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Monte Carlo analysis for enhancing radiation safety of Thai neutron imaging system

Thailand Institute of Nuclear Technology (Public Organization), TINT, has established the Thai Research Reactor TRR-1/M1 and continuously developed a neutron imaging (NI) system for better non-destructive inspection. Neutron tomography (NT) is currently conducted with a neutron flux of 1e5 n/cm2s. Due to the strength of the neutron source, image acquisition is made by increasing exposure time to improve image quality. However, it would cause a high radiation level around the neutron imaging room and the reactor hall. Adequate radiation shielding is thus needed to improve radiation protection and safety. In this study, we implemented the geometrical model of the NI room in a Monte Carlo simulation developed with Particle and Heavy Ion Transport System (PHITS version 3.07) to optimize the material, thickness, and position of the shielding. Lead and borated polyethylene (12% boron) were mainly used as a shielding material for the design to reduce gamma ray and neutron. The added shielding will be mainly installed around a neutron shutter, at the entrance of the imaging room and above the room. The simulation was performed at the power reactor of 1 MW. The total number of simulated particles was about 1e8 (7 repeats) to make the simulated results achieve good statistics. Detectors were set in the area of the imaging room to study radiation intensity. The radiation profile and intensity were determined at the condition that the shutter is open and closed, corresponding to neutron beam off and on, respectively. The simulated results show that the added shielding could enhance the radiation safety for the staff and the public and collimate the neutron beam and radiation in the NI station. In addition to improving radiation shielding, the neutron camera and the scintillation screen have been deteriorated due to long use. Therefore, changing a new neutron camera is further planned to improve the NI system.

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