

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-TOS-OF
No. 086
Week 20
17.05.04
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 08.05.04 until 14.05.04 (both dates inclusive) and covers the revolutions 192 & 193.

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 Carina (RA 10:36:31.39; DEC -58:21:54.7), the Galactic Plane and GRS 1915+105 (RA 19:15:11.50; DEC +10:56:44.0). The activities consisted of raster and hexagonal dithering as well as 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.

A STR 1750 Processor Fault interrupted the mapping after close loop slew 01920014 during the Carina observations. The reason was probably the Eta Carinae Nebula, part of which fell into the ESW that also contained the Guide Star on its border.

Two slews were missed from the timeline. The cause of one was a TCE communications problem, which led to the queuing of the commands by the NCTRS and the second was caused by a short drop in the TM/TC links.

The fuel consumption over the period between 07/05/2004 and 14/05/2004 was 0.133 kg. The remaining propellant is in the order of 170.660 Kg on the 14th of May.

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 Reconditioning operations were completed on 14th May. The important statistics are summarised in the following table

	Battery 1	Battery 2
Discharge Duration	9 days 20h 23m	9 days 17h 13m
Discharged capacity	35.75Ah	35.91Ah
Recharge Duration	21h 49m	21h 45m
Recharged Capacity	38.2Ah	38.2Ah

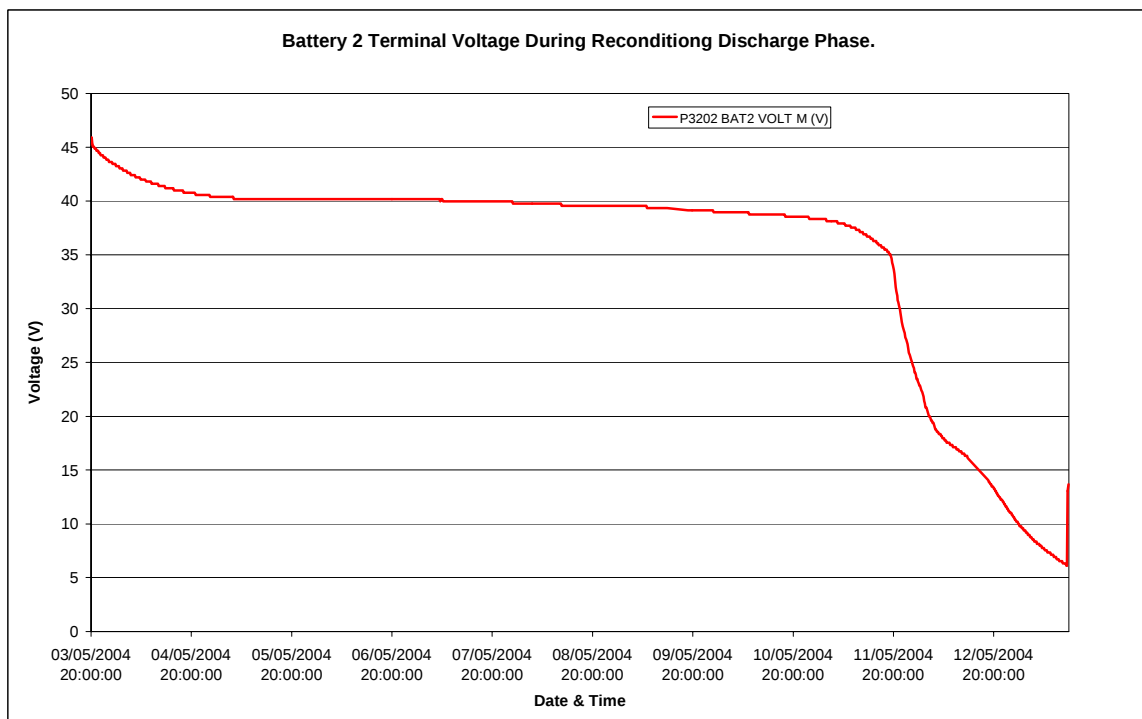
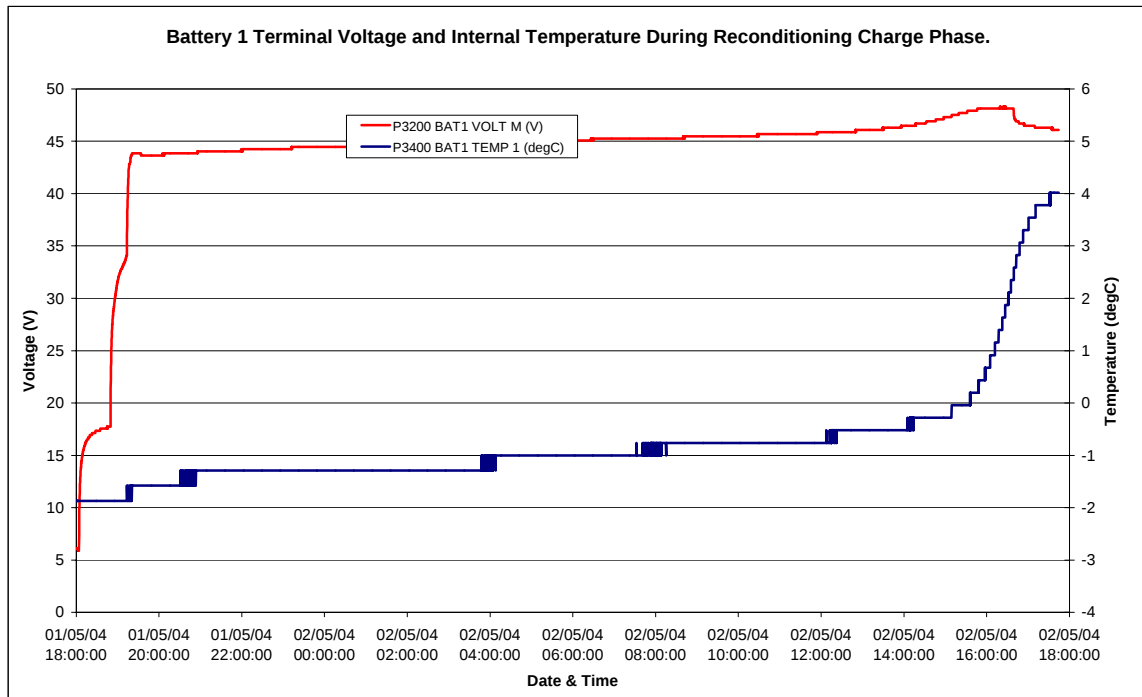
End of discharge detection was performed using the On-board monitoring function to switch off the reconditioning relays when a battery terminal voltage of 6V was reached.

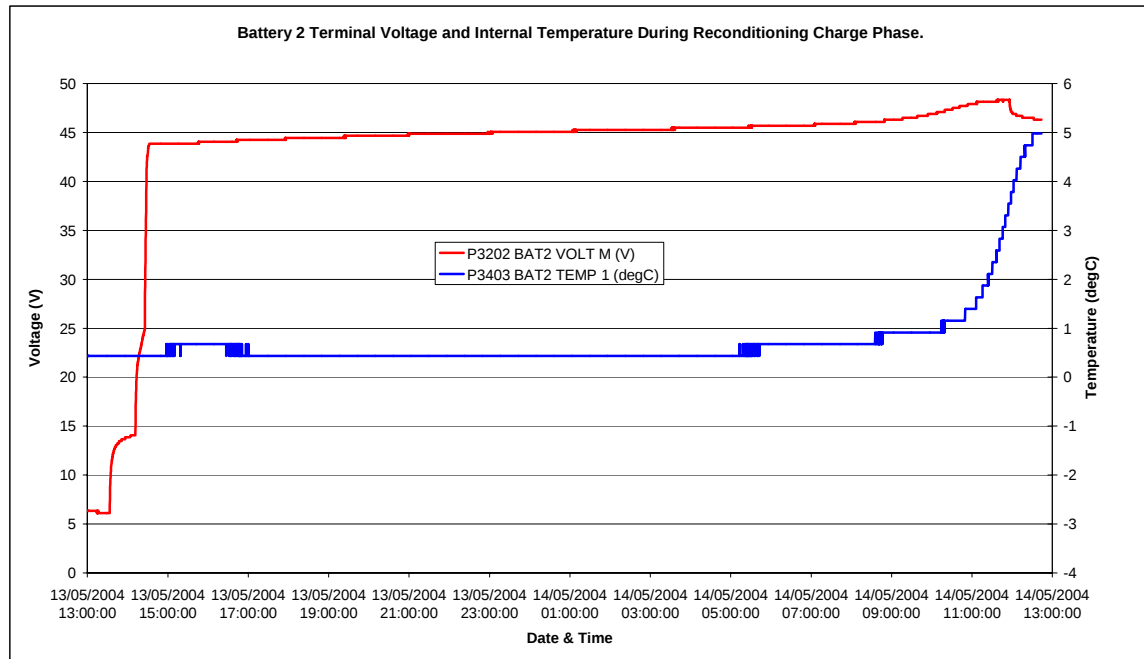
End of charge detection was performed using the on-board ECD task with an appropriate discharge initialisation integral loaded.

The reconditioning operations executed nominally in all aspects. The discharged and recharged capacity integrals were very close to their expected values. Cell Voltages and temperatures behaved nominally throughout the reconditioning operations. All indications are that both batteries are still in good condition.

The following plots show the both battery terminal voltages during the discharge and recharge phases of the reconditioning operations; as well as the batteries internal temperatures during the recharge phase.







The increase in internal battery temperature towards the end of the recharge phase of both batteries indicates that the batteries were fully charged. This increase in temperature correlates well with the planned overcharge of about 7.5% of capacity.

The next reconditioning operations are currently planned for late 2005, before the winter eclipse season.

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 95.1 pkts/cycle (+0.3 pkts w.r.t. previous week).

The 4th annealing of the Germanium detectors has been decided to start on 17th June at rev. 204 critical altitude descending crossing. The detailed timeline is being prepared.

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.

During Rev 193 an automatic reset of the IREM S/W (SEU #9) forced the unit to SAFE Configuration.

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.

During Rev 193 an automatic reset of the IREM S/W (SEU #9) forced the unit to SAFE Mode.

Further information on the JEM-X operations can be found in the Appendix Section 8.3.4.

3.2.4 OMC

The status of OMC is nominal.

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

There were 151 OMC pointings executed nominally, 1 was interrupted and 4 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 moderate 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, several communication problems with both ground stations, two of which led to the loss of pointings. In addition there was a problem communicating with the TCE at Redu, which caused commands to be issued, only after a delay of about 13 minutes. This also led to the loss of a pointing, the relevant AR number is INT-2592.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

PSF's: Received up to rev. 200

POS and POD generated: up to rev 200
TSF's: Received up to rev 194

One ToO request received but rejected. No re-planning this week

2. Observation status

ECS for revolution up to 180 received except 168 and 179. 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 used for the planning activities this week.

5. Problems

No problems have occurred this week.

6. ISOC move to ESAC/VILSPA

A review with Systems and hardware people from ESAC/VILSPA took place this week. Network topology proposed by VILSPA agreed. Details on schedules for hardware move from ESTEC to ESAC/VILSPA as well as details on new equipment and redeployment of existing hardware has been defined.

4.3.2 ISDC

On 17/05/2004, the status of ISDC observation processing is:

- Latest Standard Analysis completed: observation 02200070002 (IGR J16318-4848, Revolution 175) on 11/05/2004
- Latest products archived: observation 01201480003 (SN 1987A, Revolution 150) on 05/04/2004
- Latest observation products sent to the observer: observation 01201480003 (SN 1987A, Revolution 150) on 05/04/2004

5 Special Events

6 Anomalies

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

- On DoY 129 at 02:37, the TM & TC links with Redu dropped. The lines were recovered at 02:47. The impact was pointing 01910046 was lost.
- Later, at 23:50 the links were lost again, the TM link returning at 23:56 and the TC at 00:07. There was no impact.
- On DoY 130, from 07:45 to 07:55, the TM links from DSS16 dropped. At 08:04 the TM link dropped again, and at 08:05 the TC followed suit, both returning at 08:06. At 08:36, again the TM link dropped, returning almost immediately, each time there was no impact.
- On DoY 132 at 05:10, sun121 was in a yellow state with 42% of cpu usage. The number of displays was reduced to ease the work-load, there was no impact.
- Later, at 14:28, there was a short TM gap from Redu, followed by some bad TM frames. There was no impact.
- From 15:28 to 15:32, there was no TM flowing due to Firewall maintenance. There was no impact.
- On DoY 133, at 07:15, there was a brief TM drop from DSS-16, due to reasons unknown. The corresponding DR# is G123488. There was no impact.
- On DoY 133, at 21:43 the imcb was indicating yellow due to a lack of swap space. Problems were encountered during the reboot. Software Support was called. There was no impact.
- On DoY 134 at from 01:17 to 01:20, the TM & TC links with Redu dropped, there was no impact.
- At 08:03, the imca MMI was restarted, which had not been visible, there was no impact.
- At 08:59, the ninth IREM SEU triggered the immediate SAFING of IBIS, JEM-X and OMC. See the instrument report section for details.
- At 20:48, an AOCS command failed release due to the Interlock. Initially commands were delayed then they stopped going altogether. The TCE at Redu was re-booted, and the attitude recovered. The impact was pointing 01930028 was lost.
- On DoY 135, from 10:51 to 10:52, the TM link with DSS-16 was lost, then from 10:53 to 10:56 the TC link was down. The impact was pointing 01930041 was lost.

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-2590	11/05/2004	TM Loss from DSS16 – DoY 127	NASA Station	Pending
INT-2591	11/05/2004	TM & TC Drop from Goldstone – DoY 127	NASA Station	Pending
INT-2592	14/05/2004	Commands Buffered by NCTRS due to TCE Communications Problem.	ESA Stations	Pending

7 Future Milestones

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 192

In revolution 192 a raster dithering observation of Carina (RA 10:36:31.39; DEC - 58:21:54.7) was performed throughout the available observation time (~61 hours).

Revolution 193

The observations in revolution 193 began with a GPS lasting ~5 hours. This was followed by a hexagonal dithering observation of GRS 1915+105 (RA 19:15:11.50; DEC +10:56:44.0), performed for the remaining ~56 hours of observation time.

Throughout this observation 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

2004-04-26T06:53:24.000Z	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.
2004-04-30T14:11:03.000Z	170.9434	F	Automatic TM processing.
2004-04-30T20:16:39.000Z	170.8804	F	Automatic TM processing.
2004-05-02T06:30:59.000Z	170.8632	F	Automatic TM processing.
2004-05-03T13:43:26.000Z	170.8513	F	Automatic TM processing.
2004-05-03T20:00:31.000Z	170.8370	F	Automatic TM processing.
2004-05-06T13:44:45.000Z	170.8123	F	Automatic TM processing.
2004-05-06T19:45:02.000Z	170.7931	F	Automatic TM processing.
2004-05-08T05:56:10.000Z	170.7681	F	Automatic TM processing.
2004-05-09T11:47:41.000Z	170.7480	F	Automatic TM processing.
2004-05-09T19:31:57.000Z	170.6958	F	Automatic TM processing.
2004-05-12T13:16:37.000Z	170.6806	F	Automatic TM processing.
2004-05-12T19:13:50.000Z	170.6604	F	Automatic TM processing.

This report was generated Fri May 14 08:00:16 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, 121 Closed Loop Slews and 5 Momentum Bias were executed. 2 slews were missed or executed manually. This is equivalent to a 1.2%.

08/05/04 (Day of Year 129, Revolution 191)

Nothing to report.

09/05/04 (Day of Year 130, Revolution 191-192)

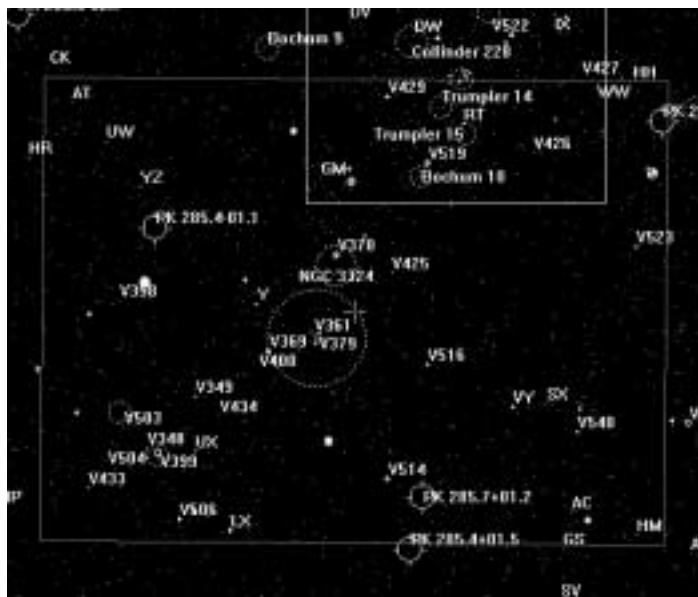
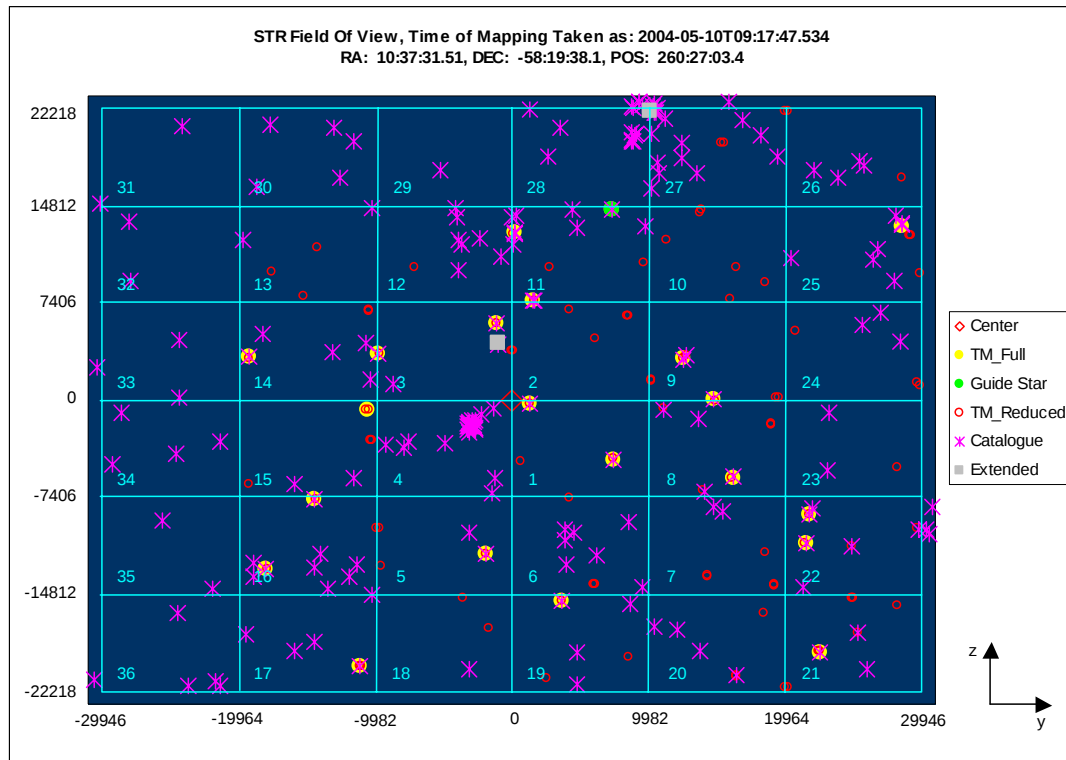
Nothing to report.

10/05/04 (Day of Year 131, Revolution 192)

Star Tracker 1750 Processor Fault: A STR 1750 Processor Fault interrupted the mapping after close loop slew 01920014, during the Carina observations. The Guide Star was 8626-02804 with 5.65 Mi and was located at CCD location [7345, 14533], on the border between Elementary Search Windows 11 and 28. No indication of the fault was reported in telemetry, as its occurrence was not in synch with the TM cycle. The mapping was aborted while processing ESW 28:

- 09:16:47 End of Close loop Slew
- 09:17:47 Start of STR Mapping
- 09:18:31 Interruption of the Mapping by the fault
- 09:18:31 IMU-1 switched on

ESW 28 also contained part of the Great Carina Nebula (NGC 3372) with Eta Carinae located near the edge of the STR FOV on the border between ESWs 27 and 28. The reconstructed STR FoV during the mapping is shown below:



The OTF remained low during PID 01920014. The FDS was able to use the aborted mapping for attitude determination and update the next Close loop slew, which was executed correctly.

11/05/04 (Day of Year 132, Revolution 192)

Nothing to report.

12/05/04 (Day of Year 133, Revolution 192-193)

Nothing to report.

13/05/04 (Day of Year 134, Revolution 193)

Slew missed because of a TCE communications problem, Redu: The sequence of slew 01930028 was interrupted at 20:48 because of a delay in response from the TCE. The reason is probably a TCE communications problem, which resulted in the buffering of the commands by NCTRS. For details refer to INTEGRAL ARTS entry INT-2592. Slew ID 01930028 was missed and a manual Open Loop Slew was performed to the attitude of PID 01930029.

14/05/04 (Day of Year 135, Revolution 193)

Slew missed due to a short drop in TM/TC links (Goldstone, DSS-16): A short drop in the TM and TC links after station handover from Redu to DSS-16 stopped the execution of the sequence for slew 01930041 and resulted in the missing of the slew. After re-establishment of the links, a manual Close Loop Slew was performed to the attitude of PID 01930041. The next slew executed from the Timeline.

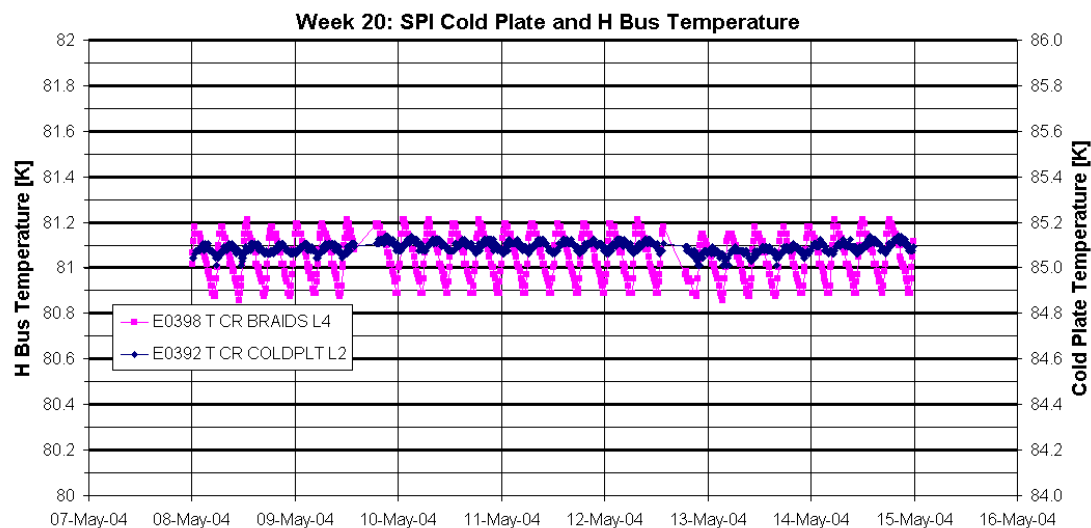
8.3.2 SPI Operations

Cryo-cooler / Detector Cold-Plate:

The performance of the cryo-cooler is nominal.

The cold plate temperature is leveled off at around 85.1K with a negligible drift over the whole week.

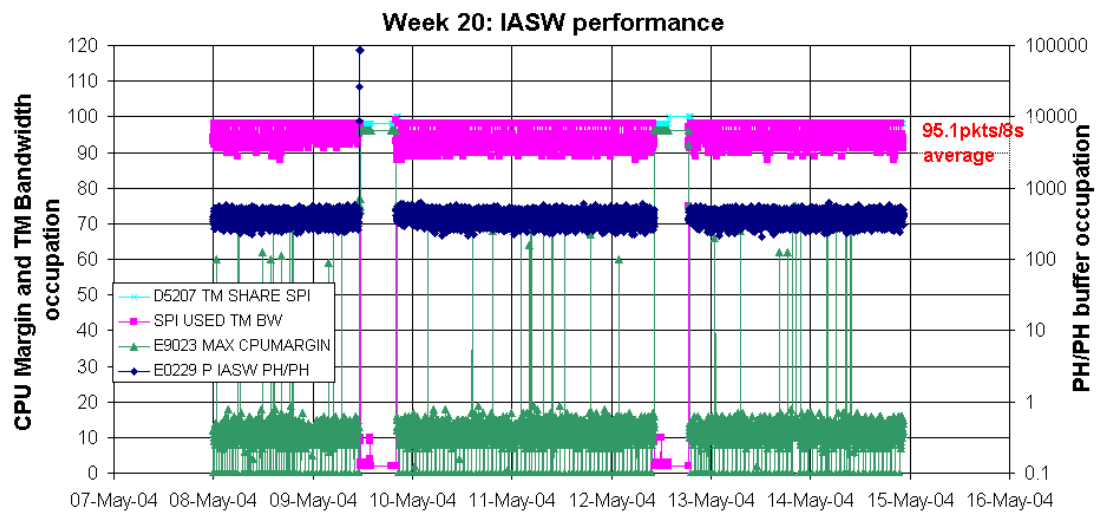
The following plot shows the evolution of the cold-plate and H bus temperatures during the reporting period.



IASW/DPE:

The performance of the IASW/DPE is nominal. The average TM bandwidth occupation was 95.1 pkts/cycle in the science windows (+0.3pkts w.r.t. previous week).

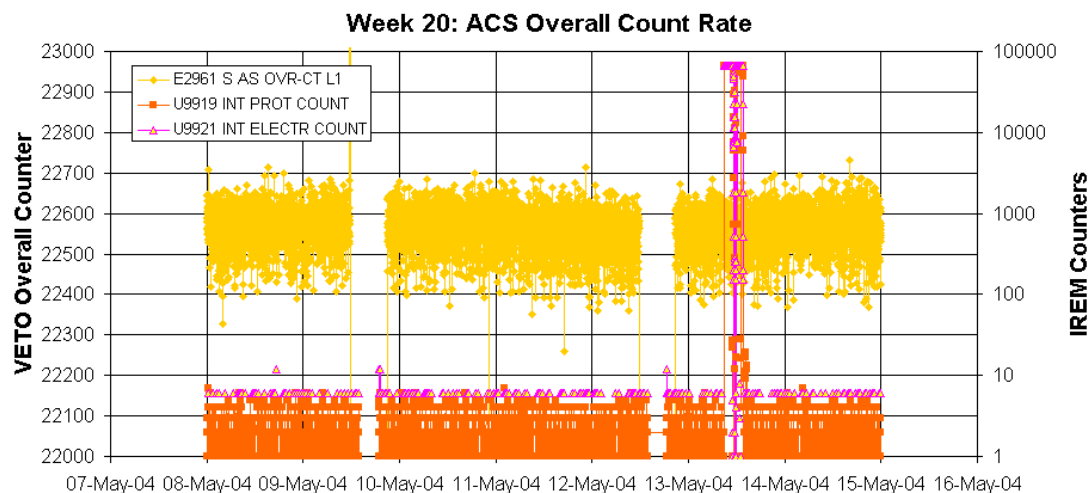
The following diagram shows the IASW performance in terms of TM bandwidth and event buffer occupation during the reporting period.



ACS:

The performance of the ACS is nominal.

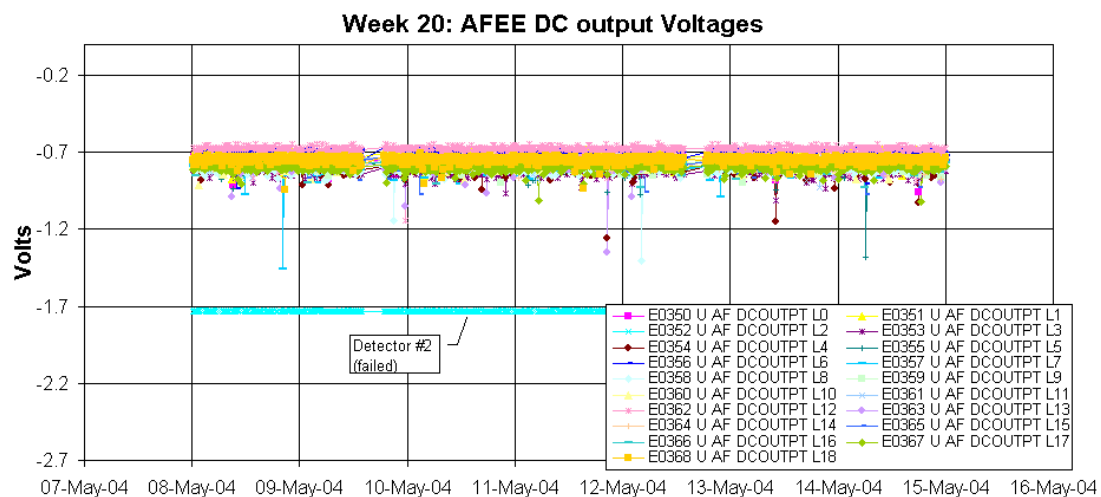
The following plot shows the ACS overall counts and IREM counters evolution during the reporting period. The evident peaks on the IREM counts are due to a crash of the IREM software.



AFEE:

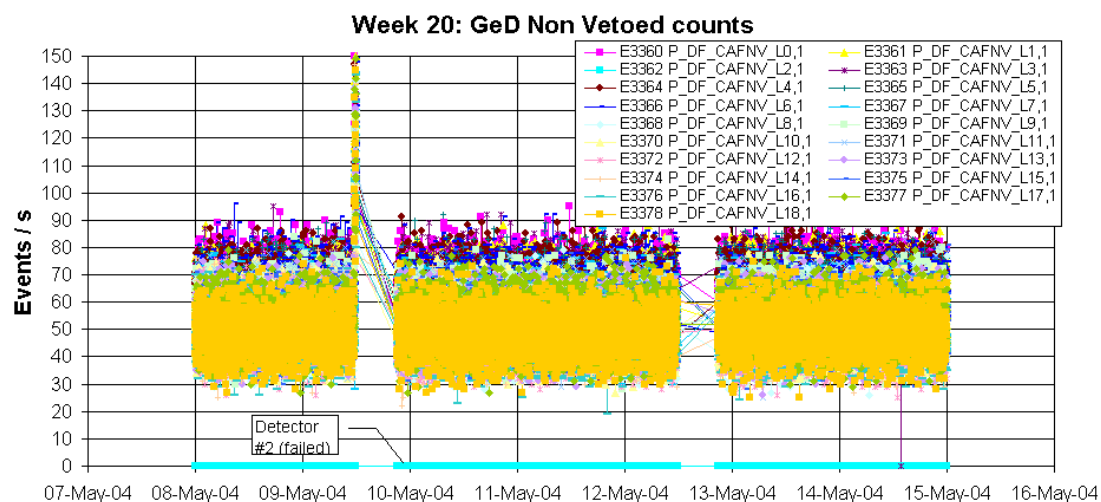
The performance of the detectors is nominal except for the detector #2 failed since 06.12.2003 (see anomaly report INT_SC-72).

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:

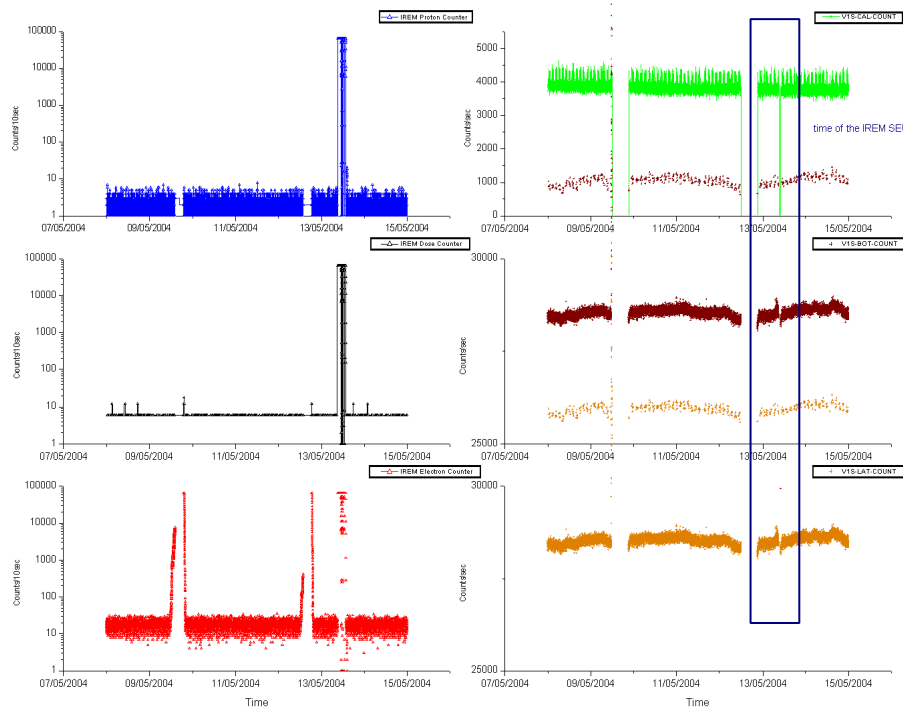
The performance of the unit is nominal.
 Nothing to report.

8.3.3 IBIS Operations

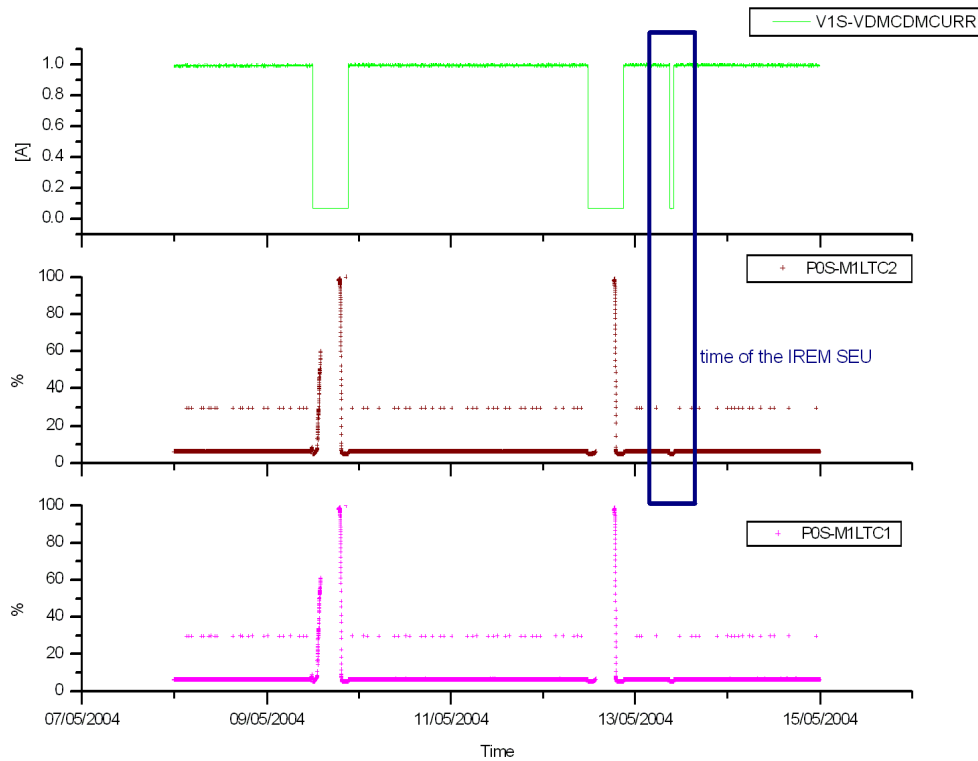
IBIS event counters plot

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:

VETO Counters Rev 191-192

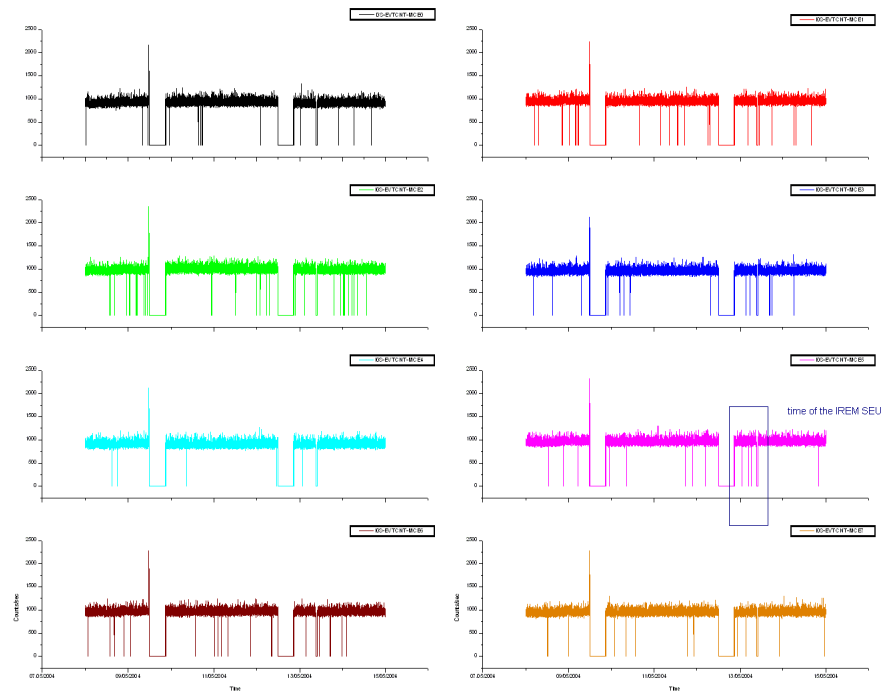


IBIS VETO VDM Current & PICsIT dead time Rev 191-192

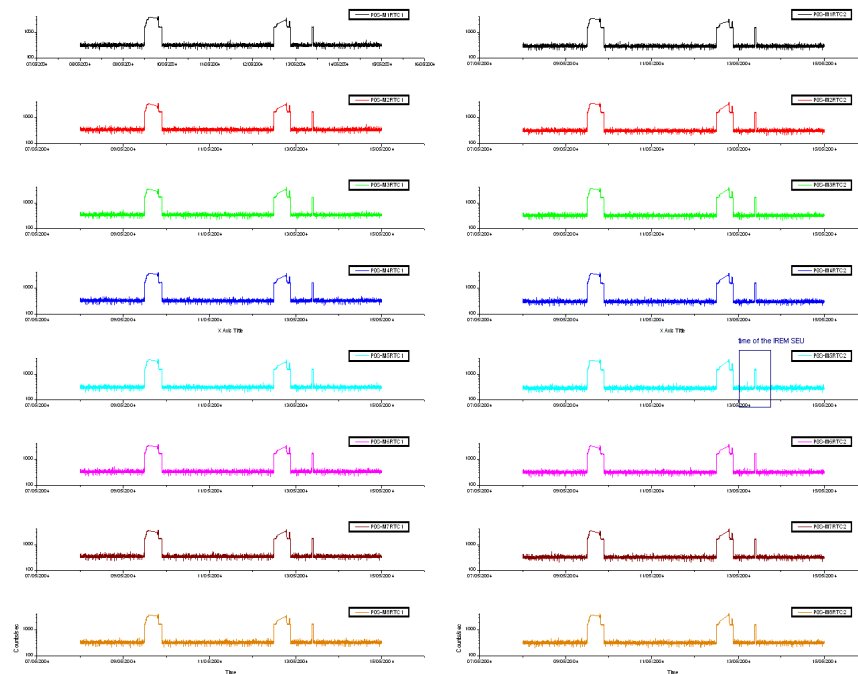


Plots of the ISGRI and PICsIT counters, during the observation period, are shown below:

IBIS-ISGRI Counters Rev 191-192



IBIS-PICsIT Counters Rev 191-192



IBIS daily report

DOY 2004.129 (08/05/04)

Nothing to report

DOY 2004.130 (09/05/04)

At 08.23Z the following OEMs were reported:

APID 1280 ID 133 CLASS 2 << IBIS1 IASW LSL TRANSFER FAILED (LOW LEVEL)>>

APID 1280 ID 131 CLASS 2 <<IBIS1 IASW LSL TRANSFER FAIL REPORT FOR HIGH-LEVEL MODULE RESET>>;

Due to the single occurrence of both OEMs no action was taken, as suggested by the Payloads Contingencies Recovery document.

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 2004.131 (10/05/04)

Nothing to report.

DOY 2004.132 (11/05/04)

Nothing to report

DOY 2004.133 (12/05/04)

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 2004.134 (13/05/04)

At 08:59Z there was an IREM automatic transition to Standard Mode (reset of the CSCI S/W). The anomaly affected the instrument status via BCP and forced the automatic transition of IBIS to Stand-By with all the High Voltages and Biases OFF. The recovery of the unit was completed at 10:41Z (see IREM report for the details).

DOY 2004.135 (14/05/04)

Nothing to report

8.3.4 JEM-X Operations

2004-05-08 (DoY 129, Rev 191) to 2004-05-12 (DoY 133, Rev 193)

Nothing to report.

2004-05-13 (DoY 134, Rev 193)

At 08:59Z there was an IREM automatic transition to Standard Mode (reset of the CSCI S/W) triggered by a SEU. The anomaly affected the instrument status via BCP forcing the automatic transition of JEM-X1 to Safe. During this SEU, moderate count rates in JEM-X were observed.

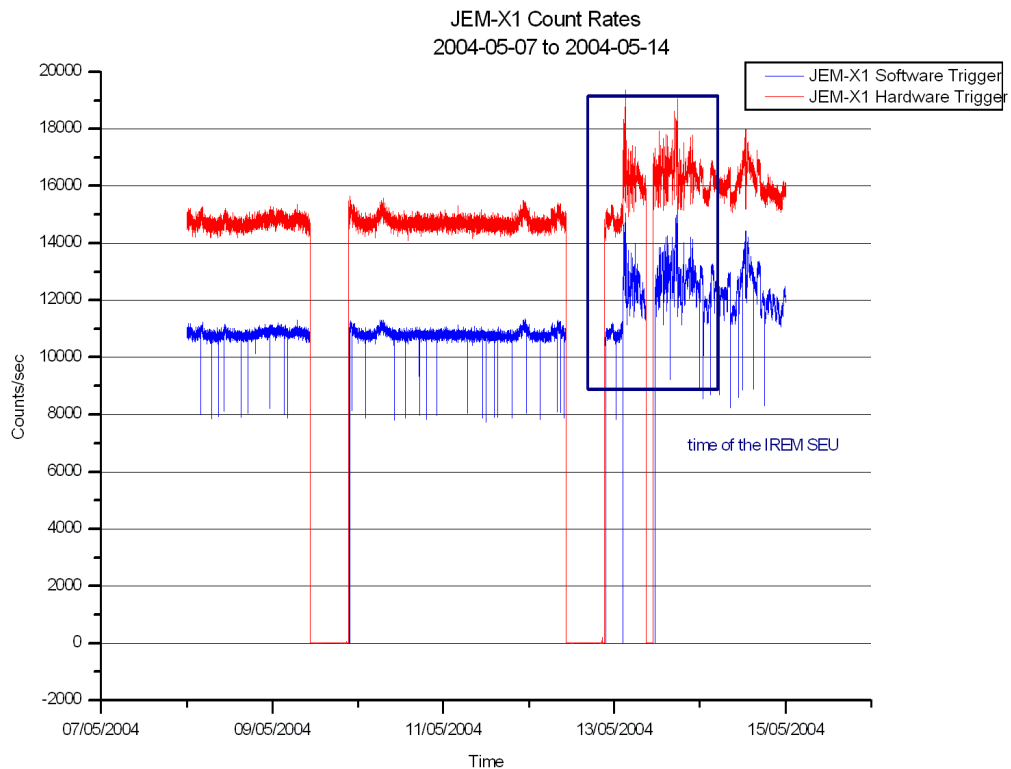
The recovery of the unit was completed at 11:26Z (see IREM report for the details).

2004-05-14 (DoY 135, Rev 193)

Nothing to report

8.3.4.1 JEM-X Count Rates

JEM-X1 count rates over the reporting period are displayed in the following graph.



8.3.5 OMC Operations

On DoY 129 at 02:37, the TM & TC links with Redu briefly dropped, this caused the OEM indicating the start of OMC pointing 01910046 to be missing, the observation itself took place nominally.

On DoY 134 at 08:59:54, a Single Event Upset within the IREM unit caused OMC to switch to SAFE mode. The unit was recovered from SAFE mode at 09:44:09. The impact was pointing 01930016 was interrupted and pointings 01930017 & 01930018 were lost.

On DoY 134, at 20:52:40, the commands for pointing 01930028 should have been sent, but due to a problem with the TCE at Redu, they were not transmitted until 21:01 and were subsequently rejected:

```
2004.134.21.01.13.905 2004.134.21.01.05.649 1792 Real Time Rejection 131
REJECTED TC1
FIX2=0 M5010=6,NORMAL M9079=3 M9080=131 M5001=60,IM A M9068=1 FIX2=0
M9069=1576
2004.134.21.01.13.816 2004.134.21.01.04.399 1792 Real Time Rejection 131
REJECTED TC1
FIX2=0 M5010=6,NORMAL M9079=3 M9080=131 M5001=130,RESET IM M9068=1 FIX2=0
M9069=1575
```

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

On DoY 135, at 10:56, due to problems with the links with DSS-16, pointing 01930041 was lost, it was at this time that the following pair of commands were rejected:

```
2004.135.10.56.49.970 2004.135.10.56.40.680 1792 Real Time Rejection 131
REJECTED TC1
FIX2=0 M5010=6,NORMAL M9079=3 M9080=131 M5001=60,IM A M9068=1 FIX2=0
M9069=1638
2004.135.10.56.42.776 2004.135.10.56.34.180 1792 Real Time Rejection 131
REJECTED TC1
FIX2=0 M5010=6,NORMAL M9079=3 M9080=131 M5001=130,RESET IM M9068=1 FIX2=0
M9069=1637
```

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

On DoY 130 at 11:58:13, and DoY 133 at 11:45:19, OMC was switched by the Timeline to SAFE mode, at the nominal times.

8.3.6 IREM Operations

IREM daily report

DoY 2004.134 (13/05/04)

At 08:59Z there was a local reset of the IREM CSCI S/W (SEU #9): as previously (see anomalies on 16/12/2002 ,01/01/2003, 03/06/03, 11/07/03, 19/07/03, 5/08/03, 24/08/03, 26/12/03) the status of the unit, before the anomaly, was nominal, here is the summary:

1) temperatures nominal;

- IBIS re-enabled at 10:41Z
- JEM-X1 re-enabled at 11:26Z

The cause of this S/W reset is apparently due to an upset of the unit's memory, as it was already in the past: an external single ionising radiation (probably an heavy ion/cosmic radiation) produced a burst of hole-electron pair large enough to cause a bit status change in the IREM memory: this event was detected by the checksum control logic that triggered the reset of the CSCI sw.

It is interesting to notice that:

- **No SEU occurred since December 2003.**
- **The SEUs observed since 2002 are distributed only in two specific period of the year, i.e. December-January and May-June-July-August.**
- **During this SEU, moderate count rates in JEM-X were observed.**

Due to the need to recover the unit as soon, following the previous agreement with IREM PIs, the dump of the complete memory was not executed.

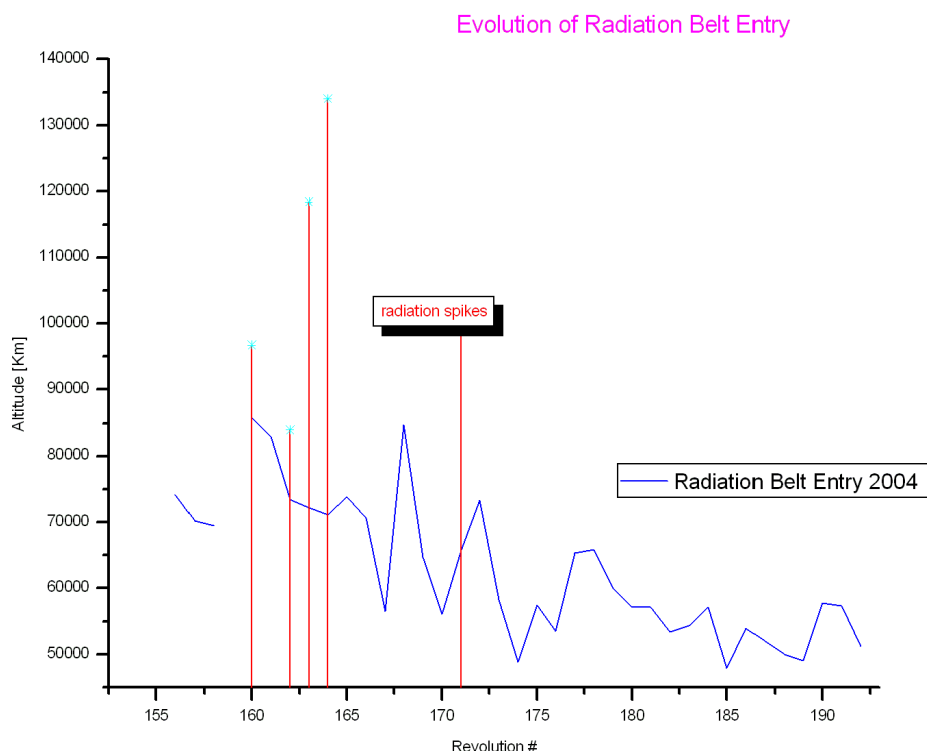
After the patch, IREM has been verified with different scalers and with the Ground Link ON/OFF function (see Transfer Data Block attached). The final setting of the unit is:

- accumulation time 60 sec
- HK files every 5 SCI files
- TC3 scaler for the electron counter
- S14 scaler for the proton counter

The unit was monitored for few hours, as suggested in the CRP, and the DRMC flag in the BCP re-enabled at 17.03Z.

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 191-->192, 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]
191	RAD_ENTR R 2004-05-09T11:57	09/05/2004 12:18	57387	09-May-2004 12:36	54739
192	RAD_EXIT R 2004-05-09T21:01	09/05/2004 19:42	26552	09-May-2004 19:36	26099
192	RAD_ENTR R 2004-05-12T11:45	12/05/2004 12:51	51264	12-May-2004 12:25	54547
193	RAD_EXIT R 2004-05-12T20:48	12/05/2004 19:16	24841	12-May-2004 19:25	26398

Reference

Small error vs reference

Large error vs reference

Radiation Spike

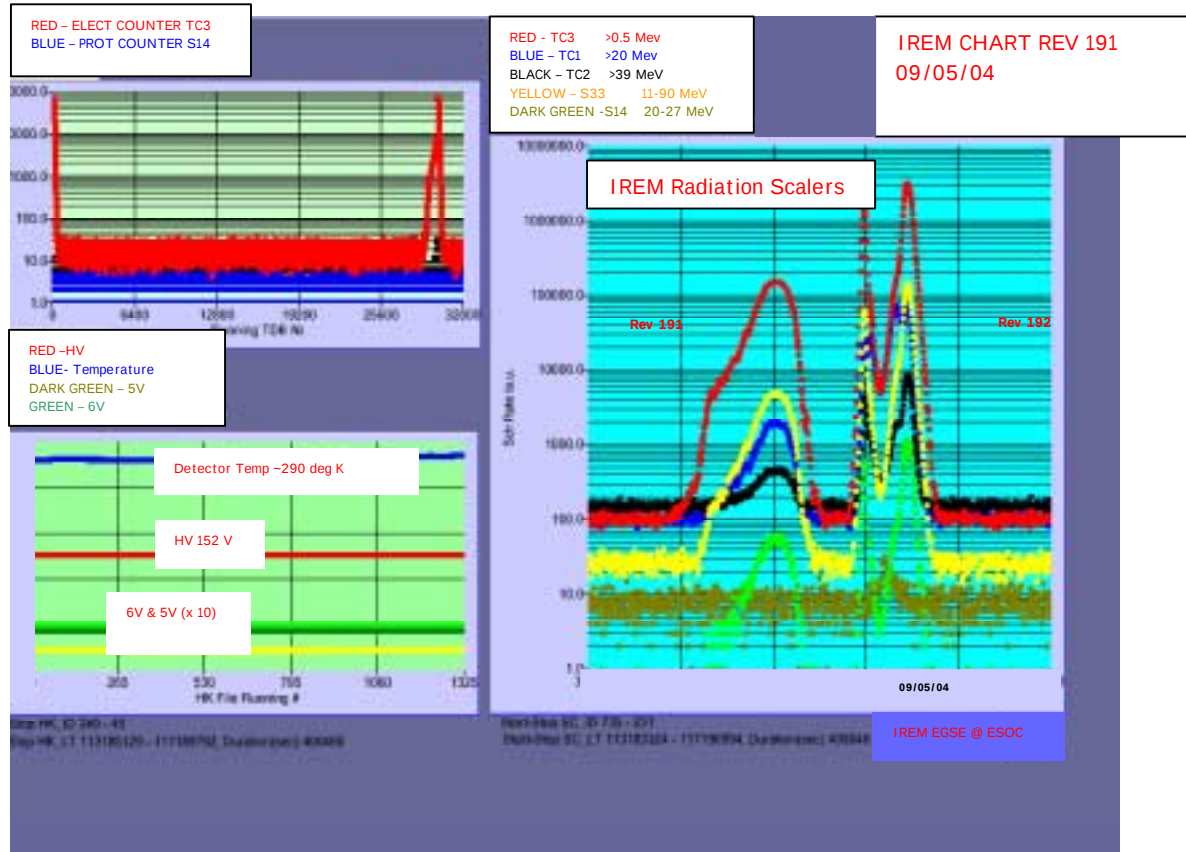
Proton Belts

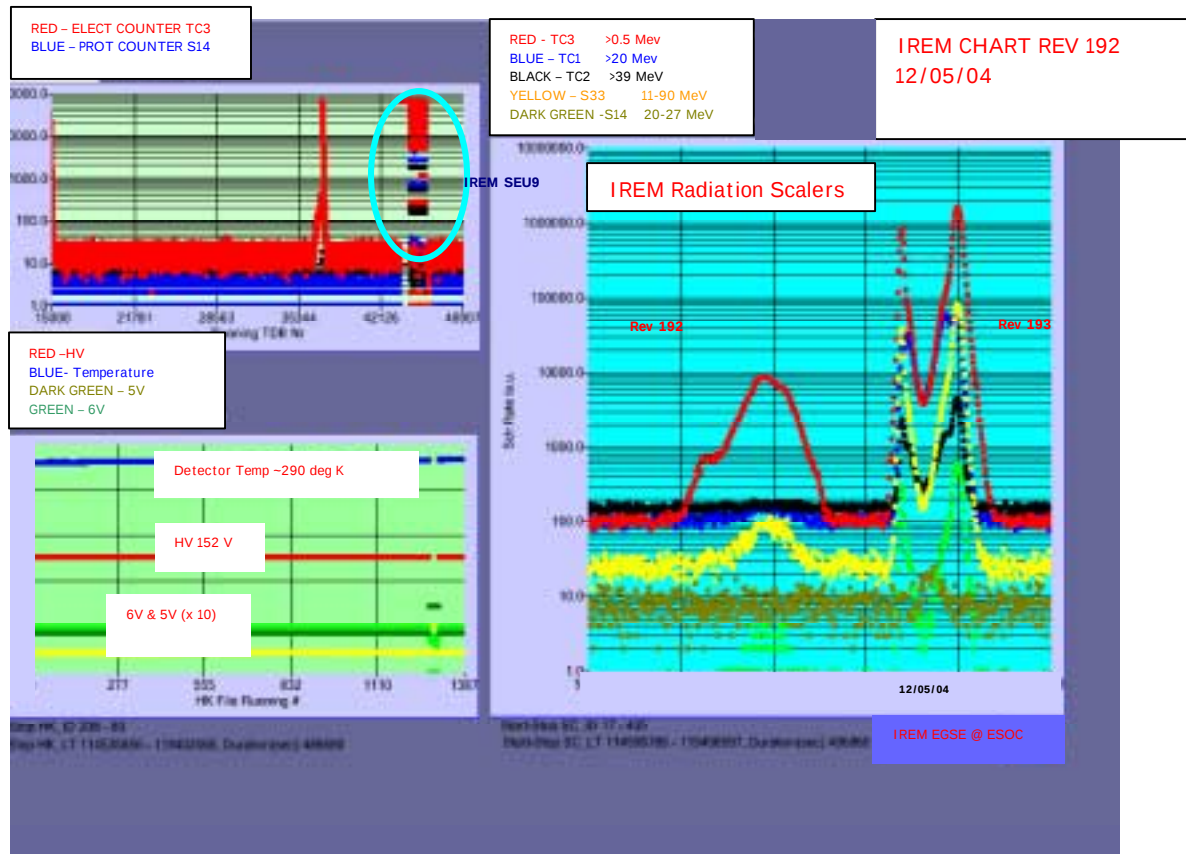
REV	S/C BCPKT (proton)	Proton CUT - OFF	ALT[Km] predicted
-----	--------------------	------------------	-------------------

Predicted Entry/Exit			
191	PROTON_RAD_ENTR	09-May-2004 18:06	12440
191	PROTON_RAD_EXIT	09-May-2004 18:26	14755
192	PROTON_RAD_ENTR	12-May-2004 17:45	11706
192	PROTON_RAD_EXIT	12-May-2004 18:15	14946

IREM radiation counters plot

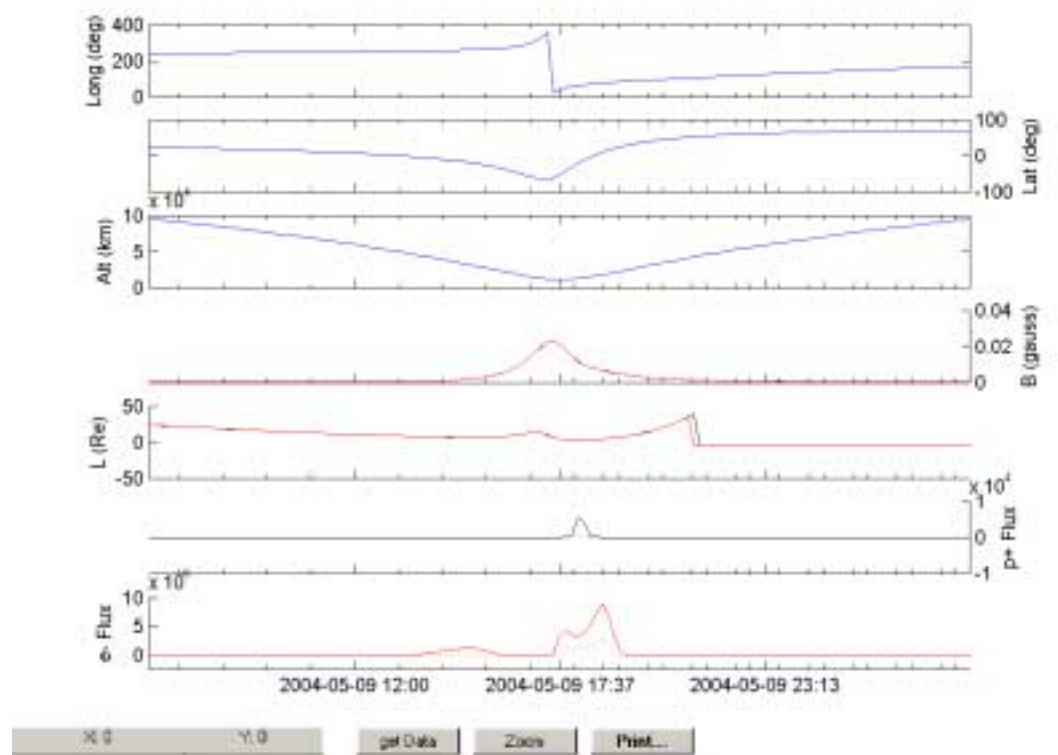
Plots of the evolution of the IREM counters from revs 191 & 192 are shown below:

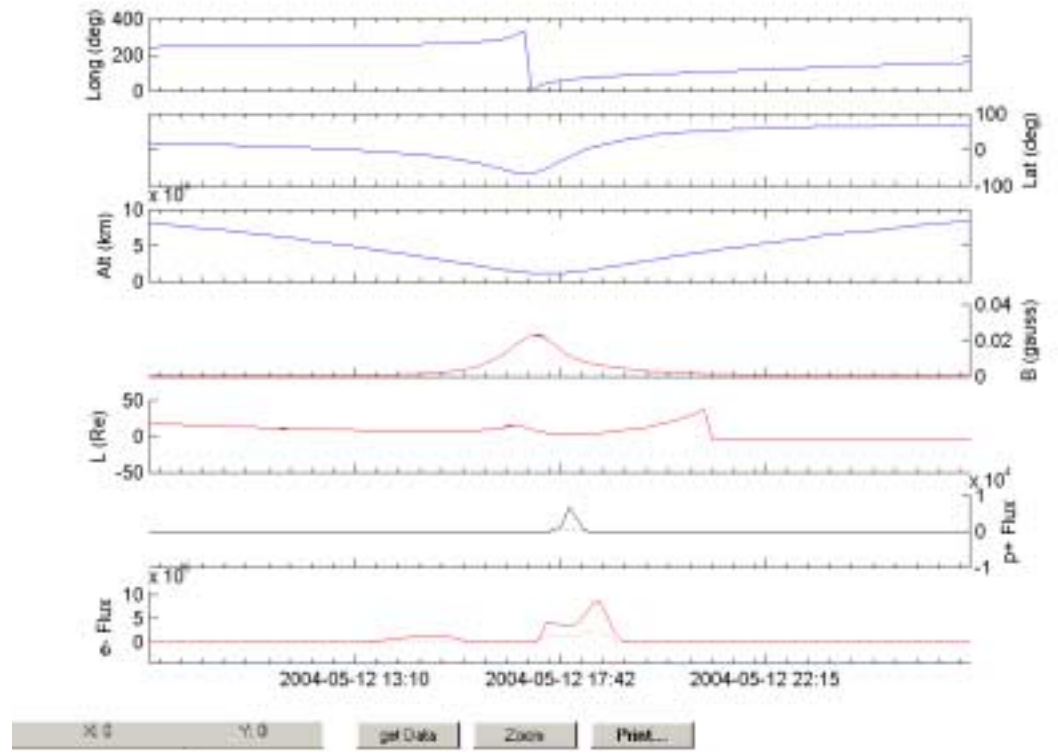




IREM predicted radiation counters

The predicted Belts passages, as calculated with AP8Max and AE8Max models (by using the RADMON tool) are:





SEC-GOES observed particles fluxes

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

