AbstractID: 3158 Title: Development of a sealed water calorimeter for clinical electron beams

Purpose: The purpose of this project is to develop a water calorimeter for use in clinical electron beams to directly determine absorbed dose to water. This work presents the design of the Electron Sealed Water (ESW) calorimeter, preliminary measurements and evaluation of correction factors.

Method and Materials: The calorimeter contains a 30 x 30 x 20 cm^3 water phantom surrounded by a cooling system to allow for operation at 4^{o}C. Two thermistor probes measure the temperature change inside a glass vessel filled with high-purity nitrogen-saturated water. Correction factors for the glass perturbation were calculated using Monte-Carlo simulations. Corrections for thermal conduction were simulated using Femlab finite element modeling software. Resistance of the thermistor probes was measured using a lock-in amplifier and an AC bridge circuit. Measurements were done for 6, 9, 12, 16 and 20 MeV electron beams from a Varian Clinac 21EX with a 10 x 10 cm^2 applicator at 105.5 cm SSD with the thermistor probes positioned at d_{ref}. Irradiations of 667 MU were done at 1000 MU/min for an irradiation time of 40 s. Measurements were also taken with a PTW Roos ion chamber inside the calorimeter phantom.

Results: The standard error on the mean temperature change for each energy was less than 0.2%. Reproducibility for measurements on separate occasions was 0.2%. When normalized to the 12 MeV measurements, values of $k'_{R\text{-}50}$ for the Roos chamber calculated from calorimeter measurements for the 9, 16 and 20 MeV beams and agreed with TG-51 values within 0.7 %.

Conclusion: Water calorimetry in electron beams has previously been regarded as unfeasible as high dose gradients were thought to provoke unmanageable temperature gradients. Using the ESW calorimeter, we have shown for the first time that reproducible measurements can be performed in electron beams with energies as low as 6 MeV.