Overview of the Graphical User Interface for the GERM code (GCR Event-based Risk Model)

Myung-Hee Y. Kim¹ and Francis A. Cucinotta²

¹USRA, Division of Space Life Sciences, SK/SRPE/B37, 2101 NASA Parkway, Houston, TX 77058, USA, myung-hee.y.kim@nasa.gov
²NASA Johnson Space Center, SK, 2101 NASA Parkway, Houston, TX 77058, USA, francis.a.cucinotta@nasa.gov

Abstract

The descriptions of biophysical events from heavy ions are of interest in radiobiology, cancer therapy, and space exploration. The biophysical description of the passage of heavy ions in tissue and shielding materials is best delivered by a stochastic approach that includes both ion track structure and nuclear interactions. A new computer model called the GCR Event-based Risk Model (GERM) code was developed for the description of biophysical events from heavy ion beams at the NASA Space Radiation Laboratory (NSRL). The GERM code calculates basic physical and biophysical quantities of high-energy protons and heavy ions that have been studied at NSRL for the purpose of mimicking space radiobiological effects. For mono-energetic beams, the code evaluates the Bragg peak transfer (LET), range (E), and absorption in tissue equivalent material for a given Charge (Z), Mass Number (A) and kinetic energy (E) of an ion. In addition, a set of biophysical properties are evaluated such as the Poisson distribution of ion on deoxyribonucleic acid for a specified cellular area, cell survival curves, and mutation and tumor probabilities.

The GERM code also calculates the radiation transport of the beam line for either a fixed number of user-specified depths or multiple positions along the Bragg curve of the particle. The contributions from primary ion and secondary particles are evaluated.  The GERM code accounts for the major nuclear interaction processes of importance for describing heavy ion beams, including nuclear fragmentation, elastic scattering, and inelastic cascade processes by using the quantum multiple scattering model of heavy ion fragmentation (QMSFRG) model.  The QMSFRG code has been shown to be in excellent agreement with available experimental data for nuclear fragmentation cross sections, and has been used by the GERM code for application to thick target environments. The GERM code provides scientists participating in NSRL experiments with the data needed for the interpretation of their experiments, including the ability to model the beam line, the shielding of samples and sample holders, and the estimations of basic physical and biological outputs of the designed experiments. We present an overview of the GERM GUI, as well as providing training applications.

REFERENCES