A RL-BASED VERTICAL STABILIZATION SYSTEM FOR THE EAST TOKAMAK

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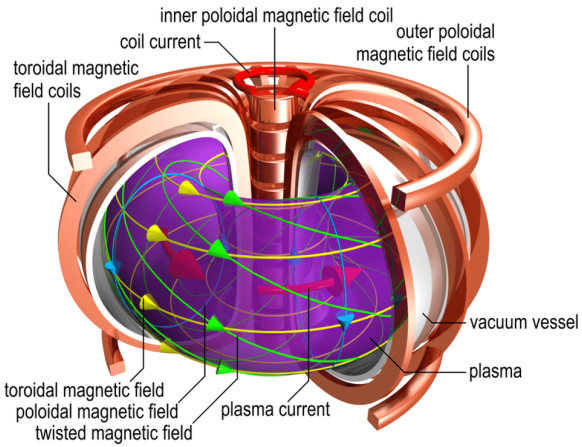
DIETI. UNIVERSITA' DEGLI STUDI DI NAPOLI FEDERICO II
DIPARTIMENTO DI INGEGNERIA ELETTRICA E DELLE TECNOLOGIE DELL'INFORMAZIONE

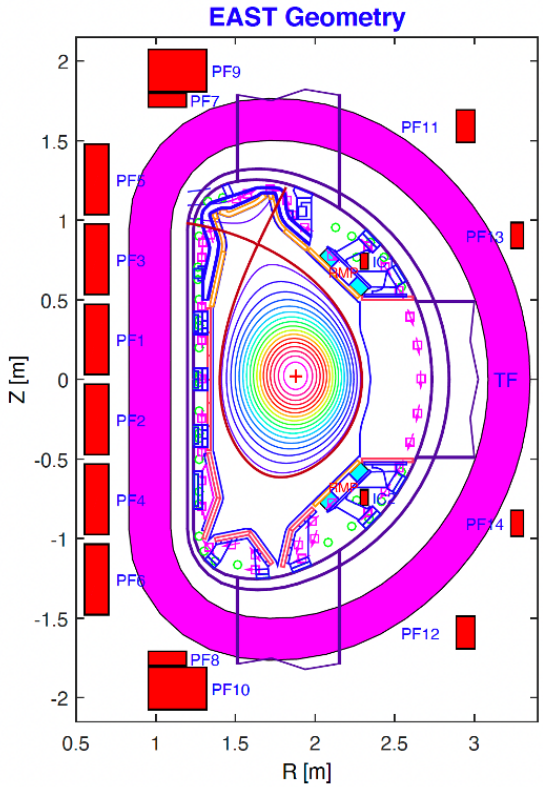
Nuclear Fusion, Plasma and Tokamaks

- Nuclear fusion is foreseen as a promising source of clean and sustainable energy for the next century
- Tokamak are experimental devices aimed at producing energy from nuclear fusion reactions that occur in a **fully ionised** and **magnetically confined** gas of hydrogen isotopes $\rightarrow$ the plasma
- The plasma is heated up to temperatures of tens to hundred millions degrees.
  - at such a high temperature the particles' thermal agitation can overcome the Coulomb repulsive force, and hence making produce fusion reactions



Elongated and unstable plasmas

- **Plasma magnetic control** aims at controlling the current, position and shape of the plasma column inside the vacuum vessel by means of **external magnetic** fields generated by the Poloidal Field coils
- High performance plasmas, as the ones achieved at the EAST tokamak, have elongated poloidal cross-section which turn to be **vertically unstable**
- A **Vertical Stabilization (VS)** system is needed to run any modern tokamak



Our contribution

- Many different model-based control approaches have been applied to solve the VS problem (linear, H_∞, sliding-mode, MPC)
- In practice, solution are tailored on each specific machine and adaption of control parameters is needed depending on the scenario (i.e. on the type of experiment)

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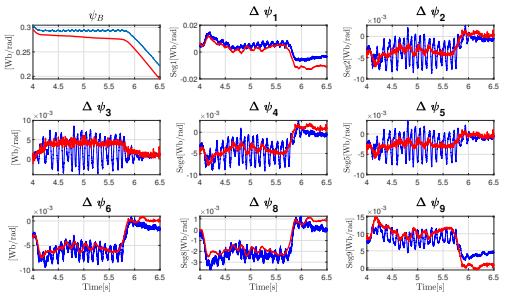
We propose an RL-based agent trained on a simplified linearized model of the EAST tokamak and validated in simulation against previous experiments carried out in 2019



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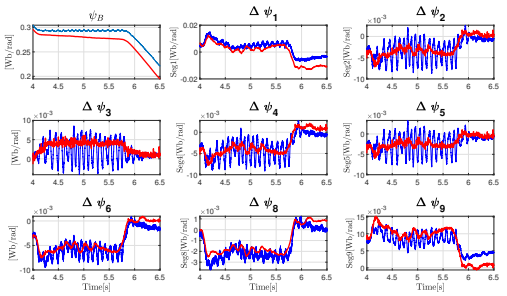

After our paper get accepted at ACC. . .

- . . .Swiss researchers from TCV (Losanne) together with DeepMind *solved* the problem on that machine

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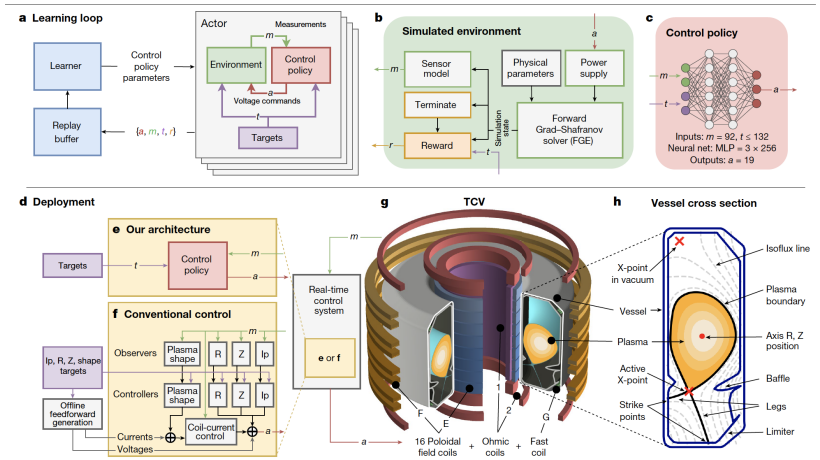

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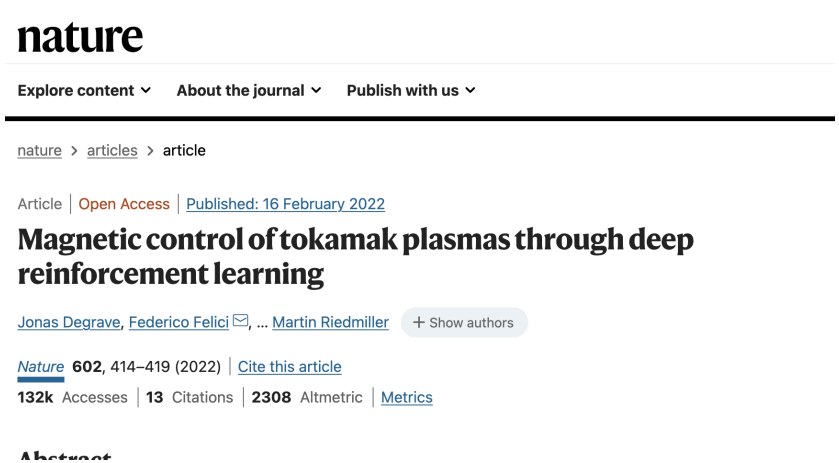

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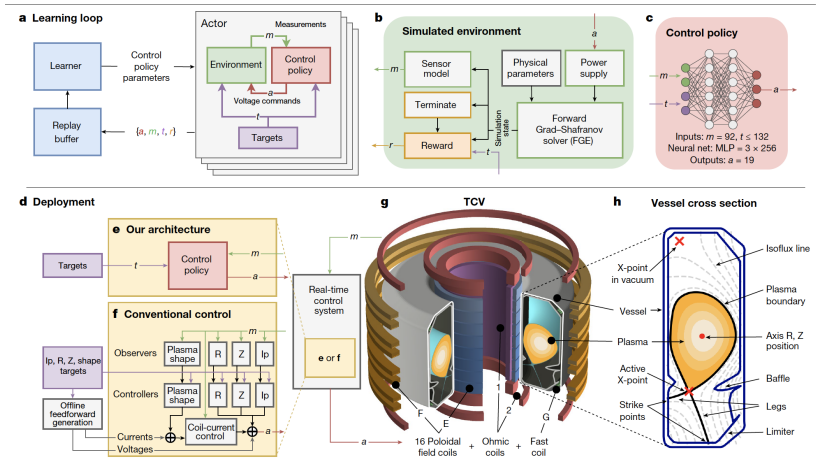
Abstract



- . . .however, the details were not revealed (they are patented), hence there is still work to do and room for improvements

Questions?

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