

# A Brief Note on the Limitation of Treatment Planning in Proton Therapy

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Currently, proton therapy is being used for the cancer treatment at 11 centers in the United States of America [1], and there is an increasing interest in using proton therapy at many other institutions, which have proton centers either at the planning stage or under construction. [1] The primary reasons of using protons over photons for the cancer treatment is because of proton's physical properties such as finite beam range, near-zero exit dose, and sharp lateral penumbra. [2,3] Treatment planning in proton therapy is done with an aim of depositing the majority of the dose in the tumor, which is typically covered by the spread-out Bragg peak (SOBP) and avoiding the proton beam ranging into the critical structure.

In uniform scanning proton therapy, the beam delivery system deposits an uniform dose for a near rectangular scanning area after the degraded proton beam is scanned laterally. [4] One of the commercially available treatment planning systems (TPS) for the uniform scanning proton therapy is XiO (CMS Inc., St. Louis, MO). The commissioning data in the XiO TPS are generally based on the measurements performed in water medium. Recently, it was reported that the XiO TPS could overestimate the lateral penumbra in uniform scanning proton therapy planning, and this study was based on the measurements done in the homogeneous (water) medium. [5] In real clinical situations, however, proton beams may pass through the inhomogeneous media consisting of tissues with different electron densities. Although the impact of heterogeneities on the measured lateral penumbra may be minimal [6], it is necessary to investigate the accuracy of TPS in predicting lateral penumbra in the presence of low-and high-density heterogeneities for various beam conditions. Additionally, it is imperative to investigate the limitation of TPS in predicting proton range for different clinical situations.

The dependency of range uncertainties on the tumor location also needs further investigation since same range uncertainty value may not be applicable for all the proton beams. At present, commercially available TPS in proton therapy do not incorporate dose contribution due to secondary neutrons. [7] The results from different studies on neutron dose in proton therapy may not agree with each other due to dependency of neutron production on the treatment conditions and beam shaping components. [7] Hence, it is recommended to carry out an independent neutron study at the proton center before treating cancer patients using proton therapy technique.

## References

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