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

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CHARACTERIZING SPACE RADIATION INSIDE THE ISS: ANISOTROPIES AS MEASURED BY LIDAL DETECTOR IN COLUMBUS.

Abstract

Radiation exposure is one of the five main threats identified by NASA during human space missions. Beyond the protection of Earth atmosphere and magnetic field, astronauts will be exposed to increased levels of ionizing radiation from two main sources: energetic particles from the Sun, mainly protons, and galactic cosmic rays, nuclei up to Fe (that are relevant from an exposure point of view). This radiation can easily pass through the spacecraft hull and devices reaching living tissues. The damage caused by space radiation has been shown to produce distinct biological damage compared with radiation on Earth. Crew exposure limits based only on absorbed dose are insufficient to correctly evaluate health risks and provide recommendations on requirements for long-duration missions. A more detailed knowledge of the radiation field inside space habitats is then required. The Light Ion Detector for ALTEA (LIDAL) is a device designed to measure flux, energy spectra and time of flight of ions composing space radiation. It has been active inside Columbus module since Jan 2020, and it will be operative on board the International Space Station until at least 2028. With the first Time of Flight (ToF) detector system in a space habitat, LIDAL is a unique instrument able to perform nuclear discrimination, dosimetry, tracking, and kinetic energy evaluation for all passing ions, and then able to give specific inputs to the newest risk models. LIDAL detector is periodically moved along the three orthogonal axes of the ISS (X, Y, Z) to obtain information on the radiation field from all directions, exploiting its narrow field of view, to study in detail the radiation anisotropies due to the mass distribution of the Station. The observed anisotropy in Y and X directions could be mostly accounted for by the increased number of fragmentation products originated by secondary radiation but also presents a contribution by the East-West external radiation field anisotropy.

In this work the results of the LIDAL measurements during the four and a half years of operations are presented. Particle flux, dose rate, ToF are analyzed in the three orthogonal directions in which the LIDAL detector was repositioned within Columbus during this period. This study demonstrates LIDAL's ability to improve our understanding of ISS radiation environment and provides details that are a step forward from the averaged dose measurements currently used to assess the astronauts' risk by cosmic radiation.