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A solid-state microdosimeter for dose and radiation quality monitoring for astronauts in space

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Space exploration is currently aiming to reach further destinations, increasing astronauts' exposure to hazardous radiation. Although at the altitude of the International Space Station, the main radiation source is protons, heavy ions (e.g. C, O, Si, Fe) cover a wide energy range up to hundreds of GeV/n. Their high LET makes them strong contributors for radiobiological effects on humans, also because the incur in fragmentation.
Microdosimetry is a powerful approach for evaluating the quality factor Q of a mixed radiation field typical of space radiation, without knowing the energy or type of particles.
The Centre for Medical Radiation Physics, University of Wollongong in collaboration with SINTEF, and ANSTO, has been active in the development of SOI microdosimeters, for radiation protection purposes. Compared to conventional TEPCs, SOI microdosimeters are portable, don't require a high voltage power and have an easy readout system. SOI consist of a matrix of 400 silicon sensitive volumes (SVs) with dimensions comparable to cell nucleus.
In this abstract, we present results obtained at the Heavy Ions Medical Accelerator in Chiba (HIMAC), Japan, where the novel SOI "Mushroom" was tested with Oxygen, Neon, Silicon and Iron ions, in a energy range of 400÷500MeV/u.

The "Mushroom" was preliminary tested using the ion beam induced charge collection technique with 5.5 MeV He2+ at ANSTO. Results confirm excellent SV definition and uniform charge collection without cross talk between the adjacent SVs.
At HIMAC, we studied the spacecraft's wall effect for shielding energetic heavy ions, in terms of Q and dose equivalent Hp(10). A realistic multi-layers sample of spacecraft wall was reproduced and placed in front of the detector. Different wall's configurations were used to study the shielding effect of each layer. Secondly, we measure the Hp and Q at different depths in a water phantom, mimicking different positions in the human body.

An example of results obtained from irradiations carried out with 500MeV/u Fe56 ions shows that the microdosimetric spectra when we considered only aluminium layers of the wall is broader due to the presence of fragments produced by primary beam interacting with the wall, compared to the sharp peak of primary particles when no wall is used. Because of the change of the radiation field's composition, the value of Q changes as well.
Results from the water phantom irradiation show how Q and Hp varies deeper in an astronaut's body. When the wall is considered (scenario of an astronaut inside the spacecraft), the Bragg Peak shifted at a shallower depth in the body causing an exposure to different organs, followed by higher Q values.

To conclude, for wide energy ranges of GCR ions, the wall does not always reduce the radiation hazard inside the spacecraft, but can produce secondary particles. Particularly, the Q and Hp can increase at shallow depth in the body of an astronaut. This study confirms that the portable SOI "Mushroom" microdosimeter is suitable for qualifying the radiation field in space and evaluating the efficiency of shielding materials, in terms of Q and H.

Speakers Gender

Female

Travel Funding

Yes

Level of Expertise

Student

Do yo wish to take part in the poster slam

Yes

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