

Two-Dimensional Array for Speckle-Free Ultrasound Imaging

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Digital Acoustic Video (DAV™)

- Ultrasound camera
- Real time C-mode imaging
- Plane imaging, NOT normal
- Speckle Free
- Standard video output

Digital Acoustic Video (DAV™)

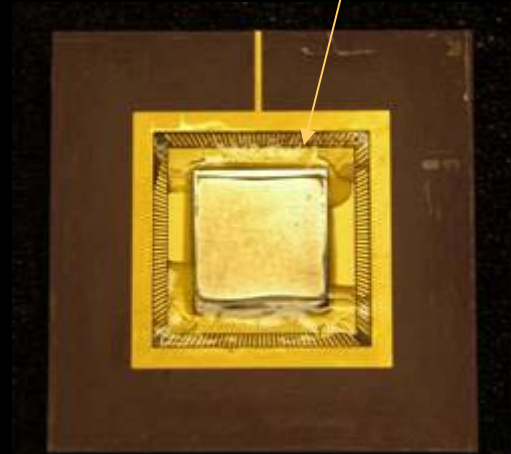
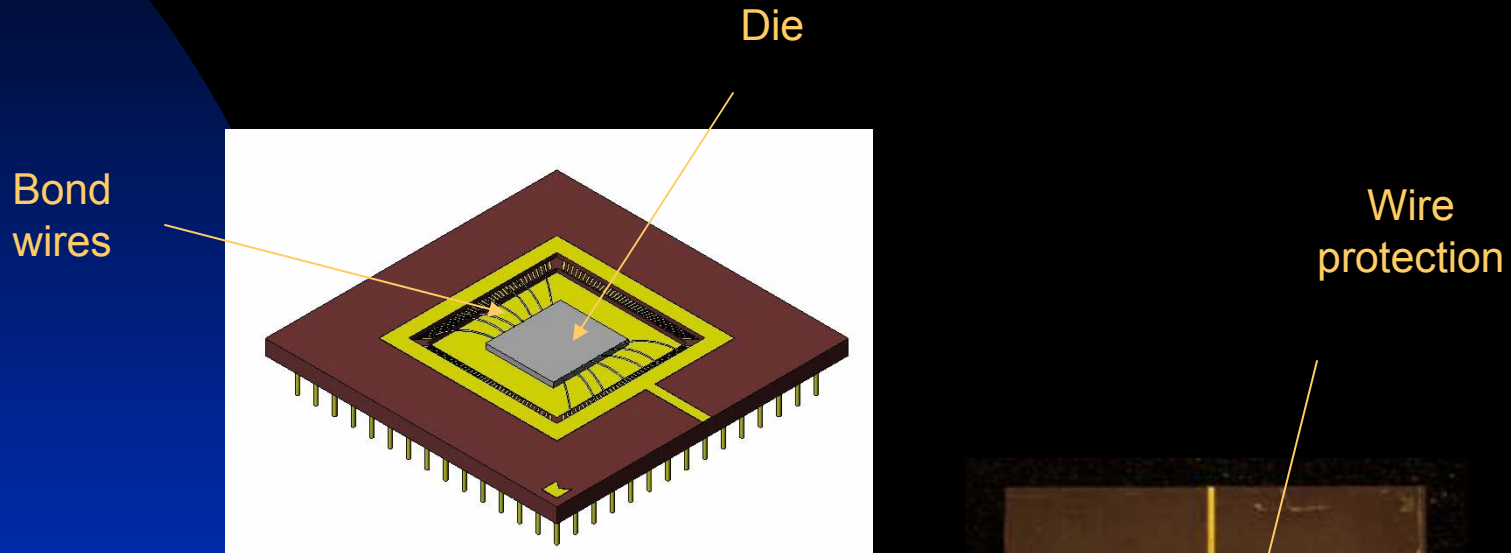
- Same “rules” of imaging as conventional ultrasound
- Two-dimensional array
- Lens based
- Broadband

DAV™ - Clinical Advantages

- Soft tissue imaging
- X-ray like
- No artifacts
- Low cost
- Commercial manufacturing techniques
- Multiple clinical applications

Ultrasound Camera Technology

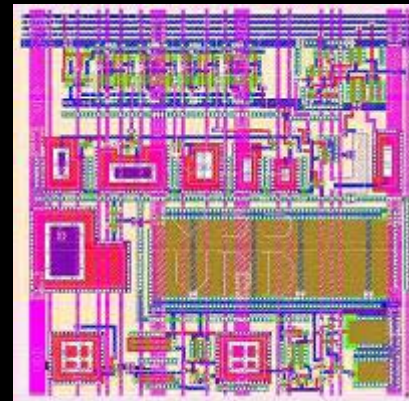
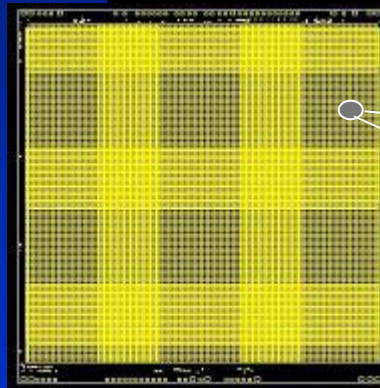
Digital Acoustic Video (DAV™): Imaging Array



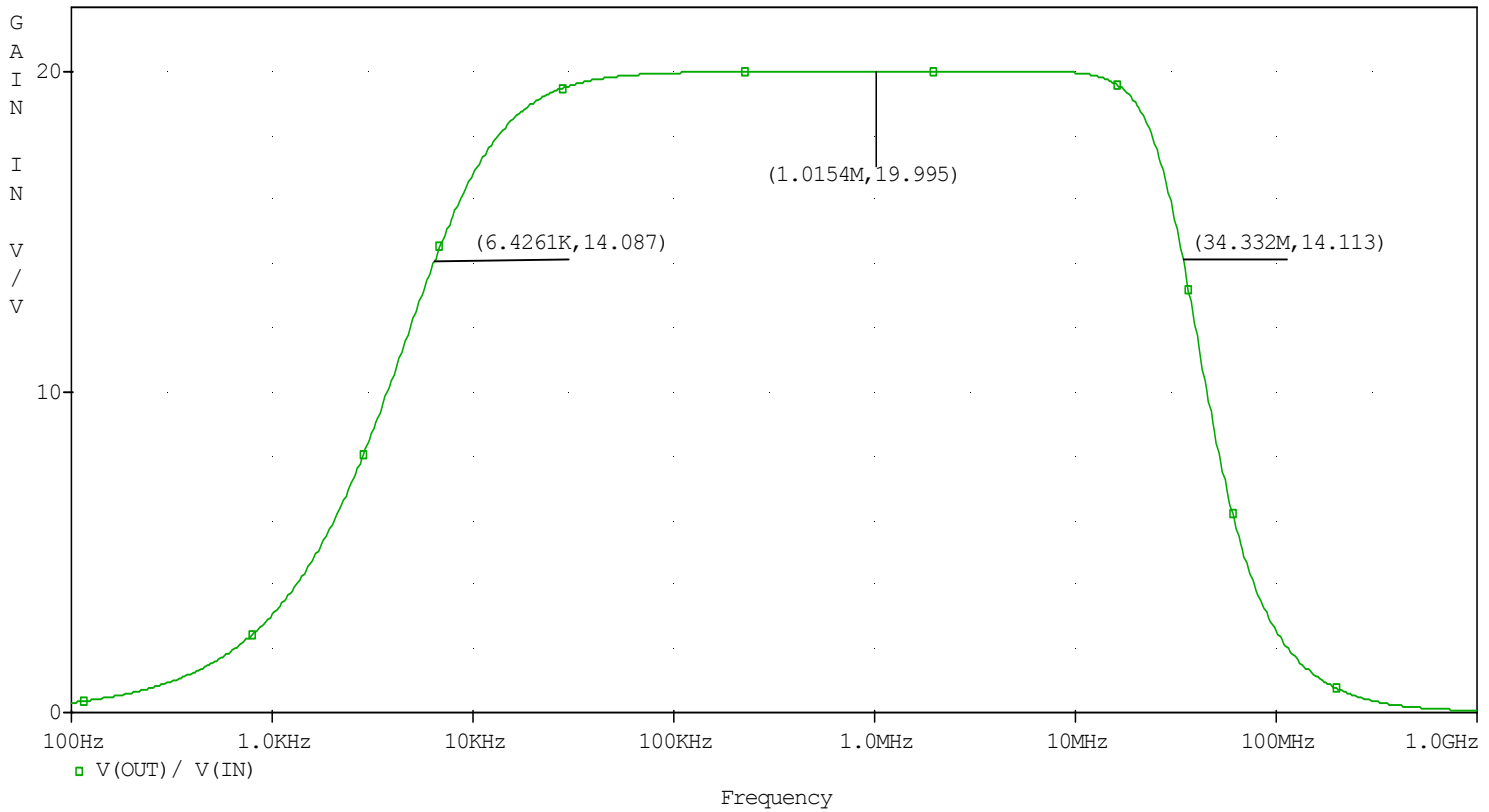
- Custom design
- $120 \times 120 = 14,400$ elements
- Piezoelectric material deposited

Two-Dimensional Array

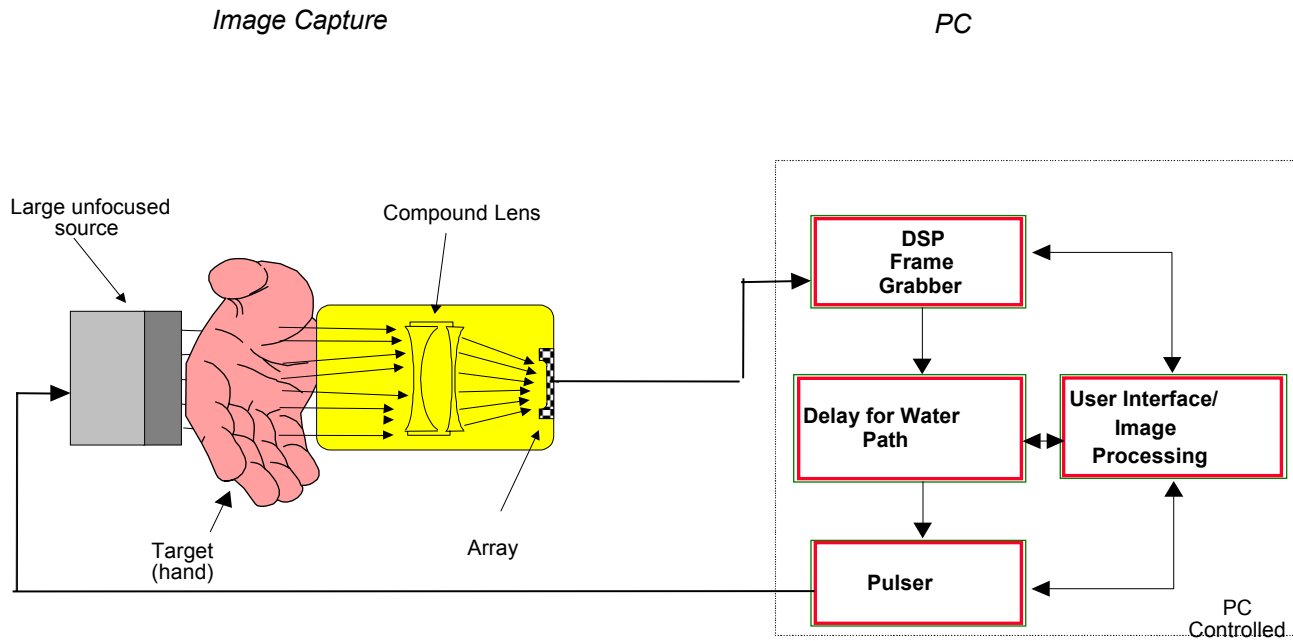
- Hybrid: Piezoelectric material deposited on silicon readout chip via semiconductor processing



Array Response

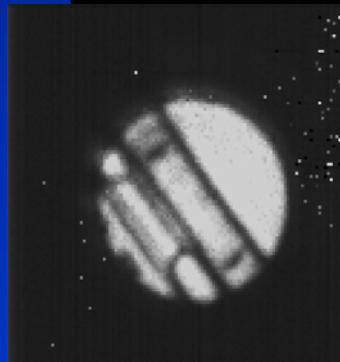


Through Transmission

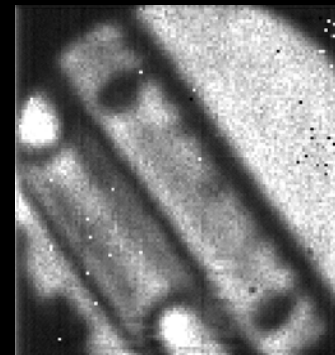


Acoustic Lens

- Zero-power beamformer
- Adjustable focus
- Adjustable zoom



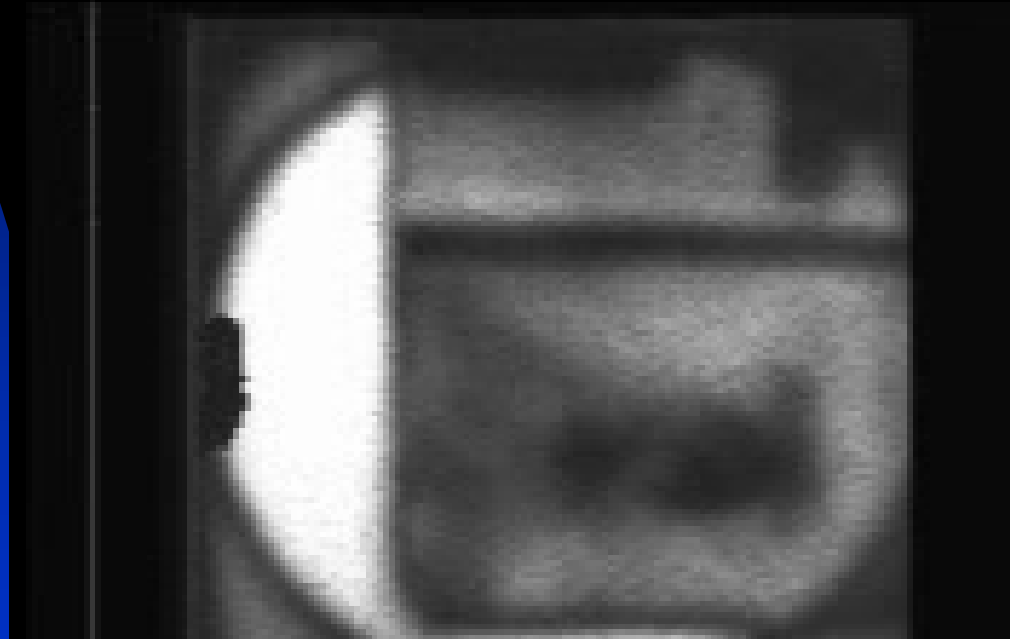
No magnification



With magnification

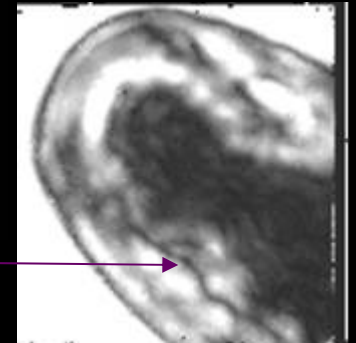
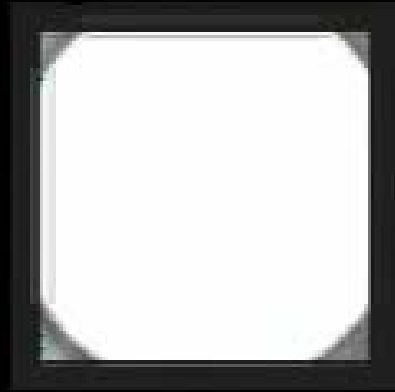
Through Transmission

3 inch Field of View – 3 MHz



Through Transmission of Fingers

1 inch Field of View – 5 MHz



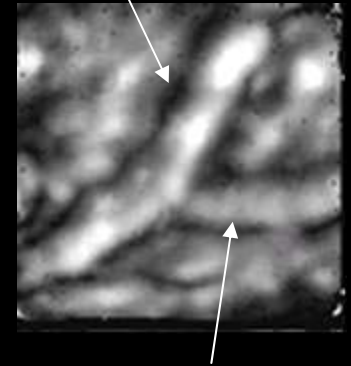
Small vessel of
digital finger

Through Transmission - Hand

1 inch Field of View – 5 MHz

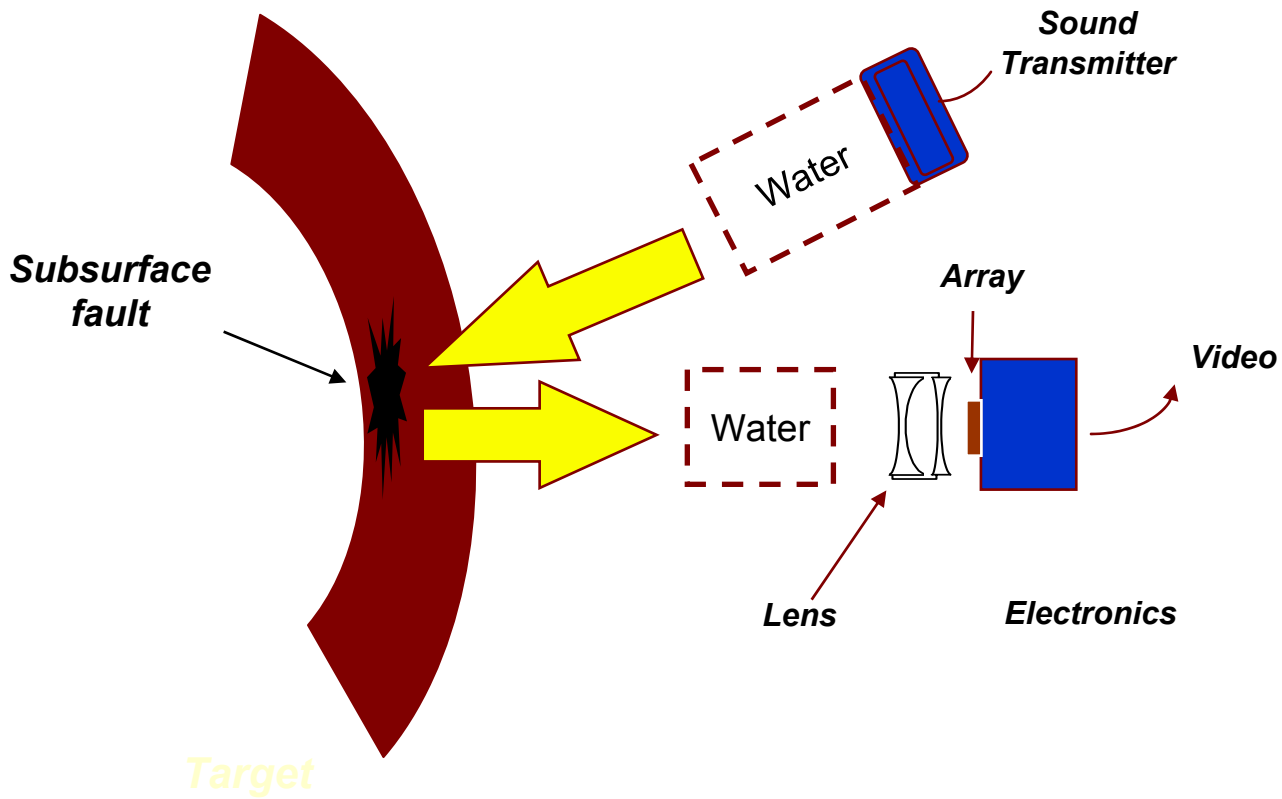


**Flexor pollicis longus
tendon & sheath**



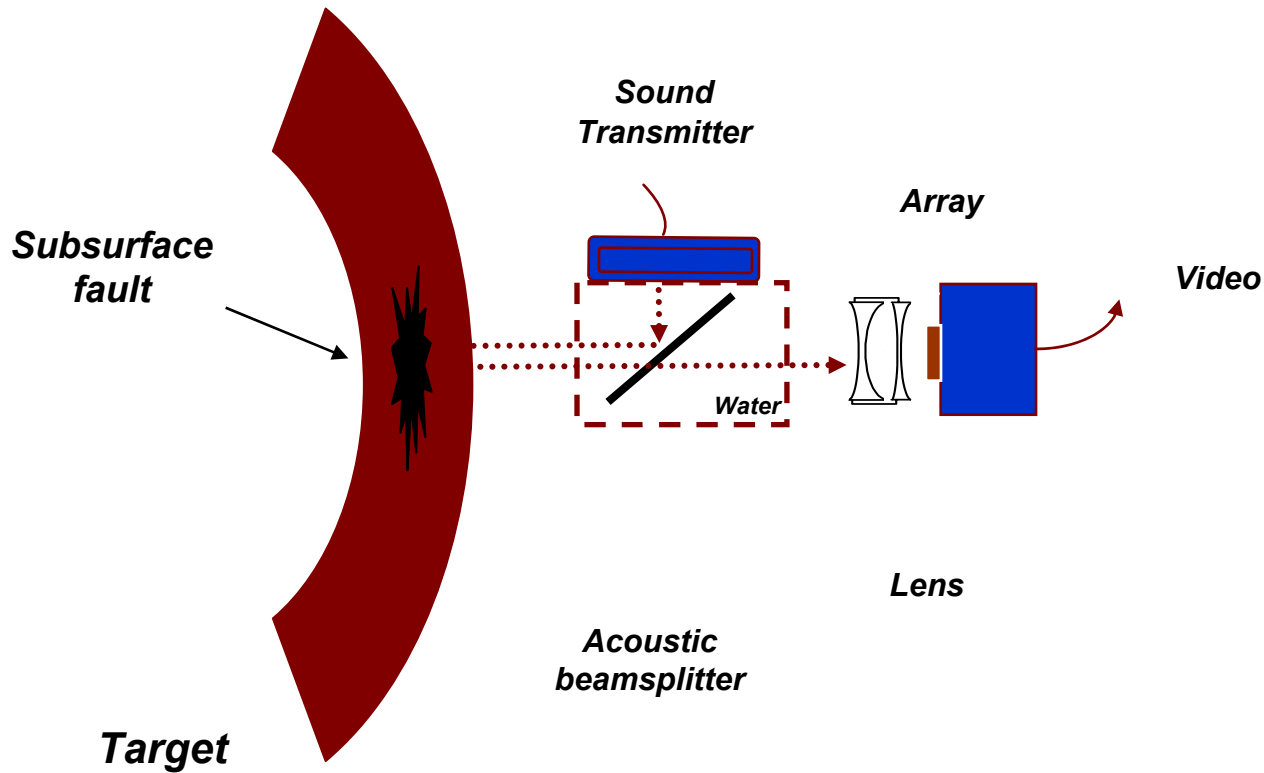
Adductor pollicis tendon & sheath

TM DAV Technology - Pulse Echo



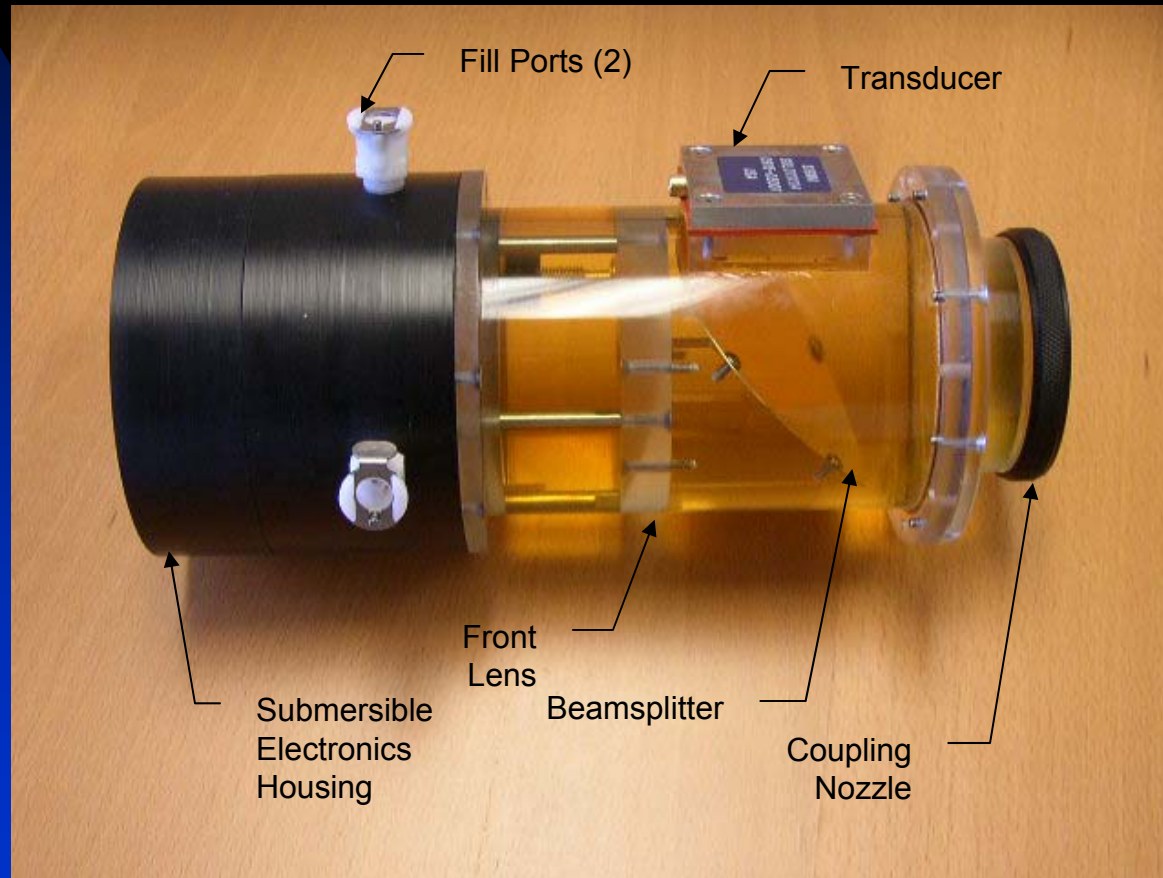
*Pulse echo
image of quarter*

Pulse Echo – 50/50 Beamsplitter



Pulse echo image of quarter

Production Camera Head



- Same as internal components of portable system with addition of rear cap to allow submersion

Portable Camera Head

Coupling
Nozzle

Focusing
Knob



LCD



Trigger for
Image Capture

LCD
Controls

Dynamic Range Study Using Stepped Wedge



Dynamic Range Study

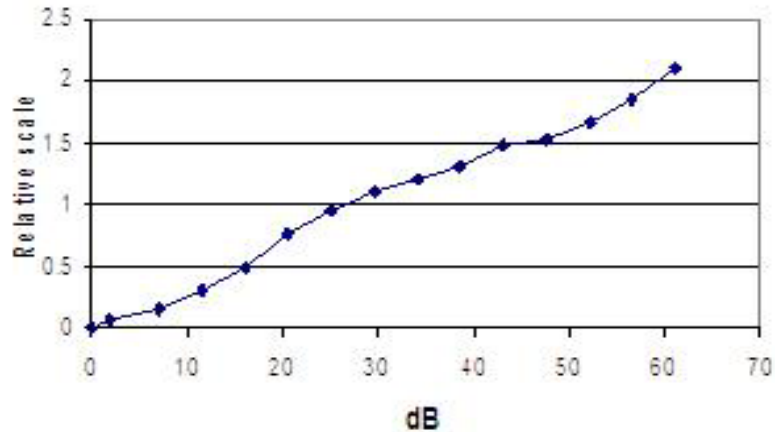
5 MHz														
steps		0dB	4.95	9.9	14.85	19.8	24.75	29.7	34.65	39.6	44.55	49.5	54.45	59.4
Background	0.2	5.4	4.95	4.5	4.05	3.6	3.15	2.7	2.25	1.8	1.35	0.9	0.45	0.
Phantom	0.2	5.4	9.9	14.4	18.9	23.4	27.9	32.4	36.9	41.4	45.9	50.4	54.9	59.4
Total (dB)	1.88	7.08	11.58	16.08	20.58	25.08	29.58	34.08	38.58	43.08	47.58	52.08	56.58	61.08

7.5 MHz														
steps		0 dB	7.425	14.85	22.27	29.7	37.12	44.55	51.97	59.4	66.82	74.25	81.67	89.1
Background	0.3	8.1	7.425	6.75	6.075	5.4	4.725	4.05	3.375	2.7	2.025	1.35	0.675	0.
Phantom	0.3	8.1	14.5	21.6	28.35	35.1	41.85	48.6	55.35	62.1	68.85	75.6	82.35	89.1
Total (dB)	2.82	10.62	17.02	24.12	30.87	37.62	44.37	51.12	57.87	64.62	71.37	78.12	84.87	91.62

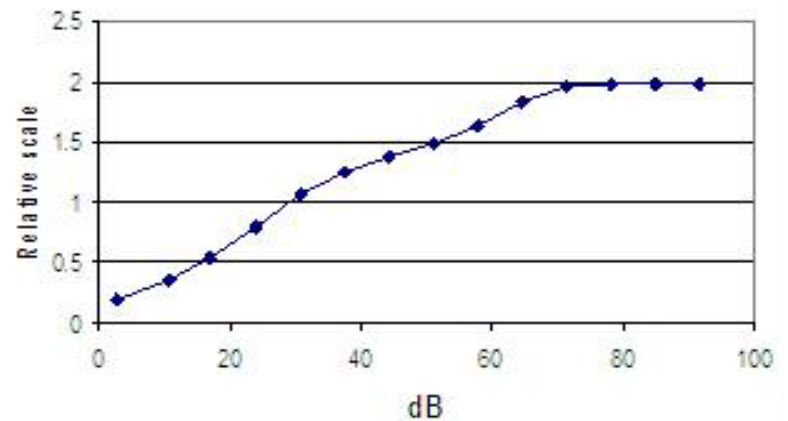
Table 1: Summary of the data acquired for the dynamic range experiment when the ultrasound prototype was operated at 5 MHz and 7.5MHz

Dynamic Range Study: 5 MHz, 7.5 MHz

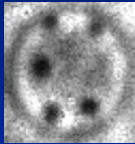
Log(Io/I) vs dB (5MHz)



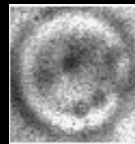
Log(Io/I) vs dB (7.5 MHz)



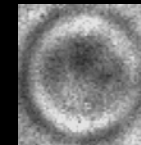
Resolution Study: CIRS microcalcification phantom



(a) 710-850 μ m Target Group

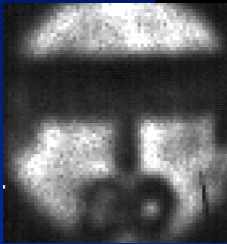


(b) 425-450 μ m Target Group

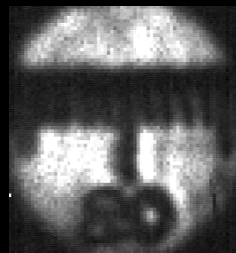


(c) 300-355 μ m Target Group

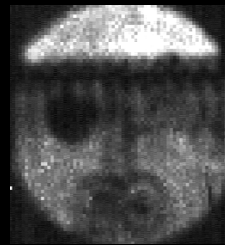
Resolution Study: Plastic Ruler



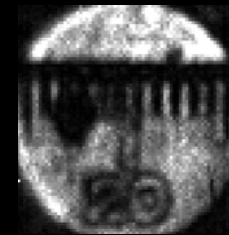
(a) 5MHz



(b) 7MHz



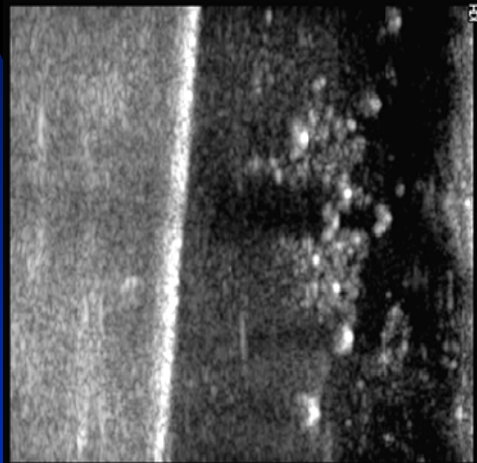
(c) 10MHz



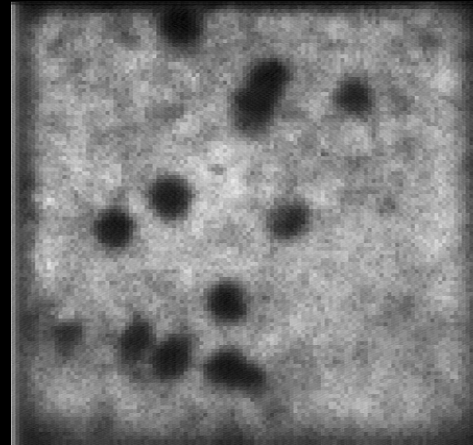
(d) 12MHz

DAV™ versus conventional ultrasound

B-scan



DAV

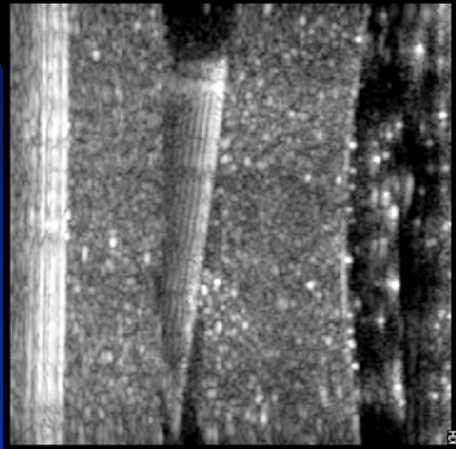


2.5 mm
objects

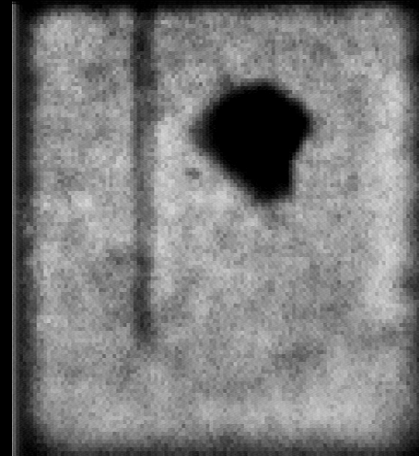
Work performed by Dr. Chris Merritt,
Thomas Jefferson University

DAV versus conventional ultrasound

B-scan



DAV



Biopsy Needle

Clinical Medical Applications

- Conventional medical applications
- Acoustocam-only applications



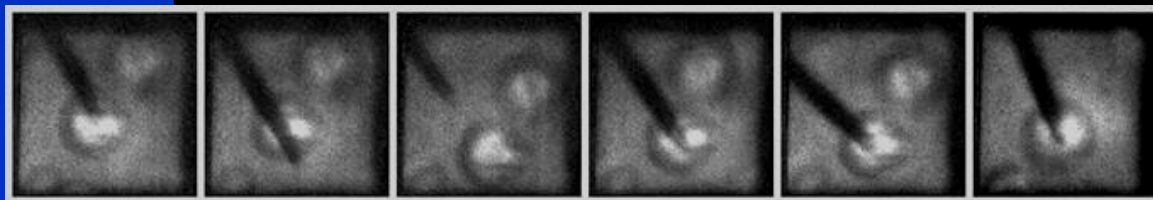
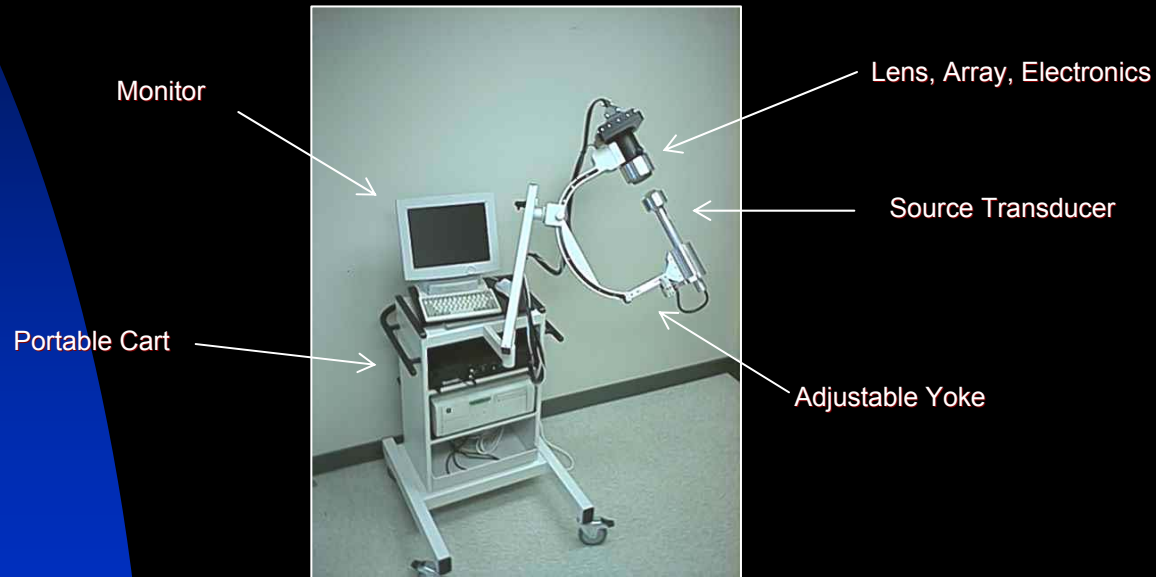
Conventional Applications

- Abdominal
- Breast
- Cardiology
- ENT
- Gastroenterology
- Musculoskeletal
- OB/Gyn
- Pediatrics
- Small Parts
- Surgery
- Urology
- Vascular

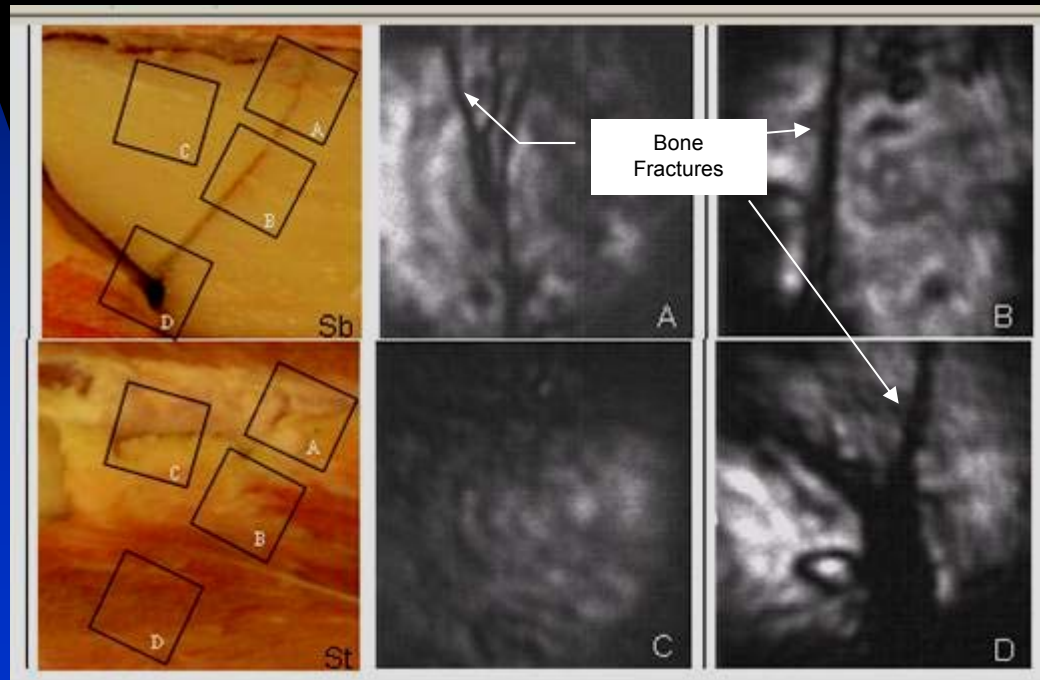
New Applications

- Foreign body detection
- Decompression sickness
- Ophthalmology
- “Fluoroscopy-like” breast imaging
- Podiatry
- Fractures/bone imaging
- Sports Medicine

DAV™ Breast Prototype at GUMC



Beef Bone Imaging



Medical Alliances

- Georgetown University Medical Center
 - ◆ Drs. Matthew Freedman, Ben Lo
- Clinical Advisory Board
 - ◆ Dr. Matthew Freedman
 - ◆ Dr. Etta Pisano
 - ◆ Dr. Chris Merritt
 - ◆ Dr. Mark Klein

Future Work

- Application specific embodiments
- False color
- Larger FOV
- Multiple camera/Multiple modality imaging
 - ◆ “Ultrasound CT”
 - ◆ Stereo imaging
 - ◆ Orthogonal imaging
 - ◆ X-ray/DAV digital overlay
 - ◆ DAV/B-mode combination