Monte Carlo Simulation for the Production of Neutrons Inside the Labyrinth Function Rooms Radiotherapy in Head Rotation of Medical Linear Accelerator Use and Energy Operation

Roque H. Silva¹, Rebello W. Freitas², Silva A. Xavier¹ and Facure A.³

¹ Coordenação dos Programas de Pós-graduação de Engenharia/COPPE - UFRJ
Programa de Engenharia Nuclear - PEN
Cidade Universitária - Ilha do Fundão
21941-909 Rio de Janeiro - RJ
roque@cbpf.br
ademir@con.ufrj.br

² Instituto Militar de Engenharia - IME
Seção de Ensino - SE/7
Praça General Tibúrcio, 80
22290-270 Rio de Janeiro - RJ
wilsonrebello@gmail.com

³ Comissão Nacional de Engenharia Nuclear - CNEN
Unidade Central
Rua Gal Severiano, 90 Botafogo
22290-901 Rio de Janeiro, RJ
facure@cnen.gov.br

ABSTRACT

This work consists of an analysis, through computer simulation using the Monte Carlo method, the production of neutrons generated by the interaction of the beam with useful materials that are heavy in head-accelerated linear medical use. We developed a computer model of the head of the linear accelerator Varian, where there was the ambient dose equivalent due to the neutrons $H^*(10)_n$ the plane of the patient and the region of the labyrinth bunker for several angles of operating at energies of 10, 15, 18 MV. It was found that production of neutrons in the plane of the patient has direct dependency with increasing beam energy useful, since the labyrinth it appears that besides energy the operating angle also has a direct influence on the production of neutrons in the region of the labyrinth, consequently the door. Therefore, a survey of $H^*(10)_n$ at various angles with different operating ranges of energy contributes to better planning studies concerning shielding doors in rooms radiotherapy.
1. INTRODUCTION

The production of neutrons through the interaction of high-energy photons above 10 MV, is of concern in radiation therapy, so studies have been widely developed in order to analyze the population of fotonêutrons that are inside the rooms, particularly in the plane of the patient and in the labyrinth of bunker [1] [2]. The use of such beams has been widely used, since it was observed greater efficiency in the treatment of cancers deep as the depth of the deposited dose is proportional to the operating power [3] which results in increased production of neutrons. Furthermore, implements Modelling useful beam in complex geometries are also being extensively used, bringing considerable production of neutrons by the interaction of photons with energy heavy materials responsible for collimating the same [4]. Another aspect that is considered important for the degree of freedom of the head of the linear accelerator as its rotation around the patient is one of the techniques used in treatment planning, and verification of the neutron population inside the labyrinth became the motivation for this work, because according to NCRP-151, the neutrons generated in the labyrinth of bunker radiotherapy influence the ambient dose equivalent. Therefore, these neutrons are considered harmful to health health, so they have a direct influence on the calculation of shielding doors [5].

2. METHODOLOGY

Was using the Monte Carlo code N-Particle version X - MCNPX to develop the computational model of the head of the medical linear accelerator from Varian brand. We simulated the energies of operation 10, 15 and 18 MV opening in the field isocenter 5 x 5 cm² for multileaf collimator jaws and - MLC, Figure 1 illustrates the inside of the head with respective linear accelerator collimator. This equipment was simulated based on the same model presented by Mao [6], and it was perfected by Rebello [7] that entered this collimator MLC. The computational model of the head of the linear accelerator was validated by Roque [8] to the energies involved in this study by comparing experimental and statistical analysis.
The values of the ambient dose equivalent due to neutron $H^*(10)n$ were calculated considering various angles of inclination of the gantry operating at energies of 10, 15 and 18 MV, we used the command F5 tally of the code [9] to simulating point detectors located in the plane of the patient and the labyrinth, Table 1 shows the positioning of the point detectors. Was inserted computational model of a sphere ICRU to provide more realistic results. Figures 2 and 3 show the points where they were calculated $H^*(10)n$, the tilt angle of the gantry assembly and the head phantom respectively. We used the computer code Moritz to dynamically verify the production of neutrons and its influence in the region of the labyrinth, can be observed in Figure 4 that the neutrons generated in the head of the linear accelerator have ample capacity to propagate to the door.

Table 1: Position of point detectors inside the radiotherapy room

<table>
<thead>
<tr>
<th>Detectors / Position</th>
<th>X (cm)</th>
<th>Y (cm)</th>
<th>X (cm)</th>
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<tr>
<td>1</td>
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<td>200</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>295</td>
<td>420</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>150</td>
<td>603</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>6</td>
<td>-510</td>
<td>623</td>
<td>0</td>
</tr>
</tbody>
</table>
Figure 2: Interior of radiotherapy. The left checks the points where were calculated $H^*(10)n$ right there is the tilt angle of the gantry.

Figure 3: Set head and ICRU sphere
Figure 4. Three dimensional view of the interior of the radiotherapy room. The right inside the room before starting the treatment, the left neutrons generated in different energy bands after the start of treatment. This image was generated with the printhead operating 0° inclination.

3. RESULTS

The figures below show the values of $H^*(10)_n$ in the maze and in the plane of the patient as a function of operating power and inclination of the gantry head of the linear accelerator.
4. CONCLUSION

From the results obtained it is clear that the $H^*(10)_n$ varies as a function of angle, and mainly due to the energy, it can be observed that the angles over 180 degrees occurs an increase in dose due to neutrons generated, thus it is feasible to suggest this behavior and consider the methodology of calculation of shielding, because the current literature there is no reference as to the operating angle.

REFERENCES


