INTEGRAL

Science Operations Centre

Announcement of Opportunity for **Key Programme Observing Proposals** for the AO-5 Cycle of Observations

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1 Introduction

1.1 Purpose of this document

This document contains the guidelines concerning the Announcement of Opportunity for **Key Programme (AO-KP)** proposals, and highlights deviations from the existing documentation applicable for the on-going observing programme (AO-4 cycle). Details on Key Programmes are provided in further detail in section 2.

1.2 Proposals for Key Programme observations

Proposals for Key Programme (see 2) observations which have been submitted in response to this AO-KP and which have been selected by the Time Allocation Committee (TAC) will be executed during the AO-5 cycle of observations (2007/2008) and will entitle the Principal Investigator(s) to use INTEGRAL science data to conduct the scientific investigations as approved by the TAC.

1.3 Nomenclature

Throughout this document the following nomenclature is used:

This AO for KP is called in the remaining body of this document: **AO-KP**.

A (standard) Announcement of Opportunity calling for observations proposals similar to previous calls AO-1 until AO-4 is called in the remaining body of this document: **AO-N**.

1.4 Schedule and scope for this AO-KP

The following is the schedule for this AO-KP (see also Figure 1 with the subsequent AO-N):

- 09 October 2006: Release of the Announcement of Opportunity
- 17 November 2006, 15:00 CET: Deadline proposal submission
- December 2006: TAC peer review and recommendations for selection
- December 2006: ESA approval of selected KP proposals

This AO-KP is open to proposers from the ESA Member States, and the countries participating in INTEGRAL (Russia, USA, Czech Republic and Poland), but proposals from other countries will also be considered by the TAC during the peer review process.

1.5 Proposals from the USA

Proposers at institutions in the USA may respond to this AO-KP either as Principal Investigators or as Co-Investigators on non-US proposals. Accepted US investigators should request funding from NASA via a separate solicitation.

1.6 Overview of this Call for Proposals (AO-KP)

This call for INTEGRAL proposals solicits proposed investigations to be considered as **Key Programmes only.** Successful KP proposals resulting from this Call will be known before the release of the next call for proposals AO-N (i.e. AO-5) scheduled for release in Spring 2007 and they will be scheduled for execution during the next AO-N observing cycle (in this case during AO-5 observing cycle which will commence in August 2007), see also Figure 1. The list of selected KP proposals will be published in the AO-5 document package such that the scientific community can then submit proposals for individual targets (point sources or extended areas) which are also covered by the sky areas exposed to KP proposals (and not blocked by the KP investigation itself) and which shall be considered as proposals "associated with KP's" in AO-5. In fact those associated proposals, selected in AO-5, will be *amalgamated*[1] with the KP proposals.

[1] "Amalgamation" here means a combination of various observations close in space from data right point of view only, not from operational scheduling point of view: the observations (i.e. pointing strategies) to be executed are purely defined by the accepted KP proposals and not changed to accommodate associated proposals from the subsequent AO-N, as during normal amalgamations performed by ISOC as described in the AO-4 document *Mission Overview*.

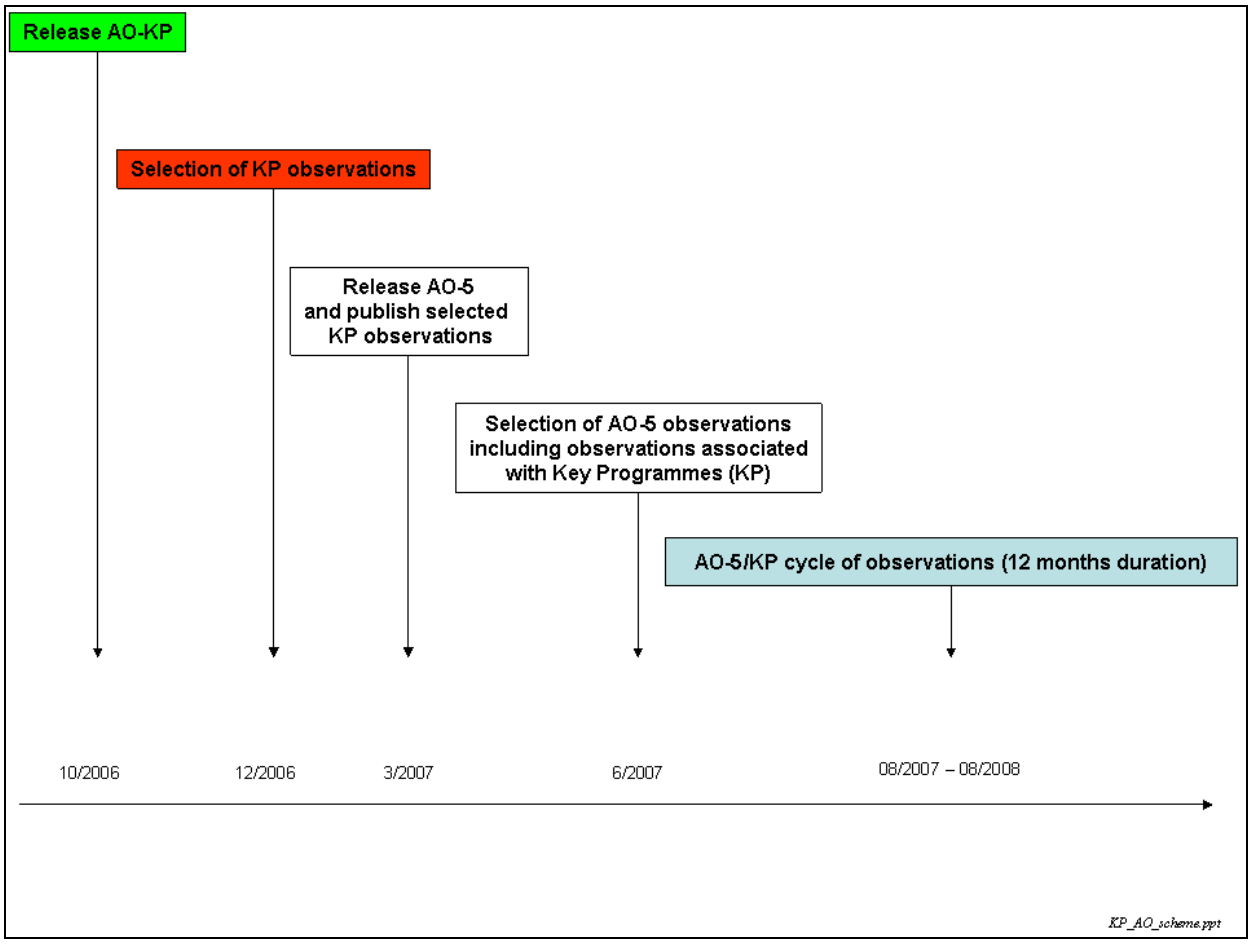

Figure 1 Schematic flow showing the connection of this AO-KP with the next AO-N (i.e. AO-5).

This document is supported by descriptions of the INTEGRAL mission, and instruments which are valid for the current AO-4 observing cycle and which can be found on-line at ESA's INTEGRAL Science Operations Centre homepage at http://integral.esac.esa.int/AO4/documentation.html.

Restrictions and deviations from the AO-4 document package are summarized in section 2.2.

On the same homepage, observers can find links to download[2] the Proposal Generation Tool (PGT) and links to access the Observing Time Estimator (OTE) and the Target Visibility Tool (TVP). Note that OTE and TVP run remotely through the web, whereas PGT needs to be downloaded and installed on the users' local machine(s).

1.7 Extended mission, future AO's and available observing time

The INTEGRAL extended mission is currently approved until December 2010, subject to a status and performance review in fall 2007. At this point in time, it is the intention that AO-N's will be issued on an annual basis, hence the duration of each AO-N cycle will be 12 months,

[2] PGT download will be available starting 23 October 2006

starting in August of each year. It is the intention that each AO-N will be preceded by an AO-KP, such that approved Key Programmes can be communicated in each subsequent AO-N release.

The estimated total time available for scientific observations per AO-N cycle of 12 months duration is of the order of 24 Ms which includes open and guaranteed time observations. The amount of guaranteed time observations is as follows:

- 25% (or about 6 Ms) of the total observing time until the end of 2007,
- 20% (or about 4.8 Ms) for the entire year 2008, and,
- yet to be determined for the years 2009 and 2010.

1.7.1 Available observing time for KP's in this AO-KP observing cycle

The exact total amount of time which will be set aside (per year) for the sum of all approved KP's to be executed in the subsequent AO-N observing cycle (here: AO-5) is to be decided. As a guideline, an amount of about 6 Ms can be considered here. If scientifically justified, however, KP proposals may extend beyond the duration of one normal AO-N cycle (i.e. "multi-year proposals").

2 Key Programmes

An INTEGRAL key programme (KP) is a scientific investigation which requires a very significant fraction of the observing time (available per AO-N cycle) in order to achieve its scientific objectives. Typical examples are ultra-deep observations of nucleosynthesis emission and/or diffuse emission (lines and continuum), or studies of (a number of) point sources in a field, each requesting a few Ms observing time. If scientifically justified, a KP could cover a time span exceeding that of one AO-N cycle ("multi-year" proposal).

Using the unique "targets multiplicity" feature of INTEGRAL's coded aperture masks, in combination with the very large field of view, allows to accommodate the various requirements of the scientific community at large, both for ultra - long KP studies, as well as for (much) shorter observations of many individual compact objects (e.g. point sources), or other deep diffuse (line) studies which are contained in those (large) KP fields as well.

Proposals for KP investigations including their observing strategies can in principle be submitted similar to standard open time proposals (AO-N) using the tools provided by ISOC. However, due to the nature of these investigations and their anticipated use by the science community at large, also in combination with future proposals to be associated with the KP's in response to the subsequent AO-N, some technical items are different or not applicable as described in the AO-4 documentation. As an example we note the possibility to propose a user-defined pointing grid. These deviations and/or restrictions compared to AO-4 are described in detail in section 2.2 .

Proposals for individual known targets (point source and extended sources) which are located within the sky areas of the selected KP's will be solicited for in the next AO-N (here: AO-5), following this AO-KP. In fact those selected associated proposals will be "amalgamated" (see footnote on page 6) with the selected KP proposals.

The KP is a new feature in the INTEGRAL observing programme. It has been successfully introduced as a "pilot project" in the 4th Call for Proposals (AO-4) which was released in March 2006 (see AO-4 document on *Key Programme*) and which has triggered the scientific community to submit 43 proposals (30% of all AO-4 proposals received) for targets to be associated with that KP for AO-4 which is investing 2 Ms on the Galactic Centre region.

The above implies, that KP proposals should anticipate the possibility that additional associated proposals on individual targets within the KP area during AO-N can be accommodated, i.e. **the usefulness of the field(s) for other (associated) studies will be a criterion for KP proposal evaluation and selection** (see section 2.3 and examples below).

In order to illustrate the philosophy of a KP observation, together with associated targets, an example is given below. The reader should also consult the AO-4 documentation describing the "pilot" Key Project in detail.

Example for a Key Programme[3]: The Cassiopeia region

Consider (as accepted KP observation) for example a deep observation of the Cassiopeia region with the scientific aim to perform an in-depth study of the SNR's Tycho and Cas A (see *Figure 2*). The observations could be performed using some combination of several 5x5 dither patterns, each pointing at a (slightly) different location, or using a user-defined (KxL) grid. While Tycho and Cas A would be the subject of the KP investigation itself, belonging to the PI of the KP observation, additional AO-N proposals could be associated for each (or more) of the following targets, covered by this KP observation (*Figure 2*):

1. 2S 0114+650 [Supergiant X-ray binary]
2. 4U 0142+614 [Anomalous X-ray pulsar]
3. RX J0146.9+6121 [Be X-ray binary]
4. IGR J00234+6141 [HMXB ?]
5. IGR J00370+6122 [Supergiant X-ray binary]
6. Gamma Cas [Be X-ray binary]
7. V709 Cas [Intermediate polar]
8. Diffuse emission from the plane region

Also note in *Figure 2* the transient (serendipitous) sources (see section 2.2.10 for details).

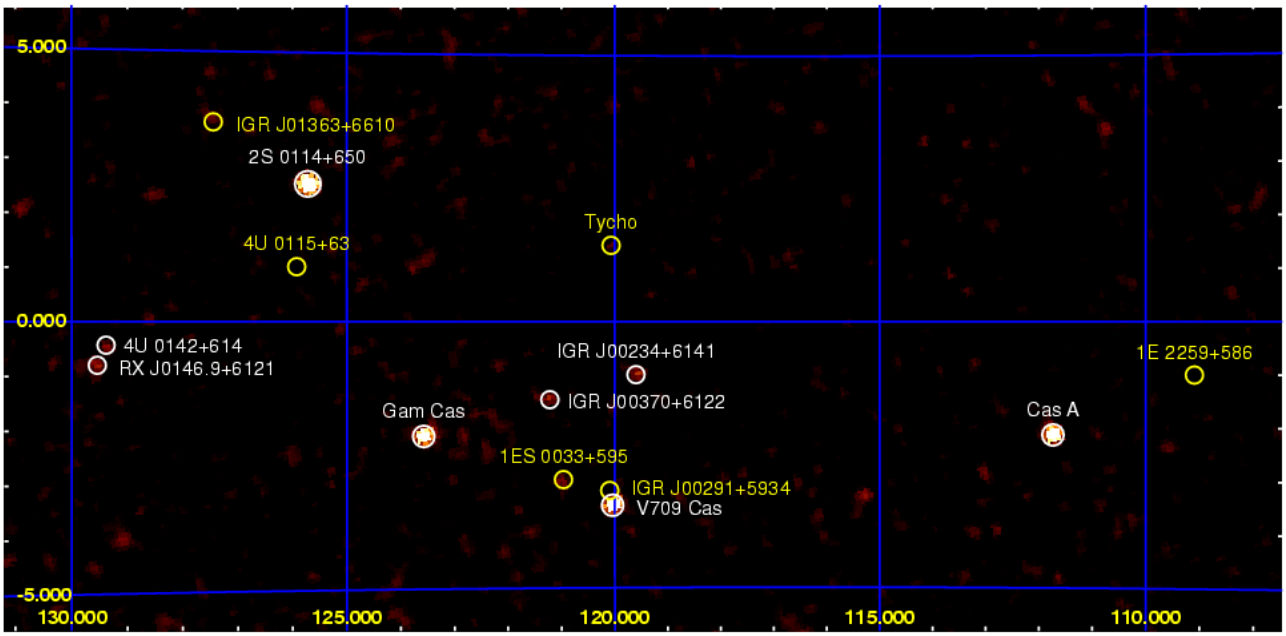

Figure 2 Significance map of the Cassiopeia region at hard X-rays (20 – 50 keV, effective exposure: 1.6 Ms) in Galactic coordinates (l, b) as observed by IBIS. All excesses with positive significances are drawn. Indicated with white circles and annotations are the sources significantly detected during these observations. Indicated with yellow circles and annotations are transient sources which have been weakly detected in this work and/or detected with INTEGRAL at other epochs. The weakest (marginally) detected source is Tycho with 3.5σ, while the brightest source in this field, 2S 0114+650, is detected with 43.1σ. Note the IBIS fully coded FOV is (9x9) deg and the SPI fully coded FOV is 16 deg (across).
Image and caption (adapted) from P. den Hartog et al. "INTEGRAL survey of the Cassiopeia region in hard X-rays", A&A, 451, 587, 2006.

[3] Another example is presented in the AO-4 document on *Key Programme*

In contrast to this example, the reader should note, that a KP proposal which, after specifying a pointing direction and dither pattern(s), **claims to investigate all targets contained within the entire field of view** (fully or partially coded) can not be considered as a valid submission for evaluation by TAC, because the usability of this KP for associated proposals can not be achieved.

2.1 Proposal submission

The scientific community is invited to submit proposals for INTEGRAL **Key Programmes only** using the PGT provided by ISOC (http://integral.esac.esa.int) and consulting associated documentation which is valid for the current AO-4 cycle and can be found on the ISOC WWW site as well.

2.2 Restrictions and limitations

In general, the policies and procedures for the submission of proposals as laid down in the current AO-4 documentation are valid for this AO-KP. However, due to the nature of these investigations and their anticipated use by the science community at large, also in combination with future proposals to be associated with the KP's in response to the subsequent AO-N, some items are different or not applicable as described in the AO-4 documentation. These deviations and/or restrictions are listed here below for each of the AO-4 documents:

List of INTEGRAL AO-4 documents

- Mission Overview, Policies and Procedures
- Guaranteed Time
- Key Programme (for AO-4, for information only)
- IBIS Observer's Manual
- SPI Observer's Manual
- JEM-X Observer's Manual
- OMC Observer's Manual
- Proposal Generation Tool (PGT) Software User's Manual
- Target Visibility Predictor (TVP) Software User's Manual
- Observation Time Estimator (OTE) Software User's Manual
- Annexe on INTEGRAL Science Data Rights

2.2.1 Misson overview, policies and procedures

In general, like previous AO's, a proposal in response to this AO-KP consists of one or more observations (using the PGT software, see 2.2.7) and a science justification.

The science justification shall demonstrate the scientific goals to be achieved by this investigation, and it shall include a specification for the target field (for example, a specific sky area to study diffuse emission), or for the proposed point source(s) (i.e. source list) which will be analysed (see section 2.2.10 on data rights) in order to achieve the scientific objectives set out in the proposal (see also below). As outlined above, KP proposals should anticipate the possibility that additional associated proposals on individual targets within the KP area during AO-N can be accommodated, i.e. the usefulness of the field(s) for other (associated) studies will be a criterion for KP proposal evaluation and selection and must be addressed in the science justification. The reader should note, that a KP proposal which, after specifying a pointing direction and dither pattern(s), claims to investigate all targets contained within the entire field of view (fully or partially coded) can not be considered as a valid submission for evaluation by TAC, because the usability of this KP for associated proposals can not be achieved. In addition, the scientific justification shall be used to provide any necessary (technical) information on user-defined grids (if applicable) and source lists (if applicable), and other technical information which will not be captured by the PGT software and the reader is referred to section 2.2.7 for further technical information to be provided in the science justification.

The following restrictions/deviations from AO-4 are applicable:

1. **Observation type:** Observations belonging to a KP proposal can only be of type "normal". Hence, the options "targets of opportunity" or "fixed time" are excluded, because the execution of a KP based on certain trigger criteria and/or using yet unknown source positions is not in line with the overall philosophy. Furthermore, the combination of a "fixed time" constraint together with a large amount of exposure time required for KP's is not desirable from ISOC planning point of view.

2. **Dithering type:** For each observation in a proposal, the user can choose to use either:

   a. the standard 5x5 dither pattern (including COP move[4]) using the default 2.17 deg step size, between individual dither pointings,

   or,

   b. a user-defined grid of size (K x L) pointings. An example would be the (10 x 5) grid implemented for the observations of the Norma and Scutum arm regions during the Core Programme observations during the AO-3 observing cycle[5]. This option is selectable from a pull down menu in the PGT. Most parameters to define this grid have to be provided in the science justification. See section 2.2.7 and the PGT User Manual for details.

[4] *See AO-4 document INTEGRAL Mission Overview*
[5] *See AO-3 document Guaranteed Time (http://integral.esac.esa.int/AO3/)*

General Notes

i. For any non-standard pattern (i.e. other than the standard 5x5 dither pattern) there will be an "enhancement" stage with ISOC and the instrument team experts after the TAC approval to optimize the observation strategy given the scientific goals and the constraint to allow associated proposals.

ii. If the user wishes to propose a combination of N (with N>1) dither patterns/grids to achieve the objectives of the proposed investigation, then the proposal must consist of N (with N>1) observations, each with its own dither pattern. For example, for the AO-4 *Key Programme*[6] N=2 patterns (standard 5x5) were arranged "side-by-side", i.e. the same pattern but with different grid centre pointings, in order to achieve an overall good coverage of the Galactic central region. In this case, the proposer would submit N=2 separate observations within one proposal, each with one different dither pattern location, such that their combination results in the desired configuration.

iii. The options on the dithering type as described above imply, that KP proposals wishing to use a hexagonal dither pattern or staring mode are **NOT** possible.

2.2.2 Guaranteed time (Core Programme)

The Core Programme (guaranteed time observations) for AO-N (here AO-5) will be defined only after the KP's have been selected as a result of this AO-KP, and the Core Programme will be published in the Announcement of Opportunity for AO-N (here: AO-5). It is the responsibility of the Project Scientist to ensure that the Core Programme for AO-N (here AO-5) does not duplicate selected KP's.

2.2.3 IBIS observer's manual

No restrictions and/or deviations compared with the AO-4 document are applicable. Please consult http://integral.esac.esa.int for possible updates on instrument settings.

2.2.4 SPI observer's manual

No restrictions and/or deviations compared with the AO-4 document are applicable. Please consult http://integral.esac.esa.int for possible updates on instrument settings.

2.2.5 JEM-X observer's manual

Please consult http://integral.esac.esa.int for possible updates on instrument settings. The usual INTEGRAL AO policy is noted here, in that KP proposals can not be submitted relying on monitor instruments only.

[6] *See AO-4 document Key Programme*

2.2.6 OMC observer's manual

Please consult http://integral.esac.esa.int for possible updates on instrument settings. The usual INTEGRAL AO policy is noted here, in that KP proposals can not be submitted relying on monitor instruments only.

2.2.7 Proposal Generation Tool (PGT) software user's manual

For this AO-KP, a special version of the PGT software has been provided which has to be downloaded from ESA's INTEGRAL Science Operations Centre home page at **http://integral.esac.esa.int/AO5KP/proposal_tools.html**.
A special version of the PGT software User Manual is available at the same address. The proposer **must** use this (special) PGT version only. For details on the contents of the PGT panels the reader is referred to the PGT Software User Manual valid for this AO-KP.

Below is an overview of the changes in the PGT version to be used for AO-KP, compared to the versions used available in AO-N's for standard proposals:

- *Proposal details panel*: It is not possible to select "associate to Key Programme".
- *Distribution details panel*: only option to select is "network". If a user has a problem to use this medium he/she needs to contact the INTEGRAL Helpdesk.
- *Observation details panel*: All source and instrument settings have been removed. There is a new sub-panel defining the celestial coordinates for the grid centre: The centre point may be different from a position of a source the proposer wishes to analyze. In this panel the observation type is limited to a 5x5 standard pattern or to a user-defined grid as mentioned in section 2.2.1.

In case a KP proposal wishes to study a number of (point) sources which will be covered by the chosen dither/grid configuration, then it is sufficient to define the dither pattern (observing strategy) once per observation, and provide the sources proposed for that investigation in a source list as part of the scientific justification. Different observations within the KP proposal can use different dither patterns (see also section 2.2.1).

As mentioned earlier, the user-defined grid requires additional information which is not possible to enter via the PGT panels. This information, which must be included in the scientific justification of the proposal for each observation using the user-defined grid, is the following:

- The grid size, (K x L) points
- The orientation of the grid with respect to instrument axes and/or with respect to the sky. With respect to instrument axes, an orientation of 11.3 degrees (only) for the grid is possible for ISGRI imaging performance reasons. With respect to the sky, the allowable range is 0 deg to 180 deg.

The step size between grid points can not be modified for user-defined grids. In order to optimise the imaging performance and to minimize coding noise within the large FOV a step size of 2.17 deg between grid points has been implemented.

For each observation the proposer must provide exposure information in the "duration" field. The dwell time for any individual dither pointing must be in the range between 1800 s and 3600 s, hence the minimum duration for a 5x5 dither pattern is 45 ks and for a user-defined grid the minimum time will be (K x L x 1.8) ks. For any value above the minimum, ISOC will adjust the dwell time per pointing such that there will always be an integral number of complete cycles of the grid.

As mentioned above, this PGT version requires the celestial co-ordinates of the centre of the dither pattern (grid) chosen by the user. This centre point of the grid may be different from the source position the proposer wishes to analyze which is likely to be the case for an ensemble of sources to be studied. The centre position may be chosen to maximize the number of point sources in the area to be observed.

The scientific justification (see also 2.2.1) shall in addition provide the following technical information for each source or field:

- Name
- Position in celestial coordinates (equatorial (J2000) or galactic)
- Flux information (needed for the TAC to asses the scientific value) in energy band relevant for the proposed investigation

2.2.8 Target Visibility Predictor (TVP) software user's manual

The user should be aware that TVP provides a conservative (10 deg resolution) viewing estimate for the centre grid pointing including the entire area covered by the 5x5 standard dither pattern. Estimating visibility periods for user-defined grids may therefore not be readily available with TVP, an estimate however could be obtained by the user replacing the user-defined grid with a standard 5x5 while running TVP.

2.2.9 Observation Time Estimator (OTE) software user's manual

The user should be aware that OTE is only designed to use the standard 5x5 pattern as observing mode (and for observing modes "staring" and "hexagonal", which, however, can not be used for this AO-KP). For more complex dither patterns, however, the usefulness of OTE is limited. One might be able to obtain an indication of the required time (or S/N) by using those time intervals during (user-defined) dither pattern execution, which match a 5x5 dither on that source under investigation, assuming the source is not located close to the edges of the user-defined-dither pattern.

2.2.10 Annexe on INTEGRAL science data rights

Concerning data rights the general policy as established for AO-4 is applicable. We note, that PI's for KP's will have the data rights for the field (e.g. a specific sky area to study diffuse emission), or specified point source(s) to achieve the scientific objectives set out in the proposal and approved by the TAC.

PI's for those observations which have been associated with a specific KP observation during the subsequent AO-N process, obtain the data rights for their individual target(s) within this FOV, only, as approved by TAC. This means that a KP observation together with associated proposals can actually be considered - from the data right point of view - as an "amalgamated" observation. All PI's participating in this "amalgamation", i.e. in the execution of the KP observation, may publish results on any other source or (extended) target which are either not proposed or not allocated by the TAC.
The same rule is – in principle - applicable for all serendipitous sources located in the area, covered by the KP, with the exception, however, for Gamma-ray bursts (GRB) and their subclass, outbursts from *known* soft-gamma repeaters (SGR): Following the results of recent AO-N peer reviews, it is highly likely that open time proposals will again be accepted by TAC during the next AO-N (here: AO-5) for the analysis of data from GRB and from outbursts from known SGR. In previous AO-N's a time window around these events was usually assigned by TAC for these serendipitous sources which are in the prime scientific interest of those PI's, while they constitute secondary science objectives for the PI's participating in the KP. In case these open time proposals would exist and approved, then these open time PI's would be granted data rights – usually for a well-specified time interval – for these sources (GRB and outbursts from known SGR), even if they occur inside the KP area and during the KP observation. In this case all PI's involved will be notified by ISOC. In contrast, any (serendipitous) emission from a new (yet unknown) SGR observed during the KP observation is open for analysis for all those PI's (only) who participate in the KP.

A list of TAC approved sources for all PI's involved in a KP observation will be published by ESA/ISOC after completion of the TAC process for AO-N.

2.3 Proposal evaluation

All received KP proposals will be peer reviewed based on the scientific merit by part, or all, of the TAC, recommended to and endorsed by the ESA Director of Science and the results will be available in time prior to the release of the next AO-N (here: AO-5). ESA/ISOC will assess all proposals on their technical feasibility. The TAC will apply the usual criteria during proposal evaluation as they have been established for AO-N's in the past. However, anticipating additional associated proposals on individual targets within the KP area during AO-N, the TAC will also assess the usefulness of the proposed sky areas for associated point source or associated diffuse emission studies as a criterion for KP proposal selection.

2.4 Using KP observations in AO-5

As a result of this AO-KP, we will be able to publish in the forthcoming AO-5 documentation a list of approved KP's so that potential proposers responding to that AO-5 are, in advance, aware of those projects, their scientific goals, but also pointing details, total exposure, observing strategy etc. The community is then via the AO-5 invited to also submit proposals which could be associated with the approved KP's, and would be combined ("amalgamated") with a KP, if approved by the TAC. Details can be found in the documentation which will be made available at the release of AO-5.