Performance of novel polymer shields aboard the ESA Biopan-5 mission

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Radiation exposure of astronaut crew has been identified as a key issue in human spaceflight. The reduction of dose by appropriate shielding measures is thus donated an essential role for the future development of space exploration, particularly with regard to long-term interplanetary missions. Optimization of shielding strategies and design may involve polymeric materials with enhanced hydrogen content, specifically developed to attenuate high charge-and-energy (HZE) particles such as those encountered in galactic cosmic rays (GCR). The projectile energy loss is proportional to $\rho \cdot Z/A$ and reaches a maximum for hydrogen targets. Light elements are also expected to minimize target fragmentation, particularly the production of secondary neutrons. The LETVAR experiment flow aboard the European Space Agency (ESA) Biopan-5 mission as part of a 27 kg payload attached to the external surface of the Foton-M2 descent capsule was dedicated to studying the shielding performance of three different polymers in reference to aluminium when exposed to the unshielded space environment in low-earth orbit (LEO). The mission was launched successfully on May 31, 2005 from the Baikonur Cosmodrome, Kazakhstan, and spent 15.6 days at an orbital altitude between 262 and 304 km, inclined by 63° to the equatorial plane. After recovery, absorbed dose and average linear energy transfer (LET) were determined in front and behind the material slabs. To support data interpretation, material samples equivalent to those flown in space were exposed—to the extent possible given the experimental constraints—to simulated GCR and LEO radiation conditions available from the Heavy Ion Medical Accelerator (HIMAC) facility in Chiba, Japan.