PhD Thesis title: 'Spatial Dosimetry with Violet Diode Laser-Induced Fluorescence of Water-Equivalent Radio-Fluorogenic Gels**'**

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ABSTRACT:
The following work describes investigations of spatial dosimetry using laser-induced fluorescence of a radio-fluorogenic detector embedded within water-equivalent media. The chemical composition of a gelatin-based coumarin-3-carboxylic acid detector was investigated and dose response characterized. Violet diode (405 nm) excitation sources were explored and laser-induced fluorescence (LIF) employed to obtain the pattern of fluorescent emission yielding images of the integrated spatial dose distribution. The design of a three-dimensional reader is proposed to provide a foundation for future work.

Radio-fluorogenic processes create fluorescent products in response to ionizing radiation. Water radiolysis produced by ionizing radiation yields hydroxyl free radicals that readily hydroxylate coumarin-3-carboxylic acid to 7-hydroxy-coumarin-3-carboxylic acid, a derivative of umbelliferone. Umbelliferone is a known fluorophore, exhibiting peak excitation in the UV to near UV range of 365-405 nm with a visible 445 nm blue emission. Coumarin-3-carboxlyic acid has been studied in an aqueous gelatin matrix.

The radio-fluorogenic coumarin-gelatin detector has been shown to respond to an absorbed dose of ionizing radiation in a measureable manner. The detector was studied with respect to concentration of gelatin and coumarin in the presence of pH buffers. Dose response of the detector was investigated with regard to ionizing radiation type, energy, and rate of irradiation. Results demonstrate a functional detector.

Patterns of energy deposition were formed in response to ionizing radiation produced by a sealed-source of radioactive Ir-192 embedded in the gelatin matrix of the detector. Spatial distributions of absorbed dose were recorded and analyzed as a function of fluorescent emission. The distribution of energy deposition was imaged with LIF excitation by a divergent beam of 405 nm light and determined by analysis of digital image pixel intensity values displaying the 445 nm fluorescent emission. Results demonstrate spatial dosimetry proof of principle.

A basic dedicated reader system was fabricated employing LIF. Images of fluorescent emission excitation profiles were obtained in multiple aqueous samples and processed to obtain a dose response. Design of an optical reader system for the radio-fluorogenic detector is explained and a three-dimensional dosimetry system proposed. Three-dimensional imaging principles with LIF have been illuminated.

Keywords:
“Radiation Dosimetry” “Chemical Dosimetry” “Gel Dosimetry” “Radio-fluorogenic” “Laser-Induced Fluorescence”

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