Contribution ID: **297** Type: **Poster**

Access Requirements for Stationary ELM-suppressed Pedestals in DIII-D and C-Mod Plasmas

Thursday 25 October 2018 14:00 (20 minutes)

Analysis of pedestal characteristics for Quiescent H-mode (QH) and I-mode plasmas from recent experiments on DIII-D and C-Mod exhibit a growing understanding of the access requirements necessary to obtain edge fluctuations or MHD that drive edge particle transport needed to remain ELM-free. In DIII-D QH-mode plasmas, critical values of ExB shear are required in experiment in order to suppress the transition from QH-mode to ELMy H-mode. The experimental shear values for QH-modes ranging between q_{95}~3-5 and δ~0.36-0.68 are compared with theory [1] to show good agreement with the predicted scaling parameters of $c_s/\sqrt{L_p \Delta x}$, where c_s is the ion acoustic velocity, L_p the pressure gradient scale length, and Δx is the radial width of the mode. The scaling of the critical shearing rate agrees with experiment, but the absolute magnitude of the limit is over-predicted by theory by two orders of magnitude. Through a normalized predictive scaling, the model demonstrates dynamic transitions into and out of QH-mode qualitatively within a single plasma discharge.

C-Mod I-mode plasmas, which lack an edge particle barrier and exhibit characteristic edge fluctuations over a broad range of B_ϕ [2], meet upper limits in performance determined by H-mode access. The maximum radial electric field well in I-mode increases with magnetic field strength, suggesting the expanded window for I-mode at high field is linked to a critical value of E_r/B required to induce an H-mode transition. C-Mod I-mode pedestals are analyzed over varied magnetic fields (2.8-5.8T) and auxiliary power (1.5-4.6 MW) to show consistent edge fluctuation behavior. Density fluctuations associated with the Weakly Coherent Mode are observed to span the pedestal region, extending out to the separatrix, while the fluctuation associated with the Geodesic Acoustic Mode is observed on the profile reflectometer near the foot of the T_e pedestal. Trends in the edge E_r, ExB shear, and rotation in I-mode show little correlation with the behavior of the edge fluctuations, suggesting an alternate driver for destabilization of the WCM and GAM, as compared to the QH-modes analyzed for DIII-D with an EHO.

Country or International Organization

United States of America

Paper Number

EX/P6-19

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Session Classification: P6 Posters