§42-11 Fundamental Study on Directional Neutron Detector with Scintillating Optical Fibers

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In order to measure the incident directions of 14 MeV neutrons, a direction sensitive detector composed of scintillating fibers (Sci. Fi.) has been used (Fig.1). In that system, the signals from the scintillating fibers were measured with a photomultiplier tube (PMT) where the penetration of recoil proton from one fiber to the other was prevented with the shielding region between the fibers. The system was applied to TFTR and JT60U to evaluate the time dependence of 14 MeV neutron emission for the triton burn-up study. In the present study, we are trying to optimize the design of the detector to use at LHD .

In TFTR and JT60U, the Sci. Fi. with the length of 10 cm and the diameter of 1 mm has been used. With PHITS code, we calculated the proton flux distribution for 14 MeV neutrons incident parallel to the Sci. Fi. Figure 2 shows that recoil protons are generated mainly in the region near the inlet, which is caused by the self-shielding by the Sci. Fi. This result suggests the necessity of design optimization of the system.

We calculated the angular dependence of counts over a threshold energy for the case of 1mm-diameter Sci. Fi. The lengths were set to 10 cm and 5cm. Also, experiments were carried out at Fusion Neutron Source (FNS) facility of Japan Atomic Energy Agency. The calculated and measured results are shown in Fig.3. It can be seen that the measured angular distribution is broader than calculated results. As Sci. Fi. is sensitive to gamma rays, the difference should be due to the background gammas. To reduce the gamma sensitivity, it is effective to adopt smaller core Sci. Fi. In Fig. 4, calculated results are shown for different core size. We can conclude that, by using smaller core Sci. Fi., higher angular resolution can also be achieved. However, smaller diameter causes lower measuring efficiency also for neutrons. For optimizing the design of Sci. Fi. detector to measure the 14 MeV neutron profile in the LHD plasma, additional simulation and experiments will be carried out.

1) Wurden, G. A. et al..: Rev. Sci. Instrum. 66 (1) (1995) 901.
2) Harano, H. : JAERI-Research 97-060 (1997) (in Japanese).

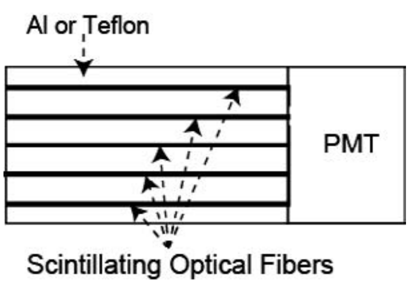

Fig. 1 Fast neutron directional detector with Sci. Fi.

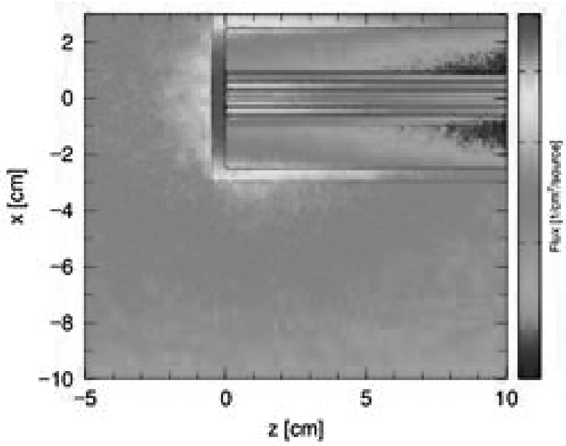

Fig. 2. Distribution of proton flux in the measurement system composed with Sci. Fi. 14MeV neutrons are incident from the left parallel to the z axis.

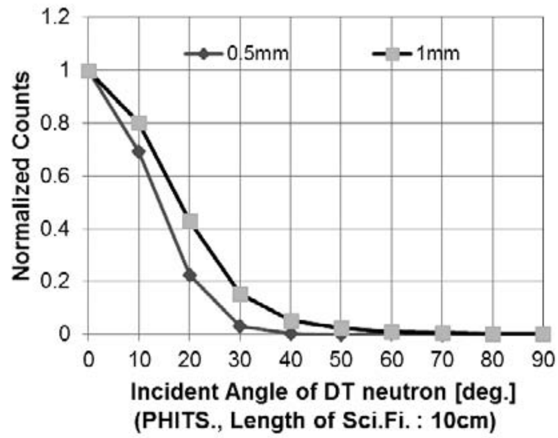

Fig. 3. Comparison of calculated and measured angular distribution. The length of the Sci. Fi. was set 10cm and 5cm with the diameter of 1mm.

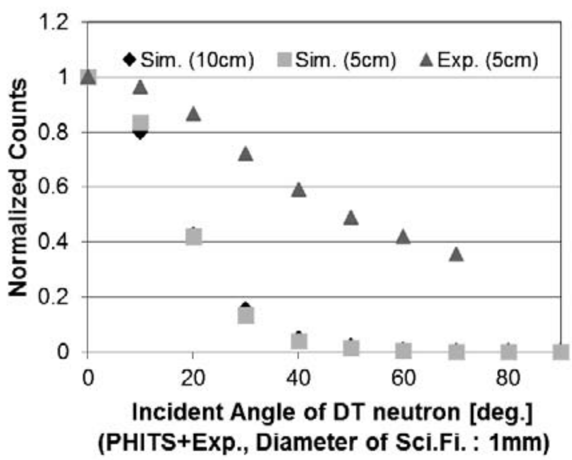

Fig. 4. Comparison of calculated angular distribution, where lengths of the Sci. Fi. were set 10cm and 5cm with the diameter of 1mm.