

# ***INTEGRAL***

## **Science Operations Centre**

### Announcement of Opportunity for **Key Programme Observing Proposals** for the AO-6 Cycle of Observations



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***INTEGRAL***  
***Key Programmes for AO-6***

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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 (KP-AO)** proposals to be performed during AO-6, and highlights deviations from the existing documentation applicable for the on-going observing programme (AO-5 cycle of observations). Details on Key Programmes are provided in further detail in section 2.

### 1.2 Proposals for Key Programme observations

Proposals for Key Programme observations which have been submitted in response to this Announcement of Opportunity and which have been selected by the Time Allocation Committee (TAC) will be executed during the AO-6 cycle of observations (2008/2009) 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: **KP-AO**.

The (standard) Announcement of Opportunity calling for normal, standard or fixed time observing proposals (and proposals to be associated with selected KPs) for the next observing cycle is called: **AO-6**.

### 1.4 Schedule and scope for this KP-AO-6

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

- 22 October 2007: Release of the Announcement of Opportunity KP-AO-6
- 30 November 2007, 15:00 CET: Deadline proposal submission
- December 2007/ January 2008: TAC peer review and recommendations for selection
- January 2008: ESA approval of selected KP proposals

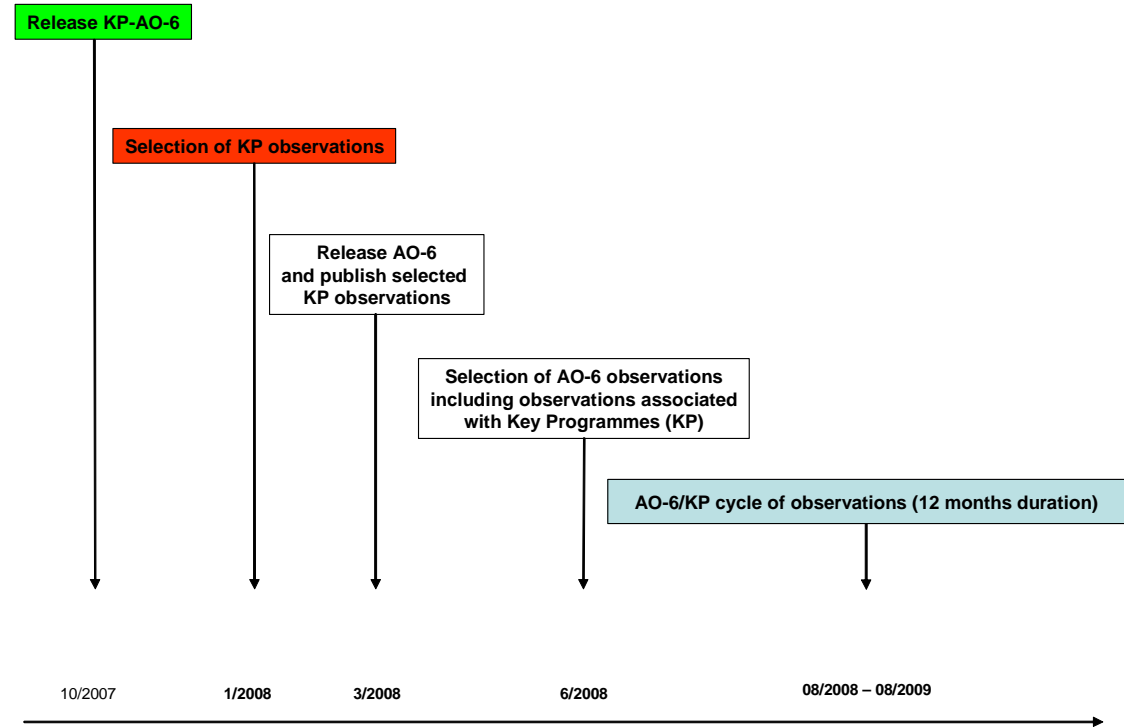
This KP-AO-6 is open to proposers from the ESA Member States, and the countries participating in INTEGRAL (Russia, USA, Czech Republic and Poland), but proposals from other countries will also be considered by the TAC during the peer review process.

### 1.5 Proposals from the USA

Proposers at institutions in the USA may respond to this KP-AO 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 (KP-AO)

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-6) scheduled for release in Spring 2008 and they will be scheduled for execution during the next AO-6 observing cycle which will commence in August 2008, see also Figure 1.



KP\_AO-6\_scheme.ppt

Figure 1 Schematic flow showing the connection of this KP-AO with the next AO-6.

The list of selected KP proposals will be published in the AO-6 document package such that the scientific community can then submit proposals for individual targets (point sources or extended

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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 Key Programmes” in AO-6. In fact those associated proposals, selected in AO-6, will be *amalgamated*<sup>1</sup> - from a data right point of view - with the KP proposals.

This document is supported by descriptions of the INTEGRAL mission, and instruments which are valid for the current AO-5 observing cycle and which can be found on-line at ESA’s INTEGRAL Science Operations Centre homepage at <http://www.sciops.esa.int/index.php?project=INTEGRAL&page=AO5>

Observers can find links to ISOC software tools and manuals at <http://www.sciops.esa.int/index.php?project=INTEGRAL&page=AO6KP>

Note that OTE and TVP run remotely through the web, whereas PGT needs to be downloaded and installed on the users’ local machine(s).

Restrictions to and deviations from the AO-5 document package are summarized in section 2.2.

## 1.7 Extended mission, future AO’s and available observing time

The INTEGRAL extended mission is currently approved until end of December 2010, subject to a status and performance review in Fall 2007. At this point in time, it is the intention that AO’s will be issued on an annual basis, hence the duration of each AO cycle will be 12 months, starting in August of each year. It is the intention that each AO will be preceded by a KP-AO, such that approved Key Programmes can be communicated in each subsequent AO release in order to facilitate the submission of proposals to be associated with Key Programme observations.

The estimated total time available for scientific observations per AO cycle of 12 months duration is of the order of 24 Ms. The guaranteed time portion (Core Programme) of the INTEGRAL observing programme, which has been conducted since the launch of the observatory in 2002 (AO-1), will be terminated at the end of the 2008 calendar year using a 20% portion of the total annual observing time. This implies that the first months of AO-6 (from 16 August until 31 December 2008) entitle to approximately 1.8 Ms Core Programme observations which are to be executed during AO-6.

### 1.7.1 Available observing time for Key Programmes in this KP-AO observing cycle

During 12 months of AO-6 cycle of observations, 12 (twelve) Ms of scientific observing time has been made available for the sum of all selected Key Programme observations. This

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<sup>1</sup> “Amalgamation” here means a combination of various observations of targets sufficiently 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, as during normal amalgamations performed by ISOC as described in the AO-5 document *Mission Overview*.

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allocation includes, however, the continuation of multi-year Key Programmes from the previous AO-5 (see Section 1.7.3, below), if approved by TAC. The remaining 12 Ms of annual observing time will be shared between remaining CP time (see above) and open time for standard AO-6 proposals.

### 1.7.2 Long observations in standard AO cycles versus Key Programmes

In view of the fact, that the introduction of Key Programmes opens the window for accommodating deep exposures in the observing programme, and following a recommendation by the INTEGRAL Users Group, proposers should take note that observing proposals exceeding approximately 10<sup>6</sup> sec exposure time should be submitted in response to this KP-AO, and not in response to the next AO-6 as standard proposal. A submission of long exposure proposals in response to the AO-6 (for standard proposals, to be issued in Spring 2008) will require a dedicated scientific justification for open time designation and can never duplicate selected KP programmes for AO-6.

### 1.7.3 Multi-year KP proposals

KP proposals may extend beyond the duration of one normal AO cycle (i.e. “multi-year proposals”). This needs to be scientifically justified and a breakdown of the requested observing time as a function of time (years) shall be provided.

#### 1.7.3.1 Multi-year programmes of the current AO-5 cycle of observations

It is **important** to keep in mind, that currently (in AO-5) out of the four approved KPs, three KP observations are multi-year programmes, beyond the duration of the AO-5 cycle of observations corresponding to one year. Whilst the TAC will have recognized the science requirements for these multi-year proposals, they could formally only recommend these programmes to ESA for one year during AO-5.

Without completely fixing the KPs for the coming years, some flexibility needs to be maintained. However, the multi-year aspects of the selected Key Programmes for AO-5 need to be taken into account during future KP-AOs.

Concerning multi-year Key Programme proposals which have been selected for AO-5, the TAC will therefore reserve the right to review the science case of each of these proposals for the coming year (AO-6 cycle). This evaluation will be done on the basis of the existing proposal (as submitted in response to AO-5), amended with updates and preliminary results where possible and necessary. The PI's of these AO-5 Key Programme observations with multi-year aspect will be invited to provide the required additional information and updates to TAC.

Assuming therefore, that multi-year programmes, selected for AO-5, might continue in AO-6, the observing time to be granted to those programmes has to be included in the total allocation of 12 Ms for Key Programme observations in AO-6.

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## 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 cycle), i.e. typically more than  $10^6$  s, 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 cycle (so-called “multi-year” proposal).

Examples for Key Programmes which are currently executed as part of the INTEGRAL AO-5 observing programme can be found in:

[http://integral.esac.esa.int/AO5/AO5\\_Key\\_Programmes.pdf](http://integral.esac.esa.int/AO5/AO5_Key_Programmes.pdf)

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 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 AOs, some technical items are different or not applicable as described in the AO-5 documentation. As an example we note the possibility to propose a user-defined pointing grid. These deviations and/or restrictions compared to AO-5 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 KPs will be solicited for in the next AO-6, following this KP-AO. In fact those selected associated proposals will be “amalgamated” (see footnote on page 7) with the selected KP proposals.

As an example, the reader may consult targets of accepted AO-5 proposals which have been associated with those AO-5 Key Programmes. These can be found on the Target Lists WWW page of the INTEGRAL Science Operations Centre at

[http://www.sciops.esa.int/index.php?project=INTEGRAL&page=Target\\_Lists](http://www.sciops.esa.int/index.php?project=INTEGRAL&page=Target_Lists)

The above implies, that KP proposals should anticipate the possibility that additional associated proposals on individual targets within the KP area during AO-6 can be accommodated, i.e. **the usefulness of the proposed KP field(s) for other (associated) studies will be a criterion for KP proposal evaluation and selection** (see section 2.3 and examples below).

In contrast to successful Key Programmes selected in the past, the reader should note, that a KP proposal submission 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

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**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>) after consulting the associated documentation which is valid for the current AO-5 cycle and can be found on the ISOC WWW site as well.

## 2.2 Restrictions, limitations and operational changes since AO-5

In general, the policies and procedures for the submission of proposals as laid down in the current AO-5 documentation<sup>2</sup> are valid for this KP-AO. At the time of writing, the description on instrument operations in the AO-5 documentation is fully valid. However, due to the nature of the KP 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-6, some items are different or not applicable as described in the AO-5 documentation. These deviations and/or restrictions are listed here below for each of the AO-5 documents:

### List of INTEGRAL AO-5 documents<sup>2</sup>

- Mission Overview, Policies and Procedures
- Science Data Rights
- Guaranteed Time
- Key Programmes and Associated Observations (for AO-5, for information only)
- IBIS Observer's Manual
- SPI Observer's Manual
- JEM-X Observer's Manual
- OMC Observer's Manual
- Observation Tools Software User Manual

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<sup>2</sup> <http://www.sciops.esa.int/index.php?project=INTEGRAL&page=AO5>

### 2.2.1 Mission overview, policies and procedures

In general, like previous AO's, a proposal in response to this KP-AO consists of one or more observations (using the PGT software, see 2.2.8) 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 2.2.2 on science 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-6 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 2.2.8 for further technical information to be provided in the science justification.

The following restrictions/deviations from AO-5 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. **Dither strategy:** From revolution 606 (Sep 2007) onwards, the implementation of the (5 x 5) patterns has been changed in order to minimize systematic effects in deep images. For N subsequent patterns within the same observation, the roll angle of the satellite and with it the whole dither pattern will be rotated in steps of  $\delta\theta = 6/(N-1)$  degrees and thus span the range from +3 deg to -3 deg as evenly as possible.
3. **Dithering type:** For each observation in a proposal, the user can choose to use either:
  - a. the standard 5x5 dither pattern (including COP move<sup>3</sup>) using the default 2.17 deg step size, between individual dither pointings,

or,

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<sup>3</sup> See AO-5 document on Mission Overview

- b. a user-defined grid of size (K x L) pointings. An example would be the (10 x 5) grid implemented for the KP observations of the Cygnus region during the AO-5 observing cycle<sup>4</sup>. 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 2.2.8 and the Observation Tools Software User Manual for details.

## 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*<sup>5</sup> 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 Science data rights

Concerning data rights the general policy as established for AO-5 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 for 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-6 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 peer reviews, it is highly likely that open time proposals will again be accepted by TAC during the next AO-6 for the analysis of data from GRB and from outbursts from known SGR. In previous AO's a time window around these events was usually assigned by TAC for these

<sup>4</sup> See AO-5 document on Key Programmes

<sup>5</sup> See AO-4 document Key Programme

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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-6.

### **2.2.3 Guaranteed time (Core Programme)**

The Core Programme (guaranteed time observations) with INTEGRAL will be terminated after calendar year 2008 and a remaining amount of approximately 1.8 Ms observing time will be scheduled during AO-6 following its definition by the Science Working Team. The Core Programme will be published in the Announcement of Opportunity for AO-6. It is the responsibility of the Project Scientist to ensure that the Core Programme does not duplicate selected KP's.

### **2.2.4 IBIS observer's manual**

No restrictions and/or deviations compared with the AO-5 document are applicable. Please consult <http://integral.esac.esa.int> for possible updates on instrument settings.

### **2.2.5 SPI observer's manual**

No restrictions and/or deviations compared with the AO-5 document are applicable. Please consult <http://integral.esac.esa.int> for possible updates on instrument settings.

### **2.2.6 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.

### **2.2.7 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.

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## 2.2.8 Observation Tools software user manual

### 2.2.8.1 Proposal Generation Tool (PGT)

For this KP-AO, a special version of the PGT software **must** be used. It can be downloaded from <http://www.sciops.esa.int/index.php?project=INTEGRAL&page=AO6KP>. The Observation Tools software user manual is available at the same address. Below is an overview of differences between this version of the PGT and the one used in the standard AO's:

- *Proposal details panel:* It is not possible to select “associate to Key Programme”.
- *Observation details panel:* The proposer provides here only the field name and celestial coordinates for the grid centre. All source properties and instrument settings have been removed from the panel. 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. The 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 sources in the area to be observed. Different observations within the KP proposal can use different patterns.

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

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dwell time per pointing such that there will always be an integral number of complete cycles of the grid.

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

- Name of the source
- Position in celestial coordinates (equatorial [J2000] co-ordinates or galactic co-ordinates)
- Flux information (needed for the TAC to assess the scientific value) in given energy band, and photon spectral index in that band (assuming a power law spectrum). For a line source, provide the central energy of the line and line width (FWHM) as well as the flux in the line.

### 2.2.8.2 Target Visibility Predictor (TVP)

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.

### 2.2.8.3 Observation Time Estimator (OTE)

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 KP-AO). 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.

## 2.3 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-6. 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's in the past. However, anticipating additional associated proposals on individual targets within the KP area during AO-6, 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-6

As a result of this KP-AO, we will be able to publish in the forthcoming AO-6 documentation a list of approved KP's so that potential proposers responding to that AO-6 are, in advance, aware



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of those projects, their scientific goals, but also pointing details, total exposure, observing strategy etc. The community is then via the AO-6 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 will be made available in the documentation which will prepared to coincide with the release of AO-6.