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

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OAI
No. 296
Week 21
26.05.08
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 17.05.08 until 23.05.08 (both dates inclusive) and covers the revolutions 683, 684 and 685.

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 Cygnus Region (RA 20:35:53.00, DEC +40:39:49.0) and a raster dither of the North Ecliptic Pole (RA 18:00:00.00, DEC +66:33:39.0).

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 16/05/2008 and 23/05/2008 was 0.0777 Kg. The remaining propellant is in the order of 140.3383 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

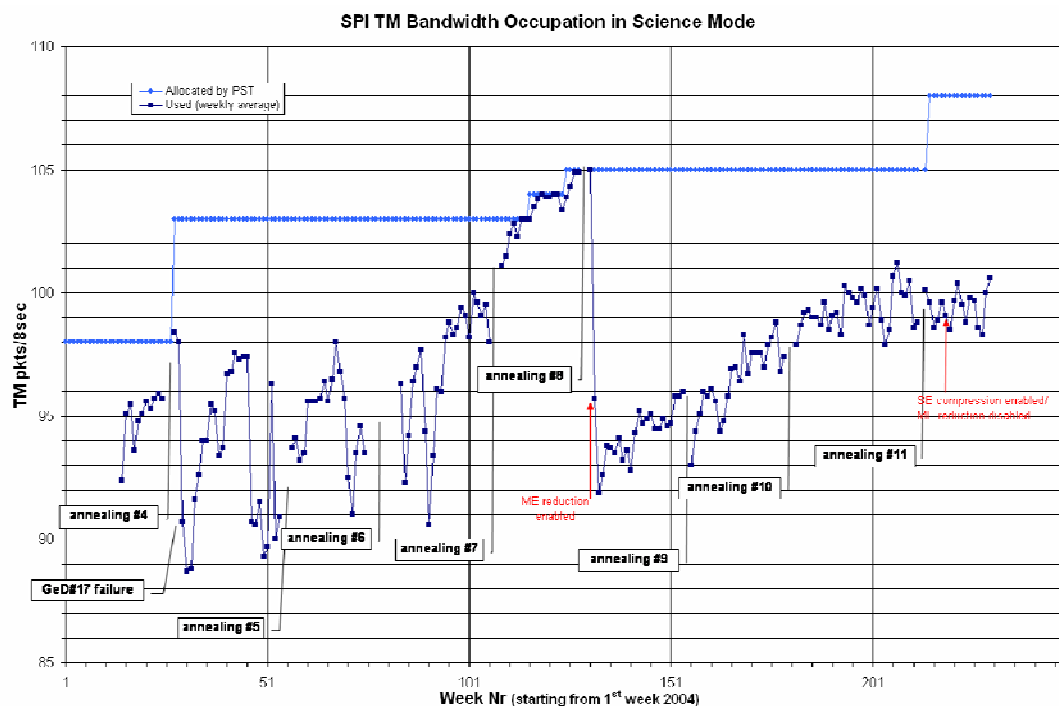
3.2.1 SPI

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. The over-allocated PST with an additional 3 packets/cycle for SPI was used however the Broadcast Packet TM allocation was not updated. The average telemetry occupation in the science window was 100.6 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.

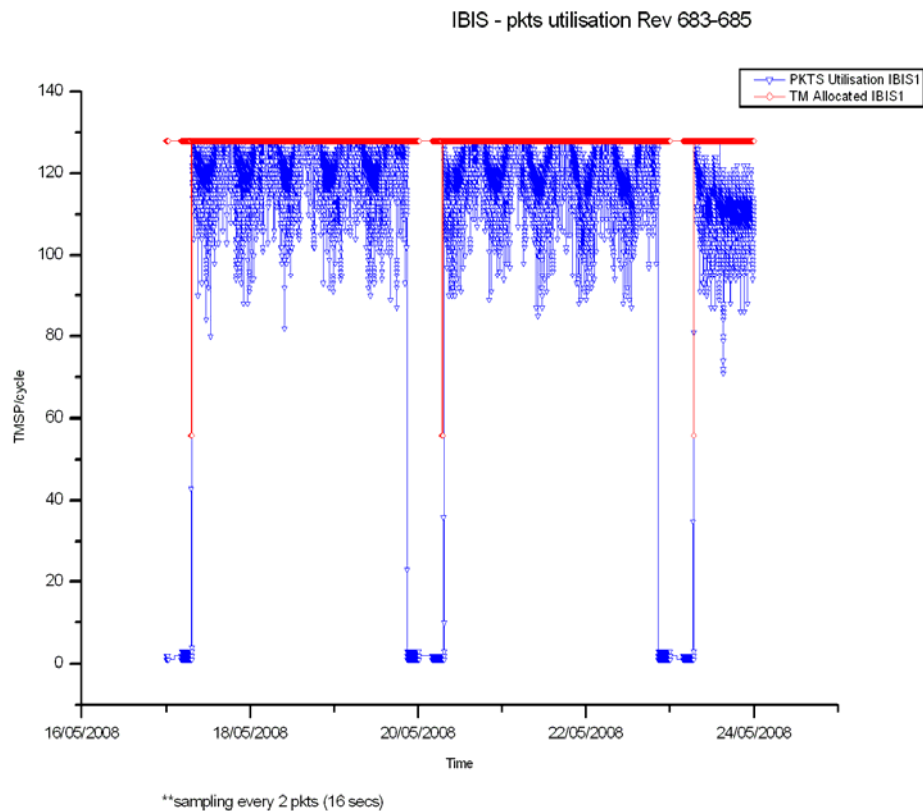
3.2.2 IBIS

The overall status of the unit is nominal.

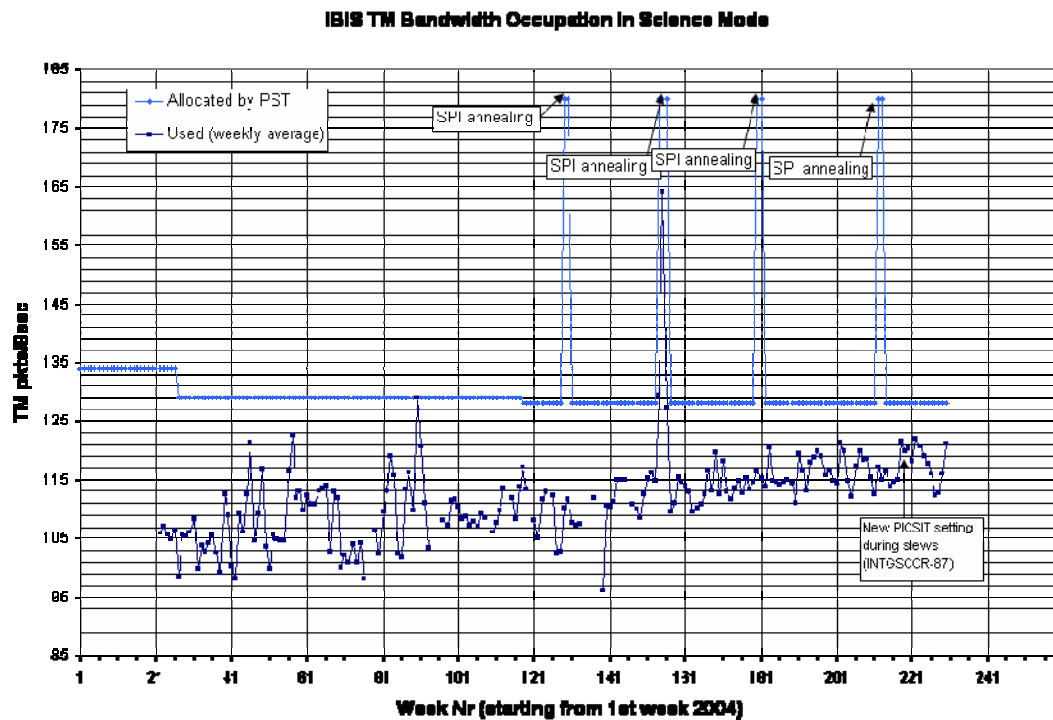
During the reporting period, the TM bandwidth statistics were as follows:

- PST allocation to IBIS above radiation belts: 128 packets/cycle
- IBIS mean bandwidth utilisation in science mode: 121.14 packets/cycle (up 5.18 on last week)
- Percentage of TM cycles in which full bandwidth was used: 37.79%

Therefore the TM bandwidth for IBIS was frequently saturated during the week. This can be seen in the plot below of the IBIS TM utilisation during the observation period. The observation during this time was of the Cygnus Region and the periods of saturation correspond to pointings close to Cygnus X-1.



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 219 planned science pointings were executed nominally.

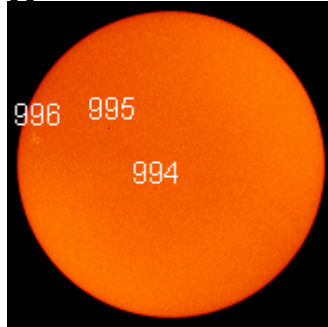
Note: Some more information concerning the OMC operations is provided in the Appendix.

3.2.5 IREM

The overall status of the unit is nominal.

Solar Activity

The observation period was characterised by low solar activity. The Sun started the week with 3 small sun-spots, none of which posed any threat of solar flares. By the 19th, spot number 995 had disappeared, the other two vanished by the 22nd.



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 were some problems reported with the manual stack and the PDSserver task, without significant impact.

4.2 Ground Stations & Network

The performance of the ground stations and Network was very good this week. There was however 4 occasions where the TM dropped from Redu, and 1 occasion where the TM dropped from DSS-27. In addition, the links to ISDC dropped three times. Each time there was no impact.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

A new PSFs has been received for revolution 691.

Observations have been planned for revolutions 688 to 691.

New TSFs have been received for revolutions 683 to 685.

2. Observation status

New ECS files have been received for revolution 672 to 674.

3. ISOC Science Data Archive

Science Window data is correctly ingested up to revolution 664.

4. ISOC system

V19.1 has been successfully tested and will be released next week.

5. Problems

None.

4.3.2 ISDC

Status of ISDC observation processing on 26/05/2008:

- Latest Standard Analysis completed: observation 05200710017 (Galactic disk, Revolutions 674) on 17/05/2008.
- Latest products archived: observation 05200710018 (Galactic disk, Revolutions 674) on 18/05/2008.
- Latest observation products sent to the observer: observation 05200710022 (Galactic disk, Revolutions 674) on 19/05/2008.

5 Special Events

6 Anomalies

The following problems were reported this week that impacted operations.

- On DoY 141, at 06:55:44, the Manual Stack on sun121 stopped without indication. It would appear that the task was not connected to the multiplexer. The impact was a slight delay in an IBIS OCR

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

AR id	Date Created	Subject	Segment	Status
INT-2999	2008-05-20	Sun121: Manual Stack not connected to Multiplexer	IMCS	Open
INT-3000	2008-05-06	FDS failed slew update		Pending
INT-3001	2008-05-11	AOCS Slew to wrong attitude		Pending

7 Future Milestones

The following activity is foreseen in the next few weeks.

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 683

The observations in revolution 683 consisted entirely of a raster dither of the Cygnus Region (RA 20:35:53.00, DEC +40:39:49.0), lasting ~56.7 hours.

Revolution 684

The observations in revolution 684 consisted entirely of a raster dither of the Cygnus Region (RA 20:35:53.00, DEC +40:39:49.0), lasting ~55.0 hours.

Revolution 685

The observations in revolution 685 began with a raster dither of the Cygnus Region (RA 20:35:53.00, DEC +40:39:49.0), lasting ~2.8 hours. They continued with a raster dither of the North Ecliptic Pole (RA 18:00:00.00, DEC +66:33:39.0), lasting ~53.2 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

2008-05-05T00:48:16.000Z	140.6126	F	Automatic TM processing.
2008-05-05T05:50:01.000Z	140.6001	F	Automatic TM processing.
2008-05-05T14:16:50.000Z	140.5668	F	Automatic TM processing.
2008-05-06T15:14:28.000Z	140.5441	F	Automatic TM processing.
2008-05-08T05:35:44.000Z	140.5308	F	Automatic TM processing.
2008-05-09T15:17:08.000Z	140.5187	F	Automatic TM processing.
2008-05-11T05:20:17.000Z	140.5091	F	Automatic TM processing.
2008-05-12T15:13:57.000Z	140.4912	F	Automatic TM processing.
2008-05-14T05:11:29.000Z	140.4293	F	Automatic TM processing.
2008-05-15T14:18:52.000Z	140.4160	F	Automatic TM processing.
2008-05-17T04:50:57.000Z	140.4019	F	Automatic TM processing.
2008-05-18T14:05:32.000Z	140.3746	F	Automatic TM processing.
2008-05-20T04:39:12.000Z	140.3656	F	Automatic TM processing.
2008-05-21T14:05:32.000Z	140.3503	F	Automatic TM processing.
2008-05-23T04:28:08.000Z	140.3383	F	Automatic TM processing.

This report was generated Fri May 23 08:00:26 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, 17/05/2008 – 23/05/2008

The AOCS operations were executed from the Automatic Timeline.

During this period, 59 Open Loop Slews, 166 Closed Loop Slews and 5 Momentum Biases were executed (as reported by ACC).

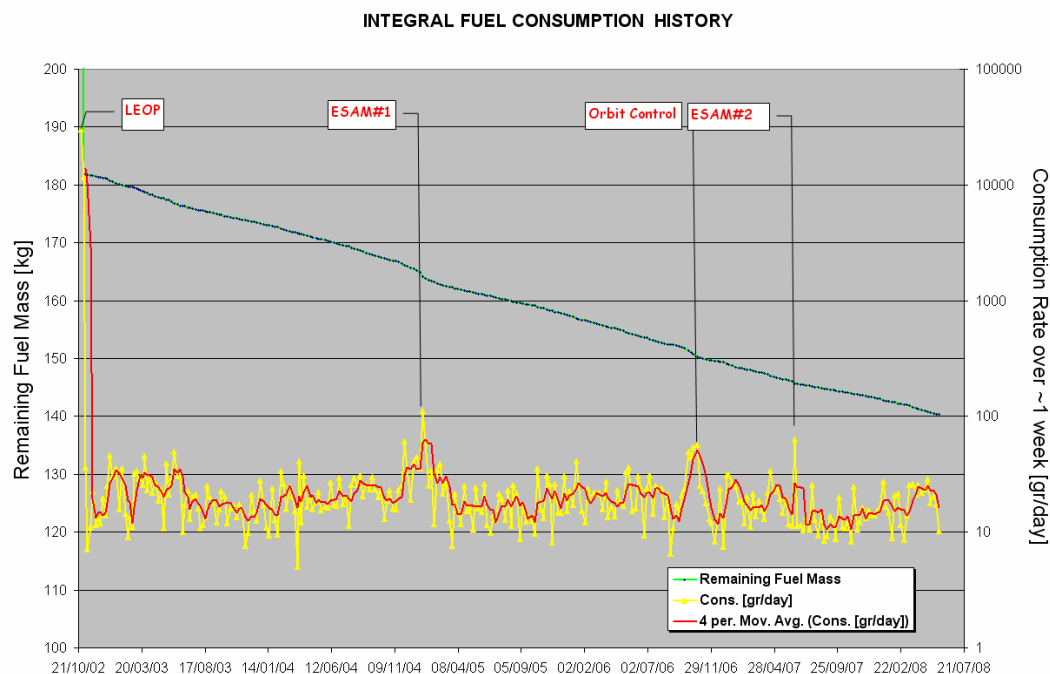
No slews were missed from TL, during the observation period.

Orbit Control

No update

Fuel consumption

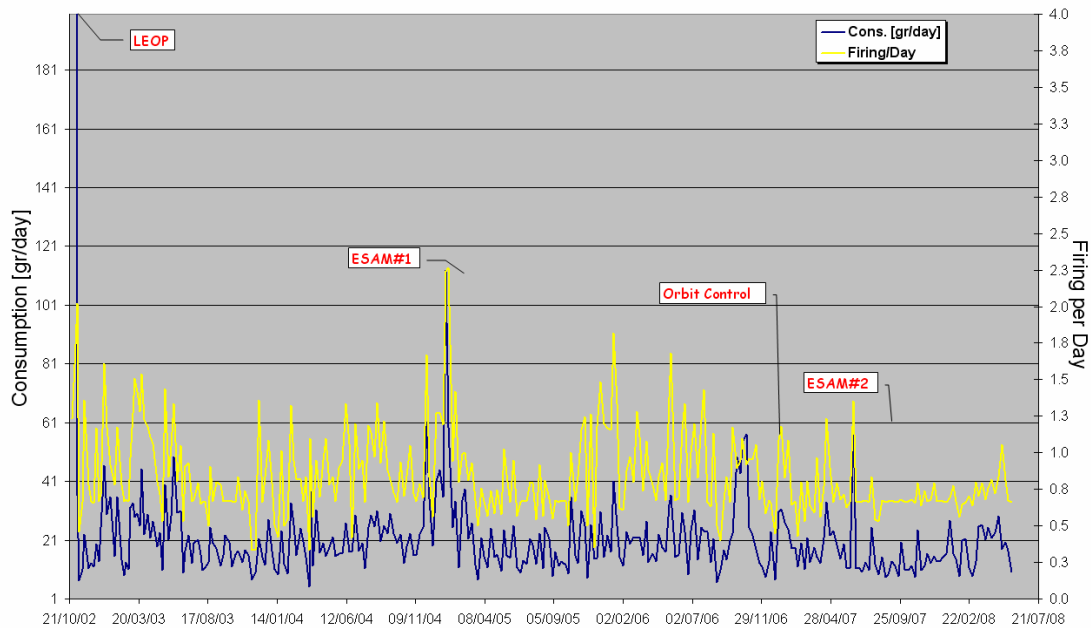
The fuel consumption (total, grams per day) over the period between 01/11/2002 and 23/05/2008 is reported in the plot below.



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 23/05/2008 is reported in the plot below.

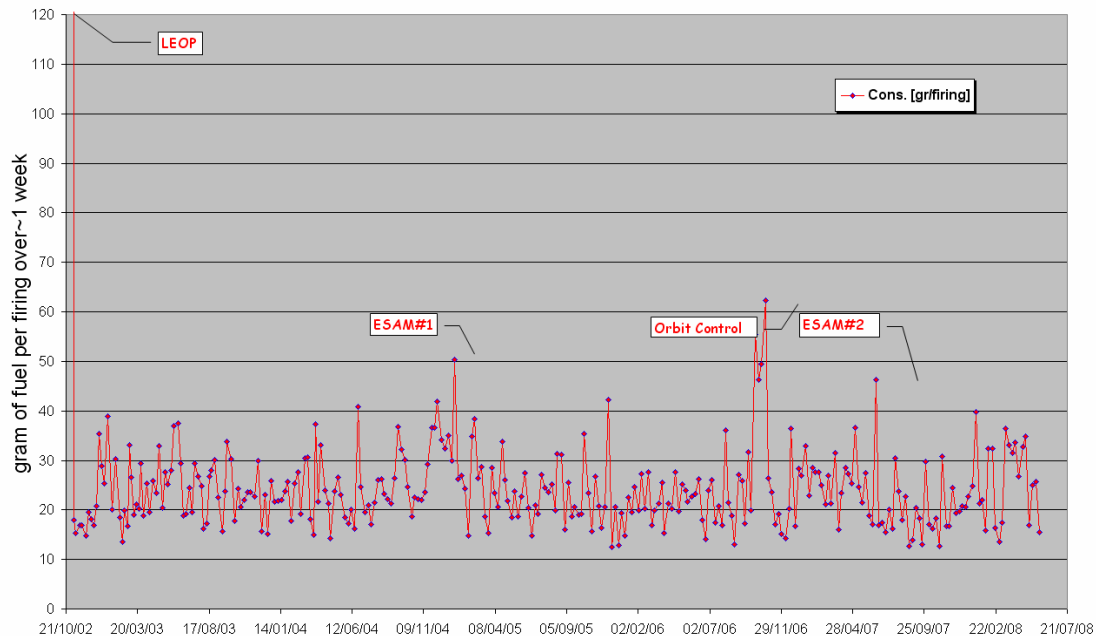
INTEGRAL FIRING PER DAY HISTORY



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 23/05/2008 is shown in the plot below.

INTEGRAL FUEL MASS PER FIRING HISTORY

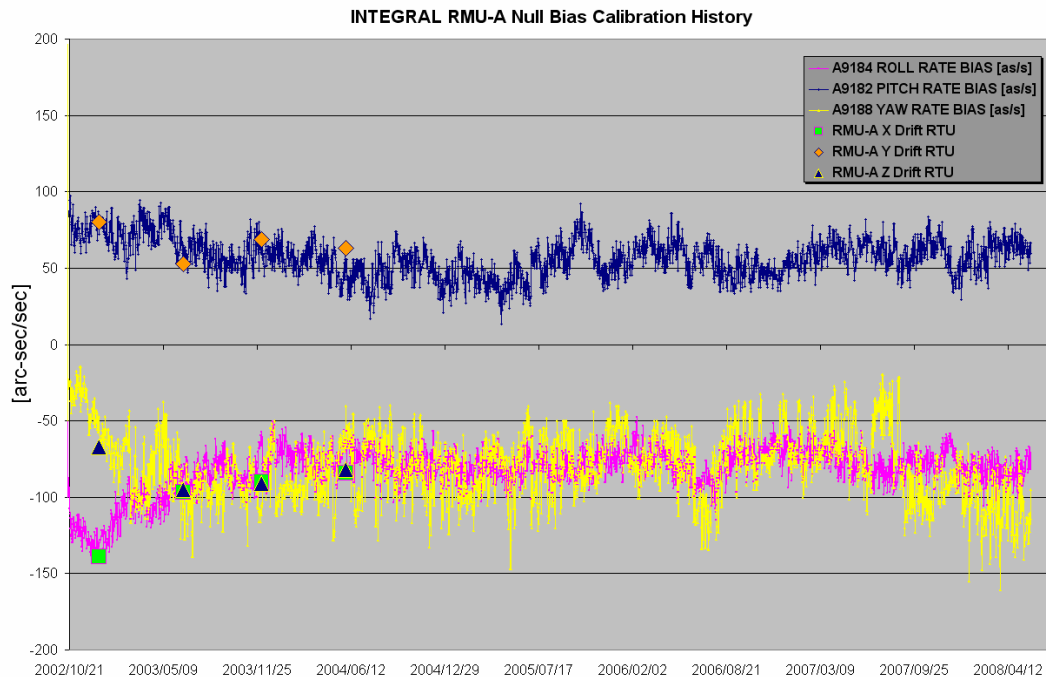


The RMU-A null bias calibration

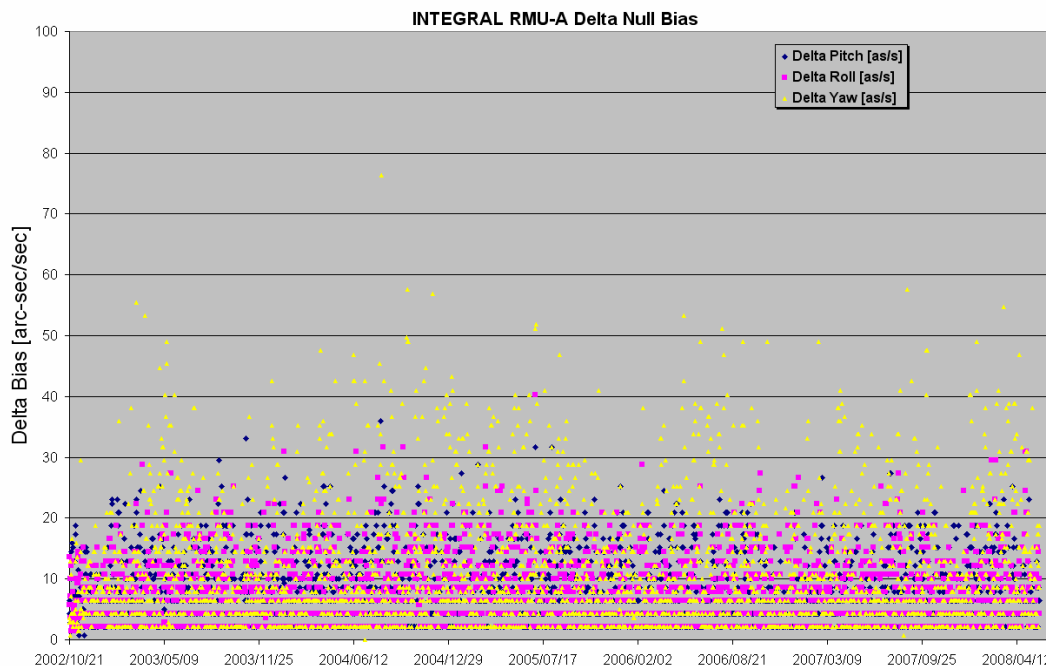
The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 23/05/2008 is reported in the plot below.

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 23/05/2008 is reported in the plot below.



17/05/2008 (Day of Year 138, Revolution 682-683)

Nothing to report.

18/05/2008 (Day of Year 139, Revolution 683)

Nothing to report.

19/05/2008 (Day of Year 140, Revolution 683)

Nothing to report.

20/05/2008 (Day of Year 141, Revolution 683-684)

Nothing to report.

21/05/2008 (Day of Year 142, Revolution 684)

Nothing to report.

22/05/2008 (Day of Year 143, Revolution 684)

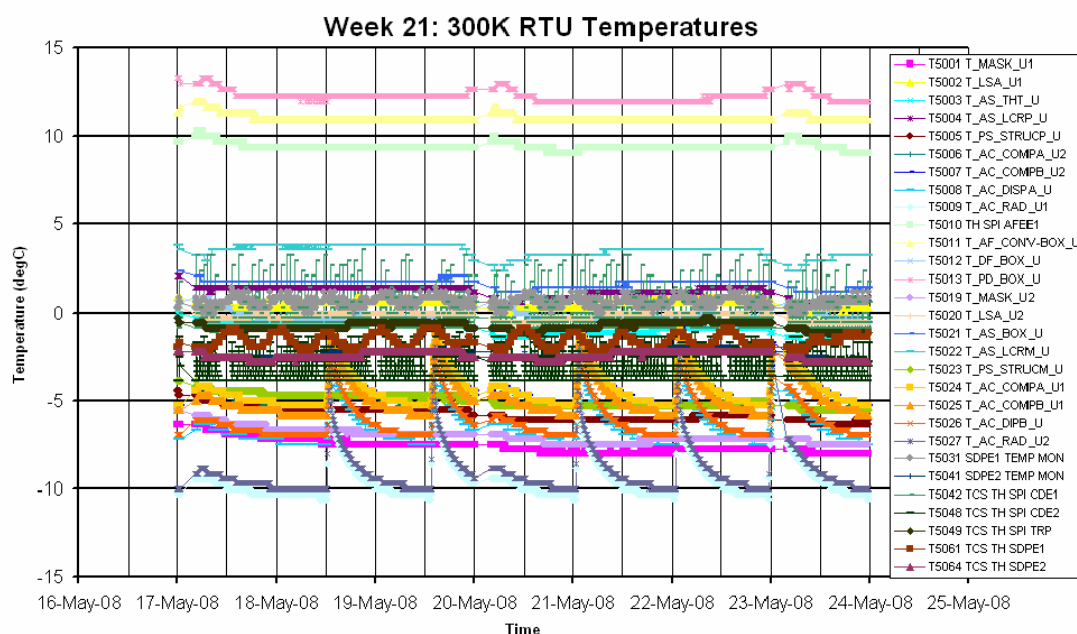
Nothing to report.

23/05/2008 (Day of Year 144, Revolution 684-685)

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.



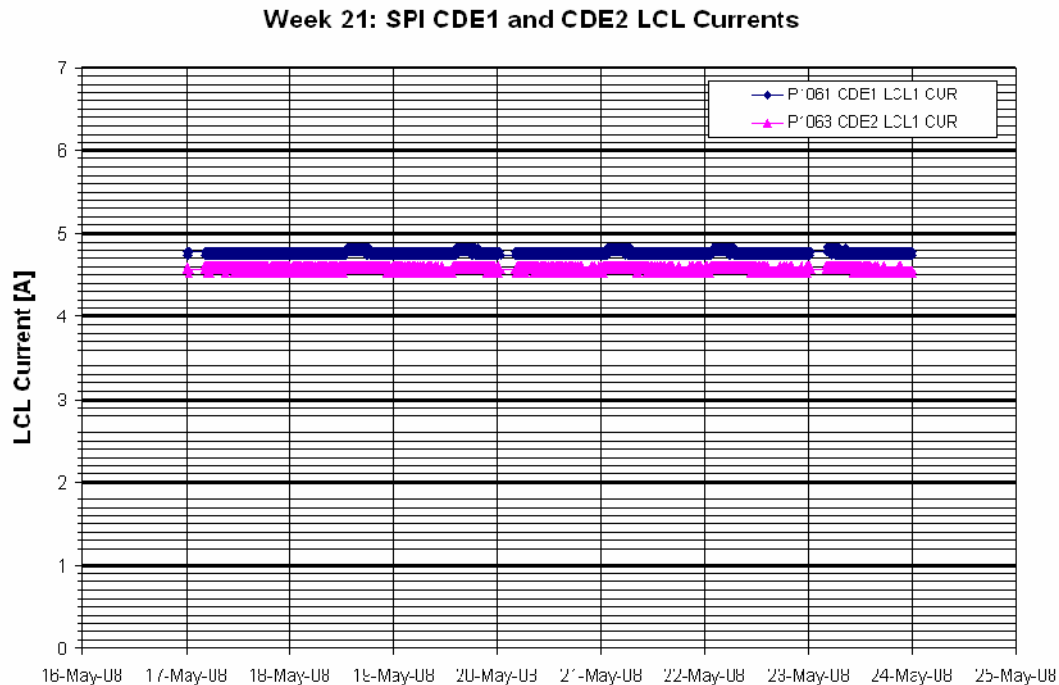
Stirling Compressors and Cryostat: The performance of the compressors is nominal. The cold plate temperature was maintained in the range 80K +/-1K.

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

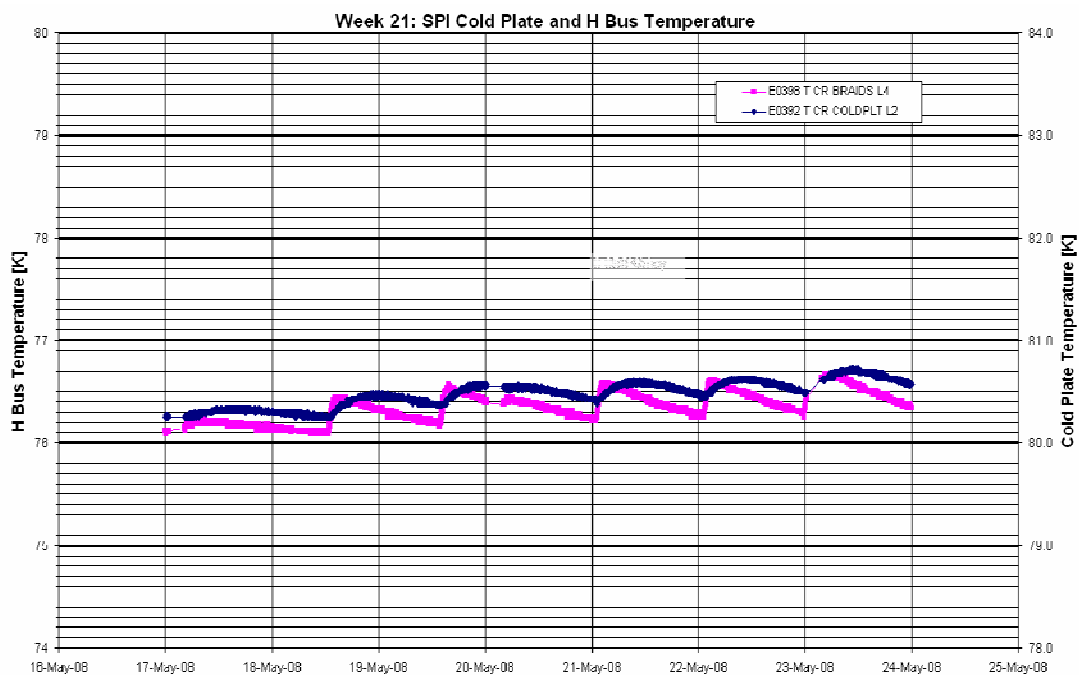
- CDE1 LCL Current = 4.77A

- CDE2 LCL Current = 4.56A

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. From this plot it can be seen that the radiator compensation heater was cycling throughout the week. With the compressors' stroke set to 40, this is still acceptable from a power budget point of view.

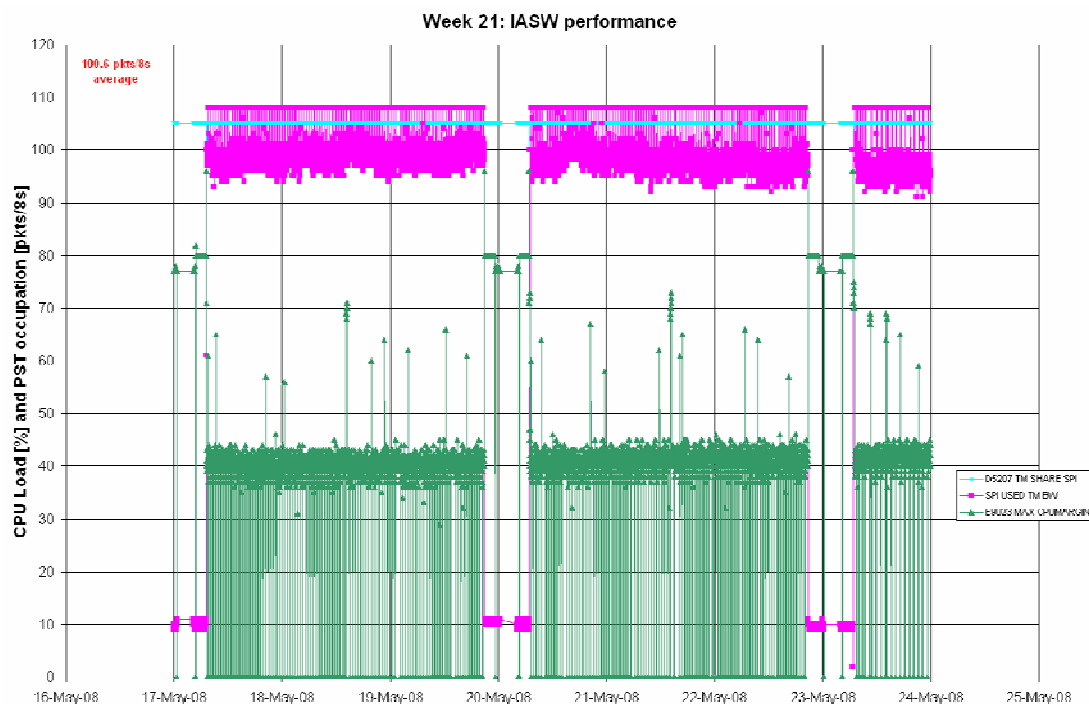


DPE & IASW: The DPE health and IASW performance is nominal.

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

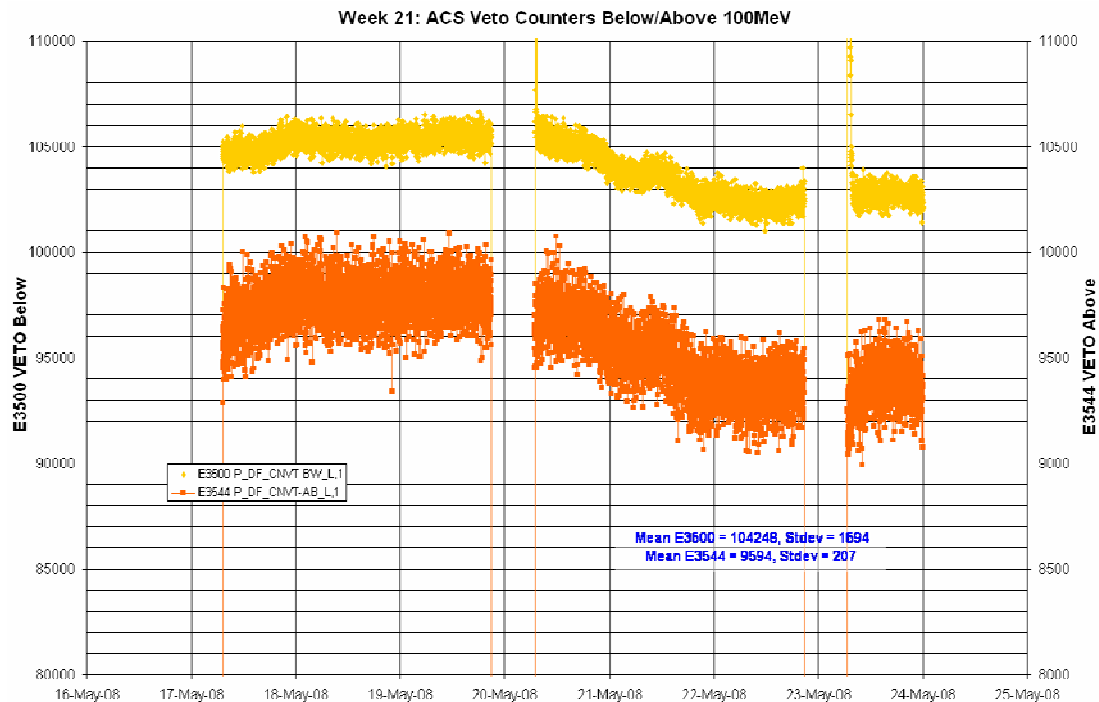
The average TM bandwidth occupation of SPI was 100.6 packets/cycle over the science window. The TM allocation in the science window was 108 packets/cycle. This allocation is considering that the over-allocated PST with the additional 3 packets/cycle for SPI was being used, however the Broadcast Packet TM allocation was not updated (see plot below).

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

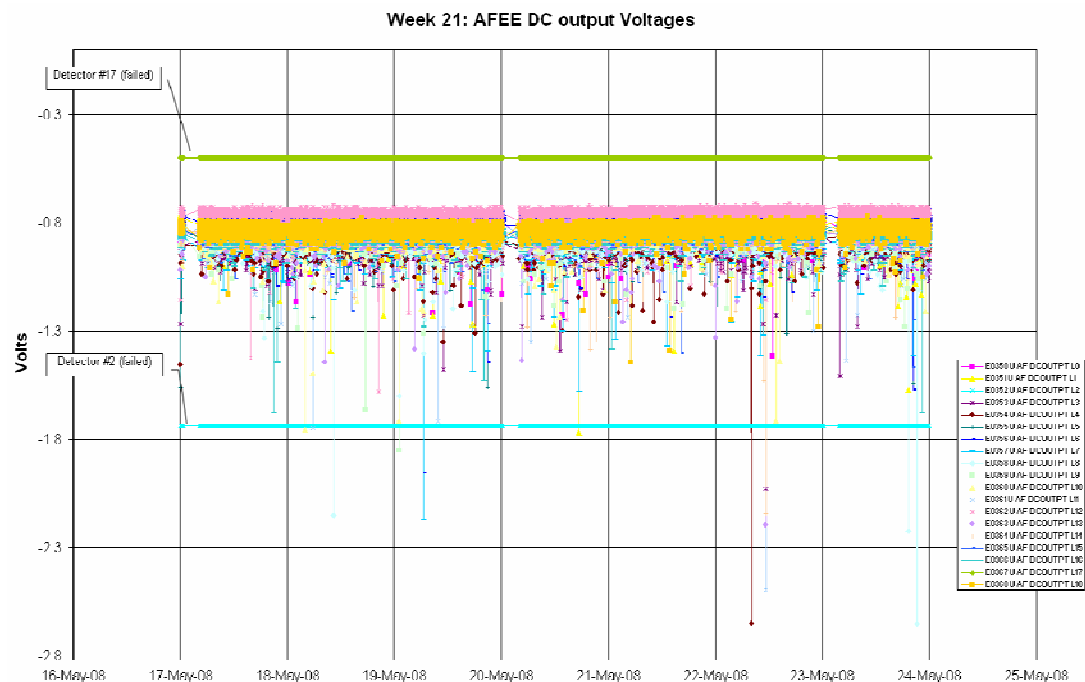


ACS: The performance of the ACS is nominal, except for FEE #81 which remains nominally switched off since the anomaly on 29/10/2006 (INT_SC-162) and FEE #57 which is nominally OFF due to the anomaly on 5/8/2003 (INT_SC-61).

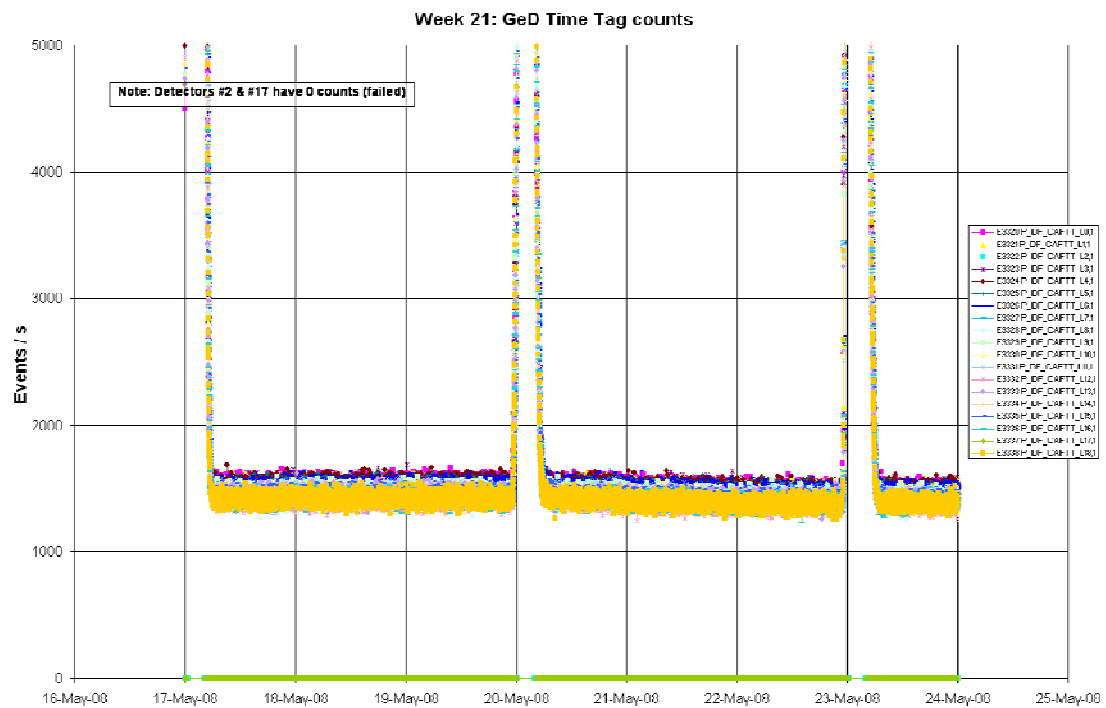
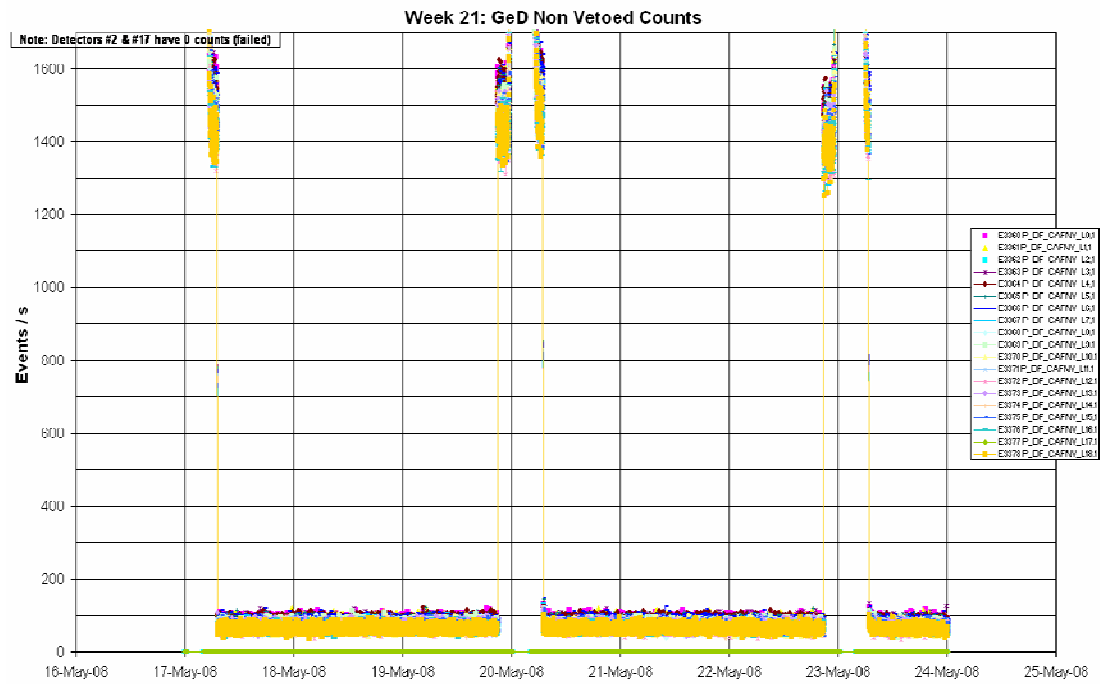
The following plot shows the ACS overall count rate evolution during the reporting period:

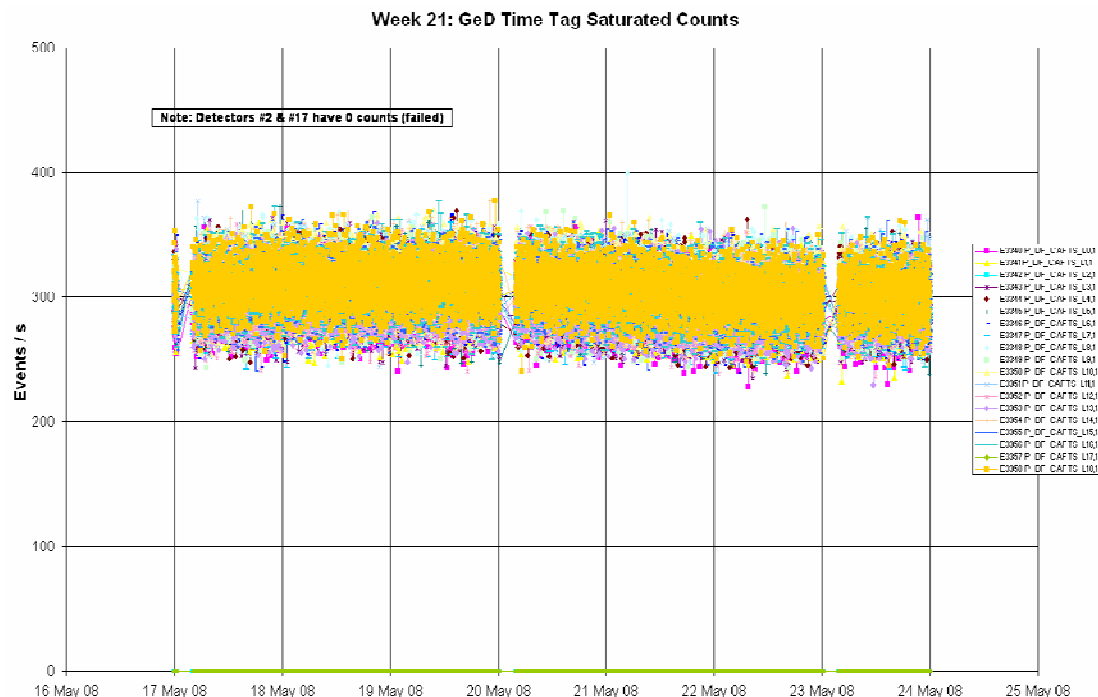


AFEE: The health of the AFEE is nominal. The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06/12/2003 and detector #17 is failed since 17/07/2004.

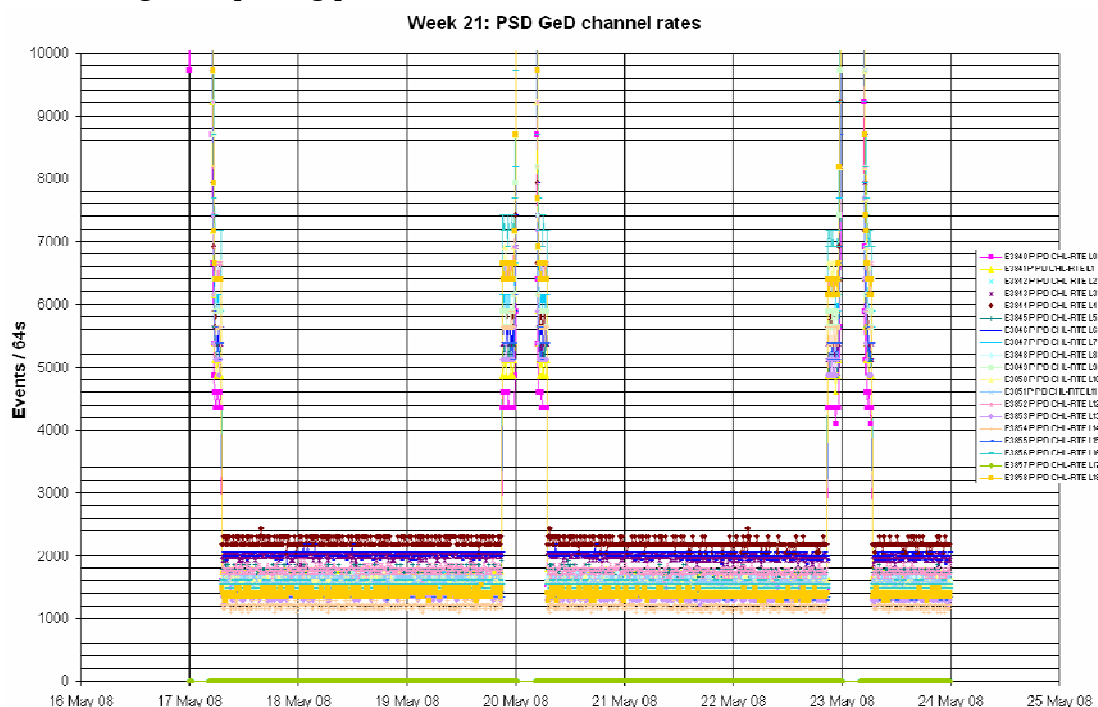


DFEE: The performance of the unit is nominal. The following plots show the Non Vetoed, Time Tag and Time Tag Saturated Event count rates during the reporting period.





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:

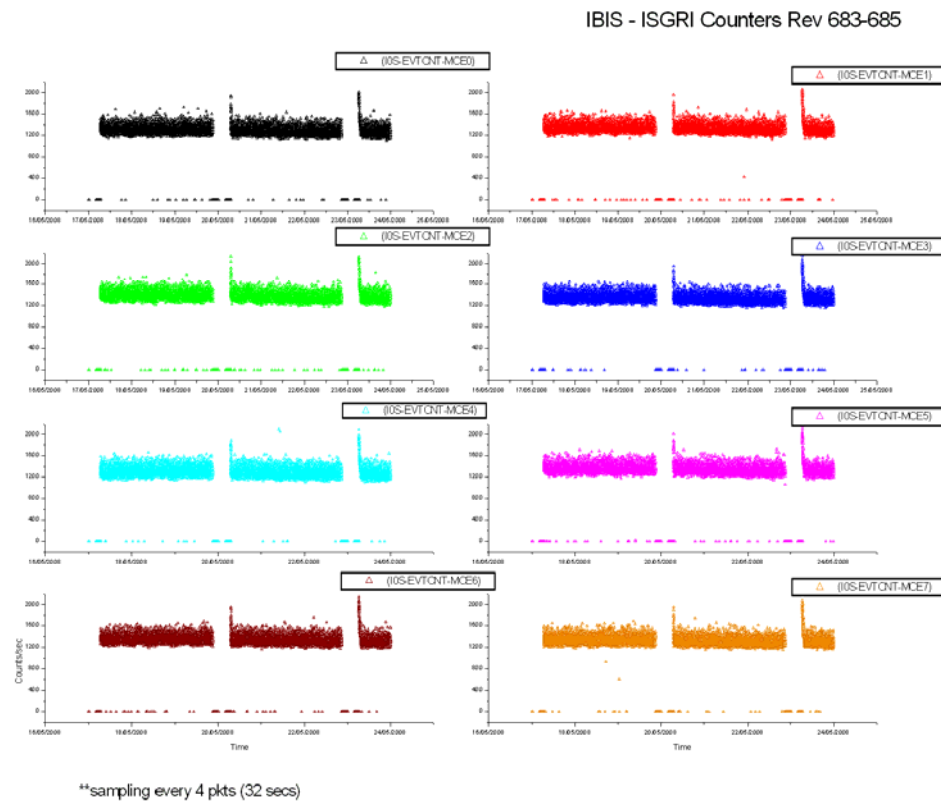
- Due to high background radiation after the expected radiation belt exit of revolution 685, TM parameter E3500 was OOL High on 2008-05-23 from 06:53:33Z to 06:54:53Z, returning within limits of its own accord.
- TM parameter E2115 went OOL Warning Low on several occasions during the week. In each case it returned within limits of its own accord and no action

was taken. However, this parameter is displaying a trend indicating degradation of the thermistor, as occurred for the TM parameter E2116. The lower limit for E2115 will be updated in the next IODB release.

8.3.3 IBIS Operations

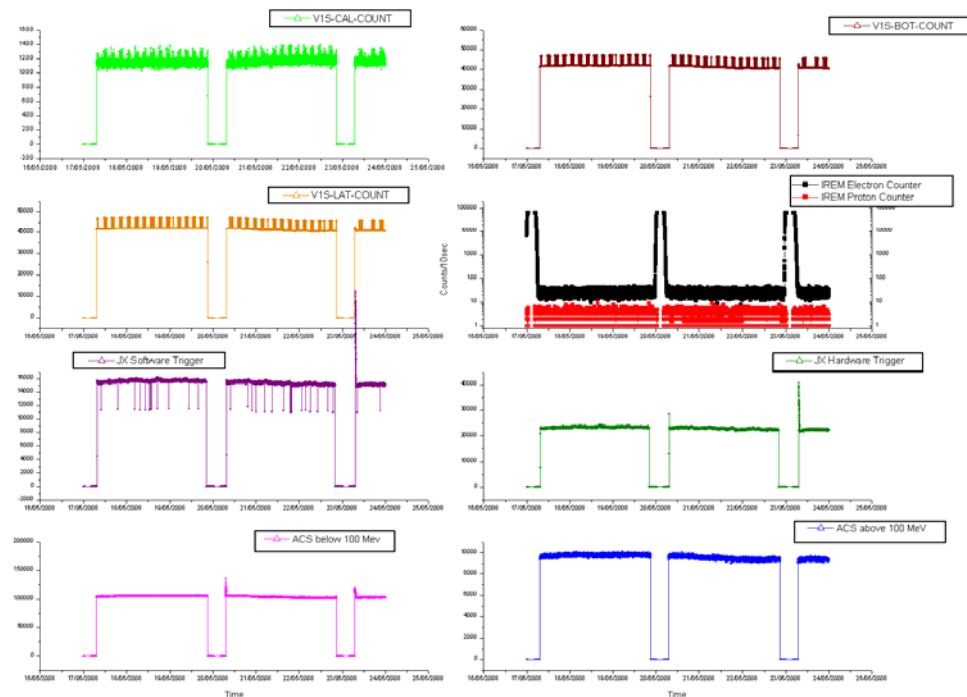
IBIS Event Counters Plots

ISGRI Counters:



VETO vs Payload Counters:

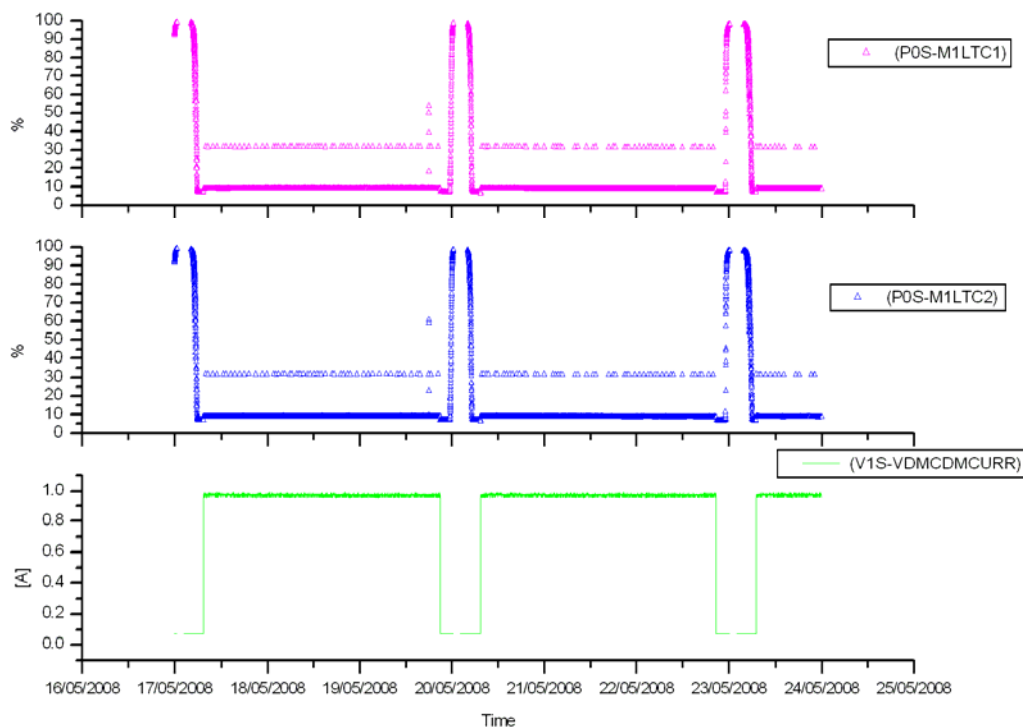
IBIS-VETO vs Payloads Counters Rev 683-685



**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:

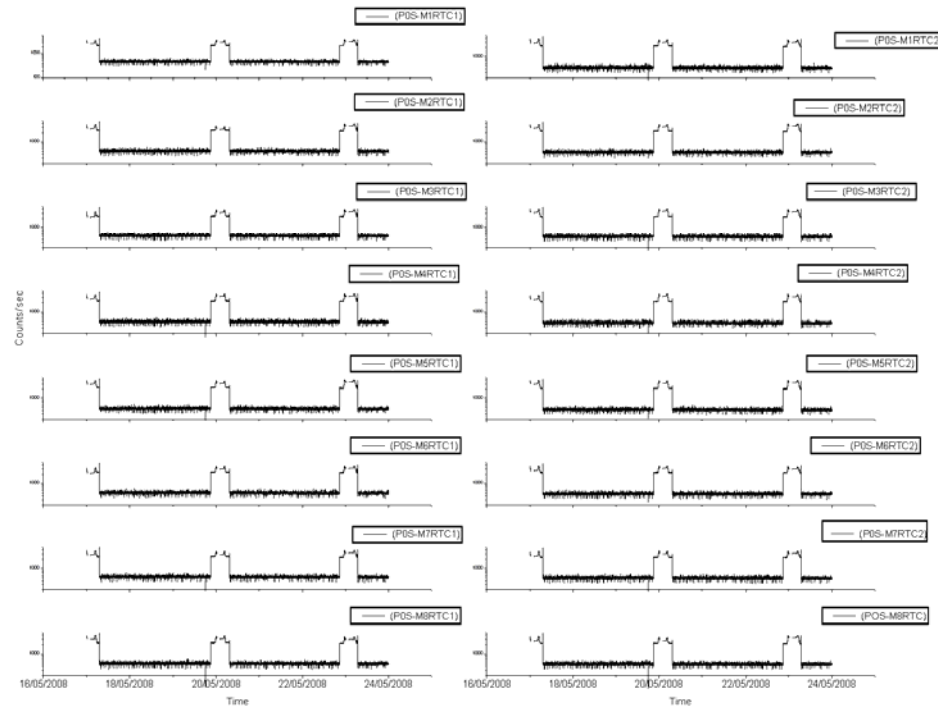
IBIS-VETO Current & PICsIT dead times Rev 683-685



**sampling every 4 pkts (32 secs)

PICsIT Counters:

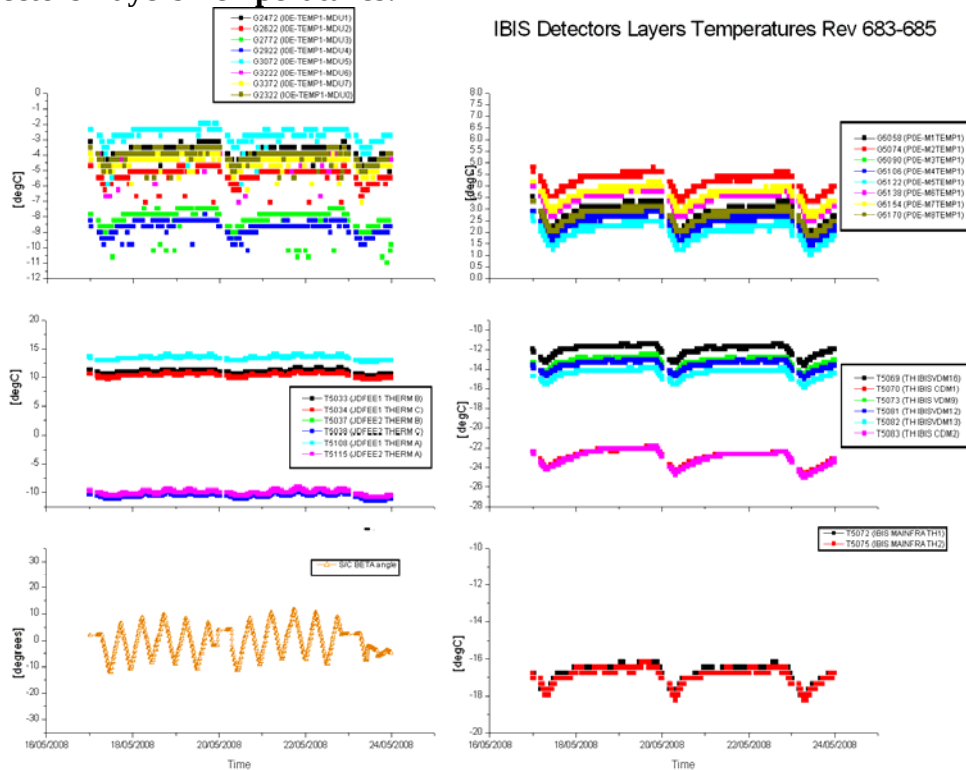
IBIS - PICsIT Counters Rev 683-685



**sampling every 4 pkts (32 secs)

IBIS Detectors Layers Temperatures:

IBIS Detectors Layers Temperatures Rev 683-685



**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.

In addition:

- Following a request from the IBIS PI, the Module Counter Maximum of the Noisy Pixel Handling System was changed from 10000 to 20000 at the start of each revolution. This was done by disabling the Timeline such that the ED GEISCL03 for the ISGRI calibration was not released and a manually edited GEISCL03 sequence with the new parameter value was uplinked instead.
- The TM parameter G6061 toggled OOL Warning Low several times during the reporting period. This is the Veto calibration source counter and the OOL is due to the decreasing value of the counter resulting from the nominal radioactive decay of the calibration source. The lower limits for this parameter will be updated in the next IODB release.

2008-05-17 (DOY 138, Rev 682-683) to 2008-05-18 (DOY 139, Rev 683)

IBIS operations executed nominally.

2008-05-19 (DOY 140, Rev 683)

At 18:00:53Z 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 returned within limits by 18:03:01Z, no action was taken.

2008-05-20 (DOY 141, Rev 683-684)

Due to a problem with the connection of the Manual Stack to the multiplexer (see Anomaly Report INT-2999) the manually edited GEISCL03 sequence was not dispatched from the Manual Stack at the planned time (06:31Z). When the problem was noticed, the GEISCL03 sequence was resent at 06:57:44Z however this was not in time to allow the other IBIS EDs to be released at the planned time from the Autostack. Therefore the other EDs for the activation of IBIS at the start of revolution 684 failed from the Timeline and were resent manually as follows:

- 07:25:21Z ED GEBENT02 uplinked
- 07:27:12Z ED GEBEXT01 uplinked
- 07:35:20Z ED GESTAN02 uplinked with the planned observation parameters and IBIS transitioned to Science Standard mode (~25 minutes later than planned).

IBIS operations continued nominally.

2008-05-21 (DOY 142, Rev 684)

At 00:29:28Z TM parameter G2056 failed status consistency check, indicating an overflow of the noisy pixel address buffer in MCE4. As it returned within limits at the next TM cycle, no action was taken.

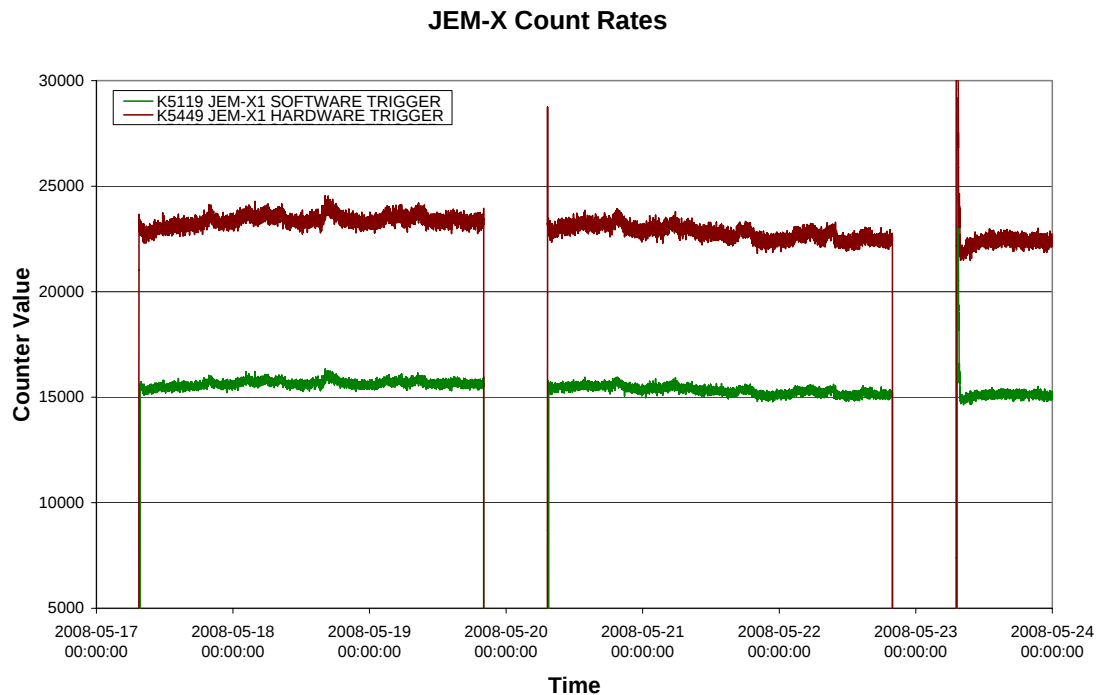
2008-05-22 (DOY 143, Rev 684) to 2008-05-23 (DOY 144, Rev 684-685)

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.



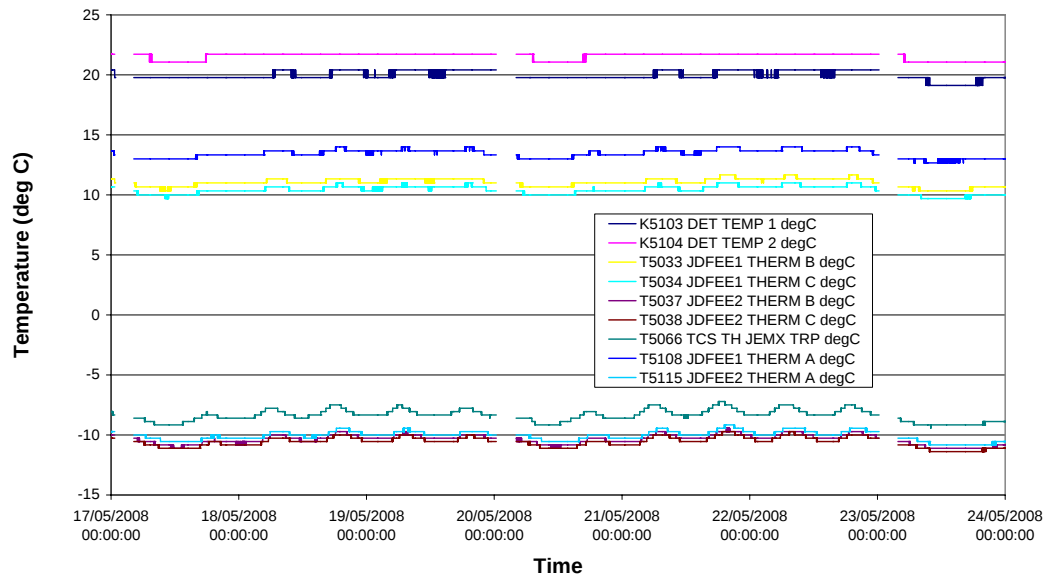
JEM-X Temperatures

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)

JEM-X Detector & DFEE Temperatures



JEM-X Daily Report

2008-05-17 (DoY 138, Rev 683)

At 11:31:10, the command K0021 terminated with a status uncertain_failed. No action was taken and there was no impact.

2008-05-18 (DoY 139, Rev 683) to 2008-05-20 (DoY 141, Rev 684)

JEM-X1 operations executed nominally.

2008-05-21 (DoY 142, Rev 684)

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

```

2008.142.10.26.23.128 2008.142.10.26.28.407 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
2008.142.10.26.23.128 2008.142.10.26.28.351 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

```

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

2008-05-22 (DoY 143, Rev 684)

JEM-X1 operations executed nominally.

2008-05-23 (DoY 144, Rev 685)

At 07:06:34, TM parameter K5449 exceeded soft limits. At 07:08:32, TM parameter K9104 exceeded soft limits. From 07:10:26 to 07:13:32, parameter KD5020D briefly exceeded hard limits. This was during start-up, and cleared without intervention. It was at this time the following OEMs were received:

2008.144.07.08.39.598	2008.144.07.08.43.913	1536	RealTime	189	EVENT	
JEM-X1 PROB DFEE 9			0	0	65535 PR	N
E E						
2008.144.07.13.27.598	2008.144.07.13.31.868	1536	RealTime	254	EVENT	
ERROR OFF			0	0	65535 PR	N
E E						

At 07:14:11 and 07:16:12, TM parameter K5136 exceeded soft limits. No action was taken on any of the above events, and there was no impact.

8.3.5 OMC Operations

2008-05-17 (DoY 138, Rev 683) to 2008-05-23 (DoY 144, Rev 685)

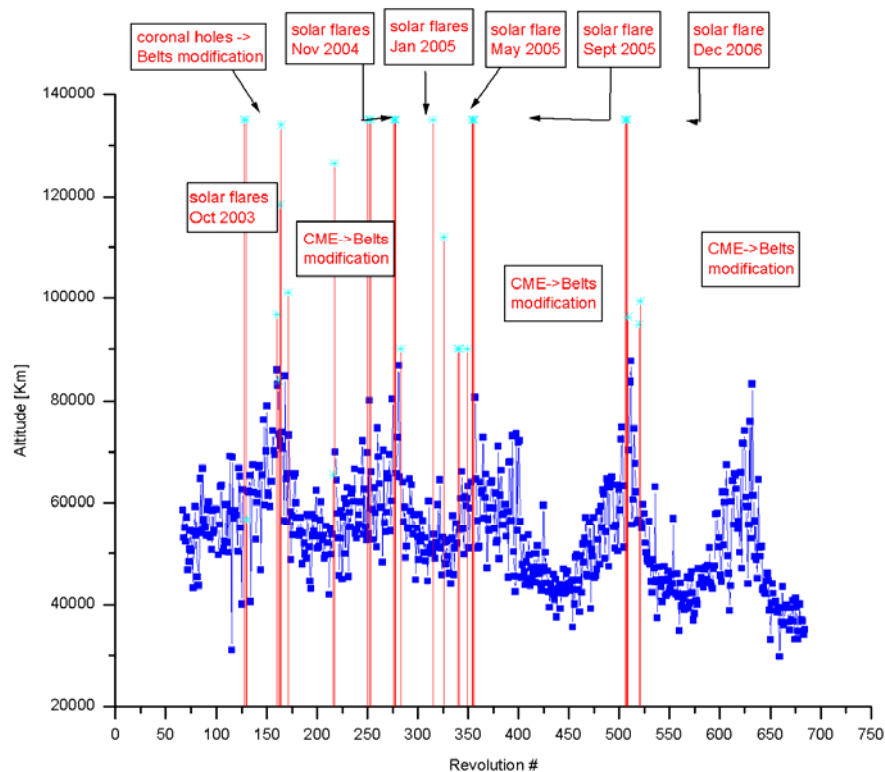
Nothing to Report.

On DoY 140 at 20:57:22 and DoY 143 at 20:47:30 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]
683	RAD_EXIT R 2008-05-17T07:07:31Z	17/05/2008 05:57:05	>>33358.2	17-May-2008 06:23:16	46633. 54
683	RAD_ENTR R 2008-05-19T20:57:21Z	19/05/2008 23:25:29	34122.3	19-May-2008 22:38:13	41067. 37
684	RAD_EXIT R 2008-05-20T06:55:37Z	20/05/2008 05:30:33	>>33389.6	20-May-2008 06:08:13	46462. 95
684	RAD_ENTR R 2008-05-22T20:47:22Z	22/05/2008 23:04:09	35137.9	22-May-2008 22:28:13	40826. 3
685	RAD_EXIT R 2008-05-23T06:44:51Z	23/05/2008 06:27:29	>>33414.4	23-May-2008 05:48:13	45285. 57

Reference

High radiation

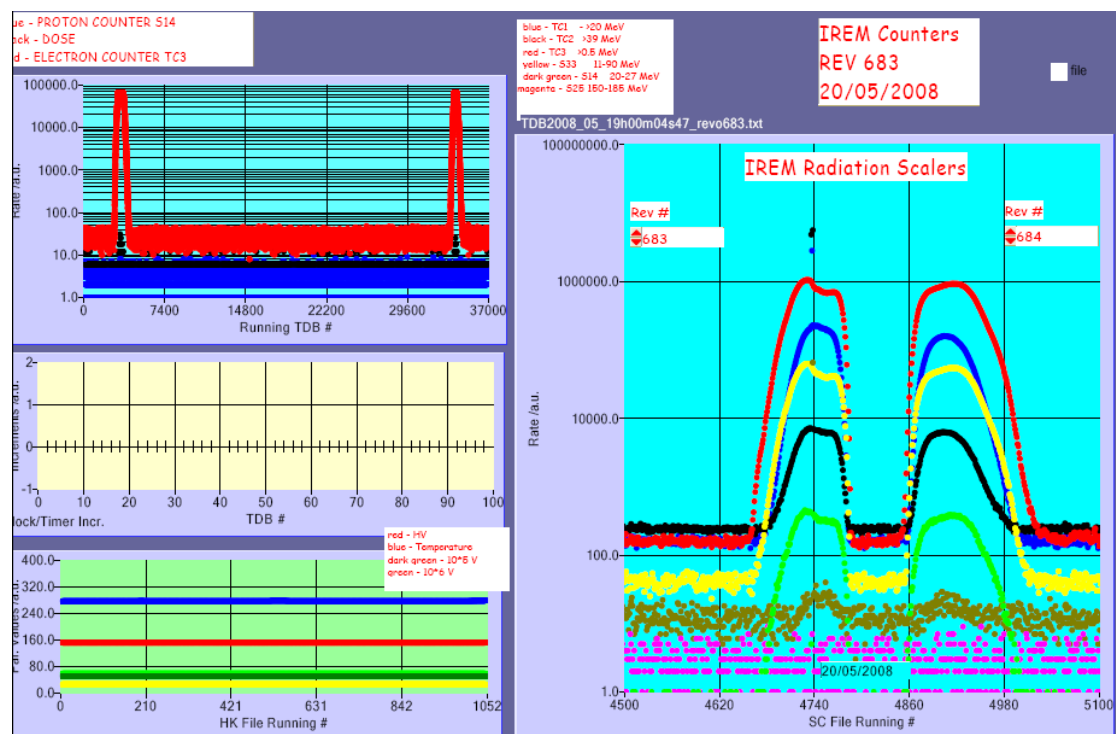
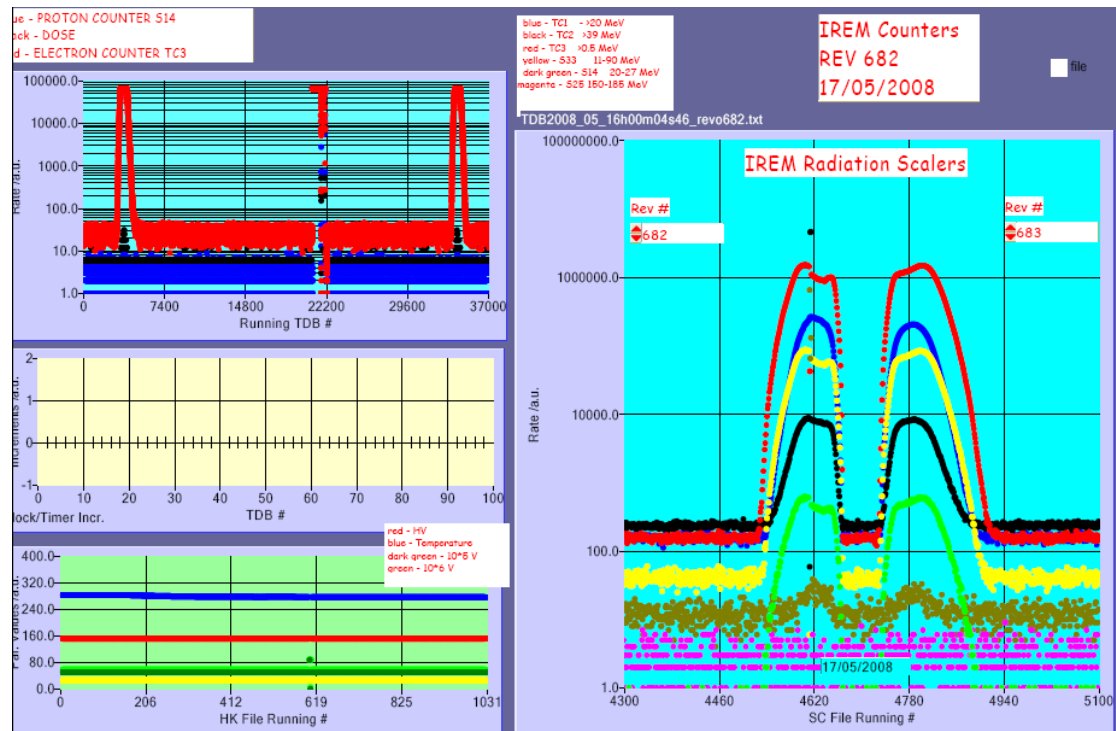
Very small error vs reference (less than 10 minutes)

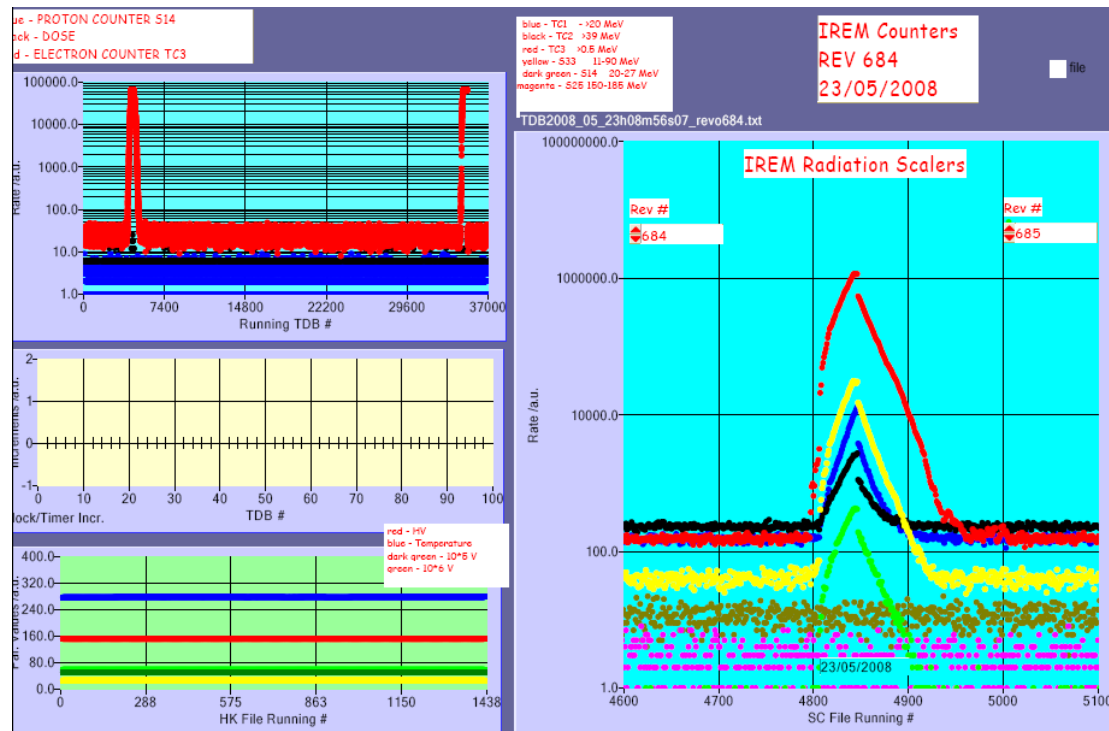
Small error vs reference (between 10 and 30 minutes)

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.

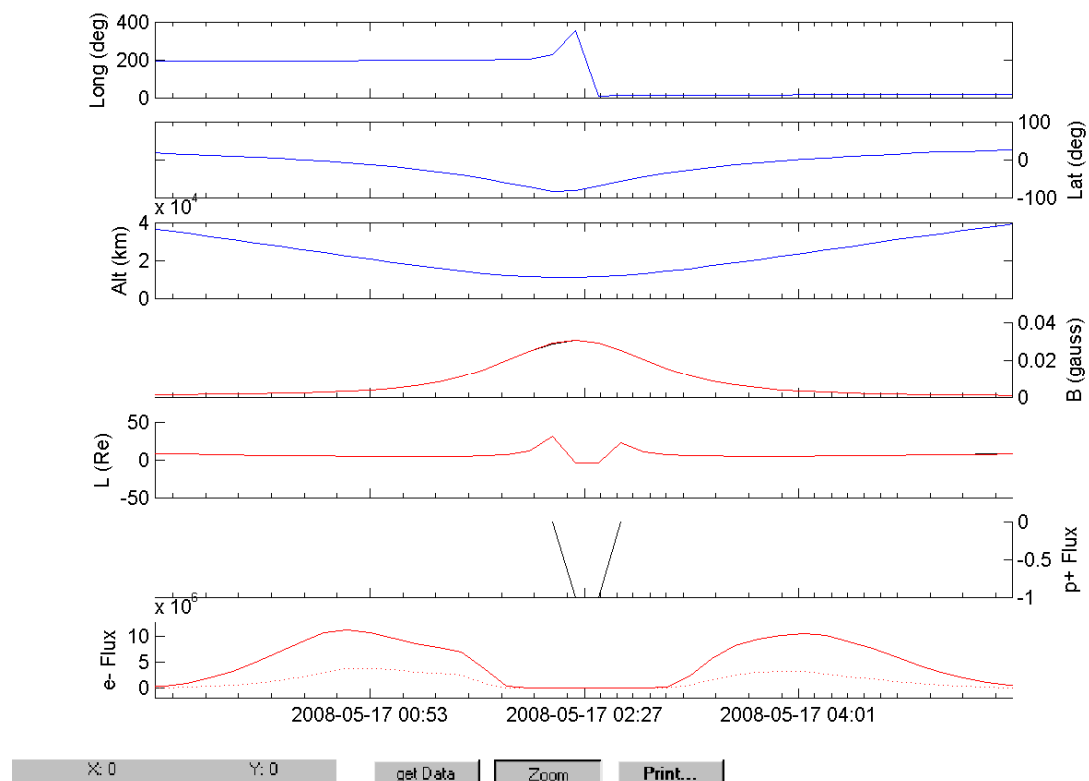
IREM radiation counters:



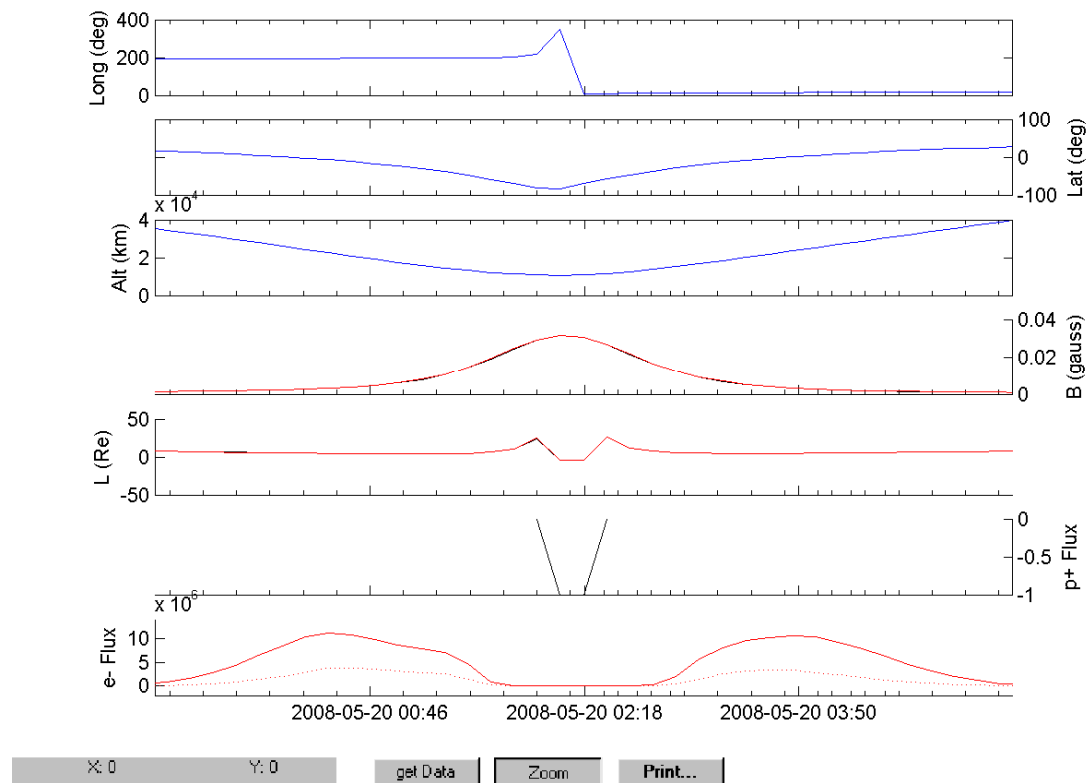


IREM Predicted Radiation Belt Passages

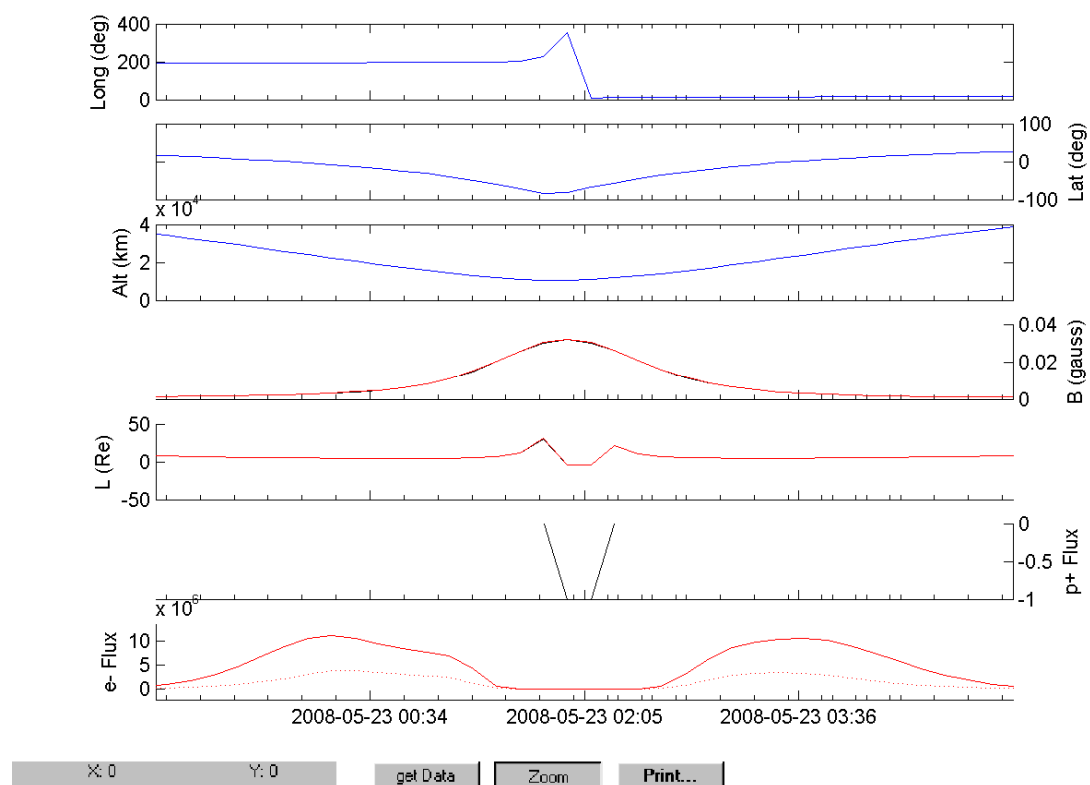
Rev 682



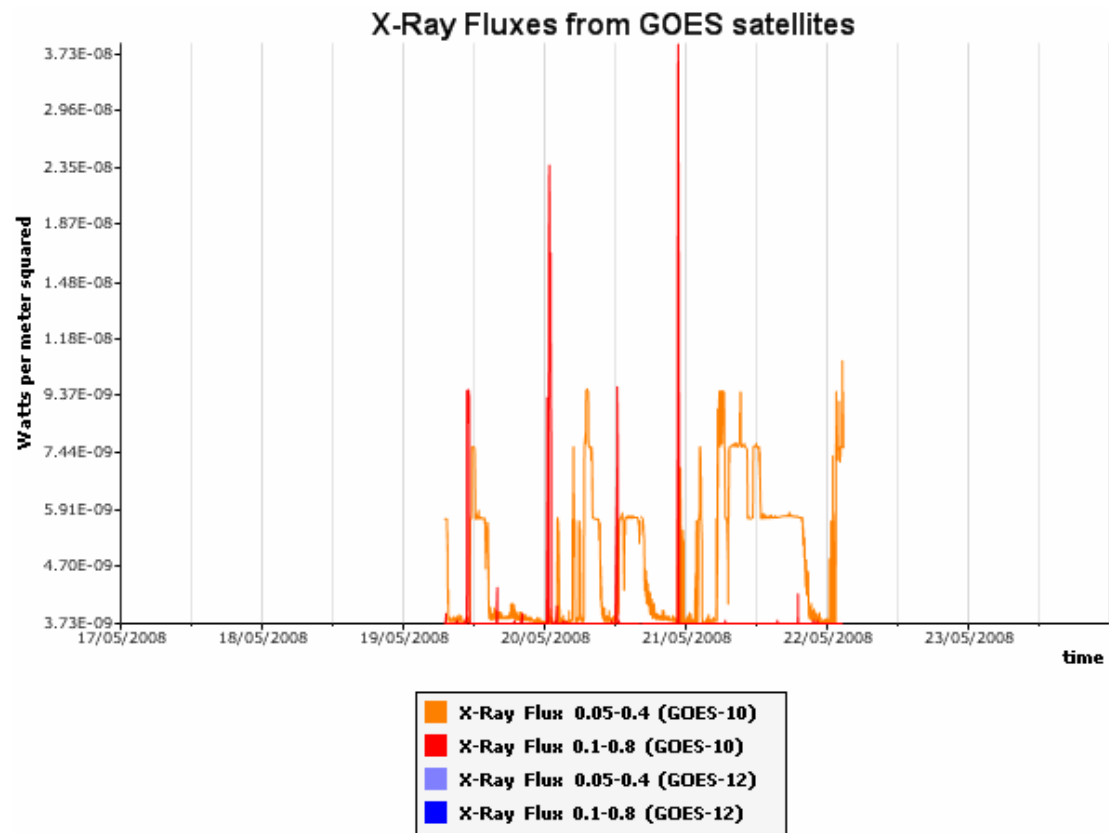
Rev 683



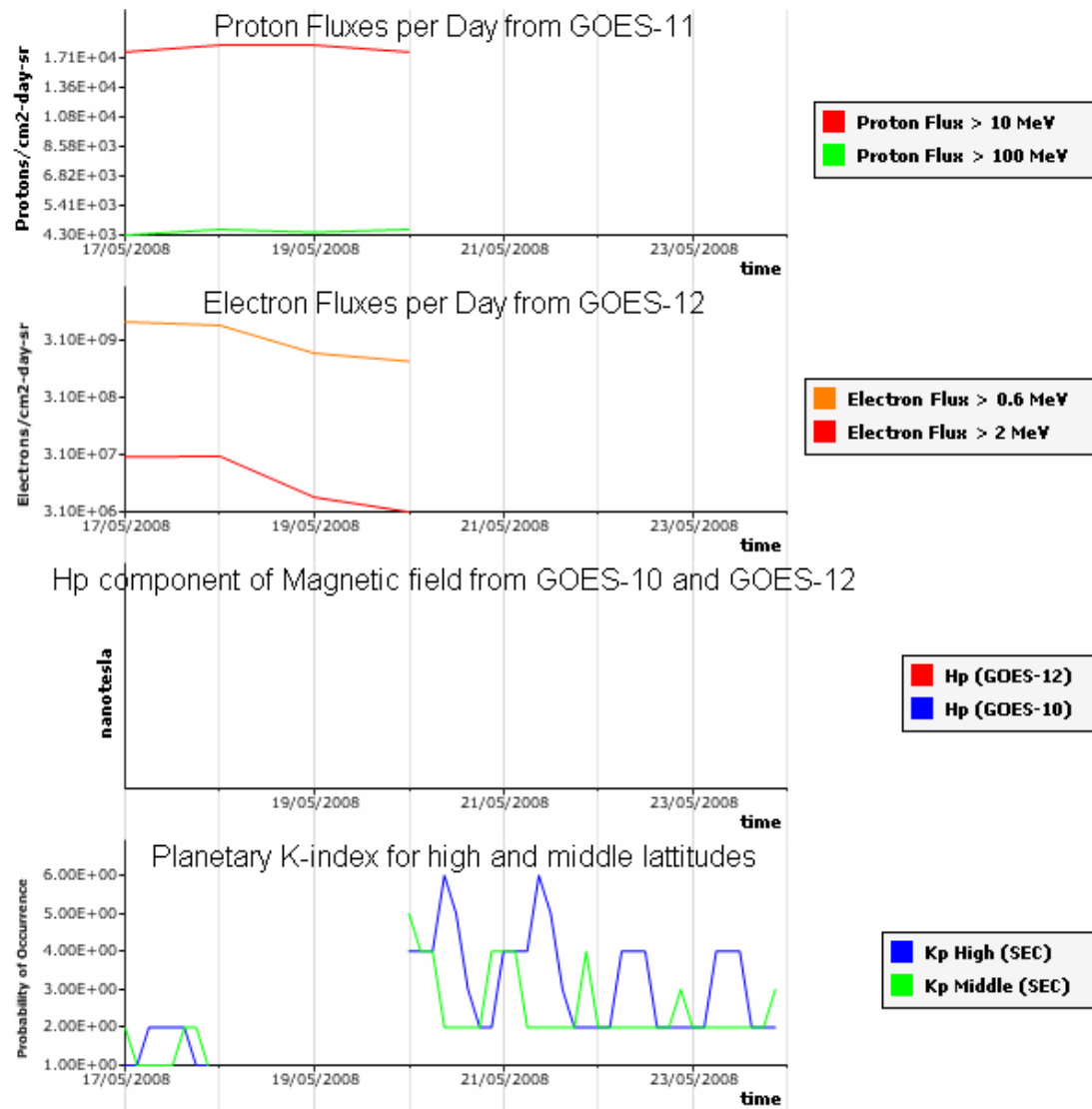
Rev 684



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.