Comparison of Patient-Specific Quality Assurance Results from a Delivery-log based Calculation System and Dose Reconstruction in Patient Anatomy based on Phantom Measurements

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INTRODUCTION

Patient-specific quality assurance (PSQA) is essential in the overall safety and quality check of the delivery process. Measurement-based PSQA is generally regarded as the most accurate method of assessing delivery accuracy[1]. However, it can be time consuming and labour intensive. Delivery-log based calculation is relative quick. But it has no information on the dosimetric and mechanical calibration accuracy, as well as setup uncertainties.

The primary goal of this project is to determine if a correlation exists between the PSQA dosimetric results obtained using delivery-log based calculations and phantom-based measurements with dose reconstruction in patient anatomy.

METHOD

Plans
- 17 6FFF SBRT VMAT clinically approved plans delivered on 2 beam-matched Varian TrueBeam STx linacs
- Plans generated using Eclipse AXB (v15.6)
- Disease sites include Lung, GU and GI
- Dose to water

Measurements
- Measurements collected using a "3D" biplanar array detector (Scandidos Delta4 phantom+)
- 3D dose in patient reconstructed using Delta4DVH Anatomy TMM algorithm
- The beam data used in the TMM algorithm had been characterized against the in-house measured data

Delivery Log calculations
- The pre-delivery planned dose distribution was initially verified by using Varian Mobius3D based on collapsed cone convolution algorithm
- Delivery log calculations and analyses were then performed using Varian MobiusFX
- The beam model in Mobius3D and MobiusFX was commissioned by the vendor based on a set of reference beam data

Analysis Methods
- Gamma comparison between Delta4DVH and MobiusFX on phantom plans, using the dose difference/distance to agreement of 3%/2mm and 3%/1mm criteria, with 20% low dose threshold
- Mean dose to target comparison of Eclipse, Delta4DVH, and MobiusFX

RESULTS

Gamma Passing Rate (GPR) Comparison

GPR comparison between Delta4 and MobiusFX in phantom did not show any significant correlation using any dose difference/distance-to-agreement criteria. To eliminate the set up uncertainties, Delta4 GPRs were also "optimized" by shifting the phantom positions until the highest GPR is obtained. Figure 1 displays the GPR comparison using the 3%/1mm and 20% low dose threshold criteria.

Mean Dose to Target Comparison

For both MobiusFX and Delta4DVH, the modelled beam profiles and PDDs for a set of field sizes ranging from 4x4 cm^2 to 20x20 cm^2 were found to be within 2% of their respective reference data. For each plan, the mean PTV dose values in patient calculated by MobiusFX, Delta4DVH and Eclipse were compared. Figure 2 displays the relationship between MobiusFX mean PTV dose/Eclipse mean PTV dose and Delta4DVH mean PTV dose/Eclipse mean PTV dose.

The ratio of mean PTV dose in MobiusFX/Delta4DVH ranged from 0.93 to 1.05, with a mean of 1.006. 15 of 17 plans had both MobiusFX and Delta4DVH calculated PTV mean dose values within 3% of Eclipse values. The remaining two plans had percent deviation of 3.2% (MobiusFX vs Eclipse) and 4.8% (Delta4DVH vs Eclipse). A negative correlation was also observed between the percent mean PTV dose deviation in MobiusFX/Eclipse and Delta4DVH/Eclipse with a Pearson correlation coefficient of -0.83.
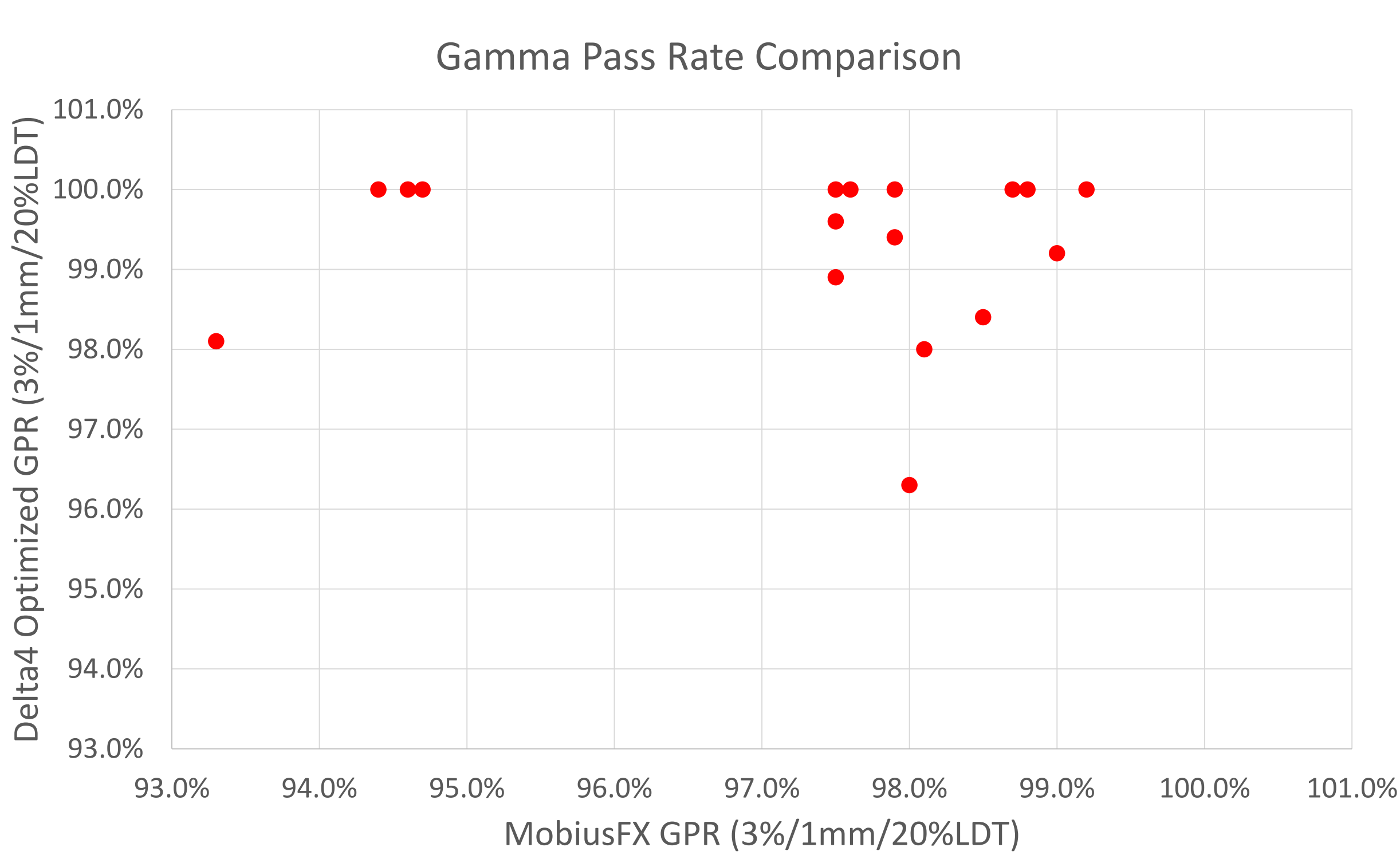

Figure 1: Gamma pass rate comparison between Delta4 and MobiusFX using 3%/1mm and 20% low dose threshold. The Delta4 values were "optimized" by shifting the phantom positions until the highest GPR was obtained.
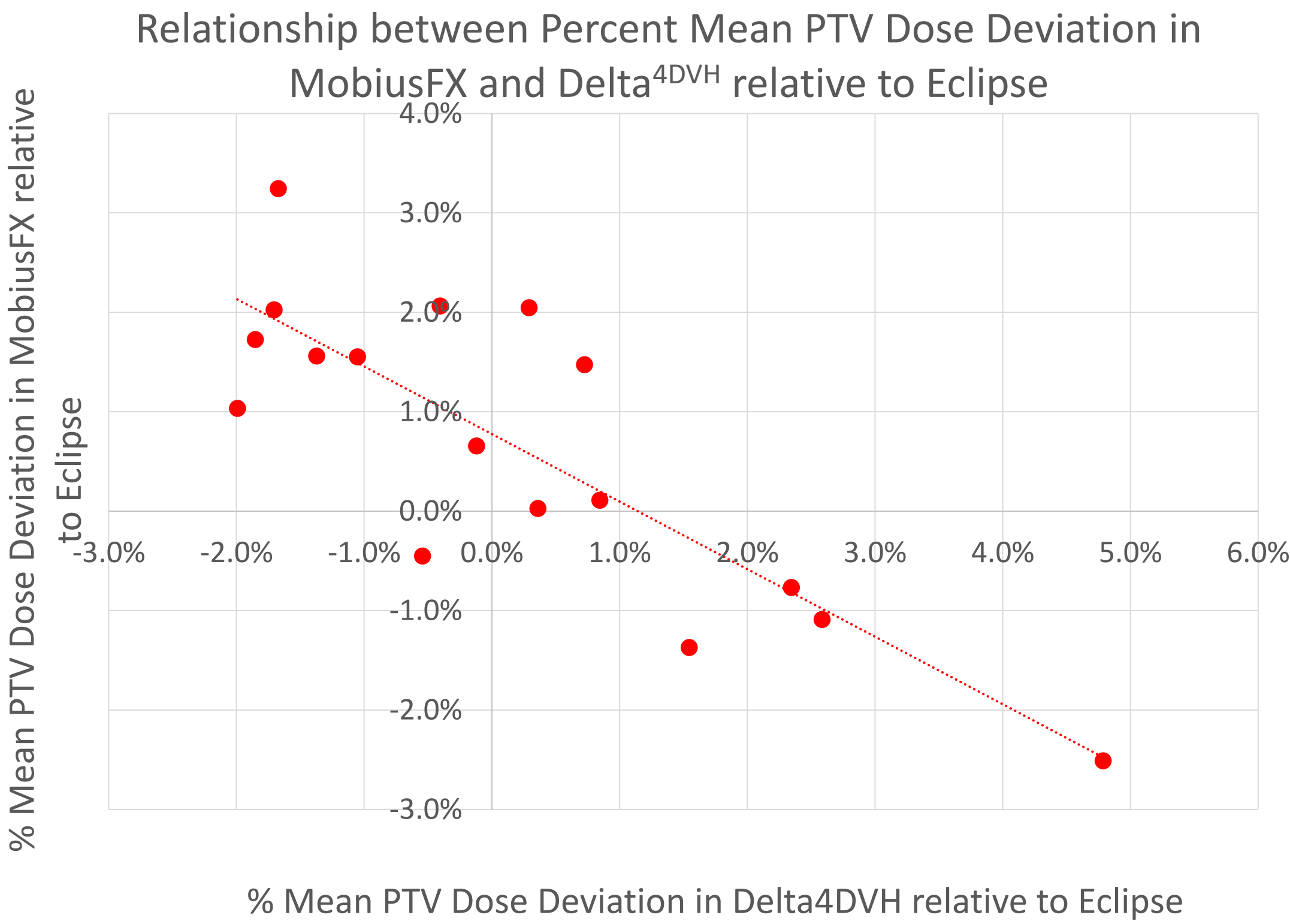

Figure 2: Relationship between the precent mean PTV dose in MobiusFX and Delta4DVH relative to Eclipse. A negative correlation is observed.

CONCLUSIONS

In 17 SBRT clinical plans, no significant correlation was found between the Delta4 in-phantom measured GPRs and the corresponding Mobius3D calculated ones.

The mean PTV dose in patient anatomy calculated using MobiusFX, Delta4DVH and Eclipse were compared in 17 SBRT clinical plans. In 88% of the plans, both MobiusFX and Delta4DVH calculated PTV mean dose values were within 3% of Eclipse planned dose. The negative correlation observed between the percent mean PTV dose deviation in MobiusFX/Eclipse and Delta4DVH/Eclipse is unexpected, and may be due to the difference in beam models between MobiusFX and Delta4DVH. Investigation into this negative correlation is ongoing.

REFERENCES

1. Miften M, Olch A, Mihailidis D, et al. Tolerance limits and methodologies for IMRT measurement-based verification QA: Recommendations of AAPM Task Group No. 218. *Med Phys*. 2018;45(4):e53-83. doi: 10.1002/mp.12810.

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