AbstractID: 6723 Title: Numerical Feasibility Study of a Novel Absorbed Dose to Water Calorimeter-based Standard for 192Ir HDR Brachytherapy.

Purpose: To study the feasibility of developing a new standard for absorbed dose to water based on water calorimetry for high dose rate iridium-192 (^{192}Ir) brachytherapy sources.

Method and Materials: The heat conduction pattern generated in water by the Nucleotron microSelectron-HDR ^{192}Ir brachytherapy source was simulated using Comsol Multiphysics™ software. Source self-heating due to self-attenuation of photons was calculated with GEANT4. A smooth, well-behaved three-dimensional function was fit to the entire dose distribution data using TableCurve3D™. The heat-loss correction K_c was calculated as the ratio of the temperature in the calorimeter under ideal conditions to realistic conditions.

Results: The feasibility of a water calorimeter based absorbed dose standard is determined by a balance between the requirements to obtain sufficient signal to perform a reproducible measurement, the effects of heat loss on the measured signal, and the positioning uncertainties. Due to self-absorption, the source equilibrium temperature was found to be above the ambient temperature by a constant amount that depends only on setup conditions and source activity. For the ^{192}Ir source inside its nylon-12 catheter inserted into water, the steady state excess temperature per unit source activity was found to be 0.5671 K/Ci. The source temperature reached 96% of its steady state temperature after 60 s. Conduction correction factors K_c were calculated for several exposure times and at various measurement points away from the ^{192}Ir source inside the calorimeter. A total exposure time between 140 s and 240 s at a distance that receives a minimum of 1 Gy of dose was found to allow reduction of K_c to below 0.1% of unity.

Conclusions: Water calorimetry for ^{192}Ir HDR brachytherapy is feasible and total uncertainties of significantly better than 5% on the dose can be achieved with current water calorimetry techniques and instruments.