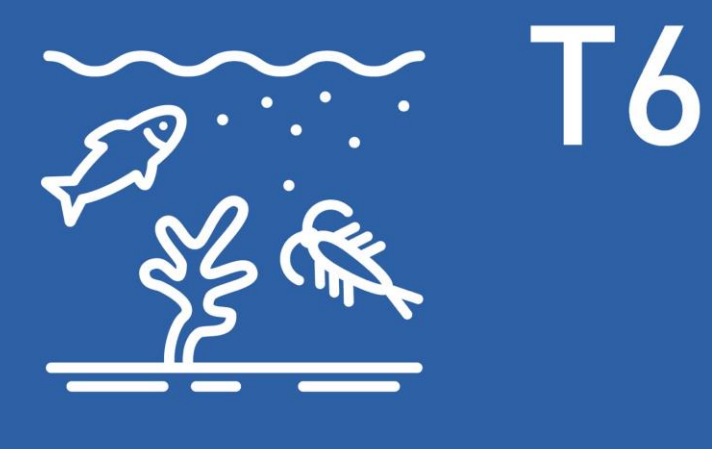


We provide AUVs with true autonomy for the automatic detection of munitions in the sea using in-situ magnetic measurements.

Helmholtz Knowledge & Technology Transfer



## Munitions in the Sea

Unexploded ordnance (UXO) from two World Wars is distributed throughout the world's seas and oceans. It is estimated that German waters alone contain around 1.6 million tons of munitions. In addition to threatening marine ecosystems, this legacy poses a direct threat to offshore construction work such as dredging, pipeline and cable laying, and windfarm construction, as well as maritime traffic, the fishing industry, and beach visitors.



Figure 1: Torpedo head from World War II lying on the seafloor in the Baltic Sea (© J. Ulrich).

## AUV-Based Magnetics

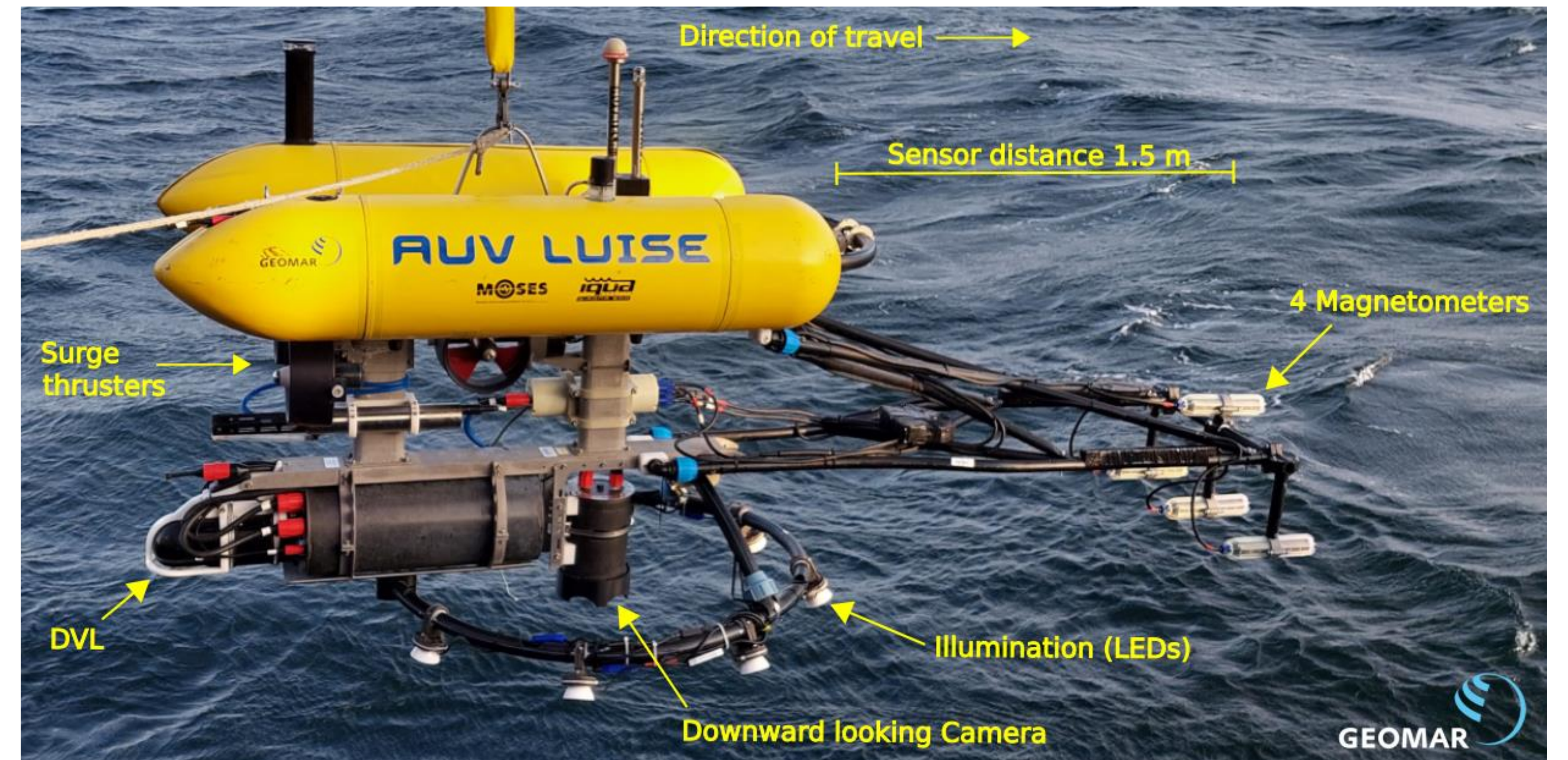


Figure 2: GEOMAR's Girona 500 AUV "Luise" with four fluxgate magnetometers and a downward-looking camera incl. LED illumination. The distance between the sensors and the platform is 1.5 m (© DSM/GEOMAR).

## Step 1: Reconnaissance

[SHOWING REAL FIELD DATA]

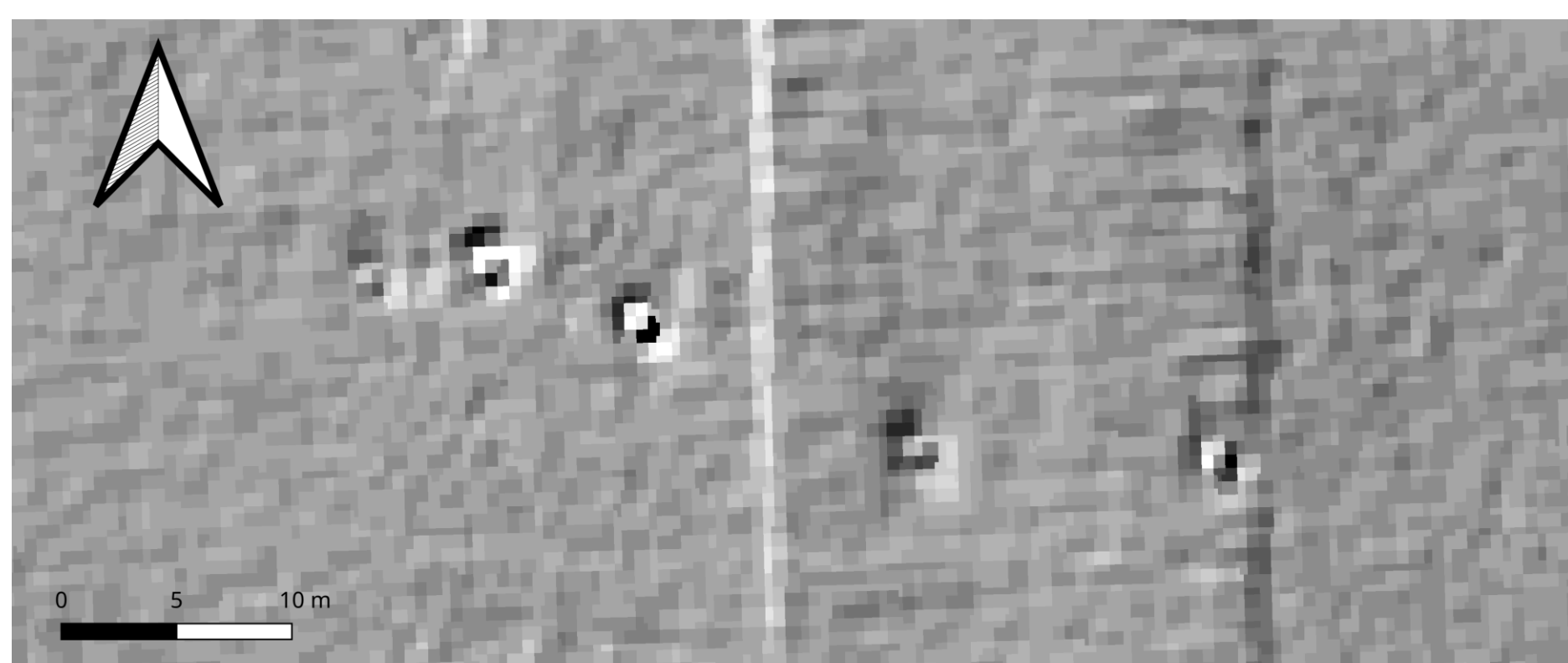


Fig. 3a: Prior sonar measurements indicate five distinct objects lying on the seafloor (real field data).

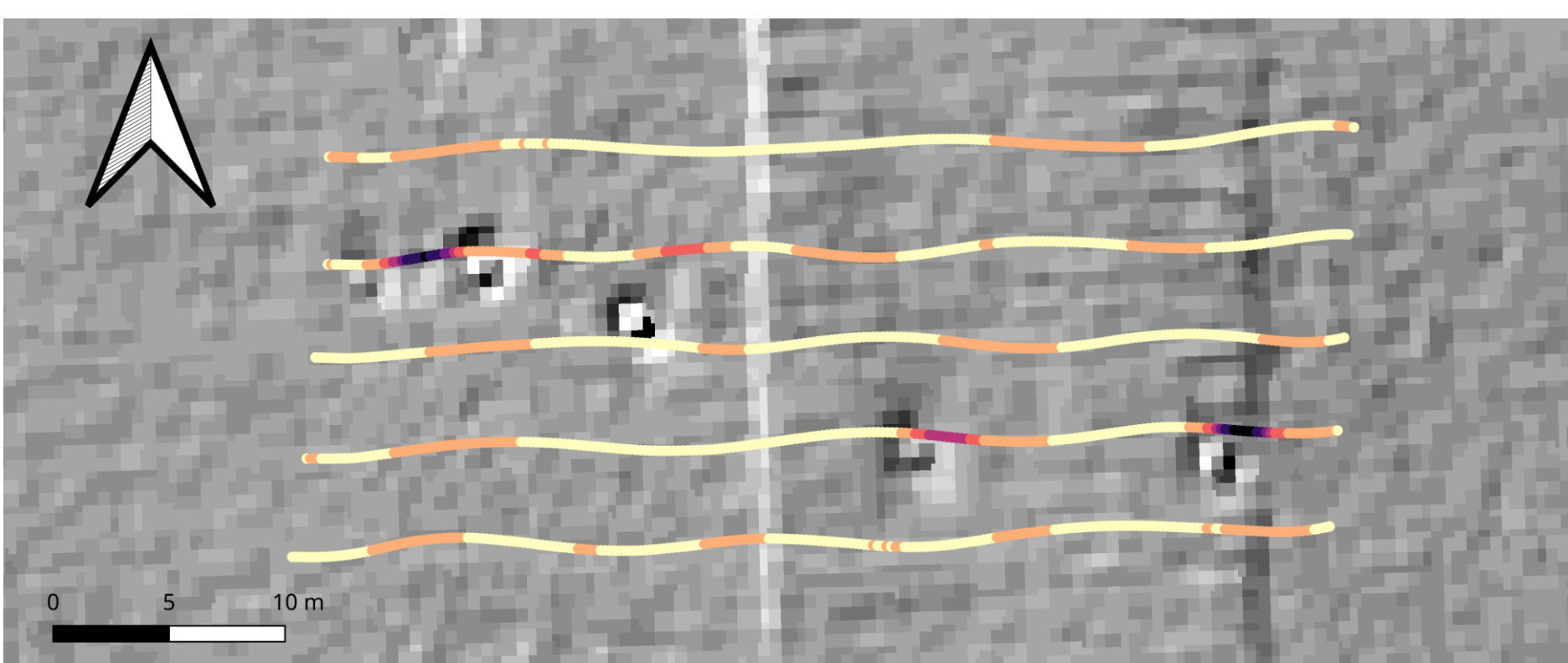


Fig. 3b: A coarse reconnaissance mission (five E-W survey lines) with line spacings of 5 m shows several magnetic anomalies.

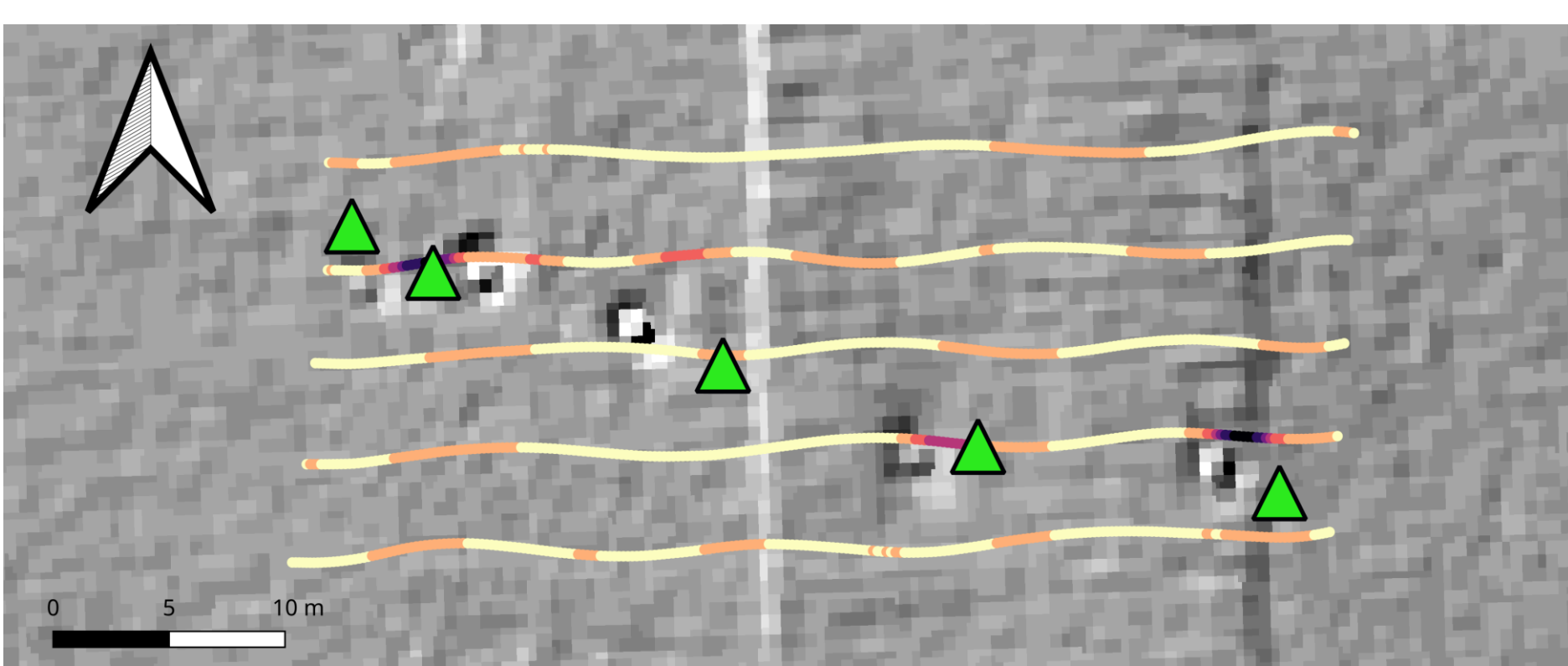
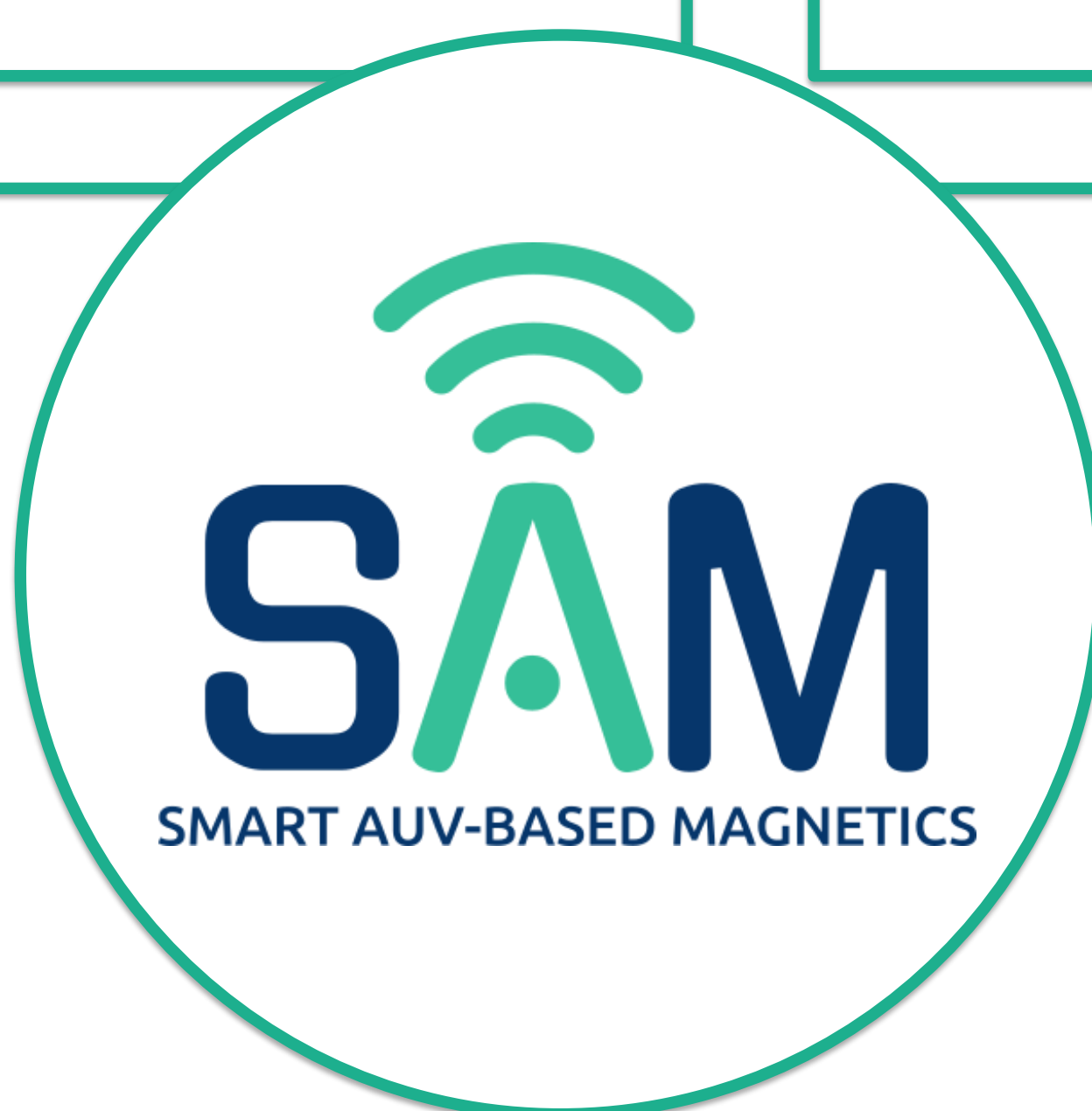


Fig. 3c: The SAM algorithms analyse these anomalies and autonomously determine five targets of interest (green markers).



To minimize the total mission time, the algorithm clusters adjacent targets of interest based on various parameters, such as the water current direction. It then solves a traveling salesman problem for the resulting clusters to obtain the shortest route along all clusters. This approach allows the AUV to examine each object thoroughly and efficiently.

## Step 3: Reporting

Automatic reports are generated for each investigated object including location, magnetic moment, estimated mass, and pictures (if available).

### Single Target Report

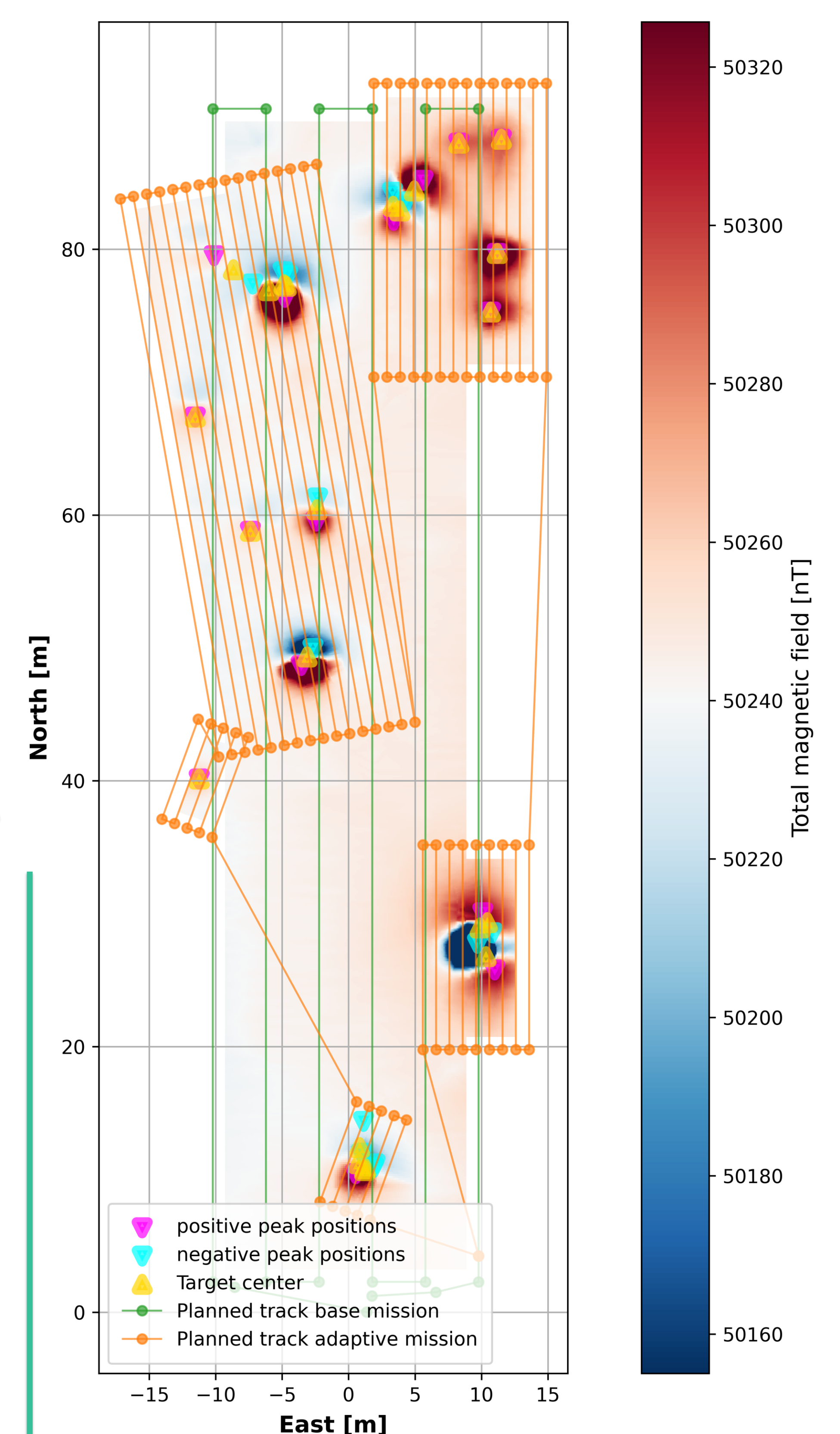
Target number 001:

#### Target Information

Date	2025-03-03 14:02	Mission name	Luise 336
Latitude	51.55972 °	Estimated ferromagnetic mass	50 kg
Longitude	11.55972 °	Magnetic strength	100 nT
Working area	Kolberger Heide	Estimated extend	20 x 20 cm

## Step 2: „Smart“ Mission Design & Detailed Investigation

[SYNTHETIC EXAMPLE APPLIED TO FIELD DATA]



More Info



QR code links to a publication containing technical descriptions about the integration of magnetometers on to AUV Luise.

For more information please visit:  
<https://sam-project.eu/>

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