F&MM
Fragrant Mountain Microwave

Application Note

High Precision Measurement

FM81 Serial Product's Technical Highlight

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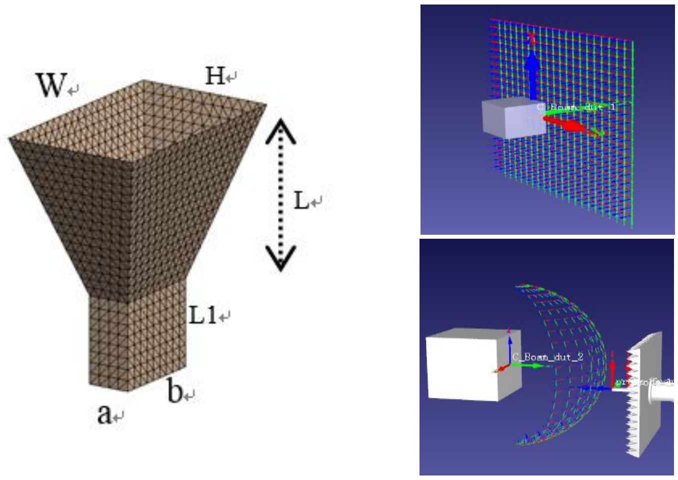
Doc.fm81note011

Part 1 - Accuracy Assurance from Algorithms Perspectives

The ever-growing market in tele-communications and commercial satellite industry drive the needs for modern innovative measurement technologies. Planar and spherical nearfield scanning techniques, not modern to certain extent, however are playing significant role in the emerging terrestrial and spacial 5G industries, for its intrinsically economic indoor testing environment and capability of parametric characterization for either isotropic or pencil beam industrial antennas. Modern robotic measurement systems developed by Fragrant Mountain Microwave (F&MM) [1] largely rely on computational electromagnetic means in extracting accurate sub-system models such as popular and irregular probes, estimating robotic positioning impacts, algorithms accuracies and exploring optimal configuration parameters. This application note reveals our common practice of assessing planar and spherical nearfield transform algorithms for two standard in-house antenna models. Experiments described in this paper provides a quantitative justification for rudimentary measurement parameters and quality check process whenever newer versions of algorithms get released.



Degree of freedoms touched in current study:

- **Planar nearfield and spherical nearfield**
- **Smaller and larger gain antennas**
- **Co-pol and Cx-pol antenna performance**
- **Partial testing space, no zero-padding**
- **Data comparison with true results**
- **Figure of merits on pointing direction, HPBW, SLL, measurement efficiency, calculation efficiency**

Fig. 1. Standard In-house DUTs (I) W=2.1, H=1.3, L=1.5, a=0.9, b=0.4, L1=0.8

One standard in-house DUT, with dimension in inch, are given in Fig. 1. It has approximate gain of 12.5dBi @ 10GHz. For planar simulation, all data is collected at 4inch distance away from the aperture; while for spherical simulation, its radius stays 20inch with origin defined at center of the radiation aperture. As of planar case illustrated in Fig.1, it generates total 41x41 measurement points. Fig.2 demonstrates the simulated planar and spherical nearfield scanning data. It is noted that the data is quite suffice in depicting the energy tapering in both co-pol and cx-pol scenarios. Also note the spherical scan only covers partial hemisphere that depicts the primary radiated power, and seems much coarser than the planar scale. Predicted radiation patterns of this horn, both E-plane and H-plane, are generated and compared with its true result, in Fig. 3- Fig. 4. For above simulated data, it is, by all means, not necessarily represent true measurement scenarios aiming at fully recovering the antenna radiation pattern at all angular range. However, relatively superior data in planar scanning, versus relatively inferior data in spherical scanning, help us understand pros and cons of various parameters. For this horn, 12.5dBi gain, both planar and spherical scanning are able to recover its pattern accurately up to +/- 50 degrees.

More design freedoms' impact for measurement accuracy is discussed in reference [4].

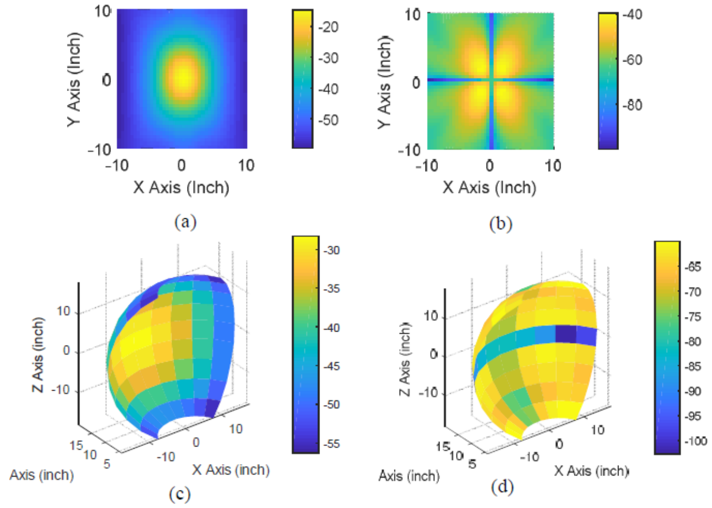


Fig.2 Simulated Nearfield Scanning Results for Modeled Horn (a) Planar Co-pol, (b) Planar Cx-pol, (c) Spherical Co-pol, (d) Spherical Cx-pol

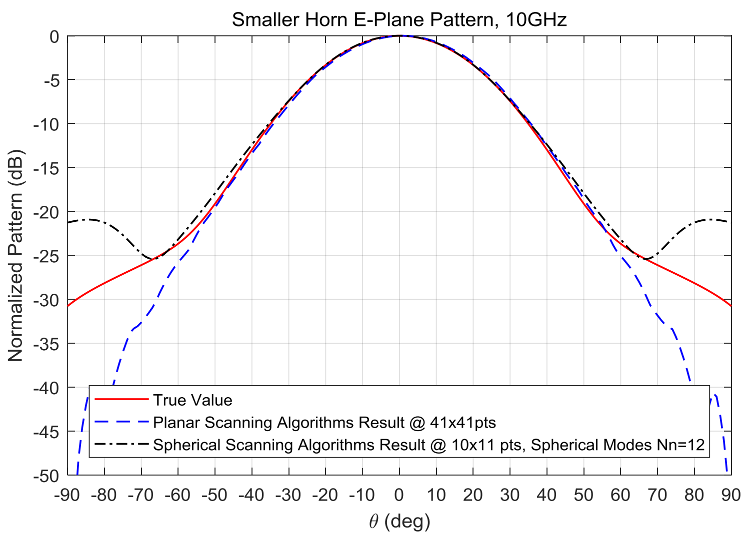


Fig. 3. Predicted E-plane Results Compared with True Value

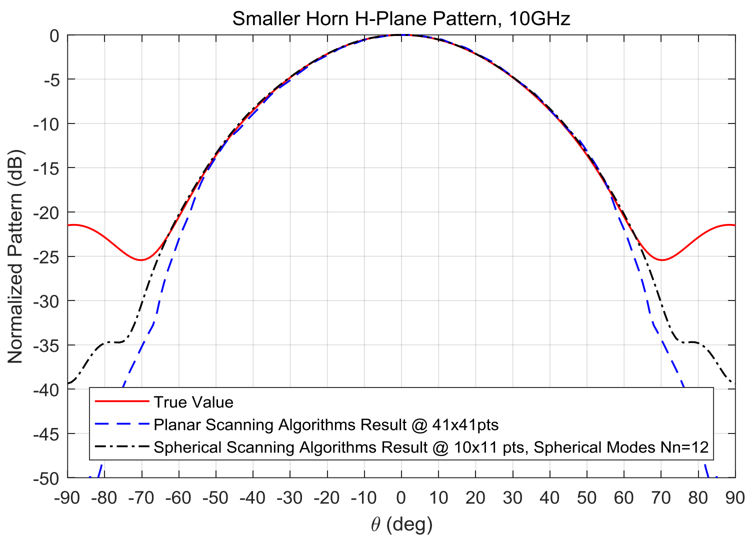


Fig. 4. Predicted H-plane Results Compared with True Value

Part 2 - Accuracy Assurance in Real Measurement

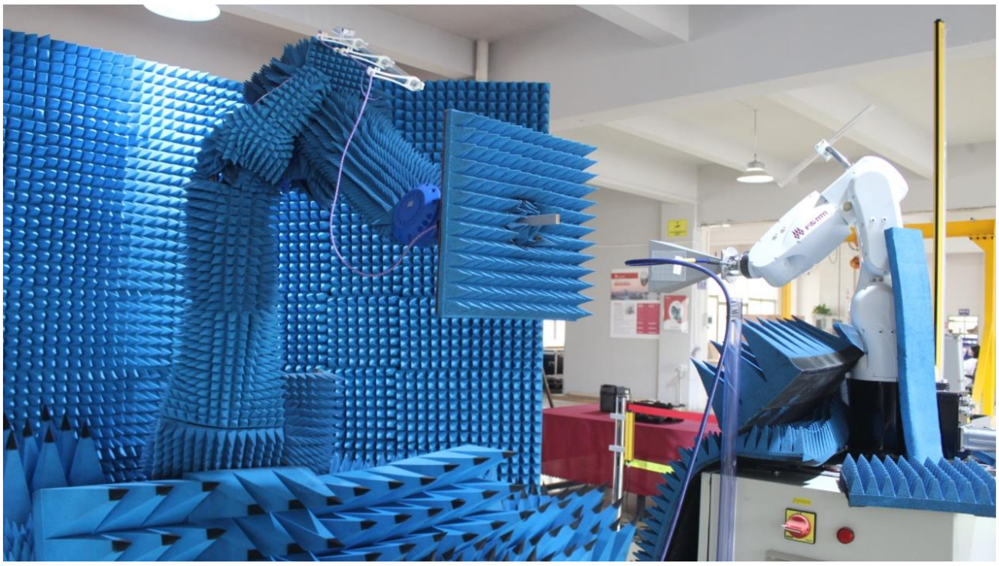


Fig. 5. Measurement for Standard Gain Horn Antenna in Open Workshop Environment

Multiple experiments were carried out in relatively open environment for Ka standard gain horn antenna. The results were compared to the farfield one measured in the same coordinate setup. Very good matching were demonstrated, as shown in Fig. 6.

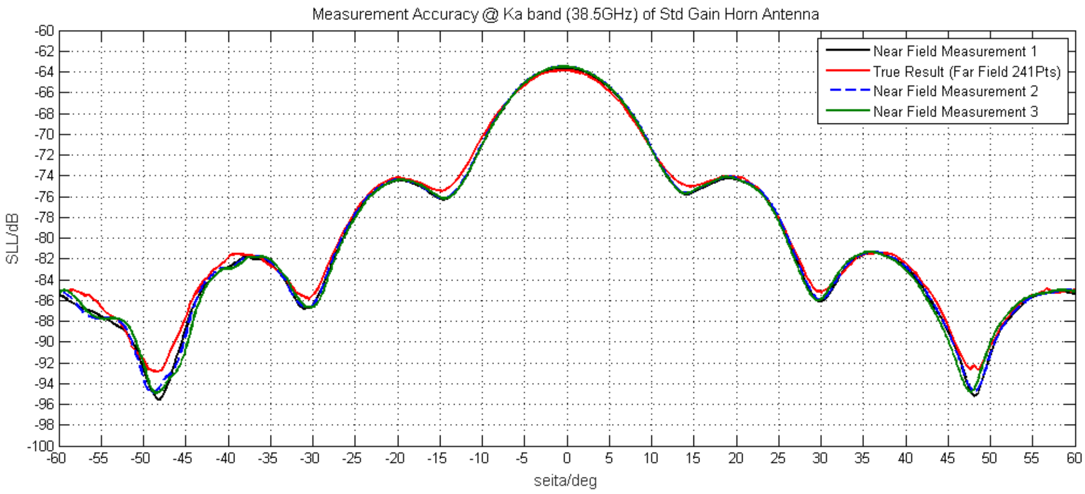


Fig. 6. Nearfield Measurement Results Compared with Farfield Result

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[4] J. Dong, "Computational Electromagnetic Modeling for Accurate Assessment of Nearfield Scanning Systems", 2019 IEEE International Conference on Computational Electromagnetics (ICCEM), 2019