THE POSEIDON PROJECT

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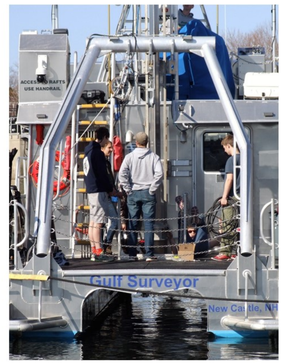
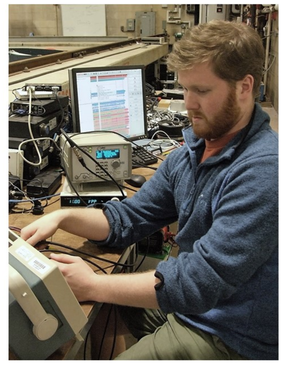
INTRODUCTION

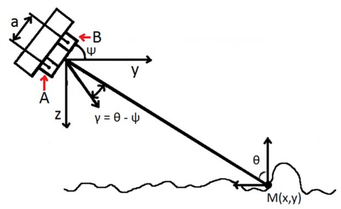
Ocean mapping and exploration is critical to understanding the world, it's resources, and how they change over time. However, only a small percentage of the seafloor is mapped at high resolution. The objective of the Poseidon Project is to design and manufacture a low-cost portable device capable of mapping ocean bathymetry in real time at depths up to 2000 meters. Unique performance parameters require the device to operate in deep water regions with high resolution with a relatively small array. Performance specifications were met with a split aperture, four quadrant, sidescan sonar design. Application of the SONAR equation in the likely operating environment yielded crucial system design parameters. A 16 kHz system frequency was selected to achieve the depth requirement while maximizing bathymetric resolution. At the operating frequency, 13 transducers in each quadrant satisfied the minimum output signal intensity. Beam pattern analysis and portability considerations determined the transducer array geometry. The transducers were manufactured and assembled. Experimental data collected in the Chase Ocean Engineering tank determined the transmit voltage response, receive sensitivity, and beam pattern, allowing for calibration. The device was tested on the R/V Gulf Surveyor to create a map of the Piscataqua riverbed.





THEORY

- Sidescan sonar systems measure the amplitude of backscattered echoes to obtain information about the seafloor
- Bathymetry is obtained by measuring phase angle, $\Delta\Phi_{AB}$



$$\Delta\phi_{AB} = \frac{2\pi\, a \sin(\gamma)}{\lambda} \qquad \gamma = \arcsin\left(\frac{\lambda\, \Delta\phi_{AB}}{2\pi\, a}\right) \quad (1)$$

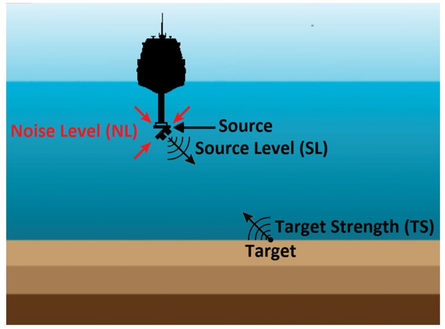
System parameters determined by the SONAR equation:

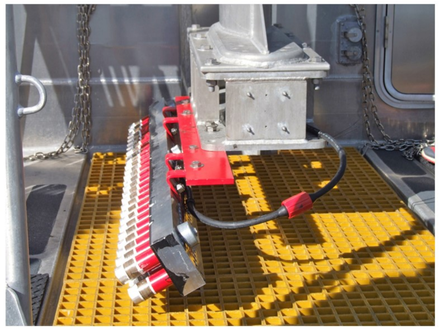
$$\mathrm{SNR\ (dB)} = \mathrm{SL} - 2\mathrm{TL} + \mathrm{TS} - (\mathrm{NL} - \mathrm{AG})$$

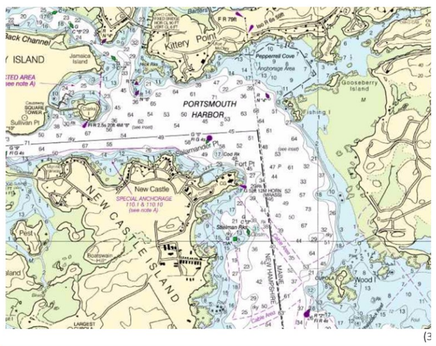
SNR = signal-to-noise ratio TL = transmission loss SL = source level
TS = target strength AG = array gain NL = noise level (1)

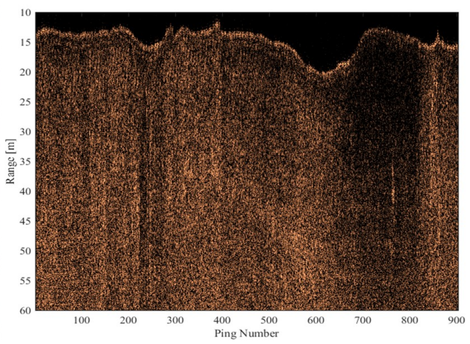
Defined system parameters at 15 kHz:

Inner swath limit:	8373 m	Resolution at 2000 m depth:	269 m^2
Source level:	209 dB	Mapping depth capability:	2000 m



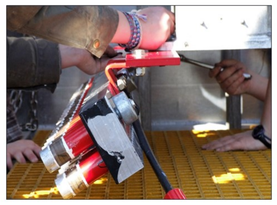






STAVE AND MOUNTING

- Stave manufactured out of 6061 aluminum
- Dimensions: 52" x 5" x 2"
- Mounted to boat and test tank using a machined stainless steel plate and angled brackets
- Angled at 60° below sea surface



TRANSDUCER DEVELOPMENT

Design

- Electro-acoustic transducer modeled as a second order spring-mass-damper system
- Utilized model to design head mass for 15 kHz transducer
- Tail mass 4 times more massive than head mass, acting as an anchor

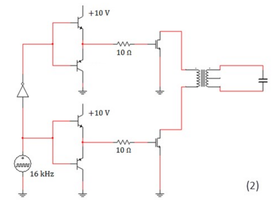
Materials

1 ½ in diameter aluminum head mass
1 ½ in diameter steel tail mass
Four 190-kHz piezo ceramic rings
Five copper mesh rings
Stainless steel cap screw
Six ¼ inch spring washers

Assembly

- Transducers individually tuned to 15 kHz using cap screw
- Ceramic ring stack protected from water by casting in polyurethane elastomer
  - Urethane casting process changed system parameters
  - Operating frequency changed to 16 kHz and inner swath limit decrease to 8285 m

ELECTRONIC SETUP



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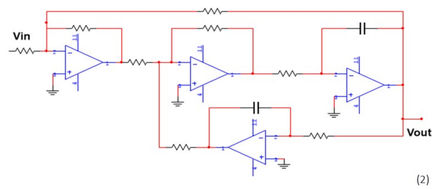
16 kHz 200W Power Amplifier



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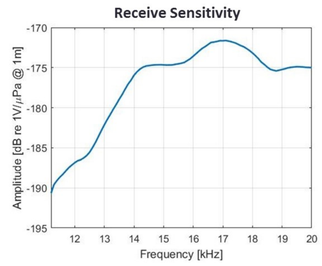
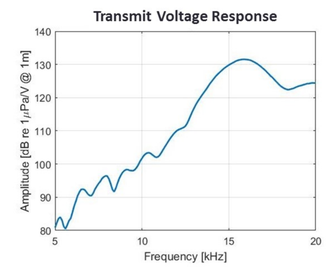
Receive Circuit with the LT1125 Quad Op Amp

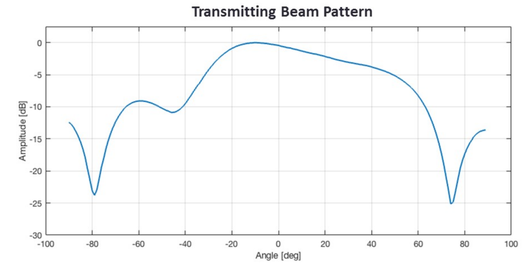
RESULTS

Lab Testing

- Individual transducer testing completed in the Chase Ocean Engineering Tank
- Fully characterized transducer properties







Field Testing

- Completed field testing of the device aboard the R/V Gulf Surveyor
- Mapped the Piscataqua riverbed along the border of Maine and New Hampshire
- Testing confirms that device successfully operates as a side-scan sonar system

REFERENCES

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3) NOAA. "Portsmouth Harbor: Cape Neddick Harbor to Isles of Shoals." *NOAA Office of Coast Survey*. Washington D.C.: n.p., 1983. N. pag. Print.

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