Numerical and experimental assessment of a phase retrieval technique applied to planar near field distribution for wide band application

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

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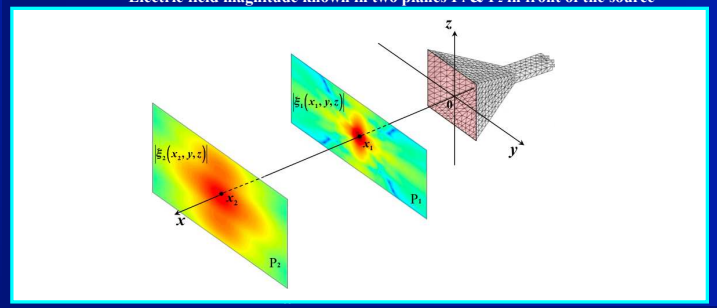
CONTEXT

- **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

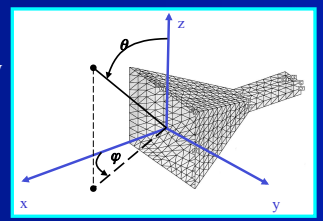
THE PHASE RETRIVAL TECHNIQUE

- **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**



NUMERICAL ASSESMENTS (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



NUMERICAL ASSESMENTS (2/8)

✦ **Parametric Study**

✓ **Criterion**

$$\Delta_n^{cmplx} = \frac{\sum_{i=1}^{N_y}\sum_{j=1}^{N_z}\left\| E_n(x_1, y_i, z_j) - \xi_n(x_1, y_i, z_j)\right\|^2}{\sum_{i=1}^{N_y}\sum_{j=1}^{N_z}\left\| \xi_n(x_1, y_i, z_j)\right\|^2}$$

✓ **planes positions**

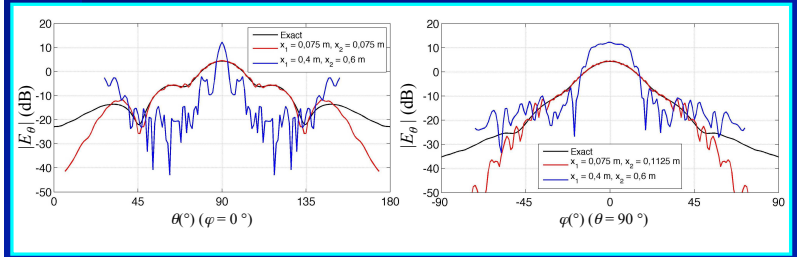
- Fields calculated in magnitude and phase using Feko
- distances : 11 values [$x_1 = 2\lambda$, …, $x_{11} = 1$ m]
- 55 phase reconstructions

NUMERICAL ASSESMENTS (3/8)

✦ **Planes positions parameter : x_1 and x_2**

✓ **Far field from using the reconstructed phase**

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

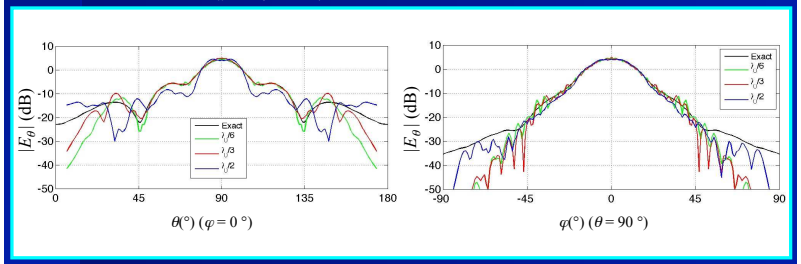


NUMERICAL ASSESMENTS (4/8)

✦ **Sampling parameter : δ_x**

✓ **Far field from using the reconstructed phase**

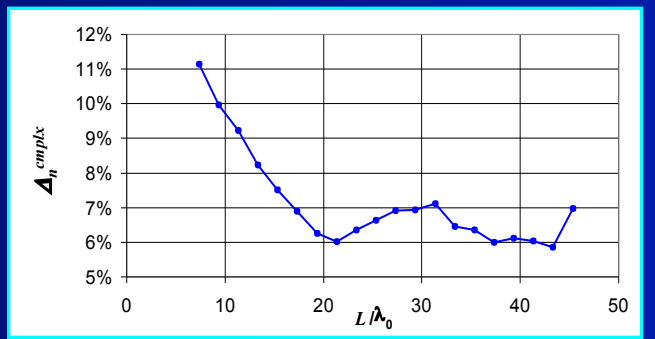
- $\delta_x = \lambda_0/6$ $\Delta_n^{cmplx} = 7.94$ %
- $\delta_x = \lambda_0/3$ $\Delta_n^{cmplx} = 6.07$ %
- $\delta_x = \lambda_0/2$ $\Delta_n^{cmplx} = 29.53$ %



NUMERICAL ASSESMENTS (5/8)

✦ **Planes dimensions parameter : L**

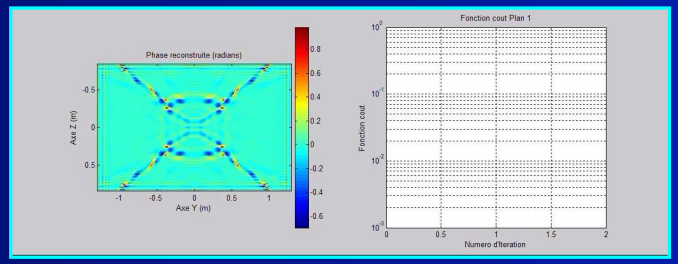
✓ $L_{min} = 20\lambda_0$



NUMERICAL ASSESMENTS (6/8)

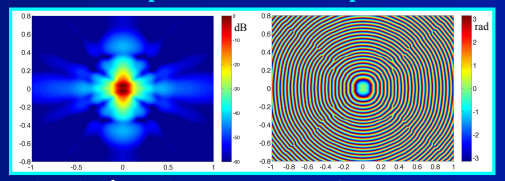
✦Phase reconstructions

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

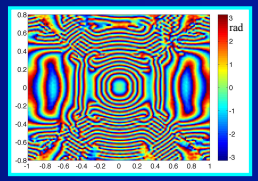


NUMERICAL ASSESMENTS (7/8)

✦Results at 8 GHz : phase on the first plane



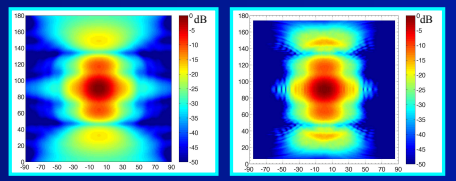
Exact Field, $d = 2\lambda$, magnitude and phase (FEKO) and reconstructed phase



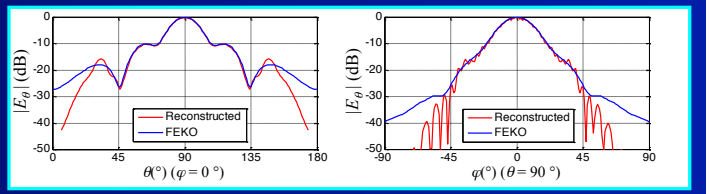
Reconstructed phase

NUMERICAL ASSESMENTS (8/8)

✦Results at 8 GHz : reconstructed far field



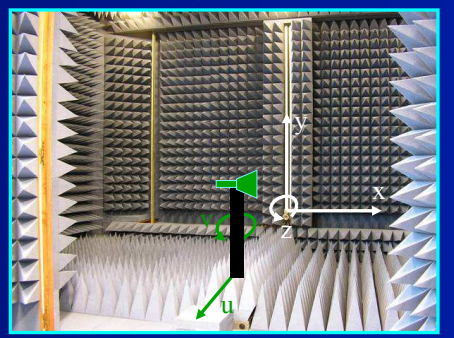
Exact and reconstructed far field



EXPERIMENTAL APPROACH

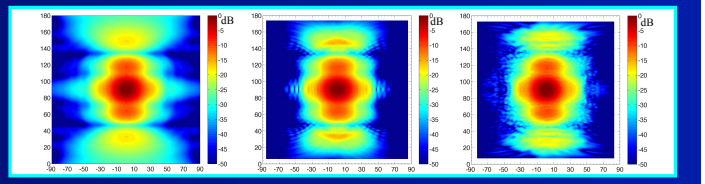
✦ Experimental validation : planar near field measurement setup

- ✓ AUT = Horn, Probe = Dipole, open end waveguide
- ✓ Frequencies = 2 GHz, 8 GHz and 18 GHz
- ✓ Distance AUT/Probe : 2λ, 3λ, … 1m

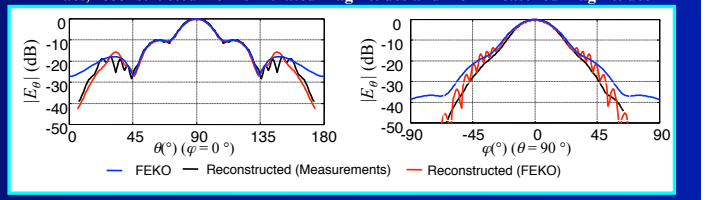


EXPERIMENTAL VALIDATION : f = 8 GHz

✦Validation of reconstructed far field

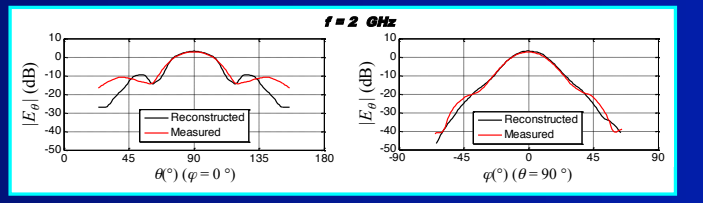


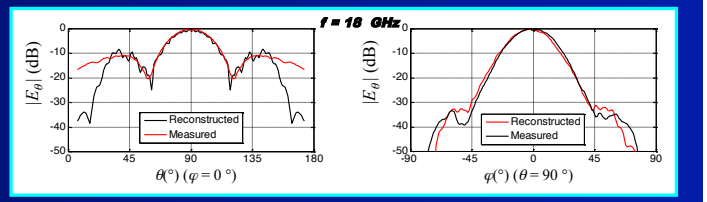
Exact, reconstructed from simulated magnitudes and from measured magnitudes



EXPERIMENTAL VALIDATION : f = 2 & 18 GHz

✦Validation of reconstructed far field





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 …