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TH/P4-07: Integrated Approach to the H-mode Pedestal Dynamics: Effects of Bootstrap Current and Resonant Magnetic Perturbations on ELMs

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The accurate prediction of Edge Localized Modes (ELMs) and their mitigation are critical for sustainable discharge operation. Two main research questions are elucidated in this study: (1) What are the effects of uncertainties in the bootstrap current computations on the ELM stability predictions? (2) How do the resonant magnetic perturbations (RMPs) that are introduced to mitigate ELMs change the overall plasma confinement? In order to answer these questions, high physics fidelity codes that have been developed during the SciDAC CPES, CSWIM, and FACETS projects are used. The computation starts from an "equilibrium cloud" generated using the FACETS framework. The edge plasma profiles are advanced using kinetic neoclassical XGC0 code. The resulting plasma pressure and bootstrap current profiles are updated in the initial equilibria by the M3D-OMP code. The updated equilibrium is analyzed in the FLUXGRID component of FACETS that incorporates several bootstrap current models. The bootstrap current predictions from these models are compared with the predictions from XGC0. Conclusions about validity ranges for each model are deduced. Differences in the predictions for the ELM stability thresholds that result from uncertainties in the computations of bootstrap current are determined using ideal MHD stability codes. The core plasma profiles from updated equilibria are advanced to steady state solutions using the integrated whole-device modeling FACETS code. The edge plasma profiles are maintained using the UEDGE component of FACETS. The effect of 3D magnetic perturbations on plasma confinement is investigated in these coupled core-edge simulations. The magnetic perturbation effect has been recently implemented in UEDGE using the magnetic field line diffusivity model. The applied RMPs degrade the edge confinement by modifying plasma profiles to the MHD stable profiles. The RMP effect on overall plasma confinement is determined by comparing the energy confinement time computed with the FACETS code with the energy confinement time for the corresponding cases without RMPs. Recommendations are made for ranges of plasma parameters for ELM-free discharge scenarios with RMPs that yield optimum energy confinement. The stabilizing effect of RMPs is confirmed through MHD stability analysis with ideal MHD stability codes.

Country or International Organization of Primary Author

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