

Development and characterization of an optical fiber-based Cerenkov dosimeter

E. Jean^{1,2,3}, S. Lambert-Girard⁴, F. Therriault-Proulx⁴ and L. Beaulieu^{1,2}

¹ Université Laval, ² CHU de Québec, ³ CHAUR de Trois-Rivières, ⁴ Medscint inc.



INTRODUCTION

This study introduces a novel hybrid Cerenkov-scintillation dosimeter. The aim is to validate the dose-light relationship of the Cerenkov probe for fixed irradiation angle using various photon and electron beams.

MATERIAL AND METHODS

- Hybrid Cerenkov dosimeter (Fig. 1)
- Ionization chamber (PTW TN30013)
- HYPERSCINT RP-200 scintillation dosimetry platform (Medscint)
- LINAC (Varian, Clinac iX)

Output factors and dose linearity at normal incidence

Photons : 6 and 18 MV

Electrons : 6, 9, 12, 16, 20 MeV

Dose calibration of the detector signal was accomplished with repeated irradiations of 200 cGy

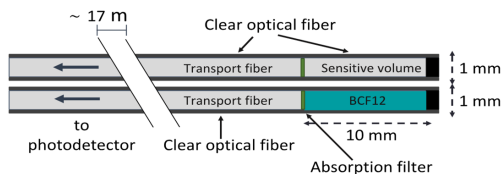


Figure 1. Design schematic of the hybrid detector showing the Cerenkov and the scintillation probe assemblies. The signal emitted by each of them is collected independently.

RESULTS

At normal incidence, the Cerenkov detector sensitive volume signal as a function of the deposited dose was found to follow a linear trend (Fig. 2). The Cerenkov signal intensity varies with beam energy.

Using the Cerenkov probe, output factors were accurately measured within $\pm 0.8\%$ for field size up to $25 \times 25 \text{ cm}^2$ with both photons and electrons (Tab. 1). The two probes provided similar accuracy even if the scintillation signal is up to 20 times greater than the Cerenkov sensitive volume signal for an exact same length.

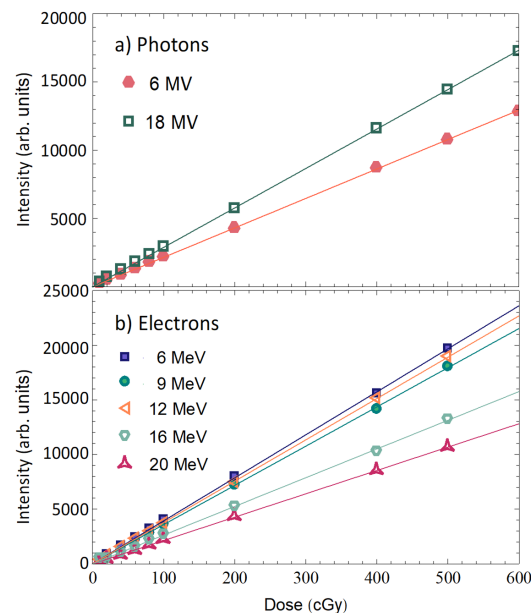


Figure 2. Signal emitted by the Cerenkov detector sensitive volume as a function of the dose obtained with 6 and 18 MV photon (a) and 6 to 20 MeV electron (b) beams at normal incidence.

Table 1: Relative difference of the output factors normalized to a $10 \times 10 \text{ cm}^2$ field size measured with the Cerenkov and scintillation detector in comparison with a TN30013 Farmer ionization chamber (PTW, Freiburg, Germany).

Field size (cm ²)	Relative difference (%)						
	6 MV	18 MV	6 MeV	9 MeV	12 MeV	16 MeV	20 MeV
6 x 6	0.8 / 0.2	0.8 / 0.9	0 / 0.3	0.8 / 0.5	-0.7 / 0.3	-0.3 / 0.6	-0.2 / 0.3
10 x10	-	-	-	-	-	-	-
15 x15	-0.1 / -0.1	0.5 / -0.1	0.2 / 0.3	0.3 / -0.3	0 / 0	0.2 / 0.1	-0.6 / -0.2
20 x 20	-0.6 / 0.2	-0.3 / -0.6	-0.2 / -0.2	-0.8 / -0.3	0.6 / -0.1	-0.1 / 0.3	0.1 / 0
25 x 25	-0.1 / 0.8	-0.3 / -0.2	-0.2 / 0.8	0.6 / -0.2	-0.7 / -0.2	0.3 / 0.1	0.4 / -0.4

CONCLUSIONS

While the detector has been employed in the same manner as a PSD for dose measurements in this study, the Cerenkov angular dependency is intended to be used for irradiation angle measurements in future work.

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