

Multi-Angle Low Cost Ultrasound Camera for Aircraft NDT

November 8, 2005

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Imperium, Inc.

Silver Spring, MD

Agenda

- Introduce Imperium, Inc.
- Acoustocam Technology Overview
- Review longitudinal wave results
- Review shear wave results
- Large area scanning results
- Future developments

Imperium, Inc.

- Headquarters outside Washington, DC
- Began 1996 by Dr. Marvin Lasser, Chairman
- Focus solely on novel ultrasound imaging technology
- First sales in 1999
- First reseller agreement in 2000
- Three U.S. patents granted, others pending
- Handheld unit developed: 2003
- 10 employees

Digital Acoustic Video (DAV™)

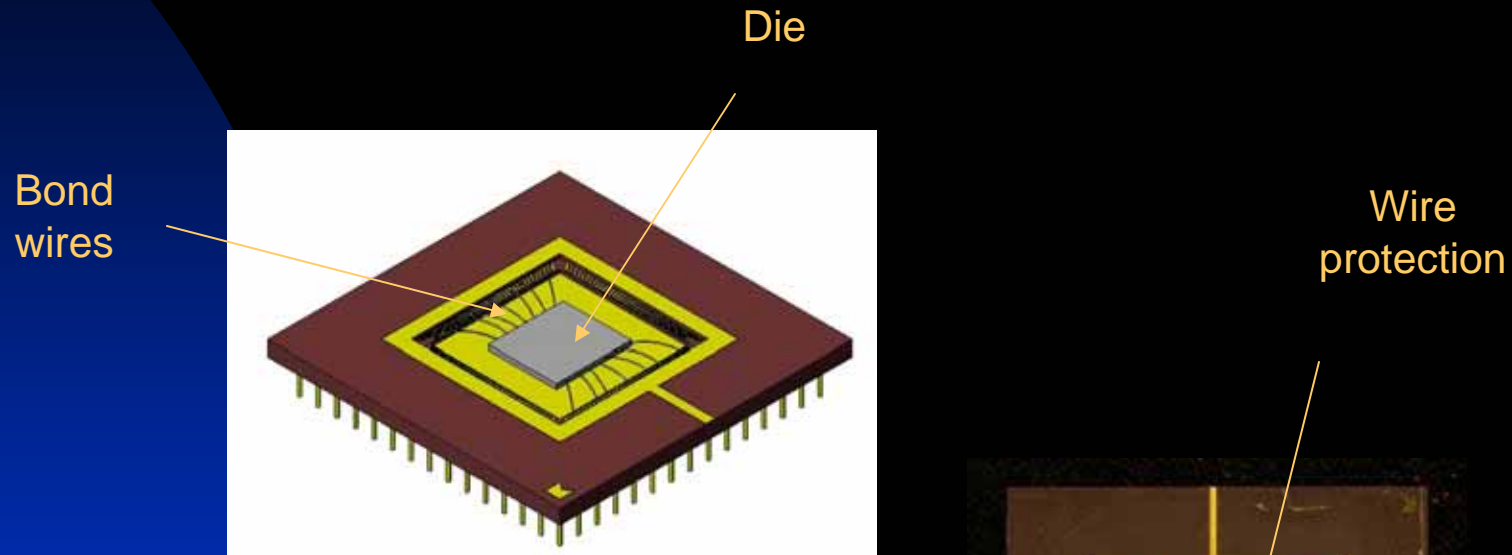
- Ultrasound camera
- Real time, C-scan imaging
- Non-specialized user
- Standard video output

Digital Acoustic Video (DAV™)

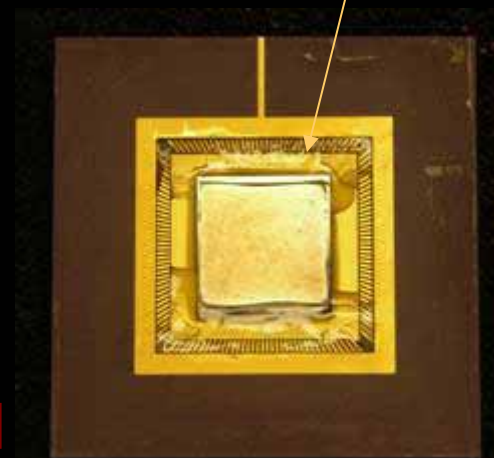
- Same “rules” of imaging as conventional ultrasound
- Two-dimensional array
- Lens based
- Broadband

Ultrasound Camera Technology

Digital Acoustic Video (DAV™): Imaging Array

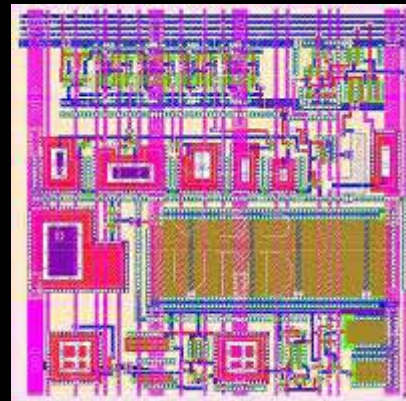
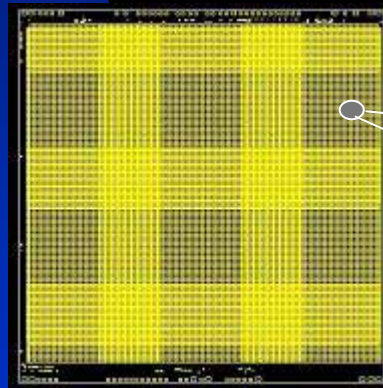


- Custom design
- $120 \times 120 = 14,400$ elements
- Piezoelectric material deposited



Two-Dimensional Array

- Hybrid: Piezoelectric material deposited on silicon readout chip via semiconductor processing



Piezo



Pre-amp



Detection

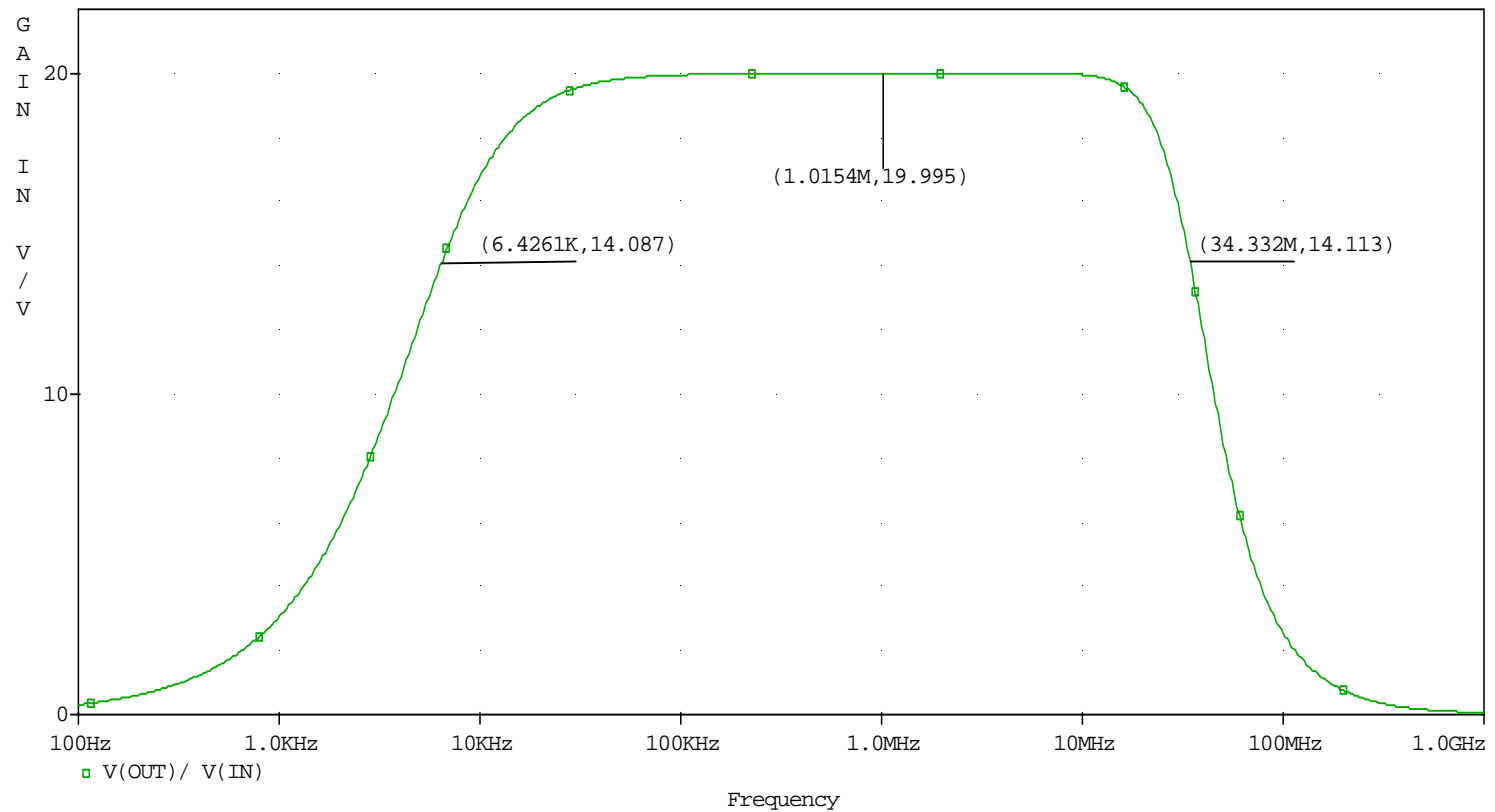


Filtering/ UC



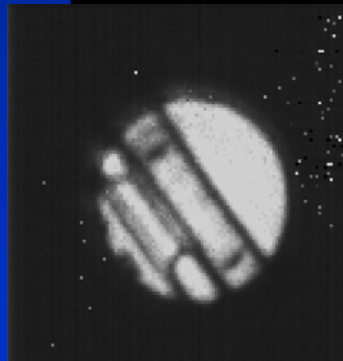
MUX

Array Response

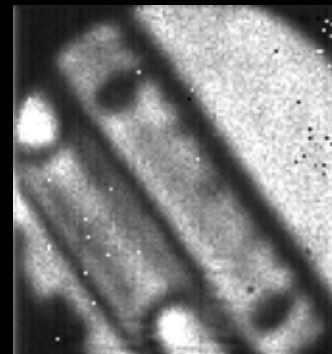


Acoustic Lens

- Zero-power beamformer
- Adjustable focus
- Adjustable zoom



No magnification

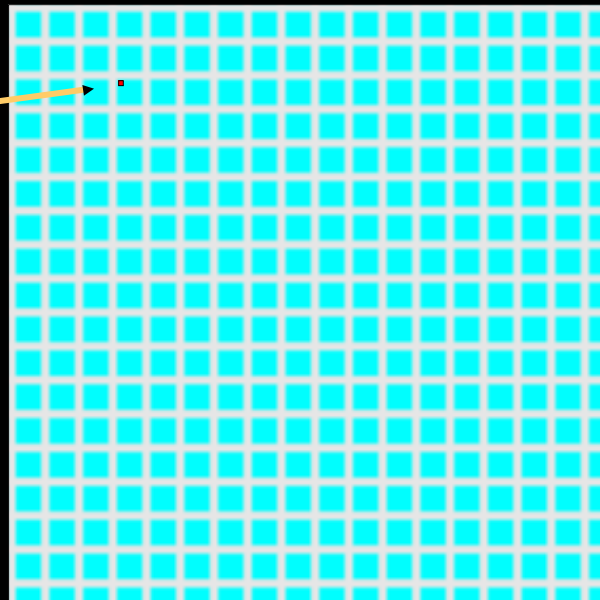


With magnification

DAV versus conventional UT

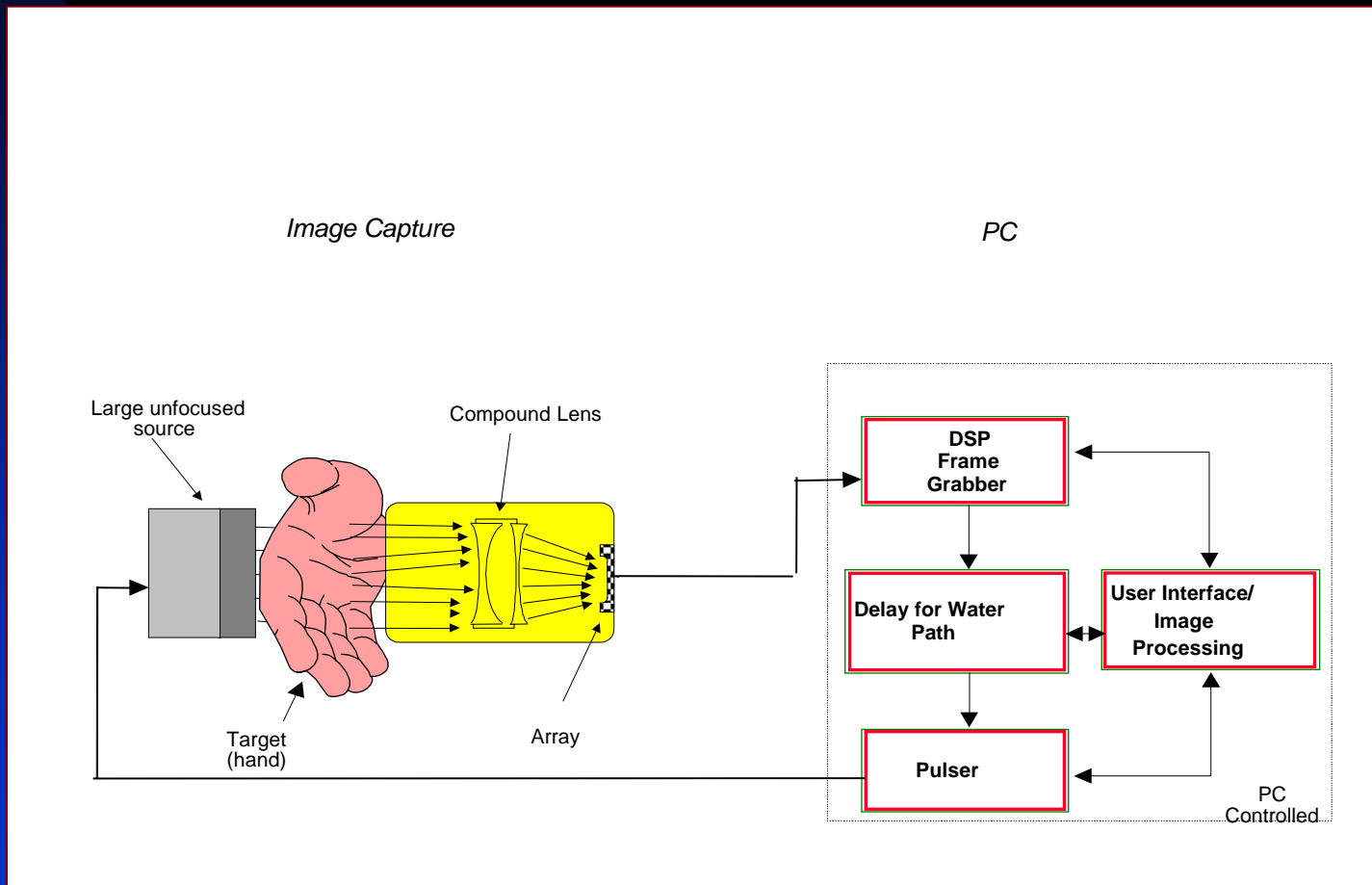
$120 \times 120 = 14,400$

Point by point
technology
captures 1 point
per snapshot



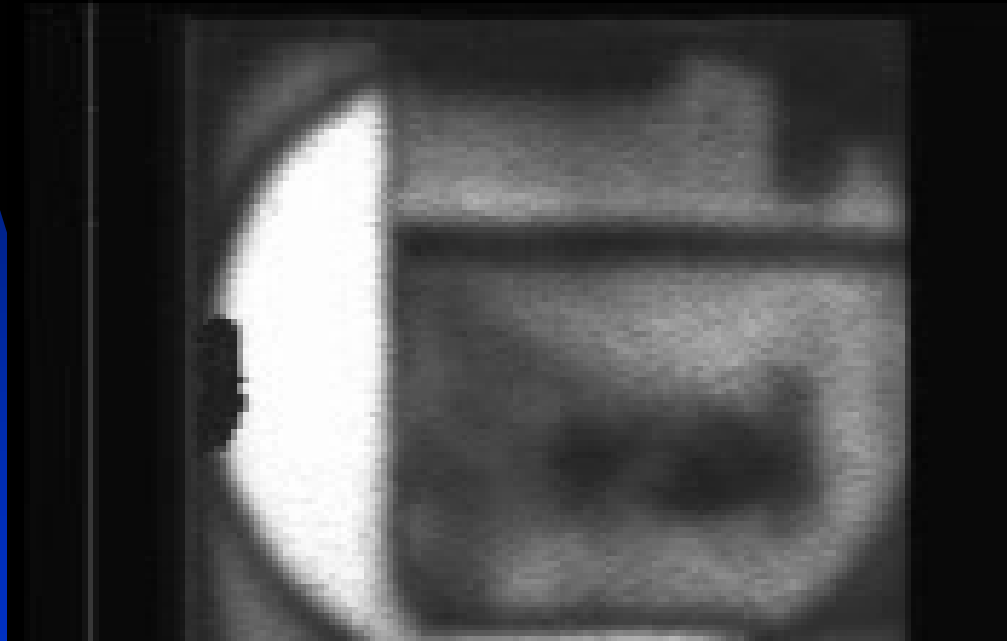
Area coverage
technology
captures 16,384
points per
snapshot.

Through Transmission

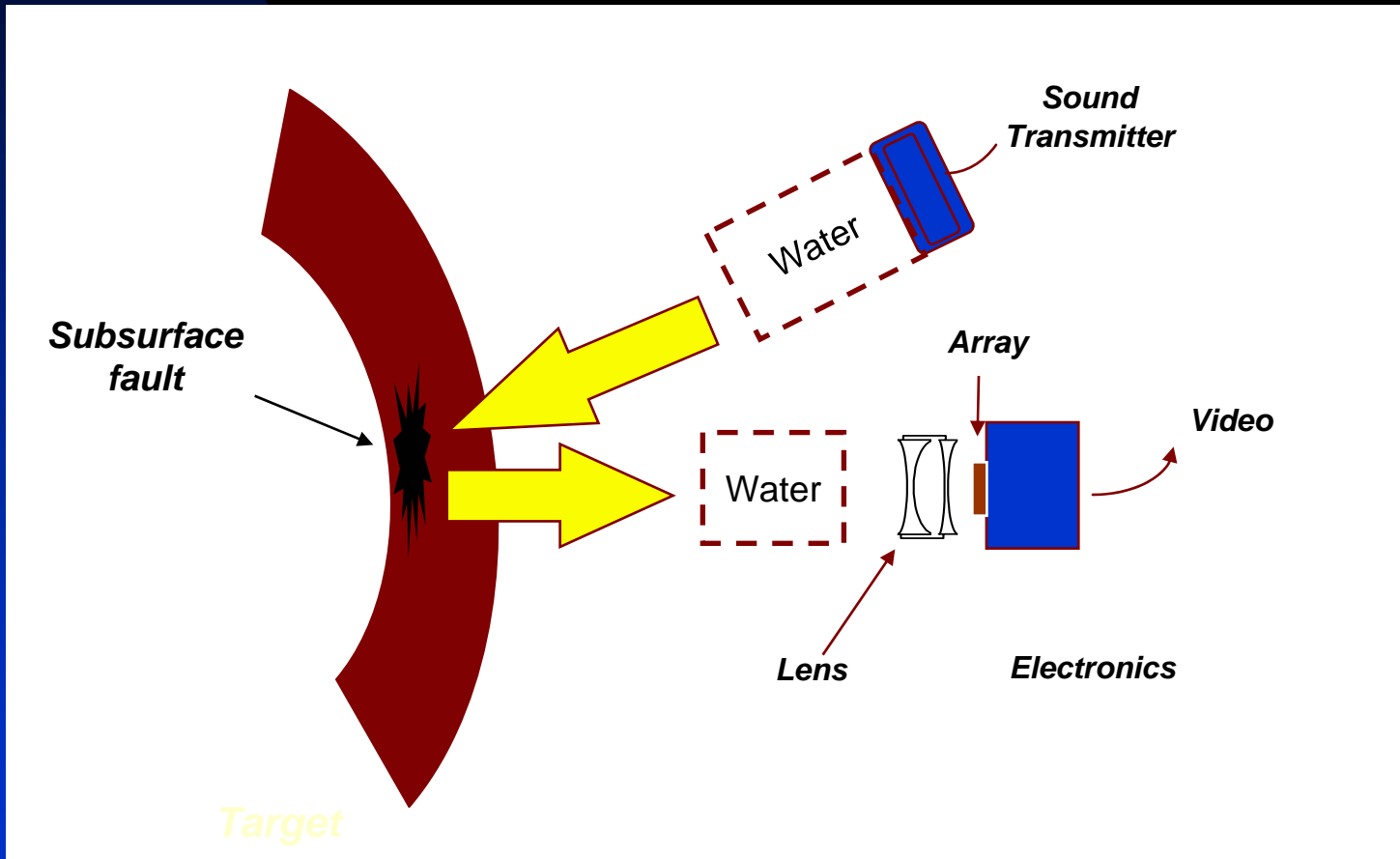


Through Transmission

3 inch Field of View – 3 MHz



DAVTM Technology - Pulse Echo

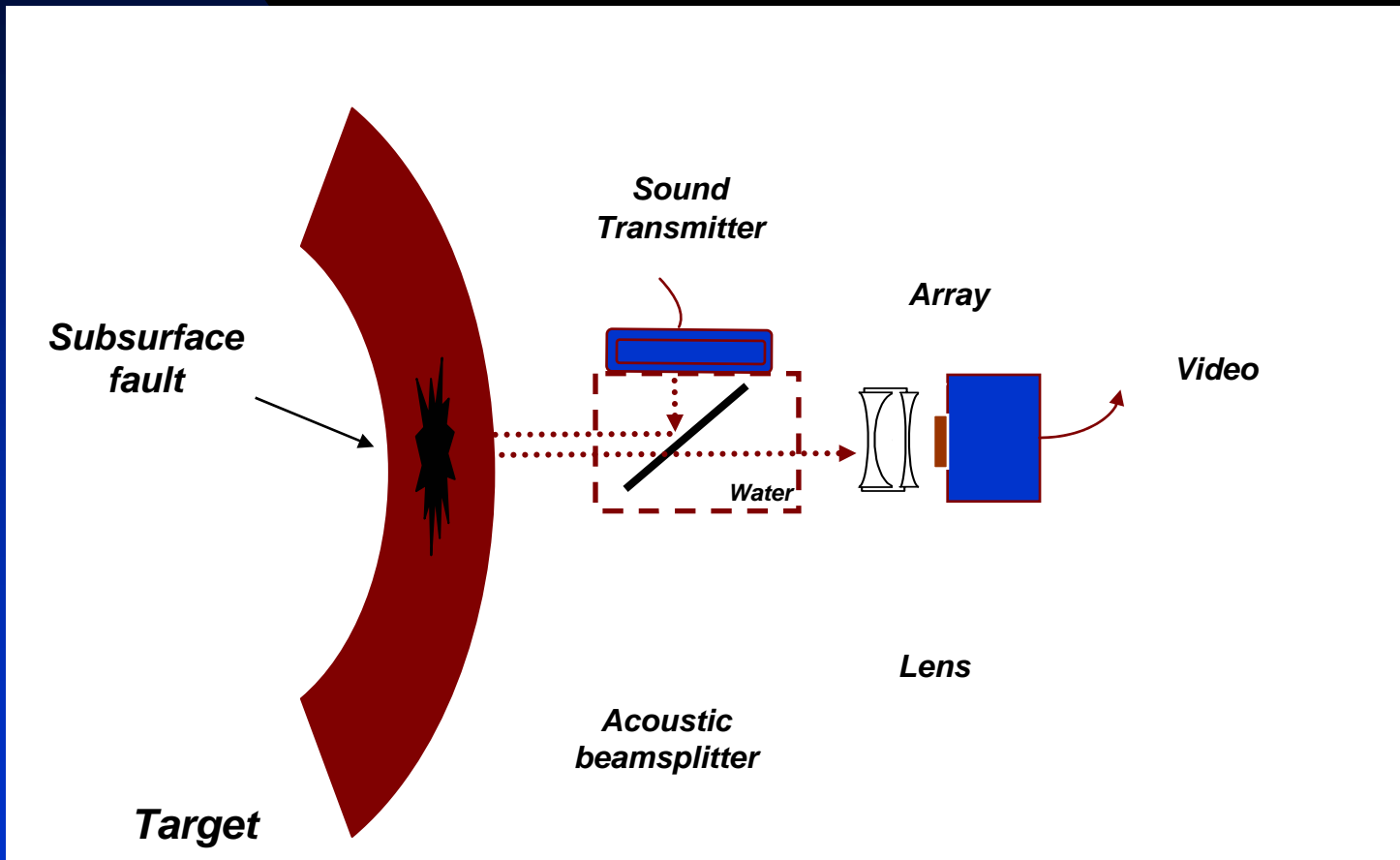


Pulse echo image of quarter

Pulse Echo – 50/50 Beamsplitter

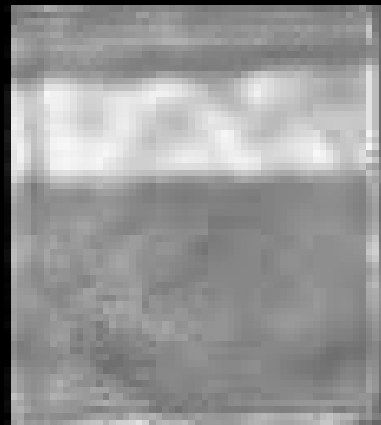


Pulse echo image of quarter



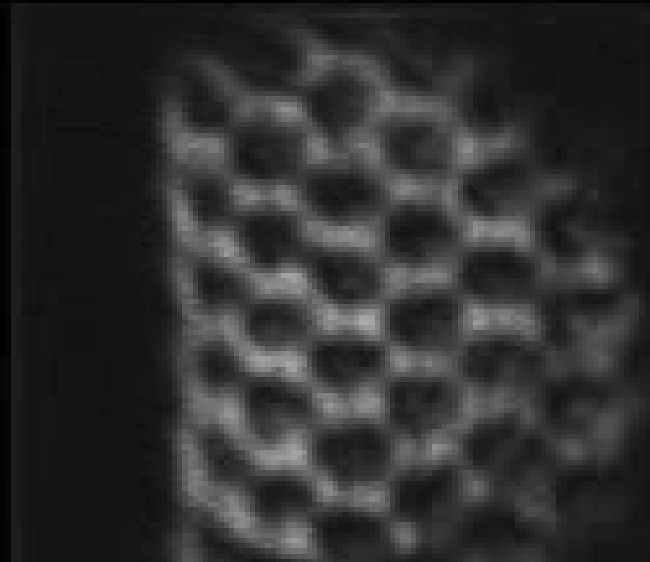
Longitudinal Wave Results: Typical Composite Images

Laminate Composite

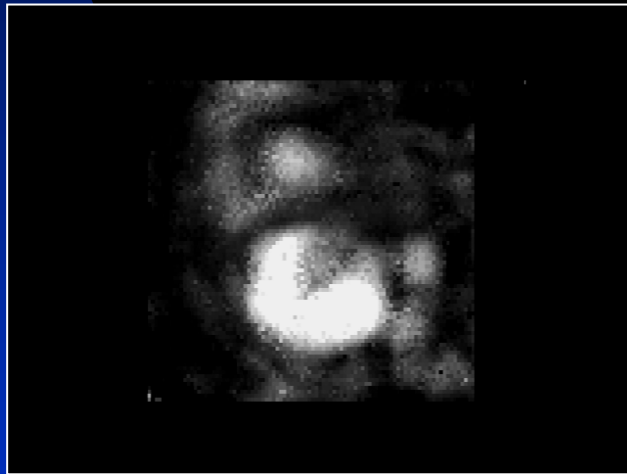


Typical Composite Images

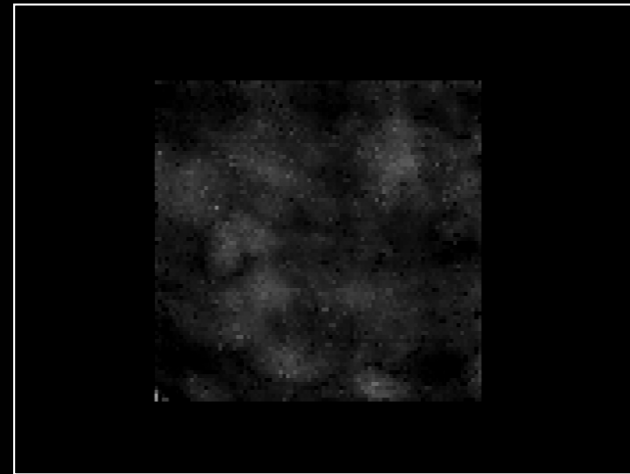
Honeycomb Composite



Results: Handheld Operation

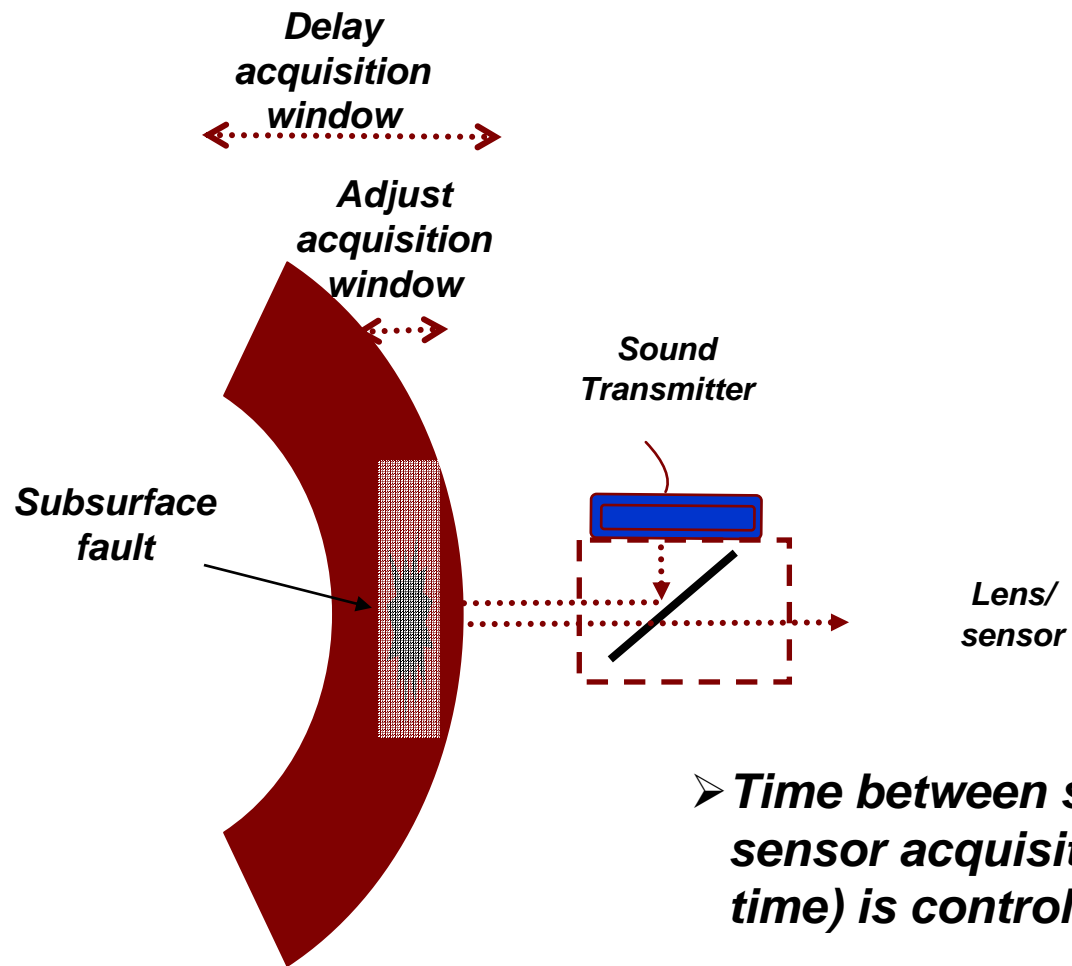


With Delamination



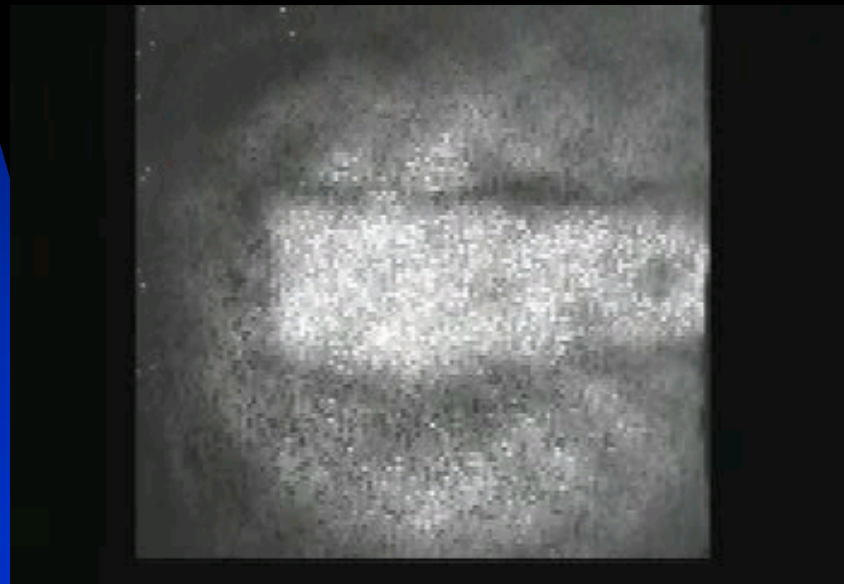
No Delamination

Pulse Echo – Depth (range gating)



Range Gating for Depth

- Front gate is moved to first eliminate front surface reflection
- Target is then gated through



Prototype Development



2002



2003



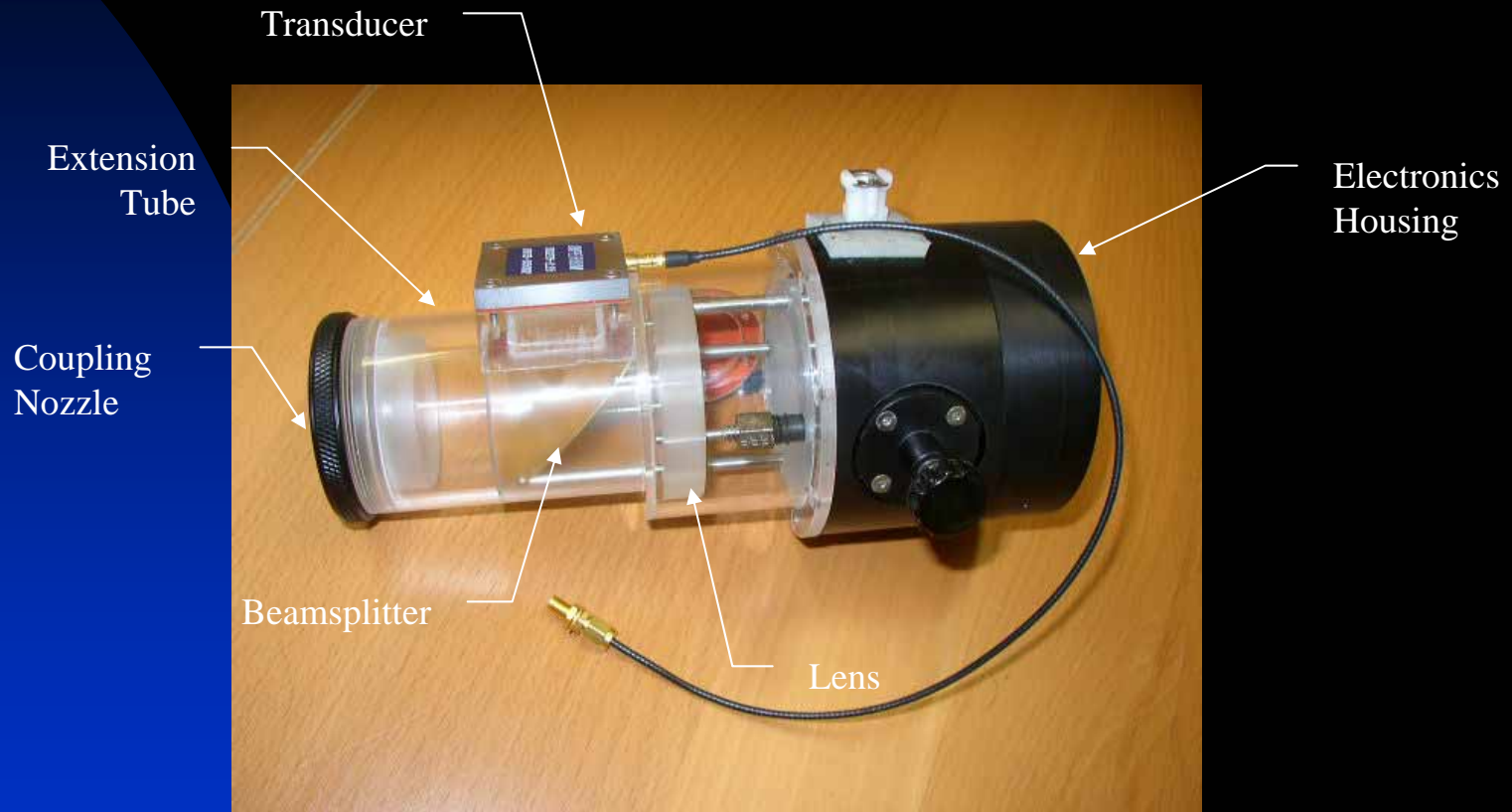
2004



2005



Production Camera Head



Portable Camera System



Computer

Camera Head

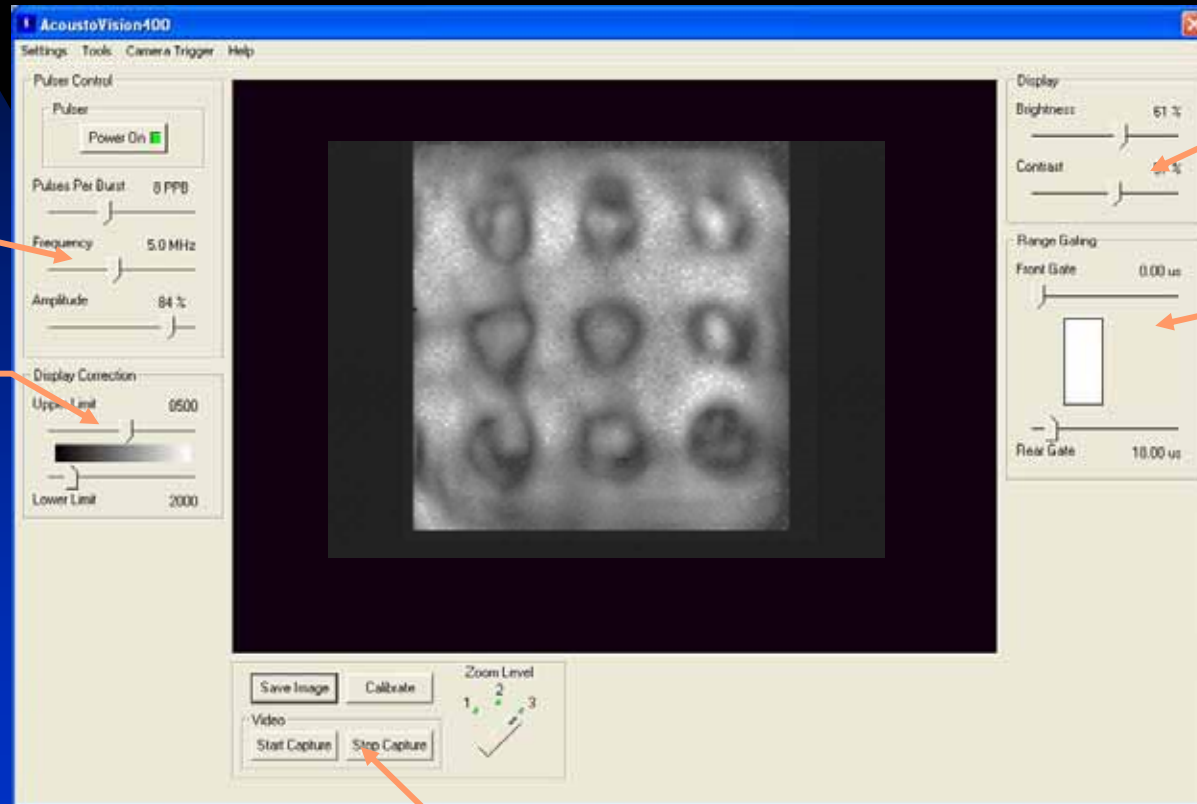
Control Unit

Transducer Replacement



- By removing auxiliary handle alternate transducers may be installed

Graphical User Interface



Frequency/ #
pulses

Dynamic
Range

Brightness/
Contrast

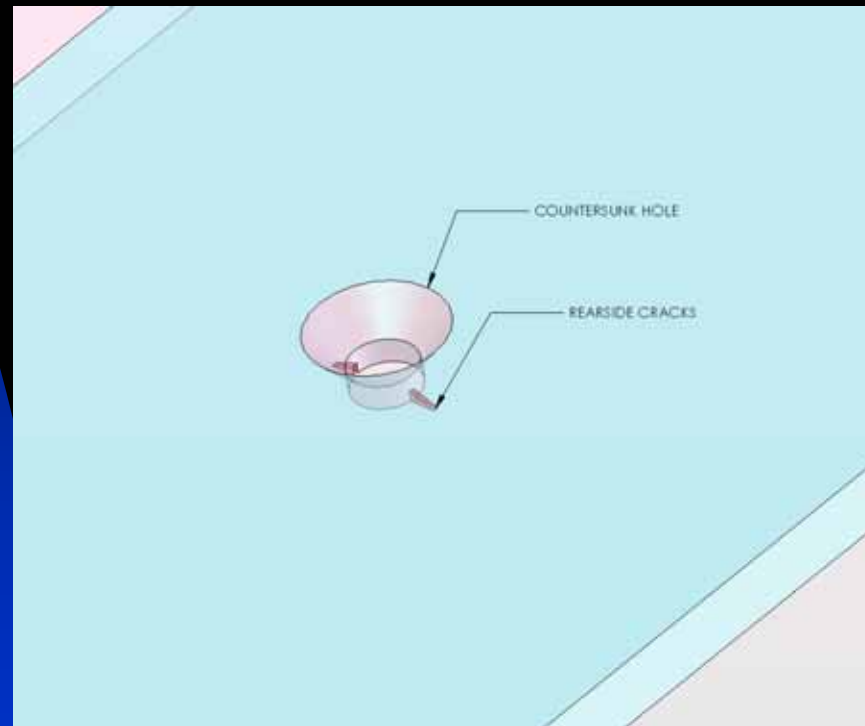
Set imaging
depth

Capture
images/
video

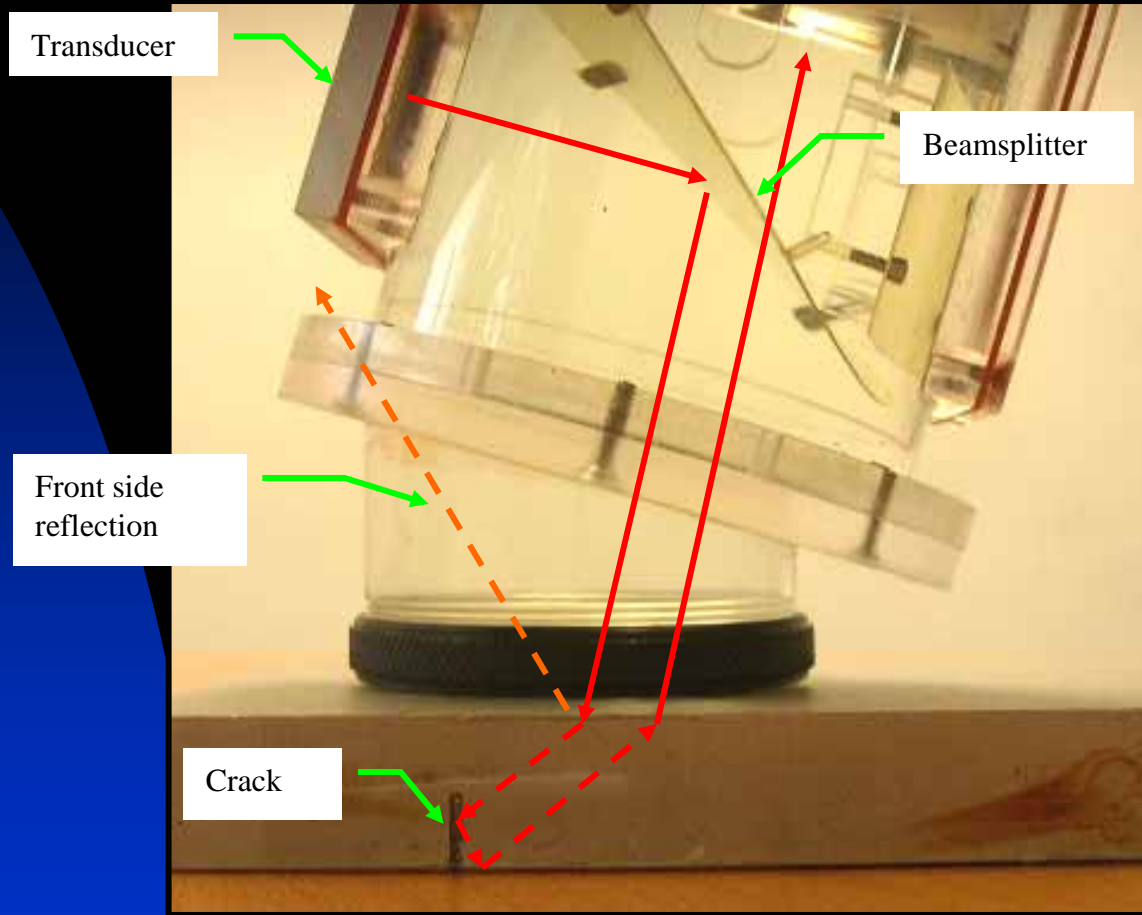
Shear wave results



Shear Wave Imaging in aluminum



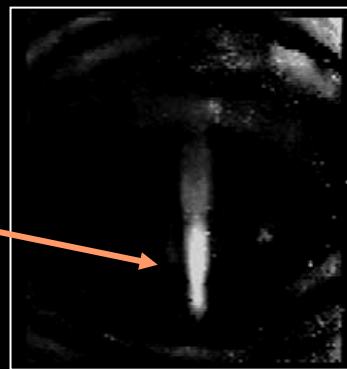
Shear Wave Handheld



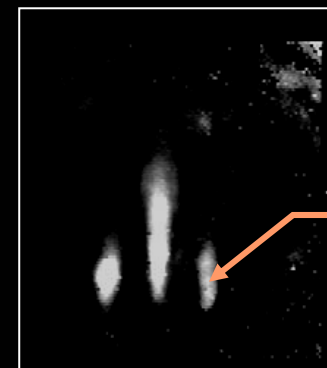
Shear Wave Handheld @ 5 MHz



Side of rivet



0.080"
Cracks



Shear Wave Handheld @ 5 MHz

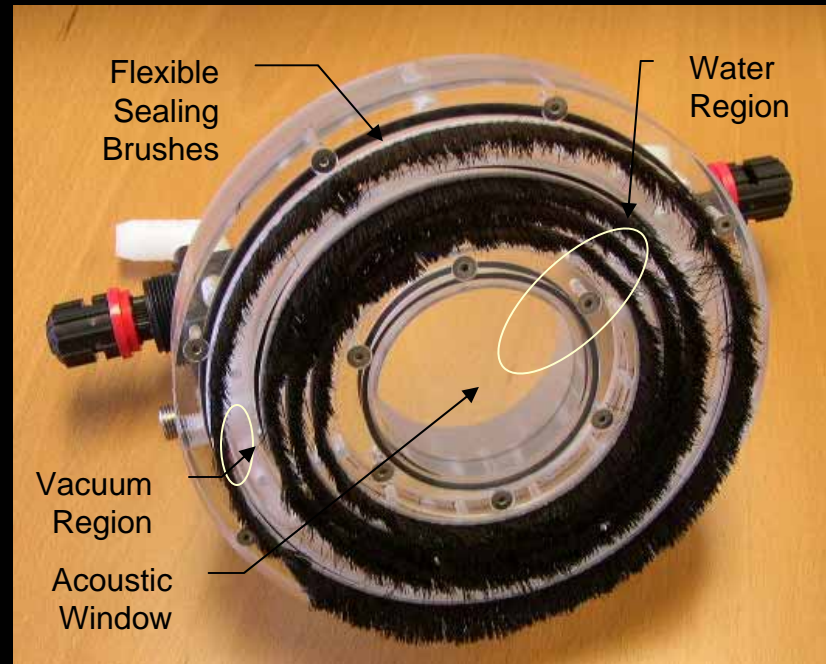
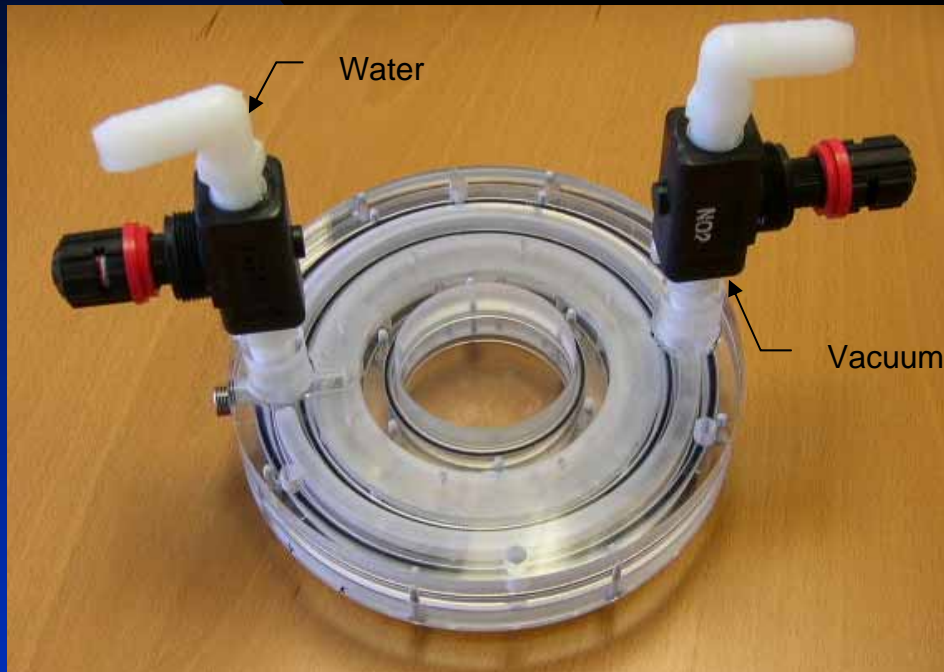


Large area scanning

Designed to interface with existing scanner

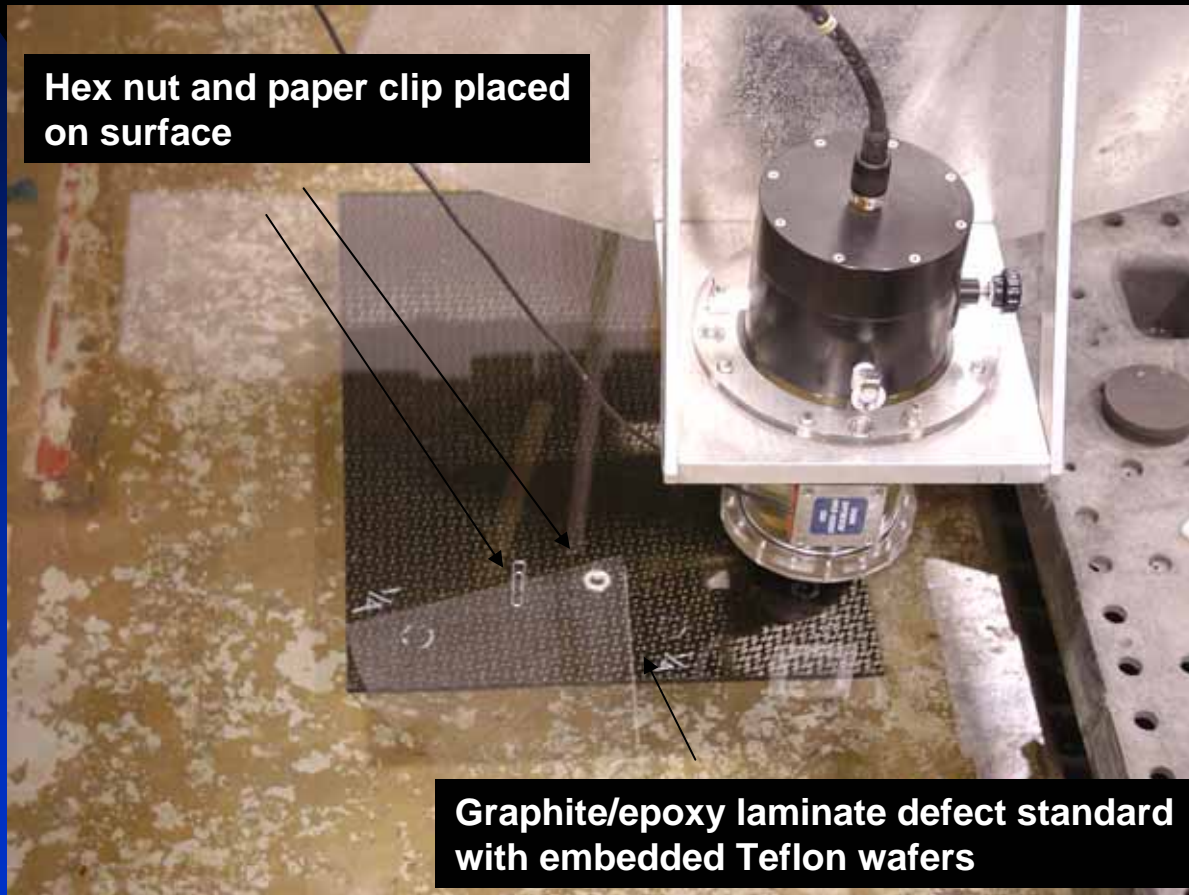


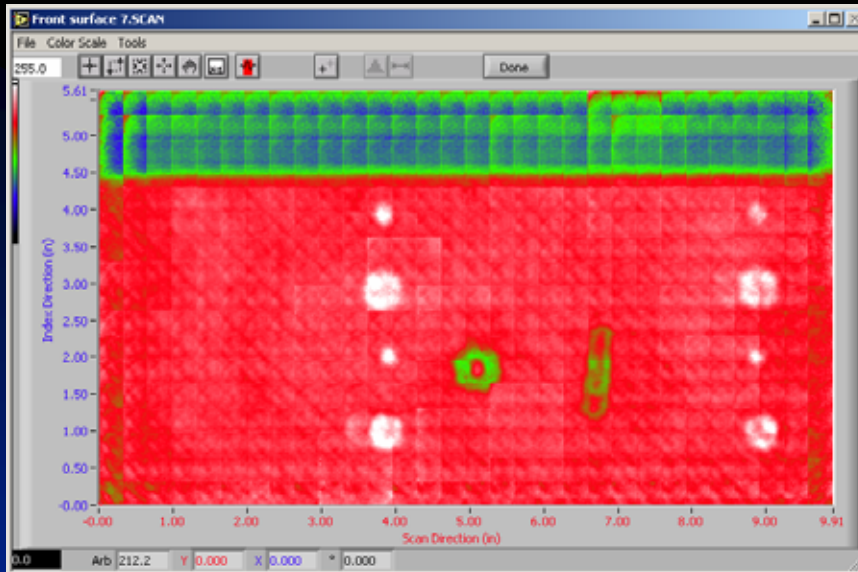
Production Scanning: Bubbler



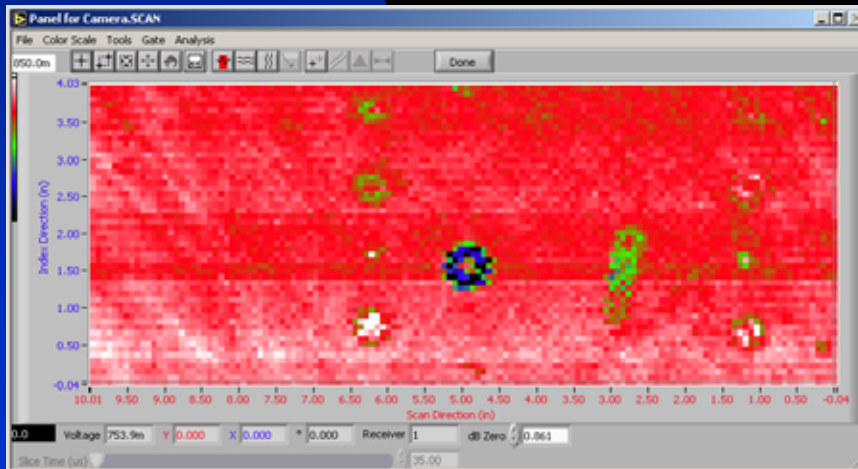
Bubbler fabricated for use with production camera

Production Scanning Results





UT camera scan with stitching
algorithm applied
- 0.3" scan increment



Conventional immersion scan
- 2.25 MHz, 0.25" diameter transducer
- 0.075 scan increment

UT Camera with Bubble Attached



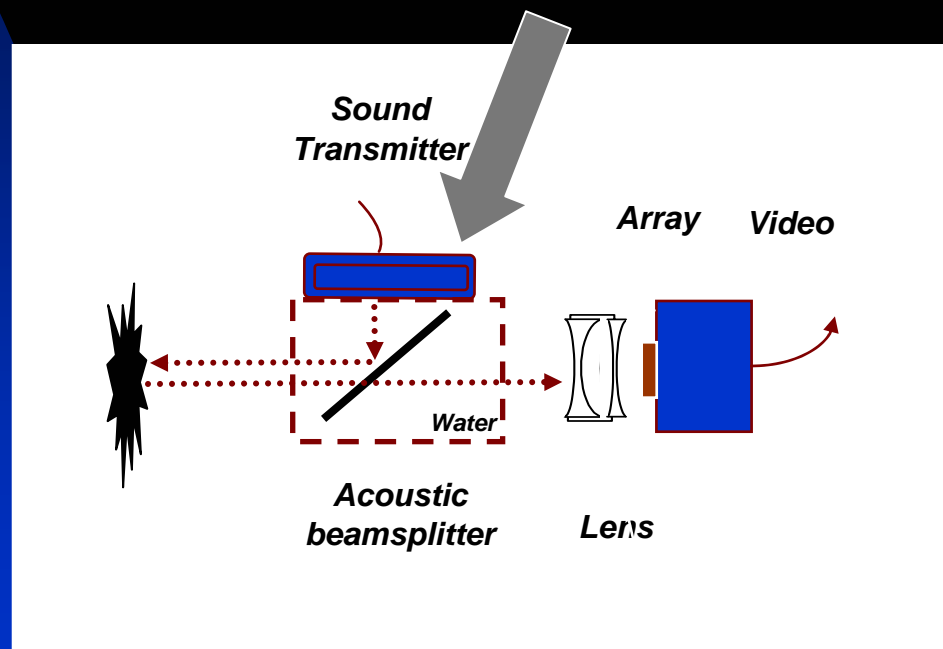
Vertical orientation test

Planned Developments

- Direct digital image download via USB
- Redo board set for handheld
- New imaging array
- A-scan built-in
- User interface development

Integrated A-scan

And receiver



Presentation of Imagery and A-scan

The screenshot displays the AcoustoVision400 software interface. The window title is "AcoustoVision400" and it includes a menu bar with "Settings", "Tools", "Camera Trigger", and "Help".

Pulsar Control:

- Pulsar:** Power On (indicated by a green square)
- Pulses Per Burst:** 8 PPB
- Frequency:** 5.0 MHz
- Amplitude:** 84 %

Display Correction:

- Upper Limit:** 8500
- Lower Limit:** 2000

Display:

- Brightness:** 61 %
- Contrast:** 57 %

Range Gating:

- Front Gate:** 0.00 us
- Rear Gate:** 18.00 us

The central display area shows a B-scan image (top) and an A-scan waveform (bottom). The A-scan waveform is labeled "Selected wave" and shows a complex signal with multiple peaks. The x-axis of the A-scan ranges from 0 to 495, and the y-axis ranges from -25 to 225.

Control Buttons:

- Save Image
- Calibrate
- Zoom Level: 1, 2, 3 (with a zoom slider)
- Video: Start Capture, Stop Capture

Conclusions

- High sensitivity/detectability
- Flexible
- Ease to use
- Video output
- Coupled with quantitative gives 'best of both worlds'