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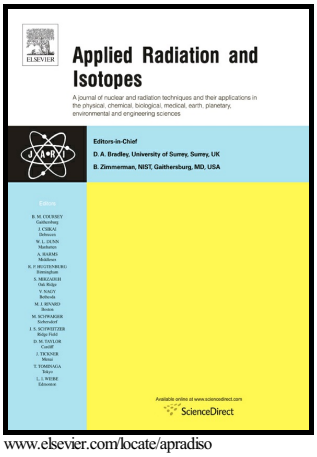

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Variance reduction technique in a beta radiation beam using an extrapolation chamber

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Abstract

This paper aims to show how the variance reduction technique “Geometry splitting/Russian roulette” improves the statistical error and reduces uncertainties in the determination of the absorbed dose rate in tissue using an extrapolation chamber for beta radiation. The results show that the use of this technique can increase the number of events in the chamber cavity leading to a closer approximation of simulation result with the physical problem. There was a good agreement among the experimental measurements, the certificate of manufacture and the simulation results of the absorbed dose rate values and uncertainties. The absorbed dose rate variation coefficient using the variance reduction technique “Geometry splitting/Russian roulette” was 2.85%.

Keywords: Variance reduction technique, extrapolation chamber, Monte Carlo, radiation source, beta radiation.

1 Introduction

The extrapolation chamber is an ionization chamber with two parallel electrodes. One of them is a circular collecting electrode surrounded by a guard ring separated by an insulating material. The other one is both the high voltage electrode and the entrance window for chamber operation. To modify the air mass of the sensitive volume, the distance between the electrodes (chamber depth), must be varied (ICRU, 1997).

The extrapolation chamber has been chosen as a primary instrument established for measuring beta radiation (Böhm, 1986; Caldas, 1986; Dias and Caldas, 1999; NIST, 2010; Bakshi et al., 2013; Vahabi et al., 2014). This chamber is supported by the Bragg-Gray theory. It determines absolutely the absorbed dose or the absorbed dose rate of beta radionuclides and other small penetration radiation sources at different depths. Thus, the main requirements of the cavity theory, which are small collecting surface and small air volume, are satisfied (Caldas, 1980; Oliveira and Caldas, 2005).

The commercial extrapolation chamber PTW model 23392, from Germany is recommended for absolute measurements of beta radiation and low energy X-rays absorbed doses (Böhm, 1986).

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