Possibili temi per attività di tesi

Prof. Gianmaria DE TOMMASI
Email: detommas@unina.it

Napoli, 19 Dicembre 2018

DIETI UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II
DIPARTIMENTO DI INGEGNERIA ELETTRICA E DELLE TECNOLOGIE DELL'INFORMAZIONE

Outline

Temi

- Non-interferenza in SED
- Opacità

Non-interference

- In system security it is important **to prevent information leaks**
- **Objective:** to prevent to an **intruder** to access to *secret* information
- DES have been used to model different information flow properties
  - opacity (the secret is a state or a sequence)
  - non-interference

Y.-C. Wu and S. Lafortune,

Comparative analysis of related notions of opacity in centralized and coordinated architectures,

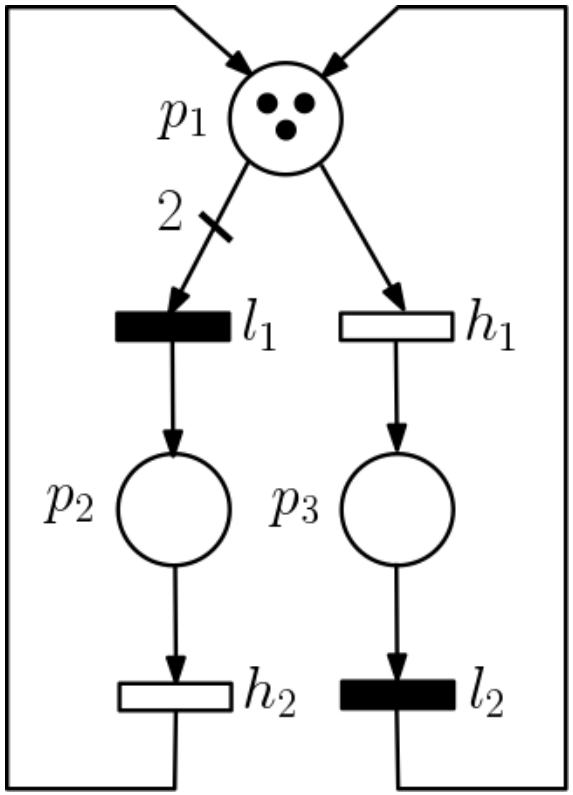
Discrete Event Dyn. Syst., vol. 23, no. 3, pp. 307–339, 2013

N. Busi and R. Gorrieri,

A survey on non-interference with Petri nets,

Lectures on Concurrency and Petri Nets, pp. 328–344, 2004

Non-interference in PN systems



- Two classes of users: **high-level** and **low-level** users
- A leak of information occurs when a low-level user (the **intruder**) obtains information meant to be visible only to high-level users
- Both high-level and low-level users know the system structure, but they interact with the system in two different ways (*views*)
- If the high-level view of the system *interferes* with the low-level one, information leaks may occur

Risultati ottenuti e possibili attività

Risultati ottenuti (2017-2018)

- **Condizioni necessarie e sufficienti per verificare due diverse proprietà di non interferenza**
- L'approccio si basa sulla rappresentazione algebrica delle reti di Petri
- Le condizioni proposte si basano sulla soluzione di problemi ILP
- **Algoritmo per determinare l'insieme più piccolo di transizioni di alto livello da disabilitare *offline* per assicurare la non-interferenza**

Possibili temi di tesi

- Estensione dei risultati di analisi alle reti etichettate
- Determinazione di un algoritmo dinamico che assicuri non-interferenza a ciclo chiuso

The *opacity* problem

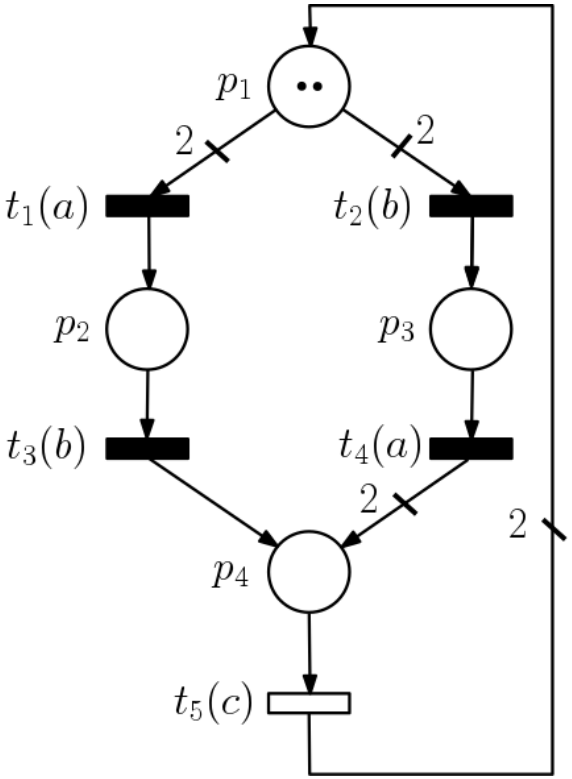
- **Opacity** in DES is related to the possibility of hiding a secret to external observers (the *intruders*)
- The secret can be either
  - a system state (initial, current, final)
  - a sequence of events $\rightarrow$ *Language-based opacity (LBO)*

Y.-C. Wu and S. Lafortune,

Comparative analysis of related notions of opacity in centralized and coordinated architectures,

Discrete Event Dyn. Syst., vol. 23, no. 3, pp. 307–339, 2013

Toy example



- the secret sequence is *abc*
- *c* is the only observable event (whose occurrence can be directly *measured*)
- observing the single occurrence of *c*, an intruder will never no if either *abc* or *bac* occurred
- the system is said to be opaque

Risultati ottenuti e possibili attività

Risultati ottenuti (2017-2018)

- **Condizione necessaria e sufficiente per verificare la *language based opacity (LBO) in reti etichettate***
- **Condizione sufficiente (ma meno onerosa computazionalmente) LBO**

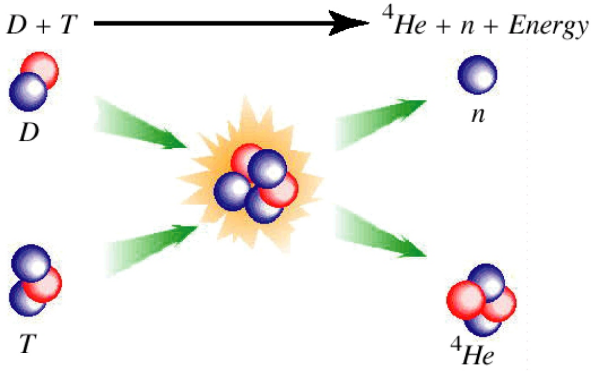
Possibili temi di tesi

- Generalizzazione dell'approccio anche alla *state opacity*
- Determinazione di un algoritmo dinamico che assicuri opacità a ciclo chiuso

Main Aim

Production of energy by means of a fusion reaction

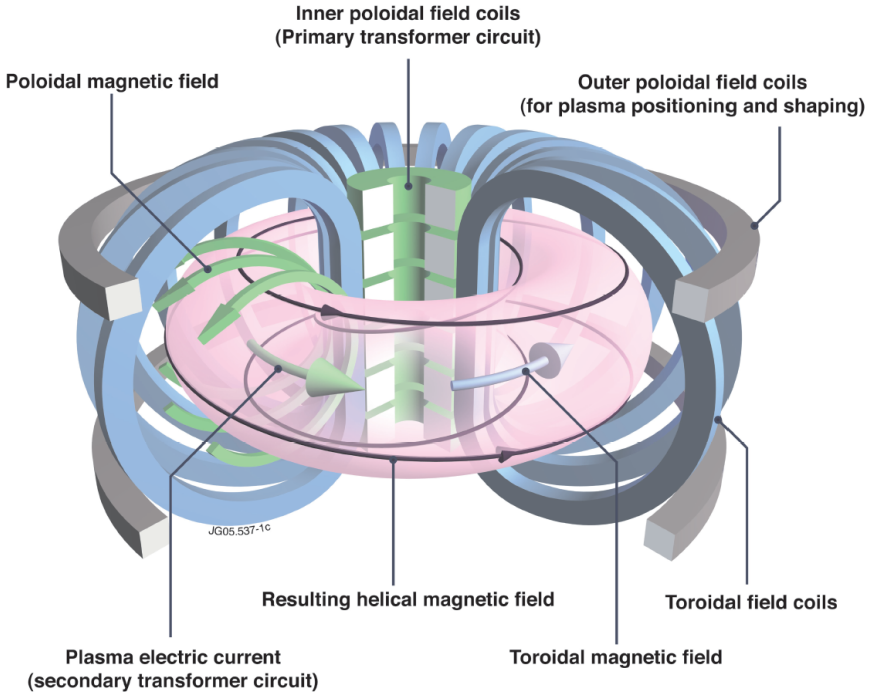
$$D + T \rightarrow {}^4\mathrm{He} + n$$



Plasma

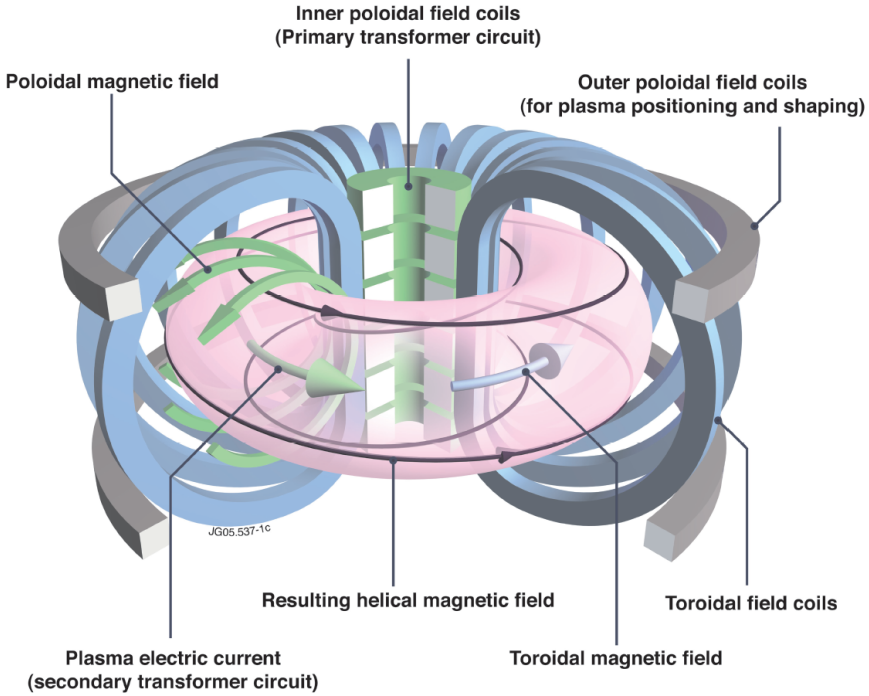
- High temperature and pressure are needed
- Fully ionised gas $\mapsto$ Plasma
- Magnetic field is needed to confine the plasma

Plasma magnetic control



- In tokamaks, **magnetic control of the plasma is obtained by means of magnetic fields produced by the external active coils**
- In order to obtain good performance, it is necessary to have a plasma with **vertically elongated cross section $\Rightarrow$ vertically unstable plasmas**
- It is important to **maintain adequate plasma-wall clearance during operation**

The magnetic control problems

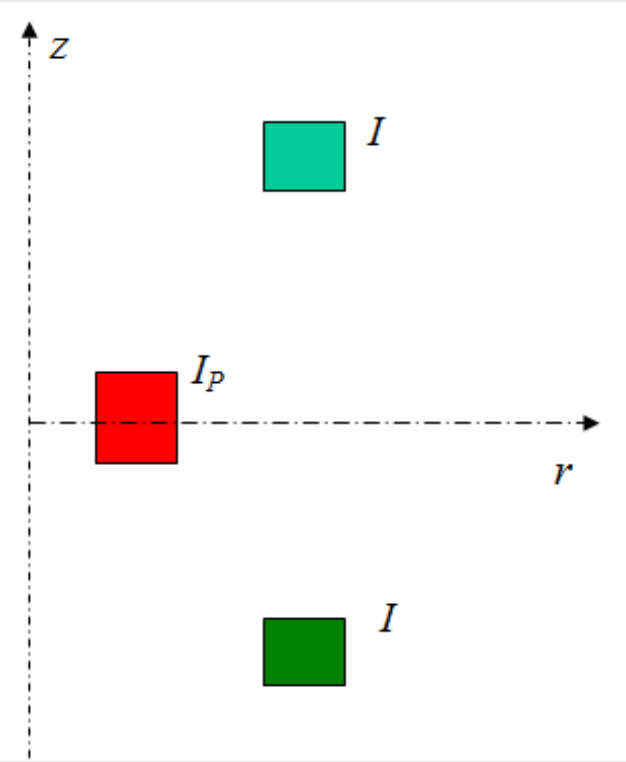


The plasma (axisymmetric) magnetic control in tokamaks includes the following three control problems

- the vertical stabilization problem
- the shape and position control problem
- the plasma current control problem

Simplified filamentary model

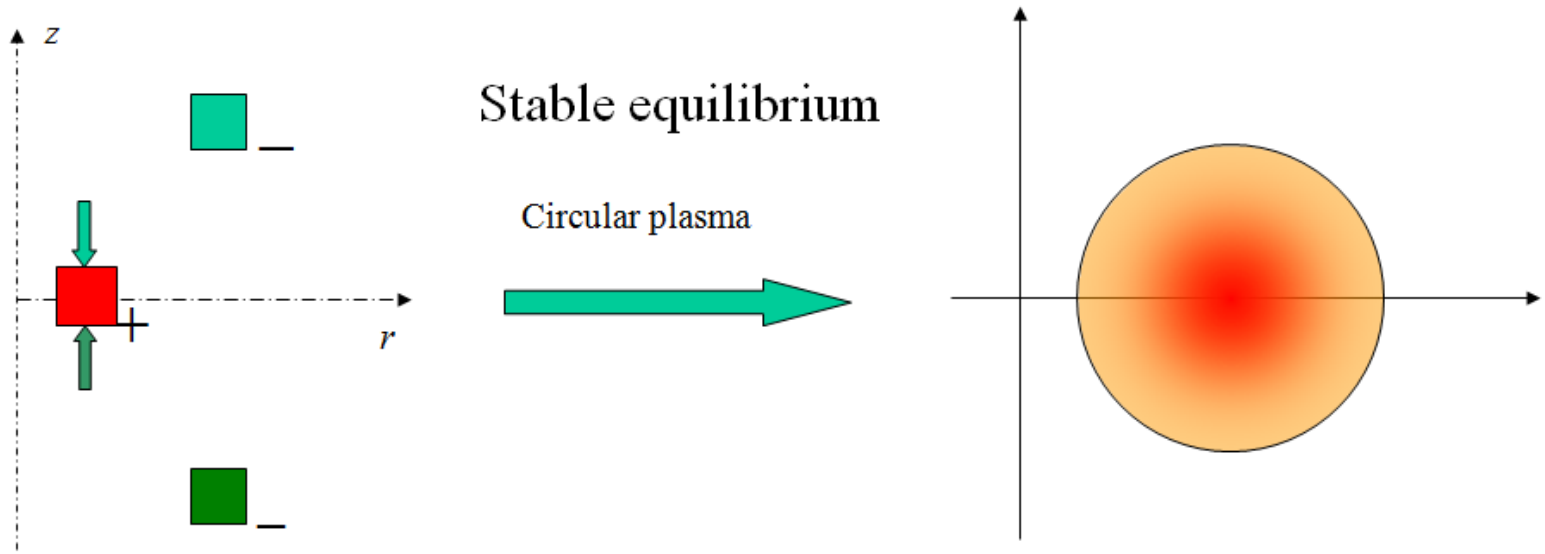
Consider the simplified electromechanical model with three conductive rings, two rings are kept fixed and in symmetric position with respect to the r axis, while the third can freely move vertically.



If the currents in the two fixed rings are equal, the vertical position $z = 0$ is an equilibrium point for the system.

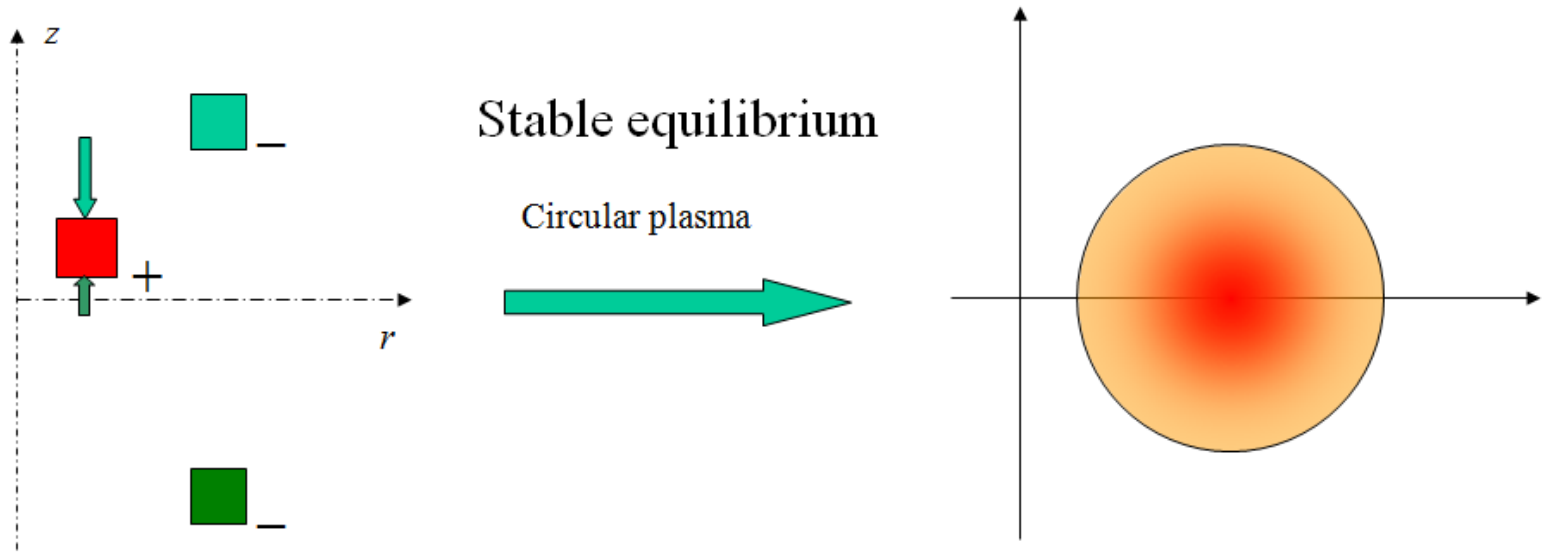
Stable equilibrium - 1/2

If $\mathrm{sgn}(I_p) \neq \mathrm{sgn}(I)$



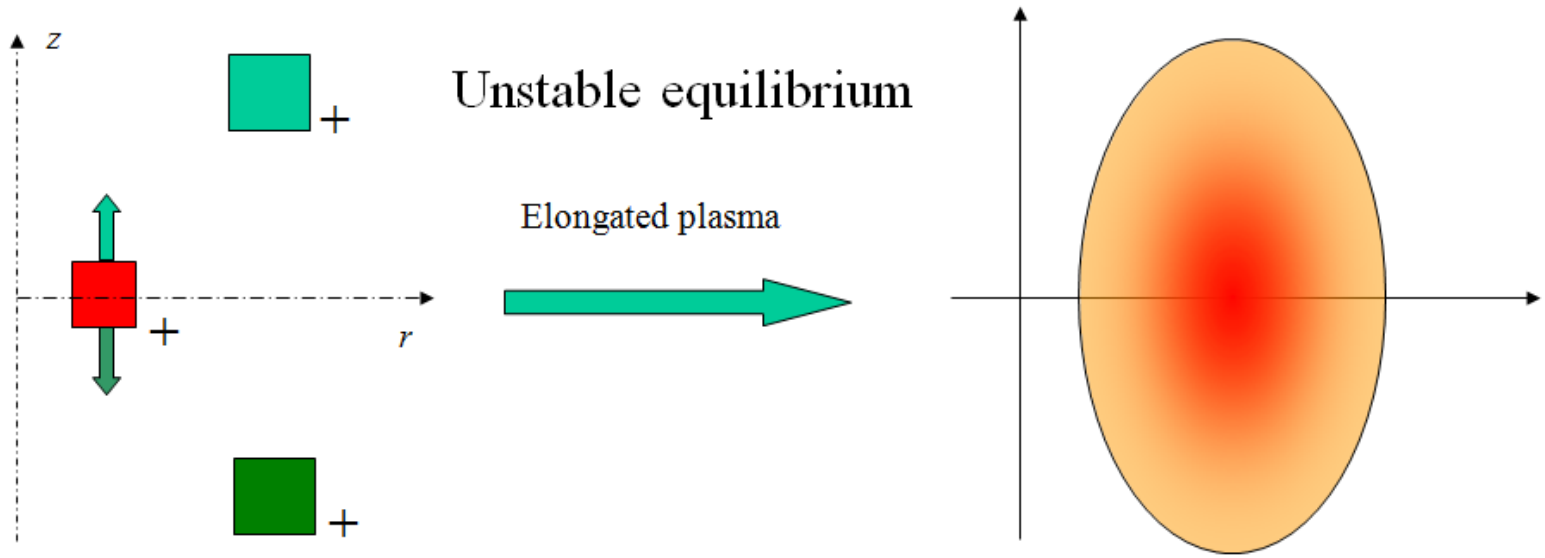
Stable equilibrium - 2/2

If $\mathrm{sgn}(I_p) \neq \mathrm{sgn}(I)$



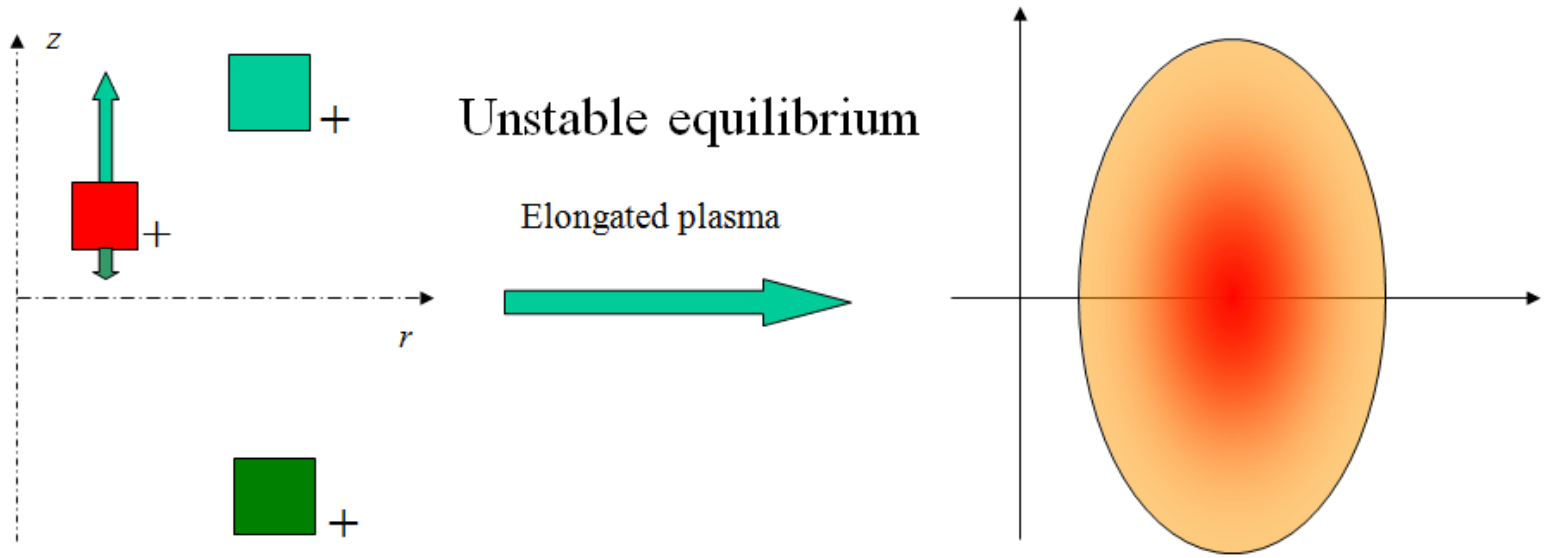
Unstable equilibrium - 1/2

If $\mathrm{sgn}(I_p) = \mathrm{sgn}(I)$

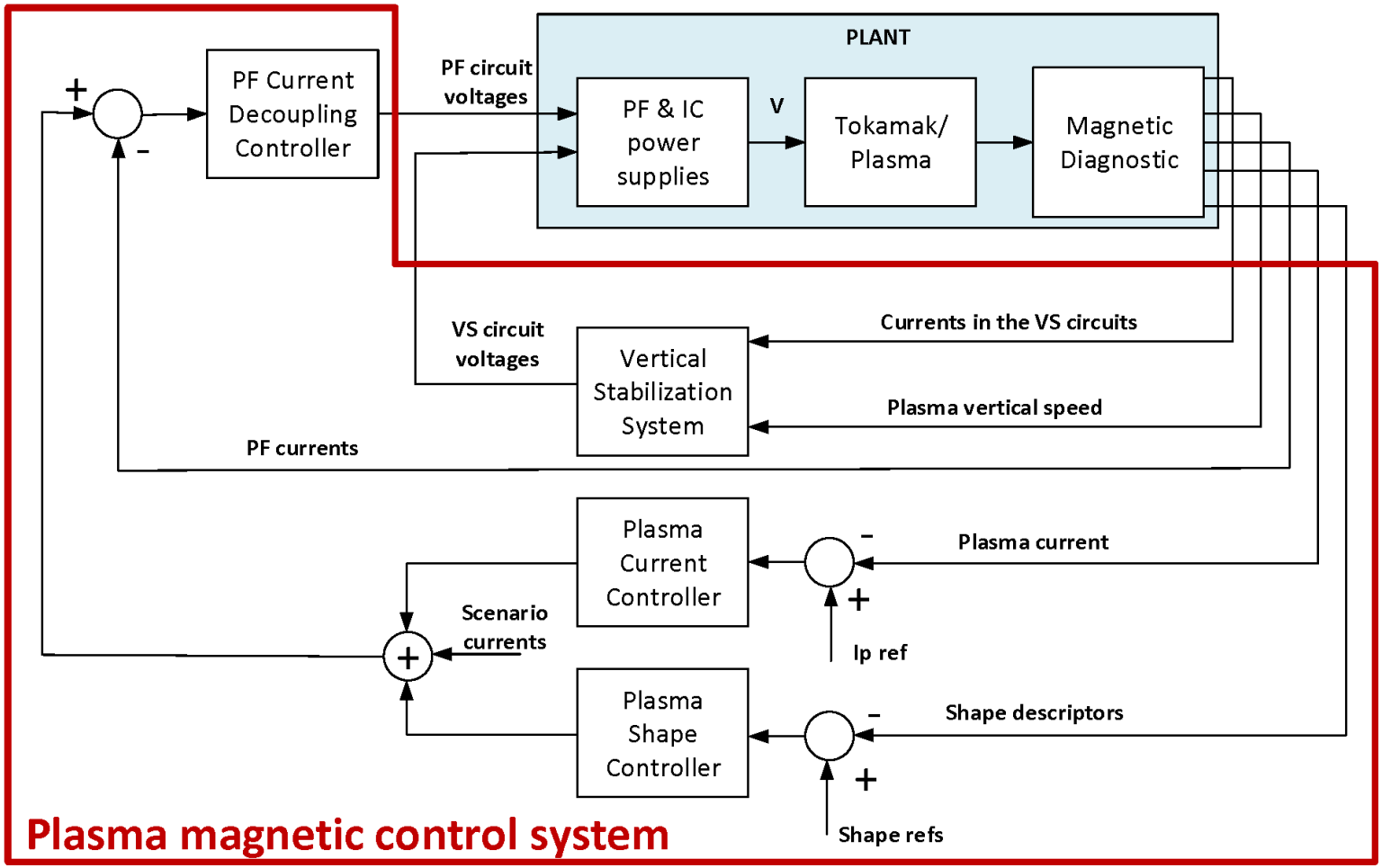


Unstable equilibrium - 2/2

If $\mathrm{sgn}(I_p) = \mathrm{sgn}(I)$



Un’architettura flessibile per il controllo magnetico nei tokamak



Collaborazioni

- Joint European Tokamak (Regno Unito)
- ITER Organization
- EAST (Repubblica Popolare Cinese)
- JT-60SA (Giappone)
- Fusion for Energy (UE)
- Max Planck IPP (Germania), IST-IPFN (Portogallo), SPC (Svizzera), . . .

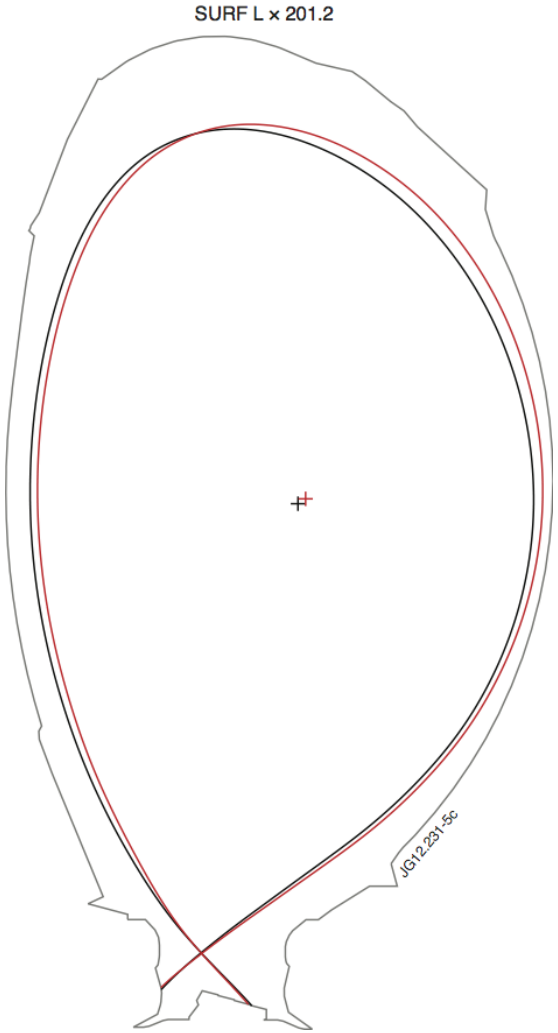


Figure: Shape comparison at 22.5 *s*. Black shape (#81710 without CLA), red shape (#81715 with CLA).

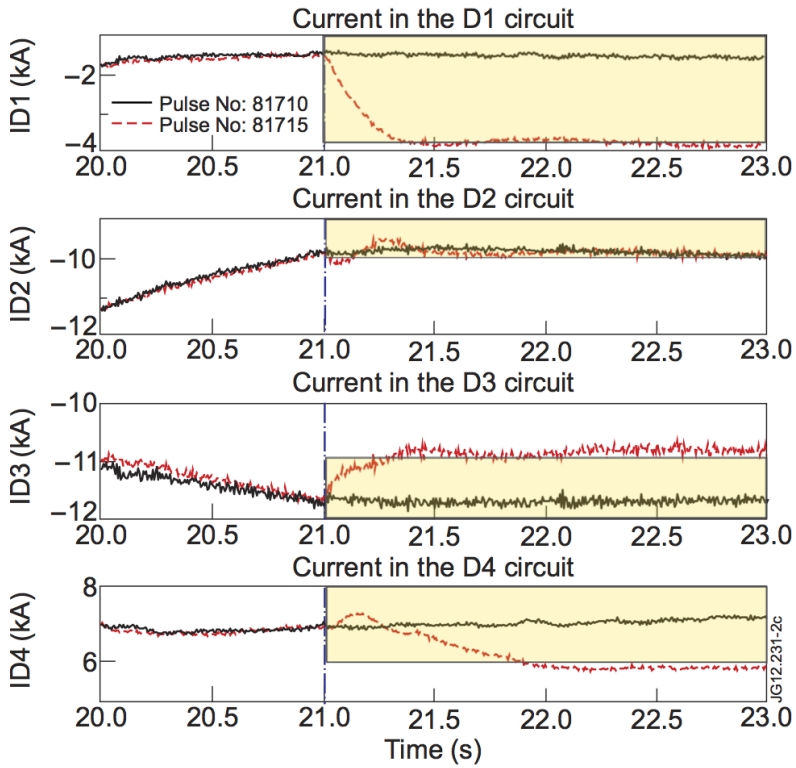


Figure: Currents in the divertor circuits. #81710 (reference pulse without CLA) and pulse #81715 (with CLA). The shared areas correspond to regions beyond the current limits enforced by the CLA parameters.

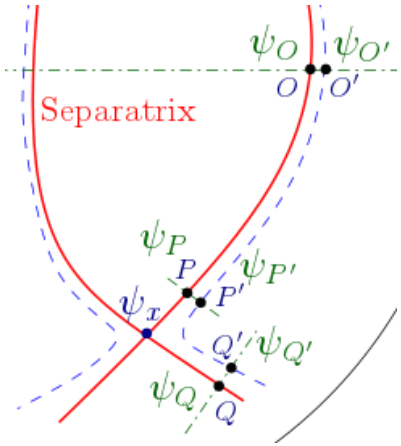


Figure: **Option #1** - integrated control of plasma shape and flux expansion.

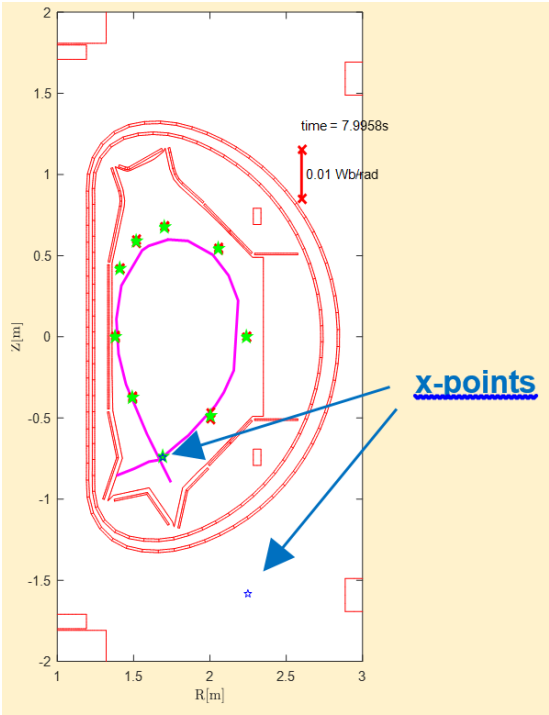
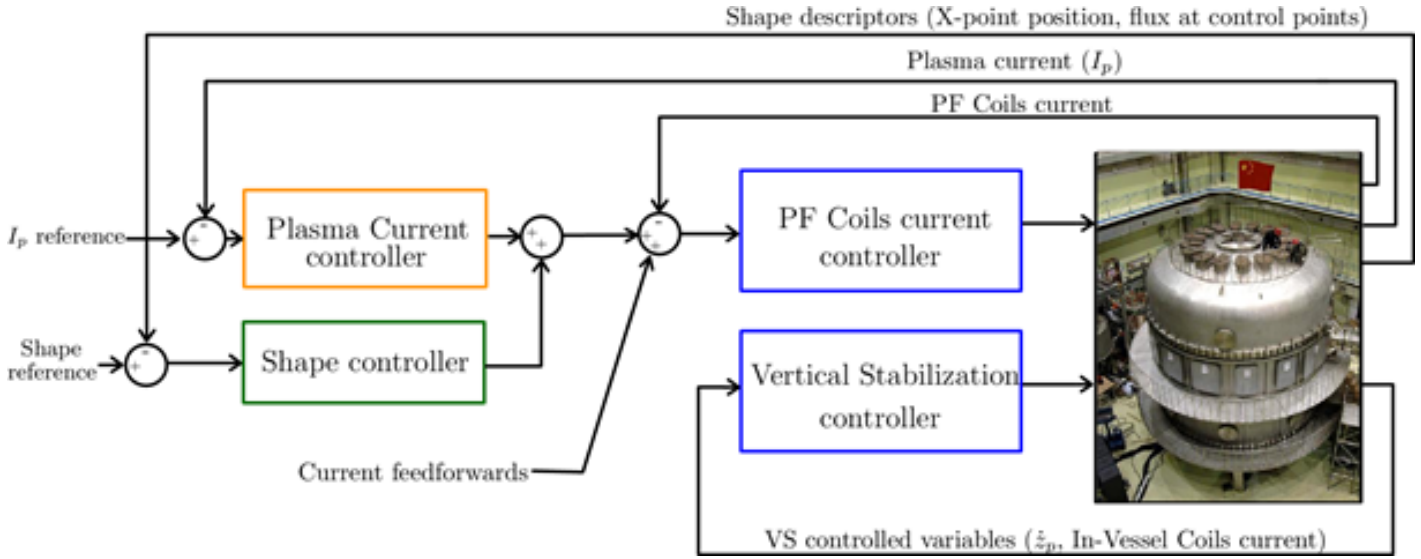


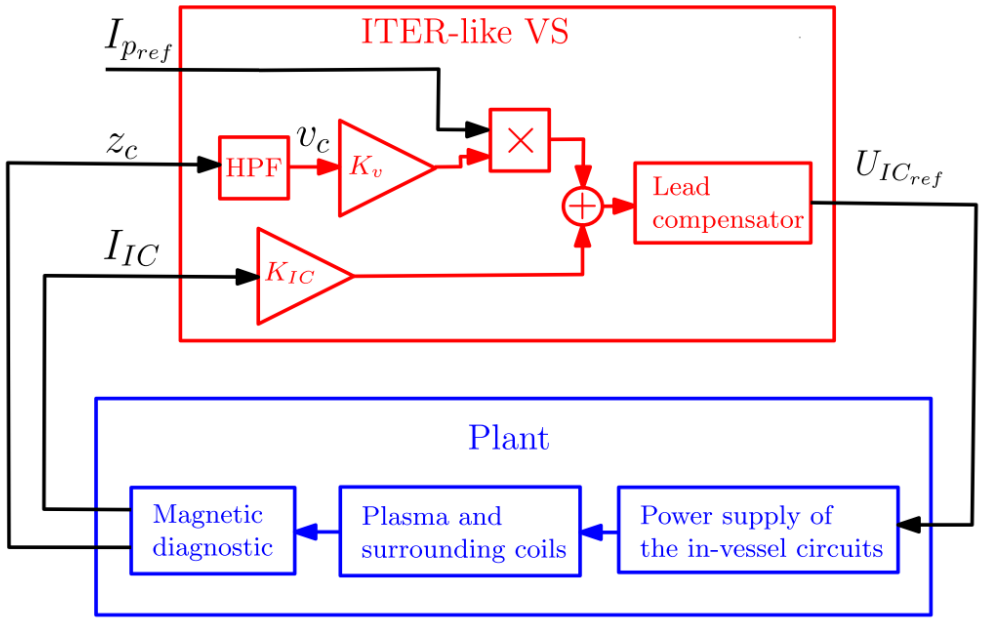
Figure: **Option #2** - integrated control of plasma shape and distance between null points.

EAST architecture



- The EAST architecture is *compliant* to the one proposed for ITER & DEMO
- **The control algorithms deployed within the EAST PCS do not satisfy the requirements needed to easily replace the shape controller**
  - **vertical stabilization is strongly coupled with plasma shape control**
  - The PF Coils current controller can be improved (better decoupling)

ITER-like VS at EAST



$$U_{IC_{ref}}(s) = \frac{1 + s\tau_1}{1 + s\tau_2} \cdot \left(K_v \cdot \bar{I}_{p_{ref}} \cdot \frac{s}{1 + s\tau_z} \cdot Z_c(s) + K_{IC} \cdot I_{IC}(s) \right)$$

Experimental results - 1/2

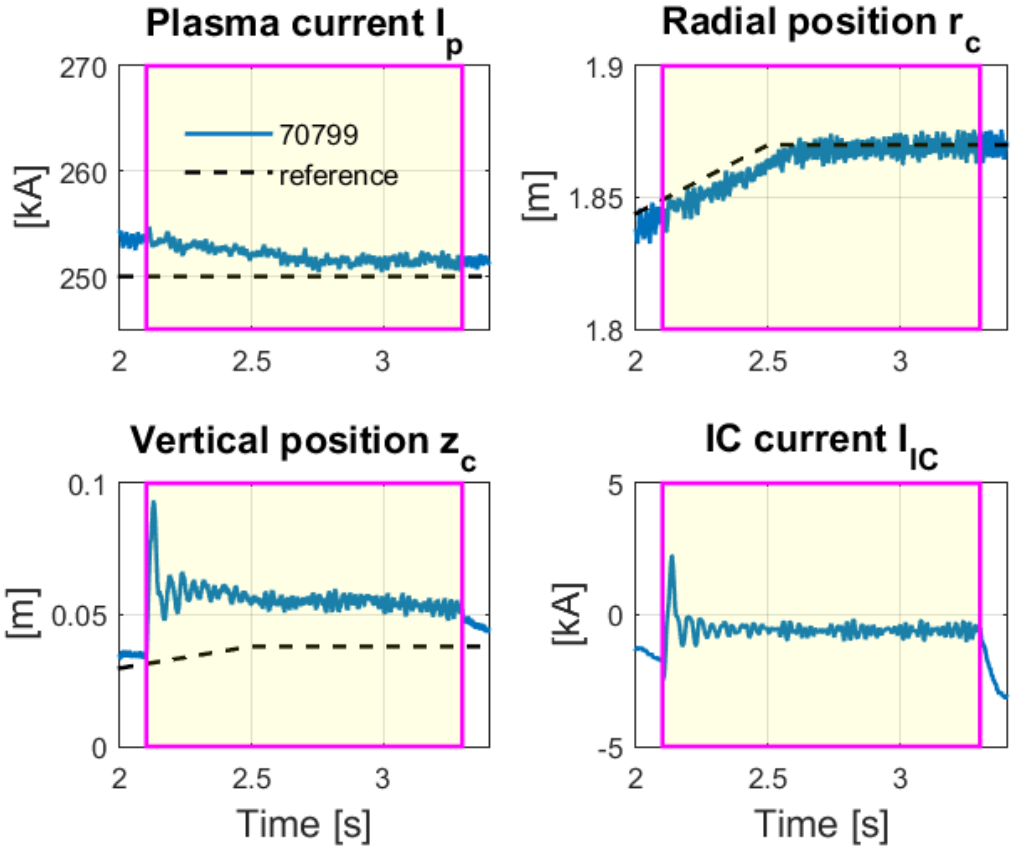


Figure: EAST pulse #70799. During this pulse the *ITER-like* VS was enabled from $t = 2.1$ s for 1.2 s, and only I_p and r_c were controlled, while z_c was left uncontrolled. This first test confirmed that the ITER-like VS vertically stabilized the plasma by controlling $\dot{z}_c$ and I_{IC}, without the need to feed back the vertical position z_c.

Experimental results - 2/2

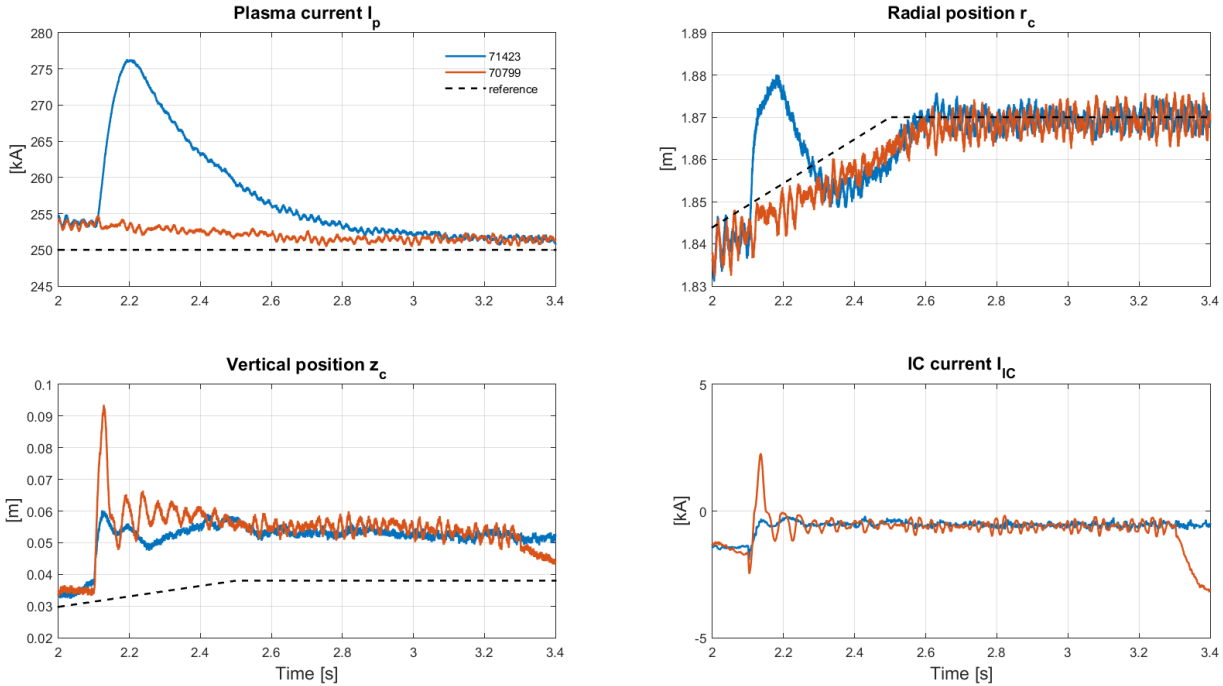


Figure: EAST pulses #70799 & #71423. Tuning of the controller parameters to reduce oscillations on z_c.

Possibili attività di tesi

- Sviluppo di sistemi di controllo magnetico (design, analisi, ecc.)
- Sviluppo di sistemi di supervisione del PCS
- Tecniche di fault detection e sviluppo di sistemi fault tollerant per diagnostiche magnetiche
- . . .

Ulteriori possibili attività di tesi

- Tesi presso aziende di automazione (province di Avellino, Salerno e Caserta)
- Tesi presso ST microelectronics
- Sviluppo di sistemi di controllo in ambito aeronautico (a partire da giugno/luglio 2019)

Stay tuned!

Tenete d'occhio le **news** sulla pagina www.automazione.it, la **pagina FB** e il **profilo Twitter**

Possibili temi per attività di tesi

Prof. Gianmaria DE TOMMASI
Email: detommas@unina.it

Napoli, 19 Dicembre 2018

Now we are ready to start :)

DIETI UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II
DIPARTIMENTO DI INGEGNERIA ELETTRICA E DELLE TECNOLOGIE DELL'INFORMAZIONE