THE FERMI LARGE AREA TELESCOPE AS A COSMIC-RAY DETECTOR

Maria Elena Monzani

on behalf of the Fermi-LAT collaboration

SLAC NATIONAL ACCELERATOR LABORATORY

HEAD Meeting – Apr 08, 2013 – Monterey, CA

The LAT as an Electron Detector

The Fermi-LAT is a pair conversion telescope

- challenges connected with energy reconstruction and background rejection largely in common with the standard photon analysis

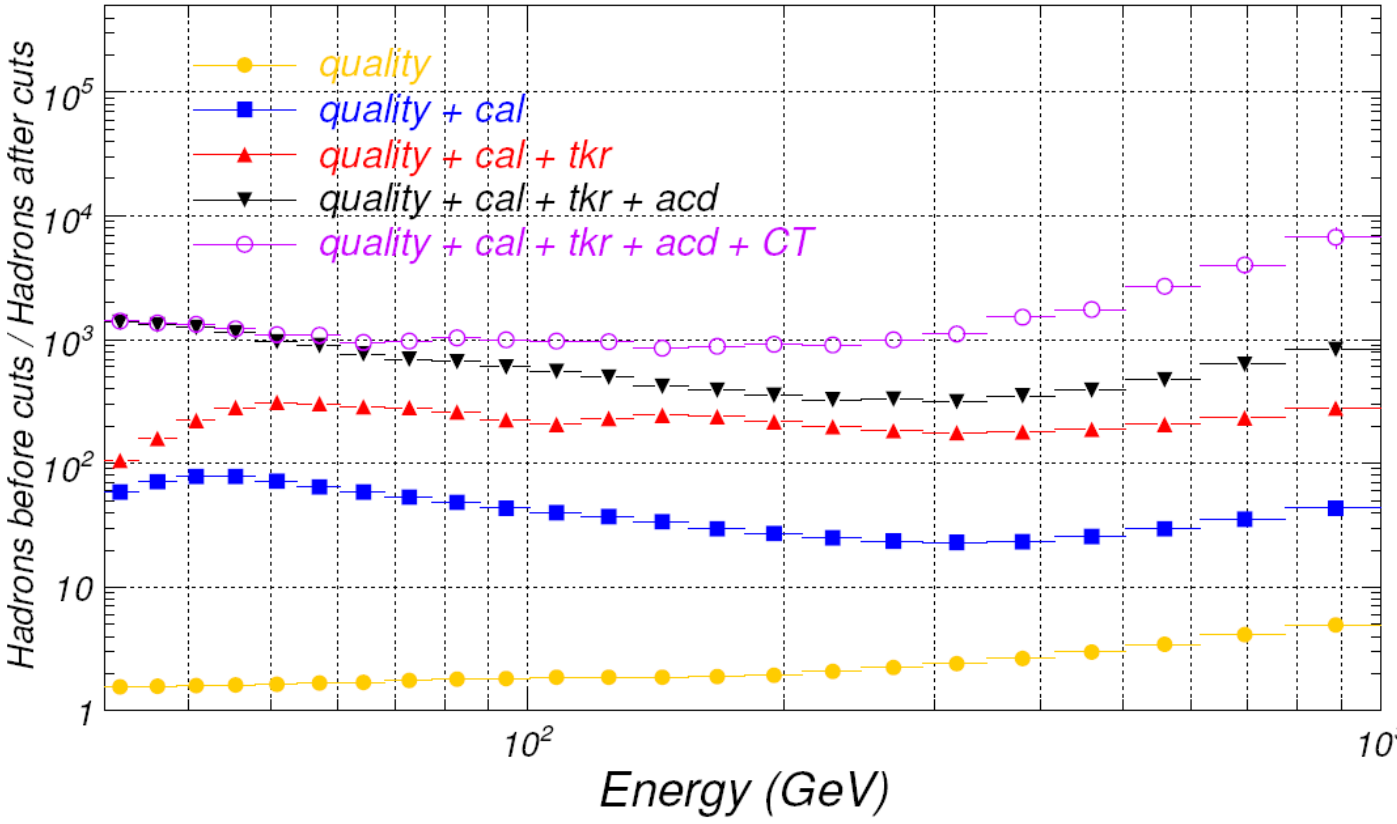
Very large statistics

- large field of view: ≈10 million of electrons per year above 20 GeV
- peak geometric factor for electrons is 2.8 m^2sr at 50 GeV

Electron identification

- the main challenge is overwhelming proton background: a rejection power of $10^3 \rightarrow 10^4$ is required (this requirement varies with energy)

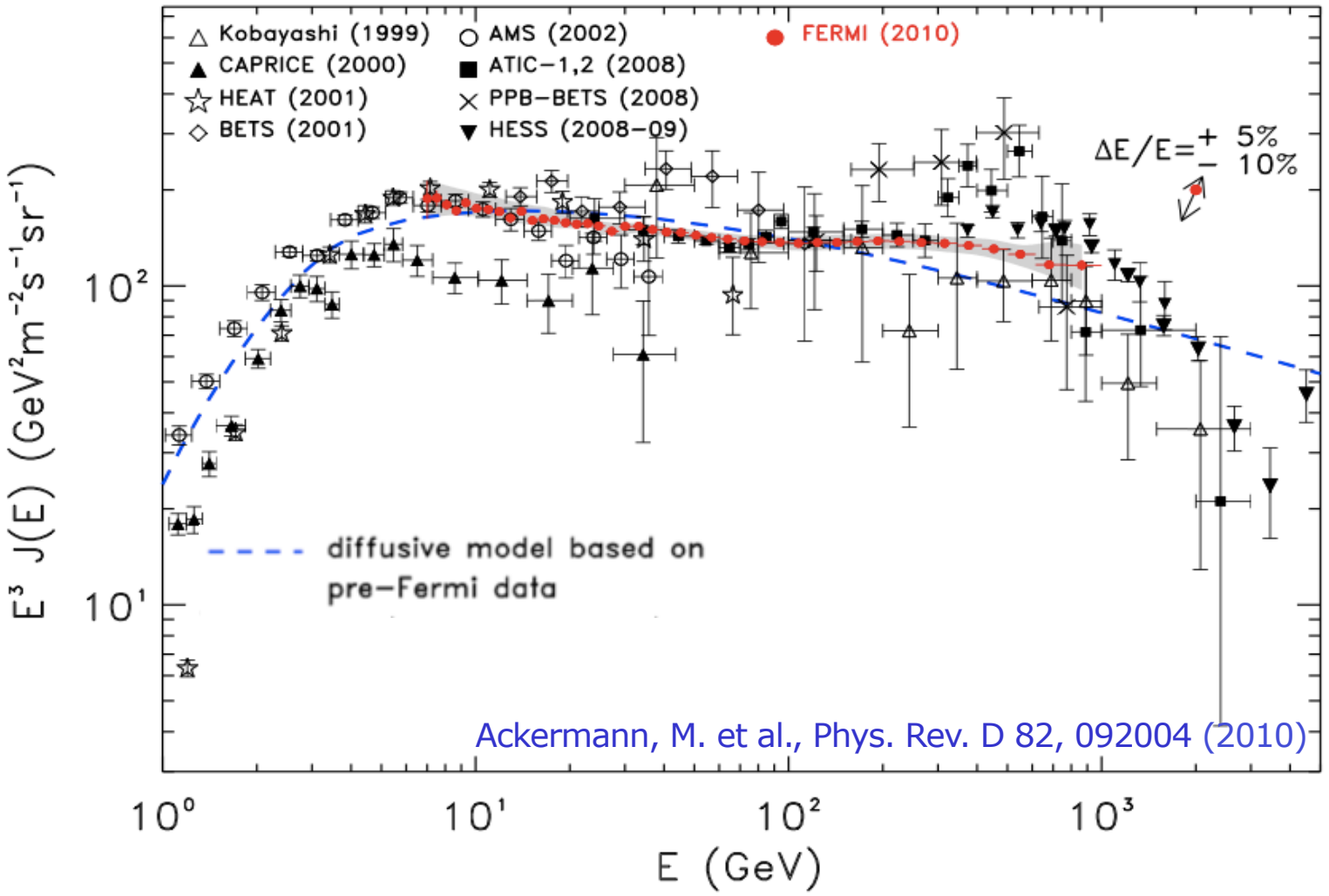
Background Rejection Strategy



Three main steps, in which all the subsystems contribute

- basic quality cuts (requiring ACD signal to remove gammas)
- event topology in the tracker, calorimeter and ACD
- classification tree analysis (tens of carefully selected input variables; energy-dependent cut to boost proton rejection at high energy)

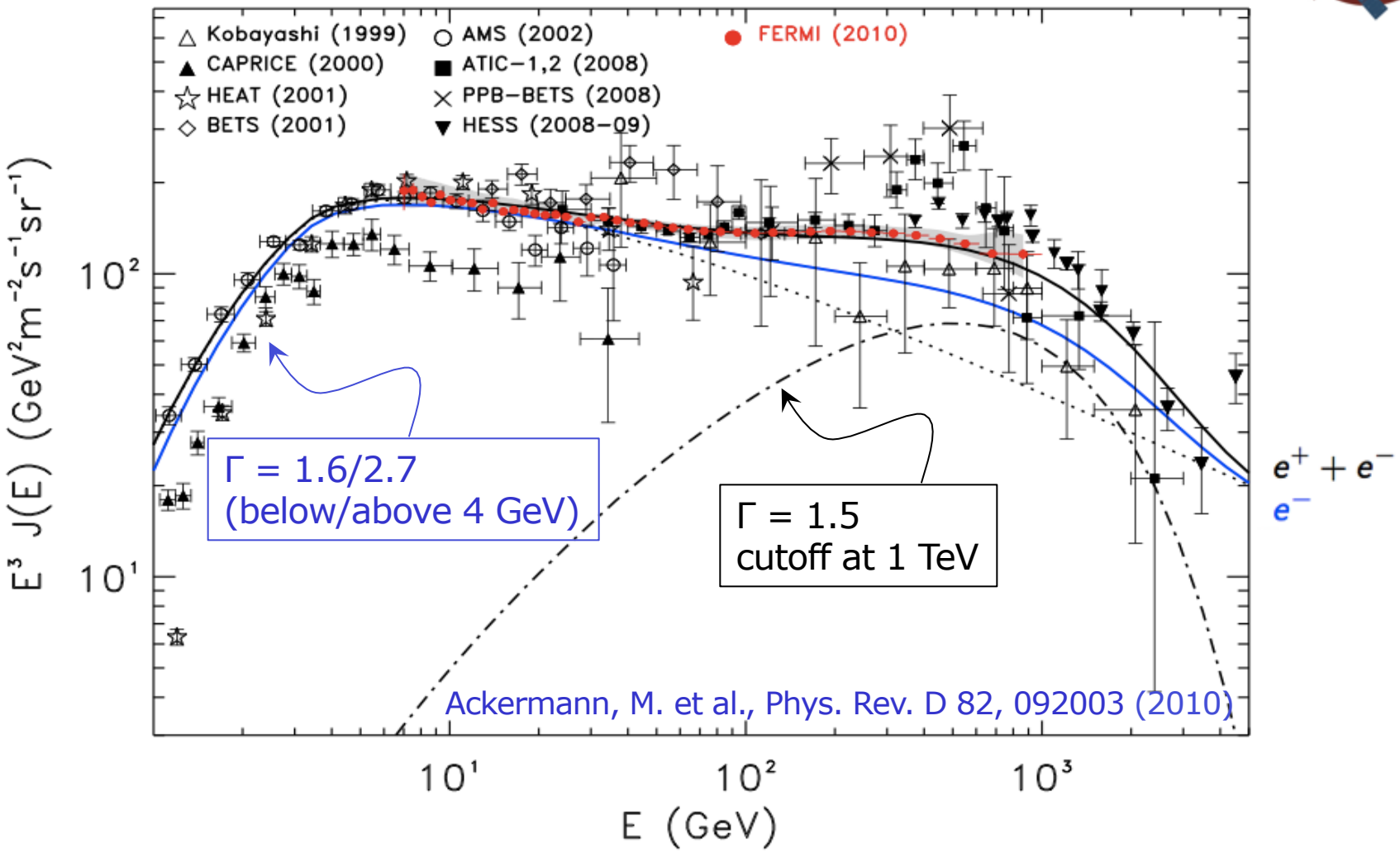
Electron + Positron Energy Spectrum



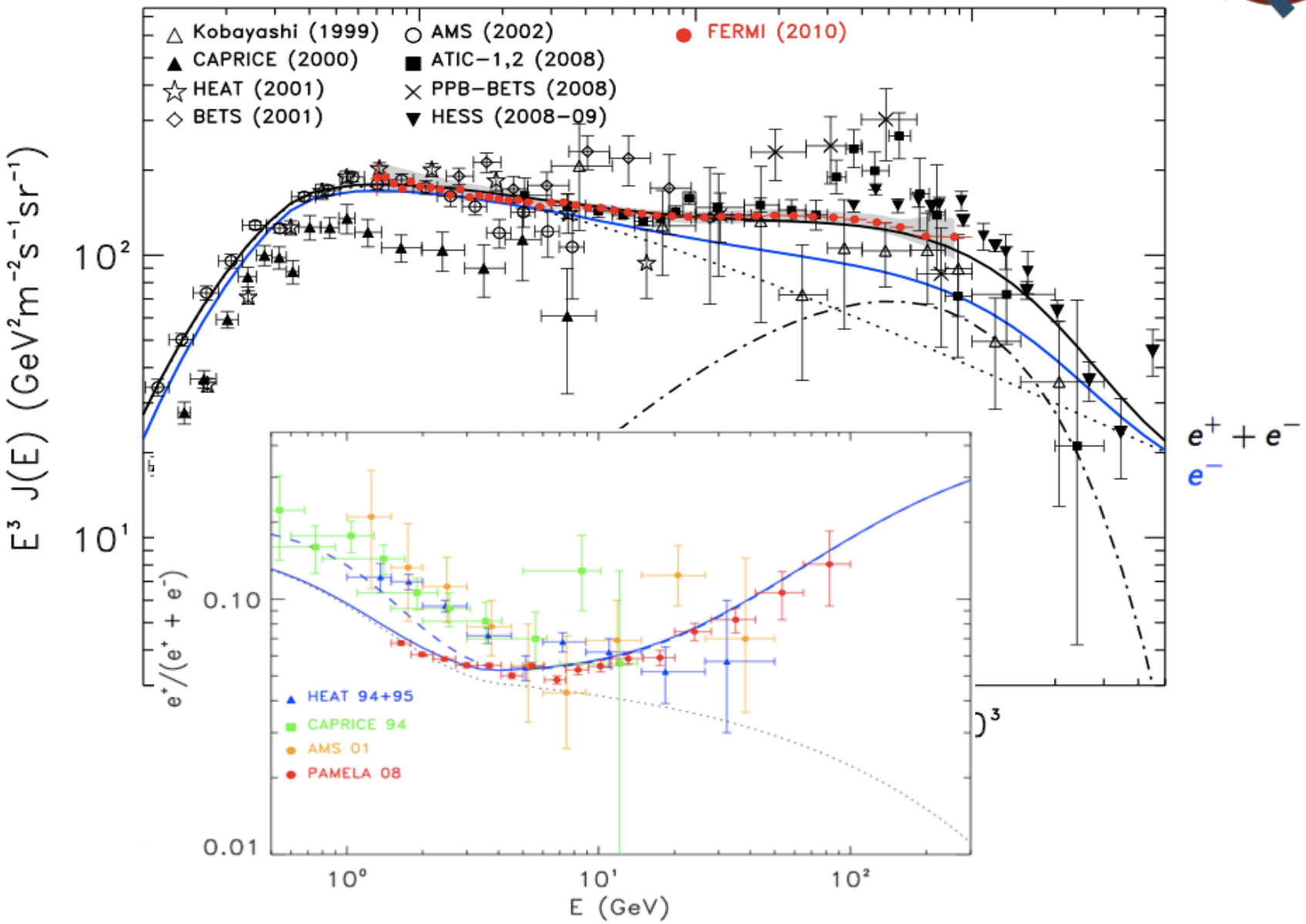
Ackermann, M. et al., Phys. Rev. D 82, 092004 (2010)

- spectrum is harder than in pre-Fermi GALPROP model ($\Gamma \sim 3.08$)
- diffusive models don't reproduce spectral features

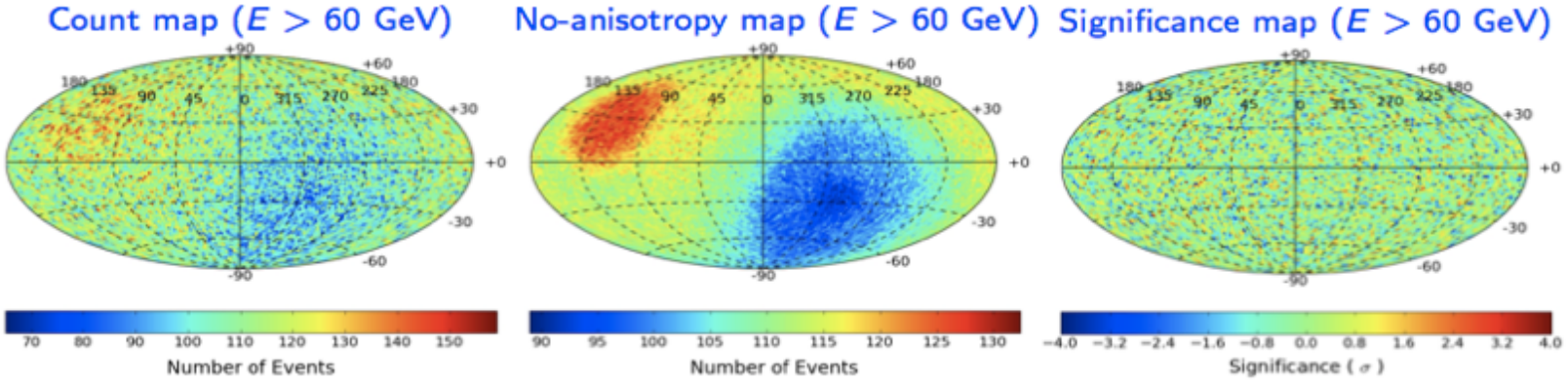
LOCAL(?) EXTRA-COMPONENT?



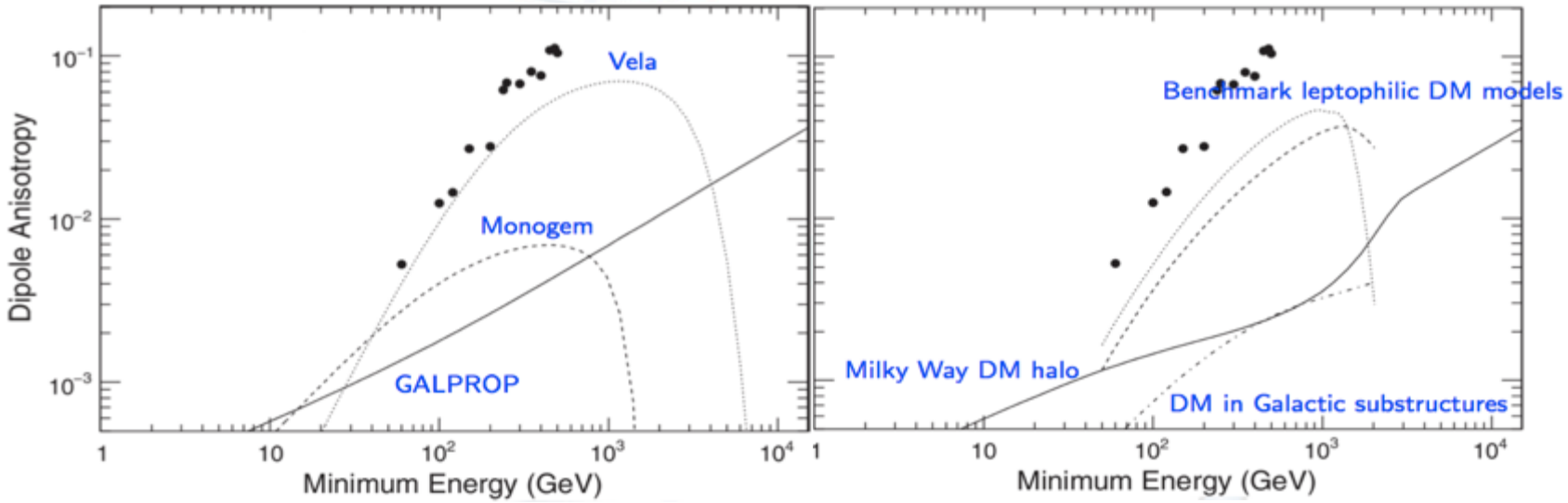
LOCAL(?) EXTRA-COMPONENT?



Search for Anisotropies in the CRE Flux



- more than 1.6 M candidate electrons above 60 GeV in the first year of the mission
- entire sky searched for anisotropies in Galactic coordinates: no anisotropies found
- upper limits for the dipole case ranging from 0.5% to 10% (comparable to the values expected for a single nearby source dominating the high-energy electron spectrum)

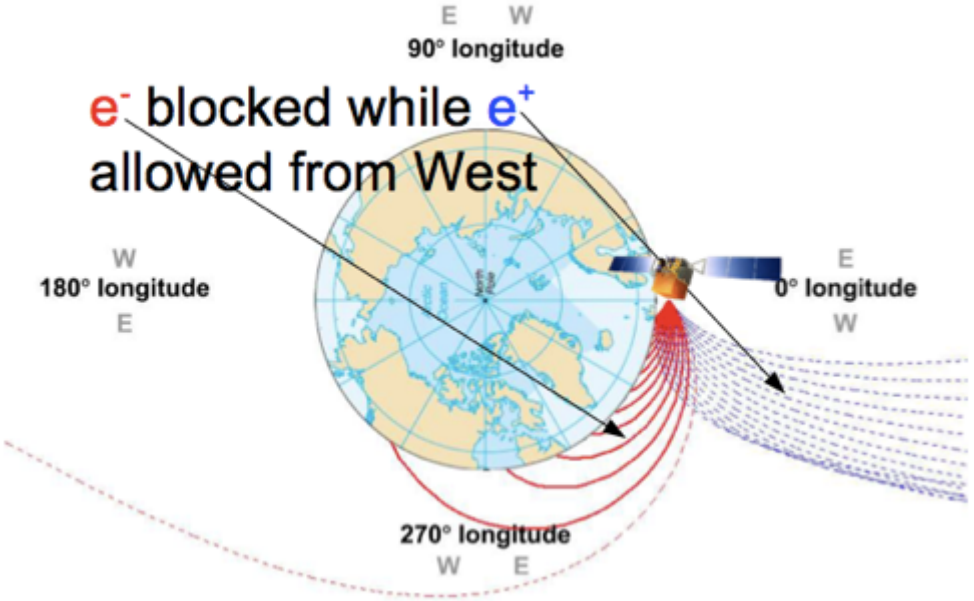


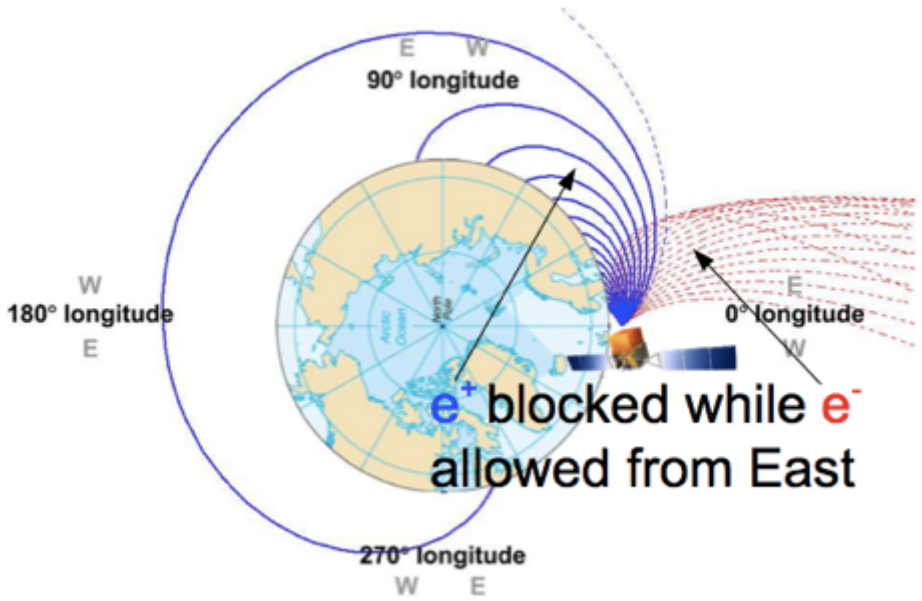
Ackermann, M. et al., Phys. Rev. D 82, 092003 (2010)

Measurement of the Positron Fraction

"Unfortunately", the LAT doesn't carry a Magnet. Therefore, we cannot Discriminate the Particle Charge ... or can we???

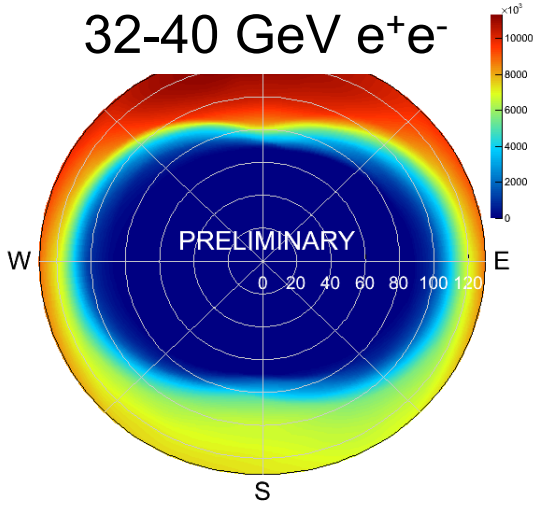
IDEA: Use the Earth Magnetic Field to Distinguish e^+ from e^-

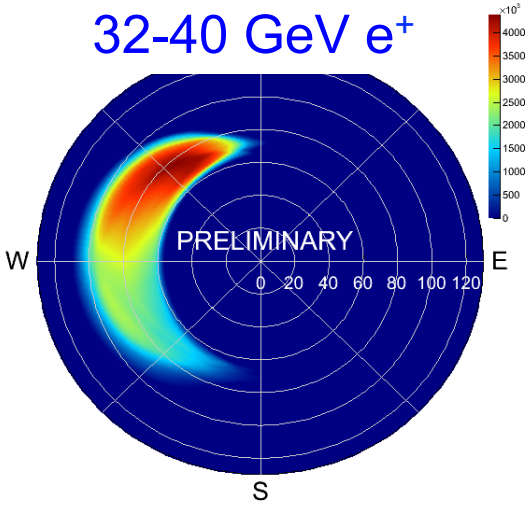


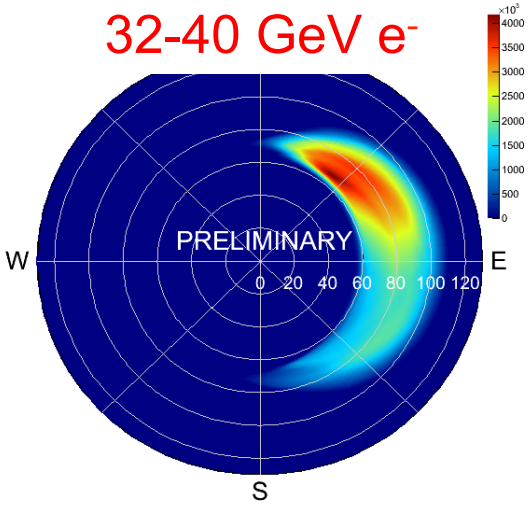


- pure e^+ region in the West and pure e^- region in the East
- the regions vary with particle energy and the LAT geomagnetic coordinates
- to locate these regions, we use a code written by Smart and Shea, which numerically calculates a particle's trajectory in the Earth geomagnetic field

Forbidden & Allowed Regions

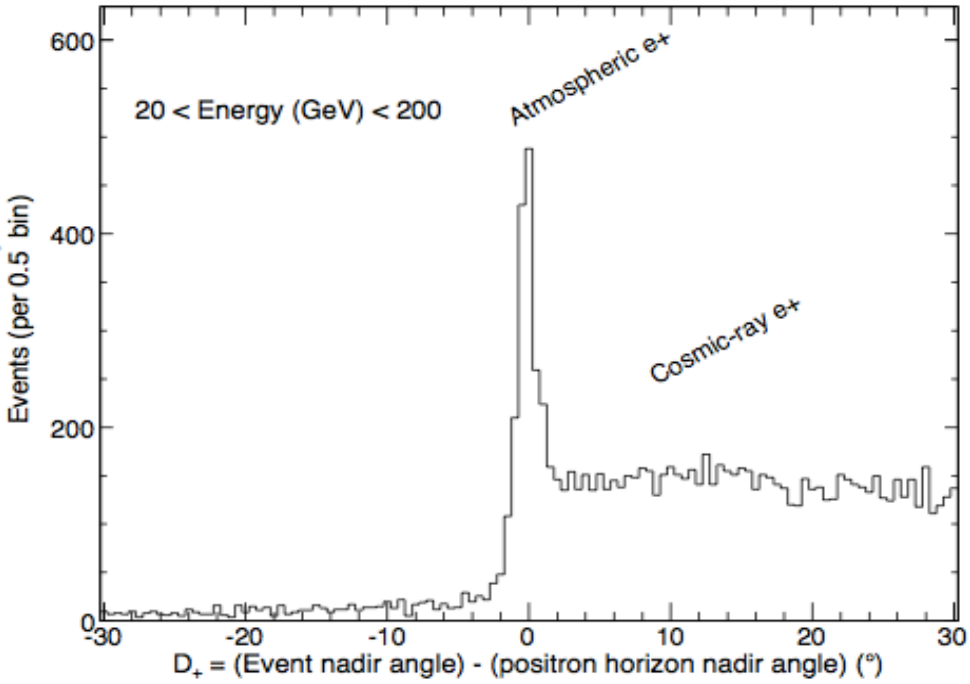




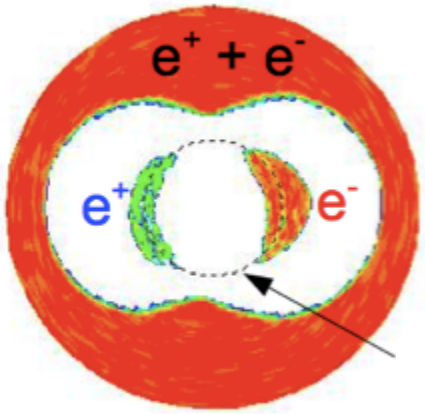


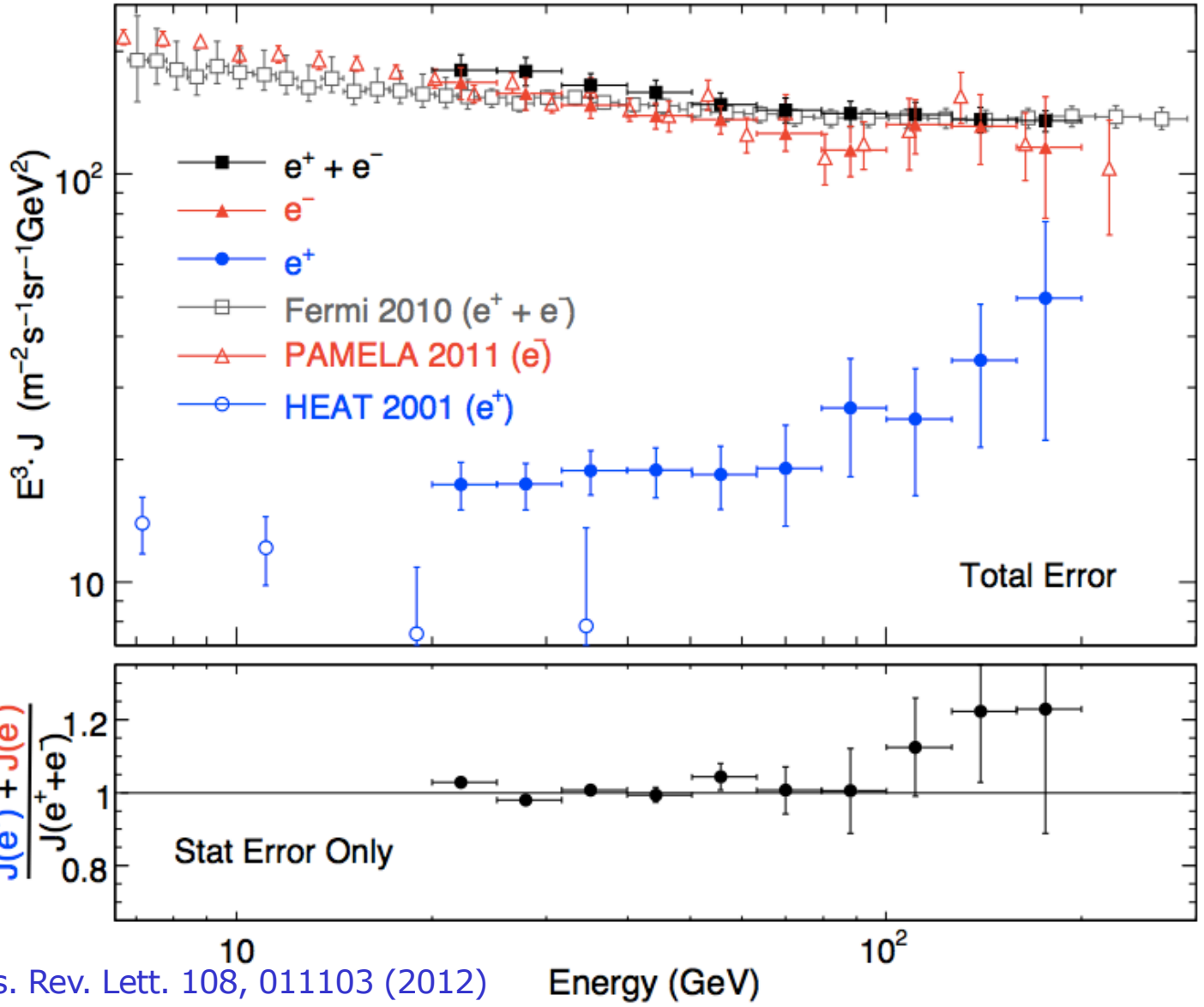
- All data when the Earth limb is within 60 deg from the center of the LAT FoV (~39 days of livetime so far)
- logarithmic energy binning, 10 bins per decade, starting from 20 GeV

- Atmospheric e^+ and e^- are located precisely where the particle tracking code predicts
- here is an example for atmospheric e^+



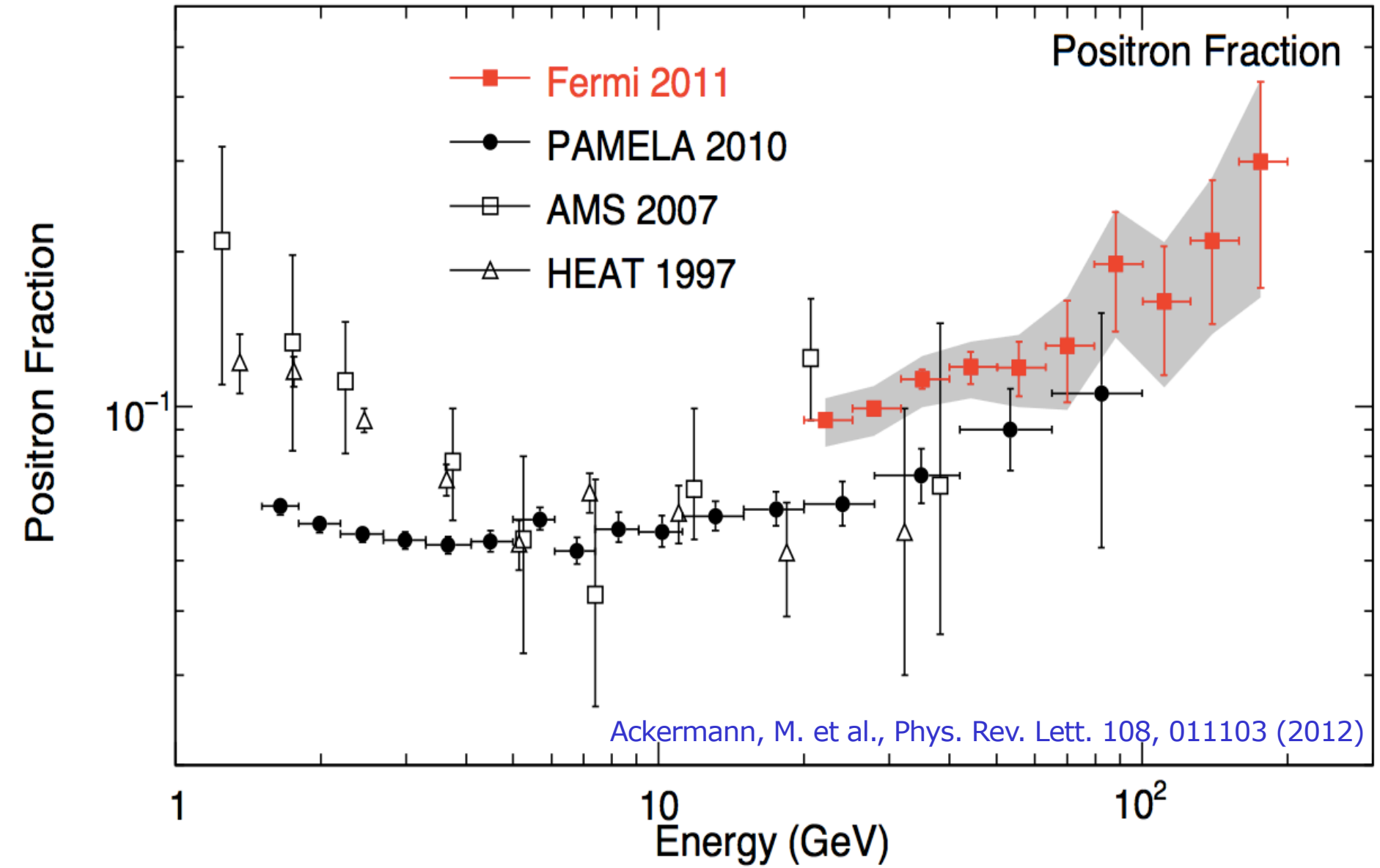
Electron and Positron Spectra



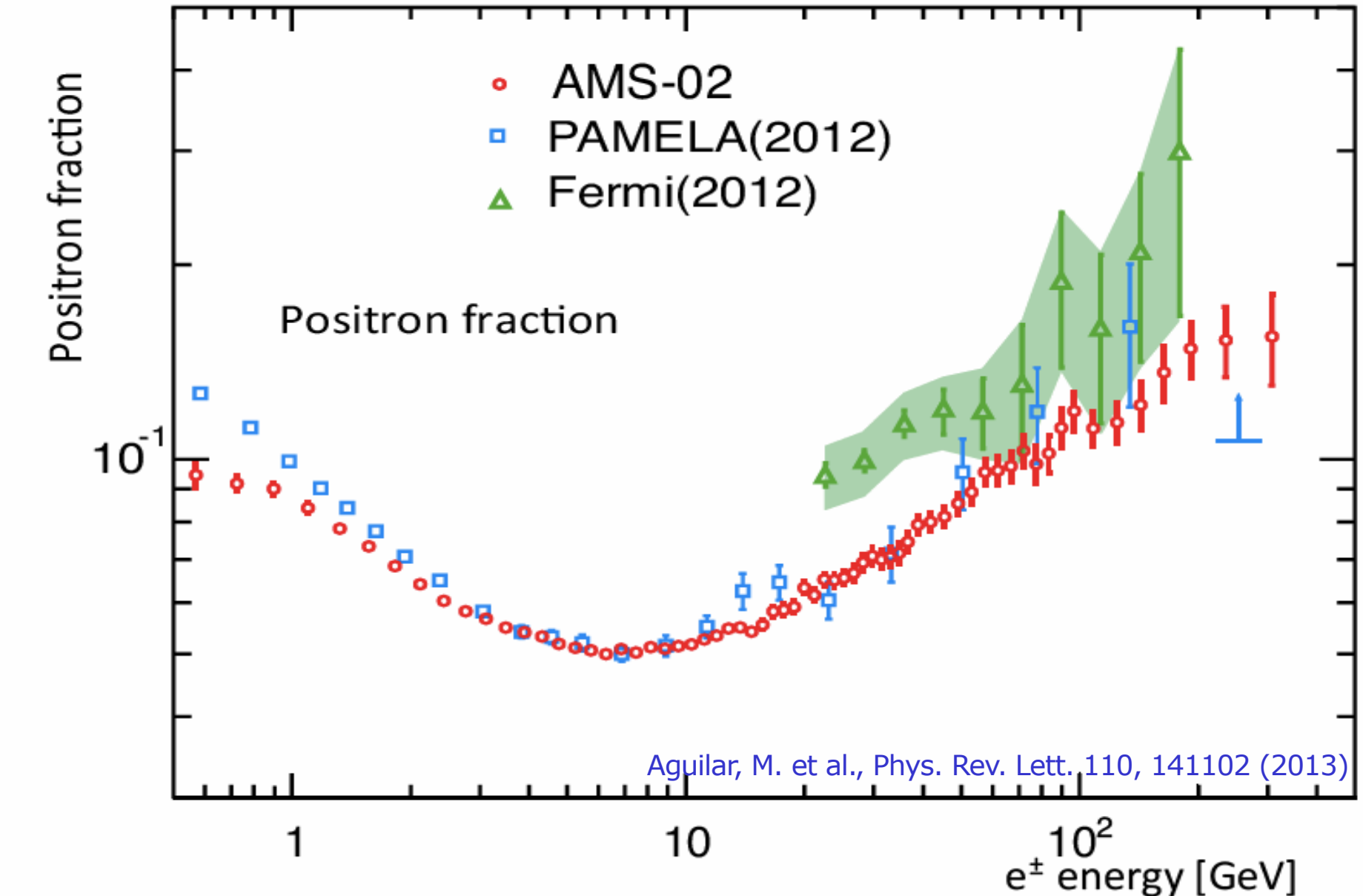


Ackermann, M. et al., Phys. Rev. Lett. 108, 011103 (2012)

The Positron Fraction with Fermi



POSITRON FRACTION: PAMELA, FERMI, AMS



Aguilar, M. et al., Phys. Rev. Lett. 110, 141102 (2013)