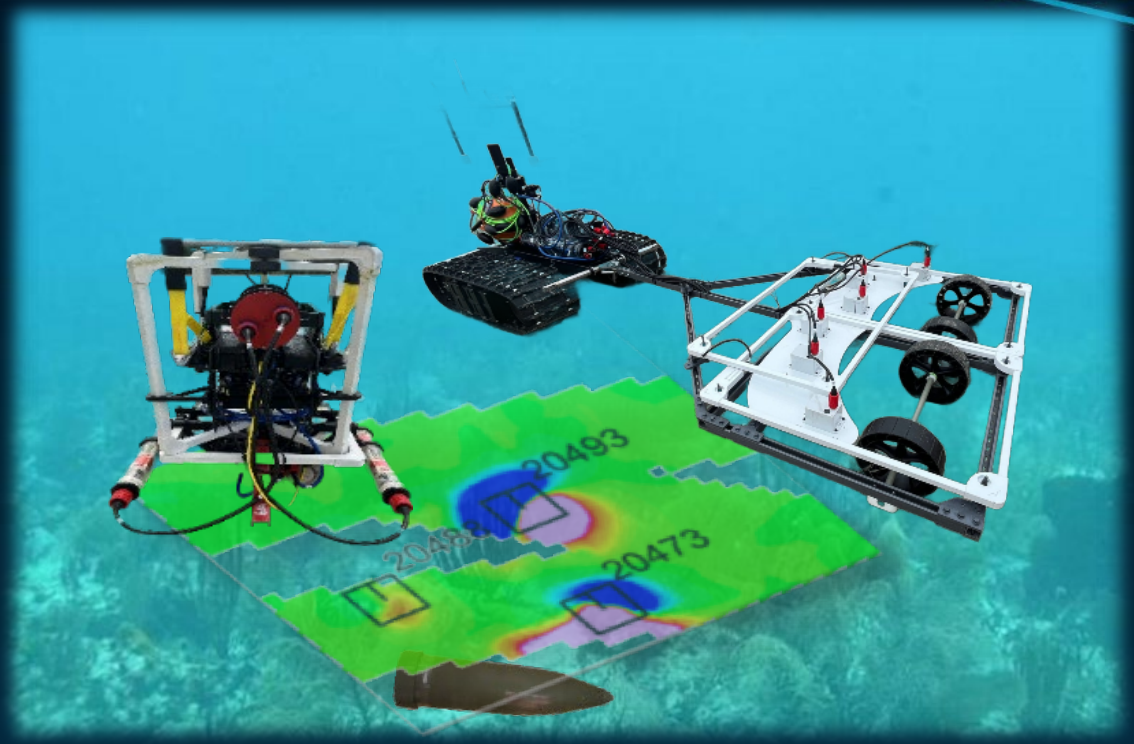
Autonomous 3DEM for Seabed Target Classification

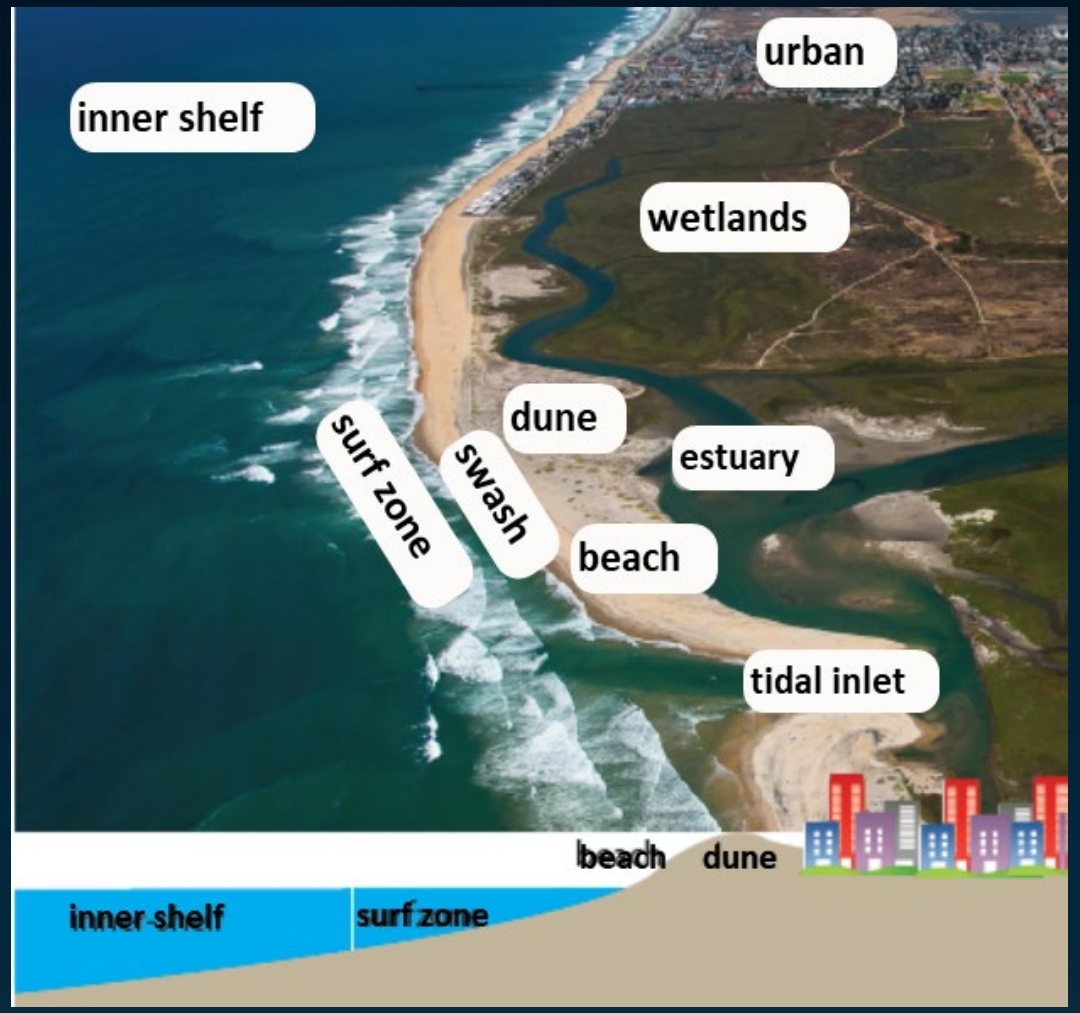


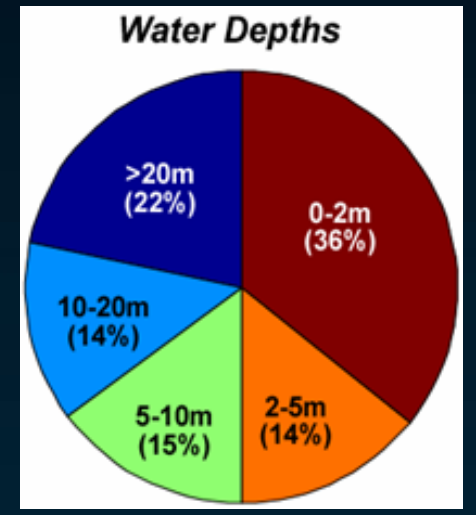
Greg Schultz

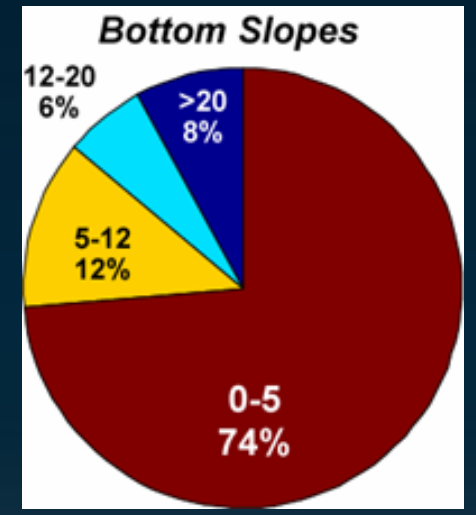
White River Technologies, Inc.
Lebanon, New Hampshire, USA

white river technologies

Nearshore Underwater UXO







Access, visibility, bottom variability, hydrodynamics, …

Current Methods

- **Diving = High cost**
- Limited depths and duration
- Push-carts in the surf and muck?

Ship-Tow Sensors

- Sonar, MAG, and EM
- Large and complex
- Limited in important nearshore areas
- Relatively expensive for smaller sites

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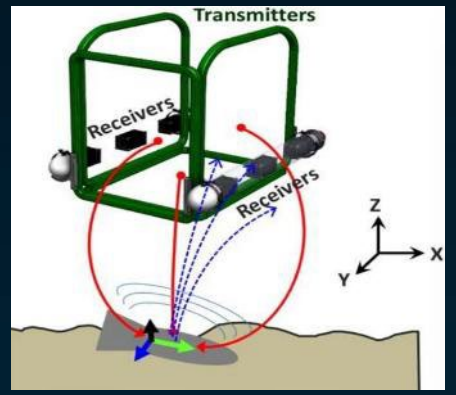
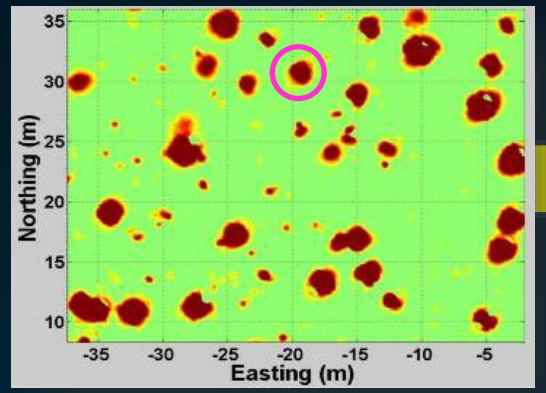
Outline for This Briefing

1. Seabed 3DEM AGC
2. ROV Implementation
3. Crawler (AUGV) Implementation
4. Experiments & Operations

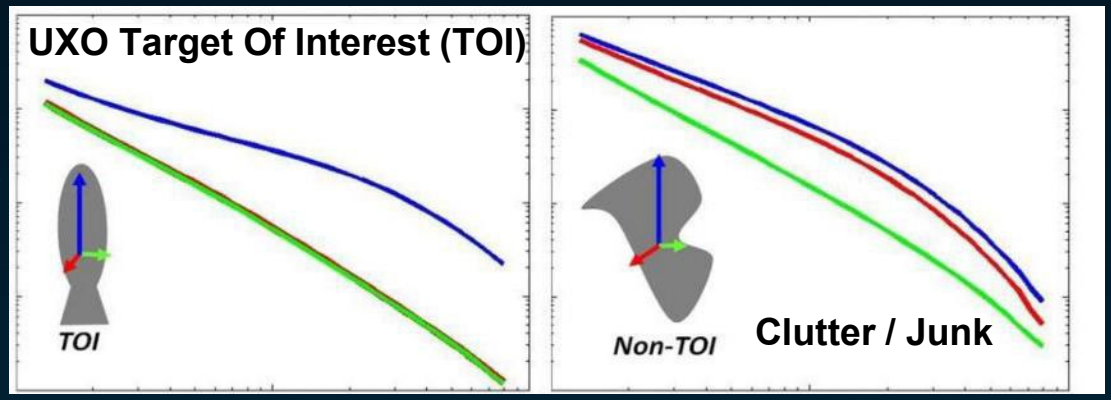
APEX 3DEM for AGC

1 Map & Detect / Reacquire





2 Classify



Based on Intrinsic Classification Features (DAGCAP style)

Polarizabilities = Fingerprint signatures unique to each target type

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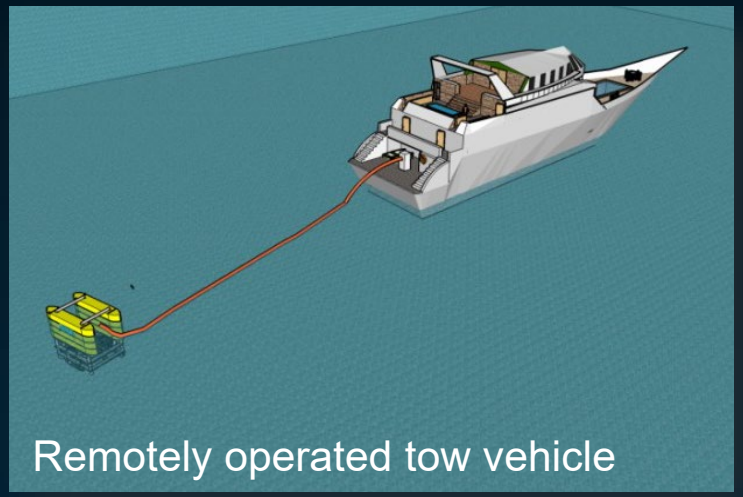
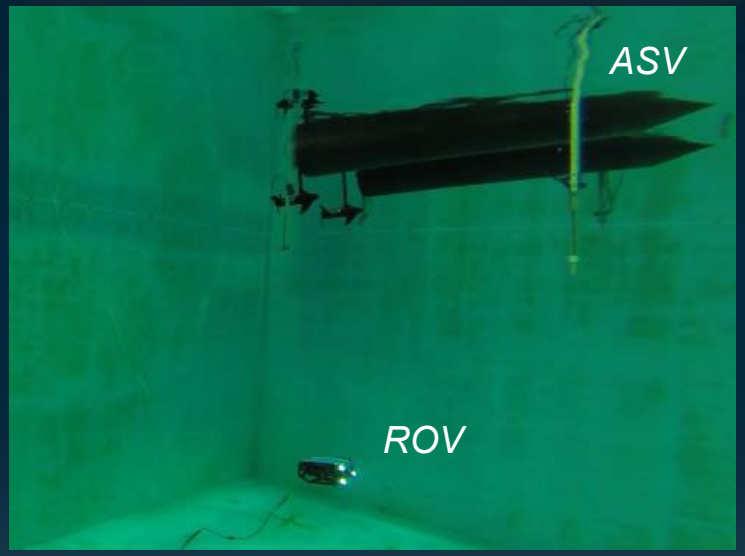
ROV 3DEM Sensor Integration

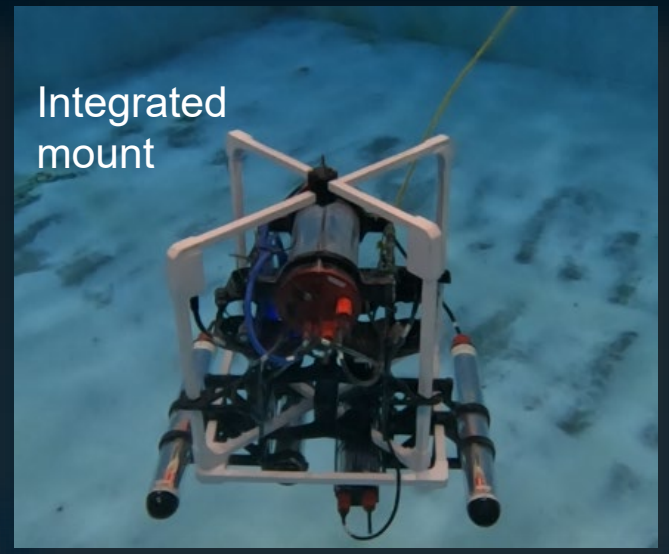
ROTV from Surface

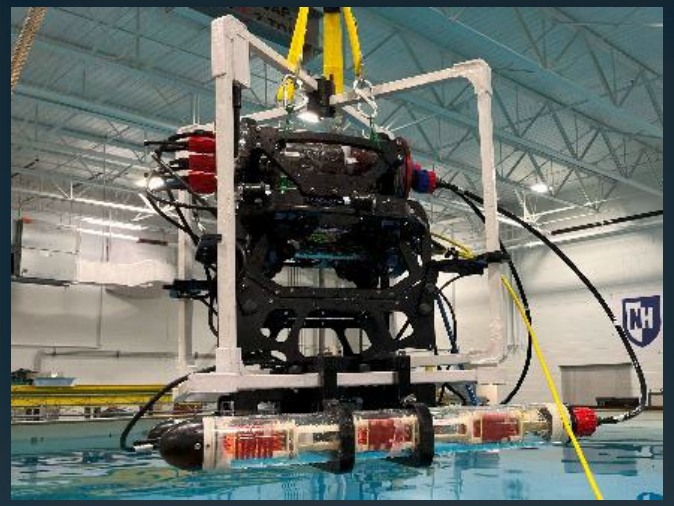




Direct Mount

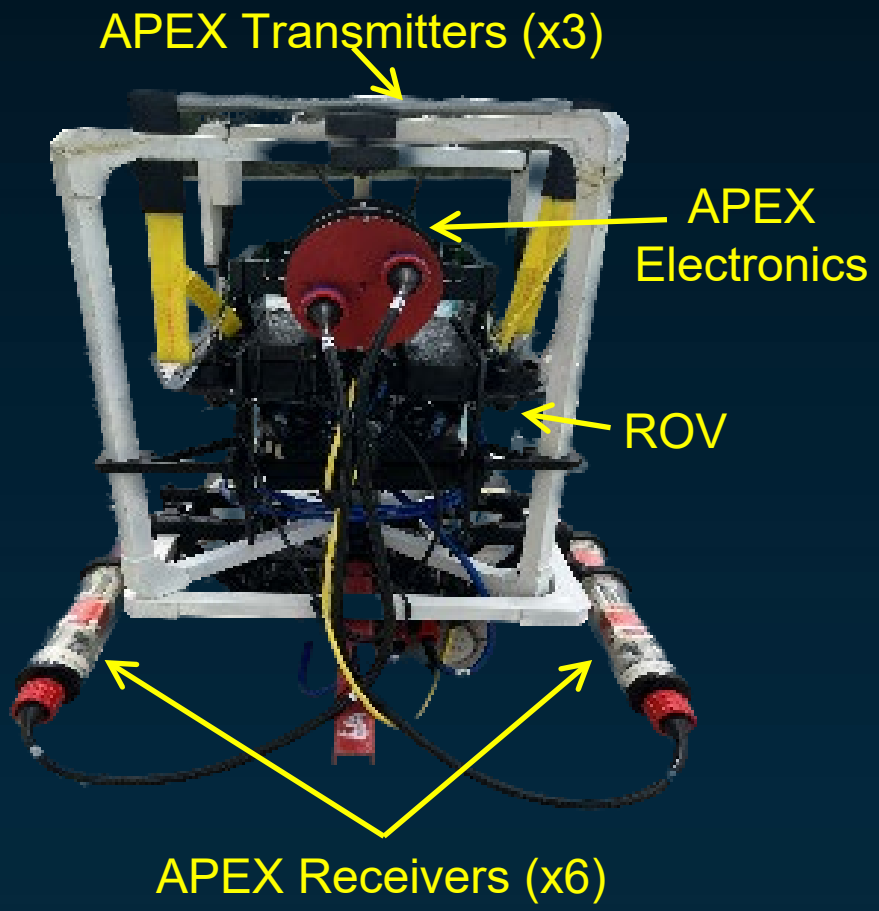
Highly Integrated





Making it smaller simplifies integration, but creates new EMI/EMC problems

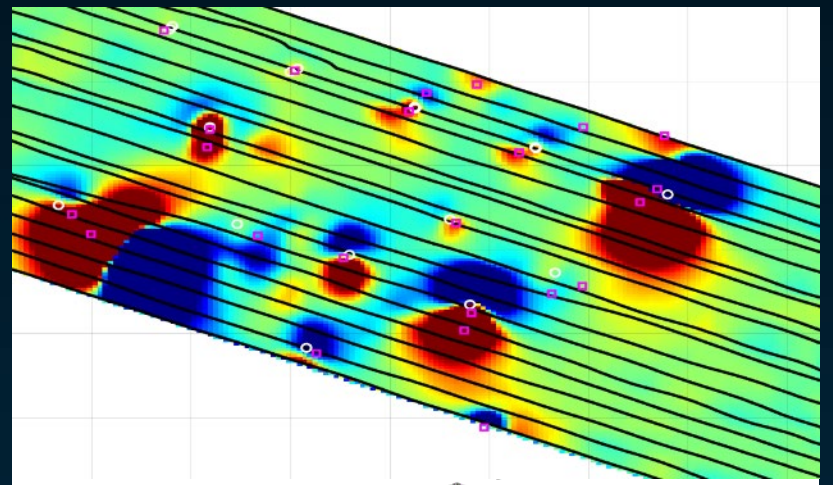
ROV APEX Sensor Integration

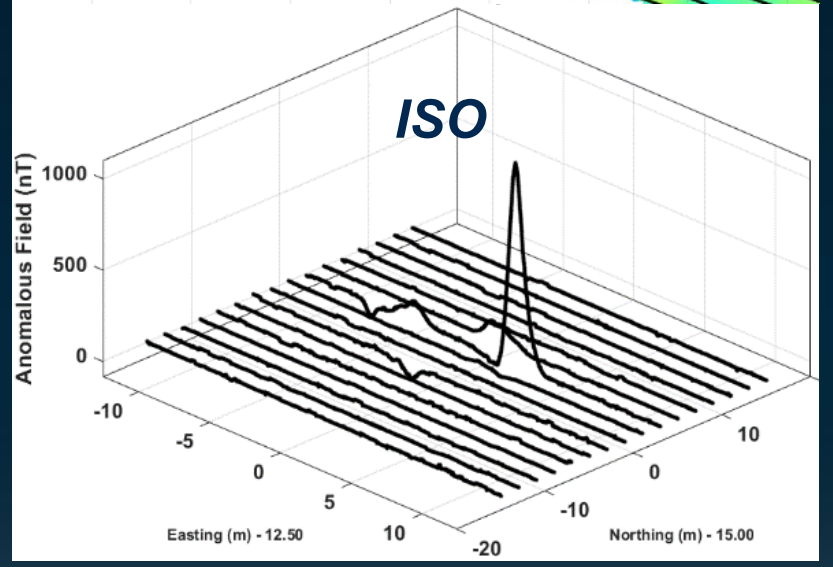


ROV MAG Sensor Integration

ROV-MAG system

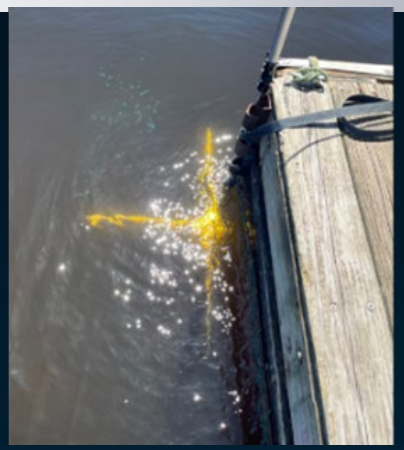
seabed target

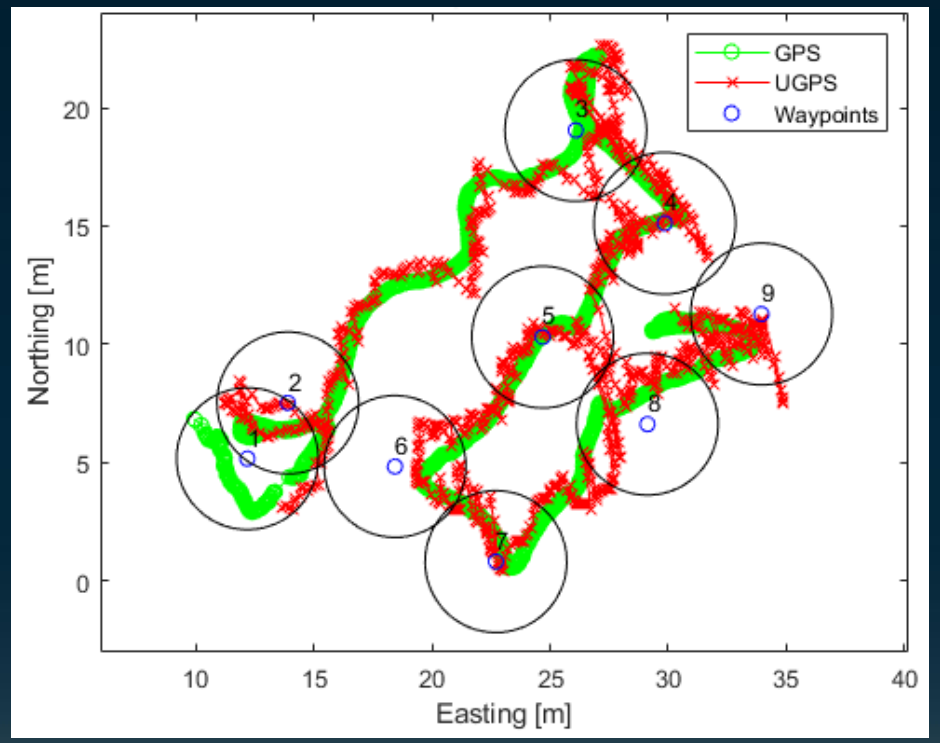


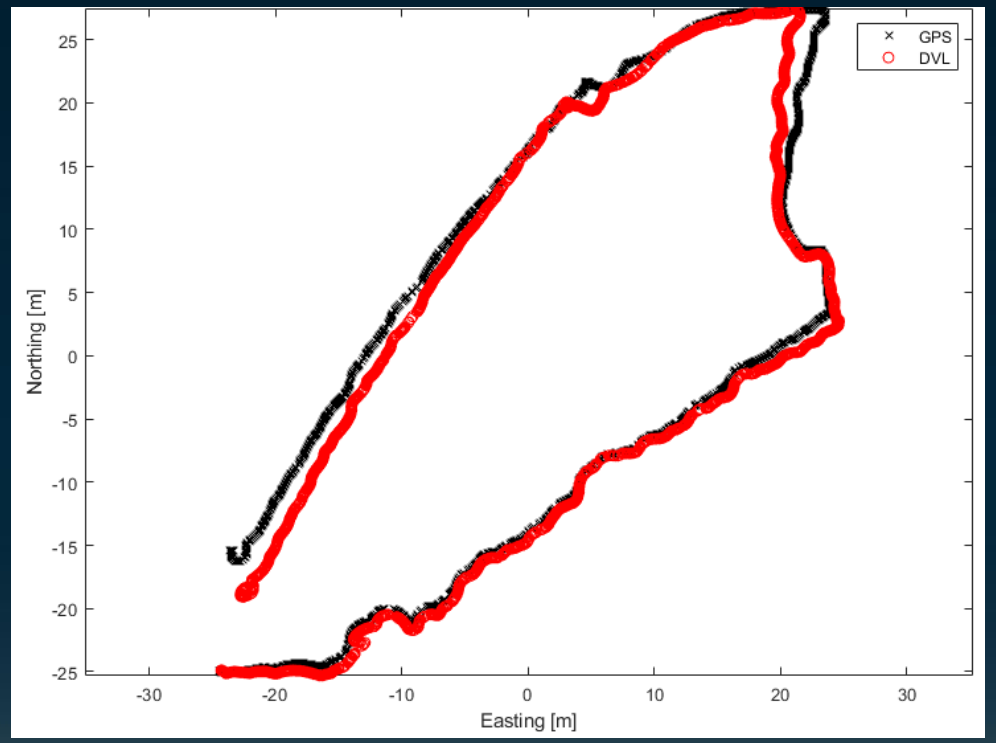


ROV APEX Sensor Integration

Bottom following and waypoint control
- Acoustics in shallow water (UGPS)
- DVL-INS positioning & control

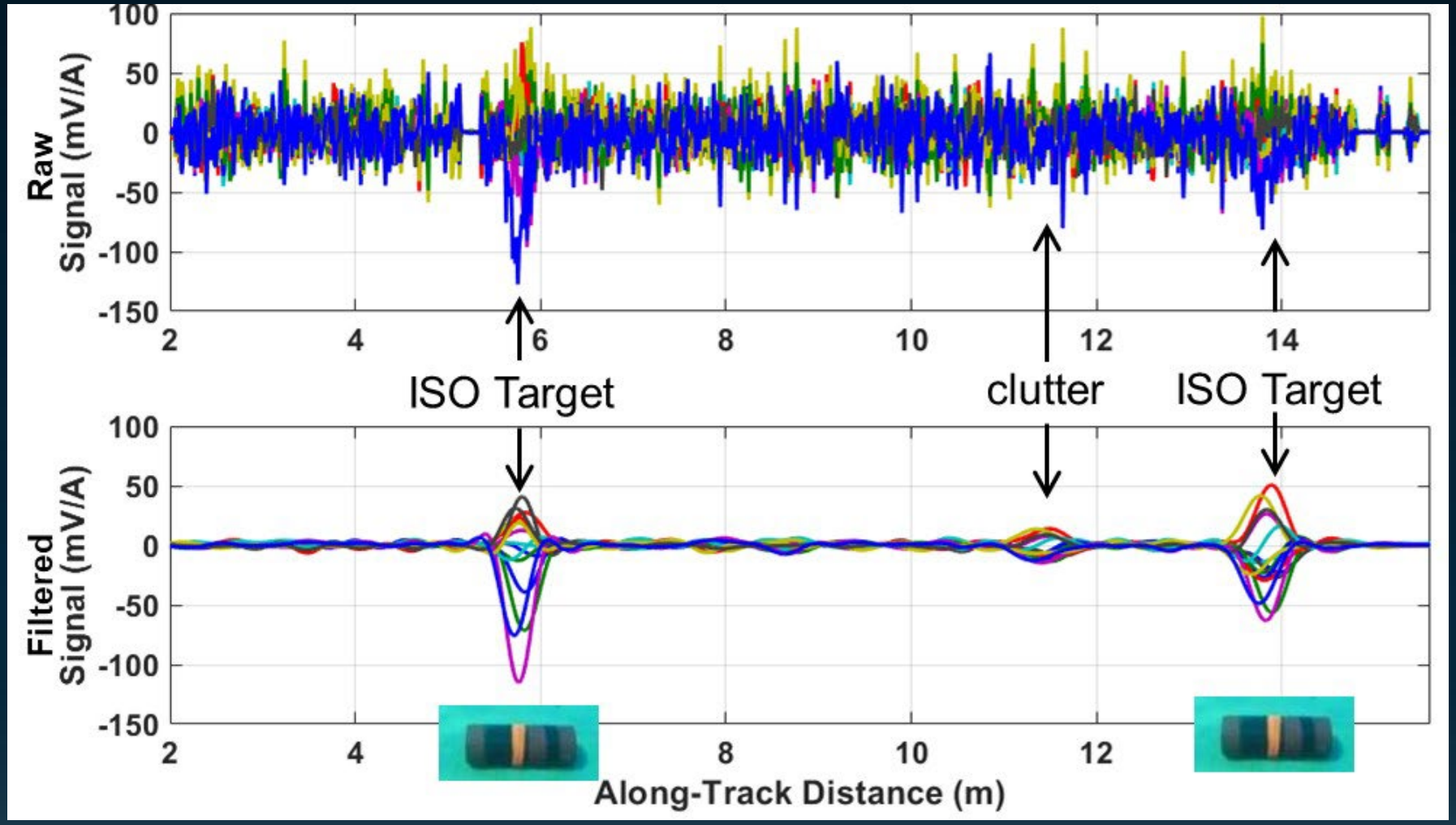






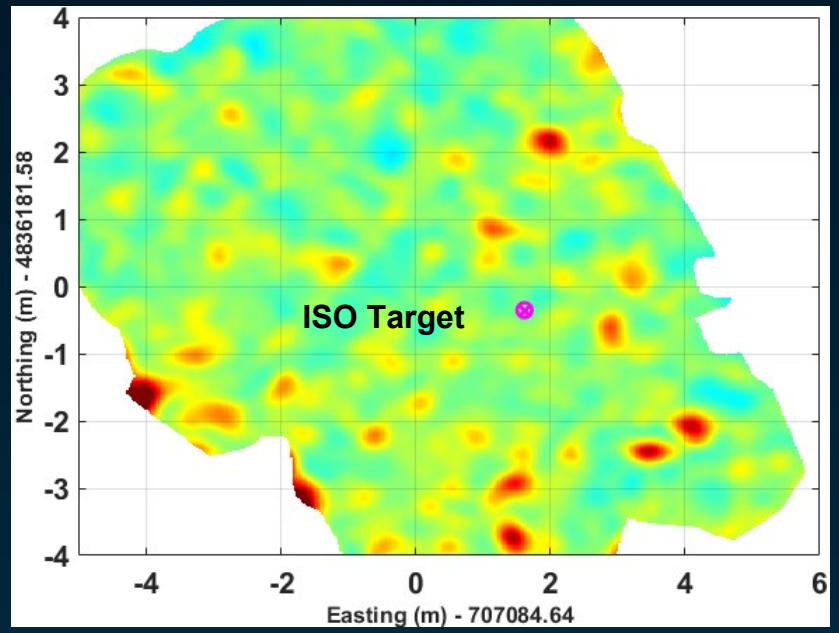
ROV APEX Sensor Integration

Mitigating ROV Motor Noise

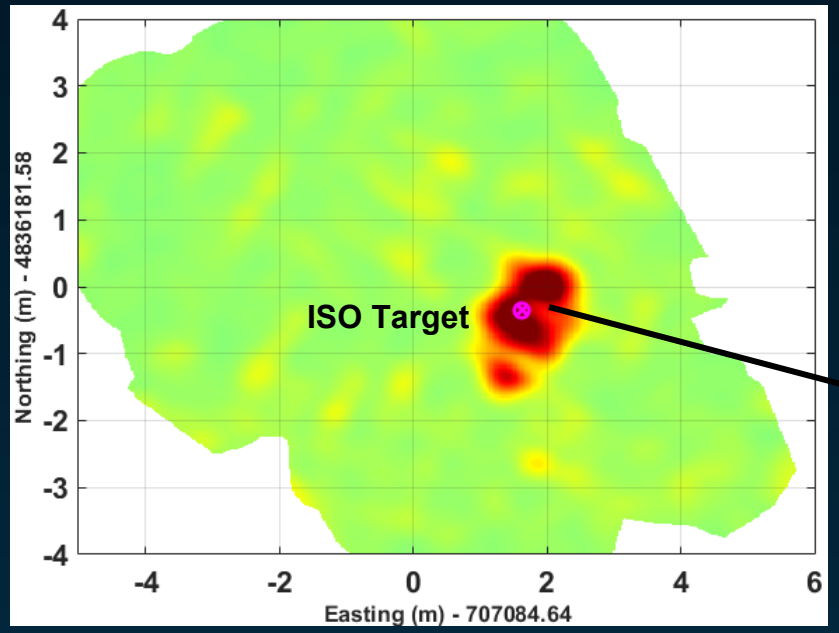


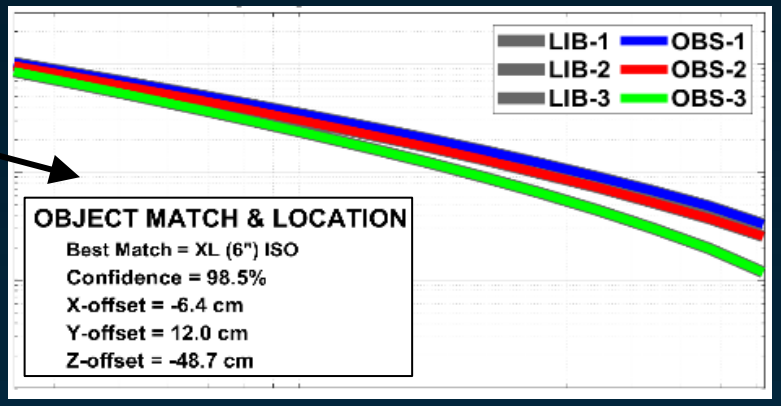
ROV 3DEM Sensor Integration

Raw Data (ROV Motor Noise)



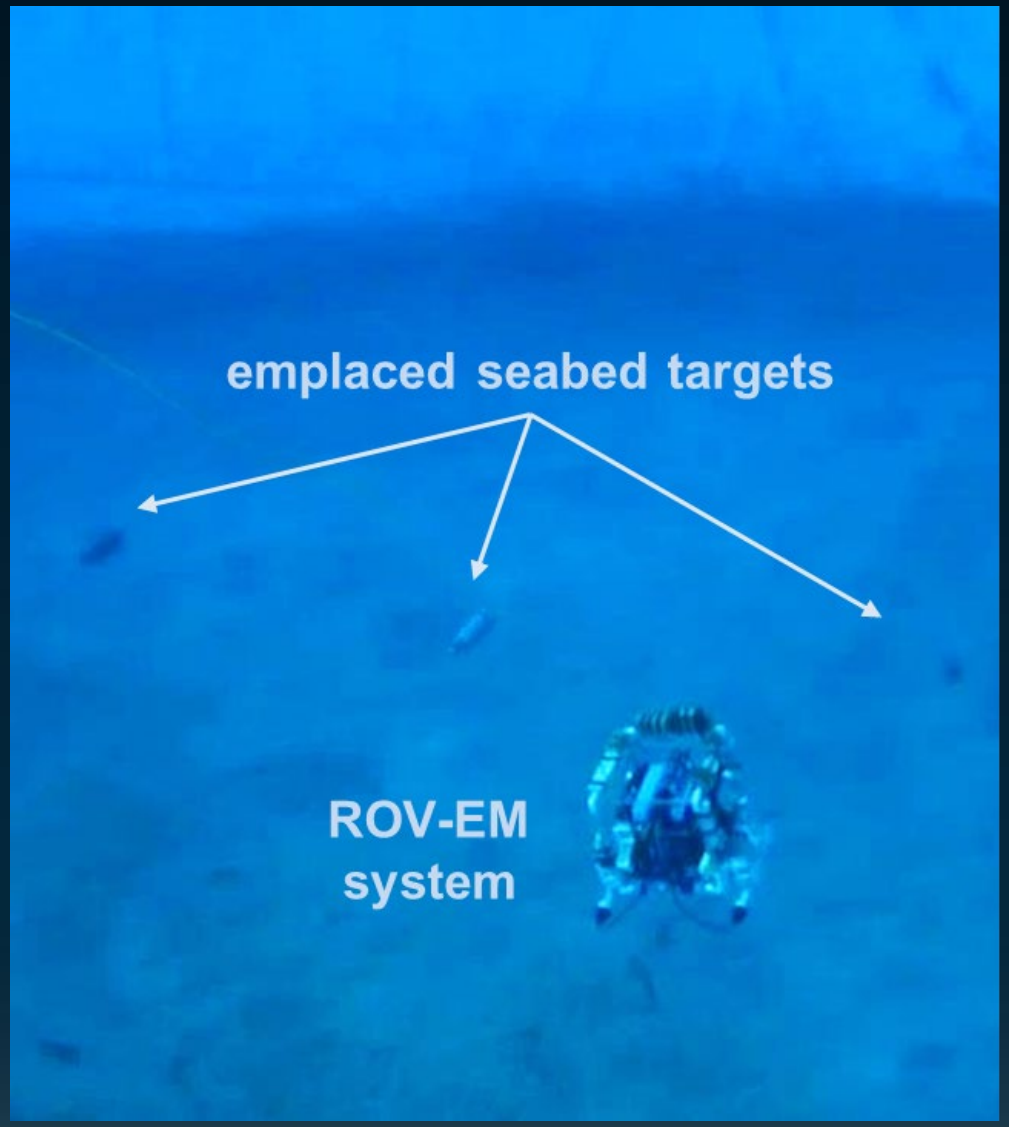
Filtered Data

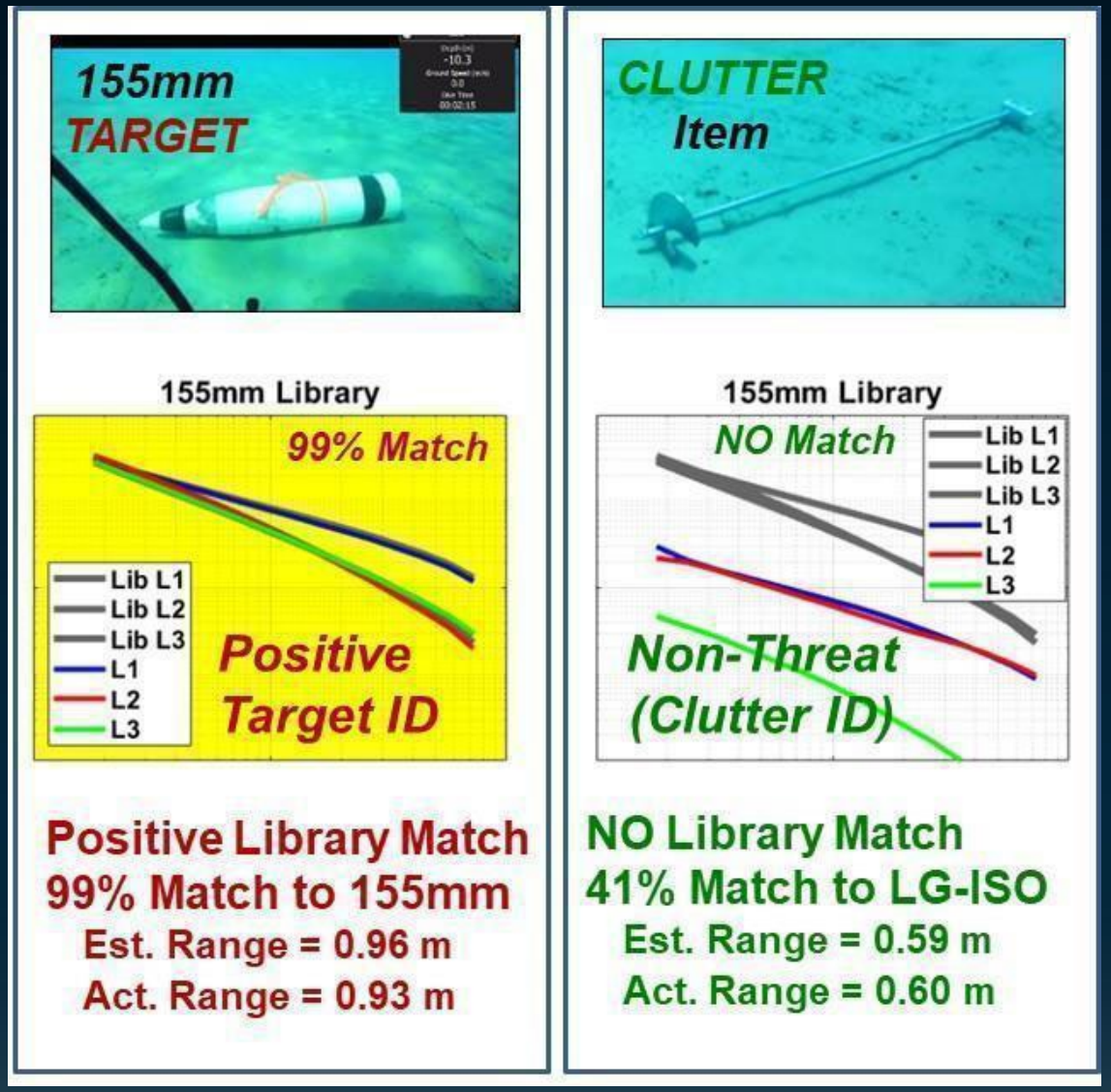




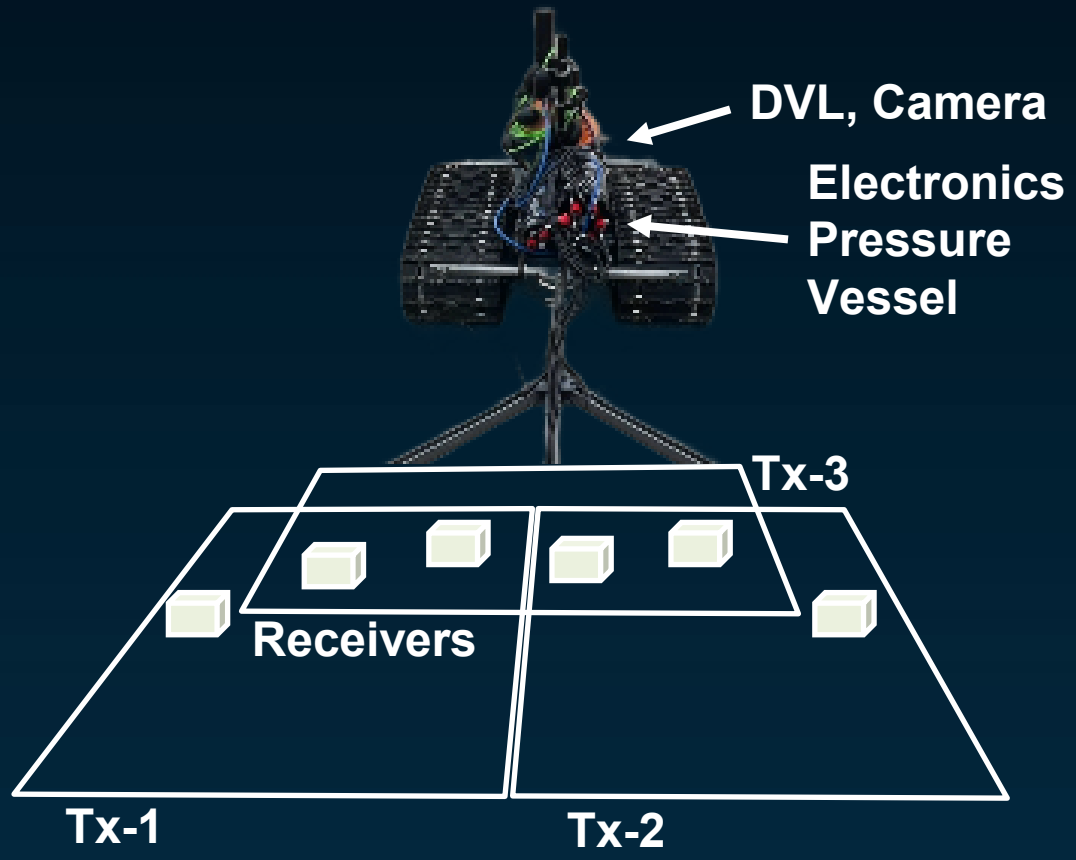
- Coherent Noise Filtering greatly reduces motor noise
- Source Separation techniques further enable data for classification

3DEM UXO Classification





Crawler-towed 3DEM

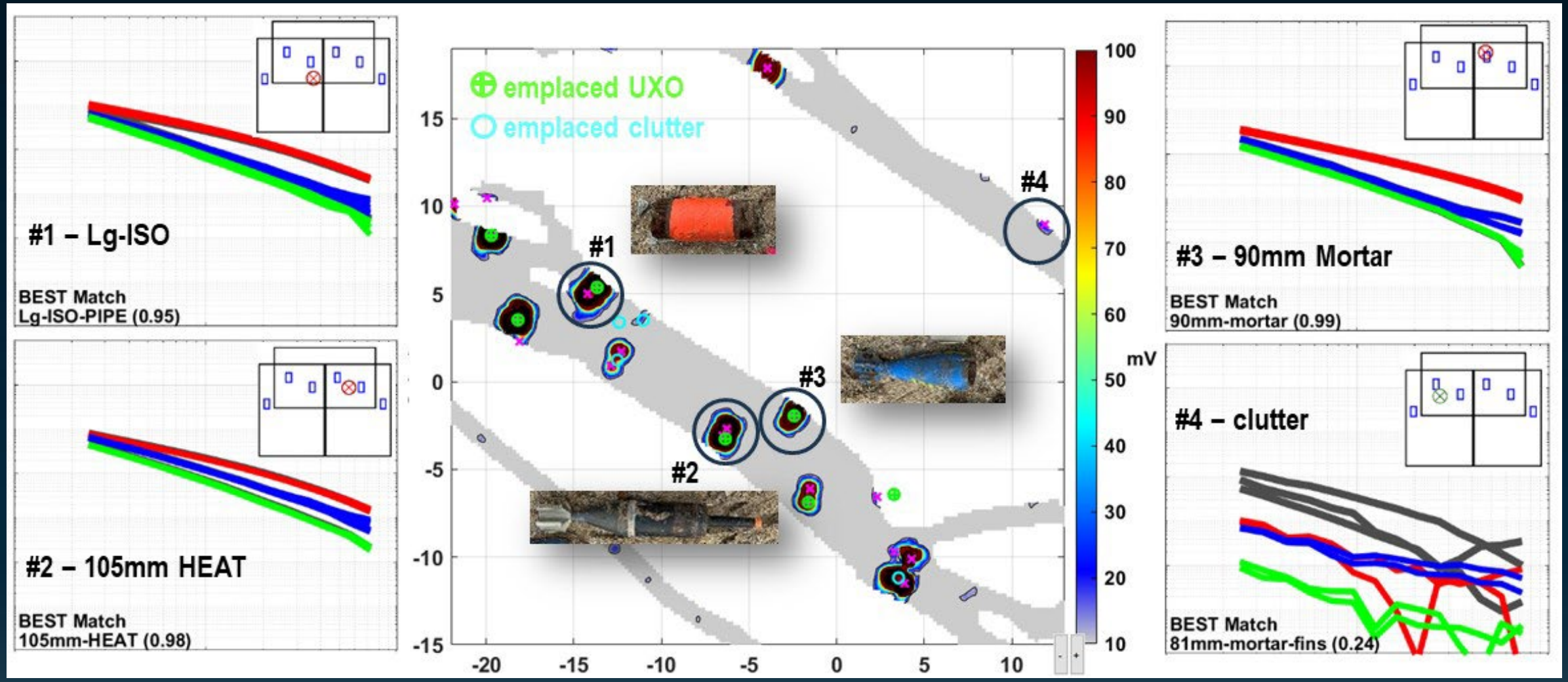


APEX HH6 Array on Bayonet AUGV Crawler

- 3 Transmitters
- 6 Receivers
- 30, 60, 120 Hz
- APEXCOM Software
- Ethernet Data to Topside
- Integrated POS & IMU
- Depth: 100m ASW
- 4-hour endurance (~10 km)
- Survey Width (1.6-2.4 m)

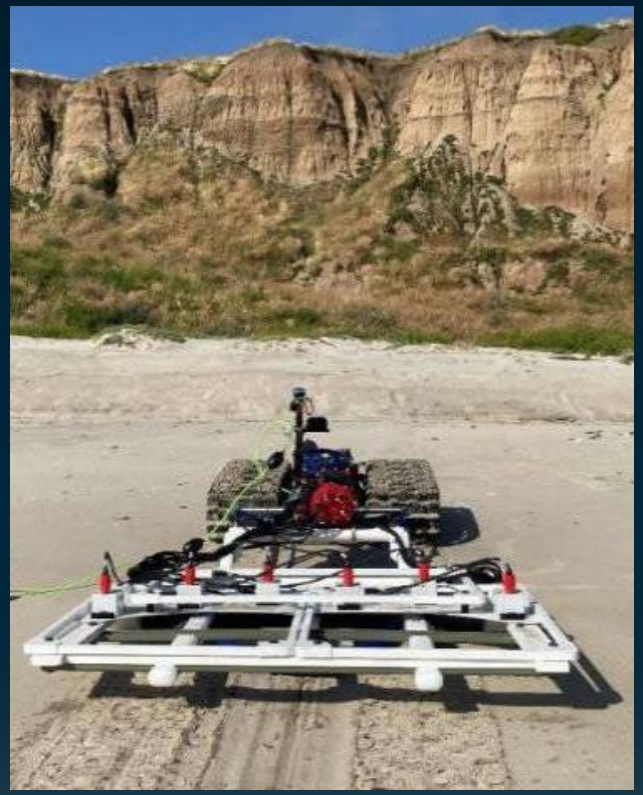
Crawler-towed 3DEM

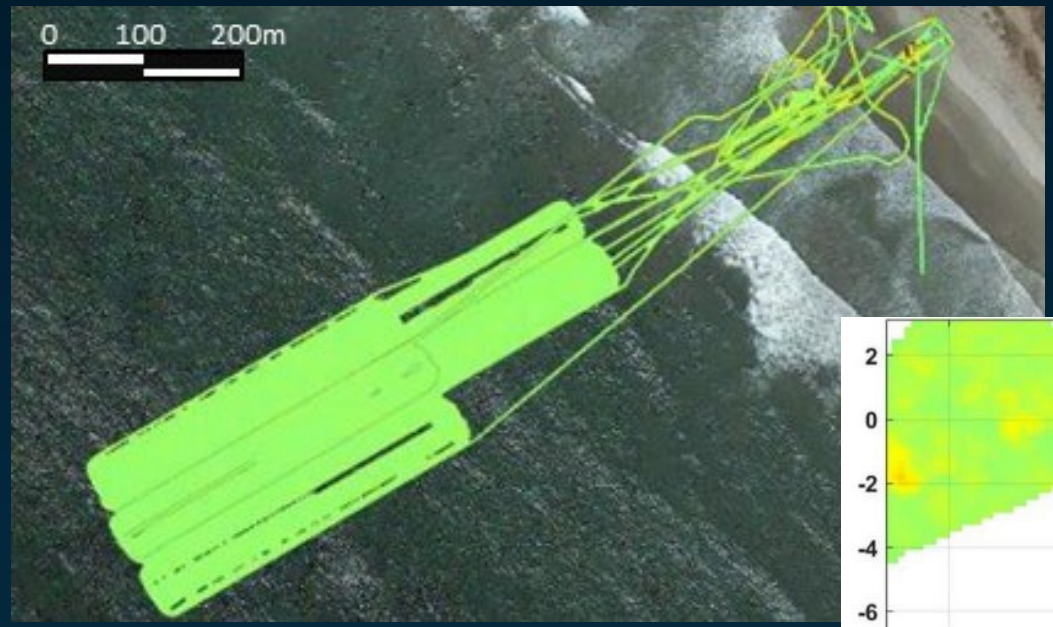
Blind trails in 0-2m water along Plymouth Bay shoreline (south of Boston, USA)

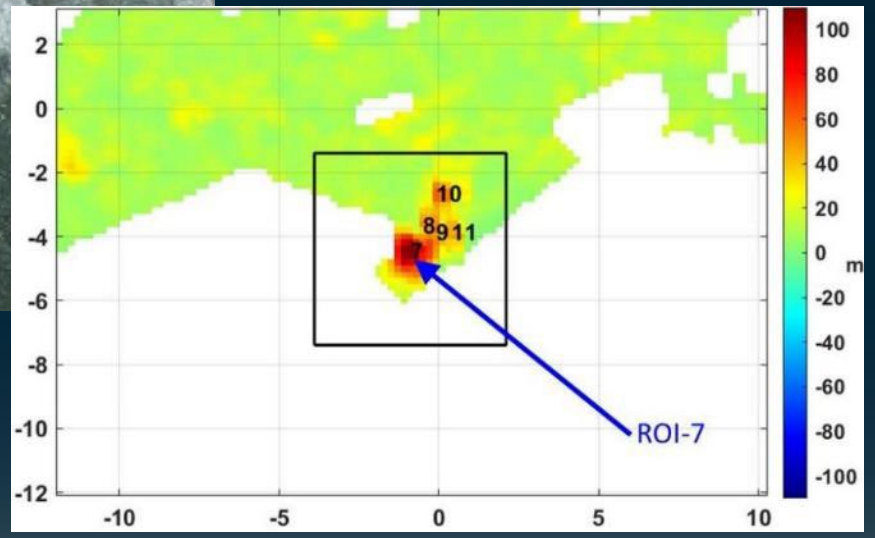


Crawler-towed 3DEM Operations

- Operational tests along California shoreline
- Through surfzone to 20-25 ft water depth
- >27 acres in 3 days (TOI found day 1)







Mapping-Detection-Classification

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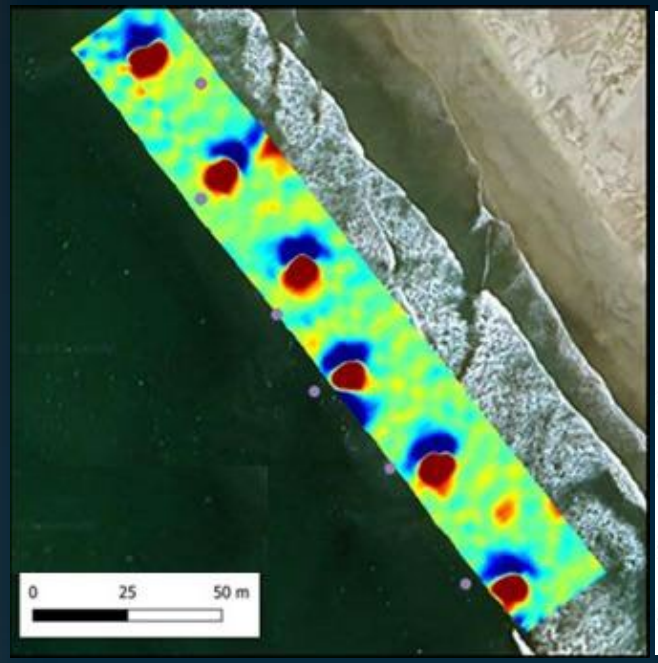
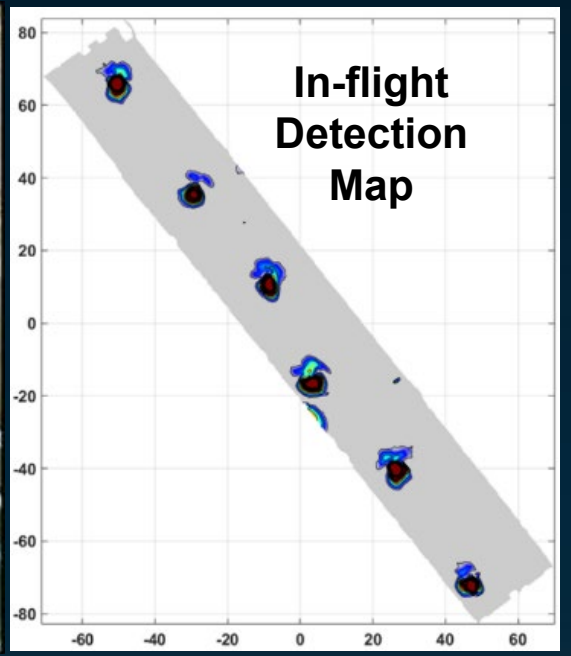
Cross-domain Aerial-Aquatic System





New Heavy Lift
Cross-domain UAS

Airborne / Drifting / Underwater MAD Operations in Single Mission

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Synopsis

1. Seabed 3DEM provides classification where ship-tow and divers cannot
2. Tight integration on ROVs requires specialized noise mitigation
3. Portable and cost-effective 3DEM classification
4. Cross-domain deployment from AUGV (Crawlers) & aquatic drones