



Multi-sensor cooperative robots for shallow  
buried explosive threat detection  
**DEMINEINGROBOTS**

Project NATO SPS G5731

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# Reduction of proximal metal structures interference for a Holographic RADAR 3D- Printed antenna

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# Outline

1. Demining by holographic RADAR mounted on robotic mechanical scanner
2. Holographic imaging RADAR improvements
3. A solution based on Faraday cage
4. Experiments in water-filled test bed
5. Conclusions and future developments



# 1

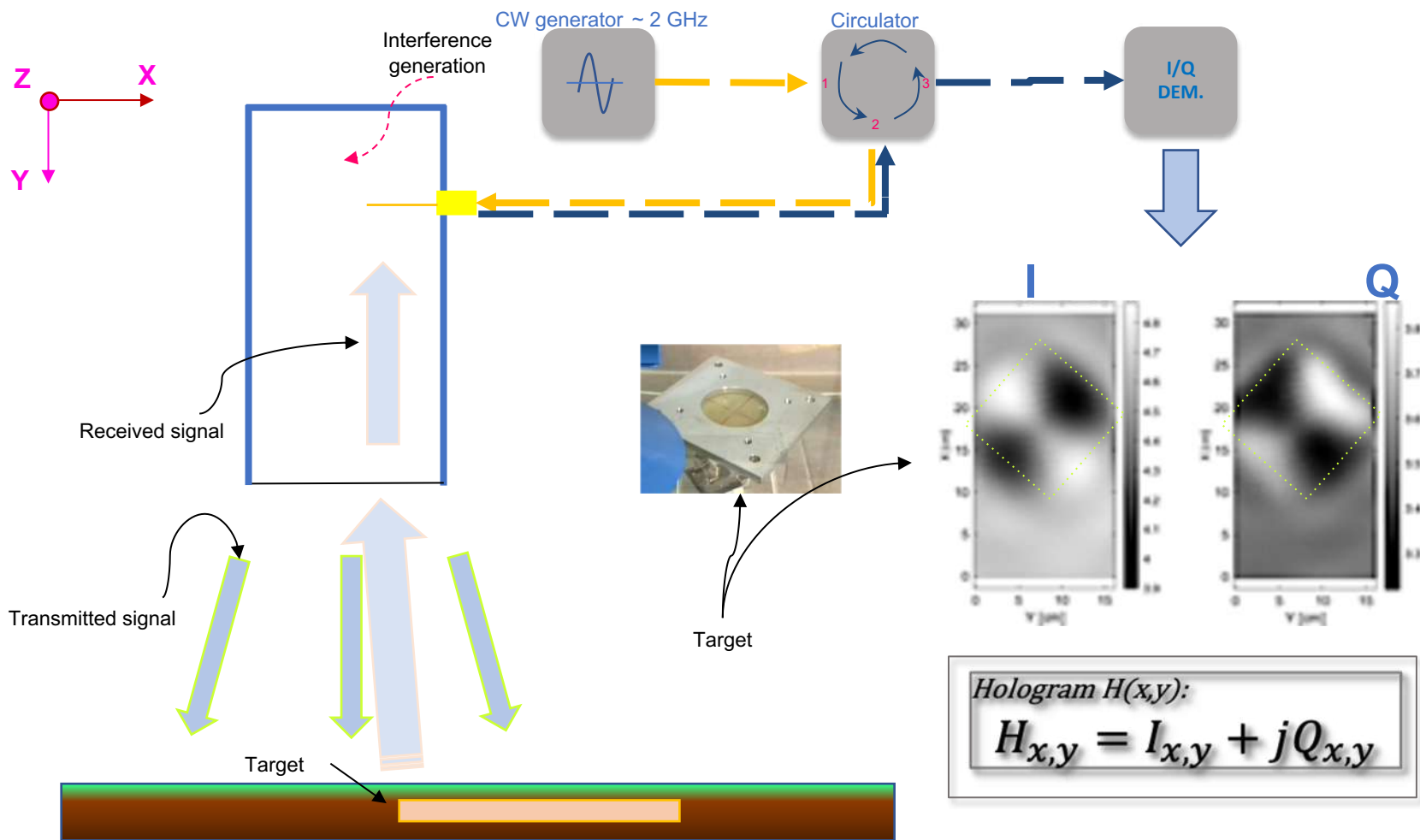
## DEMINING WITH HOLOGRAPHIC RADAR MOUNTED ON ROBOTIC MECHANICAL SCANNER

## NATO Science for Peace and Security G-5014\*



- **Multiple frequencies** CW signal around 2 GHz
- Scan a portion of terrain of 17 cm x 32 cm
- Used for **classification** of metal and **plastic** objects buried in the soil
- System is **remotely controlled**

\* <http://www.nato-sfps-landmines.eu/>



## MICROWAVE IMAGING RADAR SENSOR PRINCIPLE



# 2

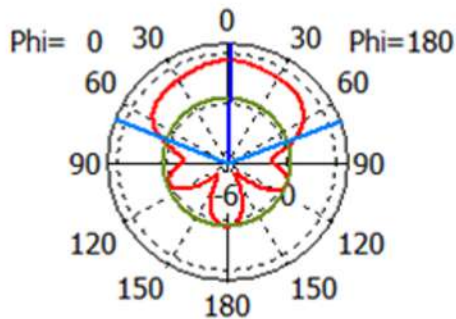
## HOLOGRAPHIC RADAR

### ARCHITECTURE AND IMPROVEMENTS

## 3D PRINTED, POLY LACTIC ACID FILLED ANTENNA

- Smaller
- Materials and printing technology are easily available and cheap
- Adaptability of the design for different needs

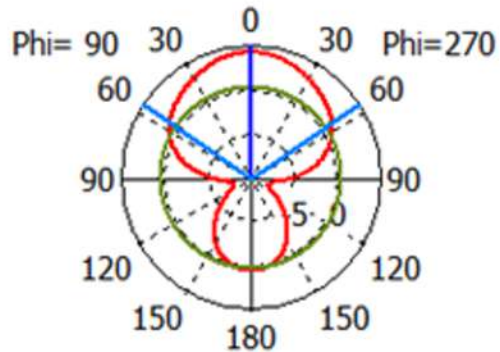
Farfield Directivity Abs (Phi=0)



Theta / deg vs. dBi

Frequency = 2.0122 GHz  
Main lobe magnitude = 4.22 dBi  
Main lobe direction = 2.0 deg.  
Angular width (3 dB) = 137.5 deg.  
Side lobe level = -3.8 dB

Farfield Directivity Abs (Phi=90)



Theta / deg vs. dBi

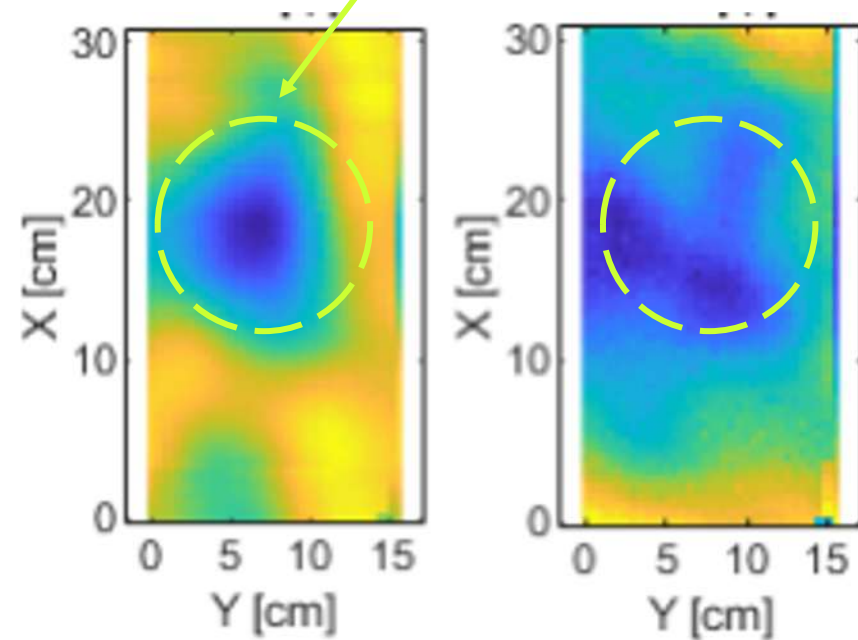
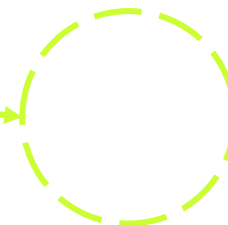
Frequency = 2.0122 GHz  
Main lobe magnitude = 4.22 dBi  
Main lobe direction = 0.0 deg.  
Angular width (3 dB) = 111.9 deg.  
Side lobe level = -3.8 dB







Plastic landmine PMN-4

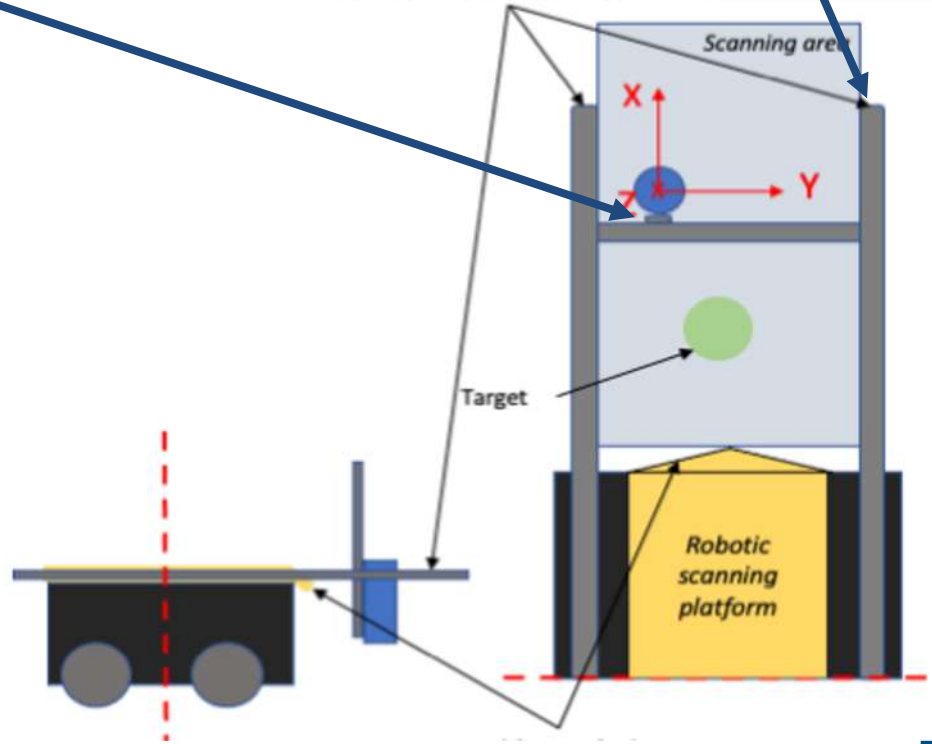
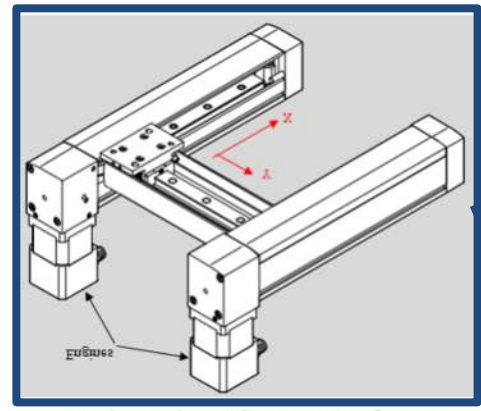
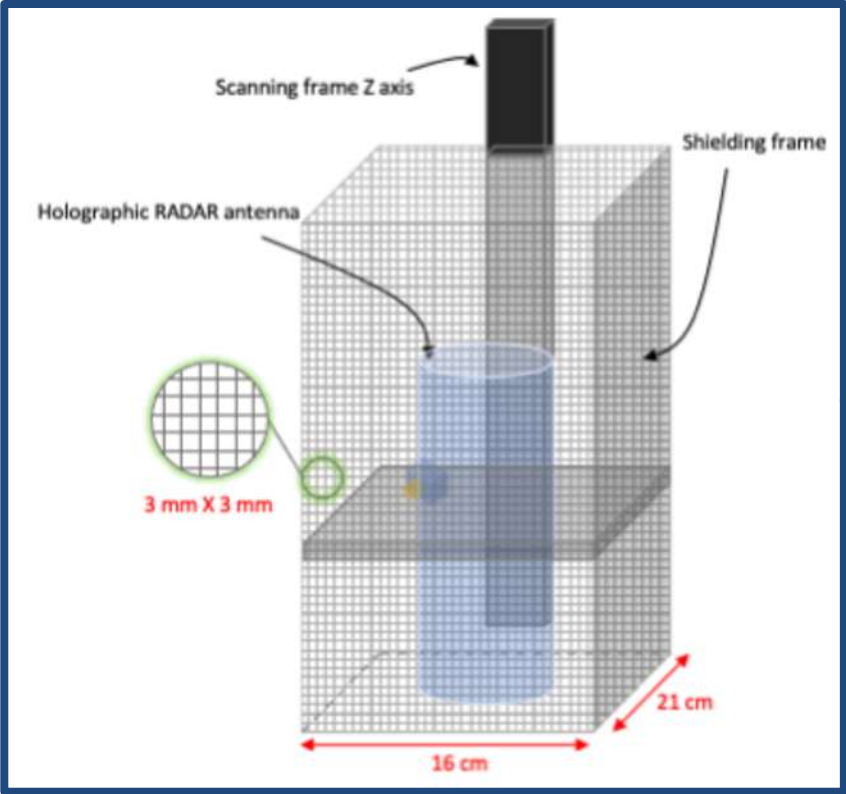






# 4

## A FARADAY CAGE FOR REDUCING THE EFFECTS OF SURROUNDING METALLIC FRAME

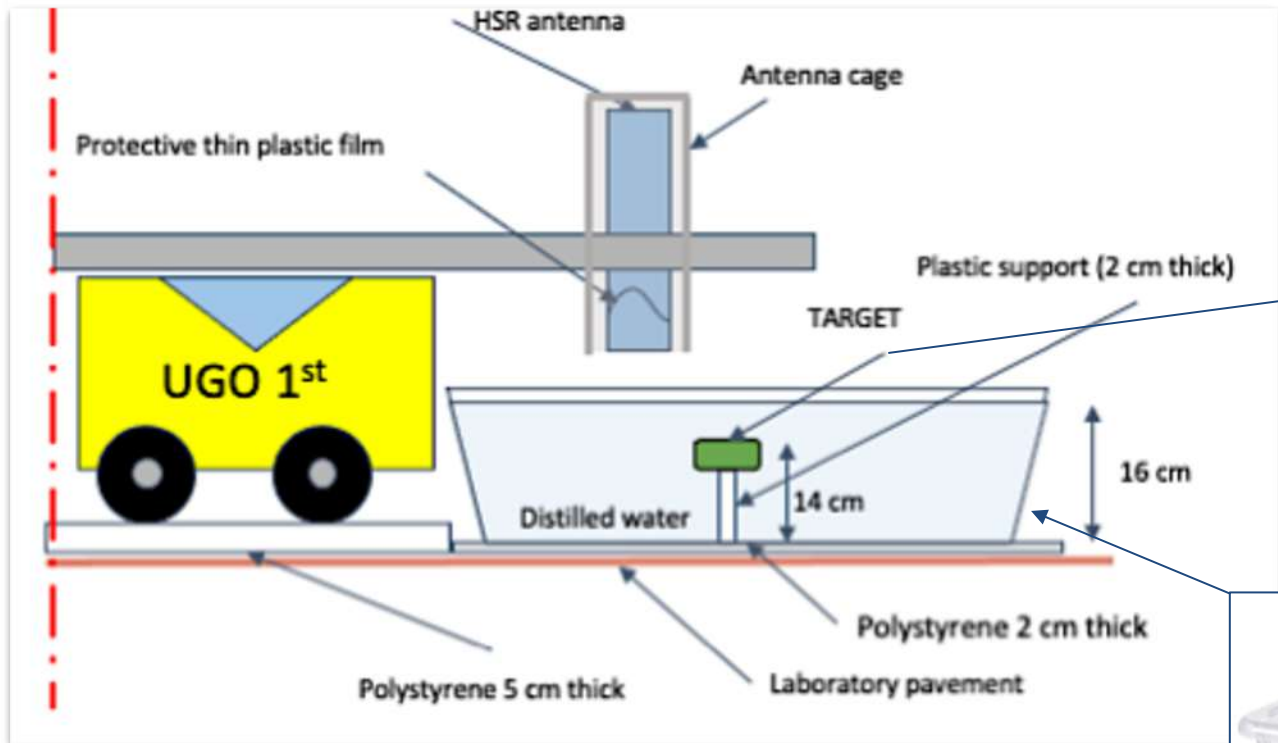


The cage is modelled starting from a folded metal mesh, made of galvanized iron. The dimensions of the grid are about 1/50 of the wavelength, and the thickness is about 1 mm.

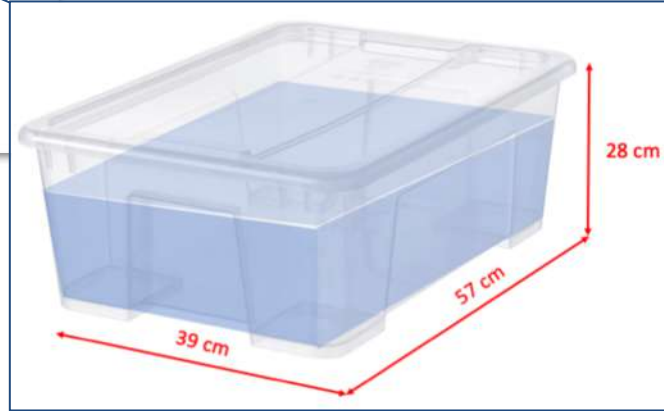


# 4

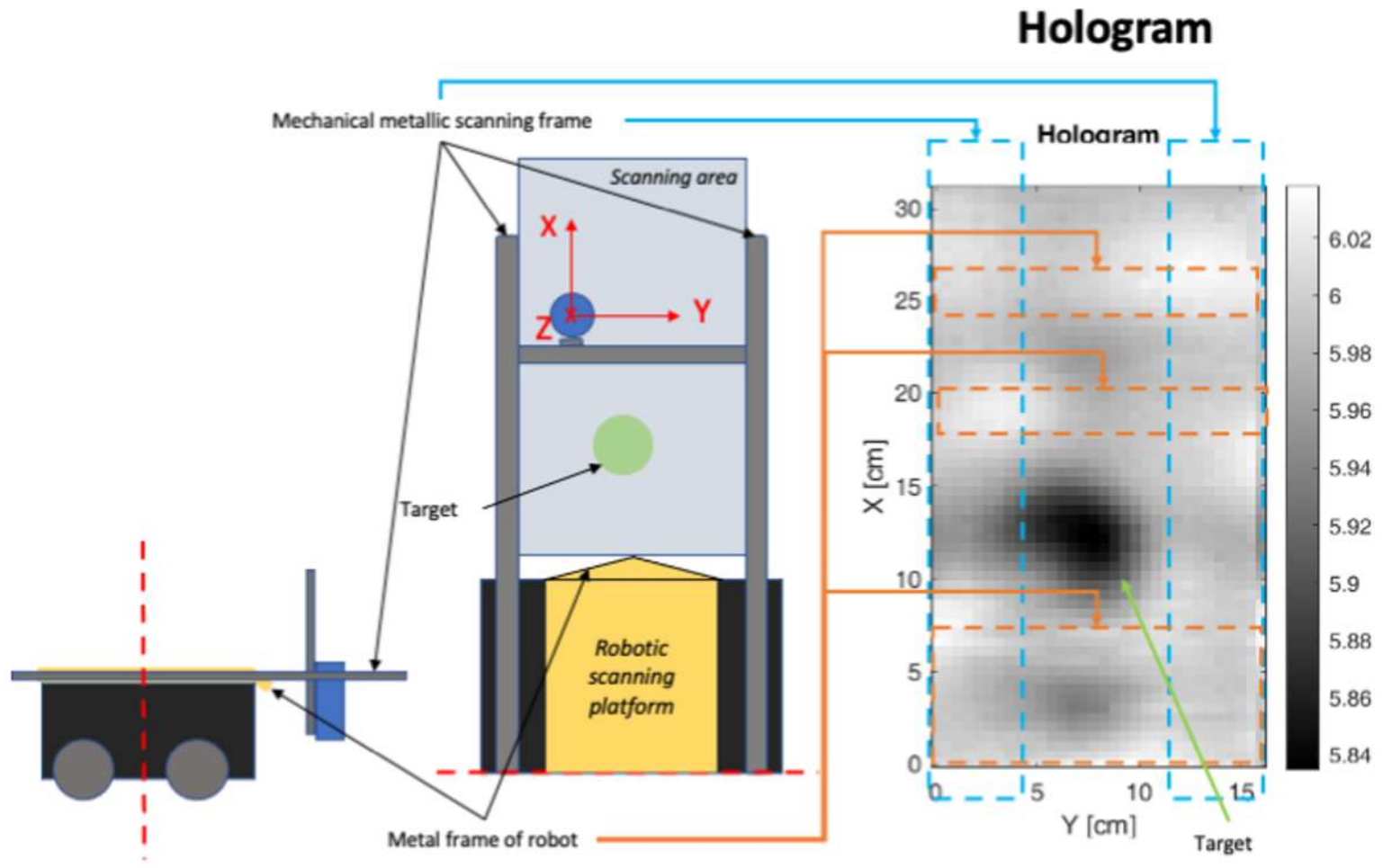
## EXPERIMENTS IN THE WATER-FILLED TESTBED



Target:  
plastic void box of 7.5 cm diam.

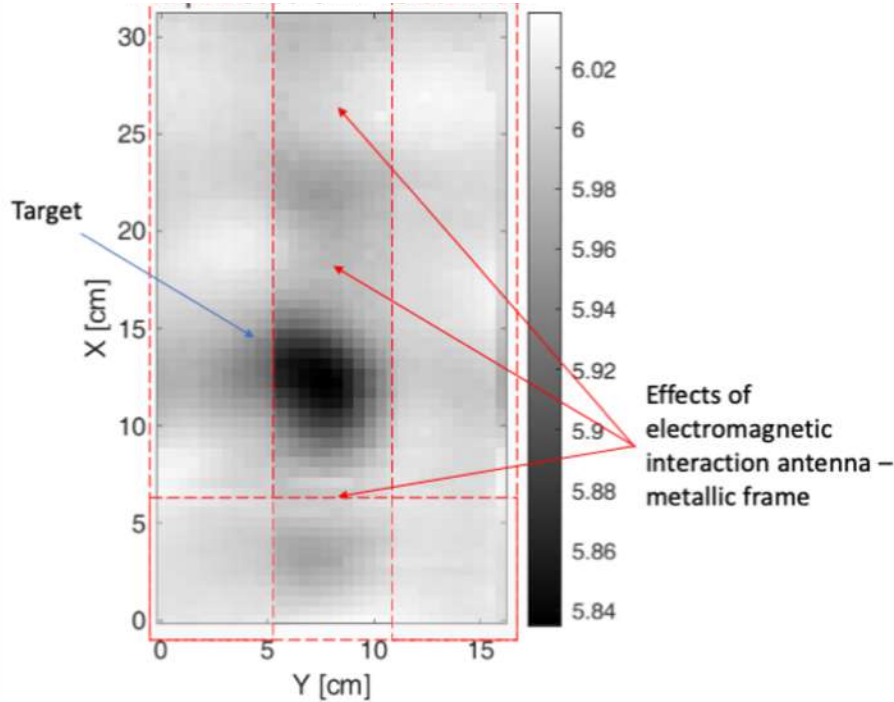


Water filled testbed



**Without Faraday cage**

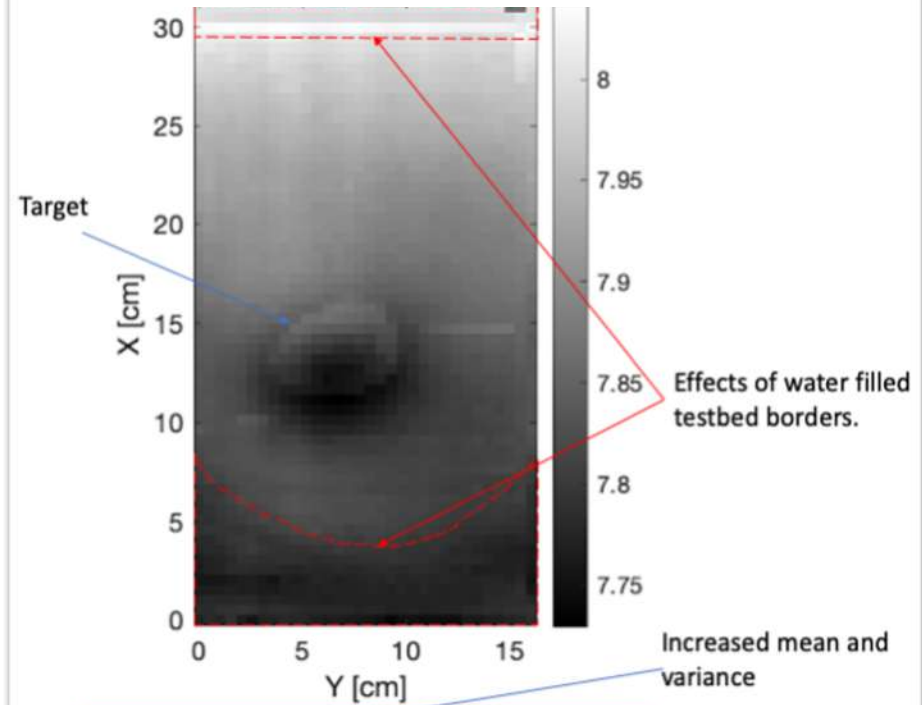
Radar Image Amplitude - Freq: 1.6635 GHz



Dynamic: 128.52 mV, Variance: 0.019579  $\mu\text{V}^2$

**Without Faraday cage**

Radar Image Amplitude - Freq: 1.6635 GHz



Dynamic: 308.39 mV, Variance: 0.2615  $\mu\text{V}^2$

**With Faraday cage**





# 5

## CONCLUSIONS AND DEVELOPMENTS

- We have presented the experimental setup and results of laboratory tests on an innovative plastic filled waveguide antenna shielded with a Faraday cage.
- The acquisitions used in our tests were conducted on a reference plastic target (box of candy of 7.5 cm diameter) that simulated a plastic landmine, in a test bed filled with distilled water.
- We have shown the effects on the images by shielding antenna and compared the result with the same acquisition without shield in terms of signal dynamic and clutter reduction.

***This first prototype gave us some indications that will be used to redesign a 3D printed plastic antenna with characteristics similar to those we have obtained with this prototype.***



# THANK YOU FOR ATTENTION

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