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Radiation Fields, Effects and Risks in Human Space Missions (5)

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THE MATROSHKA-ASTRORAD RADIATION EXPERIMENT (MARE) ABOARD ORION EM-1

Abstract

The radiation field in Low-Earth Orbit (LEO) consists of trapped radiation, galactic cosmic rays (GCR) and solar particle events (SPE), and exposure to them can potentially lead to detrimental health effects. The depth dose distribution in LEO was studied experimentally on the ISS in the frame of the Matroshka experiments. NASA's Orion Exploration Mission 1 (EM-1) will travel beyond LEO into harsher radiation environment, providing excellent opportunities for science on Orion as deep space experimental platform. The AstroRad radiation protection vest has been co-developed by StemRad and Lockheed Martin to provide crew radiation protection transferable to future Exploration architecture elements such as the deep-space habitat. The German Aerospace Center and the Israel Space Agency are preparing a flight of a phantom with the AstroRad aboard the Orion EM-1 mission. The aim of Matroshka AstroRad Radiation Experiment (MARE) will be twofold. It will perform superficial (skin) and body radiation measurements in a tissue equivalent phantom for the determination of the radiation environment internal to NASA's next generation Orion spacecraft and relevant to Astronaut crew risk assessment and protection on future Exploration missions. Furthermore, it will use a second phantom equipped with the AstroRad to evaluate shielding properties. The unshielded phantom will serve as a reference phantom. Both phantoms are equipped with thermoluminescence detectors (TLDs) to measure skin and organ depth dose distribution. TLDs and nuclear track etch detectors are combined at strategic locations to determine absorbed dose and dose equivalent values. Different threats are posed by GCR and SPE, so the ability to assess those separately using data from MARE is important. Because SPE occurrence is unpredictable, proton exposure from the Van Allen belts, which are similar to the radiation encountered during SPEs, will serve as a proxy. The phantoms will also include small, battery powered silicon detectors inside

radiation critical organs allowing for the separate analysis of the dose contribution from belt passages and GCR during the rest of the trajectory. The two MARE phantoms will be mounted on Orion seat locations, representing the crew location during much of the mission. Data will be compared with data from other radiation sensors, including in the Orion storm shelter, to experimentally compare the vest protection from that inside the storm shelter. In addition data from other sensors in the crew cabin is expected to provide a comprehensive map of the Orion shielding environment.