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(Remote) On the performance of air shower reconstruction with the SKA-Low radio telescope

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The Square Kilometre Array (SKA) is a radio telescope currently under construction in South Africa and Australia.

Its low-frequency part (50-350 MHz), located in Australia, features nearly 60,000 antennas in a core region of about 1 km diameter.

With such an extreme antenna density, surpassing e.g. LOFAR by two orders of magnitude, this observatory is well equipped to make the most precise radio measurements of individual air showers.

A decade of experience with LOFAR serves as a foundation for a next major step in reconstruction precision. We present a simulation of the reconstruction capabilities, using CoREAS-simulated showers, a realistic model of the antennas, and of the Galactic noise background.

We apply the method used at LOFAR for reconstruction the depth of shower maximum $X_{\max}$, measuring the energy fluence of the radio pulse in each antenna and using an ensemble of simulated showers to fit to the data. We consider the use of beamforming within this method, combining groups of nearby antennas to boost the signal-to-noise ratio.

The reconstruction precision that follows is about 6 to 8 g/cm² over a primary energy range of 10^{16} to 10^{18} eV, with a minimal bias from the reconstruction process.

This sets a baseline to what can be achieved, both in energy range extension downward as in reconstruction precision, from methods that haven proven robust in practice.

Further significant progress is expected, as new methods are being developed that measure the longitudinal shower profile in more detail than just its $X_{\max}$.

We also discuss expected event rates given reasonable technical limitations, relating this to suitable numbers for a mass composition analysis in narrow energy bins.

Collaboration(s)

SKA High Energy Cosmic Particles Science working group

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