SPAD BASED IMAGING OF CHERENKOV LIGHT IN RADIATION THERAPY

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During radiotherapy, X-ray beams induce Cherenkov light emission in tissue as part of the dose delivery. This light can be used for dosimetry, in order to track and image the dose as it happens. The Cherenkov light levels are in the range of 10^{-6} to 10^{-9} W/cm^2, which makes it challenging to detect in a clinical environment. However, because the radiation is pulsed in 4 microsecond bursts, time-gated acquisition of the signal allows for robust detection, even in the presence of ambient room lighting. Thus, imaging sensors for this application must be highly sensitive and must be able to time gate faster than a microsecond. In this study, the use of a solid-state detector composed of 64x32 single photon avalanche diodes (SPAD) was examined. The advantages of this technology were intra-chip amplification, superior X-ray noise rejection, and fast temporal gating of the acquisition. The results show that the SPAD camera was sensitive enough to detect Cherenkov radiation despite the 3% fill factor. 2D oversampling (x25) was also used to increase final image resolution to 320x160. In this work we demonstrate the SPAD camera performance in imaging Cherenkov emission from a tissue optical phantom and one patient undergoing radiotherapy. The SPAD camera sensors could be a viable alternative for Cherenkov imaging, as compared to current imaging methods that are mostly focused around image intensifier-based cameras and so have a range of non-linearities and instabilities which could be solved by an all solid-state camera sensor.

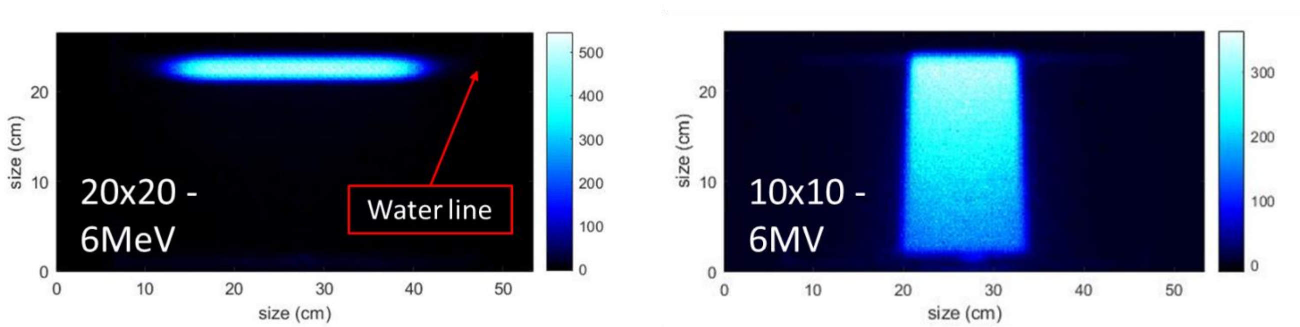

Figure 1: Water tank phantom images with different beam parameters. Left: 20x20cm electron beam, Right: 10x10cm X-ray beam.