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## Unseen GLEs (Ground Level Events)

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Over the last seventy years, solar energetic particle (SEP) ground level events (GLEs) have been observed by ground-based neutron monitors and muon telescopes at a rate of slightly more than one per year. Ground-based detectors only measure secondary particles, and matching their observations with SEP in-situ measurements at lower energies from spacecraft has been difficult. Now, the Payload for Antimatter Matter Exploration and Light-nuclei Astrophysics (PAMELA) instrument provides in-situ measurements that also include composition and pitch-angle distribution and bridge the energy between long-term SEP monitors in space (e.g. ACE and GOES) and the ground-based observations. The PAMELA data show that there are some SEP events (e.g. 23 Jan 2012) where PAMELA sees high-energy ( $> 1$  GeV) particles, yet these are not registered as GLEs. The PAMELA observations indicate that it is possible for the anisotropic distribution of the highest energy SEPs to miss the global network of neutron monitors.

### Collaboration

– not specified –

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**Primary author:** CHRISTIAN, Eric (NASA/GSFC)

**Co-authors:** BRUNO, Alessandro (Bari University, Italy); MOCCHIUTTI, Emiliano (INFN (Trieste)); Dr DE NOFLO, Georgia (NASA/GSFC Code 672); RYAN, James (University of New Hampshire); RICCI, Marco (Istituto Nazionale Fisica Nucleare Frascati (IT)); MARTUCCI, Matteo (Università di Roma Tor Vergata); MERGE, Matteo (INFN (Rome)); BOEZIO, Mirko (Università e INFN (IT)); MUNINI, Riccardo (INFN - Università Studi Trieste); STOCHAJ, Steve (New Mexico State University); BRAVAR, Ulisse (University of New Hampshire)

**Presenter:** CHRISTIAN, Eric (NASA/GSFC)

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