§18. Study of the Radio-Frequency Driven Sheath in the Ion Cyclotron Slow Wave Antennas

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Formation of Radio-Frequency Driven Sheath and resulting parasitic antenna loading in the Ion Cyclotron slow wave antennas are studied experimentally in the linear divertor plasma simurator NAGDIS-II. A phased loop antenna array with a poloidal mode of m=0 is used in the present ICRF heating experiment. Typical antenna voltage waveforms(without Faraday Screen) during RF heating are shown in Fig.1 as a parameter of the antenna current. A large DC voltage drop of about several hundreds volts is induced on the loop antennas with and without Faraday screen during high power rf heating and causes the additional power dissipation (Psh) due to the heat flux to the antenna current strap of ions accelerated by the rf driven DC sheath potential. Aditional power dissipation caused by RF induced sheath is theorically given by

$$P_{sh} = A \cdot \langle \Gamma \rangle \cdot T_e \cdot \zeta \cdot I_1(\zeta)/I_0(\zeta) \qquad (1)$$

where $\zeta = eV_{rf}/T_e$ and V_{rf} is the amplitude of antenna Voltage($V_{p\text{-}p}/2$) and $<\Gamma>$ ($=Zn_iC_s$)is the time averaged particle flux into the antenna and A is a surface area of the antenna structure and I_n is a modified Bessel function. For $\zeta >> 1$,P_{sh} is simplified to

$$P_{sh} = A \cdot n_i \cdot C_s \cdot Z \cdot e \cdot V_{rf} \qquad (2)$$

This parasitic antenna loading is measured by calorimetric method and compared with that obtained from the conventional measurement of the antenna voltage and current. When a Faraday screen is employed to reduce the antenna-plasma interaction, Psh becomes much smaller than the radiated rf power. The net antenna loading for ICRF slow wave excitation is evaluated, taking account of the rf sheath dissipation.

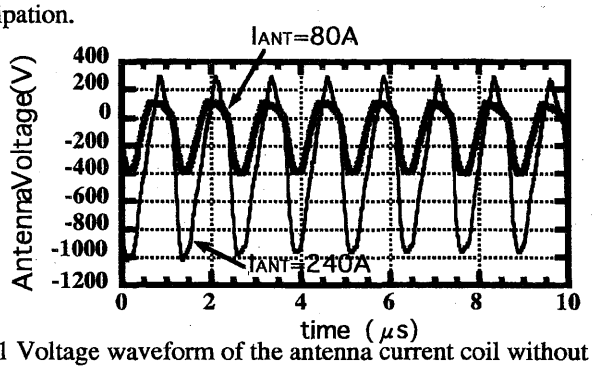

Fig.1 Voltage waveform of the antenna current coil without Faraday screen.The driving frequency of the antenna is 780kHz.

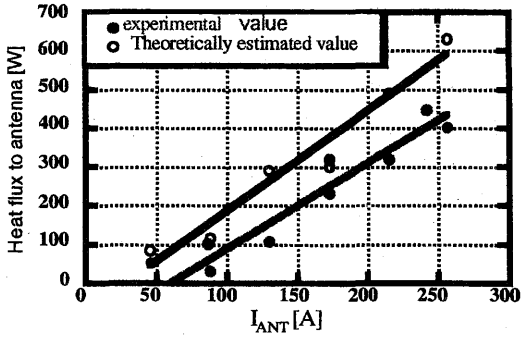

Fig.2 Comparison of the experimentally observed antenna heat load with theorical one in the case of the antenna without FS.

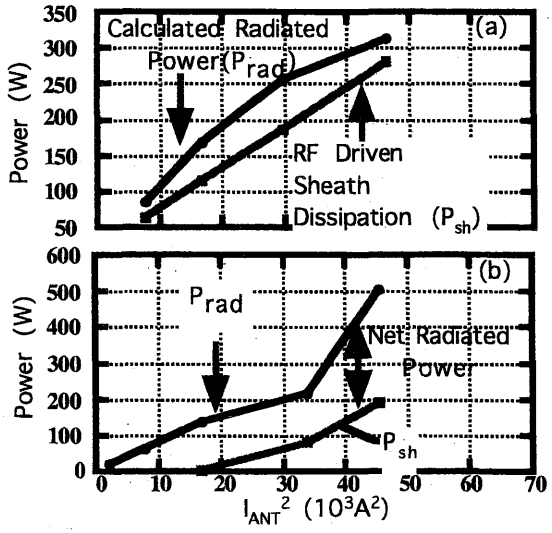

Fig.3 Radiated power calculated from the plasma impedance and the antenna[without FS (a) and with FS (b)] heat load measured by calorimetry as a function of the antenna current.

reference

1)D.AD'Ippolite and J.R.Myr ,Phys.Plasma,3 (1996) 420