

Purpose: TomoTherapy® treatment systems have exit MV detectors that record the radiation fluence during treatment. This information can be used in real time to verify delivered dose.

Method and Materials: We developed a method that can extract the MLC leaf open time from the detector data without relying on the patient CT or pre-measured database proposed by previous researchers. Because each leaf has penumbra, an open leaf will contribute signals to the detectors that correspond to adjacent leaves. Therefore, a closed leaf could be reported as open if its adjacent leaf is open. To eliminate the impact of the penumbra, we model the penumbra with a point-spread-function and apply an iterative deconvolution procedure to remove the penumbra. The iterative method successfully removes the penumbra without introducing ringing artifacts. The MLC leaf open time is then extracted with a simple thresholding method.

To verify the algorithm, we install optical sensor on each MLC leaf that reports the leaf position. The leaf open time extracted from exit detector is compared to the optical sensor report.

Results: The leaf open time extracted from the exit detector showed good agreement with the optical sensor under a variety of conditions, such as different attenuation phantom and different delivery sinogram. The detector measured leaf open time agrees with the optical sensor within 0.2 ms and a standard deviation of 3.6 ms. The impact of these uncertainties to the dose calculation is estimated to be around 0.2%. The algorithm is optimized so that it can run on the onboard computer in the machine to process the detector data in real time.

Conclusions: The exit detectors in TomoTherapy® treatment systems can provide us information of leaf behavior during delivery. Together with the monitor chambers of the linac, the actual delivered dose to patient can be calculated.