# Control of tokamak plasmas through Deep Reinforcement Learning: application to magnetic control on TCV

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Maintaining a stable tokamak discharge in the desired equilibrium requires control of the plasma position and shape using poloidal field coils. Traditionally, shape and position control have been handled by linear controllers designed using control engineering methods. In recent work [1], the first successful application of Deep Reinforcement Learning (RL) to the magnetic control of tokamaks has been demonstrated. The Deep RL algorithm learns magnetic controllers for a target TCV plasma equilibrium solely by interacting with a free-boundary evolution model, which simulates the plasma equilibrium evolution coupled to the circuit equations for external conductors. These controllers generate and maintain a plasma of the desired shape by receiving only magnetic measurements, without the need for equilibrium reconstruction, and actuating directly the coil power supply voltages in real-time. The controllers were tested in TCV experiments with success. This work represents the first use of reinforcement learning for feedback control on a tokamak and paves the way for combining physics models and machine learning for improving other aspects of control of fusion plasmas. Some potential future avenues of research in this direction will be discussed as well as the modeling challenges that need to be overcome.

## References

1. Degrave, Felici et al., Nature **602**, 414–419 (2022).