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Comparison of CsI(Tl) and NE213 responses to high-energy neutrons using PHITS simulation/PHITS による高エネルギー中性子に対する CsI(Tl) and NE213 の応答特性評価

Thursday, 14 November 2024 16:00 (2 hours)

A shielding experiment campaign using NE213 liquid scintillator was conducted to measure high-energy neutrons at the CHARM facility located in CERN [1]. From the neutron spectra obtained with the NE213 scintillator, it was observed that the high-energy components originated from nuclear reactions between the Cu target and 24 GeV/c proton beam.

However, significant discrepancies between measured and calculated data were observed, not only in their shapes but also in integrated values within the high-energy region above 100 MeV. The reason is that the maximum proton energy to fully stop within 12.7 cm thickness of the NE213 scintillator is about 124 MeV according to the SRIM calculation. Thus, the recoil protons having more than this energy pass through the scintillator, with depositing only a portion of their energies. There is a need to develop a new detector that is more sensitive to energies above 124 MeV.

Using PHITS simulation, the response differences between CsI(Tl) and NE213 scintillators were evaluated to clarify the high-energy neutron detection. The dimension of the CsI(Tl) crystal and NE213 are 5 cm x 5 cm x 30 cm-length and ϕ 12.7 cm x 12.7 cm-length, respectively. Additionally, a 3x3 assembly of CsI(Tl) crystal was modeled to increase the effective area for absorbing secondary particles from the high-energy neutron interaction. It is expected that the maximum deposition energy by neutrons can reach more than 400 MeV. This study enables a more accurate characterization of the energy distribution of high-energy neutrons that are mainly present in high-energy accelerator facilities.

References

[1] E.Lee, “Energy spectra of neutrons penetrating concrete and steel shielding blocks from 24 GeV/c protons incident on thick copper target”, NIMA 998 (2021).

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