

§20. Folded Waveguide Antenna for the LHD

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A folded waveguide(FWG) antenna can launch RF power in ion cyclotron range of frequencies (ICRF) in an accessible size of fusion experimental devices. We have collaborated with Oak Ridge National Laboratory to design the FWG antenna for the LHD plasma since 1992. The FWG antenna is designed to launch an ion Bernstein wave(IBW) and produce the plasma in even low magnetic field strength, such as 1.5T. We fabricated a real size FWG antenna to be installed from parallelogram vacuum port of the Large Helical Device. The FWG antenna size is 3m in length, 1.2m in width and 0.64m in height, h with 20 folds as shown in Fig.1. Nineteen vanes are connected to back plate. Polarization plates are attached to the front of the FWG antenna. These combination can be changed the RF electromagnetic field pattern as described later. RF power is fed to central vane through movable power feeder as shown in Fig.1.

First we examined resonant conditions of the FGW antenna. The resonant condition for the rectangular waveguide is given in following equation;

$$L = \left(\left(\frac{2f}{c} \right)^2 - \left(\frac{m}{a} \right)^2 \right)^{-1/2} \quad (1)$$

Here c is a light velocity, f is resonant frequency, a is a width of rectangular waveguide and m is a mode number, respectively. When we unfold the FWG antenna, its virtual width becomes $a=nh$, where n is a folded number, $n=20$. Figure 2 shows relations between L and f for various mode numbers, $m=1,2,3$, respectively. Resonant frequency is larger in higher mode. Experimental data are plotted as shown in Fig.2. These data agree with calculated values. Here there is no experimental datum in $m=2$, because RF power is fed to central vane as shown in Fig.1.

RF electromagnetic field perpendicular to a static magnetic field is adequate to launch IB wave. We measured this RF electromagnetic field pattern in front of the antenna. Polarizing plates are attached in every other vanes as shown in Fig.1. In this configuration, RF electromagnetic field patterns are examined in $m=1$ and $m=3$ with frequencies of 50MHz and 60.6MHz, respectively. The field pattern has one peak in 50MHz and three peaks in 60.06MHz. We changed an arrangement of

polarization plates to increase wave number in $m=1$ mode. The measured RF electromagnetic field pattern is shown in Fig.3. The wave number increased to $10.5m^{-1}$ from $2.6m^{-1}$. The wave number can be controlled by the arrangement of polarization plate.

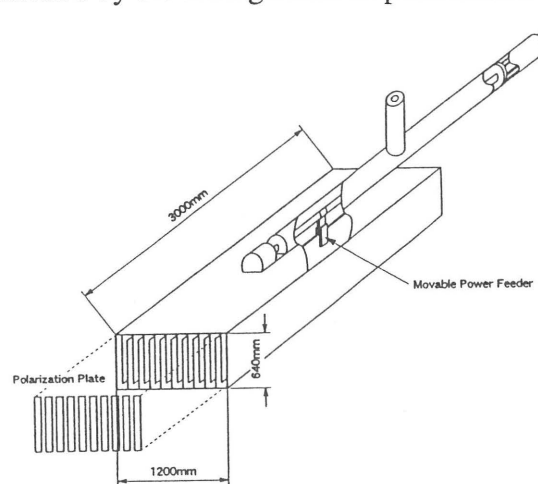


Fig.1 Schematic drawing of folded waveguide antenna with 20 folds.

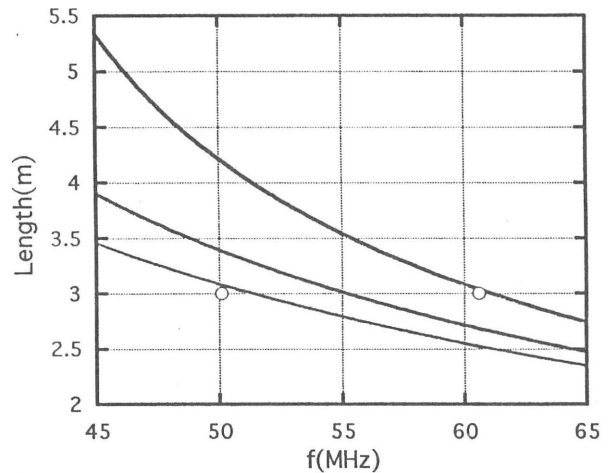


Fig.2 Relations between length and resonant frequency for $m=1,2,3$ with experimental data.

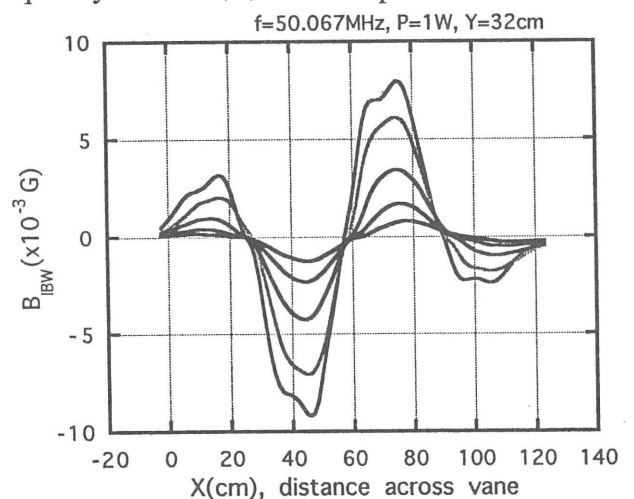


Fig.3 RF electromagnetic field pattern across vanes with higher wave number.