Experimental investigation of the mean turbulence structure tilt angle and its comparison with gyrokinetic simulations

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The experimental characterization of the turbulence and its comparison with theory and simulations is fundamental for the understanding of the turbulence dynamics in fusion plasmas. Detailed fluctuation measurements are required in order to investigate specific phenomena. In particular, the tilt angle of the turbulence structures in the radial-perpendicular plane, is a quantity predicted by theories and gyrokinetic simulations, which can provide information on the turbulence interaction with sheared flows and the type of the dominant micro-instabilities [1], e.g. ion-temperature gradient (ITG) and trapped-electron mode (TEM) instabilities. Nevertheless, tilt angle measurements are challenging, especially in the confined region of fusion plasmas.

Radial correlation Doppler reflectometry is an experimental technique that provides information on the radial structure of the density turbulence. It is based on the correlation analysis of two Doppler reflectometry channels measuring at different radial positions. A new analysis technique of the time delays of the correlation has been developed. It provides a measurement of the tilt angle and can be applied in the confined region of fusion plasmas where Doppler reflectometry measurements are usually performed.

The tilt angle measurement method is applied at the ASDEX Upgrade tokamak. A low density L-mode discharge is investigated. Two phases with either dominant ion or dominant electron heating are considered. The tilt angle is measured in the confined region $\rho_{\mathrm{pol}} = 0.70 - 0.84$ for the first time in the ASDEX Upgrade tokamak. Moreover, a tilt angle difference of 26° is observed between both phases. The linear gyrokinetic stability analysis confirms a transition from an ITG to a more TEM dominated turbulence regime between the phases with dominant ion and dominant electron heating, respectively. The tilt angle is compared with results from gyrokinetic simulations, and the use of this new measurement as a signature of the turbulence regime is discussed.

References

[1] Y. Camenen *et. al.*, Nucl. Fusion **51**, 073039 (2011)