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P2.28: Distinguishing Neutron and Gamma Pulses of EJ-200 Scintillation Detector using Artificial Intelligence

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In the field of security and defense, the detection of special nuclear materials and other radioactive materials requires the use of neutron and gamma-ray detection systems. Silicon photomultipliers have been employed in these detectors due to their advantages of being lightweight, compact, and low power consuming. Accurate identification of neutron and gamma-ray pulses from these detectors plays a crucial role in the reliability of radiation measurements. To improve the discrimination of pulse shapes, various pulse shape discrimination techniques have been studied, developed, and applied. In this research, a minimal neural network artificial intelligence (AI) configuration was designed to correspond to the identification characteristics of neutron and gamma-ray pulses obtained from an EJ-200 scintillation detector. The principle of minimum error was applied in the design, so that despite the minimal configuration, the accuracy of the identification results was not compromised. Experiments showed that with this design, AI achieved higher accuracy in identification compared to the pulse shape integration method. Monte Carlo simulations were validated by laboratory measurements and field tests were performed using real gamma-ray and neutron sources. Detection and localization within one meter were achieved using a maximum likelihood estimation algorithm for ¹³⁷Cs sources (4 MBq), as well as the detection of ²⁴¹Am–Beryllium (1.45 GBq) source placed inside the shipping container. For the measured pulses from a ⁶⁰Co source, the AI-based MNRNT accurately identified 97.90% of the pulses in the energy range of 50-2000 keVee (keV electron equivalent), and achieved 96.80% accuracy for pulses in the low energy range of 50-150 keVee. These results demonstrate that artificial intelligence methods can be applied to improve the identification and analysis of radiation events even with small-scale radiation detectors.
Keywords: Pulse shape discrimination, AI, neutron detection, scintillation detector.

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