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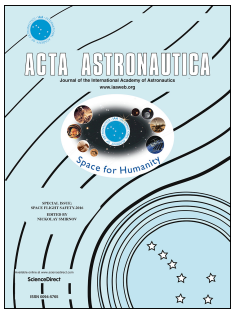

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Analysis of Space Radiation Exposure Levels at Different Shielding Configurations by Ray-tracing Dose Estimation Method

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Key words: space radiation; ray-tracing; estimation of radiation exposure levels; tissue-equivalent spherical phantom; anthropomorphic phantom; shieling modeling

Abstract: A ray-tracing method to calculate radiation exposure levels of astronauts at different spacecraft shielding configurations has been developed. The method uses simplified shielding geometry models of the spacecraft compartments together with depth-dose curves. The depth-dose curves can be obtained with different space radiation environment models and radiation transport codes. The spacecraft shielding configurations are described by a set of geometry objects. To calculate the shielding probability functions for each object its surface is composed from a set of the disjoint adjacent triangles that fully cover the surface. Such description can be applied for any complex shape objects.

The method is applied to the space experiment MATROSHKA-R modeling conditions. The experiment has been carried out onboard the ISS from 2004 to 2016. Dose measurements were realized in the ISS compartments with anthropomorphic and spherical phantoms, and the protective curtain facility that provides an additional shielding on the crew cabin wall. The space ionizing radiation dose distributions in tissue-equivalent spherical and anthropomorphic phantoms and for an additional shielding installed in the compartment are calculated. There is agreement within accuracy of about 15% between the data obtained in the experiment and calculated ones. Thus the calculation method used has been successfully verified with the MATROSHKA-R experiment data.

The ray-tracing radiation dose calculation method can be recommended for estimation of dose distribution in astronaut body in different space station compartments and for estimation of the additional shielding efficiency, especially when exact compartment shielding geometry and the radiation environment for the planned mission are not known.