

Convolutional Neural Network analyses for multi-TeV Gamma-ray Air Shower Observation with a Large Area Surface Detector Array

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The Tibet AS γ experiment, which observes gamma-ray/cosmic ray air showers above a few TeV, is located 4,300 m above sea level in Tibet, China. The experiment is composed of a surface air shower array (Tibet-III) and underground water Cherenkov muon detectors (MD).

The surface air shower array is used for reconstructing the primary particle energy and direction, while the underground muon detectors are used for discriminating gamma-ray induced muon-poor air showers from cosmic-ray induced muon-rich air showers.

This study investigated methods to improve the Tibet-III array's gamma-ray/cosmic-ray separation performance and angular resolution.

In recent years, machine learning, especially neural networks, has been widely applied in air shower observation experiments.

In the gamma-ray/cosmic-ray separation study, we applied a method with a convolutional neural network (CNN) to image-like data of particle density measured by the Tibet-III.

The method's AUC values ranged from 0.753 to 0.879 for Monte Carlo gamma-ray and cosmic-ray events from the Crab Nebula in the energy range 10–100TeV. The significance of the gamma-ray detection is expected to be improved by 1.3 to 1.8 times compared with the case without the CNN separation procedure.

Primary author: OKUKAWA, Sousuke (Yokohama National University)

Co-author: THE TIBET AS γ COLLABORATION, on behalf of

Presenter: OKUKAWA, Sousuke (Yokohama National University)

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