RECONSTRUCTION OF TURBULENCE CHARACTERISTICS in THE REFLECTOMETRY non-linear regime [[1]](#footnote-1)\*)

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The radial correlation reflectometry (RCR) is a widely used technics proposed to diagnose the plasma turbulence in magnetic fusion machines. It was believed that probing plasma with multiple frequencies can be used to determine the turbulence radial correlation length simply from the difference in the cut-off positions where the correlation of the signals disappears. However, it turned out that this naive approach is not always correct leading both to the correlation length overestimation in the linear scattering regime [1, 2] and to its underestimation in the non-linear regime typical for large devices, as it was demonstrated in the non-linear theory of the RCR in 1D [3] and 2D [4] models. According to the developed models in the case of strong turbulence the signal “spatial correlation length” depends on both the turbulence radial correlation length and its amplitude and thus seems to be not helpful for determination of any of them.

Another method of the reflectometry signal analysis was developed for extracting information on the turbulence spectrum and its amplitude [5]. 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 established under the Born approximation [6]. 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.

In the present paper it is proposed to combine the two methods 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. As the first step towards the idea practical application, we perform a numerical modelling of the proposed scheme utilizing 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.

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References

1. I. Hutchinson (1992) *Plasma Phys. Control. Fusion* **34** 1225
2. E.Z. Gusakov and B.O. Yakovlev (2002) *Plasma Phys. Control. Fusion* **44** 2525
3. E.Z. Gusakov and A.Yu. Popov (2002) *Plasma Phys. Control. Fusion* **44** 2327-2337
4. E.Z. Gusakov and A.Yu. Popov (2004) *Plasma Phys. Control. Fusion* **46** 1393-1408
5. S. Heuraux et al (2003) *Rev. Sci. Instrum.* **74** 1501
6. C. Fanack et al (1996) *Plasma Phys. Cont. Fusion* **38** 1915

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Mu/ru/BC-Tretinnikov.docx) [↑](#footnote-ref-1)