DOSIMETRIC COMPARISON OF PASSIVE SCATTERING AND PENCIL BEAM SCANNING IN CARBON ION THERAPY FOR GASTRIC CANCER (A Particle and Heavy Ion Transport Code System (PHITS)-Based Case Study)

BACHELOR'S THESIS

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ABSTRACT

This study aims to evaluate and compare the performance of Passive Scattering (PS) and Pencil Beam Scanning (PBS) techniques in optimizing dose distribution in carbon ion therapy, using Particle and Heavy Ion Transport Code System (PHITS) simulation software version 3.341. Simulations were performed on ORNL's phantom model to represent the human anatomy realistically, particularly in assessing radiation exposure to cancer and Organ At-Risk (OAR). Both techniques were simulated with the same parameters, including geometry configuration, particle energy range of 100–195 MeV, and Anterior-Posterior (AP) radiation direction, so that the results of both techniques could be compared. A total dose of 54 GyRBE is given with planning referring to ICRU guidelines, so that the target volume can be optimally covered. The simulation results showed that the PBS technique was able to concentrate the dose more precisely on the target area, and rapidly lower the dose in the surrounding tissues after the cancer has passed, thereby reducing unnecessary radiation exposure to the surrounding OAR. In contrast, the PS technique showed a wider dose distribution and left the remaining dose outside the target area. In addition, PBS requires a radiation time of 96.4 seconds and a PS of 275.8 seconds, which indicates higher dose delivery efficiency. These findings support the use of the PBS technique as a more precise, and biologically safer approach in the planning of carbon ion therapy, particularly for complex cases such as gastric cancer.

Keywords: carbon ion, dose distribution, dose optimization, Irradiation time, OAR, ONRL adult, passive scattering, pencil beam scanning, PHITS.