The Palermo Swift-BAT Hard X-ray Catalogue: Results after 66 months of sky survey.

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The Burst Alert Telescope (BAT: 14-150 keV) on board of Swift is providing the opportunity for a substantial gain of our knowledge of the Galactic and extragalactic sky in the hard X-ray domain, thanks to its continuous monitoring of the sky (50%-80%per day). Here we present the third Palermo Swift-BAT hard X-ray catalogue obtained from the analysis of the data relative to the first 66 months of the Swift mission and including about 1600 high-energy sources. With a program of soft X-ray follow-up observations and by using archival data we were able to associate a counterpart to most of these high energy emitters: 59% are extragalactic objects, 20% are Galactic objects and 9% are known soft X-ray emitters whose nature has not been determined yet. We compare our catalogue with those obtained from the INTEGRAL-ISGRI data and with the gamma-ray sky as seen by Fermi.

The software

BAT survey data were analyzed with a dedicated software (Segreto et al., A&A, 510, 47, 2009) that performs image reconstruction via cross-correlation method and generates source spectra and light curves.

The 66 months catalogue

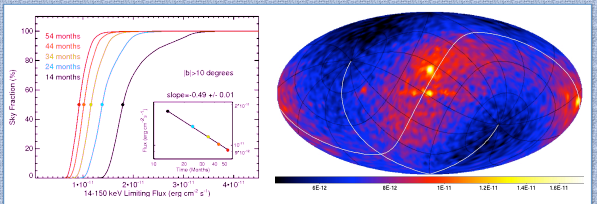
We have analyzed the survey data collected between November 2004 and May 2010 building significance all-sky maps in three energy bands (15-30 keV, 15-70 keV, and 15-150 keV). To optimize the detection of sources, we have proceeded in three steps.

1- All-sky significance maps. We have performed a blind search for significance peaks on each of the three maps, with a S/N threshold of 4.8 standard deviations.

2- Residuals significance maps. The crowding of bright sources (e.g. in the Galactic center) may hide the presence of close fainter sources. In order to make these fainter source emerge, we have subtracted from the all-sky significance maps all the sources detected in the previous step, and run the detection algorithm on this residual map.

3-Transient search. Some transient sources may be undetectable in the integrated all-sky map, where their average significance falls below the detection threshold. In order to make these sources emerge, we have built light curves for each sky pixel, at the angular resolution of 2.5 arcmin, with a time resolution of 15 days. We have thus built a "best significance" all-sky map, where we have assigned to each pixel the maximum significance value that can be obtained cumulating the signal of consecutive time bins. A detection algorithm is then run on this map.

The final catalogue of BAT sources contains **~1600** detections.



Left. Fraction of the sky covered by the survey as a function of the detection limiting flux for a detection threshold of 4.8 σ, for different integration times. The inset shows the limiting flux achieved for 50% of the sky as a function of time; the best fit is a power law consistent with $t^{-0.5}$. **Right**. The limiting flux map in galactic Aitoff projection with the ecliptic coordinates grid superimposed. The highest flux sensitivity is achieved near the ecliptic poles.

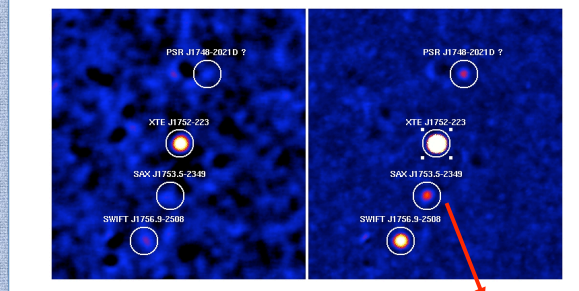
Identification strategy

In order to identify the detection excesses, we have applied two different strategies.

1- Search for bright sources in the Swift-XRT archival observations covering the sky position of the BAT excesses. A source detected inside a 6.3' error circle was associated with the BAT excess if its count rate was above 5e-3 c/s. A similar method was applied to field observations of Chandra, XMM-Newton, SAX, ASCA and Rosat.

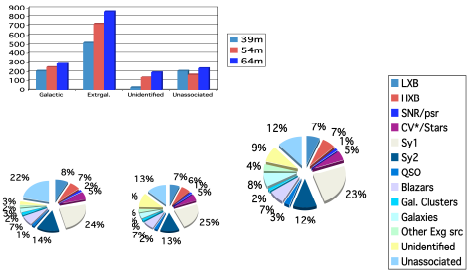
2- Cross-correlation of the remaining excesses with selected catalogues. To validate the association we require a distance between the catalogue source and the BAT excess lower than 4.2'.

The final catalogue contains **~1500** associated sources.



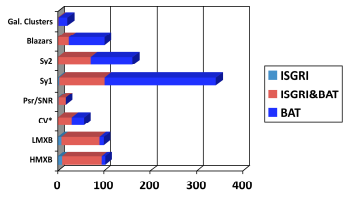
Transient search. A region of the Galactic plane as it appears in the all-sky significance map (left) and in the best significance map (right) where three new sources emerge.

Light curve of the transient source SAX J1753.5-2349. The pink line represents the average significance in the 66 months; the blue line is the maximum significance value that can be obtained cumulating the signal of consecutive time bin.



Left. Catalogue statistics and comparison with previous PBC catalogues

Right. Comparison with sources detected with ISGRI extracted from General Reference Catalogues V.31



Cross correlation with the Fermi catalogue

We compared our BAT catalogue with the Fermi Large Area Telescope First Source Catalogue (Abdo et al., ApJS, 188, 405, 2010) by searching for BAT sources whose position falls inside the error box of each Fermi source. We found **67 BAT/Fermi** correspondences (within the 95% error circle) to be associated with the same counterpart: 44 blazars, 4 Seyfert galaxies, 1 interacting galaxy, 3 high mass X-ray binaries, and 4 pulsars/supernova remnants. Moreover, there are 11 BAT/Fermi correspondences with different counterpart association. The map (Galactic coordinates) on the right shows the distribution of these sources in the sky.