Reliability Study for Protons Transport Applied to Ultra-Thin Layers

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Abstract

The use of Monte Carlo general toolkits to different applications, especially the ones that has multiple processes and models available to transport the same particle kind requires, more and more, associate to the application development the transport radiation knowledge and the validation or reliability evaluation, in order to define the best transport process and model evoked by the simulation. When the validation is impossible, due to the lack of experimental data, the reliability evaluation takes an important role. In addition, when multiple transport processes and models are available, it is important to perform a quantitative comparison among the possible options to apply a specific study case to guarantee the accuracy of simulation results. The Geant4-DNA is a Monte Carlo simulation toolkit that works in an energy range that makes it impossible, nowadays, to perform a proper microscopic validation of the cross-sections and the dynamic diffusion parameters but allows, very limited, macroscopic validation, especially because it may simulate physics, physical-chemistry and chemistry processes applied to molecular geometries for quantification of damage (such as single-strand, double-strand breaks, base oxidation...). Considering the complexity of the physics, physical-chemistry and chemistry processes simulated it is important to guaranty the accuracy of the beginning of this dynamic process by getting the best model to simulate the radiation transport and energy deposition. This paper presents a reliability evaluation for incident protons beam of 2 MeV on polymers ultra-thin films. Furthermore, comparison (Fig.1) among different available physics lists Geant4-DNA (version 10.02.p01) with incident protons beam for different energies (2 to 20 MeV) interacting with homogeneous ultra-thin layers of water (2 to 200 nm) were performed. In general, the standard (DNA) physics list of Geant4-DNA presented the most consistent results and the DNA-Opt1 physics list was more time consuming, presenting the worst results for dosimetry for ultra-thin layers.

Image

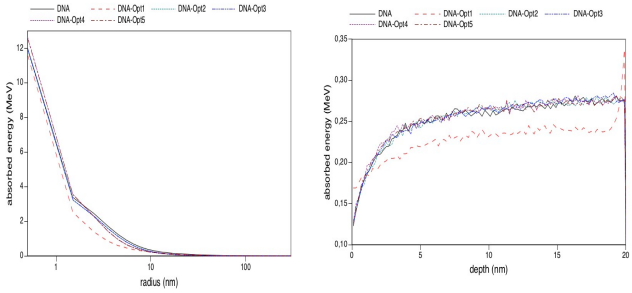
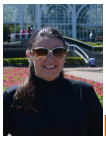


Figure 1: Graphics of radial (left) and depth (right) profiles of absorbed energy by 20 nm thick ultra-thin layers composed of water for all evaluated Geant4-DNA (version 10.02.p01) physics list.

Recent Publications

1. Silva, R; Denyak, V.; Schelin, H. R.; Hoff, G; Paschuk, S. A.; Setti, J. GEANT4 simulation of exit energy in proton medical imaging. Radiation Physics and Chemistry, p.1 - 7, 2019.
2. Thomaz, S. R.; Louette, P.; Hoff, G; Müller, S.; Pireaux J-J; Trautmann, C,; Papaleo, Ricardo M. Bond-breaking efficiency of high-energy ions in ultra-thin polymer. Physical Review Letters. , v.121, p.66101 - 66106, 2018.
3. Basaglia, Tullio; Bonanomi, Matteo; Cattorini, Federico; Han, Min Cheol; Hoff, Gabriela; Kim, Chan Hyeong; Kim, Sung Hun; Marcoli, Matteo; Pia, Maria Grazia; Saracco, Paolo. Validation of Shell Ionization Cross Sections for Monte Carlo Electron Transport. IEEE TNS. v.65, p.2279 - 2302, 2018.
4. Hoff, Gabriela; De Assis, Joaquim T.; Brunetti, Antonio; Fanti, Viviana; Golosio, Bruno Abstract ID: 69 Validation of XRMC Monte Carlo toolkit for external dosimetry applied to mammography. Physica Medica-European Journal of Medical Physics. v.42, p.14 - , 2017.
5. Hoff, G; Filipov, D; Denyak, V.; Schelin, H. R.; Paschuk, S. A.Monte Carlo Simulation Used to Calculate Energy Correction Factor for Thermoluminescent Dosimeters Used by Occupational Workers on Pediatric Exams. Radiation Protection Dosimetry. p.1 - 20, 2017.

Photograph



Biography

Dr has experience in medical physics, computer simulation, and external dosimetry, acting on the following topics: mammography, dosimetry, diagnostic radiology, quality control, and imaging. She has more than fifteen years experience in Medical Physics(dosimetry and applied Medical Physics – especially mammography, radiology), ten years working on Monte Carlo Simulation applied to different areas (geology, industry and microscopic and macroscopic Monte Carlo validation) and thirteen years experience working as a professor at PUCRS (in South of Brazil), acting as member of the Ethics in ResearchCommittee and Graduation Course coordinator. In the last ten years, her research interest are directed to Monte Carlo validation and reliability to improve the accuracy of Monte Carlo applications to dosimetry and imaging of different king of incident particles (photons, electrons, and protons) always collaborating with different Medical Physics and Biomedical Engineering professionals to develop simulations on medical applications of radiation.

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