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Electric field effects on the ionization cluster size distribution (ICSD) using the GEANT4 Monte Carlo toolkit.

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Abstract content
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In nanodosimetry, Monte Carlo procedures are used to study the physical characteristics of charged particles used in the irradiation of cancerous tumors (in particular the DNA) by conducting simulations in condensed matter. A property of relevance in this investigation is the so called "track structure" of ionising particle tracks which is characterized by nanodosimetric parameters related to the initial chemical/biological effects of radiation to DNA. To benchmark these calculations, ionisation experiments in low density gases (e.g. propane) with similar ionisation characteristics to those of water or DNA are used to measure the nanodosimetric parameters (e.g. ICSD). The gas is introduced in a low pressure chamber with an extraction aperture and an electric field is applied to aid in the extraction of the resulting ions. The ions are produced by the interaction of the particle under investigation with the chamber gas. The ions are extracted and guided to an ion counting detector. The amount of ions counted is related to the type and energy of the particle and also the physical characteristics of the chamber gas.

Simulations of protons (0.1 – 10.0 MeV) in water vapor have shown increases of up to 17% in the ICSD in an electric field of 60 V/cm which is not expected and this presents challenges in the measurement of ICSD. Results on further investigations of this effect using alpha particles and carbon ions also show this increase and will be presented.

Electric field effects on the measurement of nanodosimetric parameters should be accounted for in order to compensate for the increase in ICSD, in order to correctly predict the initial damage to DNA.

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