

High Energy Gamma-ray Observations with CALET

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Outline

CALET-CAL

Photon candidate selection

Gamma-ray observations

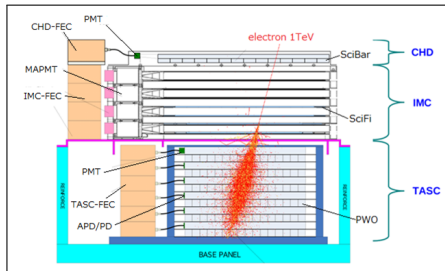
- Overview

- Galactic diffuse

- Point sources

- Transient counterparts

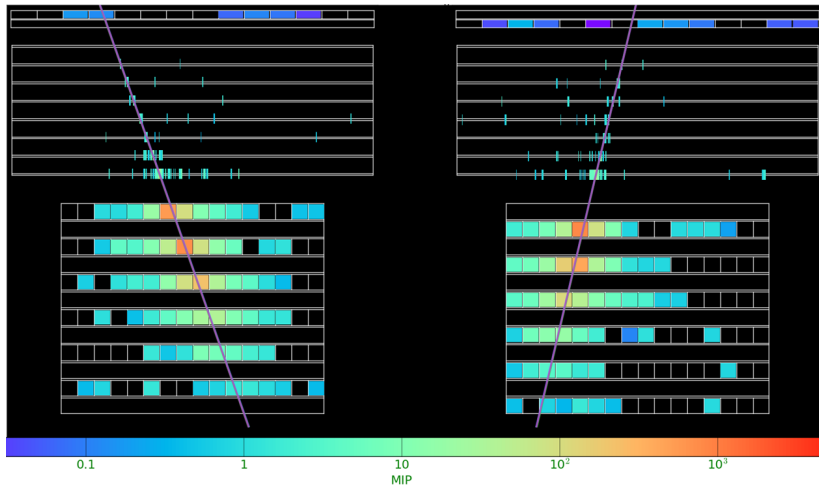
CALET-CAL Detector



CHD	CH arge D etector 14 x 2 plastic scintillators
IMC	IM aging C alorimeter 448 x 8 x 2 scintillating fibers
TASC	T otal Ab Sorption Cal. 16 x 6 x 2 PbWO ₄ logs

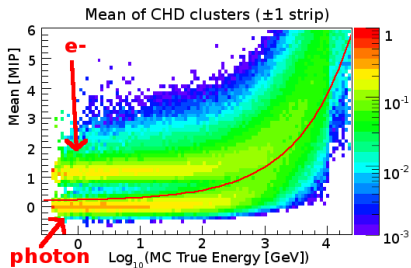
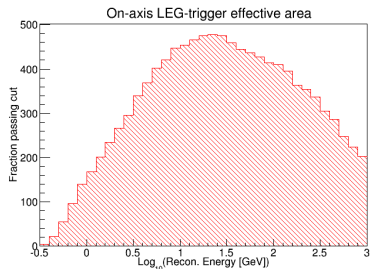
- ▶ Geometric factor:
1200 cm²sr for e[±], light nuc.
1000 cm²sr for photons
- ▶ Energy resolution:
~2% for e[±], gamma
- ▶ Charge resolution:
0.15 - 0.3 e
- ▶ Angular resolution:
~0.4° (1 GeV - 10 GeV)
~0.3° (10 GeV - 1TeV)
- ▶ Minimum photon energies:
~10 GeV (HE trigger)
~1 GeV (LEG trigger)

Sample Event ~ 15 GeV



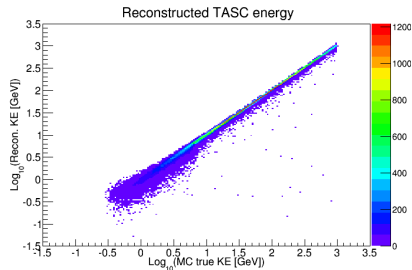
Event selection

- ▶ Pre-selection
 - ▶ Offline trigger
 - ▶ IMC 7X+8X
 - ▶ IMC 7Y+8Y
 - ▶ TASC 1X
 - ▶ Track reconstruction
 - ▶ N_{layers} in fit
 - ▶ Reduced χ^2
 - ▶ IMC EDep concentration
 - ▶ IMC 8X
 - ▶ IMC 8Y
- ▶ Charge $Z=0$
 - ▶ Mean of CHD clusters
 - ▶ Mean of IMC1 clusters



Primary energy reconstruction

- ▶ $E > 6 \text{ GeV}$:
 - ▶ Sum of all TASC logs
 - ▶ $\frac{\Delta E}{E} \approx 3\%$
- ▶ $E < 6 \text{ GeV}$:
 - ▶ Sum of TASC logs in upper layers near track
 - ▶ $\frac{\Delta E}{E} \approx 10\%$
 - ▶ Improvement using deposits in IMC in development

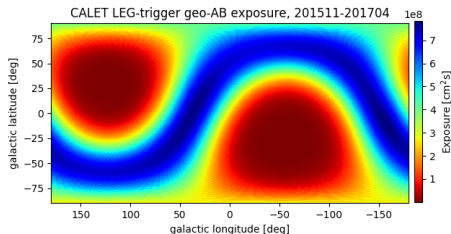


Reconstructed energy vs. true MC energy.

Sky Exposure

Exposure on sky (for each event)

- ▶ Pointing determined by calibrated ASC/ISS quaternions
- ▶ Geometric area projected as function of θ , ϕ
- ▶ Projection scaled by live time

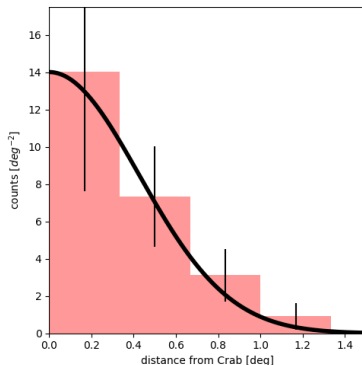


Exposure generated for LEG trigger
1511-1704

Angular Resolution

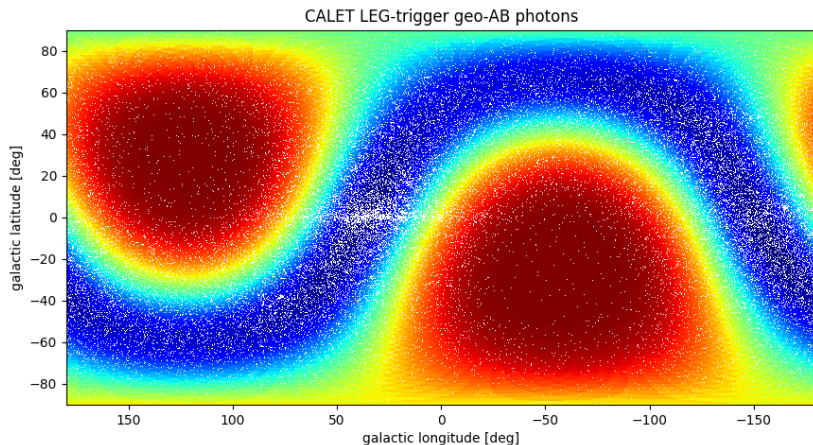
Angular response

- ▶ Photon candidates within 2° of known Crab position isolated
- ▶ Flat background contribution removed
- ▶ Gaussian profile fit with $\sigma = 0.4^\circ$

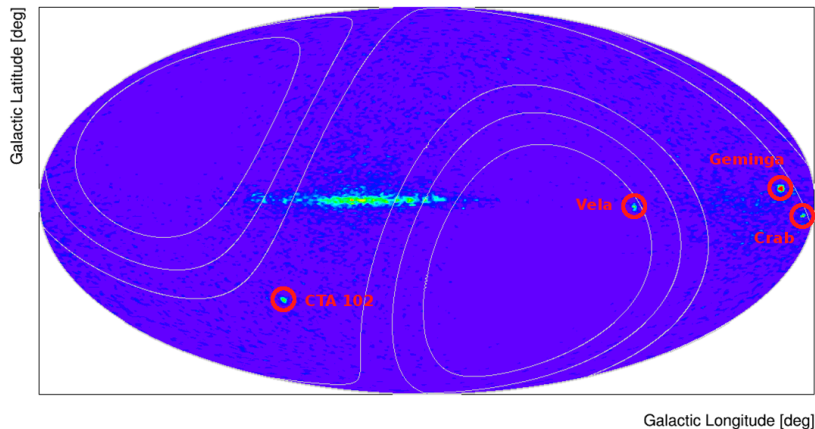


PSF derived from observations of the known Crab position.

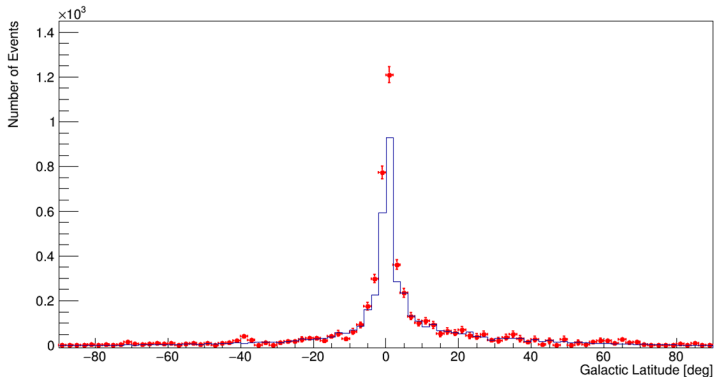
Gamma-ray Candidates



Count Map



Latitude Distribution



Projection of signal from $|\ell| < 80^\circ$ onto galactic latitude for the period 2015/11 to 2017/04. A preliminary removal of a background component which scales with exposure has been applied.

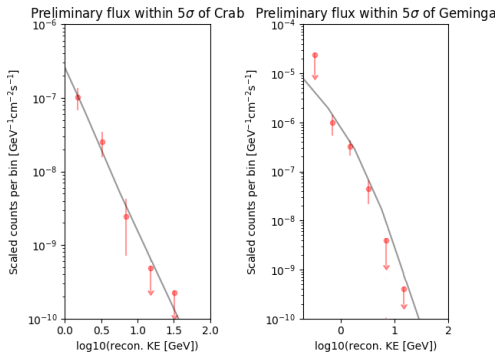
Preliminary Crab and Geminga Fluxes

► Crab

- 46 candidates
- $\sim 4 \times 10^8 \text{ cm}^2\text{s}$

► Geminga

- 119 candidates
- $\sim 5 \times 10^8 \text{ cm}^2\text{s}$

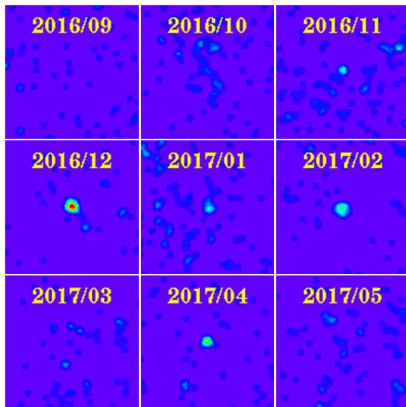


CAL observations from 2015/11 to 2017/04 (red points, statistical errors only) alongside Fermi-LAT 3FGL fluxes (black lines).

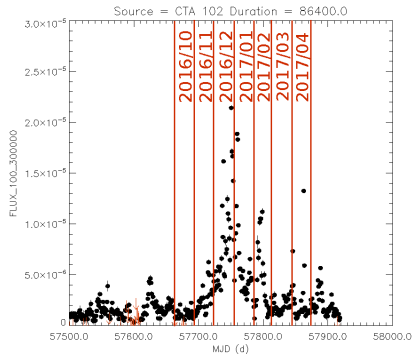
Transient Counterparts

- ▶ Search for EM counterparts to LIGO/Virgo events
 - ▶ Adriani, O. et al., Ap.J. Letters, 829, L20 (2016)
 - ▶ Mori, M. for the CALET Collaboration, #637
- ▶ Search for high-energy counterparts to GRB detections
 - ▶ Follow-up triggers by CGBM
 - ▶ Preliminary analysis searches ± 60 s around CGBM trigger time
 - ▶ Currently no significant signals above background
 - ▶ Increased sensitivity and time windows in development
 - ▶ Follow-up triggers by Swift, Fermi-GBM, et al.
 - ▶ In development
- ▶ Other flaring systems
 - ▶ CTA 102 flares in 2016/11 \sim 2017/04

CTA 102 Flare

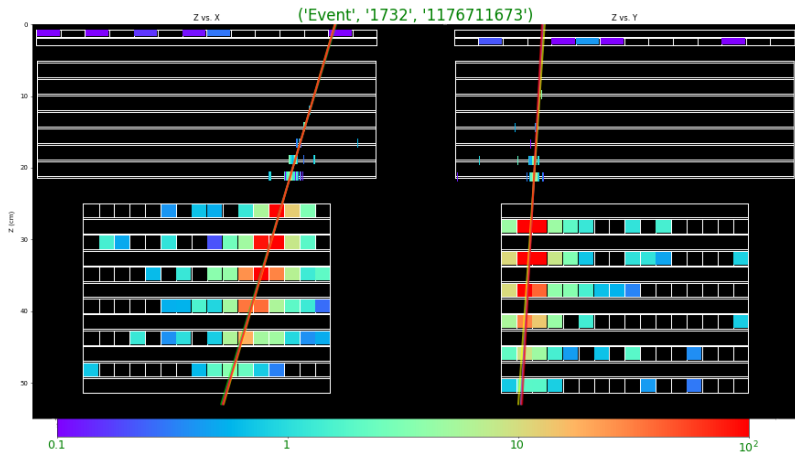


CAL observations of CTA 102 in the months 2015/10 through 2017/04.



Fermi-LAT CTA 102 light curve including the months of interest.

CTA 102 Flare



Event viewer display for 44 GeV event candidate in CAL associated with 2017/04 CTA 102 flare.

Summary

- ▶ High-energy ($\gtrsim 300$ MeV) gamma-ray events are being isolated in the CALET-CAL dataset.
- ▶ Point-source analysis demonstrates the angular resolution of the instrument at low energies on-orbit and consistency of flux measurements.
- ▶ Analysis of the galactic diffuse emission is underway for energies $\gtrsim 1$ GeV.
- ▶ Searches for transient signals from GRBs, LVC triggers, and other systems are in preliminary stages, with more results coming soon.