EVALUATION AND SIMULATION STUDY OF A HOMEMADE IONIZATION CHAMBER FOR USE IN COMPUTED TOMOGRAPHY BEAMS

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In this work, an ionization chamber with a sensitive volume of 3.40 cm^3 was evaluated at the Instituto de Pesquisas Energéticas e Nucleares for use in the dosimetry of computed tomography (CT) medical equipment. The main difference between this CT ionization chamber and the commercial ones is related to the respective constituent materials. For the manufacture of our prototype chamber only Brazilian low- cost materials were utilized. To evaluate the performance of the chamber several pre-operational tests were undertaken, such as short- and medium-term stability, leakage current, saturation curve, ion collection efficiency, polarity effect and energy dependence. Besides, the energy dependence was also evaluated using Monte Carlo simulation. The short-term stability test was done by ten readings of charge, during time intervals of 60 s, under reproducible conditions. The highest variation coefficient obtained was 0.2%, whereas according to international recommendations [1] the maximum acceptable coefficient of variation is 1%. The medium-term stability test was carried out by taking the medium value of ten measurements of the short-term stability tests during a period of one month, and the results are in agreement with the international recommendations [1]. The saturation test was performed using the diagnostic quality beam RQT 9 established at the Pantak x-ray equipment. For all voltage values applied, no significant changes in the collected charge were observed. The chosen applied voltage for the CT chamber was +100 V. From the saturation curve two other parameters could be analyzed, namely the polarity effect and ion collection efficiency. For all pairs of voltage values in the saturation test, the polarity effect did not exceed 0.6%, which is below the recommended limit of 1% [2]. The ion collection efficiency was better than 99.9% for both polarities. The leakage current was measured in time intervals of 20 minutes, after the irradiation, and the maximum value obtained was 0.06% of the ionization current produced at the minimum air kerma rate utilized in this work. The x-ray energy dependence was analyzed for the radiation qualities RQT8, RQT9 and RQT10, which correspond to voltages of 100, 120 and 150 kV, respectively. The energy dependence obtained experimentally for the CT ionization chamber was 4.3%, in good agreement with the result of Monte Carlo simulations using the PENELOPE code system. The global influence of some materials of the CT chamber on its sensitive volume could also be simulated, and was found to be 1.92. The results obtained in the undertaken tests showed that this CT ionization chamber is a good alternative to be used in computed tomography beams because it is easy to construct, and it presents a low cost.

[1] IEC 1997*, Medical electrical equipment - Dosimeters with ionization chambers and/or semi-conductor detectors as used in X-ray diagnostic imaging*, IEC 61674, International Electrotechnical Commission, Genève.
[2] IEC 2011, *Medical electrical equipment - Dosimeters with ionization chambers as used in radiotherapy*. IEC 60731. International Electrotechnical Commission, Genève.