Development of an automated routine for finding the precise location of scintillators elements and their emission spectrum in a multi-point scintillation detector

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INTRODUCTION

Scintillation dosimetry convert ionizing radiation into visible light by the means of plastic scintillators, allowing real-time measurements and good spatial resolution.

The goal of this study is to develop an approach allowing for **calibration of multi-point scintillation detector (mPSD) using only the photon beam from a linear accelerator** such that it doesn't depend on the availability of other irradiation modalities (e.g. orthovoltage irradiators). This study also aims to develop an experimental method to **validate the spatial position** of the scintillating elements within the mPSD.

EXPERIMENTAL SETUP

- Use of a **3-point mPSD** and the new **HYPERSCINT scintillation dosimetry research platform.**
- Development of an **automated translation module** for scanning the detector
- Use of a 5-mm diameter **lead collimator** to better confine the radiation
- Irradiations over the scintillators have also been performed without the use of the collimator (using only the jaws of the linac) for comparison purposes
- Reference emission spectra are acquired using a kilovoltage irradiator photon beam

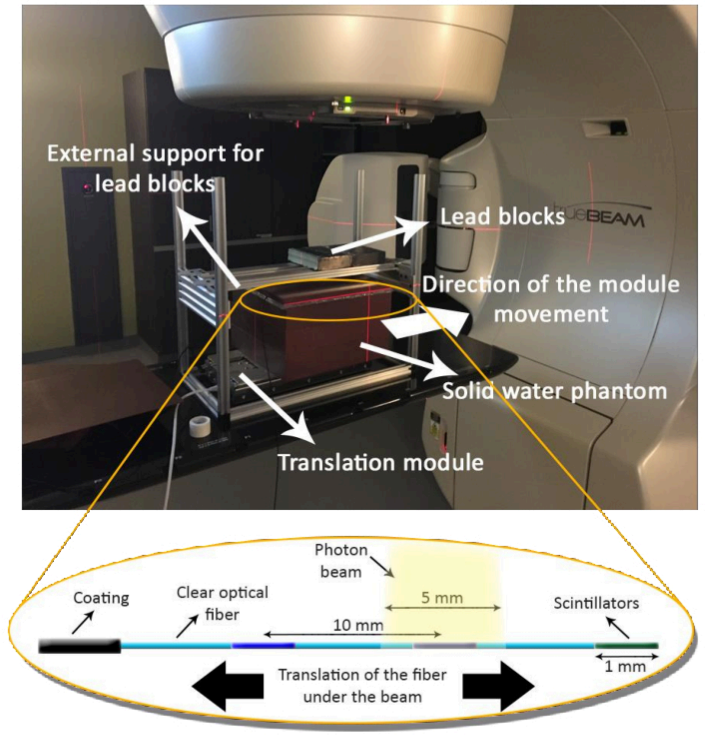

Figure 1 – Experimental setup at the linac.

RESULTS

- Possibility to do steps **as small as 20 µm** with the translation module
- **Localization accuracy of 0.5 mm and 0.7 mm** on the estimated positions of the scintillators (see figure 2)
- RMS error between the measured spectra and the reference spectra **improving by a factor of at least 2** when using the collimator (see figure 4)
- Remaining difference due to the presence of Cherenkov light in the signal (see figure 3)

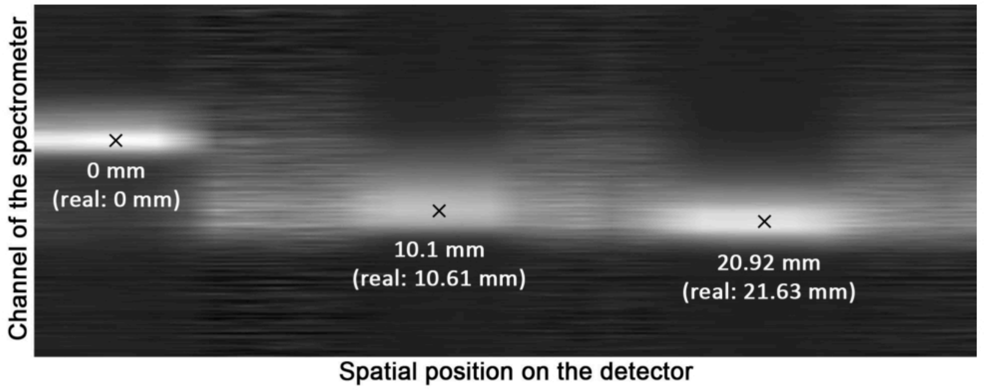

Figure 2 - Estimated positions of the scintillators within the detector shown on a map representing the spectra acquired as a function of the spatial position on the detector.

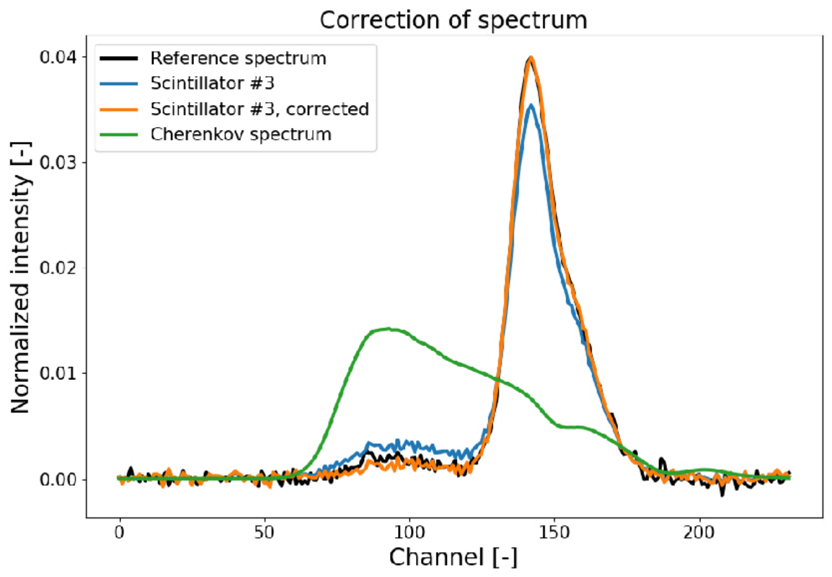

Figure 3 – Corrected spectrum for one of the scintillators by removing a proportion of the Cherenkov spectrum.

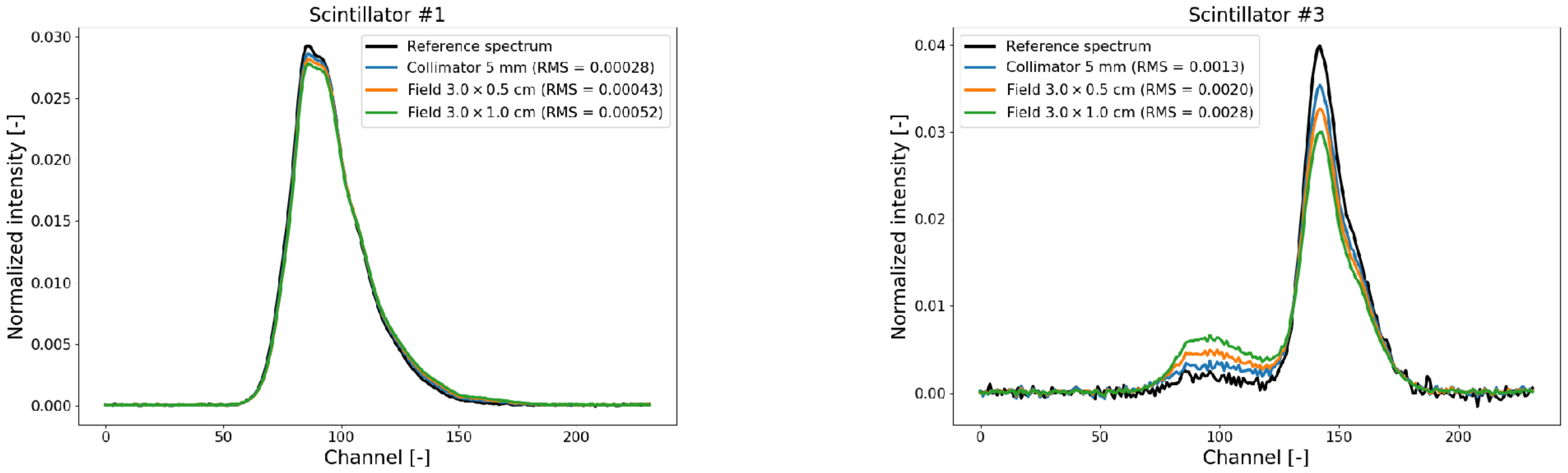

Figure 4 – Spectra acquired for two of the three scintillators, corresponding to the best (left) and the worst (right) case. The results obtained with and without the collimator are shown on both figures.

CONCLUSIONS

This study opens the door for the **fast and accurate calibration** of multi-point scintillation detector **using only megavoltage photon beams** delivered by a linear accelerator. Furthermore, the method is efficient: it automates a long and tedious process, avoids risks of mis-positioning the mPSD, and allows for extraction of high quality spectra, which is essential for accurate dose measurements with mPSDs.

The use of the automated translation module also allows to **increase the resolution of the measurements**, by allowing to do steps smaller than 1 mm if desired, which is not possible by using only the jaws of the linac.

Further techniques are being investigated to help correcting the remaining difference between the measured spectra and the reference spectra, using the proportion of Cherenkov light present in the signal.

ACKNOWLEDGEMENTS

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