A Study on Non-proportionality of Phoswich Detector Using Monte Carlo Simulation

Jae Cheon KIM[1], Jong Kyung KIM[1], Soon Young KIM[2], Yong Kyun KIM[3], and Woo Gyo LEE[3]
1 Hanyang Univ. 17 Haengdang-dong, Seongdong-gu, Seoul, 133-791, Korea
2 Innovative Technology Center for Radiation Safety, 17 Haengdang-dong, Seongdong-gu, Seoul, 133-791, Korea
3 Korea Atomic Energy Research Institute, Deokjin-dong, Yuseong-gu, Daejeon, Korea

Abstract

Using the Monte Carlo simulation, a study on the non-proportionality of the prototype phoswich detector with 2"×2" CsI(Tl) and plastic scintillator, which was made by KAERI, has been carried out and its detector response functions (DRFs) were compared with that of ^{137}Cs and ^{60}Co. To precisely simulate the DRF for the phoswich, the CsI(Tl) non-proportionality was calculated using the electron response and the simplified electron cascade sequence for treating the photoelectric absorption event. The DRFs of ^{137}Cs and ^{60}Co sources which were measured by experiments and calculated by simulations were compared with each other. For ^{137}Cs, gamma-ray responses simulated by MCNP5 are generally good agreement with the measured ones. But the DRF of ^{60}Co does not match well with the results of experiment in the energy region below second peak due to coincidence effect of two gamma-rays (1.174 MeV and 1.332 MeV). To more precisely reproduce the DRF for the phoswich, further studies in relation to the electron channeling effect and the Doppler broadening effect of a scintillator are needed as well as considering that effect of the transfer contribution.