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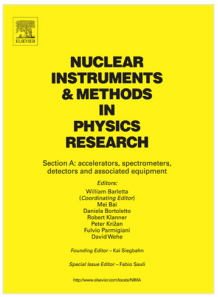

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Estimation of neutron energy distributions from prompt gamma emissions

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A technique of estimating the incident neutron energy distribution from emitted prompt gamma intensities from a system exposed to neutrons is presented. The emitted prompt gamma intensities or the measured photo peaks in a gamma detector are related to the incident neutron energy distribution through a convolution of the response of the system generating the prompt gammas to mono-energetic neutrons. Presently, the system studied is a cylinder of high density polyethylene (HDPE) placed inside another cylinder of borated HDPE (BHDPE) having an outer Pb-cover and exposed to neutrons. The emitted five prompt gamma peaks from hydrogen, boron, carbon and lead can be utilized to unfold the incident neutron energy distribution as an under-determined deconvolution problem. Such an under-determined set of equations are solved using the genetic algorithm based Monte Carlo de-convolution code GAMCD. Feasibility of the proposed technique is demonstrated theoretically using the Monte Carlo calculated response matrix and intensities of emitted prompt gammas from the Pb-covered BHDPE-HDPE system in the case of several incident neutron spectra spanning different energy ranges.

Keywords: Prompt gamma, neutron spectrum estimation, unfolding, genetic algorithm, GAMCD code, FLUKA code, Monte Carlo simulation

1. Introduction

Prompt gammas are emitted following neutron capture by nuclei in a medium with different elements. The emitted prompt gamma energies carry information about the compound nucleus and thus are characteristics of the elements. Similarly, the prompt gamma intensities indicate the neutron energy distribution that cause the prompt gamma emissions as well as the number of interacting nuclei. Analyses of these gamma intensities can be utilized to extract information