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Reconstruction of sub-threshold events of cosmic-ray radio detectors using an autoencoder

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Radio detection of air showers produced by ultra-high energy cosmic rays is a cost-effective technique for the next generation of sparse arrays. The performance of this technique strongly depends on the environmental background, which has different constituents, namely anthropogenic radio frequency interferences, synchrotron galactic radiation and others. These components have recognizable features, which can help for background suppression. A powerful method for handling this is the application of convolution neural networks with a specific architecture called autoencoder. By suppressing unwanted signatures, the autoencoder keeps the signal-like ones. We have successfully developed and trained an autoencoder, which is now applied to the data from Tunka-Rex. We show the procedures of the training and optimization of the network including benchmarks of different architectures. Using the autoencoder, we improved the standard analysis of Tunka-Rex in order to lower the threshold of the detection. This enables the reconstructing of sub-threshold events with energies lower than 0.1 EeV with satisfactory angular and energy resolutions.

Keywords

cosmic rays, air showers, radio arrays, deep learning, autoencoder

Collaboration

other Collaboration

Tunka-Rex

Subcategory

Experimental Methods & Instrumentation

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