AbstractID: 5401 Title: An improved irradiation setup for an accurate measurement of the dose rate constant of low-energy brachytherapy sources using micro-TLD cubes

Purpose: To develop an improved irradiation setup for the measurement of dose-rate-constant for interstitial brachytherapy sources using micro-TLD cubes by placing a TLD cube at the mid-point of two sources of nearly equal air kerma strength separated by a distance of 2 cm in a water equivalent solid phantom.

Method and Materials: The impact of geometric uncertainties associated with micro-TLD cubes on measuring the dose-rate-constant of low-energy brachytherapy sources was investigated quantitatively. Integral dose deposited to the volume occupied by a TLD cube in water was calculated by using the Berger formula for the conventional one-source and the proposed two-source irradiation setups. The effects of TLD size, shape-asymmetry (due to mechanical damage and manufacturing defect), and positioning uncertainty on the dose measured by TLD was quantified by comparing the integral TLD dose to expected point-dose at the measurement point.

Results: For a perfect TLD cube centered at the reference point, the integral dose to TLD was nearly identical to the expected point-dose, independent of TLD orientations. Displacements of TLD by 0.1 to 0.5 mm in the source-TLD direction resulted in dose errors of 2.3 to 10% in the one-source setup and 0.1 to 1% in the two-source setup. The dose errors were < 1% when the displacements of < 0.5 mm was in the perpendicular direction for both setups. The shape asymmetry measured by volume deficit produced similar dose errors, from 2.5% to over 9%, in both setups for volume deficits of 3 to 10%.

Conclusion: To keep geometry-induced uncertainty in dose-rate-constant measurement < 2%, the TLD cube must have 1) nearly perfect symmetry with volume deficits < 2%, 2) positional uncertainty < 0.1 mm in source-TLD direction and < 0.5 mm in perpendicular direction. The requirement for TLD positioning is greatly reduced in the proposed two-source experimental setup.