Master Thesis

Monte Carlo modelling of microdosimetric detectors in light-ion beam therapy

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Background: The radiation dose delivered to a cancer in radiotherapy is specified in terms of the amount of average energy deposited per unit mass by ionizing radiation. This macroscopic quantity works fine for radiations producing a fairly uniform pattern of energy deposition, such as high-energy x-rays and electrons, but fails to correlate well with the biological effects of radiations where the energy deposition is concentrated around the particle tracks, such as light-ion beams. The latter are becoming more common in radiotherapy and are the type of beams used at MedAustron. For these beams knowledge of the microscopic and nanometric energy deposition patterns is needed to describe the physical influence of radiation on biological effects. At MedAustron, a diamond microdosimeter is being developed as a tool for clinical use. The detector itself, however, is a source of perturbation of the microdosimetric distributions and Monte Carlo radiation transport simulations are the ideal tool to study and correct for these perturbations.

Project: The first aim of the project is to build a Monte Carlo model of the diamond microdosimeter and compare the microdosimetric distributions in the detector with those in the volume of interest in water or in the cell. This will form the basis of a correction method to derive the microdosimetric distributions of interest from those obtained with the detector. The model will then be extended to perform a component analysis to assess separately the influence of substrate, contacts, encapsulation, coating, etc. Since the detector will be used in a variety of phantoms (such as uniform phantoms, anthropomorphic phantoms and biological phantoms), and in the future also as an in-vivo dosimeter in real patients, a full Monte Carlo implementation of the phantom environment to study its influence on the microdosimetric spectra and the radiation quality forms a possible extension of the project, time allowing.

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