§16. Experimental Study of Plasma Loaded Cyclotron Resonance Maser Using TPD-II Machine at NIFS

Minami, K. (Tokyo Denki Univ. Eng.),
Sato, K.

Researchers of gyrotrons community over the world trust the principle of cyclotron resonance maser (CRM) instability characterized by $\omega > \tilde{\Omega}$ (relativistic cyclotron frequency) in which free gyration model for tenuous beams is applicable. There can be another model of constrained gyration for the high-density neutralized electron beam which results in the Cherenkov instability in the azimuthal direction (CIAD) with $\omega < \tilde{\Omega}$ [1].

We are trying to detect experimentally the CIAD in addition to CRM instability in a beam-plasma system produced by differential pumping of DC discharge plasma source of TPD-II machine. In Fig. 1, is shown the fabricated TE_{011} cylindrical cavity and two antennas made of SUS with resonant frequency near 3.5 GHz that is installed in the machine, and the beam-plasma with radius 4 mm goes through the two end holes on the axis of the cavity. In front of the cavity, a pair of SUS mesh electrodes accelerate the beam up to -15 keV, followed by a wiggler to give rise to cyclotron motions in the beam. It consists of a pair of helical windings with 4 turns and 80 mm pitch length, total length 320 mm and inner diameter 35 mm in which current of 40 A creates 8 Gauss helical magnetic field on the axis. In Fig. 2, distribution of the axial magnetic field is shown where the wiggler and the cavity are located. The mirror field increases the perpendicular motion of the electrons so that beam incident through the cavity has v(perp)/v(axial)>1.3.

Expected microwave signals through the cavity are calculated in Fig. 3. There can be cold and energetic electrons of -15 keV in the beam. The former and the latter will resonate to the microwave at 3.5 GHz for the axial magnetic field 0.1268 and 0.1306 T. The negative absorption due to CRM instability and CIAD will be observed for low-field side and high-field side of 0.1306 T $(\omega = \tilde{\Omega})$.

1) K. Minami, Y. Choyal and T. Watanabe: J. Plasma Phys. Vol. 72, pp.1-19 (2006).

Fig. 1 Fabricated TE_{011} mode Cavity at 3.5 GHz.

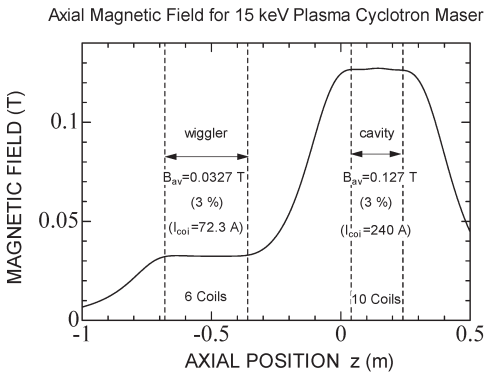

Fig. 2 Designed distribution of axial magnetic field of plasma-loaded CRM in TPD-II machine.

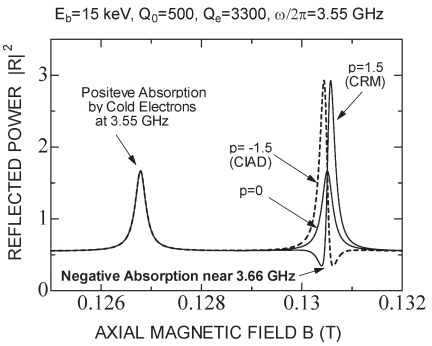

Fig. 3 Expected microwave signals through cavity at 3.5 GHz for CRM instability and CIAD.