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# **A New System-by-Design Methodology for the Design of Reflectarray Antennas**

**G. Oliveri, A. Gelmini, A. Polo, N. Anselmi, and A. Massa**

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# Contents

<b>1 Phoenix Patch Reflectarray: 25x25 SLL=-25dB</b>	<b>4</b>
1.1 Unit cell geometry . . . . .	4
1.2 Optimization target . . . . .	4
1.3 Optimization results . . . . .	5
1.3.1 Cost Function . . . . .	5
1.3.2 Geometrical Design . . . . .	5
1.3.3 Reflection Coefficient . . . . .	6
1.3.4 Superficial Currents . . . . .	7
1.3.5 Fields . . . . .	7
1.3.6 Fields Cut . . . . .	8
<b>2 Phoenix Patch Reflectarray: 25x25 SLL=-20dB</b>	<b>9</b>
2.1 Optimization target . . . . .	9
2.2 Optimization results . . . . .	9
2.2.1 Cost Function . . . . .	9
2.2.2 Geometrical Design . . . . .	10
2.2.3 Reflection Coefficient . . . . .	11
2.2.4 Superficial Currents . . . . .	12
2.2.5 Fields . . . . .	12
2.2.6 Fields Cut . . . . .	13
<b>3 Phoenix Patch Reflectarray: 25x25 SLL=-20dB notch <math>\theta = 20</math> deg SLL=-30 dB</b>	<b>14</b>
3.1 Optimization target . . . . .	14
3.2 Optimization results . . . . .	14
3.2.1 Cost Function . . . . .	14
3.2.2 Geometrical Design . . . . .	15
3.2.3 Reflection Coefficient . . . . .	16
3.2.4 Superficial Currents . . . . .	17
3.2.5 Fields . . . . .	17
3.2.6 Fields Cut . . . . .	18
<b>4 Phoenix Patch Reflectarray: 25x25 SLL=-15dB</b>	<b>19</b>
4.1 Optimization target . . . . .	19

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4.2	Optimization results . . . . .	19
4.2.1	Cost Function . . . . .	19
4.2.2	Geometrical Design . . . . .	20
4.2.3	Reflection Coefficient . . . . .	21
4.2.4	Superficial Currents . . . . .	22
4.2.5	Fields . . . . .	22
4.2.6	Fields Cut . . . . .	23

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# 1 Phoenix Patch Reflectarray: 25x25 SLL=-25dB

## 1.1 Unit cell geometry

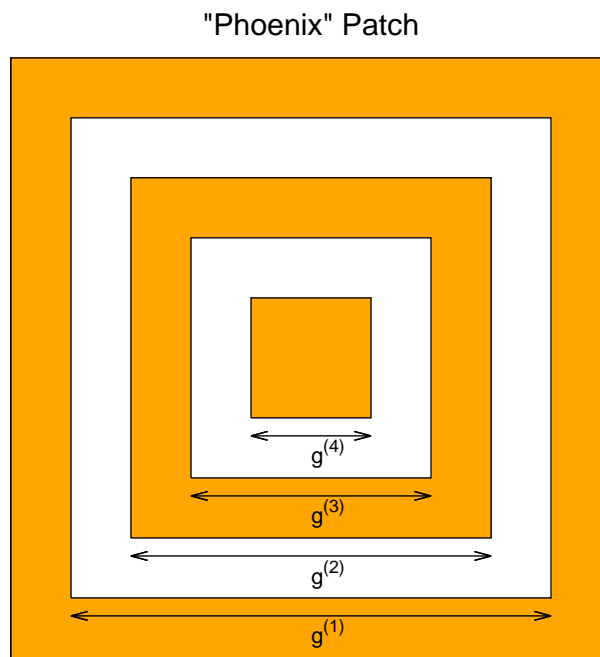


Figure 1: Phoenix Patch unit cell.

## 1.2 Optimization target

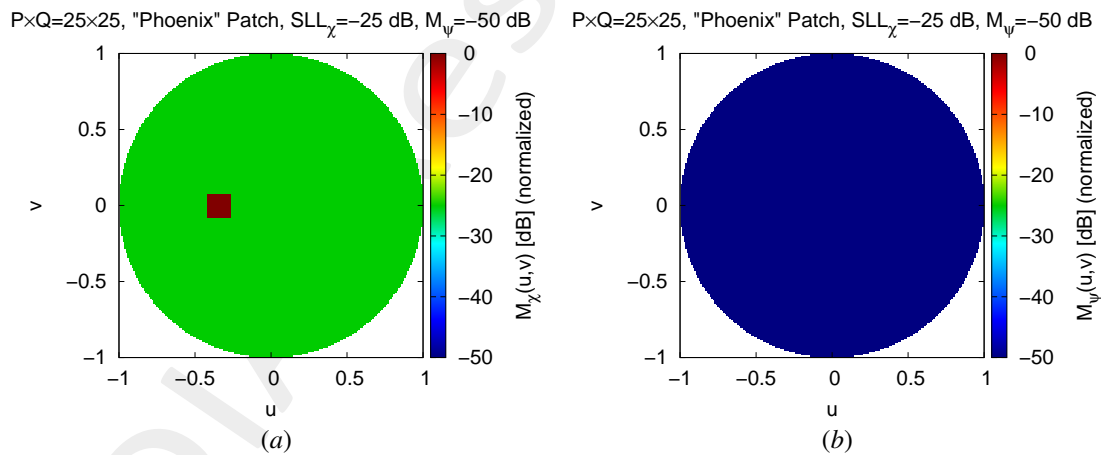


Figure 2: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-25 dB - Optimization target: SLL on the wanted polarization(a), mask on the unwanted polarization (b).

### 1.3 Optimization results

#### 1.3.1 Cost Function

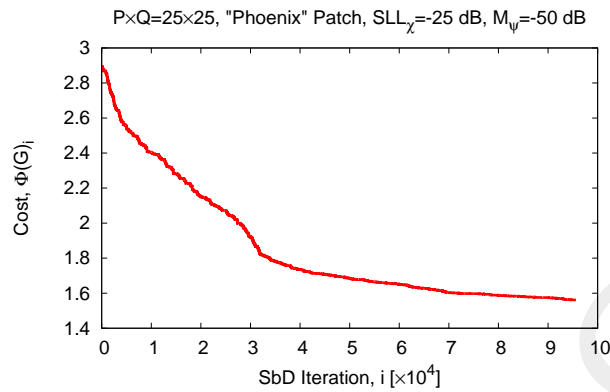


Figure 3: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-25 dB - Optimization: Cost function behavior.

#### 1.3.2 Geometrical Design

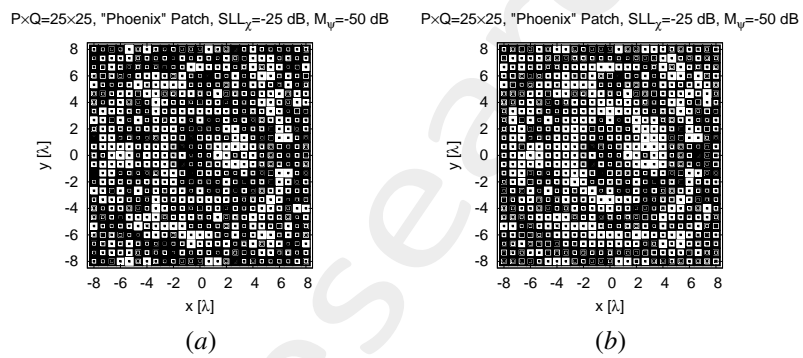


Figure 4: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-25 dB - Optimization: Starting reflectarray configuration(a) and optimized reflectarray configuration (b).

### 1.3.3 Reflection Coefficient

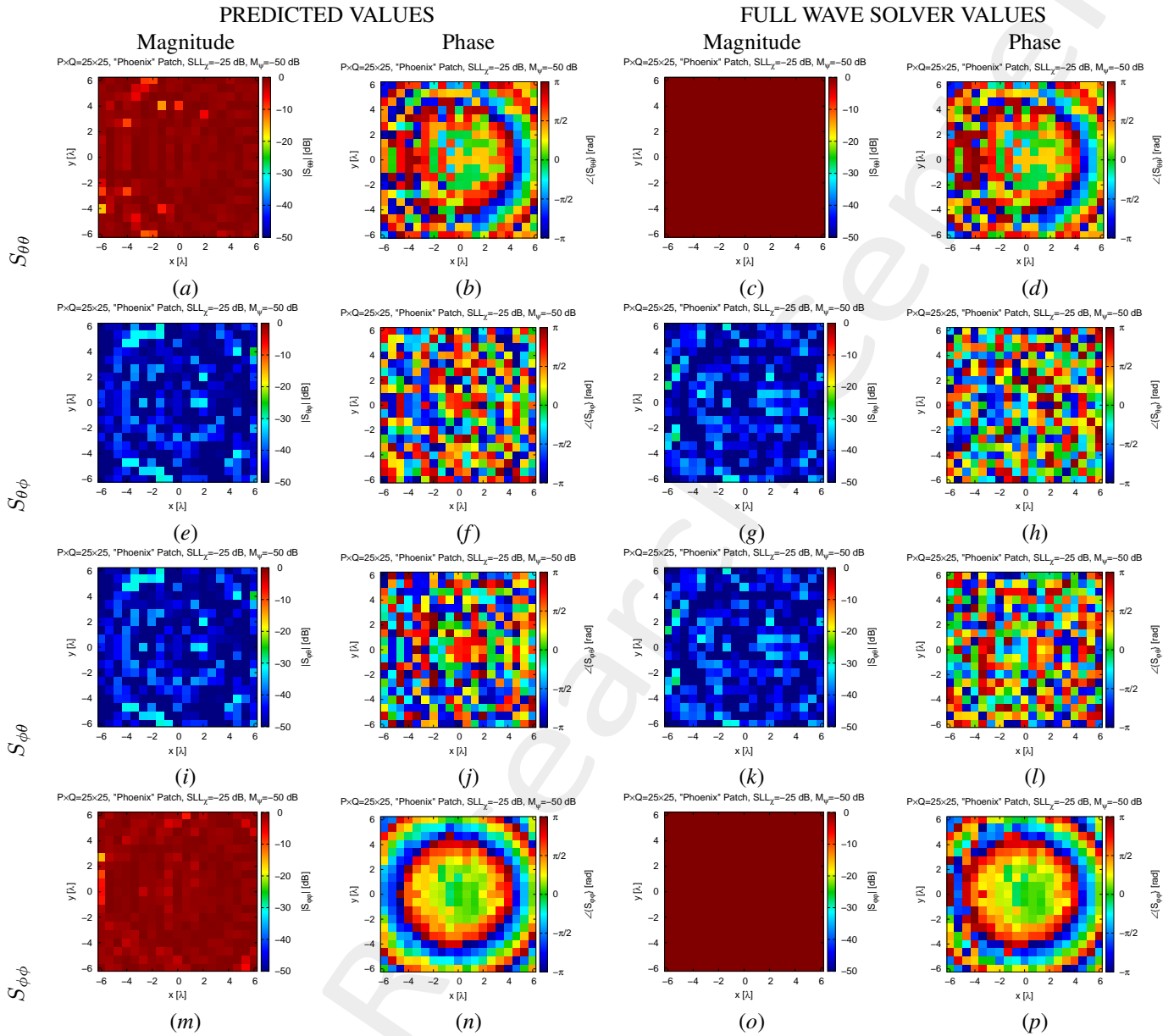


Figure 5: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-25 dB - Optimization - Reflection Coefficients: predicted(a)(b)(e)(f)(i)(j)(m)(n) vs. full-wave simulation (c)(d)(g)(h)(k)(l)(o)(p) of the magnitude(a)(c)(e)(g)(i)(k)(m)(o) and phase (b)(d)(f)(h)(j)(l)(n)(p) of  $S_{\theta\theta}$ (a)(b)(c)(d),  $S_{\theta\phi}$ (e)(f)(g)(h),  $S_{\phi\theta}$ (i)(j)(k)(l) and  $S_{\phi\phi}$ (m)(n)(o)(p).

### 1.3.4 Superficial Currents

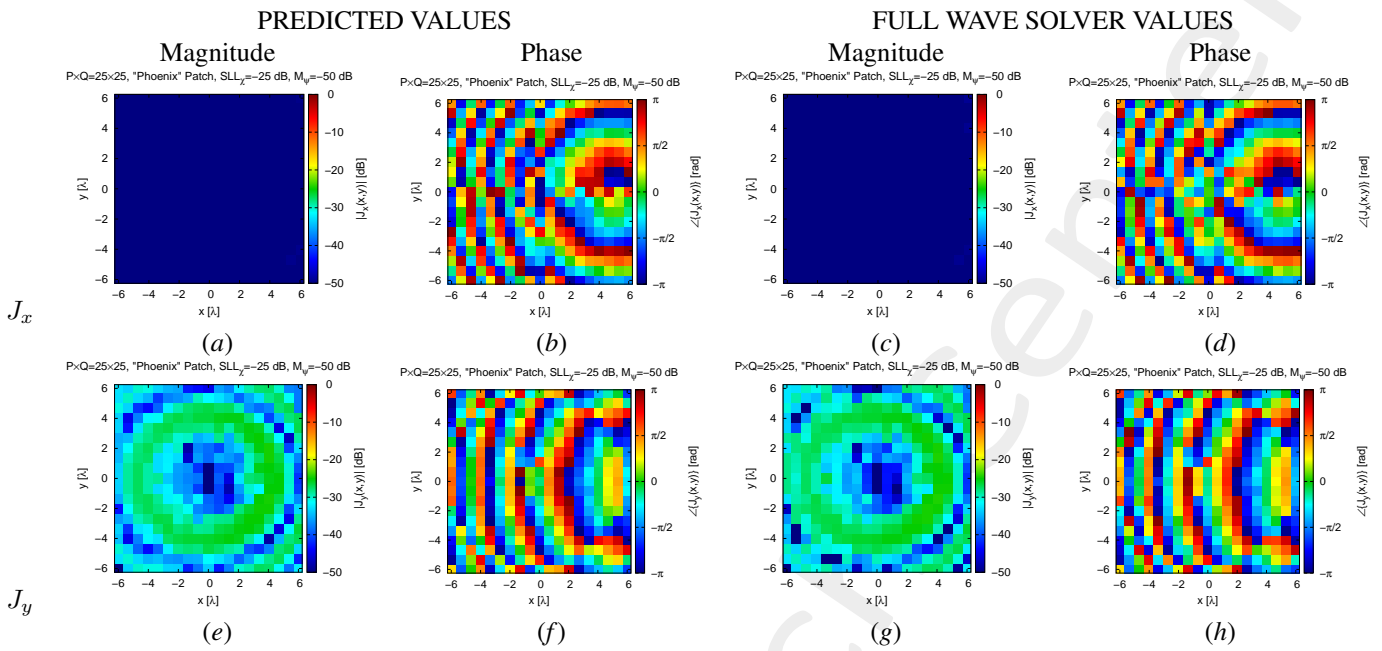


Figure 6: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-25 dB - Optimization - Superficial Currents: predicted(a)(b)(e)(f) vs. full-wave simulation (c)(d)(g)(h)of the magnitude(a)(c)(e)(g) and phase (b)(d)(f)(h) of  $J_x$ (a)(b)(c)(d) and  $J_y$ (e)(f)(g)(h).

### 1.3.5 Fields

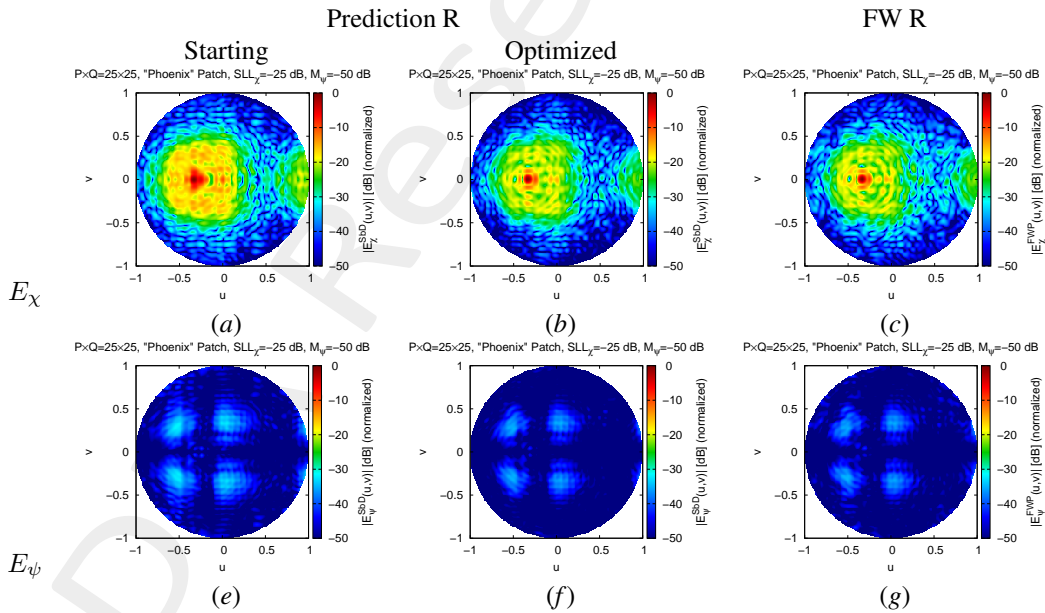


Figure 7: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-25 dB - Optimization - Radiated Fields: predicted(a)(b)(e)(f) vs. full-wave simulation of R (c)(g) vs. full-wave simulation of the entire structure (d)(h) of the magnitude of  $E_\chi$ (a)(b)(c)(d) and  $E_\psi$ (e)(f)(g)(h).

### 1.3.6 Fields Cut

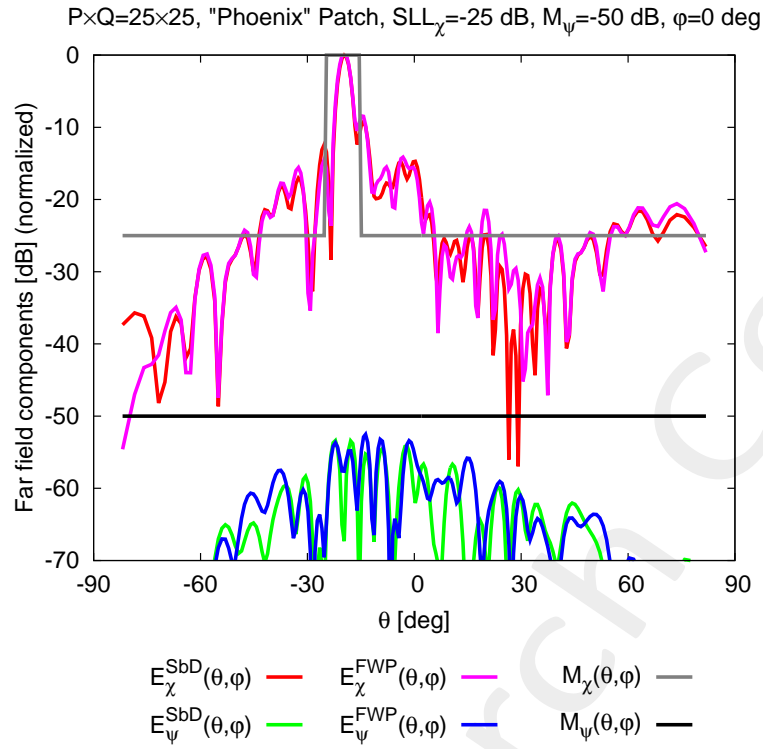


Figure 8: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-25 dB - Optimization - Radiated Field Cut with the comparison.



## 2 Phoenix Patch Reflectarray: 25x25 SLL=-20dB

### 2.1 Optimization target

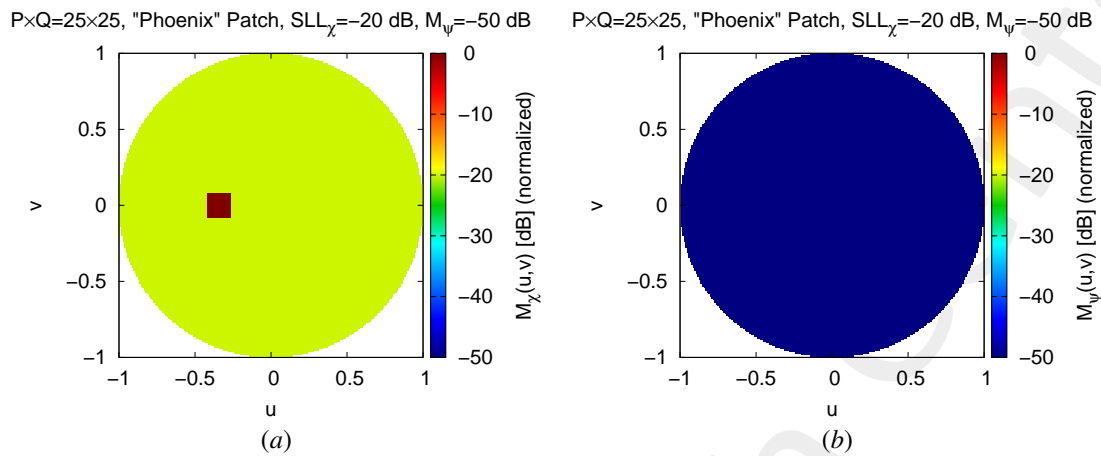


Figure 9: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB - Optimization target: SLL on the wanted polarization(a), mask on the unwanted polarization (b).

### 2.2 Optimization results

#### 2.2.1 Cost Function

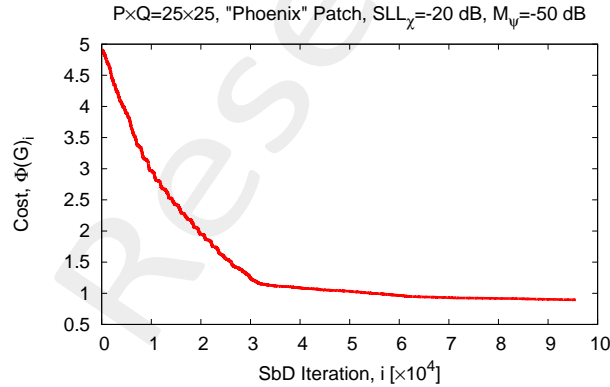


Figure 10: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB - Optimization: Cost function behavior.

## 2.2.2 Geometrical Design

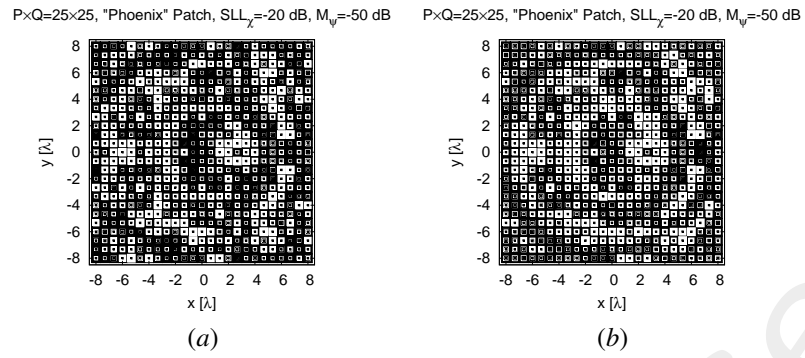


Figure 11: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB - Optimization: Starting reflectarray configuration(a) and optimized reflectarray configuration (b).

### 2.2.3 Reflection Coefficient

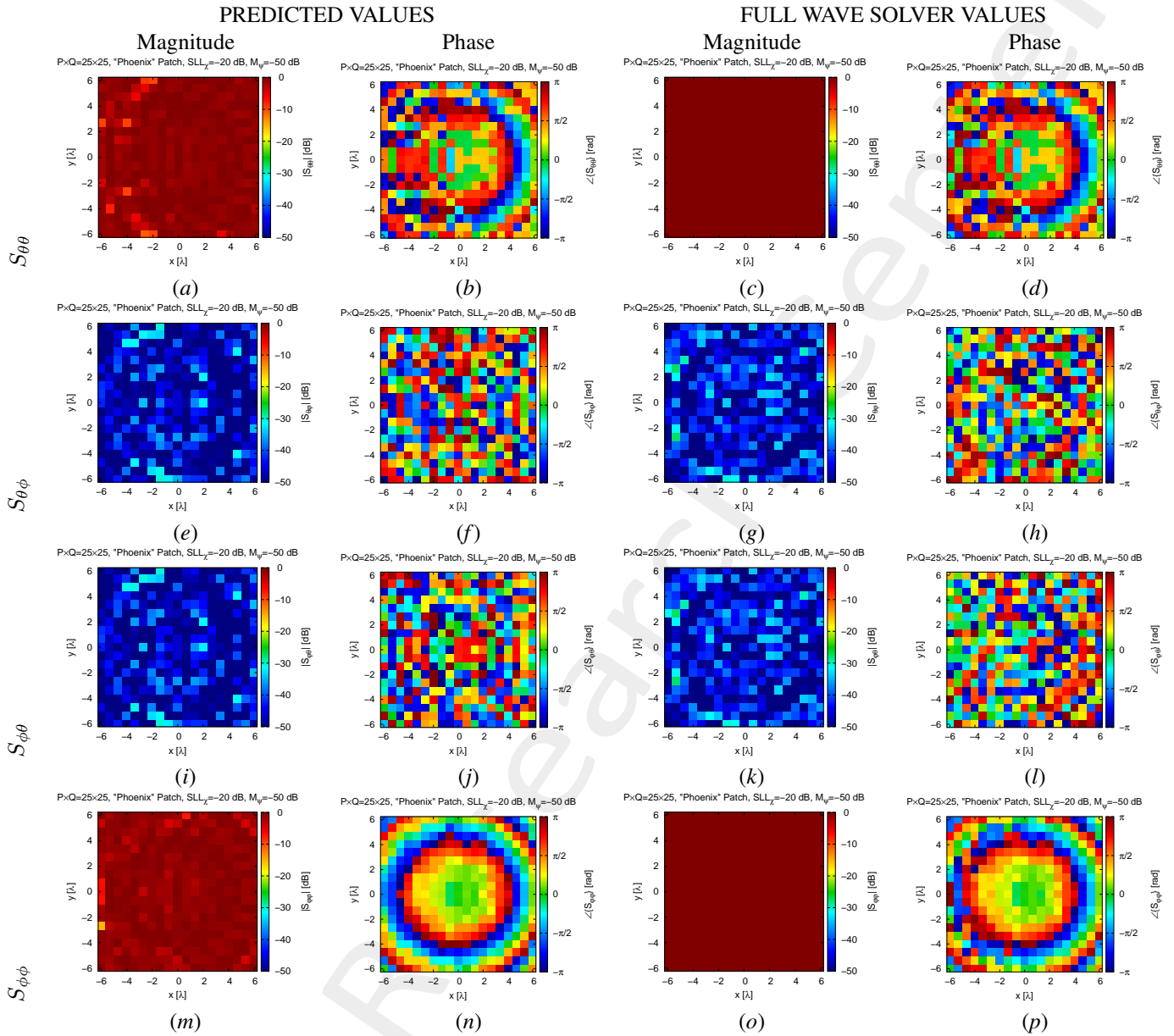


Figure 12: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB - Optimization - Reflection Coefficients: predicted(a)(b)(e)(f)(i)(j)(m)(n) vs. full-wave simulation (c)(d)(g)(h)(k)(l)(o)(p) of the magnitude(a)(c)(e)(g)(i)(k)(m)(o) and phase (b)(d)(f)(h)(j)(l)(n)(p) of  $S_{\theta\theta}$ (a)(b)(c)(d),  $S_{\theta\phi}$ (e)(f)(g)(h),  $S_{\phi\theta}$ (i)(j)(k)(l) and  $S_{\phi\phi}$ (m)(n)(o)(p).

## 2.2.4 Superficial Currents

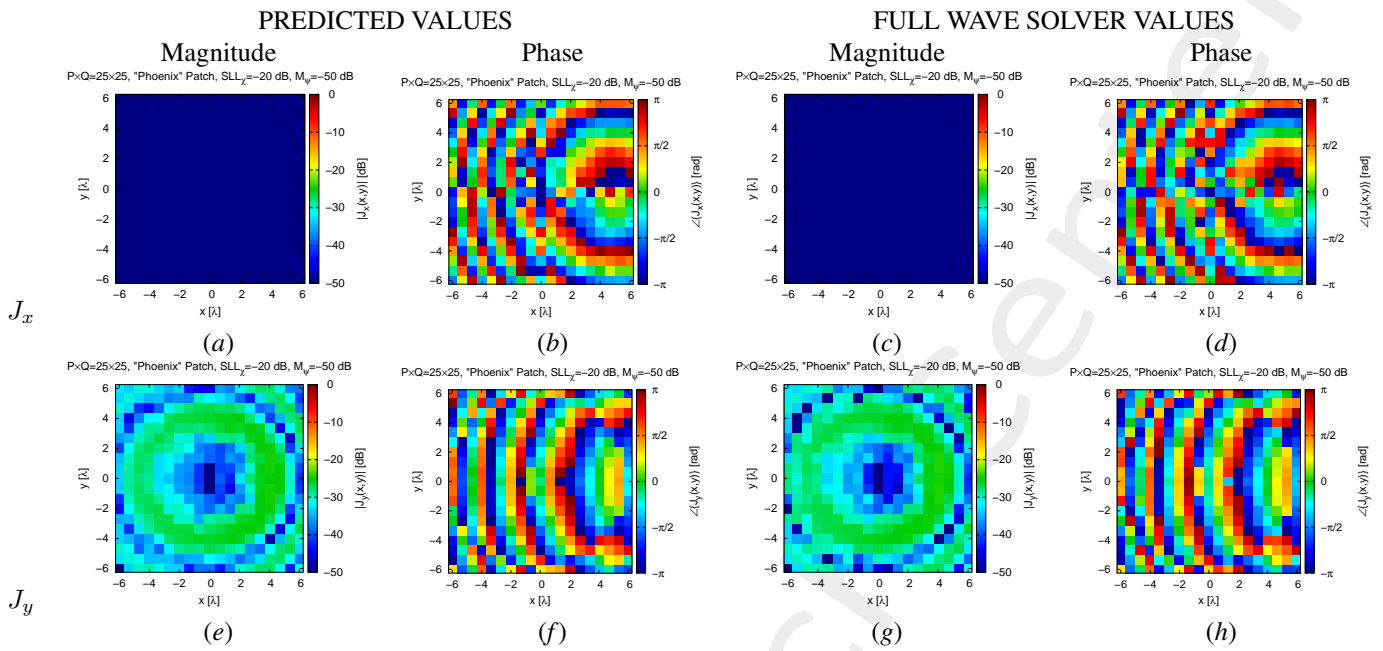


Figure 13: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB - Optimization - Superficial Currents: predicted(a)(b)(e)(f) vs. full-wave simulation (c)(d)(g)(h)of the magnitude(a)(c)(e)(g) and phase (b)(d)(f)(h) of  $J_x$ (a)(b)(c)(d) and  $J_y$ (e)(f)(g)(h).

## 2.2.5 Fields

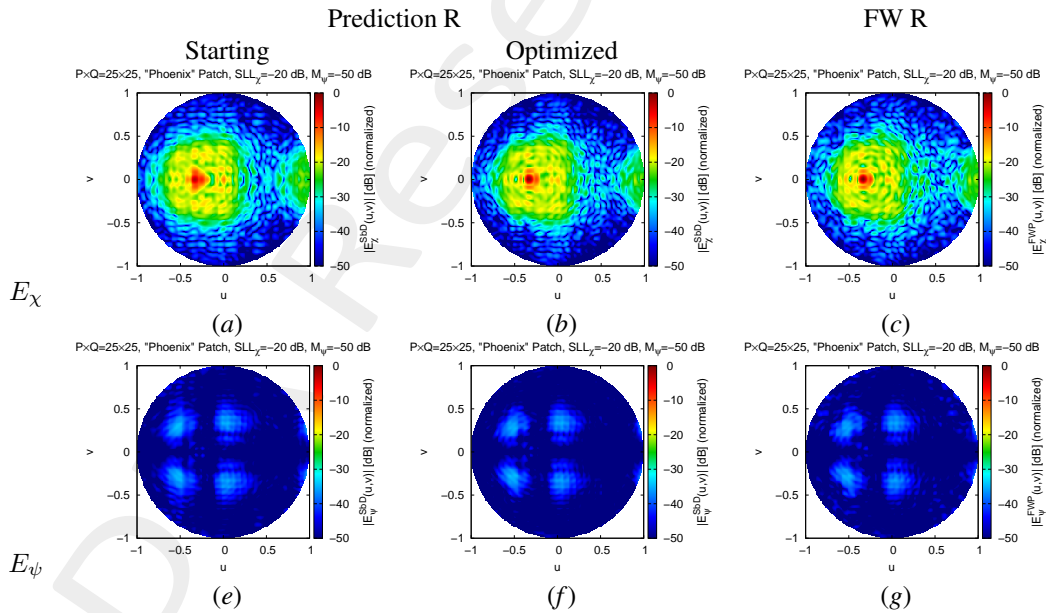


Figure 14: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB - Optimization - Radiated Fields: predicted(a)(b)(e)(f) vs. full-wave simulation of R (c)(g) vs. full-wave simulation of the entire structure (d)(h) of the magnitude of  $E_\chi$ (a)(b)(c)(d) and  $E_\psi$ (e)(f)(g)(h).

## 2.2.6 Fields Cut

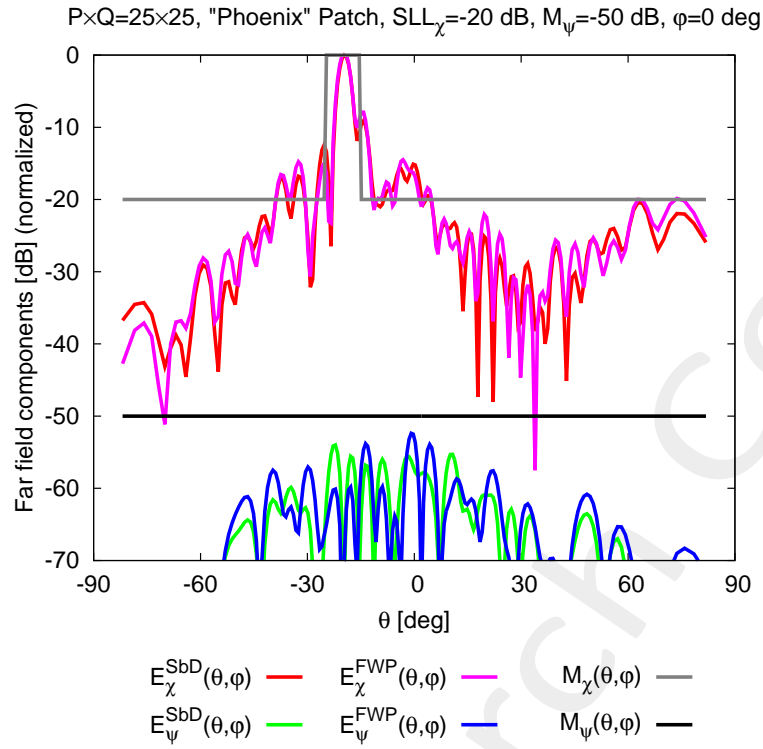


Figure 15: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB - Optimization - Radiated Field Cut with the comparison.

### 3 Phoenix Patch Reflectarray: 25x25 SLL=-20dB notch $\theta = 20$ deg SLL=-30 dB

#### 3.1 Optimization target

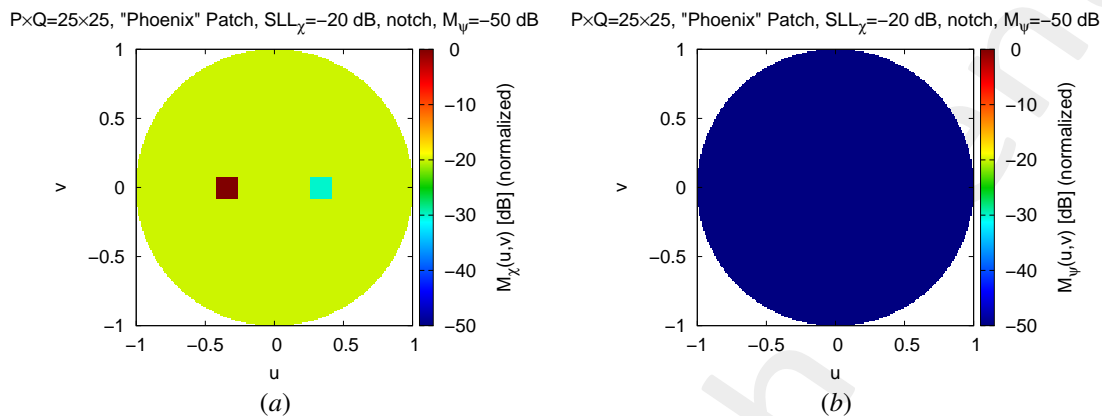


Figure 16: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB notch  $\theta = 20$  deg SLL=-30 dB - Optimization target: SLL on the wanted polarization(a), mask on the unwanted polarization (b).

#### 3.2 Optimization results

##### 3.2.1 Cost Function

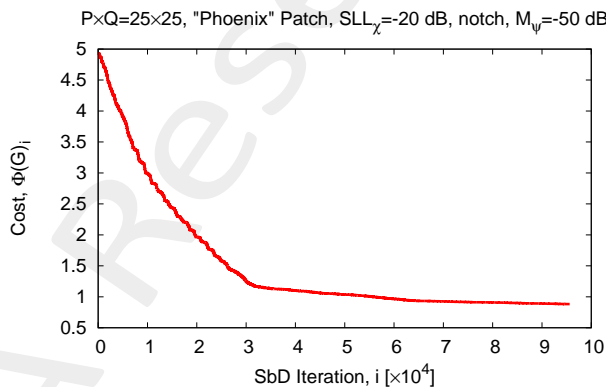


Figure 17: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB notch  $\theta = 20$  deg SLL=-30 dB - Optimization: Cost function behavior.

### 3.2.2 Geometrical Design

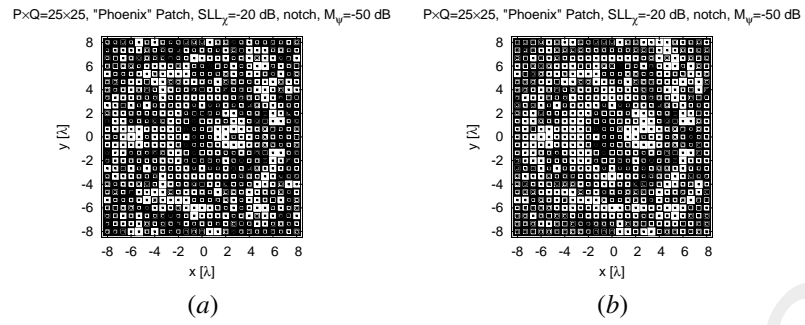


Figure 18: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB notch  $\theta = 20$  deg SLL=-30 dB - Optimization: Starting reflectarray configuration (a) and optimized reflectarray configuration (b).

### 3.2.3 Reflection Coefficient

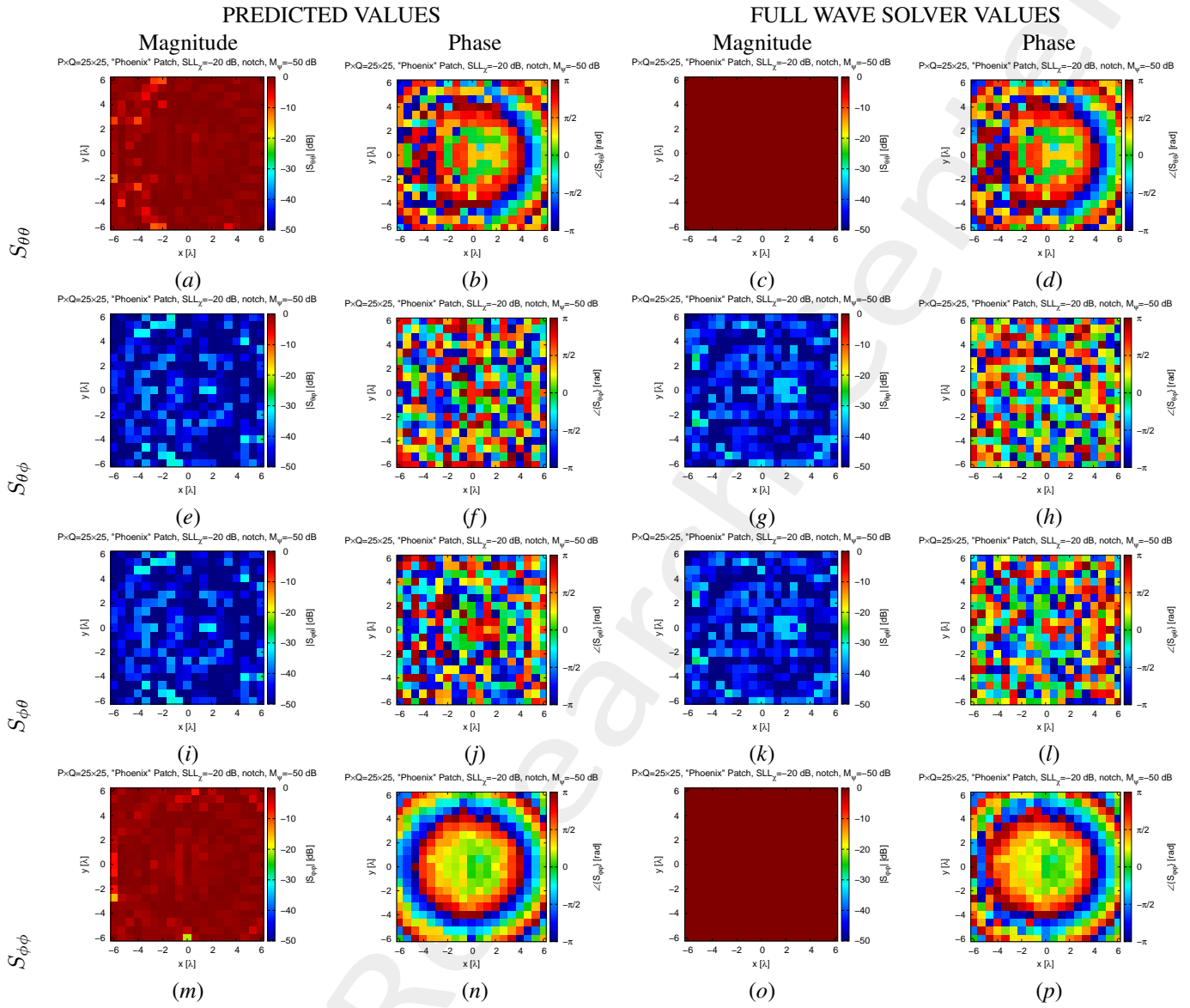


Figure 19: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB notch  $\theta = 20$  deg SLL=-30 dB - Optimization - Reflection Coefficients: predicted (a)(b)(e)(f)(i)(j)(m)(n) vs. full-wave simulation (c)(d)(g)(h)(k)(l)(o)(p) of the magnitude (a)(c)(e)(g)(i)(k)(m)(o) and phase (b)(d)(f)(h)(j)(l)(n)(p) of  $S_{\theta\theta}$ (a)(b)(c)(d),  $S_{\theta\phi}$ (e)(f)(g)(h),  $S_{\phi\theta}$ (i)(j)(k)(l) and  $S_{\phi\phi}$ (m)(n)(o)(p).



### 3.2.4 Superficial Currents

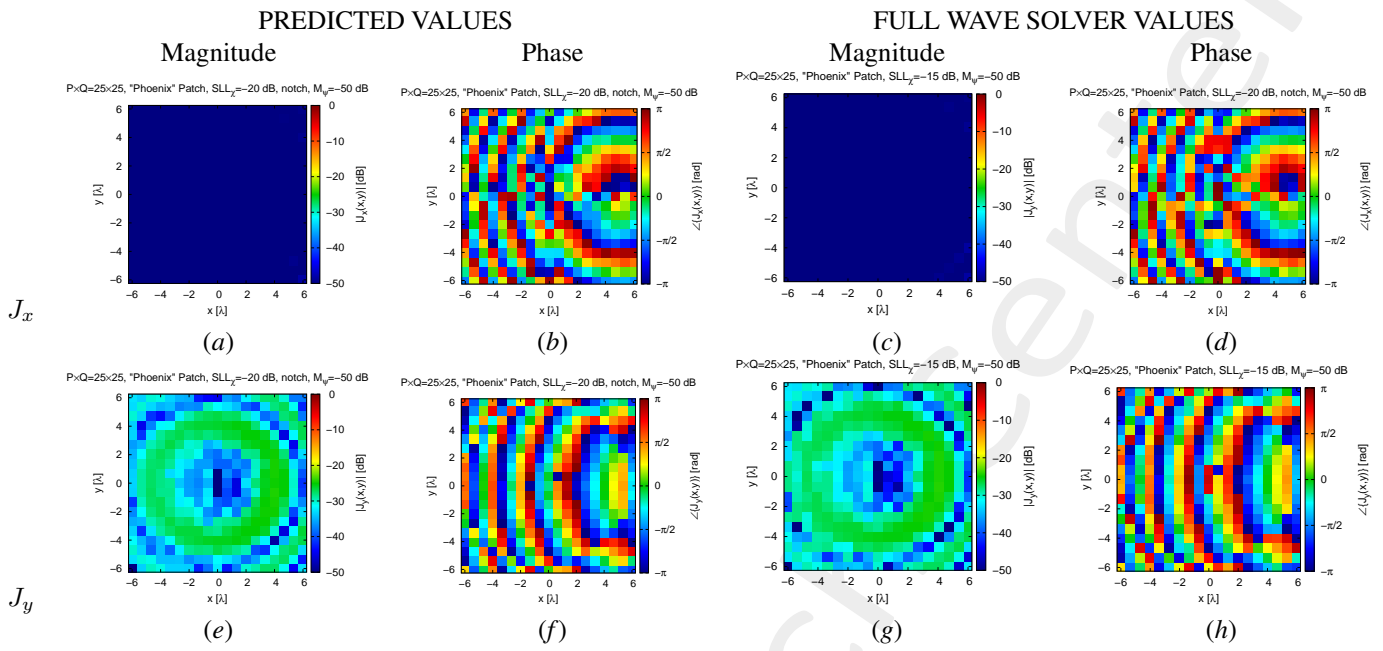


Figure 20: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB notch  $\theta = 20$  deg SLL=-30 dB - Optimization - Superficial Currents: predicted(a)(b)(e)(f) vs. full-wave simulation (c)(d)(g)(h) of the magnitude(a)(c)(e)(g) and phase (b)(d)(f)(h) of  $J_x$ (a)(b)(c)(d) and  $J_y$ (e)(f)(g)(h).

### 3.2.5 Fields

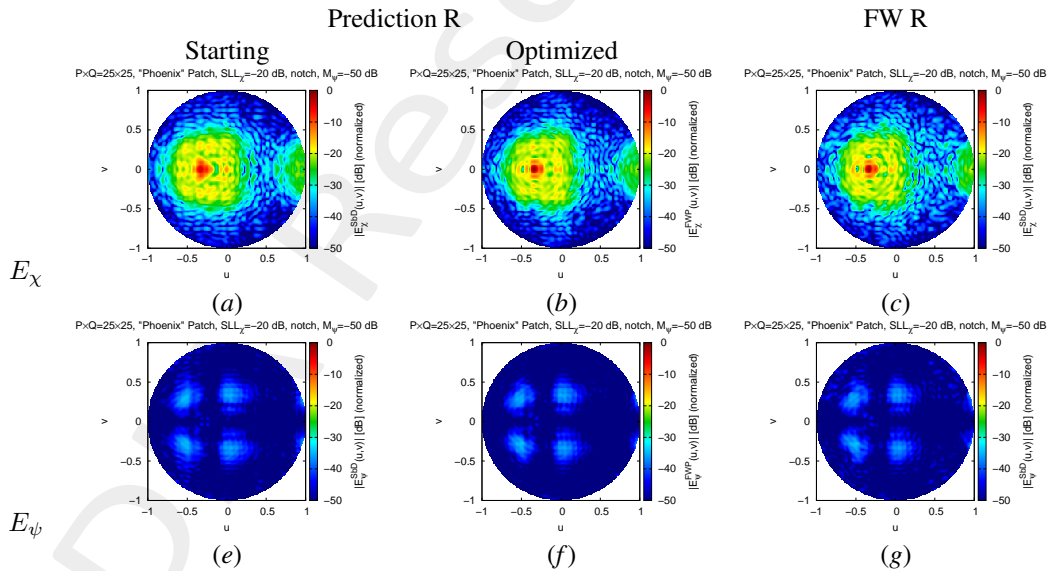


Figure 21: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB notch  $\theta = 20$  deg SLL=-30 dB - Optimization - Radiated Fields: predicted(a)(b)(e)(f) vs. full-wave simulation of R (c)(g) vs. full-wave simulation of the entire structure (d)(h) of the magnitude of  $E_\chi$ (a)(b)(c)(d) and  $E_\psi$ (e)(f)(g)(h).

### 3.2.6 Fields Cut

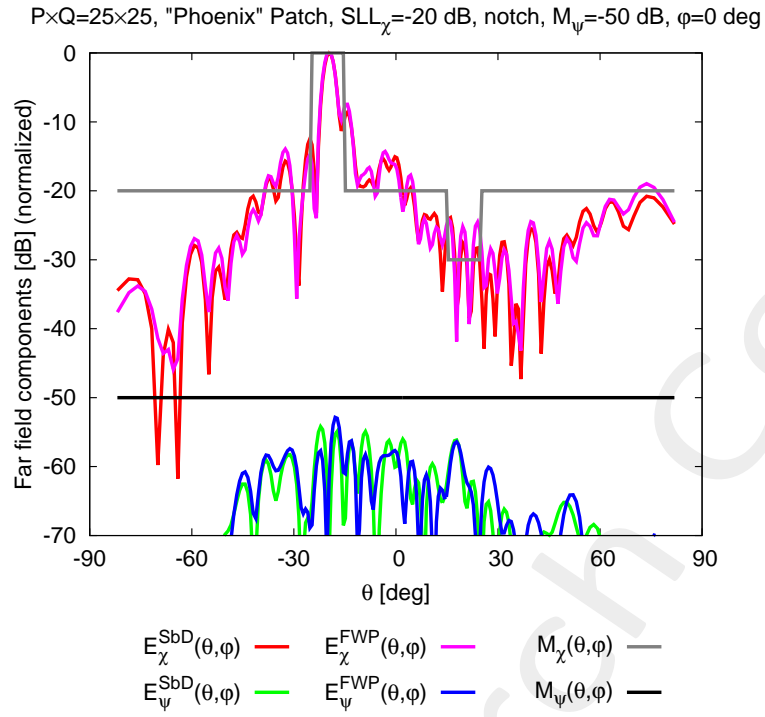


Figure 22: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB notch  $\theta = 20$  deg SLL=-30 dB - Optimization - Radiated Field Cut with the comparison.

## 4 Phoenix Patch Reflectarray: 25x25 SLL=-15dB

### 4.1 Optimization target

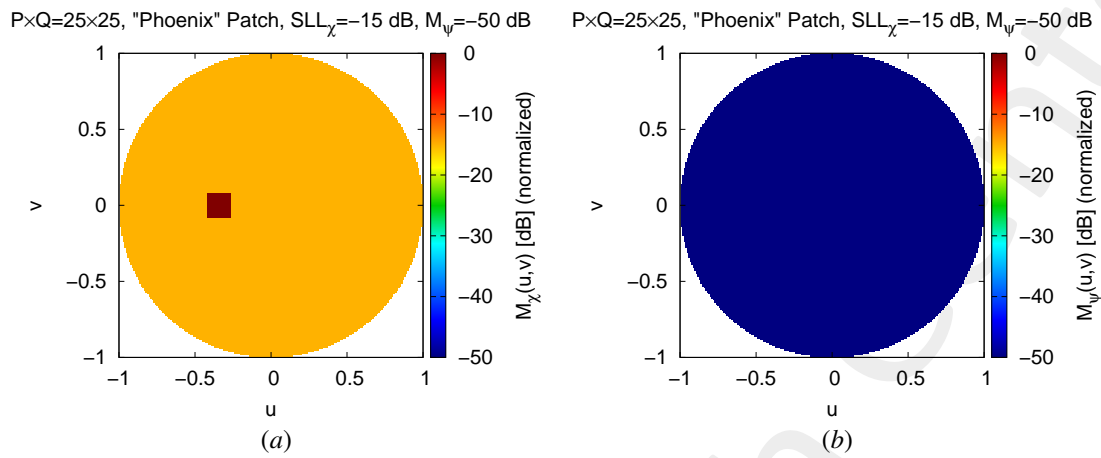


Figure 23: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-15 dB - Optimization target: SLL on the wanted polarization(a), mask on the unwanted polarization (b).

### 4.2 Optimization results

#### 4.2.1 Cost Function

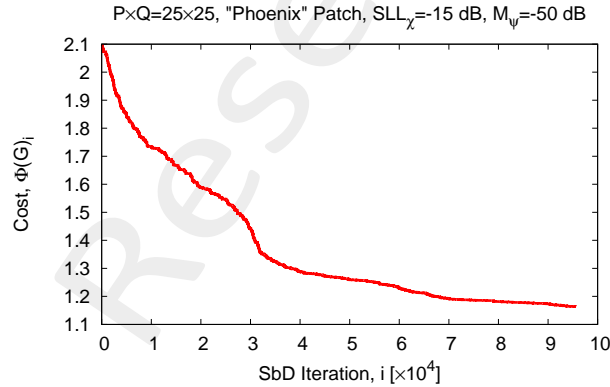


Figure 24: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-15 dB - Optimization: Cost function behavior.

## 4.2.2 Geometrical Design

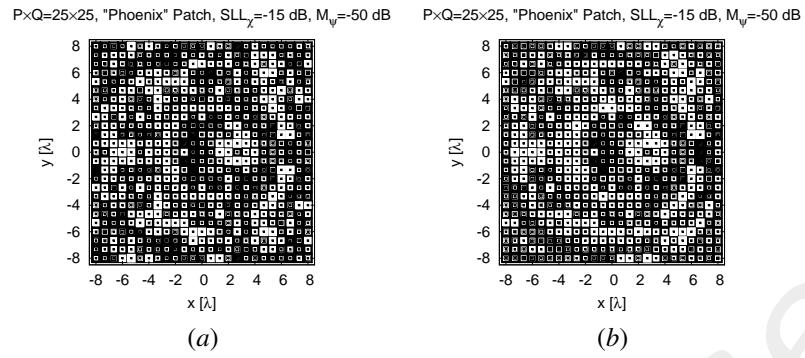


Figure 25: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-15 dB - Optimization: Starting reflectarray configuration(a) and optimized reflectarray configuration (b).

### 4.2.3 Reflection Coefficient

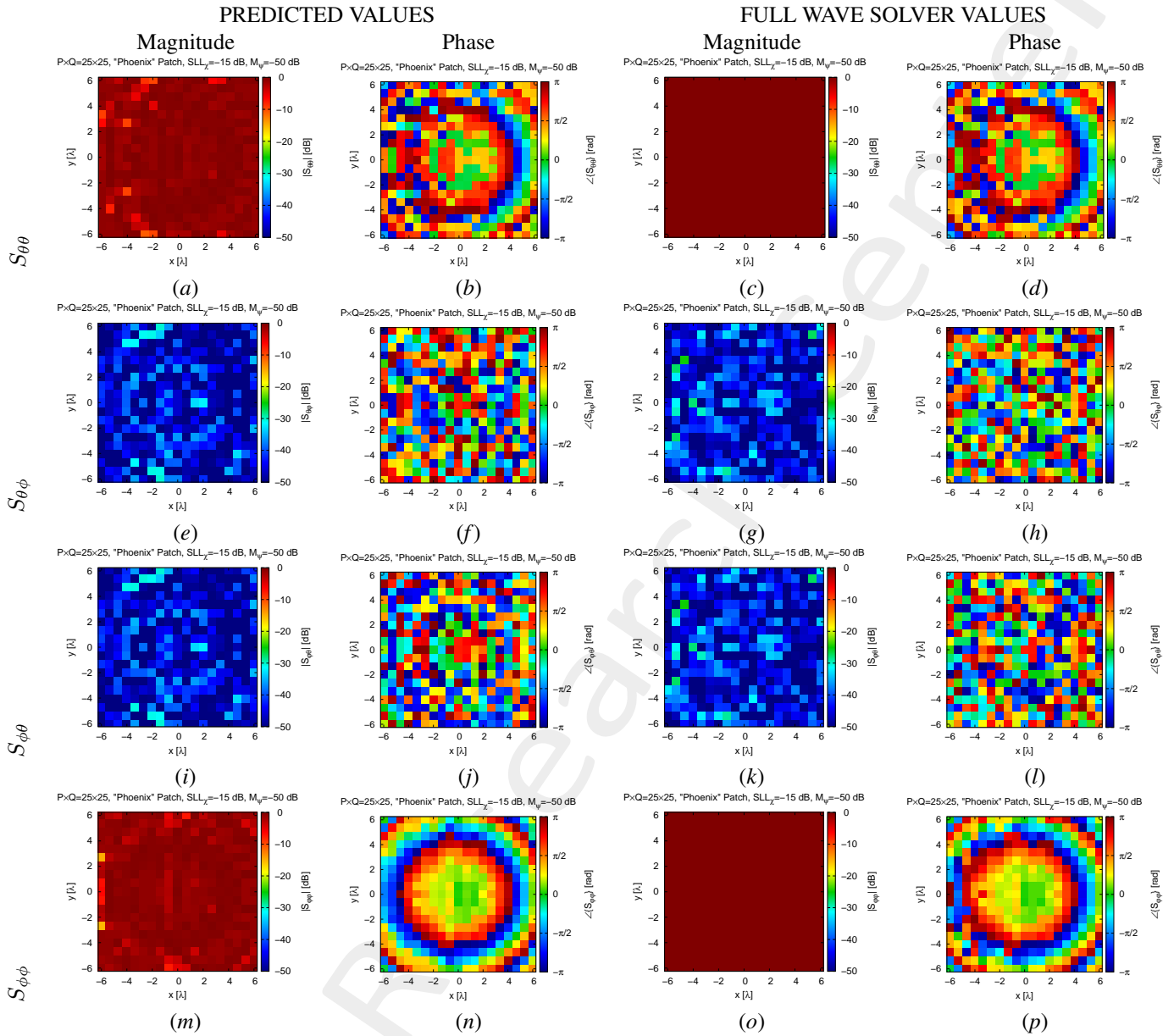


Figure 26: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-15 dB - Optimization - Reflection Coefficients: predicted(a)(b)(e)(f)(i)(j)(m)(n) vs. full-wave simulation (c)(d)(g)(h)(k)(l)(o)(p) of the magnitude(a)(c)(e)(g)(i)(k)(m)(o) and phase (b)(d)(f)(h)(j)(l)(n)(p) of  $S_{\theta\theta}$ (a)(b)(c)(d),  $S_{\theta\phi}$ (e)(f)(g)(h),  $S_{\phi\theta}$ (i)(j)(k)(l) and  $S_{\phi\phi}$ (m)(n)(o)(p).

#### 4.2.4 Superficial Currents

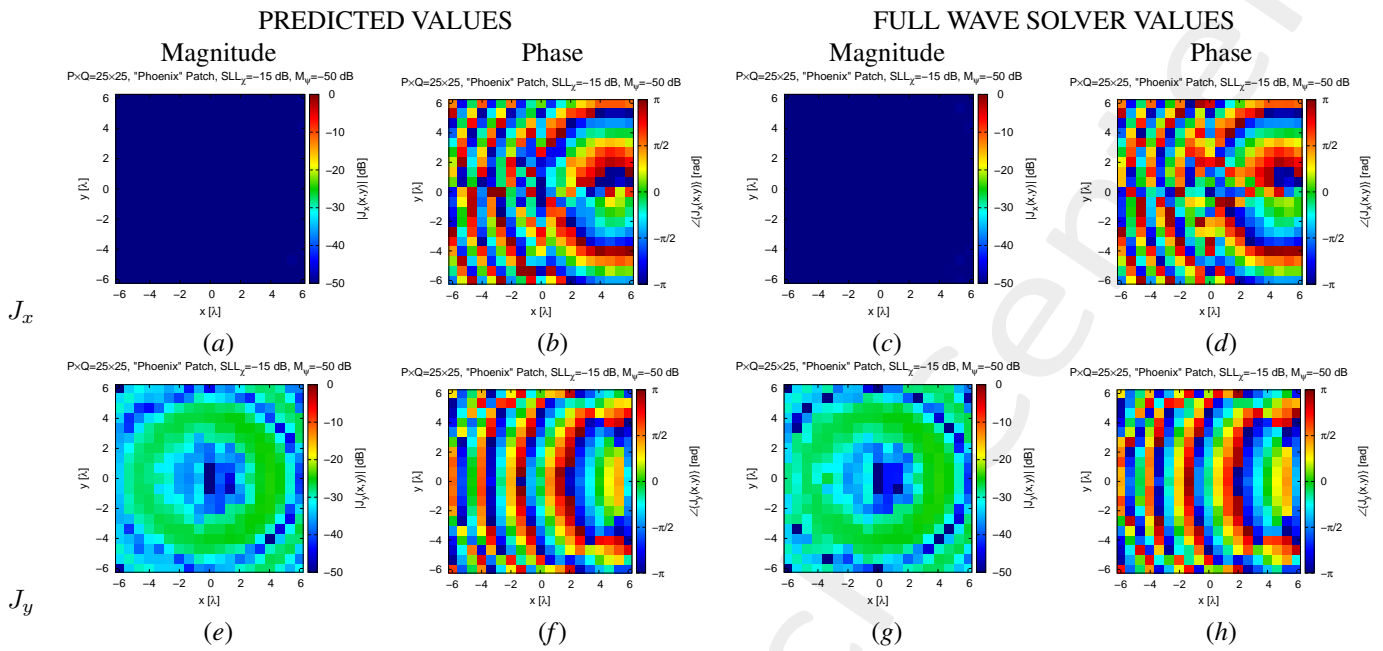


Figure 27: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-20 dB - Optimization - Superficial Currents: predicted(a)(b)(e)(f) vs. full-wave simulation (c)(d)(g)(h)of the magnitude(a)(c)(e)(g) and phase (b)(d)(f)(h) of  $J_x$ (a)(b)(c)(d) and  $J_y$ (e)(f)(g)(h).

#### 4.2.5 Fields

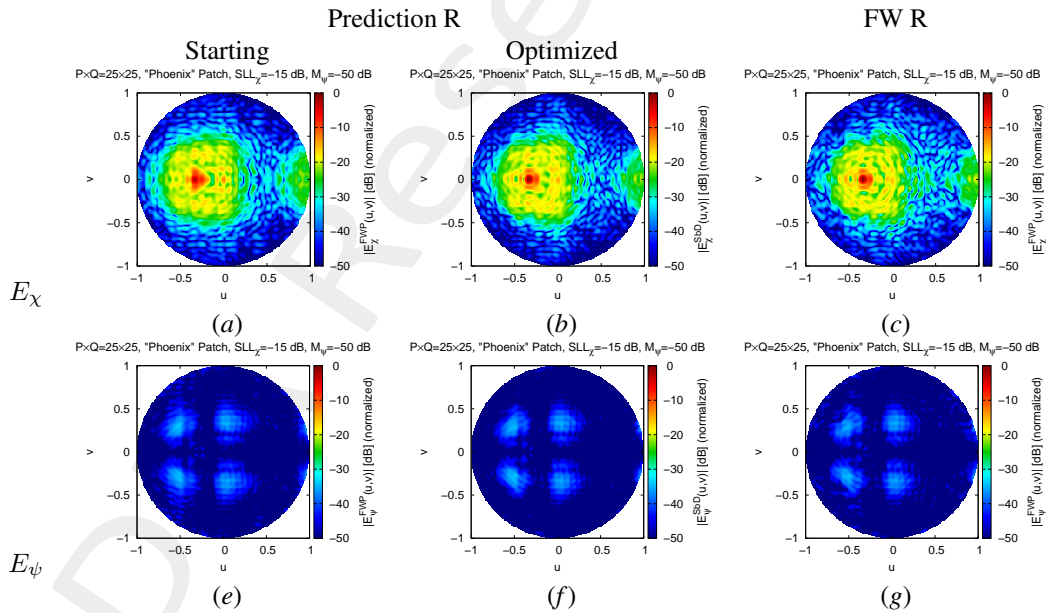


Figure 28: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-15 dB - Optimization - Radiated Fields: predicted(a)(b)(e)(f) vs. full-wave simulation of R (c)(g) vs. full-wave simulation of the entire structure (d)(h) of the magnitude of  $E_x$ (a)(b)(c)(d) and  $E_\psi$ (e)(f)(g)(h).

#### 4.2.6 Fields Cut

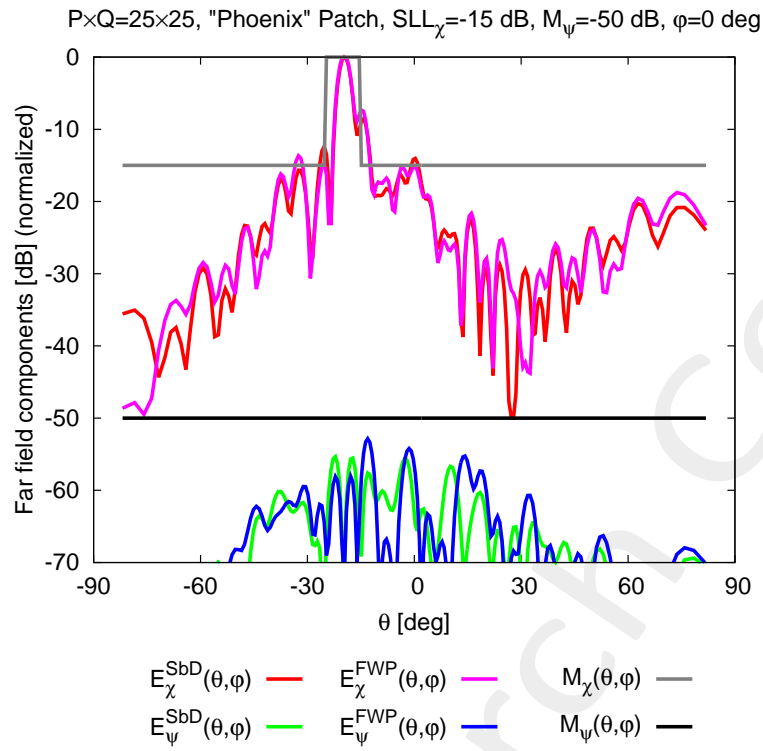


Figure 29: Phoenix Patch Reflectarray  $25 \times 25$  SLL=-15 dB - Optimization - Radiated Field Cut with the comparison.

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More information on the topics of this document can be found in the following list of references.

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