

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-OPS-OAI
No. 328
Week 01
05.01.09
Routine Phase

Prepared by: F.Schmidt (OPS-OAI) and INTEGRAL FCT

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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 27.12.08 until 02.01.09 (both dates inclusive) and covers the revolutions 757, 758 and 759.

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 hexagonal dither of the Quasar PKS 0208-512 (RA 02:10:46.20, DEC -51:01:01.9), a raster dither of the Cygnus Region (RA 20:35:53.00, DEC +40:39:49.0), hexagonal dither of the Virgo Cluster (RA 12:26:32.10, DEC +12:43:24.0) and a hexagonal dither of the North Ecliptic Pole (RA 18:00:00.00, DEC +66:33:39.0).

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.

One slew was missed from TL, during the observation period, due to problems on DSS station.

The fuel consumption over the period between 27/12/2008 and 02/01/2009 was 0.1061 Kg. The remaining propellant is in the order of 136.7199 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.

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

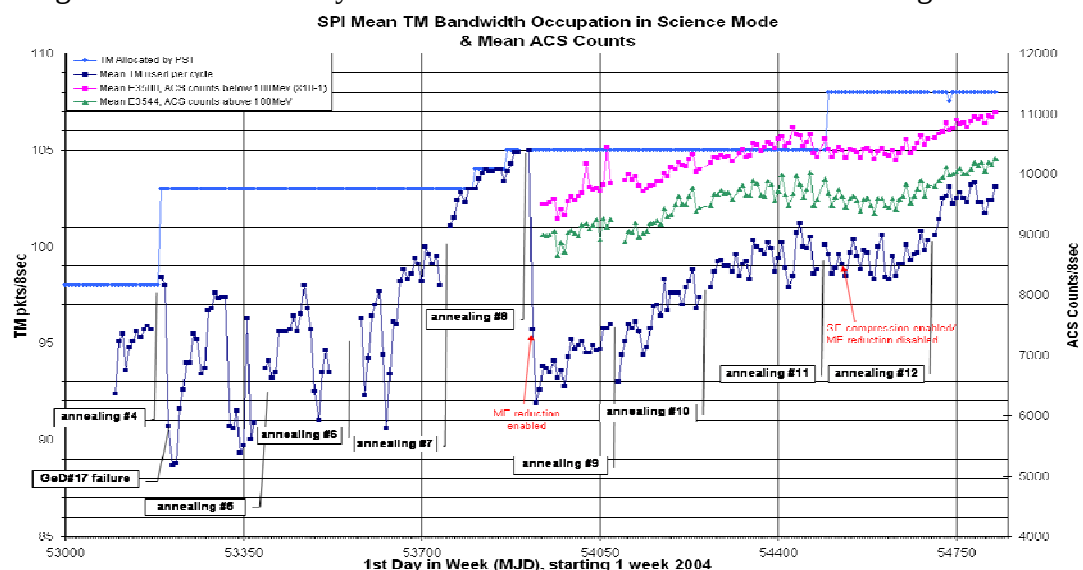
3.2.1 SPI

Following the 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 103.1 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.

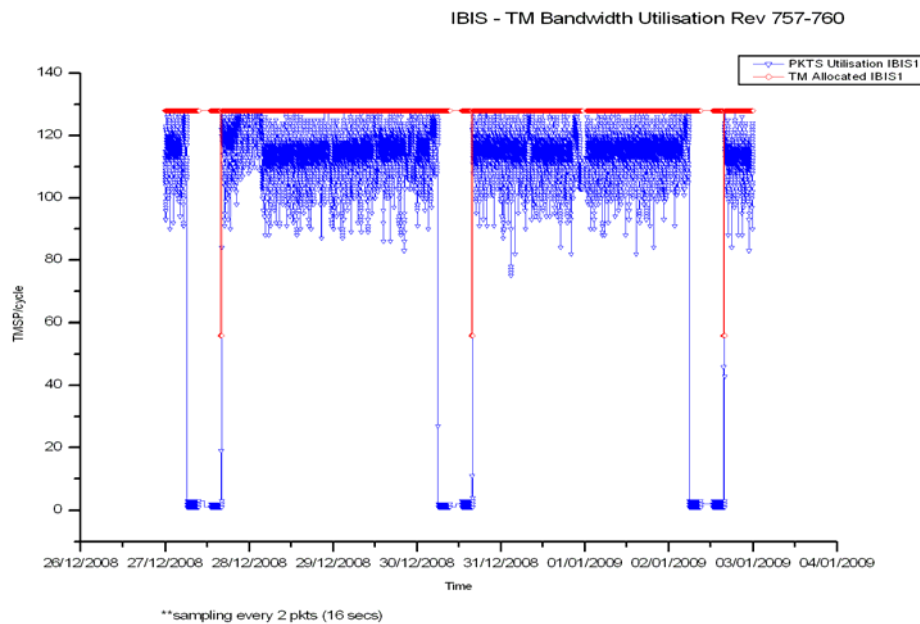
3.2.2 IBIS

The overall status of the unit is nominal.

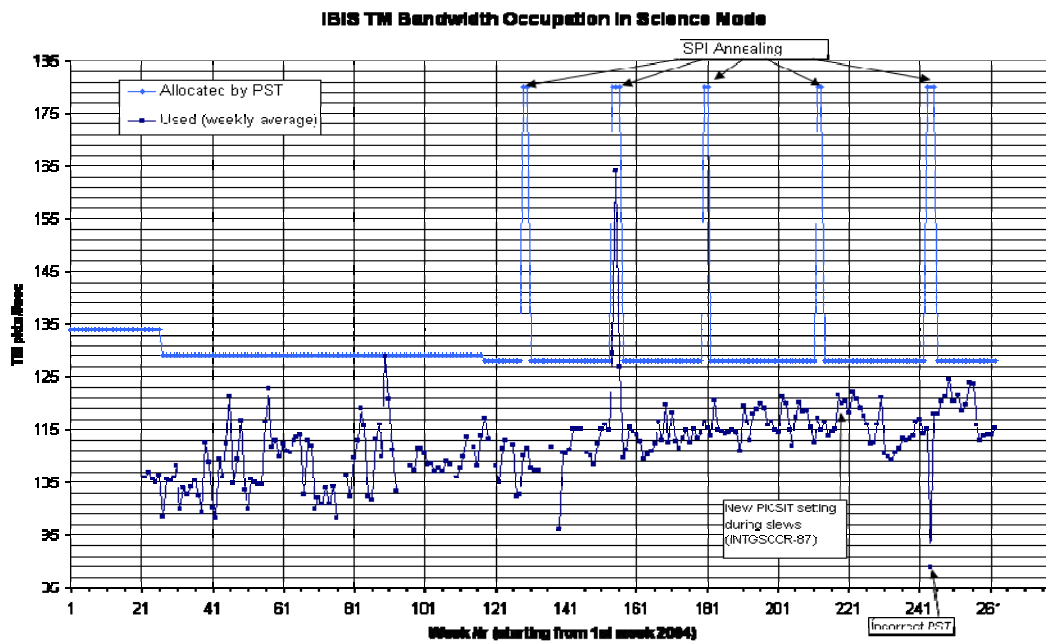
During the reporting period, the TM bandwidth statistics were as follows:

- PST allocation to IBIS above radiation belts: 128 packets/cycle
- IBIS mean bandwidth utilisation in science mode: 115.26 packets/cycle (up 1.29 on previous week)
- Percentage of TM cycles in which full bandwidth was used: 4.05%

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, 137 of the 138 planned science pointings were executed nominally, 1 was lost.

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. The sun remained 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. One pointing was lost due to ground problems. The overall performance though 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. On DoY 364 at 17:20Z and at 21:27Z there were link drops for a few seconds reported from Redu. The drop at 21:27Z caused the loss of the pointing #07580063. On Doy 366 at 16:11Z Bad Frames were received from Redu for a few seconds. On Doy 001 at 01:02Z there were two drops in TM for a few seconds reported from Redu which had no impact in commanding. At the same day at 04:55 Bad Frames were received from Redu for a few seconds.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

No new PSFs have been received and no new observations have been planned, as previously agreed.

For the same reason, no new TSFs have been received.

2. Observation status

New ECS files have been received for revolutions 748 to 753 and have been processed up to 750.

3. ISOC Science Data Archive

No news.

4. ISOC system

Work is continuing on ISOC system V20.1.

5. Problems

No new problems.

4.3.2 ISDC

Status of ISDC observation processing on 19/12/2008:

- Latest Standard Analysis completed: observation 06200210009 (GRS 1915+105, Revolution 743) on 12/12/2008.
- Latest products archived: observation 06200210009 (GRS 1915+105, Revolution 743) on 12/12/2008.
- Latest observation products sent to the observer: observation 05297000004 (Perseus OB2 Cloud, Revolutions 706-710) on 13/09/2008.

5 Special Events

31/12/09 DoY 366:

- 23:30 INT_OPS_366 LEAP SECOND OPERATIONS

6 Anomalies

29/12/08 DoY 364:

- 17:20 G/S: data gaps on VC-0 & VC-7 from G/S: DSS27 (3 min.)
- 21:27 G/S: drop VC-0 & VC-7 from G/S: DSS27. Impact: Lost TCs for AOCS S/S. OSL 07580063 failed
- 21:30 PID # 07580063 lost

31/12/09 DoY 366:

- 16:11 G/S: Bad Frames from: Redu

01/01/09 DoY 001:

- 01:02 G/S: drop VC-0 from G/S: Redu
- 01:04 G/S: drop VC-0 & VC-7 from G/S: Redu
- 04:55 G/S: Bad Frames from: Redu (31 DUs)

No anomaly reports were entered into the ARTS system this week.

7 Future Milestones

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 757

The observations in revolution 757 began with a hexagonal dither of the Quasar PKS 0208-512 (RA 02:10:46.20, DEC -51:01:01.9), lasting ~46.7 hours. They continued with a hexagonal dither of the North Ecliptic Pole (RA 18:00:00.00, DEC +66:33:39.0), lasting ~9.7 hours until the end of the revolution.

Revolution 758

The observations in revolution 758 began with a raster dither of the Cygnus Region (RA 20:35:53.00, DEC +40:39:49.0), lasting ~10.0 hours. They continued with a hexagonal dither of the Virgo Cluster (RA 12:26:32.10, DEC +12:43:24.0), lasting ~45.4 hours until the end of the revolution.

Revolution 759

The observations in revolution 759 began with a hexagonal dither of the Virgo Cluster (RA 12:26:32.10, DEC +12:43:24.0), lasting ~15.4 hours. They continued with a hexagonal dither of the North Ecliptic Pole (RA 18:00:00.00, DEC +66:33:39.0), lasting ~40.6 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

2008-12-20T00:12:23.000Z	136.9694	F	Automatic TM processing.
2008-12-21T14:08:03.000Z	136.9525	F	Automatic TM processing.
2008-12-23T00:05:27.000Z	136.9450	F	Automatic TM processing.
2008-12-23T18:52:25.000Z	136.9021	F	Automatic TM processing.
2008-12-24T09:19:30.000Z	136.8843	F	Automatic TM processing.
2008-12-24T13:53:15.000Z	136.8675	F	Automatic TM processing.
2008-12-25T23:24:15.000Z	136.8260	F	Automatic TM processing.
2008-12-27T13:42:59.000Z	136.8111	F	Automatic TM processing.
2008-12-28T03:00:12.000Z	136.7601	F	Automatic TM processing.
2008-12-30T13:30:35.000Z	136.7456	F	Automatic TM processing.
2008-12-31T08:09:17.000Z	136.7326	F	Automatic TM processing.

This report was generated Fri Jan 2 08:00:23 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, 27/12/2008 – 02/01/2009

The AOCS operations were executed from the Automatic Timeline.

During this period, 80 Open Loop Slews, 71 Closed Loop Slews and 5 Momentum Biases were executed (as reported by ACC OEM).

1 slew (OSL) was missed from TL, during the observation period, due to problem on DSS27 station on VC-0 and VC-7 links.

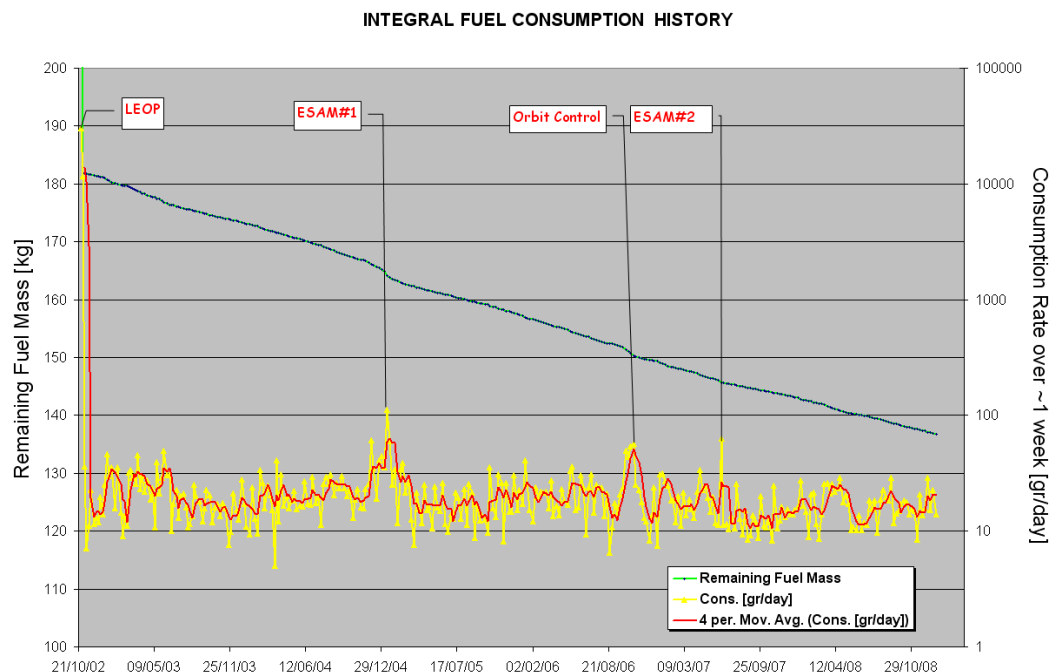
This is equivalent to $\sim 0.6\%$ of the total number of slews planned (151).

Orbit Control

No update

Fuel consumption

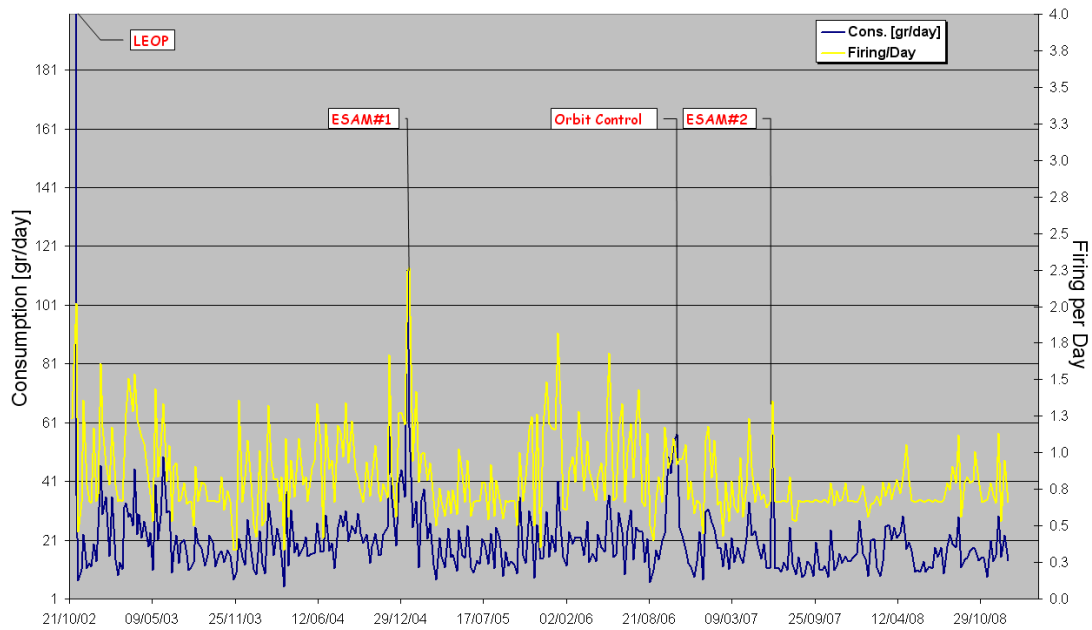
The fuel consumption (total, grams per day) over the period between 01/11/2002 and 02/01/2009 is reported in the plot below.



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 02/01/2009 is reported in the plot below.

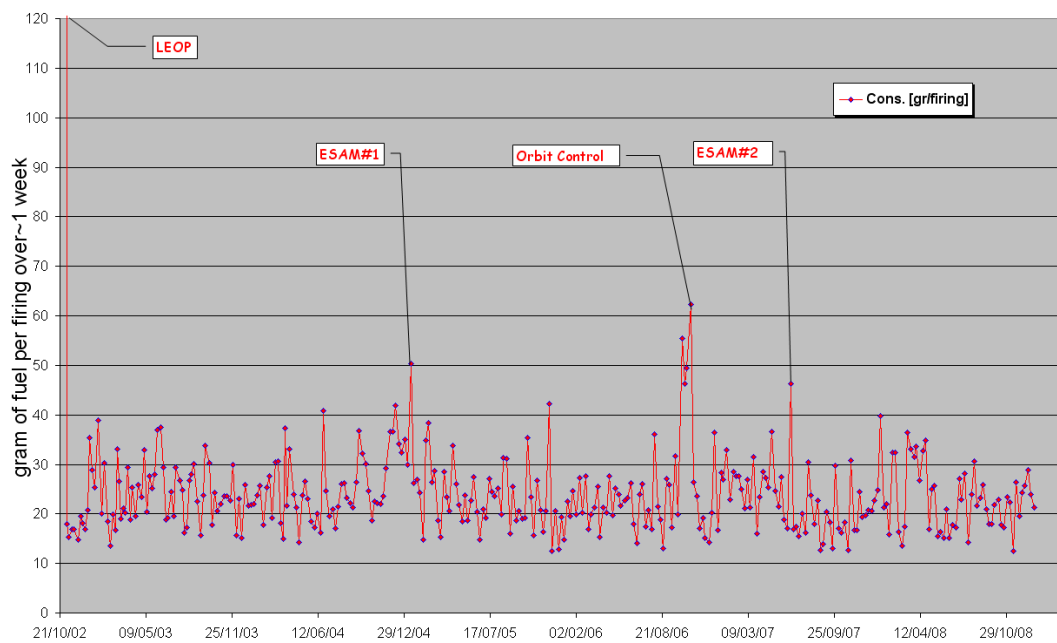
INTEGRAL FIRING PER DAY HISTORY



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 02/01/2009 is shown in the plot below.

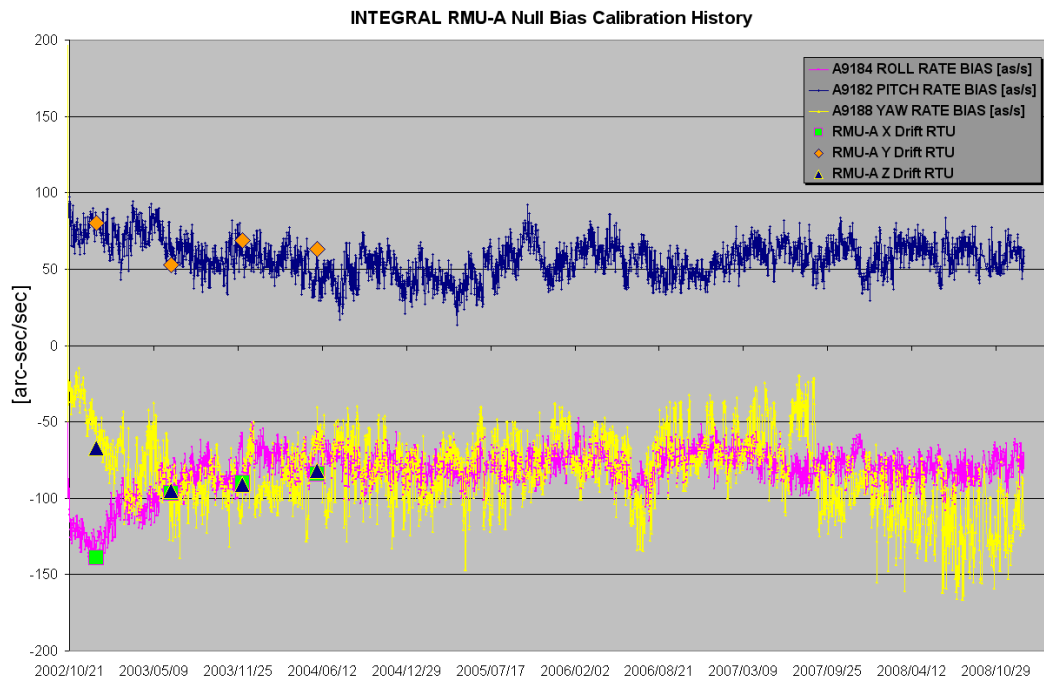
INTEGRAL FUEL MASS PER FIRING HISTORY



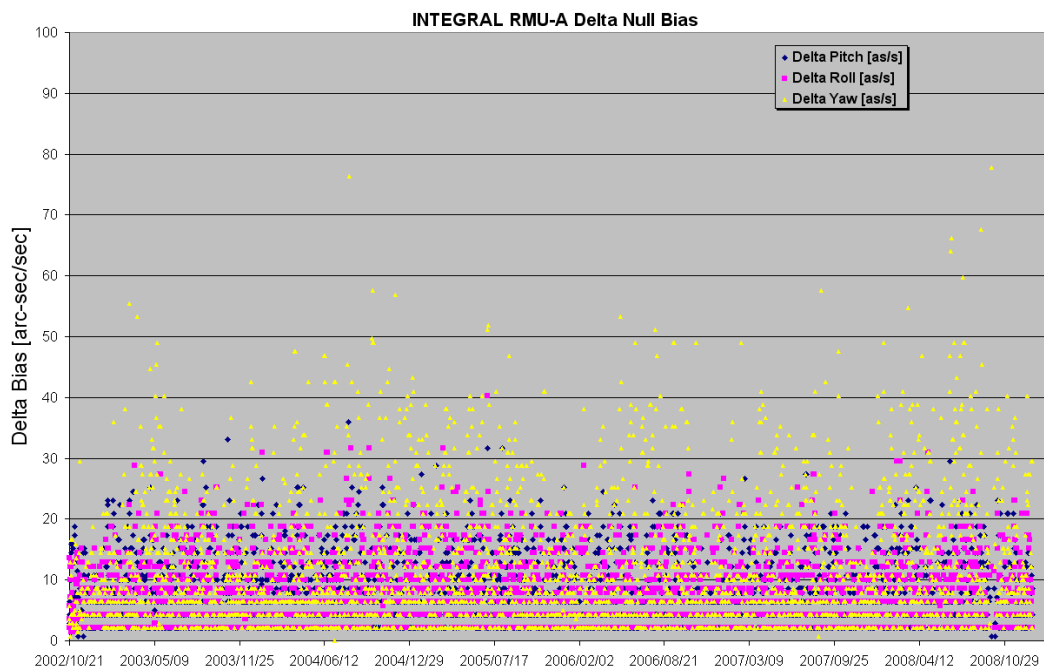
The RMU-A null bias calibration

The RMU-A null bias calibration history, on pitch, roll and yaw channel over the period between 01/11/2002 and 02/01/2009 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 02/01/2009 is reported in the plot below.



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27/11/2008 (Day of Year 362, Revolution 757-758)

Nothing to report.

28/11/2008 (Day of Year 363, Revolution 758)

Nothing to report.

29/12/2008 (Day of Year 364, Revolution 758)

Problem at DSS station: at 21:27z due to a TM links drop at DSS27 station the slew commanding fail for slew ID 07580063.

A manual recovery was then performed from the attitude of PID 07580062 to the attitude of PID 07580063 and the next slew ID 07580064 updated in TL.

The following slew was not executed in TL: PID 07580063(OSL)

30/12/2008 (Day of Year 365, Revolution 758-759)

Nothing to report.

31/12/2008 (Day of Year 366, Revolution 759)

Nothing to report.

01/01/2009 (Day of Year 001, Revolution 759)

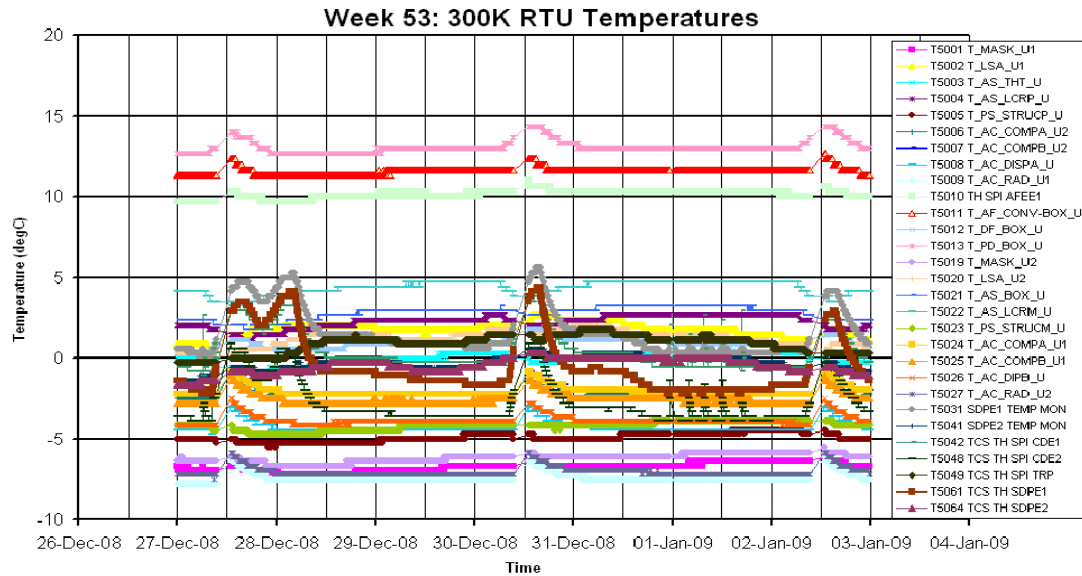
Nothing to report.

02/01/2009 (Day of Year 002, Revolution 759-760)

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.



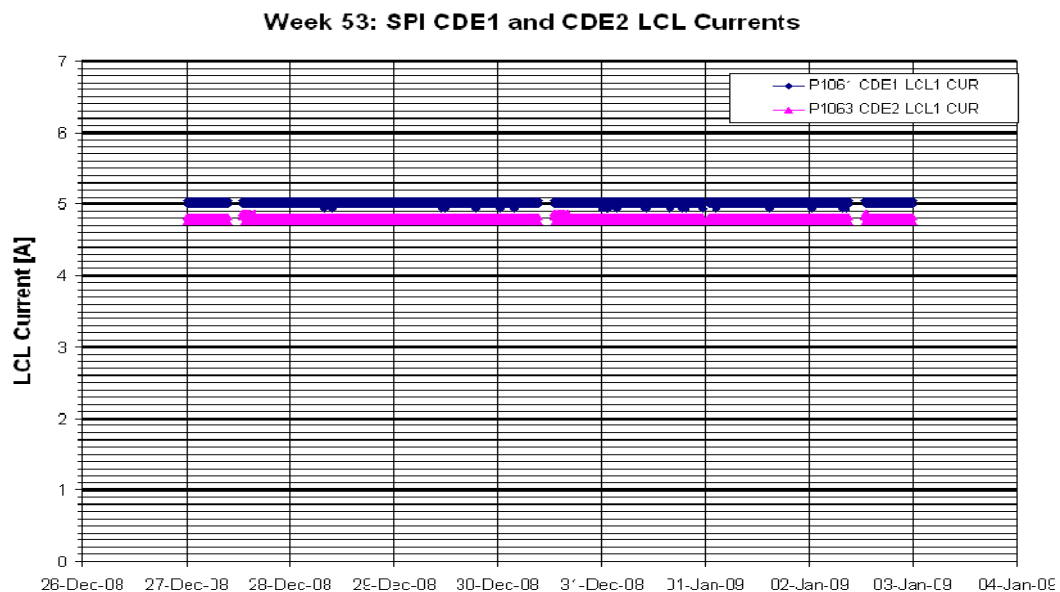
Stirling Compressors and Cryostat: The performance of the compressors is nominal.

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

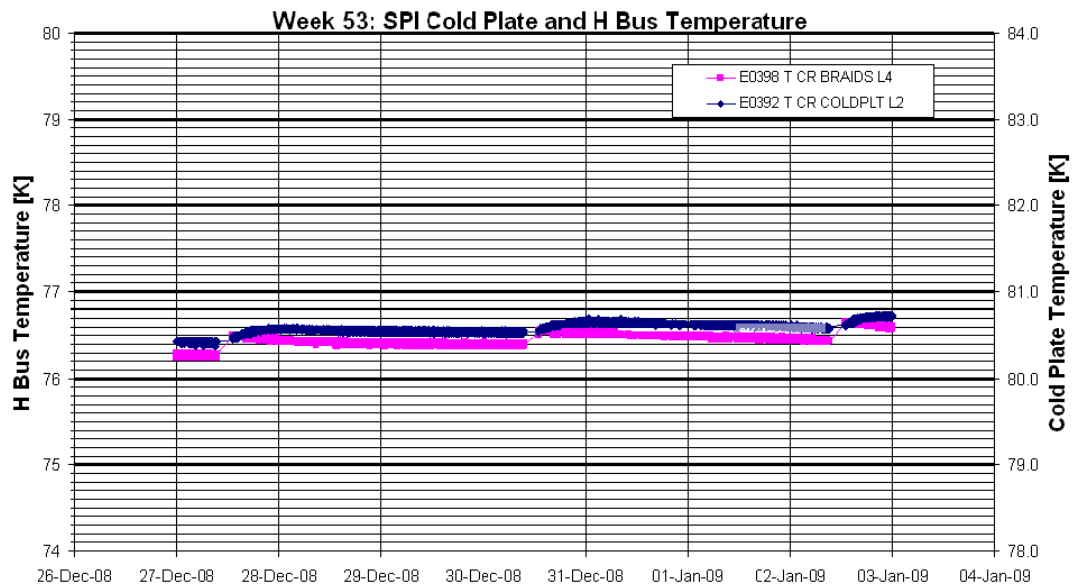
The stroke of all four compressors was set to 41 throughout the week and the average CDE LCL currents were as follows:

- CDE1 LCL Current = 5.01A
- CDE2 LCL Current = 4.80A

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



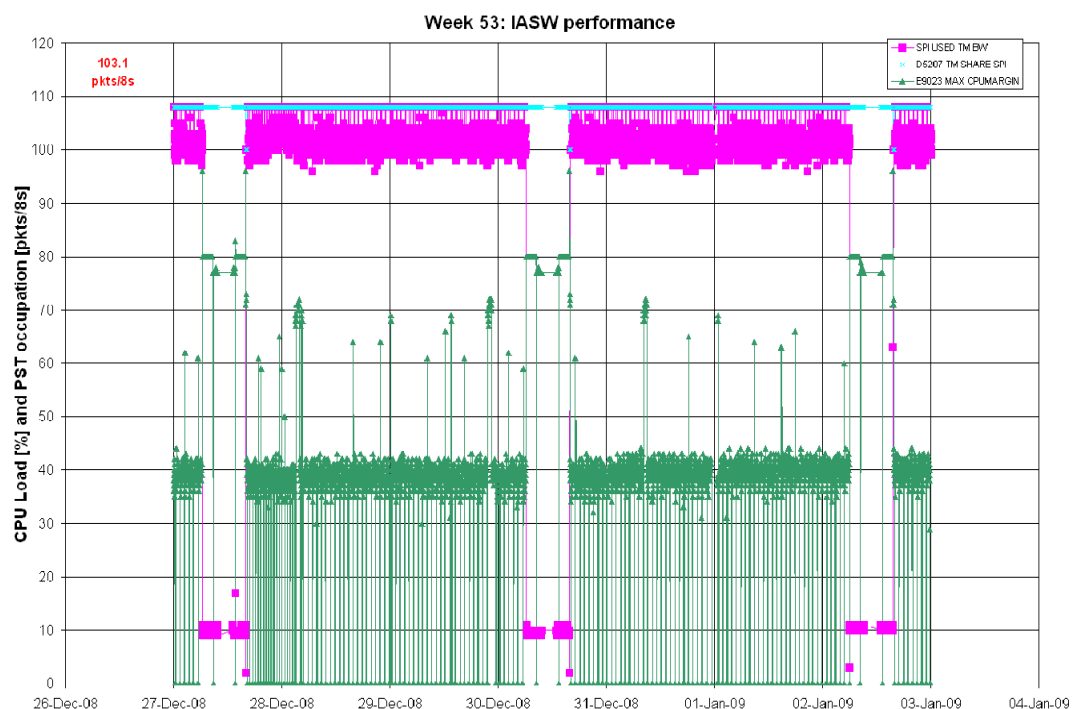
The following plot shows the evolution of the cold plate and H bus temperatures during the reporting period.



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

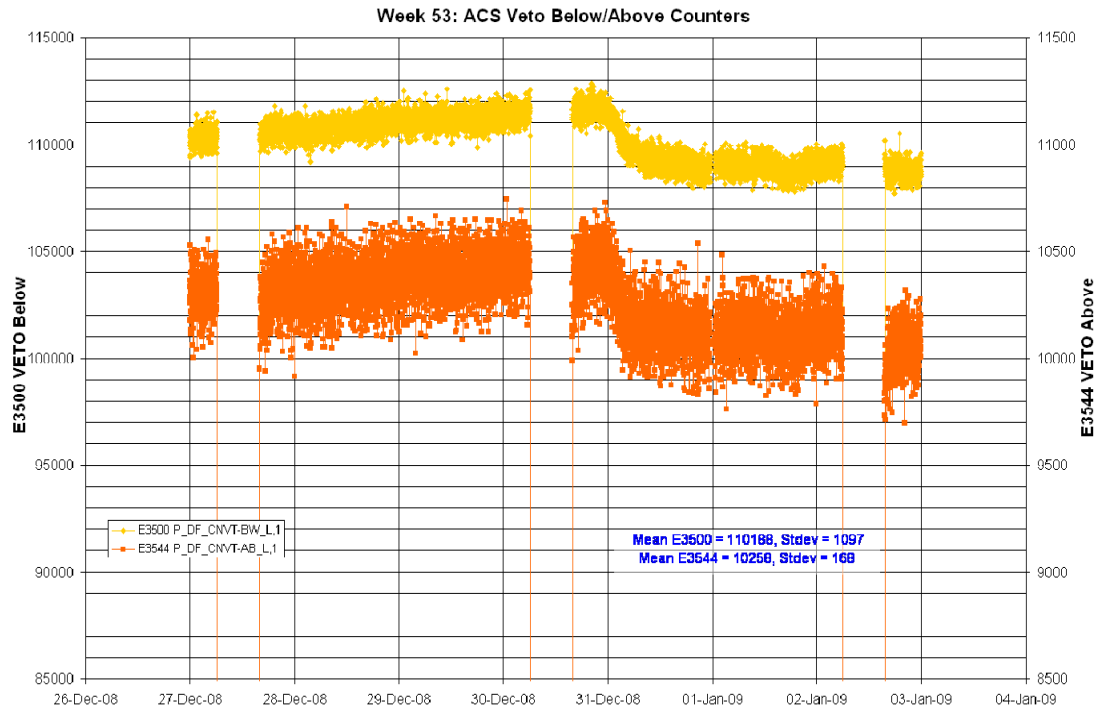
The IASW version installed is v4.3.4 with SE compression only enabled and the spectra scaling factor set to 8/19 SE. The average TM bandwidth occupation of SPI was 103.1 packets/cycle over the science window when the TM allocation was 108 packets/cycle.

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

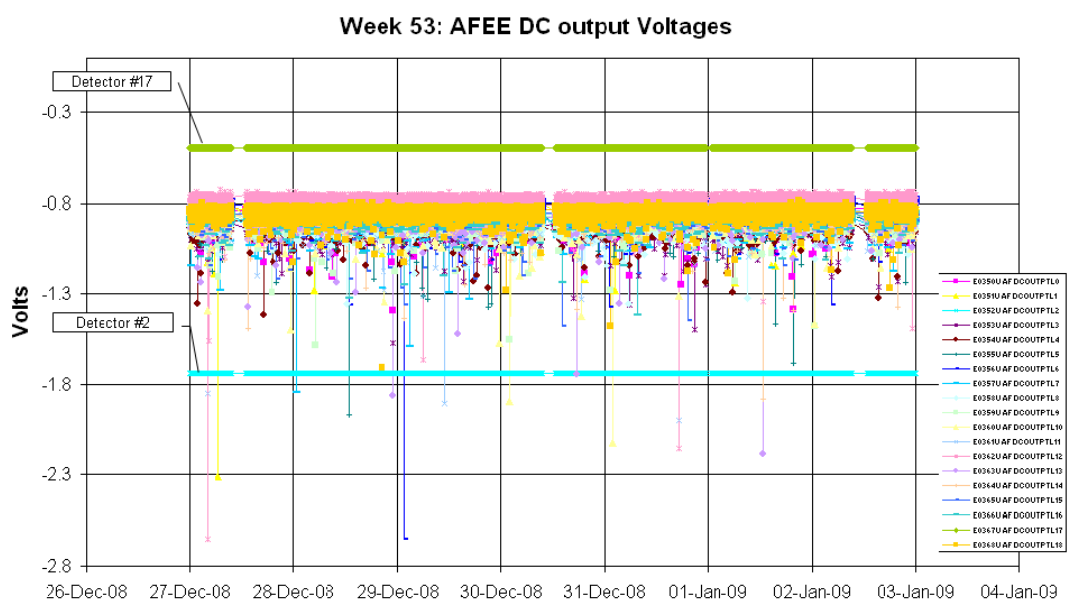


ACS: The performance of the ACS is nominal, except for FEE #81 which remains nominally switched off since the anomaly on 29/10/2006 (INT_SC-162) and FEE #57 which is nominally OFF due to the anomaly on 5/8/2003 (INT_SC-61).

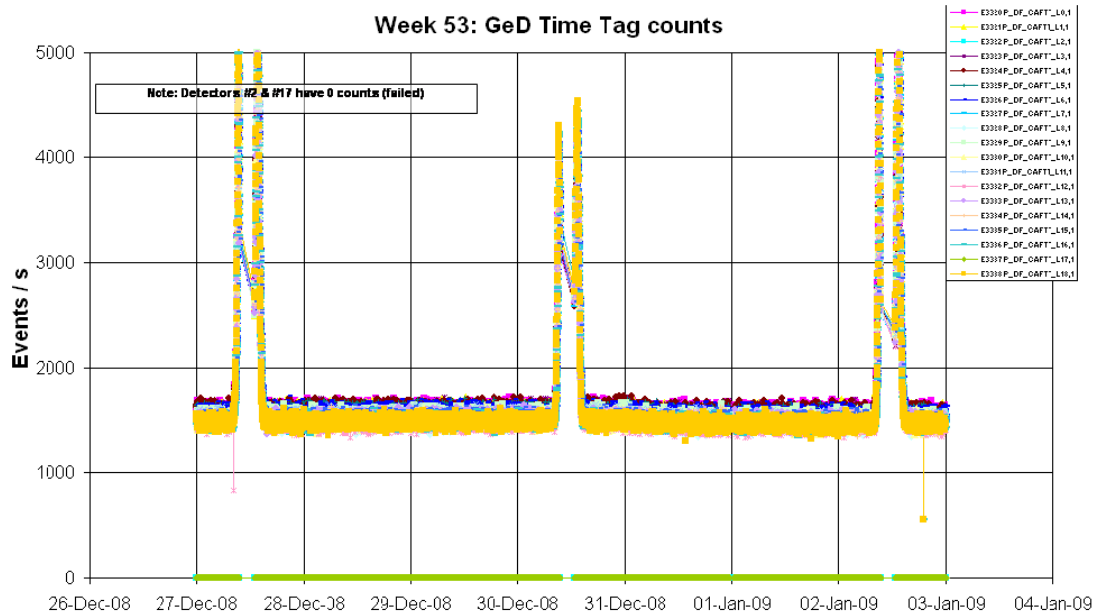
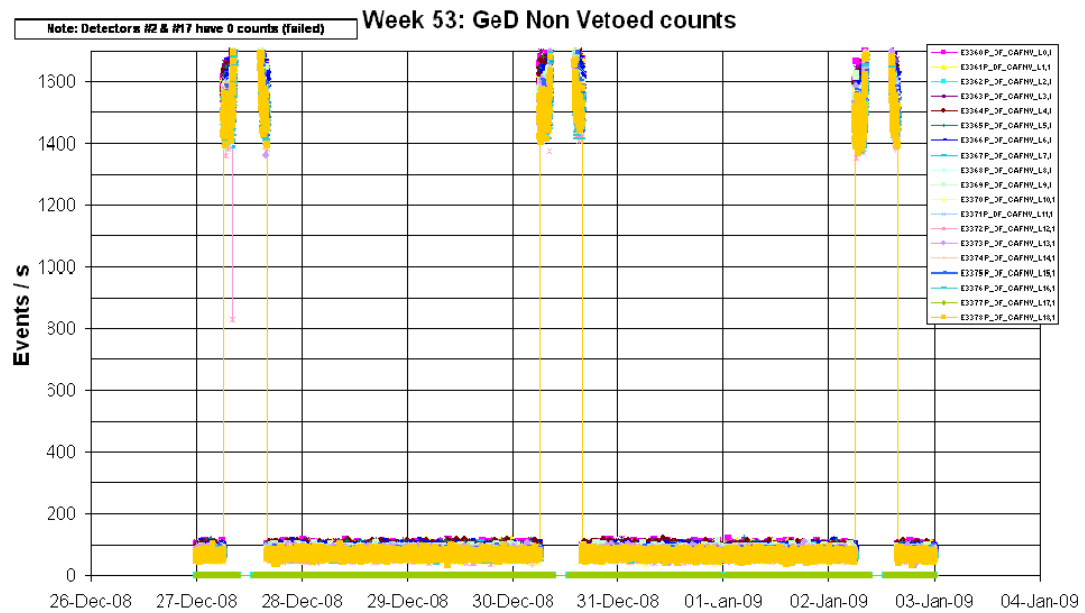
The following plot shows the ACS overall count rate evolution during the reporting period:

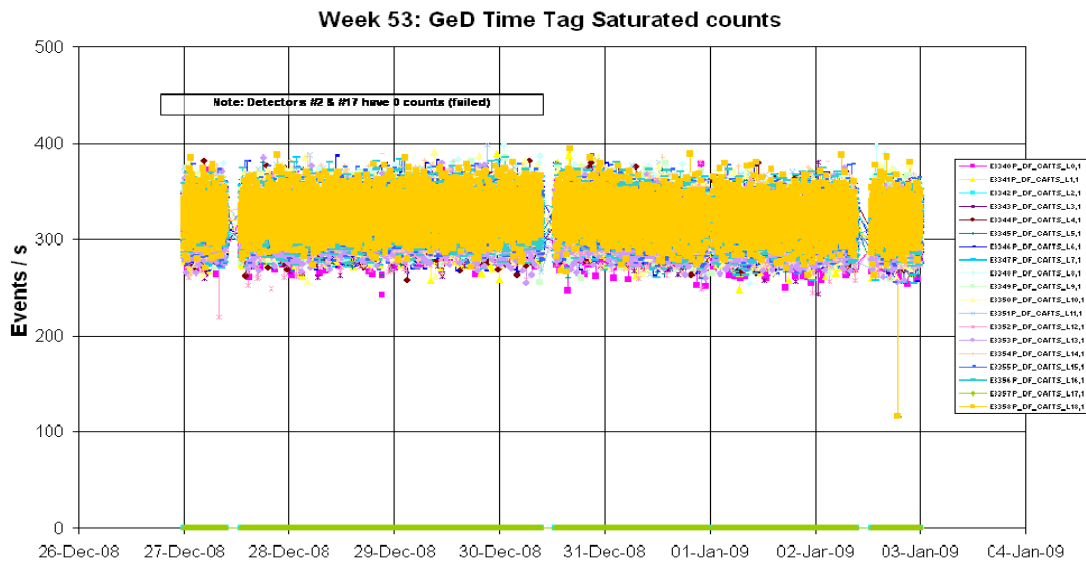


AFEE: The health of the AFEE is nominal. The following plot shows the dc voltage offset of the detector channels during the reporting period. The values are nominal. Detector #2 is failed since 06/12/2003 and detector #17 is failed since 17/07/2004.

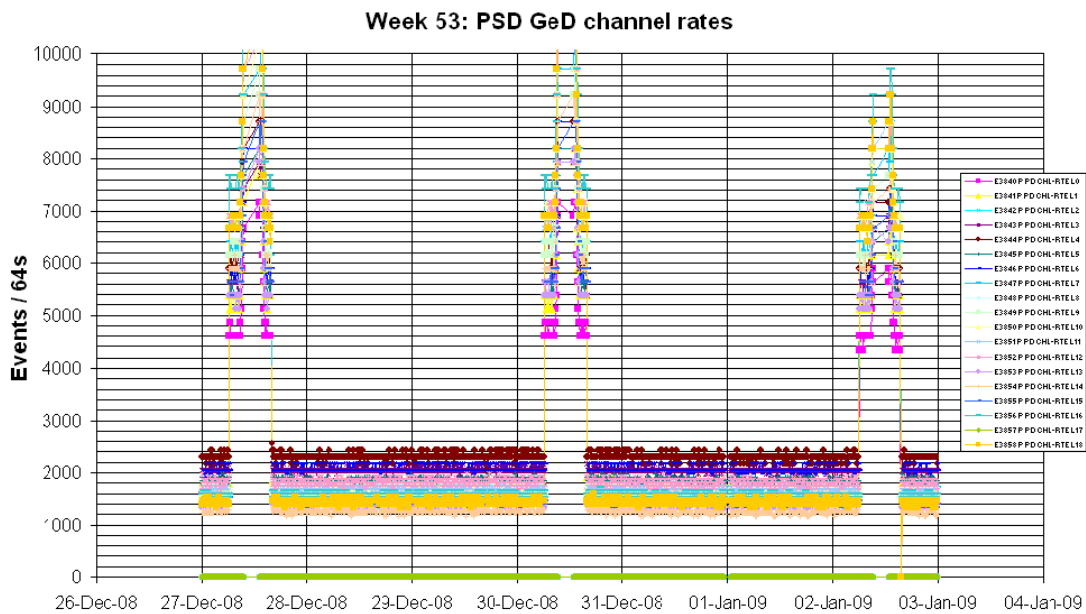


DFEE: The performance of the unit is nominal. The following plots show the Non Vetoed, Time Tag and Time Tag Saturated Event count rates during the reporting period.





PSD: The health of the unit is nominal. The following plot shows the PSD channel rates during the reporting period.



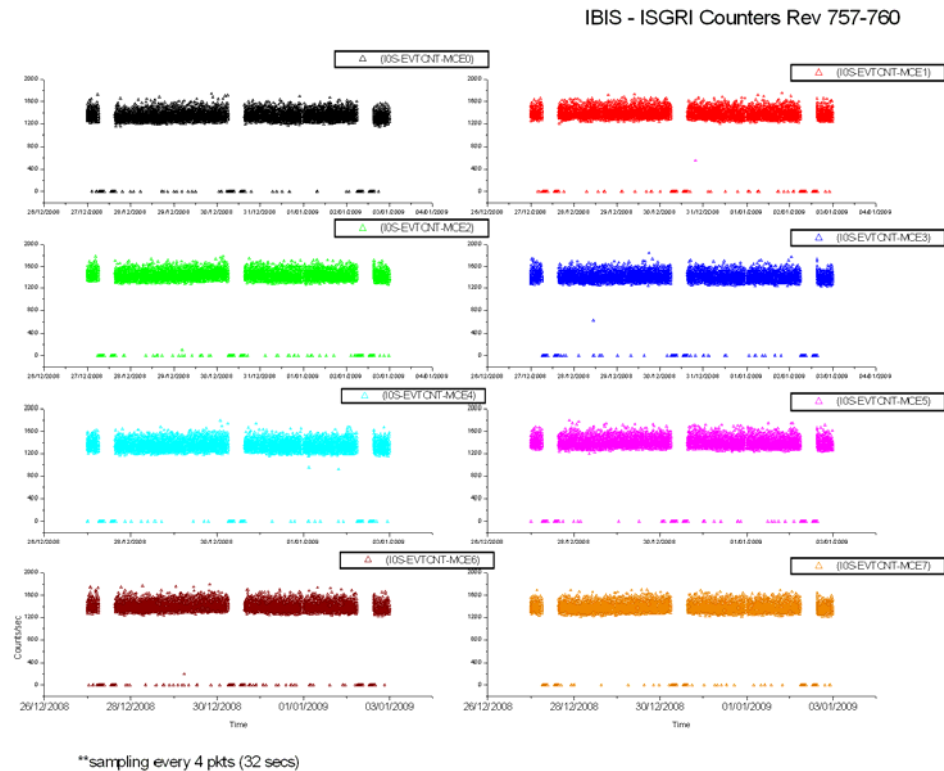
Event Log:

No non-nominal events occurred with SPI during the reporting period.

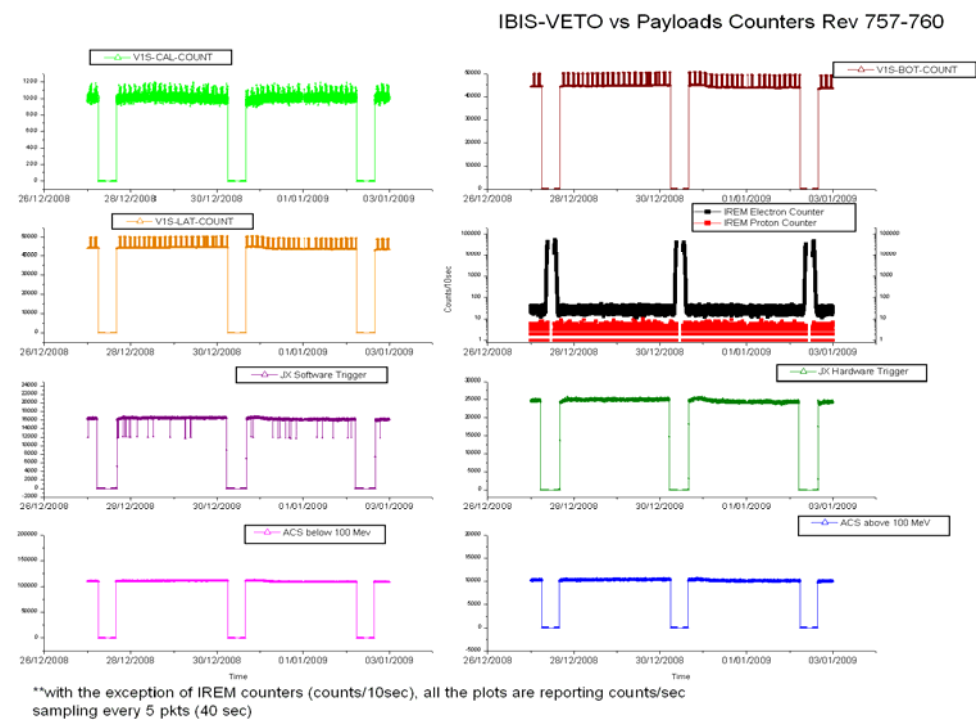
8.3.3 IBIS Operations

IBIS Event Counters Plots

ISGRI Counters:

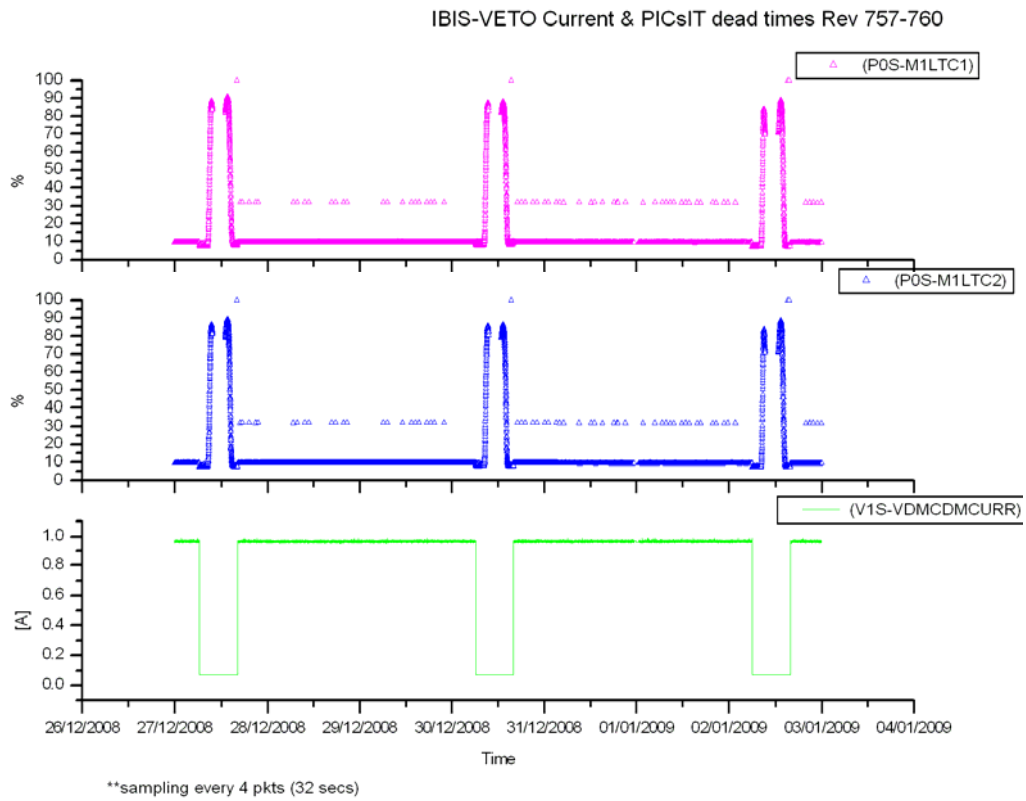


VETO vs Payload Counters:

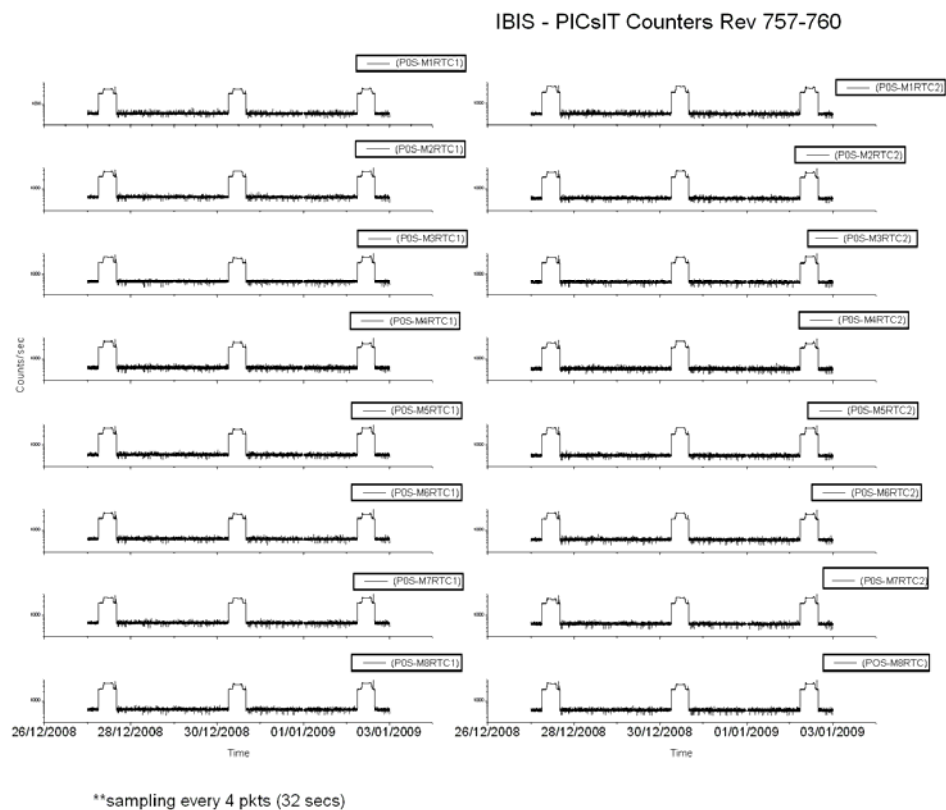


The week was characterised by low radiation as reported by the payload.

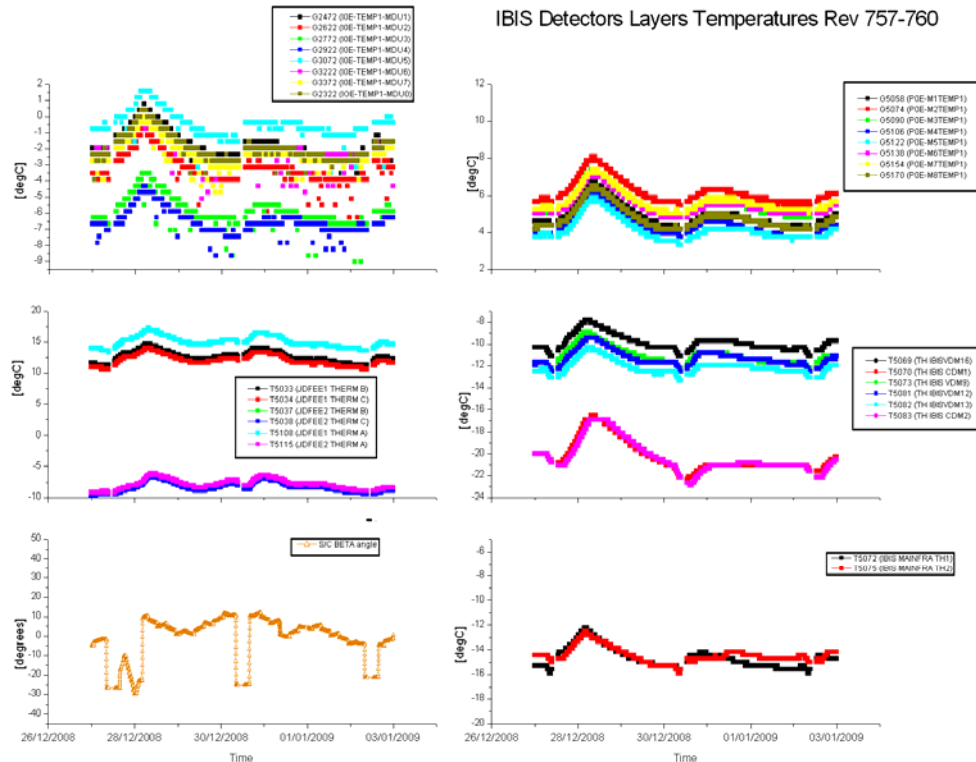
VETO Current:



PICsIT Counters:



IBIS Detectors Layers Temperatures:



**sampling every 8 pkts (64 secs)

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.

2008-12-27 (DOY 362, Rev 757-758) to 2008-12-29 (DOY 364, Rev 758)

IBIS operations executed nominally.

2008-12-30 (DOY 365, Rev 758-759)

From 22:30:28Z to 22:33:40Z TM parameter G2070 fluctuated OOL, indicating overflows of the noisy pixel address buffer in MCE5. As it returned within limits of its own accord, no action was taken.

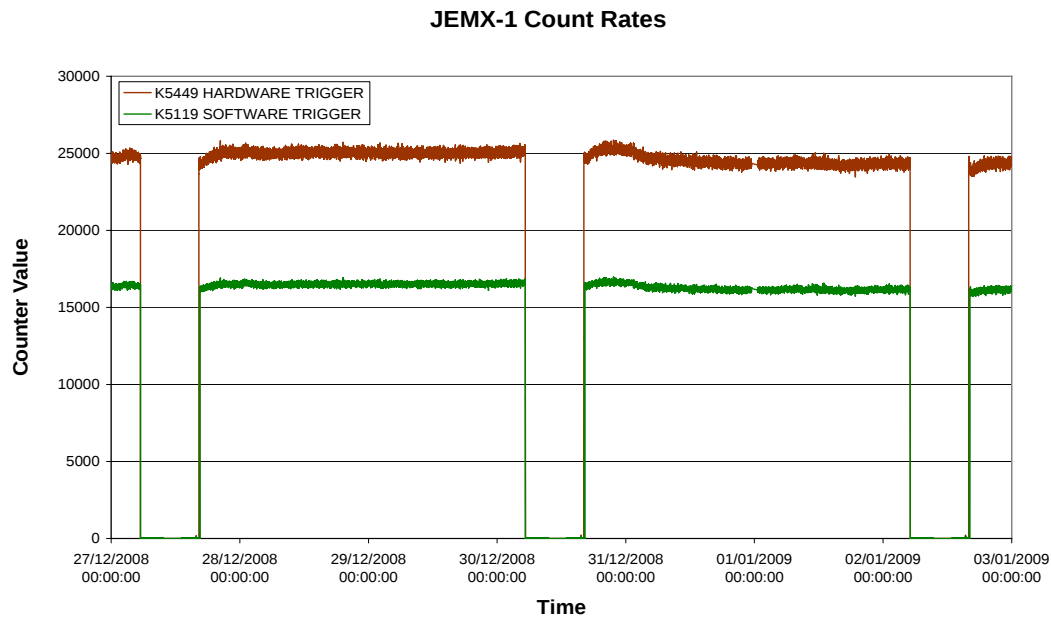
2008-12-31 (DOY 366, Rev 759) to 2009-01-02 (DOY 002, Rev 759-760)

IBIS operations executed nominally.

8.3.4 JEM-X Operations

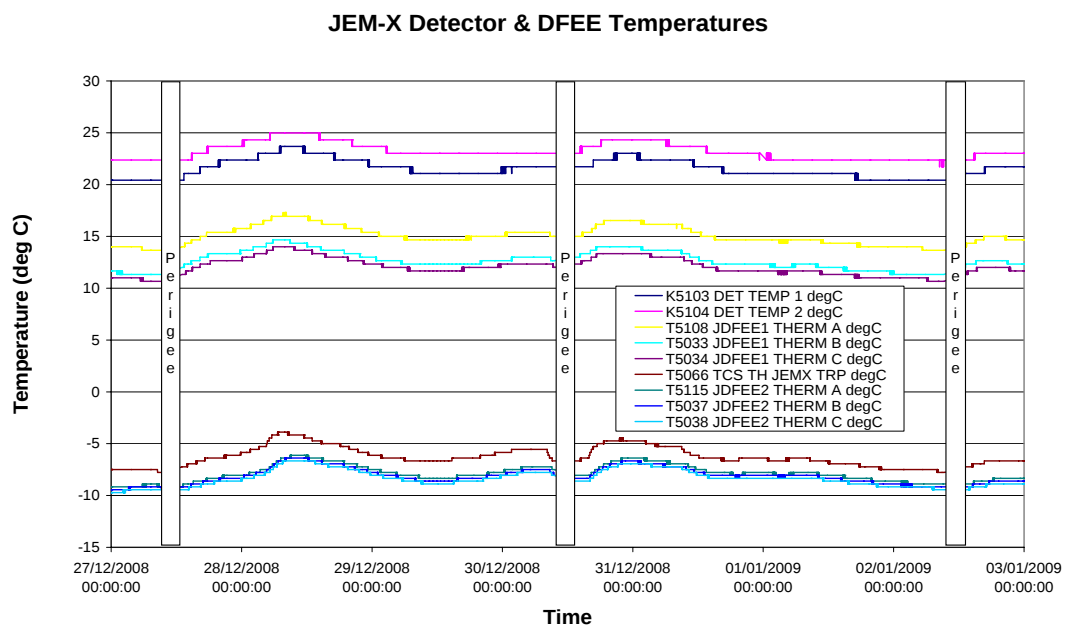
JEM-X Count Rates

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

2008-12-27 (DoY 362, Rev 757) to 2008-12-31 (DoY 366, Rev 759)

JEM-X 1 operations executed nominally.

2009-01-01 (DoY 001, Rev 759)

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

2009.001.02.05.48.221	2009.001.02.05.49.504	1536	RealTime	5		ANOMALY
JEM-X1 CSSW INT ER EXCEPTIO			0	0	65535	PR N
E	E					
FIX6		0				
K9079	MESS CLASS	2				
K9080	MESS ID	5				
K9074	TASK ID 16	12				
K9067	LOGICAL ADDRESS	4989				
2009.001.02.05.48.221	2009.001.02.05.49.538	1536	RealTime	5		ANOMALY
JEM-X1 CSSW INT ER EXCEPTIO			0	0	65535	PR N
E	E					
FIX6		0				
K9079	MESS CLASS	2				
K9080	MESS ID	5				
K9074	TASK ID 16	12				
K9067	LOGICAL ADDRESS	4989				
2009.001.02.05.48.221	2009.001.02.05.49.539	1536	RealTime	5		ANOMALY
JEM-X1 CSSW INT ER EXCEPTIO			0	0	65535	PR N
E	E					
FIX6		0				
K9079	MESS CLASS	2				
K9080	MESS ID	5				
K9074	TASK ID 16	12				
K9067	LOGICAL ADDRESS	4989				
2009.001.02.05.48.221	2009.001.02.05.49.540	1536	RealTime	5		ANOMALY
JEM-X1 CSSW INT ER EXCEPTIO			0	0	65535	PR N
E	E					
FIX6		0				
K9079	MESS CLASS	2				
K9080	MESS ID	5				
K9074	TASK ID 16	12				
K9067	LOGICAL ADDRESS	4989				
2009.001.02.05.48.221	2009.001.02.05.49.541	1536	RealTime	5		ANOMALY
JEM-X1 CSSW INT ER EXCEPTIO			0	0	65535	PR N
E	E					
FIX6		0				
K9079	MESS CLASS	2				
K9080	MESS ID	5				
K9074	TASK ID 16	12				
K9067	LOGICAL ADDRESS	4989				
2009.001.02.05.48.221	2009.001.02.05.49.541	1536	RealTime	5		ANOMALY
JEM-X1 CSSW INT ER EXCEPTIO			0	0	65535	PR N
E	E					
FIX6		0				
K9079	MESS CLASS	2				
K9080	MESS ID	5				
K9074	TASK ID 16	12				
K9067	LOGICAL ADDRESS	4989				
2009.001.02.05.48.221	2009.001.02.05.49.542	1536	RealTime	5		ANOMALY
JEM-X1 CSSW INT ER EXCEPTIO			0	0	65535	PR N
E	E					
FIX6		0				
K9079	MESS CLASS	2				
K9080	MESS ID	5				
K9074	TASK ID 16	12				
K9067	LOGICAL ADDRESS	5336				

No Action was taken, and there was no impact.

2009-01-02 (DoY 002, Rev 760)

JEM-X 1 operations executed nominally.

8.3.5 OMC Operations

2008-12-27 (DoY 362, Rev 757) to 2008-12-28 (DoY 363, Rev 758)

Nothing to report.

2008-12-29 (DoY 364, Rev 758)

At 21:27, a TM drop from DSS27 forced a suspension of the timeline. A recovery was performed, and the Timeline recovered at 22:03. The impact was the loss of pointing 07580063. It was at this time that the following pair of commands was rejected:

2008.364.21.28.11.718	2008.364.21.28.16.766	1792	RealTime	131	TC	REJECT
REJECTED TC1			0	0	65535	PR N
E E						
2008.364.21.28.17.843	2008.364.21.28.23.784	1792	RealTime	131	TC	REJECT
REJECTED TC1			0	0	65535	PR N
E E						

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

2008-12-30 (DoY 365, Rev 758) to 2009-01-02 (DoY 002, Rev 760)

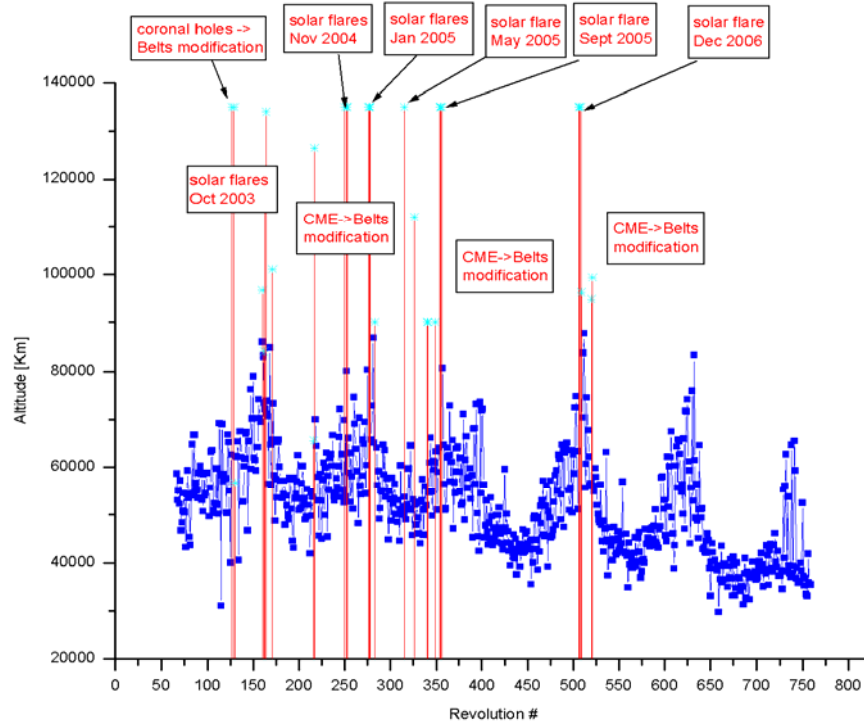
Nothing to report.

On DoY 362 at 06:18:54, DoY 365 at 06:08:06 and DoY 002 at 05:55:49 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]
757	RAD_ENTR R 2008-12- 27T06:18:48Z	27/12/2008 08:29:17	35881.1	27-Dec-2008 08:34:00	34691.9
758	RAD_EXIT R 2008-12- 27T15:59:31Z	27/12/2008 15:06:21	>>34026.3	27-Dec-2008 15:14:00	733769.63 47
758	RAD_ENTR R 2008-12- 30T06:08:04Z	30/12/2008 08:21:49	35488.1	30-Dec-2008 08:17:18	35784.14
759	RAD_EXIT R 2008-12- 30T15:49:02Z	30/12/2008 14:37:41	>>32259.2	30-Dec-2008 14:57:18	45485.13
759	RAD_ENTR R 2009-01- 02T05:55:49Z	02/01/2009 08:10:44	35481.8	02-Jan-2009 08:07:18	35441.27
760	RAD_EXIT R 2009-01- 02T15:37:23Z	02/01/2009 14:51:48	>>33989.9	02-Jan-2009 14:47:18	45729.24

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)

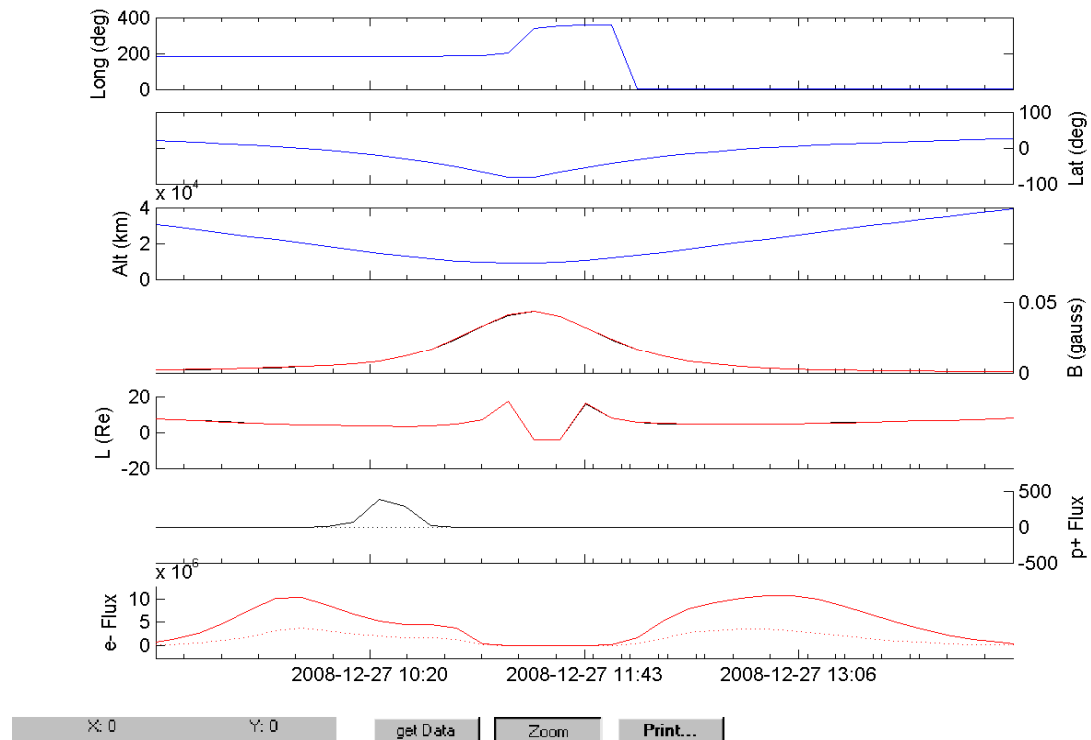
* Rad belt entry time ignoring previous threshold crossings where a gap of more than 30 minutes is present.

IREM radiation counters:

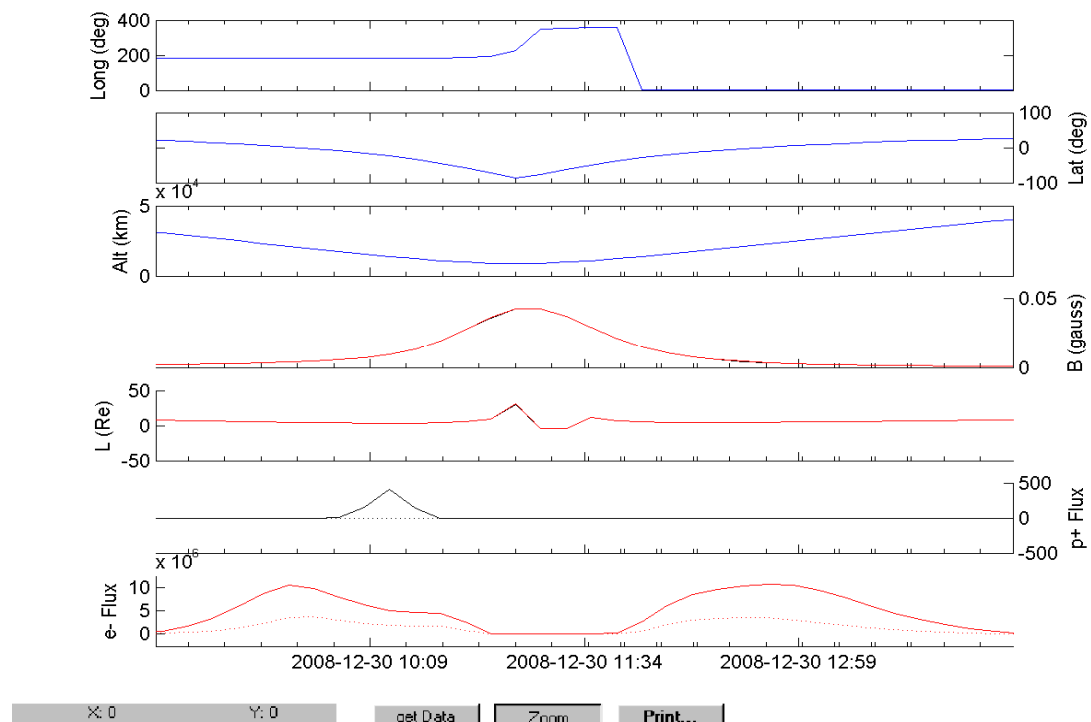
The IREM radiation counter plots are not available this week.

IREM Predicted Radiation Belt Passages

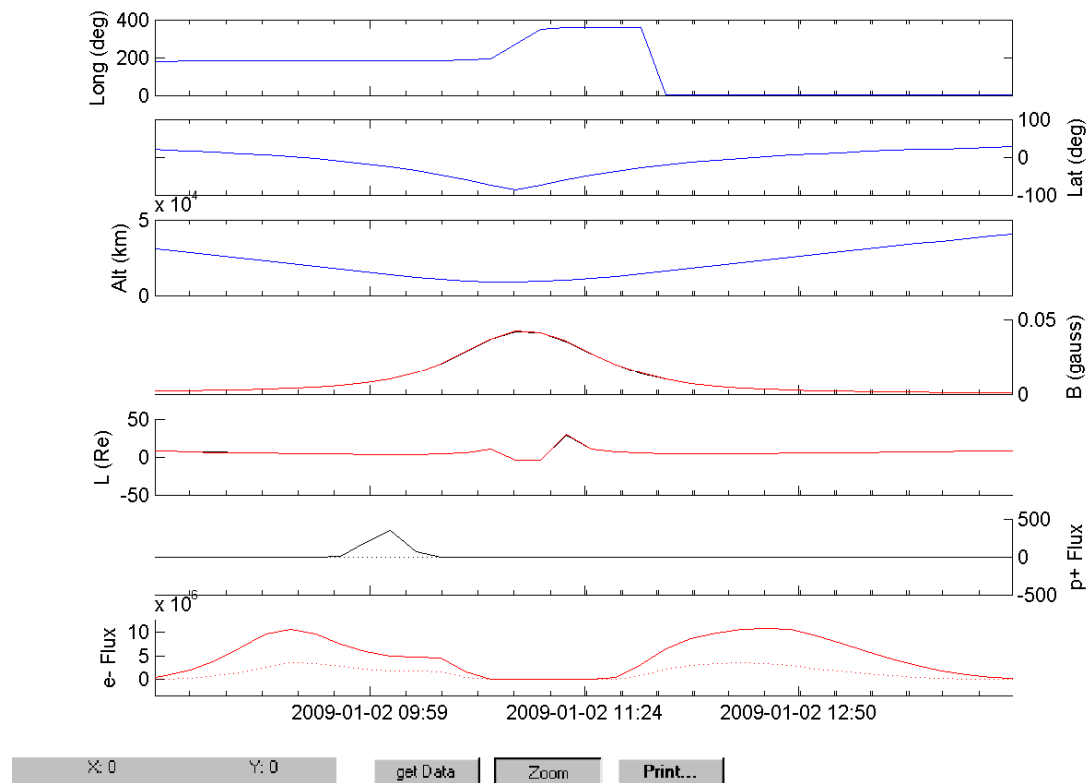
Rev 757



Rev 758



Rev 759



Radiation Assessment

Generated with SEIS Report and Analysis tool.

INTRODUCTION

This note summarises the space weather status over the observation period

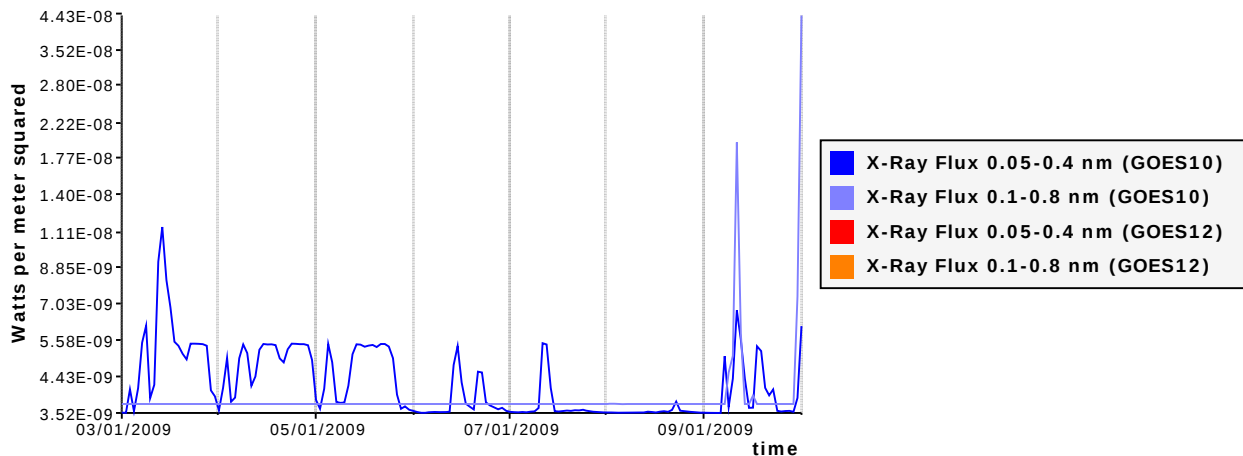
DAILY SUN

see in WR section 3.2.5

RADIATION FLUXES

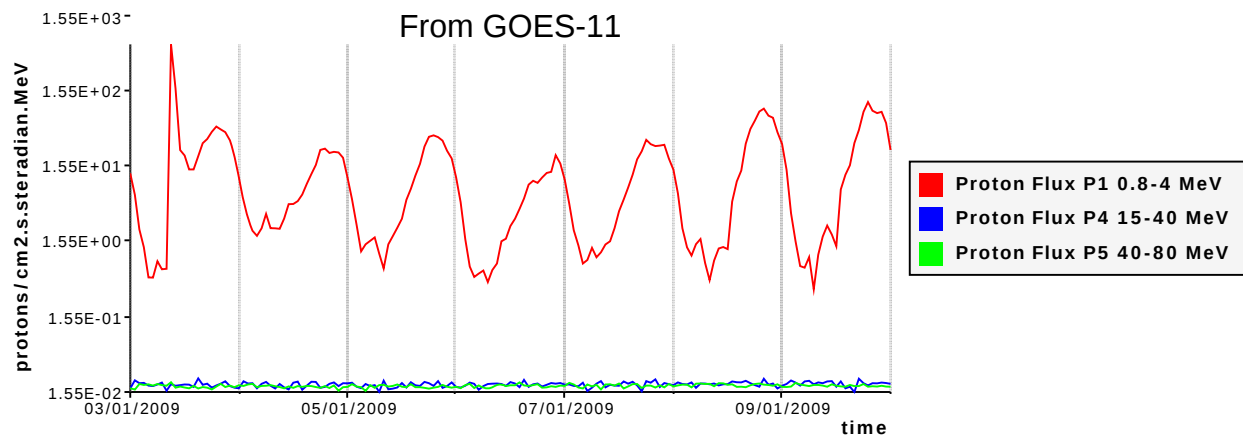
X-ray fluxes

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.



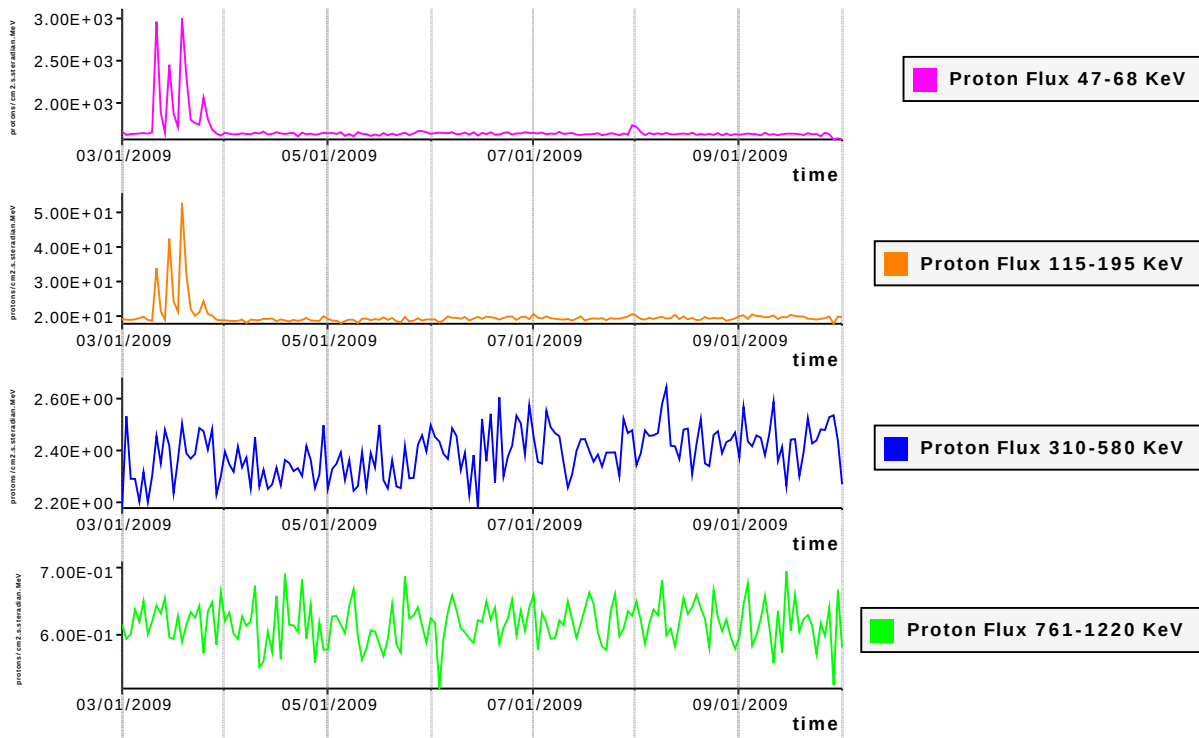
Proton fluxes (GOES-11)

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 $1\text{E-}2$.



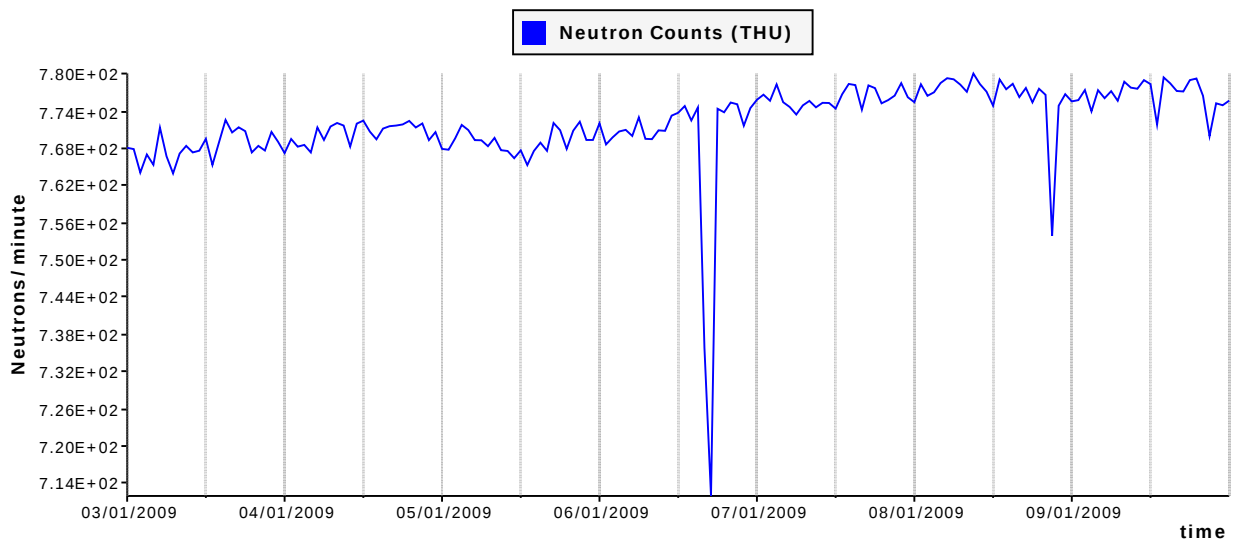
Proton fluxes (ACE)

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



Neutron counts

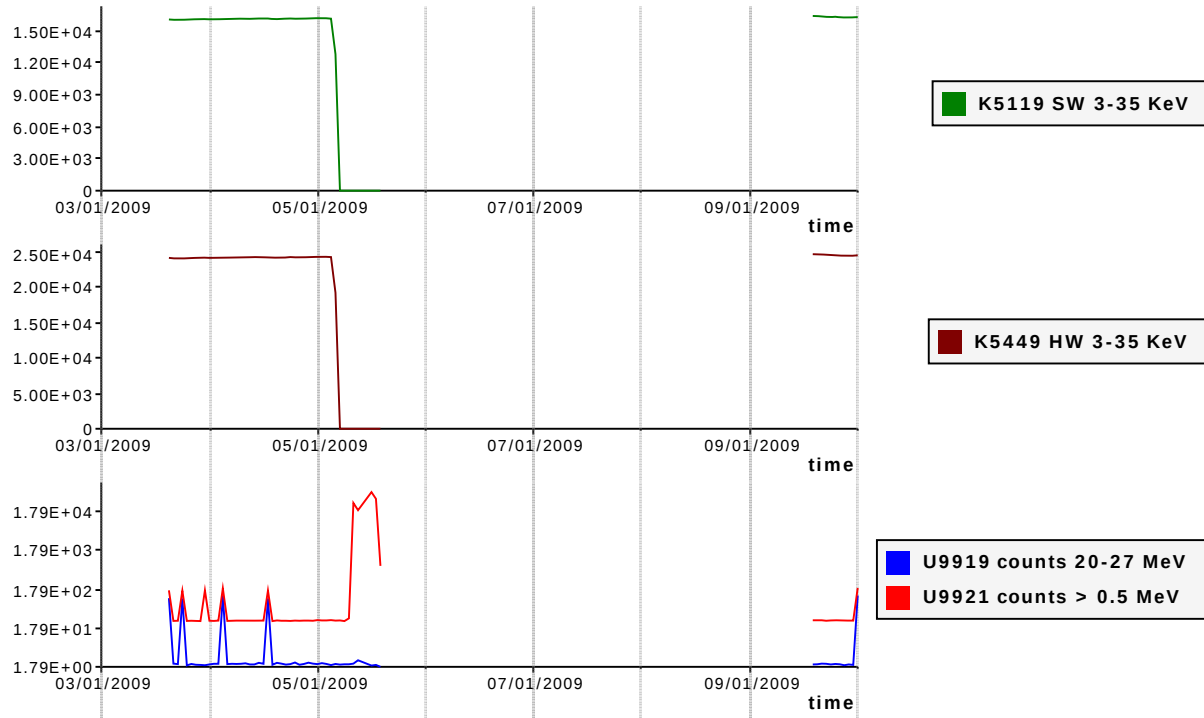
The neutron counts for the last 3 days are presented in the following plot. Nominally they remain stable around 7.2E+2.



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.

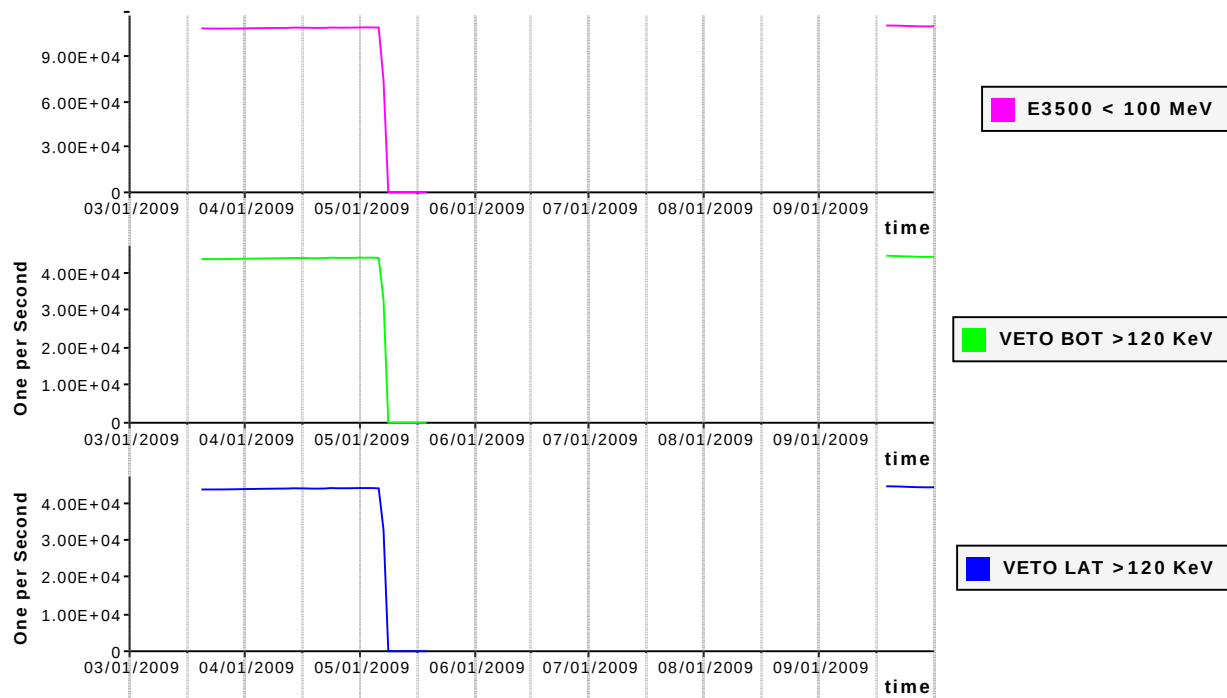
Nominal values are respectively about 1 and 18 for IREM counts, and, 13000 and 19000 for JEM-X ones.



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%.

