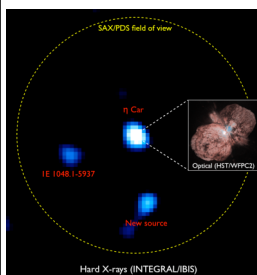
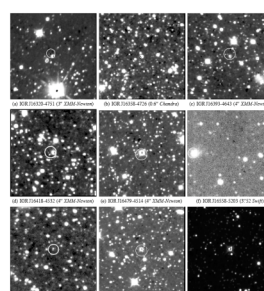
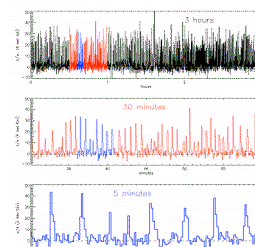
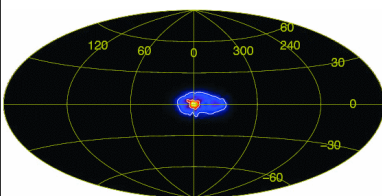


# INTEGRAL: Project Scientist Report

Nov 2007 – June 2008



- Observatory status
- Community interfaces
- Science highlights
- Outreach



11/12 June 2008

IUG Meeting, ESAC

Christoph Winkler

## Observatory status: AO-5 executed observations (ex. TOO)

Since last meeting (Nov 07) up to including rev 691 (12 June 2008)	
Target (excl. TOO)	PI
CP - Galactic plane (2, 3)	ISWT
KP - North Ecliptic Pole	Ajello
KP - Galactic Centre	Bélangier
KP - Cygnus Region	Knödlseder
Mid-latitude 511 keV	Weidenspointner
GRS 1915+105 (monitoring)	Rodrigues
3C 273	Pacciani/McHardy (amalgamated)
NGC 4151	Walter
Superbubble (loop I/IV)	Iyudin
M 31 [SPI annealing]	Kong
PKS 1510-089 [SPI annealing]	Moderski
X Per (4U 0352+309) [SPI annealing]	Kreykenbohm
Galactic disk latitude scans	Sunyaev
Orion OB1	Diehl
Galactic bulge (monitoring)	Kuulkers
Crab calibration	Public data

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## Observatory status: TOO follow-up & GRB since last meeting

- ▶ **5 approved and executed TOO follow-up requests:**

3C 454.3 (Nov 2007)	Vercellone, AGILE
SN 2008S (Feb 2008)	Leising
4U 0115+63 (Mar/Apr 2008)	Wilms
XTE J1810-189 (Mar 2008), part 1	Molkov
Mrk 421 (May 2008)	von Kienlin
  
- ▶ **6 rejected TOO follow-up requests:**
  - SAX J1810.8-2609 [Molkov]: Scheduling conflict with SS 433 (fixed time)
  - Mrk 421 [v Kienlin]: Scheduling conflict with KP Cyg and INTEGRAL/AGILE co-ordin.
  - H1742-322 [Miller]: Requested monitoring of outburst overlaps with KP GC observations of same sky region @ same time (data are there !)
  - 4U 0115+63 [Tsygankov]: Flux < TAC approved threshold, lower priority than Wilms
  - SN 2008 bk in NGC 7793 (3 Mpc) [Isern & Leising]: Type Ia not confirmed
  - XTE J1810-189, part 2 [Molkov]: Ambiguity on flux evolution to low value, as required + visibility limit + overall schedule pressure
  
- ▶ **4 GRB inside FOV**

GRB 071109	Hanlon, Wunderer (msec timing only)
GRB 080120	Sazonov, Wunderer (msec timing only)
GRB 080414	Hanlon, Wunderer (msec timing only)
GRB 080603	Hanlon, Wunderer (msec timing only)
  
- ▶ **1 GRB outside FOV**

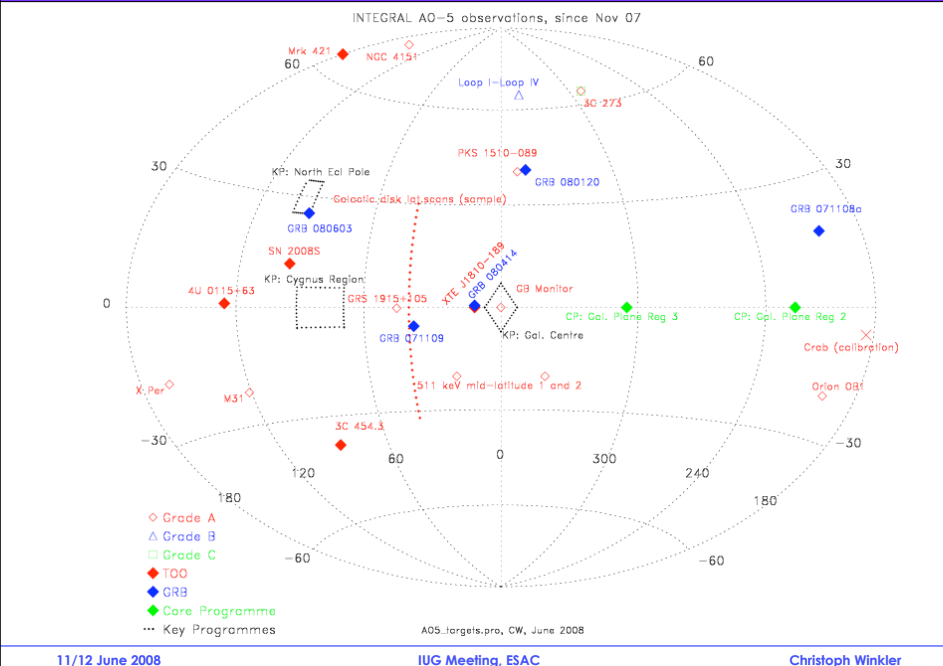
GRB 071108a	ISWT/CP ⇔ Denis
-------------	-----------------

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## Observatory status: executed observations (cont'd)

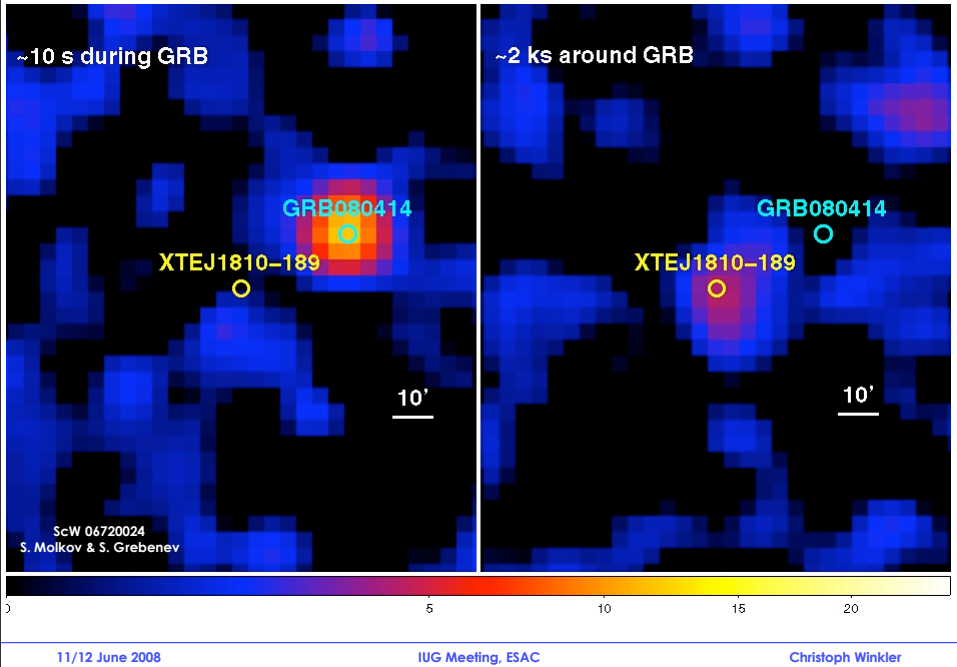


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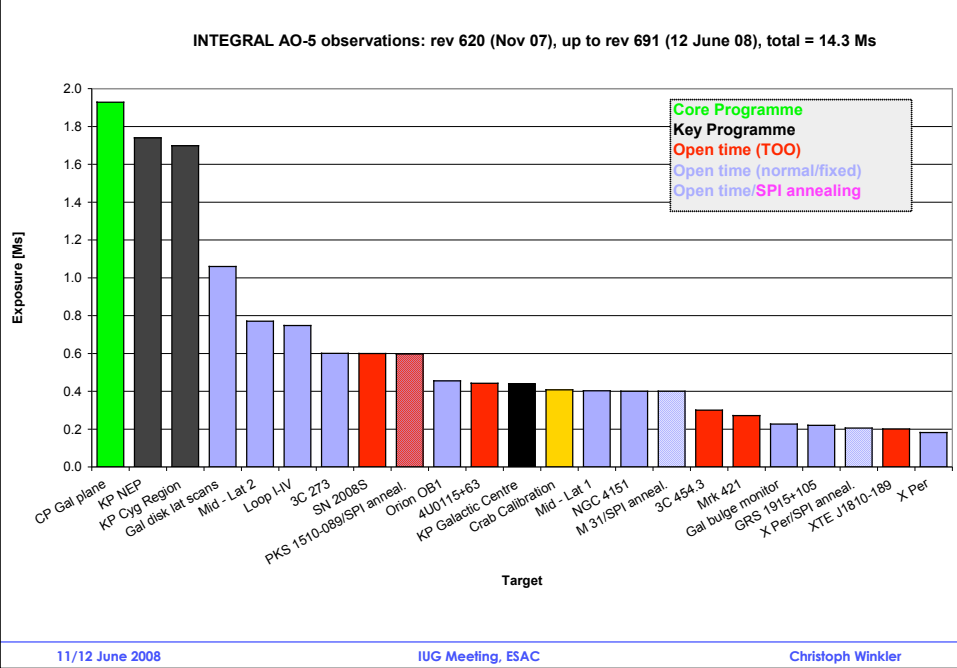
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## GRB 080414 and XTE J1810-189 (14 April 2008, 22:33 UT)



## Observations vs exposure times



## Observatory status: AO-5 carry over to AO-6

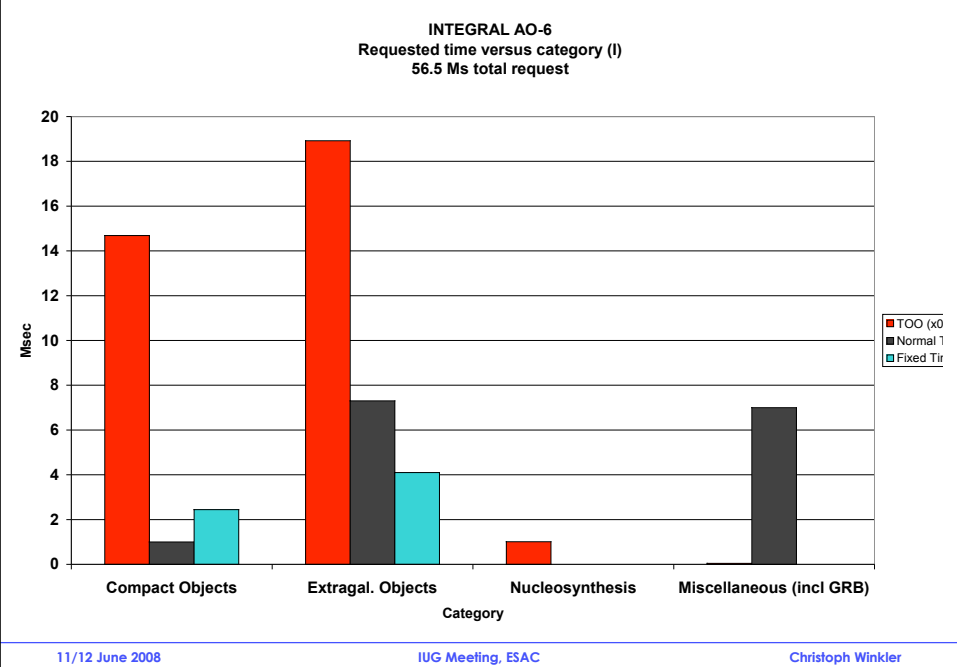
- ▶ Projected carry-over into AO-6: ~1.8 Ms total for:

Loop I/IV	Iyudin
Per OB-2	Terrier/v Kienlin, amalgamated
Mid latitude 1 & 2	Weidenspointner
Galactic disk	Sunyaev
X Per	Kreykenbohm

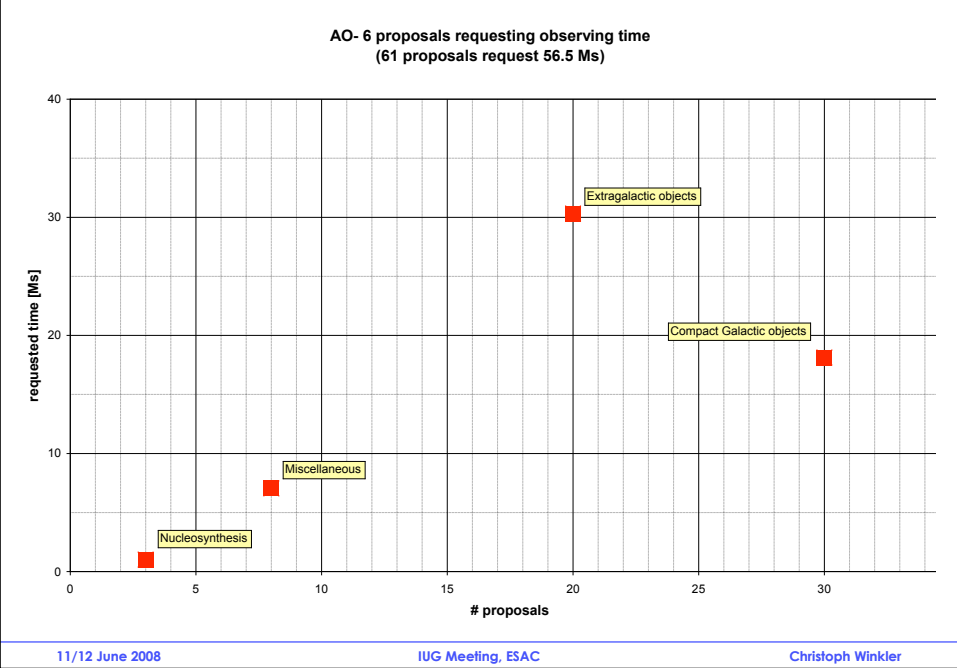
## Community interfaces: Response to AO-6

- ▶ Release: 10 March, deadline: 18 April
- ▶ # proposals received : 179
  - Proposals requesting observing time: 61
  - Proposals not requesting observing time (KP\_associated): 118
- ▶ Total requested observing time: 56.5 Ms (TOO x10% included)
- ▶ Available observing time:
  - 24 Ms (max one year) – 12 Ms (KP) – 1.8 (CP) = 10.2 Ms
  - But: TOO ear-mark (2 Ms), carry-over (2 Ms) , SPI annealing*
- ▶ Oversubscription on 10.2 Ms: 5.5
- ▶ Including the science community response to AO-6KP, total is:
  - # proposals AO-6: 192
  - oversubscription AO-6: 5.8

## AO-6: Requested time versus observation type



## AO-6: Proposals versus time



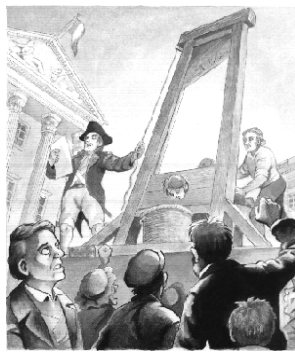
## AO-6: Statistics and "success factors"

"Success factors" for observatory missions, published (WWW) and applied by 'management', advisory bodies, funding agencies include (at least):

1. Number of refereed publications
2. Number of received proposals
3. Over-subscription in time (= requested vs available time)

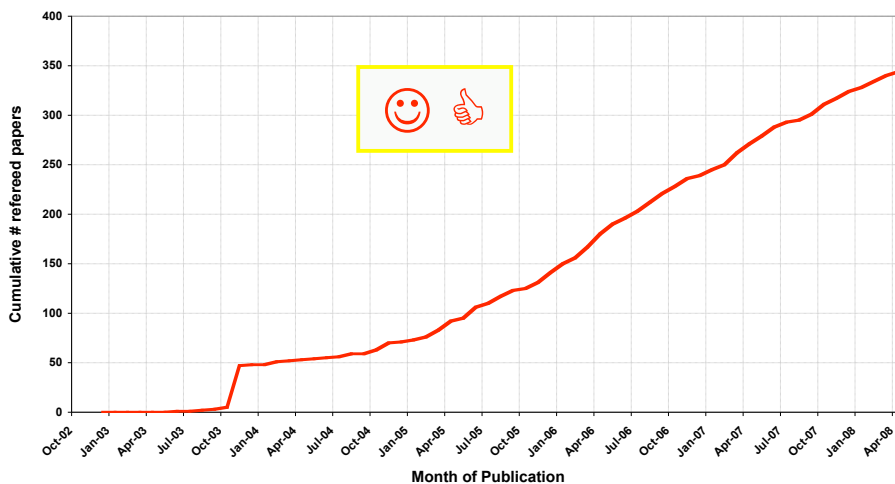


### Mission Extension

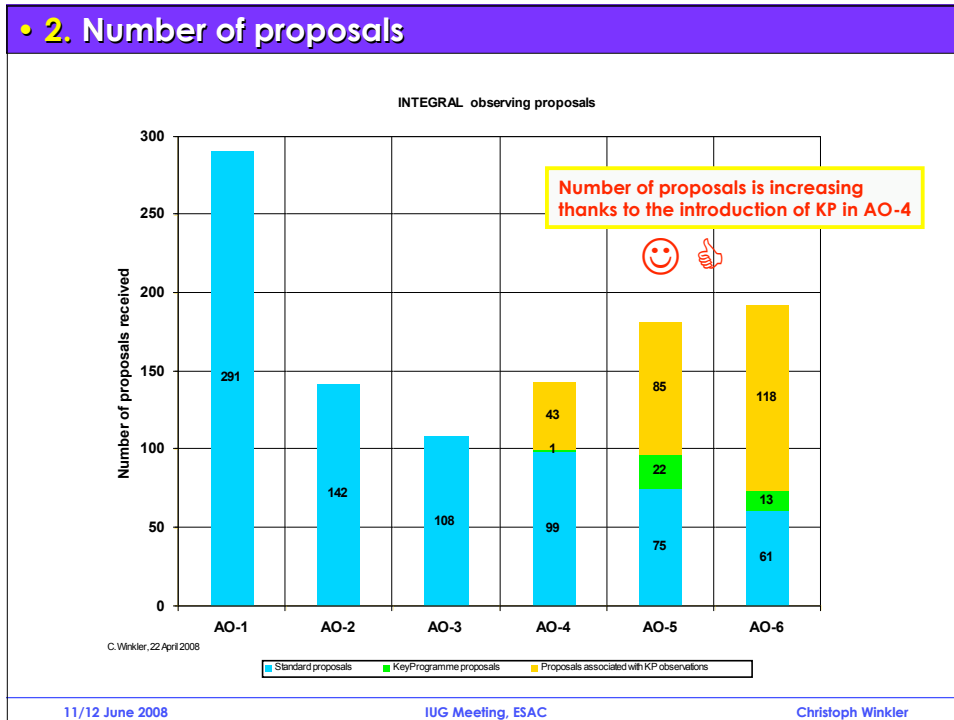


## • 1. Number of refereed publications

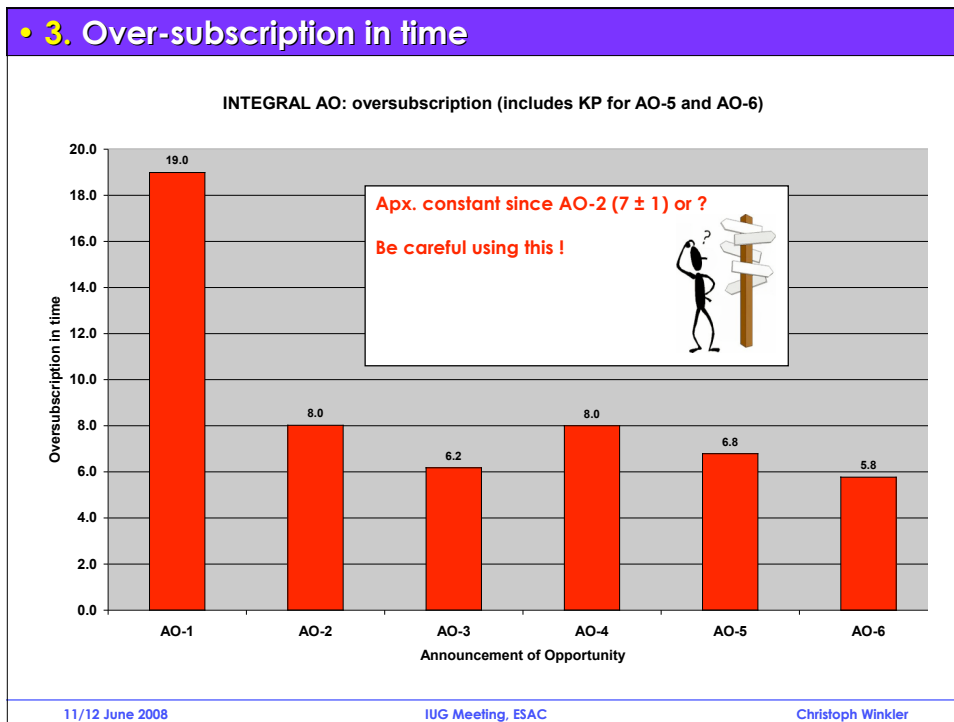
Cumulative # of refereed publications since launch (Oct 2002)



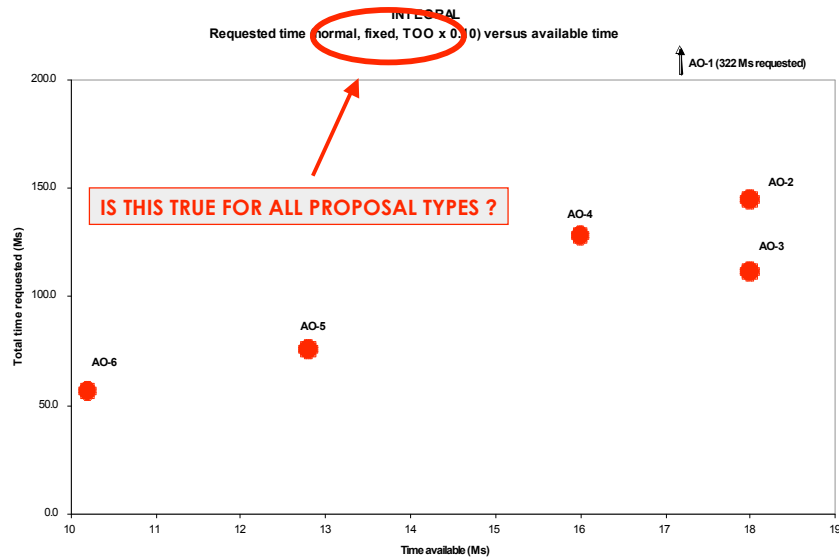
## • 2. Number of proposals



## • 3. Over-subscription in time



## Requested time versus available open time



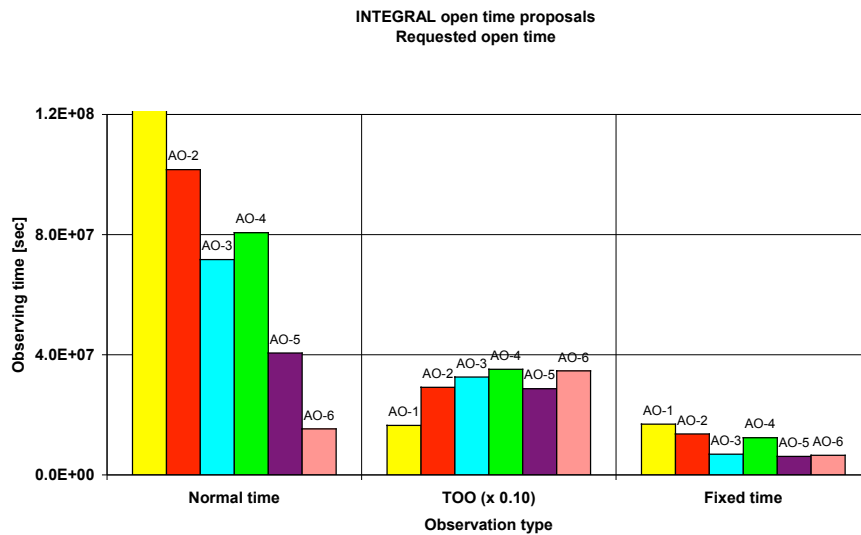
Requested time is correlated with available time, being reduced with mission duration

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## Requested time and types of observations



but, TOO proposals do not follow this trend

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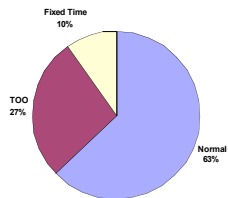
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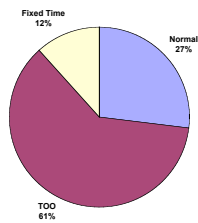
## Compare TOO proposals 2004 (AO-4) and 2006 (AO-6)

INTEGRAL AO-4  
Distribution of observation time, 128 Ms total requested  
(Includes requested TOO time x 0.10)



AO-4: 27% TOO out of 128 Ms total = 34.4 Ms

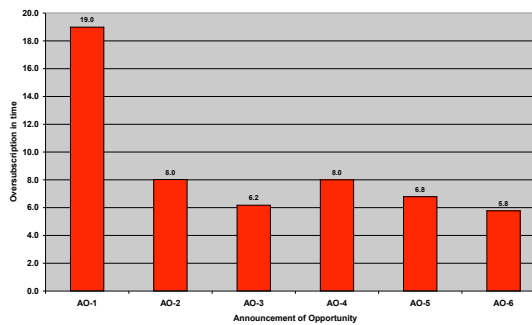
INTEGRAL AO-6  
Distribution of observation time, 56.5 Ms total requested  
(Includes requested TOO time x 0.10)



AO-6: 61% TOO out of 56.5 Ms total = 34.6 Ms

## Impact of TOO proposals on over-subscription – WHY ?

INTEGRAL AO: oversubscription (includes KP for AO-5 and AO-6)



Over-subscription uses total of requested (proposed) exposure times for

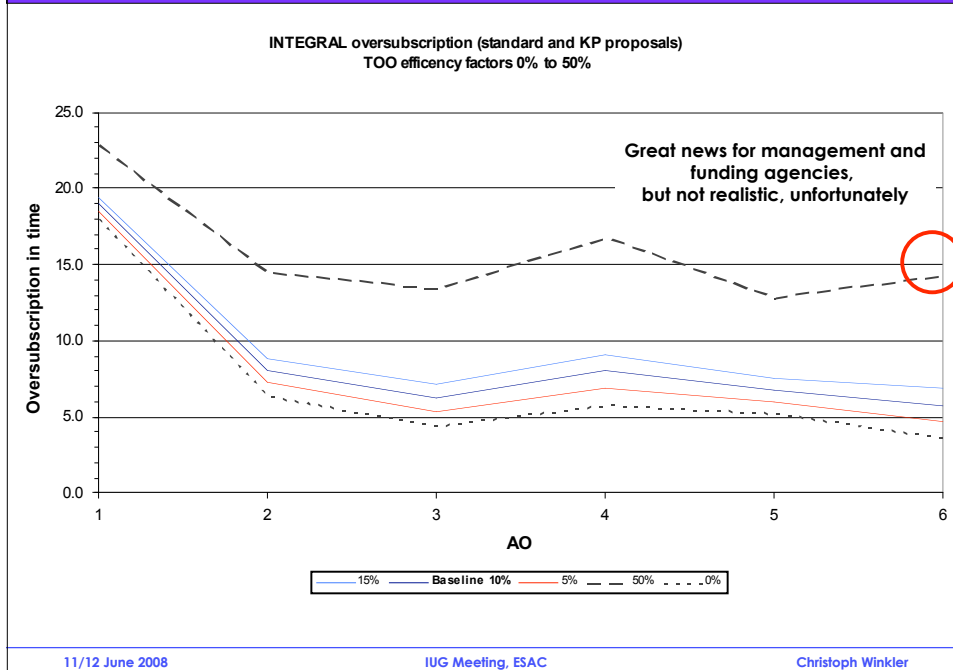
- normal time proposals (as is)
- fixed time proposals (as is)
- TOO proposals (**weighted**)

The empirical "efficiency factor" for TOO proposed exposures is **10%** :

- many sources often included with individual trigger criteria, not all selected
- intrinsic event probability (e.g. 30% (gal. transients), 20% (AGN) to 1% (e.g. SN) )
- 10% consistently applied since AO-1 to facilitate comparison of various AOs

**How large is the effect introduced by the weighted TOO time ?**

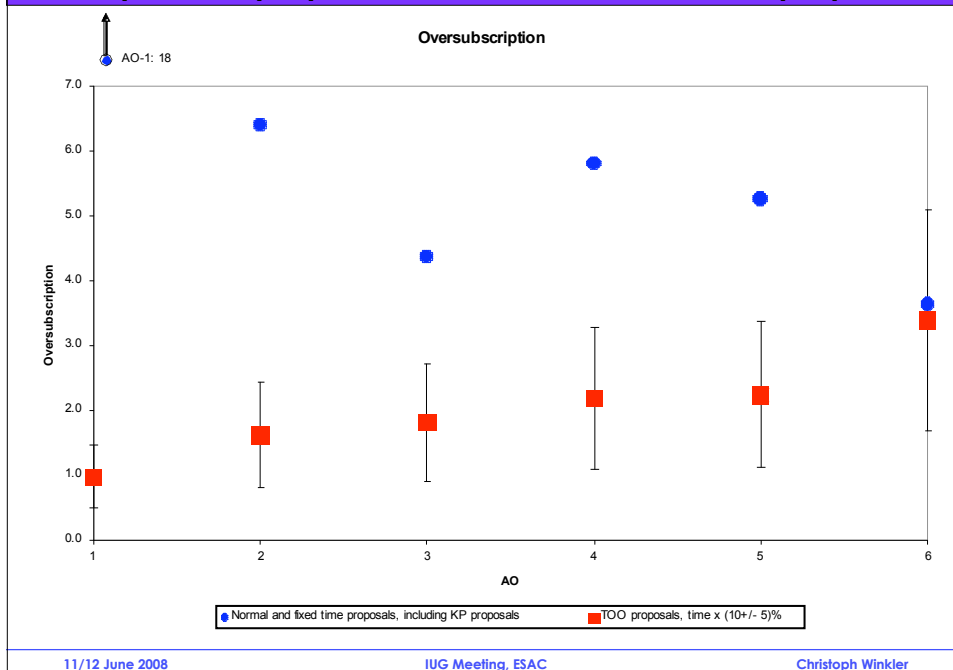
## Oversubscription and TOO efficiency factors



## Conclusions

- ▶ # refereed publications and # proposals: good “success factors”
- ▶ Over-subscription: **use with care** because of the uncertainty introduced by TOO proposals
- ▶ If requested TOO exposure dominates, the uncertainty introduced by the “efficiency” factor becomes important and may mask underlying trends.
- ▶ This is unlike XMM as their TOO proposals are 5%-8% of total time
- ❖ Is there a better way to calculate or present the over-subscription ?

## Decouple TOO proposals from normal/fixed time proposals



## Community interfaces: Response to AO-6 (cont'd)

### ► TAC Meeting 19-22 May

- Selected 46 out of 61 open time proposals (incl 25 TOO, 5 GRB)
- Selected 96 out of 118 KP\_associated proposals (max: 36 for KP-GC, min: 5 for KP-SMC)
- Good quality of proposals, in general, but for KP\_associated proposals 18 out of 73 were rejected in "compact object" panel due to very low quality (some ignoring TAC comments from earlier AOs)
- Approved: 9.8 Ms non-TOO (7.6 Ms grade A)
- Approved: 12.7 TOO
- ❖ *Russian return is 2.4 Ms (versus 6 Ms guaranteed)*
- TAC recommended programme: 22 May, approved by D/SCI on 03 June, ISOC busy to update DB, inform PI's, publish programme on WWW
- AO-6: start on 16 August 2008, duration 12 months

## Community interfaces: TAC and IUG

### ▶ TAC

- AO-6 meeting took place 19-22 May at ESAC
- TAC composition
  - Currently one TAC chair and 19 TAC members in 3 panels
  - Panel membership will be routinely "rotated" during summer, affecting about half of panel members, and 3 panel chairs
- 👉 Next task for TAC: [KP AO-7 evaluation](#) (Dec 08/Jan 09)

### ▶ IUG

- [ToR finally agreed](#) between IUG chair and PS: published on INTEGRAL WWW together with IUG membership list
- Next membership rotation (external members only): mid 2009

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## Science highlights during reporting period (personal choice)

- ▶ **HESS J1616-508 powered by PSR J1617-5055 ?**, R. Landi et al., MNRAS 380, 926, 2007
- ▶ **A new proposed mechanism responsible for SFXT outbursts**, L. Sidoli et al. A&A 476, 1307, 2007
- ▶ **Hard X-ray emission from  $\eta$  Car**, J.-C. Leyder et al., A&A 477, L29, 2008
- ▶ **Obscured HMXB: the nature of the companion star**, S. Chaty et al., A&A 484, 783, 2008
- ▶ **Her X-1: pulse profiles variation with phase & spin-up**, D. Klochkov et al., A&A 482, 907, 2008
- ▶ **Detailed high-energy characteristics of AXP 4U 0142+61 and 1 RXS J170849-400910**, P. den Hartog et al., A&A in press 2008, arXiv 0804.1640 and 0804.1641
  
- ▶ **IC origin of the hard-X/soft- $\gamma$  galactic ridge emission**, T. Porter et al., ApJ 2008, in press 0804.1774
- ▶ **Discovery of asymmetric positron annihilation line emission from inner Galactic disk**, G. Weidenspointner et al., Nature 451, 159, 2008
- ▶ **Galactic diffuse emission and point sources observed by SPI**, L. Bouchet et al., ApJ 679, 1315, 2008
  
- ▶ **MG3 J225155+2217 @  $z = 3.668$  a distant gamma-ray lighthouse**, L. Bassani et al., ApJ 669, L1, 2007
- ▶ **Cumulative local AGN spectrum and the CXB**, S. Sazonov et al., A&A 482, 517, 2008
- ▶ **Coma cluster: INTEGRAL, RXTE and ROSAT- non-thermal diffuse emission ?**, A. Lutovinov et al., ApJ subm., 2008, arXiv 0802.3742
- ▶ **Hard X-ray emission from Oph cluster**, D. Eckert et al., A&A 479, 27, 2008
  
- ▶ **Global characteristics of INTEGRAL GRB**, S. Foley et al., A&A in press, 2008, arXiv 0803.1821

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# Outreach

## Astronomy & Astrophysics

Vol. 44 | Nº 2 | October 19 2008



### nature science

#### Dark matter could be light

Gamma rays from galaxy centre may signify less massive miniparticles.

17 March 2004

Philip Ball

Gamma rays streaming from the centre of our galaxy could be signature of elusive dark matter, astrophysicists claim. The rays support an exotic theory about dark matter: that it consists of miniparticles.

Physicists know that a large proportion of the universe's mass must be accounted for by objects we can see, such as stars and planet galaxies such as our own, there could be as much as ten times dark matter than normal matter.

One popular idea suggests that the 'missing' dark matter consists of unidentified subatomic particles that are much heavier than atoms of normal matter but that hardly interact with it, except gravitationally. They are called weakly interacting massive particles, or WIMPs.

But Céline Boisson, of the Institut d'Astrophysique de Paris, France, has proposed that the dark matter could be made of miniparticles that are much lighter than atoms of normal matter, and that they interact with it, except gravitationally. They are called dark photons.

## SPACE DAILY

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Stellar Chemistry

### Integral: Stellar Winds Colliding At Our Cosmic Doorstep

ESA's Integral has made the first unambiguous discovery of high-energy X-rays coming from a rare massive star at our cosmic doorstep, Eta Carinae. It is one of the most violent places in the galaxy, producing vast winds of electrically charged particles colliding at speeds of thousands of kilometres per second.

The only astronomical object that emits gamma-rays and is observable to the naked eye.

## Goddard Space Flight Center

Putting ideas into space bringing knowledge home

### Vast Cloud of Antineutrinos Traced to Binary Stars

Robert Knapp | PhD Candidate  
Goddard Space Flight Center, Greenbelt, Md.  
301-286-4432 | rknapp@goddard.nasa.gov

Release No. 08-05

Four years of observations from the European Space Agency's Integral (INTEGRAL) Gamma-Ray Astrophysics Laboratory satellite have traced out one of the most interesting mysteries in our Milky Way: the origin of a vast cloud of antineutrinos surrounding the galactic center.

Integral's Integral mapped the glow of 111 keV gamma rays from radioactive antineutrinos. The glow shows the entire sky, with the galactic center in the middle. The antineutrinos in the right. Cold image for comparison. Credit: ESA/INTEGRAL/OEDIPUS observations.

As reported by international teams in the January 16 issue of Nature, Integral has found that the cloud extends farther on the western side of the galactic center than it does on the eastern side. This observation indicates the dark matter of a population of binary star systems that contain black holes or neutron stars, strongly suggesting that these binaries are moving out at least half of the antineutrino, and perhaps all of it.

"The repeated Integral detection of an antineutrino represents a significant step toward tracing a solution of one of the major outstanding problems in high-energy astrophysics. It will also have a collective sign of neutral matter from the community," says Marcia L. Leubner, a University of Maryland professor emerita and a pioneer in this field.

## THE AUSTRALIAN

Print this page

### French explain gamma ray mystery

From AFP

PARIS — The Milky Way, it reveals in low-energy gamma rays emitted by black holes and neutron stars, which are buried in clouds of dust and gas, according to a French study published on Thursday.

The source, which appears in the British science journal Nature, resolves a 30-year-old enigma as to where this so-called "soft" radiation comes from.

The team from France's Atomic Energy Commission (CEA) say they have found 91 gamma-ray sources, accounting for what they believe to be 90 per cent of the energy.

Twenty-one of these sources were previously unidentified, and most of the other sources are thought to be systems that had already been detected in the X-ray part of the energy spectrum.

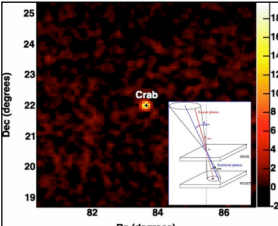
The remaining 10 per cent of the gamma radiation is likely to come from very compact stars.

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# INTEGRAL picture of the month (since Nov 07)

### December 07

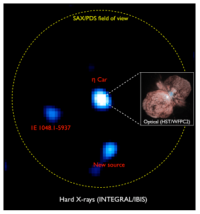
#### IBIS Compton mode



Crab

### January 08

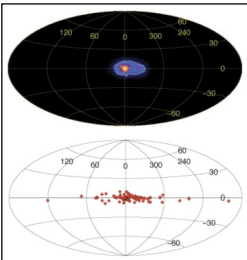
#### Hard X-rays from η Car



Hard X-rays (INTEGRAL/IBIS)

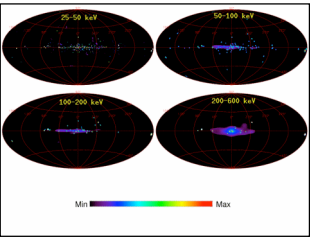
### February 08

#### Galactic positron emission



### March 08

#### Diffuse emission and point sources

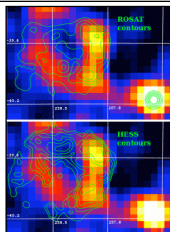


Min Max

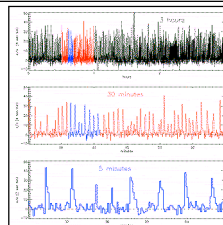
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## INTEGRAL picture of the month (cont'd)

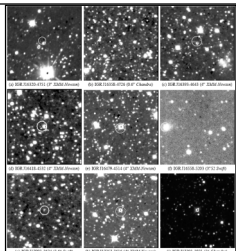
**April 08**  
Hard X-rays from SNR RXJ 1713.7-3946



**May 08**  
The Rapid Burster



**June 08**  
IR counterparts to IGR sources



**July 08**  
THIS COULD SHOW YOUR WORK



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## ESA press/web news releases

Published since November 2007

- |   |                  |
|---|------------------|
| ▶ INTEGRAL AGN and AUGER AGN sky maps             | 17 Dec 2007      |
| ▶ Positron annihilation emission asymmetry        | 09 Jan 2008      |
| ▶ Hard X-rays from Ophiuchus cluster of galaxies  | 24 January 2008  |
| ▶ Hard X-rays from $\eta$ Car                     | 20 February 2008 |
| ▶ Obscured HMXB: The nature of the companion star | 05 June 2008     |

Total: 36 ESA press/web news releases since launch  
Archive: <http://integral.esac.esa.int/press/press.html>

In preparation

- |                            |                    |
|----------------------------|--------------------|
| ▶ Accreting pulsar Her X-1 | D. Klochkov et al. |
|----------------------------|--------------------|

☞ Requests/ideas for new press releases: **feedback and input from community (IUG !)** strongly desired.

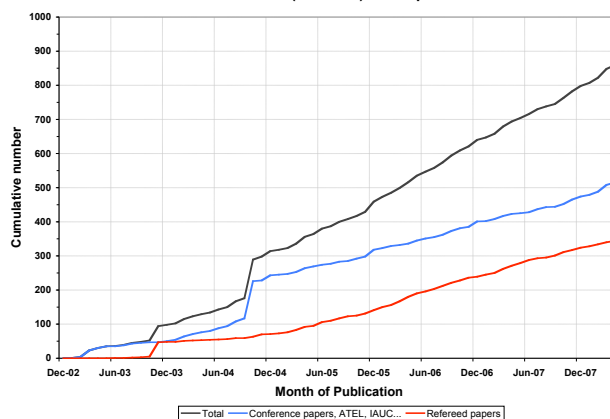
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## Publication statistics

Publications using INTEGRAL scientific data  
From launch (Oct 2002) until April 2008

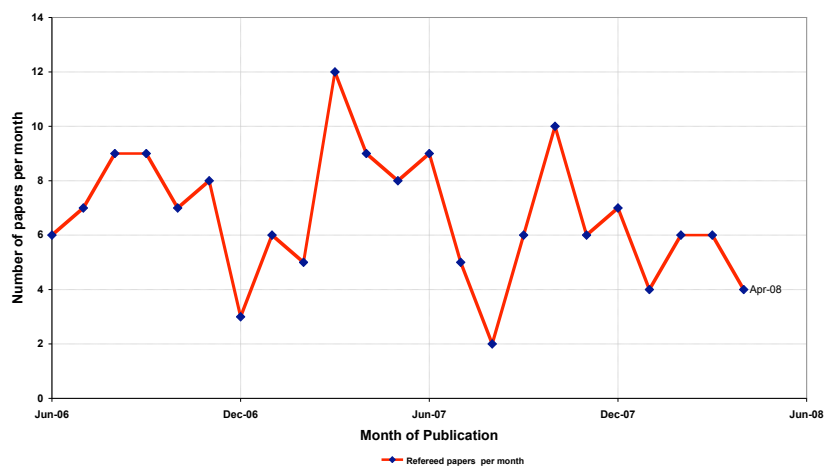


<http://integral.esac.esa.int/Publications> updated by CW using the astro-ph/ADS about 3 times per week, with links to preprints and to published papers

## Monthly publication rate over past 2 years: still solid ??

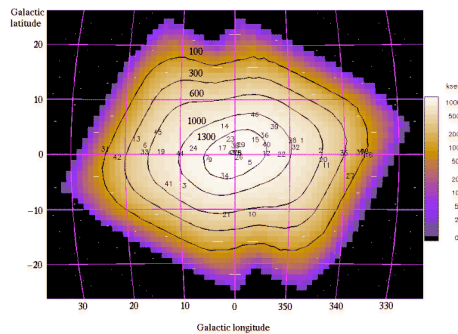
Refereed publications per month over last two years  
using INTEGRAL scientific data

[http://adsabs.harvard.edu/abstract\\_service.html](http://adsabs.harvard.edu/abstract_service.html)



Average =  $(6.7 \pm 2.4)$  papers

## KP/targets: Feed back fm larger science community?



- ▶ KP AO-4 observations completed Mar 2007
  - ▶ 43 open time proposals for associated *targets* were accepted including:
    - 117 point sources, 2 x serendipitous sources (new BH transients), 4 x diffuse line and continuum emission (extended areas)
- ☞ Publication peak 15 months after end of observation ?
- ☞ Expect a real peak or do (many ?) targets "just" improve statistics of earlier/archival observations ?

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## Top 10 Chart: Citations to science\* papers, as of April '08

Reference	Topic	Citations to paper
C. Böhm et al. <i>Phys. RevL</i> 92, 101301, 2004	MeV dark matter: has it been detected ?	126
P. Jean et al. <i>A&amp;A</i> 407, 55, 2003	511 keV line emission from 4 <sup>th</sup> quadrant	107
J. Knödseder et al. <i>A&amp;A</i> 411, 457, 2003	Constraints on the 511 keV line morphology	91
J. Knödseder et al. <i>A&amp;A</i> 441, 513, 2005	511 keV all-sky distribution	78
A. Bird et al. <i>ApJ</i> 607, 33, 2004	The first IBIS source catalogue	75
M. Revnivtsev et al. <i>AsTL</i> 30, 382, 2004	Hard X-ray survey of the GC region	60
A. Bird et al. <i>ApJ</i> 636, 765, 2006	The second IBIS source catalogue	59
J. F. Beacom & H. Yüksel <i>Phys. RevL</i> 97, 071102, 2006	Stringent constraints on Galactic positron production	<b>NEWCOMER</b> 55
A. Bird et al. <i>ApJS</i> 170, 175, 2007	The third IBIS source catalogue	53
L. Kuiper et al. <i>ApJ</i> 645, 556, 2006	Hard X-ray emission from AXP	47

\* Citations to instrument/mission papers excluded

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Poster has been printed and mailed to  $\pm$  200 addresses (mainly institutes and libraries); downloadable from Web site

Latest workshop info: see Søren's presentation

**Abstract Deadline = 20 June**



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