Simulation of the geometry of an X-ray tube using the Monte Carlos method

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Keywords: MCNPX code, air kerma, X-ray tube, X-ray spectrum

This report presents a simulation of an X-ray tube to estimate the fluency of radiation photons inside the ampoule with the aim of simulating an X-ray beam with the MCNPX code. The proposed model consists information about the geometry: the radiation source; the description of the materials used; the types of results (tallies) required by the user [1]. An input file with information similar was developed with the MCNPX code to create a geometry that simulates an X-ray tube, a tungsten target with a 30° slope bombarded by electron beams produced in a filament and a window with inherent 1 mm beryllium filtration a sample of an equivalent MS20 tissue as shown in Figure 1 [2].

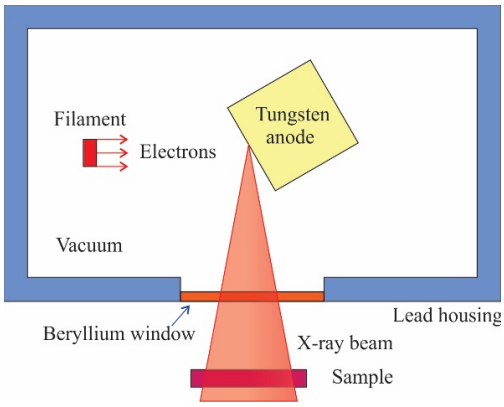

Figure 1. X-Ray tube and its characteristics

After simulating the X-ray tube shown in Figure 1, it was possible to simulate and estimate the value of the absorbed dose (Tally F6) in the equivalent tissue. The results are shown in Table 1. The MeV/g value was converted to the absorbed dose in units of Gy. The spectrum of simulated photons in the 50 keV tube was compared with the spectrum of a software [3] that generates X-rays as shown in Figure 2. The spectra were considered satisfactory, some differences in the characteristic X-rays peaks amplitudes are being investigated.

Table 1 - Tally F6 value found in the simulation.

The response of F6 is in MeV/g.
3.77349E-06 was the average simulated energy in the equivalent tissue considering a number of particles transported from 1E6, the relative error factor in the simulation was of 1.2%.
1 MeV/g = 1.6E-10Gy
3.77349E-06 = 6.037584E-16Gy = 6.0E-10 µGy

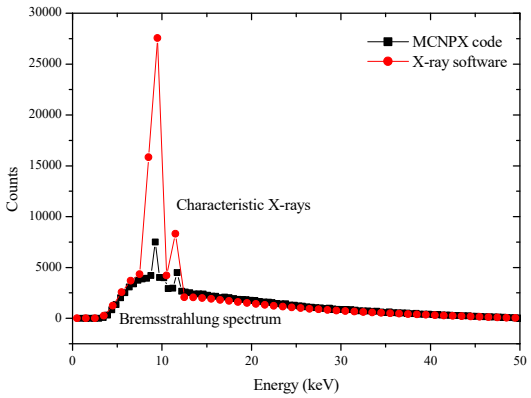

Figure 2. X-ray spectrum

The absorbed dose obtained in the MCNPX code using the tissue simulator was estimated at 6.0E-10 µGy, being considered satisfactory for validation of the simulation scenario. But for a comparative study with the values of Normative Instruction №52 2019 [4] it would be necessary a future study with milliampere values and exposure time.

References

[1] PELOWITZ, D.B. MCNPX TM User's Manual, Version 2.5.0, LA-CP-05-0369, Los Alamos National Laboratory (2005).
[2] R.J. McCONN Jr., C.J. GESH, R. T. PAGH, R.A. RUCKER; R.G. WILLIAMS III. Compendium of Material Composition Data for Radiation Transport Modeling. Revision 1 (2014).
[3] BERTIN, E.P., Introduction to X-Ray Spectrometric Analysis. Plenum Press, New York (1978).
[4] Brasil. Instrução normativa n° 52, 20 de dezembro de 2019. Diário oficial da união: seção 1, edição 249, p. 131, 26 de dezembro de 2019.