§18. Wave Measurements Utilizing Two Frequency RF Wave Excitation

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Parametric decay instability is a typical three wave coupling process, where two new daughter waves and/or modes are generated from one strong pump wave. Since the three wave coupling process is a basic process in non-linear phenomena, precise and detailed study of such process is quite important to explore much more complicated turbulent phenomena. In order to perform such a basic study, it is preferable to control the experimental condition. We propose the two frequency RF wave excitation experiment, where two of the three waves can be controlled.

In the TST-2 spherical tokamak device, high harmonic fast wave (HHFW) with a frequency of 21 MHz was injected to Ohmic plasmas, and the spectra peculiar to parametric decay instabilities were observed. The experimental results were interpreted as that the pump wave (HHFW) decays into two daughter waves: one is ion cyclotron quasi mode and the other is ion Bernstine wave or fast wave. Moreover, a clear impurity ion heating was observed. The three wave coupling was believed to occur at the harmonic resonance of the ion cyclotron frequency. However, precise analysis of electrostatic probe data revealed that the coupling also occurs where two propagating wave exists. This is different from the standard parametric decay process, and the result suggests that we can generate the third wave in the three wave coupling by adjusting the two waves, and we can perform a controlled basic study of non-linear phenomena.

Presently, the TST-2 device is equipped with a 200 MHz high power RF source and a combline antenna, by which travelling waves in the lower hybrid wave frequency range can be excited. In order to inject two frequency waves we modified the signal generation part (Fig. 1). The outputs from two signal generators are combined and fed into a wide-band amplifier followed by three stage power amplifier. The power amplifier consists of 3 units, and two units were tuned to 199.6 MHz (f) and the other was tuned to 200.1 MHz ($f+\Delta f$). Figure 2 shows the power spectra of

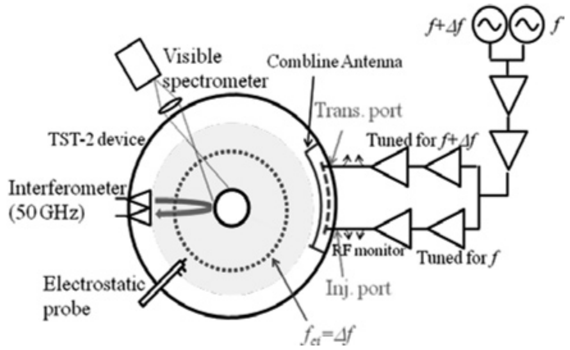

Fig. 1 Two frequency RF injection scheme and several diagnostics.

RF wave with (black) and without (red) plasma, and broadening of the spectra due to the plasma can be seen.

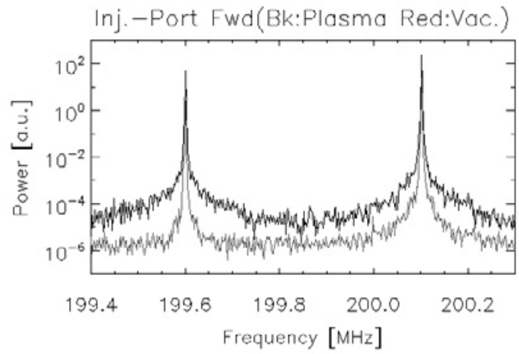

Fig.2 Power spectra of RF wave measured at the injection port of the combline antenna. Black curve represents that with plasma and red curve represents that without plasma.

The RF wave was injected to an ECH initiated discharge, where the plasma current was generated by the RF power, and an ST configuration was formed and sustained by the RF power alone (Fig. 3). If a non-linear process occurs, the component with the frequency Δf can be seen in some signals. We have observed such components in the line integrated density (Fig. 3 (c)), in the floating potential measured by an electrostatic probe and in the magnetic pick-up coil signals. The magnetic pick-up coil signals, however, were affected by the noise, which seems to be generated by a non-linear process in the RF power amplifiers. Although Δf component were not emitted through the antenna, it is preferable to remove such non-linear process in the power amplifier. For this purpose, we are preparing for splitting the RF system into two independent groups for each frequency. Although we expected impurity ion heating by adjusting Δf to be the ion cyclotron frequency, we did not observe a clear ion heating so far.

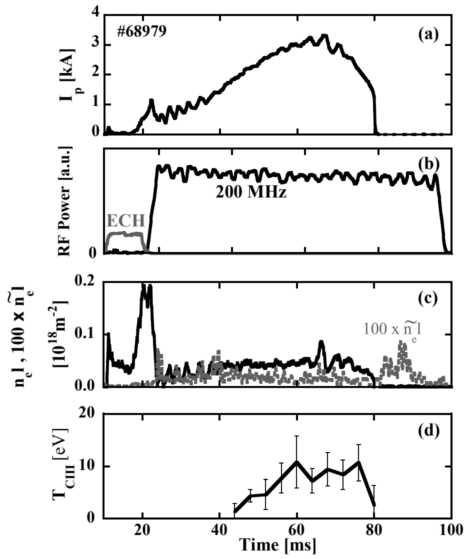

Fig. 3 Time evolution of plasma current (a), RF injection power (b), line integrated density and rms fluctuation amplitude (c) and impurity (C_{III}) temperature (d).