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Machine Learning for Correcting Simulation Outputs in Alpha Particle Measurements with Hybrid Semiconductor Detectors

Accurate modeling of alpha particle interactions in hybrid semiconductor detectors remains challenging, as standard simulation tools like Geant4 and Allpix Squared (CERN) often fail to simulate specific sensor and detector electronics responses. This results in discrepancies between simulated and experimental data, particularly in reproducing key features such as the "halo" effect surrounding particle tracks.

To mitigate these differences, we employ a machine learning approach to refine simulation outputs, making them more consistent with experimental measurements. Using alpha particle data in the 1–5 MeV energy range recorded with a Timepix 3 ASIC chip and a 500 µm silicon sensor, our model learns to correct structural and intensity variations without requiring explicitly paired training data.

Our results demonstrate that machine learning methods effectively enhance the realism of simulated data, improving their agreement with experimental observations. This approach provides a scalable method for generating synthetic experimental datasets, aiding in detector characterization and improving the accuracy of future simulations.

Workshop topics

Applications

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