DITEN

University of Genoa

Department of Electrical, Electronic, Telecommunications Engineering and Naval Architecture (DITEN)

AEM
Applied Electromagnetics Group

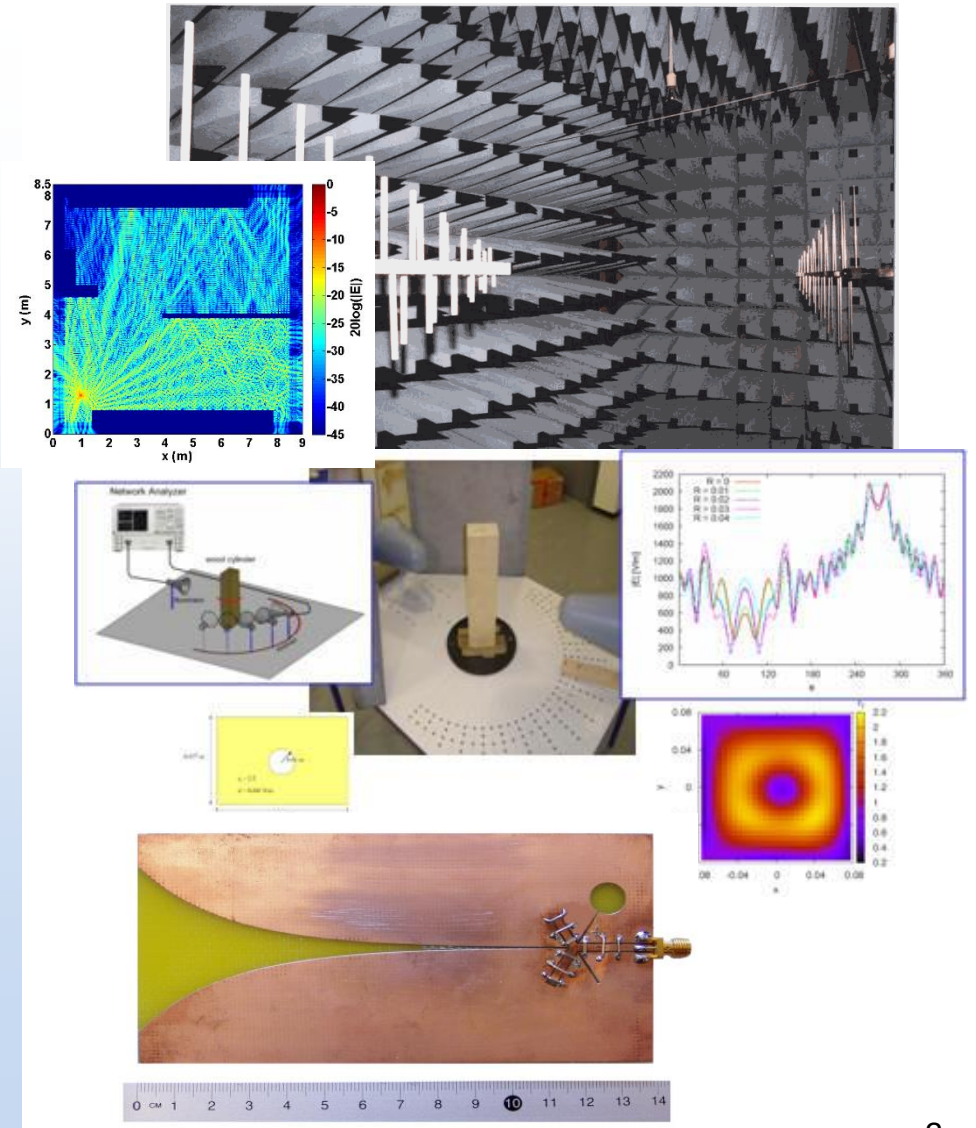
UNIVERSITÀ DEGLI STUDI
DI GENOVA

# APPLIED ELECTROMAGNETICS GROUP

# OVERVIEW OF RESEARCH ACTIVITIES

# Overview of research activities

- Computational electromagnetics
- Design of antennas for wireless devices and RFID
- RF and microwave devices
- Study of radar systems in marine, industrial, and subsurface applications (GPR)
- Development of electromagnetic diagnostic and imaging methods and systems
- Electromagnetic compatibility and interactions with biological systems

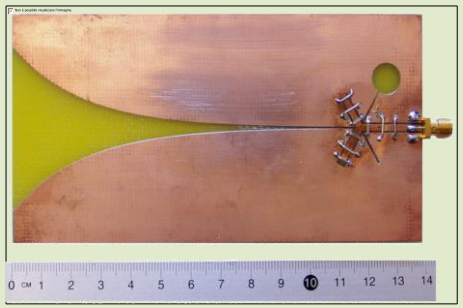


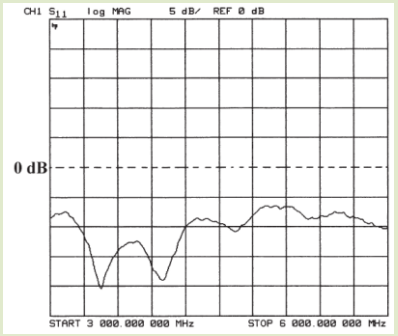
# Antenna design and characterization

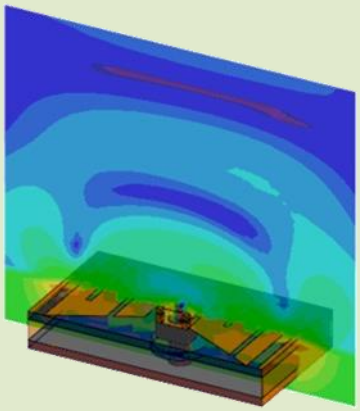
## Antennas for wireless systems operating in complex scenarios

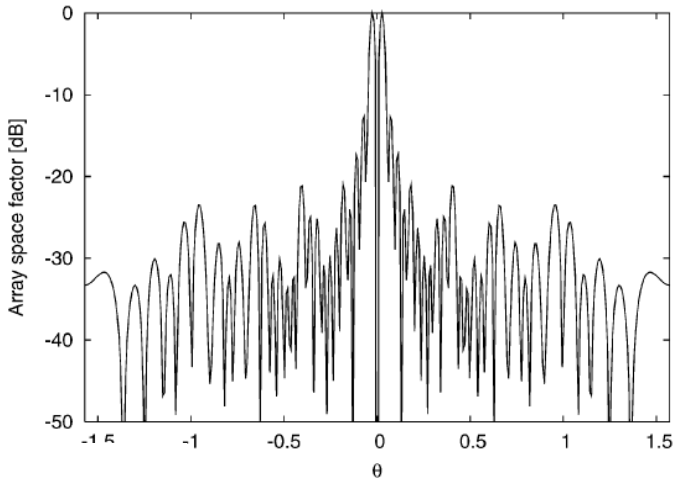
Antenna array synthesis and smart antennas

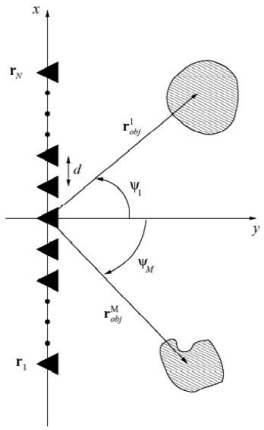
### UWB antenna design and characterization

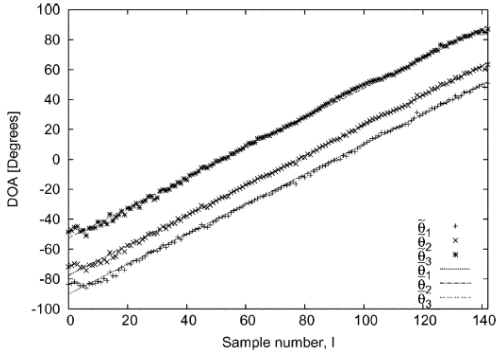






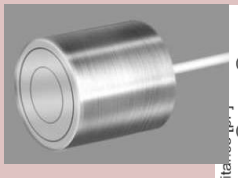



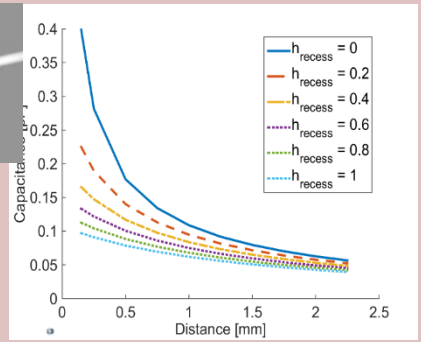



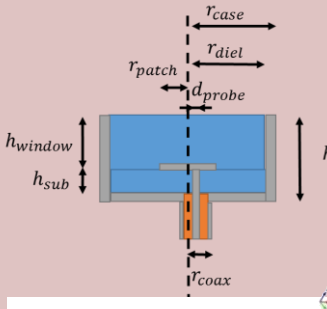
# Microwave components

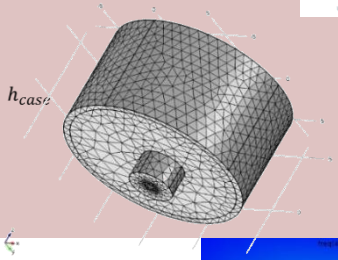
## Design, simulation and measurement of microwave components

FEM analysis of near-field radar and capacitive sensors

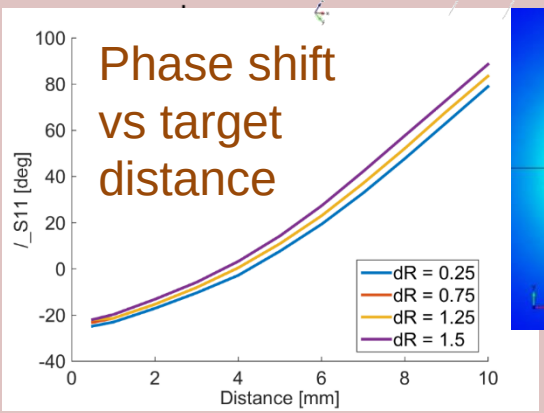


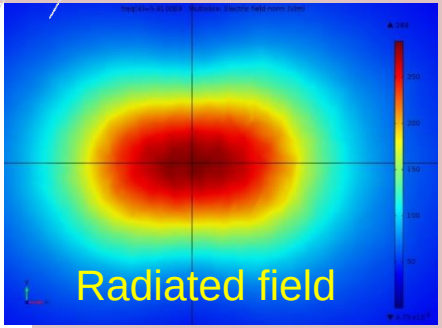


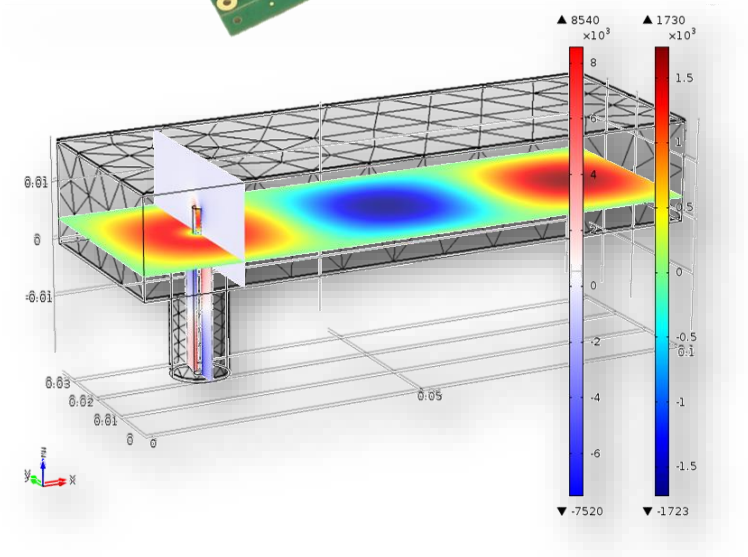




Capacity vs target distance

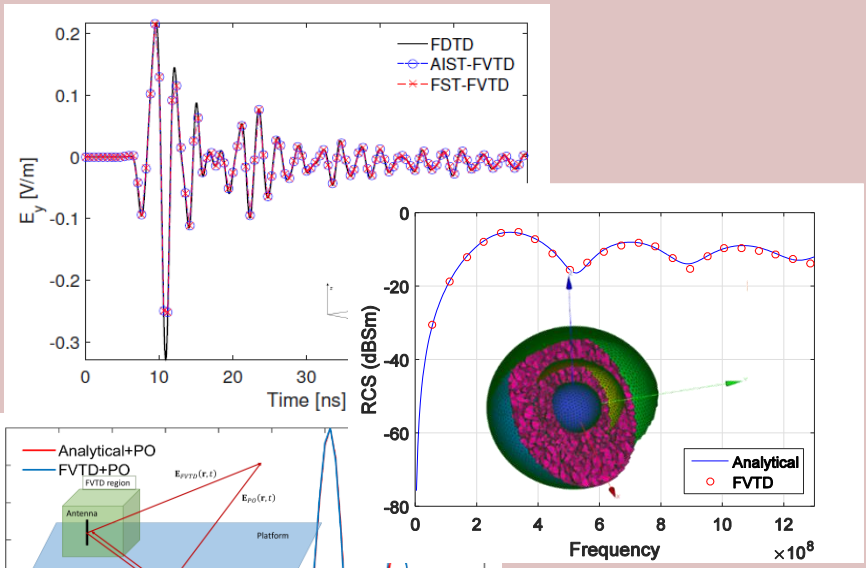


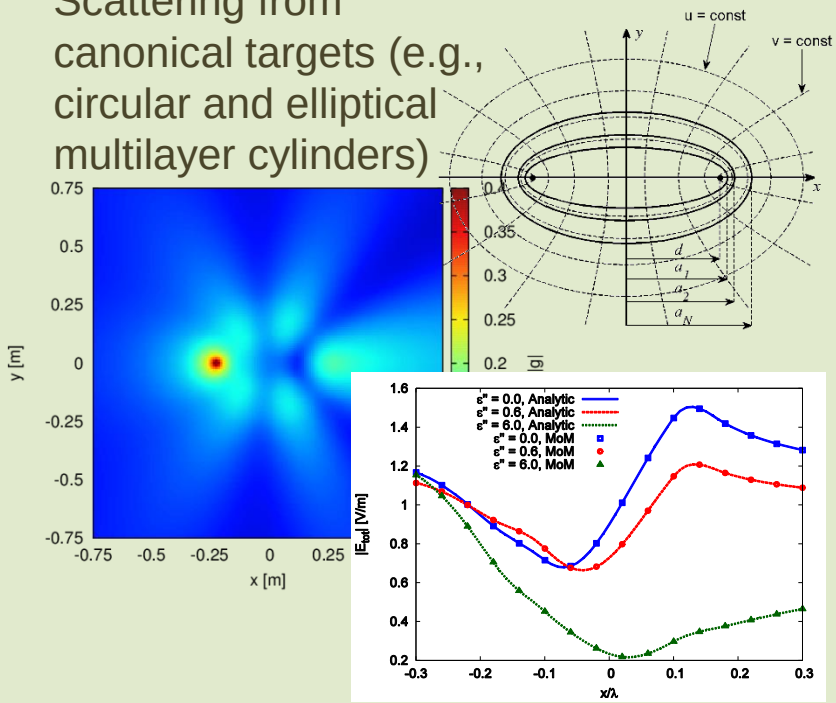
# Computational electromagnetics

## Development of analytical/ semi-analytical solvers and numerical simulators




FVTD time-domain solver with high-frequency hybridization

Scattering from canonical targets (e.g., circular and elliptical multilayer cylinders)



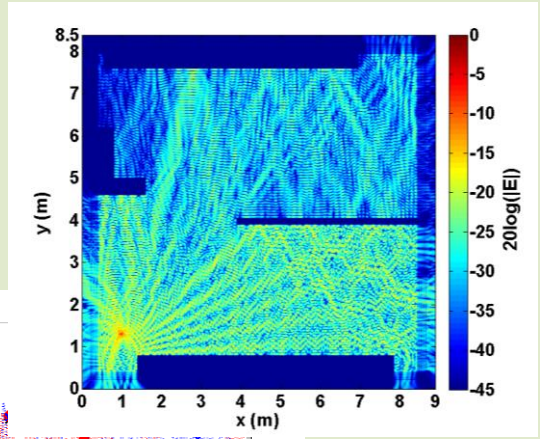

[1] A. Fedeli, M. Pastorino, M. Raffetto, and A. Randazzo, "Two-Dimensional Green's Function for Scattering and Radiation Problems in Elliptically-Layered Media with PEC cores," **IEEE Transactions on Antennas and Propagation**, vol. 65, no. 12, pp. 7110–7118, Dec. 2017.

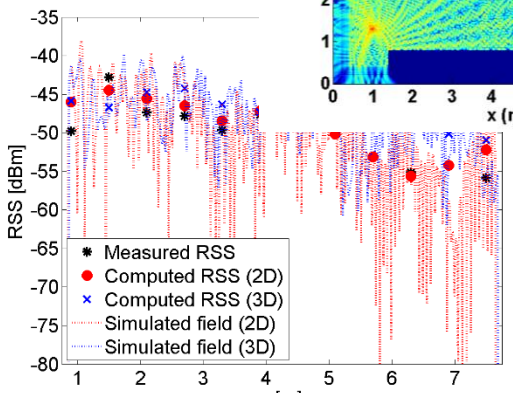
[2] G. Bozza, D. Caviglia, L. Ghelardoni, and M. Pastorino, "Cell-centered finite-volume time-domain method for conducting media," **IEEE Microw. Wirel. Compon. Lett.**, vol. 20, no. 9, pp. 477–479, Sep. 2010.

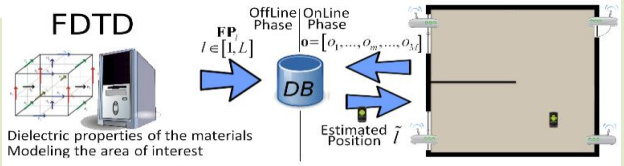
# Computational electromagnetics

## EM modeling and propagation in complex environments

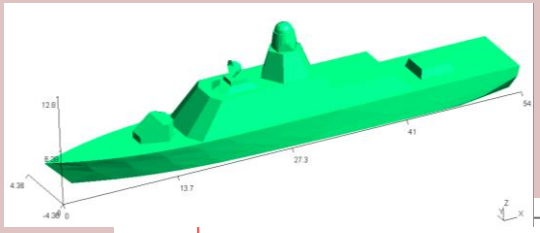
Indoor EM propagation and tracking with FDTD methods [1]

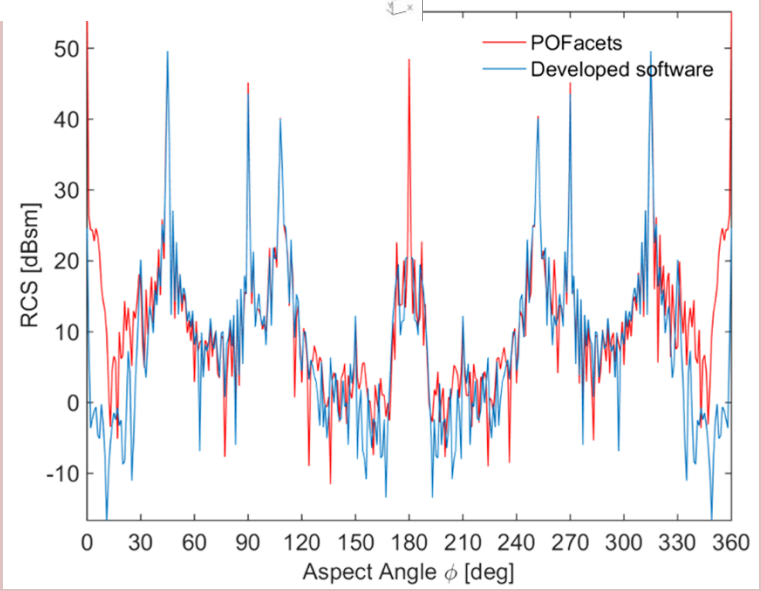



Asymptoptic RCS Prediction techniques [2]

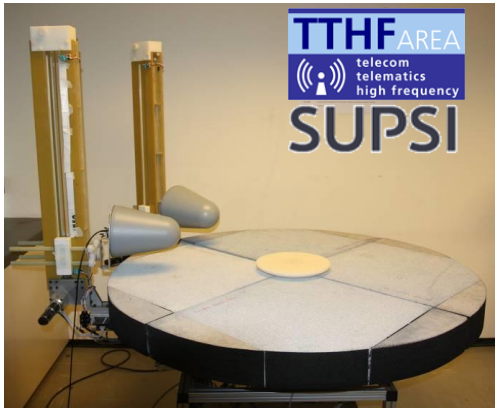




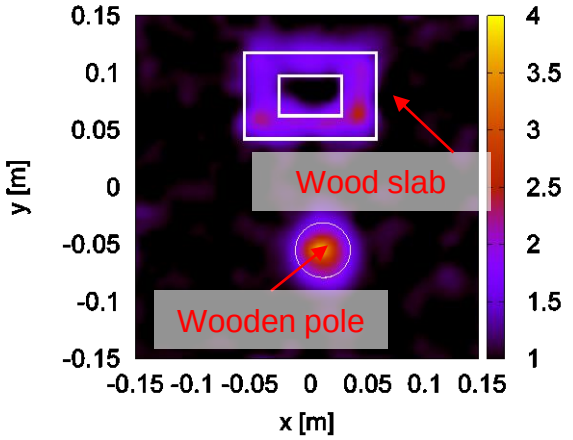

[1] I. Bisio, M. Cerruti, F. Lavagetto, M. Marchese, M. Pastorino, A. Randazzo, and A. Sciarrone, "A Trainingless WiFi Fingerprint Positioning Approach over Mobile Devices," **IEEE Antennas Wireless Propag. Lett.**, vol. 13, pp. 832-835, 2014.
[2] M. Cerruti, F. Perra, A. Guagnano, M. Pastorino, and A. Randazzo, "A Radar Cross Section and Radar Performance Evaluation Tool for the Early Stage Ship Design (ESSD) Phase," in Proc. **Oceans'15 MTS/IEEE**, 2015.

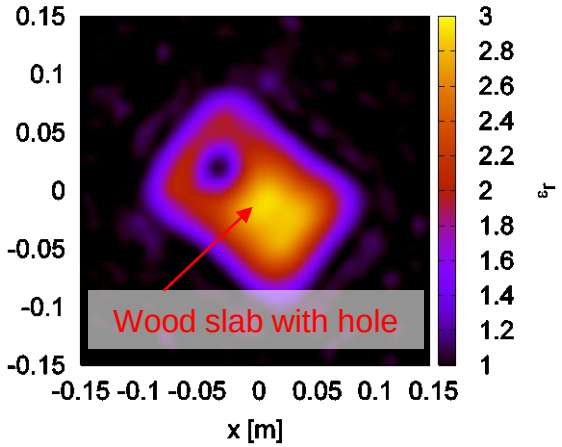
# Development of microwave tomographic systems

**First tomograph prototype**



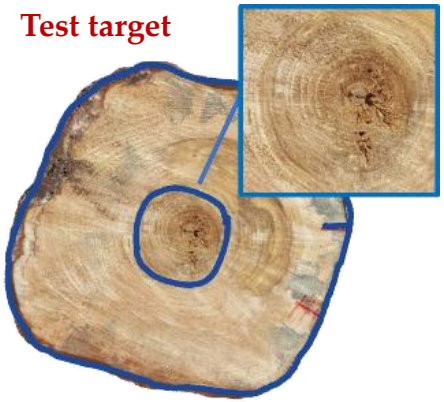

**Reconstructed relative dielectric permittivity**

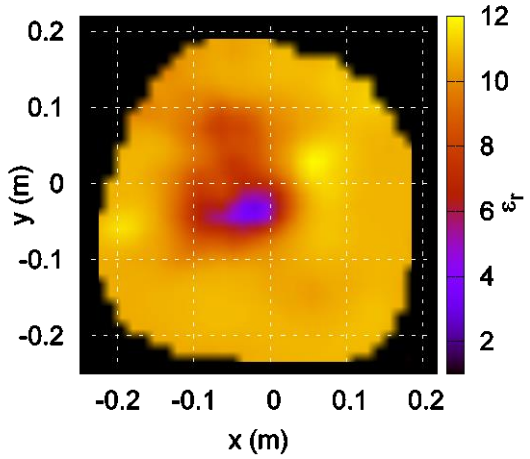



**Second prototype**

**Test target**

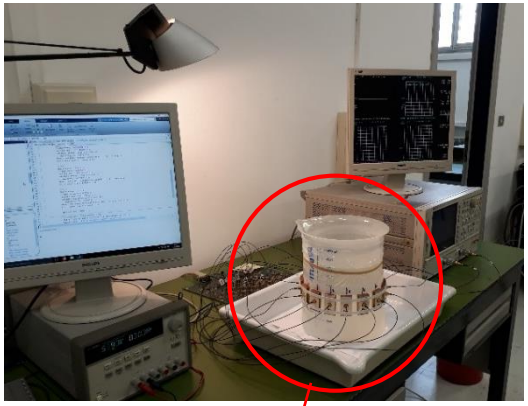


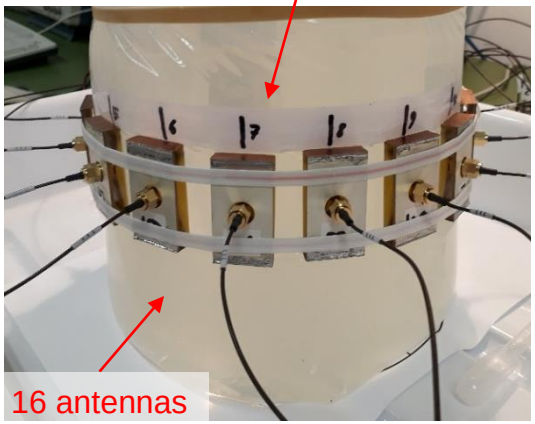


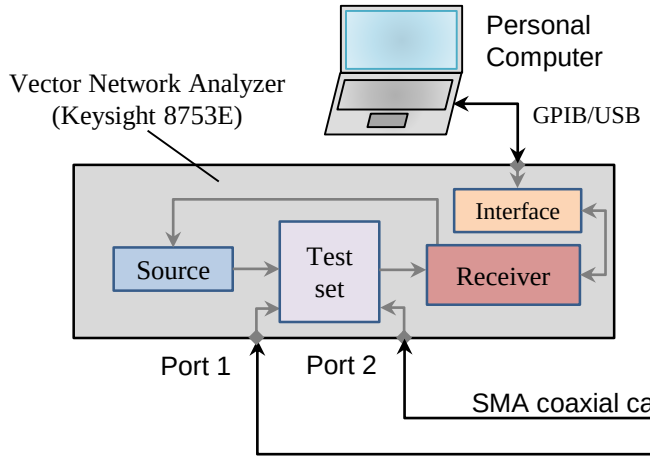

[1] F. Boero et al., "Microwave Tomography for the Inspection of Wood Materials: Imaging System and Experimental Results," **IEEE Transactions on Microwave Theory and Techniques**, vol. 66, no. 7, pp. 3497–3510, Jul. 2018.

# Microwave imaging for brain stroke detection

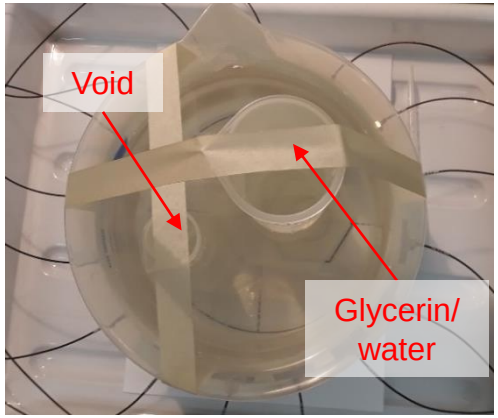
**Measurement setup with a prototype of the whole system**



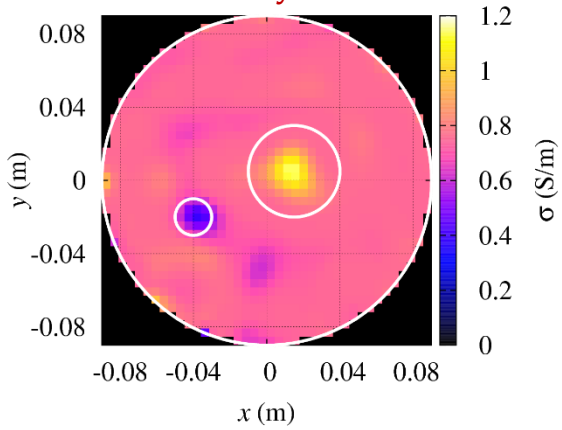



**Test target**




**Reconstructed electric conductivity at 0.6 GHz**



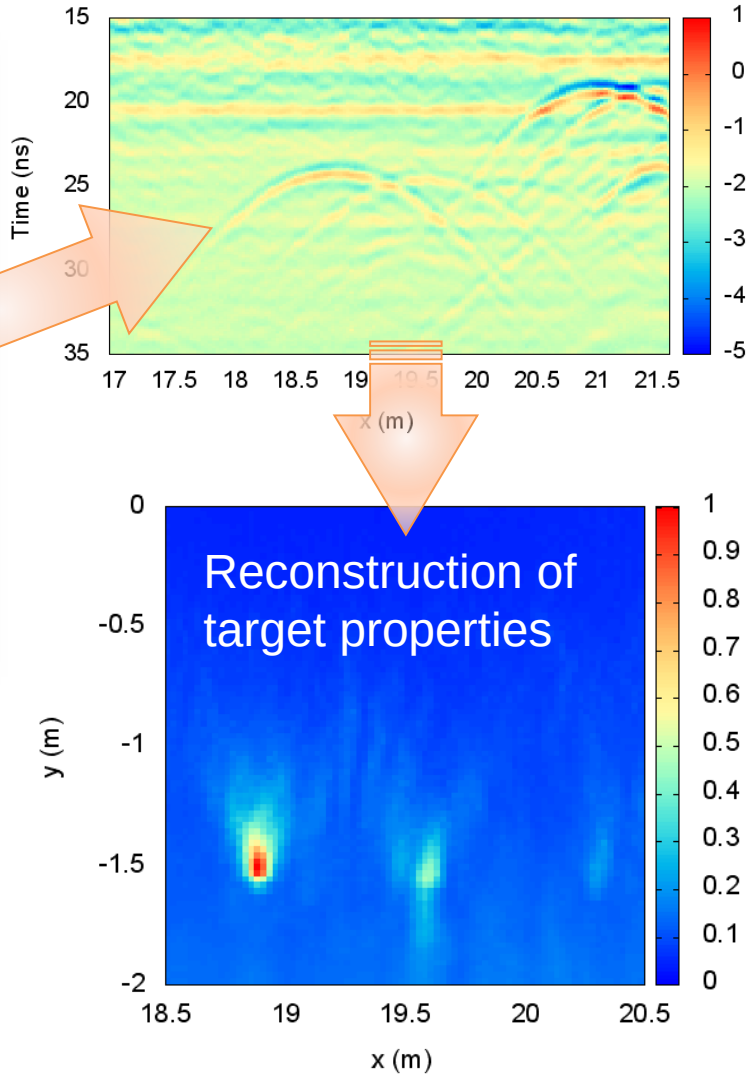

[1] I. Bisio, C. Estatico, A. Fedeli, F. Lavagetto, M. Pastorino, A. Randazzo, and A. Sciarrone, "Brain Stroke Microwave Imaging by Means of a Newton-Conjugate-Gradient Method in $L^p$ Banach Spaces," **IEEE Transactions on Microwave Theory and Techniques**, vol. 66, no. 8, pp. 3668–3682, Aug. 2018.

# Subsurface detection and GPR processing

## GPR systems


Antenna

## Radar B-scan




cost
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

COST is supported by the
EU Framework Programme Horizon2020

# Some recent scientific contributions

## Books

- M. Pastorino and A. Randazzo, **Microwave Imaging Methods and Applications.** Boston, MA: Artech House, 2018.
- M. Pastorino, **Microwave Imaging**. Hoboken, NJ: Wiley, 2010.

## International Journals

- C. Estatico, A. Fedeli, M. Pastorino, and A. Randazzo, "Quantitative microwave imaging method in Lebesgue spaces with non-constant exponents," **IEEE Transactions on Antennas and Propagation**, vol. 66, no. 12, pp. 7282-7294, Dec. 2018.
- C. Estatico, M. Pastorino, A. Randazzo and E. Tavanti, "Three-dimensional microwave imaging in $L^p$ Banach spaces: Numerical and experimental results," **IEEE Transactions on Computational Imaging**, vol. 4, no. 4, pp. 609-623, Dec. 2018.
- I. Bisio, C. Estatico, A. Fedeli, F. Lavagetto, M. Pastorino, A. Randazzo, A. Sciarrone, "Brain stroke microwave imaging by means of a Newton-conjugate-gradient method in $L^p$ Banach spaces," **IEEE Transactions on Microwave Theory and Techniques**, vol. 66, no. 8, pp. 3668–3682, Aug. 2018.
- F. Boero, A. Fedeli, M. Lanini, M. Maffongelli, R. Monleone, M. Pastorino, A. Randazzo, A. Salvadè, and A. Sansalone, "Microwave tomography for the inspection of wood materials: imaging system and experimental results," **IEEE Transactions on Microwave Theory and Techniques**, vol. 66, no. 7, pp. 3497–3510, Jul. 2018.
- A. Fedeli, M. Pastorino, M. Raffetto, and A. Randazzo, "2-D Green's function for scattering and radiation problems in elliptically layered media with PEC cores," **IEEE Transactions on Antennas and Propagation**, vol. 65, no. 12, pp. 7110–7118, Dec. 2017.
- M. Brignone, G. L. Gragnani, M. Pastorino, M. Raffetto, and A. Randazzo "Noise limitations on the recovery of average values of velocity profiles in pipelines by simple imaging systems," **IEEE Geoscience and Remote Sensing Letters**, vol. 13, pp. 1340–1344, 2016.
- C. Estatico, A. Fedeli, M. Pastorino, and A. Randazzo, "A multifrequency inexact-Newton method in $L^p$ Banach spaces for buried objects detection," **IEEE Transactions on Antennas and Propagation**, vol. 63, no. 9, pp. 4198–4204, Sep. 2015.
- S. Costanzo, G. Di Massa, M. Pastorino, and A. Randazzo, "Hybrid microwave approach for phaseless imaging of dielectric targets," **IEEE Geoscience and Remote Sensing Letters**, vol. 12, no. 4, pp. 851–854, Apr. 2015.
- M. Pastorino, M. Raffetto, and A. Randazzo, "Electromagnetic inverse scattering of axially moving cylindrical targets," **IEEE Transactions on Geoscience and Remote Sensing**, vol. 53, no. 3, pp. 1452-1462, Mar. 2015.

# Some recent projects

## PRIN2018

Project on conformal antenna diagnostics. Team leader: UNIGE. Partners: UNICAMPANIA, UNIROMATRE
Project on chipless RFID tags. Team leader: UNIPI. Partners: UNIGE, POLITO, UNICT

## PRIN2015

Project on through-the-wall radar for security applications. Team leader: UNIGE. Partners: UNISAPIENZA, UNIROMATRE, UNICAL

## POR Liguria 2014-2020

"Genova Sicura" – Development of a radar sensor for traffic monitoring
"Neuroglass" - Development of smart glasses

## EU COST Action

European network for advancing Electromagnetic hyperthermic medical technologies (CA17115)
Civil Engineering Applications of Ground Penetrating Radar (TU1208)

## Compagnia di San Paolo

Project on microwave brain stroke diagnosis.

## EU Eurostars project

Project on microwave tomography. Team leader: FOS.

## DLTM

«Pyxis» project on an integrate mast. Team leader: Fincantieri. Activity on RCS modelining and EMC.

## CTN

«MIE» project on ecosustainable smart mobility. Team leader: Leonardo. Activity on propagation modeling.

## Gruppo FOS

Project on EIT brain stroke monitoring.

## Orizzonte Sistemi Navali

Projects on simplified approaches for RCS evaluation and radar modeling.

## Ansaldo Energia

Projects on EM diagnostics and near-field radars.

## Esaote

Numerical analysis and design of RF coils for NMR systems

## SIIT

Project on advanced cooperative infomobility systems (ACIS)

# Recent industrial cooperations

- Gruppo FOS
- Fincantieri
- Medacta
- ABB
- Teknocongress Nord-Ovest
- Ansaldo Energia
- Orizzonte Sistemi Navali
- Leonardo
- ESAOTE
- Atel Antennas
- Ericsson

# Recent scientific cooperations

Telecom, Telemetry, and High Frequency Laboratory, University of Applied Sciences of Southern Switzerland

Applied Microwave Nondestructive Testing Laboratory, Missouri University of Science and Technology, USA

Embedded Electronic Systems Research Institute, ESIGELEC, France

Applied Electromagnetics Laboratory, University of Roma Tre

ELEDIA Research Center, University of Trento

Department of Electronics, Computer Science and Systems, University of Calabria

Institute of Applied Mathematics and Information Technology, CNR