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Mass Composition and More: Results from the Auger Engineering Radio Array

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The Auger Engineering Radio Array (AERA), as part of the Pierre Auger Observatory, is an array of 153 radio antennas spanning an area of 17 km^2, currently the largest of its kind, that probes 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. In this talk, we will present the recent work by AERA, such as the measurement of the muon content of inclined air showers and the stability of the measured radio signal over almost a decade, as measured with the Galactic radio background. In particular, we highlight the measurements of the depths of the shower maxima X_{max}, which we use to make inferences about the mass composition of cosmic rays. 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 $\mathrm{g\,cm}^{-2}$ 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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