**PhD Thesis title: 'Investigation of Advanced Dose Verification Techniques for External Beam Radiation Treatment'**

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**ABSTRACT:**

Intensity modulated radiation therapy (IMRT) and volumetric modulated arc therapy (VMAT) have been introduced in radiation therapy to achieve highly conformal dose distributions around the tumour while minimizing dose to surrounding normal tissues. These techniques have increased the need for comprehensive quality assurance tests, to verify that customized patient treatment plans are accurately delivered during treatment. *In vivo* dose verification, performed during treatment delivery, confirms that the actual dose delivered is the same as the prescribed dose, helping to reduce treatment delivery errors. *In vivo* measurements may be accomplished using entrance or exit detectors. The objective of this project is to investigate a novel entrance detector designed for *in vivo* dose verification.

This thesis is separated into three main investigations, focusing on a prototype entrance transmission detector (TRD) developed by IBADosimetry, Germany. First contaminant electrons generated by the TRD in a 6 MV photon beam were investigated using Monte Carlo (MC) simulation. This study demonstrates that modification of the contaminant electron model in the treatment planning system is required for accurate patient dose calculation in buildup regions when using the device. Second, the ability of the TRD to accurately measure dose from IMRT and

VMAT was investigated by characterising the spatial resolution of the device. This was accomplished by measuring the point spread function with further validation provided by MC simulation. Comparisons of measured and calculated doses show that the spatial resolution of the TRD allows for measurement of clinical IMRT fields within acceptable tolerance. Finally, a new general research tool was developed to perform MC simulations for VMAT and IMRT treatments, simultaneously tracking dose deposition in both the patient CT geometry and an arbitrary planar detector system, generalized to handle either entrance or exit orientations. It was demonstrated that the tool accurately simulates dose to the patient CT and planar detector geometries. The tool has been made freely available to the medical physics research community to help advance the development of *in vivo* planar detectors.

In conclusion, this thesis presents several investigations that improve the understanding of a novel entrance detector designed for patient *in vivo* dosimetry.

**References to author publications that relate specifically to the dissertation:**

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