

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OAI
No. 297
Week 22
02.06.08
Routine Phase

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1 General

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

It addresses the activities from 24.05.08 until 30.05.08 (both dates inclusive) and covers the revolutions 686 and 687.

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 raster dithers 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.

Two slews were missed from TL, during the observation period due to problem on Search and Track process (star in slot #2 not found) and on IMCS-A server.

The fuel consumption over the period between 24/05/2008 and 29/05/2008 was 0.0654 Kg. The remaining propellant is in the order of 140.2729 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

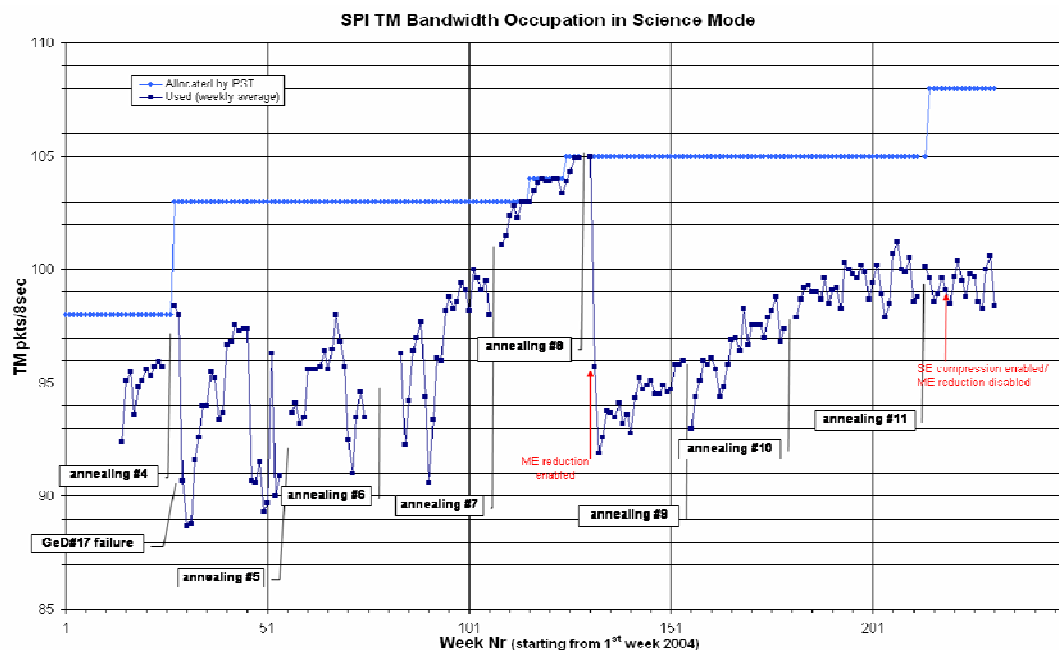
3.2.1 SPI

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 98.4 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.

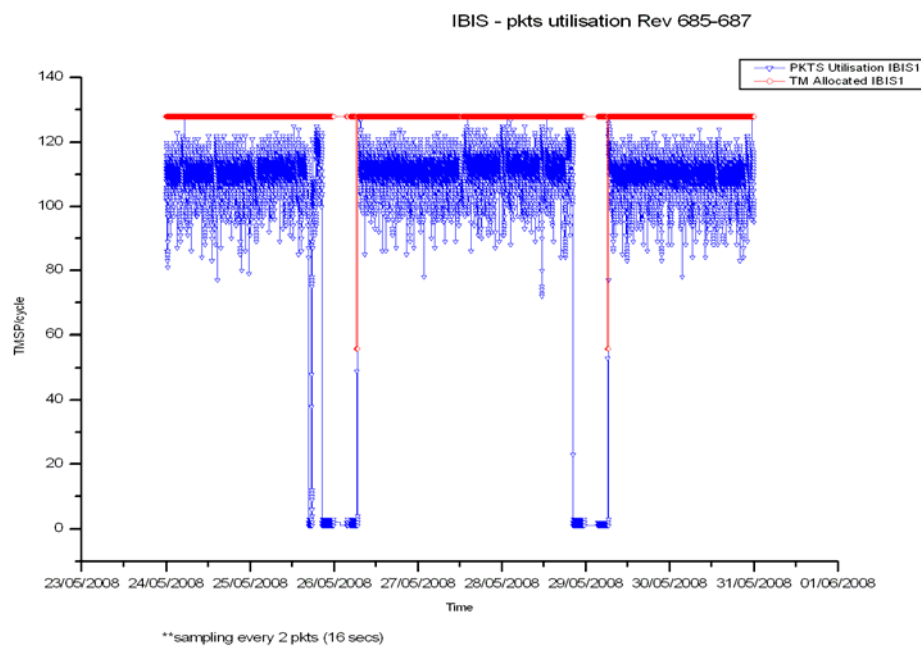
3.2.2 IBIS

The overall status of the unit is nominal.

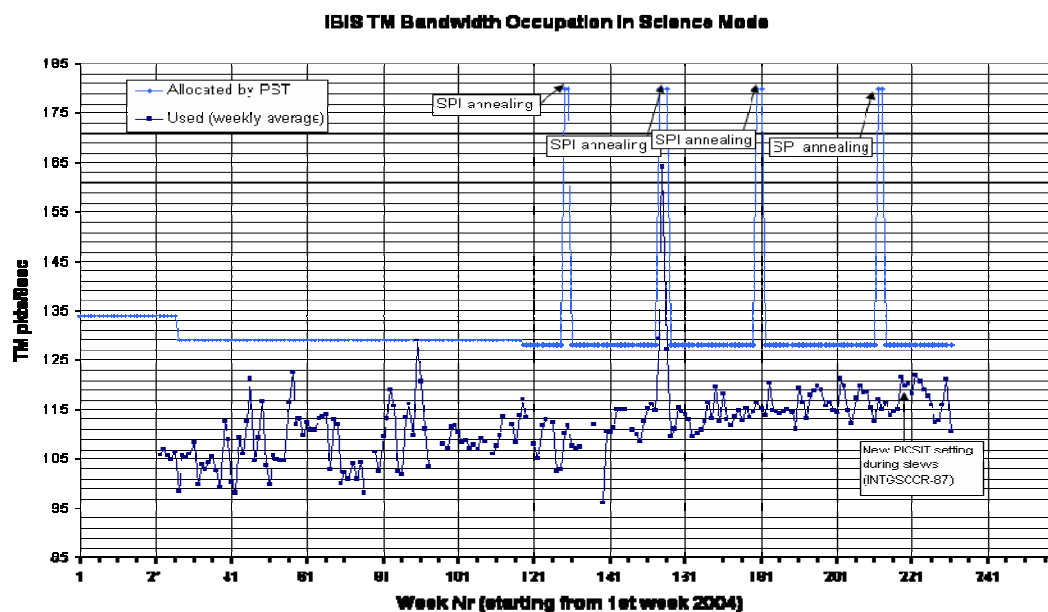
During the reporting period, the TM bandwidth statistics were as follows:

- PST allocation to IBIS above radiation belts: 128 packets/cycle
- IBIS mean bandwidth utilisation in science mode: 110.58 packets/cycle (down 10.57 on last week)
- Percentage of TM cycles in which full bandwidth was used: 0.55%

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, 139 of the 143 planned science pointings were executed nominally, 2 pointings were cut short and 2 lost.

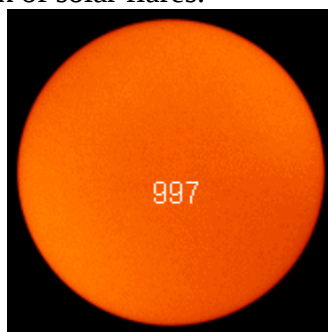
Note: Some more information concerning the OMC operations is provided in the Appendix.

3.2.5 IREM

The overall status of the unit is nominal.

Solar Activity

The observation period was characterised by low solar activity. The Sun was blank all week except between the 26th and 27th May, when a tiny sun-spot (#997) was visible. There was only a very low risk 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. 1 pointing was lost to ground problems. The overall performance was over the 95% requirement.

4.1 Mission Operations Centre

The performance of the MOC was very good this week. There were some problems with the OBQM task within the imcs, without impact.

4.2 Ground Stations & Network

The performance of the ground stations and Network was good this week. There was however 2 occasions where the TM dropped from Redu, the links to ISDC dropped once, all without impact. There was one occasion, where the network communications failed within the MOC, which led to the loss of a pointing.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

A new PSFs has been received for revolution 695, while an updated PSF was received for revolution 691, because of an extra REDU maintenance, with an extra Goldstone pass and a VILSPA pass.

Observations were replanned for revolutions 691 to 694, because of the new PSF for revolution 691.

New TSFs have been received for revolutions 687 to 689.

2. Observation status

New ECS files have been received for revolution 678 and 679.

3. ISOC Science Data Archive

Nothing to report this week.

4. ISOC system

ISOC system V19.2 was installed on the test system on 30 May 2008, and is being tested by the scientists.

5. Problems

None.

4.3.2 ISDC

Status of ISDC observation processing on 02/06/2008:

- Latest Standard Analysis completed: observation 05200680008 (4U0115+63, Revolutions 675 & 677) on 29/05/2008.

- Latest products archived: observation 05200680008 (4U0115+63, Revolutions 675 & 677) on 29/05/2008.

- Latest observation products sent to the observer: observation 05200680008 (4U0115+63, Revolutions 675 & 677) on 29/05/2008.

5 Special Events

6 Anomalies

The following problems were reported this week that impacted operations.

- On DoY 146 at 16.50:39, an IREM SEU (#63) caused the OMC, and IBIS units to switch to SAFE mode. The units were recovered, promptly, see the relevant section in the Appendix for details.
- On DoY 148 at 12:18, all MCS A-chain clients displays froze, shortly afterwards they logged out automatically. This behaviour is consistent with loss of connectivity to the server, this was verified by attempting unsuccessfully to ping or telnet from a client to the prime server. A recovery was later performed, and the timeline rejoined at 13:17. The impact was the loss of pointings 06860032.

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

AR id	Date Created	Subject	Segment	Status
INT-2995	2008-05-27	Loss of Connectivity to A-chain Servers (DENEb)	COMMS	Pending
INT_SC-227	2008-06-04	IREM Anomaly: Reset of IREM_CSCI S/W #63, 25/05/2008	Payload	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 686

The observations in revolution 686 consisted entirely of a raster dither of the North Ecliptic Pole (RA 18:00:00.00, DEC +66:33:39.0), lasting ~58.0 hours.

Throughout these observations, all instruments were in their nominal science modes, except JEM-X2, which is switched off. The TM allocation was IBIS 128; SPI 108; JEM-X1 8; JEM-X2 0; OMC 5.

Revolution 687

The observations in revolution 687 consisted entirely of a raster dither of the North Ecliptic Pole (RA 18:00:00.00, DEC +66:33:39.0), lasting ~58.0 hours.

Throughout these observations, all instruments were in their nominal science modes, except JEM-X2, which is switched off. The TM allocation was IBIS 128; SPI 108; JEM-X1 8; JEM-X2 0; OMC 5.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

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.
2008-05-24T14:17:39.000Z	140.3210	F	Automatic TM processing.
2008-05-26T05:41:52.000Z	140.3097	F	Automatic TM processing.
2008-05-27T13:54:11.000Z	140.2861	F	Automatic TM processing.
2008-05-29T04:07:12.000Z	140.2729	F	Automatic TM processing.

This report was generated Fri May 30 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, 24/05/2008 – 30/05/2008

The AOCS operations were executed from the Automatic Timeline.

During this period, 82 Open Loop Slews, 67 Closed Loop Slews and 5 Momentum Biases were executed (as reported by ACC).

1 slew (CSL) was missed from TL, during the observation period due to problem on search and track process (star in slot #2 not found).

The OTF was not reached during last part of PID 06850024.

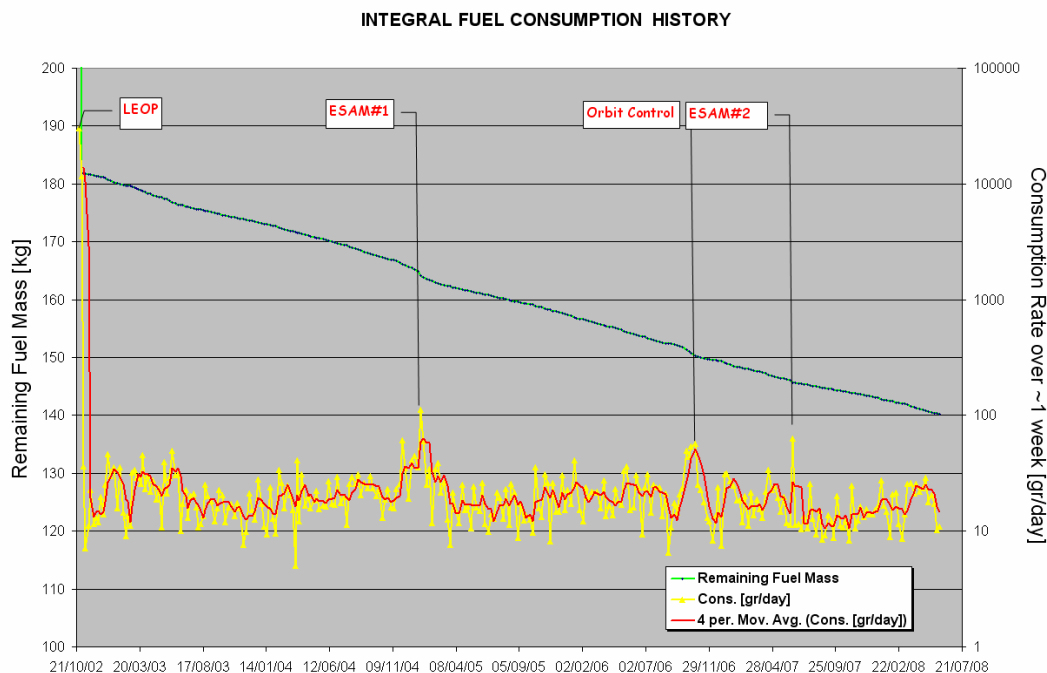
This is equivalent to $\sim 0.6\%$ of the total number of slews planned (149).

Orbit Control

No update

Fuel consumption

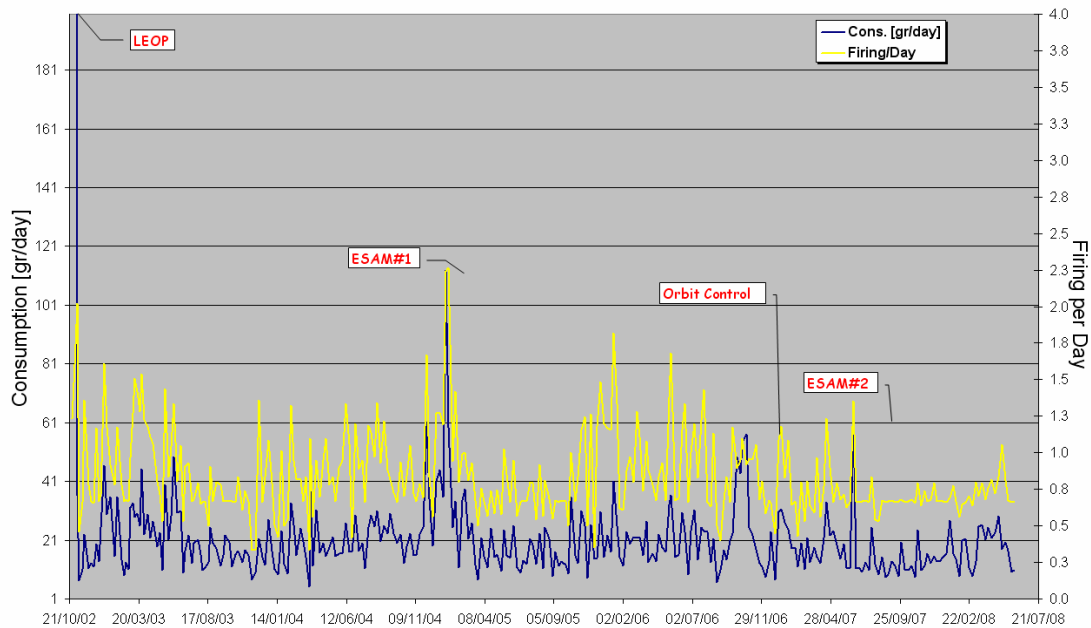
The fuel consumption (total, grams per day) over the period between 01/11/2002 and 29/05/2008 is reported in the plot below.



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 29/05/2008 is reported in the plot below.

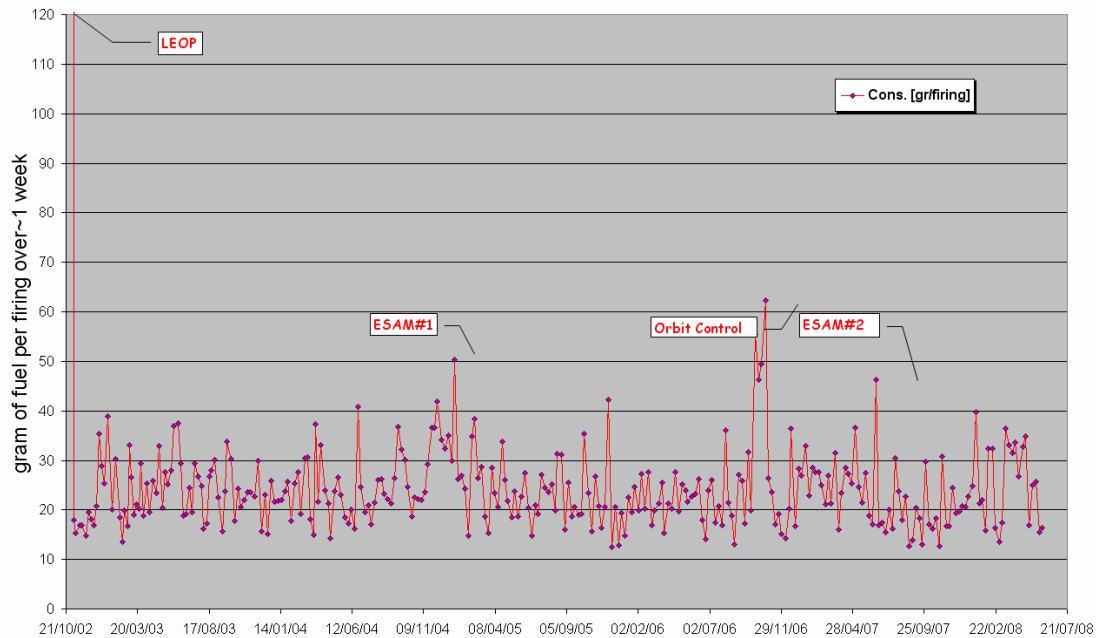
INTEGRAL FIRING PER DAY HISTORY



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 29/05/2008 is shown in the plot below.

INTEGRAL FUEL MASS PER FIRING HISTORY

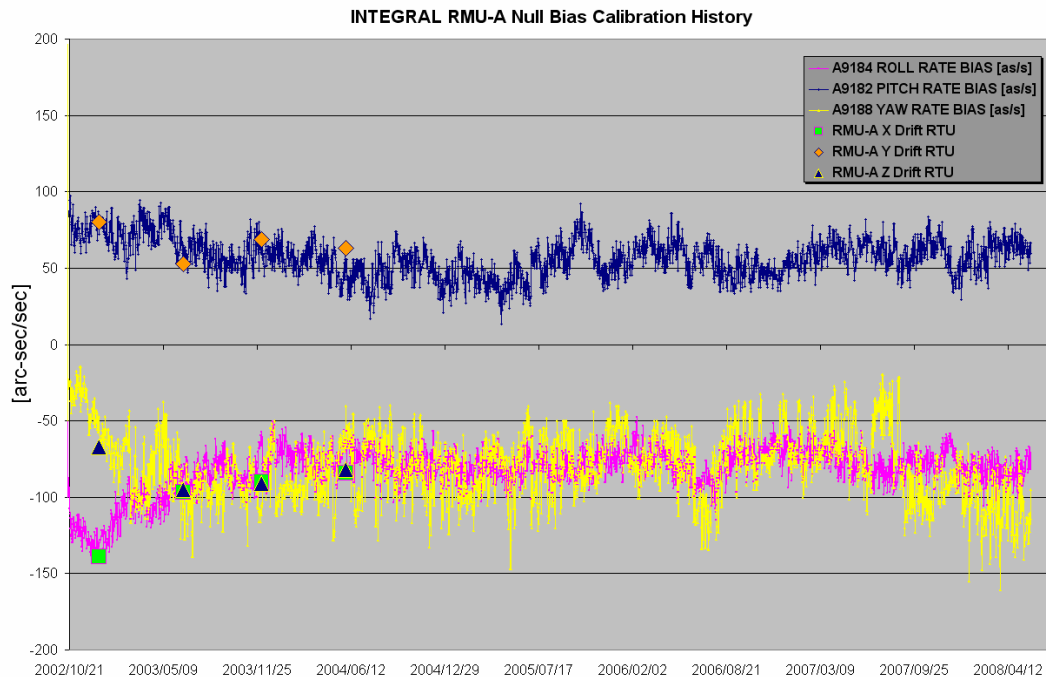


The RMU-A null bias calibration

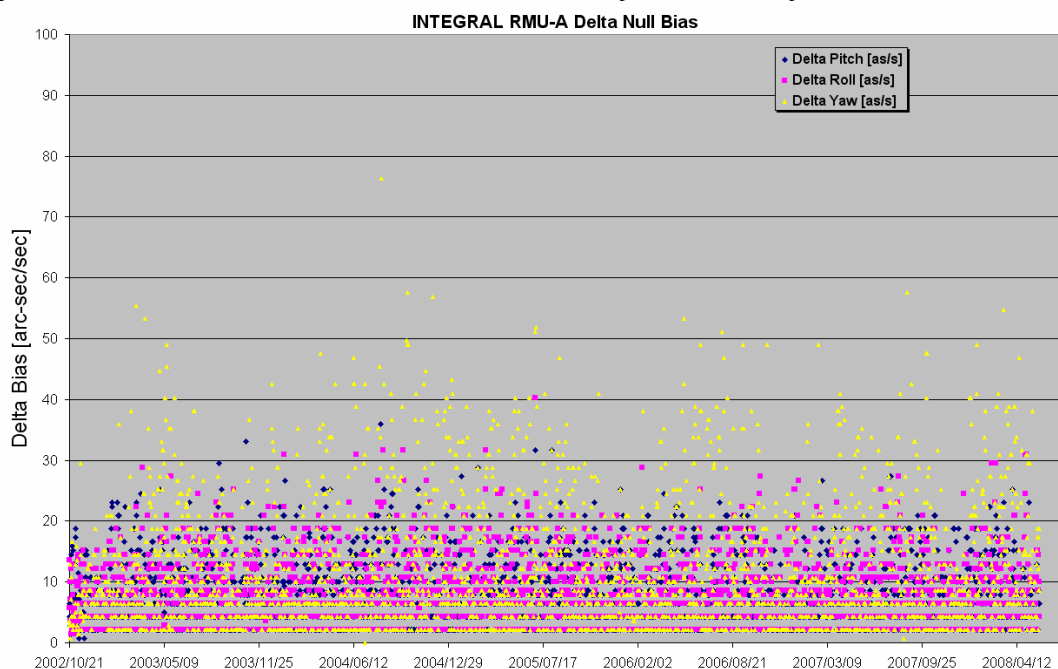
The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 30/05/2008 is reported in the plot below.

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 30/05/2008 is reported in the plot below.



24/05/2008 (Day of Year 145, Revolution 685)

Loss of guide star: at 04:45:57z a loss (false event) of the current guide star occurred. As foreseen by the IPS logic, the IMU1 went ON and a new guide star picked.

The operator performed a manual mapping and the next slew ID 06850025 was manually updated in TL.

No impact on TL. The OTF was not reached during last part of PID 06850024.

25/05/2008 (Day of Year 146, Revolution 685)

Problem during Search/Track process: at 02:30z a problem (star not found in slot #2) during the Search/Track process selecting the slew star caused the PTV to fail and the slew 06850045 to fail release.

A manual recovery was performed from attitude of PID 06850044 to the attitude of PID 06850045. The next slew ID 06850046 was manually updated in TL.

The following slew was missed in TL: 06850045 (CSL)

26/05/2008 (Day of Year 147, Revolution 685-686)

Problem on IMCS server A: at 03:46z a problem on IMCS-A server (CMD OBQM not running) forced the operator to switch TL commanding on the IMCS-B server.

During the server switch, the sequence for the Reaction Wheel Bias, planned at the beginning of the rev, failed release.

FD was called in and a manual recovery was started to perform the Bias activity lost. The first slew of the revolution ID 06860001 was manually updated in TL at 06:00z.

No slew lost.

27/05/2008 (Day of Year 148, Revolution 686)

Problem on IMCS server A: at 12:18z a problem on IMCS-A server (Loss of TM, Commanding Stacks disconnected from MULTIPLEXER) forced the operator to switch TL commanding on the IMCS-B server.

During the server switch, the slew ID 06860032, planned, failed release. At 13:00z the problem on the IMCS-A server was cleared and the commanding switched back on the A-chain. A manual recovery was started to slew from attitude of PID 06860031 to the attitude of PID 06860032. The next AOCS activity (change of guide star) in TL was manually updated at 13:44z.

The following slew was missed in TL: 06860032 (CSL)

28/05/2008 (Day of Year 149, Revolution 686)

Nothing to report.

29/05/2008 (Day of Year 150, Revolution 686-687)

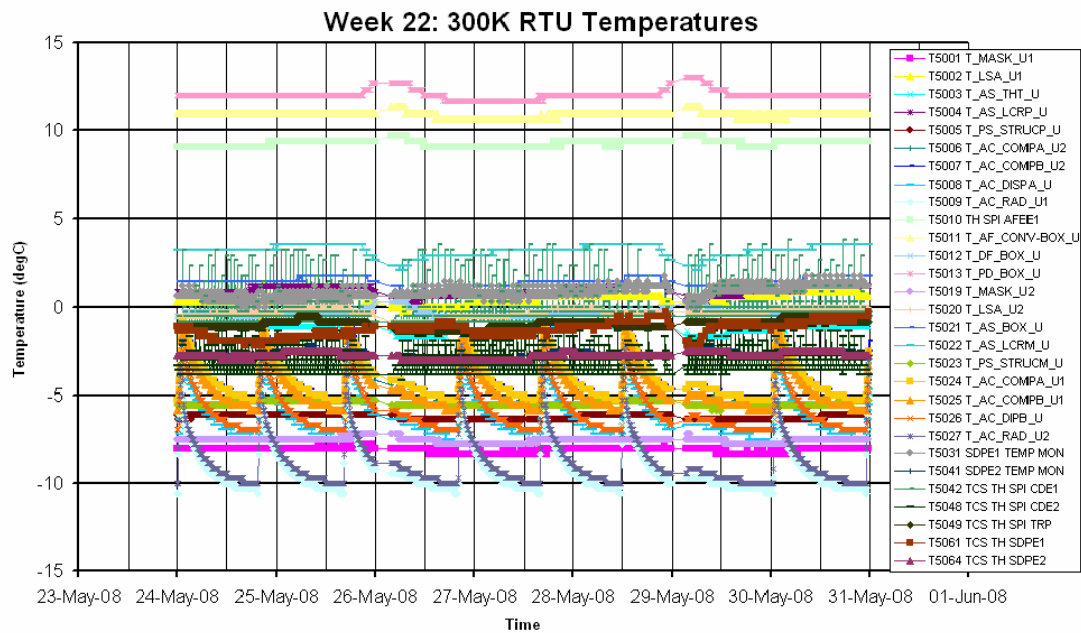
Nothing to report.

30/05/2008 (Day of Year 151, Revolution 687)

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.

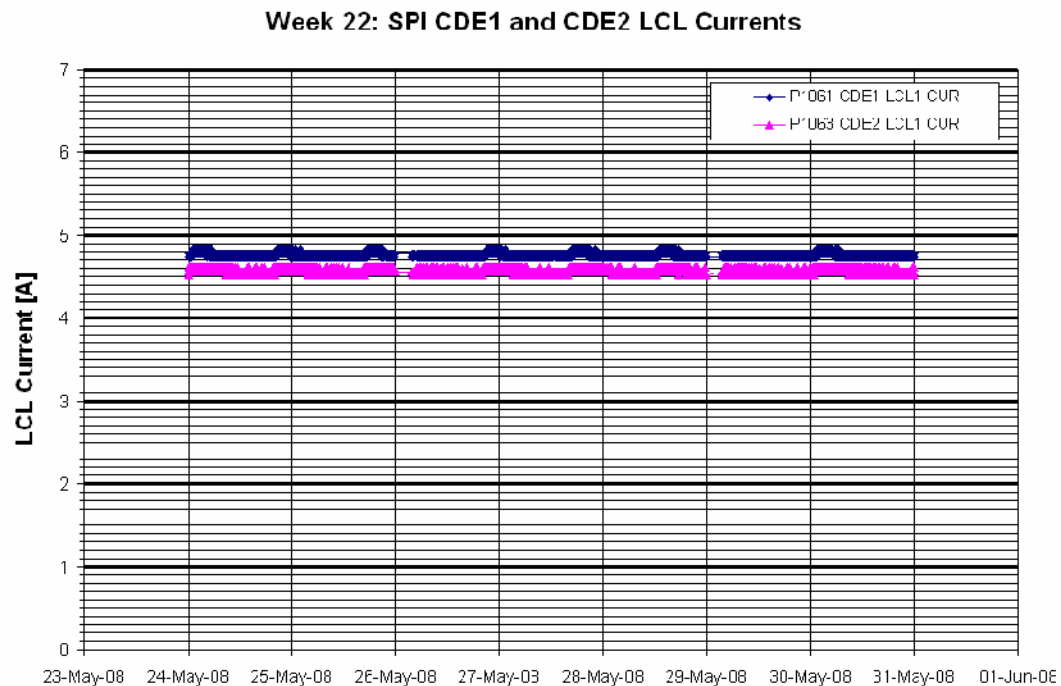


Stirling Compressors and Cryostat: The performance of the compressors is nominal. The cold plate temperature was maintained in the range 80K +/-1K.

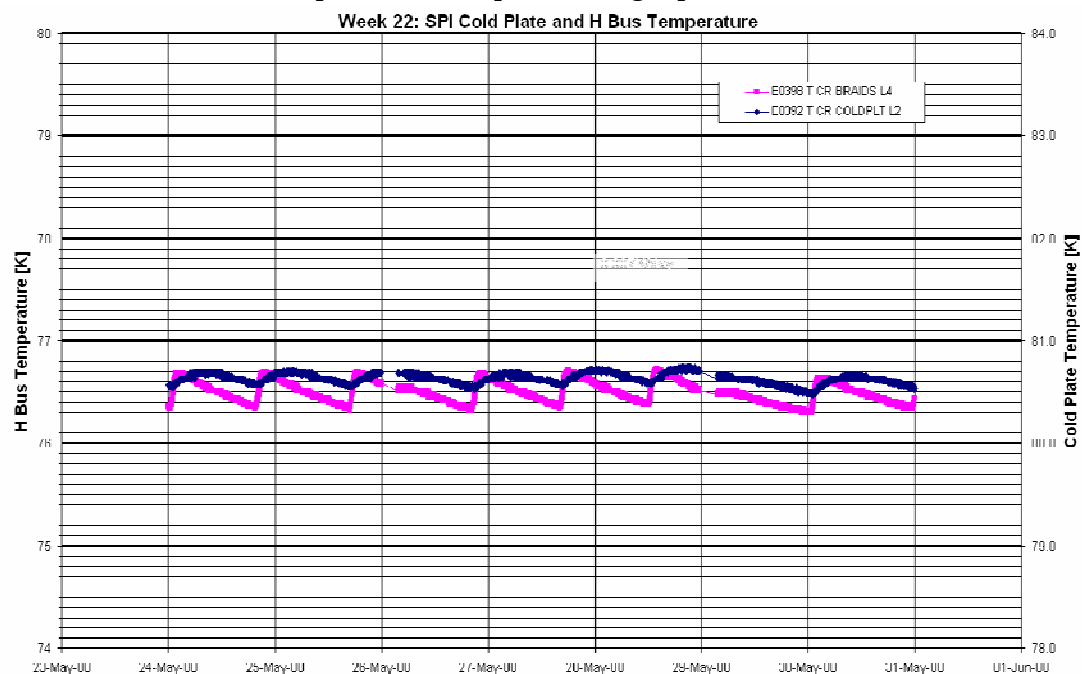
The stroke of all four compressors was set to 40 throughout the week. The average CDE LCL currents were as follows:

- 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.

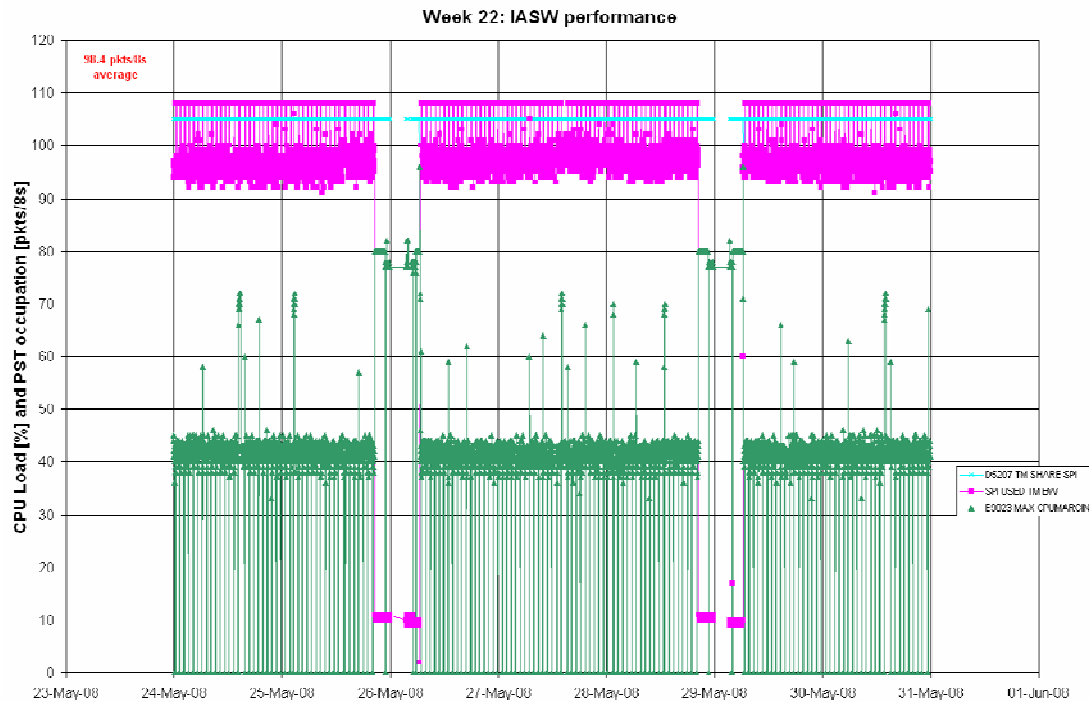


DPE & IASW: The DPE health and IASW performance is nominal.

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

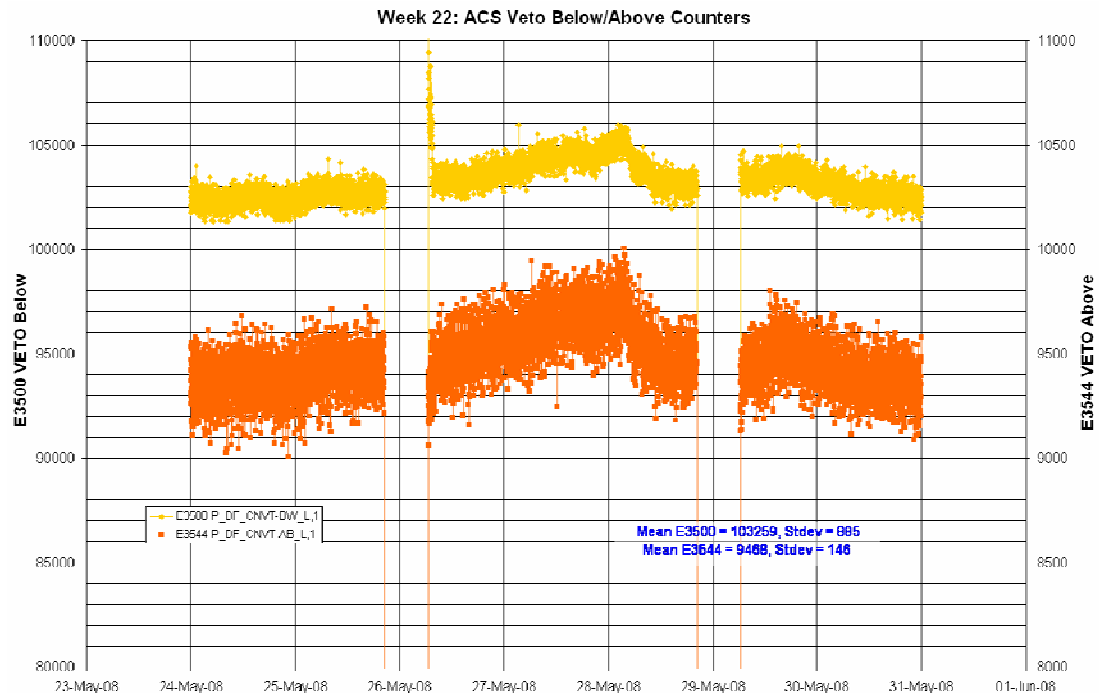
The average TM bandwidth occupation of SPI was 98.4 packets/cycle over the science window. The TM allocation in the science window was 108 packets/cycle. This allocation is considering that the over-allocated PST with the additional 3 packets/cycle for SPI was being used, however the Broadcast Packet 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.

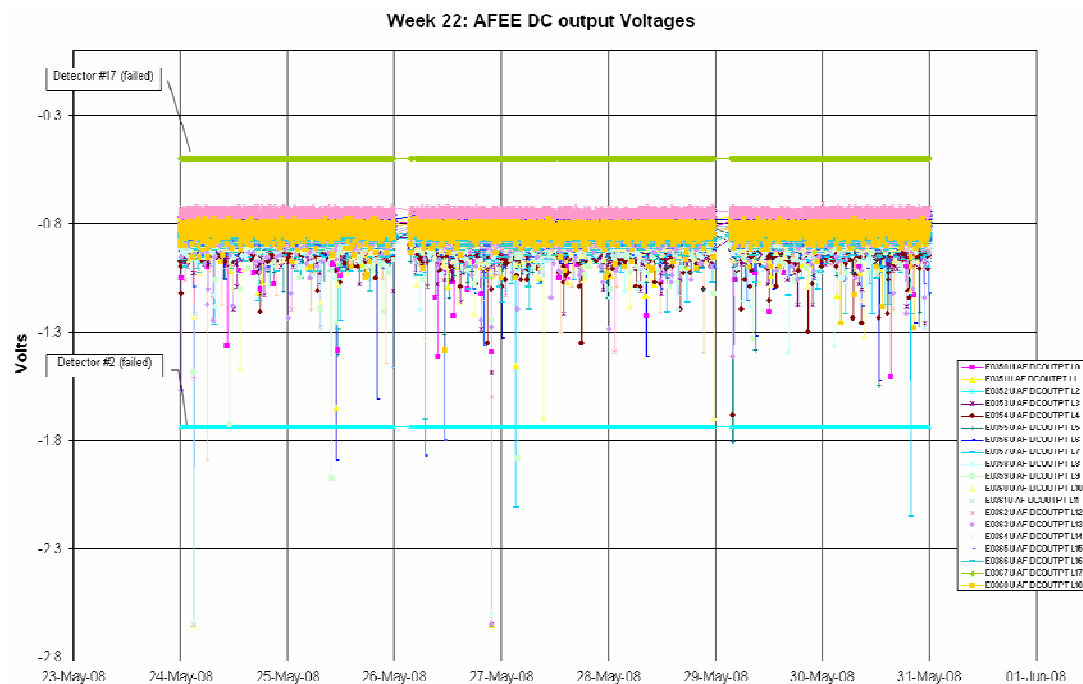


ACS: The performance of the ACS is nominal, except for FEE #81 which remains nominally switched off since the anomaly on 29/10/2006 (INT_SC-162) and FEE #57 which is nominally OFF due to the anomaly on 5/8/2003 (INT_SC-61).

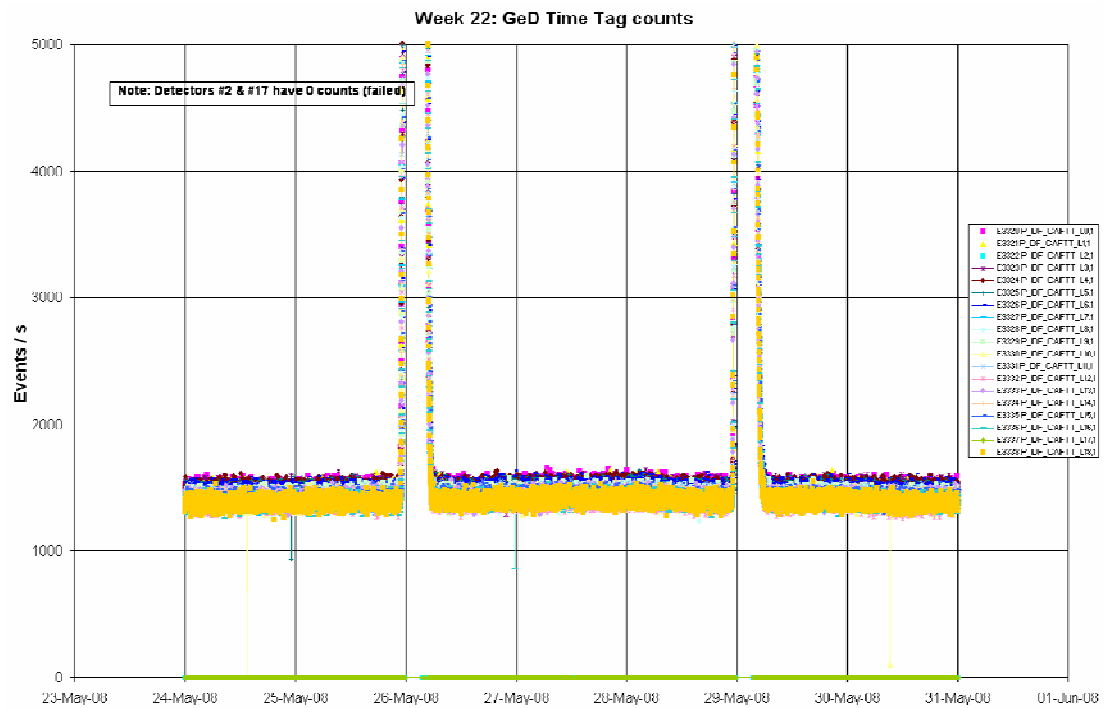
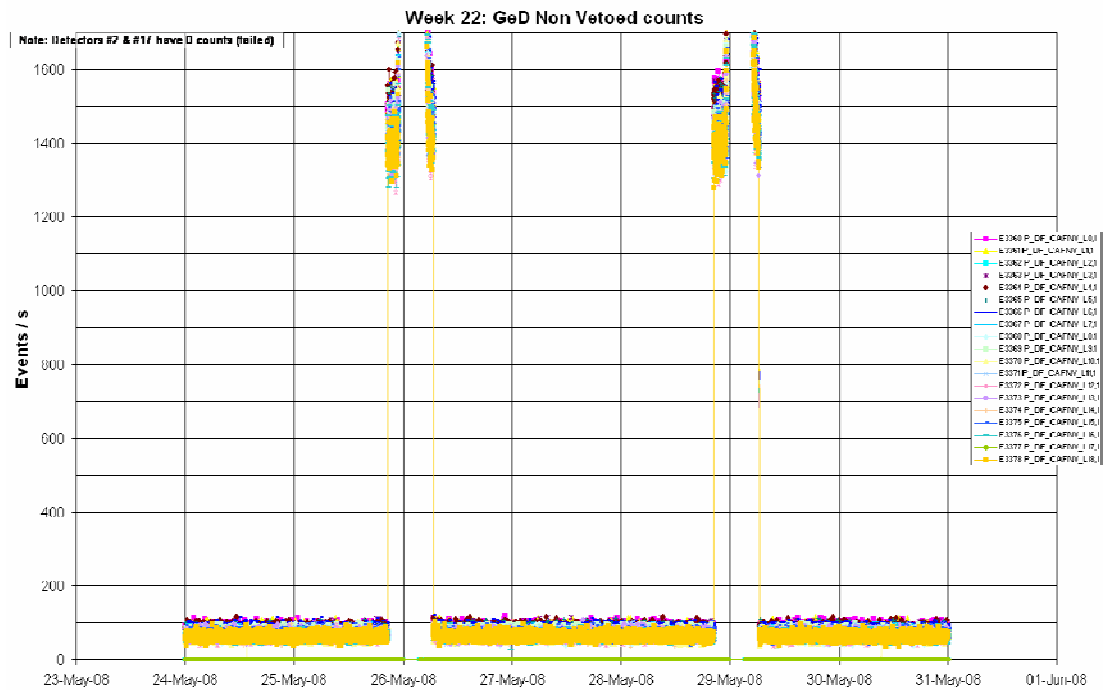
The following plot shows the ACS overall count rate evolution during the reporting period:

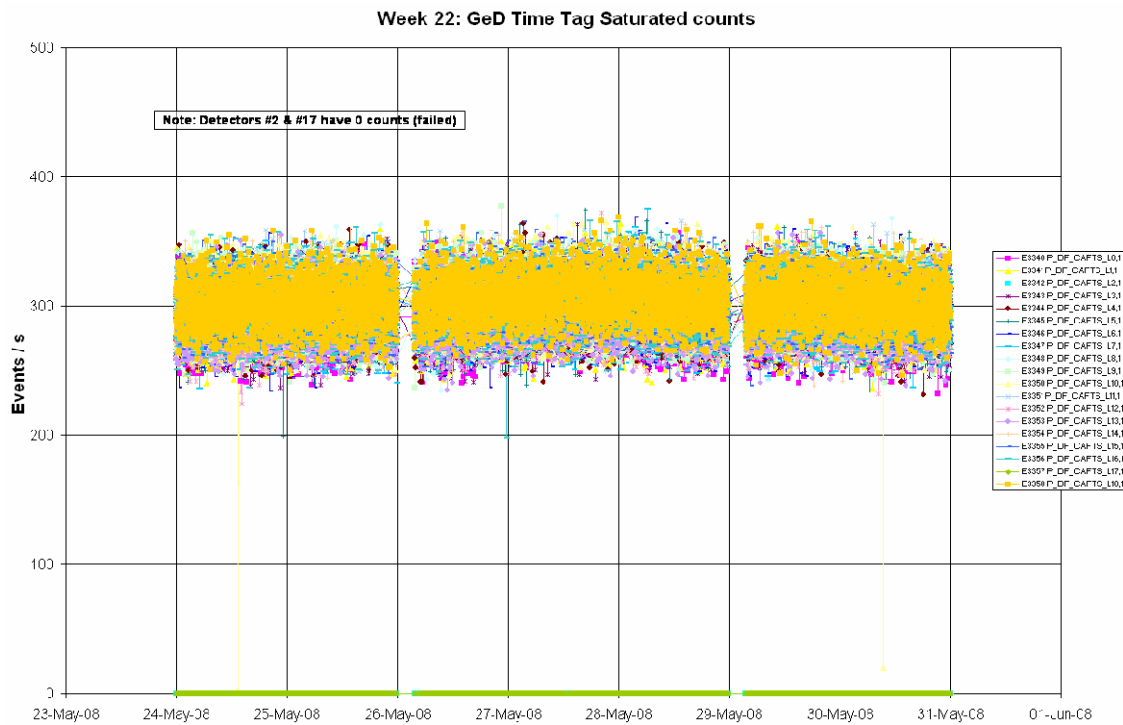


AFEE: The health of the AFEE is nominal. The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06/12/2003 and detector #17 is failed since 17/07/2004.

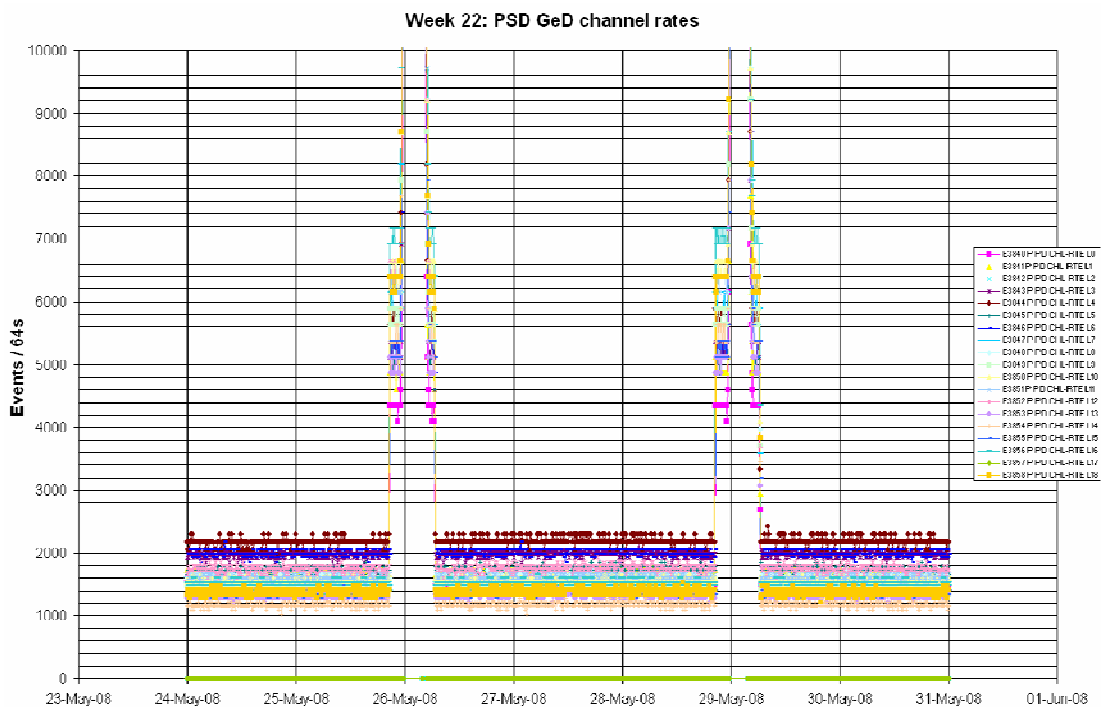


DFEE: The performance of the unit is nominal. The following plots show the Non Vetoed, Time Tag and Time Tag Saturated Event count rates during the reporting period.





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:

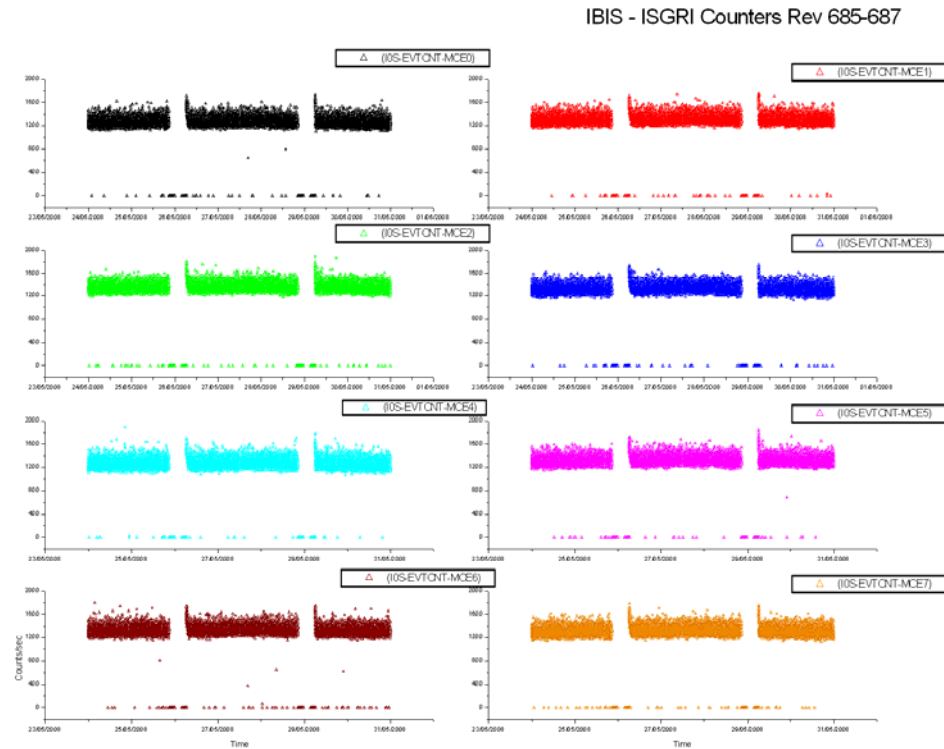
- TM parameter E2115 went OOL Warning Low on several occasions at the start of the week. In each case it returned within limits of its own accord and no action was taken. However, this parameter is displaying a trend indicating degradation of the thermistor, as occurred for the TM parameter E2116. The lower limit for E2115 was updated in a new IODB release installed during the

perigee passage for revolutions 686-687, after which this parameter stopped going OOL.

8.3.3 IBIS Operations

IBIS Event Counters Plots

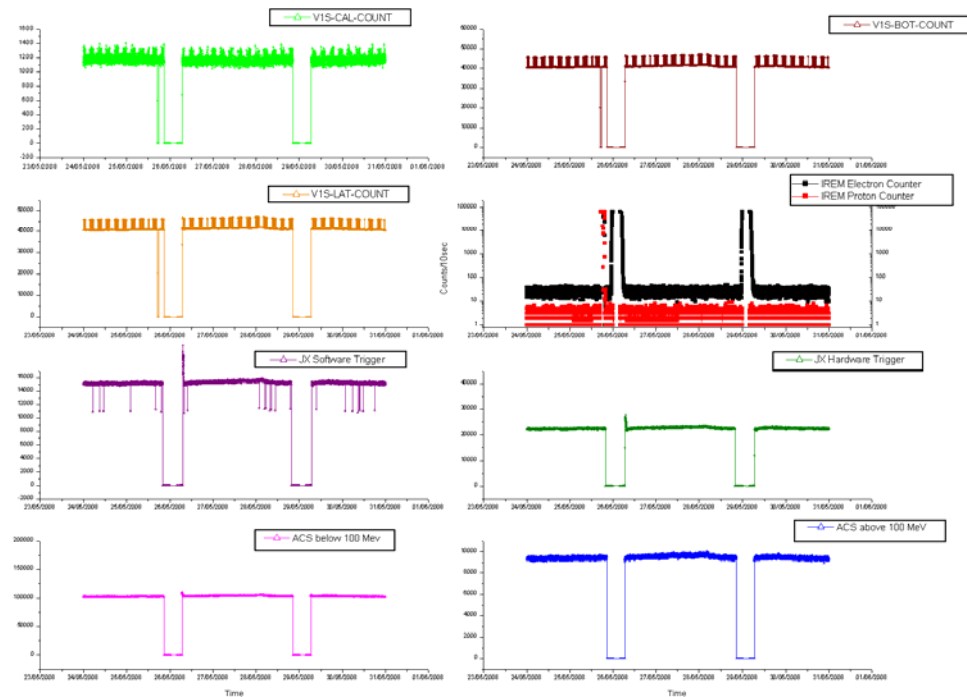
ISGRI Counters:



⁴⁴sampling every 4 pkts (32 secs)

VETO vs Payload Counters:

IBIS-VETO vs Payloads Counters Rev 685-687

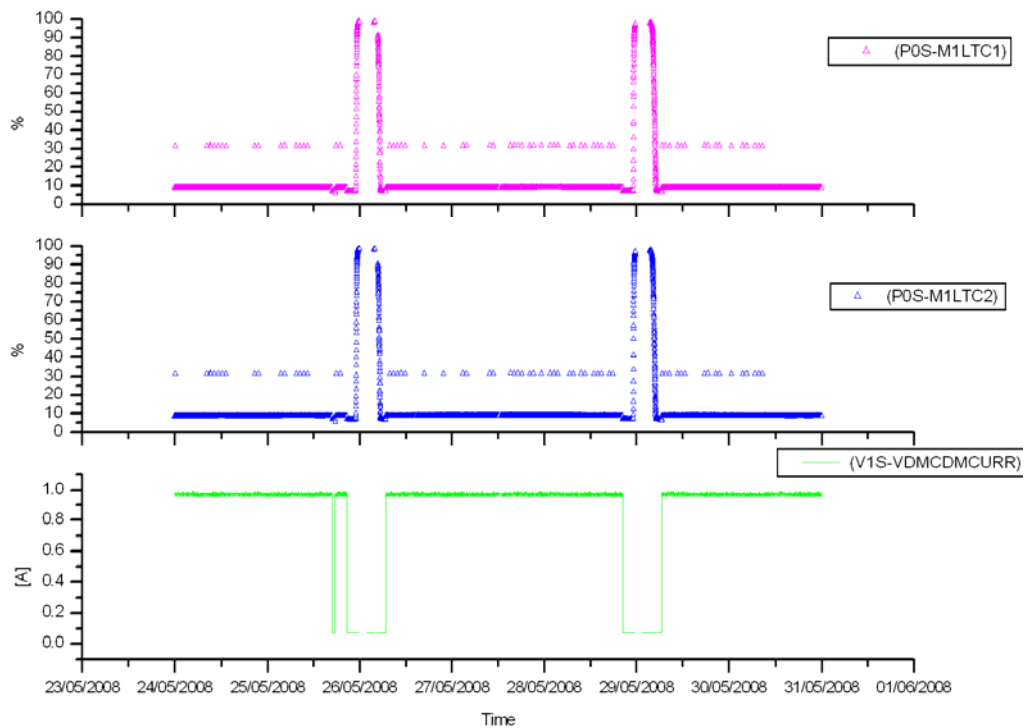


**with the exception of IREM counters (counts/10sec), all the plots are reporting counts/sec sampling every 5 pkts (40 sec)

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

VETO Current:

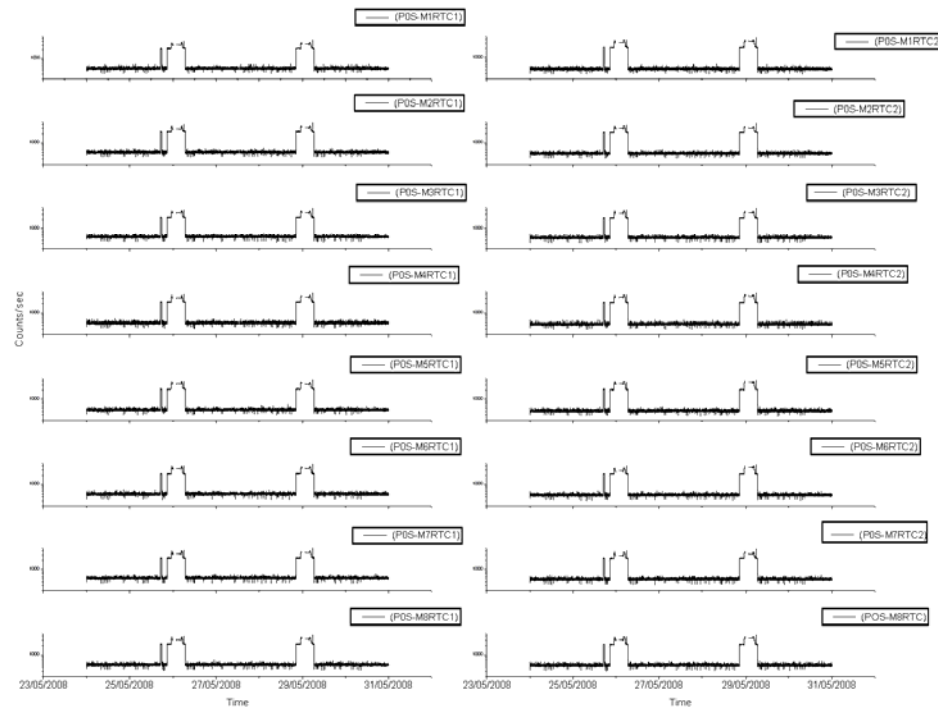
IBIS-VETO Current & PICsIT dead times Rev 685-687



**sampling every 4 pkts (32 secs)

PICsIT Counters:

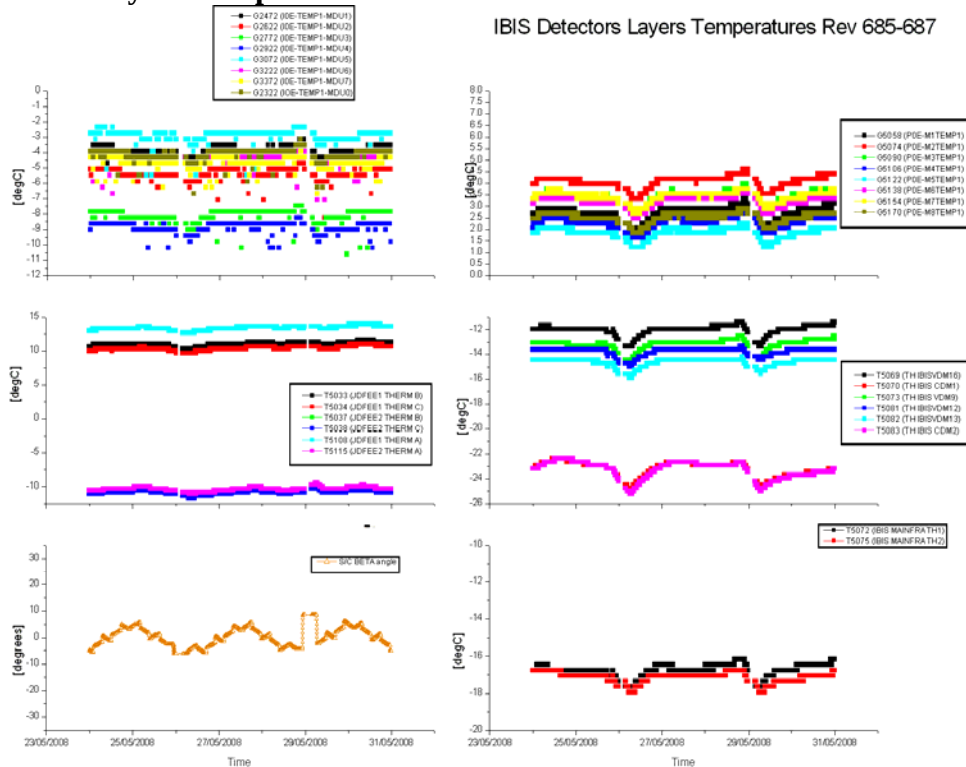
IBIS - PICsIT Counters Rev 685-687



**sampling every 4 pkts (32 secs)

IBIS Detectors Layers Temperatures:

IBIS Detectors Layers Temperatures Rev 685-687



**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.

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 revolution 686. 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 up-linked instead. A new IODB with the updated GEISCL03 sequence was installed during the perigee passage of revolution 686-687 such that from revolution 687 onwards the sequence was run from the Timeline.
- 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 limit for this parameter was updated in the new IODB release installed during the perigee passage for revolutions 686-687, after which it stopped going OOL.

2008-05-24 (DOY 145, Rev 685)

IBIS operations executed nominally.

2008-05-25 (DOY 146, Rev 685)

At 11:23:12Z 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.

Due to an IREM SEU, IBIS transitioned autonomously to Safe configuration at 16:50:42Z. It was recovered as follows:

- At 17:29:36Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE
- At 17:48:24Z ED GESTAN02 up-linked with the planned observation parameters and commanding to IBIS from the Timeline re-enabled.

IBIS operations continued nominally.

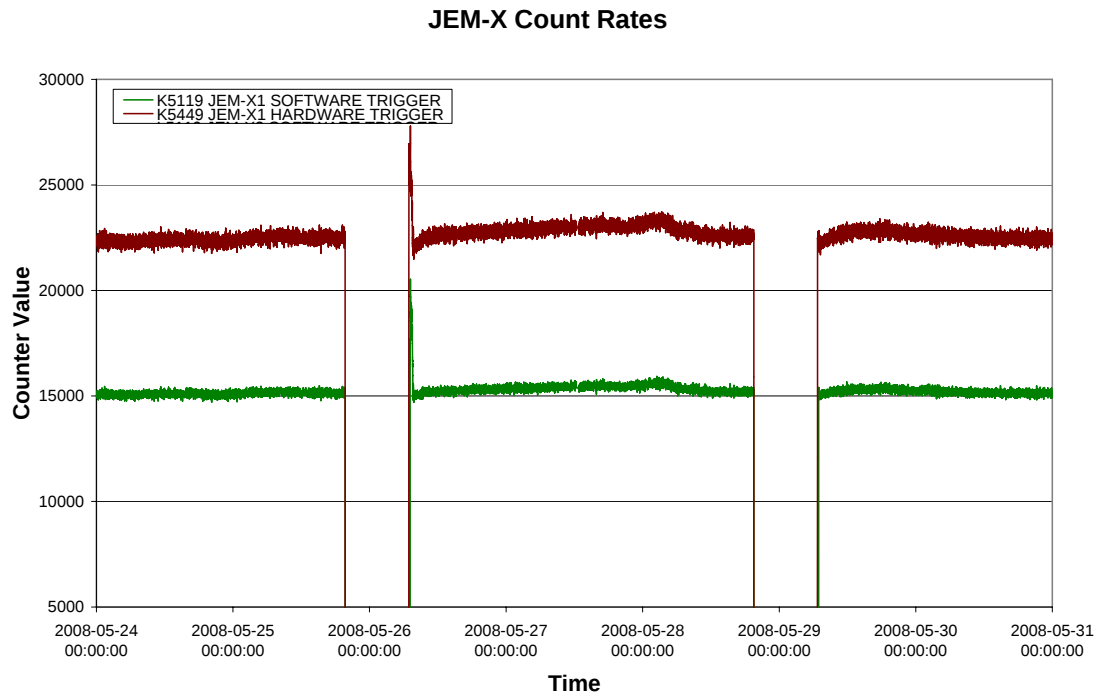
2008-05-26 (DOY 147, Rev 685-686) to 2008-05-30 (DOY 151, Rev 687)

IBIS operations executed nominally.

8.3.4 JEM-X Operations

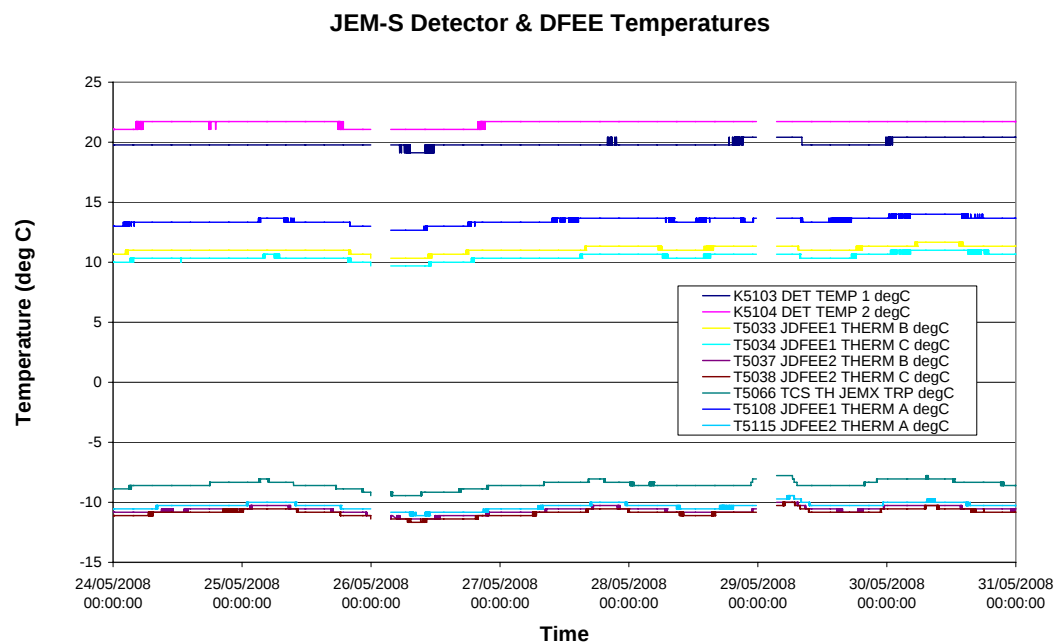
JEM-X Count Rates

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 Daily Report

2008-05-24 (DoY 145, Rev 685)

JEM-X1 operations executed nominally.

2008-05-25 (DoY 146, Rev 685)

At 16:51:14 JEMX parameters K5315, K5316 & K5317 went Out-of-Limits due to an IREM SEU (#63). There was no impact as the reaction has been disabled.

2008-05-26 (DoY 147, Rev 686) to 2008-05-30 (DoY 151, Rev 687)

JEM-X1 operations executed nominally.

8.3.5 OMC Operations

2008-05-24 (DoY 145, Rev 685)

Nothing to Report.

2008-05-25 (DoY 146, Rev 685)

At 02:30, an AOCS problem forced the suspension of the timeline. A recovery was performed and the timeline rejoined at 03:02:19. The impact was pointing 06850045 was cut short from a planned 3479 to 2328 seconds.

At 16:50:34, OMC was sent to SAFE mode by an IREM SEU (#63). A recovery was performed, and the instrument returned to Stand-by at 17:24:13. The impact was pointing 06850058 was cut short after 3168 from a planned 3479 seconds, and pointing 06850059 was lost.

2008-05-26 (DoY 147, Rev 686)

Nothing to Report.

2008-05-27 (DoY 148, Rev 686)

At 12:18, a problem with the OPSLAN caused all the workstations to freeze. After the problem was cleared, the imcs-a chain was restarted, and a recovery performed. The timeline was rejoined at 13:44. The impact was the loss of pointing 06860032.

2008-05-28 (DoY 149, Rev 686) to 2008-05-30 (DoY 151, Rev 687)

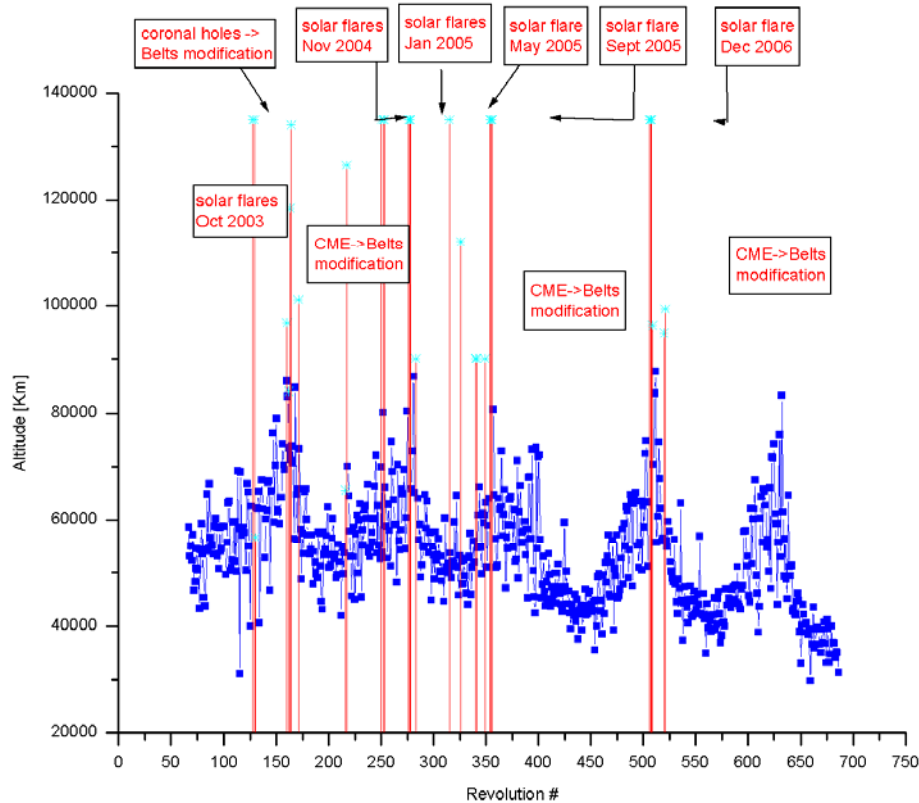
Nothing to Report.

On DoY 146 at 20:37:14 and DoY 149 at 20:25:39 OMC went to SAFE mode nominally, at the radiation belt entry time as set in the Broadcast Packet.

8.3.6 IREM Operations

Radiation Belts Entry

Evolution of Radiation Belt Entry 2003-2008



IREM daily report

DoY 2008.146 (25/05/2008):

At 16:50:39Z, a local reset of the IREM CSCI S/W (SEU #63) was observed. The status of the unit, before the local reset of the IREM CSCI S/W, was nominal, here is a summary:

- 1) The temperatures were nominal;
- 2) The LCL current was nominal;
- 3) The last HK before the anomaly showed HV, 5V and 6V voltages inside limits;
- 4) The anomaly occurred at 2008.146.16:50:39Z at 82899.1 km. The unit had performed an automatic transition to Standard Mode (ie. no block counter increasing, all the TM words= FFFF hex); just before the anomaly, radiation counters reported nominal values considering the position of the S/C along the orbit;
- 5) The recovery of the unit started at 16:52Z 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 19:21Z.

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 17:24:13Z and IBIS at 17:48Z.

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]
685	RAD_ENTR R 2008-05- 25T20:37:11Z	25/05/2008 22:55:29	34968.1	25-May-2008 22:16:49	41338. 99
686	RAD_EXIT R 2008-05- 26T06:34:28Z	26/05/2008 05:41:05	>>33421.5	26-May-2008 05:46:49	46277. 52
686	RAD_ENTR R 2008-05- 28T20:25:37Z	28/05/2008 23:07:22	31347.0	28-May-2008 22:11:00	40525. 28
687	RAD_EXIT R 2008-05- 29T06:23:12Z	29/05/2008 05:39:34	>>33412.8	29-May-2008 05:31:00	45484. 88

Reference

High radiation

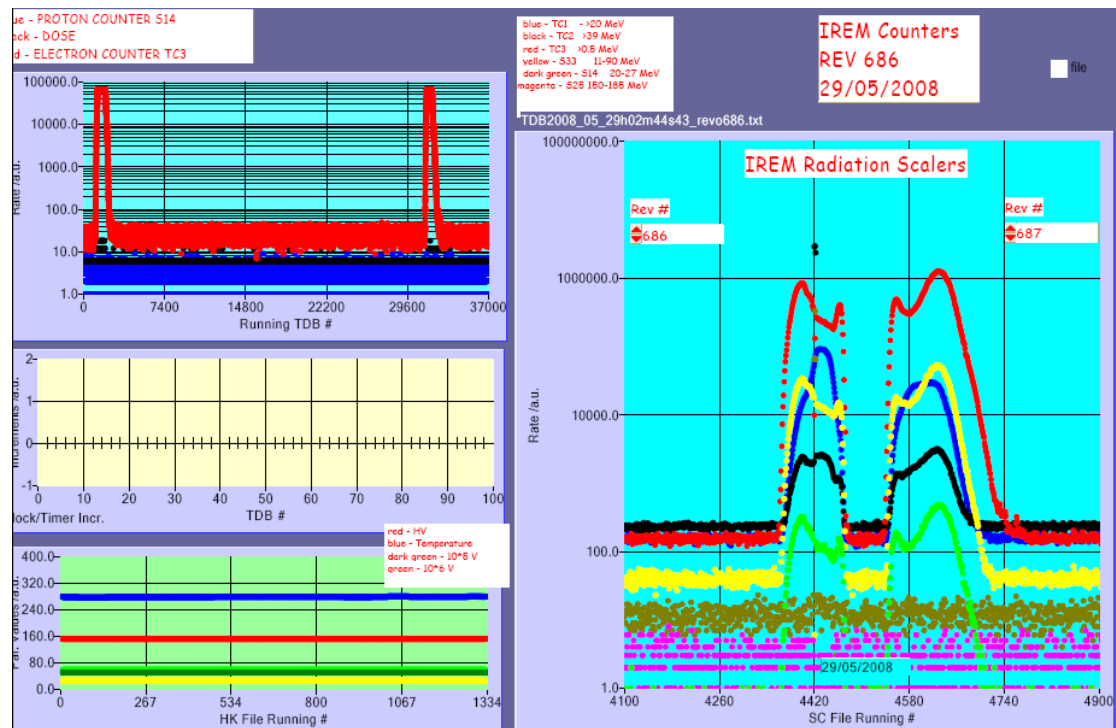
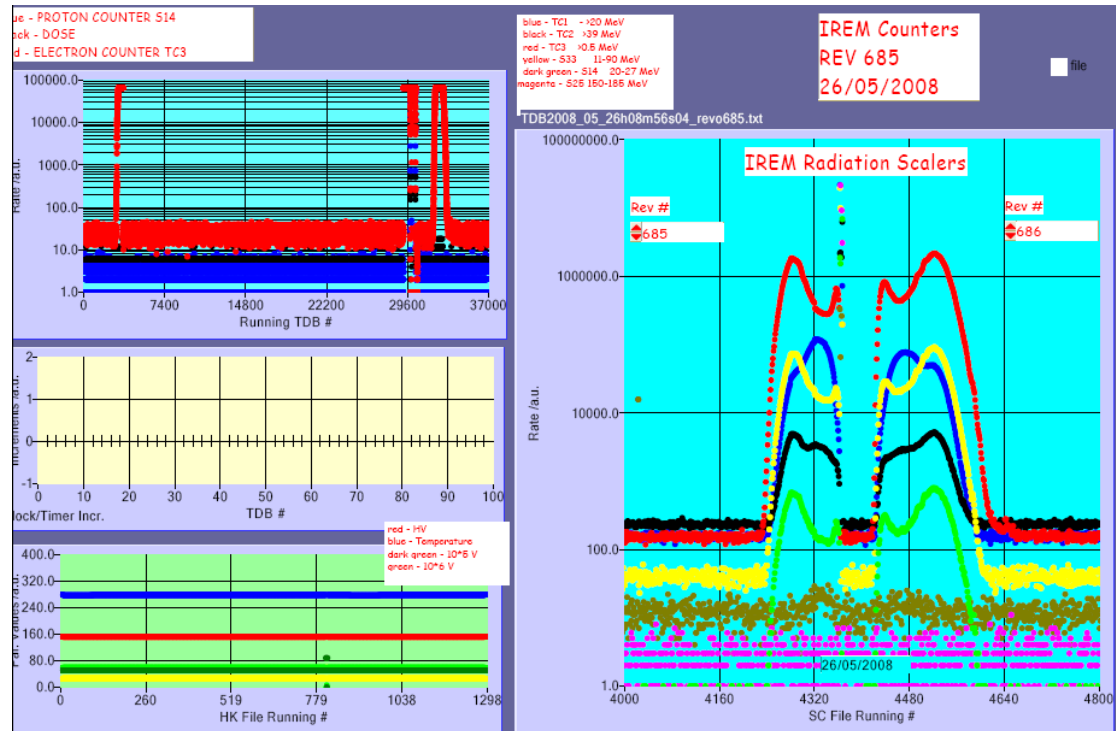
Very small error vs reference (less than 10 minutes)

Small error vs reference (between 10 and 30 minutes)

Large error vs reference (more than 30 minutes)

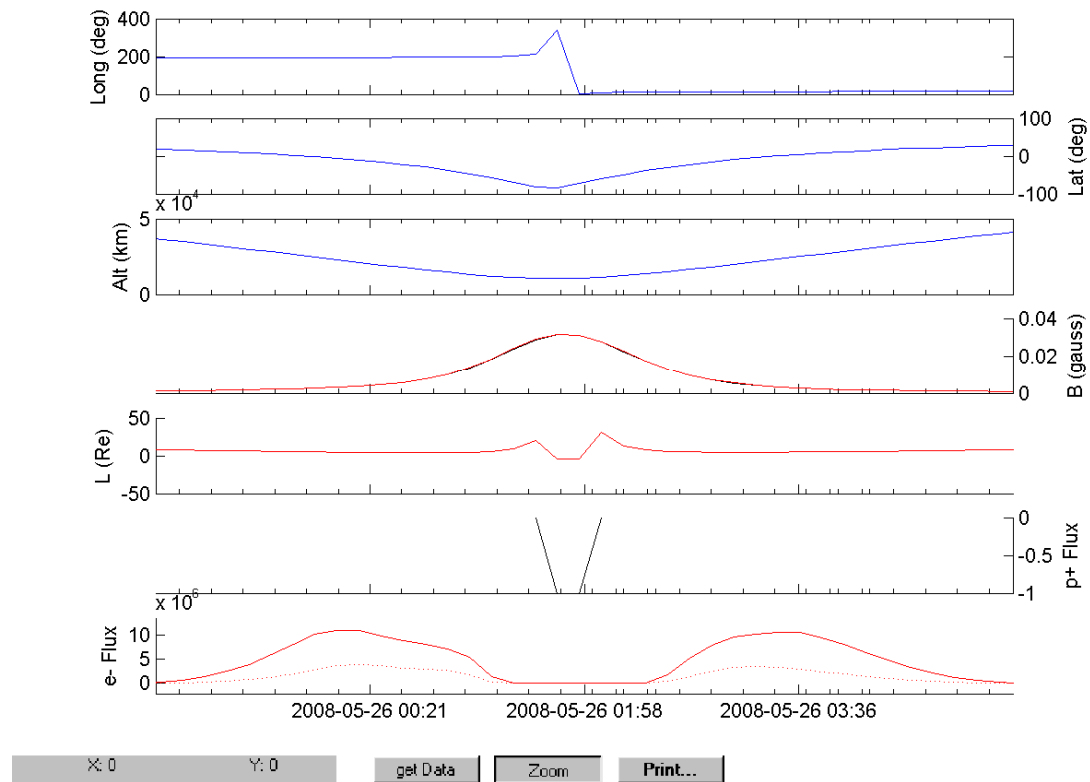
* Rad belt entry time ignoring previous threshold crossings where a gap of more than 30 minutes is present.

IREM radiation counters:

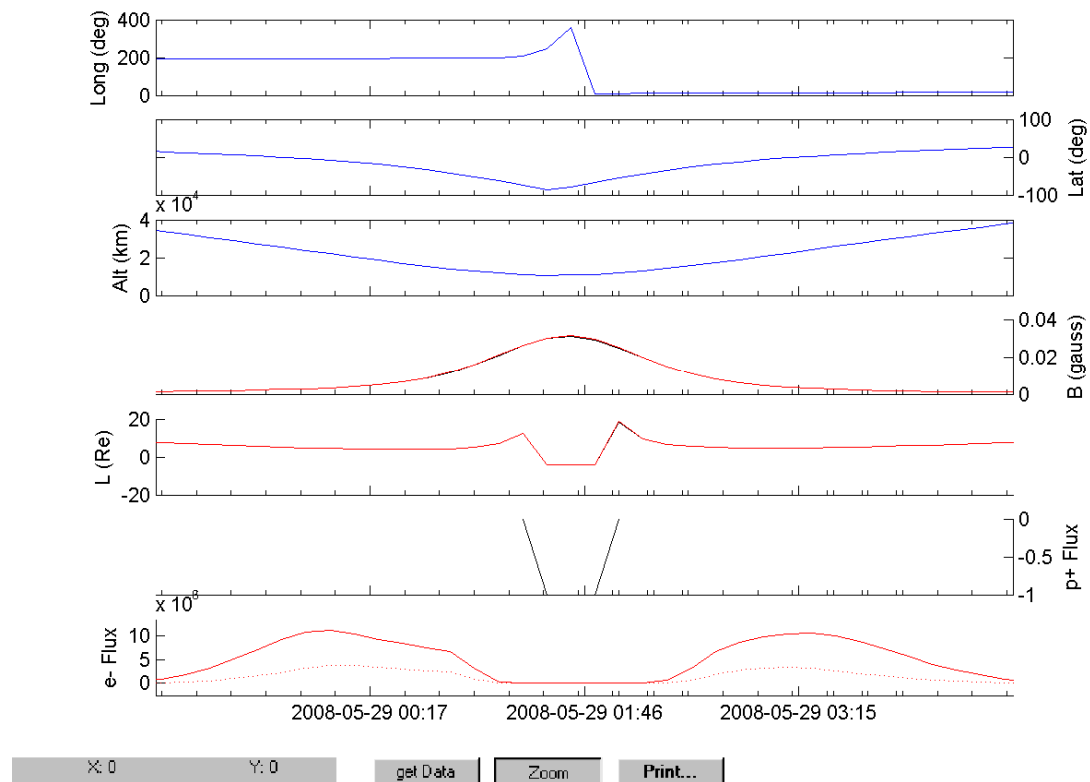


IREM Predicted Radiation Belt Passages

Rev 685

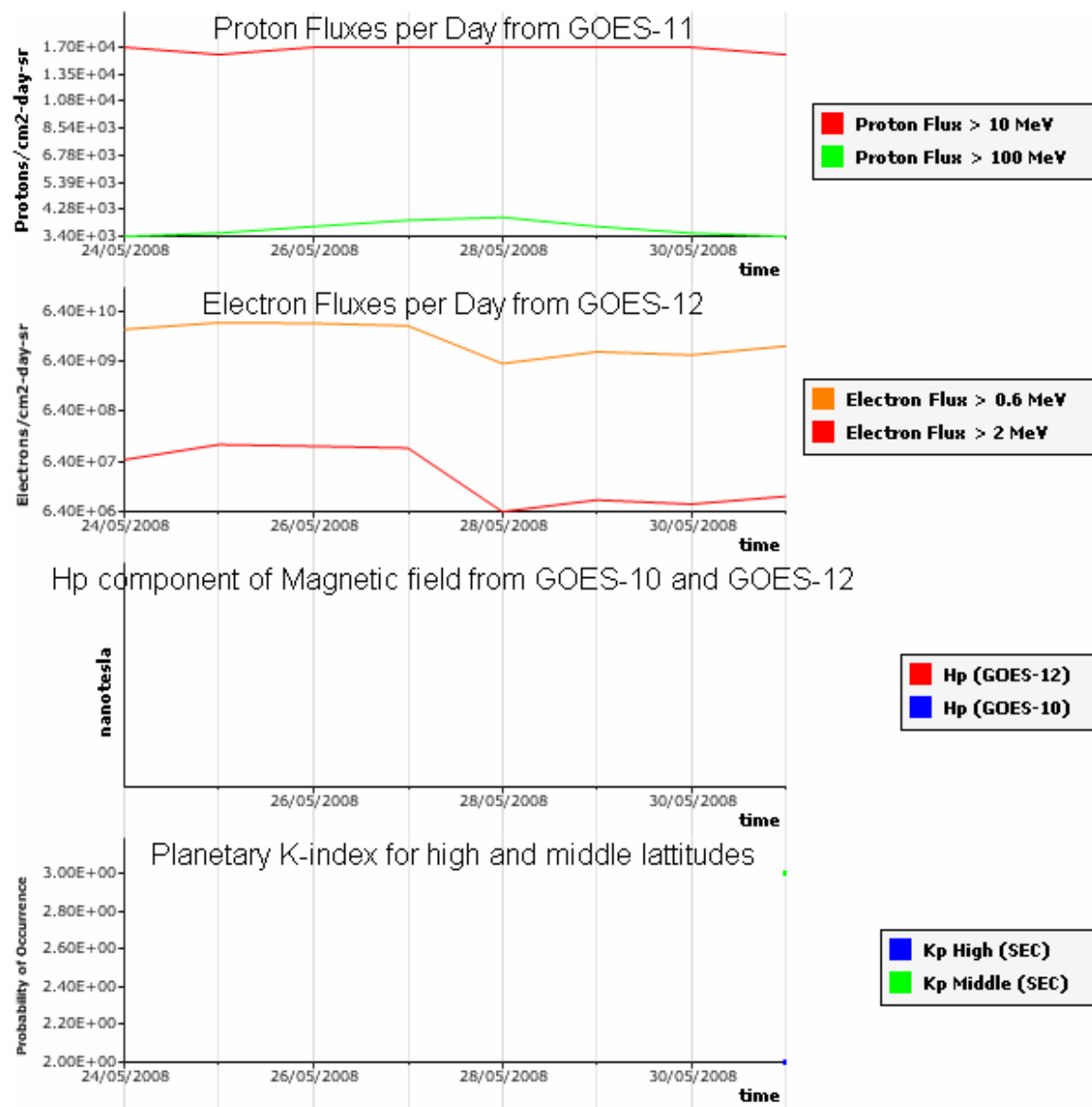


Rev 686



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

The X-Ray Flux plot is not available this week.



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.