Investigation on energy dependent anisotropic emission characteristics of prompt fission neutrons using Monte Carlo simulations

Seonkwang Yoon[1,2], Hee Seo[3], Young-Su Kim[4], Chaehun Lee[1], and Hodong Kim[1,2*]

[1] Nuclear Fuel Cycle Enabling Technology Research Division, Korea Atomic Energy Research Institute, Daejeon, Republic of Korea
[2] Quantum Energy Chemical Engineering, University of Science & Technology, Daejeon, Republic of Korea
[3] Department of Quantum System Engineering, Jeonbuk National University, Jeonju, Republic of Korea
[4] National Radiation Emergency Medical Center, Korea Institute of Radiological & Medical Science, Seoul, Republic of Korea
[*]E-mail: khd@kaeri.re.kr

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It is well known that prompt neutrons from nuclear fissions show unisotropic emission property. This characteristics can be seen through measuring prompt neutron angular distributions. This is basically due to that the emission of prompt neutrons are dominated by momentum of fission fragments. Because momentum distributions of fission fragmens depend on nuclear isotopes, angular distributions are also differently shapen for diverse isotopes. In previous studies, asymmetry of angular distributions were investigated to estimate neutron leakage multiplication of several special nuclear materials (SNMs) for nuclear material accountancy (NMA). However, those tend to be carried out for single composition of nuclear materials. In practical appications, unknown nuclear materials of mixed composition might be targeted to be measured, and that would be rather complicated. Accoridngly, it is needed to thoroughly study the anisotropic eimission property of for individual nuclear isotopes prior to analysing the complex cases. In this study, dependency of the anisotropic emission property on prompt neutron energy was investigated by Monte Carlo simulations for nuclear safegaurds purposes. To simulate fission correlated prompt neutrons FREYA2.0.5 fission event generator was integrated to Geant4. Three spontaneously fissionable nuclides, ^{252}Cf, ^{244}Cm, and ^{240}Pu were choosen as of interests. Two parameters were defined to analysis asymmetry of angular distributions, and asymmetry was evaluated with varying energy thresholds over 0.25-3.5 MeV. Also angular distributions corresponding to prompt neutrons of several energy ranges (i.e, 0.5-1.5 MeV, 1.0-2.0 MeV) were analysed. Finally, it was confirmed that change rates of asymmetry according to energy threshold is characteristic to nuclear isotopes. This results will be useful in terms of nuclear identification for single composition of nuclear material samples.

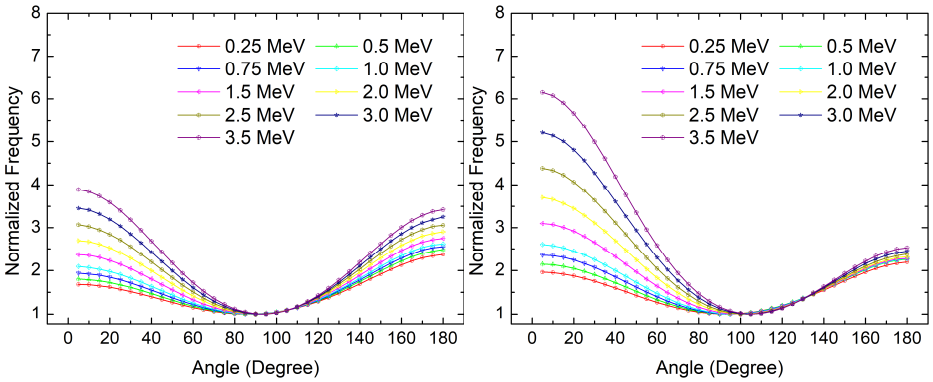

Fig. 1. Simulated prompt neutron angular distributions according to neutron energy threshold. (left: Cm-244, right: Pu-240)

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