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Poloidal Inhomogeneity of Turbulence in the FT-2 Tokamak by Radial Correlation Doppler Reflectometry and Full-f Gyrokinetic Modeling

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The drift-wave turbulence responsible for anomalous transport of energy and particles in tokamak plasma is widely studied nowadays both experimentally and in theory. An interesting and important prediction of the numerical approach based on full-f gyrokinetic modeling is statistical inhomogeneity of trapped-electron-mode turbulence typical for ohmic discharge. Though the radial variation of the mean turbulence characteristics is well known to the experimental community the data on their poloidal dependence are rare. In this paper we address the problem using radial correlation reflectometry (RCR) technique utilizing simultaneous microwave plasma probing at different frequencies in the presence of a cut off and based on correlation analysis of backscattering signals. Oblique plasma probing as a method to cope with contribution of small angle scattering off long scale turbulence component have been justified recently. It was proved that the radial correlation Doppler reflectometry (RCDR) version of the diagnostic provides a way for determination of the turbulence radial wave number spectra and its detailed investigation.
Following this approach the RCDR scheme in the 50-75 GHz frequency range from high magnetic field side have been assembled and detailed measurements in different poloidal octants were performed in FT-2 ohmic hydrogen and deuterium discharges. The turbulence parameters were measured at variable incidence angle (±10-30 degrees) corresponding to different turbulence poloidal wave numbers (6-16 cm-1) and frequency changing from 50 kHz to 400 kHz. The cut-off layer minor radius was varied in the range from 3 to 6 cm. Both frequency resolved and integrated RCDR CCFs were determined. The correlation length corresponding to the frequency averaged CCF is smaller than that, obtained in the Doppler shift frequency thus leading to its underestimation. A new antennae set from low field side and interferometer antennae are utilized for other poloidal octants. As a result of measurements using these antennae the variation of radial correlation length from 0.25 cm to 0.45 cm when moving from high-field side to low-field side of the torus was demonstrated in agreement to the results of gyrokinetic modeling performed with ELMFIRE code. A well pronounced excess of the turbulence correlation length in deuterium over its value in hydrogen discharges was shown.

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