Mobile Service Provider Generates Base Station Antenna Pattern Measurements on Their Lab Bench

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Introduction

Due to the time and cost constraints of conducting far-field measurements of base station antennas many mobile service providers cannot afford to measure the antennas as much as they would like. Directly testing far-field in an anechoic chamber is not appropriate because of the large distances required for the far-field to establish. Outdoor test sites can be difficult to find and their use is constrained by weather. Specific chambers for testing large antennas using specialized techniques are required[1,2]. In addition, many base station antennas have mechanical adjustments which alter the pattern of the array creating a need for measurement with multiple setups. Because of these difficulties, testing in an anechoic chamber costs at least US$1,800 to US$2,000 per day and testing often takes three to four days. Unless the mobile service provider had a means of pre-testing the antenna prior to chamber testing, they might well have to conduct additional tests if testing revealed that refinements to the design were required. Since lead times to schedule a test in a chamber can be up to two or three months, scheduling the test alone delays project launch considerably.

To overcome these hurdles, engineers at a major mobile service provider used the EMSCAN RFX2 Antenna Pattern Measurement System. The desktop scanner generates antenna measurement data and projects the results to far-field patterns. In this case, the measurement team conducted the measurements at 700 MHz and 1950 MHz. Because the size of the array exceeded the scanner’s available scan area, the team could not measure the antenna in one pass. To resolve this issue, they conducted four scans, each displaced by 40cm, which resulted in a total scan area of 160 cm x 40 cm.

Measurement Setup

Note in Fig. 1 that the antenna array is suspended above the RFX2 scanner surface at the maximum supported distance of 115mm to minimize any interaction between the scanner and the antenna under test. The antenna array under test weighed 20 kg and measured 150 cm long x 30 cm wide x 15 cm thick. Fig. 1 below shows the RFX2 in the first measurement position near the top of the array. The absorber material covering the scanner also helped to minimize the impact of manually moving the scanner to each subsequent position in 40 cm increments. Moving the scanner in these increments corresponded to the scan area of the scanner. During the test, the engineers monitored the S_{11} of the antenna with a network analyzer while they manually moved the scanner to the next position. The absorber material performed as desired since S_{11} showed almost no shift in return loss when the scanner was moved. After the first measurement, the scanner was shifted 40 cm to the left for the second measurement with no other changes. After each scan, which took less than two seconds, the team moved the scanner to each subsequent position until they completed all four scans. Each subsequent measurement overlapped the prior scan area to provide a calibration point to align the four scans properly. Total measurement and post-processing time required about 30 minutes.

Fig. 1: Measurement Setup

Results At 700 MHz

Using post-processing techniques, the measurement team combined the four images into one. This established phase continuity between the four measurement locations. Although the phase shift was applied manually in this case study a small change in the hardware has been developed which makes the phase continuity automatic. Fig. 2 displays the combined results of the magnetic field (H-field) at 700 MHz using very-near-field measurements. Respectively, each image below displays Hx Amplitude, Hy Amplitude, Hx Phase, and Hy Phase. The right side of each image corresponds to the end of the antenna with the connectors.

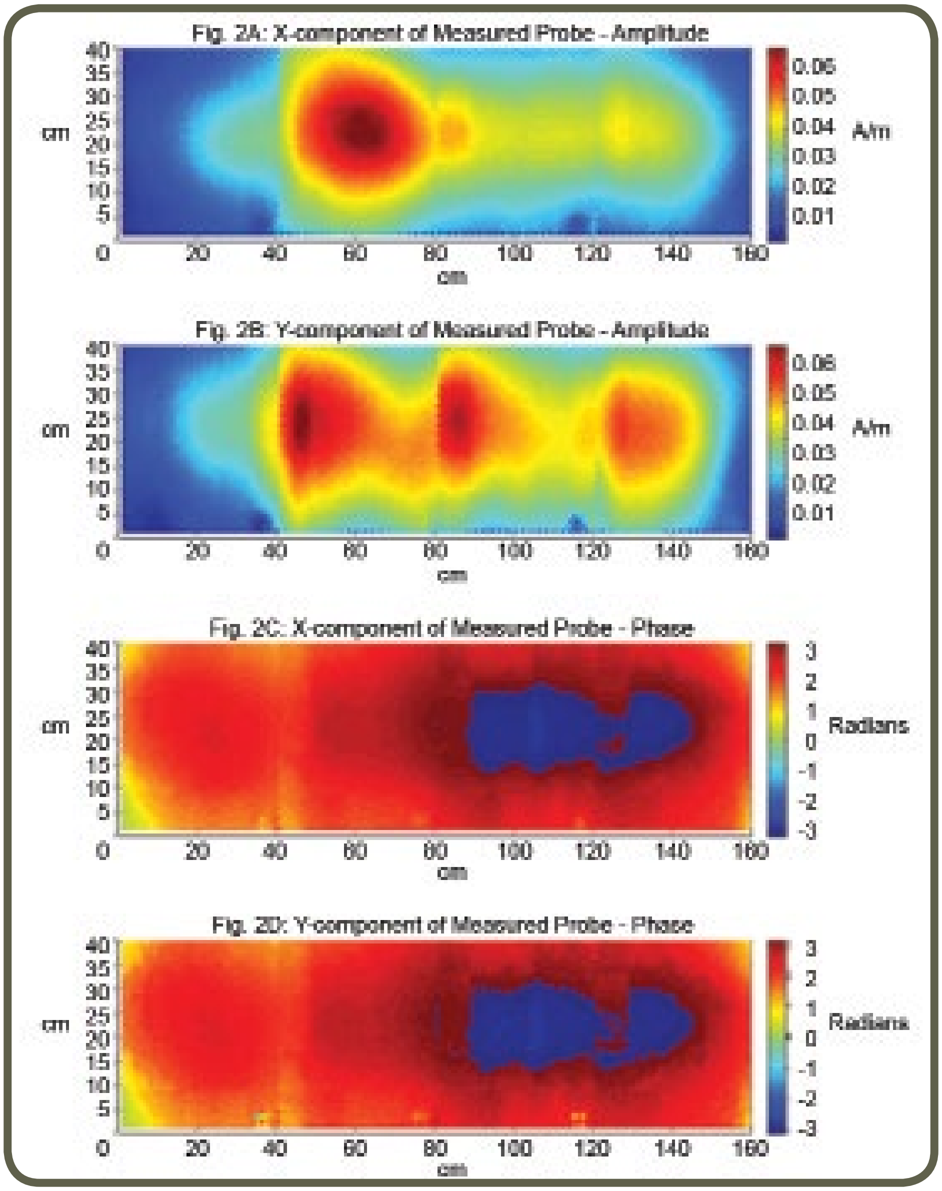


Fig. 2: Magnetic Field (H-Field) at 700 MHz

Results At 700 MHz - Continued

The very-near-field results at 700 MHz were then processed and transformed to the far-field using well-established algorithms[3,4]. A second custom and patented algorithm adjusted the far-field transformation, eliminating the predictable coupling effects of the measurement array. Fig. 3 below shows the radiation pattern versus manufacturer's data.

The φ = 0° cut is the vertical cut and the φ = 90° is the horizontal cut.

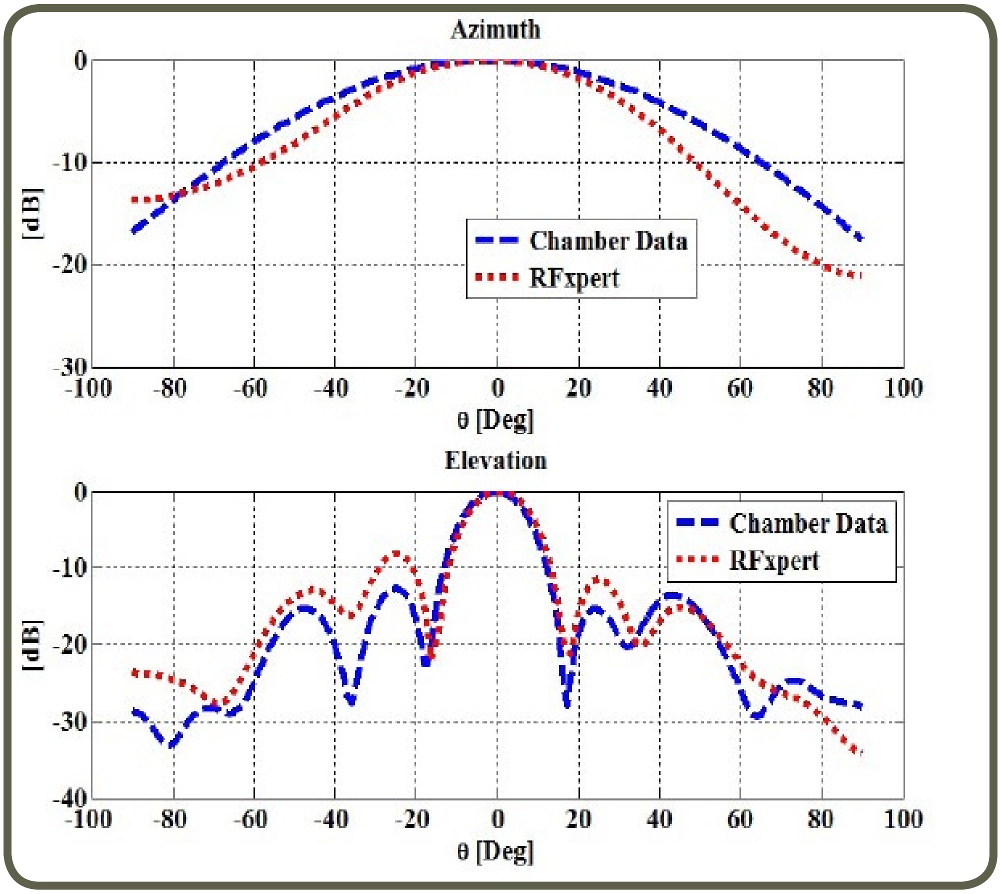


Fig. 3: Radiation Pattern vs. Manufacturer's Data at 700 MHz

Results At 1950 MHz

The following images at 1950 MHz display the same set of results as those shown on page 4 at 700 MHz. The four images in Fig. 4 respectively display Hx Amplitude, Hy Amplitude, Hx Phase, and Hy Phase.

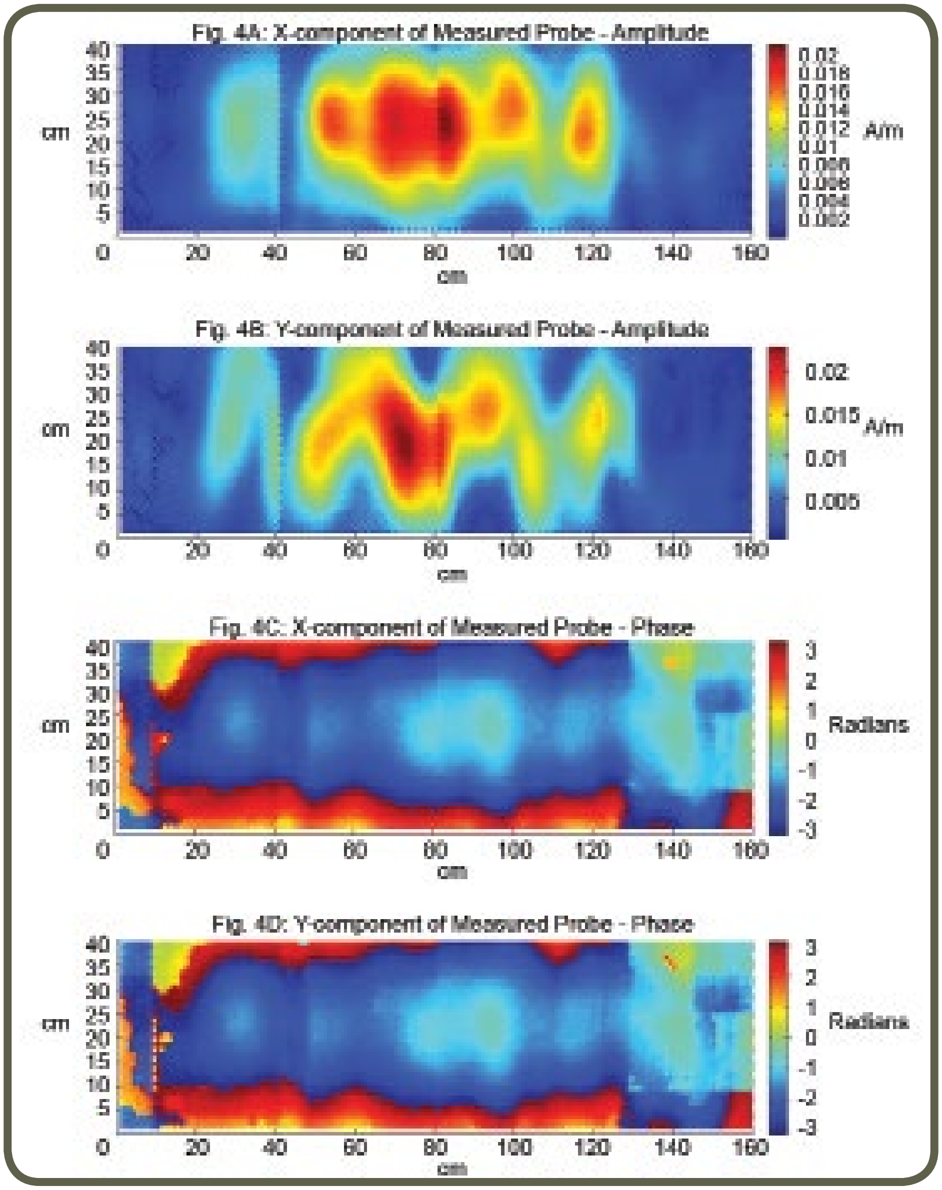


Fig. 4: Magnetic Field (H-Field) at 1950 MHz

Results At 1950 MHz - Continued

The very-near-field results at 1950 MHz were processed and transformed to the far-field [Fig. 5 below] using the same well-established algorithms[3,4] and the same custom algorithm. Note the similarities between results for the two wavelengths, but the 1950 MHz is an even narrower beam and the horizontal direction is not nearly as omnidirectional as at 700 MHz.

Again the φ = 0° cut is the vertical cut and the φ = 90° is the horizontal cut.

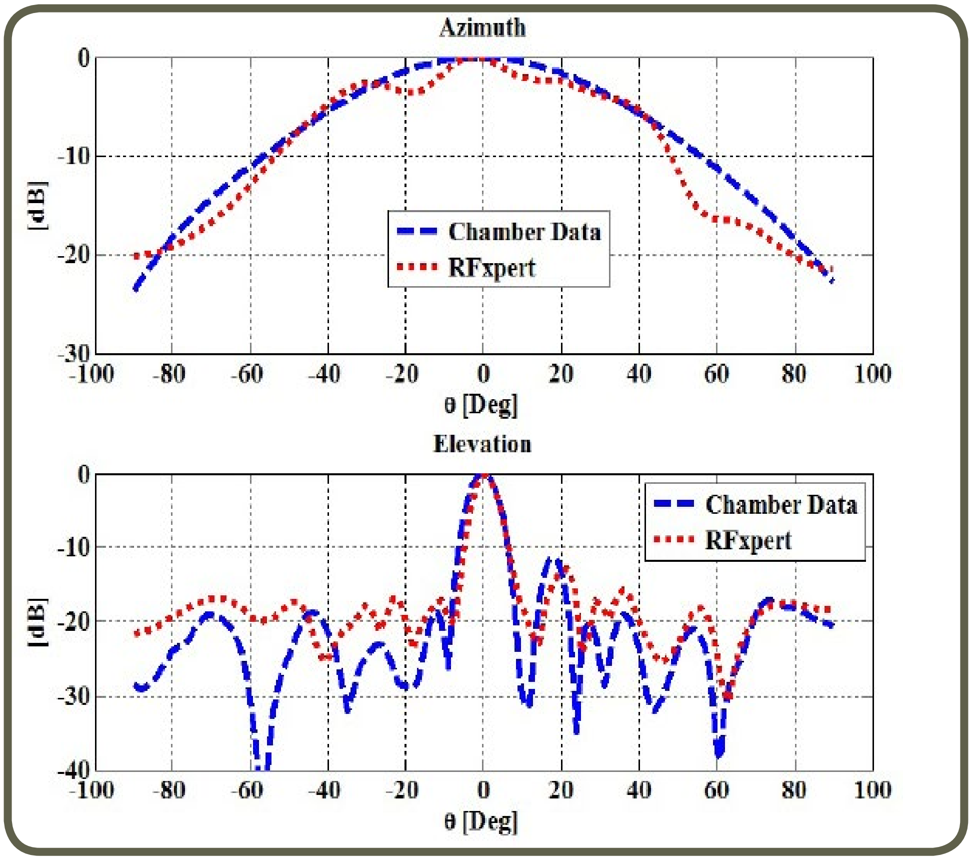


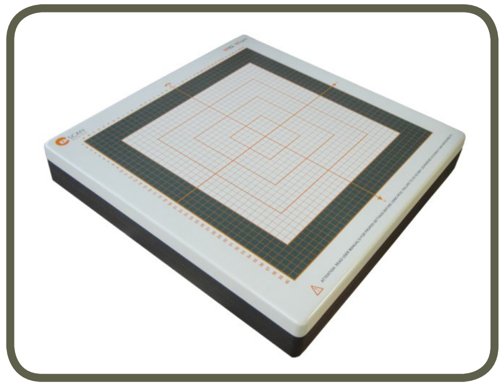
Fig. 5: Radiation Pattern vs. Manufacturer's Data at 1950 MHz

Conclusion: Advantages of Very-Near-Field Antenna Measurement

All mobile service providers face the problem of measuring a large base station antenna. Measuring such an antenna requires a large and costly anechoic chamber with specialized capabilities. For these providers, the RFX2 Antenna Pattern Measurement System solves the prohibitively expensive and time-consuming measurement process involved in a large chamber.

PS: We expect the results to be even better with a 2 x 5 set of measurements instead of the 1 x 4 set of measurements disclosed in this paper. Update will be published soon.

About RFX2 Antenna Measurement System



The desktop scanner characterizes antennas without the need for a chamber. The RFX2 generates far-field antenna patterns, bisections, EIRP, and TRP in less than two seconds. Available novel near-field results including amplitude, polarity, and phase deliver nearly instantaneous insights into the root cause of antenna performance challenges. The device also supports antenna design troubleshooters mitigate far-field radiation issues.

About EMSCAN

EMSCAN is the world leading developer of FAST magnetic very-near-field measurement technologies and applications since 1989, providing real-time test solutions to antenna and PCB designers and verification engineers, without the need for a chamber. The EMxpert, a compact EMC and EMI diagnostic tool, and the RFxpert, an antenna measurement tool, enable engineers to quickly optimize their designs. EMSCAN solutions dramatically increase designer productivity and substantially reduce time-to-market and project development costs.

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