AbstractID: 7402 Title: Characterization of the stability of respiration for patients undergoing motion-adaptive lung tumor radiotherapy

Purpose: Lung tumor motion is due mainly to respiration. Tumor tracking during radiotherapy requires prediction of the tumor motion to compensate system lag time. Complexity and instability of a patient's breathing will influence its predictability. We have characterized the stability and predictability of the breathing patterns of lung radiotherapy patients by analyzing the time-dependent behavior of the autocorrelation of the patient's breathing motion.

Method and Materials: Breathing motion data were obtained from the CyberKnife Synchrony @ respiratory tracking system at Georgetown University Medical Center. Nine freely breathing lung cancer patients were arbitrarily selected for this study. The patients showed a wide range of breathing behavior. Respiratory motion of the chest surface was recorded for up to sixty minutes during treatment. For each breathing history the autocorrelation coefficient versus delay time was computed in a window of 55 seconds. The decay of the average autocorrelation coefficient over time was computed at various times in the breathing signal history by moving the window. This measured the instability of the breathing pattern over time.

Results: The breathing patterns of all nine patients had average autocorrelation coefficients that decayed over time, indicating the breathing was non-stationary. The rate of decay of the autocorrelation ranged widely for the patients. The predictability of each patient's breathing, as measured in a prior analysis using signal prediction algorithms, was highly correlated with the stability of the breathing pattern, as measured by its autocorrelation.

Conclusion: The autocorrelation of a patient's breathing and its decay over time can characterize breathing instability. This makes it possible to compare the results of motion prediction, control and adaptation algorithms that have been tested on a variety of breathing data.