TCABR Tokamak
• TCABR is a small-sized tokamak (R₀ = 0.62 m and a = 0.2 m) operated at the University of São Paulo, Brazil. This upgrade consists mainly in the installation of:
  i. graphite tiles to cover entirely the inner surface of the vacuum vessel
  ii. new poloidal field (PF) coils to allow for the generation of various divertor configurations such as single-null, double-null, snowflake and x-point target divertors,
  iii. in-vessel HFS and LFS non-axisymmetric control coils for ELM suppression studies, and
  iv. a coaxial helicity injection system to improve plasma start-up.

• The creation of the various plasma scenarios that are envisaged for TCABR will require a robust and flexible plasma control system.
• The new TCABR plasma shape and position control is being designed and will be based on a feedback PID technique. The design of the new PID controllers will be carried out using the so-called RZIp model

TCABR Magnetic Control Overview

TCABR Upgrade – Needs and Challenges

WHY THE UPGRADE
• The proposed upgrade of the TCABR tokamak provides for the study of plasmas with more varied forms that are relevant to controlled thermonuclear fusion.

CHALLENGERS
• However, plasmas with elongated configuration are vertically unstable.
  ➢ The instability has µs time scale – too fast to control

SOLUTIONS
• For such plasma formats to be obtained, it will be necessary to control a set of 17 magnetic coils responsible for plasma control.
• Change vessel - continuous torus: induced vessel currents (“eddy currents”) creates a counteracting radial field: up-down symmetric vessel current modes are excited.

TCABR RZIp model
• RZip: The TCABR is going to use the conventional model
  • Circuit equations for active conductors, passive conductor, plasma
  • Force balance for plasma position
  • Linearized model

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REFERENCES
• D.Muller et all, Fusion Engineering and Design, 141 (2019) 9