

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-TOS-OF
No. 084
Week 18
03.05.04
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 24.04.04 until 30.04.04 (both dates inclusive) and covers the revolutions 187 & 188.

2 Summary of Activities

The operations were performed according to the planning inputs from ISOC combined with some manual commanding by MOC.

The target of these revolutions was the Sagittarius Arm tangent (RA 19:00:1.43; DEC +06:55:17.0). The science activities consisted of a raster dithering observation.

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.

The AOCS operations from the Timeline were rather smooth. In total, three slews were missed due to problems with the links to the ground stations.

The fuel consumption over the period between 23/04/2004 and 30/04/2004 was 0.071 kg. The remaining propellant is in the order of 170.960 Kg on the 30th of April.

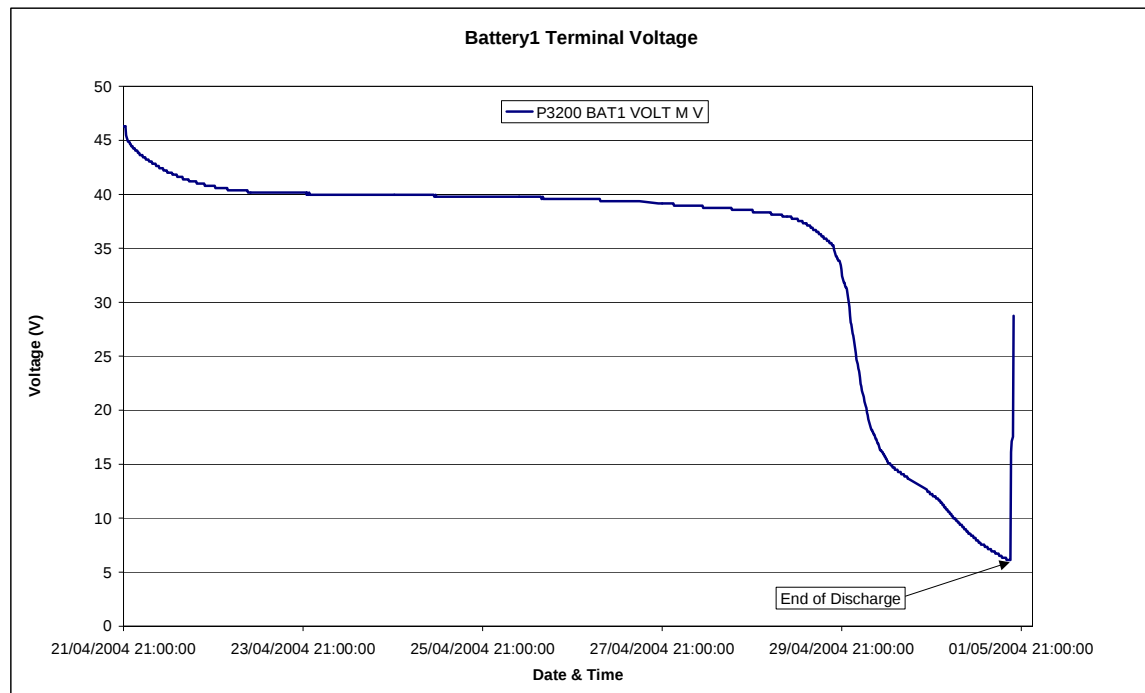
Note: Some more information concerning the AOCS operations and the fuel budget is provided in the Appendix.

3.1.2 Power

The power subsystem is working as specified. The available power from the arrays is in the order of **2200W**.

Battery 1 Reconditioning.

Battery 1 reconditioning continued throughout the week. Discharge was terminated on 1/5/2004 at 16.38.44, the discharged capacity was 35.2Ah. Recharge operations were started on the same day at 18.49.34z. The following plot illustrates the discharge profile of battery 1 Voltage:



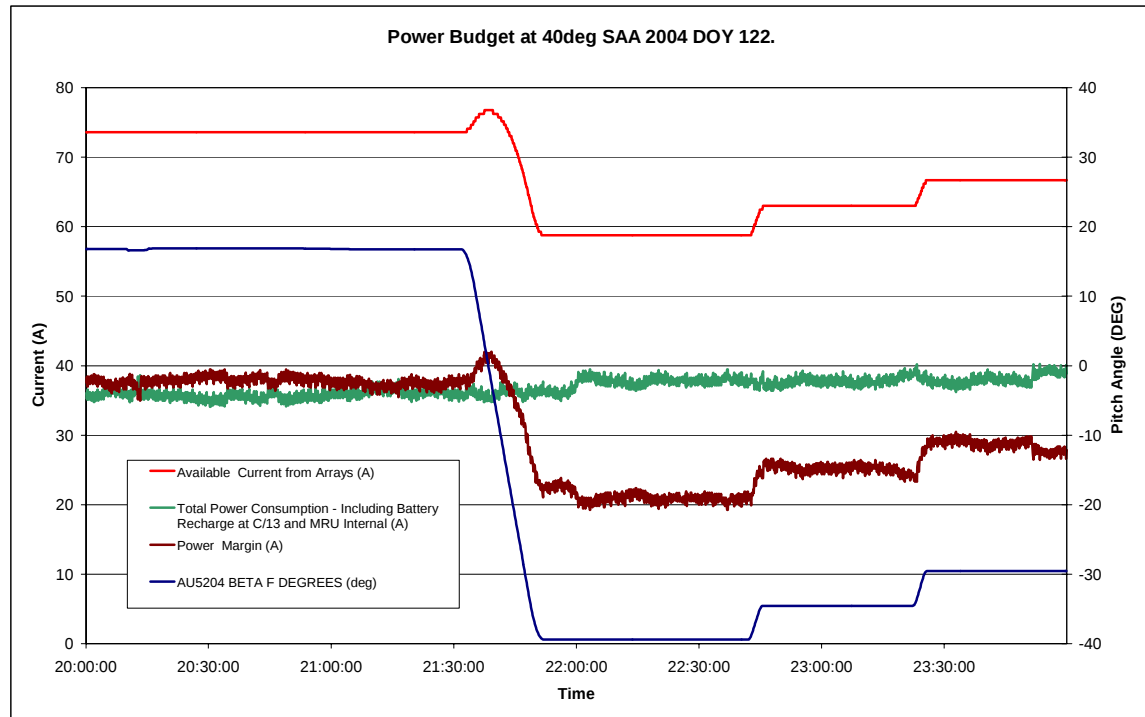
The behaviour of the battery during the reconditioning discharge phase was completely nominal.

Solar Array Output at Extreme Pitch Angle.

On DOY 212 at about 21.43z an Open Loop Slew was completed, which took the Pitch Angle to a value of -39.4° , the absolute limit on pitch angle is $\pm 40^{\circ}$. This extreme Pitch angle caused the output from the solar array sections to reduce to a value below 10A, which is the soft low limit on the IMCS.

A check was made of the available power margin at this SAA, the results are displayed in the plot below.

It can be seen that the minimum available power margin, even taking into account a battery recharge, was 20A. According to the Integral Users Manual, the Pitch angle must be restricted to $\pm 30^{\circ}$ when the power margin at $\pm 40^{\circ}$ is 5A or less, ie still well away from the current situation.



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

The overall status of the instrument is nominal.

During the reporting period the instrument was in photon-by-photon mode with spectra TM enabled, an assigned TM bandwidth in the science windows of 98

pkts/cycle and an actual average occupation of 93.6 pkts/cycle (-1.9 pkts w.r.t. previous week).

The 3rd annealing of the Germanium detectors will start on 17th June at rev. 204 critical altitude descending crossing.

The cryo-cooler is working well maintaining the temperature within 85+/-1K.

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

3.2.2 IBIS

The status of the unit is Nominal.

The TM bandwidth assigned to IBIS during the observation period was 134 pkts/cycle.

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 from the automatic Timeline.

JEM-X1 was operated in Data Taking mode during science observations, with a TM allocation of 8 packets/cycle. JEM-X2 was dormant 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.

During the reporting period OMC operations were performed by the automatic timeline, with the TM allocation to OMC of 5 packets/cycle during normal science operations.

There were 139 OMC pointings executed nominally, 2 were 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.

The observation period was characterised by low solar activity.

Note: Some more information concerning the IREM operations is provided in the Appendix Section 8.3.6.

4 Ground Facilities

The performance of the Operational ground facilities was in general good this week, well above the system performance requirements.

4.1 Mission Operations Centre

The performance of the MOC was very good in the reporting period.

4.2 Ground Stations & Network

The performance of the ground stations and Network was in general good this week. There were, however, communication problems with both ground stations, which led to the loss of science data.

Since DoY 075, the Redu station has been operating with reduced uplink power, 60W instead of 450W. This was done in an attempt to cure the problem of corrupted TM frames (Reed-Solomon errors) being received at Redu. Our theory being that this was due to cross-talk between the on-board RX and TX. During this period, the number of Reed-Solomon errors was observed to dramatically decrease.

On DoY 119, as part of a test, the uplink power was again increased to 400W, and, as expected, Reed-Solomon errors were again observed. Following this the uplink power was returned to 60W, and will remain at this level.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

PSF's: Received up to rev. 196

POS and POD generated: up to rev 196

TSF's: Received up to rev 190

No ToO requests received. Re-planned revolutions 192 and 193. The reason is the large slew out of perigee for revolution 193 could not be implemented with a suitable reaction wheel profile.

2. Observation status

ECS for revolution up to 175 received except 168. Corresponding OCS's sent to ISDC.

3. ISOC science archive

Nothing to report this week

4. ISOC system

The ISOC system version 10.4 has been installed this week. It has been used to re-plan revolutions 192 and 193. This version includes besides patches to version 10.3 some enhancements to avoid the previous problems around the JEM-X configuration from two weeks ago.

5. Problems

No problems have occurred this week. With some enhancements in ISOC software version 10.4 and enforcements of procedures the problems related to re-planning of revolutions 183 to 187 are considered resolved.

4.3.2 ISDC

On 03/05/2004, the status of ISDC observation processing is:

- Latest Standard Analysis completed: observation 01201570002 (Cygnus X, Revolution 153-160) on 02/05/2004
- Latest products archived: observation 01200470001 (NGC 4945, Revolution 149-150) on 12/03/2004
- Latest observation products sent to the observer: observation 01201250002 (Cassiopeia A, Revolution 144-148) on 19/03/2004

5 Special Events

- Battery Re-conditioning

6 Anomalies

There were a number of problems related to the ground segment that impacted the operations:

- On DoY 117 at 21:01, the imca was yellow in the mmi global overview. The mmi application, which was observed to be using 10.5% of the cpu was stopped and restarted curing the problem.
- On DoY 118, at 10:46 there was a 2 minute break in the TC link to DSS16, there was no impact.
- Later, at 22:03, an AOCS command failed release due to problems with the TM & TC links with Redu. Shortly afterwards, IBIS & SPI commands also failed, as this was just after the emergence from the radiation belts, some effort was needed to recover the situation. The AOCS & SPI sub-systems were recovered at 23:44, and the IBIS was recovered at 01:29 on DoY 119. The impact was pointings 01880001 & 01880002 were lost.
- On DoY 119, at 09:03, there were some Reed-Solomon alarms in Redu, followed by some bad frames.
- On DoY 120, at 10:55 the TM dropped briefly causing the loss of pointing 01880038.

The following new anomaly reports have been entered into the Anomaly Reporting and Tracking System this week. Repeats of existing anomalies are not shown in this table.

AR id	Date Occurrence	Subject	Segment	Status
INT-SC-78	26/04/2004	IBIS: VETO VDM 15 High Voltage break down (#2)	Payload	Open
INT-2585	26/04/2004	TDRS: the web application cannot connect to the request manager(PRQM)	IMCS	Open
INT-2586	29/04/2004	Slews missed because the STR did not pick the commanded Guide Star during...	FDS	Pending
INT-2587	29/04/2004	DSS16 had problems to establish TM at handover	NASA Station	Pending
INT-2588	30/04/2004	REDU TCE problems - Command Uplink (2nd UV) Blocked.	ESA Station	Open

7 Future Milestones

- Battery 2 Re-conditioning will commence in week 19.

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 187

In revolution 187 a raster dithering observation of the Sagittarius Arm tangent (RA 19:00:1.43; DEC +06:55:17.0) was performed throughout the available observation time (~61 hours).

Revolution 188

In revolution 188 a raster dithering observation of the Sagittarius Arm tangent (RA 19:00:1.43; DEC +06:55:17.0) was performed throughout the available observation time (~62 hours).

Throughout these revolutions all instruments were in their nominal science modes, except for JEM-X2, which was in Safe mode, and the TM allocation was IBIS 134; SPI 98; JEM-X1 8; JEM-X2 1; OMC 5.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

2004-04-11T08:35:50.000Z	171.2373	F	Automatic TM processing.
2004-04-12T21:36:50.000Z	171.2235	F	Automatic TM processing.
2004-04-15T21:28:41.000Z	171.1796	F	Automatic TM processing.
2004-04-17T07:15:49.000Z	171.1691	F	Automatic TM processing.
2004-04-18T15:00:48.000Z	171.1460	F	Automatic TM processing.
2004-04-18T21:13:36.000Z	171.1315	F	Automatic TM processing.
2004-04-19T05:46:41.000Z	171.1080	F	Automatic TM processing.
2004-04-21T14:49:52.000Z	171.0901	F	Automatic TM processing.
2004-04-21T21:04:01.000Z	171.0741	F	Automatic TM processing.
2004-04-23T06:57:08.000Z	171.0309	F	Automatic TM processing.
2004-04-24T10:21:35.000Z	171.0083	F	Automatic TM processing.
2004-04-24T20:49:12.000Z	171.0062	F	Automatic TM processing.
2004-04-26T06:53:24.000Z	170.9939	F	Automatic TM processing.
2004-04-27T14:24:55.000Z	170.9807	F	Automatic TM processing.
2004-04-27T20:36:16.000Z	170.9595	F	Automatic TM processing.

This report was generated Fri Apr 30 08:00:20 GMT 2004

8.3 Detailed Satellite Information

This section contains some detailed information concerning the various subsystems of the satellite and instruments.

8.3.1 AOCS Operations

AOCS operations were executed from the Automatic Timeline.

During this period, 41 Open Loop Slews, 112 Closed Loop Slews and 7 Momentum Bias were executed. 2 slews were missed or executed manually. This is equivalent to 1.96%.

24/04/04 (Day of Year 115, Revolution 186-187)

Nothing to report.

25/04/04 (Day of Year 116, Revolution 187)

Nothing to report.

26/04/04 (Day of Year 117, Revolution 187)

Nothing to report.

27/04/04 (Day of Year 118, Revolution 187-188)

Slews lost due to a problem in communications to Redu: At 22:04, shortly after the instrument critical altitude ascending, the execution of the Timeline was interrupted because of a delay in the uplink of commands. The delay seems to have been caused by a communication problem to Redu ground station, which had also affected the behavior of the TCE. This is still being investigated (ARTS entry INT-2588). The effect on the AOCS operations was the loss of slews 01880001 and 01880002. After the problem disappeared (by itself) the AOCS operations were resumed by manually performing an Open Loop Slew, followed by a corrective Close Loop Slew, to the attitude of PID 01880003.

28/04/04 (Day of Year 119, Revolution 188)

Nothing to report.

29/04/04 (Day of Year 120, Revolution 188)

Slew missed because of a short drop in TM (Goldstone DSS-16): Shortly after station handover from Redu to Goldstone, DSS-16, a short drop in TM interrupted the execution of the sequence for slew 01880038. After re-establishment of TM, a manual Close Loop Slew was performed to the attitude of PID 01880038. PID 38 was affected.

30/04/04 (Day of Year 121, Revolution 188-189)

Nothing to report.

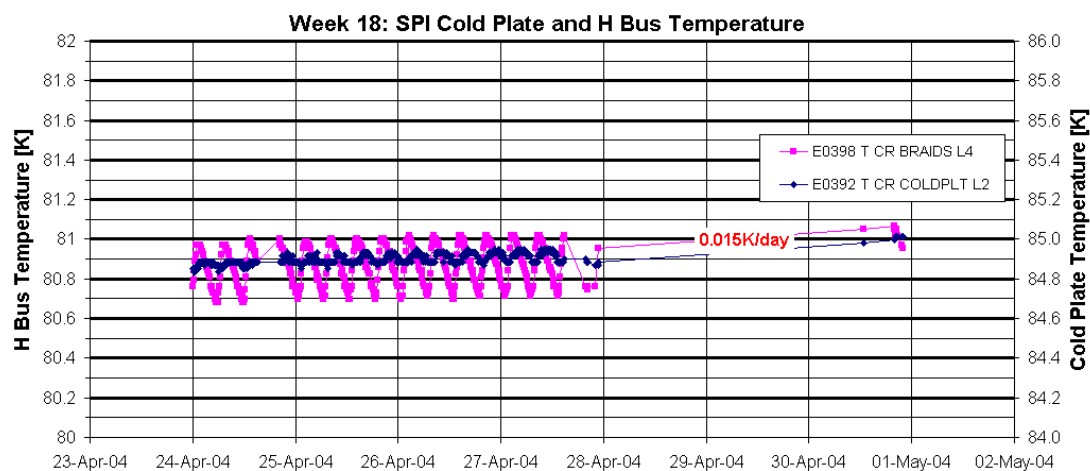
8.3.2 SPI Operations

Cryocooler / Detector Cold-Plate:

The performance of the cryocooler is nominal.

The cold plate temperature is leveled off at around 80.9K with a small positive drift of 0.015K/day, which is within the expected range.

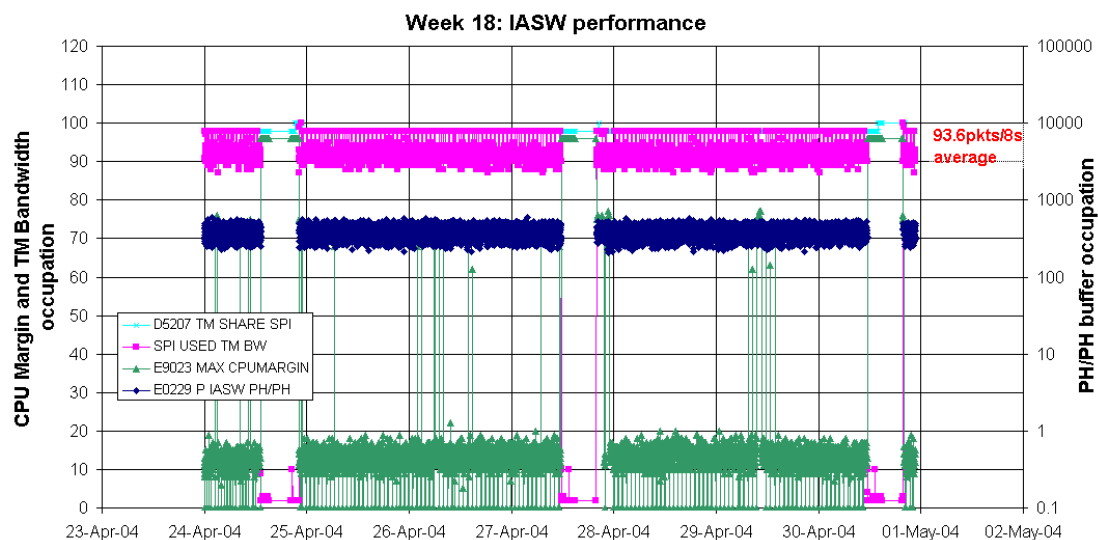
The following plot shows the evolution of the cold-plate and H bus temperatures during the reporting period.



IASW/DPE:

The performance of the IASW/DPE is nominal. The average TM bandwidth occupation was 93.6 pkts/cycle in the science windows (-1.9pkts w.r.t. previous week).

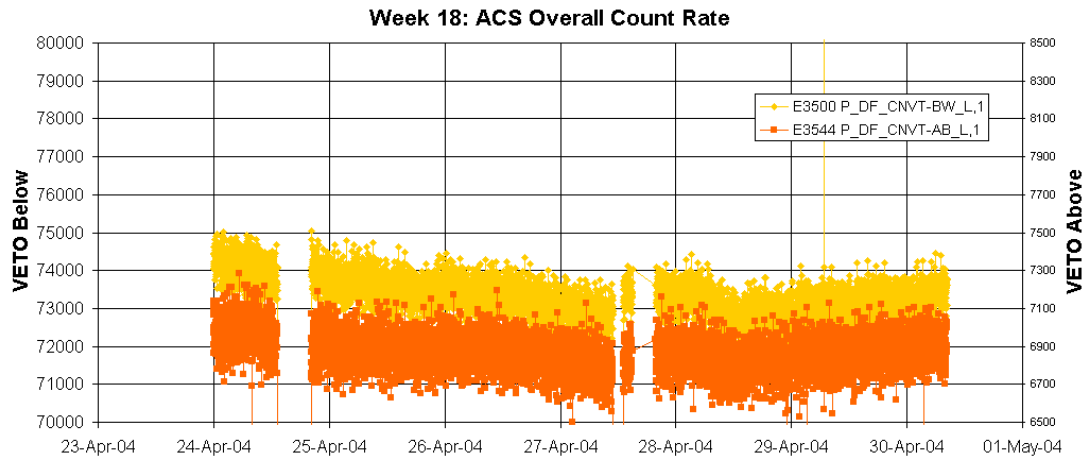
The following diagram shows the IASW performance in terms of TM bandwidth and event buffer occupation during the reporting period:



ACS:

The performance of the ACS is nominal.

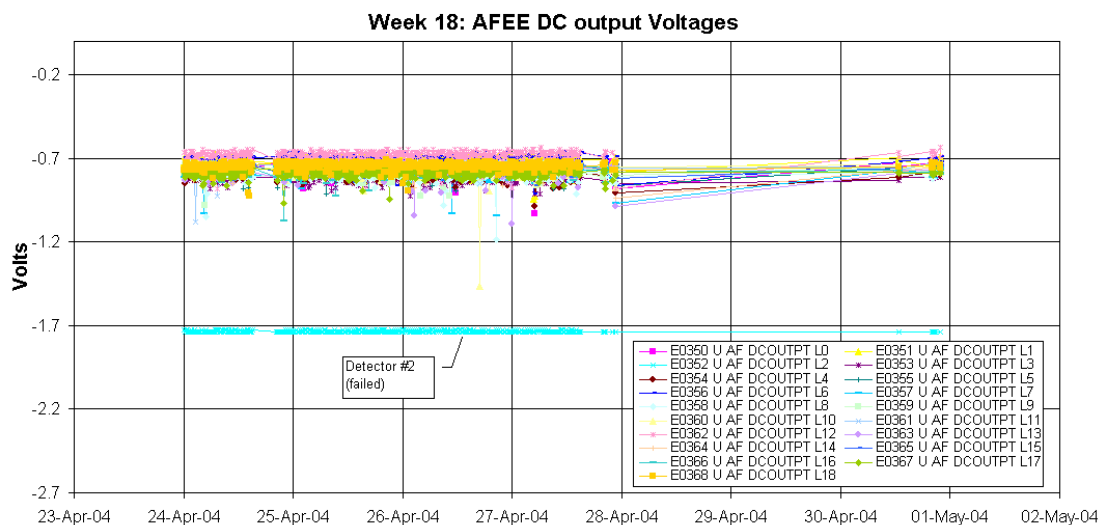
The following plot shows the ACS overall count rate evolution (Veto below / above ~100MeV counts) during the reporting period.



AFEE:

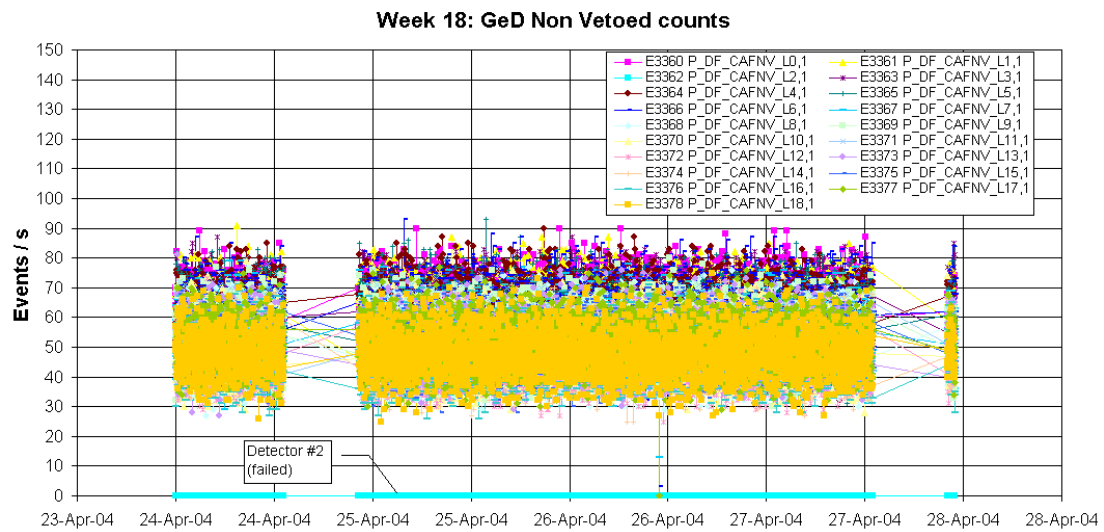
The performance of the detectors is nominal except for the detector #2 failed since 06.12.2003 (see anomaly report INT_SC-72).

The AFEE dc output signals are here after plotted during the reporting period.



DFEE:

The following plot shows the GeD Non Vetoed event rates processed by the DFEE during the reporting period. The count rate of each detector is within the expected range, except for the failed detector #2.



PSD:

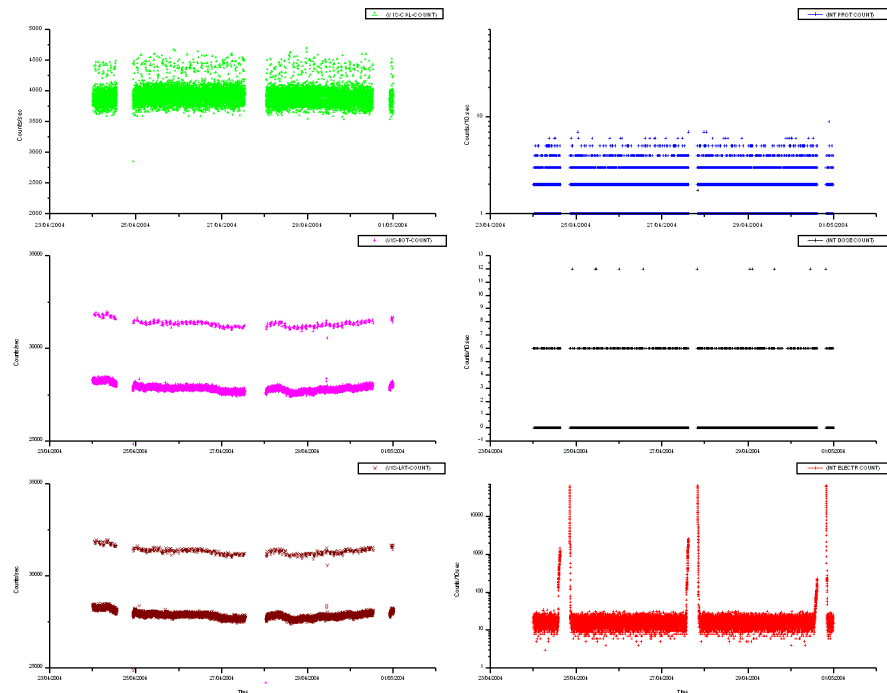
The performance of the unit is nominal.
 Nothing to report.

8.3.3 IBIS Operations

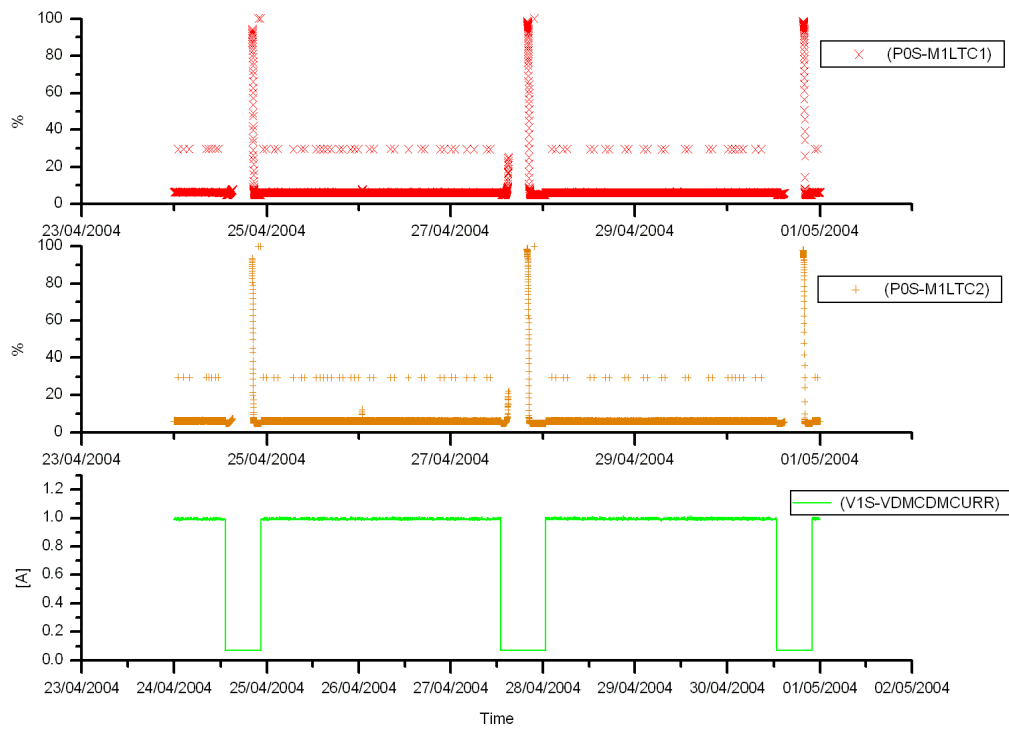
IBIS event counters plot

Plots of the reported VETO VDM/CDM current, the VETO bottom-lateral-calibration counters, the PICsIT PDM#1 SM1-2 dead times are shown below:

IBIS-VETO Counters Rev 187-188

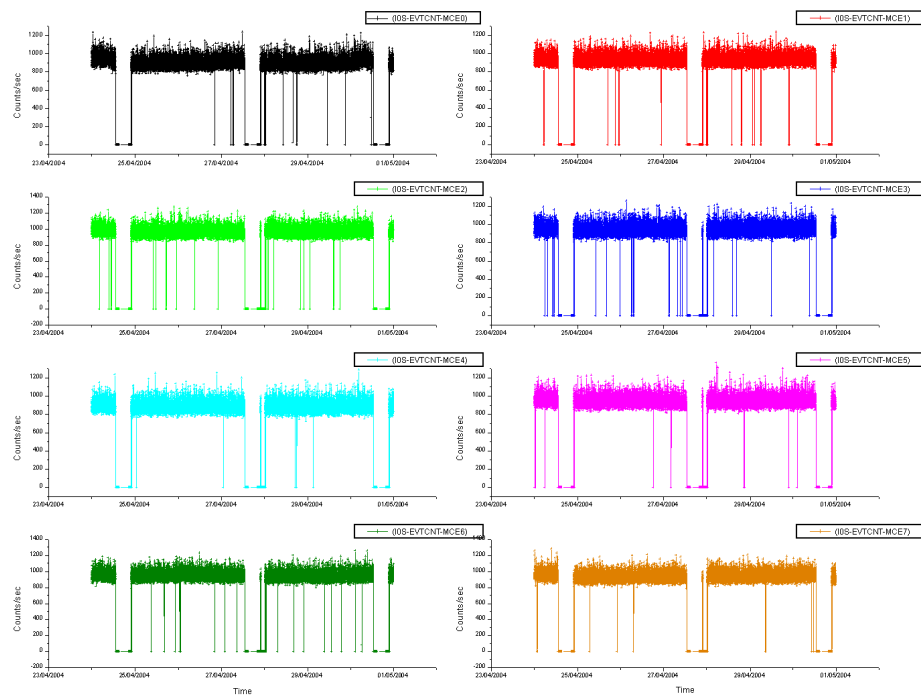


IBIS-VETO VDM Current & PICsIT dead time Rev 187-188

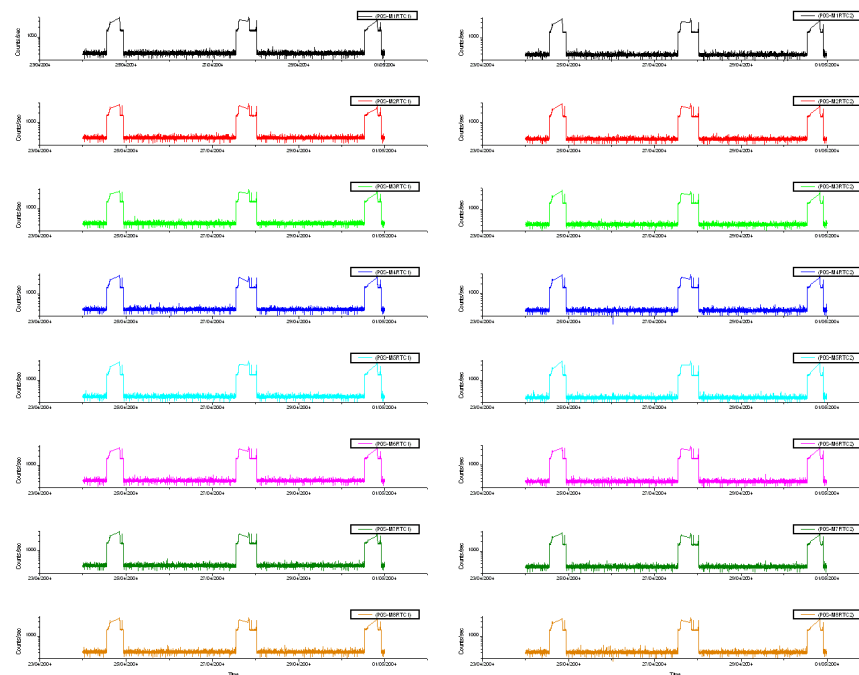


Plots of the ISGRI and PICsIT counters, during the observation period, are shown below:

IBIS-ISGRI Counters Rev 187-188



IBIS-PICsIT Counters Rev 187-188



IBIS daily report

DOY 2004.115 (24/04/04)

There were a few reports during the Belt passage of the OEM APID 1280 ID 167 Class 2 <<IBIS1 PICsIT NOISY SEMIMODULE SIGNALLING>> due to the PICsIT detectors being ON without the VETO anticoincidence system, as required by the PIs.

DOY 2004.116 (25/04/04)

Nothing to report

DOY 2004.117 (26/04/04)

At 00:49Z, the TM parameter family G5068 and G5072 (PDMx: Semimod y FIFO Error Flag) reported out of limits (Status Consistency Fail). At 00:52Z the parameters returned within limits. No action was taken, as suggested by the Payloads Recovery Document.

DOY 2004.118 (27/04/04)

At 22:05Z, due to a problem with the TC link the timeline was stopped and the unit disabled from the automatic commanding while the sequence GEISCL03 (ISGRI Calibration) was executing. To re-configure the unit, after the clarification of the TC link problem, the following actions were performed:

- the procedure CRP_IBIS1_0010 (IBIS Safe Mode)
- the latest ISGRI CTX tables received from ISDC were re-uplinked;
- the ISGRI calibration (GEISCL03);
- the VETO activation outside the Belts (GEBEXT01);
- the missed sequence GESTAN02.

On 2003.119.01.24Z the IBIS s/s was re-enabled in the timeline.

DOY 2004.119 (28/04/04)

At 07.23Z the recovery was completed by up-linking the ED GEBENT02 (IBIS Radiation Belts entry).

DOY 2004.120 (29/04/04)

Nothing to report.

DOY 2004.121 (30/04/04)

There were a few reports during the Belt passage of the OEM APID 1280 ID 167 Class 2 <<IBIS1 PICsIT NOISY SEMIMODULE SIGNALLING>> due to the PICsIT detectors being ON without the VETO anticoincidence system, as required by the PIs.

8.3.4 JEM-X Operations

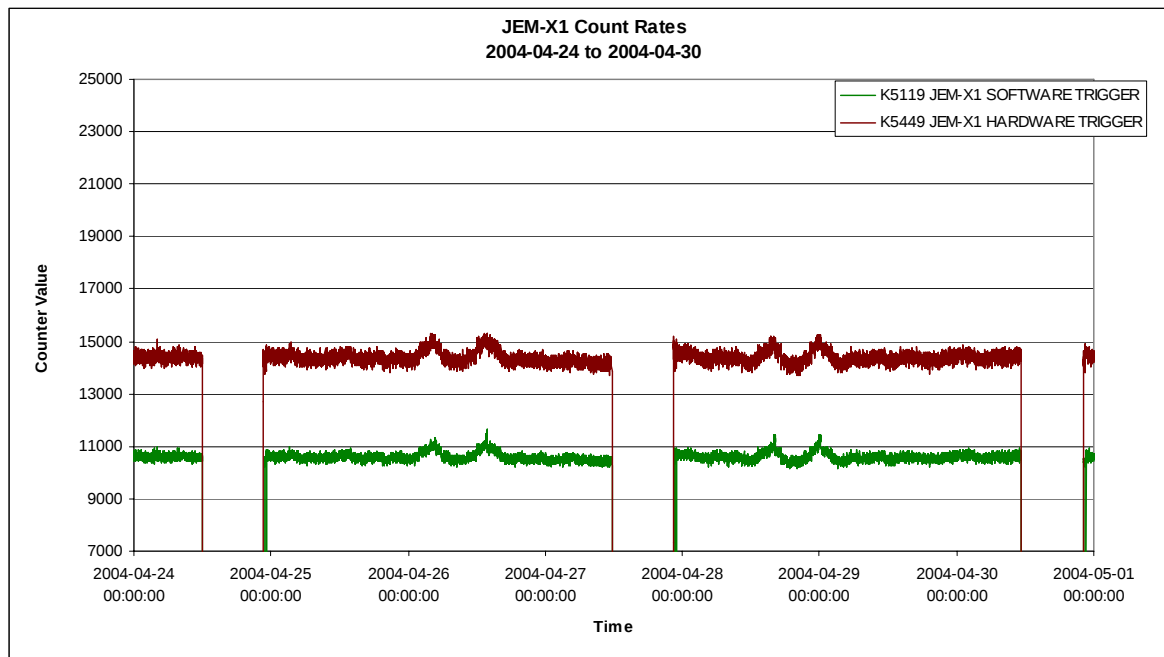
2004-04-24 (DOY 115, Rev 186) to 2004-04-30 (DOY 121, Rev 189)

Nothing to report.

8.3.4.1 JEM-X Count Rates

JEM-X1 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.



8.3.5 OMC Operations

On DoY 118, at 22:03, due to communications problems affecting both TM and TC, the timeline had to be stopped. The impact on OMC was pointing 01880002 was lost.

On DoY 120, at 10:55, a brief interruption in TM from Goldstone, caused a sequence to be interrupted. The impact was pointing 01880038 was lost.

No Commands were rejected this week.

On DoY 115 at 13:14:30, DoY 118 at 12:59:17 and DoY 121 at 12:44:45, OMC was switched by the Timeline to SAFE mode, at the nominal times.

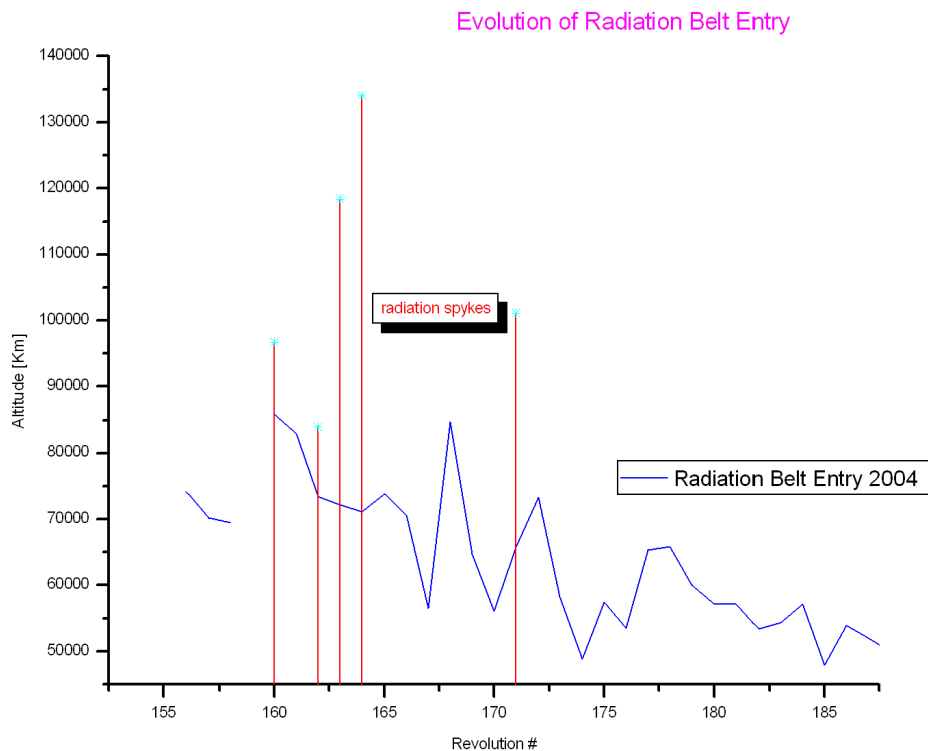
8.3.6 IREM Operations

IREM daily report

Nothing to report.

Radiation Belt Entry Analysis

The evolution of the Radiation Belt Entry in 2004, since rev 156 is reported in the following plot (the plot has been reviewed respect to the last issue, the radiation spikes are now displayed as independent event).



The Radiation Belt Entry is determined by the electron cut-off threshold (see definition below) based on JEM-X on-board radiation automatism.

The reported Electron Belts Entry/Exit for revs 187-->188, as defined by a cut-off flux of $3.76\text{E}+02$ e/cm²/sec ($E>0.5$ MeV) and the predicted Proton Belts Entry/Exit, as defined by a cut-off flux of $1.25\text{E}+03$ p/cm²/sec ($E>8$ MeV) are shown below:

Electron Belts

REV	S/C BCPKT (electron)	Electron CUT - OFF Observed Entry/Exit	Observed Entry/Exit Altitude [Km]	Electron CUT - OFF Predicted Entry/Exit	Predict ed Entry/ Exit Altitud e [Km]
186	RAD_ENTR R 2004-04-24T13:14	24/04/2004 14:04	53955	24-Apr-2004 13:47	55473
187	RAD_EXIT R 2004-04-24T22:16	24/04/2004 20:44	24841	24-Apr-2004 20:57	26974
187	RAD_ENTR R 2004-04-27T12:58	27/04/2004 13:58	51957	27-Apr-2004 13:35	55131
188	RAD_EXIT R 2004-04-27T22:01	27/04/2004 20:43	26559	27-Apr-2004 20:35	25698
188	RAD_ENTR R 2004-04-30T12:44	30/04/2004 13:53	50036	30-Apr-2004 13:17	55466
189	RAD_EXIT R 2004-04-30T21:47	30/04/2004 20:17	24841	30-Apr-2004 20:27	27034

Reference

Small error vs reference

Large error vs reference

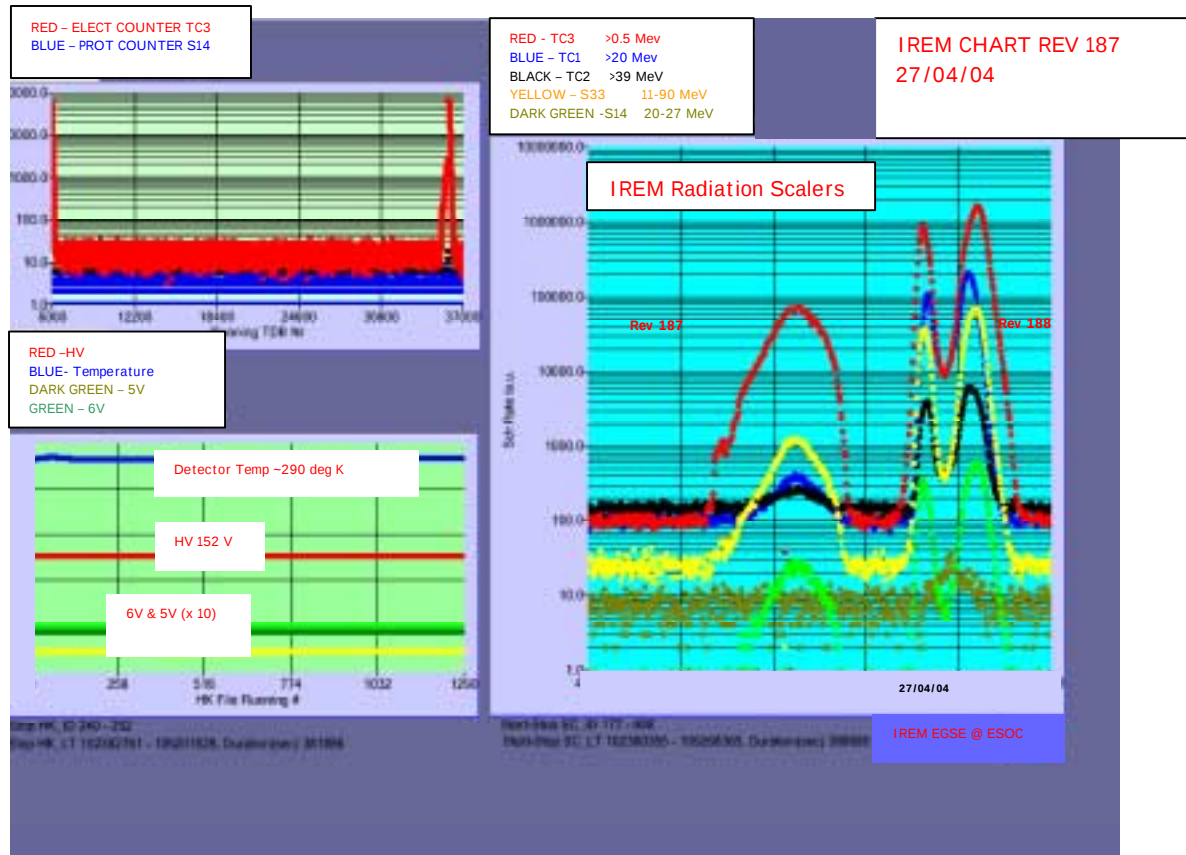
Radiation Spike

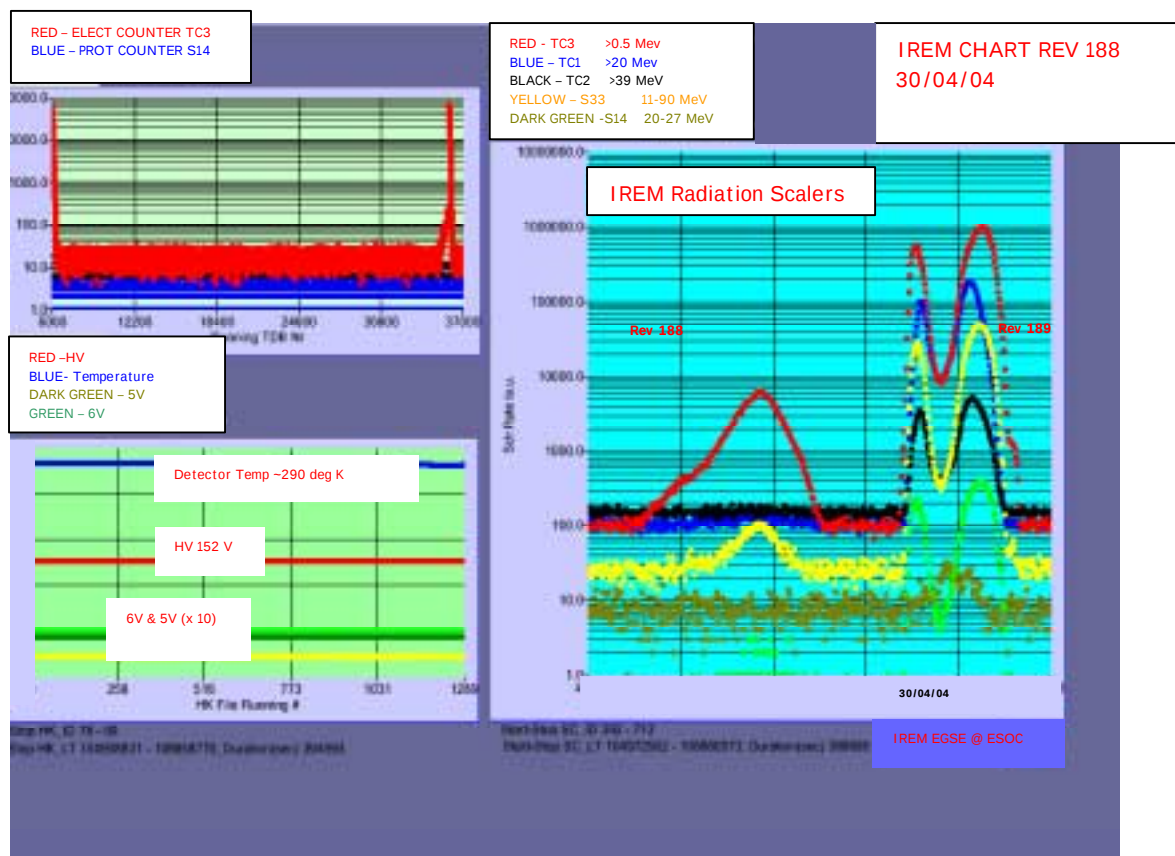
Proton Belts

REV	S/C BCPKT (proton)	Proton CUT - OFF Predicted Entry/Exit	ALT[Km] predicted
187	PROTON_RAD_ENTR	27-Apr-2004 19:05	12134
187	PROTON_RAD_EXIT	27-Apr-2004 19:25	14369
188	PROTON_RAD_ENTR	30-Apr-2004 18:47	11895
188	PROTON_RAD_EXIT	30-Apr-2004 19:17	15414

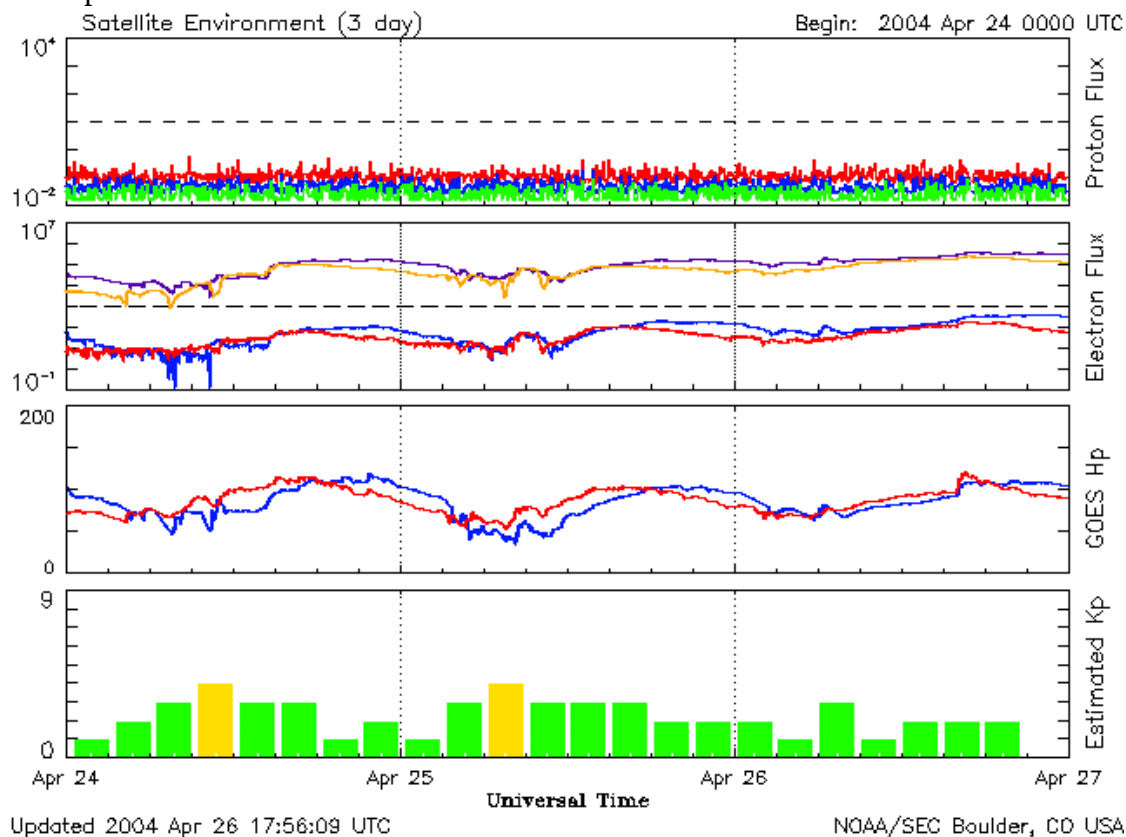
IREM radiation counters plot

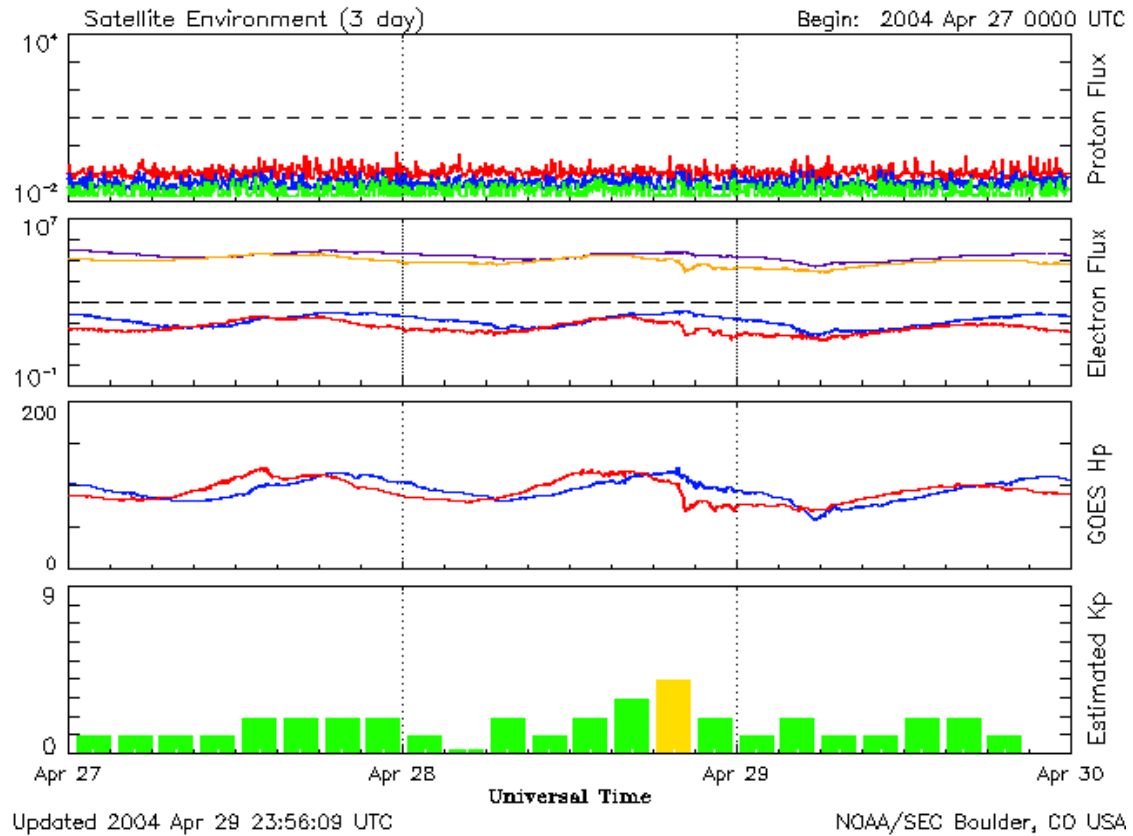
Plots of the evolution of the IREM counters from revs 187 & 188 are shown below:





the observed proton and electron Fluxes, as reported from GOES satellites for the same period are shown below:





The corresponding predictions for the Belts passages (as calculated with AP8Max and AE8Max models by using the RADMON tool) are:

