Summer activity at Stanford University 23.8.2018 – 30.9.2018

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The summer activity at Stanford University aimed to characterize and upgrade the performance of the LAT for the search of the electromagnetic counterparts of future events of gravitational waves, triggered by Ligo/Virgo.

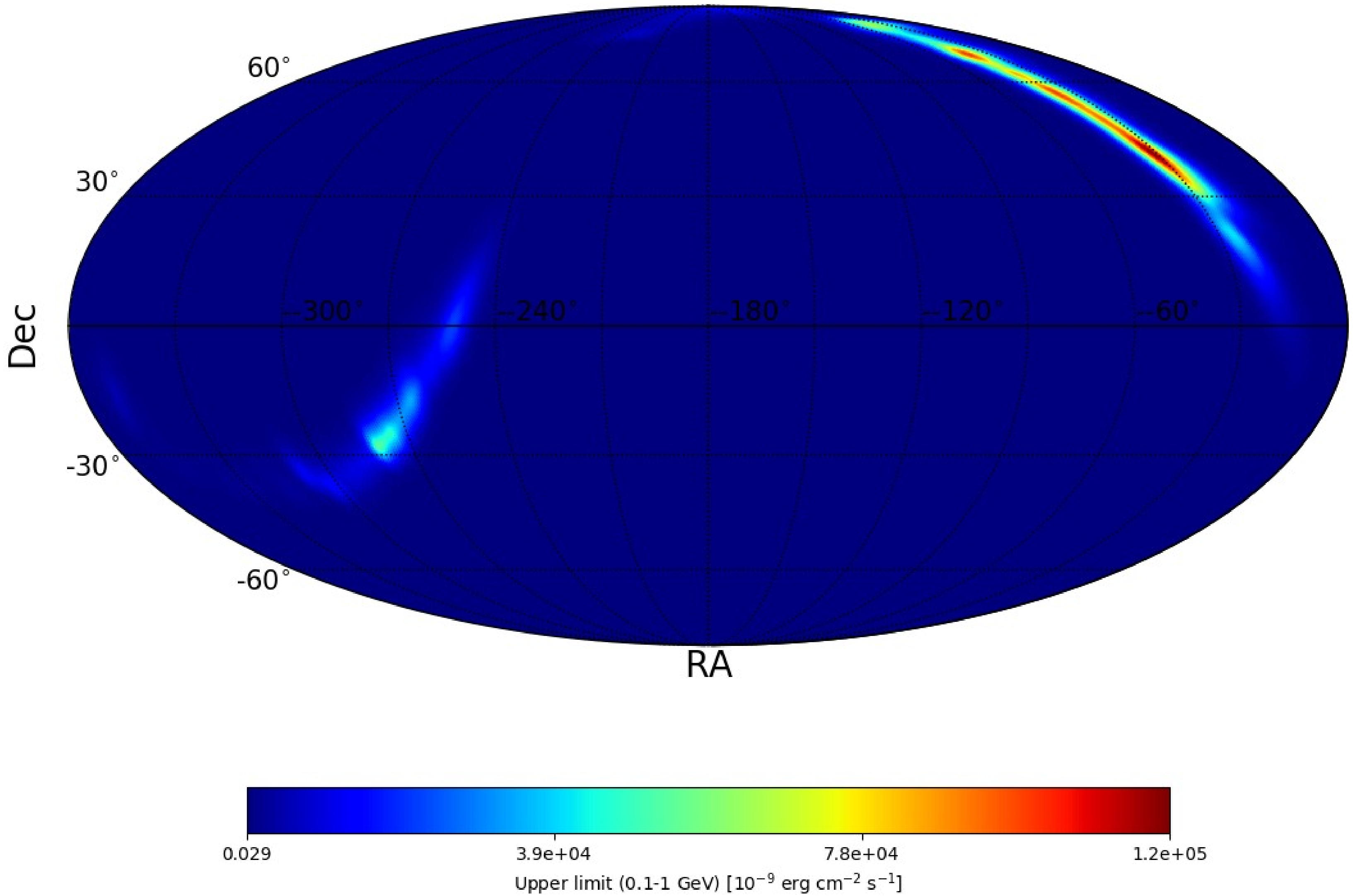
The activity followed two different directions:

1. Giacomo and Rupal studied how likely is the LAT to reveal a GRB due to only statistical fluctuations of the electromagnetic flux revealed (Type 1 error)

2. Nicola and Lorenzo studied how likely is the LAT to reject a GRB signal in presence of a real detection (Type 2 error)

The second direction will be described in the next slides.

We selected an event from Ligo catalog, bnG299232



We simulated LAT data corresponding to the region of the event (ROI).

The ROI was divided into a grid of points: in each point is simulated a GRB source. We want to find, for each point of the ROI, what is the value of the detected flux so that 50% of the TS is above 25.

The grid is made of 44 points: in each of them we simulated a GRB source with a given flux (total of 20 values) and a given seed (total of 20 values).

Flux = (1.e-10 ÷ 1.e-7) erg/cm2/s

Seed = determines a random number sequence that describes one of the possible realizations of the data. Many realizations are possible, given the hypothesized model of the sky and the best understanding of the detector response.

The seed determines how many photons arrives at the LAT, given a flux and an effective area.

For a low number of photons, the Poissonian statistical fluctuations are significative: so we average the realizations over a number of seeds.

We simulated a GRB source with:

DURATION = 1.e+4 seconds

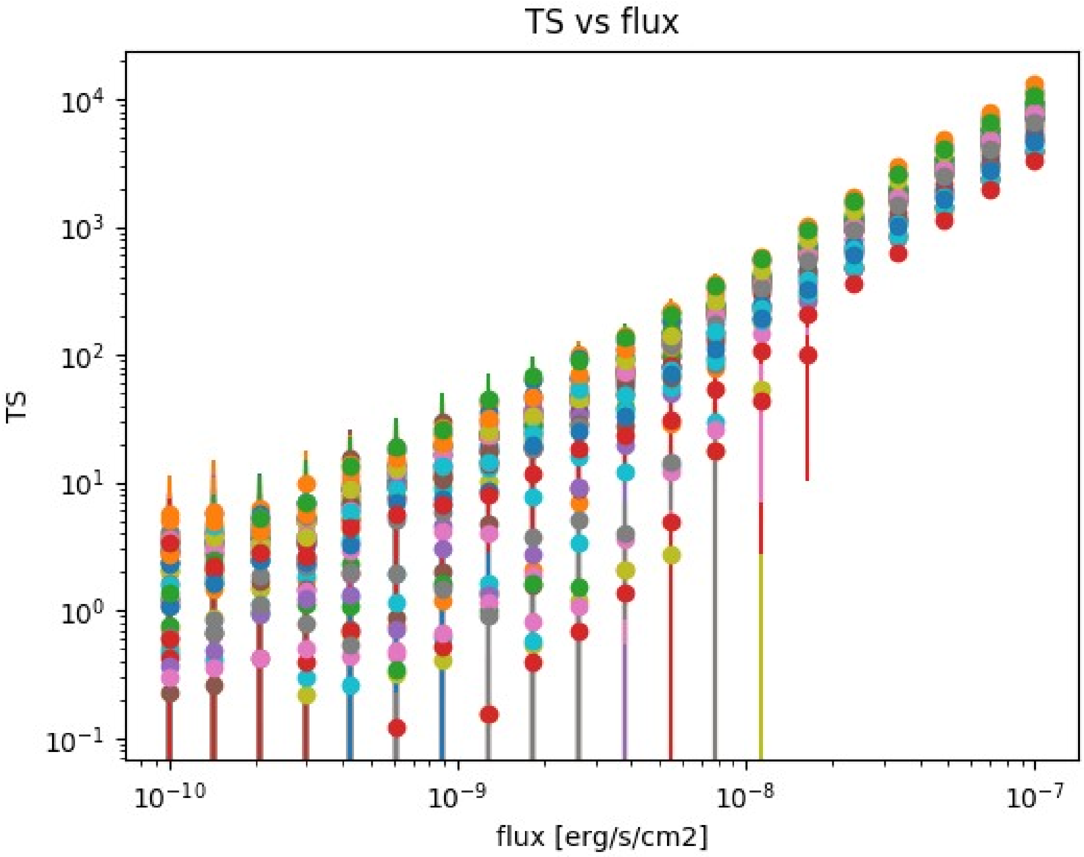
Power law INDEX = -2.0

Energy = 100 MeV ÷ 100 GeV

IRF = P8R2_SOURCE_V6

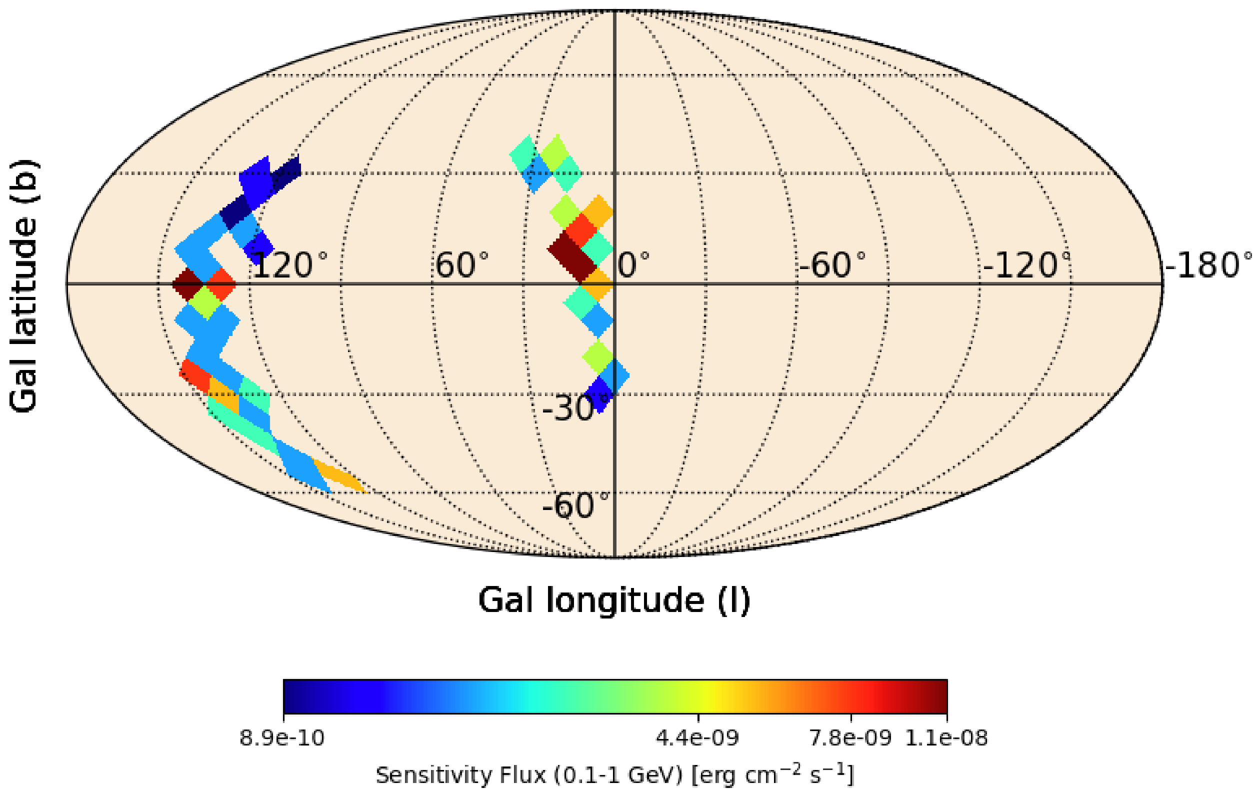
It was runned a Fixed Time Interval Likelihood Analysis for each point of the grid.

As result we had a TS value, each for a different combination of Flux and Seed. Averaging the TS over the Seeds we had TS – Flux correspondence for each point of the ROI.



Here is shown the TS vs Flux dependence for each point of the ROI.

In particular can be shown the map of flux values in Galactic Coordinate. The flux values are such that 50% of the TS values are above of 25.



It can be noted that the fluxes shown increase towards the galactic disk and the galactic centre. We can expect it since the background is greater on the galactic plane.

Appendix : Photon flux - Power Law

$$conv = \frac{1.0 + index}{2.0 + index} \cdot \frac{E_{max}^{index+2.0} - E_{min}^{index+2}}{E_{max}^{index+1.0} - E_{min}^{index+1.0}}$$ if index ≠ - 2.0

$$conv = \frac{E_{min} \cdot E_{max}}{E_{max} - E_{min}} \cdot \ln\left(\frac{E_{max}}{E_{min}}\right)$$ if index = -2.0

$$photon\,flux = \frac{energy\,flux}{conv} [erg/s/cm^2]$$

with energy flux = (1.e-10 ÷ 1.e-7) erg/s/cm2