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

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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 Alfvén 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.

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