§11. Study of High-performance Array Antennas for Millimeter-wave Imaging Array

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It is considered to be one of the major issues to clarify the behavior of various instabilities and relations between instabilities and plasma confinement. ECE imaging (ECEI) is a promising method to measure electron-temperature profile and its fluctuations precisely. An ECEI system is composed of a detector array, quasi-optical system, and IF system. Each subsystem plays following roles. The optical system is composed of optical mirrors and dielectric lens. These optics are utilized to focus ECE from plasma on the detector array within the specific bandwidth. In the present plan of the beginning experiment, we will collect the 2nd harmonic of ECE with frequency range from 70 to 80 GHz. The ECE is then received by the detector array, and is frequency-converted to IF signal by means of LO. In the IF system, signal is then fed to power dividers and bandpass filters to resolve radial temperature distribution, since the frequency of ECE is proportional to magnetic field strength. While poloidal and toroidal temperature distribution is obtained by 2D array of the detector. We have studied and improved design of the detector to be suitable for ECEI measurement. In this report, we will describe prototype design of newly developed detector for ECEI.

In the last year, we have developed the detector called DBMA[1] which works in X-band range, and confirmed that properties such as conversion loss, antenna directivity and antenna pettern show good performances. We have proceeded to develop this detector which works in E-band range in this year. Figure 1 shows a sample of the detector fabricated on a Teflon substrate by Electro Fine Forming (EF2) technology.

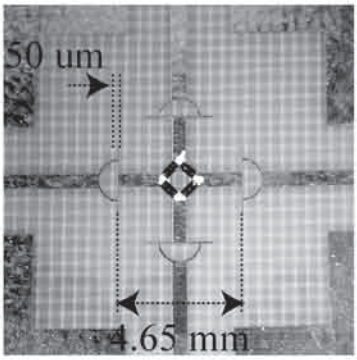

Fig. 1 Picture of E-band DBMA

This detector consists of two dipole antennas, four diodes, and four low-pass filters connected to end of the antenna legs. One dipole antenna is arranged perpendicular to another dipole antenna. One is used for detecting RF (LO), and another is used for detecting LO (RF).

We have performed this detector sensitivity measurement by injecting LO and RF power from the back and forth of the substrate, and we have confirmed IF output by a spectrum analyzer as shown in Fig. 2.

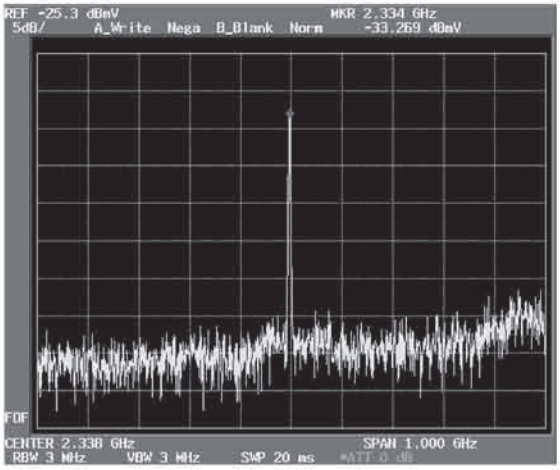

Fig. 2 Confirmation of IF output and detector sensitivity

In addition to development of the ECE detectctor, we have proceeded to develop the microwave components utilized in the IF system. Components indicated inside the broken line box in figure 3 show a block diagram of the IF system. Each component such as broadband amplifiers, power dividers, and band-pass filters have been realized on a dielectric substrate by microwave integrated circuit (MIC) technology.

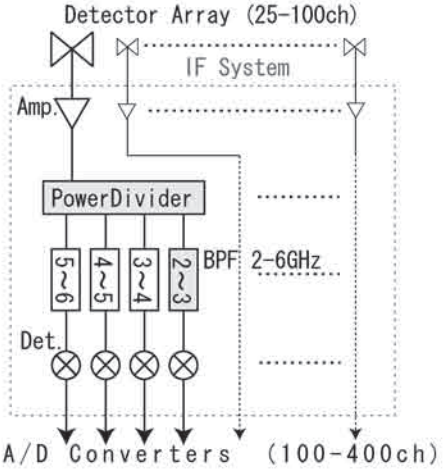

Fig. 3 Block diagram of the IF system

When we apply ECEI measurement, number of microwave component in the IF system attains over several hundreds. If we employed the microwave components on the market, huge cost and installation space become a important problem. By using MIC technology, we have succeeded to develop the microwave components of low-cost and small space installation.

[1] S. Maas, "The RF and Microwave Circuit Design Cookbook", Artech House, 1998.