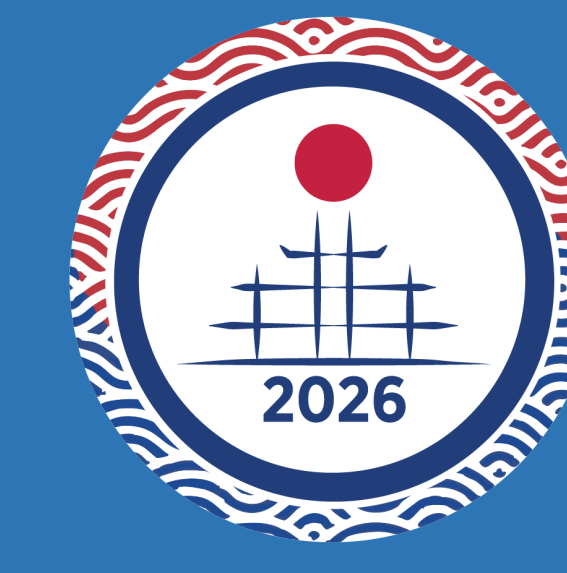




P2.267: Clinical Implementation of Automated IMRT/VMAT Planning for Lung Cancer Radiation Therapy Using the ECHO System



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BACKGROUND

- Lung cancer radiotherapy planning is inherently complex due to:
 - Wide variation in tumor size and location
 - Multiple critical OARs in the thoracic cavity (cord, esophagus, heart, lungs)
 - Various fractionation schedules ranging from conventional (1.8–2.0 Gy/fx) to SBRT (8–34 Gy/fx)
- This complexity often leads to significant planning time and inconsistency in manually optimized plans.

WHAT IS ECHO?

- ECHO (Expedited Constrained Hierarchical Optimization) is an in-house automated treatment planning system that:
 - Accepts **contours + clinical dose/volume criteria** as inputs
 - Generates optimized **fluence maps** (IMRT) or **leaf trajectories** (VMAT)
 - Runs **independently of the commercial TPS optimizer**
 - Returns results for Eclipse's (FDA-approved) final dose calculation
- Two-step optimization:
 - Step 1 — Enforces **hard constraints** for OARs and PTV
 - Step 2 — **Minimizes OAR doses** beyond hard constraint thresholds
- ECHO has generated **over 10,000 clinical plans** since 2017 (prostate, spine, metastases) — expanded to **lung in May 2021**

METHOD

- IMRT**: Conventional to moderately hypofractionated schedules
- VMAT**: 3–4 fraction lung SBRT (peripheral tumors only)
- Training**: 5–7 patients per fractionation schedule
- Validation**: 20–25 additional patients per schedule
- Pre-specified beam templates** based on isocenter location:
 - IMRT: 7–8 equispaced static beams (Left / Medial / Right)
 - VMAT: 2 half-arcs (Left / Right)

	Rx Scheme	Fx Dose (Gy)	# Fx	Total Dose (Gy)	Training	Validation
ECHO IMRT	Conventional	1.8-2.0	27-35	50.4-70	7	25
	Hypo-fractionated	2.75	20	55	5	25
		4	15	60	7	21
	Palliative	3	15	45	5	20
ECHO VMAT	3-fx SBRT	9-18	3	27-54	5	20
	4-fx SBRT	12-12.5	4	48-50	5	25

RESULTS

Clinical cohort

- From May 2021 – December 2025: total **524 patients** treated

	ECHO IMRT	ECHO VMAT
Patients treated	431	93
Clinical start	May 2021	April 2023
Average PTV volume	390 cm ³	17 cm ³
PTV range	12–3,441 cm ³	2.5–56 cm ³
Average fields/arcs	7 fields	2 arcs
Retreatment cases	Yes (up to 36%)	None

Plan Quality

- ECHO IMRT vs. Manual:
 - Superior and more consistent** target coverage
 - Significantly **lower D_{max}** and **higher D_{min}** within PTV → improved dose homogeneity
 - Slight improvements in esophagus and heart D_{mean}
- ECHO VMAT vs. Manual:
 - Equivalent** target coverage (PTV/CTV V_{100%} nearly identical in all ECHO plans)
 - Significantly reduced variability** between patients → critical advantage for SBRT
 - Intentional **central hotspot** → promotes steeper dose fall-off
 - OAR differences minimal and **not clinically significant**

ECHO calculation time and robustness

- Average calculation time (Figure 1)
 - IMRT: 33 minutes** (range: 7–126 min); **VMAT: 56 minutes** (range: 21–178 min)
 - Planners can work on other clinical tasks** while the optimization runs in the background
- First run success rate (Figure 2)
 - Most ECHO plans (**IMRT: 68%, VMAT: 85%**) were **clinically acceptable on the first run**
 - Most re-runs were due to clinical changes**, which also occur in manual planning but require **far more time to address** than ECHO's quick resubmission

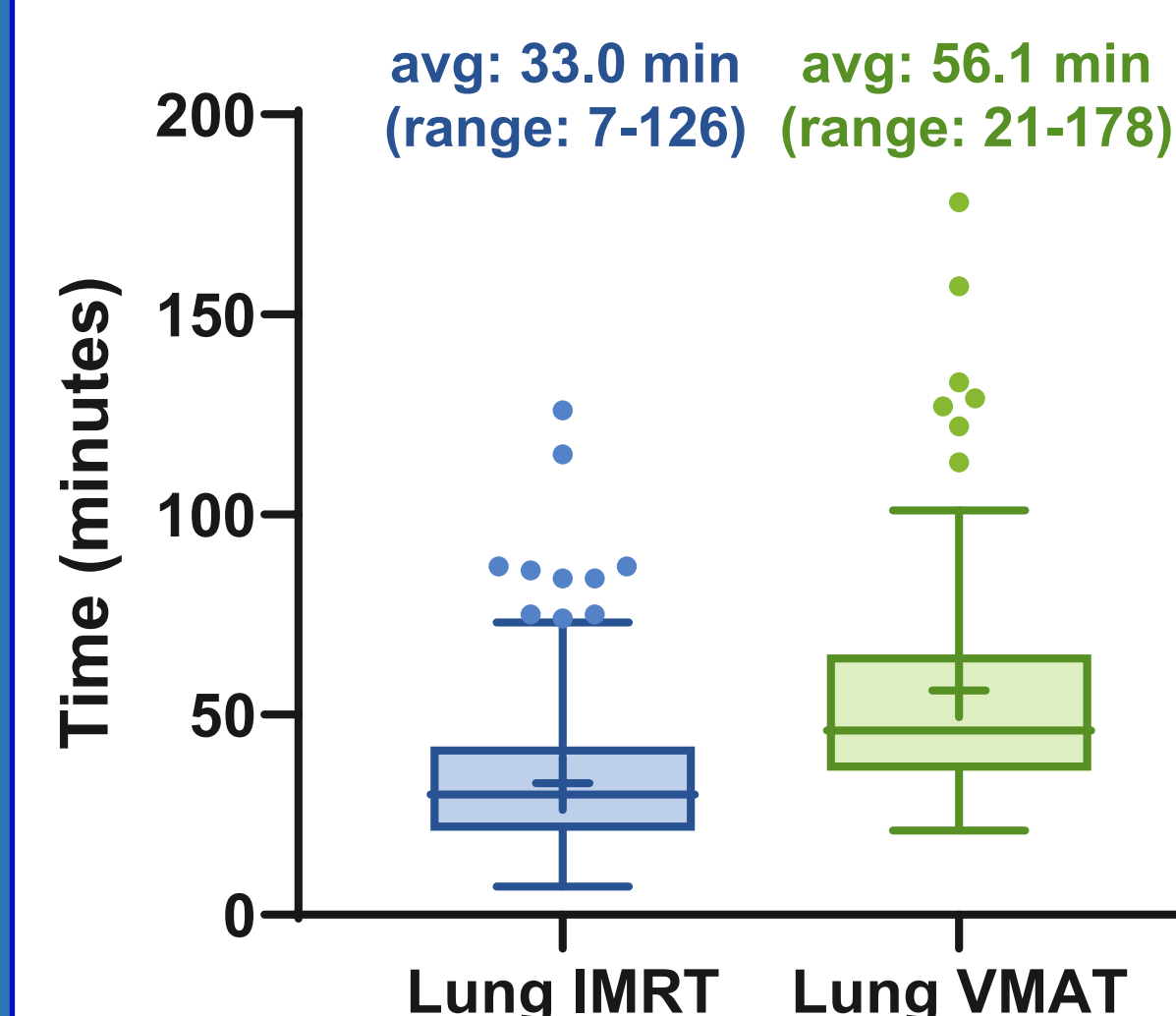


Figure 1. ECHO calculation time

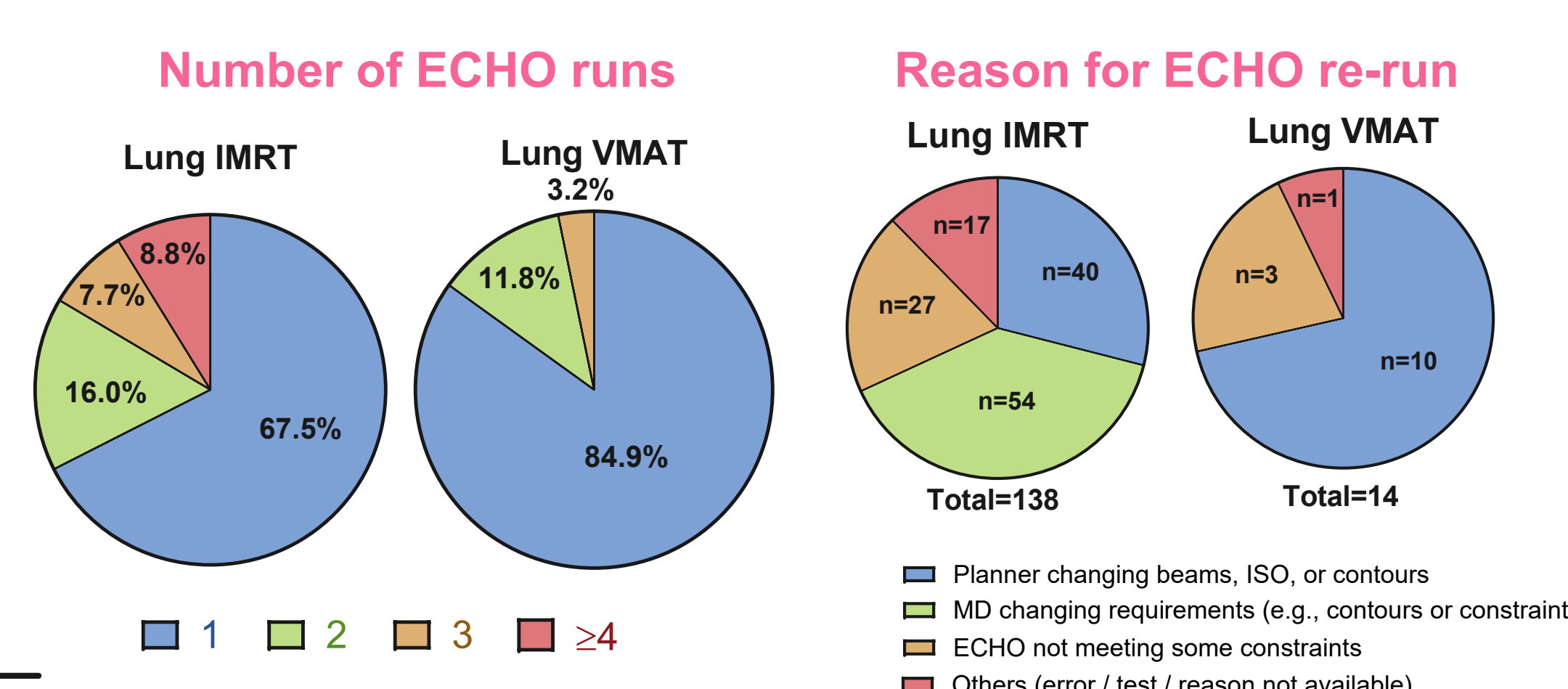


Figure 2. (left) number of ECHO runs to create a satisfactory plan; (right) the reasons for multiple runs

Efficiency

- During ECHO background optimization, **planners can work on other clinical tasks**
- ECHO plan takes **only 10% of manual planning time**
 - **saving 1.5 hours** of active planner time per plan
- Even with re-runs, substantial time savings are preserved
 - resubmission takes **<10 min**

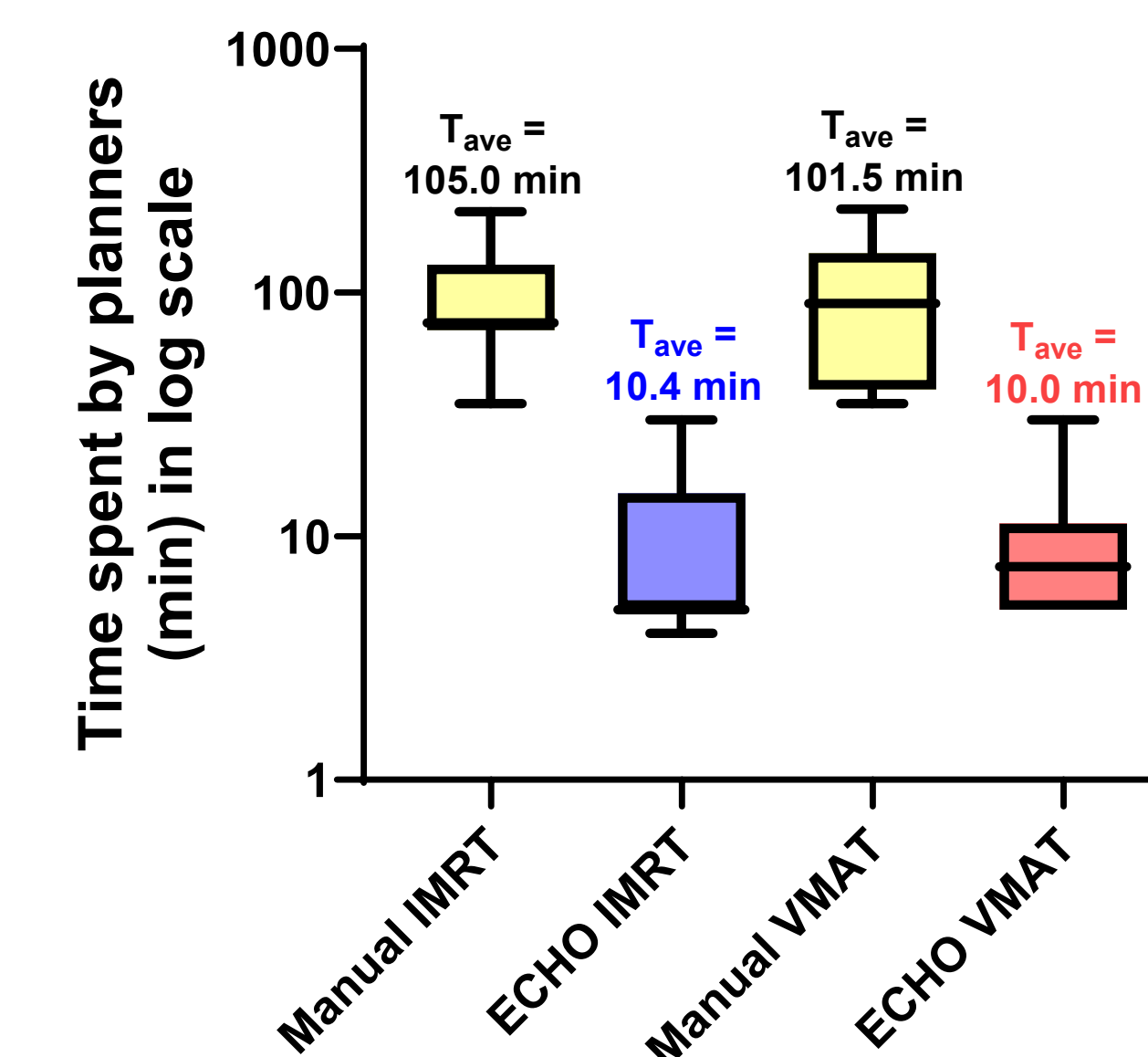


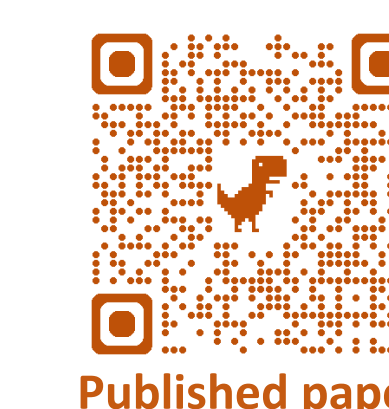
Figure 3. Comparison of the time spent by planners on lung plans (shown in log scale)

SUMMARY

- **Automated treatment-planning** was implemented for **lung cancer** radiotherapy
- **431 IMRT** and **93 VMAT** lung cases were clinically planned using ECHO optimization
- ECHO delivers **consistent, high-quality plans** across **7 fractionation schedules** — conventional to SBRT
- **Superior target dose homogeneity** (IMRT) and **reduced inter-patient variability** (VMAT SBRT) vs. manual planning
- Saves **~1.5 hours of active planner time** per plan — only 10% of manual planning effort required
- **No algorithm changes or retraining needed** when clinical criteria are changed

REFERENCES / ACKNOWLEDGMENTS

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Published paper

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* **AI Use Disclosure**: No generative AI tools were used in this study or in the preparation of this poster

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