

Geant4-DNA: Modelling biological damage induced by ionising radiation at the DNA level

Monday, September 9, 2024 10:50 AM (1 hour)

Geant4-DNA is an extension of the Geant4 Monte Carlo toolkit designed for mechanistic studies of cellular radiobiological effects at the DNA scale. It simulates the physical, chemical, and biological stages of ionizing radiation, including electrons, protons, alpha particles, and heavier ions, for various applications. The applications of Geant4-DNA range from predicting radiotherapy outcomes to radiation protection and space applications. These lectures provide an overview of the progress achieved with physical, physicochemical, chemical, and biological geometry models integrated into Geant4-DNA. The latest developments are highlighted, including user-friendly applications such as 'molecularDNA' and 'dsbandrepair', which are based on these models. These applications allow for quantitative predictions of early DNA damage, such as single-strand breaks (SSBs), double-strand breaks (DSBs), and the complexity of clustered lesions across different levels of DNA structure, from the DNA base to the full genome of a human cell. The lectures will present sets of models, functionalities, and user examples in Geant4-DNA. These capabilities allow for the investigation of radiation quality across a range of ionizing radiations, covering a broad spectrum of radiotherapeutic modalities. This spectrum includes high-energy hadron beams, as well as low-energy gamma, beta, or alpha emitters used in brachytherapy sources and radiopharmaceuticals.

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