

DOSIMETRIC OPTIMIZATION OF A NON-INVASIVE BREAST  
BRACHYTHERAPY APPLICATOR

BY  
YUN YANG

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Dissertation Supervisors:

Off-campus advisor: Mark J. Rivard, Ph.D.  
Professor and Chief Medical Physicist  
Department of Radiation Oncology  
Tufts University School of Medicine  
Tufts Medical Center, Boston, MA

On-campus advisor: David C. Medich, Ph.D., CHP  
Director of Radiation Safety Office  
Radiological Sciences Program  
University of Massachusetts Lowell, Lowell, MA

## **ABSTRACT**

The AccuBoost<sup>®</sup> applicators have been developed to apply brachytherapy for breast cancer in a non-invasive manner. Both the D-shaped and round applicators have been dosimetrically characterized and clinically used to treat breast cancer patients. While the AccuBoost<sup>®</sup> round applicators provide conformal dose coverage, dose to the breast skin may be higher than preferred. The purpose of this study was to modify the round applicators to minimize skin dose while not substantially affecting treatment time or dose uniformity within the target volume.

In order to irradiate the intended volume while sparing critical structures like the skin, the current round applicator design has been augmented through addition of an internal truncated cone (*i.e.*, frustum) shield. Monte Carlo methods and clinical constraints were used to design the optimal cone applicator. With the cone applicator now defined as the entire assembly including the surrounding tungsten alloy shell holding the HDR <sup>192</sup>Ir source catheter, the applicator height was reduced to diminish the treatment time while minimizing skin dose. Monte Carlo simulation results were validated using both ionization chamber and radiochromic film measurements based on established techniques.

The optimal cone applicators diminished the maximum skin dose by 15% to 32% (based on applicator diameter and breast thickness) with tumor dose reduced by less than 3% for a constant exposure time. Furthermore, reduction in applicator height diminished

the treatment time by up to 30%. Radiochromic film and ionization chamber dosimetric results in phantom agreed with Monte Carlo simulation results typically within 3%. Larger differences were outside the treatment volume in low dose regions or associated with differences between the measurement and Monte Carlo simulation environments.

A standardized optimization criterion was established based on clinical rationale and measured results. A new radiotherapy treatment device was developed and dosimetrically characterized. This set of applicators significantly reduces the skin dose and treatment time while retaining uniform target dose. This study is of particular importance to consider the applicators for APBI breast treatment.