AbstractID: 7209 Title: High-resolution digital ultrasonic thermometers

Purpose: To develop and test **1)** fully digital μK-resolution ultrasonic thermometer for non-invasive measurements of absorbed radiation dose in water; **2)** rapid ultrasonic 2D temperature mapping system for precise characterization of radiation beam intensity profiles.

Method and Materials: Monitoring tiny phase shifts of ultrasonic signals in water heated by ionizing radiation allows assessing water temperature changes at the μK level. Instead of the analog frequency-driven Pulsed Phase-Locked Loop (PPLL) used in the earlier work to track signal phase, the current system relies on fast digital phase algorithms that extract signal delay with resolution of 100ppb and better. Another ultrasonic system was built to produce 2D temperature maps in water. This system contains a 128-element, 14”-diameter circular transducer array operating in a tomographic fan-beam data acquisition mode. The system acquires temperature maps in seconds and allows monitoring evolution of thermal processes in time.

Results: The single-channel digital ultrasonic thermometer demonstrated resolution equivalent or better than analog PPLL-based prototype at overall lower noise level. The 2D temperature mapping system was constructed and went though a preliminary testing round. It monitored evolution of temperature profile in the cylindrical tank every 3-4 seconds acquiring each time a 64-projection data set with 45 rays per projection. After extracting phase information from the acoustic waveforms the system reconstructed a sequence of phase shift images and converted them to temperature maps using newly developed calibration procedure. The maps were combined into movies to watch temperature evolution dynamics.

Conclusion: The digital high-resolution ultrasonic thermometer demonstrated performance improvement and will replace its analog predecessor in the radiation-testing lab. The 2D ultrasonic temperature mapping system was successfully tested with a light radiation heating source. We plan to continue characterizing its spatial and temperature resolution and incorporate all findings into a next-generation prototype for ionizing radiation testing.

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