Run-time differences between the EGSnrc code and the EGS5 code in Medical Simulations

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An agreement between EGS5 calculation results and EGSnrc code results for linac modelling was shown in recent work in our group. However, a large simulation run-time difference was found for the same conditions and statistical precision between these two codes. For example, the EGS5 code simulation duration of percentage-depth-dose curves of linac electron beam was three times longer than the EGSnrc code. The EGS5 code took a longer period to obtain the same results compared to the EGSnrc code . The electron transport in EGSnrc is based on the ESTEPE parameter, which is the maximum fractional energy loss per electron step. We investigated the ESTEPE parameter influence on the run-time and on the results accuracy.

EGS5 Monte Carlo code is a general purpose code for calculating photons and electrons transport for complex geometries in a wide range of energies. EGSnrc Monte Carlo code (BEAMnrc enclosed) was specially developed for medical physics usage, in particular for linac modeling and dose calculations. Both EGS5 an EGSnrc were based on the former EGS4 code. For each of the codes, changes were made in the electron transport methods and in the geometrical utilities.

Our study was planned to point out the reason for the run-time difference between the two codes. Time dependency due to the transport parameters and due to the materials and geometrical definitions were investigated in this research by running the same problem on both codes on the same computer for each. The simulation geometry was consisting of a high Z metal (Iron) cylinder with a radius of 1mm and 2 mm length, as an electrode of a small ion-chamber, inside a cylindrical water phantom (10 cm X 5 cm).

Set of variety simulations were performed using both codes, for several photon energies. We found that the EGSnrc run-time is strongly influenced by choosing different ESTEPE parameter values. While setting larger fractional energy losses per step, reduced simulation run-time was achieved, nevertheless, this could lead to dose resolution deficiency.

Prior knowledge of the geometry and materials of the simulated problem has to be taken into account for choosing the parameters in order to run it with the EGSnrc code. Hence, for optimal dose, one should define the optimal ESTEPE and maximum step-size parameter to achieve the desired dose results resolution. The use of the EGS5 code, based on the electron transport method improvements, is automatically adapted to the desired dose results quality without any user interference. Choosing the proper ESTEPE parameter for a given simulation for the use of EGSnrc is resulting a similar run-time duration as with the use of EGS5.