Contribution ID: **27** Type: **Poster**

Comparison of particle types in longitudinally heterogeneous irradiation treatment plan simulations for Particle Minibeam Radiotherapy

Thursday 21 March 2024 13:15 (1h 30m)

Proton minibeam therapy (pMBT) using sub-millimeter beams spaced a few millimeters apart has demonstrated the ability to reduce side effects in normal tissues and possible increase of the therapeutic ratio. Preclinical studies also indicate that FLASH irradiation, delivering ultra-high dose rates (>40 Gy/s), minimizes tissue toxicity while maintaining effective tumor control. However, integrating the FLASH technique with pMBT and Spread-Out Bragg Peak (SOBP) presents technical challenges. Previous simulations proposed investigating a single-energy distal-edge Bragg Peak from opposing directions to reduce toxicity further while enabling successful FLASH application. Additionally, heavy ion minibeams, such as helium or carbon, might offer similar advantages, potentially improving tissue sparing in deeper tissue due to reduced angle scattering compared to protons.

This study compares longitudinally heterogeneous irradiation modes of different particle minibeams: protons, helium, and carbon ions. A 25 cm-thick water phantom, with a 5cm-thick tumor, was irradiated in TOPAS (Tool for Particle Simulation) with varying beam sizes ($\sigma = 0.05$ mm, $\sigma = 0.1$ mm, and $\sigma = 0.2$ mm) for each scenario. The minimum prescribed dose within the tumor volume was achieved through the overlay of minibeams from two opposing directions using the same single energy from each direction for each particle type. From the resulting dose distributions, the normal tissue-sparing effect was estimated and compared through calculated mean clonogenic cell survival using the linear-quadratic model, employing averaged model parameters from PIDE (Particle Irradiation Data Ensemble) database for each particle type.

Helium ions may offer the best balance in tissue sparing between protons and carbon ions, attributed to their smaller beam spread relative to protons and smaller fragmentation tail, smaller uncertainty in Relative Biological Effectiveness (RBE) prediction compared to carbon ions.

Primary authors: AUNG, Thandar (Technical University of Munich/ University of Bundeswehr); ROUSSETI, Aikaterini (Universität der Bundeswehr München); Dr GIRST, Stefanie; DOLLINGER, Günther (Universität der Bundeswehr München); REINDL, Judith

Presenter: AUNG, Thandar (Technical University of Munich/ University of Bundeswehr)

Session Classification: Postersession

Track Classification: Treatment planning and simulations