



Medical Ultrasound Lab

NEW ADVANCES OF BIO-MEDICAL ULTRASOUND IMAGING IN HUST

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Huazhong University of Science and Technology
Wuhan, China

June 26, 2015



第 1 页

Outlines

- Introduction to MUL
- 2D array-based 3D US Imaging
- Ultrasound Computed Tomography for Breast Imaging
- Target Nano-particles Agent for US Molecular Imaging
- High Frequency US Fused Scanning Probe Microscopy

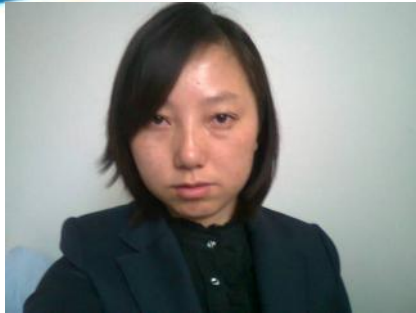
Introduction to MUL



- Medical Ultrasound Laboratory (MUL) was founded in 2006 as part of “Image Processing and Intelligent Control” Key Laboratory of The Ministry of Education of China, HUST.
- The goal of MUL lab is :
Explore the theory and principles in bio-medical ultrasound imaging, educate outstanding engineers oriented to application and become one of the most important ultrasound imaging research facilities in the world.
- Upgrade to a national lab within 5-10 years.

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Faculty in MUL



Longhui Wang, Lecturer
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(Director)



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Professor
huowenguang99@163.com



Ming Yuchi, Associate Professor
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Photo not available

Yu Yuan, Associate professor
yyan@mail.hust.edu.cn

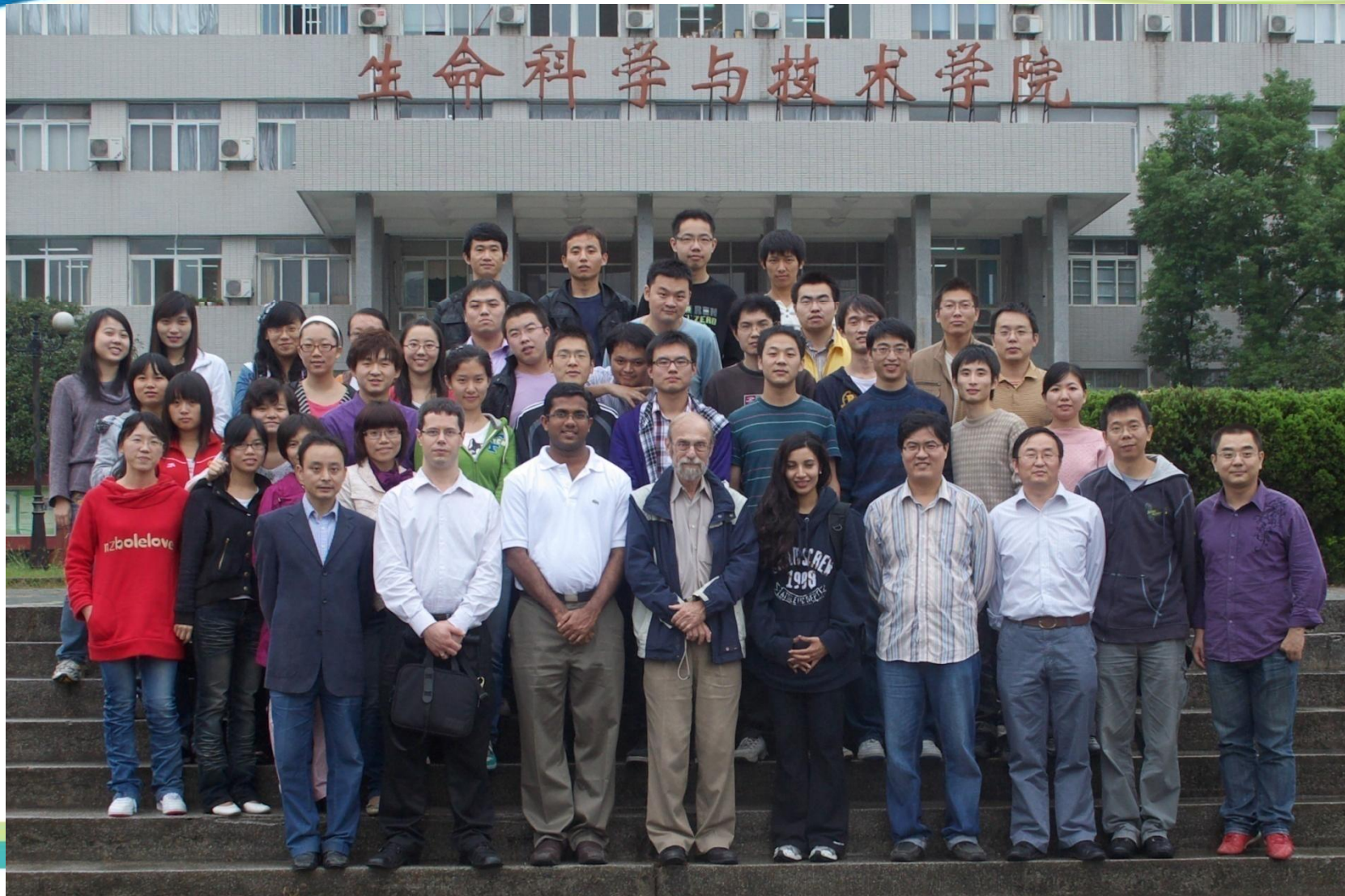


Xuming Zhang, Associate Professor
xmboshi.zhang@gmail.com

MUL members in Sept. 2010



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3D ultrasound imaging system for urological diseases diagnosis & therapy

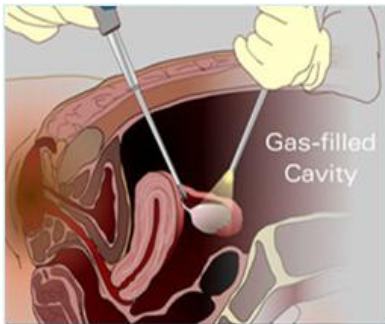


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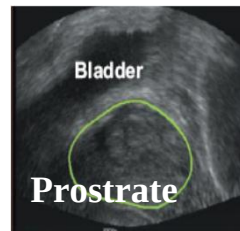
Urological
organs

Pre-
planning

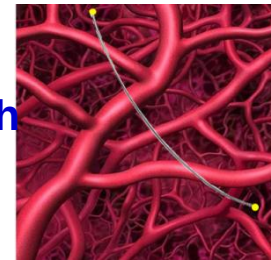
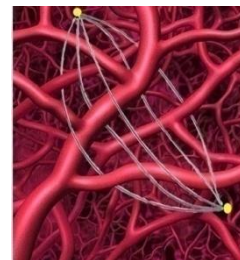
Surgery
navigation



2D probe based imaging :
24 × 24 ,
0.6mm × 0.6 mm × 0.6mm
25f/s



Automatic path
planning



Surgery tools
Tracking &
localization

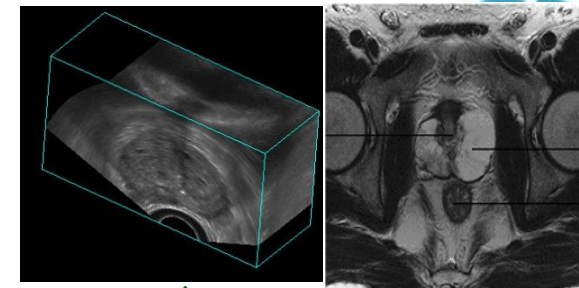
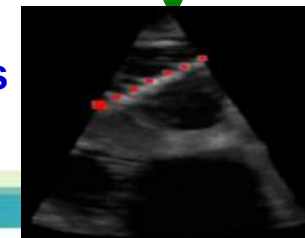


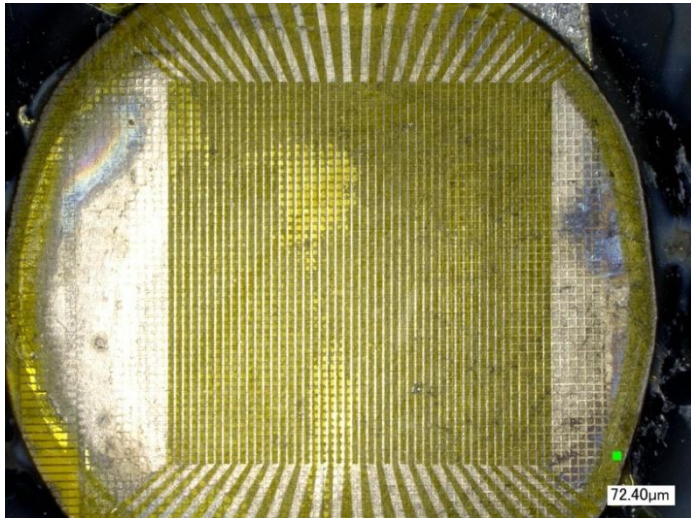
Image registration
& fusion



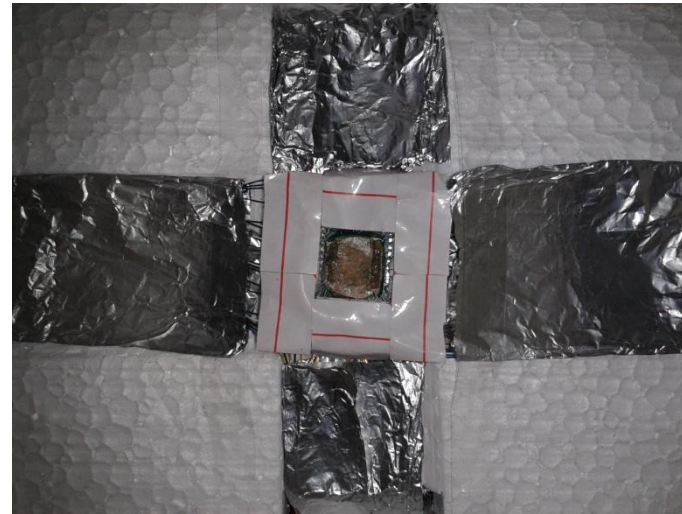
2D probe design and fabrication



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Elements & connection



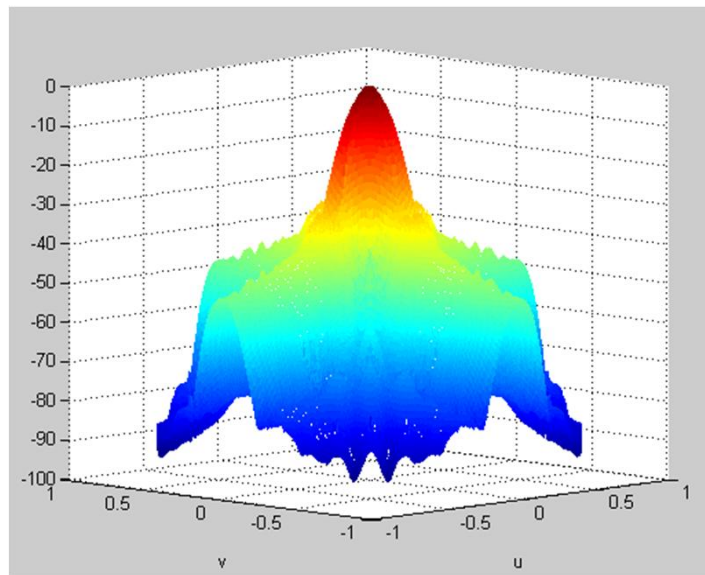
48×48 probe mask

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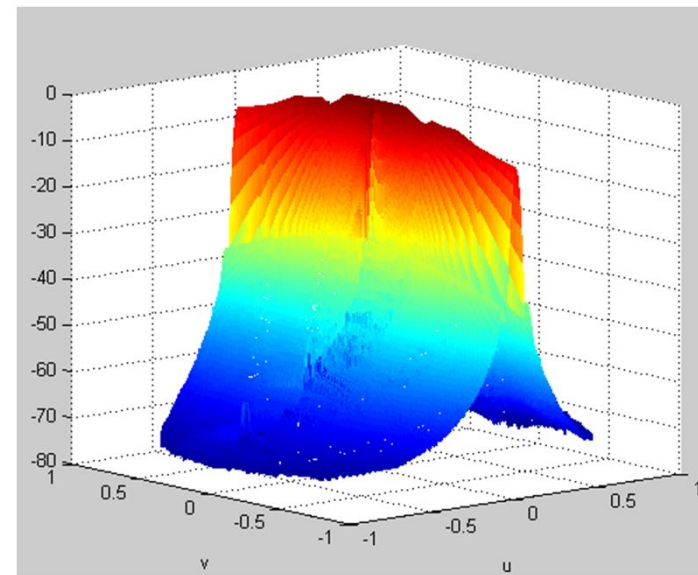
Row-Column addressing simulation



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8*8 probe fully connection



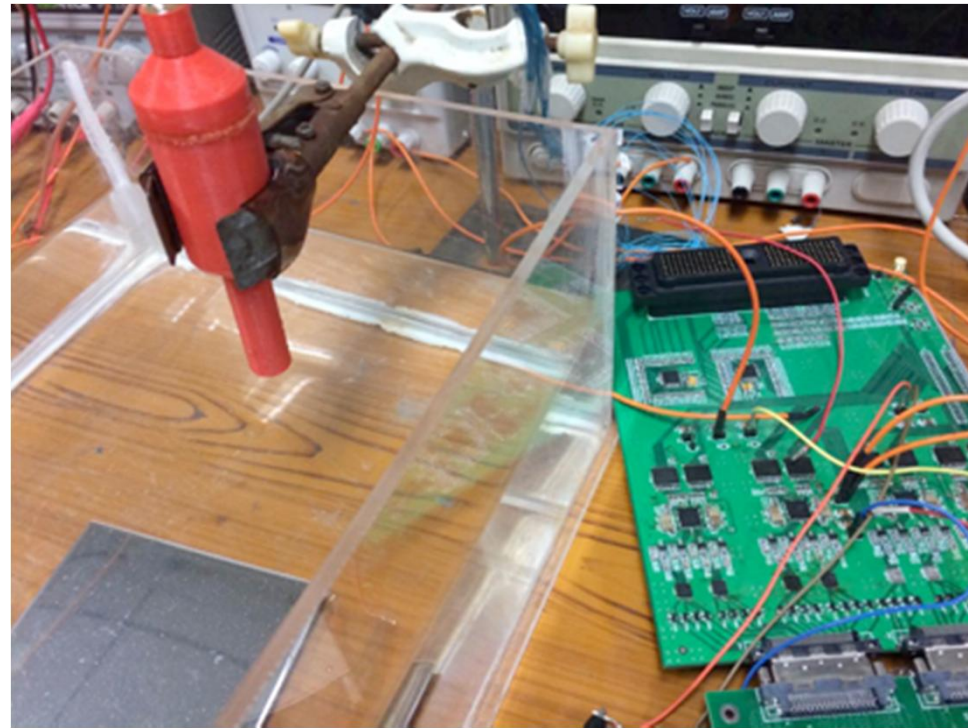
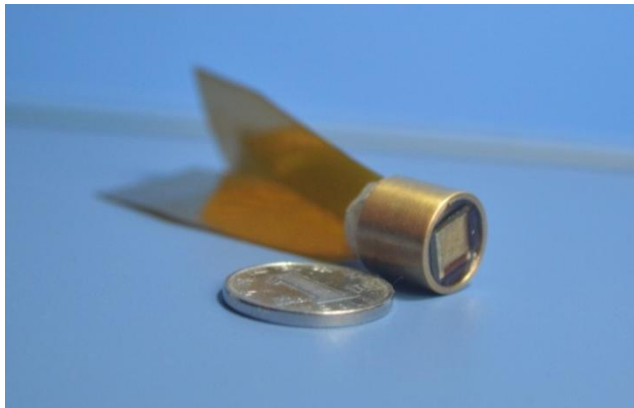
32*32 row-column addressing

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2D array probe & 3D imaging system



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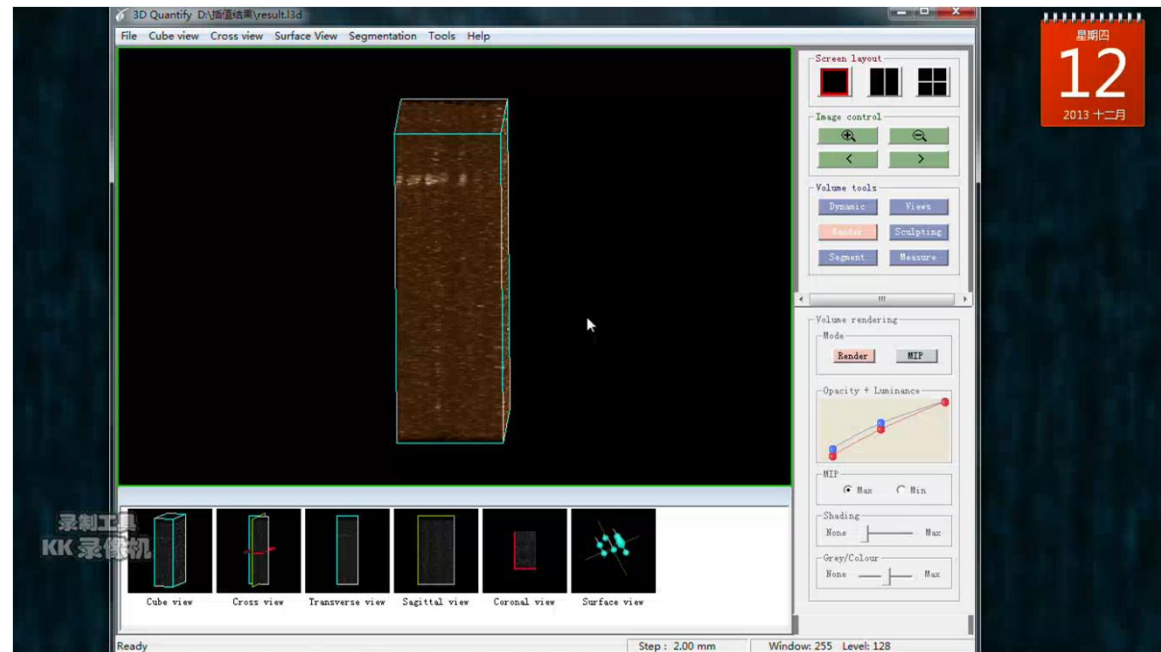
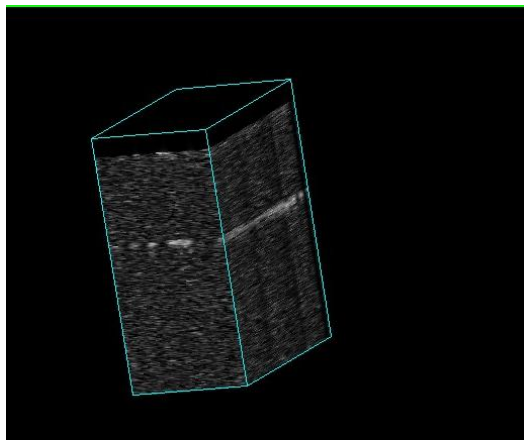
Proto-type 3D imaging system

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2D array probe & 3D imaging system



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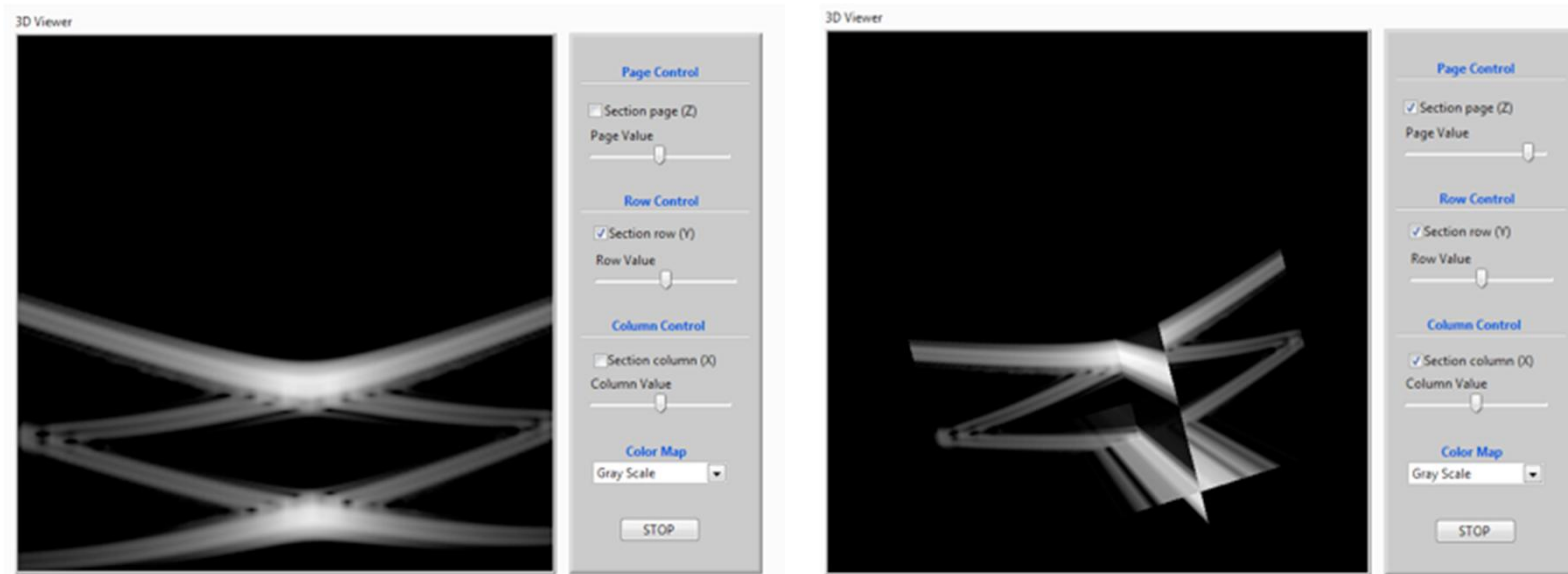


星期四
12
2013 十二月

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Off-line reconstruction : 240 X 560 X 116

2D array probe based 3D imaging

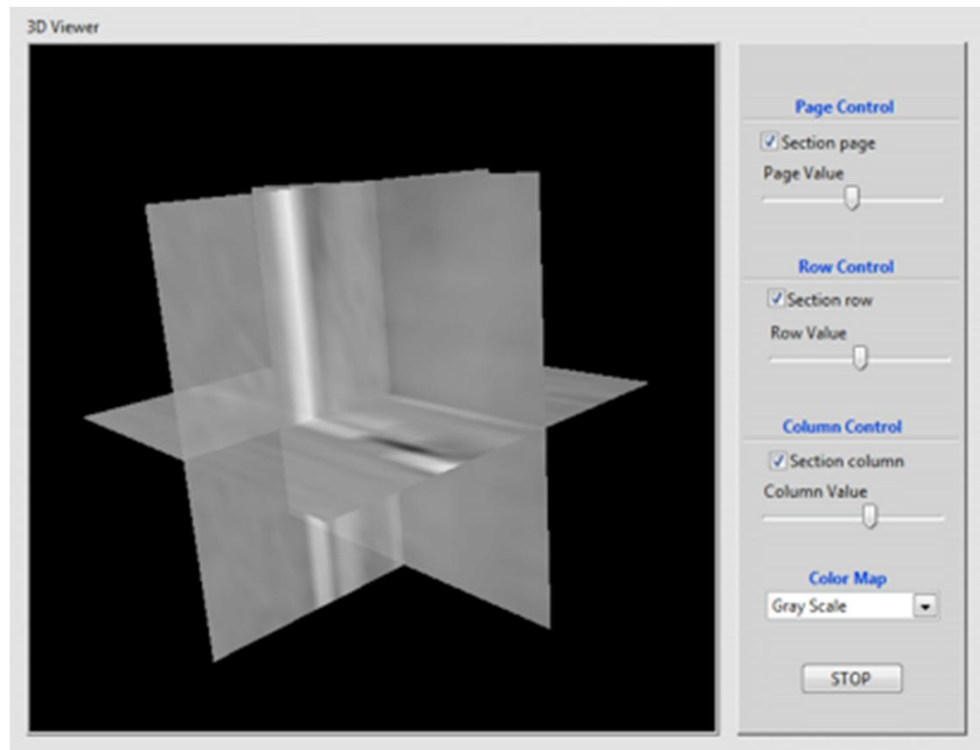


On line real time 3D US imaging

3D image of board



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SoftVue- Breast UCT for breast imaging



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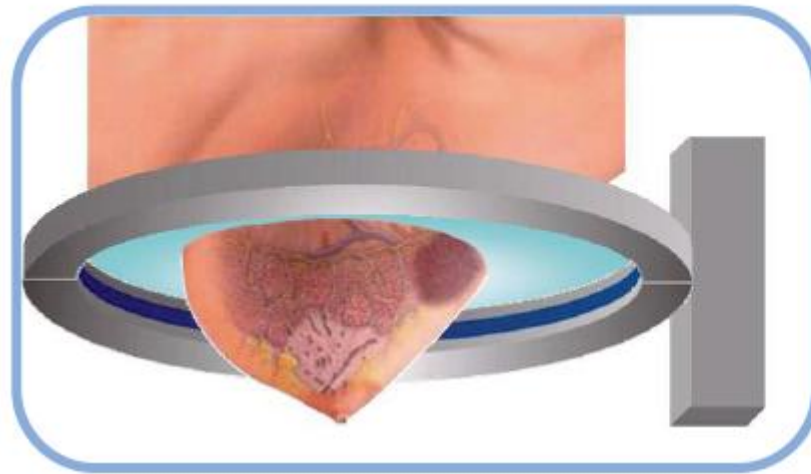


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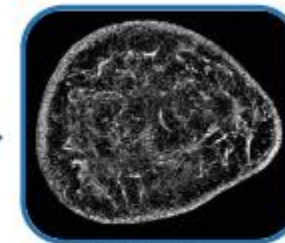
UCT imaging with three different image components



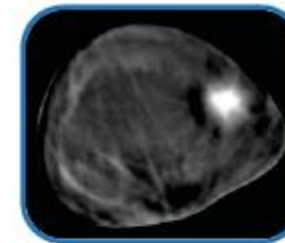
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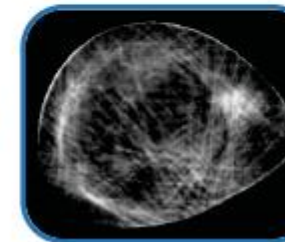
Ultrasound Tomography



Reflection

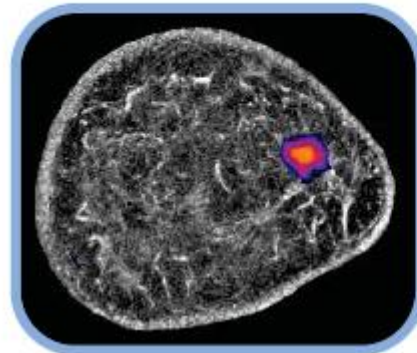


Sound Speed



Attenuation

Fusion Imaging

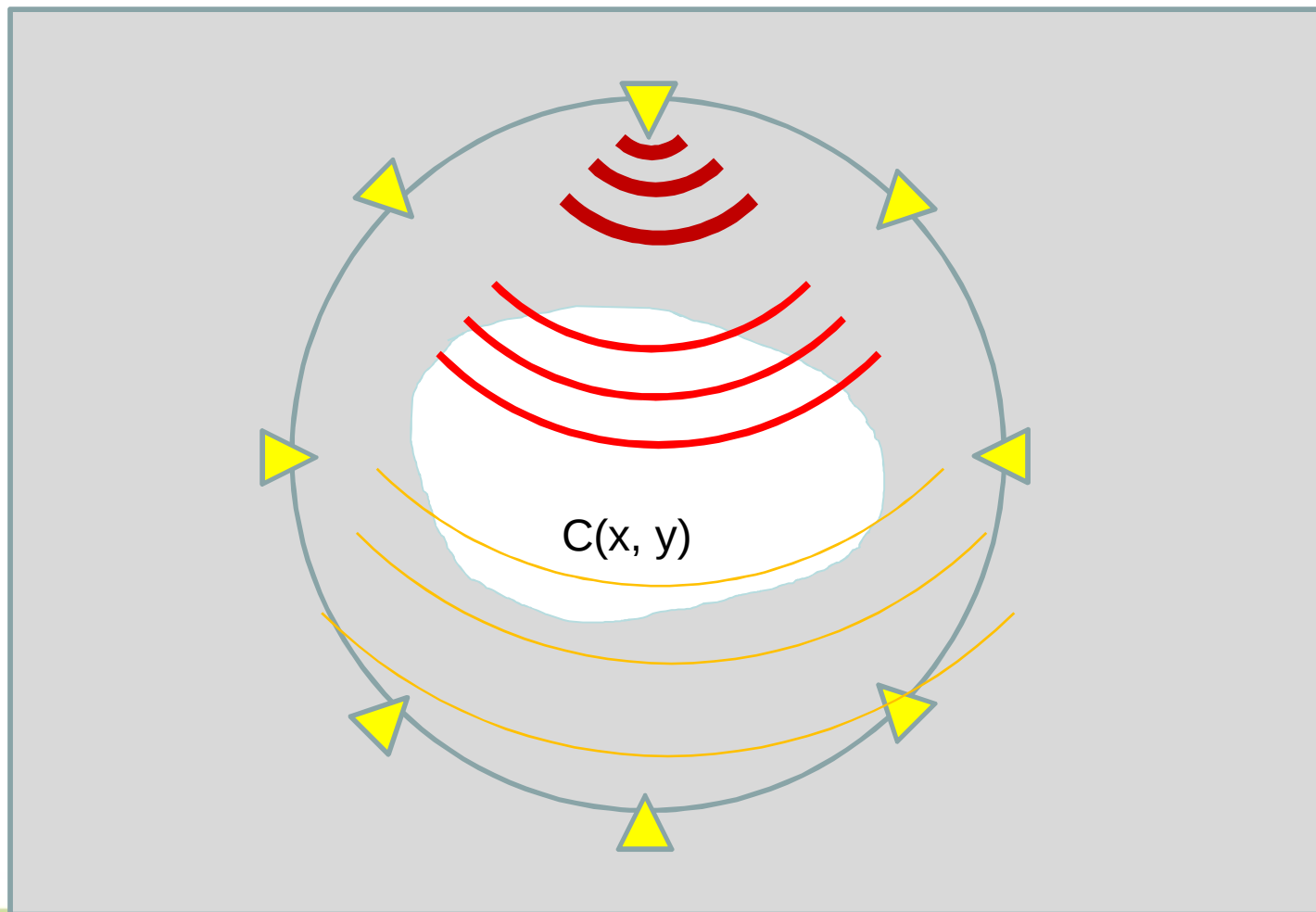


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Ring probe : one transmission, the rest receiving



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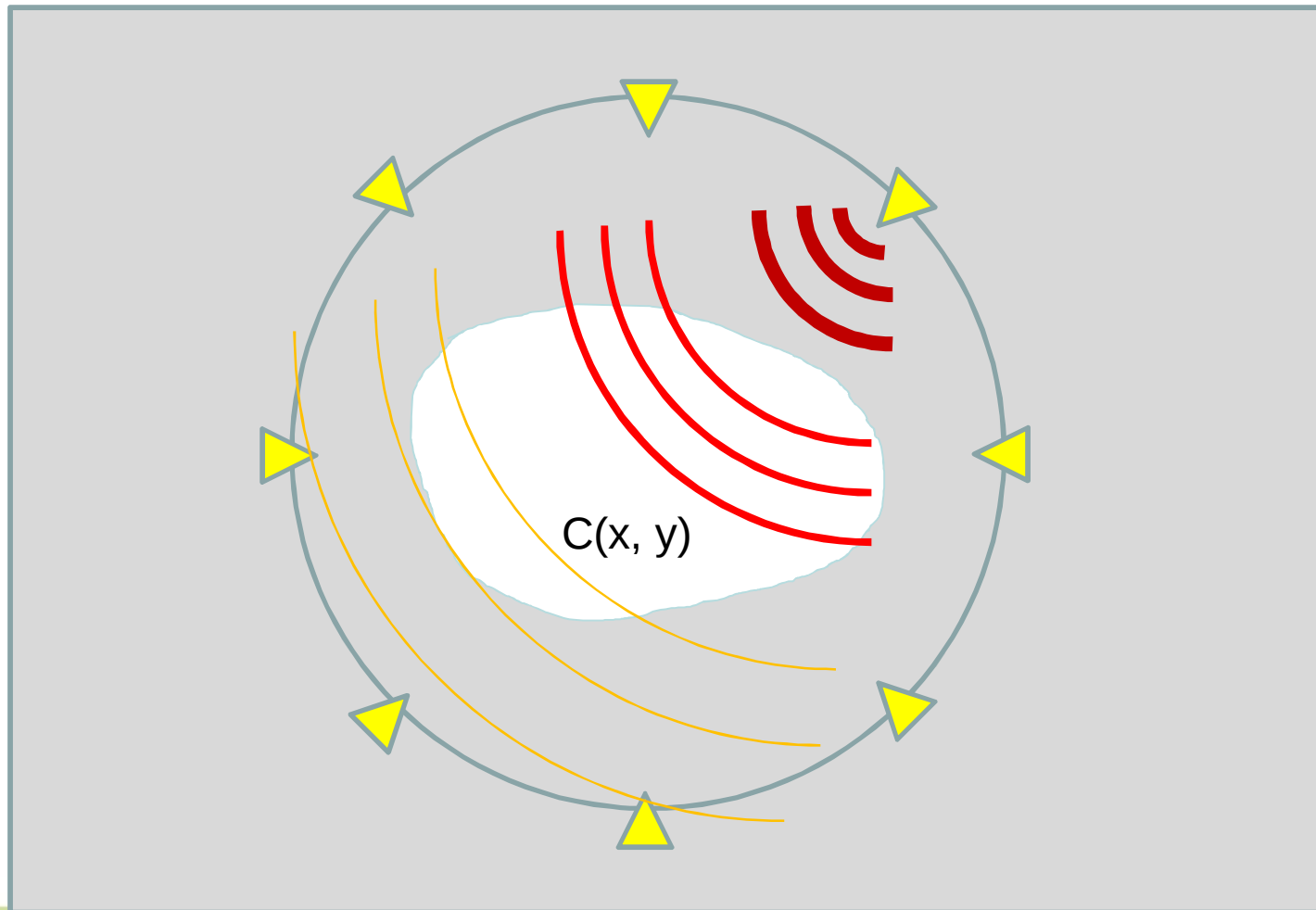


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The other element transmission



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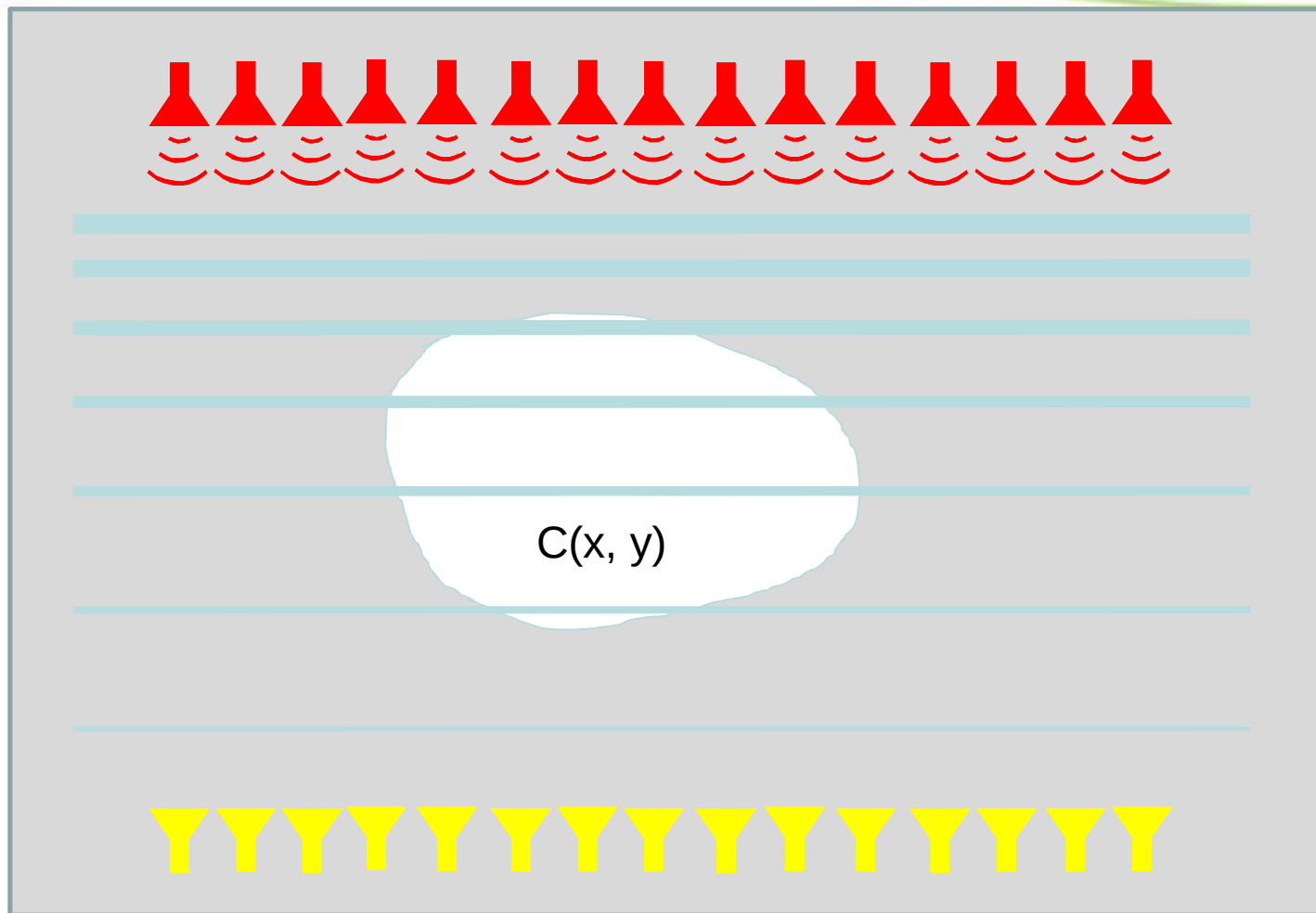


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Linear probe : one transmission ,
the another receiving



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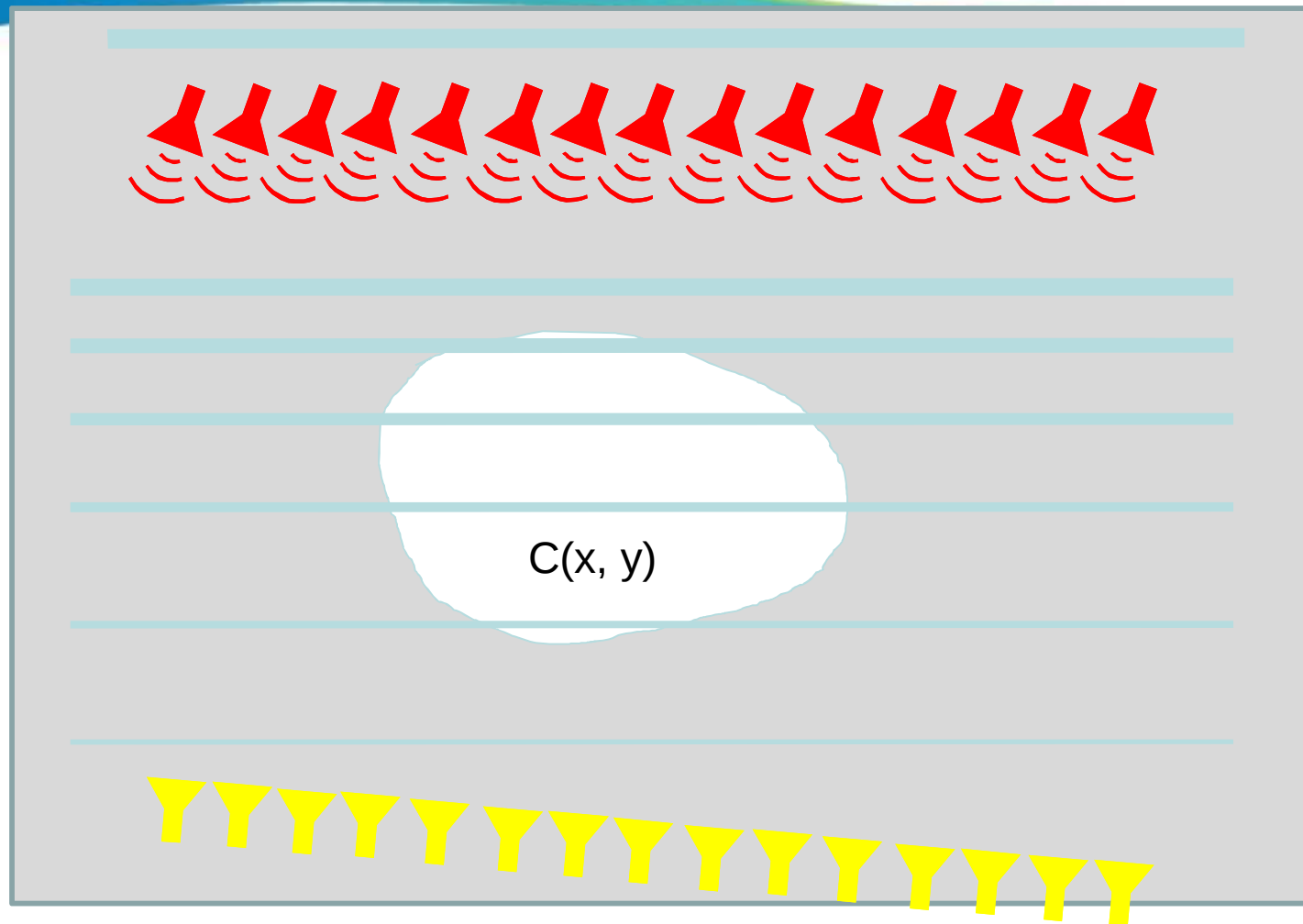


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Transmission from different angle



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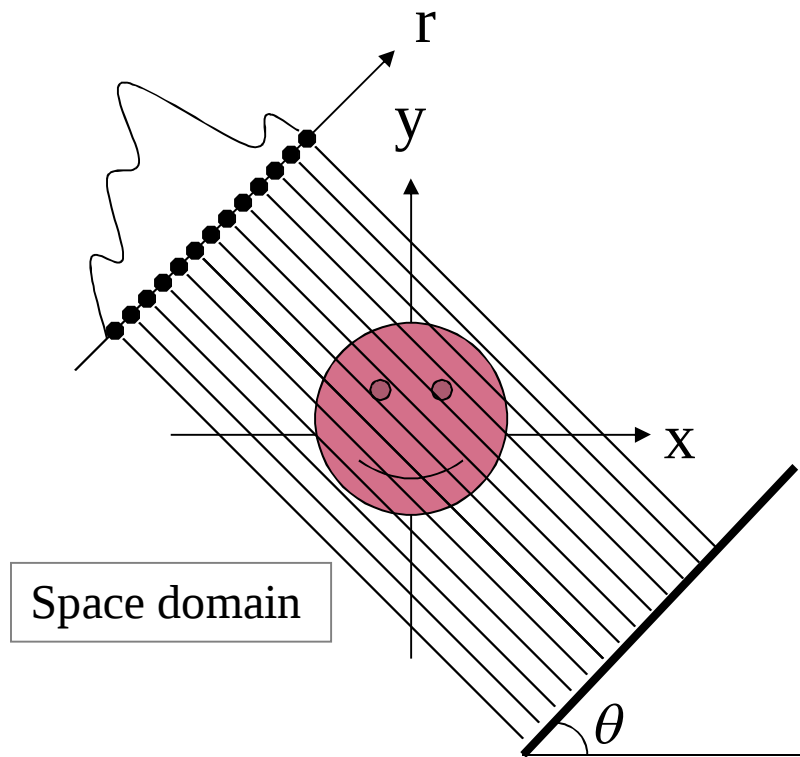


Medical Ultrasound Lab

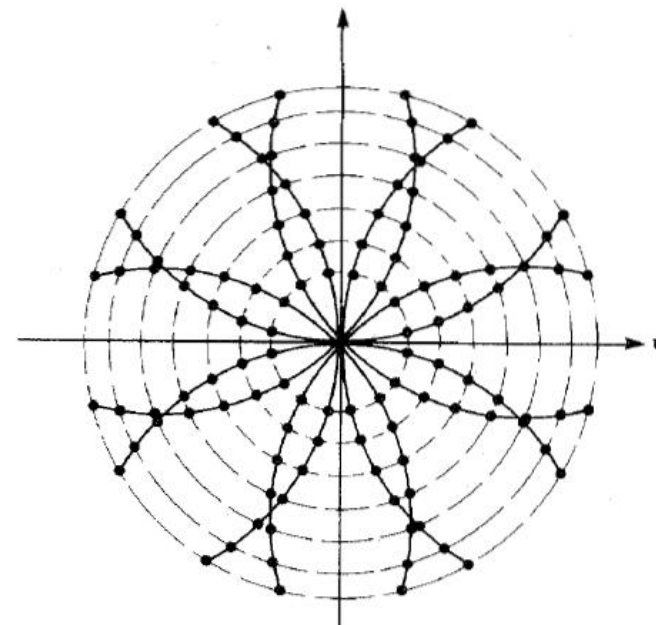
Comparison of X-ray and US projection



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Xray CT



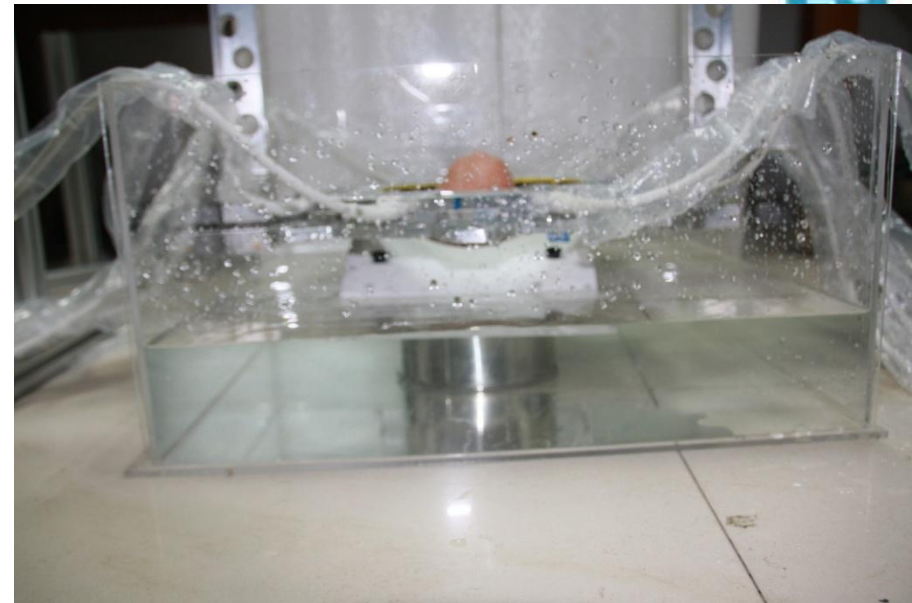
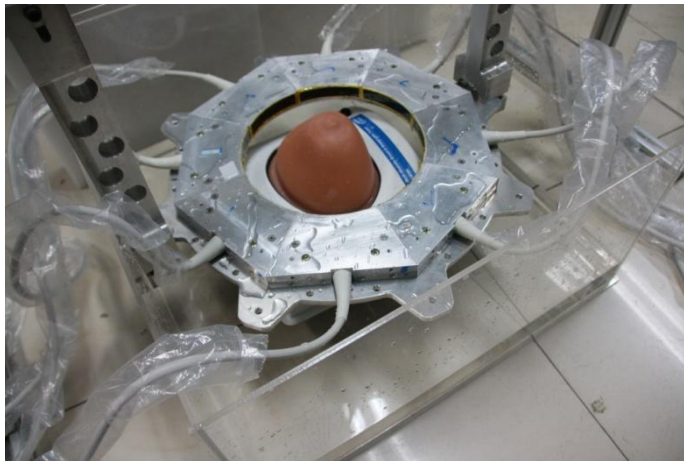
UCT

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Ring transducer for breast imaging system



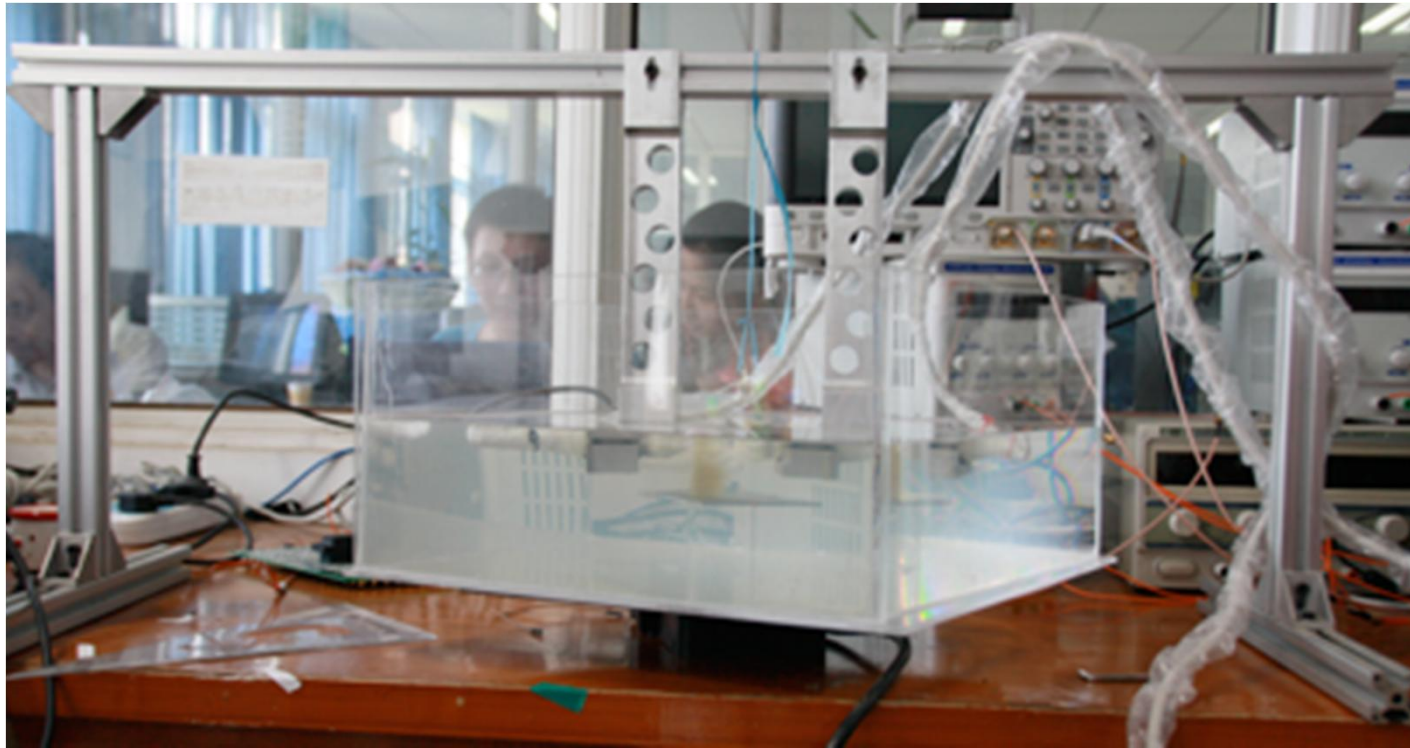
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UCT with two linear array probes

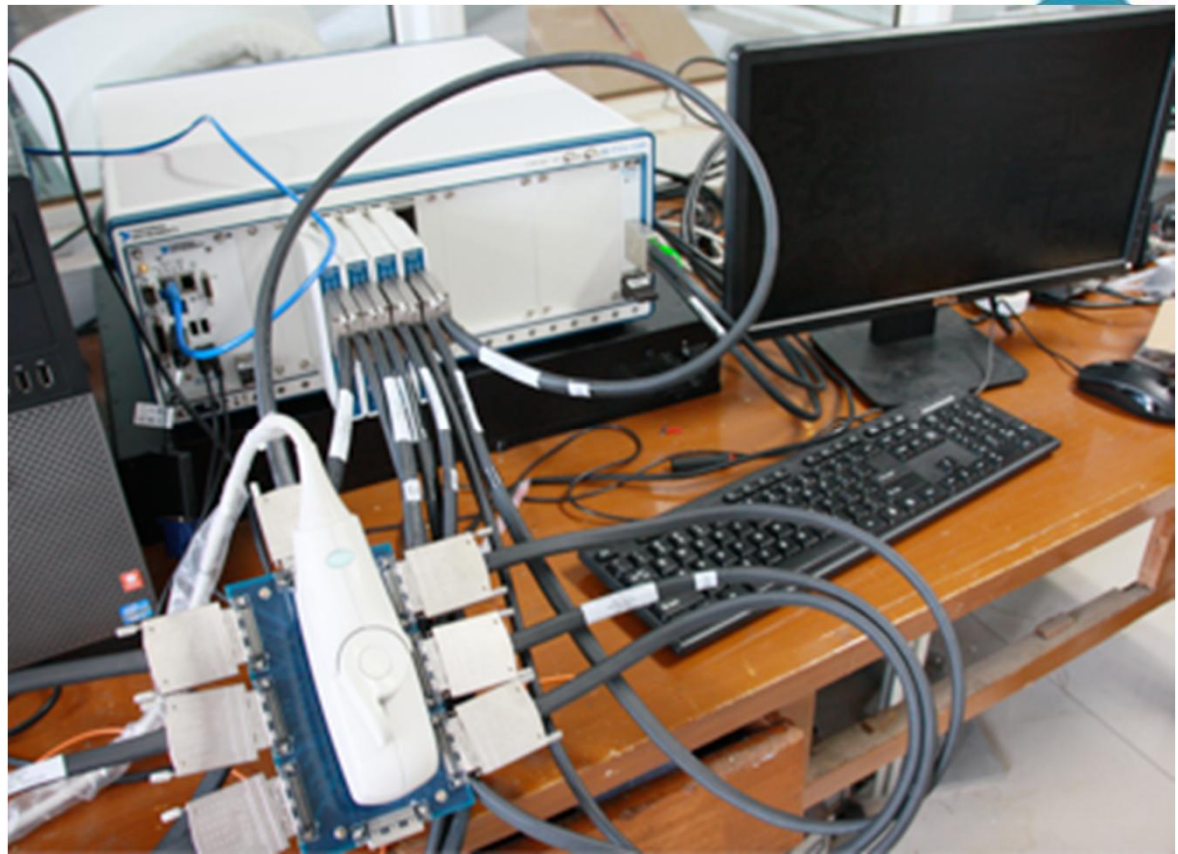
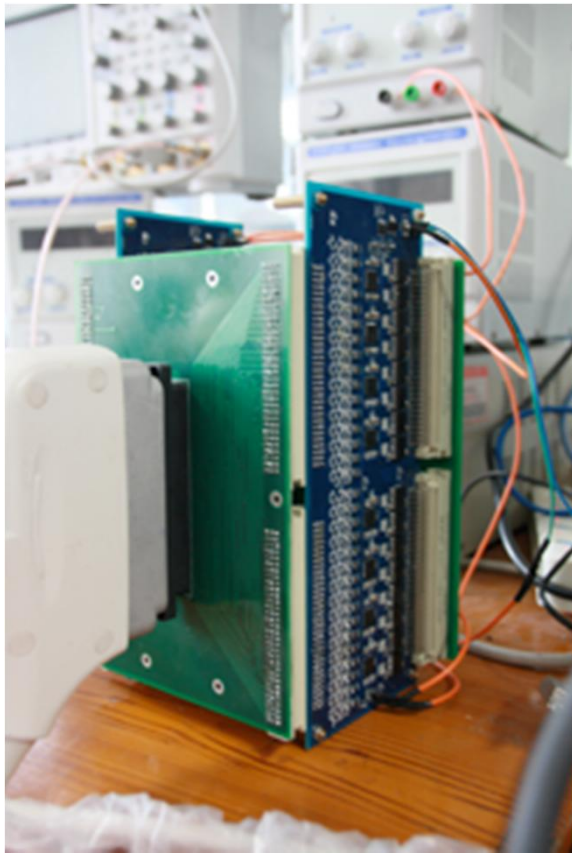


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Hardware system of UCT for 3D breast imaging system



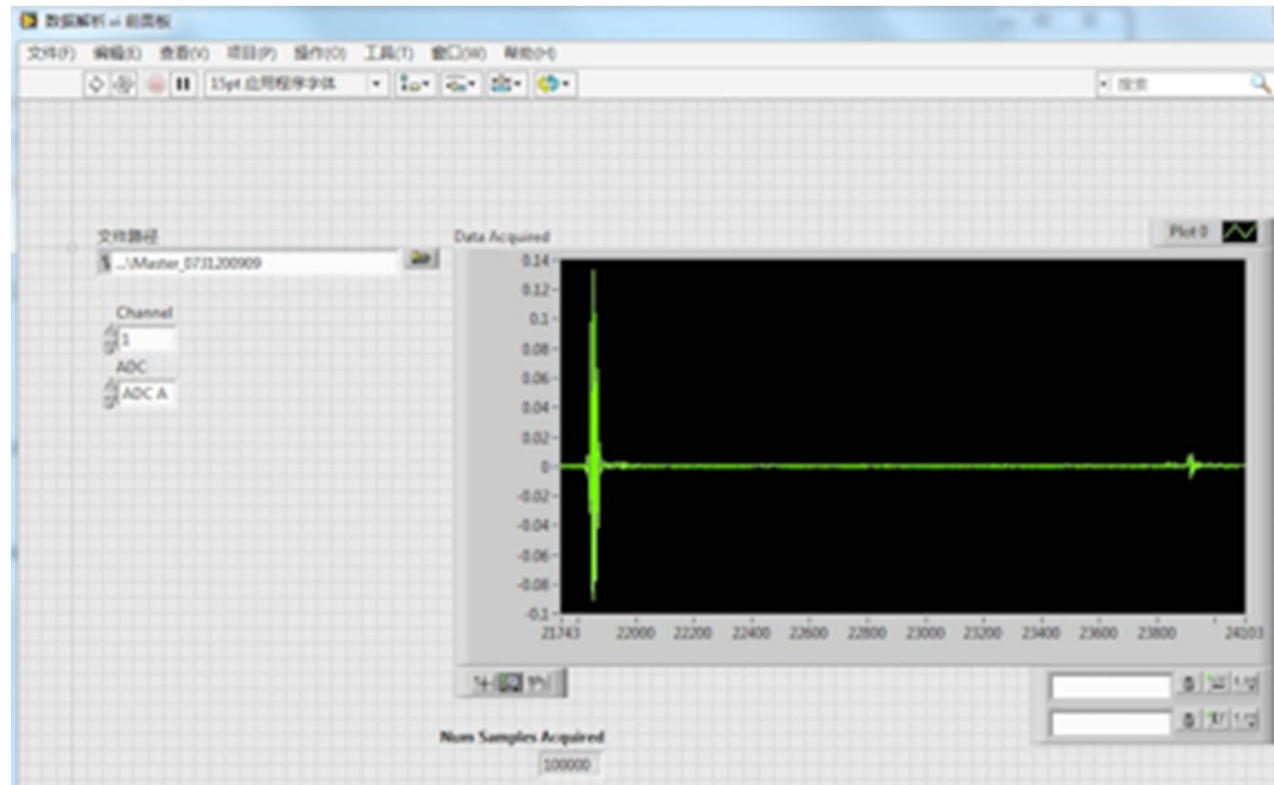
Transmit part

Capture part

Echo signal received in system



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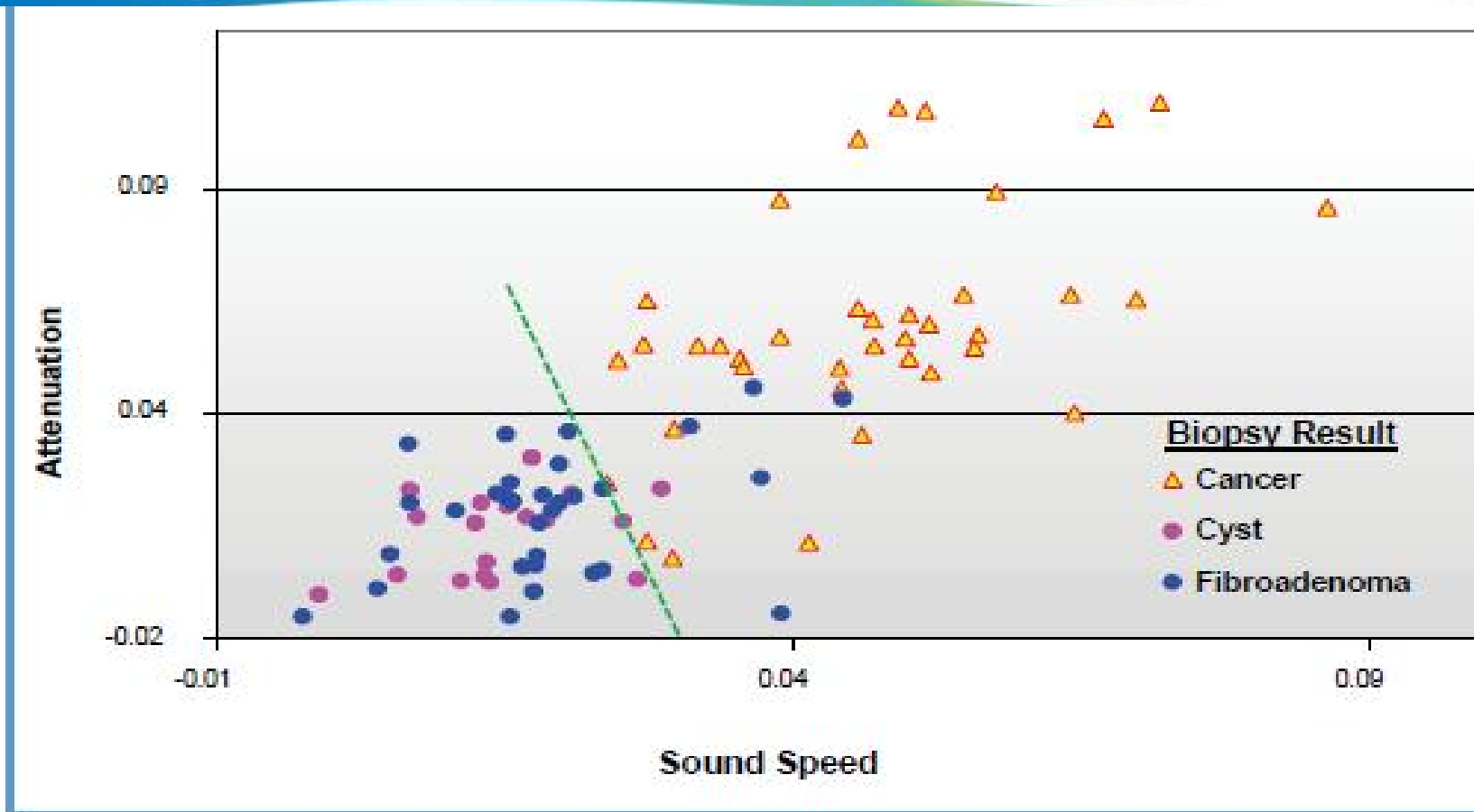


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Diagnosis results of breast cancer



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Correct rate UCT >85% , mammogram 55%



IMPROVEMENTS AND ENHANCEMENTS

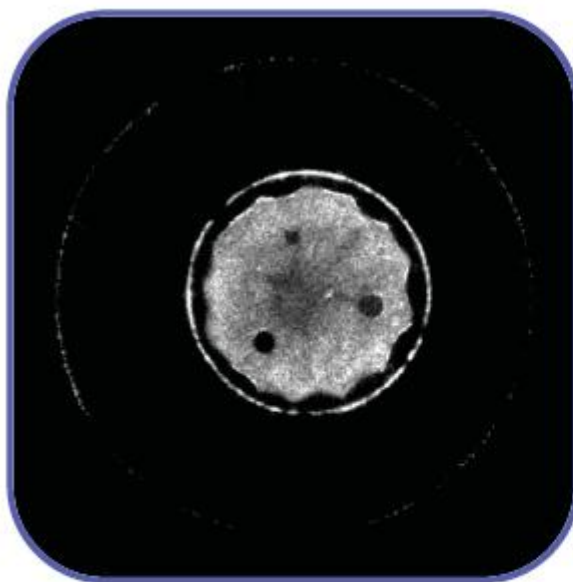
Technical Feature	UST prototype	SoftVue	Improvement
Number of transducer elements	256	2048	8x
Number of receive channels	256	512	2x
Number of transmit channels	11	512	40x
Data resolution	12 bits	14 bits	4x
Data rate	24 MB/s	3 GB/s	125x
Physical size of electronics	3100 cu. in.	512 cu. in.	6x
Water usage	48 gal.	2.5-5 gal.	10x
Reconstruction time per slice	9,000 s	4 s	2250x

Clinical Feature	UST prototype	SoftVue	Improvement
Image resolution (volume)	5 x 0.5 x 0.5 mm	2.5 x 0.3 x 0.3 mm	5x
Max. breast diameter	20 cm	22 cm	10%
Scan time w/ data transfer	12.5 min.	1.7 min.	7x
B-mode	No	Yes	+
Power Doppler	No	Yes	+
Harmonic imaging	No	Yes	+

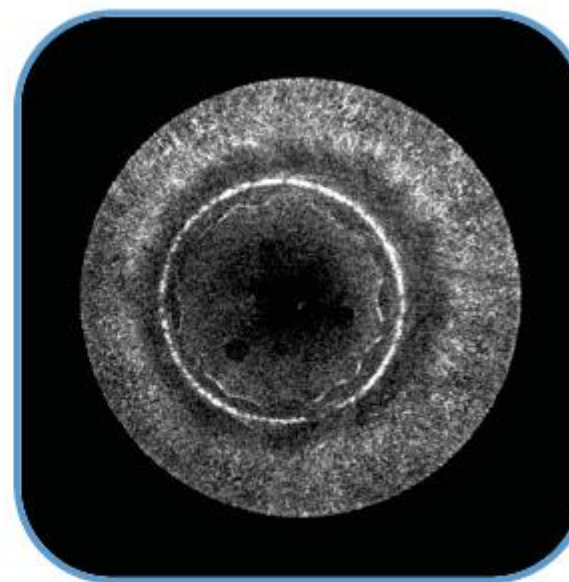
Comparison of proto-type and 1st generation system



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SoftVue Phantom
Image



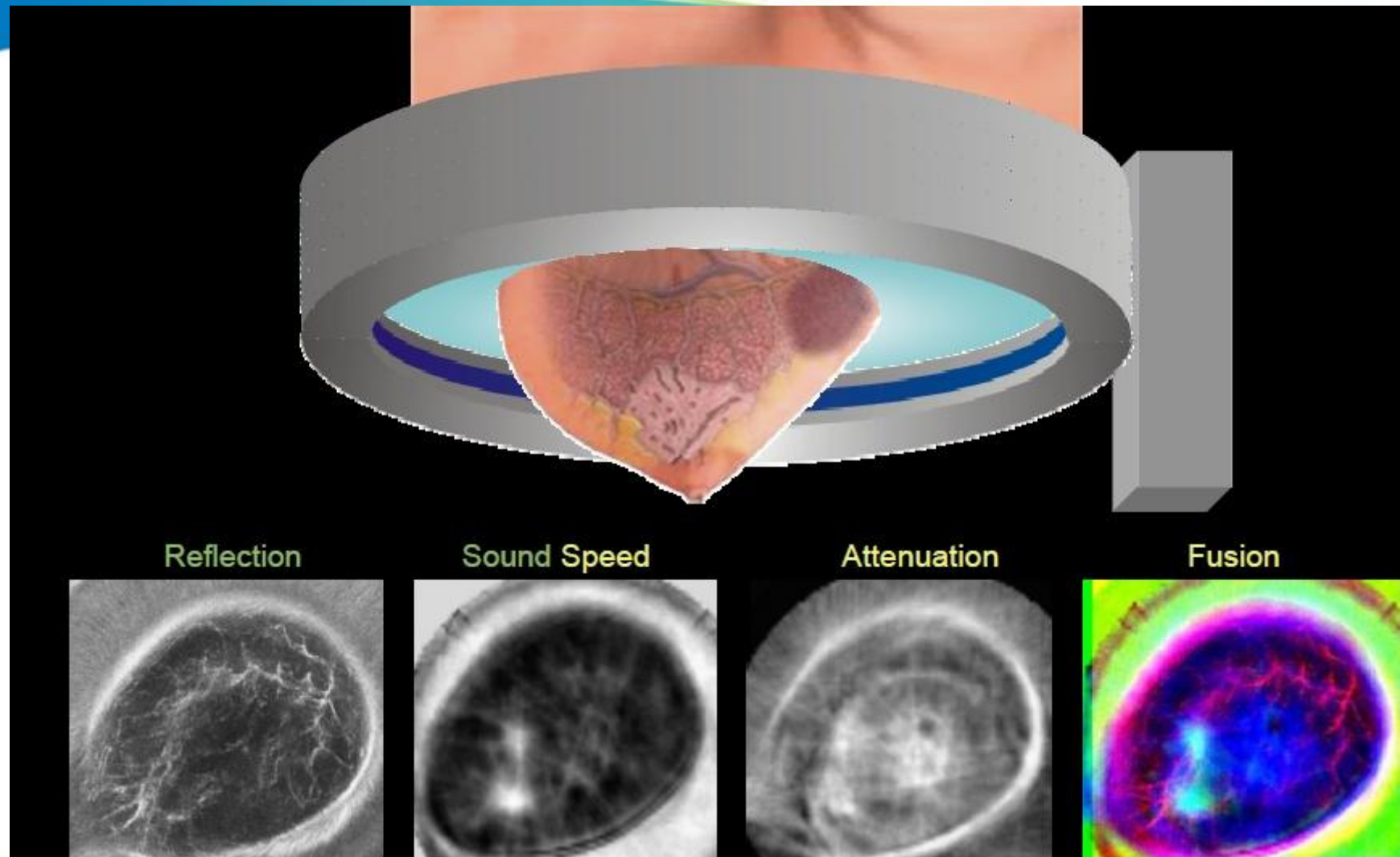
Prototype Phantom
Image

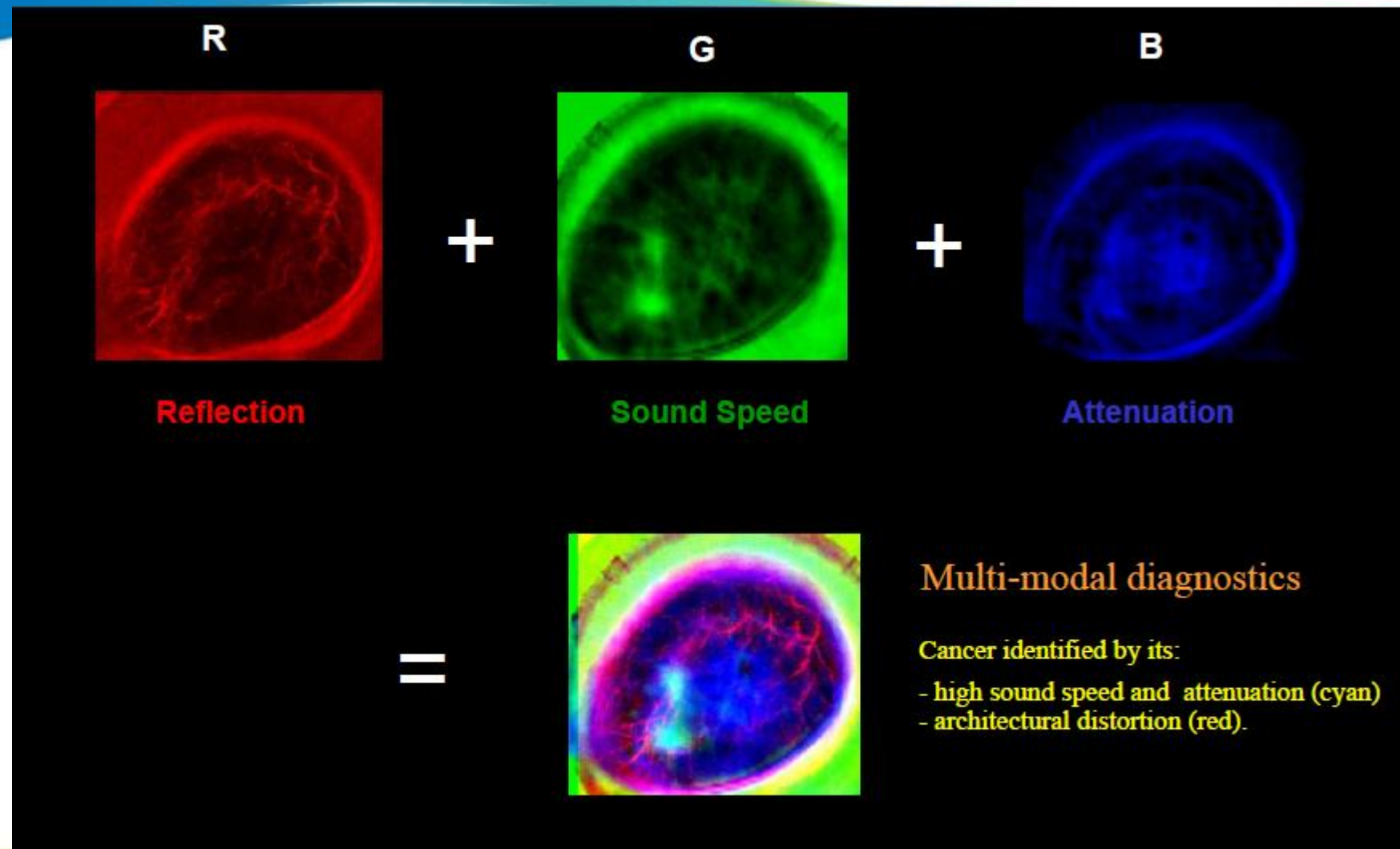
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Fusion image from 3 US components



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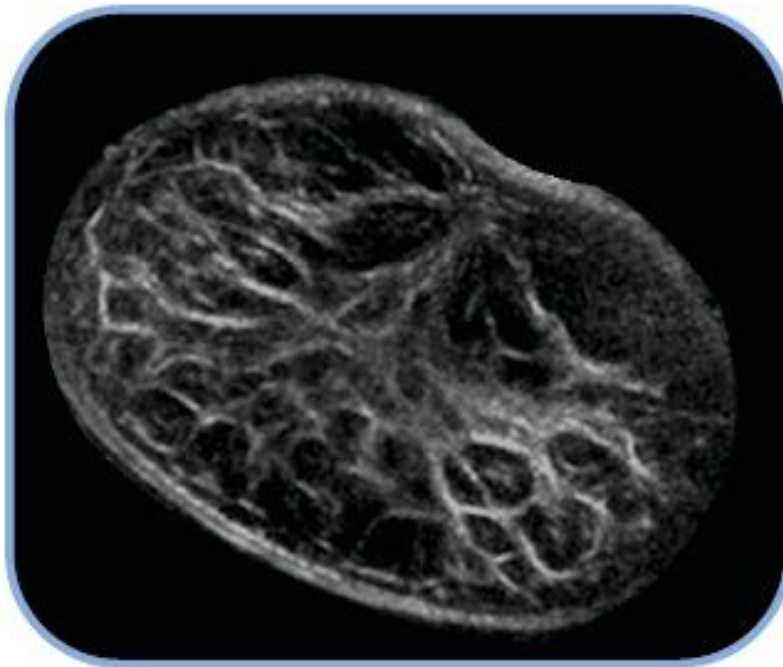




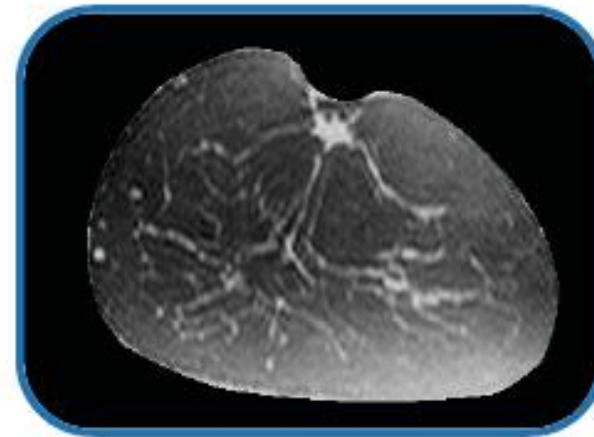
Comparison between UCT and MRI



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SoftVue image shows
residual distortion of same
region after lumpectomy



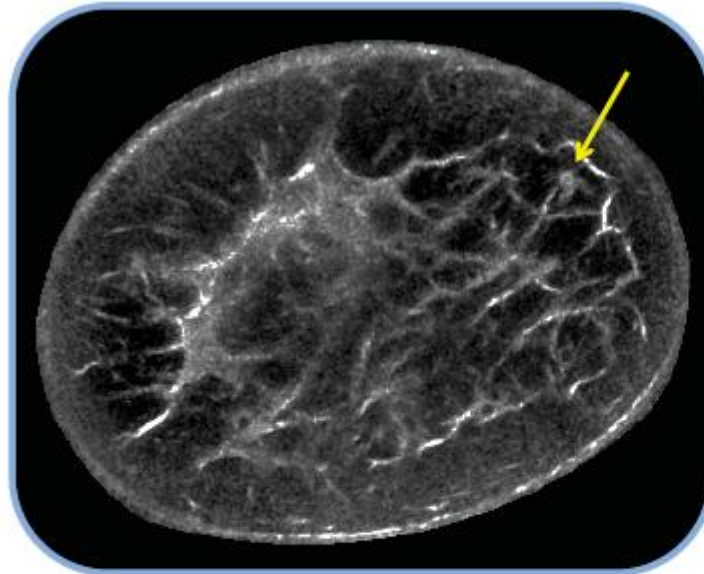
MRI image depicts tumor
and breast deformation at
time of diagnosis

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Comparison between UCT and mammogram



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SoftVue image shows a cross-section of breast parallel to the chest wall. A clip from a needle cyst aspiration is rendered clearly by SoftVue (arrow)



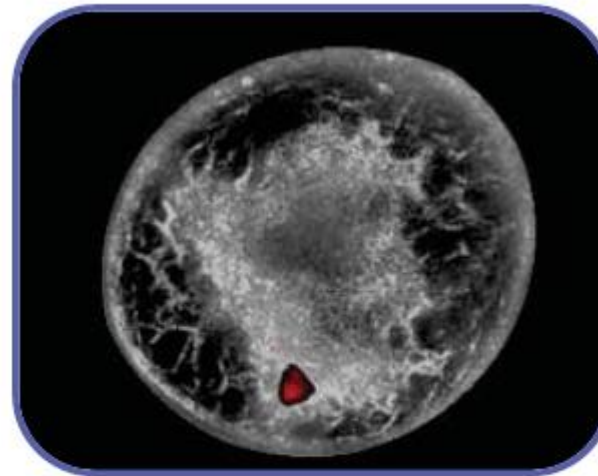
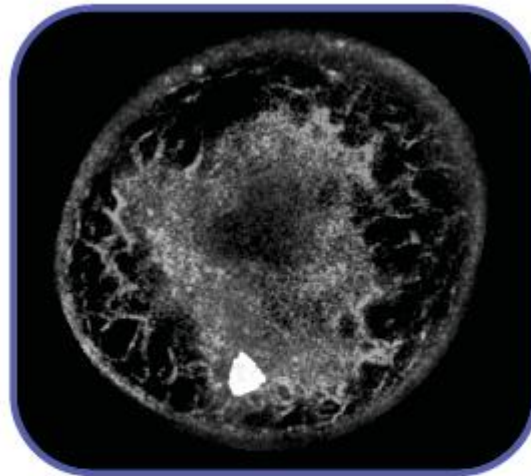
Mammogram shows an image of a compressed breast

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Fusion of tumor



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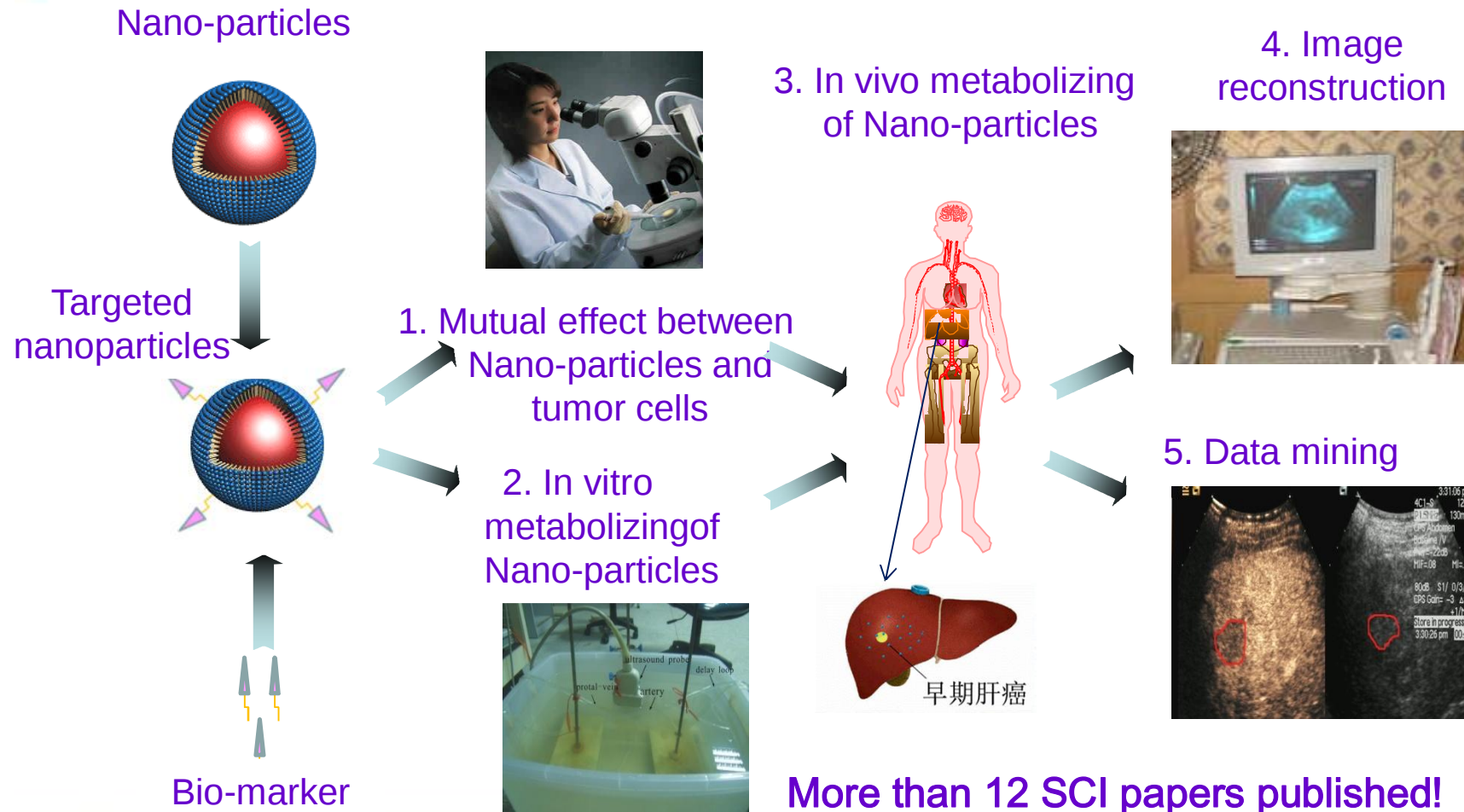
Dense breast:
1.5 cm Invasive Ductal Carcinoma (IDC) identified

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Target Nano-particles Agent for early liver diagnosis



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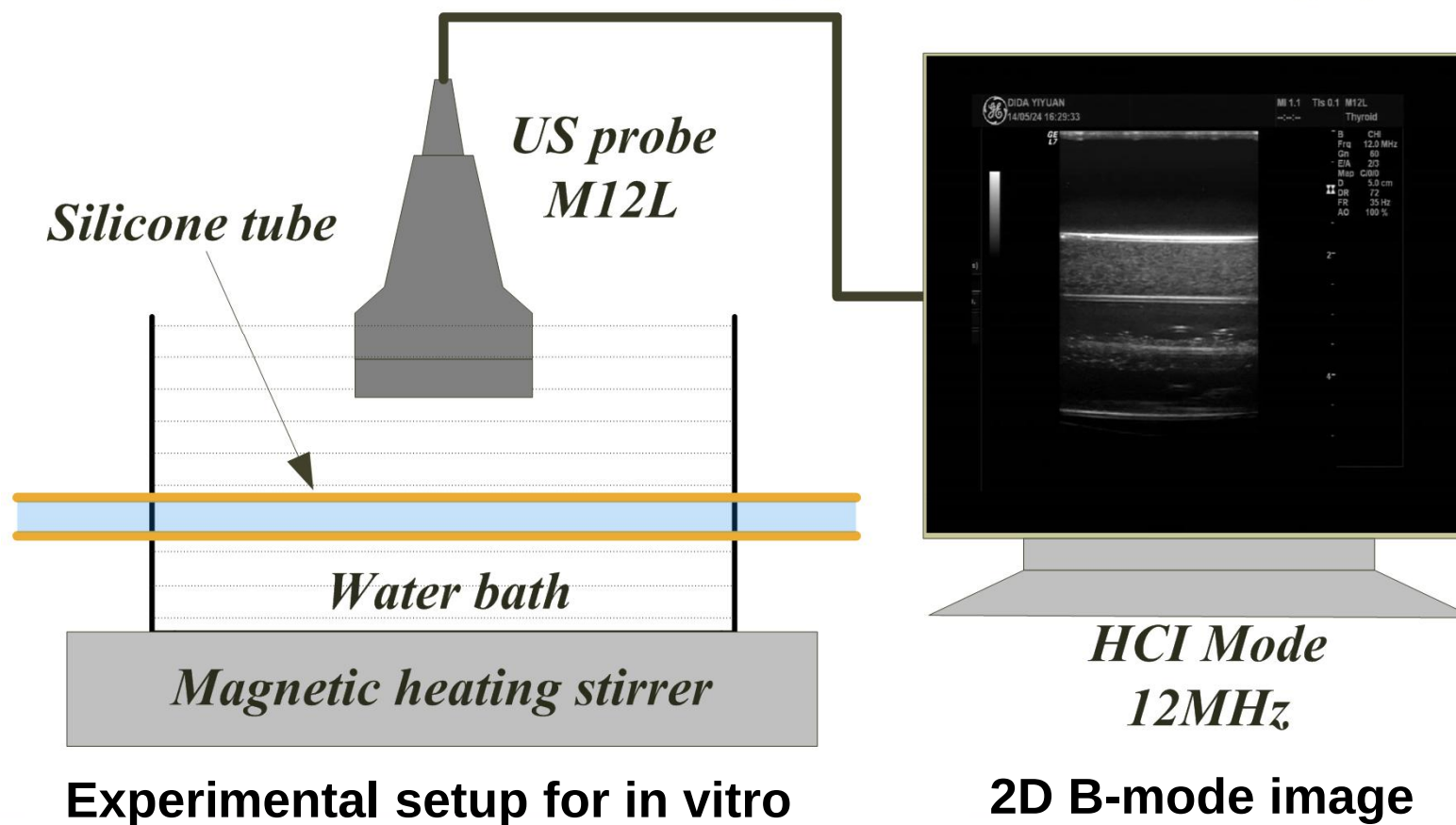
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In vitro experiments



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GE Logiq 7 Ultrasound Imaging System



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In vivo experiments



Wistar rat



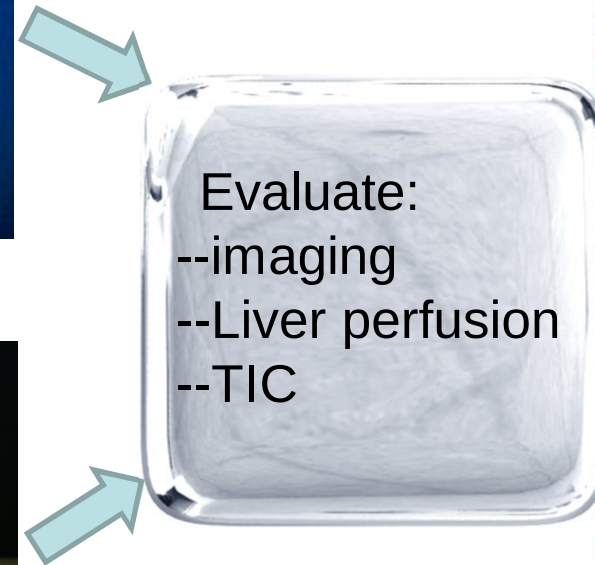
Micro-bubble



GE logiq7



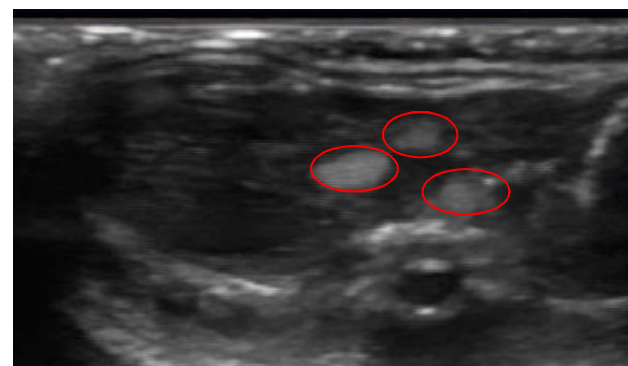
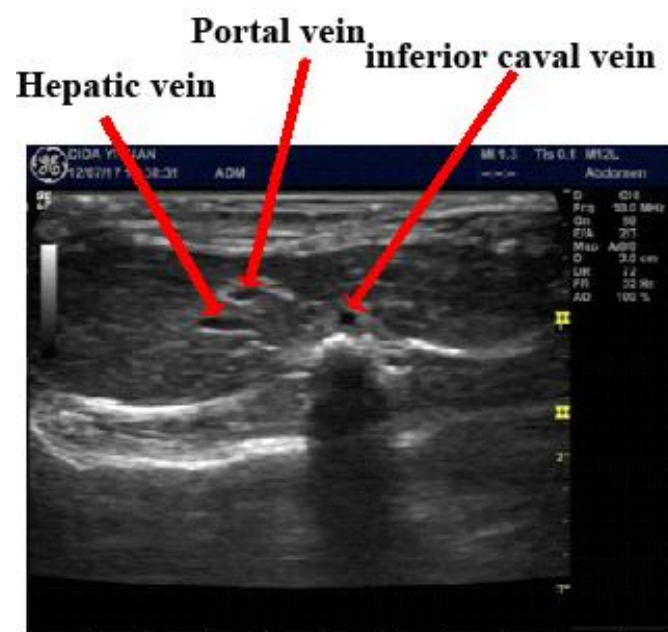
Target-nanoparticles



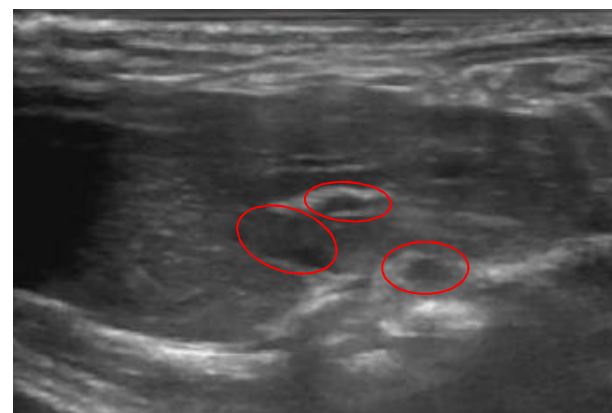
In vivo experiments



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SonoVue



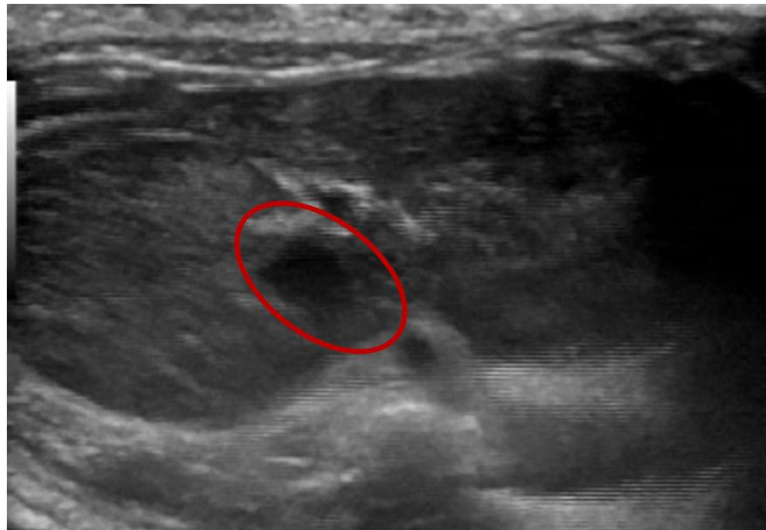
Nanobubble

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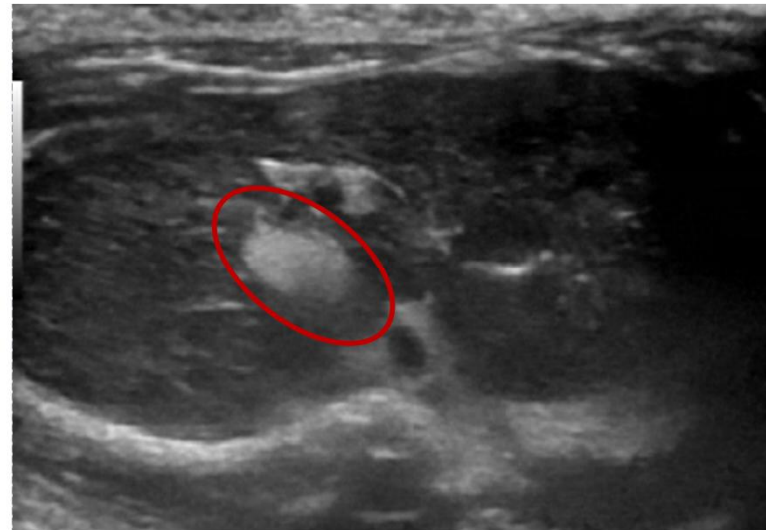
In vivo experiments



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(a)



(b)

The rat liver ultrasound image before (a) and 10s after (b) injection of the targeted nanobubbles

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Proto-type system for 3D imaging



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SonixTouch US data acquisition system



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SonixTOUCH
The New Face of Ultrasound



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Simens Acuson 512



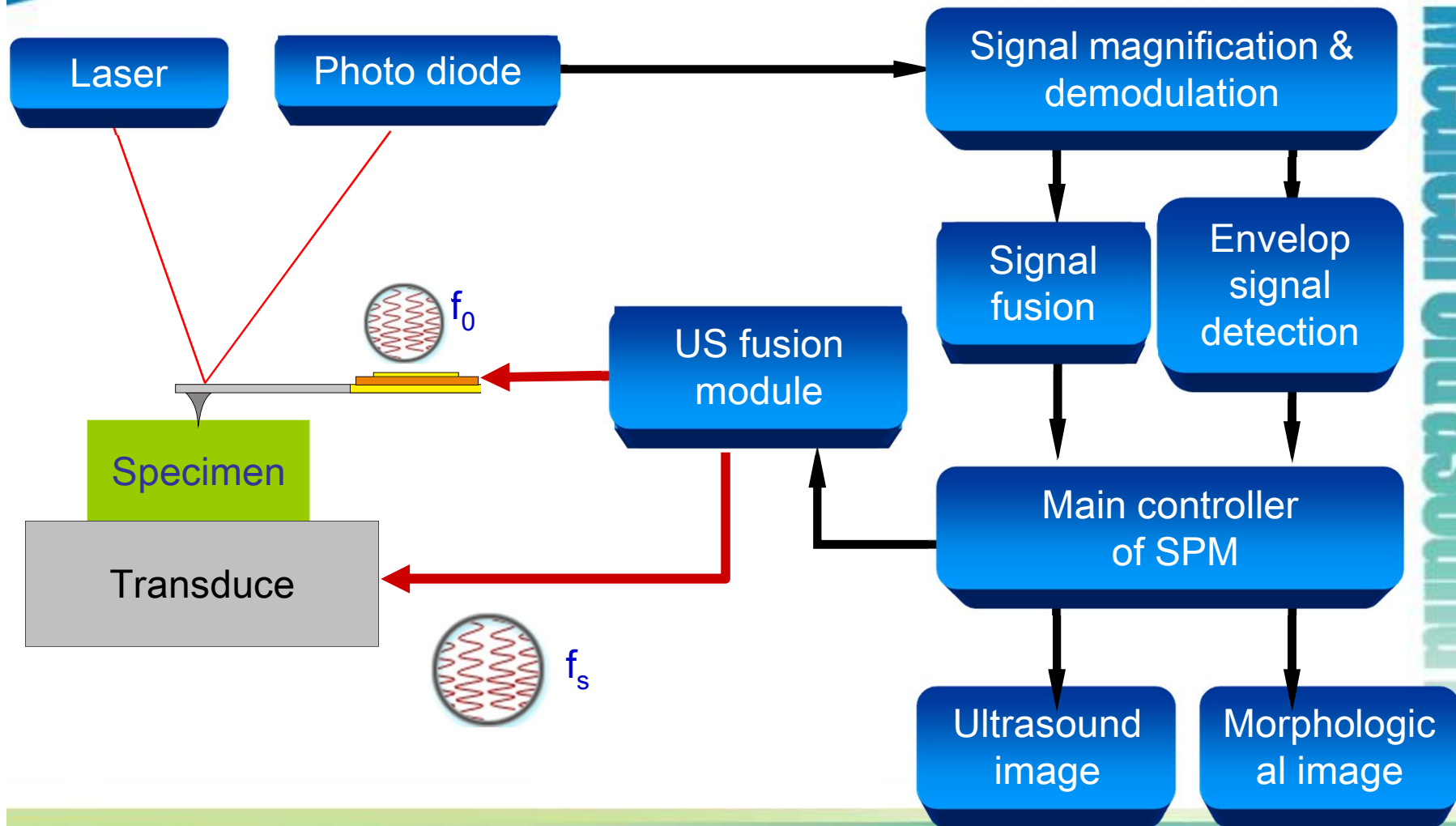
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Schematic structure of SPAM



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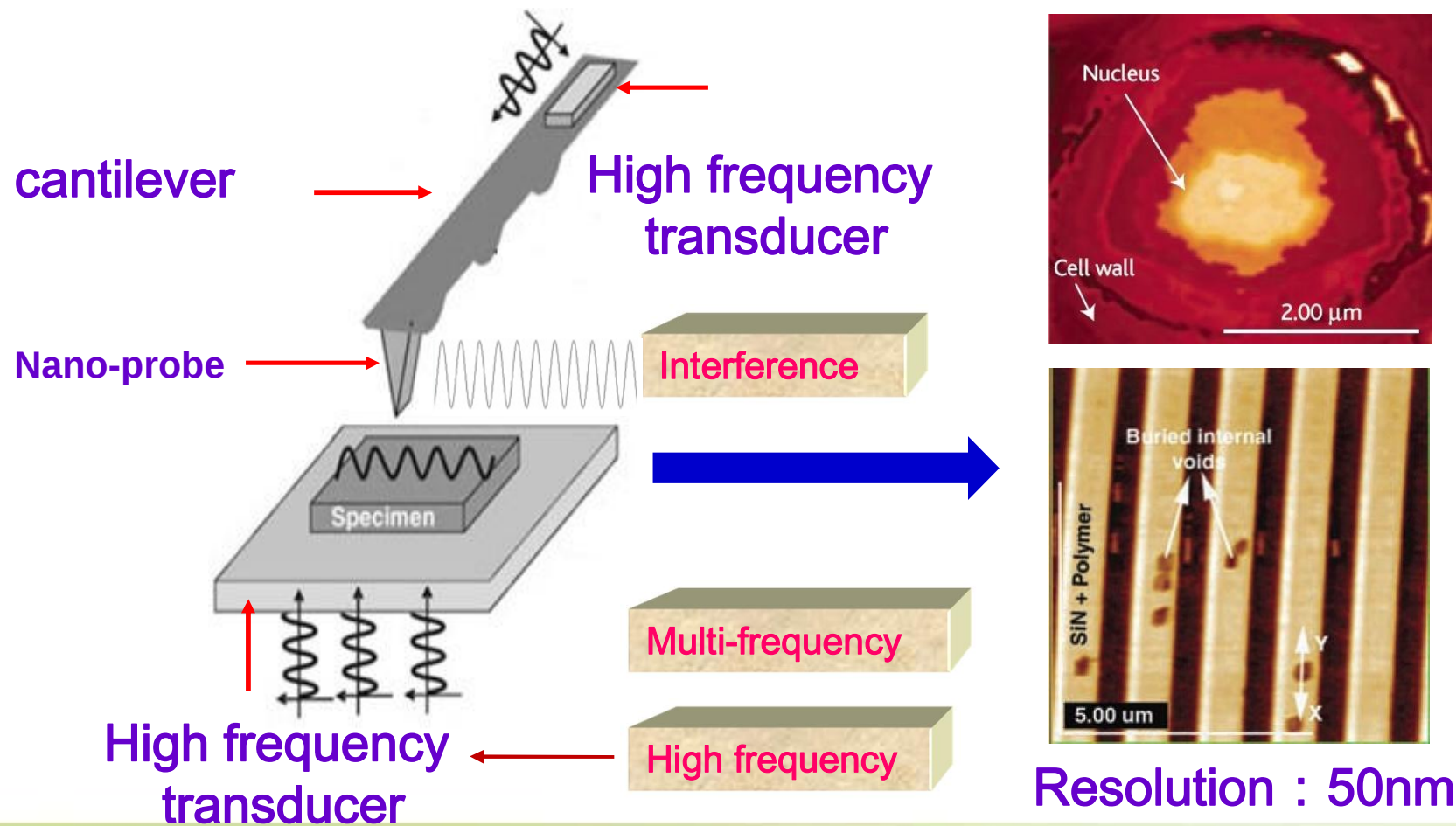


High Frequency Ultrasound Fused Scanning Probe Microscopy



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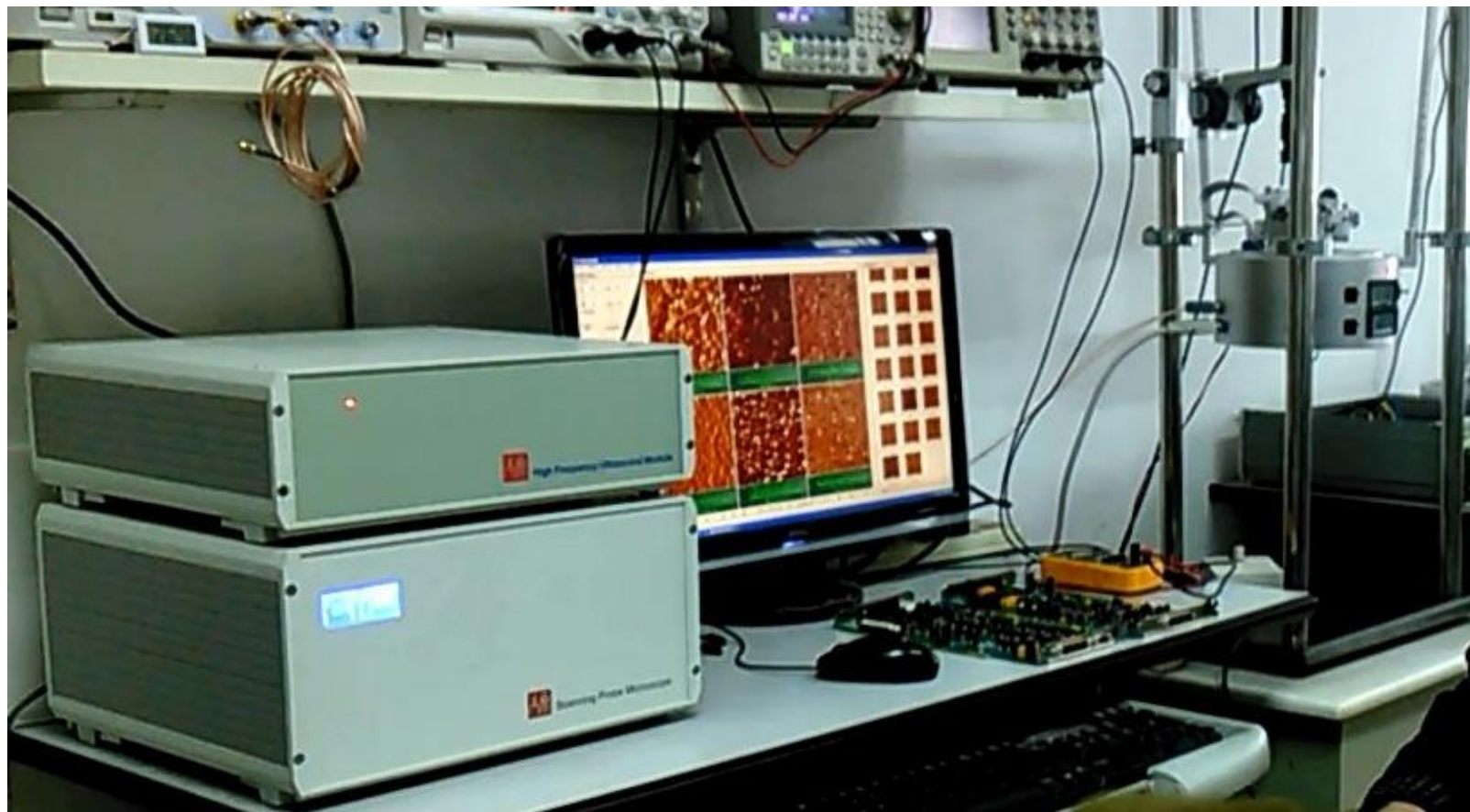
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Proto-type HFUF SPM system



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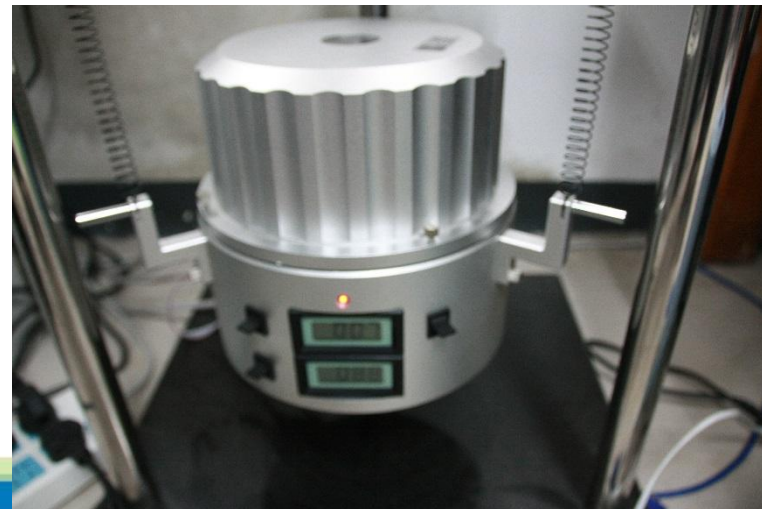
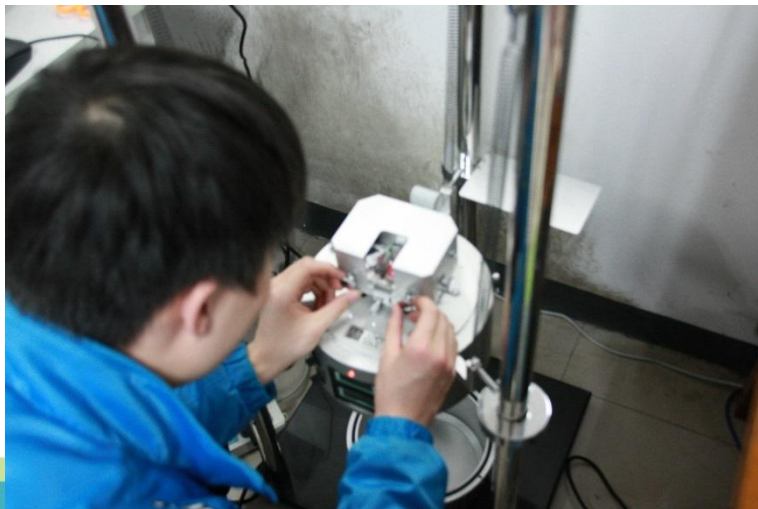
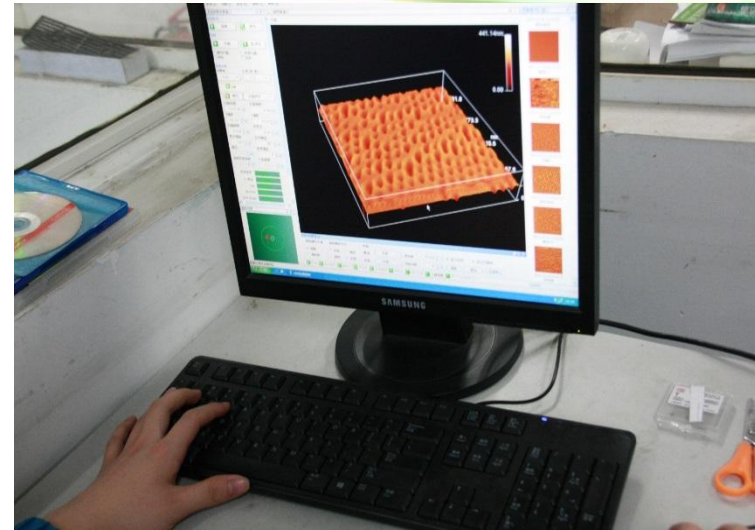
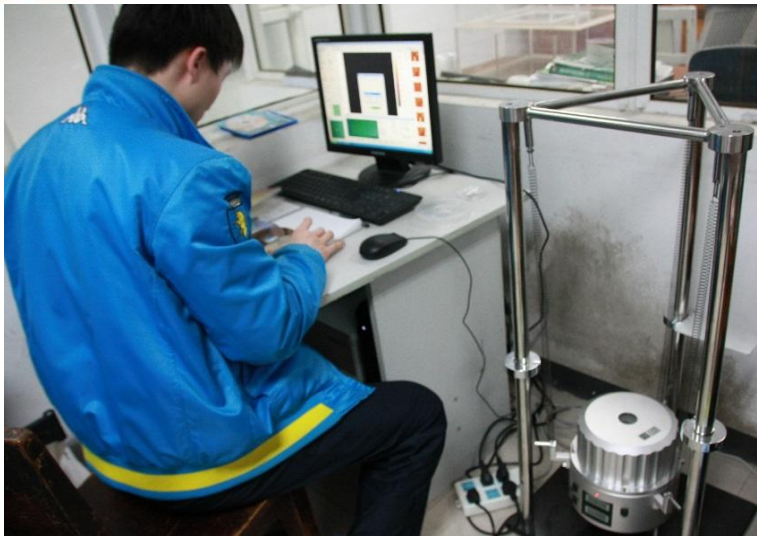


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Experiments



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DVD, NVD and specimens



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DVD , Blue DROM , NVD

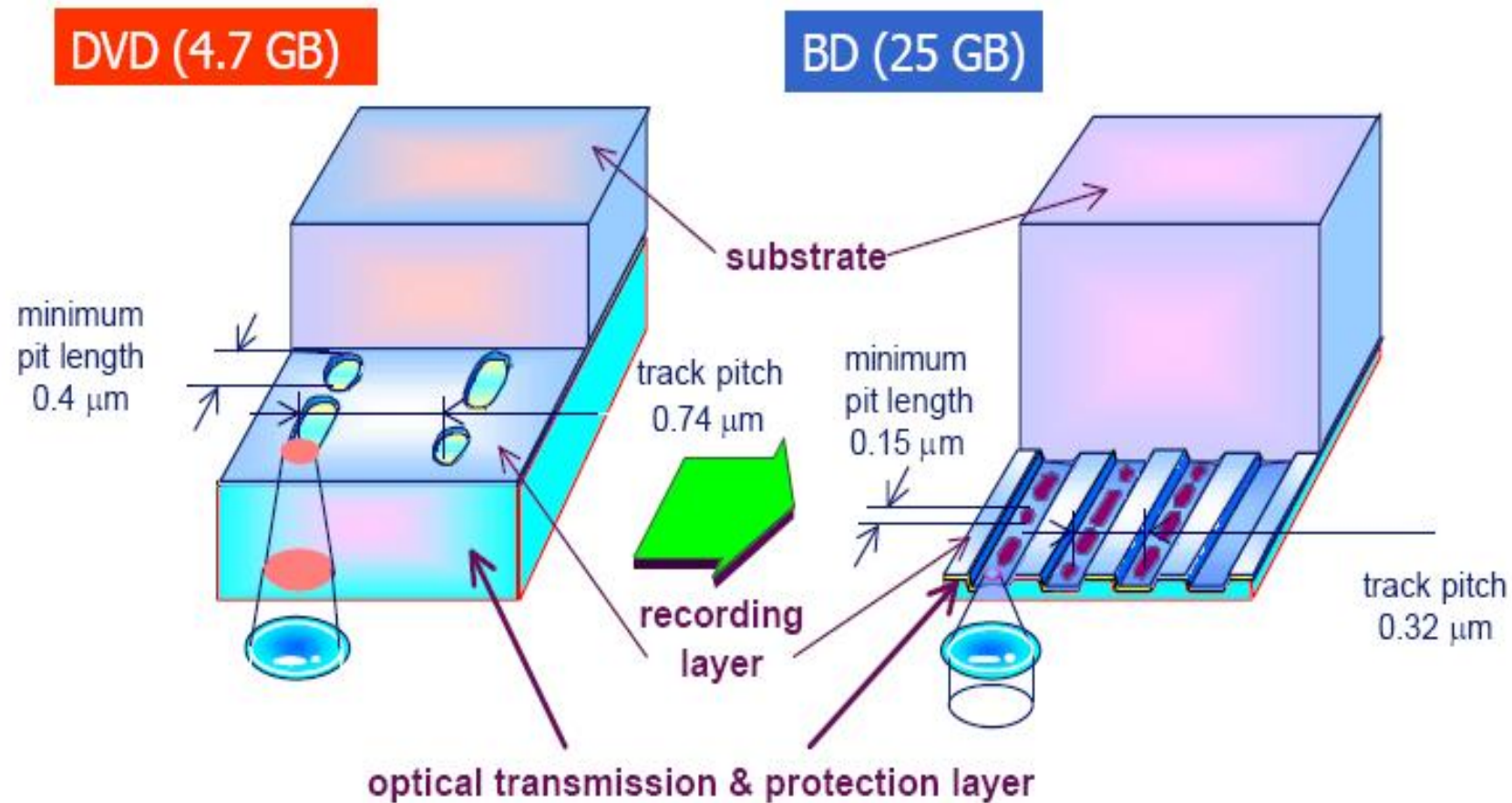
Specimens piled off are 0.60mm , 1.12mm , 0.62mm respectively.

Medical Ultrasound Lab

Structures of DVD and BD



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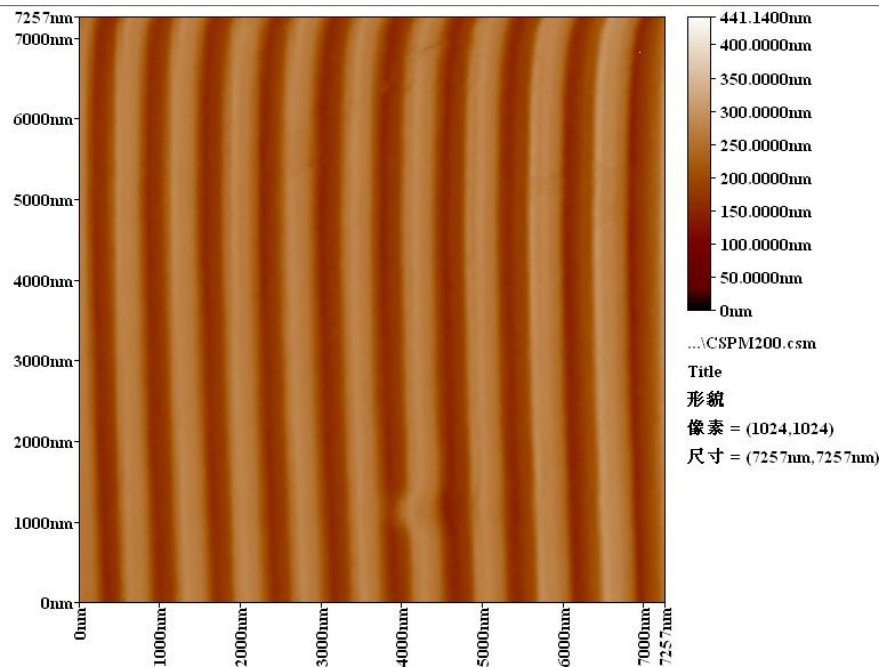


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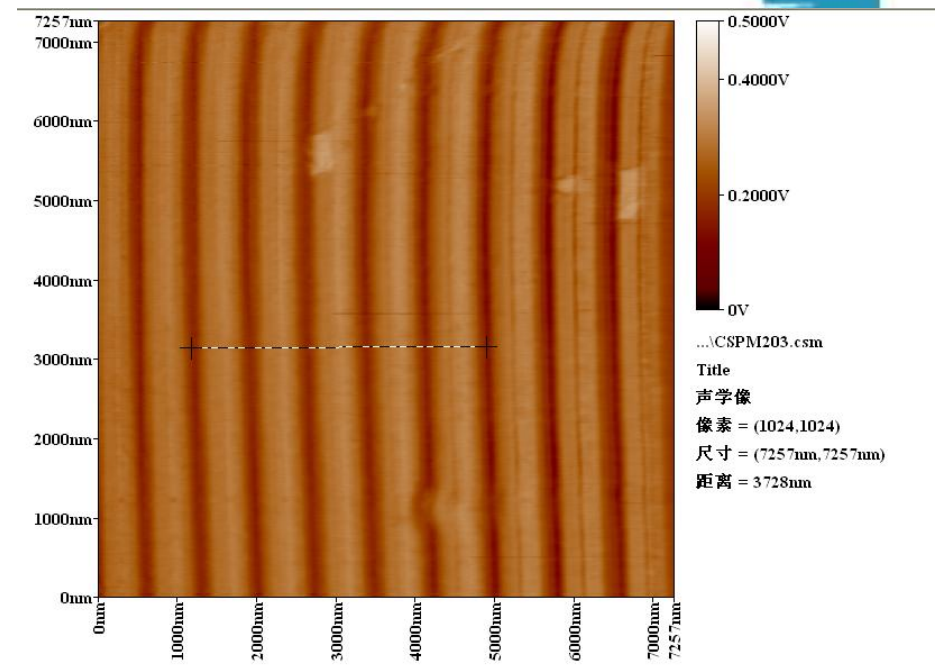
7 μm ×7 μm of DVD



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Morphological image



Ultrasound image

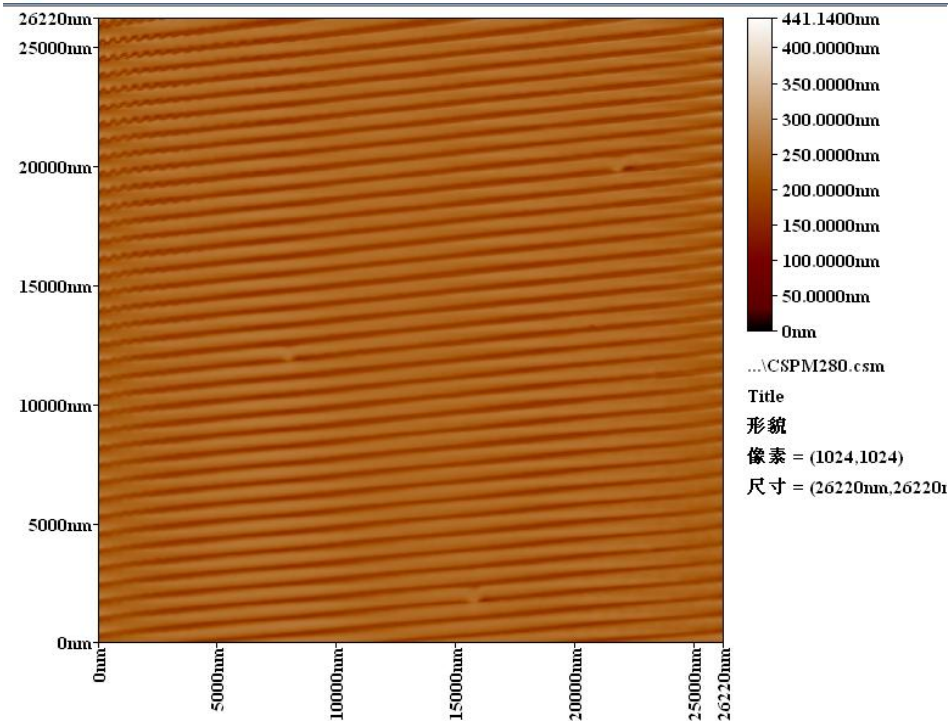
Measured five strips is 3725nm and the ground truth is 3700nm with a error rate of 0.6%.



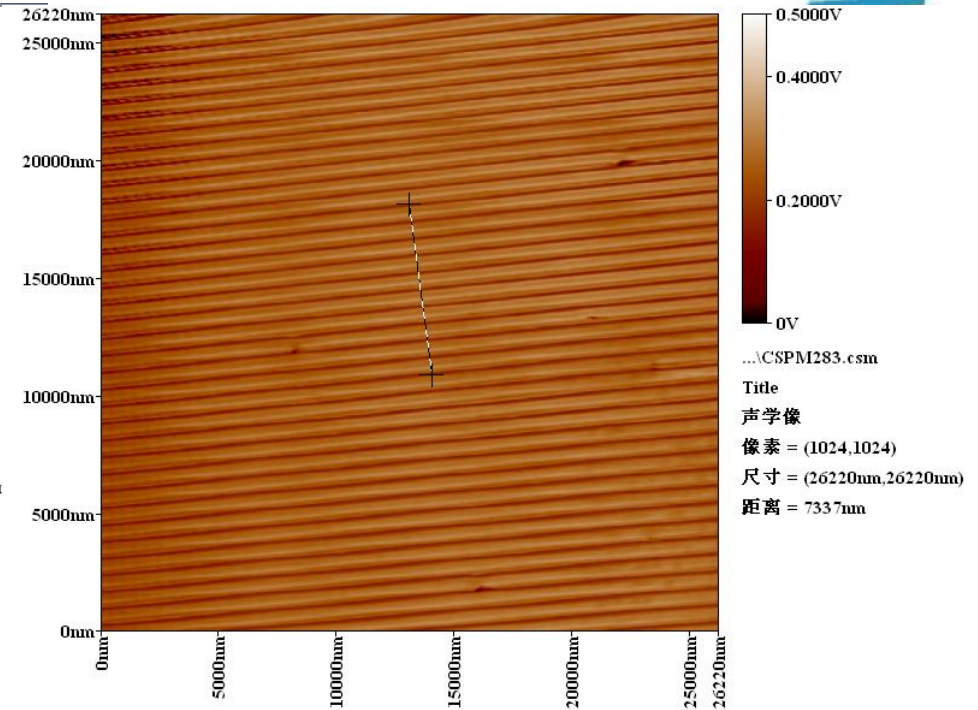
26 μm ×26 μm of DVD



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Morphological image



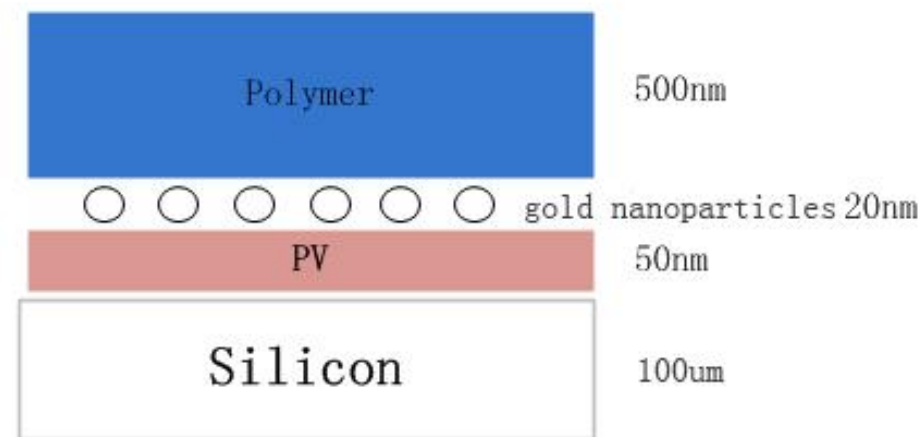
Ultrasound image

Measurement of 10 strips is 7337nm with the ground truth of 7400nm , the error rate is 0.8%

Phantom designed for ultrasound image resolution measurement



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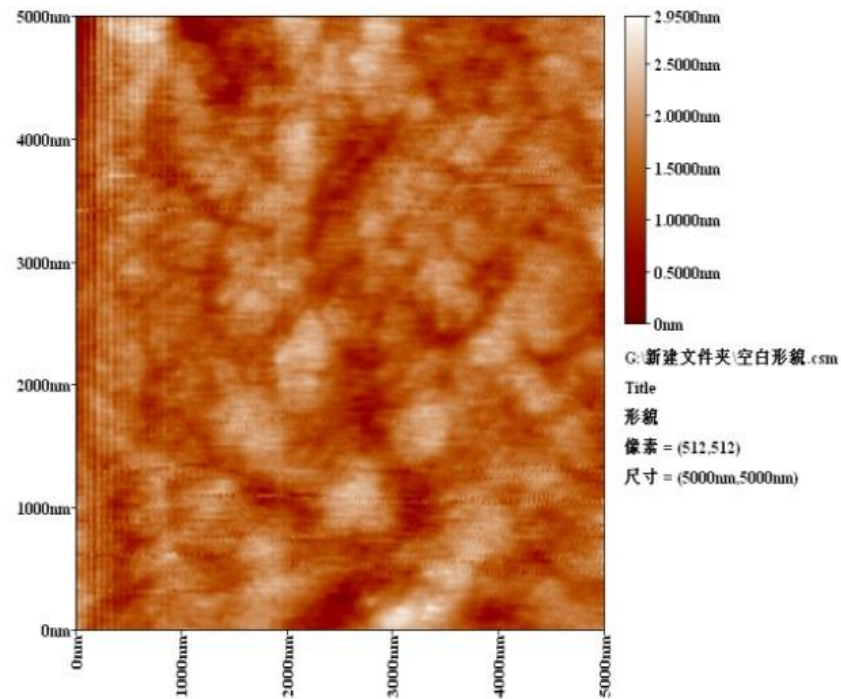


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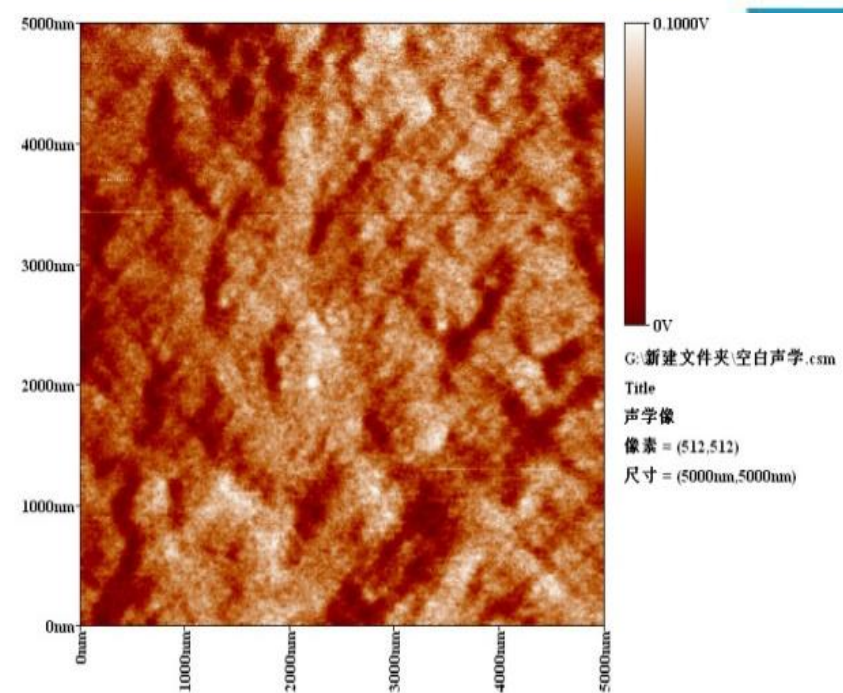
Silicon wafer without gold particles



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Morphological image



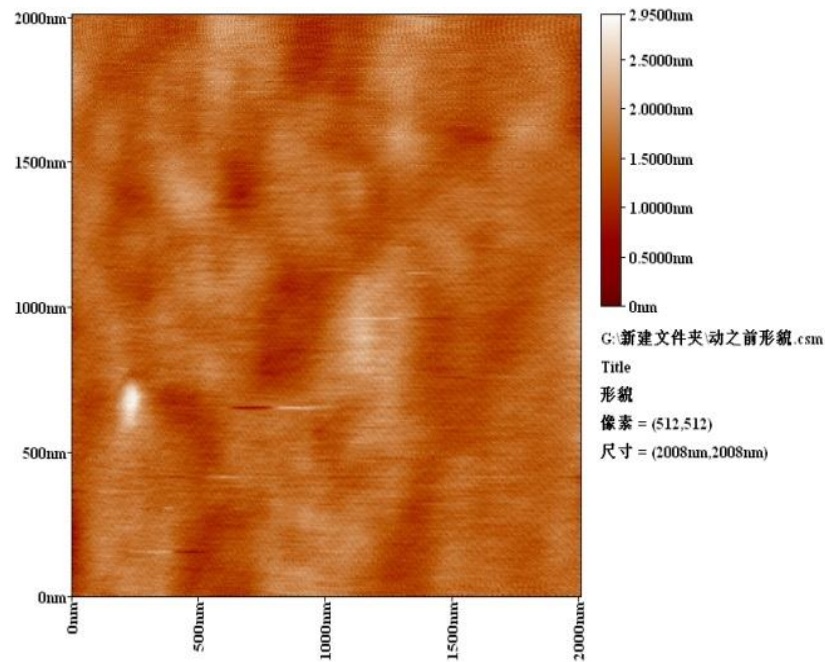
Ultrasound image

mulab

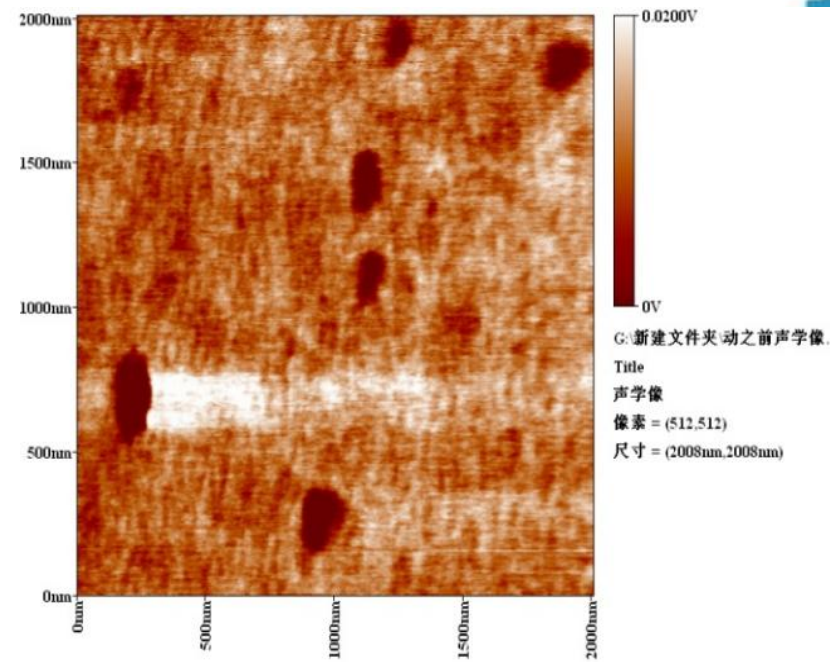
Silicon wafer with god particles



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Morphological image



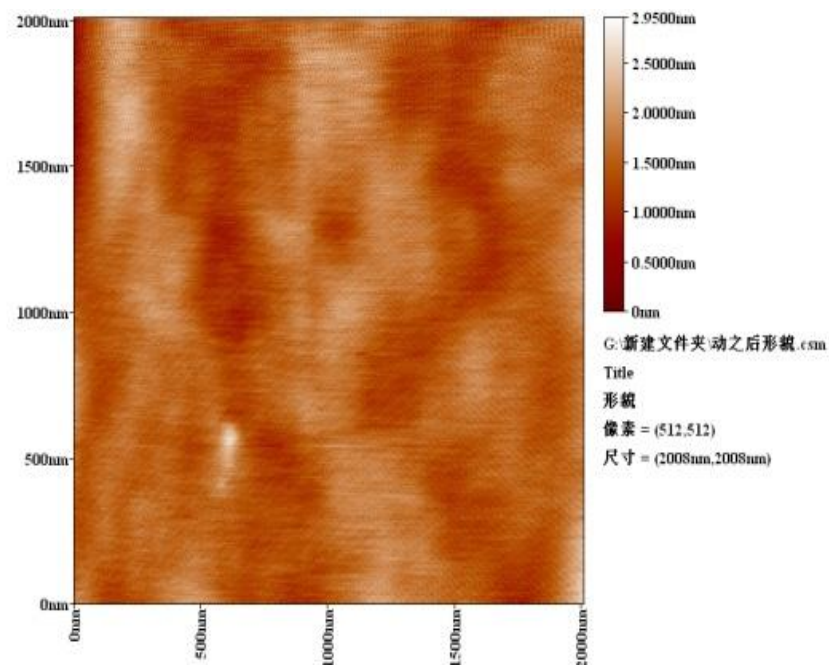
Ultrasound image

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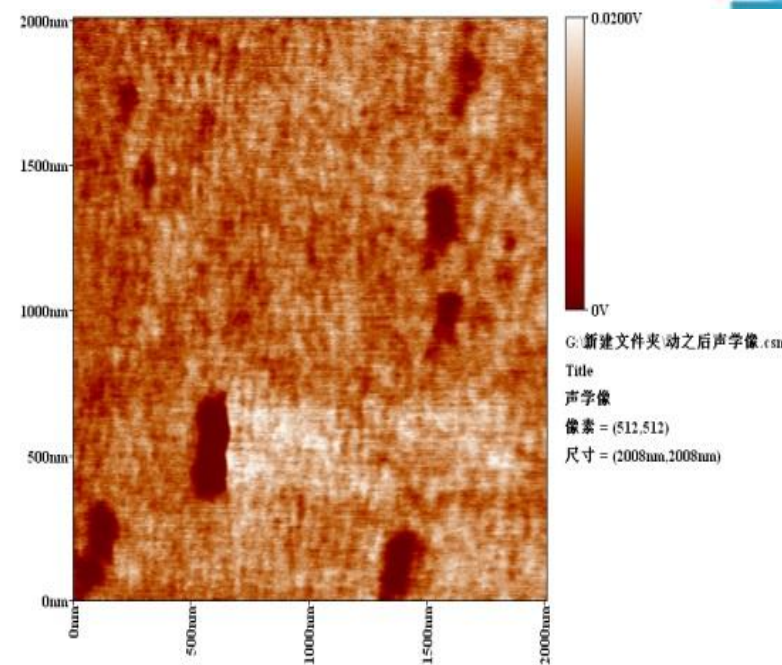
The same specimen moved to the left



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Morphological image



Ultrasound image

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Thanks!

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