Use of DLG Tuning to Achieve Beam Matching for TrueBeam Linacs

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INTRODUCTION

The Eclipse treatment planning system uses parameters of MLC, dose transmission and dosimetric leaf gap (DLG), to model the rounded edge of leaves in Varian linacs due to radiation dose distribution. These parameters are instrumental in comparison of dose distribution from plan delivery against initial plan created in Eclipse. Specifically, changes to DLG parameters affects plans with highly modulated fields. Each energy is assigned an individual set of values during commissioning.

AIM

The clinical motivation for performing this study is to determine if machine equivalency between two TrueBeam linacs (TB1 and TB2) can be achieved based on matching DLG parameters. If both linacs achieve ideal machine equivalency based on changes made to the DLG parameters, then patients can be transferred from one machine to the other machine without having to re-calculate or re-optimize the plans. This would ensure efficient patient management and enhance clinical workflow.

METHOD

- 8 patient VMAT plans for various anatomical sites were selected and re-calculated for all available photon energies These plans were delivered on MapCheck2 device via TB1 and TB2. Gamma pass rates were analyzed using relative dose with 3% and 2mm parameters.
- Two MLC dynamic field plans (dynamic chair & AIDA) were re-calculated for all available photon energies and delivered using MapCheck2 device via TB1 and TB2. Plans for TB2 were delivered on TB1 by using machine override feature. The measurement files collected from plan delivery on both machines were compared. In order to do so, the measurement files from one machine were converted from .txt format into .dcm format and data smoothed using Python script.

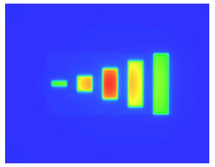

Figure 1: AIDA

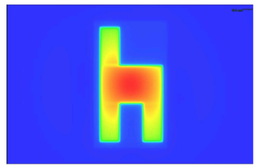

Figure 2: Dynamic chair (DC)

RESULTS

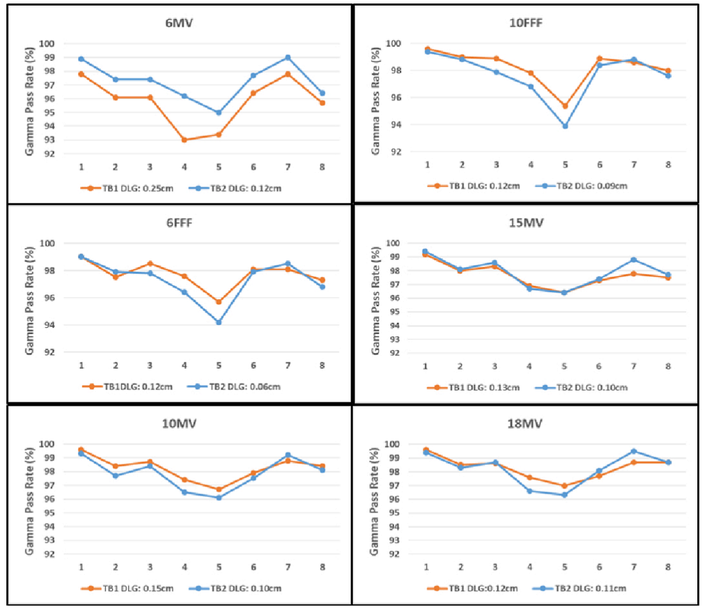

Figure 3: Each graph plots the gamma pass rates of 8 patient VMAT plans that were re-calculated and delivered on TB1 and TB2. The respective DLG values for each energy is provided.

Plan	Energy	Relative Dose (%) TB1 vs TB2	
		Before Shift	After Shift
AIDA	6FFF	82	94.8
AIDA	6X	82.5	96.5
AIDA	10FFF	84.4	97.9
AIDA	10X	86.2	97.4
AIDA	15X	87	98.2
AIDA	18X	89.3	97.4
DC	6FFF	94.4	97.3
DC	6X	92.5	98.2
DC	10FFF	95.8	100
DC	10X	95.7	100
DC	15X	95	100
DC	18X	96.4	100

Figure 4: Gamma pass rates for AIDA and DC plans delivered on TB1 and TB2 before and after shift was applied to correct for any setup misalignment.

- Patient VMAT plans were analyzed with much stringent parameters (3% & 1mm) since plans displayed high pass rates in the range of 98% to 100% with standard threshold (3% & 2mm).
- Gamma pass rates were consistent for energies with DLG values being close to each other. However, the results for 6MV displayed clear distinction between both linacs. Plans delivered on TB2 consistently yielded better pass rates than that on TB1.
- MLC dynamic field plans (DC and AIDA) used during commissioning were re-delivered on both machines. TB2 which was commissioned less than a year ago was set as the reference for DLG. Plans for TB2 were delivered on TB1 without re-calculation and re-optimization to determine if DLG values of TB1 can be matched to DLG values of TB2.
- Comparison of measurement files of AIDA and DC plans from both linacs cannot be performed with application of shift correction in Sun Nuclear software. The conversion of .txt file format into .dcm format with data smoothing using an in-house Python script enabled comparison in Sun Nuclear software with shift to correct for setup misalignment.

CONCLUSIONS

- Gamma pass rates for patient VMAT plans with 6MV displayed major discrepancy between both machines compared to other photon energies. This discrepancy was attributed to DLG values set for 6MV which were 0.25cm (TB1) and 0.12cm (TB2). The results indicate that minor difference in DLG values yields significant difference in gamma pass rates.
- Comparison of AIDA and DC across both linacs show close agreement after alignment shifts have been corrected. This indicates that dose distribution from both linacs based on DLG values of TB2 are almost similar.
- The primary energy of interest is 6MV due to its DLG values being different between both linacs. Also, this is the most commonly used energy for treatments.
- The second phase of this study will involve changing the DLG values of TB1 in Eclipse to match that of TB2. Patient VMAT plans from the same cohort will be re-calculated and delivered on TB1. If the gamma pass rates are comparable to TB2 results, then patients can be transferred between machines for daily treatment.

CONTACT INFORMATION

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