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# 12C ion beam dose distribution in presence of medium inhomogeneities: comparison between different measurements and simulations with the treatment planning system for particles TRiP98

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Heavy-ions beams offer several advantages compared to other radiation such as low lateral scattering and high biological effectiveness (RBE) in the Bragg peak region, making them particularly attractive for the treatment of radio-resistant tumors localized close to organs at risk [1]. To cope with these unique properties, a dedicated treatment planning system (TPS), TRiP98, was developed and clinically used in the carbon ion pilot project [2,3]. It is now used as a research prototype. The theoretical models and experimental databases included in TRiP98 are presently mainly based on measurements in water. This approximation can be applied successfully to reproduce many biological tissues with the exception of bones, where the presence of heavy elements, like calcium, might change significantly the composition of the resulting mixed radiation field. Presently, the TriP98 physical beam model takes into account for the bone only its density variation, but it neglects difference between bones and water in attenuation of the primary and production of secondary particles through nuclear fragmentation. However, a detailed knowledge of the particle field at each point of the treatment area is crucial for an accurate estimate of the actual dose. A previous study [4] investigated the influence of different types of bone on the carbon particles range. In the present work we aim at understanding the influence of medium inhomogeneities on the 12C beam dose distribution. For the experiment, a bone target was placed inside a water phantom. The irradiation of the target volume positioned partially behind the bone target and partially directly in water was simulated with TRiP98 and the dose at the interface measured at several depths along the primary beam direction. Absolute dose measurements were achieved with a system of pin-point ionization chambers, while the relative dose distribution was investigated with two different solid states detectors: thermoluminescence detectors of type TLD-700 and alanine ESR pellets. The position of the target volume, the thickness and the type of bone were changed to investigate the influence of the inhomogeneity in different quasi-clinical scenarios. The experimental results were compared with the values predicted by TRiP98.

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