Digital Data Acquisition Techniques for Fast Neutron Detection UsingLiquid Scintillator

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Abstract

The motivation of this project is to explore the use of digital pulse processing techniques for fast neutron and gamma ray detection in liquid scintillator. Digital techniques can simplify the performance of scintillation detectors where both timing information and pulse-height spectroscopy are required. Software based PSD and timing algorithms have been developed that can be used in various neutron experiments in the time-of-flight (TOF) mode over a wide neutron energy range. These algorithms can be applied to current pulses produced directly from the photomultiplier tube and thus removing the need for processing electronics, which are typically required in an analog pulse shape system. The digital techniques developed in this study were applied to a large volume "Demon" liquid scintillator detector. The Demon detector has a high intrinsic efficiency over a large energy range that is 50% for neutrons of 10 MeV and about 50% for γ-rays of 1275 keV. During the normal Demon experiments the energy of fast neutron is measured using analog TOF methods.

Application of the digital techniques developed in this work can be extended to neutron gamma coincidence experiments to measure the neutron energy spectrum using the time-of-flight technique. In this work the performance of the digital TOF and PSD techniques were investigated by measuring the fast neutron energy spectrum from an Am-Be source.

The use of digital pulse processing is a powerful technique that allows acquires both the time and energy information from a single data set. Good n/γ separation was obtained using digital PSD applied to the Demon detector. The PSD figure-of-merit was investigated and the performance of different algorithms was compared. The application of digital timing methods was investigated and the results are compared to those obtained using conventional techniques.