

INTEGRAL
Mission Report
INT-MOC-SYS-RP-1001-TOS-OF
No. 011
Week 49
06.12.02
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)
- ☐ ISOC.

This report addresses the activities from 30.11.02 until 06.12.02 (both dates inclusive). It covers the revolutions 15, 16 and 17.

2 Summary of Activities

The operations were mostly performed according to the planning inputs provided by ISOC. Several change requests have been implemented to modify the configurations of the instruments and the timing of activities to fulfil the requirements of the instrument teams. The tuning of the instrument parameters have been mostly finalised in this period.

The target of the revolutions was Cygnus-X1. The revolution 16 consisted basically of an on-staring observation for the entire revolution. The revolution 17 started with an on-axis staring observation, followed by a series of off-axis pointings and finished with an on-axis staring.

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. Only one malfunction concerning the AOCS has been identified in the reporting period. In addition the losses of the Guide Star have not been observed during this week. The reason might be that more favourable Guide Stars were available for the operations. The toggling of the OTF was only seen once.

3.1.1 AOCS

The overall performance of the AOCS subsystem is good. There were not a lot of AOCS operations since the observations consisted mainly of staring activities. The operations were performed according to the automated Timeline without any interruptions.

The toggling of the OTF that was observed on 03 December might have been due to a problem in the ACC, see sections 6 and 8.3.1. This event requires some further analysis.

The fuel consumption over the last 12 days was 0.15 Kg. The remaining propellant is in the order of 180.8 Kg on 03 December.

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 is in the order of 2380 W as since the beginning of the mission, i.e. no degradation has been identified so far.

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 satellite has reached its nominal configuration, i.e. all units are switched on. The OBDH subsystem is working flawlessly.

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 functions and performances of the various instruments are currently being assessed. The instruments work mostly as expected. A few new anomalies / problematic areas have been identified, see chapter 6.

3.2.1 SPI

SPI is working as expected. Operations have been mostly conducted from the Automatic Timeline as derived from the planning inputs. A few corrections have been introduced in a few occasions mainly to allow correct handling of SPI Spectra acquisition / compression / transmission. The following additional manual activities have been implemented to cope with the automatic timeline and TM bandwidth restrictions:

- PI-OPS-194 Set SPI configuration for 59 TM pkt/cycle for rev.16
- PI-OPS-199 Set SPI configuration for reduced TM bandwidth/Short pointing durations in rev.17
- PI-OPS-203 Set SPI configuration for 59 TM pkt/cycle for rev.18

Special attention is given to the SPI cryocoolers and the whole active cooling assembly as it still shows positive temperature drift in spite of a further stroke increase. A special test is under discussion to try to understand the phenomena.

3.2.2 IBIS

IBIS was operated mostly in normal science mode according to the planning inputs provided by ISOC. A few manual commands have been introduced mainly to cope with the anomalies that were noted.

The ISGRI context table that was uploaded in the revolution 16 and 17 seems to have cured the problem of the high count rate affecting the ISGRI MDUs.

The configuration of the instrument for the belt passages that was requested by the IBIS PI has been implemented. The PDMs 3 and 5 remain on to verify the thermal evolution during the Perigee Passage and the effects on the instrument reactivation.

A few anomalies have been noted concerning the VETO VDMs, see section 6.

3.2.3 JEM-X

The JEM-X instrument team was still activated by manual commands because the required corrections in the database concerning the settings of the Low Level Discriminator were not yet implemented. This has been changed now for revolution 18. The JEM-X PI is still assessing the performance of the instrument considering the reduced gain.

It is currently foreseen to keep both JEM-X's on during the Commissioning Phase to verify their performance but only one unit (JEM-X1) will be operationally used. The other unit (JEM-X) will remain on but without high voltage in order to maintain the proper temperature environment.

Note: Some more information concerning the JEM-X operations is provided in the Appendix.

3.2.4 OMC

The OMC is working nominally. The OMC imaging activities are operated from the automatic Timeline.

3.2.5 IREM

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

4 Ground Facilities

The overall performance of the ground segment was good. However, the operations were sometimes impacted by problems that were already previously identified.

4.1 Mission Operations Centre

The overall performance of the MOC was good and the configuration was stable.

The processing of the received data and the distribution to the PI workstations located at MOC and to the ISDC is working in general well. The main problem areas are still the consolidation of the TM archive and the generation of the CD ROMs needed by the ISDC for the science processing.

The problem concerning the failing of JEM-X related commands that was reported previously seems to be fixed by a change within the Operational Database. A further improvement will be provided by the IMCS S/W release that is planned for the upcoming week-end.

The Timelines and procedures that were prepared by the MOC were of good quality.

4.2 Ground Stations & Network

The performance of the operational network was in general good. However, one pass over Goldstone was again significantly impacted by frequent interruptions of the TM and TC links. Despite several attempts by the operators at JPL / Goldstone to reboot the system the problem persisted and impacted most of the pass. The passes afterwards were rather smooth showing only small interruptions of a few minutes.

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

4.3 Science Ground Segment

4.3.1 ISOC

The planning inputs for the revolutions have been provided and could be processed by the MOC. However, they had still to be manually assessed at MOC and some modifications were required, which concern mainly the timing of activities to achieve the required scientific results.

ISOC input:

During this week ISOC had a hectic replanning session for revolution 17. The main purpose of this activity was to ensure that SPI would to a maximum extent get histogram accumulation. The activity was completed in time to allow the new time line to be used. An effort was also performed this week together with MOC and the SPI team to see how to make the SPI histogram generation more robust. No final solution yet in place. However the problem is expected to be less critical in the upcoming revolutions and certainly for routine phase. The ISOC system, 7.8 has been used all the time. No problem has been encountered.

4.3.2 ISDC

No ISDC Input has been provided

5 Special Events

None

6 Anomalies

A list of the pending is presented in the Appendix. The main anomalies that had an influence on the operations are summarised in following.

There were again a few problems at the MOC that impacted the operations. These are problems that were already noted before and need to be solved soon because they would impact the execution of the routine operations.

- The consolidation of the TM archive is still causing some problems. Some operational workarounds have been implemented to improve the situation. An upgrade of the overall system is in preparation. The main problem is that currently not all small data gaps can be identified with the existing tools so that a 100 % consolidation of the archive applying retrieval from the ground stations is not possible.
- The problem concerning the production of the CD ROMs that has delayed significantly the distribution of the CD ROMs has been cured. Some additional manpower has been allocated to accelerate the generation of the CD ROMs to catch up with the backlog as soon as possible.

The performance of the involved ground stations (Redu and Goldstone) was good during the reporting period. While the TM and TC flow via Redu worked flawlessly the TM / TC interface to / from Goldstone was severely impacted during one pass in revolution 16. The assessment of this malfunction is ongoing.

The platform did only show one potential anomaly. The On Target flag has been set to false again in one occasion. In this case it seems that the problem was different with respect to previous occurrences of the event. It seems that this time it was caused by a combination of excessive step in roll demand (still < 3 arcmin) and the logic in the ACC. The detailed sequence of events is shown in section 8.3.1.

The main anomalies related to the instruments identified this week concern IBIS.

- The high voltages of the VETO VDMs 4 and 12 have shown a break down during the revolutions 16 and 17. The actual reason for this behaviour is still to be identified. However, a preliminary analysis indicated that so far only units positioned on the -z side of the satellite are impacted, i.e. the side that is not directly illuminated by the sun and hence shows a colder environment. This might indicate a possible temperature effect together with a not complete outgassing of the unit. The detailed analysis is still ongoing. The recovery action foresees to set the high voltage of the affected VDMs to a minimum value and to load a different set of the gains.
- The problem of the VETO LSL Error (see Anomaly Report INT-002013) has been again observed. This coincided with an error concerning the VETO H1 HK packet that was filled with zeros for one cycle.

The TM data rate that is available to the instruments is not sufficient to operate SPI and IBIS in an efficient way. In order to support the current commissioning activities some special arrangements have been implemented to reallocate some TM packets to the instrument that requires them for the operations. This was handled mainly via change requests. IBIS and SPI are currently assessing the situation and are preparing some modifications of the On-Board S/W (OBS) to improve the utilisation of the available TM data rate.

The timing of activities as foreseen in the ISOC planning inputs is not always appropriate and requires some tuning. This concerns for example the generation of the SPI Spectra. A meeting held at ESOC indicated a potential flaw in the planning process. It might be necessary to perform an assessment of the planning process concerning the scientific objectives once the planning for a revolution is finished. This needs to be further discussed within the ground segment.

7 Future Milestones

The Mission Commissioning Results Review is planned at ESTEC for 12 & 13 December.

A new release of the Mission Control S/W is planned for the upcoming week-end.

8 Appendix

The appendix includes various detailed information.

8.1 Overview of Revolutions

Revolution 16 consisted of a Cygnus-X1 on-axis staring for the entire revolution. The TM allocation was 59 SPI, 122 IBIS, 5 OMC and a total of 9 for JEM-X. JEM-X TM share was divided 6 JEM-X1, 3 JEM-X2 for the first part of the revolution, alternating to 3 JEM-X1, 6 JEM-X2 during the reconfiguration after the RWB at apogee. The parameters for the IBIS ED for Standard Mode (GESTAN) were modified in the APF, allowing IBIS to be configured completely from the automatic TL for the first time. SPI continued to be configured manually, with spectra TM enabled.

Revolution 17 consisted of a Cygnus-X1 staring (TM allocation initially 59 SPI, 122 IBIS, 5 JEM-X1, 4 JEM-X2, 5 OMC, then changed during this staring to 55 S, 117 I, 9 J1, 9 J2, 5 O). Following this, a series of Cygnus off-axis pointings were performed, starting at 2deg off and incrementing by 1deg up to 6deg off. During this series of pointings, the TM allocation was adjusted several times to incrementally reduce the JEM-X allocation, giving the TM back to SPI and IBIS. The remainder of the revolution consisted of a Cygnus on-axis staring with TM allocation 59 SPI, 122 IBIS, 9 JEM-X (total), 5 OMC. During this staring the split of TM between JEM-X1 and JEM-X2 and their relative configurations were alternated. IBIS was activated in Standard mode throughout the revolution by the automatic TL. SPI was commanded in PPM mode by the TL but was also configured manually and did not always have spectra TM enabled.

8.2 Consumables

8.2.1 Detailed Fuel Book-keeping

2002-11-21T08:23:46.000Z	185.1890	F	Automatic TM processing.
2002-11-22T18:38:30.000Z	185.1640	F	Automatic TM processing.
2002-11-24T08:13:05.000Z	185.1440	F	Automatic TM processing.
2002-11-25T15:44:52.000Z	185.1220	F	Automatic TM processing.
2002-11-25T18:27:01.000Z	185.1130	F	Automatic TM processing.
2002-11-27T08:00:56.000Z	185.0970	F	Automatic TM processing.
2002-11-28T18:14:28.000Z	185.0830	F	Automatic TM processing.
2002-11-30T07:55:43.000Z	185.0697	F	Automatic TM processing.
2002-12-01T18:00:51.000Z	185.0610	F	Automatic TM processing.
2002-12-03T07:46:06.000Z	185.0377	F	Automatic TM processing.

This report was generated at Wed Dec 4 08:00:08 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.

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 28/11/2002-05/12/1002

The AOCS had a low level of activity in the reporting period, covered by staring pointings for most of the time. The week was in general very smooth from the AOCS operations point of view.

28/11/2002 from 19:00 (Day of Year 332, Revolution 15)

Nominal AOCS operations executed from the Automatic Timeline.

29/11/2002 (Day of Year 333, Revolution 15)

Nominal AOCS operations executed from the Automatic Timeline.

30/11/2002 (Day of Year 334, Revolution 15-16)

Nominal AOCS operations executed from the Automatic Timeline.

01/12/2002 (Day of Year 335, Revolution 16)

Nominal AOCS operations executed from the Automatic Timeline.

02/12/2002 (Day of Year 336, Revolution 16)

Nominal AOCS operations executed from the Automatic Timeline.

03/12/2002 (Day of Year 337, Revolution 16-17)

Nominal AOCS operations executed from the Automatic Timeline.

Slew-Update software upgrade in the Flight Dynamic System

In revolution 17 an improved version of the update slew FD software was introduced to solve the problem observed at the beginning of rev 12. This problem was related with the propagation of the attitude for non-inertial pointings (SSL not enabled), see the relevant weekly report for more details (Report number 9, week 47). The update was successful, and a slew executed after 1.7 hours of non-inertial pointing introduced a roll demand step of 30 arcseconds, that would have been around 255 if the software modification had not been included. These 30 arcseconds are nominal, and do not create any problem to the OTF or the controller.

On Target Flag set to False (jitter at the end of slew)

At the end of the Open Loop Slew to the perigee passage attitude, the ACC issued the On Event Message:

01:24:12.498 ACC ROLL ERROR OOL

This message is issued when the threshold for the OTF in roll (1 arcminute) is exceeded. This is only to be expected when the step change in roll at the time the SSL is enabled exceeds 3

arcminutes, due to overshoot in the error correction. In this case the problem seems to be different, and due to a combination of excessive step in roll demand (but less than 3') and the logic in the ACC.

The approximate sequence of events was:

- The update of the OSL parameters was calculated at the end of the previous AOCS activity, which in this case happened to be on 2002-12-01 18:29:11, i.e. more than one day before the slew.
- During all the time in between the update and the actual slew execution, the Sun Steering Law parameters were not updated. This is not nominal, since for the routine phase the SSL parameters should be updated every 3 hours of static pointing, but the relevant function is still not in place in the Flight Dynamics System.
- Due to the long time elapsed, and the simplified sun motion model onboard, at the start of the slew the roll angle was 1.7 arcminutes different with respect to the predictions.
- This error propagated to the end of the slew, so that when the SSL was re-enabled (in this case automatically since it was a small slew), the difference between the demanded roll and the current one was above the OTF threshold.
- At this point it seems that there is a logic problem in the ACC assertion of the OTF for the first cycle. The ACC should assert the OTF when: "the guide start is OK" and "the SSL is enabled" and "the error is below the threshold". Looking to the TM, it seems that the ACC set the OTF before the SSL roll demand was introduced:

In regular TM:

01:24:11.806 OTF set to TRUE
01:24:12.306 OTF set to FALSE
.....
01:24:17.806 OTF set to TRUE and stable

In the OEM TM:

01:24:11.815 Slew end, (α and α_{demand} almost identical)
01:24:12.315 RGA to 6
01:24:12.498 ACC Roll error OOL.

Independently from some apparent timing discrepancy between the time stamping of the regular TM and the OEM, to be investigated, it seems clear that the OTF is asserted with an error calculation based on pre-SSL roll demand, even if the SSL is a pre-condition for it. This looks at a first glance as a problem in the ACC software logic.

In this case, the jitter of the OTF was not seen in the Broadcast Packet, since due to the different sampling time the Broadcast Packet reflected OTF reached for the first time at 01:24:29.

From the operations point of view, it is expected that this problem does not appear once the SSL parameters are regularly updated during long pointings, since the step in roll should then be always less than one arcminute.

04/12/2002 (Day of Year 338, Revolution 17)

Nominal AOCS operations executed from the Automatic Timeline.

05/12/2002 (Day of Year 339, Revolution 17)

Nominal AOCS operations executed from the Automatic Timeline.

8.3.2 JEM-X Operations

OVERVIEW

Since the new nominal setting of the Low-Level Discriminator was still not implemented in the database, activation of both JEM-X units at the beginning of revolutions 16 and 17 were performed by manual commanding.

Both JEMX units are being switched to SAFE mode at 90 minutes before the BCP radiation belt entry time.

DETAILS

29-Nov-2002, DOY 333, Revolution 15

- 23:17:00, JEM-X1 to SAFE by time-tag TC
- 23:17:10, JEM-X2 to SAFE by time-tag TC

30-Nov-2002, DOY 334, Revolution 16

- 09:00:00, commanding from the automatic timeline to JEMX1&2 was disabled to manually activate the units with low-level discriminator of 2.
- 10:00:00, after calibration and activation of the HVs to the nominal values, commanding from the automatic timeline to JEM-X was enabled.
- 11:32:00, Time-tag commands were uplinked to put JEMX1 and JEMX2 in SAFE mode at 90 minutes before Rev 16 BCP radiation belt entry time.

2-Dec-2002, DOY 336, Revolution 16

- 23:04:00, JEMX1 to SAFE by time-tag TC
- 23:04:10, JEMX2 to SAFE by time-tag TC

3-Dec-2002, DOY 337, Revolution 17

- 08:00:00, commanding from the automatic timeline to JEMX1&2 was disabled to manually activate the units with low-level discriminator of 2.
- 09:40:51, after the diagnostic data collection, which is part of JEM-X activation process, JEM-X1 issued OEM 189 (JEM1 DFEE PROB 9). This problem caused IASW DFEE state to remain in DIAG mode after completion of the diagnostic data dump.
- 09:48:00, TC K0009 was sent to correct the JEM-X1 mode and set the IASW DFEE state to SETUP.
- 09:49:00, after calibration and activation of the HVs to the nominal values, commanding from the automatic timeline to JEM-X was enabled.
- 16:10:15, Time-tag commands were uplinked to put JEMX1 and JEMX2 in SAFE mode at 90 minutes before Rev 17 BCP radiation belt entry time.

5-Dec-2002, DOY 339, Revolution 17

- 22:50:00, JEMX1 to SAFE by time-tag TC
- 22:50:10, JEMX2 to SAFE by time-tag TC

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: 04.12.02). 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 - 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 - 002025	28/10/2002	Telemetry and Telecommand outages due to Antenna Mispointing	Ground	NASA Sta.	Pending
INT - 002024	28/10/2002	OEM: SPI1 Fixed print overflow	Space	SPI	Pending
INT - 002058	06/11/2002	Telemetry Play Back Failed	Ground	NASA Sta.	Pending
INT - 002049	07/11/2002	Beginning of a gradual erosion of the anodes on the microstrip plates	Space	JEM-X	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 - 002055	09/11/2002	IBIS VETO anomalous count rates.	Space	IBIS	Pending
INT - 002061	12/11/2002	TM Desktop performance collapses when de-selecting supercommutated	Ground	IMCS	Pending

		processing.			
INT - 002062	13/11/2002	Static PTV wrongly handled by IMCS when commands are copied	Ground	IMCS	Pending
INT - 002066	13/11/2002	Data routing to ISDS	Ground	I/F to SGS	Pending
INT - 002082	13/11/2002	TM packet production lower than allocation.	Space	SPI	Pending
INT - 002070	14/11/2002	TDRS: data Rerievals cancelled	Ground	IMCS	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 - 002077	15/11/2002	SPI Spectra at Belt Exit	Space	SPI	Pending
INT - 002083	16/11/2002	SPI DPE Crash	Space	SPI	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 overrun	Space	SPI	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 - 002118	25/11/2002	Autostack crashed	Ground	IMCS	Pending
INT - 002121	26/11/2002	ISGRI countrates increase up to 8000 counts/sec in one module	Space	IBIS	Pending

INT - 002116	27/11/2002	SPI Spectra process / cycle stopped	Ground	ISOC	Pending
INT - 002117	27/11/2002	Command releaser failed	Ground	IMCS	Pending
INT - 002124	29/11/2002	Telemetry Drops from GoldStone	Ground	NASA Stat	Pending
INT - 002125	29/11/2002	Data loss between IMCS and ISDC	Ground	I/F to SGS	Pending
INT - 002128	01/12/2002	Wheel Speed monitor crashed	Ground	FDS	Pending
INT - 002122	02/12/2002	IBIS VDM4 HV broke down	Space	IBIS	Pending
INT - 002127	02/12/2002	Telemetry loss from REDU	Ground	ESA Stat	Pending
INT - 002129	03/12/2002	VC-7 data loss	Ground	ESA Stat	Pending
INT - 002130	04/12/2002	Reaction Wheel Task Stopped	Ground	FDS	Pending
INT - 002131	04/12/2002	Lost TC capability via GoldStone(Dss-16)	Ground	NASA Stat	Pending
INT - 002132	05/12/2002	TM/TC loss via REDU	Ground	ESA Stat	Pending
INT - 002133	05/12/2002	Loss of Frames	Ground	IMCS	Pending