AbstractID: 7653 Title: Experimental observation of convection in an ultrasound calorimeter for absorbed dose

Purpose: To create, measure, and attempt to characterize convection effects experimentally in a water phantom and cell in terms of simple physical parameters, in order to obtain accurate calorimetric measurements of absorbed dose in both Domen-type devices and especially the ultrasonic calorimeter under evaluation at NIST.

Method and Materials: Experiments have been performed to investigate radiation induced convection in an open water phantom equipped with a bare thermistor and an ultrasound transducer in addition to using thermsitors in a sealed core; and to investigate convection threshold by using one thermistor as a point heating source. We employ both impulse-response testing and continuous square-wave excitation, and analyze the data in frequency domain in an attempt to decompose the responses due to conduction and convection.

Results: Single shot, impulse response testing shows periodic ringing following after the response to the initial excitation has faded, observable for both thermistor and ultrasound sensors. The period for this ringing can be estimate via Rayleigh formula. The Fourier series expansion of the square wave excitation dictates that no even harmonics should be present; however, this is violated at elevated radiation durations, strongly suggest the presence of convection. This is experimentally observed in both thermistor and ultrasound detections, but suppressed when the thermistors are within the glass vessel. To understand the onset of convection, the point source experiment establishes a threshold for convection with increasing power.

Conclusions: Using the frequency domain technique, we have observed experimentally the distinction of system response between convection and conduction. Both impulse-response and stationary spectra indicate large-scale oscillations of water in phantom that are likely to pose more of a problem for ultrasound than for thermistors with convection barrier. Once the behavior of convection is understood, one may be able to use spectral methods to remove its effects by data processing.