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

INTEGRAL
Mission Report

INT-MOC-SYS-RP-1001-TOS-OF

No. 009
Week 47

22.11.02

Commissioning Phase

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1 General

This report comprises inputs from various teams involved in the Commissioning activities:
- Flight Control Team,
- Flight Dynamics Team (Fuel book-keeping)
- ISDC.

This report addresses the activities from 16.11.02 until 22.11.02 (both dates inclusive). It covers the revolutions 11, 12 and parts of revolution 13.

2 Summary of Activities

The operations were performed partially according to the Commissioning Timeline (mainly SPI) that was produced by the Flight Control Team and partially according to the planning inputs from ISOC. All routine operations and the science operations planned by ISOC were performed using the routine mission set-up. This means that the planning was done using the mission planning system and the operations were executed from the automated Timeline.

The focus of this week was on the finalisation of the instrument commissioning activities so that the Performance Verification (PV) Phase can start in revolution 14 for all instruments.

The following table provides an overview of the main operations. A more detailed overview is provided in the Appendix, see section 8.2.

Date	Revolution	Activity
15.11 – 18.11	11	SPI Commissioning OMC Flat Field and Dark Current calibrations Hexagon dither pattern around Cygnus X1
18.11 – 21.11	12	Slew to Cygnus X1 Leonides Passage SPI commissioning PV phase for JEM-X, OMC and IBIS Slew to Empty Field
21.11 – 24.11	13	SPI Commissioning PV phase for JEM-X, OMC and IBIS

The planned operations could be performed according to the Timelines and flight procedures. In addition some change requests provided by the Payload Support Team have been accommodated.

The execution of the operations were impacted by several problems of the ground and space segment, see chapter 6.

3 Satellite Status

3.1 Platform

The platform is in general working well. There was no on-board failure that required the utilisation of redundant equipment. However, a few observations have been made that entail some further investigation. It is not yet clear whether the observed behaviour requires some modifications concerning the way the S/C is operated.

3.1.1 AOCS

The overall performance of the AOCS subsystem is good. A few points have been identified that are currently being analysed to identify the possible implications on the operations.

The Guide Star has been lost due to a Single Event Upset (SEU) during the Perigee Passage between revolutions 12 and 13. The magnitude of the star was 6.75. Before this event the Guide Star was already lost 5 times since Launch. Since a new star has been automatically selected on-board and tracked by the Star Tracker (STR) the AOCS commands in the automated Timeline have been suspended to assess first the situation. Afterwards the automatic execution of the Timeline could be resumed.

The On Target Flag (OTF) toggled several times, see detailed report in the Appendix. Since the toggle is usually very short (one AOCS cycle is 0.5 sec) not all occasions when the OTF toggled were recognised by the Broadcast Packet.

The thermal environment of the Star Tracker is not very stable. The thermal cycle has a period of about 5 hours with an amplitude of 6 degrees. The corresponding heater has a power consumption of 7.4 W. The increase of the temperature from – 9 ºC to – 3 ºC is achieved within about half an hour. The behaviour was assessed by industry and is not considered as an area of concern.

The remaining propellant was on 19 Nov, 181 Kg. The average power consumption was 0.11 Kg within 10 days in the phase. However, it should be kept in mind that this is not a representative figure for the routine phase when the science related activities that drive the number and size of slews and of Reaction Wheel Bias manoeuvres will be different.

Note: A detailed report concerning the AOCS operations and the fuel budget is provided in the Appendix, see sections 8.1.1 and 8.3.1.

3.1.2 Power

The power subsystem is working as specified. The available power is in the order of 2380 W, i.e. no degradation has been identified so far.

3.1.3 Thermal

The thermal control of the satellite is working satisfactory. The temperatures are currently all within the specified operational limits.

The modification of the thermal control concept of the RCS lines had the effect that lower temperatures are reached. It is currently under investigation whether these low temperatures can cause any problems in the future.

3.1.4 OBDH

The functions of the On-board data handling subsystem is as expected. The satellite has reached its nominal configuration, i.e. all units are switched on and the on-board communications is properly working.

3.1.5 RF

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

The commissioning of the instruments has been mostly finalise according to the planning. However, some fine tuning of the instruments is still to be performed.

3.2.1 SPI

SPI was in normal science mode during most of the time of the reporting period. Some special tests were performed, e.g. to check the influence of the Anticoincidence System (ACS) thresholds on the background or to tune the PSAC for the sensitivity of the detectors. A quick assessment of the data recorded by the SPI, e.g. during the CYGNUS X observation, indicates a very promising performance of the instrument.

SPI needs more time to perform the tuning of the parameter settings. It is currently under discussion how this can be accommodated in the upcoming revolutions.
It is currently discussed whether a patch of the Data Processing Electronics (DPE) S/W is needed to improve the TM bandwidth usage, to solve the problem of the missing TM packet and to introduce additional flexibility in the management of the Spectra Accumulation – Compression – Transmission function.
As a short tem solution for the shortage of the TM bandwidth different minimal configurations of the instrument are tested. The output of this process should be a predefined set of configurations applicable during the PV phase as a function of the available TM allocation.

In addition some anomalies have been identified that are currently being verified, see section 6.

3.2.2 IBIS

IBIS was in nominal science mode during most of the time. The commissioning of the instrument has been mostly finished but some fine tuning is still required in the upcoming revolutions.

The performance of the instrument was good during the reporting period. This is for example confirmed by the analysis of the science data taken during the CYGNUS X observation.

Note: Some more information concerning the IBIS operations is provided in the Appendix, see section 8.3.2.

3.2.3 JEM-X

Both JEM-X instruments were in Data Taking Mode during most of the reporting period. The instruments are operated at lower voltages (80 V below). This measure which reduces the gain by a factor of 2.6. The analysis of the data have shown that no more anodes are affected.

For health reasons the instrument is switched off by time tag commands 90 minutes before an altitude of 60.000 Km is reached, which is an altitude at which the radiation becomes high.

Note: Some more information concerning the IBIS operations is provided in the Appendix, see section 8.3.3.

3.2.4 OMC

The OMC is operating nominally. The OMC imaging activities are now planned according to the planning inputs provided by ISOC.

Note: Some further information concerning operational problems is provided in the Appendix, see section 8.3.4.

3.2.5 IREM

The INTEGRAL Radiation Monitor (IREM) is working nominally. No special operations have been performed.

The previous settings of the Belt entry at 60.000 Km and of the Belt exit at 40.000 Km have been maintained. These are the critical altitudes that are used for the relevant times in the Broadcast Packet.

4 Ground Facilities

The overall performance of the ground segment was good. However, a few operations were impacted by some malfunctions within the ground segment, see section 6.

4.1 Mission Operations Centre

The overall performance of the MOC was good. Some special problems have been identified, see section 6.

The processing of the received data and the distribution to the PI workstations located at MOC and to the ISDC is functioning in general well. There were a few situation, during which the distribution has been impacted, see section 6. However, the control and monitoring of the satellite was always ensured.

The Flight Dynamics System (FDS) was working properly. Some fine tuning of the Flight Dynamics products is still required. This concerns for example the accuracy of the prediction of the occurrence (timing) of special orbital events, such as the Perigee Belt entry / exit time. The accuracy of the prediction depends mainly on the quality of the prediction of the orbit evolution that is impacted by the Reaction Wheel Bias (RWB) manoeuvres. Since the location of the RWBs around the orbit depends on the scientific planning the prediction of the effects is more difficult. Some experience is to be built up.

The operations are mainly performed using the automated Timeline. This Timeline was interrupted a few times, e.g. due to the loss of the Guide Star or the loss of the link to the ground station.

The Timelines and procedures that were prepared by the MOC were of good quality. The change requests provided by the Project Support Team concerned mainly the tuning of the instrument configuration.

4.2 Ground Stations & Network

The performance of the operational network was in general good. There was one problem with the Firewall at MOC that impacted the operations.

The performance of the Redu station was good during the reporting period.

The performance of the Goldstone station was good in revolution 11 but was bad in revolution 12. Two of the passes were impacted by frequent drops of Telemetry (TM).

4.3 Science Ground Segment

4.3.1 ISOC

No input was provided by ISOC.

The planning inputs for the revolutions have been provided and could be processed by the MOC. The planning process in general was smooth. However, some fine tuning of the planning products is still required. It is expected that the planning system will be in a satisfying state when the Routine Mission Phase will start.

One problem is that ISOC introduces fictitious slews (slews to the same target), at the beginning of the start of new exposures (for example after station hand-overs). Since these slews are not needed as the satellite is already pointing on the target and result in empty slews it should be avoided to modify the AOCS configuration if this is not really required because this introduces additional risks of failing the Timeline. It was agreed with ISOC to take this into account for the generation of the planning inputs.

4.3.2 ISDC

ISDC Input:

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Here is a short report on the ISDC activities one month after launch.
The week highlight has been the first PV observation and the
simultaneous detection of Cygnus X-1 by all INTEGRAL instruments.

• Data processing

The first PV observation was performed during revolution 11.
Operations were very similar to nominal operations with 49 dither
pointings planned on Cygnus X-1 and all instruments on.

During revolution 11 several new aspects of the system have been used
because operations were run according to scientific mission planning
and because most routine auxiliary data have been received.

However for ground reason this revolution was not smooth. We
experienced a long interruption of TM (5% of TM was lost),
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interruption and recovery of the timeline and a long delay in the delivery of auxiliary data.

Despite this, the TM was processed in real time smoothly and processed data were made available within 2 hours of real time to scientific analysis. Revolution 11 generated 5 GB of data.

144 out of the 148 science windows of revolution 11 were processed successfully. The processing failed on 4 science windows because of strange timing in some IBIS packets (under investigation) and because of a problem in the decoding of IBIS spectral timing data (that is being fixed).

OMC planning information (generated by ISOC) were wrongly attached to the science windows because of peculiar pointing ID used (side effect of some commissioning activities). A more robust algorithm is now being implemented.

Since revolution 10, the new ISGRI low threshold context are generated at ISDC and sent to MOC for uploading at the beginning of every revolution.

- Scientific analysis

Cygnus X-1 has been detected by SPI, ISGRI, both JEM-X and the OMC. The last two days (and nights) were very exciting here (and at other places).

The SPI analysis was performed on the complete dataset (72 ksec) and provided a 50 sigma detection. The source was detected from 20 to 100keV and displays a powerlaw spectrum.

ISGRI detected Cygnus X-1 at 23 sigma in a single pointing of 1800sec. The source was detected from 15 to 100 keV. Effort are on going to perform data analysis adding the data from many pointings together.

Both JEM-X detected Cygnus X-1 very clearly in each pointing. Spectra were not produced as the JEM-X analysis software still need to be modified to take the new reduced high voltage into account.

PICSIT did not yet detected Cyg X-1. The data are good but Cyg X-1 is not so bright above 100 keV and the software needs to be improved.

The INTEGRAL burst alert system (specially tuned for the occasion) was the first to detect Cygnus X-1, using ISGRI data.

Two Gamma-Ray Bursts detected with the SPI ACS have been used to verify that the absolute timing of the mission is correct within 100msec by triangulation methods.

- Operations

We have not yet received consolidated TM from MOC. Consolidated processing has therefore not yet started.

The alerts of IBIS and SPI are being tuned, the number of spurious alerts has started to decrease.

End of revolution reports and anomaly reports are being written and followed up. The operational software is updated every two revolutions on average to correct for the problem found in the processing.

Since last week several new instrument anomaly reports have been written following-up the analysis of the data.

In addition to Operation Status Monitoring Meetings held per revolution we had a first PV coordination video conference with MOC and ISOC and we will have our first scientific analysis meeting this week to assess (and improve) the scientific products.

This week we made a big step forward, and the focus is now clearly moving towards generating reliable science products and alerts.

5 Special Events

The satellite has passed the Leonides shower without any damage. The satellite has been oriented in such a way that the bottom part of the satellite was pointing towards the incoming Leonides and that the solar arrays were not exposed. The instruments have been put into a safe configuration, i.e. the high voltages were switched off.

The next Eclipse season will start on 30 December.

6 Anomalies

A list of the anomalies that were identified so far and are still pending is presented in the Appendix. The main anomalies that had an influence on the operations are summarised in following.

There were a couple of problems at the MOC that impact mainly the processing and archiving of the data.

- The consolidation of the TM archive is currently causing some problems because the retrieval of data from a station in parallel to the real-time processing of incoming TM data is causing data gaps related to the real-time data. Hence the retrieval of data has to be moved to the Perigee Passages. This cannot always be accommodated because the Perigee Passages are also used to accommodate the maintenance activities of the Mission Control System and the Operational Database to avoid impacting the science activities. The other complication is that the storage capacity of data at the Redu ground station is limited to about 5 days, i.e. if one Perigee Passage is missed for retrieval the data might be lost. The process for improving the situation has been started. For the time being a workaround has been implemented.

- The CD ROM production has been delayed significantly. There were a couple of problems to produce the CD ROMs with all required data. When the first set of CD ROMs were produced we noted that not all data were included and the generation had to be restarted. The production of CD ROMs is now ongoing and the complete set of CD ROMs should be available soon.

- The timing of operations within the INTEGRAL mission is rather complicated. The operations of the satellite are driven on one side by the Broadcast Packet that provides the timing of orbit events, such as the Perigee Belt entry and exit, to the instruments and on the other side by the automated ground Timeline. Since we were requested to implement a

system that does not lose seconds we do not have a lot of margin in the operational schedule. The problem is that the various products are produced at different times. While the automated Timeline is based on the planning inputs that can be a few weeks old the inputs in the Broadcast Packet is based on the latest orbit information. This can cause mismatches. Some tuning of the various products is required and appropriate margins are to be introduced.

- The Firewall of ESOC had to be rebooted on 17.11. This caused an interruption of the data flow to ISDC. Since we have implemented a data flow control mechanism to ensure proper data flow to the ISDC and the PI workstations this had also an impact on the real-time TM flow. The real-time TM to the Mission Control System was interrupted shortly and the automated Timeline had to be stopped because commands cannot be verified. Though the actual interruption of the TM was short the recovery of the Timeline took longer because Engineering Support had to be called (Sunday morning). The recovery was done rather quick but nevertheless three pointings of the hexagon pattern were lost.

While the station performance was OK during revolution 11 two of the Goldstone passes in revolution 12 were impacted by frequent TM drops. The first pass was impacted by a failure of an equipment that already impacted previous passes and the second pass was impacted by a failure in the gateway at JPL.

The AOCS and Thermal Control subsystems have shown some unexpected behaviour, see section 3.1. The main problem related to the platform that impacts the operations is the loss of the Guide Stars. Since the operational orbit has been reached the Guide Star has been lost three times, twice due to SEUs during the Perigee Passage. Even though the environmental conditions are not favourable during the Perigee Passages the AOCS should be able to maintain the Guide Star. The implication of the behaviour is that the Timeline has to be stopped.

There were a few problems concerning the instruments in the reporting period. The main problems that impacted the operations concerned SPI.

The SPI instrument has suffered the crash of the Instrument Application S/W (IASW) that is sitting in the Data Processing Electronics (DPE) unit. This malfunction is under investigation by the SPI Team.
Another area of concern within SPI is the generation of multiple On Event Messages when generating the Spectra in certain circumstances (DPE CPU not sufficient).

7 Future Milestones

The PV phase of all instruments was supposed to start with revolution 14 on 24 November.

However, the SPI and IBIS PI’s have stated that they require more flexibility than offered by the automatic Timeline. It was agreed to keep the current set-up for the revolutions 14 and 15.

8 Appendix

The appendix includes various detailed information.

8.1 Consumables

8.1.1 Detailed Fuel Book-keeping

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The last 10 entries in the history file for INTEGRAL

2002-11-09T14:09:26Z     185.3562      F     Automatic TM processing.
2002-11-10T19:52:48Z     185.3493      F     Automatic TM processing.
2002-11-12T08:51:00Z     185.3270      F     Automatic TM processing.
2002-11-13T19:40:48Z     185.3170      F     Automatic TM processing.
2002-11-15T08:43:39Z     185.2920      F     After 0011_0009_M.RWB
2002-11-16T19:31:43Z     185.2760      F     Automatic TM processing.
2002-11-18T08:33:06Z     185.2650      F     Automatic TM processing.
2002-11-18T15:32:35Z     185.2576      F     Automatic TM processing.
2002-11-19T18:45:27Z     185.2563      F     Automatic TM processing.
2002-11-19T22:45:59Z     185.2435      F     Automatic TM processing.

This report was generated at  Wed Nov 20 08:00:07 GMT 2002


Note: fuel-book initial value included 4.24kg pressurant
      which will not be exhausted  -  thus when the fuel
      book reaches a value of 4.24kg this represents the
      ZERO PROPELLANT value
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8.1.2 IMU Utilisation

The following table shows the in-orbit utilisation of the IMUs until 21 November.

IMU	SWITCH-ON TIME (HH:MM:SS)
1	156:08:51
2	3:52:16
3	70:03:27
4	80:50:03

8.2 Overview of Commissioning Timeline (Rev 11 & 12)

On top of the nominal routine S/C, instrument and ground stations operations, the following commissioning specific activities have been performed:

Rev.11 (2002-11-15 07:13:35 to 2002-11-18 07:00:00)

- **Planned activities**

Commissioning of ISGRI Calibration commanding using ISDC TPF input
Slew to attitude suitable for OMC Flat Field and Dark Current Calibrations
SPI Influence of ACS thresholds on the background
OMC Dark Current Calibrations (several instances)
OMC Flat Field Calibrations (several instances)
SPI Influence of the extension of the saturated events on the background
Slew to Cygnus-X1 and repetitive hex dithering patterns execution (more than 1 day)
SPI Influence of the ACS + PSAC parameters on the sensitivity - ACS best configurations
OMC imaging at each pointing of the hex dithering
Slew to Perigee Passage attitude

- **Additional activities:**
  - Additional IBIS optimisation activity in parallel to OMC calibrations (CR PI-OPS-0163)
  - SPI DPE Power Cycle (Reset) to investigate AR INT-002082 “Missing TM packets” (CR PI-OPS-0164) ➔ power cycle successful but problem still present
  - SPI DPE crashed during the hex dithering execution. SPI instrument was restarted (see AR INT-TBD)
  - IBIS special setting for Cygnus-X1 hex dithering (CR PI-OPS-0170)

Rev.12 (2002-11-19 08:08:04 to 2002-11-21 07:30:00) {Leonids passage revolution}

- **Planned activities**

Slew back to Cygnus-X1 attitude
Staring observation for IBIS and JEMXs at Cygnus-X1 (for ISOC PV purposes)
OMC Imaging at Cygnus –X1
Slew to Leonids avoidance attitude
Instrument safe configuration for Leonids (all detector HVs turned off)
Leonids meteors passage
Resume of instrument nominal configuration Instrument check-out post-Leonids
Slew to Empty Field 1
OMC Imaging at Empty Field 1
SPI Influence of the ACS + PSAC parameters on the sensitivity – PSAC effect on the sensitivity
Slew to Perigee Passage attitude

- **Additional activities:**
  - Execution of several test cases for SPI TM bandwidth optimisation (CR PI-OPS-0158) cases B1, B2, C, D, E, F, G

- Further optimisation test for the SPI veto gate size and delay (CR PI-OPS-0159)
- Adjustment of IBIS VME amplifier gain and HVs on VETO VDMs (CR PI-OPS-0178).

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 15/11/2002-21/11/1002

15/11/2002 (Day of Year 319, Revolution 10-11)

Nominal AOCS operations executed from the Automatic Timeline.

RMU Drift TPF not produced

The last RMU calibration of the revolution was started from the Automatic Timeline, but a TPF was not produced by the Flight Dynamics System. The reason was a configuration problem in the transition from manual calibrations to fully automatic calibrations (the script tried to open a display in a machine that was actually not logged in at this time in the night).
The result of the calibration was uplinked the next morning.
RMU calibrations are to be processed manually by FD until the problem is fixed.

Last Change of Guide Star for revolution not executed

At the end of each revolution there is a CGS (Change of Guide Star) planned in the Automatic Timeline. The purpose is to select a guide that is suitable for the Reaction Wheel Bias at the beginning of the next revolution. The uplink of this CGS is part of the LOS_CHECK window. It revolution 10 the LOS for TC was a few minutes before what was assumed at timeline preparation, and as a consequence the CGS was not uplinked. The Spacon contacted the on call engineer, and it was decided not to take any action at the beginning of the next revolution, since the current guide star was also satisfying all the RWB constraints.

16/11/2002 (Day of Year 320, Revolution 11)

Nominal AOCS operations executed from the Automatic Timeline.

First Dither started

In this day the first dithering pointing hexagonal pattern was started from the Automatic Timeline. No problem was observed with the timing of the relevant AOCS command sequences.

Timeline Offset Slew uplink failed

The automatic uplink from the timeline for slew id 00110007 failed. The reason was a TM drop (at 22:21) that caused the loss of the Report Packet of the change of guide star pending parameters. Due to this, the Report Pending command failed Command Execution Verification, which blocked subsequent AOCS commanding from the Automatic Timeline.
At the time of the problem FD and Engineer support were on site, and the automatic schedule was rejoined by re-generating and uplinking manually the missed offset. The next slew (00110008) was nominally performed from the Automatic Timeline.

17/11/2002 (Day of Year 321, Revolution 11)

Nominal AOCS operations executed from the Automatic Timeline.

On Target Flag set to False

At 08:42:53 the ACC issued the On Event Message:

ACC PITCH ERROR OOL

This message is issued when the threshold for the OTF in pitch is exceeded. The reason for the problem was an instantaneous change in the guide star detected position, for one cycle, which seems a case of undetected False Event in the STR CCD:

Time	Mag	CCDY	CCDZ
08.42.52.575	8.50	2429	-5037
08.42.53.075	8.40	2543	-4990
08.42.53.575	8.50	2418	-5031

The change of magnitude of 0.1 is below the False Event threshold in the STR (relative change in energy bigger than 0.22 with respect to the previous cycle), but the change in the STR Y coordinate was of 114 CCD units, or 27.9''. This is above the OTF threshold for pitch (18'').
The ACC Pointing Bit (OTF), was set to FALSE for 0.5 seconds, but this was not seen by the sampling used in the Broadcast Packet and consequently was not transmitted to the Payload. The height in the orbit at the moment of the event was 138000 Km.

This happened at pointing 00110024, which was acquired via an Open Loop Slew, this is why the magnitude of the star (picked up automatically on board) was so dim.

Timeline interrupted

TM was lost at 08:16. This caused the Automatic Timeline to stop, at pointing 00110024. Pointings 25, 26 and 27 could not be acquired from the automatic timeline. On call support from FD and FCT was triggered by the Spacon (it was a Sunday), and the recover schedule activities started at 08:59, to acquire manually the attitude for pointing 00110027. The Sun Steering Law was not enabled for this manually acquired pointing (OTF not set). The first pointing that was performed again nominally from the timeline was 00110028 (Pointing Request time 10:01).

Slew parameters not updated

The parameters for the slew ID 00110034 were not updated in real time. The relevant TPF (Task Parameter File) was not generated by the Flight Dynamics System. The reason was a misidentification of one of the stars present in the mapping. Due to this misidentification the star exceeded the maximum error criteria that the FDS applies to consider the attitude determination as valid. Since there was no error in the attitude, this problem did not affect the Timeline execution. The next slew was updated correctly.

On Target Flag set to False (and reflected in Broadcast Packet)

Pointing 00110045 had the same attitude as pointing 00110024 mentioned above, and the same guide star was selected. During this pointing the following OEM was generated:

20:01:11 ACC PITCH ERROR OOL

For the meaning of this message, see above. Once again this was presumably an undetected False Event. The star data were:

Time	Mag	CCDY	CCDZ
20.01.11.213	8.45	2539	-5153
20.01.11.713	8.30	2444	-5136
20.01.12.213	8.45	2542	-5153

In this case, the change in the STR Y coordinate was of 98 CCD units, or 24''. This is above the OTF threshold for pitch (18'').
The ACC Pointing Bit (OTF), was set to FALSE for 0.5 seconds. In this case this was reflected in the Broadcast Packet, and consequently transmitted to the payload, for one BP cycle. This is purely depending on the ACC cycle the problem occurs with respect to the BP acquisition. The ACC generates one sample every 0.5 s, but only one every 8 s is picked up by the CDMU to put it into the BP.
The height in the orbit at the moment of the event was 96000 Km.

On Target Flag set to False (and reflected in Broadcast Packet)

Again in the same pointing, the following OEM was generated:

20:08:23 ACC YAW ERROR EXCEEDED

Once again this was presumably an undetected False Event. The star data were:

Time	Mag	CCDY	CCDZ
20.08.23.225	8.45	2539	-5152
20.08.23.725	8.45	2583	-5283
20.08.24.225	8.40	2542	-5152

In this case, the change in the STR Z coordinate was of 131 CCD units, or 32.1''. This is above the OTF threshold for yaw (18'').
The ACC Pointing Bit (OTF) was set to FALSE for 0.5 seconds. In this case this was reflected in the Broadcast Packet, and consequently transmitted to the payload, for one BP cycle.
The height in the orbit at the moment of the event was 95500 Km.

18/11/2002 (Day of Year 322, Revolution 11-12)

Nominal AOCS operations executed from the Automatic Timeline.

On Target Flag set to False (out of coverage)

At revolution 12, at AOS after perigee passage, the following OEM was in the ACC OEM buffer:

05:29:23 ACC YAW ERROR OOL

Since there was no TM at the occurrence of the event, no additional information is available.

On Target Flag set to False (twice)

After AOS, the ACC generated the message:

08.11.16 ACC YAW ERROR OOL

For an explanation of this OEM, see the same event reported for day 17/11/2002

The star data at the time were:

Time	Mag	CCDY	CCDZ
08.11.17.057	7.60	16500	-6741

08.11.17.557 7.50 16453-6639
08.11.18.057 7.55 16504-6742

In this case, the change in the STR Z coordinate was of 102 CCD units, or 25''. This is above the OTF threshold for yaw (18'').
The ACC Pointing Bit (OTF) was set to FALSE for 0.5 seconds. It was not reflected in the Broadcast Packet.
The height in the orbit at the moment of the event was ≈16000 Km.

The same thing happened a few minutes after:

08:14:32 ACC YAW ERROR OOL

For an explanation of this OEM, see the same event reported for day 17/11/2002

The star data at the time were:

Time Mag CCDYCCDZ
08.14.31.940 7.55 16502-6739
08.14.32.440 7.50 16481-6628
08.14.32.940 7.55 16501-6741

In this case, the change in the STR Z coordinate was of 111 CCD units, or 27.2''. This is above the OTF threshold for yaw (18'').
The ACC Pointing Bit (OTF) was set to FALSE for 0.5 seconds. It was not reflected in the Broadcast Packet.
The height in the orbit at the moment of the event was ≈16000 Km.

OTF Flickering at the end of a slew

After the completion of the open loop slew to pointing ID 00120001, the ACC issued the message:

10:27:47 ACC ROLL ERROR OOL

This means that the OTF threshold was exceeded for roll. In fact the OTF was set at the end of this slew, but lost again. The sequence of events was:

10.27.05 Slew End
10.27.30 Sun Steering Law enabled by ground command.
10.27.37.164 ACC OTF set to True.
10.27.40 Broadcast Packet OTF set to True (reached).
10.27.47.644 ACC OTF set to False.
10.27.48 Broadcast Packet OTF still reads True (due to the sampling).
10.27.56 Broadcast Packet OTF set to False.
….
10.28.15.665 ACC OTF set to True again.
10.28.20 Broadcast Packet OTF set to True again.

The reason for the OTF flickering was a difference of 4.78 arcminutes between the FSS setpoint at the end of the slew, and the one commanded by the SSL. It is expected by simulations that a difference greater of 3 arcminutes will trigger this type of behaviour. The reason for this difference can be traced back to the beginning of the slew. The slew parameters were updated based on an attitude reconstruction performed after a Reaction Wheel Bias, at 08:14. The Flight Dynamics Software assumes that the attitude is going to be maintained inertially fixed between the time of the update and the start of the slew. This was not true in this particular case, since the SSL was not re-enabled after the RWB. Due to the apparent motion of the sun, the S/C rotated by 4.63 arcminutes between the time of the

update and the start of the slew (10:23). This error was just propagated to the final attitude after the slew.
A solution to avoid this type of problem in the future needs to be discussed at Mission Planning level and implemented. Note that in general, a corrective offset should be implemented after a RWB if the pointing is going to be maintained. This corrective slew includes the re-enable of the SSL.

Safe Attitude for the Leonid shower acquired

The slew to the Leonid 'avoidance' attitude was started from the timeline at 15:55. This was an attitude facing the rear part of the satellite towards the Leonid incoming direction. No effect of the Leonid shower was observed on the AOCS.

19/11/2002 (Day of Year 323, Revolution 12)

Nominal AOCS operations executed from the Automatic Timeline. For most of the day, the AOCS was just pointing to the Leonid 'avoidance' attitude.

Uplink of Slew failed

The uplink of the slew 00120007 failed to complete, due to a crash of the Releaser task in the control system at 23:07. This was the open loop slew away from the Leonid attitude. On call FD and FCT Engineer support was triggered, and the recover schedule actions were started at 20/11/2002 00:00. The process was slowed down by several problems with the ground station (Goldstone). Finally the slew was manually started at 00:35. The corrective offset was performed at 01:44, and at 02:00 the Automatic Timeline was rejoined.

20/11/2002 (Day of Year 324, Revolution 12)

Nominal AOCS operations executed from the Automatic Timeline. See problem at the end of previous day.

21/11/2002 (Day of Year 325, Revolution 12-13)

Nominal AOCS operations executed from the Automatic Timeline.

Uplink of Offset Slew failed

The offset slew 00120010 failed the uplink at 02:26, due to continuous TM drops from the ground station (Goldstone). This was the last slew of the revolution 12. The on call FCT Engineer was contacted. A closer look to this offset shown that this was a 'fictitious' slew to the same attitude where the S/C already was. Since the failed offset was supposed to change the guide star, and the last AOCS operation of the revolution was a change of guide star selecting back the same star as was currently selected, the Spacon was instructed to just disable the AOCS subsystem from the Automatic timeline for the rest of the revolution.
It should be noted that, from the AOCS point of view, the introduction of this type of fictitious slews by the ISOC Mission Planning system is not a good practice.

Guide star released (SEU Filter Trigger)

Shortly after AOS in revolution 13, the ACC issued the OEM:

08:38:09 ACC STR THR EX

Which means that the SEU Filter was triggered. The message was followed by the other normal messages in these cases (IMU ON, start of STR mapping, DCA and RGA change). The SEU filter is in place to prevent the usage of STR data in the control law in the presence of an excessive rate of SEU's in the CCD (the STR freezes the reported star coordinates to the last value when a False Event is detected). The current values used are:

Every time the STR reports a False Event, counter is increased by 1.
Every ACC cycle (0.5 s) that the STR does not report False Event, counter is decreased by 1.
If the accumulated counter reaches 7, the SEU Filter triggers.

In this case it can be seen in the TM that the STR reported False Event for 8 cycles in a row, from 08:38:05.699 to 08:38:09.199, before the star was released by the ACC commanded mapping.

The magnitude of the released star was 6.75, the coordinates in the CCD (-12774, 2301), and the altitude in the orbit was 23200 Km. While this altitude is still in the radiation belt area, a retrieval shown that from 08:00 until the time of the problem, only 1 False Event had been detected. After the problem, the new star acquired was a magnitude 7.5, and no False Event was detected at least until 10:00. Taking this into account, it does not seem likely that 8 independent SEU's occurred in a row, and it looks more likely that a single event somehow created an effect that lasted (either in the CCD or in the software) for at least 3.5 seconds. When the star was seen again, during the subsequent mapping, it was 08:38:28, and both the magnitude and the coordinates were nominal (6.75 (-12767, 2302)).

8.3.2 IBIS Operations

The IBIS parameter optimisation has been fairly completed but some fine tuning for example of the HV setting for the VDM's is still required.

The ISGRI LTA calibration has been executed in an automatic manner using the ISDC provided inputs in form of Task Parameter Files (TPF) based on the data recorded in revolution 10.

From revolution 14 onwards the optimisation of the NP algorithm will be applied.

The configuration of IBIS for the Perigee Passages has been modified according to the change request from the instrument team. The PDM's will be switched off for the Radiation Belt Passage.

The first X-ray source (CYG-X1) was observed by ISGRI in the energy range 14 – 40 KEV to 40 – 140 KEV. The first processing of the image was performed by the IBIS team at MOC. No image has been taken with the PICSIT detectors due to the long integration time requested and the low sensitivity of the specific source.

8.3.3 JEM-X Operations

The JEM-X operations were impacted by a mismatch in the timing of activities in revolution 13. Due to the very short window between the BCP radiation belt exit time and the instrument activation window, the HV switch ON EDs for both units failed. The HV switch ON and the HV nominal setting were performed by manual commanding and the instrument was set to DATA taking mode with the same configuration as required by the automatic timeline.

The MOC has received several change requests from the JEM-X PI that are currently being processed. It is foreseen to implement the changes for the revolution 14.

- The JEMX1&2 DFEE image files as well as the respective (JEMX specific) software update TCs, corresponding to JEMX1 and JEMX2 DFEE software version 4.2.0 were received at MOC. The new TC parameters are imported in the database.
- The new JEMX1&2 DPE image files corresponding to DPE software version 0.0.2 were received at MOC.
- The new on-board pulseheight conversion tables for both JEMX units were received at MOC and imported into the database.
- It is planned to uplink the DFEE and DPE S/W updates as well as the new pulseheight conversion tables in revolution 14 and before the Cygnus observation window.

8.3.4 OMC Operations

There were a few problems that impacted the OMC operations:

- At 323:23:07:41 due to loss of commanding capability, slew 00120007 was not performed by the automatic timeline. After performing the timeline recovery procedure, the timeline was rejoined at 234:02:00. This caused the OMC imaging parameter TCs not to be uplinked and OMC remained in STANDBY mode. At 324:07:32:00 the missed imaging parameter TCs from the timeline were uplinked and OMC started science operations.
- In revolution 13 because of the very short window between the BCP radiation belt exit time and the instrument activation window, the MEBEXT01 ED, containing the TC to reset the ROE before start of observation failed. By the time recovery action was started, OMC was already in NORMAL Science mode, so the RESET ROE TC was not sent manually. This has no operational implications if the S/C is not coming out of eclipse.

8.4 List of Anomalies since Launch

The following table presents the list of all identified anomalies that have been registered since Launch and that are still pending (Status: 22.11.02). Though these Anomaly Reports still have a pending status most of the problems have been analysed and solutions or at least workarounds are already in place. The ARs have just not yet been formally closed.

ARid	Date Occurrence	Subject	Segment	Element	Status
INT - 002003	19/10/2002	Command failure from TCE2 at Redu1.	Ground	ESA Sta.	Pending
INT - 002007	22/10/2002	Command sequence TENPE_00 is incorrect.	Space	Procedures	Pending
INT - 002010	22/10/2002	Time correlation not applied correctly to time parameters in TM type 8 reports.	Ground	IMCS	Pending
INT - 002018	22/10/2002	Loss of TM and TC with Goldstone.	Ground	NASA Sta.	Pending
INT - 002021	22/10/2002	JEM-X: Unexpected OEM during HV ramp up.	Space	JEM-X	Pending
INT - 002017	23/10/2002	INCTRB crashed.	Ground	NCTRS	Pending
INT - 002013	24/10/2002	VETO LSL error.	Space	IBIS	Pending
INT - 002015	24/10/2002	HSL error (loss of SYNCH).	Space	JEM-X	Pending
INT - 002023	27/10/2002	SPI: ACS status error.	Space	SPI	Pending
INT - 002025	28/10/2002	Telemetry and Telecommand outagesd due to Antenna Mispointing	Ground	NASA Sta.	Pending
INT - 002026	28/10/2002	Sun144 forced logout whilst SPACON was commanding!	Ground	IMCS	Pending
INT - 002036	03/11/2002	TM Desktop running very slow	Ground	IMCS	Pending
INT - 002037	03/11/2002	Telemetry loss from REDU	Ground	ESA Sta.	Pending
INT - 002042	06/11/2002	Timeline stopped due to PTV Failure	Ground	IMCS	Pending
INT - 002058	06/11/2002	Telemetry Play Back Failed	Ground	NASA Sta.	Pending

INT - 002046	07/11/2002	Propellant Heater System Behaviour.	Space	Spacecraft	Pending
INT - 002047	07/11/2002	VPD Task Problem when Displaying OEMs.	Ground	IMCS	Pending
INT - 002049	07/11/2002	Beginning of a gradual erosion of the anodes on the microstrip plates	Space	JEM-X	Pending
INT - 002059	07/11/2002	Problems with handover to GoldStone	Ground	NASA Sta.	Pending
INT - 002048	08/11/2002	TM Data Retrieval Jobs not executed	Ground	IMCS	Pending
INT - 002051	09/11/2002	Loss of Guide Star	Space	Spacecraft	Pending
INT - 002054	09/11/2002	OEM on SPI Spectra Building.	Space	SPI	Pending
INT - 002055	09/11/2002	IBIS VETO anomalous count rates.	Space	IBIS	Pending
INT - 002053	12/11/2002	AD verification failed twice with Vilspa	Ground	ESA Sta.	Pending
INT - 002060	12/11/2002	The BCPKT Belts Exit Time in the EPOS for revolution 10 was incorrect.	Ground	FDS	Pending
INT - 002061	12/11/2002	TM Desktop perfomance collapses when de-selecting supercommutated procesing.	Ground	IMCS	Pending
INT - 002062	13/11/2002	Static PTV wrongly handled by IMCS when commands are copied	Ground	IMCS	Pending
INT - 002064	13/11/2002	Failed to handover to VIL-2	Ground	ESA Sta.	Pending
INT - 002066	13/11/2002	Data routing to ISDS	Ground	I/F to SGS	Pending
INT - 002070	14/11/2002	TDRS: data Rerievals cancelled	Ground	IMCS	Pending
INT - 002071	14/11/2002	Generation of OEM ID 5 and 6 by JEMX-1 in Diagnostic Dump Mode	Space	JEM-X	Pending
INT - 002072	15/11/2002	Times in EPOS not in line with Scheduling	Ground	FDS	Pending
INT - 002073	15/11/2002	Commanding too close to LOS	Ground	FDS	Pending
INT - 002074	15/11/2002	RMU calibration failed	Ground	FDS	Pending
INT - 002075	15/11/2002	Provision of TPF failed	Ground	FDS	Pending
INT - 002076	15/11/2002	TM share below the Belt	Science	ISOC	Pending

INT - 002077	15/11/2002	SPI Spectra at Belt Exit	Space	SPI	Pending
INT - 002078	14/11/2002	Antenna Tracking Problems	Ground	ESA Sta.	Pending
INT - 002079	14/11/2002	Timing Problem with Telecommands	Ground	ESA Sta.	Pending
INT - 002081	15/11/2002	Temporary desktops lost after database propagation.	Ground	IMCS	Pending
INT - 002082	13/11/2002	TM packet production lower than allocation.	Space	SPI	Pending
INT - 002083	16/11/2002	SPI DPE Crash	Space	SPI	Pending
INT - 002084	17/11/2002	NCTRS Failure	Ground	NCTRS	Pending
INT - 002085	17/11/2002	Commands not verified due to lost packets	Ground	IMCS	Pending
INT - 002086	17/11/2002	Link to ISDC interrupted	Ground	I/F to SGS	Pending
INT - 002087	17/11/2002	Loss of Telemetry	Ground	IMCS	Pending
INT - 002089	17/11/2002	Firewall Restart	Ground	COMMS	Pending
INT - 002091	18/11/2002	A-Chain Frozen	Ground	IMCS	Pending
INT - 002092	19/11/2002	Load-Dump comparison uses also non-released load commands	Ground	IMCS	Pending
INT - 002093	19/11/2002	Incorrect MOUT in POS/EPOS/TSF	Ground	ISOC	Pending
INT - 002094	19/11/2002	TDRS does not work with supercommutated parameters	Ground	IMCS	Pending
INT - 002095	19/11/2002	TDRS incomplete retrievals.	Ground	IMCS	Pending
INT - 002096	19/11/2002	Retrieval from the stations	Ground	IMCS	Pending
INT - 002097	19/11/2002	Unexpected dithering process when SPI spectra accumulation = 0	Space	SPI	Pending
INT - 002098	19/11/2002	FEE 3 has 2 occurences of 3 status parameters OOL	Space	SPI	Pending
INT - 002099	20/11/2002	SPI1 periodic task overun	Space	SPI	Pending
INT - 002101	19/11/2002	ISDS-ISDC Link	Ground	I/F to SGS	Pending
INT - 002103	19/11/2002	Command releaser failed	Ground	IMCS	Pending

INT - 002106	20/11/2002	Redu Ranging Problems	Ground	ESA Sta.	Pending
INT - 002107	21/11/2002	TDRS produces gaps in the retrieval, that don't correspond to gaps in the archive	Ground	IMCS	Pending
INT - 002108	22/11/2002	Introduction of unnecessary Slews	Ground	ISOC	Pending