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Evaluation of a 300 GHz Near Field Antenna Measurement System

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Abstract:
Terahertz (THz) and millimeter-wave technology has been identified as one of the most promising techniques for high data rate mobile communications beyond 5G, next generation autonomous radars and security imaging. 0.3 THz is one of the preferred candidate frequency bands due to its relatively low atmospheric absorption rate, sub-millimetre resolution and tens of GHz bandwidth. At these frequencies, antenna characterisation particularly in the far-field, is very challenging due to low output power and dynamic range of commercial test equipment.

In this paper, we present the evaluation of a near-field antenna measurement system operating at sub-millimetre wave frequencies e.g. 220 GHz- 325 GHz. The system, as shown in Fig.1 consists of a Keysight VNA, a small aperture open-ended near field waveguide probe (Fig. 1 inset), and a motorised two-axis high precision translation stage. An in-house LabVIEW programme has been developed to control the VNA and stage and acquire and analyse the data. To demonstrate the system, we measured a standard 20 dB gain horn antenna from Flann Microwave as an antenna under test (AUT). The probe is connected to the VNA's Port 1 and the AUT is connected to the VNA's Port 2. The probe antenna and AUT are separated by 5 mm, which is within the near field regime of the AUT, and they are aligned to their broadsides which are vertical E-fields. Table I summarises the measurement setup. The near-field to far-field transformation was made using [1] and the measurement results of the AUT are shown in Fig. 2. Fig.2 (a) and (b) show the measured magnitude of S21 and its phase at 260 GHz, respectively. Fig. 2 (c) shows the transformed far-field E- and H-plane cuts which are in good agreement with the expected. Some ripples are visible in E/H cut plots and may be due to the stage's stability which can be improved by averaging multiple measurements or increasing dwell time between measurement points and by accounting for IF cable bending during the measurement. Further discussion and analysis on results and the system will be given in the full paper.

To summarise, we have demonstrated evaluation of a 220 GHz-325 GHz near field antenna measurement system at University of Glasgow. The measurement results are in good agreement with theoretical design. We will further improve the system by improving measurement speed, reducing system noise and evaluating measurement uncertainty.

Table I Summary of the measurement setup.

Probe-AUT distance	Scan area	Scan resolution	Scan speed	IF bandwidth
5 mm	16 mmx16 mm	0.4 mm	6 mm/s	200 Hz

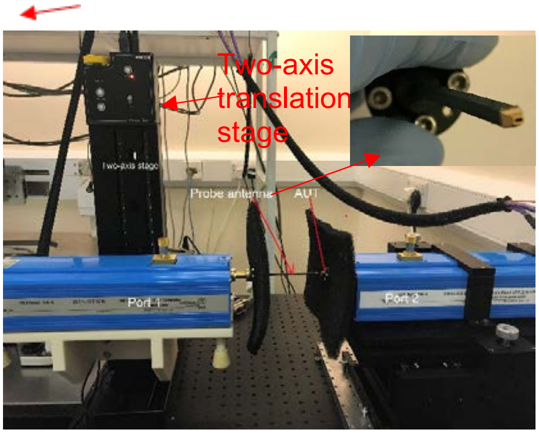

Fig. 1 Measurement setups and the AUT
Fig. 1 The 300 GHz near field antenna measurement setup.

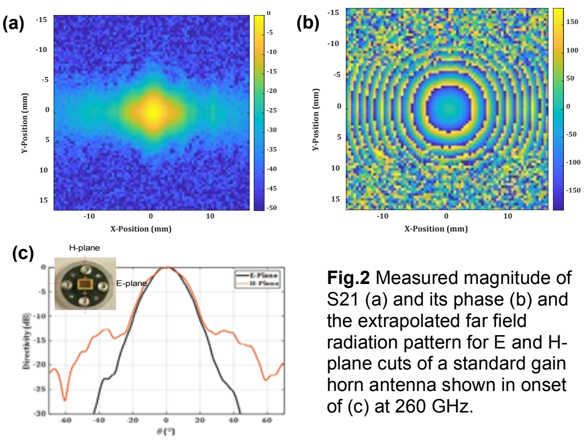

Fig.2 Measured magnitude of S21 (a) and its phase (b) and the extrapolated far field radiation pattern for E and H-plane cuts of a standard gain horn antenna shown in onset of (c) at 260 GHz.

References:

1. E. Joy, W. Leach and G. Rodrigue, "Applications of probe-compensated near-field measurements," in IEEE Transactions on Antennas and Propagation, vol. 26, no. 3, pp. 379-389, May 1978.