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How hard are strong Ground Level Enhancement (GLE) events?

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We present the result of an analysis of the hardness of most (59 out of 67) Ground Level Enhancement (GLE) events recorded by the worldwide neutron monitor network. We calculated the event-integrated omnidirectional fluence of protons above 30MeV (F30) and above 200MeV (F200) using a reconstruction by Tylka and Dietrich, and considered their ratio F200/F30 as the measure of the spectrum hardness. We used the Band-function approximation of the spectrum shape and checked its validity with direct data of PAMELA space-borne instrument for GLE 71. We used the relative increase of the neutron monitor count rate above the galactic cosmic rays flux from the neutron monitor with the highest record to characterize the strength of each event. We found that, while weak and medium GLE events have very different spectra, soft or hard, without any apparent relation to the events strength, all strong GLE events (with the integral intensity exceeding 1000 %*hr) are characterized by a very hard spectrum. This allows to evaluate the lower-energy fluence of solar energetic particles for strong GLE events in the pre-space era.

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