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DEVELOPMENTS OF SPACE DOSIMETRY SYSTEMS FOR HUMAN EXPLORATION MISSIONS

Abstract

Space radiation poses one of the most important risks during long-term crewed missions, especially those going beyond low Earth orbit. The expected dose to the astronauts leaving the protection of the geomagnetic field on their future trips to Moon or Mars might be comparable, or in many cases, may exceed the corresponding lifetime dose limits, not to mention non-cancer effects, the associated risk of which is not considered in dose limits defined for LEO missions. The Internal Dosimeter Array (IDA) instrument suite is the very first internal ESA experiment on board Gateway. The IDA payload is accommodated inside the US HALO module within a Payload Bank and it is composed of the following already existing and flight proven instruments:

- TRITEL 3D silicon detector telescope provided by Centre for Energy Research (EK);
- European Active Dosimeter (EAD) provided by German Aerospace Center (DLR);
- Medipix (MPX) detector provided by Advacam s.r.o. (ADV);
- PADLES and D-SPACE provided by Japanese Space Agency (JAXA).

IDA instruments provide, based on measurements of energy deposition and particle track analysis, particle fluxes and fluences, LET spectra, mean quality factors, absorbed dose and dose equivalent rates, as well as integrated absorbed dose and dose equivalent from the charged particle component of space radiation. Besides charged particles (electrons, protons, He ions and HZE particles), X-rays and gamma-rays are also measured. The scientific radiation data provided by IDA will help the space dosimetry community to improve radiation physics models for cancer and non-cancer (cardio-vascular system, central nervous system) effects. These are of utmost importance in supporting crew risk assessment for deep space exploration missions, not only in the frame of the Artemis programme but for the future plans of human missions to Mars. Radiation data provided by the Instruments will serve also as inputs for studying radiation effects on electronics in deep space. In the frame of the Hungarian astronaut program HUNOR, a combined TRITEL/PILLE Space Dosimetry System (TRIPIL) and a Personal Space Dosimeter System (PSDS) are being developed, and demonstrated on the ISS. The developments conducted by EK and REMRED Ltd. aim to provide complex dosimeter systems that can be directly used in Moon or Mars exploration and combine environmental and personal dosimetry into one dosimeter system. The present paper gives a system level overview and measurement capabilities of these instrument suites under development.