FindMine gGmbH and Project findmine

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FindMine gGmbH – Explosives search with the help of UAVs.

Public Presentation 07/2025

Urs Endress Foundation

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Mission

Make the world safer by helping to get rid of mines and unexploded ordnances with latest technologies.

Promotion of projects making humanitarian minesweeping faster, safer, and cheaper by new technologies especially the use of UAV (Unmanned Airborne Vehicle) with high performance sensors.

Foundation Board:
Urs Endress and
6 board members

Motivation

APM cost:
- Production: 3$ - 5$
- Clearance: 500$ - 1000$.

Area Reduction:
- Up to 500 false alarms for one mine.
- Just 10% of suspected areas contain hazardous objects.
- Clearance cost: > 500K$/km²

Image: FSD FONDATION SUISSE DE DÉMINAGE

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- > 100 Mio buried mines.
- Dramatical rise of UXO contamination in quantity and quality from ongoing and rising conflicts of the last few years.
- Consequences:
  - Deaths, injuries.
  - Blocked Humanitarian aid.
  - Refugees, Starvation.
  - Impeding of development and reconstruction.

Findmine Research Basis

2015
Feasibility study on UAV-based automated detection and localization of buried landmines

2016 – 2022
Intensive research on ground penetrating synthetic aperture radar (GPSAR) mounted on an UAV flying autonomously a few meters above ground (< 6m)

2019 – 2023
Complementary research on UAV-carried metal-detection and vegetation and soil-effects in low height (<1m) GPR

2024
New GPSAR evaluation algorithms

Since 2025 mainly development work.

INFO and Publications www.findmine.org

Research partners:

- Technische Hochschule Ulm (IAF)
- Universität Stuttgart (IFR, TTI)
- Universität Ulm (MWT)
- ETH Zürich (IRIS)
- Fachhochschule Nordwestschweiz (FHNW)
- Endress+Hauser Technologieentwicklung
- École Polytechnique Fédérale de Lausanne (EPFL)

FindMine gGmbH

- Startup-like company
- Non-profit
- 8 employees (6.5 40h FTEs)
- UAV-based explosive hazard detection systems
- Bridging research results to useable systems
- 100% shareholder
  Urs Endress Foundation
- Operational since July 2022
- First products planned for end of this year (2025)

FindMine gGmbH
Josef-Henle-Straße 3
89257 Illertissen
Phone: +49 7303 163990
Trade register Memmingen: HRB19916
CEO Dr. Winfried Mayer

Location: Illertissen, Bavaria, Germany; 30km south of Ulm.

Projects

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FM-GPSAR

Ground Penetrating Synthetic Aperture Radar

- Large Area Scan
- Non-Technical Survey
- Demining Quality Scan

FM-METAL

Multi-Mode Metal Detector

- Confirmation for GPSAR
- False-alarm reduction
- Spot Measurements
- Demining Quality Check

FM-LSCAN

Linear Scanning Radar

- Path and Road-Side scanning
- Areas with fly-over restrictions
- Shadowed areas

FM-TEST

Activities and Facilities for Test and Validation

- Testfields
- Dummies
- Reference conditions
- Data Collection

FM-GPSAR Principle

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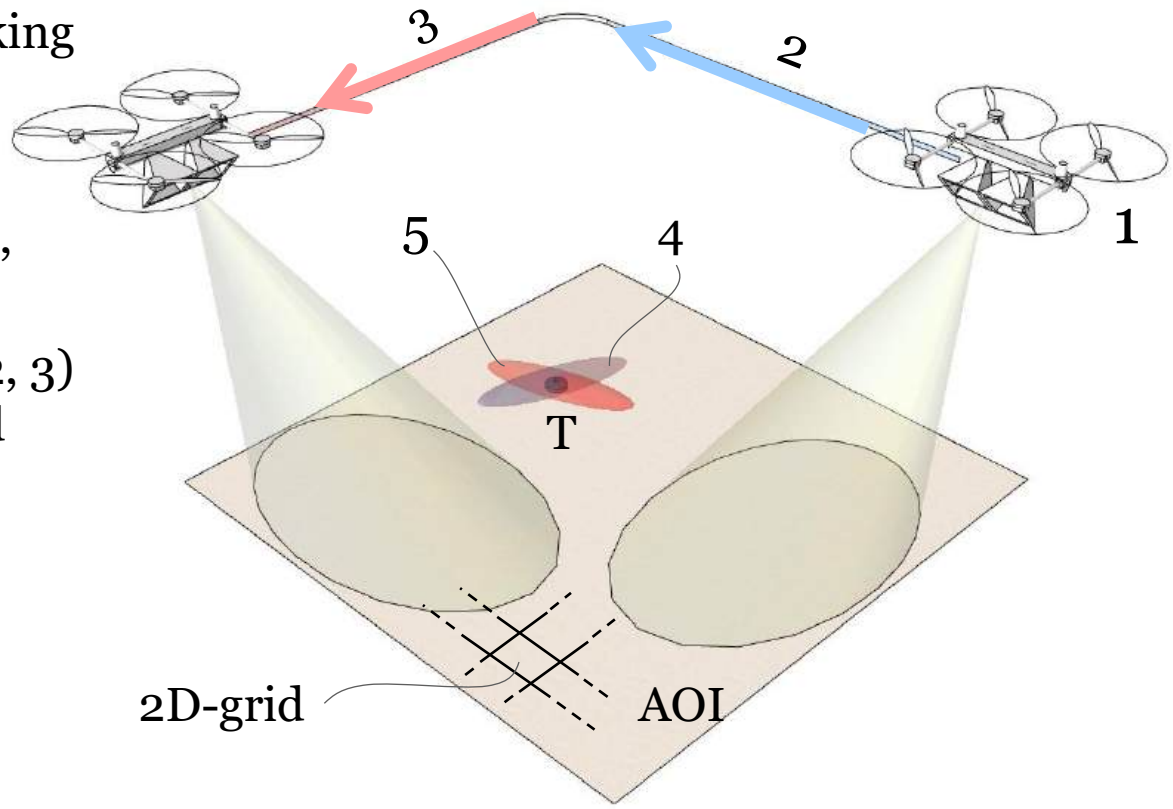
- UAS with broad-band ground penetrating radar (1)
- Rectangular resolution (2D-grid) of the area of interest (AOI)
  - in one dimension by range resolution and side-looking
  - in second dimension by SAR-combination along a linear flight section (2)

→ Targets (T) cause high intensity spots (4) in the 2D-grid, but blurred, spread and ambiguous by soil refraction

- Combining the spots (4, 5) from different flight paths (2, 3) by special processing concentrates detection results and provides depth resolution

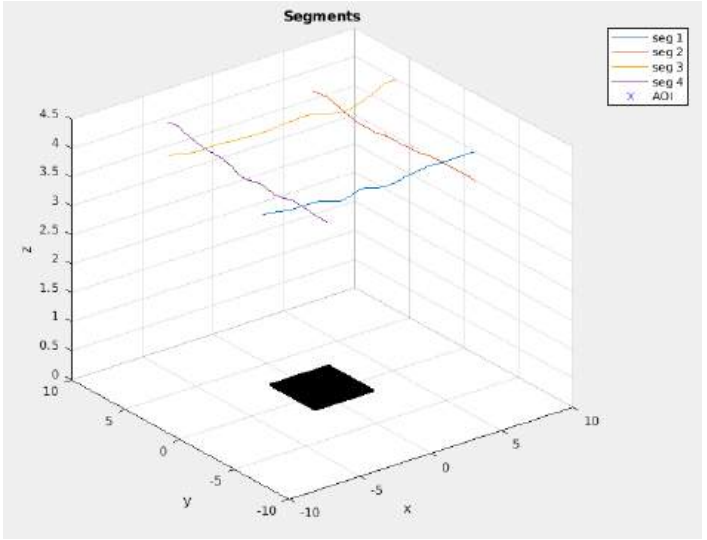
→ GPSAR-Results: Layered radar images of the upper soil with high-intensity spots from

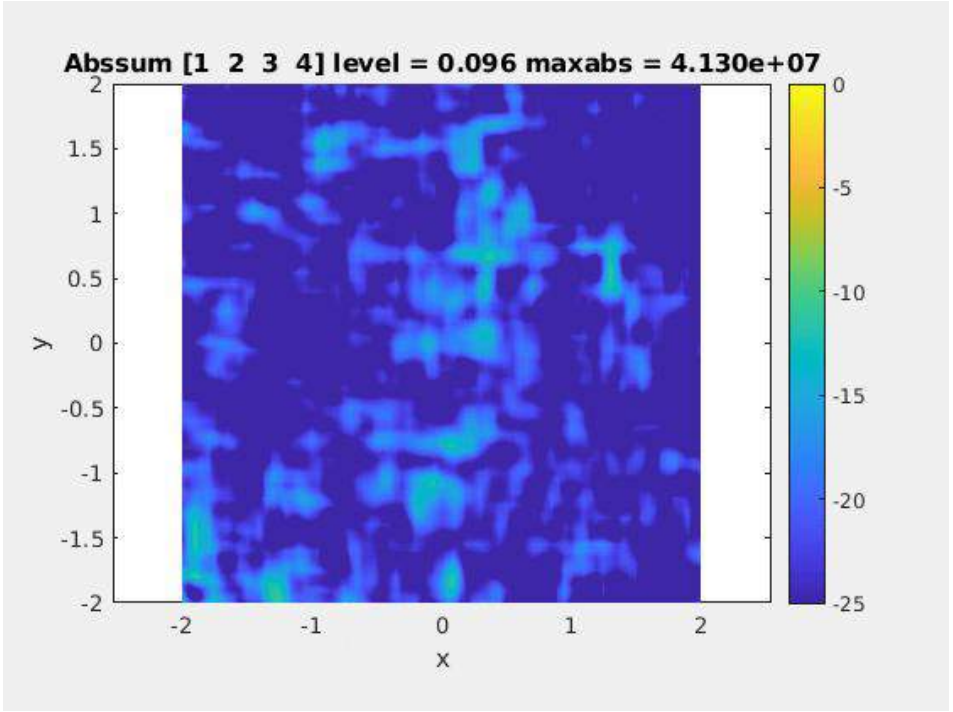
~ Microwave Tomography

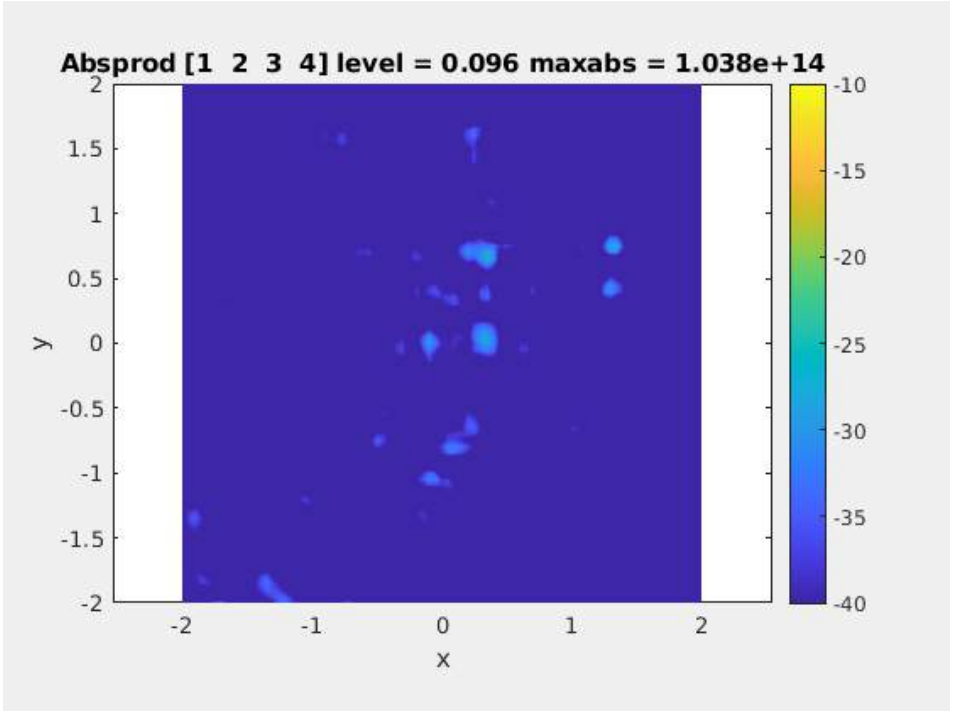


FM-GPSAR Results

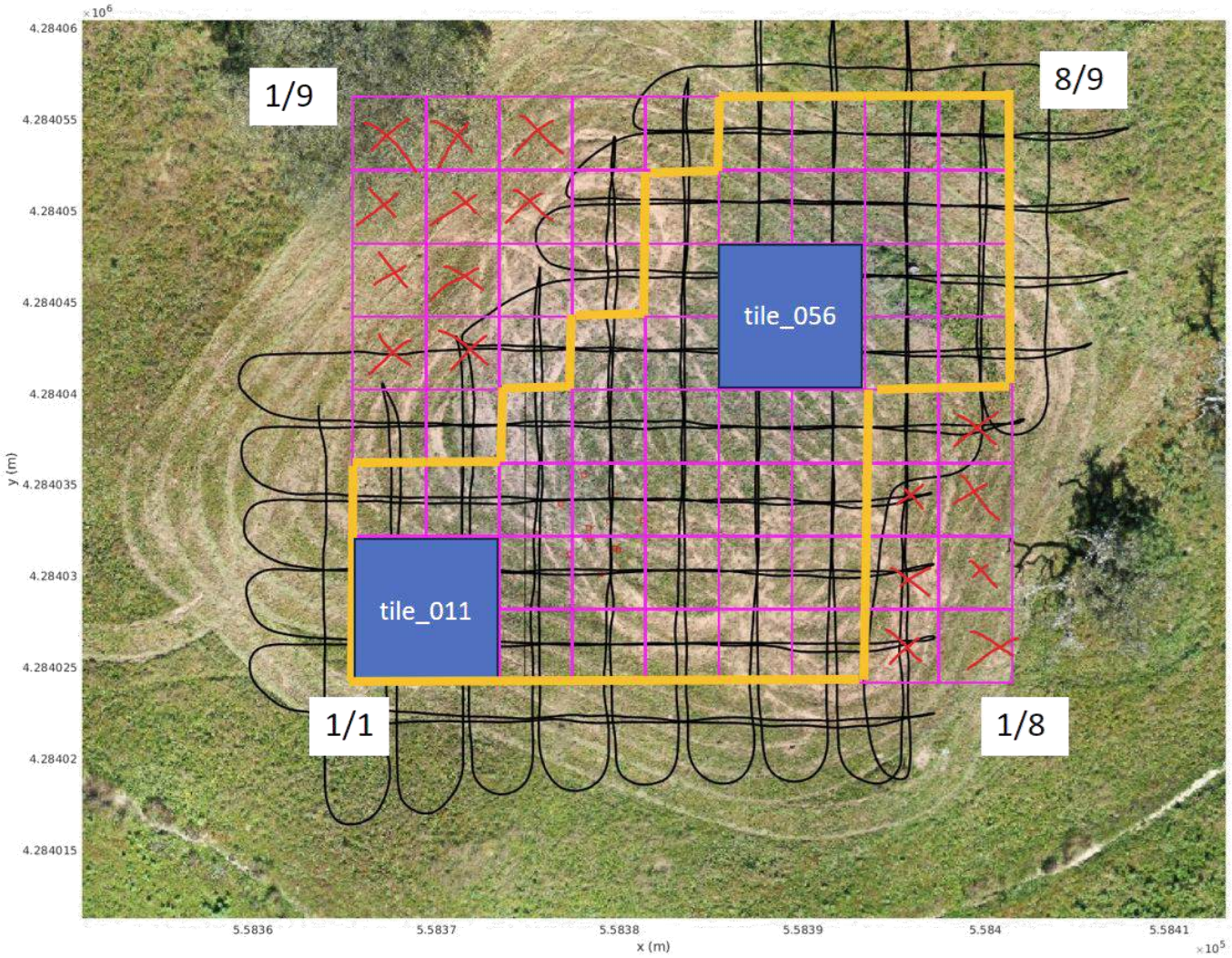
3 metal APM-dummies
buried 3-5cm below low
grass in natural terrain







FM-GPSAR System



- GPSAR offline processing
  requires powerful and GPU-supported computing system
- Search flight speed up to 2000m²/h
- Processing time equals search flight time
- Processing depending on resolution
- Typical voxel resolution horizontal 5cm, vertical 1cm

FM-GPSAR Test-Results

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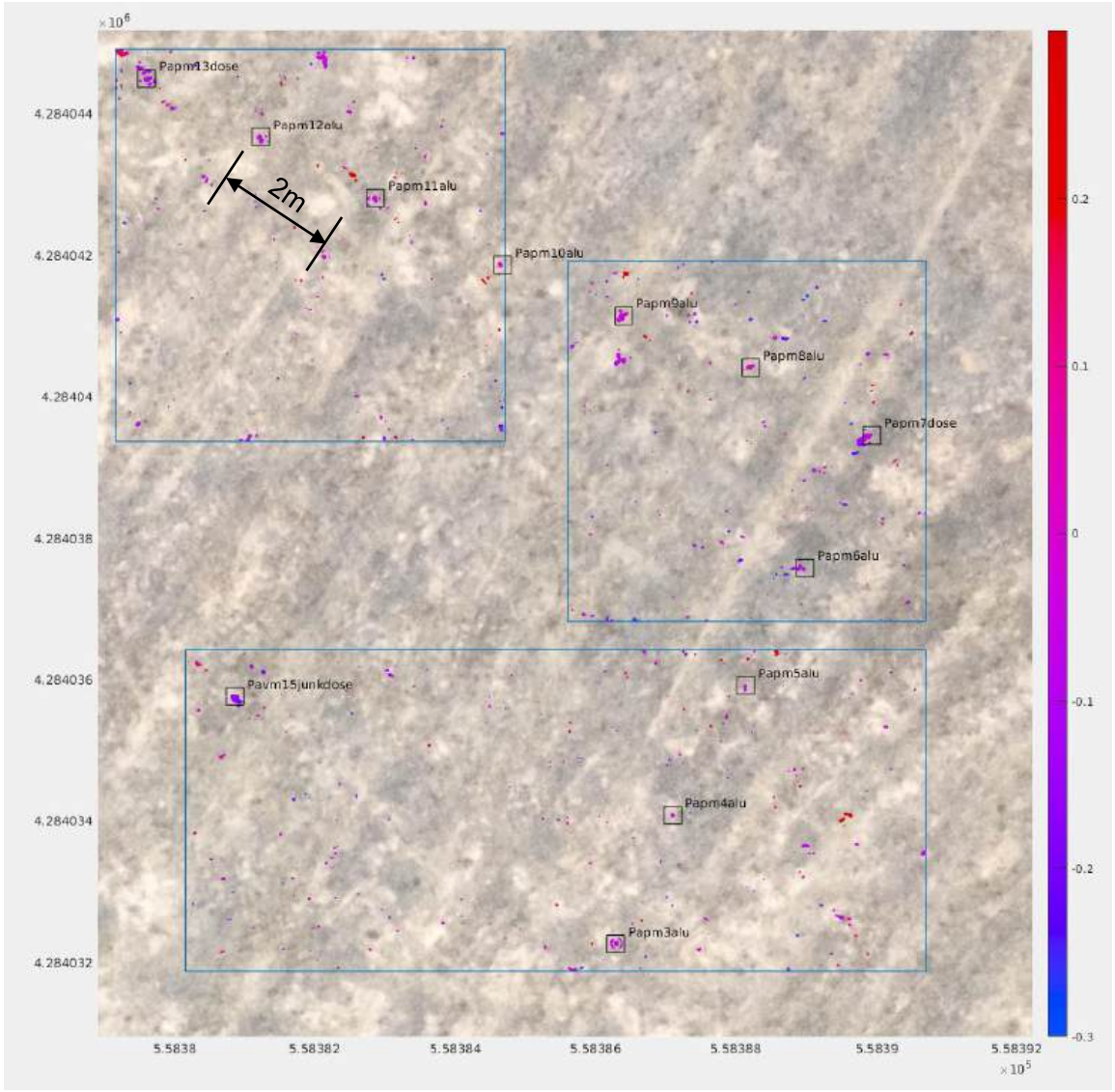
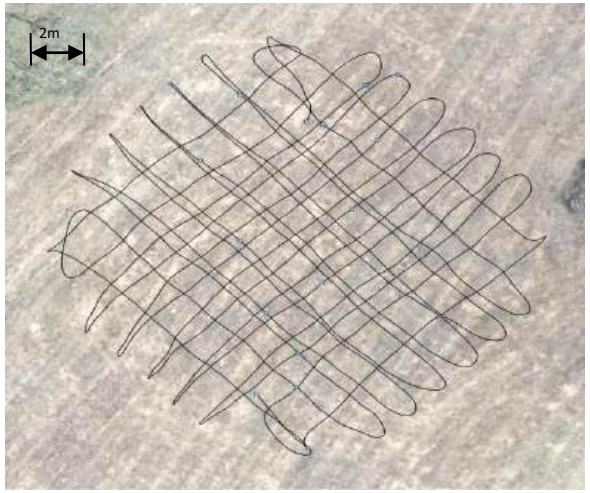


- Successful results in natural terrain with dry vegetation
- Dummies buried 4 moths before measurement
- Cross-meander flight paths
- Despite strong winds and high temperature



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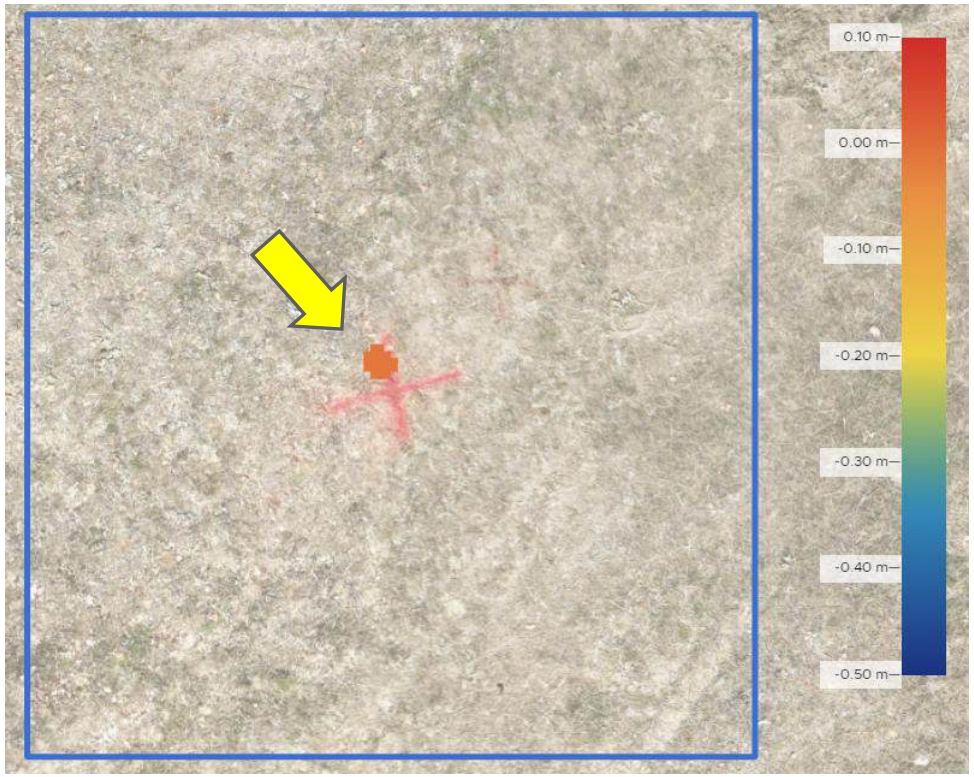
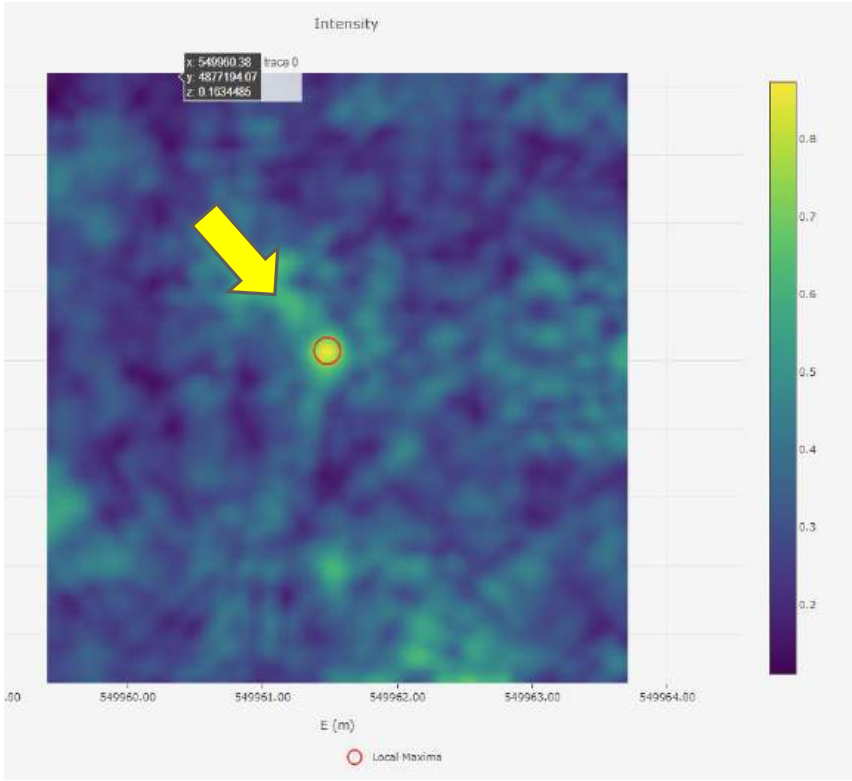
Detection of real defused mines in CTRO test-field Benkovac

Minetype and close photograph of the the 1m² containing it



Detection diagram from 4m x 4m evaluated with orthophoto as background



Intensity diagram for 0.15m depth

FM-GPSAR Test-Results

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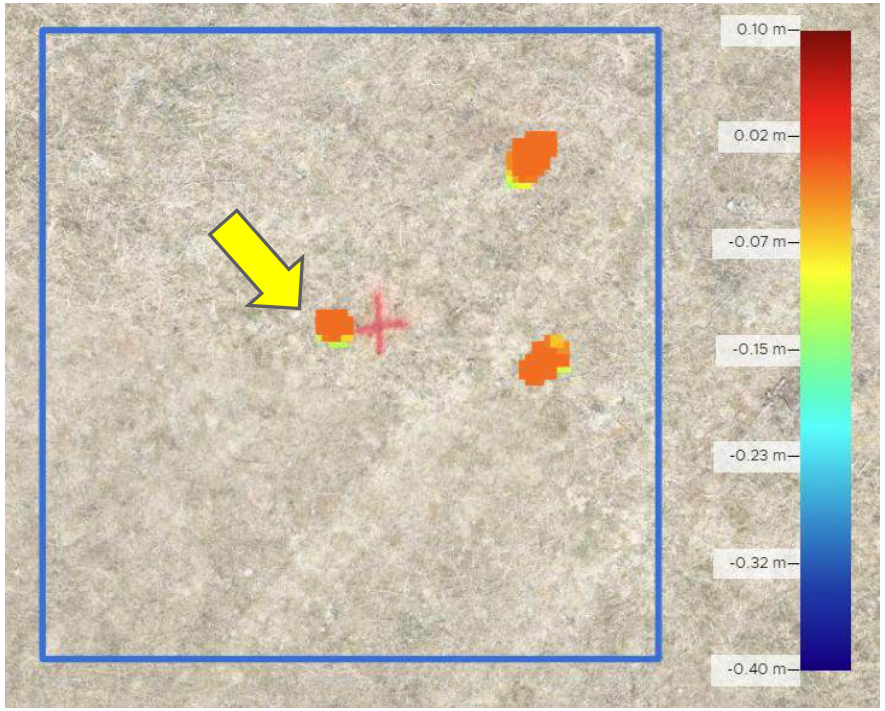
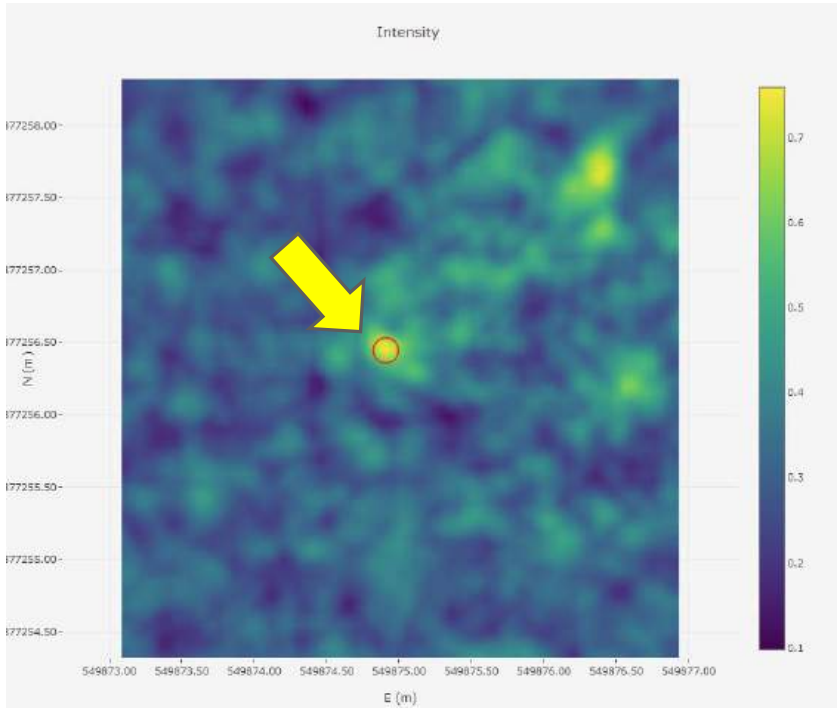
Detection of real defused mines in CTRO test-field Benkovac

Object and photograph of the 1m² containing it.



Detection diagram from 4m x 4m evaluated.



Intensity diagram for 0.2m depth.

FM-GPSAR Test-Results

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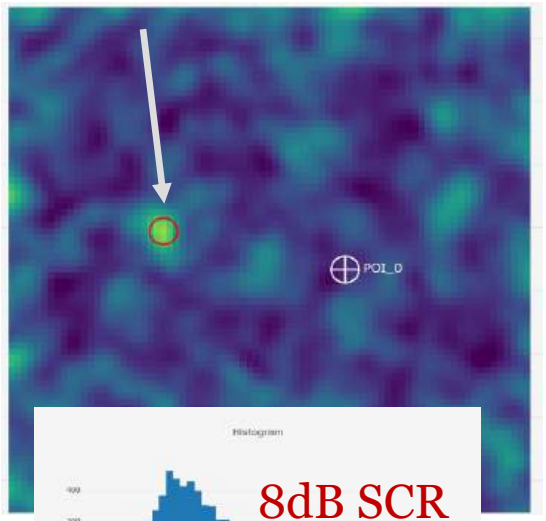
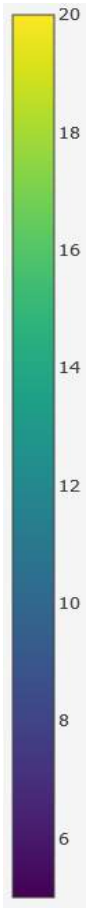
Detection of surface laid AVM and APM-dummies hidden in vegetation

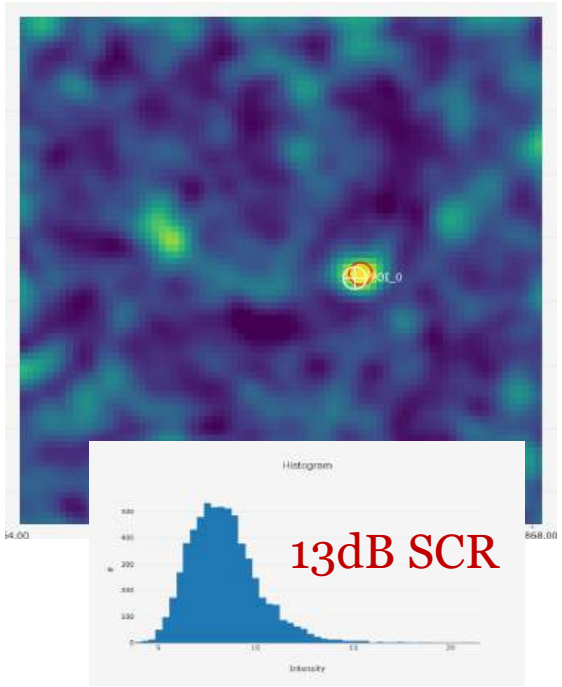
Empty area

ants‘ hill

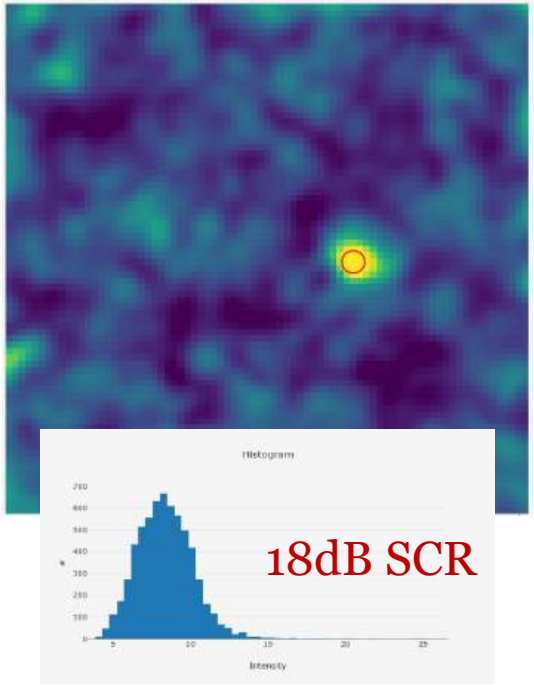




with PMR3 dummy



with TMRP-6 Dummy



FM-GPSAR Hardware

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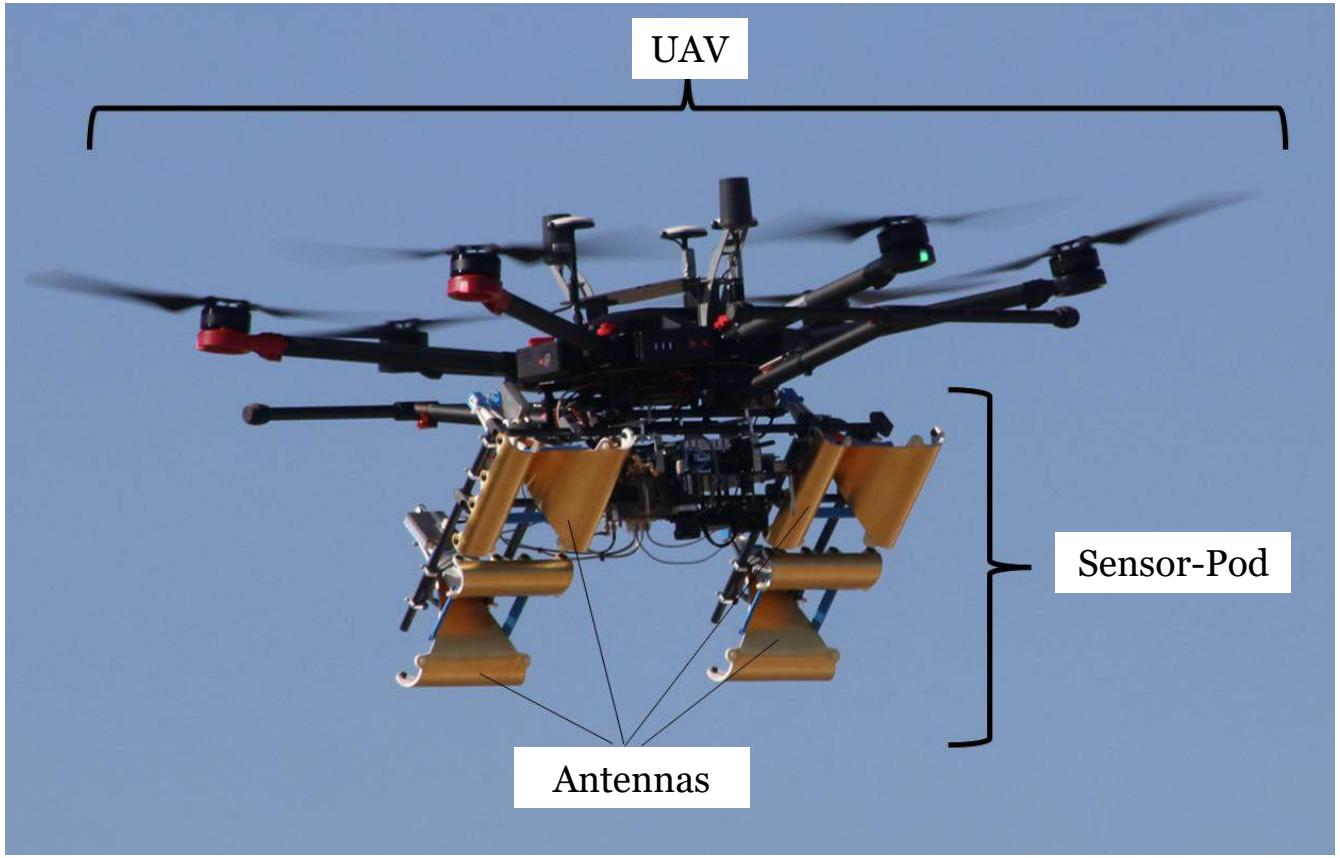
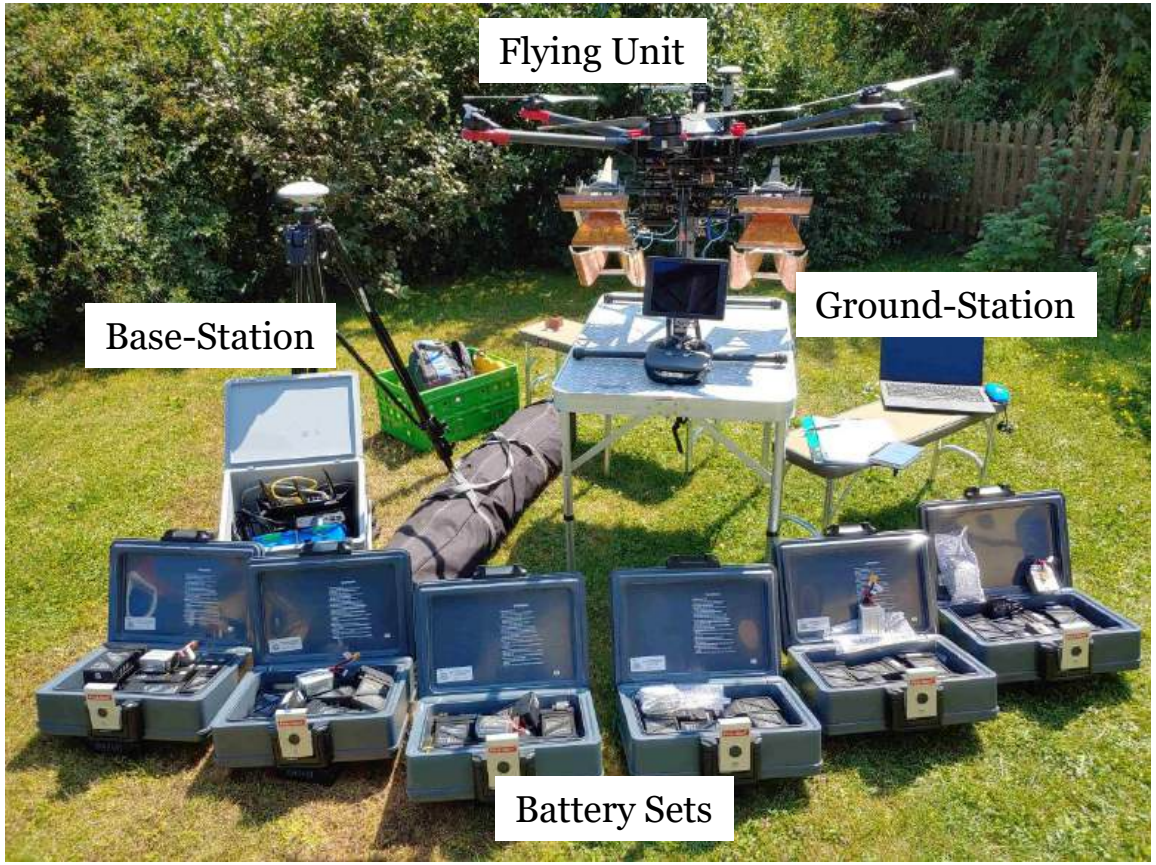
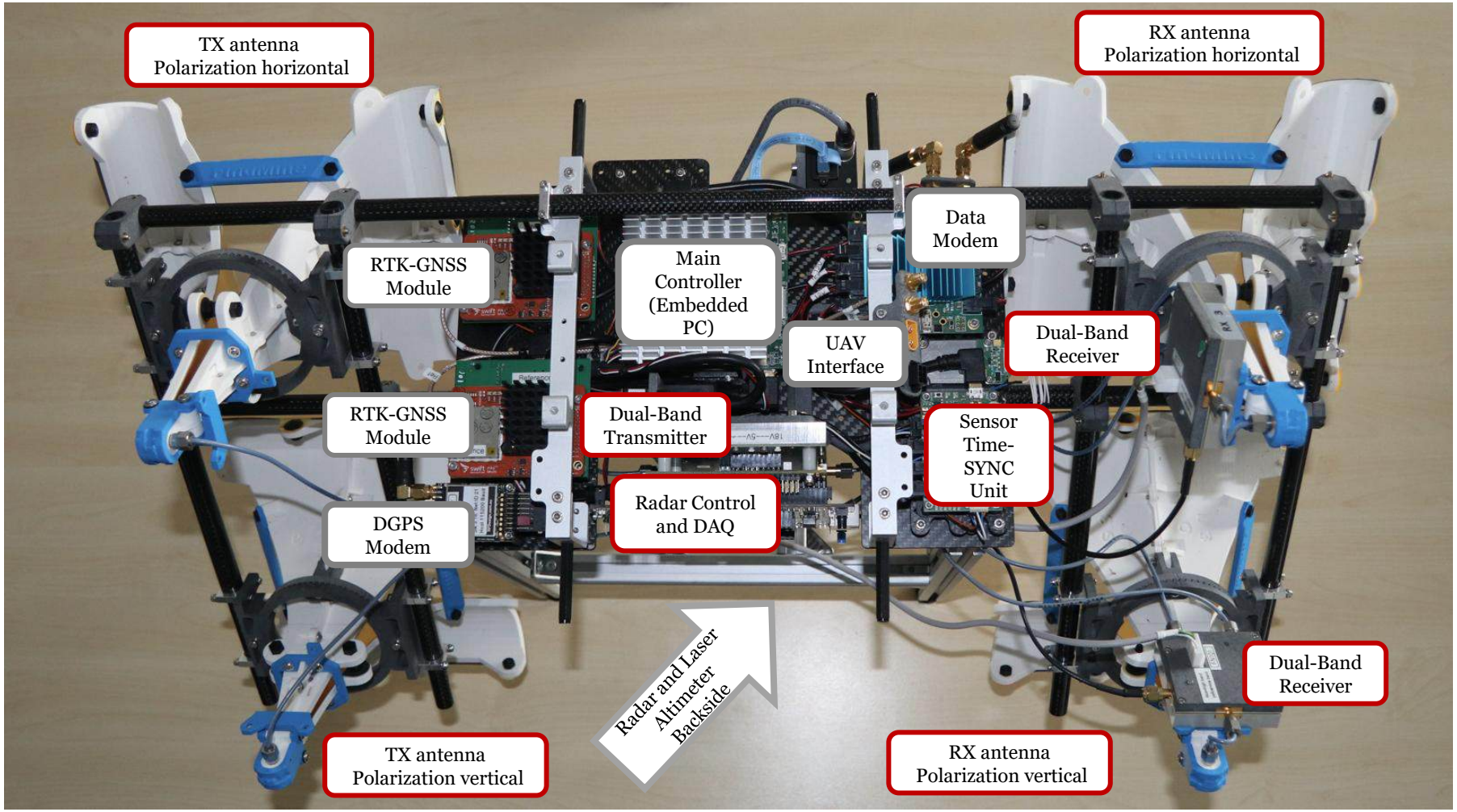




FM-GPSAR Sensor-Pod



in-house design

purchased part

Available
4 operating
2 experimental
1 spare-parts

FM-METAL Concept

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- Multi-Layer and Multi-Mode Detector with several parallel channels
- Low false alarm rate and fast evaluation
- Light-weight for UAV-operation
- Metal content confirmation for locations with GPSAR-detections from area-scan
- Requires low altitude precision RTK-based flights
    - Low area throughput

FM-METAL Sensor

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- Multilayer PCB-based sensor
  - Vibration insensitive
  - Simple calibration and adjustment
  - Different coils in one multi-layer PCB
  - Low-cost and high-quality
- Maximum use of common electronics for radar and metal sensors
- 2 frequencies for metal type distinction

FM-METAL Results

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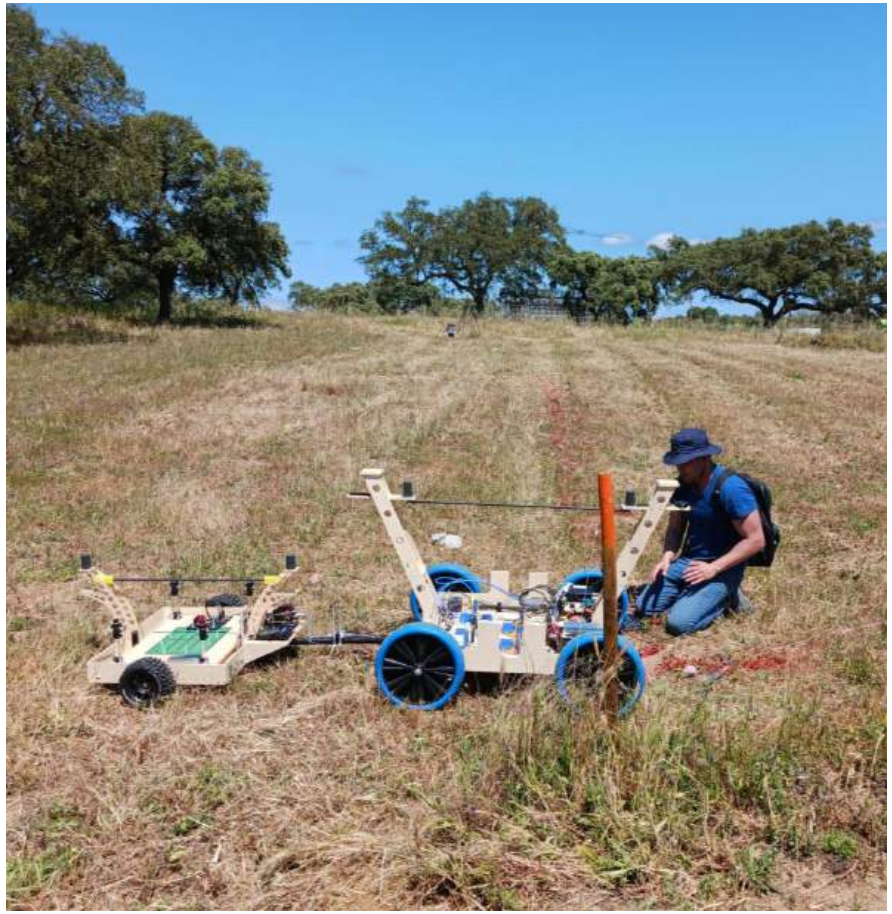
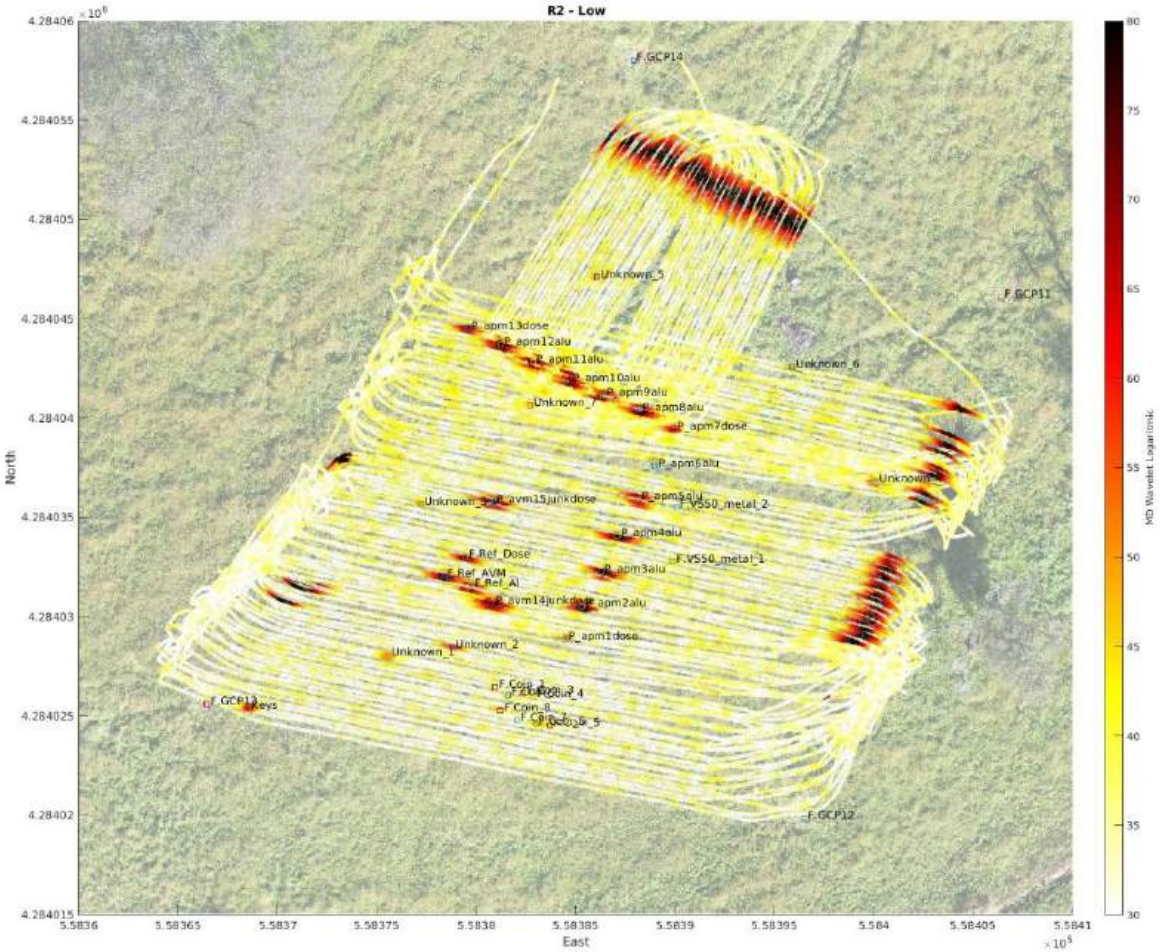
Rover as test platform for sensor-optimization.





FM-TEST Gannertshofen DE

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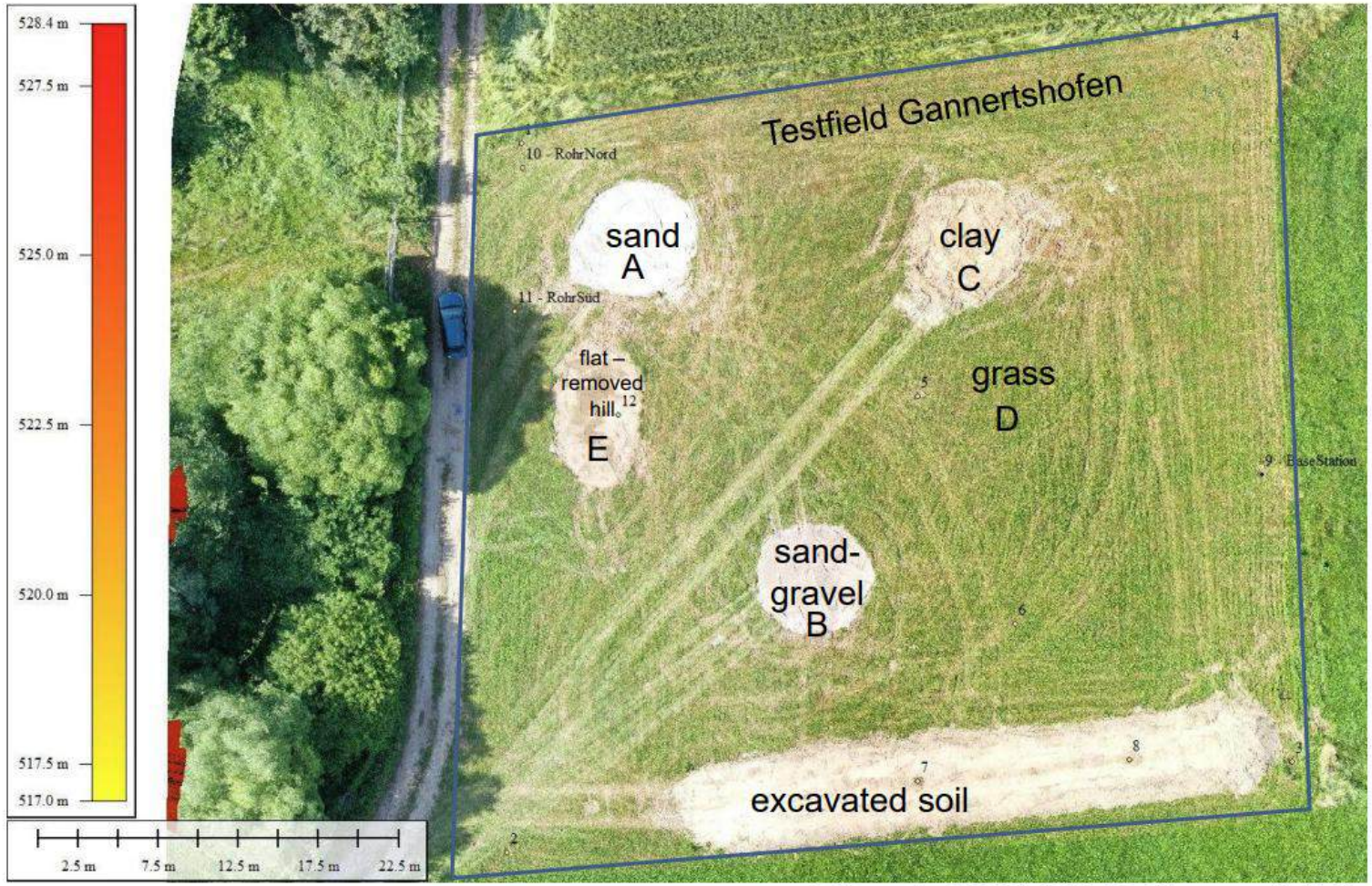
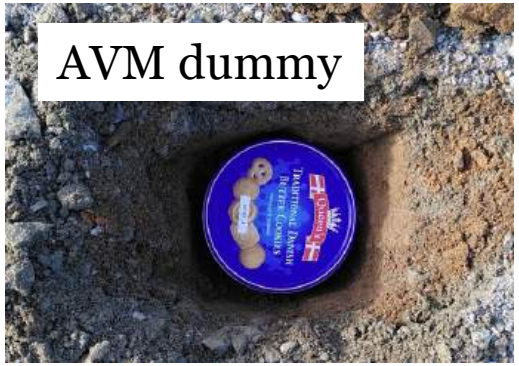


APM Simulants

More than 100 buried simulants.

FM-TEST
Freixo Portugal


AVM dummy


GPSAR in operation

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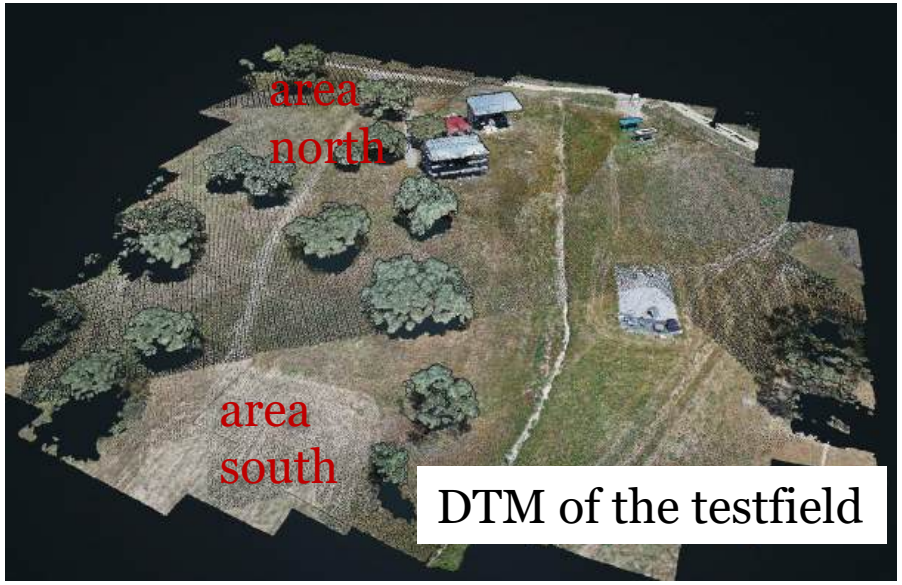
dirt road scenery



DTM of the testfield


Ground control


logistics

Contact for questions and ideas on findmine R&D activities, results, technological cooperation:	Contact for general questions on humanitarian demining, and if you are interested to support us:
FindMine gGmbH **Josef-Henle-Straße 3** **89257 Illertissen** **Germany** **Tel: +49 7303 163990** **info@findmine.org** **www.findmine.org**	**Urs Endress Foundation** **Rebgasse 46** **4144 Arlesheim,** **Switzerland** **info@ue.foundation** **www.ue.foundation**

Further interest ?

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