Ph.D. Thesis Abstract for Shannon M. Holmes

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Investigation of Beta Emitting Brachytherapy Sources

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Precise and accurate knowledge of brachytherapy source strength is paramount for accurate treatments regardless of whether the sources in question are beta emitting seeds for intravascular brachytherapy or the more widely used photon emitting low dose rate sources. The dosimetric parameters of these sources begin with the source strength. Measurements of the radial dose function of beta emitting brachytherapy sources in liquid water are also given to establish other dosimetric parameters. Calorimetry, which is an absolute measure ment, has been investigated as a method for improving brachytherapy source calibration. Cryogenic calorimetry offers a direct and fundamental method for measuring both total contained power as well as emitted power, and these values can be used for direct comparison with Monte Carlo calculations. As Monte Carlo based treatment planning systems are likely to be the future of radiotherapy, source power is an attractive metric because it offers a much more intuitive measure of source strength as an input parameter and requires far fewer corrections to the measured value than does air kerma strength. This thesis work establishes methods for measuring dose falloff near beta emitting brachytherapy sources in liquid water and for determining total source strength through active radiometric calorimetry. Source strength measurements for beta emitting sources in this work are obtained with a drastically improved expanded uncertainty of 2:4% compared to 6:1% expanded uncertainty in the current calibrated source activity. The design and function of an active radiometric calorimeter operating at liquid helium temperatures is presented along with brachytherapy source strength measurements.

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