The Commissioning and Validation of GPUMCD for an Elekta VersaHD Linear Accelerator in the Elekta One Treatment Planning System

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INTRODUCTION

GPUMCD, a GPU-accelerated Monte Carlo dose calculation algorithm, was recently released for clinical implementation in the Elekta One Treatment Planning System (v6.2.3, EOP) for c-arm Elekta linear accelerators (linac). The purpose of this work was to validate and commission this algorithm for clinical use.

METHODS

Beam models were generated for all photon energies of a VersaHD linac (6X, 6FFF, 10X, 10FFF, 18X) from open field water tank data measurements acquired at an SSD of 90cm. A validated version of the Monaco Commissioning Utility was used to compare the generated percent depth dose (PDD) profiles and lateral profiles against measurements. An adapted MPPG 5.b. methodology was used to verify the clinical feasibility of using this algorithm in both homogeneous and heterogeneous media using the ArcCheck, solid water, the CIRS ZEUS phantom, and the IROC HN, lung, and spine phantoms.

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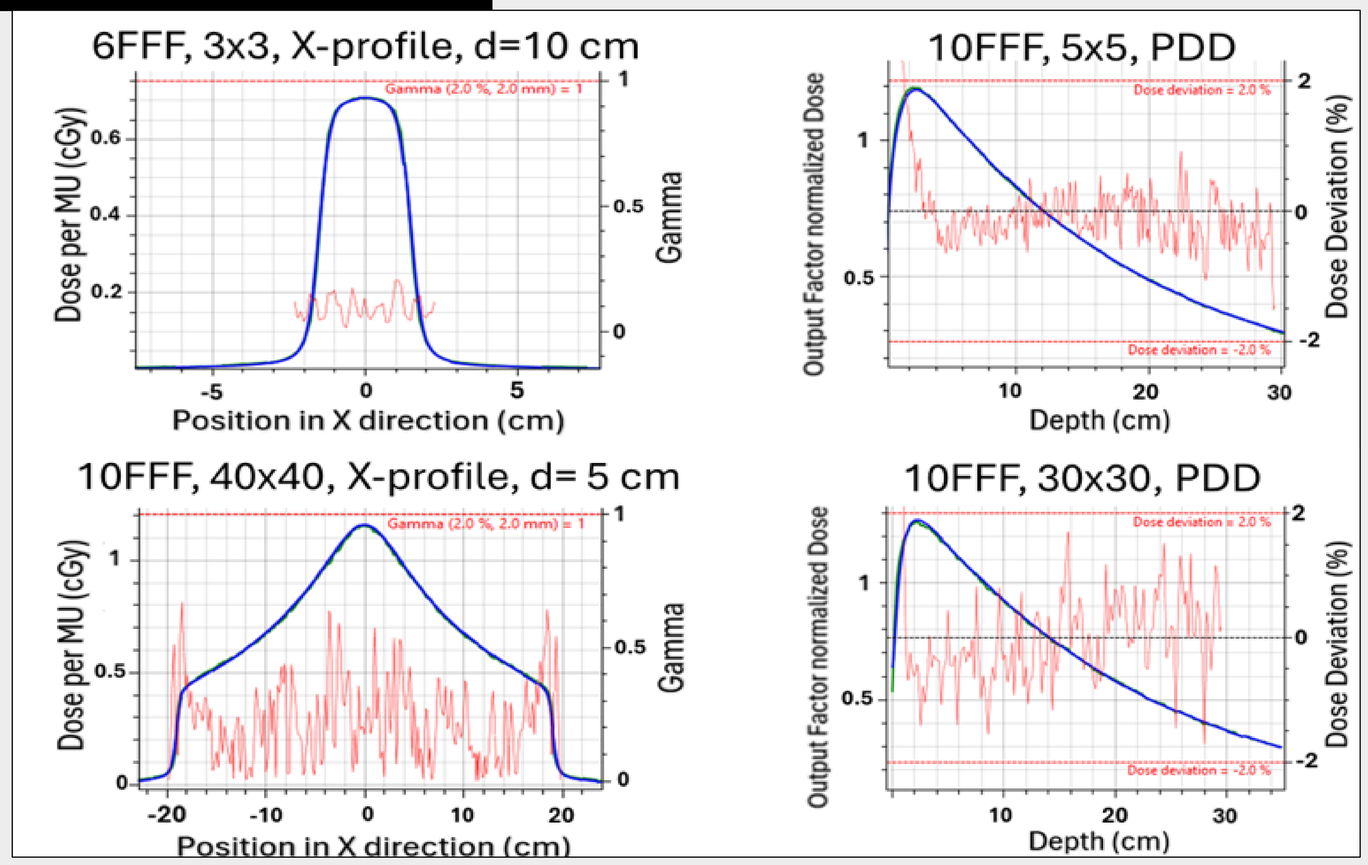
RESULTS



Excellent agreement was noted for all profile comparisons. A subset of PDD and profile comparisons between GPUMCD (green) and measured data (blue) for flattening filter free beams at small and large field sizes is presented above.

An average agreement of 98.4±2.3% across all energies was observed using a local 2% dose difference (DD) for fields greater than 5x5 cm² in the high dose region (>80% of max dose) between measured and calculated PDDs and beam profiles. For all fields, an agreement of 99.9±0.5% was found using a 2% DD and 2mm distance-to-agreement (DTA) gamma criteria with a 5% dose threshold.

Field Size	XVMC	GPUMCD	Time Difference	% reduction
2x2	83.9	1.3	82.6	98
10x10	355.7	25.1	330.5	93
40x40	2568.6	358.1	2210.6	86
		Average	874.6	92.3

Table 1: Time difference in seconds and percent reduction between XVMC and GPUMCD for field sizes (cm) (0.2 cm dose grid, 0.5% uncertainty)

Energy	Percent Dose Difference (%)	QA Gamma (3%/2 mm)
6 MV	0.94	98.0
6 FFF	0.08	98.5
10 MV	0.87	96.7
10 FFF	-0.22	99.5

Table 2: End to End percent point dose difference and patient specific VMAT QA Gamma percent passing rates

A ~92% calculation time reduction was observed when using GPUMCD compared to Elekta's X-ray voxel Monte Carlo (XVMC), for open fields, using the same hardware (Table 1). Point dose and heterogeneity measurements agreed within 3%. End-to-end testing data for each energy is in Table 2.

DISCUSSION

GPUMCD demonstrated excellent dosimetric accuracy across all tested photon energies and field sizes, meeting all tolerance limits for the adapted MPPG 5.b testing. All plan measurements passed the recommended gamma criteria from TG-218. IROC external validation testing passed for HN, lung, and spine cases.

The most clinically impactful finding is the ~92% average reduction in calculation time compared to XVMC on the same hardware without sacrificing accuracy. This makes GPUMCD a compelling upgrade for clinical departments currently using XVMC.

CONCLUSIONS

The GPUMCD algorithm in the Elekta One Treatment Planning System was successfully commissioned for clinical use with the VersaHD linac for all photon energies.

REFERENCES

1. Elekta One / GPUMCD Documentation
2. MPPG 5.b Report (Smilowitz et al.)
3. TG-218 (Miften et al.)
4. Rusu SD, Smith BR, Hutchinson GH, Jen JH, Hyer DE. Commissioning and validation of the Elekta One GPUMCD algorithm for an Elekta VersaHD linear accelerator. J Appl Clin Med Phys. 2026; 27:e70540. https://doi.org/10.1002/acm2.70540