Expected gamma-ray signals from CALET on board the ISS

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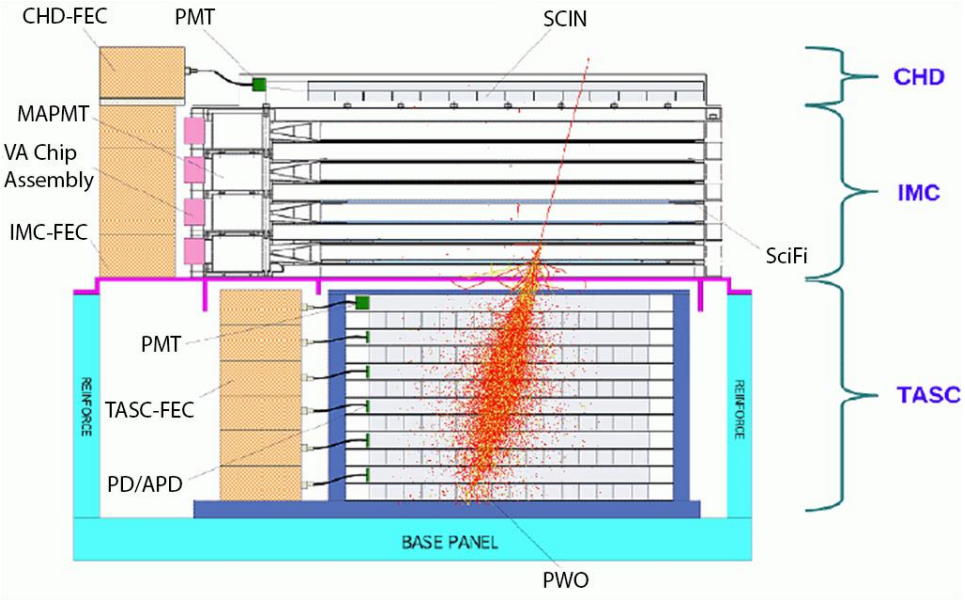
The CALET Instrument

The CALorimetric Electron Telescope will be deployed onto the ISS in August 2015

- 30 X_0 deep calorimeter
- sensitive to cosmic ray electrons in the energy range ~1 GeV - ~20 TeV
- also sensitive to gamma-rays in the same energy range
- three subsystems:
  - CHD: charge detector
  - IMC: imaging calorimeter (3 X_0)
  - TASC: total absorption cal. (27 X_0)



The CALET calorimeter detector schematic shown with a 1 TeV simulated electron shower

Generated events

EPICS/Cosmos simulation package used to generate 2,000,000 gamma-rays and electrons for energy ranges

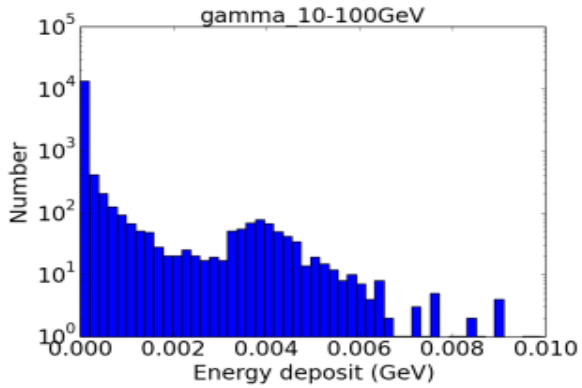
- 10 – 100 GeV,
- 100 – 1000 GeV,
- 1 – 10 TeV.

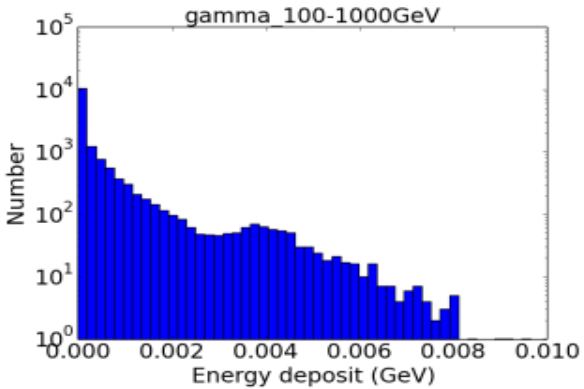
Events were generated on the LSU-HPC SuperMike-II cluster

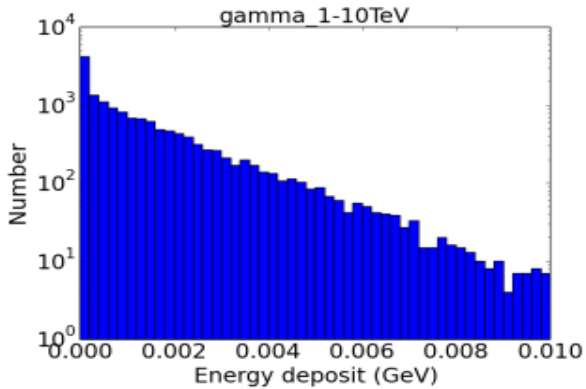
Filtered events to pass through the top of the CHD and the bottom of the TASC for preliminary algorithm

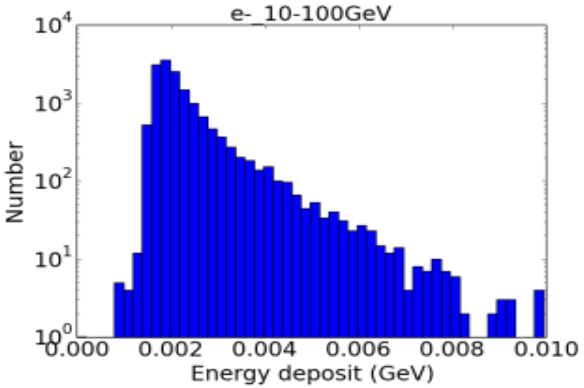
For events where more than one CHD strip is passed through for a single layer, deposits in the hit strips are summed.

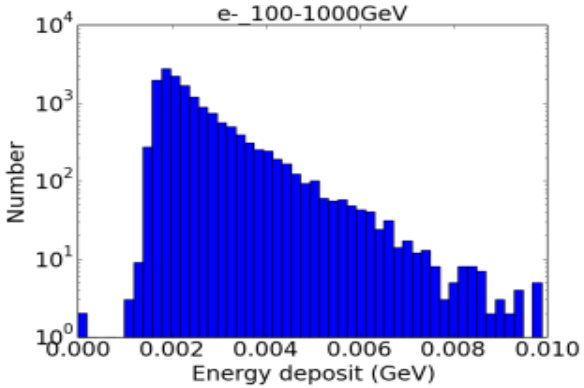
CHD hit strip histograms

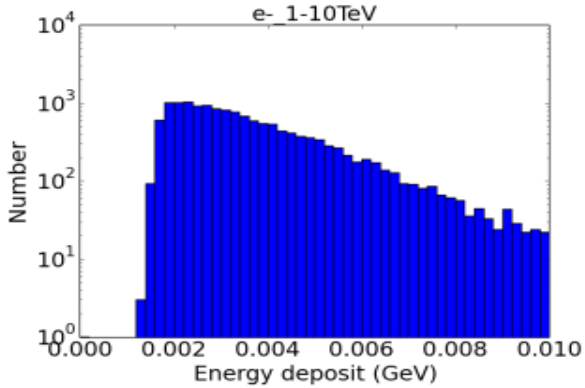




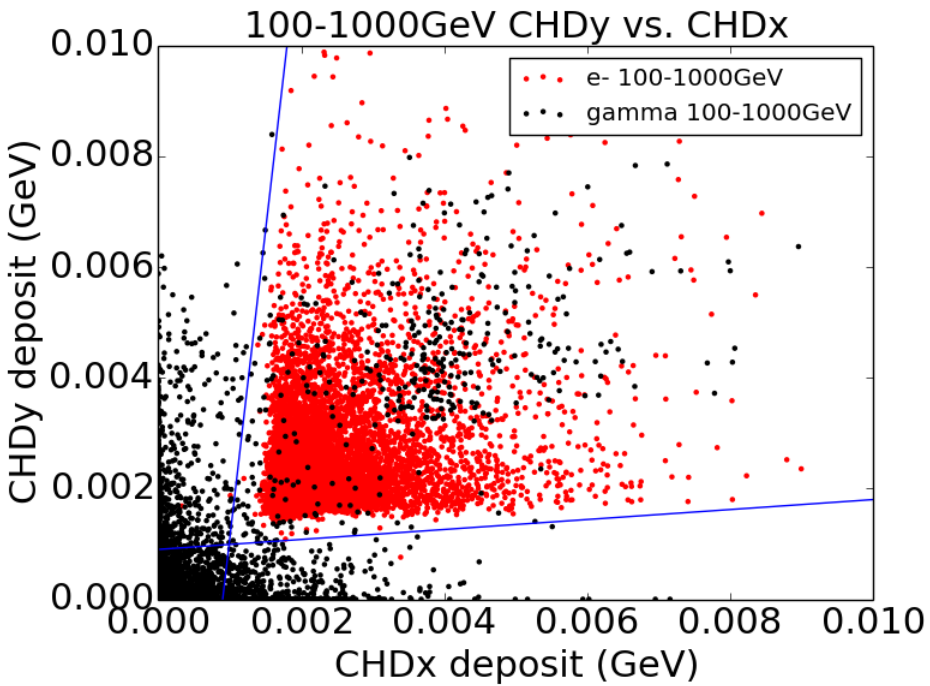






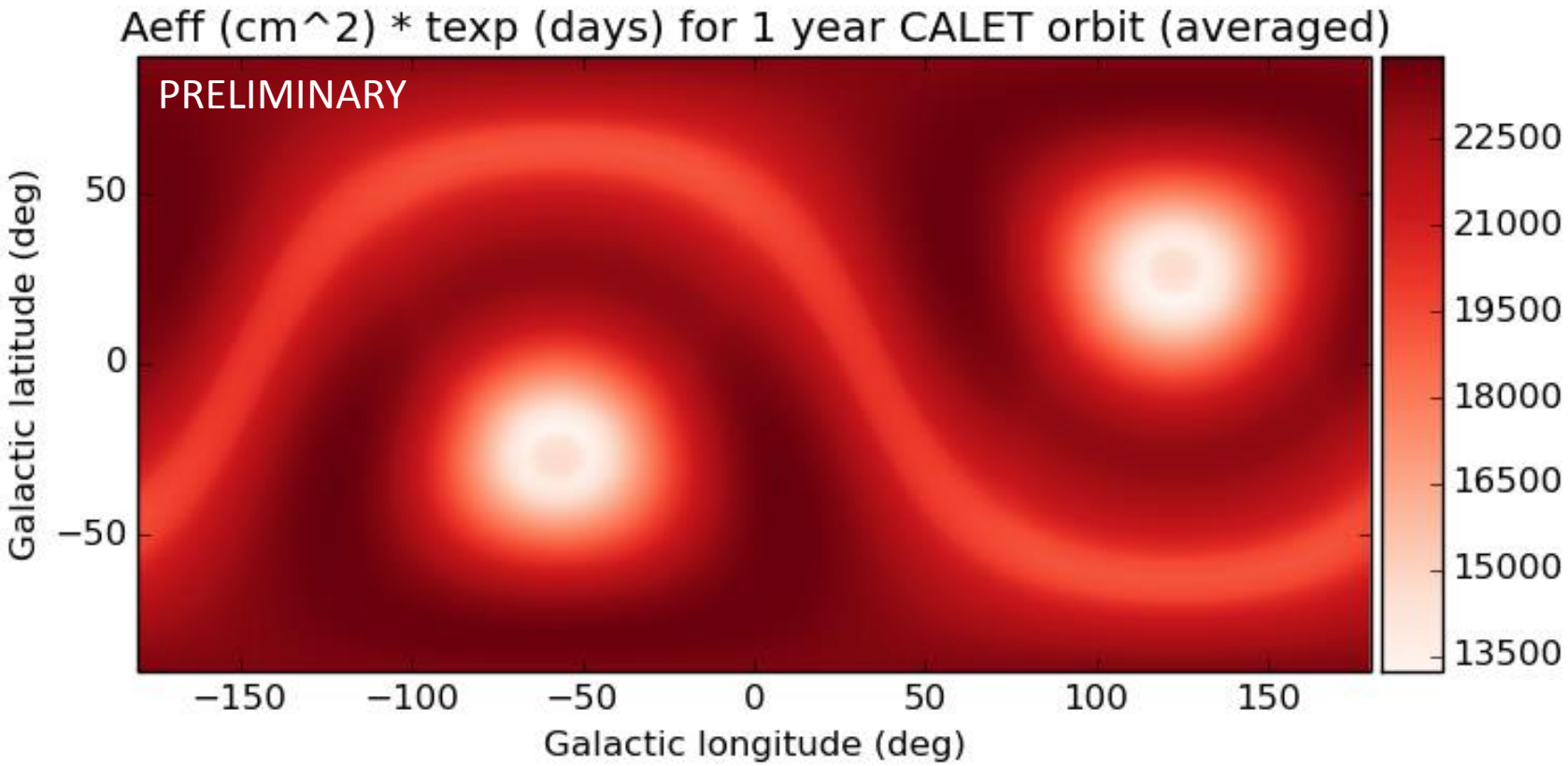


Preliminary separation results



- Simple cut put in place based only on deposits in CHD strips passed through
- Below 1 TeV, this achieves >95% gamma-ray acceptance and electron pollution less than 1 in 10^4
- Electron rejection will improve with incorporation of IMC deposits

100 GeV exposure map



Photons incident

Using the Fermi-LAT 2FGL fluxes for energies up to 100 GeV and the 1FHL fluxes for energies from 100 – 500 GeV, we expect approximately

- 1000 total photons from discrete sources
  - 190 from Vela, 110 from Geminga, and 44 from Crab
- 250 photons above 10 GeV
  - 16 from Vela, 6 from Geminga, and 13 from Crab

Using the Fermi-LAT galactic and isotropic background models, we expect approximately

- 5700 from galactic
  - 1700 above 10 GeV
- 1700 from isotropic
  - 820 above 10 GeV

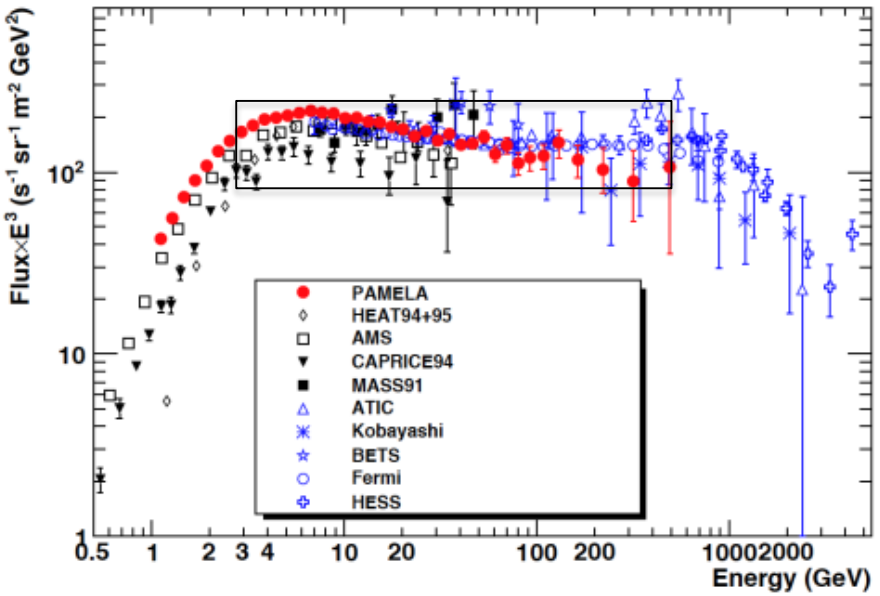
Decreasing the 100% detection threshold to 5 GeV increases these photon counts by a factor of 5-10.

Preliminary electron contamination

Integrating the PAMELA electron spectrum convolved with the CALET effective area from 1 GeV up to 500 GeV results in an isotropic signal of

$$0.17\ s^{-1}sr^{-1}$$

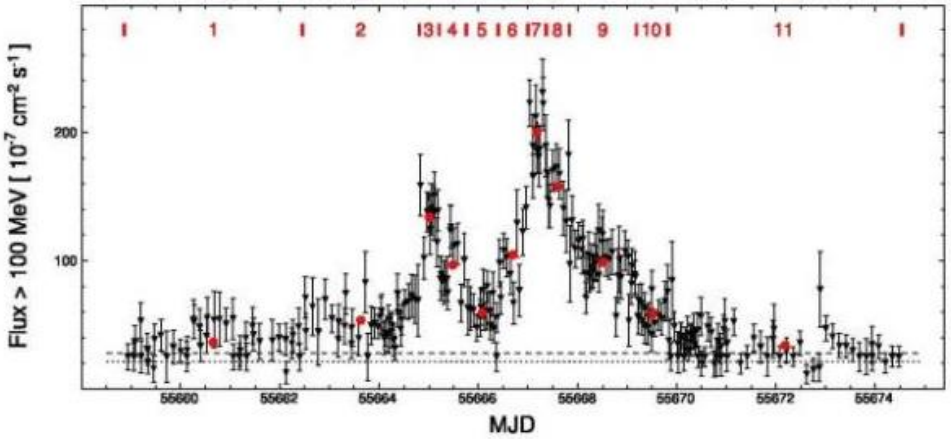
Integrating this across our exposure map gives an annual total electron estimate on the order of 10,000,000.



PAMELA electron spectrum from Adriani et al. 2001

Crab Nebula flares

- Historical flares:
  - 04/2011: α ≈ 30, t ≈ 10 d
  - 03/2013: α ≈ 20, t ≈ 14 d
- Crab observed for 16% of day, on average
- Expected number of photons:
  - 35 from either of the noted flares (~6σ significance)
- Detection at these energies would indicate IC component in flare



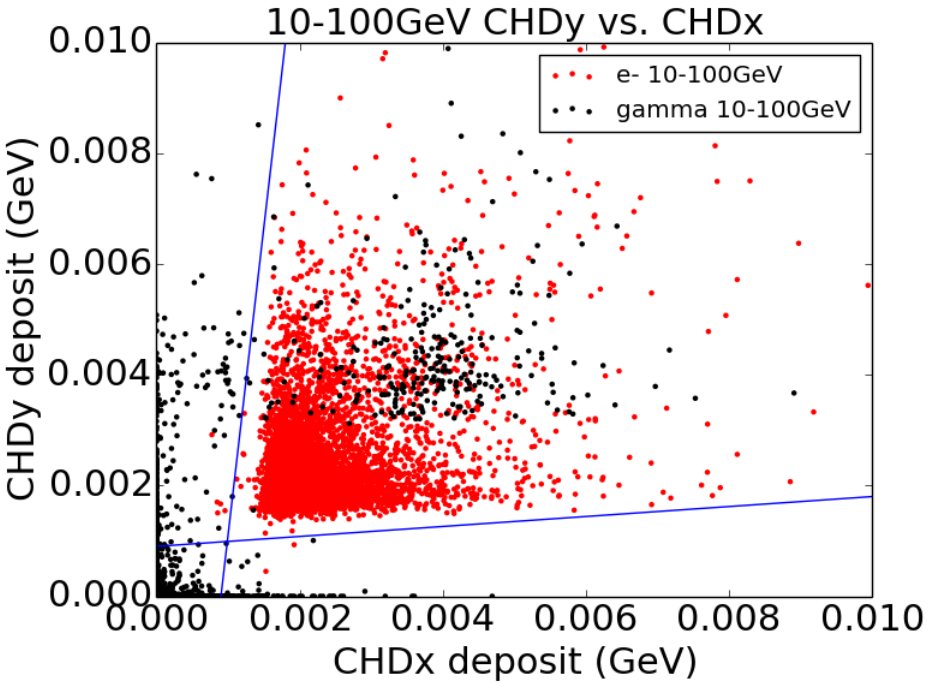
Fermi-LAT >100 MeV light curve of Crab 04/2011 flare (Buehler, R. et al. 2012)

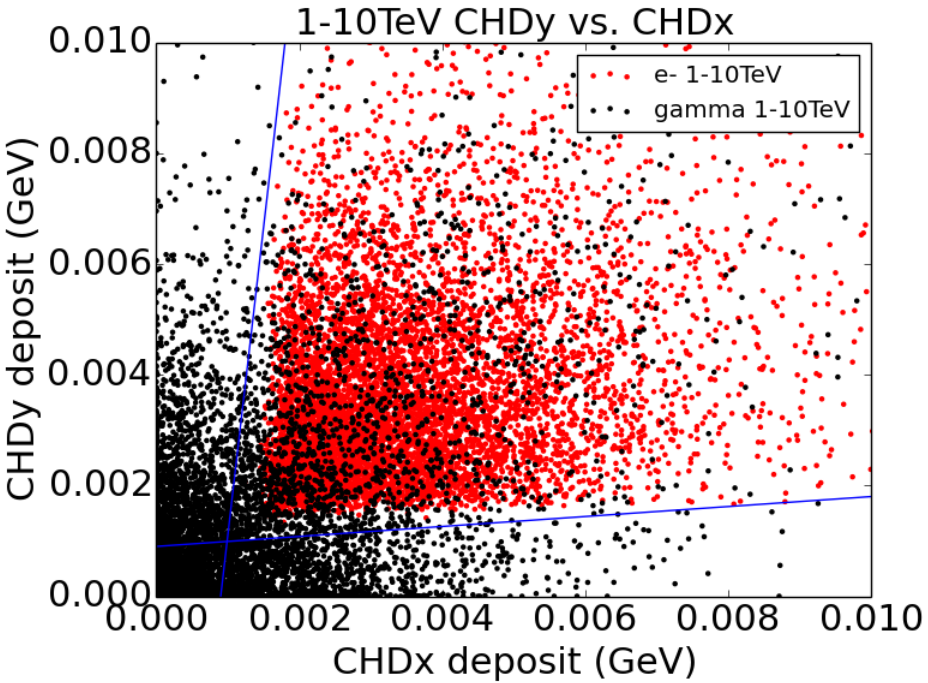
Results

- Gamma-rays can be easily separated from electrons up to 1 TeV with >95% efficiency and electron rejection on the order of 1 in 10^4
  - Work ongoing to improve electron rejection
- CALET will significantly detect some persistent sources, especially if we are able to lower the 100% detection threshold below 10 GeV
- All-sky scanning will be possible with CALET, making it a valuable tool for detecting high-energy flares such as those from Crab

Extra slides

Preliminary separation results





Flat exposure map