

## §16. 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.

There are several points to be considered when we develop an imaging detector. The most important point is that Gaussian-like transmission pattern of the antenna, which is equivalent to reception pattern, is required in E and H plane. By forming the smooth pattern in front of the antenna so that the reception sensitivity attains a maximum along the axis to the normal to the substrate, the antenna works as an imaging unit. Second, highly sensitivity is also required in order to measure fluctuations with small amplitude. It is considered that amplitude of temperature fluctuation is less than few percent of absolute value of the temperature. Third, structure of the antenna must be small to form a multi channel detector array inside a limited area. Fig. 1 shows a newly developed detector that is mostly satisfied with these conditions.

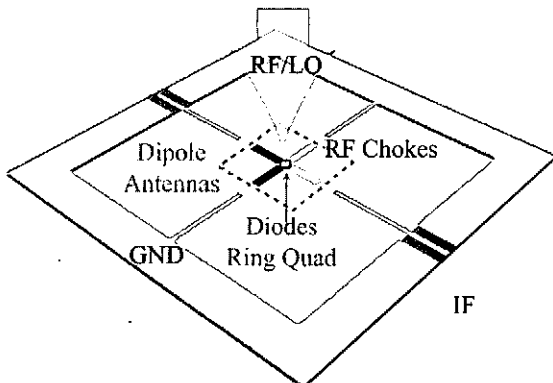


Fig. 1 Schematic view of DBM antenna

This detector consists of two dipole antennas, four diodes, and four RF choke coils. 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). Each antenna leg is connected by the diodes, and opposite side leg is connected to the RF chokes. The four diodes convert RF and LO signal to IF signal. IF signal is then passing through the RF chokes. Two IF signal lines are just connected with each other since phase of the IF signal of each line is same. While, RF and LO signals can not propagate through the RF chokes. Conversion loss becomes minimum by confining power of RF and LO inside the antenna area. From the electrically point of view, this detector is equivalent to doubly balanced mixer. Fig. 2 shows conversion loss as a function of LO power. When the LO power over 15 dBm is applied to the detector, the conversion loss saturates around -12 dB.

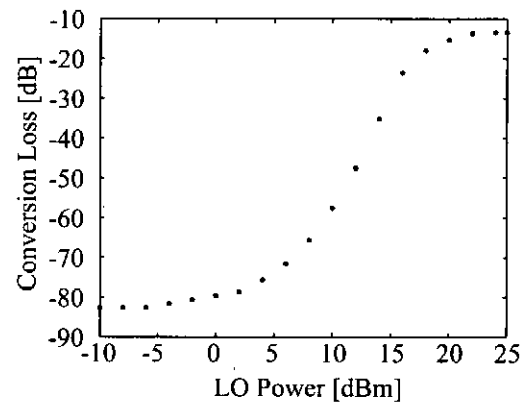


Fig. 2 Conversion loss plotted as a function of LO power

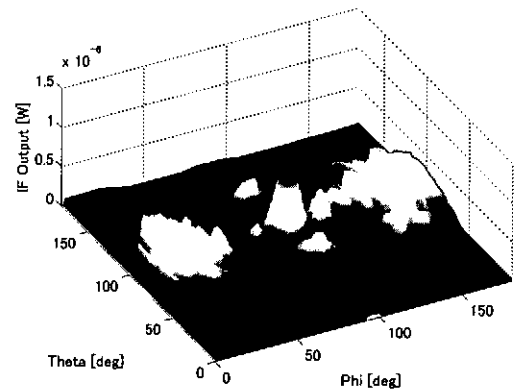


Fig. 3 Field pattern of DBM antenna

Fig. 3 shows field pattern of the detector. It is confirmed that developed detector realizes Gaussian-like field pattern, however, small side lobe can be seen in E and H plane.

In summary, we have developed new type of detector for ECEI. As a result of fabricating the detector, and performing investigation of the detector properties, it is confirmed that detector sensitivity and field pattern show a good performance.