AbstractID: 8220 Title: Development of a Novel Absorbed Dose to Water Calorimeter-Based Standard for HDR Ir-192 Brachytherapy

Purpose: To study parameters affecting the design of a new standard for absorbed dose to water for high dose rate iridium-192 (^{192}Ir) brachytherapy sources based on 4 ºC stagnant water calorimetry.

Method and Materials: The absorbed dose rate of a Nucleotron microSelectron-HDR ^{192}Ir brachytherapy source was measured for sources with nominal air kerma strength $S_{k,air}$ 21000 and 38000 U at several source-detector separations $d_{src-det}$ ranging between 25-30 mm. The irradiation time was adjusted to ensure a minimum dose of 1 Gy delivered to the measurement point. The heat-loss correction was calculated using COMSOL MULTIPHYSICS™ and is defined as the ratio of the temperature in the calorimeter under ideal conditions to realistic conditions.

Results: The heat-loss corrected dose rate measurements had a standard deviation of 1.5%, while the agreement between our measurements and the calculated dose rate results obtained using the TG-43 formalism was within 6.5%. The effects of convection were calculated to be negligible as the glass vessel serves as a convective barrier significantly decoupling the water velocity in the interior and exterior of the vessel (differences in velocity reaching one to two orders of magnitude). It was found that small uncertainties on $d_{src-det}$ significantly affects the shape of the drift curve, while varying the exact value of $S_{K,air}$, irradiation time, and differences in initial source temperature at the time of insertion into calorimeter have minimal effects. Differences between the shape of experimental and calculated drift curves can be used to optimize the calculation parameters.

Conclusions: Feasibility of water calorimetry for absolute dosimetry for HDR ^{192}Ir brachytherapy sources has been shown both numerically and experimentally. We believe absolute absorbed dose rate measurements with uncertainties significantly better than 5% are possible. Revisions to experimental designs are underway to improve the robustness of setup and improve the repeatability and uncertainty on measurements.