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Towards 2D Dosimetry using Monolithic Active Pixel Sensors and a Copper Grating

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Higher energy and intensity X-ray radiotherapy treatments are coming into wider use, having the benefit of requiring fewer treatment fractions and fewer hospital visits per patient. However, small percentage errors in MLC positioning and dose become bigger problems with higher doses per fraction. Hence, real-time treatment verification becomes essential. Where devices downstream from the patient suffer from scattering in the patient, upstream devices can disturb the therapeutic beam. Here, a method is proposed for performing dosimetry using Monolithic Active Pixel Sensors, which can be made thin enough to disturb the beam by <1%. To calculate the dose to the tumour, a verification device needs to make a measurement of the photon field. Some photons will Compton scatter an electron in the silicon and generate a signal. However, this signal is obscured by energy deposits from contamination electrons, originating from Compton scattering in the accelerator head and air. Often extensive build-up material is added to verification devices to reduce the electron contamination and enhance the photon signal. However, this leads to degradation of the beam intensity to the patient. Instead we propose using thin strips of 50 um thick copper in a grating pattern and measuring the difference in the signal with and without it. The contamination electrons are relatively undisturbed by the presence of the thin copper strips and the photon signal generated via Compton scattering is enhanced. Hence the difference in the two signals mostly consists of energy deposits originating from the therapeutic photons. From this the dose to the patient can be derived. Using this technique, we show that the electron contamination signal can be reduced from 38% of the total signal to 2.6%. This allows to extract the photon signal only from the data and thus the dose to patient with a very thin upstream detector.

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