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Development of a new Monte Carlo as a dosimetric tool to be implemented in Brachytherapy.

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The influences of inhomogeneities are understood such as an altered attenuation of radiation with possibly cloyed dose distribution and disturbance of secondary electron equilibrium near interfaces. Such effects are ignored at the majority of modern 3D planning system algorithms in brachytherapy which are based on calculations in homogeneous water. Therefore, the actual challenge in the medical physics is the determination of the effects of the inhomogeneities in the calculations of dose distribution.

An account of the above explained, a new C++ code MC named Brachy++ localized within the EGSnrc Monte Carlo packages platform was developed. In contrast to the well established Monte Carlo Codes (PENELOPE, EGSnrc and ITS) whose computes only the dose distribution on homogeneous media, Brachy++ was designed to perform fluence calculations around general 3D inhomogeneous medium surrounding a brachytherapy source with arbitrary size and form. The goal of this development is to facilitate the construction of complex geometry in heterogeneous media using an intuitive text based approach and the use of the standard Monte Carlo Transport parameters from the EGSnrc systems. With help of the EGSpp library developed to the EGSnrc system within a series of simulations from very complex geometries was performed for calculating the perturbation effect due of inhomogeneities within a water tank.

Brachy++ was successfully benchmarked against own calculations from PENELOPE and EGSnrc Monte Carlo codes packages. At the same time, all simulations were compared with several measurements and calculations reported in the literature. The Benchmarking of Brachy++ against the well established codes EGSnrc (Flurznrc/Dosrznrc) was also desirable and relevant to validate Brachy++ such as standard MC user-code. The calculated dose distribution with Brachy++ around a single Ir-192 was found to be very consistent with previously published data consisting in thermoluminescent dosimetry and measurement as well as Monte Carlo researches. The dose distributions along the transverse axis and the two dimensional dose rate tables have been calculated. All Calculations are in good agreement with corresponding accurate Monte Carlo results which have been reported by other authors.

Dose parameters based on TG43 formalism are derived from 2D dose rate in the region of 0.5 - 7cm. Radial dose and anisotropy functions calculated using the three different Monte Carlo codes mentioned above show excellent agreement with published data. The influence of nature and size of the phantom and of inhomogeneities are investigated. Up to 44 % difference was found for huge heterogeneities calculating the absorbed dose near to interfaces.

In conclusion, Brachy++ has been successfully validated and tested against other Monte Carlo Codes. Based on research consideration, Brachy++ performs adequate dose calculations taking into account a realistic geometrical setup of the source and the heterogeneous surrounding medium.