§18. Development of New Antenna for Fast Wave Current Drive Experiment in JIPP T-IIU Tokamak

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To operate the tokamak device in steady-state, it is necessary to drive the plasma current noninductively. Fast Wave Current Drive (FWCD) is one of the promising methods and suitable for driving the high temperature and density plasmas as predicted by theories. However, few experiments have been done and it is very difficult to detect the driven current directly.

In 1989, we have conducted the FWCD experiment in high harmonic of ion cyclotron frequency range (130 MHz). In those experiments, we observed that the waves interacted only with the high energy electrons in the slide away regime.

In developing the new antenna, we tried to reduce the phase velocity in toroidal direction launched by antenna. In order to achieve this, the wave number parallel to magnetic field \( k_{\|} \) has to be raised. We narrowed the space between the current straps of antenna and placed it in the low field side of the vacuum vessel in expecting \( k_{\|} \) up-shift by toroidal effect. We expect to get 21.5 m\(^{-1}\) of \( k_{\|} \) with toroidal antenna phasing of \((0, \pi/2, \pi, 3\pi/2)\) and this value is four times as large as that of the former fast wave antenna. The wave phase velocity corresponds to the thermal velocity of 4.1 keV electrons. The number of the current strap is 12, so we can get the good shape of the antenna current spectrum.

We developed the new antenna using a mock-up of the JIPP T-IIU vacuum vessel. Figure 1 is a photograph of the antenna which has been installed in the JIPP T-IIU tokamak. The twelve current straps can be seen. They will be covered with one Faraday shield of single layer and protected from the plasma particles by the carbon plates arranged around them.

Figure 2 shows the measured power spectrum of this antenna. In this figure, the current of the straps is phased in \((0, \pi/2, \pi, 3\pi/2)\). The main peak of the amplitude of the spectrum is located about 22 m\(^{-1}\) of \( k_{\|} \) and others are small enough compared to this one.

Fig. 1. Photograph of the new FWCD antenna installed in the JIPP T-IIU tokamak.

Fig. 2. Measured current spectrum of the new FWCD antenna.

References