PROSPECTS FOR GAMMA RAY BURSTS DETECTION WITH LHAASO

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INTRODUCTION

Gamma Ray Bursts (GRBs) are among the most powerful sources in the sky, with an energy spectrum extending from radio to gamma rays of tens of GeV.

The high energy tail of GRBs above 1 GeV can be detectable in follow up mode by EAS array. The LHAASO detector capabilities in the GRB search are discussed.

THE DETECTOR

The Large High Altitude Air Shower Observatory (LHAASO), foreseen in the Sichuan Province (China) at 4410 m a.s.l., will study the highest energy γ-ray sources and cosmic rays in the range [0.1-1000] TeV, combining different air shower detection techniques. The lower end [0.1-30] TeV will be covered by the Water Cherenkov Detector Array (WCDA Fig. 1) made by:

- 4 ponds, 150×150 m^2 each, total surface 90000 m^2
- 900 cells/pond: each cell 5×5 m^2 and 4 m depth seen by one PMT in the center looking up to detect the direct Cherenkov light produced by EAS particles
- PMT threshold set @ 1 pe level , 35 KHz noise

Signal amplitude and arrival time are recorded. For small multiplicities ($2<n_{hit}<12$), the primary energy for gammas corresponds to a few GeV, overlapping the actual satellite detectors.

Angular resolution (Fig. 2a) and effective areas (Fig. 2b) for both gammas and protons of WCDA have been obtained by Monte Carlo simulations.

Expected trigger rate: 70 KHz @ $n_{hit}\geq 12$ (1 KHz random coincidences)

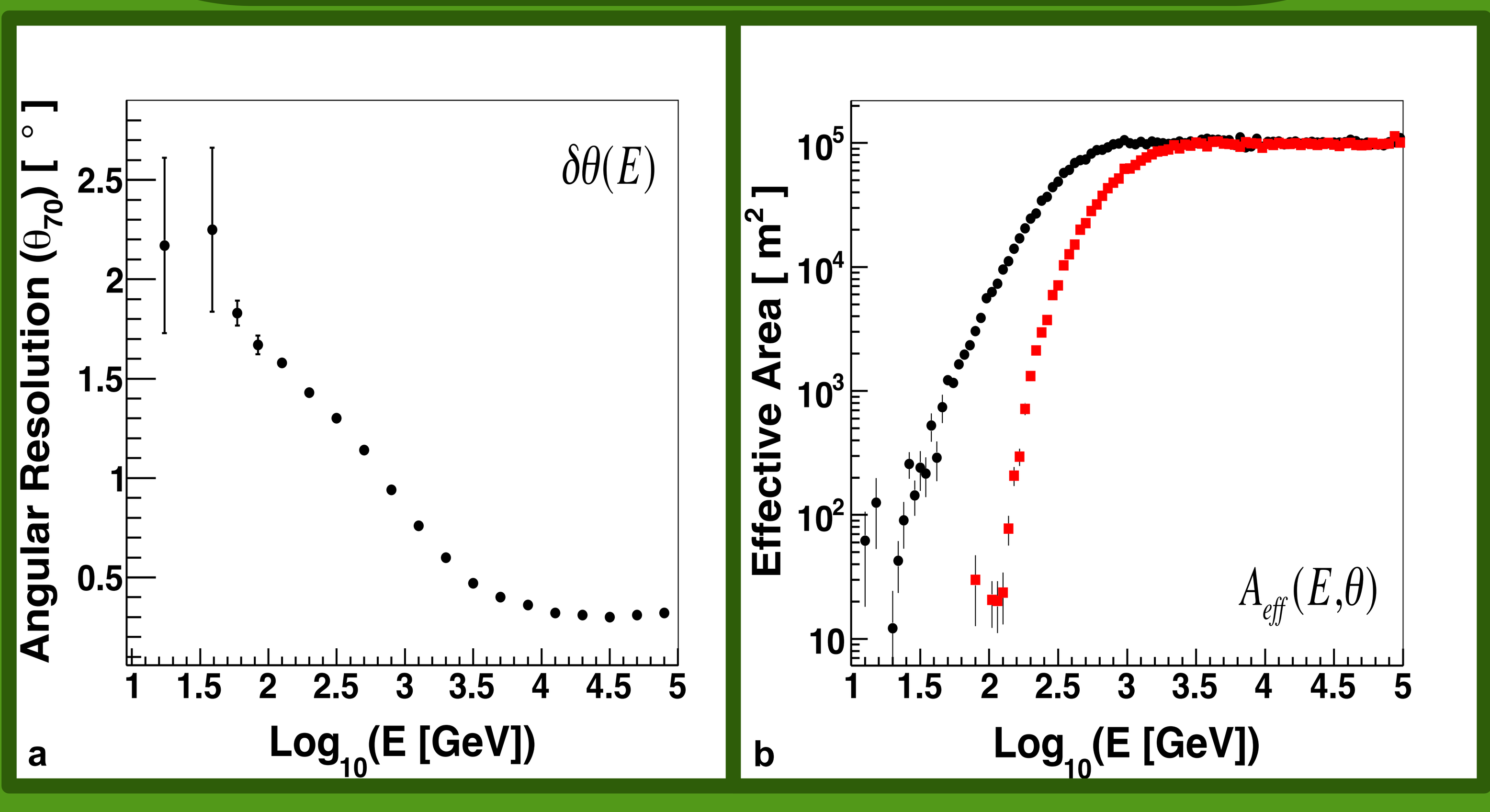

Fig. 2: a) Expected angular resolution and b) effective areas for gammas (black dots) and protons (red squares) of the WCDA.

THE GRB MODEL

To estimate the WCDA sensitivity, GRBs (long and short) are simulated sampling the experimental features (by Fermi-GBM/LAT & Swift-BAT) :

- Duration t_{90} and redshift (Fig. 3 a,b)
- High energy ([1-1000] GeV) emission assumed as a pure power law $E^{-\gamma}$ with γ=2 (1.5) for long (short) GRBs, without intrinsic spectrum cutoff
- High energy fluence scaled from low energy ones with ratio 1/1 for short GRBs and 1/10 for long GRBs (Fig. 4 a,b)
- EBL attenuation included as in Kneiske et al. *A&A* 413, 807 (2004)
- Zenith angle in the range [0-50] degrees with uniform solid angle distribution

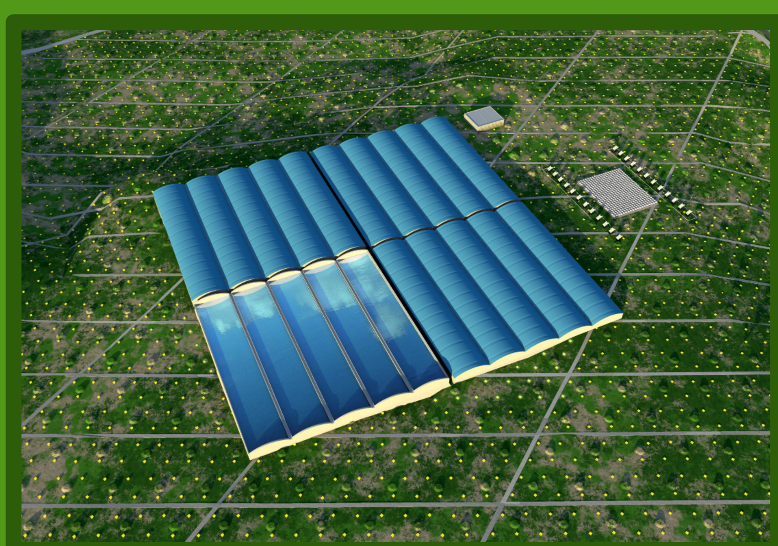

Fig. 1: Pictorial view of the WCDA detector at LHAASO site

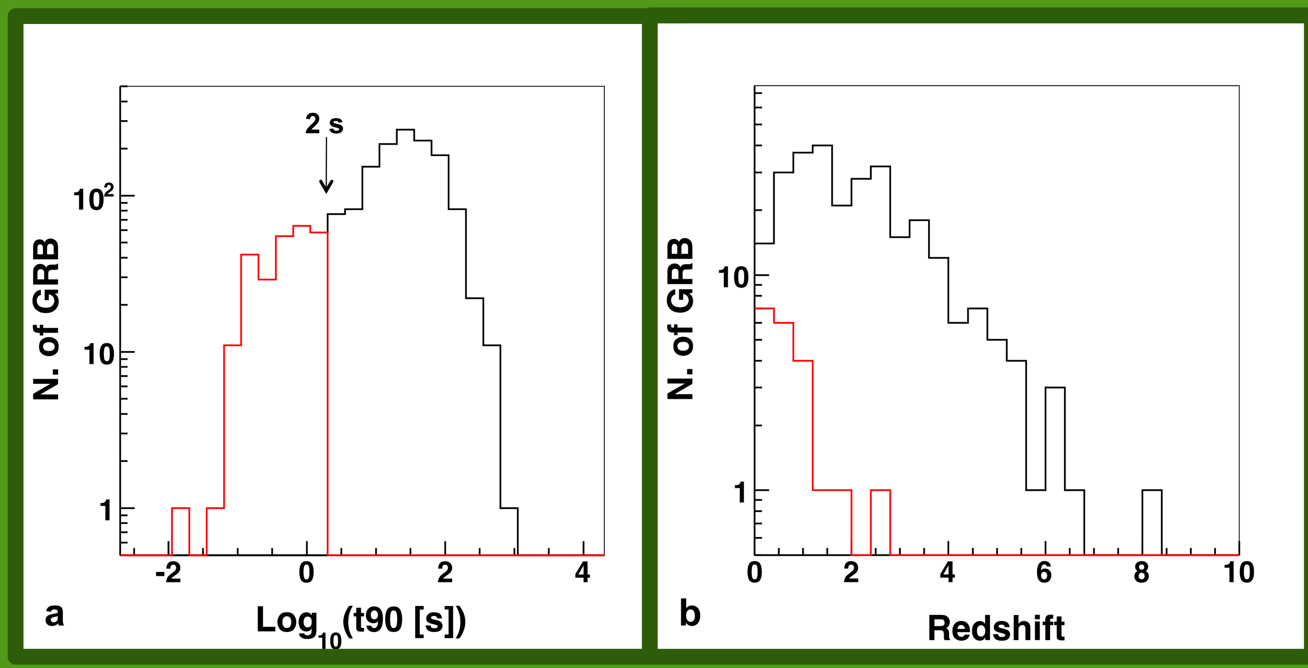

Fig. 3: a) Distribution of t_{90} durations for long (black) and short (red) GRBs detected by Fermi-GBM; and b) redshift of GRBs measured by Swift-BAT.

THE WCDA SENSITIVITY

Signal

$$S=\int_{1GeV}^{1TeV}\phi_{\gamma}(E)\times EBL(E,z)\times A_{eff}^{\gamma}(E,\theta)\times t_{90}\,dE$$

Background

$$B=\int_{1GeV}^{1TeV}\phi_{p}(E)\times A_{eff}^{p}(E,\theta)\times \Omega(\delta\theta(E))\times t_{90}\,dE$$

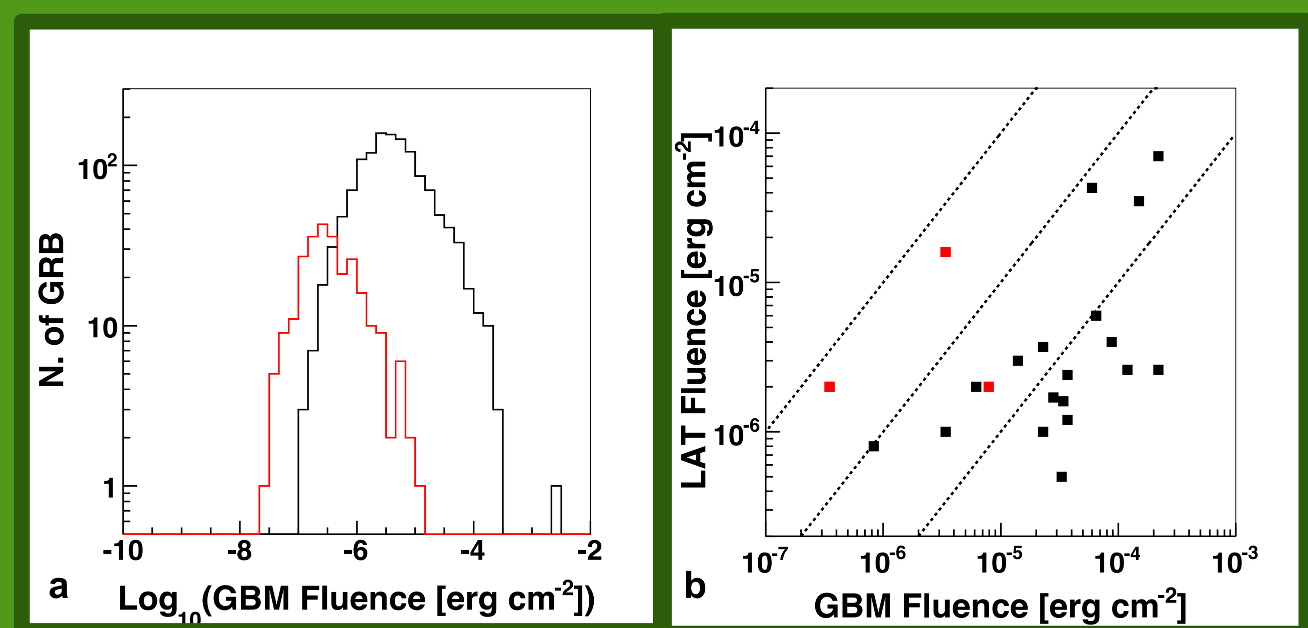

Fig. 4: a) Fluences for long (black) and short (red) GRBs in the [10-1000] MeV range; b) comparison of the LAT and GBM fluences in the [0.1-10] GeV and [10-1000] MeV range respectively. Black (red) squares are for long (short) GRBs; dashed lines indicate LAT-GBM fluence ratio of 0.1, 1.0, 10.0 (bottom to top).

Sensitivity of WCDA will be defined as Signal/(Background fluctuations) ≥ 5 s.d.

$$R=\frac{S}{\sqrt{2B}}\geq 5\quad s.d.$$

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