MONTE CARLO STUDY OF AN INTEGRAL QUALITY MONITORING (IQM) SYSTEM

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Introduction and Aim

The Integral Quality Monitor (IQM) is an independent real-time treatment verification system which validates the integrity and accuracy of treatment plan data. The IQM also functions as a pre-treatment quality control (QC) tool for radiotherapy. The IQM is essentially a large wedge-shaped ionization chamber that is fixed to the treatment head of the Linac as depicted in Figure 1. The aim of this study was to model the IQM device for Monte Carlo (MC) simulation purposes and validate the MC study with experimental measurement.

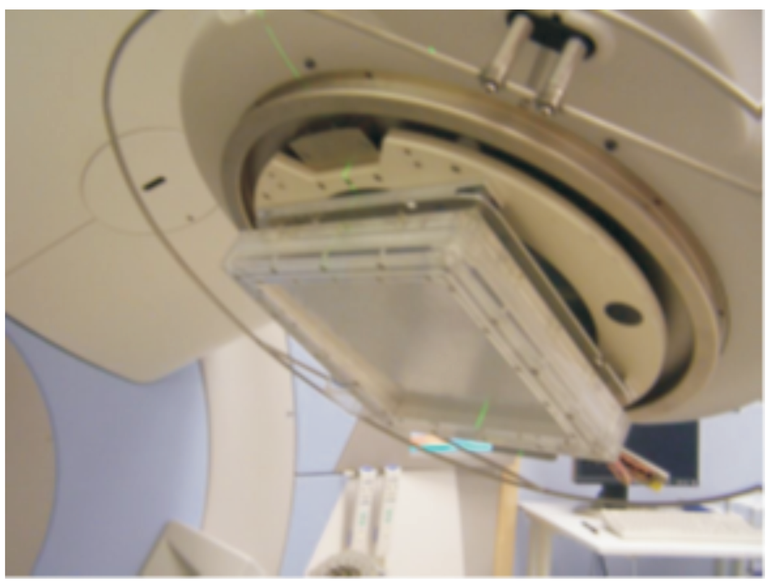

Figure 1: IQM system mounted on the Linac head.

Materials and Methods

The wedge-shaped ionization chamber is made of metallic electrode plates in an insulating material frame. The central electrode serves as the collecting plate covered by the gradient plates. An Elekta Synergy equipped with 160 Leaf MLC was built using BEAMnrc with the IQM component module CM attached to it as arranged in figure 2. Figure 3 depicts the graphical design of the IQM CM that was developed by the authors and added-on to the available CM list in the BEAMnrc code. During MC simulation, the integral signal was evaluated for square fields ranging from 1 x 1 cm^2 up to 40 x 40 cm^2 for 6 MV, 10 MV and 15 MV photon beams and compared with the experimental measurement.

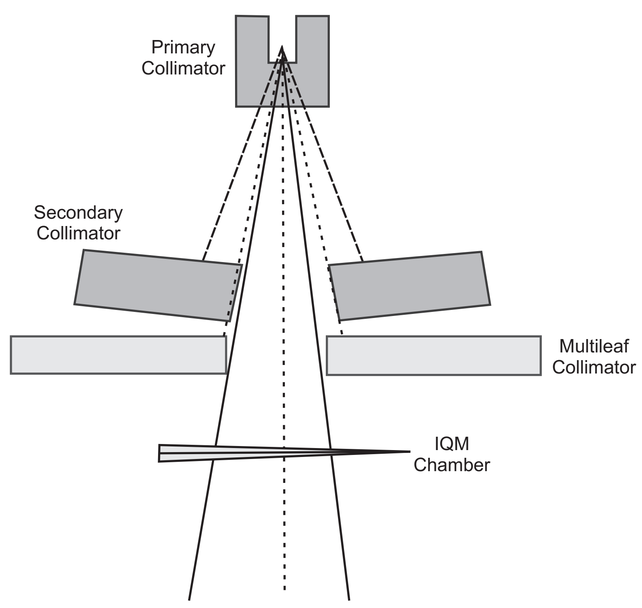

Figure 2: Linac setup with the IQM chamber.

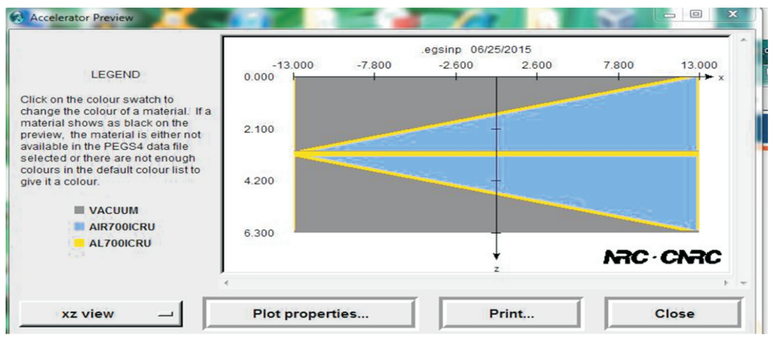

Figure 3: Illustration of the IQM model on BEAMnrc GUI.

Results

Figures 4, 5, and 6 show the outcome the measured and simulated normalized IQM signals for 6 MV, 10 MV and 15 MV photons respectively. Figure 7 depicts the photon beam variation for the IQM model and figure 8 shows the blown up part of figure 7 (segment 1 to segment 5). The uncertainty in the MC simulation was within 1%

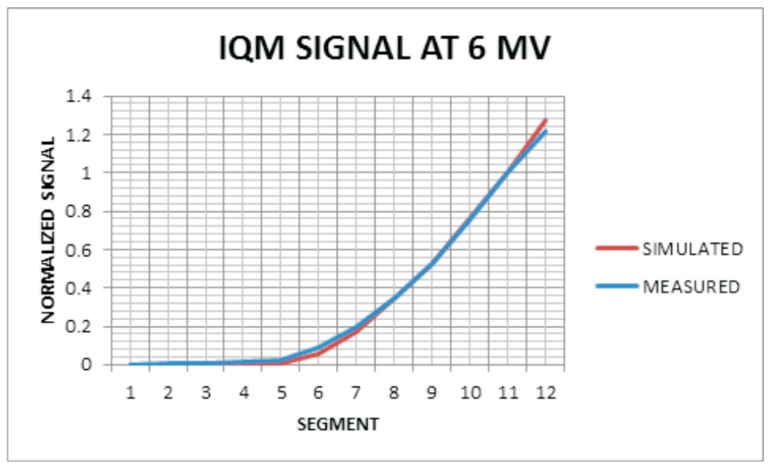

Figure 4: Comparison of measured and simulated IQM signal for 6 MV.

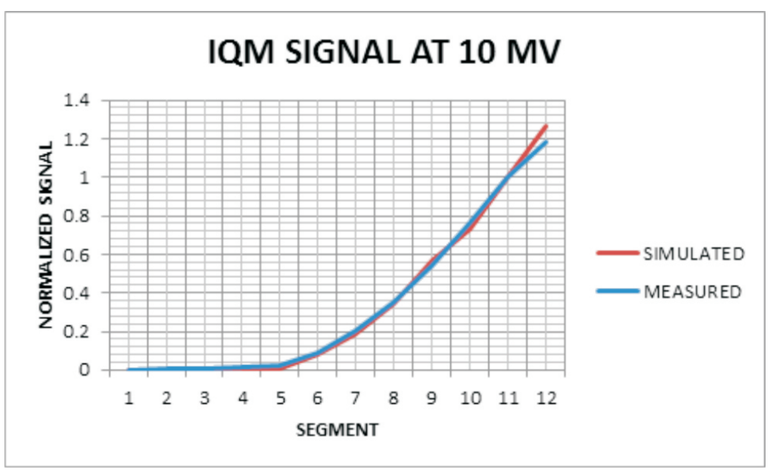

Figure 5: Comparison of measured and simulated IQM signal for 10 MV.

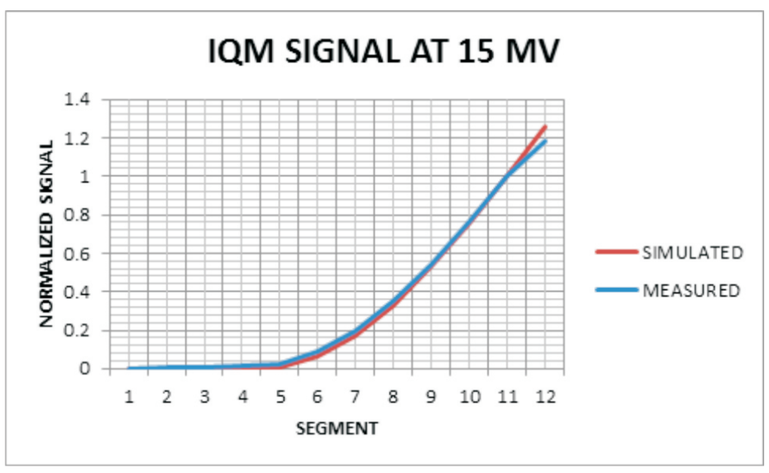

Figure 6: Comparison of measured and simulated IQM signal for 15 MV.

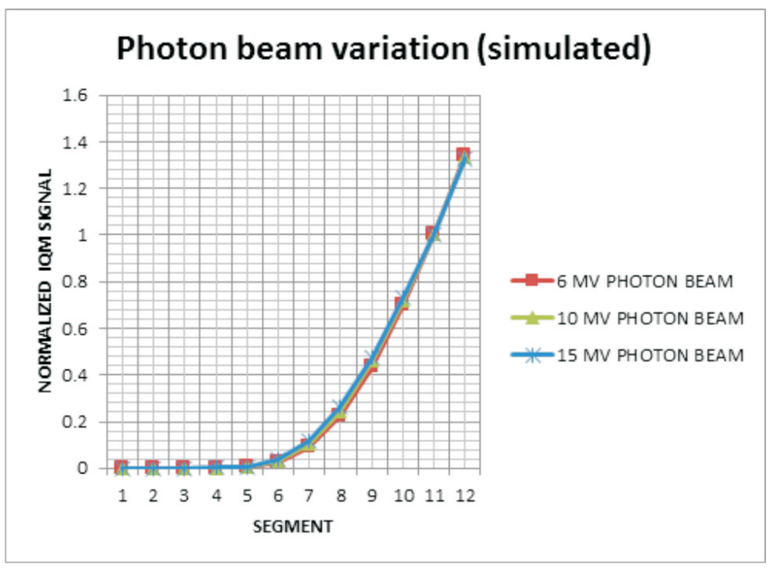

Figure 7: Photon beam variation for the IQM signal model.

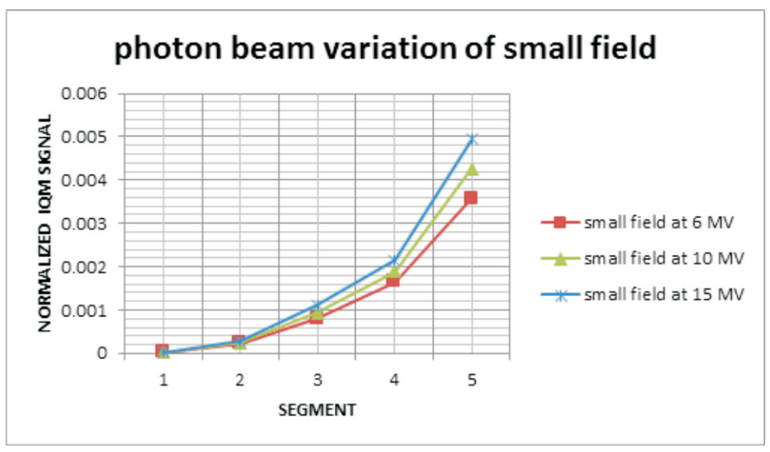

Figure 8: Photon beam variation for the IQM signal model for small field (segment 1 to 5 of figure 6)

Discussion and Conclusion

The results confirm the validation of the IQM MC model. Comparisons show the agreement between the measured and the simulated IQM response as a function of field size. The IQM device can be modelled using the BEAMnrc component module, IQM. This model stands as the basis for MC study of IQM system for researchers who are interested in online radiotherapy dose monitoring especially for advanced radiotherapy quality control techniques. This IQM code takes the advantage of the available BEAMnrc code and EGSnrc platform.

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