Influences of High Voltage Wires on Far-Field Antenna Measurement

Jing Shen , Xue Quan Yan , Li Zhi You

Abstract: Surrounding environment is one of the main factors which significantly affect the far-field antenna measurement system. To analyze the influences of high voltage wires on far-field antenna measurement, a method is provided that the amplitude and phase of transmission data are compared whether there are high voltage wires beside the antenna measurement field or not. The analysis method and the simulation results obtained by FEKO are given in this paper.

Key words: high voltage wires，electromagnetic coupling，transmission parameters，FEKO

I. INTRODUCTION

With the rapid development and the application of phased array radar, monopulse antennas, large interferometers and adaptive technology, antenna measurements have become widely used[1]. Far-field measurement technique is one of the main measures to obtain the antenna radiation patterns. Compared with compact range[2] and near-field measurement methods[3], it possesses the advantage of directly perceived, easy operation, fast scan velocity and high accuracy. But there are many difficulties in construction of far-field antenna measurement field and it is difficult to control the test environment around[4], especially the far-field sites for low-frequency and large-size antennas. Although the environment effects of the antenna under test, the test errors should be in an acceptable range. So the applications of far-field measurement techniques have been limited greatly.

One test site is intended to be constructed which has met the requirement of the far-field distance between transmitting antenna and receiving antenna. The minimum distance met the formula[5] $R_{\min} = 2D^2/\lambda$, where D is the maximum diameter of the testing antenna and λ represents the operating wavelength. But there are programmed high voltage wires by National grid on one side of the test site. To assess and inspect the feasibility of the test site, the influences of high voltage wires on far-field antenna measurement are studied and analyzed. Because the transmitting antennas can choose reflector antenna with high beam steering during the antenna far-field measurement at the frequencies above S-band and they are all placed in semi-open chamber, the surrounding environment or other factors play a little role on antenna measurement and the effects can restrained by radar absorbing material (RAM). So the influences of high voltage wires on antenna measurement are only discussed at P-band in this paper.

II. RESEARCH METHODS

The precise and efficient computation of electrically large metal model by software FEKO effectively made the study of the influences of high voltage wires on far-field antenna measurement possible. The transceiver antenna system which approach real environment of ground reflection field test was constructed. Then the amplitude and phase of transmission data are simulated by fixing the transmitting antenna, as well as rotating and moving the receiving antenna within the quiet zone. The differences of simulation results at the frequencies P-band (350MHz~450MHz) will be used to determine whether the high voltage wires affect the antenna measurement or not.

Figure.1 has given the sketch map of antenna far-field measurement site. The transmitting antenna and receiving antenna are Yagi antennas, which are widely used structure for achieving high gain. The transmitting antenna is about 3 meters high from the ground plane and the altitude of the receiving antenna is 37 meters. The transmitting antenna is directly opposite to the receiving antenna and the angle between the direction and the ground is 6.69° .The horizontal distance between two antennas is 290 meters. The diameter of the high voltage wire is 30 millimeters. The high voltage wire A is about 20 meters from the antenna system and the other high voltage wire B is about 90 meters from the antenna system, see Figure.1.The theoretical curve of the high voltage wire is a typical catenary and it satisfies the function $y+\lambda = C\cosh(x-C_1/C)$.The curve of the high-voltage wire is determined by the location of the two endpoints (x_1, y_1), (x_2, y_2) and its length.

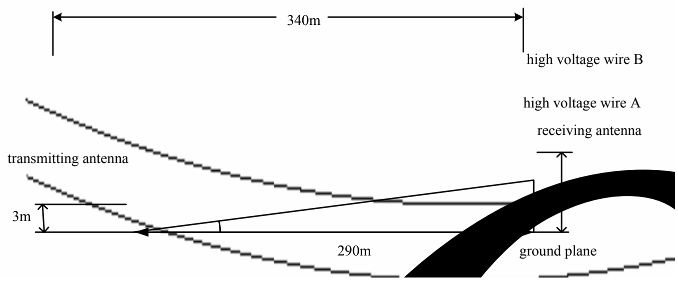


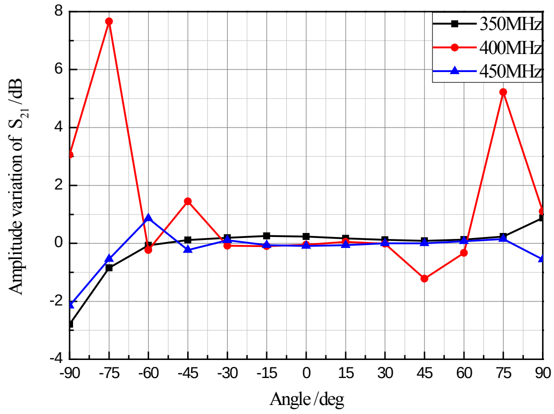
Figure.1 The sketch map of antenna far-field measurement site

III. RESEARCH ANALYSIS

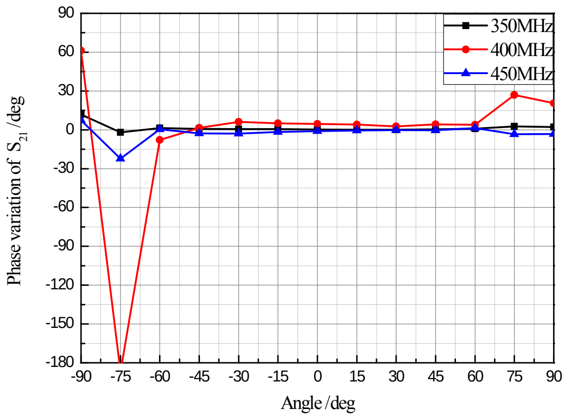
To investigate the role of the high voltage wires on antenna far-field measurement, the amplitude and phase of transmission data were computed by FEKO. We proceeded in four steps. The differences of simulation results have been used to determine whether the high voltage wires affect the antenna measurement or not.

Figure.2 shows the amplitude and phase variations of S_{21}(values with high voltage wires minus values without high voltage wires) with fixing the transmitting antenna and rotating the receiving antenna from -90° to $+90^{\circ}$ in azimuth plane. As seen from Figure.2, the changes of amplitude and phase are subtle when the receiving antenna rotated from -60° to $+60^{\circ}$,where the changes in amplitude are less than $1.5dB$ and the changes in phase are less than 10°.However, when the receiving antenna rotates at -75° or even larger angles, the changes in amplitude and phase are relatively notable. The amplitude varies about $8dB$ and the phase changes nearly 180°.

From Figure.3 to Figure.5, we can see the amplitude and phase variations of S_{21} with fixing the transmitting antenna and moving the receiving antenna in horizontal, vertical direction and longitudinal direction. Figure.3 (a) shows that the amplitude changes of S_{21} are less than $0.6dB$ when the receiving antenna moves within ± 4 meters from the receiving center in the horizontal direction. But the phase change with the working frequency of 350MHz nearly reaches 80° when the receiving antenna moves at 3 meters. Then we consider the case when the receiving antenna moves within ± 4 meters from the receiving center in the vertical direction. Figure.4 illustrates that the amplitude variations of S_{21} are less than $1dB$ and the phase variations are less than 5°. Figure.5 presents the amplitude and phase variations of when the receiving antenna moves within meters from the receiving center in the longitudinal direction. From Figure.5 (a), it is clear that amplitude variations are less than $0.3dB$. The phase changes less than 5° , shown as in Figure.5 (b).

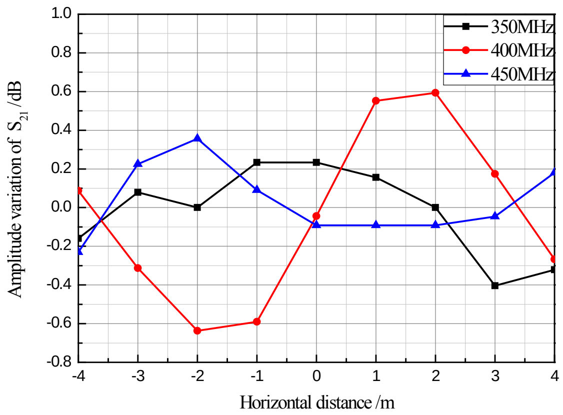


(a) Amplitude

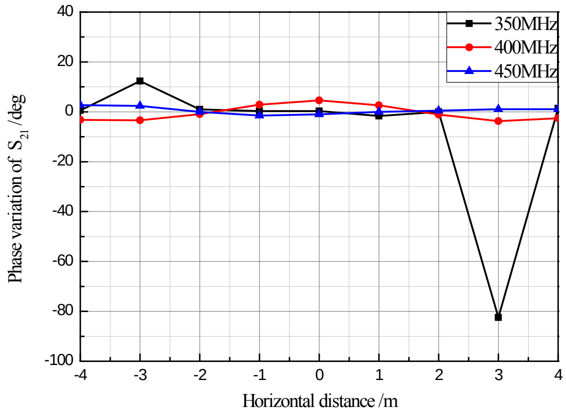


(b) Phase

Figure.2 Amplitude and phase variations of S_{21} when the receiving antenna rotates in azimuth plane.

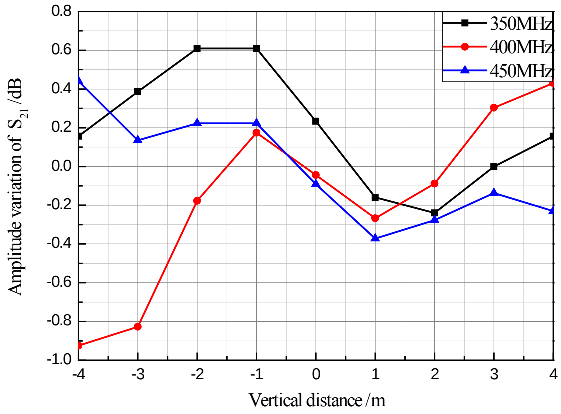


(a) Amplitude

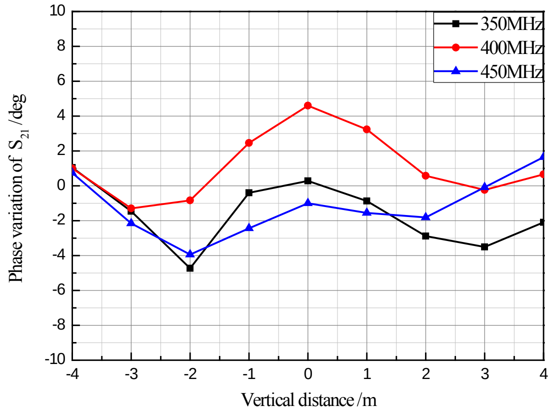


(b) Phase

Figure.3 Amplitude and phase variations of S_{21} when the receiving antenna moved in the horizontal direction.

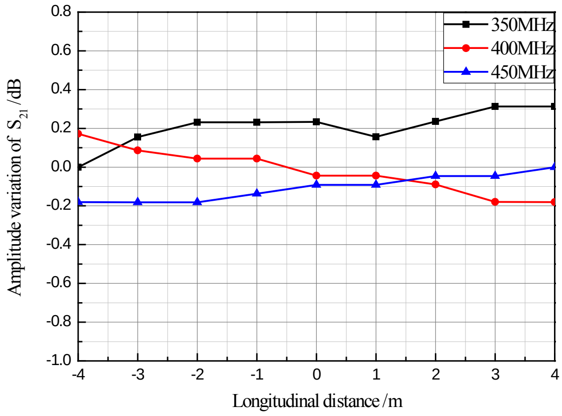


(a) Amplitude

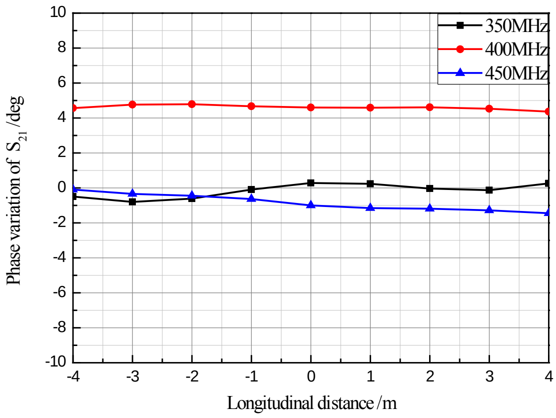


(b) Phase

Figure.4 Amplitude and phase variations of S_{21} when the receiving antenna moved in the vertical direction.



(a) Amplitude



(b) Phase

Figure.5 Amplitude and phase variations of S_{21} when the receiving antenna moves in the longitudinal direction.

From simulation results above, it was found that the influences of high voltage wire on antenna far-field measurement are subtle when the antenna under test rotates from -60° to $+60^{\circ}$, moves within ± 2 meters in the horizontal direction, ± 4 meters in the vertical and longitudinal direction from the receiving center. In addition, the high voltage wires affect antenna measurement, which depends significantly on the type of the transmitting antenna. The influences could be weakened if we adopt antennas with high gain and high beam steering as transmitting antennas.

IV.CONCLUSIONS

In this paper, we primarily discussed the influences of high voltage wire on one test site to be built. The precise and efficient computation of electrically large metal model by software FEKO effectively made the study of the influences of high voltage wires on far-field antenna measurement possible. The analysis results revealed that the applications of far-field measurement technique are limited by the existence of high voltage wires. So it’s appropriate to select the site for the antenna far-field measurement away from the high voltage wires.

REFERENCES

[1] Edmond S. Gillespie, “Antenna Measurements 1900-1980”, IEEE AP Society Sysmposium, Digest, 1630, 2000.

[2] Olver A D,“The Practical Performance of Compact Antenna Ranges” Antenna testing technigues, 1977.

[3] Johnson J. H. Wang, “An Examination of the Theory and Practices of Planar

Near-Field Measurement", IEEE Transaction on Antennas and Propagation, Vol.36, No.6, 1988.

[4] Z J Zhang, L Jin、X R Shu, "Radar Antenna Technology" , Publishing House of Electronics Industry, 2005.

[5] Hanse R C, "Measurement Distance Effects on Low Sidelobe Patterns", IEEE Transaction on Antennas and Propagation, Vol.32, No.6, 1984.

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