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Analysis of LACT Prototype Data

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- 1 Introduction to LACT
- 2 Prototype Data Analysis
- 3 Summary & Discussion



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The Concept

- ▶ An array of **32 IACTs** located at the LHAASO site (4410m a.s.l.).
- ▶ **Scientific Mission:** Dedicated to the deep observation of UHE sources (PeVatrons) discovered by LHAASO.
- ▶ **Key Advantages:**
 - ▶ **Morphology:** Superior angular resolution to resolve complex source structures.
 - ▶ **Spectrum:** Precise measurement of spectral cutoffs to identify CR acceleration limits.

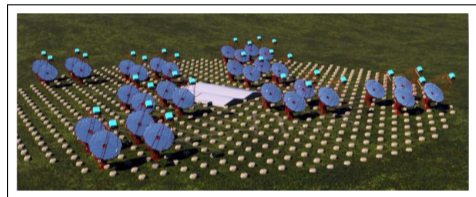
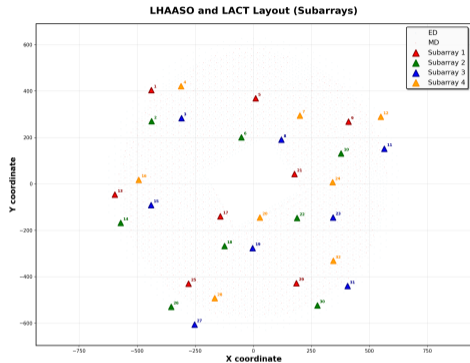
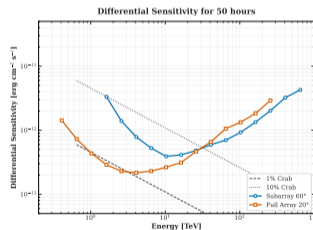
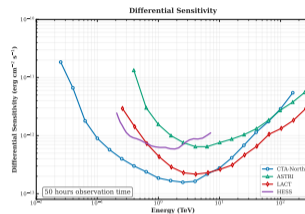


图: Schematic view of LACT and LHAASO



Final array configuration (including subarrays)



Differential sensitivity (50 h; 20° vs. 60°)

Two Observation Modes: *Full Array* at 20° zenith

| *4 Subarrays* at 60° zenith





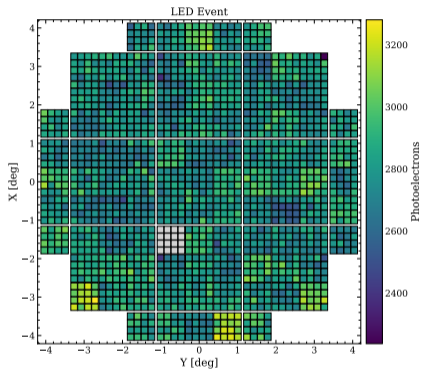
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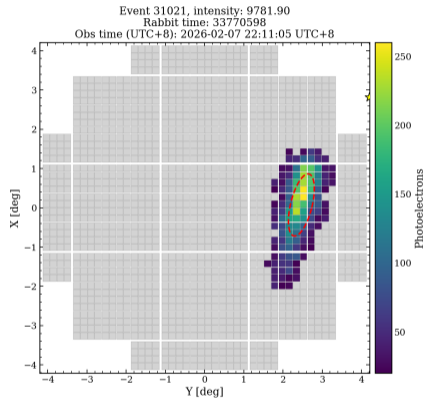
The first prototype of LACT began operation on January 26, 2026.



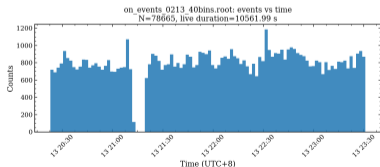
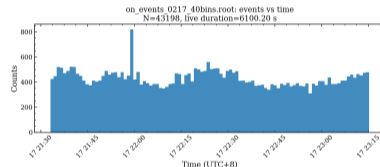
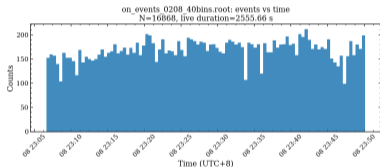
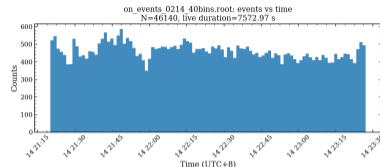
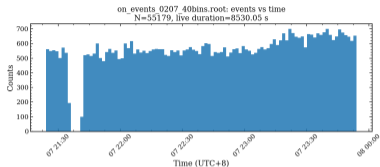
Second telescope under construction



LED Events: Flat-field and
Calibration



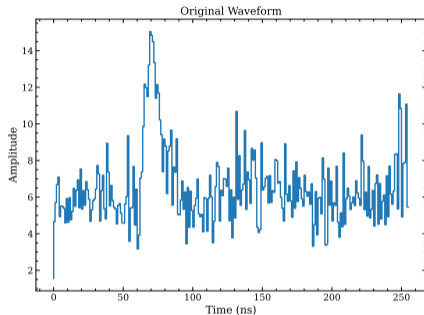
Cosmic Ray events



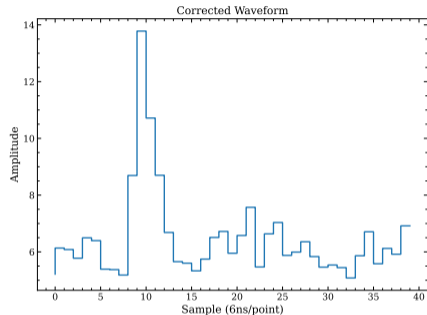
Observation Statistics:

- ▶ **Target:** Crab Nebula (On-axis)
- ▶ **Selection:** Zenith Angle 0° – 30°
- ▶ **Total Live Time:** ≈ 9 hours

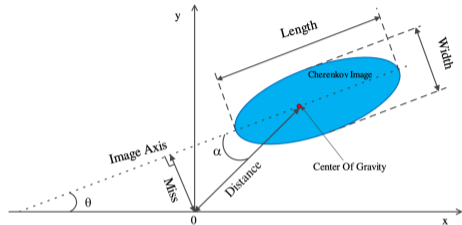
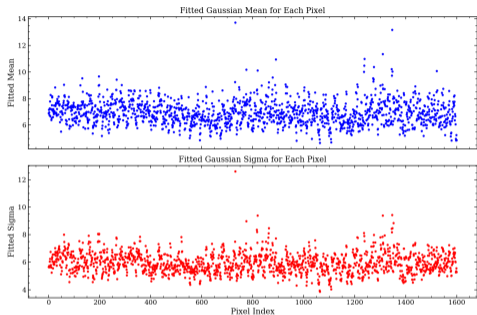
Original Waveform



Corrected Waveform



- ▶ **Pre-processing:** Median filter (noise suppression) + merge 6 bins (rebinning) for improved SNR.
- ▶ **Integration:** Signal **Area** extraction within a fixed time window.
- ▶ **Calibration:** Conversion to **Photoelectrons (p.e.)** using LED calibration.



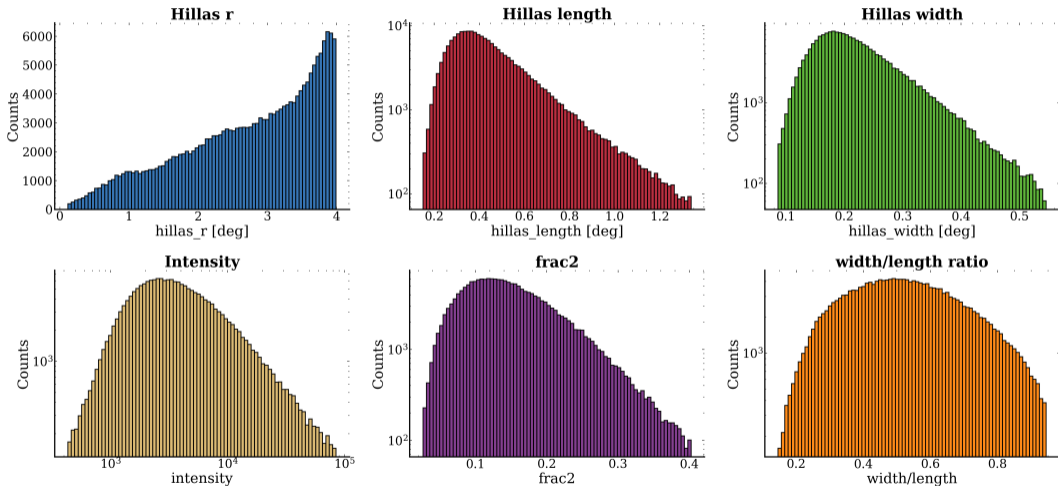
Hillas Parametrization:

► Tail-cuts Cleaning:

- Core pixels: $> 6\sigma$ pedestal
- Boundary pixels: $> 3\sigma$ pedestal

- Moment analysis of cleaned image.
- Extraction of Width, Length, Size, and Dist, ALPHA

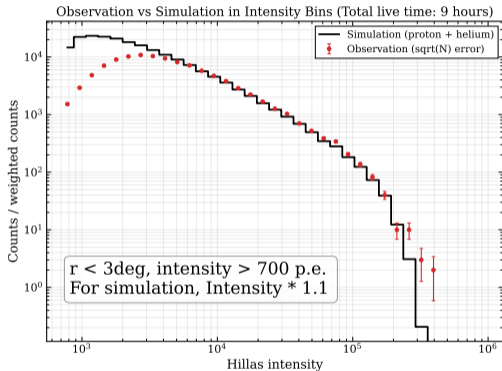
Parameter Distribution of All On Events



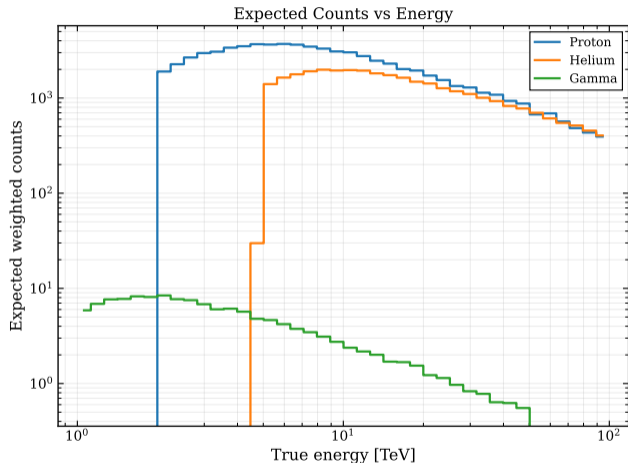
MC Dataset Production

- ▶ **Proton:** 2–100 TeV ($\Gamma = -2.0$)
 - ▶ Reweighted to $\Gamma = -2.7$
 - ▶ $N_0 = 0.096 \text{ TeV}^{-1} \text{ m}^{-2} \text{ s}^{-1} \text{ sr}^{-1}$
- ▶ **Helium:** 5–120 TeV ($\Gamma = -2.0$)
 - ▶ Reweighted to $\Gamma = -2.64$
 - ▶ $N_0 = 0.0719 \text{ TeV}^{-1} \text{ m}^{-2} \text{ s}^{-1} \text{ sr}^{-1}$

Trigger Efficiency



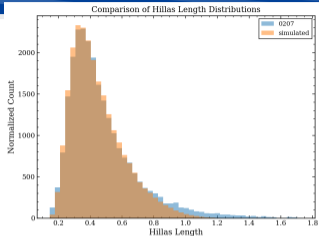
- ▶ Observed efficiency rollout below the intensity peak.
- ▶ Critical for understanding the energy threshold of the prototype.



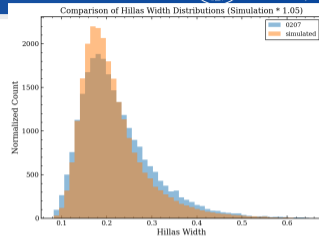
Energy Threshold (E_{th})

Defined as the energy at the peak of the differential detection rate:

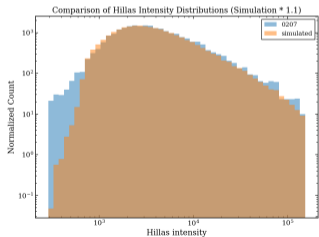
- ▶ **Gamma rays:** ≈ 2 TeV
- ▶ **Protons:** ≈ 6 TeV
- ▶ **Helium:** ≈ 10 TeV



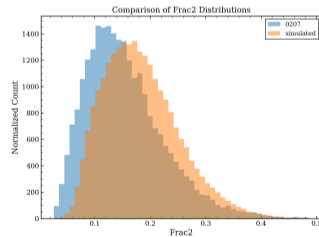
(a) Length



(b) Width

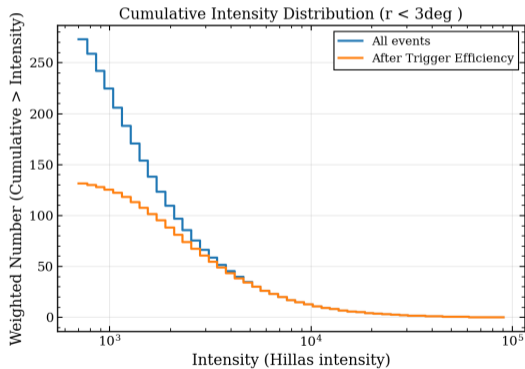
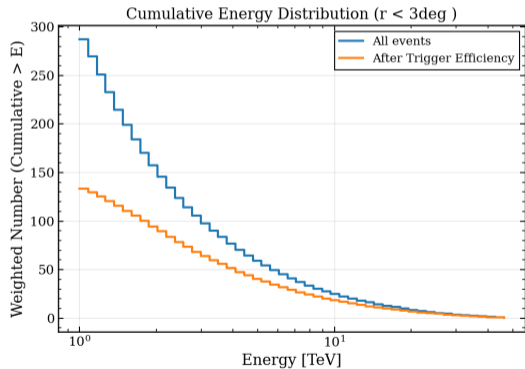


(c) Intensity

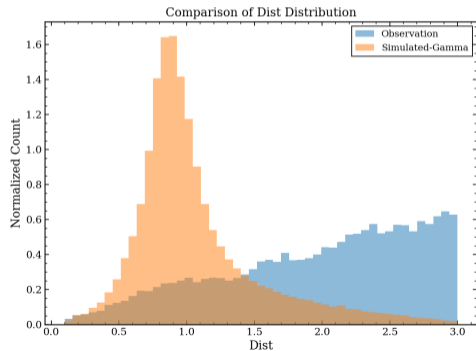
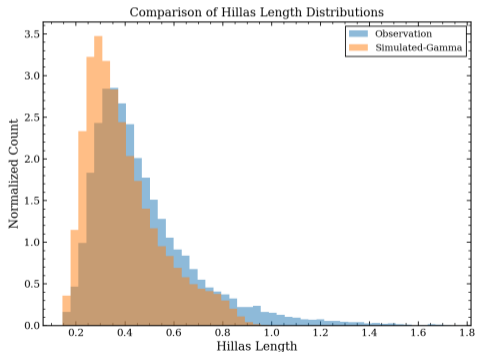


(d) Frac2

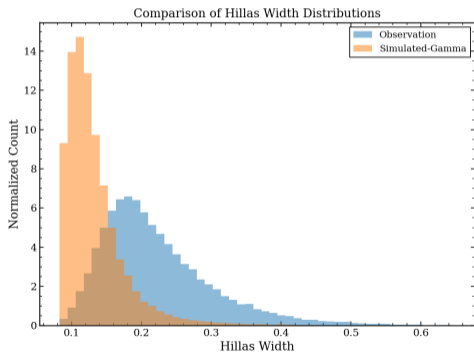
- ▶ **Observation Time:** 9 hours
- ▶ **Expected Statistics:**
 - ▶ Typical total numbers: ~ 120



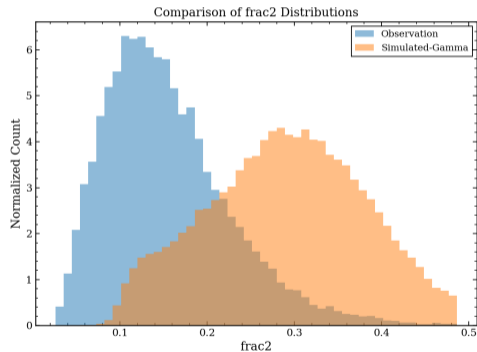
- ▶ **DataSet:** Comparison of simulated γ -rays (MC) vs. observed Crab Nebula candidates.
- ▶ **Supercuts I:**
 - ▶ $0.5^\circ < \text{Dist} < 1.5^\circ$.



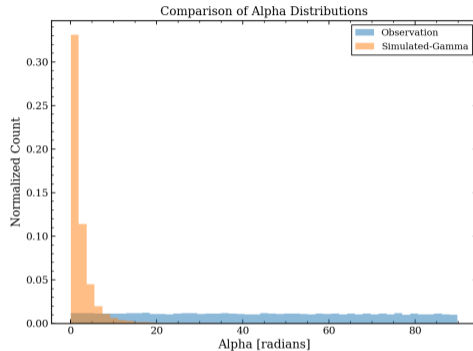
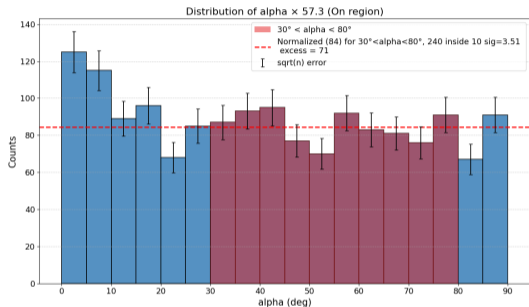
- ▶ **Width:** $0.08^\circ < \text{Width} < 0.14^\circ$
 - ▶ Filters out broader hadronic showers and narrow single-pixel noise/muon arcs.
- ▶ **Concentration (Frac2):** > 0.26



Shower Width distribution.



Frac2 (Concentration) distribution.



MC γ vs. Real Cosmic Rays.



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- ▶ **Trigger Optimization:**
 - ▶ The telescope trigger conditions require **stringent optimization**, as they directly dictate the analysis energy threshold.
- ▶ **Stereoscopic Potential:**
 - ▶ The imminent commissioning of the **second telescope** will enable stereoscopic reconstruction, significantly enhancing angular resolution and background rejection.
- ▶ **Cross-Instrument Validation:**
 - ▶ Synergistic observations with **LHAASO-WCDA** and **LHAASO-KM2A** will provide crucial independent cross-calibration and validation for the LACT prototype results.



Thank you for your attention!

Special thanks to everyone who contributed to this analysis:

Razmik, Yiyun, Shilong

and all members of the **LACT Analysis Group**.