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Formation of the radial electric field profile in the WEST tokamak

L. Vermare[1], P. Hennequin[1], C. Honore[1], M. Peret[2], G. Dif-pradalier[2], X. Garbet[2], J. Gunn[2], C. Bourdelle[2], F. Clairet[2], R. Varennes[2], J. Morales[2], R Dumont[2], M. Goniche[2], P. Maget [2]

and the WEST team

[1] LPP, CNRS, Ecole polytechnique, 91128 Palaiseau, France

[2] CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France

e-mail (speaker): laure.vermare@lpp.polytechnique.fr

Sheared flows are known to reduce turbulent transport by decreasing the correlation length and /or intensity of turbulent structures. Transport barriers that take place at the edge during improved regimes such as H mode, correspond to the establishment of a large shear of the radial electric field. In this context, the radial shape of the radial electric field or more exactly of the perpendicular E×B velocity appears as a key element in accessing improved confinement regimes. In this paper, we present radial profiles of the perpendicular velocity measured in the low field side equatorial plan using Doppler back-scattering system at the edge of the plasma, dominated by the E×B velocity [1], during the first campaigns of the WEST tokamak. As visible in Figure 1, it is found that the radial velocity profile is clearly more sheared in Lower Single Null (LSN) than in Upper Single Null (USN) configuration for ohmic and low current plasmas, consistently with the expectation for respectively "favourable" versus "unfavourable" configurations. Interestingly, this tendency is sensitive to the plasma current and to the amount of additional heating power leading to plasma conditions in which the E×B velocity exhibits a deeper well in USN configuration.

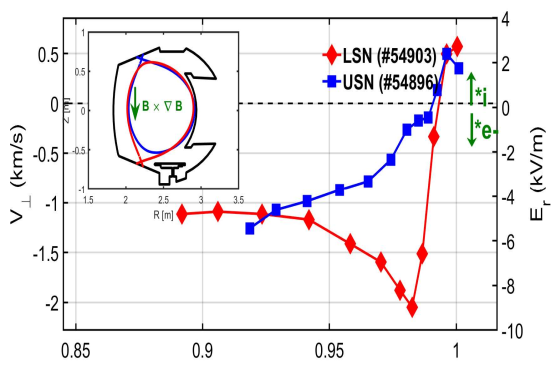

Figure 1 : Radial profile of the perpendicular velocity of density fluctuations in USN and LSN. *e and i* arrows indicating, respectively, the sign of electron and ion diamagnetic velocity

In particular, experiments have been performed to compare the profiles at the edge in both USN and LSN at different plasma current Ip keeping B=3.7T. During this scan the safety factor is varying by a factor 1.7. Note that during these scans, it is found from the radial profiles of the safety factor that the magnetic shear does not change significantly. It appears that the plasma current impacts significantly the velocity profile in the USN discharges. When increasing the plasma current, the E×B velocity starts to form a well to end up with a deeper profile than in LSN at high current (see Figure 2). Indeed, in LSN configuration, the increase of the plasma current also deepens the radial electric field well ; however, the effect is less pronounced than in USN.

In addition, approaching the L-H transition, the velocity profile forms a deeper well in USN than in LSN. More precisely, while the velocity profile exhibits a clear and deep well just inside the separatrix concomitant with the formation of a density pedestal during L-H transitions observed in LSN, deeper Er wells are observed in USN configuration during similar transitions with less pronounced density pedestal [2].

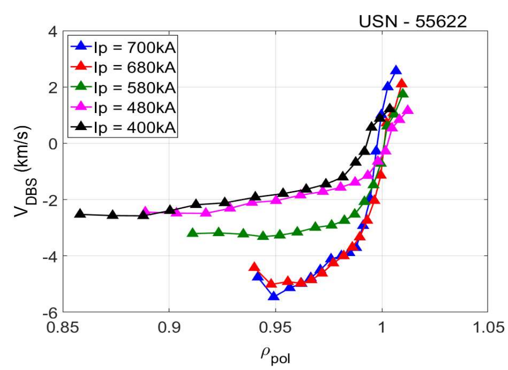

Figure 2 : Radial profiles of the perpendicular velocity of density fluctuations in USN at different plasma current

References

[1] L. Vermare et al., submitted NF, IAEA Fusion Energy Conference (FEC) 2020

[2] L. Vermare et al., Physics of Plasmas **25**, 020704 (2018) https://doi.org/10.1063/1.502212