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Unveiling the seasonal variation of multi-muon events at the NOvA Detector

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In this contribution, we investigate the seasonal variation of multi-muon events, as observed by the NOvA Near Detector (ND) at Fermilab, using the general-purpose Monte Carlo code FLUKA, which simulates the transport and interaction of the air-shower particles in the atmosphere and other media. The upper atmosphere temperature suffers a seasonal variation over the year. Due to this phenomenon, an increasing flux of muons in summer over winter is expected, as observed for single muons, but not for multi-muon events, which presents an opposite seasonal variation. Our atmospheric model uses air densities for winter and summer calculated from the temperature and geopotential information at 37 pressure levels given by the European Center for Medium-Range Weather Forecasts (ECMWF) datasets in situ. Our FLUKA geometry model also considers a layered underground approximated to match the NOvA ND location. We compare our simulation results with the seasonal flux modulation of the multi-muon events detected by NOvA-ND. For the first time, we can quantitatively describe the multi-muon excess in winter over summer and obtain the dependence on the multi-muon event multiplicity observed by NOvA. Finally, we compare our results with the previous work from other authors based on CORSIKA simulations. We try to understand the reasons for the discrepancy by nearly a factor of four between the results of two Monte Carlo codes.

Submitted on behalf of a Collaboration?

No

Authors: SANTOS, Eva; TUNEU, Jordi (Institute of Physics of the Czech Academy of Science); Dr FILIP, Peter (Institute of Physics, ASCR, Prague)

Presenter: TUNEU, Jordi (Institute of Physics of the Czech Academy of Science)

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