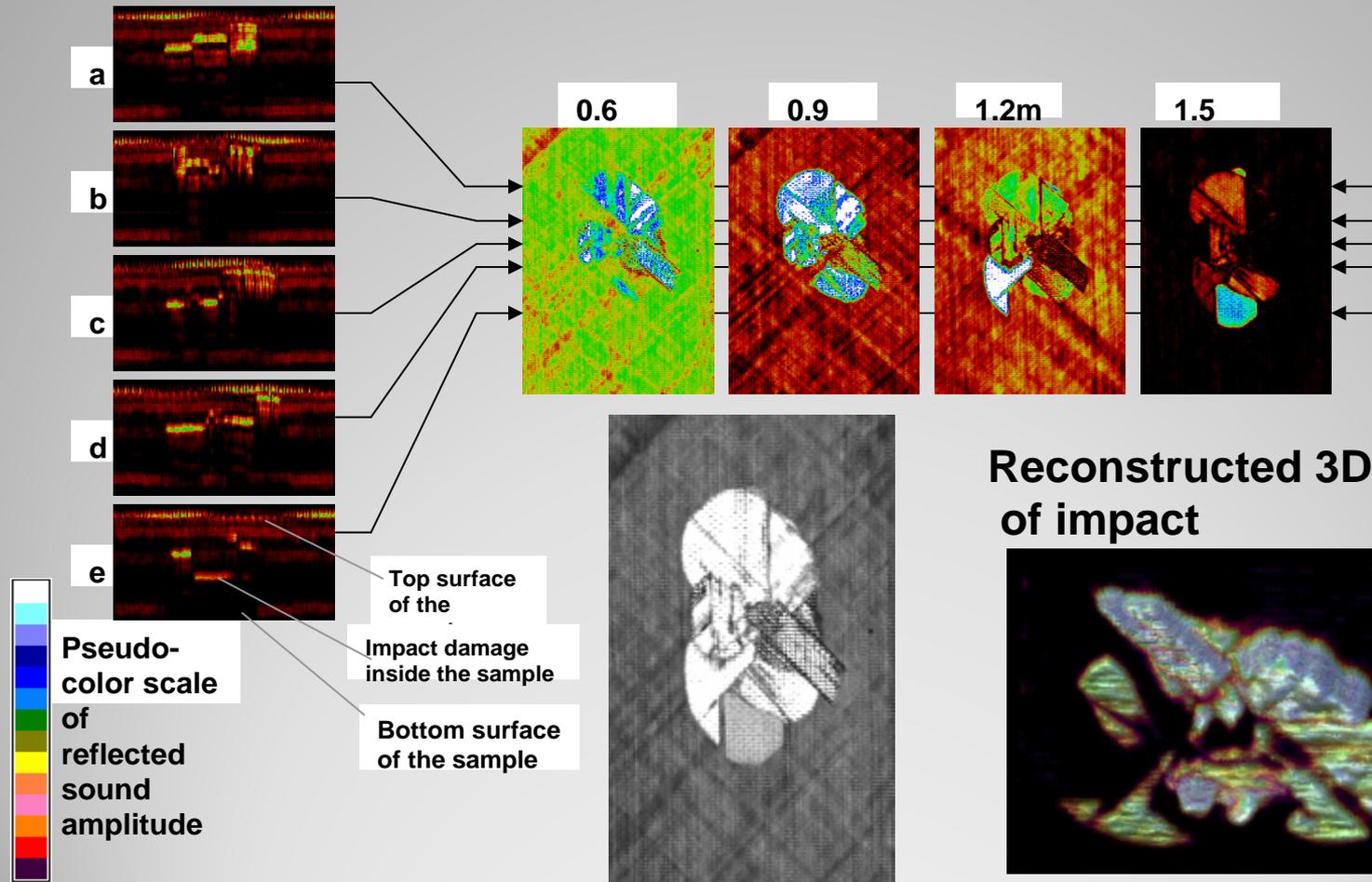
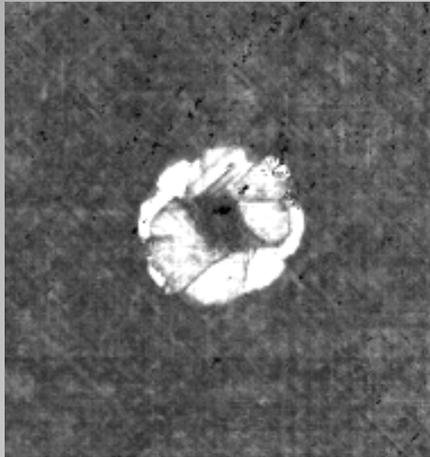


Impact damage in fiber-reinforced composites

SAM imaging of the Impact



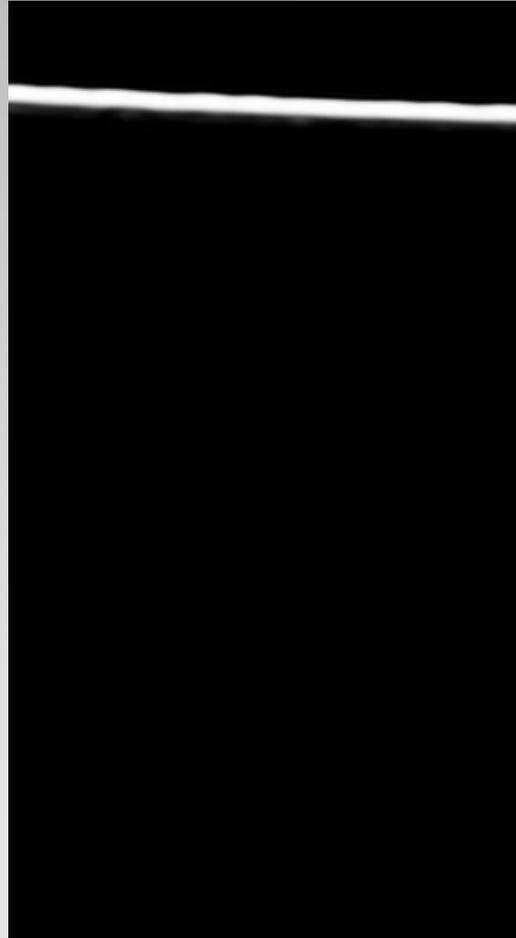
3D Reconstruction



- Original data slices
- 50 MHz
- 40 x 40 mm scan field
- 267 slices
- 267 A-scans in each slice
- 2250 samples per A-scan

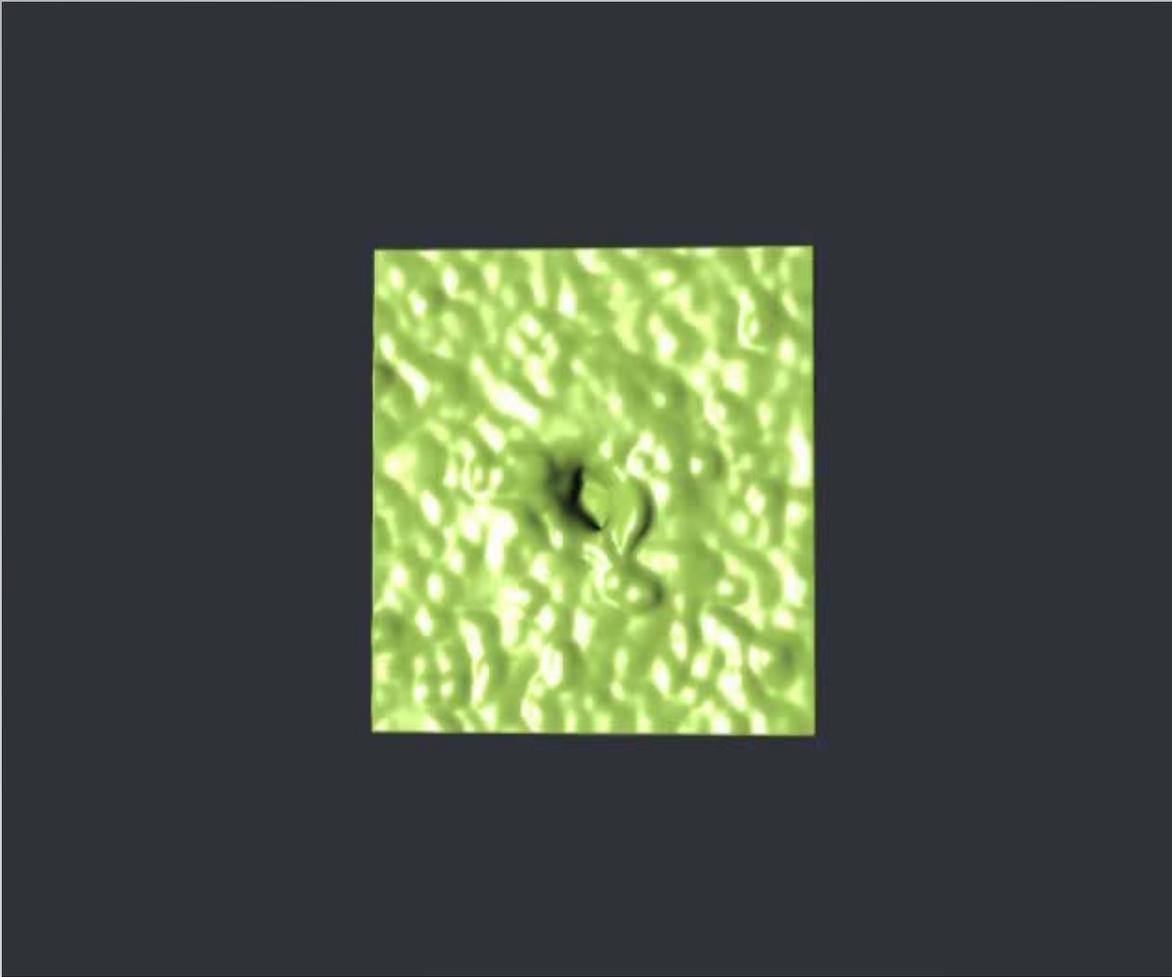


3D Reconstruction



- Band pass filtering
- Envelope filter (using Hilbert transform)
- Envelope conditioning (proprietary Tessonics algorithm)

3D Reconstruction



Adhesive bonding of the fiber-reinforced composites

Samples description

Synthetic fibers reinforces plastic (CFRP) composites plates jointed by adhesive strips

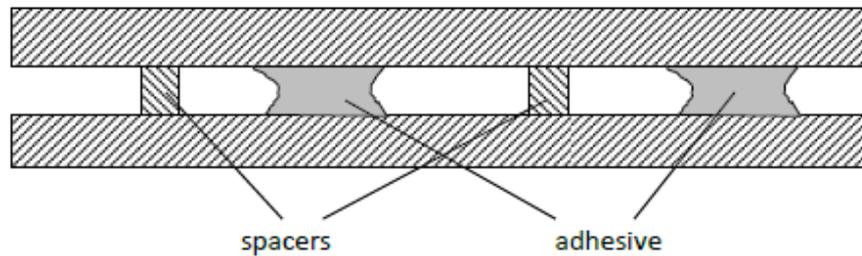
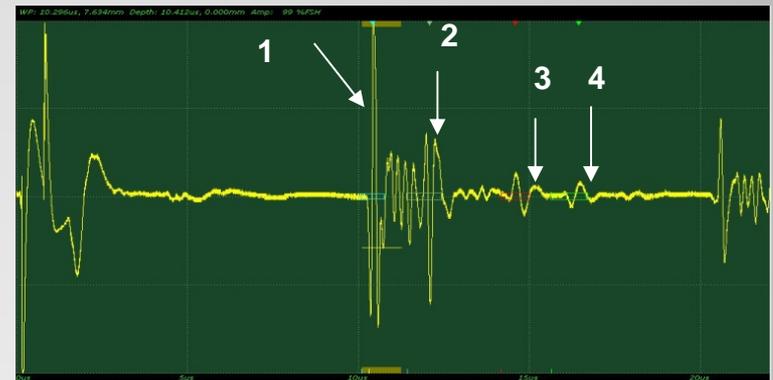


Plate thickness 2.3-2.5 mm
Adhesive thickness 1.8-2.1 mm



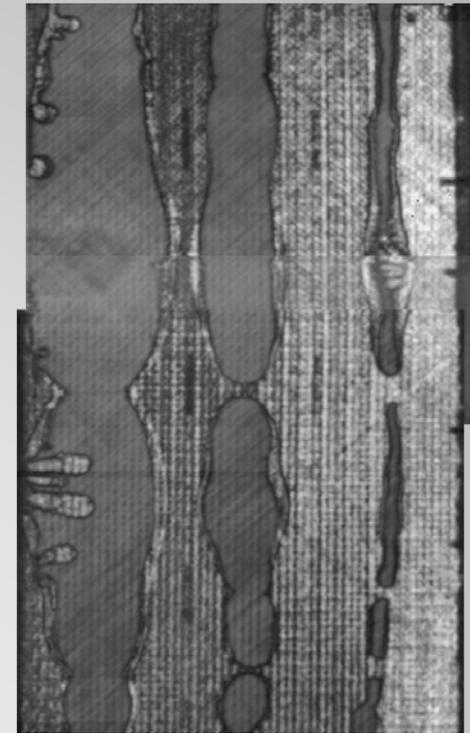
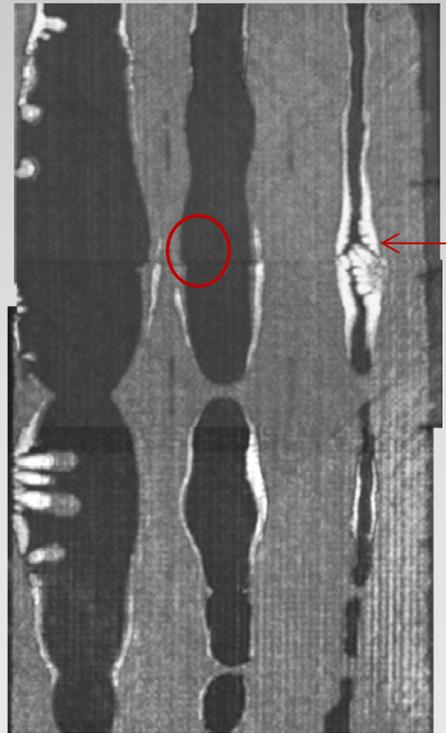
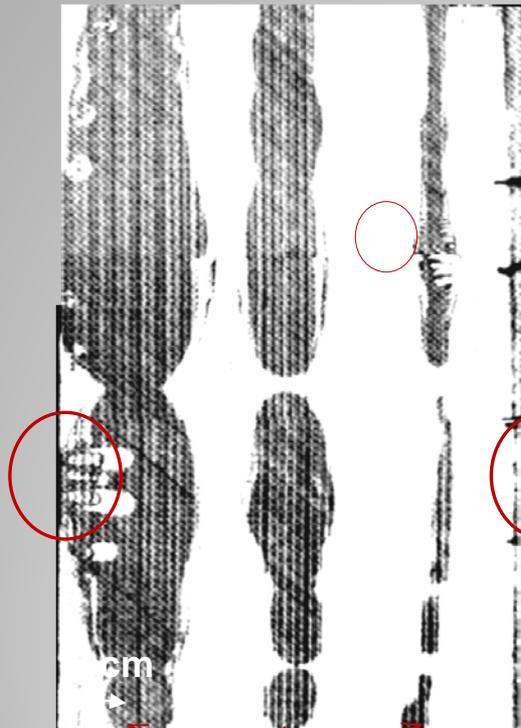
Nominal Adhesive approximate width 10, 35, and 50 mm

Composite Adhesive Joint Analysis, Scanning Acoustic Microscopy

Composite/adhesive interface

Below interface

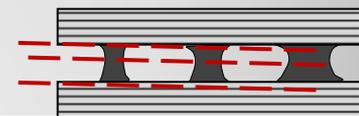
Lower adhesive/composite interface



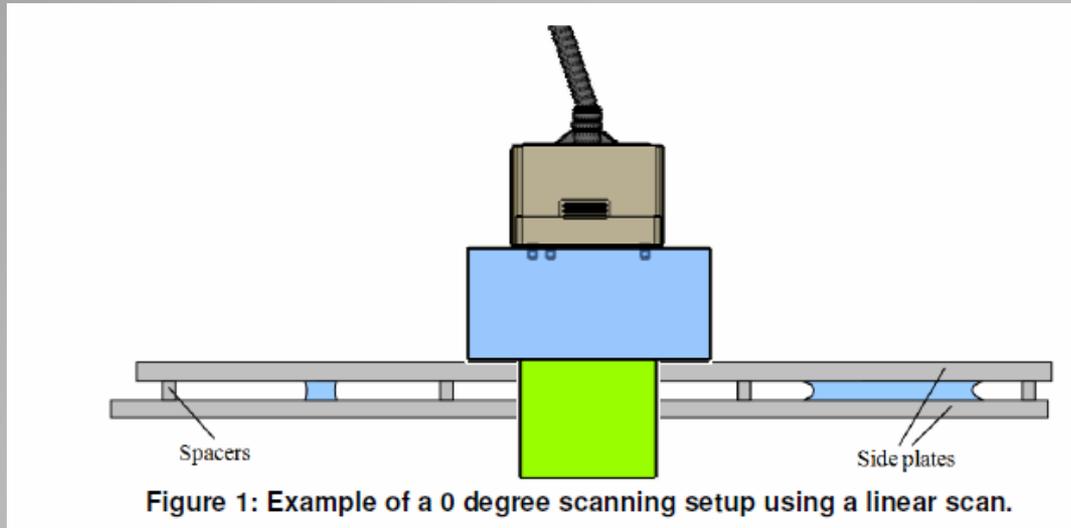
Adhesive

Voids due to the "springback" effect

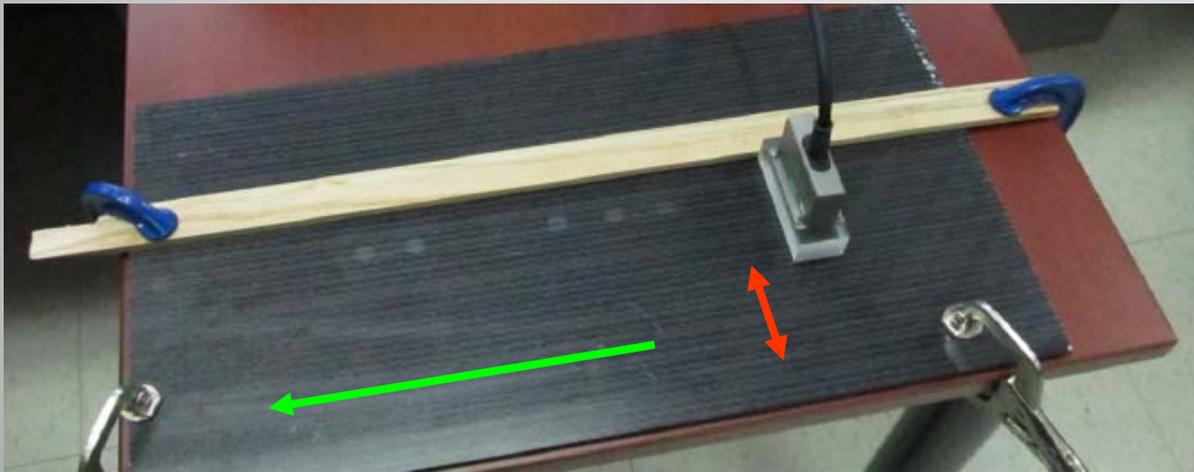
Adhesive "shoulders"



Ultrasonic imaging with phased array

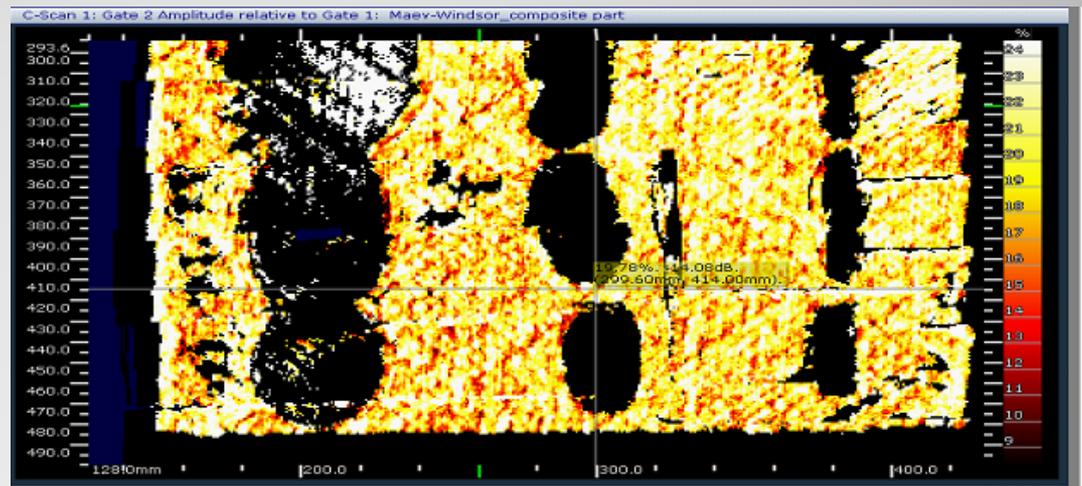
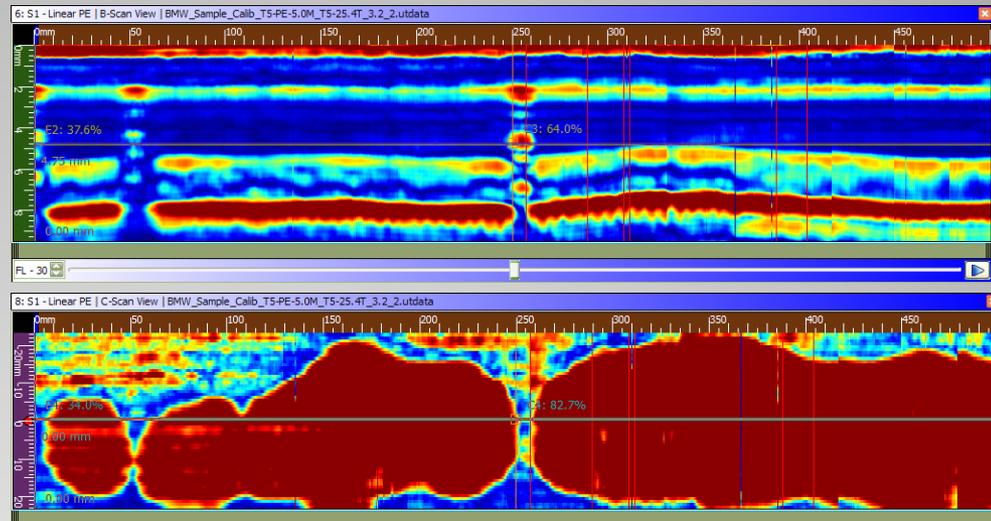


Arrays:
2.25 and 5 MHz
Number of elements 64
Pitch 0.8 mm
Width app. 50 mm

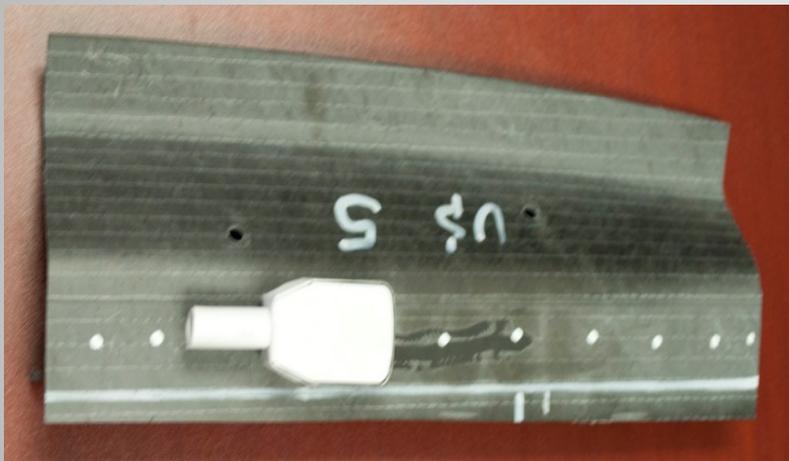
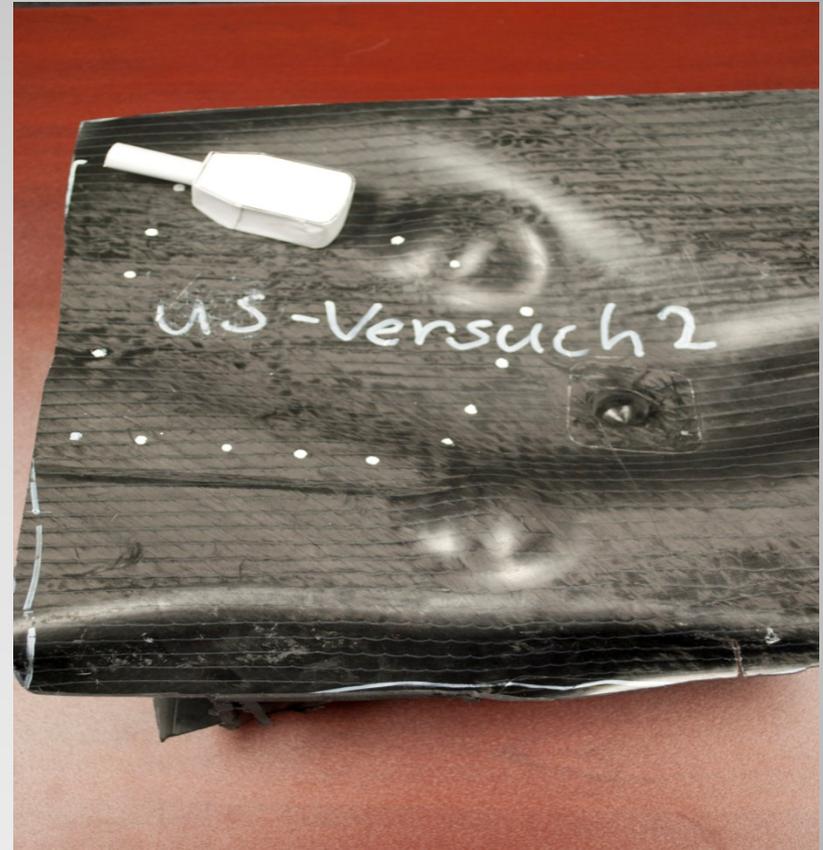


← Manual translation
↔ Electronic scanning

Composite Adhesive Joint Analysis, Phased array



Complex shape of the samples



New generation of adhesive testers



- Phased array 64 elements
- Frequency 5 MHz
- MEMS and optical positioning

The Air-Coupled Acoustic Imaging Technique

The air-coupled imaging technique

Pros and cons

- High acoustical mismatch
- High attenuation of ultrasound in air
- Absence of contaminations and damages
- Fast scan of the object

Technology employed

- NCA1000-2E
- Techno Stepper DaVinci
- Three pairs of Ultran transducers

$f = 221 \text{ kHz}$
Bandwidth = 80 kHz
Active Diameter = 25 mm

$f = 485 \text{ kHz}$
Bandwidth = 148 kHz
Active Diameter = 12.5 mm

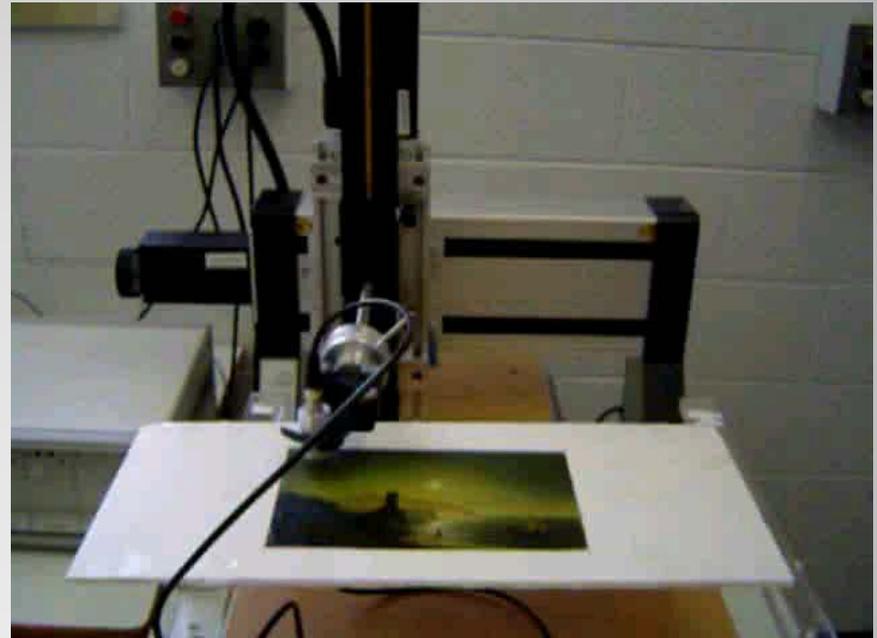
$f = 910 \text{ kHz}$
Bandwidth = 290 kHz
Active Diameter = 12.5 mm



Air-coupled Ultrasound

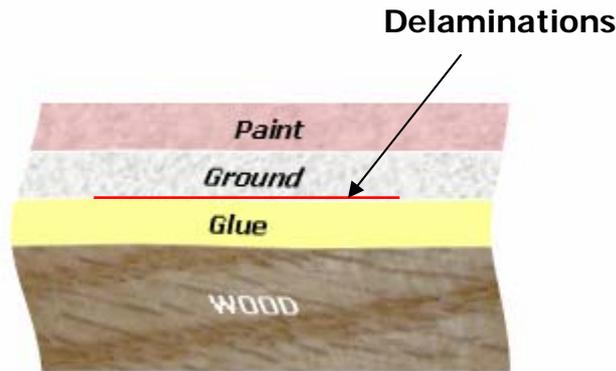
- At the UoW, researches have been carried out on wooden panel paintings
- The lateral resolution of the used planar transducers goes from 15 mm up to 3.5 mm
- By using focused transducers, we can achieve a lateral resolution of few tenths of mm

Air-coupled system in through-transmission configuration



Wooden Paintings

Structure of a typical panel painting

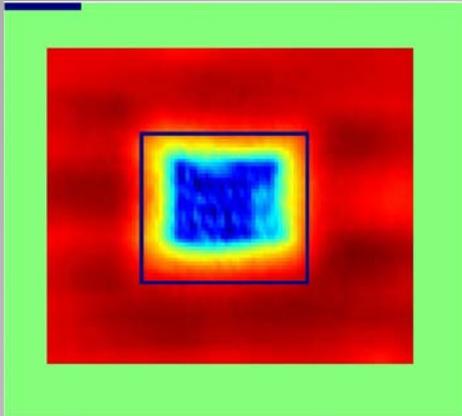


The layered structure is formed by:

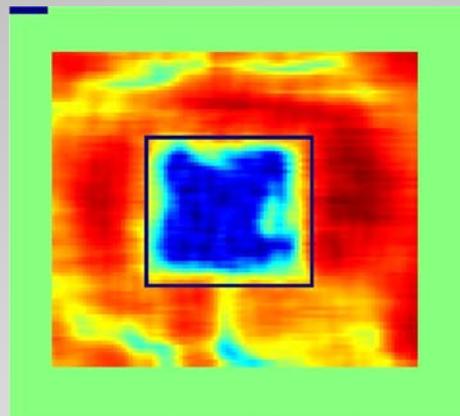
- Wood support
- Animal Glue
- Ground (gesso + animal glue)
- Design layers: underdrawing, imprimatur, underpaintings, paint, glazing, varnish, retouchings

Non-Contact Ultrasound

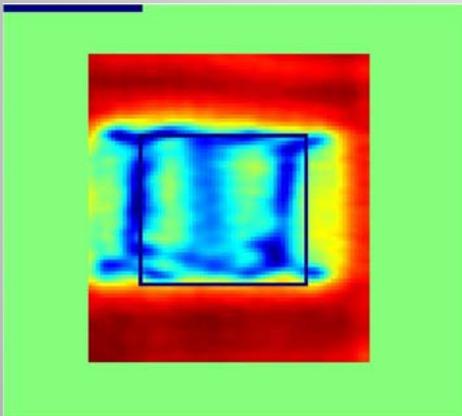
Through Transmission configuration
 $f = 200 \text{ kHz}$



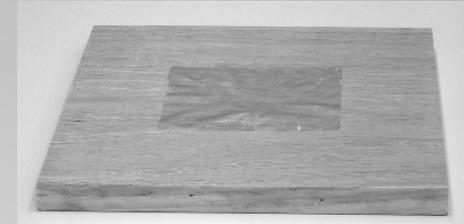
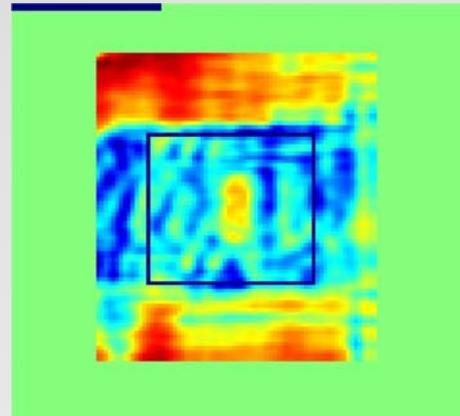
Through Transmission configuration
 $f = 1000 \text{ kHz}$



Single Sided configuration
 $f = 200 \text{ kHz}$



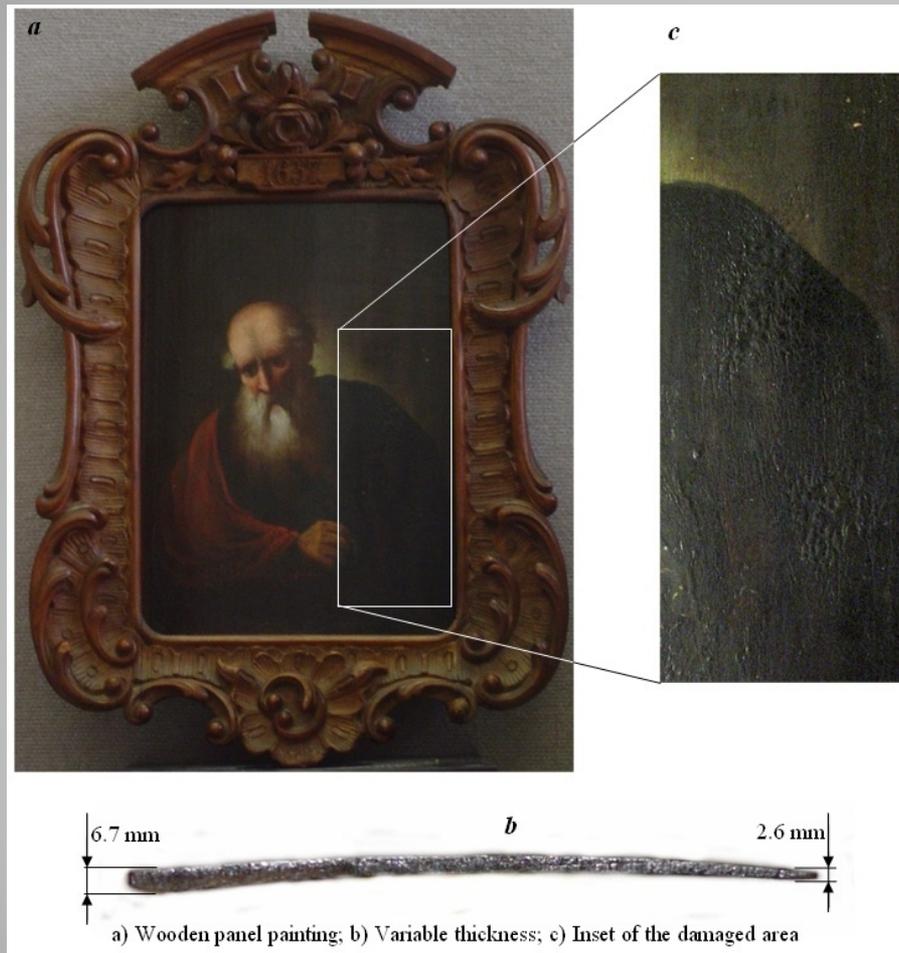
Single Sided configuration
 $f = 500 \text{ kHz}$



Studying simulated rectangular delamination between the wood support and the ground:

C-scans in various non contact ultrasonic layouts (*through-transmission and single-sided configurations*)

Non-Contact Ultrasound



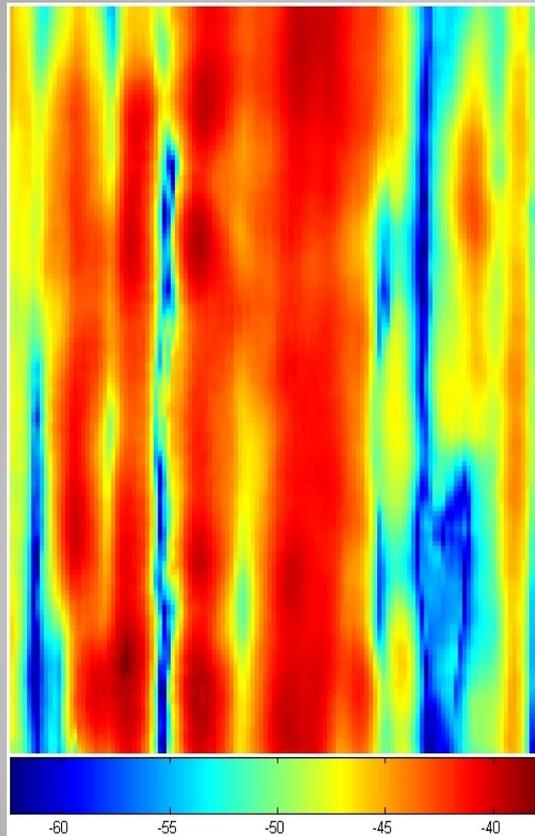
Four hundred years old painting (Private collection)

Characteristics:

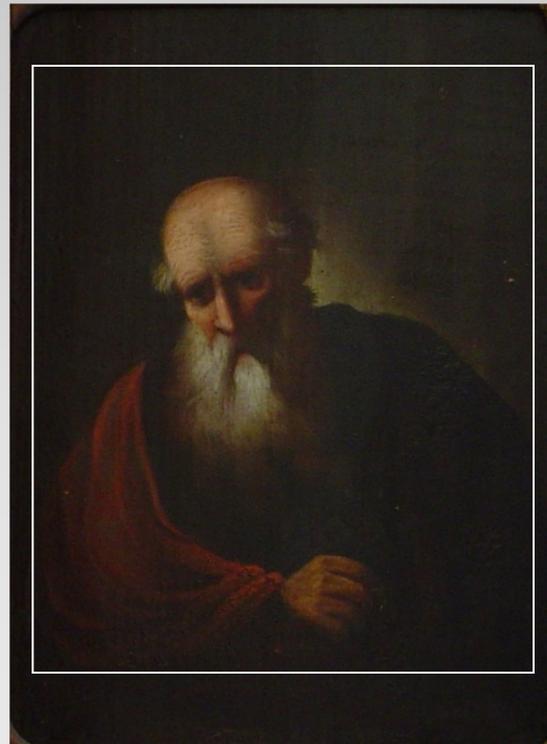
- Mahogany support;
- Dimensions: 187 x 263 mm²
- Really variable thickness (*Fig.b*) from 2.6 mm (right) up to 6.7 mm (left)
- Suspect damaged area in the lower right region (*Fig.c*)
- Recently restored region around the forehead of the subject

Non-Contact Ultrasound

Single-sided scan using the 200 kHz transducers



Optical image with checked region highlighted



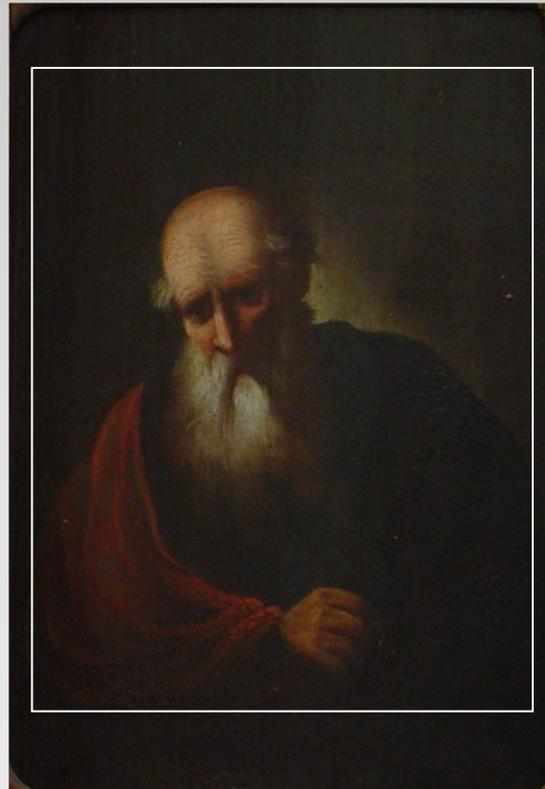
Scan in single-sided configuration. Confirmed the results obtained in through-transmission configuration. The visible damaged area is effectively a defective region, but the real extension of the detachment is wider than what was visible to naked eyes

Non-Contact Ultrasound

Binary image



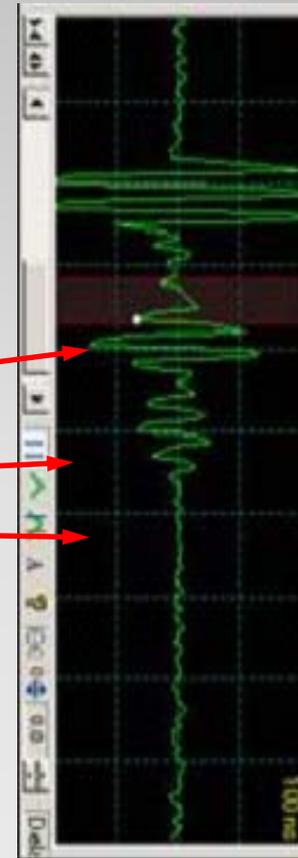
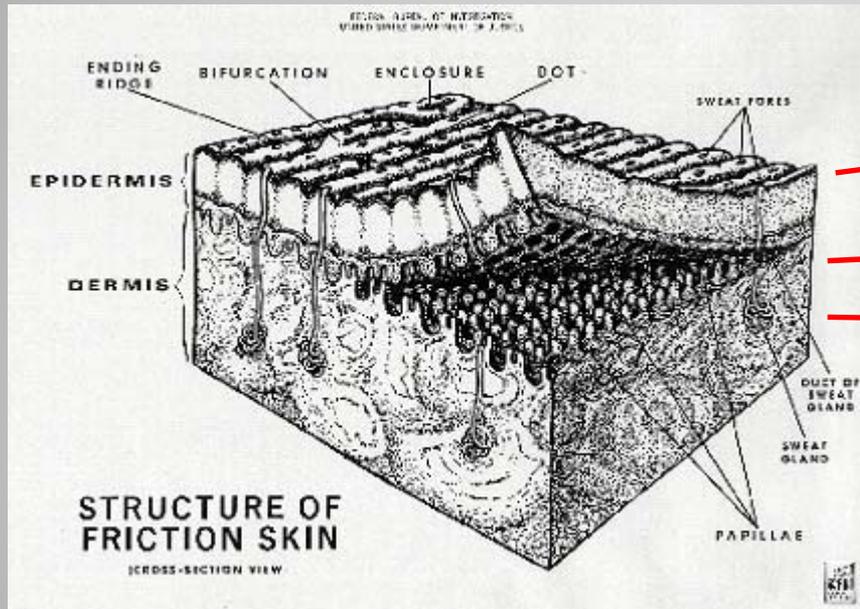
Optical image with checked region highlighted



Scan in single-sided configuration.
Binary images with highlighted the delaminated regions (White -> sound zones; black -> detached zones)
The scanned region is that one inside the rectangle

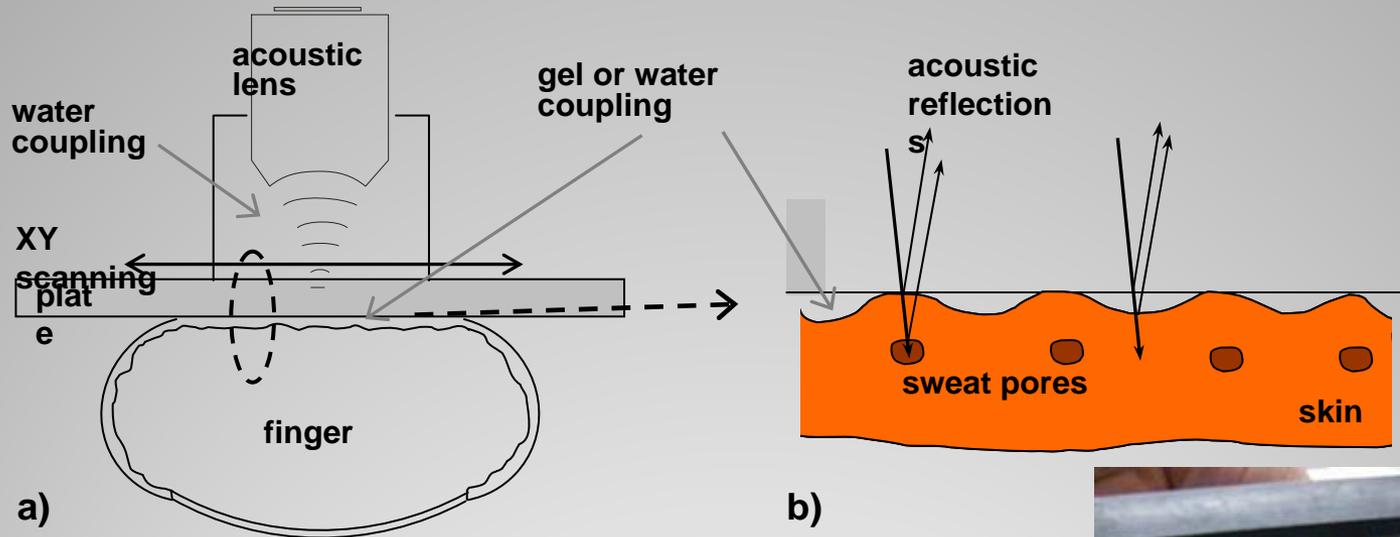
High-resolution 3D ultrasonic fingerprint imaging

Acoustic image of skin structure



- Reflection from skin surface
- Reflection from dermis
- Reflection from skin / subskin tissue interface

Imaging with acoustic microscope



Hardware:

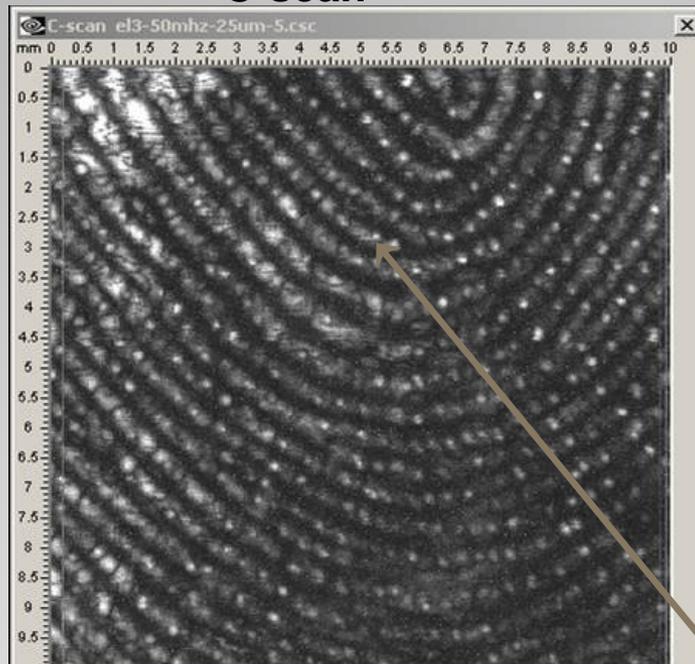
- Scanning acoustic microscope "Tessonics AM-1103" (Tessonics Corp., Canada),
- Short-pulse reflection mode,
- Narrow-aperture focused ultrasonic transducer with a frequency of 50 MHz (Panamatrix), spatial resolution of about 50 μm (when focused under the plate).



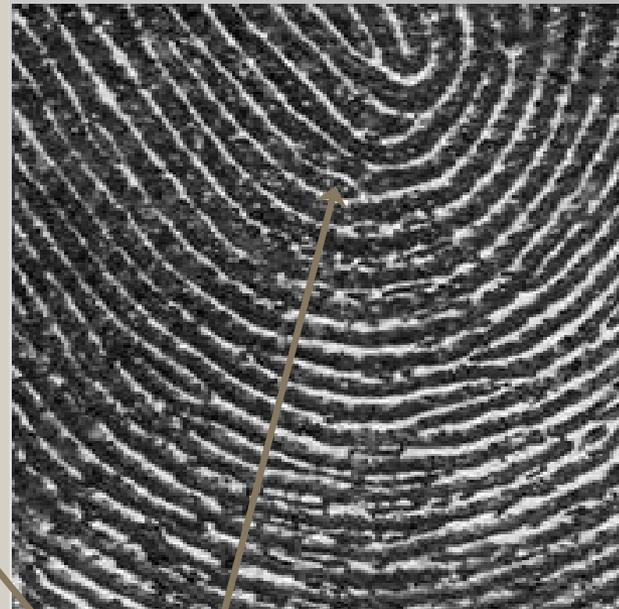
Experimental results

Acoustical and optical images of the same fingerprint area

C-scan



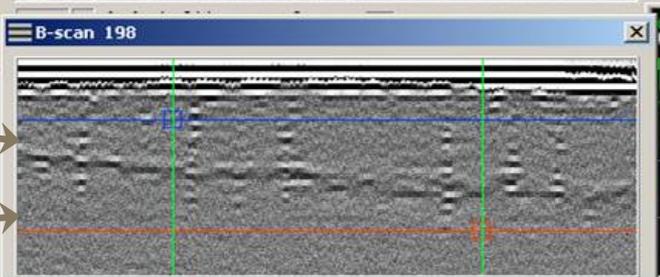
Paper ink-print



Wide C-scan gate

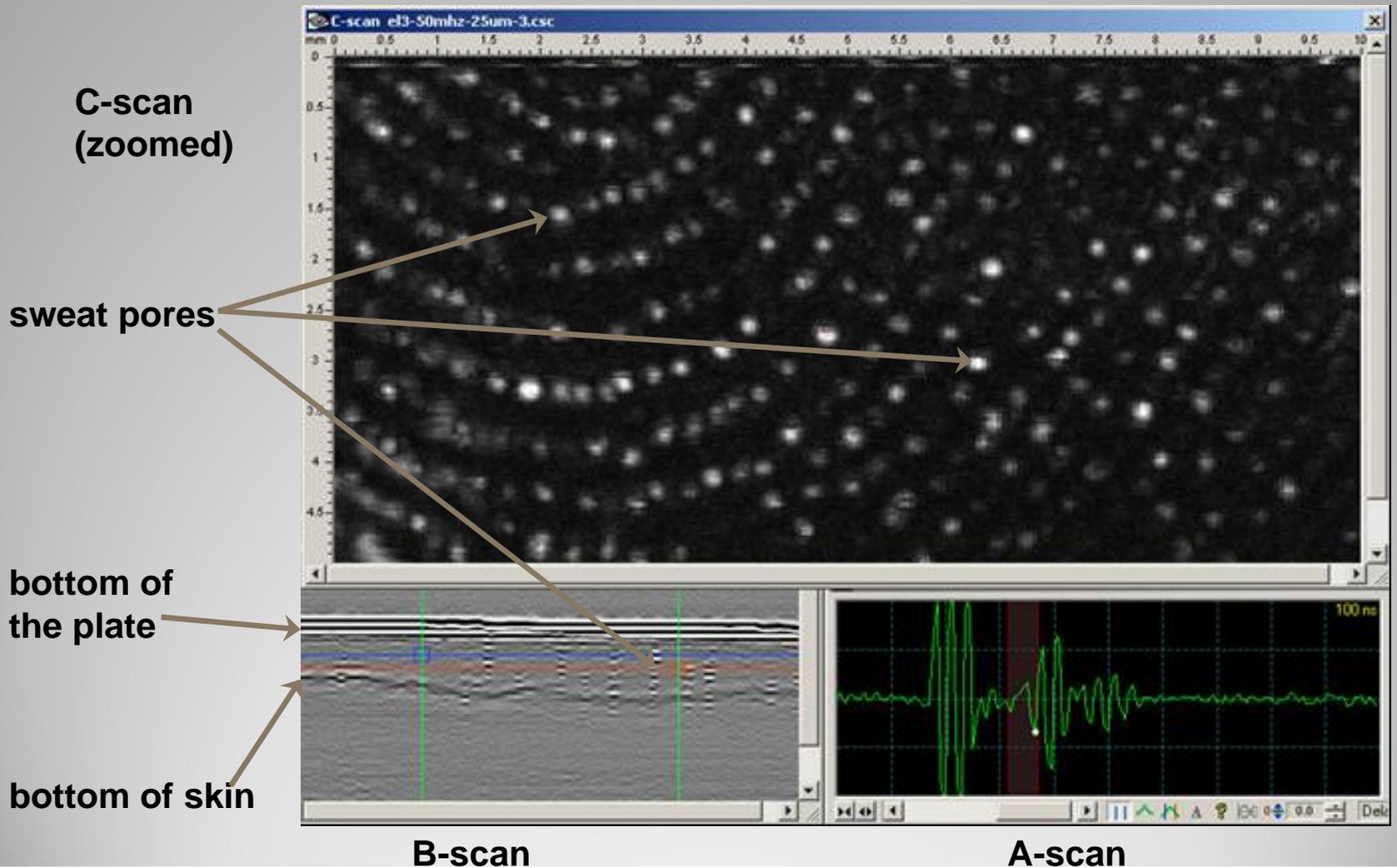
bottom of the plate

bottom of skin



grooves are seen as light regions in C-scan and as dark regions in paper print

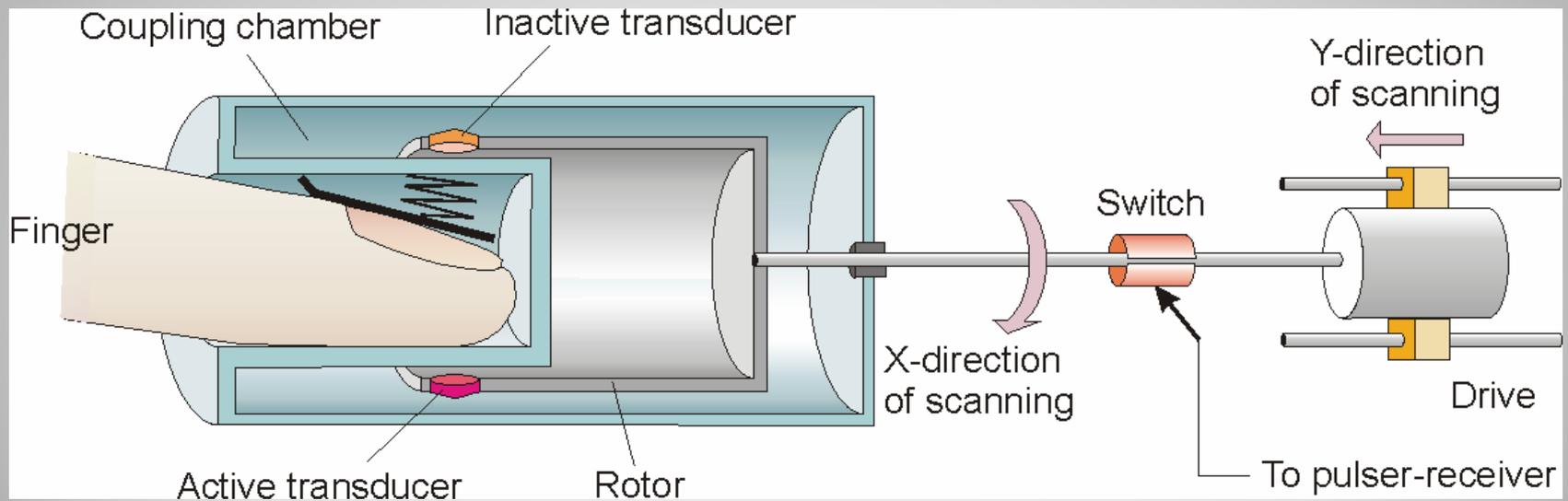
Experimental results



Fast multi-lens cylindrical scanner

Prototype design of a fast-scanning multi-lens fingerprint imaging system:

A finger is inserted into a hollow cylinder of the scanner and pressed onto the concave surface of the cylinder, and a system of rotating focused ultrasonic transducers scans over the cylinder



The first prototype (2011)

was presented at the Biometrics Conference in Washington DC, in January 2011

Our first prototype:

It was developed procedures and algorithms

- Simplified mechanical design
- Assembled from market-available parts

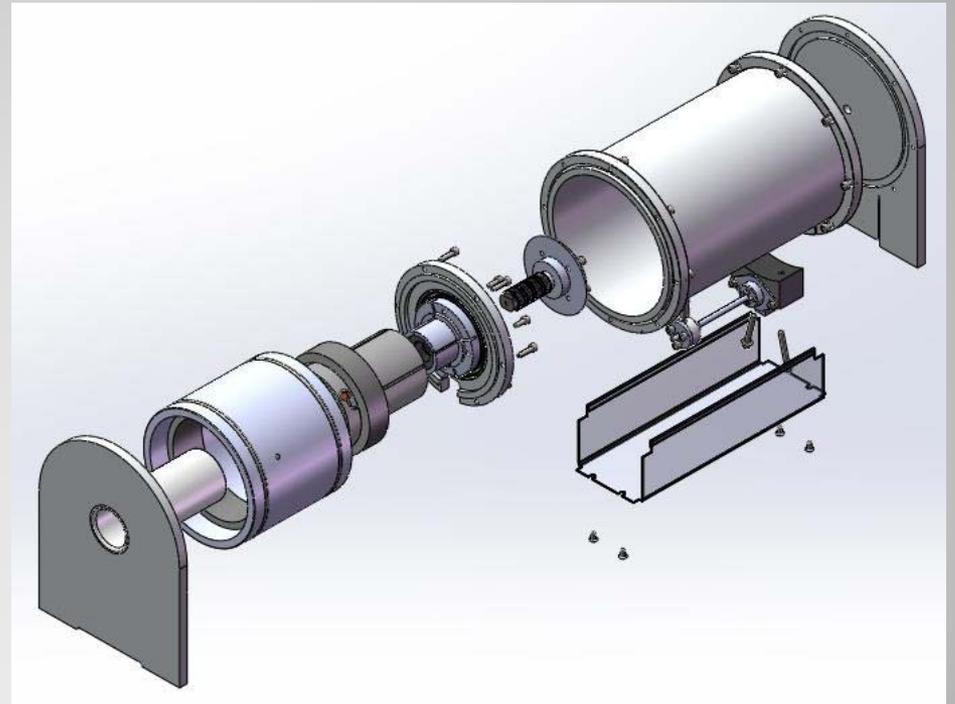


Newest design



- Commercial production
- Affordable price

- Compact and robust
- Direct rotor drive
- Higher accuracy



Thank you for your attention

