Ph.D. Thesis Abstract for Albert J. Alter

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Measurement of X-Ray Intensity in Mammography by a Ferroelectric Dosimeter

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Each year in the US over 20 million women undergo mammography, a relatively high dose x-ray examination of the breast, which is relatively sensitive to the carcinogenic effect of ionizing radiation. The radiation risk from mammography is usually expressed in terms of mean glandular dose (MGD) which is calculated as the product of measured entrance exposure (ESE) and a dose conversion factor which is a function of anode material, peak tube voltage (23 to 35 kVp), half-value layer, filtration, compressed breast thickness and breast composition. Mammographic units may have anodes made of molybdenum, rhodium or tungsten and filters of molybdenum, rhodium, or aluminum. In order to accommodate all these parameters, multiple extensive tables of conversion factors are required to cover the range of possibilities.

Energy fluence and energy imparted are alternative measures of radiation hazard, which have been used in situations where geometry or filtration is unconventional such as computed tomography or fluoroscopy. Unfortunately, at the present there is no way to directly measure these quantities clinically. In radiation therapy applications, calorimetry has been used to measure energy absorbed. A ferroelectric-based detector has been described that measures energy fluence rate(x-ray intensity) for diagnostic x-ray, 50 to 140 kVp, aluminum filtered tungsten spectrum [Carvalho & Alter: IEEE Transactions 44(6) 1997].

This work explores use of ferroelectric detectors to measure energy fluence, energy fluence rate and energy imparted in mammography. A detector interfaced with a laptop computer was developed to allow measurements on clinical units of five different manufactures having targets of molybdenum, rhodium and tungsten and filters of molybdenum, rhodium, and aluminum of various thicknesses. The measurements provide the first values of energy fluence and energy imparted in mammography. These measurements are compared with conventional parameters such as entrance exposure and mean glandular dose as well as published values of energy imparted for other types of x-ray examinations. Advantage of measuring dose in terms of energy imparted in mammography are simplicity of comparison with other sources of radiation exposure and potential (relative ease) of measurement across a variety of anode and filter combinations.

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