AbstractID: 11383 Title: A Feasibility Study on Frameless Gated Head Stereotactic Radiosurgery/Radiotherapy via Real-Time Optical Position Monitoring and Adaptive Head Motion Compensation

Purpose: To reduce patient setup time and to perform accurate non-invasive frameless head radiosurgery/radiotherapy by use of real-time position feedback for treatment beam gating and head motion stage guiding.

Method and Materials: A Polaris 4D tracker (NDI) was used to monitor four optical reflective markers rigidly fixated to a biteblock at 30fps with an RMS accuracy of 0.25mm. Head motion monitoring was performed on healthy volunteers using a styrofoam head cast for support. Simulation and prototyping were investigated using the head motion as the feedback input for beam gating and head motion compensation. Design specifications include using Labview to import the real-time biofeedback information and to monitor whether the center of the PTV is within a 3D motion tolerance of 1.0mm. If the PTV exceeds the tolerance, a relay switch is activated and the MV beam is turned off. After a 5s stabilization period, provided that the PTV has reentered the set tolerance, the beam is automatically turned on. However, if the patient stabilizes to a new position outside the tolerance, an automatic position correction is performed using a stepper motor controlled head stage.

Results: With only a head cast cradle, healthy volunteers mimicked natural sudden sporadic motions on the treatment couch. Data showed that the simulated PTV stayed within the 1mm tolerance for extended periods (~50s) between large motion excursions. Simulations using recorded head motion data as an input for gating, suggested a total beam-on time, or duty cycle of 75%. With active head position correction, the duty cycle and spatial accuracy can be further improved.

Conclusion: With an optical tracking system and minimal back-of-the-head support, healthy volunteers demonstrated the ability to maintain submillimeter head position with sufficient time windows for treatment. Adaptive motion compensation can be helpful in implementing a high-efficient and accurate frameless SRS/SRT system.