Full wave modeling of Doppler backscattering from filaments

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It is recognized that the filaments have a significant effect on the anomalous energy and particle transport in the tokamak periphery. They are actively investigated using various diagnostics in this regard. Recently three studies of filaments using the Doppler backscattering (DBS) method have been performed in Globus-M2 [1] and ASDEX-Upgrade [2, 3]. Backscattering from filaments manifests itself in approximately the same way as a burst of quasi-coherent oscillations of the signals of IQ detectors. Such signals are easy to describe in the Born approximation using the diagnostic weighting function [1]. However, the filaments in tokamaks differ noticeably in their size and intensity. With an increase in the amplitude of the filaments, it is necessary to consider the transition from linear scattering to nonlinear scattering up to the transition from backscattering to reflection from a moving filament. This problem can be solved only using a full wave code. Our simulation was carried out using finite-difference time-domain code IPF-FD3D in slab and realistic geometry [4]. We did not resort to using well-known non-linear MHD codes to determine filament parameters. In the simulation artificial filament-like 2D perturbations were used, the parameters of which varied over a wide range. Modeling DOR signal was focused on the identification of the influence of the amplitude of the filament and its size on the shape and size of the DOR output signal. The results obtained largely explain the similarity of the IQ detector data registered in different tokamaks.

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