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Benchmarking of Full-f Global Gyrokinetic Modeling Results Against the FT-2 Tokamak Doppler Reflectometry Data Using Synthetic Diagnostics

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The fast linear (Born approximation) version of the X-mode Doppler reflectometry (DR) synthetic diagnostics is developed in the framework of the ELMFIRE global gyrokinetic modeling of the FT-2 tokamak ohmic discharge. The DR signal frequency spectra and the dependence of their frequency shift and shape on the probing antenna position are computed and shown to be similar to those measured in the high magnetic field side probing DR experiment at the FT-2 tokamak thus demonstrating a correct reproduction of the electric field behavior in the FT-2 tokamak by the ELMFIRE GK code. However, the computed and measured dependences of the DR signal power on the antenna position characterizing the «poloidal correlation lengths» appear to be different presumably due to underestimation of the small-scale TEM turbulence component in the measurement region by the code. The fluctuation poloidal velocities and the geodesic acoustic mode (GAM) amplitudes are determined using DR experiment and synthetic diagnostics and shown to be close within a 20% accuracy, whereas the GAM frequency spectra demonstrate clear differences. In the case of multi-frequency probing the cross-correlation function of radial correlation DR obtained in the experiment is shown to be a factor of four narrower than the computed one due to the phase modulation of the DR signal by long-scale turbulent density fluctuations. A comparison to the alternative version of the DR synthetic diagnostics based on the nonlinear full-wave modelling is also performed. It is shown that in spite of a better description of the radial correlation DR data nonlinear synthetic diagnostics fails to reproduce the DR frequency spectra as opposed to linear version of the synthetic diagnostic. The nonlinear effects in the DR spectra formation are shown to be responsible for this under conditions of small scale turbulence level underestimation by the GK code.

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