COMPUTATIONAL TRANSPORT MODELING OF HIGH-ENERGY NEUTRONS FOUND IN THE SPACE ENVIRONMENT

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The high charge and high energy (HZE) particle radiation environment in space interacts with spacecraft materials and the human body to create a population of neutrons encompassing a broad kinetic energy spectrum. As an HZE ion penetrates matter, there is an increasing chance of fragmentation as penetration depth increases. When an ion fragments, secondary neutrons are released with velocities up to that of the primary ion, giving some neutrons very long penetration ranges. These secondary neutrons have a high relative biological effectiveness, are difficult to effectively shield, and can cause more biological damage than the primary ions in some scenarios.

Ground-based irradiation experiments that simulate the space radiation environment must account for this spectrum of neutrons. Using the Particle and Heavy Ion Transport Code System (PHITS), it is possible to simulate a neutron environment that is characteristic of that found in spaceflight. Considering neutron dosimetry, the focus lies on the broad spectrum of recoil protons that are produced in biological targets. In a biological target, dose at a certain penetration depth is primarily dependent upon recoil proton tracks. The PHITS code can be used to simulate a broad-energy neutron spectrum traversing biological targets, and it account for the recoil particle population. This project focuses on modeling a neutron beamline irradiation scenario for determining dose at increasing depth in water targets. Energy-deposition events and particle fluence can be simulated by establishing cross-sectional scoring routines at different depths in a target. This type of model is useful for correlating theoretical data with actual beamline radiobiology experiments. Other work exposed human fibroblast cells to a high-energy neutron source to study micronuclei induction in cells at increasing depth behind water shielding. Those findings provide supporting data describing dose vs. depth across a water-equivalent medium. This poster presents PHITS data suggesting an increase in dose, up to roughly 10 cm depth, followed by a continual decrease as neutrons come to a stop in the target.