

# 3D Ultrasound Computer Tomography

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## Aim and Motivation

- Build 3D imaging device based on ultrasound for early breast cancer diagnosis.

## Advantages

- 3D imaging
- No radiation with ultrasound based method
- Sub-millimeter resolution
- Three different modalities at once: reflectivity, speed of sound and attenuation.

## Prominent Features

- Unique full 3D system
- Sparse aperture

## Challenges 3D USCT

- Large **number of ultrasound sensors** for high resolution and image quality
- **Low cost** sensors for low overall price
- **Reproducible** sensor characteristics
- High signal to noise ratio with small active area
- High signal dynamics
- Short data acquisition time to prevent patient movement
- Large amount of raw data at **high data rates**
- Time consuming image reconstruction

## Optimized System: 3D USCT II

- Aim: Imaging volunteers
- Volume acquisition time: 2 minutes
- 480 DAQ channels, 40 GByte on-board memory

### Next steps

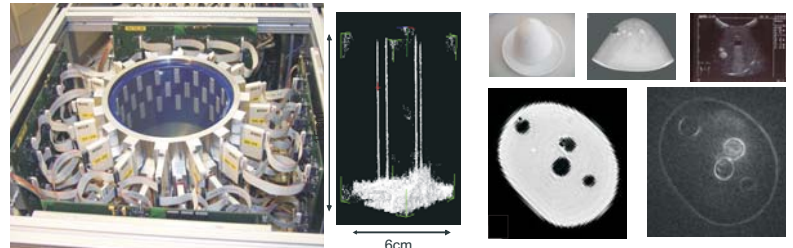
- Launch system
- Permission of Ethics commission (with University Hospital Jena)
- First images of living breast
- First clinical study

## Patents

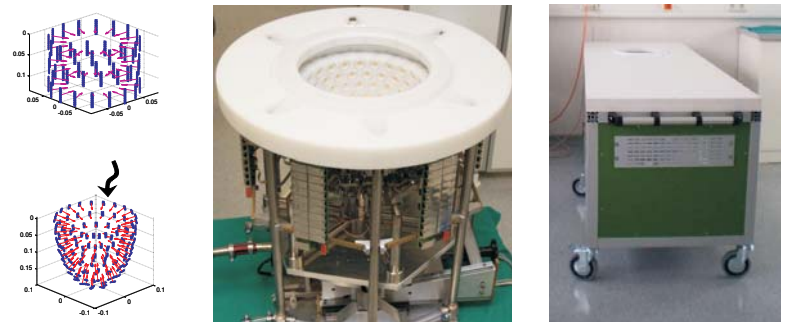
- Ultrasonic Tomograph: US 6786868 (granted: 09/07/2003)
- Ultraschalltomograph: GM 29923642 (utility model, granted: 01/18/1999)
- Ultrasound transducers: EU 1744837 (granted: 10/01/2004)
- Aperture Optimization for 3D Ultrasound Computer Tomography: EU patent (pending)

## Cooperations

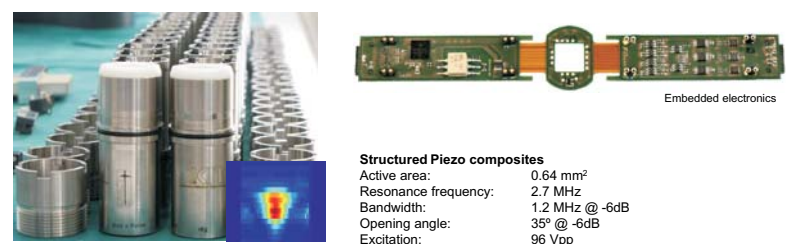
- KIT, Steinbuch Centre for Computing
- KIT, Institute for Information Processing Technology
- University Hospital Jena, Institute of Diagnostic and Interventional Radiology
- University Brno, Department of Biomedical Engineering, Czech Republic
- University Delft, Laboratory of Acoustical Imaging and Sound Control, The Netherlands
- Karmanos Institute, Detroit, USA



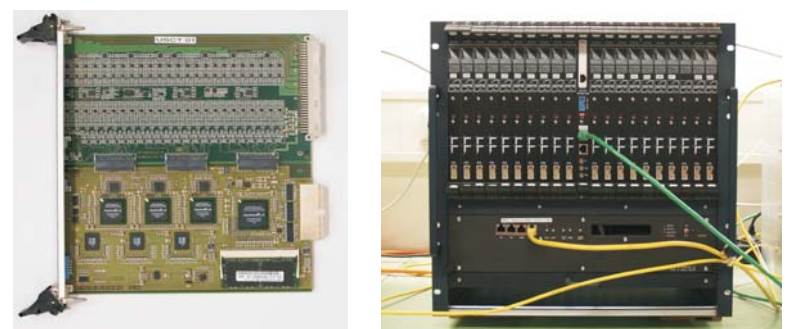
3D USCT I: Cylindrical sensor aperture (left) and resulting images (right): volume of 0.2 mm nylon threads and clinical breast phantom (top left to bottom right: Photo, X-ray mammogram, sonography, MRI slice and corresponding 3D USCT slice)



From 3D USCT I to optimized 3D USCT II: Optimized semi-ellipsoidal aperture (left), realization of aperture (middle), patient bed (right).



In house developed transducer array systems (TAS). Second generation TAS with sound intensity map (left), embedded electronics and specification (right).



3D USCT II data acquisition hardware: First Level board (left), DAQ system (right)