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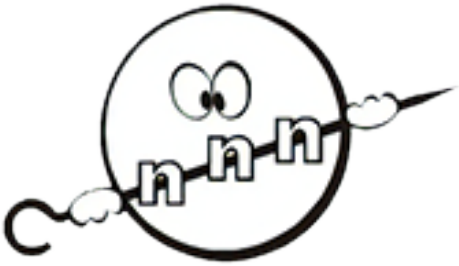

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Development and Performance Testing of Liquid Detector Array for Investigation of Prompt Fission Neutron Emission

The measurement of fast neutron emission in nuclear reactions plays a critical role in studying nuclear fission processes, reaction dynamics, and their applications in nuclear energy and astrophysics [1,2]. To facilitate such studies, an experimental setup consisting of liquid neutron detector array and an ionization chamber, ENGREN, has been developed at the Joint Institute for Nuclear Research (JINR) in Dubna, Russia. The experimental setup consists of 16 EJ-309 liquid scintillator (LS) neutron detectors arranged in a cylindrical configuration around a gas ionization chamber (GIC), which can be replaced with a twin Frisch grid ionization chamber. Each neutron detector, with a diameter of 76 mm and a thickness of 50 mm, is coupled to a 76 mm ETL-9821 photomultiplier tube (PMT) to enable time-of-flight (ToF), pulse shape discrimination (PSD), and pulse height (PH) measurements. The GIC, filled with P-10 counting gas (90% Ar + 10% CH_4), is continuously flowing and contains a 235U fission target to detect fission events. The detectors are positioned 51 cm from the fission source. Data acquisition was performed using digital signal recorder (DSR-32) (32 channels, 200 MHz, 11 bit) developed at JINR, which controlled using Romana software developed under the TANGRA project [3]. Additionally, CAEN digitizers N6742 and N6725 were also tested.

To characterize the detector response, measurements were conducted using point calibration gamma and PuBe neutron sources, placed at the position of the ionization chamber. The energy calibration of LS, which is typically challenging due to Compton scattering effects, was performed by comparing the experimental detector response with Monte Carlo-generated spectra. Furthermore, the pulse shape neutron/gamma discrimination (PSD) was evaluated using PuBe neutron source, and PSD performance was analyzed as a function of applied voltage. Preliminary test measurement with a ^{235}U target were performed at the Intense Resonance Neutron Source (IREN), Frank Laboratory Neutron Physics, JINR [4, 5]. This work focuses on the calibration and optimization of the ENGREN setup, including scintillator calibration, neutron-gamma discrimination, timing performance and validation of detector response through simulations and experimental data.

References

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