CFNSA: An Introduction

Zhong Chen
ETS-Lindgren

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zhong.chen@ets-lindgren.com

The Challenge for Log Antennas

- Correction factors have been included in ANSI C63.5 for two popular types of biconical antennas with 50 or 200 Ω baluns.
- For log antennas, site performance depends on the antenna patterns and physical lengths (phase center positions). These antenna parameters are different by models and manufacturers. Universal correction factors are not possible.

FSAF, GSAF and Site Validation

- There are several methods for obtaining (near) free-space AFs for log antennas
  - Vertical calibration over absorber-lined ground plane (NPL), and approximate phase center positions.
  - Time domain gating that removes late arrival waves. (NIST)
  - Traditional OATS calibration with height scanning at 10m distance (e.g. d=10m, h_1=1m, and h_2=1~4m, horizontal polarization).
- None of these provide solutions for site validation tests, which require geometry-specific factors.

What are we doing now?

- Currently, site-to-site comparison method is the de facto standard for validating test sites in the log antenna frequency range (200-1000 MHz).
- ANSI C63.5 provides a means to generate reference NSA data using statistical averaging on a good-quality ground plane for any antennas other than bicons.

Why CFNSA?

- **Complex Fit NSA** (CFNSA) is a theoretical model that can complement the site comparison method.
- Site-to-Site comparison can be time consuming. Reference NSA requires 5 or more runs for each of the 8 geometries. All future calibrations are required to go through the same process (5x8=40 or more NSA runs) for one antenna pair.
- CFNSA is theoretically traceable. Antenna patterns and phase center positions can be obtained from the same traditional OATS calibration (1-4m scan). CFNSA data is intrinsically averaged over statistically significant samples (data at all heights are used for averaging).

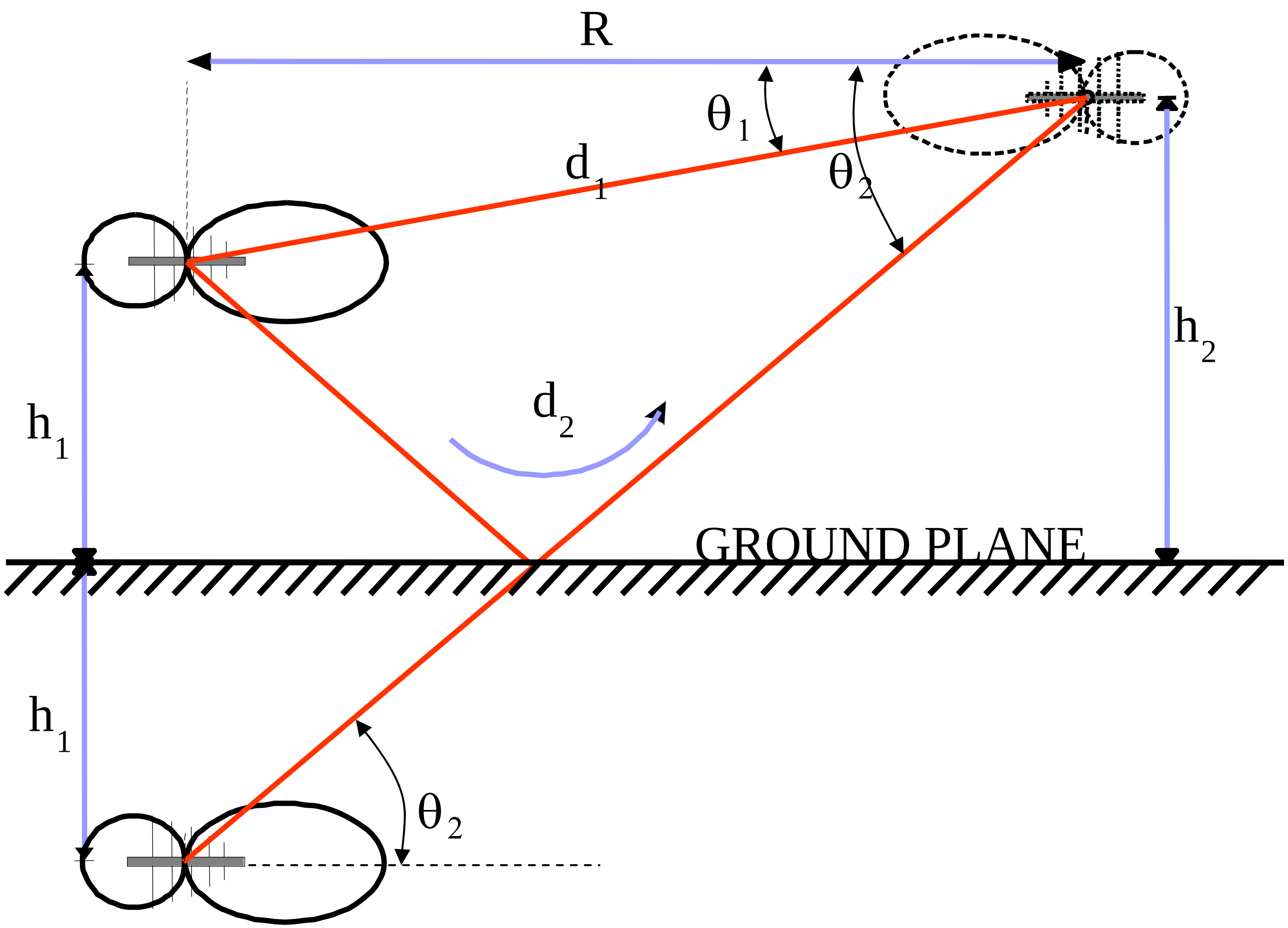
Is CFNSA a big undertaking?

- Calibration procedure is no different from regular calibration on OATS (1~4m height scan over conducting ground plane).
- Antenna patterns and phase centers can be extracted because traditional calibrations discard all data but the maximum response between antennas. CFNSA takes advantage of these available data.
- CFNSA requires more book-keeping and is more mathematically involved. However, the method can be standardized. Also, only antenna manufacturers (calibration labs) need to be concerned with the details. End users need not to be involved in the computations.

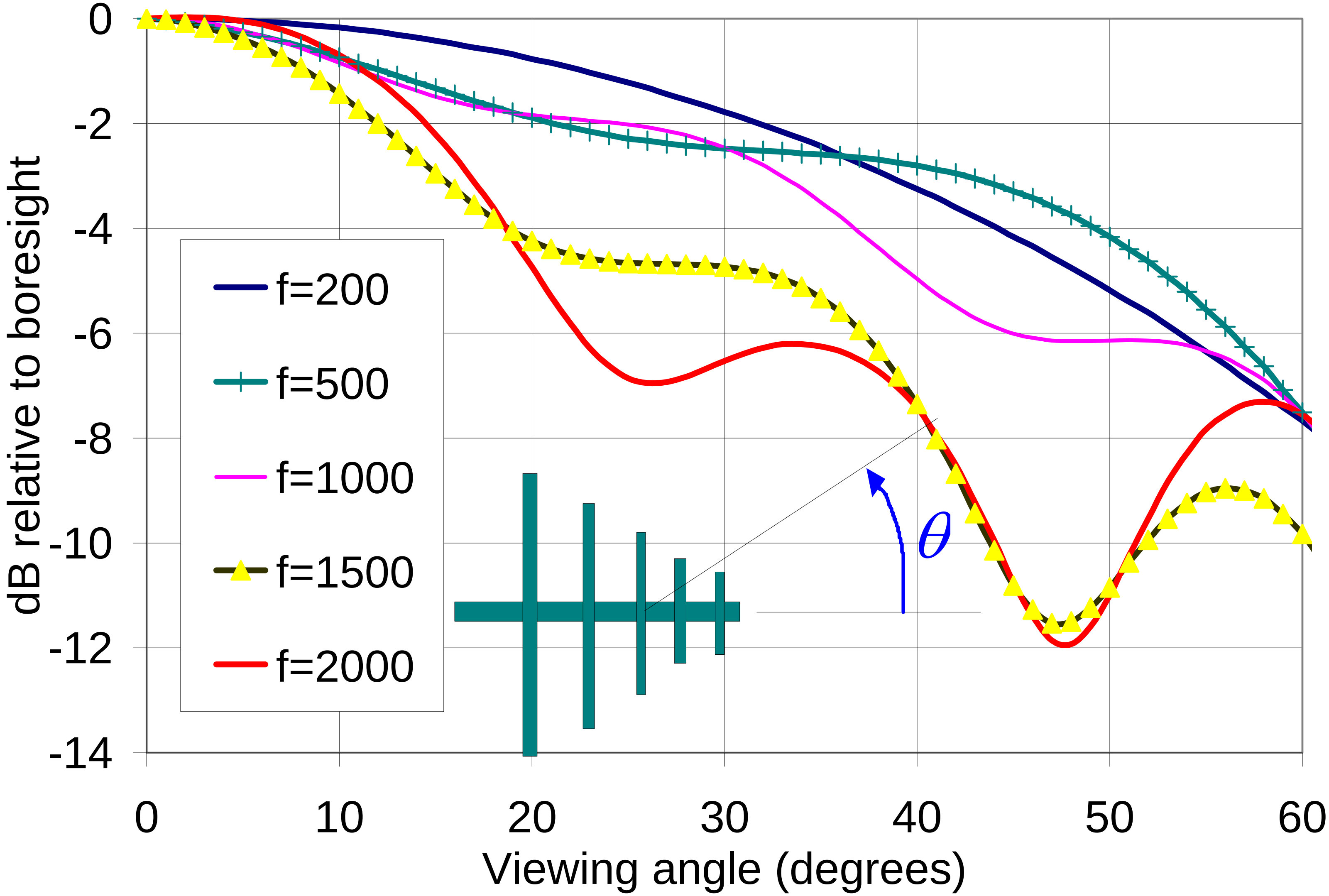
How does it work?

- The only difference from the traditional NSA is instead of keeping only the max response, CFNSA keeps track of site responses during the antenna height scan.
- CFNSA accounts for phase center and antenna pattern variations by solving for these parameters using S_{21} at multiple heights.

A typical graphical representation of the NSA Model

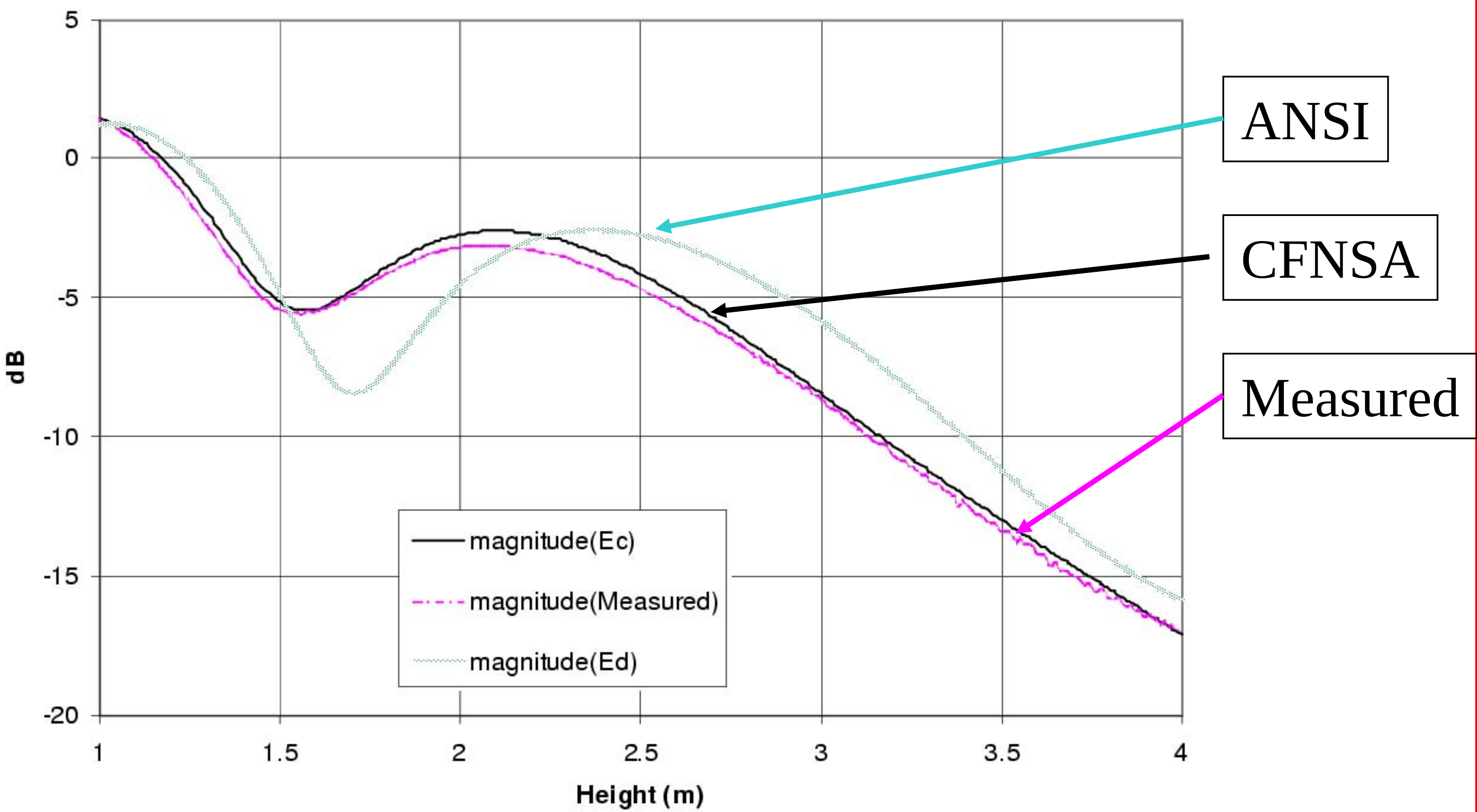


Measured E-plane Pattern of An LPDA

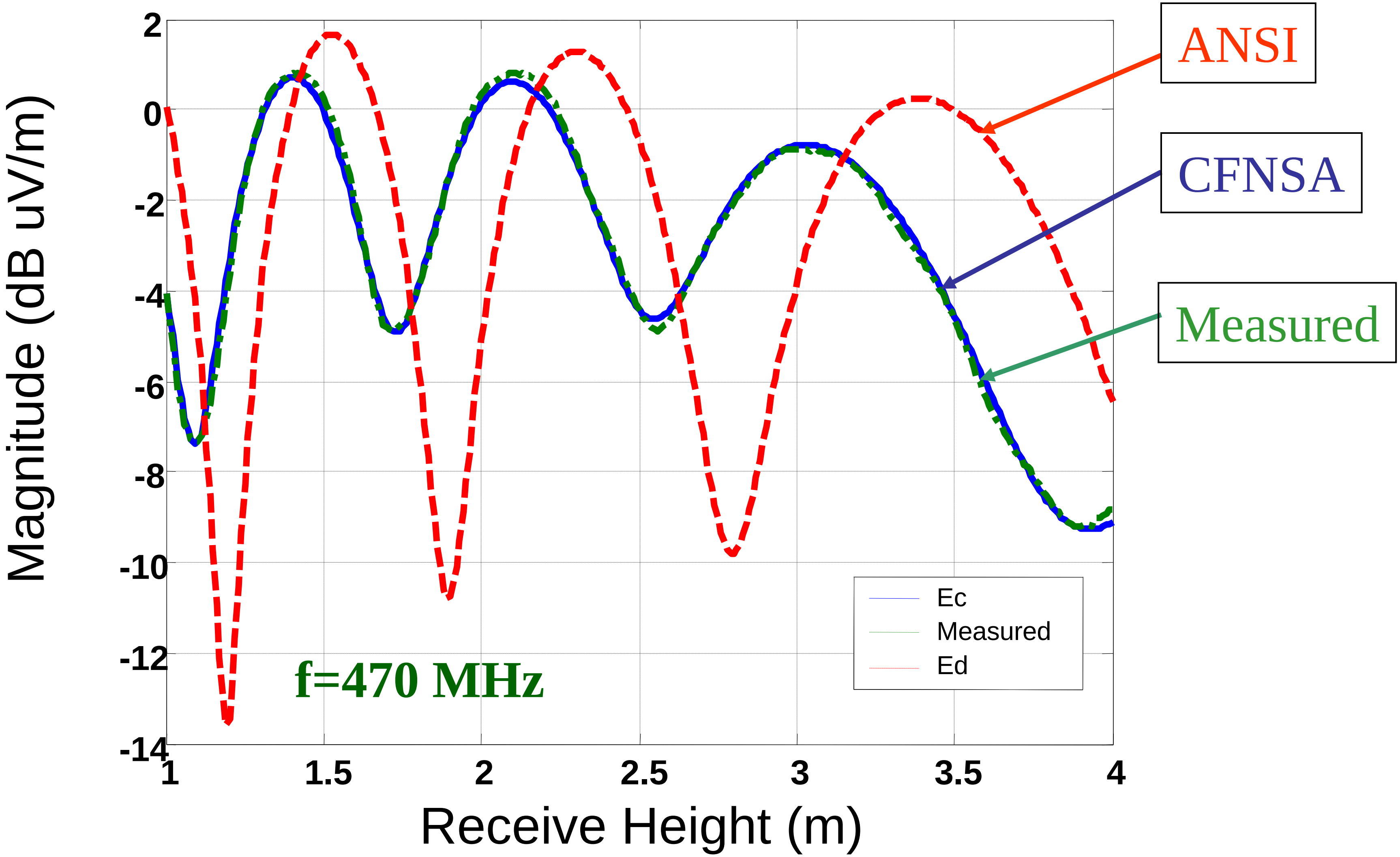


- At each frequency, If the pattern (a_0 .. a_n) and the separation (R) between the transmit and receive antennas are known,
  - The shape of $|S_{21}|$ between the transmit and receive antennas vs. receiving height is determined.
  - The phase response vs. receiving height is determined.
- By mathematically matching (least square fit) the measured shape of S_{21}, the unknowns (a_0 .. a_n, R) can be solved!

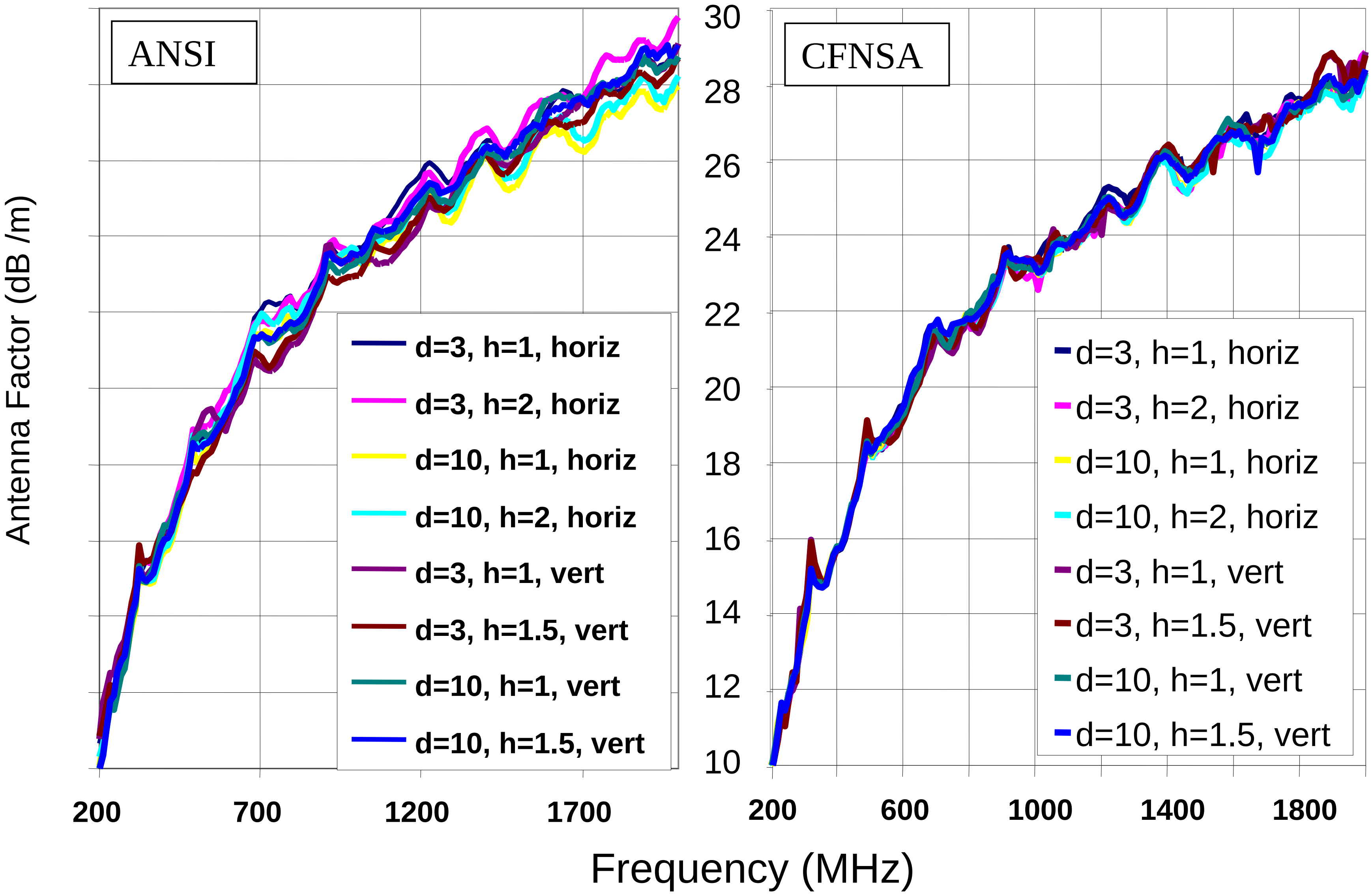
$|S_{21}|$ at distance=3m transmit height=1m, Vertical, 470 MHz



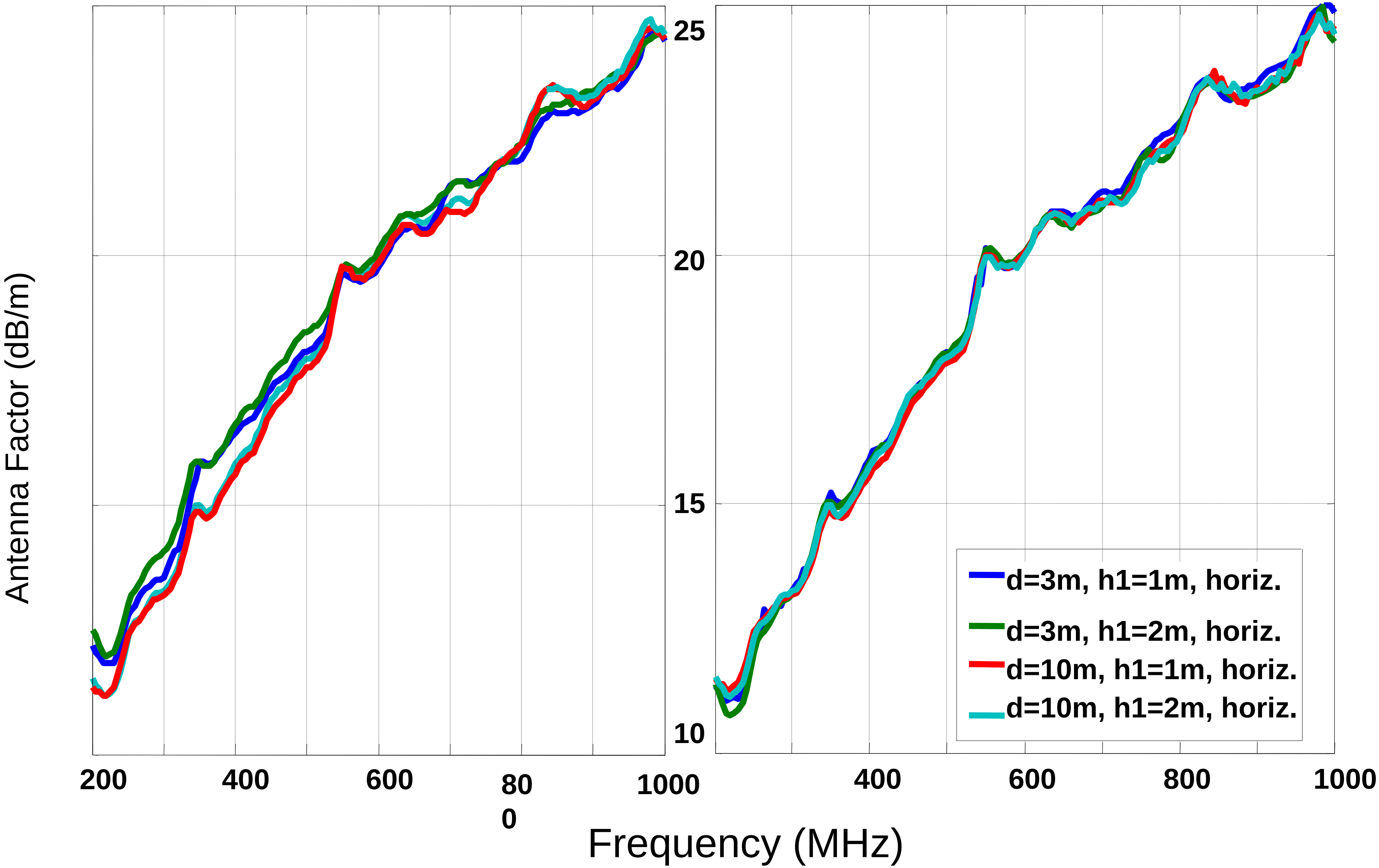
$|S_{21}|$ at distance=3m transmit height=2m, horizontal



Antenna A: All ANSI Geometries



Antenna B: All ANSI Horizontal Geometries



CFNSA Example

- Software demonstration:

Cfnsa_replaypw:

e3148d3h2_9_magang

Discussions

- For LPDAs, NSA depends on antenna patterns and phase center positions. CFNSA method provides the solutions during antenna calibration process.
- If we can assume that antenna patterns and phase centers do not vary greatly within the same antenna design, it is possible to go through the CFNSA process in the initial design process only. In other words, manufacturers specify CFNSA per antenna model.

Discussions …

- For subsequent calibrations, only free-space calibrations are required. Geometry specific correction factors for all NSA geometries are obtained by simple calculations (based on the a priori knowledge of antenna patterns and phase center positions) – this is the same as the correction factor method used for bicons in ANSI C63.5 today!

Still need to do…

- Verify against a variety of log antennas from different manufacturers. Need help from working group members.
- Improve the algorithm by analyzing the large data sets from these antennas.
    - Is magnitude-only fitting scheme sufficient – thus making vector network analyzer optional?