
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

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

Activities and Publications Report

PhD Student: **Vittorio Di Marzo**

Student DR number: DR996630

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. Roberto Ambrosino

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PhD scholarship funding entity:

Università Federico II/Eni S.p.A. (PNRR - DM 352)

General information

Vittorio Di Marzo received in year 2022 the Master Science degree in Mechanical Engineering from the University of Napoli Federico II. He attended a curriculum in Automation Engineering within the PhD program in Information Technology and Electrical Engineering. He received a grant from Università Federico II/Eni S.p.A (PNRR - DM 352).

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1 st	Automatica	MSc Course	6	Roberto Ambrosino	ITEE
1 st	Plasmi e Fusione Nucleare	MSc Course	9	Raffaele Albanese, Massimiliano Mattei	ITEE
1 st	Modellistica e Simulazione	Course	9	Roberto Ambrosino	ITEE
1 st	Teoria dei Sistemi	Course	9	Alfredo Pironti	ITEE
2 nd	Modellistica e Dinamica dei Campi	MSc Course	9	Amedeo Capozzoli	ITEE
2 nd	Advanced course on plasma control and CODAC	Ad hoc Course	6	Gianmaria De Tommasi	University of Padua and University of Naples
2 nd	Strategic orientation for STEM research & writing (Type B)	Ad hoc Course	5	Chie Schin Fraser	University of Naples
3 rd	Innovation & Entrepreneurship	Ad hoc Course	3	Pierluigi Rippa	University of Naples

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1 st	Scuola Nazionale Dottorandi di Elettrotecnica "Ferdinando Gasparini"	Napoli, Italy	4	23/01/2023 – 27/01/2023	University of Naples Federico II, Italy
2 nd	Scuola Nazionale Dottorandi di Elettrotecnica "Ferdinando Gasparini"	Napoli, Italy	4	05/02/2024 – 09/02/2024	University of Naples Federico II, Italy
2 nd	4TH International School On Numerical Modelling for Applied Superconductivity	Barcelona, Spain	2	17/06/2024 – 21/06/2024	Fusion for Energy, Spain

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1 st	Entangled Relativity	0.3	Olivier Minazzoli	Observatoire de la Cote d'Azur	Scuola Superiore Meridionale
1 st	Is control a solved problem for aerial robotics research?	0.2	Antonio Franchi	University of Rome La Sapienza	ITEE
1 st	Effective behavior of random media	0.4	Felix Otto	Max Planck Institute	Scuola Superiore Meridionale
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 learning for signal and image processing	0.2	Vishal Monga	Pennsylvania State University	ITEE
1 st	Multi-robot control of heterogeneous herds	0.4	Eduardo Montijano	University of Zaragoza	Scuola Superiore Meridionale
1 st	Non-destructive testing in aeronautics	0.2	Giovanni Gravina	Italian Air Force	ITEE
1 st	Discrete De Giorgi theory: analysis and applications	0.2	Suli Endre	University of Oxford	ITEE
1 st	Analysis and control of functional brain networks	0.2	Fabio Pasqualetti	University of California at Riverside	Scuola Superiore Meridionale
1 st	Ripple-trapped energetic particle resonances in DTT	0.4	Gianluca Spizzo	RFX Consortium	ENEA Research Center
1 st	Some advances in isogeometric analysis of coupled and complex problems	0.2	Alessandro Reali	University of Pavia	Scuola Superiore Meridionale
1 st	Accessibility of high H98 and β_N above no-wall limit operations for BEST	0.4	Vincent Chan	Massachusetts Institute of Technology	ENEA Research Center
1 st	Particle orbit resonance and stellarator design	0.2	Roscoe B. White	University of Princeton	ENEA Research Center
1 st	The Dynamics of social systems with higher-order interactions	0.2	Vito Latora	University of Catania	Scuola Superiore Meridionale
1 st	The hours of the sun: astronomy geometry and art in ancient sundials	0.2	Alessandra Pagliano	University of Naples Federico II	Scuola Superiore Meridionale
1 st	Kinetic control of tokamaks	0.4	Federico Felici	École Polytechnique Fédérale de Lausanne	University of Tuscia
1 st	Decision making under	0.2	Athanasios	Athens University	Scuola Superiore

Activities and Publications – Final Report

UNINA PhD in Information Technology and Electrical Engineering – XXXVIII Cycle

PhD candidate: Vittorio Di Marzo

	model uncertainty with applications in finance and insurance		Yannacopoulos		Meridionale
1 st	Cosmic Explosions in the Violent Universe	0.2	Massimo Della Valle	Istituto Nazionale di Astrofisica	Scuola Superiore Meridionale
1 st	Modelling and Understanding Human Behaviour and Action Decisions for Predictive Human-machine Systems	0.2	Michael Richardson	Macquaire University	Scuola Superiore Meridionale
1 st	Nonlinear equilibria and transport processes in burning plasmas	0.2	Matteo Falessi	ENEA Research Center	ENEA Research Center
1 st	Ricerca e formazione nella società della transizione digitale	0.4	Consorzio Interuniversitario Nazionale per l'Informatica	Consorzio Interuniversitario Nazionale per l'Informatica	Consorzio Interuniversitario Nazionale per l'Informatica
1 st	Come può tornarci utile la scienza	0.4	Giorgio Parisi	University of Rome La Sapienza	University of Naples Federico II
2 nd	Muon radiography and its applications	0.2	Giulio Saracino	University of Naples Federico II	Scuola Superiore Meridionale
2 nd	Ensuring electronic Reliability against CERN's Radiation Environment	0.2	Salvatore Danzeca	ITEE	ITEE
2 nd	Digital Twin Technology for Acceleration of Fusion R&D	0.2	Jae-Min Kwon	Korea Institute of Fusion Energy	ENEA Research Center
2 nd	An overview of polytopal approximations of partial differential equations	0.2	Daniele Di Pietro	Université de Montpellier	Scuola Superiore Meridionale
2 nd	Fondamenti di dinamica delle strutture e controllo delle Vibrazioni	3	Nicolò Vaiana	University of Naples Federico II	University of Naples Federico II
2 nd	Understanding material microstructure	0.2	Sir John Ball	Heriot-Watt University	Scuola Superiore Meridionale
2 nd	Description of magnetic field lines without arcana	0.2	Barbara Momo	RFX Consortium	ENEA Research Center
2 nd	IEEE Authorship and	0.3	Rachel	IEEE	IEEE

Open Access Symposium: Tips and Best Practices to Get Published from IEEE Editors		Berrington		
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Research activities

Vittorio Di Marzo participated in the research activities of the Ph.D. program in Information Technology and Electrical Engineering, focusing on the design and analysis of superconducting systems for magnetic confinement fusion devices. During the first year, his work addressed plasma equilibrium studies for DEMO and the investigation of alternative techniques for power exhaust mitigation, such as strike point sweeping. He also contributed to the analysis of the plasma control system (PCS) of the Divertor Tokamak Test facility (DTT), exploring its implications for magnetic and plasma stability.

In the second year, his research expanded to the pre-design phase of the Volumetric Neutron Source (VNS), including the development of plasma equilibria and meshing strategies for electromagnetic simulations, together with preliminary studies on hysteresis phenomena in ferromagnetic materials.

From the second half of the second year onward, his work focused exclusively on the Central Solenoid (CS) of DTT, developing an integrated electromagnetic and mechanical modeling framework for superconducting coils. The activity combined theoretical and applied superconductivity, optimization procedures, and finite-element validation. The research outcomes contributed to the understanding and preliminary design of both Low-Temperature Superconducting (LTS) and High-Temperature Superconducting (HTS) configurations for future fusion magnet systems.

Tutoring and supplementary teaching activities

During the Ph.D. program, Vittorio Di Marzo took part in some tutoring and teaching support activities within the Department of Electrical Engineering and Information Technology. He co-supervised two thesis students: one BSc student, who carried out a study on plasma controllability in the Volumetric Neutron Source (VNS) tokamak, and one MSc student, who worked on the electromagnetic modeling of plasma behavior. In addition, he assisted in written exam supervision for courses in “Modellistica e Simulazione” and “Automatica”.

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1 st	37	5.9	26	1.6
2 nd	26	4.5	37	0.4
3 rd	3	0	57	0

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
2 nd	Fusion Energy for	Alfredo Portone	03/05/2024-25/07/2024 & 01/09/2024-10/12/2024	Research on applied superconductivity and DTT Central Solenoid alternative designs as a full HTS-CS
3 rd	Eni S.p.A.	Fabio Zanon	01/02/2025-31/07/2025	Research on applied superconductivity and DTT Central Solenoid alternative designs as an LTS CS with an HTS insert

PhD Thesis

In the Ph.D. Thesis, Vittorio Di Marzo developed a comprehensive electromagnetic and mechanical design methodology for the Central Solenoid (CS) in tokamak devices, moving from Low-Temperature Superconducting (LTS) to High-Temperature Superconducting (HTS) technologies. The research was motivated by the need to enhance the performance and reliability of the CS, a key magnet responsible for plasma initiation, current ramp-up, and overall scenario control in magnetic confinement fusion reactors.

The work proposes an integrated workflow combining optimization algorithms, analytical modeling, and finite-element validation to support the pre-design phase of superconducting magnets. The methodology enables the identification of optimal CS configurations capable of maximizing magnetic flux swing while ensuring structural integrity and fatigue compliance over reactor operational cycles. Both electromagnetic and mechanical aspects were investigated in detail, introducing a consistent “global-to-local” approach for the assessment of stresses and deformations within metallic and non-metallic components.

The methodology was applied to the Divertor Tokamak Test (DTT) device currently under construction in Frascati, Italy. Two main case studies were analyzed: (i) a full-HTS CS configuration, and (ii) the current DTT reference design featuring an LTS CS with an HTS insert. The analyses included the evaluation of AC losses, field distributions, and mechanical stresses through 3D finite-element simulations in ANSYS, supported by homogenization techniques for the winding pack. Results confirmed the robustness of the proposed approach, showing promising electromagnetic and mechanical performances for the HTS-based configurations and providing useful design guidelines for next-generation superconducting magnets in fusion applications. The developed workflow represents a significant step toward the integration of advanced superconducting materials and multi-physics modeling in the design of large-scale fusion devices.

Research products

Research results appear in 3 papers published in international journals, 0 papers published in national journals, 3 contributions to international conferences, 0 contributions to national conferences, 0 patents.

List of scientific publications

International journal papers

F. Romanelli, V. Di Marzo et al.

Divertor Tokamak Test facility project: status of design and implementation,
Nuclear Fusion,
vol. 64, 2024, DOI: 10.1088/1741-4326/ad5740.

R. Ambrosino, V. Di Marzo et al.

DEMO in-vessel equatorial coils for power-exhaust and fast plasma control,
Fusion Engineering and Design,
vol.197, 2023, DOI: 10.1016/j.fusengdes.2023.114029.

E. Acampora, V. Di Marzo et al.

Scenario feasibility and plasma controllability for Volumetric Neutron Source (VNS),
Fusion Engineering and Design,
vol.217, 2025, DOI: 10.1016/j.fusengdes.2025.115053.

V. Di Marzo et al.

Electromagnetic and Mechanical analyses of an explorative HTS-based Central Solenoid for the DTT Tokamak,
IEEE Transactions on Applied Superconductivity, Special Issue on MT-29, paper accepted, 2025.

International conference papers

F. Maviglia, V. Di Marzo et al.

Studies on EU-DEMO In-Vessel Coils requirements and conceptual design for axisymmetric plasma control,
49th EPS Conference on Plasma Physics,
Bordeaux, France, 2023, DOI: 21.11116/0000-000E-2835-A.

E. Acampora, V. Di Marzo et al.

Scenario feasibility and plasma controllability for Volumetric Neutron Source (VNS),
33rd Symposium on Fusion Technology,
Dublin, Ireland, Sept. 2024, DOI: 21.11116/0000-000F-F2F0-0.

V. Di Marzo et al.

Electromagnetic and Mechanical analyses of an explorative HTS-based Central Solenoid for the DTT Tokamak,
29th Magnet Technology Conference,
Boston, MA (USA), July 2025, poster session.

Patents and/or spin offs

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Awards and Prizes

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Date 22/10/2025

PhD student signature

Vittorio Di Marzo

Supervisor signature

Roberto Ambrosino