STUDY ON THE EFFECT OF SIDEBANDS OF KSTAR-LIKE TRAVELING WAVE ANTENNA POWER SPECTRUM ON HELICON WAVE CURRENT DRIVE IN EXL-50U SPHERICAL TORUS PLASMA

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Abstract

Considering the effect of two KSTAR-like traveling wave antennas' (TWAs) structure (FIG. 1), this paper investigates the influence of sidebands of their spectra on helicon current drive (HCD) in spherical tokamak EXL-50U by coupling them generated by COMSOL with GENRAY (FIG. 2). First, two sets of 476 MHz KSTAR-like TWAs are designed based on optimized parameters obtained through extensive scanning (FIG. 3), whose spectra have the same parallel refractive index $N_{||} = -3.2$ corresponding to the main peak and different sidebands. Then, comparing the current driven by them with Gaussian-like spectrum, the effects of sidebands of these two TWAs spectra on HCD are discussed. The analysis reveals that under medium-density low magnetic field and low-density high magnetic field conditions, the sidebands have a significant impact on HCD, with a maximum driven current absolute difference of 178 kA for two KSTAR-like TWAs spectra and Gaussian-like spectrum with the same injection power (FIG. 4). Higher temperature leads to an increase in the impact of sidebands on HCD. The sidebands not only affect the magnitude of HCD, but also cause the current peak to shift towards the plasma center or edge (FIG. 5). Under certain conditions, narrow sidebands with parallel refractive index close to the strong Landau damping condition may be beneficial to improve the driven current magnitude and local control. Relevant research provides certain guidance for the design of RF antenna and HCD experiments.

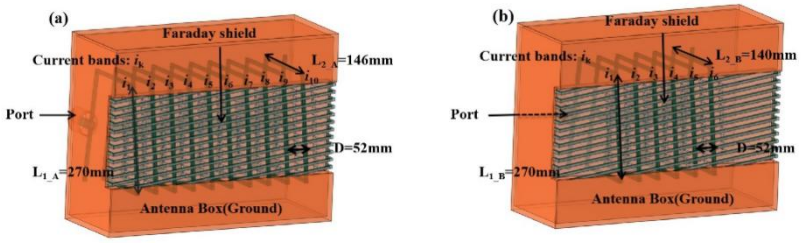

FIG. 1. Basic structure of KSTAR-like TWA (a) A, (b) B.

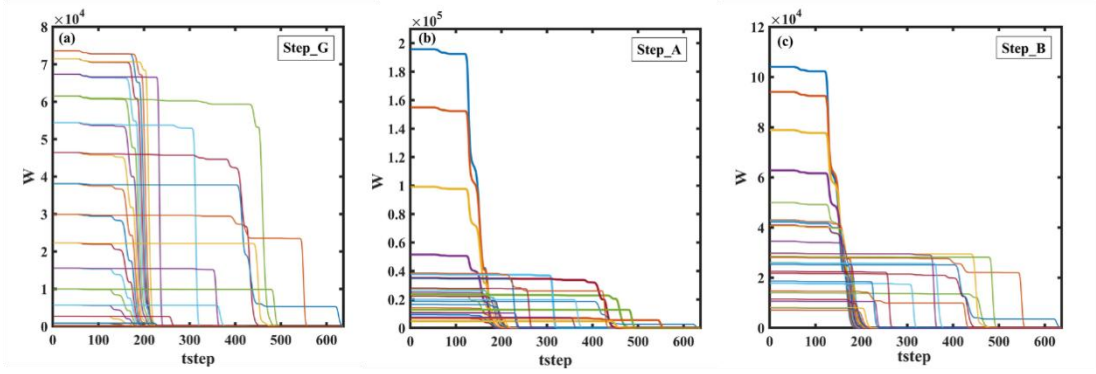

FIG. 2. The variation of power in each ray over time .(a) Step_G, (b) Step_A, (c) Step_B.

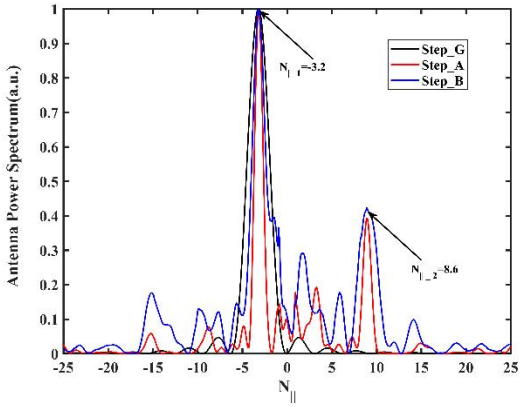

FIG. 3. $N_{||}$ power spectra for Step_A, Step_B and Step_G.

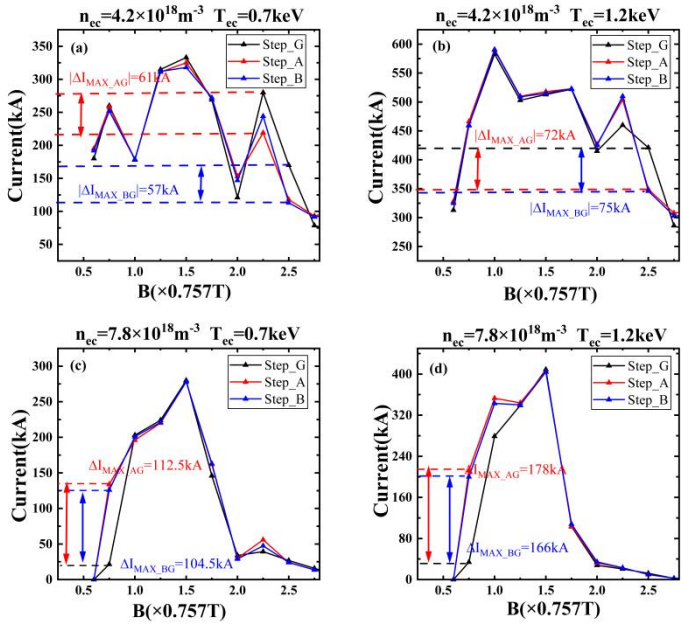

FIG. 4. Dependence of the driven current with magnetic field for three $N_{||}$ power spectra.
(a) n_{ec} = 4.2 × 1018 m-3, T_{ec}= 0.7 keV, (b) n_{ec} = 4.2 × 1018 m-3, T_{ec}= 1.2 keV,
(c) n_{ec} = 7.8 × 1018 m-3, T_{ec}= 0.7 keV, (d) n_{ec} = 7.8 × 1018 m-3, T_{ec}= 1.2 keV.

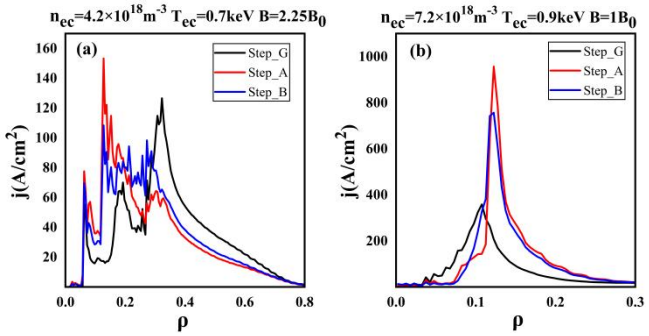

FIG. 5. Current profiles of three $N_{||}$ power spectra.
(a) n_{ec} = 4.2 × 10^{18} m^{-3}, T_{ec} = 0.7 keV, B = 2.25 B_0, (b) n_{ec} = 7.2 × 10^{18} m^{-3}, T_{ec} = 0.9 keV, B = 1 B_0.

REFERENCES

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[2] Du D et al 2023 *Nucl. Fusion* 63 **126027**