Radial electric fields, turbulence and transport studies in W7-X and TJ-II

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A systematic characterization of radial electric fields (E_r) and turbulence has been carried out using Doppler Reflectometry (DR) in the stellarators W7-X and TJ-II, covering a broad range of operational regimes. The most relevant scenarios have been explored to address key topics and whenever possible, the results have been compared with neoclassical (NC) and gyrokinetic (GK) simulations, aiming for both a proper interpretation of the experimental results and testing the predictions of simulations.

- Radial profiles of E_r and density fluctuations ($\tilde{n}_e$) have been measured during the post-pellet high performance phase achieved in W7-X plasmas [1]: A strong negative E_r develops, well reproduced by NC simulations, and a reduction in $\tilde{n}_e$ occurs that depend on the magnetic configuration. These results are consistent with a more general observation showing a reduction in the turbulent transport as the density gradient increases, as expected for ITG-driven turbulence [2]. Though less pronounced, similar post-pellet enhanced confinement regime has been recently observed in NBI heated plasmas in TJ-II.
- The impact of magnetic islands on turbulence and flow, experimentally investigated in dynamic magnetic configuration scans in TJ-II, has been recently addressed also in W7-X [3]. In these experiments, the 5/5 magnetic island positioned inside the LCFS modifies the flow at the island boundaries, increasing the flow-shear, and produces a reduction in $\tilde{n}_e$ nearby the island O-point. An increase of the plasma energy content and confinement time is also observed. These observations show similarities with results found in other devices and in GK simulations.
- A systematic comparison of turbulence and E_r profiles, measured at poloidally separated positions on the same flux-surface in TJ-II, show asymmetries which can be explained based on the spatial localization of instabilities, as predicted by GK simulations, and on the electrostatic potential variation on a flux surface, as calculated by NC codes [4]. Similar studies will be possible in the next campaigns after the upgrade of the DR systems in W7-X.

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