Abstract ID: 15377 Title: Real-time 4DCT using magnetic tracking methods and magnetic shielding

Purpose: Real-time, tumor tracking for 4DCT does not exist, which is needed for accurate gated therapy. Magnetic tracking is a possible method, however, eddy currents induced from the magnetic source create magnetic noise that is difficult to filter from the signal; the noise shares the same frequency as the signal and other characteristics have to be addressed. We present a method, based on a specialized algorithm, sensor configuration, and magnetic shielding to accurately calculate the transponder position.
Method: The CT and transponder were modeled to calculate the magnetic fields within the ideal CT environment, where the gantry was a conducting cylinder. The magnetic fields were simulated using the Ansoft Maxwell electromagnetic solver. The sensors were modeled as search coils of finite dimension, with different size, number, and geometry. An innovative algorithm was developed to use magnetic gradient information to filter eddy current noise. Magnetic material applied to the gantry was modeled to optimize the signal frequency, the magnetic permeability, and thickness.
Results: We found that 4 detectors, with 7 sensors, were able to locate the transponder within 2 mm over the majority of points within the CT bore; however, there were regions where the errors were in excess of 4-5 mm. After modeling the magnetic layer on the gantry surface, we found that the localization accuracy was a function of permeability and magnetic thickness. Results showed a minimum in error as a function of magnetic thickness. The localization error in that region was less than 1 mm.
Conclusions: We have developed an innovative method to localize a tumor in 4DCT to within 1 mm using a specifically developed algorithm, sensor configuration, and magnetic material along the CT surface. We believe this technique may solve the problem of real-time 4DCT.