
EUROPEAN SPACE AGENCY
DIRECTORATE OF TECHNICAL & OPERATIONAL SUPPORT
MISSION OPERATIONS DEPARTMENT

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-TOS-OF
No. 087
Week 21
24.05.04
Routine Phase

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LIST OF CONTENTS

1	General.....	3
2	Summary of Activities	3
3	Satellite Status.....	3
3.1	Platform	3
3.1.1	AOCS	3
3.1.2	Power	4
3.1.3	Thermal.....	5
3.1.4	OBDH.....	5
3.1.5	RFS	5
3.2	Payload	5
3.2.1	SPI	5
3.2.2	IBIS	6
3.2.3	JEM-X	6
3.2.4	OMC.....	7
3.2.5	IREM	7
4	Ground Facilities.....	8
4.1	Mission Operations Centre.....	8
4.2	Ground Stations & Network.....	8
4.3	Science Ground Segment.....	8
4.3.1	ISOC	8
4.3.2	ISDC.....	9
5	Special Events.....	9
6	Anomalies.....	9
7	Future Milestones	10
8	Appendix.....	11
8.1	Overview of Revolutions	11
8.2	Consumables	11
8.2.1	Detailed Fuel Book-keeping.....	11
8.3	Detailed Satellite Information	12
8.3.1	AOCS Operations	12
8.3.2	SPI Operations.....	13
8.3.3	IBIS Operations.....	15
8.3.4	JEM-X Operations.....	19
8.3.5	OMC Operations	20
8.3.6	IREM Operations	21

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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 15.05.04 until 21.05.04 (both dates inclusive) and covers the revolutions 194 & 195.

2 Summary of Activities

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

The targets of these revolutions were the galactic plane and Carina (RA 10:36:31.39; DEC -58:21:54.7). The activities consisted of GPS and raster dithering 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.

5 slews were missed from the Timeline because of different problems:

- One slew was missed in revolution 193 due to the loss of guide star just before the start of the slew.
- Three slews were missed in revolution 194 due to a delay in the uplink of a telecommand.
- Another slew was lost in revolution 194 due to a problem with the DSS-16 antenna.

The fuel consumption over the period between 14/05/2004 and 21/05/2004 was 0.092 kg. The remaining propellant is in the order of 170.568 Kg on the 21st 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**.

The evolution of the six Solar Array sections output currents from launch to 26th May 2004 is shown in the plots below.

Figure 1 shows the output currents, normalised to a pitch angle of 0 degrees, the seasonal effects can be clearly seen. From this plot it can also be seen that the minimum available current per section on 4th July (greatest distance from sun) will be about 12.5A.

Figure 2 shows the output currents, normalised to a pitch angle of 0 degrees, with the seasonal variation also removed. Here it can be seen that the rate of degradation is (as expected) slowing.

In both plots the downward step in October 2003 was caused by the Solar storms at that time.

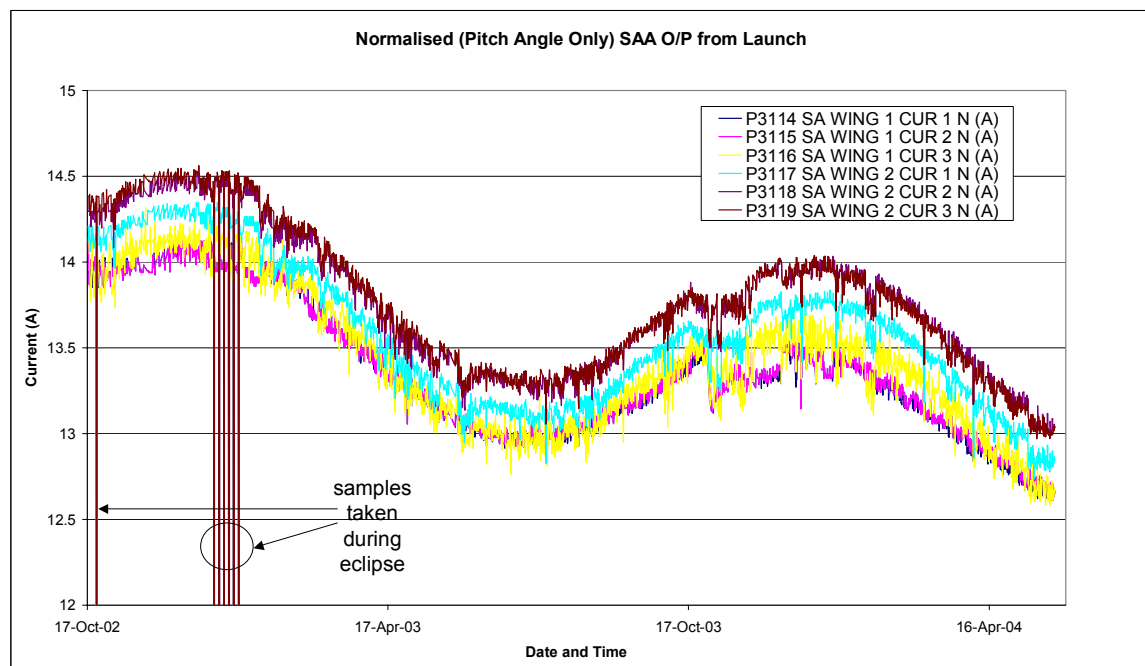


Figure 1

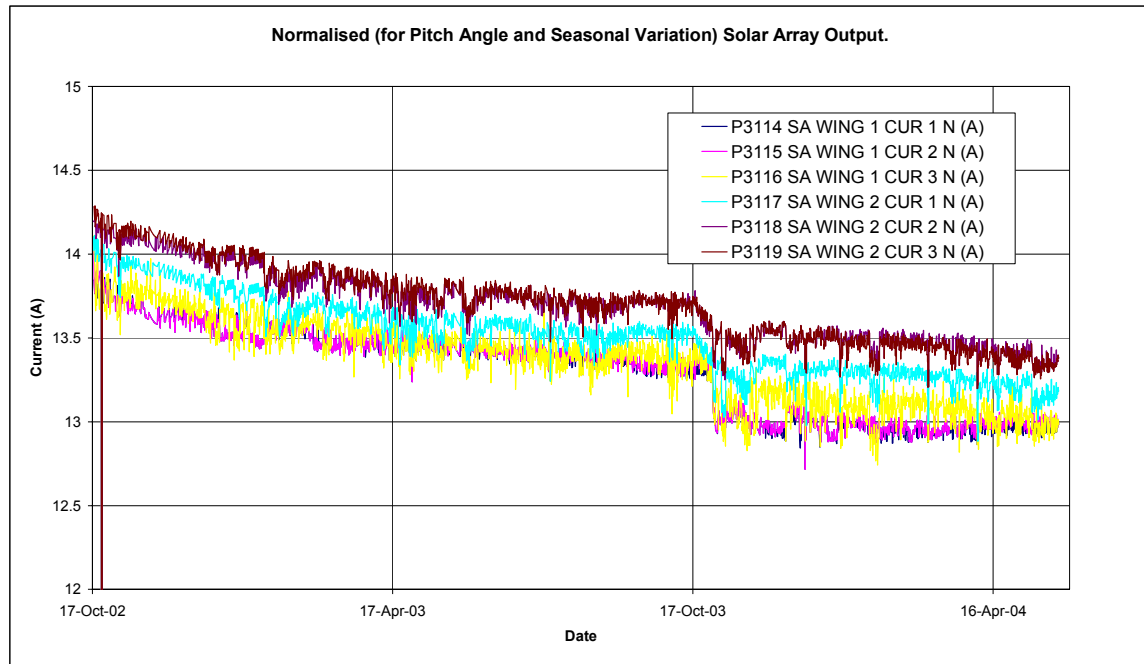


Figure 2

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 95.6 pkts/cycle (+0.5 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. A summary timeline is published in this report, under the future activities section.

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 overall status of the unit is Nominal.

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

During revolution 194 an automatic reset of the IREM S/W (SEU #10) forced the unit to Safe configuration. During the following revolution, number 195 a spike in the IREM proton counter (due to an internal timing problem of the unit) forced the unit to Safe configuration again.

The Hard low limit of the Calibration Counter was updated in order to cope with the natural decay of the on-board radioactive (0.4 mCi of Na²², half time=2.58 years) calibration source.

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 during science observations, with a TM allocation of 8 packets/cycle. JEM-X2 was dormant with a TM allocation of 1 packet/cycle.

On 2004-05-16 at 18:05Z an IREM S/W reset caused JEM-X1 to transition to Safe mode. The unit was recovered to Data Taking, without IREM protection, at 20:29Z. It then operated as such until 2004-05-17 at 00:51Z, when IREM was recovered and all the IREM RMC protections were re-enabled.

The wraparound of the DPEs' LOBT occurred on 2004-05-21 at 14:41:08Z, during the perigee passage of revolution 195-196. No special activities were required.

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.

On DoY 137 at 18:05:54 a SEU within the IREM unit caused OMC to switch to SAFE mode. The unit was recovered to STANDBY, without IREM protection, at 18:57:32, and returned to SCIENCE at 19:02:17. It then operated as such until 2004-05-17 at 00:51Z, when IREM was recovered and the IREM protections re-enabled.

On DoY 140 at 13:42:19, a spike from the IREM unit caused OMC to switch again to SAFE mode, it was recovered to STANDBY at 14:10:02, and to SCIENCE at 14:39:45.

There were 131 OMC pointings executed nominally, 3 were shorter than planned and 5 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.

During revolution 194 an automatic reset of the IREM S/W (SEU #10) had an impact on the instruments (OMC, IBIS and JEM-X1) forcing them to SAFE Configuration. During revolution 195 a spike (lasting one TM cycle) in the proton counter (due to an internal timing problem) had an impact on the instruments (OMC and IBIS) forcing them to SAFE Configuration.

The Unit was successfully recovered, an analysis of the telemetry synchronisation is on-going.

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, there was also a problem with the brakes on the y-axis at DSS-16, which led to an interruption, and the partial loss of two pointings. The performance though was well above the 95% requirement.

4.3 Science Ground Segment

4.3.1 ISOC

1. Mission planning

PSF's: Received up to rev. 204

POS and POD generated: up to rev 203

TSF's: Received up to rev 197

No ToO request received. MOC had a problem with the first slew in rev 202. Therefore rev 201 and 202 were re-planned so that a different perigee entry attitude was used in rev 201. Rev 203 contains an OMC flat field calibration observation.

2. Observation status

ECS for revolution up to 185 received except 168 which is still pending. 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.

4.3.2 ISDC

On 24/05/2004, the status of ISDC observation processing is:

- Latest Standard Analysis completed: observation 02200490062 (S5 0716+71, Revolution 179-180) on 21/05/2004
- Latest products archived: observation 02201140001 (Sgr A*, Revolution 178) on 19/05/2004
- Latest observation products sent to the observer: observation 02200350004 (GX 339-4, Revolution 166) on 24/05/2004

5 Special Events

The wrap around of the DPEs On-Board Time (OBT) occurred on 21 May at 1441. Since this happened during the perigee Passage it had no impact on the operations.

6 Anomalies

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

- On DoY 136 from 00:28 to 02:51, there were problems with the flight dynamics idsb machine. The available disk space dropped sharply, which led to the tpf transfer failing, and then system errors on sun128. It is thought a rogue process filled the disk, then crashed. A tidy-up script then cleaned the disk removing all evidence. At 02:51, the system was fine. The threshold for detecting low disk space has been increased from 1GB to 6GB, to allow time to investigate should this happen again.
- Later, at 04:46 ISDC reported that the snapshot file for slew 01930054 had not been received.
- At 09:43, AOCS problems caused the start of pointing 01930062 to be delayed.
- On DoY 137 at 01:15, an AOCS command failed verification stopping the Timeline. Difficulties were experienced during the recovery, and FD were called in. The impact was pointings 01940010, 01940011 and 01940012 were lost. The Timeline was rejoined at 03:07.
- At 12:35, a hit on the line to Redu caused the TM & TC to drop, the links returned at 12:36 and 12:40 respectively. There was no impact.
- At 18:05, a Single Event Upset was experienced in the IREM unit, which caused IBIS, JEM-X and OMC to go to SAFE mode. OMC was recovered at 18:58, IBIS at 19:47, JEM-X at 20:35, and IREM at 22:32. The impact was pointing 01940030 was lost to OMC, pointings 01940030 & 01940031 to IBIS and 01940030, 01940031 & 01940032 to JEM-X. SPI was not affected.
- On DoY 138, at 09:34, the TLM links from DSS-16 were lost. DSS-16 reported that the y-axis brakes were engaged. The corresponding DR# is 104410. A link from Redu replaced the VC0 TLM, but there was no-uplink possible. At 09:41 the Timeline was stopped, the links re-established at 09:53, the timeline was eventually restarted at 10:24. The impact was pointing 01940044 was interrupted, and 01940045 had a delayed start.
- On DoY 139, at 10:25, there were bad frames from DSS-16, and at the same time a drop in the VC7 online complete link from DSS-16. There was no apparent impact.
- On DoY 140 at 13:42, a transient peak in the IREM radiation counts sent OMC and IBIS to SAFE/STANDBY mode. OMC was recovered at 14:10, and IBIS at 14:22. The impact was pointing 01950018 for these instruments was lost.
- At 14:25, the NCTRS-B was re-booted, as the swap space was low, there was no impact.

- On DoY 141 at 20:28, the PSRV task on idda was stopped and started after ISDC reported that the TDRS was not working, at 21:05, CCC restarted all applications on ISDS-B, as TDRS still not working. At 21:16, the ISDS-B machine was rebooted, at 21:26 TDRS was working again.

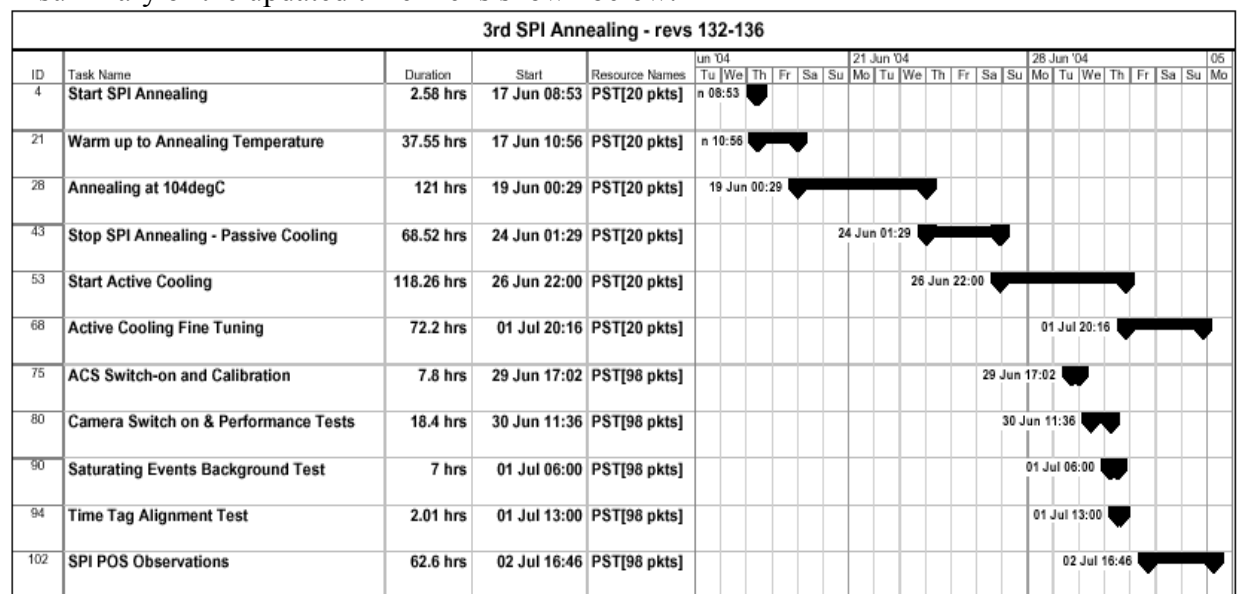
The following new anomaly reports have been entered into the Anomaly Reporting and Tracking System this week. Repeats of existing anomalies are not shown in this table.

AR id	Date Occurrence	Subject	Segment	Status
INT-2593	17/05/2004	Problems dumping the JEMX DFEE memory	Simulator	Open
INT-2594	17/05/2004	Unable to restore breakpoint.	Simulator	Open
INT-2595	17/05/2004	Valid values for IBIS parameters required in breakpoints.	Simulator	Open
INT-2596	17/05/2004	PIT Counter for TM Bit rate	Simulator	Open
INT-2597	17/05/2004	Set Reaction Wheel speed User Command does not correctly update s/c...	Simulator	Open
INT-2598	17/05/2004	SPI Protected Mode, Model deficiencies	Simulator	Open
INT-2599	18/05/2004	Delayed Uplink of TC causes loss of 3 Slews	NCTRS	Open

7 Future Milestones

The 4th SPI annealing will start on 17th June and will last until 2nd July (revs 204 to 209). The annealing timeline includes 121hours annealing time at 104degC, a few additional tests to calibrate the ACS, investigate the background of the camera saturating events, align the ACS veto pulse with the camera time tag events. During the warm phase, the instrument will also be maintained in photon by photon to catch any signal from GeD#2 channel - faulty since 06.12.2003 - triggered by thermal noise.

A summary of the updated timeline is shown below:



8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 194

The observations in revolution 194 began with a GPS lasting ~10 hours. This was followed by a raster dithering observation of Carina (RA 10:36:31.39; DEC -58:21:54.7), performed for the remaining ~50 hours of observation time.

Revolution 195

In revolution 195 an amalgamated raster dithering observation of Carina (RA 10:36:31.39; DEC -58:21:54.7) was performed throughout the available observation time (~62 hours).

Revolution 196

In revolution 196 an amalgamated raster dithering observation of Carina (RA 10:36:31.39; DEC -58:21:54.7) 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

2004-04-30T20:16:39.000Z	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.
2004-05-15T13:07:01.000Z	170.6516	F	Automatic TM processing.
2004-05-15T19:03:17.000Z	170.6123	F	Automatic TM processing.
2004-05-16T04:03:42.000Z	170.5920	F	Automatic TM processing.
2004-05-18T18:51:33.000Z	170.5682	F	Automatic TM processing.

This report was generated Fri May 21 08:00:15 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, 20 Open Loop Slews, 124 Closed Loop Slews and 5 Momentum Bias were executed. 5 slews were missed or executed manually. This is equivalent to 3.5%.

15/05/04 (Day of Year 136, Revolution 193-194)

Close Loop Slew missed due to loss of Guide Star: At 09:43:12, at an altitude of about 73000 km, the STR SEU Filter of the ACC released the Guide Star after the number of detected False Events exceeded its threshold. The 7.10 Guide Star was located at CCD coordinates [19856, -15346]. Apparently, an undetected False Event caused a change in the CCD position of the Guide Star ([19842, -15337], 6.90 Mi) in one cycle. In the next cycle the actual Guide Star was detected as a False Event and its status was latched as such, until the SEU filter threshold was exceeded and the star was released. An automatic mapping was commanded by the ACC and a new Guide Star was picked: [9075, 3572], 8.30 Mi. This happened at the same time when a Search-and-Track was in progress to pick the Guide Star for the upcoming Close loop Slew. The star was in fact picked and tracked in slot Nr. 2. However, since there was not enough time to analyze the situation and to make sure that the next slew will start with a clear status, the AOCS commanding from the Timeline was stopped and slew 01930062 was missed. A manual Close Loop Slew was then performed to the attitude of PID 01930062.

16/05/04 (Day of Year 137, Revolution 194)

Slews lost due to a delay in uplink of an AOCS TC: At 01:15:11, the command to load the Manoeuvre Timer failed execution verification, which interrupted the sequence of slew 01940010. The reason for this was a delay in the uplink of the telecommand caused by a communications problem. See INTEGRAL ARTS Entry INT-2599. Slews 01940010 to 01940012, inclusive, were missed. The Timeline was rejoined by performing a manual open Loop slew to the attitude of PID 01940012. Slew 01940013 was executed from the timeline after being manually updated.

17/05/04 (Day of Year 138, Revolution 194)

Slew lost due to a problem at the station (Goldstone, DSS-16): At 09:34 the TM links from DSS-16 were lost. According to the station, the problem was caused by the engagement of the Y-axis brakes of the antenna (DR# 104410). The Timeline was

stopped and close loop slew 01940045 was missed. After the problem was solved at the station and the links were re-established, a manual close loop slew was performed to the attitude of PID 01940045. The next slew was executed from the Timeline.

18/05/04 (Day of Year 139, Revolution 194-195)

Nothing to report.

19/05/04 (Day of Year 140, Revolution 195)

Nothing to report.

20/05/04 (Day of Year 141, Revolution 195)

Nothing to report.

21/05/04 (Day of Year 142, Revolution 195-196)

Nothing to report.

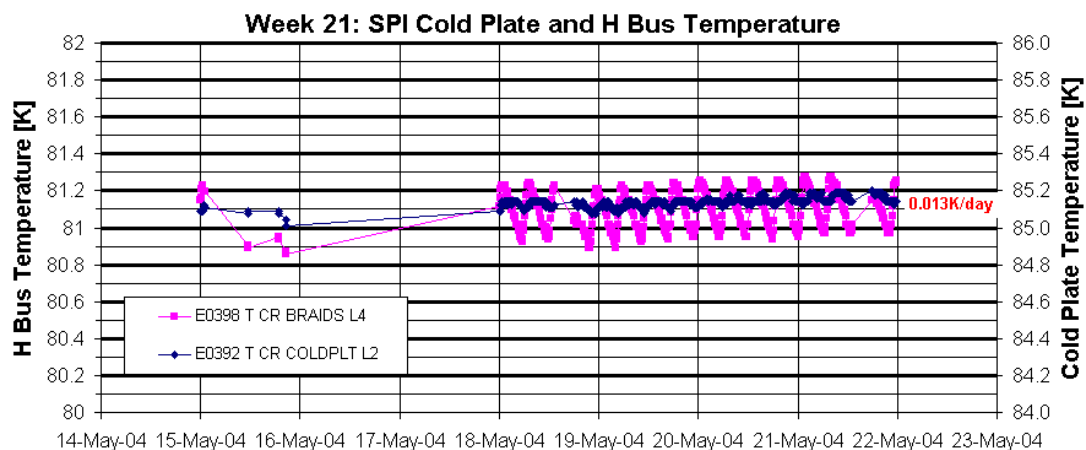
8.3.2 SPI Operations

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 drift over the whole week of +0.013K/day, which is well within the expected range.

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

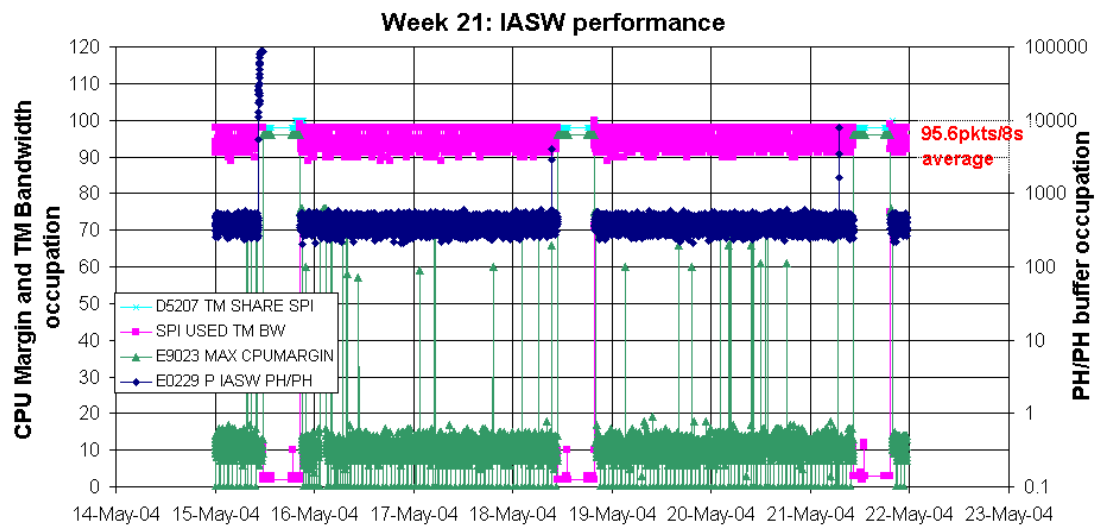


IASW/DPE:

The performance of the IASW/DPE is nominal. The average TM bandwidth occupation was 95.6 pkts/cycle in the science windows (+0.5pkts w.r.t. previous week).

As the occupation is approaching the maximum allocated bandwidth (98 pkts/cycle), the disabling of the PSD pulse shape sample downlink is being considered as a recovery step to gain (reduce) about one pkt/cycle.

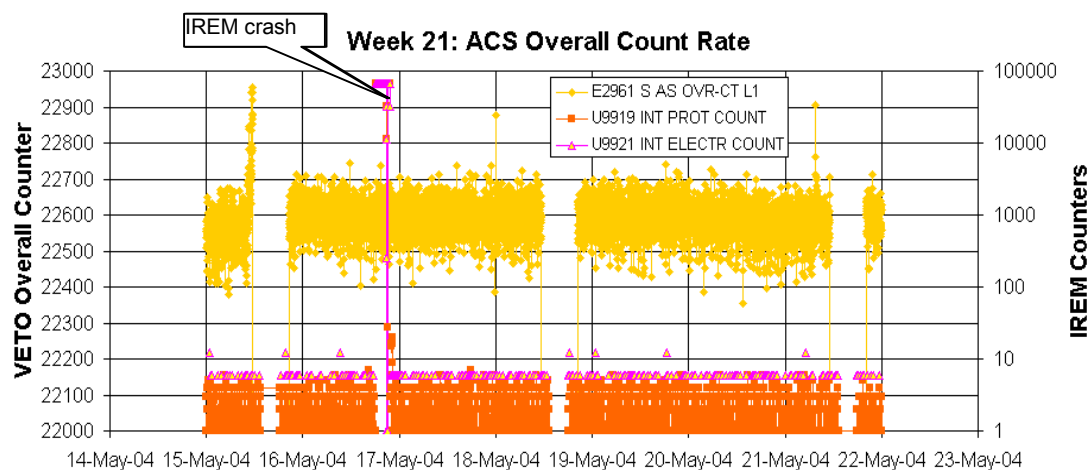
The following diagram shows the IASW performance in terms of TM bandwidth and event buffer occupation during the reporting period.



ACS:

The performance of the ACS is nominal.

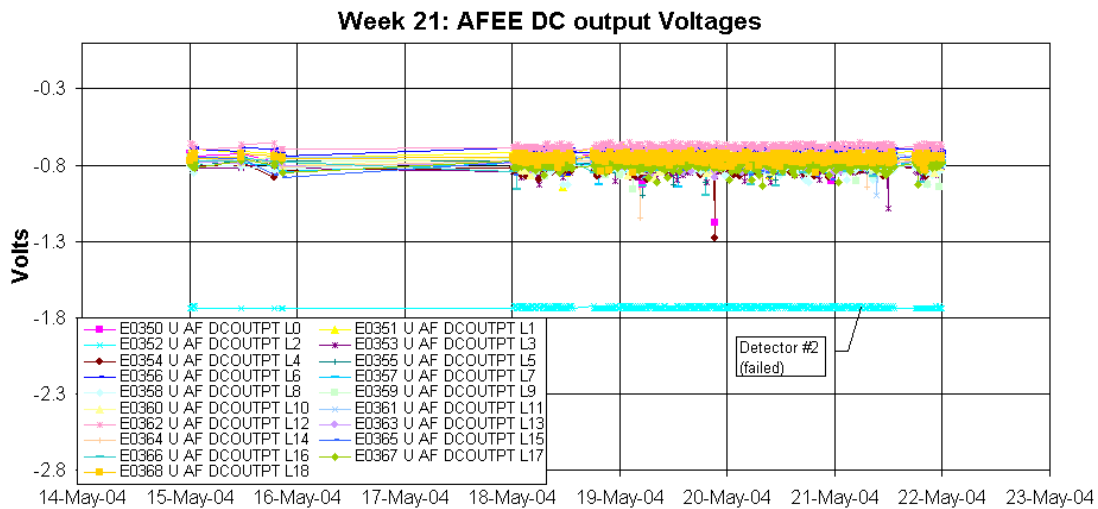
The following plot shows the ACS overall counts and IREM counters evolution during the reporting period. The evident peaks on the IREM counts are due to a crash of the IREM software.



AFEE:

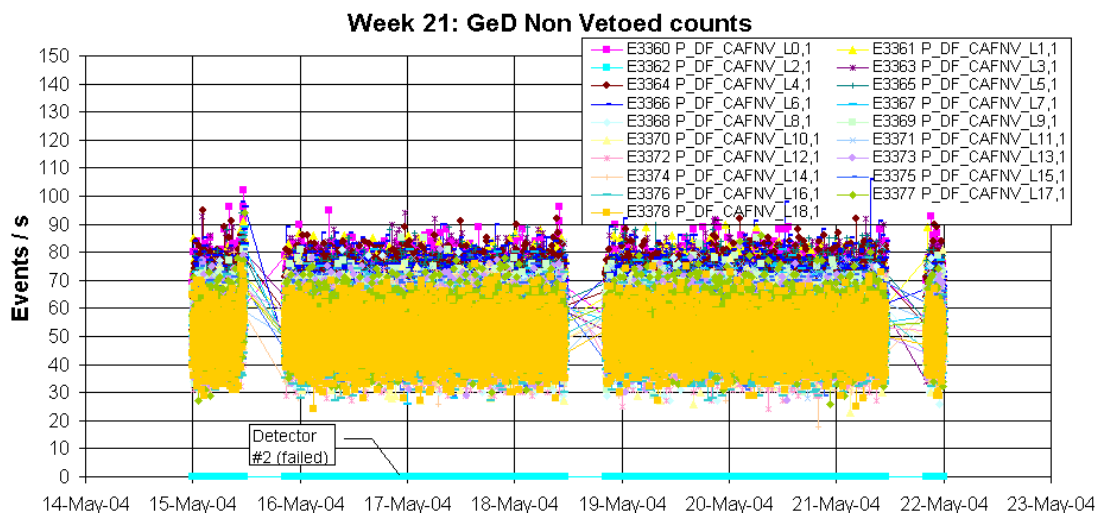
The performance of the detectors is nominal except for the detector #2 failed since 06.12.2003 (see anomaly report INT_SC-72).

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:

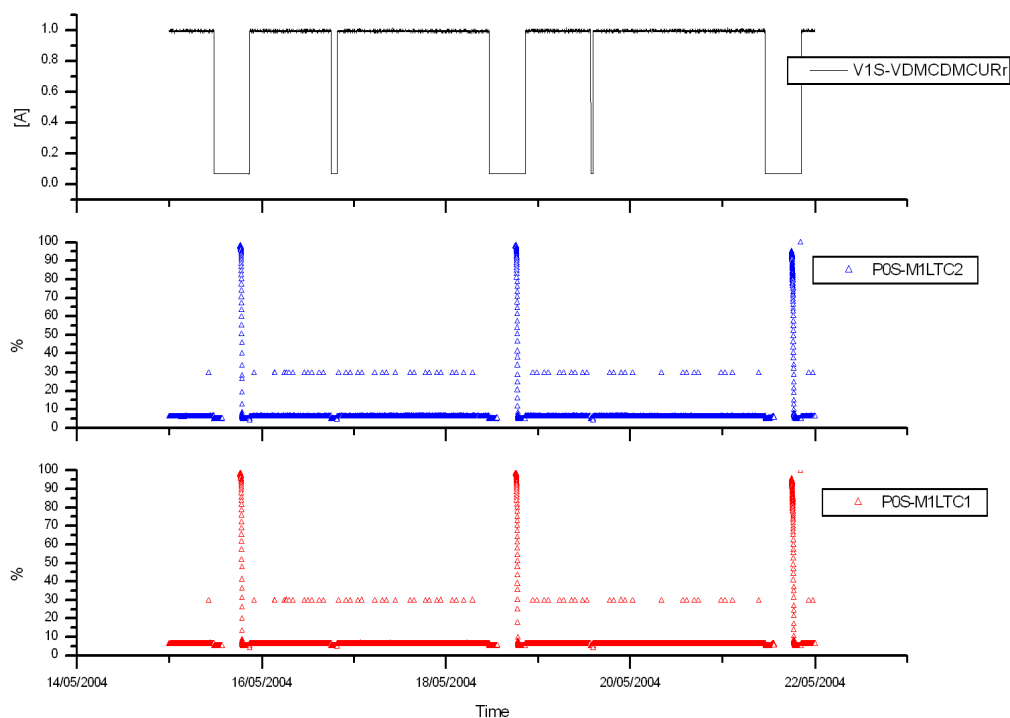
The performance of the unit is nominal.
 Nothing to report.

8.3.3 IBIS Operations

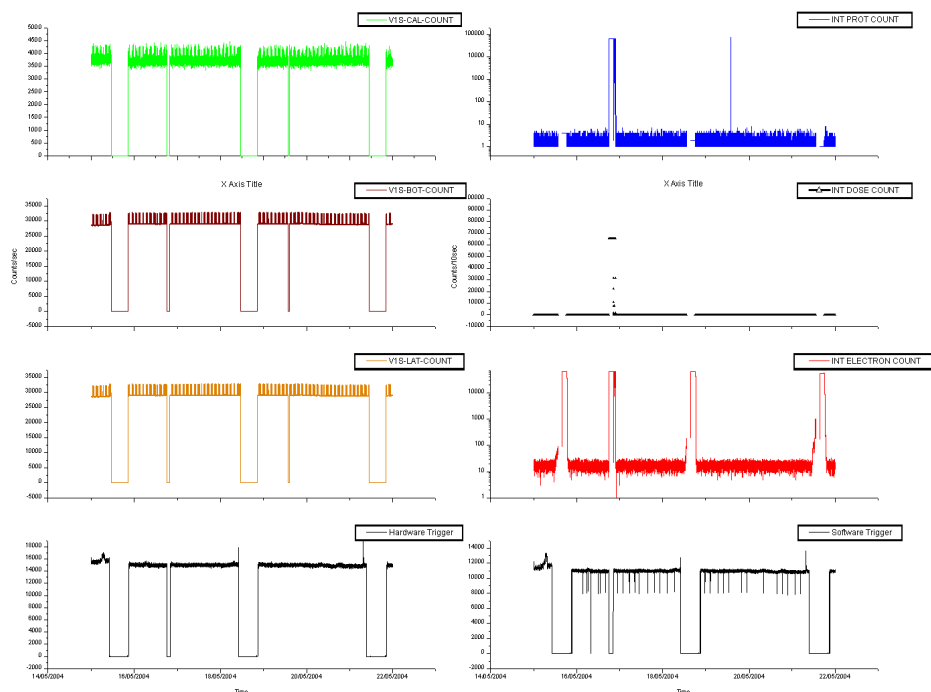
IBIS event counters plot

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:

IBIS - VETO VDM current & PICsIT dead time Rev 193-195

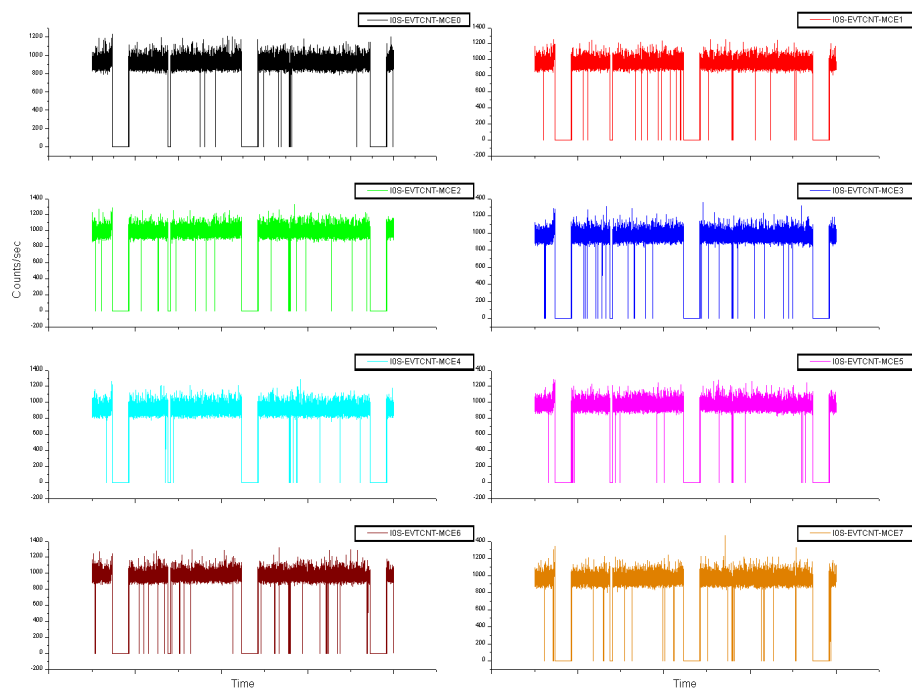


IBIS - VETO Counters Rev 193-195

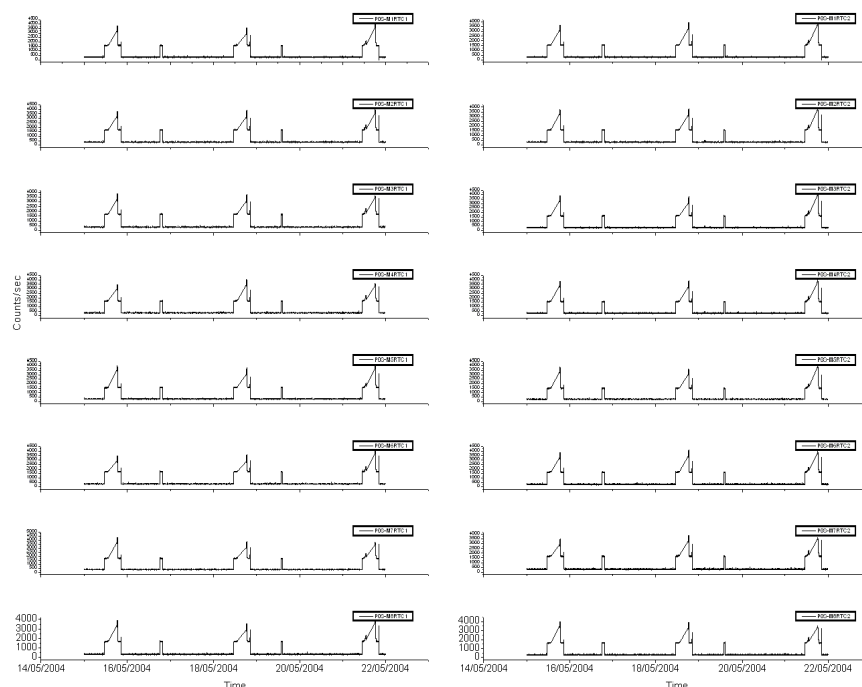


Plots of the ISGRI and PICsIT counters, during the observation period, are shown below:

IBIS - ISGRI Counters Rev 193-195



IBIS - PICsIT Counters Rev 193-195



IBIS daily report

DOY 2004.136 (15/05/04)

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 2004.137 (16/05/04)

At 18:05Z the IREM automatic transition to Standard Mode (reset of the CSCI S/W) was reported. The anomaly affected the instruments status via BCP as the S/C was in observation mode 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 19:47Z (see IREM report for the details).

DOY 2004.138 (17/05/04)

Nothing to report.

DOY 2004.139 (18/05/04)

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 2004.140 (19/05/04)

At 13:42Z a spike on the IREM proton counter was reported: preliminary investigations indicate it was due to an IREM internal timing problem and not to a genuine radiation event. The anomaly affected the instruments status via BCP because the S/C was in observation mode 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 14:22Z (see IREM report for the details).

DOY 2004.141 (20/05/04)

Nothing to report.

DOY 2004.142 (21/05/04)

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.

At 19:51Z the parameter G2014 (Overflow of the noisy pixel address buffer in MCE1) failing the SSC was reported. The parameter went back in limit after few TM cycle and no further action was taken.

8.3.4 JEM-X Operations

2004-05-15 (DOY 136, Rev 193-194)

Nothing to report.

2004-05-16 (DOY 137, Rev 194)

At 18:05Z an IREM S/W reset (SEU # 10) occurred, with all radiation monitor counters from IREM (TM parameters K/L5315-K/L5317) giving a value of 65535, causing JEM-X1 to transition to Safe mode, issuing OEM 231 JEM-X1 AUTO EVENT 1. Commanding to JEM-X1 from the automatic Timeline was disabled at 18:08Z.

As part of the instruments' recovery procedure in case of an IREM S/W reset, procedure FCP_DHS_1301 was executed to set the broadcast packet DRMC flag to DISREGARD at 18:52Z. JEM-X1 then transitioned to Setup mode and issued OEM 233 JEM-X1 AUTO EVENT 3.

The reconfiguration of JEM-X1 for resumption of science activities was started at 19:57Z, with the procedure FCP_JEM1_1010, followed by procedure FCP_JEM1_0044. JEM-X1 was commanded back to Data Taking at 20:29Z.

At 20:35Z FCP_JEM1_0120 was executed to set the JEM-X1 broadcast packet overrides for the IREM Radiation Monitor Count flags (TM parameters K5474 to K5476) to DISABLED and commanding to JEM-X1 from the automatic Timeline was then re-enabled.

JEM-X1 was thus operated in Data Taking without IREM protection for the remainder of the day.

2004-05-17 (DOY 138, Rev 194)

At 00:31Z, once IREM had been recovered, FCP_DHS_1301 was executed to set the broadcast packet DRMC flag back to REGARD. At 00:51Z the JEM-X1 RMC flags were set back to ENABLED by procedure FCP_JEM1_0120.

JEM-X1 operations then continued nominally.

2004-05-18 (DOY 139, Rev 194-195)

Nothing to report.

2004-05-19 (DOY 140, Rev 195)

Nothing to report.

2004-05-20 (DOY 141, Rev 195)

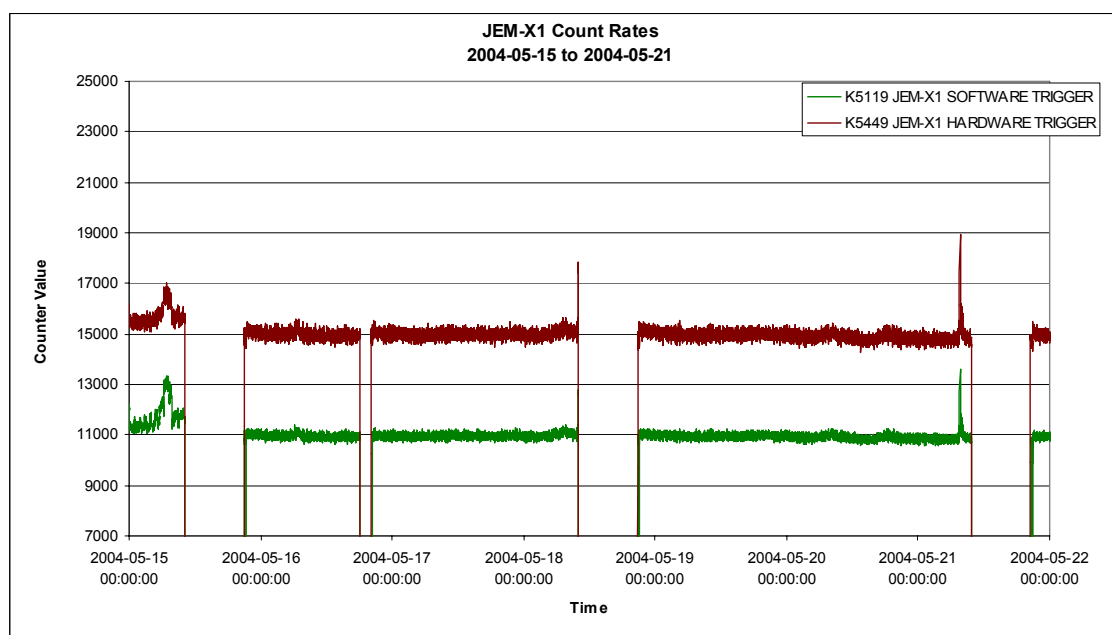
Nothing to report.

2004-05-21 (DOY 142, Rev 195-196)

The wraparound of the DPEs' LOBT occurred at 14:41:08Z. This was during the perigee passage of revolution 195 to 196 (outside of coverage). As JEM-X was therefore not in a scientific mode at the time of the wraparound, there were no special activities to be performed.

8.3.4.1 JEM-X Count Rates

JEM-X1 count rates over the reporting period are displayed in the following graph¹.



8.3.5 OMC Operations

On DoY 136, at 09:43, AOCS problems caused the start of pointing 01930062 to be delayed by 20 minutes.

On DoY 137, at 01:18:50, after an AOCS command had failed the CEV, the commands for pointing 01940010 were sent, and subsequently rejected:

```
2004.137.01.18.50.052 2004.137.01.18.45.266 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=1775
2004.137.01.18.50.023 2004.137.01.18.39.141 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=1774
```

¹ Data sampled (1 frame in 4) and smoothed to remove spikes in S/W Trigger due to flushing of buffer after slews.

These correspond to the M1130 (RESET IM) and MU1310 (IMAGING-A) commands for that pointing. Pointings 01940011 and 01940012 were subsequently also lost.

On DoY 137 at 18:05:54, the 10th IREM Single Event Upset was experienced. OMC was switched to SAFE mode at this time, and recovered at 18:57, and switched back into SCIENCE at 19:02:57 for pointing 01940031, the impact was pointing 01940030 was lost.

On DoY 138, at 09:34, the TLM links from the ground station were lost. At 09:41 the Timeline was stopped, the links re-established at 09:53, the timeline was eventually restarted at 10:24. The impact was pointing 01940044 was interrupted, and 01940045 had a delayed start.

On DoY 140 at 13:42:19, a single spike within IREM caused the unit to switch spuriously to SAFE mode. The unit was recovered at 14:10:02, and switched back to SCIENCE at 14:39:45 for pointing 01950019. The impact was pointing 01950018 was lost.

On DoY 136 at 11:33:05, DoY 139 at 11:19:45 and DoY 142 at 11:03:59, OMC was switched by the Timeline to SAFE mode, at the nominal times.

8.3.6 IREM Operations

IREM daily report

DOY 2004. 136 (15/05/04)

At 13:26Z the failing of the CEV (Command Execution Verification) for the TC U4921 (INT GND LINK OFF) due to a late TM verification in the Command Verifier Task was reported. The operator verified the successful execution of the TC against the TM parameter U9903 (in TM Monitoring Task) and no further action was taken.

DOY 2004. 137 (16/05/04)

At 18:05Z the local reset of the IREM CSCI S/W (SEU #10): 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, 13/05/04) the status of the unit, before the occurrence of the anomaly, was nominal. Here is a summary:

- 1) Temperatures nominal;
- 2) LCL current nominal;
- 3) Last HK before the anomaly reported HV , 5V, 6V voltages inside limits;

4) The anomaly occurred at ~141123 Km altitude,. The unit performed an automatic transition to Standard Mode (i.e. no block counter increasing, all the TM words= FFFF hex);

a few seconds before the anomaly, the radiation counters reported the following values:

U9919 (proton counter)=3

U9920 (dose counter) =0

U9921 (electron counter) =11

5) The recovery of the unit started at 18:33Z using the procedure CRP_SYS_2570. The first dump of the status word reported the value 'BCC0' hex=

```
1
0
1
1
1
1
1
0
0
1
1      Checksum Failure ON
0
0
0
0
0
0
0'
```

i.e. with the checksum failure flag ON . Looking at the checksum failure counter in the register bank # 3, it resulted incremented of 1 unit (the past value was 1 due to the previous IREM power cycle on 27/12/03 and SEU#9 on 13/05/04). The second dump of the status word reported the value 'BC80' where the checksum failure flag was reset.

6) The patch was performed successfully with the correct re-starting of the S/W. The operation was completed at 22:32Z.

The IREM automatic transition to Standard Mode (reset of the CSCI sw) affected the instruments status via BCP as the S/C was in observation mode and forced the automatic transition of the payloads (OMC, IBIS and JEM-X1) to "SAFE" configuration, with the exception of SPI (automatism disabled, upon request of SPI PIs).

The recovery of the payloads was performed as follows:

- OMC re-enabled in the automatic scheduling system at 18:58Z
- IBIS re-enabled at 19:47Z
- JEM-X1 re-enabled at 20:35Z

The cause of this S/W reset is apparently due to an upset of the unit's memory, as previously: 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;**
- **this is the first time having two consecutive SEUs (13/05/04 and 16/05/04) separated by a very short period (3 days) .**

Due to the need to recover the unit as soon as possible, 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 on DoY 138 at 00:30Z.

DOY 2004.140 (19/05/04)

At 13:42Z a spike on the MSW block counter triggered a high proton count-rate. The anomaly affected the instruments status via BCP as the S/C was in observation mode and forced the automatic transition of IBIS and OMC to Safe configuration. The JEM-X1 unit was not affected by the anomaly as the radiation monitoring logic is only triggered by two consecutive readings exceeding the radiation thresholds.

No recovery of the unit was necessary.

Preliminary investigations indicate it was due to an internal timing problem of IREM and not caused by genuine radiation event: the MSW of the internal block counter jumped at the mentioned time from 0 to 282 and again to 0. During the jump the TM provided by the unit reported not valid values that triggered the proton thresholds of two of the four payloads, forcing them to Safe configuration.

The status of the unit pre anomaly (13.41.57Z) was:

- the LCL current reported a normal value of 0.073 A
- the radiation counter reported values proton=3, dose=0 and electron=24.
- the LSW of the IREM block counter reported the value 28746 dec

- the MSW of the IREM block counter reported the value 0 dec
- the last IREM HK file reported nominal values

during the occurrence of the anomaly (13.42.05Z)

- the LCL current reported a normal value of 0.088 A inside the indetermination of the lsb~0.01 A
- the radiation counter reported the following values, proton=13115, dose=152 and electron=24
- the LSW of the IREM block counter reported the value 28747 dec
- the MSW of the IREM block counter reported the value 282 dec
- the reported status word was '000000101010001100'bin

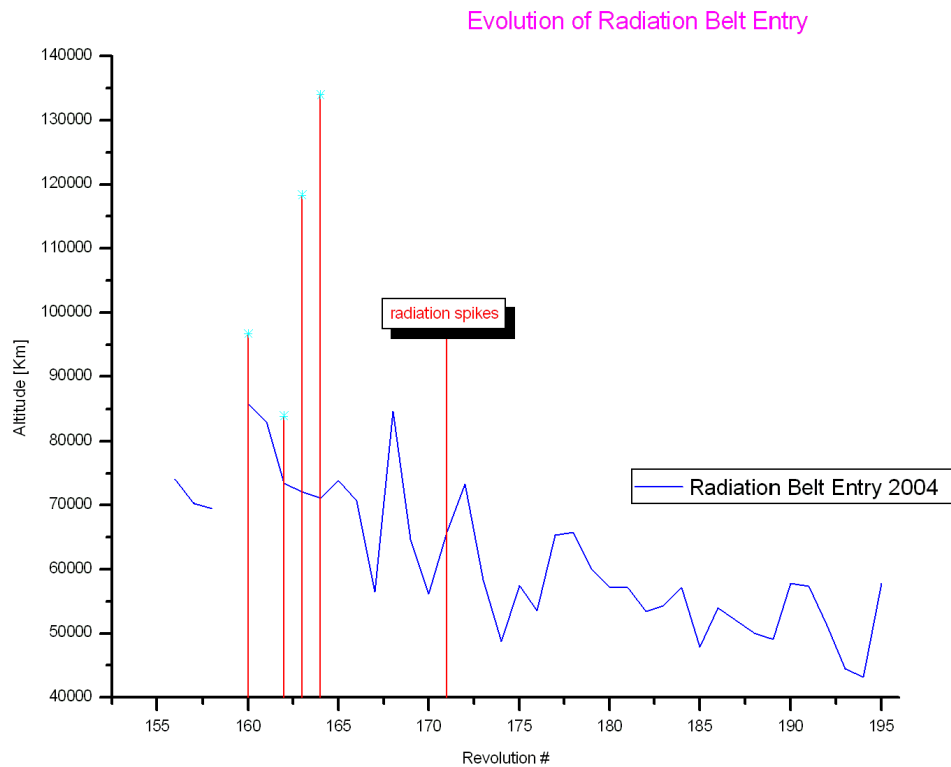
after the anomaly

- the LCL current reported a normal value of 0.088 A inside the indetermination of the lsb~0.01 A
- the radiation counter reported the following values, proton=0, dose=0 and electron=23
- the LSW of the IREM block counter reported the value 28748 dec
- the MSW of the IREM block counter reported the value 0 dec
- the reported status word was nominal for the Integral Mode

Investigations are on going in MOC to find correlation between this anomaly and the previous SEU reported for the unit.

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 193-->195, as defined by a cut-off flux of $3.76\text{E}+02 \text{ e/cm}^2/\text{sec}$ ($E>0.5 \text{ MeV}$) and the predicted Proton Belts Entry/Exit, as defined by a cut-off flux of $1.25\text{E}+03 \text{ p/cm}^2/\text{sec}$ ($E>8 \text{ MeV}$) 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]
193	RAD_ENTR R 2004-05-15T11:32:47Z	15/05/2004 13:23	44557	15-May-2004 12:13	54385
194	RAD_EXIT R 2004-05-15T20:36:34Z	15/05/2004 18:56	23128	15-May-2004 19:13	26545
194	RAD_ENTR R 2004-05-18T11:19:31Z	18/05/2004 13:14	43141	18-May-2004 12:00	54099
195	RAD_EXIT R 2004-05-18T20:24:05Z	18/05/2004 18:48	24841	18-May-2004 19:00	26782
195	RAD_ENTR R 2004-05-21T11:03:39Z	21/05/2004 11:23	57795	21-May-2004 11:46	54264

Reference

Small error vs reference

Large error vs reference

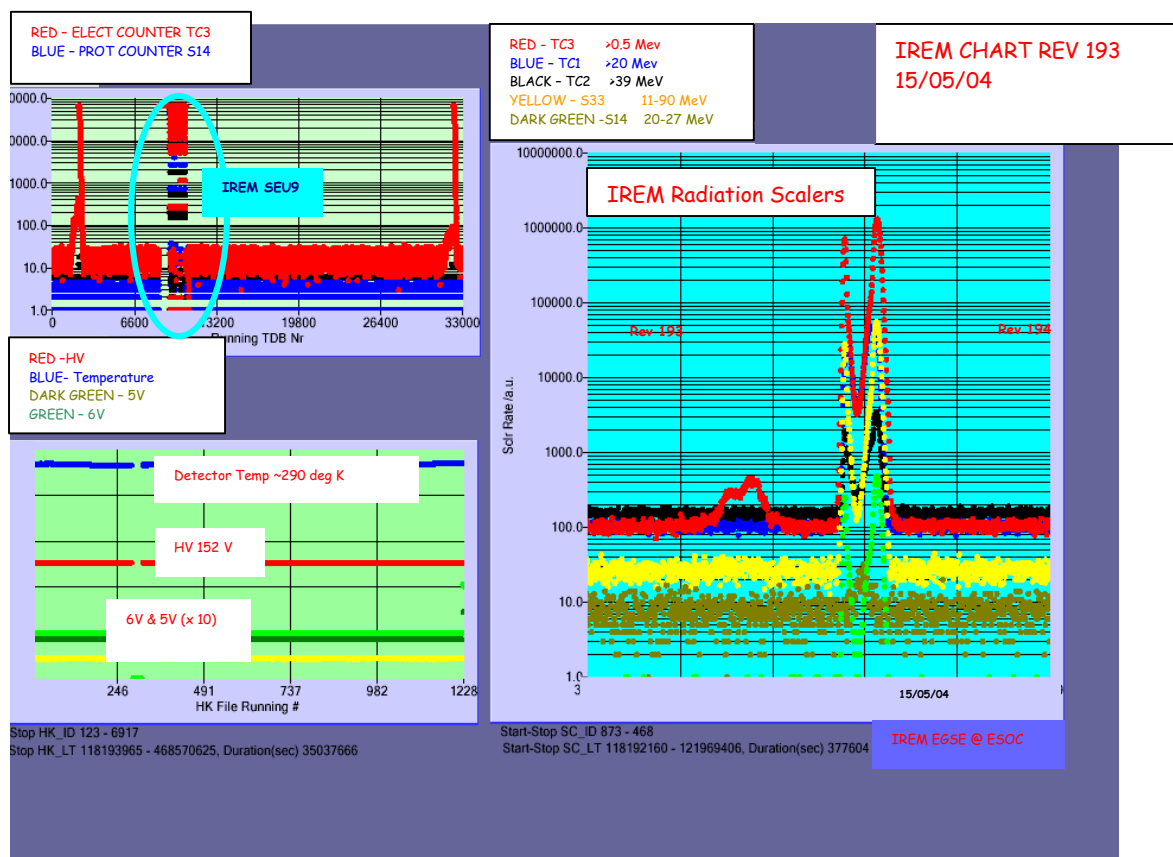
Radiation Spike

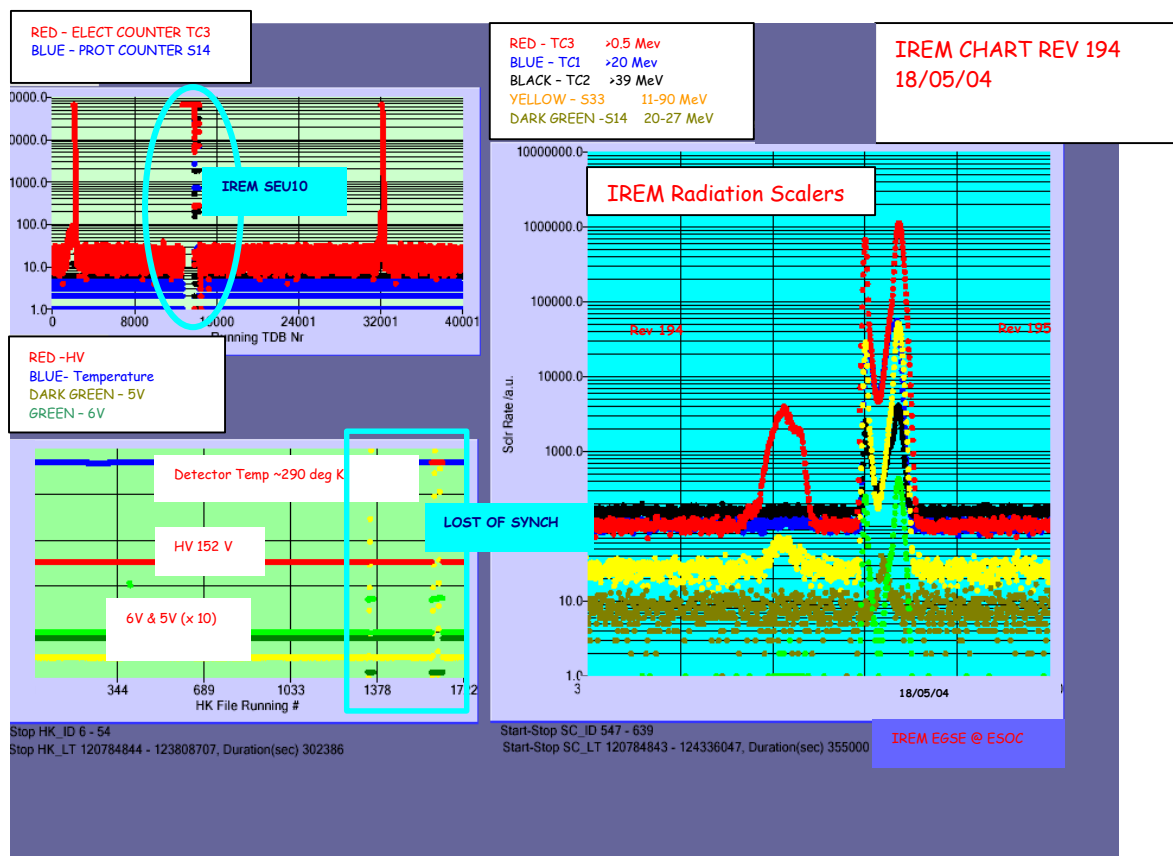
Proton Belts

REV	S/C BCPKT (proton)	Proton CUT-OFF Predicted Entry/Exit	ALT[Km] predicted
193	PROTON_RAD_ENTR	15-May-2004 17:33	11830
193	PROTON_RAD_EXIT	15-May-2004 18:03	15109
194	PROTON_RAD_ENTR	18-May-2004 17:20	12064
194	PROTON_RAD_EXIT	18-May-2004 17:50	15392

IREM radiation counters plot

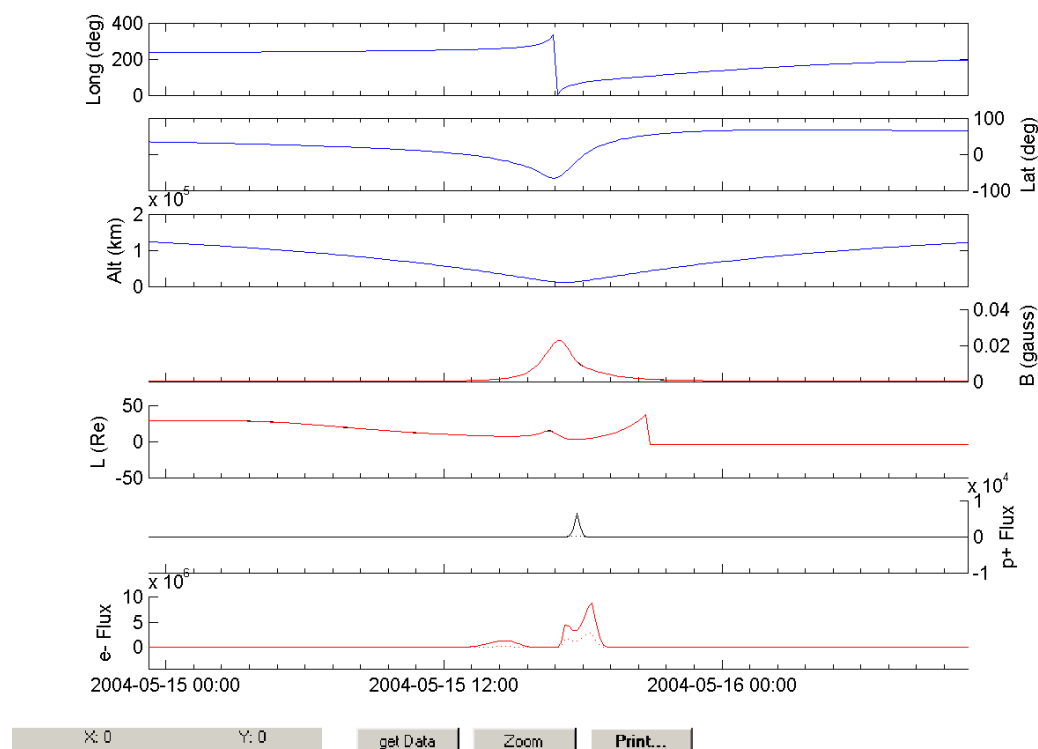
Plots of the evolution of the IREM counters from revs 193 & 194 are shown below (it was not possible to produce the plot for rev 195 this week):

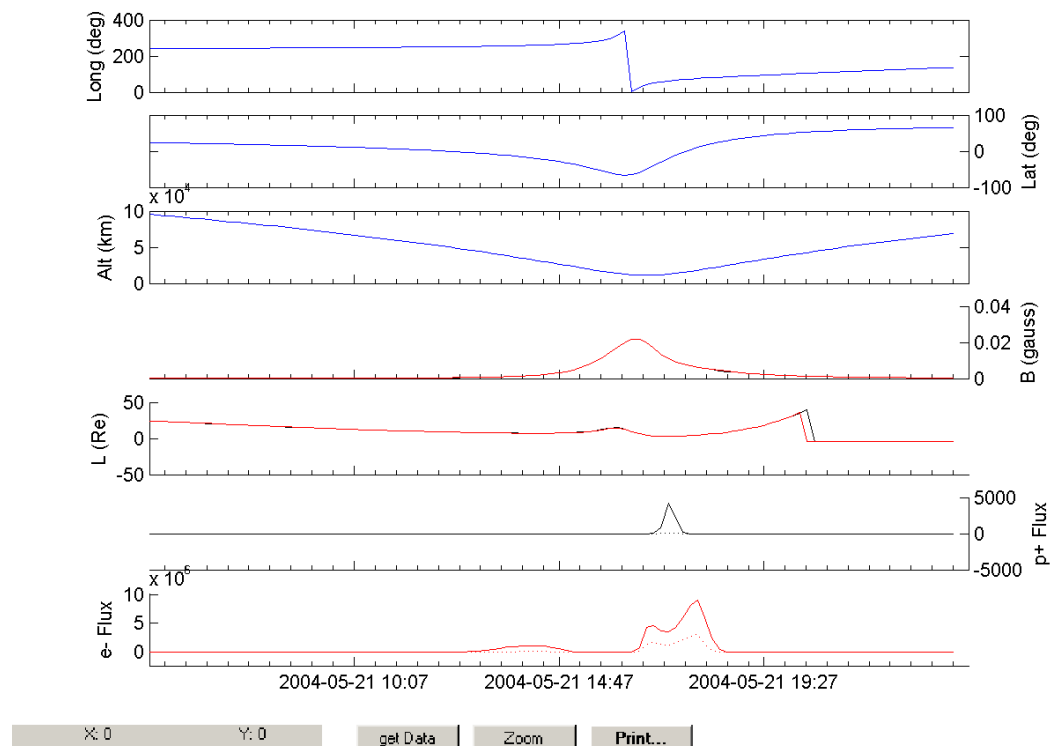
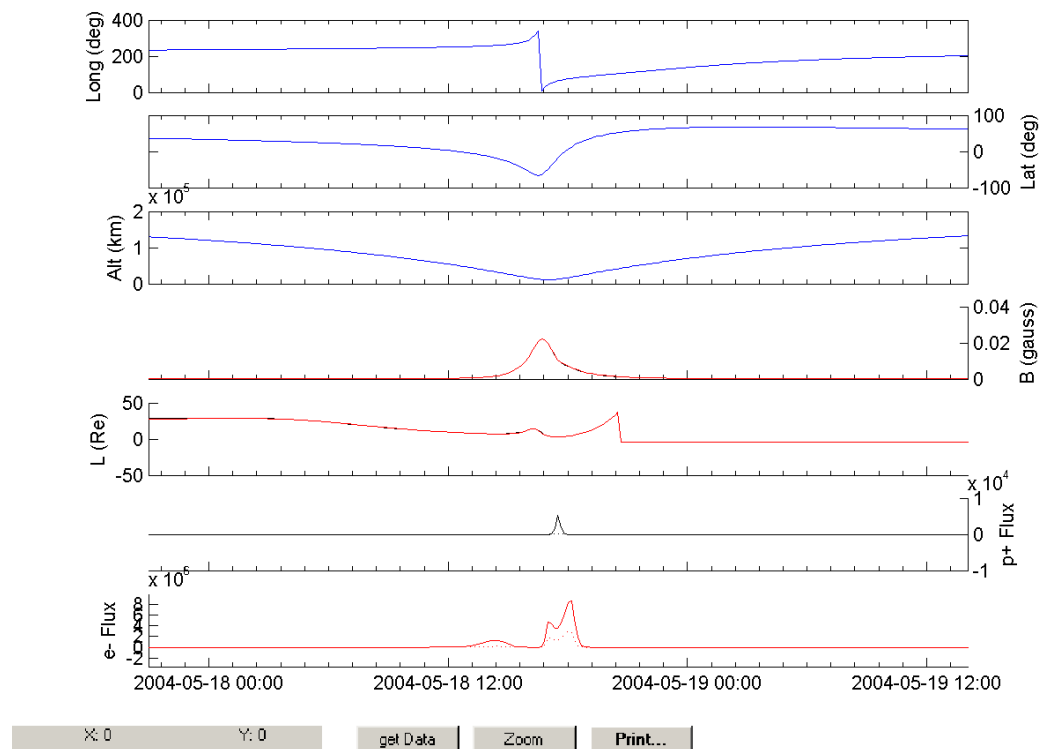




IREM predicted radiation counters

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:

