

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OAI
No. 331
Week 04
26.01.09
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 17.01.09 until 23.01.09 (both dates inclusive) and covers the revolutions 764, 765 and 766.

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 a Target of Opportunity, a hexagonal dither of the blazer PKS 1510-089 (RA 15:12:50.53, DEC -09:05:59.8), a hexagonal dither of the radio galaxy Centaurus A (RA 13:25:27.61, DEC -43:01:08.9) and a hexagonal dither of the gamma-ray blazer 3C 279 (RA 12:56:11.17, DEC -05:47:21.5).

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 missed from TL, during the observation period.

The fuel consumption over the period between 17/01/2009 and 23/01/2009 was 0.0995 Kg. The remaining propellant is in the order of 136.3858 Kg.

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

3.1.2 Power

All the other units of EPS are 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.

The PST was over-subscribed by 3 packets, which were allocated to SPI during the Instrument window for the entire reporting period.

On 23/1/2006 the procedure to adjust the CLCW distribution in HK TM was executed, the distribution was reversed from its value of 80% in favour of decoder 2, to 80% in favour of decoder 1.

To recap, this procedure is necessary when changing the RF switch in use, SWA requires use of decoder 2, SWT requires use of decoder 1. In order to ensure fast command verification it is necessary to ensure that there are sufficient frame verification messages in the processed HK TM for the commanded decoder. The procedure to do this consists in switching back and forth between low and high bit rate until a phasing of the TM frame generation with regard to the RTC interrupt is obtained which gives a good distribution.

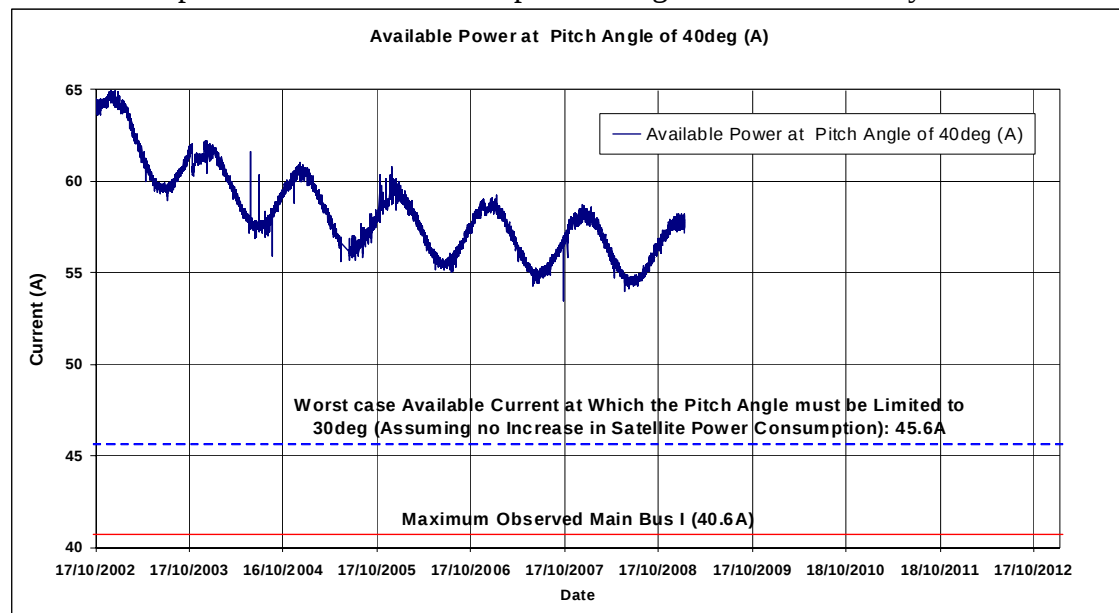
From now until the next adjustment decoder 1 should be used for all commanding activities, for Antenna swaps the SWT must be commanded.

The RF switch in use is cycled periodically in order to minimise for as long as possible any degradation in the TC / TM path via the 2 switches which may be caused by a high number of switchings on one individual switch. To date we have executed 978 switchings on SWA and 758 on SWT.

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.

The attached plot illustrates the current power margin on the solar arrays.



- The wave form superimposed on the long term trend is the seasonal variation caused by the variation in earth-sun distance.

- The power output figures are based on the output current of Wing 1 panel 1 which is always connected to the Main Bus and gives the most representative current.
- The power output figures are adjusted to show the output at a pitch angle of 40degrees. No correction is made for roll angle or temperature.
- The plot of maximum observed main Bus Current and Array current output current at which the pitch angle must be limited show that we should have sufficient margin to operate the satellite without constraint for the foreseeable future.

3.2 Payload

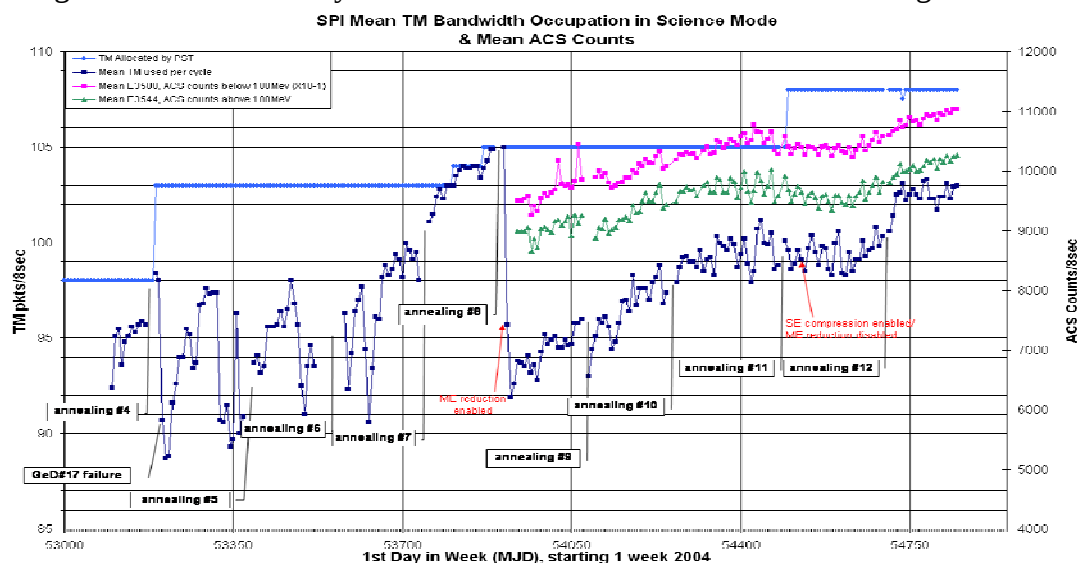
3.2.1 SPI

Following the 12th annealing, ended on 04/09/2008 at 23:50Z, the overall status of the gamma-ray spectrometer is nominal, except for detector #2 (failed since 06/12/2003) and detector #17 (failed since 17/07/2004). The energy resolution of the previously degraded GeD#12 has improved following this annealing and the bias of this detector is now set to 4kV as for the other detectors.

The Stirling compressors are working nominally. The Germanium detectors temperature was kept in the range 80K $\pm$ 1K throughout the week.

During science operations, the instrument was kept in photon-by-photon mode with spectra TM enabled. The assigned TM bandwidth in the science observation windows was 108 packets/cycle and the average telemetry occupation was 103 packets/cycle.

The following plot shows the evolution of the assigned and the average occupation of the SPI TM bandwidth along with the mean ACS count rate evolution (since July 2006). As can be seen, there is a strong correlation between the evolution of the background as measured by the ACS and the overall TM bandwidth usage.



Note: Some more information concerning the SPI operations is provided in the Appendix 8.3.2.

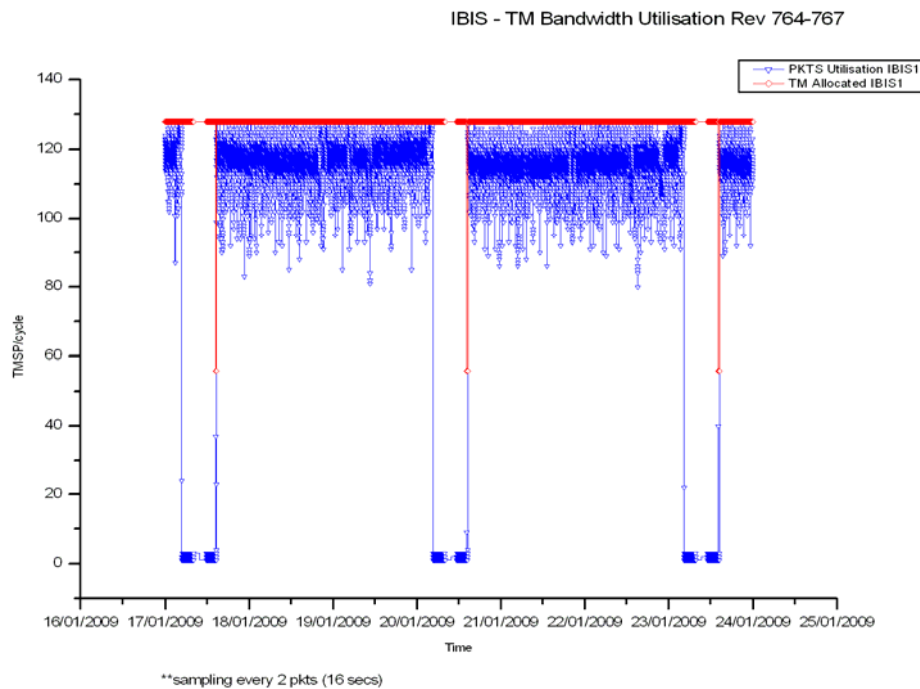
3.2.2 IBIS

The overall status of the unit is nominal.

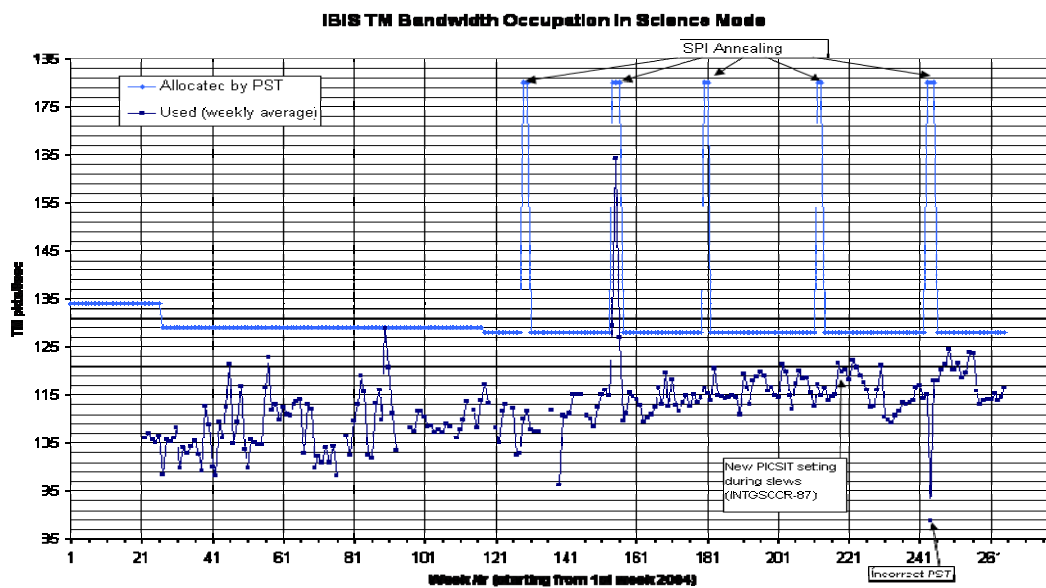
During the reporting period, the TM bandwidth statistics were as follows:

- PST allocation to IBIS above radiation belts: 128 packets/cycle.
- IBIS mean bandwidth utilisation in science mode: 116.38 packets/cycle (up 2.06 on previous week)
- Percentage of TM cycles in which full bandwidth was used: 2.57%

The plot below shows the IBIS TM utilisation during the reporting period.



A plot of the IBIS weekly bandwidth utilisation since 2004 is shown below:



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

3.2.3 JEM-X

The status of both JEM-X units is nominal.

JEM-X operations were performed by the automatic Timeline.

JEM-X1 was operated in Data Taking mode with a TM allocation of 8 packets/cycle. JEM-X2 was dormant (DPE OFF) with no TM slots allocated.

Note: Some more information concerning the JEM-X operations is provided in the Appendix 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 per cycle.

During this reporting period, all of the 136 planned science pointings were executed nominally.

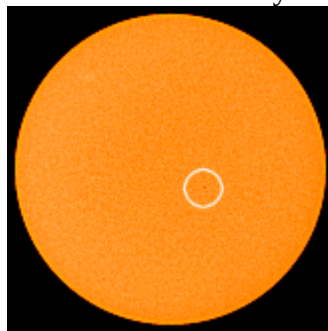
Note: Some more information concerning the OMC operations is provided in the Appendix.

3.2.5 IREM

The overall status of the unit is nominal.

Solar Activity

The observation period was characterised by low solar activity. A new sun spot appeared on the 19th, but faded away by the following day, apart from that, the sun was blank all week. The risk of solar flares was very low.



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. No pointing was lost due to ground problems. The overall performance was above the 95% requirement.

4.1 Mission Operations Centre

The performance of the MOC was good this week. No pointing was lost to MOC related issues.

4.2 Ground Stations & Network

The performance of the ground stations and Network was good this week. No slews were missed from TL, during the observation period. On DoY 020 Bad Frames were received from redu for a few seconds at 02:03z.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

New PSFs have been received for revolutions 771 and 772.

Revolution 766 was replanned again in order to include observations of 3C279 coordinated with XMM-Newton and others. Revolutions 768 to 771 were planned normally.

Triggered by several independent TOO requests, a public TOO on the AXP 1E1547.0-5408 was implemented on short notice in revolution 767, requiring also a replanning of revolutions 768 and 769.

The planning of the subsequent revolutions will also need to be redone, due to the TOO.

Updated TSFs have been received for revolutions 766 to 768.

2. Observation status

ECS files has been received and processed for revolutions 755 to 759.

3. ISOC Science Data Archive

Work has picked up again on creation of high level data products.

4. ISOC system

ISOC system V20.1 is in use. Work is ongoing on V21, expected for early February.

5. Problems

No new problems. Work is ongoing to resolve the issue with Telefonica regarding SMS alerts.

4.3.2 ISDC

Status of ISDC observation processing on 23/01/2009:

- Latest Standard Analysis completed: observation 06200210009 (GRS 1915+105, Revolution 743) on 12/12/2008.
- Latest products archived: observation 06200520002 (PKS 0208-512, Revolution 746) on 12/12/2008.
- Latest observation products sent to the observer: observation 06200520002 (PKS 0208-512, Revolution 746) on 12/12/2008.

5 Special Events

JPL informed that the s/w patch to solve the frequent antenna stops at DSN stations has been delivered and the installation is pending.

Connectivity from C-Chain to both Vil-2 TMTCSs was successfully tested. Verification of proper MCS processing of PSS data is pending.

6 Anomalies

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

AR id	Date Created	Subject	Segment	Status
INT-3054	2009-01-23	Incorrect PST settings in CCCF EDs	ISOC	Open

7 Future Milestones

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 764

The observations in revolution 764 began with a Target of Opportunity, a hexagonal dither of the blazer PKS 1510-089 (RA 15:12:50.53, DEC -09:05:59.8), lasting ~28.6 hours. They continued with a hexagonal dither of the radio galaxy Centaurus A (RA 13:25:27.61, DEC -43:01:08.9), lasting ~28.6 hours until the end of the revolution.

Revolution 765

The observation in revolution 765 began with a Target of Opportunity, a hexagonal dither of the blazer PKS 1510-089 (RA 15:12:50.53, DEC -09:05:59.8), lasting ~28.6 hours. They continued with a hexagonal dither of the radio galaxy Centaurus A (RA 13:25:27.61, DEC -43:01:08.9), lasting ~28.5 hours until the end of the revolution.

Revolution 766

The observations in revolution 766 began with a Target of Opportunity, a hexagonal dither of the blazer PKS 1510-089 (RA 15:12:50.53, DEC -09:05:59.8), lasting ~28.6 hours. They continued with a hexagonal dither of the gamma-ray blazer 3C 279 (RA 12:56:11.17, DEC -05:47:21.5), lasting ~28.6 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 108; JEM-X1 8; JEM-X2 0; OMC 5.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

2008-12-31T08:09:17.000Z	136.7326	F	Automatic TM processing.
2009-01-02T13:21:29.000Z	136.7199	F	Automatic TM processing.
2009-01-03T22:59:41.000Z	136.6970	F	Automatic TM processing.
2009-01-05T13:07:45.000Z	136.6835	F	Automatic TM processing.
2009-01-06T22:45:50.000Z	136.6669	F	Automatic TM processing.
2009-01-08T12:54:10.000Z	136.6532	F	Automatic TM processing.
2009-01-09T22:31:58.000Z	136.6124	F	Automatic TM processing.
2009-01-11T12:43:54.000Z	136.5808	F	Automatic TM processing.
2009-01-12T22:01:09.000Z	136.5465	F	Automatic TM processing.
2009-01-14T12:32:33.000Z	136.5217	F	Automatic TM processing.
2009-01-15T22:07:01.000Z	136.4853	F	Automatic TM processing.
2009-01-17T12:11:29.000Z	136.4771	F	Automatic TM processing.
2009-01-18T22:22:53.000Z	136.4618	F	Automatic TM processing.
2009-01-20T12:00:41.000Z	136.4431	F	Automatic TM processing.
2009-01-21T21:33:56.000Z	136.4213	F	Automatic TM processing.

This report was generated Fri Jan 23 08:00:24 GMT 2009

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, 17/01/2009 – 23/01/2009

The AOCS operations were executed from the Automatic Timeline.

During this period, 74 Open Loop Slews, 75 Closed Loop Slews and 5 Momentum Biases were executed (as reported by ACC OEM).

No slews were missed from TL, during the observation period.

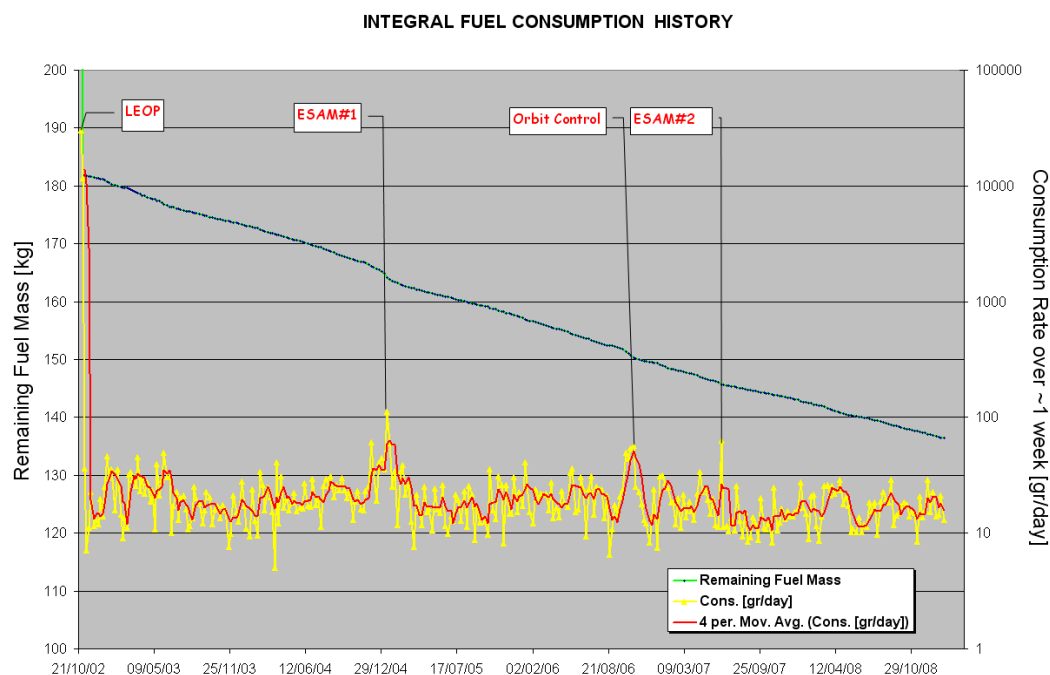
The OTF was not reached during part of PID 0765006, due to loss of guide star.

Orbit Control

No update

Fuel consumption

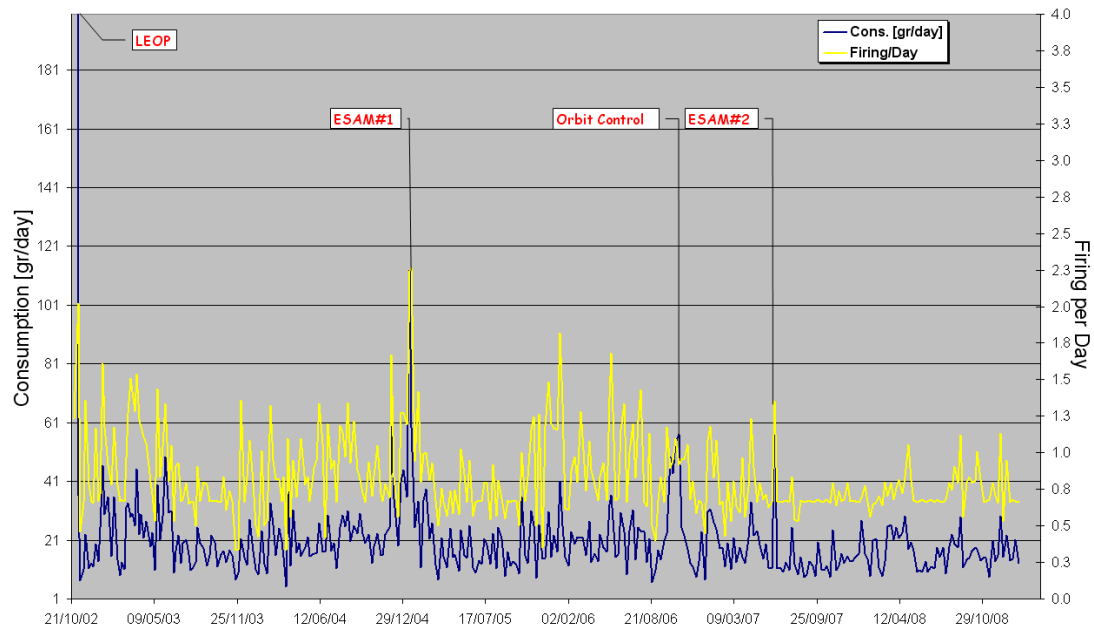
The fuel consumption (total, grams per day) over the period between 01/11/2002 and 23/01/2009 is reported in the plot below.



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

The firing per day over the period between 01/11/2002 and 23/01/2009 is reported in the plot below.

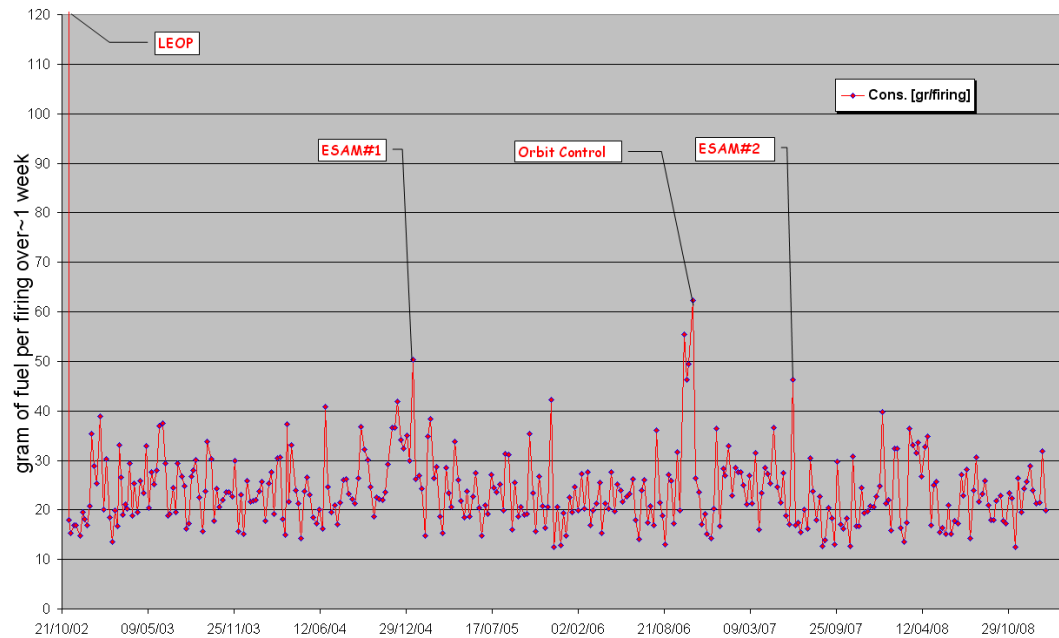
INTEGRAL FIRING PER DAY HISTORY



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

The fuel per firing over the period between 01/11/2002 and 23/01/2009 is shown in the plot below.

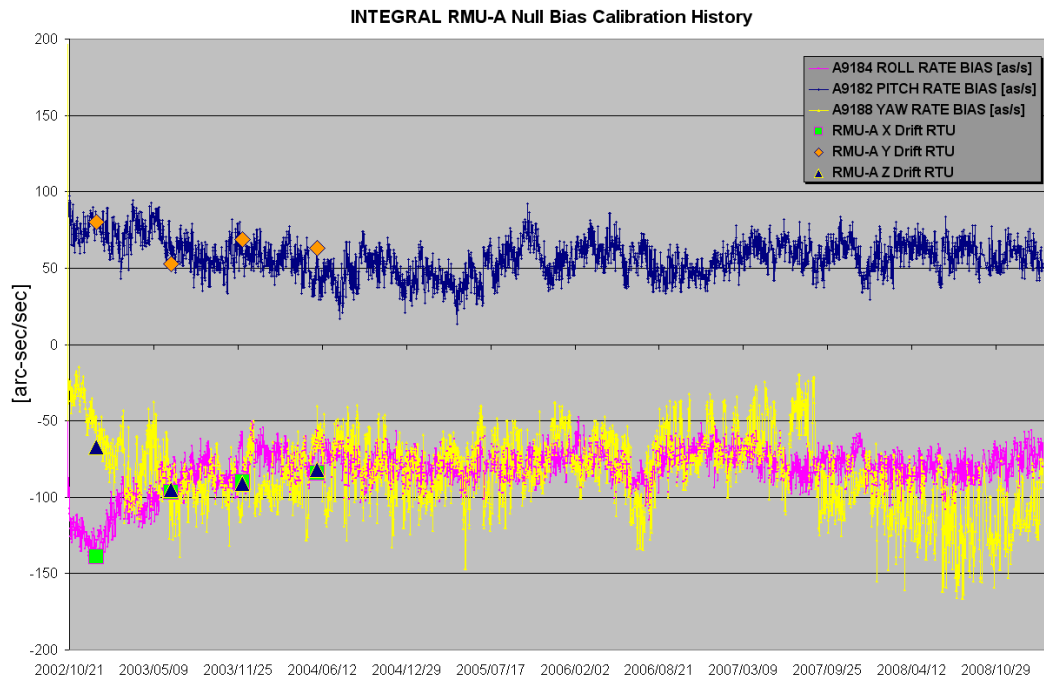
INTEGRAL FUEL MASS PER FIRING HISTORY



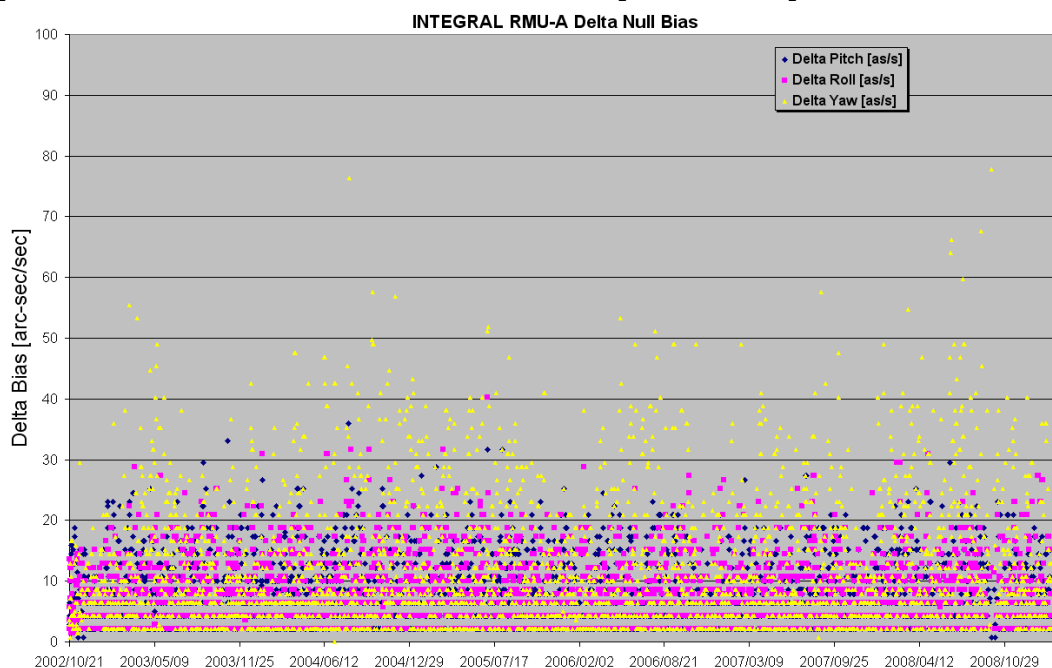
The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 23/01/2009 is reported in the plot below.

The evolution of the drift on yaw channel is under constant monitoring but the values are still well within the specs. At moment the current constraints (for drift update generation) on the FDS have been relaxed to cope with the current situation.



The RMU-A delta null bias calibration history, on pitch, roll and yaw channel over period between 01/11/2002 and 23/01/2009 is reported in the plot below.



17/01/2009 (Day of Year 017, Revolution 764-765)

Nothing to report.

18/01/2009 (Day of Year 018, Revolution 765)

Nothing to report.

19/01/2009 (Day of Year 019, Revolution 765)

Nothing to report.

20/01/2009 (Day of Year 020, Revolution 765-766)

Loss of guide star: at 06:01:21z a loss of the selected guide star occurred during PID 07650064. The origin of the event is not clear, likely due to SEU affecting the STR.

As foreseen by the IPS logic, the ACC switched ON the IMU 1, a new automatic mapping was commanded and a new guide star picked. The next slew 07650065 was manually updated in TL.

No impact on TL.

The OTF was not reached during the last part of PID 0765006.

21/01/2009 (Day of Year 021, Revolution 766)

Nothing to report.

22/01/2009 (Day of Year 022, Revolution 766)

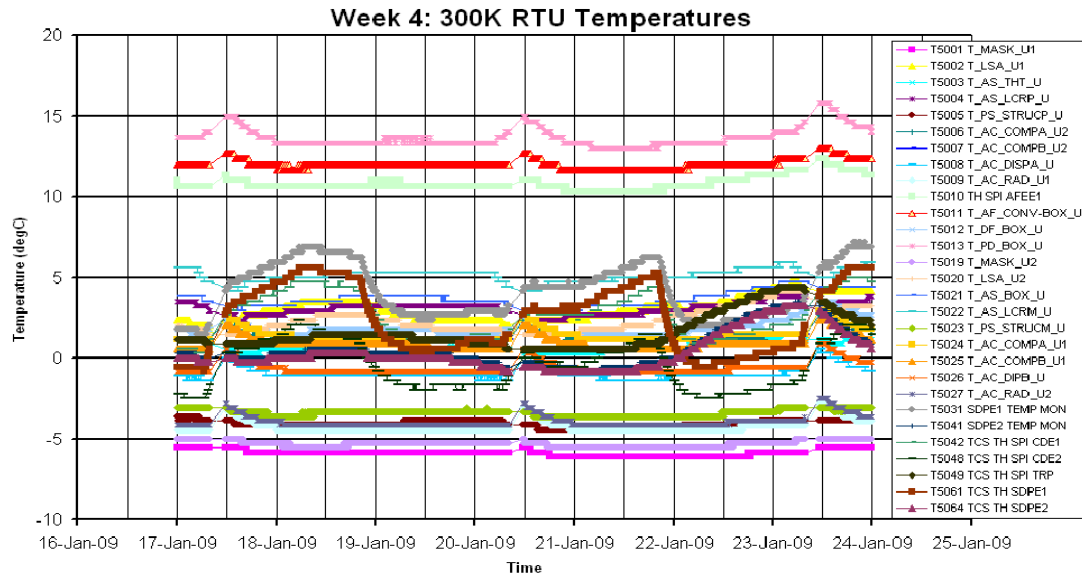
Nothing to report.

23/01/2009 (Day of Year 023, Revolution 766-767)

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.



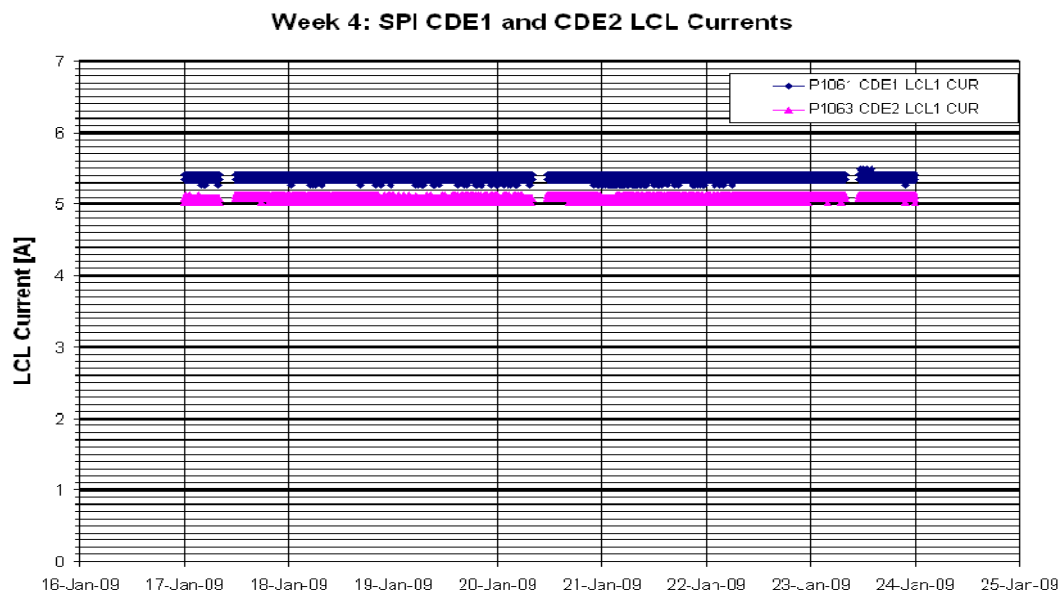
Stirling Compressors and Cryostat: The performance of the compressors is nominal.

The cold plate temperature was maintained in the range 80K +/-1K.

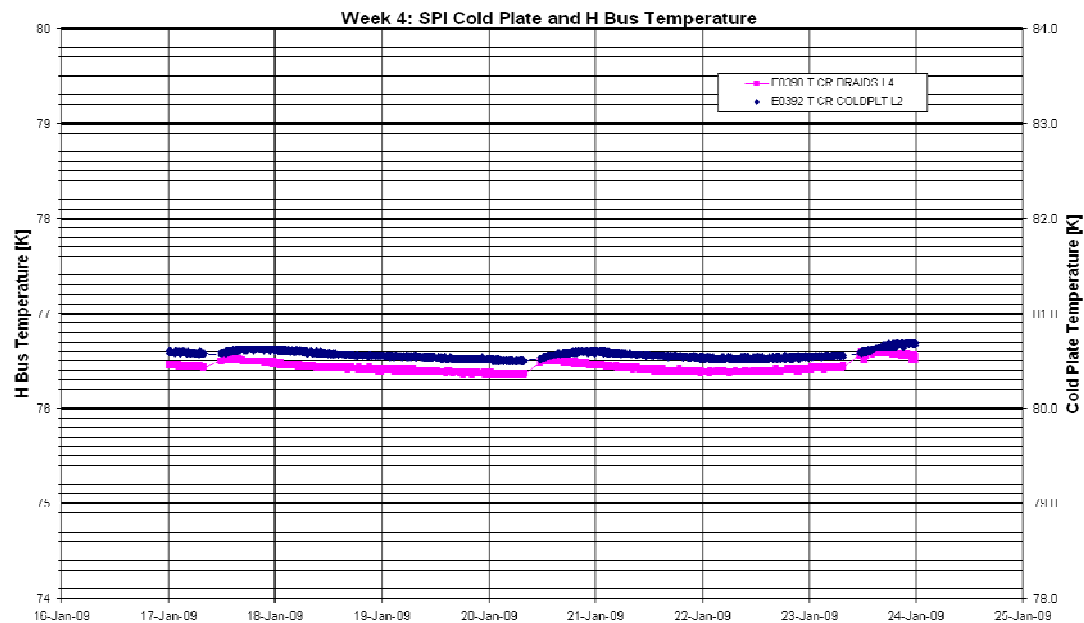
The stroke of all four compressors was set to 42 throughout the week and the average CDE LCL currents were as follows:

- CDE1 LCL Current = 5.36A
- CDE2 LCL Current = 5.08A

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



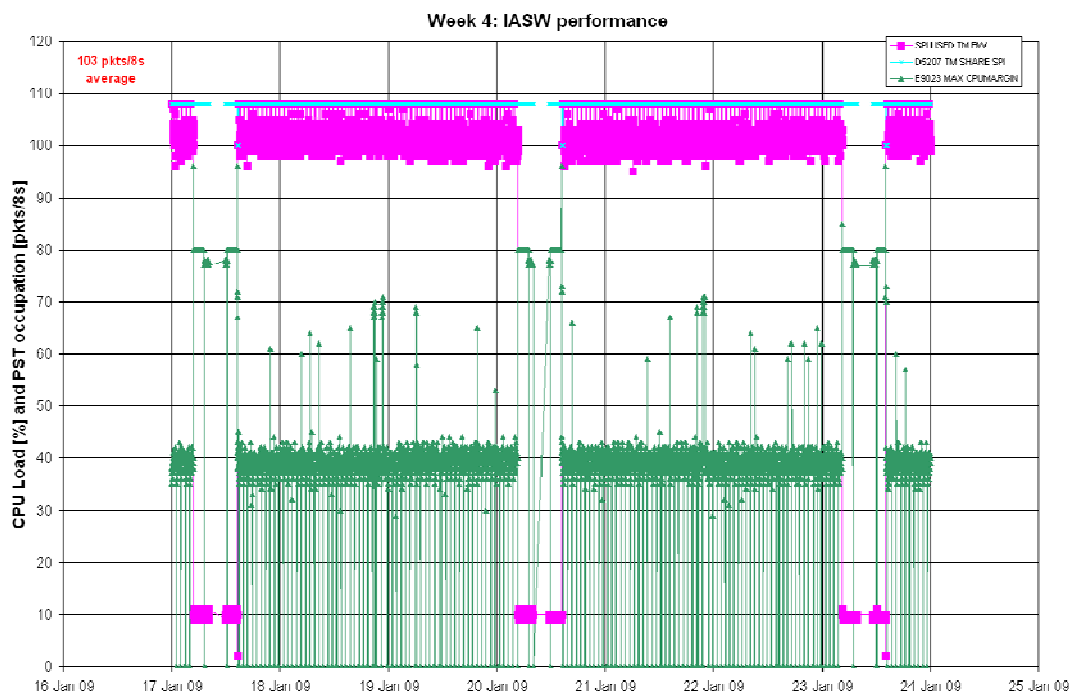
The following plot shows the evolution of the cold plate and H bus temperatures during the reporting period.



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

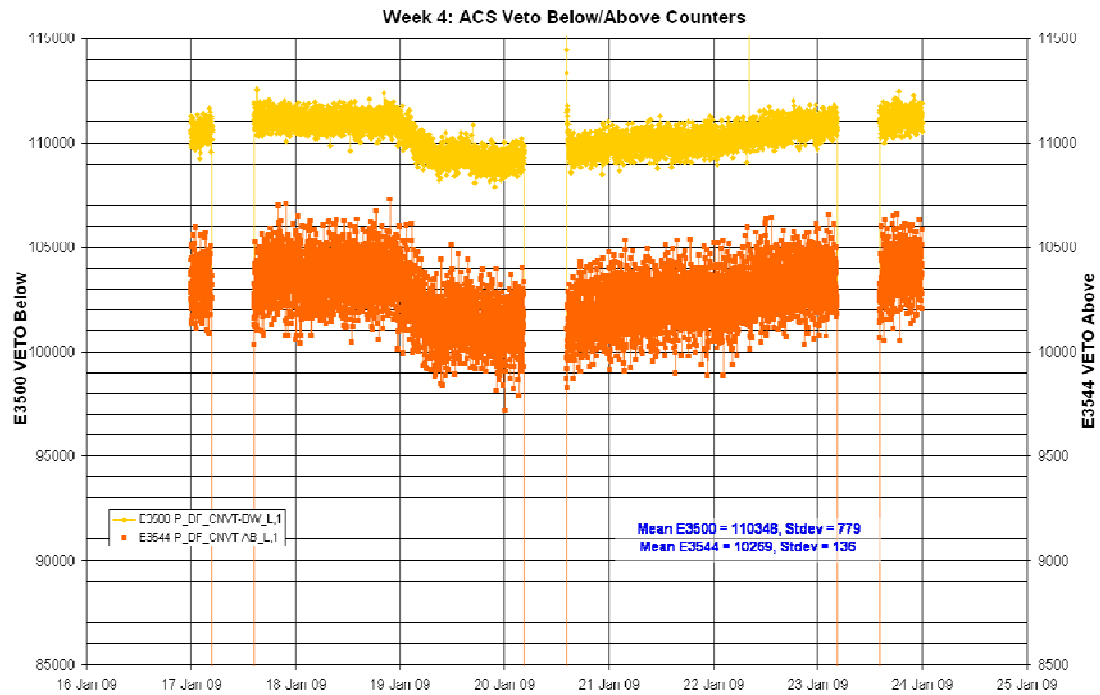
The IASW version installed is v4.3.4 with SE compression only enabled and the spectra scaling factor set to 8/19 SE. The average TM bandwidth occupation of SPI was 103 packets/cycle over the science window when the TM allocation was 108 packets/cycle.

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

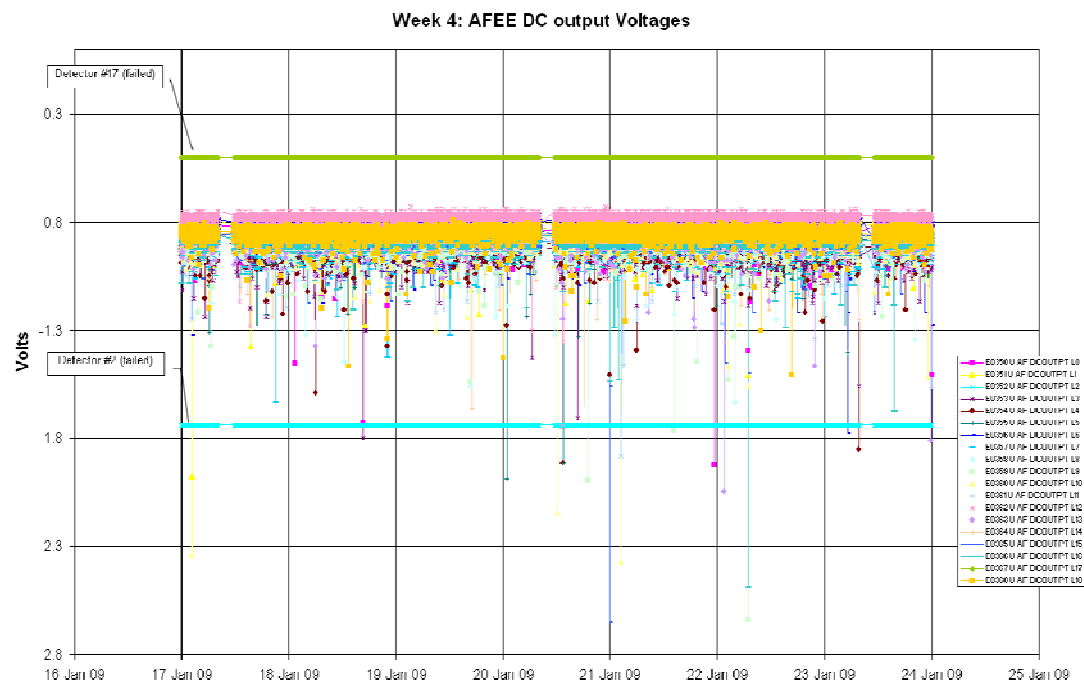


ACS: The performance of the ACS is nominal, except for FEE #81 which remains nominally switched off since the anomaly on 29/10/2006 (INT_SC-162) and FEE #57 which is nominally OFF due to the anomaly on 5/8/2003 (INT_SC-61).

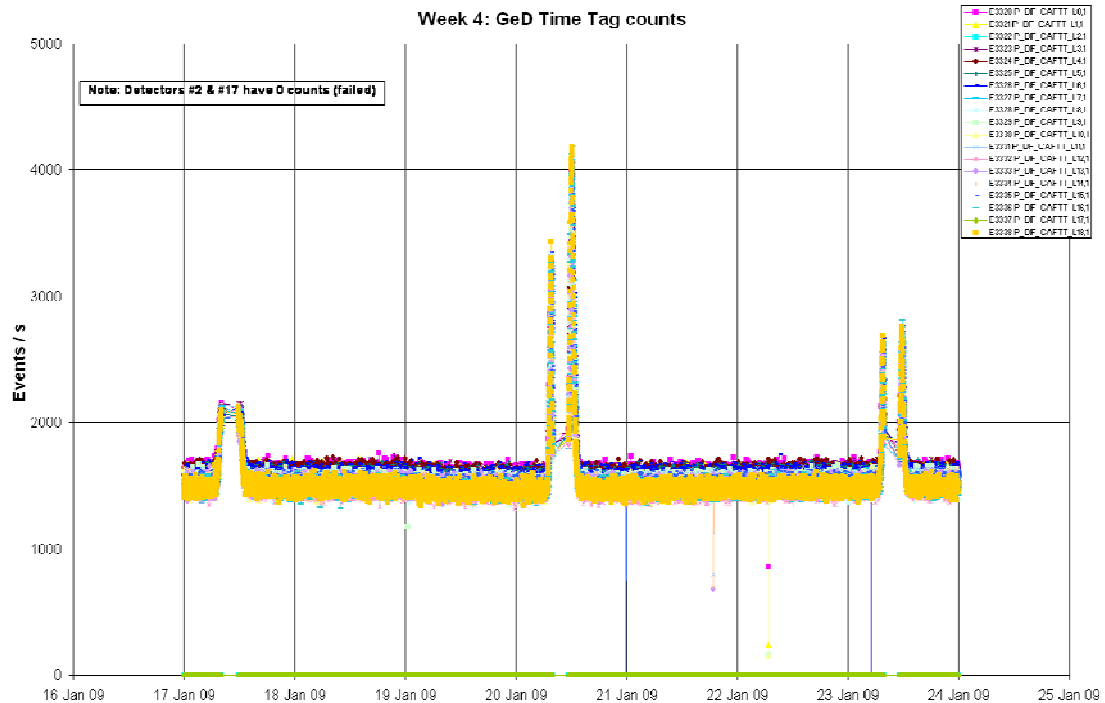
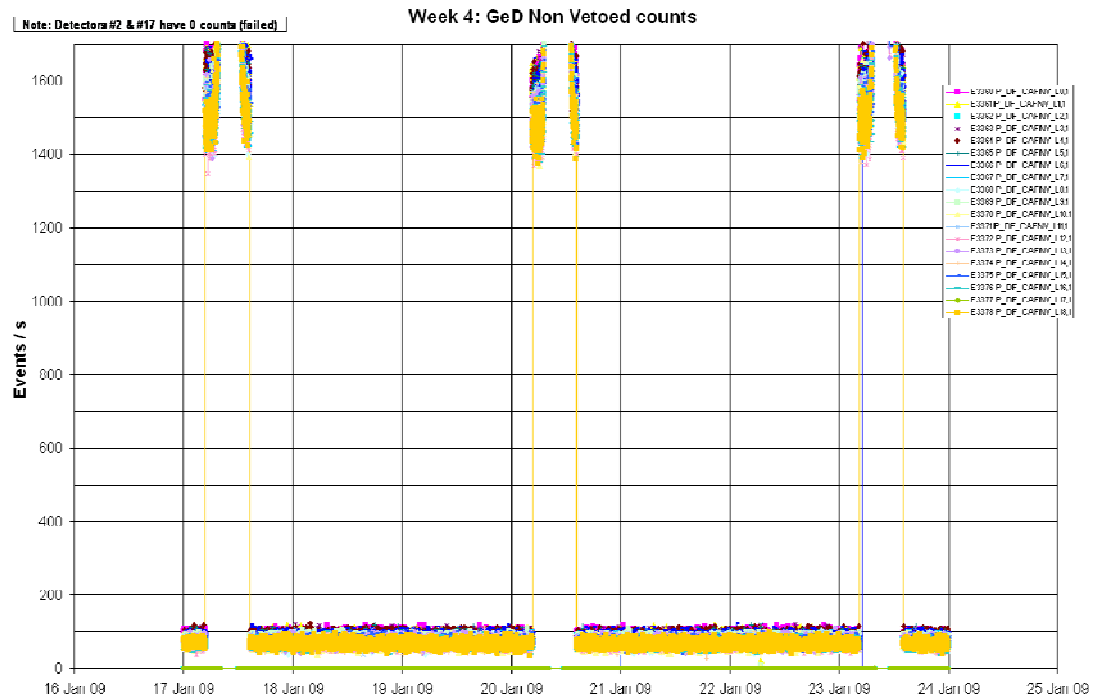
The following plot shows the ACS overall count rate evolution during the reporting period:

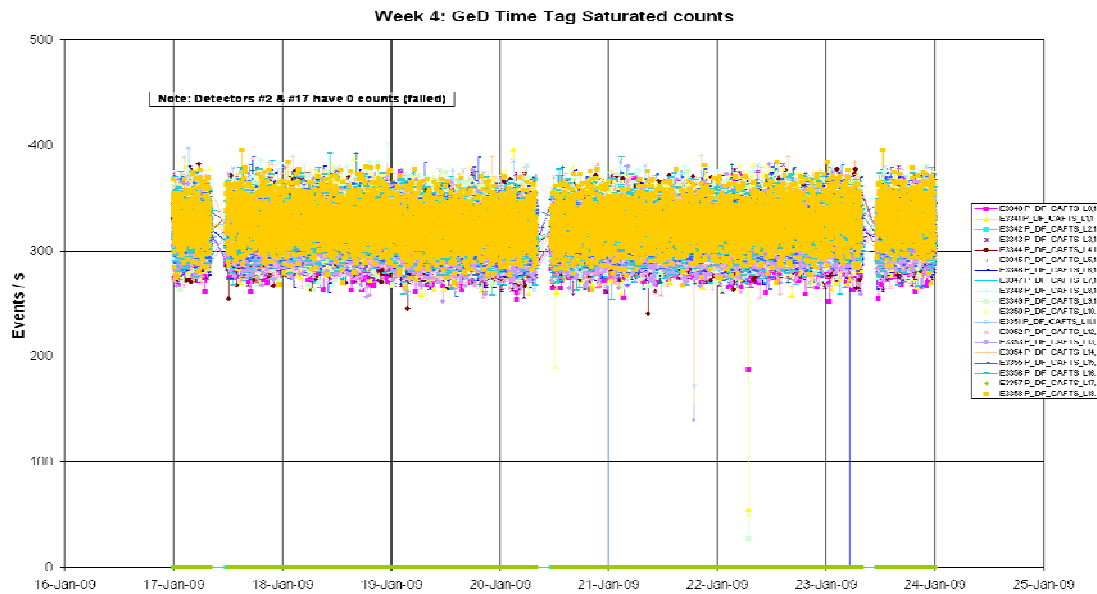


AFEE: The health of the AFEE is nominal. The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06/12/2003 and detector #17 is failed since 17/07/2004.

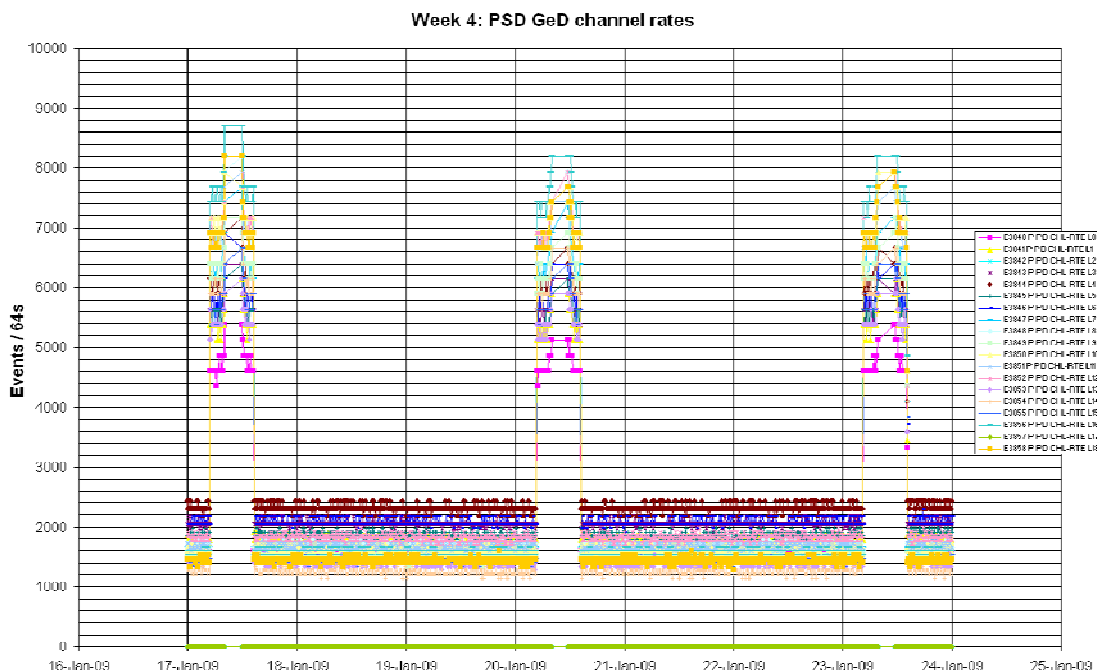


DFEE: The performance of the unit is nominal. The following plots show the Non Vetoed, Time Tag and Time Tag Saturated Event count rates during the reporting period.





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 events occurred with SPI during the reporting period:

- On 2009-01-18 at 15:13:22Z TM parameter E2200 went OOL (value = PARAM > SPEC). This is the ACS FEE digital status 5V #50. As it returned within limits of its own accord when the next packet was received at 15:24:02Z, no action was taken.
- On 2009-01-23 at 15:29:06Z OEM APID 1024 ID 243 EXCEPTION SPI1 SPECTRA BUILDING NOT COMPLETED was received with parameter E9780 DETECTOR ID = 13. As it was a single occurrence, no action was taken.

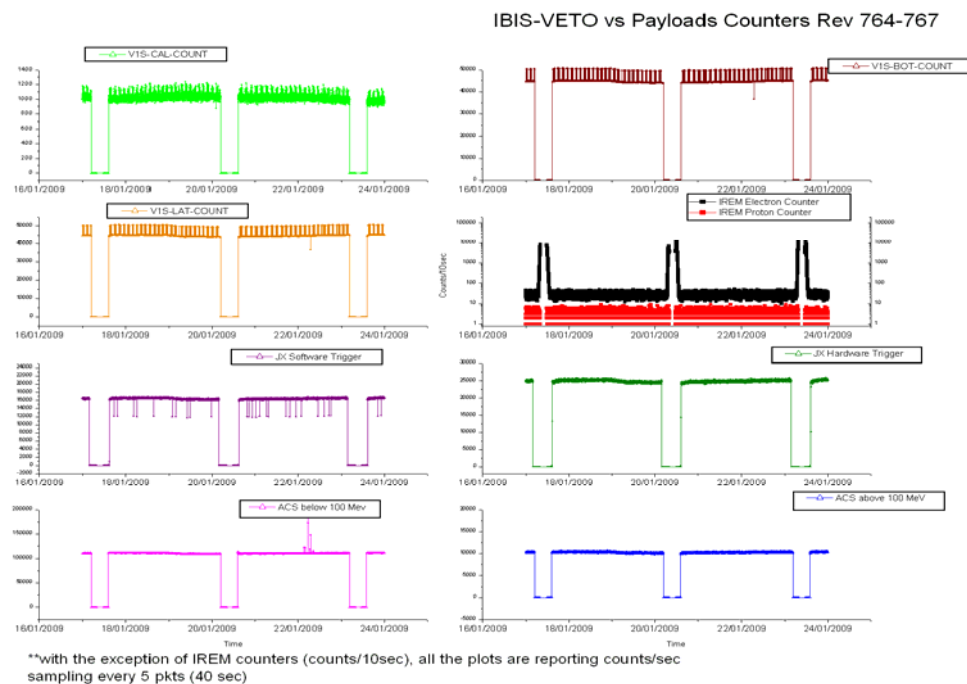
8.3.3 IBIS Operations

IBIS Event Counters Plots

ISGRI Counters:

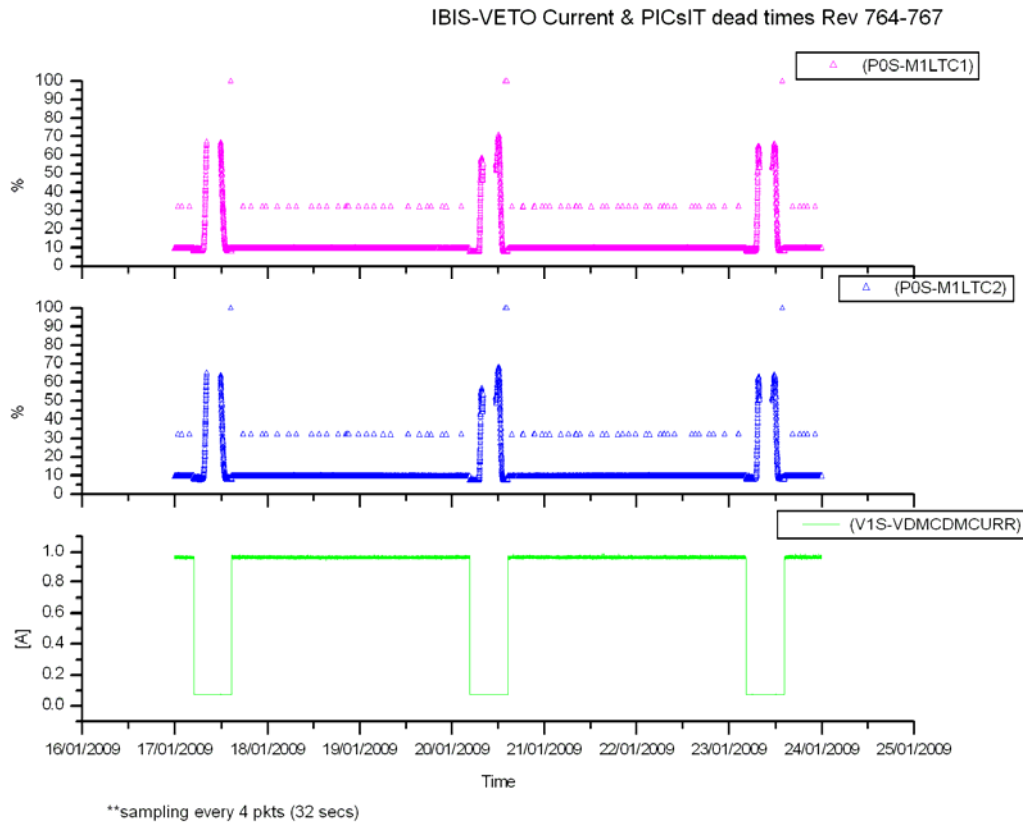


VETO vs Payload Counters:

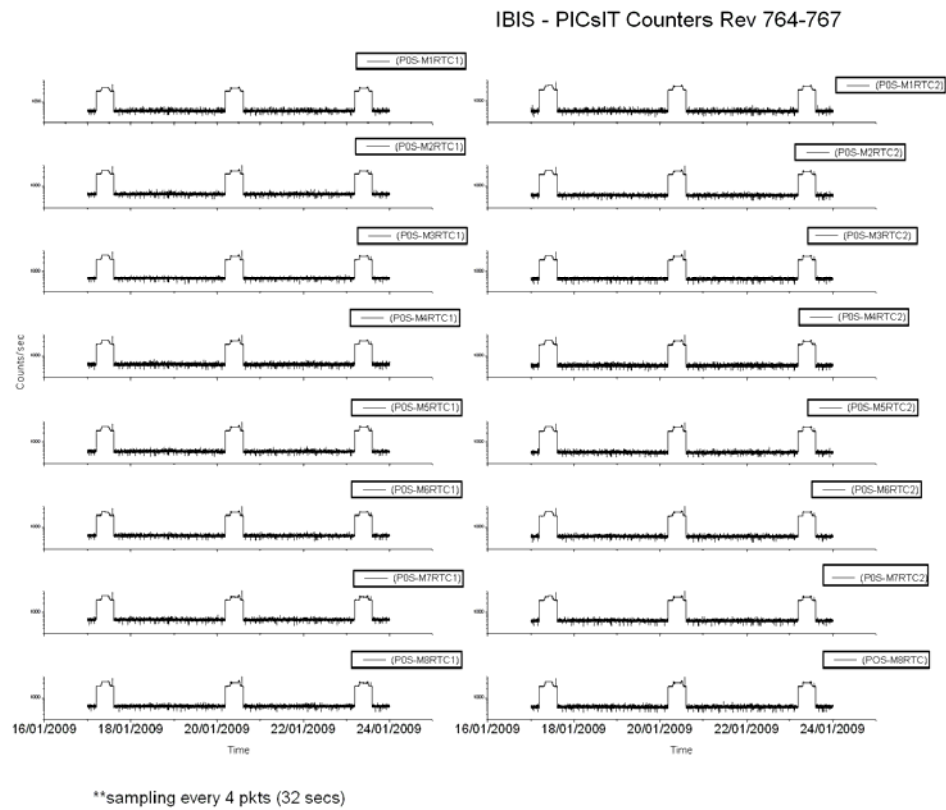


The week was characterised by low radiation as reported by the payload.

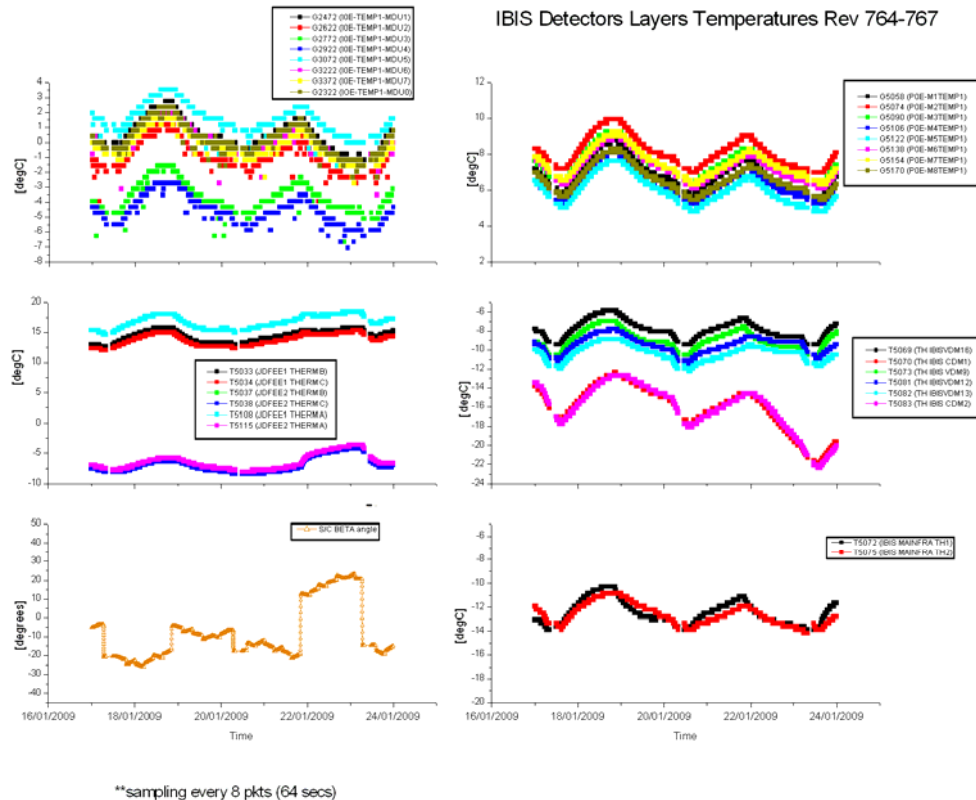
VETO Current:



PICsIT Counters:



IBIS Detectors Layers Temperatures:



IBIS daily report:

The usual Out Of Limits on TM parameter G8015 (S1E-A2_PMT_V), G5002 (POS-Mi_RTC1) and G5003 (POS-Mi_RTC2) families and G2000 family (IOE-OVFWPXADD-Mi) were received during the radiation belt passages.

2009-01-17 (DOY 017, Rev 764-765)

At 07:41:21Z, during the radiation belt passage of revolution 764-765, TM parameter G5079 went OOL (value = 2.60509804). This is the PDM2 +2.5 V. As it returned within limits of its own accord at 07:41:53Z, no action was taken.

2009-01-18 (DOY 018, Rev 765) to 2009-01-19 (DOY 019, Rev 765)

IBIS operations executed nominally.

2009-01-20 (DOY 020, Rev 765-766)

At 12:08:33Z, during the radiation belt passage of revolution 765-766, TM parameter G5079 went OOL (value = 2.60509804). This is the PDM2 +2.5 V. As it returned within limits of its own accord at 12:09:05Z, no action was taken.

2009-01-21 (DOY 021, Rev 766) to 2009-01-22 (DOY 022, Rev 766)

IBIS operations executed nominally.

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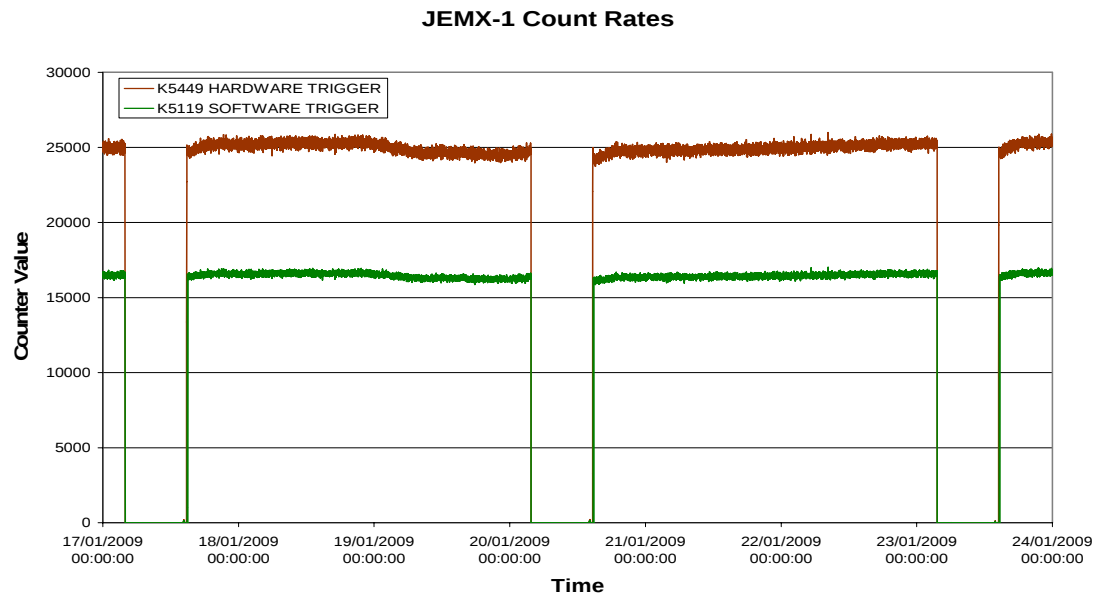
2009-01-23 (DOY 023, Rev 766-767)

At 07:15:13.Z, during the radiation belt passage of revolution 766-767, TM parameter G5079 went OOL (value = 2.60509804). This is the PDM2 +2.5 V. As it returned within limits of its own accord at 07:15:45Z, no action was taken.

8.3.4 JEM-X Operations

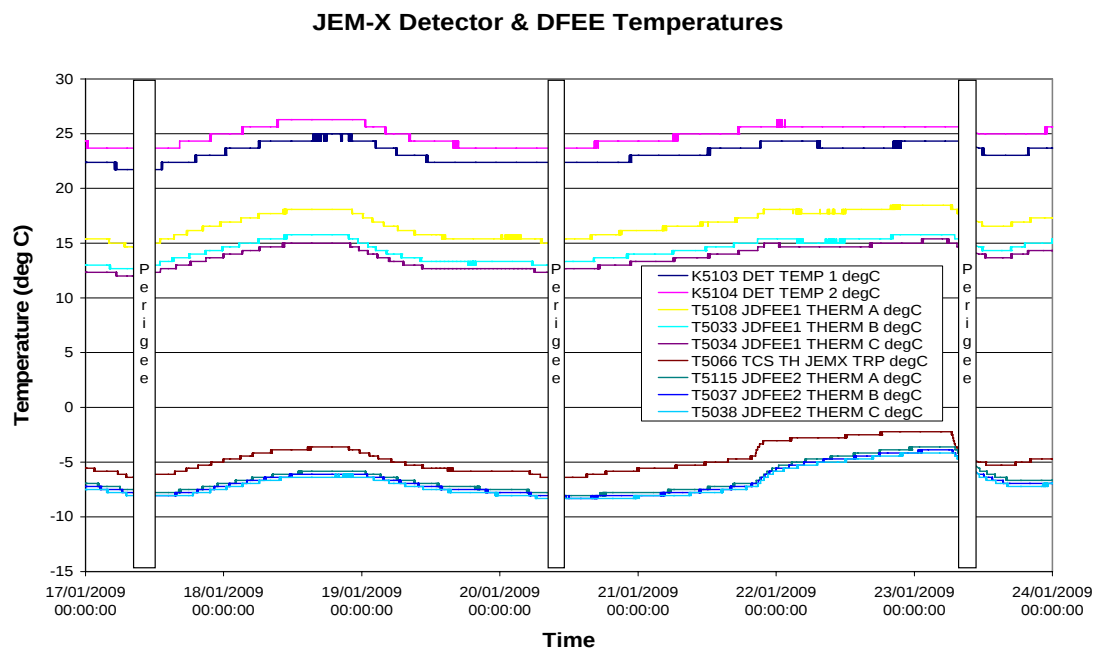
JEM-X Count Rates

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)

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JEM-X Daily Report

2009-01-17 (DoY 017, Rev 764-765) to 2009-01-22 (DoY 022, Rev 766)

JEM-X 1 operations executed nominally.

2009-01-23 (DoY 023, Rev 766-767)

The following On-Event Messages were received, at the indicated times:

2009.023.01.17.47.361	2009.023.01.17.50.404	1536	RealTime	6	EXCEPTION
JEM-X1 EXC IACS INTERF CULP			0	0	65535 PR N
E E					
FIX6		0			
K9079	MESS CLASS	1			
K9080	MESS ID	6			
K9065	CSSW OPERAT ID	START			
K9066	TASK ID 8	IASW			
K9067	LOGICAL ADDRESS	19726			
2009.023.01.17.47.361	2009.023.01.17.50.350	1536	RealTime	5	EXCEPTION
JEM-X1 EXC IACS INTERF EXID			0	0	65535 PR N
E E					
FIX6		0			
K9079	MESS CLASS	1			
K9080	MESS ID	5			
K9065	CSSW OPERAT ID	START			
K9066	TASK ID 8	IASW			
K9067	LOGICAL ADDRESS	4989			

No Action was taken, and there was no impact.

8.3.5 OMC Operations

2009-01-17 (DoY 017, Rev 764) to 2009-01-23 (DoY 023, Rev 767)

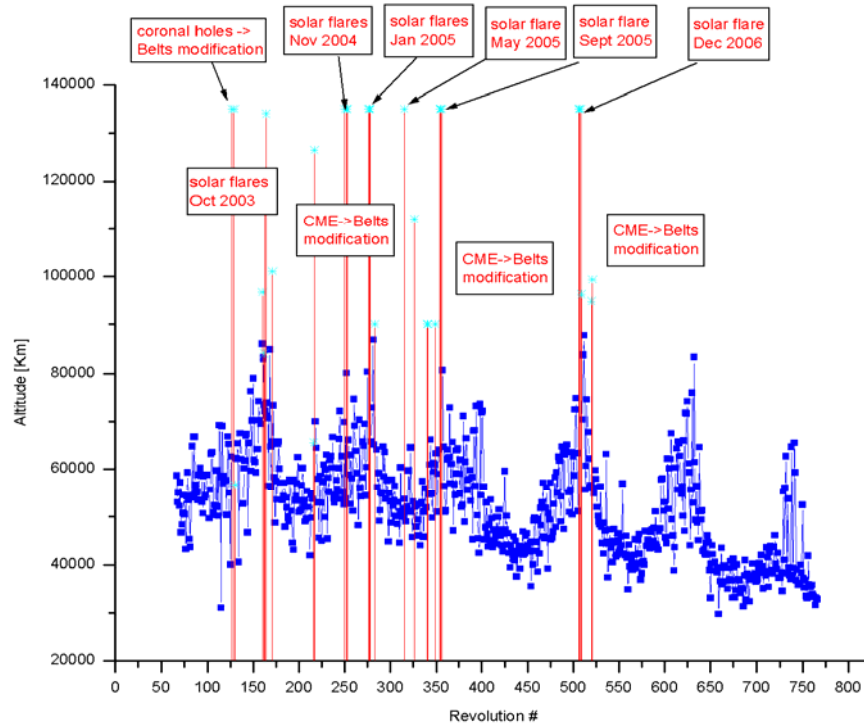
Nothing to report.

On DoY 017 at 04:48:14, DoY 020 at 04:37:42 and DoY 023 at 04:27:42 OMC went to SAFE mode nominally, at the radiation belt entry time as set in the Broadcast Packet

8.3.6 IREM Operations

Radiation Belts Entry

Evolution of Radiation Belt Entry 2003-2008



IREM daily report

Nothing to report.

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]
764	RAD_ENTR R 2009-01-17T04:48:11Z	17/01/2009 07:21:49	31674.4	17-Jan-2009 07:06:53	34234.65
765	RAD_EXIT R 2009-01-17T14:29:10Z	17/01/2009 13:06:05	>>32257.1	17-Jan-2009 13:46:53	46879.68
765	RAD_ENTR R 2009-01-20T04:37:40Z	20/01/2009 07:03:41	33128.3	20-Jan-2009 06:51:23	34981.6
766	RAD_EXIT R 2009-01-20T14:18:04Z	20/01/2009 13:24:37	>>32279.7	20-Jan-2009 13:31:23	46307.2
766	RAD_ENTR R 2009-01-23T04:27:41Z	23/01/2009 06:55:17	32843.5	23-Jan-2009 06:41:23	34842.61
767	RAD_EXIT R 2009-01-23T14:07:56Z	23/01/2009 12:59:57	>>32284.6	23-Jan-2009 13:21:23	46453.8

Reference

High radiation

Very small error vs reference (less than 10 minutes)

Small error vs reference (between 10 and 30 minutes)

Large error vs reference (more than 30 minutes)

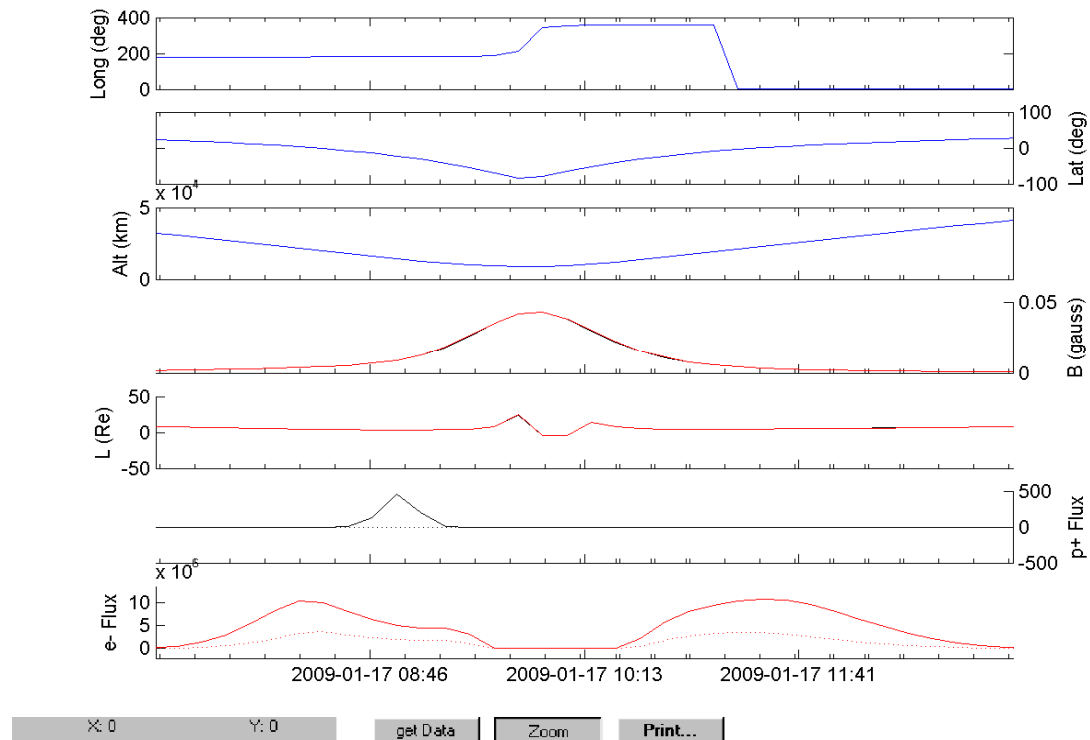
* Rad belt entry time ignoring previous threshold crossings where a gap of more than 30 minutes is present.

IREM radiation counters:

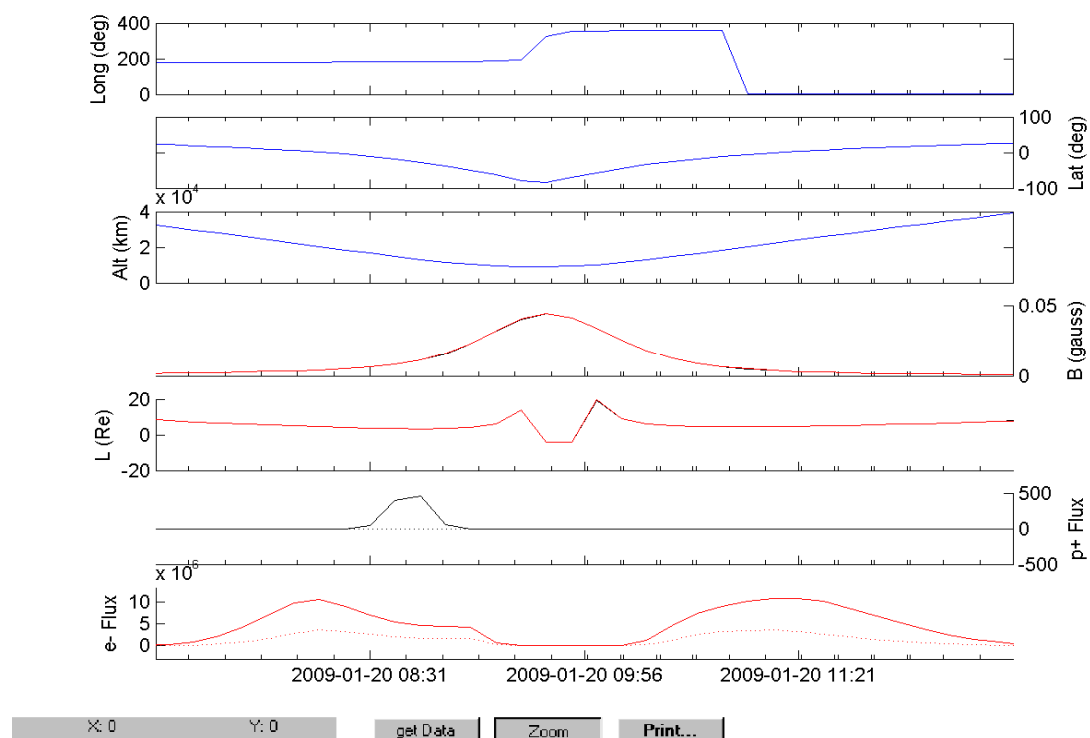
The IREM radiation counter plots are not available this week.

IREM Predicted Radiation Belt Passages

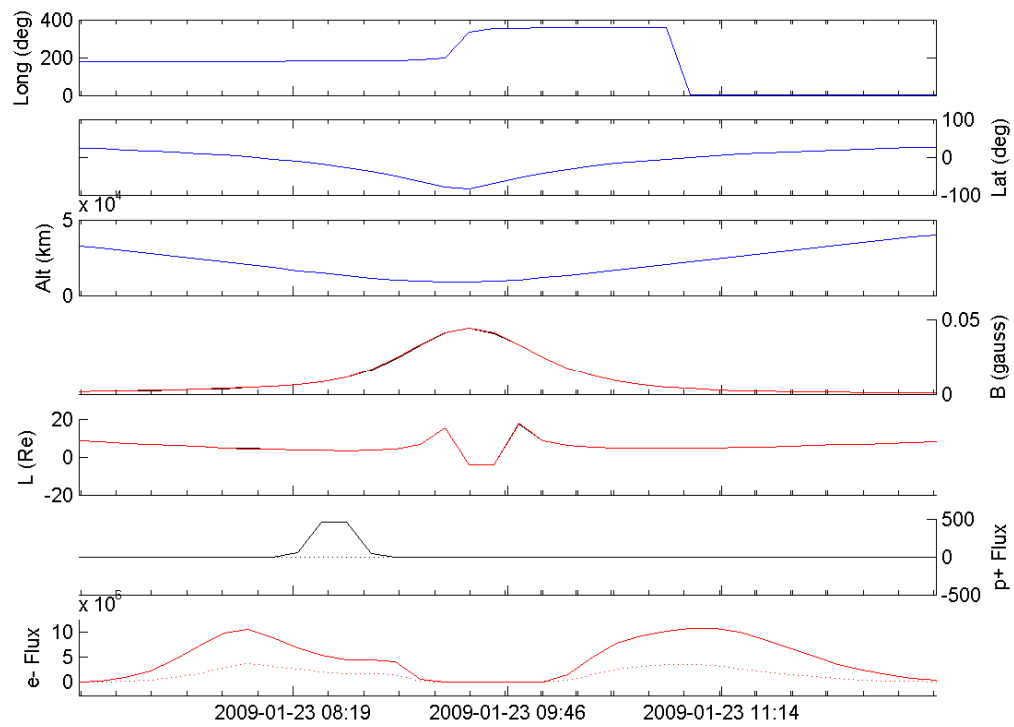
Rev 764



Rev 765



Rev 766



Radiation Assessment

Generated with SEIS Report and Analysis tool.

INTRODUCTION

This note summarises the space weather status over the observation period

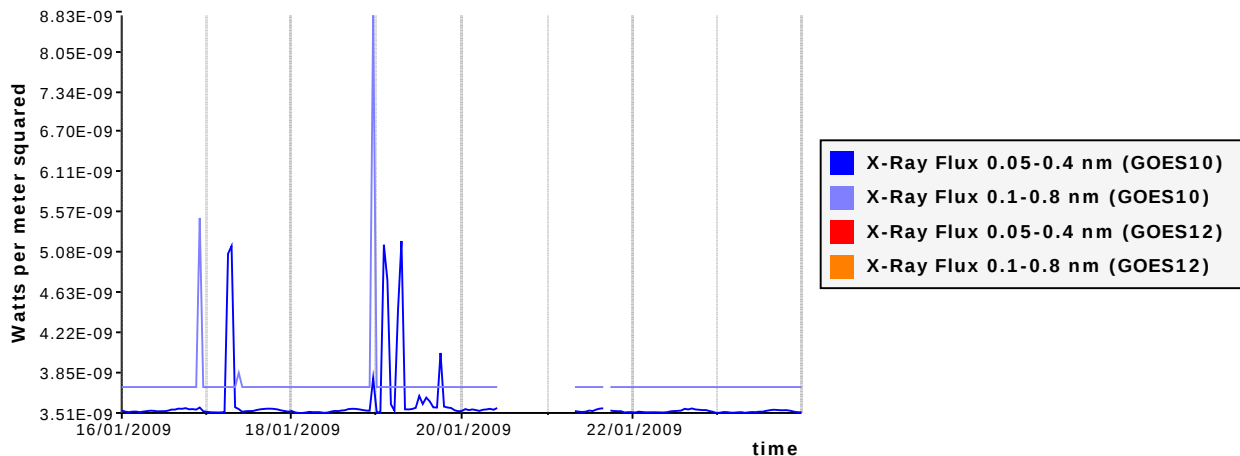
DAILY SUN

see in WR section 3.2.5

RADIATION FLUXES

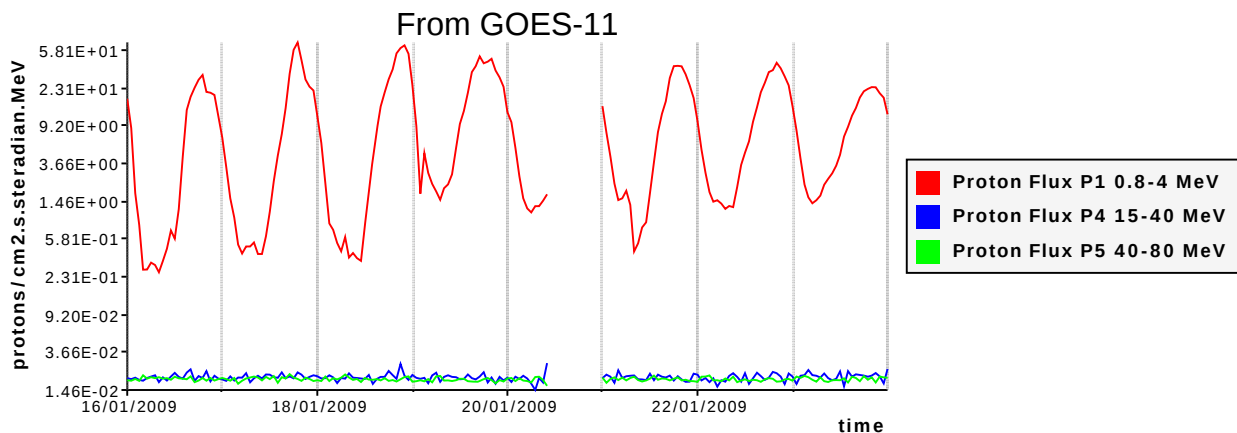
X-ray fluxes

X-ray fluxes for different energies are presented below as reported by GOES satellites. From $1\text{E-}5$ W/m², they start featuring significant radiation activity corresponding to M-class solar flares from $1\text{E-}5$ to $1\text{E-}4$ W/m², and to X-class solar flares from $1\text{E-}4$ and onwards.



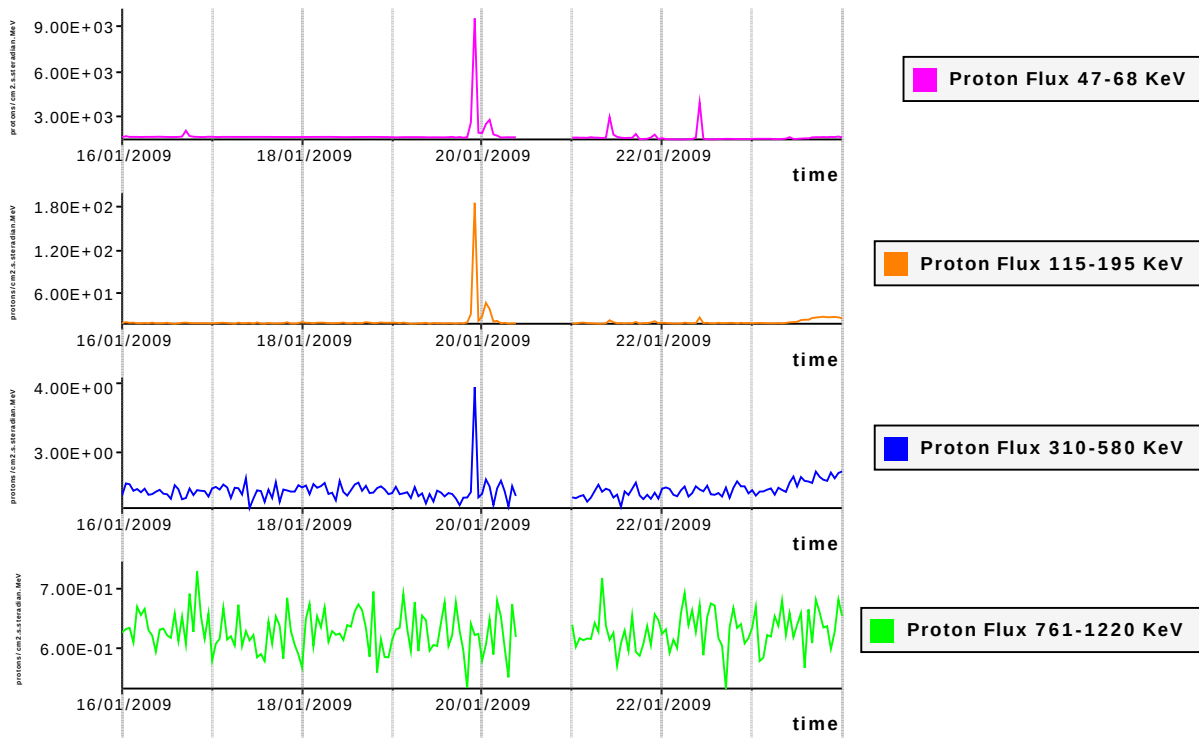
Proton fluxes (GOES-11)

Proton fluxes as measured by GOES satellites are presented in the following plot. Usually P1 oscillates between $1\text{E}+1$ and $1\text{E}+2$, while P2 and P3 evolve around $1\text{E-}2$.



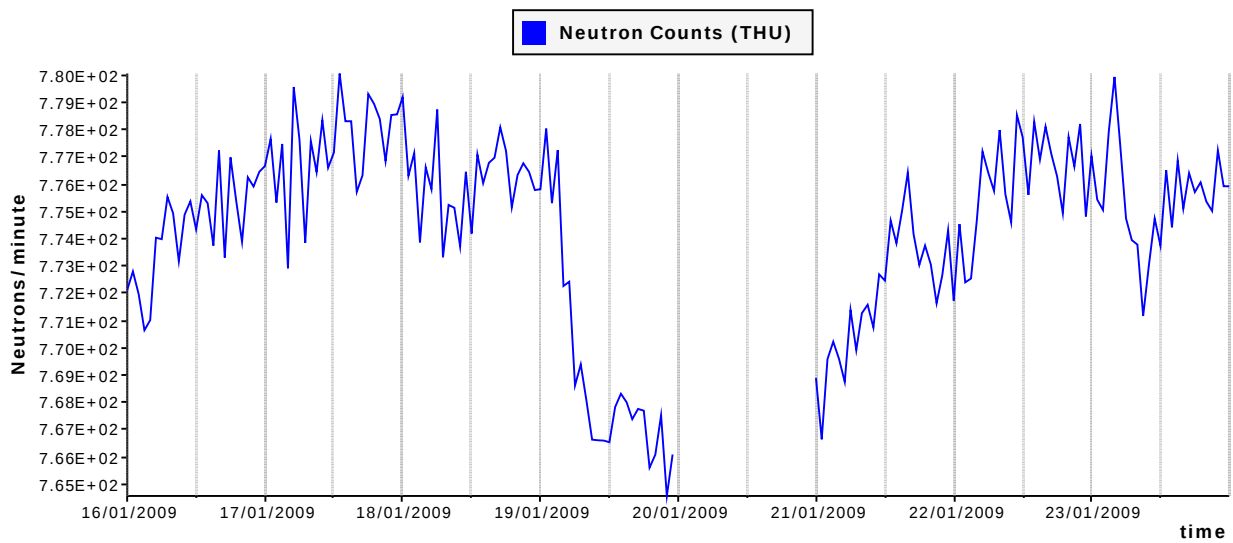
Proton fluxes (ACE)

Proton fluxes as measured by ACE satellite are presented in the following plot.



Neutron counts

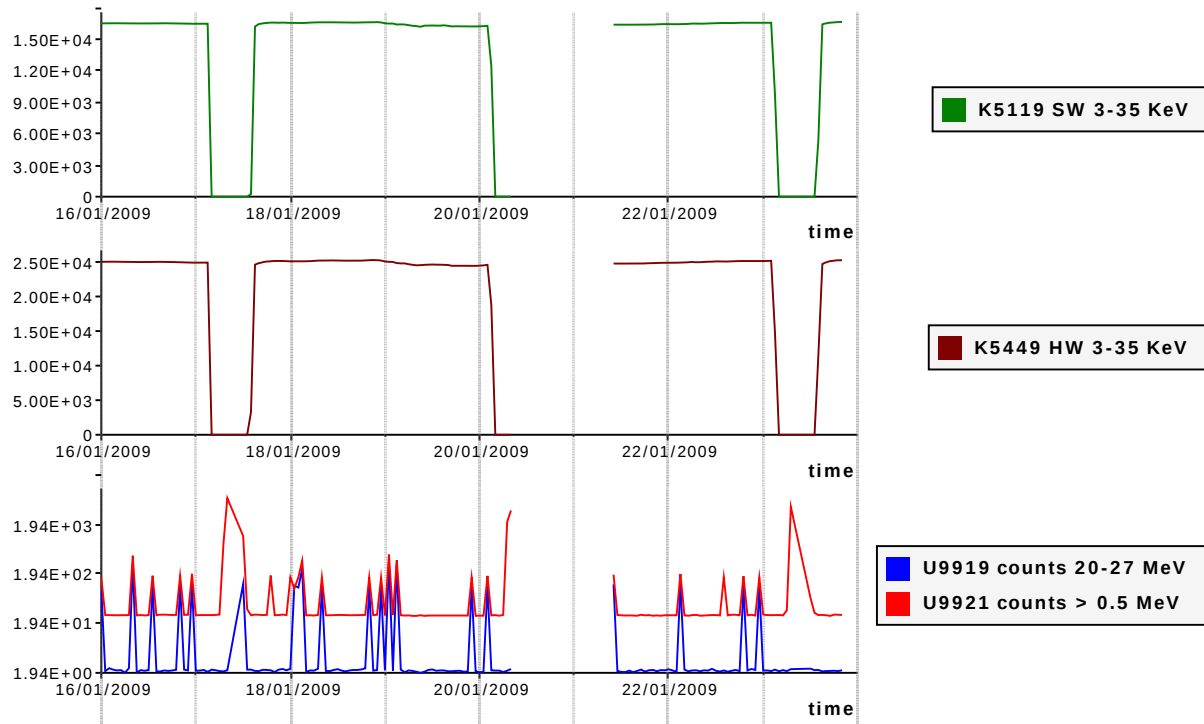
The neutron counts for the last 3 days are presented in the following plot. Nominally they remain stable around 7.2E+2.



IREM and JEM-X (INTEGRAL)

IREM proton and electron fluxes as well as JEM-X1 software and hardware triggers are presented in the following plots.

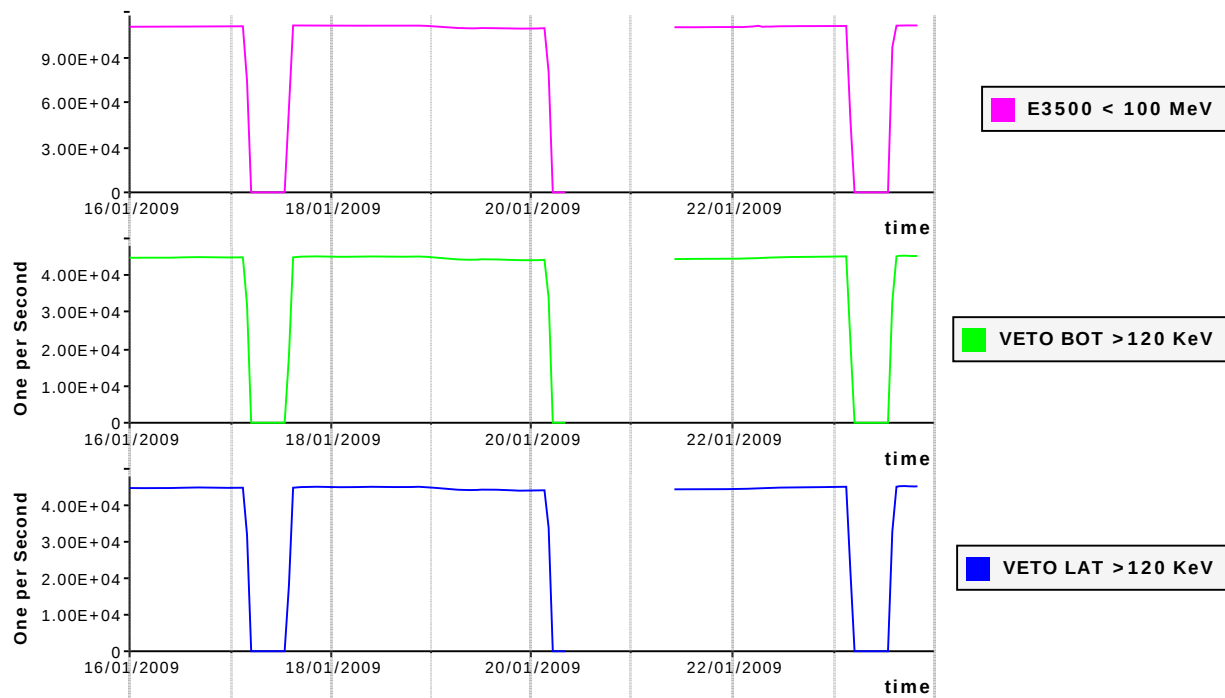
Nominal values are respectively about 1 and 18 for IREM counts, and, 13000 and 19000 for JEM-X ones.



SPI and IBIS (INTEGRAL)

SPI-ACS counters below 100MeV as well as IBIS-VETO bottom and lateral counters are presented in the following plots.

Nominal values are respectively about 90000 for SPI counts, and 36000 for IBIS ones.



SOLAR FLARES FORECAST

The probabilities of M and X-class solar flares during the last month are presented below. Chances of solar flare start to be meaningful from 15%.

