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Multiplicity of TeV muons in air showers measured with IceTop and IceCube

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The IceCube Neutrino Observatory at the South Pole can provide unique tests of muon production models in extensive air showers by measuring both the low-energy (GeV) and high-energy (TeV) muon components. We present here a measurement of the TeV muon content in near-vertical air showers detected with IceTop in coincidence with IceCube. The primary cosmic-ray energy is estimated from the dominant electromagnetic component of the air shower observed at the surface. The high-energy muon content of the shower is studied based on the energy losses measured in the deep detector. Using a neural network, the primary energy and the multiplicity of TeV muons are estimated on an event-by-event basis. The baseline analysis determines the average multiplicity as a function of the primary energy between 3 PeV and 300 PeV using the hadronic interaction model Sibyll 2.1. Results obtained using simulations based on the post-LHC models QGSJet-II.04 and EPOS-LHC are presented for primary energies up to 100 PeV. For all three hadronic interaction models, the measurements of the TeV muon content are consistent with the predictions assuming recent composition models. Comparing the results to measurements of GeV muons in air showers reveals a tension in the obtained composition interpretation based on the post-LHC models.

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