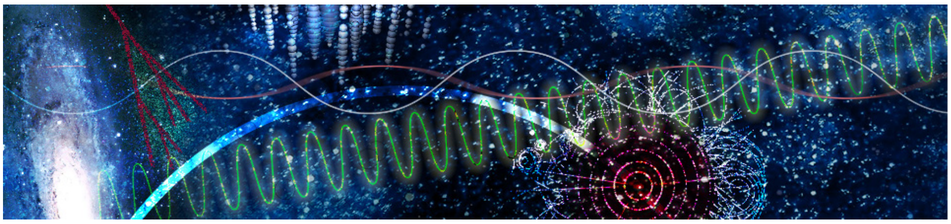

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Investigations of a Novel Energy Estimator Using Deep Learning for the Surface Detector of the Pierre Auger Observatory

Exploring physics at energies beyond the reach of human-built accelerators by studying cosmic rays requires an accurate reconstruction of their energy.
At the highest energies, cosmic rays are indirectly measured by observing a shower of secondary particles produced by their interaction in the atmosphere.
At the Pierre Auger Observatory, the energy of the primary particle is either reconstructed from measurements of the emitted fluorescence light, produced when secondary particles travel through the atmosphere, or shower particles detected with the surface detector at the ground.
The surface detector comprises a triangular grid of water-Cherenkov detectors that measure the shower footprint at the ground level.
With deep learning, large simulation data sets can be used to train neural networks for reconstruction purposes.

In this work, we present an application of a neural network to estimate the energy of the primary particle from the surface detector data by exploiting the time structure of the particle footprint.
When evaluating the precision of the method on air shower simulations, we find the potential to significantly reduce the composition bias compared to methods based on fitting the lateral signal distribution.
Furthermore, we investigate possible biases arising from systematic differences between simulations and data.

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