

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OAI
No. 295
Week 20
19.05.08
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 10.05.08 until 16.05.08 (both dates inclusive) and covers the revolutions 681 and 682.

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 hexagonal dither of the Gamma Ray Source 1915+105 (RA 19:15:11.50, DEC +10:56:44.0), a raster dither of the mid-latitude 2 region (RA 19:42:44.23, DEC -15:04:03.4) and a raster dither of the Cygnus Region (RA 20:35:53.00, DEC +40:39:49.0).

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.

Three slews were missed from TL, during the observation period, due to a problem on the link with REDU station.

The fuel consumption over the period between 10/05/2008 and 15/05/2008 was 0.1027 Kg. The remaining propellant is in the order of 140.4160 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

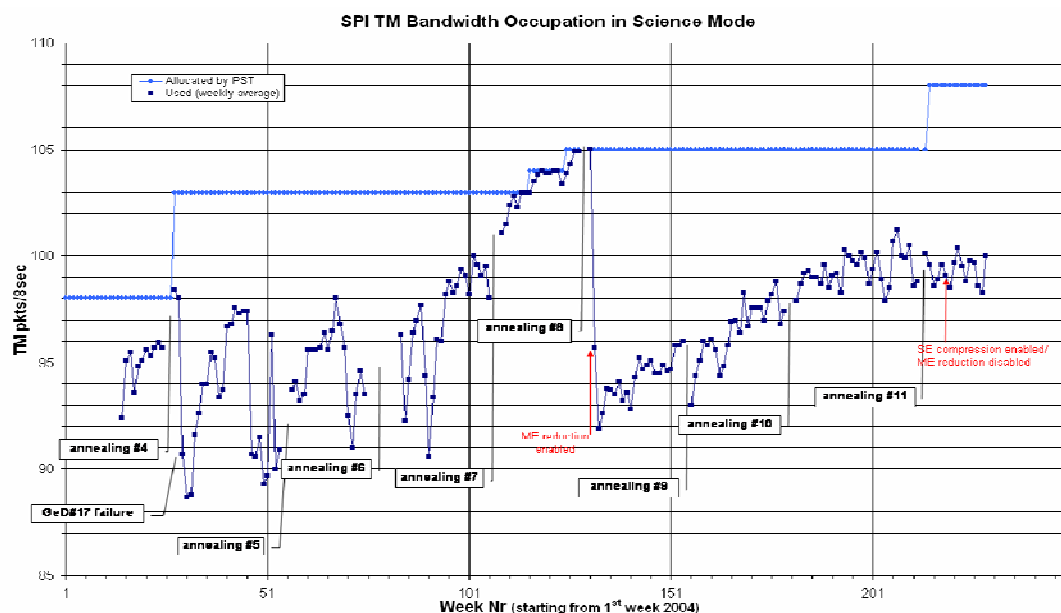
3.2.1 SPI

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 packets/cycle.

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



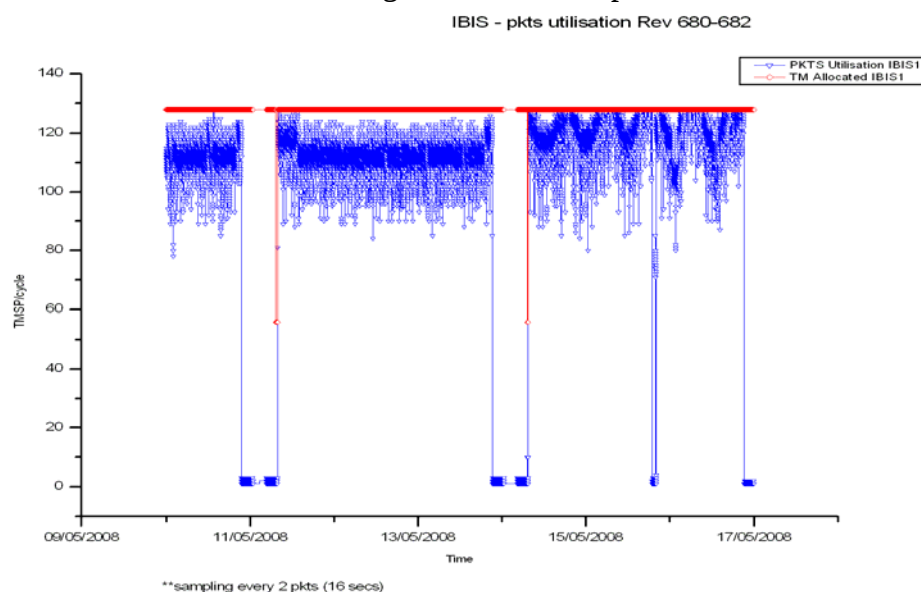
Note: Some more information concerning the SPI operations is provided in the Appendix.

3.2.2 IBIS

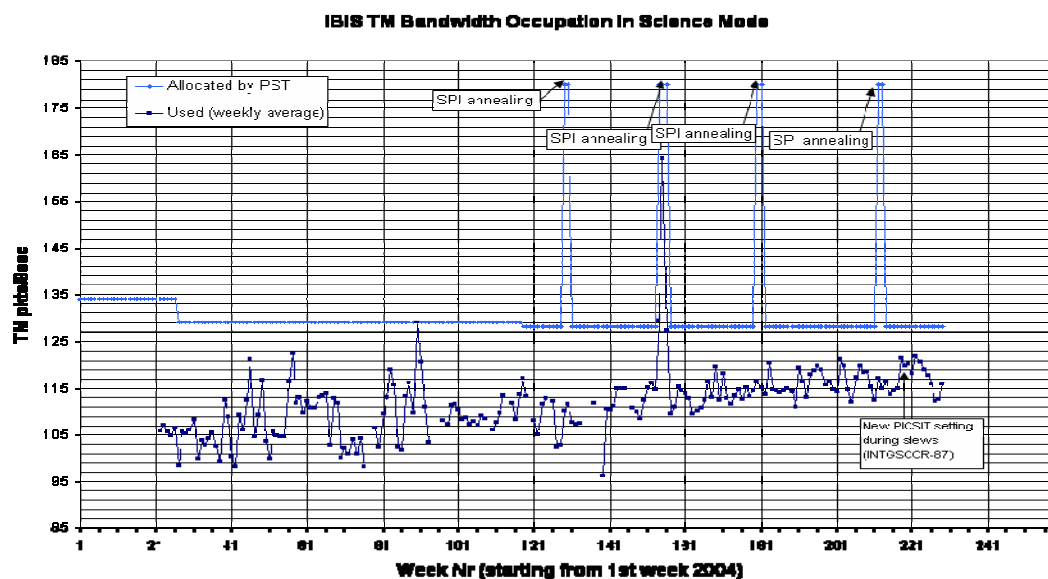
The overall status of the unit is nominal.

During the reporting period, the PST allocation to IBIS above the radiation belts was 128 packets/cycle. During the observation period, when IBIS was in science mode, the IBIS mean bandwidth utilisation was 115.97 packets/cycle (up 3.34 on last week) and the percentage of TM cycles in which the full bandwidth of 128 packets was used was 14.4%.

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, 176 of the 182 planned science pointings were executed nominally, 1 pointing was performed at an incorrect attitude, 1 pointing was interrupted, and 4 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 until the 16th, when 3 new sun-spots began to emerge. They were very small and posed no 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. 3 pointings were 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 OBDQ and OBQM tasks 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 1 occasion where the TM dropped from Redu, 2 occasions where the TM dropped from DSS-27, and 1 occasion where the TM dropped from DSS24, problems with the nctrs led to the loss of 3 pointings. In addition, the links to ISDC dropped four times.

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 19/05/2008:

- 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 132, at 19:01:58, a closed loop slew was performed using the wrong guide star. This happened after the star mapper lost the selected star, and switched to star number 2. For full details see the AOCS section of the report. The impact was an incorrect attitude during pointing 06810015.
- On DoY 136 at 19:00:41, an IREM SEU (#62) 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 137 at 01:10:00, the TC link from Redu dropped. The link was recycled, then the nctrs rebooted. After removing and reconnecting the links, full communication was restored at 02:05:00. The impact was the loss of pointings 06820072, 06820073 & 06820074.

The following anomaly report was entered into the ARTS system this week.

AR id	Date Created	Subject	Segment	Status
INT_SC-226	2008-05-29	IREM Anomaly: Reset of IREM_CSCI S/W #62, 15/05/2008	Payload	Pending

7 Future Milestones

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 681

The observations in revolution 681 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 raster dither of the mid-latitude 2 region (RA 19:42:44.23, DEC -15:04:03.4), lasting ~51.3 hours until the end of the revolution.

Revolution 682

The observations in revolution 682 consisted entirely of a raster dither of the Cygnus Region (RA 20:35:53.00, DEC +40:39:49.0), lasting ~56.7 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

2008-04-29T14:42:27.000Z	140.6962	F	Automatic TM processing.
2008-04-30T21:58:22.000Z	140.6940	F	Automatic TM processing.
2008-05-02T01:02:24.000Z	140.6719	F	Automatic TM processing.
2008-05-02T06:02:57.000Z	140.6683	F	Automatic TM processing.
2008-05-02T19:56:58.000Z	140.6341	F	Automatic TM processing.
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.

This report was generated Fri May 16 08:00:20 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, 10/05/2008 – 16/05/2008

The AOCS operations were executed from the Automatic Timeline.

During this period, 54 Open Loop Slews, 135 Closed Loop Slews and 4 Momentum Biases were executed (as reported by ACC).

3 slews (CSL) were missed from TL, during the observation period, due to a problem on the TC link between ESOC and REDU station.

This is equivalent to $\sim 1.6\%$ of the total number of slews planned (191).

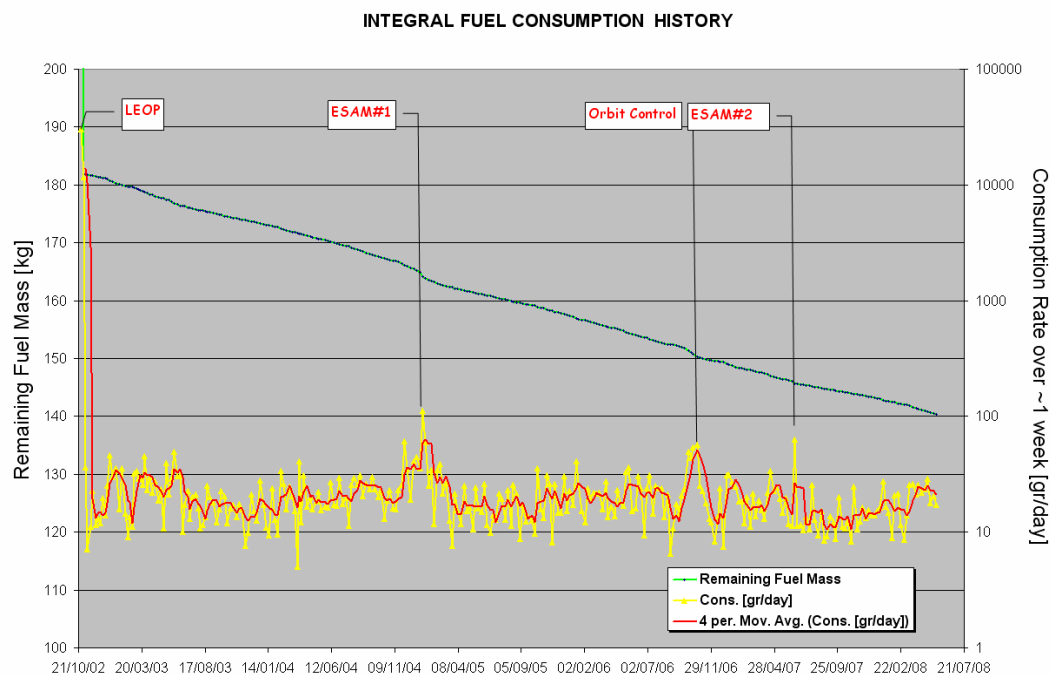
PID 06810015 reported a target attitude error of ~ 2 deg.

Orbit Control

No update

Fuel consumption

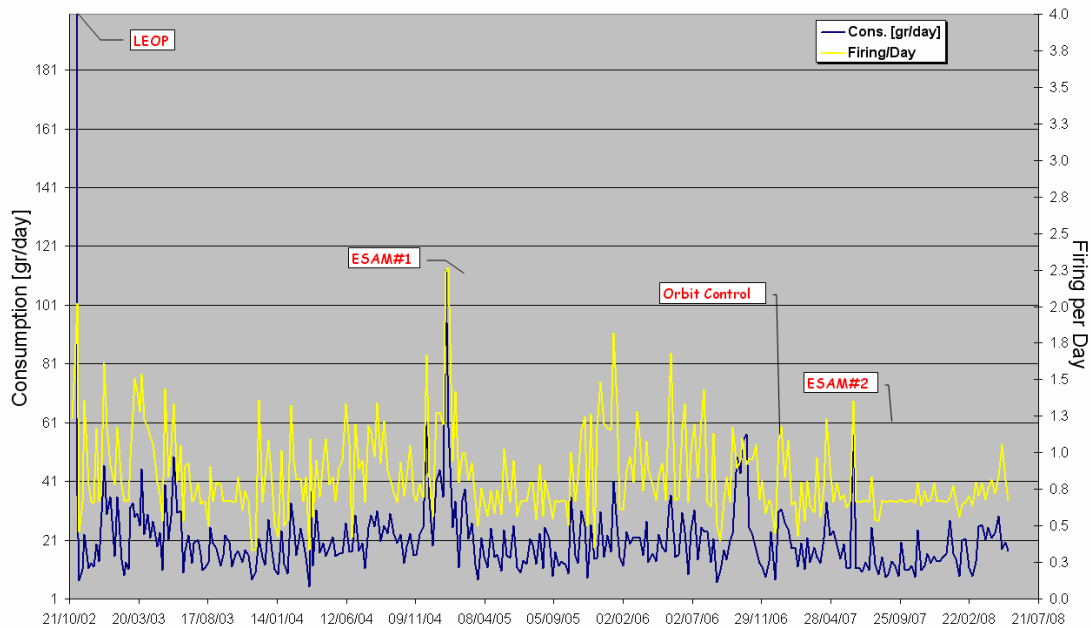
The fuel consumption (total, grams per day) over the period between 01/11/2002 and 15/05/2008 is reported in the plot below.



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 15/05/2008 is reported in the plot below.

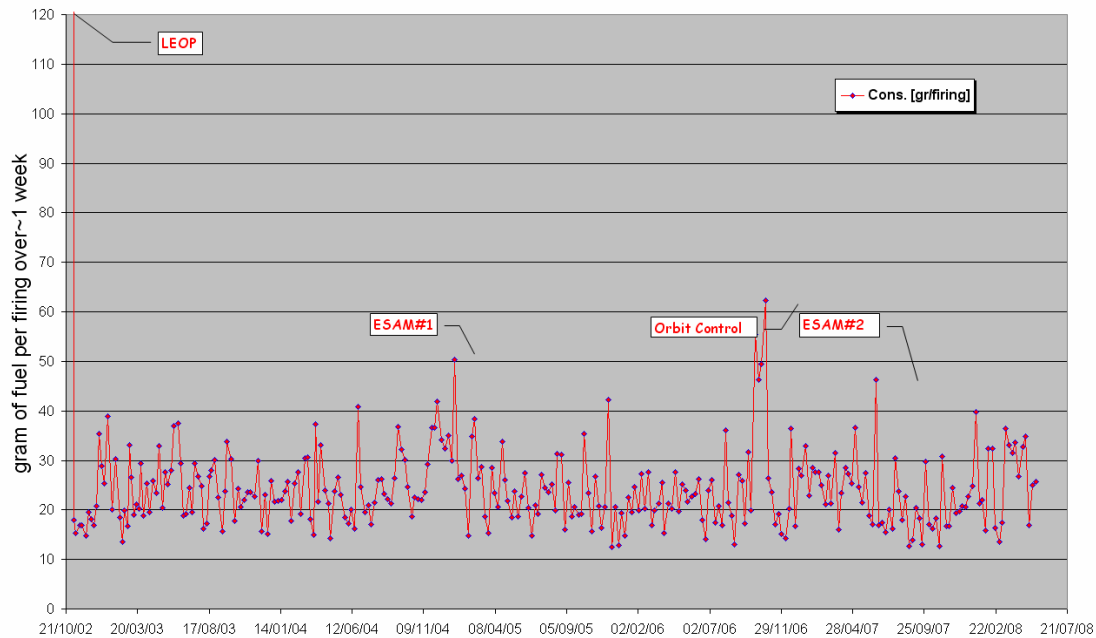
INTEGRAL FIRING PER DAY HISTORY



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

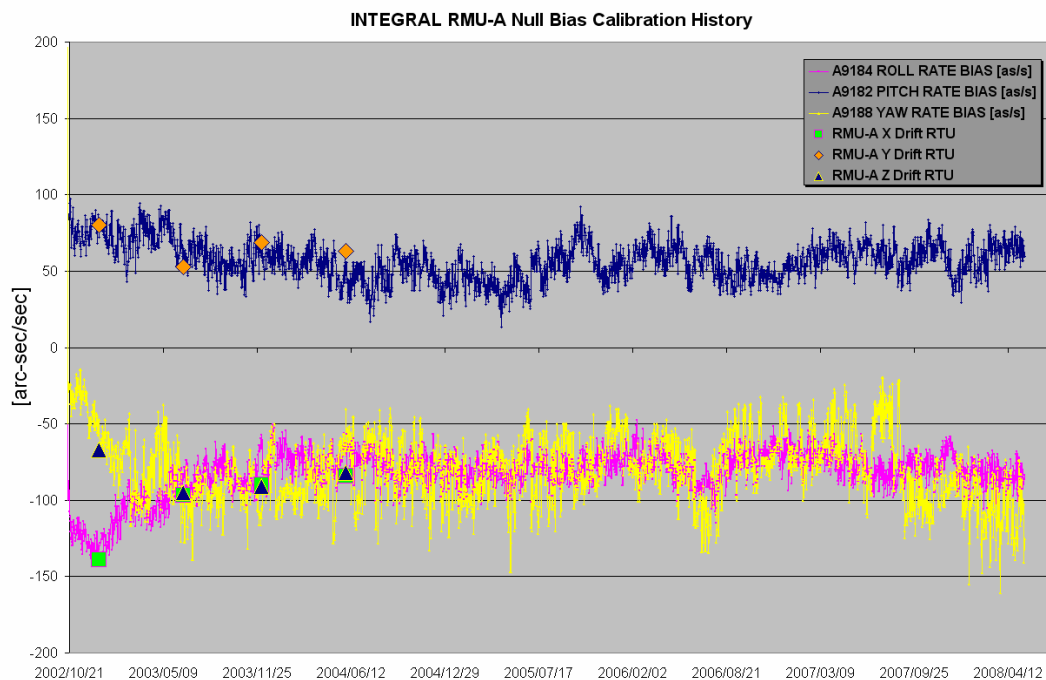
The fuel per firing over the period between 01/11/2002 and 15/05/2008 is shown in the plot below.

INTEGRAL FUEL MASS PER FIRING HISTORY



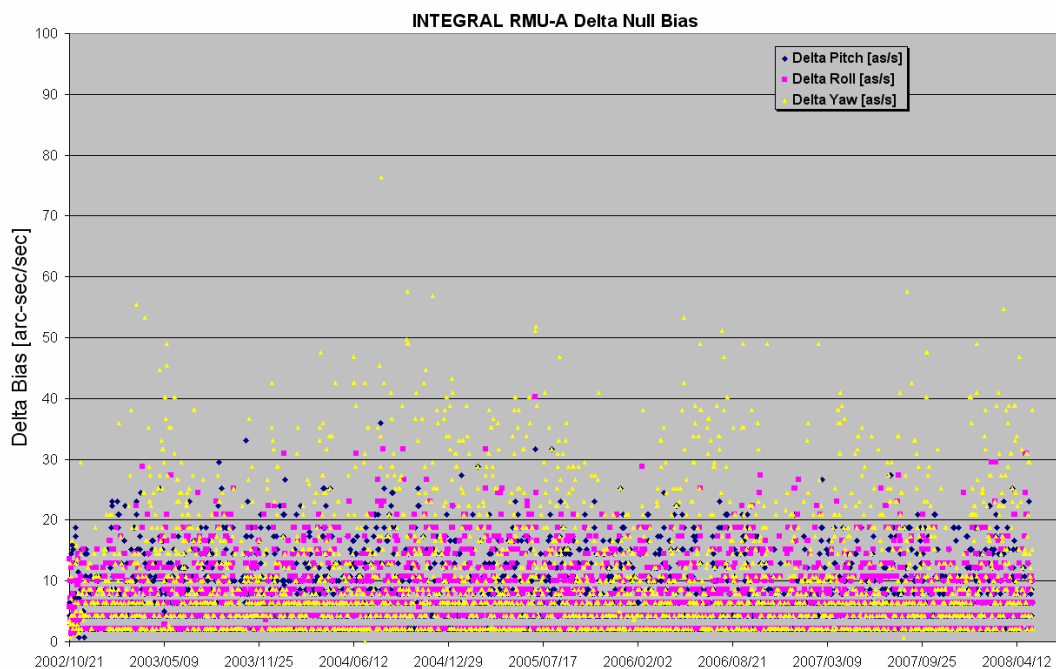
The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 16/05/2008 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 16/05/2008 is reported in the plot below.



10/05/2008 (Day of Year 131, Revolution 680)

Nothing to report.

11/05/2008 (Day of Year 132, Revolution 680-681)

Slew to wrong attitude: at 19:01 the guide star was lost (and consequent IMU 1 ON) during the uplink of the slew commands for PID 06810015. Unfortunately by the time of investigation, the slew already started at 1904z.

As result the Spacecraft used a different (not planned) guide star and slewed to wrong attitude for PID 06810015. Currently there is no mechanism implemented in the slew sequence, based on guide star coordinates, to prevent this kind of problem.

The reached attitude was

RA19:23:41.81
DEC-15:53:18.8

while the planned target was

RA19:25:49.18
DEC-13:57:35.2

The attitude error was estimated in ~2 deg. Next slew (OSL) for pointing 06810016 was updated automatically.

F/D on call advised to stay at this attitude as next slew updated OK.

No impact on TL execution. PID 06810015 reported a target attitude error.

12/05/2008 (Day of Year 133, Revolution 681)

Nothing to report.

13/05/2008 (Day of Year 134, Revolution 681)

Nothing to report.

14/05/2008 (Day of Year 135, Revolution 681-682)

Nothing to report.

15/05/2008 (Day of Year 136, Revolution 682)

Nothing to report.

16/05/2008 (Day of Year 137, Revolution 682)

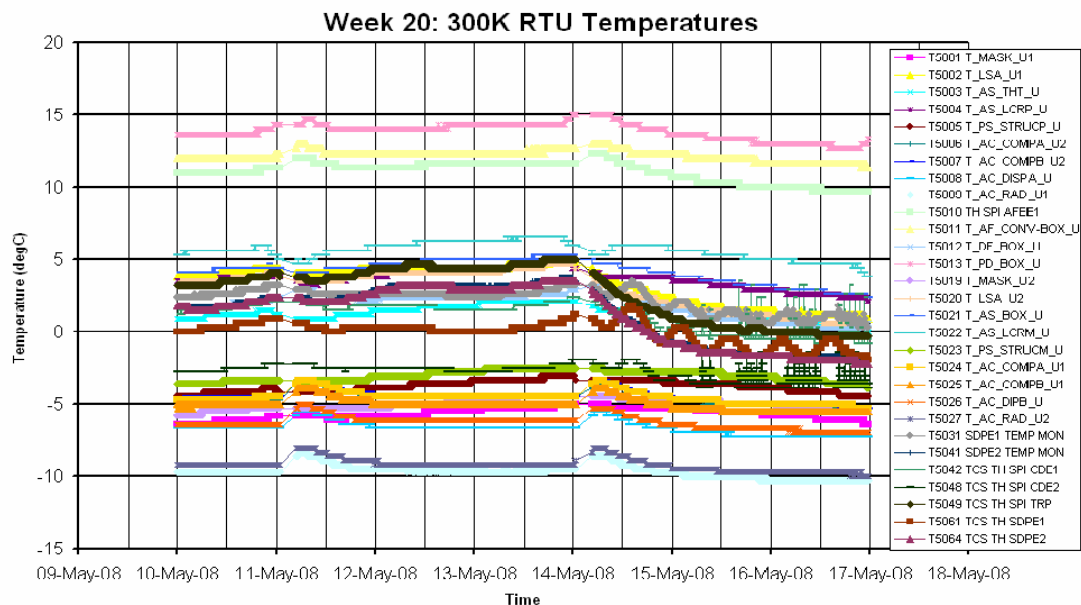
Problem on the link with REDU station: at 01:10z a problem on the TC link between ESOC and REDU station caused the slew 06820072 to fail release.

At 02:15z, once a stable TC link was set with DSS24 station, the operator started a complex manual recovery from attitude of PID 06820071 to the attitude of PID 06820074. The next slew in TL 06820075 was manually updated at 03:05z.

The following slews were missed in TL: 06820072(CSL)-73(CSL)-74(CSL).

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.

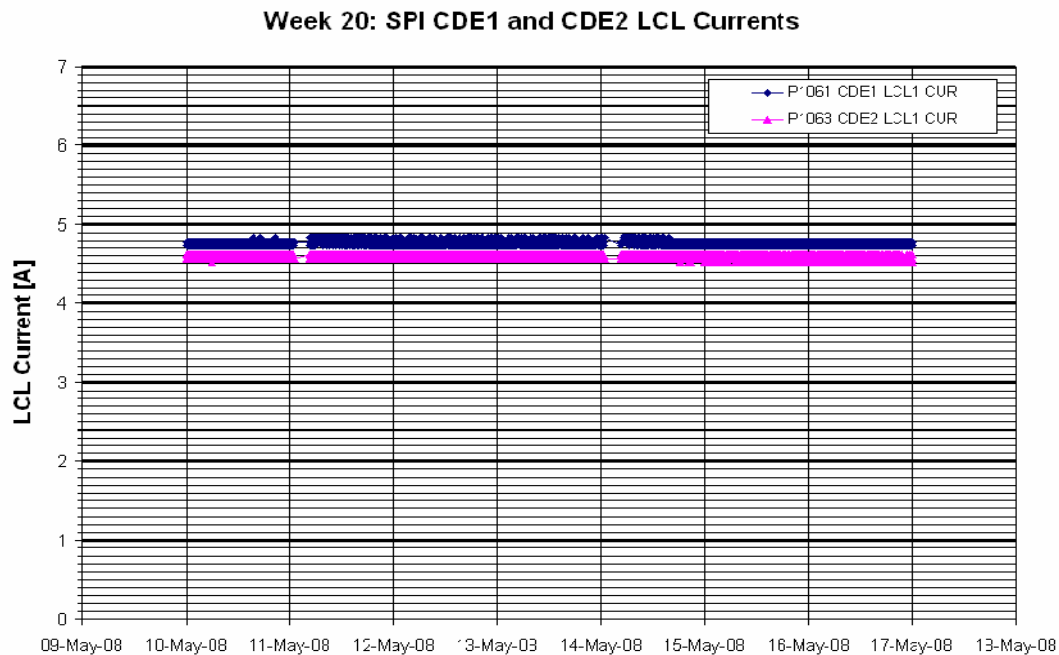


Stirling Compressors and Cryostat: The performance of the compressors is nominal. The cold plate temperature was maintained in the range 80K +/-1K.

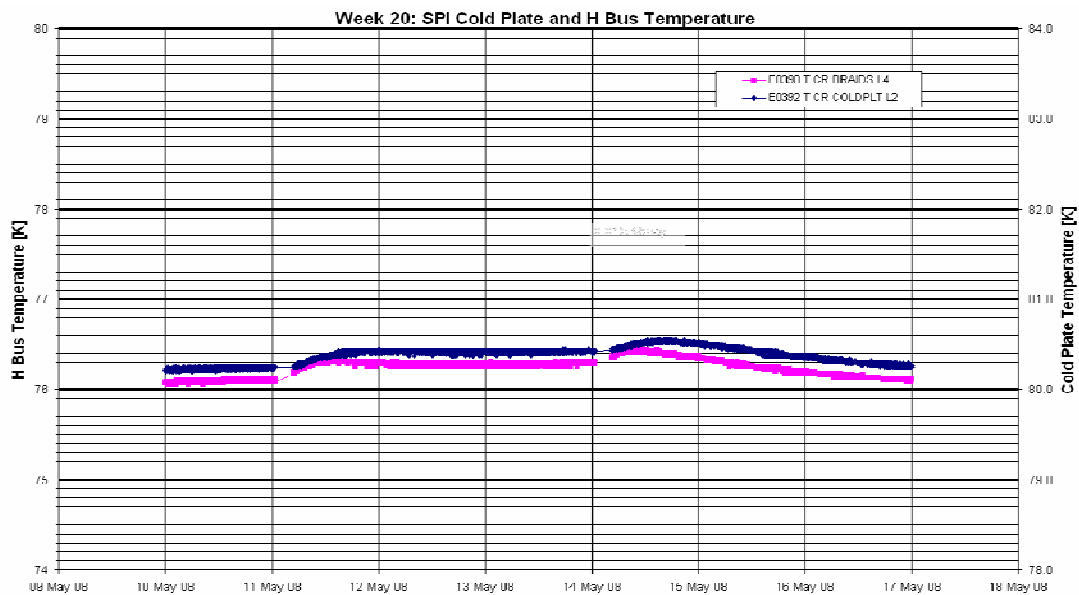
The stroke of all four compressors was set to 40 throughout the week. The average CDE LCL currents were as follows:

- CDE1 LCL Current = 4.77A
- CDE2 LCL Current = 4.57A

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



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

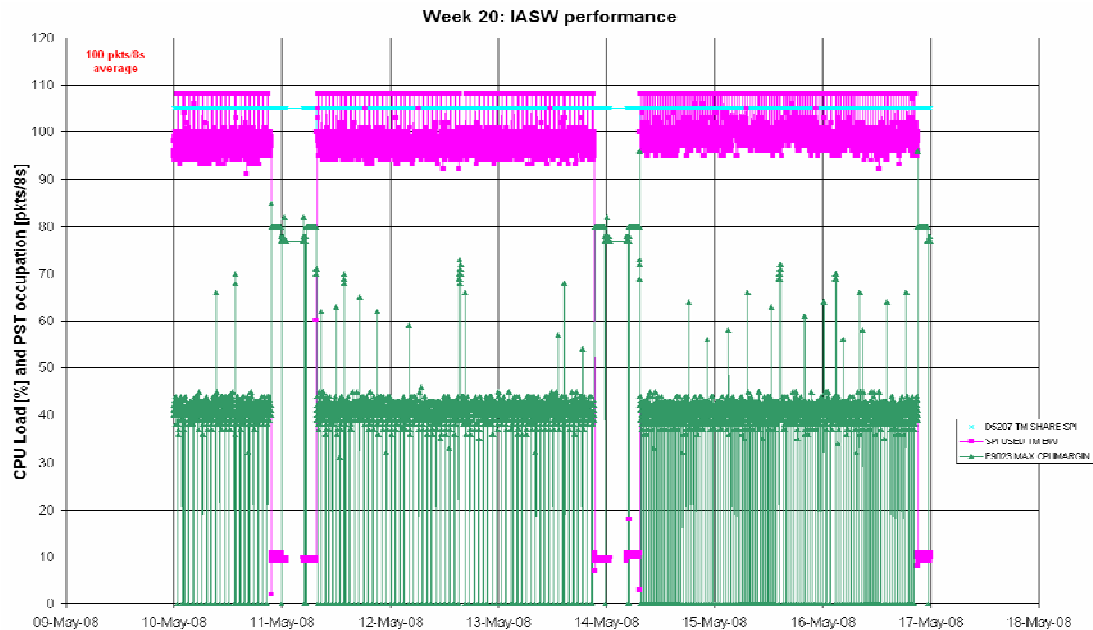


DPE & IASW: The DPE health and IASW performance is nominal.

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

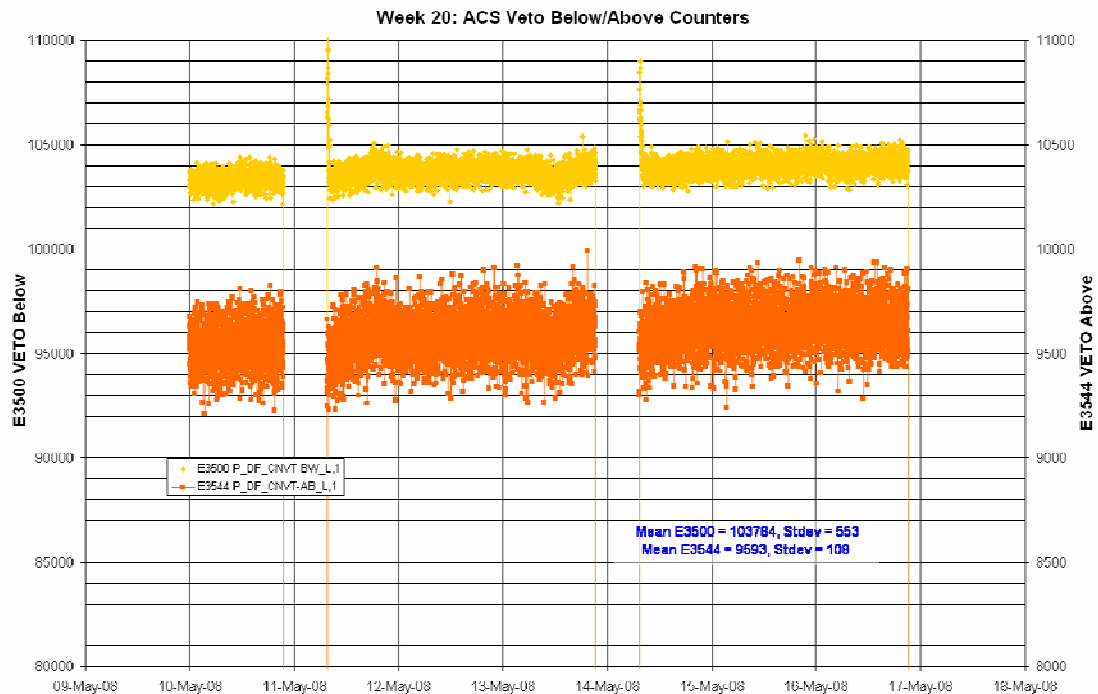
The average TM bandwidth occupation of SPI was 100 packets/cycle over the science window. The TM allocation in the science window was 108 packets/cycle. This allocation is considering that the over-allocated PST with the additional 3 packets/cycle for SPI was being used, however the Broadcast Packet 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.

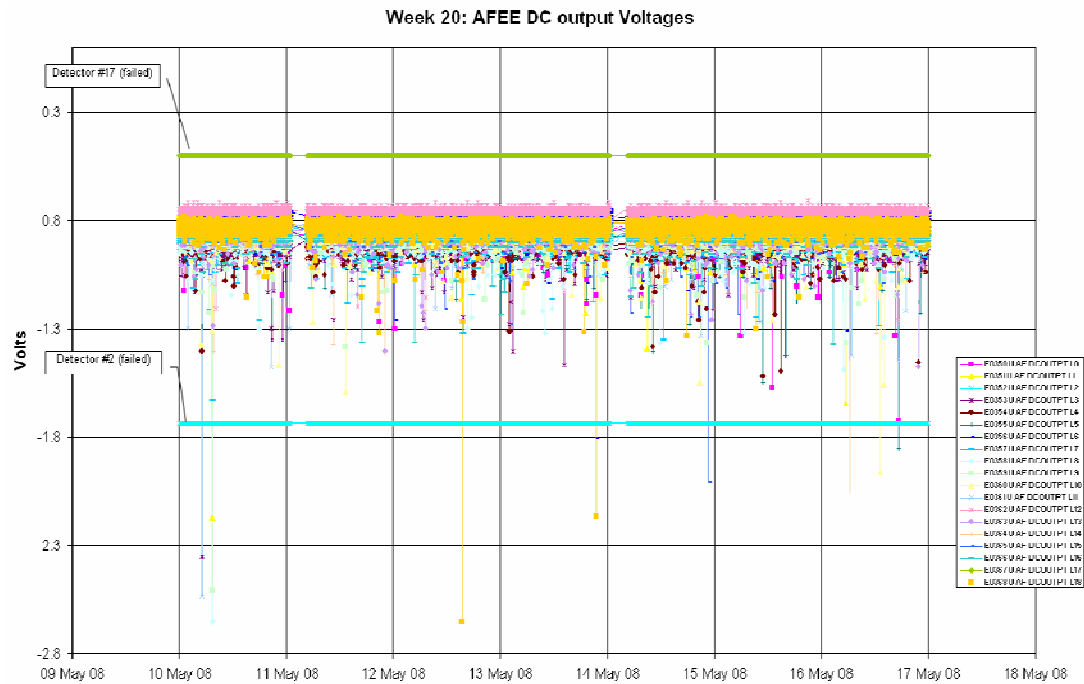


ACS: The performance of the ACS is nominal, except for FEE #81 which remains nominally switched off since the anomaly on 29/10/2006 (INT_SC-162) and FEE #57 which is nominally OFF due to the anomaly on 5/8/2003 (INT_SC-61).

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

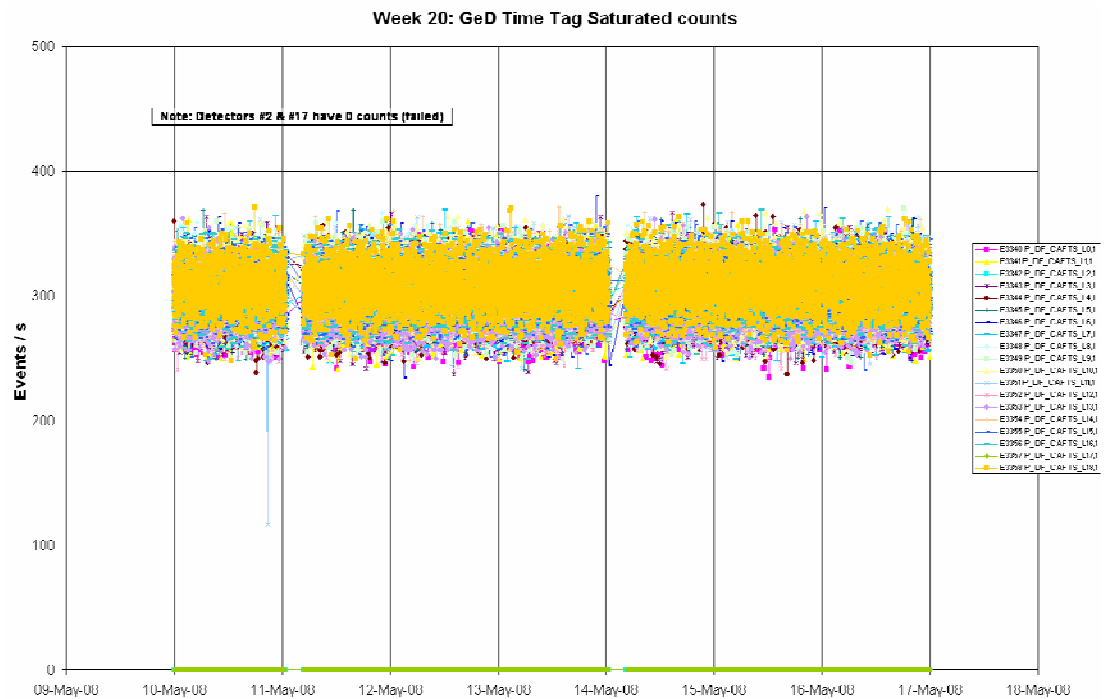
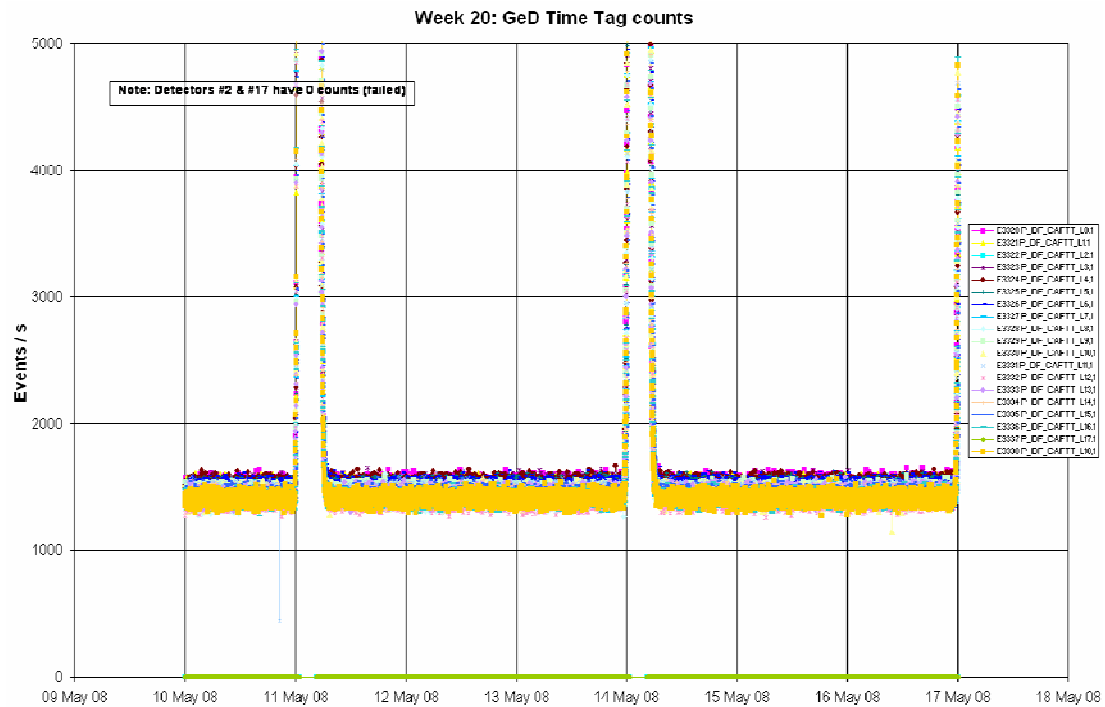


AFEE: The health of the AFEE is nominal. The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06/12/2003 and detector #17 is failed since 17/07/2004.

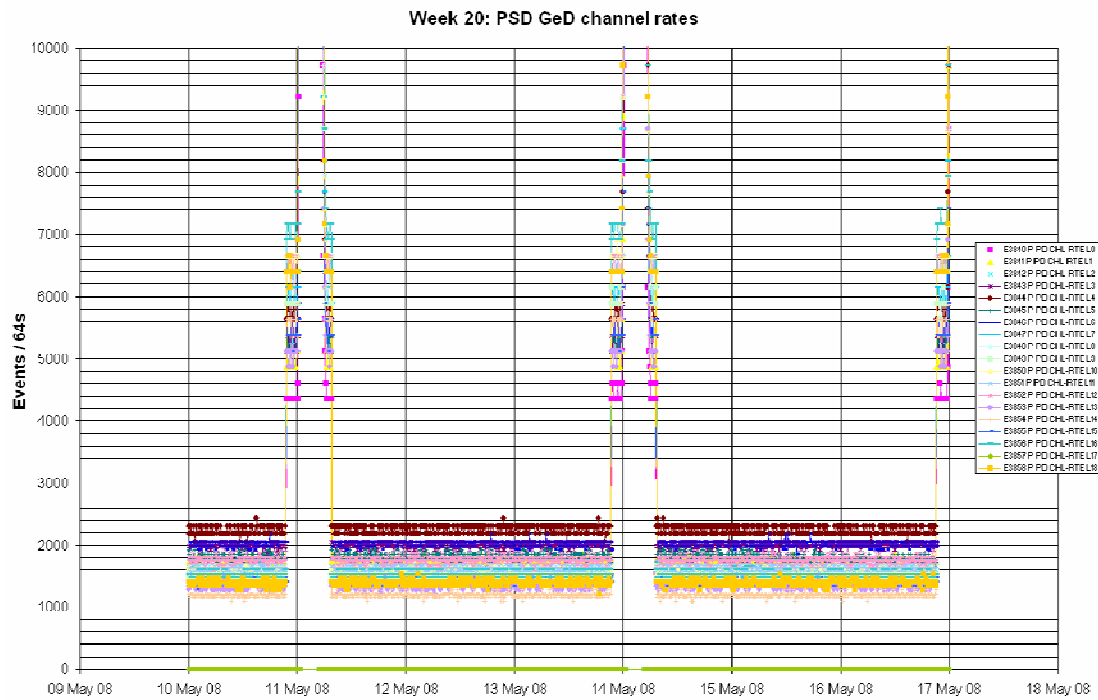


DFEE: The performance of the unit is nominal. The following plots show the Non Vetoeed, Time Tag and Time Tag Saturated Event count rates during the reporting period.





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



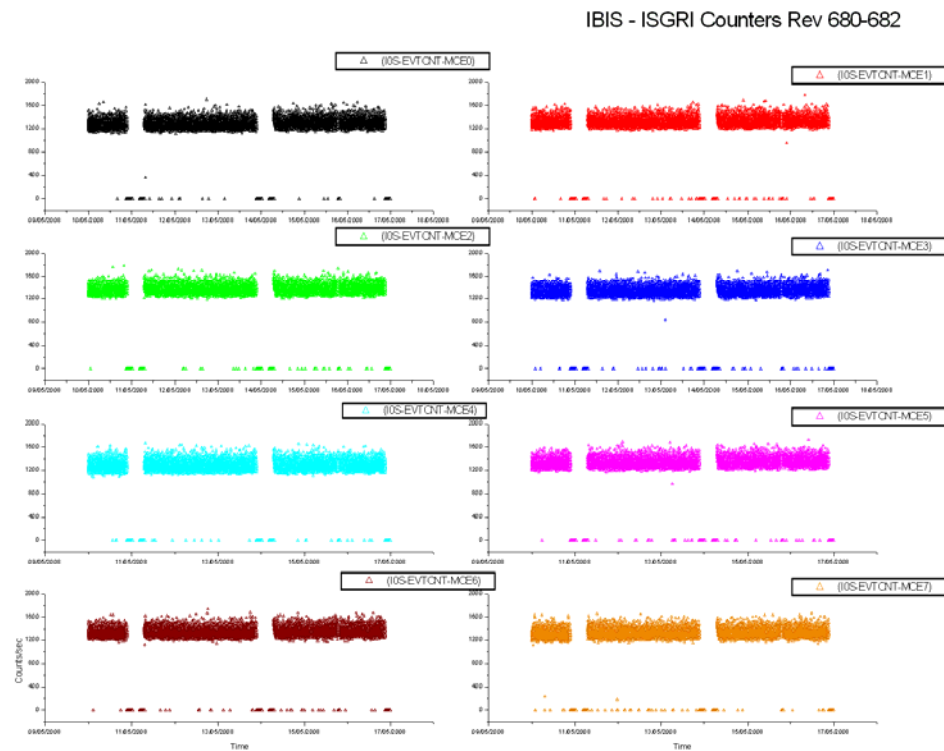
Event Log:

No non-nominal events occurred on SPI over the reporting period.

8.3.3 IBIS Operations

IBIS Event Counters Plots

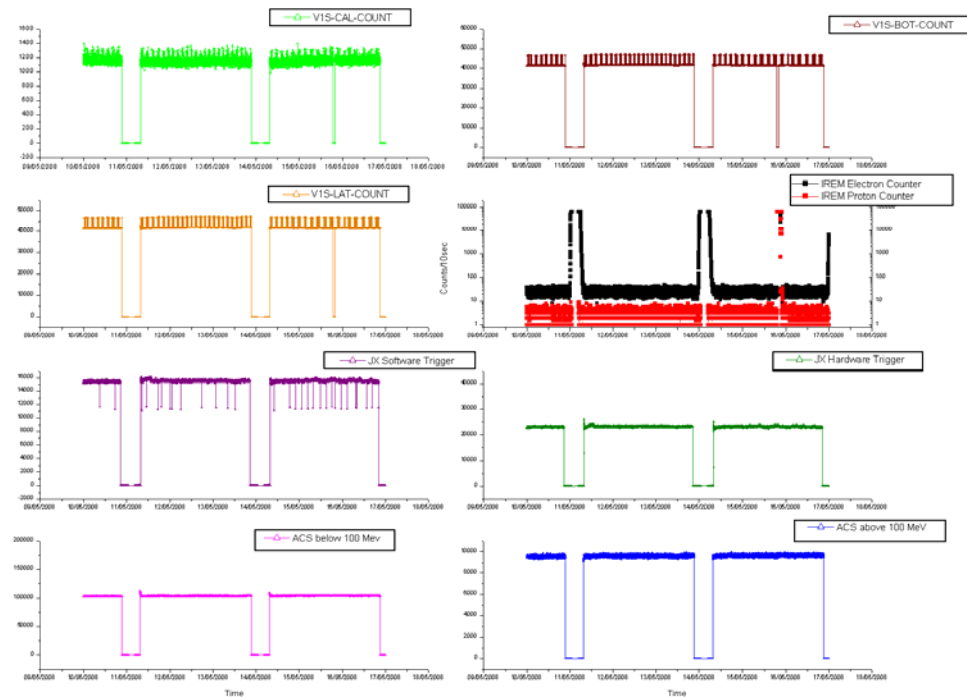
ISGRI Counters:



**sampling every 4 pkts (32 secs)

VETO vs Payload Counters:

IBIS-VETO vs Payloads Counters Rev 680-682

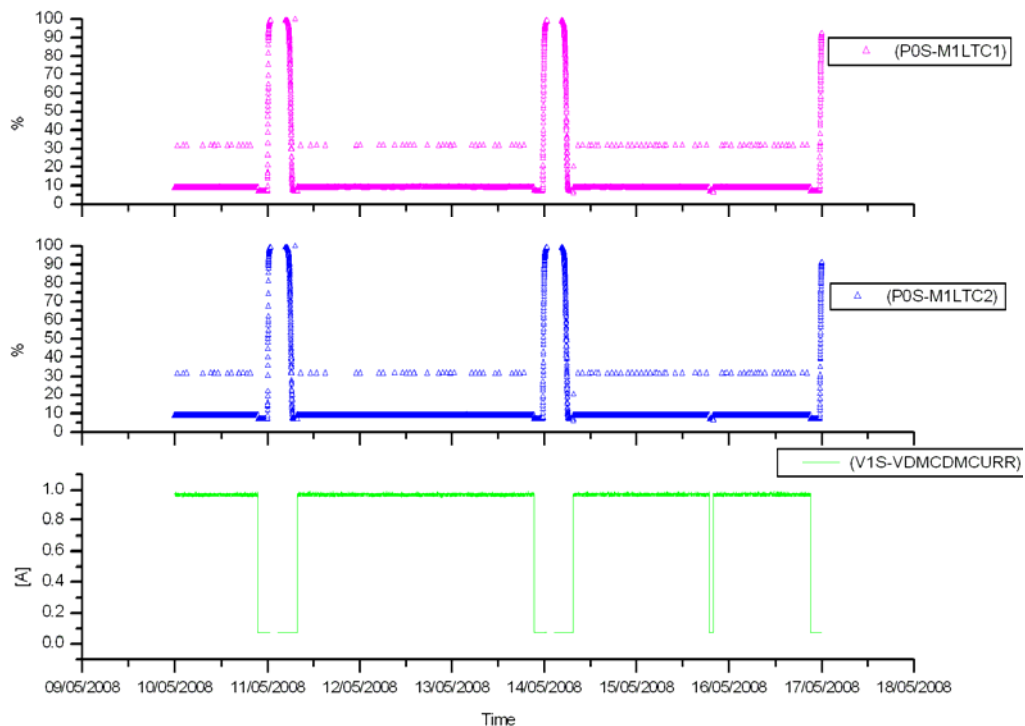


**with the exception of IREM counters (counts/10sec), all the plots are reporting counts/sec sampling every 5 pkts (40 sec)

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

VETO Current:

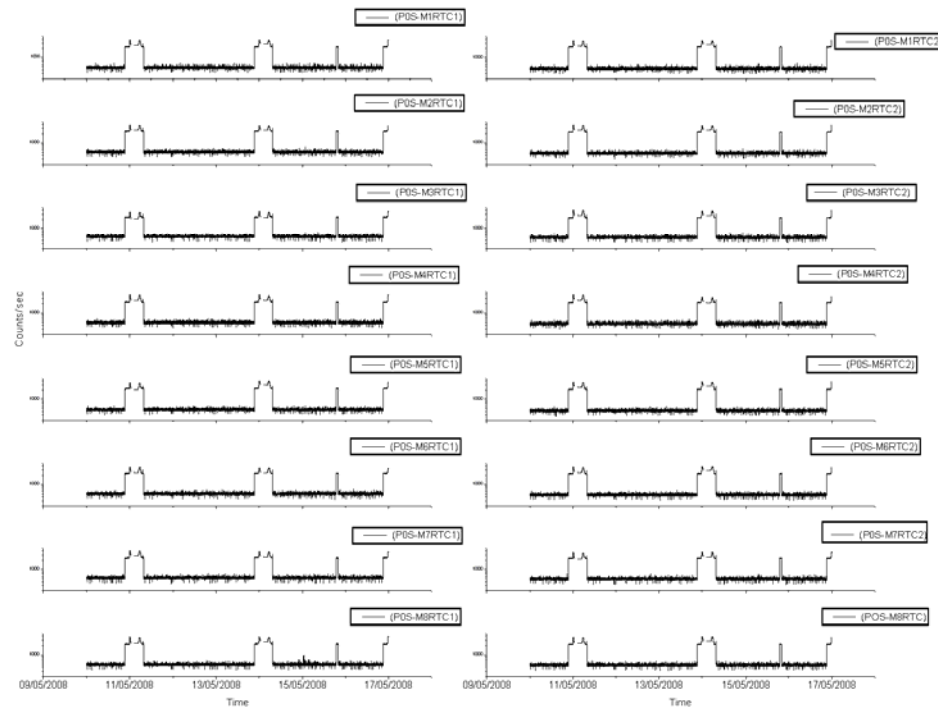
IBIS-VETO Current & PICsIT dead times Rev 680-682



**sampling every 4 pkts (32 secs)

PICsIT Counters:

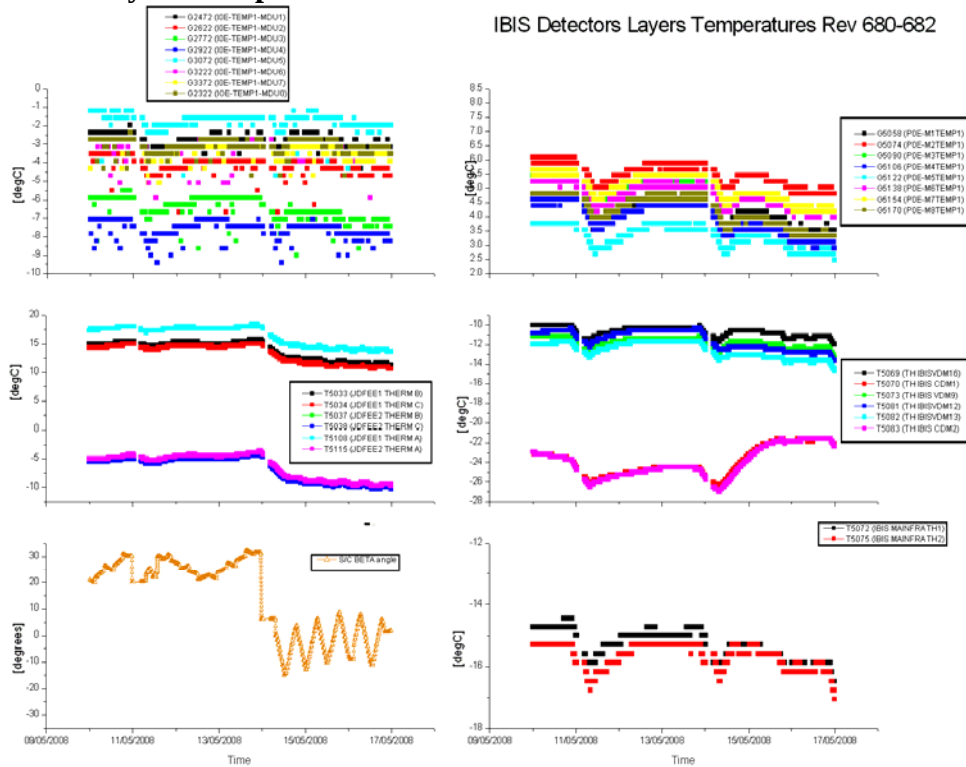
IBIS - PICsIT Counters Rev 680-682



**sampling every 4 pkts (32 secs)

IBIS Detectors Layers Temperatures:

IBIS Detectors Layers Temperatures Rev 680-682



**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 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 up-linked 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.

2008-05-10 (DOY 131, Rev 680) to 2008-05-14 (DOY 135, Rev 681-682)

IBIS operations executed nominally.

2008-05-15 (DOY 136, Rev 682)

Due to an IREM SEU, IBIS transitioned autonomously to Safe configuration at 19:00:53Z. It was recovered as follows:

- At 19:51:26Z FCP_IBIS1_0803 IBIS EXIT FROM SAFE MODE
- At 20:15:16Z ED GESTAN02 up-linked with the planned observation parameters and commanding to IBIS from the Timeline re-enabled.

IBIS operations continued nominally.

2008-05-16 (DOY 137, Rev 682)

IBIS operations executed nominally.

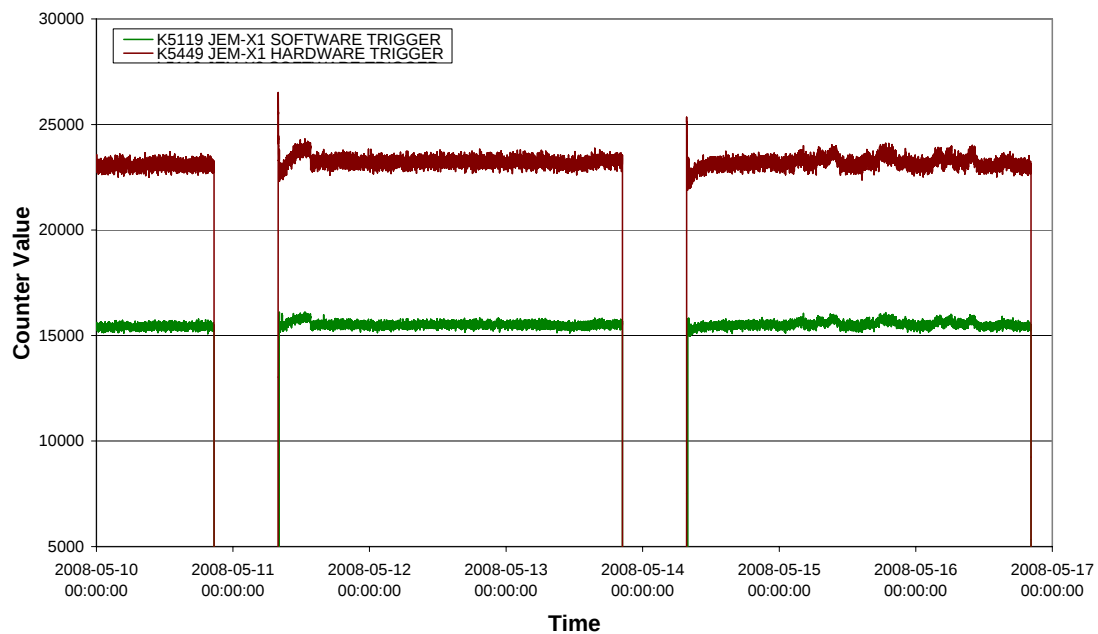
8.3.4 JEM-X Operations

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.

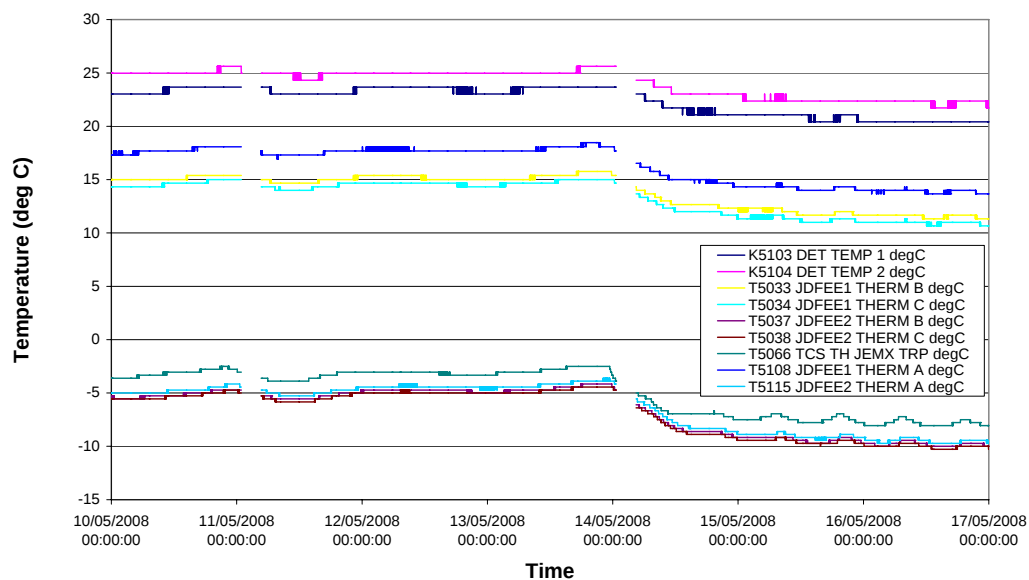
JEM-X Count Rates



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.

JEM-X Detector & DFEE Temperatures



JEM-X Daily Report

2008-05-10 (DoY 131, Rev 679) to 2008-05-14 (DoY 135, Rev 682)

² Data sampled (1 frame in 8)

JEM-X1 operations executed nominally.

2008-05-15 (DoY 136, Rev 682)

At 19:01:22 JEMX parameters K5315, K5316 & K5317 went Out-of-Limits due to an IREM SEU (#62). There was no impact as the reaction has been disabled.

2008-05-16 (DoY 137, Rev 682)

JEM-X1 operations executed nominally.

8.3.5 OMC Operations

2008-05-10 (DoY 131, Rev 680)

At 15:01:00, the OMC lens temperature (T5016) went out of soft limits for about 8 minutes. No action was taken, and there was no impact.

2008-05-11 (DoY 132, Rev 680)

At 19:01:58, the AOCS system used an incorrect guide star for a Close Loop Slew. The impact was pointing 06810015 was performed at a wrong attitude. It was at this time that 81 centring cycle OEMs were produced.

2008-05-12 (DoY 133, Rev 681) to 2008-05-14 (DoY 135, Rev 682)

Nothing to Report.

2008-05-15 (DoY 136, Rev 682)

At 19:00:42, OMC was sent to SAFE mode by an IREM SEU (#62). A recovery was performed, and the instrument returned to Stand-by at 19:37:57. The impact was pointing 06820061 was cut short after 729 from a planned 2000 seconds, and pointing 06820062 was lost.

2008-05-16 (DoY 137, Rev 682)

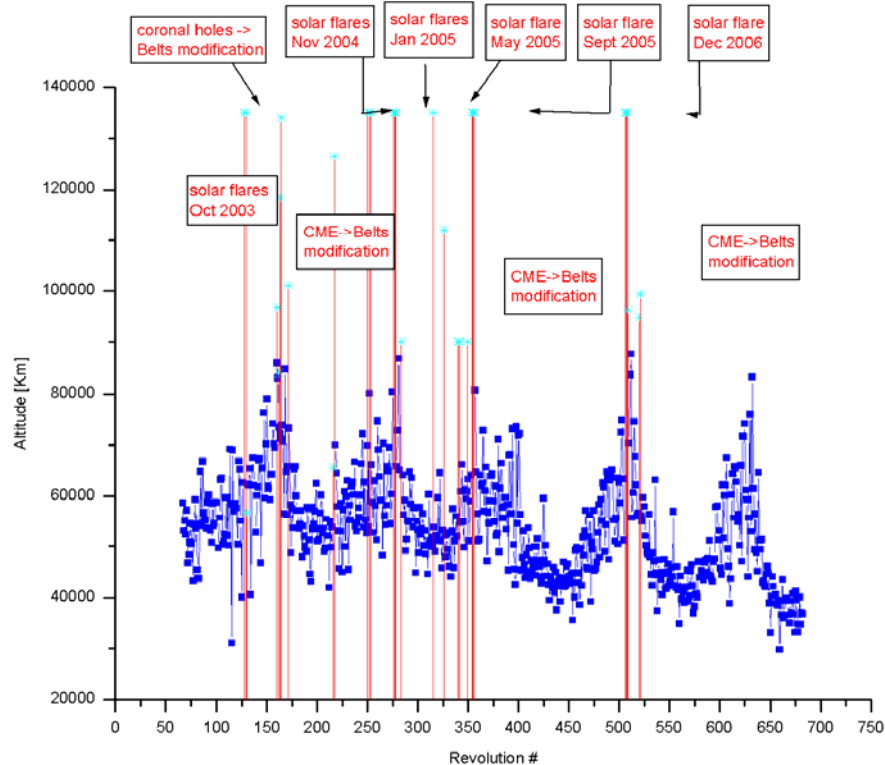
At 01:10:00, the TC link dropped. The link was recycled, then the nctrs rebooted. After removing and reconnecting the links, full communication was restored at 02:05:00. The impact was the loss of pointings 06820072, 06820073 & 06820074.

On DoY 131 at 21:34:50, DoY 134 at 21:20:58 and DoY 137 at 21:08:18 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 2008.136 (15/05/2008):

At 19:00:41Z, a local reset of the IREM CSCI S/W (SEU #62) 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 2008.136.19.00:41Z at 150125.7 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 19:10Z 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 22:11Z.

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 19:37:57Z and IBIS at 20:17Z.

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]
680	RAD_ENTR R 2008-05- 10T21:34:49Z	10/05/2008 23:59:53	34755.3	10-May-2008 23:19:13	40676.71
681	RAD_EXIT R 2008-05- 11T07:34:43Z	11/05/2008 06:58:01	>>34990.9	11-May-2008 06:49:13	46622.23
681	RAD_ENTR R 2008-05- 13T21:20:52Z	13/05/2008 23:30:17	36894.4	13-May-2008 22:55:48	42207.42
682	RAD_EXIT R 2008-05- 14T07:20:45Z	14/05/2008 06:49:37	>>34990.5	14-May-2008 06:35:48	46627.36
682	RAD_ENTR R 2008-05- 16T21:08:15Z	16/05/2008 23:24:09	36770.7	16-May-2008 22:45:48	41835.01

Reference

High radiation

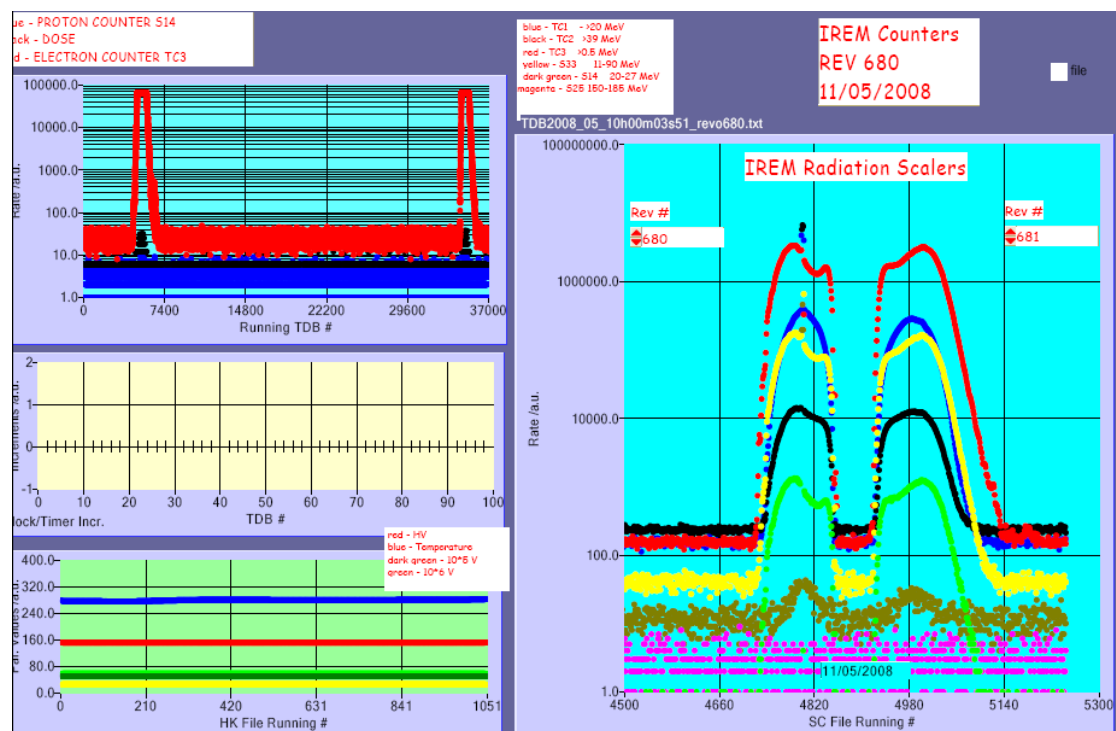
Very small error vs reference (less than 10 minutes)

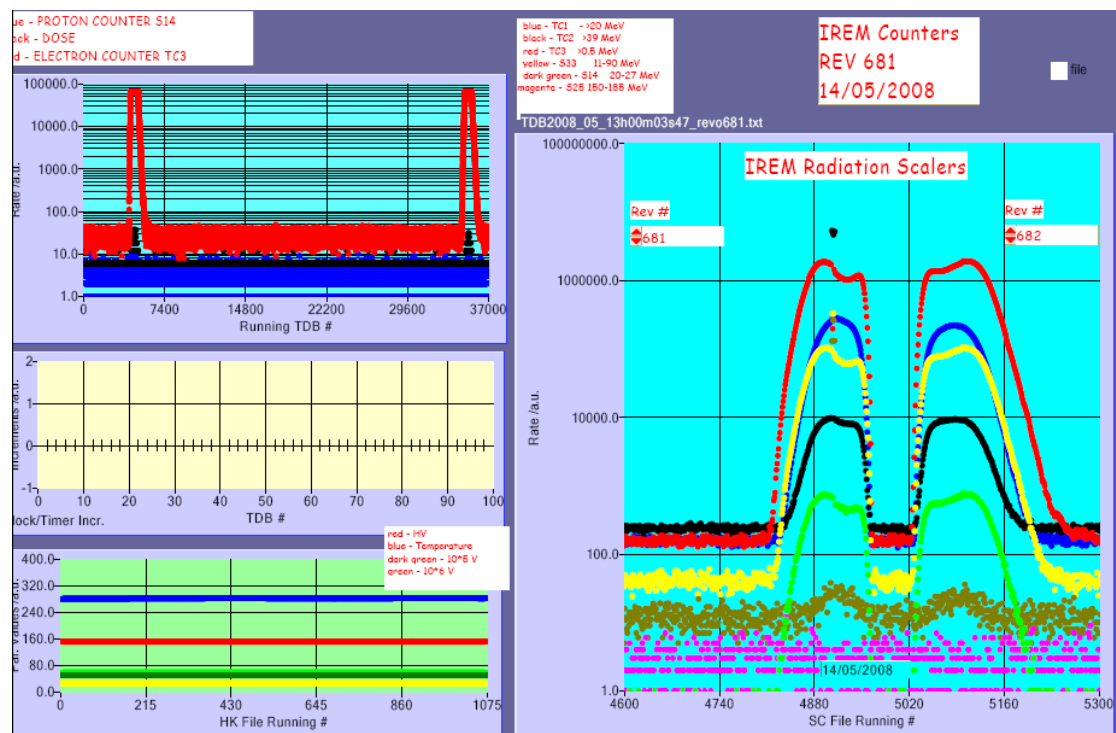
Small error vs reference (between 10 and 30 minutes)

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.

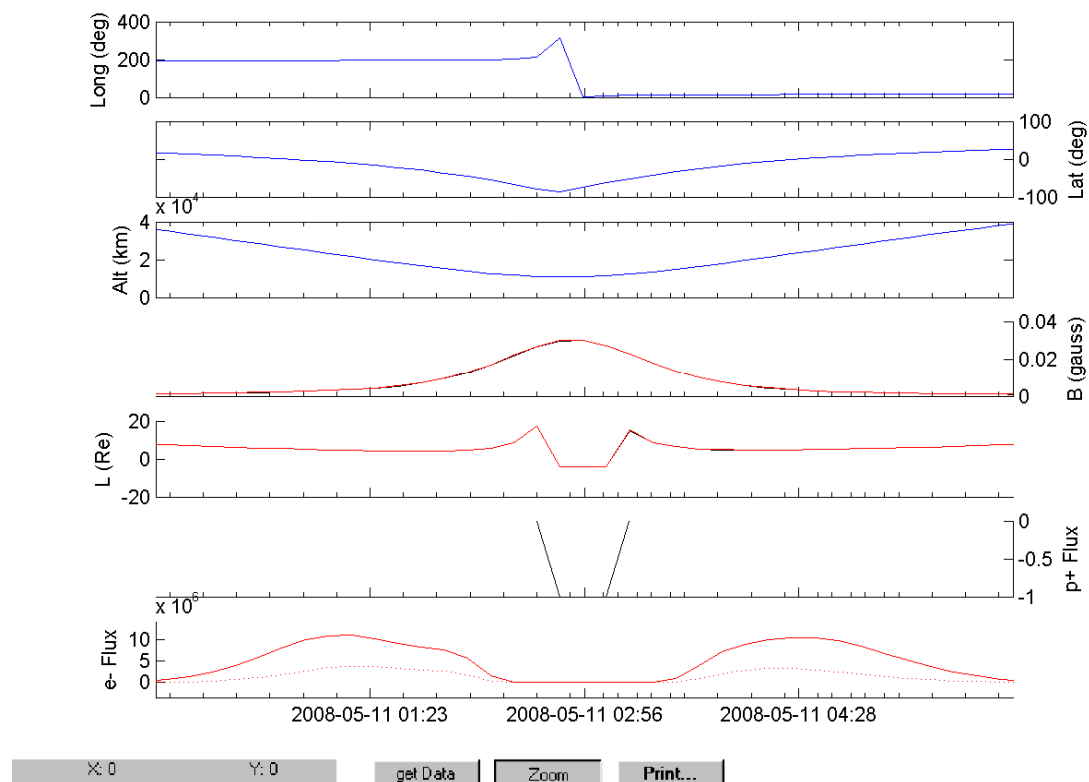
IREM radiation counters:



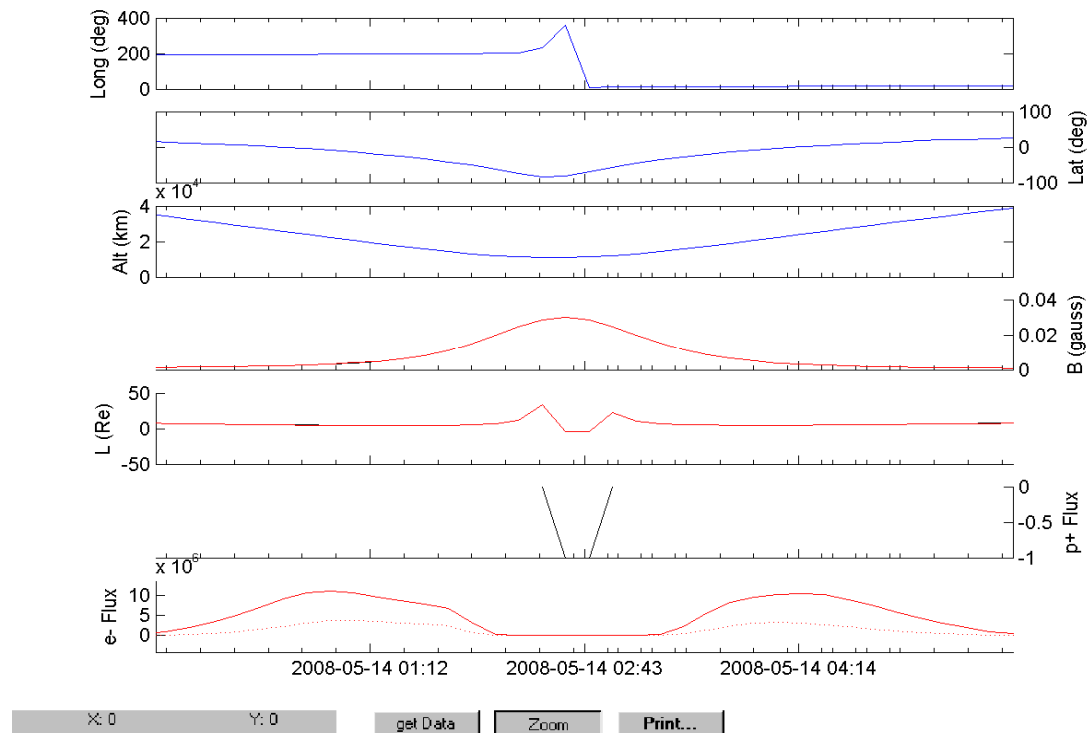


IREM Predicted Radiation Belt Passages

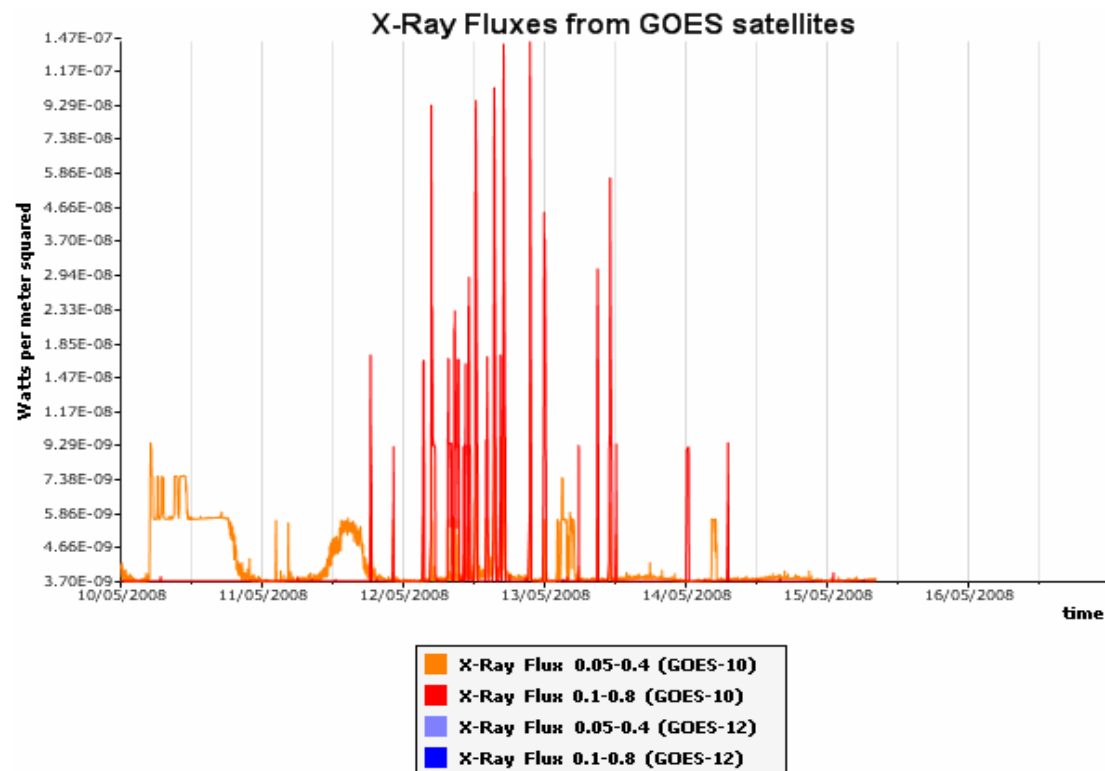
Rev 680



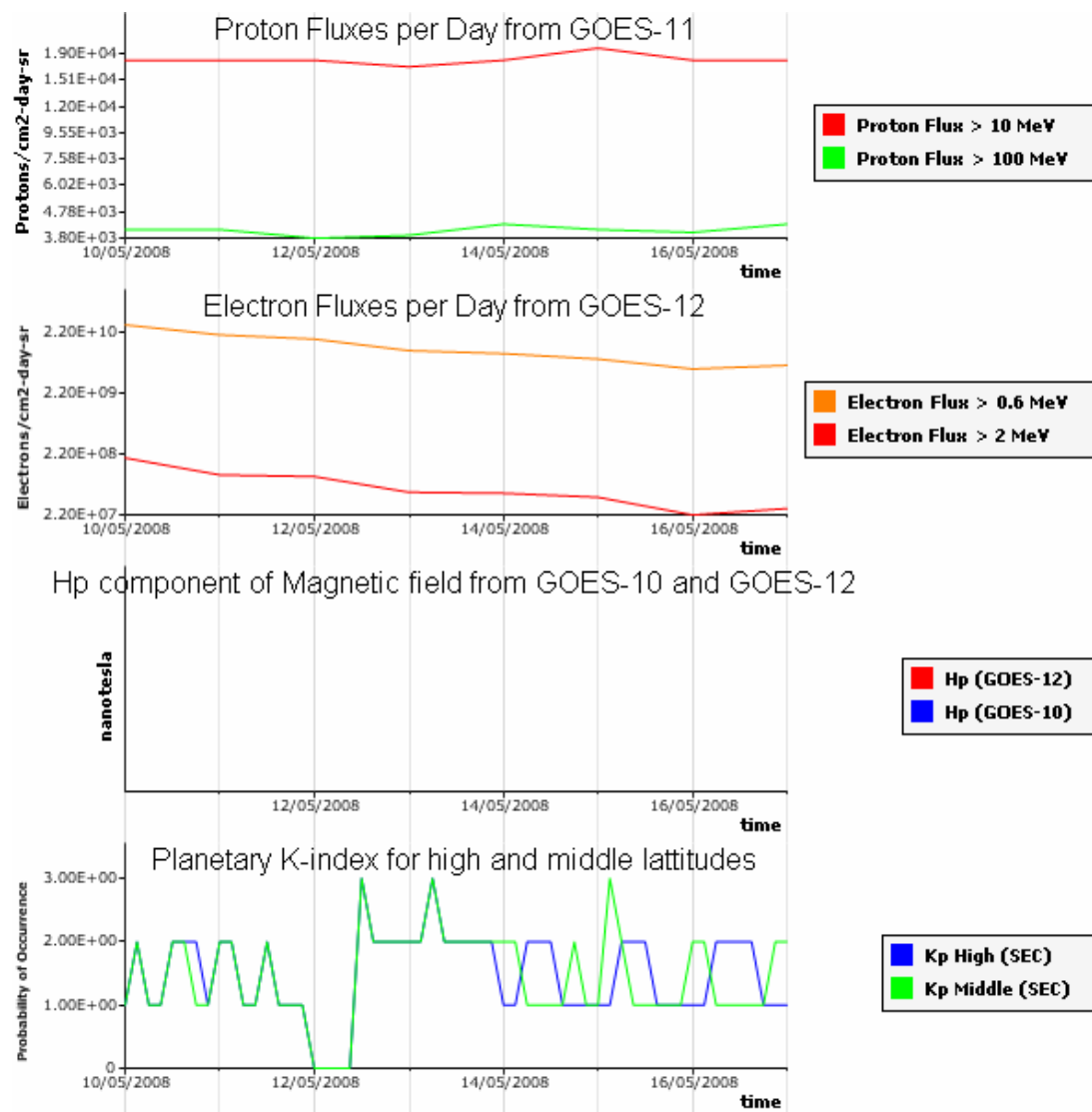
Rev 681



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.