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## Precision measurements of cosmic rays up to the highest energies with a large radio array at the Pierre Auger Observatory

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High-energy cosmic rays impinging on the atmosphere of the Earth induce cascades of secondary particles, the extensive air showers. Many particles in the showers are electrons and positrons. Due to interactions with the magnetic field of the Earth they emit radiation with frequencies of several tens of MHz. In the last years huge progress has been achieved in this field through strong activities of various groups. The radio technique is now routinely applied to measure the properties of cosmic rays, such as their arrival direction, their energy, and their particle type/mass.

Horizontal air showers have a large footprint of the radio emission on the ground and they can be detected with sparse arrays with kilometer-scale spacing. With the Auger Engineering Radio Array (AERA) horizontal air showers are measured. Recent results will be presented. These measurements clearly demonstrate the feasibility to measure horizontal air showers with the radio technique. Ideas will be outlined to install radio antennas on all surface detector stations of the Pierre Auger Observatory in order to measure the properties of cosmic rays (in particular their particle type/mass) up to energies exceeding  $10^{20}$  eV.

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