Triangularity Dependence of BOUT++ Nonlinear ELM Simulation Validation By DIII-D Fast Measurements*

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Validation of BOUT++ [1] nonlinear edge localized mode (ELM) simulations against fast measurements from DIII-D ELMing H-mode plasmas is extended to a range of single-null (SN) plasma shapes. This paper presents work to validate both simulations of high frequency ELMs from low triangularity SN discharges and low frequency ELMs from high triangularity discharges, against fast diagnostic measurements. The ELM simulations are done with up to a six-field model ($\tilde{n}_e, \tilde{n}_i$, $\tilde{T}_e$, $\tilde{T}_i$, magnetic flux Ì$_{||}$, electric potential $\tilde{\Phi}$) [2] in BOUT++ using the experimental X-point geometry, at realistic plasma collisionality. To avoid the unphysically large and vanishingly thin current layers typical of nonlinear MHD ELM simulations at low experimental collisionality, the upgraded BOUT++ uses a hyper-resistivity model [3] which asserts that the electron viscosity is set by micro-turbulence and therefore comparable to turbulent electron thermal diffusivity. This allows the current sheets to diffuse at small scales, relaxes the ideal MHD constraint on magnetic field evolution and allows for ELM driven magnetic reconnection at finite current density. Validation of three-field (Ì$_{||}$, $\tilde{\Phi}$, and pressure $\tilde{p}$) nonlinear simulations in high triangularity DIII-D discharges with fast measurements [4] showed the importance of: 1) sufficient extent of the grid into the core to cover the radial extent of the ELM perturbation, 2) the boundary conditions applied to the inner (core) side of the computational grid, 3) covering sufficient timescale with the simulation to account for the total energy loss due to the ELM event, and 4) extending to higher field models to simulate the density and temperature evolution separately in order to calculate target heat fluxes. Measurements used for validation of new higher-field simulations of low triangularity ELMs include pedestal energy loss, pedestal density profile evolution through the ELM event, divertor volumetric visible emission, fast divertor target heat flux and saturation currents, line integrated divertor particle fluxes and fast magnetic perturbations.

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*This work was performed under the auspices of the US Department of Energy by LLNL in part under W-7405-ENG-48 and DE-AC52-07NA27344, and the US Department of Energy under DE-FC02-04ER54698, DE-AC02-09CH11466, and DE-FG02-08ER54984.