

## High-Energy Ground Level Events Measured with Neutron Monitors and the Milagro Instrument

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We report on Ground Level Events (GLE) seen simultaneously in the global neutron monitor (NM) network and the Milagro instrument. We pay special attention to the events of 1997 November 6 and 2005 January 20. These events were registered by Milagro, Climax and other NMs.

Milagro is a ground-level TeV gamma-ray telescope [1]. It detects gamma rays through the Cerenkov light emitted by secondary electrons in a large pond of water. The pond is light tight, is viewed by arrays of photomultiplier tubes and sits in the Jemez mountains in New Mexico, USA at an elevation of approximately 2630 m, 385 km south of the Climax NM. It registers solar protons by way of Cerenkov light emitted by secondary muons and electrons from reactions of cosmic-ray protons with the atmosphere. Consequently, because it is near Climax it has a similar geomagnetic vertical cutoff rigidity, but because of the process for detecting solar protons, it has a greater atmospheric cutoff than Climax. Thus, these two stations are well suited for studying GLEs, especially those that are anisotropic. Little intrinsic difference is expected in the flux of protons at these locations but they register the same event differently. Beyond this, Milagro has several data channels (scalers) in which to measure the intensity of the event. These channels differ in the number of photomultiplier tubes that trigger at any time. Greater multiplicity signals arise, statistically speaking, from higher energy protons at the top of the atmosphere. By combining data from Climax and several Milagro data channels one can investigate the behavior of the high end spectrum of many GLEs, including the spectrum cutoff, onset and rise time. If the cosmic-ray energy is great enough an extensive air shower is produced and the response of the instrument is recorded on an event-by-event basis, providing an incident direction.

We present results from two GLEs, the 1997 November 6 event detected with the Milagro prototype[2] and the 2005 June 20 event. We also present results from the 2003 October/November period of solar activity, including the Forbush decrease on October 31 seen in some of the highest energy channels of Milagro.

Keywords: CME; solar energetic particles; solar protons; solar cosmic rays; ground level events; Forbush decreases.

## References

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