

Accepted Manuscript

Estimation of neutron energy distributions from prompt gamma emissions

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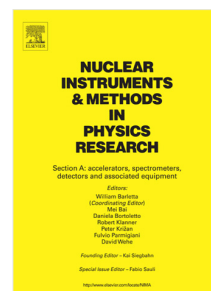
PII: S0168-9002(17)30841-0
DOI: <http://dx.doi.org/10.1016/j.nima.2017.07.066>
Reference: NIMA 60015

To appear in: *Nuclear Inst. and Methods in Physics Research, A*

Received date: 22 May 2017
Revised date: 24 July 2017
Accepted date: 31 July 2017

Please cite this article as: P. Panikkath, A. Udupi, P.K. Sarkar, Estimation of neutron energy distributions from prompt gamma emissions, *Nuclear Inst. and Methods in Physics Research, A* (2017), <http://dx.doi.org/10.1016/j.nima.2017.07.066>

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1 Estimation of neutron energy distributions from prompt gamma emissions

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

21
22 **Keywords:** Prompt gamma, neutron spectrum estimation, unfolding, genetic algorithm,
23 GAMCD code, FLUKA code, Monte Carlo simulation

24

25 1. Introduction

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

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