Synthetic radial correlation Doppler reflectometry diagnostic for FT-2 tokamak.

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Turbulent transport plays a key role in plasma confinement which makes understanding and control of plasma turbulence one of the major goals of fusion research. The tools for turbulence characterization include radial correlation reflectometry, which utilizes simultaneous probing with two microwaves at different frequencies incident normally onto magnetic surface in the presence of the cutoff. By performing correlation analysis of reflected signals, the information about turbulence properties, such as radial correlation length can be extracted. However, due to dominant contribution of small-angle scattering off long-scale fluctuations in the reflected signal, the radial correlation length is overestimated at small turbulence levels \cite{1,2}. One of the methods to counteract this effect is so called radial correlation Doppler reflectometry (RCDR) or backscattering (BS) technique, which utilizes probing beam at oblique incidence high enough to suppress small-angle scattering contribution to the BS signal. This approach was justified in analytical theory \cite{3} and applied in FT-2 tokamak experiment, where the first comparison of the RCDR data to the results of the global gyrokinetic modeling with ELMFIRE code was performed \cite{4}.

In the present paper detailed benchmarking of drift-wave turbulence characteristics provided by the code against the experimental data is performed using synthetic RCDR diagnostic based both on reciprocity theorem valid in linear theory and on full-wave IPF-FD3D code \cite{5}. The latter code is accounting for the nonlinear effects, in particular, for the multiple small-angle scattering leading to underestimation of the turbulence radial correlation length \cite{6}. The importance of nonlinear effects for interpretation of the RCDR data is shown.

\cite{1} Gusakov E, Yakovlev B. 2002 Plasma Phys. Control. Fusion 44 2525
\cite{3} Gusakov E, Irzak M and Popov A 2014 Plasma Phys. Control. Fusion 56 025009
\cite{4} Altukhov et al. 2016 Plasma Phys. and Controlled Fusion 58 105004
\cite{5} Lechte C, IEEE Transaction on Plasma Science 37, 6 (2009)