DANISH NATIONAL SPACE CENTER

JEM-X: status & performance

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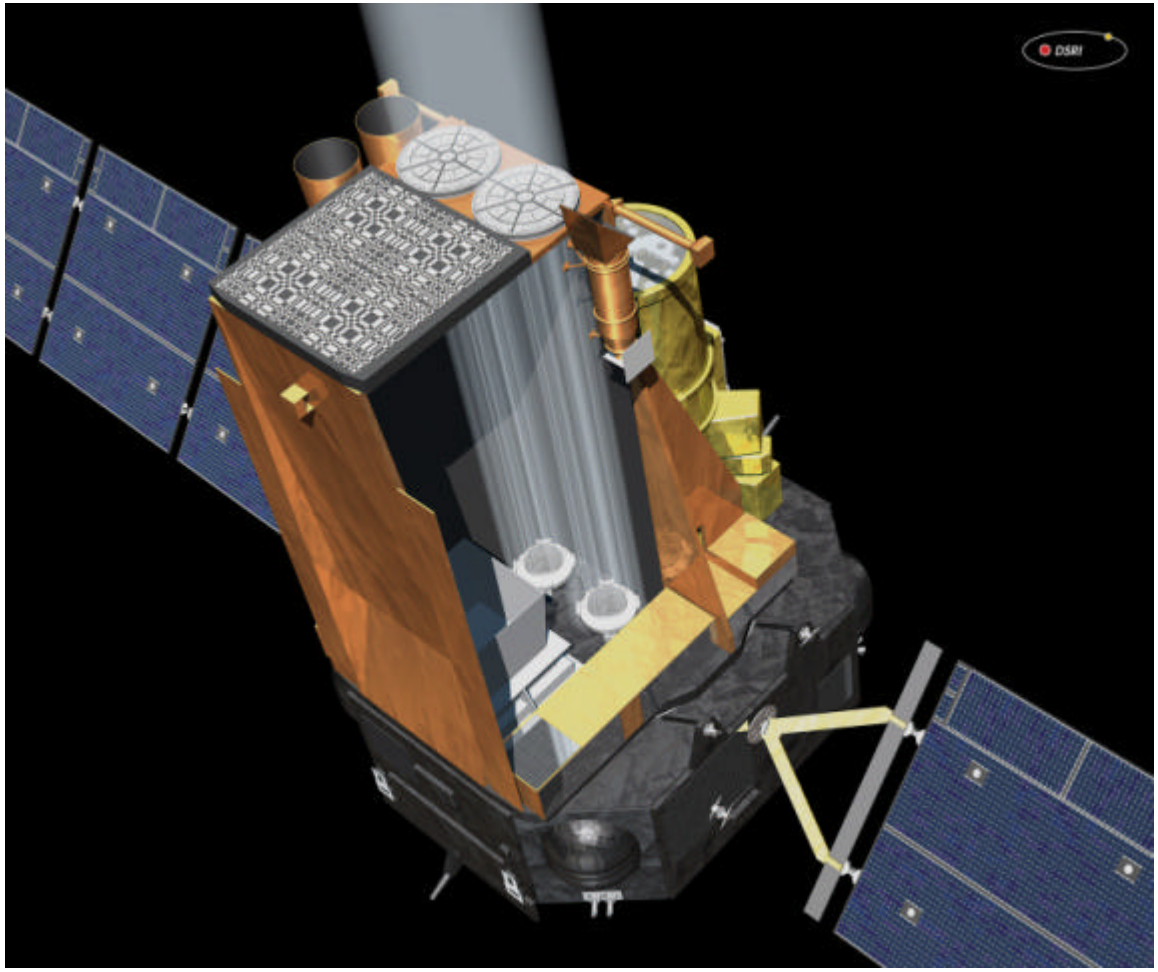


Status for JEM-X on INTEGRAL

- Instrument
  - Microstrip detector
  - Background Evolution
- Analysis software
  - Source detection & localization
  - Image mosaics
  - Energy spectra & Light curves

JEM-X operational status

The JEM-X hardware is performing well and we expect that the it will continue to provide good service as the INTEGRAL X-ray monitor.

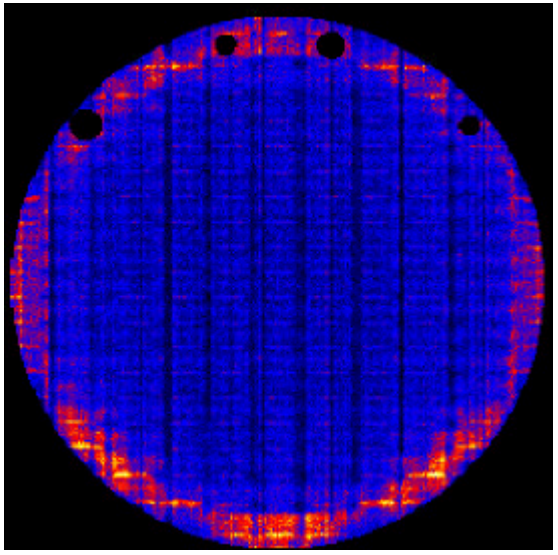
However, JEM-X has quite a few peculiarities which keeps us as a science team quite busy understanding and correcting them.

I will mention a couple of technicalities which may be important for you when analyzing JEM-X data.

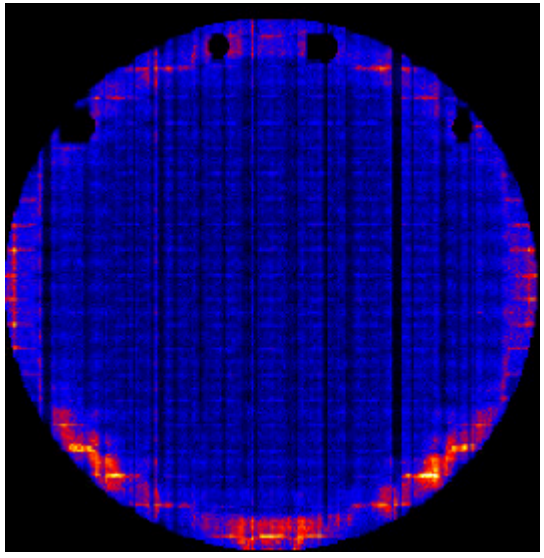
Loss of anodes on the microstrip detector

Soon after launch we found that the microstrip detectors were degrading rapidly. Within the first week we lost about 10 anodes in each JEM-X unit. This anode erosion was almost completely halted by lowering the gas gain in the detectors by a factor 3. The missing anodes only have a very slight impact on the JEM-X imaging capabilities.

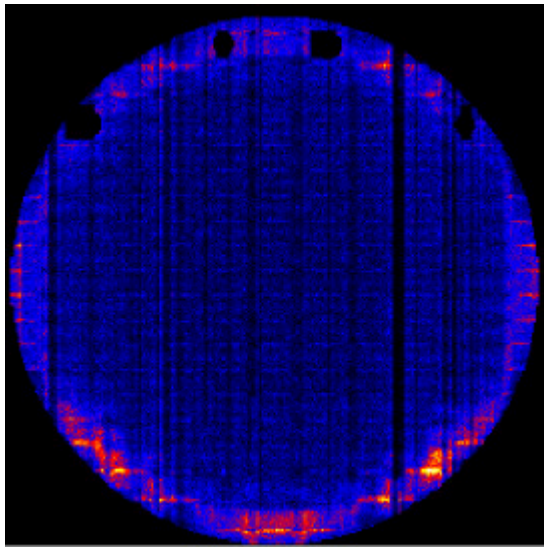
But operating at low gain implies difficulties for the calibration of the response below 5 keV. We have not yet found a fully satisfactory solution for the low energy calibration.



JEM-X1 February 2003



JEM-X1 March 2004



JEM-X1 January 2005

Time drift of the microstrip gain

The JEM-X microstrip detector exhibits significant gain drifts on both many time scales. Most of these gain drifts are taken care of by our calibration software which uses the signals from four radioactive sources to monitor and correct for time drifts on timescales between minutes and years. But in the first half hour or so after detector switch-on, (f.i. after coming out from the radiation belts) the gain may change rapidly and the correction system may not always be able to follow the change accurately.

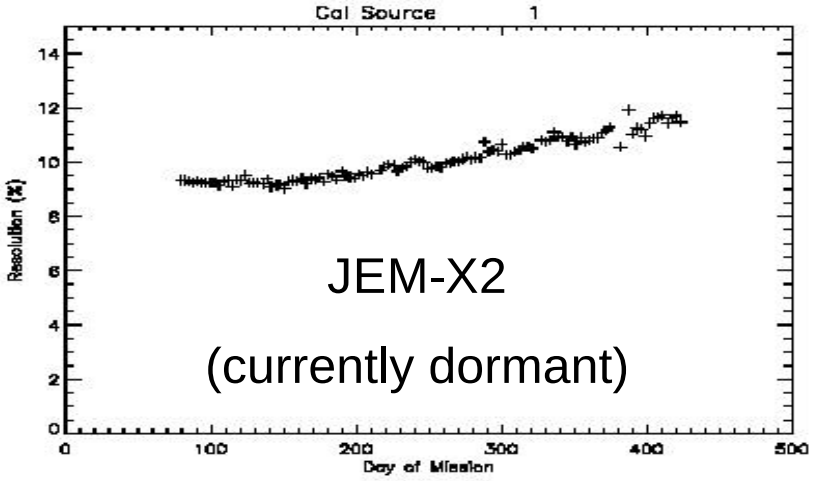
Therefore, if you want to derive accurate spectra you should probably avoid using data from the first science window after detector switch-on. For imaging and source detection the gain drifts are of no great consequence.

There is also a long term steady increase of the detector gain. The calibration system corrects for this in terms of pulseheight, but until now we have not corrected for the corresponding change in the low energy detection efficiency. We expect to have such corrections included in OSA 5.

Detector resolution evolution

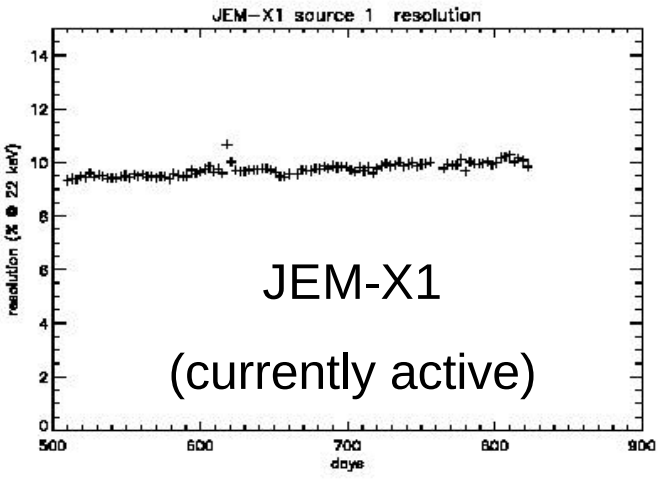
The energy resolution of the microstrip detectors are slowly degrading. The resolution is now 13% (JEM-X2) and 10.5% (JEM-X1) at 22 keV compared to 9% for both units just after launch.

Laboratory experiments have indicated that the degradation of the energy resolution is caused by uneven migration of ions in the glass substrate on which the conducting microstrips are deposited.



JEM-X2

(currently dormant)



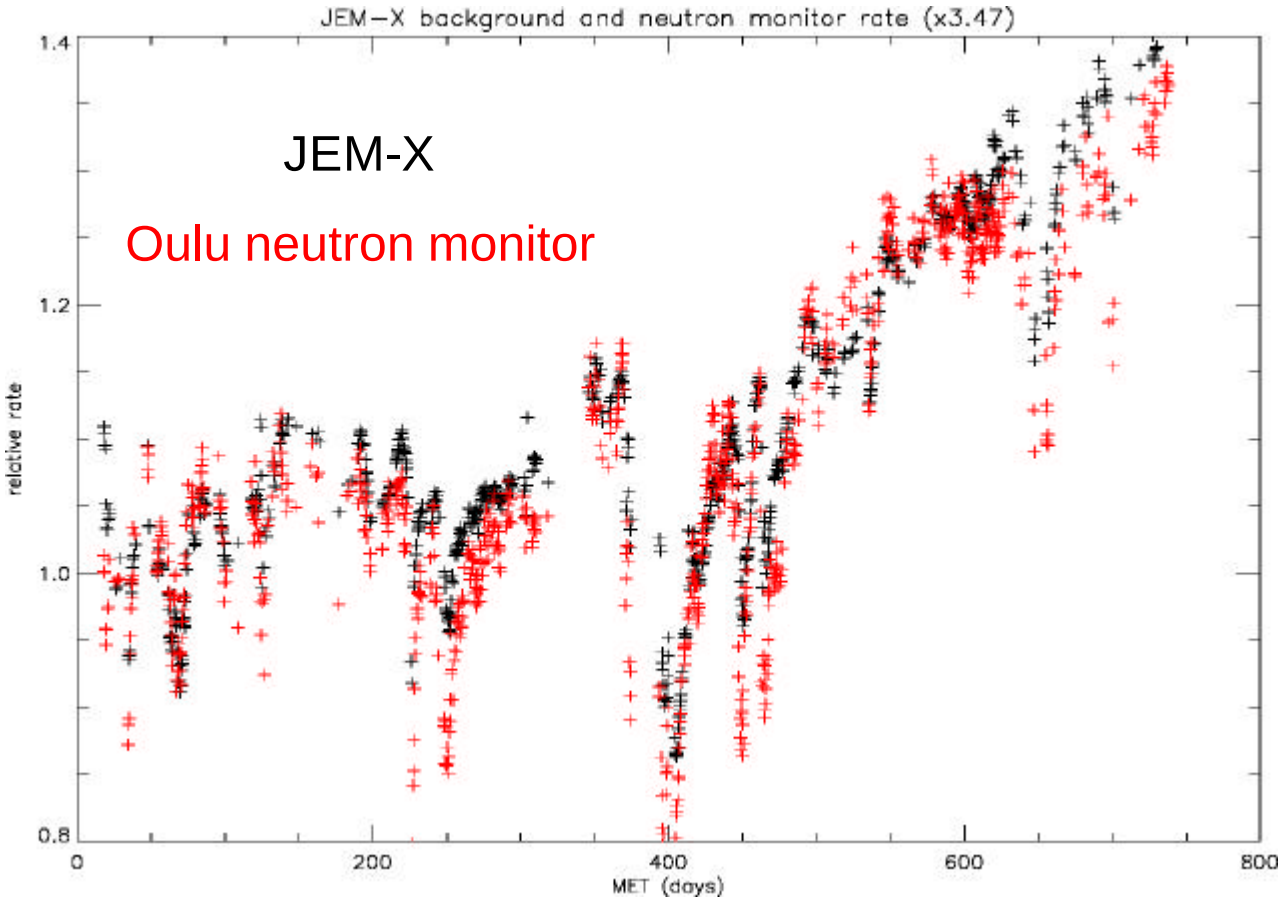
JEM-X1

(currently active)

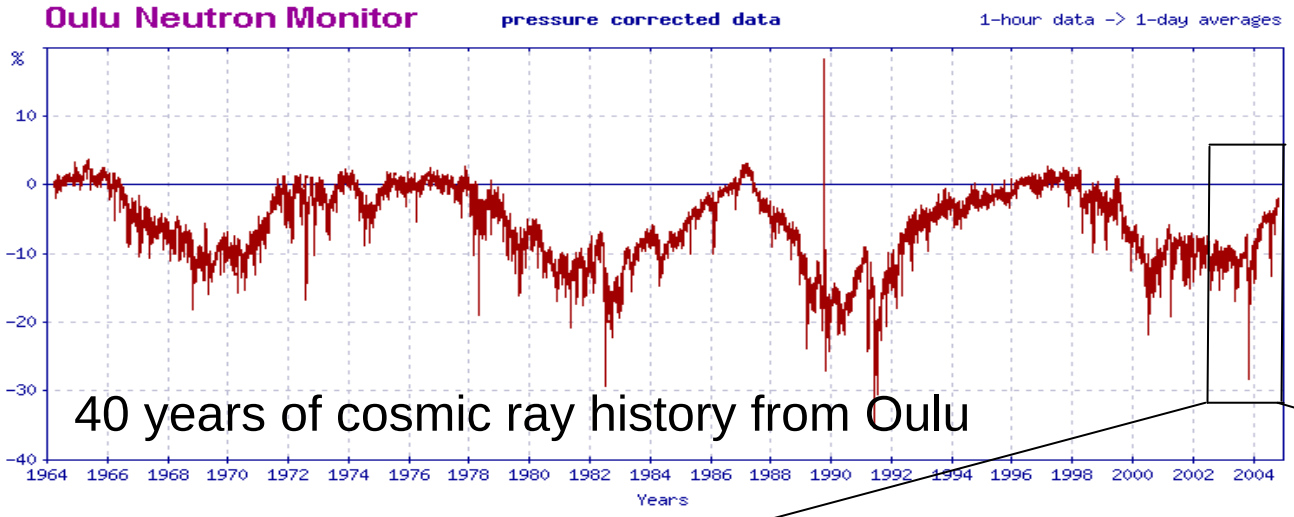
Evolution of the JEM-X background rate, comparison with cosmic ray neutron monitor data

The JEM-X noise count rate has grown by 40 % since the start of the mission.

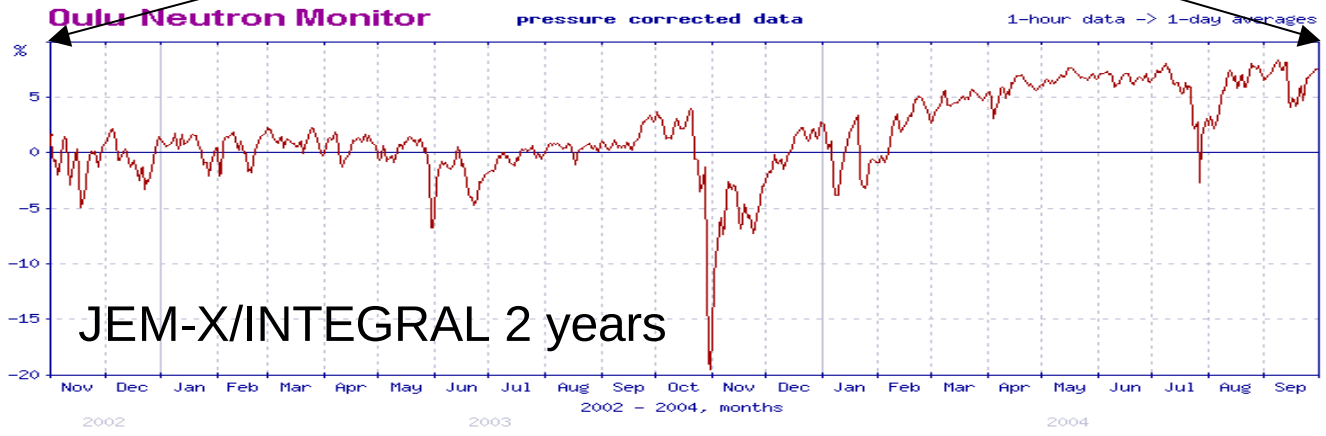
The increase is closely correlated with the cosmic ray activity as measured by ground based neutron monitors.



Expected evolution of the background



The prediction is that the JEM-X rate will increase by another 20-40% as the Solar minimum evolves



Coded mask fact of life
and a consequence for JEM-X

All sources in your image contribute to the background noise for all other sources .

This is particularly important for JEM-X because the signal from sources frequently is much larger than the diffuse and internal background count rate. So the JEM-X sensitivity does depend on which part of the sky you survey.

INTEGRAL dithering observations - and a consequence for JEM-X

Typical INTEGRAL observations are made with a 5x5 dither pattern with most of the pointings more than 4 degrees off the the central target position. This observation strategy optimizes the data quality for SPI.

The JEM-X design includes a collimator supporting the detector window. This collimator reduces the sensitivity of the instrument by a factor 2 or more for sources outside 4 degrees*). As a consequence the JEM-X sensitivity for a source varies dramatically during the dithered observations. Construction of a continous light curve is difficult/impossible for such observations. And the effectiv exposure for is only about 30% of the exposure for IBIS/SPI. Hexagonal dither is much better for JEM-X – but worse for SPI.

*)Advices for the coming generations:

1) Match the FOV for your monitor instruments to those of your main instruments!

2) Dont use a collimator to constrain the field for a coded mask instrument!

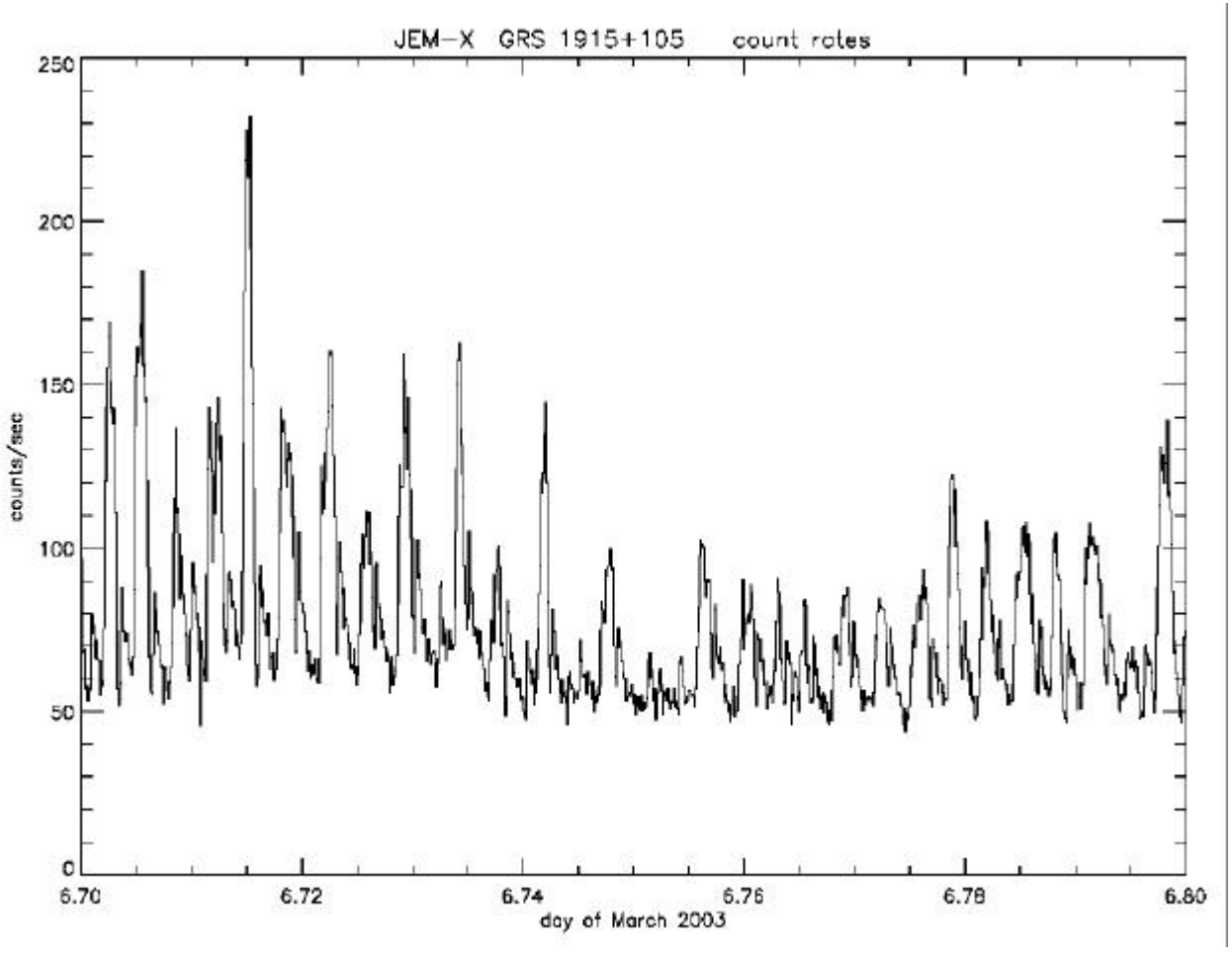
When to use JEM-X – and when not!

JEM-X is a small instrument – effectively only collecting photons over 100 cm^2. In comparison the PCA on RXTE has 6000 cm^2 of collecting area.

So if you can plan your observation and if you know the position of your source then you will be much better off with data from the RXTE PCA than from JEM-X on INTEGRAL.

But if your source is transient or time variable or located within arcminutes of another source then the JEM-X data may be unique, and should be exploited as far as possible.

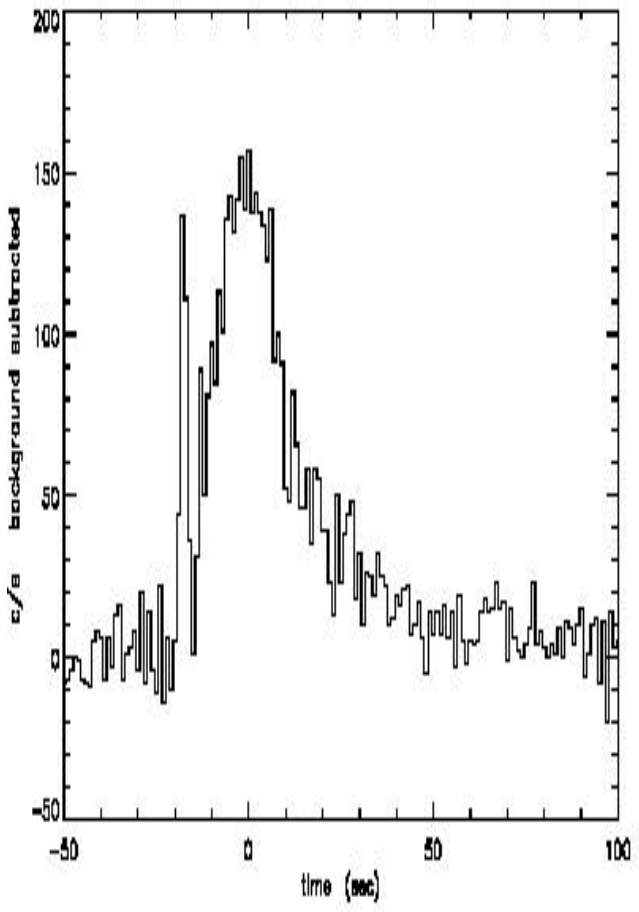
GRS 1915+105 the time variable source par excellence



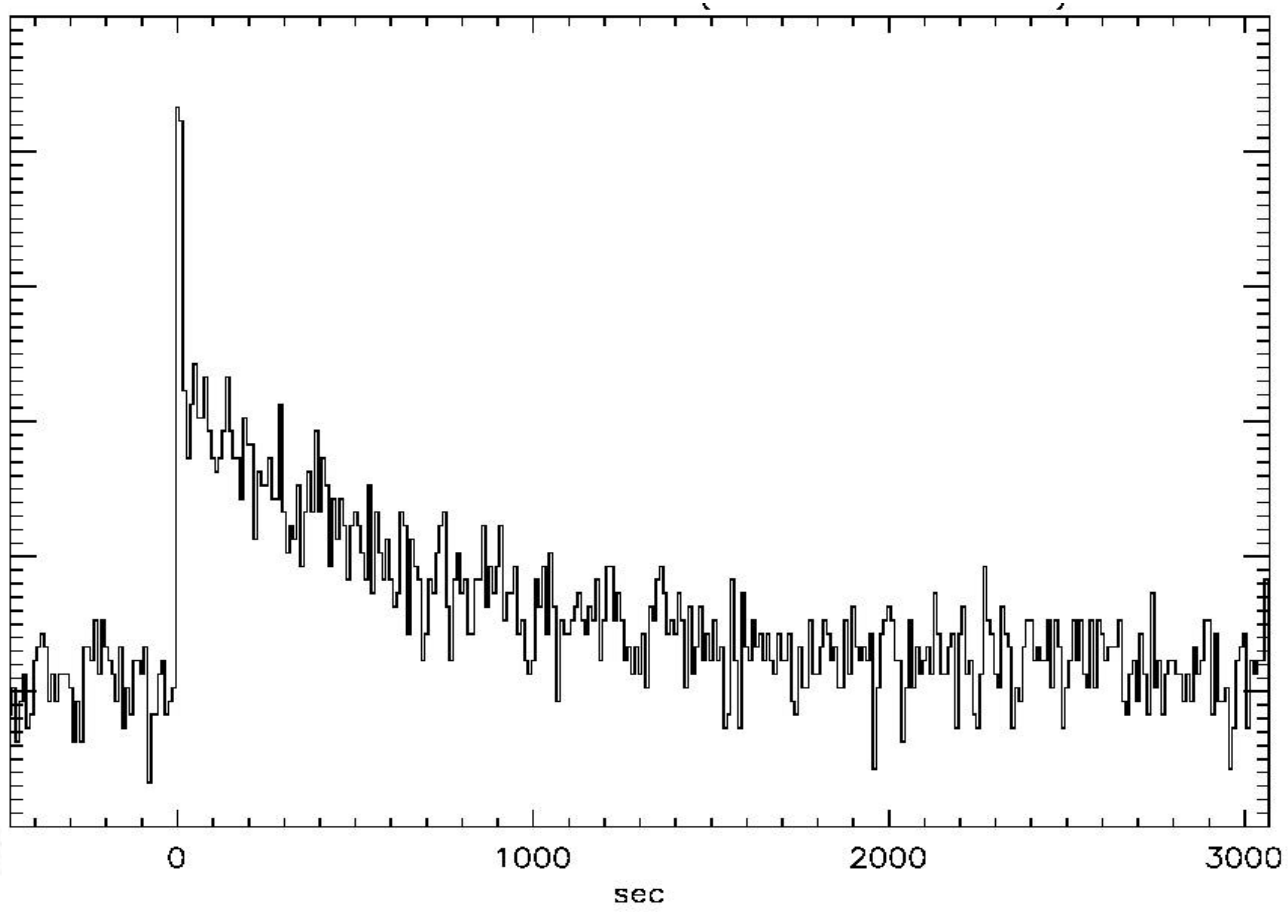
X-ray bursts

JEM-X detects more than 100 bursts from galactic X-ray sources annually

Normal burst from 4U1722

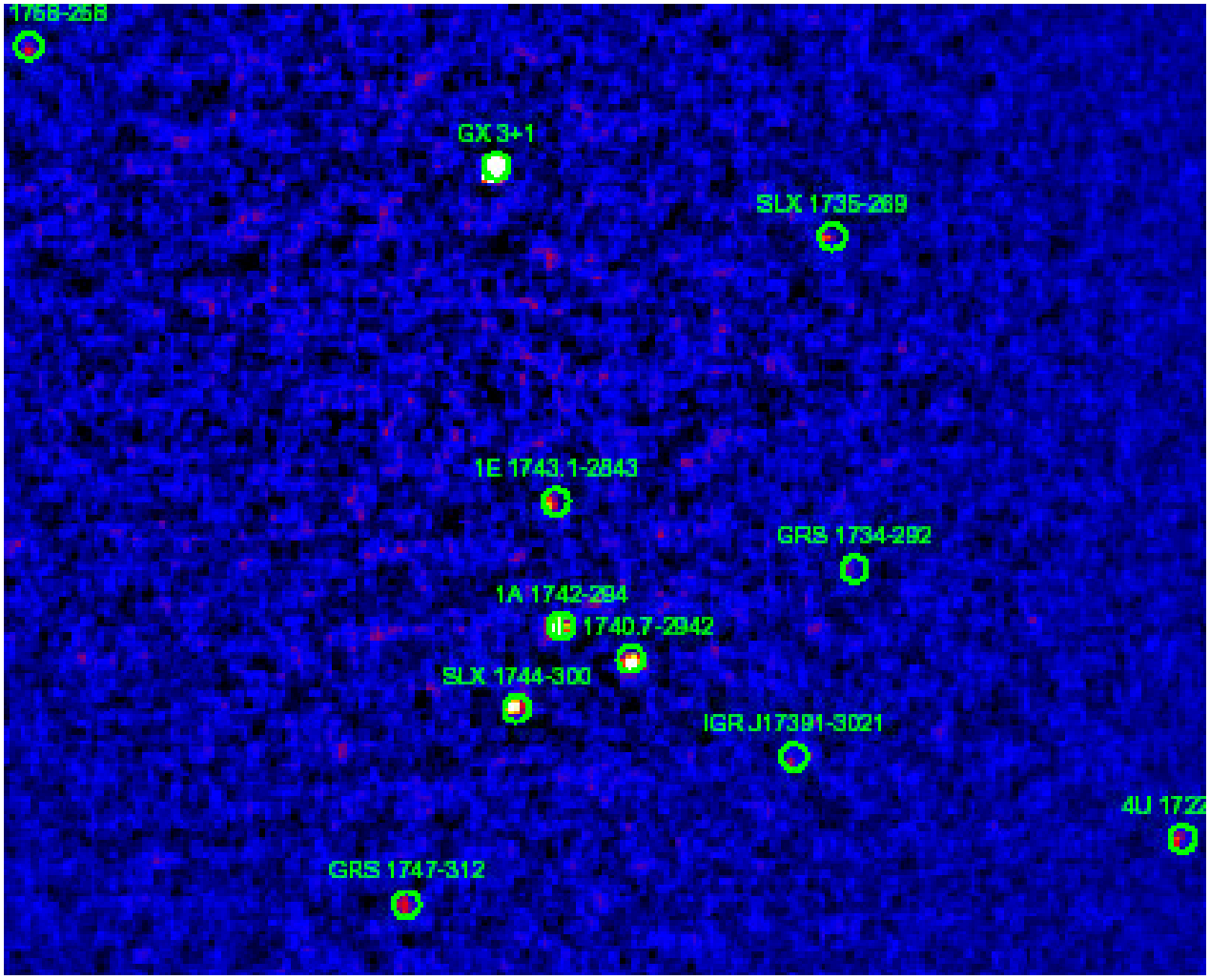


Unusually long burst from GX3+3



Galactic Center, September 2003

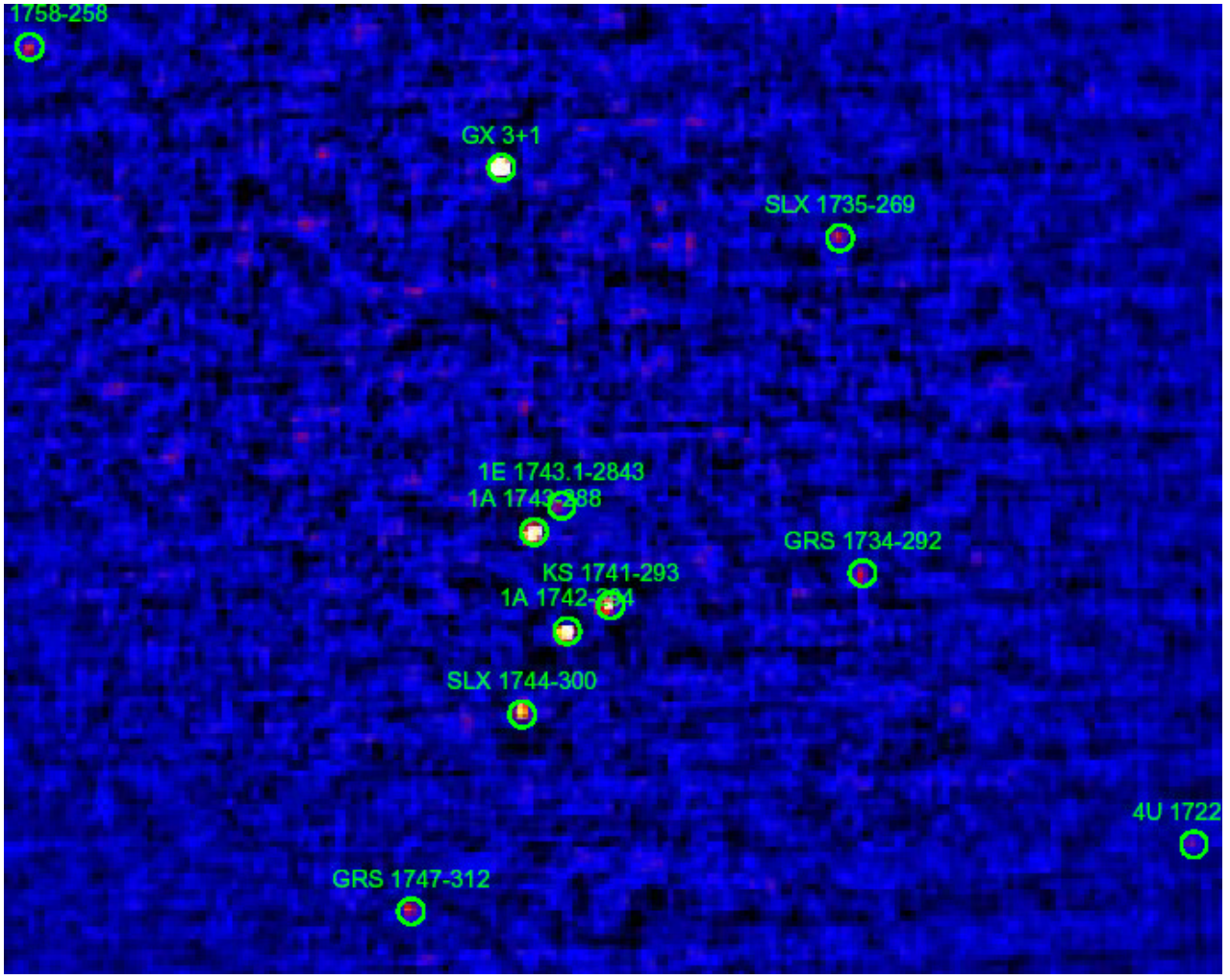
(GCDE)



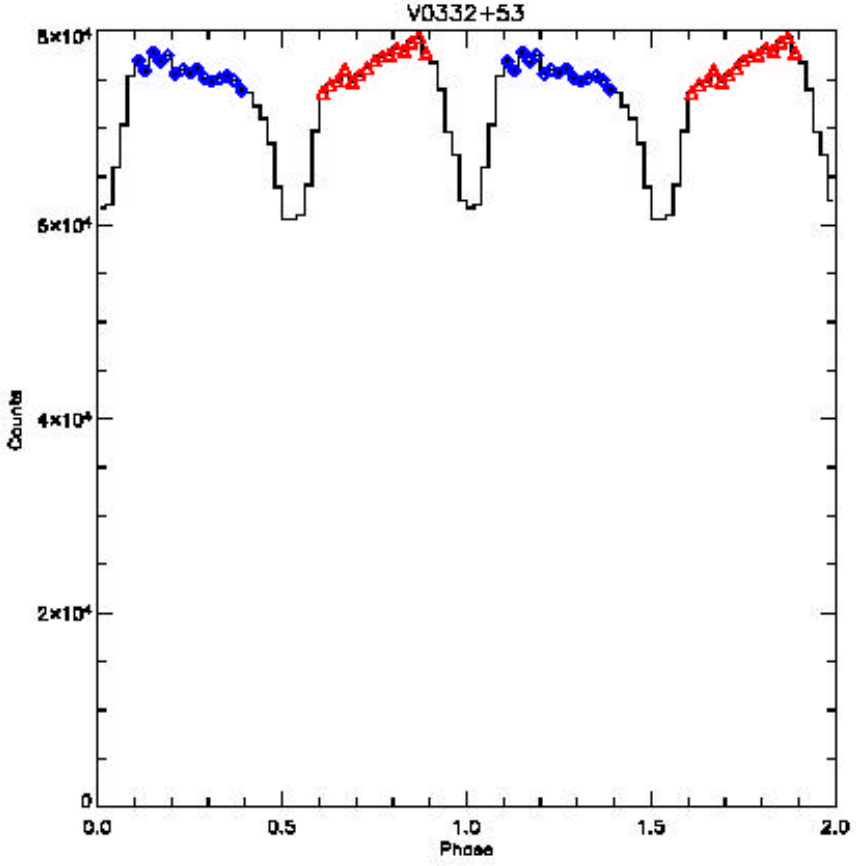
Galactic Center – April 2004

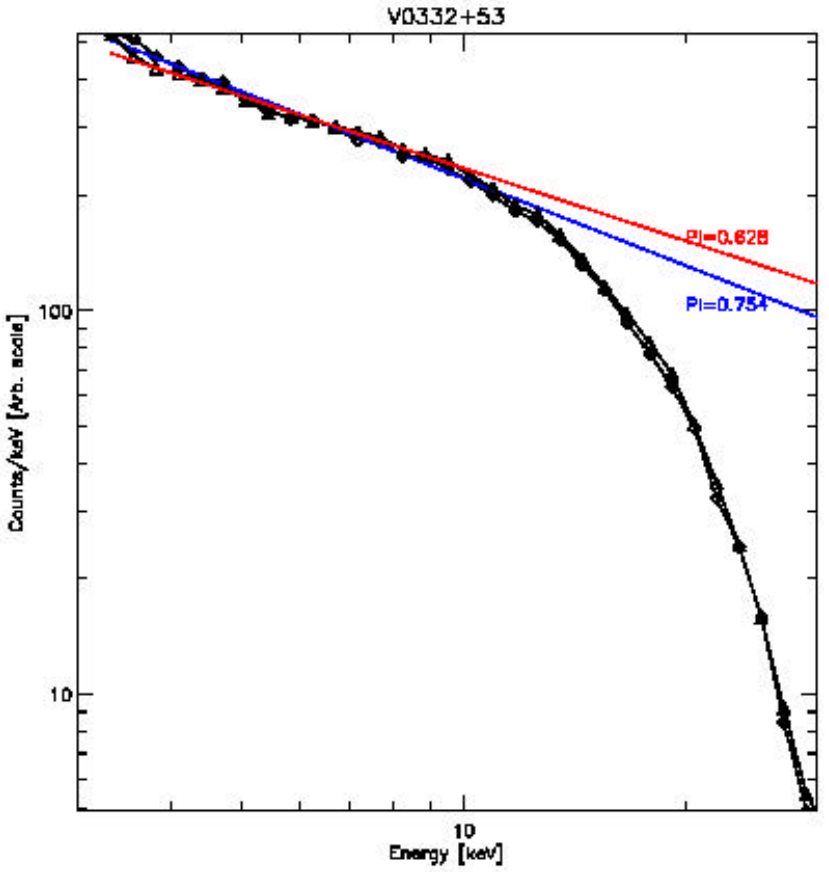
PI:

A.Goldwurm



Phase resolved energy spectra from VO332+53 (public INTEGRAL data from ongoing TOO observation)





How to analyze JEM-X data

For spectra and lightcurves:

Use ISDC OSA software. Avoid to (if possible) to use science windows where the source is more than 3 degrees off axis.

For imaging:

Use OSA software or ”Midisky” software*).

For mosaics:

Use ”Mosaic weight” software*).

*)Both ”Midisky” and ”Mosaic weight” are available via ftp from ftp.dsri.dk/pub/jemx

*)Both ”Midisky” and ”Mosaic weight” will be part of OSA 5

Microstrip detector gain

The detector gain increases by about 1% per 6.3 days.

The rate has been lowered somewhat by reduction of the temperature after switching off the JEM-X2 DFEE