The GLAST Background Model

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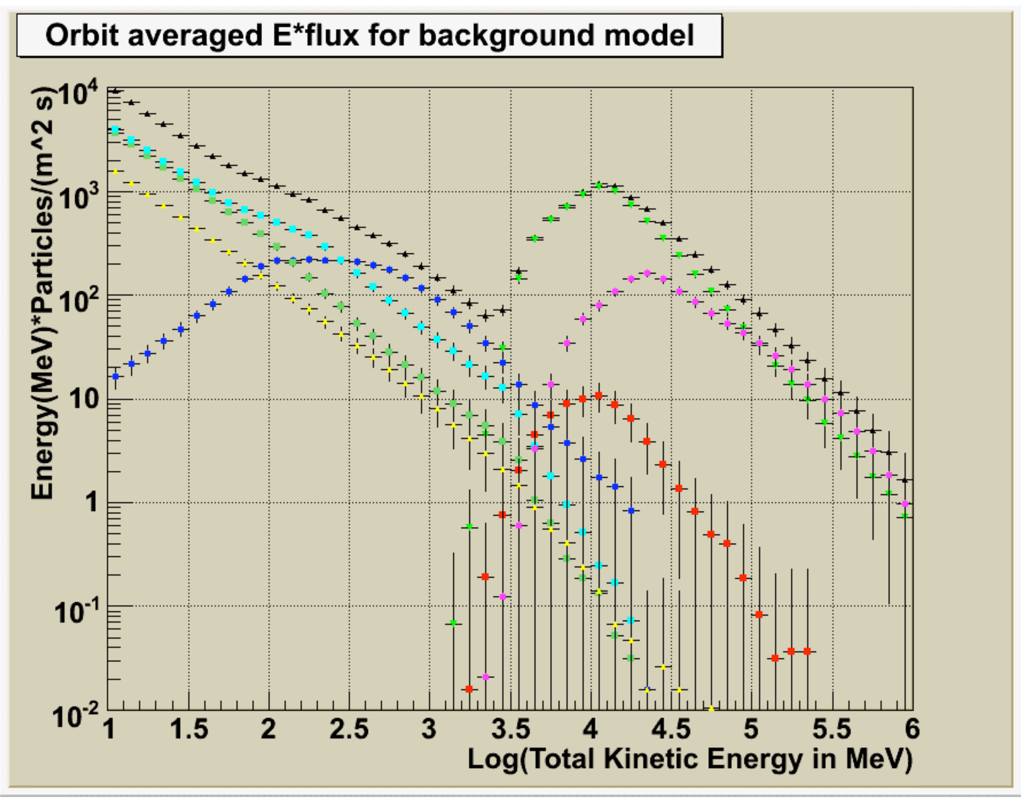
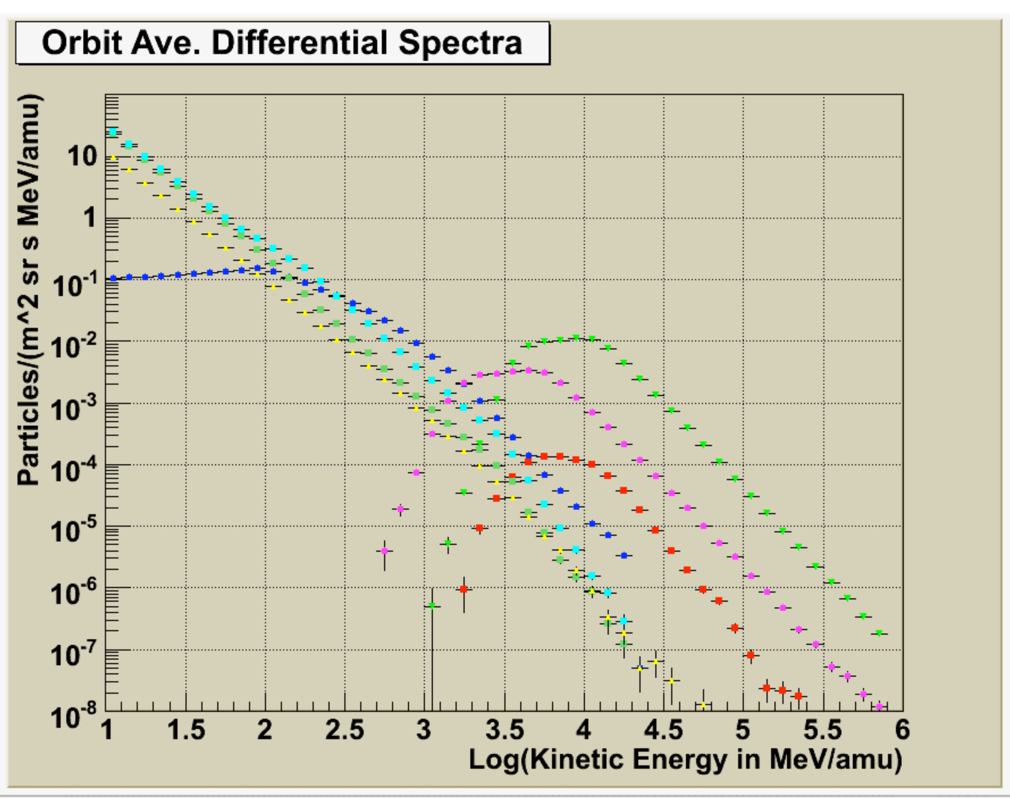
on behalf of the GLAST mission team

Abstract In order to estimate the ability of the GLAST/LAT to reject unwanted background of charged particles, optimize the on-board processing, size the required telemetry and optimize the GLAST orbit, we developed a detailed model of the background particles that would affect the LAT. In addition to the well-known components of the cosmic radiation, we included splash and reentrant components of protons, electrons (e+ and e-) from 10 MeV and beyond as well as the albedo gamma rays produced by cosmic ray interactions with the atmosphere. We made estimates of the irreducible background components produced by positrons and hadrons interacting in the multilayered micrometeorite shield and spacecraft surrounding the LAT and note that because the orbital debris has increased, the shielding required and hence the background are larger than were present in EGRET. Improvements to the model are currently being made to include the east-west effect.

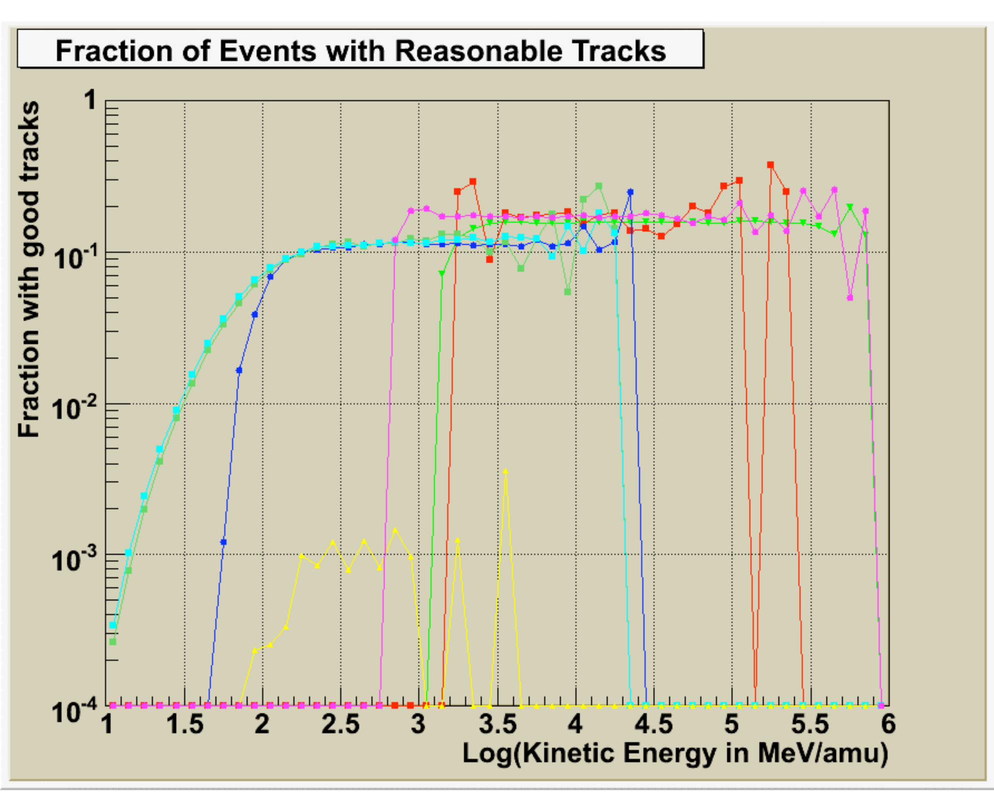
The details of the GLAST background flux model are outlined in this poster. Irreducible background will be produced by positrons annihilating in multilayer micrometeorite shield and protons, both galactic and albedo interacting in this same material. Positrons can annihilate in flight. Electrons and positrons can undergo a high fractional loss of energy by Bremsstrahlung. Protons can have interactions in which no resultant particle passes through a charge identifying counter (especially the anti-coincidence detector - ACD) while producing a gamma ray that is detected by the LAT. Also, in some orientations of the spacecraft, Earth Albedo gamma rays may not all be eliminated. The several components of this background are expected to vary along the orbit. The relative importance of each component will be determined by the orbit position and the arrival direction in local zenith pointing coordinates. By studying modulations of the background as a function of orbital parameters and arrival direction, the magnitude of these effects will be understood. The east-west effect will be helpful in separating components caused by particles of the opposite sign.



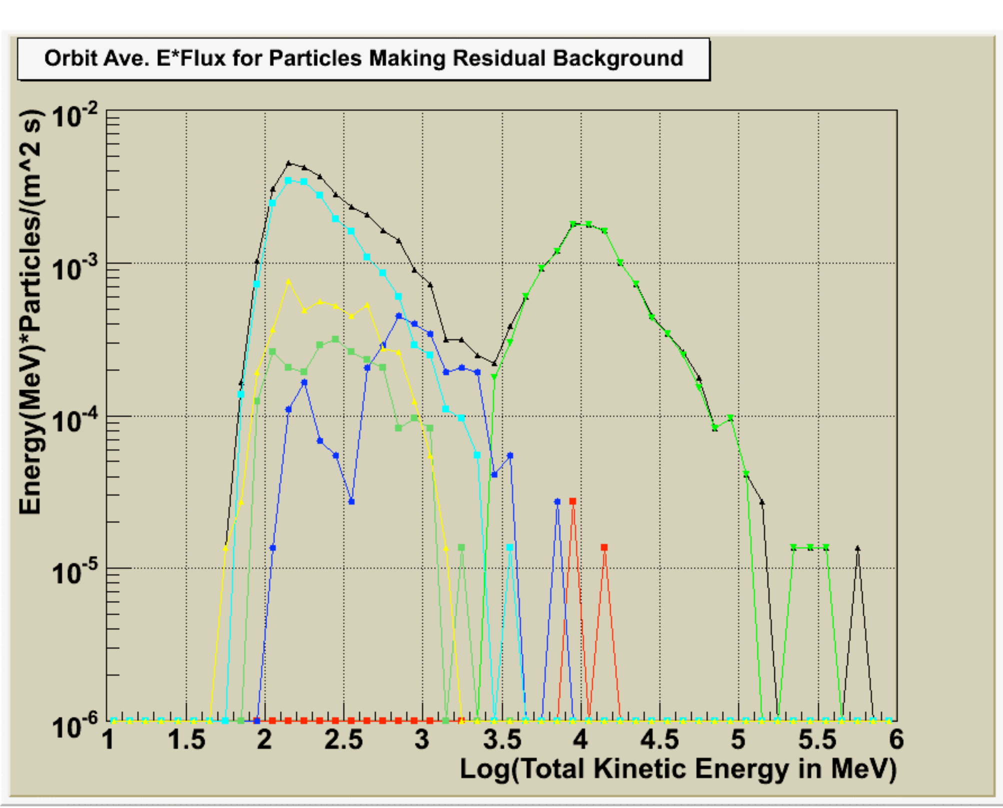
Orbit averaged background E*flux for estimating trigger rates and required downlink bandwidth.



Orbit averaged background differential model spectra for comparing with the input spectral data.



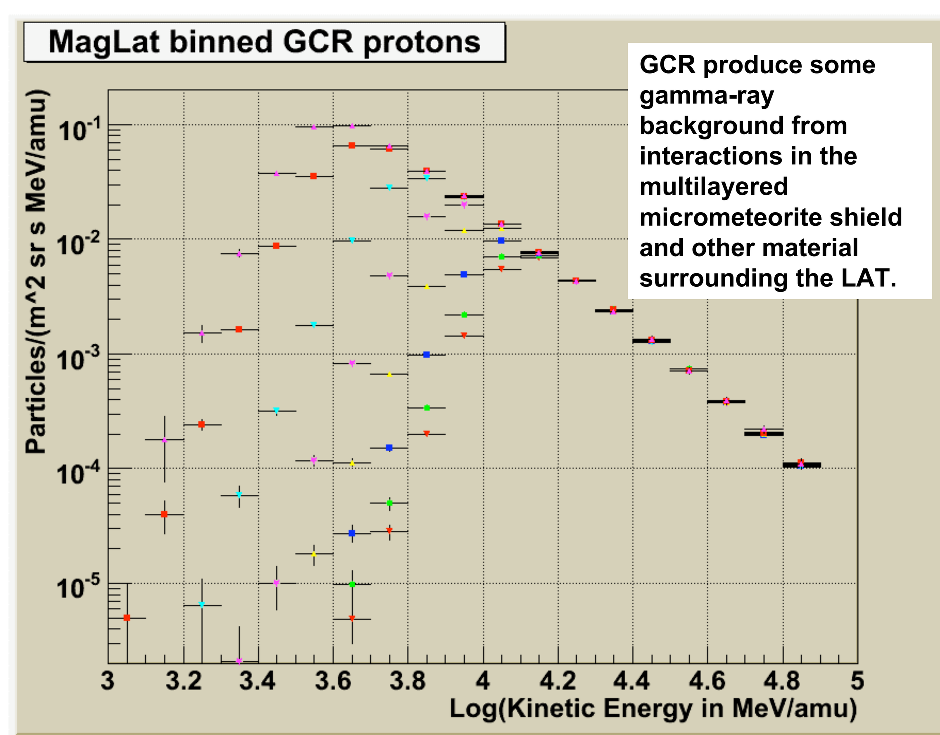
The fraction of simulated events that leave a well defined track as a function of particle type and energy. This plot can be thought of as the efficiency for events thrown at the 6 m^2 sphere to make a trigger.

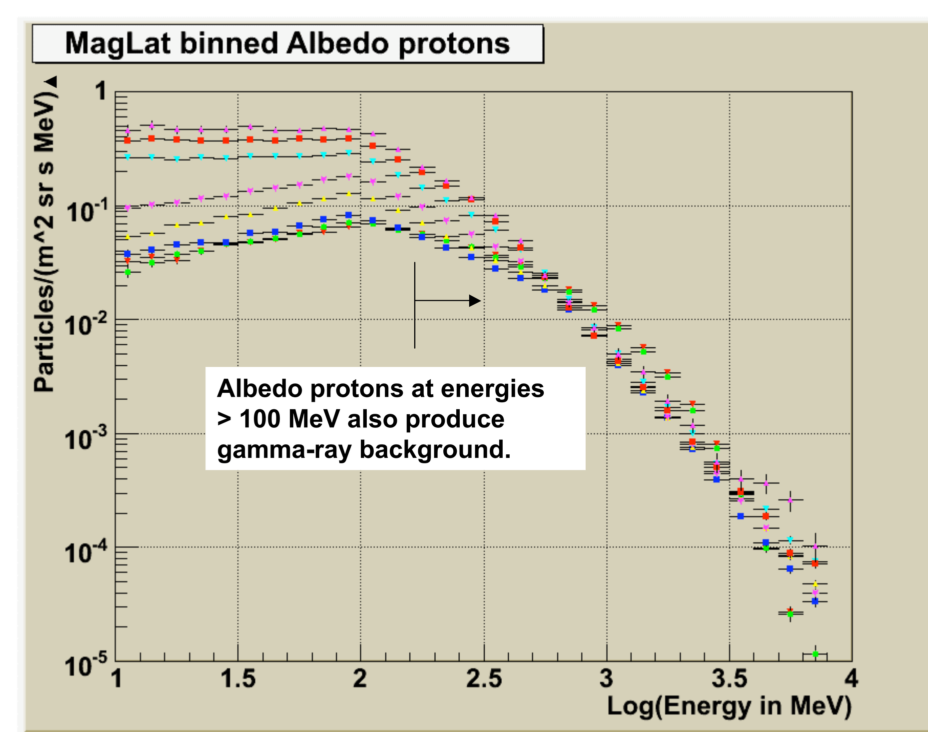


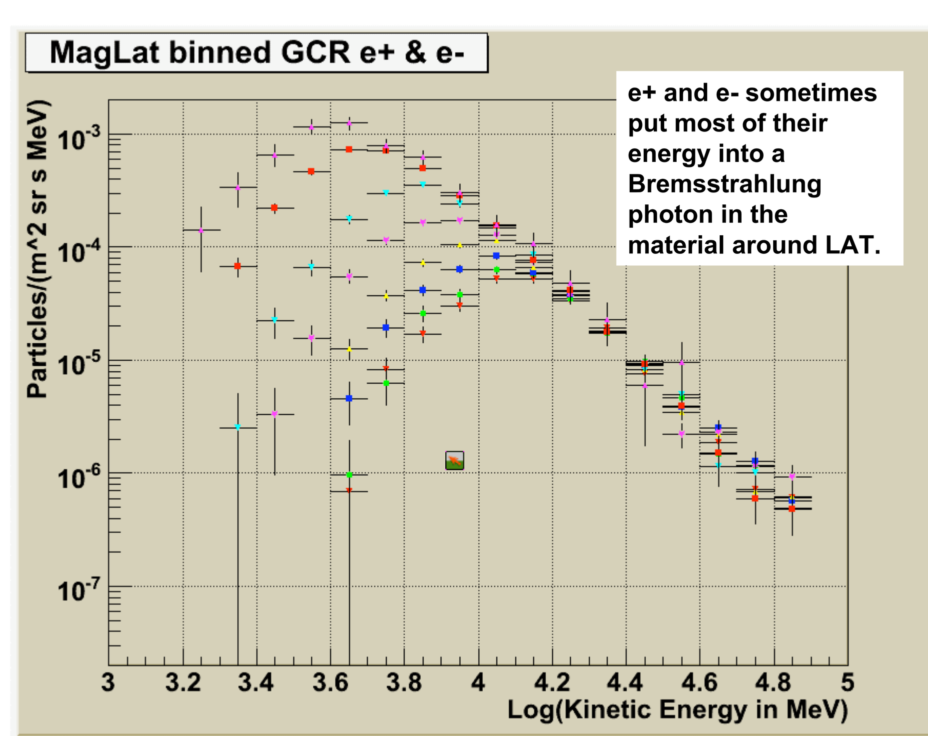
Input E*Flux plot for events that end up as residual gamma ray background by particle type. Comparing the top and bottom plots in this panel, we see that GCR protons are reduced by the factor 2 x 10^(-6) and one in a little over 100,000 positrons are creating a residual background.

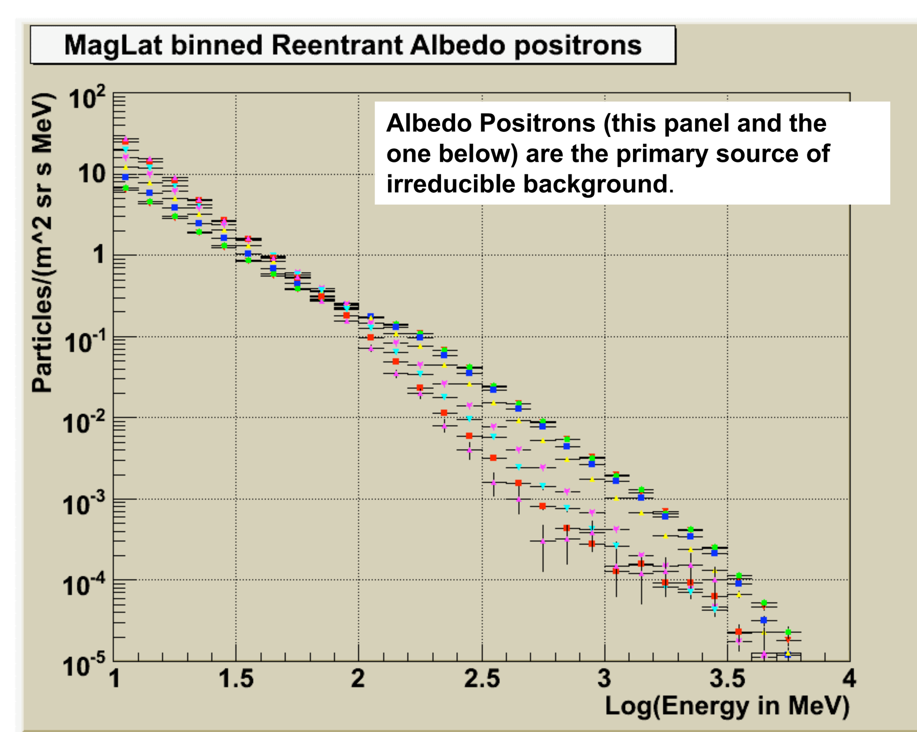
Legend for plots above: Black, total; light green, GCR protons; lavender, GCR He; red, GCR electrons; blue, albedo protons; light blue, albedo positrons; green, albedo electrons; and yellow albedo gammas.

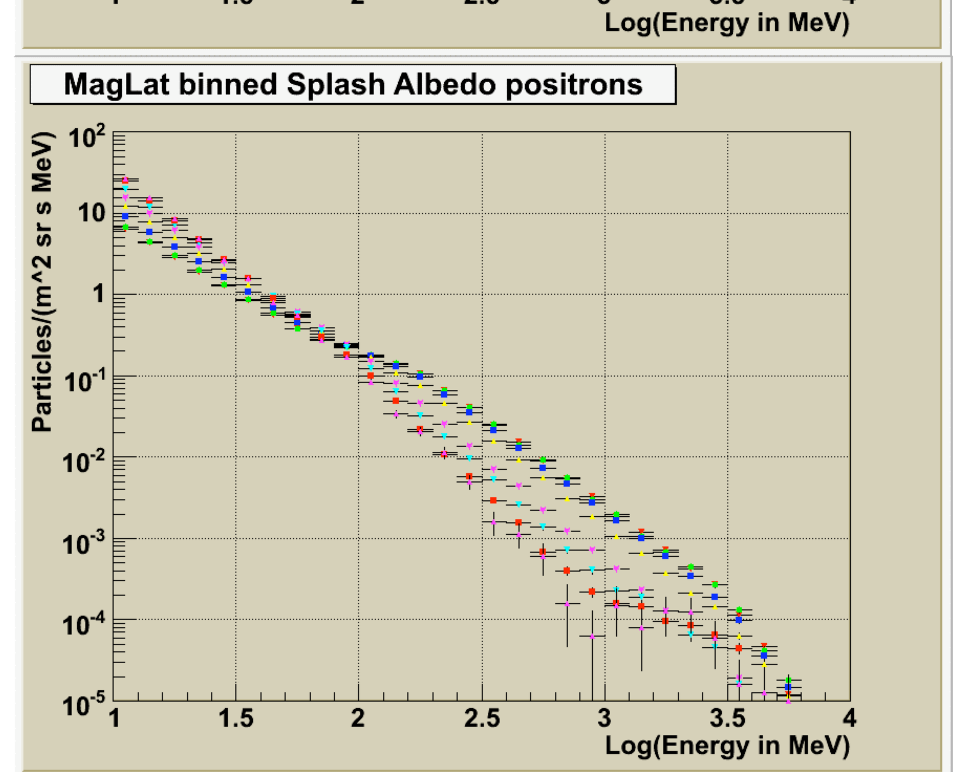
Galactic Cosmic Ray (GCR) Background Components for different Magnetic Latitudes (MagLat) from 0.1 to 0.8 radians









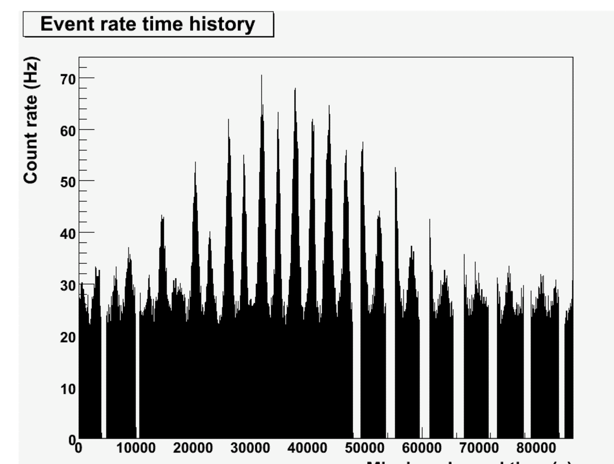


Above: Model GCR spectra in 0.1 radian geomagnetic latitude bins. These model spectra agree with the source data to within a few %.

- 0.0-0.1 down-pointing red triangles
- 0.1-0.2 green circles
- 0.2-0.3 blue squares
- 0.3-0.4 up-pointing yellow triangles
- 0.4-0.5 purple stars
- 0.5-0.6 down-pointing blue triangles
- 0.6-0.7 red squares
- 0.7-0.8 up-pointing purple triangles

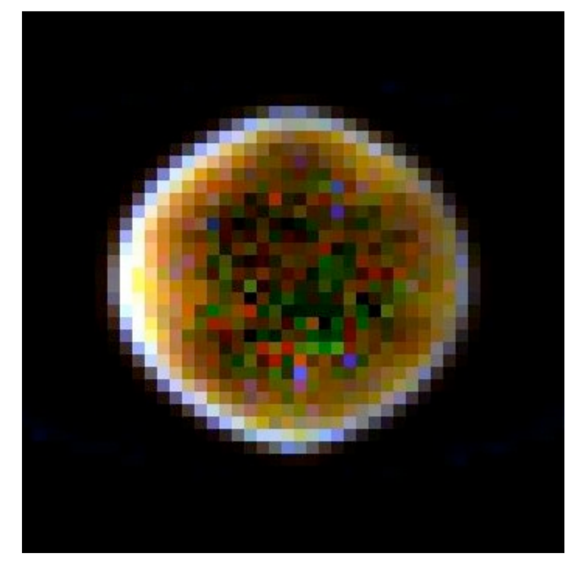
Right hand column: Model Earth albedo spectra in 0.1 radian geomagnetic latitude bins. These spectra are based on measurements by AMS and, below 100 MeV, by a series of Russian experiments. Protons >100 MeV and e+ > 20 MeV can interact in the multilayered micrometeorite shield (2 x as thick as that of EGRET) and make photons indistinguishable from celestial photons. Reentrant and splash albedo are modeled separately for e-, e+ and protons.

The model allows us to estimate the trigger rates under various conditions. The Figure shows the total trigger rate as a



function of time for a typical day. The rate drops to zero during SAA passages. The orbital period is 5400 s. There are two peaks per orbit from the highest latitudes (north and south).

The Earth's Gamma-ray Albedo as Observed by EGRET



The Earth albedo gamma-ray spectrum we use in the model is latitude independent. The east-west effect is clearly seen in the image. We have incorporated the east-west effect for this background component. The east-west effect will be implemented soon for charged particles.

References

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Conclusions

- The background model accurately reflects the measured galactic cosmic ray fluxes from 10 MeV up to 100 GeV
- Earth albedo positrons and electrons are modeled down to 10 MeV, but the uncertainties are increasingly large as we go below ~200 MeV reaching +/- 50% at 10 MeV. Sensitivity to background falls rapidly below 100 MeV.
- Estimating the uncertainty in the irreducible background depends on knowing the flux of positrons – results from Pamela will be able to improve the model and extend it to higher latitudes
- The east-west effect is being implemented
- This model is far more detailed than any other available model for satellites in low Earth orbit

Collaborating Institutions

The LAT is managed at Stanford Linear Accelerator Center (SLAC),
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