
# The GLAST Large Area Telescope (LAT) approach to γ-ray source identification


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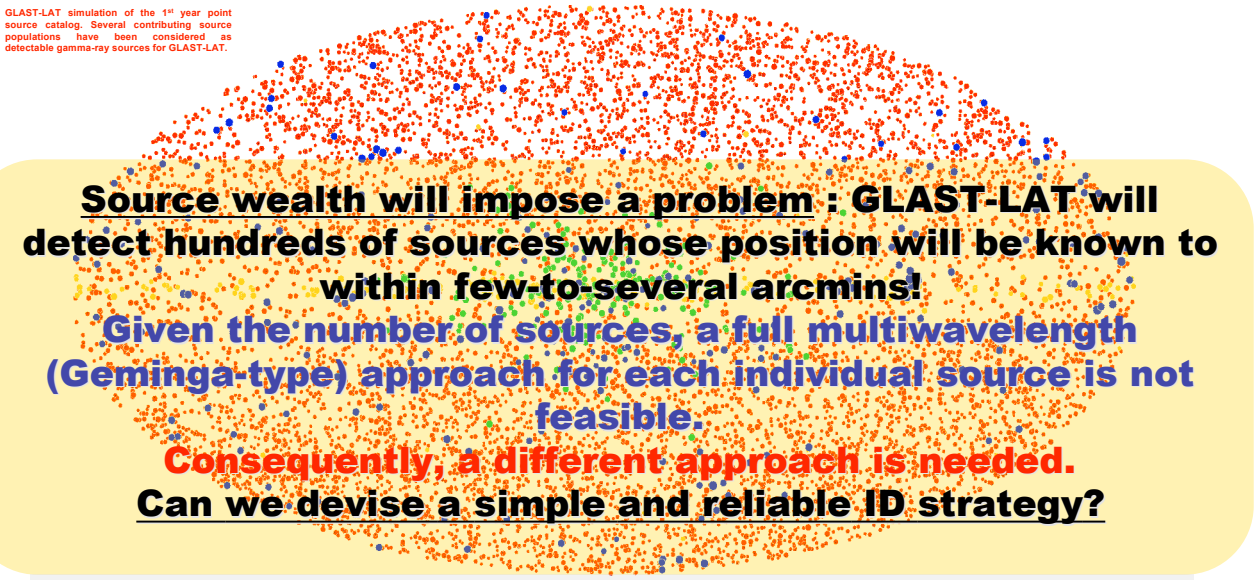
Abstract

Basic source parameters, such as position, positional accuracy, flux, spectral shape or hardness ratio, variability on various timescales, will be considered when individual gamma-ray sources are being cross-correlated for potential counterparts with objects in a numerous existing catalogues and deep multifrequency observations. Figure-of-merit estimates will be used to assess the likelihood of counterpart candidates. Positional coincidences and variability timescales will be the most decisive parameters in a figure-of-merit ranking. The LAT superior positional accuracy will substantially reduce the sources' error boxes, thus strengthening the positional coincidence criterion. However, additional pieces of information, possibly specifically related to any given potential source class, will also play a role. Chance occurrence probability as well as energetic plausibility of an individual association will further constraint the FoM estimate. Positional coincidence with a pulsar with a rotational energy loss too low to sustain the source flux should lead to an unacceptably low value of the overall FoM. A variable high-latitude source, whose position is compatible with a known AGN, will be labelled as a putative AGN, while a steady source in the galactic plane, whose position is compatible with a young, energetic pulsar, will be scrutinized for the characteristic pulsar timing signature as the definitive proof of identification or for source extension reminiscent of a high-energy plerion.

If the cross-correlation process does not yield a unique counterpart, or if the source has failed the acceptance tests devised for a given class of gamma-ray emitters, the source will be studied in-depth by the GLAST Unidentified Sources WG, who will be responsible for the organization and efficient interpretation of results from multiwavelength campaigns aimed at finding (or discriminating between) potential counterpart candidates. The anticipated searches will be conducted mainly in nearby regions of the electromagnetic spectrum, i.e. in the VHE and soft X-ray domains, characterized by more accurate source positioning, and complemented to the overall observational characteristics from radio through optical in order to compile the broadband Spectral Energy Distribution (SED).



GLAST-LAT simulation of the 1st year point source catalog. Several contributing source populations have been considered as detectable gamma-ray sources for GLAST-LAT.

**Source wealth will impose a problem : GLAST-LAT will detect hundreds of sources whose position will be known to within few-to-several arcmins!**

**Given the number of sources, a full multiwavelength (Geminga-type) approach for each individual source is not feasible.**

**Consequently, a different approach is needed.**

**Can we devise a simple and reliable ID strategy?**

## From detection → association → identification

## The LAT collaboration is developing a FoM (Figure of Merit) approach

## Identification is pursued with multidimensional searches

### Space dimension

**Positional coincidences**

Given the anticipated size of the GLAST error boxes, we expect chance coincidences to happen quite frequently when we x-correlate the GLAST detections' positions with existing catalogues. Thus, all positional coincidences should be closely scrutinized

**1st question: Is the counterpart a "certified" γ-ray source?**

**High Energy γ-ray sources**
Sun, Moon
Pulsars
AGNs, CenA, LMC
Molecular clouds

**VHE γ-ray sources**
Pulsars, PWNe, SNRs, Binary systems (Microquasars)
AGNs
Molecular clouds

**Possible γ-ray sources**
WR stars, OB associations, SNOBs, Black holes, Galaxy clusters, ULIRGs, Starburst Galaxies, further Local Group Galaxies

A "certified" γ-ray source will receive an higher grade, but this should not limit the discovery potential

**2nd question: What is the Chance Occurrence Probability?**

A COP must be assigned to each source class

Less abundant classes will fare better

**3rd question: Is the association energetically plausible?**
(e.g. a pulsar with an unfavorable combination of energetics and distance)
If not, the counterpart will not qualify

**4th question: Is the source behaving as expected on the basis of our knowledge of its class?**
If not, deep follow-up campaigns and theoretical modeling will clarify the viability of the counterpart
Introduction of ranking schemes within a source population

### Time dimension

Variability (or inherent lack thereof)
Periodicity (either previously known or "blind")

**Correlated variability remains the best ID tool BUT**
→Can be applied only to KNOWN sources
→NEEDs contemporary MWL data of good quality
(something we could not always rely upon)

### Anticipated Results

On the basis of this elementary approach we hope to be able to identify new source classes and to improve our FoM ranking technique during the first year of GLAST science operation.

The traditional multiwavelength approach will be the last resort to achieve and verify the correct identification of a newly detected gamma-ray source, but we hope to restrict ourselves to a limited number of sources.