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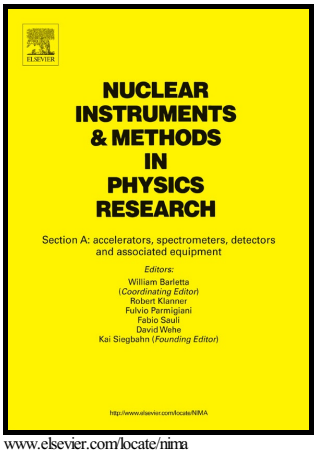

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Presence of neutrons in the low-level background environment estimated by the analysis of the 595.8 keV gamma peak

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Abstract

In order to explore possible improvements of the existing techniques developed to estimate neutron fluence in low-background Ge-spectroscopy systems, gamma spectra were collected by an HPGe detector in the presence of the ^{252}Cf spontaneous fission neutron source. The spectra were taken with and without Cd envelope on the detector dipstick, with different thicknesses of plastic used to slow-down neutrons. We have analyzed the 595.8 keV gamma peak, as well as several more gamma peaks derived after neutron interactions in detector itself and surroundings materials. This complex peak is created simultaneously after the neutron capture on the ^{73}Ge and the inelastic neutron scattering on the ^{74}Ge. The investigation shows that some changes of initial neutron spectra can be monitored by the analysis of the 595.8 keV gamma peak.

Keywords: Low-background gamma spectroscopy; Neutron capture; Inelastic scattering of neutrons; HPGe detector; Evaporated neutron spectra.

1. Introduction

Reduction of different background effects induced by neutrons is very important in different types of low background gamma measurements such as dark mater search experiments, rare nuclear events research or measurements of the low level environmental activity [1-7]. Consequently, significant efforts were made in order to methods that can estimate the level of neutron presence in the Ge-spectroscopy systems during the low-level background gamma measurements [8-10]. Besides the low-background measurements, it is also important to know the background neutron contribution in different types of prompt neutron activation experiments [11].

Neutrons in the low-background gamma spectroscopy systems usually come from muon interactions and from spontaneous fission of heavy elements [12]. In the ground level laboratory, neutrons are mainly produced by muon capture in a lead shield of the gamma-ray spectroscopy systems [13]. There are a number of studies about neutron induced activity during gamma spectroscopy measurements [8, 13-17]. All of those analysis show that gamma peaks following neutron capture and scattering reactions with the detector itself (and surrounding materials) can give measurable contribution to the background spectra.

Peaks created in neutron interactions with the detector and surroundings materials can be used for determination of neutron presence during gamma spectroscopy measurements. Methods for determination of the slow neutron flux using intensity of the 139.9 keV gamma peak