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# Hourly measurements of cosmic-ray spectral variation during Forbush decreases using ground-based neutron and muon detectors

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Solar storms can disturb Galactic cosmic-ray (GCR) fluxes within the heliosphere at short time scales in events known as Forbush decreases (FDs). We extract hourly GCR spectral variations during FDs from a global network of ground-based neutron monitors and muon detectors using two independent methods: A) fitting a GCR rigidity spectral model with anisotropy up to second order, and B) analyzing time delay distributions between successive neutron detections by each counter of the South Pole Neutron Monitor to obtain the "leader fraction". Both methods provide consistent results for spectral index variations during five major FDs between 2015 to 2023 and agree very well with the daily space-based observations by AMS-02 when such data are available. This analysis demonstrates the precision level of ground-based spectral measurements and offers techniques for real-time space weather monitoring (publicly available at https://neutronm.bartol.udel.edu/realtime/southpole.html) for use in FD studies and space weather alerts. Partially supported by the National Science and Technology Development Agency (NSTDA) and National Research Council of Thailand (NRCT): High-Potential Research Team Grant Program (N42A650868).

## Collaboration(s)

The Global Muon Detector Network Collaboration

**Authors:** MITTHUMSIRI, Warit (Department of Physics, Faculty of Science, Mahidol University); RUFFOLO, David (Mahidol University); Prof. MUNAKATA, Kazuoki (Shinshu University)

**Co-authors:** NUNTIYAKUL, Waraporn (Chiang Mai University); Dr SÁIZ, Alejandro (Mahidol University); Prof. EVENSON, Paul (University of Delaware); MANGEARD, Pierre-Simon (University of Delaware); MUANGHA, Pradiphat (Mahidol University)

**Presenter:** MITTHUMSIRI, Warit (Department of Physics, Faculty of Science, Mahidol University)

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