

The depth of the shower maximum of air showers measured with AERA

Monday, 3 October 2022 17:40 (20 minutes)

The Auger Engineering Radio Array (AERA), as part of the Pierre Auger Observatory, is an array of radio antennas probing the nature of ultra-high energy cosmic rays at energies around the transition from Galactic to extra-galactic origin. It measures the MHz radio emission of extensive air showers produced by cosmic rays hitting our atmosphere. The elemental composition of cosmic rays is a crucial piece of information in determining what the sources of cosmic rays are and how cosmic rays are accelerated. This composition can be obtained from the mass-sensitive parameter X_{\max} , the depth of the shower maximum. We reconstruct X_{\max} with a likelihood analysis, by comparing the measured radio footprint on the ground to an ensemble of footprints from Monte-Carlo CORSIKA/CoREAS air shower simulations. We compare our X_{\max} reconstruction with fluorescence X_{\max} measurements on a per-event basis, a setup unique to the Pierre Auger Observatory, and show the methods to be fully compatible. Furthermore, we extensively validate our reconstruction by identifying and correcting for systematic uncertainties. We determine the resolution of our method as a function of energy and reach a precision better than 15 g cm^{-2} at the highest energies. With a bias-free set of around 600 showers, we find a light to light-mixed composition at energies between $10^{17.5}$ to $10^{18.8}$ eV, also in agreement with the Auger fluorescence measurements.

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