Measurement of output factors with various detectors in the presence of ViewRay MRIdian's magnetic field

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INTRODUCTION

Techniques for measuring output factors (OF), especially in small fields, have matured in recent years. Numerous active and passive detectors have been examined for their ability to accurately measure OFs in standard and small fields. However, the introduction of magnetic fields into the treatment field necessitates a re-examination of familiar detectors as well as a characterization of novel ones. In this work, OFs were measured using a variety of detectors in the 0.345T magnetic field of a ViewRay MRIdian Linac. The goal was to characterize the behavior of these detectors in measuring OFs in the presence of a magnetic field.

METHOD

Output factors were measured at 5 cm depth in either a 1D water phantom or a solid water phantom as appropriate. The phantom was placed at 75 cm SSD with fields ranging from 0.415 to 25.64 cm equivalent square fields and readings normalized to the 9.96 x 9.96 cm^2 field reading with the same detector. The detectors examined were the SunNuclear Edge diode, Standard Imaging Exradin W2 scintillator, and Best Medical MOSFET which were compared to the reference, Gafchromic EBT^3 radiochromic film. Additionally, all detectors were compared with the Monte Carlo (MC) calculated OFs from the ViewRay TPS.

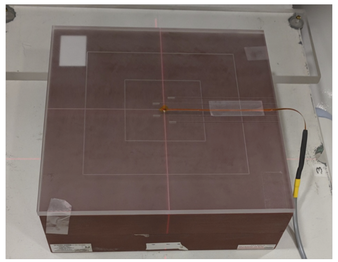

Figure 1. Setup: MOSFET detector in solid water in ViewRay's MRIdian system.

RESULTS

Output factors measured by all detectors were within 2% of the OFs determined by radiochromic film. The largest discrepancies were for the diode and MOSFET at the smallest field size measured by film, 0.83x0.83 cm^2. OFs for the diode and MOSFET were 1.9% and 1.4% larger than the radiochromic film, respectively. The W2 at this field size was within 0.6% of film. The W2's greatest difference from film was in the 3.32x3.32 cm^2 field at 1.0% lower. The MC calculation's largest deviation was 1.0% higher than film at the 0.83x0.83 cm^2 field size. Comparing each detector against the MC calculation, the film, diode, and W2 were all within 1.6%. The MOSFET had a 2.2% difference at the 12.45x12.45 cm^2 field. Besides this one field size, the MOSFET was at most 1.4% higher than the MC calculation.

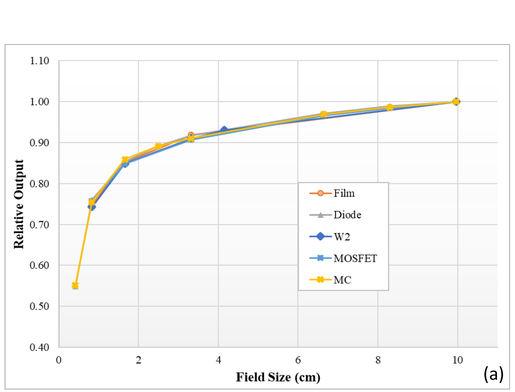

Figure 2. (a) Output factors up to the 9.96 cm square field. (b) OFs out to the 25.64 cm square field.

Table 1. Deviations of the OFs measured with each detector from film and from MC

Detector	Deviation from Film		Deviation from MC	
	Average Deviation (%)	Deviation Range (%)	Average Deviation (%)	Deviation Range (%)
Film	---	---	-0.3	2.0
Diode	0.6	2.1	0.1	1.5
W2	-0.6	0.6	-1.0	1.5
MOSFET	-0.1	2.7	0.2	3.6
MC	0.3	2.0	---	---

IMPACT

The determination of output factors is a routine measurement for any medical linac. However, since a magnetic field in the treatment beam could potentially affect detector response, the same detectors that have been used extensively in the past needed to be tested again in magnetic fields. Additionally, the W2 scintillator is a new device that has not been extensively characterized to date. This work has shown that a selection of detectors, including the new W2, are able to accurately measure output factors.

CONCLUSIONS

The detectors examined have been found to accurately measure output factors for ViewRay's MRIdian Linac. The 0.345 T field has a minimal effect, if any, on the measurement of output factors with these detectors, with all OFs within 2% of film measurements. The W2 scintillator, a new detector with little existing literature characterizing its response, measured OFs most similar to the film reference measurements. Additionally, agreement of all detector measurements with the MC calculations in a larger set of field sizes was within 2.2%.

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