Western Bridge Engineers' Seminar

Images at Depth: The Use of Acoustic Imaging on Large River Crossings – A Case Study

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AGENDA

- Background of project
- Review of underwater scanning technology
- Evaluation procedures
- Results and lessons learned

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Challenge

How to inspect large river crossings where it is nearly impossible to perform a 100% underwater inspection due to massive size of piers, depth, flow and zero visibility

Possible Solution

Use scanning technology to identify “anomalies” underwater, then have divers inspect only these locations

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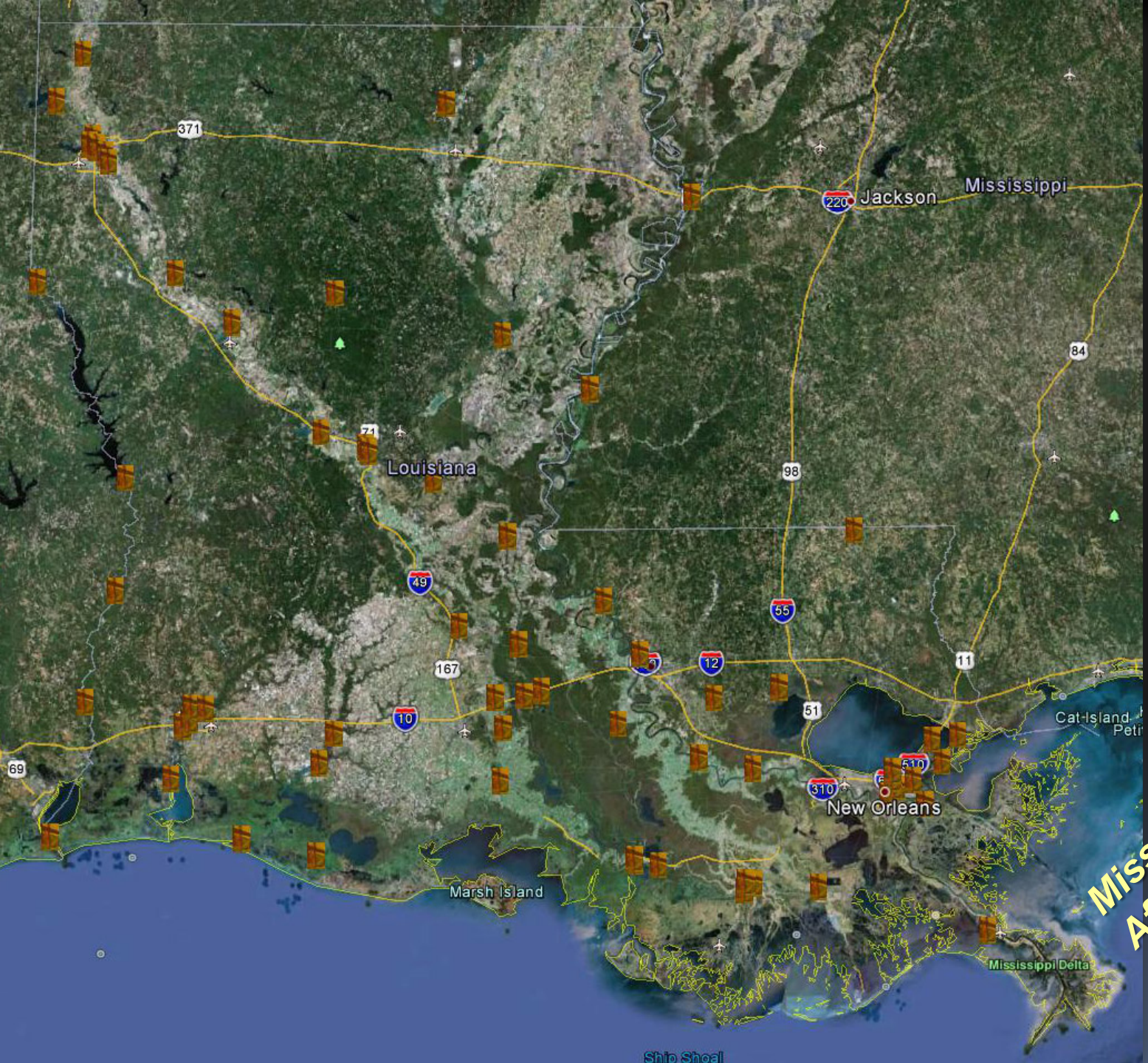


LOUISIANA'S ON THE MOVE...
DOTD
BUILDS THE WAY

69 large river crossings located across the state

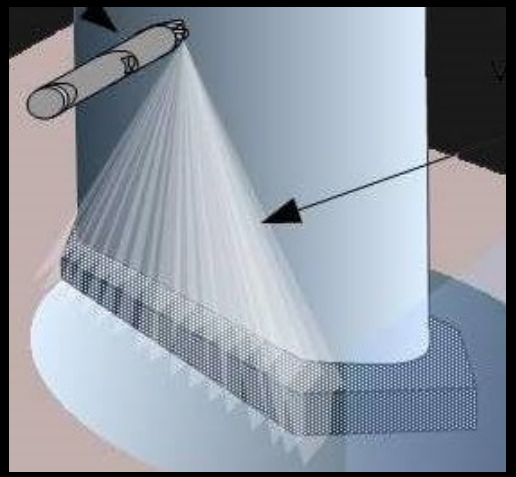
Mississippi River
Afchafalaya River
Red River
Calcasiue River
and others

Bridge Substructure Types

- *Caisson founded on monolithic piers*
- *Pile-supported spread footings with columns*
- *Drilled shafts*
- *Pile-supported waterline and above water footings*

Currently Available Remote Sensing Technology

Underwater Acoustic Systems



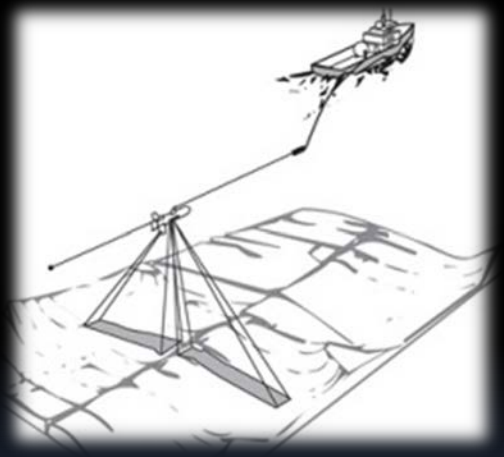
Steered Beam Sonar

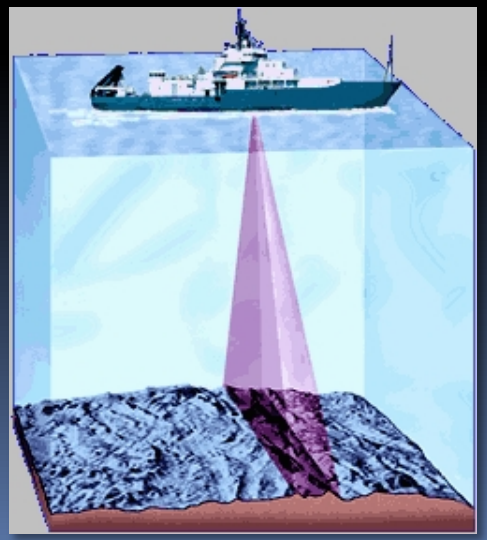
Optimal for vertical structures

Currently also the most cost effective

Side Scan Sonar

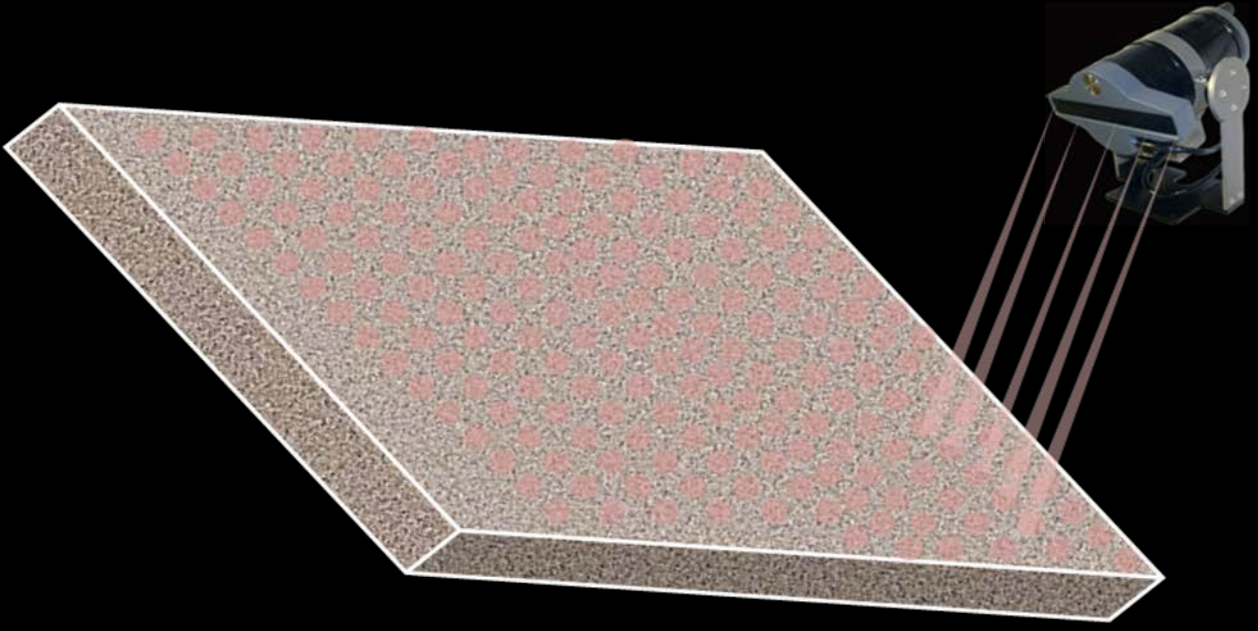
Not applicable for vertical structures





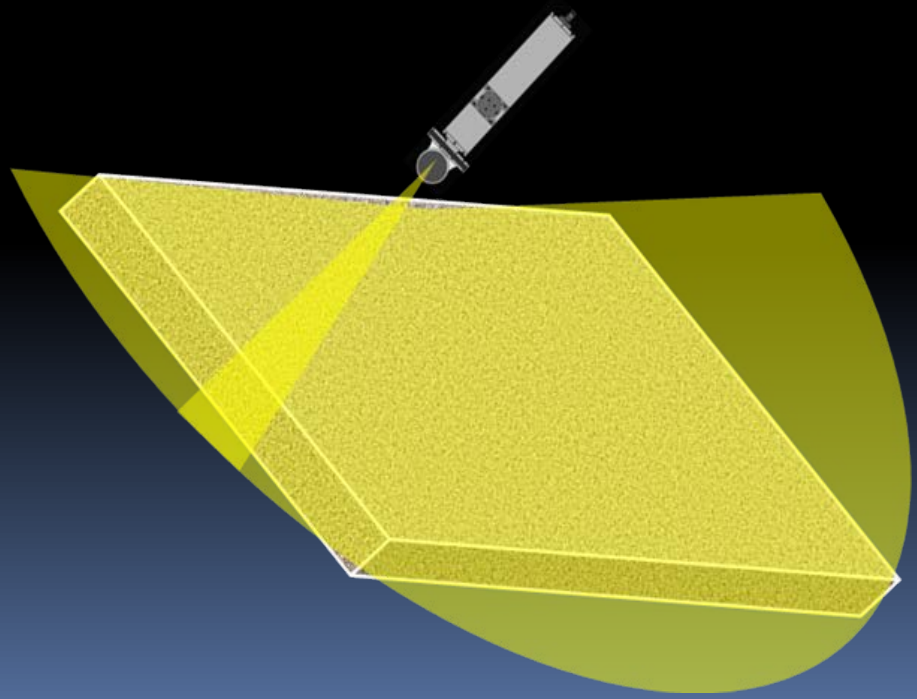
Multibeam Acoustic Systems

Can be adapted to vertical structures

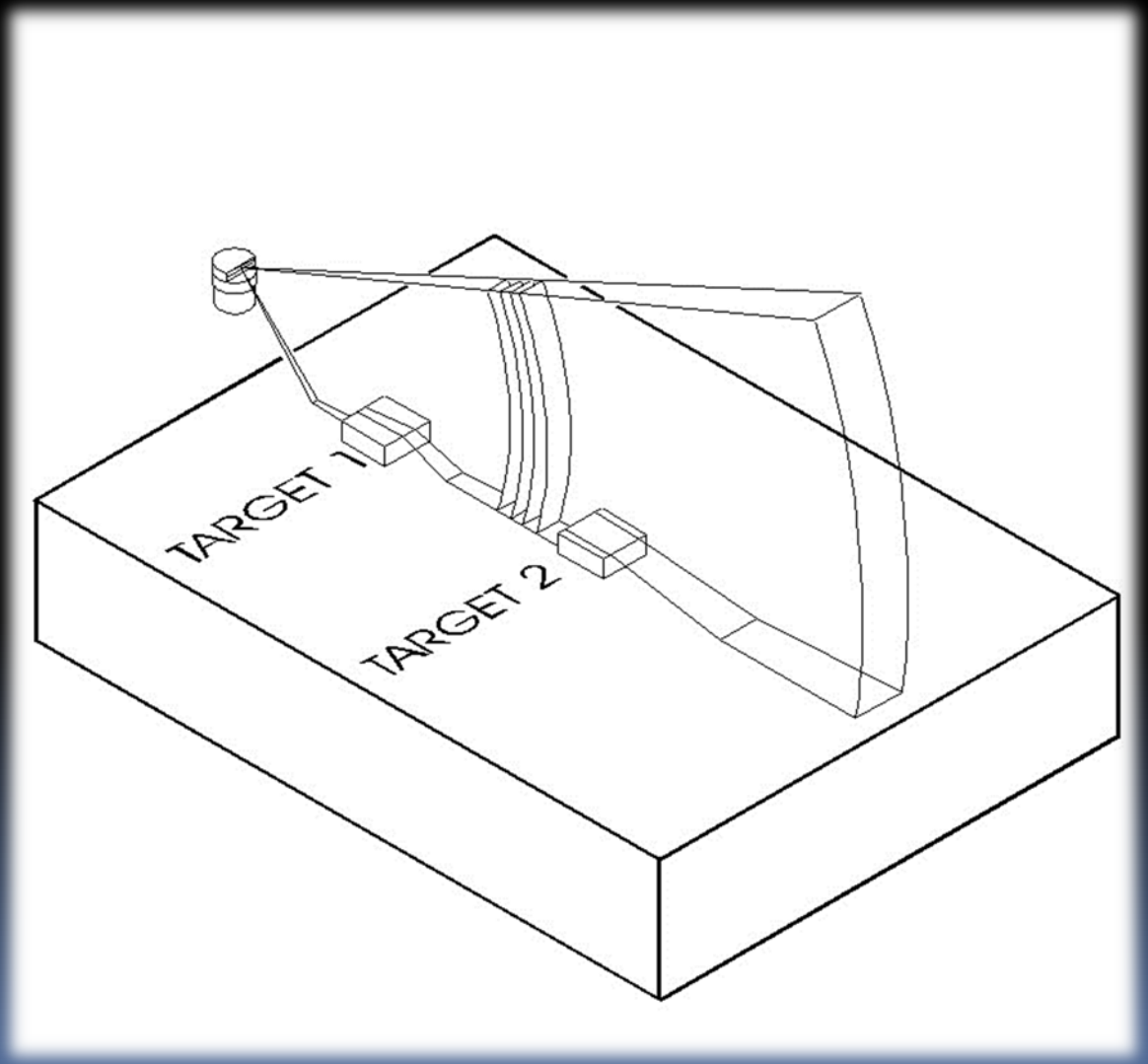


Multibeam record consists of multiple, discrete points corresponding to returns mapped at each transducer

Mechanically scanned sonar record consists of a continuous record of amplitude reflections from the transducer to the scan range limit providing a seamless image translation



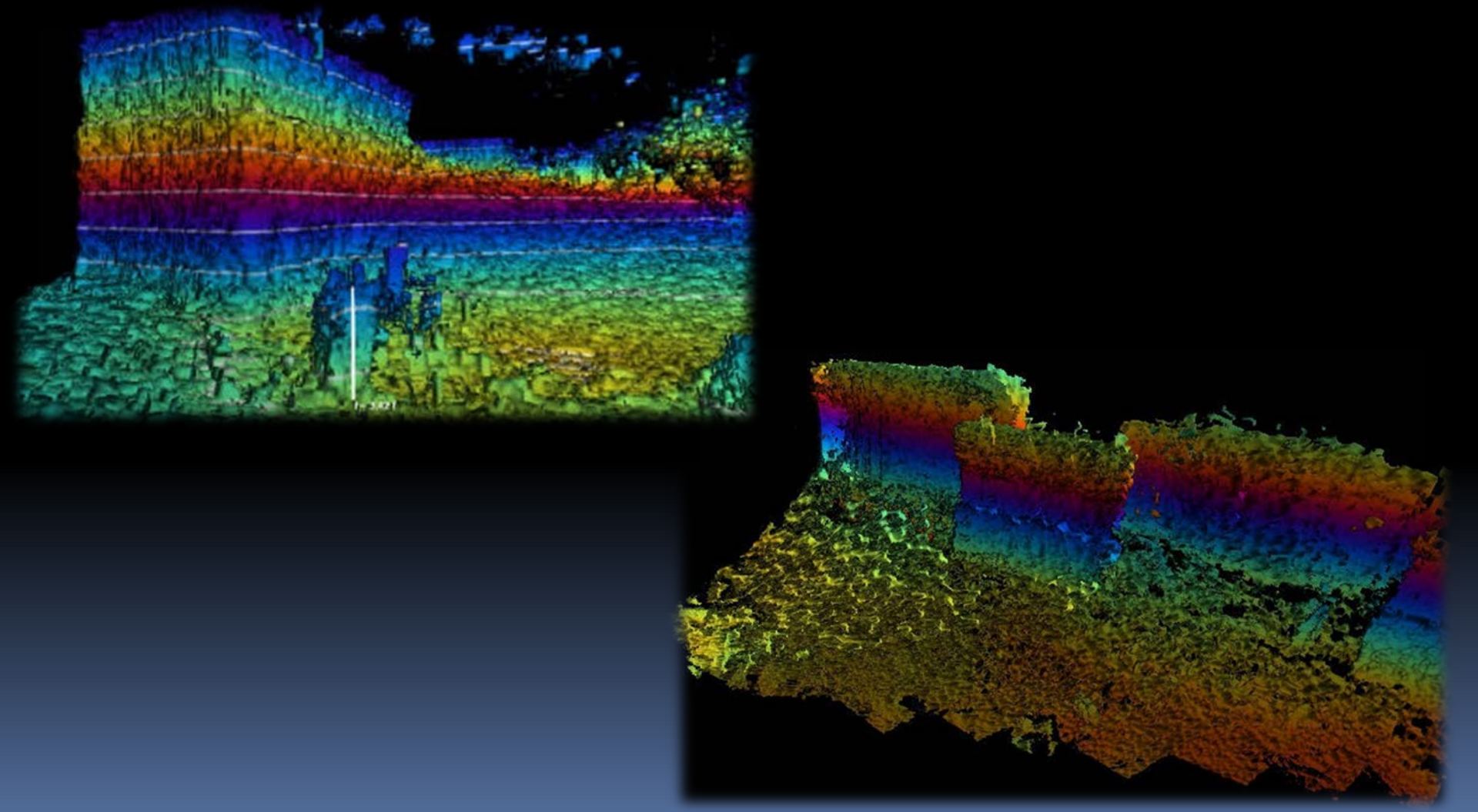
Mechanically Scanned Sonar Surface Mapping Methodology



Returns recorded from each ping to the extent of the range limit

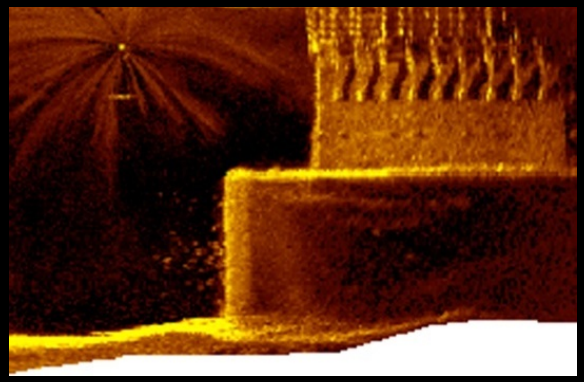
Imagery Generated with a Coda Echoscope Multibeam System

Courtesy of CodaOctopus

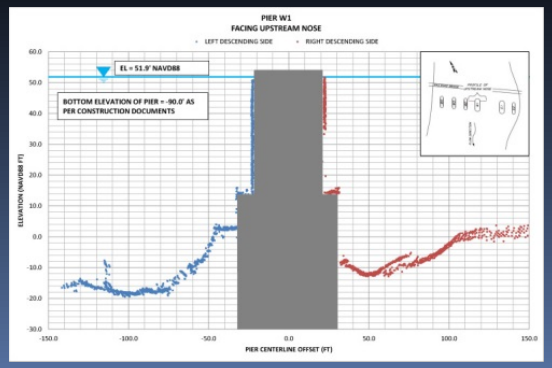


Steered Beam Acoustic Remote Sensing Systems Utilized for Acoustic Imaging & Profiling

Provides the best results over a wide range of conditions

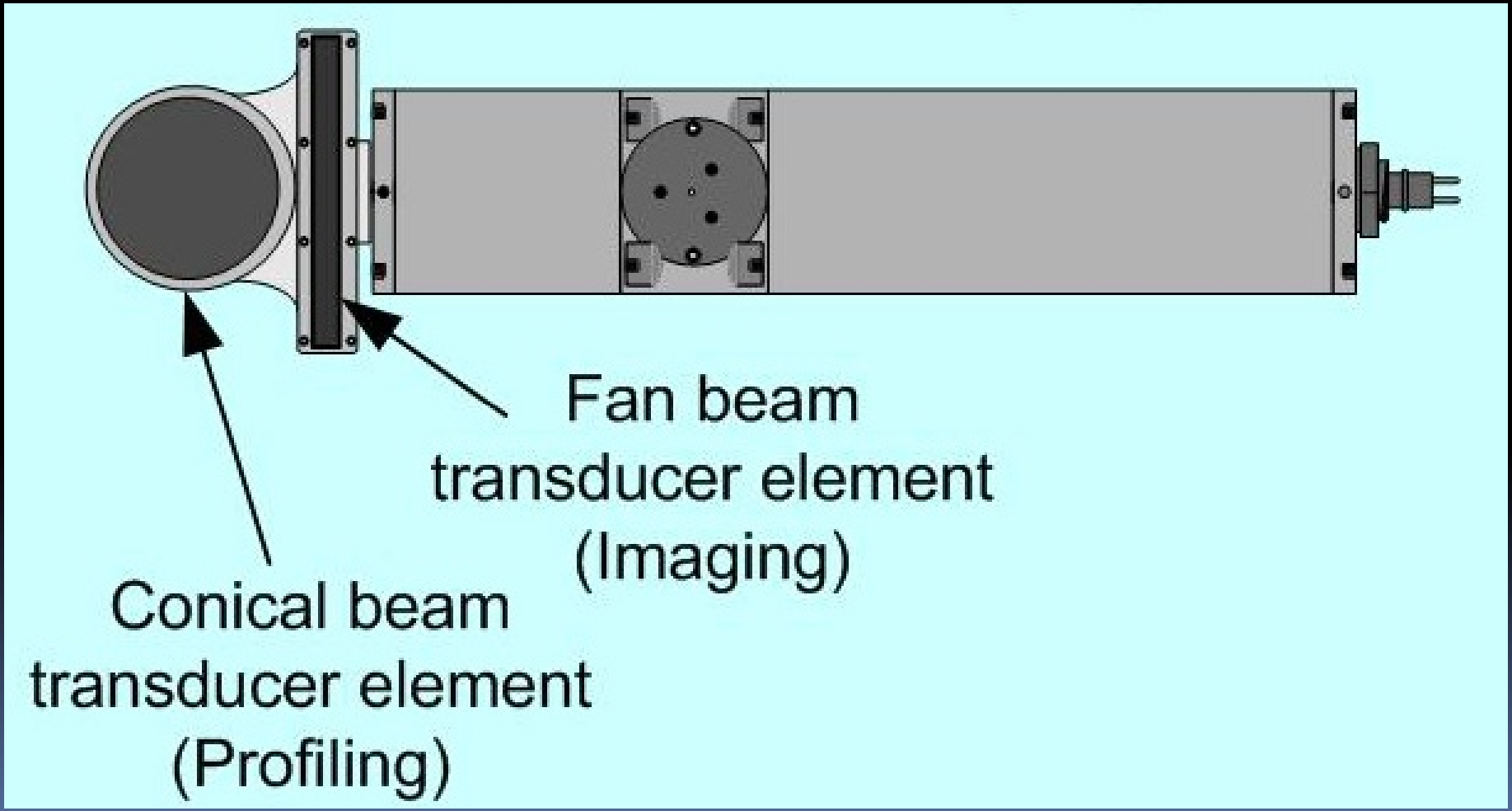


Dual element system, optimized for high turbidity, high flow environments providing imagery visualization and profiling metrology



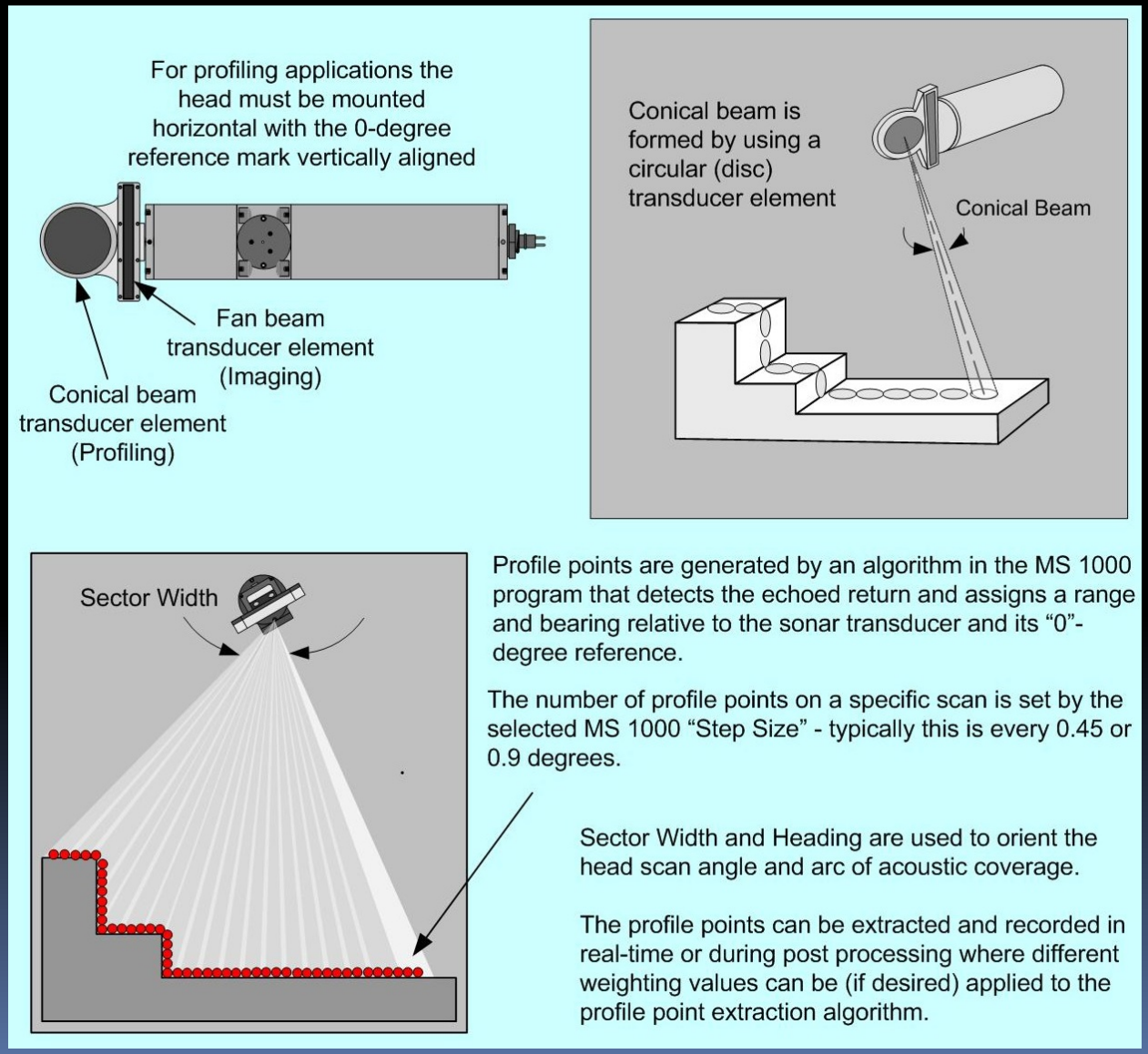
Dual Element – Multi-axis Steered Beam Remote Sensing Unit

Based on A Kongsberg Mesotech MS1000

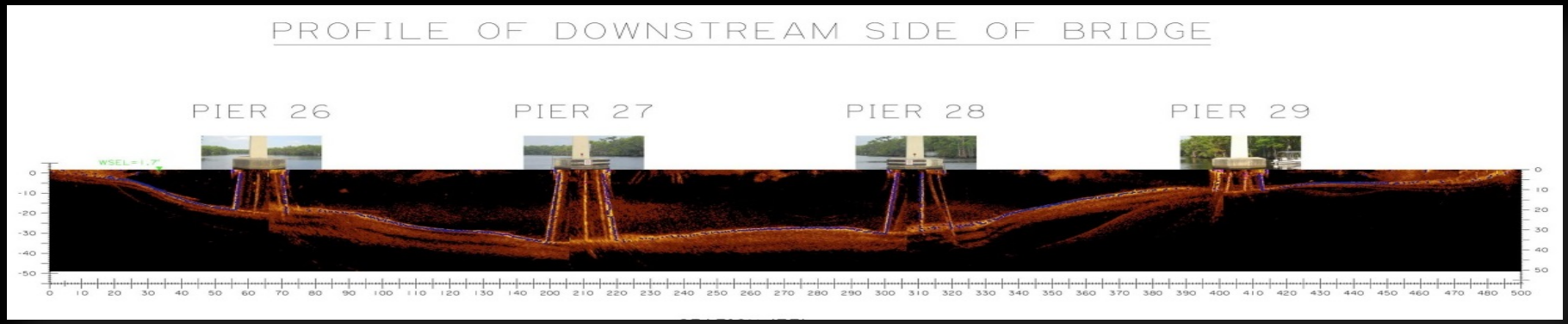


Acoustic Profiling Patterns and Achievable Resolutions

Acoustic profiling system footprint and methodology



Typical Profiling Data Results: Comprehensive Cross Channel Representation



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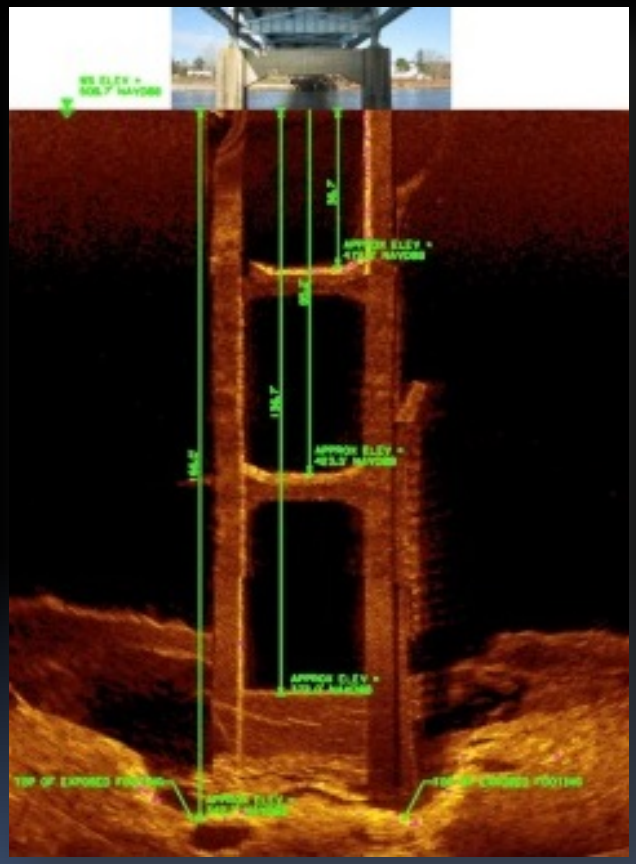
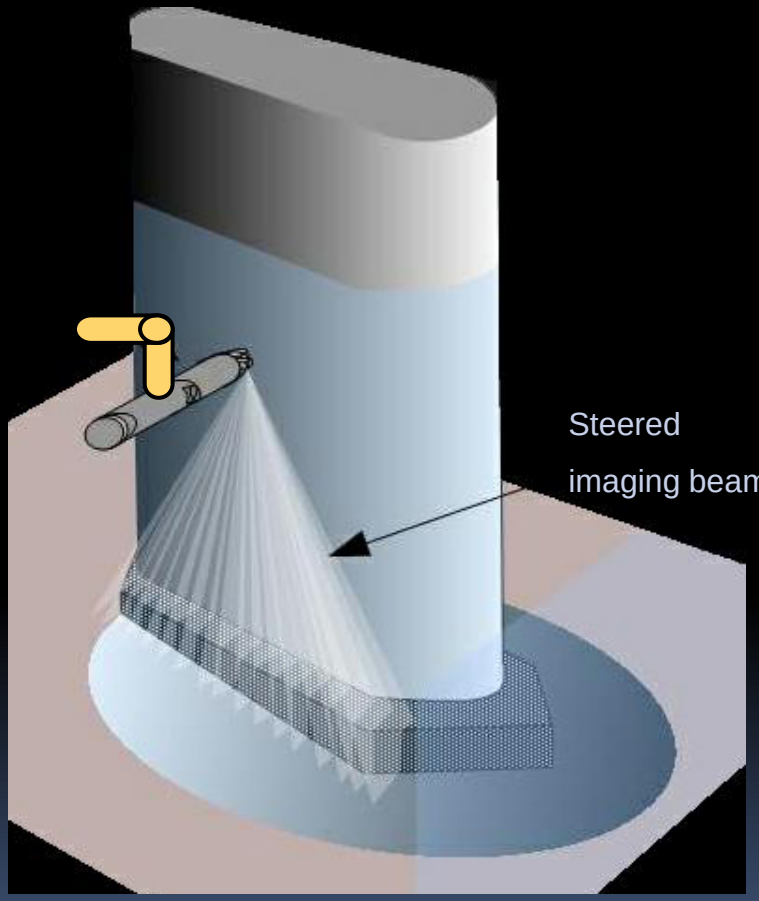
Steered Beam Sonar

Integration of multi-axis steered platform, position and tracking Instrumentation is key to providing optimal visualization results



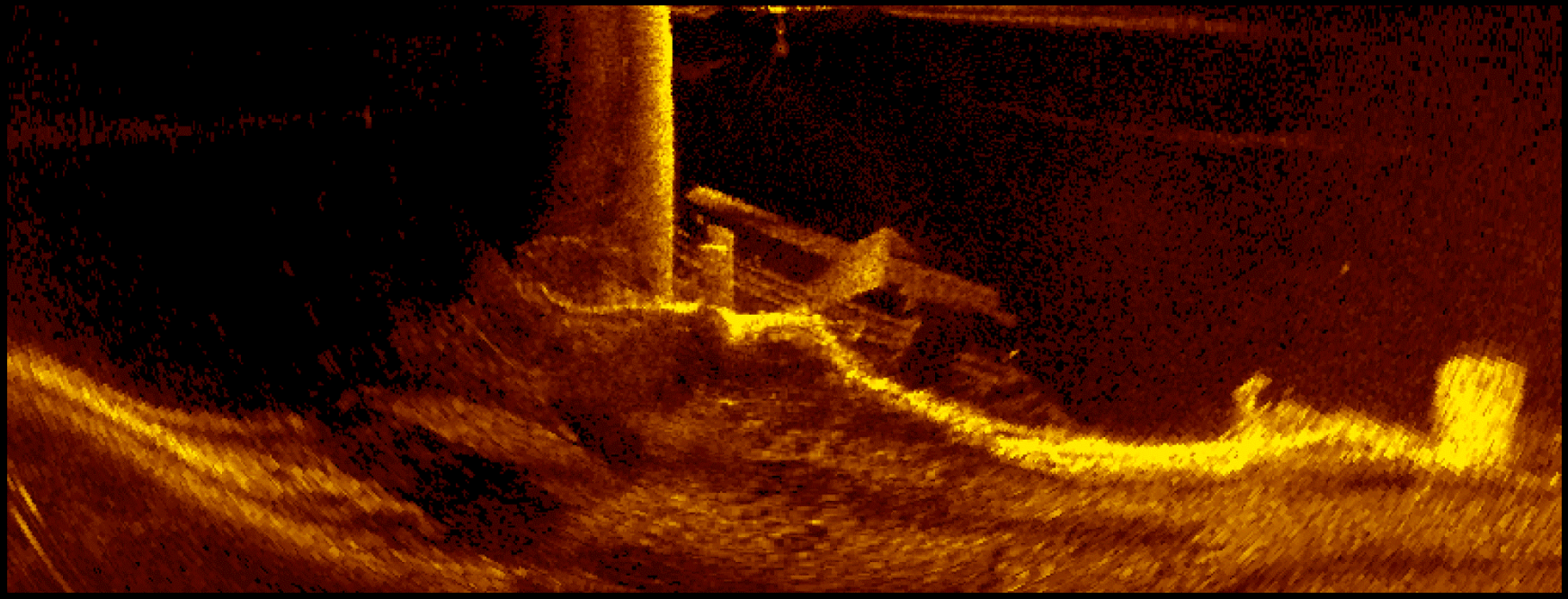


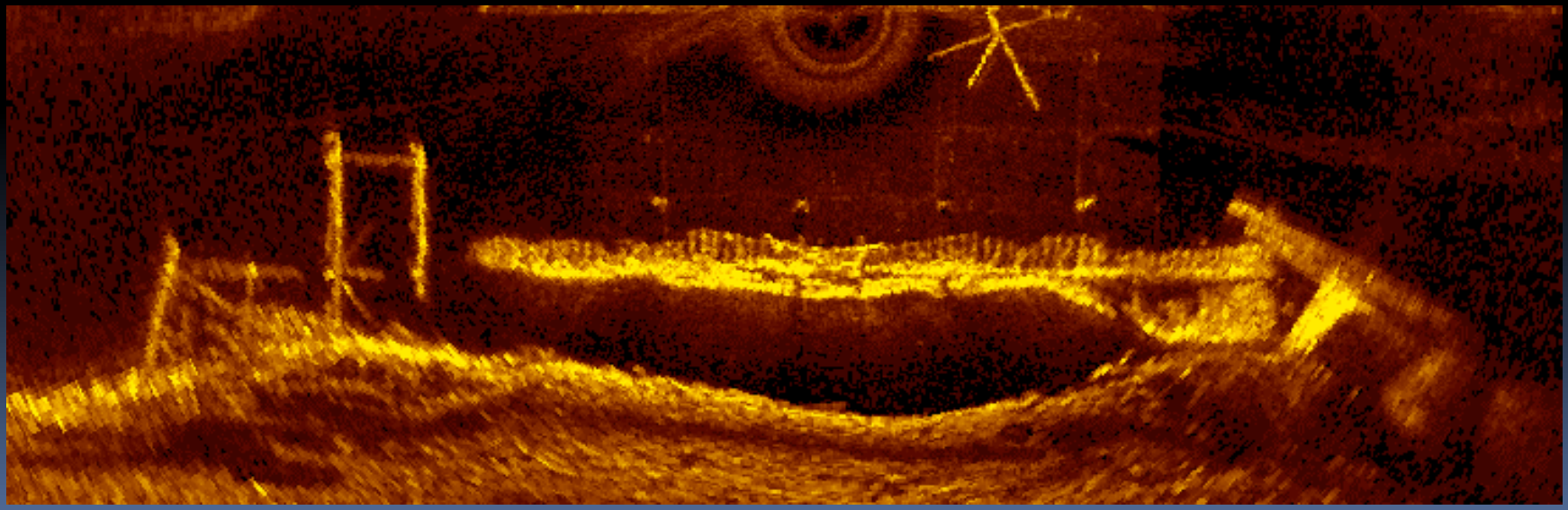
Visualization is accomplished by utilizing steered, fan acoustic beam, which is multi-axis steerable

Evaluation Procedures for Underwater Acoustic Imaging and Diving

- Step 1 - Perform the UAI inspections on bridges
- Step 2 - Construct sonar visualization mosaics and water bottom profiles
- Step 3 - Review results of UAI and identify “anomalies” warranting further investigation
- Step 4 - Perform follow-up diving investigations
- Step 5 - Generate final report comprised of all data and results

Example Sites





Customized Sensor Deployment Configurations

Boat deployment

Deep, high water current - deployment and maneuvering system

Tripod mounting for stationary, free standing deployment

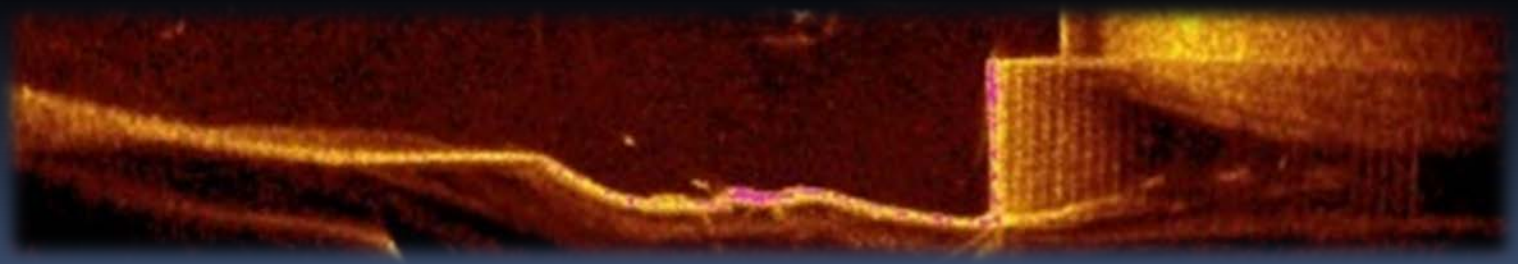
Mobile deployment and maneuvering system

Mississippi River

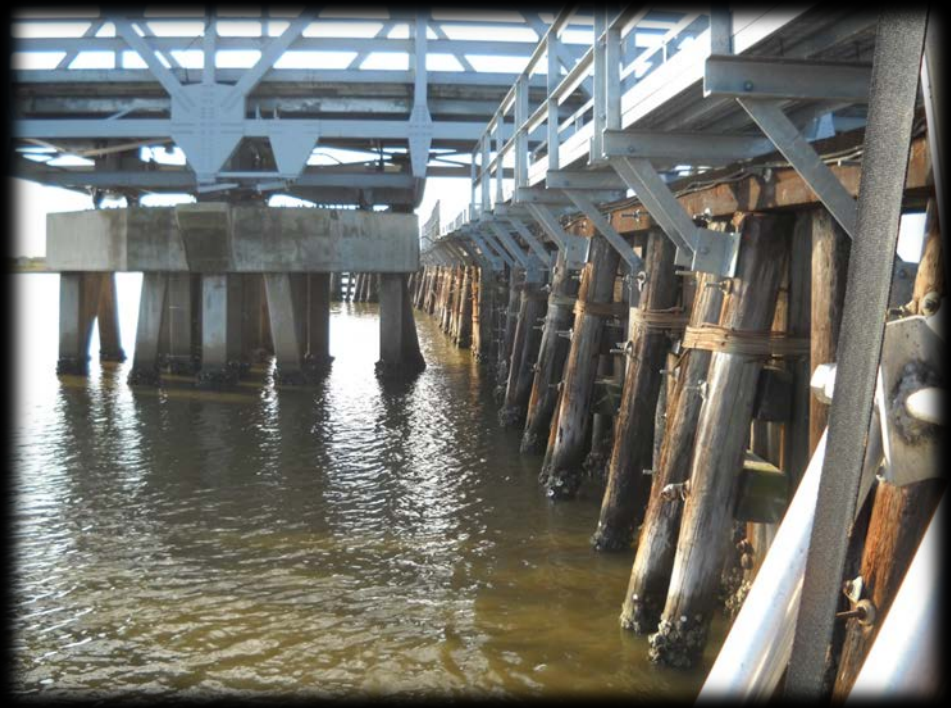
Scour and debris evident

Red River

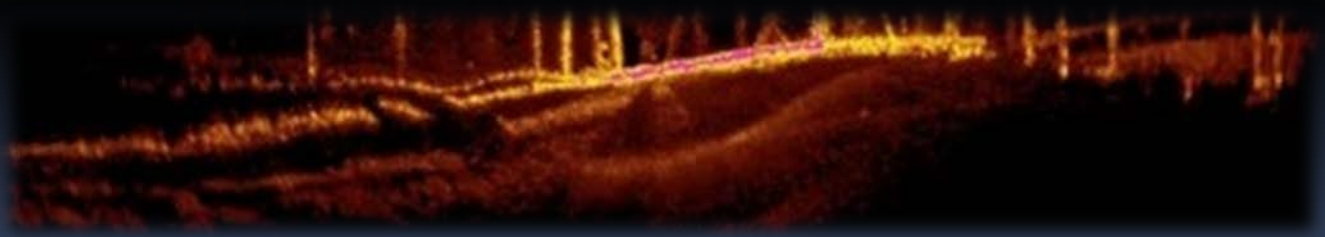
Localized scour and exposed sheet pile encasement shown



Mermentau River

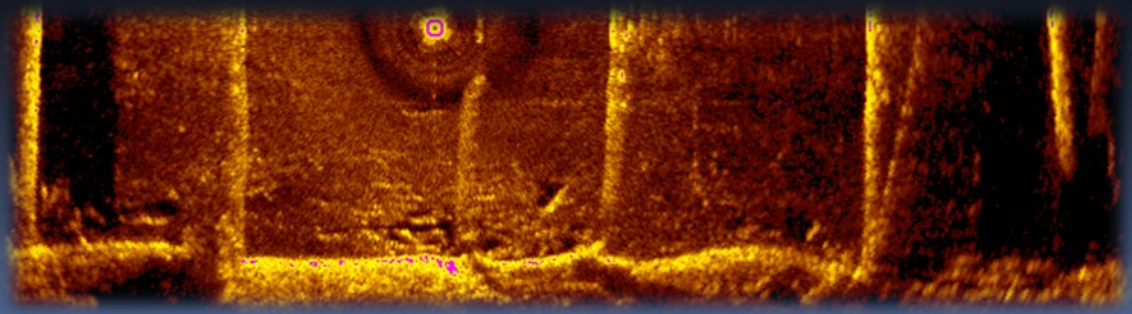


High density of closely spaced piles and close proximity of fender system produces difficulties for UAI effectiveness

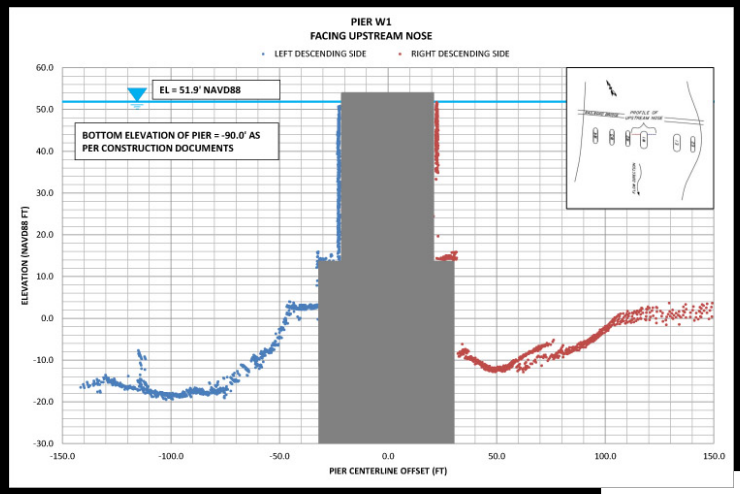


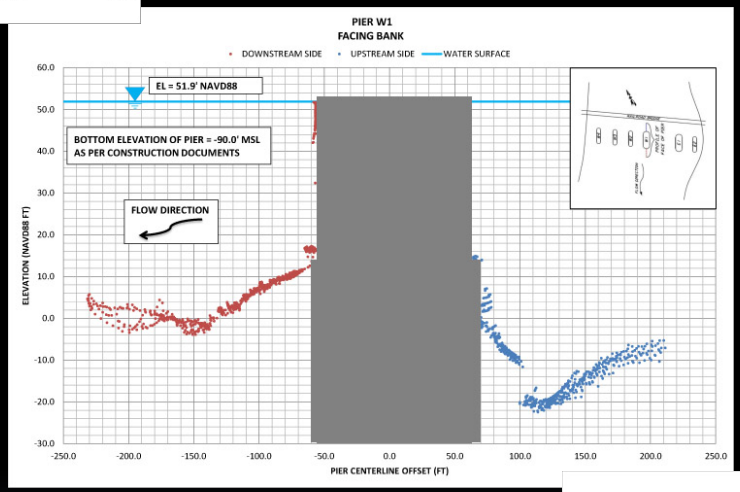
The Bayou Teche

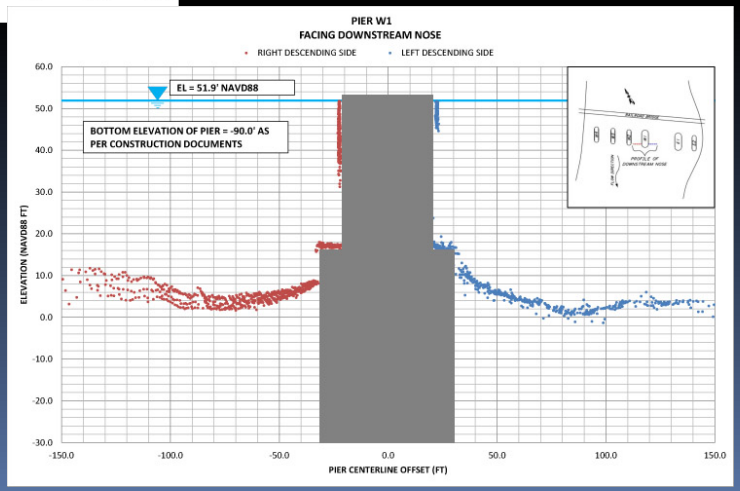
Very shallow and minor waterway; however, documents voids



Localized scour profile mapping







Analysis Review

Diving Inspections

- *Inspected “anomalies”*
- *Verification of procedure*

Results and Lessons Learned

- *Successfully scanned all bridges*
- *Dove on portions of all bridges*
- *Verified scanning with diving*
- *Documented scour*
- *Provided comprehensive reports on all bridges*

Results and Lessons Learned

<u>UAI worked well and very useful for:</u>

- *Bridges with massive piers*
- *High flow combined with significant depth*
- *No visibility with significant debris*
- *Significant scour and need to document*
- *Significant, close proximity commercial vessel traffic combined with any of the above*

Results and Lessons Learned

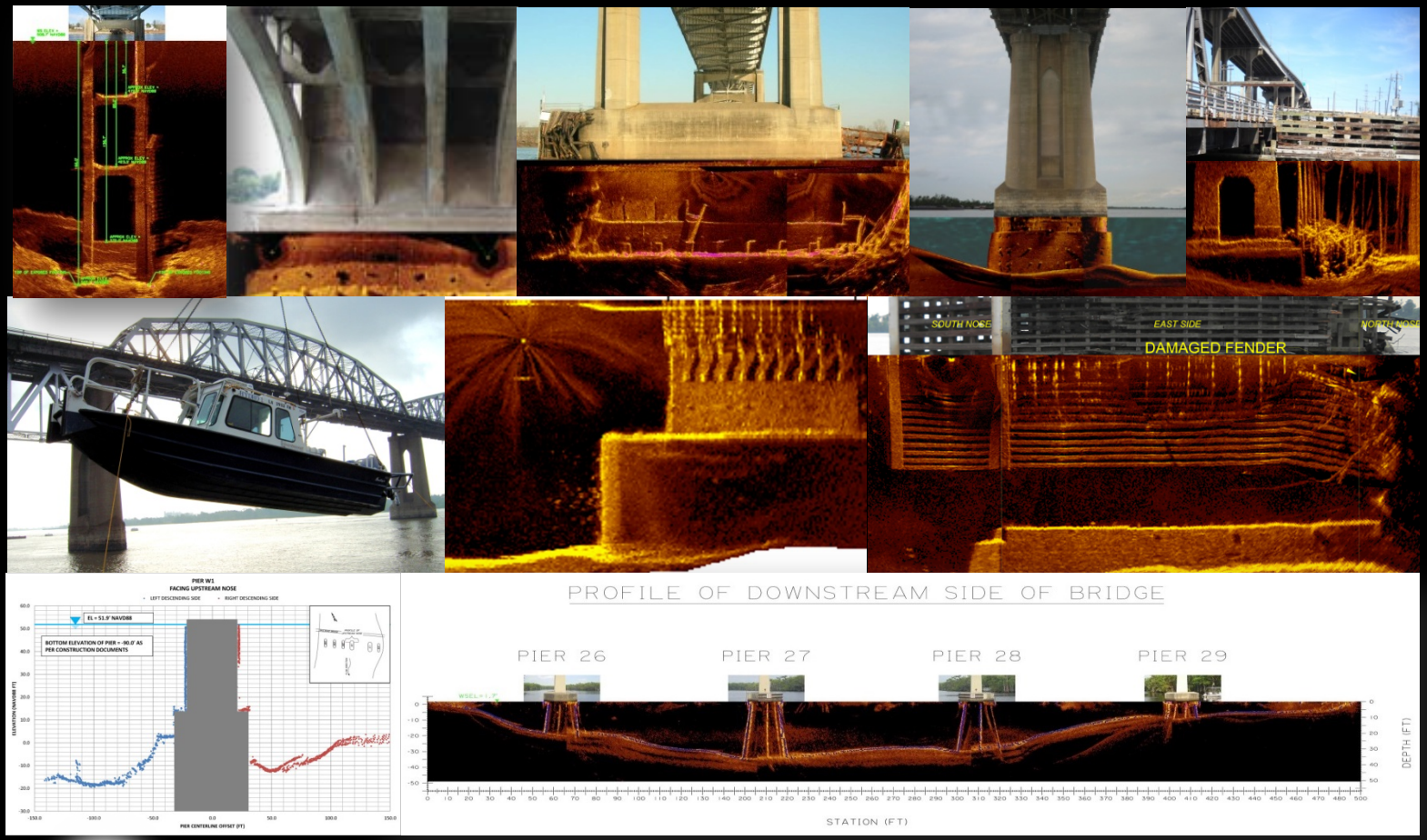
<u>UAI did not work well for:</u>

- *Waterline or above waterline footings with piles or drilled shafts below*
- *Shallow conditions <15’ especially without propensity for scour*

Benefits Provided by Underwater Acoustic Imaging

- *Comprehensive overall perspective*
- *Implementation in all environment conditions*
- *Visualization and metrology of localized scour conditions*
- *Added element of safety*

Questions?



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