RBE study using Solid State Microdosimetry in Heavy Ion Therapy

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In ^{12}C ion therapy, the determination of relative biological effectiveness (RBE) is crucial as the biological dose is required as a parameter in the patient treatment planning. Knowledge of the RBE along the Bragg Peak is essential for determination of the physical dose distribution to be delivered. Microdosimetry is extremely useful technique for RBE study in unknown mixed radiation field typical of hadron therapy. The Centre for Medical Radiation Physics, University of Wollongong, has initiated the concept of silicon microdosimetry detectors to address the shortcomings of the conventional tissue equivalent proportional counter (TEPC). New generation of microdosimeters with 3D sensitive volumes (SV) on silicon-on-insulator (SOI) are presented in this work.

The SOI microdosimeters were irradiated at the HIMAC facility in Japan using passive scattering delivery with 290MeV/u ^{12}C, 400MeV/u ^{16}O and 180MeV/u ^{14}N ions. The microdosimeter was also irradiated at Gunma University HIT facility using a 290MeV/u ^{12}C ions high intensity pencil beam with a sigma of the spot beam was approximately 3.3mm and beam intensity of approximately 10^6 particles/spill.

Dose average lineal energy $\overline{y_D}$ and derived RBE values obtained with the 3D SOI microdosimeter matched very well with those obtained with the TEPC in passive beam delivery. This work presents the first study of RBE of high intensity ^{12}C pencil beam that was possible due to developed 3D SOI microdosimeters. The obtained results have demonstrated the feasibility of using of high spatial resolution SOI microdosimeter with 3D SV arrays in heavy ion therapy using passive and scanning delivery and represents unique tool for RBE studies and quality assurance in particle therapy and space.