Newsletter of the INTEGRAL Science Operations Centre

No. 4 **January 2002**

Foreword

Christoph Winkler - Project Scientist

During the past weeks we have seen major progress on INTEGRAL: The scientific payload is complete and all flight models are integrated on the spacecraft; the scientific calibration on satellite level has started on January 23; system tests for the spacecraft and the ground segment are progressing smoothly; preparations for the launch on October 17 of this year are in full swing. This issue of the ISOC newsletter keeps you informed about the latest developments.

The IBIS detector unit is being integrated into the spacecraft's payload module at ESTEC, November 2001.

As a consequence of the internal re-organization of the former Space Science Department SSD (now called RSSD - Research and Science Support Department), the Project Scientist and the ISOC staff are now members of the Science Operations and Data Systems Division. Furthermore all e-mail addresses, including the ISOC HELPDESK, have been modified to *name@rssd.esa.int.*

Status of spacecraft and payload

Astrid Orr - Operations Scientist

The assembly of the INTEGRAL Flight Model (FM) is now finished after the very smooth and successful delivery of the IBIS Detector Unit on November 18, 2001, right on schedule. All the instruments are integrated onto the spacecraft and tested in their full flight configuration. Meanwhile, the preparatory tasks for the launcher are taking place according to schedule.

The SPI instrument is complete and is performing nominally, with the only exception of one Photo-Multiplier Tube (PMT) in the Anti-Coincidence Subassembly (ACS) which shows a slight mis-behavior. An anomaly of the cryogenic system for SPI has been resolved: both, tests and modeling yield predicted in-orbit temperatures within - or very close to - the specifications. The Pulse Shape Discriminator (PSD) has been refurbished and is working properly.

The IBIS FM was fully integrated onto the satellite before Christmas. The ISGRI and PICSIT FMs are entirely stable and both detector arrays perform nominally. The Electromagnetic Compatibility (EMC) and Thermal Vacuum (TV) tests will be performed directly on the satellite. Substantial calibration activities took place before the delivery of IBIS. They have brought an amount of very valuable data. Because the integration of IBIS went so smoothly and quickly there is more time available for further calibration work.

On December 12, 2001 the two JEM-X units were switched on for the first time simultaneously on-board the spacecraft. The JEM-X FM2 unit is performing nominally. However,

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the JEM-X FM1 is not. Its detector area and its gas gain value are strongly reduced. Therefore it has been planned to replace the FM1 unit by early March with the Flight Spare (FS) detector. Of course the FS must be performing nominally by then. The Danish Space Research Institute (DSRI) is currently working on completing the FS. The JEM-X FM1 unit will only fly if the FS is not available.

The OMC is on the spacecraft since October 2000 and is in good shape.

The scientific calibration on the system level, important for the cross-calibration of the high energy instruments and in complement to the instrument level calibration has commenced on January 23 and will last 2 weeks.

Status of AO-1 proposals (update) and results of amalgamation

Paul Barr - Resident Astronomer

Following the TAC meeting, the PI's have been notified of all recommended changes and the proposal data base at ISOC has been updated accordingly. Of the 118 successful proposals, 64 needed modifications. We are now in the process of carefully checking all of the updates we have performed. When this is complete, we will commit the amalgamations to the data base, and send the final copy of the proposal to all PI's whose observations have been modified (and/or amalgamated), aiming to complete this task by mid February.

Amalgamation has been performed, following updates to the observations (mostly dither patterns) as a result of the TAC recommendations. The initial results from amalgamation were disappointing, very little time being saved: we have since relaxed the 'rules' (see AO-1 Documentation), e.g. we can now take a grade B observation to determine the 'core' attributes, if this allows more observations to be amalgamated. In addition we now accept increases in the duration of an amalgamated observation beyond the nominal duration of the 'core', to allow more off-axis sources to be considered for amalgamation, provided some time is still recovered. Finally, we have investigated what gains (time saved) can be achieved by amalgamating observations further and further apart in the sky, even including sources in the partially coded field of view. In Table 1 on page 2 we show the time saved as we go further off-axis. Above 8.5 degrees, there is no further time saved: the computed observation durations needed for the off-axis sources exceed the total nominal time of all observations considered in that amalgamation step. The maximum amount of time saved is just over one million seconds, or approximately 6% of the total time available for AO-1.

Table 1: Amalgamation - saving time as function of angular separation

Maximum off-axis angle (degrees)	Number of amalgamations	Total number of observations amalgamated	Total time recovered (seconds)
4.5	4	15	741540
5.5	4	15	741540
6.5	4	16	841450
7.5	6	22	870190
8.5	7	24	1052810
9.5	7	24	1052810

The instrument performance and verification phase

Rudi Much - Operations Scientist

The INTEGRAL commissioning phase commences after separation from the launcher on October 17, 2002 and lasts 2 months up to December 16, 2002 inclusive. It is split into two parts. The first three weeks are dedicated to spacecraft and instrument activation and to the optimization of the instrument configurations. The second part, the performance verification (PV) phase, consists of a set of observations and lasts for 5 weeks. The PV observations are executed in preparation for the Operational Phase with the goals to validate the results of the ground calibration, to verify the instrument models and to verify the instruments' performances as advertised in the INTEGRAL AO-1 documentation. Additional calibration observations will be performed during the early Operational Phase, when the Crab region becomes visible for the first time.

The Payload Calibration Working Group (PCWG) has the leading role in the preparation and compilation of the PV phase. The PCWG comprises representatives from the four instrument teams and from the ISDC, the mission scientists and representatives from ESA. The PCWG identified suitable calibration fields and established an overall PV observation programme, which satisfies the instrument needs. The final PV programme was presented to and accepted by the INTEGRAL Science Working Team.

The PV pointings can be divided into three groups.

- observations of the Cygnus region using different dither patterns and with different offset angles.
- observations of empty fields with the main goal studying the background
- a test of the Galactic Plane Scan (GPS)

Table 3 on page 5 summarizes the PV pointings. The quoted observation duration is the exposure time, except overheads. The only exception is the test GPS, where the elapsed time of an GPS with average length is quoted.
In order to introduce more flexibility into the scheduling process a backup empty field was defined at (l, b) = (120, -60), which, if required for visibility reasons, would replace either of the empty fields 1 or 2.

The data acquired during the PV observations are used to verify and to determine the instrument response for the standard instrument configurations. Therefore the instruments are commanded to their standard configurations during the PV observations. IBIS is operated in standard science mode and SPI in photon-photon mode. OMC is commanded to the standard science mode, and, as baseline, JEM-X to the FULL imaging mode.
The Cygnus observations are mainly used to study the point spread functions of the instruments and to demonstrate the imaging capability within a crowded field. The empty field observations are used for background studies as a function of various parameters, such as altitude, orbital phase or pointing direction with respect to the sun. The GPS test is required to verify the operation of the Galactic Plane Scans and the associated data analysis.

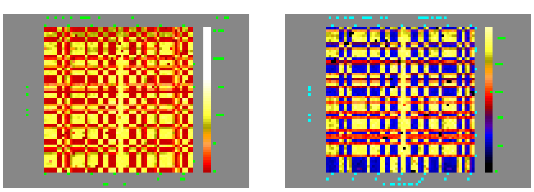
The most obvious target for any calibration at gamma-ray energies is the Crab region. Crab observations are essential for absolute flux calibrations. However, the Crab region is not visible during the PV phase. A series of dedicated calibration observations on the Crab region is intended once the Crab region becomes visible for INTEGRAL in February 2003. The various pointings are listed in Table 4 on page 5.

The Crab offset pointings require a fixed position of the Crab Nebula (off-axis and zenith angles) in the instrument coordinate system in order to measure the off-axis mask transparency. Therefore the actual pointing direction of the observation depends on the observation date as the spacecraft orientation changes with the sun position due to the solar aspect constraint. Table 4 lists the average pointing directions of the off-axis observations during the Crab visibility period. Also the JEM-X offset

calibration pointings (offsets between 0.5 and 4.9 degrees) are defined in the JEM-X instrument coordinate system. These exposures are short (<2 ksec) and are used to verify the model of the JEM-X vignetting function.
The nominal PV phase lasts till the end of the commissioning phase on December 16, 2002. Any data acquired within the commissioning phase are property of the INTEGRAL Science Working Team. However, data of PV observations or calibration observations acquired after December 16 will become public, as soon as the ISDC has processed these data. This holds for all Crab calibration observations listed in Table 4. Depending on the start date of the PV programme also data of PV observations may become public, if the PV programme is not completed by December 16. While the sequence and the durations of the PV observations are already defined, the final start date of the PV programme is not yet fixed as it depends on the detailed schedule of the first part of the commissioning phase (instrument activation and configuration optimization) which currently is in preparation and is expected to be finalized in the first quarter of this year.

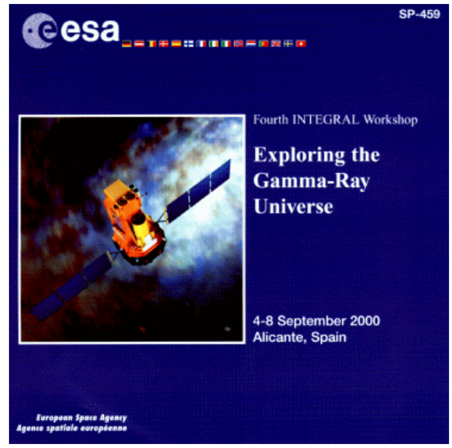
Any Other Business

The INTEGRAL WWW (http:// astro. estec. esa.nl/Integral) displays each month "The INTEGRAL Picture of the Month", shown below for January 2002.



First shadowgram obtained with the IBIS telescope at ESTEC. Radioactive sources (60 keV, ISGRI [left] and 661 keV, PICSIT [right] were used to cast shadowgrams of the IBIS coded aperture mask onto the ISGRI and PICSIT detector arrays.

The proceedings of the 4th INTEGRAL Workshop *Exploring the Gamma-Ray Universe* (Eds: A. Gimenez, V. Reglero & C. Winkler) have been published as ESA SP-459. Addi-



tional copies (book and CD-ROM, price: 60 Euro) can be obtained via the ESA Publication Division
(http://esapub.esrin.esa.it/publicat/epdi.htm).

How to reach the ISOC?

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Table 2: ISOC key personnel[a]

Name	Function	Phone	Mailcode
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Much, R.	Operations Scientist	4756	SCI-SDG
Orr, A.	Operations Scientist	3943	SCI-SDG
Sternberg, J.	System Engineer	4001	SCI-SDG
Nolan, J.	Operations Engineer	3401	SCI-SDG

a. The full list of ISOC staff can be found on the ISOC WWW

Table 3: Pointings during PV phase

Target	Coordinates (l/b)	Prime Instrument	Dither pattern	Duration [Msec]	Calibration Purpose
Cygnus onaxis	71.33/3.07	IBIS	staring	0.9	PSF, imaging in crowded fields, cross calibration
Cygnus off 2.67 degree	74/3	SPI	5x5	0.27	as above plus analysis of extended, diffuse and line emission and IBIS imaging in dither mode
Cygnus off 7.4 degree	74/10	SPI	5x5	0.27	as above
Cygnus off 9.65 degree	81/3	SPI	5x5	0.27	as above
Cygnus on axis	71.33/3.07	SPI	hexagon	0.2	as above
Empty Field 1	240/40	IBIS	staring	0.1	Background study
Empty Field 1	240/40	SPI	5x5	0.2	Background study
Empty Field 2	60/-45	IBIS	staring	0.1	Background study
Empty Field 2	60/-45	SPI	5x5	0.2	Background study
GPS test			GPS	0.044 elapsed	Test of GPS operation and analysis of GPS data

Table 4: Pointings during Crab calibration

Target	Coordinates (l/b)	Prime Instrument	Dither Pattern	Duration [Msec]	Calibration Purpose
Crab onaxis	184.56 / -5.79	IBIS	Staring	0.30	Absolute flux measurement, timing
Crab 9.6/0 degree	189.33/ +2.55	IBIS	Staring	0.08	As above
Crab 9.6/90 degree	193.21 / -10.10	IBIS	Staring	0.08	As above
Crab 9.6/180 degree	179.74 / -14.13	IBIS	Staring	0.08	As above
Crab 9.6/270 degree	176.41 / -0.69	IBIS	Staring	0.08	As above
Crab 10.4/315 degree	182.02 / +4.30	IBIS	Staring	0.08	As above
Crab onaxis	184.56 / -5.79	SPI	5x5	0.18	Absolute flux calibration, timing
Crab onaxis	184.56 / -5.79	SPI	Hexagon	0.126	As above
JEM-X Crab offset	variable	JEM-X	staring	0.008	JEM-X vignetting function