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DEVELOPMENT OF A SPACE DOSIMETRY PAYLOAD FOR THE MARS SAMPLE RETURN EARTH RETURN ORBITER

Abstract

Space radiation poses one of the most important risks during long-term crewed missions, especially those going beyond low Earth orbit. The radiation environment in space is highly variable and very complex; there is no single dosimeter or one single method to determine the dose to the astronauts in this radiation field. Instead, a wide variety of dosimeter types (sensitive to different components and particle energies) and modelling (radiation transport calculations) are needed to estimate the dose to the members of the crew. Earth Return Orbiter (ERO) of the Mars Sample Return (MSR) program, being the first spacecraft planned to travel from Earth to Mars and back again, represents a unique opportunity to characterize the return-trip radiation environment in order to inform future missions. Space radiation measurements conducted in the past in the interplanetary space between Earth and Mars, and in Mars orbit either focused only on determining dosimetry quantities or providing space weather data products (particle spectra measurements); no direct simultaneous measurements have been performed so far on the same spacecraft. The Centre for Energy Research Space Research Department (EK-UKL) providedthe technical feasibility, high-level requirements, and development roadmap of a Space Dosimetry Telescope (SDT) for implementation on MSR-ERO. The primary objectives of the SDT are:

- to determine the time series of dosimetric quantities (LET spectra, absorbed dose rate, dose equivalent rate, mean quality factor of the charged particle component of the space radiation) for the Earth-Mars cruise, the Mars orbit and Mars-Earth return mission segments of the MSR-ERO mission behind different typical shielding thicknesses expected for astronauts, in order to support radiation health risk assessment and mitigation for future human space missions; and
- to determine the time series of the charged particle flux and energy spectra of space radiation for the Earth-Mars cruise, the Mars orbit and Mars-Earth return mission segments of the MSR-ERO mission, in order to support radiation environment modelling of future human space missions.

The data products of charged particle flux and energy spectra of space radiation will enable deeper assessment of dosimetric data products to be estimated based on energy deposition measurements. Present paper gives an overview of the system level concept of the payload and the preliminary design, the targeted data products to be measured, and the results of calculations on the expected measurement performance.