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Radiation measurements in space – Past and present experiments and new developments of the Radiation Biology Department

The radiation field in free space is one of the most complex natural radiation environments consisting of contributions from Galactic Cosmic Rays (GCR) and protons due to sporadic Solar Particle Events (SPE). In Low Earth Orbit (LEO) a third contribution to human radiation exposure is given by the trapped particles in the Earth radiation belts (Van Allen belts) while the International Space Station (ISS) crosses the South Atlantic Anomaly (SAA). The determination of the radiation environmental parameters is essential for gaining knowledge about the internal radiation environment onboard the ISS and this enables us to (a) use this data as input for radiation model and benchmark calculations and (b) helps us in working towards reasonable good radiation risk estimation for future long duration space missions (Durante & Cucinotta 2011). The Radiation Biology Department (ME-SBA) had a leading role in the technical management and experiment execution for radiation experiments onboard the ISS starting already with **DosMap** in 2001 (Reitz et al. 2005) followed by **MATROSHKA** which was the first long duration (2004 - 2011) anthropomorphic phantom experiment for the determination of the effective dose equivalent performed on the ISS (Berger et al. 2013). Since 2009 the radiation environment inside the Columbus Laboratory is monitored for ESA with the **DOSIS** and **DOSIS 3D** experiments (Berger et al. 2016). In addition, the department is performing for ESA-EAC the personal dosimetry for the European Astronauts (**EuCPD**) (Straube et al. 2010) and was the prime contractor for the development of the first active personal radiation detector in the frame of the **EuCPAD** project which successfully launched to the ISS in July 2016. Leaving the space station the department just delivered two radiation detectors (**RAMIS**) for the DLR Eu:CROPIS mission and works as lead for the calculation and benchmarking of the **MSL-RAD** instrument data gathered on the surface of MARS (Matthiä et al. 2016). With the dawn of a new age for human space exploration, as seen in the NASA ORION missions and the plans of Spaxe-X for a first mission to MARS, we see new opportunities and further challenges for radiation protection and the still open questions to answer concerning the radiation risks for long interplanetary space missions.
The seminar is therefore focused on the current and planned experiments onboard the ISS and beyond focusing on highlighted results and the open questions to ask and to solve.

References: Berger, T., et al. *Radiat. Res.*, 180, 2013; Berger, T., et al. *J. Space Weather Space Clim.*, 2016;Durante, M., and F.A. Cucinotta. *Rev. Mod. Phys.*, 83, 2011; Matthiä, D., et al., *J. Space Weather Space Clim.*, 6, A13, 2016; Reitz, G., et al. *Radiat. Prot. Dosim.*, 116, 2005; Straube, U. et al., *Acta Astronaut.*, 66, 2010

EuCPAD: http://www.dlr.de/me/desktopdefault.aspx/tabid-1752/2384_read-47145/

Eu:CROPIS: http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10255/365_read-10095#/