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On the mystery of the multi-muon flux at the TeV cosmic-ray energy range

The muon component of air showers is not yet well described by actual Monte Carlo simulations. Many air shower experiments report discrepancies between data and Monte Carlo predictions, ranging from the TeV scale to the highest energies.
One example we address is the seasonal variation of multiple-muon events with energies above 50 GeV observed by the NOvA Near Detector (ND). For our studies, we use the general-purpose Monte Carlo code Fluka to treat the transport and interactions of the shower particles in several media. Our design considers a multi-layered atmosphere and a layered underground approximated to the NOvA Near Detector (ND) location and geometry. Our atmosphere model uses winter and summer air densities calculated from the temperatures and geopotential information for the pressure levels given by the European Center for Medium-Range Weather Forecasts (ECMWF) datasets *in situ*. Understanding the multi-muon flux in the High-Energy range may lead to a better description of Ultra-High-Energy muon production mechanisms in extensive air showers. In addition, it can help improve future Monte Carlo codes or hint at new physics processes or interactions.

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