maintained in the range 80K +/-1K, with a positive drift of 0.074K/day.

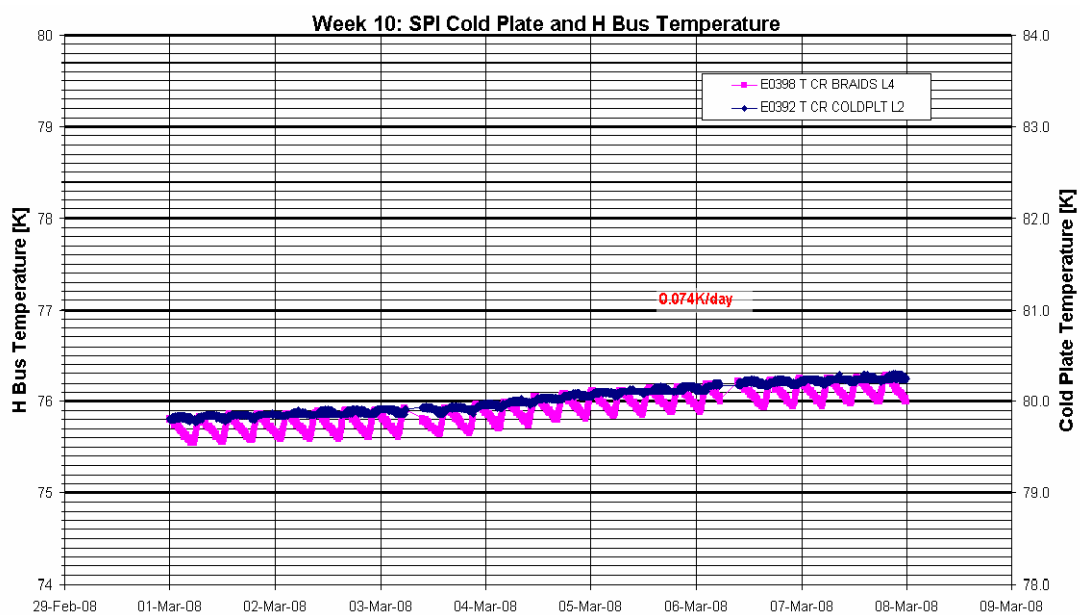
The stroke of all four compressors was set to 39 throughout the week. The average CDE LCL currents were as follows:

- CDE1 LCL Current = 4.59A
- CDE2 LCL Current = 4.37A

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.

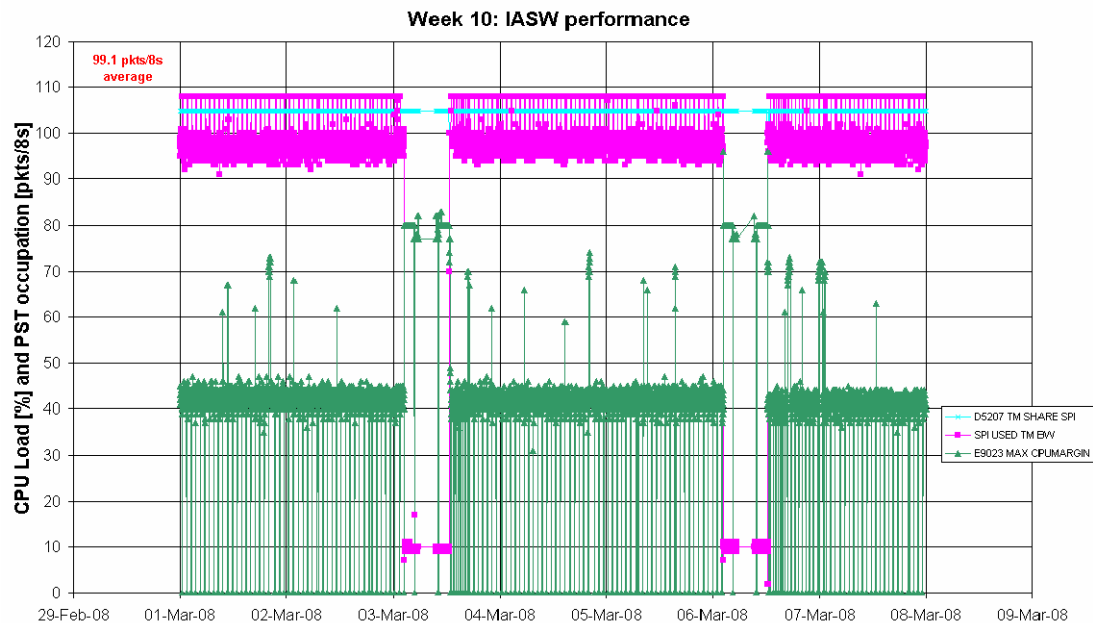


DPE & IASW: The DPE health and IASW performance is nominal.

The IASW version installed is v4.3.4. ME reduction only was enabled until the start of revolution 659, when SE compression was enabled and ME reduction disabled in line with INTGSCCR-88. This was done on 2008-03-06 at 10:15:11Z by uplinking the TPF ES1700_IASW-PAR_fmconfig_0015.TPF. The spectra scaling factor was set to 8/19 SE throughout the week.

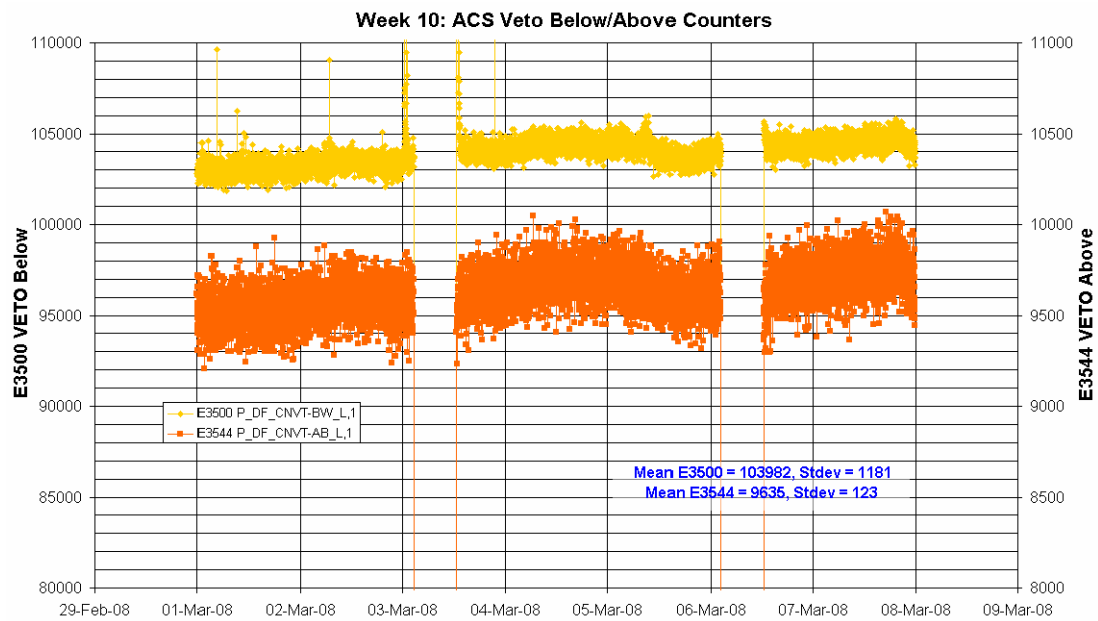
The average TM bandwidth occupation of SPI was 99.1 packets/cycle over the science window. The TM allocation in the science window was 105 packets/cycle, however the over-allocated PST with 108 packets/cycle for SPI was used (see plot below). Note that the Broadcast Packet TM allocation was not updated. 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.

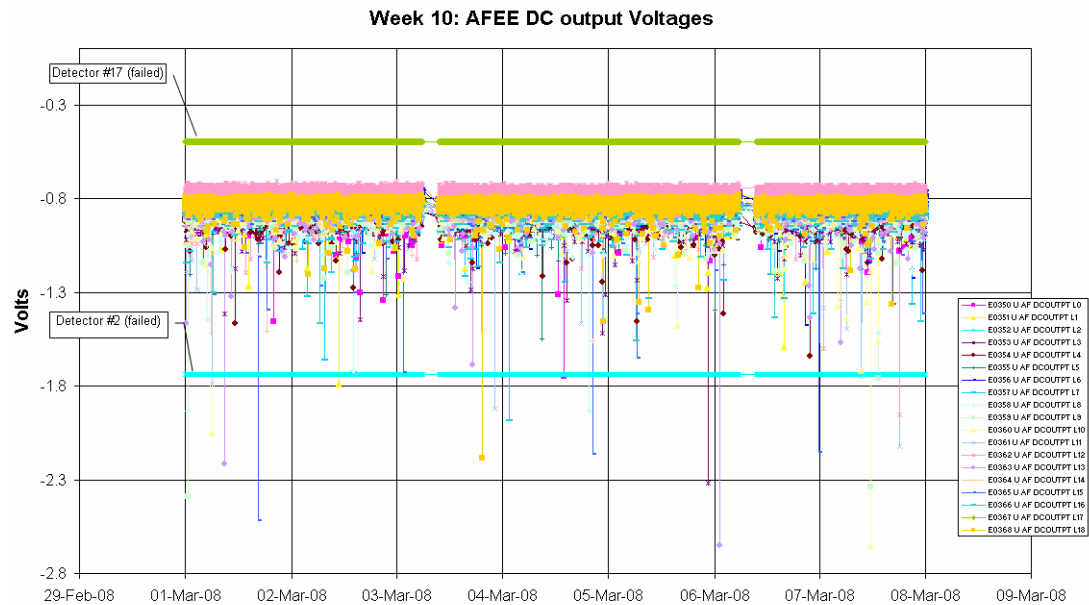


ACS: The performance of the ACS is nominal, except for FEE #81 which remains nominally switched off since the anomaly on 29/10/2006 (INT_SC-162) and FEE #57 which is nominally OFF due to the anomaly on 5/8/2003 (INT_SC-61).

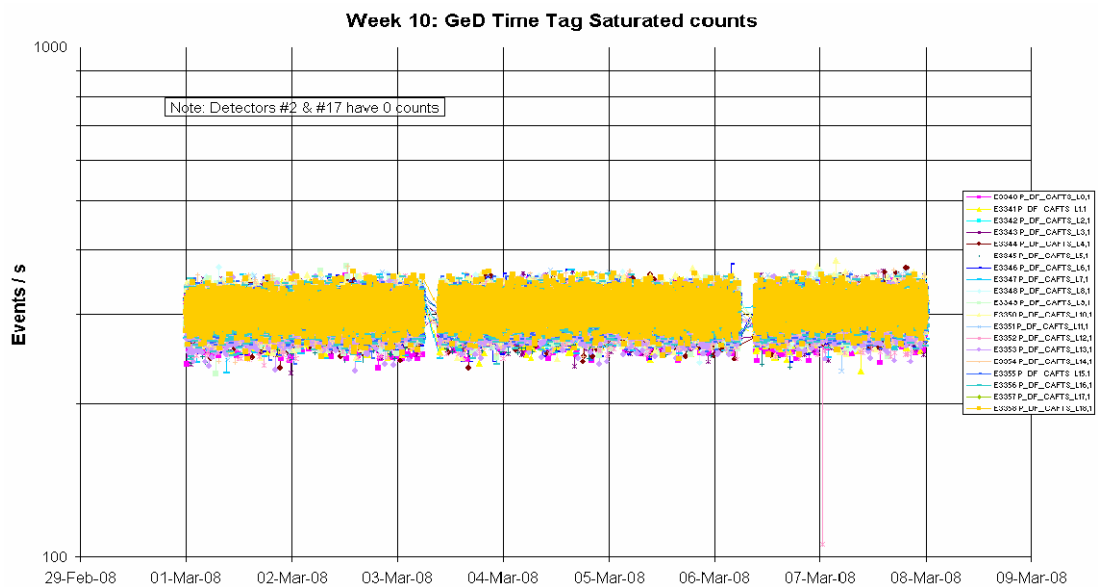
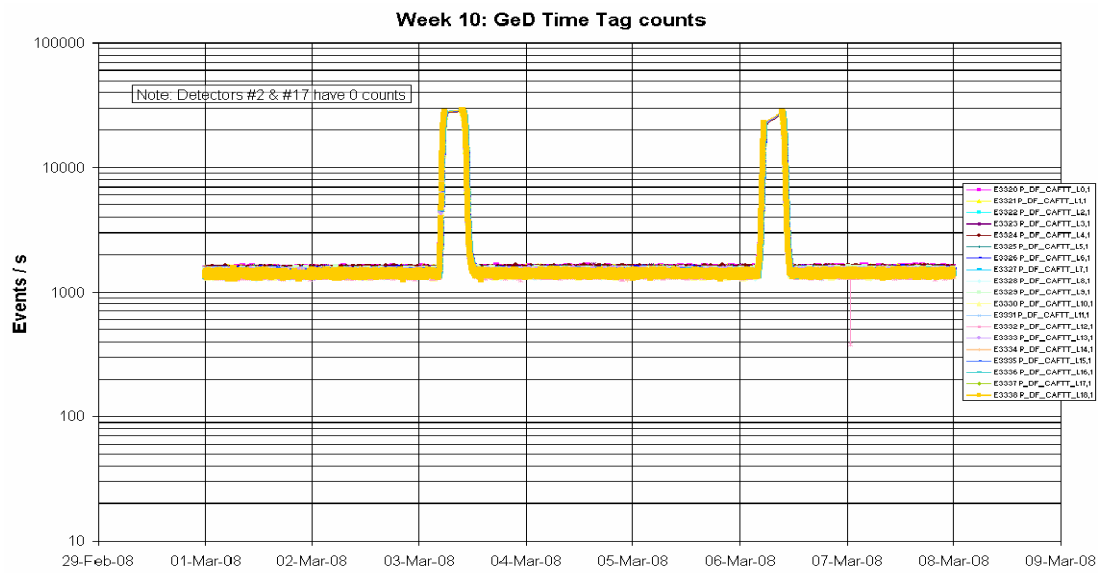
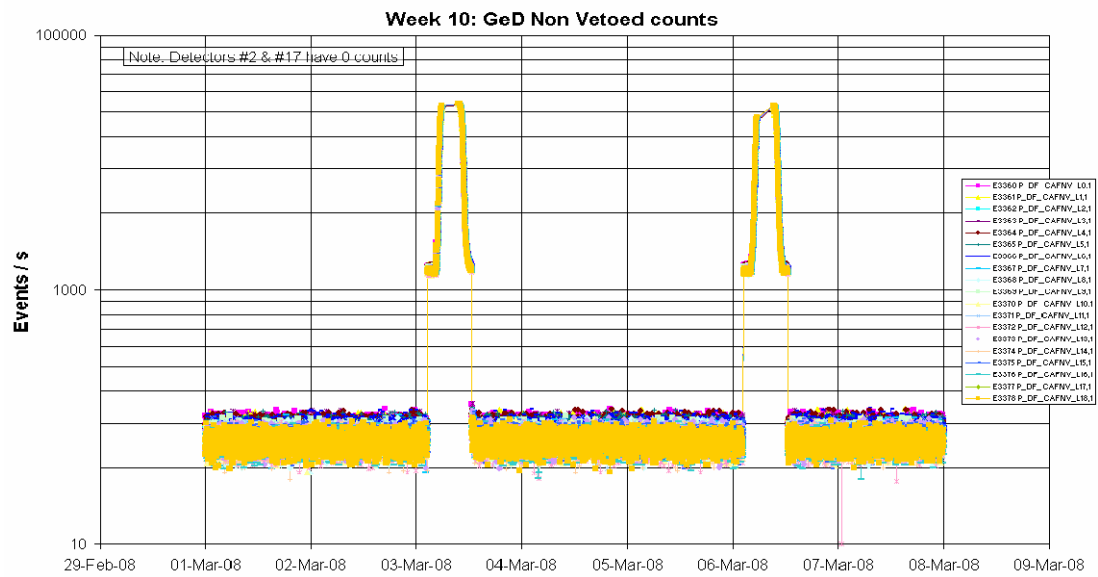
The following plot shows the ACS overall count rate evolution during the reporting period:



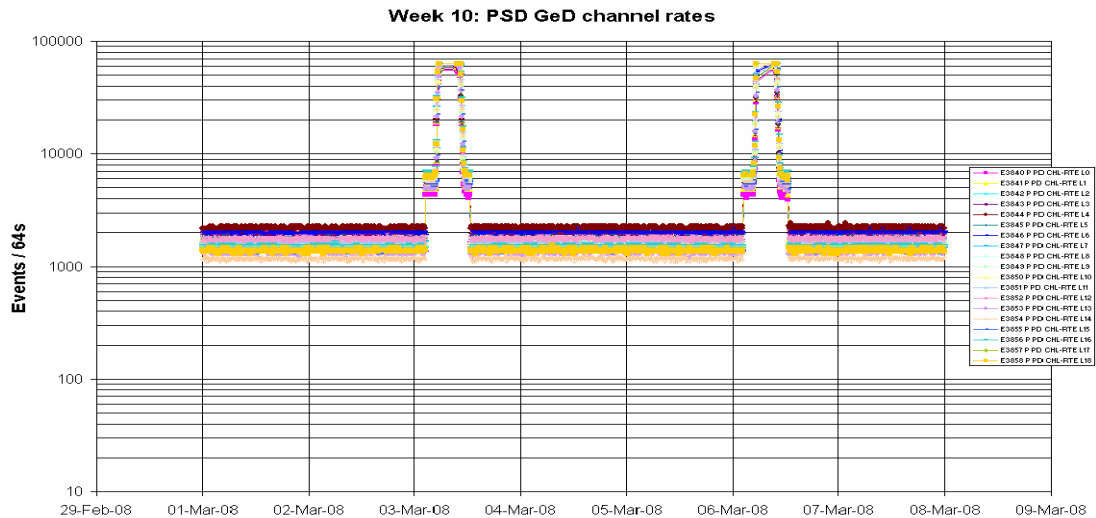
AFEE: The health of the AFEE is nominal. The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06/12/2003 and detector #17 is failed since 17/07/2004.



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.



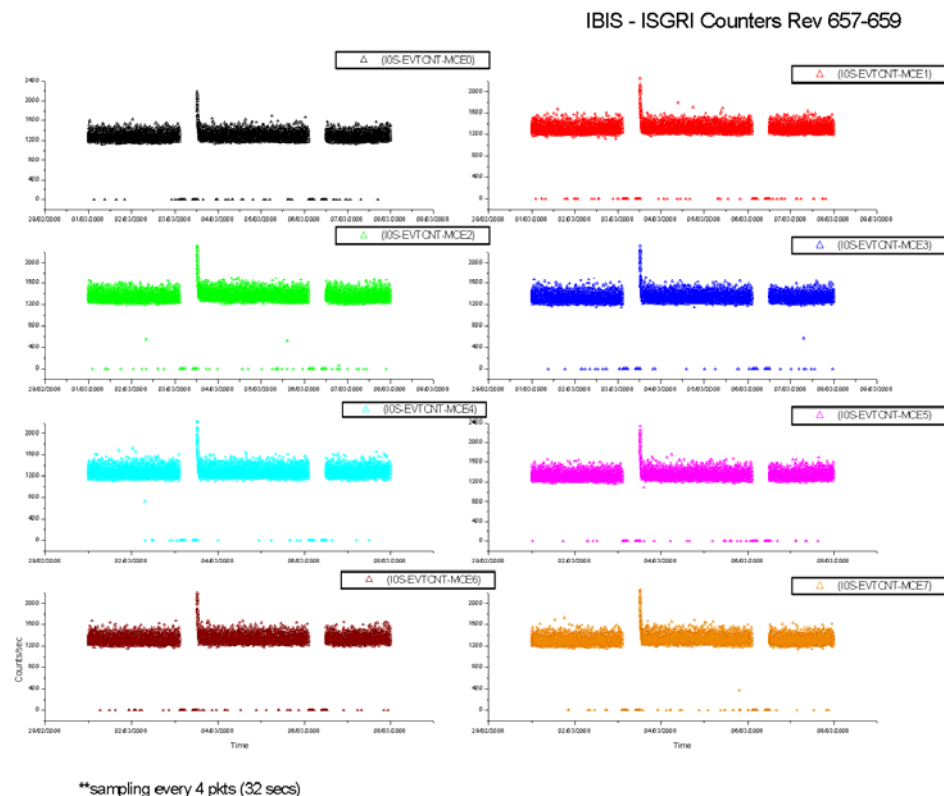
Event Log:

The following non-nominal events occurred on SPI over the reporting period:
 On 2008-03-03 at 12:46:24Z, due to continuing high radiation after the expected radiation belt exit of revolution 658, the TM parameter E3500 (ACS CntVetoBelow) went OOL High. As it returned within limits at 12:56:32Z, no action was taken.

8.3.3 IBIS Operations

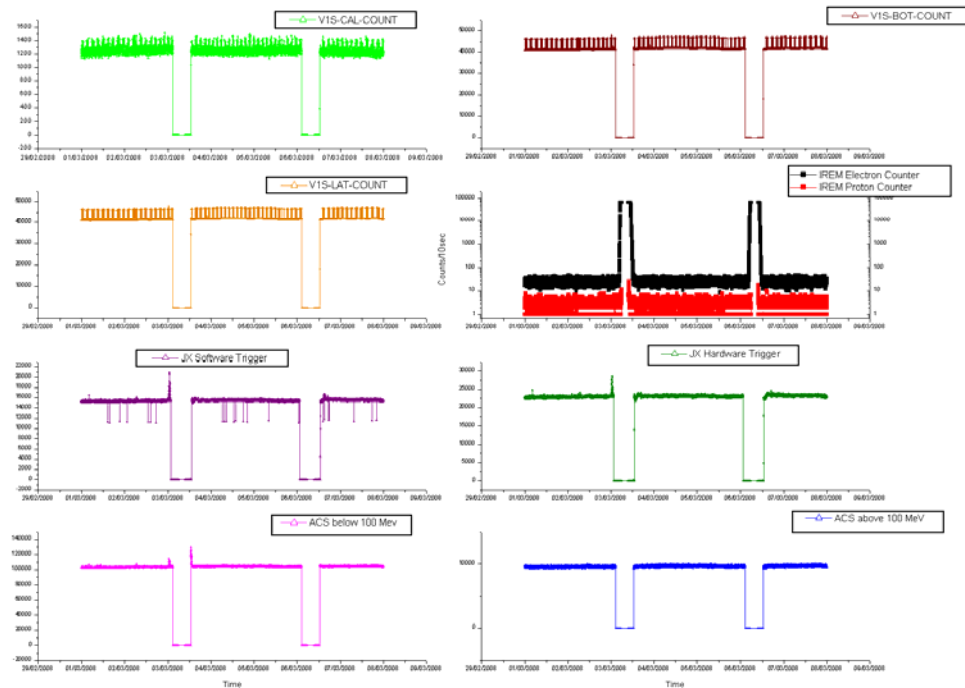
IBIS Event Counters Plots

ISGRI Counters:



VETO vs Payload Counters:

IBIS-VETO vs Payloads Counters Rev 657-659

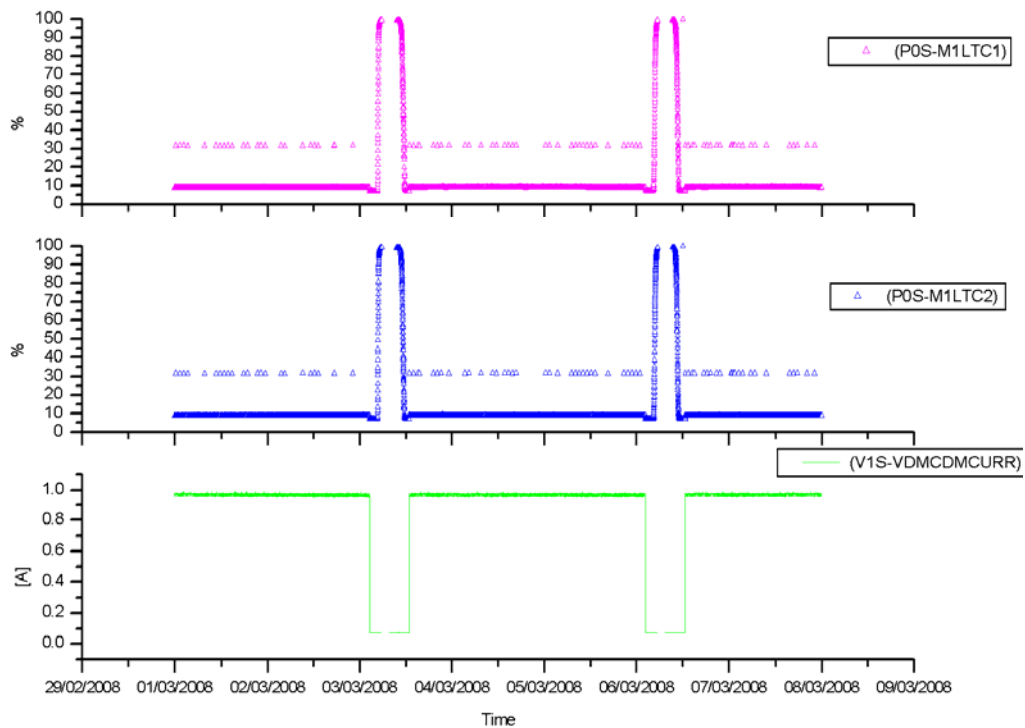


**with the exception of IREM counters (counts/10sec), all the plots are reporting counts/sec sampling every 5 pkts (40 sec)

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

VETO Current:

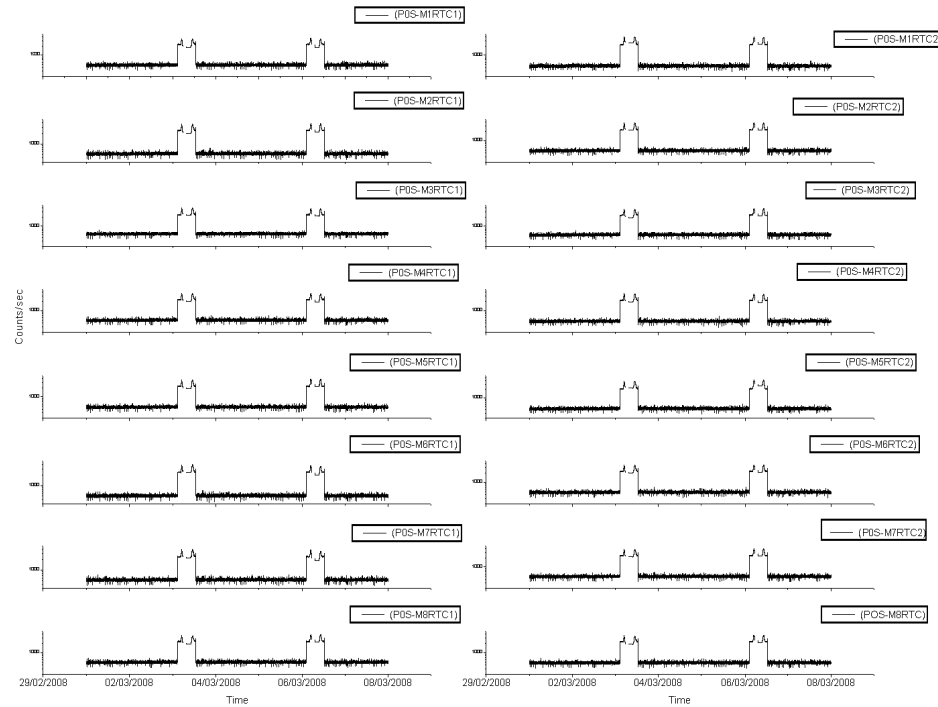
IBIS-VETO Current & PICsIT dead times Rev 657-659



**sampling every 4 pkts (32 secs)

PICsIT Counters:

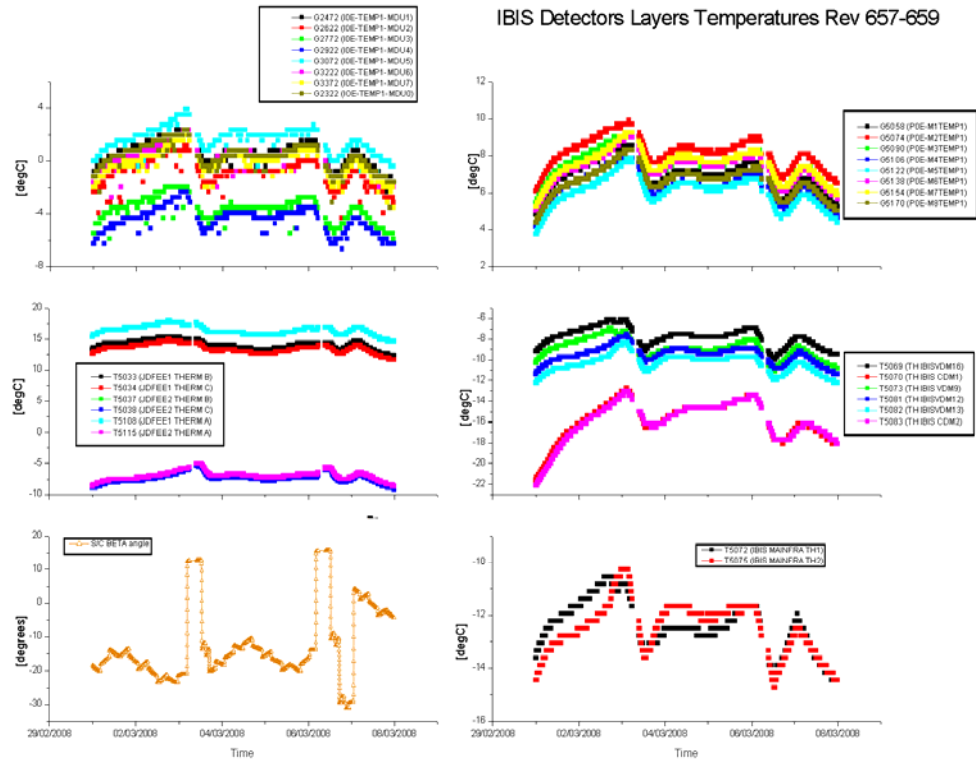
IBIS - PICsIT Counters Rev 657-659



**sampling every 4 pkts (32 secs)

IBIS Detectors Layers Temperatures:

IBIS Detectors Layers Temperatures Rev 657-659



**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.

2008-03-01 (DOY 061, Rev 657) to 2008-03-02 (DOY 062, Rev 657)

IBIS operations executed nominally.

2008-03-03 (DOY 063, Rev 657-658)

At 12:19:23Z, during the execution of the ED GEISCL03 before radiation belt exit of revolution 658, some parameters in the TM parameter family G2013 (number of events triggering the MCEi per second) started toggling OOL warning High. As they had all returned within limits by 12:27:07Z, no action was taken.

2008-03-04 (DOY 064, Rev 658) to 2008-03-05 (DOY 065, Rev 658)

IBIS operations executed nominally.

2008-03-06 (DOY 066, Rev 658-659)

At 10:38:09Z TM parameter G5079 went OOL Warning High (value = 2.60509804V). This is the PDM2 +2.5 V. As it returned within limits at 10:38:41Z, no action was taken.

2008-03-07 (DOY 067, Rev 659)

IBIS operations executed nominally.

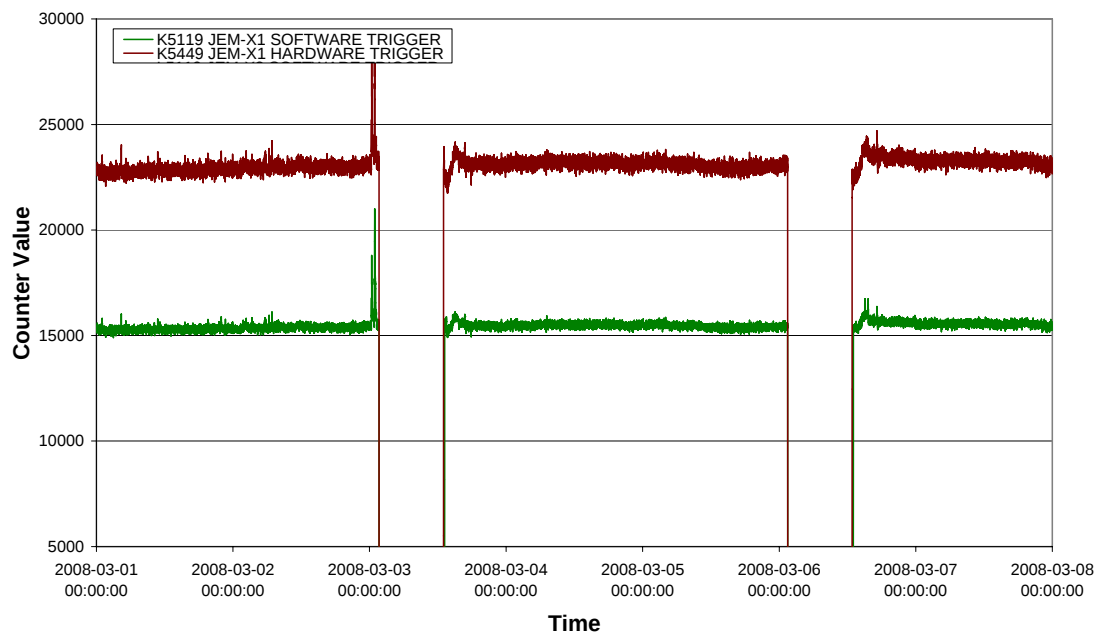
8.3.4 JEM-X Operations

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.

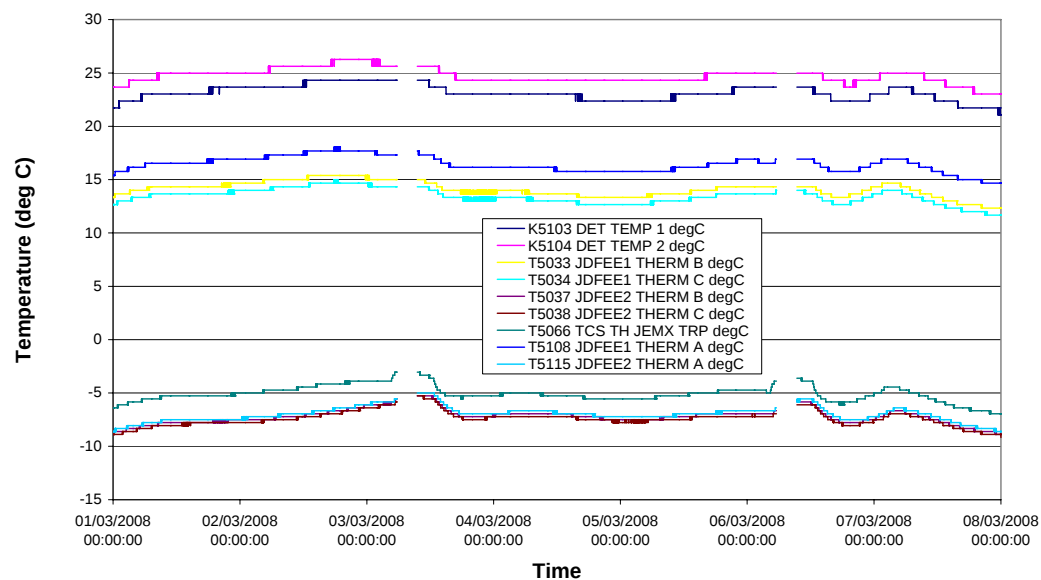
JEM-X Count Rates



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.

JEMX Detector & DFEE Temperatures



JEM-X Daily Report

2008-03-01 (DoY 061, Rev 657) to 2008-03-03 (DoY 063, Rev 657-658)

² Data sampled (1 frame in 8)

JEM-X1 operations executed nominally.

2008-03-04 (DoY 064, Rev 658)

On this day, the following anomalous OEMs were received, at the indicated times:

2008.064.22.34.58.947	2008.064.22.35.03.001	1536	RealTime	5	EXCEPTION
JEM-X1 EXC IACS INTERF EXID			0	0	65535 PR N
E E					
FIX6			0		
K9079	MESS CLASS		1		
K9080	MESS ID		5		
K9065	CSSW OPERAT ID		START		
K9066	TASK ID 8		IASW		
K9067	LOGICAL ADDRESS		4989		
2008.064.22.34.58.947	2008.064.22.35.03.062	1536	RealTime	6	EXCEPTION
JEM-X1 EXC IACS INTERF CULP			0	0	65535 PR N
E E					
FIX6			0		
K9079	MESS CLASS		1		
K9080	MESS ID		6		
K9065	CSSW OPERAT ID		START		
K9066	TASK ID 8		IASW		
K9067	LOGICAL ADDRESS		19726		

No action was taken and the messages did not reappear. There was no impact.

2008-03-05 (DoY 065, Rev 658)

JEM-X1 operations executed nominally.

2008-03-06 (DoY 066, Rev 658-659)

At 01:30:45, TC KU0014 terminated with an unknown status, the unit successfully switched to SAFE at this time. Similar warnings were received at 13:00:25, 13:00:33 & 13:00:56. At 13:00:56, TC K0021 terminated with status unknown, and at 17:25:58, the same command terminated with status 'UNCERTAIN_FAILED'. On each occasion, after inspection of the telemetry, no action was taken and there was no impact.

2008-03-07 (DoY 067, Rev 659)

JEM-X1 operations executed nominally.

8.3.5 OMC Operations

2008-03-01 (DoY 061, Rev 657) to 2008-03-07 (DoY 067, Rev 659)

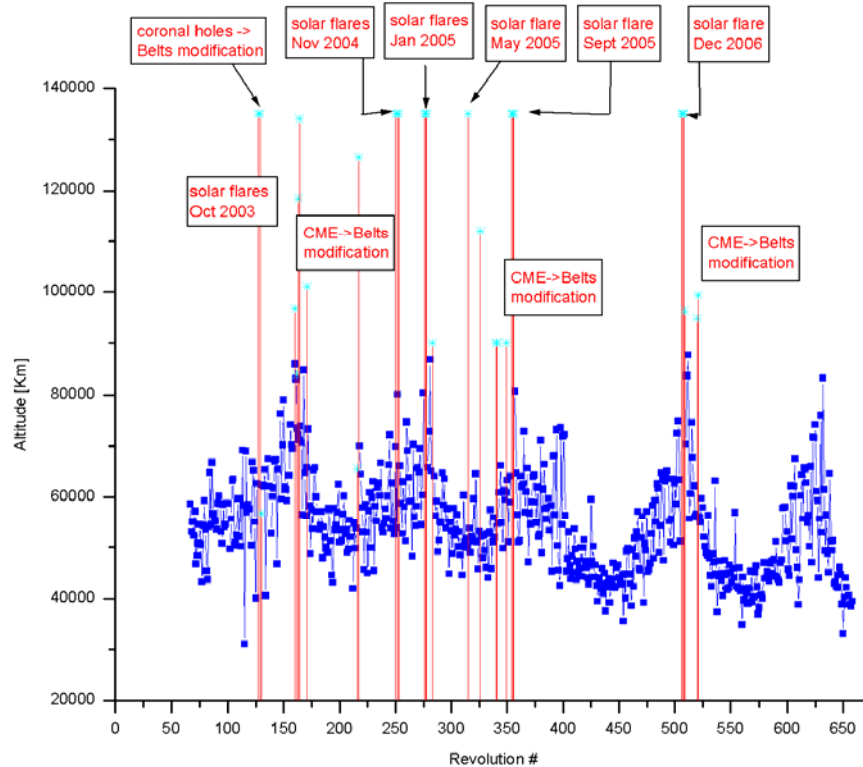
Nothing to Report.

On DoY 063 at 02:35:10 and DoY 066 at 02:23:50 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]
657	RAD_ENTR R 2008-03-03T02:35:04Z	03/03/2008 04:35:17	38438.0	03-Mar-2008 04:03:32	43133.3
658	RAD_EXIT R 2008-03-03T12:37:46Z	03/03/2008 12:07:49	>>33258.5	03-Mar-2008 11:43:32	45463.79
658	RAD_ENTR R 2008-03-06T02:23:43Z	06/03/2008 04:17:33	39439.6	06-Mar-2008 03:53:09	43116.35
659	RAD_EXIT R 2008-03-06T12:26:56Z	06/03/2008 11:13:17	>>33243.6	06-Mar-2008 11:33:09	45376.1

Reference

High radiation

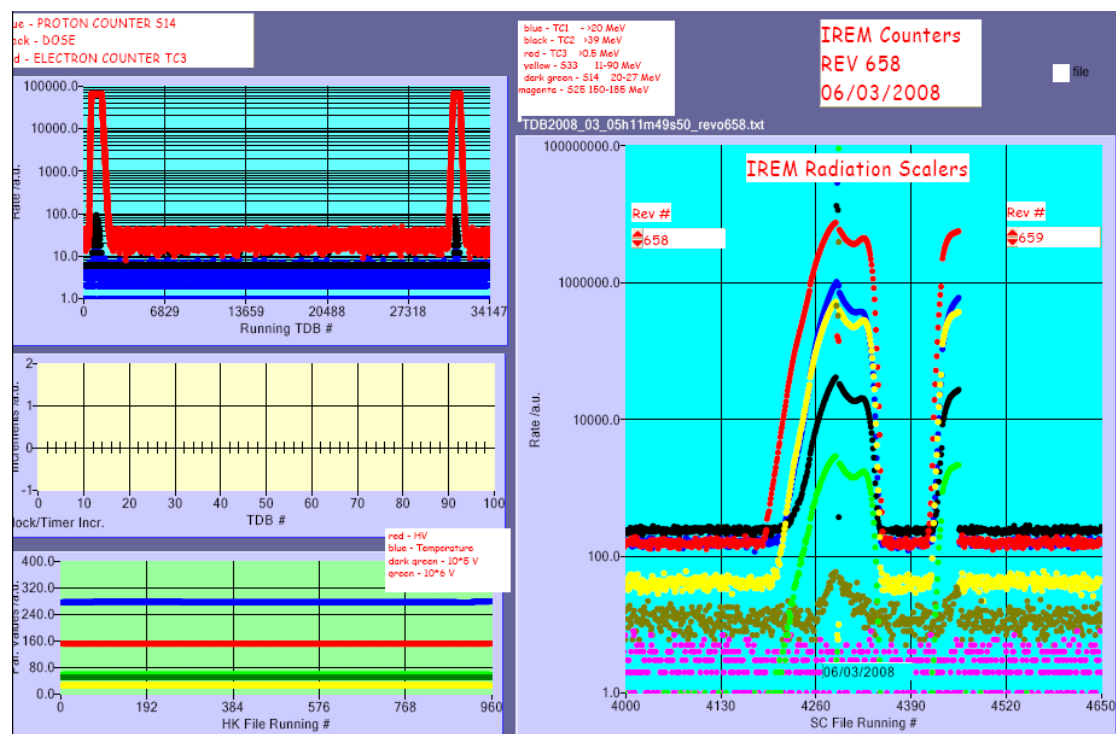
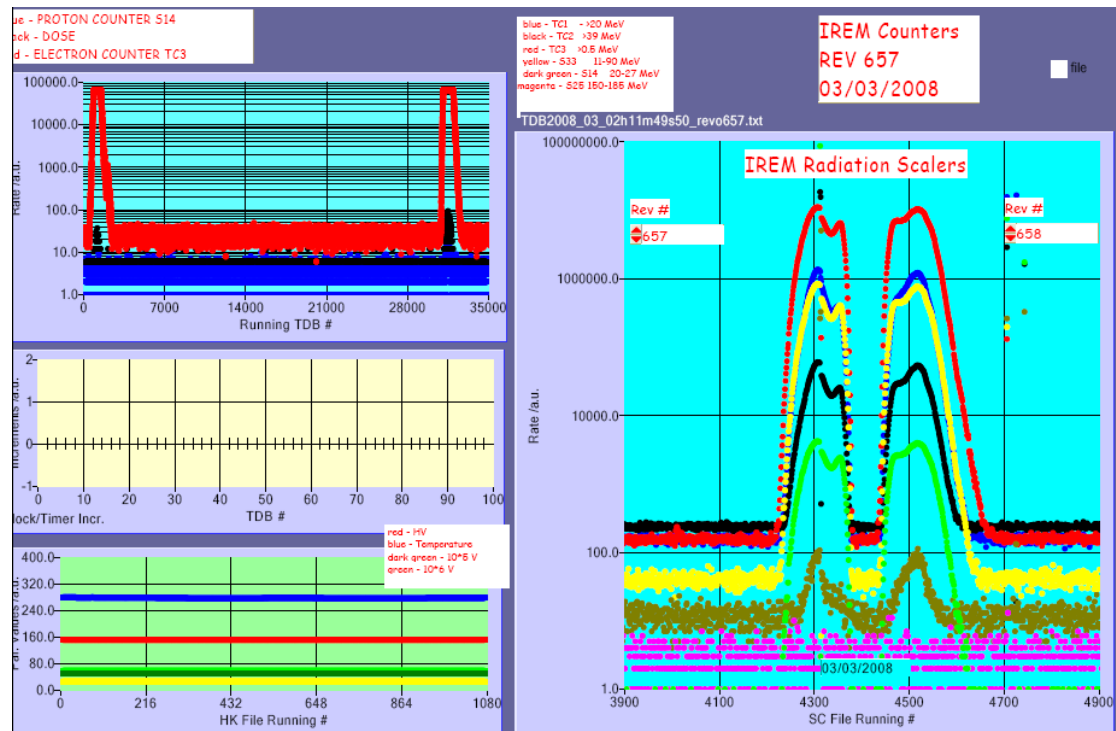
Very small error vs reference (less than 10 minutes)

Small error vs reference (between 10 and 30 minutes)

Large error vs reference (more than 30 minutes)

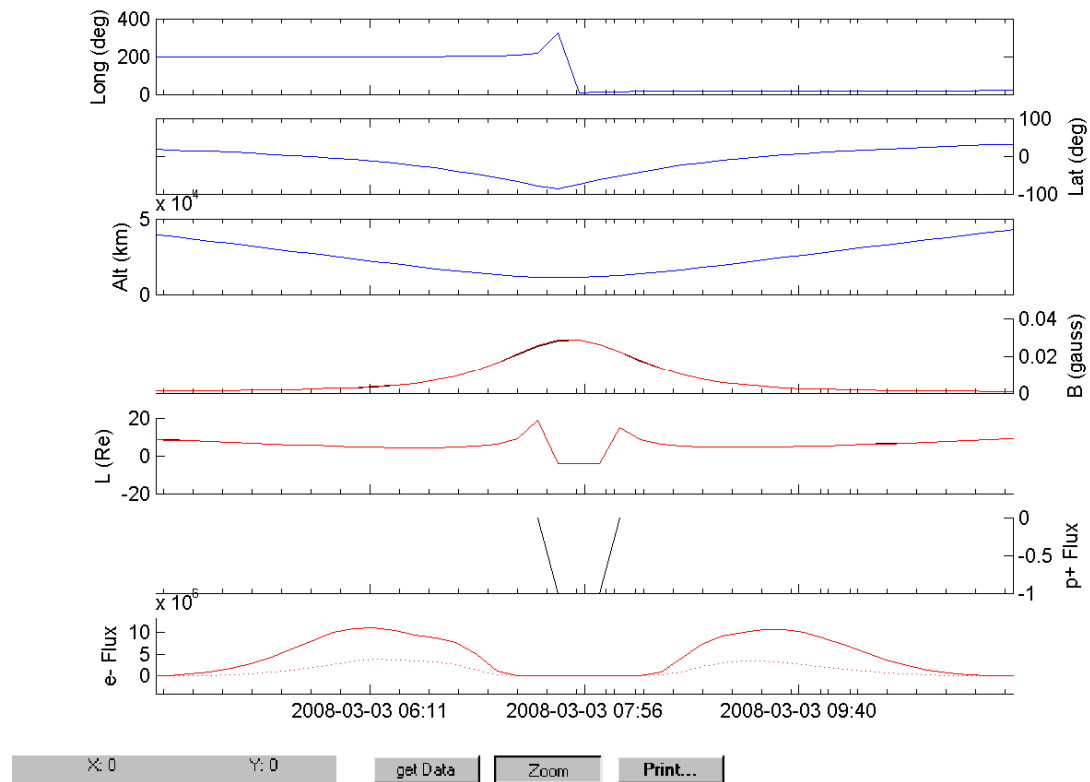
* Rad belt entry time ignoring previous threshold crossings where a gap of more than 30 minutes is present.

IREM radiation counters:

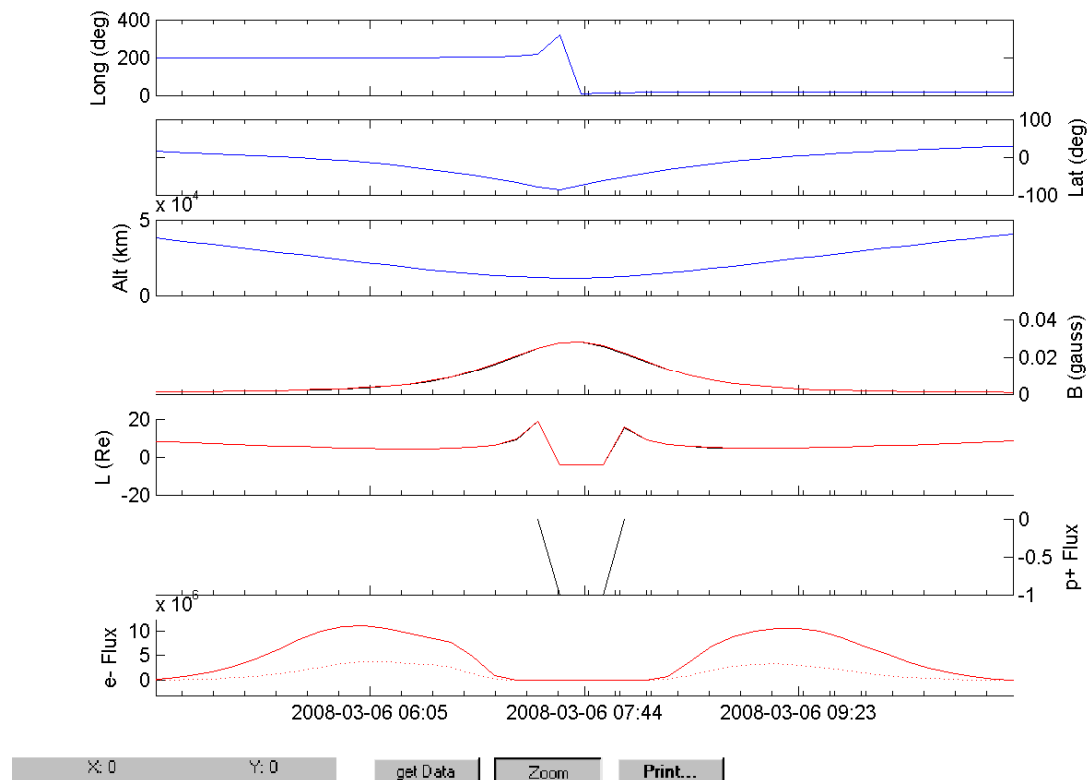


IREM Predicted Radiation Belt Passages

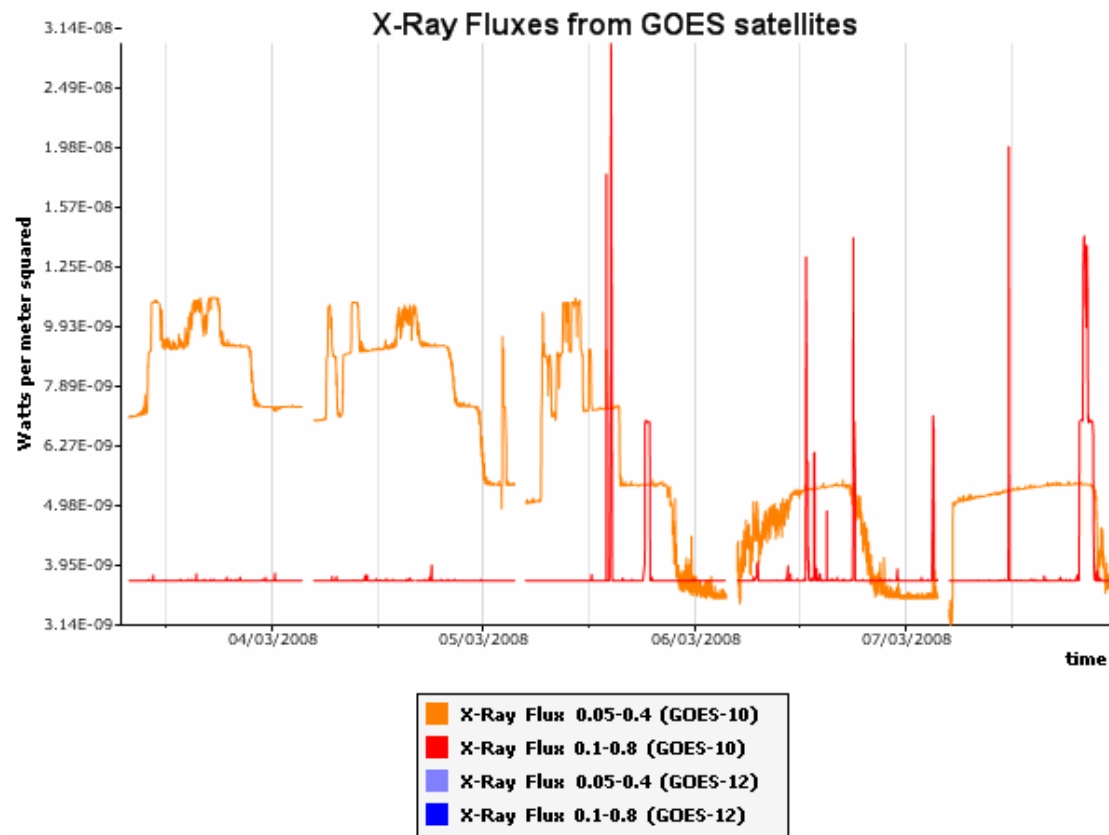
Rev 657



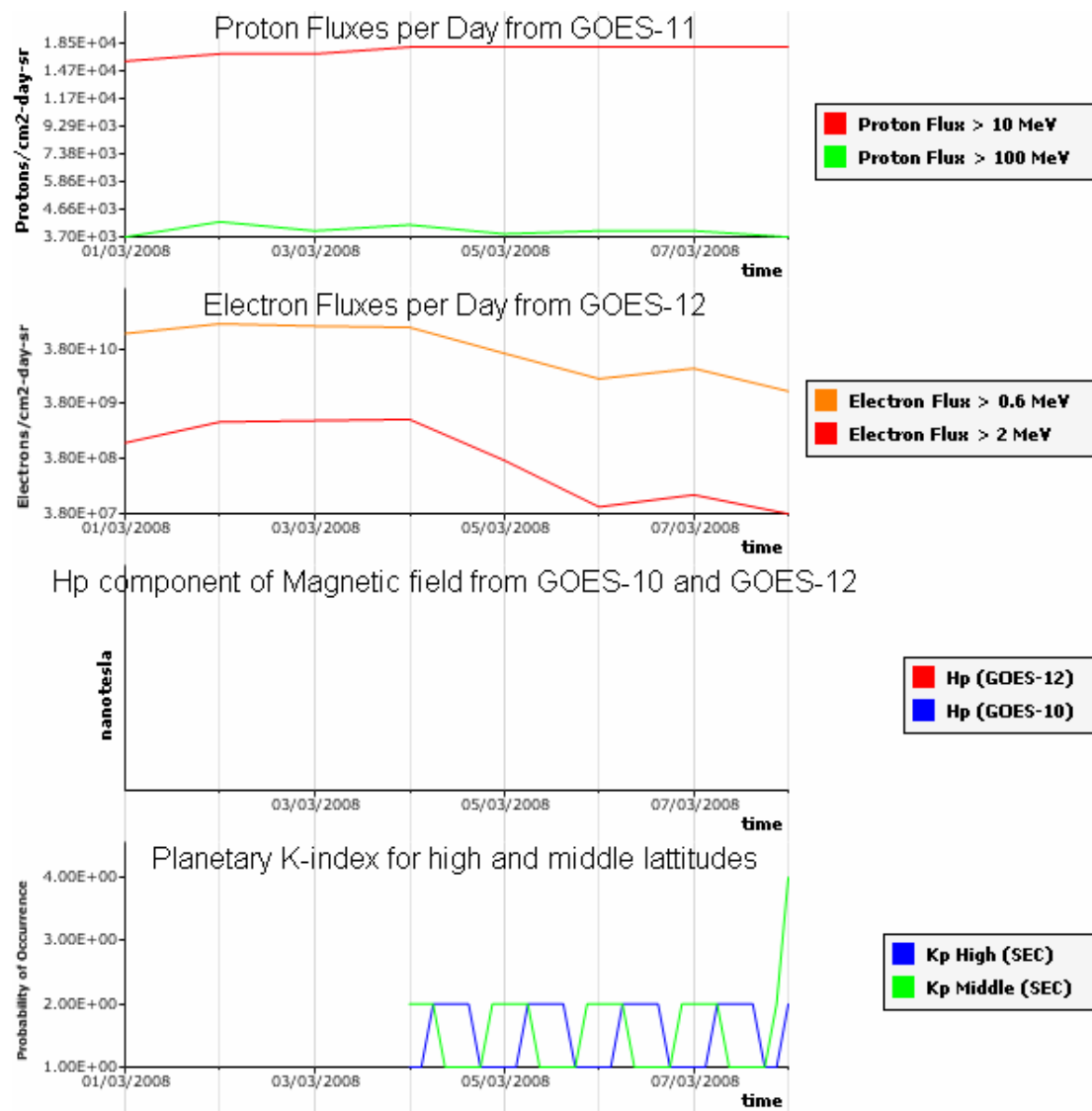
Rev 658



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.