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## Robust control of the current profile and plasma energy in EAST

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Integrated control of the toroidal current density profile, or alternatively the q-profile, and plasma stored energy is essential to achieve advanced plasma scenarios characterized by high plasma confinement, magnetohydrodynamics stability, and noninductively driven plasma current. The q-profile evolution is closely related to the evolution of the poloidal magnetic flux profile, whose dynamics is modeled by a nonlinear partial differential equation (PDE) referred to as the magnetic-flux diffusion equation (MDE). The MDE prediction depends heavily on the chosen models for the electron temperature, plasma resistivity, and non-inductive current drives. To aid controller synthesis, control-oriented models for these plasma quantities are necessary to make the problem tractable. However, a relatively large deviation between the predictions by these control-oriented models and experimental data is not uncommon. For this reason, the electron temperature, plasma resistivity, and non-inductive current drives are modeled in this work as the product of an “uncertain” reference profile and a nonlinear function of the different auxiliary heating and current-drive (H&CD) source powers and the total plasma current. The uncertainties are quantified in such a way that the family of models arising from the modeling process is able to capture the q-profile and plasma stored energy dynamics from a typical EAST shot. A control-oriented nonlinear PDE model is developed by combining the MDE with the “uncertain” models for the electron temperature, plasma resistivity, and non-inductive current drives. This model is then rewritten into a control framework to design a controller that is robust against the modeled uncertainties. The resulting controller utilizes EAST's H&CD powers and total plasma current to regulate the q-profile and plasma stored energy even when mismatches between modeled and actual dynamics are present. The effectiveness of the controller is demonstrated through nonlinear simulations.

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### Topic

A. Experimental Fusion Devices and Supporting Facilities

### Preferred presentation

Poster

### Keywords

EAST, q-profile, plasma stored energy, robust control

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