

Application Research of Stilbene Crystal for the Measurement of Accelerator Neutron Sources

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Abstract : Stilbene, $C_{14}H_{12}$, is well known as one of the most useful organic scintillators for pulse shape discrimination (PSD) technique for its good scintillation properties. An on-line acquisition system and an off-line acquisition system were developed with several CAMAC standard plug-ins, NIM plug-ins, neutron/ γ discriminating plug-in named 2160A and a digital oscilloscope with high sampling rate respectively for which stilbene crystals and photomultiplier tube detectors (PMT) as detector for accelerator neutron sources measurement carried out in China Institute of Atomic Energy. Pulse amplitude spectrums and charge amplitude spectrums were real-time recorded after good neutron/ γ discrimination whose best PSD figure-of-merits (FoMs) are 1.756 for D-D accelerator neutron source and 1.393 for D-T accelerator neutron source. The probability of neutron events in total events was 80%, and neutron detection efficiency was 5.21% for D-D accelerator neutron sources, which were 50% and 1.44% for D-T accelerator neutron sources after subtracting the background of scattering observed by the on-line acquisition system. Pulse waveform signals were acquired by the off-line acquisition system randomly while the on-line acquisition system working. The PSD FoMs obtained by the off-line acquisition system were 2.158 for D-D accelerator neutron sources and 1.802 for D-T accelerator neutron sources after waveform digitization off-line processing named charge integration method for just 1000 pulses. In addition, the probabilities of neutron events in total events obtained by the off-line acquisition system matched very well with the probabilities of the on-line acquisition system. The pulse information recorded by the off-line acquisition system could be repetitively used to adjust the parameters or methods of PSD research and obtain neutron charge amplitude spectrums or pulse amplitude spectrums after digital analysis with a limited number of pulses. The off-line acquisition system showed equivalent or better measurement effects compared with the online system with a limited number of pulses which indicated a feasible method based on stilbene crystals detectors for the measurement of prompt neutrons neutron sources like prompt accelerator neutron sources emit a number of neutrons in a short time.

Keywords : stilbene crystal, accelerator neutron source, neutron / γ discrimination, figure-of-merits, CAMAC, waveform digitization

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