AbstractID: 10414 Title: Towards an absorbed dose-based calibration for Ir-192 brachytherapy dosimetry-Development of a primary standard water calorimeter

Purpose: To develop, validate and improve the accuracy of a 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 several Nucleotron microSelectron-HDR ^{192}Ir brachytherapy sources with nominal air kerma strength $S_{k,air}$ of 31600-36940 U at source-detector separations $d_{src\text{-}det}$ ranging between 51-67 mm was measured. The irradiation time was adjusted to deliver a minimum 1 Gy at the measurement position. 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: A random uncertainty of 0.6% on the calorimetric measurements was achievable. A total uncertainty of 3.0% on the final absolute dose rate to water measurement using water calorimetry is possible. Our calorimeter-measured dose rates were lower than the dose rate estimated using TG-43 based on an ADCL calibrated well chamber by 0.1-3.4%. The dose rate obtained from chamber and film reference dosimetry in water agreed with calorimetry to within one-sigma uncertainty. A reproducibility of better than 0.25 mm was achieved in measurement of $d_{src\text{-}det}$. Despite the significant source self heating (source excess temperature in-water), we found that the effects of convection can be neglected (as is usually done in 4 ºC stagnant water calorimetry) for $d_{src\text{-}det}$ larger than roughly 45 mm and an irradiation time that results in about 1 Gy of dose at the measurement point.

Conclusions: Absolute dose rate to water of HDR ^{192}Ir sources can directly be measured using 4 ºC stagnant water calorimetry with absolute accuracy of better than 3.0%. Our work provides the framework necessary for a shift from indirect HDR ^{192}Ir brachytherapy dosimetry to a more accurate, direct and absolute measurement of absorbed dose to water.