# AbstractID: 13442 Title: Analysis of influential factors of dose delivery to a moving tumor in proton radiotherapy using uniform scanning beam

**Introduction**: Tumor motion changes the dose to the tumor and organs-at-risk (OAR) from the treatment plan, which may be more serious in proton therapy, especially with a uniform scanning beam because of the energy stacking technique. This project aims to analyze the major factors on a uniform scanning beam. A 4D adaptive treatment planning strategy optimized with real-time motion pattern is proposed.

**Materials and Methods:** The CT images of a lung patient are used. The temporal beam delivery information for each energy layer is retrieved from the log file. Tumor motion tracked using fiducial markers at 30Hz is used in the simulation. The GTV to PTV margin and the smearing margin are 7 and 7.5mm. The prescribed dose is 4250 cGy. The 4D dose distribution is calculated based on dose volumes, contours, tumor respiratory motion and temporal beam delivery information under different starting respiratory phases, irregular breathing pattern and different dose rate.

**Results:** Starting respiratory phase, dose rate and breathing pattern all have noticeable effects on the actual dose distribution delivered in uniform scanning proton beam. 95% of the GTV received only 3807 cGy for irregular motion vs 4032 cGy for regular motion. The dose are 4032, 3944, 4088 and 4107 cGy respectively for beam starting phase in the middle of end-of-exhale, inhale, at the beginning of exhale, and in the middle of exhale. The dose is 4032 and 3942 cGy respectively for dose rate of 348 and 284 MU/min.

**Conclusion:** A 4D treatment planning system and real time external or internal tumor position monitor system are needed for treatment of moving target using uniform scanning proton beam. After each treatment fraction, the actual delivered dose should be calculated and the initial treatment plan may be adjusted to account for the motion so as to satisfy the predefined dose constraints.