Contribution ID: **6** Type: **not specified**

Active Dosimeter-Based Estimate of Astronaut Acute Radiation Risk for Real-Time Solar Energetic Particle Events

Thursday 26 April 2018 11:45 (30 minutes)

Radiation exposure from solar energetic particle (SEP) events becomes a much greater concern as human exploration extends beyond low Earth orbit (LEO) and the protective environment of Earth's magnetic field. Free space SEP events have an increased impact on mission planning and operations, as countermeasures may be necessary to avoid exceeding astronaut permissible exposure limits (PELs) and acute radiation syndrome (ARS). Operational analysis tools are needed to assess acute radiation risk during SEP events in order to determine courses of action during the mission. A methodology has been developed to meet this need, which utilizes onboard vehicle dosimeter measurements to estimate organ dose quantities at astronaut crew locations in real-time. The estimated organ doses provide the necessary inputs to acute biological response models that predict radiation induced performance decrement and other acute radiation effects. The real-time SEP organ dose estimate methodology has been combined with an acute biological response model, providing an active dosimeter-based acute radiation risk model for operational mission planning, and determining radiation exposure mitigation measures for deep-space exploration missions. This new tool has been developed specifically for NASA's Orion Multi-Purpose Crew Vehicle (MPCV) storm-shelter environment. The methodology for estimating SEP organ doses is evaluated and assessed in this presentation, and a simulation of the acute radiation responses in the MPCV storm-shelter are shown for the historical October 1989 SEP event. The operational acute radiation risk model will be utilized on NASA's EM-1 and EM-2 missions.

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Session Classification: Late Thursday Morning