IBIS/ISGRI Data Analysis

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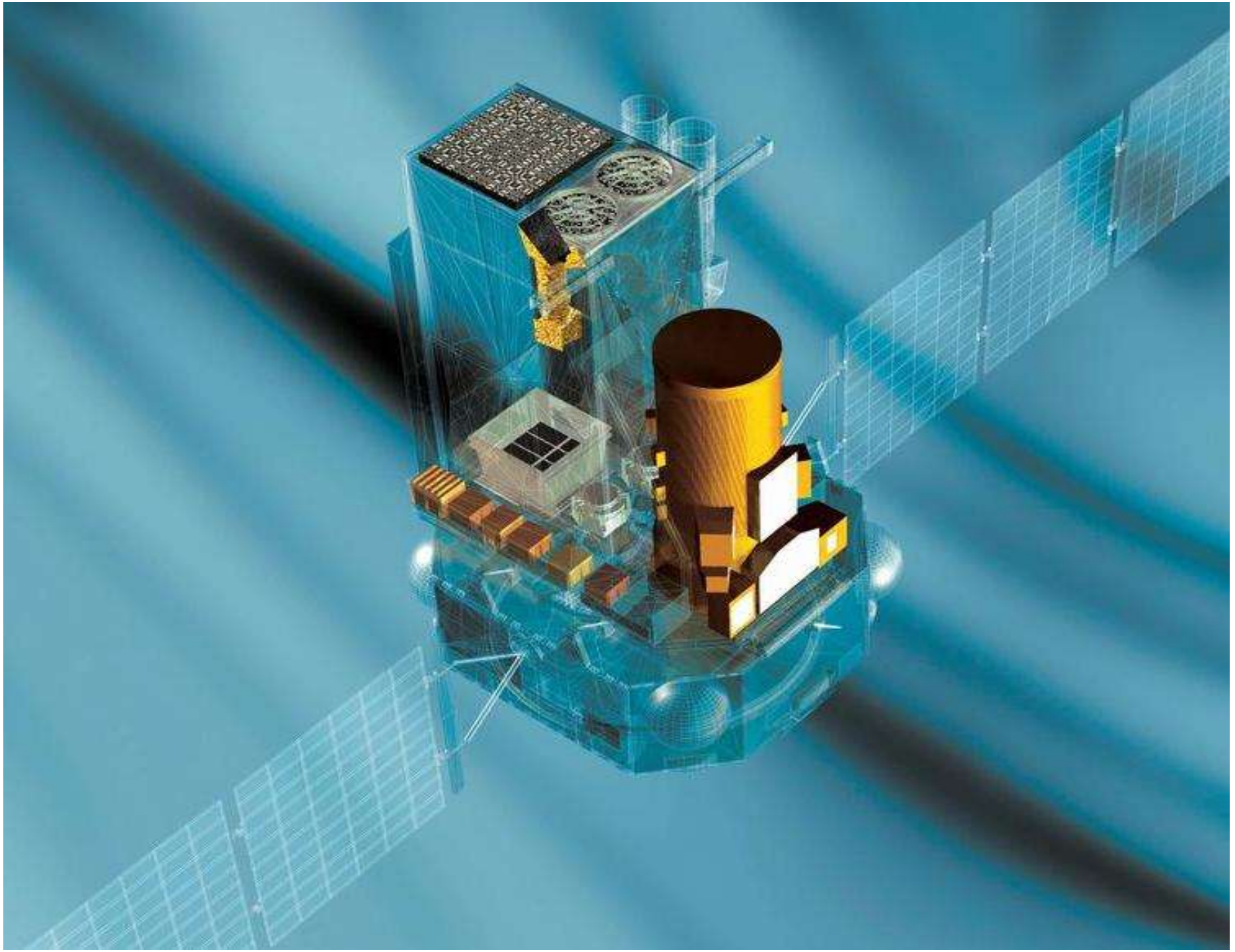
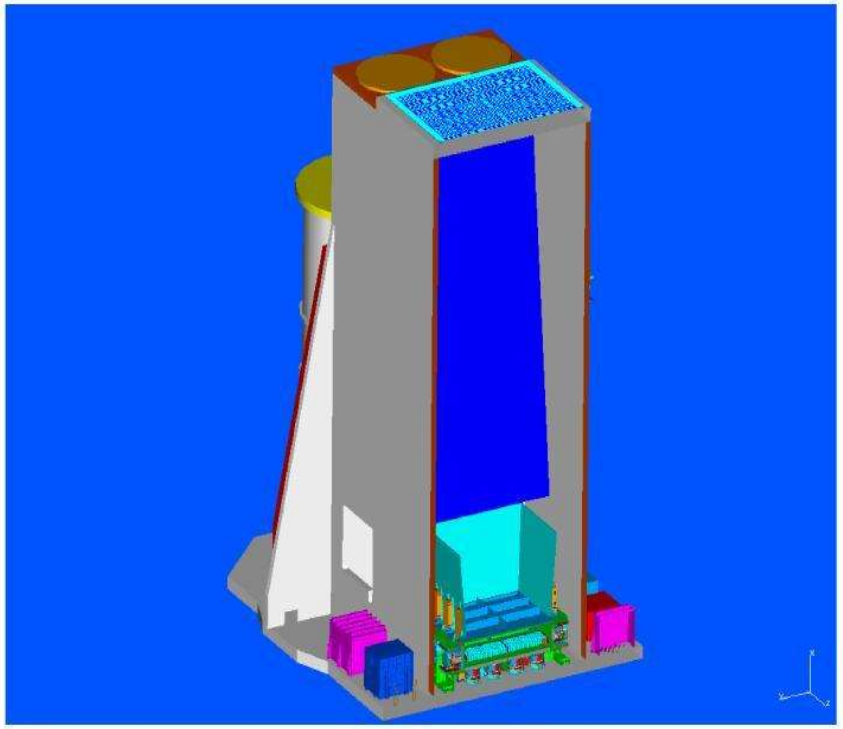
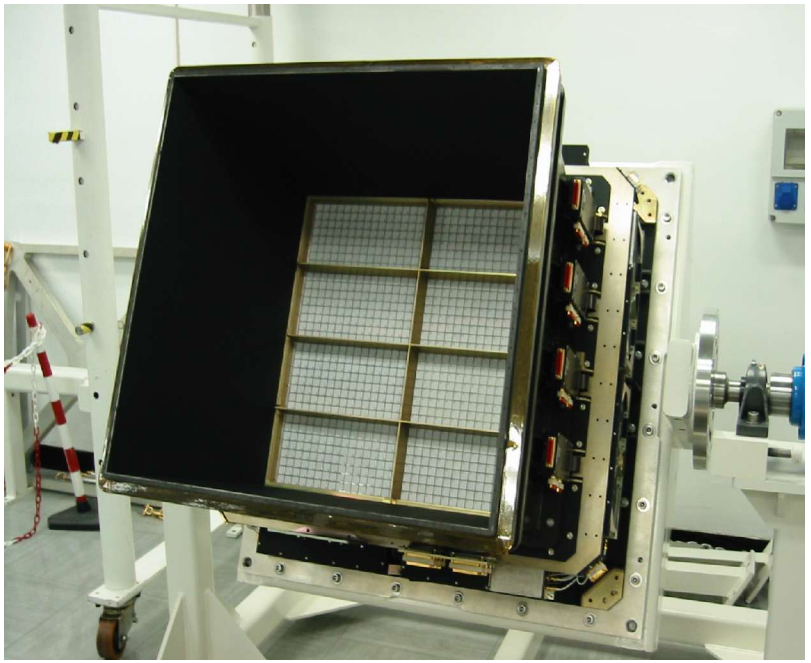
- The IBIS instrument
- OSA: behind the scenes
- Hands-on tutorial
- What else?
- ISGRI calibration

INTEGRAL Data Analysis Workshop
November 14-15, 2005-NASA/GSFC



The IBIS instrument





Mask :
53 x 53 MURA basic pattern

Positional Detectors :
ISGRI (CdTe): 15 keV – 1 MeV
PICsIT (CsI): 170 keV – 10 MeV

Shielding system, Veto and CU :
Passive (tube, hopper)
Veto Unit : 16 BGO mod
Calibration Unit : ^{22}Na Source

Imaging properties :

FCFOV	9° x 9°
FC+PCFOV	29° x 29°
Angular Resolution	12’
ISGRI/PICsIT pixels	5’ / 10’

Sensitivity :
6 E-7 ph/sec cm2 keV @ 100keV
(ΔE=E/2, 3s, 10^6 sec)

Spectral Resolution
8 keV @ 100 keV (FWHM)

http://www.bo.iasf.cnr.it/Research/INTEGRAL

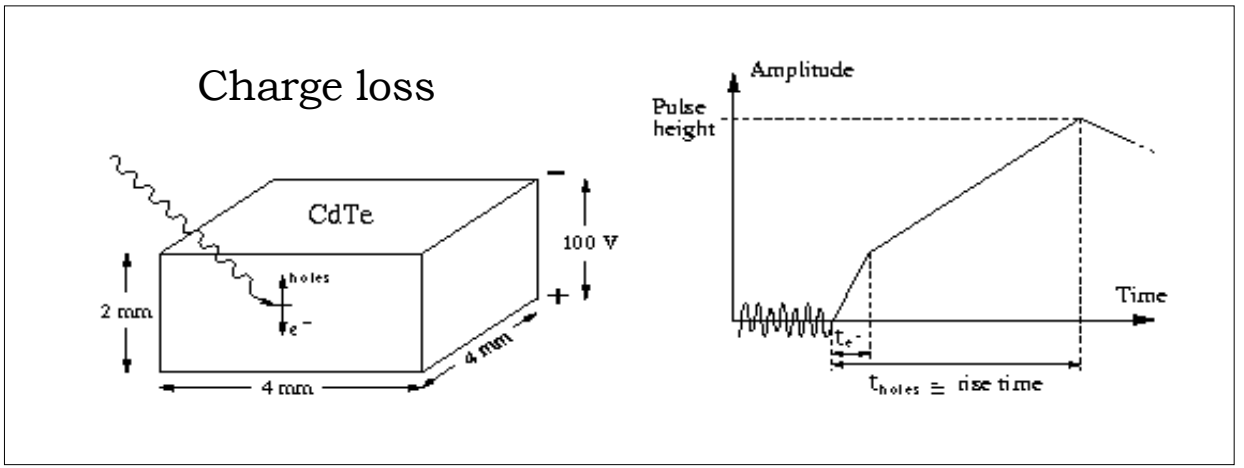
OSA: behind the scenes

I	COR GTI DEAD	• Prepare the data for scientific analysis • Mandatory (rev_2!)
II	BIN_I BKG_I CAT_I IMA	• Extract images and source properties • ~Optional
III	BIN_S SPE	• Extract spectra • ~Optional
IV	LCR	• Extract lightcurves • Optional

There is a script that does all the above for you: *ibis_science_analysis*
You decide start, end and intermediate steps.

I - Prepare the data

- COR
  - Computes the deposited energy of the events

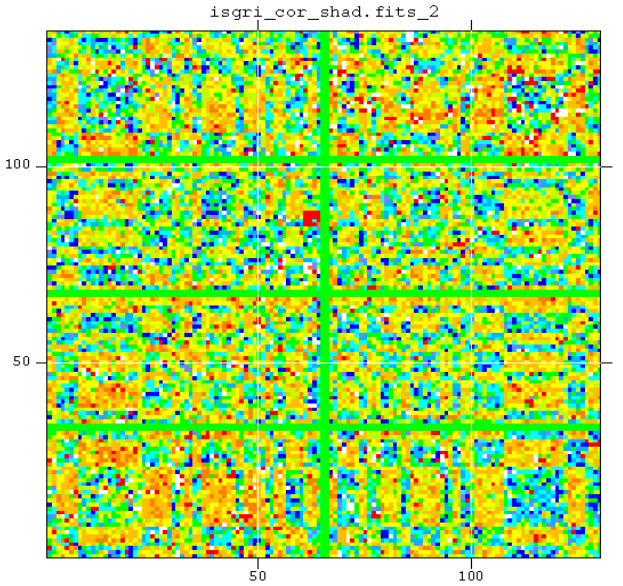


- GTI
  - Extracts good time interval information and merges it (HK data, satellite stability, data gaps)

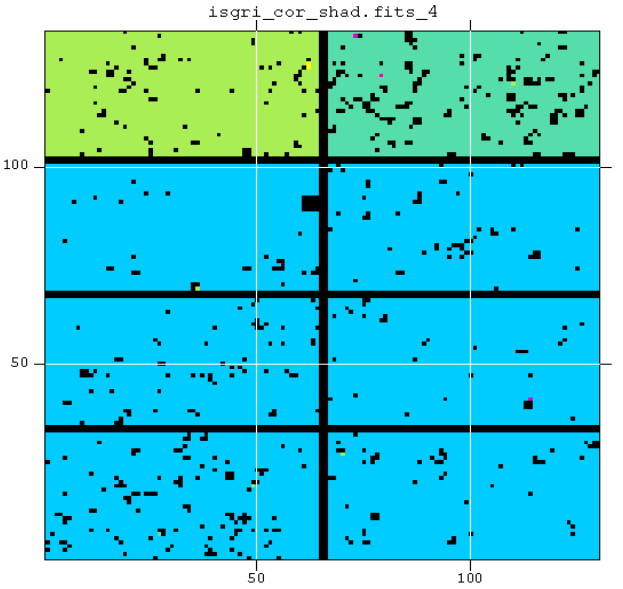
- DEAD
  - Computes dead time (instrument, veto, calibration)

II - Images

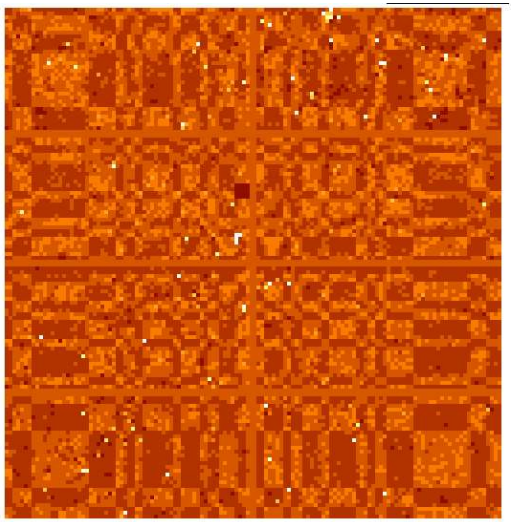
- BIN_I
  - Creates shadowgrams in Ebins



  - Computes efficiency maps in Ebins



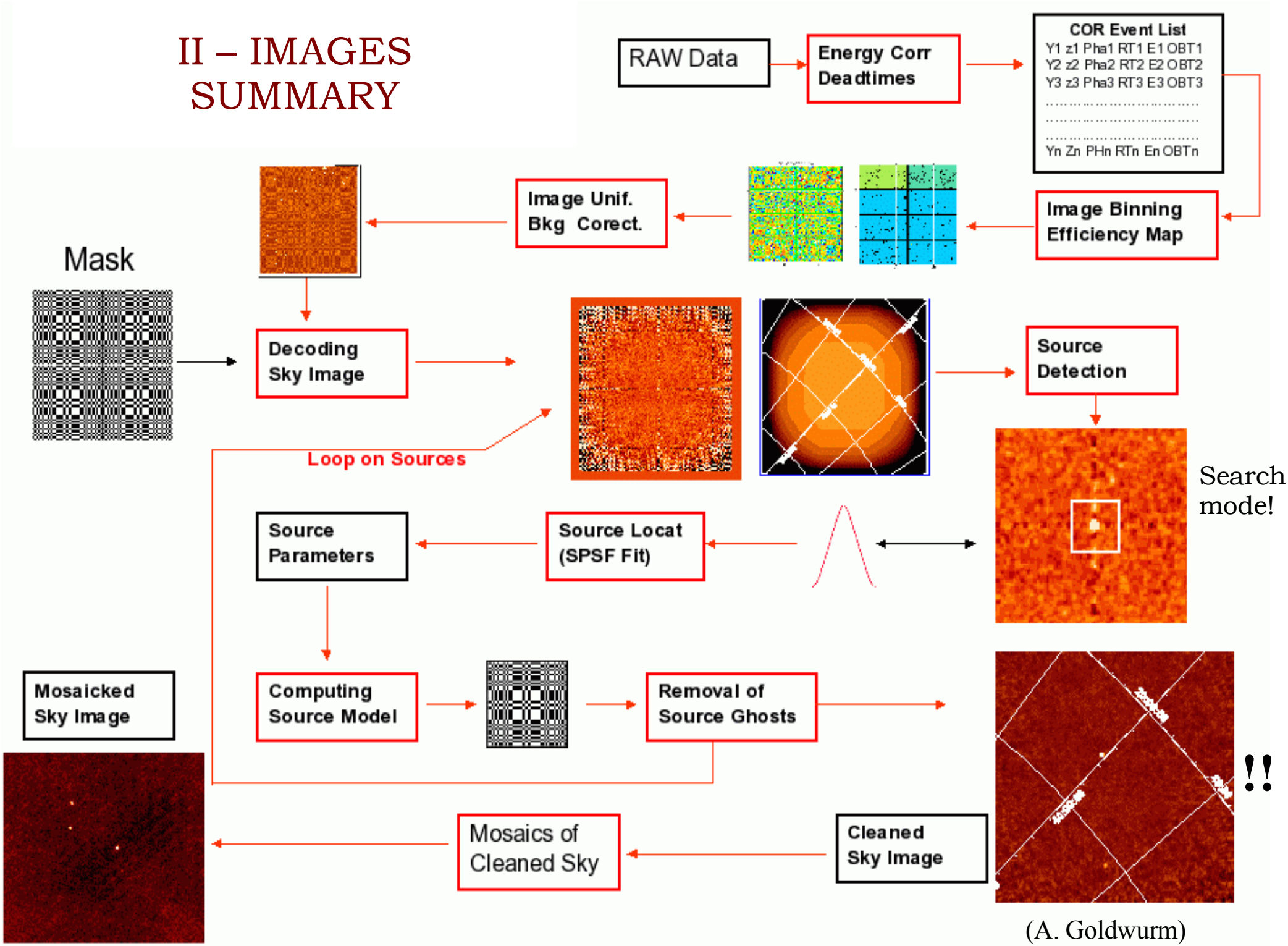
- BKG_I
  - Use background and uniformity maps to obtain a “correct” shadowgram



- CAT_I
  - Create a catalogue with sources in the FOV

- IMA
  - Sky image reconstruction
  - Source search
  - Mosaic images

II – IMAGES SUMMARY

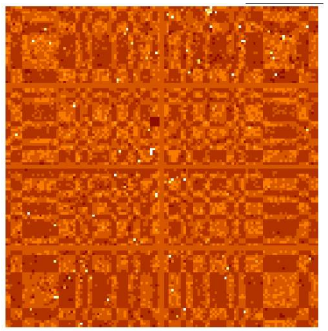


(A. Goldwurm)

III - Spectra

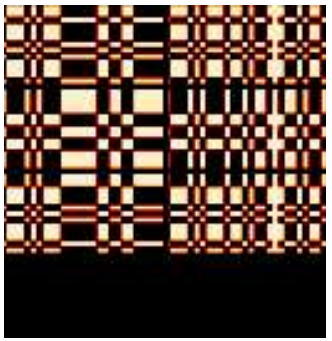
- BIN_S
  - Shadowgrams and efficiency maps in new Ebins

- SPE



+ source list from the image step

- **For each active source in the FOV** (catalog from imaging) it builds a model of the source contribution in each energy band (PIF)



Pixel Illuminated Function

time consuming!

PIF Source_1 PIF Source_2 …

- Extract spectra of the sources and background

IV Lightcurves

LCR

- You need PIF from SPE level
- Same as in SPE part with Tbin!

Summary of analysis levels

Launch the script that performs the following

- "Prepares" the data: COR-GTI-DEAD
- Extracts images and source list
- Uses IMA source list (manually modified) to extract SPE
- Uses PIF (SPE) to run LCR

Do this during the hands-on session!

Hands-on tutorial

[A] BUILD A GROUP

(1) Prepare your ascii file

[…]
scw/0175/017500180010.001/swg.fits[1]
scw/0175/017500190010.001/swg.fits[1]
scw/0175/017500200010.001/swg.fits[1]
[…]

(2) Build a group ONCE (*og_create*)

→ og_ibis.fits

Hands-on session: 3 scws, 100Mb, run time ~ 1hour on a 1.5 GHz linux machine

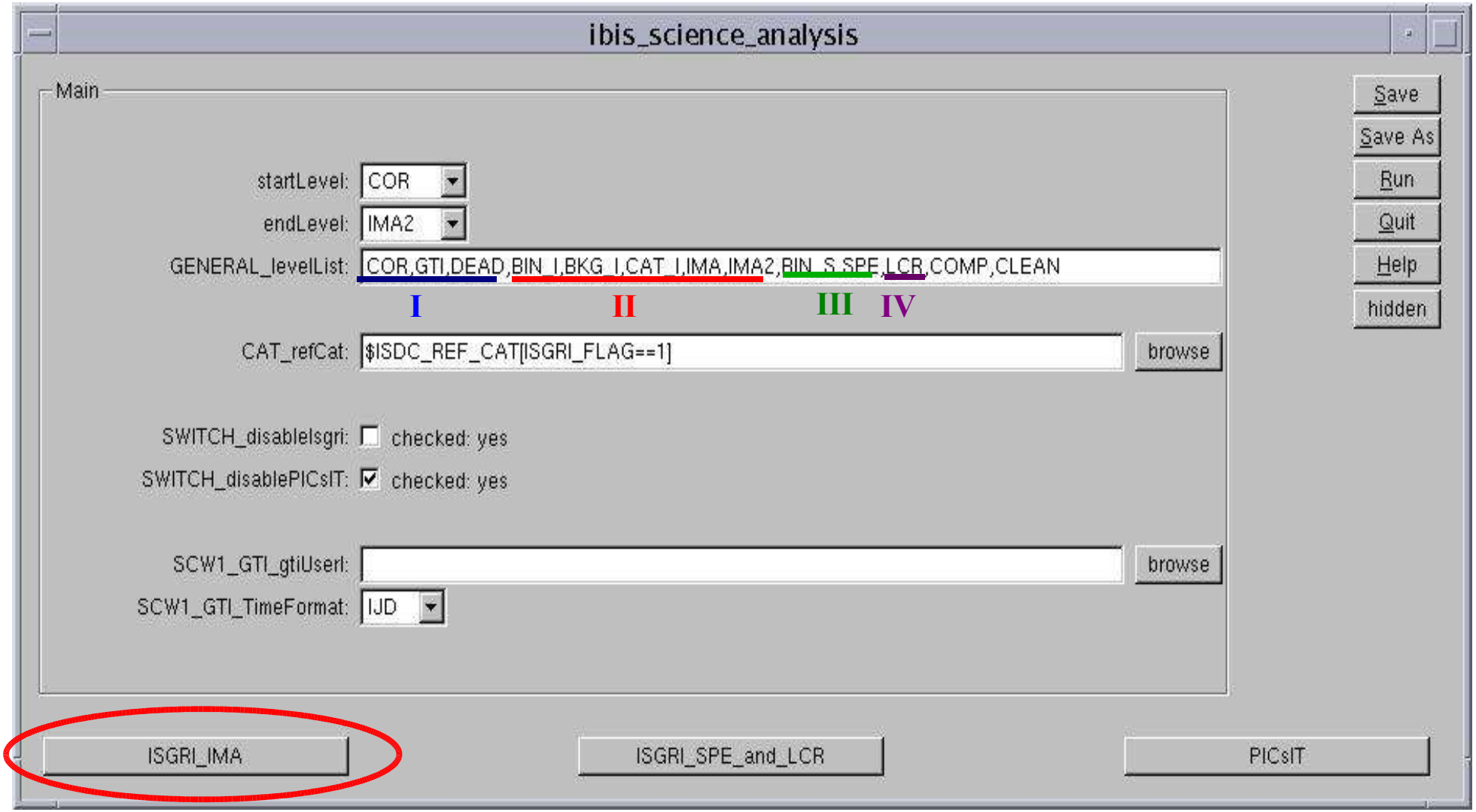
Call the ascii file SCW_IBIS.txt and

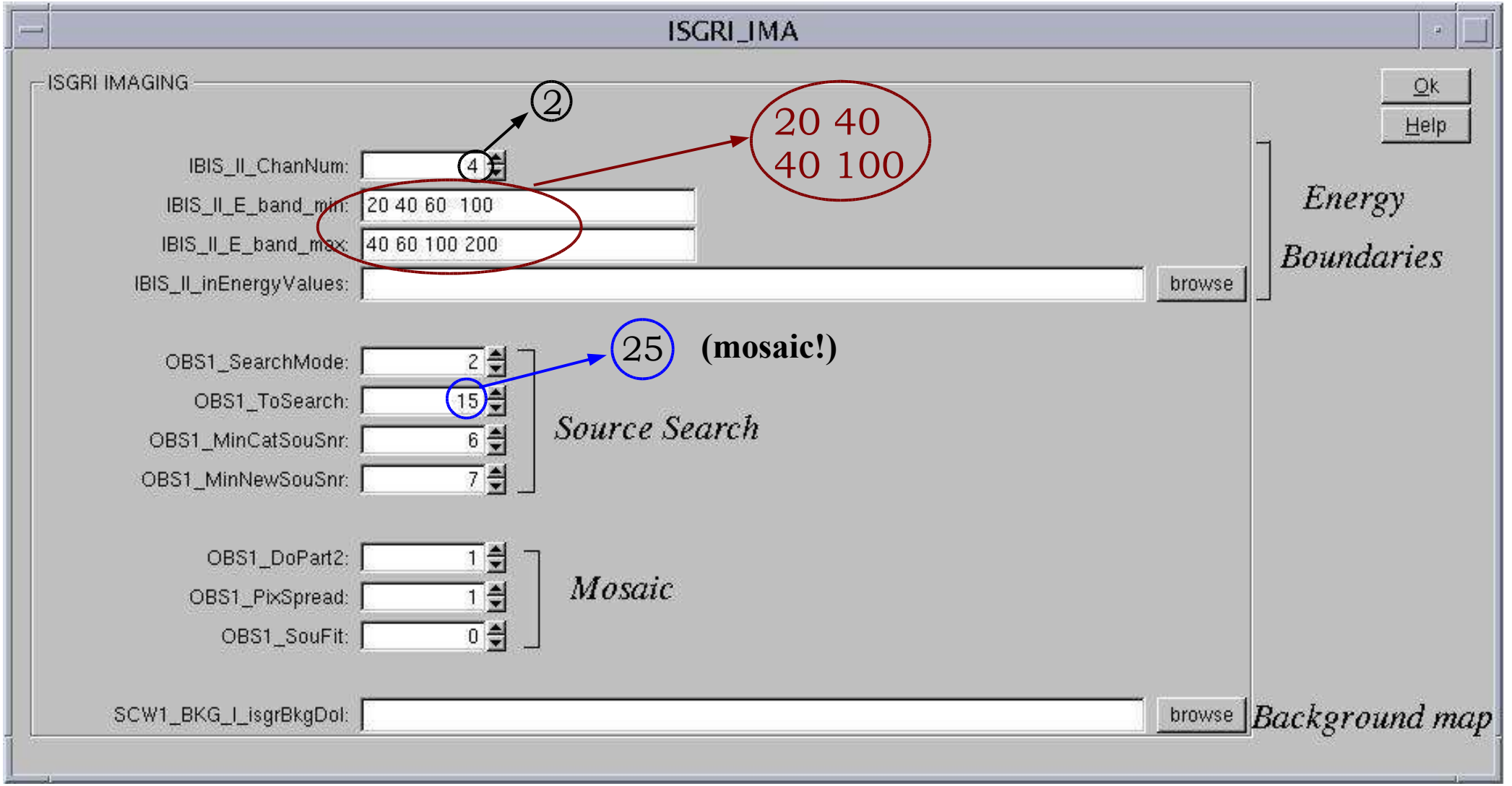
og_create idxSwg=SCW_IBIS.txt ogid=IBIS_3scw basedir="./" instrument=IBIS

cd obs/IBIS_3scw

[B] Launch till the IMA step

ibis_science_analysis





Press “OK” and on the main GUI, “Save” and “Run”

Results:

- each pointing
  isgri_sky_ima.fits
  isgri_sky_res.fits

- mosaic
  isgri_mosa_ima.fits
  isgri_mosa_res.fits

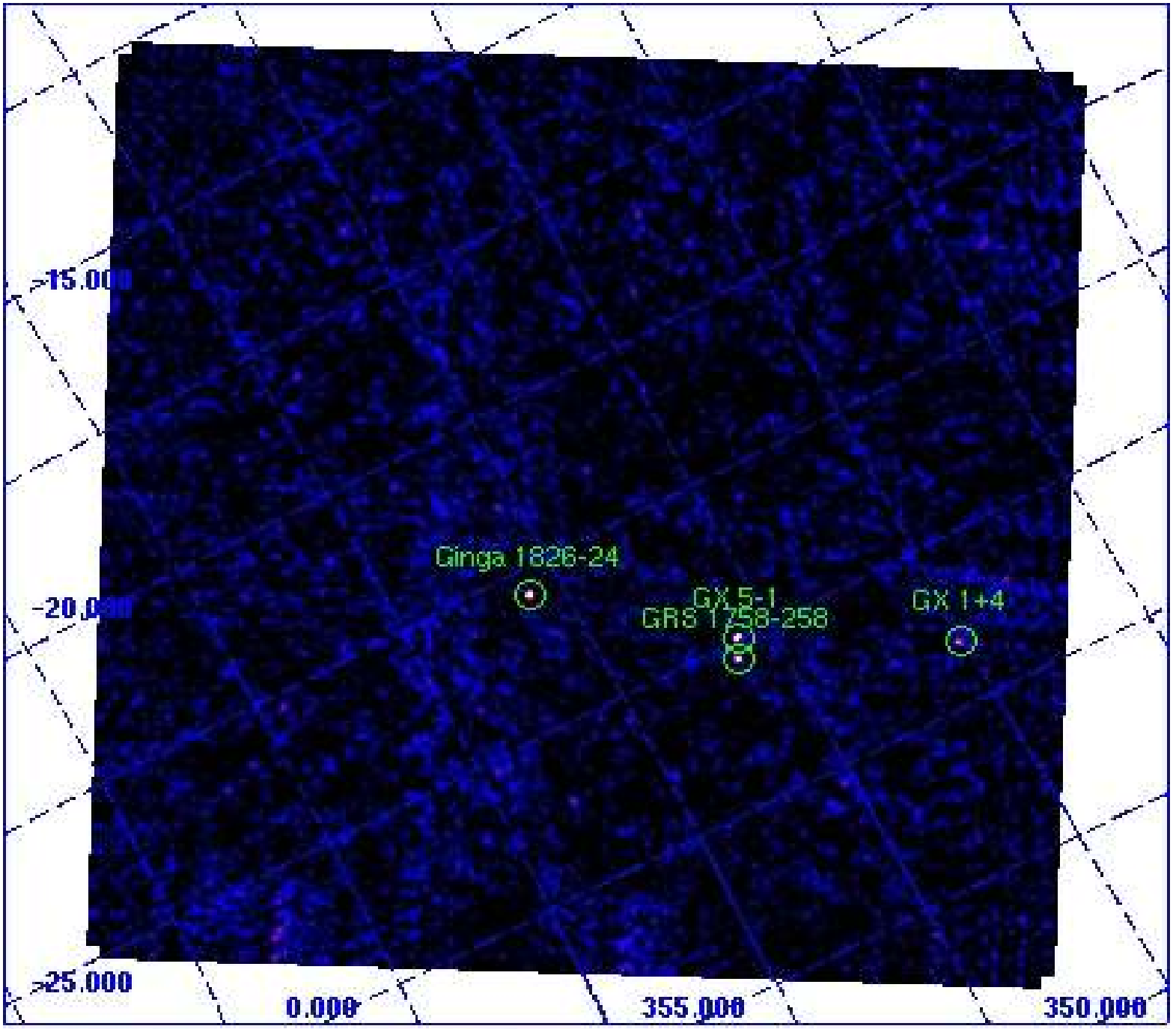
You need info from “sky” and “mosa”!!!

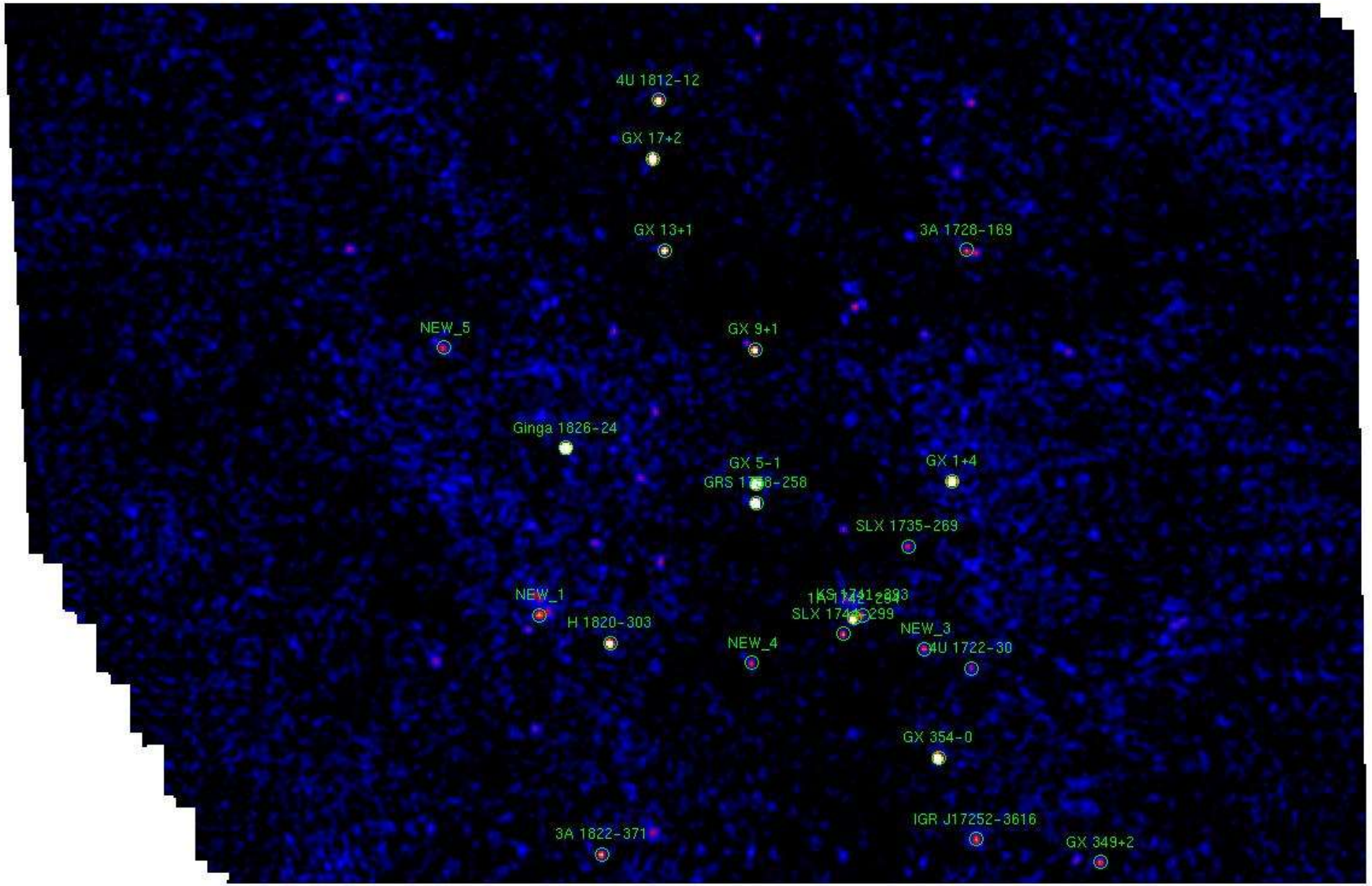
- Summary and “average”

  isgri_srcl_res.fits

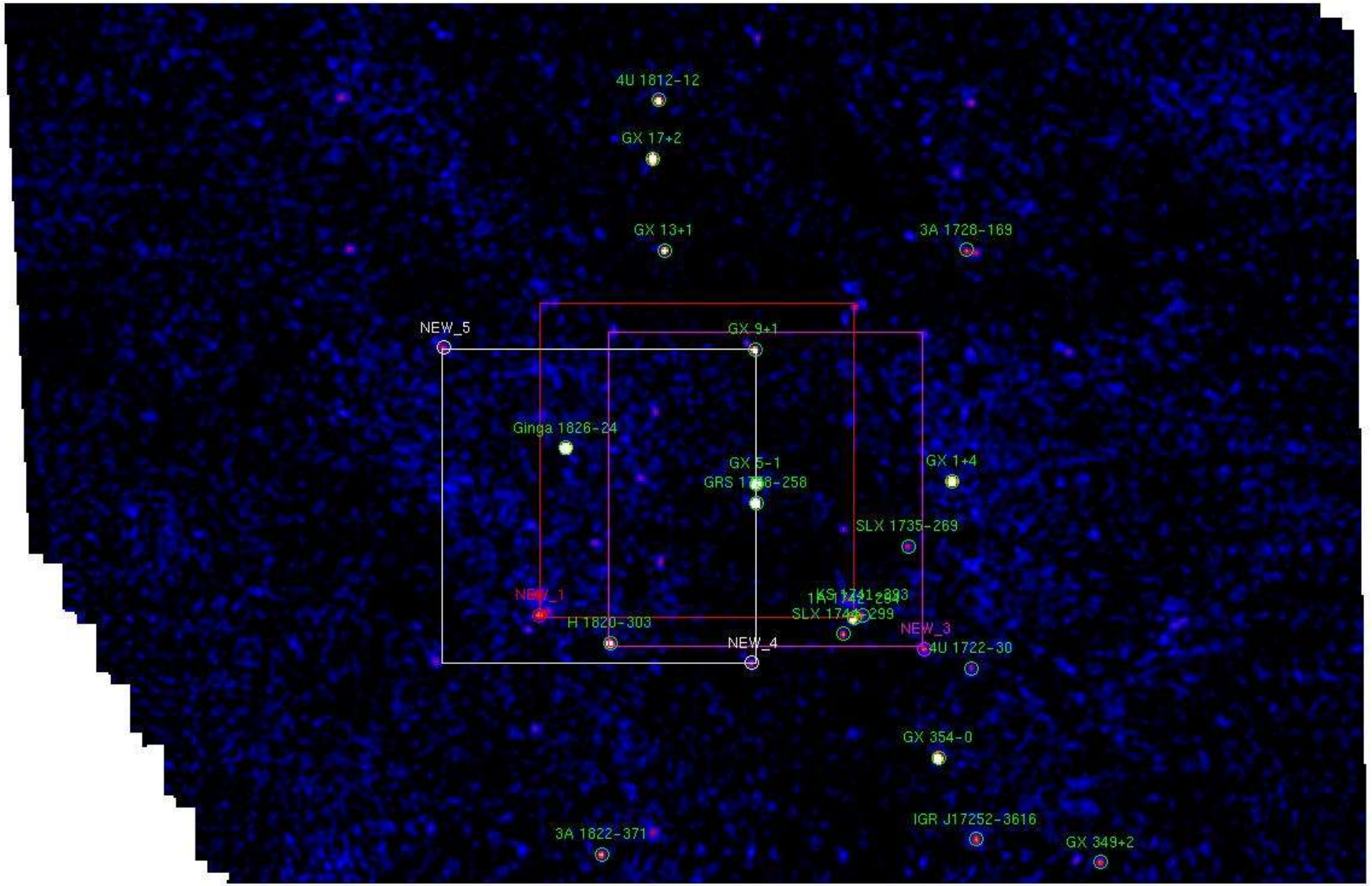
  This file contains all sorces in the FOV (detected or not) with results for the detected sources.
  Could be 80 sources with only 10 detected (check DETSIG!!!).

1 scw: 4 sources
20-40 keV





Mosaic: 22 sources
20-40 keV



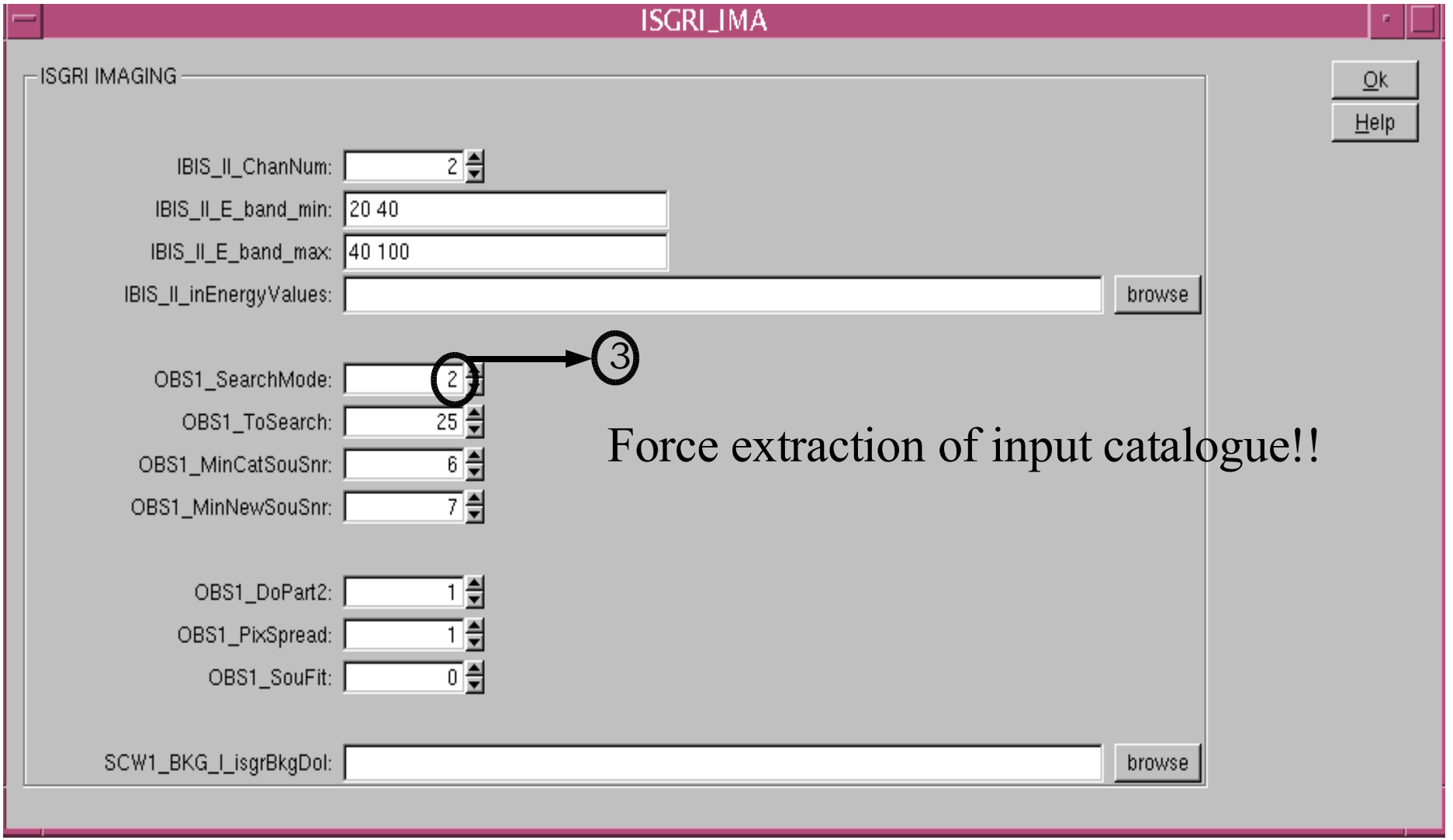
The NEW sources are ghosts (SearchMode=2)!!!!!
(this is on 38 scws)

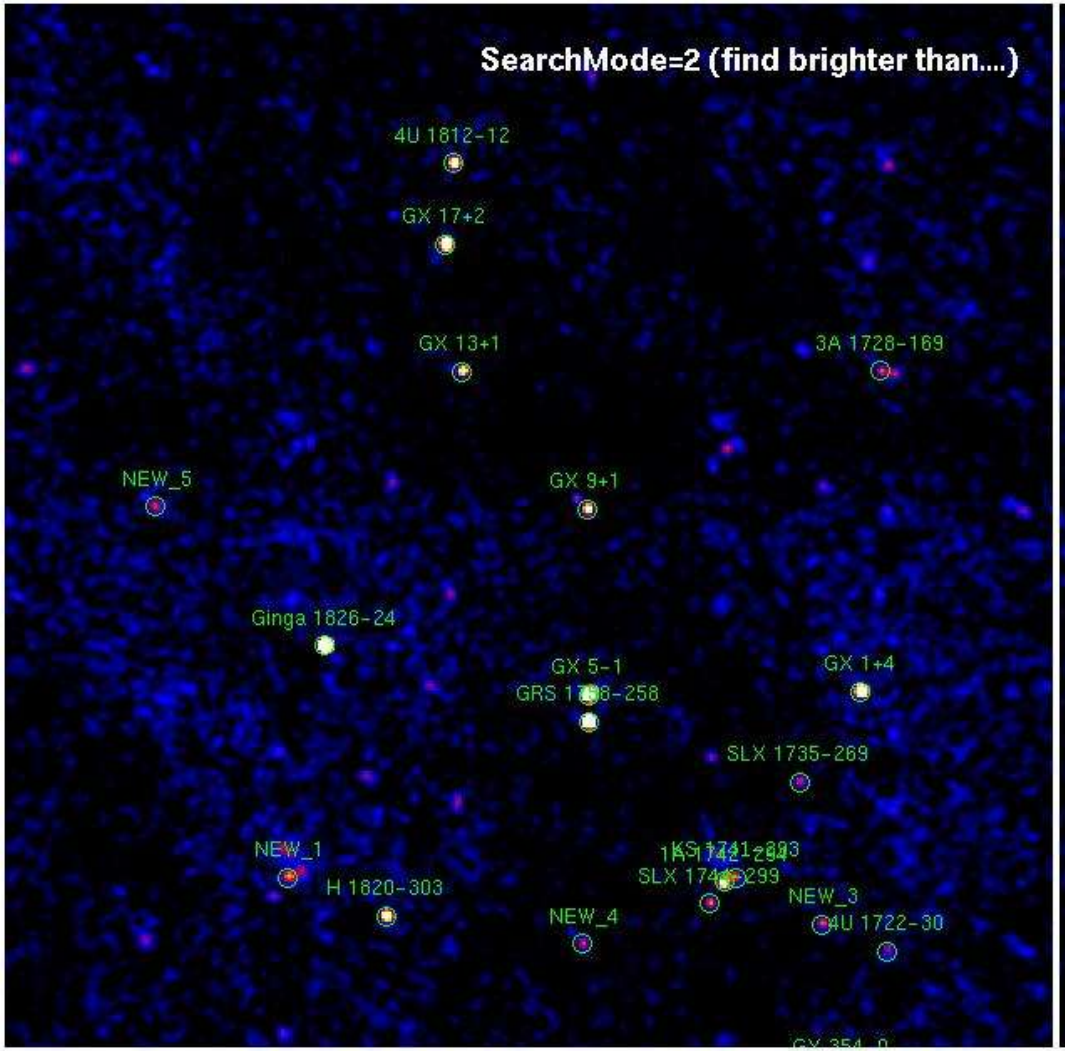
cd ../../

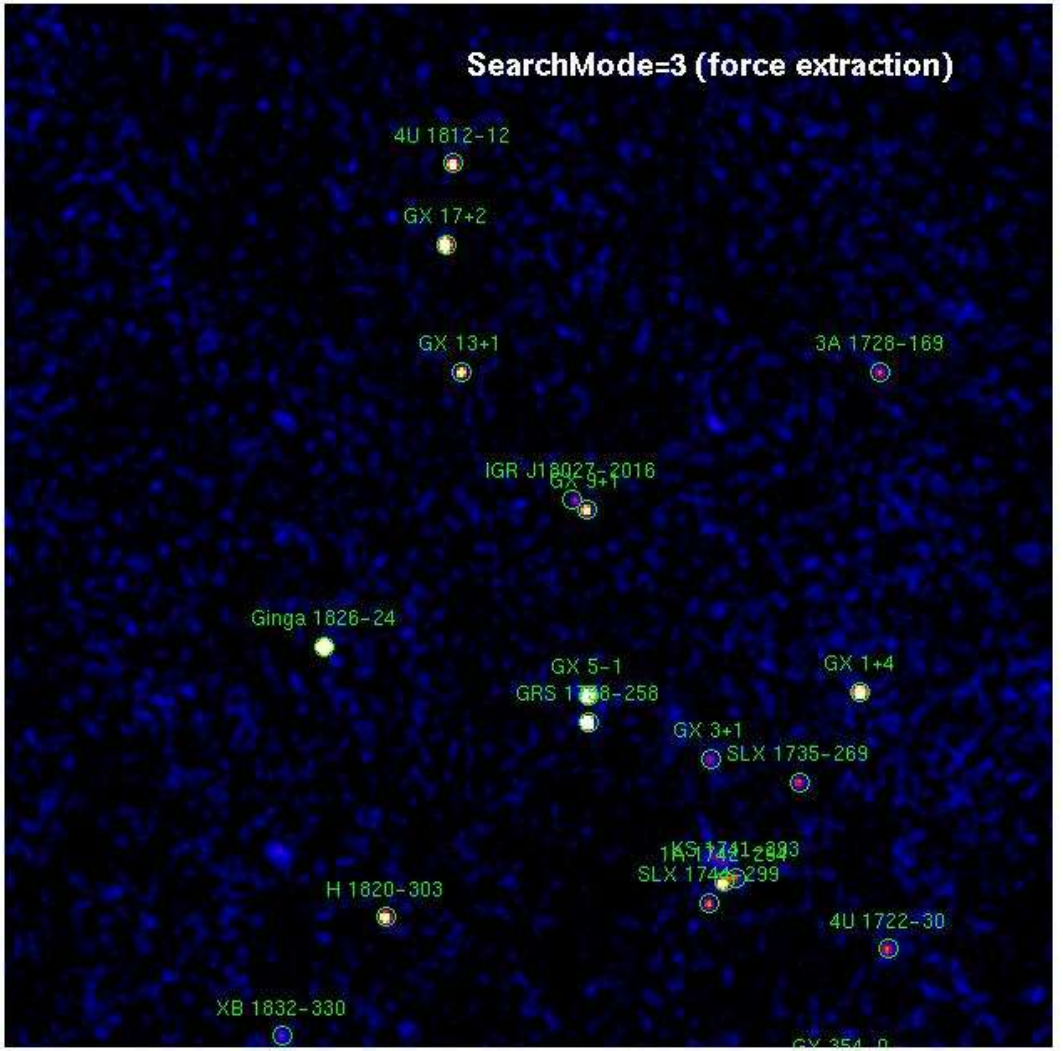
og_create idxSwg=SCW_IBIS.txt ogid=IBIS_3scw_mode3 basedir="./" instrument=IBIS

cd obs/IBIS_3scw_mode3

ibis_science_analysis




SearchMode=2 (find brighter than....)
4U 1812-12
GX 17+2
GX 13+1
3A 1728-169
NEW_5
GX 9+1
Ginga 1826-24
GX 5-1
GX 1+4
SLX 1735-269
NEW_1
H 1820-303
NEW_4
NEW_3
4U 1722-30


SearchMode=3 (force extraction)
4U 1812-12
GX 17+2
GX 13+1
3A 1728-169
IGR J18027-2016
Ginga 1826-24
GX 5-1
GX 1+4
GX 3+1
SLX 1735-269
H 1820-303
4U 1722-30
XB 1832-330

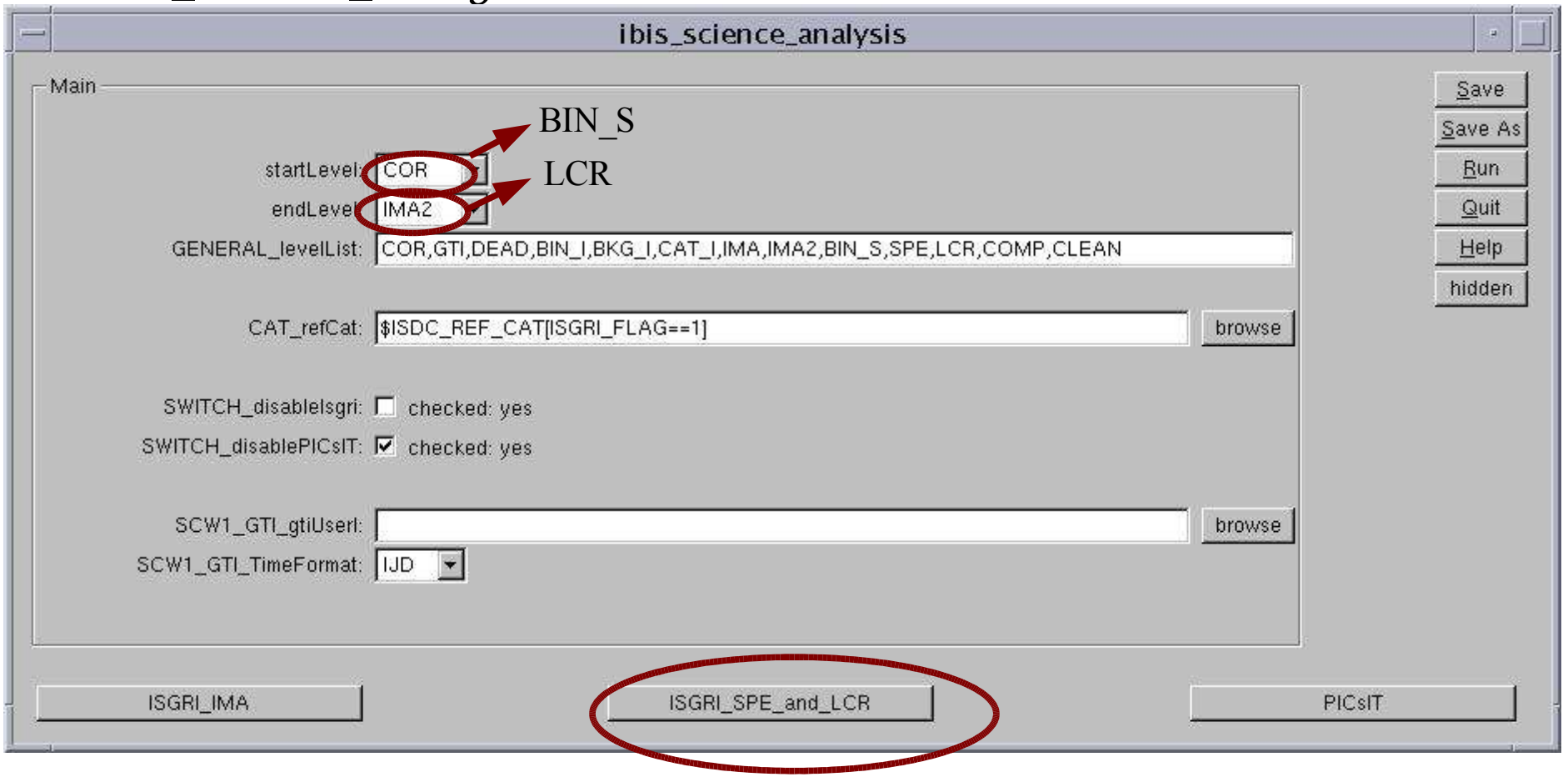
[C] EXTRACT SPE AND LCR

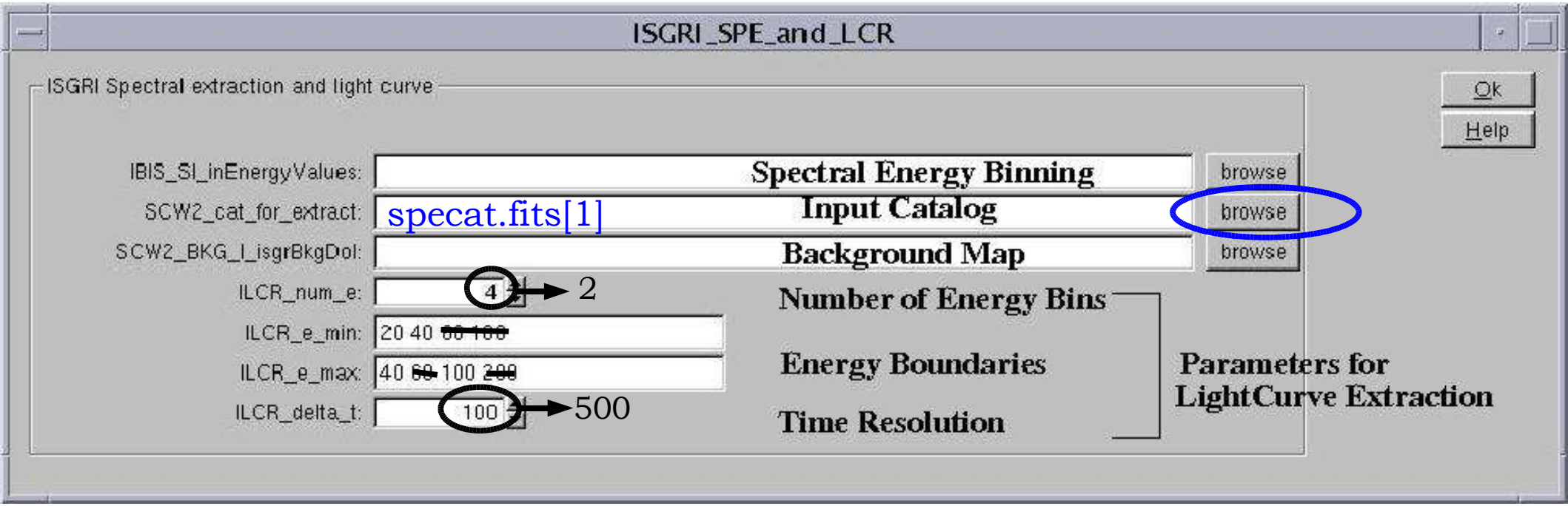
Coded mask: you need to extract SPE and LCR for all active sources

cp ***isgri_srcl_res.fits*** *specat.fits*

in specat.fits keep sources DETSIG> 6

ibis_science_analysis





Specat.fits is IMPORTANT!
Default is isgri_scrl_res.fits: long, useless and might fail!!
specat.fits: POSITION FROM FIT OR FROM CATALOGUE?

OK, Save and Run

Results:

- each pointing

obs/.../scw/017500180010.001/

isgri_spectrum.fits

isgri_lcr.fits

(and isgri_sky_res.fits from IMA)

Interested in all the results from GX 5-1?

How to collect the results:

src_collect	IMA
lc_pick	LCR
spe_pick	SPE

Aim of hands-on session: IMA and stop. Change catalogue and run SPE, LCR. Then collect!

What else?

Main options

- Prepare the data
  - User GTI
- Images
  - Do mosaic?
  - Fit source position?
  - Background removal
  - Spectrum from image?
- Spectra
  - Spectrum from fit position or catalogue one?
  - Energy binning
  - Background removal
  - Phase resolved spectroscopy
    - Hours to days: scw by scw
    - Minutes to hours: define user GTI
    - Below minutes: start from event list

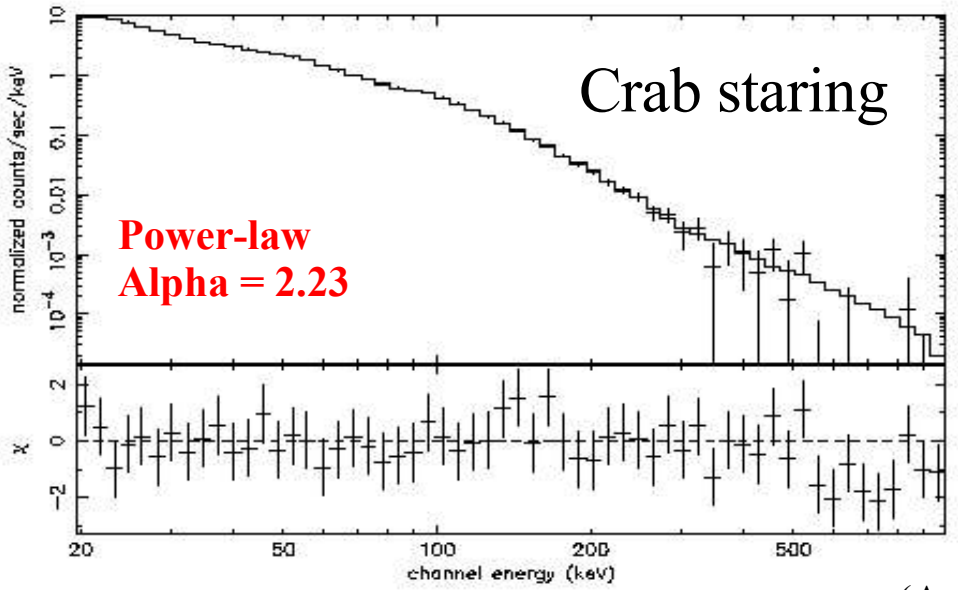
- Lightcurves
  - up to about 60 sec binning: standard LCR
  - up to about 0.1 sec: *ii_light*
  - below 0.1 sec: start from event list

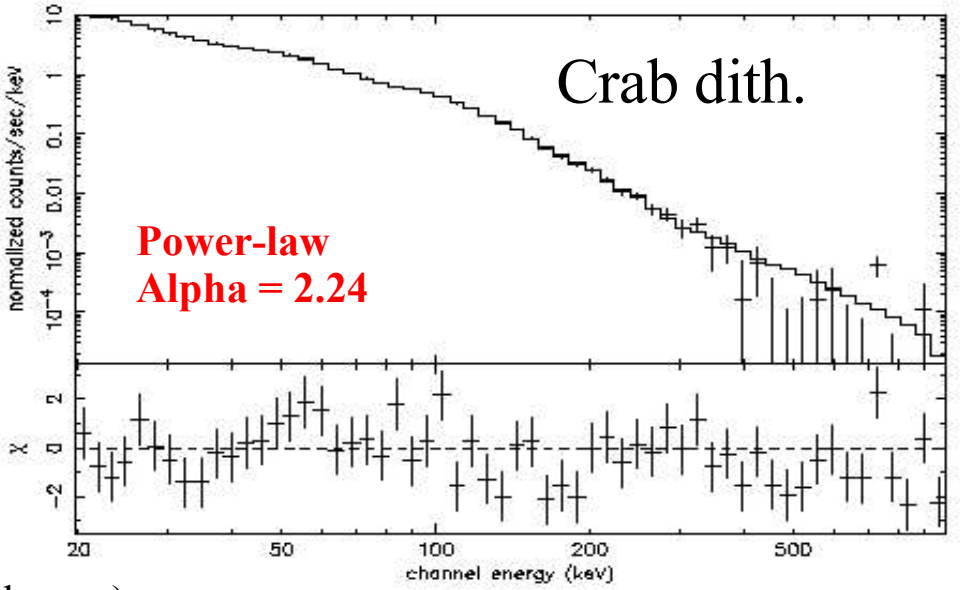
- No GUI!
  - You can run the analysis from command line

og_create idxSwg=SCW_IBIS.txt ogid=IBIS_3scw basedir="./" instrument=IBIS

- Database?
  - Analyse science window by science window (15000 scws!)

ISGRI calibration





(A. Golwurm)

OSA 5 Crab spectrum – staring r. 102
Exp. ~20 ks – on axis – Fit 20-500 keV
Systematic required: 1 %

OSA 5 Crab spectru – 5 x 5 dit r. 102
Exp. ~54 ks – on ax - Fit 20-500 keV
Systematic required: 1 %

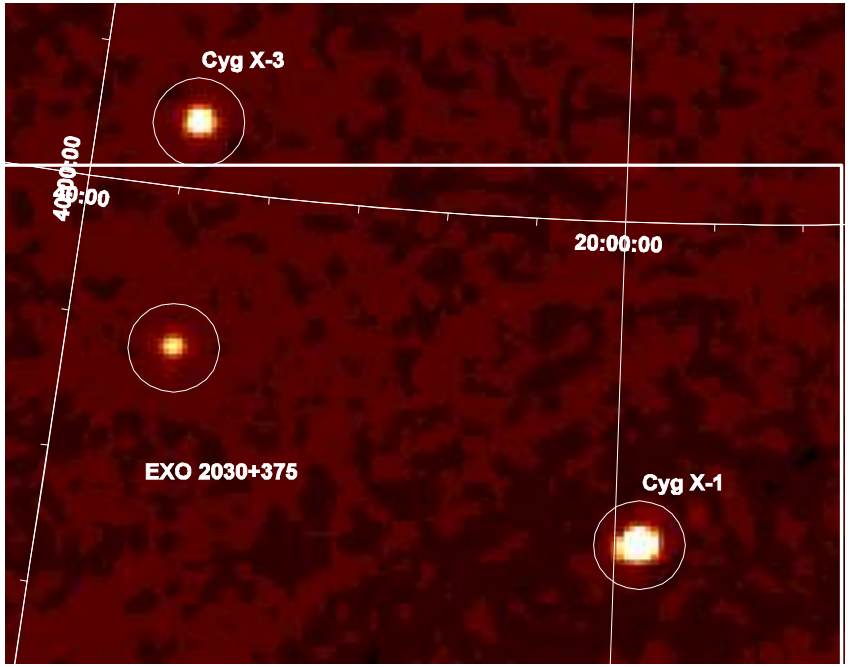
On larger data set:
rev. 65 to 255 in 23-100 keV systematic distortions smaller than 2%
Before rev. 65 and after rev 255 they can reach 5%

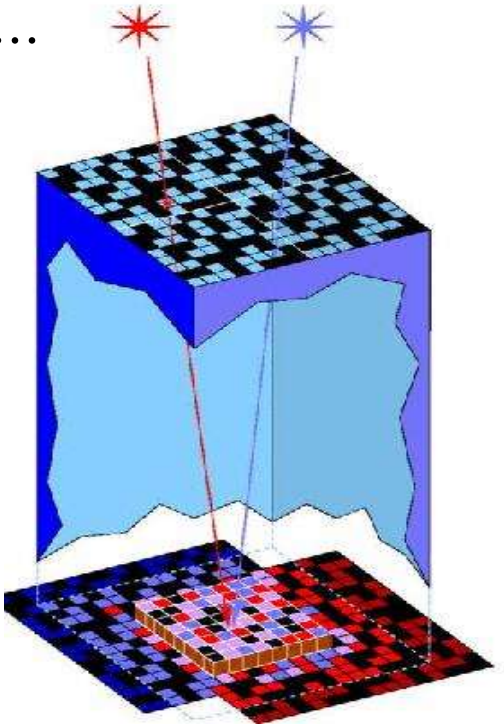
See *"INTEGRAL cross calibration status for OSA 5.1"*
Lubinski, Dubath and Paltani
Soon on ISDC web pages.

Summary & Recommendations

ISGRI is a great instrument!!!!! but be careful…

Ghosts
new source?





Each source is background for the rest
you have to extract spectra for all the active sources in the FOV (specat.fits)

Read the Cookbook, Calibration report, Known issues, Scientific Validation on ISDC web pages.