INTEGRAL

Science Operations Centre

Announcement of Opportunity for Observing Proposals (AO-4)

AO-4 Key Programme

INT/SDG/05-0241/Dc

Issue 1.0

13 March 2006

Prepared by C. Winkler
Authorised by A.N. Parmar

This page was intentionally left blank

Table of Contents

This page was intentionally left blank

1 Introduction

1.1 INTEGRAL key programme

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

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 nucleosynthesis and diffuse emission studies, as well as for (much) shorter observations of many individual compact objects (e.g. point sources) which are contained in those large fields.

Following initial discussions in 2005 within the INTEGRAL Users Group and the INTEGRAL Science Working Team, ESA's Astronomy Working Group has recommended in September 2005 that *"exploitation of INTEGRAL's unique capabilities through key programmes should be encouraged"*.

ESA has therefore decided to implement one KP (as a pilot project) within the current AO-4 cycle, and intends to release, later in 2006, a special Announcement of Opportunity calling for new KP proposals to be implemented in the AO-5 cycle.

2 The Galactic Centre as a pilot key programme in AO-4

2.1 Introduction

In order to introduce the new KP philosophy into the INTEGRAL observing programme and to gain experience for future AO's, ESA has decided to allocate 2 Ms out of the approximately 18 Ms available for open time observations in AO-4, to point the INTEGRAL spacecraft at the Galactic Centre as described below. The scientific community is invited to submit, in response to this AO-4, scientific proposals for targets (point or extended sources) which will be covered by the KP pointing area (see section 2.3). These proposals (indicated by a KP flag in PGT, see section 3.1) shall be submitted following the general guidelines for AO-4 proposals, described elsewhere, and they will be peer reviewed by the TAC as any other proposal received in response to this AO. However, as these target proposals will be "amalgamated" to the KP pointings with its 2 Ms total exposure, they will not use dedicated observatory time (see section 3.1 and the PGT *Users Manual* for more details).

2.2 Scientific rationale

The Galactic Centre region has been already observed during previous INTEGRAL AO's. These observations have contributed to the most important results to date of the INTEGRAL mission. Examples include the resolution of the Galactic emission below 200 keV into compact sources, the discovery of a new class of obscured sources, the discovery of emission from the Sgr A* region and the measurement of the spatial extent of the 511 keV line emission, hence a continuation is warranted for at least the following reasons:

- to further study the contribution of compact sources to diffuse continuum emission, in particular above 200 keV
- to further constrain the morphology of the 511 keV line emission that is essential to pin point its origin,
- to monitor the emission in the Sgr A* region in an attempt to detect a high energy outburst and to extend at higher energy the spectral measurements of this particular source,
- to monitor (time-variable) point sources (e.g. accreting black holes 1E1740.7-2942 and GRS 1758-258), bursters (e.g. GS 1826-24), LMXB's, SGR 1806-20 and other X-ray transients and to provide an opportunity for pre-planned multi-wavelength investigations using space- and ground-based observatories,
- to observe known supernova remnants (G347.3-0.5, G11.2-0.3, Kepler) and to detect yet unknown young supernova remnants through their ^{44}Ti line emission.

2.3 Observing strategy

The KP pointings of the GC region will be performed using two 5x5 dither grids, "side-by-side" around the Galactic Centre (Figure 1). The dwell time per point will be 2667 s, which will allow to perform 30 complete 5x5 grids, 15 at each side of the GC, hence 750 pointings in total for 2 Ms science exposure time. We note that this observing strategy is similar to the GC observations of the Core Programme executed during AO-3, which used a total exposure of 1.3 Ms.

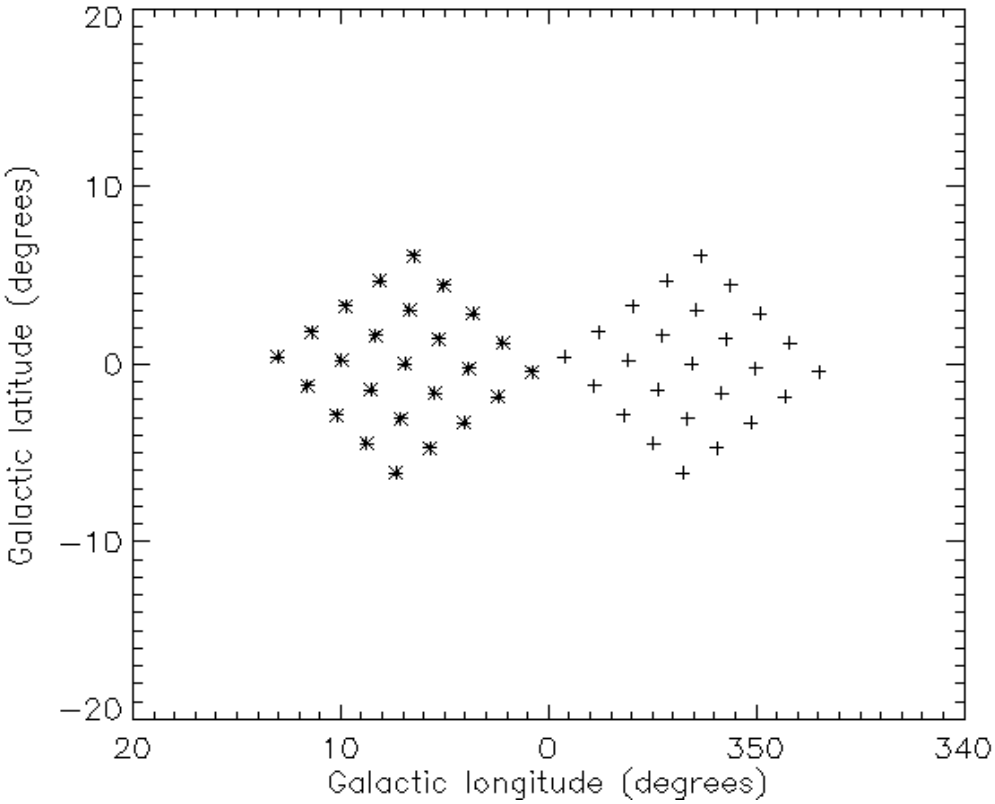

Figure 1 Grid of pointings for the KP observations: 750 pointings of 2667 s each can be performed. Each 5x5 grid is therefore executed 15 times. Each grid will be shifted from the previous one by a small offset[1].The centres of the grids are along the Galactic plane, at 6.9^o on both sides from the Galactic Centre. The instrument axes are usually inclined by 58^o to 62^o with respect to the Galactic plane, therefore the grid axes will be inclined by 47^o to 51^o (11.3^o with regard to the instrument axes). The grid step size is 2.17^o, optimal for the ISGRI image uniformity

[1]*The amount of this shift is about 0.3^o after each grid cycle. This shift improves the IBIS background uniformity. Details are provided in the INTEGRAL Manual.*

The exposure map resulting from these KP observations of the GC area is shown in Figure 2 overlaid with exposure time contours and with locations of sources observed by INTEGRAL. Note that the source list shown is not complete and should only be consulted for information. Sources shown in Figure 2 are listed in Table 1.

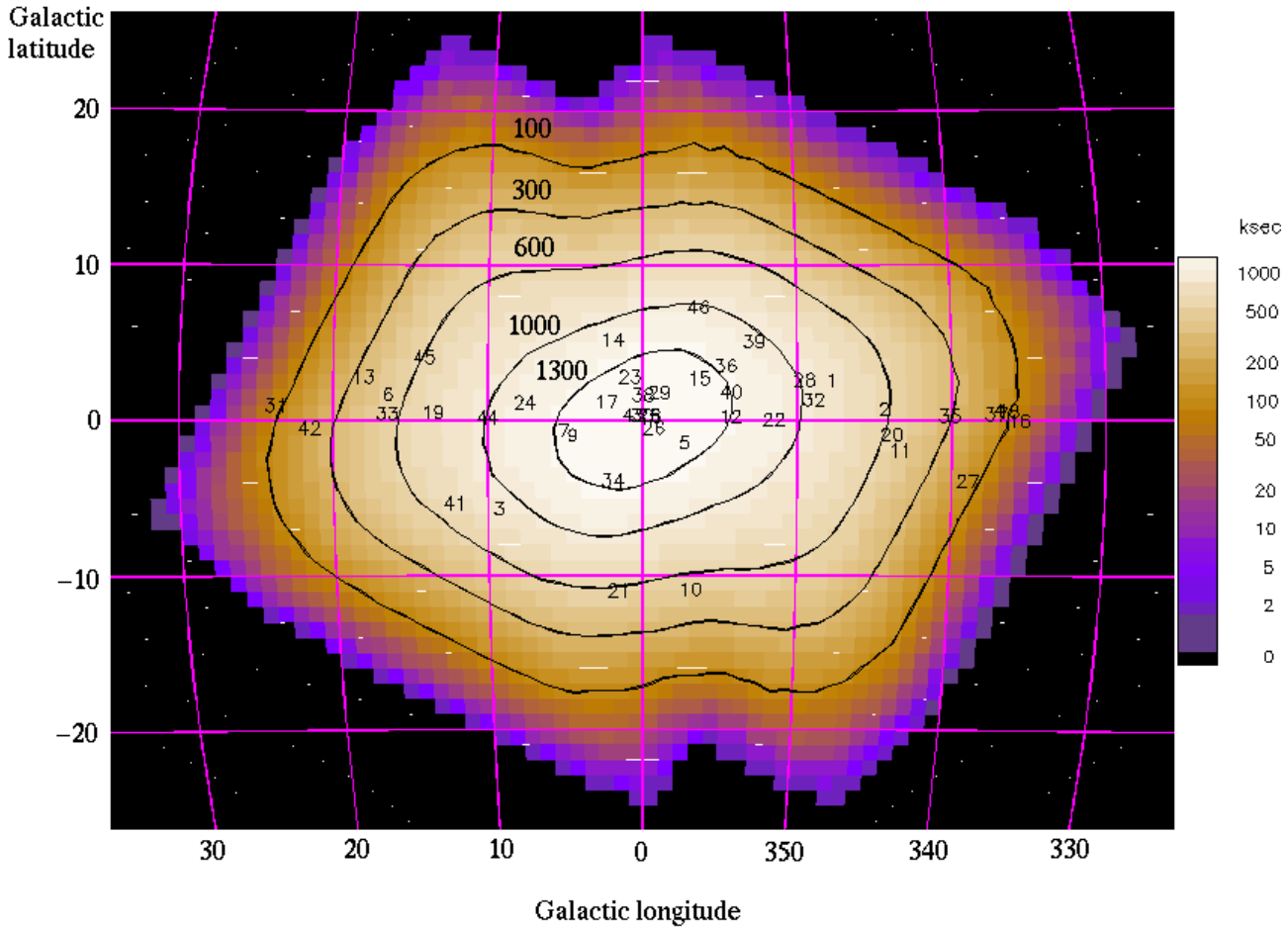

Figure 2 Exposure map (using a total exposure of 2 Ms) for the GC observations of the KP with contours indicating exposure times of 100, 300, 600, 1000 and 1300 ks, respectively. Sources shown (see also Table 1) are for the brightest (20-40) keV sources from the 1st IBIS source catalogue (Bird et al., ApJ 607, L33, 2004) with galactic longitude $l < 25^o$ or $l > 335^o$ and with galactic latitude $-20^o < b < +20^o$. The higher the source ID number, the fainter the source (flux is count rate in the (20 – 40) keV band). Note that the source list is not complete and should be consulted for information only. The two crowded regions near the GC itself and including the Norma spiral arm (at $l \sim 335^o$) are shown enlarged in Figure 3 and in Figure 4, respectively.

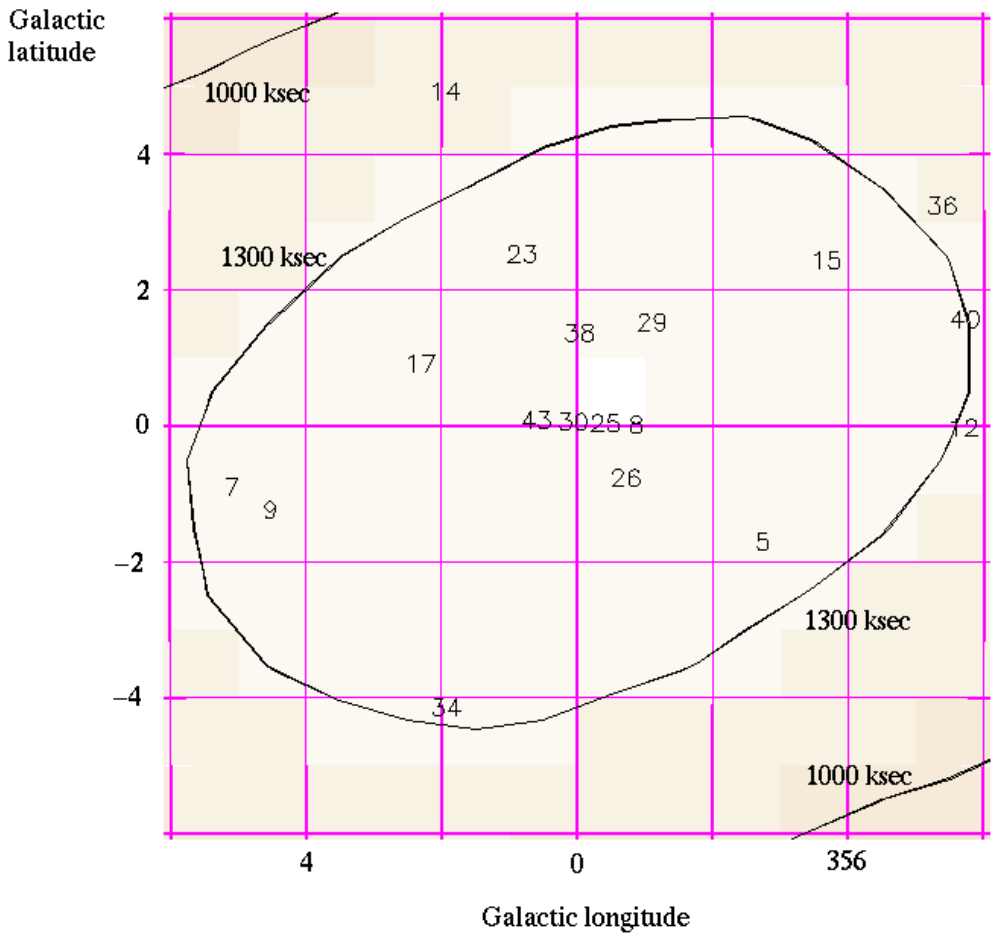

Figure 3 Zoom of the GC region (see Figure 2 and Table 1 including caption).

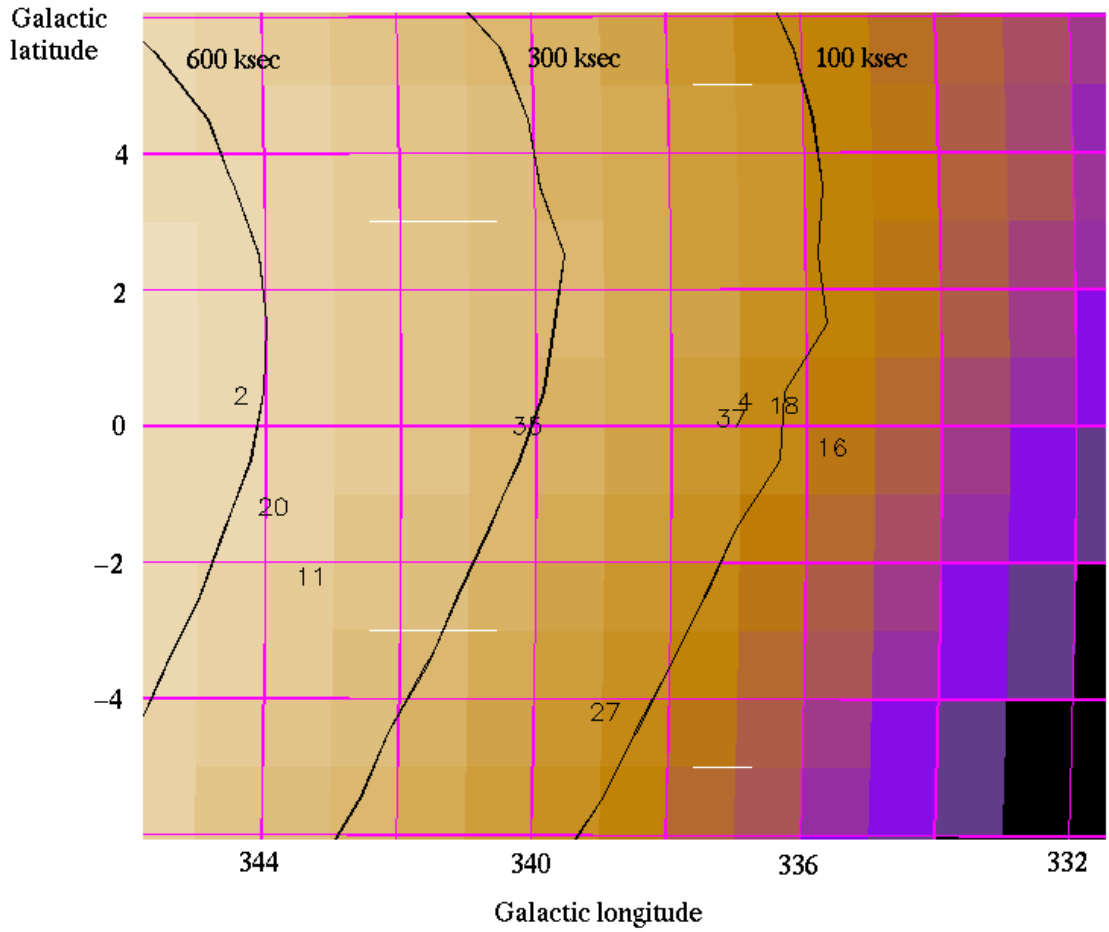

Figure 4 Zoom of the Norma arm region (see Figure 2 and Table 1 including caption).

Table 1 Sources observed by INTEGRAL in the GC region (see Figure 2, Figure 3, Figure 4). Included are the brightest (20-40) keV sources from the 1st IBIS source catalogue (Bird et al., ApJ 607, L33, 2004) with galactic longitude $l < 25^o$ or $l > 335^o$ and with galactic latitude $-20^o < b < +20^o$. The higher the source ID number, the fainter the source (flux is count rate in the (20 – 40) keV band). Note that the source list is not complete and should be consulted for information only.

ID	Source
1	4U 1700-377
2	OAO 1657-415
3	GS 1826-24
4	4U 1630-47
5	IGR J17464-3213
6	GX 17+2
7	GX 5-1
8	1E 1740.7-2943
9	GRS 1758-258
10	4U 1822-371
11	4U 1705-440
12	GX 354-0
13	M1812-12
14	GX 1+4
15	GRS 1724-308
16	IGR J16318-4848
17	GX 3+1
18	AX J1631.9-4752
19	GX 13+1
20	4U 1702-429
21	RX J1832-33
22	IGR J17252-3616
23	SLX 1735-269
24	IGR J17597-2201
25	M1741-293
26	SLX 1744-299
27	GX 339-4
28	IGR J17091-3624
29	GRS 1734-292
30	1E 1742.5-2859
31	IGR J18325-0756
32	SAX J1712.6-3739
33	AX J1820.5-1434
34	XTE J1807-294
35	IGR J16479-4514
36	XTE J1720-318
37	IGR J16358-4726
38	SLX 1737-282
39	4U 1705-32
40	IGR J17254-3257
41	PKS 1830-211
42	SNR 021.5-00.9
43	IGR J17475-2822
44	SGR 1806-20
45	IGR J18027-1455
46	XTE J1710-281

3 Proposals for targets associated with the KP pointings

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 nucleosynthesis and diffuse emission studies, as well as for (much) shorter observations of many individual compact objects (i.e. point sources) which are contained in those large fields.

In Figure 2, Figure 3, Figure 4 and Table 1 we indicate the locations of a number of high energy point sources which have been observed by INTEGRAL. Note that this is an indication only for the brighter sources and not a complete source list for proposed targets. We have also indicated exposure time contours in units of ks.

Proposers wishing to submit proposals to be associated with this KP observation should realize that only source locations[2] or extended target areas which are enclosed by the 100 ksec contour of Figure 2, that is:

> **Locations of sources/areas receiving a KP exposure of 100 ks or more, can be considered only as candidate sources to be proposed in response to this AO and to be evaluated by the TAC**.

As is required for all proposals, the exposure required to achieve the scientific objectives has to be justified.

All these proposals will be reviewed by the TAC during the standard AO-4 peer review process, and TAC will assign for successful proposals the data rights on specific source(s), not on the FOV, only per proposal/PI. Concerning un-proposed/non-allocated sources and serendipitous sources in the FOV, we refer to section 4 of this document on page 15, and to the AO-4 document on *Science Data Rights* describing serendipitous sources.

A proposal to be associated with the KP may or may not be recommended by TAC to be associated with the KP. Likewise, any standard proposal (i.e. disabling the KP flag) may or may not be associated with a KP during the peer review.

3.1 Details concerning PGT for associated KP proposals

In this section we provide some technical information about the submission of proposals to be associated with the KP. The user is referred to the PGT *Users Manual* for further details.

Proposers who are interested to obtain scientific data from this KP observation on any target (point or extended diffuse source) as specified in their proposal given the above constraints, i.e. **associated with this KP observation,** shall indicate this by enabling the **KP flag** in PGT while submitting their proposals in response to this AO-4 release and providing the information required by PGT. Technically, proposers for these observations have less options to choose from in the PGT menu. Obviously, the scientific goals to be obtained by the proposed investigation

[2] *Note that point sources/extended targets can be proposed which are not identified in Figure 2, Figure 3, Figure 4 and Table 1 provided their locations are within the 100 ksec exposure contour.*

(e.g. required exposure and/or significance of detection) must be compatible with the source location/total exposure map as described above (see also Figure 2).

In the PGT panel "Proposal Details" a button referring to "Key Programme" shall be enabled. Once this KP flag is set, the following parameters are then disabled in the PGT panel "Observation Details":

- Duration (of observation)
- Observation Type
- Dither Pattern including preferred orientation,

as these are fixed by the observing strategy implemented for the KP.

Likewise, all information containing "Instruments modes" in the same panel are disabled.

Note: It is important to keep in mind that the disabled PGT option "Observation Type" actually implies that sources associated with the KP can only be "observed" as "normal type" observation. In other words, proposals including sources which rely on specific TOO criteria and/or fixed time requirements are not possible in this context of KP and associated observations.

4 Data rights

The general policy for AO-4, as outlined in the AO document on *Science Data Rights* is applicable. The reader should note that this "pilot" KP observation of the GC, as described in this document, has, for technical reasons only, the Project Scientist associated as PI (without formal data rights, cf. ISOC WWW pages on short- and long-term scheduling).

The execution of the KP observation, covering targets from approved associated proposals is considered as an "amalgamated" observation and the reader is referred for further details to the section on "Multiple targets in the large instrument FOV, and serendipitous sources" as described in the AO document on *Science Data Rights* for further information on data rights for these observations. Essentially, PI's participating in amalgamated observations will receive the entire FOV data for processing and analysis as this is required by the coded aperture characteristics of the instrumentation. However, **PI's have proprietary data rights on those source(s) or extended area(s) only, which have been approved for them by the TAC**. After completion of the TAC process, ISOC will inform all participating PI's about all sources/extended areas which have been allocated by the TAC to individual proposals/PI's. All PI's participating in this amalgamation, i.e. in the KP observation, may publish results on any other source or target contained in the KP observations which are either not proposed or not allocated by TAC, including serendipitous sources.

5 Key programmes in AO-5 and beyond

The current planning in ESA is to issue - well in time before AO-5 (i.e. before Spring 2007) - a separate Call for Proposals (AO) soliciting proposals on Key Programmes **only.** At this point in time, a KP is essentially defined as a scientific investigation which justifies the usage of a significant amount of observing time, not excluding the option to cover more than one AO-cycle. The total amount of time which will be set aside (per year) for the sum of all approved KP's to be executed is not yet defined, but could be of the order of 20% to 25% of the available open time per year.

All received KP proposals will be peer reviewed 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 AO-5.

As a result of this, we will be able to publish in the 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 submit (associated) proposals which could be combined ("amalgamated") with the KP, if approved by the TAC, very similar to the "pilot" project described above. However, modifications to the implementation can not be excluded at this time based on the experience obtained on the implementation of the "pilot" KP in AO-4 and the community will be informed in due course.