Determination of the X-ray spectrum of a small animal PET/CT employing the MCNP5 Monte Carlo code

Lucio P. Neves[1]; Ana P. Perini[1]; William de S. Santos[1]; Peterson Squair[1]; Linda V. E. Caldas[1]; Ana F. Maia[2] and Lorena Pozzo[1]

[1]Instituto de Pesquisas Energéticas e Nucleares, IPEN/CNEN-SP, São Paulo, Brasil
[2]Federal University of Sergipe, Department of Physics, Sergipe, Brazil

lpneves@ipen.br; aperini@ipen.br; wssantos@ipen.br; peterson.squair@ipen.br; lorena.pozzo@ipen.br; afmaia@ufs.br; lcaldas@ipen.br

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Introduction: During the past years, small animal PET/CT are becoming more common, and several laboratories now employ these equipment in cancer studies. Besides efforts in the use of computer-simulated models, small-animals represent a critical, and so-far irreplaceable, bridge between discoveries at the molecular level and implementation of clinically relevant diagnostics or therapeutics. At the Instituto de Pesquisas Energéticas e Nucleares (IPEN), several *in vivo* studies are under development involving the use of mice and rats, for cancer treatment and diagnosis. One of the equipment employed in these studies is a recent acquired ALBIRA small animal PET/CT scanner. In order to evaluate, in more depth, the doses to the mice and rats associated with the CT exams performed by this equipment, Monte Carlo simulations were also employed. In this scenario, the X-ray tube spectrum must be determined. It is important to note, that due to the confined space of this equipment, the scattered radiation from several structures may become an important part of this spectrum besides the X-ray tube itself.
Methods: The simulations were executed employing the MCNP5 Monte Carlo code, with a detailed description of the X-ray tube and gantry geometries. The electrons were transported until they slow down and stop in the target. Both bremsstrahlung and characteristic x-ray production were considered in this work. The X-ray tube used in this equipment is a microfocus X-ray source with a focal spot size of 35 μm (Oxford Instruments XTF5011, X-Ray Technologies Inc., Scotts Valley, California, USA), that operates with a tube tension of 50 kV and beam filtration of 0.5 mmAl. The exit window is made of beryllium, with a thickness of 125 μm. The X-ray tube is sealed and has a fixed tungsten anode (anode angle of 22°).
Results: The spectrum was obtained in a small sphere, located at the position of the animal, in order to take into account the air influence inside the equipment. The simulated X-ray spectrum was compared with the spectrum determined by the IPEM report number 78 for validation. There is a good agreement between these two spectra, although there are some differences in the distance between focal spot and measurement point.
Conclusion: The results indicate that the MCNP5 general purpose Monte Carlo code is a useful tool for generating x-ray spectra and may be used for further studies involving this equipment. The simulations results were considered satisfactory, and this spectrum may be used for further studies involving this equipment.
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