Contribution of the Scattered Radiation on the Neutron Beam Fluence in the Neutron Calibration Laboratory at IPEN

Tallyson S. Alvarenga¹; Ivon O. Polo¹; Walsan P. Pereira²; Felipe S. Silva²; Evaldo S. Fonseca² and Linda V. E. Caldas¹

¹Instituto de Pesquisas Energéticas e Nucleares, Comissão Nacional de Energia Nuclear (IPEN/CNEN). Av. Prof. Lineu Prestes, 2242, Cidade Universitária, CEP 05508-000 São Paulo/SP, Brazil.


In the past few years, Brazil and several other countries in Latin America have experimented a great demand for the calibration of neutron detectors, mainly due to the increase in oil prospect and extraction procedures. The only laboratory for dosimetry of neutron detectors in Brazil is located at the Institute for Radioprotection and Dosimetry (IRD/CNEN), Rio de Janeiro. This laboratory is the national standard calibration laboratory in Brazil. With the increase in the demand for the calibration of neutron detectors, the need for more calibration services became evident. In this context, the Calibration Laboratory of IPEN/CNEN, São Paulo, which already offers calibration services of radiation detectors with standard X, gamma, beta and alpha beams, recently projected a new calibration laboratory for neutron detectors. One of the main problems in this kind of calibration laboratory is related to the knowledge of scattered radiation. In order to evaluate it, simulations were performed without the presence of the structural elements and with the complete room. Fourteen measurement points were evaluated in two directions at various distances. As part of the characterization process of the radiation fields of the new Neutron Calibration Laboratory (LCN), this work intends to evaluate the influence of the radiation dispersed by the structural components of the room: walls, doors, ceiling and floor, in different calibration positions, on the detector response. Therefore, the neutron radiation attenuation and the scattering parameters were determined at different source-detector distances, through computational simulation, using the MCNP5 Monte Carlo code.

Keywords: Neutron radiation, Scattered radiation, Neutron calibration, Neutron detector

Conference topics: New radiation sources, techniques & detectors

Monte Carlo

Mirko S. A.

Introduction: Photodynamic therapy (PDT) is a treatment for malignant diseases that has a varying depth of penetration ranging from 0.5 to 1 cm, depending on the wavelength beam used. The treatment involves the intravenous administration of a photosensitizing agent (PS) and light exposure. When the material containing the PS is exposed to the light, the PS is excited to a higher energy state and can subsequently react with oxygen to produce reactive oxygen species (ROS), which causes cellular damage and finally cell death. The treatment is usually performed in a controlled environment with the patient under general anesthesia.

Materials and Methods: A phantom consisting of a cylindrical phantom with 1 cm diameter and 1 cm height was filled with a solution of methylene blue 1% and finally was covered with a 0.5 cm layer of paraffin. The phantom was irradiated with a light source emitting light at 660 nm, the wavelength beam was located at 1 cm above the phantom and the diameter of the beam was located at 0.5 cm diameter. To guarantee the homogeneity of the light source, it was placed at the center of the phantom. The light intensity was measured at different points on the surface of the phantom using a photodetector. The measurement was performed in triplicate to ensure accuracy.

Results: The average light intensity at the surface of the phantom was 1500 mW/cm², and the deviation was less than 10%. The light penetration depth was approximately 0.5 cm. Percentual differences in light intensity were observed, with the highest intensity recorded at the center of the phantom and the lowest intensity recorded at the edges. The light intensity was found to be homogeneous within the first 0.5 cm layer of the phantom.

Discussions: The results obtained in this study are consistent with previous research and confirm the feasibility of using PDT in the treatment of malignant diseases. The accuracy of the light source was observed to be within the acceptable range, which is important for the successful treatment of malignant diseases. These findings support the use of PDT in the treatment of malignant diseases, which can lead to improved outcomes for patients.

Keywords: Photodynamic therapy, Methylene blue, Light intensity, Light penetration depth.