§12. Two Frequency Wave Excitation Experiments

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In order to perform controlled nonlinear wave physics experiments, we have proposed a two frequency wave injection. We have modified the RF transmission system (with a frequency around 200 MHz) installed at the TST-2 device to perform the experiments. In addition, a new RF pickup coil was developed.

In fiscal year 2011, we modified the RF transmission system, and split the original system into two independent RF transmission units. The units feed RF power to the two ports of a combline antenna, which are connected to the different ends of the 11-element combline antenna. The nonlinear wave generation in the RF transmission is expected to be quite low.

Figure 1 shows the photograph of the new RF pickup coil. The coil is made of 1-turn semirigid cable wounded around a dielectric bobbin. The coil is covered withstainless steel sheath with or without a slit in front, and the cable is connected to a vacuum feedthrough. The pickup coil without slit on the sheath was used as a monitor of noise. The noise is generated by leak RF wave through some unexpected paths, which may not represent the local RF field at the slit. The resultant noise level was lower than the target signal by more than 20 dB as shown in Fig. 2 (a).

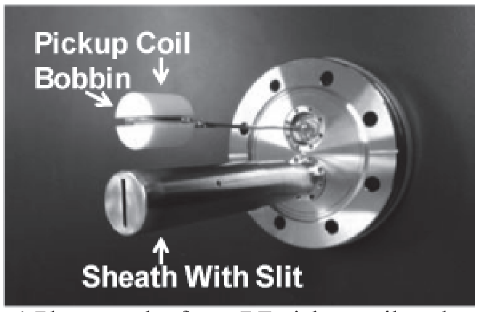

Fig. 1 Photograph of two RF pickup coils, where the stainless sheath of the upper coil was removed to show the inner structure.

RF waves with a frequency difference up to about 1 MHz were injected to non-inductive start-up plasmas, which were sustained by the RF power. The typical RF injected power was 100 kW for one frequency and 20 kW for the other frequency wave. Hereafter, we express them as the first and the second frequency, respectively.

Figure 2 shows typical power spectra of the signals from RF pickup coils, low frequency pickup coil and microwave interferometer. It should be noted that the discharge for (a) and that for (b), (c) are different. In the case of Fig. 2 (a), the injected wave frequencies are 200 MHz and 200 – 0.92 MHz, and corresponding peaks can be seen in the spectrum. Figure 2 (b), (c) shows the spectrum around the difference frequency, which was nonlinearly generated from the two different frequency waves.

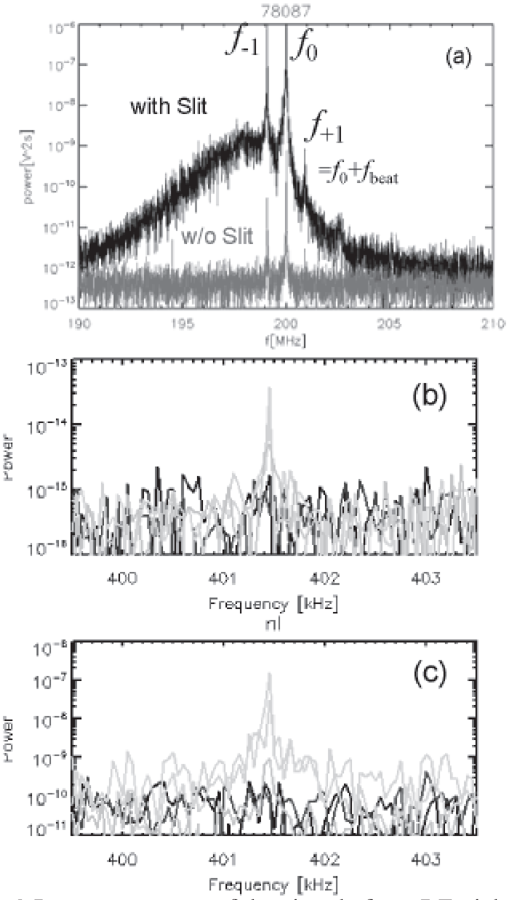

Fig. 2 Power spectrum of the signals from RF pickup coils (a), low frequency pickup coil (b) and microwave interferometer (c). The different colors in Figs. (b), (c) represent difference of the analyzed time window.

According to the interferometer spectrum, the density oscillation level of the nonlinear component was the order of 0.01 %. The response of the nonlinear components was investigated by varying the power and the frequency of the second frequency wave, while those of the first frequency wave were fixed. The power of the nonlinear components of the microwave interferometer signal is proportional to the power of the second frequency wave. When we sweep the second frequency (i.e., the frequency difference), the amplitude of the low frequency components measured by the low frequency pickup coil is not uniform, but it is enhanced at the following three frequency ranges: ~120 kHz, ~300 kHz and ~480 kHz. Theses ranges roughly correspond to the Alfven eigenmode gap frequencies, estimated from the q-profile obtained by an equilibrium analysis.