An INTEGRAL archive at IASF Milano
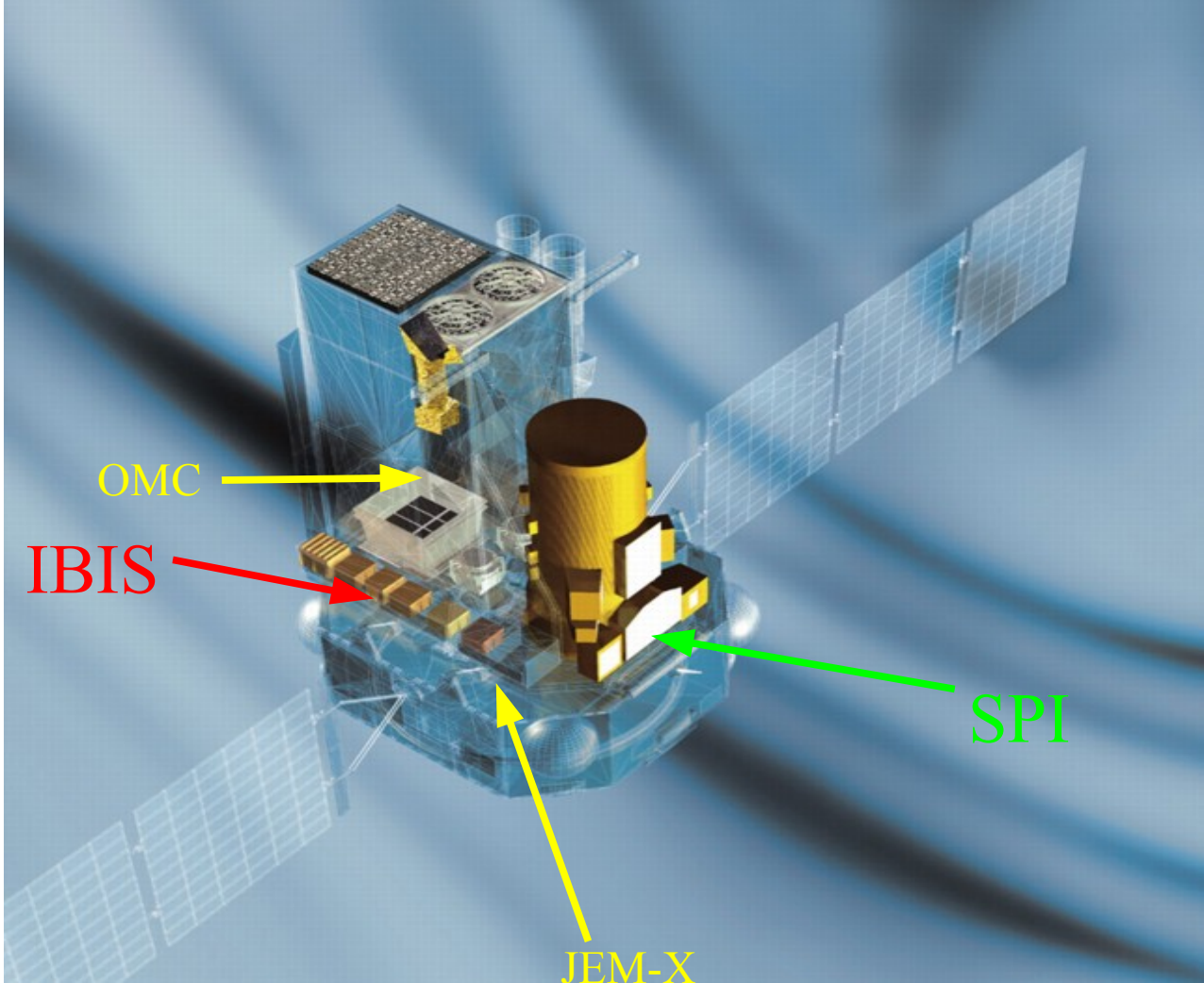
A. Paizis

Astro-Siesta
27 Febbraio 2014

INTEGRAL

Launched in 2002

- IBIS: Imager
  (15 keV - 10 MeV)

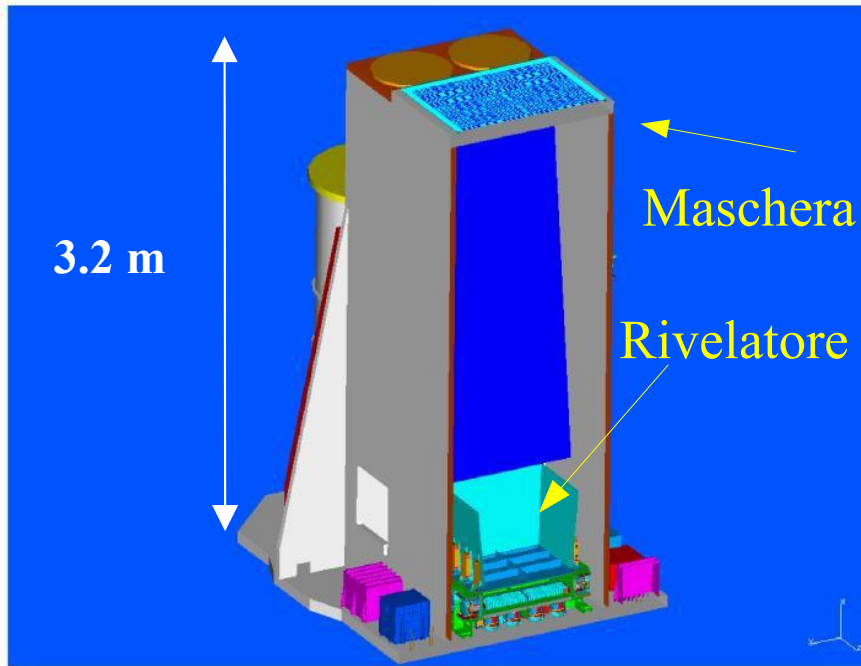- SPI: Spectrometer
  (20 keV - 8 MeV)

+ 2 monitoring instruments
- JEM-X (4.5 - 35 keV)
- OMC : optical camera

!! I DOWNLOAD ALL BUT SPI AND I ANALYZE IBIS/ISGRI !!

I ANALYZE IBIS/ISGRI

3.2 m

Maschera

Rivelatore

ISGRI: CdTe
15 keV - 600 keV

It's a coded mask instrument

IBIS

* TCFOV: 29º × 29º
  (9º × 9º, FCFOV)

* Angular Res: ~12'

* Sensit.: $2.9 \ 10^{-6}$ ph/sec cm^2
  @ 100keV
  ($\Delta E = E/2$, 3σ, 10^5 sec)

* Absolute timing accuracy: 61 µs

* Spe Res:
  8 keV @ 100 keV (FWHM)

SPI: 3 keV @ 1.7 MeV (FWHM)
JEM-X: 2 keV @ 22 keV   (FWHM)

Watch out the mask!

· Each source is background for the rest
· Tricky for weak sources
· Two step analysis: IMA and then
extract SPE and LCR for all the sources
active in the field of view
· Ghosts as new sources

A standard automatic analysis is NOT optimized
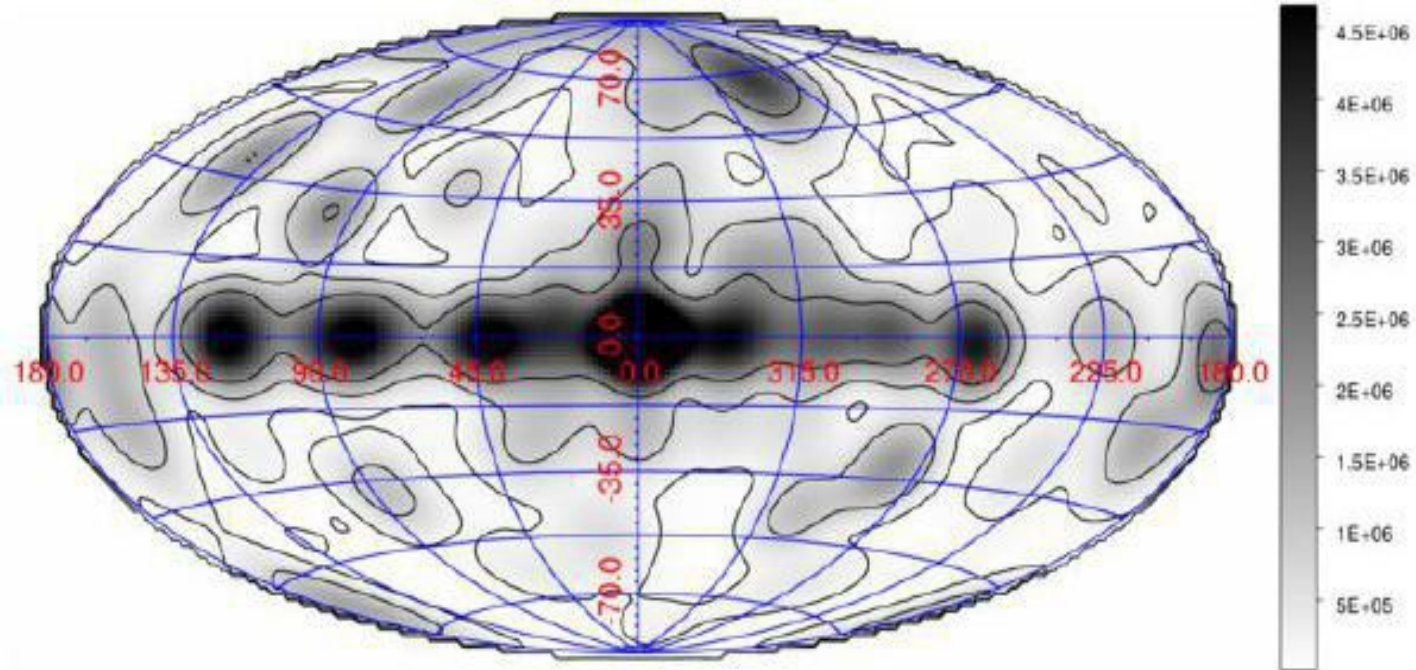for alla cases *!!be careful what you use*

and how you use it!!
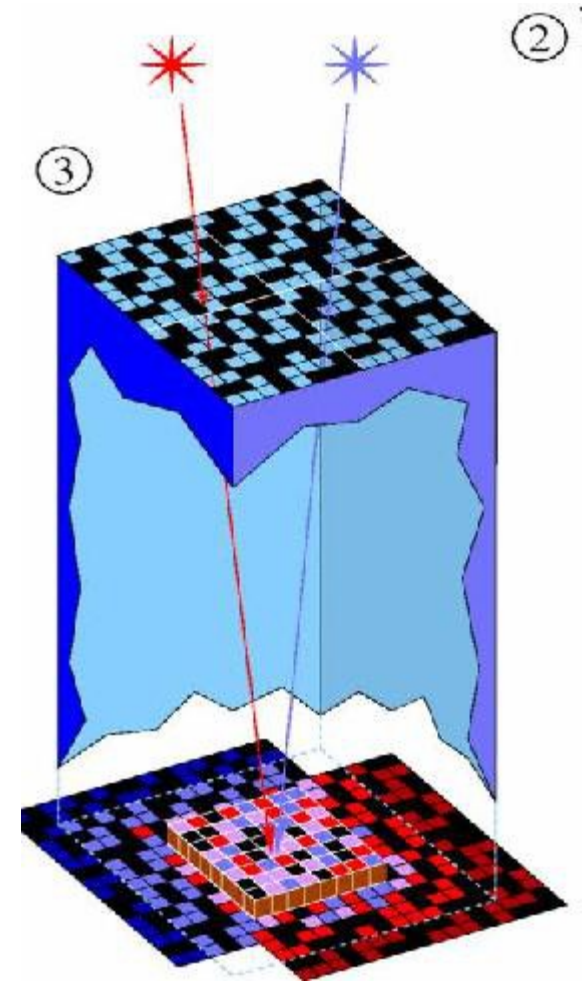
The sources

Bird+2010, OSA s/w
70 Ms, Core Program
+ public data (5.5 yrs):
723 sources

Cat 1, Cat 2, Cat 3, Cat 4

AGN   CV   HMXB   LMXB   Other   Unknown
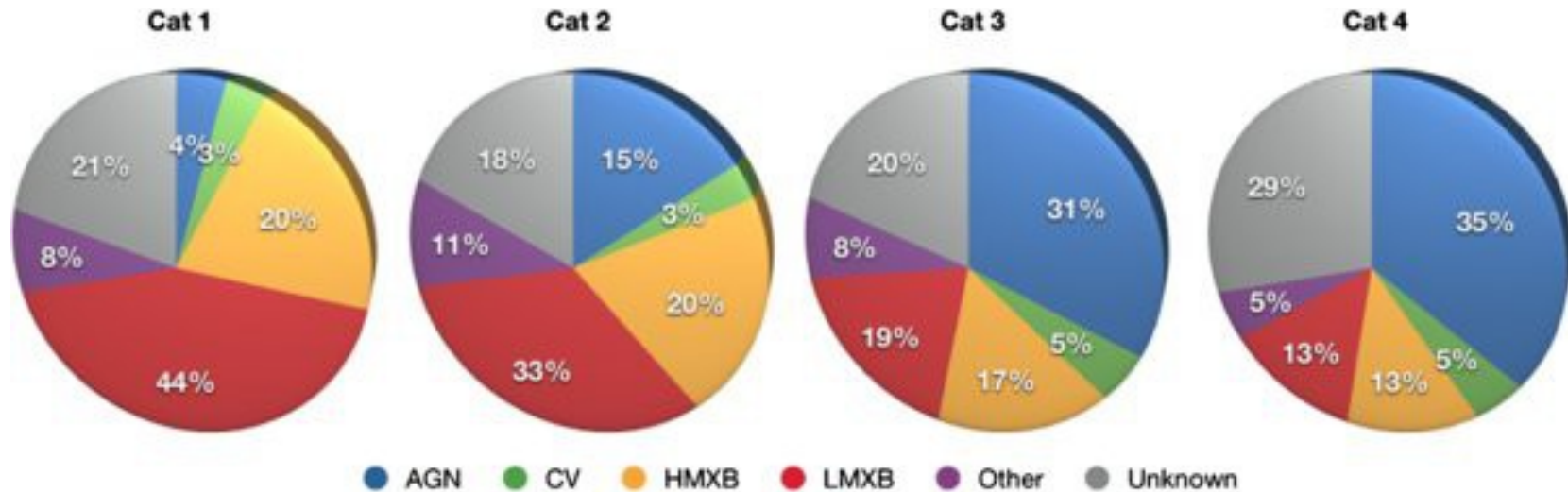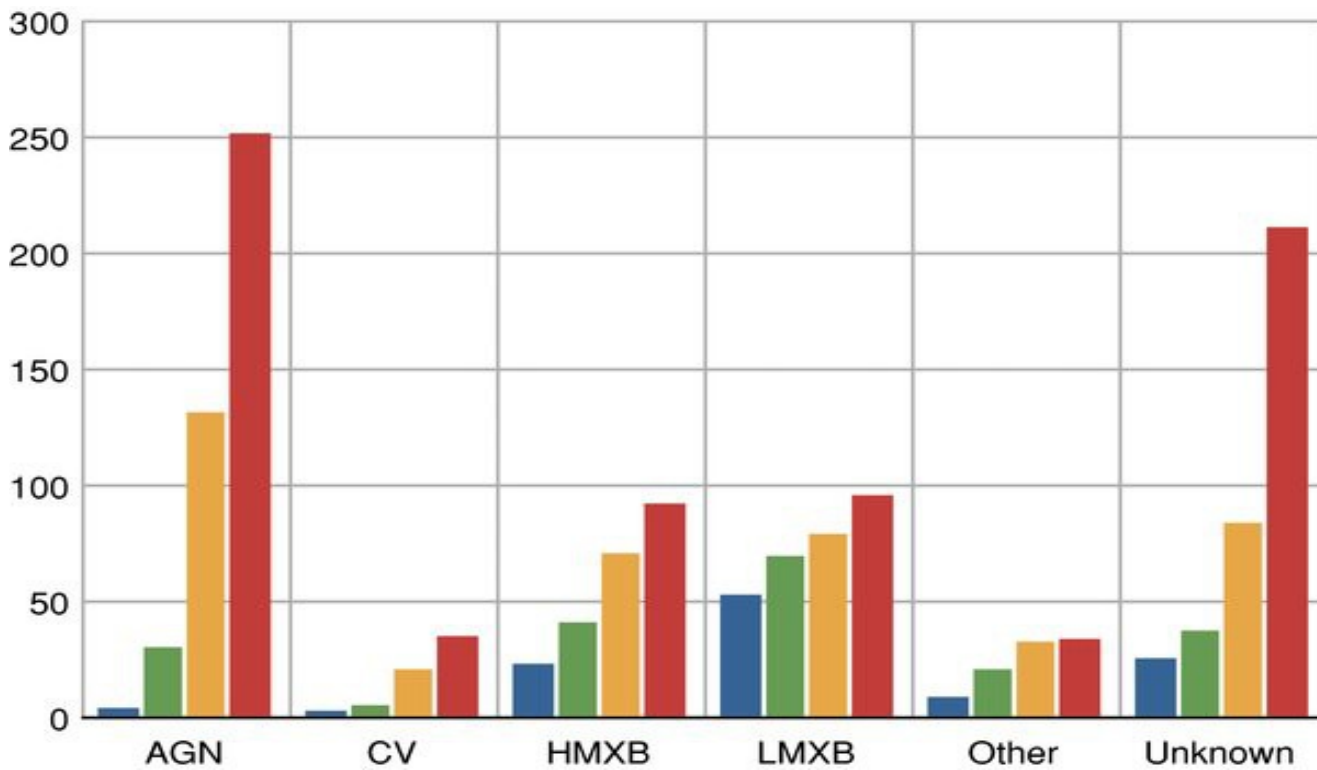
Exposure map

Dead time corrected exposure map INTEGRAL all sky survey, Jan 2011, public data. From Krivonos+2012

Krivonos+2010 (7year all sky hard X-ray survey, with their sw)

$$F_{lim}^{5\sigma} = 0.77 \times (T/Ms)^{-1/2} \text{ mCrab}$$

→ !! ~20 mCrab in one pointing!!

Weakest detection: 0.26 mCrab, 3.7×10^{-12} erg sec^{-1} cm^{-2}, 17-60 keV

Data et al.

Today @ revolution 1389 (each rev is 3 days, **11.4 yrs** of operations)

1252 revolutions are public (**10.3 yrs**)

I have analyzed up to rev 1239 (**Dec 2002 - Dec 2012**)

Storage: _Golia_
/golia/archivio/   6T
/golia2/archivio/   6T
Very "touchy" storage.

Server: _Panacea_
Single server HP ML330G6, two processors Xenon Quad-Core, 2.13 GHz, RAM 8Gb
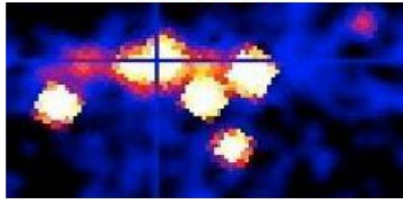
GOLIA

INTEGRAL data (Download, 'O')

↓

Image reconstruction
(launch_IMA)

OSA (Process, 'O')   OSA (Process, 'O')

Sky maps   Source lists   → Lists as input to LCR → **Light-curve extraction**
                                                                        (launch_LCR)

IMA
Energy bins: 17-30, 30-50, 17-50, 50-100 keV
Time bin: one ScW (~2 ks)
LCR
Energy bin: 17-30 keV
Time bin: 100 s

OSA ('U')   ima-pick !!!   OSA (Process, 'O')
                            (Post-process, 'O')

1 Mosaics   ASCII source files   100s bin light-curves
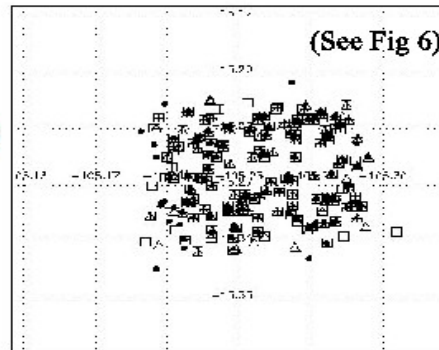   (1 multi-source file per ScW)

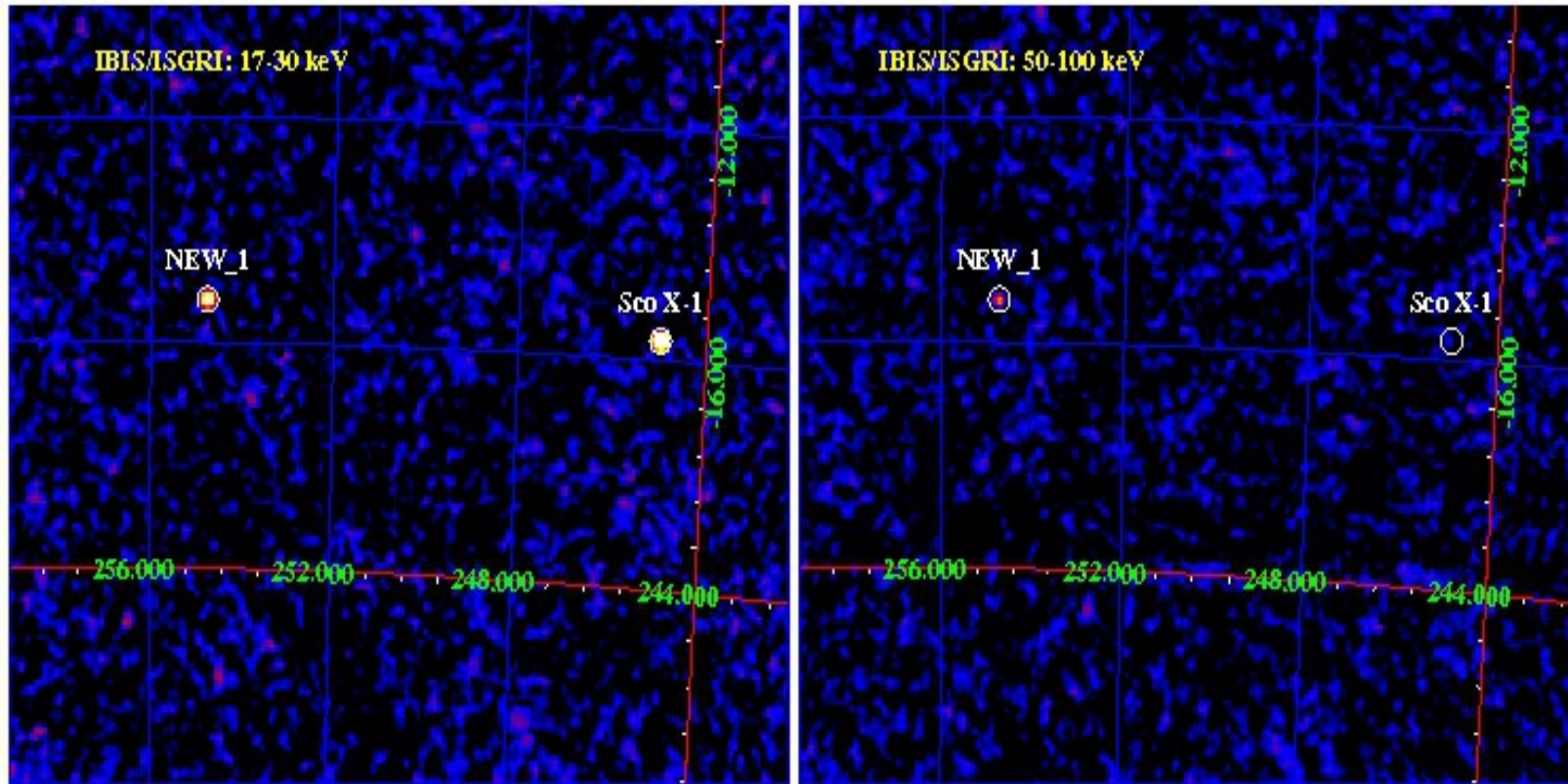   readnew ('U')   lc-pick ('U')

                                            3   **4**

readarcres ('U')

2

(See Fig 3)

(See Fig 6)

(See Fig 5)

(**Paizis**, Mereghetti, Gotz, **Fiorini**, Gaber, **Regni Ponzeveroni**, Sidoli, Vercellone 2013)
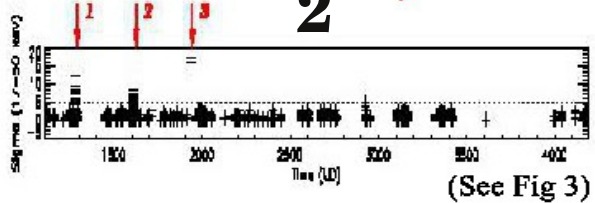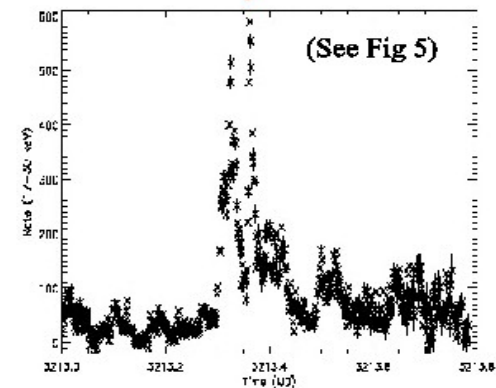
1. Sky maps and mosaics

- You need to launch OSA to make a mosaic
- Watch-out "New" sources (Here NEW_1 is MAXIJ1659-152)
- You reach: ~20 mCrab in 1 pointing and ~0.77 x $(T/Ms)^{-1/2}$ mCrab in mosaic
- Focus on a source/sky region (all-sky maps are extremely time consuming)
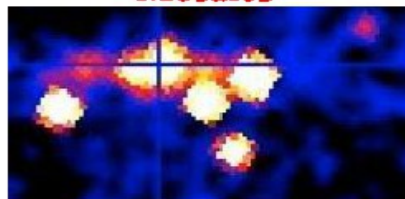
GOLIA

INTEGRAL data (Download, 'O')

Image reconstruction
(launch_IMA)
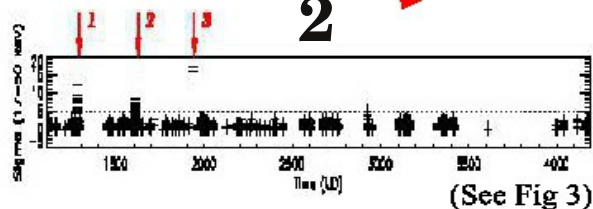
IMA
Energy bins: 17-30, 30-50, 17-50, 50-100 keV
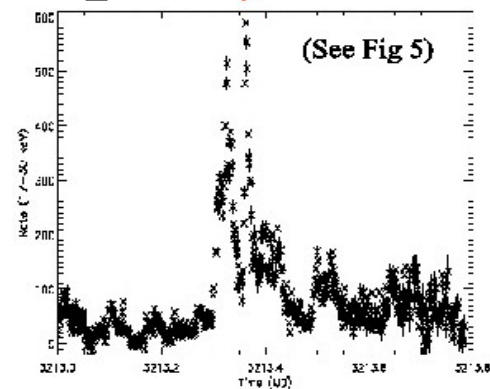Time bin: one ScW (~2 ks)

LCR
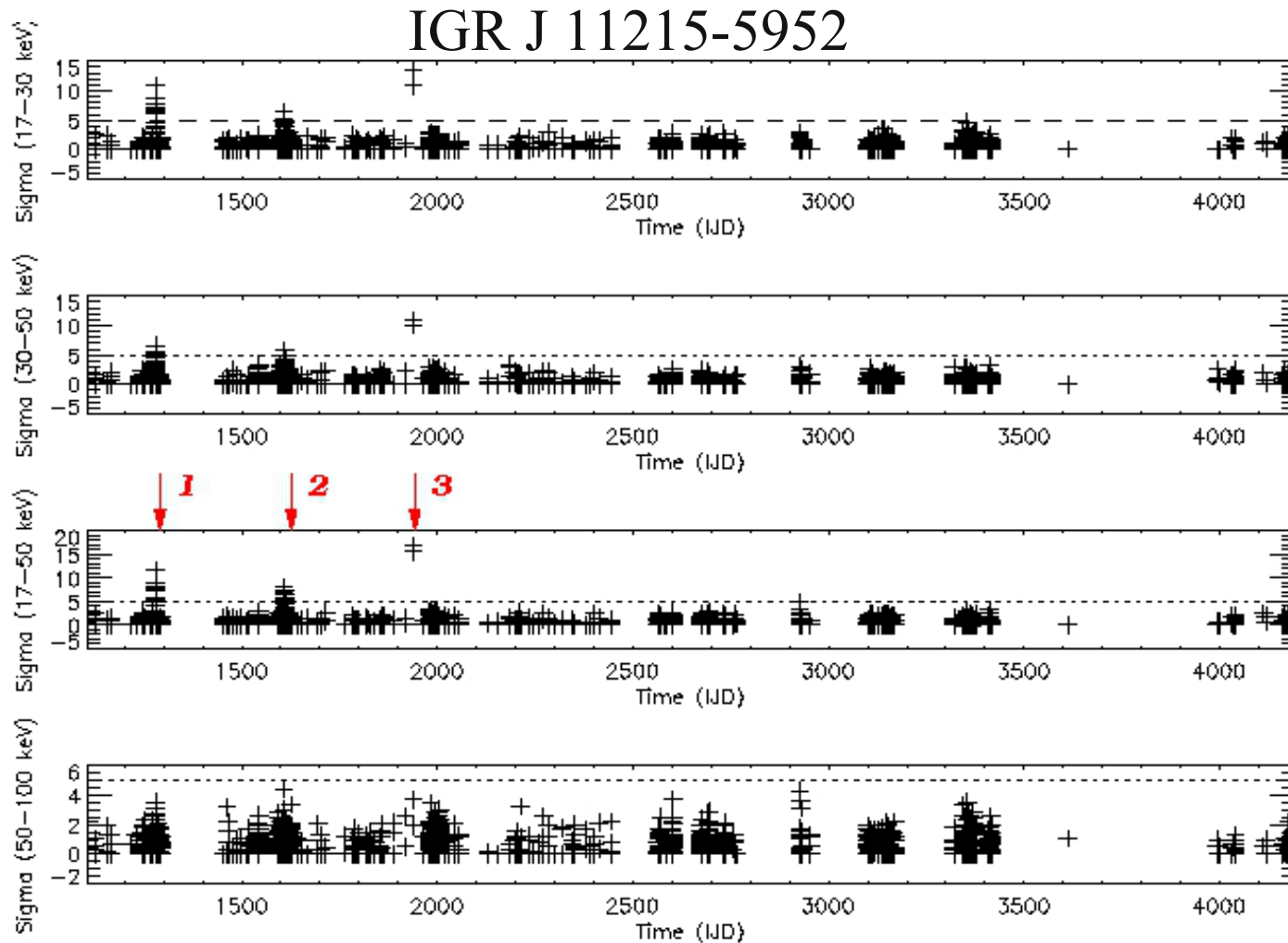Energy bin: 17-30 keV
Time bin: 100 s

OSA
(Process, 'O')

OSA (Process, 'O')

Sky maps

Source lists

Lists as input to LCR

Light-curve extraction
(launch_LCR)

OSA ('U')

ima-pick
(Post-process, 'O')

OSA (Process, 'O')

1 Mosaics

ASCII source files

100s bin light-curves
(1 multi-source file per ScW)

readnew ('U')

lc-pick ('U')

readarcres ('U')

3

(See Fig 6)

4

(See Fig 5)

2

(See Fig 3)

IGR J 11215-5952
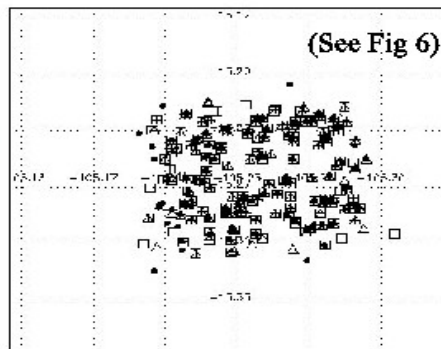
• No need to launch OSA sw, just IDL to read an ASCII file (IMA -2 in cookbook)
• You obtain plot and pointing lists with relative detections for further analysis
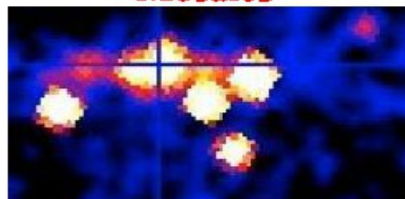
GOLIA

INTEGRAL data (Download, '*O*')

↓

Image reconstruction
(*launch_IMA*)

OSA
(*Process*, '*O*')

OSA (Process, 'O')

```
IMA
Energy bins: 17-30, 30-50, 17-50, 50-100  keV
Time bin: one ScW (~2 ks)

LCR
Energy bin: 17-30 keV
Time bin: 100 s
```

Sky maps

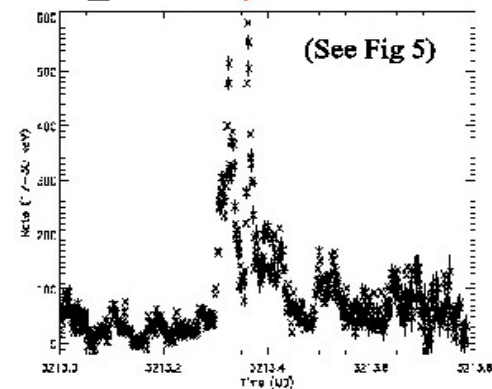Source lists — Lists as input to LCR → **Light-curve extraction**
(*launch_LCR*)

OSA ('U')

ima-pick
(*Post-process, 'O'*)

OSA (Process, 'O')

1 Mosaics

ASCII source files

100s bin light-curves
(1 multi-source file per ScW)

readnew ('U')

3

lc-pick ('U')

4

(See Fig 6)

(See Fig 5)

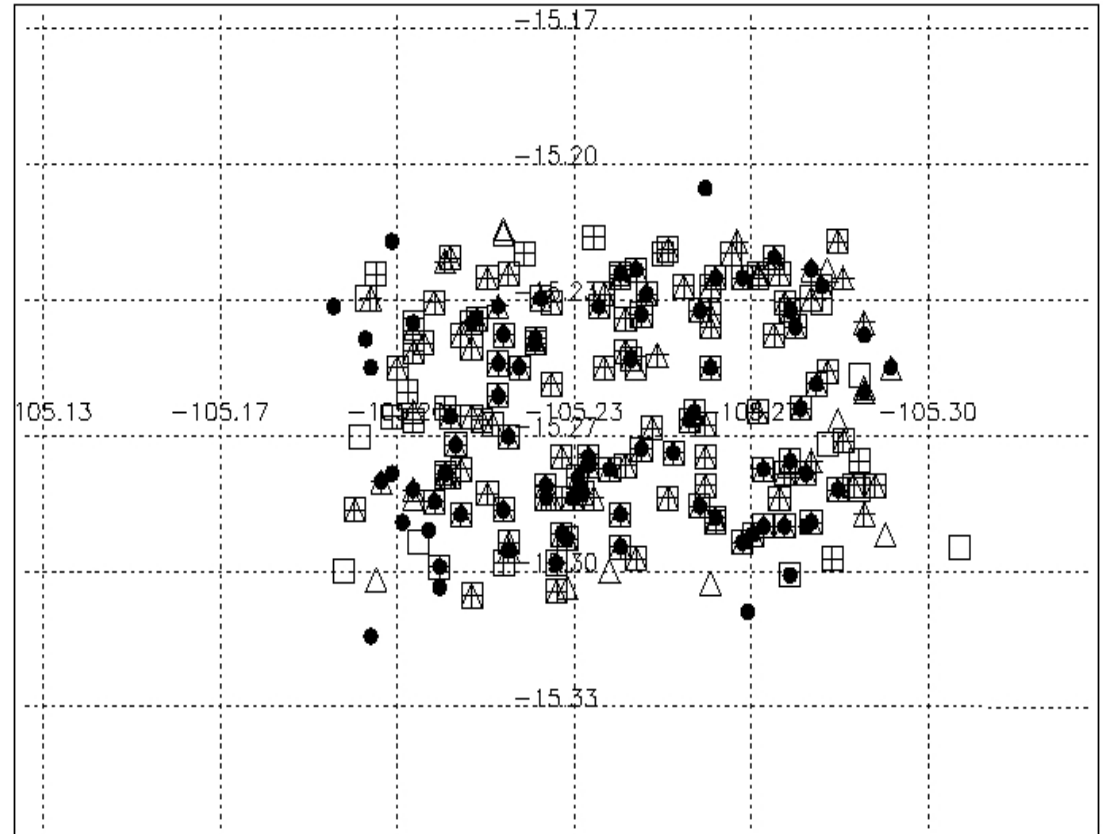*readarcres ('U')*

2

(See Fig 3)

3. NEW sources

NEW 1 is not the same
all over the archive!

```
========================
Where do you want to zoom?
Enter R.A. [degrees]? 254.77
Enter DEC [degrees]? -15.2630
Enter size [degrees]? 0.1
IDL>
=================================
Triangles: sources with detsig(17-30keV)  > 7
Squares : sources with detsig(30-50keV)  > 7
Crosses : sources with detsig(17-50keV)  > 7
Circles  : sources with detsig(50-100keV) > 7
=================================
Select the energy band <1/2/3/4>:
```


- No need to launch OSA analysis, just IDL to read an ASCII file
- All the NEW* grouped by position (this again is MAXIJ1659-152)
- This helps tracing back to see if a new source passed unnoticed in the archive (EXTraS?)

GOLIA

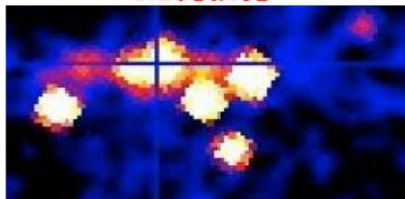*INTEGRAL* data (Download, 'O')

↓

Image reconstruction
(launch_IMA)

OSA
(Process, 'O')

OSA (Process, 'O')

IMA
Energy bins: 17-30, 30-50, 17-50, 50-100 keV
Time bin: one ScW (~2 ks)

LCR
Energy bin: 17-30 keV
Time bin: 100 s

Sky maps

Source lists

Lists as input to LCR

Light-curve extraction
(launch_LCR)

!!

OSA ('U')

OSA (Process, 'O')

1 Mosaics

ima-pick
(Post-process, 'O')

ASCII source files

100s bin light-curves
(1 multi-source file per ScW)

readnew ('U')

3

lc-pick ('U')
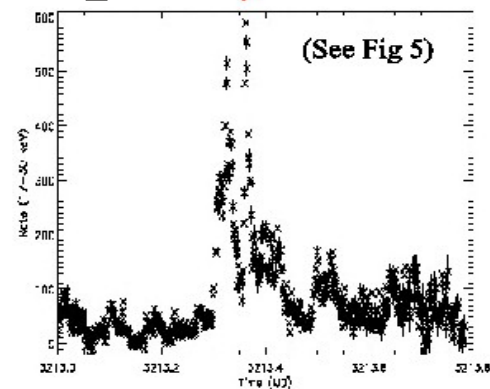
4

readarcres ('U')

2

(See Fig 3)

(See Fig 6)

(See Fig 5)
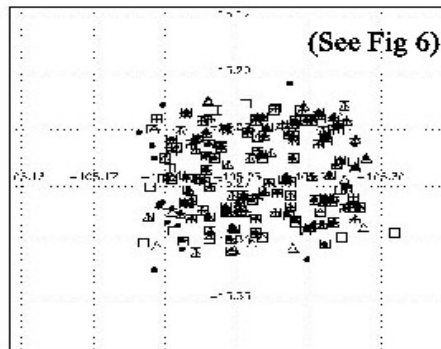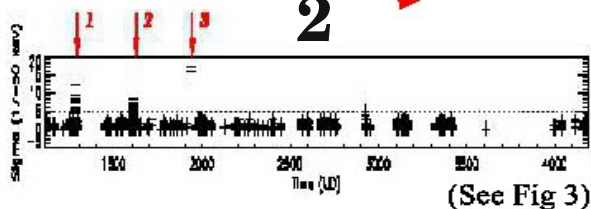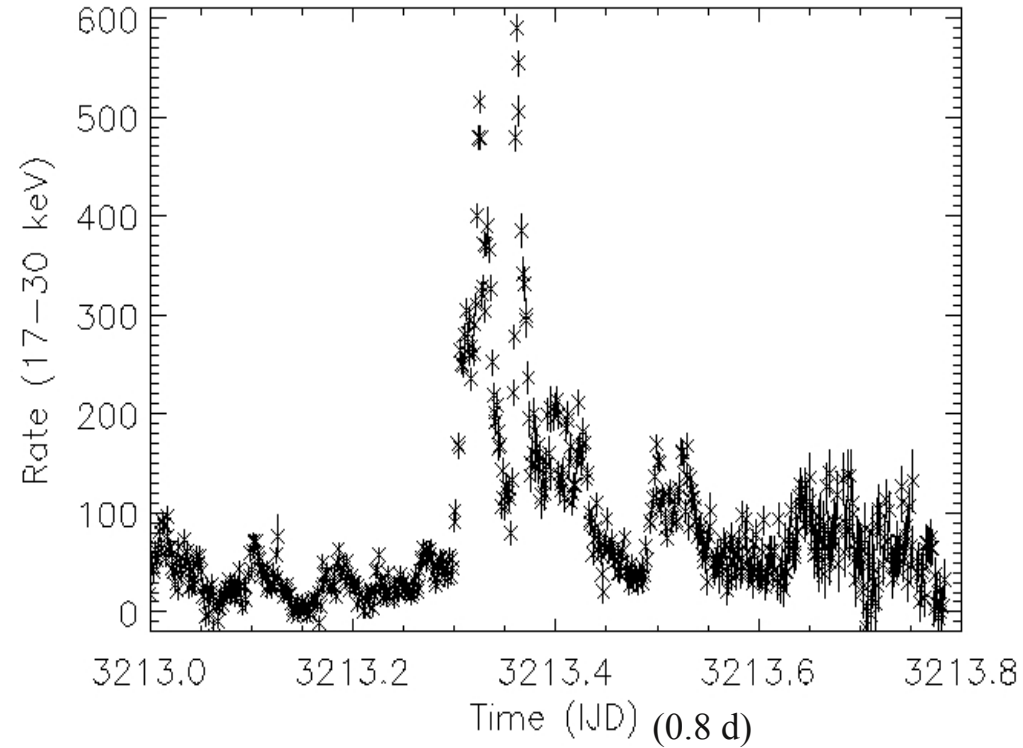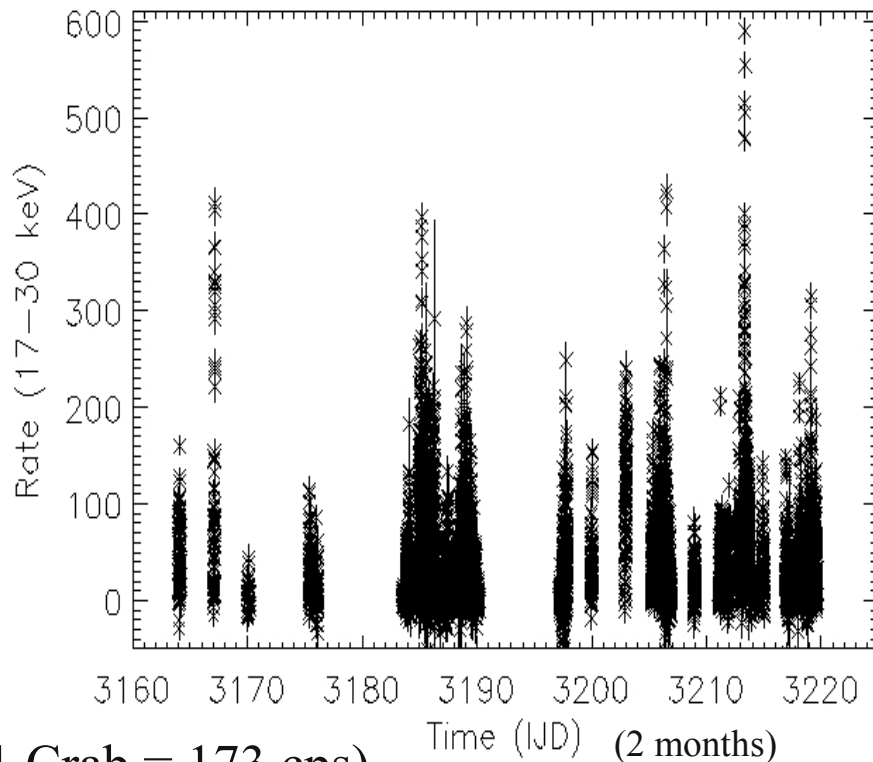
4. 100sec light-curves: load of data!!

4U 1700 -377 (17-30 keV)

(1 Crab = 173 cps)

- You need to launch OSA to extract a source all archive LCR
- Time consuming
- Warning: results obtained after some choices that may include bias
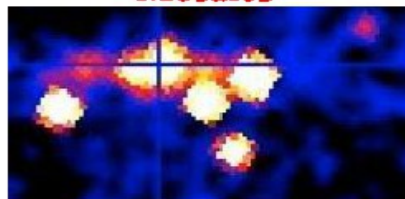
GOLIA

INTEGRAL data (Download, 'O')

↓

Image reconstruction
(launch_IMA)

OSA
(Process, 'O')

OSA (Process, 'O')

IMA
Energy bins: 17-30, 30-50, 17-50, 50-100 keV
Time bin: one ScW (~2 ks)
LCR
Energy bin: 17-30 keV
Time bin: 100 s

Sky maps

Source lists

Lists as input to LCR → **Light-curve extraction**
(launch_LCR)

OSA ('U')

ima-pick
(Post-process, 'O')

OSA (Process, 'O')

1 Mosaics

ASCII source files

100s bin light-curves
(1 multi-source file per ScW)

readnew ('U')

3
(See Fig 6)

lc-pick ('U')

4
(See Fig 5)

readarcres ('U')

2
(See Fig 3)
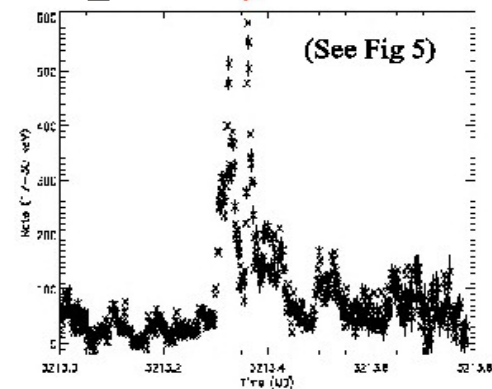
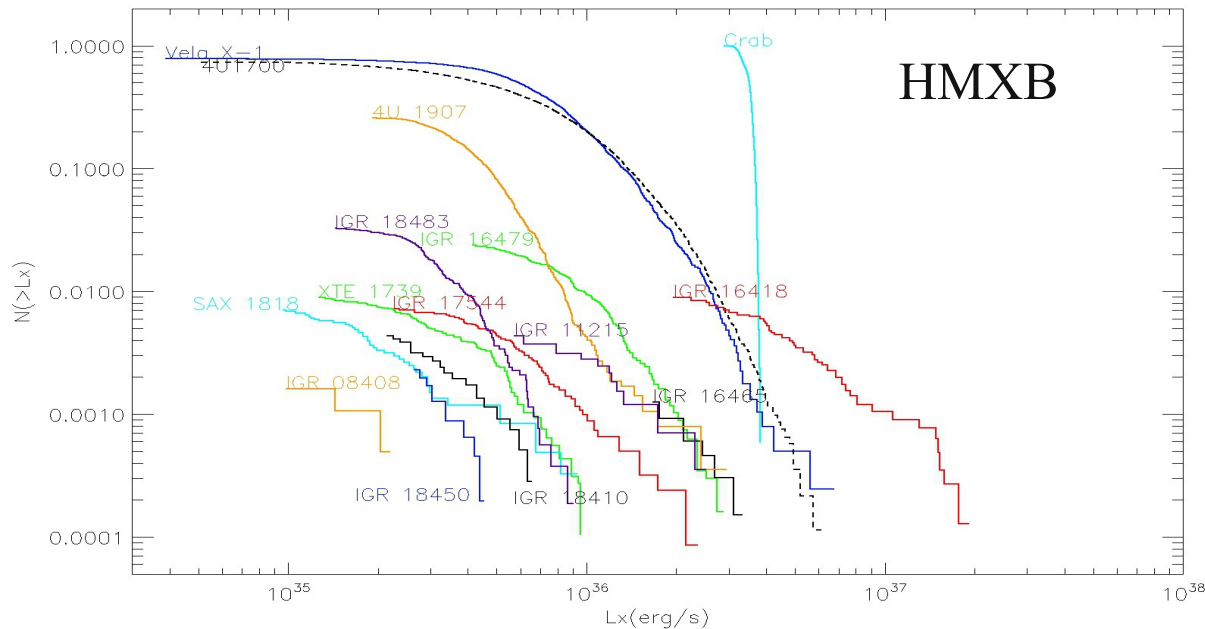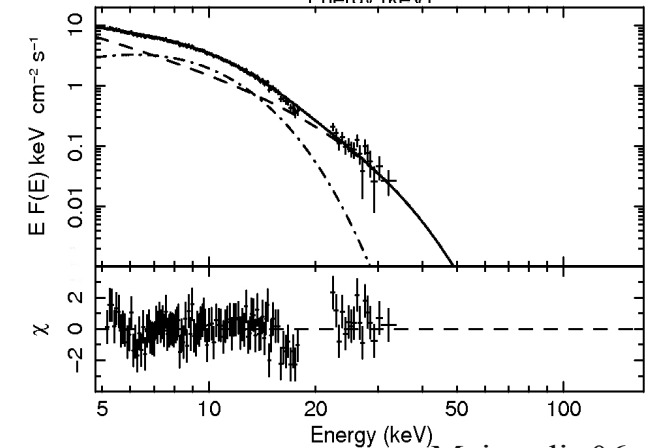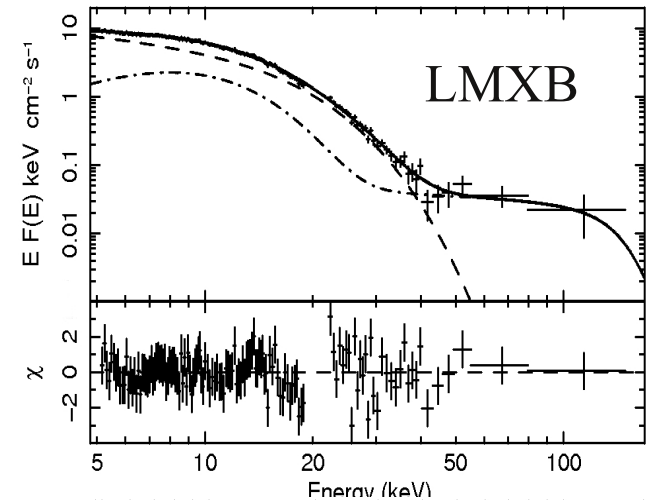# Results from INTEGRAL archive @IASF

- In the years this archive has been used for
  AGN
  PWN
  HMXB
  LMXB
  SGR/AXP

LMXB

HMXB

Paizis&Sidoli14

Mainardi+06

@ IASF Milano

I prepared a cookbook
/venus/ada/ARCHIVIO/cookbook.txt
(tested on few platforms, OpenSUSE 11.x)

<u>For High energy Group</u>
You need to see
/golia
/golia2
/red/Software

<u>For the rest: come to see me :-)</u>

Out of IASF Milano

GOLIA

An *INTEGRAL* archive at INAF-IASF Milano

GOLIA: an INTEGRAL archive at INAF-IASF Milano
A. Paizis, S. Mereghetti, D. Götz, M. Fiorini, M. Gaber, R. Regni Ponzeveroni, L. Sidoli, S. Vercellone
Astronomy and Computing, Volume 1, February 2013, Pages 33-39   (Link to paper)

A. Paizis thanks the ISDC staff since most of the know-how needed to set-up such an archive was gained during her years at the ISDC (2000-2005).

Abstract

We present the archive of the *INTEGRAL* data developed and maintained at INAF-IASF Milano. The archive comprises all the public data currently available (revolutions 0026-1079, i.e., December 2002 - August 2011). *INTEGRAL* data are downloaded from the ISDC Data Centre for Astrophysics, Geneva, on a regular basis as they become public and a customized analysis using the OSA 9.0 software package is routinely performed on the IBIS/ISGRI data. The scientific products include individual pointing images and the associated detected source lists in the 17-30, 30-50, 17-50 and 50-100 keV energy bands, as well as light-curves binned over 100 s in the 17-30 keV band for sources of interest. Dedicated scripts to handle such vast datasets and results have been developed. We make the analysis tools to build such an archive publicly available. The whole database (raw data and products) enables an easy access to the hard X-ray long-term behavior of a large sample of sources.

Scripts to build your GOLIA

All the *INTEGRAL* public data can be freely downloaded via the ISDC dedicated web page.
A tar file with the scripts we used to build GOLIA (Process and Post-process phases, i.e. the ones performed by the archive *Owner*) can be downloaded from this page. These include the Shell scripts *launch_IMA.sh* (and its sub-routine *analysis_IMA.csh*), *launch_LCR.sh* (and its sub-routine *analysis_LCR.csh*), and the PERL script *ima_pick.pl*. Together with OSA, they complete the set of tools we used to build GOLIA. They use freely available interpreters and need no compilation.
Please refer to Paizis et al. (2013) for a description of the archive.

TAR FILE WITH SCRIPTS: GOLIA_scripts.tar (~41 kb)
SHORT DESCRIPTION: README

If our scripts have been useful to you, please acknowledge us by including the following in your work:
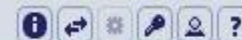"This research has made use of the scripts provided by the GOLIA group (Paizis et al., 2013, http://www.iasf-milano.inaf.it/~ada/GOLIA.html)."
Thank you.

!

www.isdc.unige.ch/heavens/

ISDC INTEGRAL Planck Gaia ASTRO-H POLAR CHEOPS
HEAVENS FACT CTA LOFT SAFARI JEM-EUSO ATHENA CAP

ISDC

HEAVENS

Query parameters

ⓘ ⇄ ✿ 🔑 ⚲ ?

Basic | **Advanced**

Source name: [   ] or select a famous object ▼

or RA DEC: [   ] [   ] Equatorial FK5 ▼

Time interval 🗋 : [   ] [   ] MJD (TT) ▼

All | None

☑ **Planck** ☑ **INTEGRAL OMC** ☑ **XMM-Newton EPIC** ☑ **RXTE ASM** ☑ **INTEGRAL JEM-X** ☑ **RXTE PCA** ☑ **INTEGRAL ISGRI**

☑ **INTEGRAL PICsIT** ☐ **INTEGRAL SPI** ☑ **INTEGRAL SPI ACS** ☑ **FERMI LAT** ☑ **HEGRA** ☑ **INTEGRAL IREM**

☑ **Sky image**

Energy band [keV]: 17.3-80.0 ▼

☑ **Lightcurve** with a bin size of [   ] hours ▼

Min - Max: 13.0 ▼   520.9 ▼

☑ **Spectrum**

Submit   Reset

Conclusions

- All ***INTEGRAL data*** (but SPI) are already downloaded @IASF (IC!)

- ***IBIS/ISGRI products for point sources*** are available
  (Diffuse emission non done but I kept the useful files – FOR NOW)

- ***Use it for your personal analysis*** (2 second check of a 10yr archive!)

- Give me ***feedback*** (also for next run)

- ***Other usage***: EXTraS? Other HE archives to match GOLIA to?

Grazie!
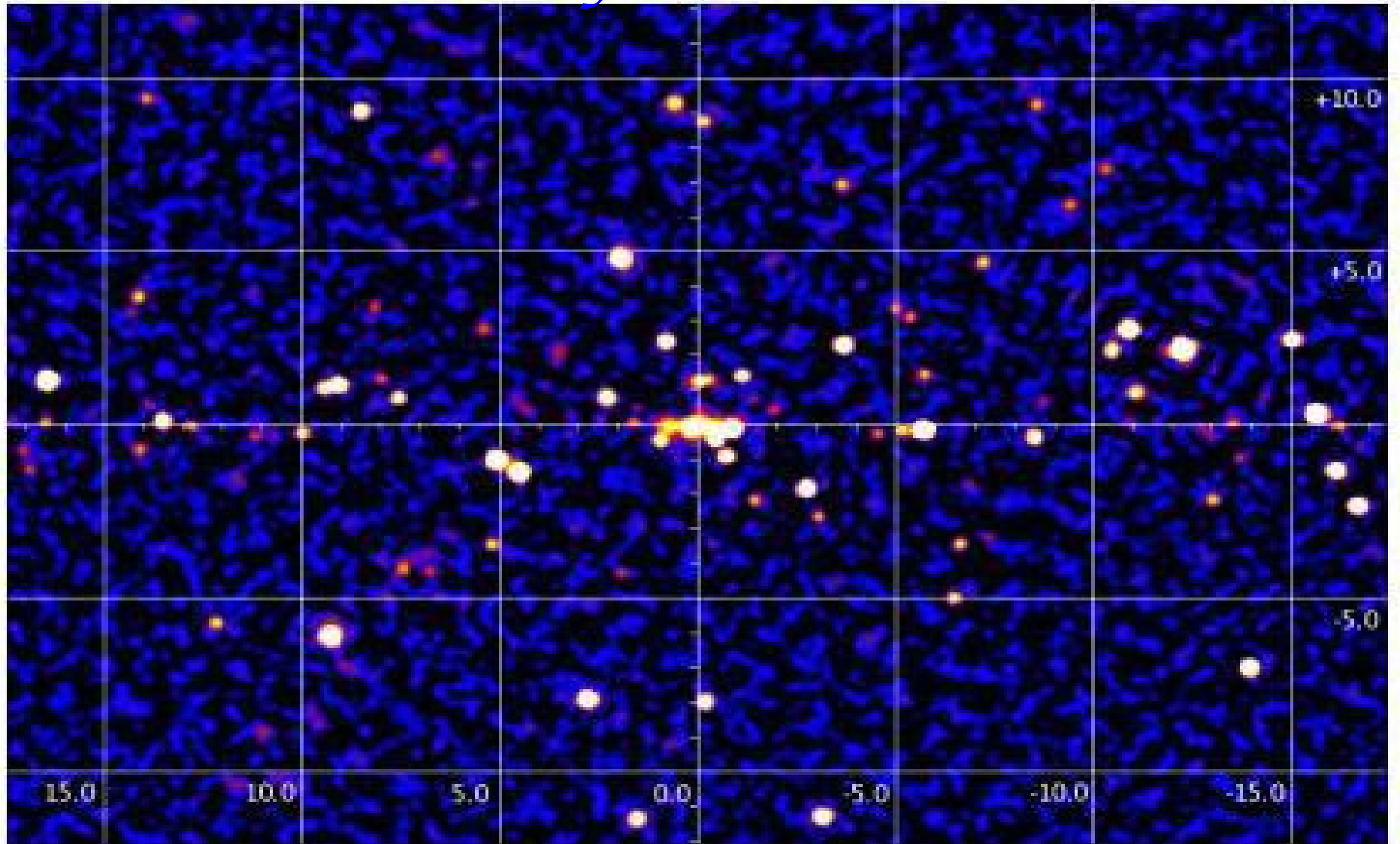
Krivonos+2010

P.S. Your mosaic is not going to be so cool!