A reference field for GCR simulation and an LET-based implementation at NSRL

Tony C. Slaba[1], Steve R. Blattnig[1], Steven A. Walker[2], John W. Norbury[1]

[1] *NASA Langley Research Center, Hampton VA 23681-2199 USA*
[2] *Old Dominion University, Norfolk VA 23529 USA*

Exposure to galactic cosmic rays (GCR) on long duration deep space missions presents a serious health risk to astronauts, with large uncertainties connected to the biological response. In order to reduce the uncertainties and gain understanding about the basic mechanisms through which space radiation initiates cancer and other endpoints, radiobiology experiments are performed. Some of the accelerator facilities supporting such experiments have matured to a point where simulating the broad range of particles and energies characteristic of the GCR environment in a single experiment is feasible from a technology, usage, and cost perspective. In this work, several aspects of simulating the GCR environment in the laboratory are discussed. First, comparisons are made between direct simulation of the external, free space GCR field and simulation of the induced tissue field behind shielding. It is found that upper energy constraints at the NASA Space Radiation Laboratory (NSRL) limit the ability to simulate the external, free space field directly (i.e. shielding placed in the beam line in front of a biological target and exposed to a free space spectrum). Second, variation in the induced tissue field associated with shielding configuration and solar activity is addressed. It is found that the observed variation is within physical uncertainties, allowing a single reference field for deep space missions to be defined. Third, an approach for simulating the reference field at NSRL is presented. The approach allows for the linear energy transfer (LET) spectrum of the reference field to be approximately represented with discrete ion and energy beams and implicitly maintains a reasonably accurate charge spectrum (or, average quality factor). Drawbacks of the proposed methodology are discussed and weighed against alternative simulation strategies. The neutron component and track structure characteristics of the proposed strategy are discussed in this context.

HRP Investigators Workshop, 2015