AbstractID: 4729 Title: Absorbed radiation dose measurement with a μK-resolution ultrasonic thermometer

Purpose: To develop a μK-resolution ultrasonic thermometer for non-invasive measurements of absorbed radiation dose in water and to characterize the intensity profile of radiation beams used for medical treatment.

Method and Materials: Subtle temperature changes in water were measured by monitoring the phase of an ultrasonic disturbance propagating in it. The current system includes a thermally insulated water tank, an ultrasonic transducer, a frequency counter, and a Pulsed Phase-Locked Loop connected to a PC. The alpha-prototype was initially tested and characterized experimentally with time-controlled light pulses, and was subsequently evaluated with radiation heating from a therapy-level Co-60 source. The system was subjected to 30 one-minute, 50% duty cycle radiation exposures; the temperature history was recorded and analyzed.

Results: Preliminary Fourier analysis of the temperature changes caused by periodic radiation heating showed that the absorbed dose rate corresponds to 1.80 Gy/min, deduced from a 0.43 mK (±3% 1σ) per cycle temperature rise in water. The estimated nominal dose rate at 81.6 cm from the source and 3.2 cm below the water surface is estimated to be 1.65 Gy/min. The discrepancy can be attributed to the non-standard water tank size and incomplete temperature calibration of the alpha prototype at test time. We expect to resolve these issues by equipping the system with a standard water tank and implementing a more advanced calibration procedure.

Conclusions: The alpha prototype has been tested in Co-60 radiation and produced reasonable results. The feedback from these tests has recently been incorporated into the design of a beta prototype. The new system routinely detects less than 10 μK temperature changes in water and shows great promise for precise dose measurements and beam profile characterization. The new calibration procedure does not require external sensors and makes the system more portable and fully self-contained.

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