Vittorio Di Marzo

Modeling and Magnetic Control for Controlled Thermonuclear Fusion

Tutor: Prof. Roberto Ambrosino

Cycle: XXXVIII

Year: 2022/2023

My background

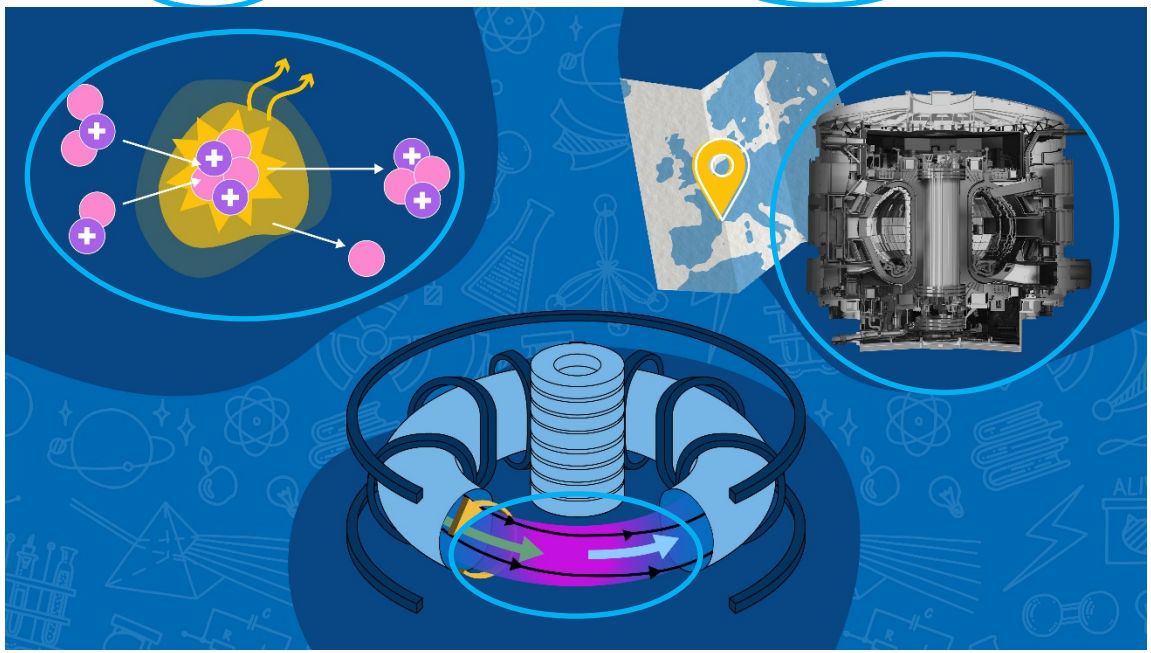
- MSc degree in Mechanical Engineering for Design and Production (July, 2022)
- Research group/laboratory: DIETI Plasma Control Group
- PhD start date: 01/11/2022
- Scholarship type: PNRR - DM 352
- Partner company: Eni S.p.A.

Research field of interest

- Plasma modeling and control

What is Nuclear fusion?

“Nuclear fusion is the process by which two light atomic nuclei **combine** to form a single heavier one while releasing massive amounts of energy. Fusion reactions take place in a state of matter called **plasma** in a device known as **‹Tokamak›”**

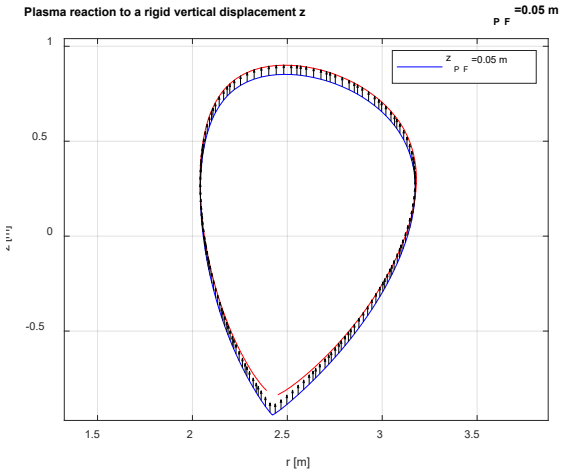


Summary of study activities

- **Courses borrowed from MSc curricula:**
  - Plasmi e Fusione Termonucleare (9 CFU)
  - Automatica (6 CFU)
  - Modellistica e Simulazione (9 CFU)
  - Teoria dei Sistemi (9 CFU)
- **Ad hoc PhD courses / schools:**
  - Scuola Nazionale Dottorandi di Elettrotecnica "Ferdinando Gasparini"
- **Conferences / events attended:**
  - "Accelerating Innovation", Annual MIT-Eni Workshop, Milano, 21/06/2023
  - KOM DTT Plasma Control System, Frascati, 04/07/2023

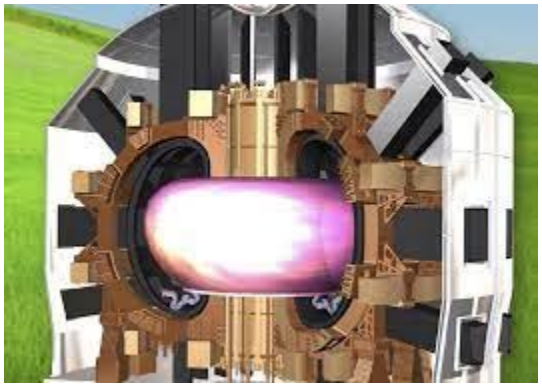
Electromagnetic Modeling

- Development of an innovative linearized model for the study of the plasma response to bidimensional external magnetic perturbations.



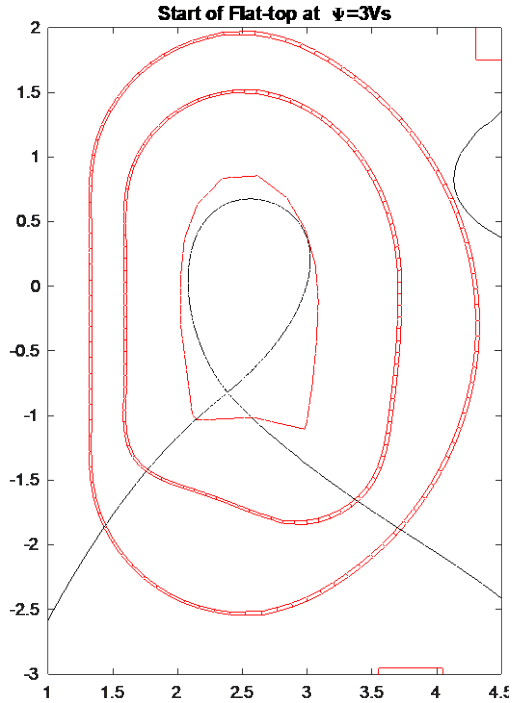
"Development of a new linearized plasma response model in a tokamak device" M.Neri's Master thesis, Supervisor: R. Albanese, Co-supervisor V. Di Marzo

- Analyses of induced currents on active conductive components during fast plasma transients



Sectional view of DTT Tokamak

- Development of plasma scenarios and design of next generation devices

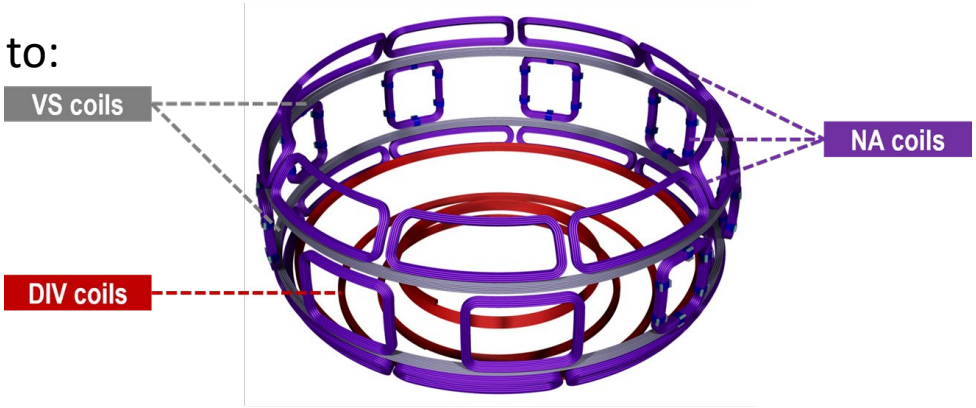


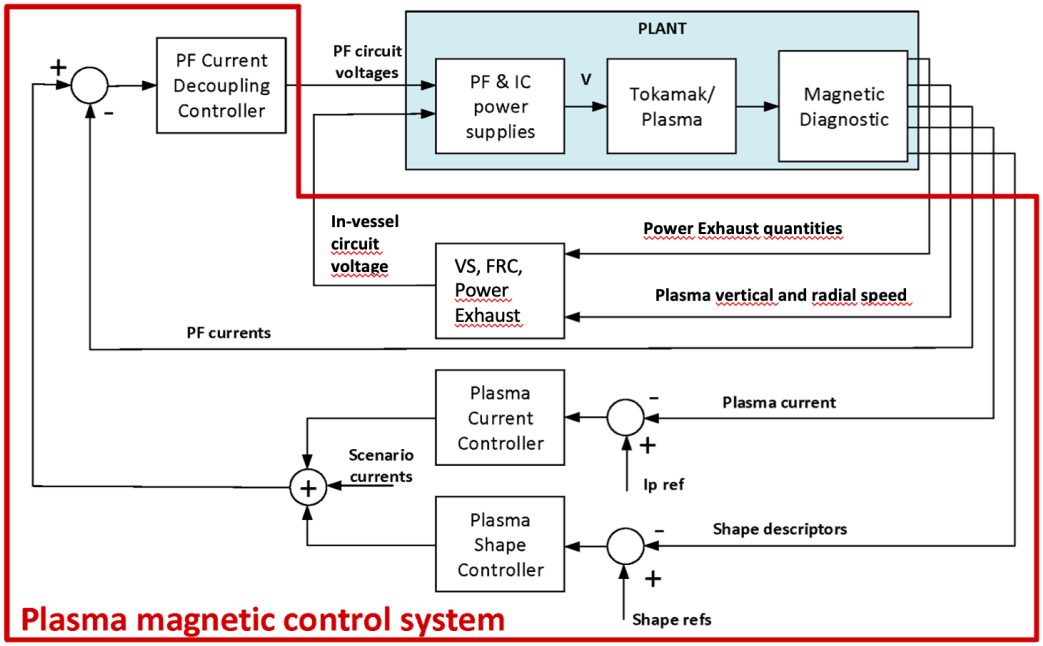
Poloidal section of FUTURE tokamak with plasma in Start Of Flat top

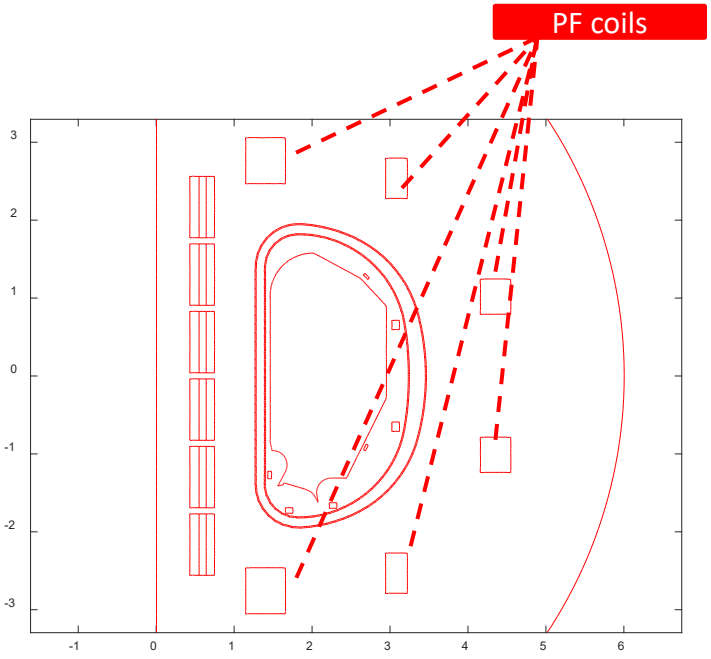
Magnetic control

Main issues of magnetic control are related to:

- Shape and plasma current control
- Vertical stability
- Power exhaust control (sweeping and wobbling control strategies have been examined)







Products: Journal papers

[J1]	R. Ambrosino, E. Acampora, R. Albanese, A. Castaldo, V. Di Marzo, F. Maviglia, A. Portone and H. Zohm , "**DEMO in-vessel equatorial coils for power-exhaust and fast plasma control**", Fusion Engineering and Design. (Current status: submitted)

Products: Conference proceedings

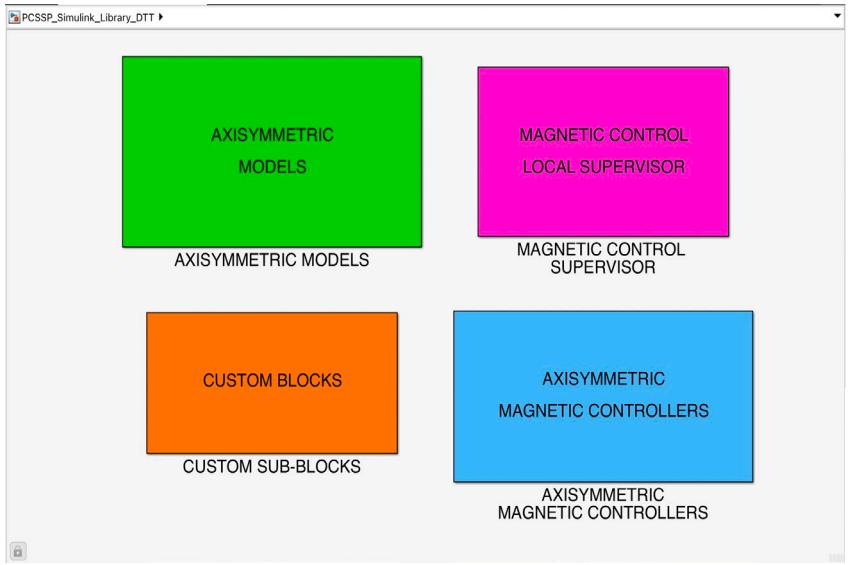
[C1]	R. Ambrosino, E. Acampora, R. Albanese, T. Bolzonella, A. Castaldo, A. G. Chiariello, A. Cucchiaro, M. Dalla Palma, A. Lampasi, M. de Magistris, V. Di Marzo, P. Fanelli, R. Fresa, A. Iaiunese, P. Innocente, V.P. Loschiavo, R. Martone, L. Pigatto, A. Pizzuto, G. Polli, G. Rubinacci, F. Villone, F. Vivio, P. Zumbolo, "**Effects of electromagnetic transients on DTT in-vessel coils**", 29th IAEA (International Atomic Energy Agency) Fusion Energy Conference, London, 2023.

Next year: Electromagnetic modeling

- Design of next generation Tokamaks (e.g. DTT, FUTURE);
- Development of plasma scenarios for FUTURE Tokamak;
- Analyses of electromagnetic effects on active conductive components;
- Analyses of electromagnetic transients for other tokamak devices;
- Development of a general linearized MHD model by defining 3Dimensional effects.

Next year: Magnetic control

Next step: Adaptation of the CREATE Magnetic Control platform for the DTT device



Adaptation of a Simulink library for the plasma magnetic modeling and control

Definition of closed loop simulations for the design, testing and real time implementation of the controllers