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

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Fast-neutron directional detectors using scintillating optical fibers have been adopted for neutron emission profile measurement in magnetic confinement fusion devices[1,2]. Because of their benefits of rapid response and directional properties to reduce restrictions on shielding, they are anticipated for installation in the Large Helical Device (LHD) of the National Institute for Fusion Science (NIFS). The system design has been re-examined based on the results of recent experiments and simulations. Fig. 1 shows the calculated distribution of the recoiled protons in a scintillating fiber, when incident angles were set to 0 deg and 90 deg, respectively. Results show that fast neutrons with high energy of 14 MeV are attenuated by a self-shielding effect of scintillating fiber. Moreover, from the experiment where the incident gamma ray position was changed as shown in Fig.2, it has been demonstrated that the scintillation photons are attenuated in several centimeters before reaching the photon detector. Fig. 3 shows the measured pulse height distributions with and without the anti-reflection layer on the surface of the Sci. Fi. From these figures, the counts over a threshold (500ch) with change of the gamma ray incident position were calculated and shown in Fig. 4. Data were normalized to the value at the distance of 0.5 cm. It can be seen that the control of the photon transmission efficiency is important to enhance the directional property of the system. Further evaluation should be conducted to design a detector system considering the detecting efficiency, directional property, and gamma ray effect for application to an actual radiation field of the LHD.

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

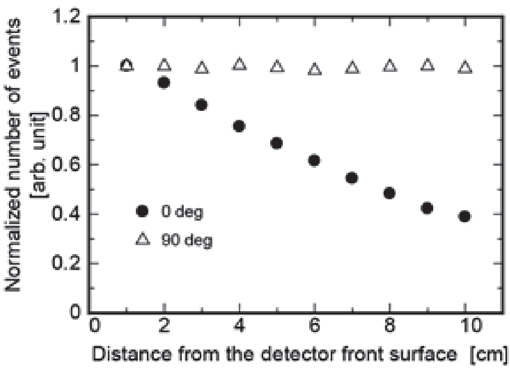


Fig. 1 Calculated distribution of the recoiled protons in a scintillating fiber.

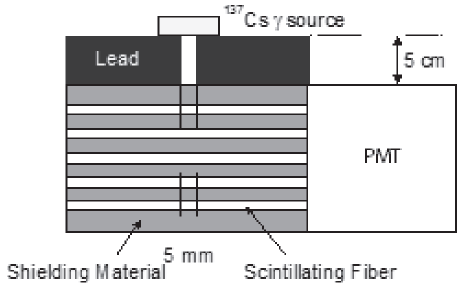
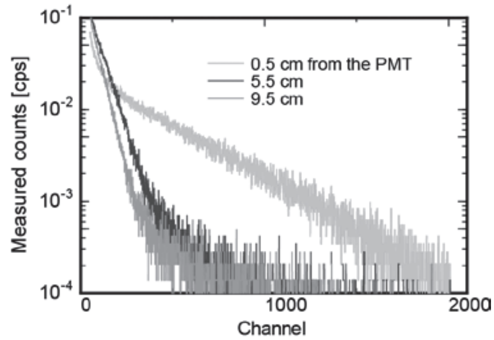
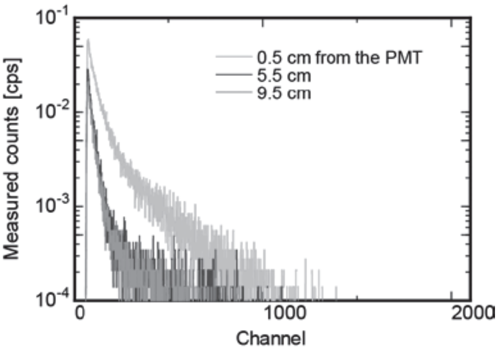


Fig. 2. Experimental setup to evaluate the attenuation of photons with changing the gamma ray incident position.



(a) Without an AR layer



(b) With an AR layer

Fig.3 Measured pulse height distributions when ^{137}Cs gamma rays were irradiated on to some points along the scintillating fiber.

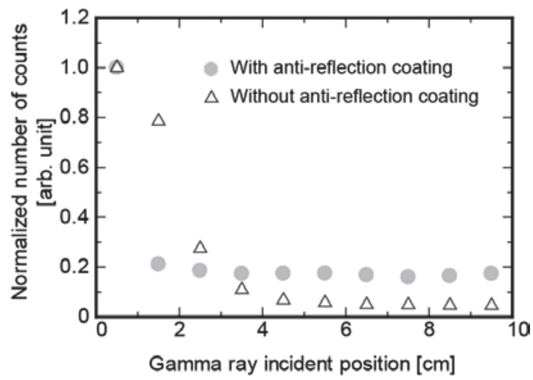


Fig. 4. Measured counts over a threshold (500ch) with change of the gamma ray incident position. Data were normalized to the value at the distance of 0.5 cm.