Contribution ID: **92** Type: **poster**

# Deep Learning-Based Pile-Up Correction Using Trapezoidal Shaping and Derivative Peak Detection Method for Gamma Spectroscopy

In high-count-rate environments, such as those present in nuclear facilities or radiological emergency scenarios, radiation events often arrive in rapid succession, resulting in pile-up pulses that distort the original pulse height information. This distortion significantly reduces the accuracy of reconstructed gamma spectra, making isotope identification and quantification more difficult. Pulse height estimation (PHE) methods based on deep learning have recently emerged as effective alternatives to conventional pile-up correction techniques, offering improved performance with reduced data loss and real-time capability [1]. However, their effectiveness largely depends on the robustness of peak detection, particularly when pulses occur within short time intervals (e.g., below 12 ns), where conventional detection methods fail to resolve closely spaced signals.
In this study, we present a novel pile-up correction method that combines trapezoidal signal shaping with a deep-learning-based PHE approach. Exponential pulses are first reshaped into trapezoidal form to extend the temporal visibility of peak features. A peak detection method using first- and second-order derivatives is then applied to identify peaks in the presence of pile-up. From these detected peaks, pulse height pairs—representing both piled-up and true values—are extracted to construct a supervised learning dataset. A deep neural network (DNN) is trained on this dataset to predict true pulse heights directly from pile-up signals.
The proposed method was validated through both synthetic and hardware-emulated trapezoidal pulse datasets. Results show significant improvements in count recovery and energy resolution compared to conventional approaches. The method demonstrates strong generalizability and robustness, offering a practical and efficient solution for real-time gamma spectroscopy in high-count-rate environments.

## Workshop topics

Applications

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