Performance of a Multi Leaf Collimator System of a 1.5T MR-Linac

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INTRODUCTION

A new MLC system is made by Elekta and integrated into Unity, which is improved based on Agility™ and customized for MR-linac. The new MLC system is similar to the Agility™ of non-MR-linac, but a few differences were made. And most of the difference were directly related with beam so the dosimetric characterization of the new MLC system is different.

AIM

To evaluate the performance of Agility multileaf collimator (MLC) in the high-magnetic-field of Elekta Unity MR linac

METHOD

The MLC motor RF shielding was evaluated using homogeneous phantom with real-time imaging and quantified by signal-to-noise ratio (SNR). Field of 200 x 200mm was measured for calculating leaf width. Output of 100 x 100mm fields at center and off-axis positions were used for determining leaf transmission and profiles for field penumbra. Output was measured with PTW TW31021 ion chamber. While profiles were measured with microDiamond detector and BEAMSCAN® MR water phantom. A 190 x 220 mm field composed of two strip segments was exposed on EBT3 film to assess tongue-and-groove effect, and the minimal gap fields were also exposed on EBT3 film at center and off-axis position to assess leakage between leaf tips in the closed position. Picket fence test with EPID was performed for analyzing leaf positional reproducibility.

RESULTS

Leaf motion leads to small fluctuation for transverse plane's SNR with thorax and abdomen bFFE images (Fig.1). Leaf width is 7.1mm. The leaf transmission is 0.22% and reduced to 0.17% when diaphragm blocks the field with minimum MLC gap (Fig.2). Leaf penumbra ranges from 5.75 to 6.98 mm in the GT direction and from 6.52 to 7.7 in the AB direction (Fig.3). The tongue-and-groove effect causes an underdose up to 27% (Fig.4). Leaf tip leakage improved from 60% at field center to 3% at 10cm off-axis (Fig.5). Average leaf positioning error is -0.01mm for all leaves based on picket fence test in two months (Fig.6).

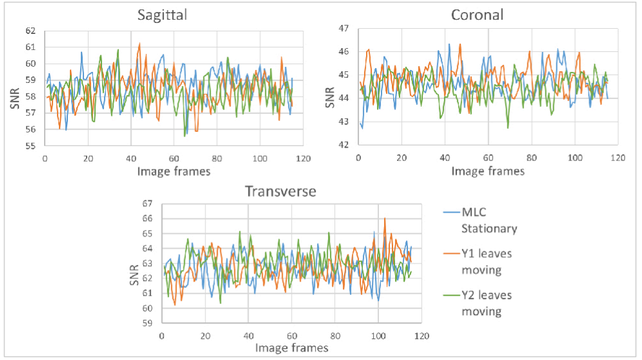

Figure 1. The SNR data for thorax bFFE MR images in sagittal, coronal and transverse planes with MLC stationary, Y1 leaves moving and Y2 leaves moving

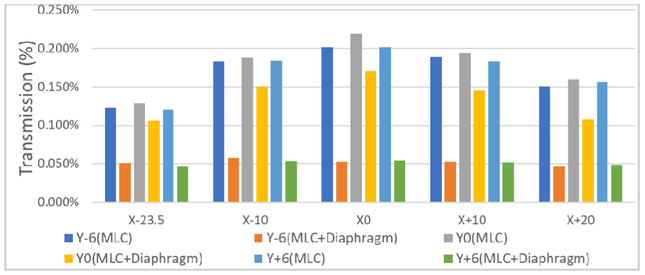

Figure 2. Transmission for MLC and MLC plus Diaphragm

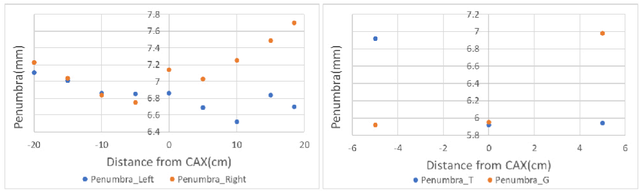

Figure 3. Penumbra for MLC side (left) and MLC tip (Right)

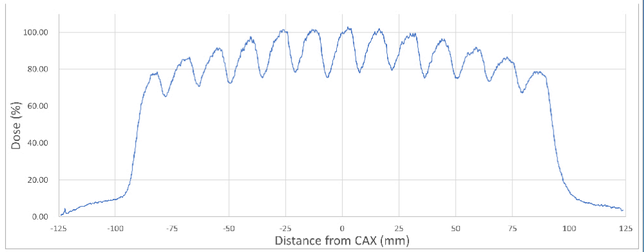

Figure 4. Dose profiles for tongue-and-groove effect

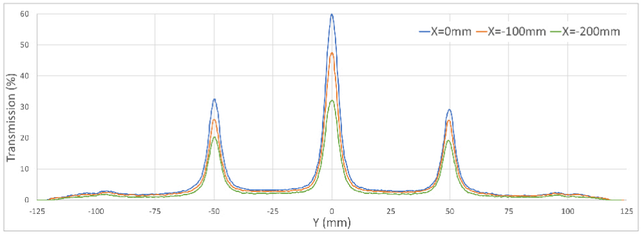

Figure 5. The inline profiles at X = 0, -100 and -200 mm for minimum MLC gap at Y = 0, ±50 and ±100 mm.

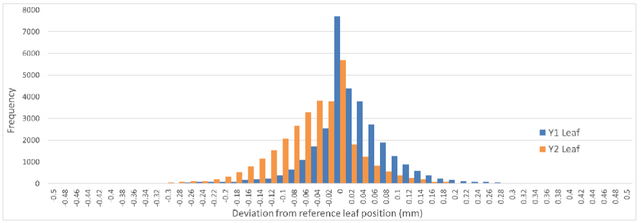

Figure 6. MLC leaf positioning reproducibility

CONCLUSIONS

The Agility MLC has a good RF noise shielding design, low radiation leakage, comparable tongue-and-groove effect and high positioning reproducibility on the Elekta Unity MR linac

ACKNOWLEDGEMENTS

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REFERENCES

1. Boyer A BP, Galvin J, et al. Basic applications of multileaf collimators. Report of Task Group No.50 Radiation Therapy Committee. AAPM Report No. 72. Medical Physics Publishing. Medical Physics; . 2001.
2. Thompson CM, Weston SJ, Cosgrove VC, Thwaites DI. A dosimetric characterization of a novel linear accelerator collimator. Med Phys. 2014;41(3).
3. Cai B, Li H, Yang DS, et al. Performance of a multi leaf collimator system for MR-guided radiation therapy. Med Phys. 2017;44(12):6504-6514.
4. Budgell G, Brown K, Cashmore J, et al. IPEM topical report 1: guidance on implementing flattening filter free (FFF) radiotherapy. Phys Med Biol. 2016;61(23).
5. Association NEM. NEMA Standards Publication MS 1-2008 (R2014): Determination of Signal-to-Noise Ratio (SNR) in Diagnostic Magnetic Resonance Imaging. 2014.

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