Fast and Super-Fast Analysis of AGILE Gamma-Ray Transients

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In this poster we focus on the scientific operations of the Gamma-Ray Imaging Detector (GRID) on board the AGILE space mission. This work presents the AGILE innovative approach to fast γ-ray transient detection, which is a challenging task and a crucial part of the AGILE scientific program. The goals are to describe (1) the AGILE Gamma-Ray Alert System, (2) a new algorithm for blind search identification of transients within a short processing time, (3) the AGILE procedure for γ-ray transient alert management, and (4) the likelihood of ratio tests that are necessary to evaluate the post-trial statistical significance of the results. Special algorithms and an optimized sequence of tasks are necessary to reach our goal. The system is capable of generating alerts within two to three hours of a data downlink, an unprecedented reaction time in γ-ray astrophysics.

The most relevant results
1. The first detection of transient γ-ray emission from Cygnus X-3 in the energy range of 100 MeV–50 GeV (Tavani et al. 2008b), which was confirmed by the Fermi/LAT collaboration (Abdo et al. 2009b) and reported in Tavani et al. (2009b), Bulgarelli et al. (2012b), and Piano et al. (2012).
2. The discovery of γ-ray flares from the Crab Nebula in 2010 September (Tavani et al. 2010) (confirmed by Fermi-LAT within 1 day; see Buehler et al. 2010). The first detection of a Crab Nebula flare was made in 2007 September by the ISASFO SAS pipeline.
3. The first ATel that alerted the astrophysical community of the extraordinary activity of the blazar 3C444.0 in 2010 December, which was in addition to the detection, early in the mission (2007) and at a later stage (2009 and 2010), of very bright gamma-ray emission (Vercellone et al. 2010, 2011).
4. The detection of many gamma-ray flares from blazars.

Conclusion
In this paper we described the main features of the fast γ-ray data processing of the AGILE mission. In particular, we focused on the "spotfinder" algorithm, the optimization of software tools, the data link from the satellite to data processing centers, the orbit-by-orbit data analysis, and the statistical characterization of the data analysis system. An important part of the data processing is the extensive use of mobile technologies coupled with the simultaneous implementation of two independent pipelines of the AGILE Alert System. Identifying unexpected transient astrophysical events within a very short time is of crucial importance for high-energy astrophysics. The AGILE Alert System has demonstrated to be quite successful in source detection and rapid alert capability. The AGILE mission and the scientific community have certainly benefited from its implementation, which maximizes the scientific return of γ-ray observations.