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

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OF
No. 206
Week 35
04.09.06
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 26.08.06 until 01.09.06 (both dates inclusive) and covers the revolutions 473 and 474.

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 2 hexagonal dithers of the Galactic Bulge region (RA 17:45:36.00, DEC -28:56:00.0), a raster dither of the Galactic Centre (RA 17:45:40.00, DEC -29:00:28.0), and a raster dither of the Galactic Plane Region 1 (RA 18:33:10.67, DEC -08:49:48.0).

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.

1 slew was missed during the observation period due problem on DSS27 station.

The fuel consumption over the period between 24/08/2006 and 31/08/2006 was 0.0814 Kg. The remaining propellant is in the order of 152.3357 Kg.

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

3.1.2 Power

The EPS is working nominally, available power from the arrays is of the order of 2100W.

3.1.3 Thermal

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

3.1.4 OBDH

The OBDH subsystem is working flawlessly. No on-board communications problem has been identified.

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

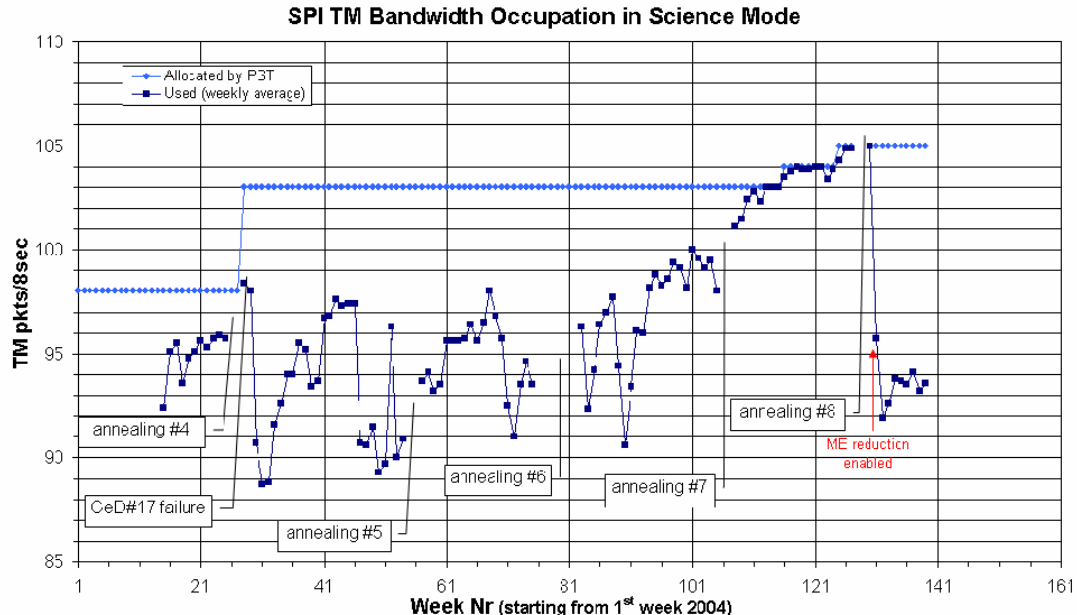
3.2.1 SPI

Following the 8th annealing, which ended on 26th June, the overall status of the gamma-ray spectrometer is nominal, except for the Ge detectors #4 and #12 which are showing a slightly degraded energy resolution. The energy resolution of GeD#15 was recovered with this annealing. 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 82 +/-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 pkts/cycle. The average telemetry occupation in the science window was 93.6 packets/cycle.

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



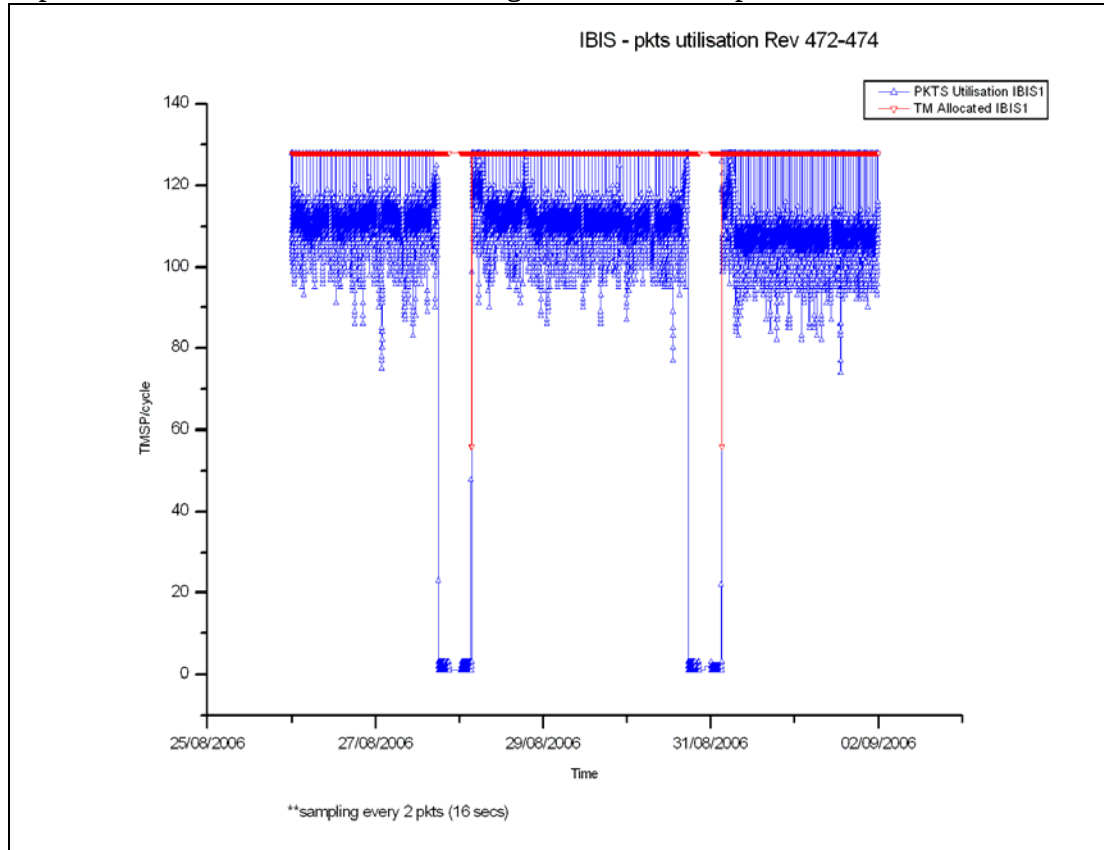
Note: Some more information concerning the SPI operations is provided in the Appendix.

3.2.2 IBIS

The overall status of the unit is nominal.

During the reporting period, the PST allocation to IBIS was 128 TMPS/cycle. The IBIS mean bandwidth utilisation during the observation period was 110.65 TMPS/cycle, up 14.42 on last week.

A plot of the IBIS TM utilisation during the observation period 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 during science observations. JEM-X2 was dormant (DPE OFF) with no TM slots allocated.

Further information on the JEM-X operations can be found in the Appendix Section 8.3.4.

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, 167 of the 168 planned science pointings for OMC were executed nominally, 1 was lost.

Note: Some more information concerning the OMC operations is provided in the Appendix Section 8.3.5.

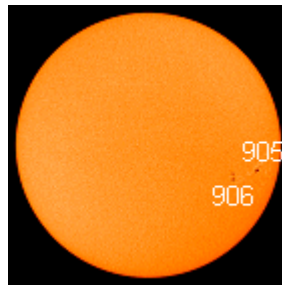
3.2.5 IREM

The overall status of the unit is nominal.

Solar Activity

The observation period was characterised by low solar activity.

From 26/08/2006 to 28/08/2006, sunspot 905 kept posing threat for M-class flares. Then, it started decaying until the end of the observation period, posing no threat for strong solar flare. On 31/08/2006 new sunspot 906 appeared (see picture). It posed no threat either.



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 much better this week. However, an OMC pointing was lost when the TC link with DSS-27 dropped. Also a lost pass meant the spacecraft had to go into perigee with an incorrect, but safe configuration. The overall performance was below the 95% requirement.

4.1 Mission Operations Centre

The performance of the MOC was much better this week. There were only minor problems reported, such as the TC History crashing, the manual stack freezing, and the connection to the MISCdynamic server dropping, none of which had any impact. The overall performance was well above the 95% requirement.

4.2 Ground Stations & Network

The performance of the ground stations and Network was much better this week. A pass with DSS-27 was lost, but Redu was able to step in, and no data was lost. A second DSS-27 pass was lost, leading to an incorrect, but safe perigee configuration, a recovery was performed after AOS, and no science data was lost. Another problem with the TC link with DSS-24 caused an OMC pointing to be lost. There were also several occasions of bad frames and link drops with Vil2, all of which had no impact.

There were a few errors sending data to the isds, but these also had no impact. The overall performance was well above the 95% requirement.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

PSFs have been received up to revolution 481. Up to revolution 478 has been planned and sent to MOC. Substantial work spent on finalising the plan for the next CRAB calibration campaign. It is not intended to be performed in revolution 483. In preparation for this calibration JEM-X2 will be switched on in revolution 482 as well.

2. Observation status

No ECS was received this week.

3. ISOC science data archive

Nothing to report this week.

4. ISOC system

A version 13.0 is produced and is being user tested before release for operational use

5. AO-4

The remaining tasks mentioned last week, i.e. the "latitude scan" observations (PI: Sunayev) still need to be set up and amalgamation is still pending but not urgent.

7. Problems

4.3.2 ISDC

Status of ISDC observation processing on 04/09/2006:

- Latest Standard Analysis completed: observation 03201080014 (Field_14, Revolution 453, 455 & 459) on 29/08/2006.
- Latest products archived: observation 03201080014 (Field_14, Revolution 453, 455 & 459) on 04/09/2006.
- Latest observation products sent to the observer: observation 03201080010 (Field_10, Revolution 458) on 04/09/2006.

5 Special Events

6 Anomalies

The following problems that impacted operations were reported:

- On DoY 239, at 07:07, the TC link via DSS-24 dropped. The OBDH commanding was disabled, and not re-enabled until after the recovery. The impact was Broadcast packet command did not go, and the OMC pointing 04720057 was lost.
- On DoY 242, at 19:30, network was unable to connect the TC to DSS-27. The impact was the loss of this pass, which meant the loss of Slew 04730065 to the perigee attitude, the Reaction Wheel Bias and the antenna swap. A recovery was performed at the start of the next revolution, and no science data was lost.

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

7 Future Milestones

There are battery re-conditioning activities currently planned for mid-September, more details later.

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 473

The observations in revolution 473 began with a hexagonal dither of the Galactic Bulge region (RA 17:45:36.00, DEC -28:56:00.0), lasting ~3.5 hours. This was followed by a raster dither of the Galactic Centre (RA 17:45:40.00, DEC -29:00:28.0), lasting ~54.1 hours, until the end of the revolution.

Revolution 474

The observations in revolution 474 began with a hexagonal dither of the Galactic Bulge region (RA 17:45:36.00, DEC -28:56:00.0), lasting ~3.5 hours. This was followed by a raster dither of the Galactic Plane Region 1 (RA 18:33:10.67, DEC -08:49:48.0), lasting ~53.3 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 105; JEM-X1 8; JEM-X2 0; OMC 5.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

2006-08-10T11:24:18.000Z	152.6066	F	Automatic TM processing.
2006-08-11T13:25:32.000Z	152.5836	F	Automatic TM processing.
2006-08-12T21:56:56.000Z	152.5752	F	Automatic TM processing.
2006-08-13T02:28:32.000Z	152.5484	F	Automatic TM processing.
2006-08-13T11:50:25.000Z	152.5307	F	Automatic TM processing.
2006-08-13T17:41:30.000Z	152.5093	F	Automatic TM processing.
2006-08-14T12:53:00.000Z	152.4909	F	Automatic TM processing.
2006-08-16T02:12:08.000Z	152.4724	F	Automatic TM processing.
2006-08-17T12:55:00.000Z	152.4560	F	Automatic TM processing.
2006-08-19T08:14:24.000Z	152.4392	F	Automatic TM processing.
2006-08-22T02:38:55.000Z	152.4350	F	Automatic TM processing.
2006-08-23T12:21:39.000Z	152.4171	F	Automatic TM processing.
2006-08-26T11:20:10.000Z	152.4032	F	Automatic TM processing.
2006-08-28T01:10:00.000Z	152.3791	F	Automatic TM processing.
2006-08-31T00:54:07.000Z	152.3357	F	Automatic TM processing.

This report was generated Fri Sep 1 08:00:39 GMT 2006

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, 26/08/2006 – 01/09/2006

AOCS operations were executed from the Automatic Timeline.

During this period, 103 Open Loop Slews, 70 Closed Loop Slews and 4 Momentum Biases were executed.

1 slew (CSL) was missed during the observation period due to problem on configuring DSS27 station.

This is equivalent to ~0.6 % of the total number of slews planned (174).

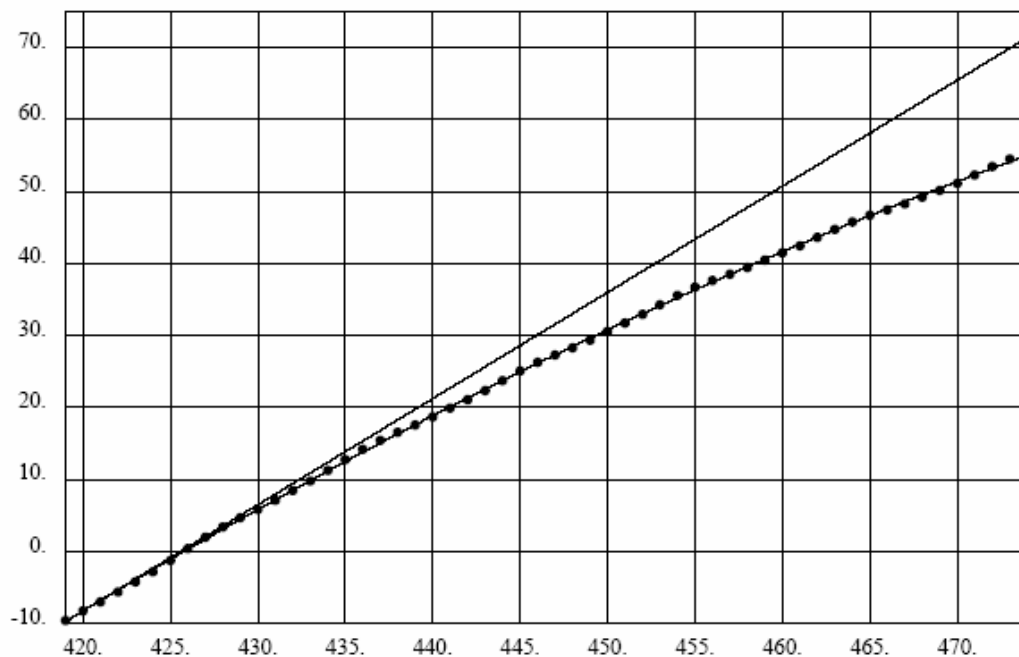
Orbit Control

The attached plot shows the apogee longitude of Integral as a function of the orbit number. From the approximation of the apogee longitudes with a parable the average semi-major axis increase due to momentum dumping manoeuvres is estimated to have been 586 m per orbital revolution.

Rev AOS REDU - 45000 km altitude
(Crit.Instr.Alt.Asc.)
463 174 minutes
474 165 minutes

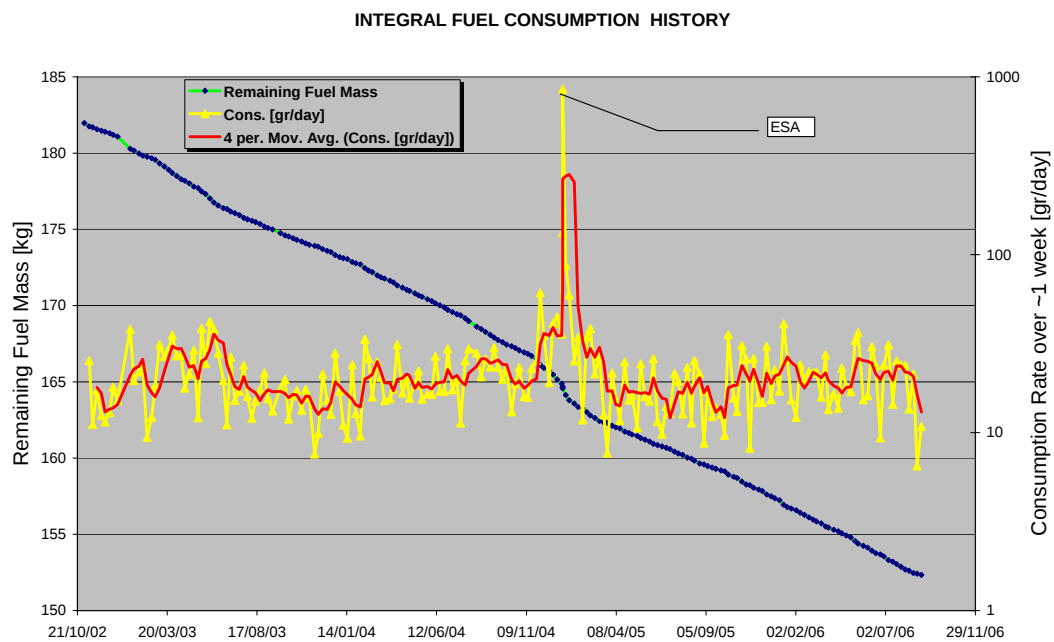
LOS REDU - 56000 km altitude
(Crit.Instr.Alt.Des.)
119 minutes
141 minutes

APOGEE LONGITUDES OF INTEGRAL 21.03.2006 - 01.09.2006
LEAST SQUARES APPROXIMATION WITH PARABLE

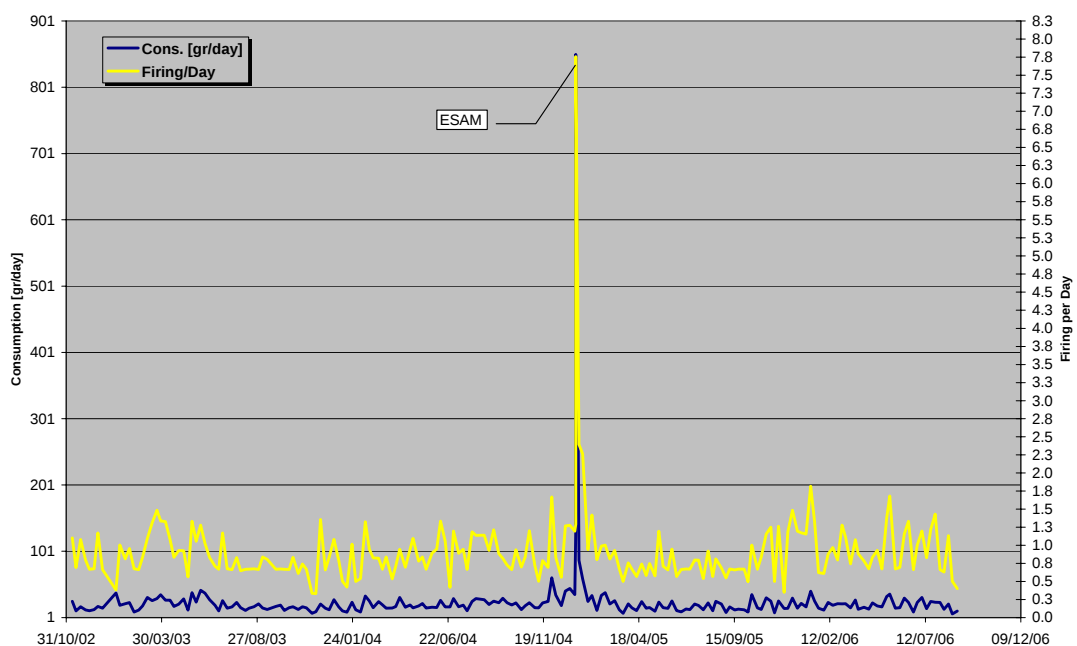


Fuel consumption

The fuel consumption (total, grams/day) over the period between 01/11/2002 and 31/08/2006 is reported in the plot below.

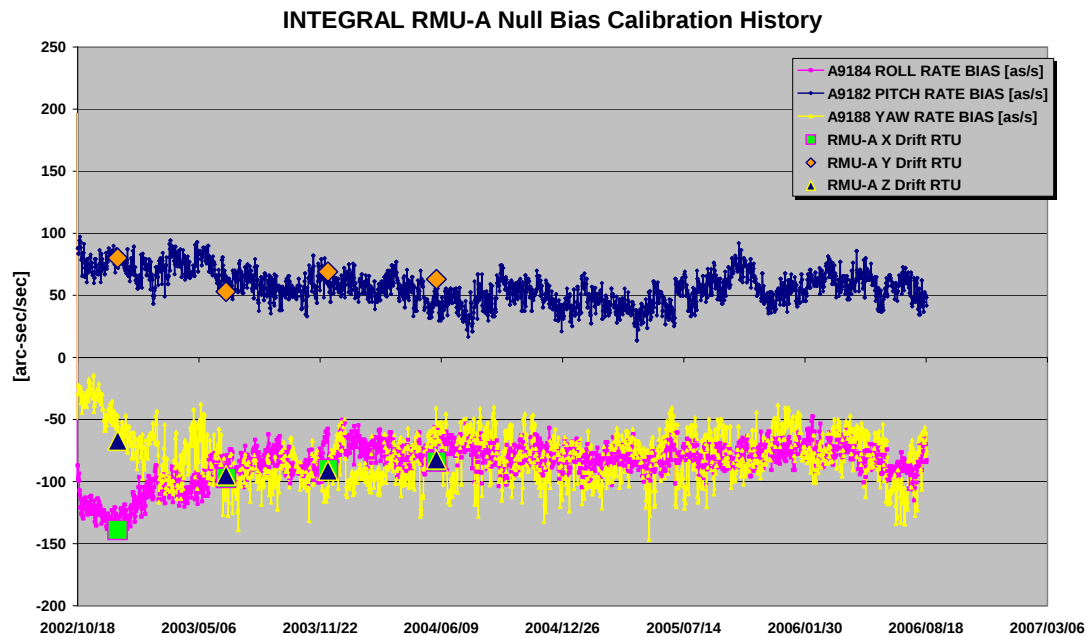


The firing\day over the period between 01/11/2002 and 31/08/2006 is reported in the plot below.

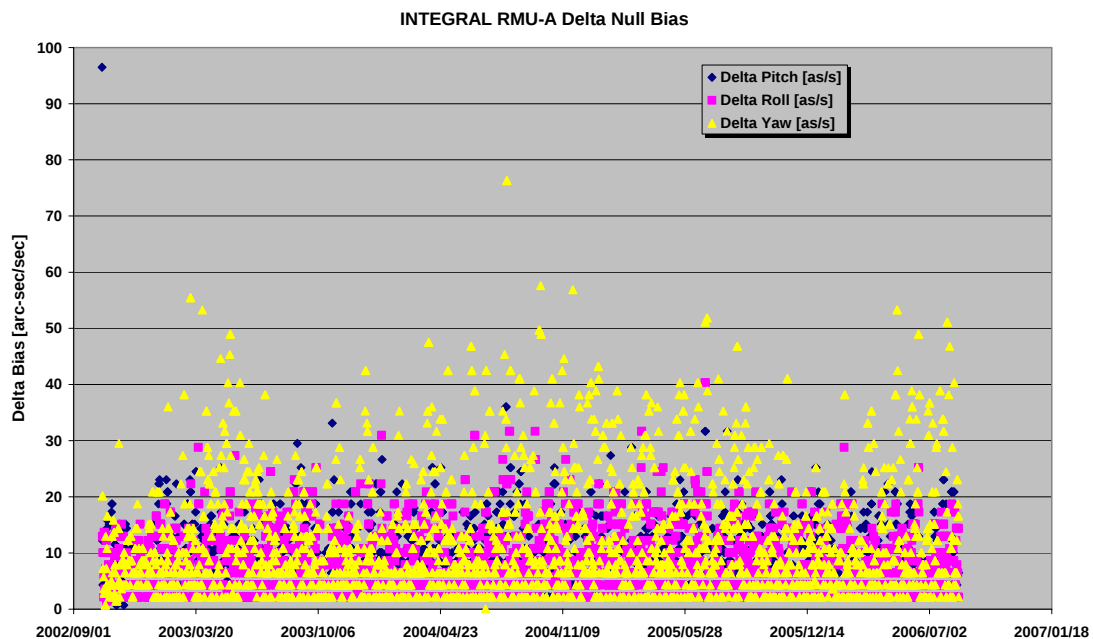


The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 25/08/2006 is reported in the plot below.



The RMU-A delta null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 25/08/2006 is reported in the plot below.



26/08/06 (Day of Year 237, Revolution 472)

Nothing to report.

27/08/06 (Day of Year 238, Revolution 472)

Problem on DSS27 station: at 00:56z due to several problems during the handover from Vilspa 2 to DSS27 station (see anomaly report section), was requested the support of DSS24 and REDU stations. At 07:07z the TC and TM links dropped due to

low elevation for DSS24. No TM was received in the meanwhile from FD system and this caused the failing of the slew update process for SID 04720058.

A manual recovery was then started at 07:33z. The next slew in TL (04720058) was manually updated at 07:45z.

No impact on TL.

28/08/06 (Day of Year 239, Revolution 472-473)

Nothing to report.

29/08/06 (Day of Year 240, Revolution 473)

Nothing to report.

30/08/06 (Day of Year 241, Revolution 473)

Problem on TC link at DSS27 station: at 19:30z due to several problems during the handover from Vilspa 2 to DSS27 station (see anomaly report section), the AOCS s/s was disabled at 19:42z. The sequence for slew ID 04730065 failed release. As consequence the last CGS and RWB of the revolution could not be executed.

A recovery , manual RWB, was then started at the beginning of rev 474, on 31/08/2006 08:14z. The first slew in TL (04740001) was manually updated at 01:07z.

The following slew was not executed from TL: ID 04740065(CSL).

31/08/06 (Day of Year 242, Revolution 473)

Nothing to report.

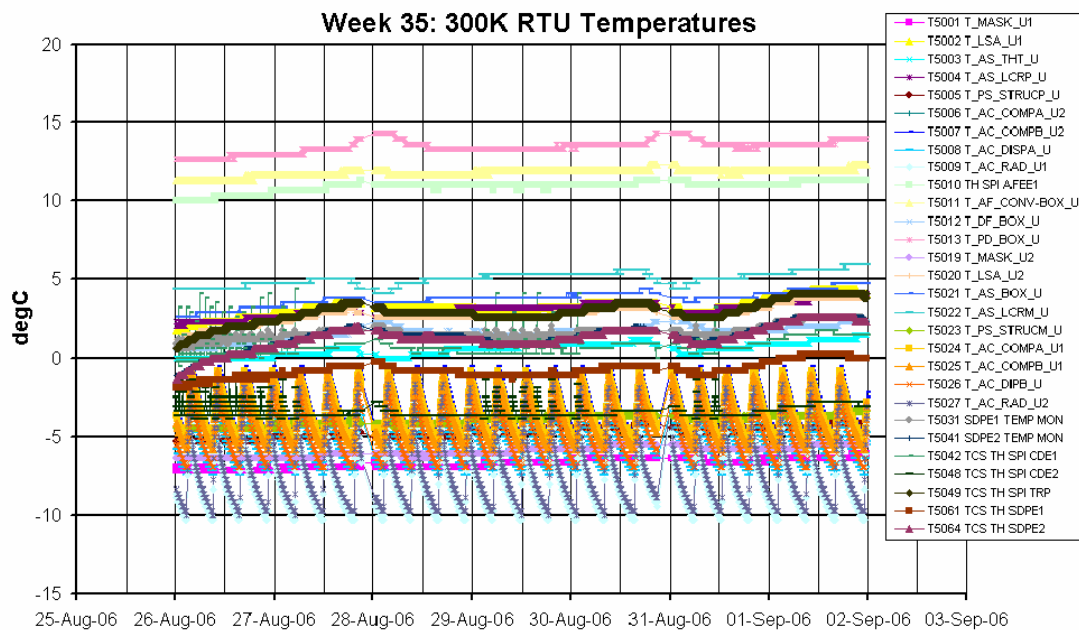
01/09/06 (Day of Year 243, Revolution 473-474)

Nothing to report.

8.3.2 SPI Operations

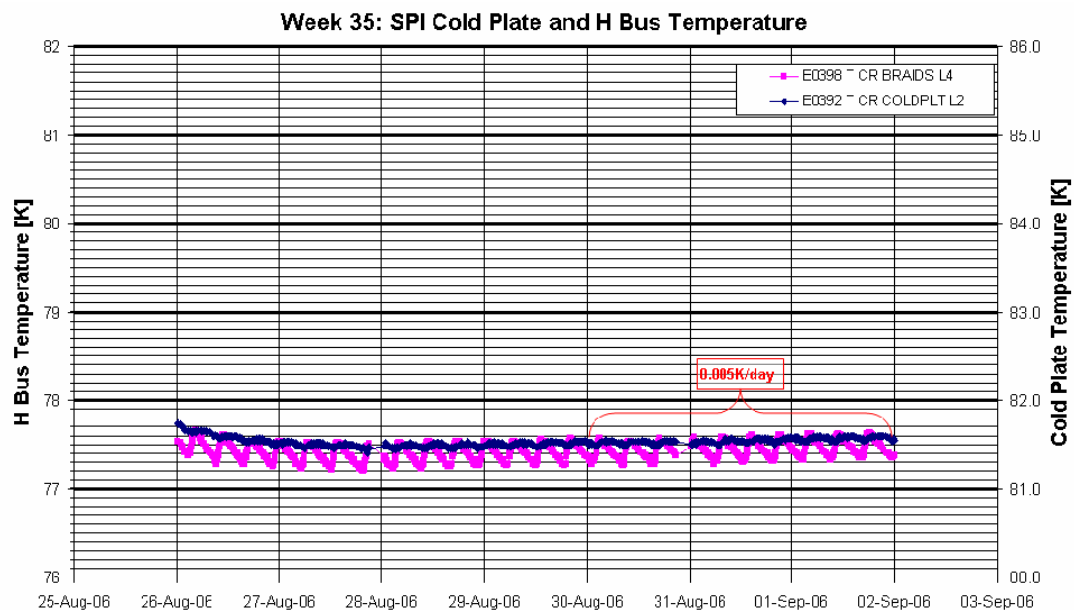
Unit Temperatures:

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 to 82K $\pm$ 1K with a positive of 0.005deg/day towards the end of the week. 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 current IASW version installed is 432.

The average TM bandwidth occupation of SPI was 93.6 packets/cycle over the science window, when the TM allocation was 105 packets/cycle.

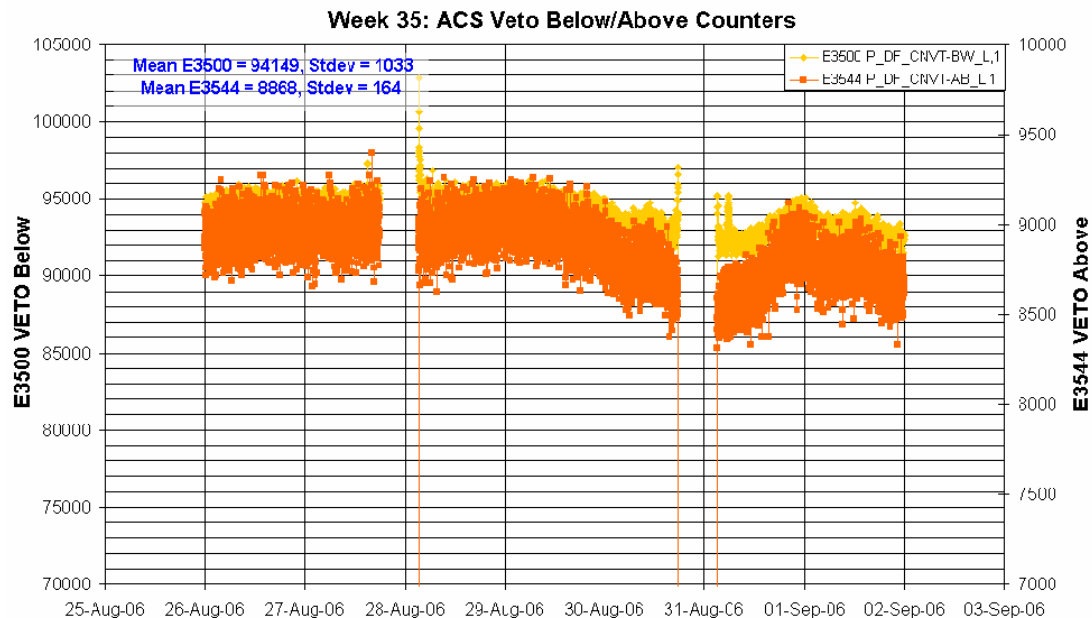
The following plot shows the IASW performance in terms of TM bandwidth, event buffer occupation and DPE CPU load during the reporting period.



ACS:

The performance of the ACS is nominal.

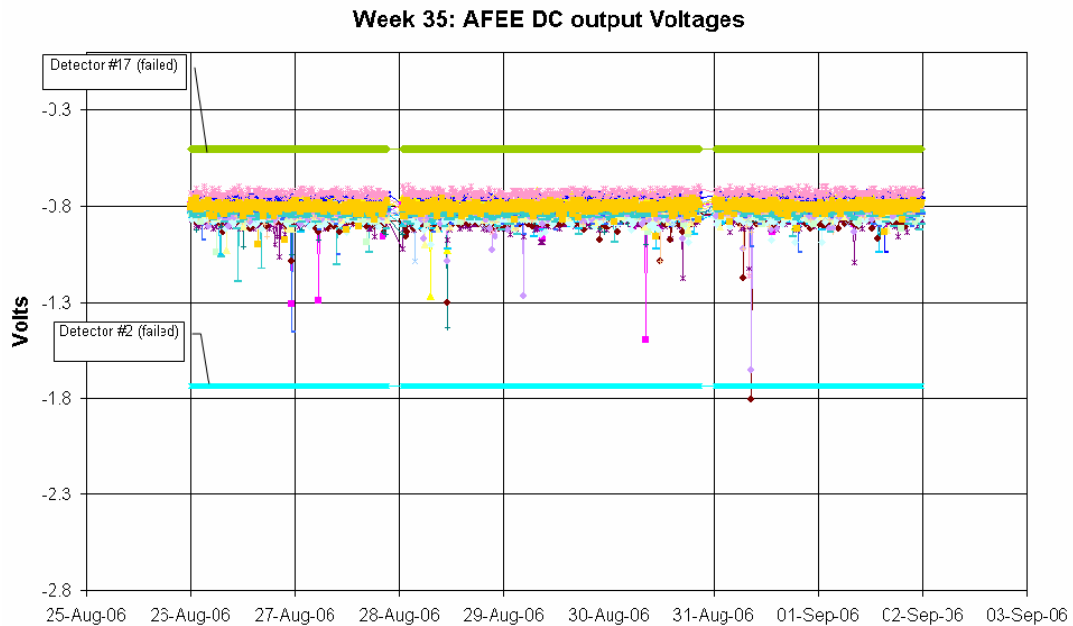
The following plot shows the ACS overall count rate evolution during the reporting period:



AFEE:

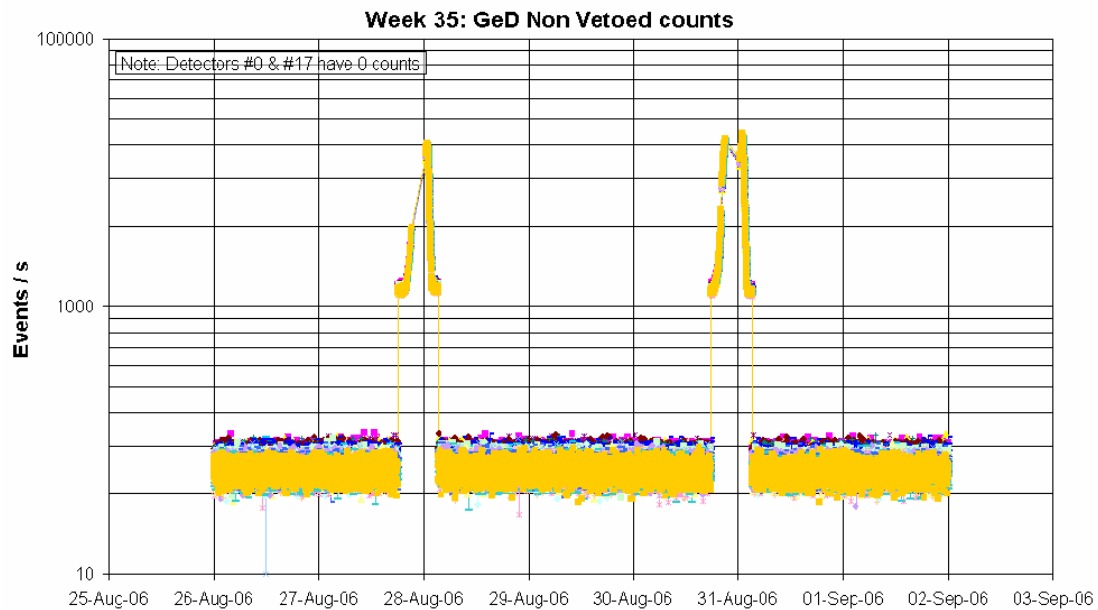
The health of the AFEE is nominal. The performance of the AFEE and the detectors is nominal, except for the Ge detectors #4 and #12 which are showing a slightly degraded energy resolution. The energy resolution of GeD#15 was recovered with the last annealing.

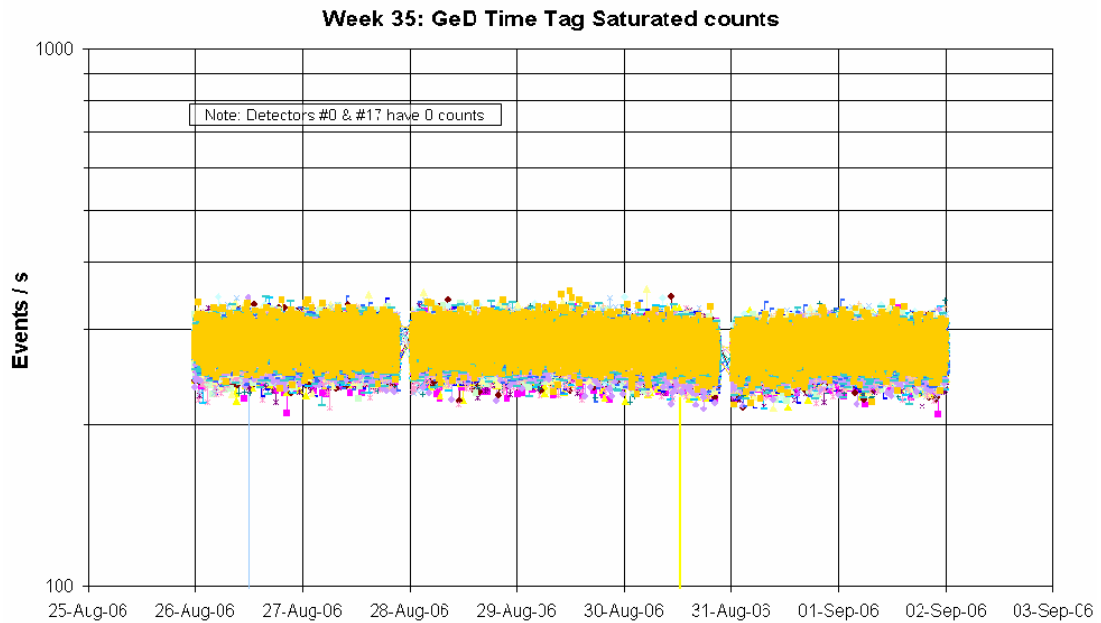
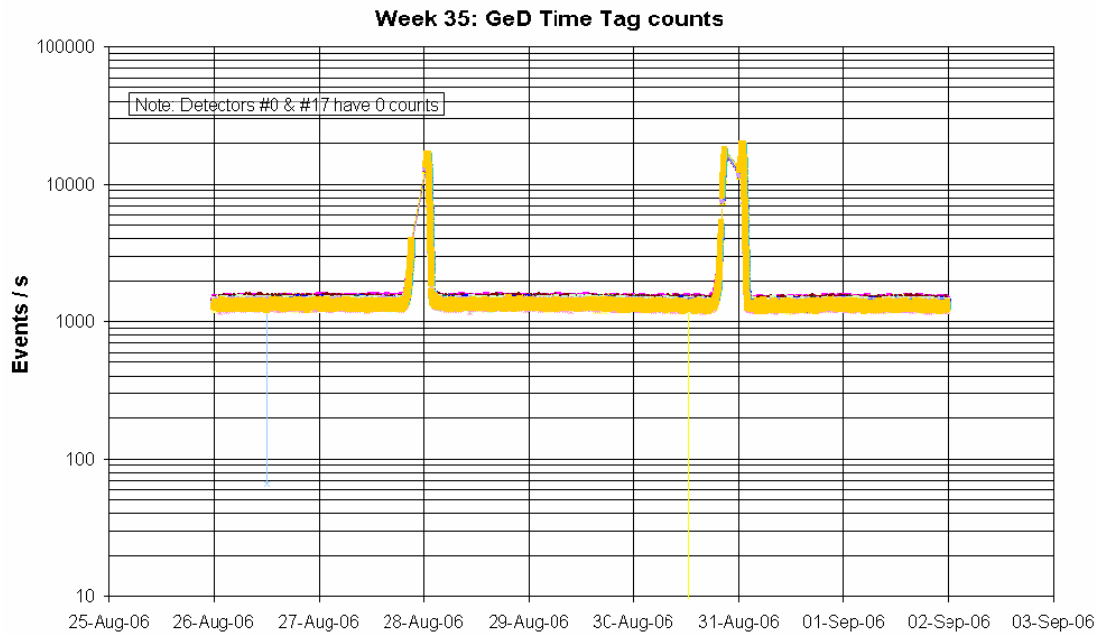
The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06.12.2003 and detector #17 is failed since 17.07.2004



DFEE:

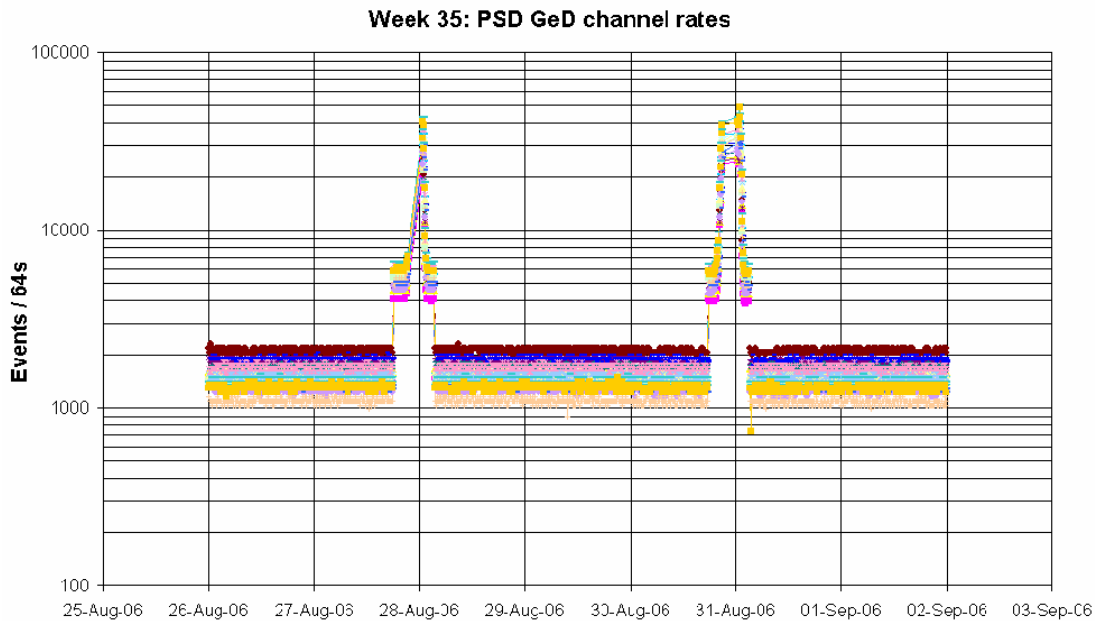
The performance of the unit is nominal. The following plots show the Non Vetoes, Time Tag and Time Tag Saturated Event Count Rates during the reporting period.





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 OOLs and OEMs were received from SPI during the reporting period:

- Several occurrences of OEM APID 1024 ID 229 EXCEPTION SPI1 PARTIAL FLAG OVERFLOW were received as follows:
 - o 5 occurrences on 2006-08-26 at 22:07:30Z (SUBBLOCK ID SP15; SP6; SP12; SP18; SP6)
 - o 1 occurrence on 2006-08-28 at 16:00:02Z (SUBBLOCK ID SP15)
 - o 2 occurrences on 2006-08-29 at 21:57:46Z (SUBBLOCK ID SP5; SP6)
 - o 8 occurrences on 2006-08-29 at 21:57:54Z (SUBBLOCK ID SP8; SP10; SP12; SP14; SP16; SP0; SP3; SP5)
 - o 8 occurrences on 2006-08-29 at 21:58:02Z (SUBBLOCK ID SP7; SP9; SP11; SP15; SP1; SP6; SP14; SP12)

These were all during nominal science pointings and no other alarms were received at these times.

- On 2006-08-30 at 20:33:24Z TM parameter E4009 S DF HSLERR L went OOL High (value = 1), indicating that the number of erroneous HSL transfers in the previous second exceeded the threshold. It returned within limits at the next TM cycle. This was just before LOS of revolution 473.
- On 2006-08-31 at 03:04:20Z, at radiation belt exit of revolution 474, the following TM parameters went OOL (value = PARAM > SPEC):
 - o E2195-E2240: FEE digital status 5 V #45 -90
 - o E2241: FEE PSAC power 3 status
 - o E2295-E2340: FEE analogue status 5 V #45-90
 - o E2341: FEE PSAC power 4 status
 - o E2395-E2399; E3121-E3161: FEE analogue status -5 V #45-90
 - o E3162: FEE PSAC temperature status
 - o E3209-E3254: FEE temperature status #45-90
 - o E3289: FEE power1 status

Doc. Title : INTEGRAL Mission Report #206
Doc. Ref. : INT-MOC-SYS-RP-1001-OPS-OF
Date : 04/09/06

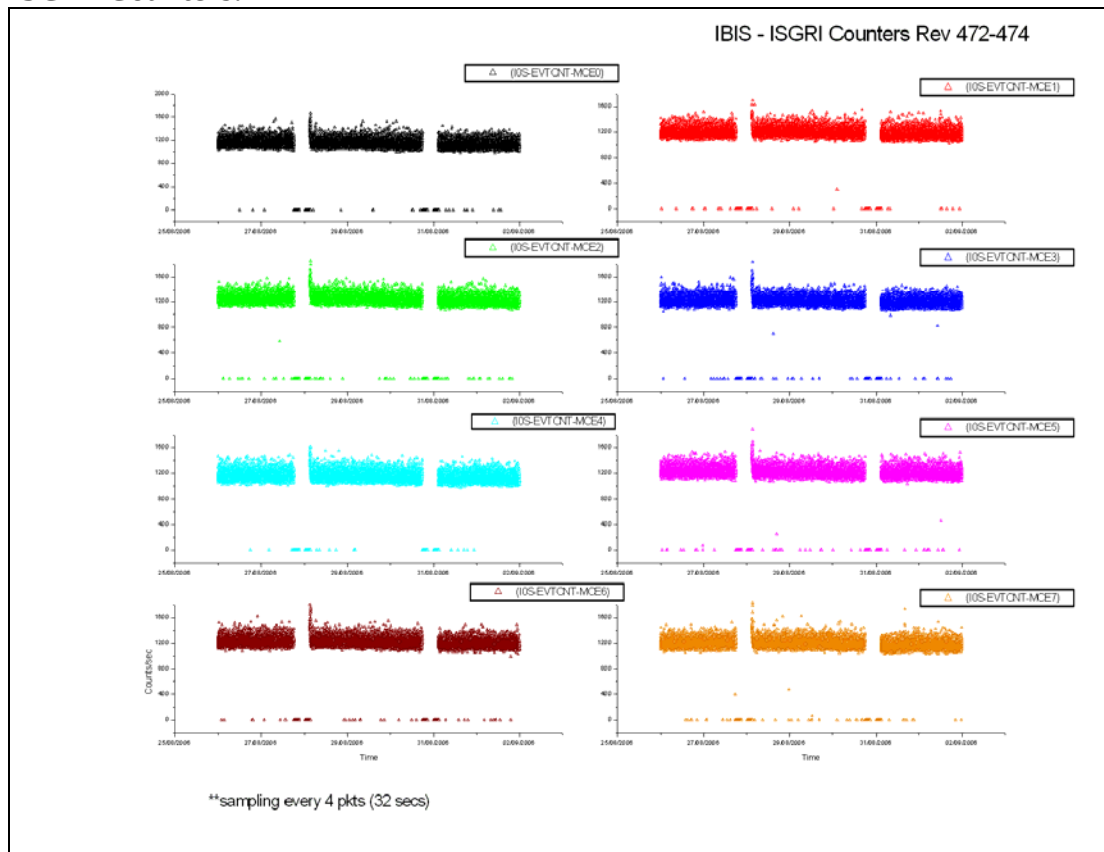
Issue : 1
Rev. : 0
Page : 19

All the above had returned within limits by 03:08:28Z, once the ED
EEORTM01 to refresh the SPI HK TM was sent.

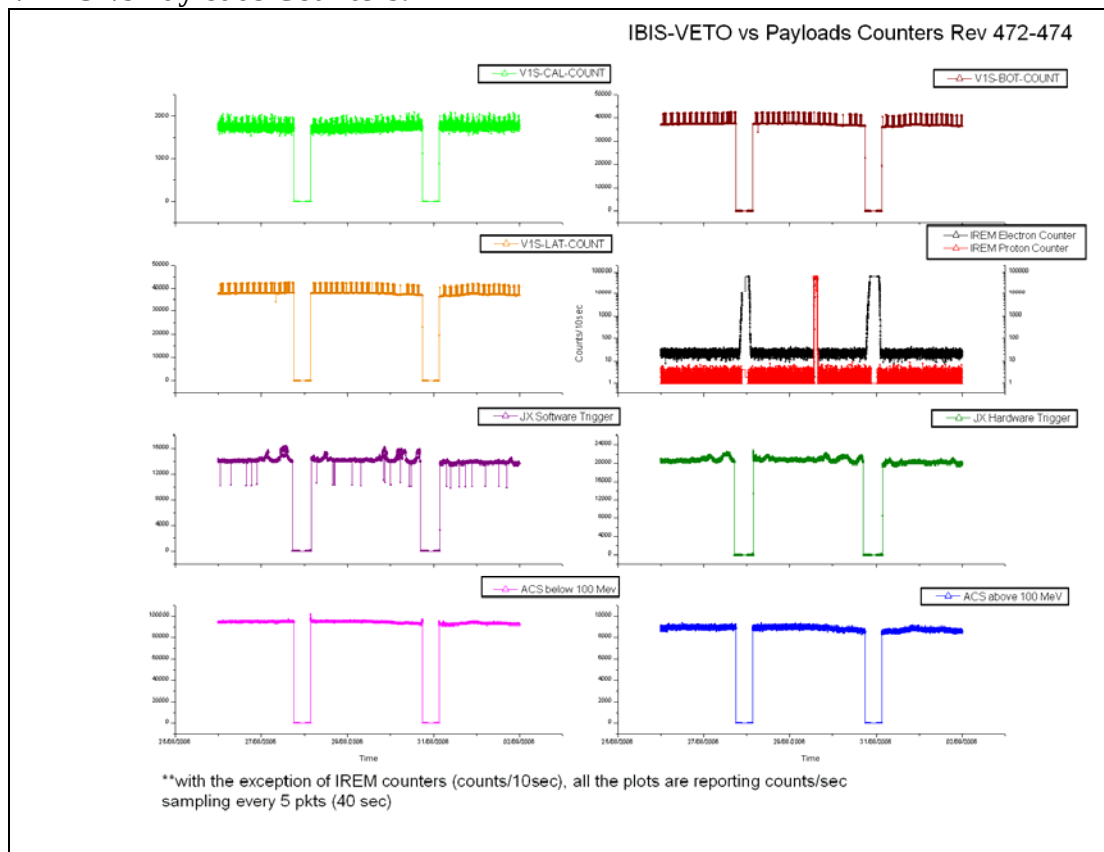
8.3.3 *IBIS Operations*

IBIS Event Counters Plots.

ISGRI Counters:

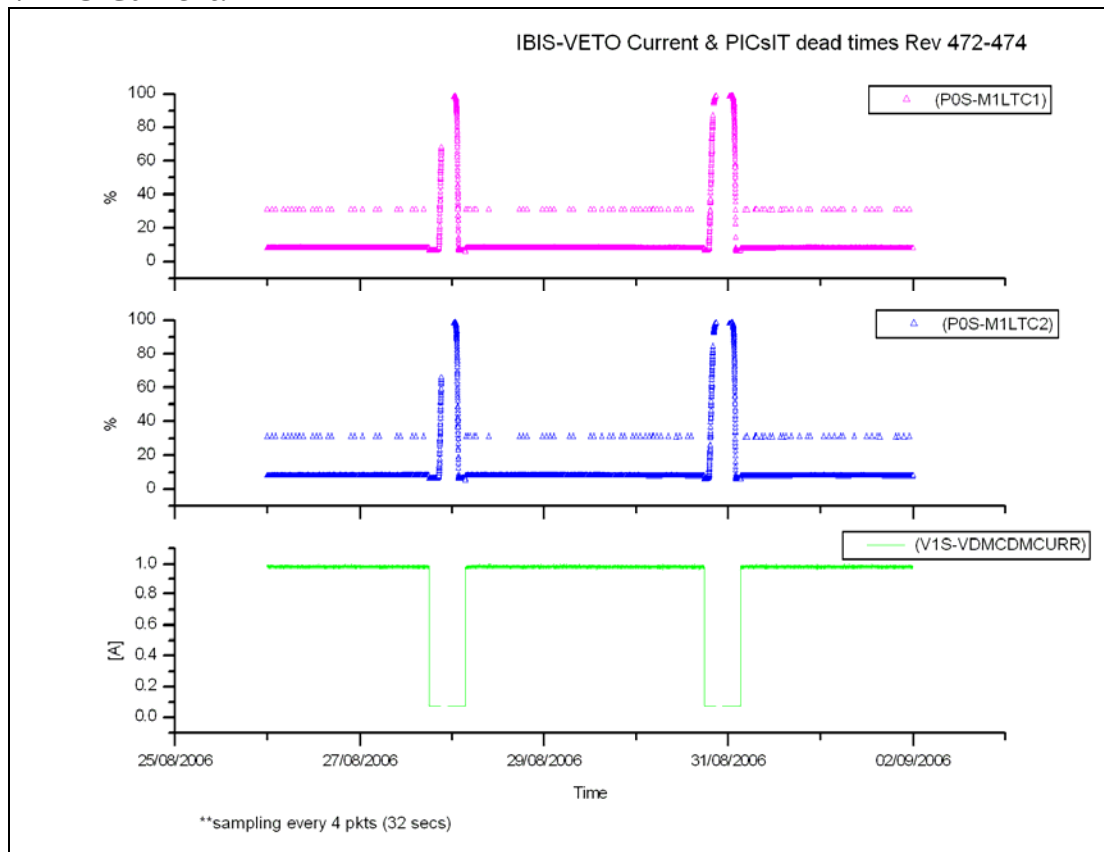


VETO vs Payloads Counters:

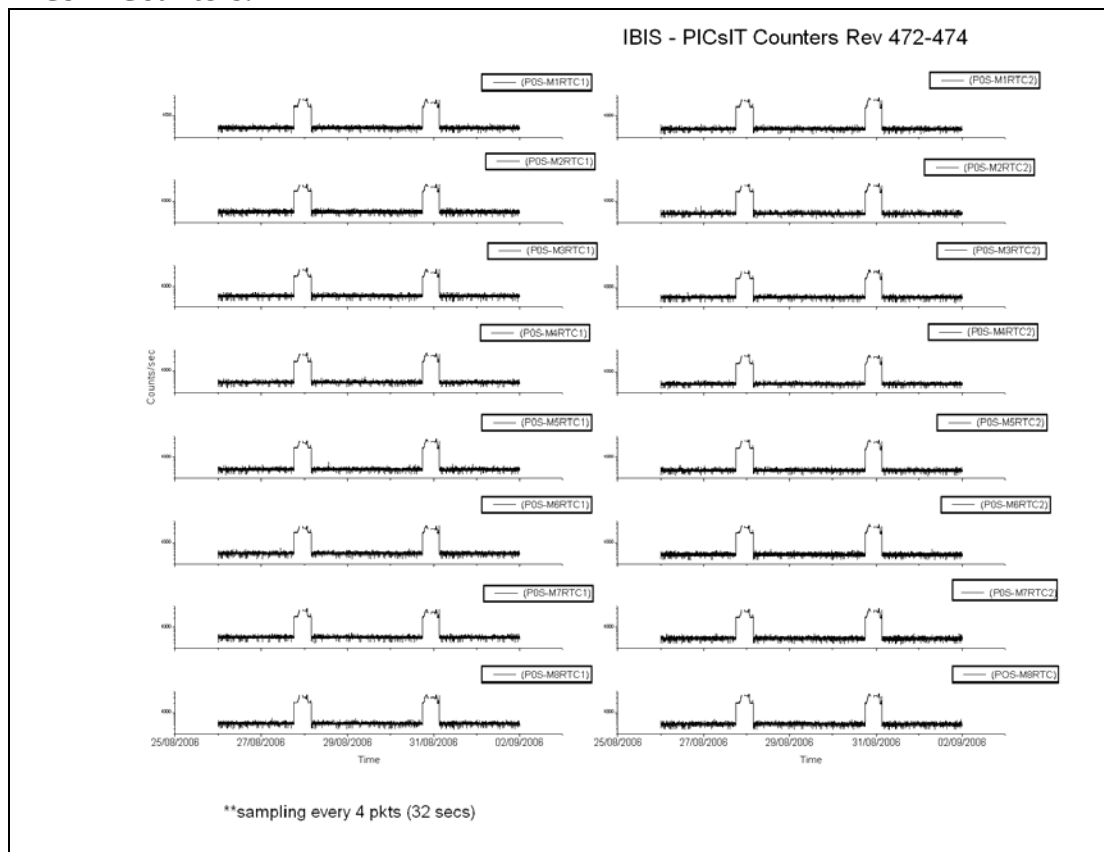


The week was characterised by low radiation.

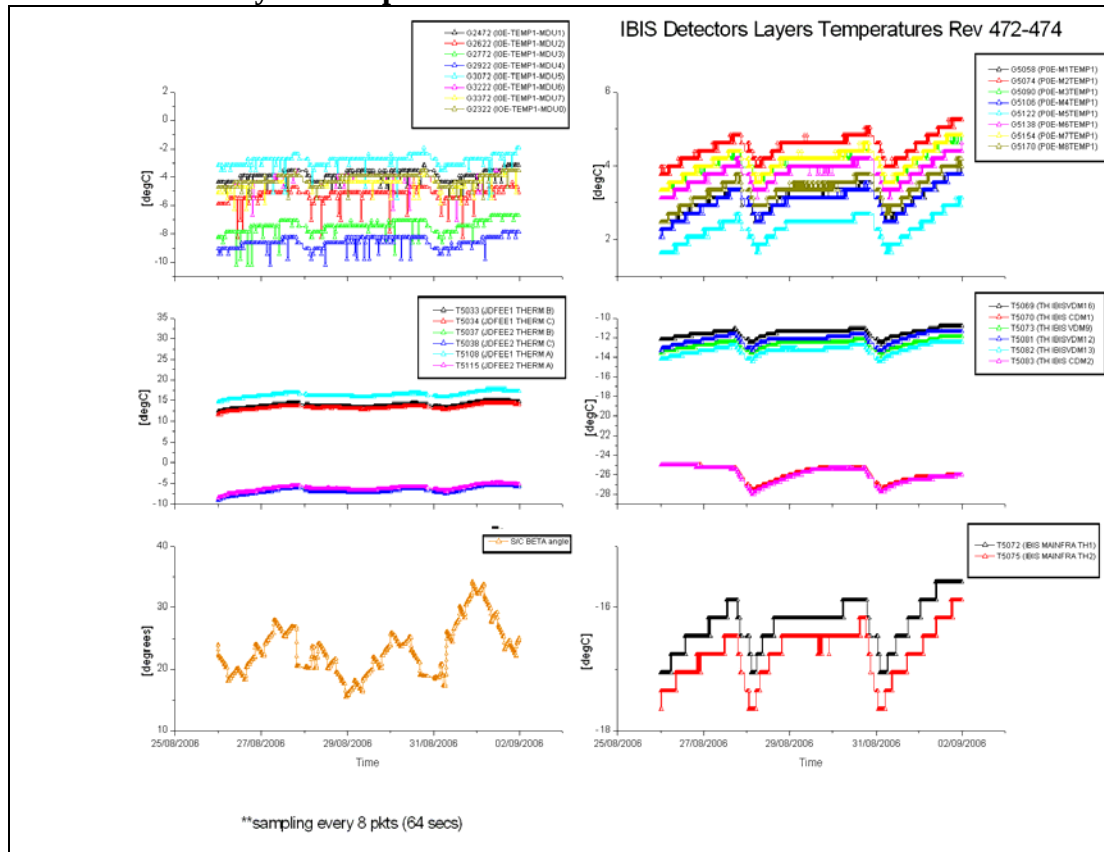
VETO Current:



PICsIT Counters:



IBIS Detectors Layers Temperatures:



IBIS daily report

DoY 239 (27/08/2006):

At 18:03Z, TM parameter G8015 (S1E-A2 PMT V) was reported Out Of Limit high. It went back inside limit on DoY 240 at 03:34Z. As this happened inside the radiation belts (following VETO Stand-By mode), according to V-VLT-1 no action was taken.

During the Belts, several TM parameters from families G5002 (P0S-Mi RTC1) and G5003 (P0S-Mi RTC2) went OOL High and back. According to P-CNT-1, no action was taken.

DoY 240 (28/08/2006):

At 03:05Z TM parameter G2084 (I0E-OVFWPXADD-M6) failed SCC and back. According to I-OVF-1, no action was taken.

DoY 242 (30/08/2006):

At 17:46Z, TM parameter G8015 (S1E-A2 PMT V) was reported Out Of Limit high. It went back inside limit on DoY 243 at 03:18Z. As this happened inside the radiation belts (following VETO Stand-By mode), according to V-VLT-1 no action was taken.

During the Belts, several TM parameters from families G5002 (P0S-Mi RTC1) and G5003 (P0S-Mi RTC2) went OOL High and back. According to P-CNT-1, no action was taken.

At 19:44Z, TM parameter G5079 (P0E-MiASICLINE) was reported OOL High. According to P-VLT-2, as this lasted only 1 cycle, no action was taken.

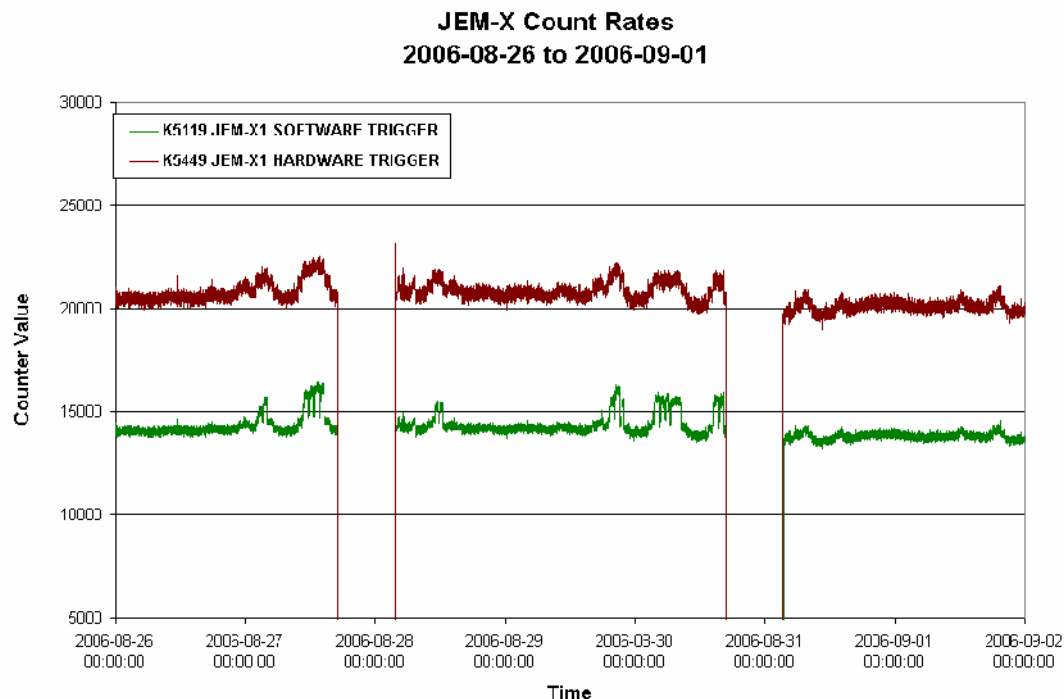
DoY 243 (31/08/2006):

At 03:02Z TM parameter G2084 (I0E-OVFWPXADD-M6) failed SCC and back. According to I-OVF-1, no action was taken.

8.3.4 JEM-X Operations

JEM-X Count Rates

JEM-X count rates over the reporting period are displayed in the following graph¹.

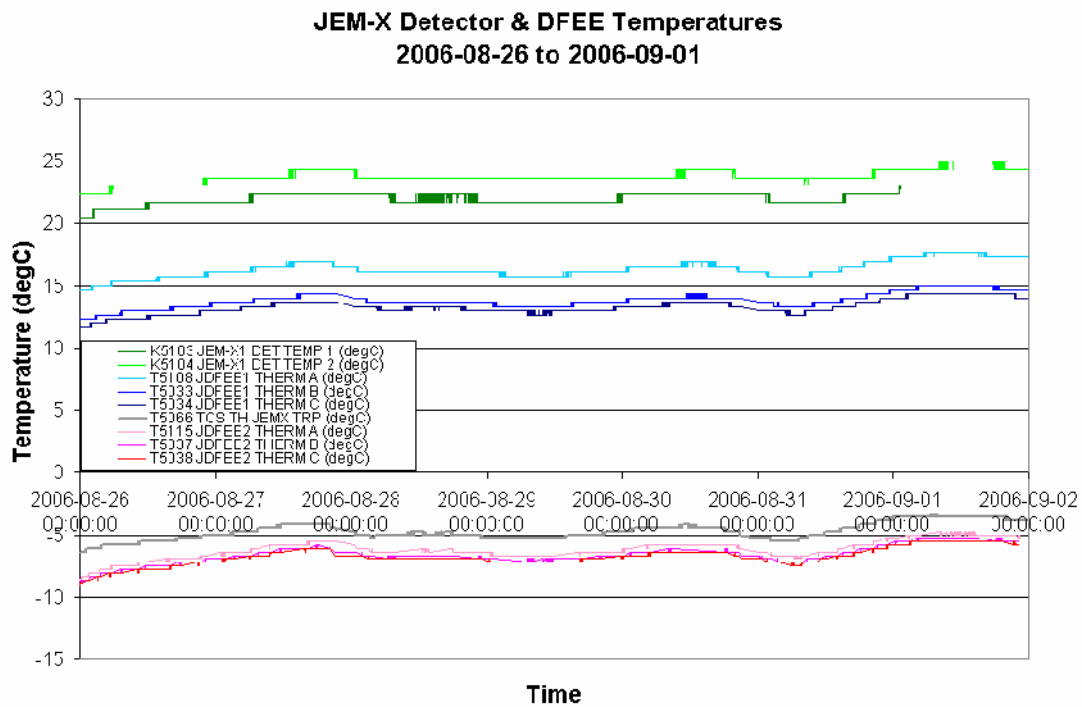


JEM-X Temperatures

JEM-X Detector and DFEE temperatures, along with the temperature on the detector bench between the two units, over the reporting period are displayed in the following graph².

¹ Data sampled (1 frame in 4) and smoothed to remove spikes in S/W Trigger due to flushing of buffer after slews.

² Data sampled (1 frame in 8)



JEM-X Daily Report

2006-08-26 (DOY 238, Rev 472) to 2006-09-01 (DOY 244, Rev 474)

Nothing to report

8.3.5 OMC Operations

2006-08-26 (DOY 238, Rev 472) to 2006-09-01 (DOY 244, Rev 474)

Nothing to report

2006-08-27 (DOY 239, Rev 472)

At 07:07, a problem with the links with DSS-24, led to the Broadcast packet commands failing to be sent. The impact was the loss of OMC pointing 04720057.

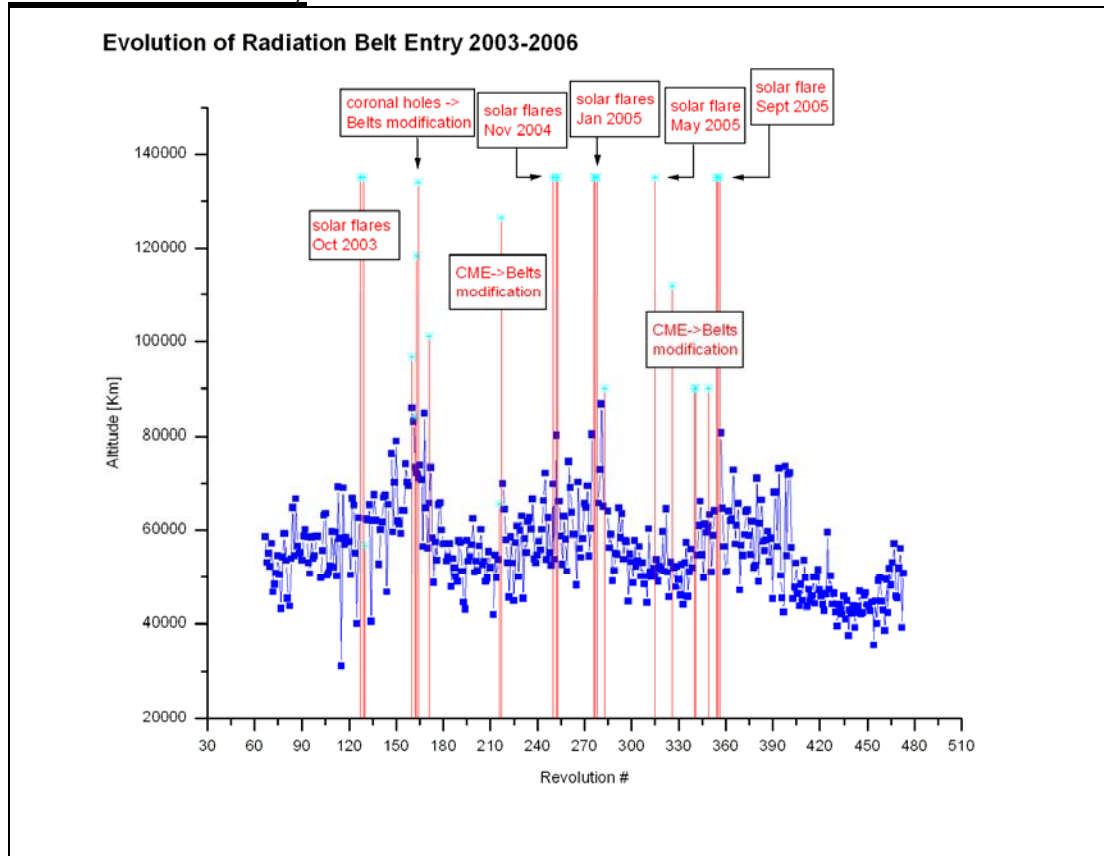
2006-08-28 (DOY 240, Rev 473) to 2006-09-01 (DOY 244, Rev 474)

Nothing to report

On DoY 239 at 18:02:57 and DoY 242 at 17:46:17 OMC was switched by the Timeline to SAFE mode, at the nominal time.

8.3.6 IREM Operations

Radiation Belts Entry



IREM daily report

DoY 2006.241 (29/08/2006, Rev 473):

The third forced IREM reset was performed to try to reduce the number of SEU affecting the unit. This activity has been run every 2 months since April. After a test period of 6 months, the efficiency of this operation will be assessed and possible extensions will be discussed.

The activity took place as follows:

1. Radiation assessment with SEIS tool
2. At 13:06Z, power OFF of IREM with FCP_RM_9000
3. At 13:11Z, power ON of IREM with FCP_RM_0010
4. At 13:15Z, patch for IREM counters rescaling factors with FCP_RM_0081.

This operation did not affect the instruments as the DRMC flag was disabled.

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]
472	RAD_ENTR R 2006-08-27T18:02:55Z	2006-08-27 20:02:23	39196.3	2006-08-27 18:59:09	48138
473	RAD_EXIT R 2006-08-28T03:21:49Z	2006-08-28 02:00:15	>>26538.3	2006-08-28 02:39:09	38872
473	RAD_ENTR R 2006-08-30T17:46:15Z	2006-08-30 18:24:47	50758.4	2006-08-30 18:35:12	49282
474	RAD_EXIT R 2006-08-31T03:05:06Z	2006-08-31 02:02:15	>>26539.1	2006-08-31 02:25:12	39184

Reference

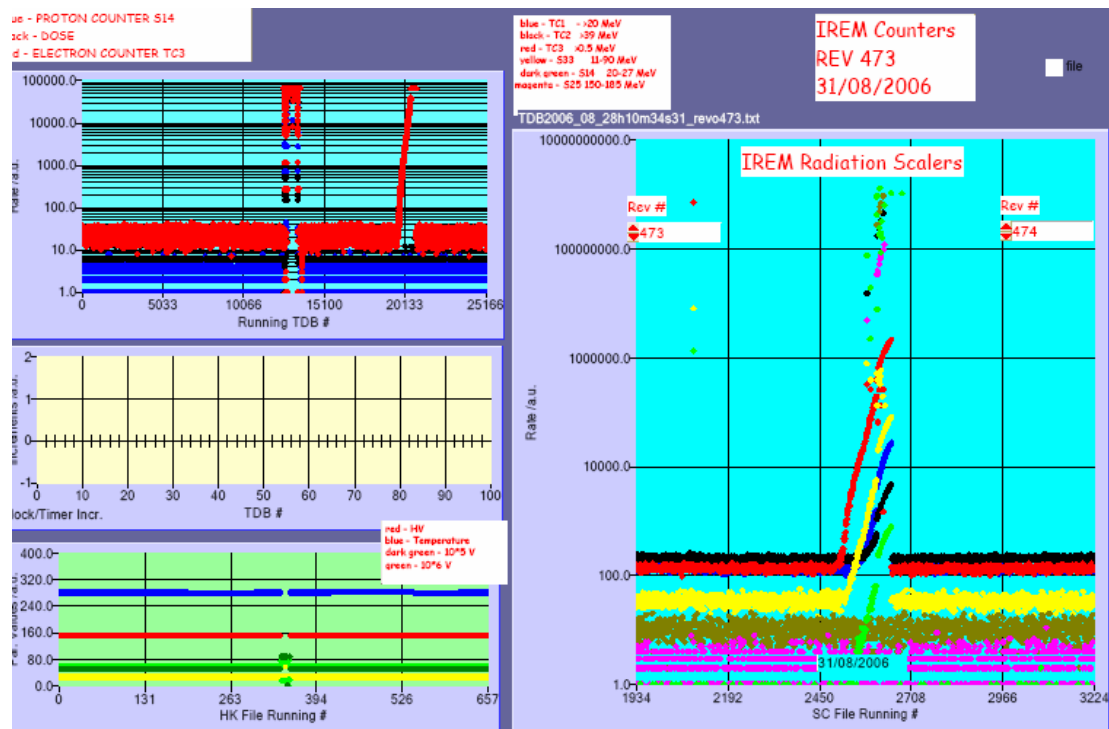
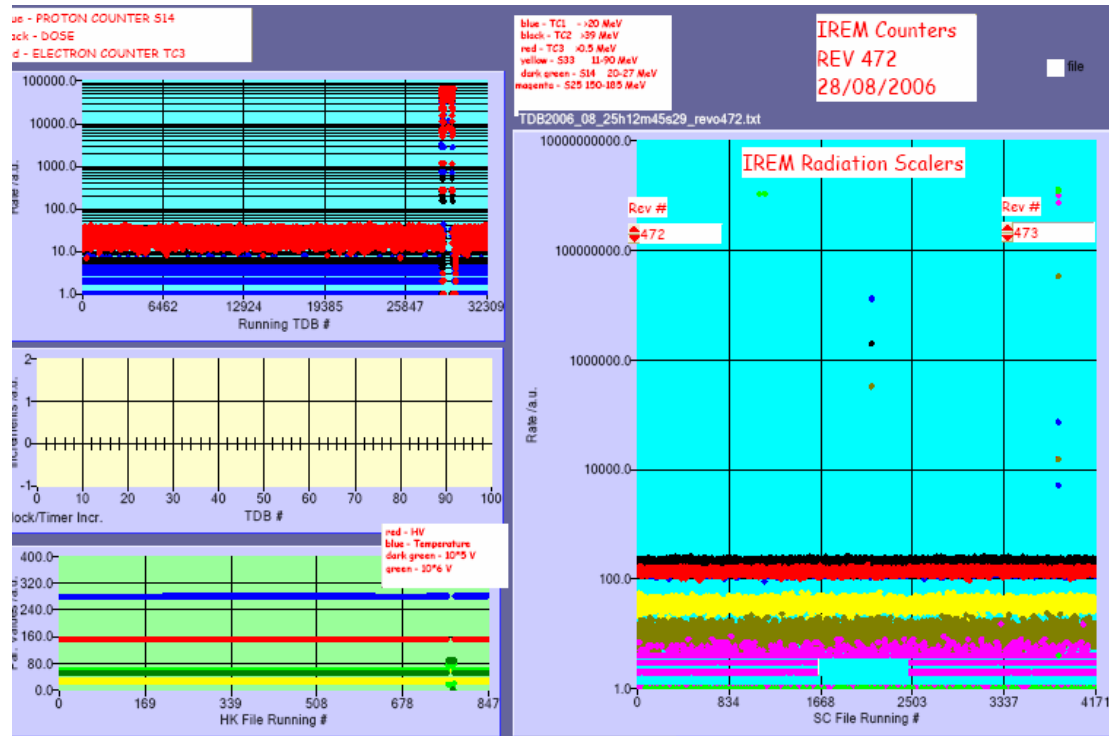
Very small error vs reference (less than 10 minutes)

Small error vs reference (between 10 and 30 minutes)

Large error vs reference (more than 30 minutes)

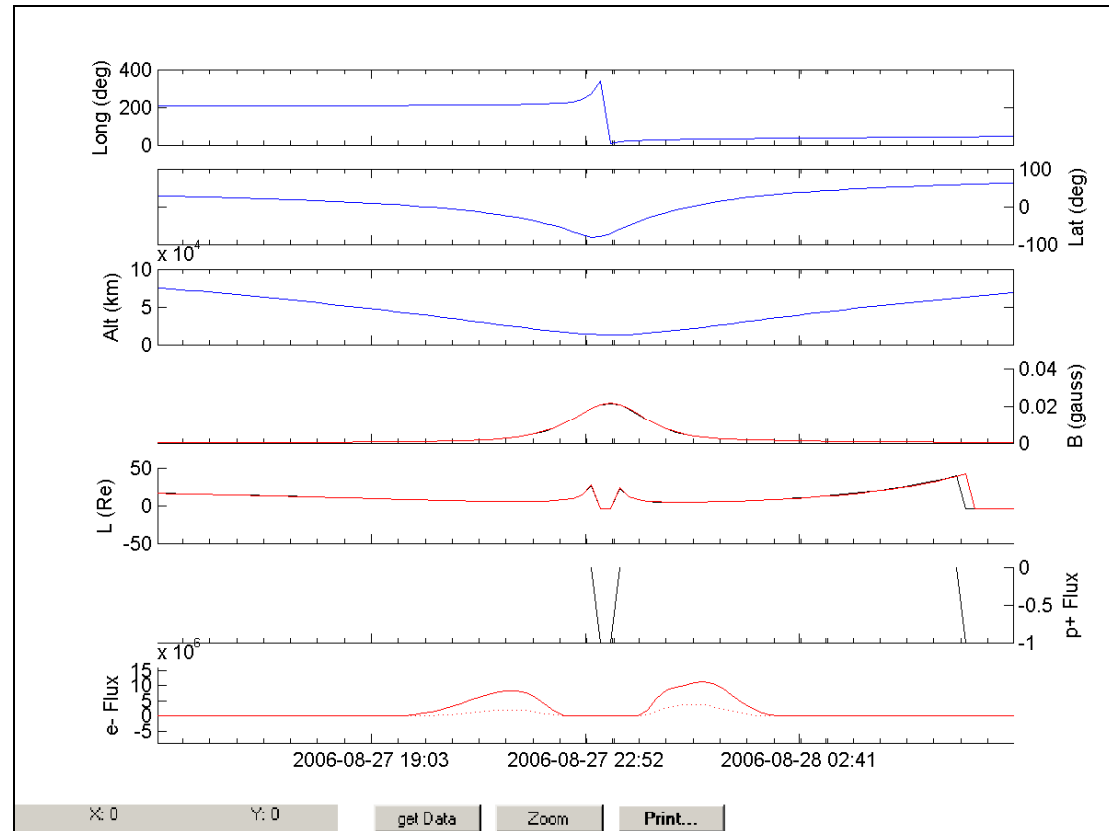
Radiation Spike

IREM radiation counters:

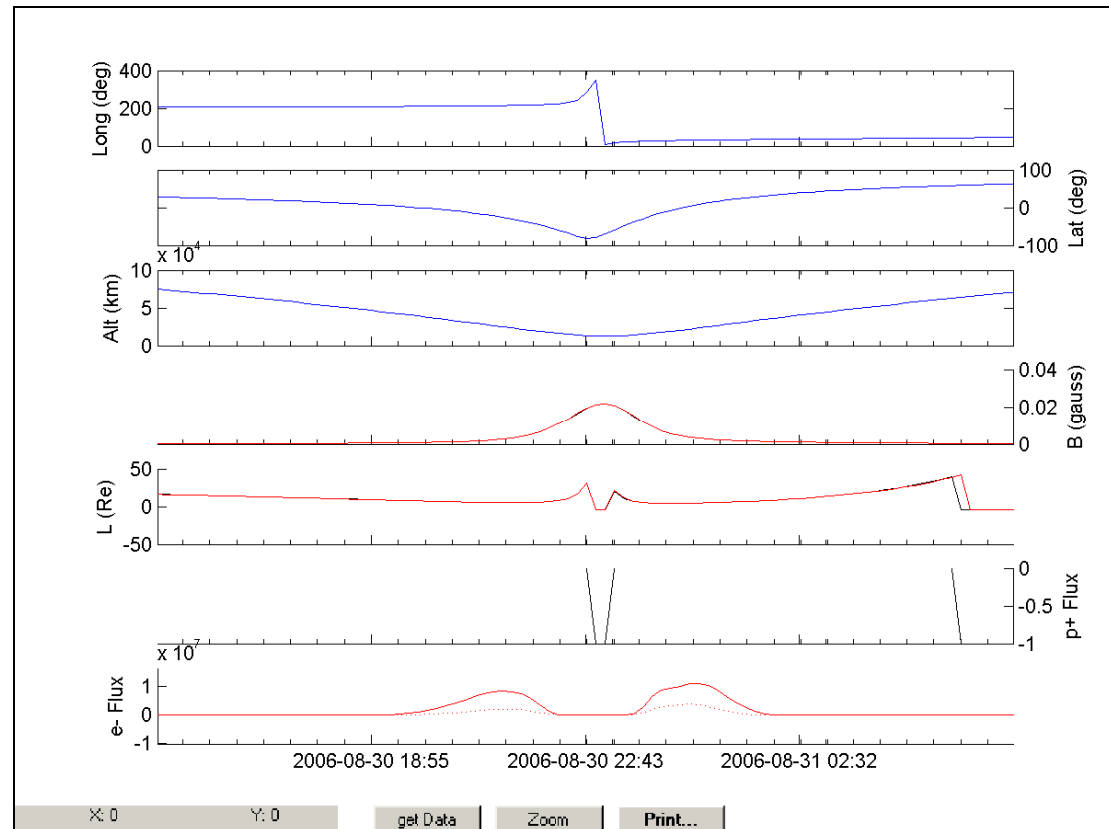


IREM Predicted Radiation Belt Passages:

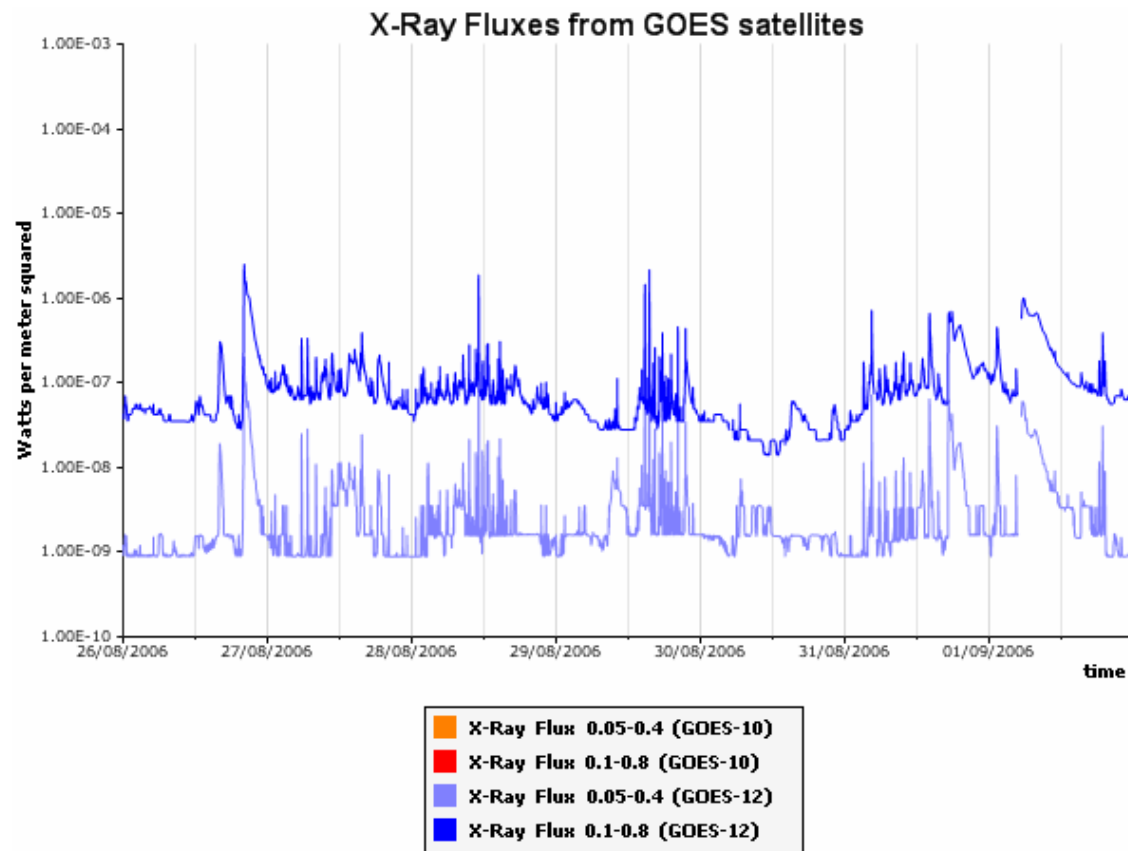
Rev 472



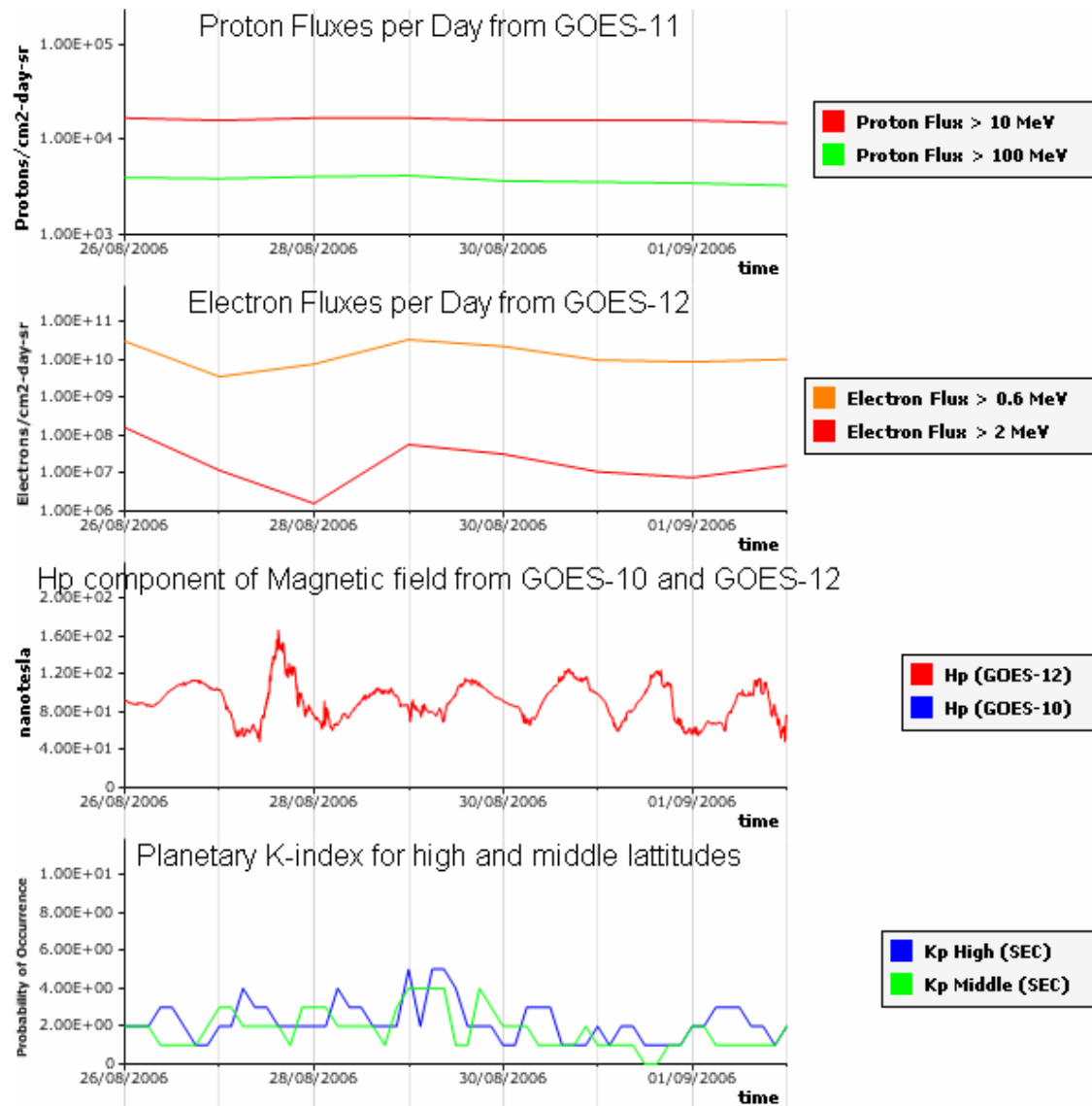
Rev 473



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.