§3. Design of a Multi-Layer-Type Neutron Monitor for Measuring Dose of Three Energy Groups

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A neutron monitor for measuring dose of three energy groups is being developed. The radiation quality factors that ICRP recommends differ among neutron energies. In order to evaluate neutron dose precisely, it is expected that the neutron fluence of each energy group should be measured. Therefore, we propose a measuring instrument with a three-layer configuration. A liquid scintillator (LS) is arranged at the center, while Li-6 glass scintillators (GS) are arranged in an external layer and interposed layer. The cross section of the monitor is shown in Fig. 1. The monitor is cube-shaped. Fast neutrons are detected by the LS, and low energy neutrons are measured by the GS of the outer layer. Other middle energy neutrons are measured by the GS of the inner layer. The configuration of external layer and interposed layer was discussed using MCNP. The calculation model is shown in Fig.1. The monochrome energy neutrons were injected toward the center of the monitor from a point located 250 mm away from the front surface of the monitor. Neutrons were injected into the surface of the monitor perpendicularly. The incident energies were chosen to be from 10^{-8} to 10 MeV, every one or two columns. The reaction rate of ^{6}Li(n,alpha)T was considered to be the count rate of the GS. Boron nitride was placed as a neutron absorption material between the external layer and intermediate layer.

Figure 1 shows the response in the 2nd detection layer when the thickness of the BN was gradually changed from 0 mm to 35 mm. The thicker the BN, the higher the bottom energy of the sensitivity, because the BN layer limited the injection of a low energy component. In addition, the monitor was covered with polyethylene at a thickness of 10 mm, thus flattening the energy response of the first detection layer. Finally, the energy response of the first detection layer and the second layer were calculated as shown in Fig. 2. In addition, the monitor was covered with polyethylene at a thickness of 10 mm, thus flattening the energy response of the first detection layer. Finally, the energy response of the first detection layer and the second layer were calculated as shown in Fig. 2.

As a result of this design, the outer and inner GS can measure low energy neutrons in the range of thermal neutrons to 10^{-2} MeV, and middle energy neutrons from 10^{-2} to 1 MeV, respectively.

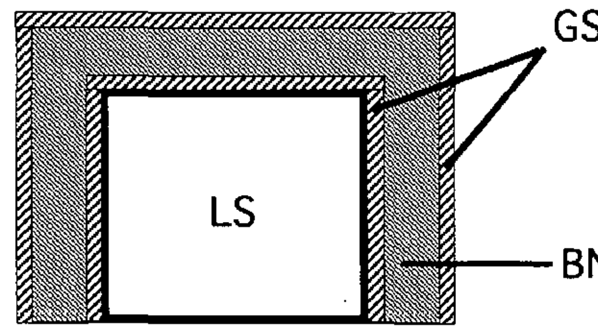

Fig. 1 Crossection of the calculation model
LS; Liquid Scintillator, GS; Li-6 Glass Scintillator, BN; Boron Nitride

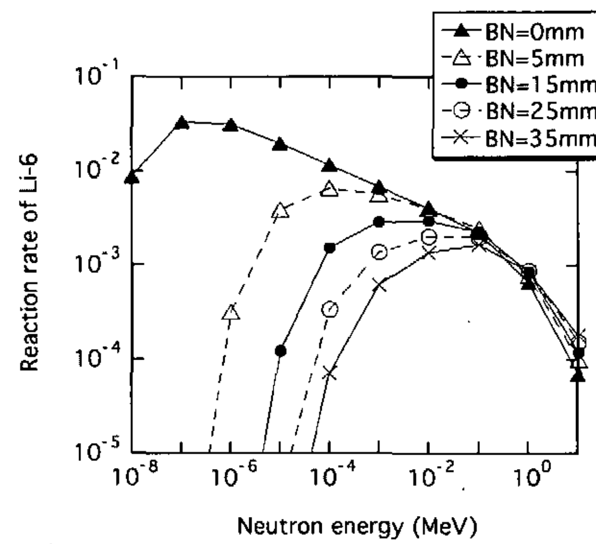

Fig. 2 Energy response of the 2nd detection layer (thickness of the BN layer; 0~35mm)

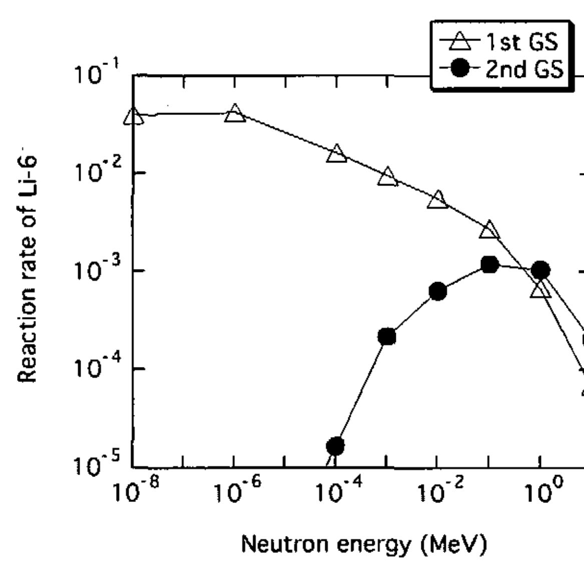

Fig. 3 Energy response of the 1st and 2nd detection layer (BN; 35 mmt, Polyethylene; 10 mmt)