AbstractID: 3900 Title: Verification of Monte Carlo simulations of proton dose distributions in biological media

Purpose:

Aim of this work is to suggest a method for verifying the ability of Monte Carlo codes at simulating proton transport through biological tissues defined by CT Hounsfield units.

Material and Methods:

The method is based on the assumption that the main physical processes leading to proton energy deposition are Coulomb interactions. It consists first in simulating the two- or three-dimensional dose distributions from a monoenergetic proton pencil beam impinging in various homogeneous phantoms filled with water and with biological tissue. The indicators for the Coulomb interactions are extracted from the dose distributions: these are the proton stopping powers relative to water and the lateral scaling factors, which characterize respectively the longitudinal loss of energy and the scattering properties in the material traversed. Third, these values extracted from the Monte Carlo simulations are compared to the expected analytical values of the stopping powers and of the lateral scaling factors for various proton energies in water and in several biological materials.

Results:

This method was applied to two versions of the Monte Carlo code GEANT4. Results show that while the values for the stopping powers extracted from the simulations are in good agreement with the analytical or tabulated values, non negligible discrepancies in the simulation of proton scattering exist between the former version of GEANT4 and the analytical predictions: in the former version about 16.0% deviations were found in the simulation of the proton beam broadening in water and in material. The best agreement with the analytical values for the Coulomb indicators (less than 3.0%) was provided by the current latest version GEANT4.7.0

Conclusion:

The evaluation of GEANT4 using this validation method for Coulomb interactions shows that GEANT4 can be used as a benchmarking tool for proton dose calculations on CT data.

Conflict of interest:

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