Secondary electron tracks generated by synchrotron radiation in water

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When high energy photons interact with matter produce secondary electron which are the main responsible of the radiation damage. These high energy electrons, by successive collisions with the atomic and molecular constituent of the medium generate cascades of low energy electrons until their final thermalization. Recent studies showed the damaging effects of those electrons producing molecular dissociation and strand breaking even for energies much lower than the ionization level [1-2].
In this study we present a method to simulate individual tracks of secondary electrons from energies close to that of the primary photons down to thermal energies in water. The input parameters for the simulation code are the experimental and theoretical interaction probability distribution functions we previously obtained for the considered energy range [3]. Information about actual irradiated areas, detailed energy deposition maps and radiation damage at the molecular level are derived from the simulated electron track structure. Assuming that photons, in the keV energy range, follow the pattern interaction given in the literature [4] we are focusing our study on the secondary electrons produced by photoelectric and Compton processes. For energies above 10 keV electron scattering processes in water are considered as accurately described by the Born-Bethe theory. Below 10 keV specific experimental and theoretical methods have been used to determine electron scattering cross sections with single H_2O molecules. Total electron scattering cross sections have been measured in a transmission beam experiment [3]. Ionization cross sections were derived by measuring simultaneously the ion and electron intensities in a synchronized pulsed beam system.These measurements allow also electron energy loss determinations as a function of energy and scattering angle. Differential and integral elastic cross sections have been calculated with an optical potential method [5] by assuming an independent atom representation with screening corrections. Finally, cross sectional data and energy loss distribution functions obtained with these methods has been used as input parameter for a Monte Carlo code we have developed [6] to simulate single electron tracks from high initial energies (keV or MeV) down to thermal energies (meV).

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