

European School  
of Antennas



European Cooperation in  
Science and Technology



Actions TD1301 and TU1208

# Microwave Imaging and Diagnostics: Theory, Techniques, and Applications

Madonna di Campiglio, Trento, Italy  
24-28 March 2014

Course Coordinators:

**Prof. Andrea Massa**

ELEDIA Research Center  
University of Trento



**Prof. Tommaso Isernia**

LEMMA Research Group  
University Mediterranea of Reggio Calabria





# Microwave Imaging and Diagnostics

## Introduction

The exploitation of electromagnetic field data as a sensing tool paves the way to a number of interesting engineering applications including antenna testing and characterization, biomedical diagnostics, humanitarian demining, archeological prospection, through-the-wall imaging, non-destructive testing of transport infrastructures and buildings, and many others.

This course, after reviewing fundamental equations and main difficulties of inverse problems in high-frequency electromagnetics, will focus on classical and recently introduced solution procedures and algorithms, discussing capabilities, limitations, and perspectives of both approximate and 'exact' reconstruction methods. Applicative examples, including exercises and lessons regarding specific applications, with focus on the topics of the co-organizing COST Actions (BIO Imaging: [www.cost.eu/td1301](http://www.cost.eu/td1301); GPR: [www.gpradar.eu](http://www.gpradar.eu)), will corroborate the developed concepts.

## Course Contents

- Introduction to inverse scattering and basic theory
- Qualitative imaging methods
- Quantitative imaging: approximated and complete methods
- Imaging applications:
  - GPR applications
  - BIO applications
  - Antenna diagnostics
- Further issues and advanced topics

## Teachers:

Dr. CROCCO Lorenzo  
Prof. ISERNIA Tommaso  
Prof. LAS-HERAS Fernando  
Dr. LESSELIER Dominique  
Prof. LO VETRI Joe  
Prof. MASSA Andrea  
Prof. SCHETTINI Giuseppe  
Prof. TOSCANO Alessandro

## Registration deadline:

**March 10<sup>th</sup>, 2014**

## Availability:

**35 attendees**

## Course Info:

32.5 hours of classes:

- 27 hours of theoretical lectures
- 3.5 hours of guided software exercises
- 2 hours of final exam

## Registration fee:

440 EUR for non-profit institutions

880 EUR for companies

13 grants of 650€ from COST Actions TD1301 and TU1208 (already assigned)

## Venue:

Sala Comunale @ Chalet Laghetto

Via Monte Spinale, Madonna di Campiglio

Trento, Italy

All information on registration, transportation, lodging, and else at:

[http://www.antennasvce.org/Community/Education/Courses?id\\_folder=481](http://www.antennasvce.org/Community/Education/Courses?id_folder=481)



# Microwave Imaging and Diagnostics

## Class Scheduling

MONDAY - March 24th, 2014			INTRODUCTION AND BASIC THEORY
9.15-9.30		15'	Welcome
9.30-11.00	A. MASSA	90'	Introduction to Inverse Scattering (IS) Problems and Formulation
11.00-11.15			<i>coffee break</i>
11.15-12.45	A. MASSA	90'	Mathematical Issues of IS Problems
12.45-14.30			<i>lunch</i>
14.30-16.30	T. ISERNIA	120'	Inverse Source Problems: Radiated Field Properties, Basic Limitations, and Regularization Techniques
16.30-16.45			<i>coffee break</i>
16.45-18.15	T. ISERNIA	90'	Inverse Source Problems: Applications to Antenna Characterization, Diagnostics and Synthesis
TUESDAY - March 25th, 2014			QUALITATIVE IMAGING METHODS
8.30-9.30	L. CROCCO	60'	Qualitative Imaging Problems: Intro
9.30-10.30	L. CROCCO	60'	The Linear Sampling Method: Theory and Examples (Part 1)
10.30-10.45			<i>coffee break</i>
10.45-11.45	L. CROCCO	60'	The Linear Sampling Method: Theory and Examples (Part 2)
11.45-12.45	D. LESSELIER	60'	The MUSIC Method: Theory and Examples
12.45-14.30			<i>lunch</i>
14.30-16.30	D. LESSELIER	120'	The Level Set Method: Theory and Examples
16.30-16.45			<i>coffee break</i>
16.45-18.45	Tutors (Dr. Morabito)	120'	<i>SW Exercise : solving inverse source problems</i>
WEDNESDAY - March 26th, 2014			QUANTITATIVE IMAGING: APPROXIMATED AND COMPLETE METHODS
8.30-10.00	T. ISERNIA	90'	Quantitative Imaging Problems: Intro and Approximated Methods
10.00-10.30	J. LO-VETRI	30'	Deterministic Strategies: Theory (Part 1)
10.30-10.45			<i>coffee break</i>
10.45-12.45	J. LO-VETRI	120'	Deterministic Strategies: Theory (Part 2) and Examples
12.45-14.30			<i>lunch</i>
14.30-16.00	A. MASSA	90'	Stochastic Strategies: Theory and Example (Part 1)
16.00-16.15			<i>coffee break</i>
16.15-17.15	A. MASSA	60'	Stochastic Strategies: Theory and Example (Part 2)
17.15-18.45	Tutors (Drs. Oliveri/Rocca)	90'	<i>SW Exercise : solving microwave imaging problems by means of global optimization</i>
20.30			<i>social dinner</i>
THURSDAY - March 27th, 2014			IMAGING APPLICATIONS
till 14.30			<i>free time</i>
14.30-16.30	L. CROCCO	120'	Case Study 1: BIO Applications and COST Action
16.30-16.45			<i>coffee break</i>
16.45-18.45	F. LAS-HERAS	120'	Case Study 2: Antenna Diagnostics
FRIDAY - March 28th, 2014			FURTHER ISSUES & ADVANCED TOPICS
8.30-10.30	G. SCHETTINI/A. TOSCANO	120'	Case Study 3 : GPR Applications and COST Action
10.30-10.45			<i>coffee break</i>
10.45-12.45		120'	Concluding Remarks and Future Trends
12.45-14.30			<i>lunch</i>
14.30-16.30	All	120'	Final Exam/Test

# Microwave Imaging and Diagnostics

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