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Muon measurements at the Pierre Auger Observatory

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The Pierre Auger Observatory is the world's largest detector for the observation of ultra-high-energy cosmic rays (UHECRs) (above the energy of 10ˆ17eV), consisting of a Fluorescence Detector and surface particle detectors known as the Surface Detector (SD). Observations of extensive air showers by the Pierre Auger Observatory can be used to probe hadronic interactions at high energy, in a kinematic and energy region inaccessible to man-made accelerators and to measure muons numbers. Air showers induced by different primaries have different muon contents - with increasing mass of the primary cosmic ray particle, it is expected that the muon content in the corresponding air showers should also increase.Therefore, the determination of the muon component in the air shower is crucial to infer for each event to conclude about the mass of the primary particle, which is a key ingredient in the searches conducted to pinpoint the sources of UHECRs. Recent results obtained from the Pierre Auger Observatory and other experiments indicate that all the simulations underestimate the number of muons in the showers compared to hadronic model expectations, which is the so-called muon deficit. In this talk we will briefly review the muon measurements, and we will present in more detail recent results from the Observatory on fluctuations in the muon number. These results provide new insights into the origin of the muon deficit in air shower simulations and constrain the models of hadronic interactions at ultrahigh energies. With the current design of the surface detectors it is also difficult to straightforwardly separate the contributions of muons to the SD time traces from the contributions of photons, electrons, and positrons. Therefore, we will also present a new method to extract the muon component of the time traces recorded by each SD detector using recurrent neural networks. The combination of such algorithms, with the future data collected by the upgraded Pierre Auger Observatory, will be a major step forward, as we are likely to achieve an unprecedented resolution in mass estimation on an event-by-event basis.

Preferred track

Cosmic Rays and Astrophysics

Subfield

Astrophysics

Attending in-person?

Yes

On behalf of collaboration?

Pierre Auger Collaboration

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