



# Four Years of *Fermi* LAT Flare Advocate Activity

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(on behalf of the *Fermi* LAT collaboration; on behalf of the *Fermi* LAT Flare Advocates)

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## Abstract

The Flare Advocate/Gamma-ray Sky Watcher (FA-GSW) program, belonging to the *Fermi* LAT Science Instrument Operations, provides for a prompt review of the gamma-ray sky seen day by day by *Fermi* LAT and for a quick-look analysis of the Automatic Science Processing (ASP) products.

The FA-GSW service offers alerts of potentially interesting seeds for LAT science groups, looking at flares, transients, brightness trends and possible new gamma-ray sources, in addition to communications to the external astrophysical community.

This service increases the rate of multi-frequency observations and follow-ups that can maximize science return. For example during the first about 4 years of the *Fermi* mission, FA-GSWs discovered many gamma-ray flares from blazars, short and long duty cycles, unidentified transients near and off the Galactic plane, flares from Galactic sources (like the Crab Nebula), observed the gamma-ray emission of the quiet and flaring sun (M- and X-class flares), compiled about 210 Astronomical Telegrams, pointed out new gamma-ray source candidates, and led some follow-up multi-frequency campaigns.



## *Fermi*/LAT Flare Advocate Service

*Fermi* LAT is an all-sky survey monitor and the high-energy sky is often variable and transient, therefore the FA-GSW activity is performed with continuity all the year through weekly shifts. About 70 shifters served as least one time as FA-GSW or deputy FA with weekly shifts.

The FA-GSW points out something potentially interesting and first seeds to the different LAT science groups. Basic summaries about the gamma-ray sky on six and twenty-four hour intervals are communicated along with any relevant news to the external astrophysical community (through the LAT-MW mailing-list, Astronomical Telegrams and the *Fermi* Sky Blog, see Fig.1). This allows us to promote and increase the rate of multi-frequency collaborations and observations.

The role and activity of the FA-GSW is therefore twofold.

### Gamma-ray Flare Advocate (FA) task

This is a role similar to the LAT burst-advocate (for GRBs). Sources exceeding  $10^{-6}$  photons/cm<sup>2</sup>/s (at  $E > 100$  MeV) are always deserving attention. This activity is addressed to release internal fast notes, ATels, ToO triggers for multi-frequency observations, and to start possible ToO multi-frequency campaigns, LAT multi-frequency papers, and on single sources in general (with the possibility to be also a contact person for a LAT source).

### Gamma-ray Sky Watcher (GSW) task

All the daily and 6h ASP results are quickly inspected, looking at the detected LAT sources in the sky (Galactic and extragalactic source candidates), searching for flares and brightness trends, and for possible new candidate gamma-ray sources.

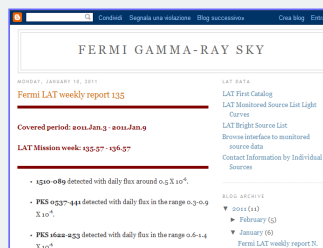


Figure 1: the *Fermi* Gamma-ray Sky Blog, containing basic weekly summaries about the LAT sources detected on short timescales (1-day and 6-hour intervals) during the week, and compiled by the LAT Flare Advocates Gamma-ray Sky Watchers (FA-GSW).

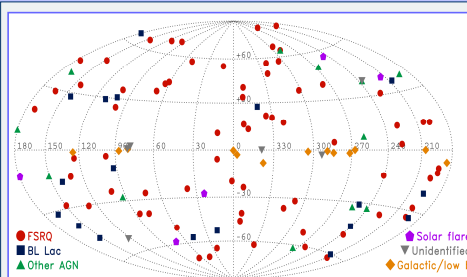


Figure 2: Outline of the all-sky map distribution, in Galactic coordinates, of the new gamma-ray sources, flares and transients found by *Fermi* LAT and announced through Astronomer's Telegrams (ATels). These flaring, transient, or new gamma-ray sources are represented with different symbols for different class (preliminary). Most of the sources reported here follow the FA-GSW service.

Different class of sources are discovered by FA-GSWs to be in high flaring state, or to pop up in the sky as new candidate gamma-ray sources not previously listed in *Fermi* LAT Catalogs. Among these, the LAT sources that were subject of ATels are represented in Fig. 2, based on a preliminary coordinate localization estimate and based on a preliminary source counterpart spatial association.

For particularly interesting or possible new gamma-ray sources a likelihood check of detection, flux and spectral index is performed joined with the inspection of count maps, exposure maps and localization. A short daily internal report is compiled day by day and a monthly internal summary is issued in the LAT Collaboration. The *Fermi* sky blog (Fig. 1) is updated with the public weekly summary. Finally software or other technical issues are also reported during the FA shift.

## Some results

FA-GSWs discovered many new gamma-ray blazars and flares and big outbursts from flat spectrum radio quasars, BL Lacertae objects, other type of AGN, gravitationally lensed quasars. Some galactic plane transients, quiet-sun and flaring-sun emission, peculiar and new findings like gamma-ray flares from the Crab Nebula and the Novae stars (see Fig. 3) were discovered thanks also to the FA-GSW service. Transients and flares still un-associated or not clearly associated to known sources were also found. Many ToO following-up LAT flares were submitted to *Swift*, allowing a productive scientific synergy between the *Fermi* and *Swift* mission.

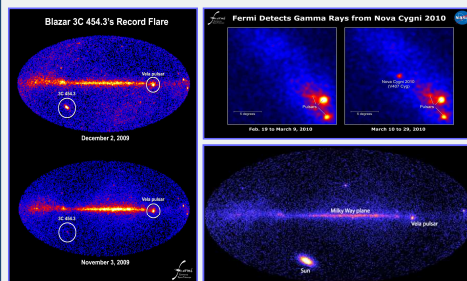


Figure 3: The record gamma-ray flare of the flat spectrum radio quasar 3C 454.3 (Ackermann et al. 2010), the surprising gamma-ray flare from the Galactic nova V407 Cyg and the X5.4-class solar flare of 2012, March 7 discovered by *Fermi* LAT and reported in public news. The on duty FA-GSW shifters were among the first that observed these new events in the *Fermi* LAT sky.

The rate and type of the 203 *Fermi* LAT ATels published till August 2012, are illustrated in Fig.4 and Fig. 5. More exactly such plots refer to the *Fermi* LAT ATels issued from 2008, July 24<sup>th</sup> (ATel #1628) to 2012, August 28<sup>th</sup> (ATel #4333) i.e. in the interval MJD 54671-56167 corresponding to about 4 years. It is important to remark that the rate of LAT ATels continues to increase steadily, showing that the gamma-ray sky continues to show interesting new features.

The FA-GSW activity is inherently also a multi-frequency and preliminary quick-look research, starting from the spatial association of 6h/daily-detected sources, using multifrequency tools and databases (e.g. GSFC-FSSC, ASDC, NED, CDS databases) for a guess-association, until the organization of a dedicated multifrequency observing campaign. The FA-GSW service is helping us in getting the best science from *Fermi* LAT representing also a benefit for international cooperation, completing the wide-field of view and high sensitivity, all-sky survey of *Fermi* LAT.

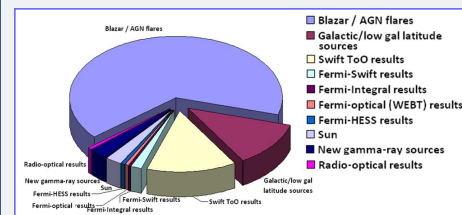


Figure 4: The 203 ATels published on behalf of the *Fermi* LAT Collaboration from 2008, July 24<sup>th</sup>, to 2012, August 28<sup>th</sup>, grouped by topic.

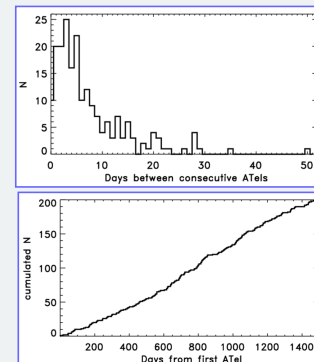


Figure 5: some statistics about the *Fermi* LAT Astronomical Telegrams (ATels) published till 2012, August 28<sup>th</sup>.

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