REACHING NEW HEIGHTS WITH SGRT

SGRT COMMUNITY — SURFACE GUIDED RADIATION THERAPY

# Advancing Motion Control: An Evaluation of VRT In-Bore Guided Breath-Hold Using a CBCT-Guided Adaptive System

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# Advancing Motion Control: An Evaluation of AlignRT In-Bore Guided Breath-Hold Using a CBCT-Guided Adaptive System

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# Disclosure

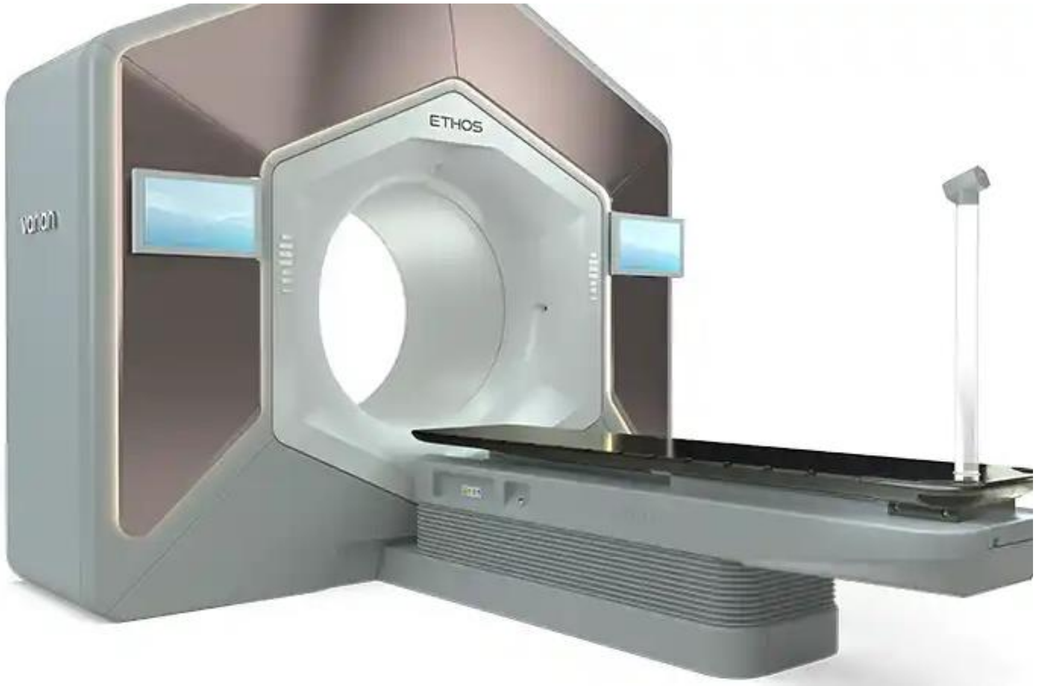
- No conflicts of interest

# Outline

- CBCT-Guided Online Adaptive Treatment: Managing Inter-Fraction Motion
- Breath-Hold in CBCT-Based oART? Managing Intra-Fraction Motion
- Surface Guidance Meets Adaptive Workflow: AlignRT InBore
- Clinical Workflow Implementation: From Simulation to Treatment
- Clinical Evaluation
  - Intra-fraction Motion Analysis
  - Time Cost Evaluation
- What We Learned

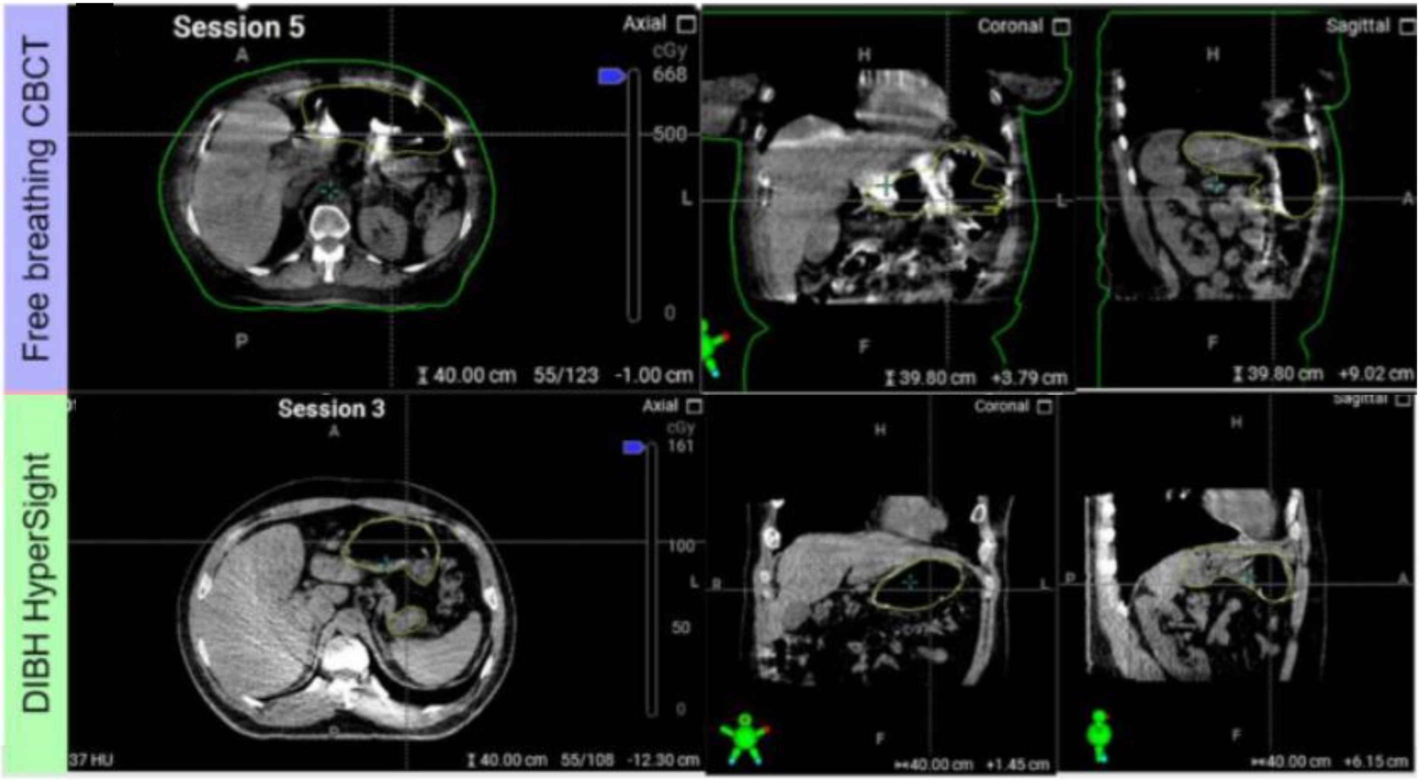
# CBCT-Guided Online Adaptive Treatment: Managing Inter-Fraction Motion

- Utilizes daily CBCT for contouring, planning and dose calculation
- Addresses inter-fraction motion
  - Daily Target Contour: better target coverage
  - Reduced Margin and Daily OAR contour: lower OAR dose
- Varian Ethos with HyperSight Imaging
  - Ring based gantry
  - 6s image acquisition time with improved image quality



# Breath-Hold in CBCT-Based oART? Managing Intra-Fraction Motion

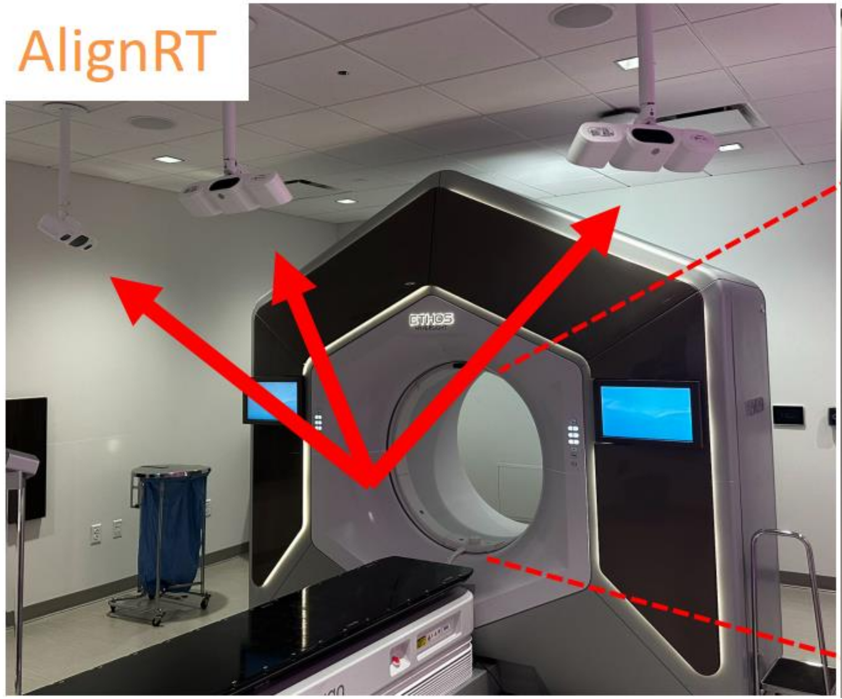
- Improved image quality for contouring with reduced motion artifact
  - Better target and OAR visualization
  - Improved AI-based auto-contouring for organs at risk (OARs)
- Increasing distance between target and OARs
- Potential for margin reduction




[1] Zhong, X., Rahman, M., et. al. *Advances in Radiation Oncology*, *2025*

# Surface Guidance Meets Adaptive Workflow: AlignRT InBore

- AlignRT InBore enables real-time surface tracking during treatment delivery, compatible with the Ethos ring gantry system
  - Setup isocenter: 3D ceiling-mounted cameras
  - Treatment isocenter: InBore camera ring system







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# Surface Guidance Meets Adaptive Workflow: AlignRT InBore

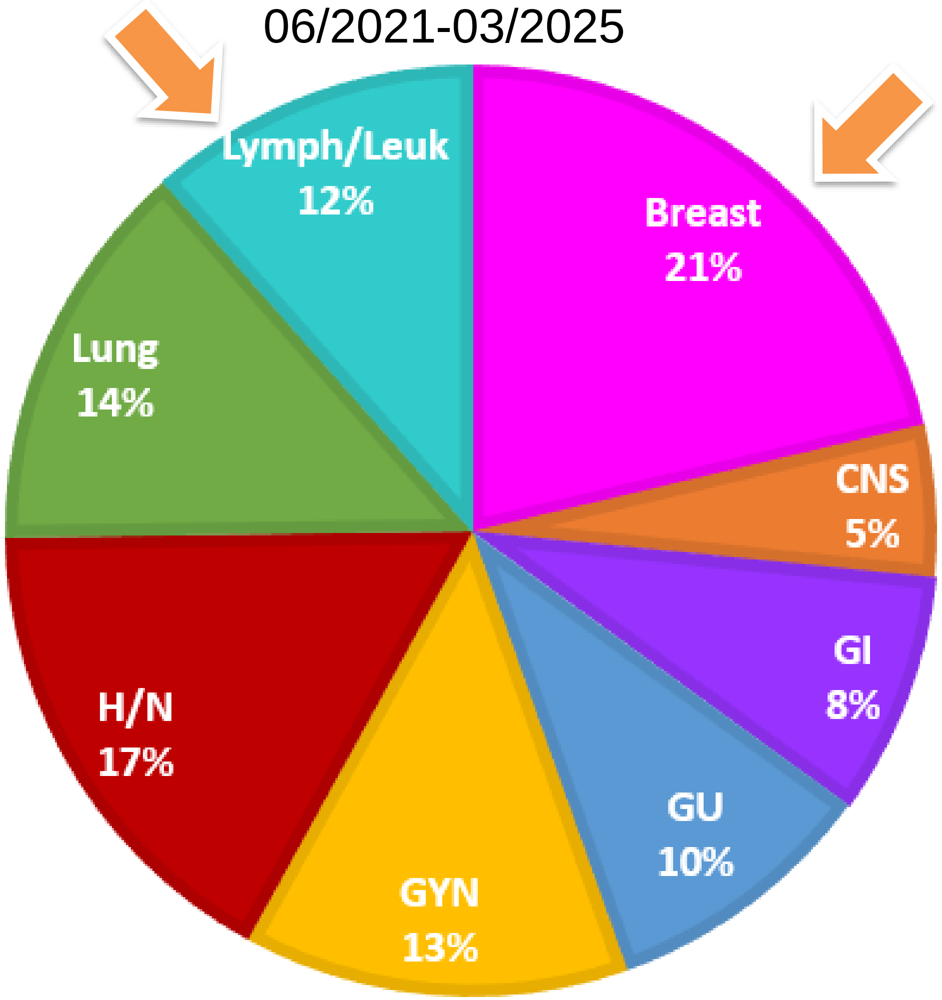
| | Setup Cameras | | InBore Cameras | |
|---|---|---|---|---|
| | With ACO | Without ACO | With ACO | Without ACO |
| Accuracy Near Isocenter | ≤ 0.2 mm<br>≤ 0.1 deg | ≤ 0.5 mm<br>≤ 0.3 deg | ≤ 0.4 mm<br>≤ 0.1 deg | ≤ 0.5 mm<br>≤ 0.3 deg |
| Accuracy Periphery | ≤ 0.5 mm<br>≤ 0.2 deg | ≤ 1.0 mm<br>≤ 0.5 deg | ≤ 0.5 mm<br>≤ 0.2 deg | ≤ 1.0 mm<br>≤ 0.5 deg |
| FOV | 650 x 1000 x 350 $mm^3$ | | 660 x 480 x 325 $mm^3$ | |

ACO = Advanced Camera Optimization
This process compensates for the curved lens geometry of the cameras

# Surface Guidance Meets Adaptive Workflow: AlignRT InBore

- Free breathing setup
  - Consistent setup across machines for adapt-on-demand treatments
  - Markless setup for breast treatments
  - Sim-omitted treatments
  - Remaking immobilization devices
- Breath-hold
  - Breast: mostly whole breast (fast-forward)[1]
  - Lymphoma[2]: abdomen

Treatment Cases distribution on Ethos at UTSW
06/2021-03/2025





[1] Brunt AM, et. al. The Lancet. 2020.
[2] Kumar K,, et. al. International Journal of Radiation Oncology, Biology, Physics. 2025

# Questions Before the Clinical Implementation

- What is the residual intra-fraction motion of target positioning when using AlignRT InBore-guided breath-hold (BH)?
- What is the cost of time to introduce surface-guided BH to the adaptive workflow?
- How does a longer treatment workflow affect the consistency across breath-holds (intra-fraction motion)?

# Clinical Workflow Implementation: From Simulation to Treatment

- Depth of tumor
  - Breast: targets are closer to the surface
  - Abdomen: targets are typically deeper and further from the surface

- Simulation Evaluation

| Breast | Abdomen |
|---|---|
| **BH coaching (SimRT)**<br>BH consistency check regarding surface from SimRT | |
| 1FB and 1 BH CT scan<br>✓ FB and BH surface separation<br>✓ FB and BH spine shift | 1FB and 3 BH CT scans<br>✓ BH Surface consistency<br>✓ BH Target consistency |

Simulation:
Motion Evaluation
(SimRT)

⇩

Planning:
Scan and Margin Selection

⇩

Treatment:
Motion Monitor and Verification
(AlignRT Inbore)

⇩

Data Analysis:
Motion Validation with CBCT

# Clinical Workflow Implementation: From Simulation to Treatment

Simulation:
Motion Evaluation
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⇩

Planning:
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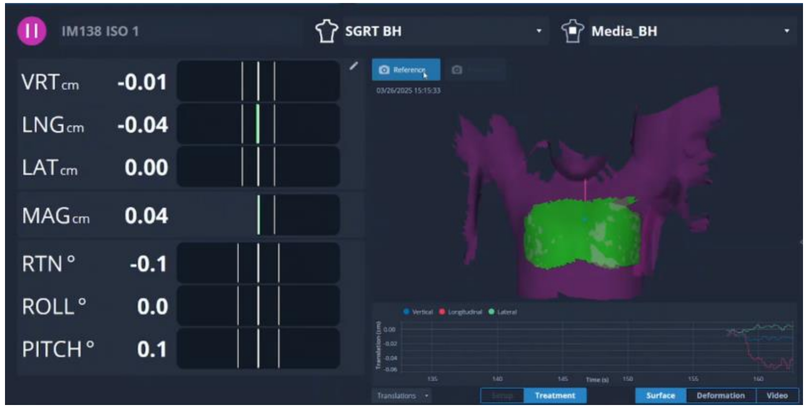
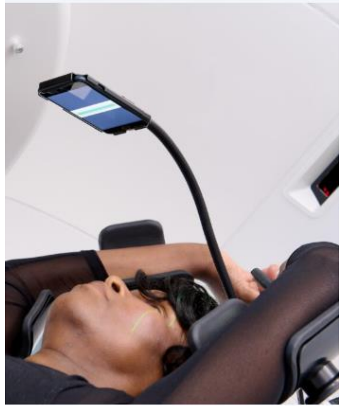
Data Analysis:
Motion Validation with CBCT

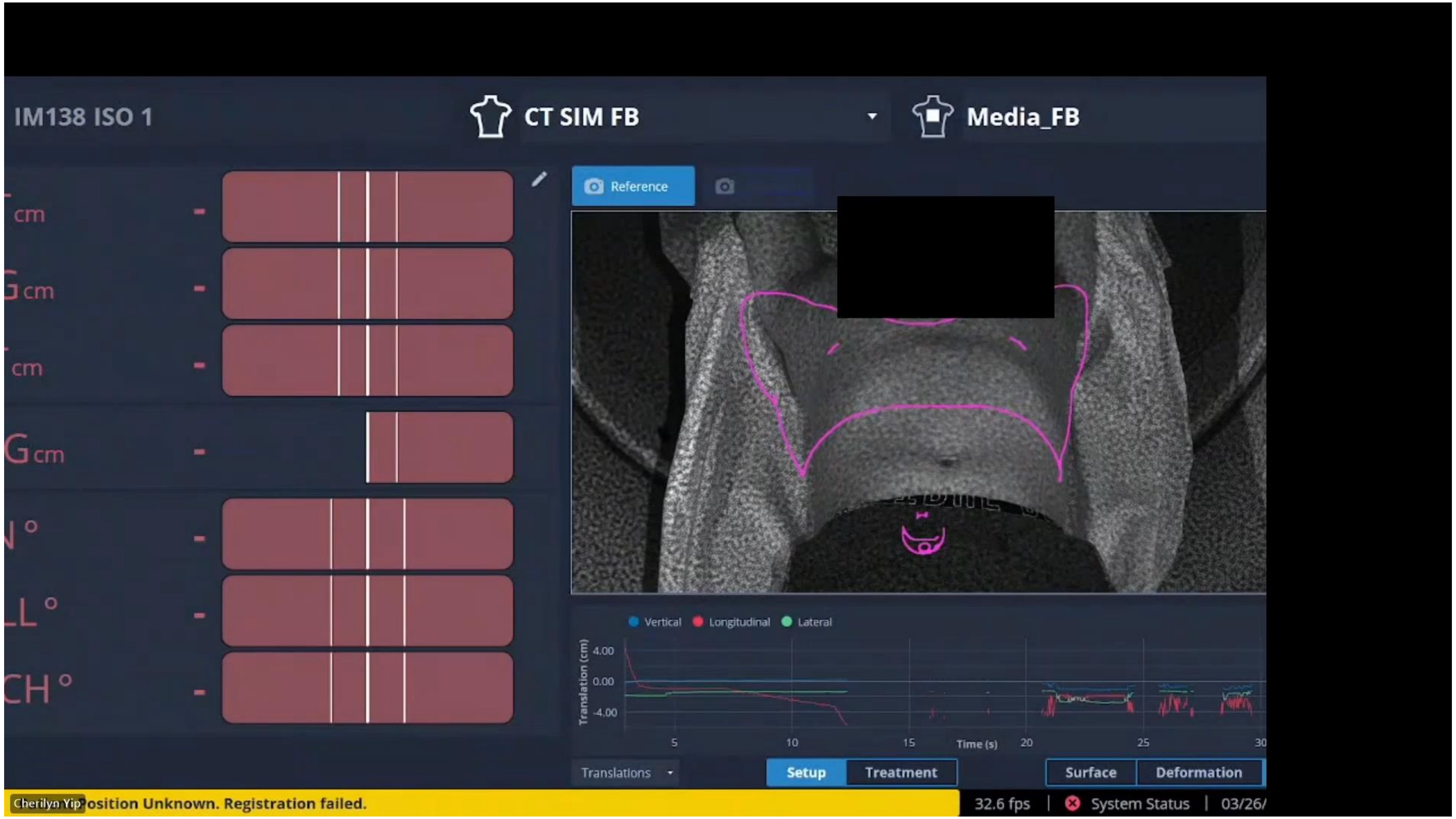


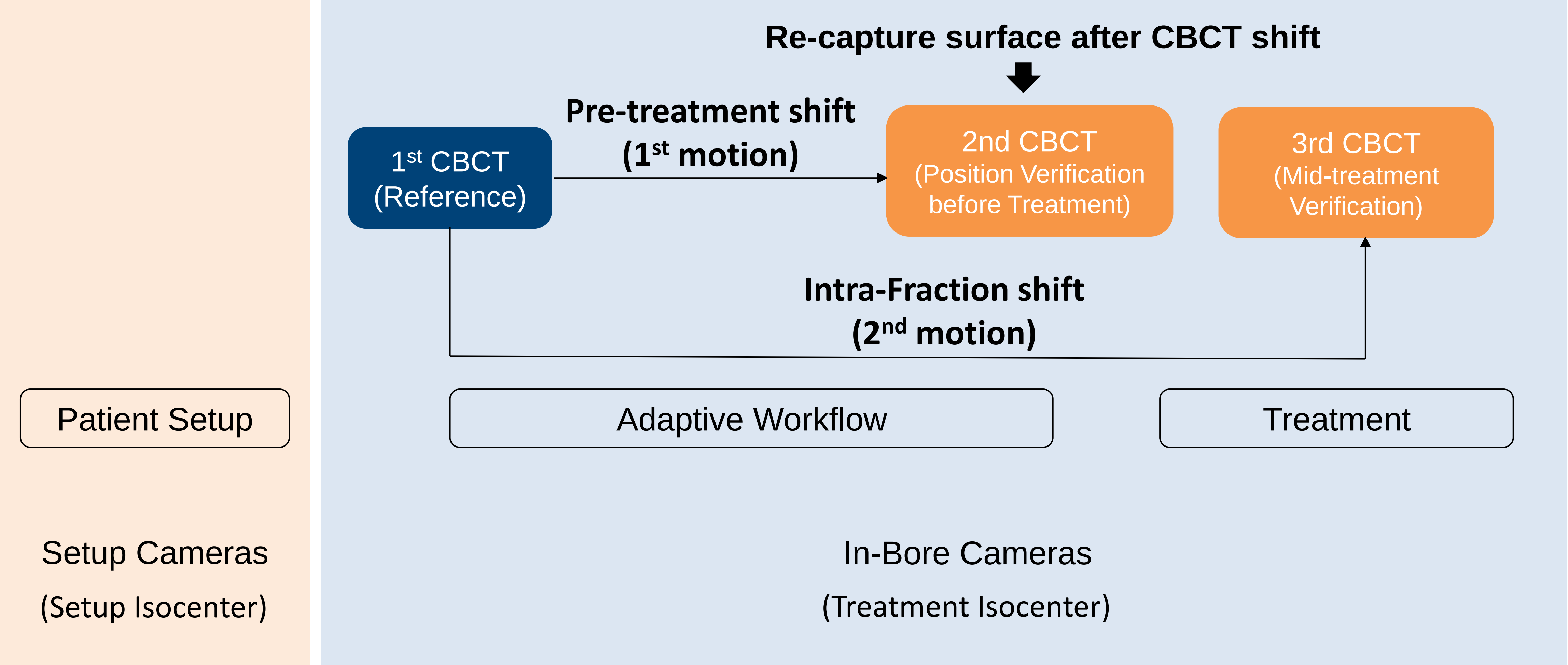
**VRT Inbore Setup**

- Free-breathing setup verified at setup isocenter
- BH consistency verified at treatment isocenter
- Recapture surface for new consistent BH before CBCT
- <u>3mm motion tolerance for SGRT BH (5.2mm magnitude)</u>

# Clinical Workflow Implementation: Setup Demonstration

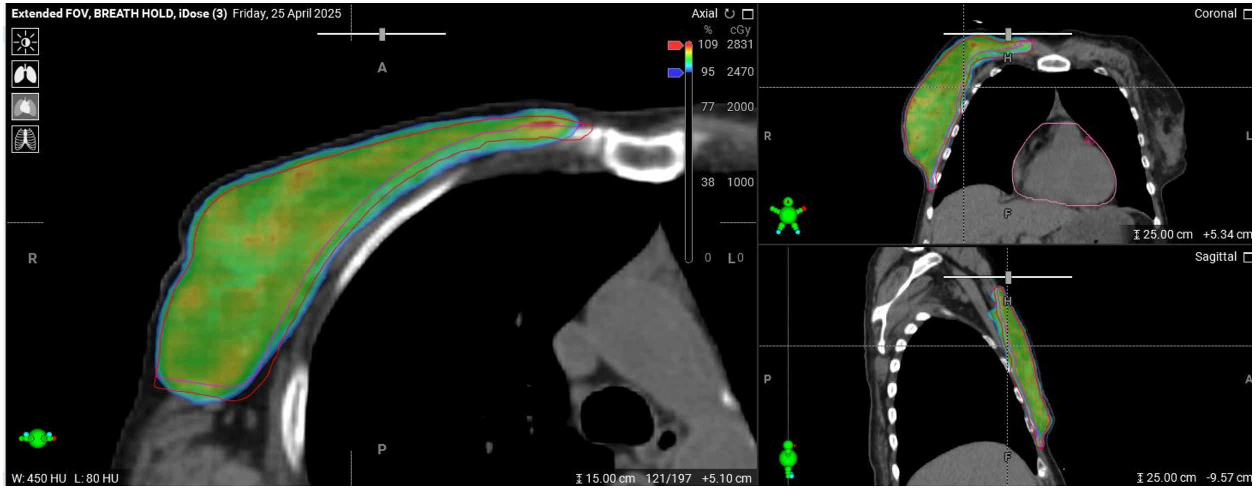


# Clinical Evaluation: Motion Analysis

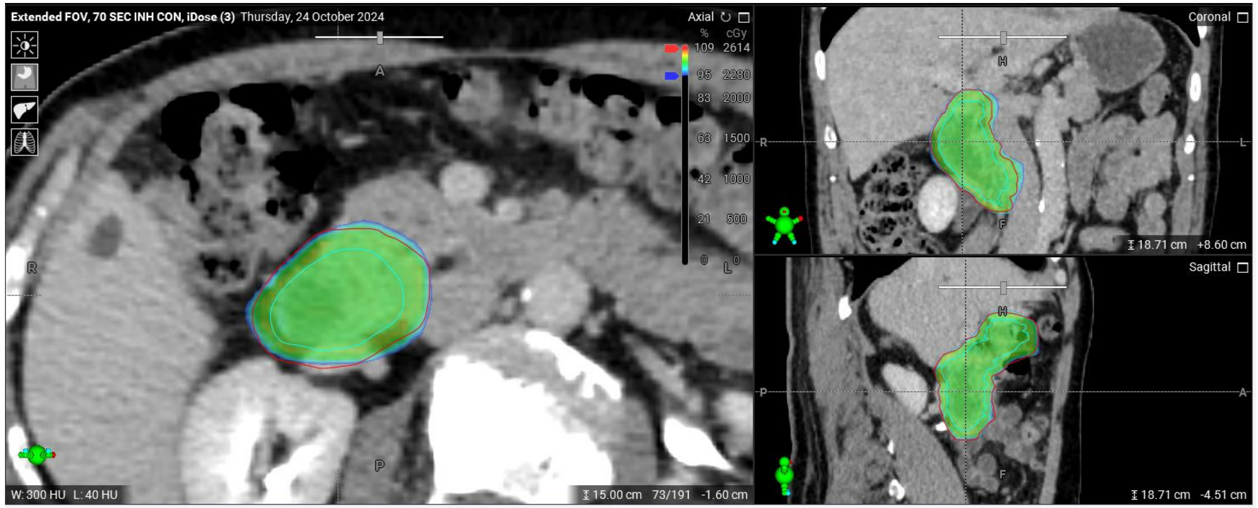


# Clinical Evaluation: Patient Cohort

- Breast Fast Forward Patient
  - FB: 10 patients (50 fractions)
  - BH: 10 patients (49 fractions)
  - Whole breast treatment
  - Prescription dose: 26 Gy in 5 fractions




- Lymphoma Patients
  - FB: 20 patients (53 fractions)
  - BH: 10 patients (65 fractions)
  - Treatment sites and Prescription dose vary



# Motion Analysis: breath hold consistency for breast patients

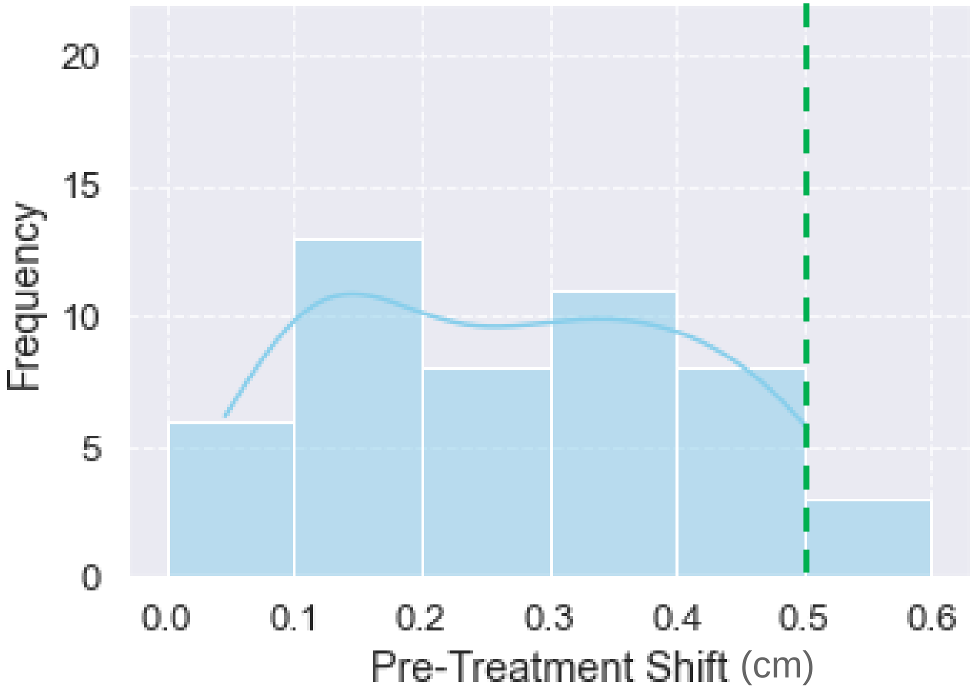
3mm motion tolerance for SGRT (5.2mm mag)
3-5mm isotropic PTV margin

1 fraction shift > 5mm

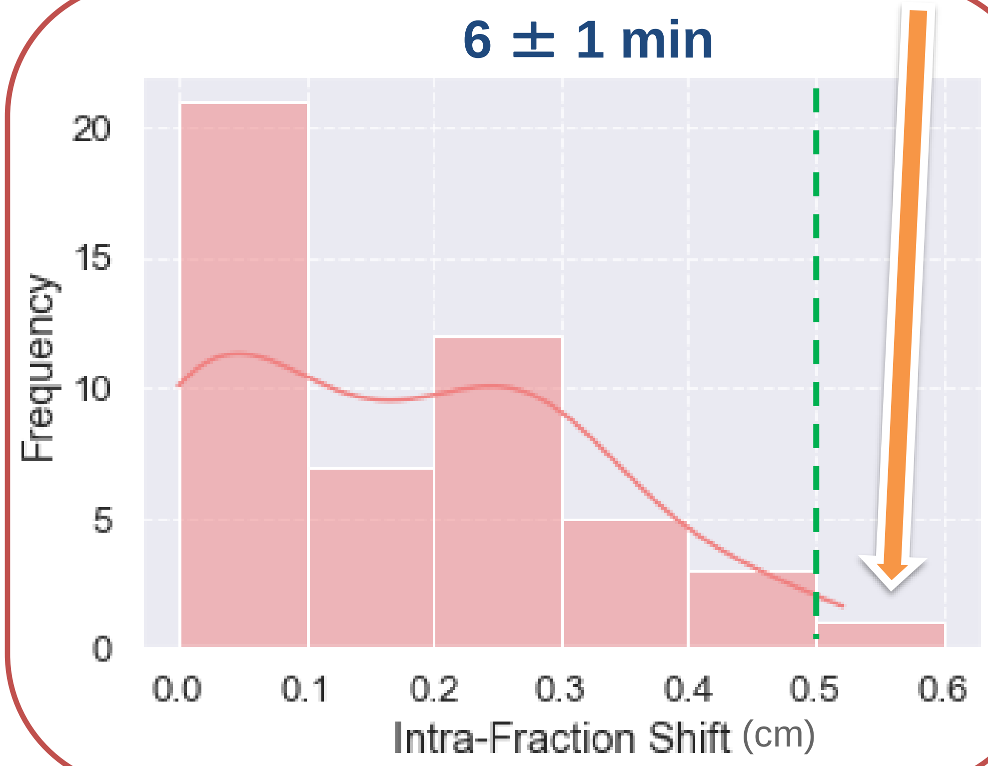
(5.2 mm)

## Time from the latest surface capture to the CBCT

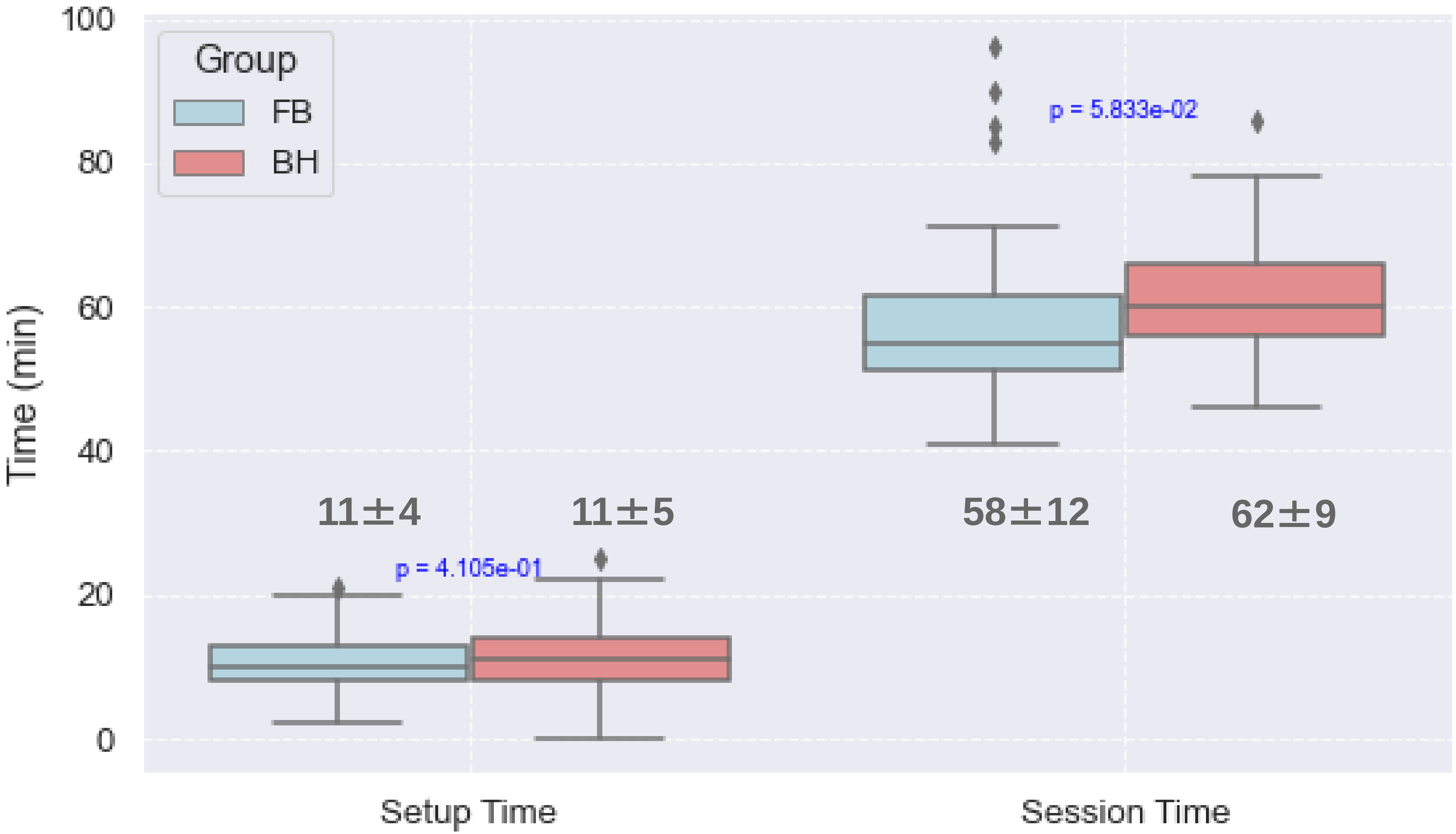
**38 ± 7 min**




**6 ± 1 min**



# Time Cost Evaluation: Breast Patients



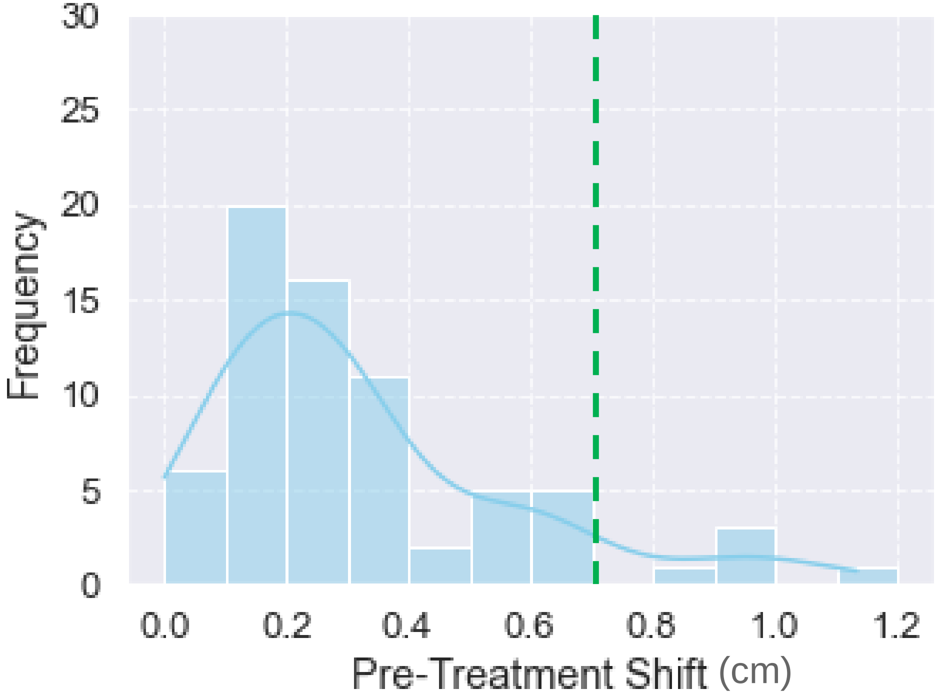

* Setup time is calculated as the time from session open at the console to 1st CBCT acquisition

# Motion Analysis: breath hold consistency for lymphoma patients

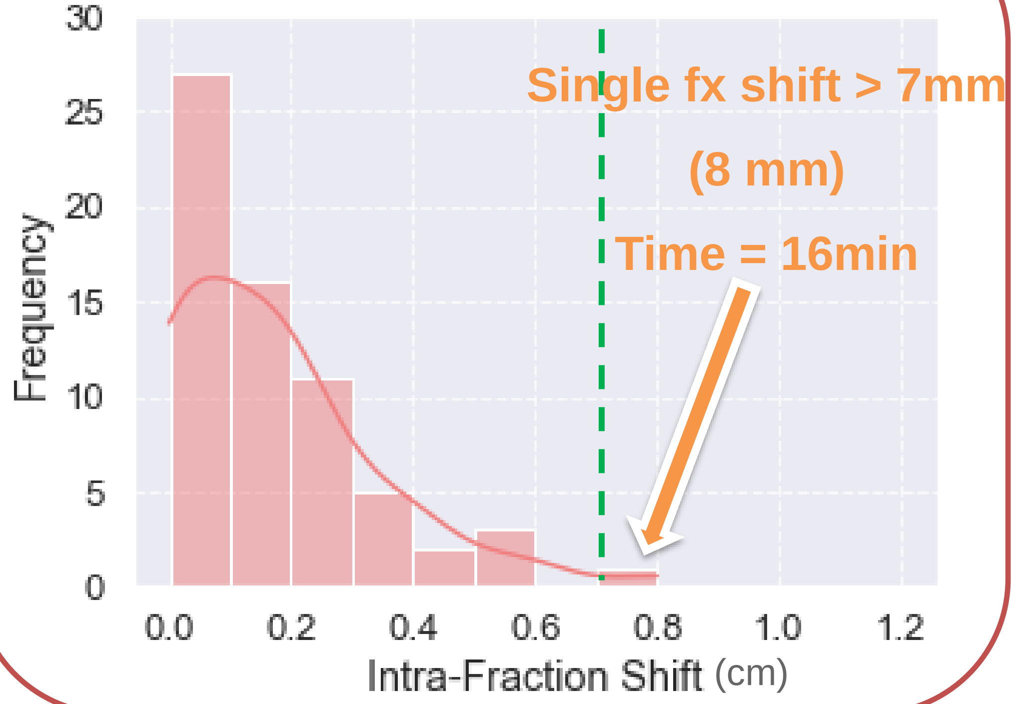
3mm motion tolerance for SGRT (5.2mm mag)
5-7mm PTV margin

## Time from the latest surface capture to the CBCT

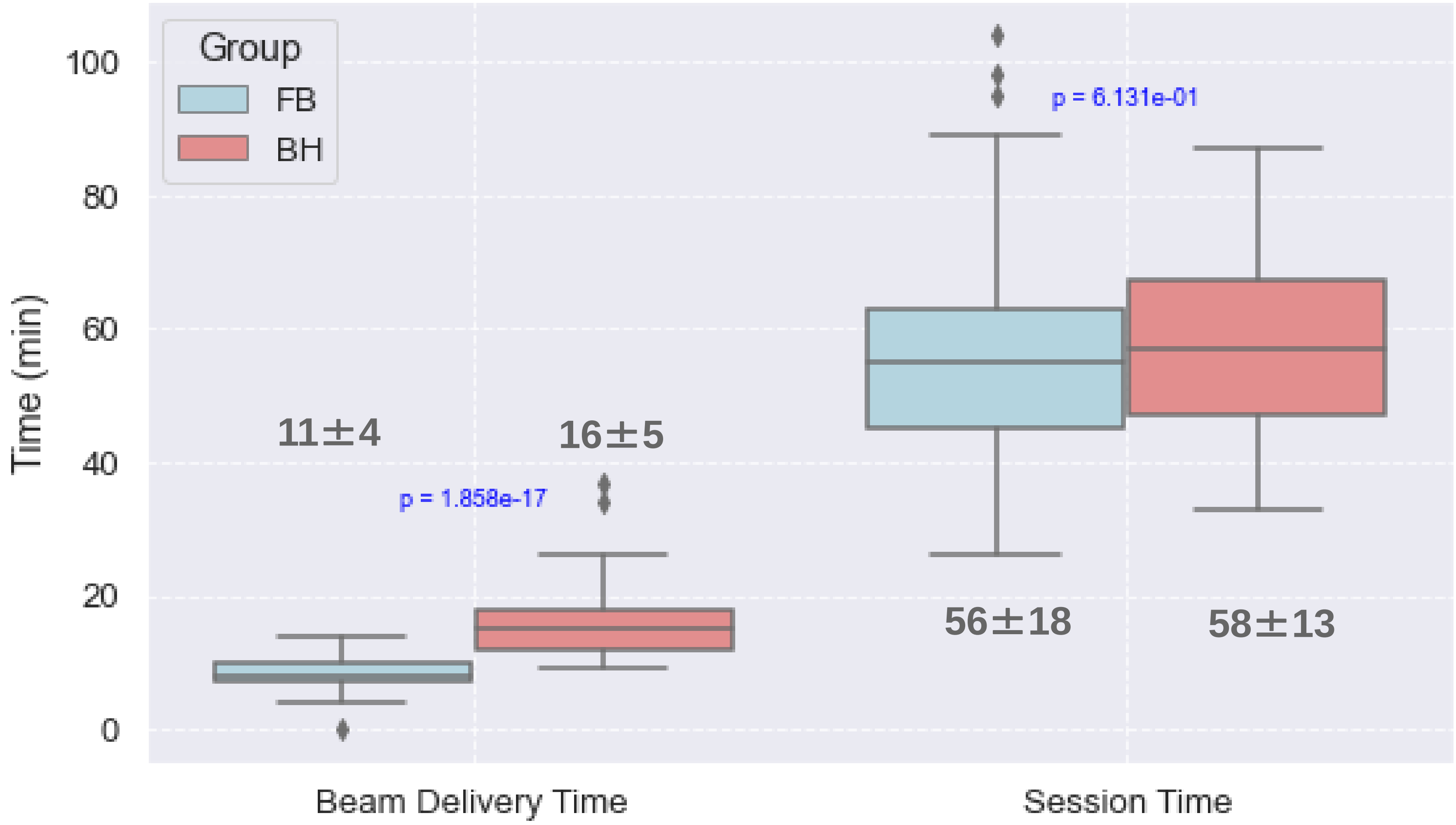
**28 ± 8 min**




**9 ± 3 min**



# Time Cost Evaluation: Lymphoma Patients




* Beam Delivery time is calculated as the time from adapted plan acceptance to session closure

# What we learned

- Patient education and motion evaluation during simulation are essential for successful breath-hold motion management workflow.
- AlignRT in-bore guided breath-hold (BH) provides reliable intra-fraction motion control with appropriate margins for whole breast and abdominal lymphoma patients.
- Although breath-hold treatment may slightly increase setup time and beam delivery times, the additional time required for breath-hold is minimal compared to the overall session duration.
- If a significant time has passed since the last surface capture, it may be beneficial to verify breath-hold consistency using CBCT in the middle of the beam delivery.

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  - Denise Salazar

# Thank you!

## Questions?

# Quiz 1

- **Which SGRT system is compatible with Ethos machine?**

A. SimRT

B. MapRT

C. AlignRT

D. AlignRT InBore

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**D. AlignRT InBore**

# Quiz 2

- **Which of the following can surface-guided breath-hold (SGRT-BH) *not* address?**

A. Target Growth

B. Breath-Hold Inconsistency

C. Intra-Fraction Motion

D. Motion Artifact

# Quiz 2

- **Which of the following can surface-guided breath-hold (SGRT-BH) *not* address?**

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# Quiz 3

- **Why can surface-guided breath-hold (SGRT-BH) improve image quality for CBCT?**

  A. Improved Signal-to-Noise Ratio (SNR)

  B. Enhanced Resolution

  C. Reduced Motion Artifact

  D. Increased Contrast

# Quiz 3

- **Why can surface-guided breath-hold (SGRT-BH) improve image quality for CBCT?**

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B. Enhanced Resolution

C. Reduced Motion Artifact

D. Increased Contrast

# Quiz 4

- **Which of the following is not necessary to evaluate during the breath-hold simulation for abdominal lymphoma patients?**

A. Breath-hold (BH) surface consistency

B. Breath-hold (BH) target location consistency

C. Surface separation between free-breathing (FB) and breath-hold (BH)

D. Breath-hold (BH) capability of the patient

# Quiz 4

- **Which of the following is not necessary to evaluate during the breath-hold simulation for abdominal lymphoma patients?**

   A. Breath-hold (BH) surface consistency
   B. Breath-hold (BH) target location consistency
   C. Surface separation between free-breathing (FB) and breath-hold (BH)
   D. Breath-hold (BH) capability of the patient

# Quiz 5

- **What imaging modality serves as the ground truth for assessing intra-fraction motion in our current study?**

A. kV Images

B. Fluoroscopy Images

C. CBCT Images

D. MRI Images

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