On possibility of turbulence wave number spectra reconstruction using radial correlation reflectometry data.

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Fluctuation reflectometry is widely used technique providing information on the tokamak plasma low frequency turbulence. Technical simplicity and operation at a single access to plasma are among its merits, which however cause interpretation problems related to localization of measurements and wave number resolution. In order to improve the fluctuation reflectometry wave number selectivity a more sophisticated radial correlation reflectometry (RCR), using simultaneously different frequencies for probing was proposed. The coherence decay of two scattering signals with growing difference of probing frequencies is studied in this diagnostic and applied for estimation of the turbulence radial correlation length. This estimation is often performed in a manner similar to that developed in the probe correlative technique, namely it is supposed that fluctuating part of the reflectometer signal is produced by backscattering in the nearest vicinity of the cut off point so that the coherence dependence on probing frequency difference can be interpreted as dependence on the separation of measurement points.

However already in 1D numerical Born approximation analysis [1] a role of small angle scattering was shown, reducing the diagnostic special resolution and leading to slow decay of coherence in RCR. This effect was confirmed in RCR linear analytic theory in 1D and 2D model [2-4] and by 1D full wave numerical modeling [5].

In the present paper it is shown that the reason for slow coherence decay both in slab and cylinder plasma geometry is provided by specific behavior of scattering efficiency at long scales inverse proportional to radial wave number. This behavior is universal persisting both in 1D and 2D linear RCR theory [2-4] and for arbitrary density and turbulence profiles. The procedure of turbulence radial wave number spectrum reconstruction accounting for the universal scattering efficiency dependence on fluctuation radial wave number is proposed.