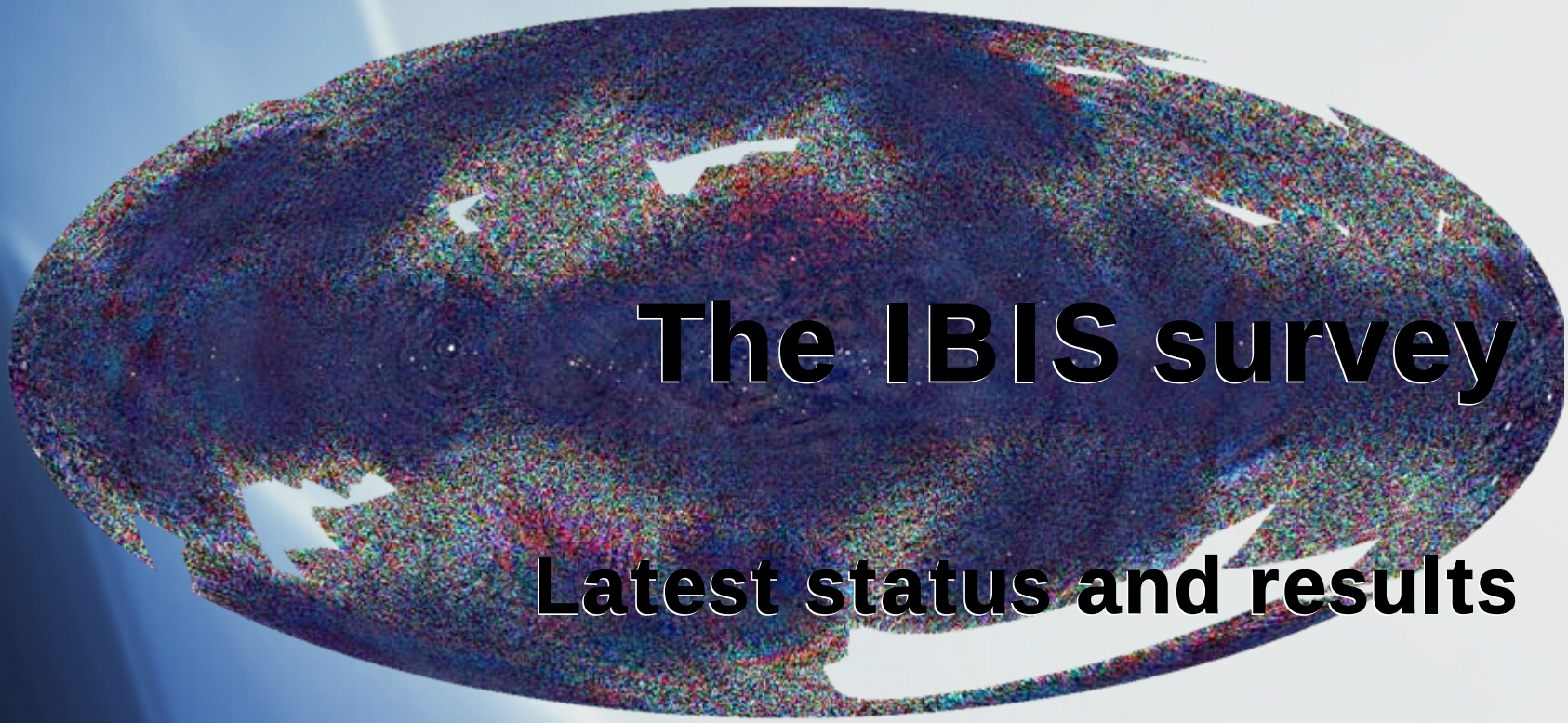


The IBIS survey

Latest status and results

Pietro Ubertini

on behalf of A.J.Bird,

On behalf of the IBIS Survey Team

IBIS survey aims

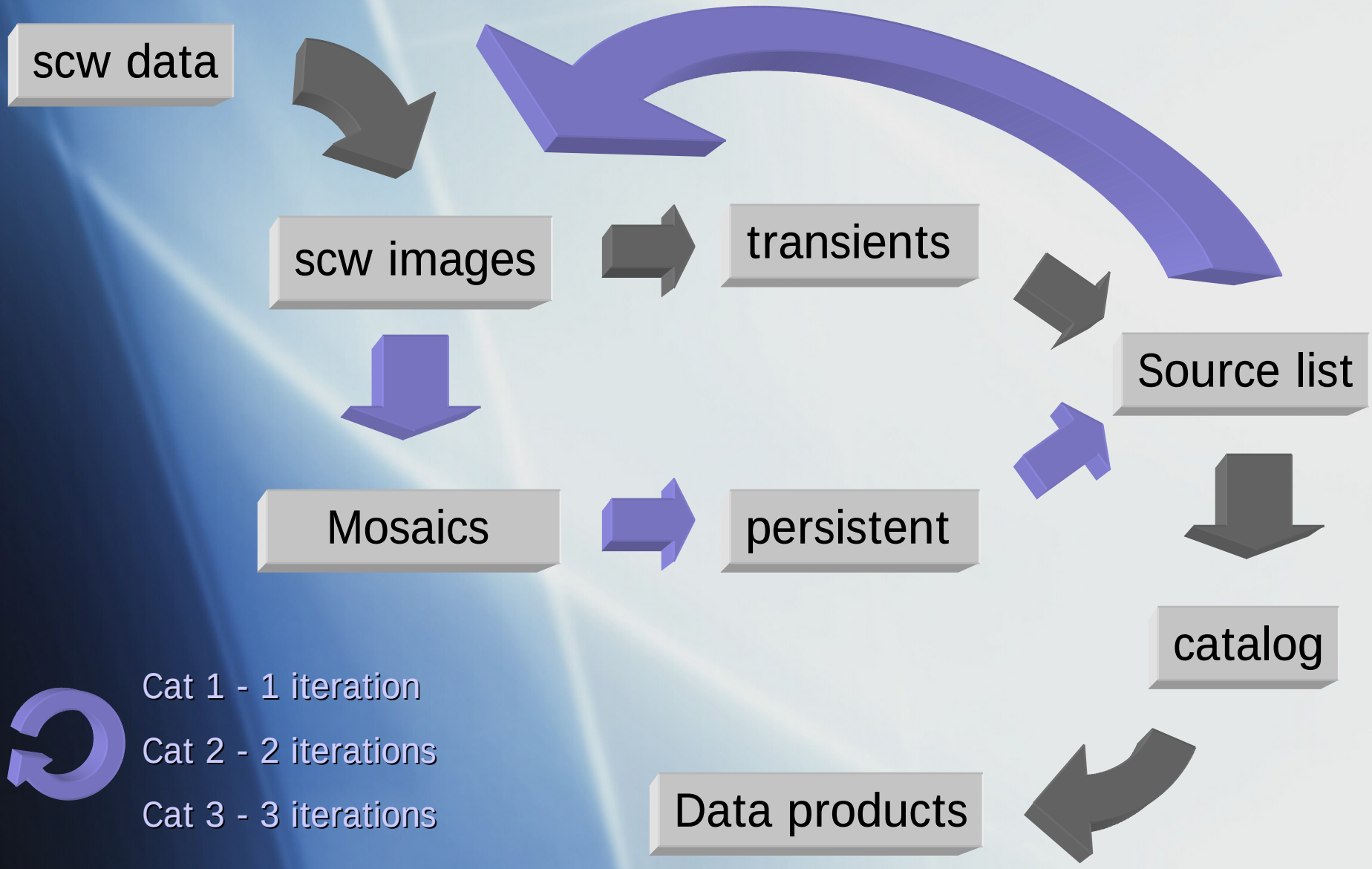
- Takes advantage of the large FOV of IBIS for source detection
- Unbiased search of the IBIS core programme and public datasets
- Looking for weak persistent sources only visible on long timescales
- Looking for transient sources on various timescales
- Follow-up of new and unidentified sources in other wavebands
- Analysis of the overall source populations

The dataset

- All public and core programme data
  - revolutions 12 to 559
- 35200 pointed science windows
- Total telescope time of 63 Ms
- Spans a duration of IJD =1052 - 2688
  - 1600+ days
  - Big implications for source searching

*(note that from here, all exposures shown will be **effective time on source**, after all dead times and FOV effects are taken into account)*

Survey processing loop



Scw filtering

- Each of the 35200 input scw images are tested according to:
  - Flux and significance rms within tolerance (after removal of bright sources)
    - Beginning and end of orbits
    - Bad ‘space weather’
  - Staring data removed to a separate map for source searching->> they are BAD!!
  - Data before rev 46 removed to a separate map for source searching

Mosaic creation

Mosaics made on:

- 5 energy bands
  - 20-40, 30-60, 20-100, 17-30, 18-60

Optimises the search for different underlying spectra

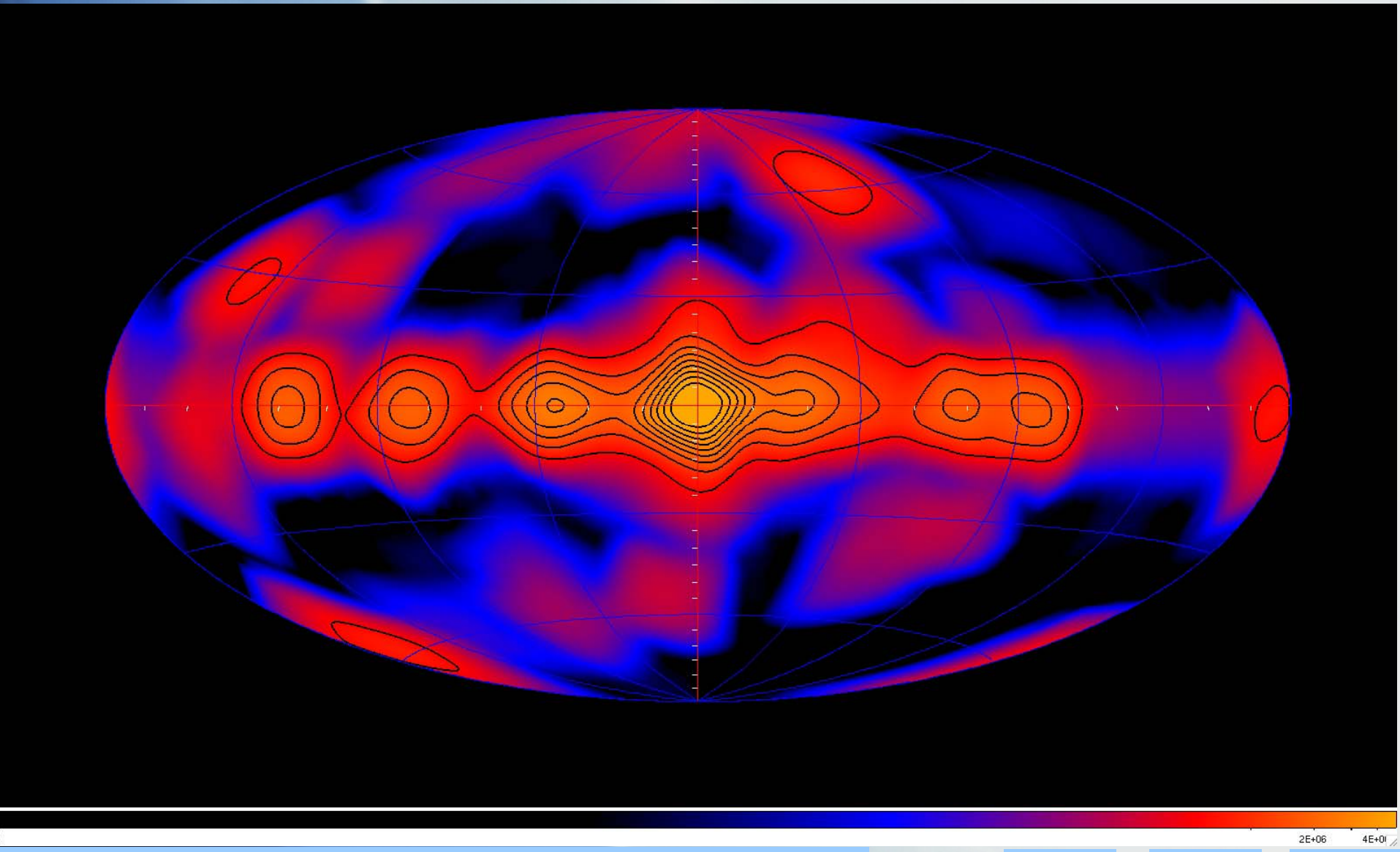
- 3 timescales
  - Revolutions (no single SW)
  - Revolution sequences
  - Whole archive

Optimises the search for different outburst timescales

- 4 projections
  - Galactic centre (all-sky)
  - Galactic anti-centre (all-sky)
  - North and south polar

Optimises the PSF for source search algorithms

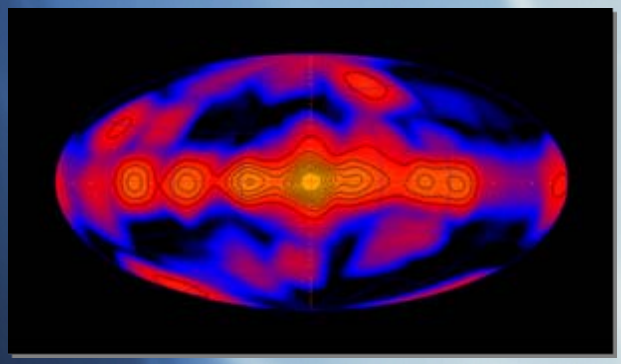
Sky coverage



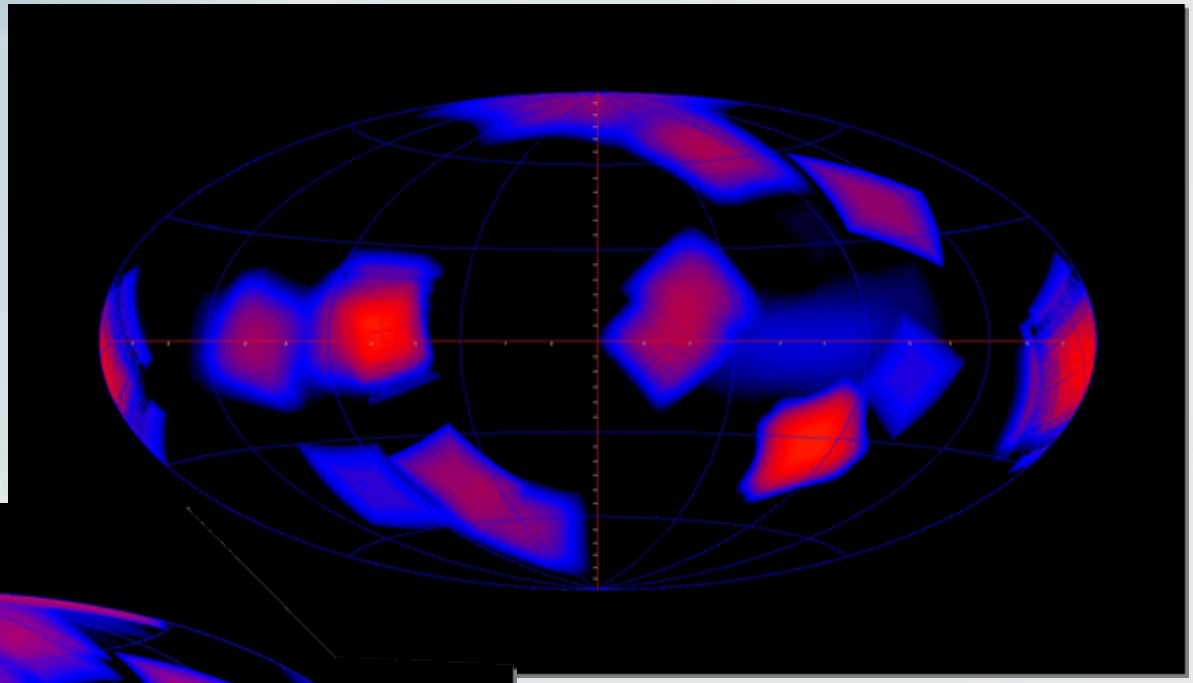
All-sky galactic projection - contours at 500ks intervals

Cat 1 Cat 2 Cat 3

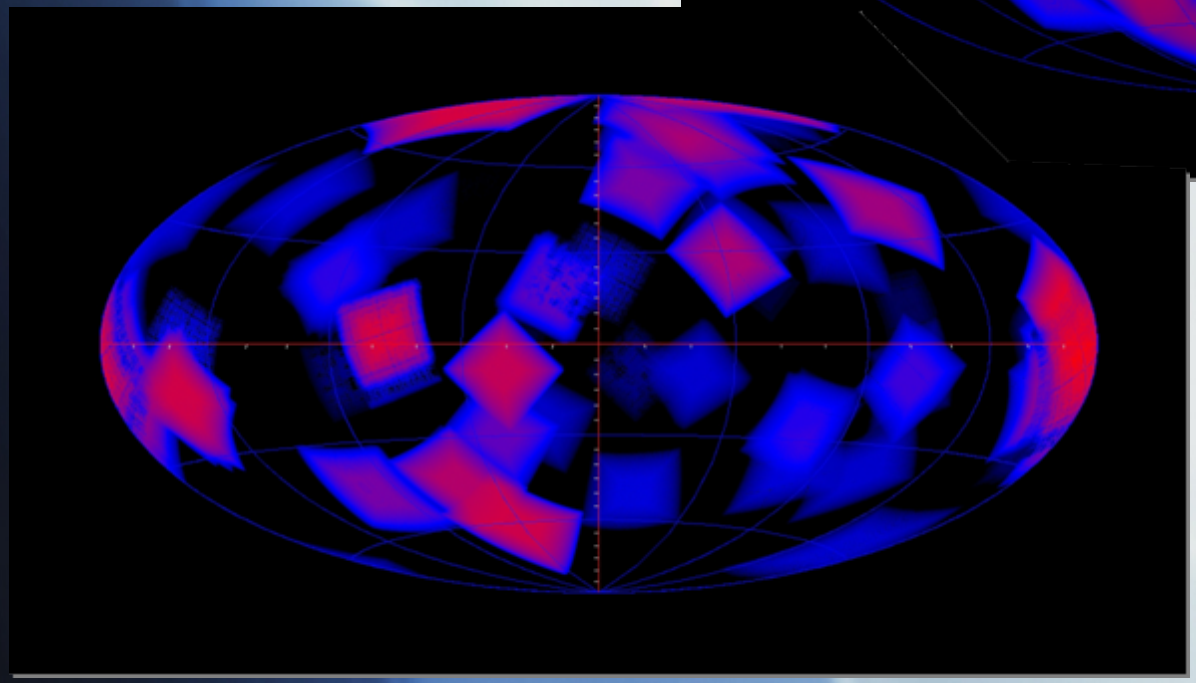
Sky Coverage (cat3)



Main maps (33.5 Ms)



Pre rev 46 (4.2 Ms)

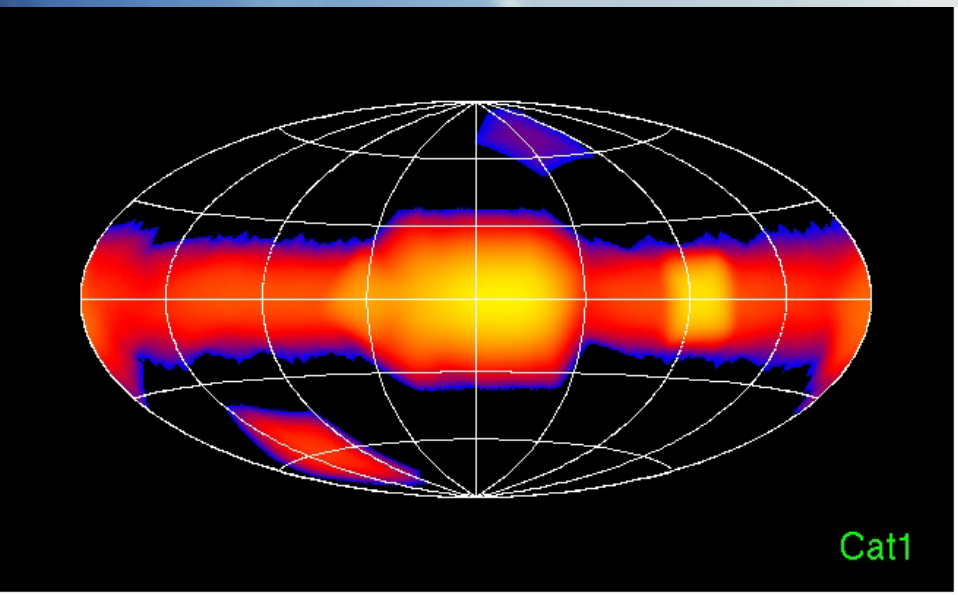


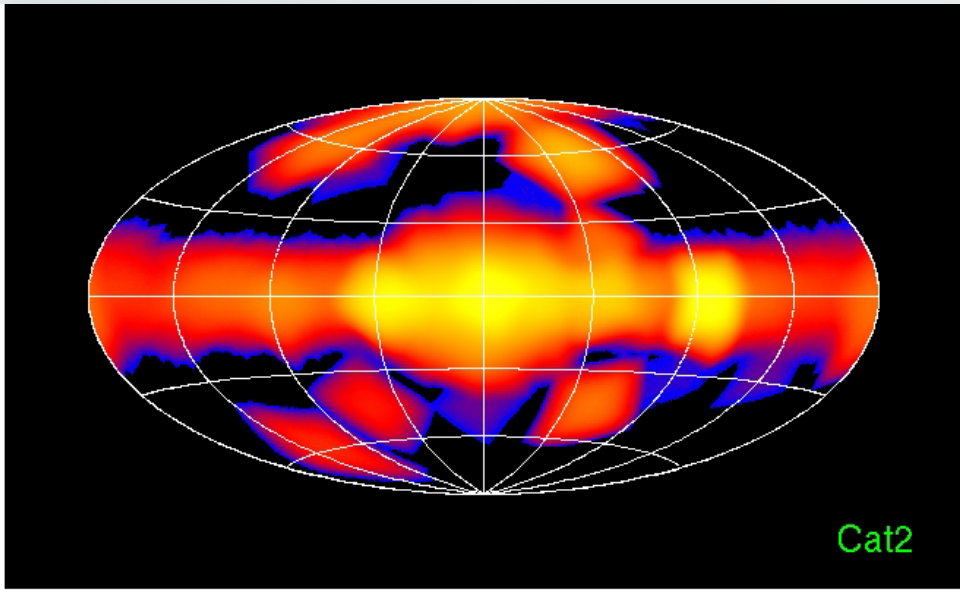
Staring (3.7 Ms)

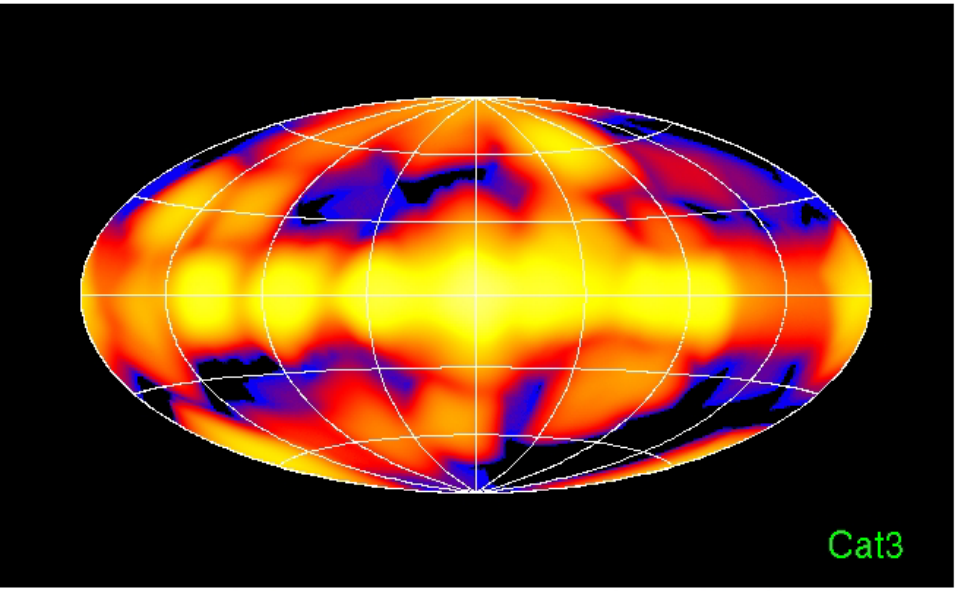
Searching for sources

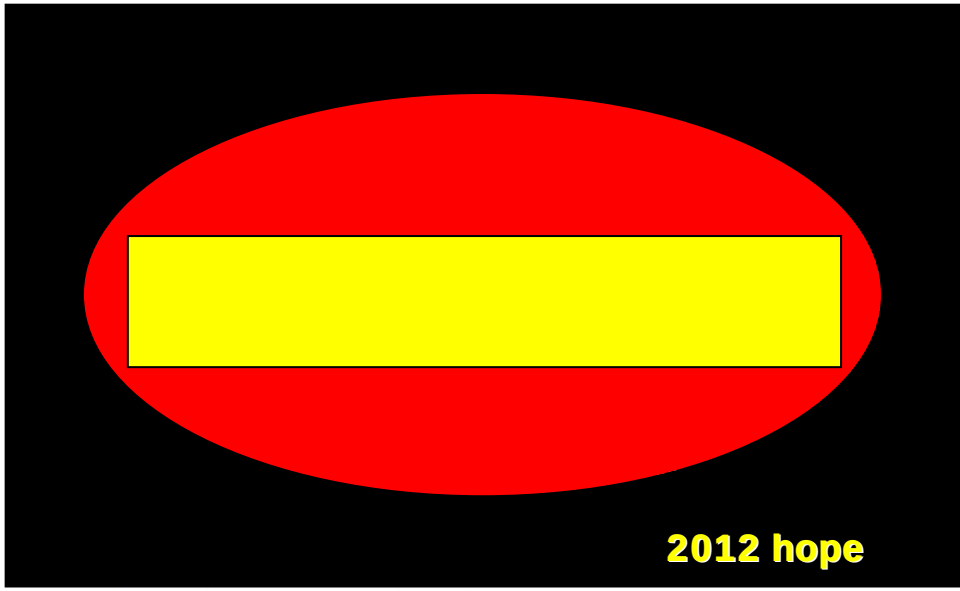
- Relies on three methods
  - SExtractor (not Sex-Tractor as YOU may think)
    - Map pre-filtering
  - Peakfind
    - Allows comparison to local rms
  - PSF fitting
    - Useful post-filtering of possible sources
  - Visual inspection
- All multiplied by 746 maps (for cat3) !

Sky coverage (evolution)



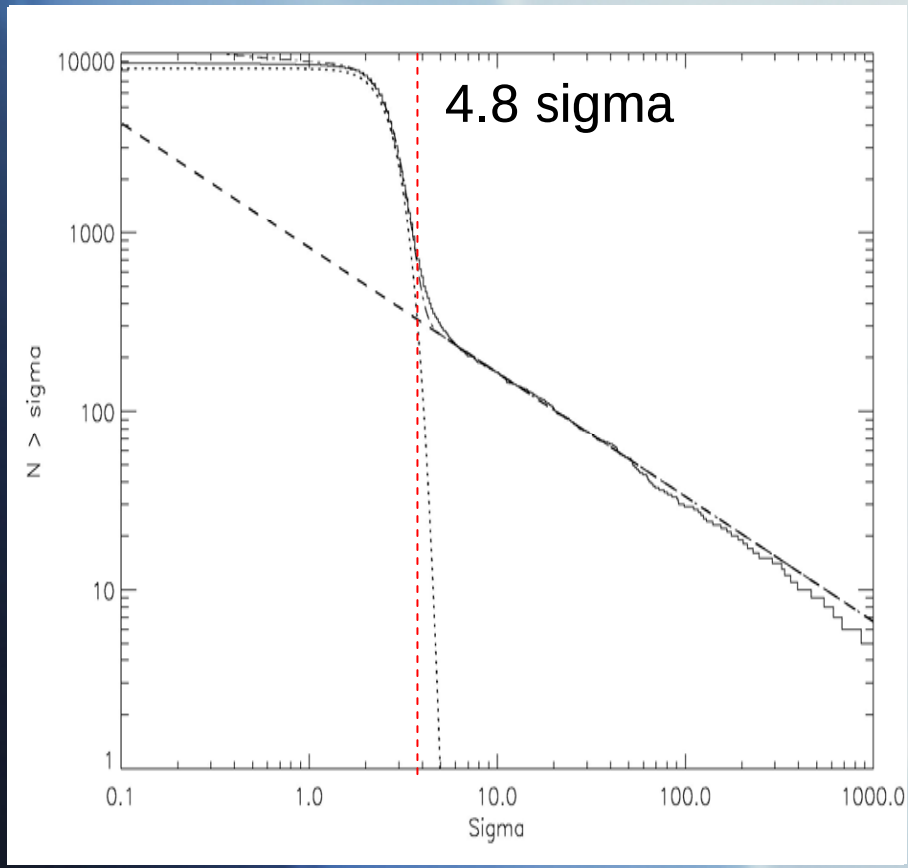






2E+06 4E+06

Map quality (1)

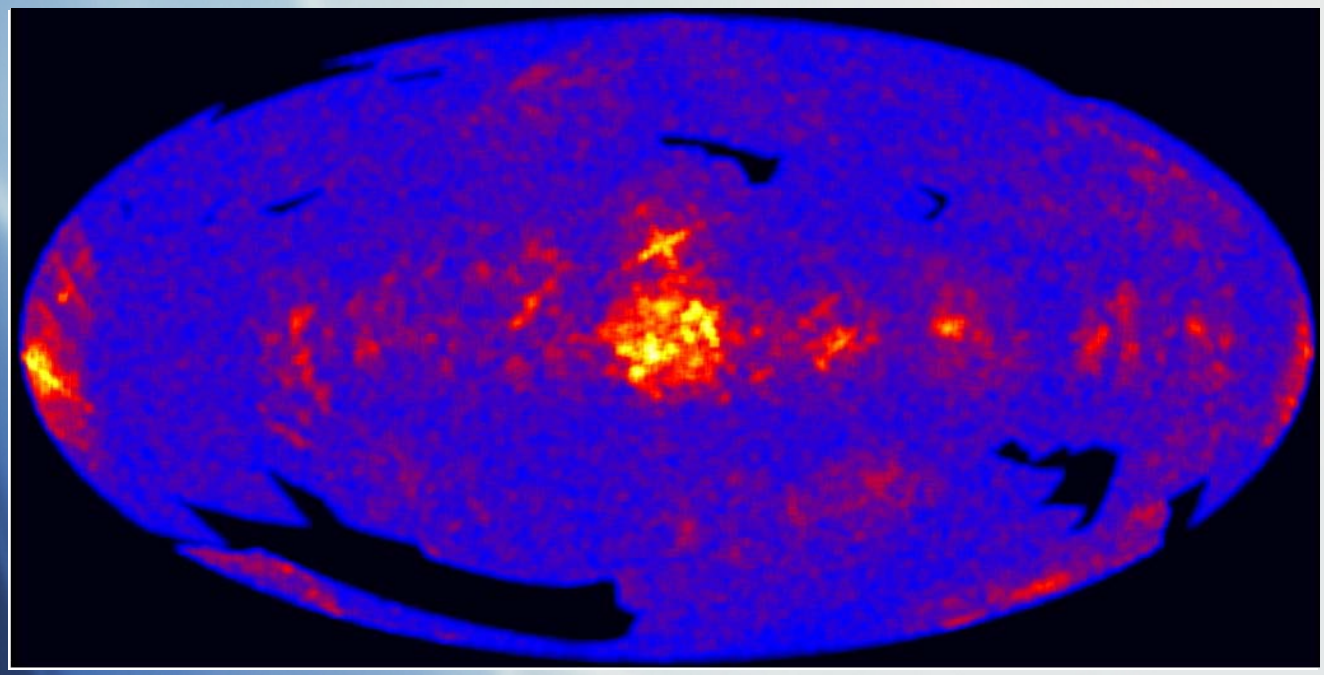


30-60 keV

- Statistics compiled on all excesses found by Sextractor
- Distribution of excesses fitted by source and noise distributions.
- Residuals likely to be due to source-related artefacts.
- GLOBAL threshold set to value where noise excesses are 1% of total.
- But some parts of map are noisier than others, so global values are not the whole story...

Local v Global Quality

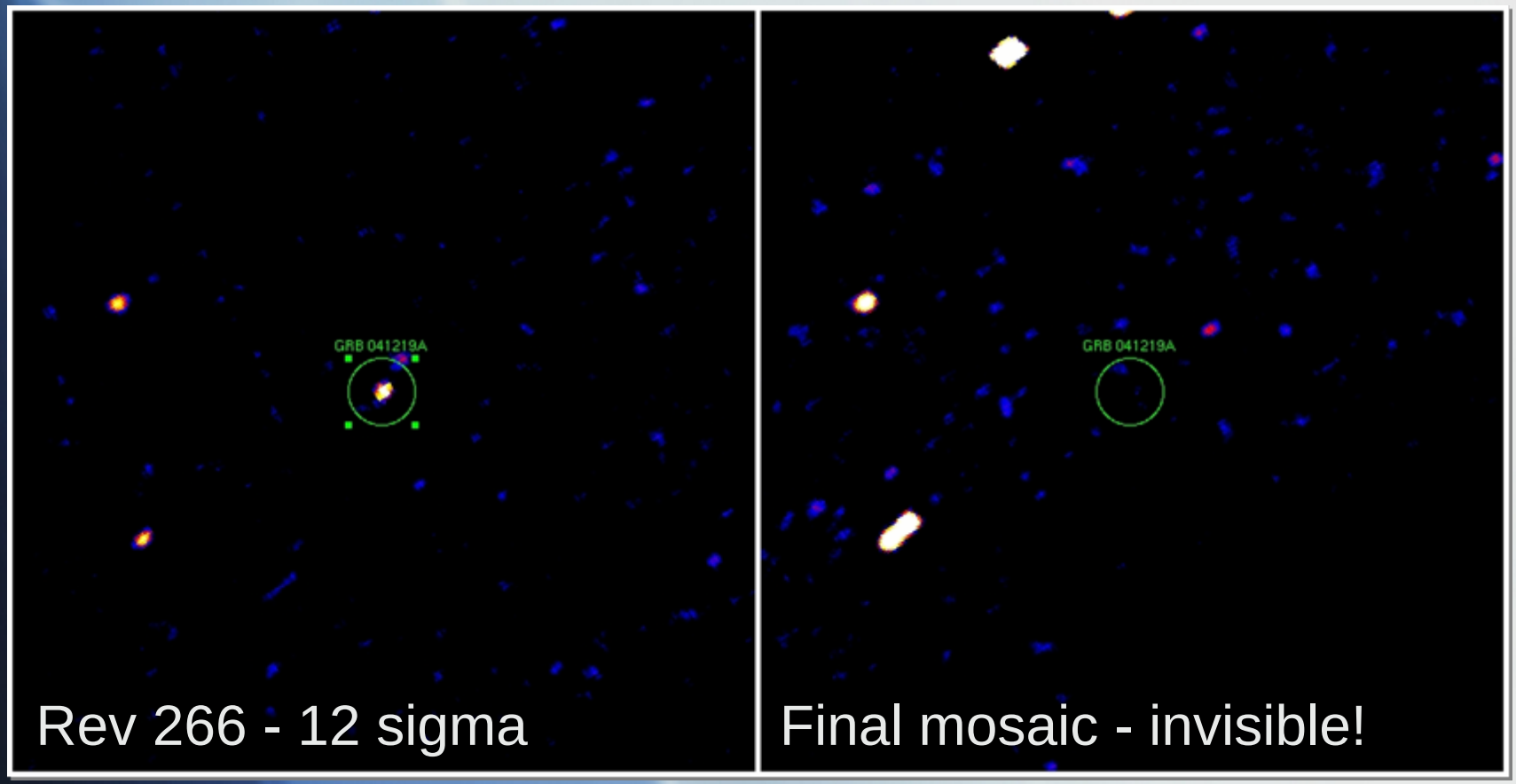
- Map of local rms after removal of sources:



- In absence of bright sources, local significance threshold is better than the global one.

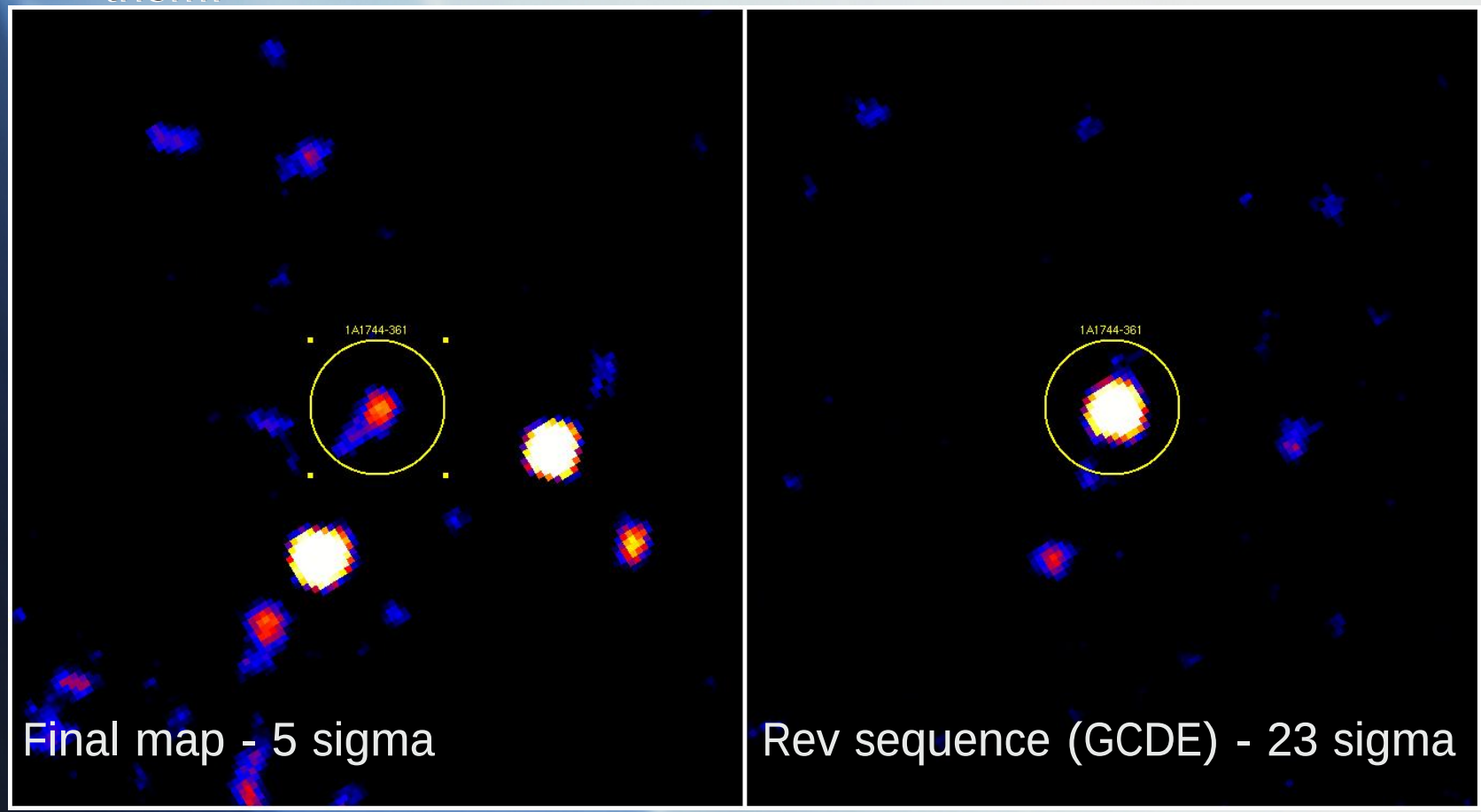
Search timescales

- GRB 041219A is a good test-case
- 60 sigma in one science window (but we don't check individual scw)

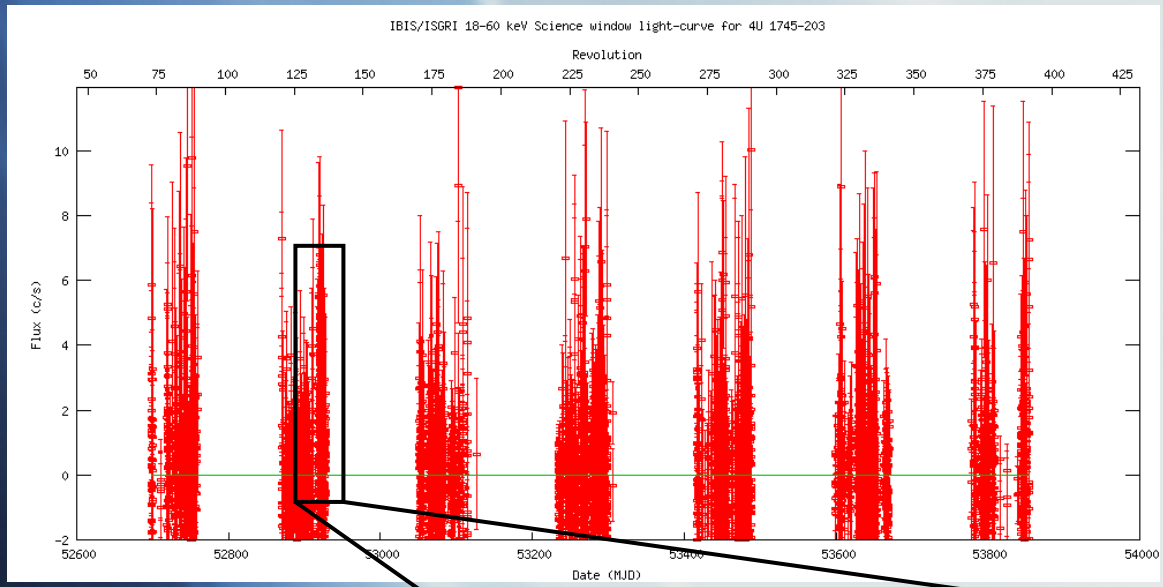


Search timescales

- Key output of the catalogue is best possible source positions
- Revolutions and revolution sequences often the best way to get them!



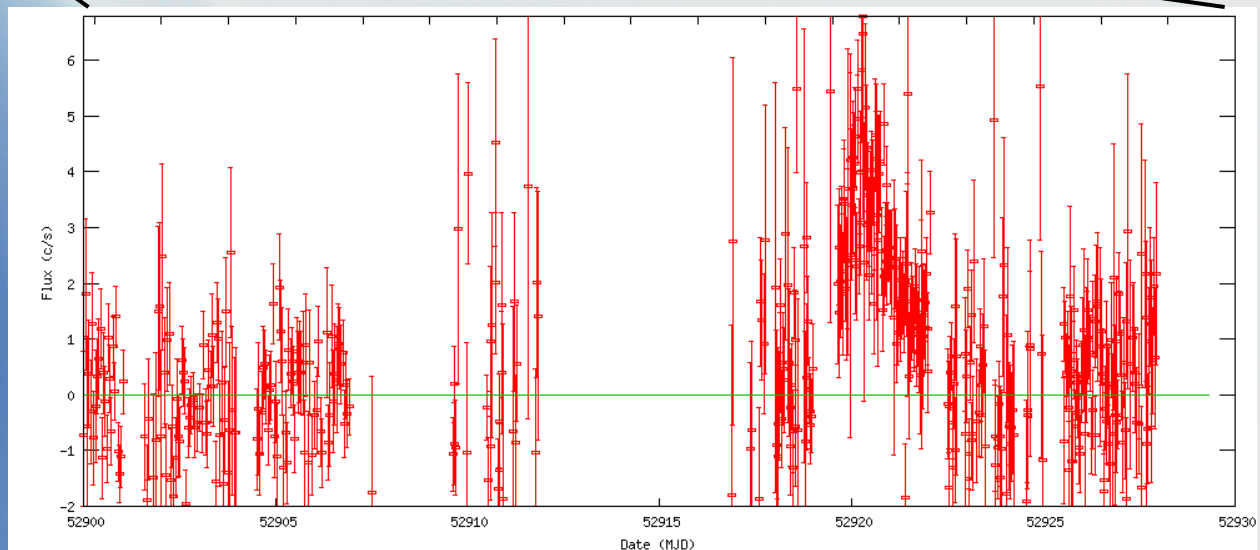
A less quantized approach



Looking on the right timescale is crucial.

For known or suspected sources, we can quickly generate a light curve and search on **all** timescales.

⇦ Overall, 2.7 sigma in 1200 days



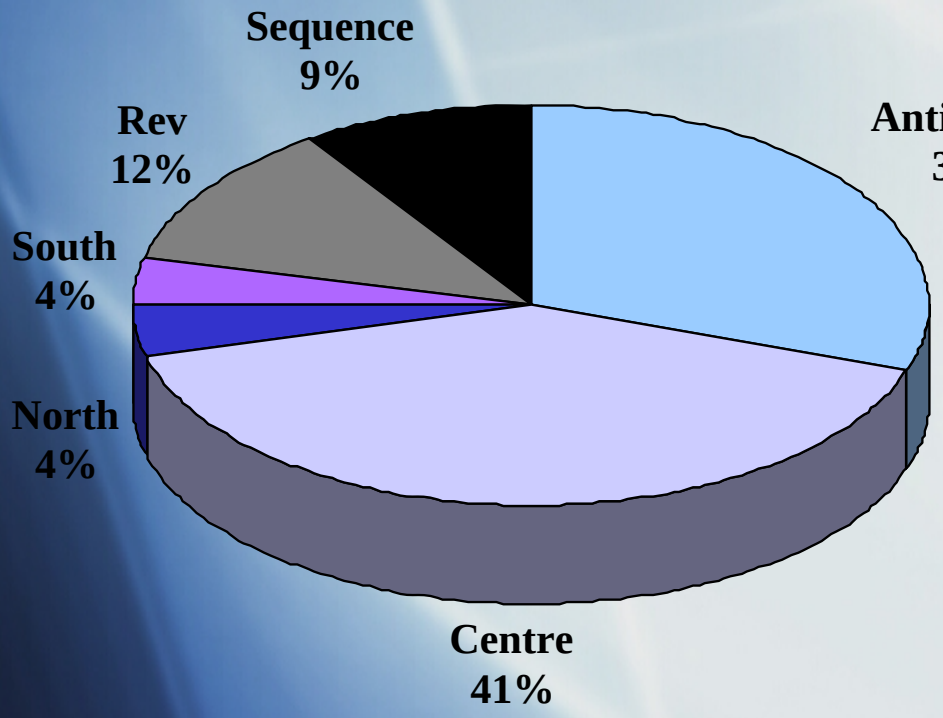
‘Best’, 23.8 sigma (over 4.5 days) ⇨

Increasing source numbers

- After first catalogue (2004)
  - **123 sources**
  - 14 new unidentified sources + 14 other sources of unknown nature
- After second catalogue (2006)
  - **209 sources**, including:
  - 21 new unidentified source + 22 other sources of unknown nature
- AGN catalogue (2006)
  - 62 sources
- HE census (2006)
  - 49 sources detected above 100 keV.
- Third catalogue (2007)
  - **421 sources**, including:
  - 48 new unidentified sources + 29 other sources of unknown nature
- Current status
  - **460 sources**

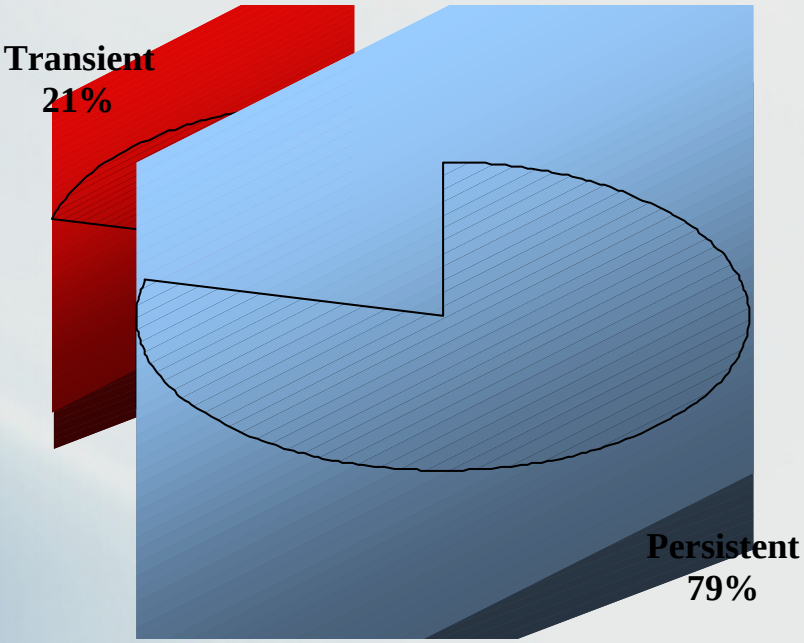
How we find the sources

(maps & timescales)



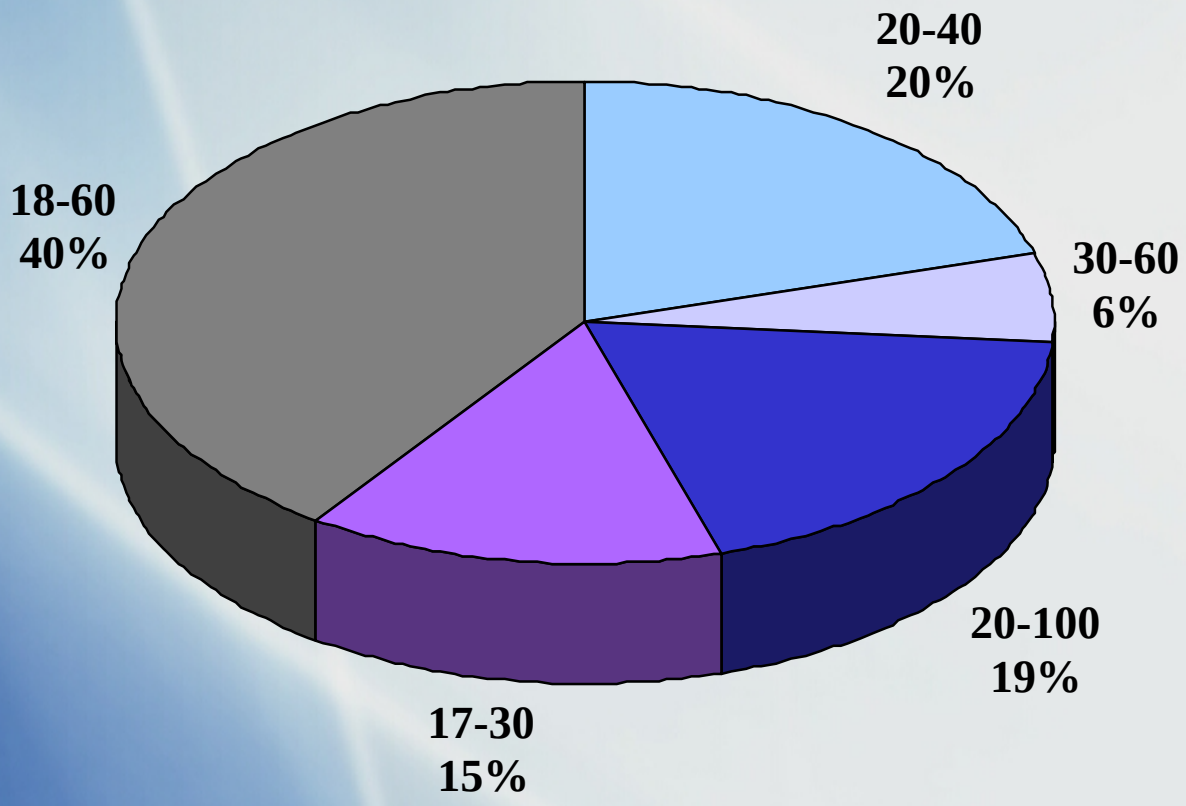
Most sources come from the ‘main all-sky maps’, only ~1/3 come from ‘extra’ maps of staring data, polar regions etc.

In 21% of the sources, the highest significance is found on a timescale shorter than the full dataset.



How we find the sources

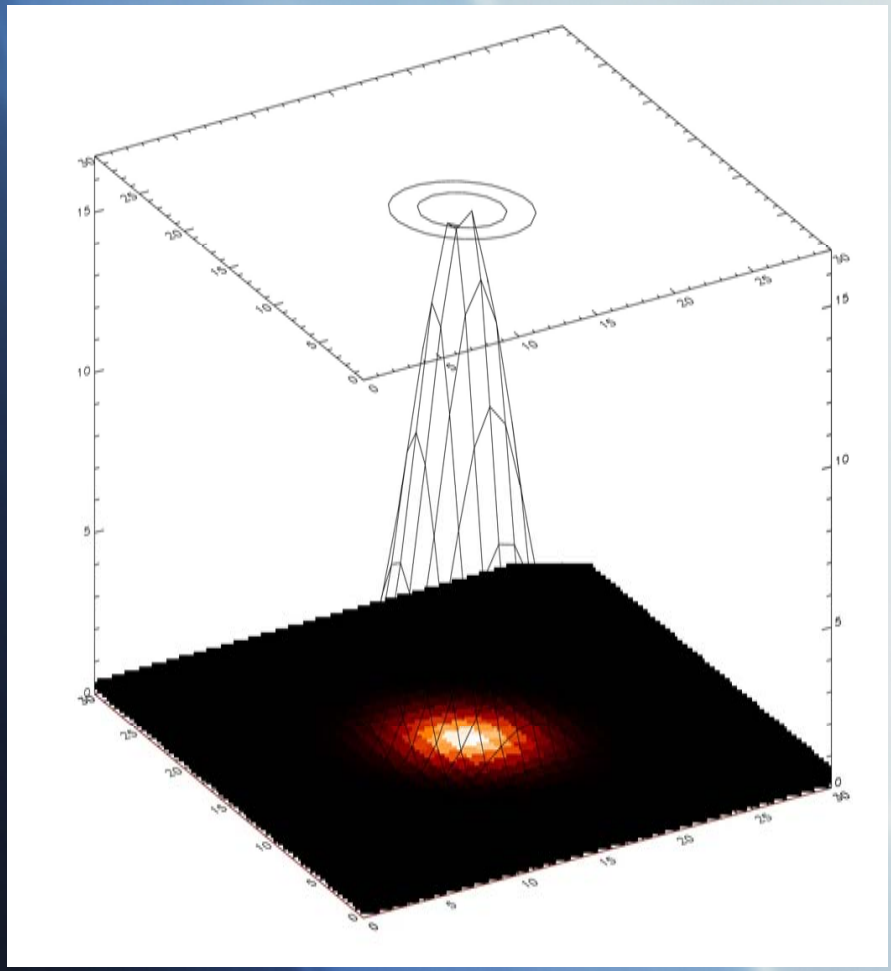
(energy band)



Actually - this is ‘what band do we get the best significance in?’

18-60 keV serves as a good general-purpose band; moderately broad and acceptable levels of background and image structure.

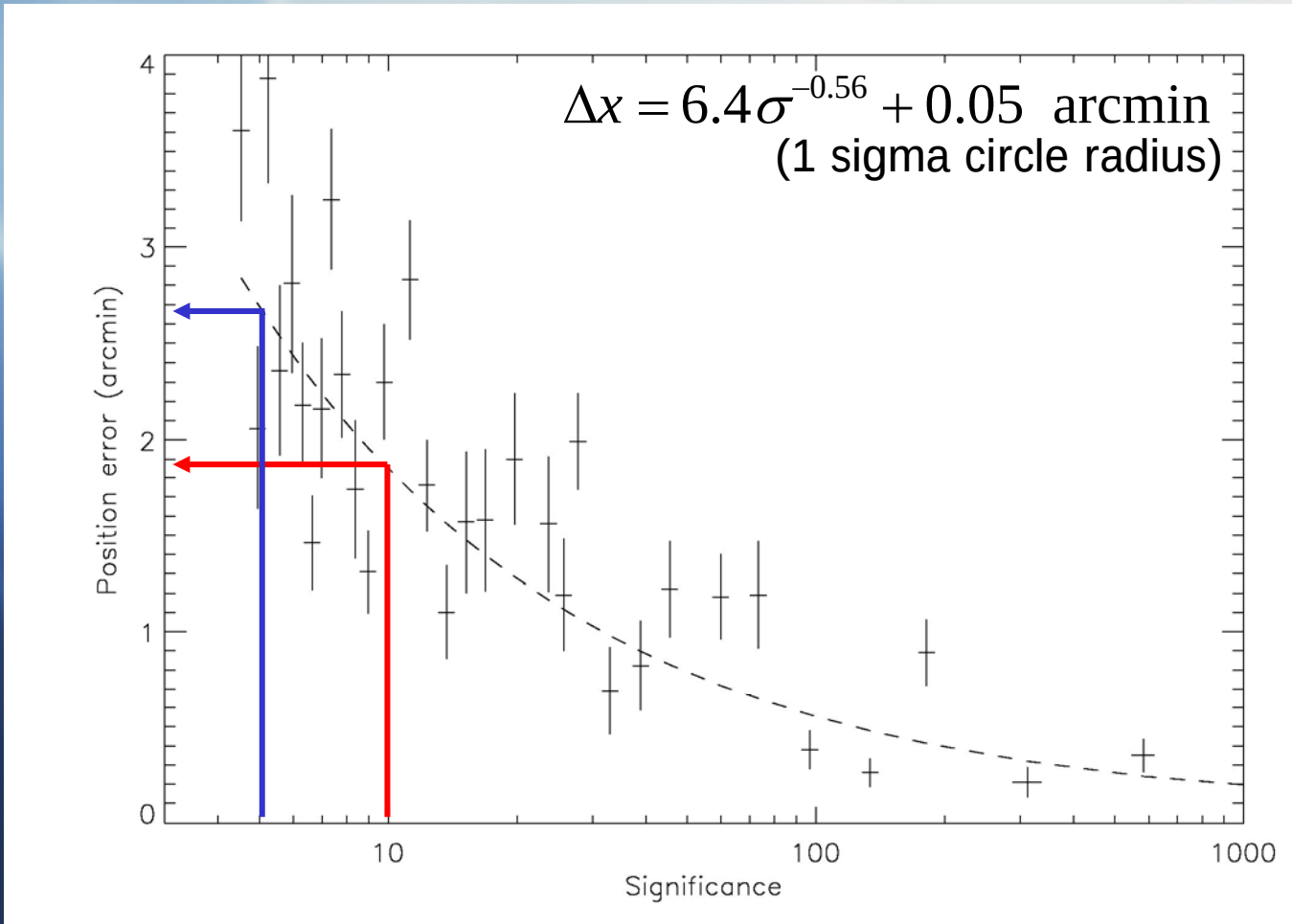
Source positions



- Most positions come from Sextractor centroiding routine
- Sextractor *occasionally* fails for
  - Blended sources
  - Sources in structured regions
- Positions automatically extracted from **map with highest significance** for each source
- Positions checked manually to confirm
- In doubtful cases, PSF peak fitting used

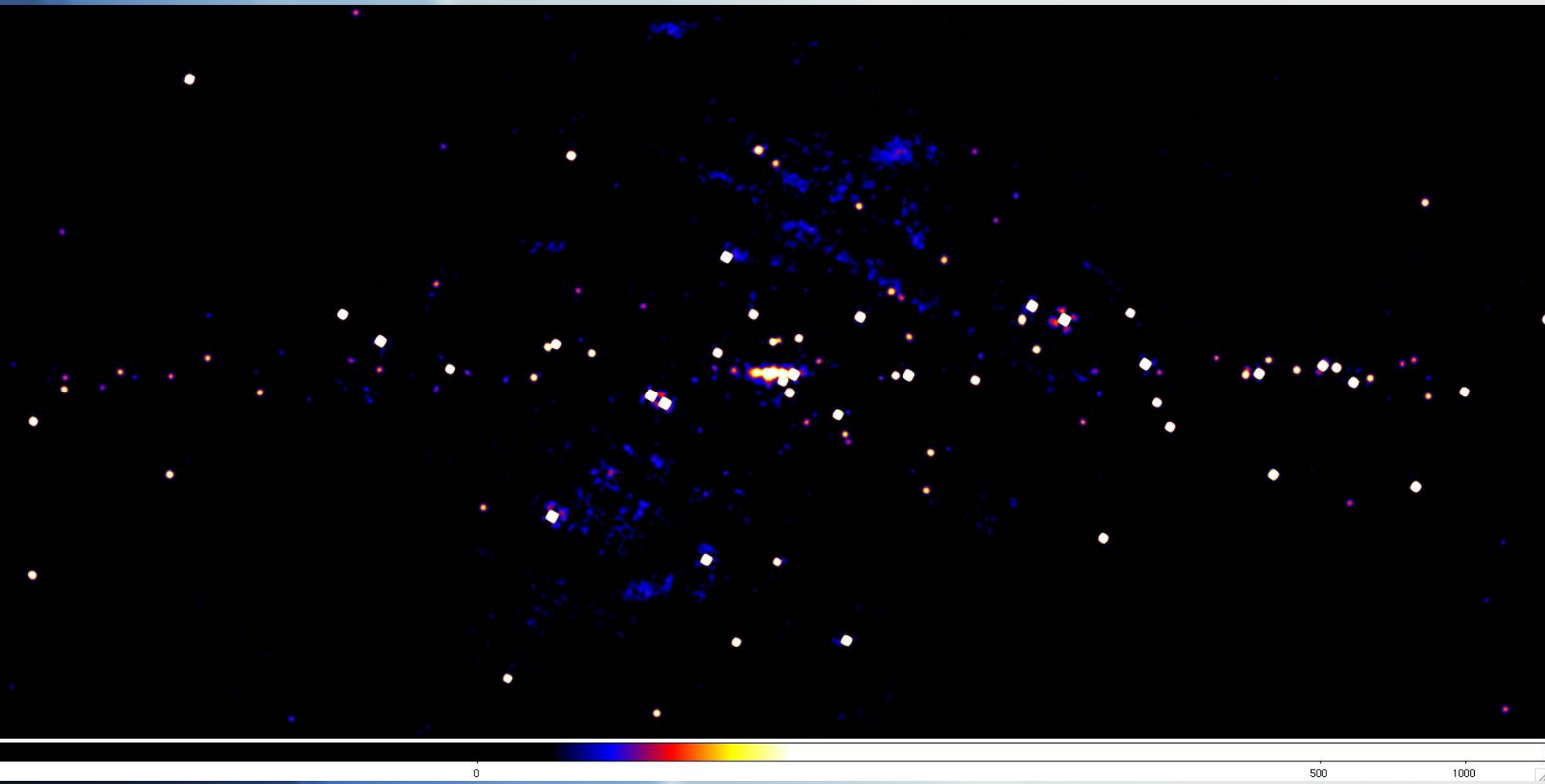
Source location accuracy

- Catalogue positions measured against best available positions...



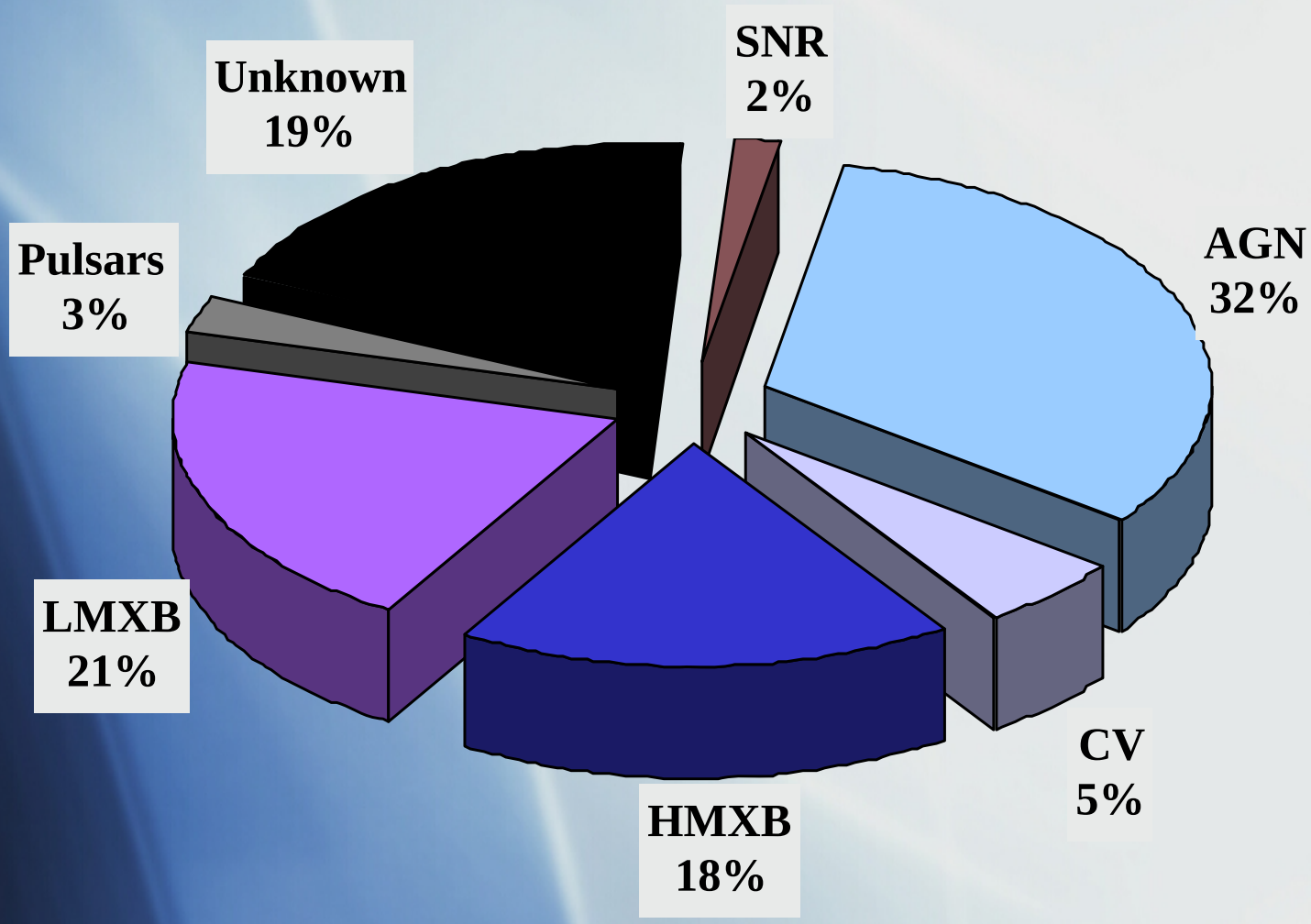
Entirely consistent with Gros et al formulation

The sky (according to IBIS…)

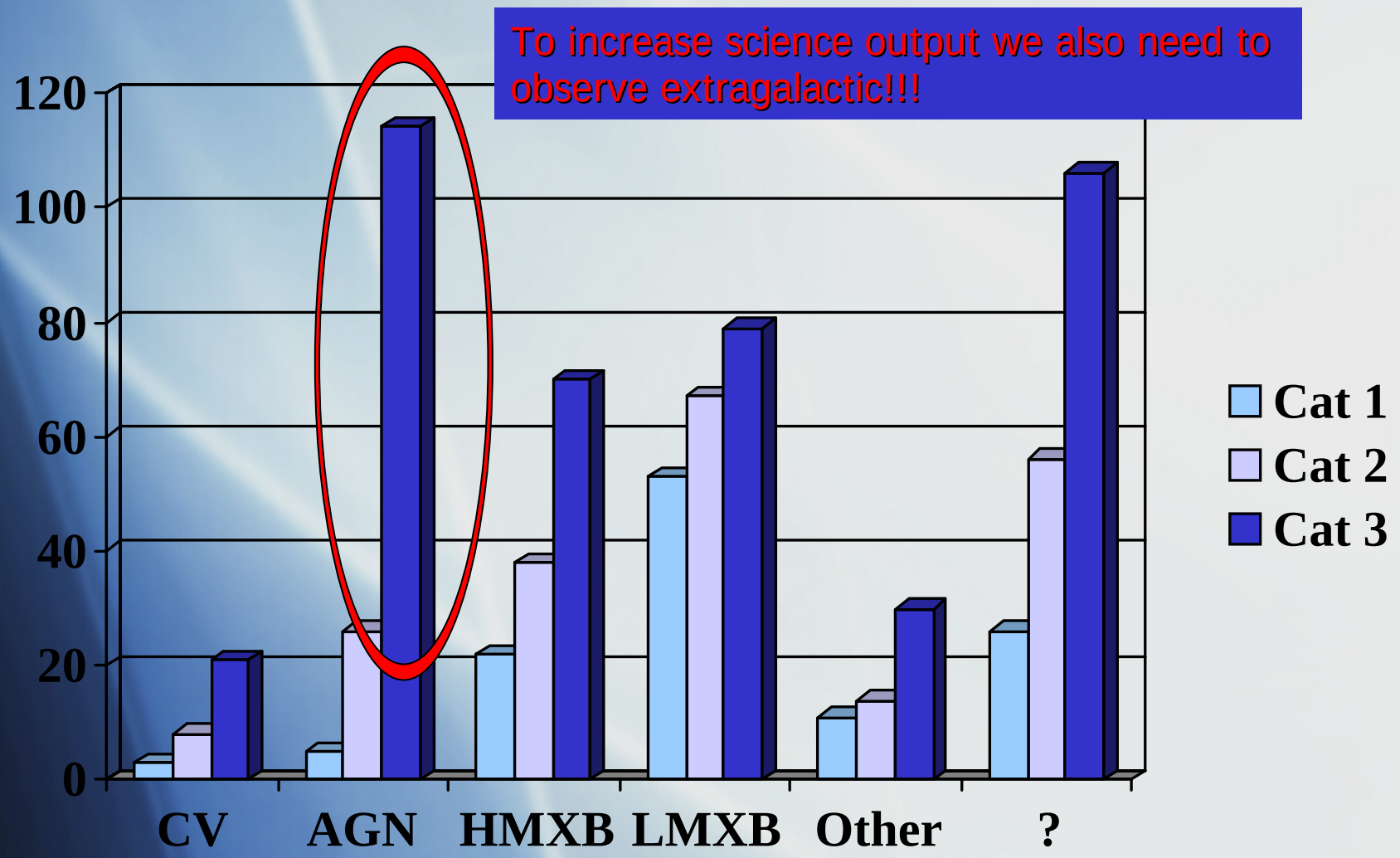


The sky (according to IBIS…)

Source populations



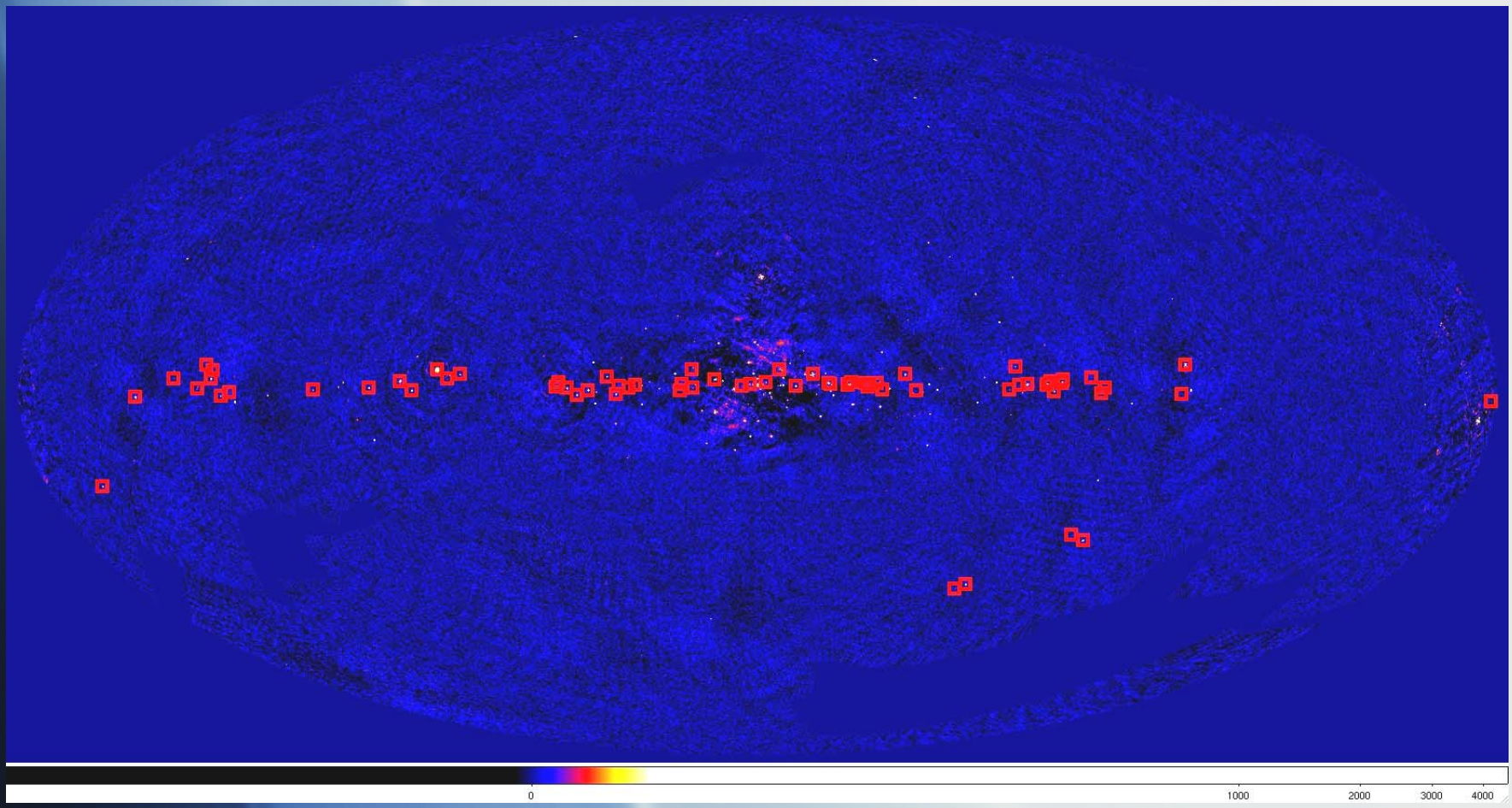
Source populations



Unknown population has stayed approx constant percentage of the sources

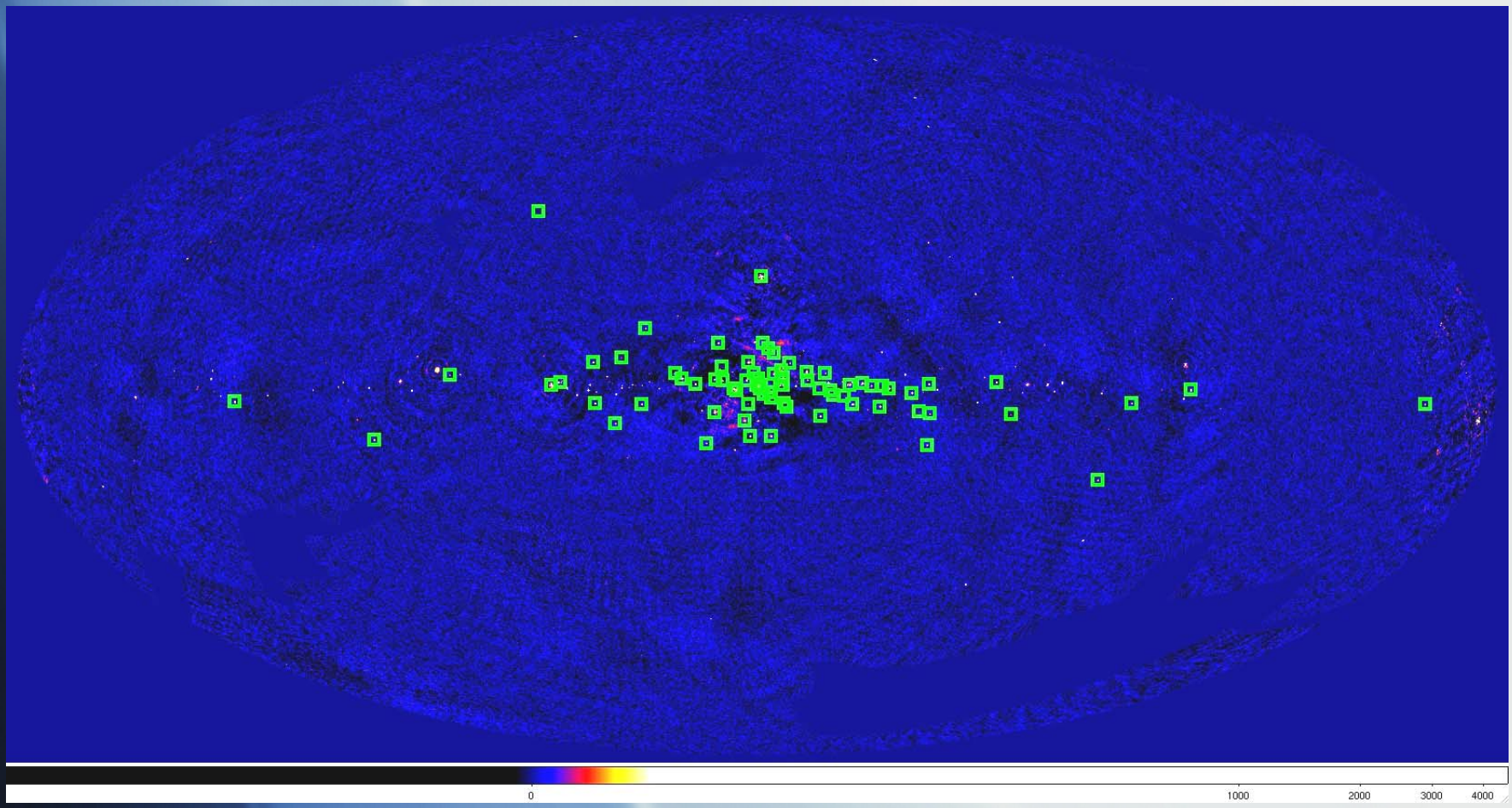
Source distributions

HMXB (69 sources)



Source distributions

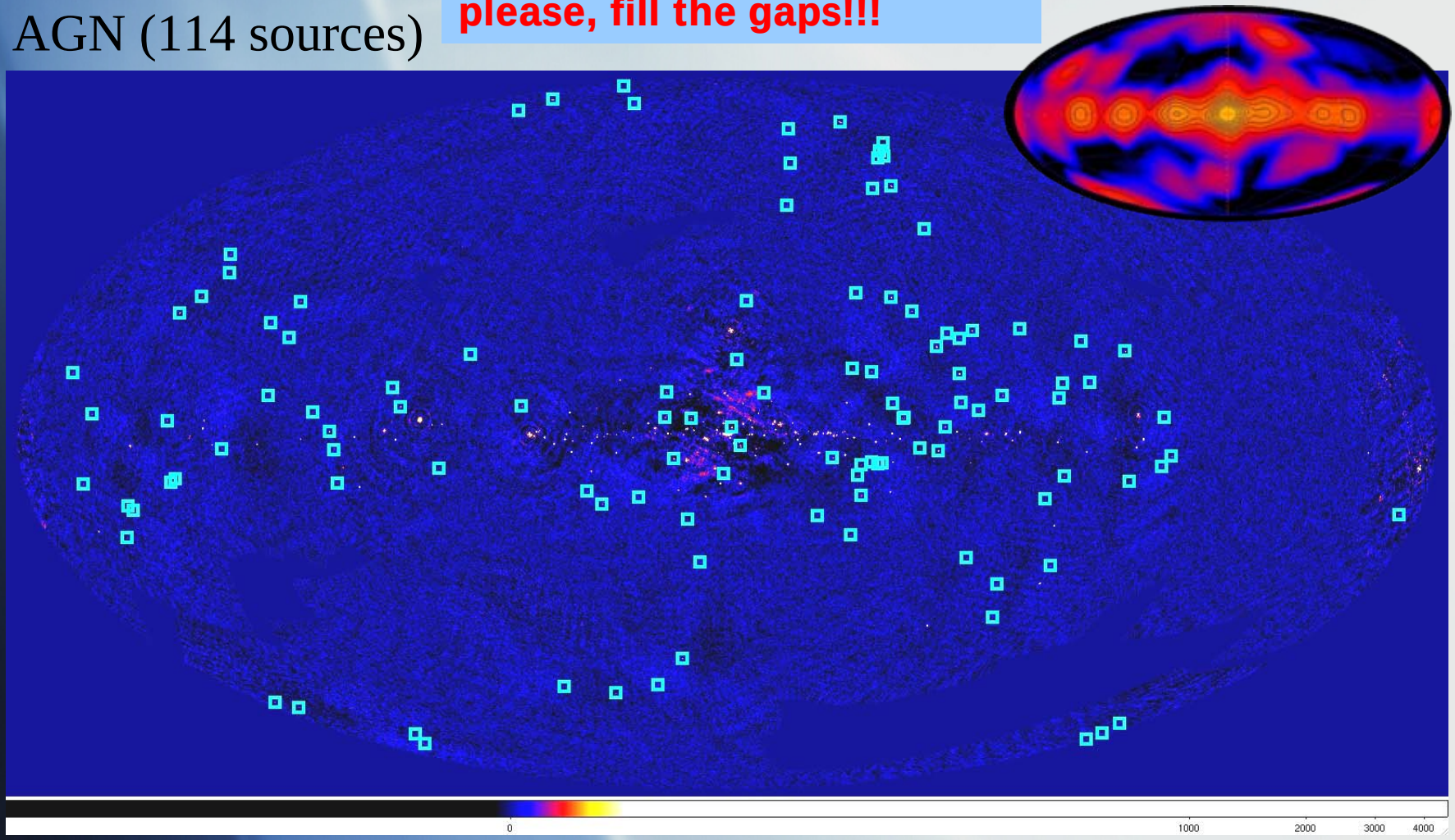
LMXB (79 sources)



Source distributions

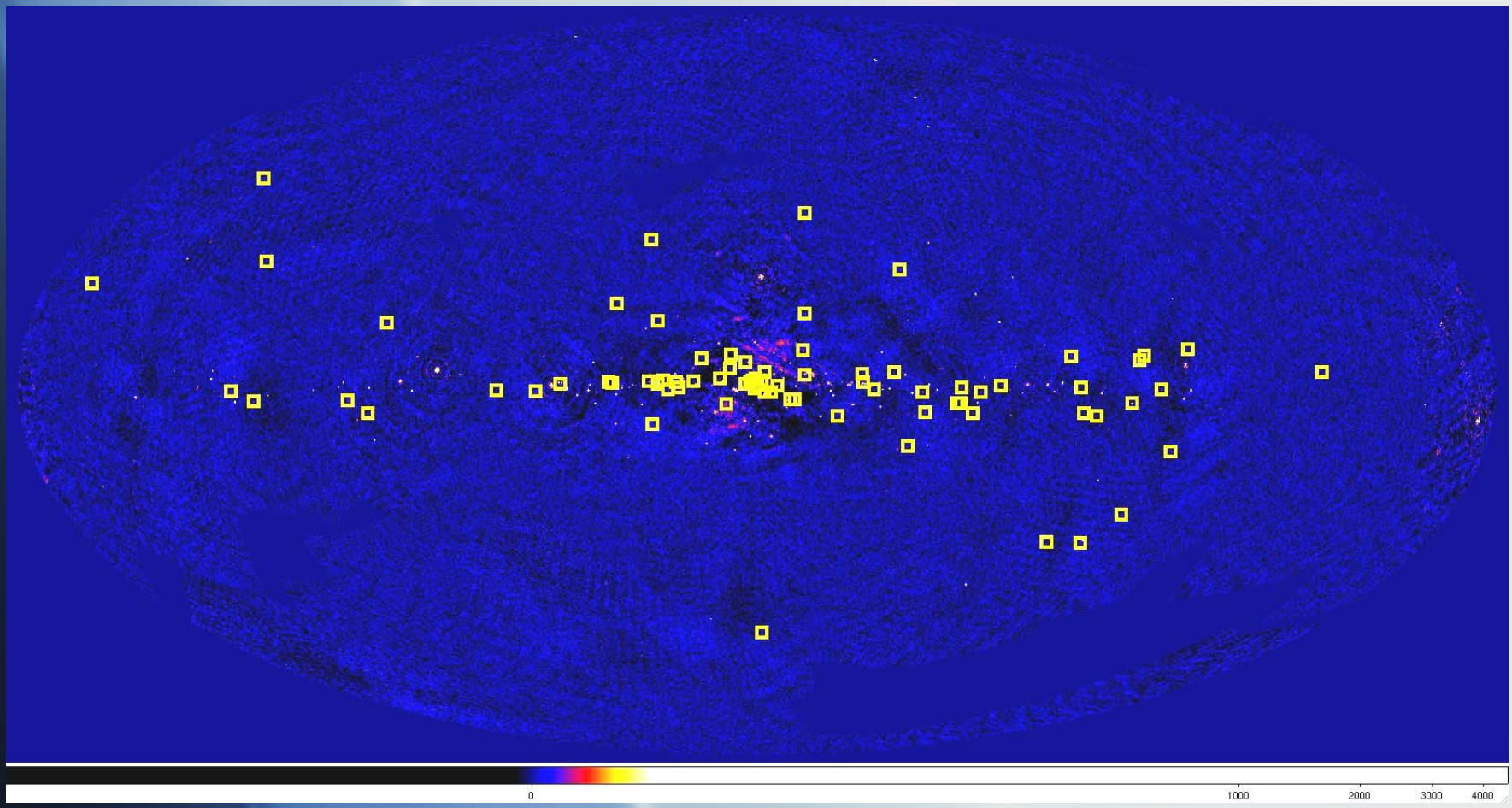
No Core Program any more, please, fill the gaps!!!

AGN (114 sources)

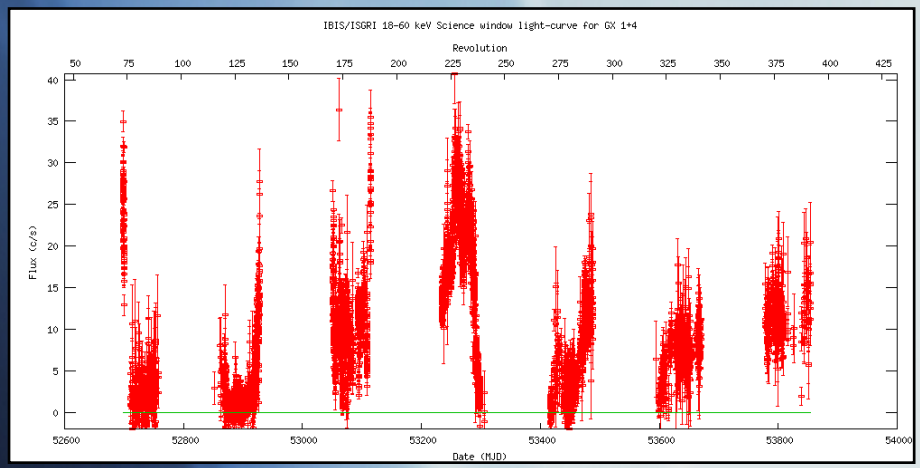


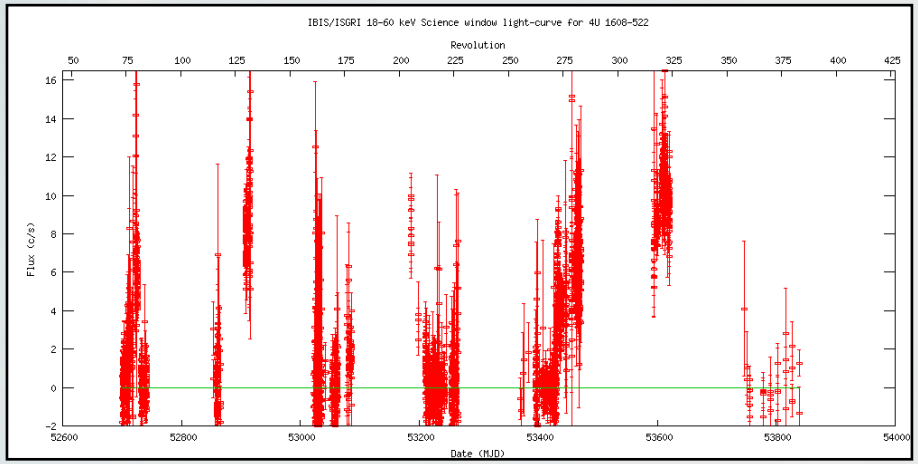
Source distributions

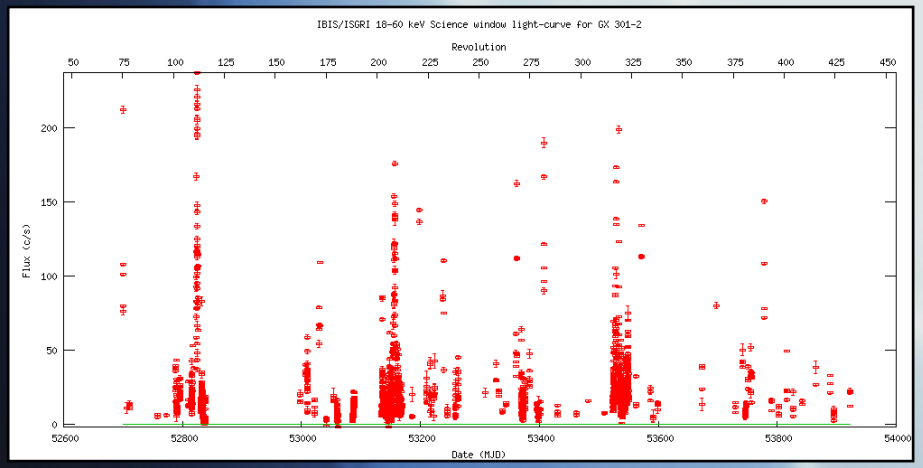
Unknown type (78 sources)

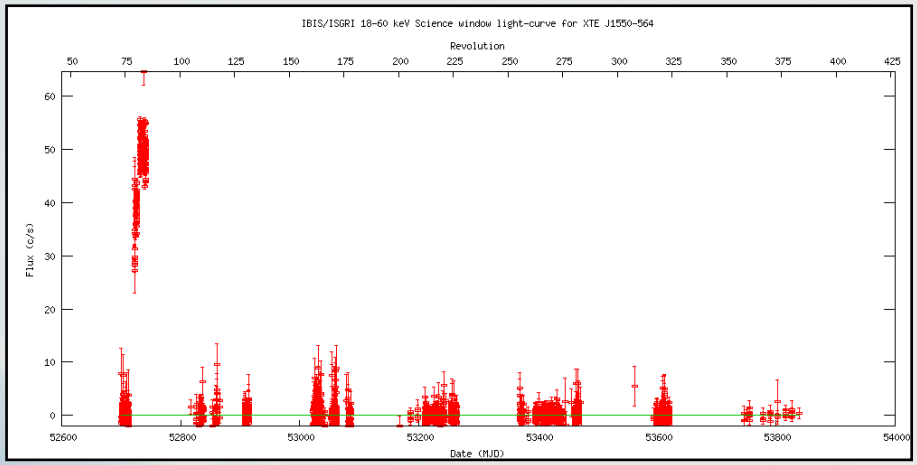


Data products (light curves)



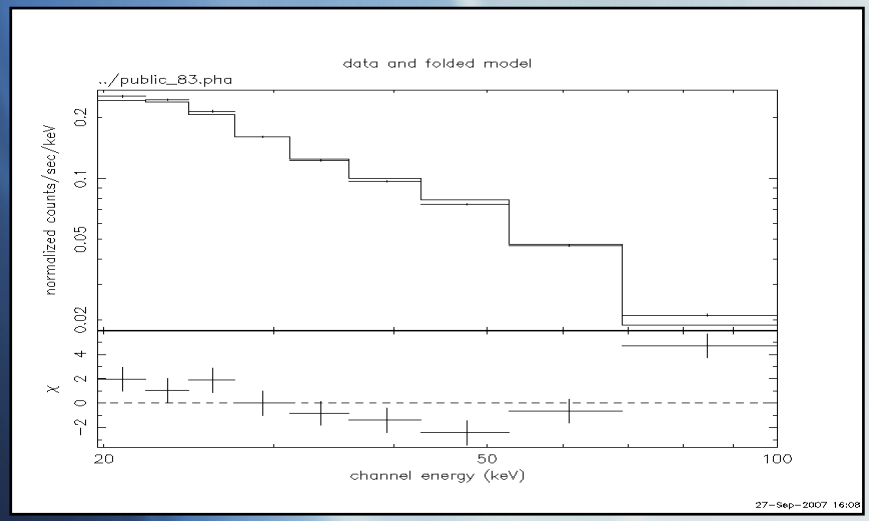


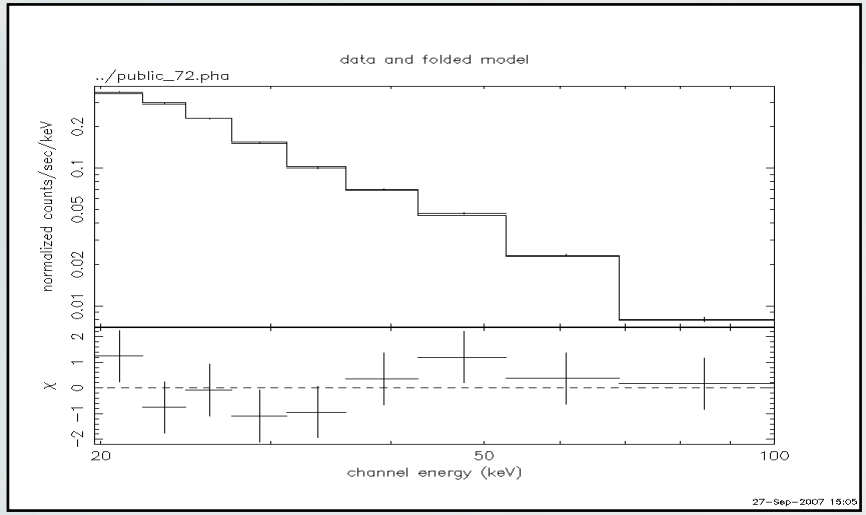


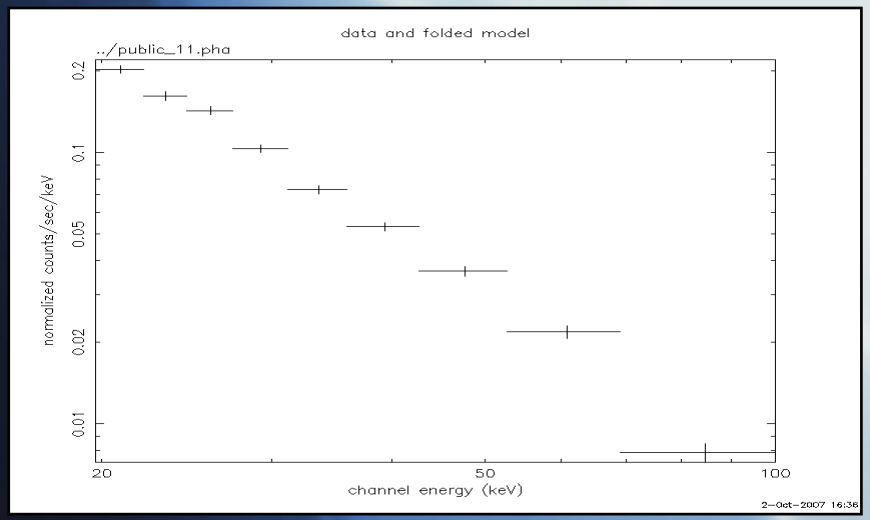


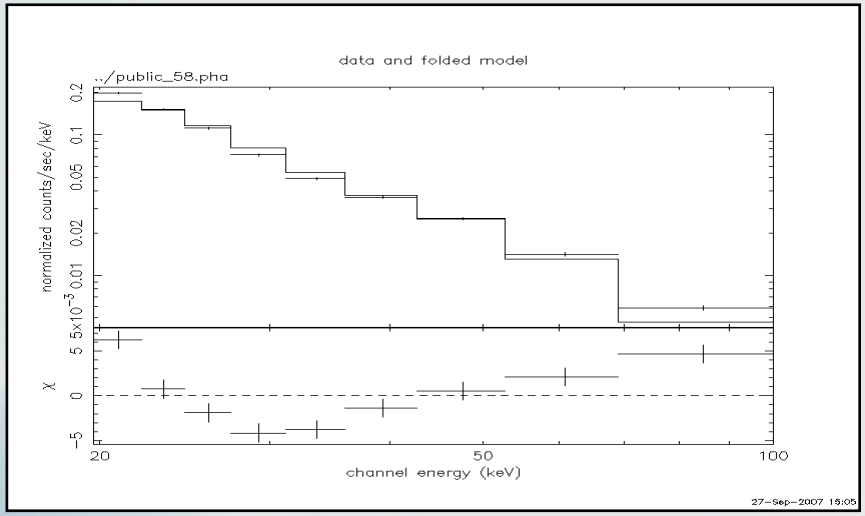
For every source...

Data products (spectra)









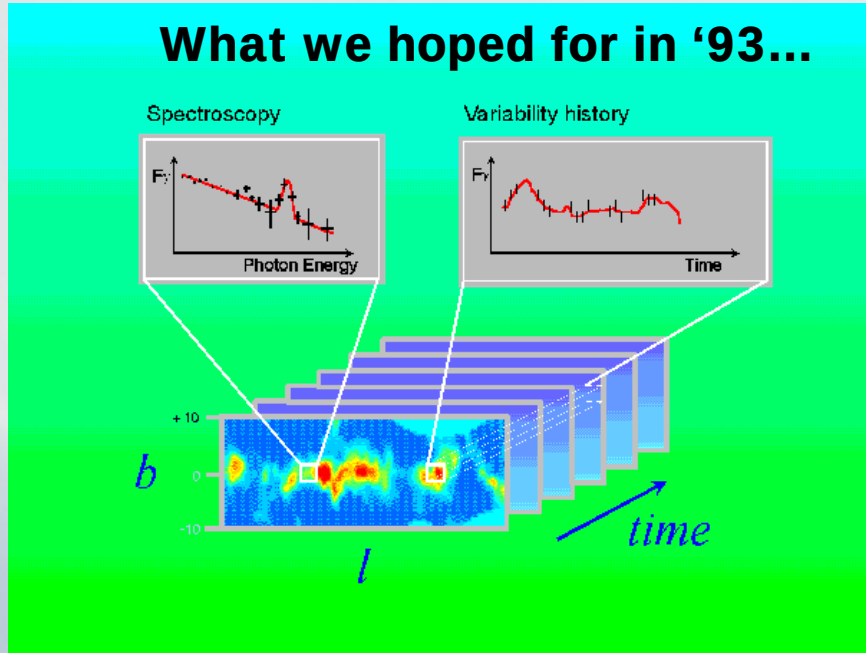
For every source...

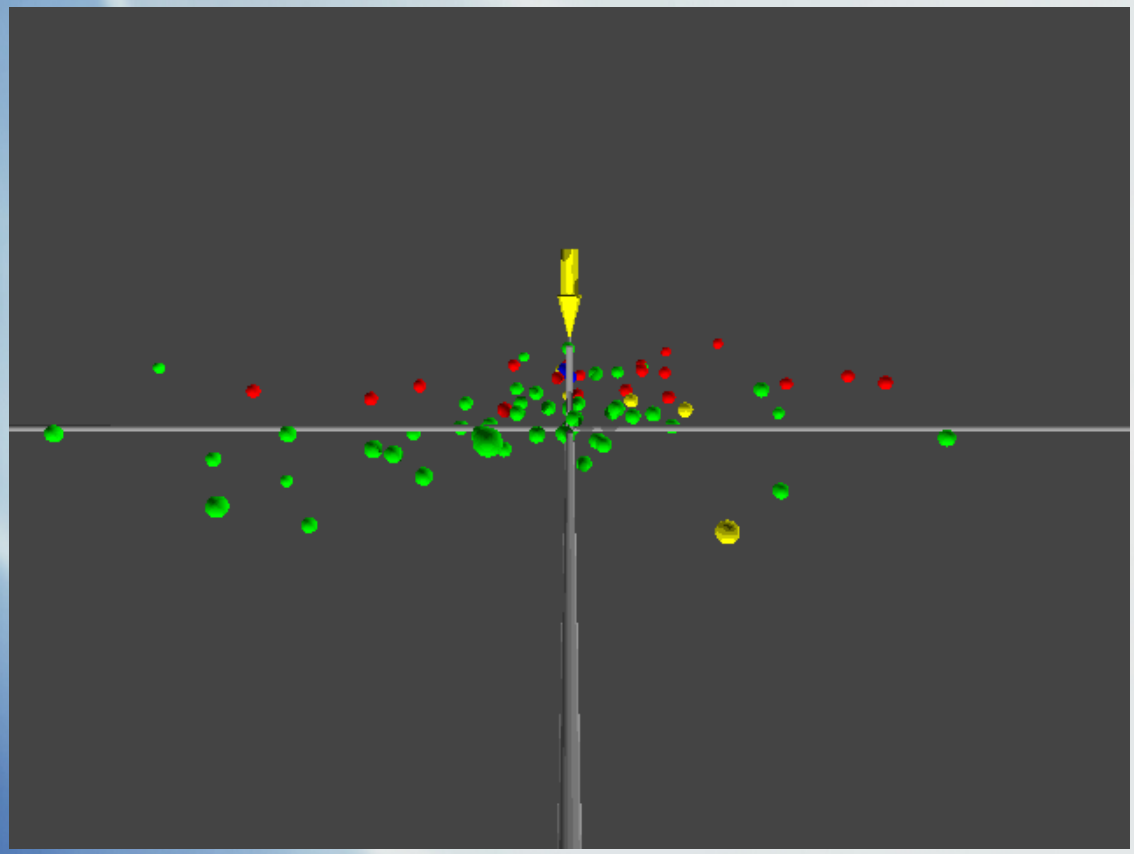
Conclusions

- Numbers of sources continue to increase dramatically
- HMXB numbers increasing faster than LMXB after initial GCDE campaign
- AGN numbers increased to ~130 in cat3 – more now!
  - **boosted by exposure and follow-up campaigns**
- SFXT have emerged as a new class
  - 14 (including candidates) now seen
  - Have been observed when not in outburst
- Significant numbers of CVs visible
  - Almost exclusively IP sub-class
- Sky above 100 keV is becoming more populated

GRS 1915-105

17-30, 30-60, 40-100 colours





With big thanks to all in the IBIS survey team - you know who you are!