

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OF
No. 212
Week 41
16.10.06
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 07.10.06 until 13.10.06 (both dates inclusive) and covers the revolutions 487 and 488.

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 Orion OB1 (RA 05:17:00.30, DEC +01:47:17.7), a hexagonal dither of the Galactic Bulge region (RA 17:45:36.00, DEC -28:56:00.0), a raster dither of AO-4 KP: l=-6.9 (RA 17:28:08.54, DEC -34:45:18.6) and a raster dither of the Region at l=0, b=-25 (RA 19:36:28.82, DEC -39:08:24.8).

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 during the observation period due to problems on FDS.

The fuel consumption over the period between 06/10/2006 and 13/10/2006 was 0.3242 Kg. The remaining propellant is in the order of 151.0551 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

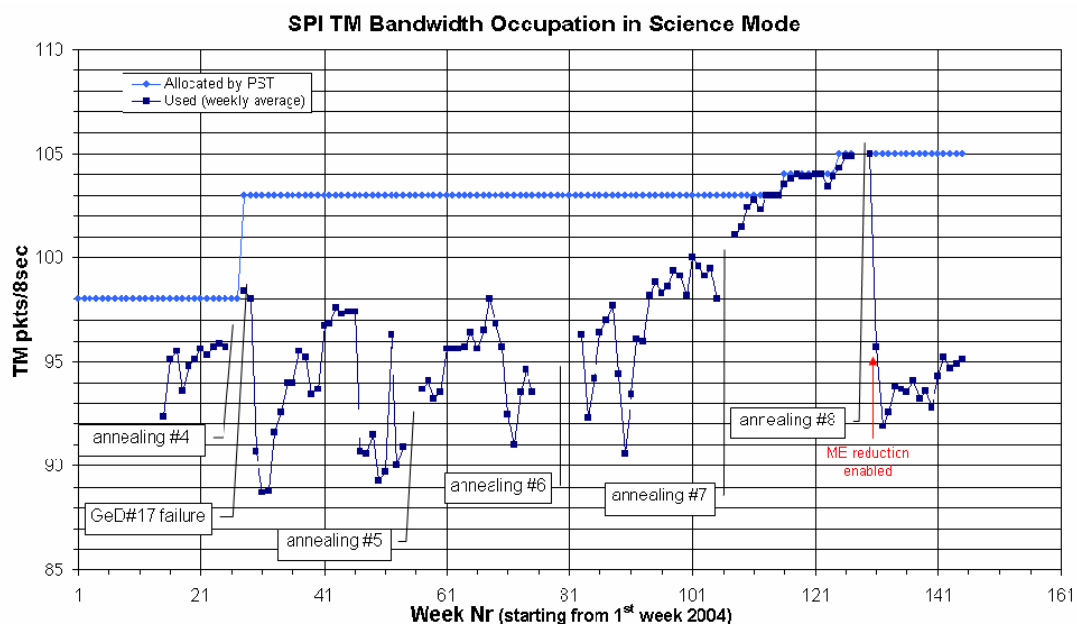
3.2.1 SPI

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 packets/cycle and the average telemetry occupation was 95.1 packets/cycle.

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



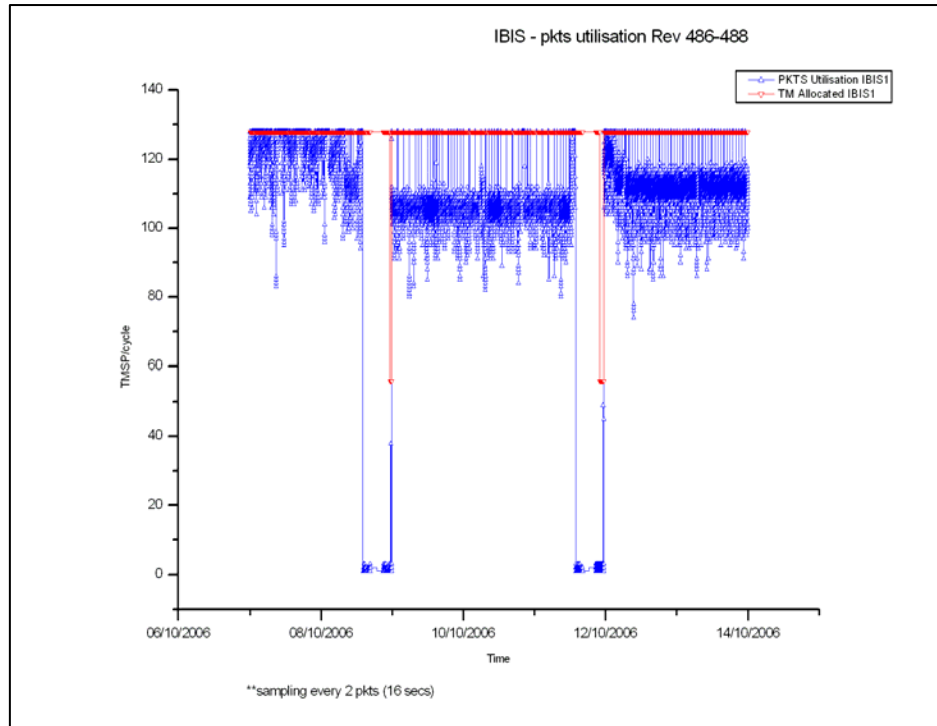
Note: Some more information concerning the SPI operations is provided in the Appendix.

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 112.18 TMPS/cycle, down 2.82 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, all 149 planned science pointings for OMC were executed nominally.

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 07/10/2006 to 09/10/2006 sunspots 913 and 914 have been dissolving. On 10/10/2006 new tiny sunspot, 916, appeared and disappeared. After that, during the remaining observation period, the sun was blank.

None of the above sunspots posed a threat of strong 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 good this week. 2 slews were lost due to FD problems. The overall performance, however, was well above the 95% requirement.

4.1 Mission Operations Centre

The performance of the MOC was good this week. The main problems reported were with the FD system failing to update the parameters of several slews. The overall performance was well above the 95% requirement.

4.2 Ground Stations & Network

The performance of the ground stations and Network was good this week. There was, however, a few data drops from Redu. There were also several occurrences of errors sending data to the isds. 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 495. Observations have been planned and files sent up to revolution 494.

TSF's up to revolution 489 have been received.

2. Observation status

No new ECS have been received this week.

3. ISOC Science Data Archive

License problems with the development environment have caused a delay in the delivery of ISDA 2.6 beta 1. This is now expected 19th October.
Integration of the IVT prototype into the ISDA is underway and expected 20th October.

4. ISOC system

ISOC software version 13.1 has been installed as planned.
A bug fix was installed as version 13.1.1 on 11 October.

5. Problems

No new problems.

4.3.2 ISDC

Status of ISDC observation processing on 16/10/2006:

- Latest Standard Analysis completed: observation 03200920004 (Galactic Center, Revolution 476) on 14/10/2006.
- Latest products archived: observation 03200920004 (Galactic Center, Revolution 476) on 16/10/2006.
- Latest observation products sent to the observer: observation 03200130003 (Mid-latitude North, Revolution 471) on 15/10/2006.

5 Special Events

6 Anomalies

The following problems that impacted operations were reported:

- On DoY 281, at 13:26Z, a FDS problem caused the update for the slew 04860064 to fail. The recovery of both slew #0064 and #0065 was performed with FD support, and the Timeline was recovered at 16:17Z.
- On DoY 284, investigations were performed as a problem with the OLF files production had been reported.

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

AR id	Date Created	Subject	Segment	Status
INT-2887	2006-10-12	CD Production not working	IMCS	Pending
INT-2886	2006-10-11	Application FRCKmain not working	IMCS	Pending
INT-2885	2006-10-09	OLF files with incomplete content	IMCS	Pending
INT_SC-160	2006-10-11	SPI Automatic Reconfiguration Anomaly at Radiation Belt Exit	Payload	Open

7 Future Milestones

The next eclipse season starts on 26/10/2006, it consists of 8 eclipses. The maximum duration will be just over one hour on 7th November.

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 487

The observations in revolution 487 consisted entirely of a raster dither of Orion OB1 (RA 05:17:00.30, DEC +01:47:17.7), lasting ~59.4 hours.

Revolution 488

The observations in revolution 488 began with a hexagonal dither of the Galactic Bulge region (RA 17:45:36.00, DEC -28:56:00.0), lasting ~3.5 hours. Subsequently, a raster dither of AO-4 KP: l=-6.9 (RA 17:28:08.54, DEC -34:45:18.6), lasting ~3.0 hours was executed. Finally a raster dither of the Region at l=0, b=-25 (RA 19:36:28.82, DEC -39:08:24.8), lasting ~52.0 hours, was performed, which lasted 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

2006-09-26T22:37:25.000Z	151.8220	F	Automatic TM processing.
2006-09-29T16:55:08.000Z	151.8096	F	Automatic TM processing.
2006-09-29T22:25:09.000Z	151.7589	F	Automatic TM processing.
2006-09-30T08:06:06.000Z	151.6764	F	Automatic TM processing.
2006-10-01T08:11:12.000Z	151.6145	F	Automatic TM processing.
2006-10-02T16:44:12.000Z	151.5518	F	Automatic TM processing.
2006-10-02T22:08:12.000Z	151.5497	F	Automatic TM processing.
2006-10-04T08:12:25.000Z	151.4539	F	Automatic TM processing.
2006-10-05T22:00:45.000Z	151.3793	F	Automatic TM processing.
2006-10-08T14:31:56.000Z	151.3692	F	Automatic TM processing.
2006-10-08T21:45:09.000Z	151.2790	F	Automatic TM processing.
2006-10-11T14:41:16.000Z	151.1619	F	Automatic TM processing.
2006-10-11T15:58:04.000Z	151.0921	F	Automatic TM processing.
2006-10-11T21:23:32.000Z	151.0713	F	Automatic TM processing.
2006-10-13T07:27:28.000Z	151.0551	F	Automatic TM processing.

This report was generated Fri Oct 13 08:00:34 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, 07/10/2006 – 13/10/2006

AOCS operations were executed from the Automatic Timeline.

During this period, 78 Open Loop Slews, 82 Closed Loop Slews and 6 Momentum Biases were executed.

Two slews (1 OSL, 1 CSL) were missed during the observation period due to problems on FDS originated by violation of the RW speeds constraint during the TPF update process.

This is equivalent to a ~1.2% of the total number of slews planned (160).

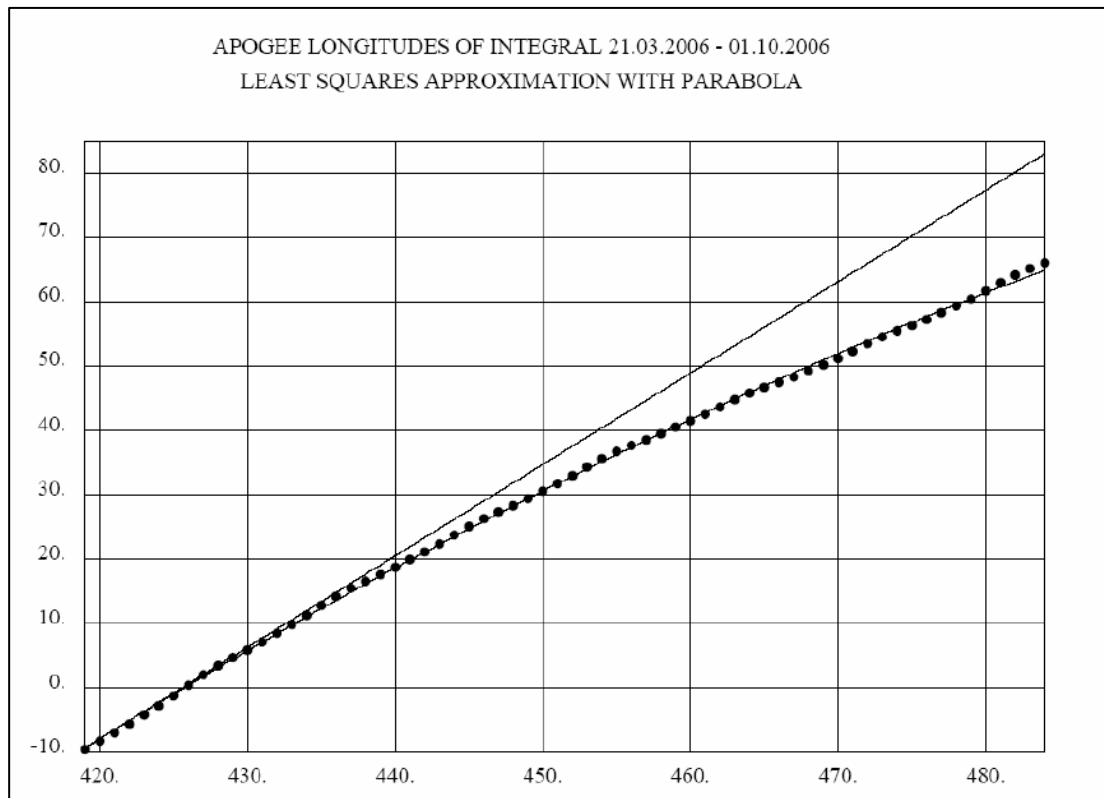
Orbit Control

It has been noticed that the orbit is evolving in an unfavourable manner since May 2006 and it might be necessary to use Goldstone again to close the Apogee gap. This situation should be avoided as it will impact science activities. It has been decided to force the orbit in a more favourable direction.

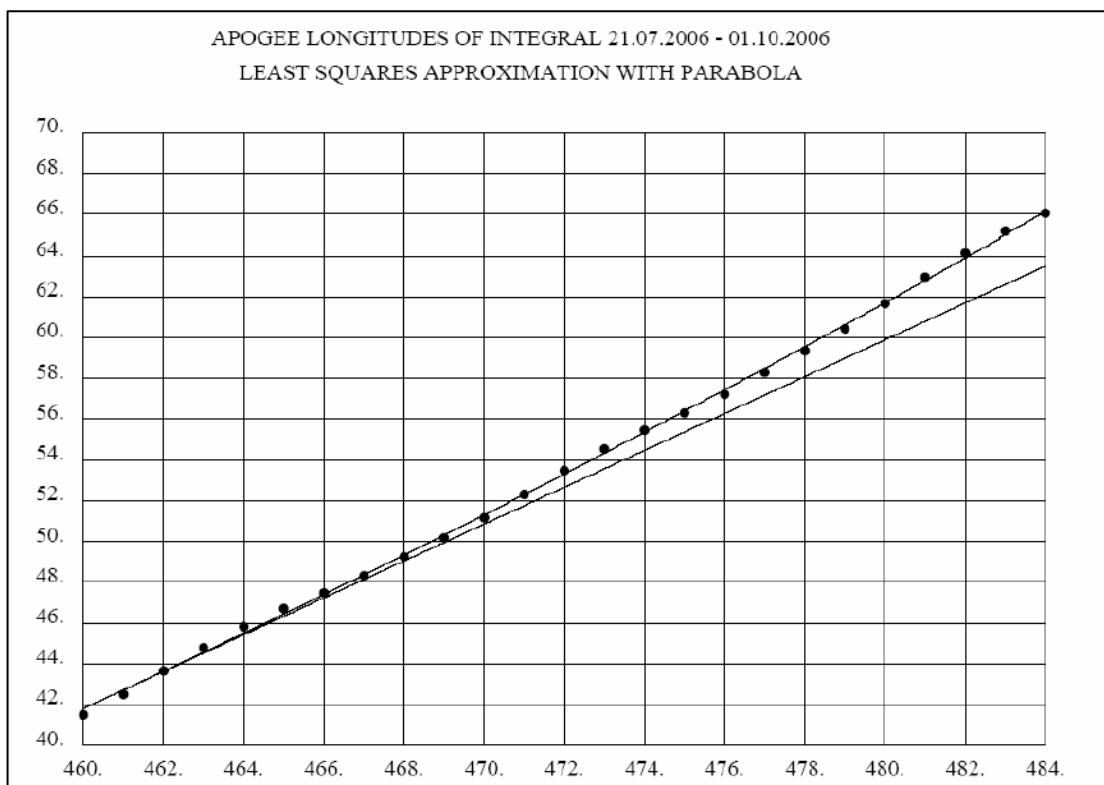
The margins of Redu coverage relative to the period with sufficient altitude to operate the instrument:

Orbit	AOS REDU - 45000 km altitude (Crit.Instr.Alt.Asc.)	56000 km altitude(Crit.Instr.Alt.Des.) - LOS REDU
463	174 minutes	119 minutes
474	165 minutes	141 minutes
484	155 minutes	157 minutes

The attached plot shows the apogee longitude of Integral as a function of the orbit number. Using a parabolic approximation, the average semi-major axis increase due to momentum dumping manoeuvres is estimated to have been 464 m per orbital revolution.



Making the same analysis for the last 2.5 month:



It can be seen that in this period the drift rate has increased slightly instead of decreasing. The reason for this is that the pointing in this period has been towards the galactic centre and this attitude is unsuitable for momentum dumping activities close to perigee. In future this situation will be corrected by:

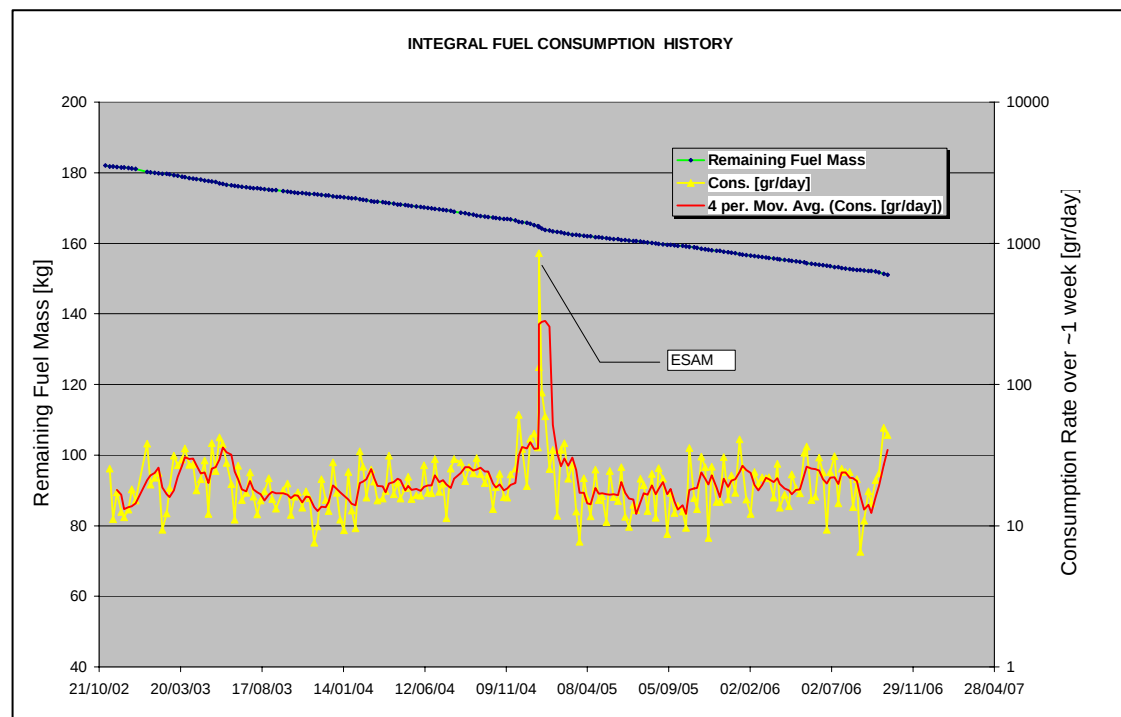
1. avoiding making momentum dumping manoeuvres close to perigee when pointing towards the "galactic centre";
2. performing artificial large momentum dump manoeuvres when the pointing is suitable for orbit control

In this way it should be possible to compensate for the lack of drift rate decrease during the last two months and achieve a REDU only situation in the future.

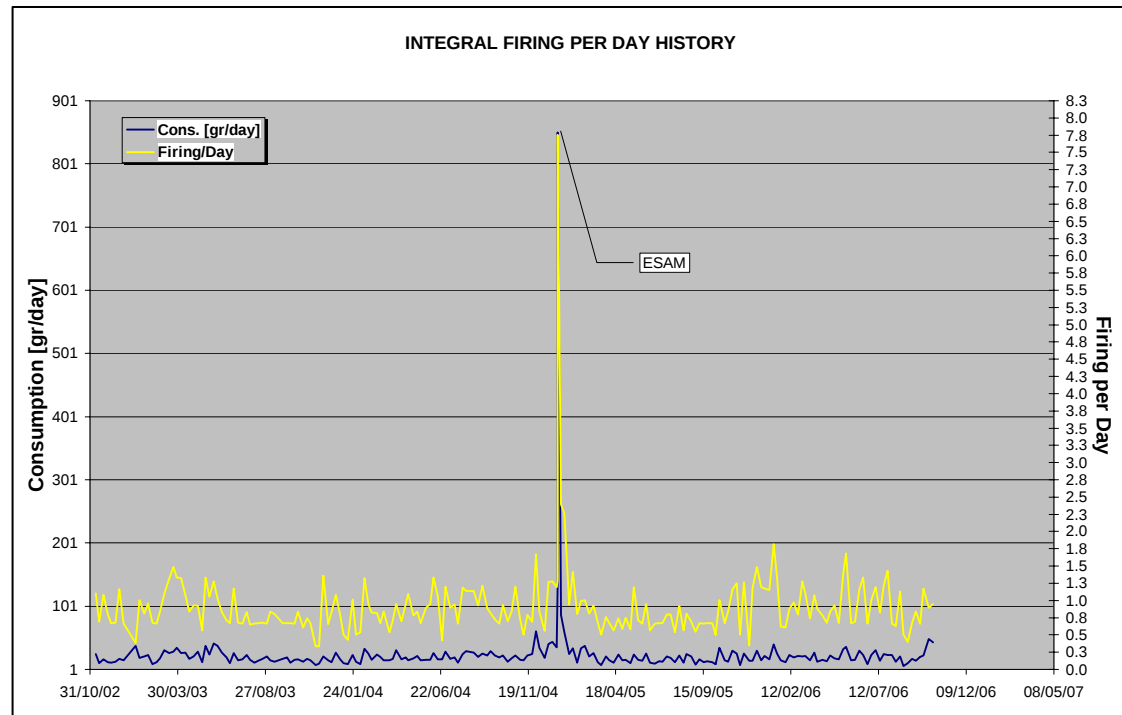
Fuel consumption

The fuel consumption (total, grams/day) over the period between 01/11/2002 and 13/10/2006 is reported in the plot below.

The large fuel consumption observed this last week is still due to the new strategy to perform artificial large momentum dump manoeuvres when the pointing is suitable for orbit control. In this way it will be possible to compensate for the lack of drift rate decrease during the last two months and achieve a REDU only situation in the future.

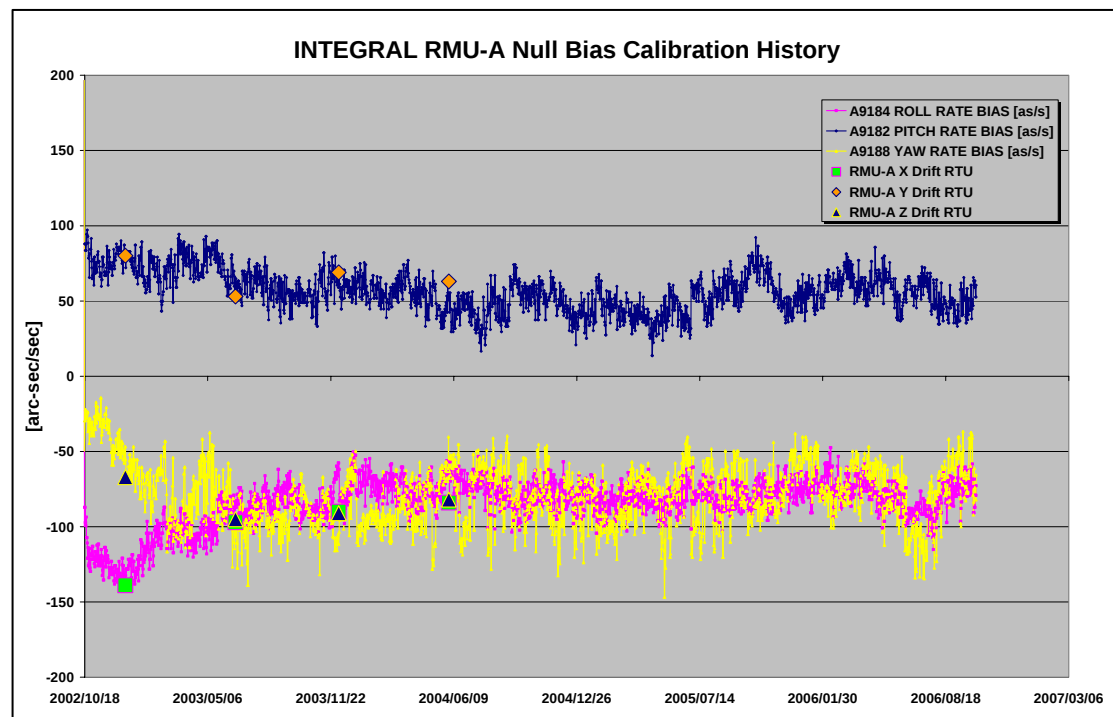


The firing\day over the period between 01/11/2002 and 13/10/2006 is reported in the plot below.

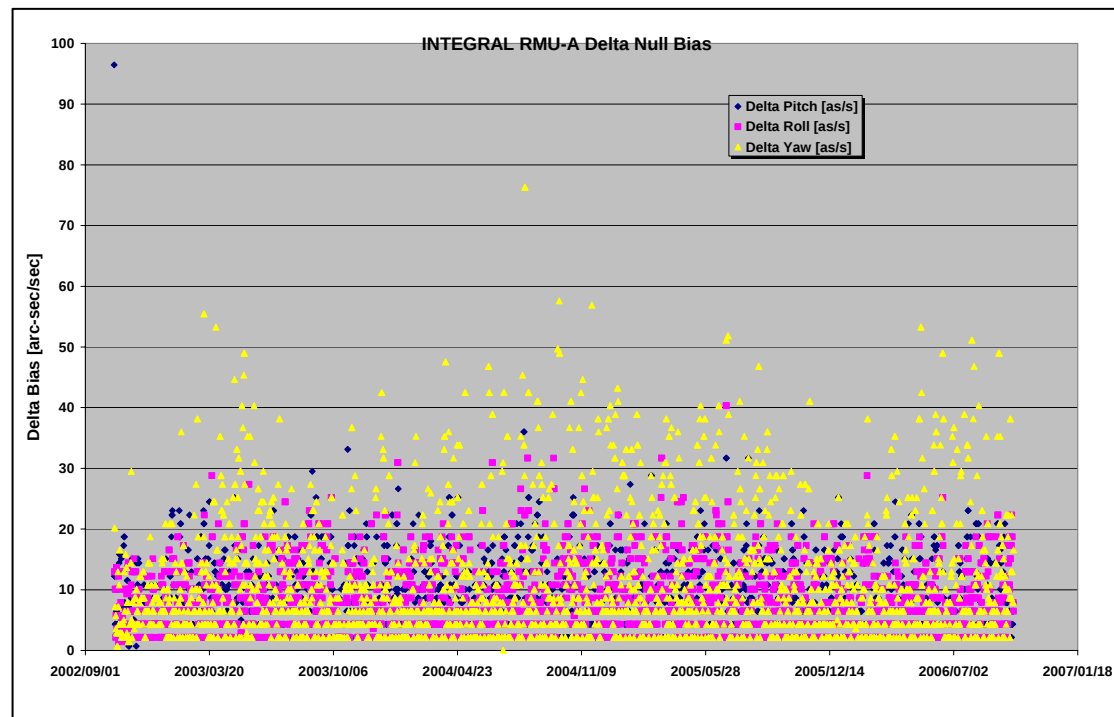


The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 06/10/2006 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 06/10/2006 is reported in the plot below:



07/10/06 (Day of Year 280, Revolution 486)

Nothing to report.

08/10/06 (Day of Year 281, Revolution 486)

ACC STR SEU threshold exceeded: at 01:55z the STR SEU filter threshold was exceeded due to false event and the IMU was switched ON by the ACC.

The guide star at moment of the false event was Mi 8.0 at CCD location [-7124 , 6323]. A new guide star was picked after the mapping commanded by the ACC autonomously. The AOCS s/s was disabled in TL at 01:57z.

A manual recovery was then started at 02:05z and the next slew in TL (04860051) manually updated at 02:14z. The AOCS s/s was enabled in TL at 02:17z.

No impact on TL, except the OTF not reached for PID 04860050.

FDS failed update slew due to wheels speed constraints violation: at 13:26z the update of slew ID 04860064 failed, at the end of revolution, as it happened already during rev 485 (see relevant AR).

FDS reported an error during the update process invoking a wheel constraint violation during the generation of the TPF for the next OSL: an additional RWB was requested by FDS in order to continue with the planning.

The AOCS s/s was disabled from TL, FD support called in and a manual recovery was performed as follows:

- at 14:26z a manual RWB was performed to recover the wheel speed constraints violation;
- at 14:54z a manual OSL was performed from the attitude 04860063 to the attitude of PID 04860064;
- at 15:58z a manual CSL was performed from the attitude 04860064 to the attitude of PID 04860065;

No further corrective change of guide star was requested.

The following slews were missed: 04860064(OSL)-65(CSL).

09/10/06 (Day of Year 282, Revolution 486-487)

Nothing to report.

10/10/06 (Day of Year 283, Revolution 487)

STR lost of guide star: at 19:56z due to lost of guide star the IMU was switched ON by the ACC, during the execution of PID 04870045.

The guide star at moment of the false event was Mi 8.45 at CCD location [14050 , 22024]. A new guide star was picked after the mapping commanded by the ACC autonomously.

A manual recovery was then started at 20:20z and the next slew in TL (04870046) manually updated at 20:27z.

No impact on TL, except the OTF not reached for PID 04870045.

11/10/06 (Day of Year 284, Revolution 487)

Nothing to report.

12/10/06 (Day of Year 285, Revolution 487-488)

Nothing to report.

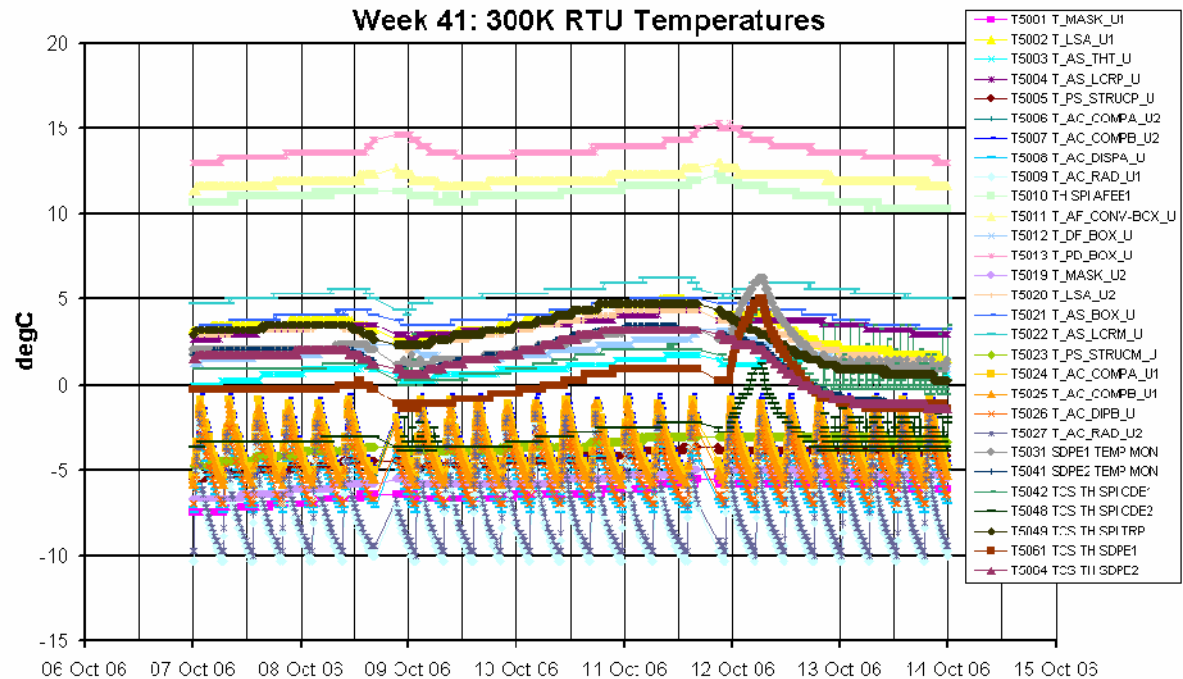
13/10/06 (Day of Year 286, Revolution 488)

Nothing to report.

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8.3.2 SPI Operations

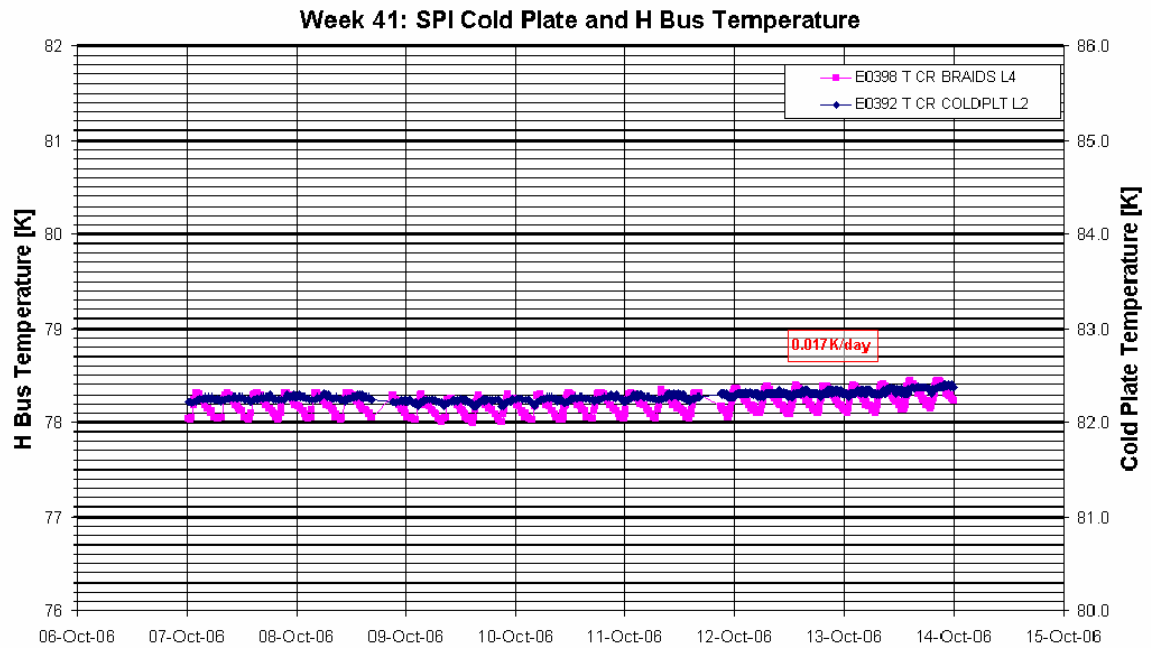
Unit Temperatures: All the equipment temperatures are inside the operational limits. The following plot shows their evolution during the reporting period:



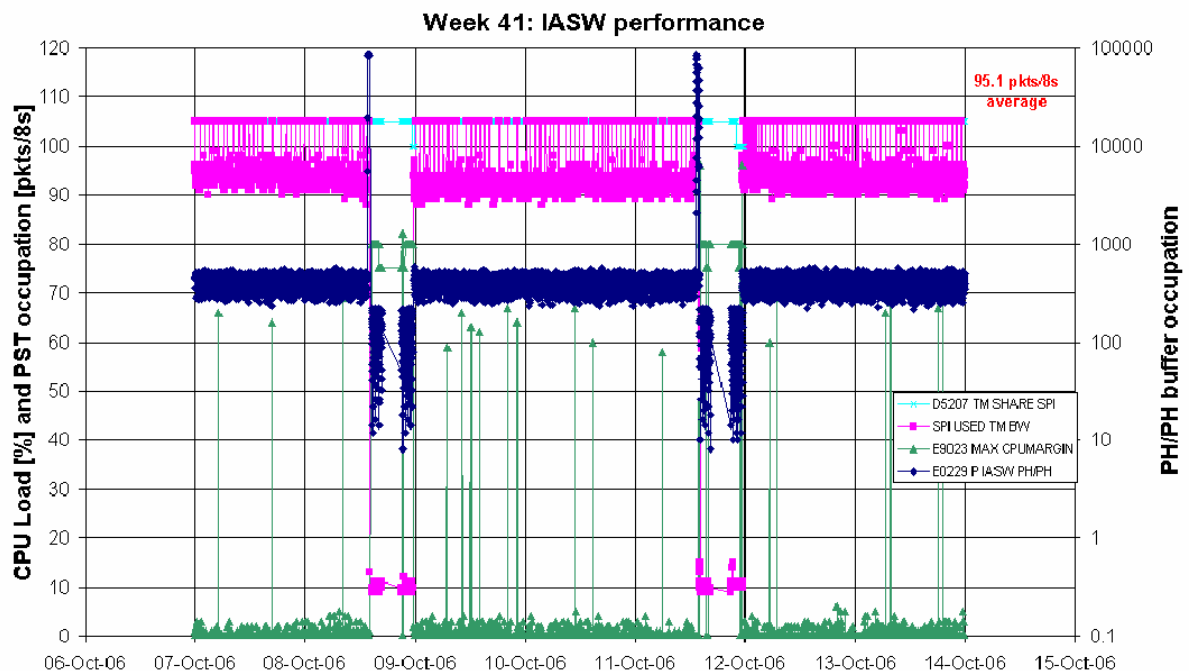
Stirling Compressors and Cryostat: The performance of the compressors is nominal. The cold plate temperature was maintained in the range to 82K +/-1K with a positive drift of 0.017deg/day. The stroke of all four compressors is currently set to 39. The average LCL currents of the CDEs over the week were:

- Average CDE1 LCL Current = 4.57A
- Average CDE2 LCL Current = 4.35A

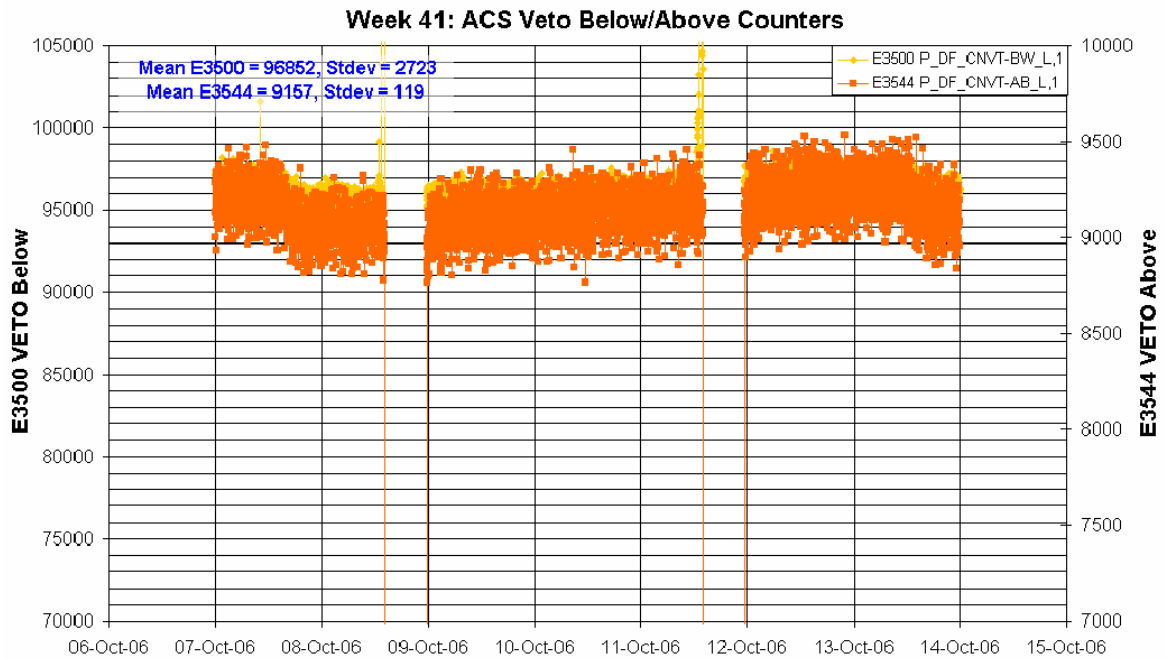
The following plot shows the evolution of the cold plate and H bus temperatures during the reporting period.



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 95.1 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.

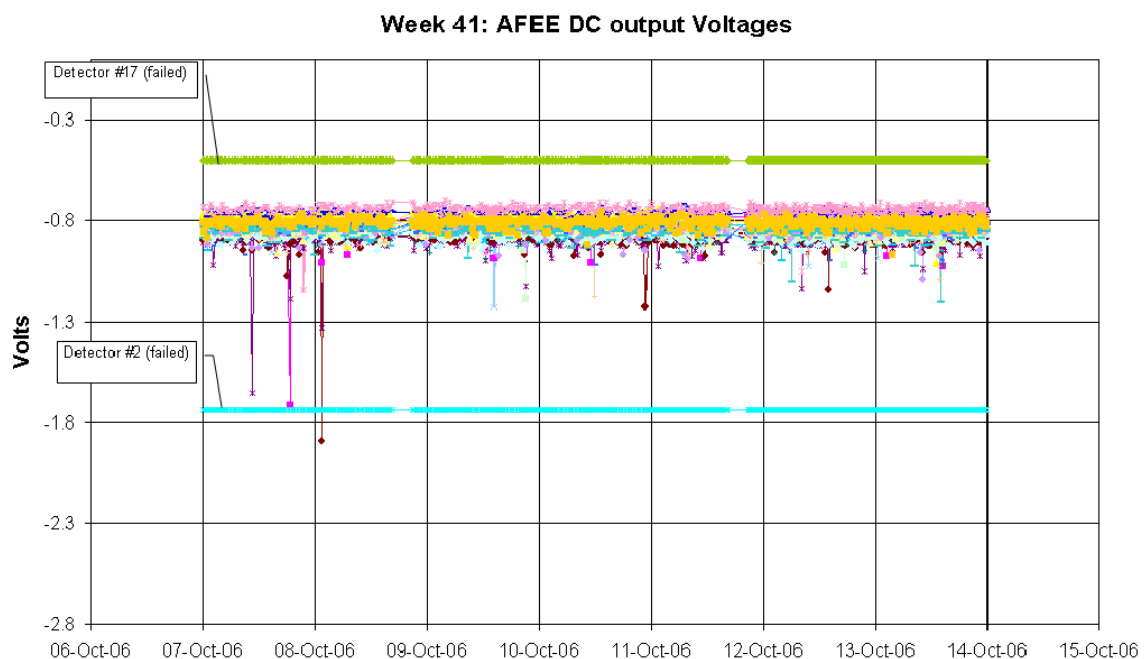


ACS: The performance of the ACS is nominal. The following plot shows the ACS overall count rate evolution during the reporting period:

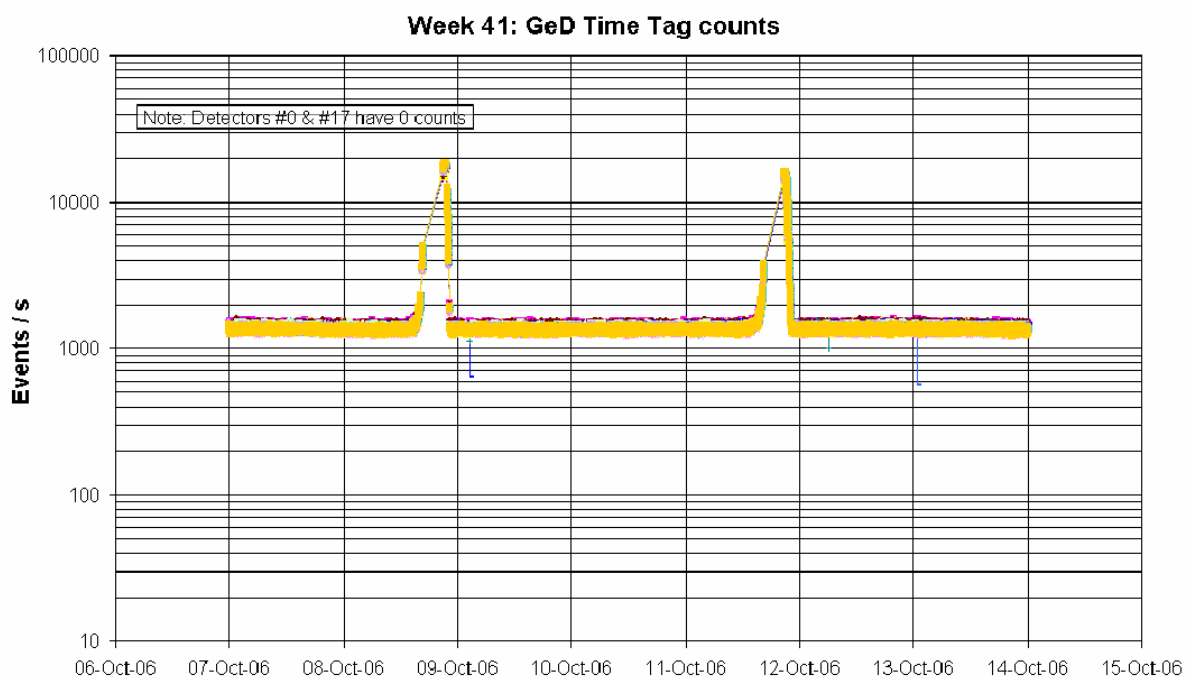
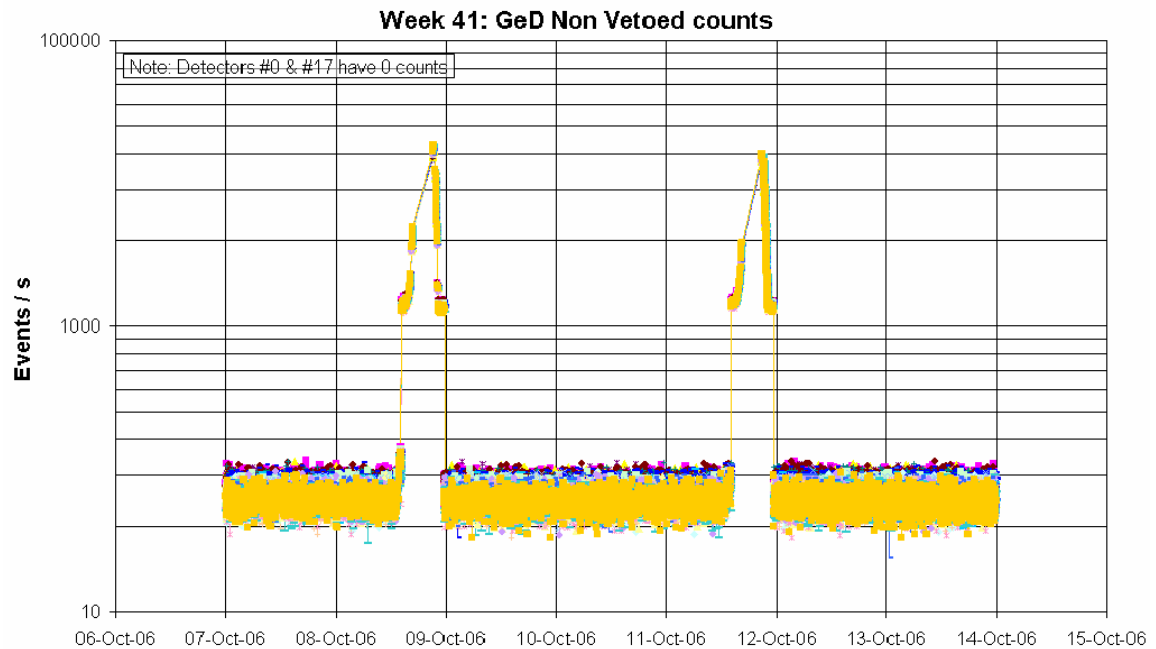


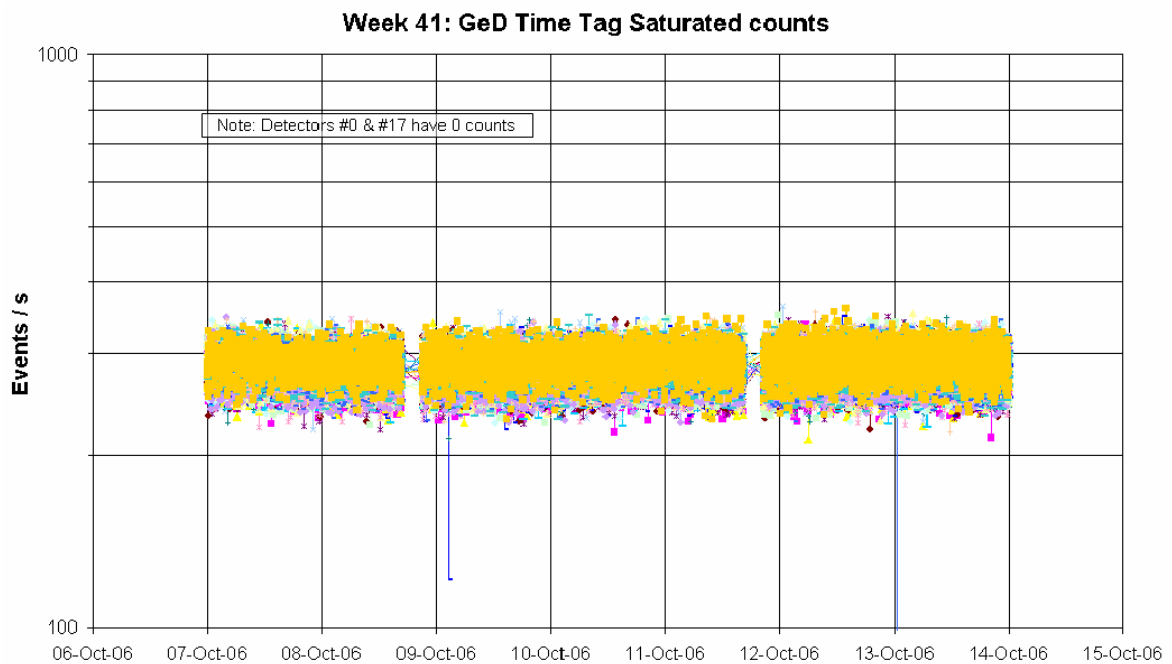
AFEE: The health of the AFEE is nominal. The performance of the AFEE and the detectors is nominal, except for the Ge detectors #4 and #12 which are showing a slightly degraded energy resolution. The energy resolution of GeD#15 was recovered with the last annealing.

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

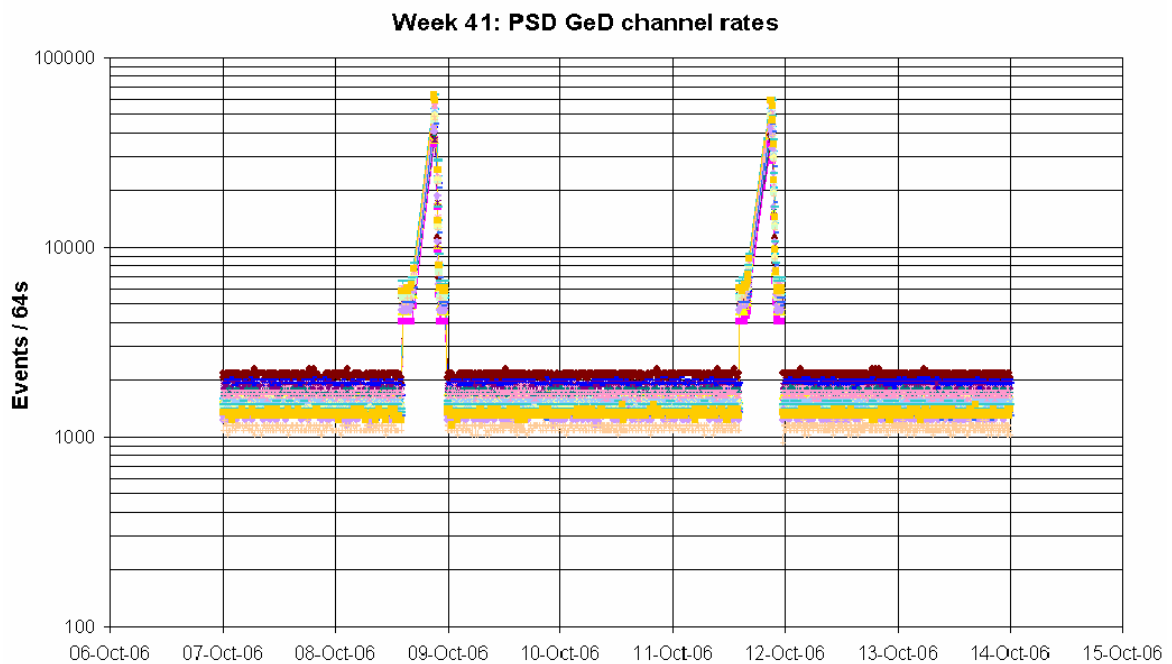


DFEE: The performance of the unit is nominal. The following plots show the Non Vetoes, Time Tag and Time Tag Saturated Event Count Rates during the reporting period.





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 OEM were received from SPI during the reporting period:

- On 2006-10-08 at 13:31Z the TM parameter E3500 P_DF_CNVT-BW_L went OOL High (value = 111381). This was ~45 minutes before radiation belt entry

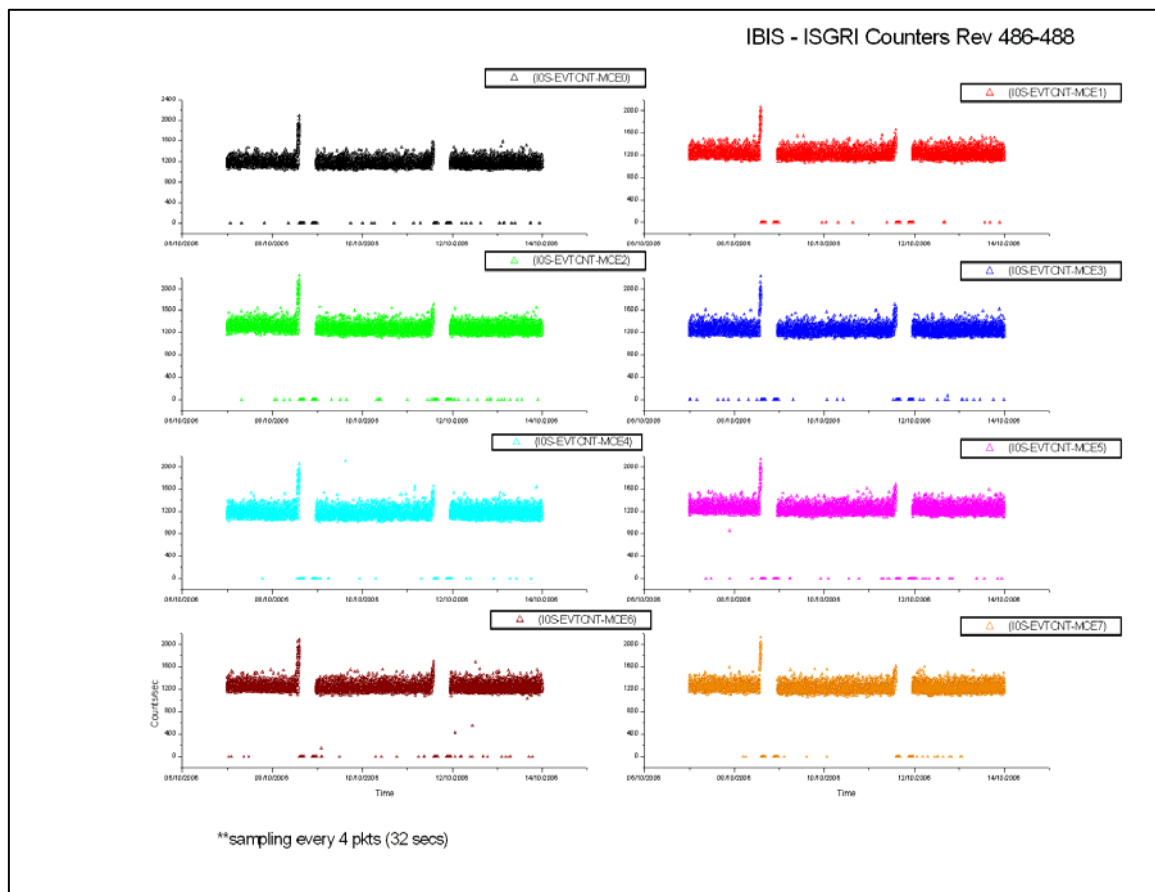
of revolution 486 and therefore no action was taken. This parameter remained OOL until radiation belt entry.

- On 2006-10-08 at 16:26:44Z APID 1024 ID 1 EXCEPTION SPI1 FIXED POINT OVERFLOW was received. This was during the LOS_CHK window of revolution 486, when the SPI1 DPE time verification TC was sent. This OEM is sometimes received when this TC is sent and no action was taken.
- On 2006-10-11 at 13:05Z the TM parameter E3500 P_DF_CNVT-BW_L went OOL High (value = 105912). This was ~1 hour before radiation belt entry of revolution 487 and therefore no action was taken. This parameter toggled in and out of limits until radiation belt entry.
- TM parameter E2116 T AS PSAC L2 (Plastic Scintillator temperature) went OOL Low several times during the week. No action was taken as this is a known and recurring problem due to this thermistor being unreliable.

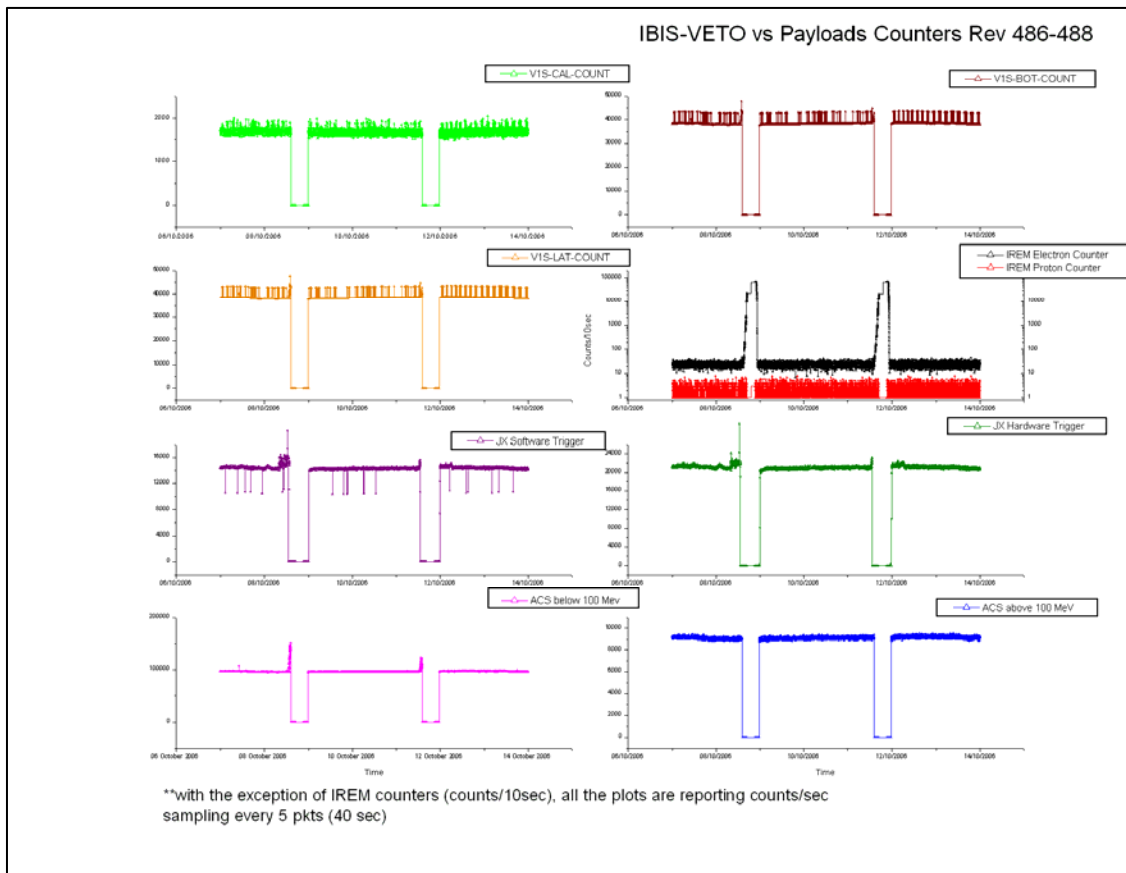
8.3.3 IBIS Operations

IBIS Event Counters Plots.

ISGRI Counters:

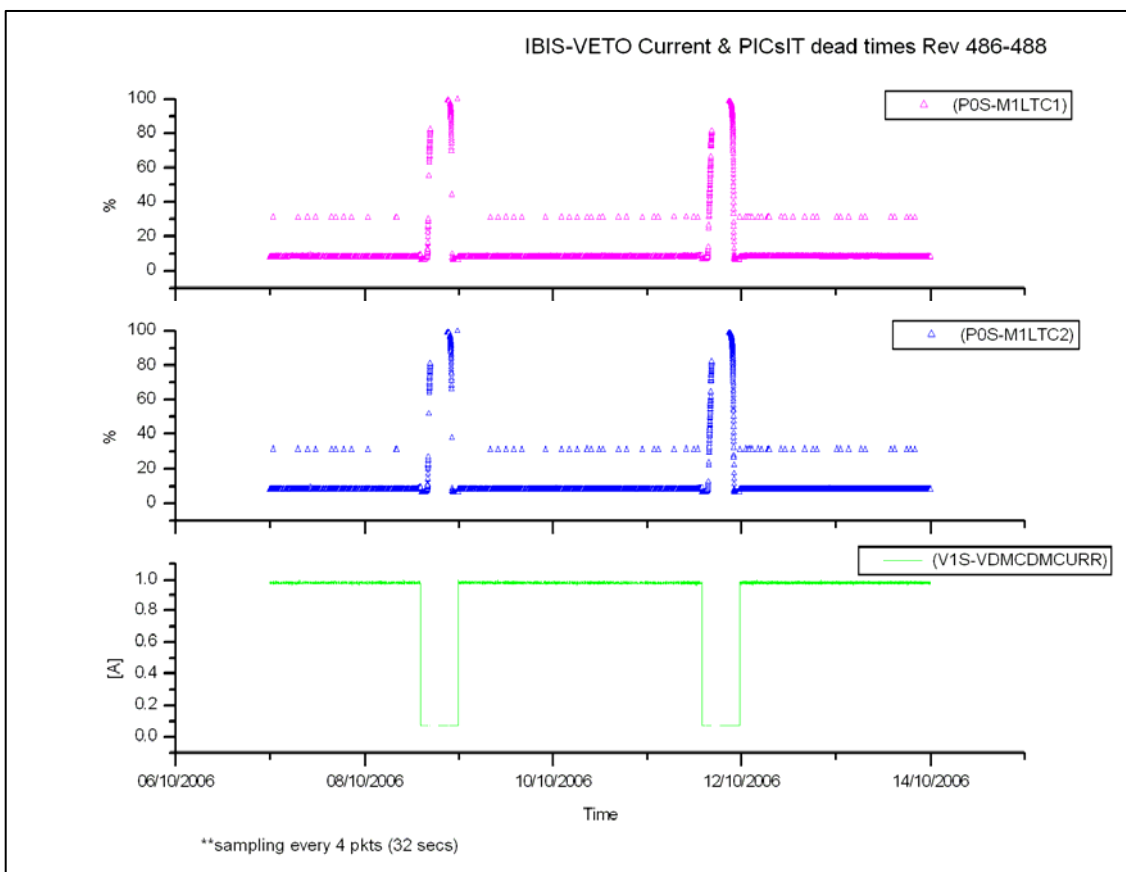


VETO vs Payloads Counters:

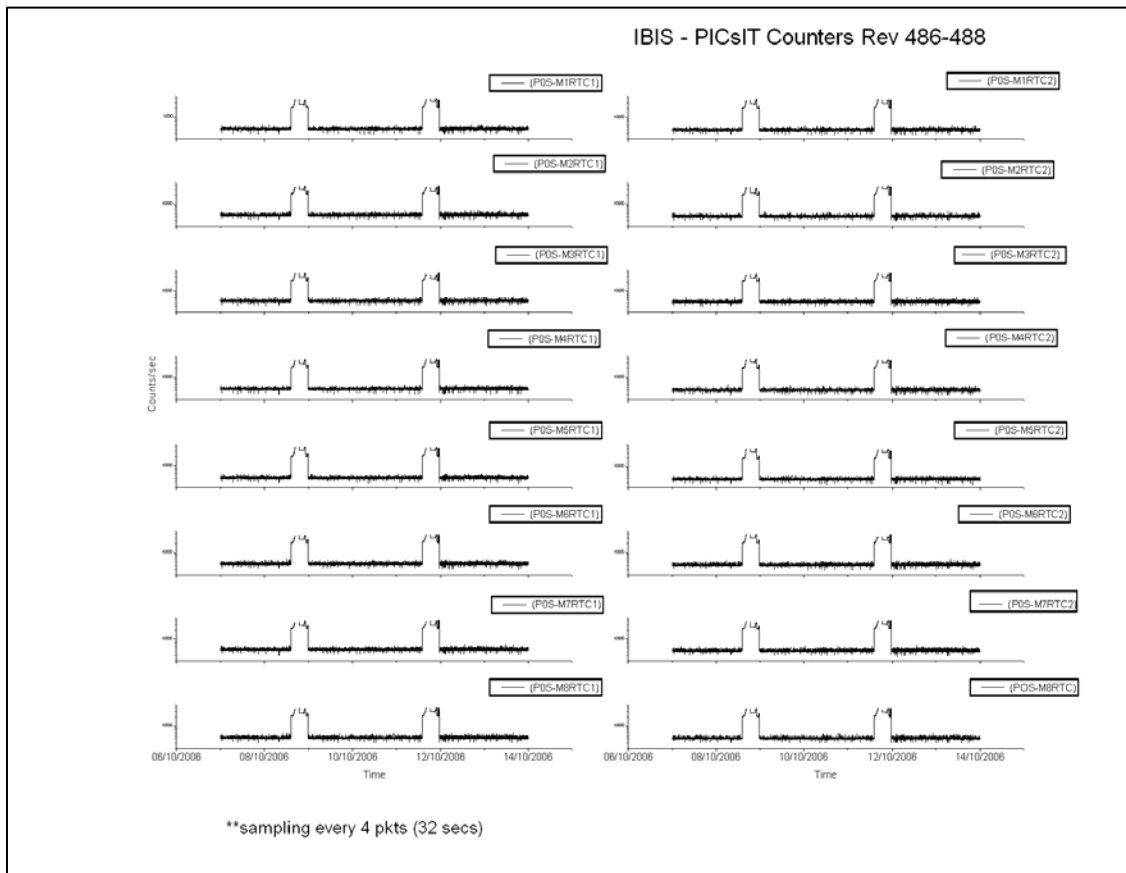


The week was characterised by low radiation.

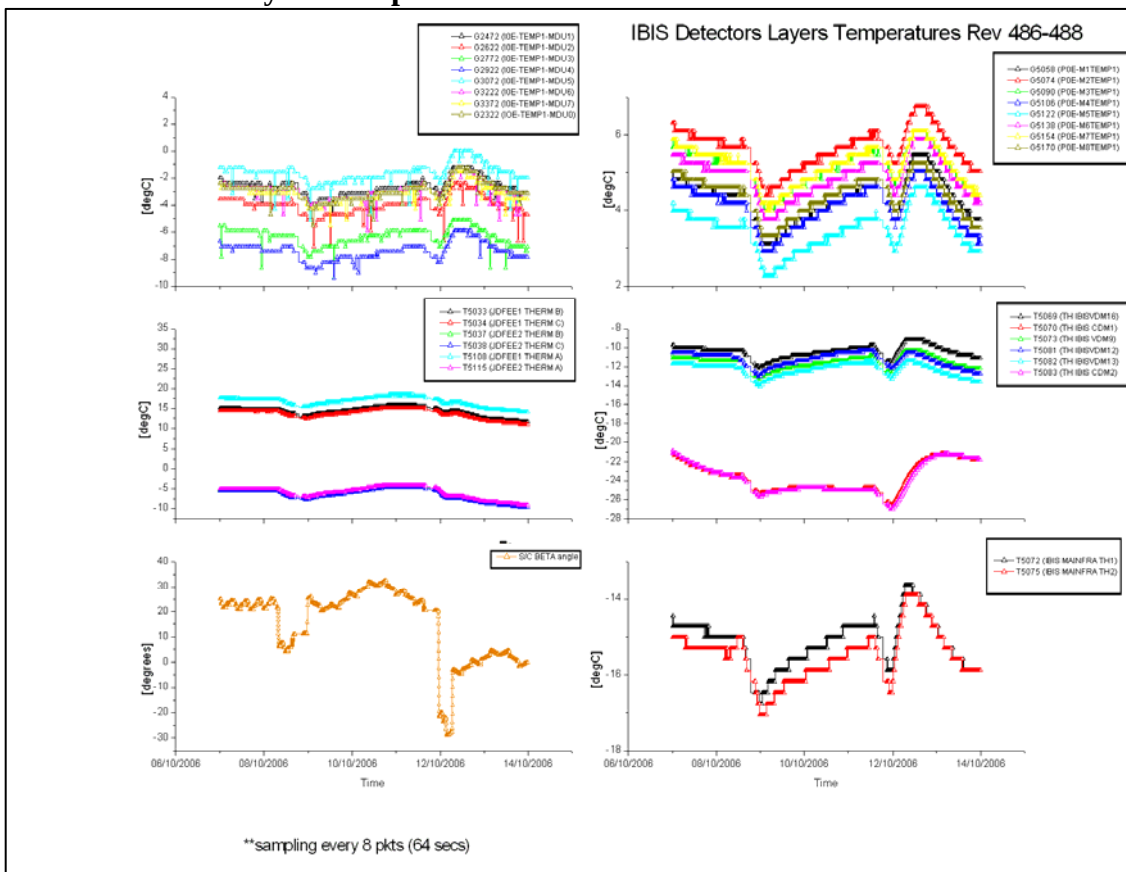
VETO Current:



PICsIT Counters:



IBIS Detectors Layers Temperatures:



IBIS daily report

DoY 281 (08/10/2006):

At 14:17Z, TM parameter G8015 (S1E-A2_PMT_V) was reported Out Of Limit High. It went back inside limits at 23:49Z. As this happened inside the radiation belts (following VETO Stand-By mode), according to V-VLT-1 in FDIR, no action was taken.

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

DoY 282 (09/10/2006):

At 14:52Z, TM parameter G2056 (I0E-OVFWPXADD-M4) failed Status Consistency Check. According to I-OVF-1 in FDIR, no action was taken.

DoY 284 (11/10/2006):

At 14:00Z, TM parameter G8015 (S1E-A2_PMT_V) was reported Out Of Limit High. It went back inside limits at 23:31Z. As this happened inside the radiation belts (following VETO Stand-By mode), according to V-VLT-1 in FDIR, no action was taken.

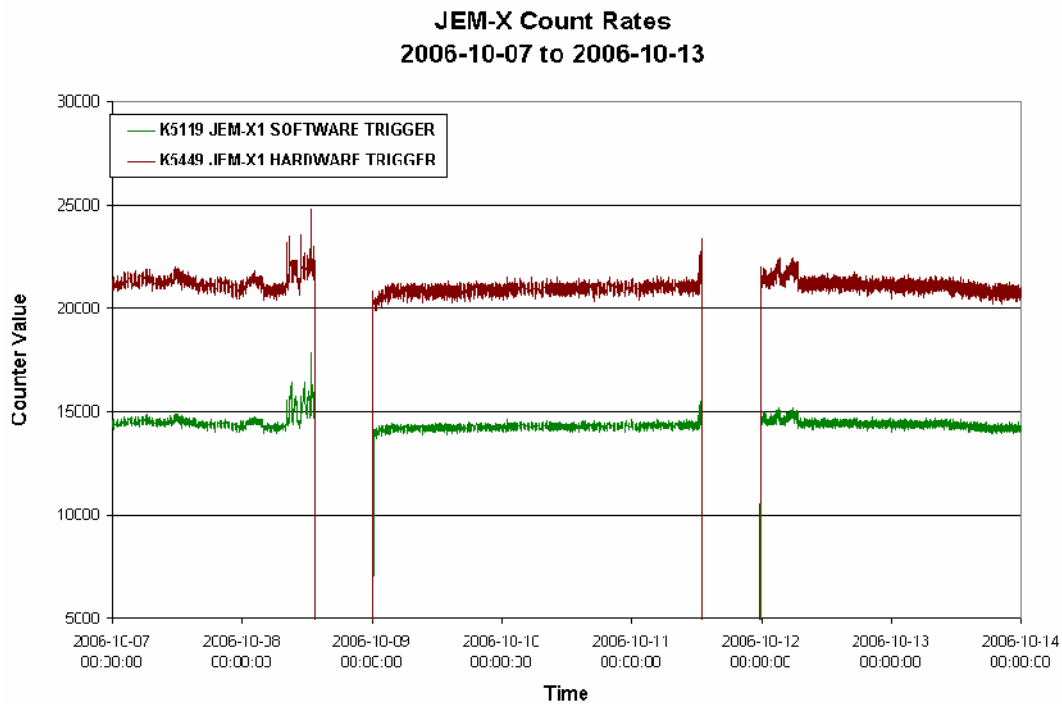
During the Belts, several TM parameters from families G5002 (P0S-Mi RTC1) and G5003 (P0S-Mi RTC2) went Out Of Limit High and back. According to P-CNT-1 in FDIR, no action was taken.

At 23:01Z, TM parameter G2014 (I0E-OVFWPXADD-M1) failed Status Consistency Check. At 23:04Z, TM parameter G2070 (I0E-OVFWPXADD-M5) failed Status Consistency Check. According to I-OVF-1 in FDIR, no action was taken.

8.3.4 JEM-X Operations

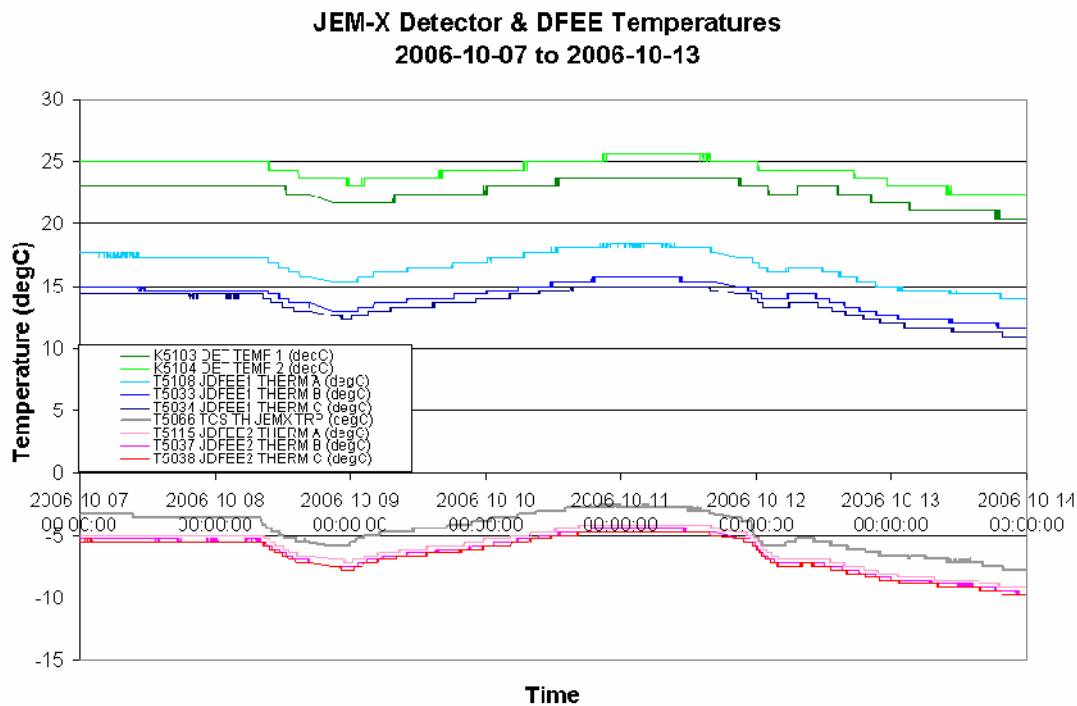
JEM-X count rates over the reporting period are displayed in the following graph¹.

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



8.3.4.2 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.



² Data sampled (1 frame in 8)

8.3.4.3 JEM-X Daily Report

2006-10-07 (DOY 280, Rev 486) to 2006-10-13 (DOY 286, Rev 488)

Nothing to report

8.3.5 OMC Operations

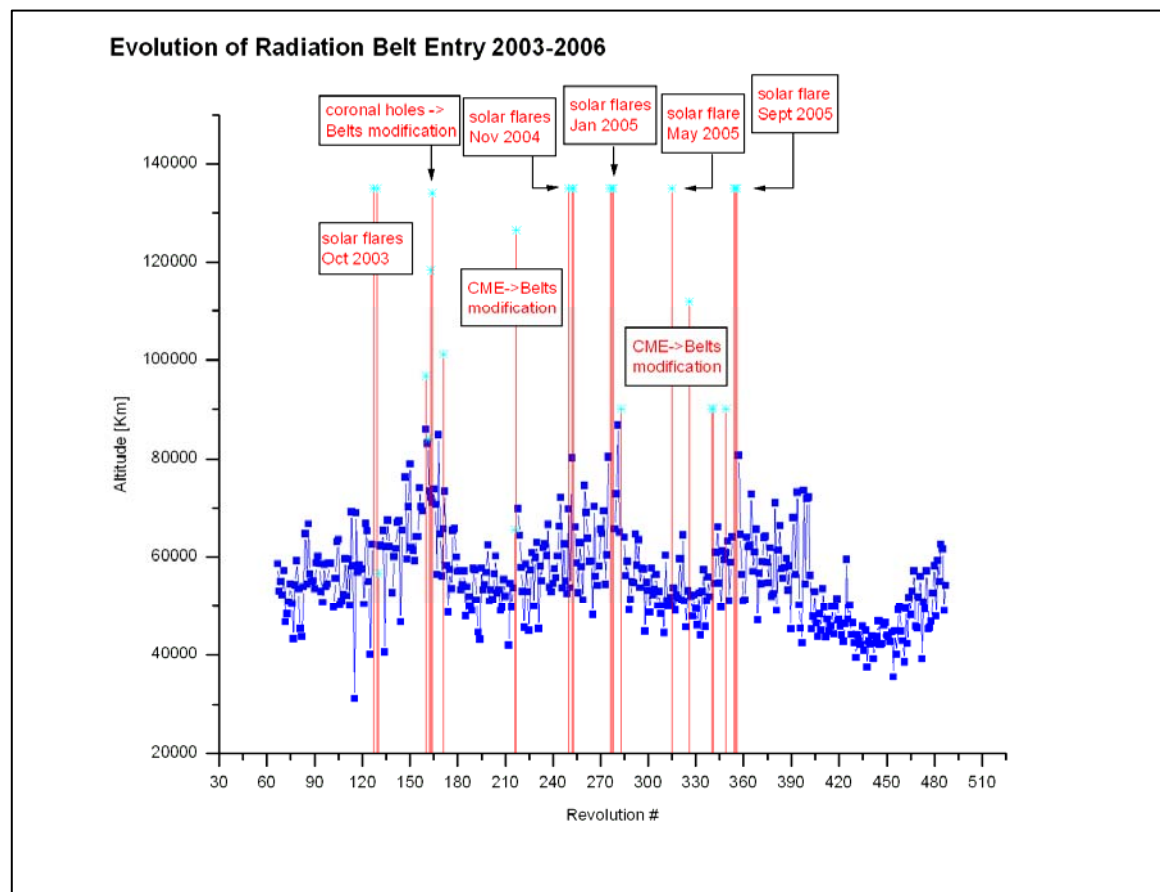
2006-10-07 (DOY 280, Rev 486) to 2006-10-13 (DOY 286, Rev 488)

Nothing to report

On DoY 281 at 14:17:48Z and DoY 284 at 14:00:37Z 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



IREM daily report

On 2006-10-11 at 16:13Z, TC U4921 (INT GND LINK OFF) failed the CEV due to a late update of the relevant TM parameter in the Command Verifier task. No further action was taken after positive verification of the Ground Link Status (TM parameter U9903 = OFF) in the TM desktop.

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]
486	RAD_ENTR R 2006-10-08T14:17:31Z	2006-10-08 15:09:29	49028.1	2006-10-08 15:01:29	50041
487	RAD_EXIT R 2006-10-08T23:38:47Z	2006-10-08 22:22:33	>>28141.6	2006-10-08 23:11:29	41010
487	RAD_ENTR R 2006-10-11T14:00:21Z	2006-10-11 14:18:41	<54250.2	2006-10-11 14:49:49	49347
488	RAD_EXIT R 2006-10-11T23:21:48Z	2006-10-11 22:12:35	34800.7	2006-10-11 19:59:49	15174

Reference

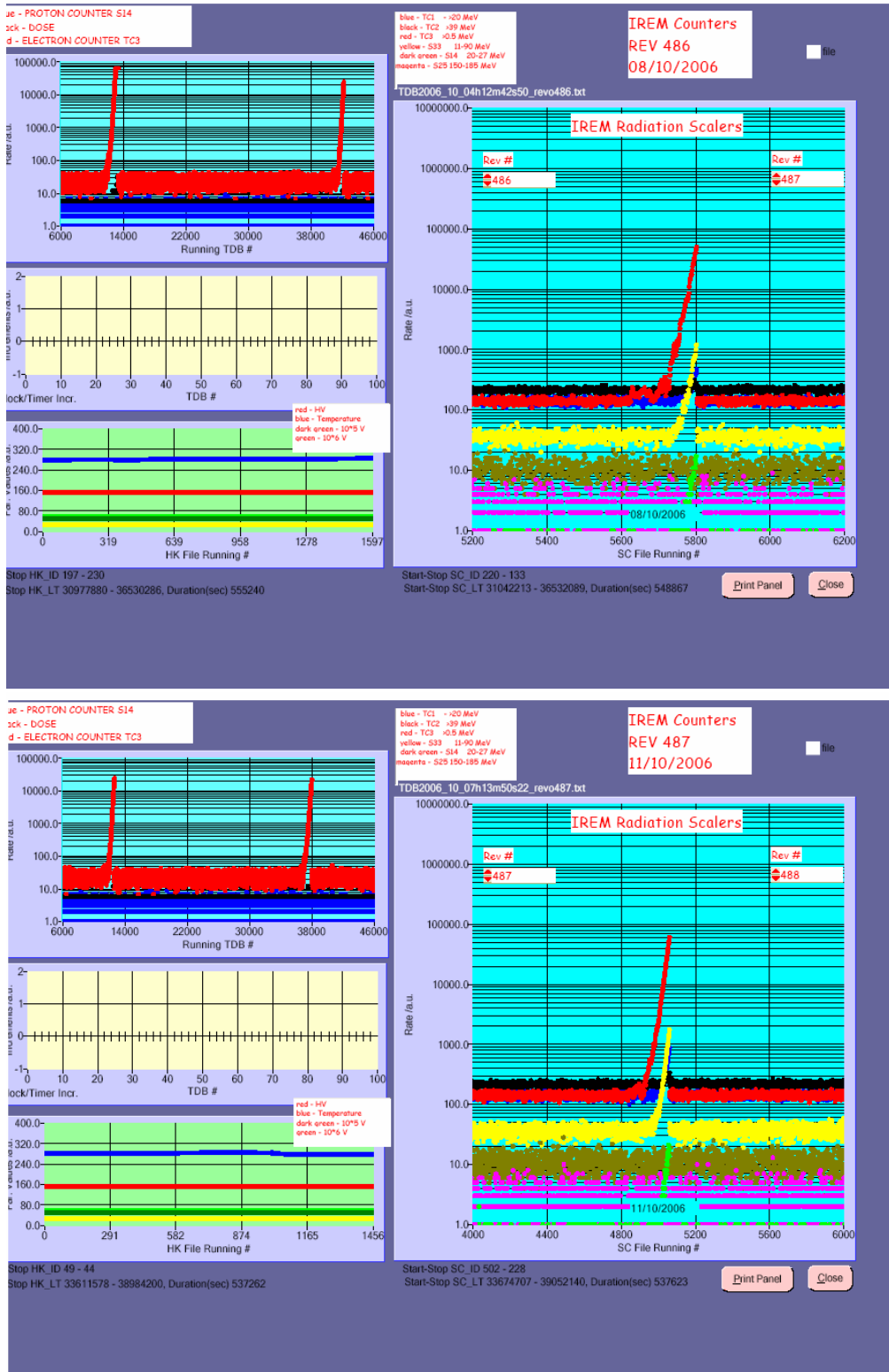
Very small error vs reference (less than 10 minutes)

Small error vs reference (between 10 and 30 minutes)

Large error vs reference (more than 30 minutes)

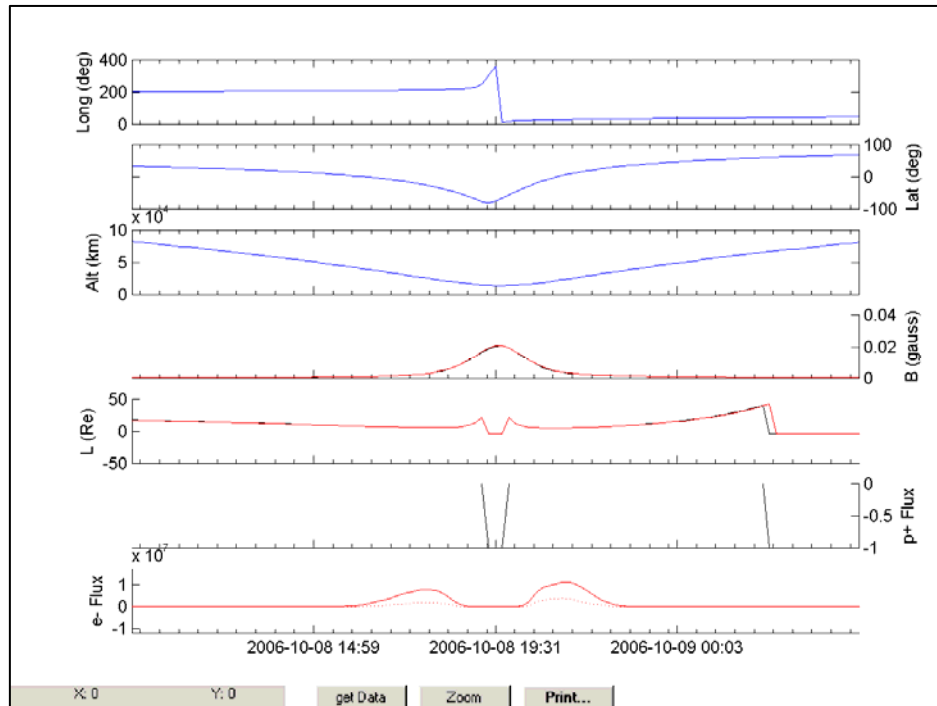
Radiation Spike

IREM radiation counters:

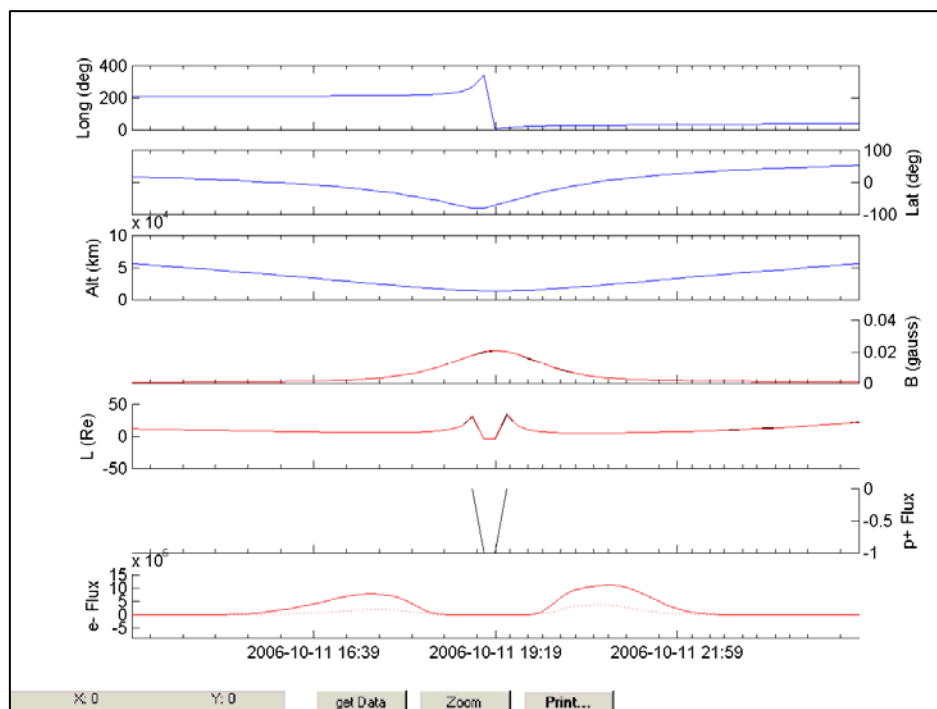


IREM Predicted Radiation Belt Passages

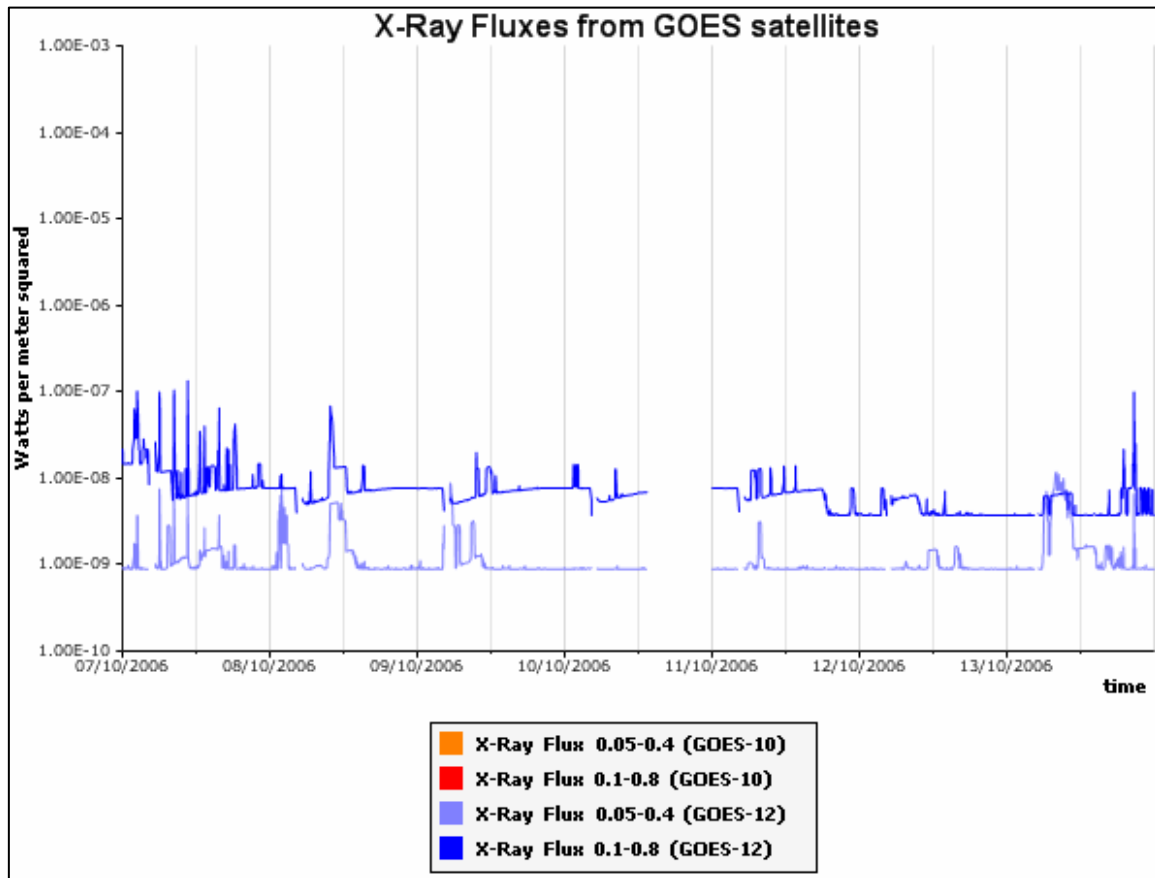
Rev 486



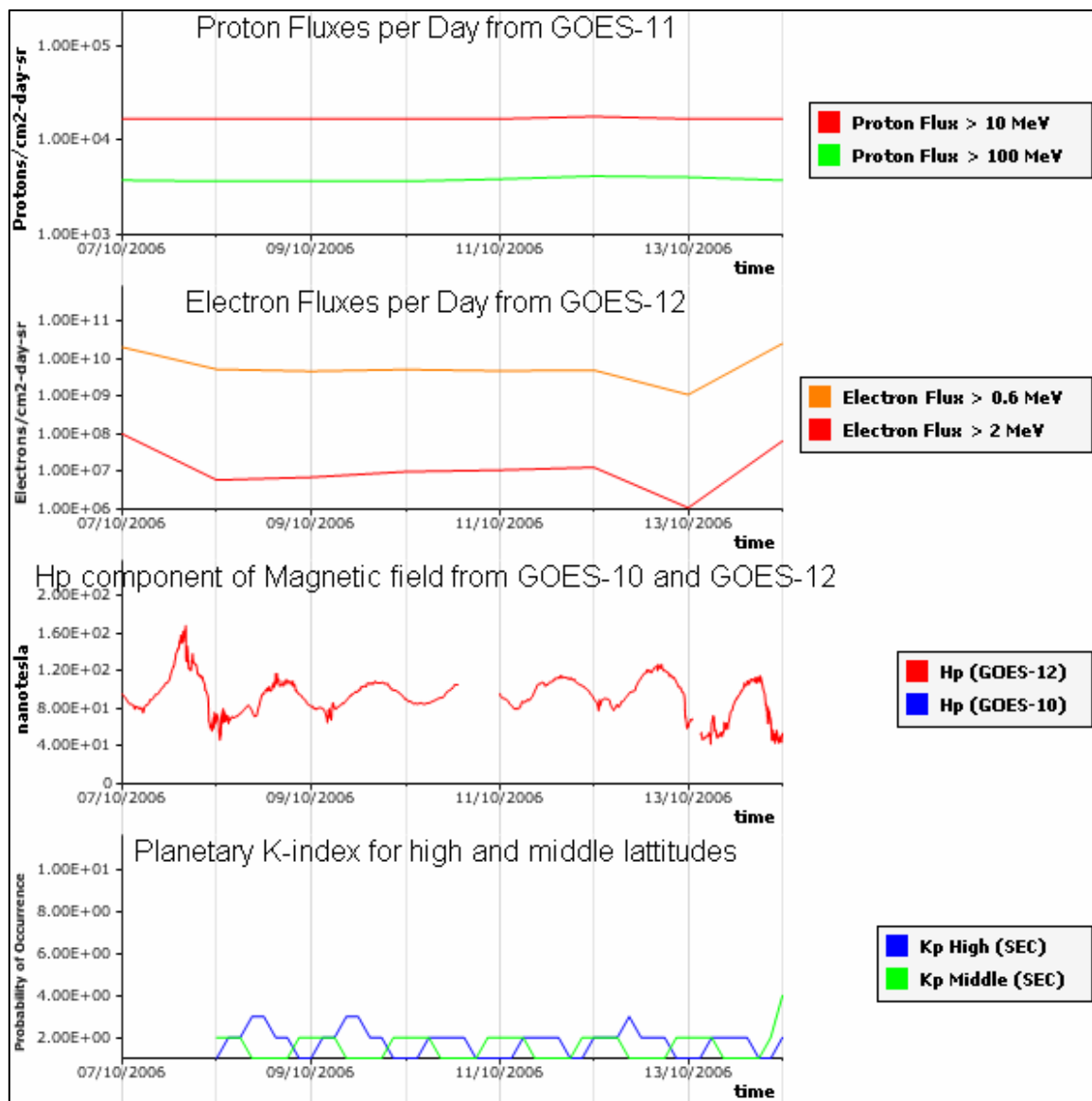
Rev 487



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.