

AbstractID: 8688 Title: Impact of track structure calculations on biological treatment planning in carbon ion radiotherapy

Purpose: To analyze predictions of the relative biological effectiveness (RBE) for carbon ion treatment planning based on different descriptions of the radial dose distributions around ion tracks and to discuss the implications on clinically relevant depth dose profiles.

Method and Materials: We investigate the impact of track structure on calculations of RBE values using the Local Effect Model (LEM). It calculates the RBE for cell lines or tissues starting from the corresponding experimental/clinical photon data and an amorphous track structure model. Different track structure models that use energy-dependent as well as energy-independent core radii are investigated and compared to in vitro and in vivo data. Additionally, we apply them to calculate the biologically effective dose along a spread-out Bragg peak for typical chordoma treatments.

Results: We show that the LEM is sensitive to different descriptions of the radial dose distributions. However, by changing a single model parameter of the photon reference curve, reasonable RBE values can be achieved for all dose distributions. The general improvement of predictions using a modified version of the LEM with an energy-dependent core radius is demonstrated by comparison to in vitro data of human cell lines and to experimental data of the radiation tolerance of the rat spinal cord. Additionally, we find a larger therapeutic ratio for the modified model version relative to the original LEM for a typical treatment scenario for chordoma patients.

Conclusion: The Local Effect Model is sensitive to the inner part (few nanometers) of different track structure descriptions. Since these interactions of ions with liquid water are neither well understood experimentally nor theoretically, more studies should address the energy deposition around ion tracks. This will be in particular useful for further optimization of carbon ion therapy in general and with respect to comparison with other treatment modalities like protons or IMRT.