Controlled Wave Number Spectrum

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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 a US-Japan collaboration 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) so that its vanes should be set perpendicular to the magnetic field lines. On the other hands, the conventional FWG antenna is set with the vanes parallel to the magnetic field lines to excite an electromagnetic RF field parallel to the magnetic field lines.

The prototype FWG antenna studied here has a sharply defined wave number spectrum in the direction of magnetic field lines. Various combinations of polarization plates or shorting bars(as shown in Fig.1) allow spatial control of the RF power. A test FWG antenna has been fabricated to acquire its basic characteristics. The dimensions are 40cm wide, 20cm high and 400cm long. It has 6 folds with five vanes as shown in Fig.1. The resonance conditions was examined[1].

We explored two different approaches for producing the desired radiating spectrum: 1) Shorting bars were installed instead of polarizing plates (large k antenna) and 2) Polarizing plates are attached in two adjacent folds (small k antenna). Figure 2 shows the RF field pattern across the vanes, as measured by an RF magnetic probe for the case with shorting bars. It has a peak between vanes and a sharp k spectrum. We tried various depths of shorting bars and found the maximum RF field is produced with 2cm-deep shorting bars. A similar RF field pattern is obtained without the shorting bars, however, the fast wave component perpendicular to the vanes is radiated with the same strength. The fast wave component is eliminated with shorting bars. Figure 3 shows the RF field pattern with polarization plates. The polarization plates are attached to two adjacent folds near the central vane. The phase of the radiated RF field from adjacent open folds is opposite to each other. In this arrangement, the RF power is radiated from open folds separated by 20cm as shown in Fig. 3. The k value is half of that shown in Fig.2. The peak value of the radiated field is slightly larger than that in large k FWG antenna. The fast wave component is not observed.

IBW heating on the Large Helical Device has been explored. The k spectrum can be controlled with various polarization plates or shorting bars.

Reference

1)Kumazawa, R., et al., Annual Report 1993-1994, 74.

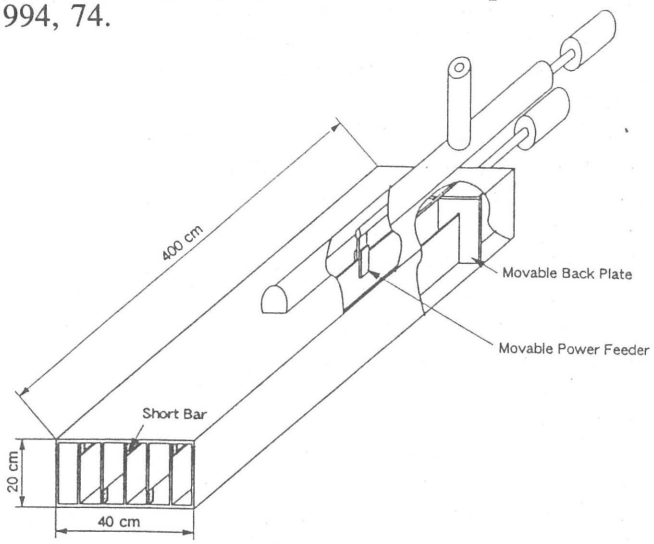

Fig.1 Schematic drawing of folded waveguide antenna.

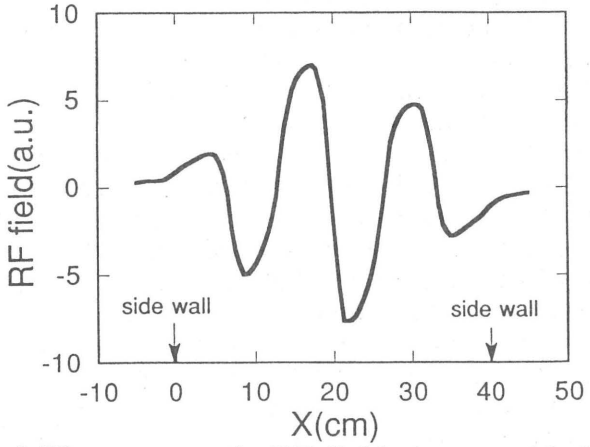

Fig.2 Electromagnetic RF field pattern with 2cm short bars.

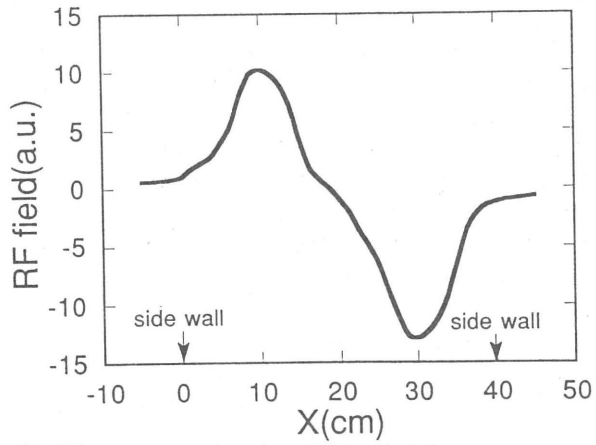

Fig.3 Electromagnetic RF field pattern with polarization plates.