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Optimization of Scintillators for Stacked-layer Detectors of FNGR

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For the detection of FNGR(Fast Neutron and Gamma Radiography), usually a plastic scintillator coupled photo-sensor and a CsI crystal scintillator coupled photo-sensor are used respectively for fast neutrons(14 MeV) and gamma-rays(1.17 & 1.33 MeV of Co-60). Owing to the high energy of radiations, the thickness of the scintillator cannot be sufficiently thickened, and the energy cannot be completely absorbed in the scintillator. Although it is optimized, there is dissipation and penetration as much as absorption. This study provides the FNGR detector modules as a stacked-layer structure to be counted at the same time in order to enhance the performance of existing FNGR system. This obtains more absorbed energy penetrated from the existing form of scintillator.

As a standard form, BC408 plastic scintillators(2cm x 2cm x 7.5cm) and CsI(Tl) crystal scitillators(1cm X 1cm X 5cm) are simulated for the fast neutron and gamma-ray respectively through the Monte Carlo simulation by the MCNPX and the DETECT97 codes. For the investigation, We have separated the scintillators by pieces in layers to be analyzed with respect to absorbed energy, light generation, and the LTE(Light Transmission Efficiency) of each part to yield the scintillation count of the existing scintillator. Next, we have deducted the optimum thickness of the stacked-layer structure of FNGR in the same manner.

The comparison between the existing structure and stacked-layer structure was conducted by evaluating spectrums derived from each condition. The new structure was needed to be more thickened against the existing structure, and 75% and 36% higher efficiencies result for gamma-ray and neutron detection respectively throughout the study. We have planned the experiment with the structure simulated and foresee the possibility of applications for other high-energy radiography systems as well.

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