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EX/P7-05: Relating the L-H Power Threshold Scaling to Edge Turbulence Dynamics

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Understanding the physics of the L-H transition power threshold scaling dependencies on toroidal field and density [1] is critical to operating and optimizing the performance of ITER. Measurements of long-wavelength ($k_{\perp} \rho_{I < 1}$) turbulent eddy dynamics, characteristics, flows, and flow shear in the near edge region of DIII-D plasmas have been obtained during an ion gyro-radius scan (varying toroidal field and current) and density scan in a favorable geometry (ion ∇B drifts towards the X-point), demonstrating the underlying mechanisms that influence the macroscopic L-H power threshold scaling relations. It is found the integrated long wavelength density fluctuation amplitudes scale with ρ^* approaching the L-H transition, suggesting stronger drive of zonal flows for more favorable condition at lower toroidal field. Turbulence poloidal flow spectrum evolves from Geodesic Acoustic Mode (GAM) dominant at lower power to Low-Frequency Zonal Flow (LFZF) dominant near the L-H transition, and the effective shearing rate correspondingly increases. An inferred Reynolds Stress, $\langle \tilde{u}_r(t) \tilde{u}_\theta(t) \rangle$, from BES velocimetry measurements [2] is found to increase near the L-H transition. Similar observations were made by the Langmuir probe measurements. At lower density, a clear increase of the LFZF is observed, which is not evident at higher density. Taken together, these results are qualitatively/semi-quantitatively consistent with the density and toroidal field scaling of the L-H transition power threshold.

[1] E.J. Doyle, et al., Nucl. Fusion 47, S18, 2007.

[2] G.R. McKee, et al., Rev. Sci. Instrum. 75, 3490, 2004.

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