Austrian results from Matroshka poncho and organ dose determination

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Cosmic rays in low-earth orbits (LEO) primarily consist of high-energy charged particles originating from galactic cosmic radiation (GCR), energetic solar particle events (SPE) and trapped radiation belts. These radiations of high linear energy transfer (LET) generally inflict greater biological damage than that resulting from typical terrestrial radiation hazards. Particle and energy spectra are attenuated in interaction processes within shielding structures and within the human body. Reliable assessment of health risks to astronaut crews is pivotal in the design of future expeditions into interplanetary space and requires knowledge of absorbed radiation doses in critical radiosensitive organs and tissues. The European Space Agency (ESA) Matroshka experiment—conducted under the aegis of the German Aerospace Center (DLR)—is aimed at simulating an astronaut's body during extravehicular activities (EVA). Matroshka basically consists of a human phantom torso attached to a base structure and covered with a protective carbon-fibre container, acting as a spacesuit model. The phantom is divided into 33 tissue-equivalent polyurethane slices of specific density for tissue and organs. Natural bones are embedded. Channels and cut-outs enable accommodation of active and passive radiation monitors. The torso is dressed by a skin-equivalent poncho which is also designed for dosimeter integration. The phantom houses in total 7 active and more than 6000 passive radiation sensors. Thereof, the Atomic Institute of the Austrian Universities (ATI) provided more than 1100 thermoluminescence (TL) detectors for spatially resolved dosimetry and estimation of the biological effectiveness of the radiation field. Matroshka was mounted outside the Russian Segment (RS) of the International Space Station (ISS) on February 26, 2004, and recovered on August 18, 2005. Absorbed dose accumulated during this 18-month exposure and average LET assessed by means of the high-temperature ratio (HTR) method are reported for the LiF:Mg,Ti TL phosphors distributed in the poncho and at the sites of critical organs, i.e. the eye, lung, stomach, kidney, and intestine.