§24. Fundamental Study on Directional Neutron Detector with Scintillating Optical Fibers

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In order to measure the incident directions of fast neutrons, a directional detector composed of scintillating fibers has been used. In that system, the signals from the scintillating fibers were measured with a single photomultiplier tube (PMT) where the penetration of recoil proton from one fiber to the other was prevented with the shielding region set between the fibers. At present, as we can purchase multi-anode PMTs at low cost, the authors propose a new directional measurement system to measure the neutrons from LHD with bundled scintillating fibers where each fiber is connected to the independent anode of a multi-anode PMT. By analyzing the signals from the multiple anodes, we are investigating to realize higher directional property and neutron-gamma discrimination possibility.

The concept of the proposed system is shown in Fig. 1. We have developed a signal processing system shown in Fig. 2 to process the signals from the 2mm-diameter fibers, where anti-coincident measurement is possible between the anode signals. To implement the anti-coincident measurement, we used one comparator for each channel and a logical circuit. In the present and preliminary system, the discrimination level of the comparator was set common for all the channels.

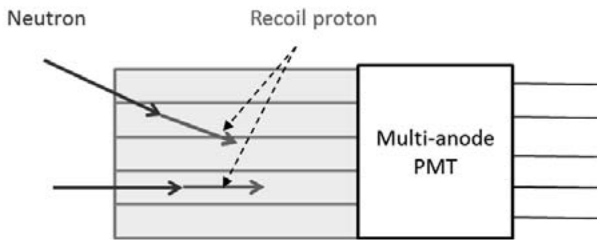

Fig. 1 Concept of the system.

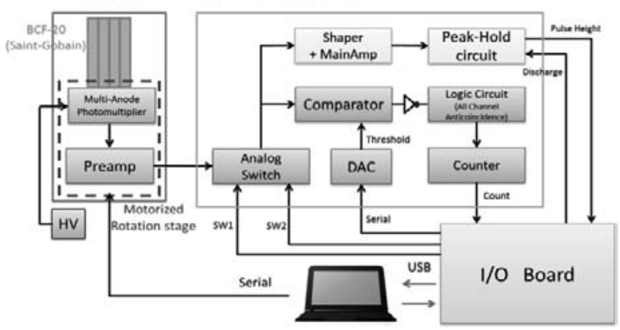

Fig. 2 Developed signal processing system for anti-coincident measurement.

Directional property of the developed system was measured at Fusion Neutronics Source (FNS) facility of Japan Atomic Energy Agency (JAEA). Neutrons with the energy of 14 MeV were generated in the 1st target room of ENS. We measured the anti-coincident counts with changing the neutron incident angles onto the developed system. Fig. 3 depicts the angular distribution of the measured anti-coincident counts. Simulations with the Particle and Heavy Ion Transportation code System (PHITS) were carried out to evaluate the angular distribution of the anti-coincident events. The results are shown in Fig. 4. In the simulations, due to the self-shielding of the neutrons by the scintillating fibers, the count at 10 deg. was larger than that at 0 deg. However, in Fig. 3, the maximum value is at 0 deg. The cause of the discrepancy should be he counts by gamma rays. To reduce the sensitivity to gamma ray, we will optimize the fiber diameter. Further study will be carried out to develop a new signal processing procedure to utilize the information which can be measured from the independent anodes of the multi-anode PMT.

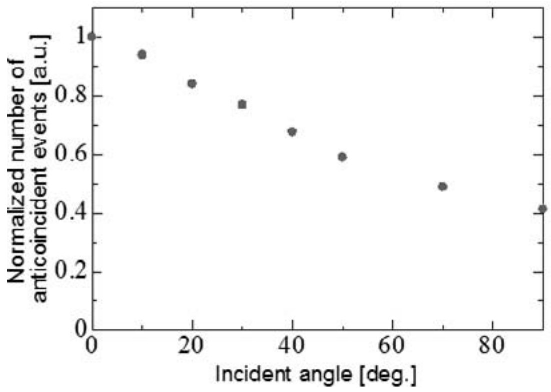

Fig. 3 Measured anti-coincident counts at each neutron incident angle, which are normalized to the value at 0 deg.

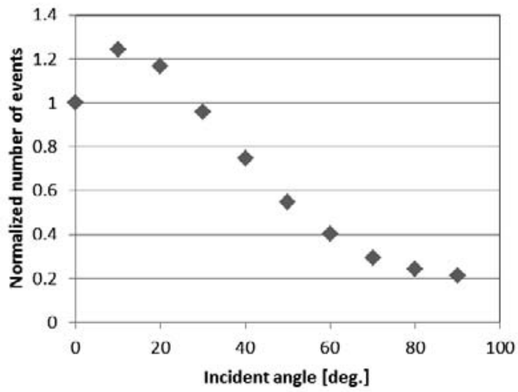

Fig. 4 Simulated anti-coincident counts at each angle. The energy values in the figure show the discrimination levels in the simulation.