

# **CMRE UXO Test Site Implementation, Demonstration and Maintenance**

Project Number: MR21-5243

PI: Stefano Biagini

NATO-STO-CMRE, Centre for Maritime Research and Experimentation  
In Progress Review Meeting

DATE: Wednesday, May 21, 2025, 10:45 AM ET

# Project Team



**PI**

Stefano BIAGINI



**Co-PI**

Per Arne SLETNER



**Admin**

Vanessa LAZZERINI



**Host Military Installation  
ITA-N CSSN / PNS**

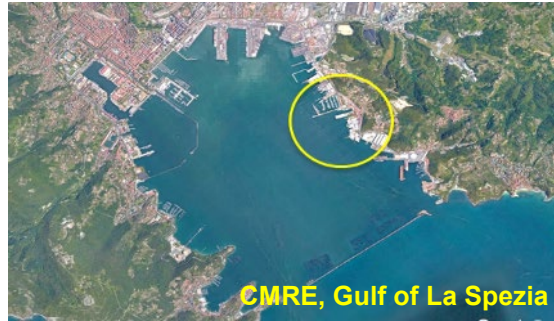
RADM(INSP)  
Cristiano NERVI

# Bottom Line Up Front

- Scope of work:
  - CMRE: design, implementation, operation and maintenance of an underwater Testbed
  - Demonstrators: deploy innovative technologies / equipment, for UXOs detection and characterization
  - IDA-ESTCP: evaluate demonstrations' results
- Working well:
  - Implementation (targets, deployment, geolocation)
  - Operation (logistic support to Demonstrators)
  - Post demonstrations Workshops/Report (with ESTCP and IDA)
  - Lessons identified/learned report
- Not working well:
  - Project significantly behind schedule
  - Few available / interested Demonstrators
  - Low TRL / insufficient performance of Systems

# Site Description

- **Testbed location:** shared ITA-N CSSN / CMRE test area (red line), in front of CMRE HQ (La Spezia, Italy)
- **CMRE laboratories, workshops and facilities** (storage, cranes, docking piers, containers, conference rooms)
- **OpArea** dimensions: 540m x 220m (blue line), depth range: 5m – 12m
- Challenging environment, mud/silt **sediment**, low visibility
- Within the natural gulf of La Spezia, mild climate, fair winds, with **limited** waves/tides/currents
- Anchoring and fishing **formally interdicted**, professional **diving** allowed



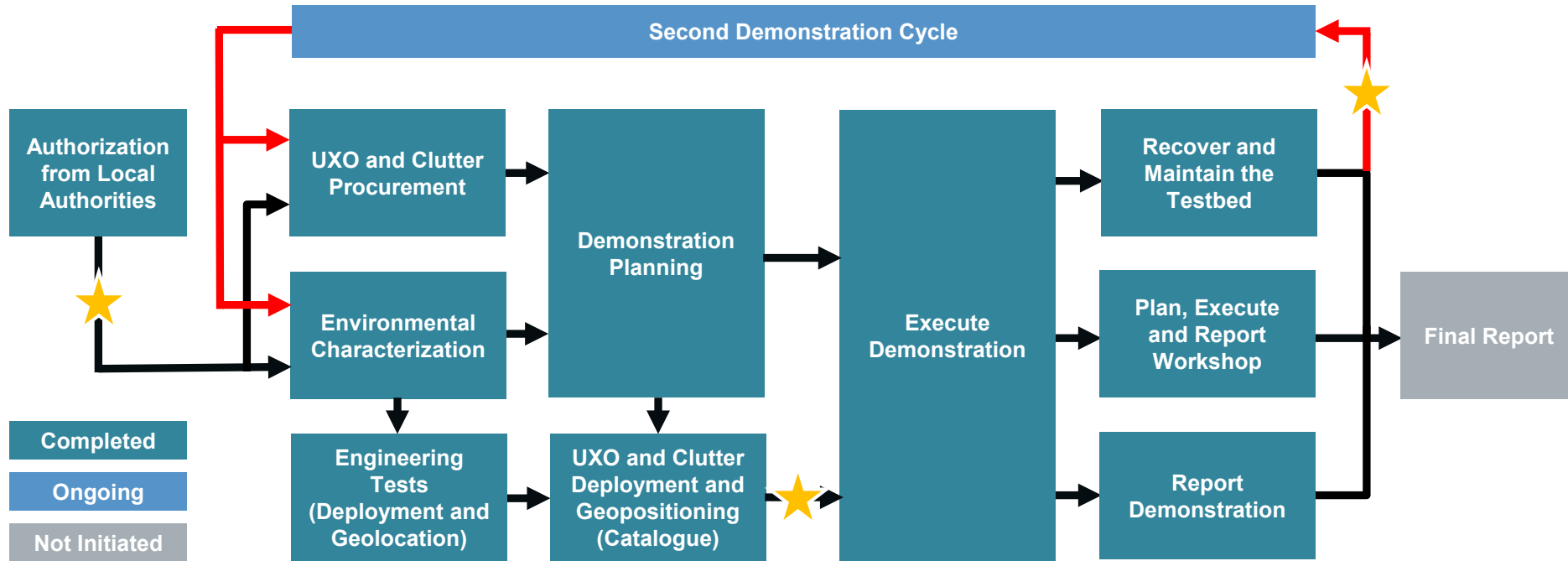
# Technical Approach and Test Design

- **Design and implement** a controlled UXO Testbed at CMRE
  - Full **environmental characterization**
  - Accurate description and location of **target objects** (UXO, clutter, scientific targets)
- Promote the **use of the Testbed** for system Demonstrators
- Provide **logistical support** (engineering, administrative, research) to Demonstrators and ESTCP/IDA
- **Maintain** the Testbed to host two Demonstration cycles
- **Develop** European and Cross-Atlantic **collaboration** via Workshops





# Technical Approach, Flow Chart

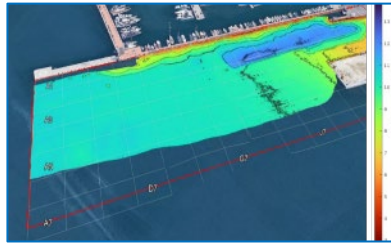
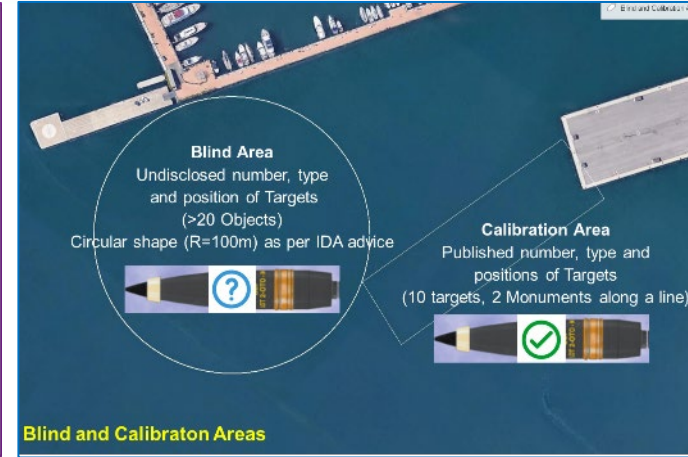
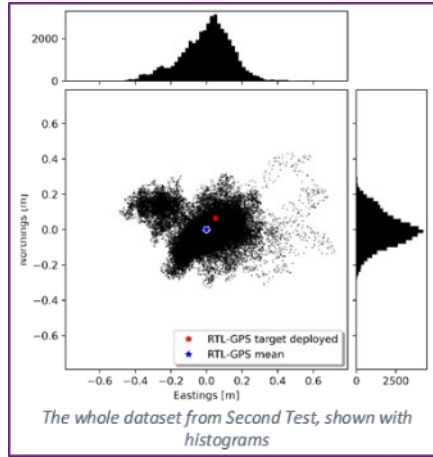


# Performance Objectives

Performance Objective	Data Requirements	Success Criteria
<b>Qualitative Performance Objectives</b>		
<ul style="list-style-type: none"> <li>• <b>Design and implement</b> a controlled UXO Testbed at CMRE</li> <li>• Promote the <b>use of the Testbed</b> for system Demonstrators</li> <li>• Provide <b>logistic support</b> to Demonstrators and ESTCP POs</li> <li>• <b>Maintain</b> the Testbed over 2 years</li> <li>• <b>Develop</b> European and Cross-Atlantic collaboration</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Testbed ready</b> for 2 Demonstrations</li> <li>• <b>Recruit</b> at least 2 Demonstrators / Year</li> <li>• <b>Support</b> 2 Demonstrations</li> <li>• <b>Testbed ready</b> for 2nd Demonstration</li> <li>• <b>Execute</b> workshops, <b>participate</b> to meetings</li> </ul>	<ul style="list-style-type: none"> <li>• (Y/N) = Y</li> <li>• <b>(Y/N) = MAYBE</b></li> <li>• (Y/N) = Y</li> <li>• (Y/N) = Y</li> <li>• <b>Ongoing (50%)</b></li> </ul>

# Results to Date (1)

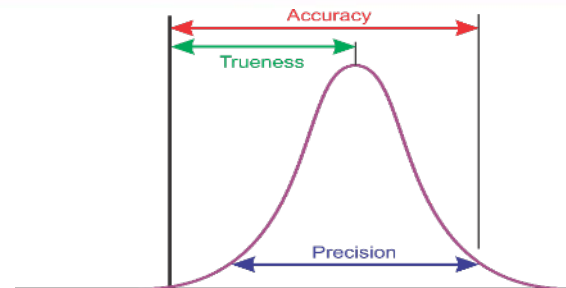
- **Authorization** and permits
- **Environmental** characterization
- **Engineering trials** on deployment and geopositioning
- Preparation of **Demonstration 1**
  - Approval of **Test Plan**
  - Testbed **seeding** (UXO, Clutter, Aco/Mag monuments)
  - Seeding **catalogue** (March 2023)



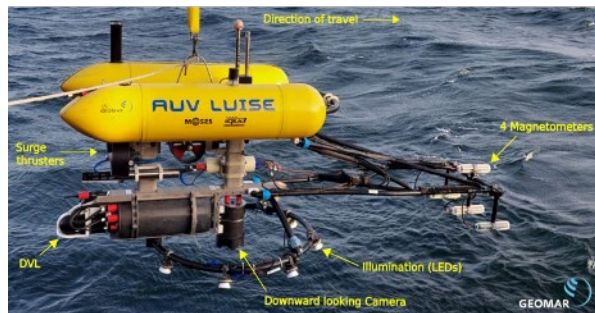


# Results to Date (2)

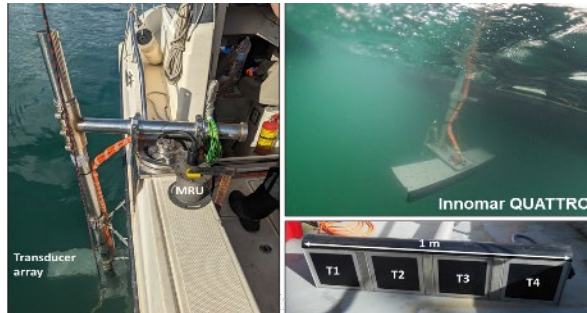
- Execution of **Demonstration 1** (GEOMAR, VLIZ, ELWAVE)
- **Follow up:**
  - **Lessons** identified / learned report
  - **Workshops:**
    - July 2024, CMRE: ESTCP, IDA, CMRE, Demonstrators
    - December 2024, ESTCP Symposium: +MR Stakeholders
  - **Review** of definitions of **geopositioning** precision and accuracy



– Measurement Error +  
Geo-Positioning -Accuracy and Precision – ISO 5725



GEOMAR (GER) – AUV, Magnetometers, Camera



VLIZ (BEL) - Boat, Parametric SBP



ELWAVE (FRA) – ROV, Octopulse CEDAR®

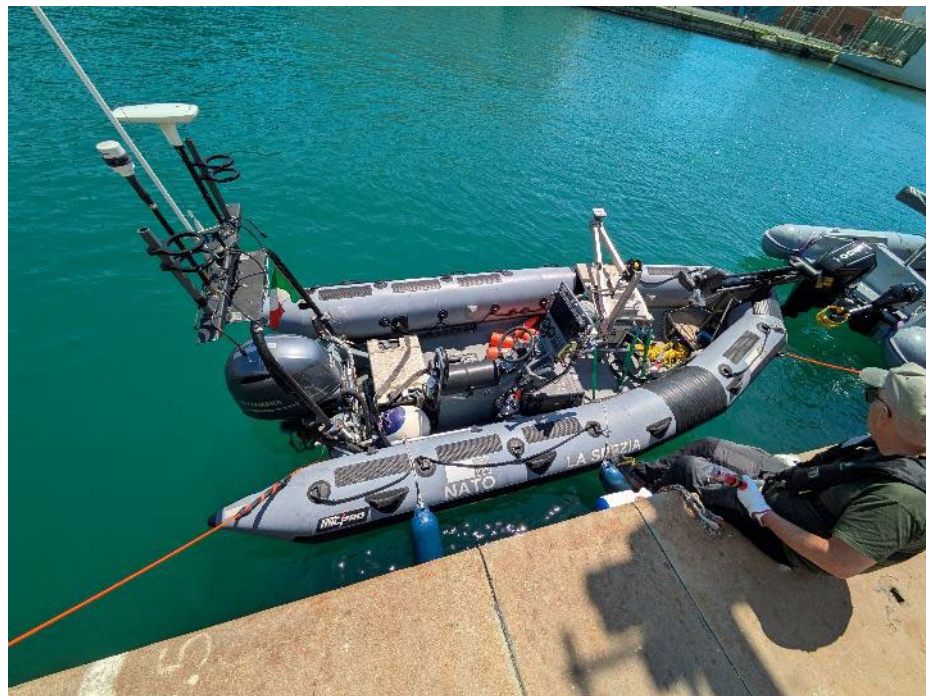
# Results to Date (3)

- Preparation of **Demonstration 2**
  - Approval of **Test Plan** (March 2025)
  - Maintenance of UXO Targets (painting, new numbering)
  - Installation of COTS Trolling Motor on RHIB
    - Allows RHIB's Dynamic Positioning
    - Remote controlled by the Operator
    - Integrated with RHIB Chart Plotter
    - Highly increased deployment efficiency
- Testbed **seeding** (UXO, Clutter, Aco/Mag monuments) and **geopositioning** (May 2025)
  - Method 1: Instant GNSS position at deployment (done)
  - Method 2: Average GNSS position of a float (end of May)
  - Method 3: HiPap system on Divers' Boat (June)
- Seeding **catalogue** (May 2025)



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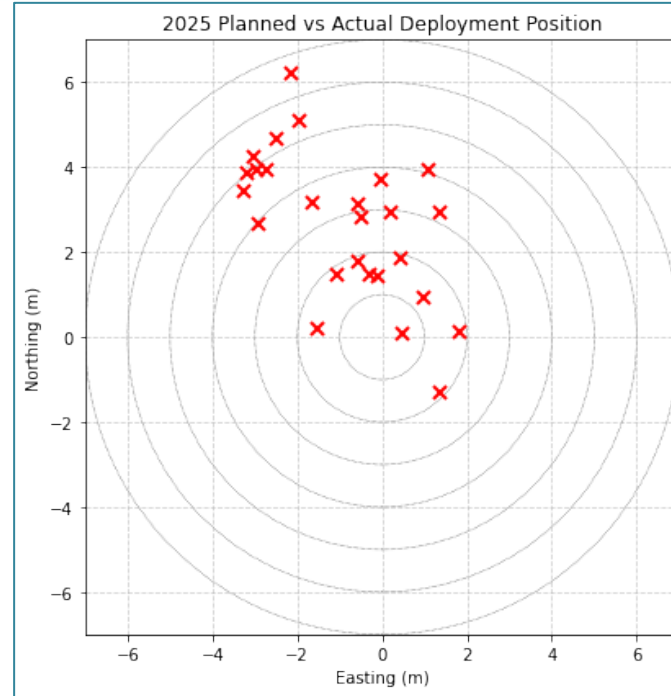
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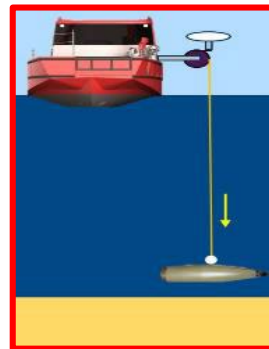
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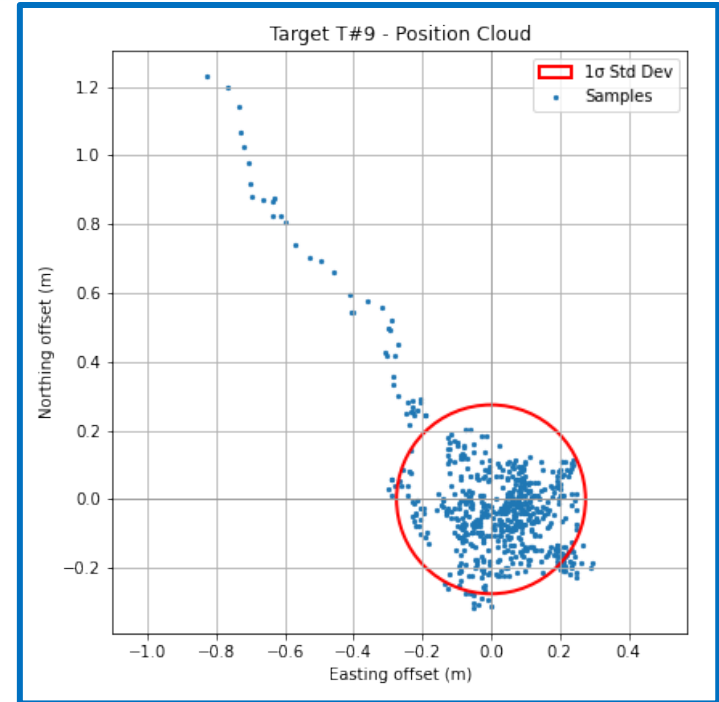
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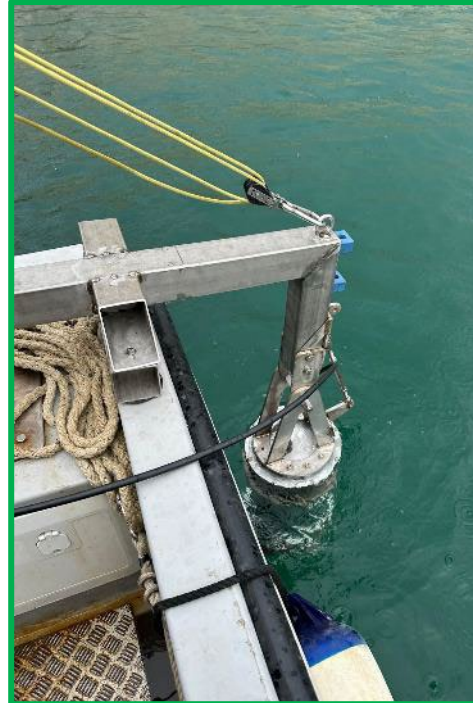
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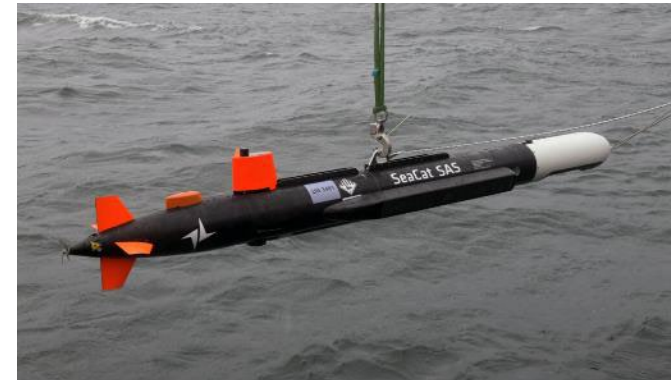
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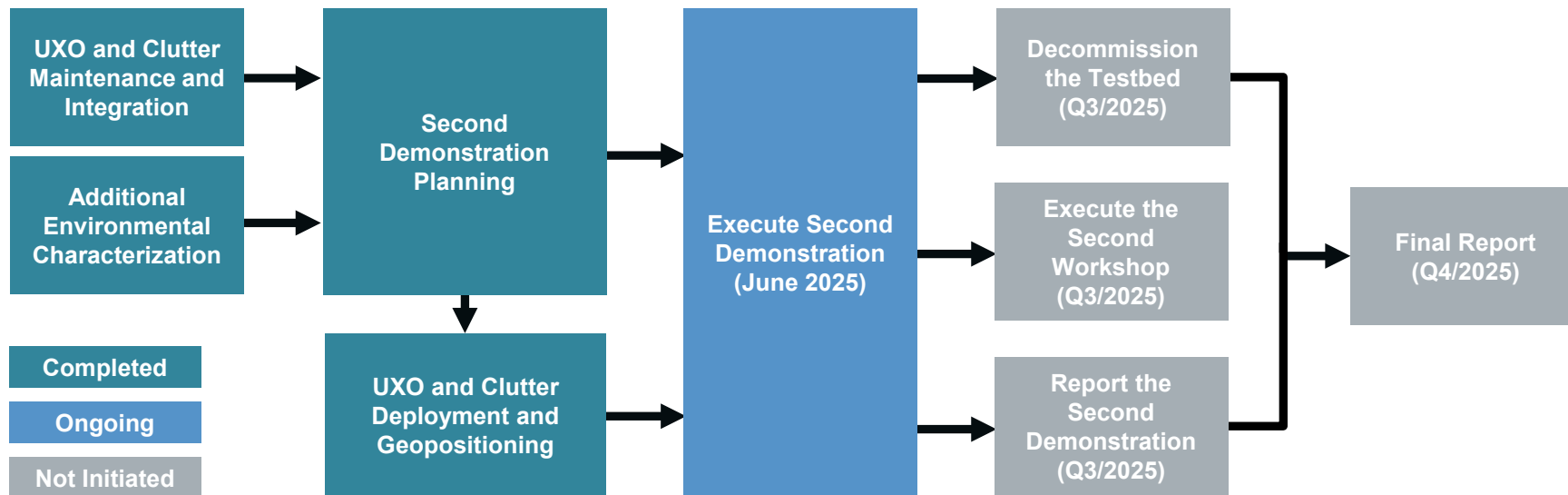


# Results to Date (4)

- Execution of **Demonstration 2**
  - **GEOMAR** (Confirmed)
    - Second Participation
    - POC: Marc Seidel ([mseidel@geomar.de](mailto:mseidel@geomar.de))
    - Dates: June 5 - 13
    - AUV1: Girona 500 “Luise” (Magnetometers, MBES)
    - AUV2: Iqua Robotics Sparus II “Albert” (forward-looking and side scan sonars)
  - **ATLAS Elektronik** (*Waiting for confirmation*)
    - First Participation
    - POC: Franziska Auer ([Franziska.Auer@atlas-elektronik.com](mailto:Franziska.Auer@atlas-elektronik.com))
    - Dates: June 16—20 *pulled out and asked to move in July*
    - AUV: SeaCat with Synthetic Aperture Sonar



# Next Step: Second Demonstration Cycle



# Technology Transfer

## ▪ Workshops

- ESTCP, IDA, CMRE, End-Users (Demonstrators), +MR Stakeholders (at ESTCP Symposium)
- Focus on Lessons Learnt during implementation and demonstration
- Way ahead

## ▪ Conferences and Seminars to advertise the Project

- SERDP/ESTCP Symposiums, IPRs, Sidebars
- Conferences (Ravenna, ITA; Rostock, Kiel, GER; NATO HQ, BEL; Kalamata, GRC; Valletta, MAL)
- NATO DIANA Partnerships

## ▪ Postings on social media and CMRE website

- **NATO-STO-CMRE Annual Reports** (Public Release)



# BACKUP MATERIAL

# MR21-5243: CMRE UXO Test Site Implementation, Demonstration and Maintenance

## Performer

- NATO-STO-CMRE, Centre for Maritime Research and Experimentation, La Spezia (Italy)

## Technology Focus

- Munition Response – Environmental Characterization - Implementation of a controlled Testbed – Demonstration and evaluation of UXO detection technologies - Logistic and engineering support

## Demonstration Site

- CMRE Water Basin, Gulf of La Spezia (Italy)

## Demonstration Objectives

- Implement and maintain an UXO Testbed, and support its use by Demonstrators in two yearly cycles
- Develop Cross-Atlantic collaboration, publicize the Project and the ESTCP / CMRE roles

## Project Progress and Results

- UXO Testbed authorized, designed, implemented
- First cycle of three Demonstrations completed
- Maintenance of the testbed completed
- Demonstration report and workshop planning completed
- Second cycle of Demonstrations in June 2025

## Implementation Status

- 12+ months delay from Project Plan (COVID-19, over-allocation of CMRE Resources)
- No other major issues currently identified or foreseen
- Next steps: decommissioning, second workshop, final report, project closure (by 12/2025)





# Plain Language Summary

- What problem are you addressing? UXO remediation from contaminated underwater sites
- What are you trying to achieve? Evaluation of autonomy, automation and performance of innovative technologies that can be operated at sites affected by military munitions, including those located underwater, to detect, characterize, and classify UXOs, and to form the initial phase of a process that ultimately could lead to their remediation
- How are you doing it? Implement a Testbed, offering well defined and controlled conditions to demonstrate UXO detection and classification technologies, and promote its integration in a worldwide network with other Sites
- What are the expected outcomes and how is it advancing existing knowledge? Several technologies are currently available, to be integrated in sensing platforms for underwater UXO remediation. New advanced sensors and platform are being developed and can be operated at the Testbeds, promoting their development to higher TRLs

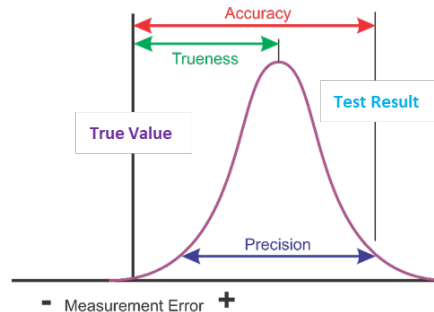
# Action Items

- 2024 MR Spring In-Progress Review: assigned action
  - “Review your definitions of precision and accuracy to ensure they align with industry standards and best practices. Provide clarification as a comment to this action item and incorporate the agreed upon definitions into your final report”
- Addressed during the 2024 SERDP-ESTCP Symposium: “CMRE UXO Demonstration Site Sidebar – (December 5th, 2024)”
- Will be inserted in the Final Report

# Action Items

**accepted reference value:** value that serves as an agreed-upon reference for comparison:

- a **theoretical** or established **value**, based on scientific principles or;
- an **assigned** or certified **value**, based on experimental work or;
- a **consensus** or certified **value**, based on collaborative experimental work of scientific or engineering groups or;
- the **expectation**, i.e. the **mean** of a specified population of measurements when the above are not available



**accuracy:** closeness of agreement between a **test result** and the **true value**

- **accuracy** refers to a combination of **precision** and **trueness**
- in practice, the **accepted reference value** is substituted for the **true value**

**test result:** value of a characteristic obtained by carrying out a specified **test method**

**precision:** closeness of agreement between independent **test results** obtained under stipulated conditions

Precision depends only on the distribution of random errors and does not relate to the **true value**

**trueness:** closeness of agreement between the expectation of test results and a **true value**

# Impact to DoD Mission

- The Program Office wants to convey the significance of your research to DoD leadership, Congress, and the broader community.
  - What's the most impactful thing that's happened since the last time you presented your work to us? **First demonstration results reported to the ESTCP MR community**
  - Why is this important? **Sharing of lessons identified and learned during the Testbed implementation and operation**
  - How is your project advancing DoD capabilities? **Cross-Atlantic exchange between MR communities, increased knowledge and awareness of legacy and innovative sensing system and platforms for UXO identification in a very challenging environment**

# Publications

ELWAVE, GEOMAR, VLIZ - "A Comparison of Magnetic, Electric and Sub-Bottom Profiler Data Acquired on the Underwater UXO Proving Ground in La Spezia, Italy" (draft).

Joint publication, comparing the different UXOs detection and identification techniques used during the first Demonstration (2023/2024)



# Acronym List

AUV – Autonomous Underwater System

BEL – Belgium

CMRE – Centre for Maritime Research and Organization

COTS – Commercial Off The Shelf

CSSN – Centro per il Supporto e la Sperimentazione Navale

DIANA - Defence Innovation Accelerator for the North Atlantic

DP – Dynamic Positioning

ESTCP - Environmental Security Technology Certification Program

GER – Germany

GRC - Greece

HQ – HeadQuarters

IDA – Institute for Defense Analyses

IPR – In Progress Review

ITA - Italy

ITAN – ITAliaN Navy

MAL – Malta

MBES – Multi Beam Echo Sounder

NATO – North Atlantic Treaty Organization

OLBP - Observations, Lessons and Best Practices

PI – Principal Investigator

PO – Program Officer

SERDP - Strategic Environmental Research and Development Program

STO – Science and Technology Organization

TRL – Technology Readiness Level

USBL – Ultra Short Baseline

UXO – UneXploded Ordnance

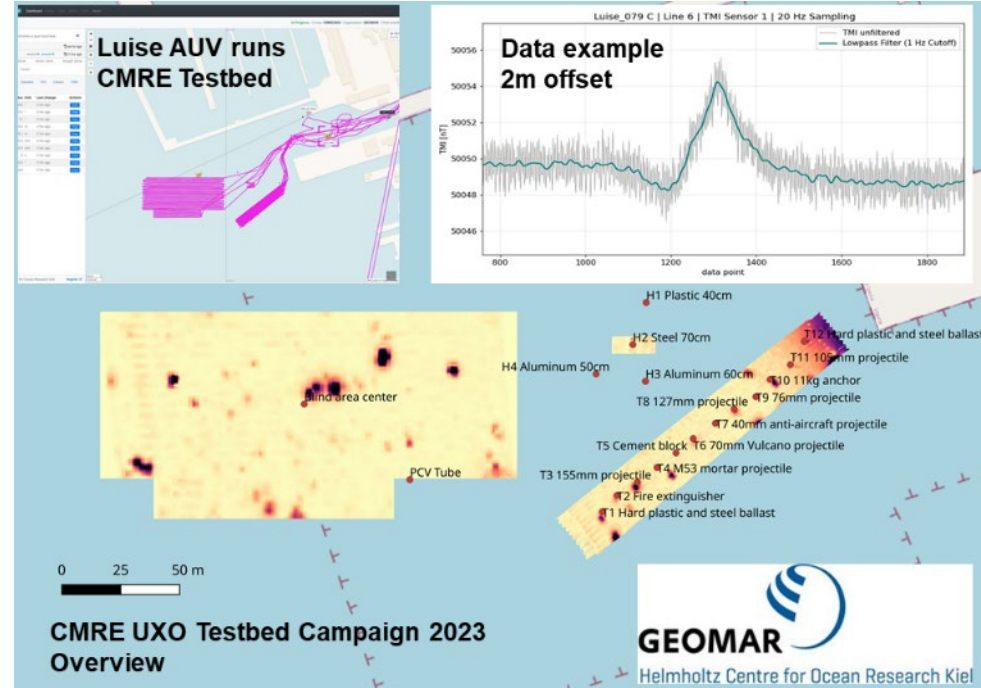
VLIZ, Vlaams Instituut voor de Zee, Flanders, (Belgium)

# BACKUP MATERIAL (2)

# Results to Date – First Demonstration Cycle

## GEOMAR (GER) – Sep 2023

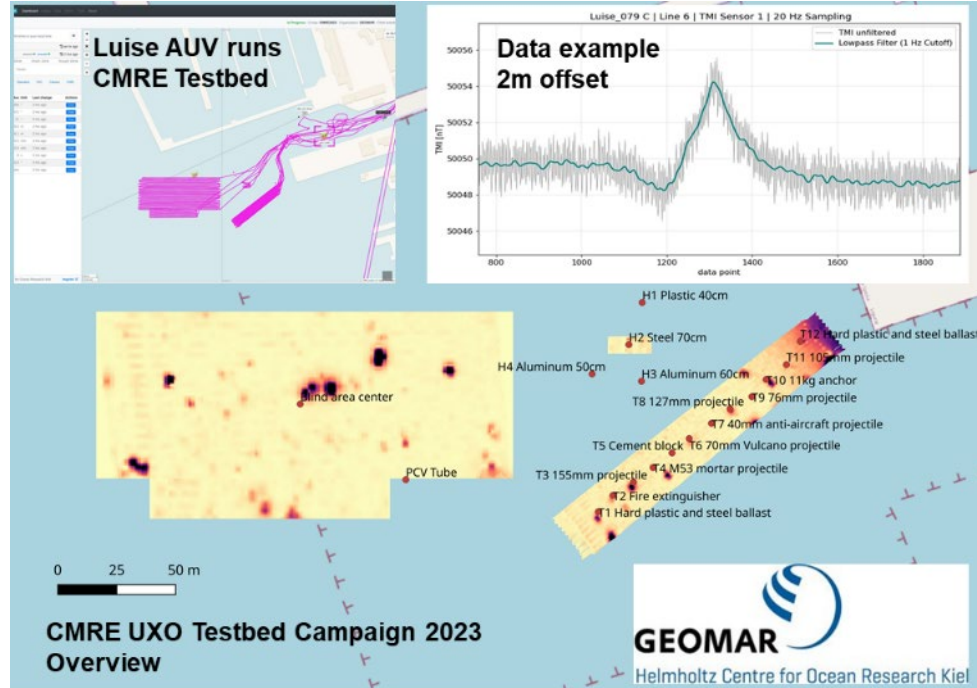
- Platform: AUV
- Sensors: Magnetometers



# Results to Date – First Demonstration Cycle

## GEOMAR

- Platform: AUV
- Sensors: Magnetometers
- UW Camera, MBES
- System under development (sensors, autonomy)
- Reliably detecting UXO down to ~80mm
- Limited by water current (>1m/s)
- Good detection at ~2m ver/hor offset
- Need for known/smooth bathymetry (or obstacle avoidance system)
- Difficult UW Camera classification in poor visibility conditions, MBES as backup
- Ranked detection shared with IDA and ESTCP

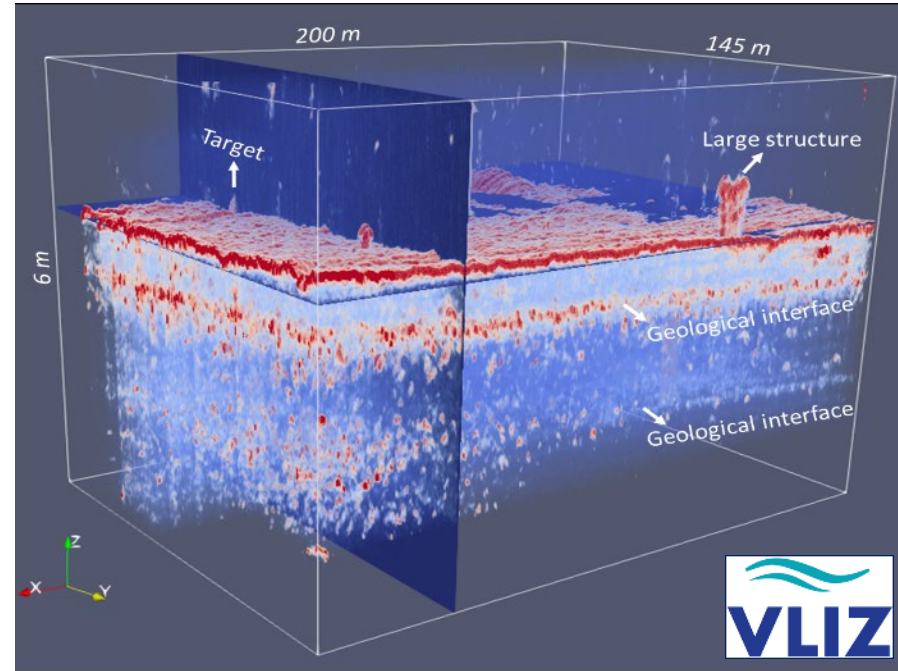
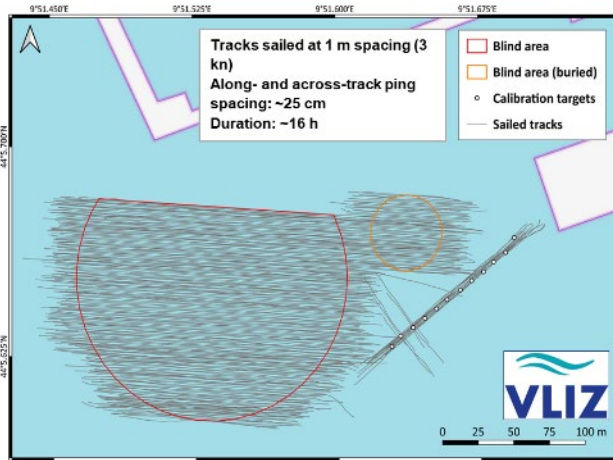




# Results to Date – First Demonstration Cycle

## VLIZ (BEL) – Sep 2023

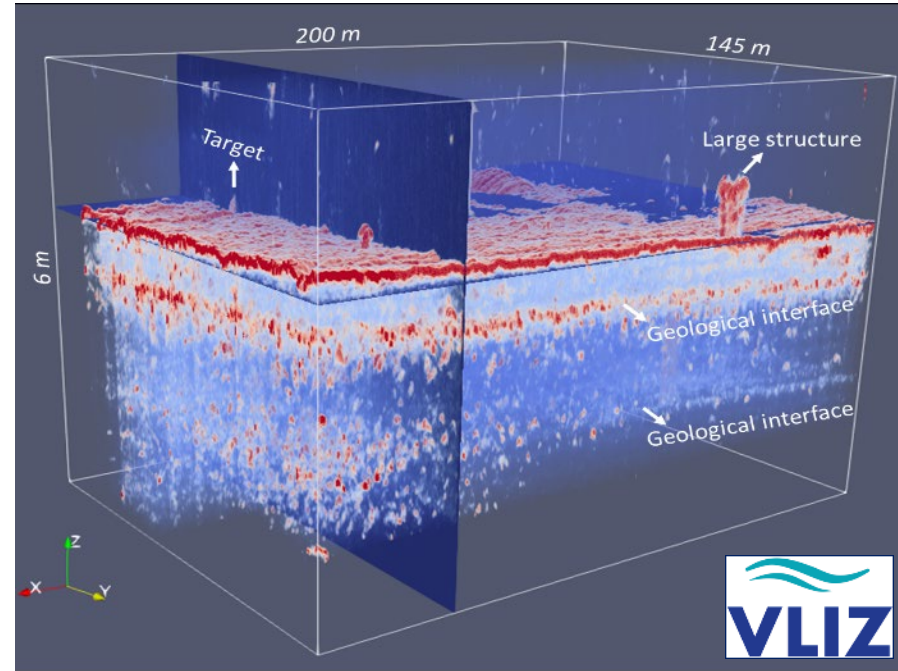
- Platform: surface boat, over the side mounting
- Main sensor: Parametric Sub-Bottom Profiler



# Results to Date – First Demonstration Cycle

## VLIZ

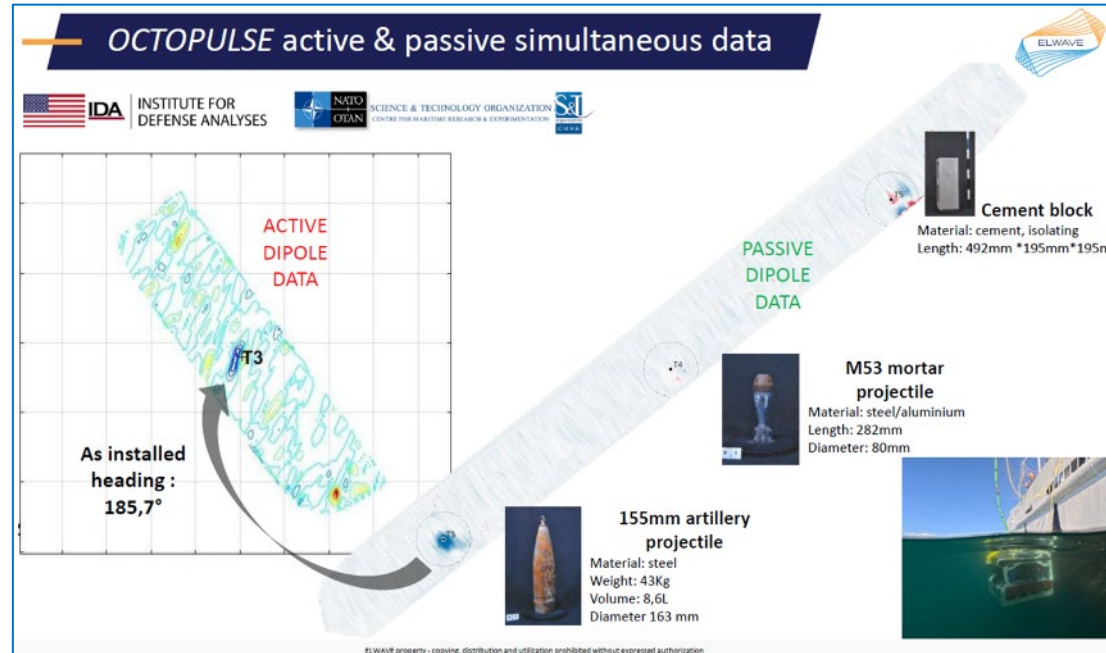
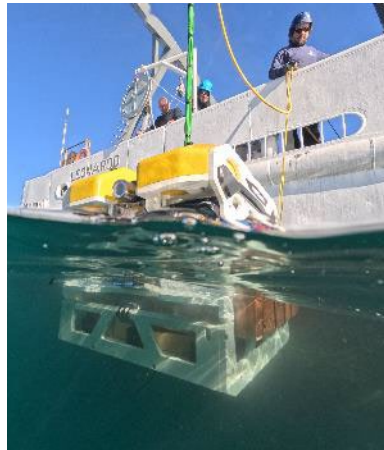
- Platform: surface boat, over the side mounting
- Main sensor: Parametric Sub-Bottom Profiler
- 3D Volume generated through interpolation of 2D sub-bottom profiles; XY plane (depth slice) and YZ plane (vertical slice) can be extracted
- Challenging analysis, lot of potential targets to be classified
- Quantitative analyses of reflection amplitudes or frequency content needed for the MR application
- Ranked detection list filled and shared with IDA and ESTCP



# Results to Date – First Demonstration Cycle

## ELWAVE (FRA) – Feb 2024

- Platform: ROV deployed from Ship
- Main sensor: Octopulse CEDAR® Sensor
- Engineering Trial on Calibration line only





# Results to Date – First Demonstration Cycle

## ELWAVE (FRA) – Feb 2024

- Platform: ROV deployed from Ship
- Main sensor: Octopulse CEDAR® (Controlled Electric Detection And Ranging) Sensor
- Bio-inspired by active electro-location perception mode of tropical fishes
- Claimed performances:
  - Real-time 360° perception
  - Location and characterization (size, shape, material, alive)
  - Metallic and non-metallic objects
  - Efficient for buried objects and in complex environments (turbid, cluttered)

