Contribution ID: **154** Type: **Poster**

#10-154 Optimization of a Convolutional Neural Network-Based Pulse Shape Analysis Model for Gamma/Neutron Signal Discrimination

Tuesday, June 10, 2025 4:30 PM (5 minutes)

Reliable discrimination between gamma-ray and neutron signals is essential for accurate neutron detection when using an organic scintillation detector. Pulse Shape Discrimination (PSD) techniques are methods of distinguishing between gamma ray and neutron pulse signals by analysing the variations in pulse formation and decay patterns associated with each type of radiation. The Charge Comparison Method (CCM) is widely used in PSD and classifies signals based on the total charge over a specified interval. However, CCM has limitations in low energy regions where accurate signal differentiation becomes difficult, reducing measurement reliability. To address this limitation, we propose a PSD approach that uses a Convolutional Neural Network (CNN)-based model to improve the discrimination of gamma-ray and neutron signals. The CNN model, selected for its ability to extract complex features through supervised learning, is implemented in a PSD process comprising five key steps: (1) data acquisition, (2) preprocessing, (3) model design, (4) training and validation, and (5) performance evaluation. This study uses gamma-ray and neutron data obtained with a pixelated EJ-276 detector exposed to Californium-252. Four pre-processing steps were applied to optimize CNN performance in the PSD: (1) signal magnitude normalization, (2) noise reduction using a moving average filter, (3) extraction of distinct gamma-ray and neutron signal intervals, and (4) labelling of gamma-ray and neutron signals as '1' and '0', respectively. Then, a CNN layer was designed and optimized for effective PSD. The layers of the CNN-based model used convolution, maximum pooling, dropout, flattening, and dense layers to effectively extract key features from the input signal. The optimized model showed high predictive performance, achieving 99.9% accuracy, 99.9% precision and 99.9% recall. In conclusion, this study has developed a CNN-based PSD model that effectively discriminates between gamma-ray and neutron signals in the low energy regions, overcoming the associated limitations of the charge comparison method. The optimized convolutional neural network model exhibits high accuracy and precision, indicating its potential to overcome the limitations of conventional techniques and improve the accuracy of neutron measurements by effectively classifying gamma-ray and neutron signals.

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Session Classification: #10 - Current Trends in Development of Radiation Detectors

Track Classification: 10 Current Trends in Development of Radiation Detectors