Turbulence Evolution and Transport Behavior During Current EX-C Ramp-Up in ITER-Like Plasmas on DIII-D

G.R. McKee[1], M. Austin[2], J. Boedo[3], R. Bravenec[4], C. Holland[3], G. Jackson[5], T.C. Luce[5], T.L. Rhodes[6], D. Rudakov[3], G. Wang[6], Z. Yan[1], L. Zeng[6], and Y. Zhao[1,7]

[1]University of Wisconsin-Madison, 1500 Engineering Dr., Madison, WI 53706-1687, USA
[2]University of Texas-Austin, Austin, Texas, USA
[3]University of California San Diego, 9500 Gilman Dr., La Jolla, CA 92093-0417, USA
[4]Fourth State Research, 503 Lockhart Dr., Austin, TX 78704, USA
[5]General Atomics, PO Box 85608, San Diego, CA 92186-5608, USA
[6]University of California Los Angeles, PO Box 957099, Los Angeles, CA 90095-7099, USA
[7]Suzhou University, Suzhou, China

University of Wisconsin-Madison, Madison, Wisconsin 53706, USA
george.mckee@wisc.edu

Low-wavenumber density fluctuations exhibit rapidly changing characteristics during the current ramp-up phase of ITER-like discharges that reflect a complex interaction between evolving electron transport, safety factor (q) and kinetic profiles and low-order rational surfaces. These measurements and analysis can explain discrepancies between various transport models and measurements during the critical ramp-up phase. ITER similar shape plasmas were performed on DIII-D to characterize performance and measure comprehensive turbulence characteristics. Comparison of these fluctuations, transport and profiles with simulations is aimed at developing a validated transport model that incorporates the unique characteristics of the ramp-up phase.

Transient windows of suppressed fluctuations are observed during ramp-up, which correspond to low-order-rational q-surfaces entering the plasma that are associated with regions and times of improved transport; the local electron temperature exhibits transient increases during these periods of reduced fluctuations. Measurements of the 2D fluctuation properties, obtained across the outer half-radius with Beam Emission Spectroscopy, illustrate the complex behavior of turbulence during current ramp-up. Density fluctuations at rho=0.55 exhibit fluctuations that decrease in amplitude with time. At rho=0.82, a very large amplitude burst of low-frequency turbulence occurs early in the current ramp, simultaneously with a set of Reversed-Shear Alfven Eigenmodes (RSAEs). A Geodesic Acoustic Mode (GAM) is evident with a frequency that increases with time as T_e increases. The scrape-off-layer T_e profile cools and narrows during the ramp-up as the core heats, consistent with increased energy confinement time at lower q_95. The amplitude profile of low-k fluctuations exhibits a strong reduction in turbulence with reduced q_95; thermal energy confinement likewise increases with decreasing q_95. Comparison of turbulence properties with time-varying linear growth rates with GYRO and GENE will allow for the development of a more complete and accurate model of transport properties during the current ramp phase.

This work was supported by the US Department of Energy under DE-FG02-89ER53296[1], DE-FG02-08ER54999[1], DE-FG03-97ER54415[2], DE-FG02-07ER54917[3], DE-FG02-08ER54978[4], DE-FC02-04ER54698[5] and DE-FG02-08ERA54984[6].