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

INTEGRAL
Mission Report

INT-MOC-SYS-RP-1001-OPS-OF

No. 182
Week 11

20.03.06

Routine Phase

Prepared by: M. Walker (OPS-OFO)

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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 11.03.06 until 17.03.06 (both dates inclusive) and covers the revolutions 417 and 418.

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 were a Galactic Plane Survey, a hexagonal dither of the Galactic Bulge region (RA 17:45:36.00; DEC -28:56:00.0), a raster dither of the Mid-latitude North region (RA 16:18:13.65; DEC -14:13:46.6), a Galactic Latitude Scan, and a Flat Field Calibration (RA 17:12:48.00, DEC -06:24:00.0).

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.

2 slews were lost during the observation period due to problem on REDU station.

The fuel consumption over the period between 08/03/2006 and 16/03/2006 was 0.1280 kg. The remaining propellant is in the order of 155.7126 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 was 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

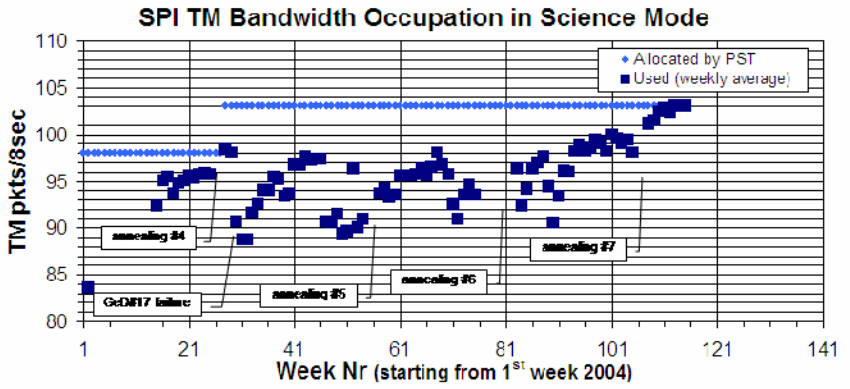
3.2.1 SPI

Following the 7th annealing, ended on 24th January, the overall status of the gamma-ray spectrometer is nominal, except for the Ge detector #15, which is showing since 09.02.2006 a slightly degraded energy resolution. Detector #2 is failed since 06.12.2003, detector #17 since 17.07.2004.

During science operations, the instrument was kept in photon-by-photon mode, with spectra TM enabled, an assigned TM bandwidth in the science observation windows of 103 pkts/cycle and an average occupation of 103 pkts/cycle.
The telemetry downlink of SPI has therefore reached saturation and since 6th March some of the Photon telemetry, acquired during the scientific observations, was lost.

The Stirling compressors work nominally, maintaining the Germanium detectors at 85K +/-1K.

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



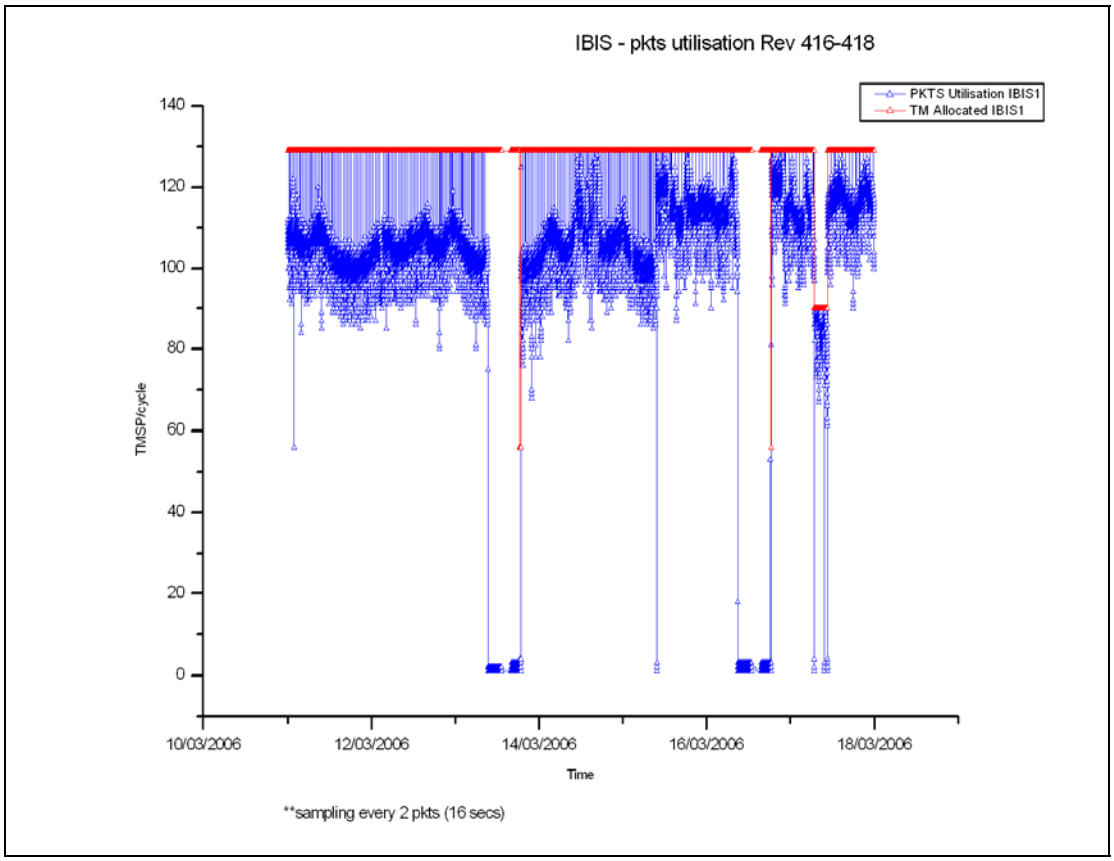
Note: Some more information concerning the SPI operations is provided in the Appendix.

3.2.2 IBIS

The Overall status of the unit is nominal.

During the reporting period, the PST allocation to IBIS was 129 TMPS/cycle. However between 2006-03-17 06:59Z and 2006-03-17 10:45Z it was 90 TMPS/cycle due to an OMC Flat Field Calibration. The IBIS mean bandwidth utilisation during the observation period was 108.34 TMPS/cycle, down 3.42 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 during science observations throughout the reporting period, with a TM allocation of 8 packets/cycle. JEM-X2 was dormant (DFEE OFF) with 1 packet/cycle.

Due to high count rates from the source being observed, the TM parameters K5449 HARDWARE TRIGGER; K5119 SOFTWARE TRIGGER and K5136 BUFFER LOSS went Out of Limits High on several occasions during the week. This did not affect the operations of JEM-X1 as the counts were not high enough to trigger a transition to Safe mode.

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, 205 of the 206 planned science pointings for OMC were executed nominally, one 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 very low solar activity.

The Sun was very quiet during the whole observation period. On 11/03/2006, sunspot 858 appeared and remained until 15/03/2006. On 16/03/2006, 2 small sunspots, 860 and 861, appeared on the Sun. None of them have posed any threat of solar flare.

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. A pointing was lost when the links with Redu dropped, and there were several minor problems with ground station and ISDC links, but these had no impact. The overall performance was well over the 95% requirement.

4.1 Mission Operations Centre

The performance of the MOC was excellent this week. There was a problem with Flight Dynamics TPF updates, but this had no impact. The overall performance was well over the 95% requirement.

4.2 Ground Stations & Network

The performance of the ground stations and Network was excellent this week A pointing was lost when the links with Redu dropped, and there were several instances though of bad frames and a few TM drops, plus a couple of problems sending data to the ISDC, but these had no impact on the mission. The overall performance though was well above the 95% requirement.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning
New PSF's for revolutions 424 to 426 have been received. Planning for these revolutions has been performed and sent to MOC. No re-planning has been performed

and no ToO request has been received. An OMC flat field calibration was performed during the week in revolution 418. Revolution 422 planning is pending inputs for the AOCS calibration and finalisation of the instrument calibration using the CRAB. No TSF was received this week.

2. Observation status
ECS's for revolution 408 was received. This ECS has been processed by ISOC and the corresponding OCS sent to ISDC. No extra time has been credited.

3. ISOC science data archive
The ISDA version 2.5 was publicly released on 15 March. A couple of points to refine this release are in work with priority. One relates to handling of observations where there is more than one data set available due to reprocessing at ISDC and the other point is to fill gaps in available icons at observation level. The DELL hardware continues to crash as before.

4. ISOC system
The version 12.2 is still in use. It is the version to support the AO 4 proposal submission.

5. AO 4
The preparation for the submission is finished. The AO was opened as planned on Monday 13 March. The Submission closes on 21 April. The preparation for the activities immediately following the closure of the submission has started.

6. Problems
None.

4.3.2 ISDC

Status of ISDC observation processing on 20/03/2006:

- Latest Standard Analysis completed: observation 03200160002 (NGC 4945, Revolution 400) on 08/03/2006

- Latest products archived: observation 03200160001 (NGC 4945, Revolutions 396) on 08/03/2006

- Latest observation products sent to the observer: observation 02297000019 (Cas A, Revolutions 352 & 384-385) on 13/02/2006

5 Special Events

6 Anomalies

The following problems relating to the ground segment impacted operations this week.

On DoY 073, at 16:20, there was no VC-0 or VC-7 TM flow from Redu, the links returned at 16:25. A manual recovery to the attitude of pointing 04170038 was performed, which proceeded nominally. The impact was the loss of pointing 04170037.

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

AR id	Date Created	Subject	Segment	Status
INT-2844	17/03/2006	Continuous VC-7 TM link drop	NASA Station	Pending
INT-2845	17/03/2006	TPF generation failure	FDS	Pending
INT-2846	17/03/2006	REDU lost lock	ESA Stations	Pending
INT_SC-143	21/03/2006	PLM PDU HLCL 4B1 Spurious Switch-off	Payload	Pending
INT-2847	22/03/2006	No SICF files at JPL	GFCC	Pending
INT_SC-144	23/03/2006	IBIS: VETO VDM 10 High Voltage break down	Payload	Open

7 Future Milestones

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 417

The observations in revolution 417 began with a raster dither of the Mid-latitude North region (RA 16:18:13.65; DEC -14:13:46.6), which lasted ~17.4 hours. Next came a hexagonal dither of the Galactic Bulge region (RA 17:45:36.00; DEC -28:56:00.0), for ~3.5 hours. For the remainder of the orbit, a Galactic Latitude Scan (Cycle 4), which lasted ~36.2 hours, was performed.

Revolution 418

The observations in revolution 418 began with a hexagonal dither of the Galactic Bulge region (RA 17:45:36.00; DEC -28:56:00.0), for ~3.5 hours. Next came a raster dither of the Mid-latitude North region (RA 16:18:13.65; DEC -14:13:46.6), which lasted ~6.8 hours. This observation was interrupted by an OMC Flat Field Calibration, lasting ~3.4 hours, which was a staring observation at attitude (RA 17:12:48.00, DEC -06:24:00.0). For the remainder of the orbit, (~43.5 hours), the raster dither of the Mid-latitude North region was resumed.

Throughout these observations all instruments were in their nominal science modes, except JEM-X2 for which the DFEE was off, and the TM allocation in this revolution is IBIS 129; SPI 103; JEM-X1 8; JEM-X2 1; OMC 5, except during the OMC Flat Field calibration from 2006-03-17T06:59:28Z to 2006-03-17T10:45:15Z, when the allocation is IBIS 90; SPI 84; JEM-X1 8; JEM-X2 1; OMC 63.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

```
2006-03-01T13:48:57.000Z     155.9897    F   Automatic TM processing.
2006-03-01T17:48:17.000Z     155.9790    F   Automatic TM processing.
2006-03-03T04:08:29.000Z     155.9596    F   Automatic TM processing.
2006-03-04T17:34:32.000Z     155.9377    F   Automatic TM processing.
2006-03-07T13:14:47.000Z     155.9279    F   Automatic TM processing.
2006-03-07T17:15:44.000Z     155.8949    F   Automatic TM processing.
2006-03-08T02:22:25.000Z     155.8846    F   Automatic TM processing.
2006-03-08T09:33:30.000Z     155.8640    F   Automatic TM processing.
2006-03-08T14:02:10.000Z     155.8406    F   Automatic TM processing.
2006-03-10T12:58:55.000Z     155.8288    F   Automatic TM processing.
2006-03-10T17:01:03.000Z     155.7819    F   Automatic TM processing.
2006-03-13T12:42:24.000Z     155.7554    F   Automatic TM processing.
2006-03-13T16:39:44.000Z     155.7442    F   Automatic TM processing.
2006-03-15T03:00:04.000Z     155.7253    F   Automatic TM processing.
2006-03-16T16:18:56.000Z     155.7126    F   Automatic TM processing.

This report was generated  Fri Mar 17 08:00:32 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, 11/03/2006 – 17/03/2006

AOCS operations were executed from the Automatic Timeline.

During this period, 78 Open Loop Slews, 139 Closed Loop Slews and 4 Momentum Bias were executed (TL + Manual Recovery).

2 slews (CSL) were lost during the observation period due to a problem on REDU station (drop in VC-0 link due to lost of on-board lock).

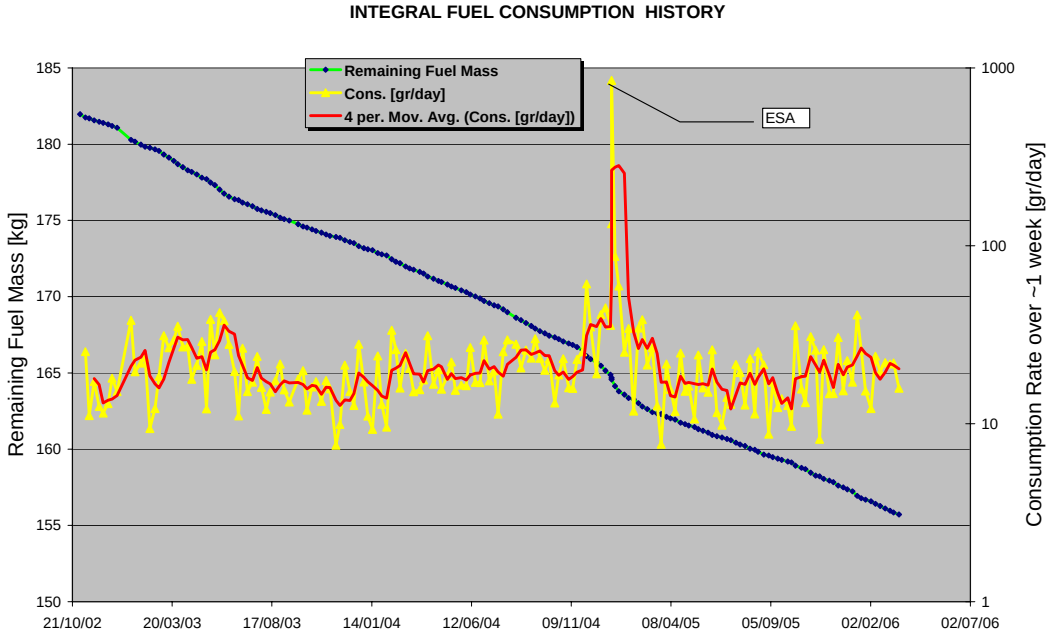
This is equivalent to a ~1 % of the total number of slews planned (218).

Orbit Control

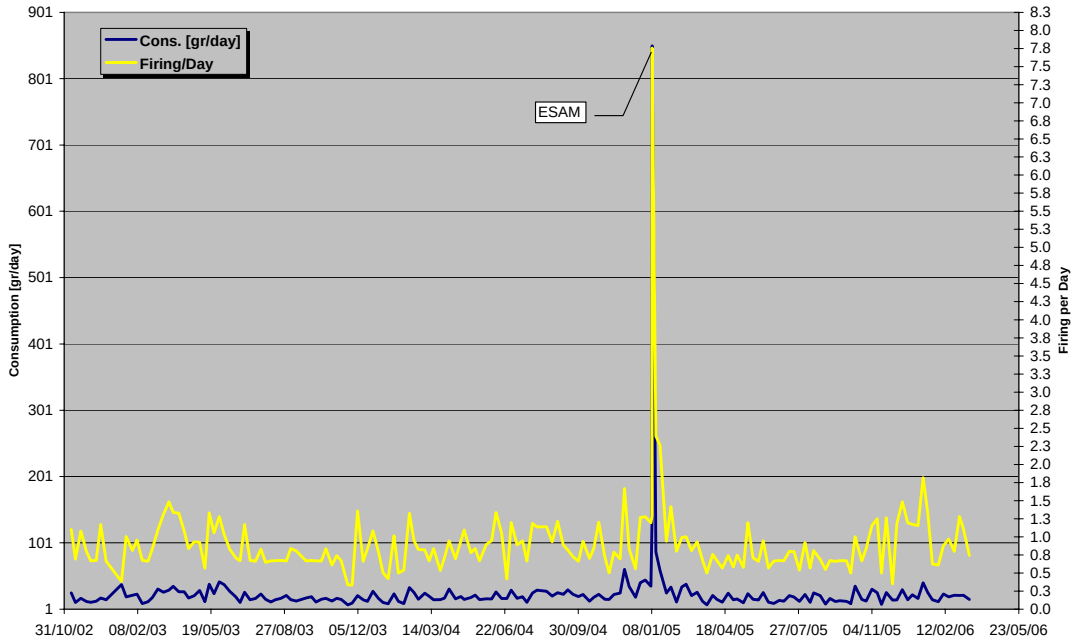
At present time the plan is to reverse the control and to increase the semi-major axis as from mid March 2006 and onwards. The "Redu only" situation could be reached in the second half of 2006, possibly mid August. The apogee longitude would then be about 32 deg East.

Fuel consumption

The fuel consumption (total, grams/day) over the period between 01/11/2002 and 16/03/2006 is reported in the plot below.

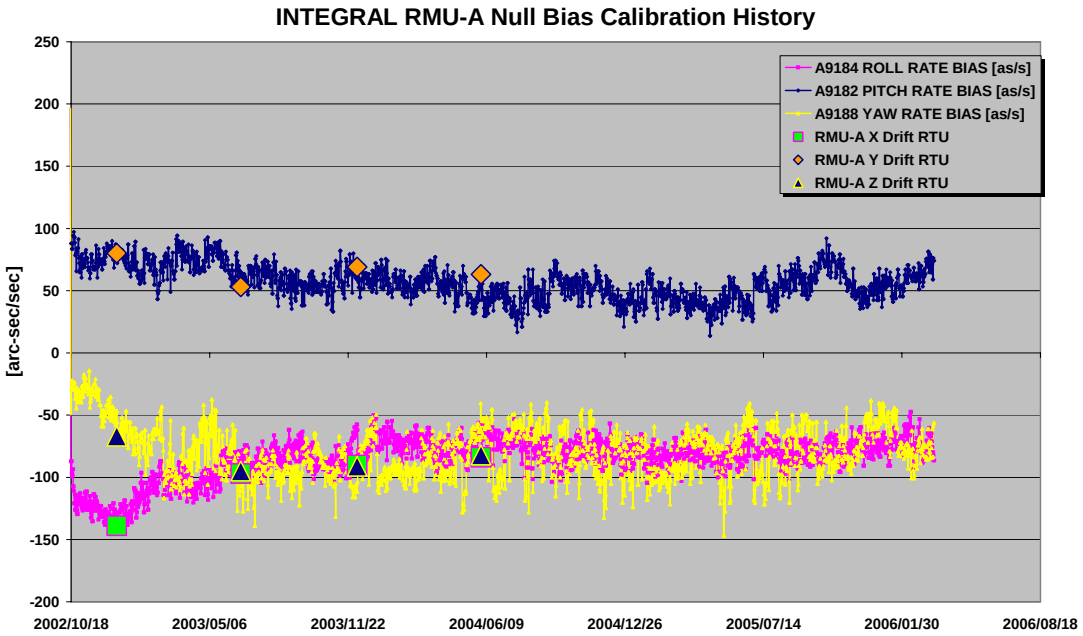


The firing\day over the period between 01/11/2002 and 16/03/2006 is reported in the plot below.

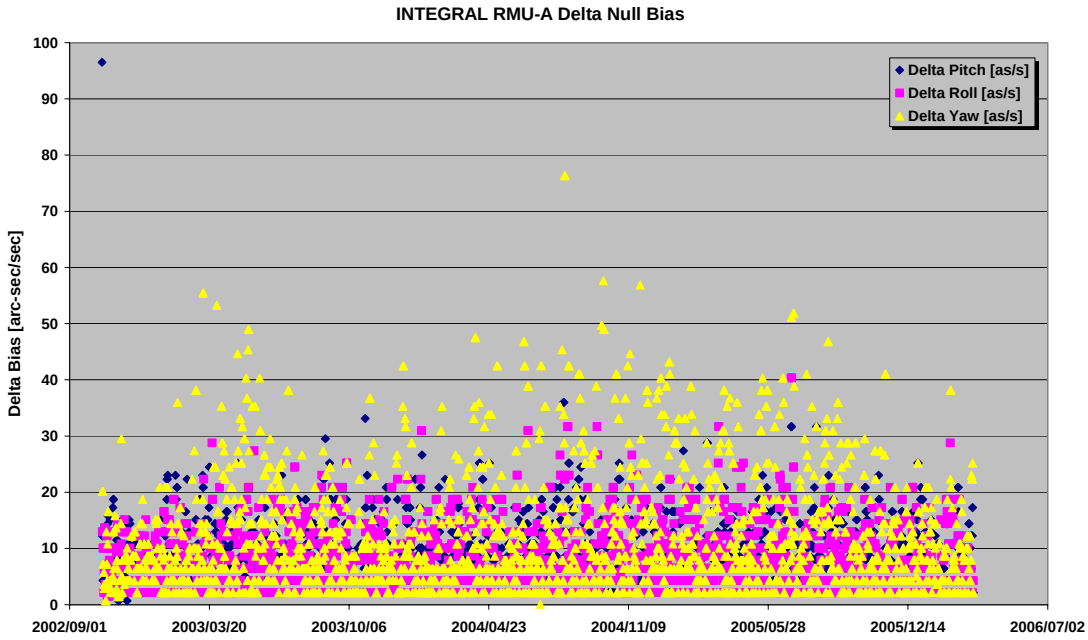


The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 17/03/2006 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 17/03/2006 is reported in the plot below.



11/03/06 (Day of Year 070, Revolution 416)

Nothing to report.

12/03/06 (Day of Year 071, Revolution 416)

Nothing to report.

13/03/06 (Day of Year 072, Revolution 416-417)

FDS failed slew update: At 19:03Z the FD system failed the update of the slew ID 04170003 (CSL). After a preliminary investigation, FD reported to be a problem due to the concurrent orbit file update when slew task update running. This overloaded the FD system and caused the failure of the TL update. Similar problems occurred already in year 2005.

The recovery was manually performed and the update for the next slew (ID 04170003) from TL was performed at 19:11Z.

No impact on TL reported.

14/03/06 (Day of Year 073, Revolution 417)

Lost of antenna lock at REDU station: At 16:20Z the REDU station lost the S/C lock and the IFMS RT tasks were restarted. Due to the drop in VC-0 link the slew ID 04170037 failed released.

The AOCS s/s was disabled at 16:22Z

The recovery was manually performed from the attitude of PID 04170036 to attitude of PID 04170038. The update for the next slew (ID 04170039) from TL was performed at 17:03Z and the AOCS s/s re-enabled in TL.

The following slews, 04170037(CSL)-38(CSL) were not executed from the TL.

15/03/06 (Day of Year 074, Revolution 417)

Nothing to report

16/03/06 (Day of Year 075, Revolution 417-418)

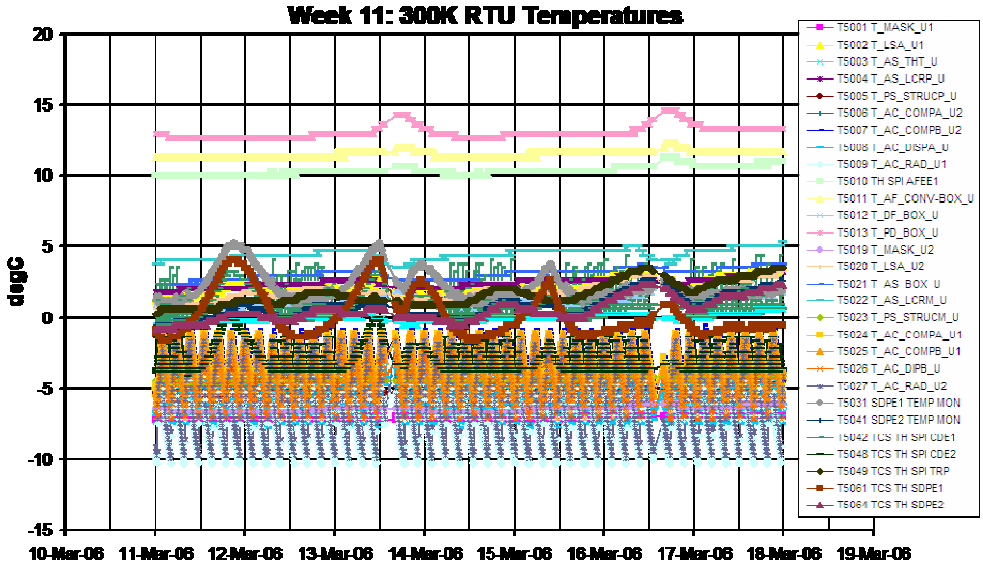
Nothing to report

17/03/06 (Day of Year 076, Revolution 418)

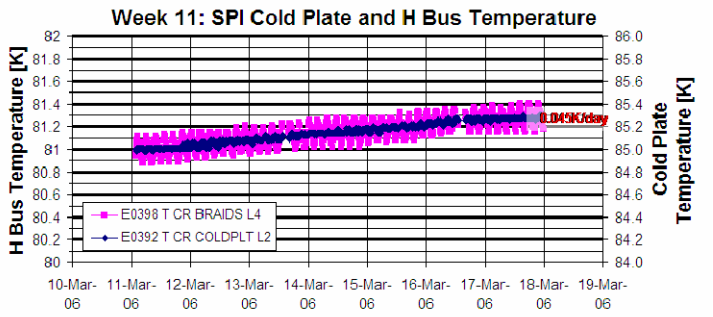
Nothing to report.

8.3.2 SPI Operations

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



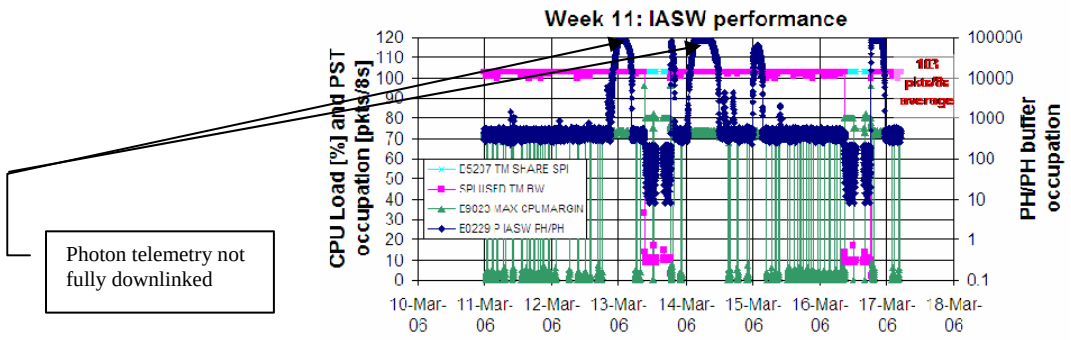
Stirling Compressors and Cryostat:
The performance of the compressors is nominal. The cold plate temperature was maintained at 85K+/-1K showing the expected positive drift.
The following plot shows the evolution of the cold-plate and H bus temperatures during the reporting period.



DPE & IASW:

The Iasw performance is nominal. The current IASW version installed is 432.

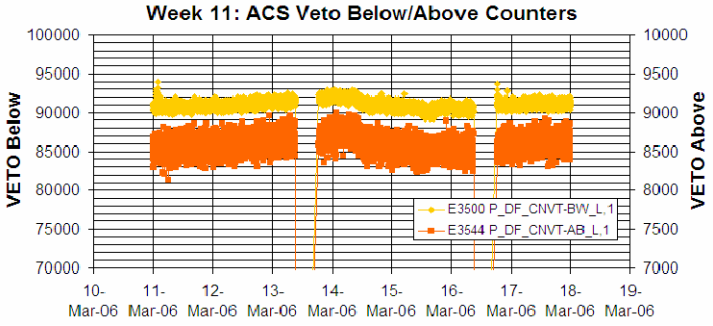
The following plot shows the IASW performance in terms of TM bandwidth, event buffer occupation and DPE CPU load during the reporting period.



ACS:

The performance of the ACS is nominal.

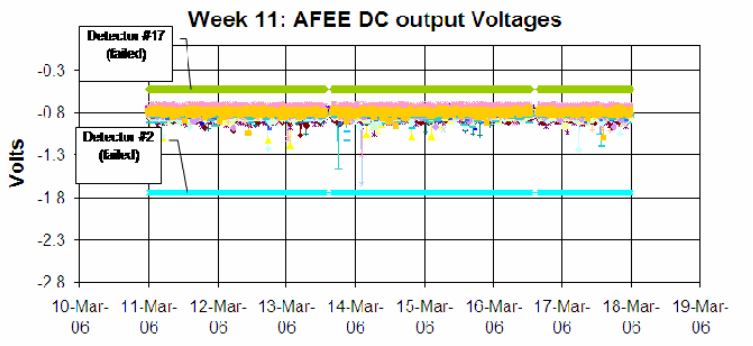
The following plot shows the ACS overall count rate evolution during the reporting period



AFEE:

The performance of the AFEE and the detectors is nominal, except for detector #15, which shows a degraded energy resolution. The anomaly has been recorded in the ESOC Anomaly Report and Tracking System (ARTS) as INT_SC-140.

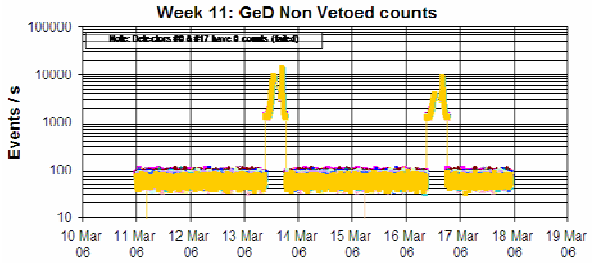
The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06.12.2003 and detector #17 is failed since 17.07.2004.

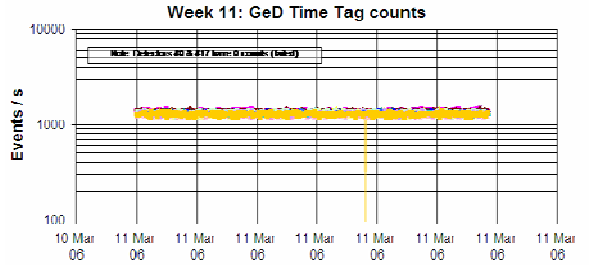


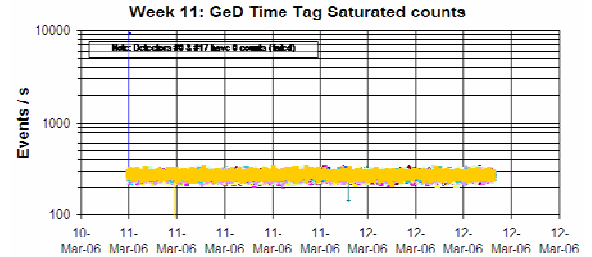
DFEE:

The performance of the unit is nominal.

The following plots show the count rates of the detectors during the reporting period (due to problems in the data retrieval tool, some gaps could be present).



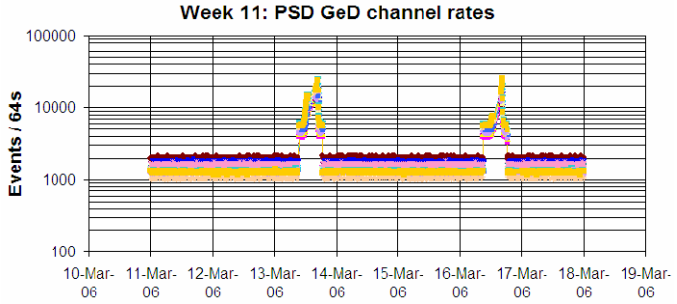




PSD:

The performance of the unit is nominal

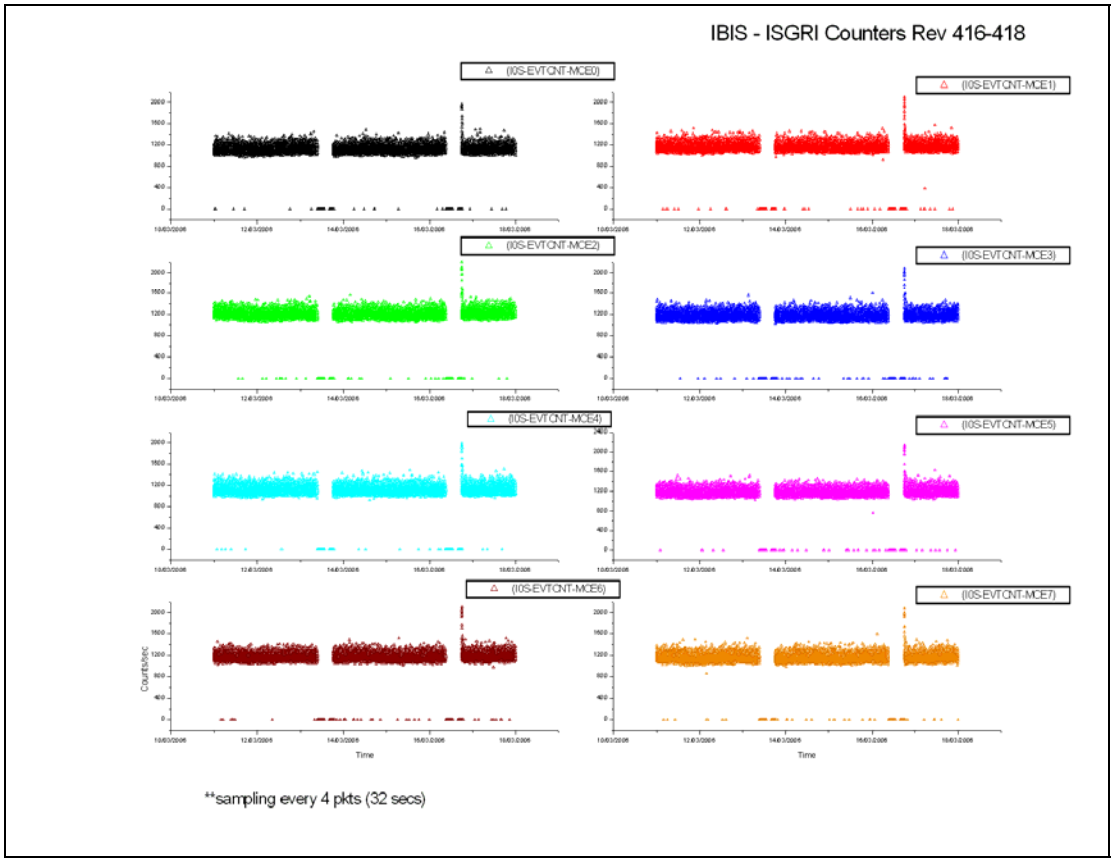
The following plots show the PSD channel rates during the reporting period.



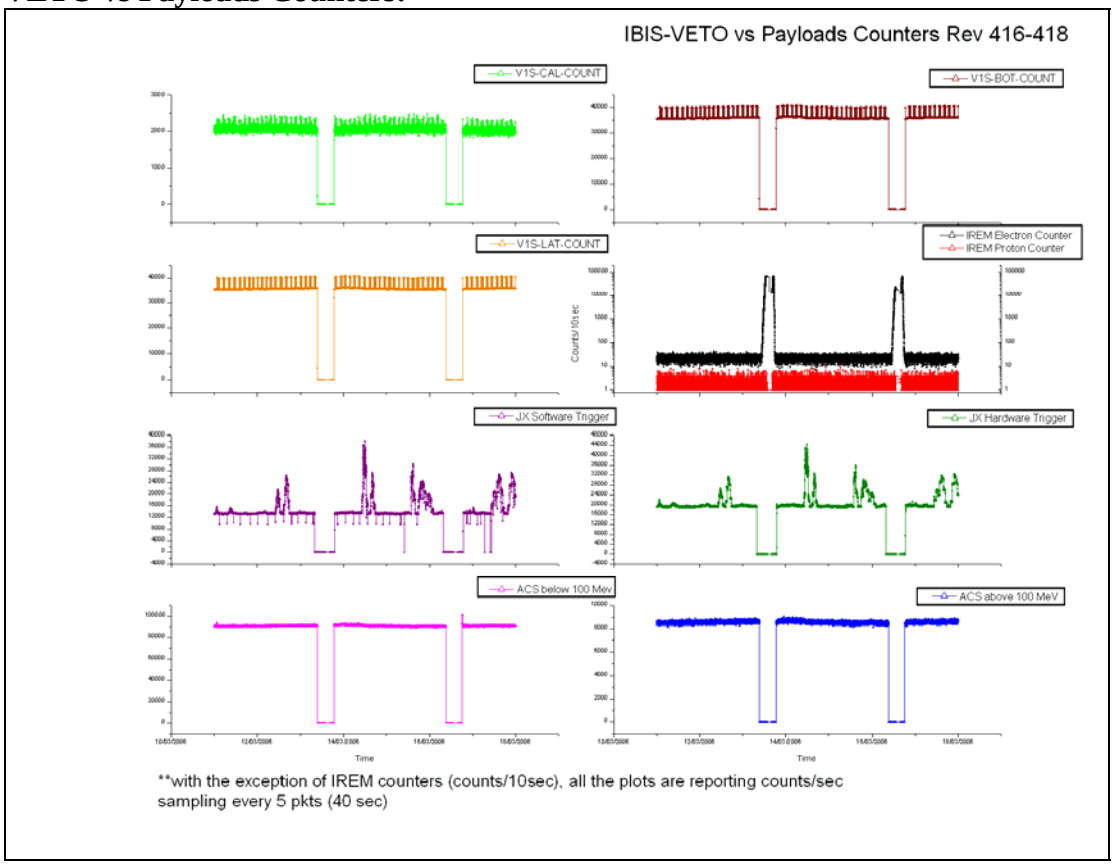
8.3.3 IBIS Operations

IBIS Event Counters Plots.

ISGRI Counters:

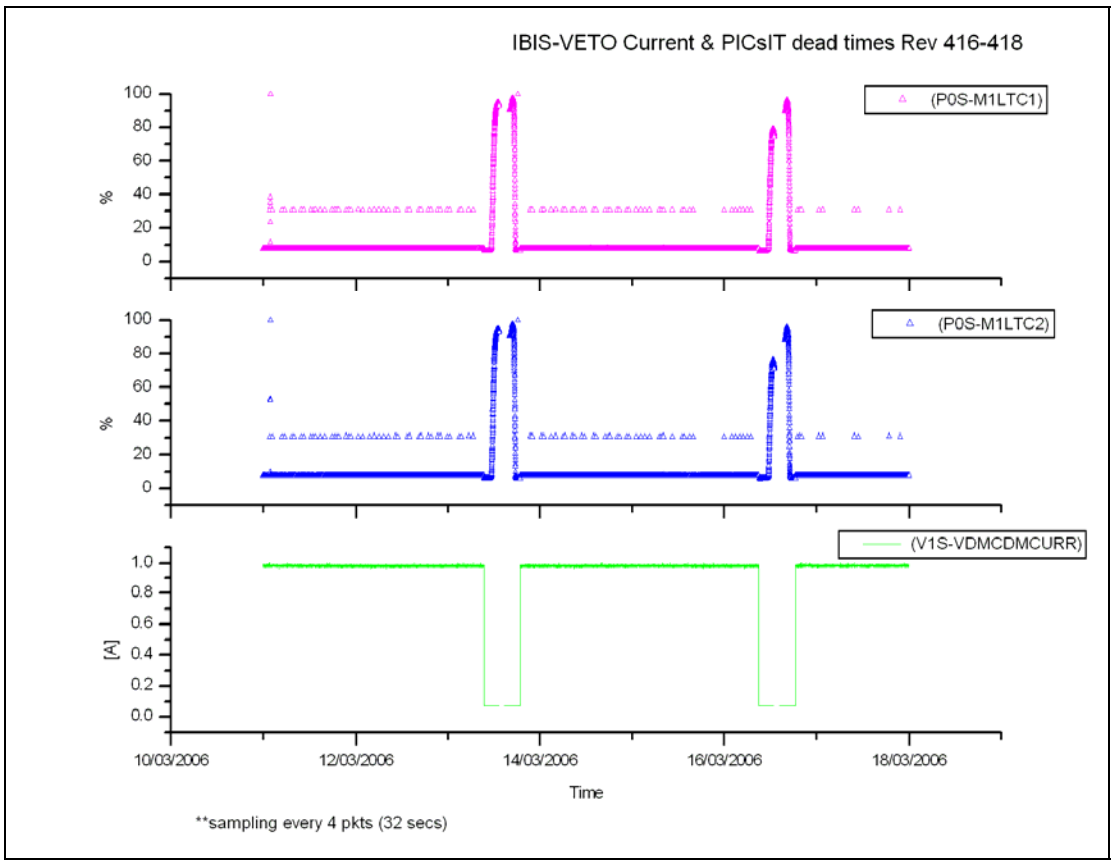


VETO vs Payloads Counters:

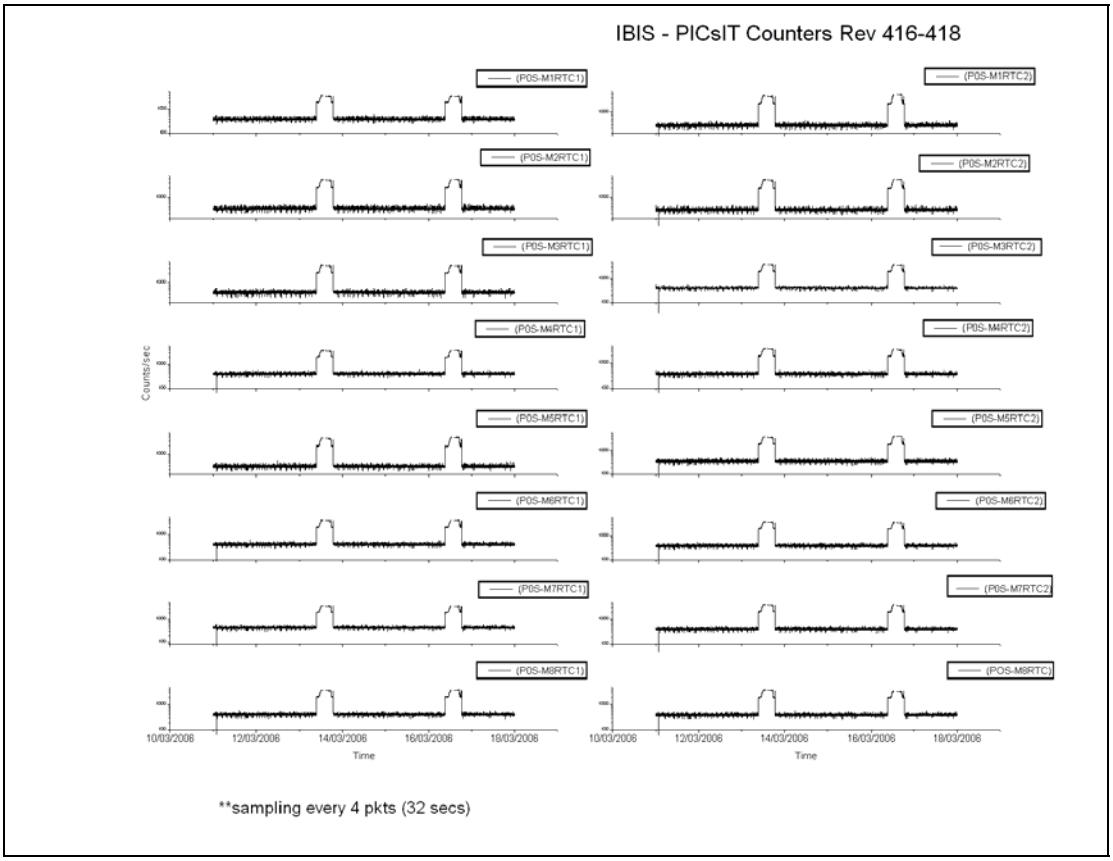


The week was characterised by low radiation.

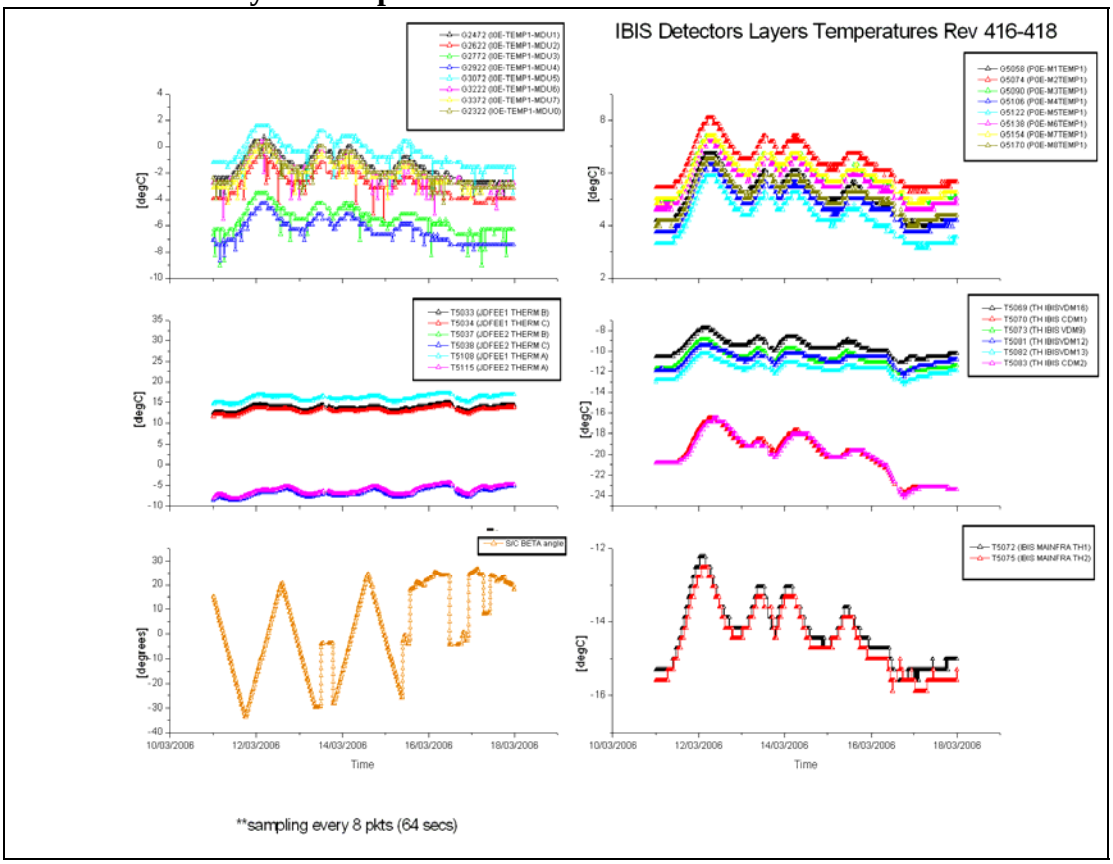
VETO Current:



PICsIT Counters:



IBIS Detectors Layers Temperatures:



IBIS daily report

DoY 2006.070 (11/03/2006):

At 01:52Z, TM parameters G5084 (P0S_M2F1ERRF) and G5100 (P0S_M3F1ERRF) failed SCC. At the same time most of G5002 and G5003 families went OOL low-low. Finally at 01:55Z, OEM id 132 class 0 "HEPI IASW resynchronised" was reported.
As per P-FIF-1, these 3 events flagged a resynchronisation of HEPI and did not require any action.

DoY 2006.072 (13/03/2006):

At 09:23Z, TM parameter G8015 was reported Out Of Limit high. It went back inside limit at 18:52Z. As this happened inside the radiation belts, according to V-VLT-1 no action was taken.

Inside the radiation belts, TM parameter G5002 (P0S-M1RTC1) was toggling OOL high. According to P-CNT-1, no action was taken.

Between 18:22Z and 18:28Z, TM parameters G2014 (I0E-OVFWPXADD-M1) and G2084 (I0E-OVFWPXADD-M6) failed SCC and back several times. According to I-OVF-1, as this happened inside radiation belts, no action was taken.

DoY 2006.075 (16/03/2006):

At 09:04Z, TM parameter G8015 was reported Out Of Limit high. It went back inside limit at 18:33Z. As this happened inside the radiation belts, according to V-VLT-1 no action was taken.

Inside the radiation belts, TM parameters G5022 (P0S-M5RTC1) and G5023 (P0S-M5RTC2) were toggling OOL high. According to P-CNT-1, no action was taken.

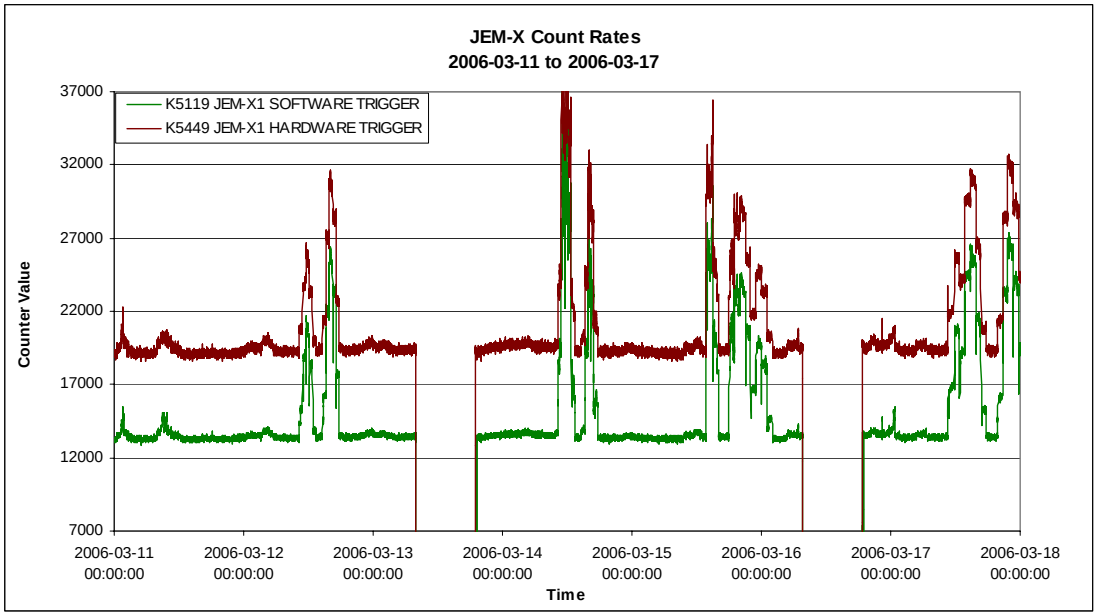
At 18:04Z, TM parameters G2042 (I0E-OVFWPXADD-M3) failed SCC and back. At 18:18Z, TM parameters G2070 (I0E-OVFWPXADD-M5) failed SCC and back. According to I-OVF-1, as this happened inside radiation belts, no action was taken.

8.3.4 JEM-X Operations

8.3.4.1 JEM-X Count Rates

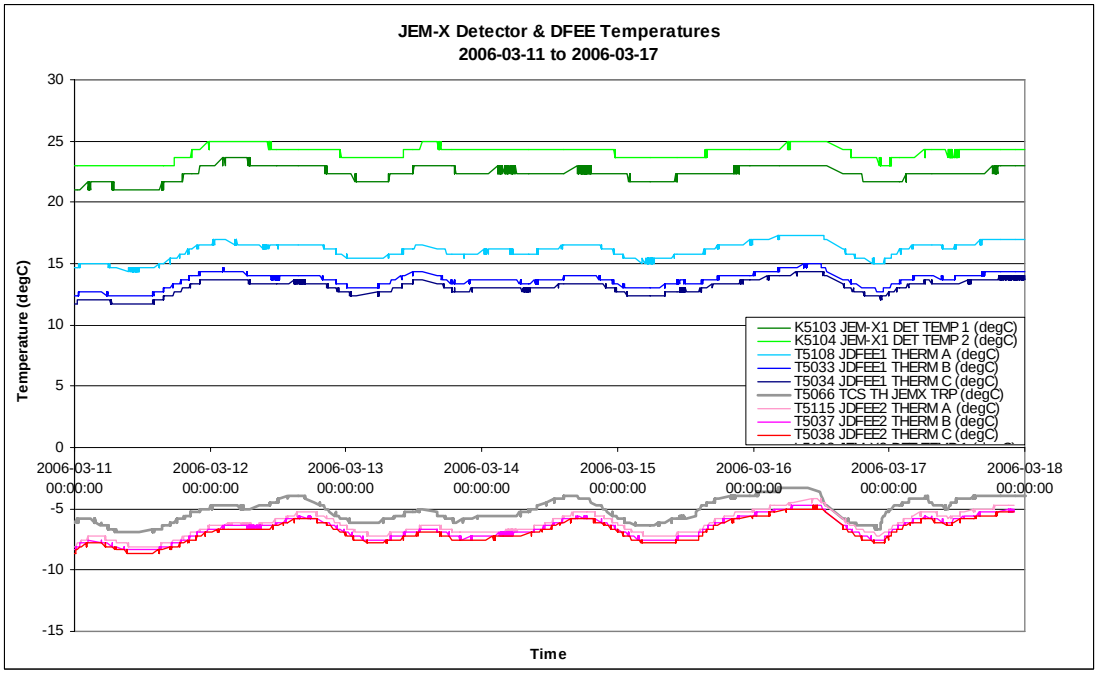
JEM-X count rates over the reporting period are displayed in the following graph[1].

[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 graph[2].



8.3.4.3 JEM-X Daily Report

2006-03-11 (DOY 070, Rev 416)

[2] Data sampled (1 frame in 8)

Nothing to report

2006-03-12 (DOY 071, Rev 416)

Due to high counts from the source being observed, the following parameters were OOL High over the following periods:

- K5136 BUFFER LOSS from 11:34:54Z to 11:36:06Z (continuous) and from 15:16:22Z to 16:31:10Z (toggling)
- K5449 HARDWARE TRIGGER from 15:52:22Z to 16:28:54Z (toggling)

2006-03-13 (DOY 072, Rev 416-417)

Nothing to report

2006-03-14 (DOY 073, Rev 417)

Due to high counts from the source being observed, the following parameters toggled OOL High over the following periods:

- K5449 HARDWARE TRIGGER from 10:55:26Z to 12:45:42Z and from 15:52:46Z to 16:27:50Z
- K5136 BUFFER LOSS from 10:56:22Z to 12:11:10Z and from 15:51:42Z to 16:28:54Z
- K5119 SOFTWARE TRIGGER from 10:59:26Z to 12:09:02Z

2006-03-15 (DOY 074, Rev 417)

Due to high counts from the source being observed, the following parameters toggled OOL High over the following periods:

- K5136 BUFFER LOSS from13:45:10Z to 15:02:14Z and again between 19:00:46Z and 21:02:06Z
- K5449 HARDWARE TRIGGER between 13:49:26Z and 14:59:58Z and for 1 TM cycle at 19:01:02Z

2006-03-16 (DOY 075, Rev 417-418)

Nothing to report

2006-03-17 (DOY 076, Rev 418)

Due to continuing high counts from the source being observed, the following parameters toggled OOL High over the following periods:

- K5136 BUFFER LOSS from 11:46:14Z to 15:47:26Z and again from 20:46:22Z to 22:47:10Z
- K5449 HARDWARE TRIGGER from 14:24:22Z to15:44:06Z and continuously OOL High from 21:45:02Z to 22:45:34Z

8.3.5 OMC Operations

2006-03-11 (DOY 070, Rev 416) to 2006-03-13 (DOY 072, Rev 417)

Nothing to report

2006-03-14 (DOY 073, Rev 417)

At 16:20, a VC-0 and VC-7 TM drop caused the loss of pointing 04170037, it was at this time that the following pair of commands was rejected:

```
2006.073.16.27.03.140   2006.073.16.27.13.501   1792   RealTime   131     TC REJECT
REJECTED TC1                                              0       0    65535   PR    N
E   E
 2006.073.16.26.57.140   2006.073.16.27.05.535   1792   RealTime   131     TC REJECT
REJECTED TC1                                              0       0    65535   PR    N
E   E
```

Which correspond to the M1130 (RESET IM) and MU1310 (IMAGING-A) commands for that pointing.

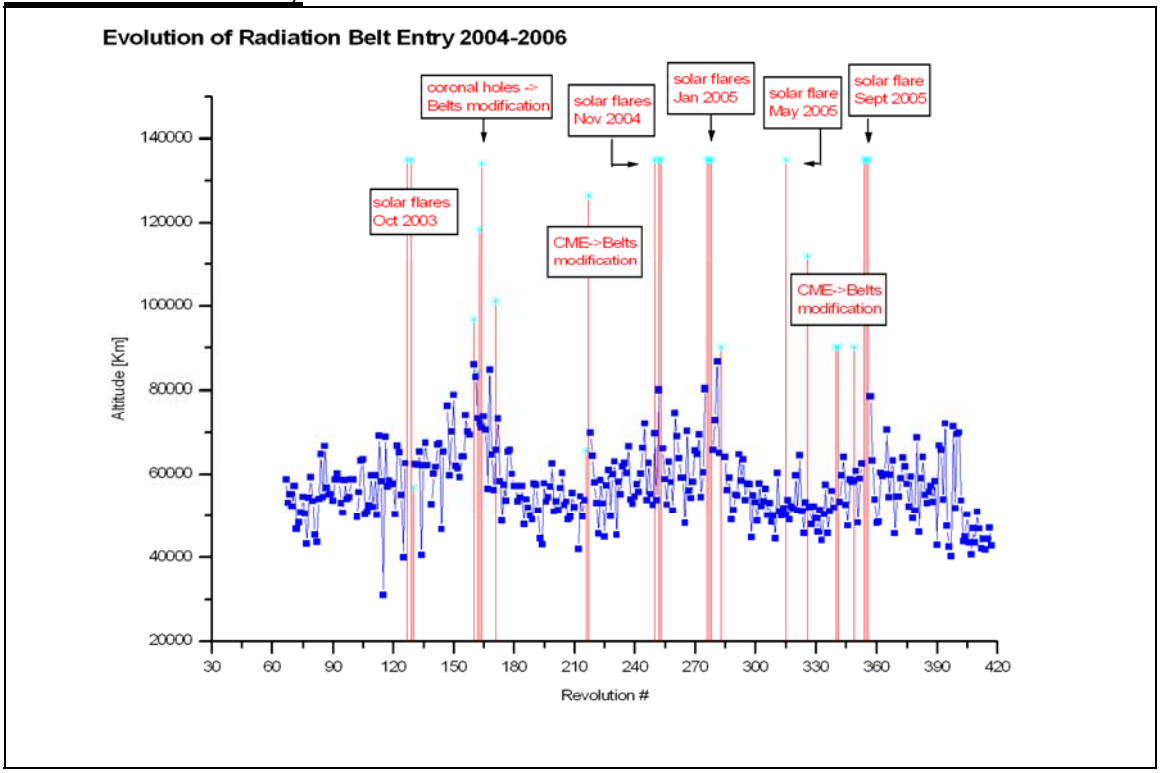
2006-03-15 (DOY 074, Rev 417) to 2006-03-17 (DOY 076, Rev 418)

Nothing to report

On DoY 072 at 09:23:52 and DoY 075 at 09:04:24 OMC was switched by the Timeline to SAFE mode, at the nominal time.

8.3.6 IREM Operations

Radiation Belts Entry



IREM daily report

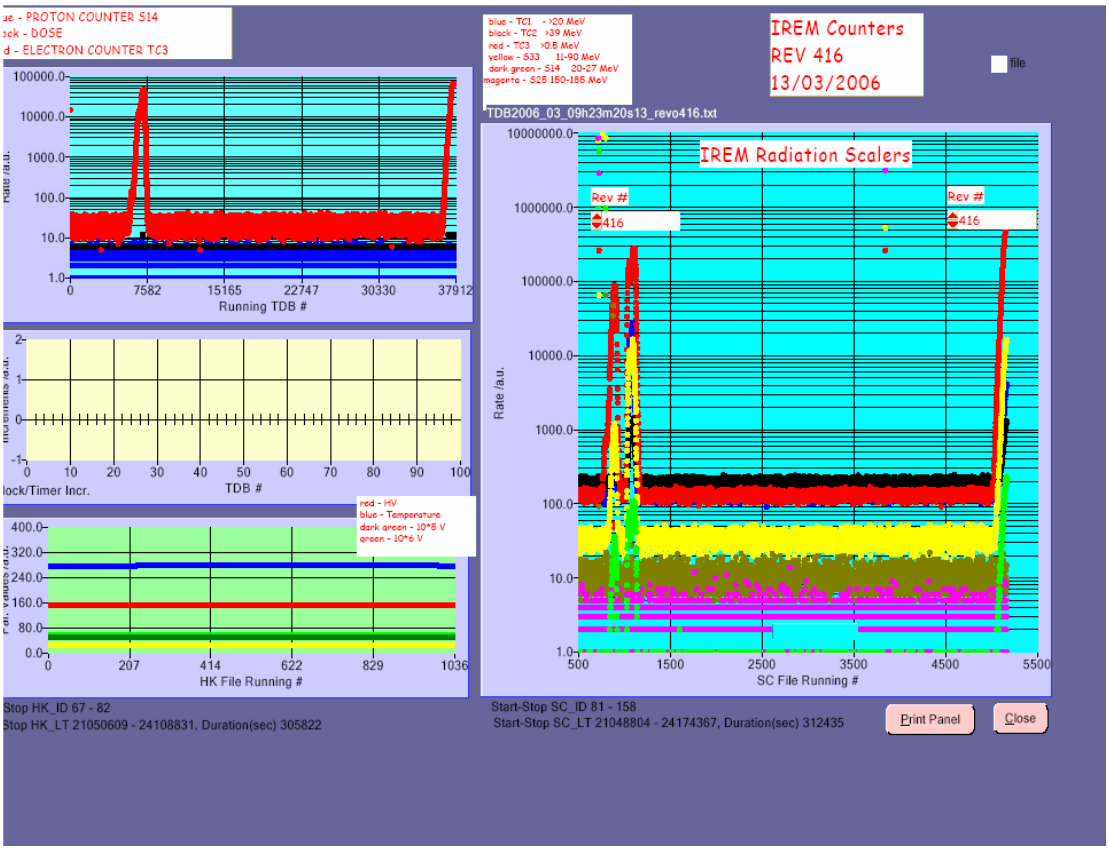
On 13/03/2006 (DoY 072) at 16:33Z TC U4920 failed CEV but checking the TM desktop confirmed the proper execution of this TC.

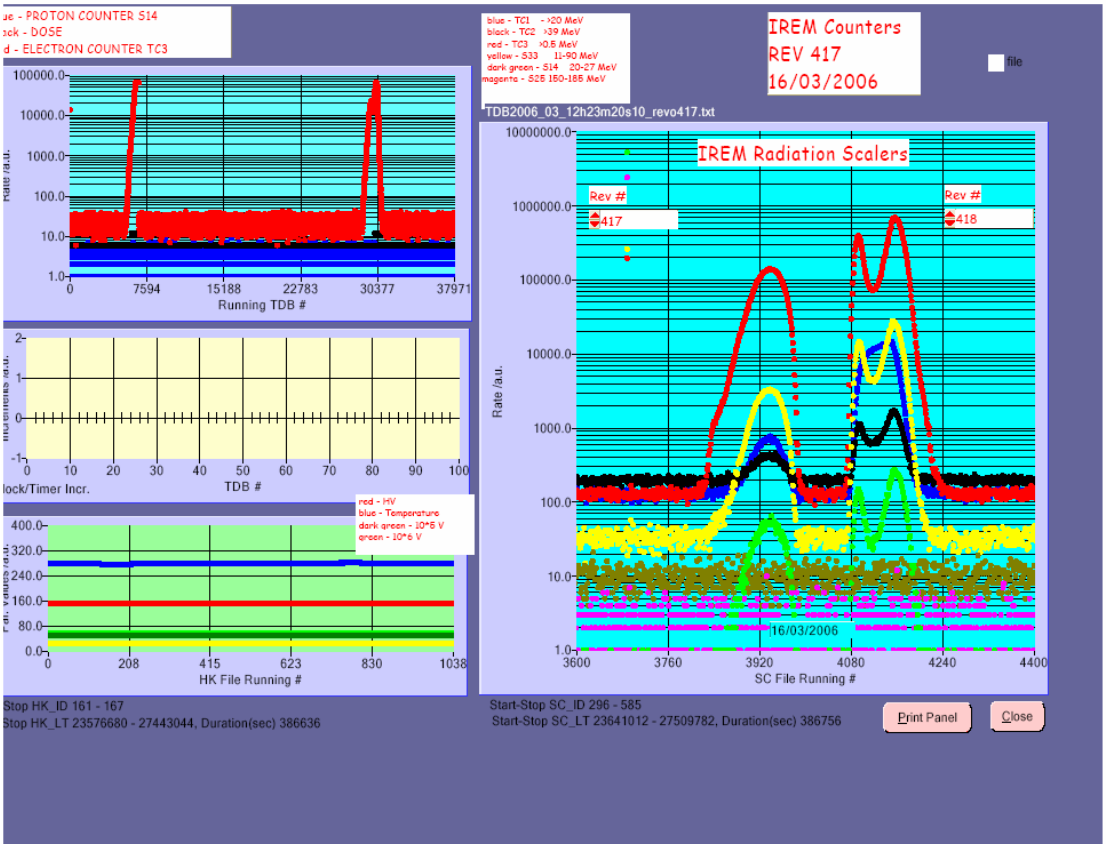
Electron Belts

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]
416	RAD_ENTR R 2006-03-13T09:23:44Z	2006-03-13 10:57:11	>47118.8	2006-03-13 10:48:44	49166
417	RAD_EXIT R 2006-03-13T18:39:29Z	2006-03-13 18:03:51	<<38841.4	2006-03-13 17:58:44	33166
417	RAD_ENTR R 2006-03-16T09:04:21Z	2006-03-16 11:15:03	<42838.7	2006-03-16 10:39:25	48516
418	RAD_EXIT R 2006-03-16T18:20:39Z	2006-03-16 17:49:19	<<42281.4	2006-03-16 17:49:25	33824

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

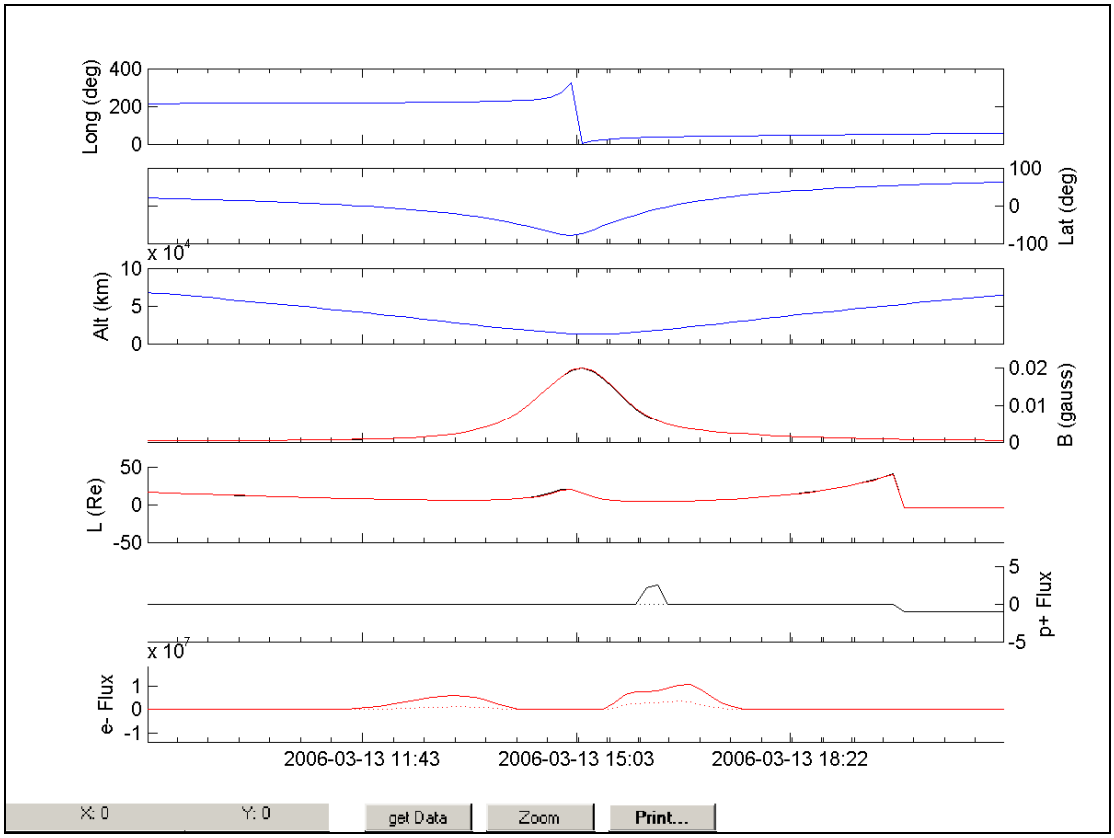
IREM radiation counters:



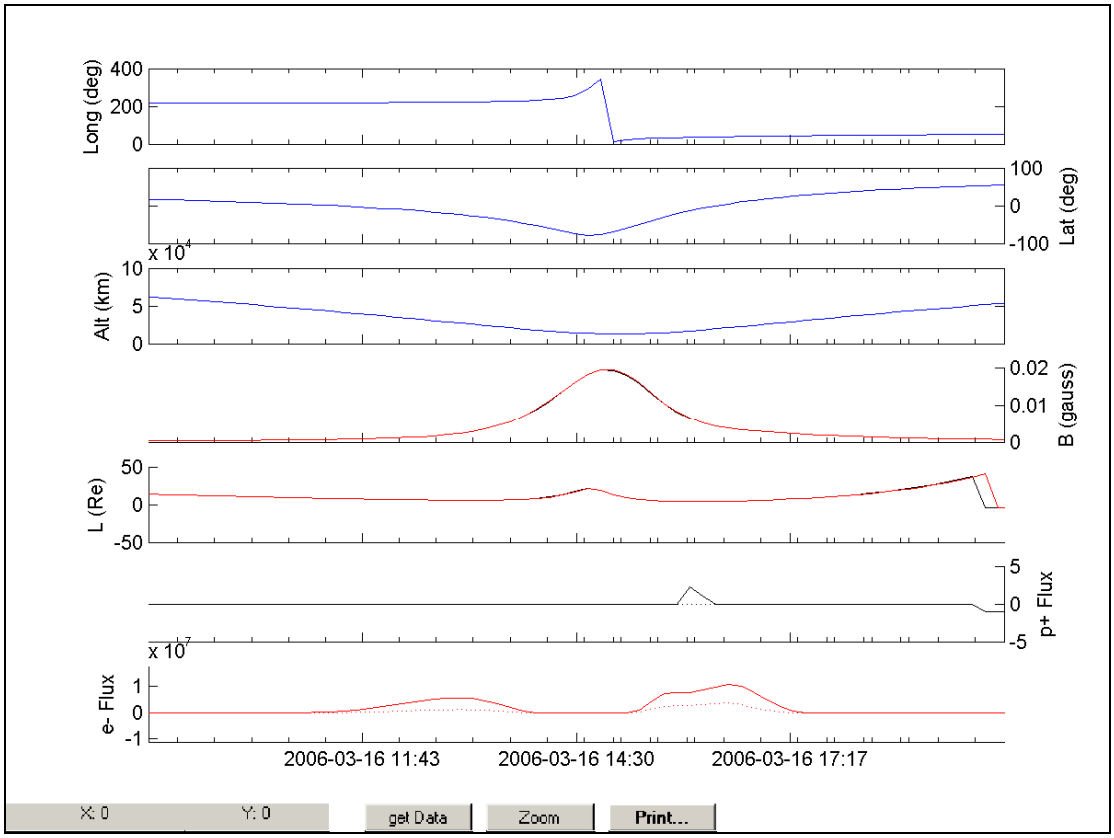


IREM Predicted Radiation Belt Passages:

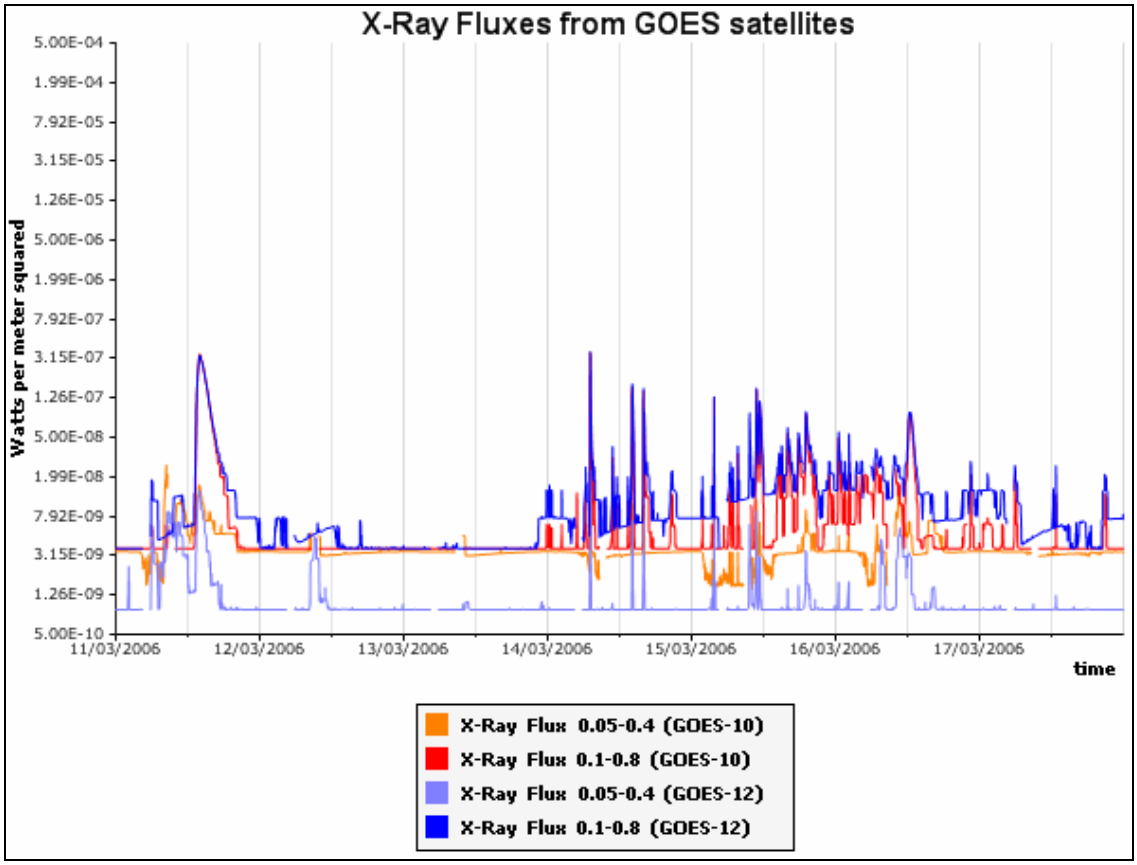
Rev 416



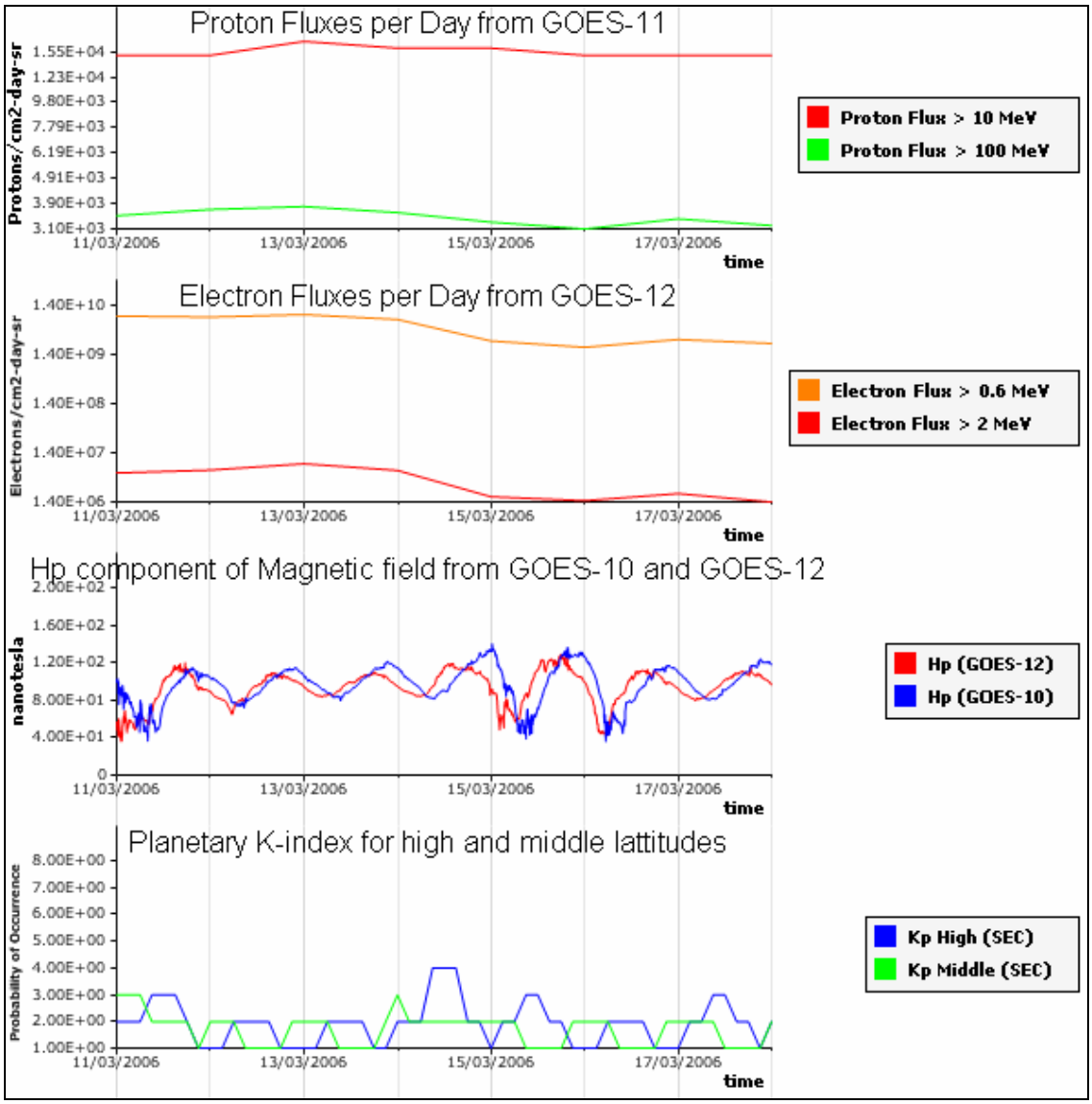
Rev 417



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 are rather low, reporting no high 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.