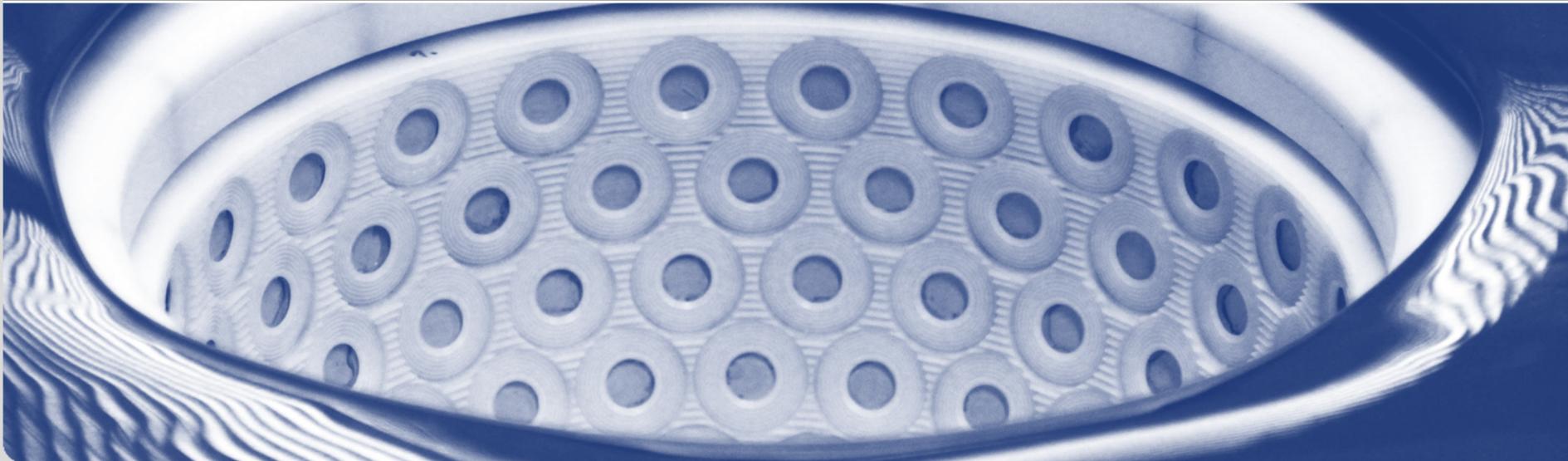


Medical Imaging with 3D Ultrasound Computer Tomography for early breast cancer diagnosis

T. Hopp, N.V. Ruiter et al.

Karlsruhe Institute of Technology, Institute for Data Processing and Electronic, Karlsruhe, Germany

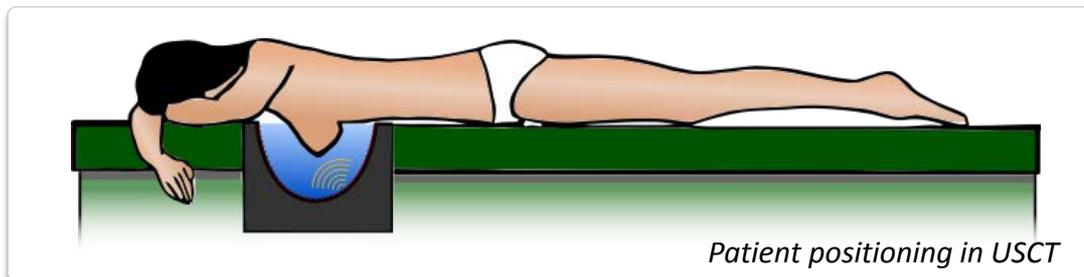


3D Ultrasound Computer Tomography

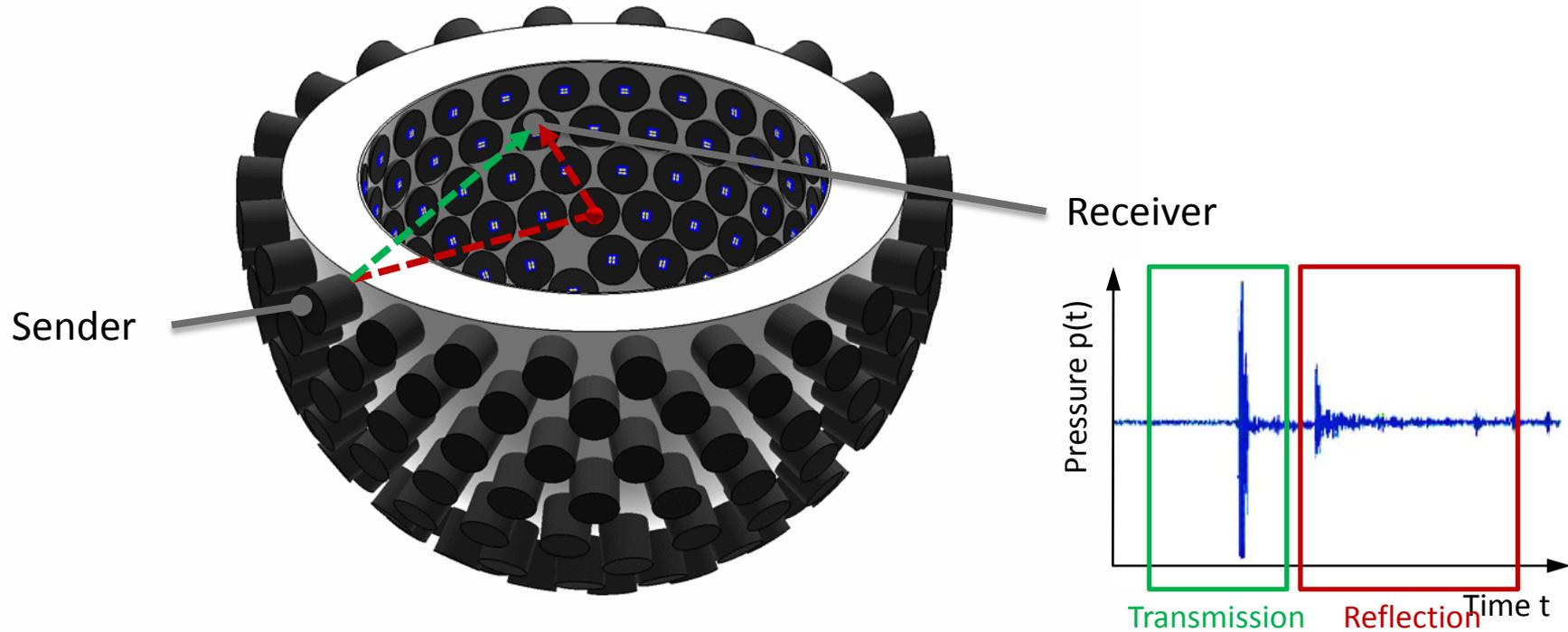
- WHO 2012: **1,600,000** new breast cancer cases worldwide
 - ~25% of all cancer cases in women

3D Ultrasound Computer Tomography (USCT) for early breast cancer diagnosis ...

- as harmless as diagnostic ultrasound
- as economical as X-ray mammography
- as sensitive as MRI



3D USCT imaging principle

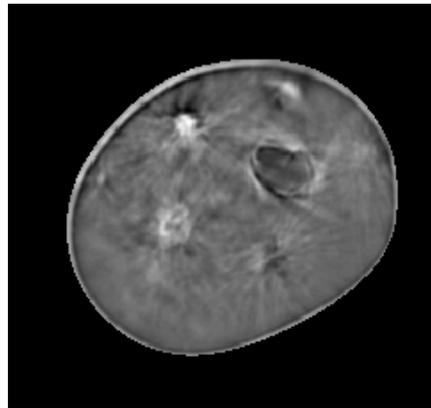


- >10 Mio. signals
- 40 GB raw data per breast
- Measurement time 10 s to 4 min.

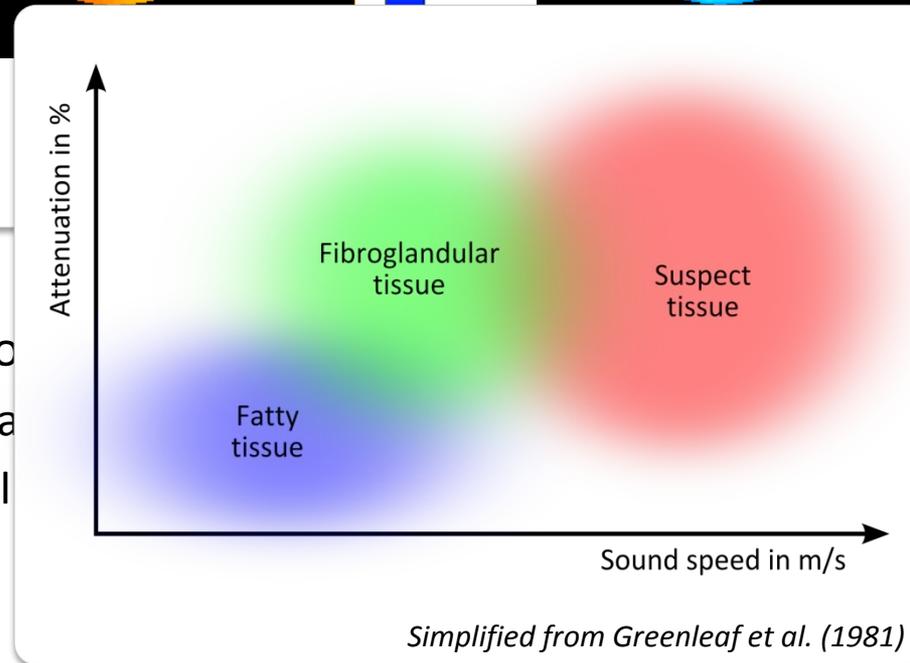
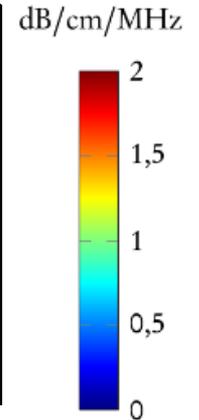
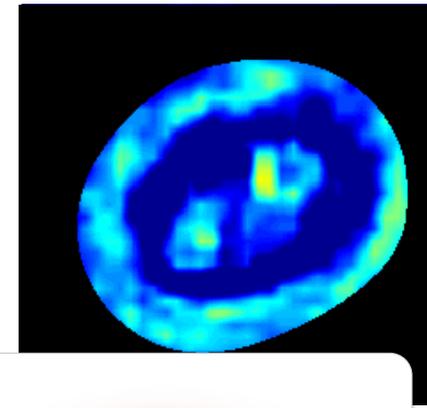
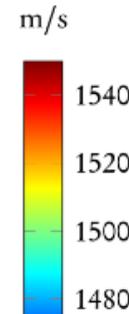
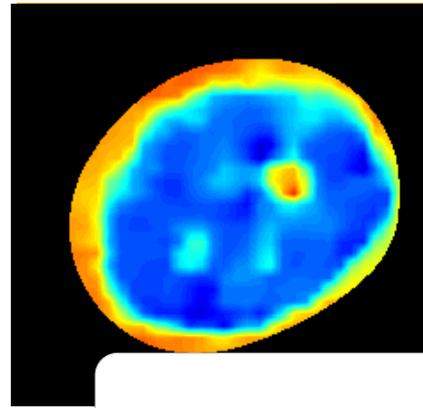


- ### Image reconstruction
- Sound speed
 - Attenuation
 - Reflection

Image reconstruction



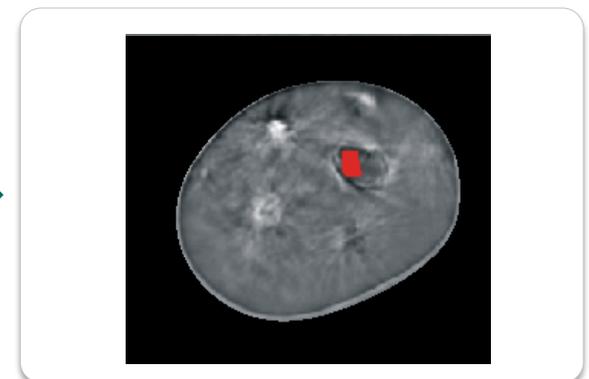
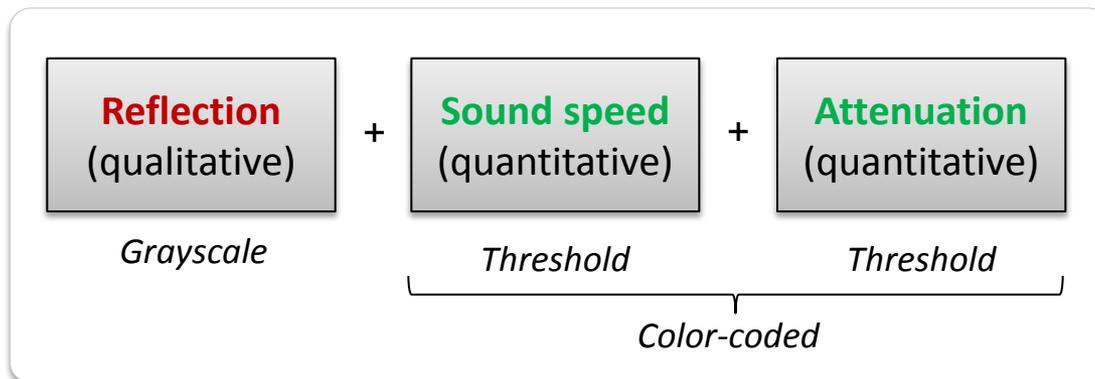
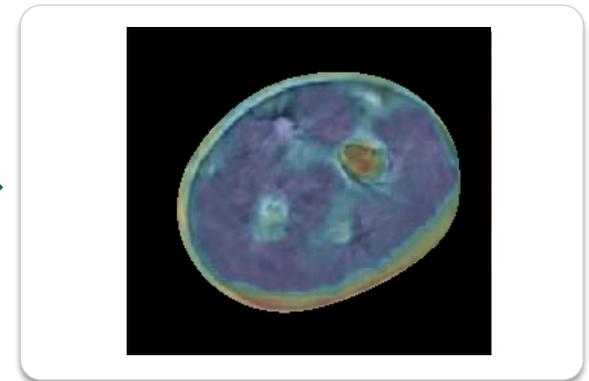
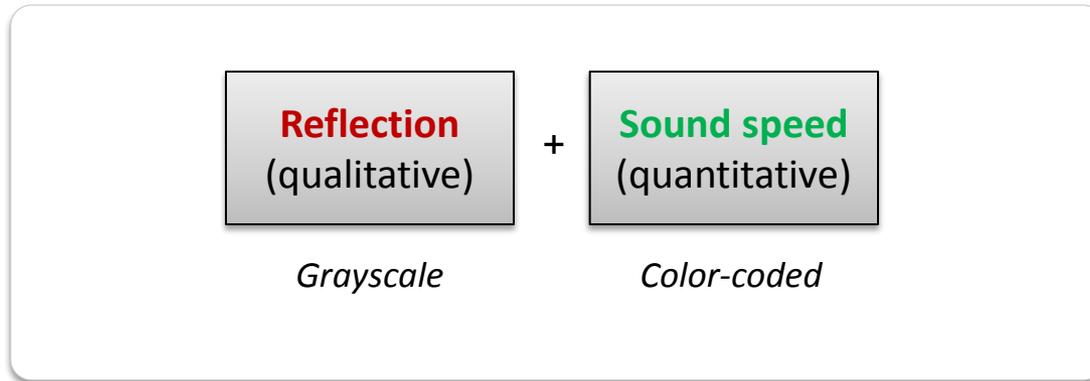
Reflection



Simplified from Greenleaf et al. (1981)

- Parallel and multi GPU co
- Sound speed + attenua
- Reflection: ~2h per vol

Image fusion

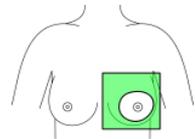


Pilot in-vivo study

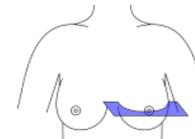
- **Aim:** Test KIT 3D USCT with 10 patients
 1. Test data acquisition and image reconstruction
 2. Test display/combination of multimodal images
 3. Compare tissue structures with established imaging method

- Study performed on 3 days at University Hospital of Jena, Germany
- MRI images as ground truth

Patient 1: breast implant

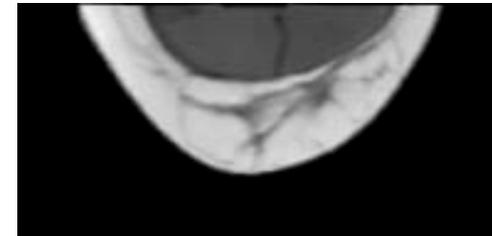
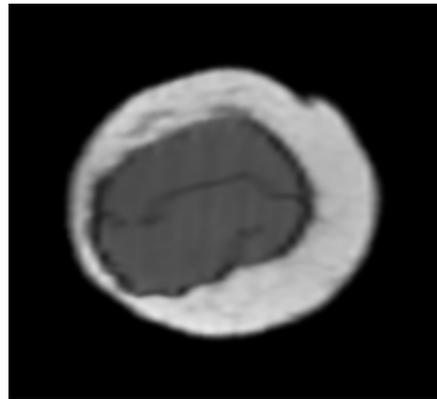


Coronal plane

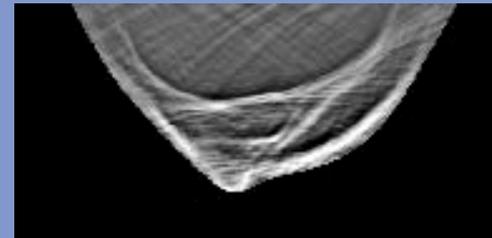


Transversal plane

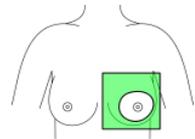
Registered MRI
T1-weighted



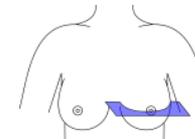
USCT
Reflection



Patient 2: connective tissue structure

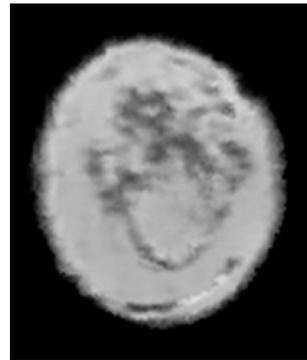


Coronal plane

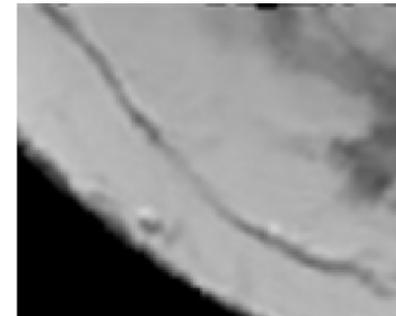


Transversal plane

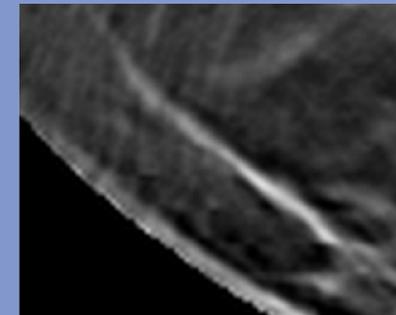
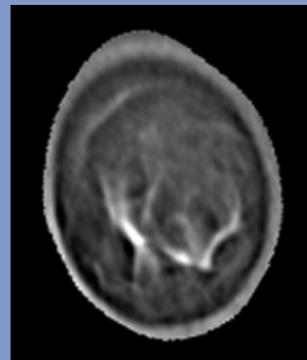
Registered MRI
T1-weighted



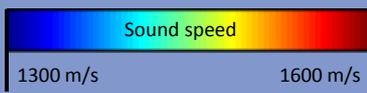
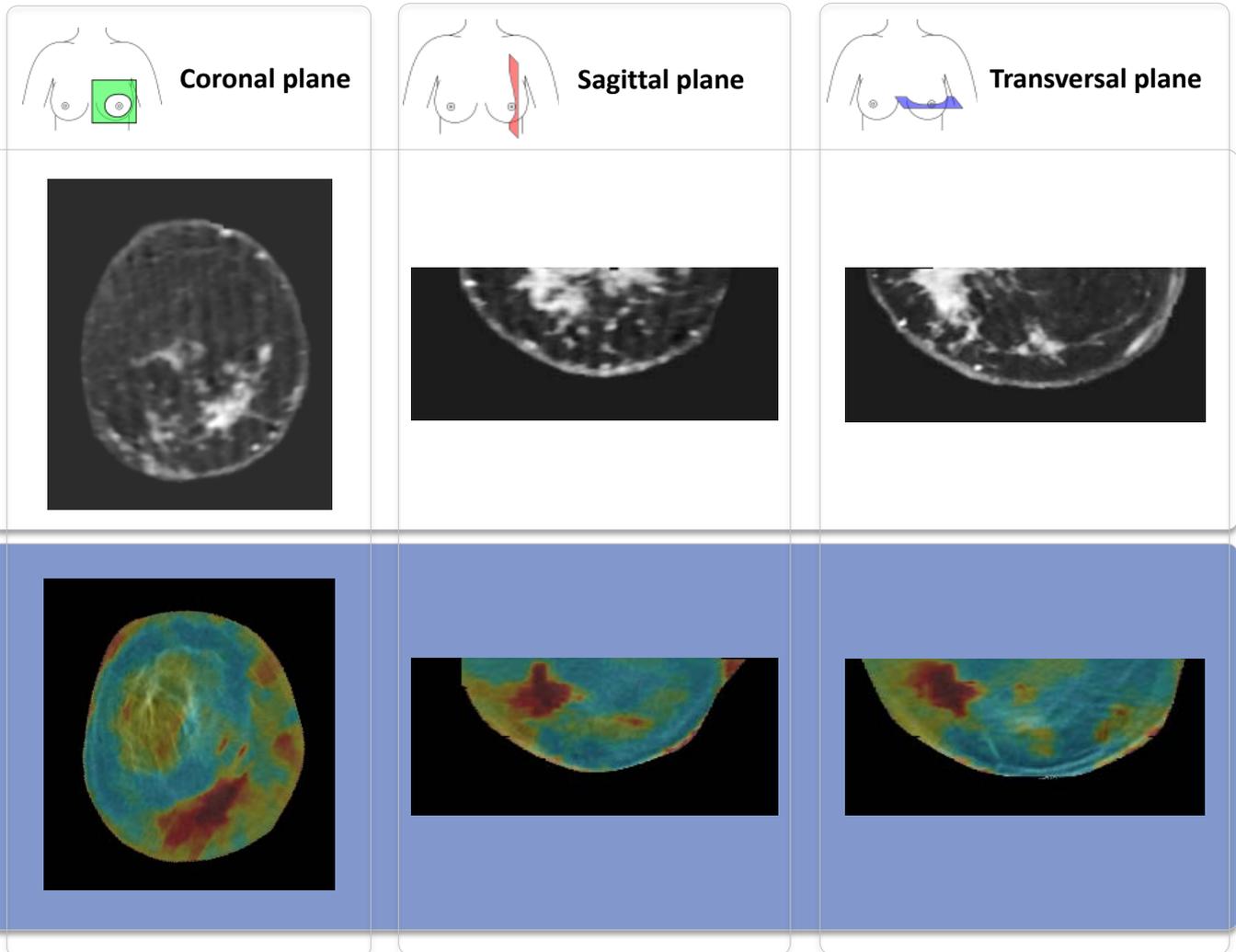
(detail view)



USCT
Reflection



Patient 3: inflammatory carcinoma



Patient 4: multicenter carcinoma

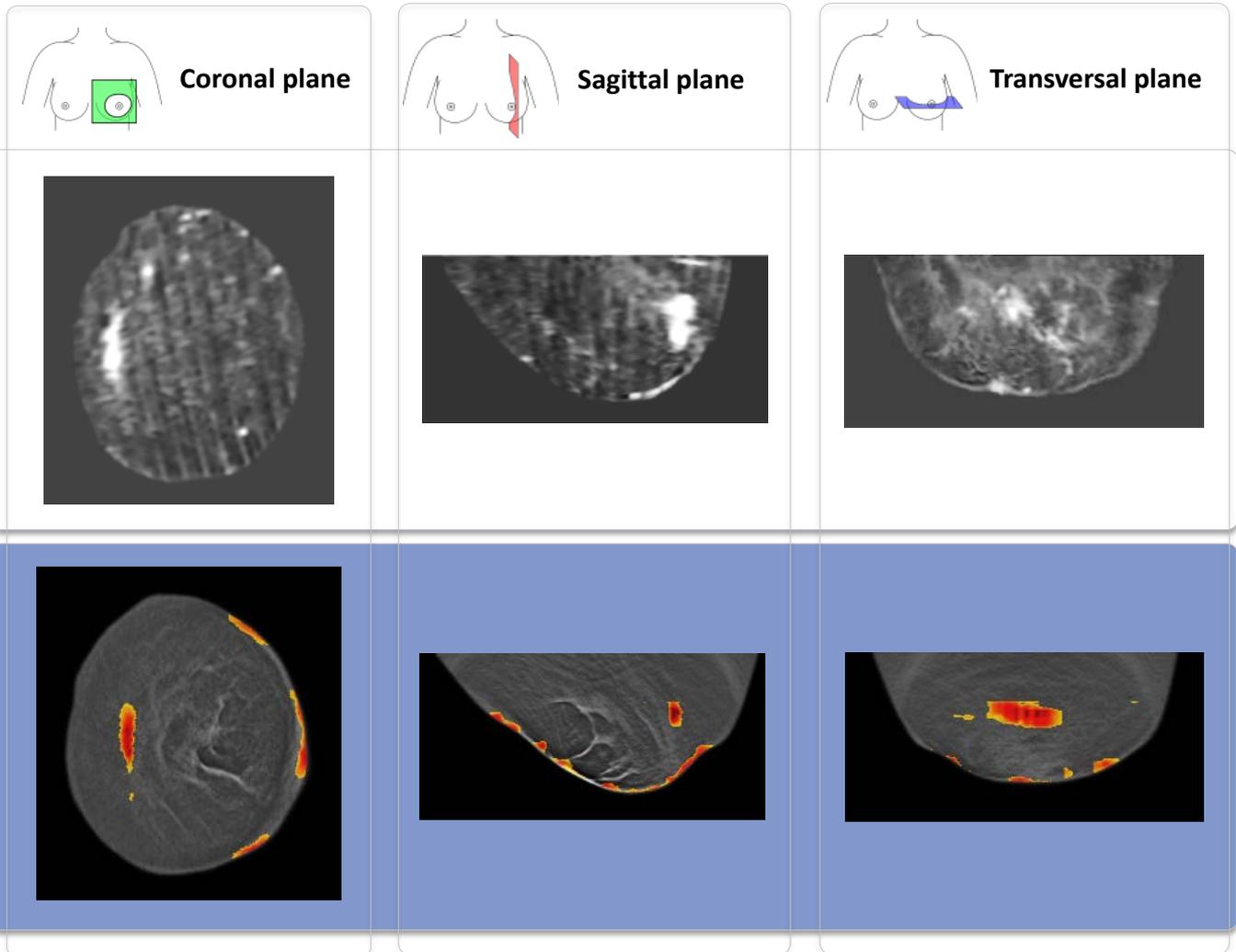


Image segmentation

- Artifacts due to sparse aperture
- Breast \leftrightarrow background segmentation essential
- (Semi-)automated approach

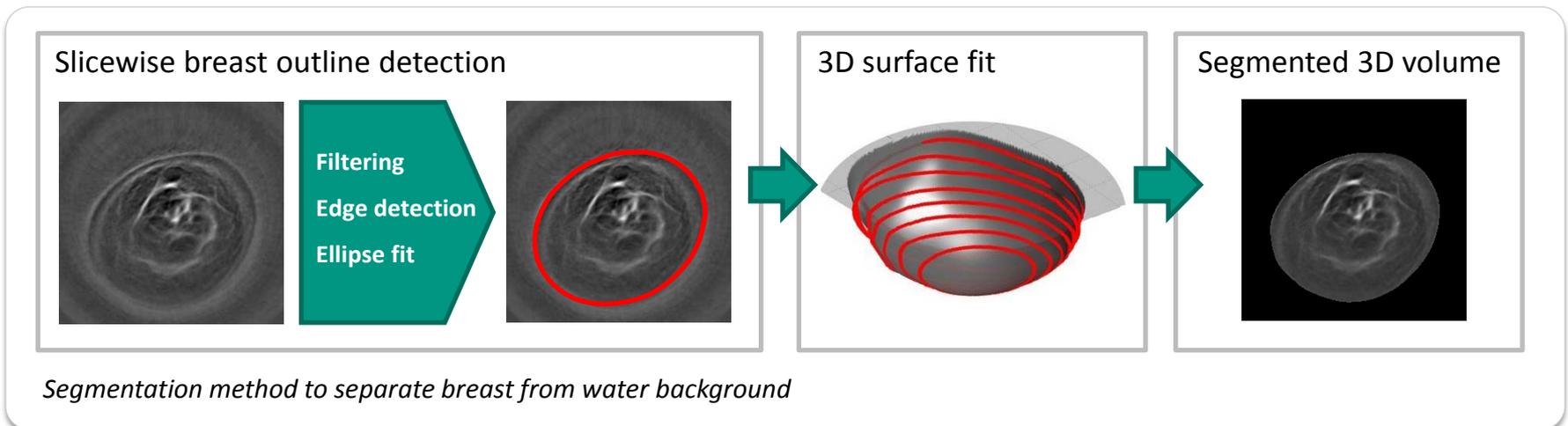
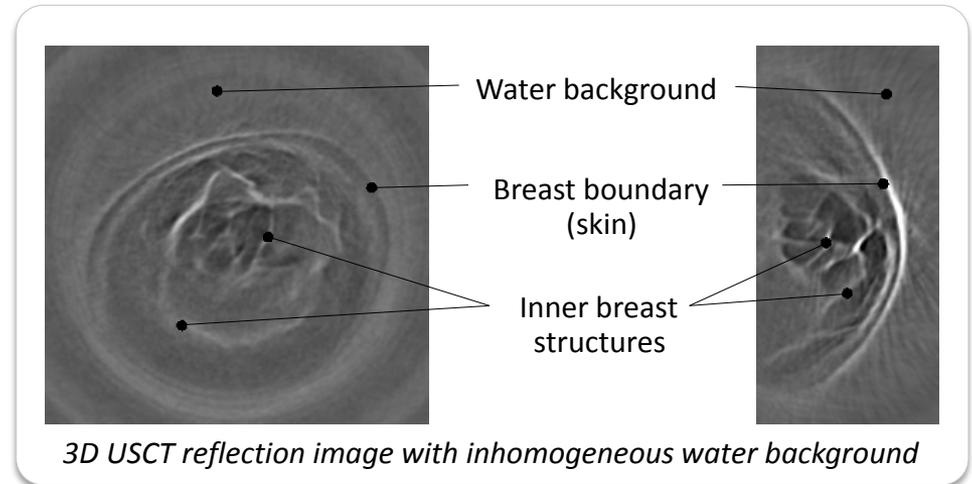
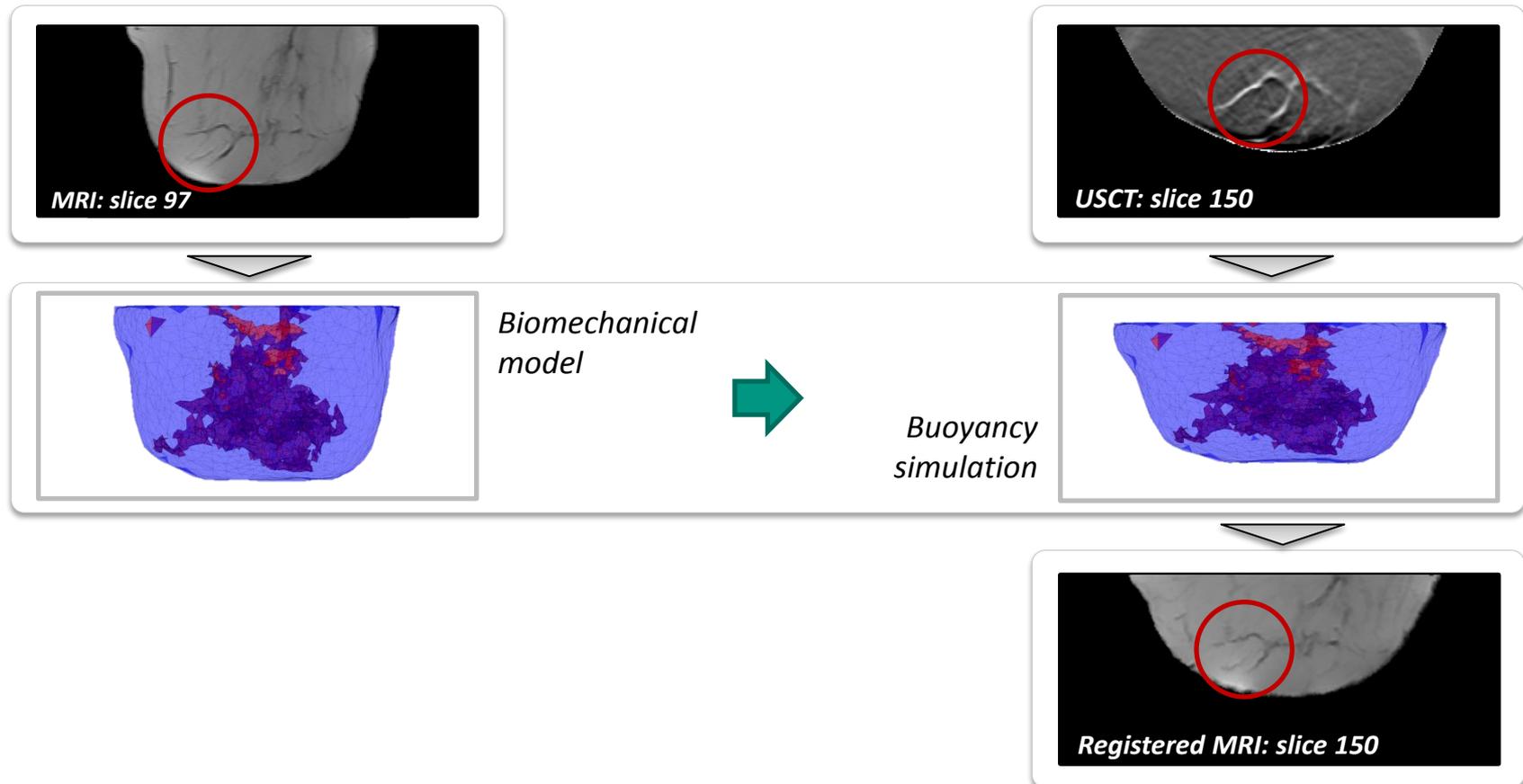


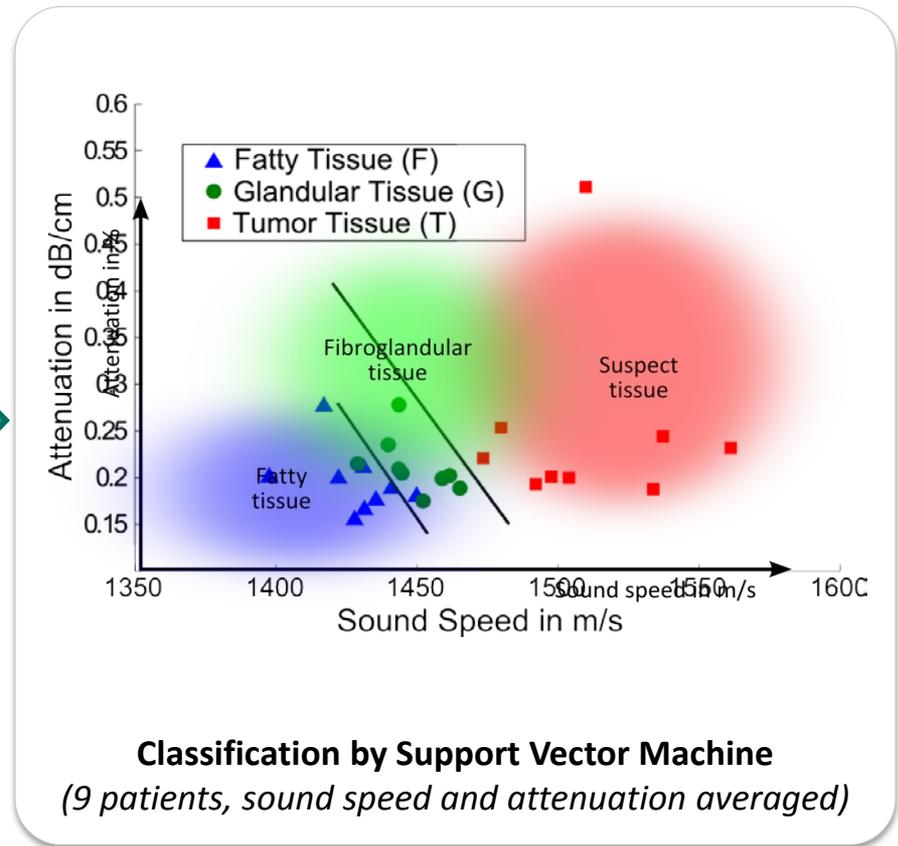
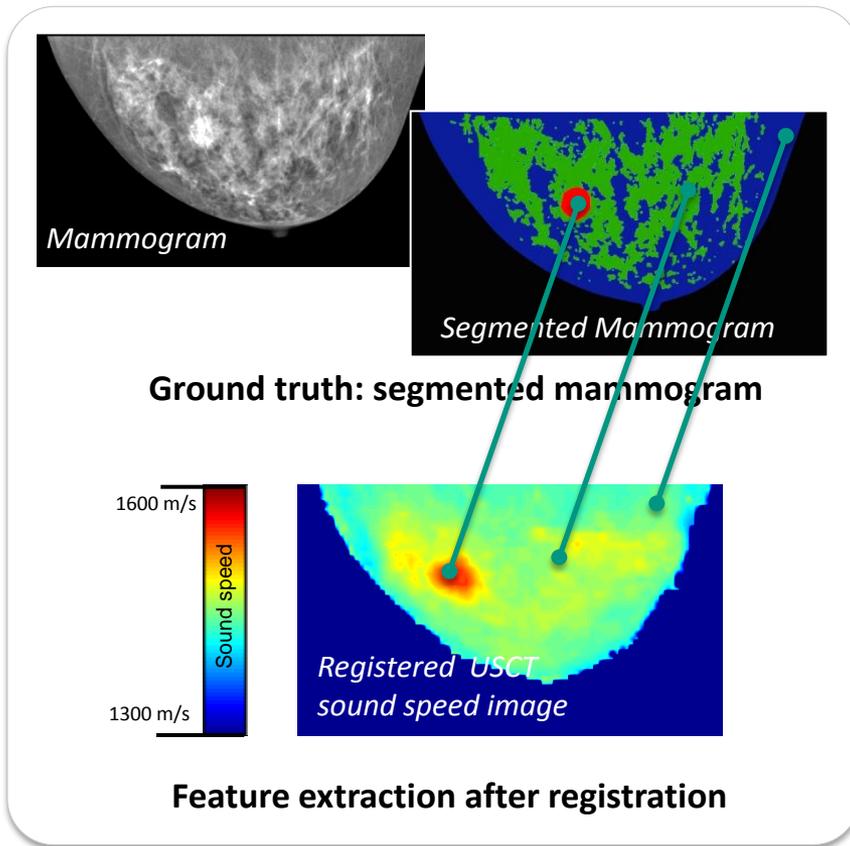
Image registration

- Comparison of USCT and MRI is challenging due to buoyancy
 - ➔ Image registration to estimate spatial correspondence



Quantitative imaging evaluation

- Application of a classifier to distinguish between tissue types
- Example based on registration to mammography (*Karmanos Cancer Institute*)



Summary & conclusion

- **First in-vivo images with 3D USCT: it really works!**
 - Successful test of data acquisition and image reconstruction with 10 patients
- Image segmentation, registration, fusion involved for clinical evaluation
- First indications: combination of modalities is promising!
 - Pattern recognition for evaluation and computer aided diagnosis
- KIT 3D USCT is **ready for a larger clinical study** (200 patients)
 - Starting in spring 2015 at University Hospital Mannheim

Thank you!

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