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Digital pulse shape discrimination between fast neutrons and gamma rays with para-terphenyl scintillator

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Registration of fast neutrons against the background of gamma radiation is an important task both for the case of low particle intensity (measurement of the neutron and gamma background in neutrino and dark matter particle detectors, environmental monitoring) and the case of high neutron and gamma-ray fluxes (neutron flux from neutron generators and particle accelerators, control of spent nuclear fuel). To detect fast neutrons, scintillation detectors with organic scintillators are used. In such scintillators, two components of de-excitement are present: the fast and the slow. Intensity of the slow component in such scintillators depends on the type of particle detected. In the presented work, we investigated several digital methods of signals from fast neutrons and gamma quanta discrimination. The experimental setup consists of a Pu-Be neutron source, a scintillation detector with an organic para-terphenyl monocrystal, and a digitizer (CAEN DT5730, 500 MHz). Mixed waveform sequences were saved and then separated by pulse shape. Four methods used for signal separation are described. A new method of Figure of Merit (FOM) calculation is presented. Comparison of the traditional and the new methods of FOM calculation is given. In our setup, for the minimum threshold value FOM = 1.5 was obtained, while for the known BC-501A liquid scintillator FOM≈1. Neutron detector with a para-terphenyl crystal is used for measuring neutron yield in the neutron generator that is now being developed using carbon nanotubes. The work is performed with financial support of the Ministry of Science and Education of Russia, the Project no. 14.578.21.0192 (RFMEFI57816X0192).

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