Innovative Synthesis of WAIM Layers for Waveguide-Fed Planar Phased Arrays

G. Oliveri, M. Salucci, N. Anselmi, and A. Massa

Abstract

This work deals with the design of wide-angle impedance matching (*WAIM*) layers aimed at mitigating reflection issues arising in waveguide-fed planar phased arrays. The synthesis problem is formulated within the System-by-Design (*SbD*) framework, by minimizing the antenna input reflections caused by impedance mismatching when the array is steered through the optimization of the geometrical descriptors of the *WAIM* unit cells. Some numerical results are shown in order to assess the effectiveness of the proposed synthesis strategy.

1 Numerical Results

1.1 GUIDA D'ONDA CIRCOLARE - LATTICE ESAGONALE

Parametri Lattice:

- S1_x =$1.06680E-002$ [m]
- S1_y = 0.000 [m]
- S2_x = $5.33400E-003$ [m]
- S2_y =$9.23876E-003$ [m]

Parametri Waveguide:

- Raggio = $4.191E-003$ [m]
- eps = 2.54
- Frequency: f= 15.25 [GHz]

1.1.1 FORMA: Croce "1a"

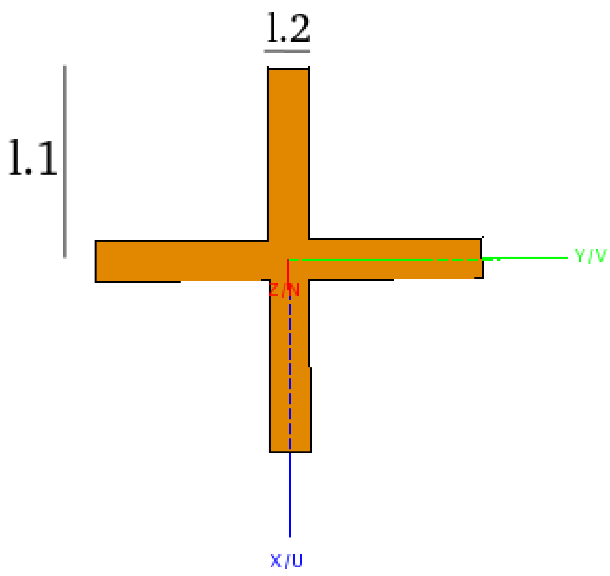
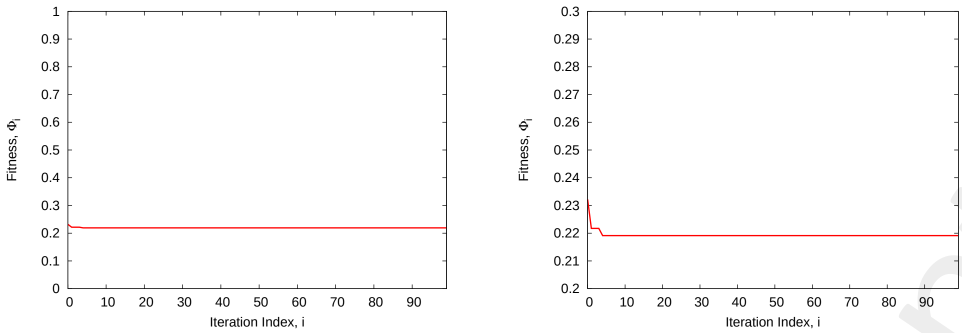
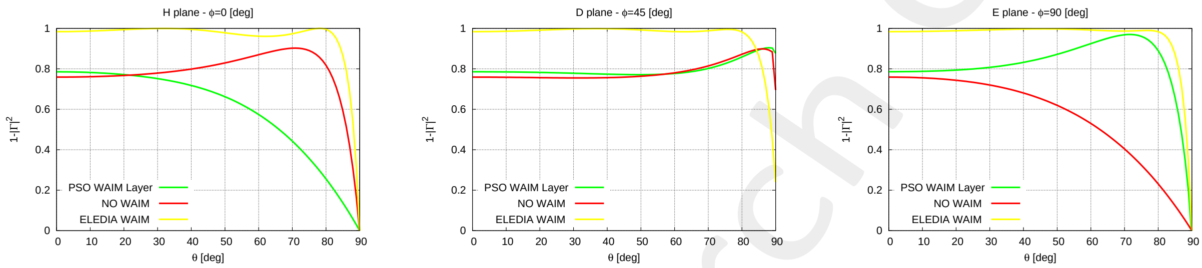


Figure 1: Croce, modello FEKO



a) b)

Figure 2: a) Fitness , b) zoom



a) b) c)

Figure 3: Coefficiente di Trasmissione , a) Piano H, b) Piano D, c) Piano E

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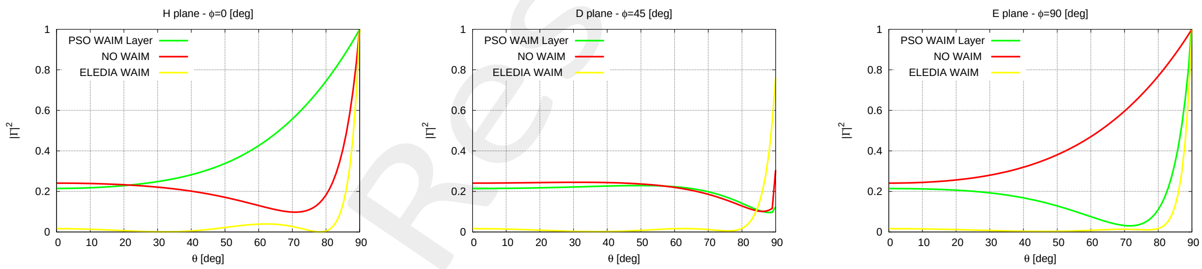
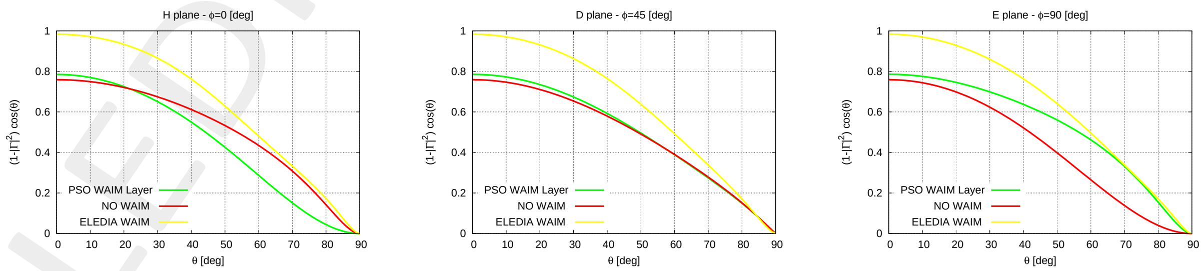


a) b) c)

Figure 4: Coefficiente di Riflessione, a) Piano H, b) Piano D, c) Piano E



a) b) c)

Figure 5: Coefficiente di Trasmissione $\cdot \cos(\theta)$, a) Piano H, b) Piano D, c) Piano E

Note:

- La croce utilizzata, anche con lattice esagonale, non riesce a produrre risultati buoni.

1.1.2 FORMA: Croce “2” (5 croci)

Come il modello croce “1a”, è possibile modificare lunghezza e larghezza delle braccia e angolo di tilt.

- $CrossLength$
- $CrossWidth$
- $TiltAngle$

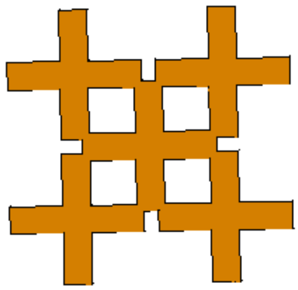
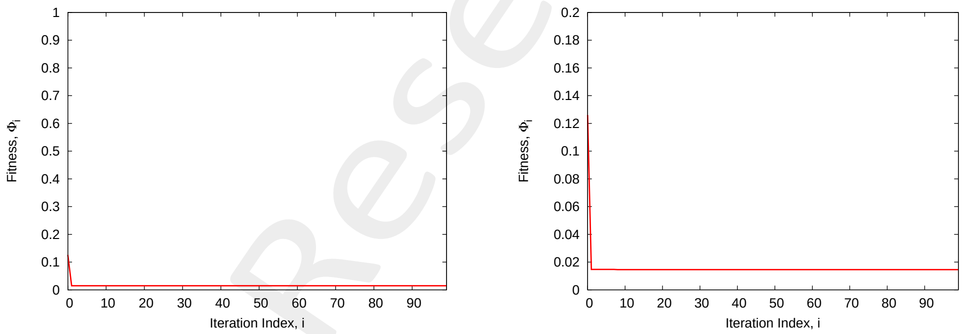


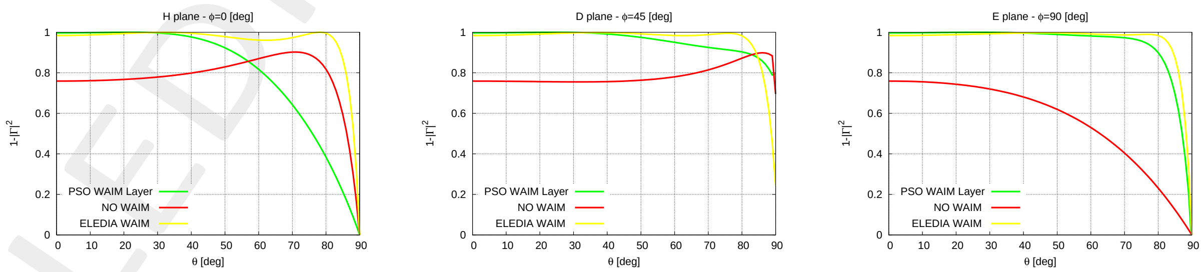
Figure 6: Croce, modello FEKO

Questa forma riporta a valori di $\varepsilon \in [1, 3]$



a) b)

Figure 7: a) Fitness , b) zoom



a) b) c)

Figure 8: Coefficiente di Trasmissione, a) Piano H, b) Piano D, c) Piano E

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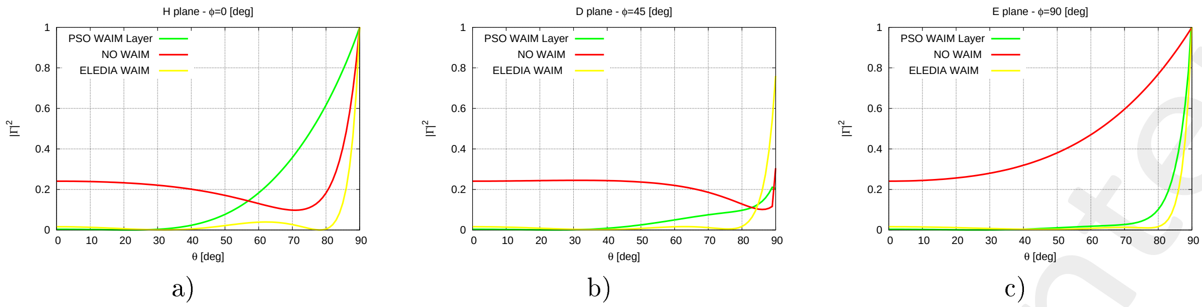
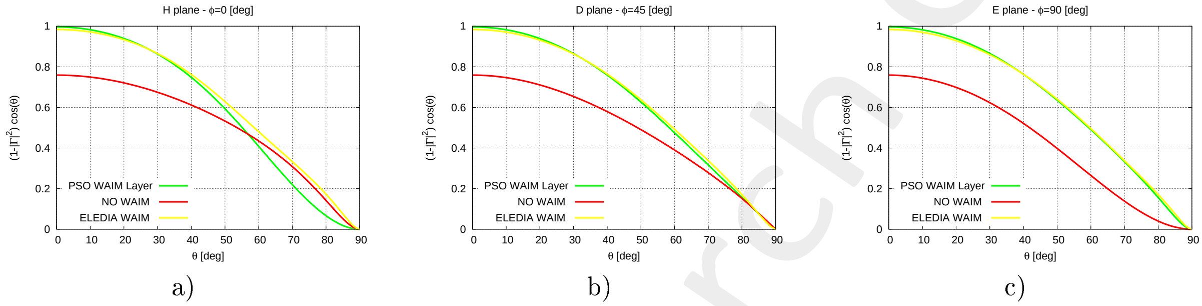


a) b) c)

Figure 9: Coefficiente di Riflessione, a) Piano H, b) Piano D, c) Piano E



a) b) c)

Figure 10: Coefficiente di Trasmissione $\cdot \cos(\theta)$, a) Piano H, b) Piano D, c) Piano E

Note:

- Questa tipo di forma del metamateriale e il tipo di lattice esagonale riesce ad ottenere risultati molto buoni, con fitness pari a $1.45E-002$ (valore minimo tra tutte le casistiche)

1.2 GUIDA D'ONDA QUADRATA - LATTICE TRIANGOLARE

Parametri Lattice:

- S1_x =1.966$E-002$ [m]
- S1_y = 0.000 [m]
- S2_x = 9.830$E-003$ [m]
- S2_y =5.675$E-003$ [m]

Parametri Waveguide:

- L = W = 7.040$E-003$ [m]
- eps = 2.54
- Frequency: f= 15.25 [GHz]

1.2.1 FORMA: Croce "1a"

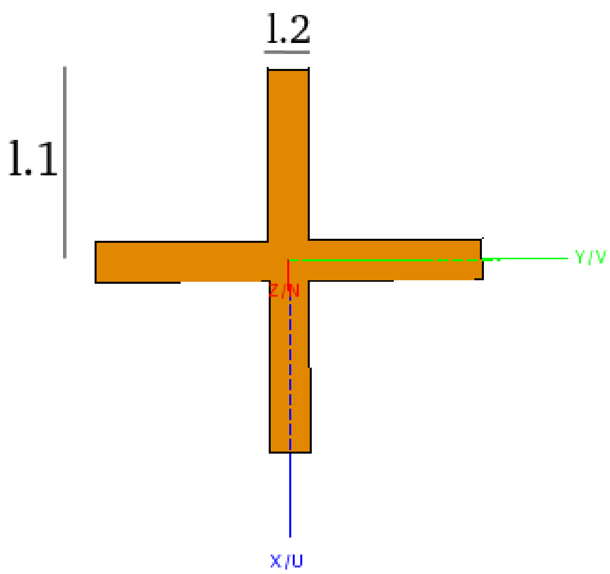
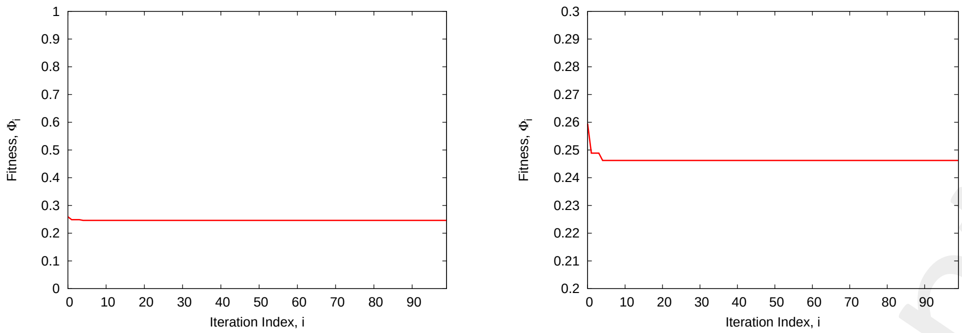
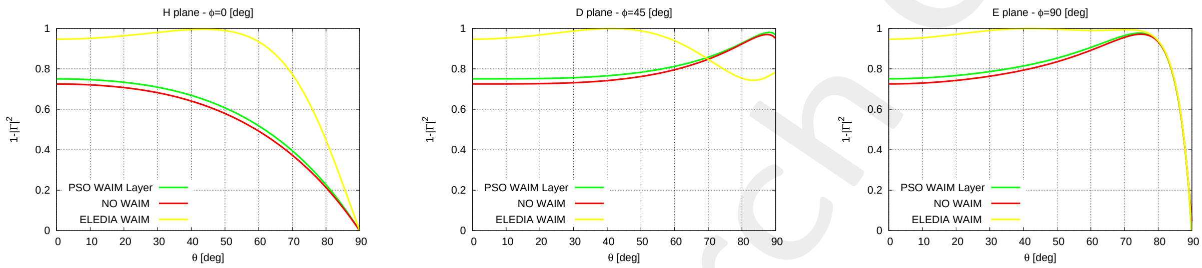


Figure 11: Croce, modello FEKO



a) b)

Figure 12: a) Fitness , b) zoom



a) b) c)

Figure 13: Coefficiente di Trasmissione , a) Piano H, b) Piano D, c) Piano E

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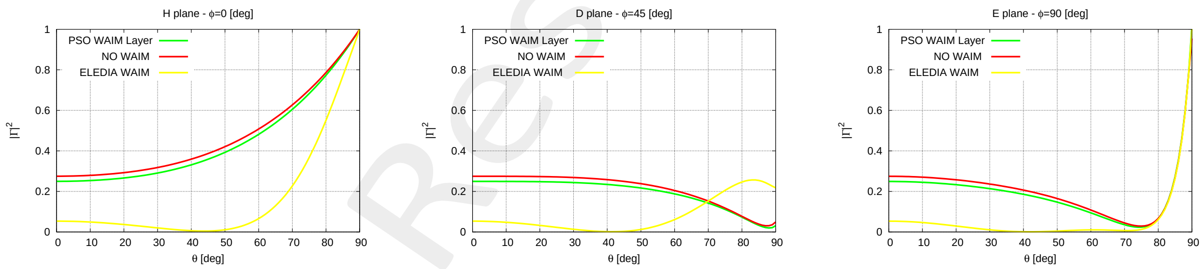
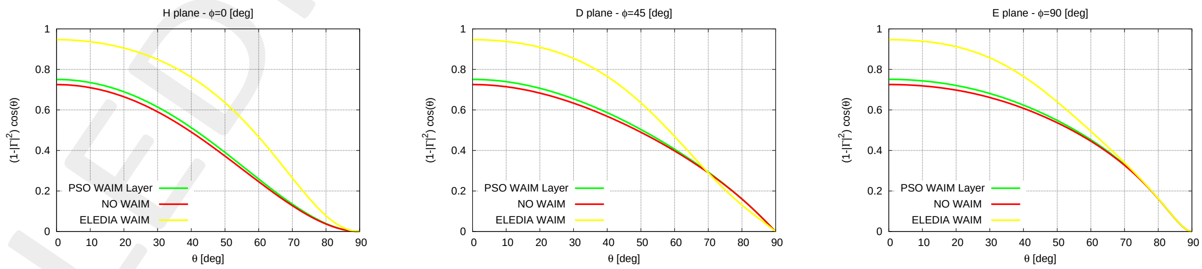


a) b) c)

Figure 14: Coefficiente di Riflessione, a) Piano H, b) Piano D, c) Piano E



a) b) c)

Figure 15: Coefficiente di Trasmissione $\cdot \cos(\theta)$, a) Piano H, b) Piano D, c) Piano E

Note:

- La croce, con guida d'onda quadrata e lattice triangolare non restituisce risultati soddisfacenti.

1.2.2 FORMA: Croce "2" (5 croci)

Come il modello croce "1a", è possibile modificare lunghezza e larghezza delle braccia e angolo di tilt.

- $CrossLength$
- $CrossWidth$
- $TiltAngle$

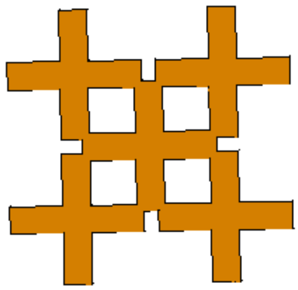
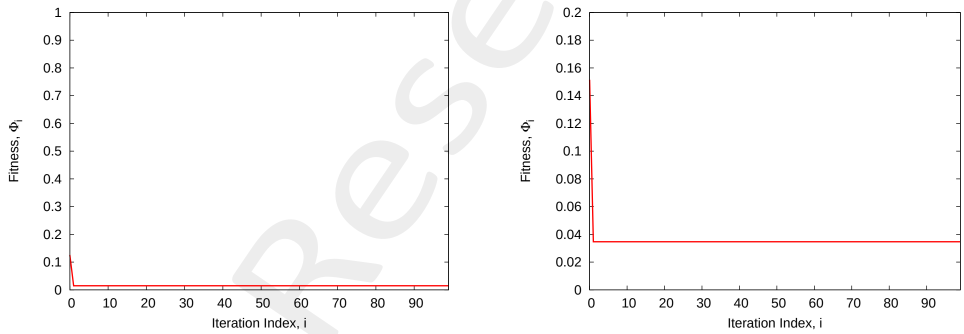


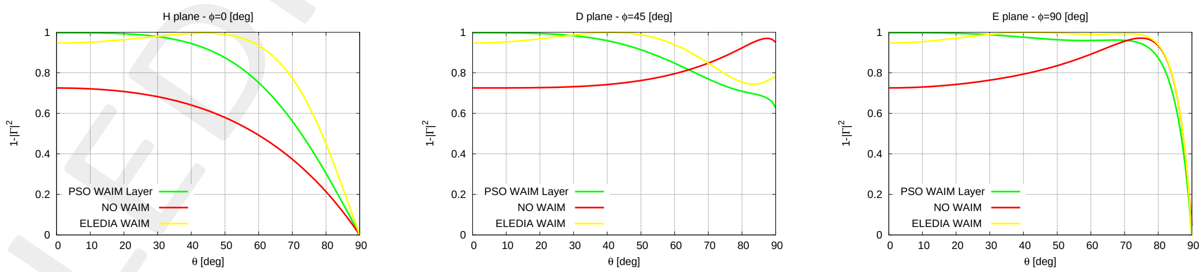
Figure 16: Croce, modello FEKO

Questa forma riporta a valori di $\varepsilon \in [1, 3]$



a) b)

Figure 17: a) Fitness , b) zoom



a) b) c)

Figure 18: Coefficiente di Trasmissione, a) Piano H, b) Piano D, c) Piano E

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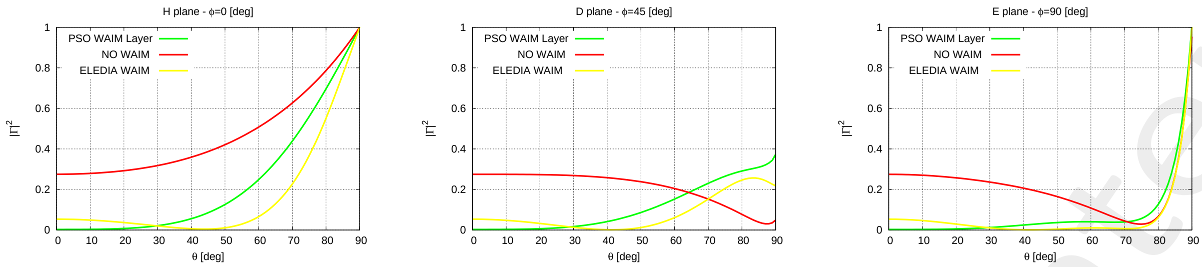
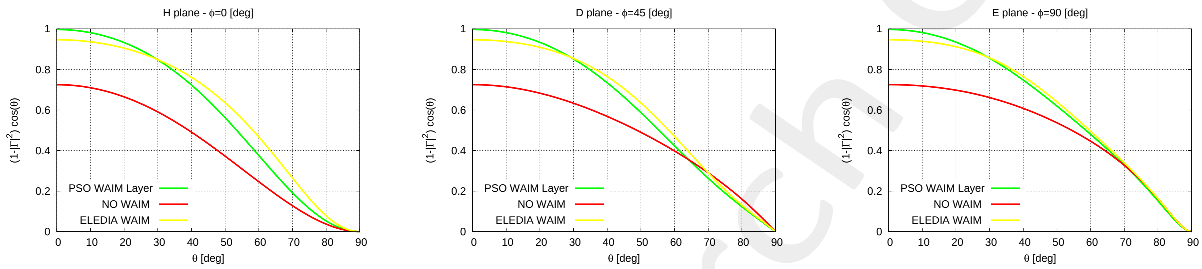


a) b) c)

Figure 19: Coefficiente di Riflessione, a) Piano H, b) Piano D, c) Piano E



a) b) c)

Figure 20: Coefficiente di Trasmissione $\cdot \cos(\theta)$, a) Piano H, b) Piano D, c) Piano E

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