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Development and testing of multilayer neutron detectors

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One of the tasks of the precision hybrid magnetic spectrometer SCAN-3 at the Joint Institute for Nuclear Research (JINR) in Dubna is to register neutrons from the decay of the η-meson nucleus via the πn- and pn-channels. The only way to provide neutron spectrometry is to use the time-of-flight method. Taking into account the geometry of the SCAN-3, confines are imposed on the accuracy of measuring the time-of-flight for neutron δt=2.2 ns for the πn-channel and δt=0.4ns for the pn-channel in the region of the energy of neutrons from 100 to 300 MeV. The development, development and testing of such a neutron detector is not a trivial task for researchers. The most promising approach for this task is to create a multilayer hadron detector based on a plastic scintillator. The purpose is to achieve a time-of-flight resolution of better than 50 ps for each particle.

The main problem with the detection and spectrometry of high-energy deuterons at the NUCLOTRON accelerator at JINR is the lack of direct signals from the neutrons passing through the detector's material. Neutron registration is performed by the secondary product of neutron interaction with the material of detector. During elastic neutron scattering, rebound proton nuclei are registered, and in the case of detection by nuclear reactions, the resulting secondary particles, nuclear fragments, and ɣ-quanta are registered.

The point of neutron interaction in a material is a random value that depends on the interaction cross section of the neutron energy and the detector thickness. The method used for high-energy neutron time-of-flight spectrometry has a measurement error that depends on the thickness and time resolution of the detector.

To accurately determine the interaction point, a multi-layer neutron meter scheme was chosen, in which the interaction point is determined with the accuracy of the thickness of the plate used. The detector is based on 5 plastic scintillators with dimensions of 700 x 200 x 20 (mm)3. Light registration in the neutron detector is performed using the FEU-87 and FEU XP2041 with a time resolution not worse than 0.1 ns.

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