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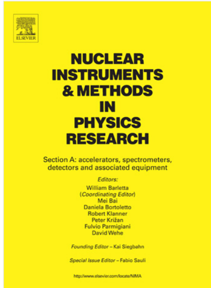

Optimization of the n/γ separation algorithm for a digital neutron spectrometer

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Keywords

Digital signal processing; pulse shape discrimination; n/γ separation algorithms; organic scintillators; stilbene crystal; time-of-flight.

Abstract.

An analysis of various n/γ separation algorithms for a digital neutron spectrometer based on a stilbene crystal is performed. The same set of digital signals is used to test the following n/γ separation algorithms: the algorithm based on the correlation analysis; the algorithms based on the direct comparison of the pulse fast component and the pulse tail; SDCC (Simplified Digital Charge Collection) algorithm; PGA (Pulse Gradient Analysis) and FGA (Frequency Gradient Analysis) algorithms. It is shown that the algorithm based on the correlation analysis makes it possible to carry out the most effective n/γ separation for the entire pulse areas range.

The shape of the distributions of the separation parameter for electrons and protons is analyzed. The correctness of these distributions approximation by the Gaussian curve is justified.

An algorithm for the selection of the recoil protons resulting from the neutron interaction with the scintillator is proposed. It is based on the dynamic change of the separation parameter threshold depending on the pulse area. The distributions of the separation parameter for electrons and recoil protons strongly overlap for small pulse areas. In this case, the threshold for the separation parameter is chosen on the basis of the fixed probability of the event false identification. In our work, for example, the contribution of false events was fixed at 1%. With the increase of the pulse area, the distributions for electrons and protons begin to separate well. In this case it is convenient to set the threshold on the separation parameter at the point of their intersection. The use of this algorithm makes it possible to control the fraction of the falsely identified events for the entire range of the pulse areas. This is especially important for low-energy recoil protons, for which the probability of false event identification reaches its maximum. This algorithm was applied to the measurements performed by the time-of-flight method with a ^{252}Cf source. The suppression degree of the prompt gamma-ray peak was 1100 at the neutron detection threshold of 275 keV. The contribution of the falsely identified events for the different parts of the time-of-flight spectrum using the proposed event selection algorithm was studied. The largest contribution to the false pulses was found for the neutron distribution edges - for the neutrons with the energies above 8 MeV and below 0.5 MeV, and it didn't exceed 0.23% in the entire range of the pulse areas.

1. Introduction.

Organic scintillators are widely used for the detection of fast neutrons. One of the most interesting problems solved with their aid is the prompt fission neutron spectra (PFNS) measurements using the time-of-flight method [1-13]. However, the measurements results given in [14-18] show considerable discrepancies in the experimental data on the neutron yields at different energies. There are serious problems with the simultaneous approximation of low-energy (<0.5 MeV) and high-energy (>6-8 MeV) parts of the PFNS by all theoretical models. This situation is mainly due to the presence of significant methodological problems arising from neutron measurements at low and high energies [16]. Even small errors in the neutron yield for the energy regions that are very far from the average energy value can substantially distort its