



Extending the Operational Envelope of the UltraTEM Marine System

MR24-8267

Dr Stephen Billings

Black Tusk Geophysics Inc

In Progress Review Meeting

12-Jan-2026

Project Team



**Dr Stephen
Billings**
Black Tusk

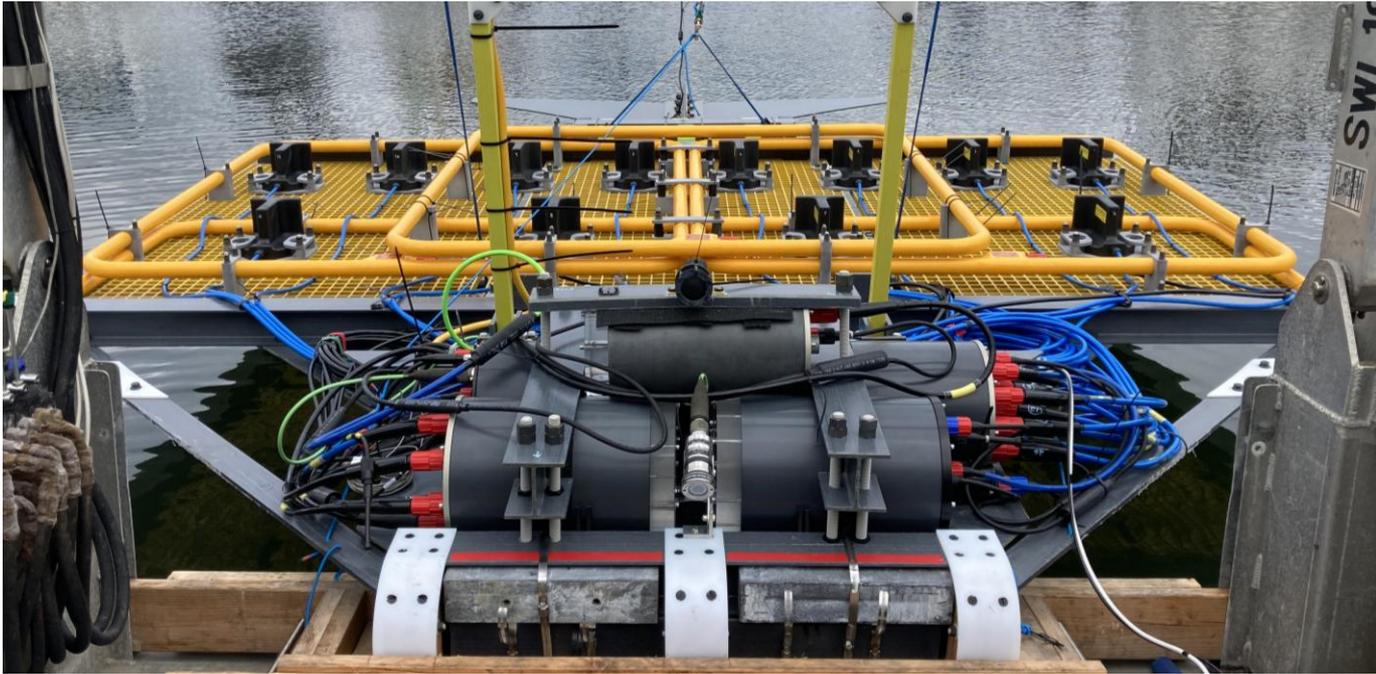
- Black Tusk Geophysics (Canada)
 - **Dr Stephen Billings**
 - David Lutes (Software engineer)
- Sea View Geophysical (USA)
 - **Matthew Cook (effectively a co-PI)**
 - Darren Linderman
- Gap Explosive Ordnance Detection (Australia)
 - Will Rowlands (Operations Manager)
 - Stephen Mitchell (Mechanical engineer)

Bottom Line Up Front

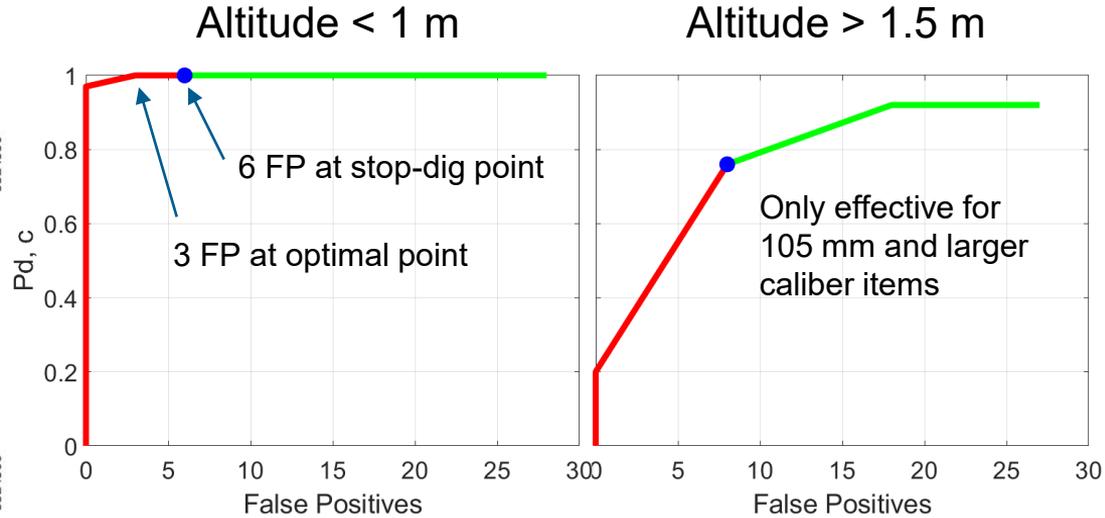
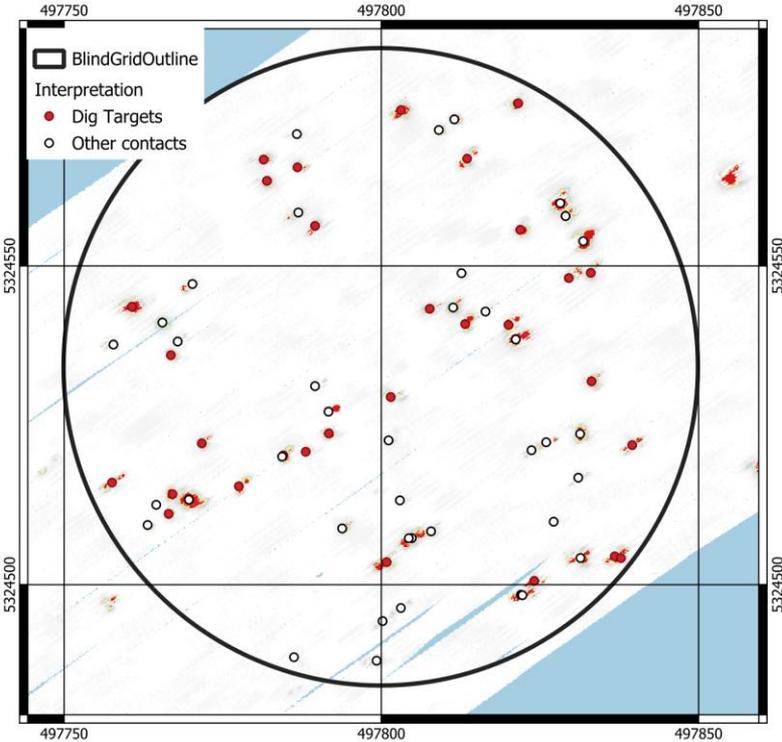
- In MR19-5073 we demonstrated the feasibility of Advanced Geophysical Classification in the marine environment using the UltraTEM Marine system at Sequim Bay
- Demonstrations were performed in protected waters without any complications due to swell, winds or waves
- This project aims to extend the operational envelop of the system with scope for two demonstrations



UltraTEM Marine: Layout



2022 Sequim Bay Blind-Grid



Extending the Operational Envelop of the UltraTEM Marine



Other related work



- Production project in 2024 at Kodiak Island
- Returning for more work in April 2026
- ESTCP MR25-8926: Live site demonstration in San Diego Harbor



- Shallow water system deployed from minimum metal pontoon boat
- Two large production projects in 2024
- Transect survey in 2025 (~90 miles)

Technical approach

1. Shallow water demonstration

- Use existing equipment
- Test ROTV system and control
- Verify ability to collect low-noise EMI data



2. Deep-water system

- Build custom Active Heave Compensated Winch
- Build deeper water ROTV using lessons learned from Task 1



4. Offshore demonstration

- Use vessel of opportunity
- Site subject to ocean swell
- Verify ability to keep tow-fish close to the sea-bottom



3. Extended shakedown testing

- Phase 1: Basic handling
- Phase 2: Offshore dummy load
- Phase 3: Offshore full system

Original proposal

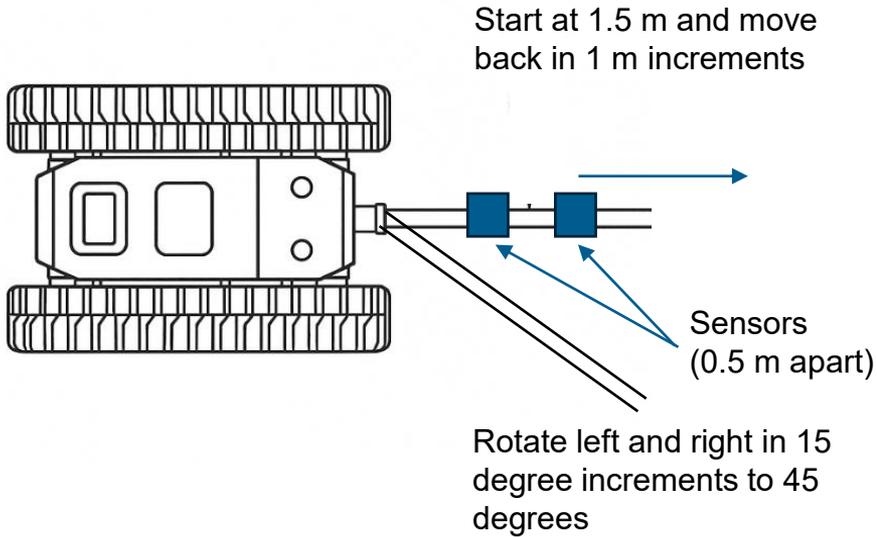
Shallow water: 1.2 to 6 m (4 to 20 feet)



Changed scope to focus on: Surf-zone crawler towed system

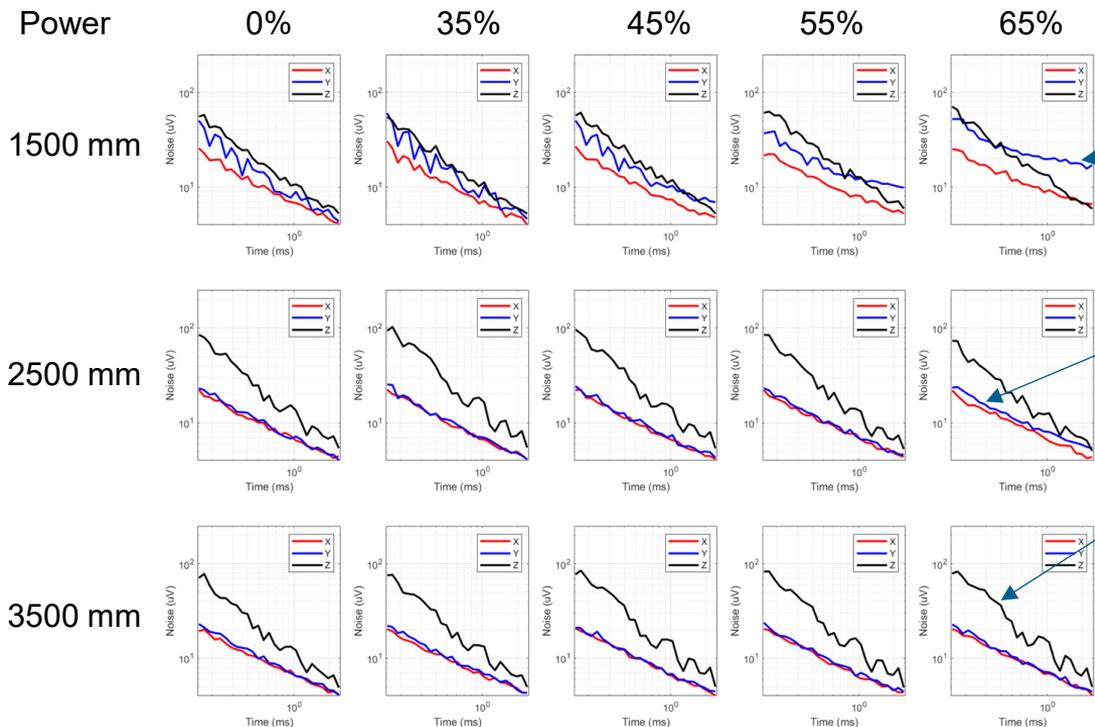


SurfRover: Standoff distance tests



Noise characteristics

Example noise plot



Y-component very noisy at close standoff and increases with crawler power

X- and Y-components comparable

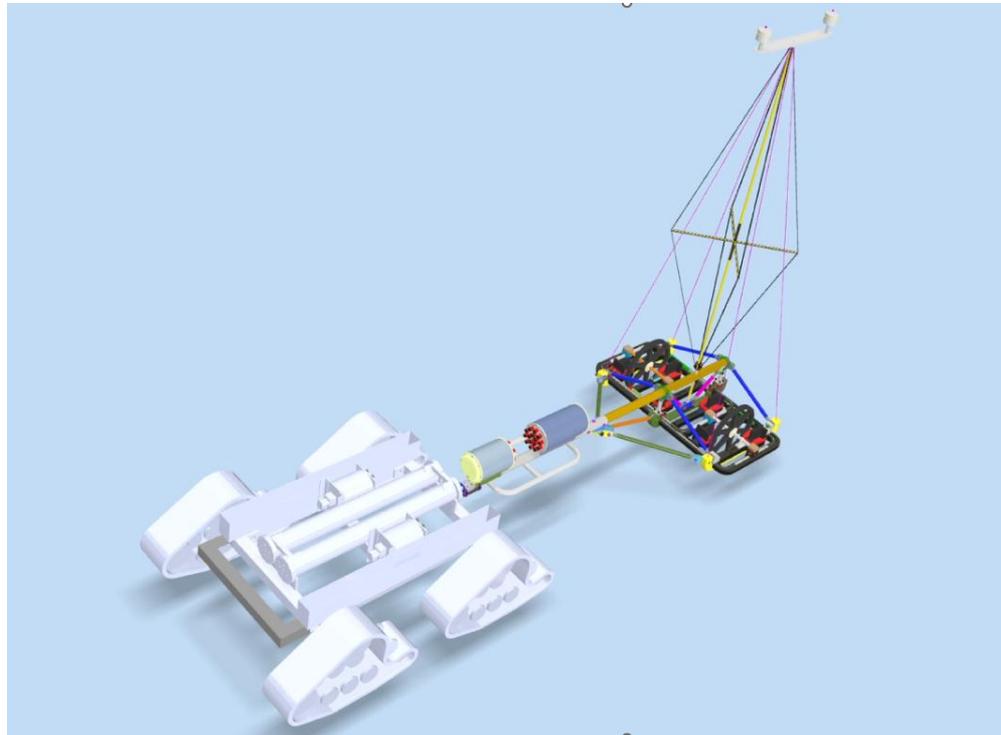
Z-component always noisy (ambient electrical noise in car-park)

Selected a 2.7 m (~ 9 foot) standoff between tow-hitch and leading edge of transmitter

Towed-array for surf-zone



With wheels and electronics attached



Project schedule

Task	2024 Q3/Q4	2025 Q1/Q2	2025 Q3/Q4	2026 Q1/Q2	2026 Q3/Q4	2027 Q1/Q2
Shallow water system	Build	Build	Duck	Duck		Demo
Offshore system development (complete)		Build	Build			
Offshore system extended shakedown			Michigan	Florida		
Offshore system demonstration					Demo	Report

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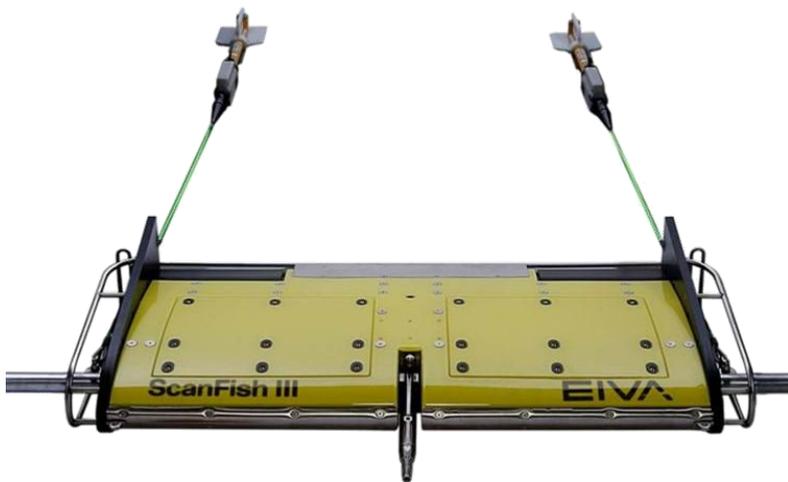


3. Extended shakedown testing

- Phase 1: Basic handling
- Phase 2: Offshore dummy load
- Phase 3: Offshore full system

Slow survey speed = low-speed ROTV

- ROTV / tow-depressor like the ScanFish Katria
 - Requires high towing speed of 4 to 6 knots
- Custom tow-fish with control surfaces



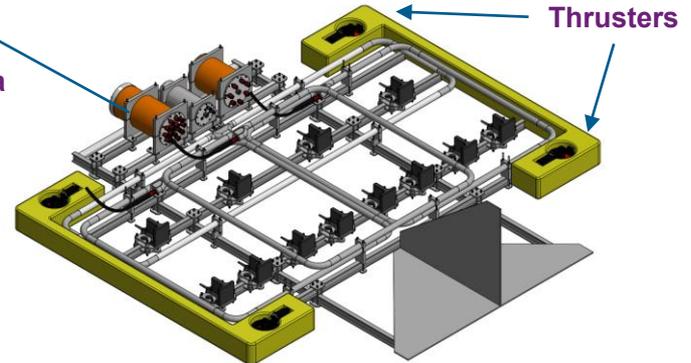
Deeper water: 6 m+ (20 feet +)



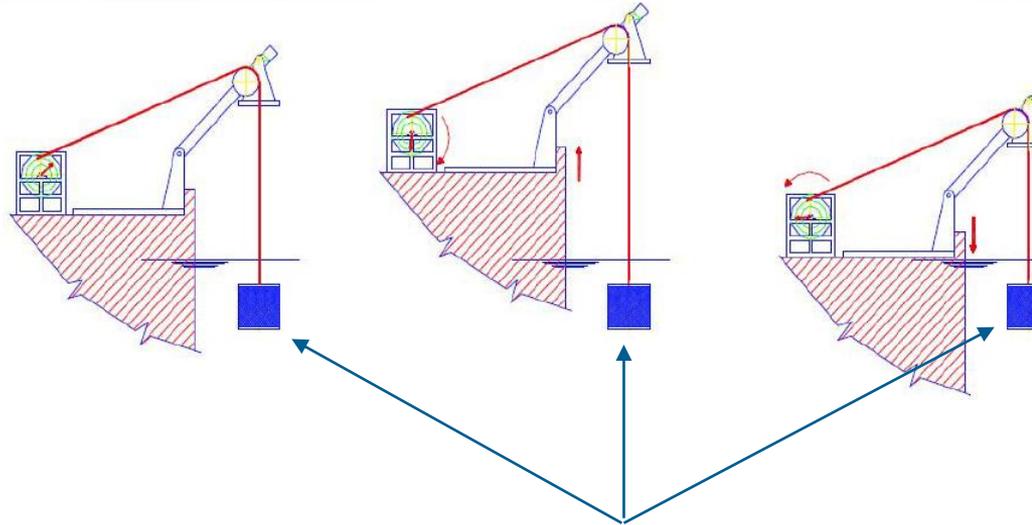
- Vessel of opportunity preferably with dynamic positioning capability & good low-speed control
- AHC Winch and controller
- GPS / AHRS / USBL
- Hypack Mapping software & Ardusub control software

- UltraTEM Marine system (3 Tx and 12 Rx)
- 3.8 m wide
- DWT-1 thrusters
- USBL / DVL / INS
- Large standoff distance

Tow-cable +
Power + Data



Heave compensated winch



Keep item at constant position regardless of heave

Tow platform height controlled by boat speed and length of cable

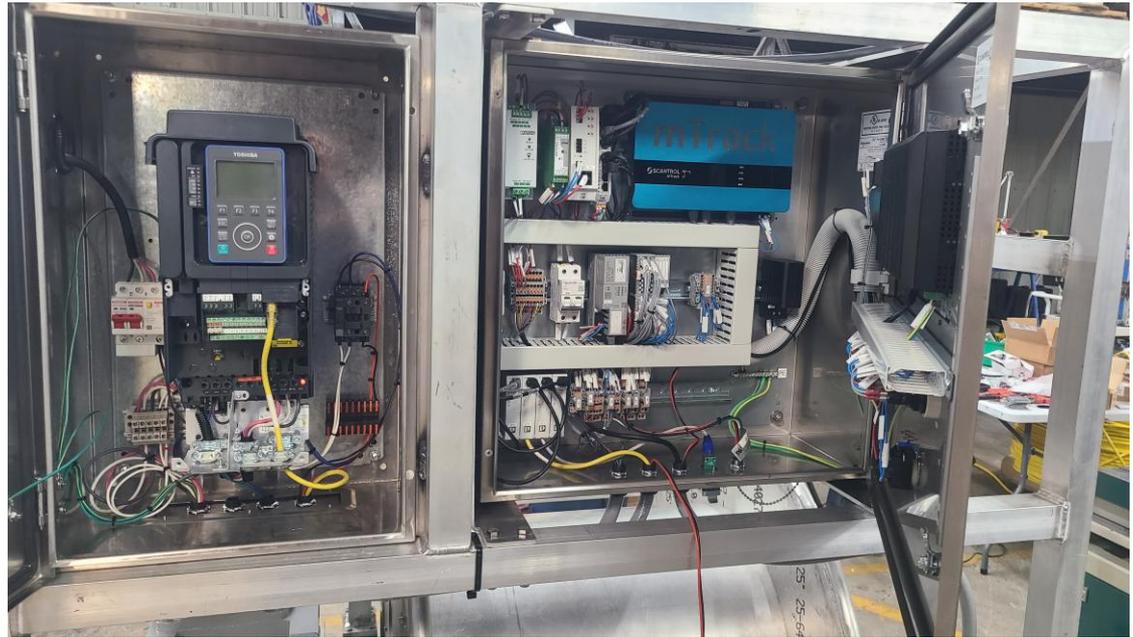
Custom Active Heave Compensated Winch

- SVG built a custom winch
- 7 – 10 kW Variable Frequency Drive
- Hybrid power and optical fiber umbilical with suitable strength member



Custom Active Heave Compensated Winch

- Scantrol mTrack AHC controller (Norwegian company)
- Built in Motion Reference Unit
- Well documented and proven track record of integrating the AHC controller with other control software
- Has a “Follow Sea-bed” mode



Active Towed-Array



Technical approach

1. Shallow water demonstration

- Use existing equipment
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Go/
No-Go

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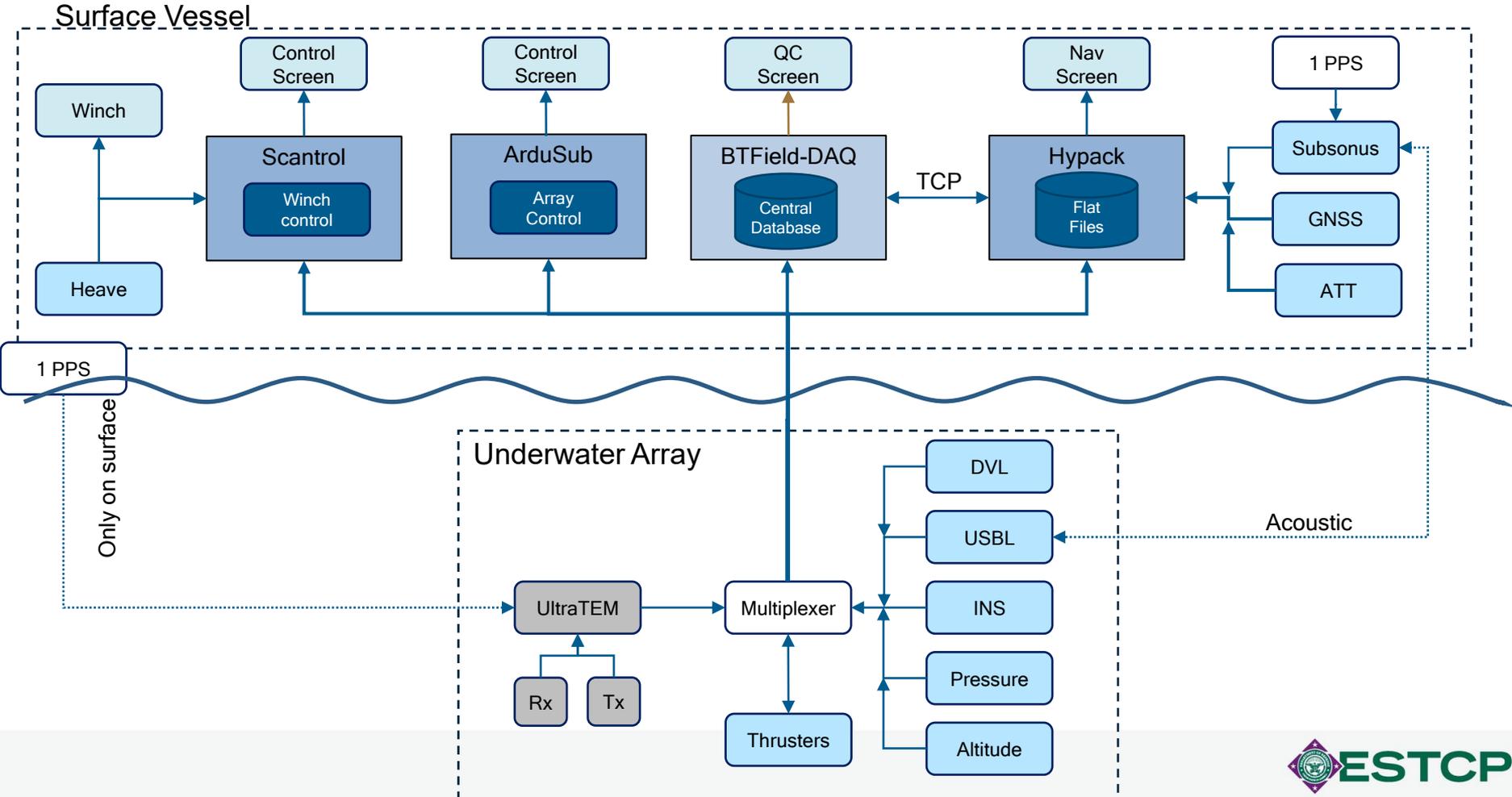
Go/
No-Go



4. Offshore demonstration

- Use vessel of opportunity
- Site subject to ocean swell
- Verify ability to keep tow-fish close to the sea-bottom

Offshore UltraTEM Marine system

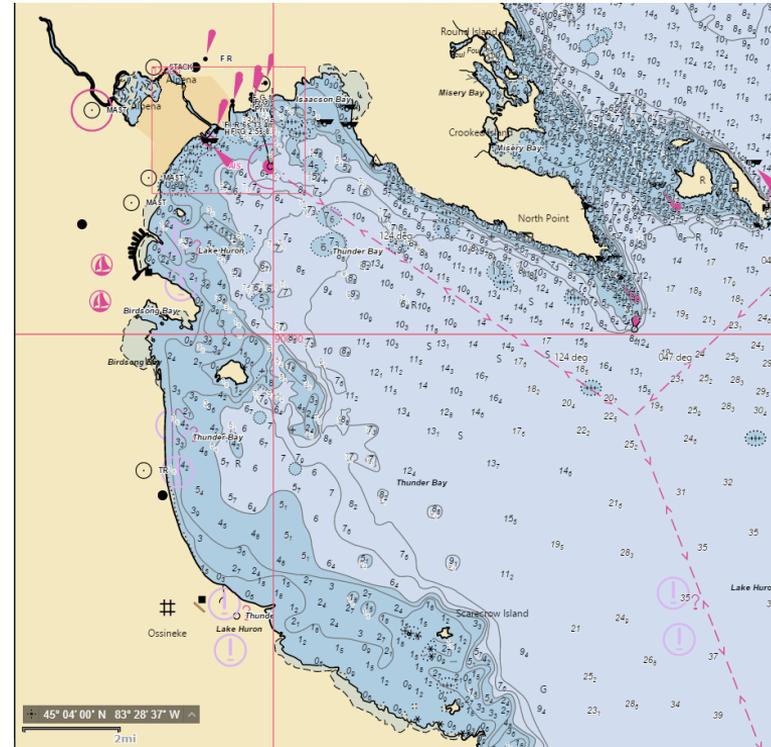


Extended shakedown testing goals

Item	Goal	Phases	Outcome
Active Towed Array Pitch/Roll control	PID control parameters <5 degree variation	1 & 3	
Active Towed Array Altitude control	PID control parameters <30 cm variation	1 & 3	
Active Towed Array Noise	Noise with thrusters < 2 x Seqium Bay	1 & 3	
AHCW heave	Compensate heave to sea-state 3	2 & 3	
AHCW bottom follow	Compensate heave and maintain altitude sea-state 3	2 & 3	
USBL/INS location accuracy	Calibrate USBL and maintain < 50 cm location accuracy	1 & 3	

Test Phase I: Basic handling

- Fresh-water test in Lake Huron near Alpena to confirm the operational characteristics of the system using the Geosearch pontoon boat
- ATA system and AHCW were tested separately
- Work was performed in August-early September 2025



Deployed on the Geosearch

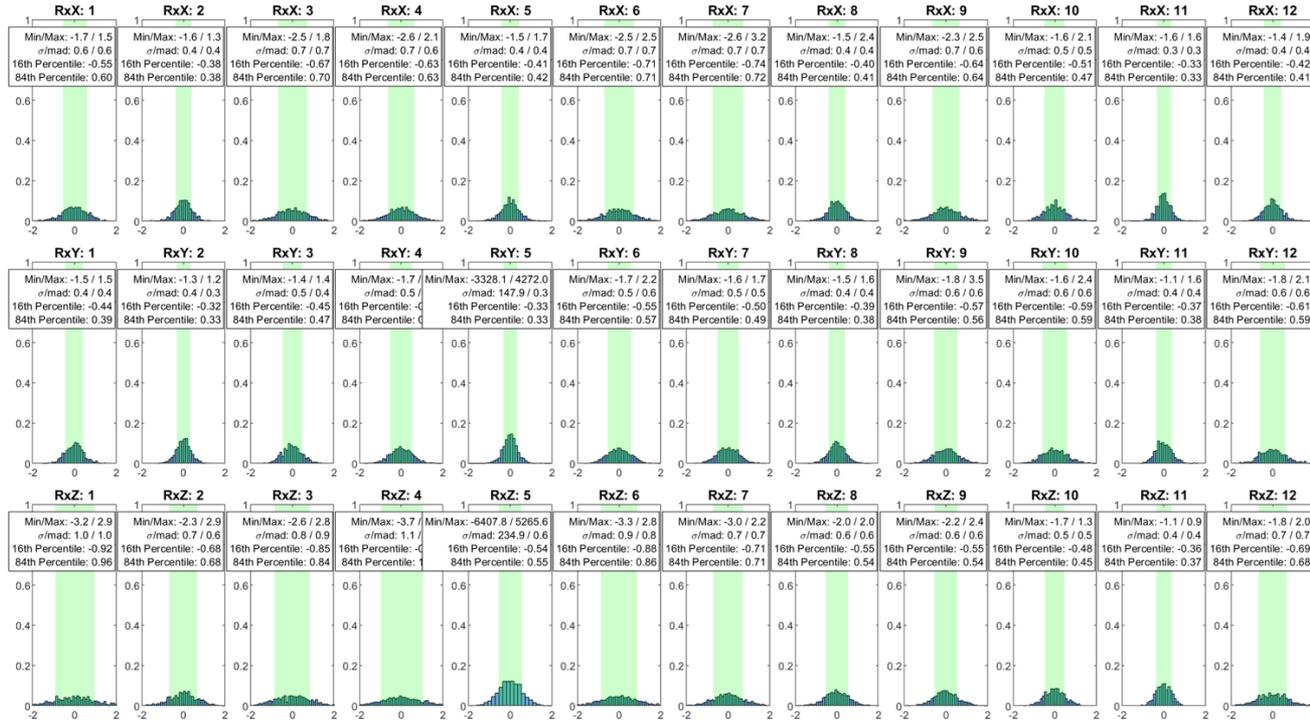


With Subsonus USBL



Noise performance: 2024 Array

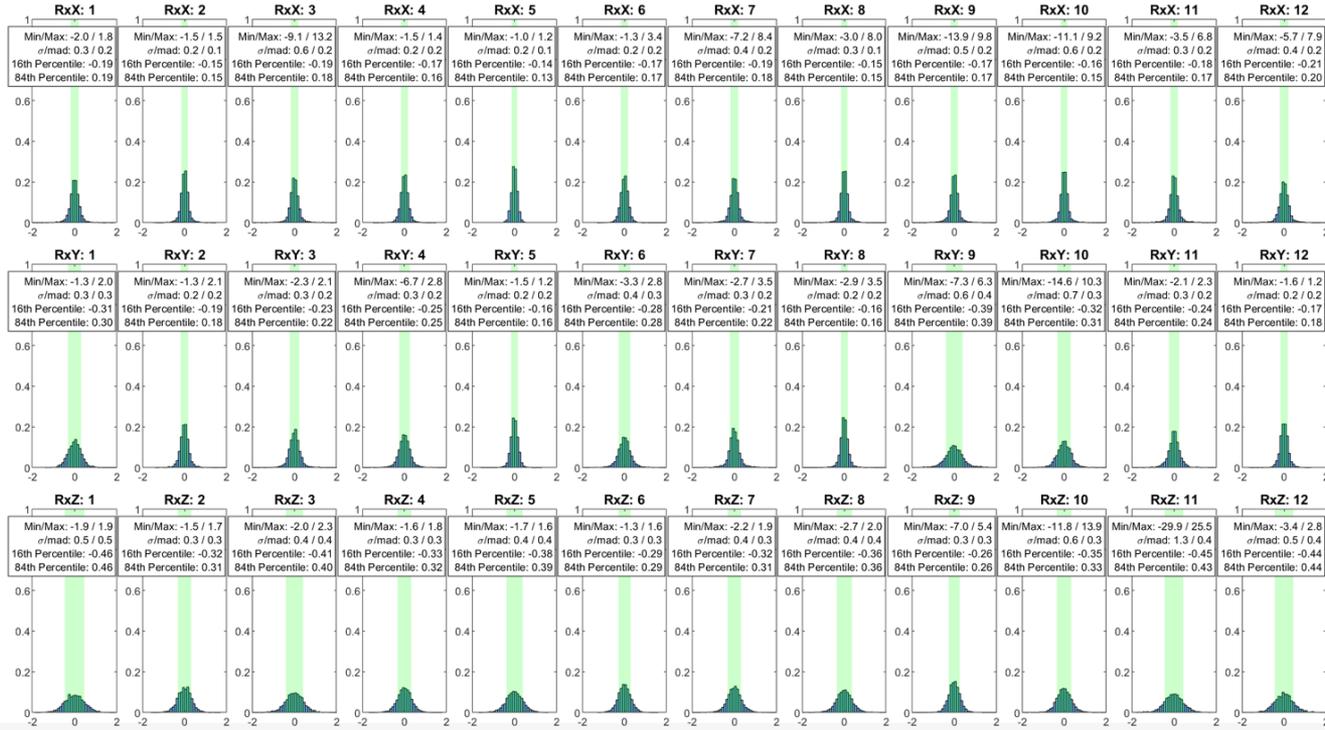
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Threshold: 1.00

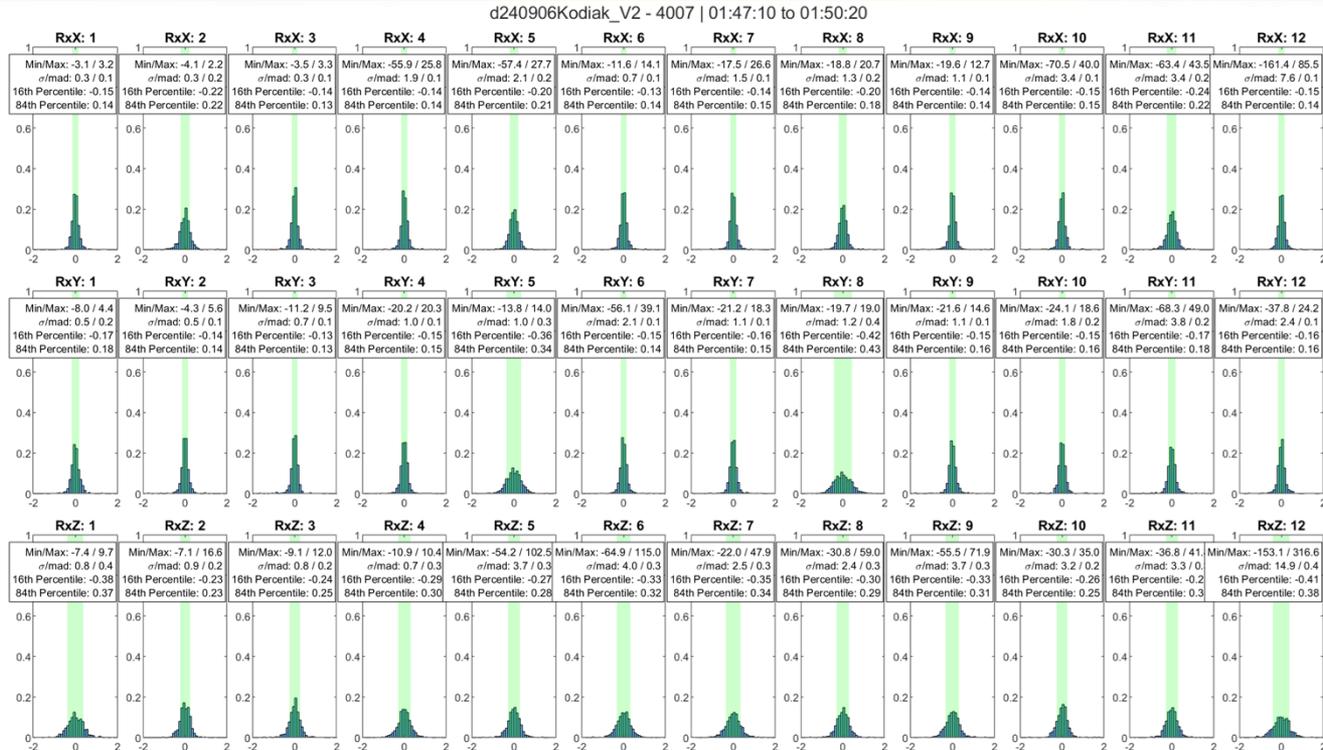
Noise performance: 2025 Array

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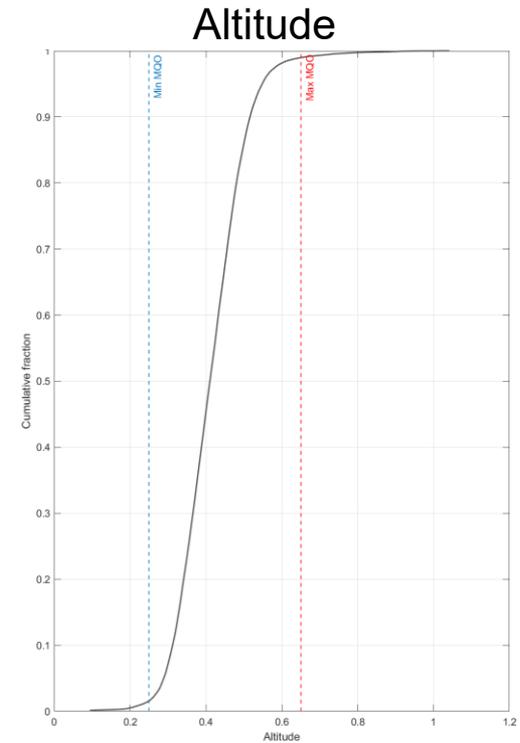
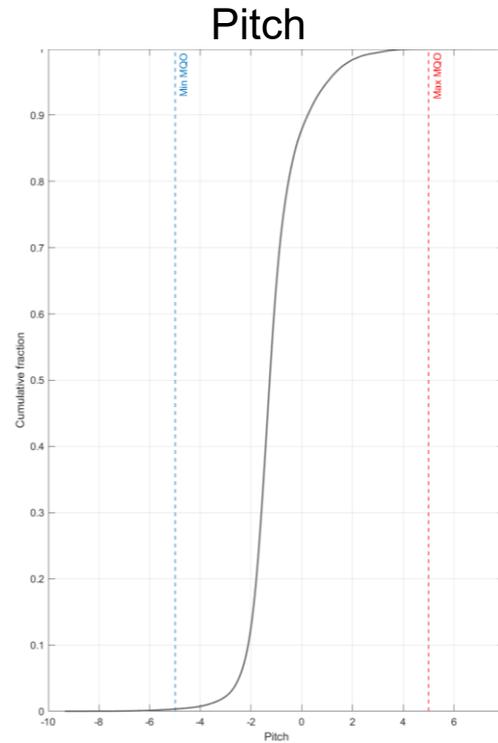
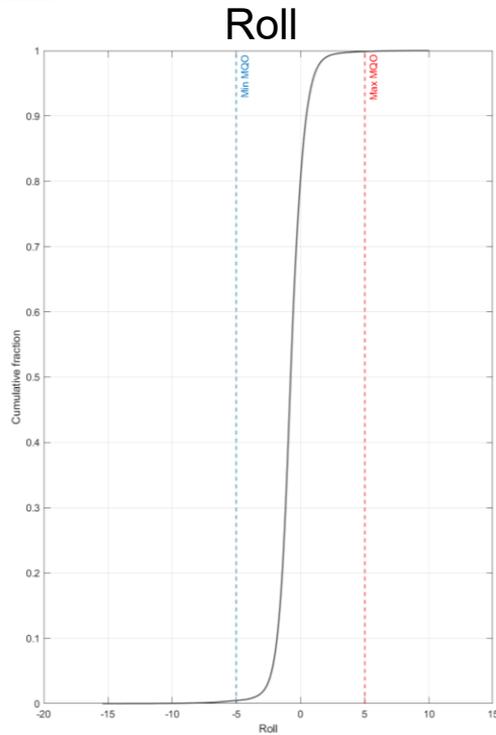
Threshold: 1.00

Noise performance: UltraTEMA platform

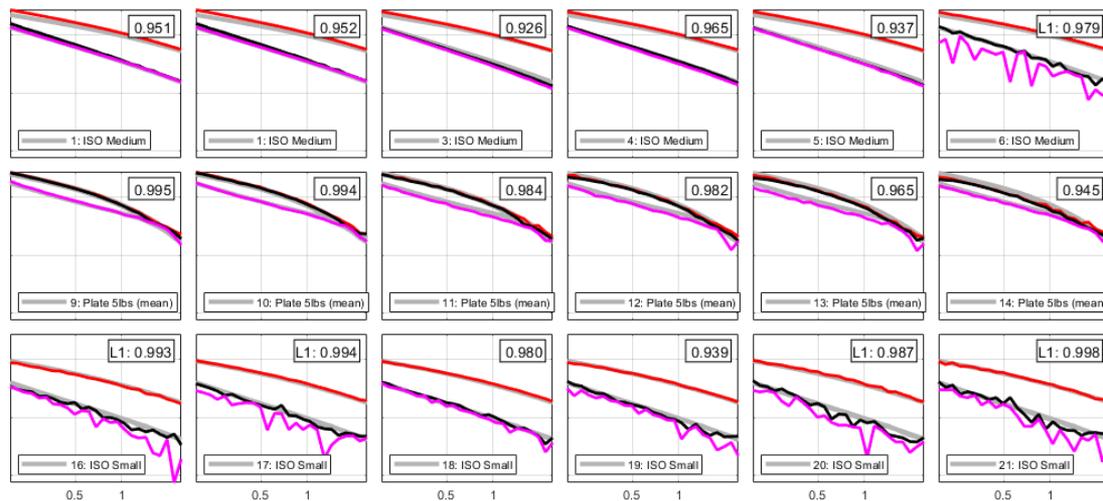
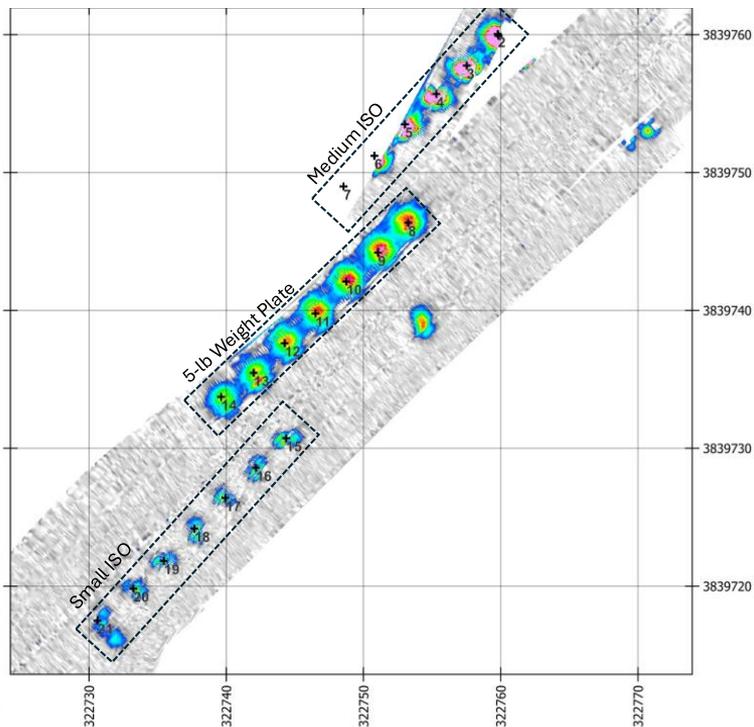


Active Towed-Array: October 2026 project

Roll, Pitch and altitude



Active Towed-Array: October 2026 project IVS performance (with GPS not INS)

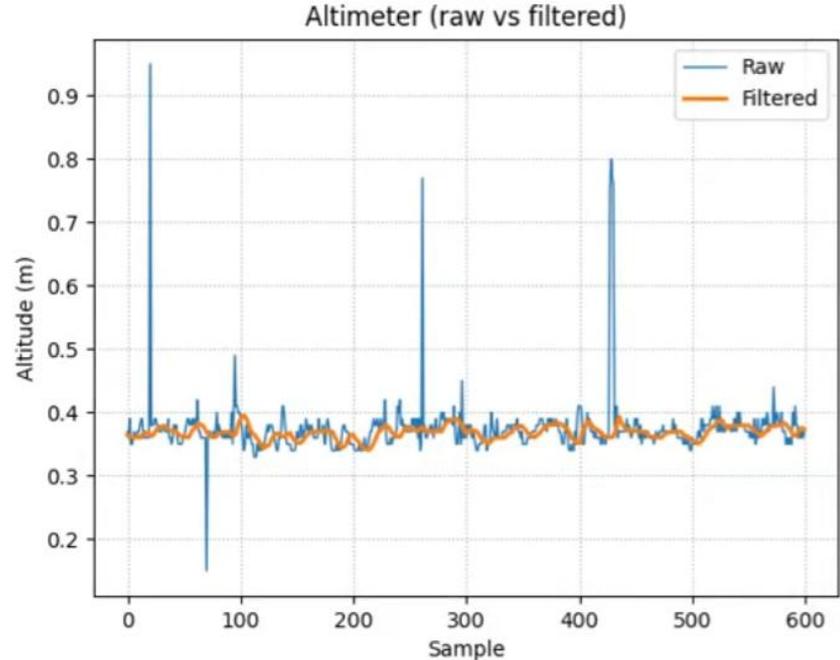


AHCW on the Geosearch



Test Phase II: Complications

- Ran out of time to fully-test the “Follow Sea-Bed” mode due to poor weather
- Altimeter may have been the source of the problem (needs preprocessing)
- Made a simulator to test system in the laboratory
- Use altimeter data collected at Alpena and inject an offset



Test Phase II: Lab-tests

- Verified correct behaviour of AHCW controller when synthetically increasing and decreasing the altimeter



Status after test phases 2 and 3

Item	Goal	Phases	Outcome
Active Towed Array Pitch/Roll control	PID control parameters <5 degree variation	1 & 3	Achieved in Phase 1 and confirmed in production survey
Active Towed Array Altitude control	PID control parameters <30 cm variation	1 & 3	Achieved in Phase 1 and confirmed in production survey
Active Towed Array Noise	Noise with thrusters < 2 x Seqium Bay	1 & 3	Achieved in Phase 1 and confirmed in production survey
AHCW heave	Compensate heave to sea-state 3	2 & 3	Confirmed in minor chop. Need Phase 3
AHCW bottom follow	Compensate heave and maintain altitude sea-state 3	2 & 3	Confirmed in lab. Need Phase 3
USBL/INS location accuracy	Calibrate USBL and maintain < 50 cm location accuracy	1 & 3	Confirmed in static mode in phase 1. Need Phase 3

Test Phase III: Engineering test

- Establish IVS with ROV and conduct visual search of survey area
- Test the integrated UltraTEM + AHCW system in both calm and rough conditions.
- Evaluate positional accuracy, data quality, and overall stability.
- Trial different altitude-control strategies to identify the most reliable configuration:
 - Follow-bottom mode: mTrack adjusts cable length for altitude and heave; ATA thrusters manage pitch and roll.
 - Heave-compensation mode: mTrack handles heave only; ATA thrusters control altitude and attitude.
 - (If needed) Clump-weight mode: mTrack maintains clump-weight altitude; ATA thrusters independently manage array motion.

Vessel of opportunity: NOAA Class III



- Small vessel of opportunity (~ 40 to 65 feet)
- Shallow draft but capable but stable off-shore
- Several day mission duration

- Designed to carry full sensor survey suites.
- Typically have an A-frame
- Deck space for stowage of arrays



Potential vessels: Richard L Becker

- 96-ft Graham offshore supply vessel
- 24-ft beam and 50 × 22 ft main cargo deck
- A-Frame and plenty of deck space
- **Main issue is control at low speed (under 3 knots)**

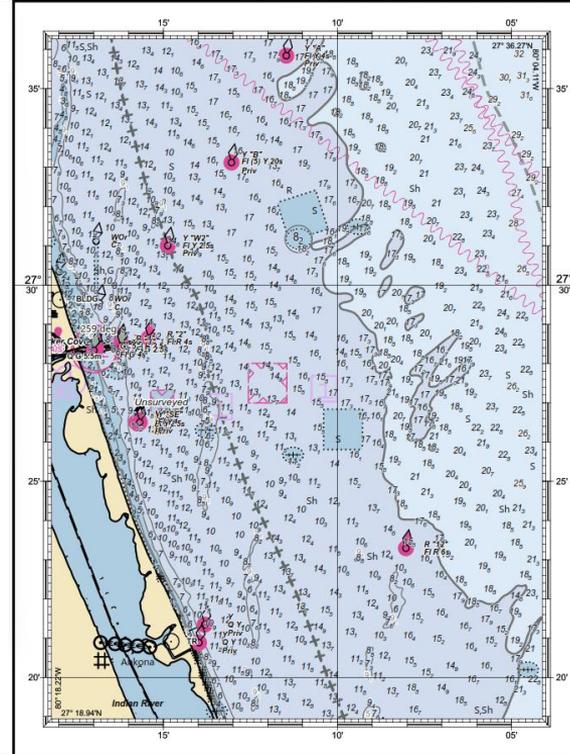
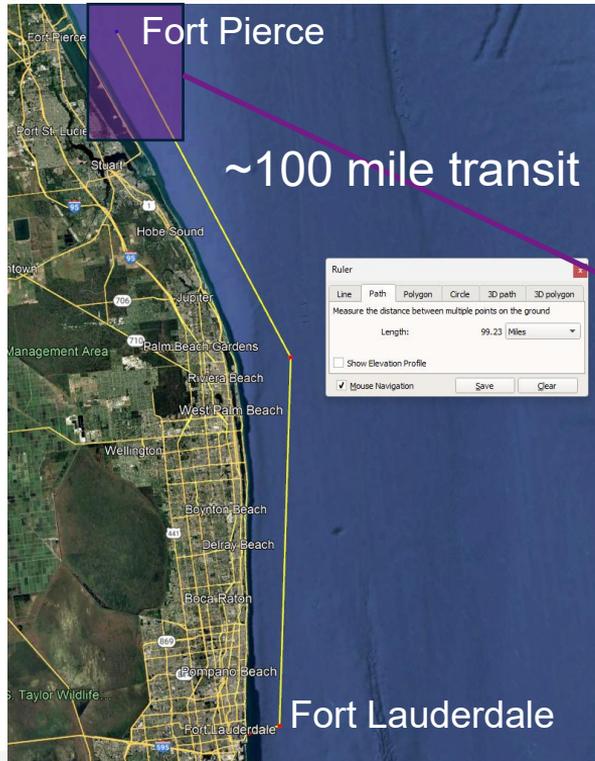


Potential vessels: Lady Katherine

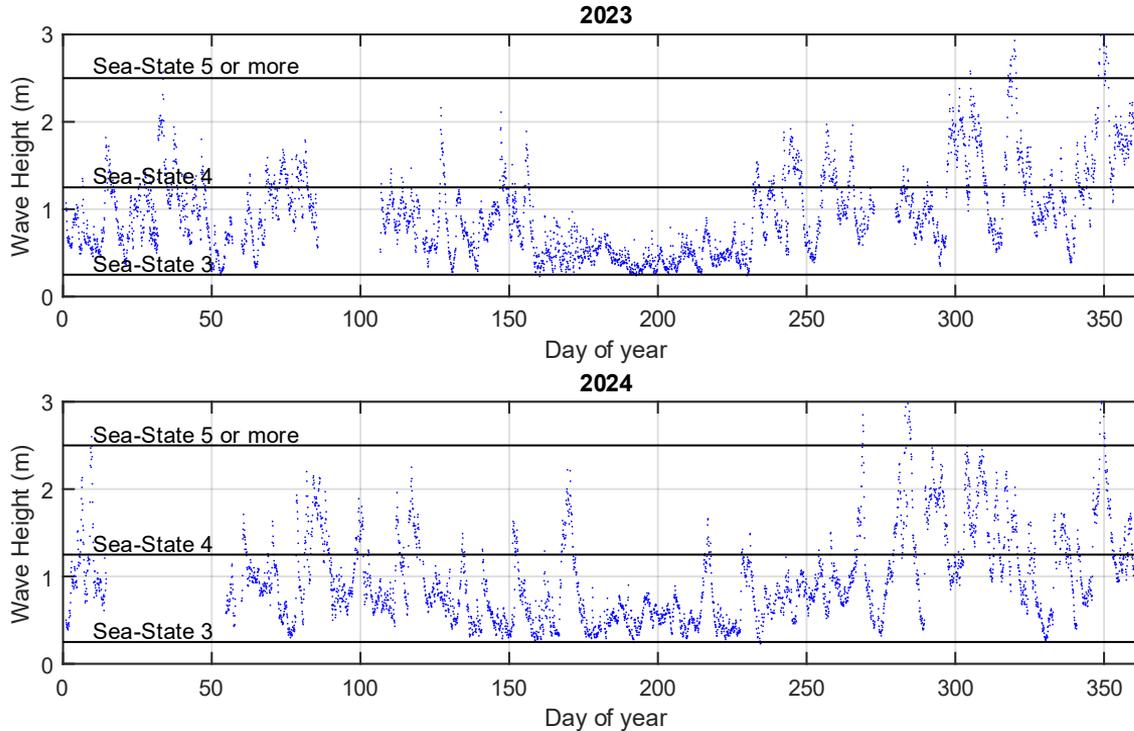
- 58-ft length overall
- 16-ft 9-in beam
- Smaller and cheaper vessel
- Main issues are limited deck space, no A-frame and difficulty with low speed survey



Location: Fort Pierce FL



Location: Fort Pierce FL



Need a plan B for the engineering test

- Hard to get a suitable reasonably priced “Vessel of opportunity”
- Neither TowBoatUS vessel is capable of low-speed survey
- Total cost of engineering test would be around 250k (expensive and not worth the investment)
- Any modifications will be specific to the charter vessel and will not help with the upcoming demonstration in Vieques

Technical approach

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Go/
No-Go

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3. Extended shakedown testing

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Go/
No-Go



4. Offshore demonstration

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- Verify ability to keep tow-fish close to the sea-bottom

Offshore demonstration in Vieques

- Daniel Hood from NAVFAC put us in touch with BlueTide
 - San Juan Bay Marina in Puerto Rico
- Blue Manta research vessel
 - 73' x 26.7' aluminum catamaran
- Ticks all our boxes
 - Good low-speed control
 - A-frame
 - Deck space
 - Set-up for surveying



Plan B for the engineering test

Do the shakedown test in Puerto Rico, either in March or several weeks prior to live-site demonstration to reduce double-up of mob/demob costs

Pros

- Same vessel as the demonstration so any modifications won't be wasted effort
- Lessons learned have direct applicability to live-site demo
- Sandy area within 20 min transit from marina

Cons

- Higher mob/demob costs than Florida
- Longer downtime if specialist equipment/ electronics need to be sent
- Potential short review time for go/no-go decision

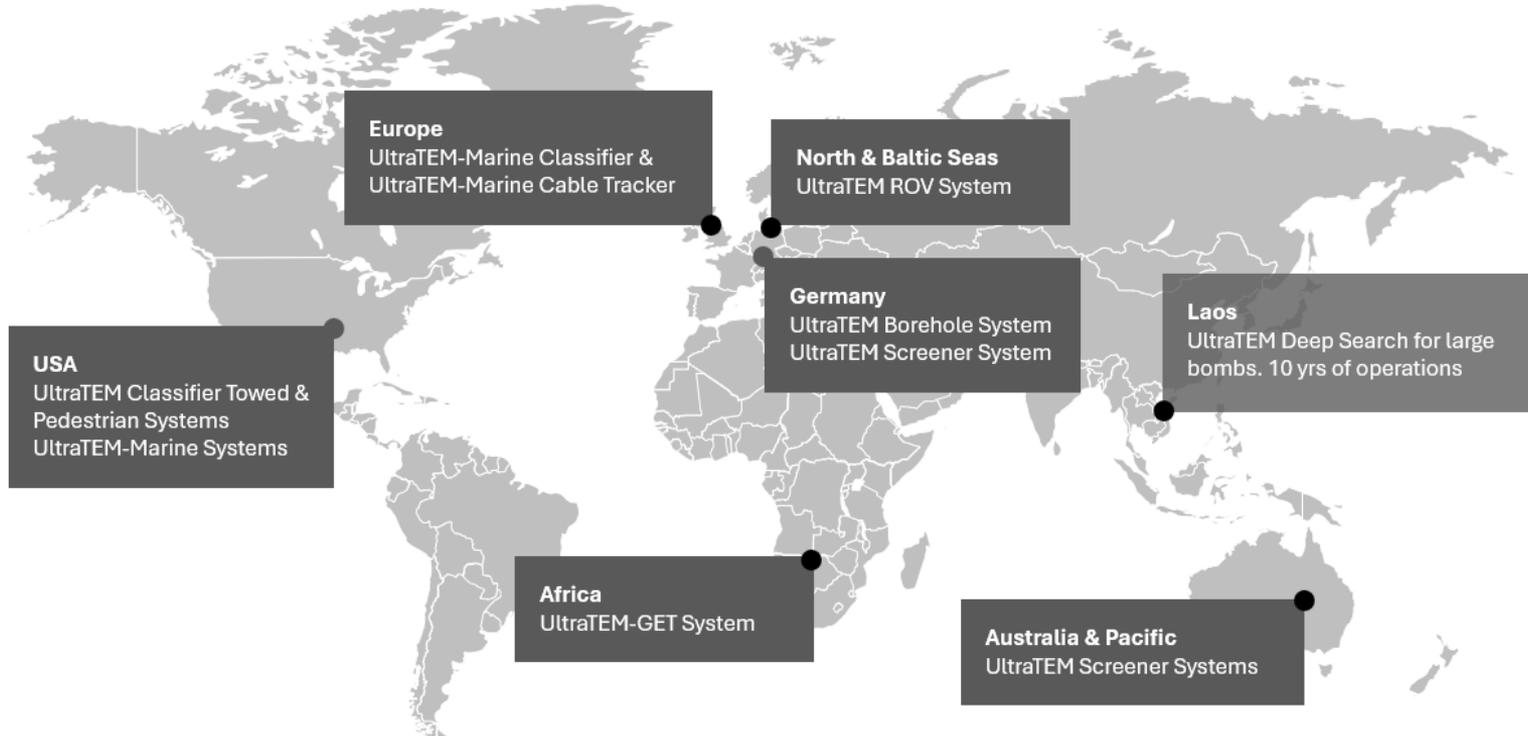
Key aspects and objectives of demonstration 2

- Feasibility and cost of deploying the UltraTEM Marine system onto a vessel of opportunity
- Ability of system to accurately track the position of the tow-fish at larger standoffs than the shallow water system
 - Use Subsonus USBL system
- Test ability to navigate along planned survey lines
- Test ability to collect low-noise EMI data
- Test ability to compensate for heave and control the ROTV attitude and altitude

Project schedule

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Shallow water system	Build	Build	Duck	Duck		Demo
Offshore system development (complete)		Build	Build			
Offshore system extended shakedown			Michigan	Puerto Rico		
Offshore system demonstration					Demo	Report

Technology Transfer



Technology Transfer

- Marine surveys are more complicated than terrestrial surveys so we anticipate on-site support will be required
- While lease of the hardware is a possible option, a service model with SVG leading the data collection effort is likely a better alternative
- Marine processing is also not yet fully mature so BTG support for processing and interpretation will likely be required

Issues: Some budget uncertainty

What we proposed

- **CONUS** demonstration of shallow water estuarine system using the same towed-array as the off-shore system and using the Geosearch pontoon boat
- Extended shakedown test of the offshore system
- **CONUS** demonstration of the offshore system, vessel supplied

What we are trying to cover

- Duck shakedown test of **crawler system** for surf-zone
- **OCONUS** demonstration of the **crawler system**
- Extended shakedown test of the offshore system
- **OCONUS** demonstration of the offshore system and **vessel charter**



BACKUP MATERIAL

These charts are required and will be used by the Program Office but may not be presented.

MR24-B3-8267: Extending the Operational Envelope of the UltraTEM Marine System Project

Performers:

- Black Tusk Geophysics
- SeaView Geophysics
- Gap Explosive Ordnance Detection

Technology Focus

- *Advanced Geophysical Classification using EMI data in the marine environment*

Demonstration Site

- *TBD, but possibly Culebra Puerto Rico and Duck, NC*

Demonstration Objectives

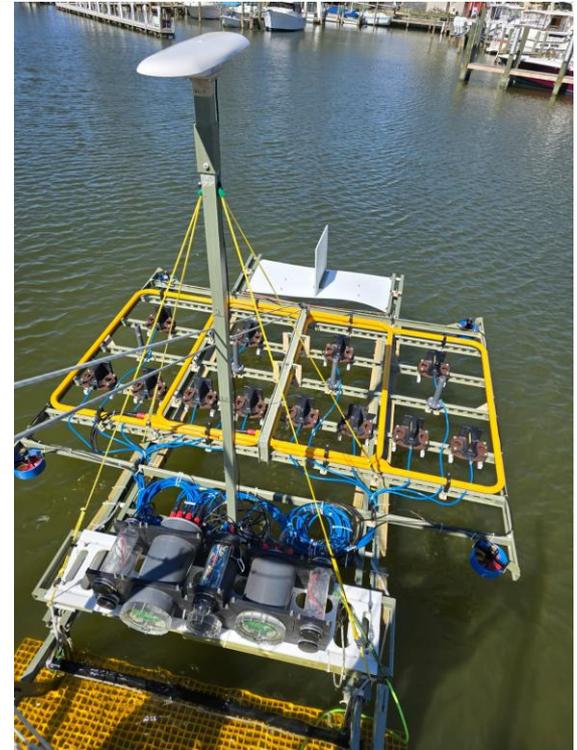
- *Demonstrate the feasibility of AGC in more challenging environments than the benign conditions of Sequim Bay*

Project Progress and Results

- *Built AHCW system and Crawler towed-array. Both systems ready for engineering shakedown tests*

Implementation Status

- *UltraTEM Marine hardware is available for lease*
- *Deployment platforms are under development*



Plain Language Summary

- Marine UXO surveys are limited by rough water and changing depth. Current towed systems can't keep a stable height or orientation, reducing detection accuracy and increasing risk.
- We're integrating an Active Heave Compensated Winch (AHCW) and Active Towed Array (ATA) with the UltraTEM Marine sensor to maintain constant altitude and low noise. Controlled trials on Lake Huron proved the concept; final sea trials off Fort Lauderdale will validate performance in real waves.
- The outcome will be a field-ready, heave-compensated towed platform that can hold near-bottom altitude in Sea State 3, extending EMI-based AGC surveys to deeper, rougher water. This improves data quality, safety, and productivity for UXO remediation contractors.

Impact to DoD Mission

- Most impactful development since last review: Successful integration and testing of the Active Heave Compensated Winch (AHCW) with the UltraTEM Marine system, demonstrating reliable altitude control and stable EMI data collection in open-water conditions.
- Why this is important: Maintaining precise tow-body altitude in dynamic sea states is a major limitation for current marine munitions response systems. Overcoming this barrier enables safe, efficient surveys in deeper and rougher environments previously considered impractical.
- How the project advances DoD capabilities: Provides a next-generation, heave-compensated towed platform that expands the operational envelope of Advanced Geophysical Classification (AGC) to offshore and nearshore sites. This enhances underwater UXO remediation, reduces risk to personnel, and supports faster, more cost-effective clearance of legacy munitions.

Publications

- None

Literature Cited

- None

Acronym List

ATA	Active Towed Array	L123	Fit metric derived from all three polarizabilities
BTG	Black Tusk Geophysics	MEC	Munitions and Explosives of Concern
DVL	Doppler Velocity Log	NTRIP	Networked Transport of RTCM via Internet Protocol
EM	Electromagnetic	PPS	Pulse Per Second
GapEOD	Gap Explosive Ordnance Detection	RMS	Root Mean Squared
GAPS	Global Acoustic Positioning System	ROTV	Remote Operated Tow Vehicle
GNSS	Global Navigation Satellite System	RTK	Real-Time Kinematic
IDA	Institute for Defense Analysis	SSL	Site Specific Library
INS	Inertial Navigation System	TOI	Target of Interest
ISO	Industry Standard Object	UltraTEM	Ultra Time-Domain Electromagnetic
IVS	Instrument Verification Strip	USBL	UltraShort BaseLine
L1	Fit metric derived from primary polarizability		