

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OF
No. 186
Week 15
17.04.06
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 08.04.06 until 14.04.06 (both dates inclusive) and covers the revolutions 426 and 427.

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 the Galactic Center (RA 17:45:40.00; DEC -29:00:28.0); the Galactic Bulge region (RA 17:45:36.00; DEC -28:55:60.0) and the Galactic Plane. The activities consisted of raster and hexagonal dithering and GPS observations.

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.

No slews were lost during the observation period.

The fuel consumption over the period between 08/04/2006 and 14/04/2006 was 0.1016 kg. The remaining propellant is in the order of 155.1979 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

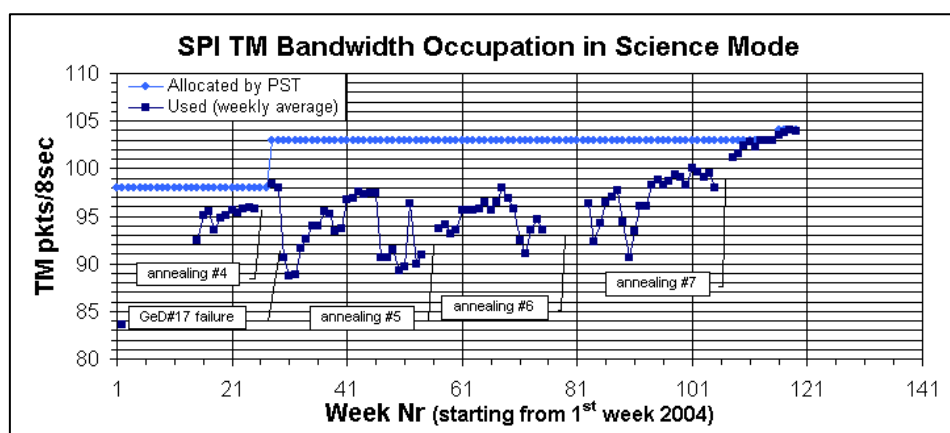
Following the 7th annealing, ended on 24th January, the overall status of the gamma-ray spectrometer is nominal, except for the Ge detector #15, which is showing since 09.02.2006 a slightly degraded energy resolution. Detector #2 is failed since 06.12.2003, detector #17 since 17.07.2004.

During science operations, the instrument was kept in photon-by-photon mode, with spectra TM enabled, the assigned TM bandwidth in the science observation windows of 104 pkts/cycle and the average telemetry occupation was 103.9 pkts/cycle.

The telemetry downlink of SPI has therefore reached the saturation.

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.



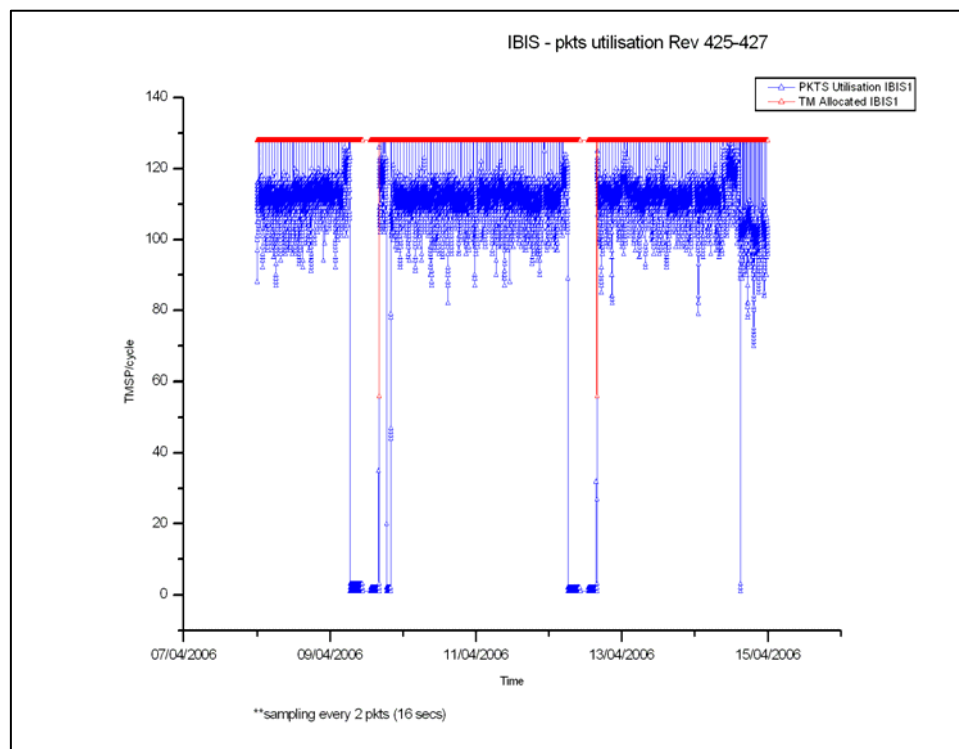
Note: Some more information concerning the SPI operations is provided in the Appendix.

3.2.2 IBIS

The Overall status of the unit is nominal.

During the reporting period, the PST allocation to IBIS was 128 TMPS/cycle. The IBIS mean bandwidth utilisation during the observation period was 112.04 TMPS/cycle, down 1.21 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 and JEM-X2 was dormant (DFEE OFF) with a TM allocation of 1 packet/cycle.

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, 152 of the 155 planned science pointings for OMC were executed nominally. 1 pointing (04260005) was cut short and 2 pointings (04260006 and 04260007) were missed due to OMC being in Safe mode as a result of an IREM SEU.

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

3.2.5 IREM

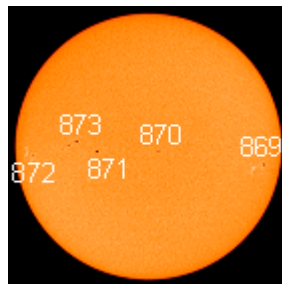
The overall status of the unit is nominal.

On 09/04/2006 at 18:39Z the IREM reset #29 occurred. Following recovery procedure CRP_SYS_2570, instruments were put back in their Science configuration at 19:48Z and 20:07Z respectively for OMC and IBIS. IREM was recovered at 22:32Z.

Solar Activity

The observation period was characterised low solar activity.

Sunspot 865 was vanishing on 08/04/2006. Other 3 sunspots (866, 867 and 869) did not pose any threat of solar flare. On 09/04/2006 appeared sunspot 870, on 11/04/2006 sunspot 871, and on 12/04/2006 sunspots 872 and 873; all sunspots were tiny and posed no threat of solar flare. On the picture below is presented the sun on 13/04/2006 with 5 sunspots.



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. There were several minor problems with REDU 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 were only minor problems reported, which 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 very good this week. There were several instances of bad frames and TM drops, plus an interruption in sending data to the ISDC for 2 minutes, but these had no impact on the mission. The overall performance was well above the 95% requirement.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

New PSF's for revolution 435 and 436 have been received. Due to the short work week no planning has been performed in ISOC. No ToO request was received and no replanning has been performed. TSF for revolutions 430 and 431 were received.

2. Observation status

ECS for all revolutions up to 413 and 415 to 419 were received. The corresponding OCS's will be generated early next week.

3. ISOC science data archive

The version 2.5.1 was released to the public as planned this week.

4. ISOC system

The ISOC system version 12.3 has been used. A couple of problems related to mass printing of proposals have been fixed. Also an exposure map is now available to support the proposal evaluation and TAC process.

5. AO 4

An updated version of the internal procedures (IFOM) including updates for the creation of the proposal data package for the TAC members is now available.

6. Problems

The archive hardware problem is still remaining.

4.3.2 ISDC

Status of ISDC observation processing on 17/04/2006:

- Latest Standard Analysis completed: observation 03700010001 (IGR J17269-4737, Revolution 367) on 16/04/2005

- Latest products archived: observation 03700010001 (IGR J17269-4737, Revolution 367) on 17/04/2005

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

5 Special Events

6 Anomalies

There were a number of problems that impacted the operations:

- On DoY 098, at 12:05Z, the TC link was not operational for 5 minutes after TMP swap. There was no impact.
- On DoY 102 at 16:05Z, the Flight Dynamics System failed to update Pointing 0002 after slew. The missing file was manually generated. There was no impact.

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

AR id	Date Created	Subject	Segment	Status
INT_SC-146	2006-04-10	IREM Anomaly: Reset of IREM_CSCI S/W #29, 09/04/2006	Payload	Open

7 Future Milestones

On the 3rd of May starts the summer eclipse season. It will last until the 24th of May when eclipse #8 occurs.

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 426

The observations in revolution 426 began with a hexagonal dither of the Galactic Bulge region (RA 17:45:36.00; DEC -28:56:00.0), for ~3.5 hours. The rest of the orbit was devoted to a raster dither of the Galactic Centre (RA 17:45:40.00; DEC -29:00:28.0), which lasted ~55.1 hours.

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 128; SPI 104; JEM-X1 8; JEM-X2 1; OMC 5.

Revolution 427

The observations in revolution 427 began with a raster dithering observation of the Galactic Center (RA 17:45:40.00; DEC -29:00:28.0) lasting ~42.5 hours. A hexagonal dithering observation of the Galactic Bulge region (RA 17:45:36.00; DEC -28:55:60.0) lasting ~3.5 hours was then performed, followed by a GPS, performed for the remaining ~15 hours of observation time.

Throughout these observations all instruments were in their nominal science modes, except JEM-X2 for which the DFEE was off, and the TM allocation was IBIS 128; SPI 104; JEM-X1 8; JEM-X2 1; OMC 5.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

2006-03-28T08:50:46.000Z	155.4740	F	Automatic TM processing.
2006-03-28T11:16:14.000Z	155.4620	F	Automatic TM processing.
2006-03-28T15:09:51.000Z	155.4480	F	Automatic TM processing.
2006-03-31T09:40:15.000Z	155.4272	F	Automatic TM processing.
2006-03-31T14:54:15.000Z	155.4069	F	Automatic TM processing.
2006-04-01T00:02:08.000Z	155.3696	F	Automatic TM processing.
2006-04-02T01:26:27.000Z	155.3487	F	Automatic TM processing.
2006-04-03T14:32:07.000Z	155.3347	F	Automatic TM processing.
2006-04-05T01:39:14.000Z	155.3135	F	Automatic TM processing.

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2006-04-06T14:15:10.000Z	155.2995	F	Automatic TM processing.
2006-04-08T00:33:30.000Z	155.2750	F	Automatic TM processing.
2006-04-09T13:58:06.000Z	155.2652	F	Automatic TM processing.
2006-04-11T00:16:34.000Z	155.2414	F	Automatic TM processing.
2006-04-12T13:39:34.000Z	155.2363	F	Automatic TM processing.
2006-04-14T00:03:14.000Z	155.1979	F	Automatic TM processing.

This report was generated Fri Apr 14 08:00:28 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, 08/04/2006 – 14/04/2006

AOCS operations were executed from the Automatic Timeline.

During this period, 107 Open Loop Slews, 53 Closed Loop Slews and 6 Momentum Bias were executed.

No slews were lost during the observation period.

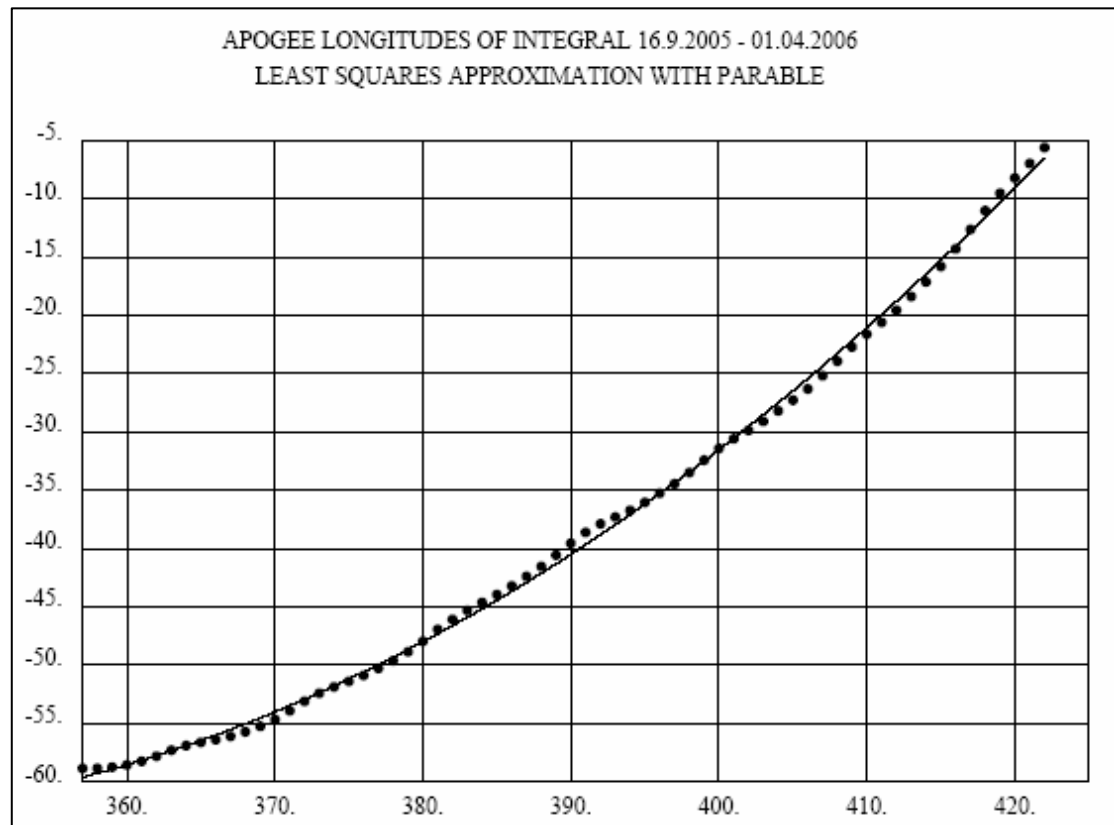
Orbit Control

At present time the target is to reduce the eastward drift, by reversing the control and to increase the semi-major axis. From mid July onwards Redu should have coverage down to 40000 km altitude. The apogee longitude will be about 32 deg East.

The following table shows the shortening of the necessary Goldstone pass:

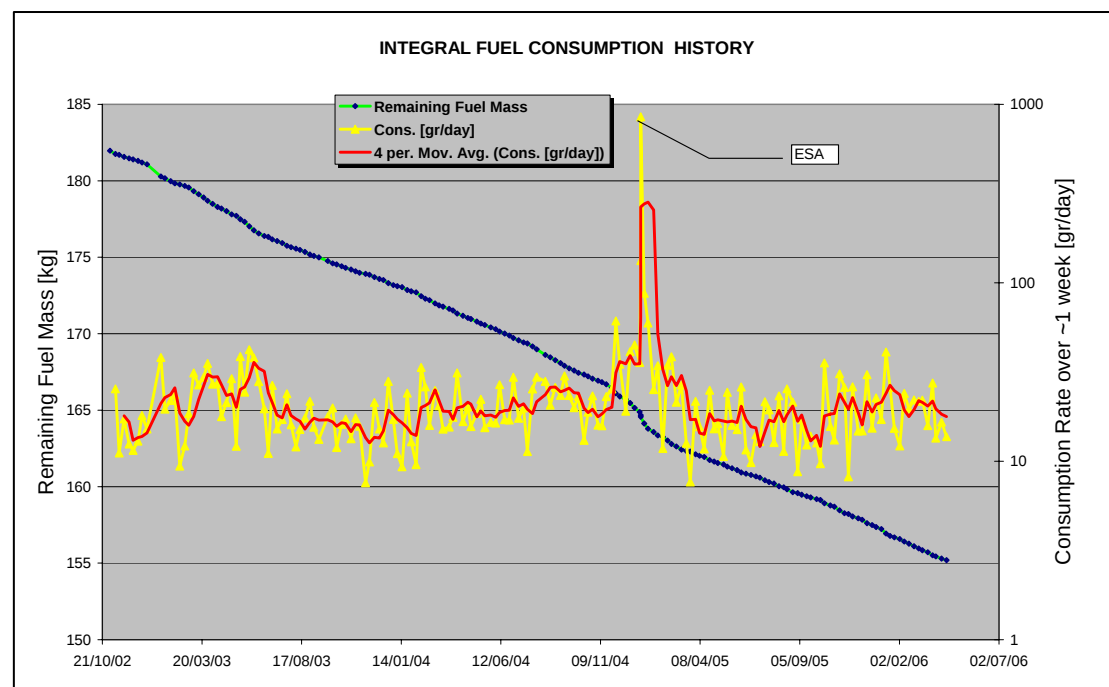
Orbit number	Apogee passage date	Time from LOS Redu to 40000 km altitude
362	2005/10/01	284 min
372	2005/10/31	268 min
382	2005/11/30	244 min
393	2006/01/02	213 min
402	2006/01/29	188 min
412	2006/02/28	159 min
422	2006/03/30	122 min

The attached plot shows the apogee longitude of Integral as a function of the orbit number. According to the linear least squares approximation with a parable the drift rate is 1.30 deg eastward shift per orbit at the end of the period.

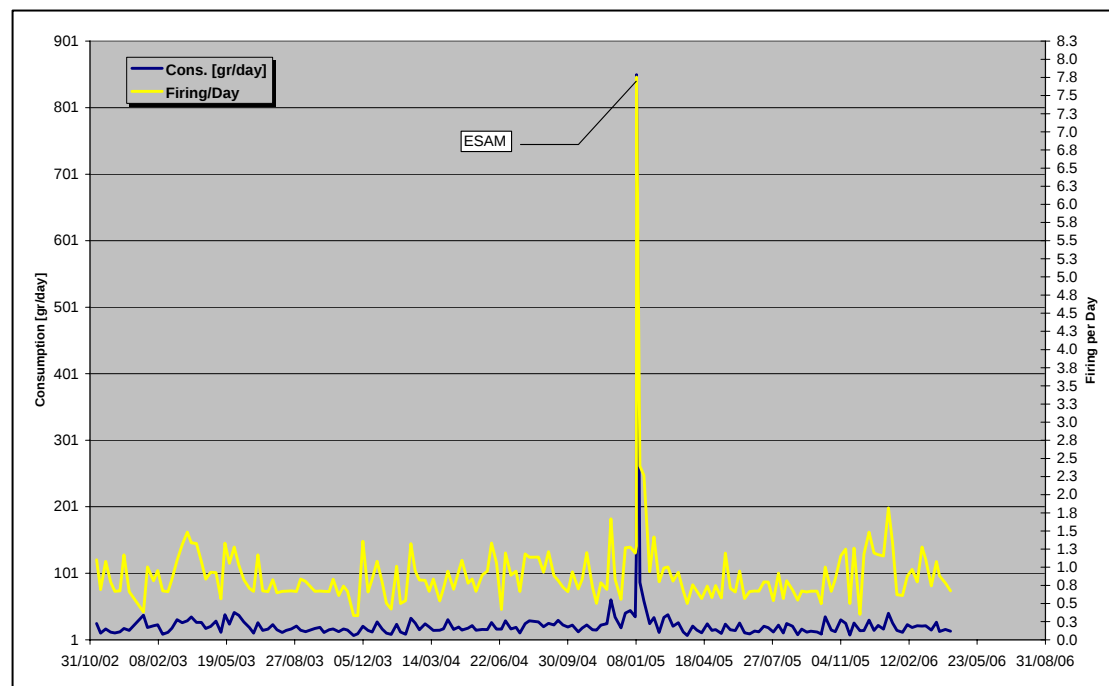


Fuel consumption

The fuel consumption (total, grams/day) over the period between 01/11/2002 and 14/04/2006 is reported in the plot below.

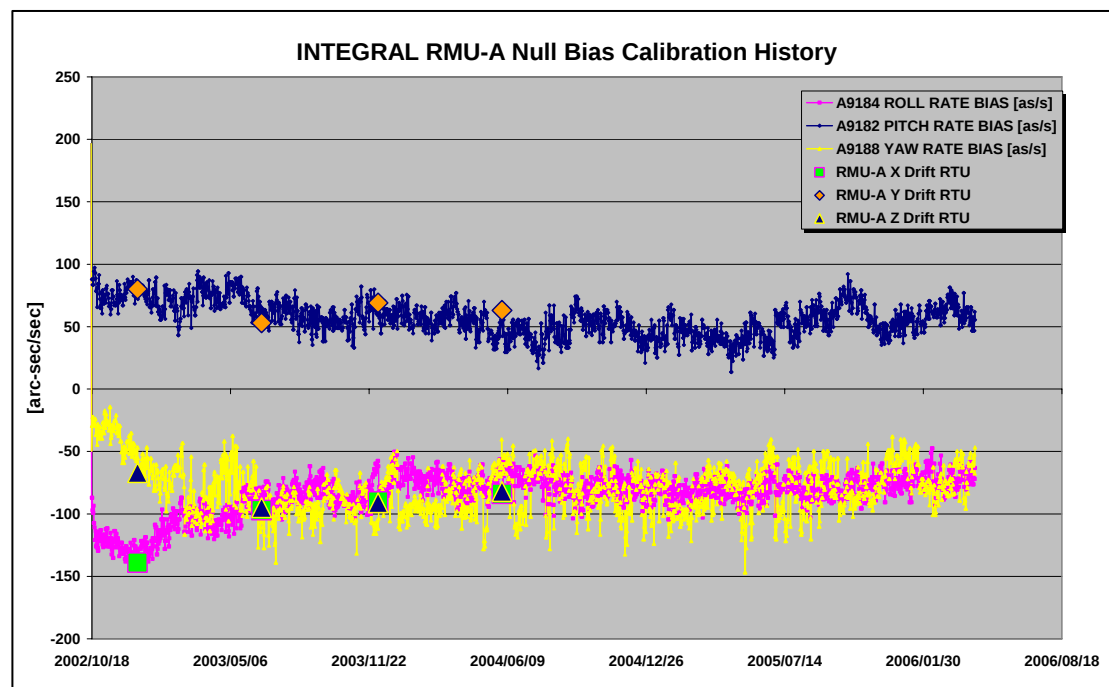


The firing\day over the period between 01/11/2002 and 14/04/2006 is reported in the plot below.

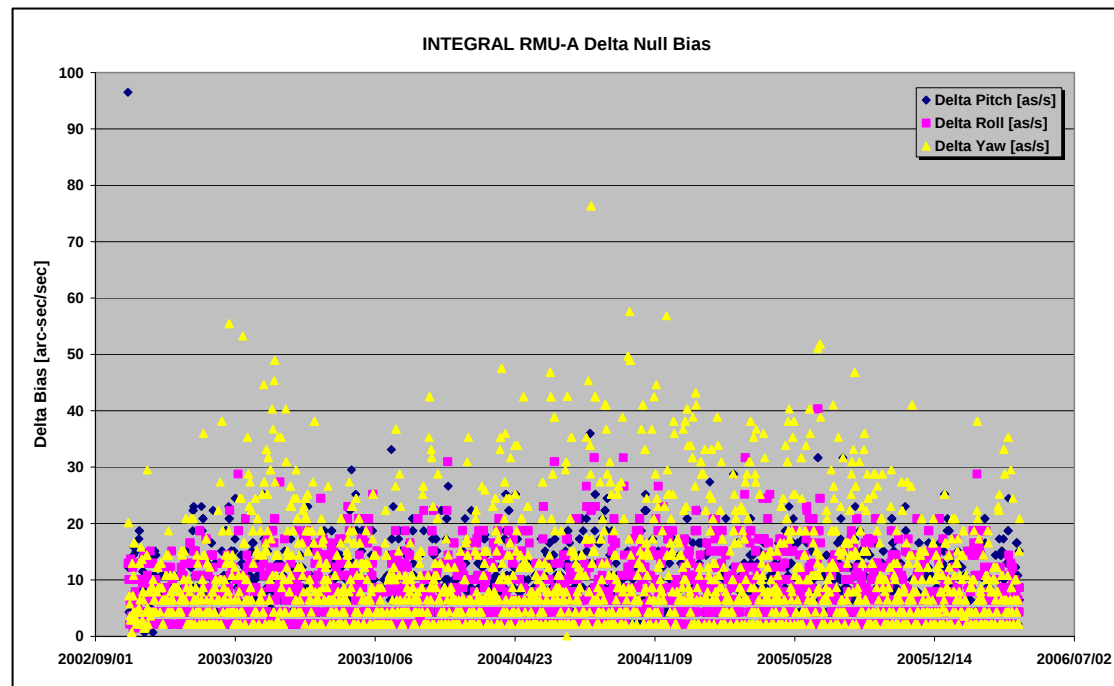


The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 14/04/2006 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 14/04/2006 is reported in the plot below.



08/04/06 (Day of Year 098, Revolution 425)

Nothing to report

09/04/06 (Day of Year 099, Revolution 425-426)

Nothing to report

10/04/06 (Day of Year 100, Revolution 426)

Nothing to report

11/04/06 (Day of Year 101, Revolution 426)

Guide star released by the STR SEU Filter: at 22:19Z the ACC reported STR threshold exceeded: the guide star was released during pointing ID 04260058 and the IMU1 was switched ON. A new guide star was picked in the first automatic mapping, which was kept afterwards. The OTF was not reached during the end of PID 04260058. The update for the slew ID 04260059 was manually performed at 22:29Z.

No impact on TL reported, except that the OTF for the PID 04260058 was not reached.

12/04/06 (Day of Year 102, Revolution 426-427)

Guide star released by the STR SEU Filter: at 13:09Z the ACC reported STR threshold exceeded: the guide star was released and the IMU1 was switched ON. A new guide star was picked in the first automatic mapping, which was kept afterwards.

No impact on TL reported being the event occurred after AOS REDU at the beginning of the revolution 427.

FDS failed slew update: At 16:05Z the FD system failed the update of the slew ID 04270002 (OSL). After a preliminary investigation, FD reported to be a problem due to the concurrent orbit file update when slew task update running. This prevented the FDS to read the file (considered as corrupted) and caused the failure of the TL update. Similar problem occurred already on 13/03/2006.

The recovery was manually performed and the update for the next slew (ID 04270003) from TL was performed at 16:15Z.

No impact on TL reported.

13/04/06 (Day of Year 103, Revolution 427)

Nothing to report

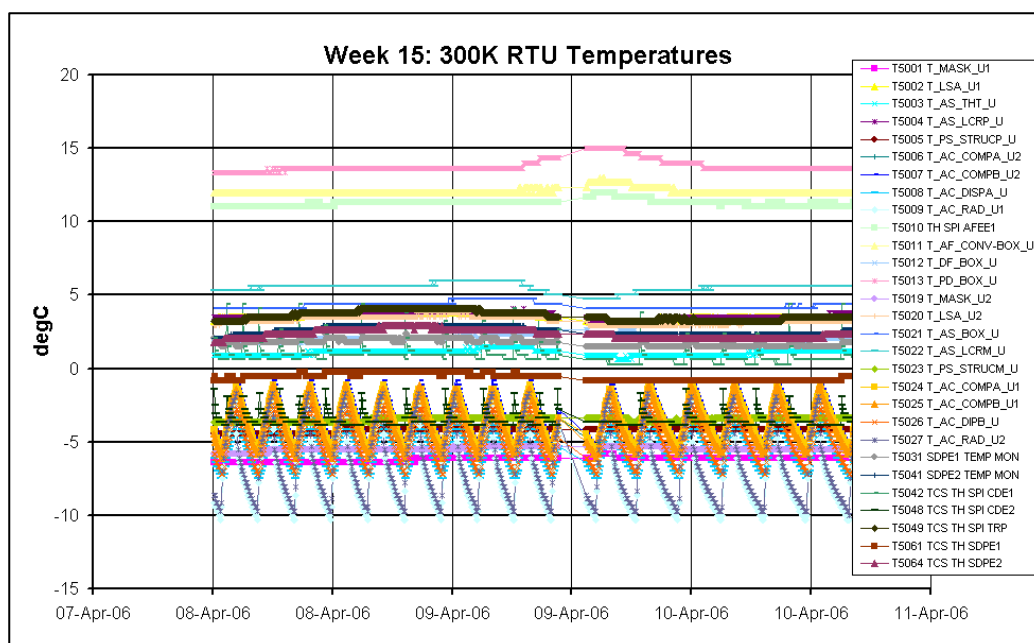
14/04/06 (Day of Year 104, Revolution 427)

Nothing to report

8.3.2 SPI Operations

Unit Temperatures:

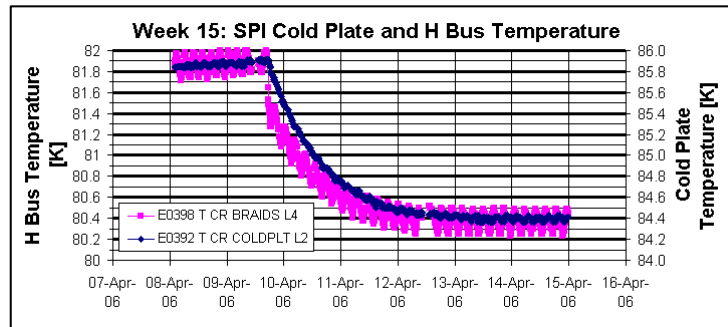
All the equipment temperatures are inside the operational limits. The following plot shows their evolution along the reporting period.



Stirling Compressors and Cryostat:

The performance of the compressors is nominal. The cold plate temperature was maintained at 85K $\pm$ 1K showing the expected positive drift. The stroke was increased during this week to compensate the accumulated effects of the drift.

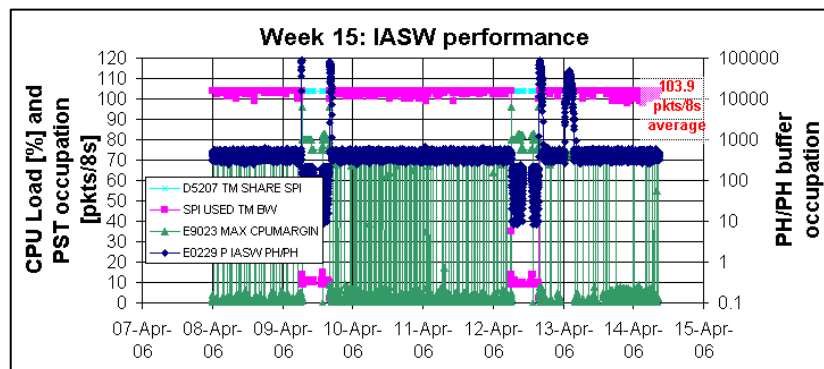
The following plot shows the evolution of the cold-plate and H bus temperatures during the reporting period.



DPE & IASW:

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

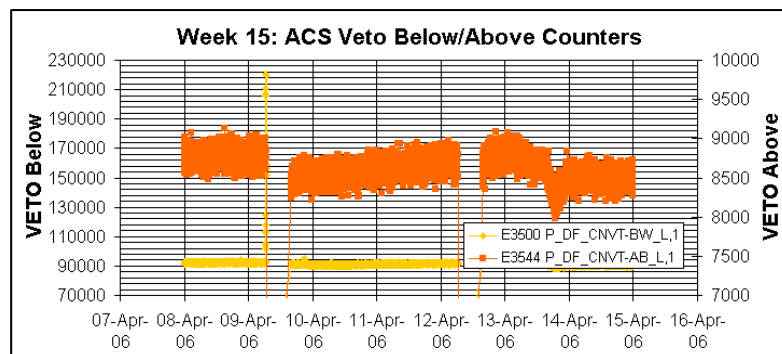
The following plot shows the IASW performance in terms of TM bandwidth, event buffer occupation and DPE CPU load during the reporting period.



ACS:

The performance of the ACS is nominal.

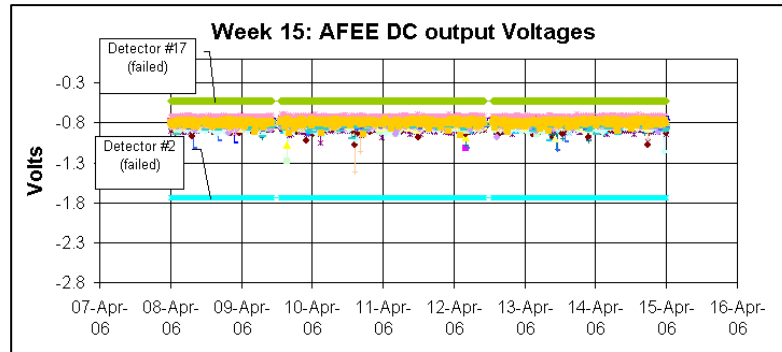
The following plot shows the ACS overall count rate evolution during the reporting period



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.

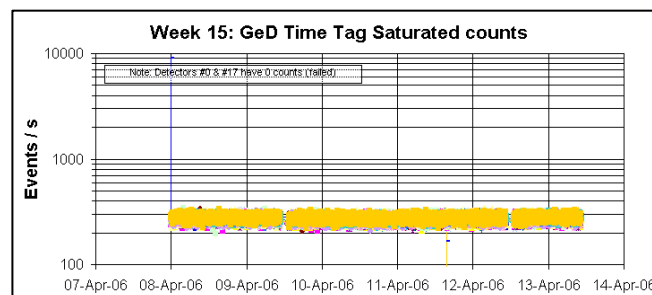
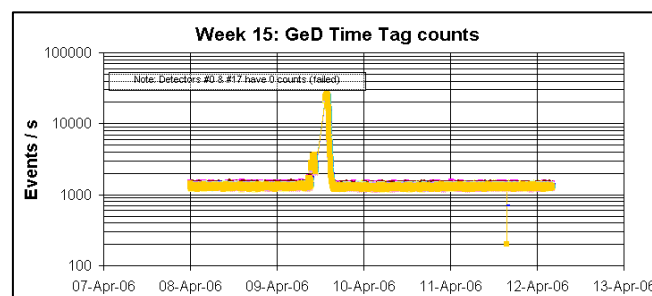
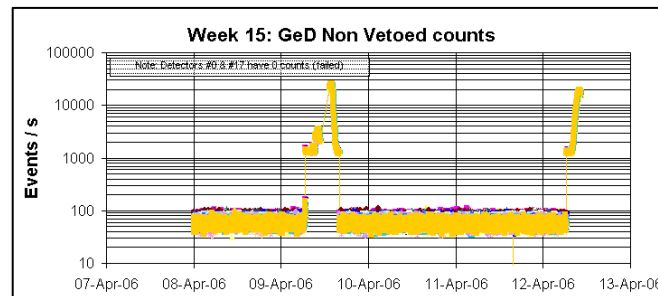
The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06.12.2003 and detector #17 is failed since 17.07.2004.



DFEE:

The performance of the unit is nominal.

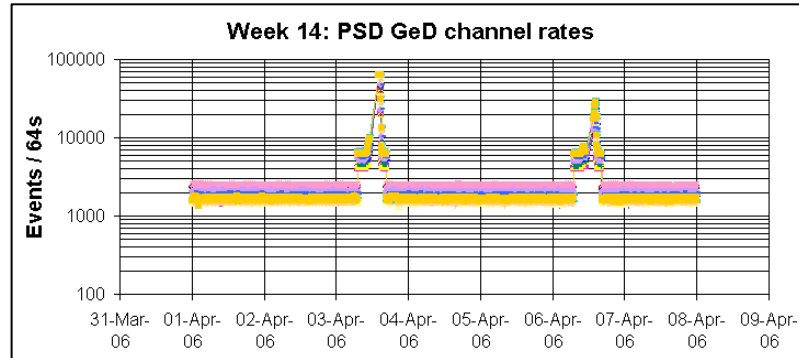
The following plots show the Non Vetoed, Time Tag and Time Tag Saturated Event Count Rates during the reporting period.



PSD:

The performance of the unit is nominal.

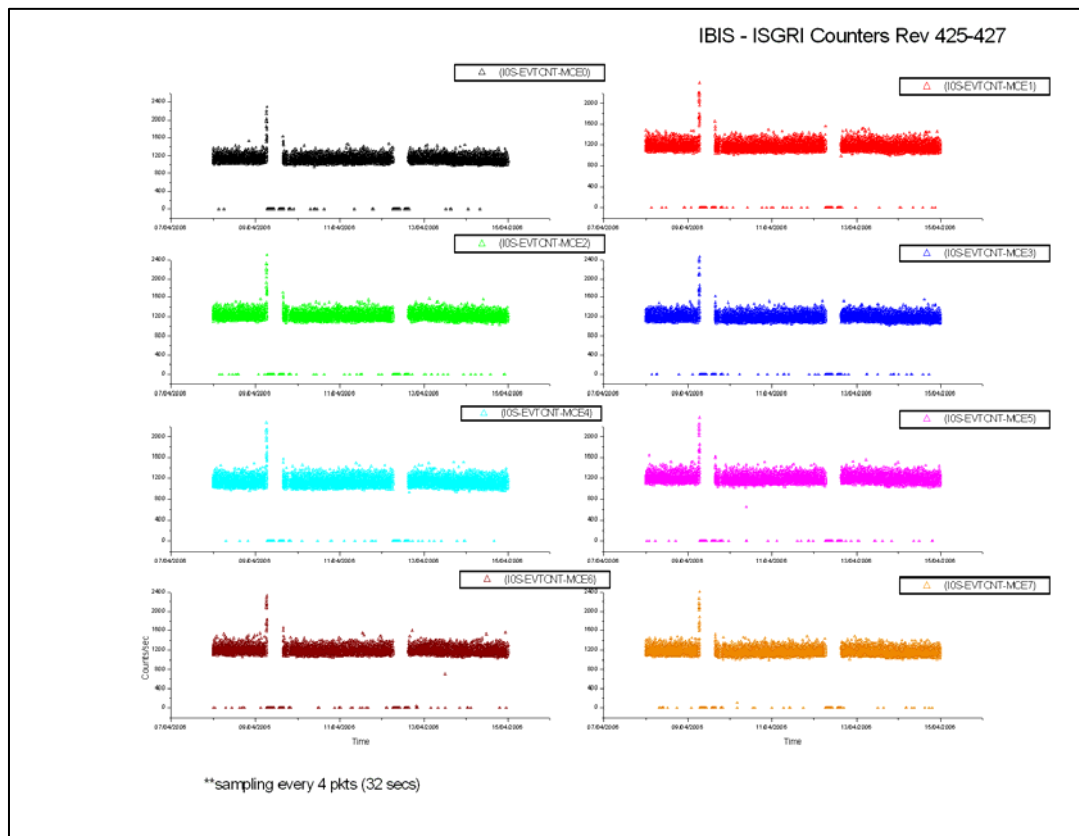
The following plot show the PSD channel rates for week 14; the one for week 15 will be provided next week.



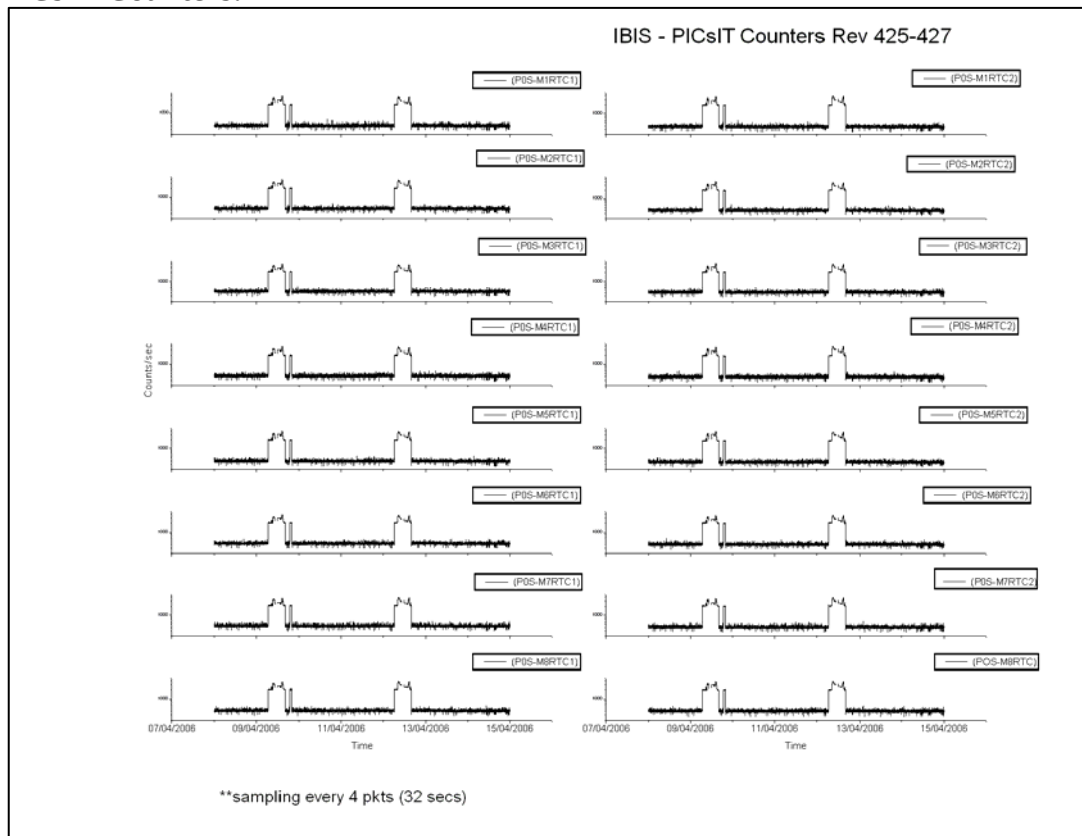
8.3.3 IBIS Operations

IBIS Event Counters Plots.

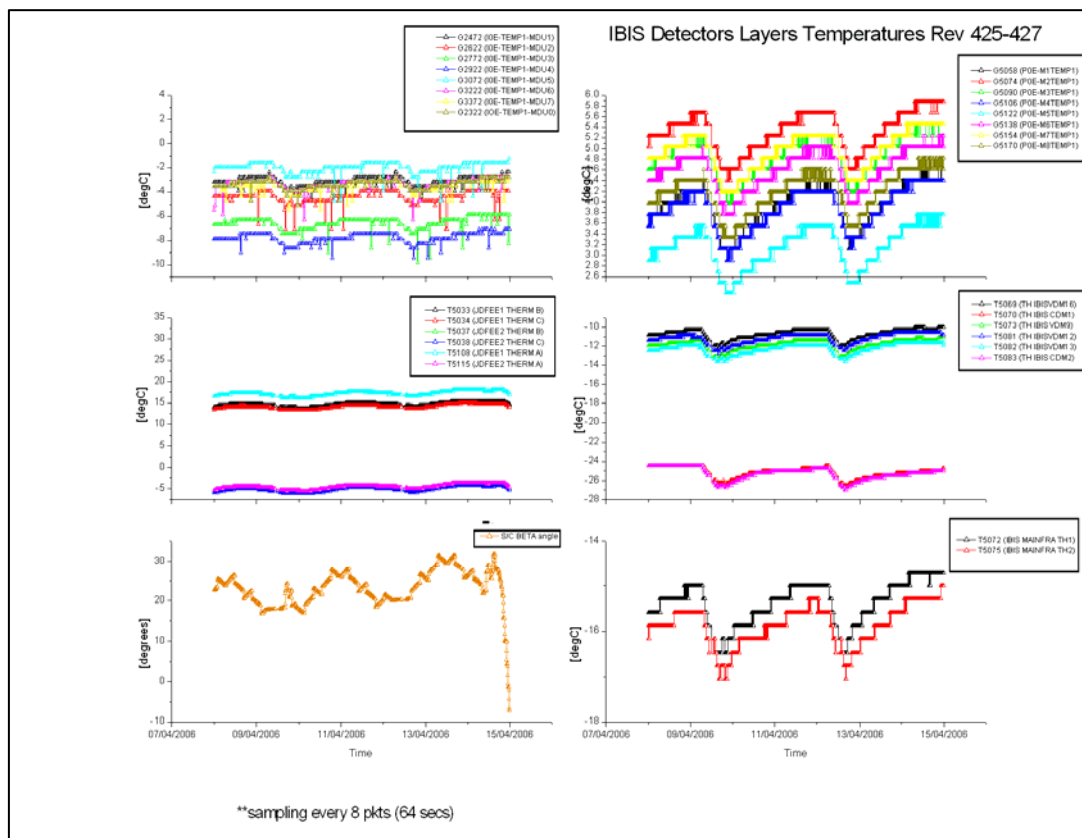
ISGRI Counters:



PICsIT Counters:



IBIS Detectors Layers Temperatures:



IBIS daily report

DoY 2006.099 (09/04/2006):

At 06:31Z, TM parameters G6062 (V1S-BOT-COUNT) and G6063 (V1S-LAT-COUNT) were toggling Out Of Limit High as the S/C was approaching the Radiation Belts.

At 06:40Z, TM parameter G8015 was reported Out Of Limit high. It went back inside limit at 16:11Z. As this happened inside the radiation belts (following VETO Stand-By mode), according to V-VLT-1 no action was taken.

Inside the radiation belts, TM parameters G5008 (P0S-M2RTC2) and G5013 (P0S-M3RTC2) were toggling OOL high. According to P-CNT-1, no action was taken.

At 15:42Z, TM parameter G2014 (I0E-OVFWPXADD-M1) failed SCC and back. At 15:55Z, TM parameter G2070 (I0E-OVFWPXADD-M5) failed SCC and back. According to I-OVF-1, as this happened inside radiation belts, no action was taken.

DoY 2006.099 (09/04/2006): IREM SEU #29

At 18:39Z, due to an IREM reset (#29), IBIS went automatically into safe configuration with ISGRI and VETO in Stand-By. The recovery was performed following FCP_IBIS1_0803, and IBIS was back into Scientific Standard mode at 20:05Z.

During the whole time when VETO was in Stand-By mode, TM parameter G8015 was reported Out Of Limit high.

DoY 2006.102 (12/04/2006):

At 06:22Z, TM parameter G8015 was reported Out Of Limit high. It went back inside limit at 15:52Z. As this happened inside the radiation belts (following VETO Stand-By mode), according to V-VLT-1 no action was taken.

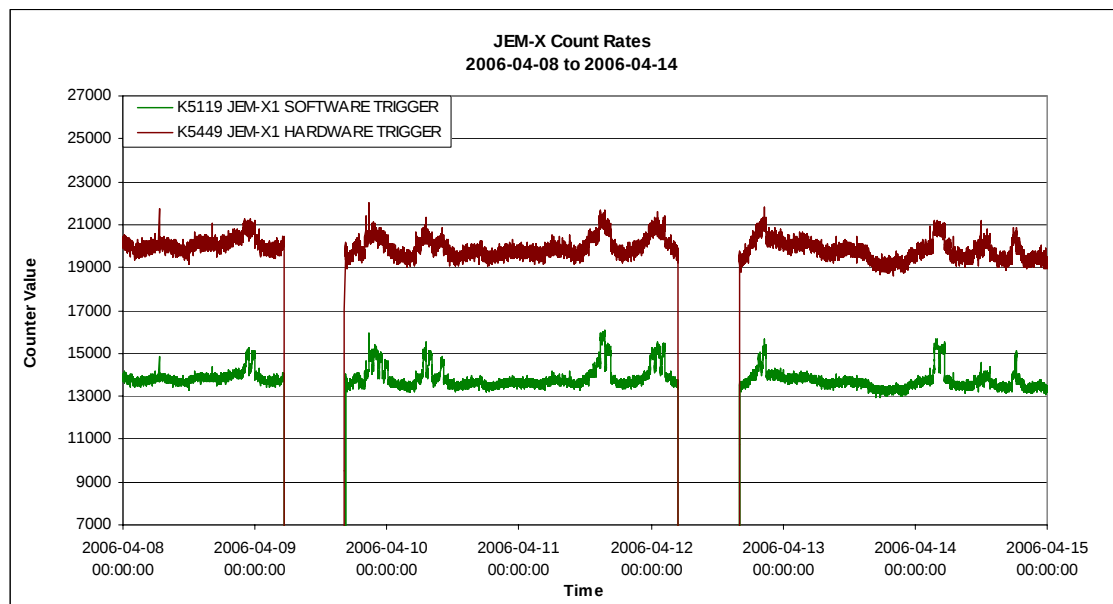
At 15:16Z, TM parameter G2028 (I0E-OVFWPXADD-M2) failed SCC and back. According to I-OVF-1, as this happened inside radiation belts, no action was taken.

8.3.4 JEM-X Operations

8.3.4.1 JEM-X Count Rates

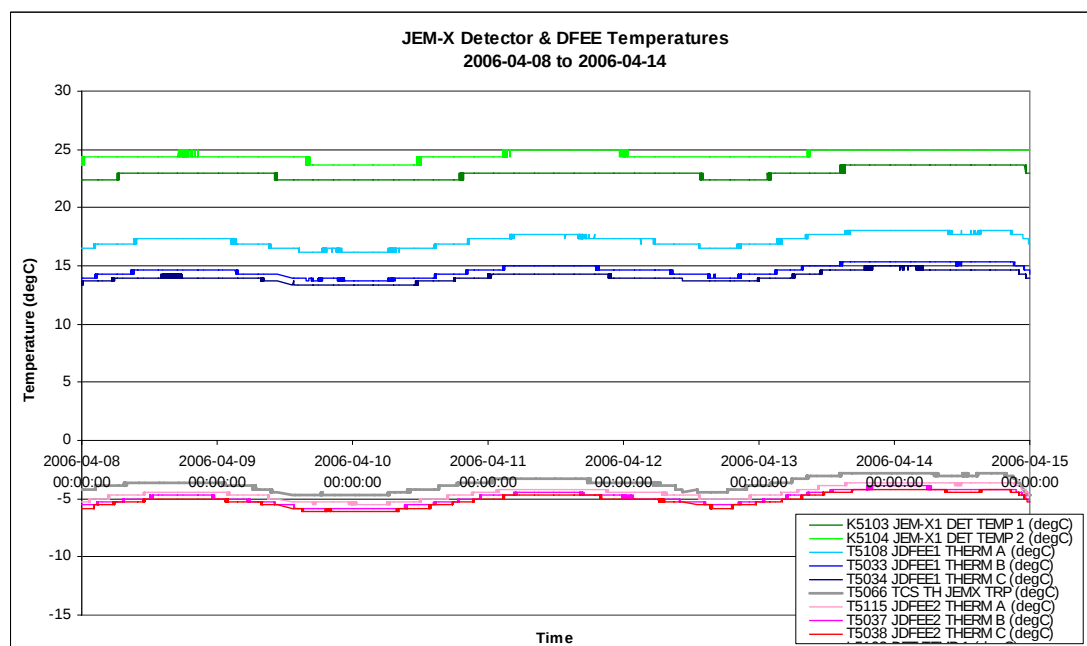
JEM-X count rates over the reporting period are displayed in the following graph¹.

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.



8.3.4.3 JEM-X Daily Report

2006-04-08 (DOY 098, Rev 425) to 2006-04-14 (DOY 104, Rev 427)

Nothing to report

² Data sampled (1 frame in 8)

8.3.5 OMC Operations

2006-04-08 (DOY 098, Rev 425)

Nothing to report

2006-04-09 (DOY 099, Rev 425-426)

At 18:39:22Z, during pointing ID 04260005, OMC went to Safe mode autonomously due to an IREM SEU (see Anomaly Report INT_SC-146) and commanding to OMC from the Timeline was then disabled at 18:45Z. As part of the recovery procedure, OMC was commanded out of Safe mode at 19:47:39Z via FCP_OMC_0041 and commanding to OMC from the Timeline was re-enabled. OMC resumed nominal operations from pointing ID 04260008 onwards.

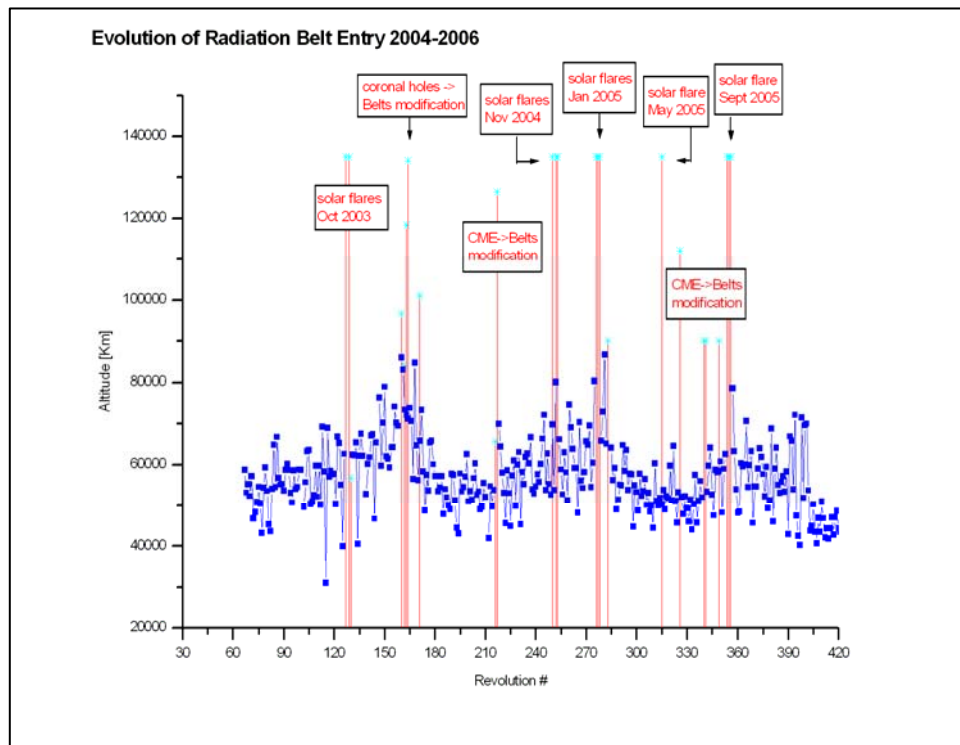
2006-04-10 (DOY 100, Rev 426) to 2006-04-14 (DOY 104, Rev 427)

Nothing to report

On DoY 99 at 06:40:59Z and DoY 102 at 06:22:26Z 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

DoY 2006.099 (09/04/2006):

At 18:39Z a local reset of the IREM CSCI S/W (SEU #29) occurred: as previously (see anomalies on 16/12/02, 01/01/03, 03/06/03, 11/07/03, 19/07/03, 05/08/03, 24/08/03, 26/12/03, 13/05/04, 16/05/04, 09/06/04, 12/06/04, 10/09/04, 14/09/04, 28/10/04, 06/11/04, 01/12/04, 11/12/04, 30/01/05, 11/02/05, 04/03/05, 11/05/05, 17/05/05, 15/06/05, 30/07/05, 07/09/2005, 20/09/2005, 21/11/2005) the status of the unit, before the anomaly, 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 2006.099.18.39.12Z at 62469.6 km when the unit 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 18:54Z using procedure CRP_SYS_2570. The first dump of the status word after the anomaly showed a value of BCC0 HEX = 48320 DEC = 1011110011000000, ie. the unit was still reporting the status as if it was in Integral mode with counting ON, accumulation ON and checksum failure flag 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) A dump of all the registers gave a status word BC80 HEX = 48256 DEC = 1011110010000000, ie. the unit was still reporting the status as if it was in Integral mode but the checksum failure flag was this time OFF and the checksum counter in the register number 3 incremented by 1 unit.
- 7) The patch was performed successfully with the correct re-starting of the S/W. The operation was completed at 22:32Z.

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.

The recovery of the payload was performed with OMC re-enabled at 19:48Z, and IBIS at 20:07Z.

The cause of this S/W reset is still under investigation, but it is apparently due to the unit's memory device that is sensitive to ionising radiation.

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]
425	RAD_ENTR R 2006-04-09T06:40:43Z	2006-04-09 06:45:44	<59571.2	2006-04-09 08:02:11	49153
426	RAD_EXIT R 2006-04-09T15:58:29Z	2006-04-09 15:32:08	<<42212.7	2006-04-09 15:22:11	34539
426	RAD_ENTR R 2006-04-12T06:22:12Z	2006-04-12 08:01:36	<47312.1	2006-04-12 07:44:16	48992
427	RAD_EXIT R 2006-04-12T15:40:30Z	2006-04-12 15:06:48	<<42162.4	2006-04-12 15:04:16	34628

Reference

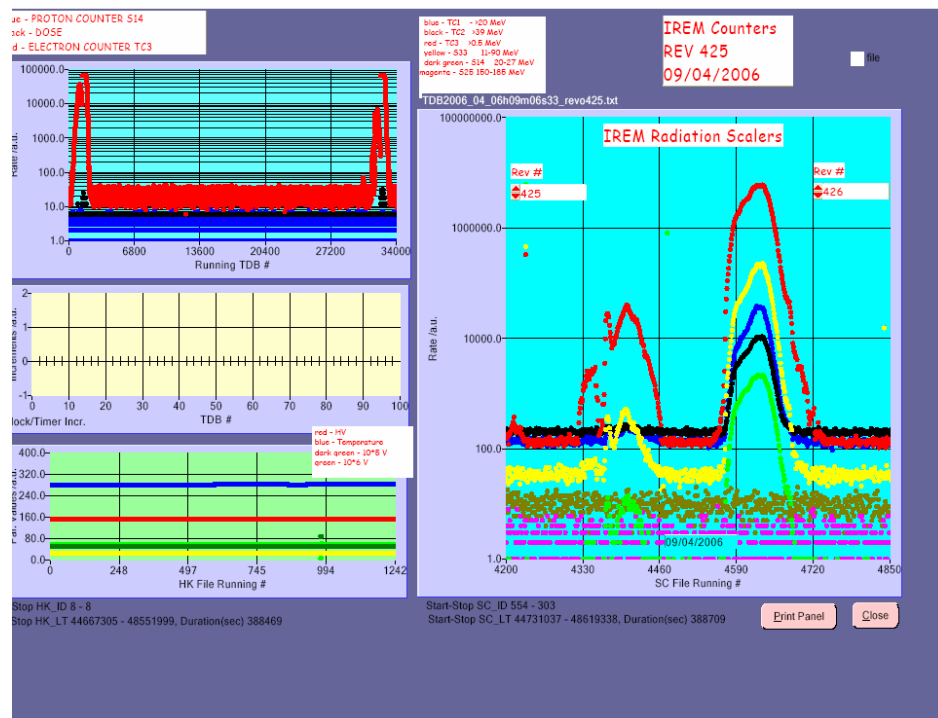
Very small error vs reference (less than 10 minutes)

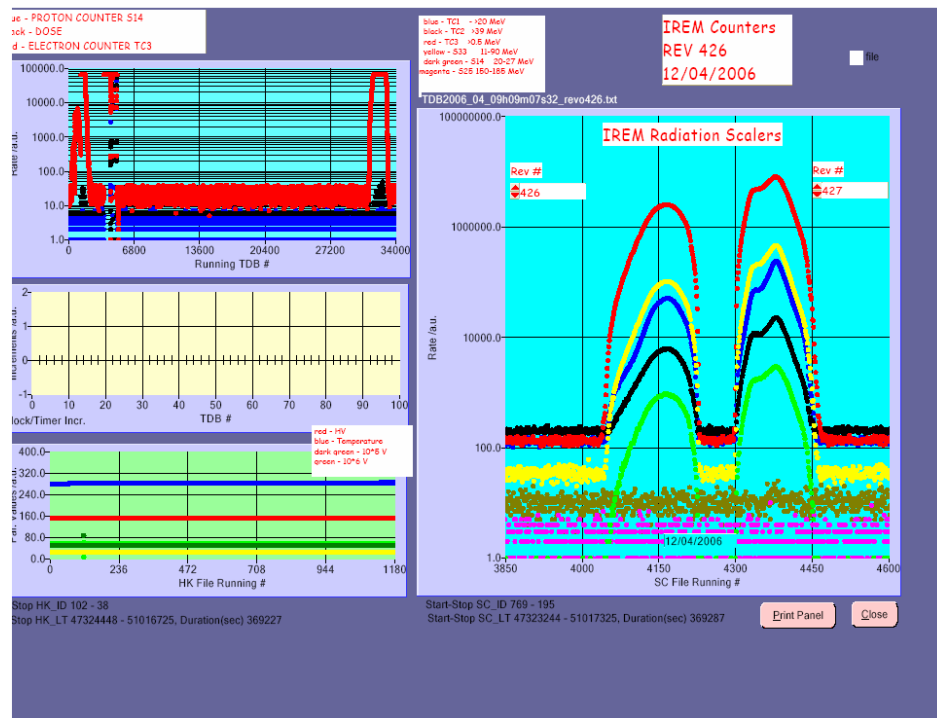
Small error vs reference (between 10 and 30 minutes)

Large error vs reference (more than 30 minutes)

High Radiation

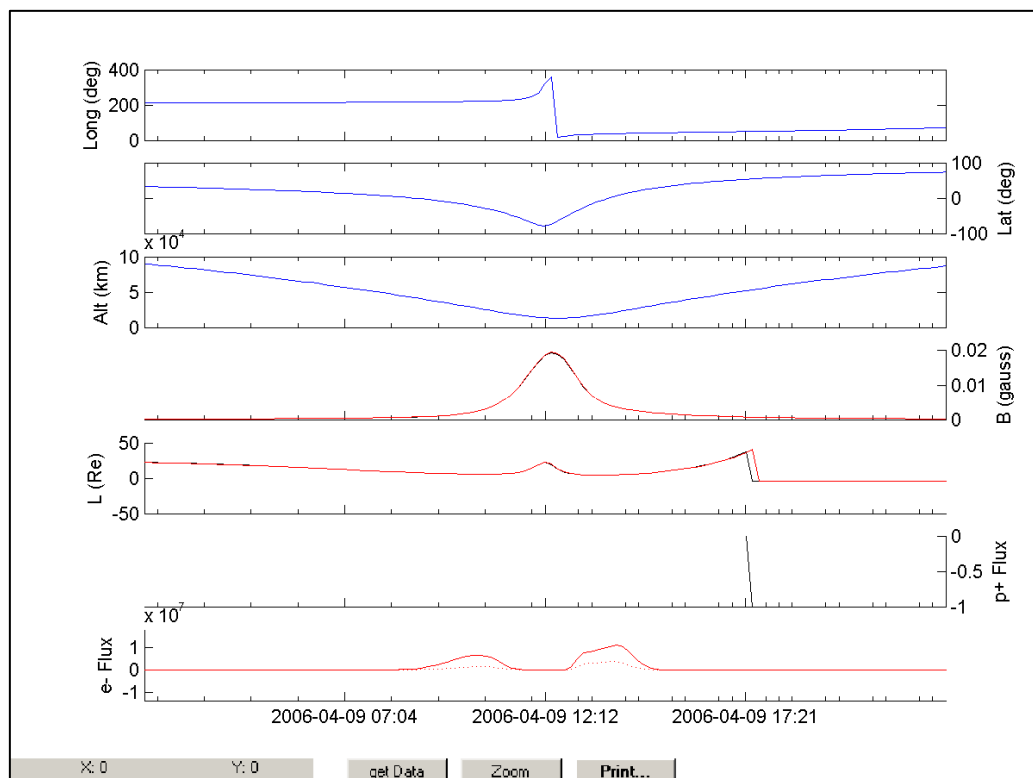
IREM radiation counters:



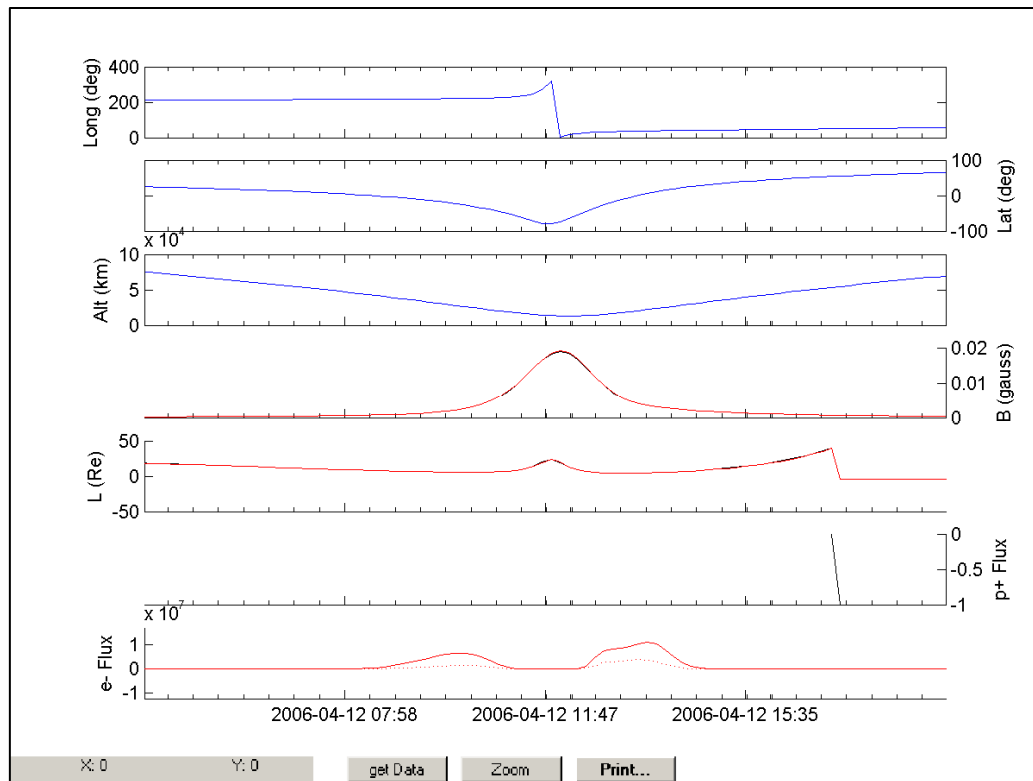


IREM Predicted Radiation Belt Passages

Rev 425

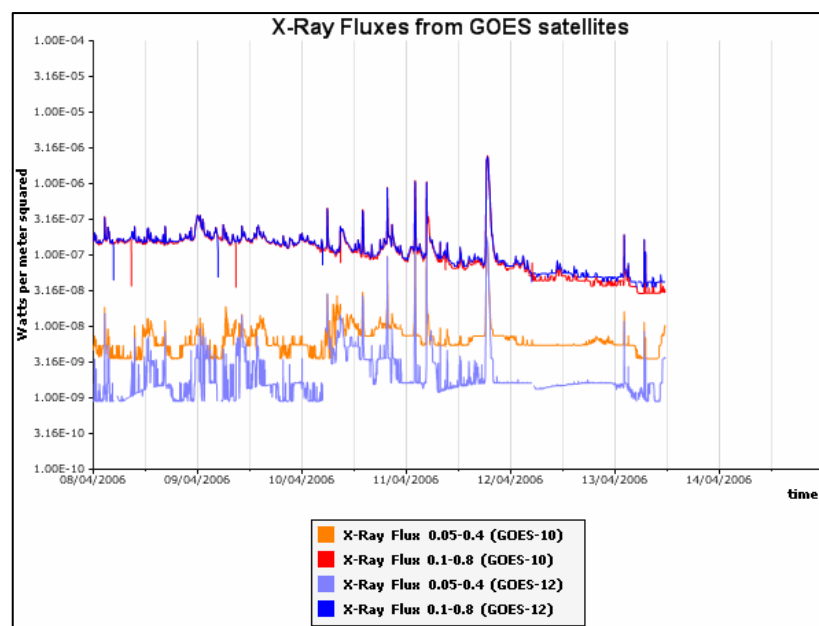


Rev 426

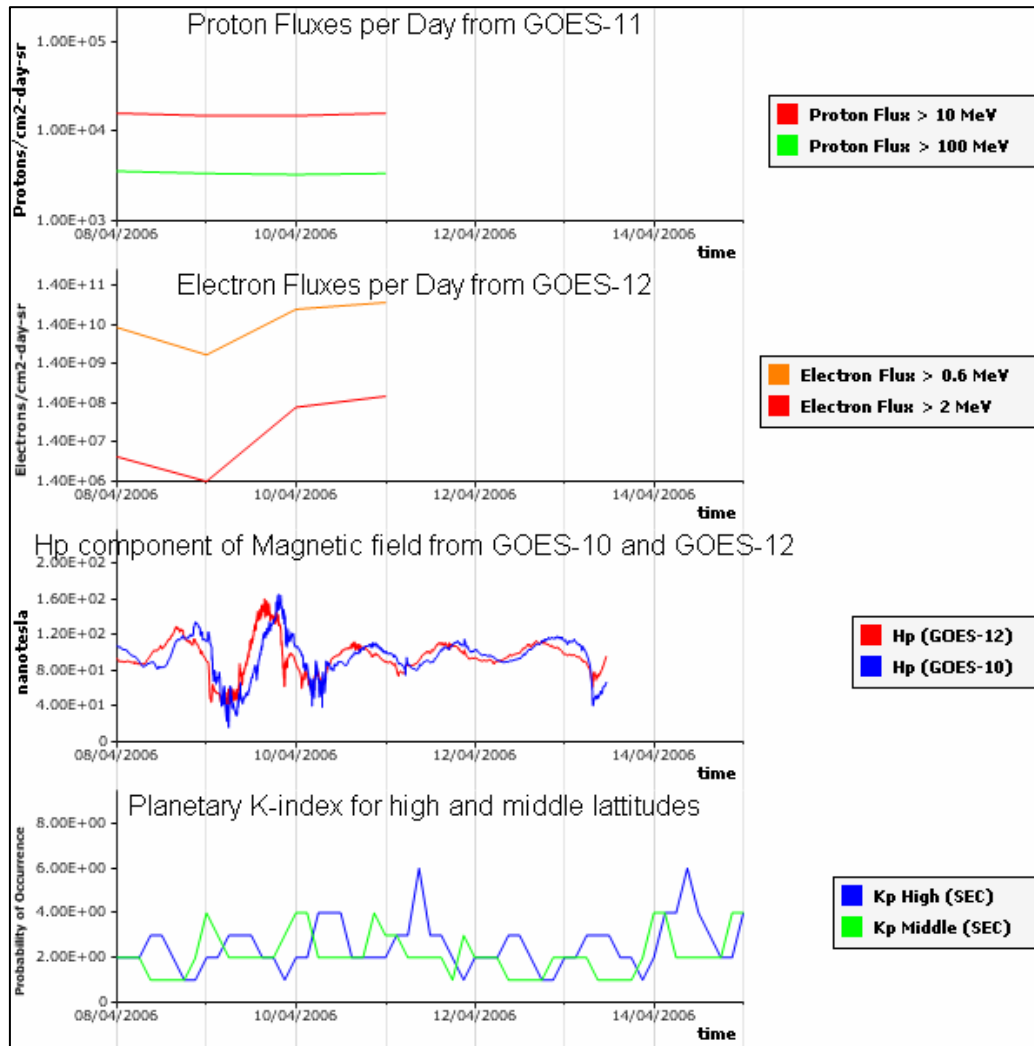


SEC-GOES Observed Particles Fluxes (using SEIS/RAT tool):

Some data are missing from the plot. Investigation is on-going with SEIS-RAT support team. However, from other sources, it is confirmed that the particles fluxes (X-Ray, Proton and Electron) are in usual range.



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.