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

Kogi, Y. (Fukuoka Inst. of Tech.),
Yoshikawa, M. (Univ. Tsukuba),
Mase, A. (Kyushu Univ.),
Nagayama, Y., Kawahata, K.

Measurement of electron density distribution is important to control and investigate the plasma confinement. There are various promising ways to measure electron density distribution. Interferometer, reflectometer, Thomson scattering are frequently used in various plasma experimental devices. These measurement systems measure electron density of fixed position, and cannot scan the measurable area without changing the system configuration. We have proposed the digital-scannable millimeter wave interferometer system as shown in Fig. 1.

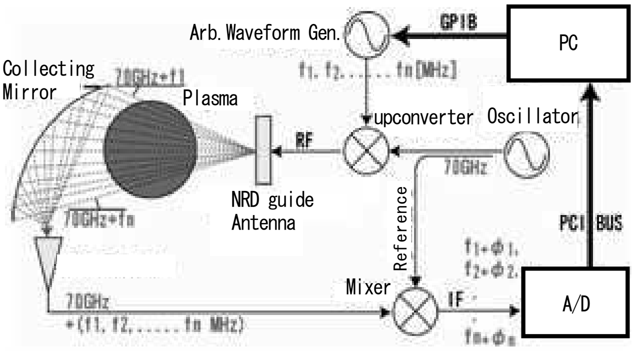

FIG. 1 Experimental apparatus of the digital-based millimeter-wave interferometer

The key device of this measurement is a transmitting antenna, located in the side port. Directivity of the transmitting waves can be scannable by changing the input frequency. Transmitter feeds a RF with around 100 individual frequencies simultaneously, which frequency step is equally spaced by the comb generator. So, the beam shape of the injected wave is like a fan beam. The transmitted wave is collected and received by one receiver, and mixed with the reference signal. Intermediate frequency (IF) signal is sampled by the high speed A/D converter. The digitized data contains all the interference signals which correspond to the measurement path. The measurement path can be distinguished by digital band-pass filters. Finally, line integrated density distribution is calculated from the sets of the filtered data.

In the fiscal year of 2010, we have designed and made the transmitting antenna called a NRD guide antenna. Fig. 2 shows experimental setup of antenna directivity measurement. The NRD guide antenna can be rotated by two sets of rotator, which axes are aligned to the normal of the antenna aperture. Gunn oscillator is a mechanically tuned oscillator which tunable range is from 68 to 72GHz. Power of the received wave is detected and monitored by a video detector and a digital multimeter.

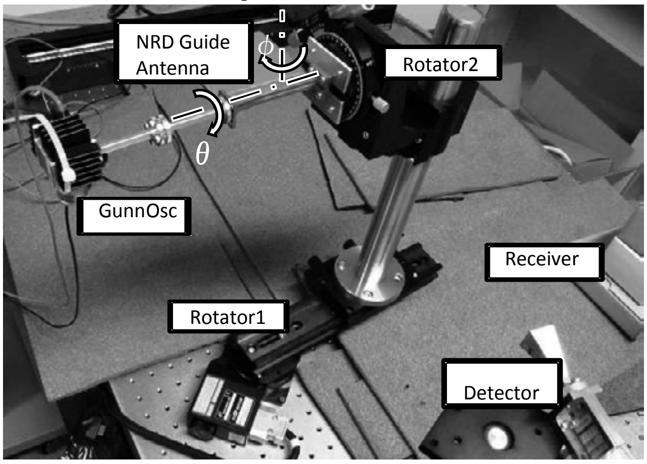

Fig. 2 Experimental setup of antenna directivity measurement

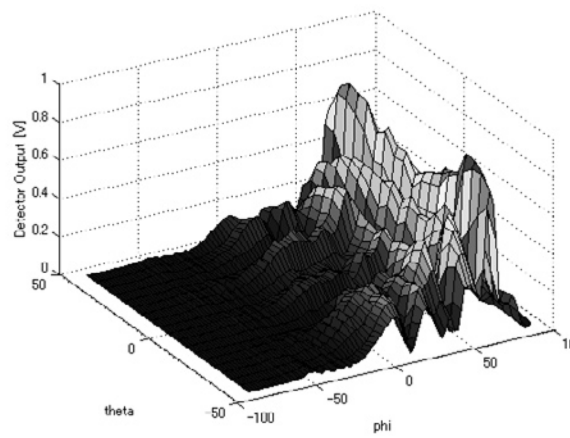

Fig. 3 Directivity of the NRD guide antenna. Frequency is 71.8GHz.

Fig. 3 shows a result sample of the directivity measurement. Frequency is fixed at 71.8 GHz during the measurement. Strong transmission like fun shape appears around phi equals to 80 degree. Transmission distribution along to theta axis is like saddle shape. This transmission shape is acceptable and is what we expected when designing. However, this beam shape does not move, when the input frequency to the antenna is changed. We think this unwanted situation is occurred from that the aperture is fixed at small area. And this small aperture is thought that normal of the aperture is along to the wave number vector in the NRD. In order to form the scannable beam pattern, the normal to the aperture must be perpendicular to the wave number vector in the NRD. We are now adjusting the antenna in order that the transmitting wave is leaking gradually along to the NRD guide.