Enhancing Delivery Efficiency on the Elekta Unity MR-Linac

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2026 JOINT AAPM | COMP MEETING
JULY 19–22 | VANCOUVER, BC

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Purpose

MRI-guided online adaptive radiotherapy offers significant clinical advantages through superior soft-tissue visualization and adaptation to daily anatomy changes. However, these benefits come with longer treatment sessions, with recent analyses showing a median Adapt-to-Shape (ATS) workflow time of 34 minutes, of which beam delivery accounts for approximately 40%. Improving delivery efficiency is therefore essential for patient comfort and maximizing throughput on the Elekta Unity system.

This study retrospectively reviewed historical Elekta Unity IMRT plans from a single institution, focusing on delivery efficiency, plan complexity, and optimization parameter settings. In addition, dosimetric experiments were performed to systematically evaluate the impact of selected IMRT parameters on treatment delivery time. Based on these analyses, we propose practical recommendations for parameter selection to improve delivery efficiency on Unity.

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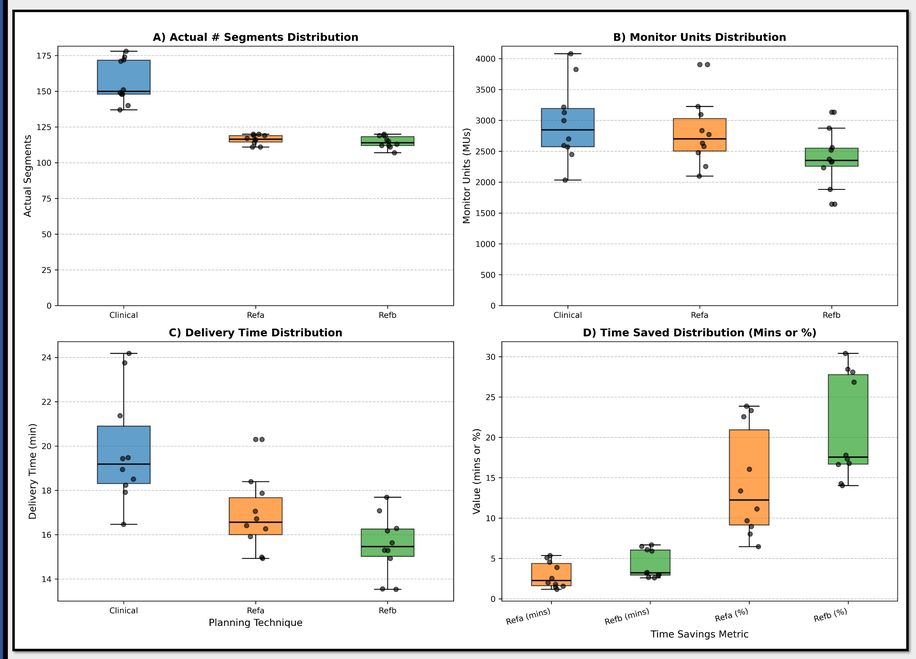

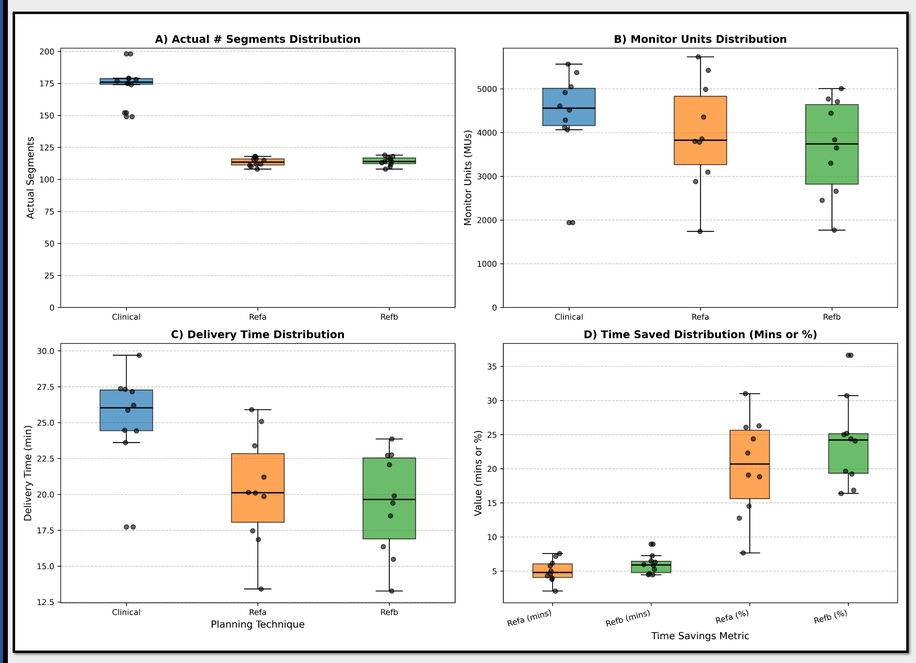

Figure 1: Comparison of clinical and experimental plans (Refa and Refb) for (top) prostate cases and (bottom) Liver cases

CONCLUSIONS

Systematic adjustment of Unity IMRT planning parameters - specifically limiting total segment number, reasonable minimum segment width, and fluence smoothing - can markedly improve delivery efficiency while maintaining clinically acceptable dosimetric quality. These findings provide practical, evidence-based guidelines for parameter selection in Unity planning, supporting reduced treatment times, improved patient throughput, and broader clinical feasibility of MR-guided online adaptive radiotherapy.

METHODS AND MATERIALS

Patient cohort

- 10 prostate SIB patients (45 Gy/40 Gy in 5 fractions)
- 10 liver SBRT patients (42–54 Gy in 3–5 fractions)

Planning strategies

- Clinical: Original clinical treatment plan
- Refa: Segment-limited plan (≤120 segments)
- Refb: MU-optimized plan with:Larger minimum segment width (0.7–1.0cm) Increased fluence smoothing (medium/high)

Plan evaluation

Delivery efficiency metrics; Total segments&MUs; Estimated delivery time: Plan quality assessment: Target DVH metrics, OAR DVH metrics

Online adaptive evaluation

- Representative prostate and liver cases selected
- Clinical, Refa, and Refb plans adapted to daily anatomy using the Unity ATS workflow
- Compared:
  - Online optimization time
  - Adaptive plan quality
  - Clinical goal achievement

RESULTS

Prostate cohort

- Segment count reduced from 137–178 to <120
- MUs reduced from 3022 to 2899 (Refa) and 2497 (Refb)
- Average delivery time reduced by 2.6 min (Refa) and 4.0 min (Refb)
- Maximum time savings of 5.4 min (Refa) and 6.7 min (Refb)

Liver cohort

- Segment count reduced from 149–198 to <120
- Monitor units reduced from 4233 to 3528 (Refa) and 3309 (Refb)
- Average delivery time reduced from 24.4 min to 18.9 min (Refa) and 18.3 min (Refb)
- Maximum time savings of 7.6 min (Refa) and 8.9 min (Refb)

Plan quality and clinical feasibility

- PTV coverage and OAR sparing maintained across all strategies
- No statistically significant dosimetric differences ($P > 0.05$)
- All adaptive plans completed within 5–13 minutes, consistent with standard online adaptive workflows
- Similar delivery time reductions observed for both offline and adaptive plans