Radial correlation Doppler reflectometry in the TJ-II stellarator:
Measurements and two-dimensional full-wave simulations

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Radial correlation reflectometry both conventional and Doppler has been studied numerically using a two-dimensional full-wave code and experimentally using the Doppler reflectometer system installed in the TJ-II stellarator [1]. The turbulence level, the radial correlation length, and the probing beam angle has been scanned to study the behaviour of the radial correlation length Lr measured by reflectometry with the help of the full-wave code [2]. The numerical results show that in most cases the Lr measured by conventional reflectometry is different from the turbulence radial correlation length. It is also shown that Doppler reflectometry provides a major improvement over conventional reflectometry if the probing beam angle is properly chosen and the measurements are performed in linear regime, i.e. at low turbulence levels. In non-linear regime the full-wave results show that both conventional and Doppler reflectometry underestimate the turbulence radial correlation length. In order to asses the results obtained in the simulations we have performed a series of experiments in TJ-II where broad scans in the probing beam angle have been performed under different plasma conditions [3]. The comparison between the numerical results and the experimental ones indicates that both linear and non-linear regimes have been found. Based on the simulation results an experimental iterative procedure has been applied to the experimental data to determine the turbulence radial correlation length providing sensible results. Recently, the linear theory of radial correlation Doppler reflectometry has been developed [4]. According to this theory radial correlation Doppler reflectometry is expected to provide accurate Lr values if the probing beam angle clearly exceeds a critical one. However, this theoretical conclusion may not be completely general as it has been obtained under some approximations which can be questionable in small fusion devices like TJ-II. The numerical results and the experiments performed in TJ-II show that if the probing beam angle is too large the measured Lr may be smaller than the turbulence radial correlation length. More simulations are in progress to help in the interpretation of radial correlation Doppler reflectometry.

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