

Patient-Centric Imaging Via 3D Surface Fusion

Alexander Geiersbach¹, David J. Gladstone, ScD¹, Allison Matous, MD², Lesley A Jarvis, MD, PhD³, Brian W Pogue, PhD¹ and Petr Bruza, PhD¹

¹Thayer School of Engineering, Dartmouth College, Hanover, NH, ²Dartmouth Health, Lebanon, NH, ³Dartmouth Cancer Center, Lebanon, NH

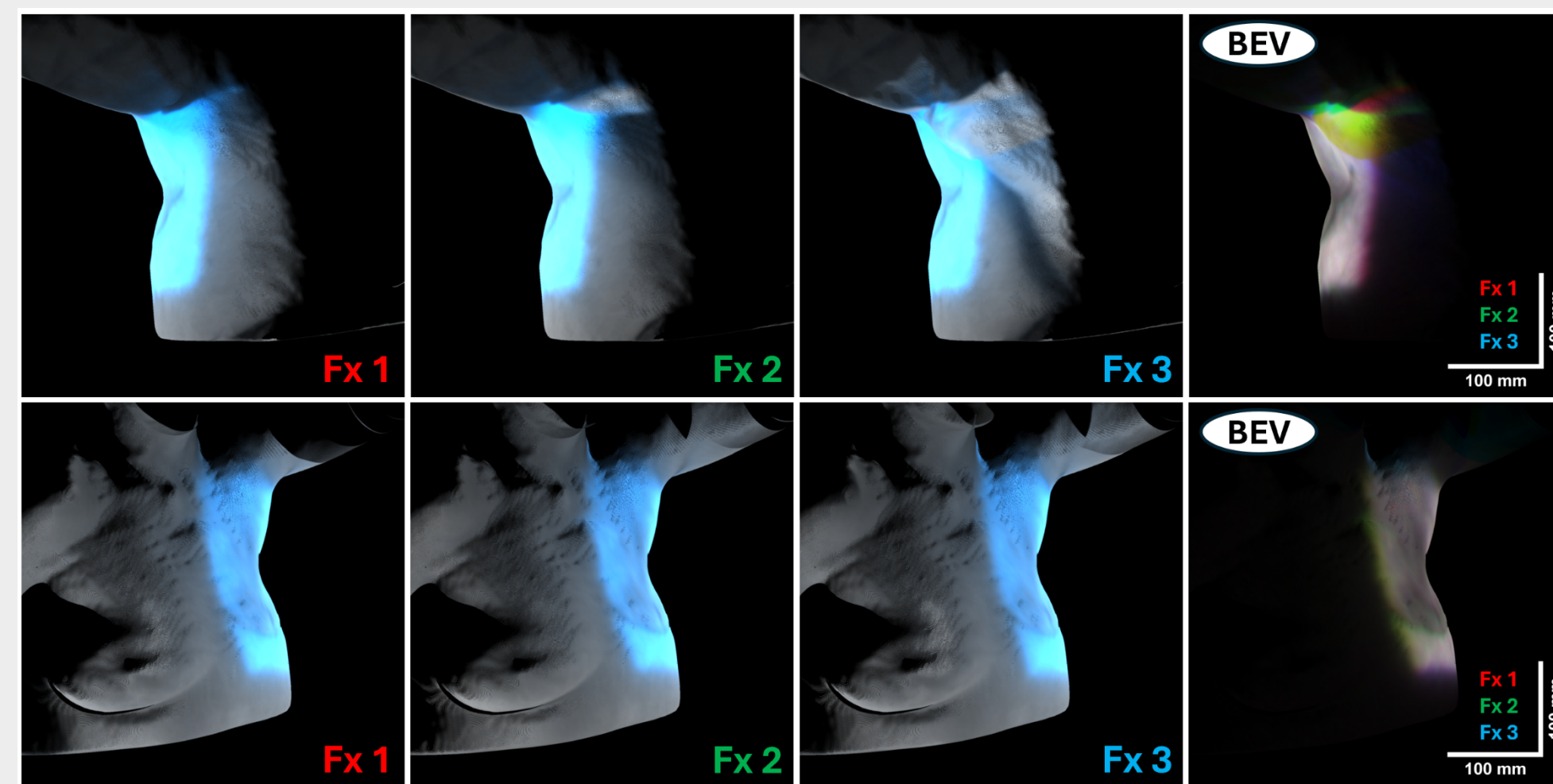
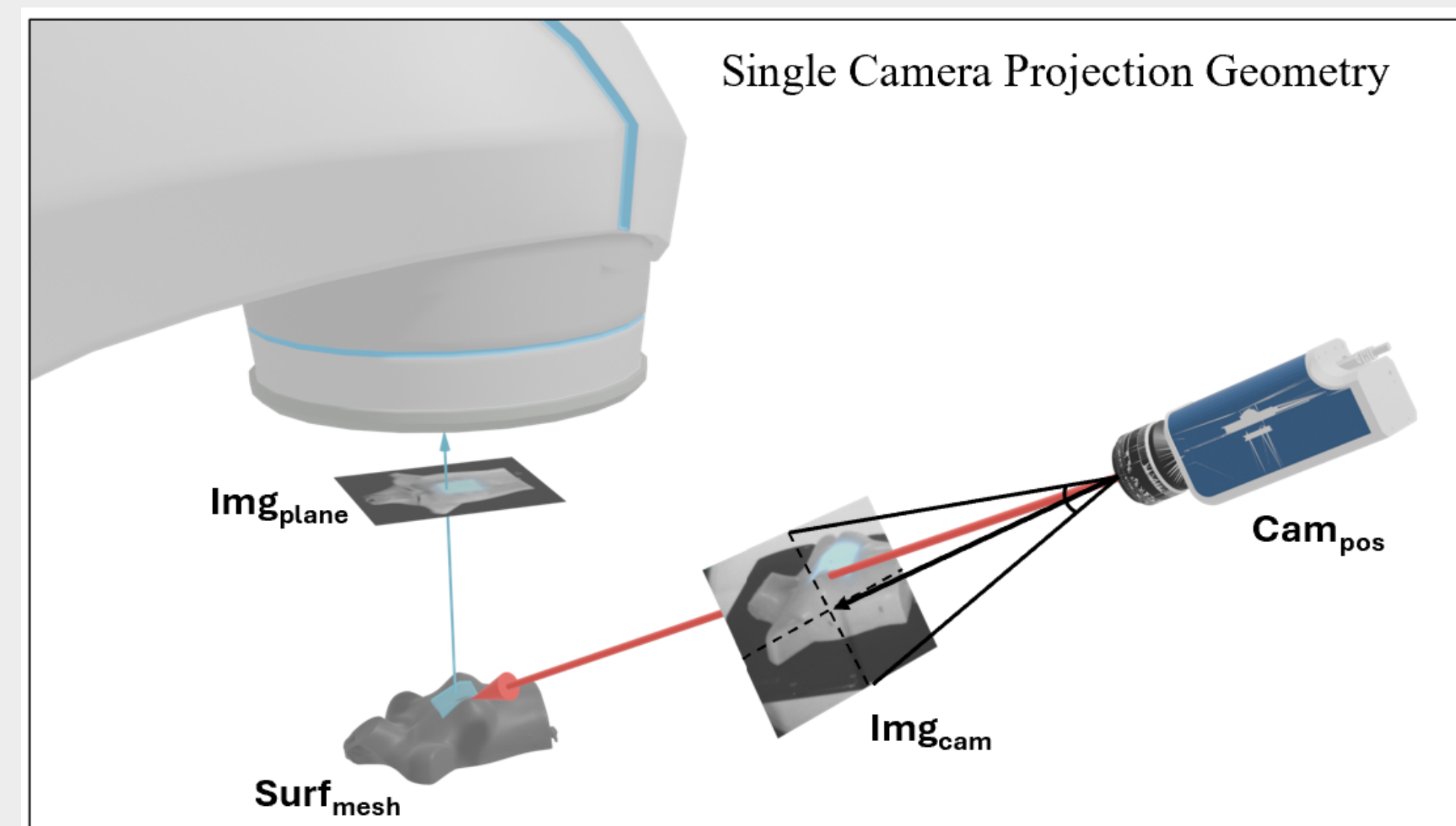
ABSTRACT

Purpose: Cherenkov imaging provides valuable beam delivery information, but fixed treatment camera positions are subject to gantry occlusions and couch rotation artifacts that inhibit imaging for a significant percentage of clinical cases. To overcome these limitations, we introduce a patient centric approach to Cherenkov imaging where 2D images are projected and fused onto 3D patient surfaces to generate patient centric images. The purpose of this work is to quantitatively compare planned surface dose maps to delivered Cherenkov beam outlines in clinical cases with couch kicks and gantry occlusions.

Methods: Calibrated Cherenkov cameras and CT surface meshes were utilized as inputs for the raytracing model. Gantry position data was retrieved from Varian log files and used to determine camera occlusion parameters. Cherenkov images were then raytraced onto patient surfaces and transformed into 3D patient centric datasets. These datasets were then used to reconstruct virtual unobstructed camera views and a virtual beam's eye view image. To validate the accuracy of patient centric datasets, a phantom study was conducted where fixed collimator angles with variable couch angles were compared to fixed couch angles with variable collimator angles and gamma analysis was performed.

Results: Camera fusion achieved >98% surface coverage on an anthropomorphic phantom and phantom study demonstrated clinically acceptable 2% match with 1.5 mm resolution between non-coplanar beam outlines and reference outlines. 10 patient datasets from a range of whole breast treatments were analyzed and presented to demonstrate the advantages of patient centric imaging. Patient centric Cherenkov beam outlines were compared to planned surface dose outlines to quantify the impact of couch rotations on clinically relevant metrics such as supraclavicular match lines and inter-fraction motion.

Conclusion: Patient centric Cherenkov imaging demonstrates that gantry occlusions and couch rotations can be corrected for, enabling quantitative Cherenkov imaging to be useful for complex treatment deliveries.



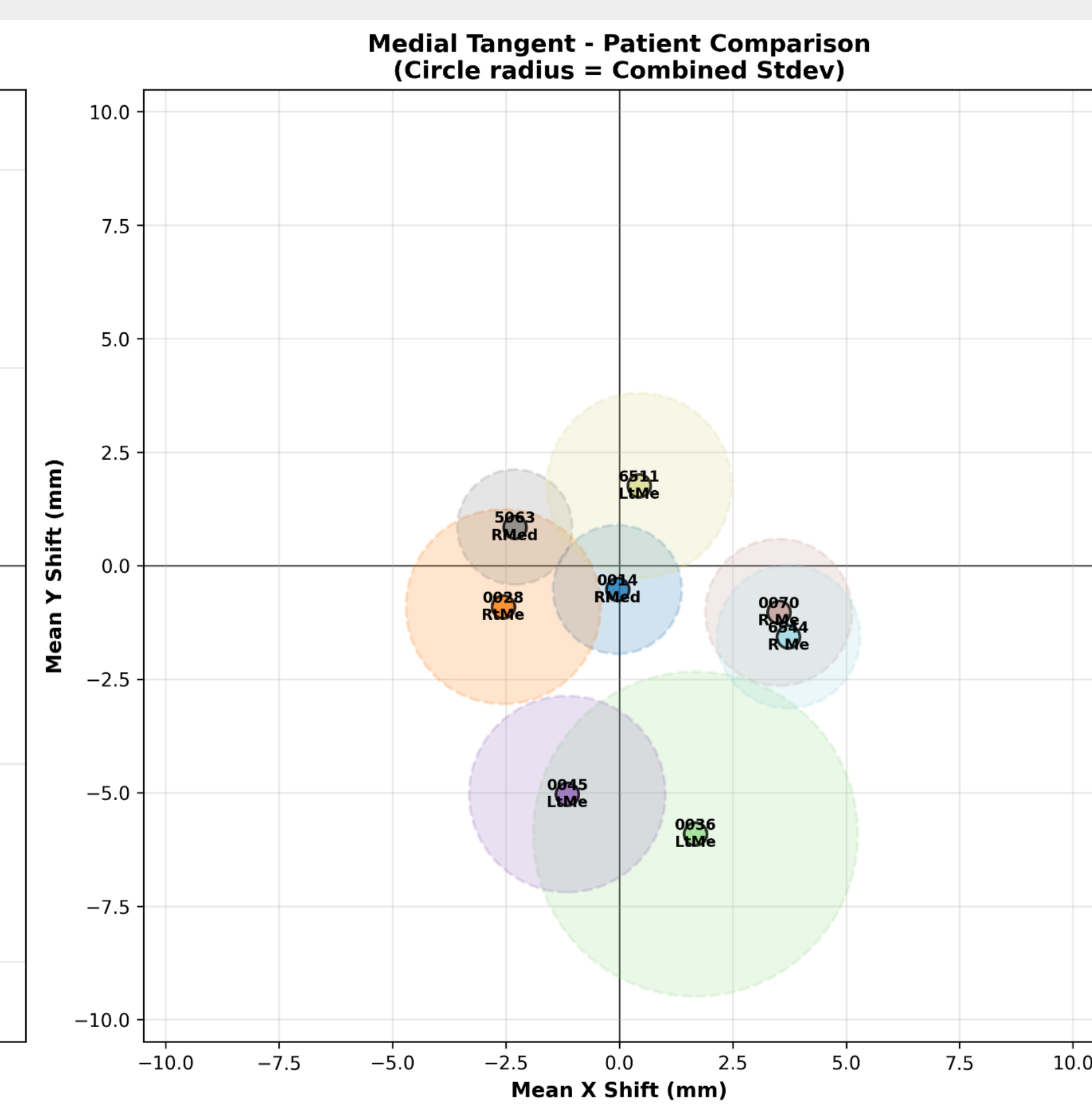
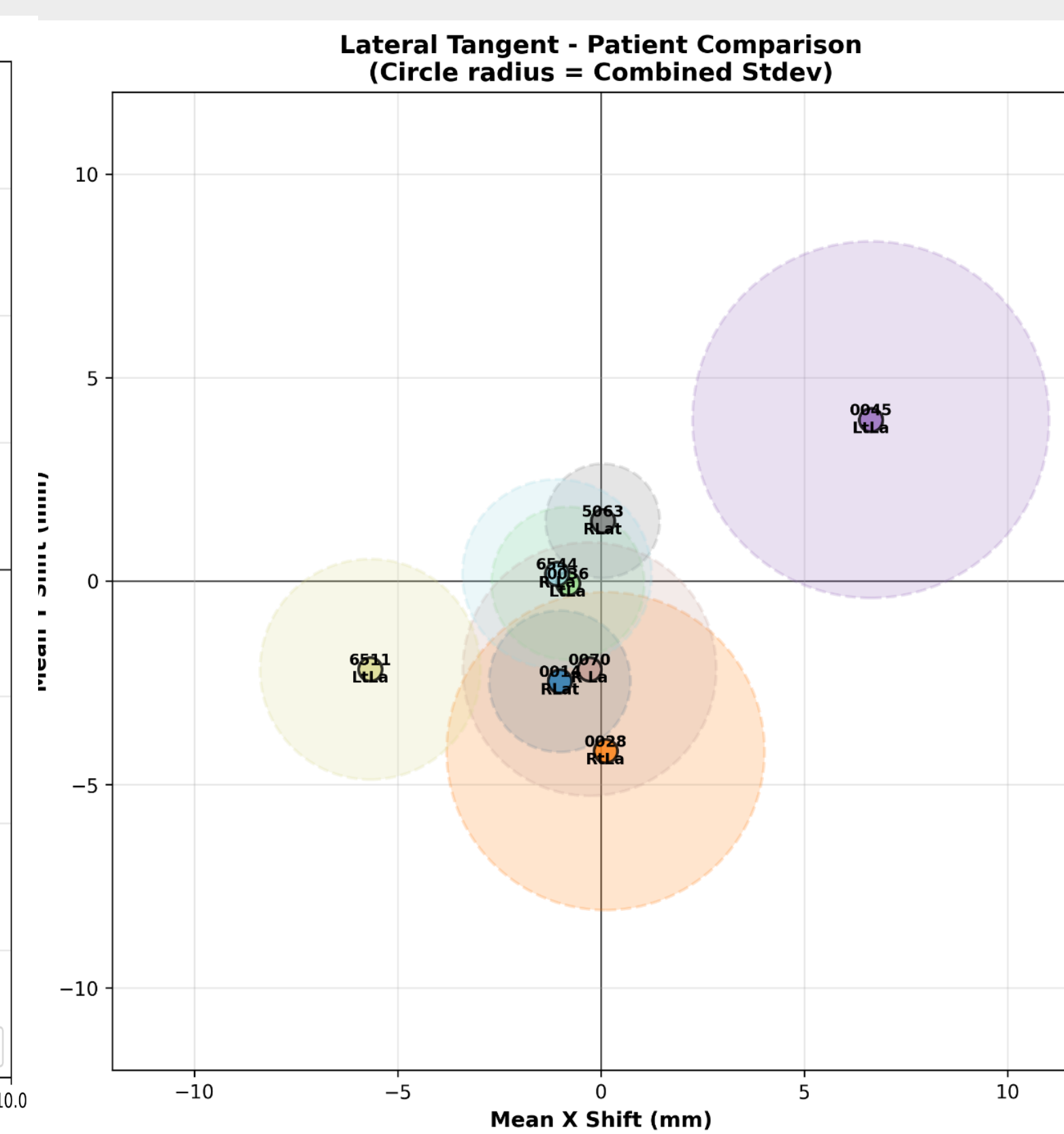
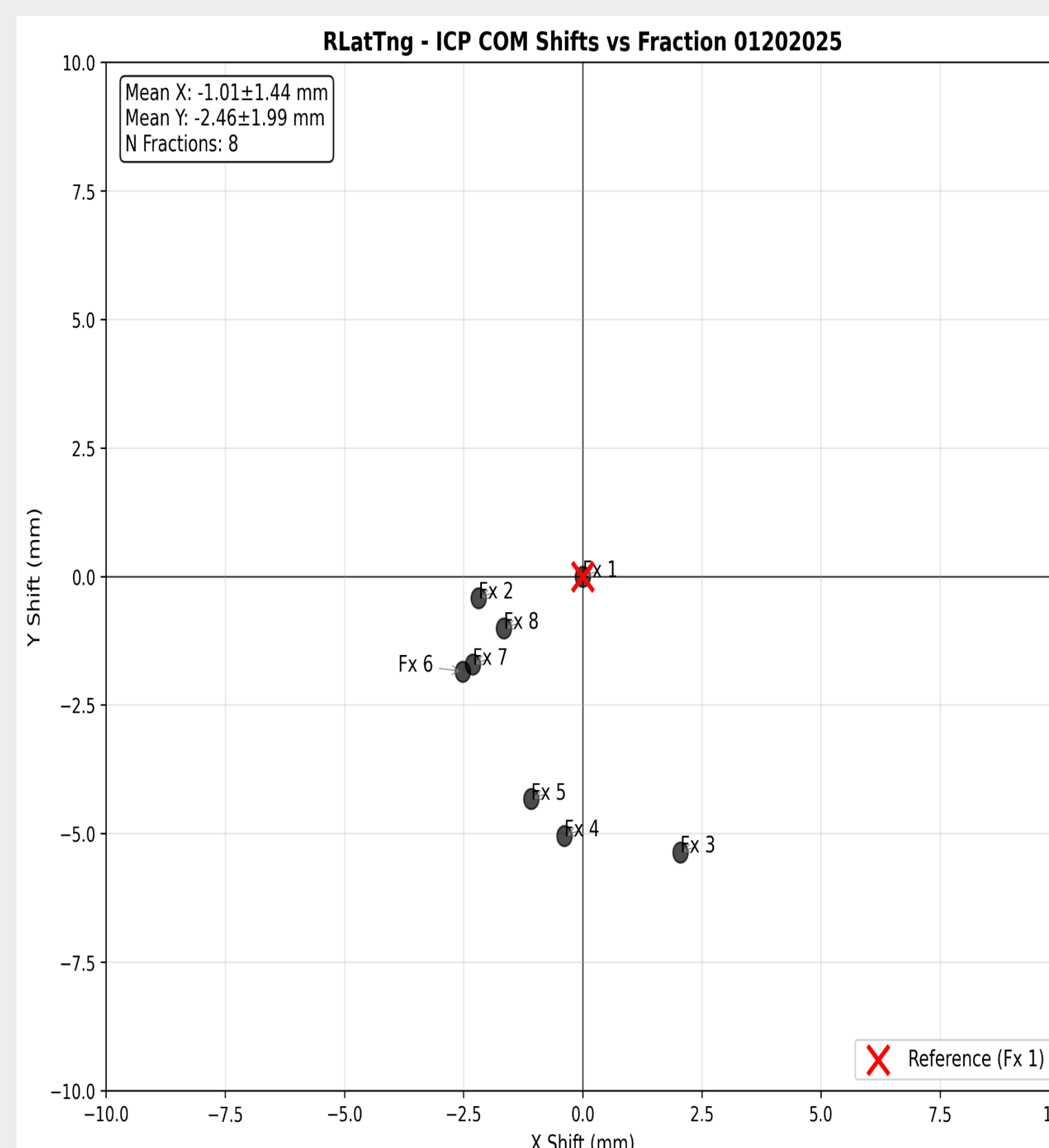
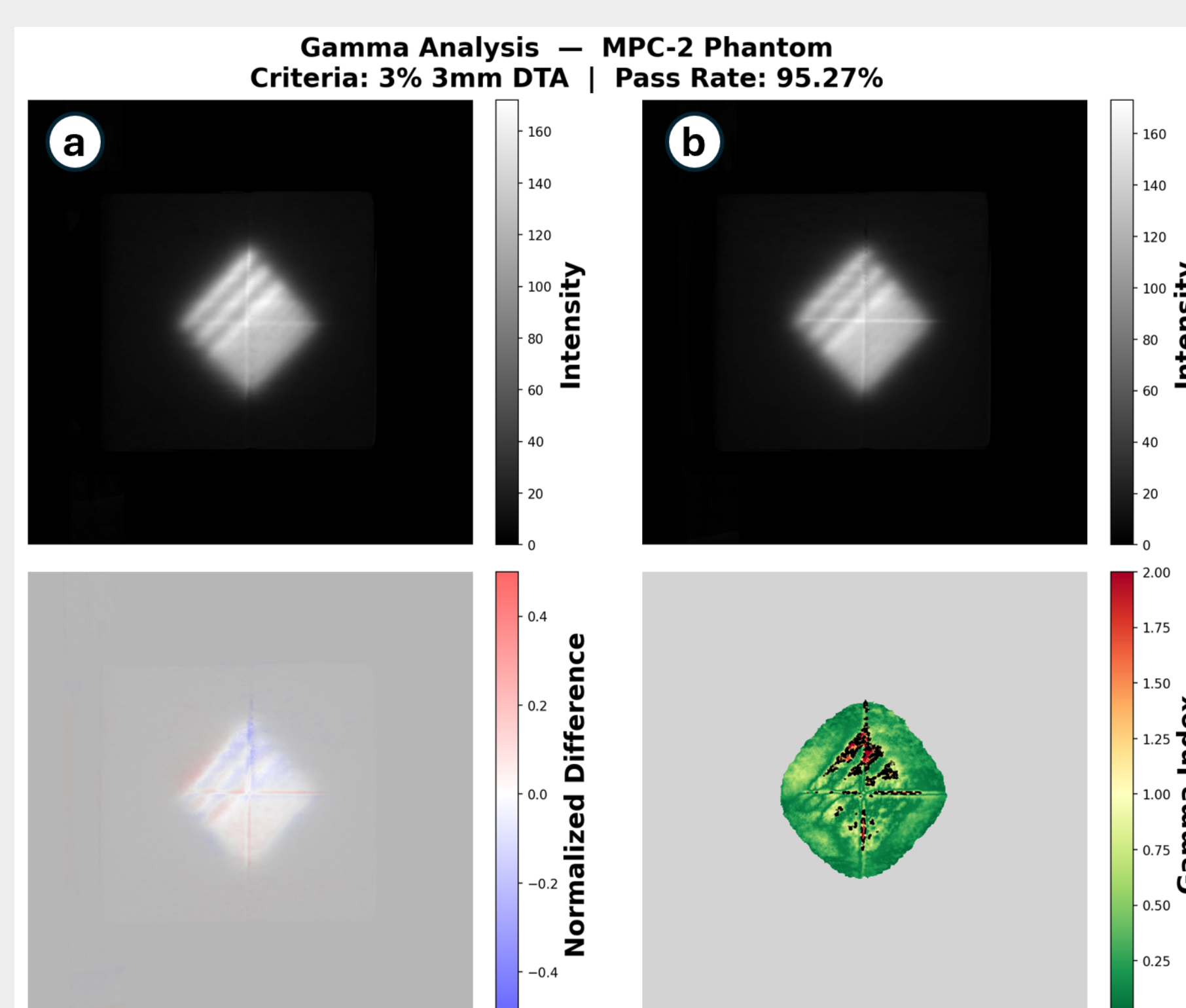
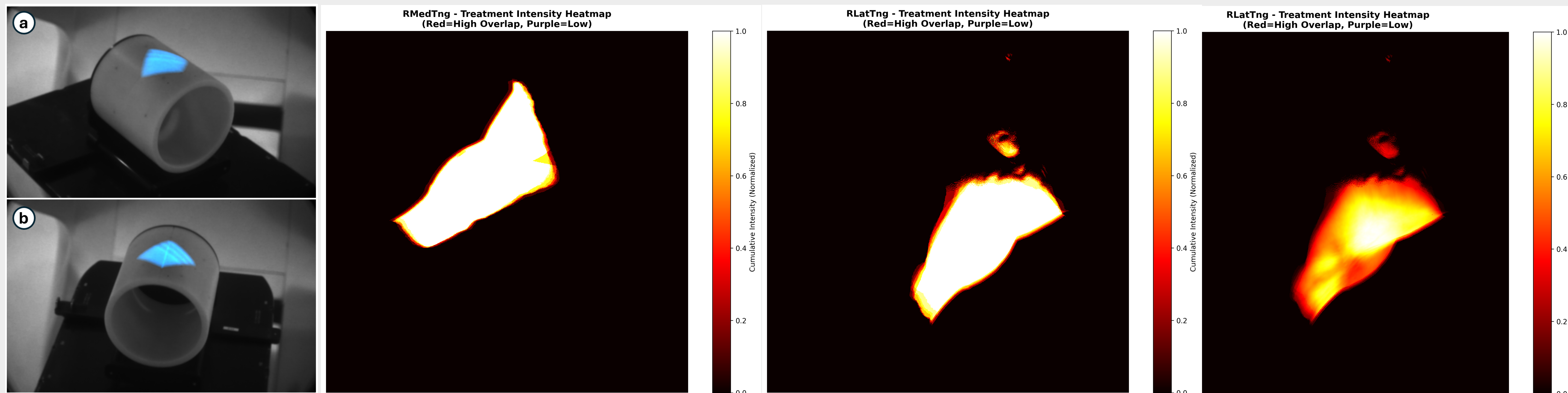
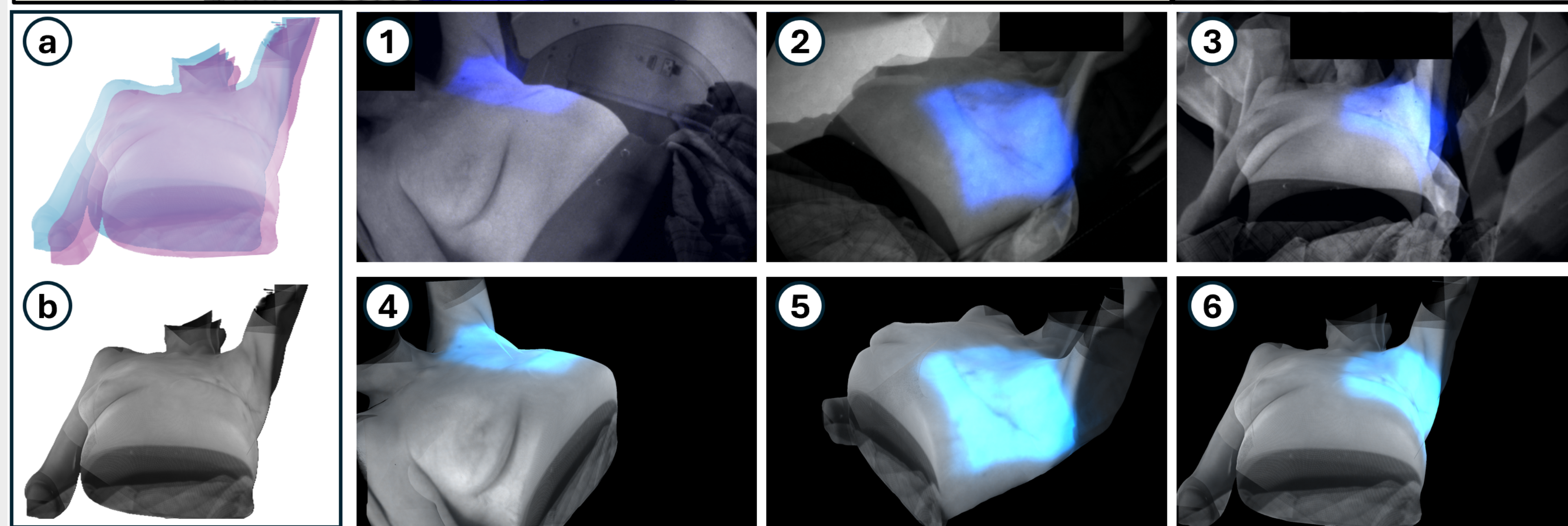
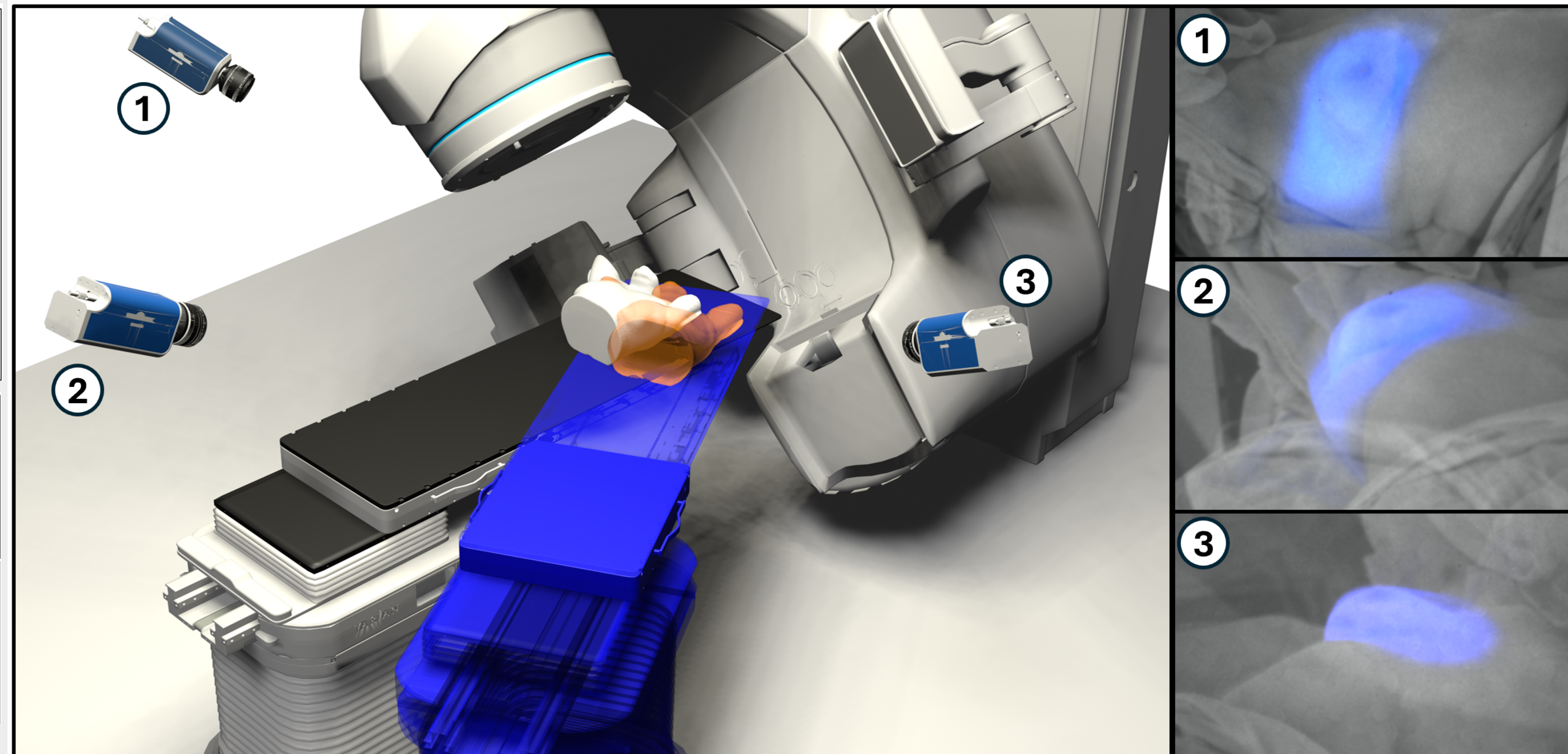
[Above]: Patient Centric Raycasting methodology and fraction-to-fraction quantitative analysis

[Top and Middle Right]: Couch rotation example with cumulative image ghosting artifacts. Patient centric imaging eliminates image artifacts

[Bottom Left]: Phantom validation study with gamma analysis

[Bottom Right (Middle)]: Patient Beam's Eye View (BEV) images with multi-fraction analysis.

[Bottom Right]: Interfraction BEV shifts and overall field shifts for each patient shown in



CONTACT

Alexander Geiersbach
(302)-824-6834
Alexander.Geiersbach.TH@Dartmouth.edu