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Control-Oriented Current-Profile Response Modeling Using Neural Network Accelerated Versions of TGLF and NUBEAM for DIII-D[1]

S. MOROSOHK, T. RAFIQ, E. SCHUSTER, Lehigh U., O. MENEGHINI, GA, M.D. BOYER, PPPL — Model-based control methods for robust current-profile regulation rely on control-oriented as opposed to physics-oriented models. These typically use a number of limiting assumptions to be able to achieve the necessary calculation speeds. The evolution of the current profile depends both on the plasma resistivity, which is primarily a function of the temperature, and on the deposition characteristics of the heating and current drive sources. Recent work [1, 2] has shown success with the use of neural networks to recreate the neutral-beam heat and current depositions computed by the Monte Carlo module NUBEAM and the heat and particle fluxes computed by the quasilinear transport model TGLF. These neural network models can be run in CPU-microseconds, enabling the possibility of real-time prediction for profile control purposes. In this work, the electron heat flux profile computed by the TGLF neural network and the neutral-beam heat and current depositions computed by the NUBEAM neural network are integrated into the magnetic diffusion and electron heat transport equations within COTSIM (Control-Oriented Transport Simulator). This eliminates the need for empirical correlations for the electron temperature and the neutral-beam heat and current depositions. [1] S. Morosohk, M.D. Boyer and E. Schuster, APS-DPP 2018. [2] O. Meneghini et al. 2017 Nuclear Fusion 57 086034.

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