§7. Analysis for Transmitted EC-wave Power Measurement in CHS

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Investigation on power absorption of plasma heating millimeter wave based on measurement of transmitted wave power has been done. In plasmas, especially in heliotron/torsatron plasmas which have a strong magnetic shear given externally, the wave polarization direction is expected to be affected during its propagation into the plasmas.

Here, results of numerical calculation, which takes the effect of polarization direction change for mm-wave power absorption are presented. The equation used for evaluation of the polarization direction evolution in a plasma with sheared magnetic field was derived by I. Fidone and G. Granata [1]. In the calculation, wave power is supposed to be injected from the outer side of a horizontally elongated plasma cross section and it propagates across the magnetic axis. A last closed magnetic surface extends from - 23 cm to 27 cm, taking the origin at the magnetic axis. The wave electric field at the beginning of injection is linearly polarized and in vertical direction (parallel to the major axis). The frequency of the wave is 53.2 GHz and its corresponding 2nd harmonic resonant magnetic field is 0.95 Tesla. The position of the magnetic axis in a vertically elongated plasma cross section is 92.1 cm. The value 92.1 cm is standard for CHS experiment.

The parameter Bt, by which magnetic field strength at each point in the plasma is given, was changed from 0.803 T to 0.943 T. With Bt = 0.803 T, there is no 2nd harmonic resonance on the 1st path of the injected wave. With Bt = 0.846 T, the wave crosses one 0.95 T layer about 6 cm inside from the magnetic axis. A radial distribution of the magnetic field strength has its peak there. With Bt = 0.885 T, the wave crosses two 0.95 T layers. One is near the magnetic axis and another at about 14 cm inside from the magnetic axis. The wave also crosses two 0.95 T layers when Bt is 0.943 T. These are at about 7 cm outside and at about 19 cm inside from the magnetic axis.

Figure 1 shows the transmitted electric field power components in the vertical direction measured with Bt values noted above. An EC-wave power is injected into NBI-sustained plasma from 55 to 65 ms. The left wave form in Fig. 1A shows a transmitted power without plasma, that is, a reference injected power. The right wave form in Fig. 1A corresponds to Bt = 0.946 T, 1B: 0.885 T, 1C: 0.846 T and 1D: 0.803 T.

In Fig. 2, square of electric field amplitude (normalized to unity) in vertical direction is calculated. Even when Bt = 0.803 T, w/o resonance on the 1st wave path, the power looks to be reduced (absorbed). On the other hand, total transmitted power (sum of squares of electric fields in vertical and horizontal directions) is calculated to be unity with Bt = 0.803 T. This means that for an investigation on power absorption, precise measurement of electric field components in two orthogonal directions is needed.

[1] I. Fidone and G. Granata, Nucl. Fusion **11** (1971) 133

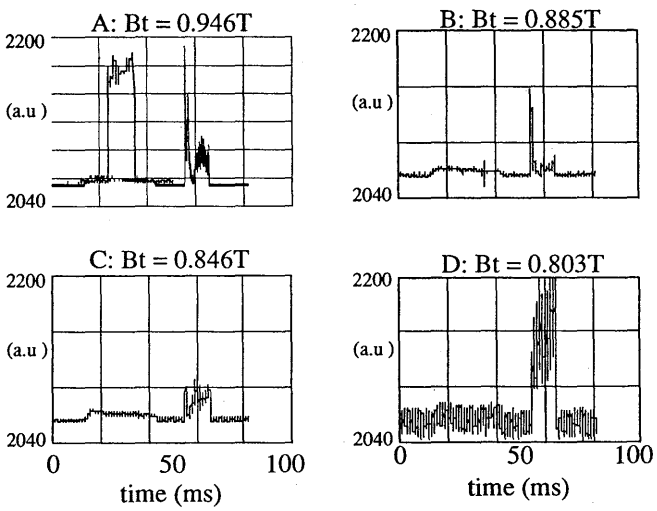

Fig. 1 Measured transmitted power in the vertical direction.

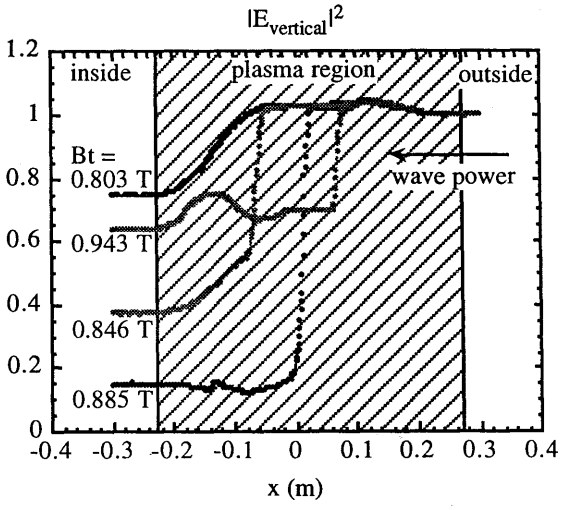

Fig. 2 Calculated square of electric field amplitude in the vertical direction.