GRB 221009A observations with LST-1 at VHE gamma rays

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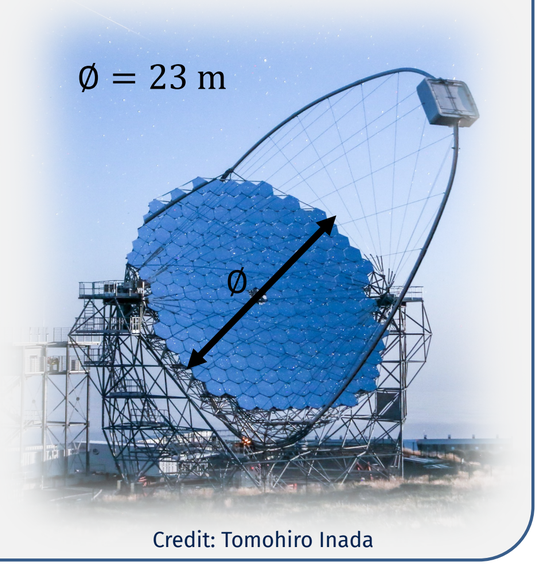
ABSTRACT

On October 9th, 2022, the brightest gamma-ray burst (GRB) since the first GRB observation in the late sixties was initially detected by the Fermi-GBM and Swift-BAT telescopes (GRB 221009A). The outstanding characteristics of this GRB triggered extensive follow-up observations of the source across all wavebands, including at very-high-energy (VHE) gamma rays with the Large-Sized Telescope prototype (LST-1) of the upcoming Cherenkov Telescope Array Observatory (CTAO). In this contribution, we present the analysis results of the LST-1 observation campaign focused on GRB 221009A in October 2022 in nominal atmospheric conditions.

Large-Sized Telescope prototype (LST-1)

LST-1 is one of the largest telescope of the future CTAO

- **Very well suited for observations of transient sources**
  - **Fast re-positioning speed: $180°$ in 20 seconds**
  - **Low energy threshold**



Credit: Tomohiro Inada

GRB 221009A observations with LST-1

LST-1 data in October 2022 was recorded under different atmospheric conditions

- **Moon conditions**
  - **Refined analysis required due to high night-sky-background (NSB) level**
- **Nominal (dark) and mild-moon conditions**

Data analysis and preliminary results

- **Moon analysis (3h obs. time between days 1 - 4)**
  - **Detailed study under investigation to reduce the NSB**
    - **Refined calibrations to account for fast changes in the observation conditions**
    - **Test signal-integration and image-cleaning methods**

- **Dark analysis (15h obs. time between days 6 – 19, Fig. 1)**
  - **No detection with LST-1**
  - **Assumed intrinsic spectral shape $\propto E^{-2}$**
  - **Fitting energy range: $[0.2, 10]$ TeV**
  - **Energy flux upper limits (ULs) on mildly distant and distant observations from the burst (Fig. 2)**

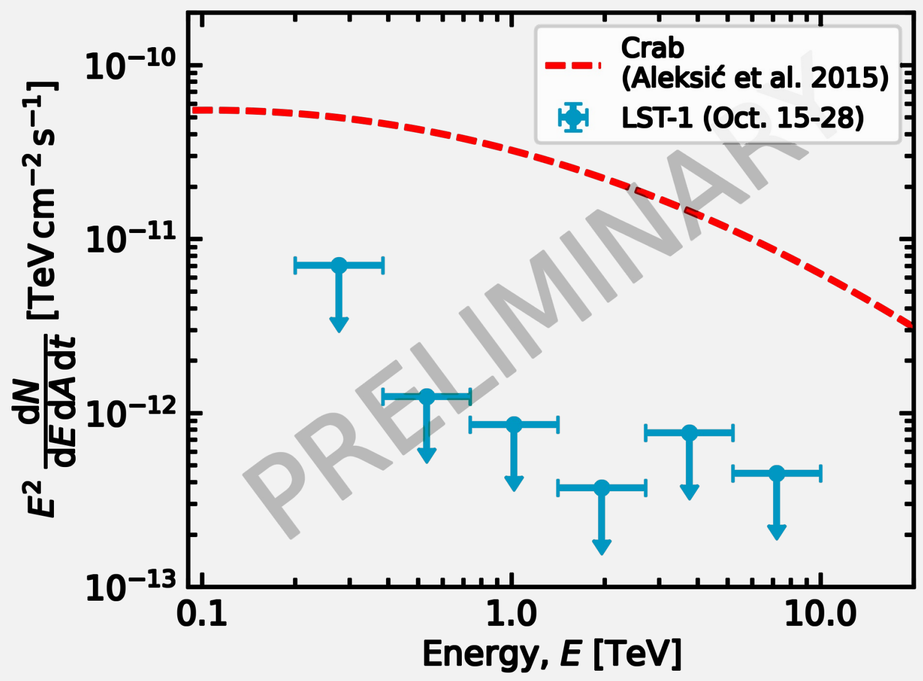


Fig. 1: Spectral energy distribution using all observations in dark conditions. The Crab spectrum is shown as a dashed red line.

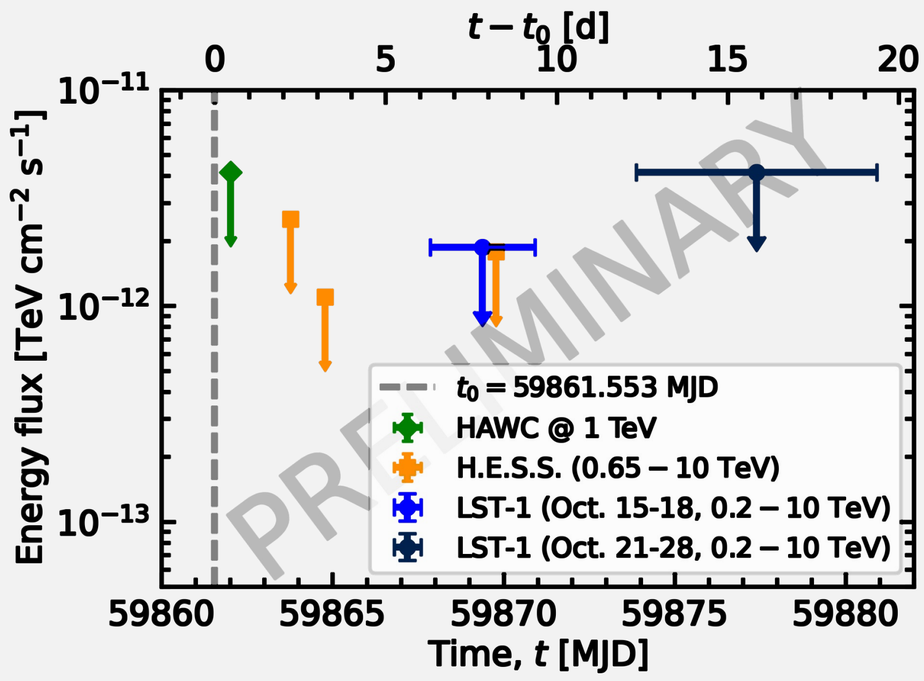


Fig. 2: Energy flux for LST-1 dark observations (Oct. 15-18 and 21-28). The ULs from HAWC (green; [1]) and H.E.S.S. (orange; [2]) are shown. The dashed line marks the *Fermi*-GBM trigger time (t_0; [3]).

Conclusions

Deep monitoring campaign of a total of 18 hours giving unique insights in the afterglow emission of the GRB

- **The data analysis under moon conditions is ongoing**
- **GRB 2021009A is not detected with LST-1 after day 6**
  - **The afterglow energy flux is constrained between $0.2 - 10$ TeV below $\sim 2 \times 10^{-12}$ TeV cm^{-2}s^{-1}**

References: [1]. Ayala & HAWC Collaboration, GCN (2022) [2]. Aharonian et al., ApJL (2023) [3]. Veres et al., GCN (2022)

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