

Purpose: To present and characterize a fluence monitoring transmission detector for the online quality control of radiotherapy treatments. This work presents extended detection capability of the detector using a new formalism for the representation of the beam quality control.

Methods: Sixty 27-cm scintillating fibers were aligned in the direction of motion of each of the 60 leaf pairs of a 120 leaves Millennium MLC on a Varian Clinac iX. Because of the significant light attenuation in scintillating fibers, combined information from the two sides of each fiber allowed for both position coding and integral fluence information of the incident fluence passing through each MLC leaf pair. The whole device was placed in the accessory tray of the linac to enable fluence verification during the treatment delivery. The impact of a wide range of delivery errors was evaluated using a graphical representation of the treatment validity. The influence of the transmission device on the radiation beam was also evaluated.

Results: The presented online detector allowed the detection of MLC leaf positioning errors below 1mm, symmetric leaf displacement of 1.6mm, blocking jaws errors of 2mm and absolute dose rate de-calibration of less than 1%. The formalism used for the graphical representation of the beam quality control allowed the instantaneous detection of critical delivery errors such as deleted segments or wrong energy selection. The fluence monitor also achieved a uniform beam transmission of 98.3%.

Conclusions: This work shows that an optical attenuation-based detector can be used to monitor both intuitively and precisely the incident fluence during radiotherapy delivery. The performance of such a system would enable real-time quality control of the incident fluence both in current MLC-driven treatments and in future adaptive radiotherapy procedures where new treatment plans will have to be delivered without passing through the current standard quality control chain.

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