24th IAEA Fusion Energy Conference - IAEA CN-197

Contribution ID: **385** Type: **Poster**

EX/P7-10: Studies of Turbulence, Transport and Flow in the Large Plasma Device

Friday, 12 October 2012 08:30 (4 hours)

The edge and scrape-off-layer region of tokamaks has a direct and important impact on overall performance of these devices: e.g. because of stiffness in core transport, the pedestal pressure directly impacts fusion power in burning plasma experiments. Developing first-principles understanding of and a predictive capability for processes in the edge region is critically important to ensure the success of future experiments like ITER. In this paper, we describe studies of an important edge-physics related process, the interaction of flow and flow shear with turbulence and efforts to validate two-fluid models of turbulent transport against LAPD data. LAPD is a 17m long, 60cm diameter magnetized plasma column with typical plasma parameters $n_e \sim 10^{12}$ cm^{-3}, $T_e \sim$ 10eV, and $B \sim$ 1kG. Broadband, fully-developed turbulence is observed in the edge of the LAPD plasma along with spontaneously driven azimuthal flows. Recently, the capability to continuously vary the edge flow and flow shear has been developed in LAPD using biasing of an annular limiter. Spontaneous flow is observed in the ion diamagnetic direction (IDD), biasing tends to drive flow in the opposite direction, allowing a continuous variation of flow from the IDD to the electron diamagnetic direction, with a near-zero flow and flow shear state achieved along the way. Enhanced confinement and density profile steepening is observed with increasing shearing rate; degraded confinement is observed when spontaneous flow is nulled-out and near-zero shear is achieved. Particle flux and radial correlation length are observed to decrease with increasing shear; consistency with theoretical models of shear suppression is found. The decrease occurs with shearing rates which are comparable to the inverse turbulent autocorrelation time in the zero flow state. The control over edge flows and flow shear and extensive measurement capability in LAPD provides an opportunity to validate edge turbulence models. LAPD turbulence has been modeled using the 3D Braginskii fluid turbulence code BOUT++. Good qualitative and semi-quantitative agreement is found between BOUT++ simulations and LAPD experimental measurements in low flow regimes.

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Session Classification: Poster: P7

Track Classification: EXC - Magnetic Confinement Experiments: Confinement