Nonlinear Doppler reflectometry power response.

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Understanding and control of plasma turbulence is one of the major goals of fusion research, since the turbulent transport plays a key role in plasma confinement. One of the tools used for turbulence characterization is Doppler reflectometry, which utilizes a microwave beam to probe the plasma at oblique incidence with respect to the magnetic surface. The backscattered signal can provide turbulence "poloidal" wavenumber spectrum and its Doppler shift, which is connected to poloidal velocity of plasma. However, interpretation of experimental measurements is not always straightforward.

In case of small turbulence level, when Born approximation over the turbulence amplitude is applicable, the diagnostic response was extensively studied both analytically [1] and numerically [2]. In the case of strong turbulence, when multiple forward scattering is dominant, analytical predictions have been made [3] and nonlinear effects were observed in full-wave simulations [4, 5]. Recently, intermediate regime with power of scattering signal enhanced due to high order nonlinear scattering effects was observed numerically in full-wave computations utilizing IPF-FD3D code [4] and interpreted using physical optics model [6]. While simple and effective, this model possesses a limited domain of validity because it only takes into account plasma-wave interaction in the very vicinity of the cutoff.

To overcome this limitation, transition from linear regime to regime with enhanced power is studied in the present paper analytically using the first (Born) and the second order of approximation over the turbulence amplitude. Transition criteria are derived and their discrepancies from the physical optics model predictions are discussed. To confirm analytical results, full-wave numerical modeling with IPF-FD3D code [4] is performed.

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[1] E Z Gusakov and A V Surkov Plasma Phys. Control. Fusion **46** (2004)1143

[2] Hirsch M, Holzhauer E, Baldzuhn J, Kurzan B and Scott B Plasma Phys. Control. Fusion **43** (2001)1641

[3] E Z Gusakov, A.V. Surkov, and A Yu Popov Plasma Phys. Control. Fusion **47** (2005) 959

[4] C Lechte *et al* Plasma Phys. Control. Fusion **59** (2017) 075006

[5] O. L. Krutkin, A.B. Altukhov, A.D. Gurchenko, *et al.* Proc. 44th EPS Conf. on Contr. Fusion and Plasma Physics (Belfast) ECA vol. 41F (2017) P2.108

[6] J R Pinzón *et al* Plasma Phys. Control. Fusion **59** (2017) 035005