

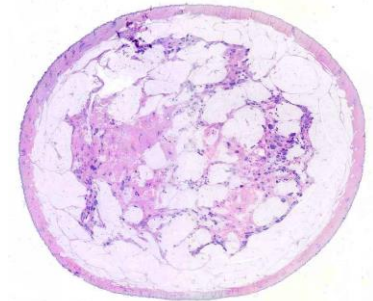
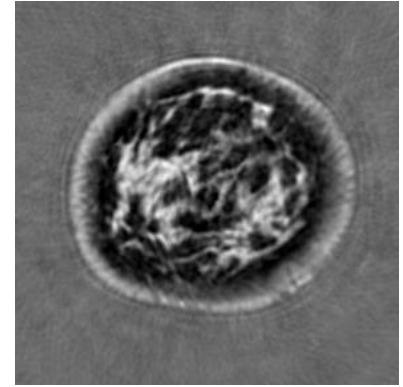
Radiologic-pathologic validation of transmission ultrasound tomography using microscopy with UV surface excitation

Bilal Malik¹, Austin Todd², Alyson Terry¹, Farzad Fereidouni², Rajni Natesan¹, John Klock¹, James Wiskin¹, Mark Lenox¹ and Richard Levenson²

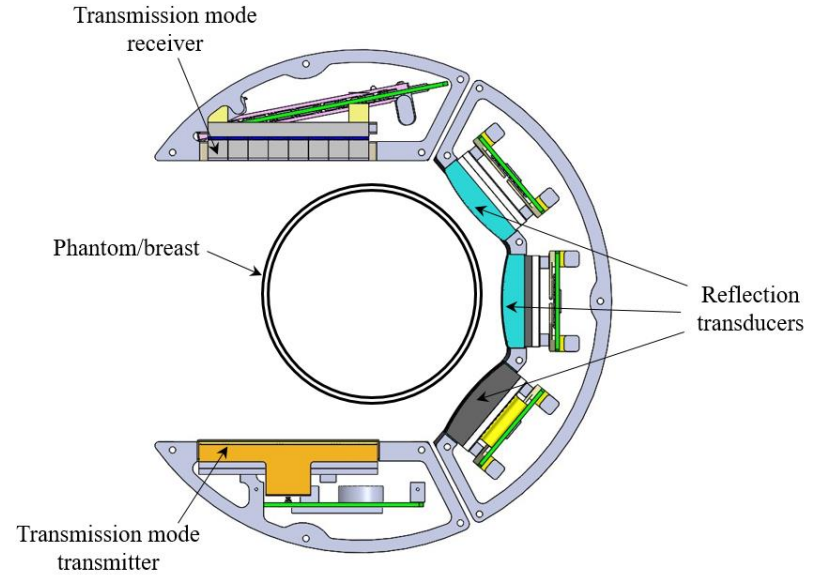
Visualizing breast anatomy in transmission ultrasound

- Transmission ultrasound tomography is a relatively new modality, now FDA-approved for breast imaging.
- Essentially multimodal imaging: provides both transmission and reflection properties.
- Compares well with breast MR and CT images.

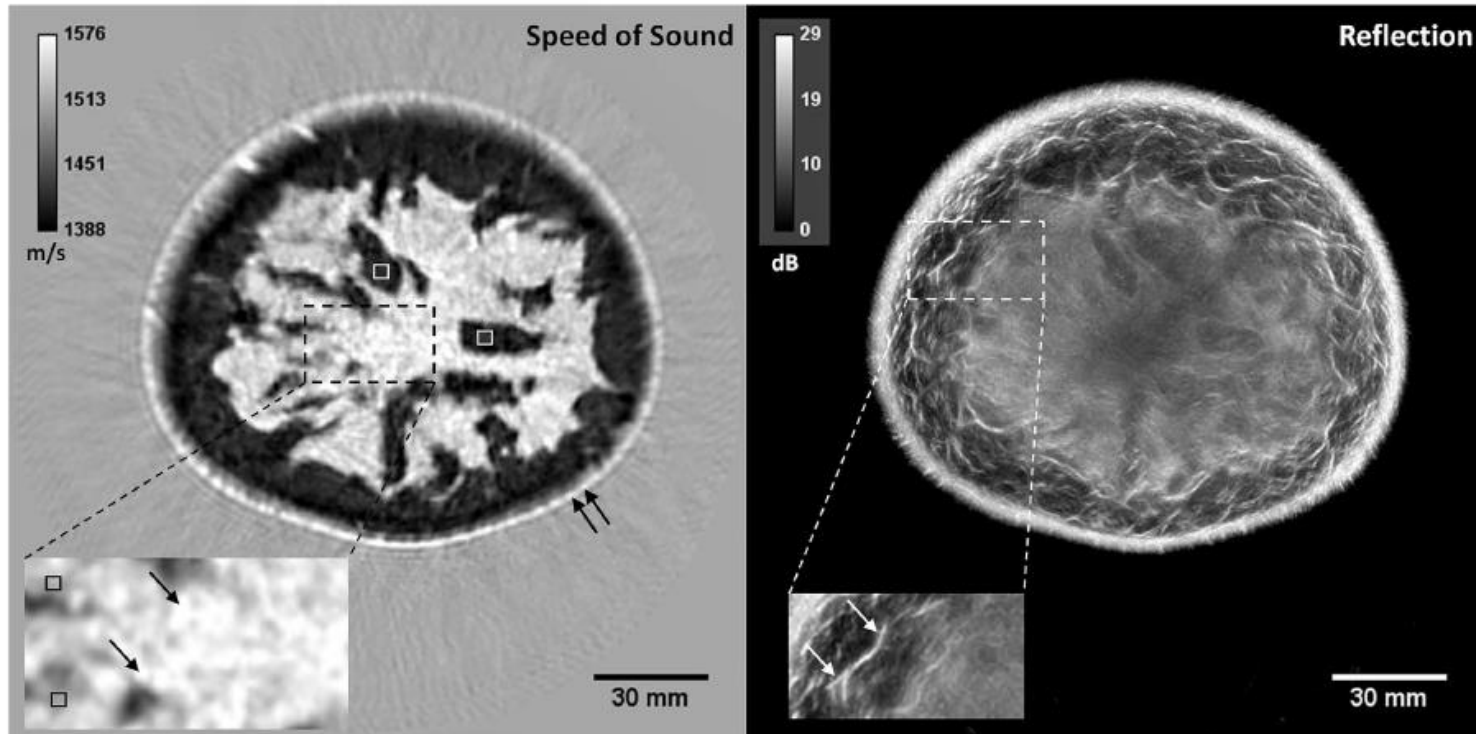
We show that the features delineated by ultrasound tomography identify actual breast tissue type – compared to ground truth.



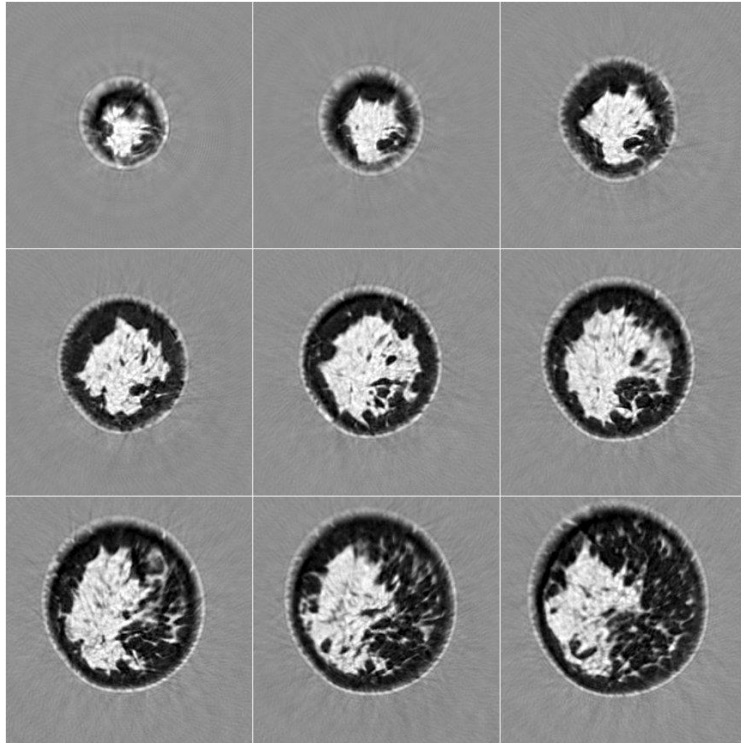
QT Scanner – transmission and reflection ultrasound



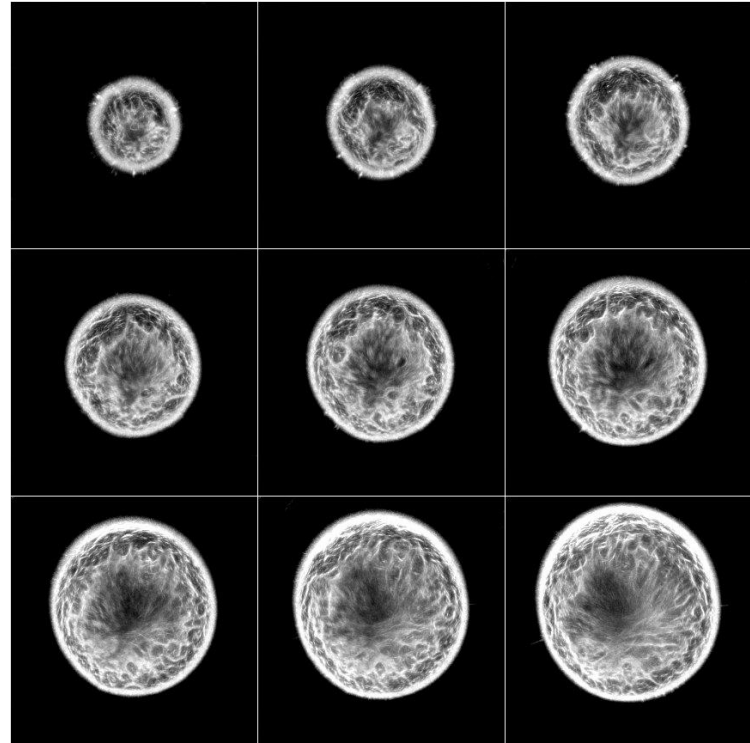
QT speed of sound and reflection images



3D image volume of speed of sound and reflection

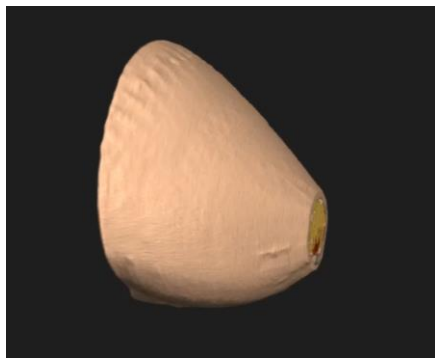


Speed of Sound

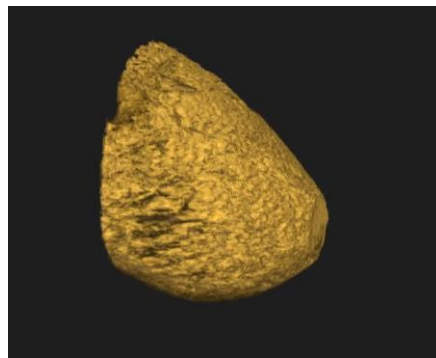


Reflection

Segmented tissue volumes



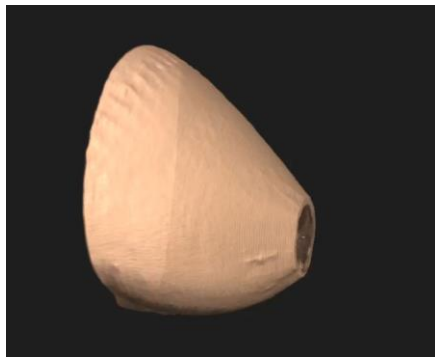
Whole breast



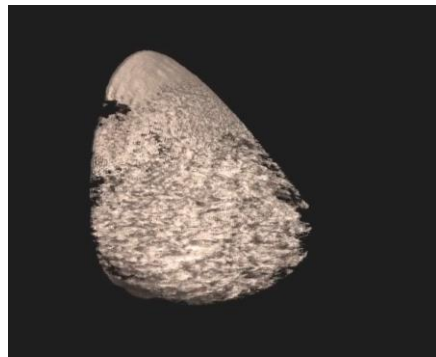
Fat



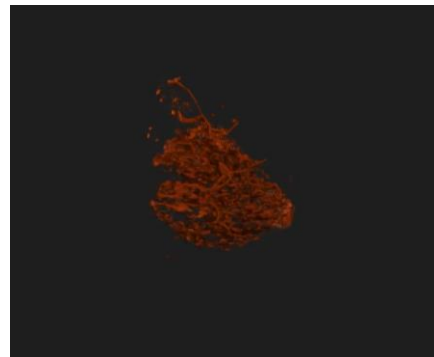
Glands



Skin

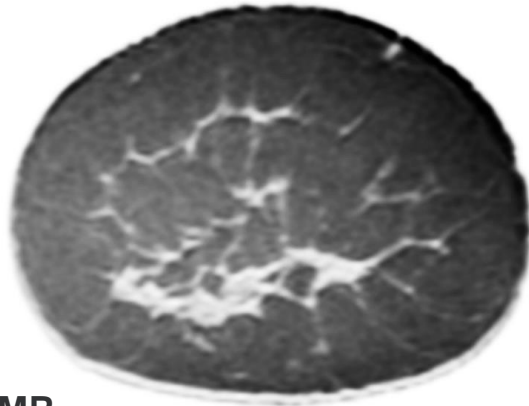


Connective tissue

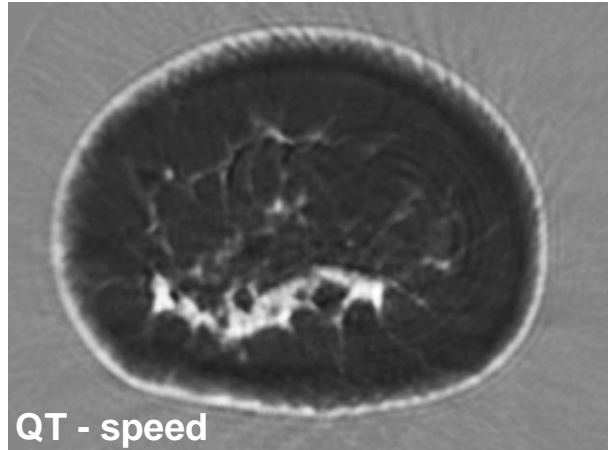


Ducts

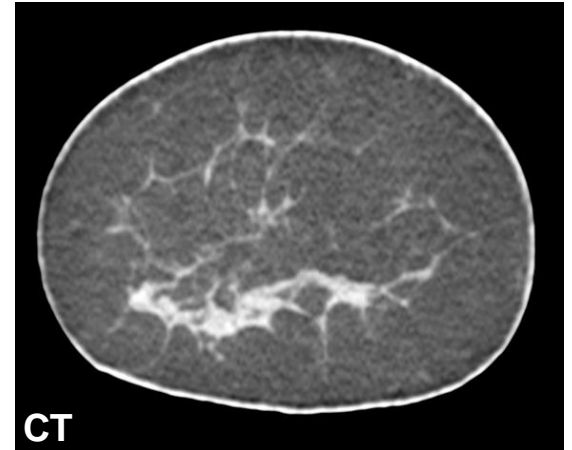
Comparative imaging of cadaver breasts



MR

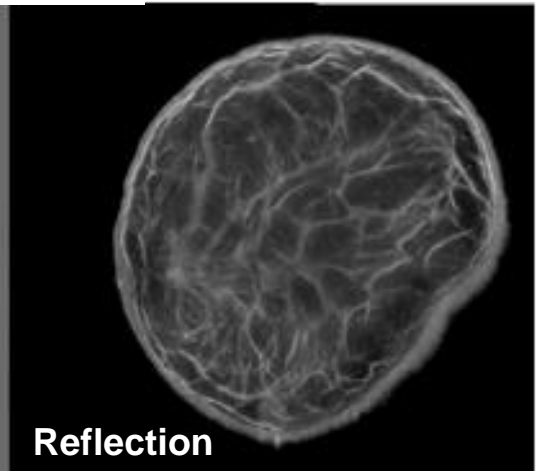
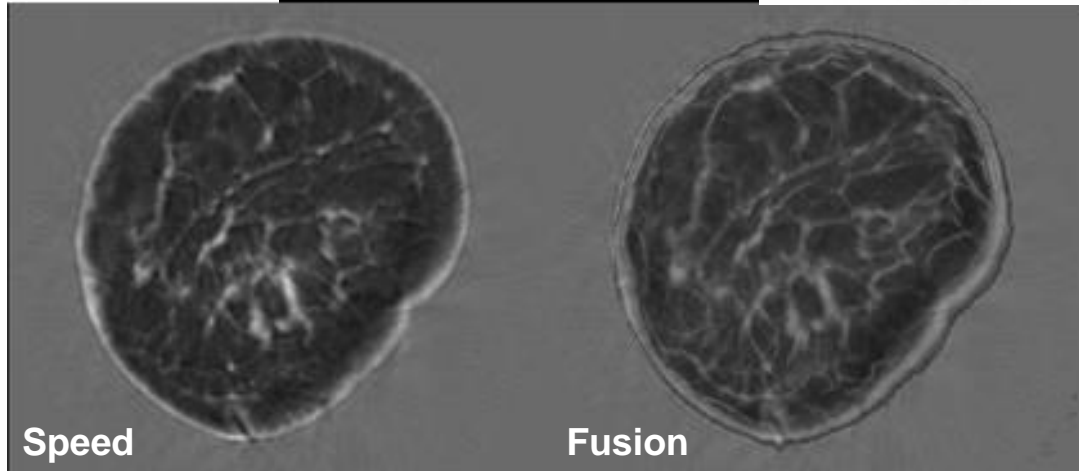
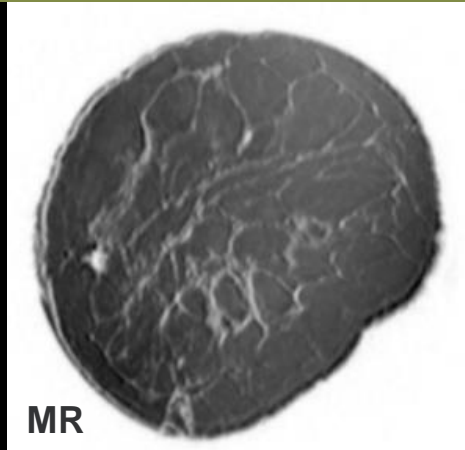
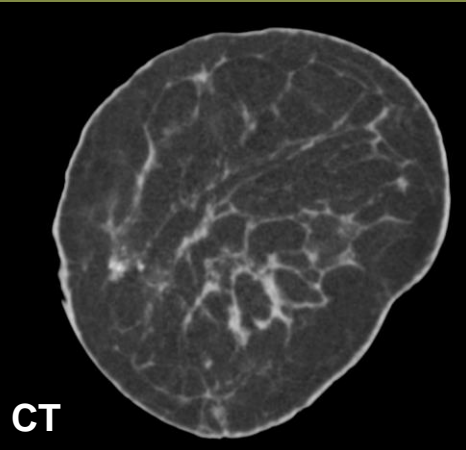


QT - speed

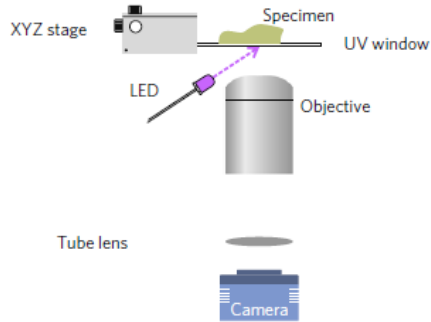


CT

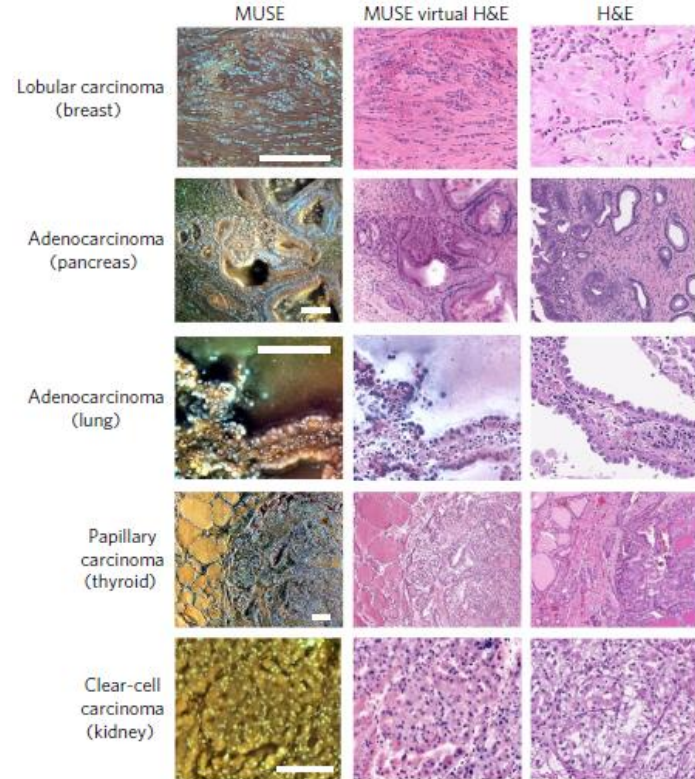
Comparative imaging of cadaver breasts



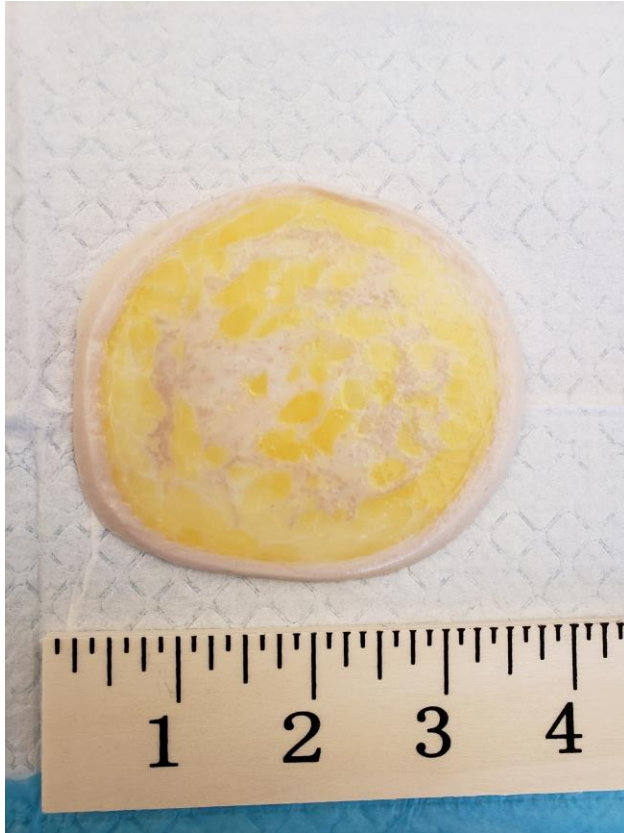
Microscopy with ultraviolet surface excitation (MUSE)



- Rapid slide-free histology
- Requires minimal tissue prep
- Images resembling those obtained from conventional H&E histology
- Has no impact on downstream molecular assays (e.g. FISH and sequencing)

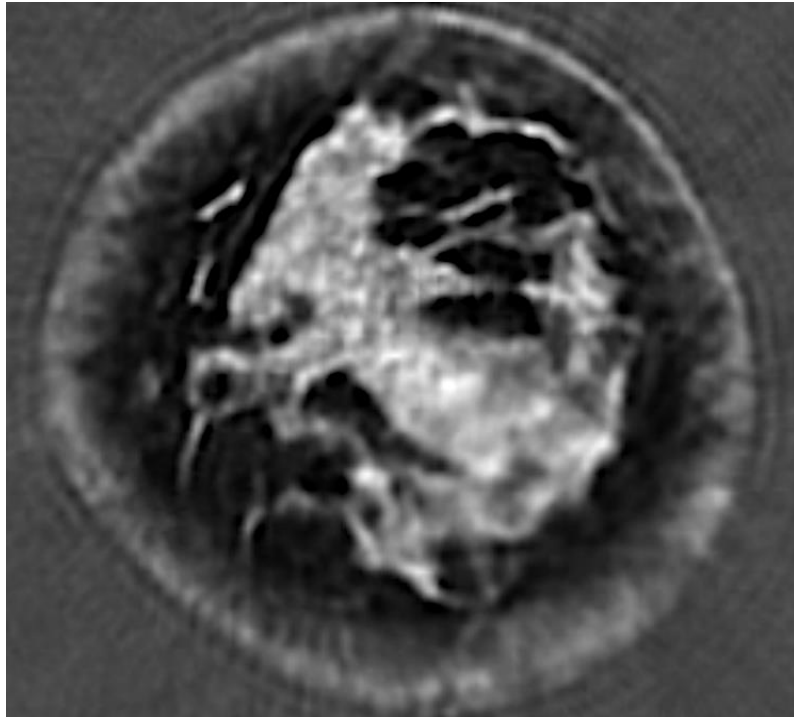


MUSE of cadaver breast tissue

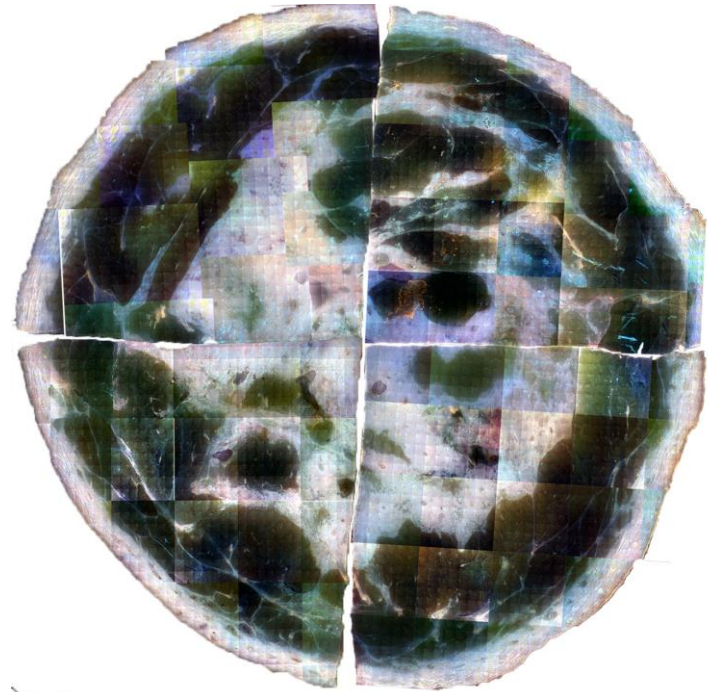


- Cadaver tissue section divided into four slices to fit the imaging area
- Rhodamine-Hoechst solution for staining
- Immersed in stain for 20 seconds following by rinsing with DI water for 20 seconds.
- Tissue section immediately placed on sapphire plate of the microscope

QT correlation with ground truth using UV microscopy

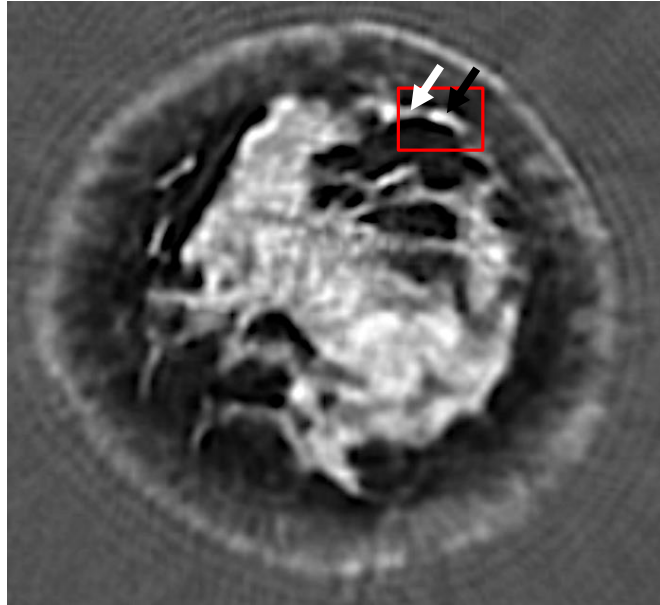


QT speed of sound image

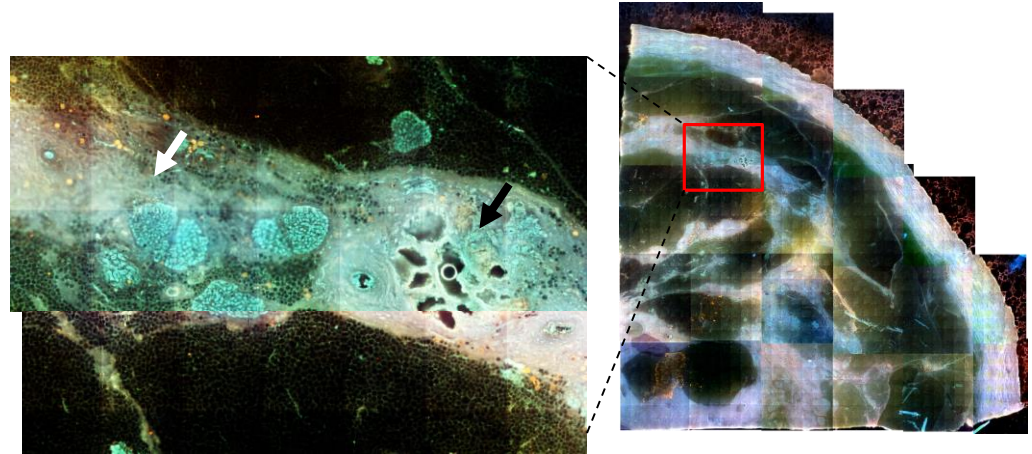


Histology image generated by UV microscopy

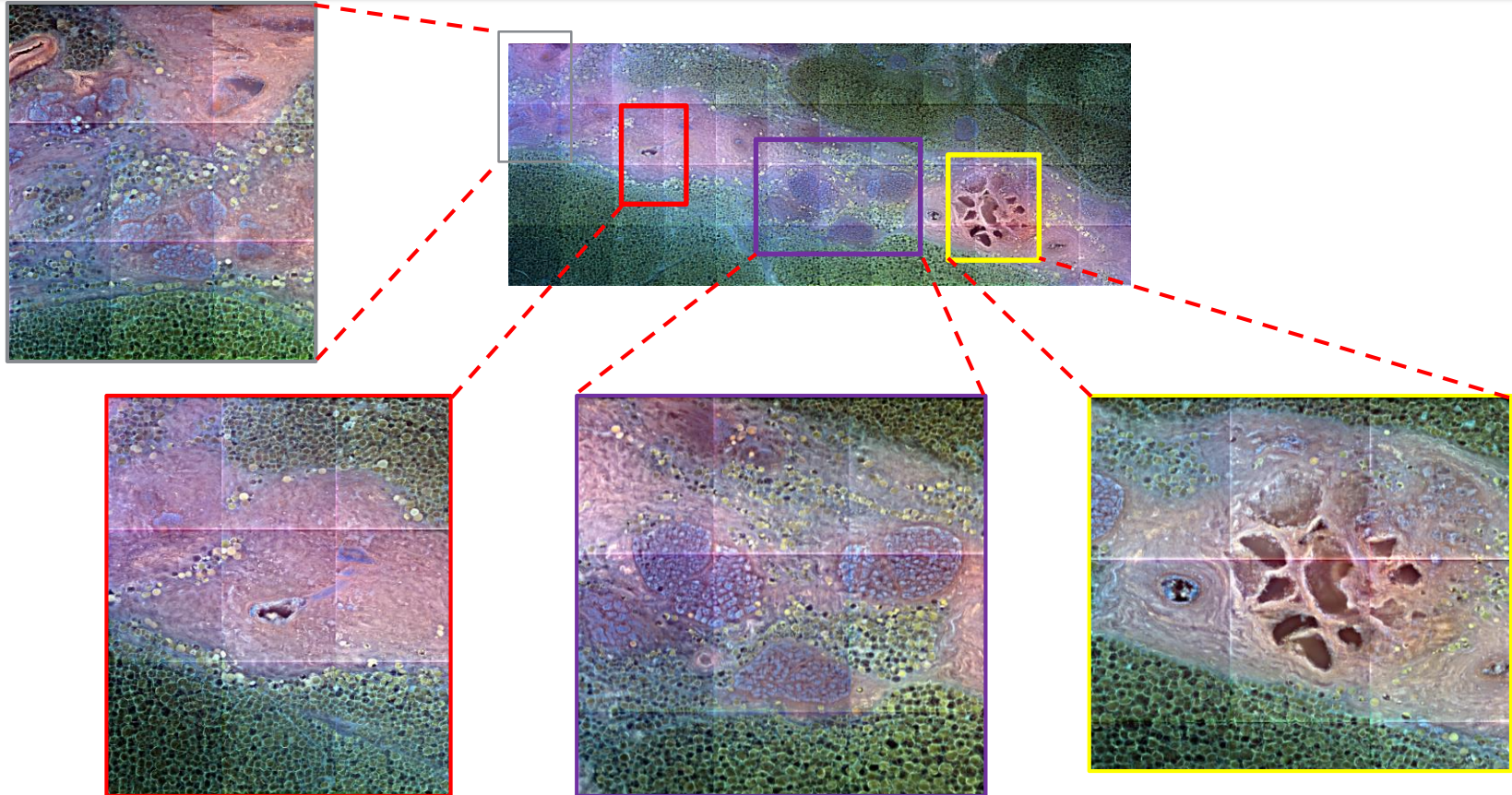
Correlation with ground truth – ducts



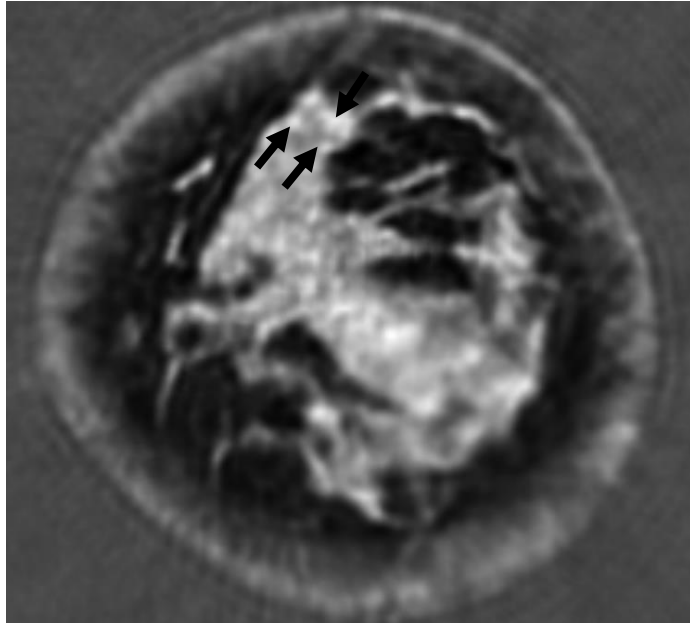
QT speed of sound image



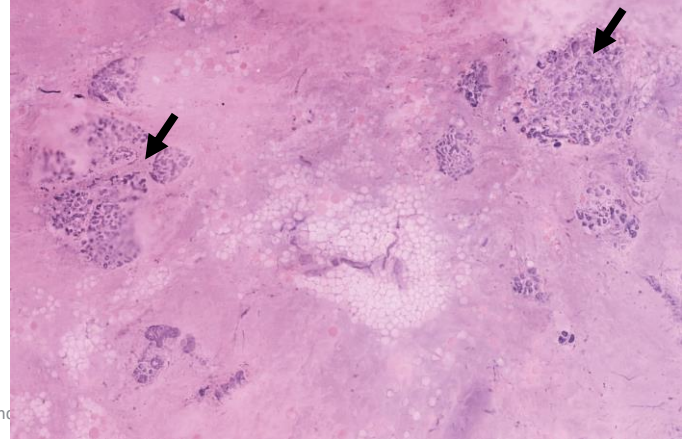
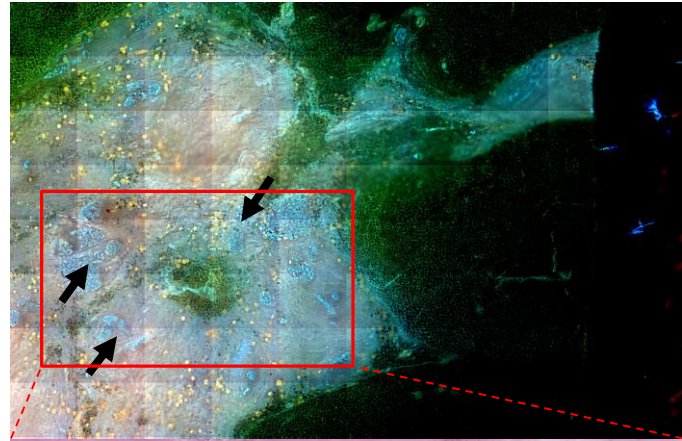
Anatomy as identified by MUSE



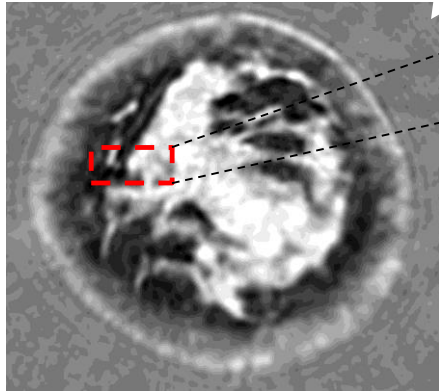
Correlation with ground truth – glandular tissue



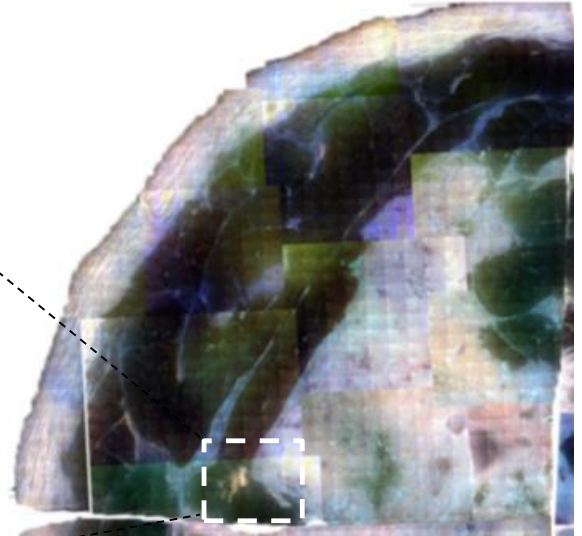
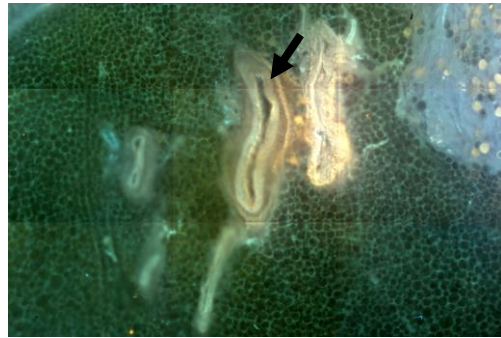
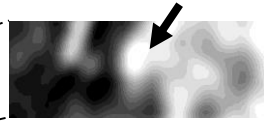
QT speed of sound image



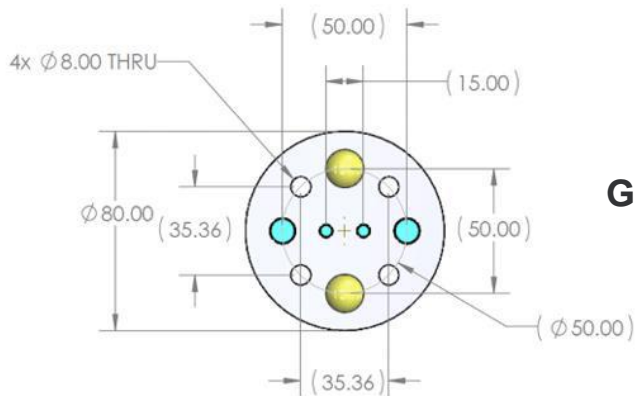
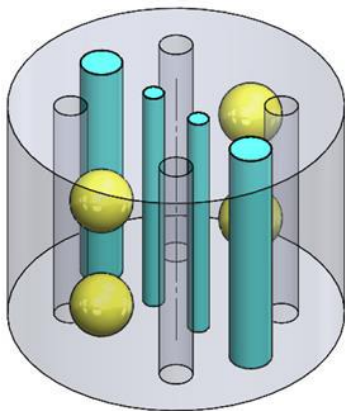
Correlation with ground truth – blood vessels



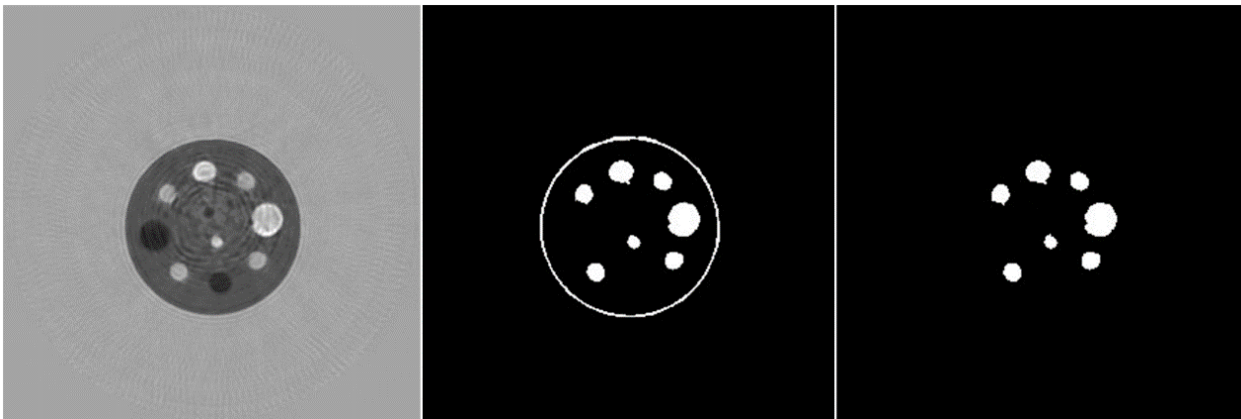
QT speed of sound image



Ground truth for quantitative breast density (QBD) - phantom



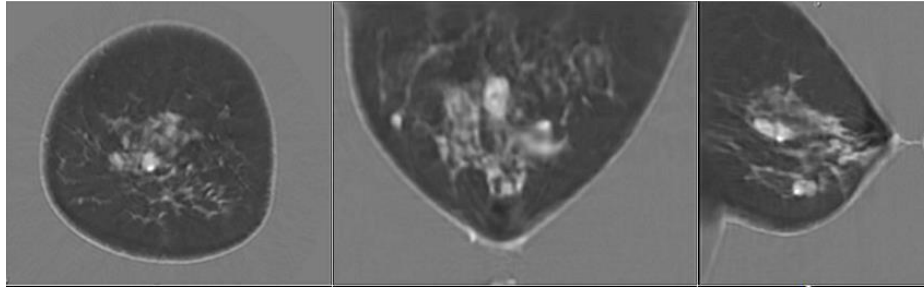
Geometric density = 18.66 %



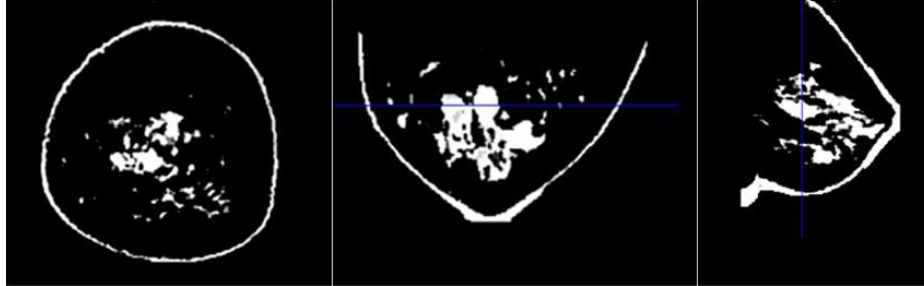
QBD = 18.70 %

Ground truth for quantitative breast density – breast tissue

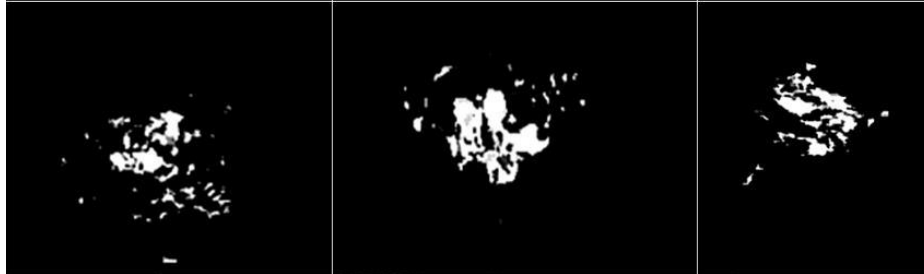
QT speed of sound image



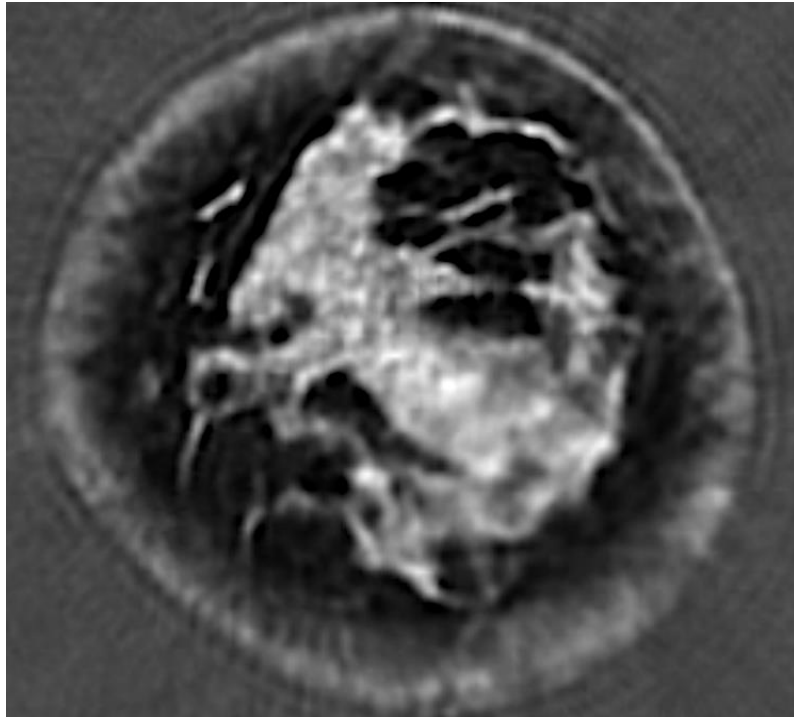
Segmented high speed tissue



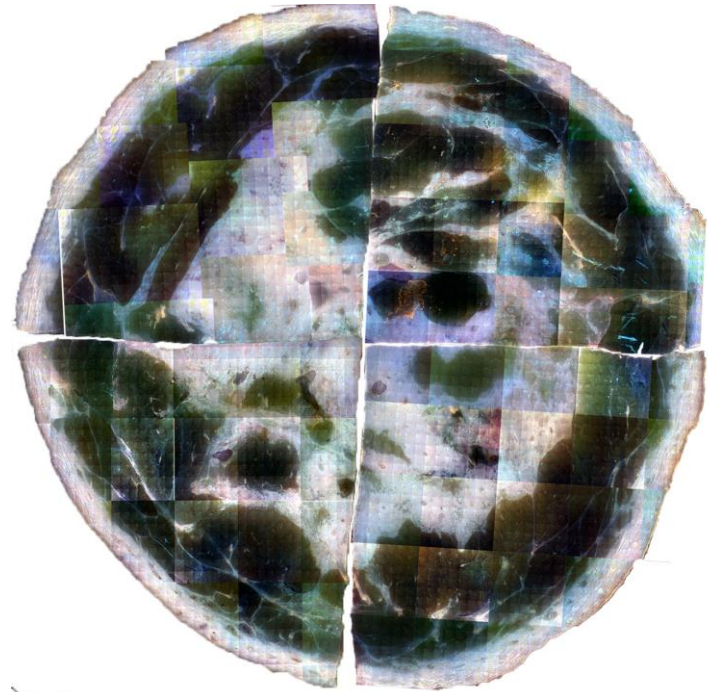
Segmented fibroglandular tissue



Quantitative Breast Density – amount of fibroglandular tissue

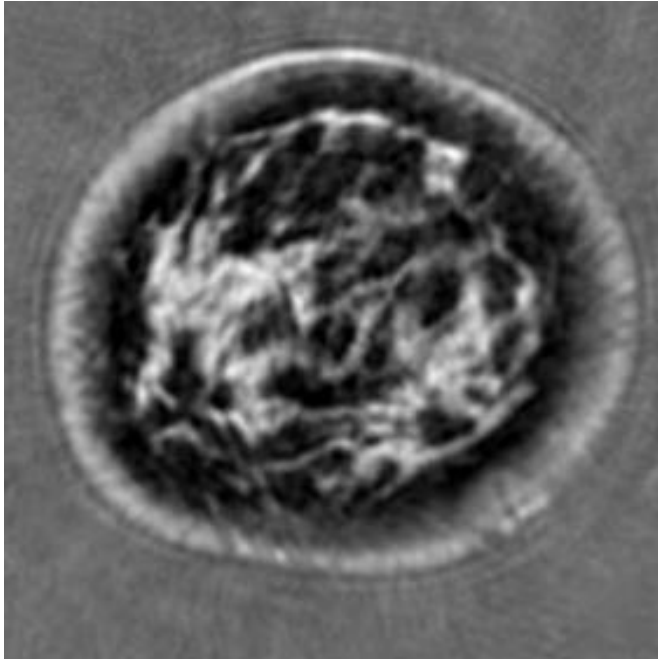


QT speed of sound image – QBD= 34.7%

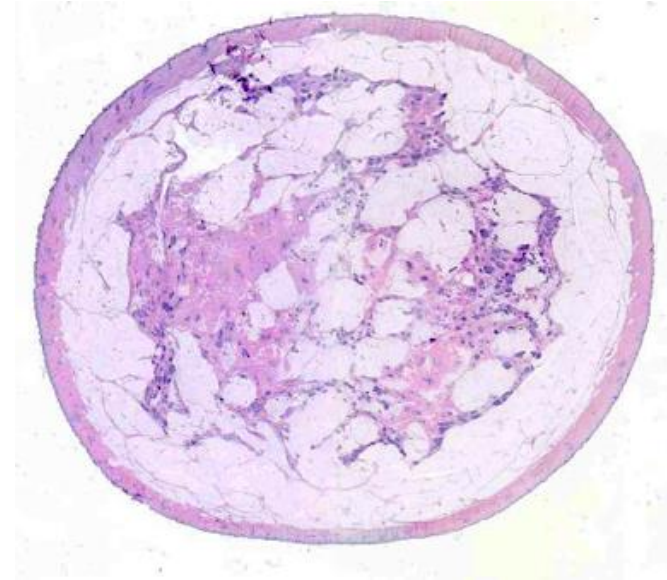


MUSE image – equivalent breast density = 37.9%

Quantitative Breast Density agreement using H&E



QT speed of sound image – QBD = 45.1 %



H&E image – equivalent breast density = 42.3 %

However, H&E process requires multiple days. MUSE process requires minutes to hours.

Conclusion

- Full 3D transmission ultrasound has a remarkable ability in identification of breast anatomical structures.
- Multimodality comparison shows that transmission ultrasound tomography can be useful in understanding breast anatomy and physiology.

Next Steps:

- Comparison of volumetric images generated by QT and MUSE

Acknowledgements

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 - Farzad Fereidouni

