

# Measurement of the muon content in air showers at the Pierre Auger Observatory

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The muon content of extensive air showers produced by the ultra-high energy cosmic rays is an observable sensitive to the composition of the primary particle and to the properties of hadronic interactions driving the air-shower cascade. We present different methods to estimate the muon number at the ground and the muon production depth using measurements of the longitudinal, lateral, and temporal distribution of particles in the air showers recorded by the Pierre Auger Observatory. The results, obtained at about 140 TeV center-of-mass energy for proton primaries, are compared to the predictions of LHC-tuned hadronic interaction models for different primary masses. The models exhibit a deficit in the predicted muon content. The Pierre Auger Observatory is a hybrid detector sensitive to muons and the combination of these results with other independent mass composition analyses such as  $X_{\text{max}}$  provides additional constraints on hadronic interaction models for energies beyond the LHC reach.

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