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Recent development of solid-state microdosimetry for RBE study of ion therapeutic beams and radiation protection of astronauts in space

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Based on many years of experience in development of semiconductor radiation sensors, the Centre for Medical Radiation Physics (CMRP), University of Wollongong in collaboration with ANSTO and SINTEF, has successfully developed a MicroPlus probe for microdosimetry. The probe is based on a Silicon On Insulator (SOI) sensors with 3D micron sized sensitive volumes (SVs) mimicking dimensions of biological cells, known as the "Bridge" and "Mushroom" microdosimeters, Fig 1 shows the MicroPlus probe with the SOI Mushroom microdosimeter.
The silicon microdosimeters provide extremely high spatial resolution and were used to measure the microdosimetry spectra in different heavy ions fields at Heavy Ion Medical Accelerator in Chiba (HIMAC), Japan and in a proton pencil-beam scanning (PBS) and passive scattering system at different accelerator facilities. Measured microdosimetric parameters were used for derivation of RBE10 using Microdosimetric Kinetic Model (MKM). Derived RBE10 values in response to 290 MeV/u carbon-ions SOBP is presented in Fig. 2. The RBE10 values obtained with the SOI microdosimeters match very well with those obtained from the TEPC measurements. Due to the high spatial resolution of the microdosimeter, a more detailed RBE10 distribution was obtained at the end of the SOBP compared to the TEPC.
Fig. 3 shows the comparison of the Geant4 simulated and microdosimetric measurement based RBE10 for the 400 MeV/u 16O beam in water. Due to submilimetre spatial resolution, it was possible to see that the peak of physical dose does not coincide with the maximum RBE10.
The developed SOI microdosimeters can be very useful for dose equivalent measurements in Solar Particle Events (SPE) and Galactic Cosmic Rays (GCR) mixed radiation fields for radiation protection of astronauts and evaluation of radiation shielding. Recently an experiment with different thicknesses of Al alloy to mimic the ISS wall was carried out in 500 MeV/u Fe ions field at HIMAC to determine the quality factor, $\bar{Q}$ and the dose equivalent, Hp(10) per incident ion cm-2 at different depths in a phanotm downstream of the Al wall. Fig 4 shows the microdosimetric spectra and corresponding to them $\bar{Q}$ for different scenarios.

This work presented an application of SOI microdosimeters for RBE evaluation in heavy ion therapy and for $\bar{Q}$ and H determination in mimicking GCR radiation environment that can be used for radiation shielding optimization and radiation protection in space.

Speakers Gender

Male

Travel Funding

No

Level of Expertise

Expert

Do yo wish to take part in the poster slam

No

Primary author(s) : Prof. ROZENFELD, Anatoly (University of Wollongong); PERACCHI, Stefania (University of Wollongong); TRAN, LT (Centre for Medical Radiation Physics, University of Wollongong,); JAMES, B (Centre for Medical Radiation Physics, University of Wollongong,); Mr PROKOPOVICH, Dale; PATUOVIC, Z

(ANSTO); COHEN, David (ANSTO); DAVIS, Jeremy (University of Wollongong); GUATELLI, S (Centre for Medical Radiation Physics, University of Wollongong,); PETASECCA, M (Centre for Medical Radiation Physics, University of Wollongong,); LERCH, M (Centre for Medical Radiation Physics, University of Wollongong,); MATSUFUJI, N (National Institute of Radiological Science, Japan); PVOLI, M (SINTEF MiNaLab, Gaustadalleen, Norway); KOK, A (SINTEF MiNaLab, Gaustadalleen, Norway)

Presenter(s) : Prof. ROZENFELD, Anatoly (University of Wollongong)

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