AbstractID: 5397 Title: Respiration monitoring using radiotherapy treatment beam

Purpose: Real-time monitoring intra-fraction motion is essential for four-dimensional **(**4D) radiotherapy. Surrogate-based and internal-fiducial-based methods may suffer from drawbacks such as false correlations, being invasive, delivering extra patient radiation, or require additional hardware.
We developed a non-surrogate, non-invasive method to real time monitor respiratory motion during radiotherapy treatments. This method directly utilizes the treatment beam and thus imposes no extra radiation to the patient.

Method and Materials: The method requires a real time detector system and a 4DCT image. The basic idea is to correlate the real-time measured detector signal from the treatment beam with the pre-calculated signals assuming that beam passed through the different phase of 4DCT image. The on-line processes only involve detector signal readout, and 1D correlation of the measured signal with the pre-calculated signals. The respiration phase is determined as the position of peak correlation.
The method was tested with extensive simulations based on a 4DCT of a lung cancer patient. Three different IMRT delivery fluence maps were used. Three arbitrary breathing patterns and two dose levels, 2Gy/fraction and 2cGy/fraction, were used to study the robustness of this method against detector quantum noise.

Results: For the 2Gy/fraction simulations, the respiration phases were accurately determined in real-time for most projections of the treatment, except for a few projections in which beam intensities were extremely low. At 2cGy/fraction dose level, the method can still determine the respiration phase very well with only about 5% of projections having errors greater than 1 phase (0.5 second).

Conclusion: It is demonstrated that our method can monitor the respiratory motion within +/-1 phase in real time. This method can be easily implemented in any radiotherapy machine with high speed detector system. The motion information obtained can be used to either verify or correct the treatment delivery in real-time.