LOW NEUTRON FLUX MEASUREMENTS IN UNDERGROUND LABORATORY IN MODANE USING IODINE-CONTAINING SCINTILLATORS

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This work presents results of measurements of neutron flux in the LSM underground laboratory with new highly sensitive method for the detection of neutrons developed in our group [1]. The method uses the $T_{1/2}$ = 845 ns delay in the decay of ^{128}I at the 137.8 keV energy level, resulting from the capture of thermal neutrons by iodine nuclei in NaI(Tl) scintillation detector. Since accidental background is almost quadratically proportional to the overall background signal the use of delayed coincidence techniques with a several μs delay time window for delayed events allows for the highly effective discrimination of neutron events from any existing background signals.

First measurements in the LSM underground laboratory with the proposed method were started in April of 2017 with 720 grams NaI(Tl) scintillation detector (Ø 63 mm × 63 mm). Two low background proportional ^{3}He counters [2] have been used for verification of the obtained results. After 241.84 days of measurements 67 delayed events were detected in the region of interest (137.8 keV energy) for prompt-delay time window 1.8–5 μs. The calculated background for above selection criteria is 31.809(2) events (mainly due to internal potassium content of the detector) agrees well with 35 events found in the shifted delay time window between 11.8 and 15 μs. Neutron events are the excess in 0.15(3) counts per day above the background. The resulting thermal neutron flux is $2.3 \pm 0.5 \times 10^{-6}$ n· cm^{-2} ·sec^{-1}. This value was found to be in the excellent agreement with neutron fluxes in 2.3×10^{-6} n·cm^{-2}·sec^{-1} and 3.1×10^{-6} n·cm^{-2}·sec^{-1} measured by ^{3}He detectors one placed near the lead shield of the setup and second one near the wall of the laboratory.

Performed measurements experimentally demonstrated the efficacy of the proposed detection method for low neutron fluxes. In future, the method can provide low-background experiments, using NaI or CsI, with measurements of the rate and stability of incoming neutron flux to a greater accuracy than 10^{-8} n·cm^{-2}·s^{-1}.

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2. S.V.Rozov *et al.* // Bull. Rus. Acad. Sci. Phys. 2010. V.74. №4. P.464.