AbstractID: 12886 Title: Introducing and evaluation of energy margin to minimize the dose variation due to setup uncertainty in the distal edge tracking (DET) based intensity modulated proton therapy (IMPT)

Purpose: Intensity modulated proton therapy (IMPT) generates plans with better target conformity and less normal tissue dose. However, the planned dose distribution is subject to degradation due to the presence of setup uncertainty which is acerbated by density heterogeneity in the patient. In this work, we propose the concept of an energy margin (EM) to reduce the dosimetric variation due to the setup uncertainty.

Method and Materials: The concept of EM are proposed and successfully implemented in rotational distal edge tracking (DET) based IMPT. The original (ORG) and energy margin (EM) plans are generated on five head and neck cancer patients to evaluate the efficacy of the energy margin. Three beam arrangements are planned with prescription of 60Gy to the PTV: full arc, half arc, and 2 fan beams. The delivery simulation with rigid setup shift is also performed by sampling its value from a Gaussian (σ = 2mm). The dose has been recalculated by Geant4 Monte Carlo code. The normalized total dose for both the CTV and the normal tissue after 30 random shifts are calculated for comparison.

Results: Both EM and ORG have the same CTV coverage with higher dose to the normal tissue given by the EM. On average, the delivered ORG plans result in 2Gy underdose to 5% of the CTV volume, whereas EM plans do not underdose the CTV. No significant extra dose to the normal tissue has been observed for both ORG and EM plans after delivery. The differences among the three beam arrangements are not significant.

Conclusion: The plans with EM are robust to the setup uncertainty in the head and neck region, but not for the plans without EM.

Conflict of Interest (only if applicable):
Thomas Mackie has financial interest in TomoTherapy, which may commercialize some aspects of this work.