Impedance Measurements of the Big Blade and Fork Antennas on Ground Screens at the LWDA Site

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Abstract

In this report, we present impedance measurements performed on the big blade and fork antennas during a visit to the LWDA site in May, 2007. Measurement data will be shown for wet and dry ground conditions, and with the antennas over three ground screen sizes.

I. Introduction

During a visit to the LWDA site the week of May 14, 2007, impedance measurements were performed on the big blade and fork antennas. The intent of this work was to shed light on the question of whether or not ground screens should be included in an LWA station design. Impedance measurements were performed on Earth ground as well as three different ground screen sizes in order to determine the effect of ground screen presence as well as size on antenna impedance.

II. Ground Screen Mesh Material

For the purpose of these measurements, we chose a standard metal mesh material that could be purchased locally. The material used was 14 gauge welded wire with a 2"x4" cell size and was manufactured by *Midwest Air Technologies* (item number 308313A) [1]. The cell size was chosen to exhibit greater than 98% reflectivity in the 20 – 80 MHz LWA frequency band [2]. The material was purchased at Home Depot for $43 per 5'x100' roll.

III. Measurements

Antenna impedance measurements were performed on Earth ground as well as on three sizes of ground screens. The smallest ground screen used was a 10'x10' and was approximately equal to the footprint of the big blade antenna frame. The medium and large ground screens were 24'x19' and 42'x19' respectively with the longer sides aligned with the E-plane of the antenna being measured.

A diagram of the measurement setup is shown in Figure 1. A portable *VIA Bravo* impedance analyzer was connected to the antenna feed point through a 40' long coaxial cable and passive balun (shown in Figure 2. The data were recorded on a laptop computer. Pictures of the big blade and fork antennas on ground screens are shown in Figures 3 and 4.

Measured impedance plots for the big blade antenna are shown in Figure 5. Data were taken without a ground screen before and after a rain storm so that results in different ground conditions could be compared. It is interesting to note that there is a significant difference in measurement result between the dry and wet ground cases. Of further interest is the finding that the antenna impedances are nearly identical for all ground screen sizes. Measured impedances for the fork antenna are shown in Figure 6. Fewer measurements were done on the fork antenna because of time limitations, but they too show that antenna impedances are different between the Earth ground and ground screen cases, but do not depend on the ground screen size.

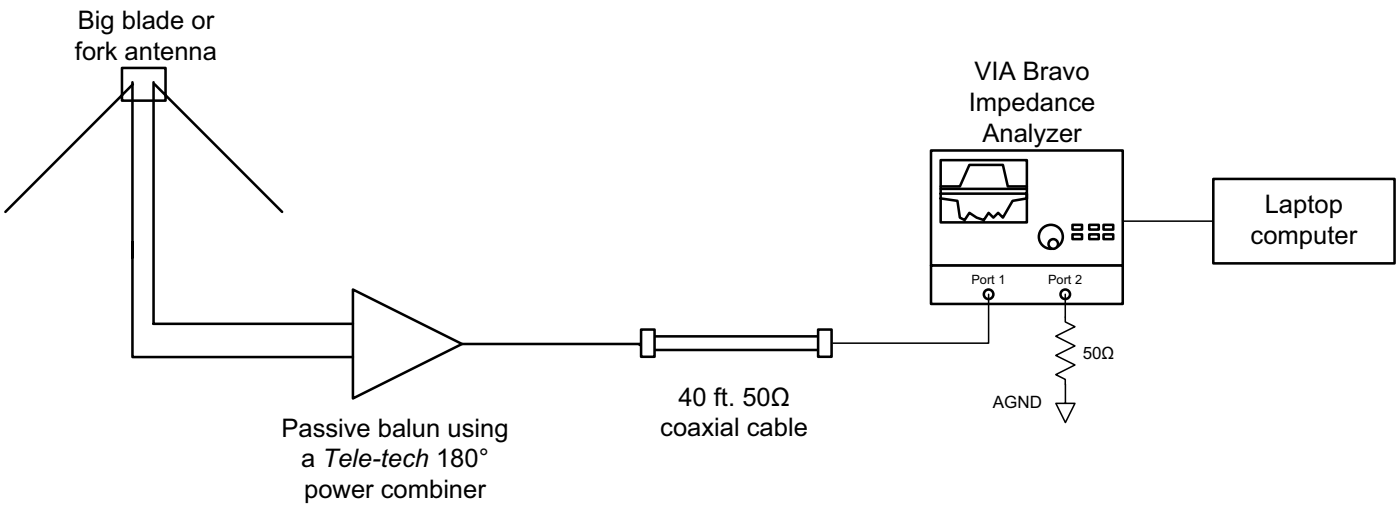

Fig. 1. Antenna impedance measurement system.

IV. Conclusion

We have reported on impedance measurements taken on the big blade and fork antennas at the LWDA site. These measurements were performed over Earth ground as well as ground screens. The data show that antenna impedances are stable and repeatable when the antenna is placed over a ground screen, and are independent of the size of the ground screen.

Our measurements also show that in the absence of a ground screen, varying ground conditions have a significant impact on antenna impedances. Variations in ground properties in one station due to changing weather conditions are likely to cause instabilities in the location of the "phase center" of the antenna, which would in turn affect antenna impedance and gain. This will necessitate frequent station calibration. Furthermore, differences in ground conditions from station to station will require each station to be calibrated independently. The use of a ground screen would stabilize antenna characteristics, and allow for all stations to be calibrated using the same procedure and less frequently.

These findings lead to the conclusion that the use of ground screens in an LWA station would be beneficial. Based on the data presented in this report, the choice of a small (10'x10') ground screen would be adequate, and would be logistically easier and more cost effective than laying a ground screen down over the entire station. However, the effect of different size ground screens on antenna collecting area, mutual coupling, and sky noise-to-antenna noise ratio should also be investigated before a final decision on the ground screen question is reached.

Acknowledgment

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References

[1] "Midwest Air Technologies, Inc.," *http://www.midwest-air.com/*.

[2] K. Stewart, "Electromagnetic Performance of a Wire Grid Ground Screen," *LWA Memo Series (Memo 83)*, February 2007.

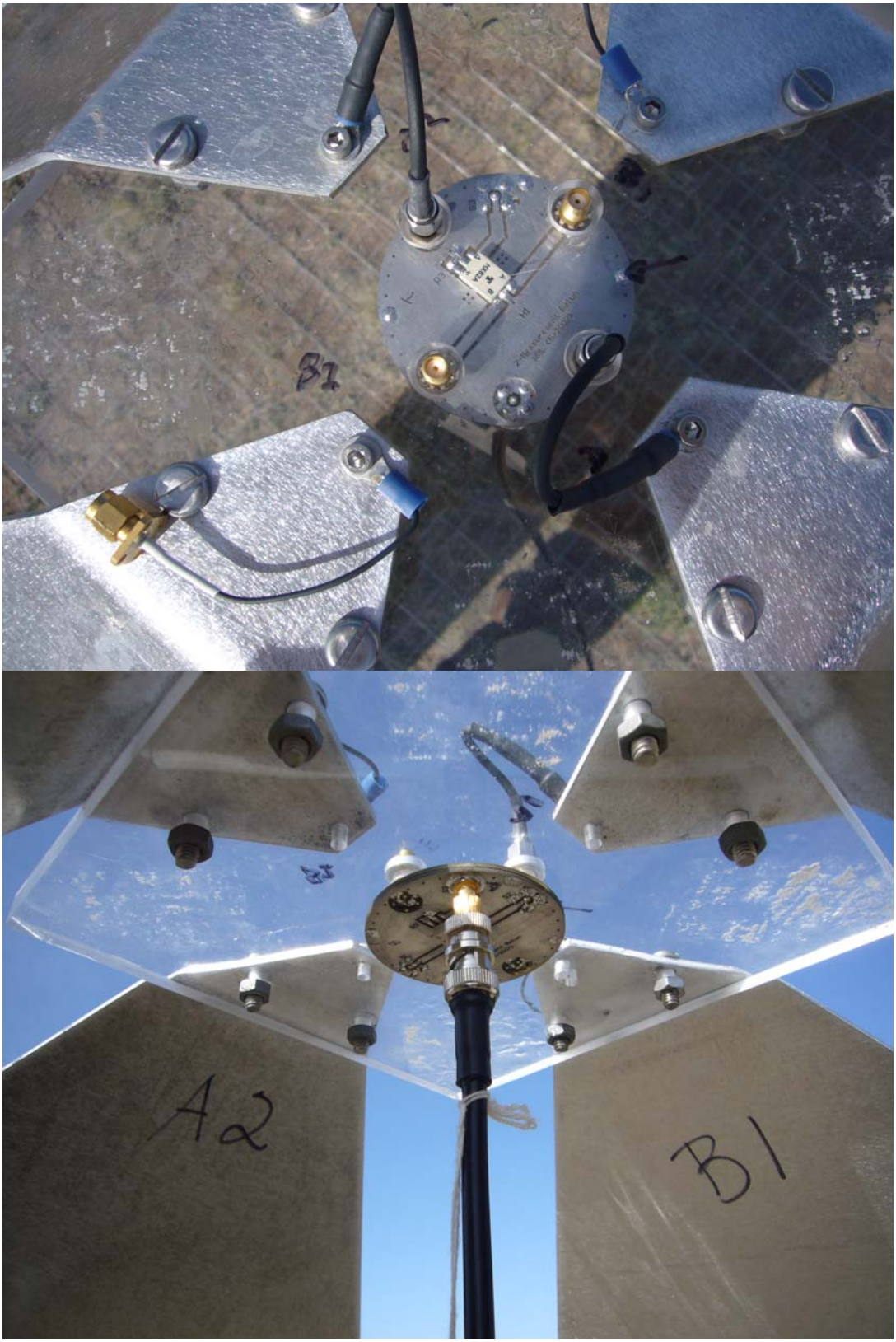

Fig. 2. Top view of the passive balun connected to the big blades (top), and bottom view of the passive balun connected to the coaxial cable (bottom).

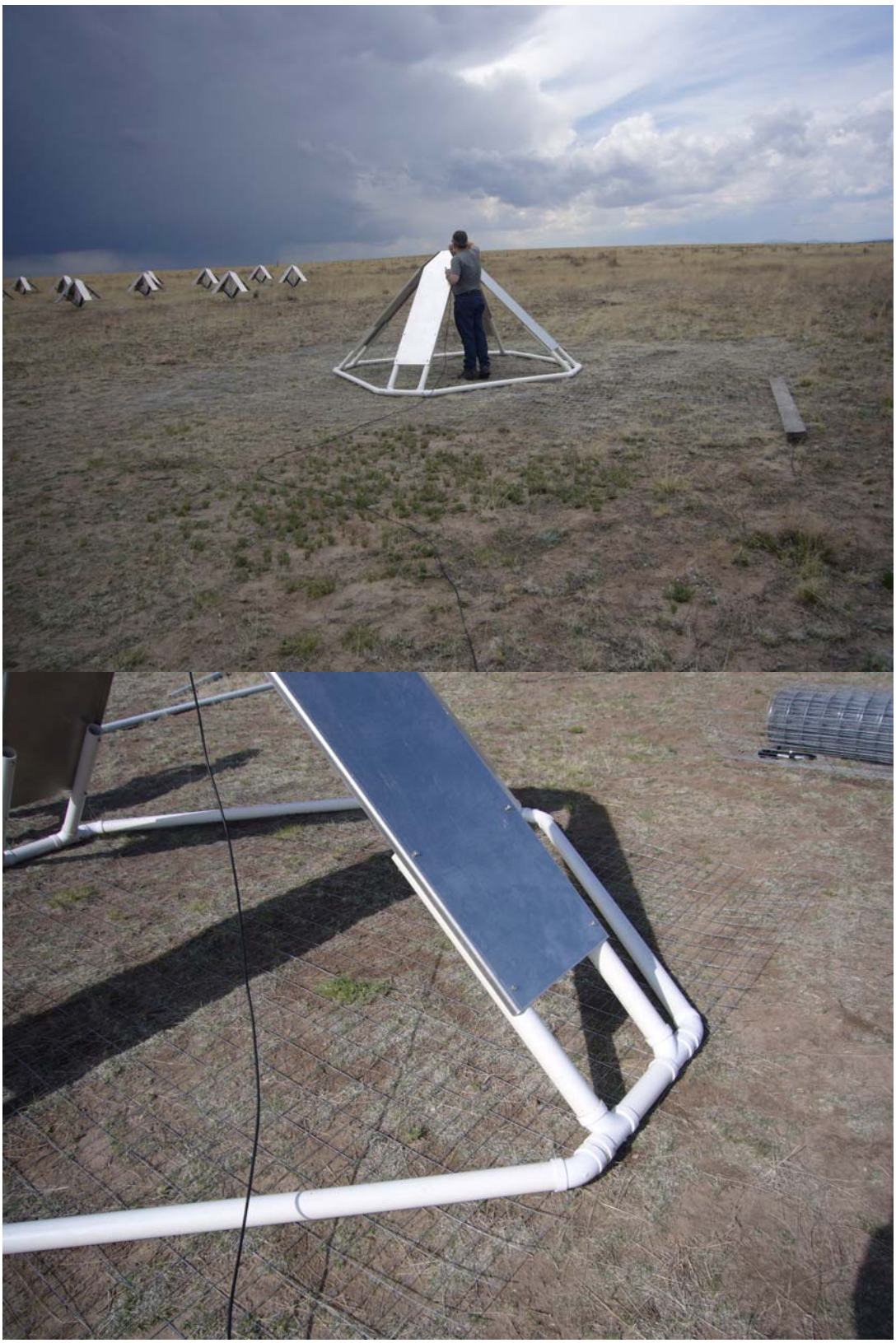

Fig. 3. The big blade antenna on the 24'x19' ground screen (top), and a closeup of the big blade antenna on the 10'x10' ground screen (bottom).

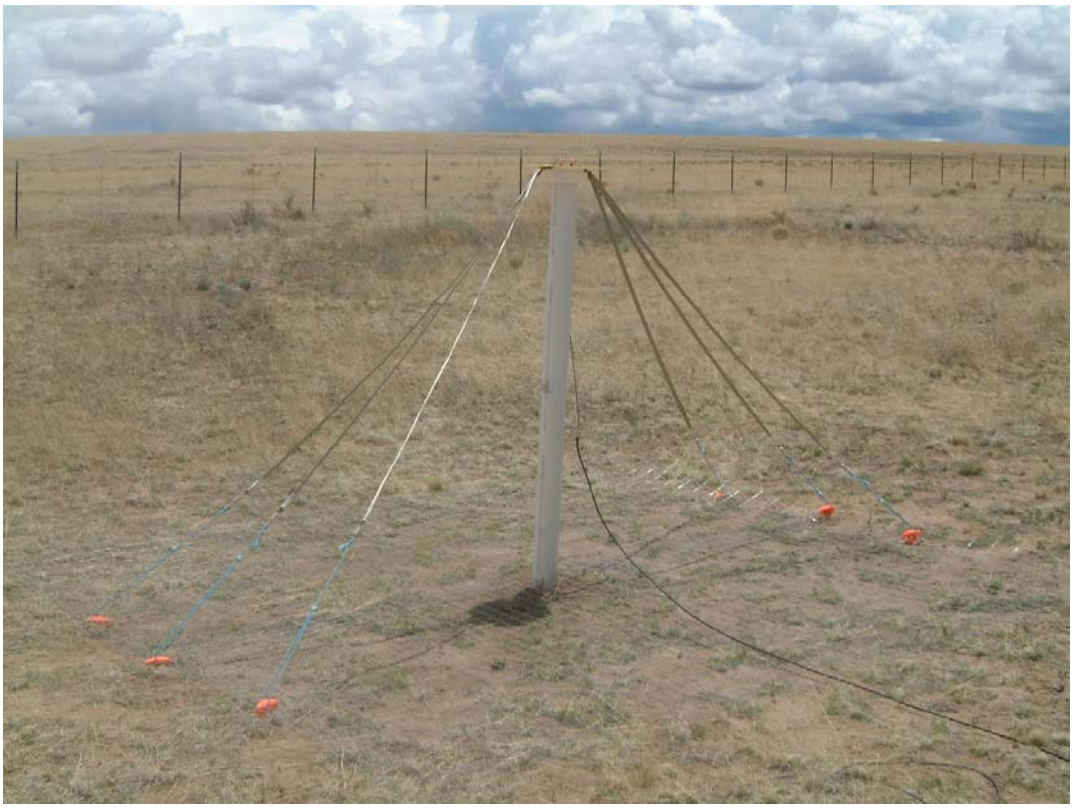

Fig. 4. The fork antenna on the 10'x10' ground screen.

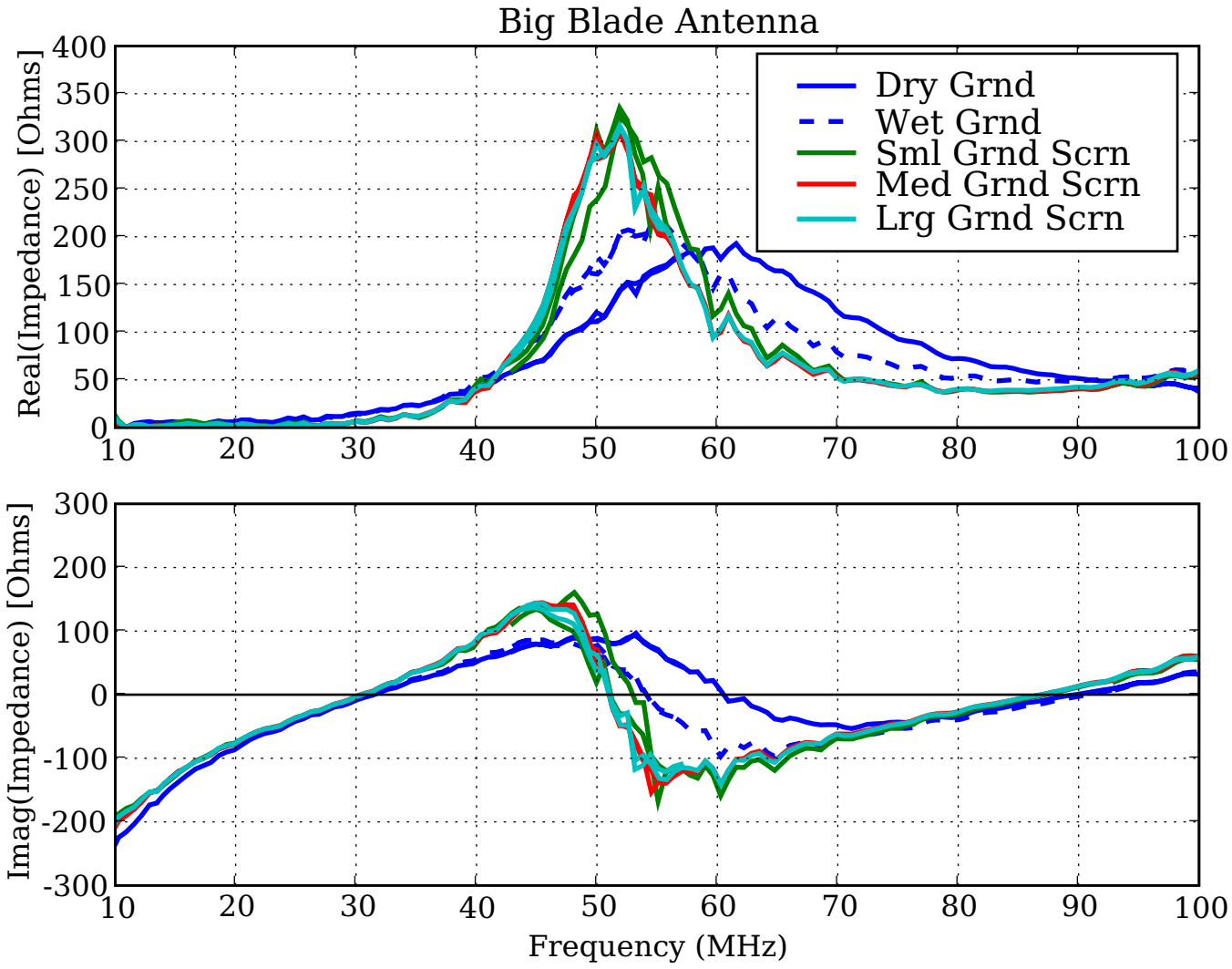

Fig. 5. Measured big blade antenna impedances.

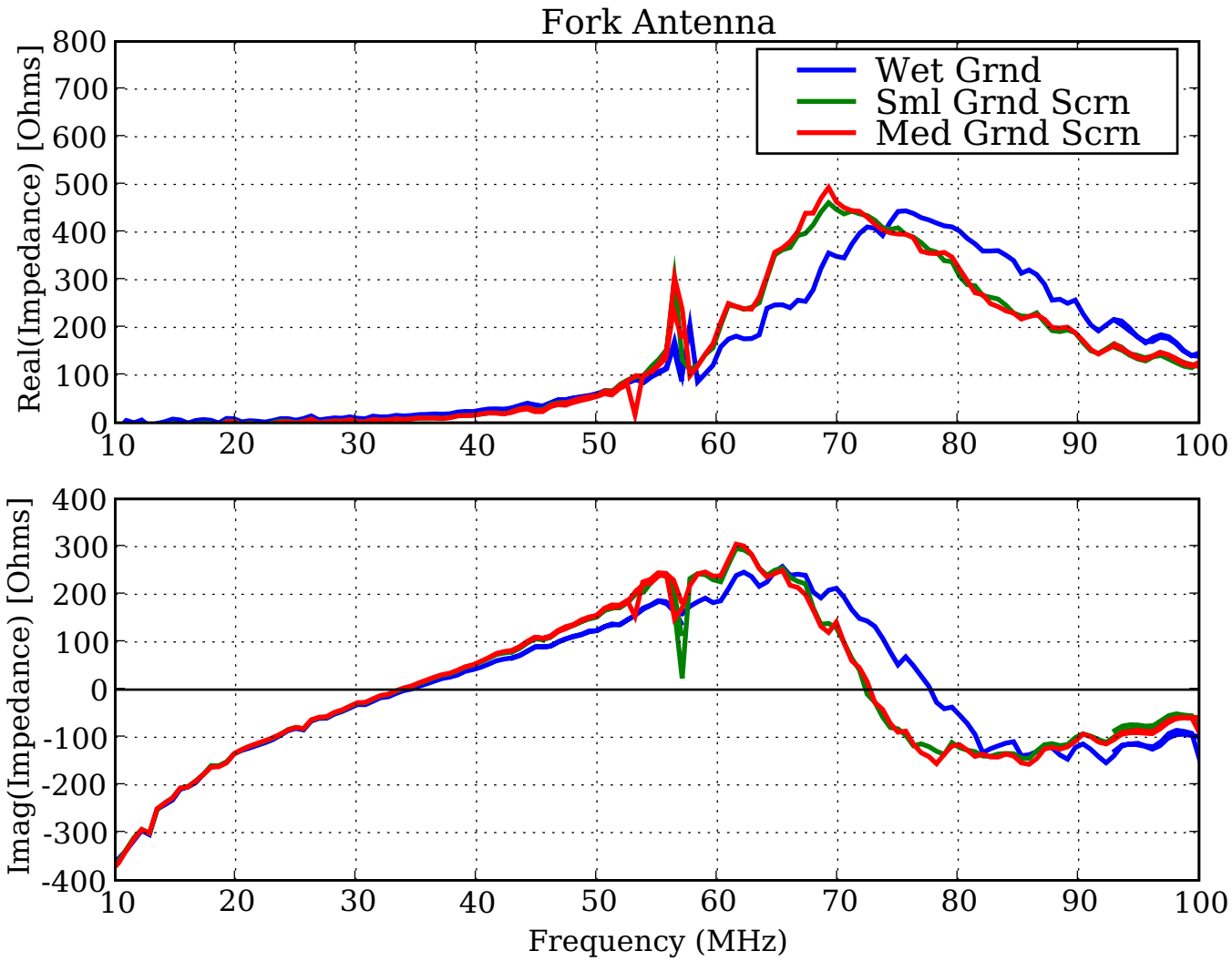

Fig. 6. Measured fork antenna impedances.