Contribution ID: **12** Type: **not specified**

Application of machine learning method for energy reconstruction on space based high granularity calorimeter

Saturday, 23 August 2025 10:00 (20 minutes)

The High Energy Cosmic-Radiation Detection Facility (HERD) is dedicated to achieving several scientific objectives, including the search for dark matter, precise measurement of the cosmic ray spectrum, and gamma-ray sky survey observations.
HERD ' s innovative design incorporates a three-dimensional imaging calorimeter with five sensitive faces, significantly enhancing geometric acceptance. However, this design introduces a new challenge for reconstructing particles incident from all directions. This article aims to integrate rapidly advancing deep learning techniques into the reconstruction task. Utilizing simulation data, Deep Neural Networks (DNN), Convolutional Neural Networks (CNN), and other deep learning networks are employed to reconstruct the energy of isotropic electrons. Model performance sees a significant boost through the application of end-layer visible energy correction and a "multi-class multi-prediction approach,involvingdifferentmodelstrainedfordistinctenergy ranges. Moreover, recognizing differences between simulation and physical samples, the model is validated using the beam test data.
The model predicts an energy resolution of better than 1% for simulation isotropic electrons ranging from 10 to 1000 GeV. In the case of beam data, the model achieves an energy resolution of 1.3% at 200 GeV, comparable to traditional methods. The results demonstrate the significant potential of deep learning in the reconstruction of three-dimensional calorimeters.

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Session Classification: Session