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

# Continuous Isocentricity Test with Dynamic Axis Motions

A. WOOD[1], B. WOLTHUIS [2], M. SCHMIDT[1], S. PANI[1], Y. HAO[1], T. MAZUR[1], T. SUDLOW[1], M. PRUSATOR[1] and N. KNUTSON[1],

[1]Washington University School of Medicine in St. Louis, St. Louis, MO

[2] University of Massachusetts Lowell, Lowell, MA

## PURPOSE / OBJECTIVES

To develop and validate a novel isocentricity test using continuous axis motion and imaging during beam delivery to characterize three-dimensional isocenter walkout.

## MATERIAL & METHODS

Custom beam delivery sequences were created as XML-formatted machine instruction files to enable imaging during continuous axis motion of interest (e.g. couch, collimator, or gantry). A front pointer was mounted to the couch and positioned at isocenter and verified using orthogonal MV imaging. Static reference images were subtracted from corresponding dynamic motion images, and geometric deviation from the motion was calculated and used to determine three-dimensional isocenter walkout for the gantry, collimator, and couch. For couch rotation, multiple gantry acquisition angles were combined to resolve the vertical component of couch-induced isocenter deviation. Concentric reference circles of different radii were overlaid on the images according to the static image isocenter to facilitate visual assessment of walkout magnitude. This approach was evaluated on three linear accelerators, one TrueBeam Edge and standard TrueBeams.

## RESULTS

- Clear, intuitive visualizations of isocenter walkout for the collimator and in-plane couch rotational axes with directionality and magnitude indicated with the asymmetric intensity patterns and overlaid radial markers.
- Dynamic gantry acquisitions and image subtraction revealed the overall magnitude of the gantry-induced isocenter walkout, but axis-specific directionality was not directly resolvable.

**Innovation/Impact:** This study introduces a continuous-imaging approach to isocentricity validation that extends beyond conventional Winston–Lutz methods based on discrete cardinal-angle sampling. Continuous imaging enables visualization of the full three-dimensional extent of isocenter walkout, providing a more complete characterization of machine isocentricity to support increasingly precise radiotherapy delivery. This dynamic test will allow testing under conditions that represent treatment conditions more closely than traditional static delivery tests and would allow testing the effects of acceleration and deceleration upon isocentricity.

**Key Results:** The continuous-imaging method was evaluated on three linear accelerators (one TrueBeam Edge and two TrueBeams) using identical delivery and setup conditions. Across all machines, subtracted images demonstrated clear, machine-specific patterns of isocenter walkout, visible as asymmetric intensity variations along the edge of the front pointer. Walkout magnitude and direction varied between machines and mechanical axes despite identical delivery configurations. This method provides a unique and clinically relevant assessment of machine isocentricity under treatment-like conditions and can still accurately determine whether machine performance is within clinical tolerances compared to traditional techniques.

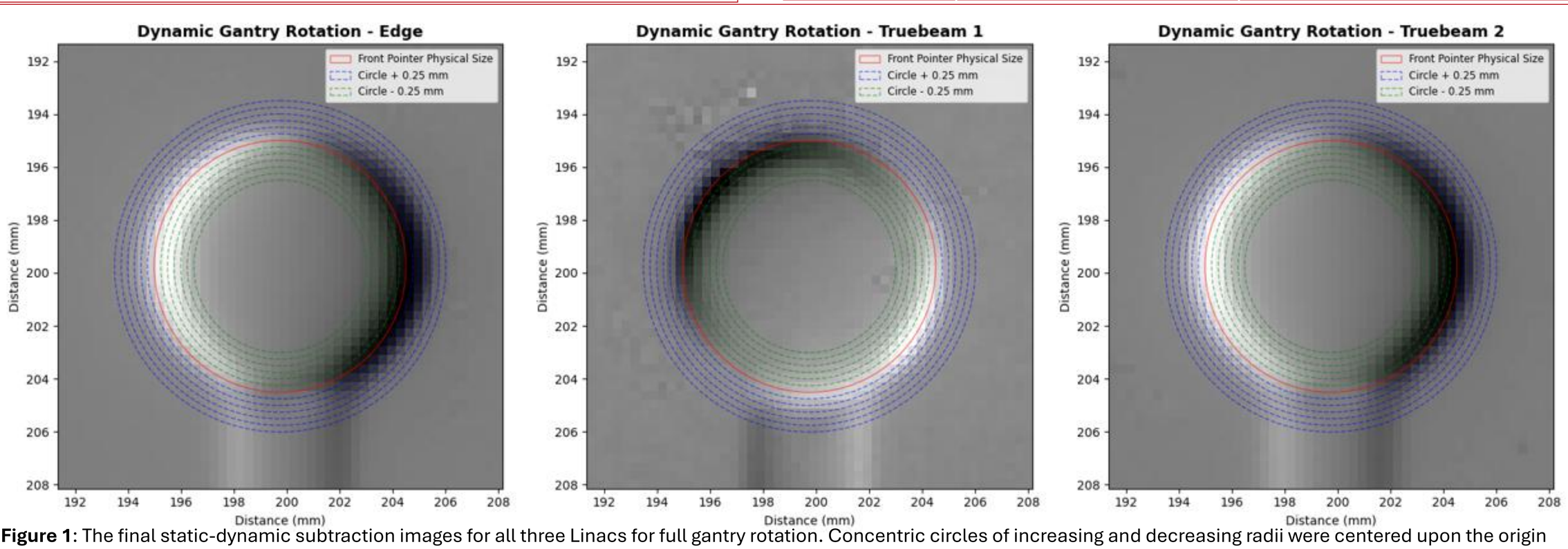


**Figure 1**: The final static-dynamic subtraction images for all three Linacs for full gantry rotation. Concentric circles of increasing and decreasing radii were centered upon the origin of the static image to help facilitate visual assessment of walkout magnitude.

## SUMMARY / CONCLUSION

This work demonstrates the feasibility of a dynamic and continuous-motion isocenter testing approach for visualizing isocenter walkout during dynamic beam delivery. The method provides clear axis-specific information for collimator and couch motion, while gantry rotation imaging currently yields walkout magnitude without directional specificity. These results suggest that continuous imaging may offer a complementary and potentially more comprehensive alternative to the conventional static imaging-based Winston-Lutz measurements, particularly if gantry-specific dimensionality can be resolved.

SITEMAN CANCER CENTER

WashU Medicine | BJC HealthCare