Modeling of ELM Cycle Using XGC0 and NIMROD in the CPES Framework

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Simulation results of large scale abrupt quasi-periodic MHD instabilities called Edge Localized Modes (ELMs) are presented in this report. The dynamics of an ELM crash depends on the properties of the edge transport barrier. A complete self-consistent model for the ELM cycle is expected to include a description of plasma relaxation after each crash and the H-mode pedestal recovery. The prediction of these instabilities and the development of mechanisms for their mitigation are among the challenging issues of integrated whole device plasma modeling. In this study, the H-mode pedestal build up is simulated with the kinetic XGC0 code (http://w3.physics.lehigh.edu/~xgc). The XGC0 code can accurately handle the neoclassical effects that are important in the plasma edge region. For this region, the turbulence is strongly reduced due to the strong $\mathbf{E} \times \mathbf{B}$ flow shear. The residual turbulence transport is modeled as a radial random walk diffusion of particle orbits. The plasma profiles computed with the XGC0 code are imported to the extended MHD NIMROD code (http://nimrodteam.org/). The NIMROD simulation results for the growth and nonlinear evolution of the instability that results in an ELM crash are discussed. It is shown that the diamagnetic rotation strongly distorts the filamentary structure of ELMs and reduces the severity of the ELM crash. Consequently, the neoclassical effects in the XGC0 code play a significant role in the dynamical evolution of the ELMs.