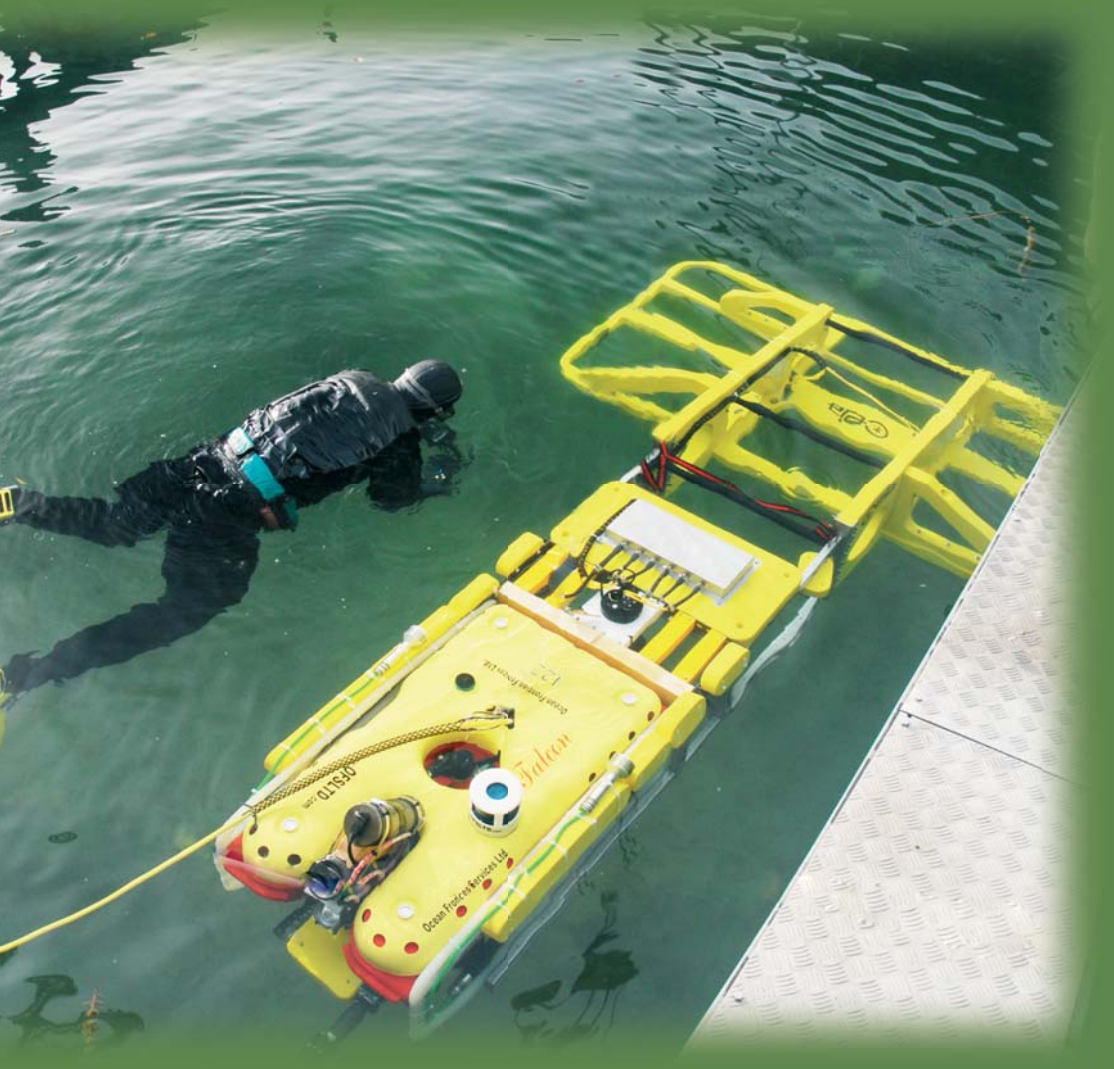

CEIA® USA

Multi-Zone UXO Metal Detector

with determination of object size and depth for Submarine Operations

GENERAL PRESENTATION

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INTRODUCTION

- In the past, **oceans and lakes were considered convenient dumping grounds** for the disposal of no longer needed **ammunition of all kinds**.

- **At that time, the current dismantling practices were not available**. Only later were the potential impact on the environment and also the potential dangers associated with this practice recognized.

INTRODUCTION

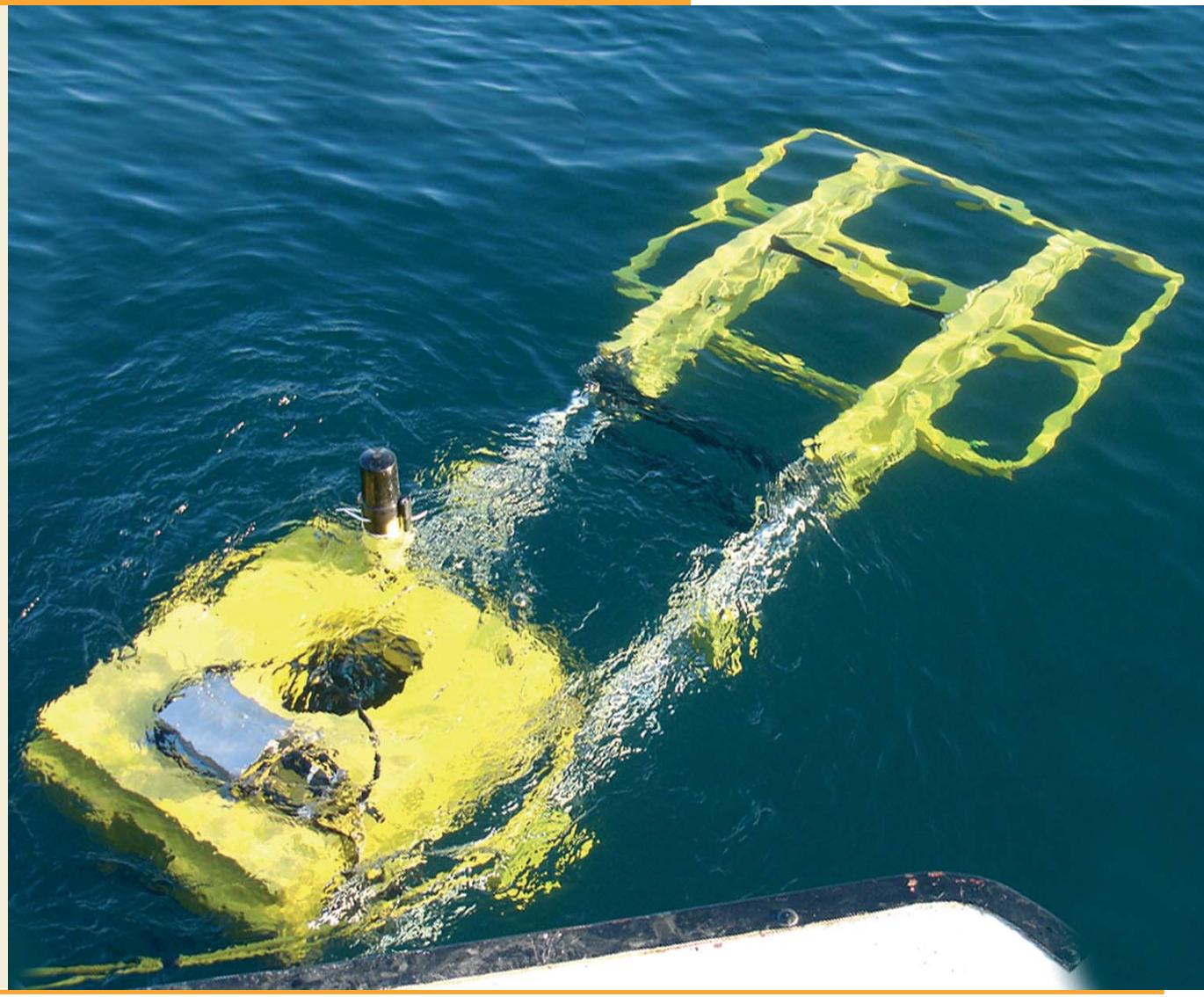
- To inspect the current condition of the dumped ammunitions, to evaluate their longevity and possibly even recover them, **it is first necessary to accurately locate the ordnance and map the dump sites**.
- Since most of the items have sunk into the ground or have been covered by silt, **finding and mapping them now is no easy task**.
- Visual inspection of the floor of a lake or sea bed may lead to some results, **but by no means can it give an accurate picture of what is present and where**.

ARMASUISSE (CH) PROJECT OF LAKES INVESTIGATION

- **The investigation procedure** followed in this project **included**:
  - Magnetometer anomalies mapping
  - Side-Scan Sonar mapping of the ground
  - Detailed detection of the objects in the areas of interest by ROV with visual inspection and special detection of buried metal masses.
- Ideally, **a discovery and mapping operation will provide data** not only on location of objects, **but also their size and possibly even their depth under the floor**.

PROJECT HISTORY

- **In 2006,** based on the initial requirements of the Swiss Department of Defense, **the design of a first underwater large coil metal detector was started**.
- The engineering phase was completed in early 2007 with the production release of the equipment.



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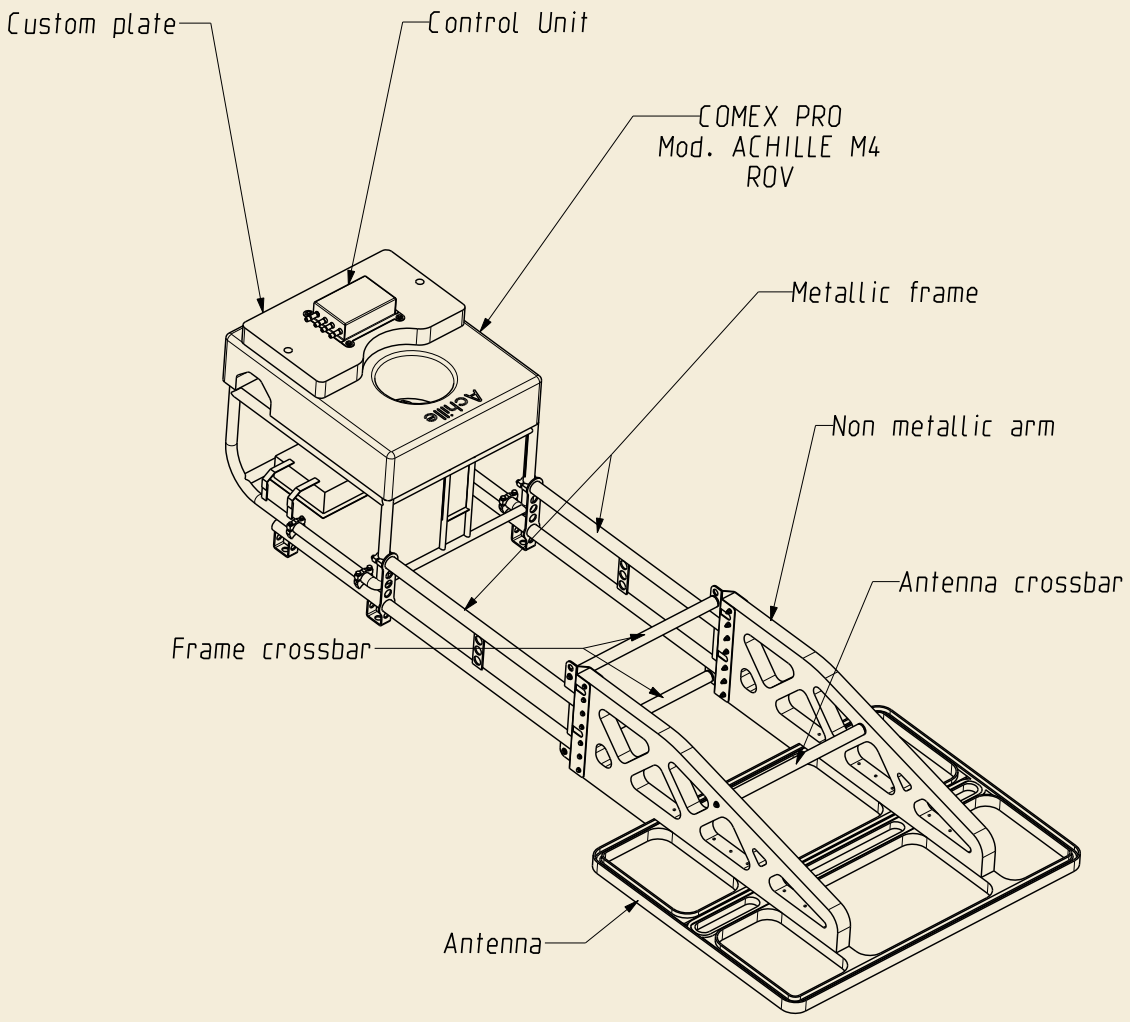
PROJECT HISTORY

SINGLE ZONE LINEAR METAL DETECTOR

The unit is a single zone EMI Metal Detector based on a bi-static Transmitter/ Receiver planar antenna with an active surface area of 1150mm (W) x 900mm (L).



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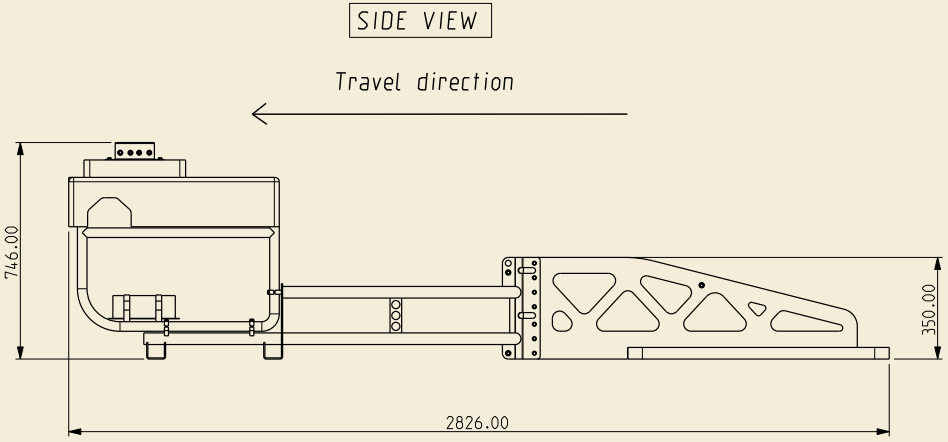
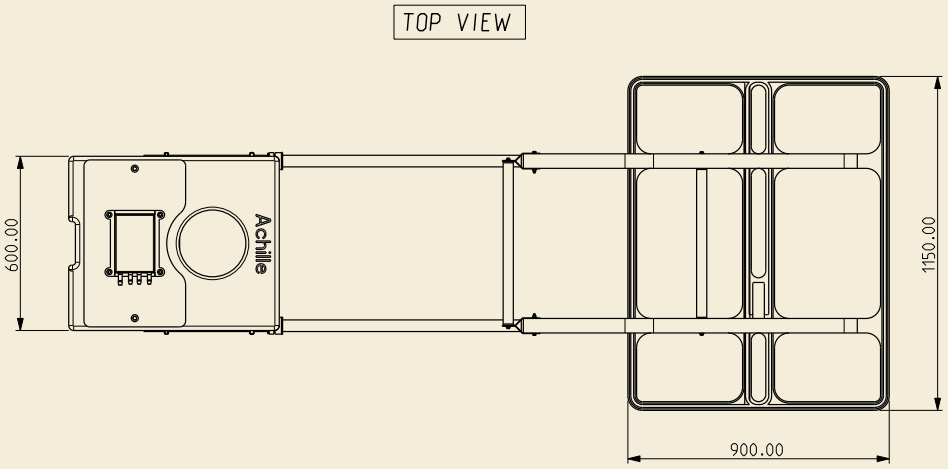
PROJECT HISTORY

SINGLE ZONE LINEAR METAL DETECTOR

The detection system is based on the transmission and receiving of a low frequency electromagnetic field and it is tuned to detect targets made of magnetic and non-magnetic metals. The antenna design and the Digital Signal processing allow the equipment to be highly adaptable to mineralized soils.





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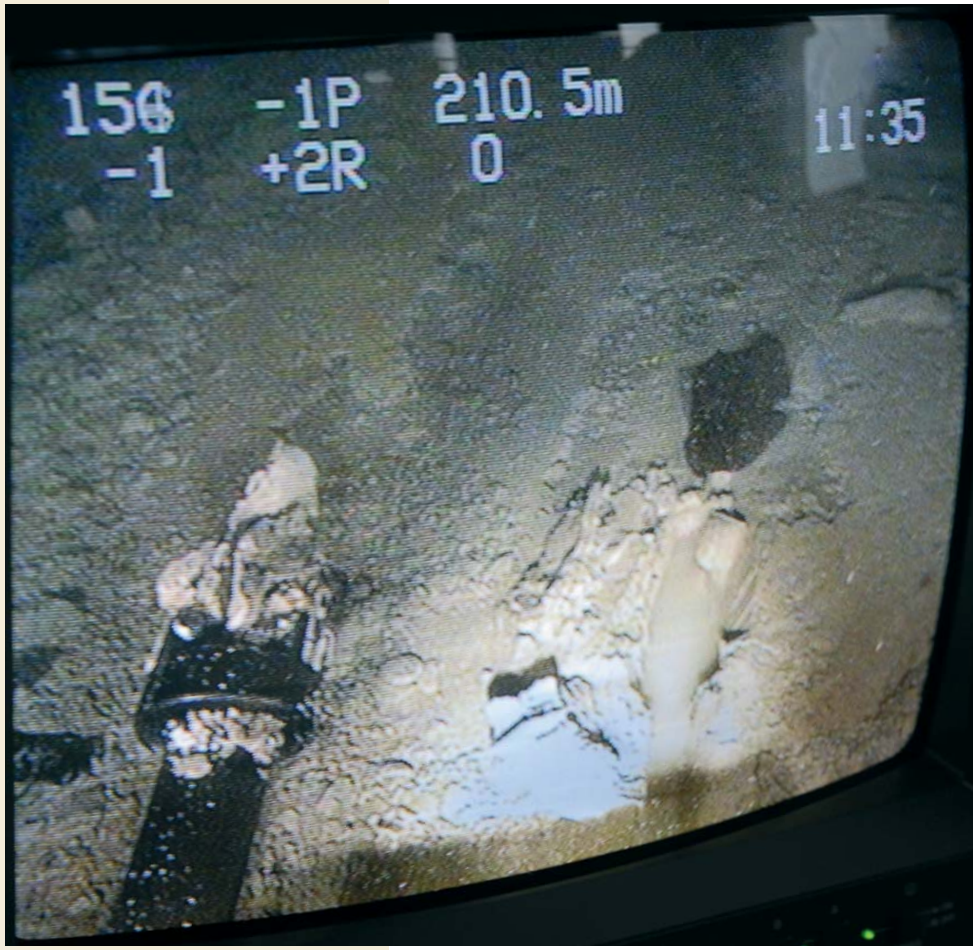
PROJECT HISTORY

SINGLE ZONE LINEAR METAL DETECTOR

- **Armasuisse Science and Technology Center** has used this linear metal detector **to survey the floor of a lake up to a depth of 705 ft** (March 2007).

- **The operation of the detector was controlled** from a surface vessel connected to the ROV by a cable and assisted by a system of lights and **cameras allowing to see visible objects and avoid obstacles** like tree trunks and rocks



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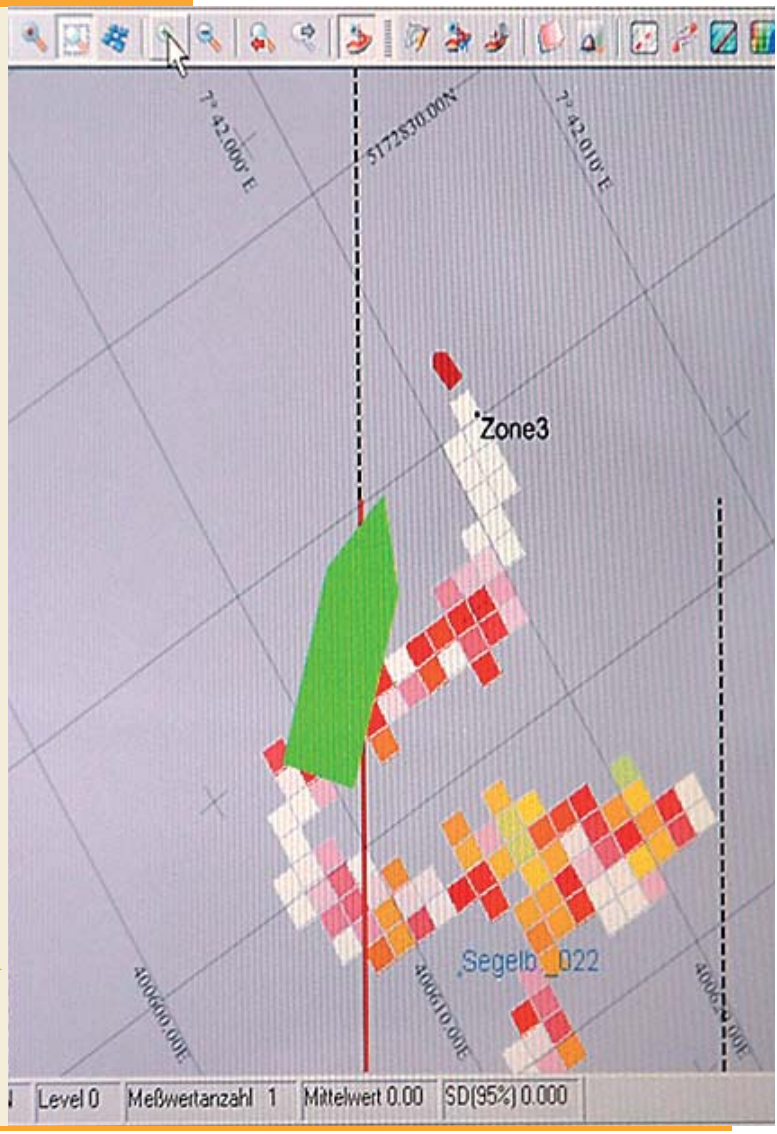
PROJECT HISTORY

SINGLE ZONE EMI METAL DETECTOR

- **The data received from the metal detector were collected by a data acquisition system**. This system based one ultrasonic waves (tranducer mounted on RoV and receiver mounted on search-vessel just underneath the water level) gives the distance and the angle from the RoV to the seach-vessel. **This data is then linked with the data from a DGPS**, a high precision compass and roll and pitch sensors to determine the exact position of the RoV

- **This resulted in a colorized map of the lake bottom**.



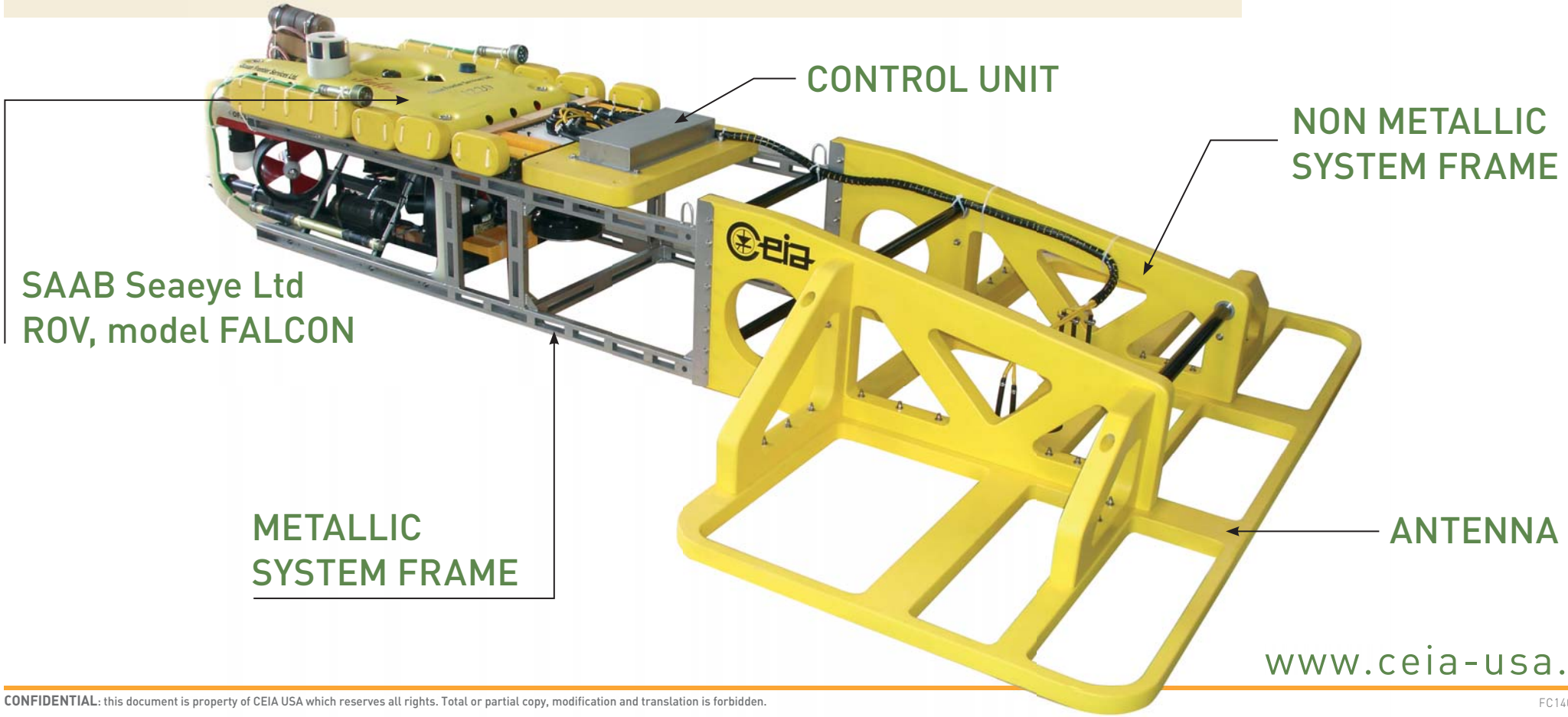
MULTI-ZONE LINEAR METAL DETECTOR ARRAY

The success of this first device resulted in the pursuit of **research and development of an even more advanced metal detector** equipped with a linear array antenna which would allow:

- Greater survey width, for each single run, to reduce the number of passages required to cover a given area, thus decreasing the survey time needed.
- Determination of the position of the objects found within the coil.
- Data on the size of the object.
- Data on how deep the object is buried.

MULTI-ZONE LINEAR METAL DETECTOR ARRAY

This second model was designed for operations at **depths of up to 1000 ft**.



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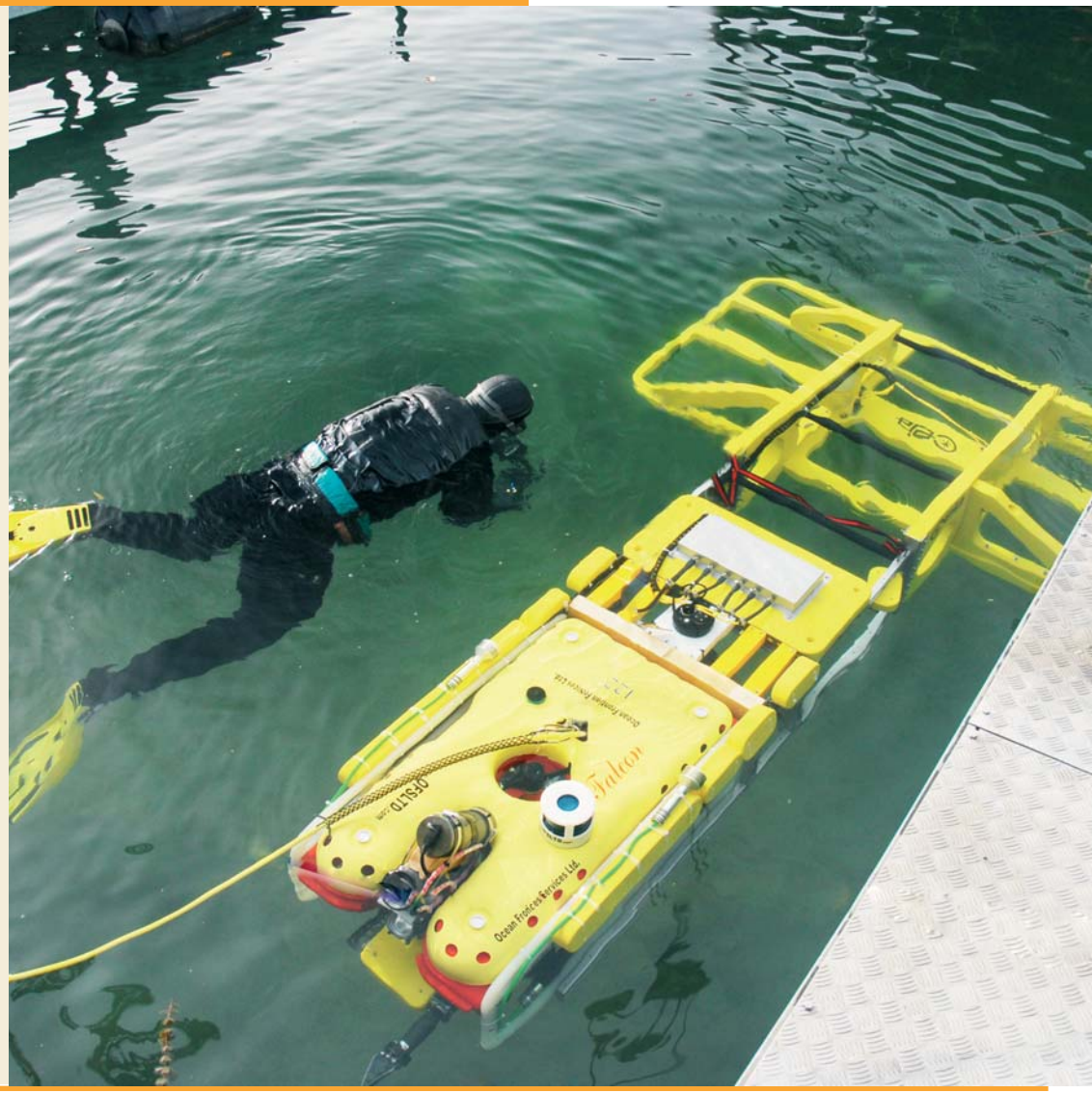
CEIA MULTI-ZONE UXO METAL DETECTOR

ANTENNA SYSTEM

- The **antenna** consists of five detection zones arranged in a single line array.

- **The planar search antenna** is two meters wide by one meter long and equipped with a mechanical support consisting of two arms with which it is attached to the ROV.



CEIA MULTI-ZONE UXO METAL DETECTOR

ANTENNA SYSTEM

- **The antenna consists of 12 independent transmission and receiving** windings for the electromagnetic field in order to satisfy the detection needs and to provide sufficient data to determine position, dimension and depth of the target.
- During design and construction, **particular care was also given to isolate the antenna from external interference sources**, which could be electromagnetic (motors, lighting systems, electronics on the ROV) or mechanical (static or vibrating metallic structures in the vicinity).

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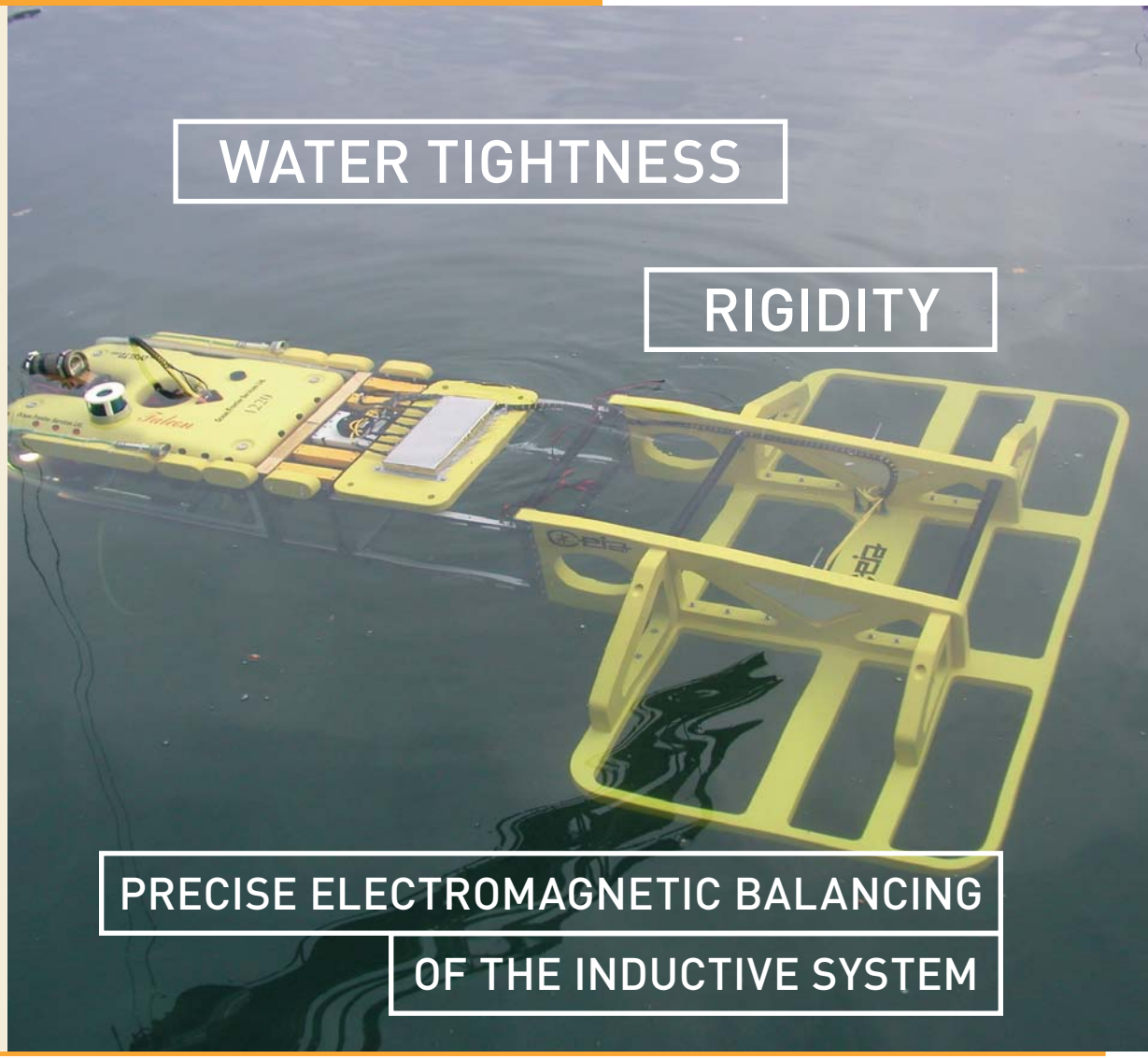
CEIA MULTI-ZONE UXO METAL DETECTOR

ANTENNA SYSTEM

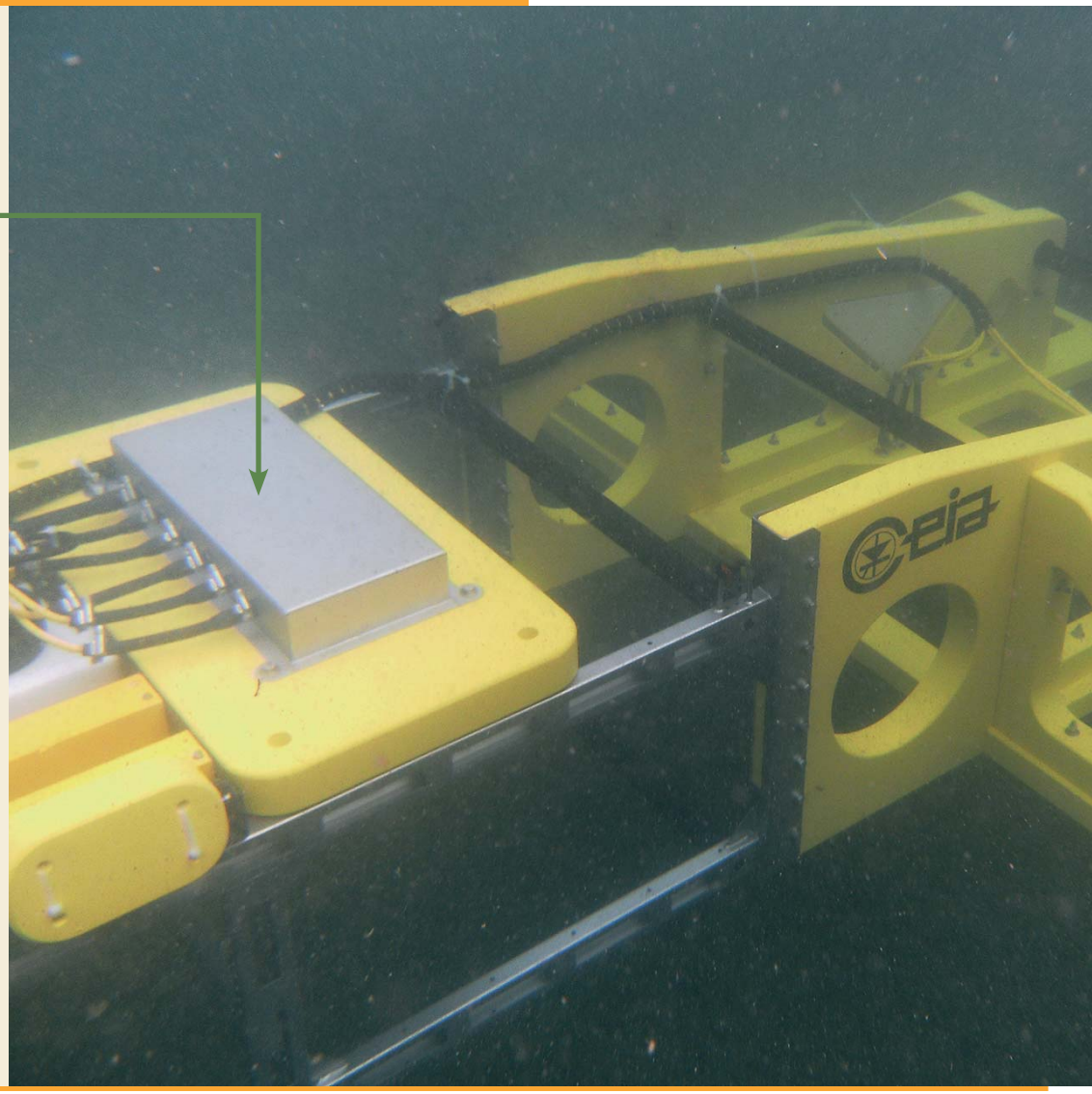
The fundamental characteristics of the antenna system needed to achieve the best signal/noise ratio and to be able to operate with high dependability **are rigidity, water tightness** (@ 3 MPa pressure) **and the precise electromagnetic balancing** of the inductive system.



CEIA MULTI-ZONE UXO METAL DETECTOR

ELECTRONIC CONTROL UNIT

- The electronic **control unit is housed in a AISI316 Stainless Steel** enclosure similar to the one used in the first single zone device.
- The enclosure is equipped with a flange for attachment to the ROV. To prevent any infiltration of water, the enclosure is filled with resin.



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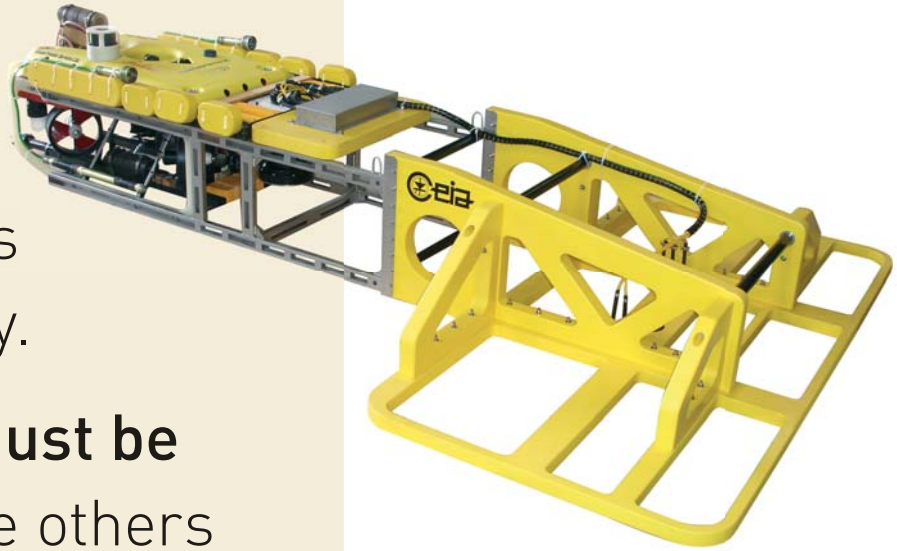
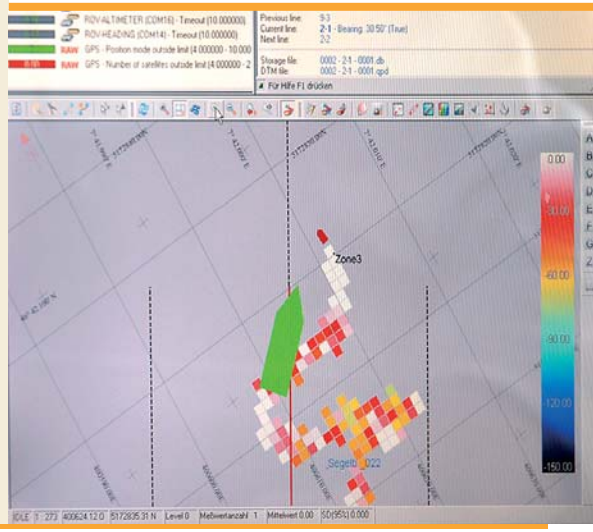
CEIA MULTI-ZONE UXO METAL DETECTOR

DETECTION RESULTS

- **The electromagnetic design of the antenna array has been particularly challenging**, as twelve emitters/receivers coils are required to work simultaneously.



- **Each coil, either emitter and receiver, must be insulated from the inductive effect** of the others surrounding it in order to provide performances and signals independent from the coupling of metal masses passing under different areas of the same antenna array.



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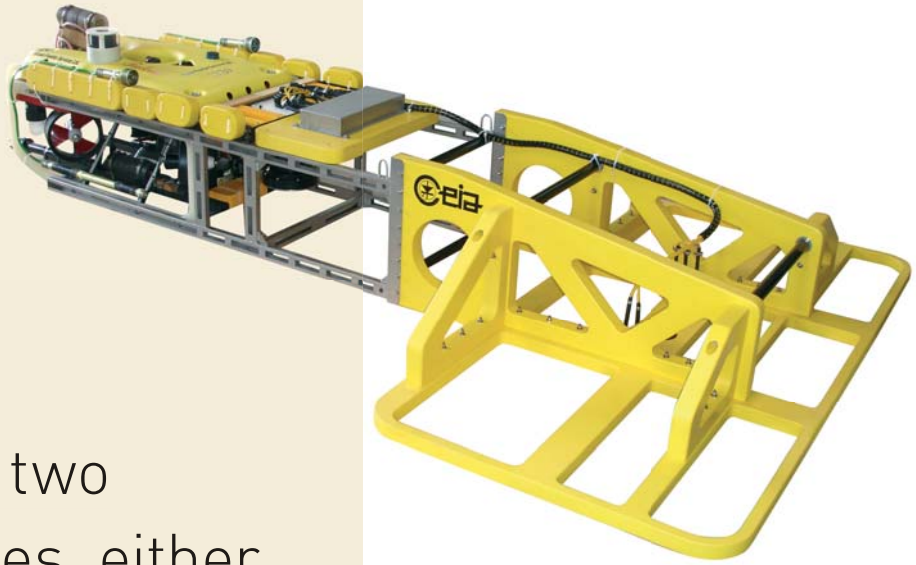
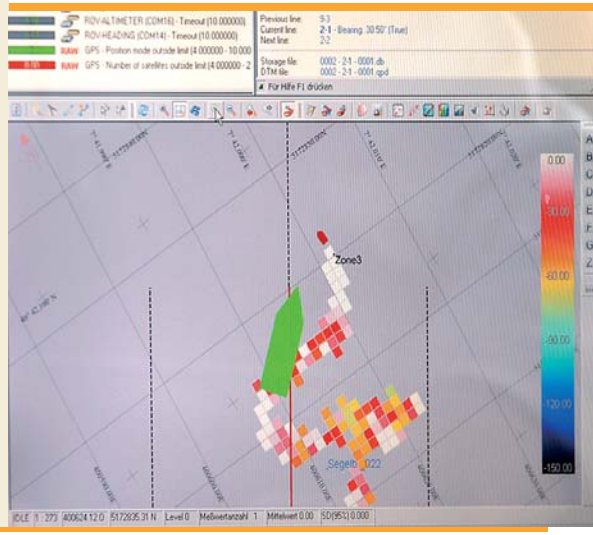
CEIA MULTI-ZONE UXO METAL DETECTOR

DETECTION RESULTS



THE CRITICAL PARAMETERS THAT EACH ANTENNA SECTION HAS TO COMPLY WITH ARE

- **SENSITIVITY**: detection distance up to two meters is required for large metal masses, either magnetic and non-magnetic which implies very low background noise of the system



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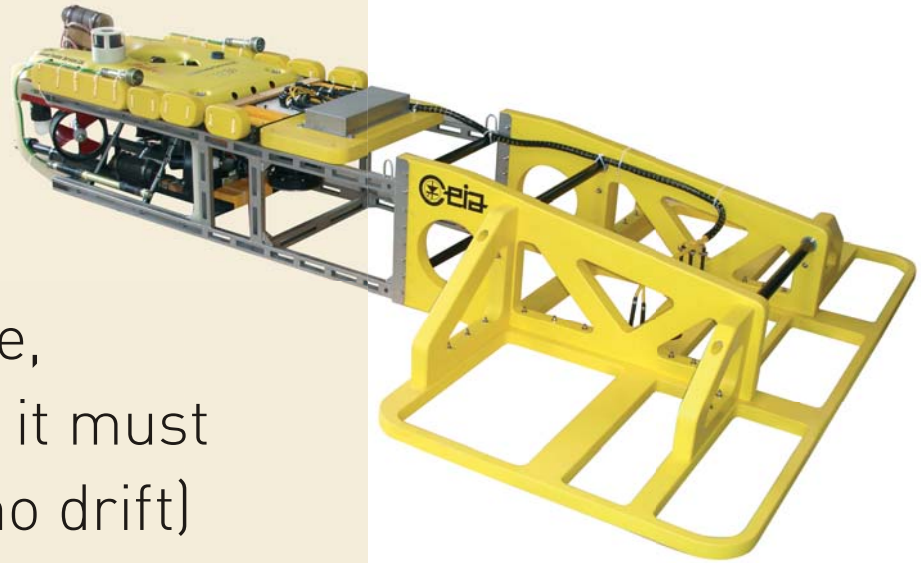
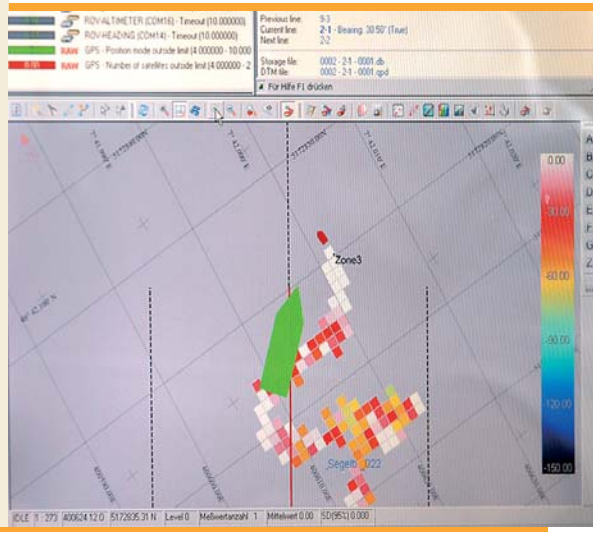
CEIA MULTI-ZONE UXO METAL DETECTOR

DETECTION RESULTS



QUASI STATIC DETECTION:

the system allows the detection of the metal masses in a wide speed range, particularly at very low speed, therefore it must be characterised by very high stability (no drift) over time and temperature, even at the maximum sensitivity



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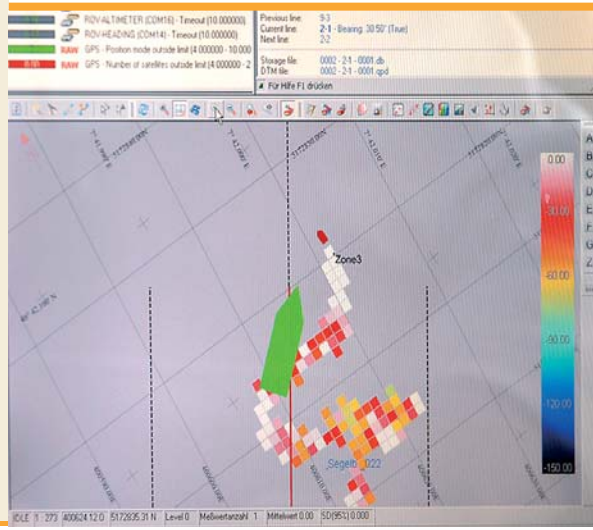
CEIA MULTI-ZONE UXO METAL DETECTOR

DETECTION RESULTS

IMMUNITY: electromagnetic noise sources, such as the lighting and the electric motors of the ROV, have to be completely filtered by the Metal Detector system, even at the maximum sensitivity.

This requires very high selectivity and sharp transition from the pass band to the stop band of the demodulated signals



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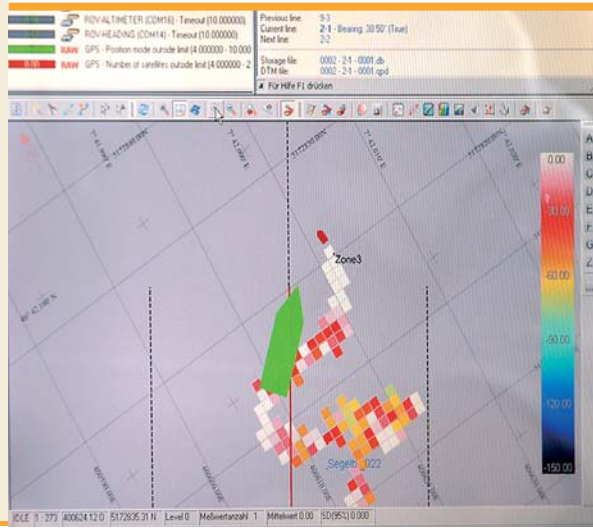
CEIA MULTI-ZONE UXO METAL DETECTOR

DETECTION RESULTS

- **DYNAMIC RANGE**: the system is intended for the detection of metal masses ranging from small to large size, buried at different depths. Therefore a very wide dynamic range and high linearity is required for correct representation and analysis of the received signals.

- According to the above considerations, **the CEIA Laboratory has conducted an intensive electromagnetic evaluation**, based on several antenna set-ups and assessed the best achievable performances of the proposed system.



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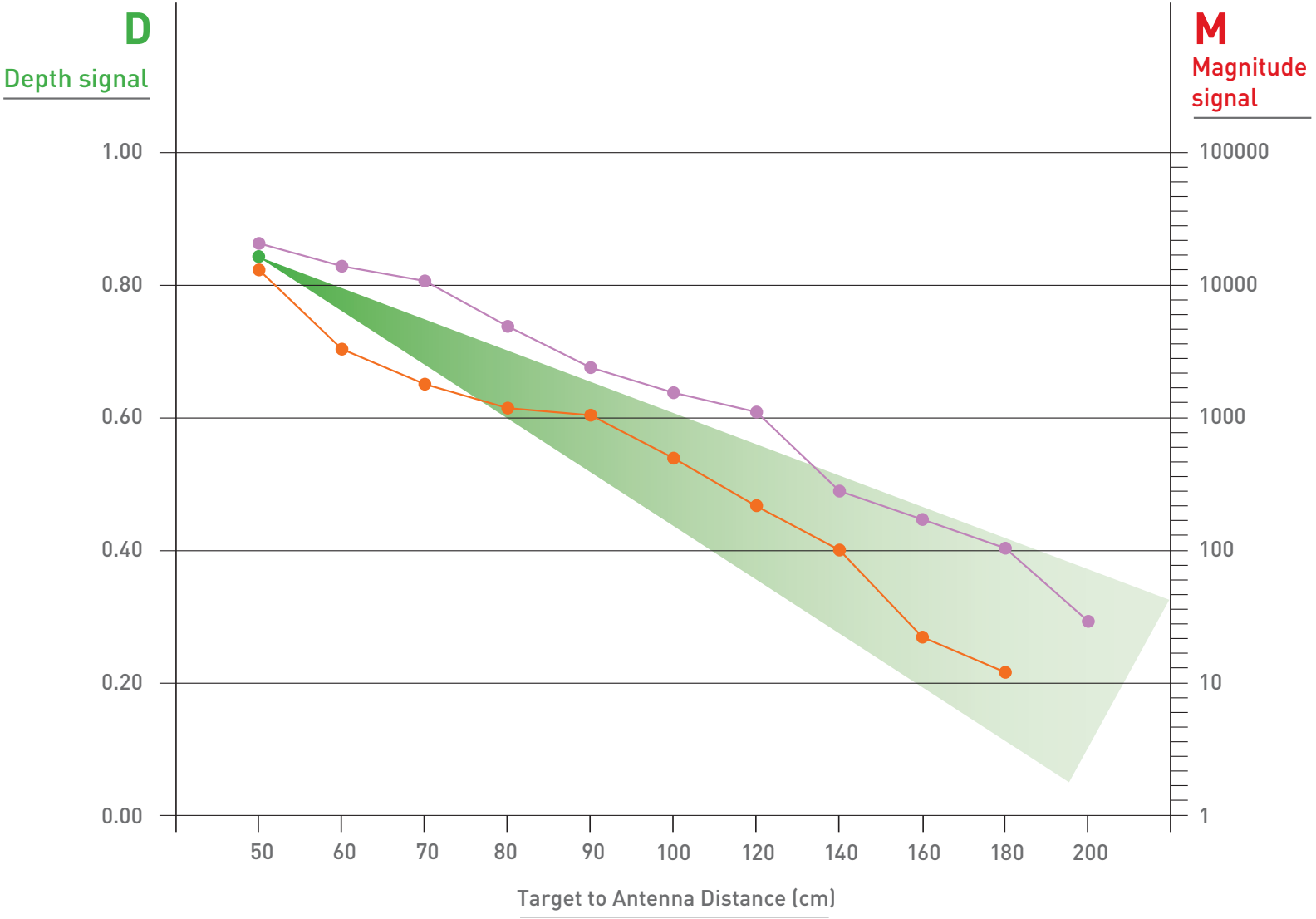
DEPTH AND MAGNITUDE SIGNALS vs ACTUAL TARGET DEPTH

SHOWN FOR TWO REFERENCE TARGETS



Steel cylinder
Ø 100 mm x h 700 mm

Steel cylinder
Ø 300 mm x h 680 mm

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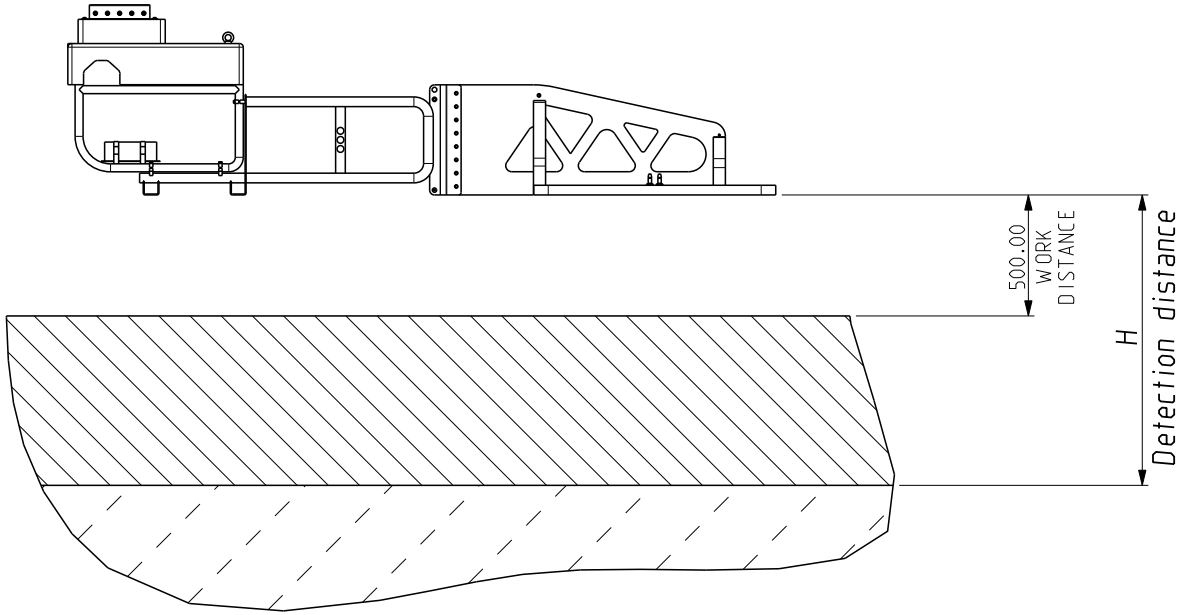
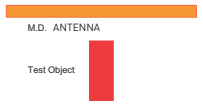
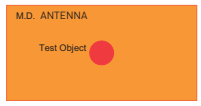
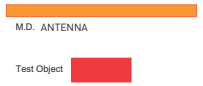
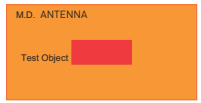
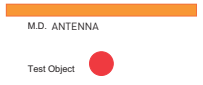
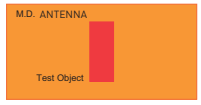
AVERAGE TARGET-TO-ANTENNA DETECTION DISTANCE



OBJECT DESCRIPTION AND SHAPE	OBJECT SIZE (mm)	AVERAGE DETECTION DISTANCE (m)		
		A	B	C
Steel Parallelepiped	45 X 45 X H 120	0,95	0,95	0,90
80 mm Mortar Ammo	∅ 80 X H 310	1,00	1,20	1,15
Steel Cylinder	∅ 110 X H 280	1,30	1,40	1,45
Steel Cylinder	∅ 100 X H 420	1,30	1,45	1,50
Steel Cylinder	∅ 170 X H 150	1,45	1,40	1,40
Steel Cylinder	∅ 100 X H 700	1,40	1,55	1,60
Steel A/T Mine Mod. Tellermine 43	∅ 310 X H 70	1,55	1,55	1,50
Steel Cylinder	∅ 300 X H 340	1,70	1,88	1,85
Steel Cylinder	∅ 300 X H 680	1,80	2,00	2,10

Test Position	Side View	Top View
A		
B		
C		

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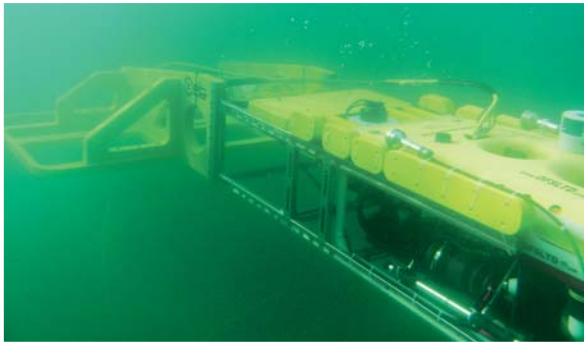
USE OF THE LINEAR METAL DETECTOR ARRAY IN UNDERWATER SURVEY

Armasuisse Science and Technology Center has verified the working of the linear Metal Detector array to survey the hot spots previously determined by a magnetometer investigation **in three lakes up to a depth of 705 ft** (September to November 2008).



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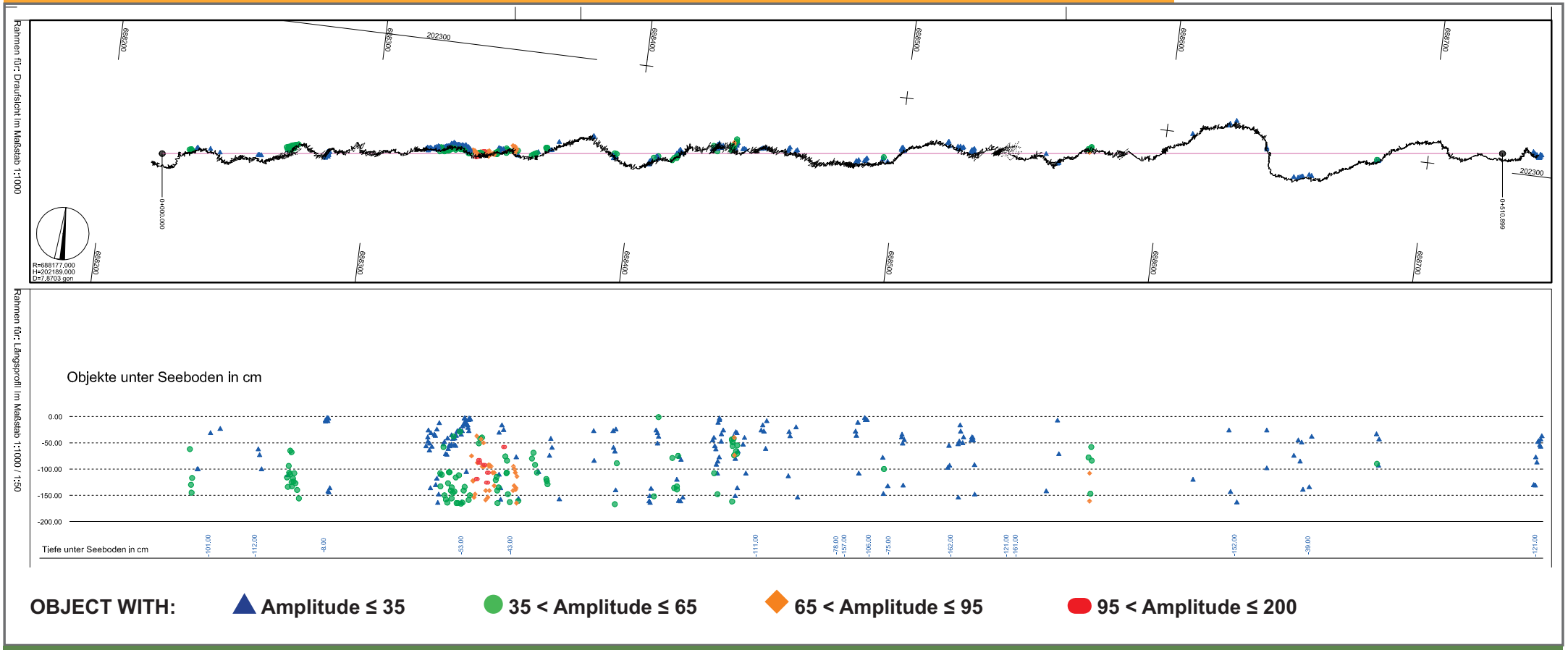
USE OF THE LINEAR METAL DETECTOR ARRAY IN UNDERWATER SURVEY

- The survey provided the expected results of detection and allowed **discovery of different metal items of interest of various size**.

CEIA MULTI-ZONE UXO METAL DETECTOR

MAPPING DETECTION RESULTS



Example of the mapping detection results, providing target size and depth information

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THANK YOU FOR YOUR ATTENTION

CONTACT INFORMATION

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phone: 330-405 3190