A Preliminary Phantom Study on the Impact of Region of Interest (ROI) Selection on LAP LUNA 3D SGRT Accuracy and Performance

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

Offormata Osunkwor, PhD; Niara, Rowe, MS; Cara Saporito; Deirdre, Ryan; Alois Ndlovu, PhD; Roland Teboh, PhD
John Theurer Cancer Center, Hackensack University Medical Center, Hackensack NJ

Hackensack Meridian
Hackensack University Medical Center

ABSTRACT

This phantom study investigated the impact of Region of Interest (ROI) selection on the performance of a 3D SGRT system, following AAPM TG-302 guidance.

By testing 15 distinct ROIs on a rigid phantom, it was found that system accuracy and stability are fundamentally dependent on the geometry of the chosen surface. Results showed that while most ROIs performed well, geometrically poor or small ROIs led to significant clinical errors, including rotational failures up to 2.0° and translational failures of 1.6 mm.

One ROI also demonstrated extreme tracking instability and high latency. This demonstrates that suboptimal ROI selection can compromise SGRT performance, highlighting the need for rigorous, data-driven ROI selection protocols for each anatomical site before clinical use.

INNOVATION/IMPACT

This study provides objective, quantitative data demonstrating that the clinical practice of Region of Interest (ROI) selection is a critical determinant of SGRT system performance. The innovation is in showing that even under ideal, rigid-phantom conditions, an SGRT system can produce clinically significant errors based solely on the user-defined input surface.

METHODS AND MATERIALS

A LUNA 3D SGRT system was evaluated using adjacent head and body phantoms (see Fig. 1) to form a contiguous, rigid surface. Following a reference capture, known 5.0 cm shifts were introduced. The system's reported 6DoF corrections were recorded using 15 distinct ROIs across the head (H1-H4), breast (B1-B3), lung/spine (LS1-LS4), and pelvis (P1-P4). Accuracy was assessed against a ±2 mm / 1° tolerance. System latency and tracking stability were quantitatively measured. Result is summarized in Table 1.

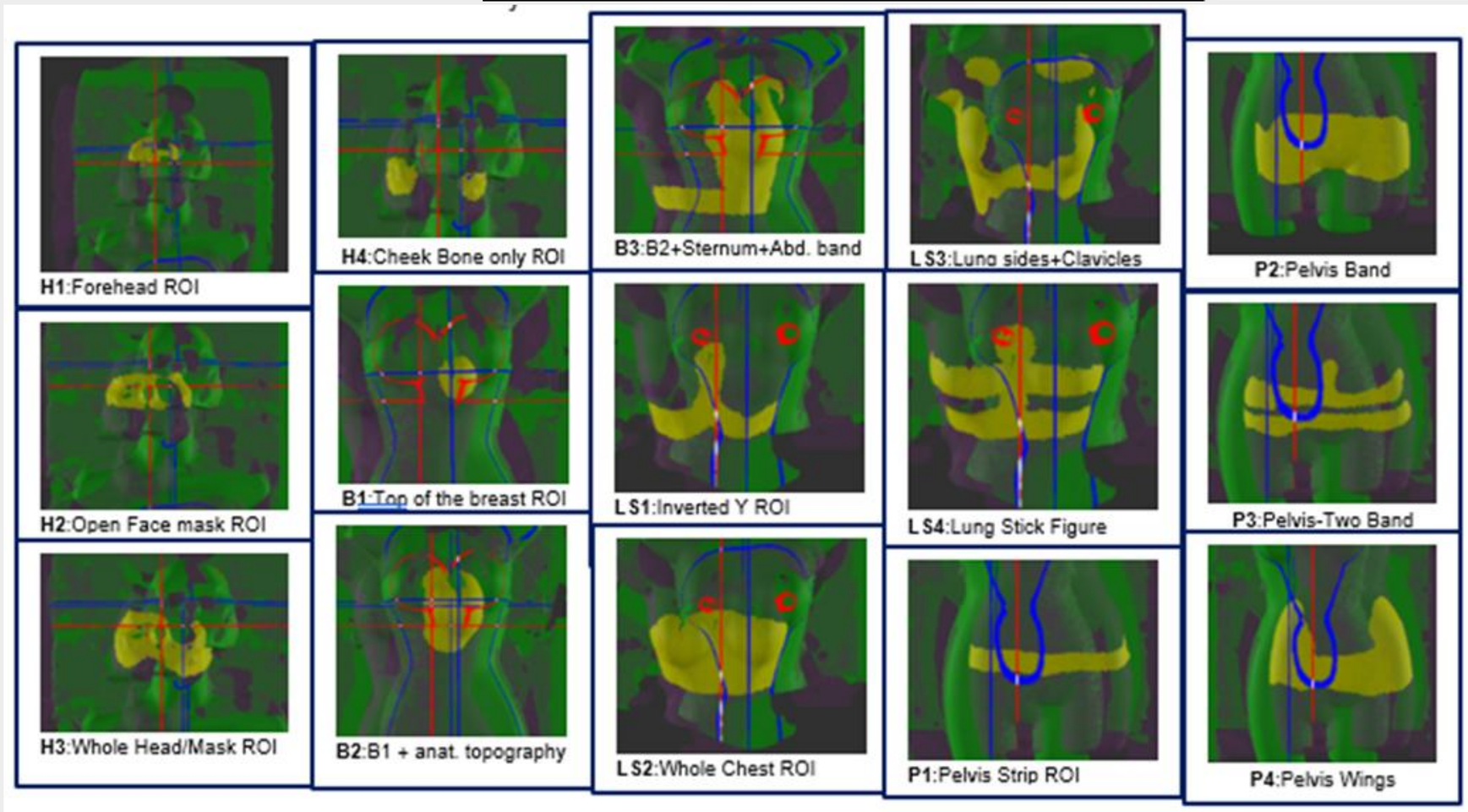
RESULTS

Fig. 1 Adjacent head and body phantoms used to form a contiguous rigid surface.

Table. 1. Summary of result of impact of ROI selection

Performance Category	Example ROI(s)	Key Quantitative Result
Critical Failure: Rotation & Stability	B1, H1	2.0° error (H1); 1.3° error & Multiple Interruptions (B1)
Critical Failure: Translation	LS1, B1	1.6 mm error
Performance Penalty: High Latency	H3, P2	261 ms latency (H3) (vs. ~185 ms baseline)
Optimal Performance	H2, H4, B2, B3, LS2-4, P1, P3-4	Errors < 1 mm / 0.3°; Stable latency (~185 ms)

- Significant localization errors were observed and directly correlated with ROI selection.
- Rotational accuracy failed for the small forehead ROI (H1: 2.0°) and the small breast ROI (B1: 1.3°).
- Translational accuracy failed for the small breast ROI (B1: 1.6 mm) and, notably, for a large "inverted Y" lung/spine ROI (LS1: 1.6 mm).
- The B1 ROI also demonstrated extreme instability, with the highest latency (341 ms) and multiple real-time data (RTD) interruptions. In contrast, 12 of the 15 ROIs performed within all tolerances.
- A latency penalty was observed for some large ROIs (e.g., H3: 261 ms) compared to the baseline of ~185 ms.



CONCLUSIONS

The ROI failures occurred because of the way the surface-matching (Iterative Closet Point) algorithm works. Small or smooth surfaces don't have enough unique shape for the system to confidently lock the rotation, causing it to settle on the wrong angle. With complex shapes or too little data, the algorithm can get confused and match points incorrectly, pulling the final position off-target. If there is not enough surface data at all, the system cannot find a stable solution, which causes the tracking to. freeze and lag

Hackensack Meridian *Health*

John Theurer Cancer Center
Part of Georgetown | Lombardi Comprehensive Cancer Center
NCI Comprehensive Cancer Center
A Cancer Center Designated by the National Cancer Institute

© Poster Template by Genigraphics® 1.800.790.4001 www.genigraphics.com