



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

itee^{PhD}
information technology
electrical engineering



Andrea Antonione

Development of the control system for gyrotrons of the ITER Electron Cyclotron (EC) system

Tutor: G. De Tommasi

co-Tutor: G. Carannante

co-Tutor: M. Giordano

Cycle: XXXIX

Year: 2024/2025

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Information

- Master's Degree in Physics (Università degli Studi di Torino)
 - Bachelor: *Energy-loss effect on the track-fitting of charged particles in Belle II.*
 - Master: *Cosmogenic radioactivity estimate and detection in asteroids and meteorites: application to Bennu (OSIRIS-REx mission).*
- DIETI Plasma Control Group
- PhD duration: 2023 – 2026
- Without bourse → Fusion for Energy contractor @ ITER site

Summary of study activities

- Courses
 - Advanced course on Plasma Physics – PhD Programme in Fusion Science and Engineering @ UNIPD
 - Controlli Automatici (exam) – UniNa – Prof. L. Villani
 - RF System Design using MathWorks tools – MathWorks – Trainer L. Garth
- Seminars
 - Nuclear Fusion: the promising potentials and ethical challenges – UniPd – Prof. L. Piron and Prof. P. Martin
 - ECRH Workshops – F4E-EUROfusion
 - Artificial Intelligence for Engineering – Fusion for Energy
 - Waves Propagation in Corrugated Waveguides – ITER – A. Danisi
- Conferences
 - SOFE 2025 – MIT (Boston)
 - Joint IFAC Conference SSSC TDS COSY 2025 – Paris-Saclay University
- Others
 - Final Design Review meeting (FDR) of the EU EC Gyrotrons – Fusion For Energy

Research area(s)

- Black box thermal lumped model to perform system identification on all the types of ITER gyrotrons
 - Definition of a base model (4 bodies interacting)
 - Adding a user-defined of additional bodies
 - Optimization of the all the parameters of the system
- Control logic for both the on and the off phase of the gyrotron
- Study of two data-driven mode loss detection methods to make up for the lack of RF detectors
 - Two different time scale mode loss detection methods

Research results

- Optimization of the black box model for the ITER European Thales gyrotron with performances compatible to the physical model
- Optimizations ongoing on the ITER Gycom gyrotron, for which there is no physical model
- Development of a custom control logic to control the gyrotron emitted electron beam during series of pulses in row, de
- Development of model wrapper for execution in the real-time framework *MARTe*

Research products

[P1]	A. Antonione, R. Bertazzoni, G. Carannante, K. Cindric, M. Ferrari, A. Leggieri, F. Sanchez, G. De Tommasi <i>Development and Benchmarking of a Thermal Lumped Model for the Magnetron Injection Gun of the MW-Power ITER European Gyrotron</i> Nuclear Fusion (02/2025)
[P2]	A. Antonione, G. Carannante, K. Cindric, M. G. Ferrari, G. De Tommasi <i>Control system development and testing for the electron beam current of ITER European gyrotrons</i> IFAC-PapersOnLine (09/2025)
[P2]	A. Antonione, G. Carannante, M. G. Ferrari, F. Sanchez, G. De Tommasi <i>Data-driven mode loss detection for the emitted radiofrequency beam of ITER gyrotrons</i> Submitted to IEEE Transactions on Plasma Science (SOFE2025 proceedings)

PhD thesis overview

- Development of control system for the electron beam current of the ITER gyrotrons
- Development of the data-driven mode loss detections at different time scales to make up for the lack of RF detectors in ITER
- ITER gyrotron commissioning