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A combined analysis from the WHISP working group on the muon data from ten extensive air shower experiments [Online]

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The muon content of extensive air showers is not only important for the study of the elemental composition of cosmic rays, but also serves as a test and validation of modern high-energy hadronic interaction models at laboratory energies well above 1 PeV. This line of research has led to the discovery of several discrepancies between the model predictions and the measurements on the muon content. The most impactful discrepancy is the deficit of muons in MC simulations in comparison to air shower data, a problem that has been called the muon puzzle. To study the characteristics of this anomaly, the WHISP working group has compiled the data from ten air shower experiments and has analyzed the behavior of the measurements in comparison with the predictions of different post-LHC hadronic interaction models and as a function of the primary energy. The study was done for energies between 10 PeV and 60 EeV. Differences in the energy scale among the experiments are corrected by applying a constant energy-scale shift per experiment. The combined analysis shows a muon deficit in the MC simulations in several experiments above 100 PeV, with the deficit in simulated muons increasing with the primary energy. However, it also reveals that this anomaly is not observed by all experiments. Some experiments are in agreement with the MC predictions and show an opposite trend as a function of energy. In consequence, the observation of the muon puzzle may depend on the experimental conditions.

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