Contribution ID: **265** Type: **Poster**

On the role of radial electric fields on turbulence spreading in the plasma boundary of fusion devices

Tuesday, 23 October 2018 08:30 (20 minutes)

Turbulence spreading is the transfer of free turbulent energy from strongly driven (i.e., unstable regions) to weakly driven locations [1]. The net effect of this phenomenon is the radial redistribution of turbulent energy, modifying local plasma features. It has been pointed out that spreading may be important in setting the Scrape-Off Layer (SOL) width. The peak heat load onto the divertor is intimately related to the SOL width, and the understanding of the mechanisms setting this width is fundamental for a reliable prediction of the SOL decay length for ITER. In this work, we report on measurements of turbulence drive and turbulent spreading, as defined by Manz, P. et al [2], from the near edge to the far SOL region of TJ-II. A 2-D Langmuir probe array [3] was used to measure both parameters as well as the profiles of floating potential, plasma density, radial turbulent particle flux, effective radial velocity, potential turbulence correlation time and phase velocity of the fluctuations. The radial electric field in the edge was modified by a biasing electrode, inserted into the edge of the plasma ($\rho \approx 0.85$), delivering a voltage $\pm$ 350 V (with respect to the wall), with a square 40 Hz waveform. All the parameters were modulated by the biasing. At -350 V, the velocity shear reached its maximum, resulting in a strong suppression of turbulent transport and the effective radial velocity fluctuations, not only at the shear layer, but also in the far SOL. Moreover, the ion saturation profile steepened at the shear layer location and was reduced in the SOL. The local turbulence drive and turbulence spreading were also impacted by the biasing. The driving term was strongly reduced in the shear layer, and only slightly reduced in the SOL. Turbulence spreading was mainly modified in the SOL when the $E_r \times B$ shear reached values close to the inverse of the turbulence correlation time in the vicinity of the Last Close Flux Surface (LCFS). In summary, biasing was found to reduce edge-SOL coupling by decreasing turbulence spreading, thus affecting the ion saturation current profile, which may have an impact on the SOL width. [1] X. Garbet et al., Nucl. Fusion 34 (1994) 963. [2] P. Manz P. et al., Phys. Plasmas 22 (2015) 022308. [3] J. Alonso. et al., Nucl. Fusion 52 (2012) 063010.

Country or International Organization

Spain

Paper Number

EX/P1-20

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Session Classification: P1 Posters