AI-based quantitative breast density assessment using transmission ultrasound

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Disclosures

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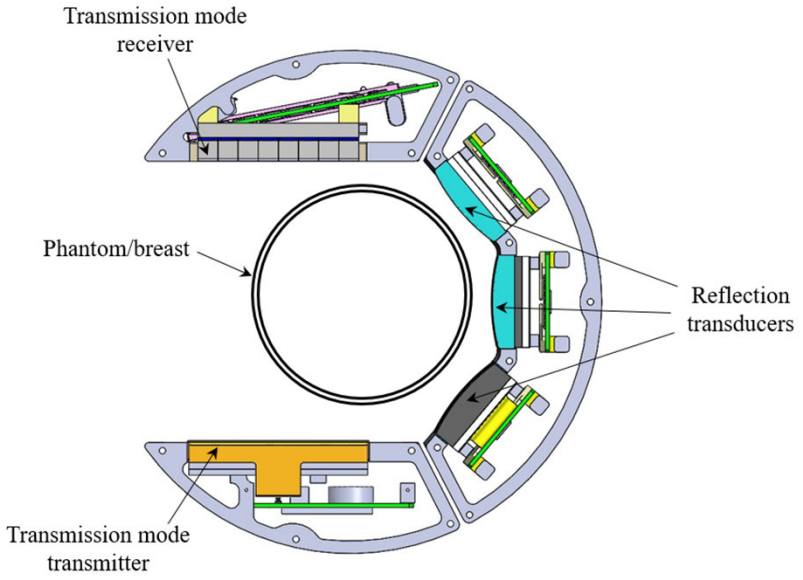
Purpose

Growing body of evidence indicates that breast density is one of the most important independent risk factors of breast cancer

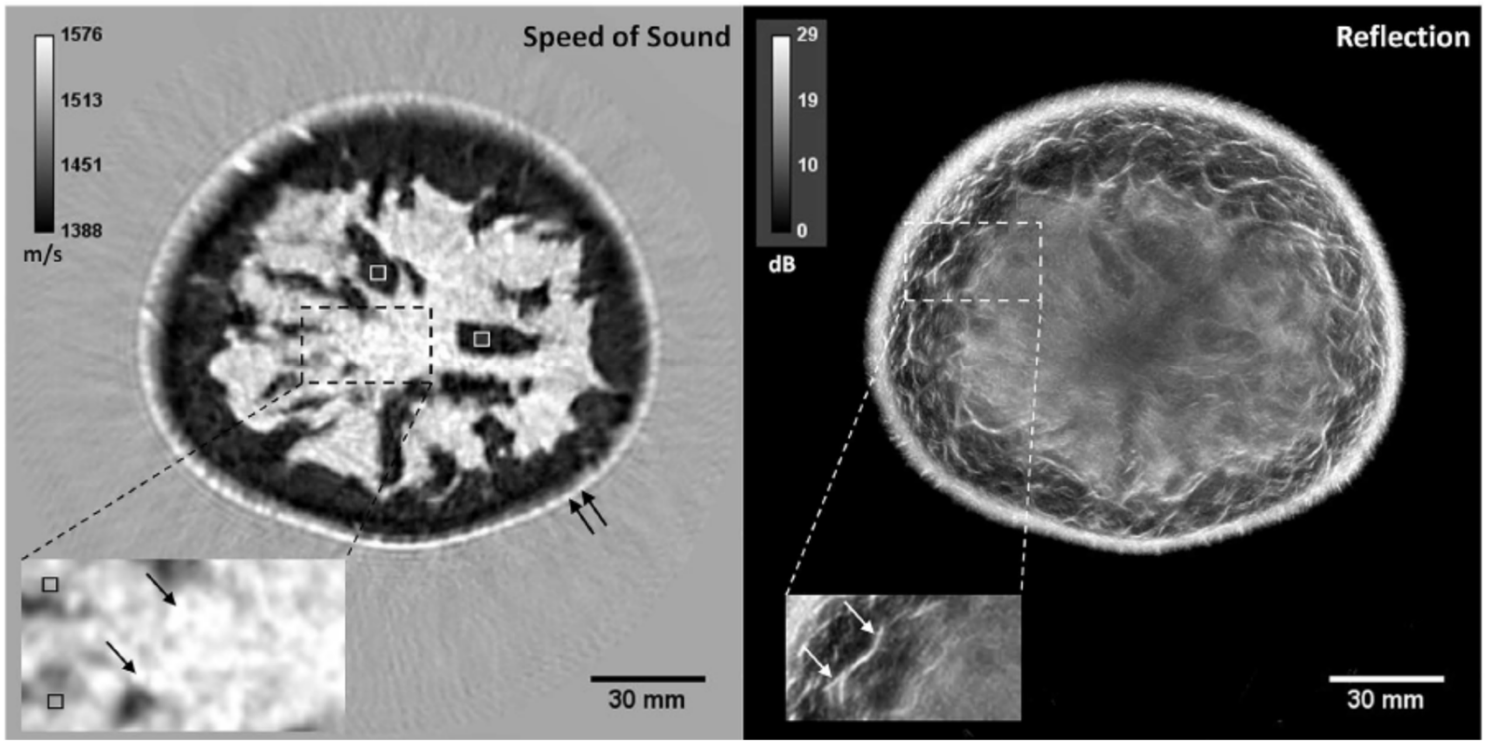
Currently, mammography is the only FDA-cleared means to evaluate breast density in a general screening population.

We present 3D transmission ultrasound as a method to visualize and differentiate fibroglandular tissue within the breast and use a fully automated segmentation method machine learning-based method to quantitatively assess the breast density

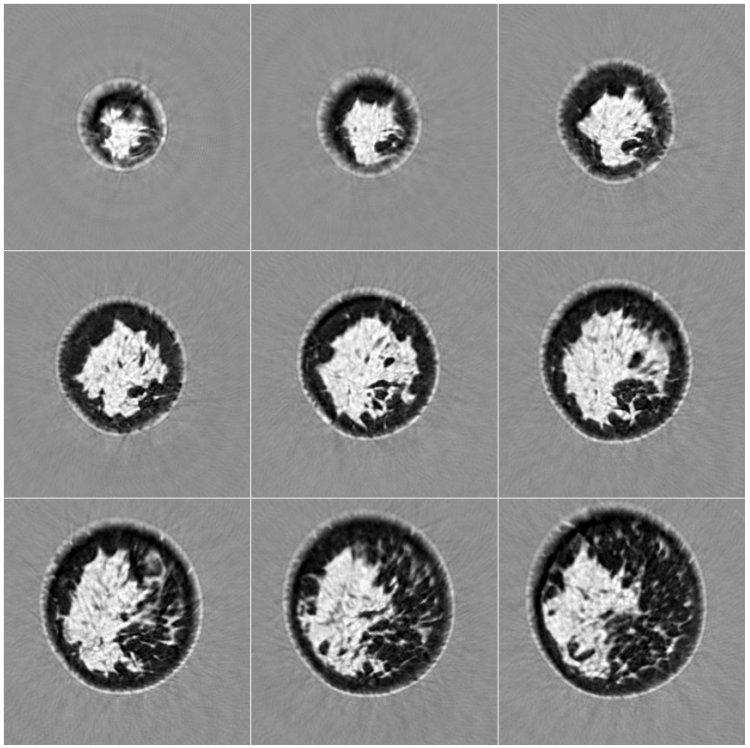
QT Scanner – transmission and reflection ultrasound



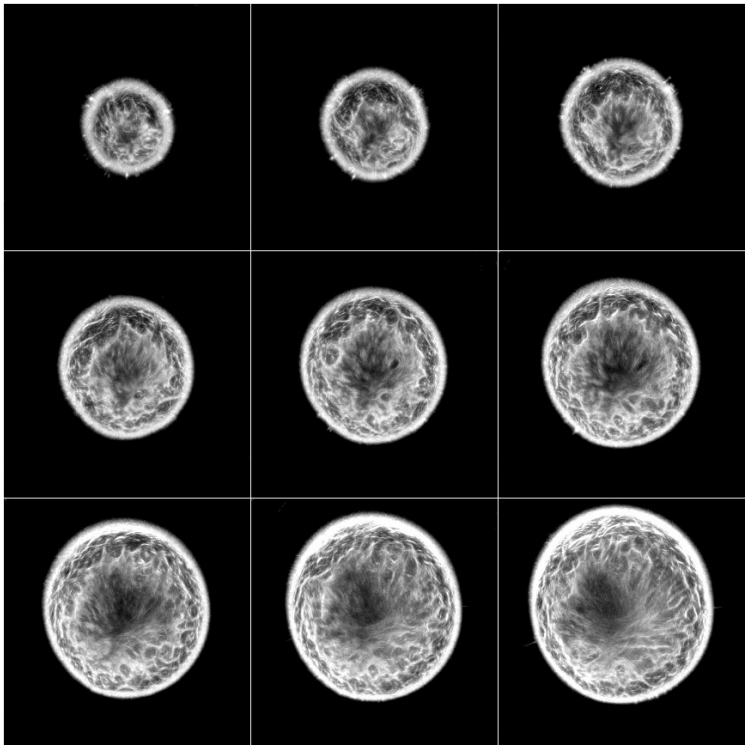
QT speed of sound and reflection images



3D image volume of speed of sound and reflection



Speed of Sound

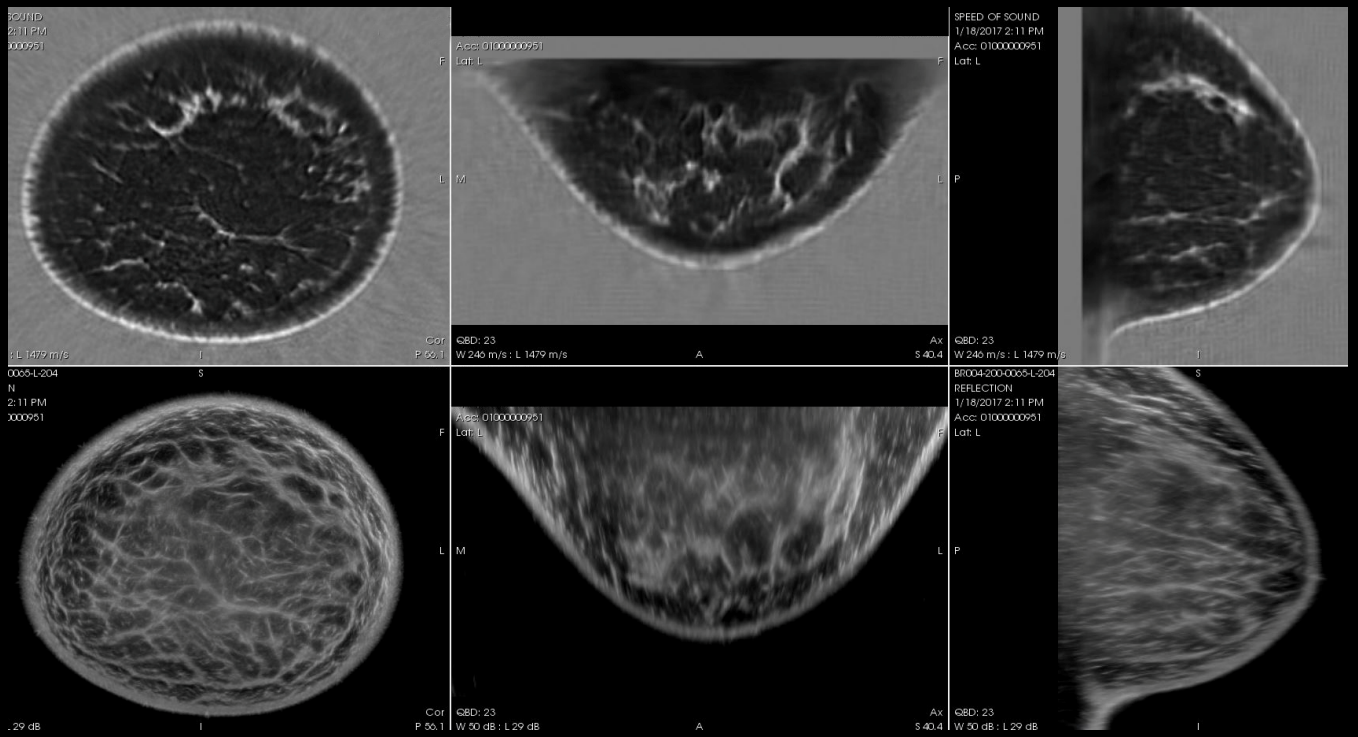


Reflection

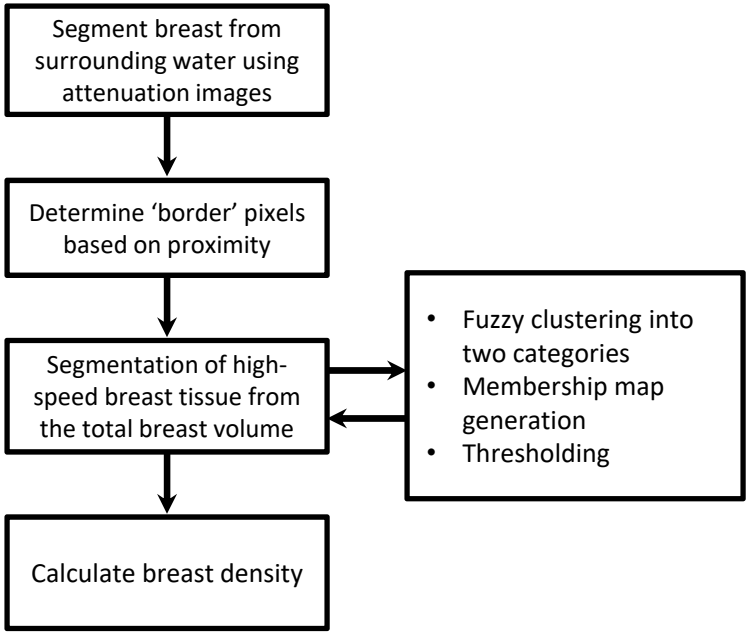
Transmission & Reflection: normal breast anatomy

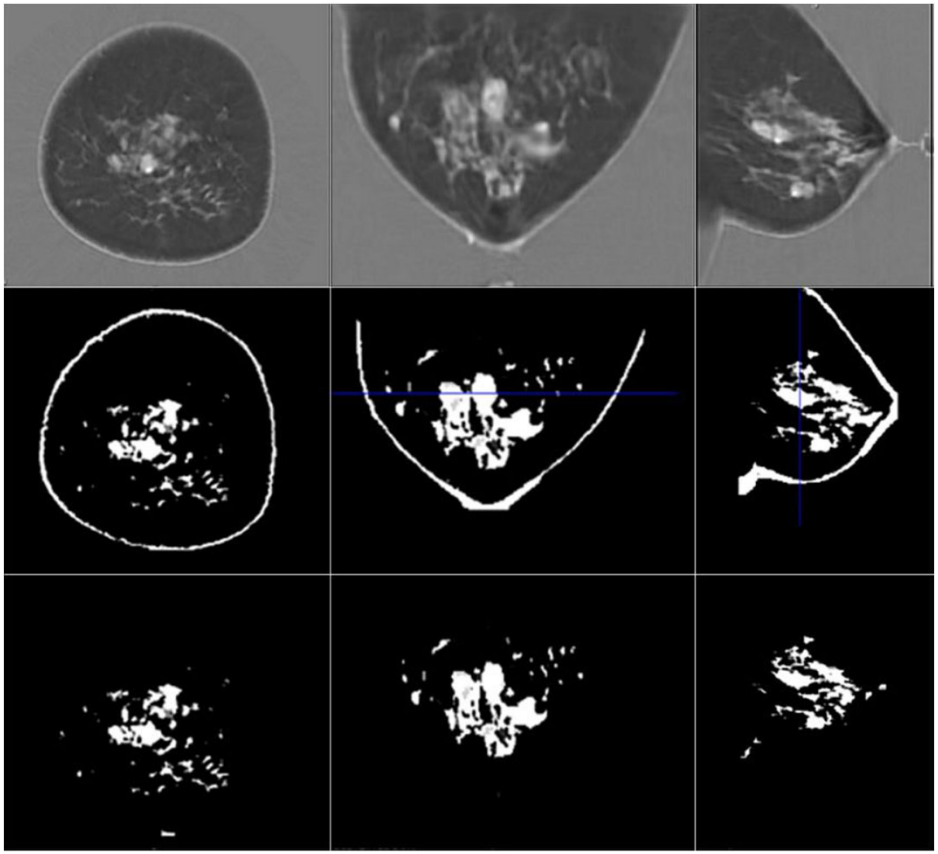
Transmission >

Reflection >

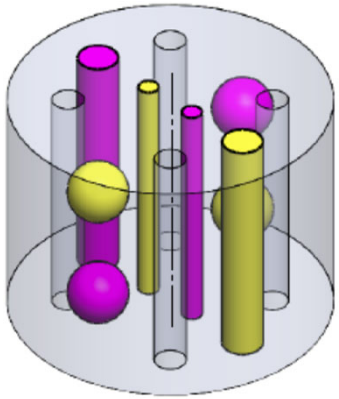


Tissue segmentation algorithm

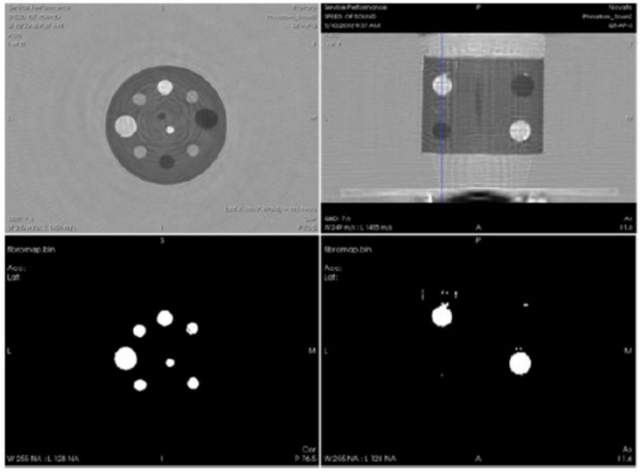




Testing on tissue phantoms



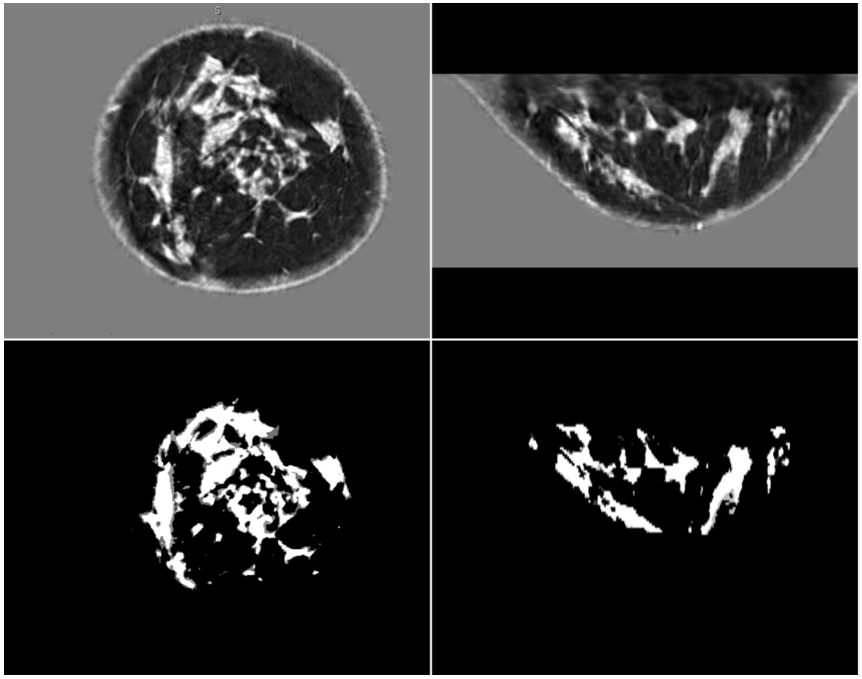
Density based on theoretical volume = 7.1%



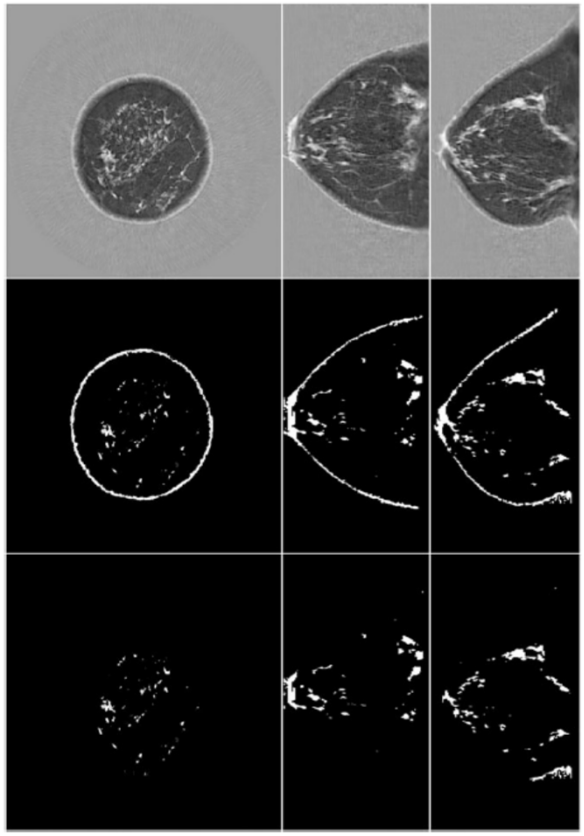
Density based on QBD = 7.6%

Testing on clinical images

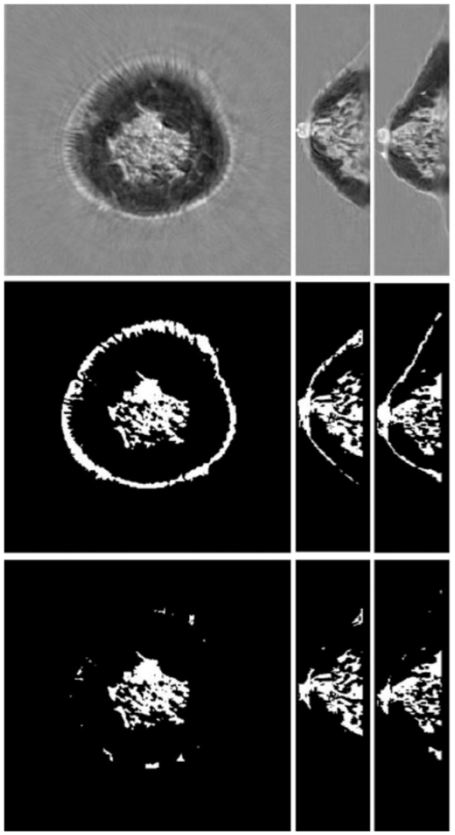
- Application of algorithm on 100 unilateral breast scans
- Mammography performed within 90 days of transmission imaging
- Both QBD and VolparaDensity™ (v3.1) scores were available.
- Correlation quantified using Spearman coefficient



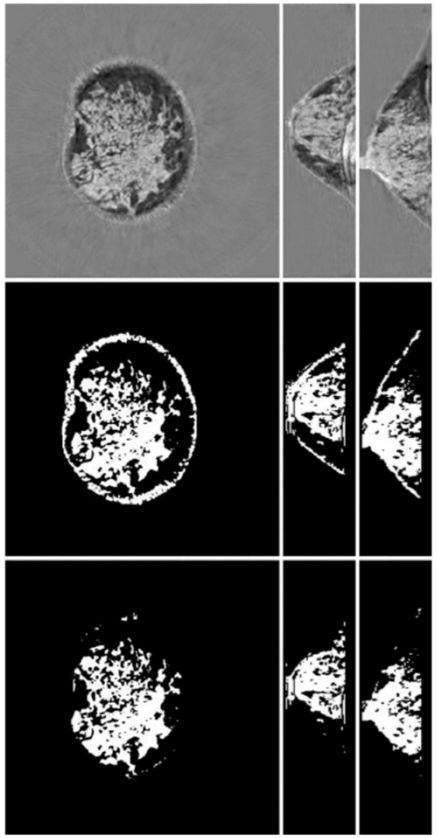
Segmentation of fibroglandular tissue



QBD= 10.9%



QBD= 29.5%



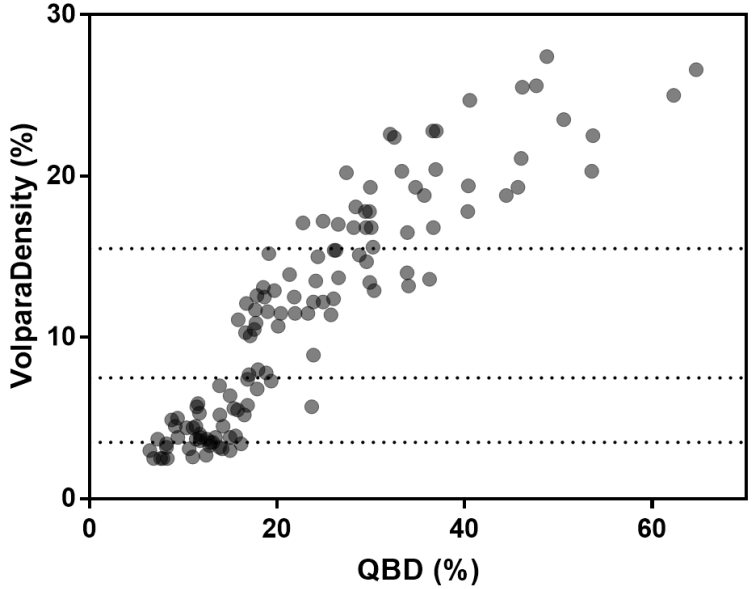
QBD= 62.4%

Wiskin et al., Medical Physics, 2019, in press

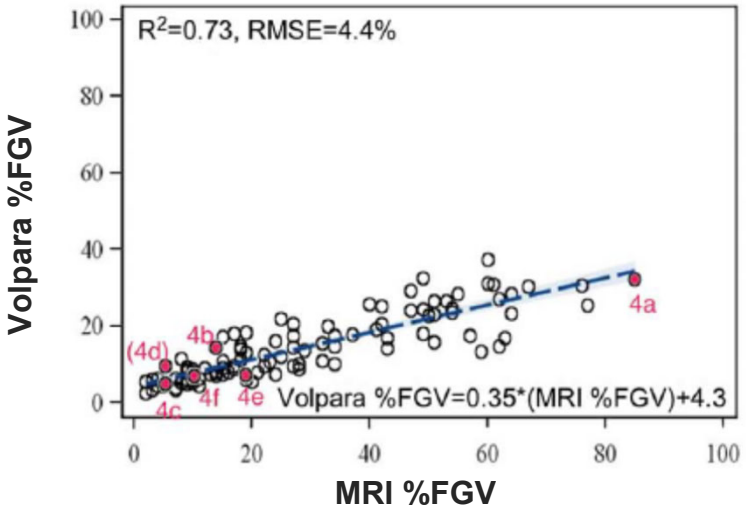
Correlation of QBD with VolparaDensity

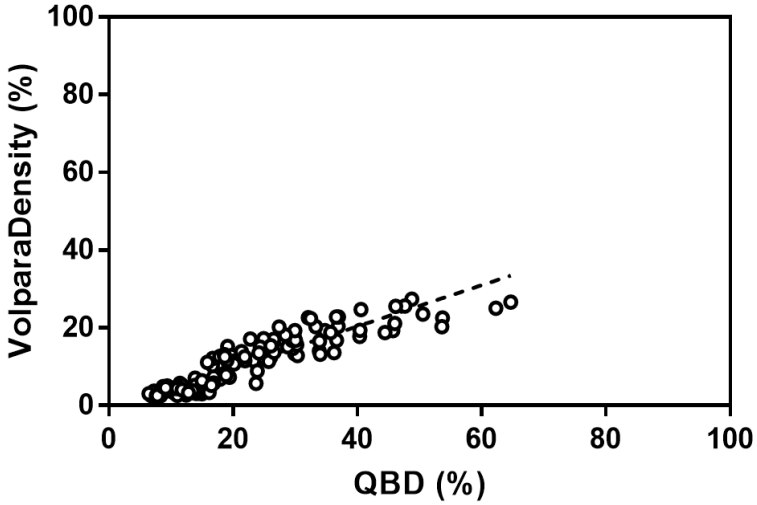
- Spearman r = 0.94 (95% CI: 0.91-0.96); p<0.0001)
- Deming linear regression shows a relationship of

  VolparaDensity = 0.53(QBD) - 0.87



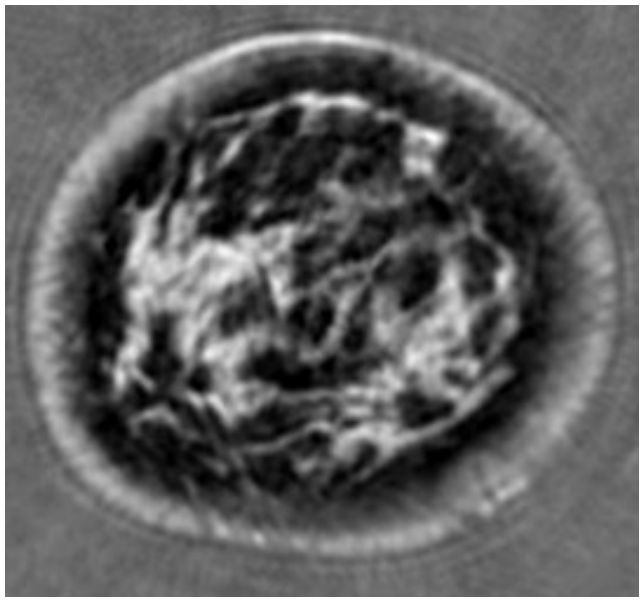
QBD relationship with VolparaDensity similar to MRI



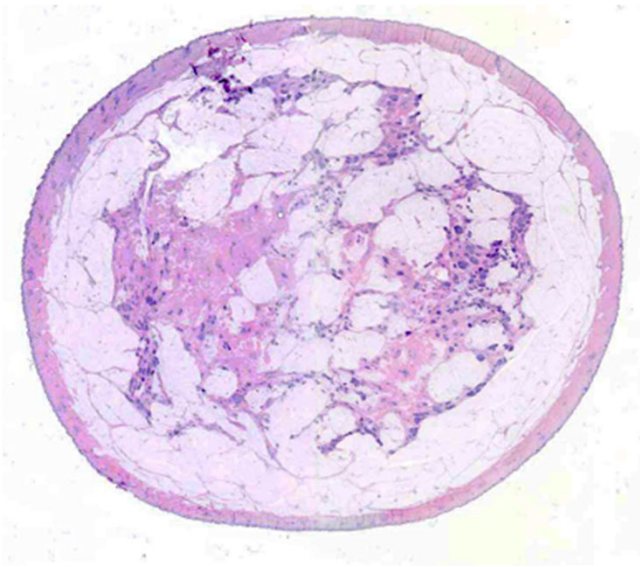


Ref: Wang et al., PLoS One, 8(12), 2013

Validation of segmentation algorithm using large format histology

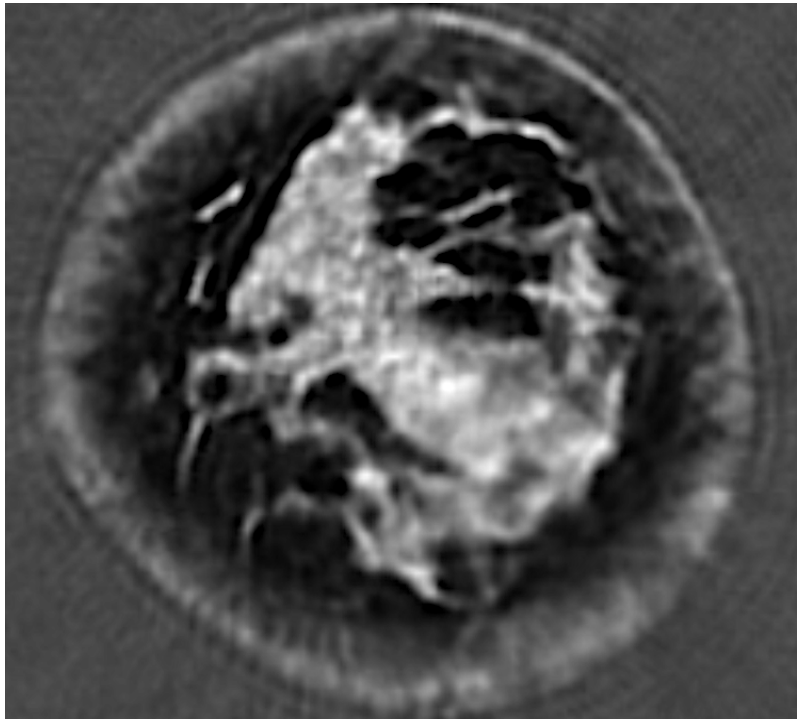


TU fibroglandular volume = 45.1 %

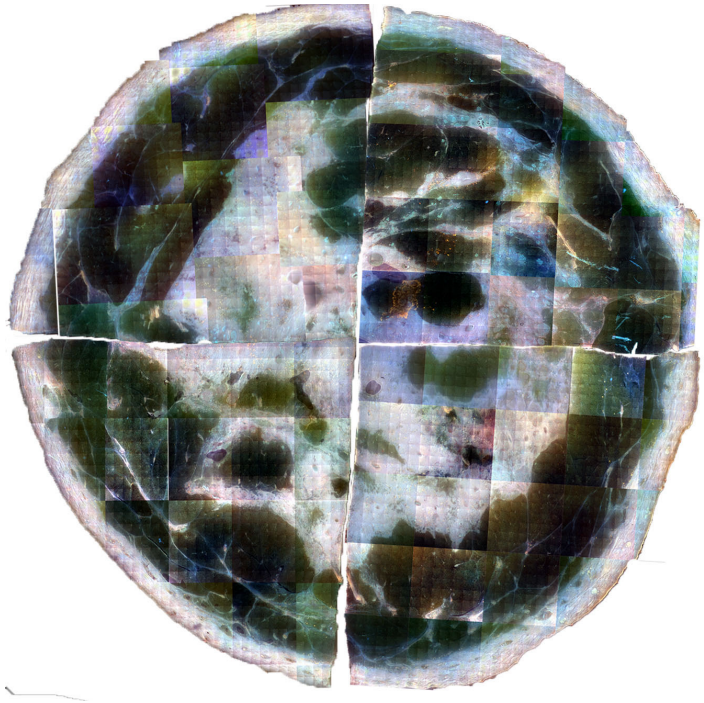


H&E fibroglandular volume = 42.3 %

Validation of segmentation algorithm using UV microscopy



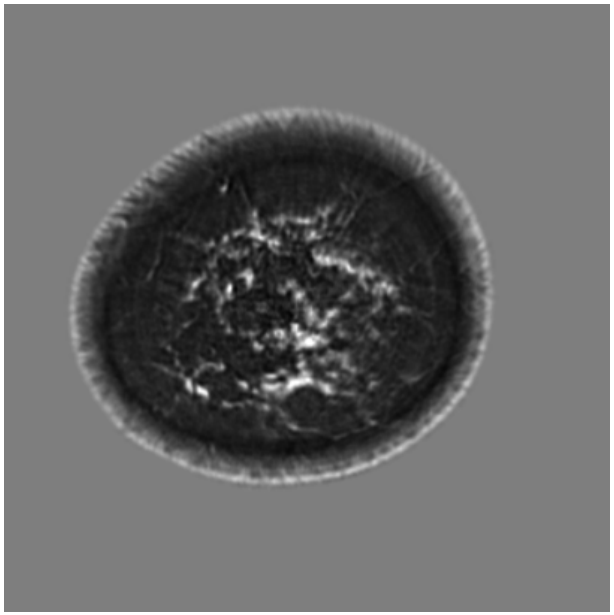
QT speed of sound image – QBD= 34.7%

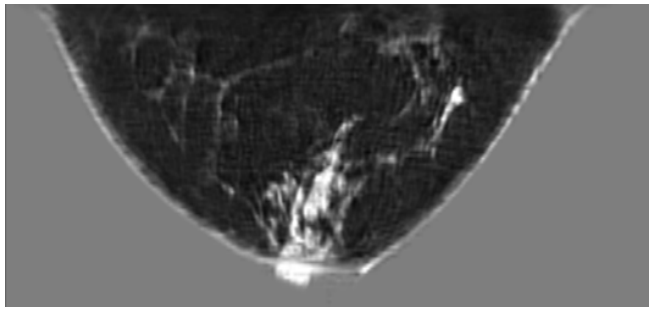


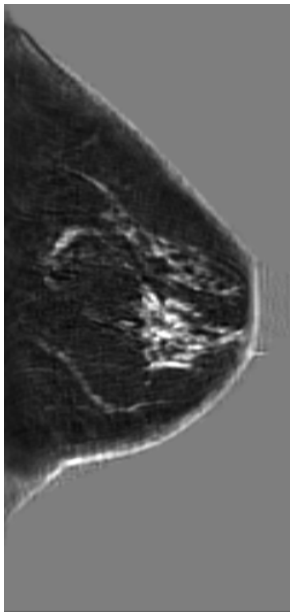
MUSE image – equivalent breast density = 37.9%

Precision of QBD measurement

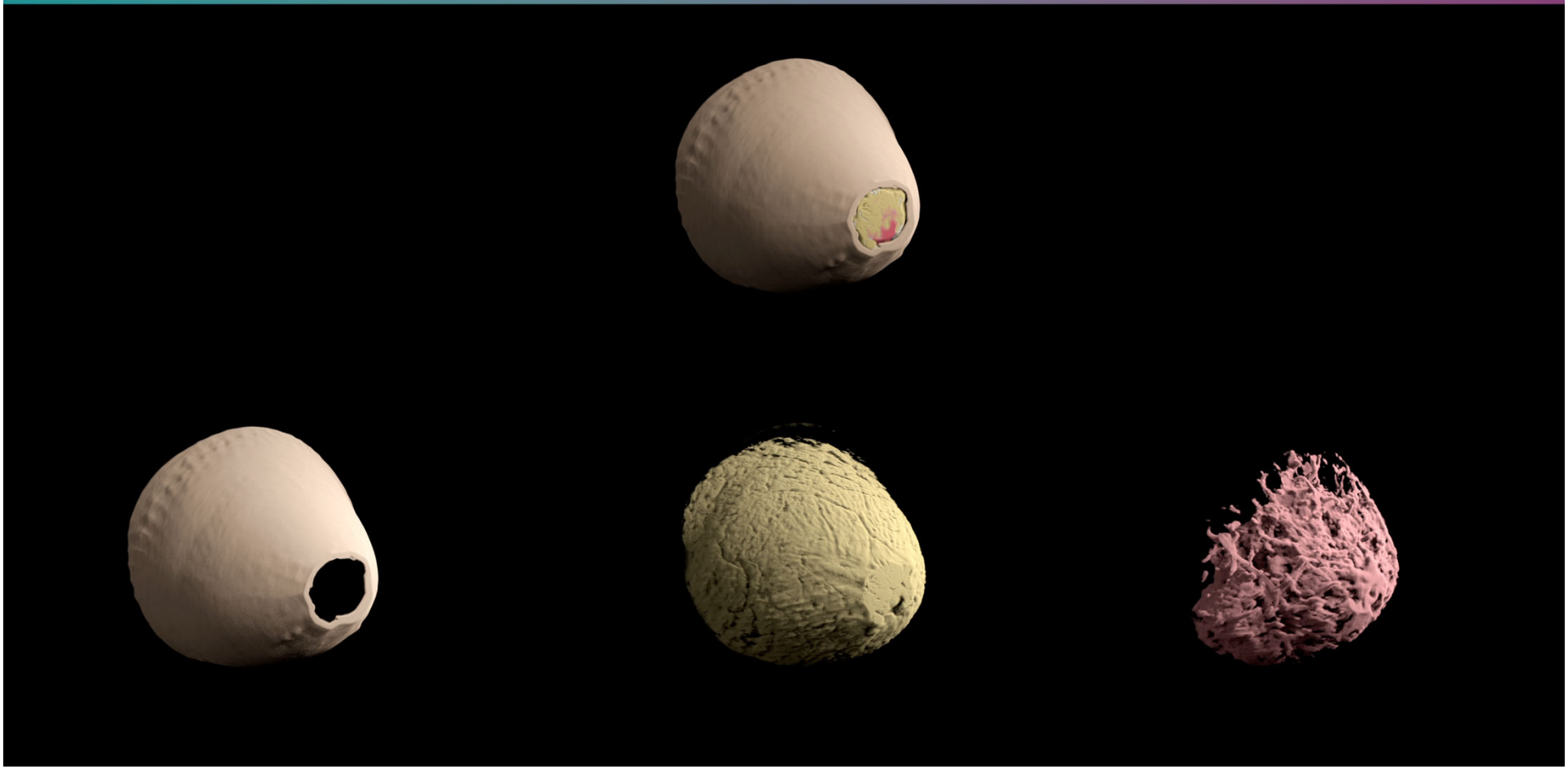
- Scanned a single breast/patient ten times
- Calculated QBD for individual scans
- Mean QBD value = 9.4 %; Standard deviation = 0.2 %







Volumetric rendering of segmented breast tissue



Conclusions

The presented segmentation method can accurately identify the fibroglandular tissue volume within the whole breast.

The results indicate that breast density as assessed by fully automated means using TU can be of significant clinical value and play an important role in breast cancer risk assessment.