

Induction of micronuclei in human fibroblasts across the Bragg curve of energetic Si and Fe ions

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The space environment consists of a varying field of radiation particles including high-energy ions, with spacecraft shielding material providing the major protection to astronauts from harmful exposure. Unlike low-LET γ or X-rays, the presence of shielding does not always reduce the radiation risks for energetic charged particle exposure. Although the dose delivered by the charged particle increases sharply as the particle approaches the Bragg peak, the Bragg curve does not necessarily represent the biological damage along the particle traversal. The “biological Bragg curve” is dependent on the energy and the type of the primary particle, and may vary for different biological endpoints. To investigate “biological Bragg curves”, we analyzed micronuclei (MN) induction along the particle traversal of Si and Fe ions at incident energies of 300 MeV/nucleon and 1 GeV/nucleon. A quantitative biological response curve did not reveal an increased yield of MN at the location of the Bragg peak. However, the ratio of mono- to bi-nucleated cells, which indicates inhibition in cell progression, increased at the Bragg peak location. These results confirm the hypothesis that “over kill” at the Bragg peak will affect the outcome of other biological endpoints.