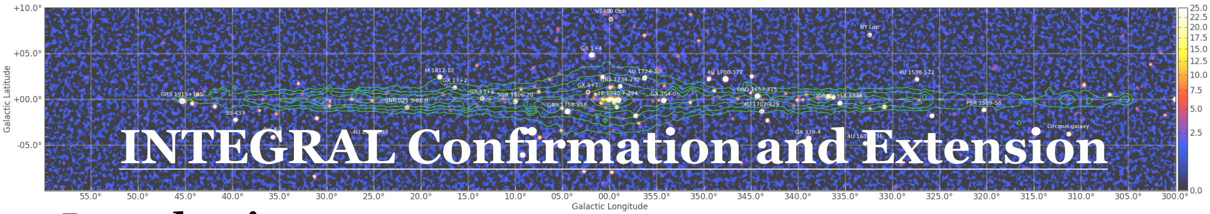

INTEGRAL Confirmation and Extension

1 - Introduction

ESA's hard X-ray and soft γ-ray observatory `**Inte**rnational **G**amma-**R**ay **A**strophysics **L**aboratory' (*INTEGRAL*) covers the 3 keV–10 MeV energy range, with excellent sensitivity during long and uninterrupted observations of a large field of view (FOV) of 100 square degrees (fully coded), with ms time resolution, keV energy resolution and unique polarimetric capability. *INTEGRAL* links the energy range of soft X-ray missions, such as *XMM-Newton,* with high-energy γ-ray observatories, such as *AGILE*, and ground-based γ-ray telescopes, such as *H.E.S.S.*. For the foreseeable future (15–20 years) there will be no mission that will provide *INTEGRAL*'s combination of sensitivity and spectral resolution in the hard X-ray/soft γ-ray parts of the electro-magnetic spectrum. For the coming years *INTEGRAL* will remain key in the synergy between observations at all possible wavelengths. The 2012 detection of the ^{44}Ti γ-ray lines of supernova SN1987A in the LMC and the 2014 detection of the ^{56}Ni and ^{56}Co decay γ-ray lines of the Type Ia SN2014J in M82 illustrate *INTEGRAL*'s unique capabilities, of key importance for understanding nucleosynthesis.

User interest in the mission remains high. The scientific performance of the mission and instruments in 2015–2016, and 2017–2018, is expected to be unchanged from the last extension request with only minor degradations since launch twelve years ago. The expected key science results for the coming years cover a wide span of high-energy astrophysics, including a more precise mapping of the distribution of positrons in the Galaxy, with potentially important implications for dark matter decay, nucleosynthesis through high-resolution γ-ray line observations of diffuse sources and transients (novae, supernovae), black holes and neutron stars, population studies of supermassive black holes (obscured and unobscured AGNs) and γ-ray polarization measurements of X-ray binaries and γ-ray bursts (GRBs). An exciting new opportunity, now that advanced gravitational wave antennas are coming on line, is *INTEGRAL*'s potential for precise localisations through the detection of short GRBs that will accompany the coalescences of double neutron stars, the most promising sources of bursts of gravitational waves. *INTEGRAL* will continue to address key questions presented in ESA's Cosmic Vision 2015–2025: *'What are the fundamental physical laws of the Universe?'* and *'How did the Universe originate and what is it made of?'*

Last year, *INTEGRAL* operations were indicatively approved until 31 Dec 2016, subject to a mid-term review and confirmation, as requested here. Also, approval for extended operations from 1 Jan 2017 to 31 Dec 2018 is requested. Here, we present *INTEGRAL*'s unique capabilities and outline specific key areas that only *INTEGRAL* can cover in the coming years.

The INTEGRAL mission

INTEGRAL carries two main γ-ray instruments: the high-resolution γ-ray spectrometer SPI (18 keV–8 MeV) and the broad-band imager IBIS (15 keV–10 MeV), both with polarimetric capability. Two monitors complement these: JEM-X (3–35 keV) and OMC (optical V band). *INTEGRAL* operates in the context of two extraordinary challenges, unique to hard X-ray/γ-ray astronomy: the large dynamical range of the images and an extremely high level of instrumental background. On one hand, state of the art methods of image reconstruction provide a dynamical range in intensity of >1000, which is beyond reach for most high-energy missions. On the other hand, the photon flux of many astrophysical hard X-ray/γ-ray sources is so low, that it is often below 1/1000 of the instrumental background level. These conditions imply that typical *INTEGRAL* exposure times exceed $(1/1000)^{-2}$ s, i.e., >1 million seconds, needed to accomplish the scientific goals set for many of the sources of interest. This holds in particular also for high-resolution γ-ray spectroscopy of nuclear decay lines – such as in SN remnants – which often require several Ms of exposure time.

2 - Science Case

2.1 Mission impact and metrics

The *INTEGRAL* observing program is established through annual Announcements of Opportunity (AOs). The community interest remains strong, which is indicated by an over-subscription of 4.8 for the coming observing period (2015). Due to the large FOV (up to ~30°x30° down to zero response; compare to, e.g., 12' of *NuSTAR*), on average, the results of each observation are used for ten different scientific projects by different scientists or groups.

The number of known cosmic hard X-ray/soft γ-ray sources has tremendously increased thanks to the 600+ sources discovered by *INTEGRAL*, and now exceeds 1000. More importantly, *INTEGRAL* has transformed our knowledge of the nature of many individual high-energy sources, by providing both accurate positions and detailed high-energy spectra for the first time. As a result, ~250 of the newly discovered sources have been firmly identified, and their dominant physical processes studied and understood in detail.

INTEGRAL observations have resulted in a total of 801 refereed publications up to July 2014, with an average publication rate of ~70 per year. The total number of PhD theses based on *INTEGRAL* is ~100. During 2013 an average of about 2.5 TB of scientific data was downloaded per month from the *INTEGRAL* archive at ISDC, with ~190 unique visits per month. Note that, about 2.5 GB per day is ingested into the archive.

2.2 Confirmation of science case for 2015 and 2016

As discussed in Sect. 3, the scientific performance of the mission in 2015/2016 is expected to be effectively unchanged from that presented at the last extension request. The key science areas of *INTEGRAL* specified in 2012 were: γ-ray lines from nucleosynthesis in supernovae and novae, and from $e^{\pm}$ annihilation, emission mechanisms in white dwarfs, neutron stars, and stellar black holes, supermassive black holes in Active Galactic Nuclei (AGN), and γ-ray bursts. It is thus expected that the scientific objectives in these key areas (exemplified by the AO program in 2015) defined for this interval in the 2012 case will be accomplished.

2.3 Science case for the extension interval 2017 and 2018

The discoveries made since the previous extension, where *INTEGRAL* either made the discovery or was a main contributor, include the following examples:

(1) Discovery of the first neutron star that switches between accretion- and rotation-powered emission states (IGR J18245-2452 [E13]; *XMM-Newton* showed it is pulsating [P13]);

(2) The first-ever detection of ^{56}Ni and ^{56}Co decay γ-ray lines from a Type Ia SN2014J, the latter allowing the direct determination of the amount of ^{56}Ni produced [D14b,C14,I14, see also Fig. 2 on page 7];

(3) Feedback from massive stars to the ISM: tracing superbubble kinematics with ^{26}Al [K13];

(4) A new phenomenon: soft γ-ray afterglow from γ-ray bursts (GRB120711A) [M14b].

These discoveries significantly expand the list of achievements reported previously:

(1) First large-scale sky-map at 511 keV (e^--e^+ annihilation), which is now refined and presents a remarkable puzzle involving anti-matter and possibly dark matter. This is the only direct evidence of the presence of anti-matter in bulk in the Universe.

(2) Discoveries and new applications in the area of astrophysics with radio-active isotopes: (i) detection of ^{44}Ti X-ray lines from core-collapse SNe Cas A and SN1987A; (ii) proof of the Galaxy-wide origin of ^{26}Al; (iii) detection of ^{60}Fe, with the ratio ^{26}Al/^{60}Fe constraining SN models; (iv) determination of the current, galaxy-wide core-collapse SN rate with ^{26}Al.

(3) Advancement of knowledge of the extragalactic sky: (i) first measurement of the fraction of Compton-thick AGN; (ii) determination of the AGN hard X-ray luminosity function; (iii) discoveries of record-distant QSOs in hard X-rays.

(4) Discoveries: (i) two new classes of relativistic binaries: compact objects enshrouded by the dense winds of massive stars (highly-absorbed high-mass X-ray binaries, HMXBs), and Supergiant fast X-ray transients (SFXTs): HMXBs characterized by extremely large

short-lasting outbursts; (ii) identification of the source of "diffuse" galactic ridge hard X-ray emission (dominance of accreting white dwarfs); (iii) hard spectral tails in ultra-magnetic neutron stars ("magnetars"); (iv) polarized high-energy emission from Cygnus X-1; (v) correlation of cyclotron-line energies with the height of the accretion columns.

(5) New high-energy features: (i) Crab is *not* a stable calibration source; (ii) polarized γ-ray emission from Crab, Cyg X-1 and GRBs; (iii) diffuse hard X-ray emission from the Vela pulsar wind nebula; (iv) 1st catalogue of rotation-powered pulsars with pulsed hard X-ray emission to ~150 keV; (v) tracing past activity of the massive black hole in the centre of our Galaxy via its Compton echo; (vi) discovery of a class of faint GRBs with long spectral lags; (vii) stringent limits on violations of Lorentz invariance using polarization of GRBs.

For the extension interval, the key science focus of *INTEGRAL* will *likely* continue to be (depending on the outcomes of AO process): (A) γ-ray line spectroscopy, (B) non-thermal physical processes, and (C) time-domain astrophysics. Dealing with each area in turn:

A – γ-ray line spectroscopy

(A1) Novae and supernovae: The internal dynamics of core-collapse supernovae and Type Ia (thermonuclear) SNe (SNIa) are not yet fully understood. *INTEGRAL* can measure γ-ray lines, which reveal freshly synthesized nuclei that ultimately power the supernova emission, and provide direct access to the SN interior and the energy sources created in these explosions. *INTEGRAL* discovered γ-rays from ^{56}Ni and ^{56}Co decay in SN2014J (Type Ia), for the *first* time, with sufficient significance [C14,D14b,I14] to constrain models for how ^{56}Ni ejecta are spatially and kinematically distributed throughout the envelope. Nearby SNIa represent rare opportunities, for which γ-ray spectroscopy offers truly unique insights [e.g., I13]. SNIa are recognised as standard candles, but an understanding of any underlying variations (due to changes in ignition sites, hydrodynamic instabilities, asymmetries, etc.) will allow their use as cosmological standards to be fully exploited.
For novae, continued observations are essential to find the expected nucleosynthesis signatures in ^{7}Be, pre-discovery 511 keV flashes, and ^{22}Na γ-rays (in rare, nearby events). X-ray novae (XN) could provide unique diagnostics of their black holes through the detection of potentially red-or blue-shifted 511 keV line emission. Bright novae are rare, but such features could yield important insights if observed by *INTEGRAL*.

(A2) Dynamical mixing of nucleosynthesis products: γ-ray lines from freshly created elements provide unambiguous signals from massive stars and their explosions and from their interaction with the interstellar medium. Measurements of the Doppler-shifted line from ^{26}Al along the plane of the Galaxy revealed velocity offsets with respect to other Galactic objects, showing that ejecta flows are asymmetric and likely associated with superbubbles at the spiral-arms' leading edges [K13]. *INTEGRAL* measurements of additional regions (e.g., Cygnus and Orion) will provide new perspectives on massive-star outflows with a velocity resolution of ~100 km s^{-1}, utilising the inherent clock of radio-active decay.

(A3) Electron-positron annihilation: The origin of the interstellar positrons that produce the 511 keV line emission observed from the Galactic bulge region is a 40-year old mystery. *INTEGRAL* has mapped this emission (511 keV + continuum) over large scales [S14a]. Positron production mechanisms range from nucleosynthesis, through binaries, to the decay of dark matter particles. The morphology and spectrum can currently *only* be measured by *INTEGRAL*. Future SPI results could have broad implications for production and propagation models for these positrons, accomplishing an accurate bulge/disk decomposition and a refined study of the detected asymmetries. The PAMELA and AMS-02 (ISS) experiments and the *Fermi*/LAT observations have greatly advanced our understanding of the local positrons, and offered support for dark matter decay models. Disentangling contributions from sources in the Galaxy and dark matter will be greatly aided by *INTEGRAL*'s refined mapping of the 511 keV signal from the bulge/disk.

B – Non-thermal physical processes

(B1) AGN primary continuum: The unique high-energy spectral coverage and sensitivity of *INTEGRAL* allows the physical mechanisms responsible for the hard X-ray/γ-ray emission of AGN/supermassive black holes to be distinguished (M13b,M14a). Relativistic jet-based emission and inverse Compton scattering in a corona near a supermassive black holes is the leading scenario. An increased exposure from *INTEGRAL*, together with measurements from *NuSTAR* and *Fermi*, will allow the long-standing question of how and where AGNs produce their high-energy emission to be addressed. The precise measurement of a spectral rollover above ~150 keV will *only* be possible with *INTEGRAL*.

(B2) AGN population studies and the cosmic X-ray background (CXB): Deep studies of hard X-ray emission from the brightest AGNs and a combination of measurements of a sample of AGNs provide information on their contribution to the cosmic hard X-ray/γ-ray background [e.g., M13c]. *INTEGRAL* is able to perform such deep surveys, free from biases caused by absorption (interstellar, or intrinsic to the source), which cannot be provided by any other existing facility. A key result from *INTEGRAL* is the detection of a large, varied sample of AGNs (including Compton thick AGNs, giant radio galaxies, etc.) and the determination of the hard X-ray AGN luminosity function in the local Universe [S12]. Combining this with narrow-field surveys, currently performed with *NuSTAR*, will make it possible to study the AGN population out to z~0.25 (i.e., within 1 Gpc from us) in an unbiased way, and, in particular, to learn about the evolution of the AGN number density and hard X-ray emissivity in this redshift range. Bias-free samples of *INTEGRAL*-detected AGN provide an important starting point for studies of the broad-band spectral behaviour of populations of supermassive black holes, which will advance further by combination with the data from new surveys at other wavelengths, such as SDSS, PanSTARRS and WISE.

(B3) Diffuse hard X-ray emission of the Galaxy: Cosmic-ray (CR) particles filling the volume of the Galaxy interact with interstellar matter and the diffuse radiation field, and create high-energy photons. Measurement of this diffuse emission component in the 50 keV–10 MeV band is difficult, because it requires accurate disentanglement of the contributions from individual point sources from the total photon flux [B11,K12 (Fig. 1)]. In the foreseeable future, *only INTEGRAL* is able to provide such measurements, due to its large FOV and - over a decade - stable instrumental background. Diffuse soft γ-ray emission of the Galaxy provides a powerful probe of the nearly inaccessible, solar-modulated low-energy regime (<1 MeV) of the CR spectrum. Continuation of the long-term survey, which *INTEGRAL* currently dedicates to this study, will produce a legacy result of highly significant scientific impact.

(B4) Soft γ-ray emission of Galactic sources (binaries and magnetars): The origin of the soft γ-ray emission detected in a number of bright accreting compact objects (e.g., Cyg X-1 and Sco X-1 [M13a]) is under debate – does it originate in a corona-like structure above the accretion disk or from a jet? *INTEGRAL*'s discovery of polarization of the high-energy spectrum of the accreting black-hole binary Cyg X-1 [e.g., J12,R14a], supports the latter. Progress in understanding the emission from compact objects at >200-500 keV is currently being driven by *INTEGRAL* observations (e.g., XSS J12270-4859 [P14a]). A new high-energy component from magnetars was discovered with *INTEGRAL* [e.g., W14], initiating new studies of plasma physics in environments with extremely strong magnetic fields. Modelling of this emission predicts that it should peak at ~1 MeV and might contain an annihilation line [B13]. *INTEGRAL* is thus able to unveil the dominant emission mechanisms in the most magnetized objects in the Universe with deep observations during magnetar outbursts.

C – Time domain astrophysics

(C1) The black hole at the Galactic centre: Our Galaxy contains a supermassive black hole (Sgr A*) at its centre, which is currently weak in X/γ-rays. *INTEGRAL* has shown that in the past the black hole was a much stronger X-ray source, as presently revealed through Compton reflection from nearby molecular clouds [G13b]. This echo exhibits variability on a time scale of years. Continuation of this study will provide the long-term accretion history of the nearest representative of the class of supermassive black holes. Thus, *INTEGRAL* contributes to our understanding of the growth mechanisms of these sources. The interaction of the molecular cloud G2 with Sgr A* may soon provide a once-in-a-lifetime flare event.

(C2) Transient sources reveal accretion physics: Different modes of accretion manifest themselves in transient outbursts in compact binaries. The high-energy domain is the key window for accretion dynamics. The sources are mainly located in crowded regions of our Galaxy. *INTEGRAL*'s large FOV and arc-min localization accuracy ensures that new faint/bright transient phenomena are found, *unambiguously* localised and promptly followed up. An important example is *INTEGRAL*'s discovery of IGR J18245-2452 [E14], the first pulsar that repeatedly changes from accretion to rotation-powered emission regimes [F14]. *INTEGRAL* has discovered ~30% of all known accreting msec pulsars, and this new multi-regime pulsar presents the best evidence for pulsar recycling in action. Other similar systems could appear in the future allowing a more systematic study of these unique objects.

INTEGRAL also discovered an important new class of Galactic X-ray sources: SFXTs – stellar binaries in which neutron stars transiently accrete matter from supergiant companions. They are characterised by intermittent and sporadic bright outbursts with a luminosity range of >10^5, sometimes separated by several months. Systematic studies of these systems indicate that their mode of accretion and duty cycles differ from that in persistent supergiant HMXBs [D13,L13,D14a,P14b,R14b] and are related to complex interaction of the intercepted stellar-wind material with the neutron star magnetospheres [S14b]. Continuation of these studies will help with developing a full understanding of the physics of interaction of matter with neutron-star magnetospheres and for determining the long-term evolution of these systems.

(C3) Extragalactic transient events and γ-ray bursts: The tidal disruption of stars by black holes produce high-energy transient events in the extra-galactic domain, such as the faint event IGR J12580+0134 detected by *INTEGRAL* [N13]. These tidal-disruption events are predicted to occur at a rate of ~1/year in a spherical volume of radius ~100 Mpc. Long-term *INTEGRAL* observations may improve on determining the rate of these events, inform us about the emission properties of these transient feeding episodes of otherwise dormant black holes, and constrain the evolution of their mass function. *INTEGRAL* furthermore continues searches for giant flares from extra-galactic magnetars in M81 and M31.

Advances in the study of GRBs depend on rapid and accurate source localisations. Arc-min positions of GRBs are derived and distributed in real-time by the *INTEGRAL* Burst-Alert System at a rate of about 10 GRBs per year (~100 to date). For about 25% of these GRBs, broad-band spectroscopy of the prompt emission from 3 keV to several MeV provides unique access to the prompt-afterglow transition regime in this energy window [B14]. Follow-up observations by other facilities have resulted in more than 50 X-ray, optical, and/or radio counterparts with z=0.1–3.8. Soft γ-ray emission lasting several hours was detected by *INTEGRAL* (GRB 120711A [M14b]). Adding further diversity, is the recent finding of ultra-long GRBs, lasting >1000 s [L14,E14]. The relative paucity of such bursts may be due to their intrinsic rarity, the low sensitivity of instruments to the very long-lasting, low-flux emission, and the short orbits of low-Earth missions. *INTEGRAL*'s sensitivity and long, 72-hr orbit provide a unique combination that promises to discover more of these sources in the future.

INTEGRAL's pioneering discoveries of γ-ray polarization in 3 bright GRBs (041219A, 061122, 120711A [G13a,M14]) allows fundamental questions about the prompt emission mechanism, the composition (magnetic versus baryonic) and geometric structure of their relativistic jet flows to be addressed. Furthermore, the variation of γ-ray polarization angle with energy (or lack thereof) due to propagation over cosmic distance, provides a test of the principle of Lorentz invariance, which is independent of the one derived from differences in arrival times of high- and low-energy photons. The detection of more distant (>100 Mpc) GRBs will test the Lorentz invariance violation hypothesis beyond the cosmic distances already probed. The use of GRBs in this context could provide one of the most lasting legacies of *INTEGRAL*.

Gravitational wave signals from coalescing double neutron stars in galaxies out to 120 Mpc distance are expected to be detected at a rate of several per year in the coming years with Advanced LIGO and other GW antennas. These signals – with poor positional accuracy – are expected to be accompanied by short GRBs; *INTEGRAL* with its large FOV and good positional accuracy will be ideal for detecting these and identifying their places of origin.

2.4 Complementarity and uniqueness

INTEGRAL remains one of the pillars in the current high-energy fleet. SPI remains unique for the coming decades as the *sole* instrument with the capability for high-resolution γ-ray spectroscopy in the MeV range, essential for Galactic and extragalactic nucleosynthesis studies. *INTEGRAL* provides a large FOV, excellent X/γ-ray sensitivity during long and uninterrupted observations, msec time resolution, keV energy resolution and unique polarimetry capabilities. *INTEGRAL,* therefore, connects X-ray missions with higher-energy γ-ray facilities. For example, while at <80 keV the focusing hard X-ray *NuSTAR* telescopes provide a significant increase in sensitivity (but over a FOV 3 orders of magnitude smaller than that of *INTEGRAL*), at >80 keV up to the MeV range, any new, superior technology is still beyond the horizon. Therefore, *INTEGRAL* will remain the *only* observatory worldwide providing broad-band, 3 keV–10 MeV, capabilities to the community in this decade.

Other new facilities dedicated to the energetic universe have recently, or will soon, become operational. These include new optical/IR and radio/submm telescopes (e.g., ALMA, LSST, LOFAR), to Cherenkov telescope arrays, complemented by ultra-high-energy CR, neutrino and gravitational wave detectors (e.g., Advanced LIGO/Virgo). Simultaneous multi-λ and multi-messenger observations of a large variety of astrophysical phenomena are creating new opportunities for this and the coming generation of scientists. *INTEGRAL* provides *exclusive* coverage of a key energy band in these studies. The non-thermal and nuclear universe contains many exotic objects ready to be utilised as test beds for physics at the extremes.

2.5 User Group recommendations

The *INTEGRAL* Users Group accentuates *INTEGRAL*'s unique capabilities and continued contributions to the field of high-energy astrophysics. There is continued strong interest from the scientific community and significant potential for discoveries from future observations. Furthermore, the synergies with existing and future space missions and ground-based observatories will add new perspectives in the coming years. The Users Group enthusiastically affirms its recommendation of the continued operation of *INTEGRAL*.

3 - Spacecraft, Payload and Ground Segment Status

The status of the satellite, instruments and GS remain excellent. No significant change in performance is expected during the requested confirmation or extension intervals. The instrument teams continue the necessary support to calibration, modelling, software maintenance and operations. Significant budget reductions in overall *INTEGRAL* GS are being implemented since 2013, reducing the GS to a workable but minimal level. *INTEGRAL*'s passages through the proton belts in the past years led only to a moderate increase in the solar arrays' degradation rate and a higher number of suspect pixels in the star-trackers, neither affecting operations nor science capabilities. With current consumption rates the fuel might last an additional 12–14 years. The slowly degrading solar arrays are expected to provide sufficient power for unconstrained operations up to mid 2020.

The performance of the SPI cryo-coolers remains nominal. 24 annealing cycles were successfully executed, maintaining the pre-launch energy resolution. The number of SPI detectors is stable since 2010. The reduction of effective area has been negligible for IBIS and JEM-X in recent years. The OMC shows no significant degradation either, with a stable flat-field calibration and still negligible dark current.

The evolving orbit will lead to a maximum perigee altitude of ~9700 km in October 2015. Perigee passages will remain above the proton belts up to March 2018. Solar activity is decreasing as we move away from solar maximum, with a stable particle background rate.

The large fuel reserves leave room for a pro-active disposal strategy. An option is being studied in which a large delta-V manoeuvre in early 2015 would lead to re-entry in 2029 in a well-constrained zone at southern latitudes with very little land coverage and a risk level well within accepted standards. The manoeuvre would use about half the remaining fuel or less, still leaving reserves for operations well beyond the requested extension period.

Implementing the 4WD attitude control scheme, as already done for *XMM-Newton*, would reduce the fuel consumption significantly and allow for longer controlled operations.

4 - MEOR Recommendations

The overall status, performance and stability of all the spacecraft elements was examined in the June 2014 Mission Extended Operation Review (MEOR) and deemed to be very good with prime units in use in all cases, i.e., full redundancy has been maintained.

5 - National Funding Status and Prognosis

The instrument and data centre consortia provide continuing critical support and expertise to the *INTEGRAL* operations with specialized expertise, anomaly investigations and calibration efforts. Support from the instrument teams and ISDC is foreseen at the level of an estimated 35 FTEs. The MEOR examined the level of support and considered it solid.

6 - Financial Request

The ESA resources necessary for INTEGRAL operations for 2015 and 2016 have previously been costed at 7.3 and 7.0 M€ (2013 e.c.), respectively (cf. ESA/SPC(2013)13). It is expected that ESA resource needs for 2017-18 would be broadly similar.

7 - Conclusions

INTEGRAL continues to operate excellently. The mission should be continued, in view of its unique set of capabilities, with high-resolution γ-ray spectroscopy, polarization, large FOV, and unparalleled imaging dynamic range as prime examples. These and the excellent technical status and outlook imply that it is fully justified to expect that the mission will continue to benefit the global science community.

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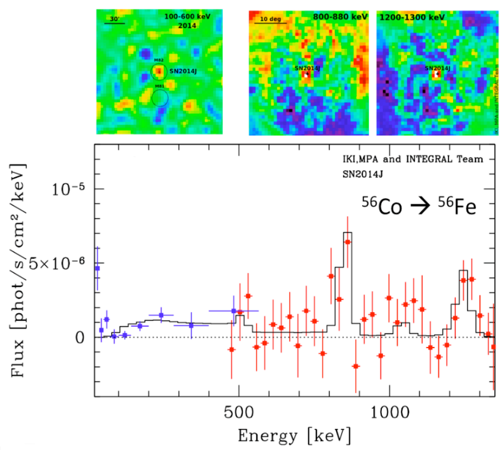

Figure 1 (*top of Page 1*):
A 120°×20° significance mosaic map of our Galaxy in the INTEGRAL/ISGRI 35-80 keV band. The green contours are isophotes of the COBE/DIRBE 4.9 micron surface brightness of the Galaxy revealing its bulge/disk structure. [Taken from K12]

Figure 2 (left):
Top: INTEGRAL images, showing the γ-ray source at the position of SN2014J. Bottom: Spectrum of SN2014J obtained by INTEGRAL between 50-100 days after the explosion. Red and blue points show the SPI and ISGRI/IBIS data, respectively. The flux below 60 keV is dominated by the emission from M82. The black curve shows a fiducial model of the SN γ-ray spectrum for day 75 after the explosion. [Taken from C14]

Appendix: contains figures, mission impact and metrics, instrument parameters, and list of PhD theses. See also: http://www.cosmos.esa.int/web/integral/teams-iug.