Abstract

Shielded Heavy-Ion Environment Linear Detector (SHIELD) experiment: an experiment for the Radiation and Technology Demonstration (RTD) mission

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The transport properties of shield materials and tissue have been investigated through programs of ground-based experiments at particle accelerators and the coincident development of models of galactic cosmic radiation (GCR) and laboratory beam transport. The presence of a large number of ion types, energies, materials and material configurations of interest require the use of theoretical transport models that accurately describe diverse physical processes related to nuclear reactions in spacecraft structures, planetary atmospheres and surfaces, and tis-sues. To date, heavy-ion transport codes that were designed to characterize shielded radiation fields have been validated only through comparison with thick-target irradiation experiments at particle accelerators. With the Radiation Technology and Demonstration (RTD) Mission comes a unique opportunity to validate existing radiation transport models and guide the development of tools for shield design. The RTD vehicle is an unmanned spacecraft that will be launched ca. 2004 to demonstrate technologies in magnetopropulsion for interplanetary space travel and to provide a platform for investigating radiological risks to crews on such missions. The RTD project was initially conceived to demonstrate a new rocket thruster technology--the Variable Specific Impulse Magneto-propulsion Rocket (VASIMR)--and a scaled-up engine--the Hall thruster. Although several mission profiles are being considered, it is most likely that RTD will be launched from the Space Shuttle and the ion rockets will then thrust continuously to raise RTD to a max altitude of 30,000 km. The SHIELD experiments will be aboard as a Human Exploration and Development of Space Enterprise (HEDS) inspired project to reduce uncertainties associated with radiological risk to humans on exploratory missions. More specifically, the SHIELD experiments were proposed in order to measure the shielded GCR heavy-ion environment outside the Earth's magnetic field. For the first time transport properties will be measured in free-space or near-free space to characterize the shielding effectiveness of materials that are likely to be aboard inter-planetary space missions. Separate target materials composed of aluminum, advanced composite spacecraft structure and shielding materials, helium (a propellant) and tissue and bone equivalent matrices will be evaluated. In the main experiment, each test material will be mounted on a target wheel that will rotate between the detector arrays on a pre-programmed schedule. Large solid state detectors will provide kinetic energy and charge identification for heavy-ions that are incident on the target material. A colinear stack of silicon detectors on the opposite side of a target will operate in coincidence with upstream detectors to detect the emitted reaction species. The detector arrays can be triggered by uncollided ions traveling from either direction. The spectrometers' solid state detectors have a great deal of heritage in ground-based experiments at particle accelerators and have been used successfully for GCR detection on previous long-duration space missions. Transport calculations using the HZETRN model suggest that 5 to 8 g cm-2 thick targets would be adequate to evaluate the shielding effectiveness during solar minimum activity conditions for a period of 30 days or

more. The anticipated data collection phase for the SHIELD experiment is approximately 6 months. Calibrations and other pre-flight testing with particle accelerator beams are necessary. In separate experiments, a particle-identification spectrometer will evaluate the shielding effectiveness of helium in the VASIMR propellant tank.

Presentation