MODELING OF CURRENT PROFILE EVOLUTION AND EQUILIBRIA IN NCS DISCHARGES IN THE DIII-D EXPERIMENT*

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Recent DIII–D advanced tokamak experiments in the negative central shear (NCS) configuration have resulted in operation with high normalized β, $\beta_N = \beta/(I/aB)$, to 4.2 and at confinement enhancement factors to H = 4 ($H = \tau_E/\tau_{ITER\text{-}89P}$; τ_E = energy confinement time) and record neutron rates for DIII–D to 2.4×10^{16} neutrons/s. These data were obtained during high triangularity, double-null, diverted operation using both low (L–mode) and high (H–mode) confinement regimes plus the DIII–D ability to control plasma position and L-H transitions. Modeling of the current profile evolution in NCS experiments using Corsica, a 1-1/2 D equilibrium and transport code, results in good agreement between the simulation and experiment with respect to the spatial and temporal variation of the q-profile. In these simulations, we use a model for the effective charge state and experimentally measured profiles of electron density and of electron and ion temperatures which avoids the need to model energy and particle transport in the NCS regime. The current profile evolution is self-consistently determined by including current diffusion resulting from early neutral beam injection (Monte Carlo calculation) to establish the NCS state and variations induced from the ohmic current ramp-up phase of the discharge along with the bootstrap current drive (Hirshman-Sigmar model) associated with pressure changes during profile evolution. We are using Corsica to examine the evolution of the equilibrium and current profiles for these recent high performance experiments in DIII–D. In these experiments, we observed a sensitivity to the degree of q-profile inversion. Analysis of the experimentally measured current profiles using the multichannel MSE diagnostic and the kinetic equilibria resulting from EFIT reconstruction will be compared with the Corsica modeling of the q profile evolution. Based on these simulations, issues associated with maintaining this configuration for long times using off-axis current drive sources will be addressed.

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