Philips Trilogy EV300 — A Non-Dedicated Ventilator for Motion Management in RT

Jee Suk Chang, MD, PhD — Yonsei Cancer Center, Seoul, Korea

International Symposium Birmingham 2026
Breathing Control for Motion Management
in Radiotherapy and Imaging

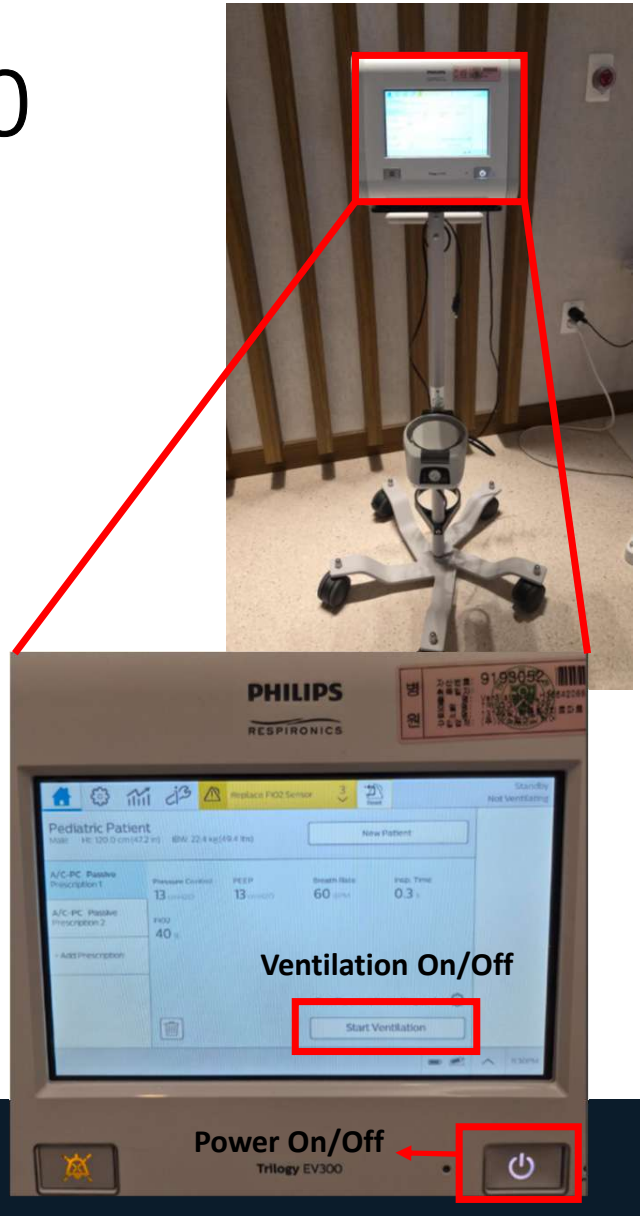
NIMV-60 Protocol on Hamilton Ventilator

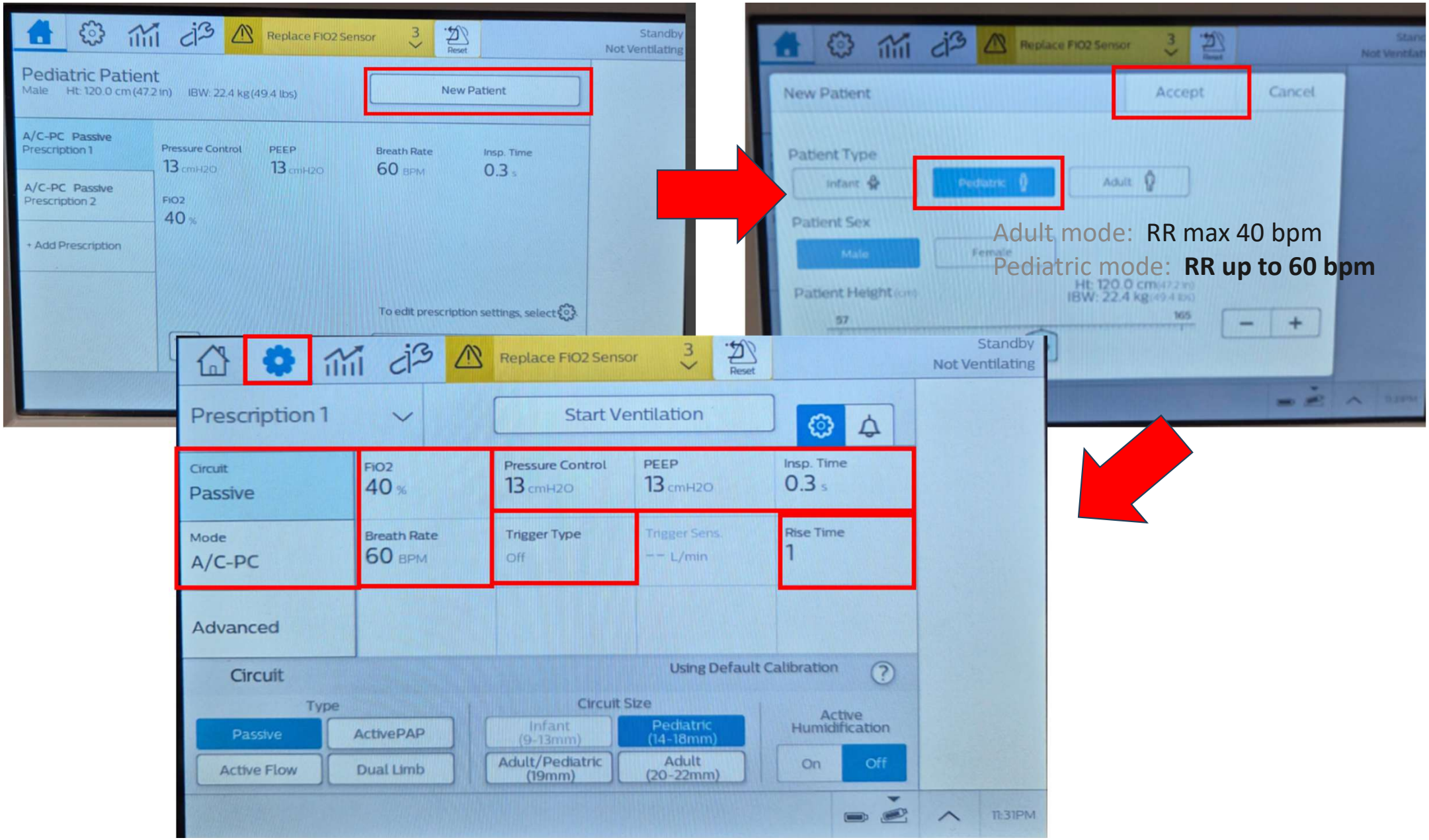
	Flow trigger	Ti	Rate	D Pinsp	PEEP	P ramp
Start in NIV-ST settings for spontaneous breathing	0.5	1.3	5	8 ~ 10	0	100ms
NIV-ST change to non-voluntary breathing for controlled breathing. Start timer	**20** OFF	1.3	**14**	**15**	0	100ms
NIV-ST change immediately to 30 brpm Spontaneous breathings readings	**20** OFF	**0.8**	**30**	15	0	**0ms**
NIV-ST change immediately to 45 brpm confirm regular ventilation pattern (wait 5 to 10s)	**20** OFF	**0.5**	**45**	15	**5**	0ms
NIV-ST change immediately to 60 brpm if subject struggles with PEEP at 15 cm, reduce PEEP (or restart from 30 brpm) to 10 cm *increase PEEP in +1 to +2 cm steps, up to 15 cm	**20**	0.5	**60**	15	**5 --> 15**	0ms

Affordable Alternatives for NIMV-60

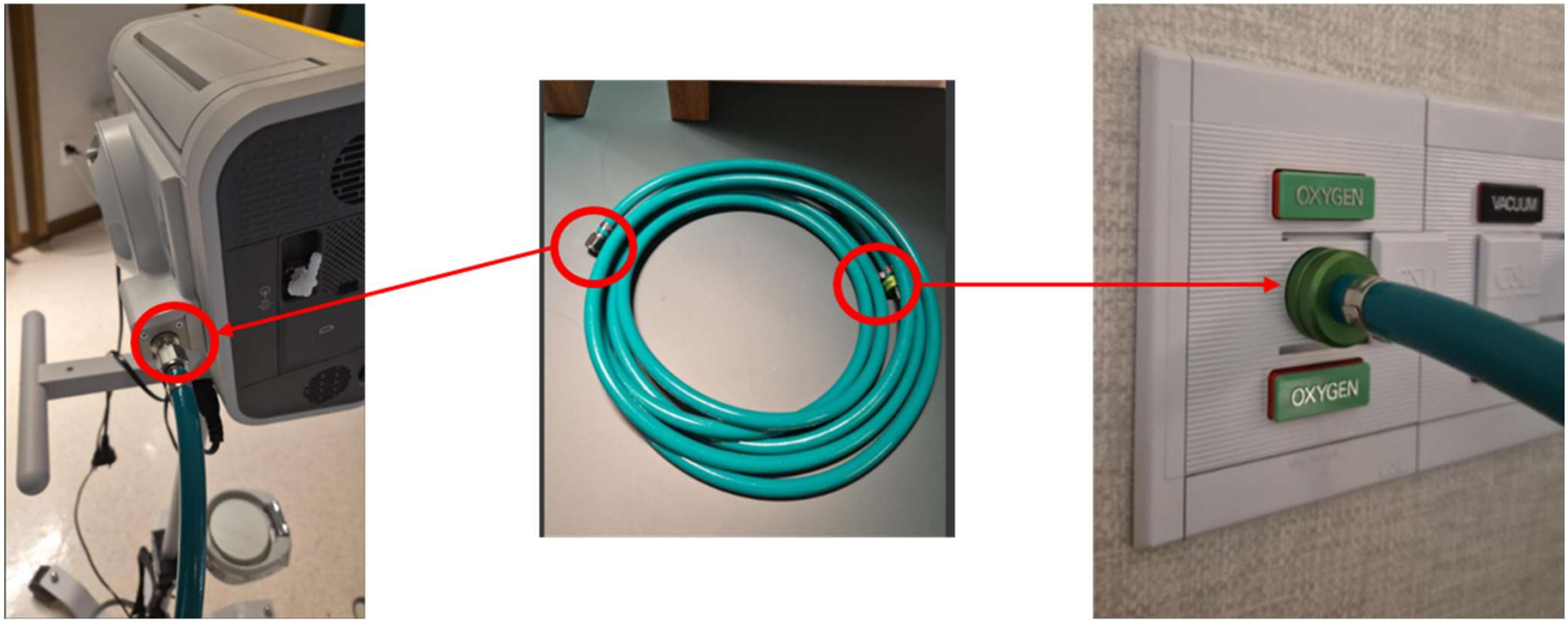
(Philips Trilogy EV300 & Evo)

- Pressure-controlled ventilator (A/C-PC mode) — fully supports NIMV-60
- RR up to 60 bpm, PEEP and PC fully adjustable
- Touchscreen, portable, mains or battery powered
- EV300: with O_2 blending
- Evo: room air only — even more affordable
- Cost: ~1/8 to 1/6 of a comparable Hamilton ventilator




Replace FiO2 Sensor
3
Reset
Standby
Not Ventilating
Pediatric Patient
Male Ht: 120.0 cm (47.2 in) IBW: 22.4 kg (49.4 lbs)
New Patient
A/C-PC Passive
Prescription 1
A/C-PC Passive
Prescription 2
+ Add Prescription
Pressure Control
13 cmH2O
PEEP
13 cmH2O
Breath Rate
60 BPM
Insp. Time
0.3 s
FiO2
40 %
To edit prescription settings, select
New Patient
Accept
Cancel
Patient Type
Infant
Pediatric
Adult
Patient Sex
Male
Female
Patient Height (cm)
Ht: 120.0 cm (47.2 in)
IBW: 22.4 kg (49.4 lbs)
57
165
Adult mode: RR max 40 bpm
Pediatric mode: RR up to 60 bpm
Prescription 1
Start Ventilation
Circuit
Passive
Mode
A/C-PC
FiO2
40 %
Breath Rate
60 BPM
Pressure Control
13 cmH2O
PEEP
13 cmH2O
Insp. Time
0.3 s
Trigger Type
Off
Trigger Sens.
-- L/min
Rise Time
1
Advanced
Circuit
Using Default Calibration
Type
Passive
ActivePAP
Active Flow
Dual Limb
Circuit Size
Infant (9-13mm)
Pediatric (14-18mm)
Adult/Pediatric (19mm)
Adult (20-22mm)
Active Humidification
On
Off
11:31PM

If O2 required (not available in Evo, but EV300)



Parameter	Hamilton (Mike)	Philips EV300 (ours)	Physical meaning
Inspiratory pressure	**ΔPinsp** Added above PEEP	→ **PC** Added above PEEP	Both set pressure relative to PEEP
End-expiratory pressure	**PEEP** cmH_2O	→ **PEEP** cmH_2O	Identical (same term)
Patient trigger	**Flow trigger** L/min value or OFF	→ **Trigger Type** Simply OFF	Disables patient-triggered breaths
Pressure rise speed	**P ramp** 100 ms → 0 ms	→ **Rise Time** 2 (normal) → 1 (fast)	How fast pressure climbs from PEEP
Ventilation mode	**NIV-ST** + Flow trigger OFF	→ **A/C-PC** + Trigger OFF	Pure time-controlled ventilation

PART 2 — NIMV

How We Do It — NIMV Protocol

	Step	RR (bpm)	Flow trigger	Ti (sec)	PC (cmH_2O)	PEEP (cmH_2O)	Rise time
	1	Natural RR (25)	OFF	1.0	7	3	2 (normal)
	2	30	OFF	0.8	7	7	1 (fast)
	3	35	OFF	0.7	10	10	1 (fast)
Monitor closely (RR ≥ 40)	4	**40**	OFF	0.5	13	13	1 (fast)
	5	**50**	OFF	0.4	13	13	1 (fast)
Target	6	**60 ★**	OFF	0.3	15	15	1 (fast)

* Step 1 uses the patient's natural breathing rate. Most patients breathe at RR 15–20; starting at 25 reduces acclimation time. (VTE: 800–1,100 mL)
* From Step 4 (RR 40), breathing cycle accelerates noticeably — monitor for patient discomfort. Instruct shallow chest breathing, not deep abdominal breaths. (Target VTE: 500–700 mL)
* Steps 5–6 are finalized at simulation based on patient body habitus and condition. (VTE 200–300 mL = excellent; 400–500 mL = controllable with respiratory gating)
* ★ RR > 40: 4D-CT acquisition currently only possible with GE Revolution CT

NIMV-60: Live Operation Video (5 min)

Natural RR

Increasing IPAP (& PEEP)

RR 40-60 bpm: Achieved

Anatomical Sites and Indications

- Lung SBRT (primary application, majority of cases)
- Liver, pancreas, kidney, upper abdomen SBRT

Do We Need an RT-Dedicated Device?

Why Non-Dedicated Works

- Affordable
- Portable, mains or battery
- Every NIMV strategy achievable
- Internationally available
- 382 patients treated

Limitations

- Learning curve (resolved by Step 3)
- Not MR compatible

4D-CT constraint

Most CT scanners: underestimation or failure at RR 60

GE Revolution (our institution):

Rotation time 0.2s · volumetric 4D · Markerless

→ RR 60 imaging possible

Current practice:

GE Revolution room → RR 60

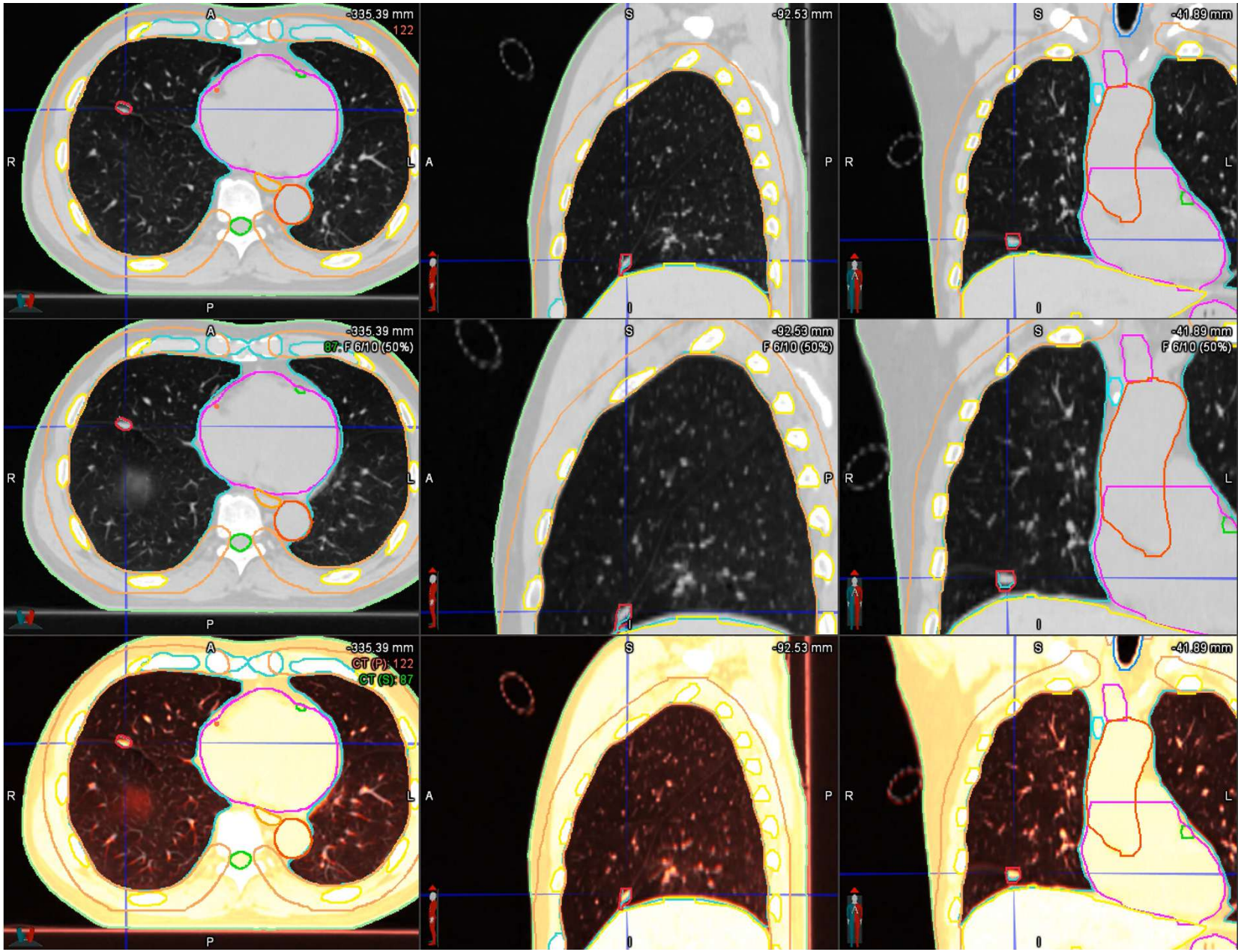
GE Revolution CT (20)

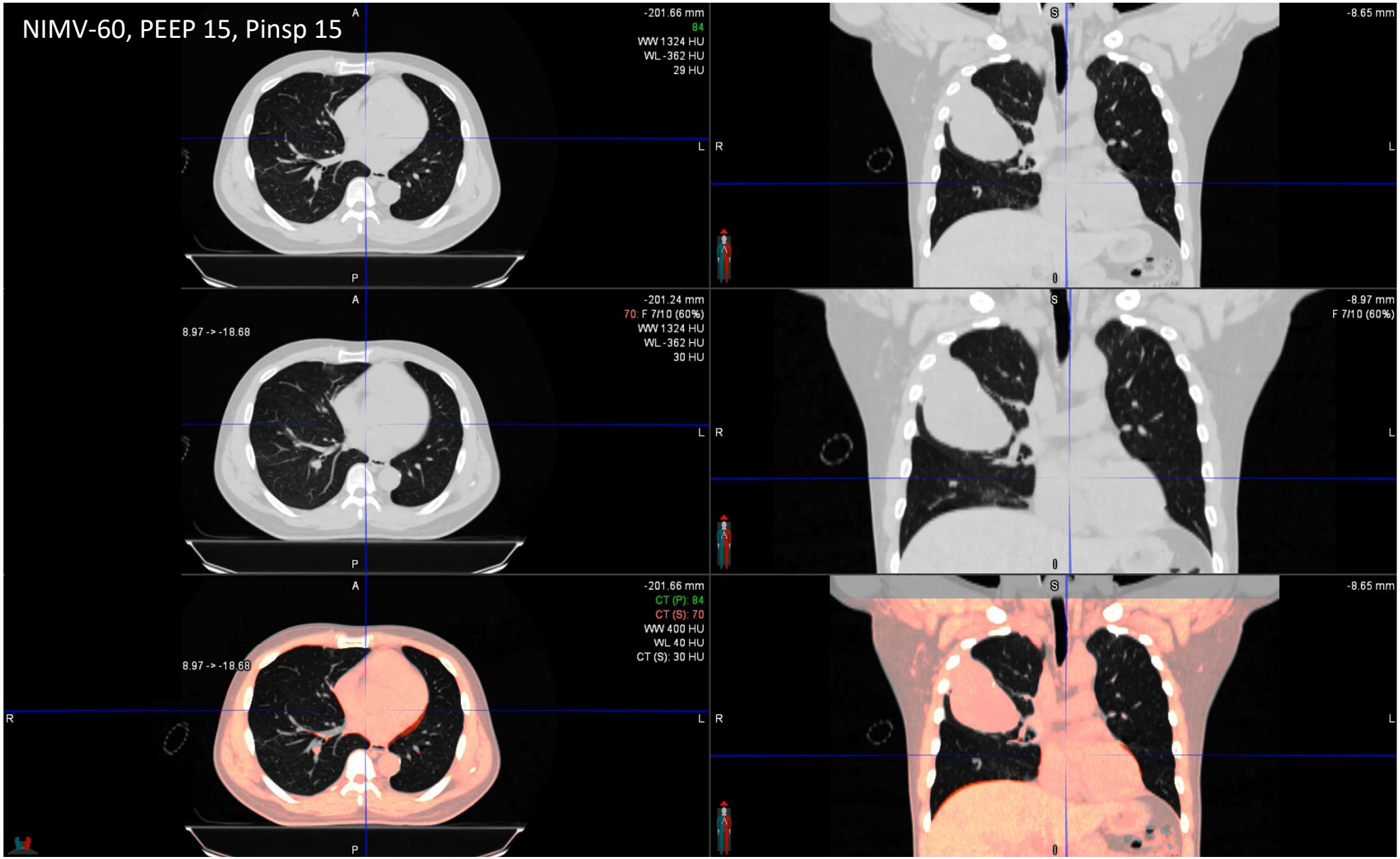
- GE Revolution CT
  - Detector Width: 8 cm
  - Slice Thickness: 0.625 mm
  - Z-axis coverage: 8 cm per rotation

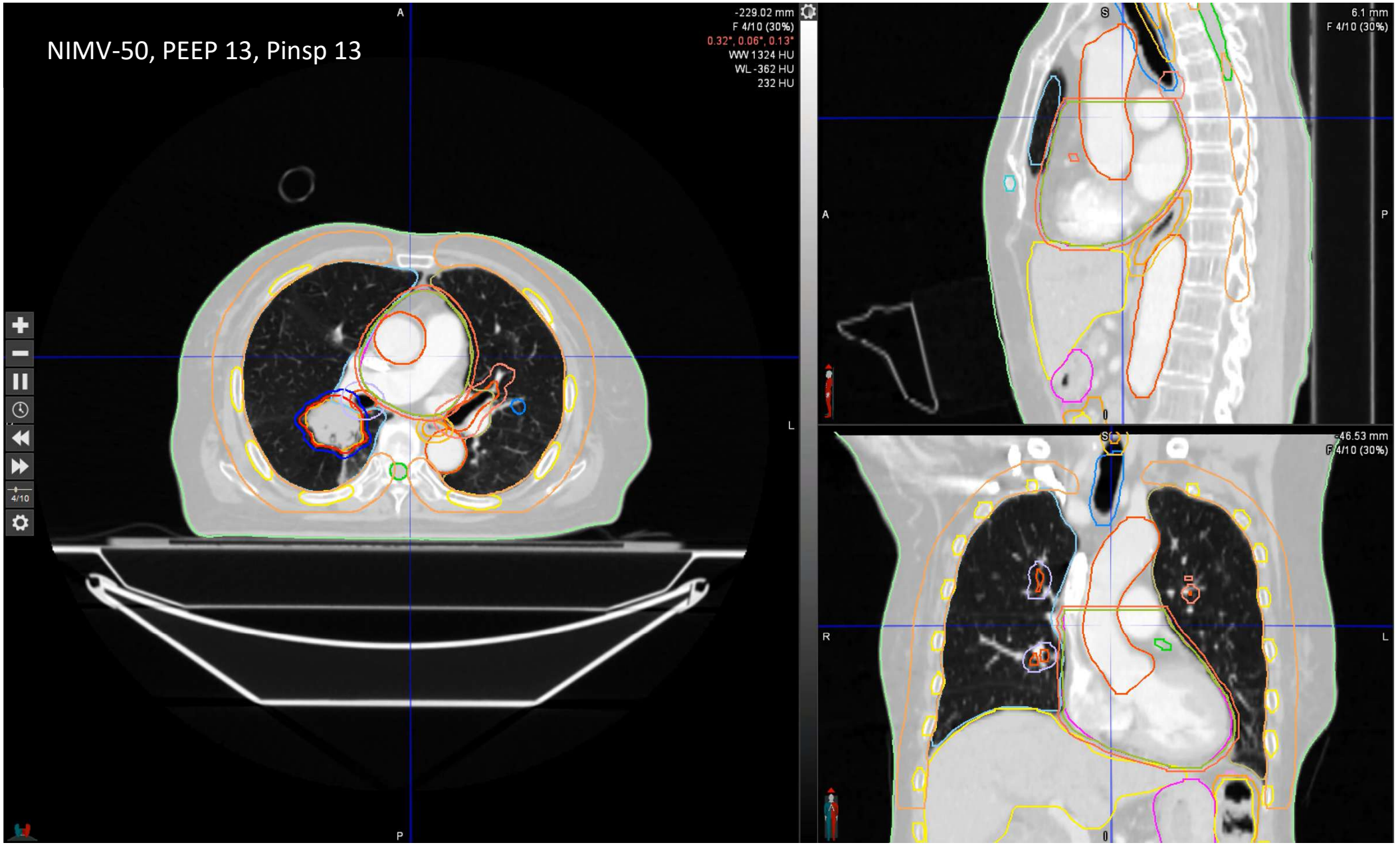
  - Gantry rotation: 0.28-0.35 sec
  - Spatial resolution: 0.23-0.28 mm
  - Temporal resolution: ~29 ms

➔ 4D CT Acquisition
- Detector Width: 4 cm
- Mode: Volumetric (Static, Step-and-Shoot) mode
- Phase-Sorting Reference: External Surrogate (RGSC) / Markerless Option

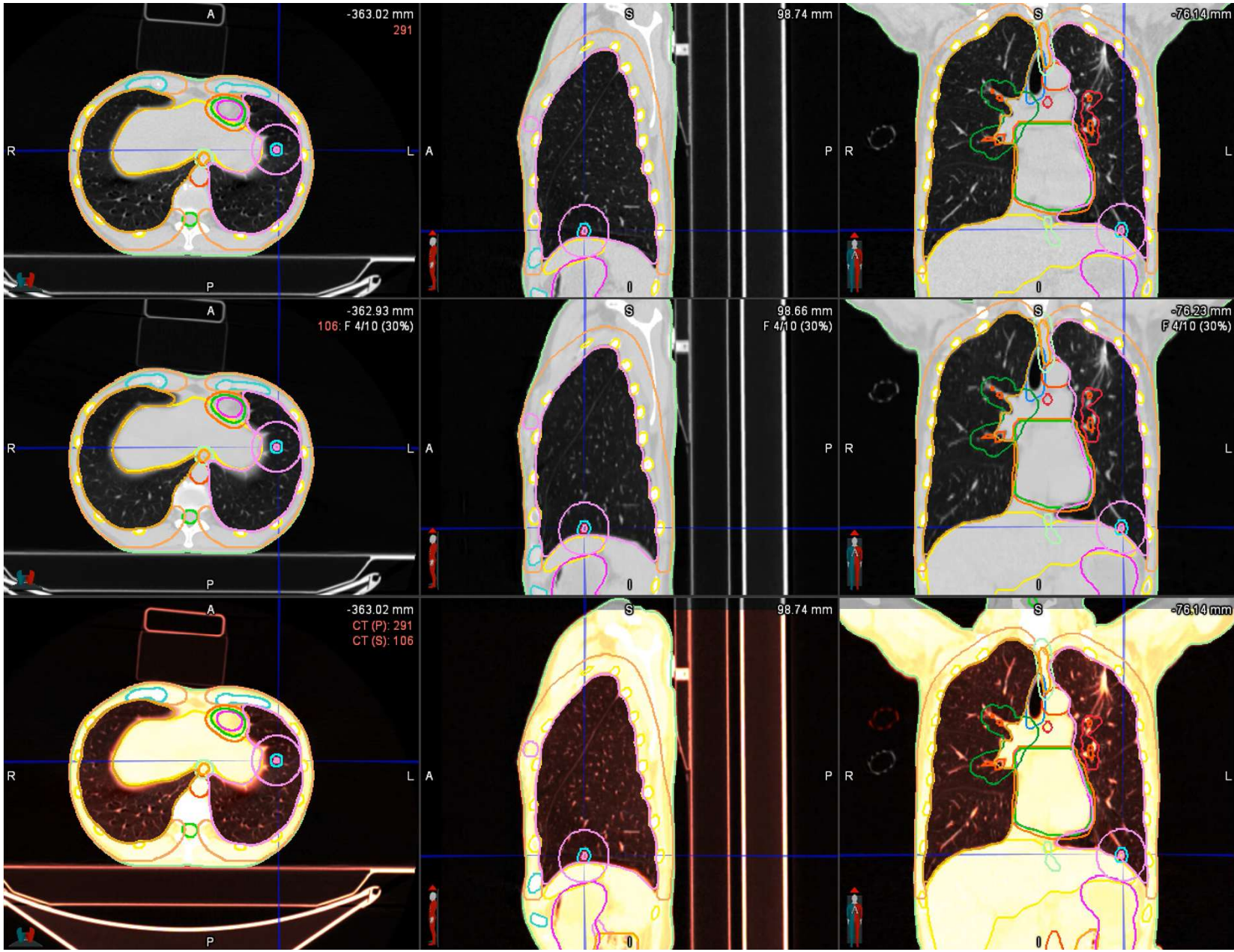
NIMV-60, PEEP 15, Pinsp 15



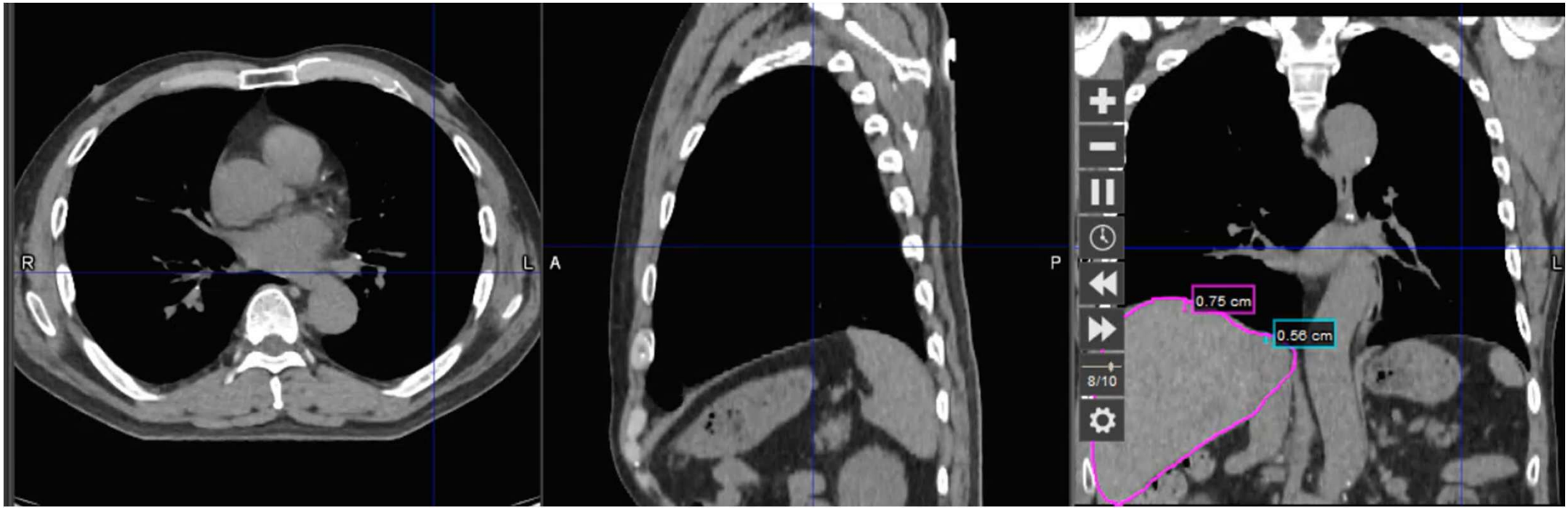

NIMV-60, PEEP 15, Pinsp 15
A
-201.66 mm
84
WW 1324 HU
WL -362 HU
29 HU
L
P
S
-8.65 mm
R
L
I
A
-201.24 mm
70: F 7/10 (60%)
WW 1324 HU
WL -362 HU
30 HU
8.97 -> -18.68
L
P
S
-8.97 mm
F 7/10 (60%)
R
L
I
A
-201.66 mm
CT (P): 84
CT (S): 70
WW 400 HU
WL 40 HU
CT (S): 30 HU
8.97 -> -18.68
R
L
P
S
-8.65 mm
R
L
I


NIMV-50, PEEP 13, Pinsp 13
-229.02 mm
F 4/10 (30%)
0.32°, 0.06°, 0.13°
WW 1324 HU
WL -362 HU
232 HU
A
P
L
S
I
6.1 mm
F 4/10 (30%)
-46.53 mm
F 4/10 (30%)
R

NIMV-50, PEEP 15, Pinsp 10



NIMV-20, PEEP 10, Pinsp 8



Next Stage and Future Plans

- SOP manual for NIMV in radiation therapy
- Structured training program for RT therapists
- High-level evidence for reimbursement
- Integration with gating, tracking, and EEBH

GE Revolution CT (20)

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  - Detector Width: 8 cm
  - Slice Thickness: 0.625 mm
  - Z-axis coverage: 8 cm per rotation

  - Gantry rotation: 0.28-0.35 sec
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Quasar Moving Phantom

- Moving phantom

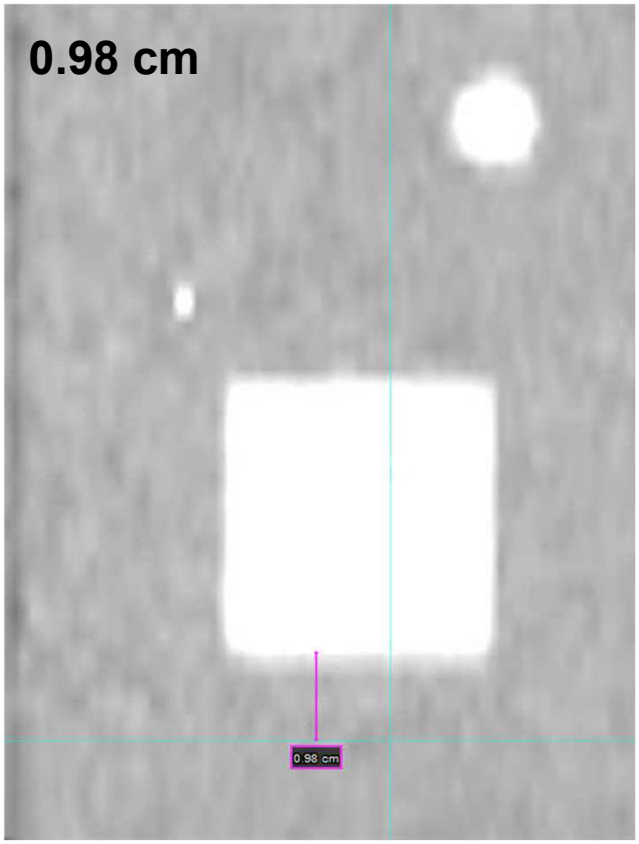
  * Different respiratory cycle (30, 40, 50, 60 RR)

  * Amplitude: **1 cm** (Superior-Inferior direction)

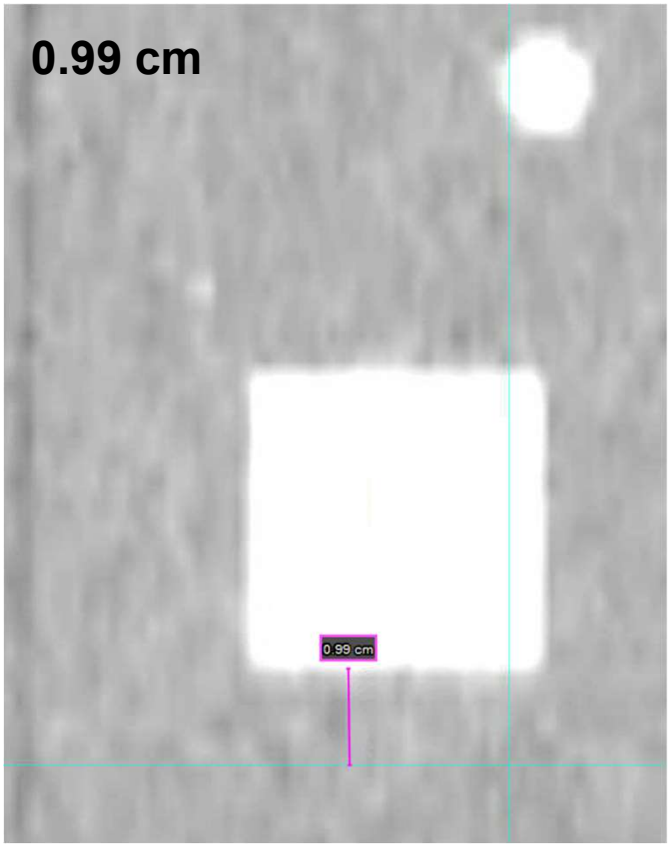
  * External marker: RGSC
    (Markerless 4D is **unavailable** for phantom)

Results (30,40,50 RR) with RGSC

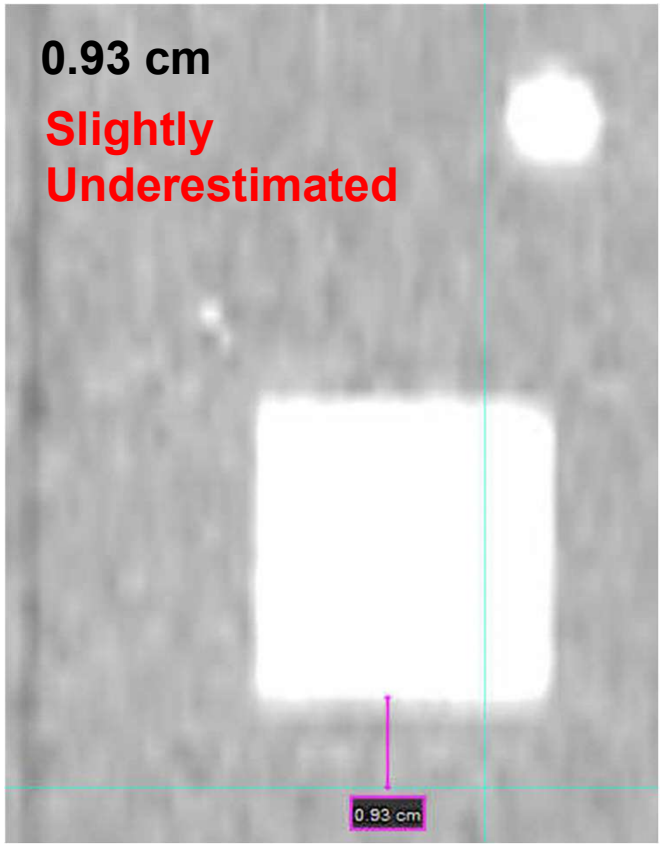
30 RR



40 RR

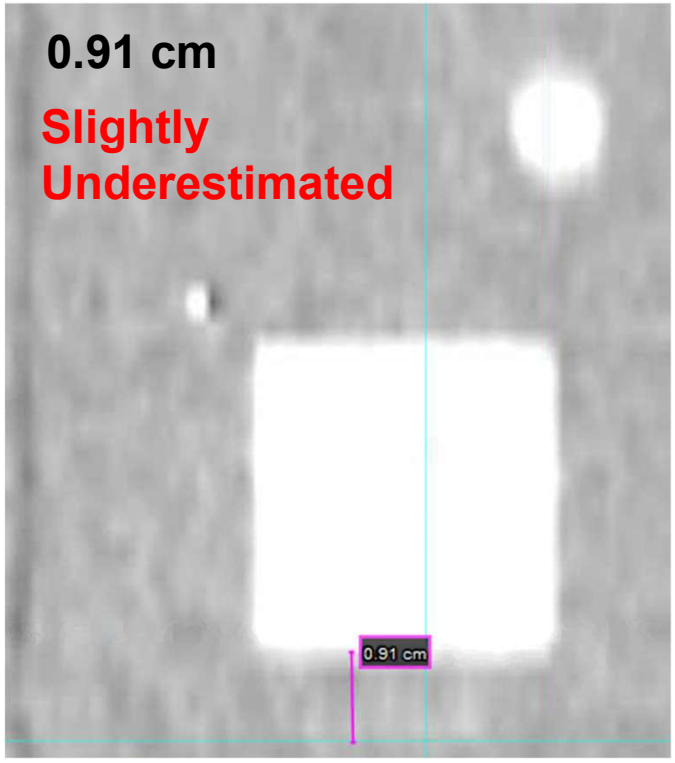


50 RR



Results (60 RR) with RGSC

60 RR



Totally Wrong Sorted Images