

NUMERICAL AND EXPERIMENTAL ASSESSMENT OF A PHASE RETRIEVAL TECHNIQUE APPLIED TO PLANAR NEAR FIELD DISTRIBUTIONS FOR WIDE BAND APPLICATIONS

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CONTEXT

◆ CONTEXT

- ✓ Final purpose
 - Experimental antenna far field pattern characterization
 - Wide frequency range
 - Pulsed sources
- ✓ Measurement constraints
 - Planar near field test setup
 - Magnitude only measurements

◆ APPROACH

- ✓ Implementation of a phase retrieval algorithm
- ✓ Assumptions on sources
 - CW
 - High directivity



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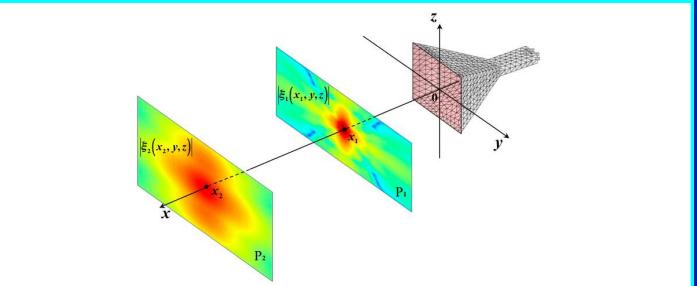
THE PHASE RETRIVAL TECHNIQUE

HISTORICAL BACKGROUND

- ✓ Gerschberg-Saxton [1972] : electron microscopy (1 plane)
- ✓ « Misell » variant [1973] : electron microscopy (2 defocused planes)
- ✓ Anderson & Ali [1984] : microwave applications

PRINCIPLE

- ✓ Algorithm initialization :
 - Electric field magnitude known in two planes P_1 & P_2 in front of the source





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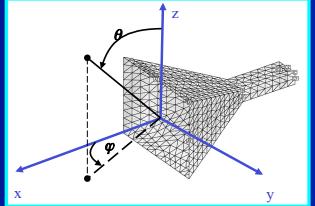
NUMERICAL ASSESSMENTS (1/8)

Models

- ✓ MoM (Feko)
- ✓ Classical horn antenna (same used for experimental approach)
- ✓ Frequency: 8 GHz

Purposes

- ✓ Validation tool
 - Agreement Models/Measurements
 - Exact phase calculation
 - Exact far field calculation
- ✓ Sets of data for parametric study
 - $d_{\text{Plane-source}}$ and $d_{\text{plane-plane}}$
 - Planes sampling
 - Planes sizes





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NUMERICAL ASSESSMENTS (2/8)

♦ Parametric Study

✓ Criterion

$$\Delta_n^{cplx} = \frac{\sum_{i=1}^{N_y} \sum_{j=1}^{N_z} \| E_n(x_i, y_i, z_j) - \tilde{E}_n(x_i, y_i, z_j) \|^2}{\sum_{i=1}^{N_y} \sum_{j=1}^{N_z} \| \tilde{E}_n(x_i, y_i, z_j) \|^2}$$

✓ planes positions

- Fields calculated in magnitude and phase using Feko
- distances : 11 values [$x_1 = 2\lambda, \dots, x_{11} = 1 \text{ m}$]
- 55 phase reconstructions



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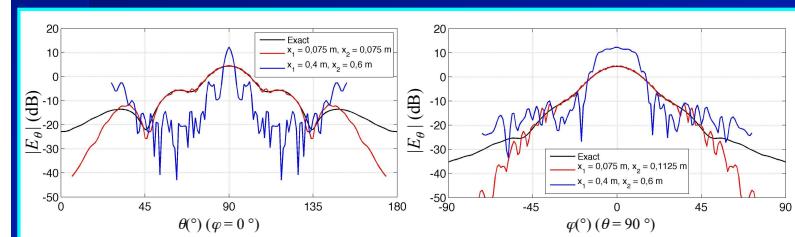
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NUMERICAL ASSESSMENTS (3/8)

♦ Planes positions parameter : x_1 and x_2

✓ Far field from using the reconstructed phase

- Worst case : $\Delta_n^{cplx} = 222.54 \%$
- Best case : $\Delta_n^{cplx} = 7.94 \%$



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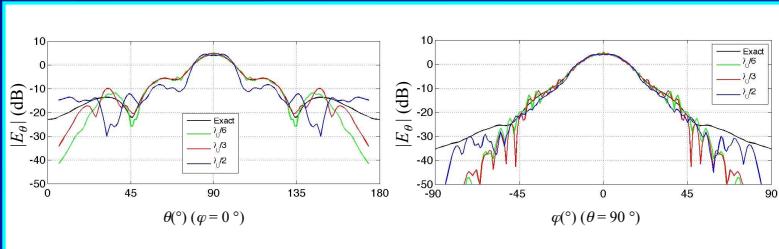
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NUMERICAL ASSESSMENTS (4/8)

♦ Sampling parameter : δ_x

✓ Far field from using the reconstructed phase

- $\delta_x = \lambda_0/6$ $\Delta_n^{cplx} = 7.94 \%$
- $\delta_x = \lambda_0/3$ $\Delta_n^{cplx} = 6.07 \%$
- $\delta_x = \lambda_0/2$ $\Delta_n^{cplx} = 29.53 \%$



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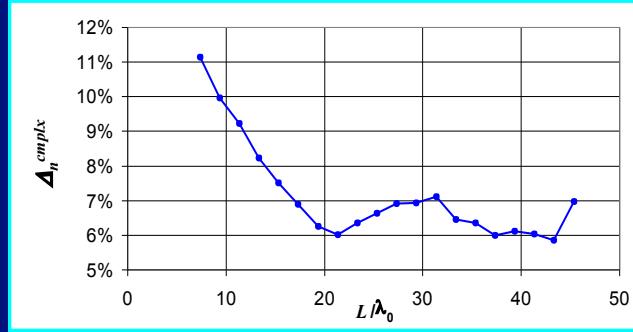


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NUMERICAL ASSESSMENTS (5/8)

♦ Planes dimensions parameter : L

✓ $L_{min} = 20\lambda_0$



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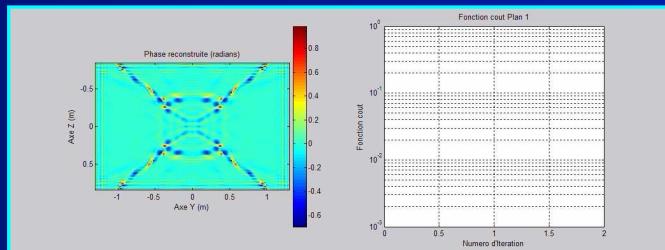


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NUMERICAL ASSESSMENTS (6/8)

♦ Phase reconstructions

- ✓ ~1000 to 10000 iterations
- ✓ Less than 1 or 2 hours on a standard PC



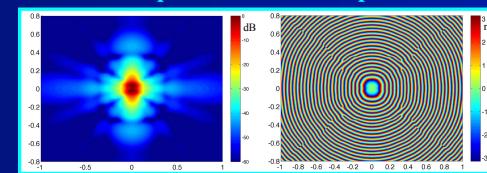
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NUMERICAL ASSESSMENTS (7/8)

♦ Results at 8 GHz : phase on the first plane



Exact Field, $d = 2\lambda$, magnitude and phase (FEKO) and reconstructed phase



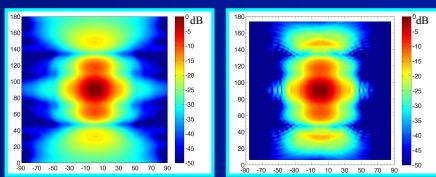
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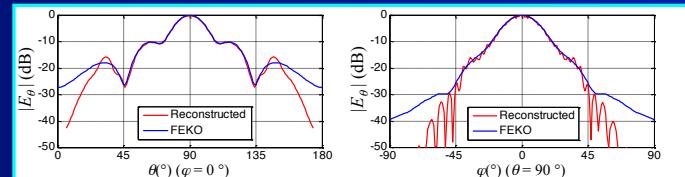
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NUMERICAL ASSESSMENTS (8/8)

♦ Results at 8 GHz : reconstructed far field



Exact and reconstructed far field



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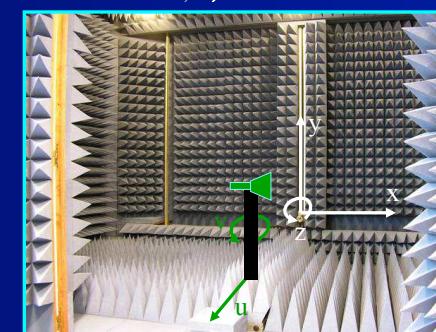


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EXPERIMENTAL APPROACH

♦ Experimental validation : planar near field measurement setup

- ✓ AUT = Horn, Probe = Dipole, open end waveguide
- ✓ Frequencies = 2 GHz, 8 GHz and 18 GHz
- ✓ Distance AUT/Probe : $2\lambda, 3\lambda, \dots 1\text{m}$



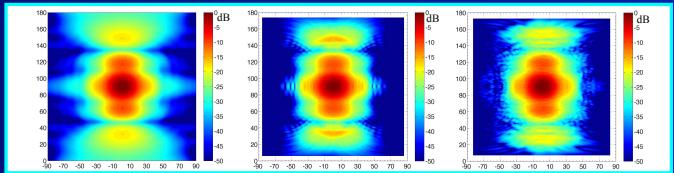
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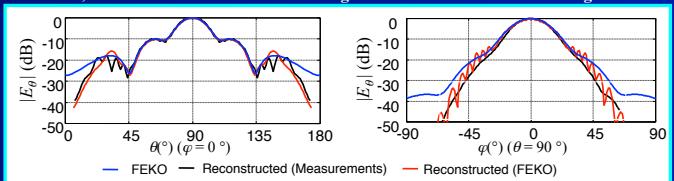
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EXPERIMENTAL VALIDATION : $f = 8 \text{ GHz}$

♦ Validation of reconstructed far field



Exact, reconstructed from simulated magnitudes and from measured magnitudes



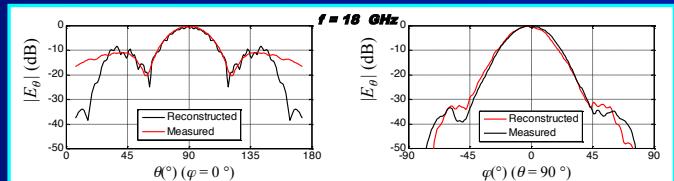
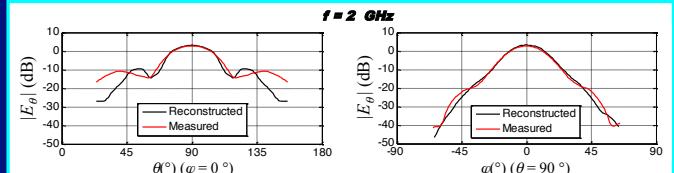
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EXPERIMENTAL VALIDATION : $f = 2 \text{ & } 18 \text{ GHz}$

♦ Validation of reconstructed far field



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CONCLUSION & FUTURE WORKS

♦ Conclusions on the phase reconstruction algorithm

- ✓ Validation on numerical and experimental data
- ✓ Parametric study for optimal use
- ✓ Wide band validation

♦ Future tasks

- ✓ Adding information to increase performances
- ✓ Expanding the parametric study
- ✓ Towards pulsed sources ...



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