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Characterization of the energy spectrum of a 30-MeV cyclotron-based quasi-monoenergetic neutron beam using a time-of-flight spectrometer

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We conducted time-of-flight (TOF) measurements to characterize the spectrum of a quasi-monoenergetic neutron beam driven by a 30-MeV proton cyclotron at the National Atomic Research Institute in Taiwan*. Neutrons were produced by irradiating 30-MeV protons onto a 1-mm-thick beryllium target. The developed TOF spectrometer comprised two 2-inch EJ-309 organic scintillators positioned 200 mm from the neutron beam port to detect gamma rays emitted from the target, and a 3-inch EJ-309 scintillator placed at a flight distance of 2940 mm to measure neutrons. As the signals of gamma-ray bursts triggered TOF measurements at an RF frequency of 73.13 MHz, repetitive distributions of coincidence events between gamma-ray and neutron-related signals were observed, resulting in an effective time window of 13.67 ns for measuring neutrons in the energy range of 16.19–30 MeV. The measured neutron spectrum exhibited a peak at 26 MeV, verifying the simulated spectrum obtained from an MCNP Monte Carlo model. Additionally, we developed a fast-timing scintillator module that measured the proton bunch duration as 0.97 ns, enabling accurate estimation of the energy resolution of the neutron spectrum.

Footnotes

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