
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

**DOTTORATO DI RICERCA / PhD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING**

Activities and Publications Report

PhD Student: **Vincenzo Miranda**

Student DR number: DR996639

PhD Cycle: XXXVIII

PhD Chairman: Prof. Stefano Russo

PhD program student's start date: 01/11/2022

PhD program student's end date: 31/10/2025

Supervisor: Prof. Giuseppe Ruello

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PhD scholarship funding entity: PNRR - DM 351

General information

Vincenzo Miranda obtained his Master of Science degree in Biomedical Engineering from the University of Naples Federico II in 2022. He is currently a Ph.D. candidate in Information Technology and Electrical Engineering, with a research focus on electromagnetic field studies. His doctoral research is funded by a scholarship awarded by the University of Naples Federico II within the framework of the *Piano Nazionale di Ripresa e Resilienza (PNRR)*, pursuant to the Italian Ministry of University and Research Decree No. 351 of April 9, 2022.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1 st	How to boost your Ph.D.	Ad hoc course	4	Antigone Marino	(ITEE)
1 st	Statistical Data Analysis for Science and Engineering Research	Ad hoc course	4	Roberto Pietrantuono	(ITEE)
1 st	Electrodynamics of continuous media	MSc course	9	Claudio Serpico	Università degli Studi di Napoli Federico II
1 st	Formazione sulla progettazione europea: Modulo 1 – FONDI EUROPEI E PROGRAMMAZIONE	External course	0.4	Tommaso Foglia	Direzione Generale della Ricerca del Ministero dell'Università
1 st	Formazione sulla progettazione europea: Modulo 2 – PANORAMICA DELLE OPPORTUNITA' DI FINANZIAMENTO	External course	0.6	Tommaso Foglia	Direzione Generale della Ricerca del Ministero dell'Università
1 st	Formazione sulla progettazione europea: Modulo 3 – TECNICHE E METODI PER LA REDAZIONE DEI PROGETTI (LEZIONE 1)	External course	0.6	Tommaso Foglia	Direzione Generale della Ricerca del Ministero dell'Università
2 nd	Radiofrequency ablations in liver surgery: a multidisciplinary point of view	Ad hoc course	2	Giuseppe Ruello, Rita Massa	(ICTH)
2 nd	Innovation and Entrepreneurship	Ad hoc course	4	Pierluigi Rippa	(ITEE)
2 nd	Matrix Analysis for Signal Processing with MATLAB Examples	Ad hoc course	3	Massimo Rosamilia	(ITEE)
2 nd	Numerical methods for thermal analysis, modeling, and simulation: application to electronic devices and systems	Ad hoc course	4	Antonio Pio Catalano	(ITEE)
2 nd	official type B tutoring activities	//	2.4	Vincenzo Miranda	Università degli Studi di Napoli Federico II

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3 rd	Tecniche Elettromagnetiche in Neuroscienze	MSc course	9	Giuseppe Ruello	Università degli Studi di Napoli Federico II
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Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1 st	Surface Electromagnetics	Trento, Italy	4	15/05/2023-19/05/2023	ELEDIA Research Center University of Trento

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1 st	Matlab Fundamentals	0.4	Salvatore Capuozzo	University of Naples Federico II	ICTH
1 st	Electromagnetic Characterization of Coatings and Structured Surfaces for Particle Accelerators	0.4	Andrea Passerelli	CERN, 1211 Geneva 24, Switzerland	Ettore Pancini Physic Department
1 st	Ricerca e formazione nella società della transizione digitale	1	//	//	Consorzio Interuniversitario Nazionale per l'Informatica (CINI)
1 st	Dagli acceleratori di particelle alla musica digitale	0.2	Di Giugno	University of Naples Federico II	Ettore Pancini Physic Department
1 st	Finite element software for electroporation techniques	0.2	Francesca Lodato	University of Naples Federico II	Ettore Pancini Physic Department
1 st	PRINCIPI ARCHITETTURALI - TOGAF I	0.6	Alberto Curcio and Pietro Boscolo	Capgemini	San Giovanni a Teduccio Technology Hub 5G Academy
1 st	OPEN DIGITAL FRAMEWORK -CRASH COURSE	0.6	Alberto Curcio and Valeria Crimaldi	Capgemini	San Giovanni a Teduccio Technology Hub 5G Academy
1 st	Embracing Data Imperfections Via Domain Enriched Visual Task Learning	0.2	Vishal Monga	Pennsylvania State University.	ITEE
1 st	Algorithm Unrolling: Efficient, Interpretable Deep	0.2	Vishal Monga	Pennsylvania State University.	ITEE

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	Learning for Signal and Image Processing				
1 st	How to public open access	0.2	Francesca Rossi, Eszter Lukacs	IEEE	ITEE
1 st	Insights into the Design of Transmit and Receive Coils for Ultra-High Field MRI	0.4	Riccardo Lattanzi	Radiology Department, New York University	ICTH
1 st	Tecniche di Elettrofisiologia Mappaggio ad alta densità e Ablazione a RF con l'utilizzo del Carto	0.4	//	Jhonson & Jhonson Institute c/o Clinica Mediterranea	University of Naples Federico II
1 st	Research and development activities	0.4	//	Teoresi Group	University of Naples Federico II
1 st	Electric Regularized Maxwell Equations with Singularities (ERMES)	1	R. Otin	Center for Numerical Methods in Engineering (CIMNE)	University of Naples Federico II
2 nd	Present and future of the European optical telescopes: the Wide-field Spectroscopic Telescope	0.2	Daniele Di Pietro	Numerical Analysis Department, Université de Montpellier	Scuola Superiore Meridionale (SSM)
2 nd	An overview of polytopal approximations of partial differential equations	0.2	Pietro Schipani	INAF	Scuola Superiore Meridionale (SSM)
2 nd	Intelligenza Artificiale e Regole del Mercato	0.4	Massimo Rubino De Ritis	University of Naples Luigi Vanvitelli	San Giovanni a Teduccio Technology Hub 5G Academy
2 nd	Some aspects of virtual medicine and human space science research	0.2	Paolo Russo	Ettore Pancini Physic Department, University of Naples Federico II	Scuola Superiore Meridionale (SSM)
2 nd	From ACE Technologies to Sustainable, Accessible and Equitable Urban Mobility: An Optimization Journey	0.4	Prof. Mauro Salazar	Eindhoven University of Technology, Eindhoven, Netherlands	ITEE
2 nd	Generative AI for software	1	Cuvi,	Capgemini	San Giovanni a

	engineering; strategies, impacts and practical applications		Favale, Zoccoli		Teduccio Technology Hub 5G Academy
2 nd	Sustainable it: Strategies and best practices for a green engineering future	1	Di Leva, Cuomo, Ramazzotti Marcozzi	Capgemini	San Giovanni a Teduccio Technology Hub 5G Academy
2 nd	High-Field Magnetic Resonance Imaging: Electromagnetic compatibility and optimization	0.6	Giuseppe Carluccio	University of Naples Federico II	ICTH
2 nd	Machine Deception	0.2	Henrik Skaug Sætra	University of Oslo, Norway Department of Informatics	University of Naples Federico II
2 nd	Myelin Mapping in the brain's white matter using a new data- driven analysis of the multicomponent MRI signals	0.2	Noam Ben-Eliezer	Radiology Department, New York University	Radiology Department, New York University
2 nd	Regolazione in Tema Di intelligenza artificiale alla luce dell'AI act	1	Elvira Raviele	Ministero delle Imprese e del Made in Italy	San Giovanni a Teduccio Technology Hub 5G Academy
2 nd	Rewire the brain: the potential of neuroplasticity	0.4	Paola Marangolo	Department of Humanities studies, University of Naples Federico II	San Giovanni a Teduccio Technology Hub 5G Academy
2 nd	CBI Science Day NYU	1	Yvonne Lui, Riccardo Lattanzi	Radiology Department, New York University	Radiology Department, New York University
3 rd	AI Powered user Interface design	1	Prof. Antonio Origlia	University of Naples Federico II	San Giovanni a Teduccio Technology Hub 5G Academy

Research activities

The research focuses on the study of high-permittivity materials (HPMs) to address challenges in high-field magnetic resonance imaging (MRI). In this context, where HPMs have attracted considerable attention for their ability to mitigate RF field inhomogeneities, enhance the signal-to-noise ratio (SNR), and provide simplicity and low cost, the work contributed to the development of

an analytical scattering model for multilayered spheres and cylinders. This model offers a physical framework for understanding how such materials can be designed to optimize MRI performance, an aspect that had not yet been fully clarified. Despite its relative simplicity, the model was benchmarked against data from literature and proved to be a valuable tool for guiding and optimizing numerical simulations. These simulations, often initiated from empirical parameters, typically require significant time and computational resources. The developed model and theory were also experimentally validated, in collaboration with the Department of Radiology at NYU, by exposing a spherical phantom coated with an HPM inside a 7T MRI scanner, thereby confirming the presented results.

Tutoring and supplementary teaching activities

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1 st	22.6	6.2	29	0
2 nd	15.4	6.8	34	0
3 rd	9	1	56	0
tot	47	14	119	0

Iter formativo	corsi / scuole	seminari	attività ricerca	tutorato / did. int.
1 anno	min 20 - max 40	min 5 - max 10	min 10 - max 35	min 0 – max 1.6
2 anno	min 10 - max 20	min 5 - max 10	min 30 - max 45	min 0 – max 1.6
3 anno	min 0 - max 10	min 0 - max 10	min 40 - max 60	min 0 – max 1.6
TOTALE	min 30 – max 70	min 10 – max 30	min 80 – max 140	min 0 – max 4.8

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
2 st	New York University, Radiology Department	Riccardo Lattanzi, CBI director	30/09/2024 30/03/2025	Design, fabrication, and 7T MRI evaluation of a spherical phantom with dielectric properties of brain tissues, coated with a high-permittivity material.
3 rd	Istituto Nazionale Tumori IRCCS Fondazione G. Pascale	Vincenzo Cerciello, Medical physicist	23/06/2024 23/09/2024 23/05/2025 23/08/2025	Numerical simulation to assess operators' exposure risk to high static magnetic fields during movement within an MRI room, in compliance with Legislative Decree No. 159/2006, for a Siemens 3T scanner at the Pascale Foundation

PhD Thesis

The aim of this work is to advance the understanding and design of High-Permittivity Materials (HPMs) for high-field Magnetic Resonance Imaging (MRI). When positioned between the patient and the radiofrequency (RF) antenna, these materials can effectively mitigate field inhomogeneities and enhance the signal-to-noise ratio (SNR), thereby addressing key challenges in high-field imaging.

However, a comprehensive physical explanation of the observed improvements remains elusive, and the optimization of specific applications often relies on time consuming numerical simulations based on empirical parameters. Addressing these limitations constitutes the main focus of the present study.

The research adopts a multidisciplinary approach combining theoretical modelling, numerical validation, and experimental verification. A novel analytical scattering model based on Mie theory was developed for canonical geometries, introducing scalar parameters such as impedance and reflection coefficient to describe the interaction between HPMs and electromagnetic fields in biological tissues and to estimate the optimal permittivity for a given application.

The model was compared against numerical simulations on a human-head configuration to assess its accuracy and potential as a fast optimization tool. Finally, to experimentally validate the approach and explore possible SNR improvements, a spherical phantom mimicking the dielectric properties of human tissues at 7~T was fabricated, coated with an HPM layer predicted by the model, and tested under ultra-high-field MRI conditions.

Research products

Research results appear in 1 paper published in international journals, 1 paper published in national journals, 7 contributions to international conferences, 0 contributions to national conferences, 0 patents.

List of scientific publications

International journal papers

- V. Miranda, G. Ruello, R. Lattanzi,
A theoretical framework to investigate the effect of high permittivity materials in MRI using anatomy-mimicking cylinders,
Magnetic Resonance in Medicine, vol. 92 (1), pp. 416–429, 2024, DOI: 10.1002/mrm.30063.

International conference papers

- V. Miranda, D. Riccio, G. Ruello, R. Lattanzi,
A novel electromagnetic method to interpret scattering suppression from spheres,
Proc. Metamaterials 2023, 2023, DOI: 10.1109/Metamaterials58257.2023.10289295.
- G. Carluccio, C. M. Collins, R. Lattanzi, V. Miranda, D. Riccio, G. Ruello,
An analytical and numerical approach to investigate the role of high permittivity materials in MRI,
URSI GASS 2023, DOI: 10.23919/URSIGASS56706.2023.10289315.
- G. Carluccio, C. M. Collins, R. Lattanzi, V. Miranda, D. Riccio, G. Ruello,
An analytical solution to investigate the impact of an insulating layer with high permittivity materials in MRI applications,
ICEAA 2023, DOI: 10.1109/ICEAA57318.2023.10297874.
- G. Carluccio, V. Miranda, C. M. Collins, D. Riccio, G. Ruello,
Optimum high-permittivity materials with parallel imaging applications in MRI,
Xpress Conference on Electromagnetics in Advanced Applications, 2024.
- G. Carluccio, C. M. Collins, D. Riccio, V. Miranda, G. Ruello,
Numerical optimization of a 3D multilayer dielectric geometry for MRI applications,
USNC-URSI NRSM 2025, ISBN: 978-1-946815-20-0.
- V. Miranda, R. Lattanzi, D. Riccio, G. Ruello,
Analytical model for RF propagation in layered spheres: use of high permittivity materials in ultra-high field magnetic resonance of the brain,
Proc. BioEM Conference, 2024.
- V. Miranda, G. Carluccio, R. Lattanzi, D. Riccio, G. Ruello,
Magnetic Resonance Imaging of the Brain: Impact of Heterogeneous Head Model on the Analytical Design of High Permittivity Materials,
Proc. BioEM Conference, 2025.

National journal papers

- V. Miranda, D. Riccio, G. Ruello, R. Lattanzi,
A physical framework to investigate scattering suppression from coated spheres,
FERMAT, 2022.

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Date 20/10/2025

PhD student signature

Vincenzo Miranda

Supervisor signature

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