Characteristics of Doppler reflectometry signal at FT-2 tokamak. full-wave computation with gyrokinetic modeling results in comparison with experiment

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Doppler reflectometry (DR) diagnostic is used to measure the rotation velocity of tokamak plasma and characteristics of drift turbulence, which is responsible for anomalous transport. Despite the wide usage of diagnostic, there is no clear interpretation method for experimental results at high turbulence levels due to nonlinear effects, such as small-angle scattering [1]. One of the methods to cope with this problem is to use numerical modeling. This approach was used for FT-2 tokamak. With the use of gyro-kinetic ELMFIRE code, density profile fluctuations were calculated. These fluctuations were later used to calculate DR signal in Born approximation [2]. In comparison with experimental results a number of inconsistencies was spotted. These inconsistencies can be explained by nonlinear effects, which are excluded from the calculation in Born approximation.

In this work, synthetic DR signals were computed with full-wave IPF-FD3D code [3]. The simulation was performed for horizontal probing by a wave of extraordinary polarization at 70GHz from high field side in accordance with the experimental configuration [2]. Compared to the calculations in Born approximation, a better agreement of correlation length and signal power with experiment have been obtained. At the same time in comparison with [2], synthetic DR spectra are less consistent with experimental ones. This inconsistency can be explained by nonlinear effects playing a role in DR signal in combination with an underestimation of small-scale fluctuations level in ELMFIRE and a nonlinear dispersion of turbulence. Decreasing the turbulence level led to disappearance of these effects and agreement of results with linear approximation calculations in [2].

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References

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