Radial dose around carbon ion tracks in liquid water

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Physical mechanisms of bio-damage are very relevant in the biomedical context. Energetic ions and electrons damage organic targets. Therefore the investigation of the associated interaction phenomena is of great importance for radio-therapy (e.g. ion-beam cancer therapy [1], radiation protection [2]).

For energetic incident projectiles, the main channel of energy loss is through inelastic collisions with the target electrons [3], which results in the production of an avalanche of secondary electrons, most of which being ejected with a few tens of eV [4].

As a consequence, the energy lost in the target by the incident ions is redistributed at small distances around their tracks. The characteristics of the radial dose distribution depend on the initial energy of the ion beam and on the nature of the target.

The radial dose can be assessed analytically [5] or through simulations [6]. Event-by-event simulation allows following the details of the complete cascade of secondary and tertiary electrons (generated, respectively, by the incident ions and by the secondary electrons) including all the possible interaction mechanisms [7].

In this communication we will review the models that we developed for describing the mechanisms of interactions, which are important for ion cancer therapy, and demonstrate the accuracy of our simulation code (SEED: Secondary Electron Energy Distribution) for the case of the interaction of energetic carbon beams with liquid water (see Figure 1 where SEED simulations are compared with the results of other authors [8-11]).

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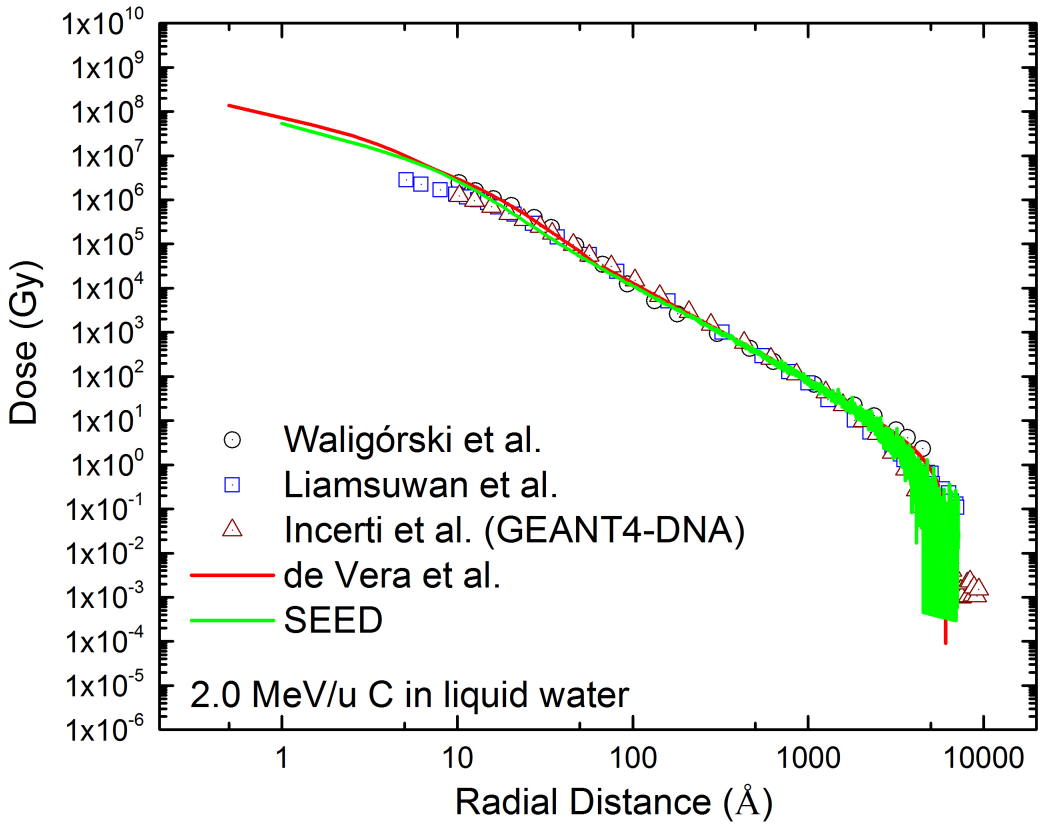

FIG. 1. SEED simulation of the radial dose around the track of a 2 MeV/u carbon beam incident on liquid water compared with the results of other authors [8-11].