Computer-Simulation of Near-Field Phased-Array Radiation-Pattern Scanning

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The recently introduced Tilted-Ellipse Representation of Standing-Wave Patterns [1, 2] provides a fast and inexpensive way for extracting the multi-dimensional, complex scattering-matrices of very large, multi-port microwave systems, by performing computer-simulations of large-scale experimental-measurements, that would require a very complex and expensive multiport Automated Vector Network Analyzer, and a long data-acquisition time. That simulation method is based on the results of a rigorous mathematical analysis [1, 2] of the simultaneous propagation of forward- and backward-waves along virtual measurement lines, connected to the ports of the microwave systems being simulated. That analysis has shown that the mutual correlation between the imaginary components, and the real components of the standing-wave fields, along the length of each virtual measurementline, can be quantitatively represented by the parametric equations of a tilted-ellipse, centered on the origin of a Cartesian frame. Clearly, very significant time- and cost-savings are attained by simulating complex S-matrix experimental-measurements, when the system under simulated test has a very large number of ports ($n \gg 4$), and/or a very large number of propagating modes. Most remarkably, measurement-simulations may be performed at early stages of system design, as no prototype is required. The S-matrix measurement-simulation method described in [1, 2] makes even possible the HPC-simulation of the multi-dimensional scattering-matrix measurements required to perform near-field scans of the radiation-pattern of electronically-steered phased-array (Figure 1).

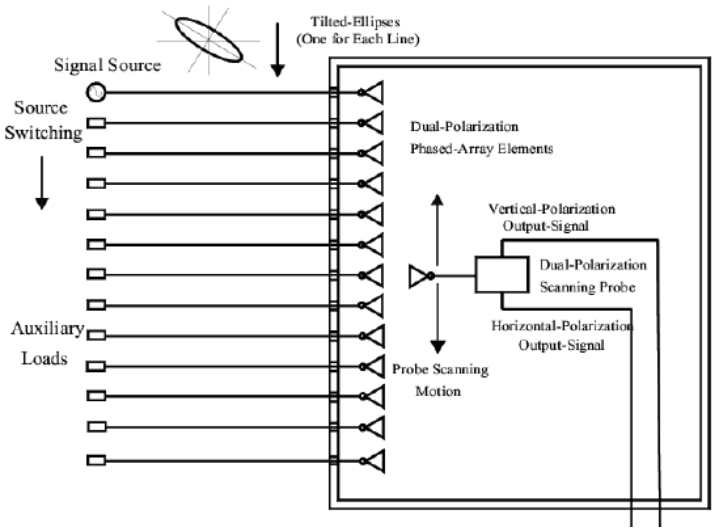

Figure 1: Phased-array in a near-field scanner.

The tilted-ellipse representation of the standing-wave patterns along each virtual line, may be used to compute the magnitudes and the phases of the forward-wave and backward-wave vectors, at any arbitrary point along all the virtual measurement-lines. The mathematical results of the previously-reported analysis of the simultaneous propagation of the forward and backward waves [1, 2], express the complex values of the forward-wave vectors, and of the backward-wave vectors, as functions of the distance from each system port, by using the semi-axes $\boldsymbol{a}$ and $\boldsymbol{b}$ of the ellipse, and the tilt-angle δ of its major axis. The new measurement-simulation performs therefore the very same wave-extraction function that, in an actual experimental measurement-session, would require the use of many Vector-Reflectometers, each composed of two directional couplers, and of a vector-voltmeter.

REFERENCES

1. Speciale, R. A., "Computing the scattering matrix of multiport systems," *PIERS 2004*, Pisa, Italy, 2004.
2. Speciale, R. A., "The tilted-ellipse representation of standing-wave patterns," *ACES 2004*, Syracuse, NY, 2004.