

# A Dosimetric Evaluation of Machine Dependent Lattice Radiotherapy Using High-definition MLCs and 6XFFF Beams

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## PURPOSE:

- To evaluate the dosimetric benefits of lattice radiotherapy using high-definition MLCs of the Edge machine versus the Millennium MLCs of the TrueBeam.

## BACKGROUND:

### Lattice Therapy

- Historically, bulky tumors have been a challenge to successfully treat due to factors such as size, location, and a hypoxic environment. Consequently, a radiotherapy approach known as spatially fractionated radiation therapy (SFRT) was designed creating areas of high and low dose (inhomogeneous dose distribution), referred to as peaks and valleys.
- With advancements in 3D treatment planning and delivery systems, a form of SFRT known as lattice radiotherapy (LRT) was developed for deep seated bulky tumors.

### Lattice Therapy at University of Maryland Medical Center (UMMC)

- LRT was developed at the University of Maryland Medical Center in 2019. LRT plans involve creating spheres or vertices 1 cm in diameter (note: some facilities create the vertice volume 2cm in diameter) and 2-3 cm apart inside the gross tumor volume (GTV).
- Prescription Dose:** Typically 12-15 Gy delivered in a single fraction to the spherical volumes, while achieving a fall-off of 3 Gy to the periphery of the GTV with VMAT.
- Modality:** Varian TrueBeam with 6X beam and Millennium multi-leaf collimator (MLC).
- Treatment Planning Workflow (Dosimetry):**

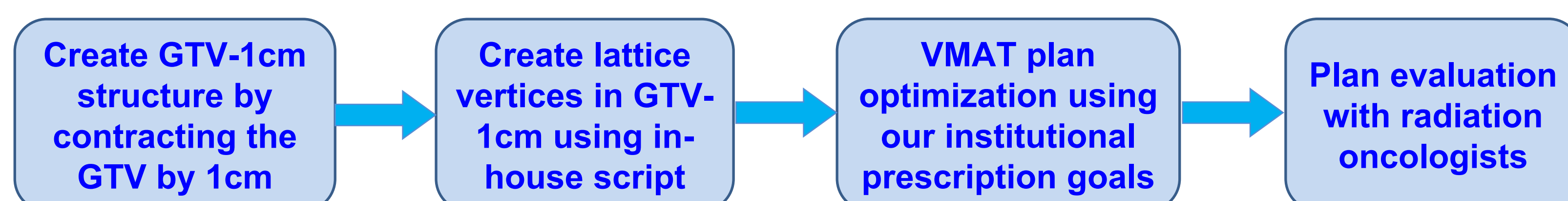


Figure 1. Clinical workflow of lattice treatment planning at the University of Maryland Medical Center



Figure 2. Lattice treatment plan delivering 12 Gy in a single fraction using VMAT delivery technique on a Varian TrueBeam, 6X LINAC with Millennium multi-leaf collimator (MLC).

- This study performed a dosimetric comparison of LRT plans using Varian Edge and TrueBeam machines.

Machine / MLC	Center MLC Size (cm)	Periphery MLC Size (cm)
Edge / High Definition (HD)	0.25	0.5
TrueBeam / Millennium	0.5	1.0



Figure 3. MLCs of Edge with 0.25 and 0.5cm leaves (Left) and TrueBeam with 0.5 and 1.0cm leaves (Right).

## METHODS:

### Patient Demographics:

In this retrospective study, 6 patients (3 lung, 2 pelvis, and 1 hip) previously treated using the Varian TrueBeam with Millennium MLC.

Treatment Site	V <sub>GTV</sub> (cc)	# Vertices	# ARCS	V <sub>Vertices</sub> (cc)	V <sub>Vertices</sub> /V <sub>GTV</sub>
Right Lung	319.3	10	6	4.1	1.3%
Right Lung	548.6	12	5	5.0	0.9%
Left Lung	757.8	14	5	6.3	0.8%
Left Hip	798.2	12	5	5.1	0.6%
Pelvis	1380.1	26	6	11.3	0.8%
Pelvis	1626.6	25	6	8.3	0.5%

### Treatment planning:

New lattice treatment plans were created utilizing Varian Edge HD-MLC using the same vertices.

### Plans Comparison:

Dose-volume histograms (DVH) parameters were compared with the clinical plans.

## RESULTS:

The Edge plan shows a smaller 50% isodose volume (purple) and tighter high dose fall-off (the 70% isodose volume in blue), resulting in higher dose conformity compared with the TrueBeam plan. The isodose distribution of the TrueBeam and Edge plans is shown in figure 4. Similar coverage is obtained to the Lattice volume with a lower GTV average dose, representing a sharper dose fall-off with the Edge plan as shown in Figure 5.

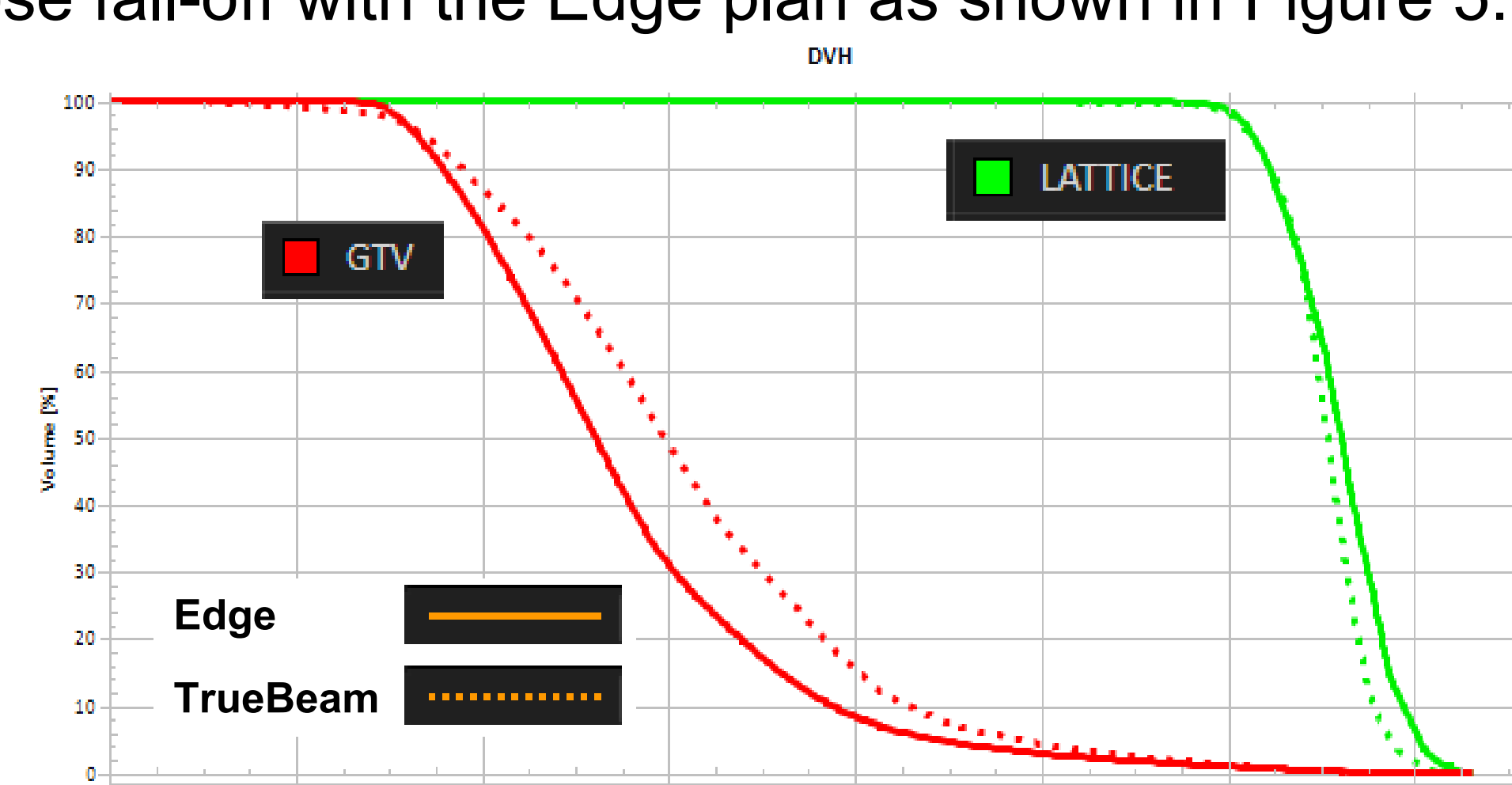


Figure 5. DVH of the Lattice (green) and GTV (red) volumes.

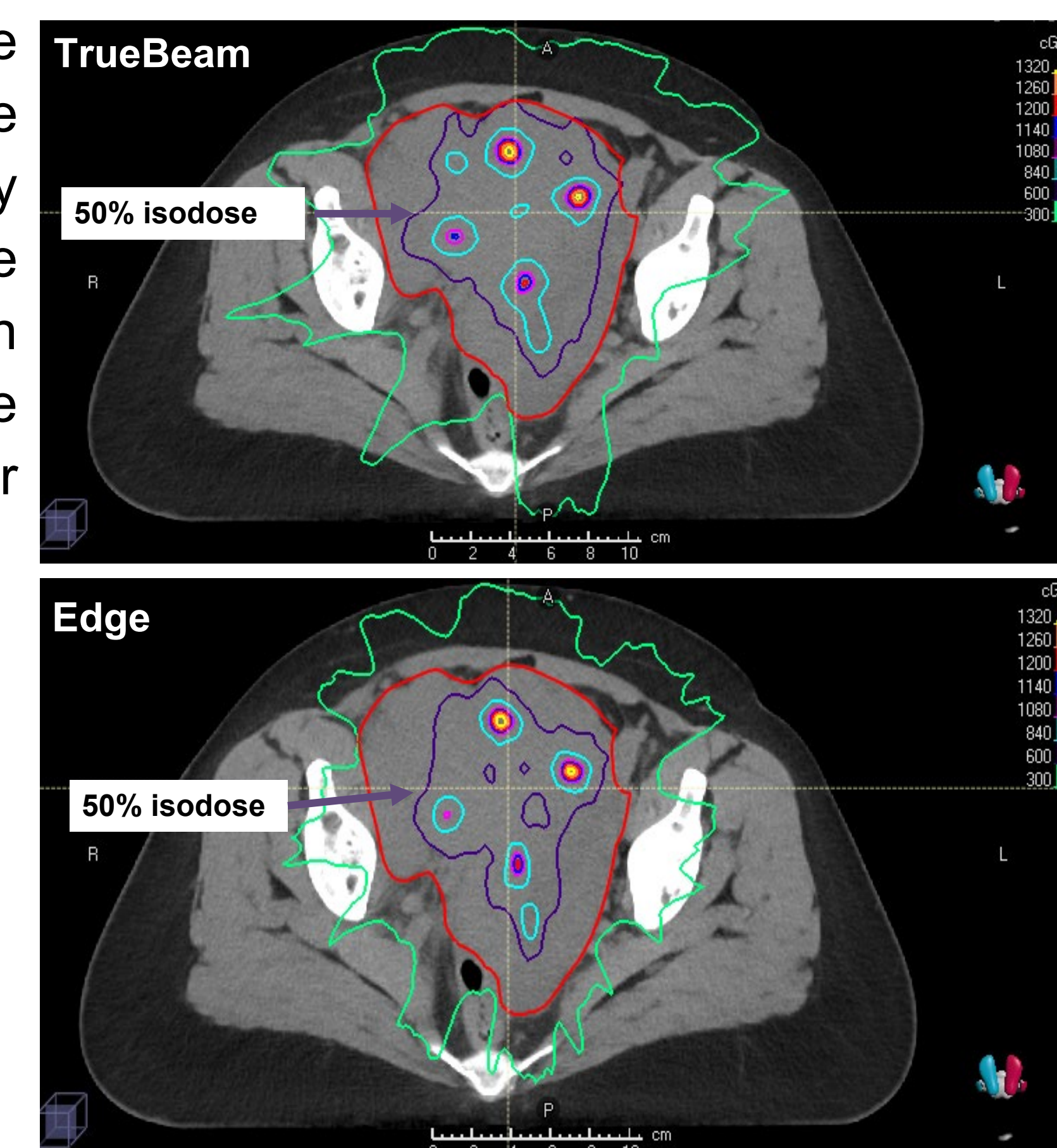


Figure 4. Lattice dose distributions of TrueBeam plan (Top) and Edge plan (Bottom).

The graphs show a higher volume of 12Gy and average dose to the vertices and a lower volume of 6Gy and average dose to the GTV with the Edge plans, representing a higher dose fall-off as compared with the TrueBeam plans.

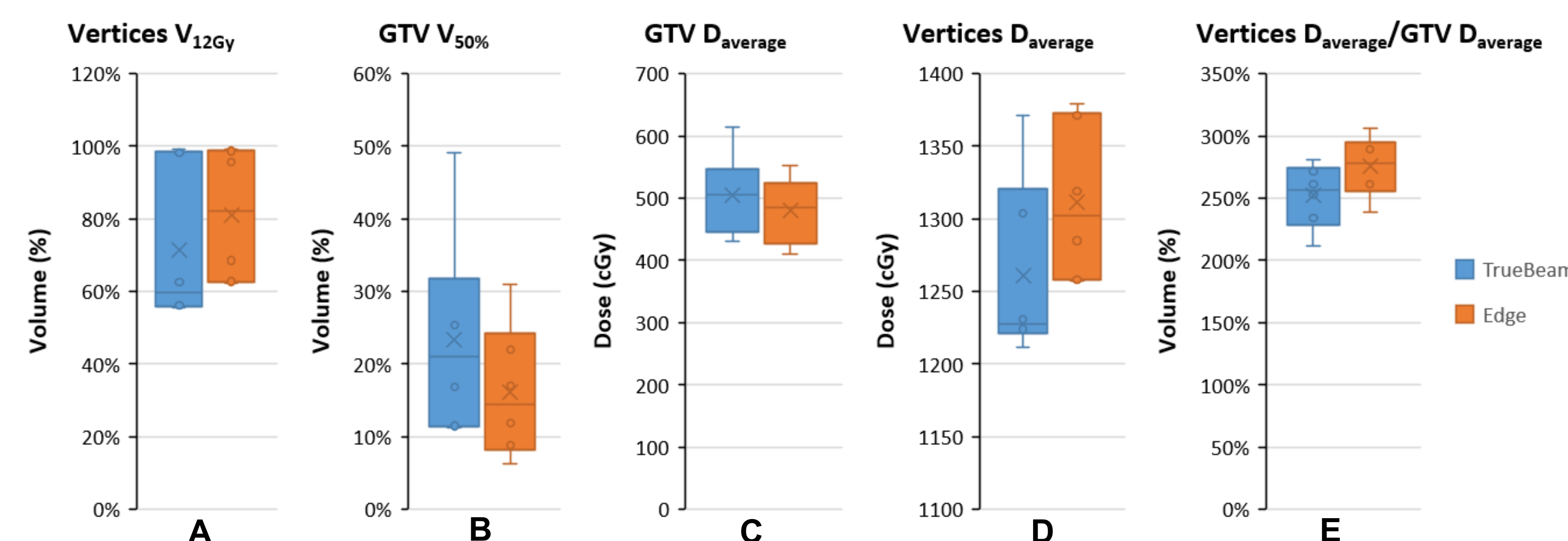


Figure 6. Comparison between TrueBeam using conventional MLCs and Edge plan using HD-MLCs for A) Volume of vertices receiving 12 Gy, B) Volume of GTV receiving 50% of prescription dose (6 Gy), C) Average dose to the GTV, D) Average dose to the Vertices, E) Ratio of average dose to the vertices and GTV showing higher dose fall-off of Edge plans.

## CONCLUSION:

- This study shows that a better plan quality, in terms of higher dose conformity and increased target volume coverage, can be achieved using HD-MLCs for patients receiving LRT with VMAT.