Experimental Design to Examine Theory Based Transport Models Using Perturbative Techniques in the DIII–D Tokamak*

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The comparison of numerous theory-based critical temperature gradient transport models, including IFS/PPPL,[1] GLF23,[2] Multi-mode,[3] and Itoh-Itoh-Fukuyama (IIF),[4] to experimental data has been an ongoing effort within the DIII–D orgainization and under the auspices of the ITER Database and Modeling Expert Group.[5] This work has focused primarily on a steady state comparison where, for example, experimentally measured temperature profiles are compared to model predictions. A series of experiments are being designed on DIII–D, in connection with the theoretical community,[1,2,3] to differentiate between models by perturbing the plasma and comparing the plasma's temporal response to that predicted by a given model. If possible, these experiments will be designed to investigate plasmas that are both close to and far away from marginality which should help to better distinguish between the various models. Perturbative methods under consideration include modulated ECH, the L to H transition, edge pellet injection, current ramps, and steps in beam power. These models can differ in stiffness $\left(\chi^{HP}/\chi^{PB}\right)$ by several orders of magnitude which will result in different temporal plasma response characteristics. Considering a very stiff ITG based transport model for example, an edge T_e modulation by ECH results in a χ_i change (from changing T_i/T_e) that will propagate to a T_i change throughout the plasma. Models with different stiffness will predict different propagation speeds. The design considerations of these experiments will be presented and will include 1) predicted plasma response and a comparison to DIII–D diagnostic measurement capability, 2) an examination of various existing DIII–D discharges for suitability as a target based on the capability to differentiate models, and 3) a comparison of these targets to the marginality condition.

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