J. Astrophys. Astr. (2011) **32,** 169–172

Fermi-LAT View of Bright Flaring Gamma-Ray Blazars

D. Bastieri[1,2,*], S. Ciprini[3,4,5] & D. Gasparrini[6]
(on behalf of the Fermi LAT Collaboration[†])

[1]*Dipartimento di Fisica 'G. Galilei', Università di Padova 35131 Padova, Italy.*
[2]*I.N.F.N. Sezione di Padova 35131 Padova, Italy.*
[3]*Dipartimento di Fisica, Università di Perugia 06100 Perugia, Italy.*
[4]*Agenzia Spaziale Italiana & Istituto Nazionale di Astrofisica, Rome, Italy.*
[5]*Tuorla Obs., Department of Physics and Astronomy, University of Turku, 21500 Piikkiö, Finland.*
[6]*ASI Science Data Center, 00044 Frascati, Rome, Italy.*
[*]*e-mail: denis.bastieri@unipd.it*

Abstract. The Fermi LAT provides a continuous and uniform monitoring of the Universe in the gamma-ray band. During the first year many gamma-ray blazar flares, some unidentified transients and emission by the Sun while in a quiet state were promptly detected. This is mainly due to the design of the mission, featuring a detector, the LAT with a wide field of view, and to the operation of the spacecraft itself, that can cover every region of the sky every 3 hours. Nevertheless, the scientific exploitation of this monitoring is more fruitful when early information about transients reaches a broader community. In this respect, the indefatigable activity of flare advocates, who worked on weekly shifts to validate the results and quickly broadcast information about flares and new detections, was the key to most scientific results.

Key words. Gamma-ray sources—active galaxies—transients.

1. Introduction

The Gamma-ray Large Area Space Telescope (GLAST) was launched on June 11, 2008, into a circular orbit at an altitude of ∼550 km, revolving around the Earth every ∼90 minutes. Two different detectors are on board: the Gamma-ray Burst Monitor (GBM), sensitive at lower energies (8 keV–40 MeV), and the Large Area Telescope (LAT), sensitive at higher energies (20 MeV–>300 GeV).

After an initial 60-day long commissioning period to check out the spacecraft and flight instruments, GLAST was renamed 'Fermi' and began officially taking science data on August 4, 2008 (Atwood *et al.* 2009).

Typically, the Fermi satellite is rocked first towards the north pole of the orbit and then, in the next orbit, toward south, alternating in this way the pointing in every

[†]See http://fermi.gsfc.nasa.gov/ or http://fgst.slac.stanford.edu/

orbit. This main operating mode, called 'All-sky scanning mode', allows for full sky coverage every two orbits, or 3 hours.

2. The flare advocate service

The Flare Advocate/Gamma-ray Sky Watcher (FA/GSW) activity is part of the Fermi LAT science operations aiming at supplying a prompt, human-in-the-loop, outlook service to the quick-look Automatic Science Processing (ASP) products (see for example, Fig. 1) and, in general, to the Fermi gamma-ray sky and all the detected sources on a daily basis (see also section 2.6.3 in Atwood *et al.* 2009).

The high energy sky is often variable and new transients are detected almost daily. Fermi LAT, while the satellite is orbiting in scanning mode, guarantees a uniform coverage of the sky, being the ideal monitor to detect high energy flares. Flare advocates, nevertheless, have to guarantee in their turn that their task is performed with continuity and they do so all year round with weekly stints.

FA/GSW activity, beside validating the ASP output, is requested to check if anything in the sky is of potential interest for the different LAT science groups. The results of this activity could thus become seeds of new discoveries or start new follow-up multiwavelength campaigns.

The activity is broadcast also to a wider community, in addition to the Fermi Collaboration working groups, by means of the LAT multiwavelength mailing list,[1] the issuing of Astronomer's Telegrams (ATels)[2] and the Fermi (weekly) sky blog,[3] in order to promote or increase the occurrence of multifrequency observations or collaborations and, more generally, to maximize the scientific return.

The role and activity of the FA/GSW is two-fold:

GSW-side: The ASP software takes care of applying a source detection algorithm to find all point sources in the data from each epoch (6-hour and daily) in such a way to detect transients. For each source that underwent a transient and for all *publicly monitored* sources [4] results are quickly inspected and validated. Each *cluster* of photons (see Fig. 1) is then associated with a known source; in the event that there is no plausible association, and the photons are unlikely to cluster there just for a statistic fluctuation, a further investigation for a possible association will follow (wider catalogues, *ad hoc* multiwavelength campaigns, . . .).

FA-side: This is a role quite similar to the LAT gamma-ray-burst-advocate. For each source detected in the previous step, the FA will then fit with a power-law the energies of all photons falling inside a solid angle, of a proper opening, centered on the putative source. The fit spans the energy interval 100 MeV–300 GeV: sources with an integrated flux in excess of 10^{-6} photons cm^{-2} s^{-1} deserve special attention. This activity is addressed to release internal fast notes, ATels or Target of

[1] More information at https://confluence.slac.stanford.edu/display/GLAMCOG/

[2] See http://www-glast.stanford.edu/cgi-bin/pub_rapid

[3] See http://fermisky.blogspot.com/

[4] List available at http://fermi.gsfc.nasa.gov/ssc/data/policy/LAT_Monitored_Sources.html. The list contains 22 AGNs, the HMXB LS I +61 303 and other sources that, at least for some time, had a flux of at least 10^{-6} photons cm^{-2} s^{-1}.

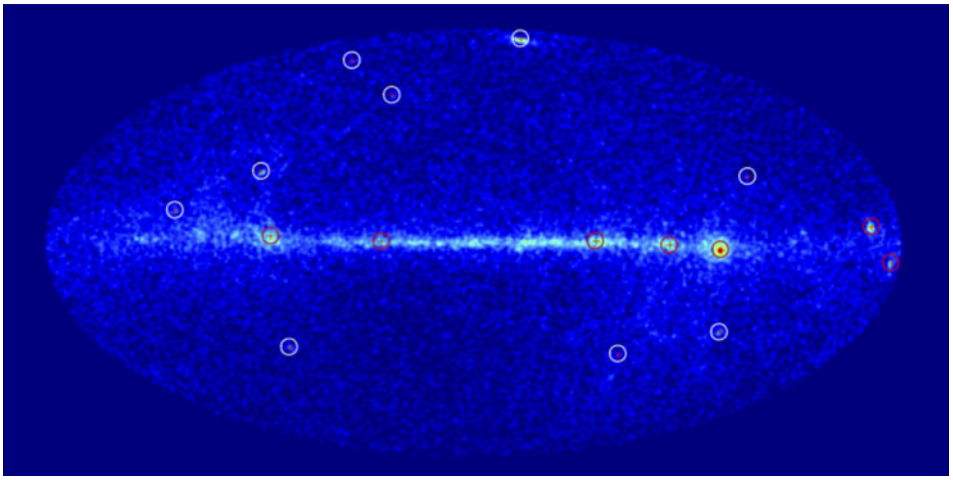

Figure 1. Typical output of the Automatic Science Processing (ASP) showing a first, rough identification of the directions where gamma-rays are clustering.

Opportunity (ToO) triggers for multifrequency observations; to start possible ToO multifrequency campaigns, or be the seed of LAT multifrequency papers and papers on single sources. Most typically, the flare advocate on duty that had a chance of discovering a new source or detect a new flare also becomes the *friend of the source*,[5] the LAT member to be contacted by anybody wishing to start multifrequency campaigns involving that source or simply requiring more insight about it.

3. Main results

Source monitoring activity has been and is still quite successful: even while in the commissioning phase, the LAT detected PKS 1502+106 (Abdo *et al.* 2010a), a well-known Flat Spectrum Radio Quasar (FSRQ) not present in the third or in the revised EGRET catalogue. The blazar could only be discovered so soon because of the flaring activity detected by the ASP tools and later recognized by the flare advocate on duty (see Fig. 2). In addition, the flare was quite interesting *per se*, as it was also quite rapid (just 2 days in the maximum flux state).

Many new interesting discoveries were also the outcome of fruitful monitoring campaigns: to mention just the most successful, the discovery of GT 0106+613 (see Vandenbroucke *et al.* 2010), a blazar shining through the galactic plane, and the detection of a nova explosion in V407 Cygni (Abdo *et al.* 2010b).

Overall, the LAT monitoring activities led to the publication of about 120 ATels, the request of more than a dozen ToOs mainly addressed to *Swift* or radio-optical facilities and the start of many successful multifrequency campaigns.

[5]The updated list of LAT friends of the source is available at: https://confluence.slac.stanford.edu/display/GLAMCOG/Contact+Information+for+Individual+Sources

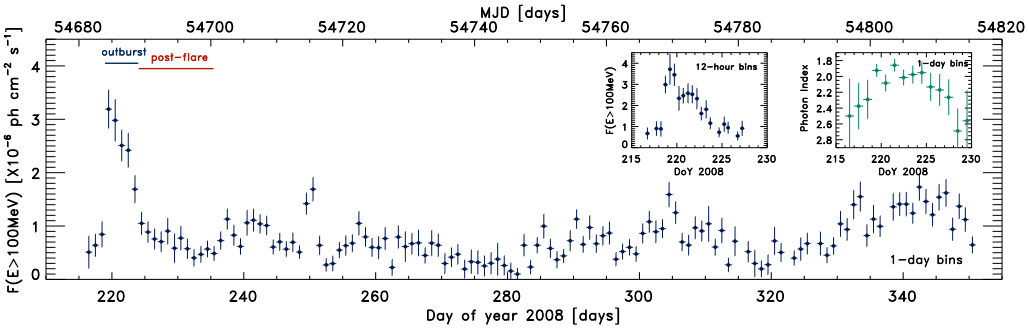

Figure 2. Light curve in daily bins from August 2 to December 15, 2008, of PKS 1502+106 (Abdo *et al.* 2010b). The LAT ended its commissioning phase on August 4 (day of year 216).

4. Conclusions

A wide instrumental field of view, a scanning mode operation and relentless source monitoring activities are all indispensable ingredients of a successful campaign aimed at targeting flaring sources from the earliest onset. The monitor activity run by flare advocates represents the liaison between LAT Collaboration and the external scientific community and is frequently the starting point of multifrequency campaigns and breakthrough articles in the field.

Acknowledgements

The Fermi LAT Collaboration acknowledges support from a number of agencies and institutes for both development and the operation of the LAT as well as scientific data analysis. These include NASA and DOE in the United States, CEA/Irfu and IN2P3/CNRS in France, ASI and INFN in Italy, MEXT, KEK and JAXA in Japan, and the K. A. Wallenberg Foundation, the Swedish Research Council and the National Space Board in Sweden. Additional support from INAF in Italy and CNES in France for science analysis during the operation phase is also gratefully acknowledged.

References

Abdo, A. A. *et al*. 2010a, *Astrophys. J.*, **710**, 810.
Abdo, A. A. *et al*. 2010b, *Science*, **329**, 817.
Atwood, W. B. *et al*. 2009, *Astrophys. J.*, **697**, 1071.
Vandenbroucke, J. *et al*. 2010, *Astrophys. J.*, **718**, L166.