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A measurement of the muon number in showers using inclined events detected at the Pierre Auger Observatory

The average muon content of measured showers with zenith angles between 60 and 80 degrees detected at the Pierre Auger Observatory is
obtained as a function of shower energy using a reconstruction method
specifically designed for inclined showers and the hybrid character of the detector. The reconstruction of inclined showers relies on a comparison between the measured signals at ground and reference patterns at ground level from which an overall normalization factor is obtained. Since inclined showers are dominated by muons this factor gives the relative muon size. It can be calibrated using a subsample of showers simultaneously recorded with the fluorescence detector (FD) and the surface detector (SD) which provides an independent calorimetric measurement of the energy. The muon size obtained for each shower becomes a measurement of the relative number of muons with respect to the reference distributions. The precision of the measurement is assessed using simulated events which are reconstructed using exactly the same procedure. We compare the relative number of muons versus energy as obtained in simulations with that measured in data. Proton simulations with QGSJETII show a factor of 2.13 +- 0.04(stat) +- 0.11(sys) at 10^19 eV without significant variations in the energy range explored between 4.10^18 eV to 7.10^19 eV. We find that none of the current shower models, neither for proton nor for iron primaries, are able to predict as many muons as are observed.

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