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RADIATION MEASUREMENTS AND DOSIMETRY FOR DEEP-SPACE EXPLORATION

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Dosimetry and radiation monitoring are key factors for the planning of future human exploration on deep-space missions outside of Low-Earth Orbit (LEO), as radiation exposure poses one of the major health risks for astronauts in deep space. The amount of radiation dose astronauts would accumulate during typical mission scenarios and durations can potentially exceed currently allowable exposure limits within months.

In space radiation monitoring the three main areas of concern are: 1) high-energy and deeply-penetrating Galactic Cosmic Rays (GCRs); 2) impulsive Solar Energetic Particle (SEP) events

with high flux intensities up to a few hundred MeVs; and 3) secondary neutrons created by interactions of primary radiation with spacecraft material or planetary atmospheres and soils. Furthermore, in-situ radiation measurements provide invaluable input for radiation transport models that are used to calculate expected radiation exposures and shielding effectiveness, and subsequently potential health risks for future deep-space mission scenarios.

Here, we present an overview of dosimetry in LEO, lunar orbit, and in deep space, and place the findings from years of measurements in context of what our current state of knowledge of space radiation implies for future exploration missions. Because the planet Mars is a prime goal for future exploration, we will focus in more detail on measurements conducted on the Martian surface with the Radiation Assessment Detector (RAD) as part of the Mars Science Laboratory (MSL) mission. Since Mars lacks a global magnetic field and its atmosphere is very thin, the surface is only weakly protected from impacts of GCRs and SEPs. This makes understanding and assessing the Martian surface radiation environment a key goal for future exploration. MSL/RAD has been characterizing in detail the charged and neutral particle environment induced by GCRs, as well as during short-term radiation enhancements from SEP events arriving at Mars.

We will discuss the capabilities of the existing space dosimetry instrumentation, as well as highlight areas outside the current scope where we need to improve our understanding of the space radiation environment.