# Prospects for detecting Gamma-Ray Bursts with the Cherenkov Telescope Array

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**ABSTRACT**

The Large Area Telescope (LAT) on the Fermi gamma-ray satellite telescope observes Gamma-Ray Bursts (GRBs) at energies above 100 MeV. Thanks to a new detection algorithm and a new event reconstruction, it is expected to publish a catalogue with more than 100 GRBs. This work aims at revising the prospects for GRB alerts with the Cherenkov Telescope Array (CTA) based on the new LAT results. We start by considering the simulation of the observations with the full CTA of two extremely bright events, the long GRB 130427A and the short GRB 090510; then we investigate how these GRBs would be observed by different subsamples of the array pointing to different directions, adopting the "coupled divergent" mode.

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## 1. CTA configurations

**In its present design, CTA will consist of two arrays for a total of more than 100 telescopes, one in the Southern (Paranal, Chile) and one in the Northern (La Palma, Spain) hemisphere, including:**

**Large Size Telescopes (LSTs)**

- **E = 20–200 GeV, N = 4 (North & South), D = 23 m**
- **Compact placement**

**Medium Size Telescopes (MSTs)**

- **E = 100 GeV–10 TeV, N = 15 (North), N = 25 (South), D = 12 m**
- **A ~ 3 km$^2$**

**Small Size Telescopes (SSTs)**

- **E = 5–300 TeV, N = 70 (only South), D = 4 m**
- **A= 6–7 km$^2$**

## 2. High-energy GRB observations

**GRB sample:**

**a) Second Fermi-Gamma Ray Burst Monitor (GBM) GRB catalog [1]:**
**~1000 GRBs, 4 yr, E = 8 keV–40 MeV**

**b) First Fermi-LAT GRB catalog [2]:**
**~35 GRBs, 3 yr, E = 30 MeV–300 GeV**

**c) Second Fermi-LAT GRB catalog [3]:**
**~100 GRBs, 6 yr, E = 30 MeV–300 GeV**

**Aims:**

- **Focus on Fermi-like GRBs with redshift (both prompt and late-time emission)**
- **Creation of a library of GRBs observed at different post-trigger epochs**
- **Extrapolation of the LAT flux to higher energies, taking into account its temporal evolution**

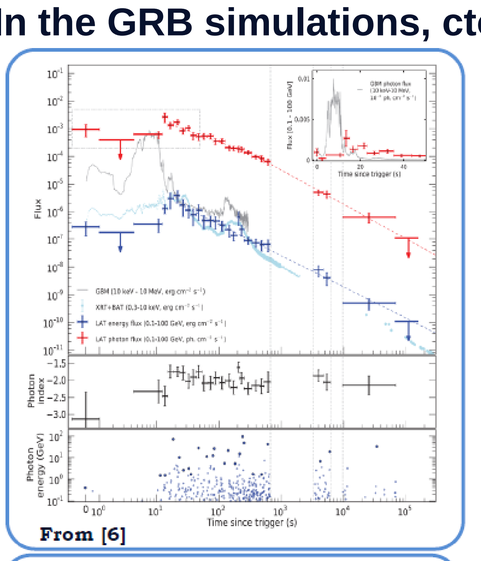
➡ **Test cases: two very bright GRBs with redshift (one long and one short)**

## 3. Effect of the EBL

**GRBs, with their cosmological distances, may be useful to add stronger constraints on the Extragalactic Background Light (EBL) and to give new hints on the existence of Axion-Like Particles. Therefore, the effect of the EBL absorption [4] was included in the simulations of GRB 130427A.**

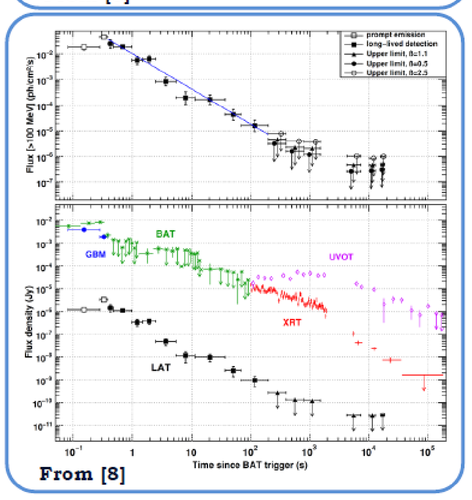
## 4. Simulations of GRB observations with ctools

**In the GRB simulations, ctools v0.9.0 [5] was used:**




**From [6]**

**Test case 1: GRB 130427A**
**Long, extremely fluent, z = 0.34,**
**with spectral and temporal indices [6]:**
**$\gamma$ = -2.2**
**$\tau$ = -1.35**
**ctools input:**
**E = 50–100 GeV**
**On axis observation, zenith angle $\theta$ = 20°**
**Instrument Response Functions (IRFs):**
**North_0.5h and North_5h [7]**




**From [8]**

**Test case 2: GRB 090510**
**Short, bright, z = 0.9,**
**with spectral and temporal indices [8, 9]:**
**$\gamma$ = -1.6 (t $\leq$ 200 s); $\gamma$ = -2.5 (t > 200 s)**
**$\tau$ = -1.38**
**ctools input:**
**E = 50–100 GeV (no EBL yet)**
**On axis observation, $\theta$ = 20°**
**IRFs = North_0.5h and North_5h [7]**

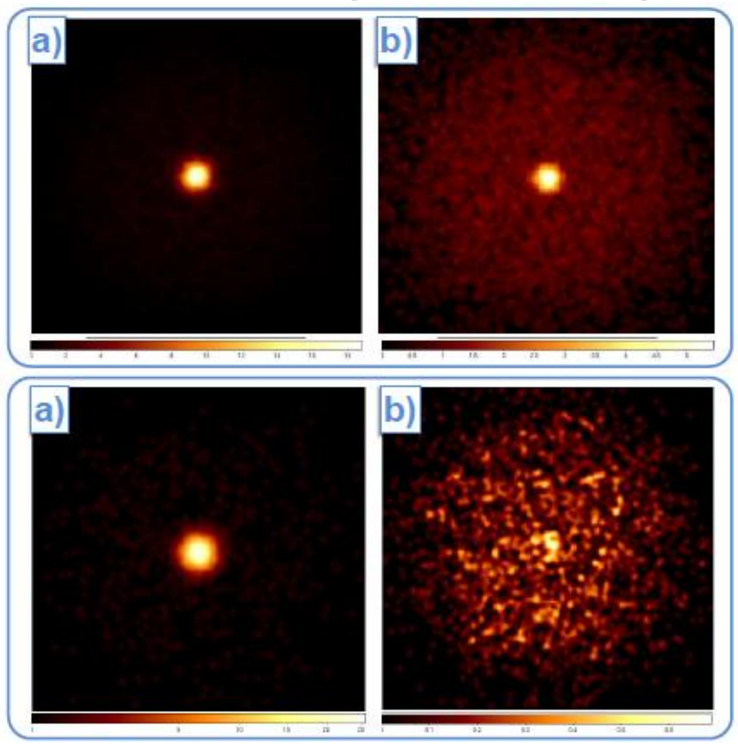
**Results → count maps at different epochs**

**GRB 130427A**

**a) 10 min of observations from t = 1 ks after the trigger**
**b) 1 hr of observations from t = 10 ks after the trigger**

**GRB 090510**

**a) 100 s of observations from t = 100 s after the trigger**
**b) 500 s of observations from t = 1000 s after the trigger**




**Further analysis is in progress.**

## ACKNOWLEDGEMENTS

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