§11. Development of 2D Microwave Imaging Detector Array

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Microwave imaging has wide variety of applications, such as the visualization of plasma turbulence and remote sensing. The 2D microwave imaging detector is a key device. In order to obtain high sensitivity, the detector element has an in-line structure of antenna, balum, mixer and amplifier on the same printed circuit board, as shown in Fig. 1. There are several choices of antenna element. Since the tapper slot antenna [1] is too big, we selected the Yagi-Uda antenna [2]. In order to connect the Yagi-Uda antenna to the amplifier circuit, a balum is required, because the Yagi-Uda antenna is a balanced circuit while the amplifier circuit is unbalanced. The former balum, which is used by Deal et al. [2], has a tilted radiation pattern, as shown in Fig. 2(a). In the present work, we have developed a taper type balum, as shown in Fig. 1. This balum gradually changes from the unbalanced circuit to the balanced circuit. The radiation pattern of the Yagi-Uda antenna with the taper balum is symmetric as shown in Fig. 2 (b).

By using this technology, we made a 2D (4x4) imaging detector array for 20 GHz, as shown in Fig. 3. The detector element consist of a 3 elements Yagi-Uda antenna, a beam lead type GaAs Schottky barrier diode, two RF amplifiers and a SAW filter, as shown in Fig. 1. This 2D detector is used in the microwave imaging reflectometry (MIR) experiment in TPE-RX. While TPE-RX experiment environment has many electromagnetic noise sources, MIR experiment is not disturbed by the electromagnetic noise. So, the experiment is successful and the electron density fluctuation due to turbulences is measured by using MIR.

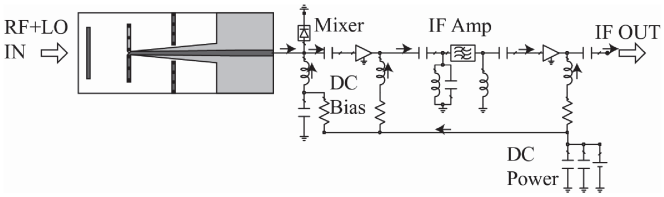

Fig. 1 Inline structure of the antenna, the taper balum, and the mixer and amplifier circuit.

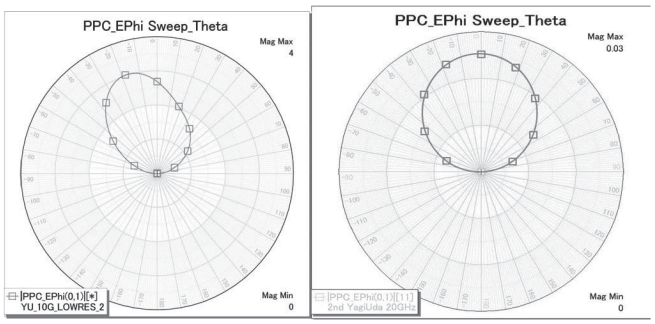

Fig.2 Comparison of radiation pattern of Yagi-Uda antenna with (a) the delay line balum, and (b) the taper balum.

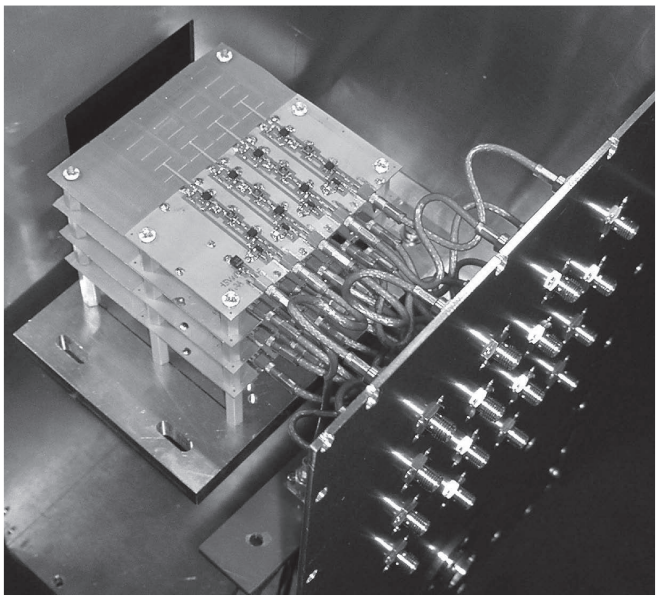

Fig.3 Photograph of the 2D imaging detector array for 20 GHz.

[1] K. Sigfrid Yngvesson, et al., IEEE Trans. Microwave Theory Tech. 37, 365 (1989).

[2] W. R. Deal, et al., IEEE Trans. Microwave Theory Tech. 48, 910 (2000).