Conclusion: Respiratory and non-respiratory motion during prolonged treatment induces significant position errors. Resulting CTV to Planning Target Volume (PTV) margins are within the 5 mm isotropic expansion generally used in clinic. Non-invasive continuous monitoring of intra-fraction motion should be implemented for an accurate definition of PTV.

Purpose or Objective: To demonstrate that respiratory and cardiac motion is observable and quantifiable on the CT detector during TomoDirect breast treatments.

Material and Methods: A preliminary study for motion management in breast radiotherapy was performed using the exit detector fluence of tangential static IMRT fields on TomoTherapy. Two patients in treatment for left breast cancer were selected randomly for study. After their radiotherapy treatments, the raw pulse-by-pulse detector data was downloaded from the CT detector for analysis. The pulse-by-pulse detector data is sampled at a frequency of 300 Hz. The exit detector channels with fluences corresponding to the breast and heart surfaces were identified within the recorded treatment sinograms. These channels’ fluences were then investigated at the temporal projections in which respiratory and cardiac motion were expected (Figures 1a-b).

Results: Sinusoidal waveform data from the detector in breast treatments. The expected heart surface averaged a period of 2.8 ± 0.1 sec during the 4 fractions that were analyzed. The cardiac waveform motion recorded on the detector data at the expected heart surface averaged a rate of 86.4 ± 2.0 bpm during the 3 fractions that were investigated (Figures 1c-d).

Conclusion: The fluence variations we have observed on the pulse-by-pulse detector data would fit reasonably within respiratory and cardiac motion. These preliminary results are indicative of the ability for visualization and quantification of markers shows larger deviations than the X-ray verification. Largest mean deviations for longitudinal and lateral direction were -1.55mm (at couch angle 270°) and 1.14mm (at couch angle 90°).

Conclusion: X-ray verification at non-zero couch angles using the ExacTrac system is sufficiently accurate to be used in SRT. Deviations in X-Ray verification were largest at couch angle 30° but this will be of minimal importance clinically, since in non-coplanar SRT treatment techniques multiple couch angles are used. The IR system shows deviations that exceed accuracy requirements for SRT.