ISGRI and JEMX view of the Galactic Center.

A.Neronov

INTEGRAL Data Analysis Workshop 2005

1. Select your data.

The Galactic Center is **the most deeply exposed region** with INTEGRAL. The list of publically available ScWs (Oct 2005) contains 2572 ScWs.

in the archive browse select “Sgr A” as the source, and look for the pointings which are at most 13 degrees away (so that the GC is at least in the paritally coded FoV of ISGRI)

Each is approximately ≥ 1.5 ksec of data. This means (naively) some 3 Msec of data (:-))

Each is approximately 50M of data. This means (naively) some 37 G of data (:- ()

So think twice before downloading them on your computer!

N.B. See below how to avoid downloading them but still have the results

2. ScW- by- ScW analysis.

The very large size of the dataset makes it convenient to run OSA scripts on the ScW- by- Scw base

Imagine that you forgot to look at the “Known issues on data” page and analysis terminates with an error at ScW number 2700.... Would you like to rerun from the very beginning?

ScW- by- ScW analysis (see Ada Paizis talk and the exercise from hands- on session) is easily “parallelazable” – for different ScWs you can run the script on different machines.

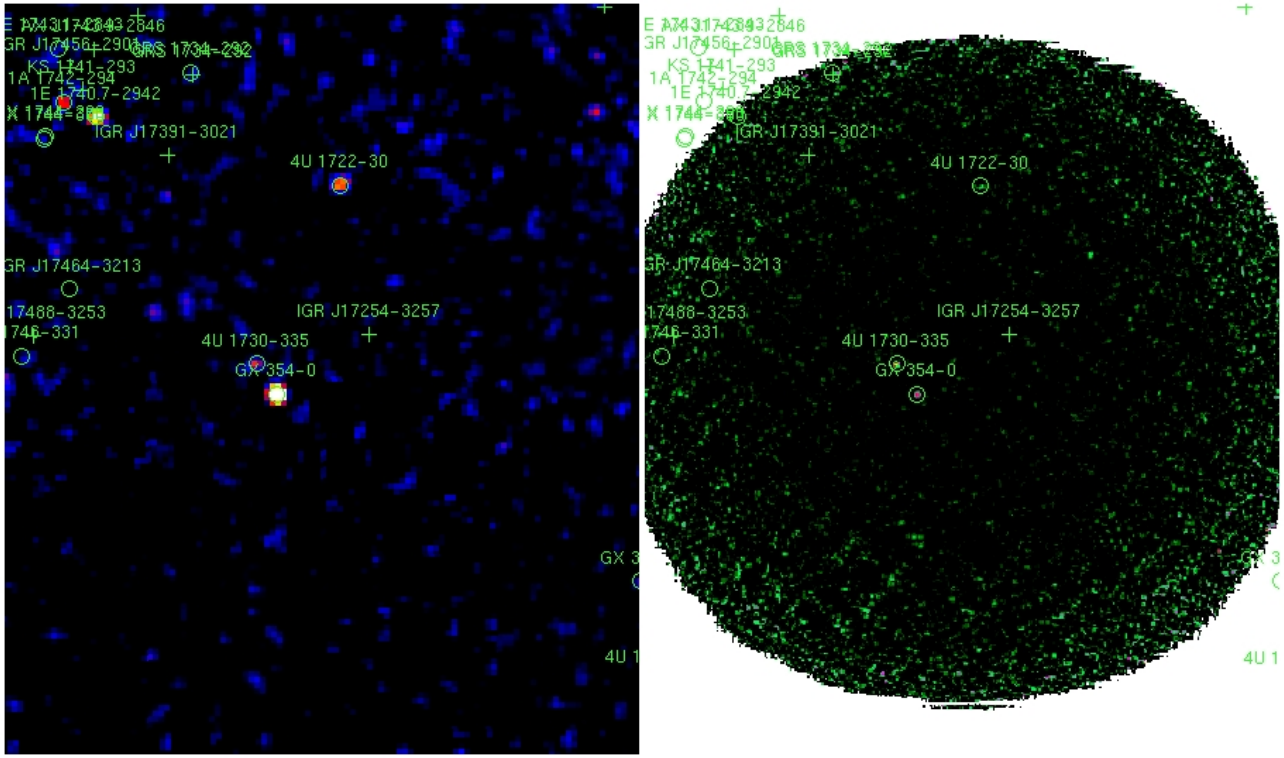
3. Useful paramters of the script.

```
jemx_science_analysis \
    jemxNum=2 \
    startLevel="COR" endLevel="SPE" \
    nChanBins=2 chanLow="46 129" chanHigh="128 223" \
    CAT_I_usrCat="/unsaved_data/neronov/OSA5/user_cat.fits"

ibis_science_analysis \
    startLevel="COR" endLevel="IMA"  \
    IBIS_II_ChanNum=2 IBIS_II_E_band_min="20 50" IBIS_II_E_band_max="50 200"\
    OBS1_MinCatSouSnr=5\
    OBS1_SearchMode=3\
    OBS1_ToSearch=30\
    OBS1_DoPart2=0
```

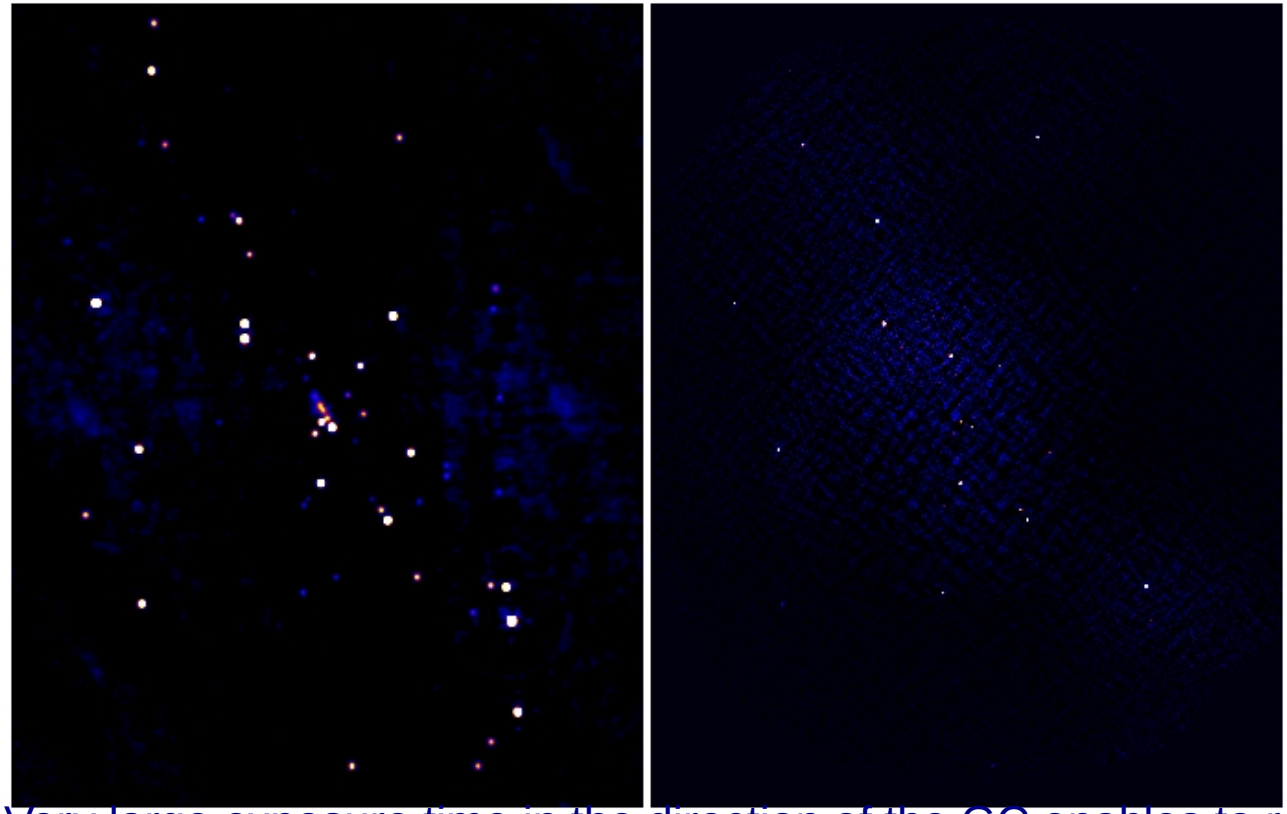
GC is a crowded field. ISGRI imaging script should know that it has to remove **ghosts** of the bright sources: OBS1_SearchMode=3 OBS1_ToSearch=30 will remove ghosts from all catalog sources plus from possible new bright sources in the FoV.

4. Individual Scw images.



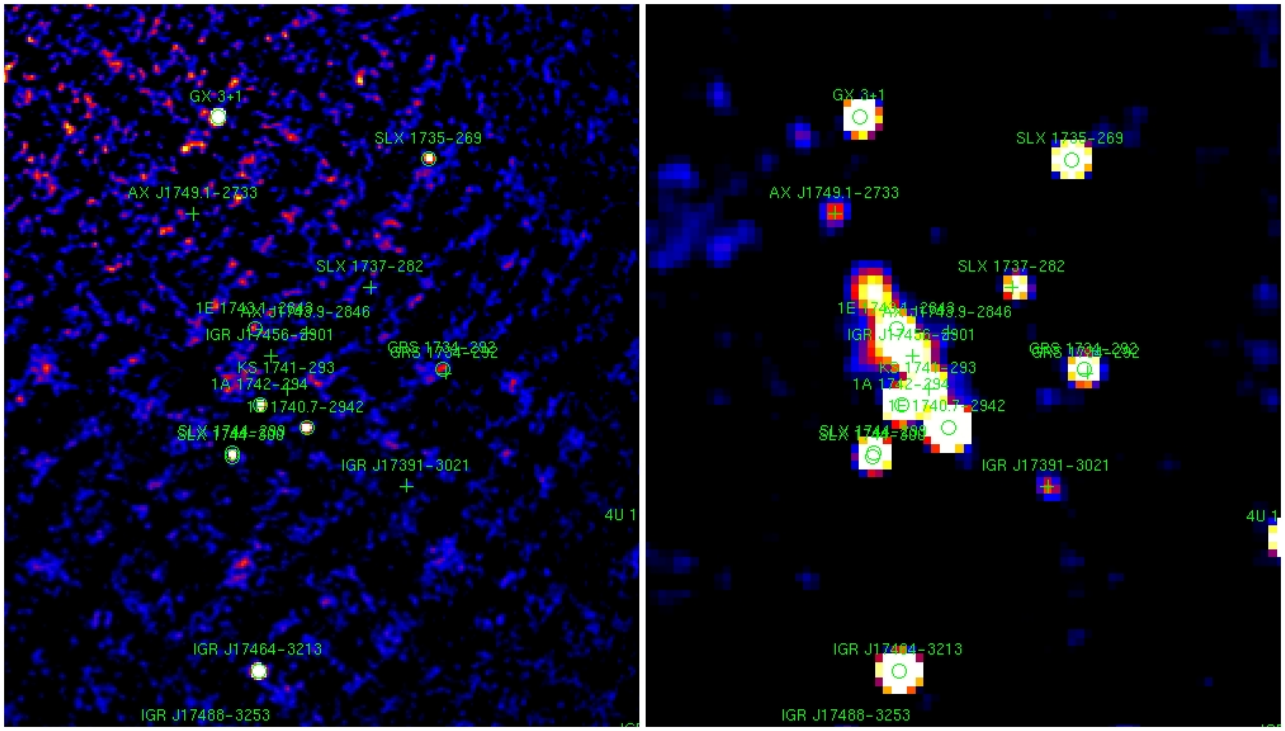
ScW images are isgri_sky_ima.fits and jmx2_sky_ima.fits files. Only brightest sources are seen.

5. The mosaic image: weak sources appear.



Very large exposure time in the direction of the GC enables to reveal sources with the flux down to 10^{-11} erg/cm$^2/s$ (compare with X-ray deep exposure images, which go down to 10^{-14-15} erg/cm$^2/s$).

6. Closer look at the INTEGRAL GC.



JEMX 3- 10 keV image vs. ISGRI 20- 60 keV band image: better angular resolution of JEMX enables better source localization. However, JEMX sensitivity is lower than that of ISGRI. Only bright sources can be localized by JEMX.

6. “Quick- n- dirty” way to make large mosaics.

The *varmosaic* ftool enables to make “quick and dirty” analysis of the sky region of your interest: to make a mosaic of large set of ScWs you do not need to download them on your computer. You even do not need to run OSA software!

```
varmosaic filelist=’’imalist.txt’’ outimage=’’mosaic.fits’’
```

This tool reads the list of image files given in imafile and produces the “weighted average” mosaic image. The list can contian images which can be not even on your computer:

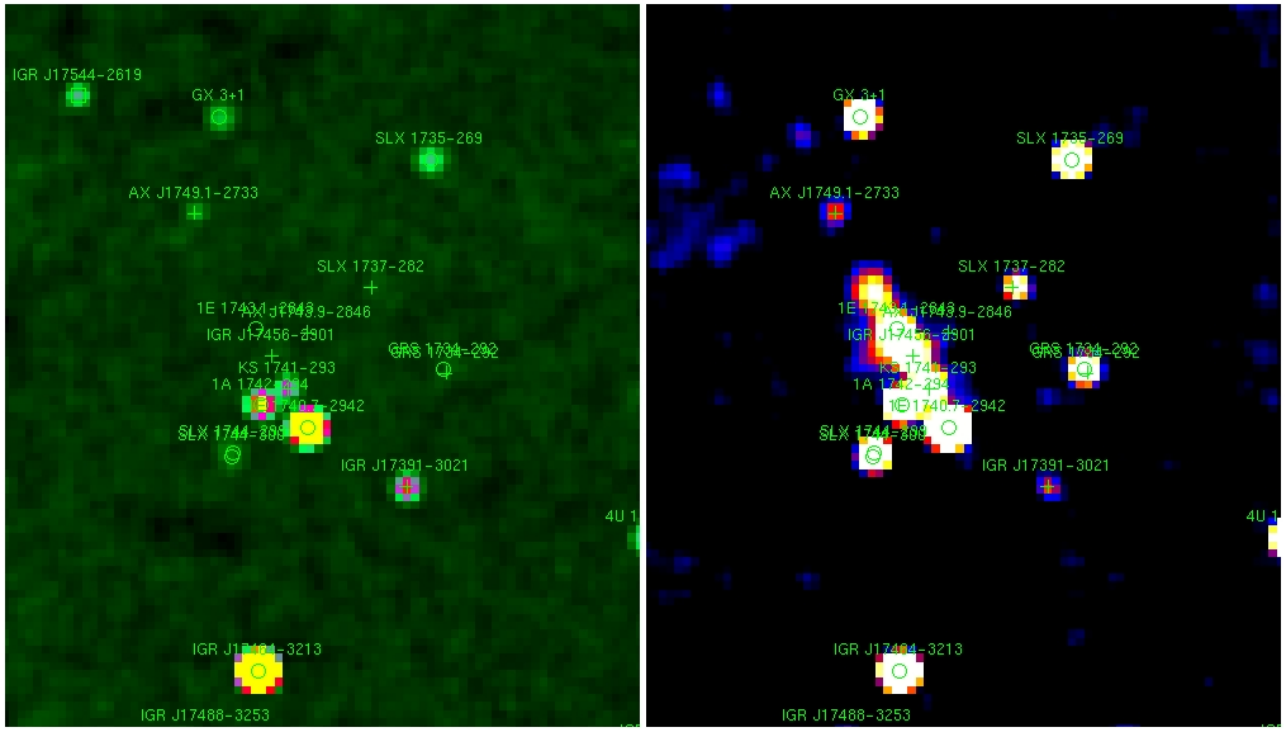
ftp://isdcarc.unige.ch/arc/rev_2/obs_jmx/0055.001/ssj2_005500480010/scw/005500480010.001/jmx2_sky_ima.fits.gz

ftp://isdcarc.unige.ch/arc/rev_2/obs_jmx/0055.001/ssj2_005500490010/scw/005500490010.001/jmx2_sky_ima.fits.gz

....

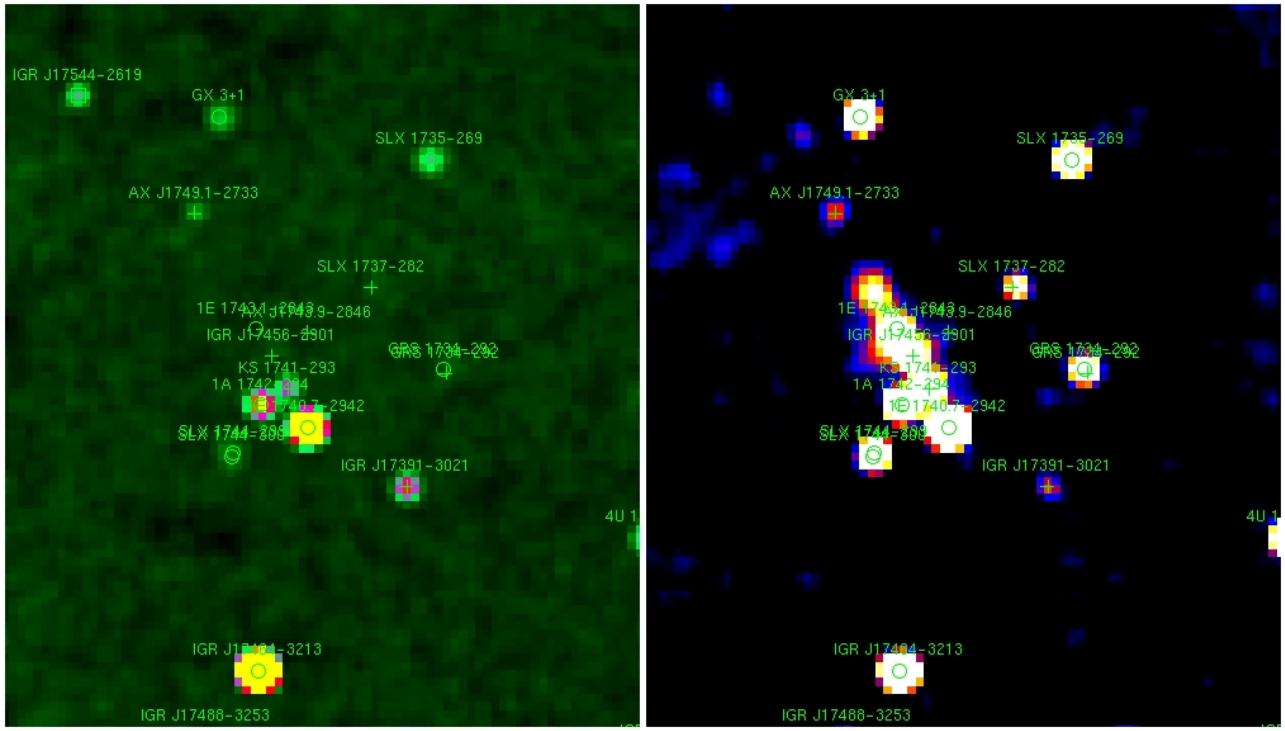
(In this example varmosaic will read images stored in the “revision 2” version of the INTEGRAL data archive. Only the resulting mosaic.fits file will be stored on your computer.)

6. Variability of the sources.



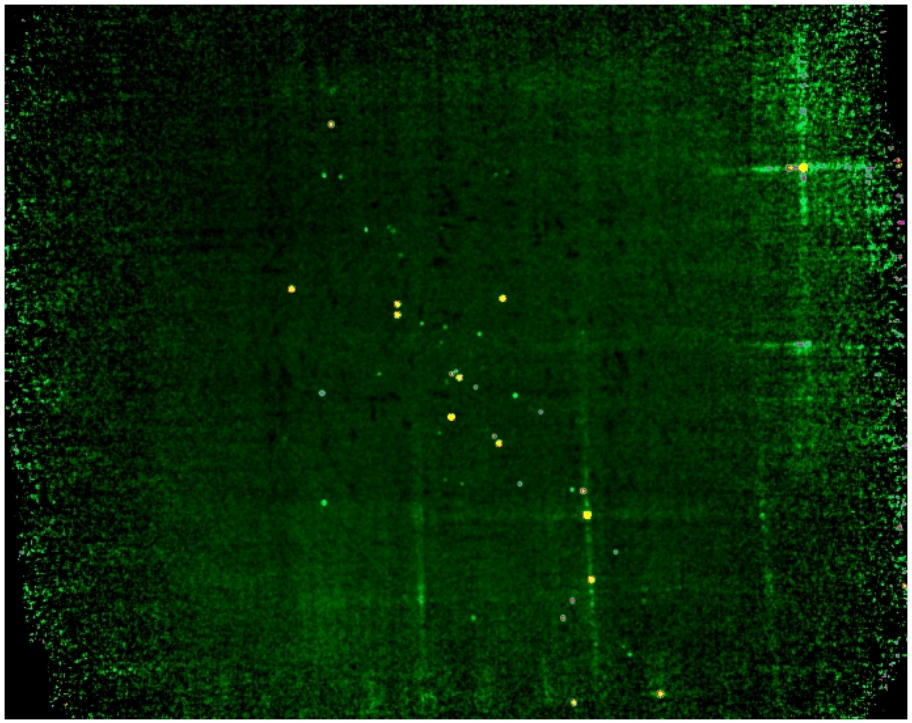
Is your source of interest variable, transient or steady? A “variability map” (left) could help: each pixel of the map is the χ^2 of the fit of the ScW- by- ScW lightcurve by a constant. Variable sources appear bright on the variability map.

6. Variability of the sources.



Note that the GC itself is not vairable in ISGRI. Note also that some bright sources almost do not show up in variability map, while a highly variable IGR J1744-2619 (left up) does not show up in the mosaic image.

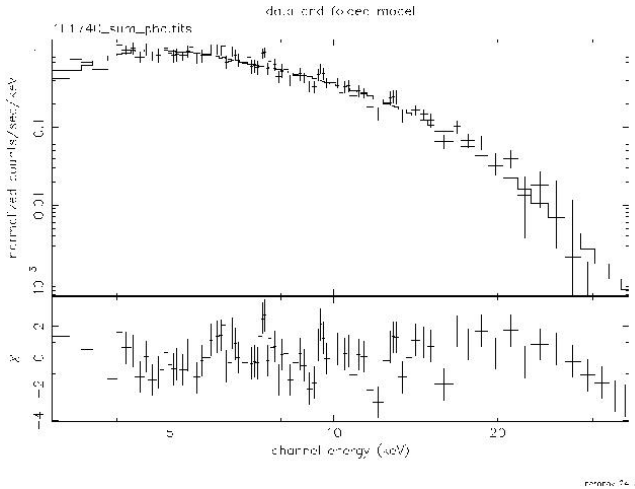
7. A note on ghosts in your images.

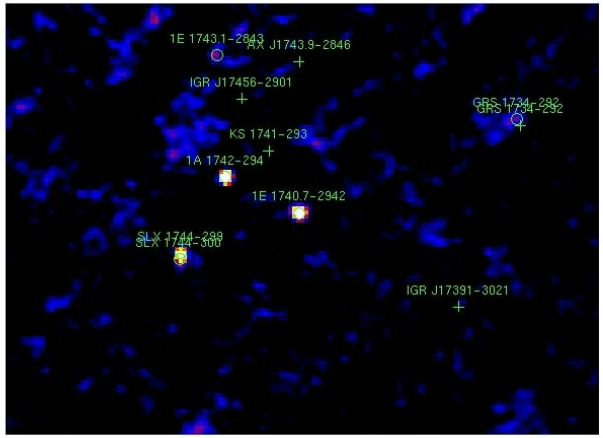


IBIS analysis software (almost) removes the ghosts ob the bright sources so that the presence of a bright source in the FoV should not affect the results for other sources (you do not see ghosts in the mosaic images). However, some “rests of the ghosts” remain present and you can see where they are located if you look at the variability image. The results for the sources on the “ghost lines” still can be affected to some extent by a bright source.

Next version of *varmosaic* will generate the variability map to provide a “quick- n- dirty” way to see your source behaviour. (try it during the hands- on session).

8. JEMX: spectra of bright sources in 3-35 keV band.

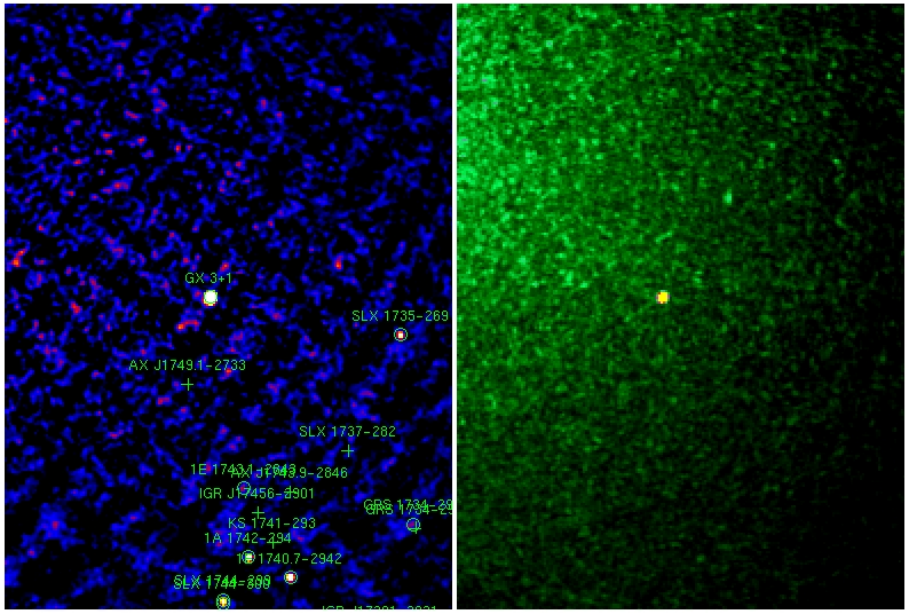




fcopy ”$ISDC_REF_CAT[NAME==’1E 1740.7-2942’]” 1E1740_cat.fits

jemx_science_analysis jemxNum=2 ogDOL=”og_jmx2.fits[1]” startLevel=”COR” endLevel=”SPE” nChanBins=2 chanLow=”46 129” chanHigh=”128 223” CAT_I_usrCat=”/unsaved_data/neronov/OSA5/1E1740_cat.fits”

8. JEMX: wide field X- ray instrument for monitoring bright sources.



The 1- 10 keV telescopes (Chandra, XMM) have very small FoV, which does not allow to “monitor” sources for long time. 5- degrees FoV of JEMX makes it useful for study of “bursting sources, like GX 3+1.

8. GX 3+1 – bursts with JEM- X.

2004ATel..327....1B - The Astronomer's Telegram, 327, 1 (2004)

Long duration X-ray burst from GX 3+1.

BRANDT S., LUND N., CHENEVEZ J., BUDTZ-JOERGENSEN C., GOLDONI P., BELANGER G., GOLDWURM A., KUULKERS E.

Abstract (from ADS): During an observation of the Galactic Center the JEM-X instrument on INTEGRAL detected an unusally long X-ray burst from GX 3+1. The burst began on August 31 at 18:57 UTC After an precursor spike lasting 7 s where the burst reached a flux of about 2000 mCrab in the 4 to 20 keV band the flux fell to around 500 mCrab and then decayed with an e-folding time of about 700 s. This burst appear as intermediate between the normal type-I X-ray bursts (e-folding times up to a few tens of seconds) and the very long "superbursts" (e-folding times of several hours).

```
fcopy "$ISDC_REF_CAT[NAME=='GX 3+1']" GX3+1_cat.fits
jemx_science_analysis jemxNum=2 ogDOL="og_jmx2.fits[1]" startLevel="COR" endLevel="IMA2" skipLevels="BKG"
CAT_I_usrCat="/unsaved_data/neronov/OSA5/GX3+1_cat.fits"
```