

§4. Development of Digital Based Millimeter Wave Interferometer and Application to Electron Density Imaging at the Potential Barrier Region on GAMMA10

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Profile measurement is important in plasma-confinement research. To control and sustain a high-performance plasma, plasma-profile diagnostics with high temporal and spatial resolution are necessary. There are several methods to measure the electron-density profile. For example, an interferometer, a reflectometer, and Thomson scattering are frequently used in many magnetic-fusion experimental device. However, these diagnostics do not always offer suitable measurement results for plasma control. We propose a new interferometer system that is more compact and easier to install. In addition, the measurement chords can be scanned spatially via electronics even during a plasma shot. Its spatial resolution can be better than that of a conventional interferometer.

In this year, we have concentrated on developing a transmission antenna for the new interferometer. The transmission antenna is a core device to realize spatial scan function. Fig. 1 shows a structure of the transmission antenna called image non-radiative-dielectric (NRD) guide antenna.

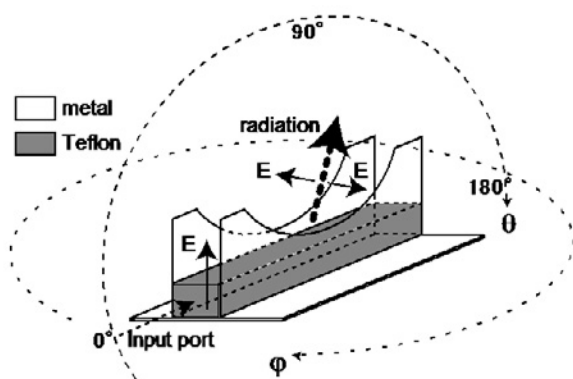


Fig. 1 Structure of the image NRD guide antenna

A dielectric rod made of Teflon is sandwiched by two metal plates made of aluminum. Millimeter waves are injected from the edge of the rod, and propagate along the dielectric rod. Direction of an electric field of the propagation wave is parallel to the two metal plates. An additional metal plate placed at the bottom of the antenna acts as an image surface for the electric field. This image

structure suppresses unwanted propagation modes in the rod. The edges of the two metal plates are cut out by the elliptical shape as shown in Fig. 1. By decreasing the distance between the edges of the plates and the surface of the rod, an electric field bounded in the rod leaks from the aperture. This leakage becomes a source of the radiation. The height and the width of the cross section of the rod are 1.4 and 1.6 mm, respectively. The relative dielectric constant of the Teflon rod is 2.2. The cutoff frequency of the NRD guide is set to 70 GHz. When the frequency of the input wave is close to the cutoff frequency, wave length of the travelling wave is long; therefore, radiation direction is almost normal to the aperture. The radiation angle from the normal to the aperture is increasing in increasing in the input frequency.

Fig. 2 shows the radiation patterns in the theta plane. Fig. 2(a) and (b) are simulation results and measurement results, respectively. The radiation patterns with the various input frequencies are plotted.

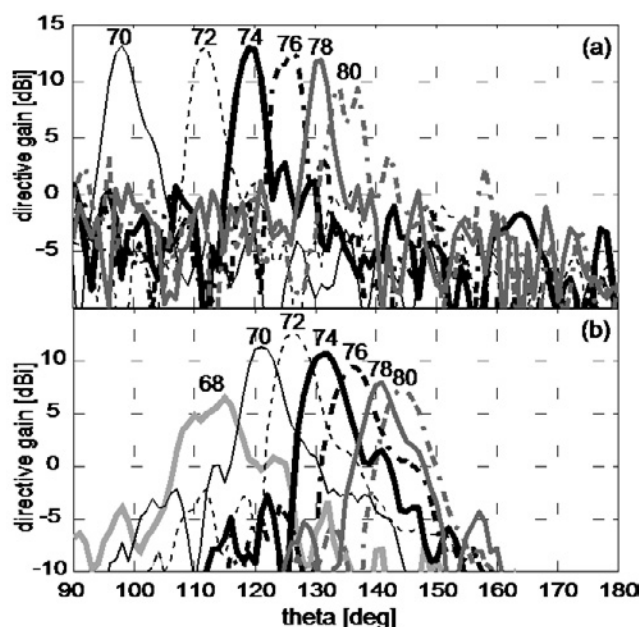


Fig. 2 Simulated radiation patterns(a) and measured radiation patterns(b). The numbers noted at the peak denote input frequencies.

Fig. 2 shows that the radiation angle is increasing in increasing in the input frequencies. The measured results agree with the simulated results. However, the radiation angle in the measured result is upshifted 20 degree from the simulation results. This difference is attributed to the manufacturing error of the dielectric rod. By the analytical estimation, it is found that the height of the fabricated rod is 1.72 mm, whereas that of the simulated rod is 1.6 mm.

It can be said that the antenna is successfully fabricated, thus, we plan to construct a whole interferometer system in the near future.