AbstractID: 13431 Title: What is the maximum number of beam spots deliverable within one gating window for synchrotron based scanning proton beam therapy of lung cancer?

Purpose:

To analyze the maximum number of spots achievable for each energy layer in respiratory-gated scanning beam delivery of proton radiotherapy when optimizing efficiency and minimizing the impact of cycle-to-cycle breathing irregularity. The ideal delivery would be to deliver all spots in each energy level within a single respiratory gate.

Method and Materials:

In-house treatment delivery simulation software was developed based on manufacturer's specification to study treatment statistics using timing information from patient's respiration patterns, and scanning beam proton treatment plans. Data from 10 patients with lung tumor were analyzed. Proton scanning beam plans were developed using 3 beams/plan. The patient's breathing traces were used to simulate respiratory gated delivery with 30%, 20% and 10 % duty cycles (DC). In the simulation, we measured 1) typical respiratory gate duration, and 2) the number of spots within this duration (spill time) in each expiration phase. We also compared the above data with number of available spots without respiratory gating.

Results:

The average duration of each respiratory gate signal was 1161±475, 841±323 and 517±208 msec for 30%, 20% and 10 % DCs respectively. This translated to 166, 120 and 74 available spots for 30%, 20% and 10 % DC respectively. Simulation of respiratory-gated scanning beam delivery over 10 respiratory patterns and 10 tumors indicated that, maximum number of spots required per energy level were 85, 83 and 77 for 30%, 20% and 10% DC respectively.

Conclusion:

Treatment plans for respiratory-gated scanning beam proton delivery on a synchrotron accelerator should be designed such that the number of available spots energy level are less than can be delivered in the respiratory gate. Our simulation study indicated that this condition could be easily met for various DCs of respiratory gating.