Newsletter of the INTEGRAL Science Operations Centre

No 22 December 2009

Foreword

Peter Kretschmar, Science Ops. Manager

Another year has passed very quickly, and this issue of the ISOC newsletter is a little late in coming. Fortunately, this attests to the fact that the mission and its ground segment are running smoothly.

In the following, we summarize this past year's experiences with the new AO scheme, and give a preview of the schedule for the next proposing rounds. There are also sections on scientific highlights and operational changes, as well as news on ISOC staff.

Contents

AO-7: Results and New Scheme

Peter Kretschmar, Science Ops. Manager
Silvia de Castro, Software Engineer
Marnix Bindels, Software Engineer

In AO-7 we implemented the new AO scheme recommended by the IUG to improve Integral Data usage[1], with two rounds of proposals: one for observing time and one for data rights. Data Rights proposals cannot be associated to accepted TOO proposals.

In the first round, we received 76 proposals for open time observations, of which 50 were accepted by the TAC (at least in part). The accepted proposals included 19 ToO follow-up observations and 5 GRB proposals.

The call for associated data-right proposals led to 72 submissions. Evaluating these proposals and resolving the complex tangle of conflicting requests for data rights on specific sources—especially in the Compact Objects panel—kept the TAC panels and their ISOC secretaries busy. In the final analysis, 62 proposals were selected.

The New AO Scheme

PIs from all over the world can submit proposals during the first phase of the announcement of opportunity. The approved open time proposals then become the basis for the second phase, in which a PI can request data rights on a source within the field of any open time proposal, where in previous AOs this was only possible for Key Programmes. This new approach evidently increases the use of Integral data in the science community because it allows to subscribe to as many fields as there are approved open time proposals.

This conceptual change had an impact on the entire chain of software from proposal submission and observation planning, to data distribution and archiving. We therefore re-designed several ISOC Software components to cope with this challenging problem. We rebuilt the Proposal Generation Tool and the Integral Database scheme to support the multi-subscription functionality. The ISDC interfaces have been updated accordingly.

In addition, a Proposal Query Tool was written to test the visibility of one or several sources in a given field. The tool does this by querying the estimated exposure map of the approved proposals. This very practical aid in identifying proposals that cover fields containing one's favourite sources was used extensively by proposers.

[1] http://www.sciops.esa.int/index.php?project=INTEGRAL&page=IUG

AO-8

Peter Kretschmar, Science Ops. Manager

We are preparing the next call for observing proposals coming up in March 2010. Here is the tentative timetable for AO-8:

AO-8 Timeline	
Call for open time proposals:	15 Mar 2010
Due date open time proposals:	23 Apr 2010
TAC Meeting:	1-3 June 2010
Call for data right proposals:	30 Aug 2010
Due date data right proposals:	8 Oct 2010
Associated targets selected:	mid Nov 2010
Start AO-8 observations:	1 Jan 2011

The Extreme Sky: Sampling the Universe Above 10 keV

Erik Kuulkers, Operations Scientist

An INTEGRAL Workshop celebrating seven years of INTEGRAL in space was held on October 13-17 in Otranto (Lecce), Italy.It took place in the wonderful setting of the beautiful remains of the ancient Castello Aragonese.

The workshop focused on all-sky, high-energy surveys carried out by INTEGRAL and other missions, with special attention to results obtained above 10 keV. There were five dedicated sessions: 1) the soft-energy gamma-ray sky (as seen by INTEGRAL, Swift, Suzaku, MAXI, etc.); 2) the high-energy gamma-ray sky (AGILE, Fermi, HESS, MAGIC, etc.); 3) the search for counterparts using the multi-waveband approach; 4) the comparison and contrasting of the soft and high-energy gamma-ray sky; and 5) prospects for future missions above 10 keV (e.g., NuSTAR, ASTRO-H). There were 112 participants, and given the relatively narrow focus of the workshop, this shows that interest in this kind of science is still widespread.

As usual, an array of different astrophysical objects and themes successively took centre stage: from X-ray binaries to gamma-ray bursts, and from AGN to the cosmic X-ray background. One clearly got the impression that INTEGRAL will keep the scientists busy for many years to come, especially since more than 700 sources have now been detected by IBIS/ISGRI in the 18–100 keV band (see below 'New sources of the 4th IBIS/ISGRI catalog'), and SPI is continuously improving its resolution of Galaxy's diffuse emission (e.g., INTEGRAL SPI All-Sky View in Soft Gamma Rays: A Study of Point-Source and Galactic Diffuse Emission, Bouchet et al. 2008, ApJ 679, 1315). At the end of the meeting INTEGRAL's 7th birthday and 7 years of successful gamma-ray astronomy was celebrated with a cake and bottles of Champagne. We thank the organizers for this wonderful workshop.

The 8th INTEGRAL workshop will take place in Dublin Castle, in Ireland's capital from September 27 to 30, 2010. The theme will be "The Restless Gamma-ray Universe". Information on workshop registration and hotel reservations, as well as instructions for authors on submitting an abstract will be made available in early 2010 on http://ssmr.ucd.ie/8thintegralworkshop.

Science Operations

Erik Kuulkers, Operations Scientist

Since 9 January 2009, INTEGRAL near-real-time (NRT) data have been made available by the ISDC to observers with a delay of only a few hours with respect to their acquisition by the satellite. NRT data can be affected by a number of defects and contains only approximate auxiliary information. The final consolidated (CONS) data continues to be provided within 6 weeks after the end of the observation.

On 19 February, following exit from a perigee passage, another Ge detector on SPI failed (No. 5). This follows the losses of detectors No. 2 in December 2003 and No. 17 in July 2004. The previous two failures both occurred some weeks after annealing suggesting a possible link, but in the case of No. 2 it is unlikely since the last annealing finished in September 2008. This failure brings the number of the remaining active Ge detectors on SPI down to 16.

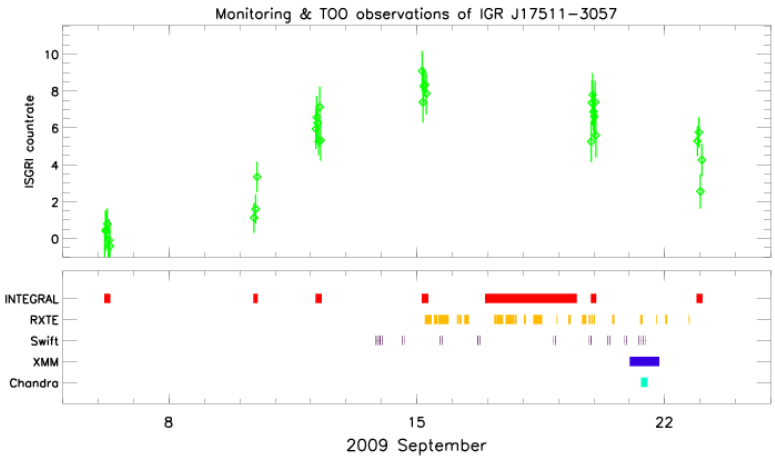
AO7 officially began on 16 October, during revolution 856, but AO7 observations of NGC 2110 and Mkn 509 coordinated with XMM-Newton started already in revolutions 854 and 855. INTEGRAL revolution 856, both monitors of JEM-X were operated, with a very low telemetry for JEM-X1 (put in a safe mode), in preparation for the final switch from JEM-X1 to JEM-X2. From revolution 856 onwards, JEM-X2 is the main instrument. The 14th SPI annealing lasted 6 revolutions, from revolution 857 to 862 (October 19 – November 6). During that time, the SPI instrument did not deliver science data (except during revolution 862); both JEM-X instruments were taking data during the whole annealing period.

During the active cooling phase following the annealing, the SPI Compressor Drive Electronics unit 2 (CDE2) unexpectedly switched off, while CDE1 continued normally. After consultation with the PI, CDE2 was reactivated. Afterwards, both units worked nominally, but cooling efficiency has decreased significantly due to contamination and another annealing will probably become necessary much sooner than usually.

SciOps in action: the discovery of the millisecond pulsar IGR J17511−3057

On 18 September 2009, the transient source IGR J17511−3057 was discovered during INTEGRAL observations of the Galactic Bulge monitoring program (Baldovin et al. 2009, ATel 2196). Subsequent observations of the Bulge and Galactic Center region allowed to follow the transient's outburst in hard X-rays. A deeper insight into the source properties have been obtained during the TOO observations of the system in revolution 846 (16–19 September).

INTEGRAL is not the only satellite which observed the outburst of IGR J17511−3057. The source was also monitored by many of the X-ray/gamma-ray observatories currently in operation. The overview below is based on available short-term scheduling, and may not be necessarily complete. For more details on the INTEGRAL observations see the scheduling pages.



Some Highlights of Science with INTEGRAL

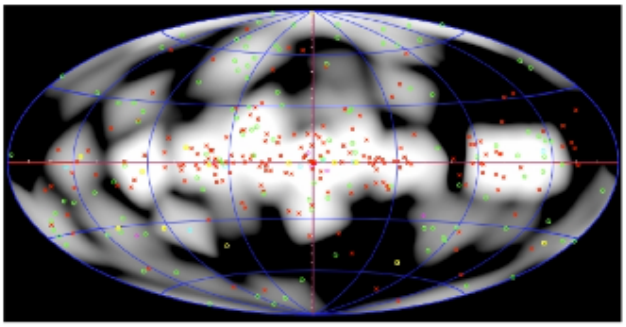
Marion Cadolle Bel,
Operations and Archive Scientist
Celia Sanchez, Operations Scientist

Important INTEGRAL results have been presented to the international scientific community since our last Newsletter. These include the publication of the 4th IBIS/ISGRI catalog; the explanation of the origin of the galactic positrons responsible for the 511 keV annihilation line; the discovery of a new magnetar called SGR 0501+4516, whose odd behaviour could force a revision of magnetar theory; the SPI observations of the Crab nebula; the recent detection of GRB 090817 by all the high-energy instruments on board INTEGRAL; and a review of PICsIT detections of GRBs.

New sources of the 4th IBIS/ISGRI catalog

INTEGRAL continues to expand our knowledge of the sky above 15 keV. The 4th IBIS/ISGRI soft gamma-ray catalog contains 723 sources that include 331 new ones with respect to the 3rd catalog. In the image taken from Bird et al. 2009, ApJS, 186, 1 shown below, we see the distribution of the new sources plotted on the exposure map since the 3rd catalog. Around 120 of those are associated with extragalactic sources (green circles), about 25 are associated with

known galactic sources, and the remainder are so far unidentified (red crosses).



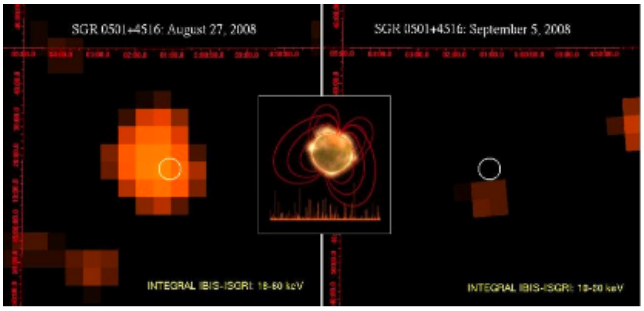
The distribution of the new sources closely follows the increase in exposure. The fact that most of these are unidentified suggests that the INTEGRAL observations along the galactic plane have reached a level of depth where previous X-ray observations were no longer able to provide associations for the new sources. When combined with the variability of the galactic sources, this indicates that further observations of our galaxy will continue to reveal new sources.

No need for dark matter to explain mystery radiation

INTEGRAL's map of the 511 keV line emission (Weidenspointner et al. 2008, Nature, 451, 159) invited many scientific papers to speculate on the dark matter origin of galactic positrons. However, Lingenfelter et al. 2009, Ph. RvL, 103, 3 ruled out the dark matter hypothesis. Before that, the assumption in the interpretation of the 511 keV data was that the positrons can not propagate over large distances without interacting with the environment and, therefore, annihilate close to their sources. Consequently, the distribution of the 511 keV radiation was expected to closely match the distribution of the positron sources. But the INTEGRAL maps showed that both distributions did not match, triggering a search for new objects able to produce positrons in a region of the galaxy devoid of any known sources of positrons. Lingenfelter and colleagues showed that it was incorrect to assume that positrons cannot propagate over large distances: they can indeed travel unhindered over kiloparsec scales as their interaction with magnetic fluctuations across most of the galaxy is too weak to affect them significantly (just like cosmic ray electrons of the same energy).

A new soft gamma-ray repeater

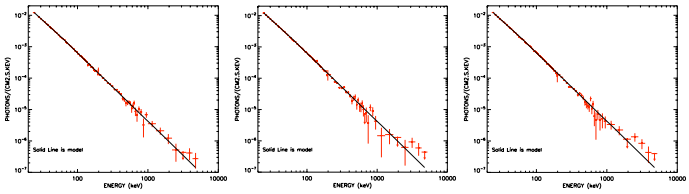
Detailed observations of the first new Soft Gamma Repeater (SGR) in 10 years, SGR 0501+4516 strengthen the unified view of the magnetar phenomenon; INTEGRAL and XMM-Newton TOO observations of the source revealed that, although this source exhibited the typical strong bursting behaviour expected of SGRs, its energy spectrum was significantly steeper than expected, rather more like an Anomalous X-ray Pulsar. This has led Rea et al. 2009, MNRAS, 396, 2419 to reconsider the two classes in which magnetars have been classified until now; all these objects should be regarded as a general magnetar class of objects. See also ESA space news briefs: Giant eruption reveals dead star and At last! After 10 years, a new Soft Gamma Repeater is observed.



The left panel shows the IBIS-ISGRI image of SGR 0501+4516 taken 5 days after the start of the outburst. The right panel we see the IBIS-ISGRI non-detection about 10 days later. On both images, the BAT error circle is superimposed on the SGR 0501+4516 position.

Another look at the Crab nebula

Since the start of the mission, INTEGRAL has performed regular observations of the Crab nebula with all its instruments covering the energy range between 20 keV and 6 MeV. This has shed light on a spectral region on which data were rather scarce.



Three SPI spectra made from observations of the Crab Nebula during three periods between February 2003 and September 2008.

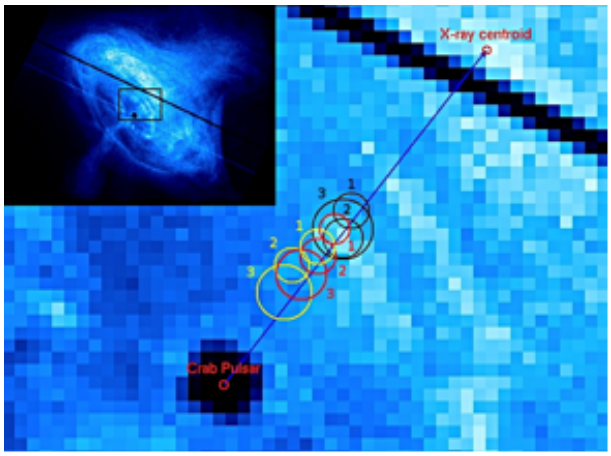
While the emission in the X-ray domain and above the MeV region follows a simple power law, the SPI data show that over the hard X-ray and soft gamma-ray domains occurs a transition of spectral index with a smooth curvature around 100 keV. In addition, this work points out the constancy of the Crab nebula spectrum, and also demonstrates the stability of the SPI instrument over six years of operation (see Jourdain et al. 2009, ApJ, 704, 17).

We have learned even more about the Crab through these regular Crab observations. The polarized emission from the Crab at various wavelengths has been known for quite some time now. In gamma-rays, however, polarization had never been conclusively detected until the main instruments on INTEGRAL, SPI and IBIS, using entirely different and independent analyses, both detected a strong polarization in its gamma-ray emission.

By analysing data from over 600 individual observations of the Crab with the INTEGRAL spectrometer SPI, Dean et al. 2008, Science, 321, 1183 measured the polarization of the 100 keV-1 MeV off-pulse gamma-rays, and compared it to the output of a sophisticated computer model. The results showed a polarization of 46±10% with an electric vector of 123±11 degrees, closely aligned with the spin axis of the neutron star, demonstrating that a significant fraction of the high-energy electrons responsible for the polarized photons are produced in a highly ordered structure, close to the pulsar. These results are consistent, at the 95% level, with the measurements reported by M. Forot et al. 2008, ApJ, 688, 29 using the IBIS telescope in Compton mode (if the same angle found by SPI is fixed for IBIS). They independently discovered a strong, linearly polarized signal from the Crab's emission at energies above 200 keV: the polarization is $47^{+0.19}_{-0.13}$% with an electric vector of 100±11 degrees parallel to the pulsar rotation axis.

These results show that the hard X-ray and soft gamma-ray observations can probe the pulsar's inner jet or equatorial wind flow, and that the achieved sensitivity has now opened a new window for polarimetric studies at energies above 200 keV.

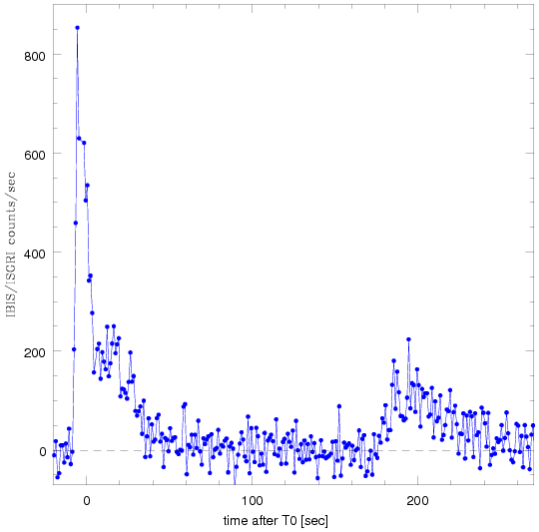
The hard X-ray morphology of the Crab

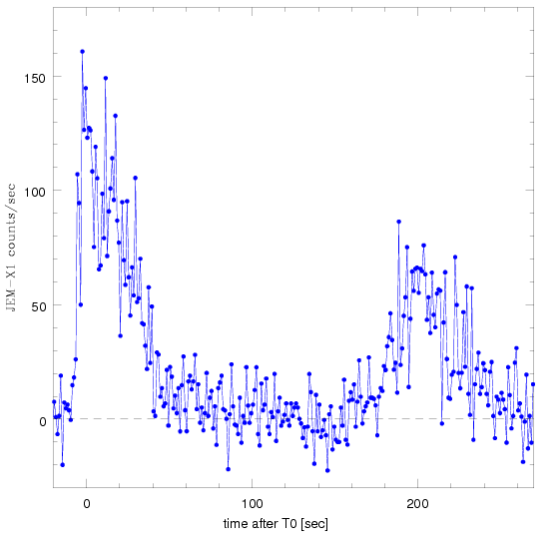


The size of the Crab nebula decreases with increasing energy. This relationship allows us to calculate the maximal energy of electrons in the outer regions of the X-ray nebula to be slightly below 10^{14} eV. The figure below shows the measurements of the position of the Crab in three energy bands (20–40, 40–100, and 100–200 keV, respectively labelled 1, 2 and 3) with the corresponding error circles (in red), superimposed on the Chandra image of the nebula at lower energies. The yellow (respectively black circles) show the measurements in the on-pulse (off-pulse) phases, i.e., to time bins where the emission from the central pulsar is maximal (minimal). For more details, see Eckert et al. 2009, A&A in press [arXiv:0910.1698].

GRB 090817 and more

INTEGRAL caught another GRB in the field of view of IBIS/ISGRI. Although this happens about 10 times a year, this GRB was special: it was not only within the field of view of both IBIS and SPI, but also in the smaller field of view of JEM-X. The combined INTEGRAL spectrum covers the whole range of a GRB, from 3 keV to several hundred keV.





The IBIS/ISGRI (top) and the JEM-X (bottom) light curves show two prominent peaks, and a comparably long duration, of about 250 seconds. In addition, the analysis of 56 revolutions between 2003–2007 shows that 11 GRBs have been detected by the PICsIT instrument—an important tool to explore the prompt emission at high energies. With its spectral timing acquisition mode, PICsIT allows a time resolution down to 1 ms and at the same time keeps the spectral information in up to 8 energy channels, from 208 to 2600 keV. Such results confirm the importance of a spectrally resolved timing analysis for the study of GRB up to several hundred keV, and show how PICsIT can contribute to the physics of MeV GRB prompt emission. More details in Bianchin et al. 2009, AdSpR 43, 1055 and Vianello et al. 2009, A&A, 495, 1005.

Changes at ISOC

Guillaume Bélanger, Operations Scientist

Arvind Parmar, the Division Head of Astronomy Science Operations, decided to step down from his post as Integral Mission Manager, in order to alleviate his growing workload. Peter Kretschmar is now our new Mission Manager in addition to keeping his post as Science Ops. Manager. It is Norbert Schartel, the XMM-Newton Project Scientist, that now acts as Deputy Project Scientist for Integral instead of Peter who formerly held this position.

Pieter-Jan Baeck, a former Software Engineer, returned to his home country Belgium. Although we were all sad to see him go, we are all happy to welcome the return of an old acquaintance, Marnix Bindels, who worked with us for a year and a half in 2006 and 2007.

Delphine Anger, a YGT that spent one year with us already, will stay for another year. Her YGT contract was extended for her to continue improving ISOC's long-term planning software.

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