Radial correlation reflectometry analysis in high-turbulence plasma scenario

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The radial correlation reflectometry (RCR) is a widely used technics that provides information on plasma turbulence characteristics. Probing plasma with multiple frequencies can simply determine the turbulence radial correlation length by the difference in the cut-off positions where the correlation of the signals disappears. It turned out that this approach is not always correct [1]. That stimulated theoretical investigation of the RCR and resulted in the non-linear theory of the RCR in 1D [2] and 2D [3] models. According to the developed models in the case of strong turbulence or small plasma density gradient the signal spatial correlation length is a function of both the turbulence correlation length and its amplitude. Another method of the reflectometry signal analysis was developed for extracting information on the turbulence spectrum thus the turbulence amplitude [4]. This approach is based on the relation between the radial wave-number spectrum of the density fluctuations and the phase fluctuation wave-number spectrum of a reflectometer signal via a transfer function or a relation established under the Born approximation [5]. Assuming that the main contribution comes mainly from the vicinity of the cut-off layer, the Parceval's theorem is used to recover the density fluctuation level, and thus the density fluctuation profile.

Theoretically the two methods can be combined for obtaining the information on both the turbulence amplitude and its radial correlation length under the conditions when the non-linear regime of the RCR takes place. Nevertheless this idea has not been used in practice yet.

This paper is devoted to the demonstration and verification of the possibility to use the two approaches of the RCR signal interpretation simultaneously. On the base of 2D simulation of a RCR experiment it is shown that this method allows us to resolve the turbulence amplitude and the turbulence radial correlation length.

[1] A. Costley et al (1990) *Rev. Sci. Instrum.* **61** 2823.

[2] E. Z. Gusakov and A. Yu. Popov (2002) *Plasma Phys. Control. Fusion* **44** 2327-2337.

[3] E. Z. Gusakov and A. Yu. Popov (2004) *Plasma Phys. Control. Fusion* **46** 1393-1408.

[4] S. Heuraux et al (2003) *Rev. Sci. Instrum.* **74** 1501.

[5] C. Fanack et al (1996) Plasma Phys. Cont. Fusion **38** 1915.