The purpose of this work is to develop and validate a reliable method for characterizing small fields on radiotherapy machines with radiochromic film. A novel multichannel analysis method is proposed that focuses on correcting film systematic errors introduced by manufacturing imperfections. To validate the technique, a controlled experimental environment is used. Initial results show that the performance of the method is promising, suggesting potential future for small field dosimetry.

Methods:

A. Experimental set up

A Cobalt-60 beam is used to irradiate radiochromic films (Gafchromic EBT-3) homogenously, allowing the determination of parameters for the film scanner homogeneity correction, multichannel analysis and film dose response calibration. The setup is shown in Figure 1, while the homogeneity of a profile across the film at an SSD of 430 cm in Figure 2.

B. Multichannel method

Prior to performing the multichannel analysis, a correction is applied to the film to account for the scanner light inhomogeneity (see Figure 3). A multichannel method developed from first principles and based on the statistical behaviour of optical density for a given dose is then applied to correct for defects in film emulsion thickness uniformity. This method allows the film response to be characterised in terms of dose and thickness perturbation, as shown in Figure 4. By applying the multichannel correction, as shown in Figure 6, a perturbation and dose index map was extracted, thus allowing the image to be corrected and the film calibration to dose to be performed (see Figure 5).

Validation of the method:

The performance of the method is validated against experimental measurements of dose distributions in a Cobalt-60 beam. Beam profiles (Figures 7 and 9), as well as percent depth dose distributions (Figures 8 and 10), are measured and used to compare the proposed method with one using single channel analysis (red only). Results with the new method show a significant improvement compared to the single channel method, with systematic errors being reduced by a factor of up to 3.

Conclusion and future work:

The proposed method based on multichannel analysis is promising for applications requiring high accuracy, such as in the characterization of small fields. Future work requires further validation of the method against other detectors as well as Monte Carlo calculation.

References:

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