Contribution ID: **8** Type: **not specified**

GCR Simulator Development Status at the NASA Space Radiation Laboratory

Friday 23 October 2015 14:40 (15 minutes)

There are large uncertainties connected to the biological response for exposure to galactic cosmic rays (GCR) on long duration deep space missions. 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 with mono-energetic ions beams. 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 at the NASA Space Radiation Laboratory (NSRL) 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 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, a reference environment for the GCR simulator and suitable for deep space missions is identified and described in terms of fluence and integrated dosimetric quantities. Analysis results are given to justify the use of a single reference field over a range of shielding conditions and solar activities. Third, an approach for simulating the reference field at NSRL is presented. The approach directly considers the hydrogen and helium energy spectra, and the heavier ions are collectively represented by considering the linear energy transfer (LET) spectrum. While many more aspects of the experimental setup need to be considered before final implementation of the GCR simulator, this preliminary study provides useful information that should aid the final design. Possible drawbacks of the proposed methodology are discussed and weighed against alternative simulation strategies.

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Session Classification: Friday Afternoon 1