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Characterization of high energy neutron standard fields and study of calibration methods

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The National Metrology Institute of Japan (NMIJ) has developed a 45-MeV quasi-monoenergetic high-energy neutron standard field using the cyclotron of the Takasaki Ion Accelerators for Advanced Radiation Application (TIARA) facility of the Takasaki Institute for Advanced Quantum Science (TIAQ), National Institutes for Quantum Science and Technology (QST). The quasi-monoenergetic neutron field generated by the 7Li(p,n) reaction consists of a high-energy monoenergetic peak and continuum neutrons down to the low energy. Neutron fluence of the high-energy peak neutrons, which is essentially used for the detector calibration, was evaluated by a recoil proton telescope consisting of a polyethylene radiator and an organic liquid scintillator (E) with a Si(Li) detector (dE). The spectral fluence of the continuum neutrons at the calibration position, which are usually contaminants for the detector calibration, was evaluated by time-of-flight measurements using an organic liquid scintillator and a lithium glass scintillator, and the Bonner unfolding method. This information can be used for correction during the detector calibration.

We also studied the applicability of the two-angle differential method for detector calibration using 100-400 MeV quasi-monoenergetic neutrons generated by the 7Li(p,n) reaction at the cyclotron facility of the Research Center for Nuclear Physics (RCNP), Osaka University. In this facility, the neutrons generated in the target can be extracted at any angle by using a target swinger and a movable collimator wall. In this study, measurements were performed for quasi-monoenergetic neutrons generated in front of the target, i.e., in the 0 degree direction, and for continuum neutrons without the high-energy peak, generated diagonally forward, 25 degrees or 30 degrees, and the difference between them was used to attempt calibration only for the virtual high-energy peak neutrons. This method was tried out for multiple Bonner sphere detectors, which have various energy response characteristics depending on the spherical diameter and material of the moderator, and the applicability of the method was discussed.

We also introduce shielding experiments for quasi-monoenergetic neutrons at RCNP and white neutrons at CHARM of CERN that were conducted as application experiments for high-energy neutrons.

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