IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Radiation Fields, Effects and Risks in Human Space Missions (5)

Author: Mr. Hesham Hussein
Lockheed Martin Space Systems, United States, hesham.hussein@lmco.com

Dr. Chirag Patel
Lockheed Martin (Space Systems Company), United States, chirag.patel@lmco.com
Mr. Torin Meyers
Lockheed Martin (Space Systems Company), United States, torin.t.meyers@lmco.com
Mr. Mark Baldwin
Lockheed Martin (Space Systems Company), United States, mark.a1.baldwin@lmco.com
Ms. Kathleen Coderre
Lockheed Martin (Space Systems Company), United States, kathleen.m.coderre@lmco.com
Mr. David Murrow
Lockheed Martin (Space Systems Company), United States, david.1.murrow@lmco.com
Dr. Oren Milstein
StemRad, Israel, oren@stemrad.com
Dr. Thomas Berger
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, thomas.berger@dlr.de
Mr. Joachim Aeckerlein
German Aerospace Center (DLR), Germany, Joachim.Aeckerlein@dlr.de
Dr. Karel Marsalek
German Aerospace Center (DLR), Germany, Karel.Marsalek@dlr.de
Dr. Ramona Gaza
NASA, United States, ramona.gaza-1@nasa.gov
Dr. Kerry Lee
National Aeronautics and Space Administration (NASA), United States, kerry.t.lee@nasa.gov
Mr. Edward J. Semones
National Aeronautics and Space Administration (NASA), Johnson Space Center, United States, edward.j.semones@nasa.gov

ORION ARTEMIS-1 RADIATION ENVIRONMENT: THE MATROSHKA ASTRORAD RADIATION EXPERIMENT

Abstract

Artemis-I will be the first integrated test of NASA's deep space exploration systems. The first in a series of increasingly complex missions, Artemis-1 will be an uncrewed flight test that will provide a foundation for human deep space exploration and demonstrate the continued commitment and capability to extend human existence to the Moon and beyond. During this mission, the Orion spacecraft will launch on the most powerful rocket in the world and fly farther than any spacecraft built for humans has ever flown. Artemis-I is scheduled to launch this year and will reach cislunar space for a total mission duration of about three to five weeks. The spacecraft will be exposed to ionizing radiation environments, including Van Allen belts, galactic cosmic rays (GCR), and potentially solar energetic particle (SEP) events. Biological effects on the human body depend upon the extravehicular environments as modulated by the spacecraft as

well as body self-shielding, leading to complex radiation exposure patterns of various organs and tissues. Accurate radiation risk assessment requires knowledge of this internal dose deposition map due to different biological susceptibilities of various organs. The Matroshka AstroRad Radiation Experiment (MARE) is a science secondary payload manifested aboard Artemis-1. MARE aims to characterize the body's internal radiation exposure using human torso analogs instrumented with radiation detectors. MARE is an international experiment led by the German Aerospace Center (DLR), Israel Space Agency (ISA) and NASA as co-principal investigators and supported by industry partners. The payload leverages heritage from the Matroshka series of experiments led by DLR on board the International Space Station (ISS). On Artemis-1, two radiation phantoms, Helga and Zohar, are located inside the pressurized cabin. Zohar is fitted with the AstroRad radiation shielding garment produced by a collaboration between Lockheed Martin and StemRad, Israel. Since Helga isn't fitted with the garment, a radiation mitigation solution is validated in parallel with the nominal environment characterization. MARE is designed to provide a comprehensive picture of the radiation environment beyond Earth orbit specific to the Orion spacecraft and internal to human body analogs. This paper presents a detailed description of the MARE payload and the integration status on board the Orion spacecraft, including the suite of radiation detectors, radiotherapy phantoms used as body analogs, and the AstroRad vest. MARE will provide valuable environment characterization specific to the Orion vehicle, validate a protection solution, and ultimately help enable longer mission durations and improve crew safety.