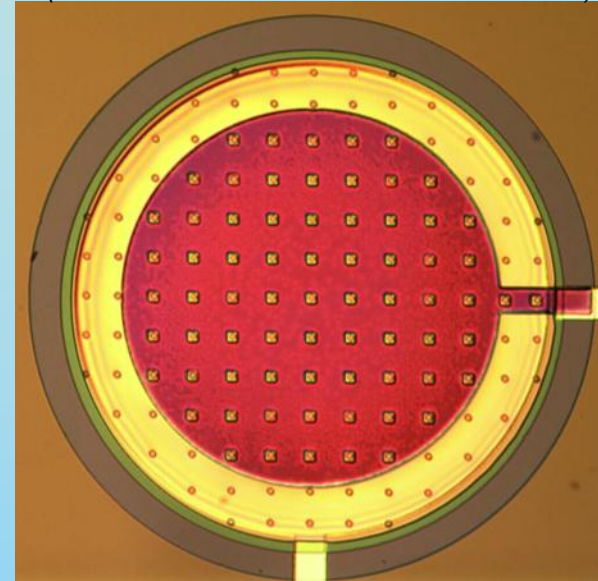


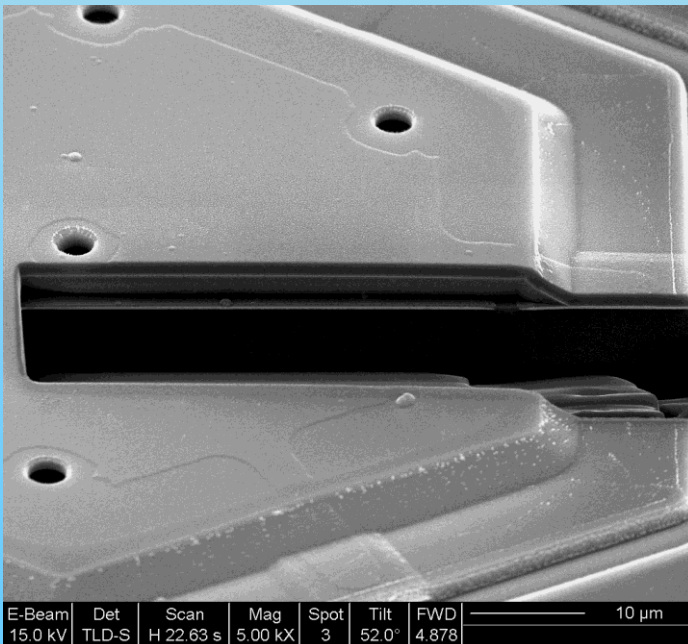
MATA – MEMS Acoustic Transducer Array

*Optical microscope image of a CMUT device
(device is about 300 micro-meters in diameter)*



What is MEMS?

- MEMS is an acronym for Micro Electro-Mechanical Systems
- MEMS uses the techniques employed by the microprocessor industry to produce electronic integrated circuits; but in MEMS, we produce mechanical structures
- One widely used MEMS device is the accelerometer in automobile air bags, used to trigger air bag deployment



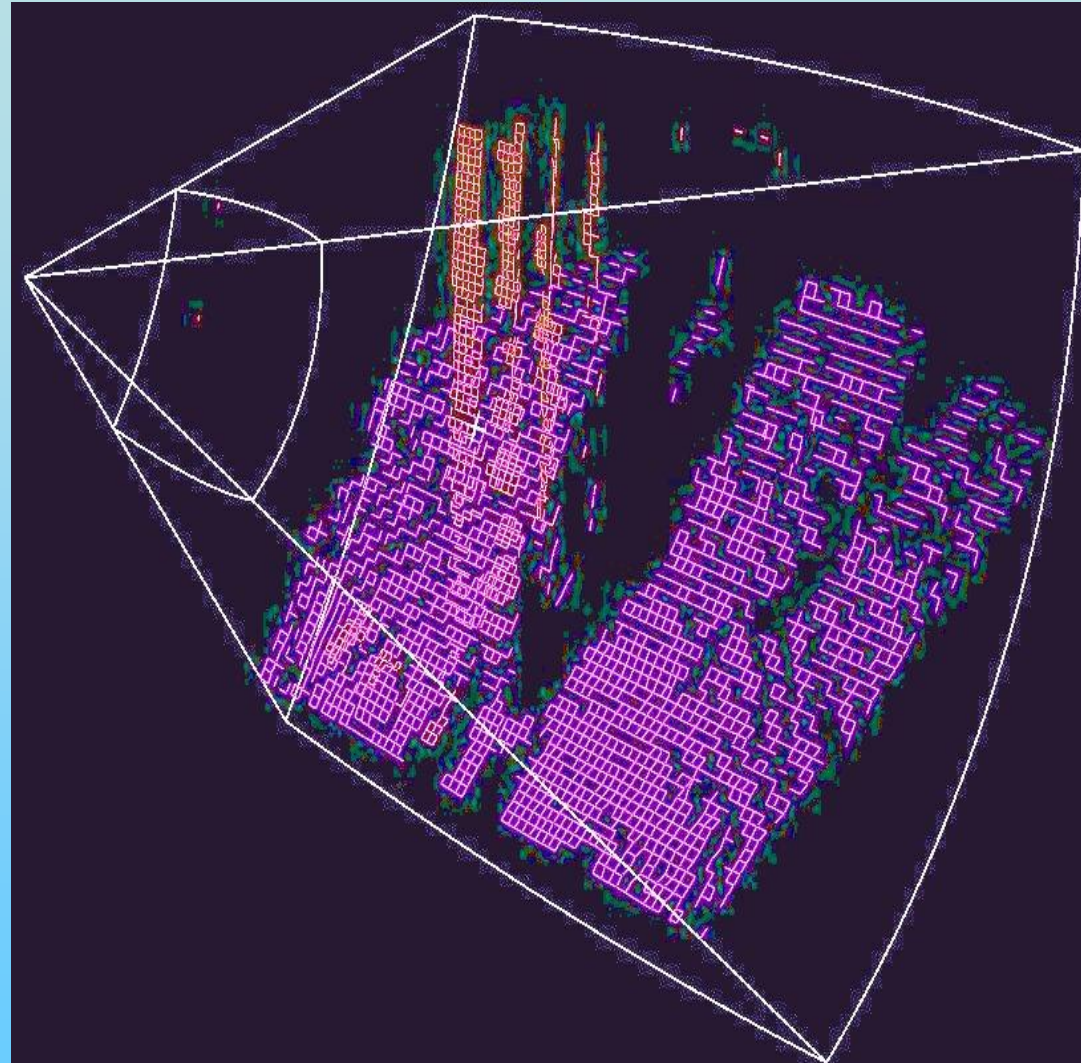
Scanning Electron Microscope cross section through a MEMS CMUT device (the device is about 120 micro-meters in diameter)

What is a MEMS Acoustic Transducer Array?

- Conventional acoustic transducers (hydrophones, microphones or geophones) mostly use the piezoelectric effect to turn an acoustic signal into an electrical one
- MEMS acoustic transducers use the physical displacement of a membrane to alter the electrical characteristics of the device
- This project involved MEMS fabrication of a ‘CMUT’ – Capacitive Micromachined Ultrasound Transducer; high frequency CMUT devices are used in some medical ultrasound machines.
- In this project we’re trying to reduce the manufacturing cost of transducers, while improving the signal to noise ratio compared with equivalent cost piezoelectric devices.

MEMS Sonar Transducer Applications: 3D Sonars

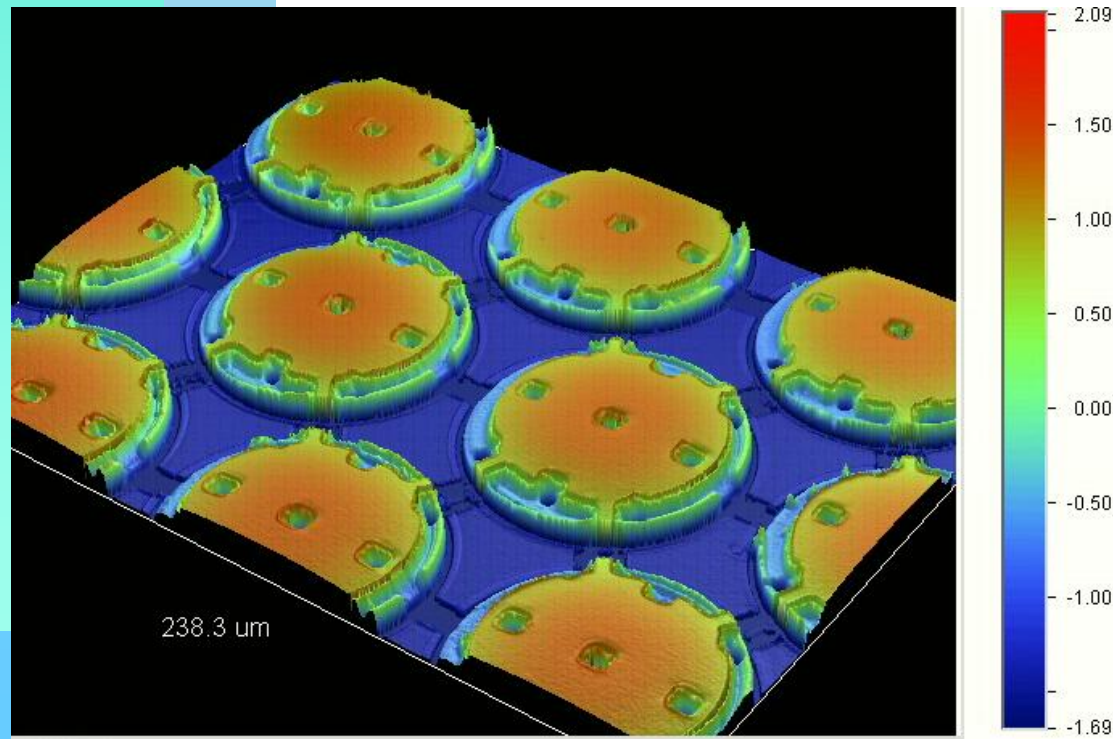
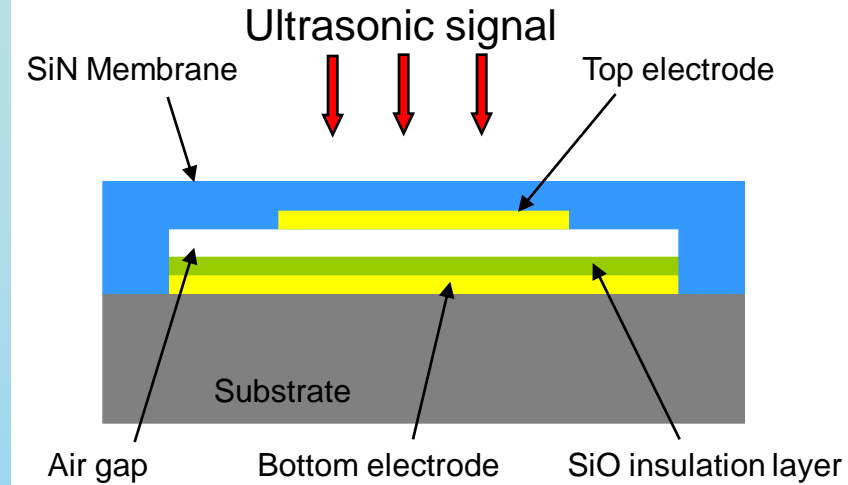
- Full 3-D image of scene from each ping
- Very high coverage rate
- Provides both imagery and 3D measurements
- Replaces sector scan and conventional multibeam (an imaging and measuring system)
- Needs large array (e.g. 48x48) of sensor elements
- The initial target application for MEMS



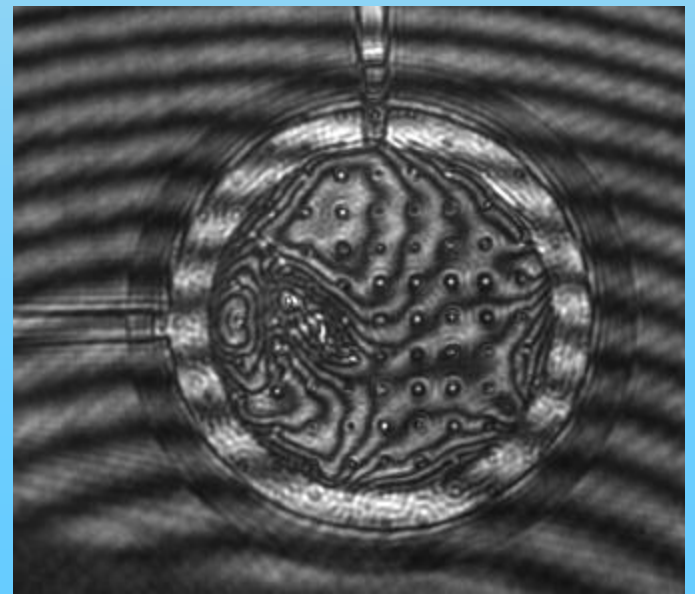
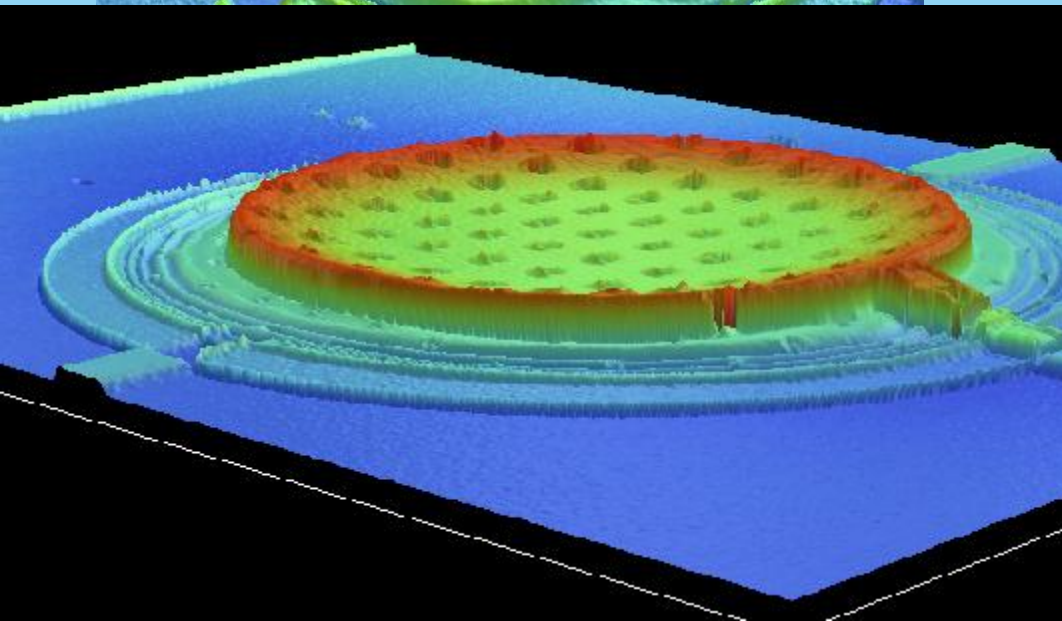
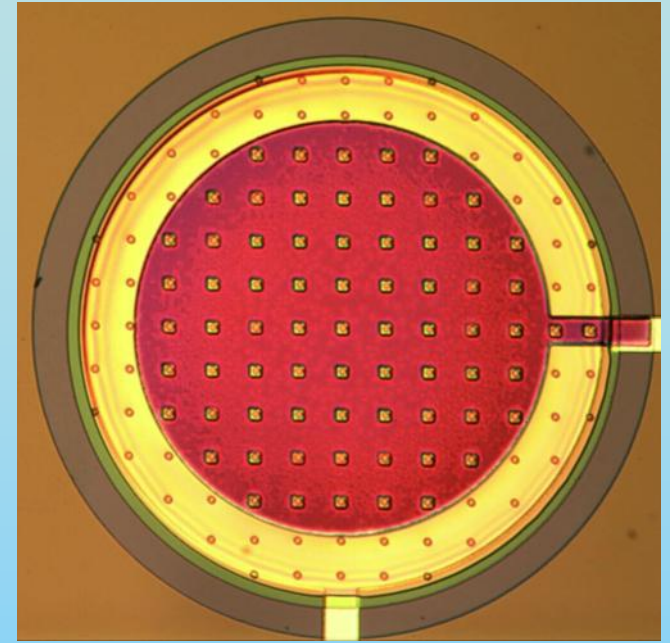
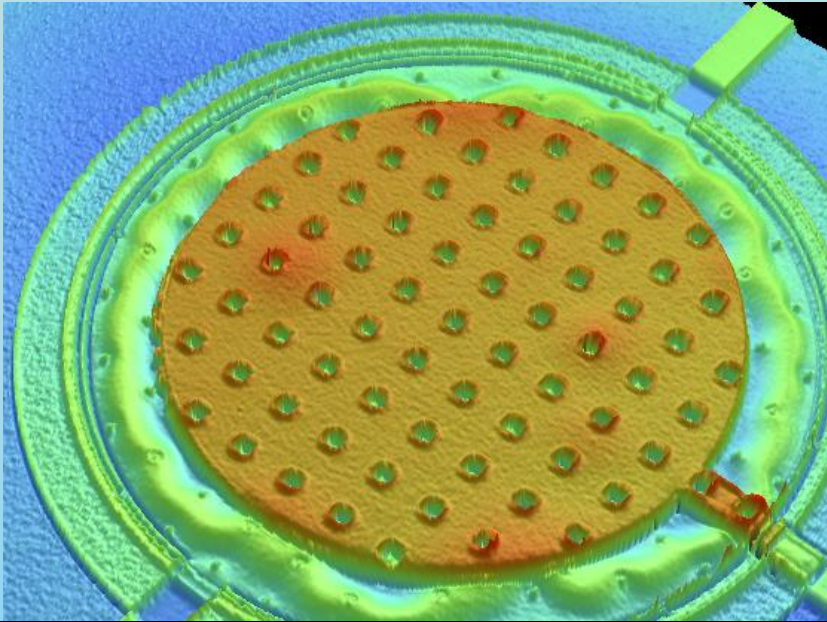
- 'Echoscope' 3-D sonar image of dolphin (wooden pilings)

Acoustic Transducer Array - MEMS Sonar Transducers

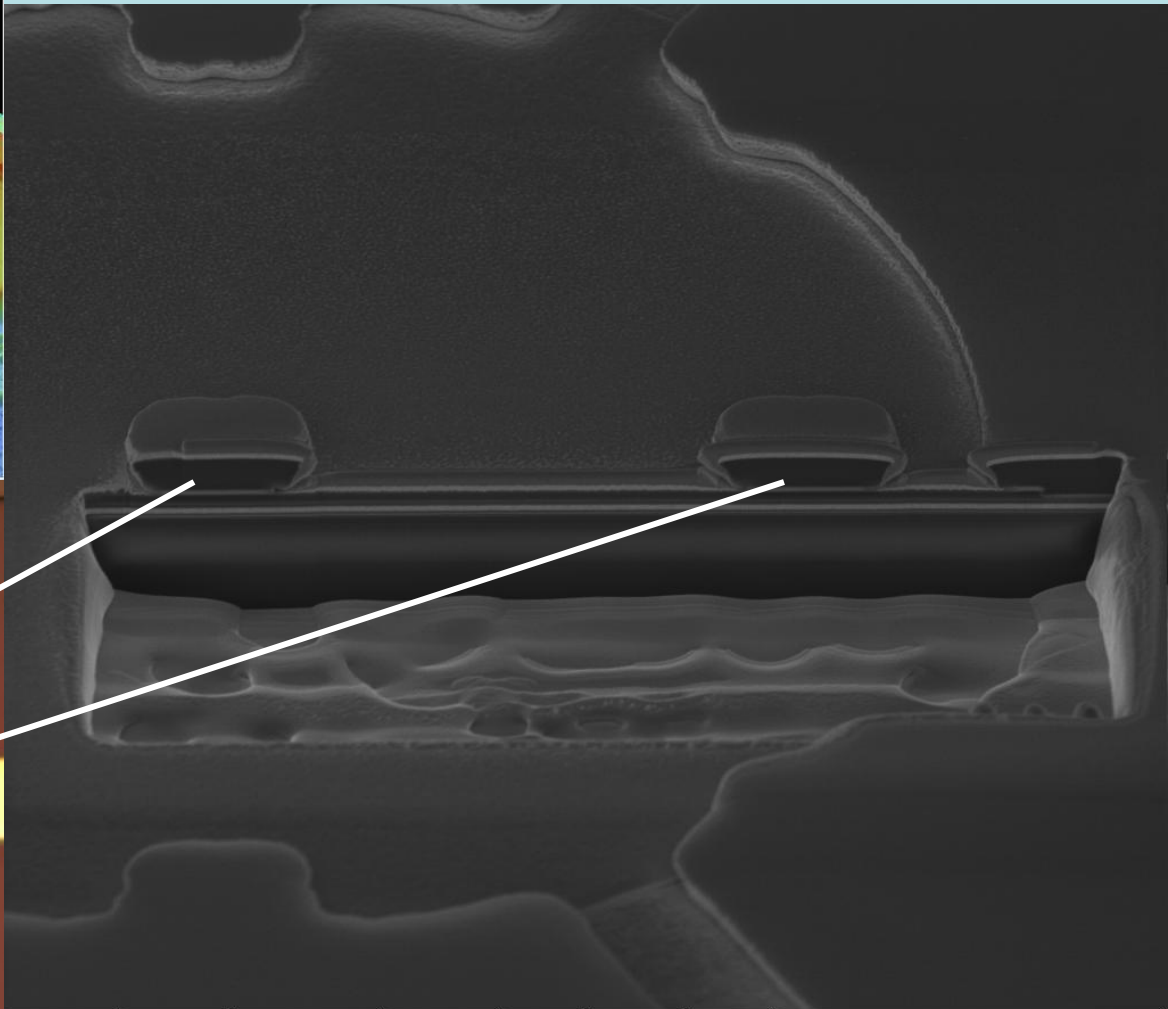
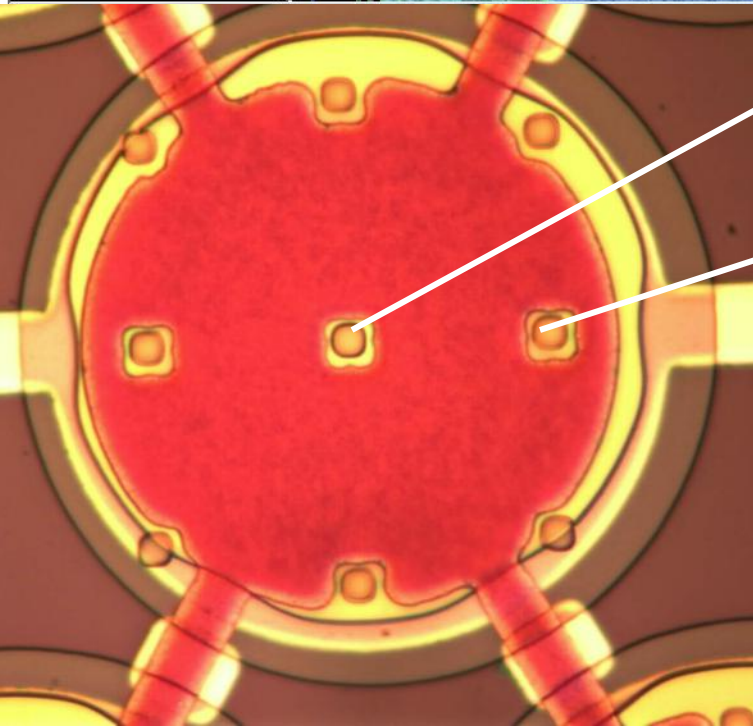
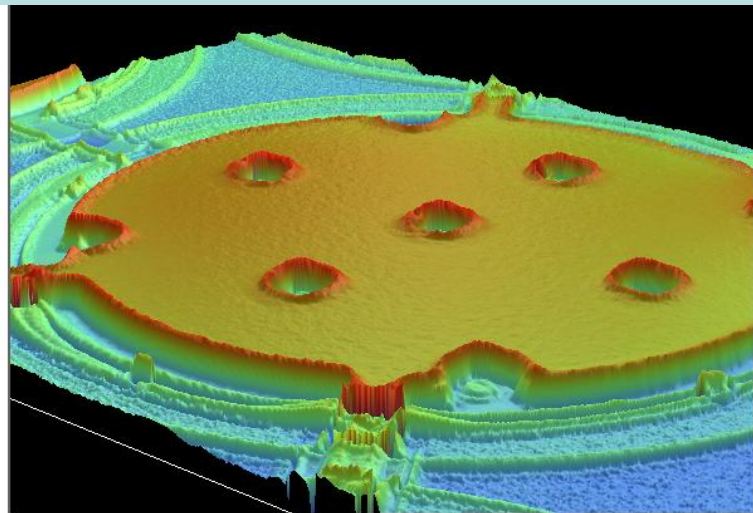
- Better, cheaper, more repeatable receivers
- Cheaper planar arrays for 3D sonars
- Integration of electronics with transducer
- Smaller form factor from die level integration
- Improved acoustic impedance matching
- Improved sensitivity & dynamic range
- Move from hand-crafted to automated transducer production



Recently Fabricated Devices (1)



Recently Fabricated Devices (2)



E-Beam	Det	Scan	Mag	Spot	Tilt	FWD	10 μ m
5.00 kV	TLD-S	H 45.26 s	6.50 kX	3	52.0°	4.921	

Acoustic Transducer Array - MEMS Sonar Transducers

- Different array sizes and shapes have been fabricated, from 300um to 80um diameter.
- Process being optimized to improve performance:
 - flatter membranes
 - smaller gaps (down from 1um to 0.2um)
- Result is lower pull-in (bias) voltage (100V in first fabricated devices, now around 30V, with expected values under 10V).
- Immersion test facility being constructed to allow in-water acoustic measurements and characterization.

