A failure correction strategy in time-modulated linear arrays

L. Poli, P. Rocca, G. Oliveri, A. Massa

Abstract

A technique for failure correction in time-modulated linear arrays is analyzed in this report. Starting from the knowledge of the array elements with failures, the on–off behavior of the switches at the other elements is properly reconfigured to radiate a pattern as close as possible to the ideal one in terms of pattern features. The array reconfiguration is carried out by solving an optimization problem through the minimization of a suitable cost function proportional to the mismatch between ideal and reconfigured pattern features.

Numerical Results

TEST CASE 1.a - $N = 16$, Single Failure (External Pulse)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Description

- Number of Elements $N = 16$
- Elements Spacing: $d = 0.5\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: *Dolph-Chebyshev*, $SLL = -30\,dB$, $BW = 7.95\,deg$
- Failure occured at the element $n = 2$

Optimization Approach: PSO [1]

- Number of Variables: $X = 16$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 1$, SR weight: $w_{SR} = 1$

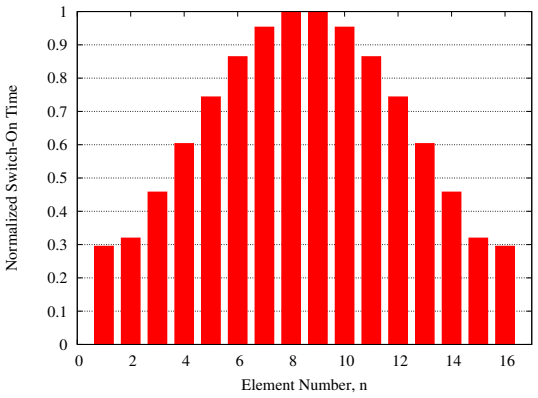

Fig. 1 - Pulse Sequence - Original

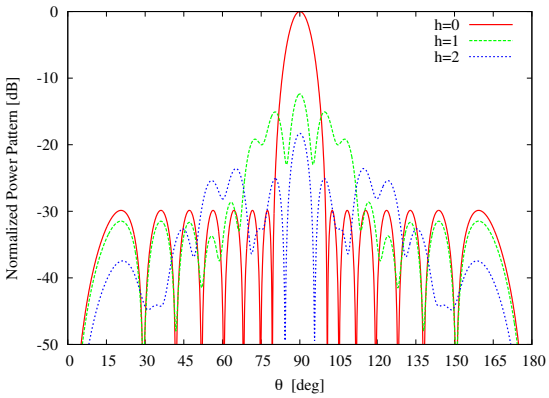

Fig. 2 - Patterns - Original

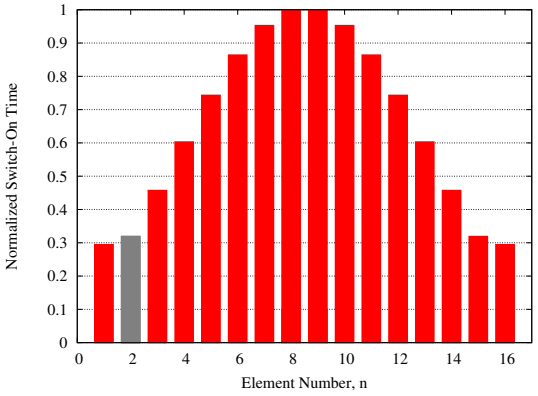

Fig. 3 - Pulse Sequence - Compromised

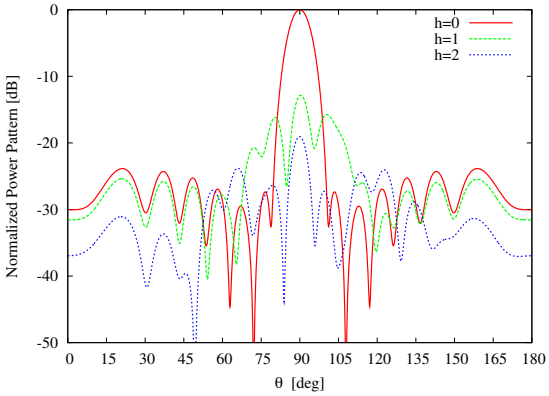

Fig. 4 - Patterns - Compromised

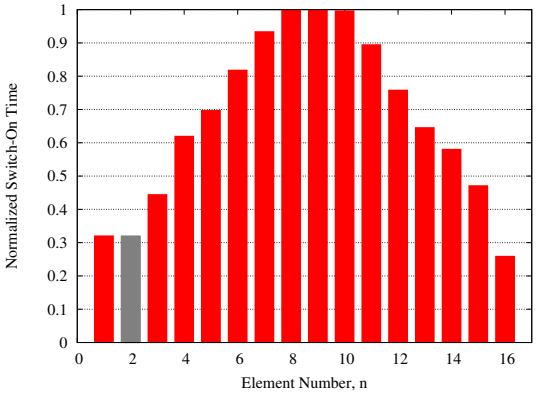

Fig. 5 - Pulse Sequence - PSO-reconfigured

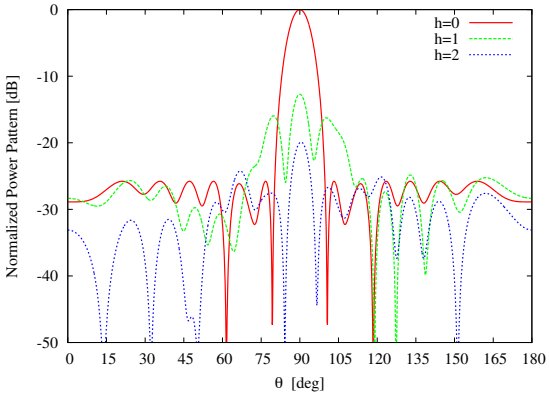

Fig. 6 - Patterns - PSO-reconfigured

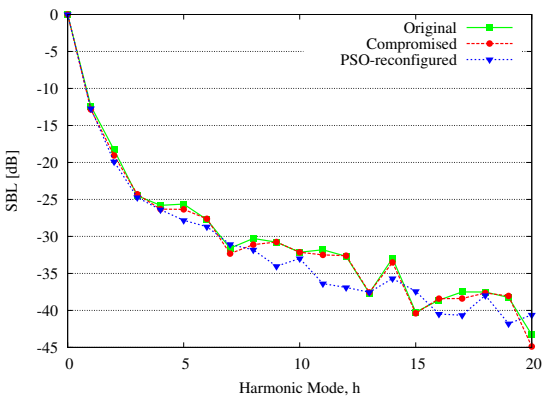

Fig. 7 - SBL - Comparison

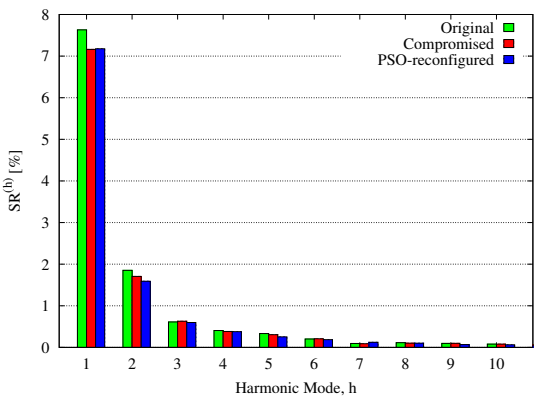

Fig. 8 - SR - Comparison

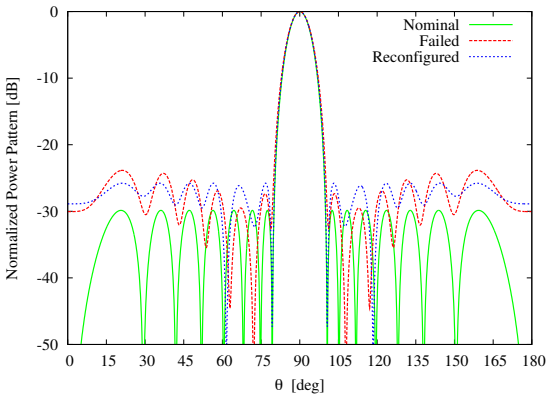

Fig. 9 - SBL - Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-29.86	7.95	8.36	-12.39	24.17
$Compromised$	-23.85	8.25	8.37	-12.84	22.79
$PSO-reconfigured$	-25.78	8.08	8.61	-12.71	22.21

Tab. I - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 1.b - $N = 16$, Single Failure (External Pulse)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: BW weight: $w_{BW} = 1$
- Current: BW weight: $w_{BW} = 0$ (*SLL*-only required matching)

Description

- Number of Elements $N = 16$
- Elements Spacing: $d = 0.5\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: *Dolph-Chebyshev*, $SLL = -30\,dB$, $BW = 7.95\,deg$
- Failure occured at the element $n = 2$

Optimization Approach: PSO [1]

- Number of Variables: $X = 16$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 0$, SR weight: $w_{SR} = 1$

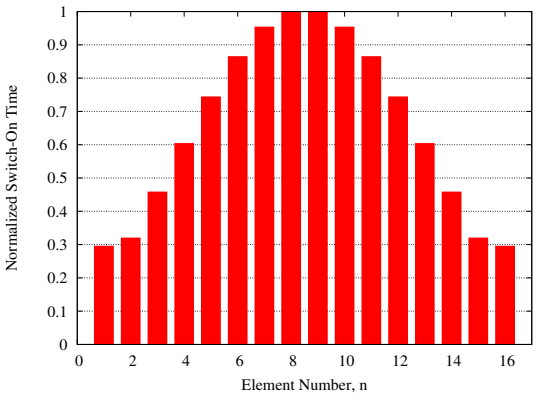

Fig. 10 - Pulse Sequence - Original

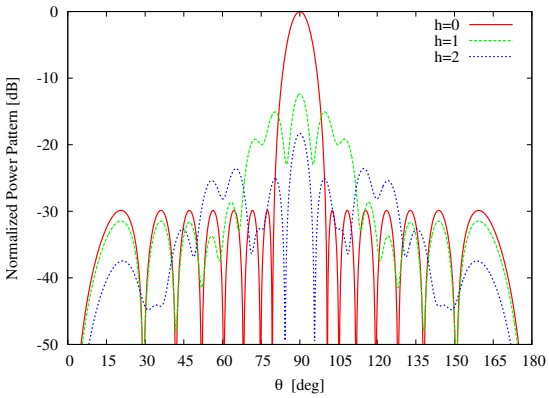

Fig. 11 - Patterns - Original

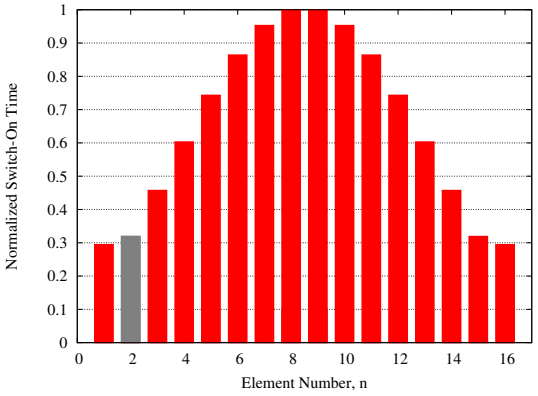

Fig. 12 - Pulse Sequence - Compromised

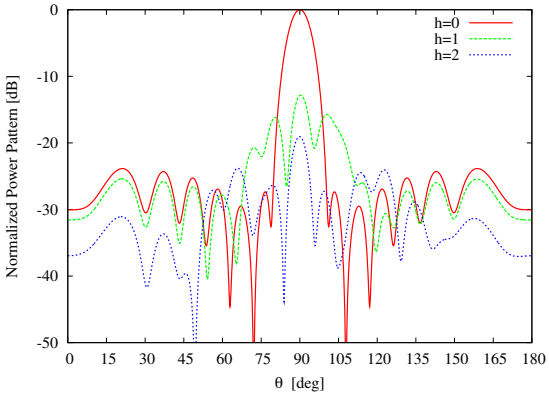

Fig. 13 - Patterns - Compromised

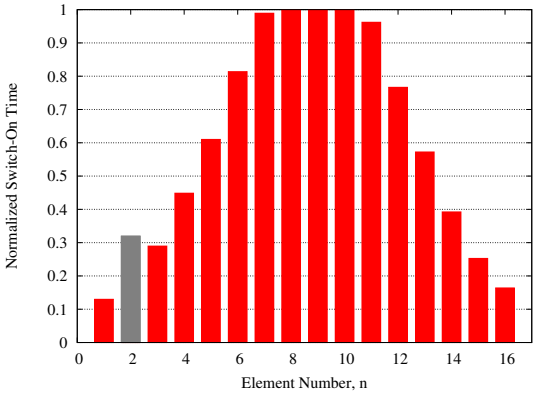

Fig. 14 - Pulse Sequence - PSO-reconfigured

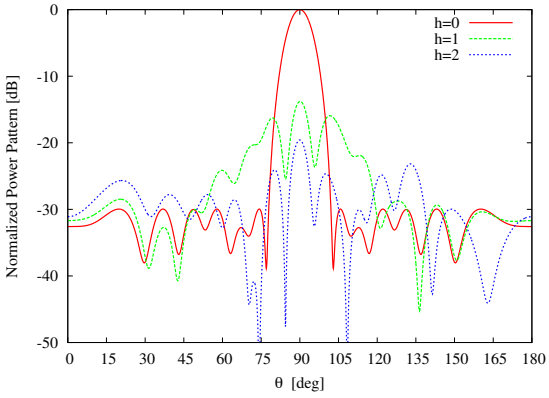

Fig. 15 - Patterns - PSO-reconfigured

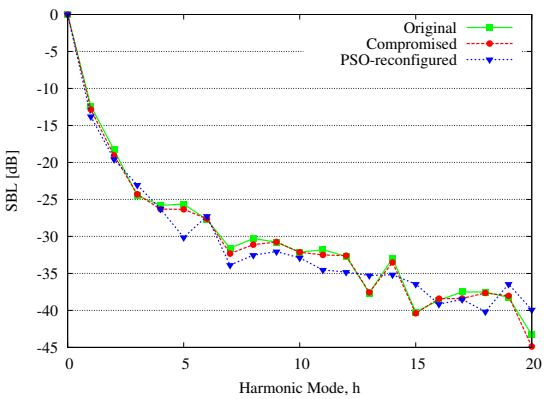

Fig. 16 - SBL - Comparison

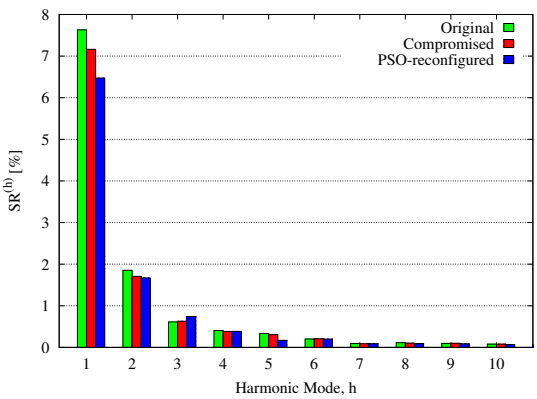

Fig. 17 - SR - Comparison

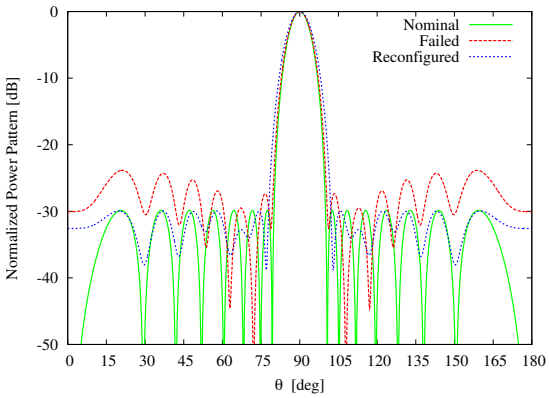

Fig. 18 - SBL - Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-29.86	7.95	8.36	-12.39	24.17
$Compromised$	-23.85	8.25	8.37	-12.84	22.79
$PSO-reconfigured$	-29.96	9.16	7.96	-13.79	21.20

Tab. II - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 1.c - $N = 16$, Single Failure (Internal Pulse)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: Failure occured at the element $n = 2$
- Current: Failure occured at the element $n = 8$

Description

- Number of Elements $N = 16$
- Elements Spacing: $d = 0.5\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: *Dolph-Chebyshev*, $SLL = -30\,dB$, $BW = 7.95\,deg$
- Failure occured at the element $n = 8$

Optimization Approach: PSO [1]

- Number of Variables: $X = 16$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 1$, SR weight: $w_{SR} = 1$

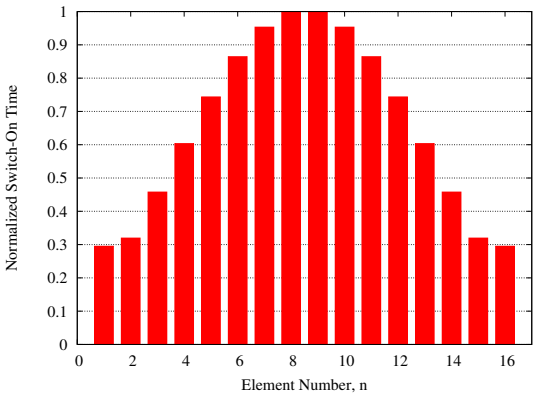

Fig. 19 - Pulse Sequence - Original

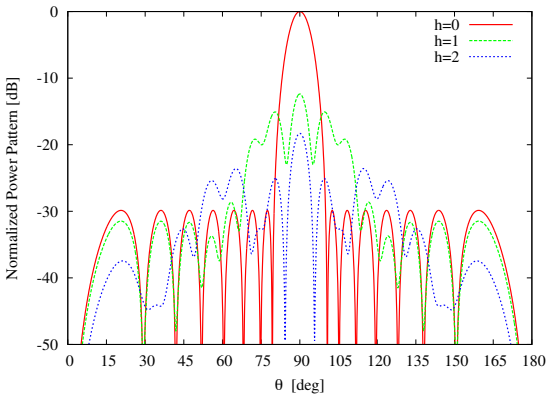

Fig. 20 - Patterns - Original

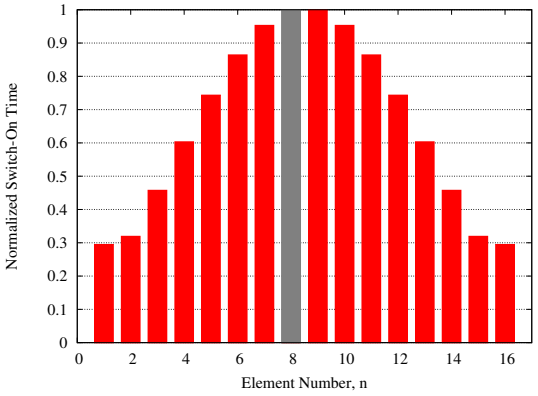

Fig. 21 - Pulse Sequence - Compromised

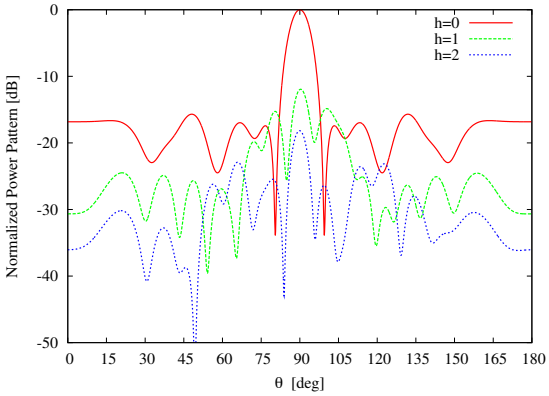

Fig. 22 - Patterns - Compromised

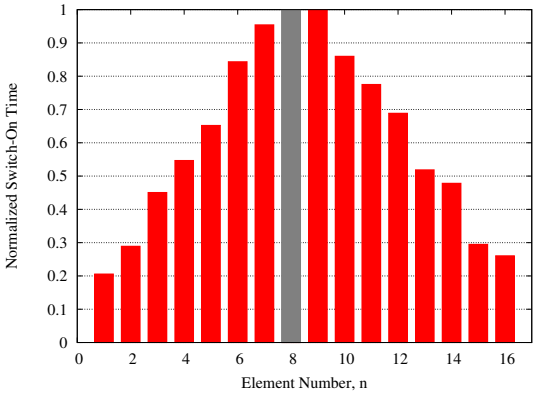

Fig. 23 - Pulse Sequence - PSO-reconfigured

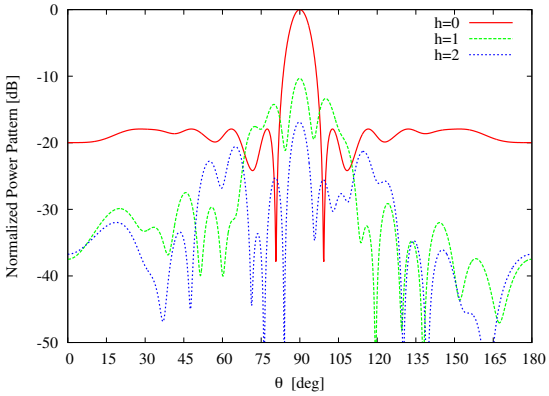

Fig. 24 - Patterns - PSO-reconfigured

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-29.86	7.95	8.36	-12.39	24.17
$Compromised$	-15.68	7.80	7.77	-11.94	25.28
$PSO-reconfigured$	-17.93	7.65	7.15	-10.33	30.35

Tab. III - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 1.d - $N = 16$, Double Failure (External Pulses)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: Failure occured at the element $n = 8$
- Current: Failures occured at the elements $n = 2, 14$

Description

- Number of Elements $N = 16$
- Elements Spacing: $d = 0.5\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: *Dolph-Chebyshev*, $SLL = -30\,dB$, $BW = 7.95\,deg$
- Failures occured at the elements $n = 2, 14$

Optimization Approach: PSO [1]

- Number of Variables: $X = 16$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 1$, SR weight: $w_{SR} = 1$

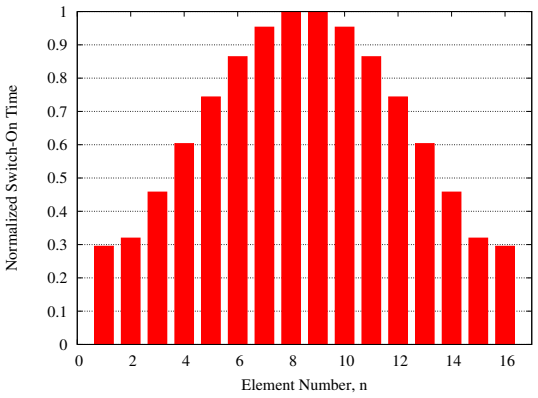

Fig. 25 - Pulse Sequence - Original

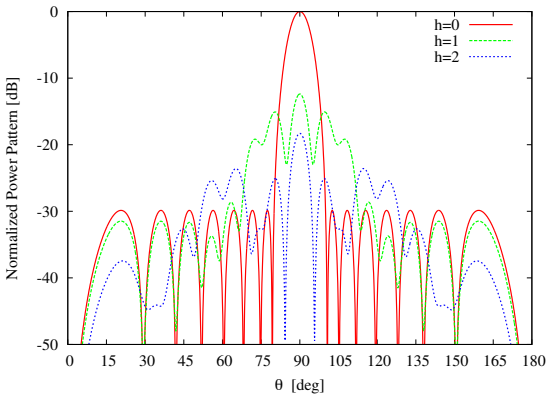

Fig. 26 - Patterns - Original

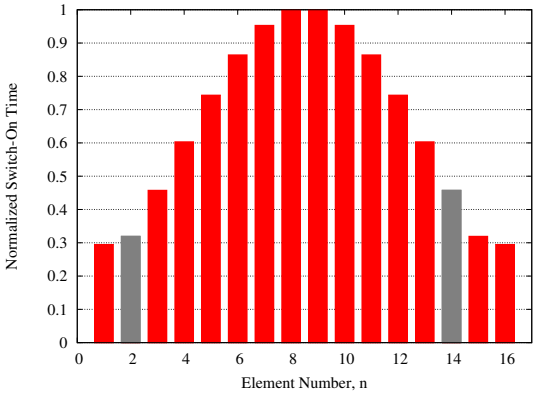

Fig. 27 - Pulse Sequence - Compromised

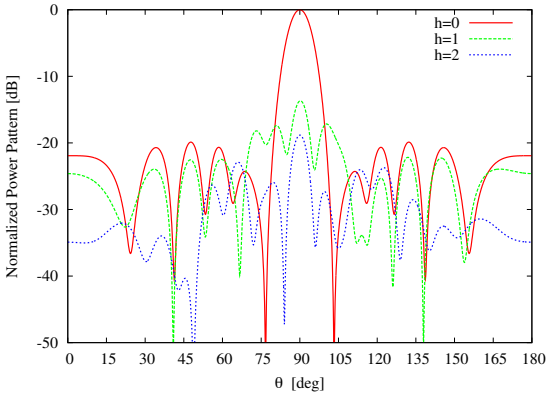

Fig. 28 - Patterns - Compromised

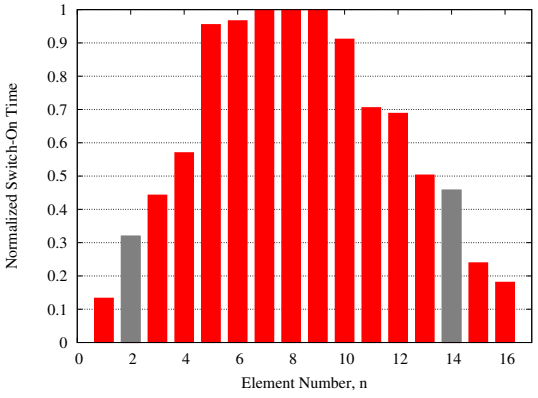

Fig. 29 - Pulse Sequence - PSO-reconfigured

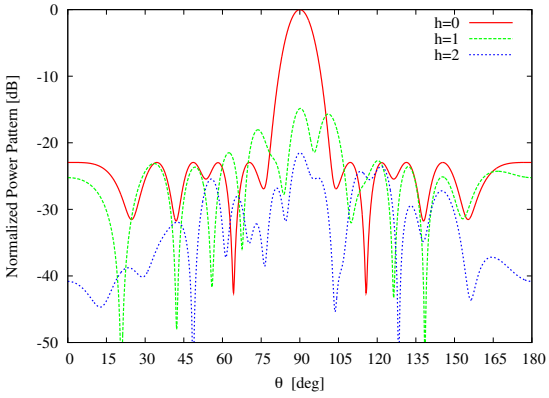

Fig. 30 - Patterns - PSO-reconfigured

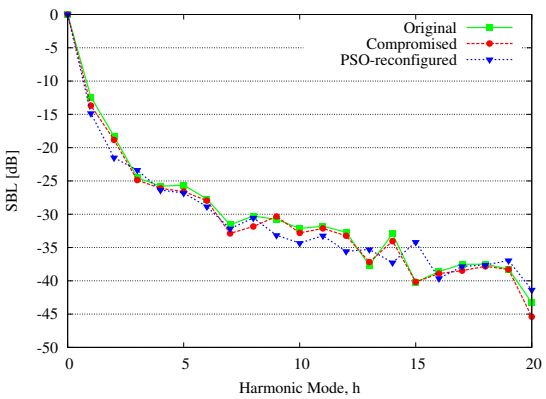

Fig. 31 - Pulse Sequence - PSO-reconfigured

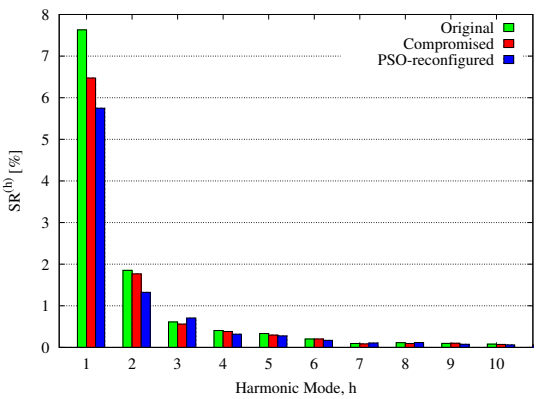

Fig. 32 - Patterns - PSO-reconfigured

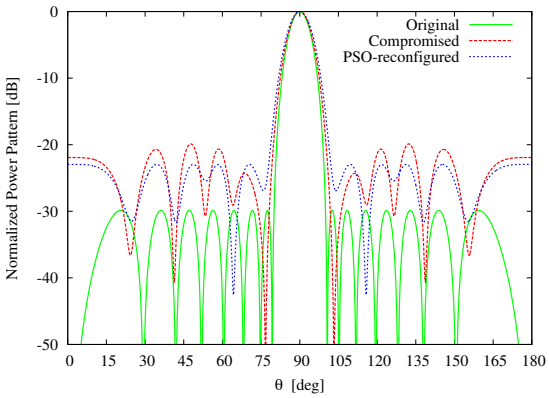

Fig. 33 - Pattern Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-29.86	7.95	8.36	-12.39	24.17
$Compromised$	-19.88	8.55	8.27	-13.68	21.30
$PSO-reconfigured$	-22.95	9.25	7.91	-14.85	19.00

Tab. IV - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 1.e - $N = 16$, Double Failure (External Pulses)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: BW weight: $w_{BW} = 1$
- Current: BW weight: $w_{BW} = 0$ (SLL-only required matching)

Description

- Number of Elements $N = 16$
- Elements Spacing: $d = 0.5\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: *Dolph-Chebyshev*, $SLL = -30\,dB$, $BW = 7.95\,deg$
- Failures occured at the element $n = 2$, 14

Optimization Approach: PSO [1]

- Number of Variables: $X = 16$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 0$, SR weight: $w_{SR} = 1$

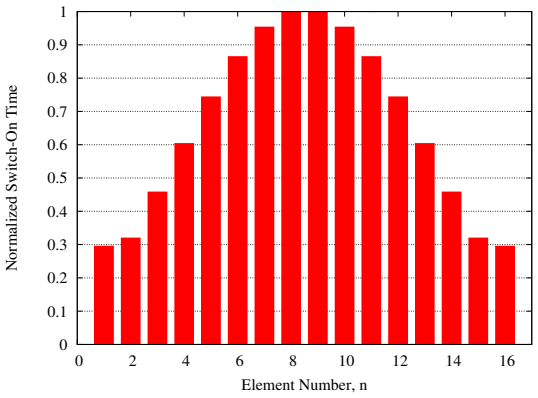

Fig. 34 - Pulse Sequence - Original

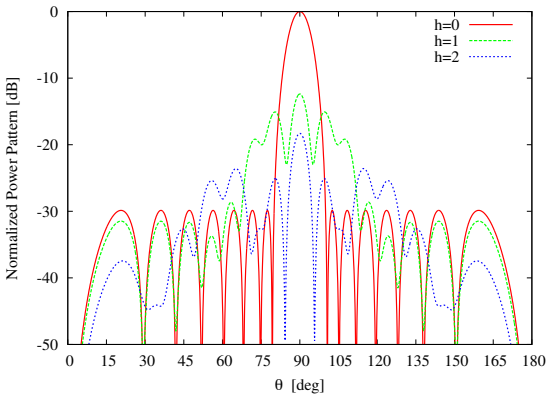

Fig. 35 - Patterns - Original

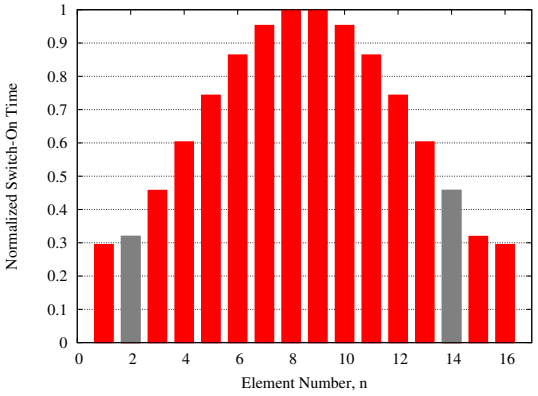

Fig. 36 - Pulse Sequence - Compromised

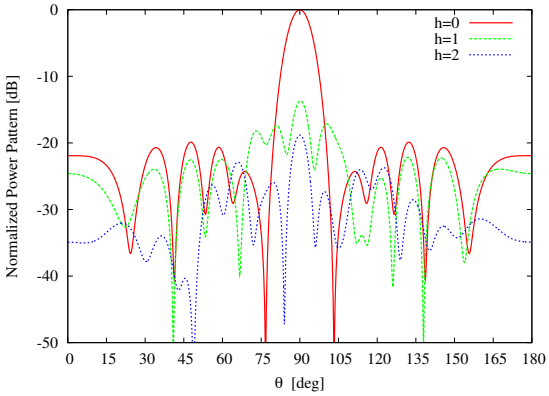

Fig. 37 - Patterns - Compromised

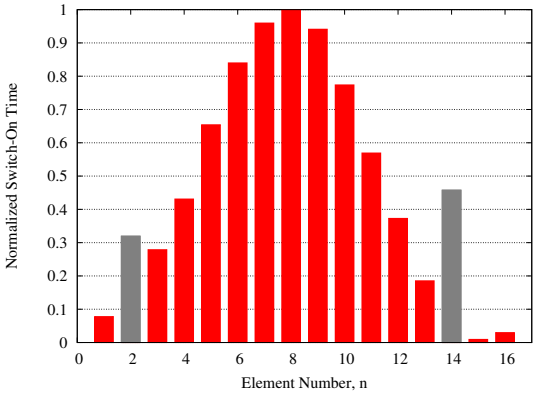

Fig. 38 - Pulse Sequence - PSO-reconfigured

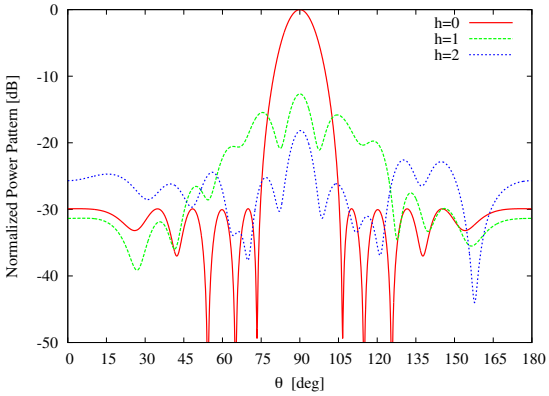

Fig. 39 - Patterns - PSO-reconfigured

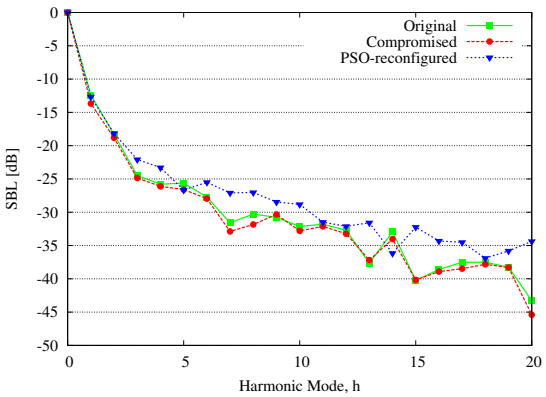

Fig. 40 - Pulse Sequence - PSO-reconfigured

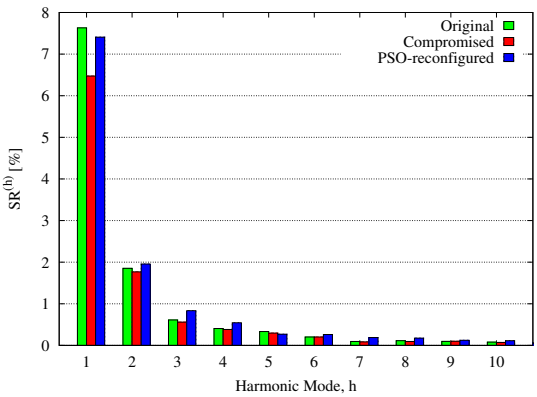

Fig. 41 - Patterns - PSO-reconfigured

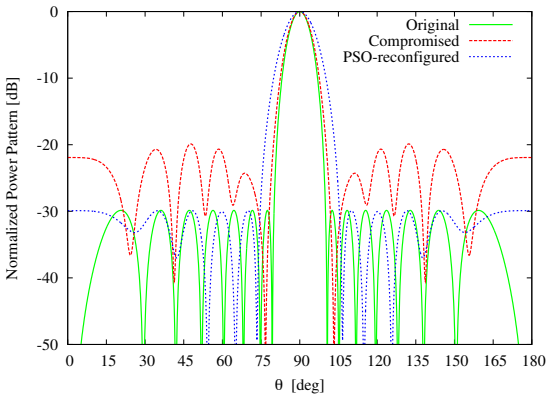

Fig. 42 - Pattern Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-29.86	7.95	8.36	-12.39	24.17
$Compromised$	-19.88	8.55	8.27	-13.68	21.30
$PSO-reconfigured$	-29.90	11.39	5.59	-12.66	25.50

Tab. V - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 2.a - $N = 32$, Single Failure (External Pulse)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: Number of Elements $N = 16$; Failures occured at the elements $n = 2$, 14
- Current: Number of Elements $N = 32$; Failure occured at the element $n = 29$

Description

- Number of Elements $N = 32$
- Elements Spacing: $d = 0.5\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: *Dolph-Chebyshev*, $SLL = -30\,dB$, $BW = 3.88\,deg$
- Failure occured at the element $n = 29$

Optimization Approach: PSO [1]

- Number of Variables: $X = 32$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 1$, SR weight: $w_{SR} = 1$

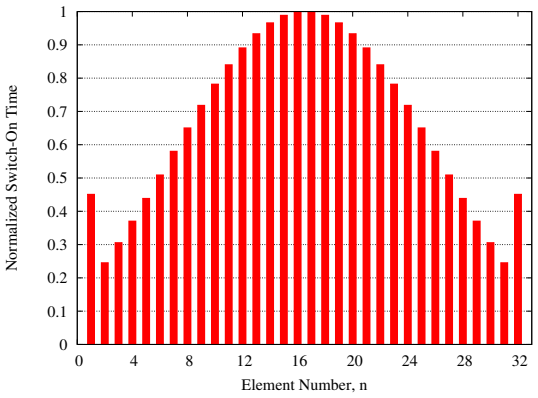

Fig. 43 - Pulse Sequence - Original

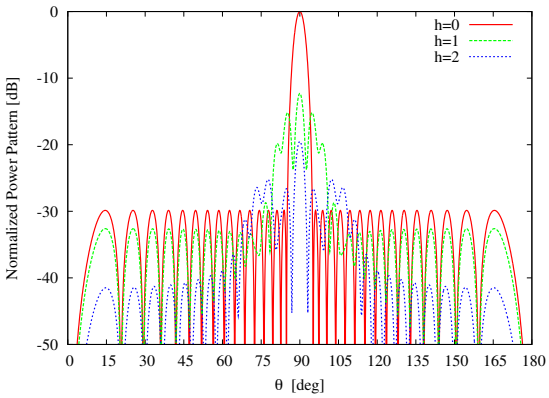

Fig. 44 - Patterns - Original

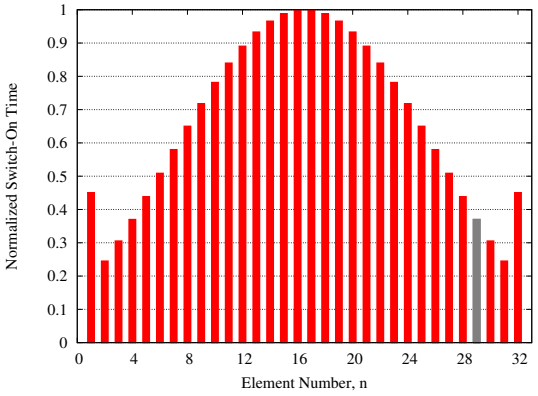

Fig. 45 - Pulse Sequence - Compromised

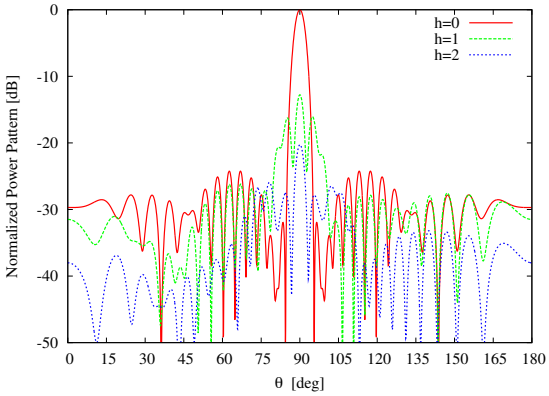

Fig. 46 - Patterns - Compromised

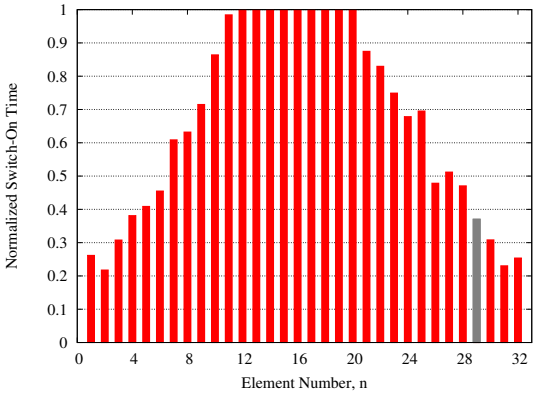

Fig. 47 - Pulse Sequence - PSO-reconfigured

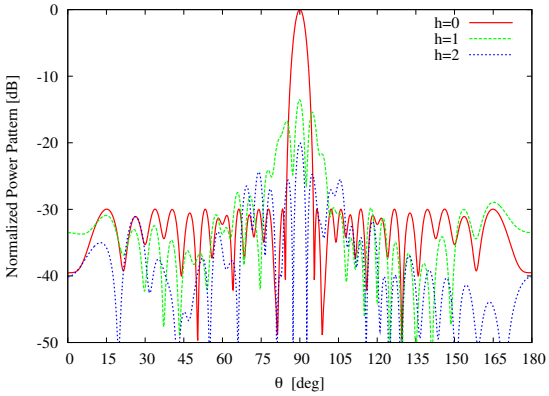

Fig. 48 - Patterns - PSO-reconfigured

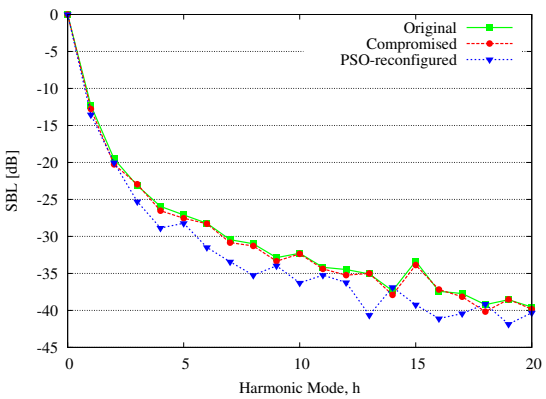

Fig. 49 - SBL - Comparison

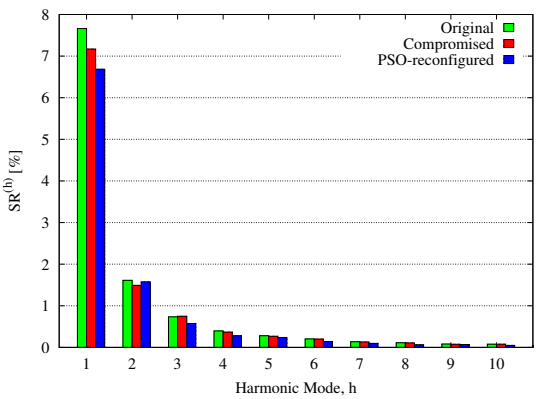

Fig. 50 - SR - Comparison

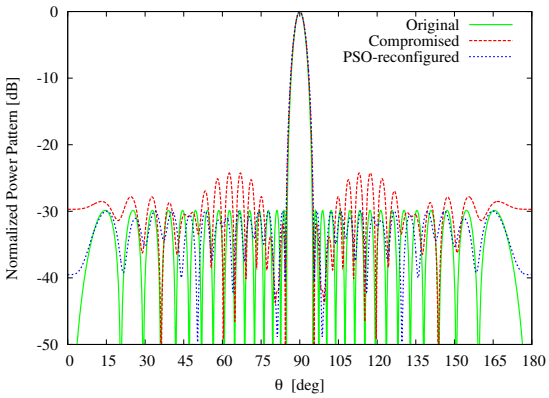

Fig. 51 - SBL - Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-29.86	3.88	11.53	-12.29	23.95
$Compromised$	-24.24	4.02	11.53	-12.77	22.58
$PSO-reconfigured$	-29.97	4.13	11.50	-13.54	20.59

Tab. VI - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 2.b - $N = 32$, Single Failure (Internal Pulse)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: Failure occured at the element $n = 29$
- Current: Failure occured at the element $n = 18$

Description

- Number of Elements $N = 32$
- Elements Spacing: $d = 0.5\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: *Dolph-Chebyshev*, $SLL = -30\,dB$, $BW = 3.88\,deg$
- Failure occured at the element $n = 18$

Optimization Approach: PSO [1]

- Number of Variables: $X = 32$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 1$, SR weight: $w_{SR} = 1$

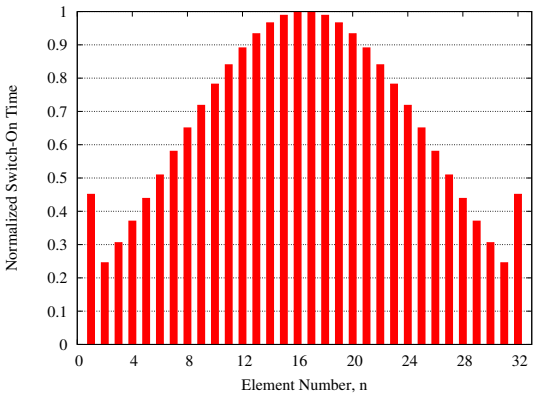

Fig. 52 - Pulse Sequence - Original

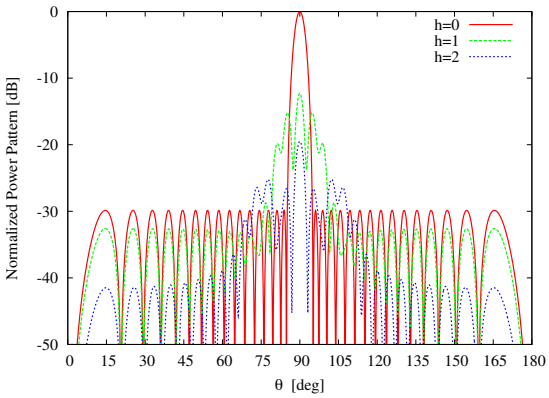

Fig. 53 - Patterns - Original

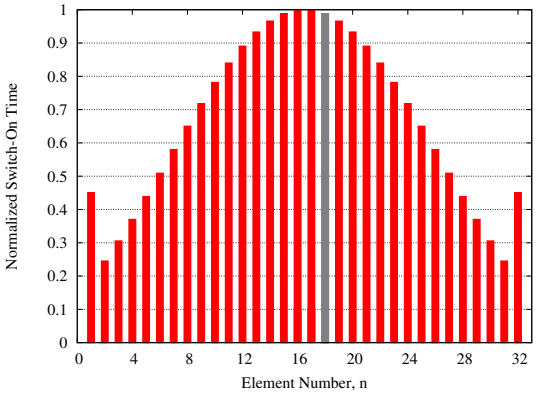

Fig. 54 - Pulse Sequence - Compromised

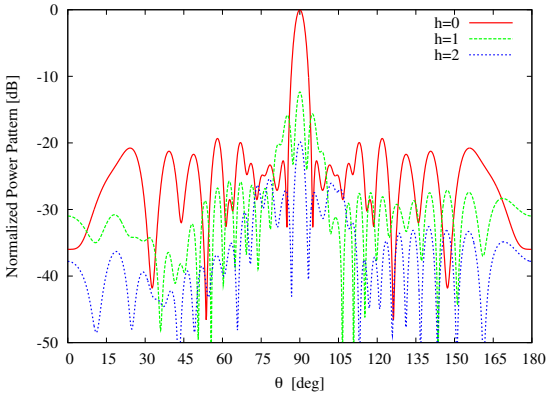

Fig. 55 - Patterns - Compromised

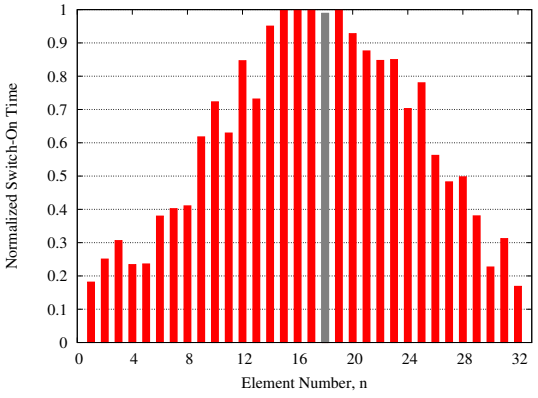

Fig. 56 - Pulse Sequence - PSO-reconfigured

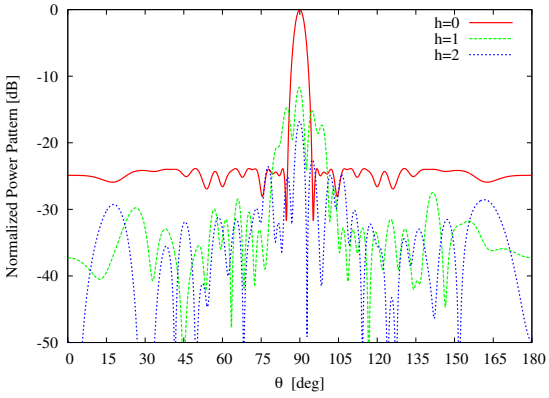

Fig. 57 - Patterns - PSO-reconfigured

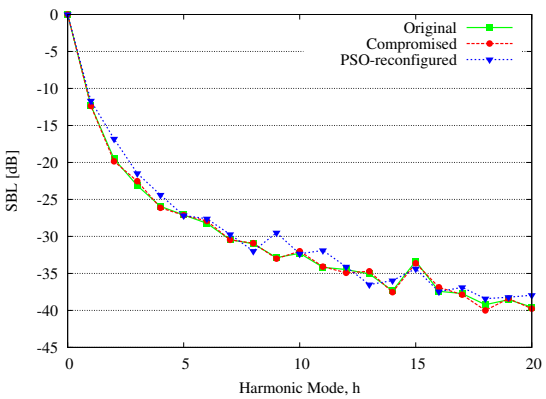

Fig. 58 - SBL - Comparison

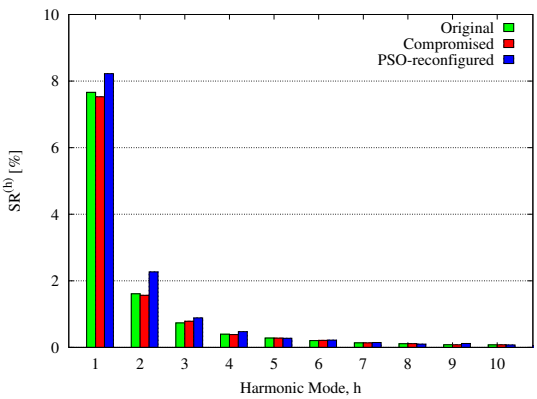

Fig. 59 - SR - Comparison

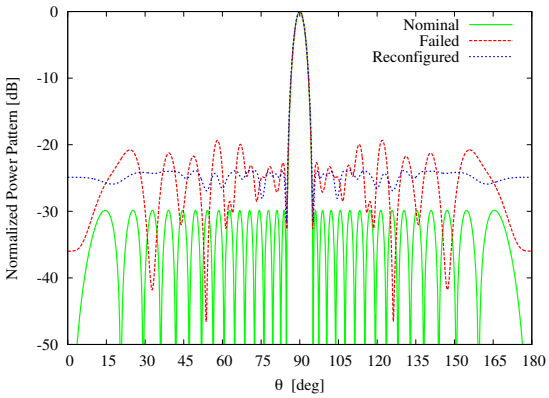

Fig. 60 - SBL - Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-29.86	3.88	11.53	-12.29	23.95
$Compromised$	-19.34	3.91	11.26	-12.35	23.66
$PSO-reconfigured$	-23.87	4.02	10.44	-11.68	27.00

Tab. VII - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 2.c - $N = 32$, Double Failure (External Pulses)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: Failure occured at the element $n = 18$
- Current: Failures occured at the elements $n = 2$, 29

Description

- Number of Elements $N = 32$
- Elements Spacing: $d = 0.5\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: *Dolph-Chebyshev*, $SLL = -30\,dB$, $BW = 3.88\,deg$
- Failures occured at the elements $n = 2$, 29

Optimization Approach: PSO [1]

- Number of Variables: $X = 32$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 1$, SR weight: $w_{SR} = 1$

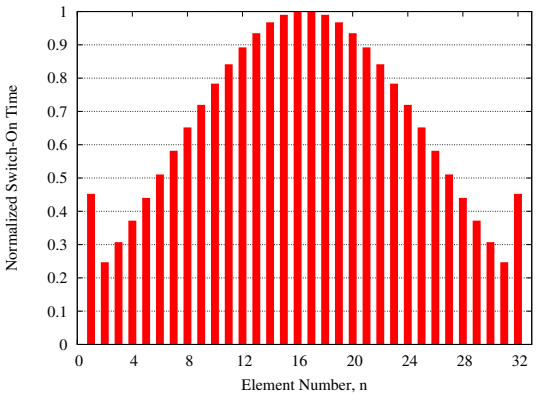

Fig. 61 - Pulse Sequence - Original

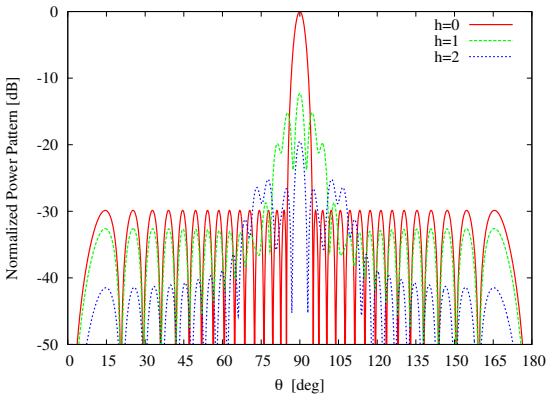

Fig. 62 - Patterns - Original

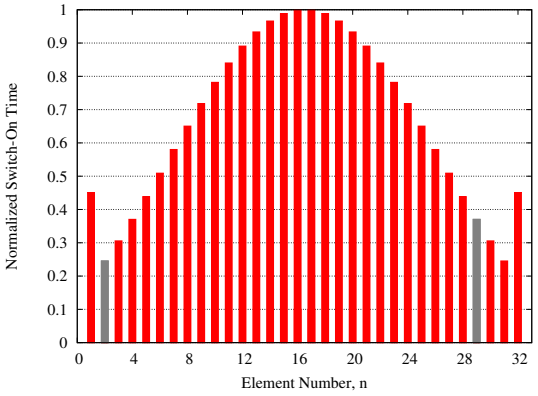

Fig. 63 - Pulse Sequence - Compromised

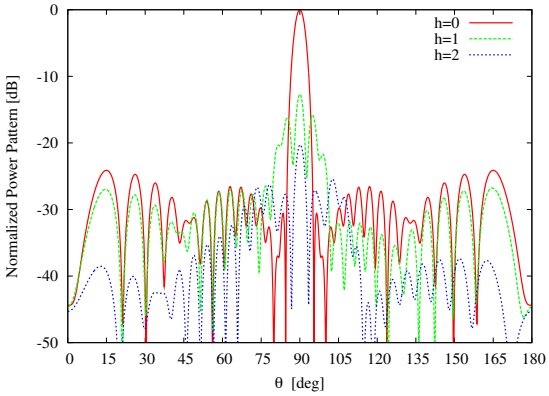

Fig. 64 - Patterns - Compromised

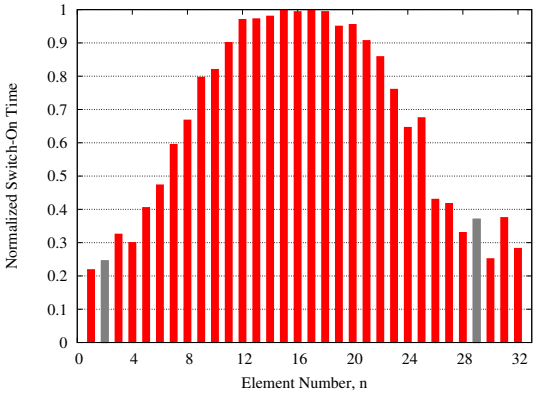

Fig. 65 - Pulse Sequence - PSO-reconfigured

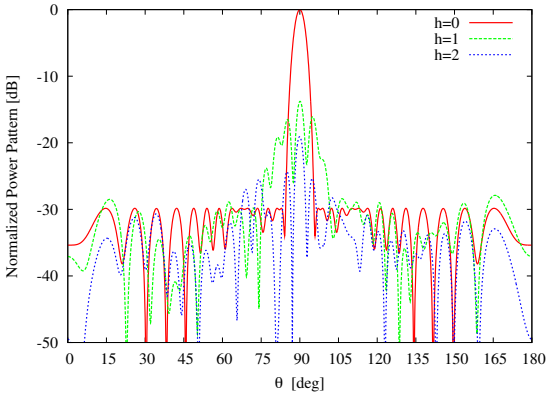

Fig. 66 - Patterns - PSO-reconfigured

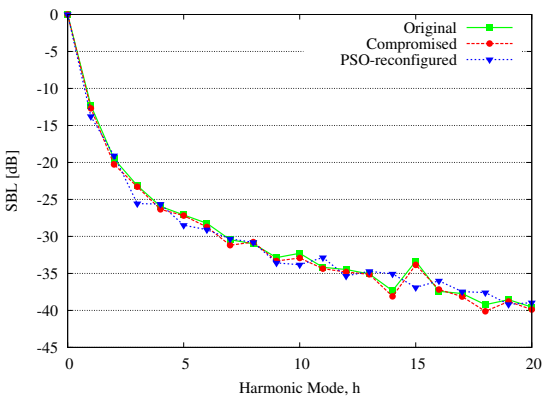

Fig. 67 - SBL - Comparison

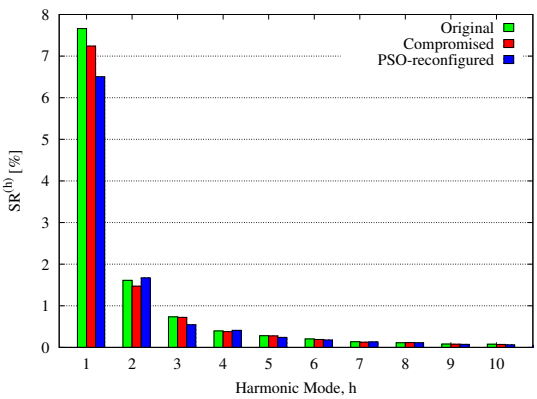

Fig. 68 - SR - Comparison

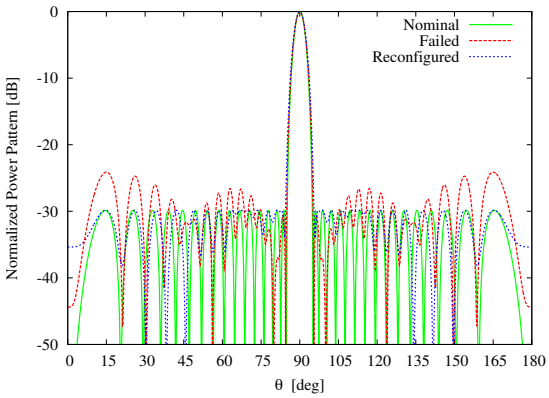

Fig. 69 - SBL - Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-29.86	3.88	11.53	-12.29	23.95
$Compromised$	-24.12	4.01	11.56	-12.69	22.64
$PSO-reconfigured$	-29.84	4.21	11.36	-13.78	21.23

Tab. VIII - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 2.d - $N = 32$, Double Failure (Internal/External Pulses)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: Failure occured at the elements $n = 2, 29$
- Current: Failures occured at the elements $n = 2, 18$

Description

- Number of Elements $N = 32$
- Elements Spacing: $d = 0.5\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \;\; n = 1, \;\; , N$
- Averaged Time-Modulated Array Excitations: *Dolph-Chebyshev*, $SLL = -30\,dB$, $BW = 3.88\,deg$
- Failures occured at the elements $n = 2, 18$

Optimization Approach: PSO [1]

- Number of Variables: $X = 32$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 1$, SR weight: $w_{SR} = 1$

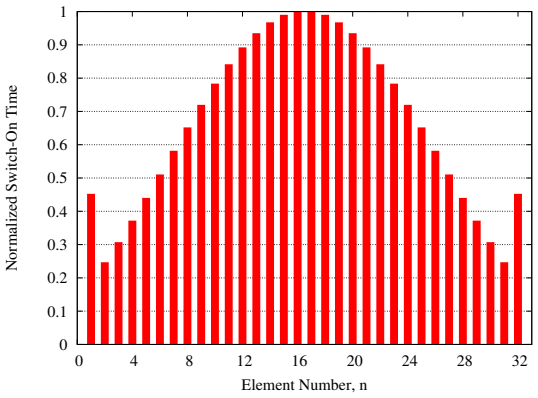

Fig. 70 - Pulse Sequence - Original

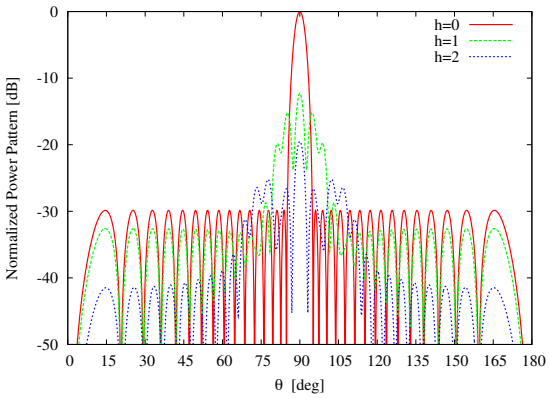

Fig. 71 - Patterns - Original

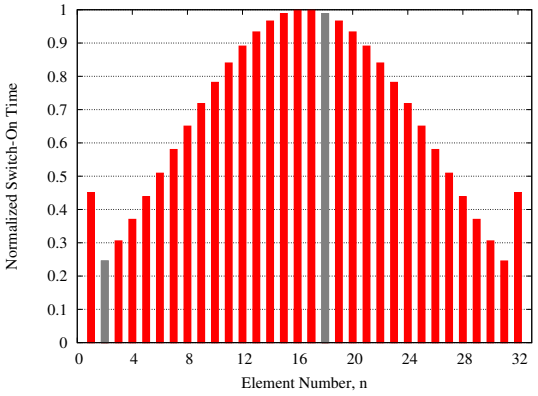

Fig. 72 - Pulse Sequence - Compromised

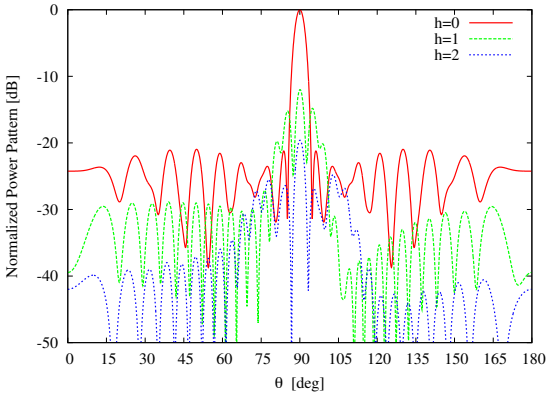

Fig. 73 - Patterns - Compromised

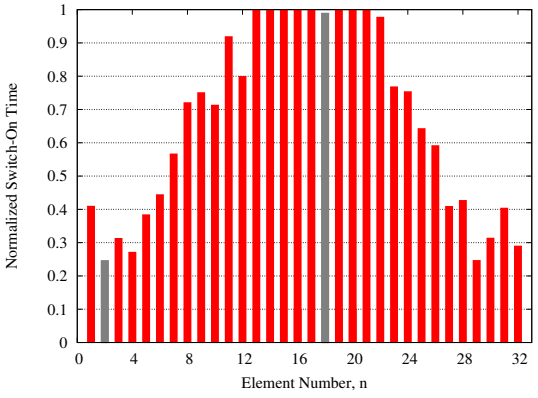

Fig. 74 - Pulse Sequence - PSO-reconfigured

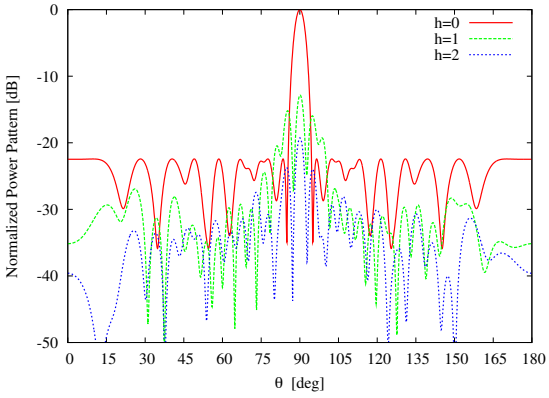

Fig. 75 - Patterns - PSO-reconfigured

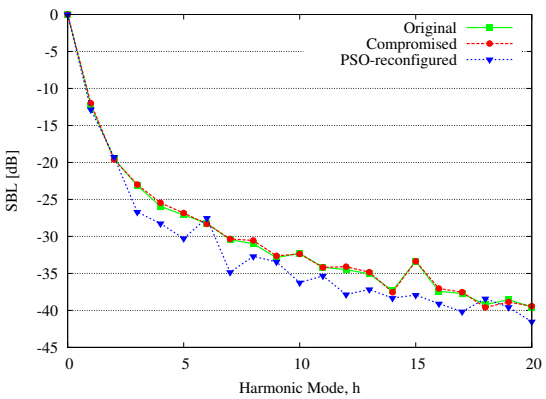

Fig. 76 - SBL - Comparison

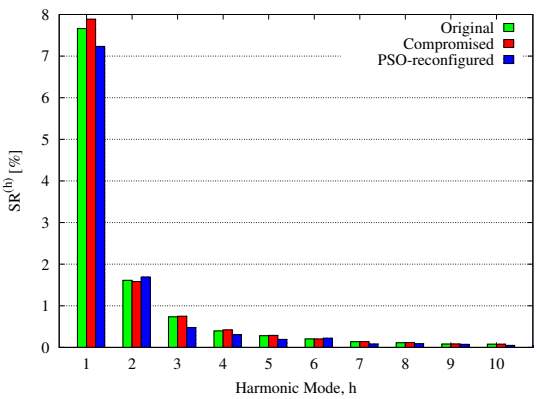

Fig. 77 - SR - Comparison

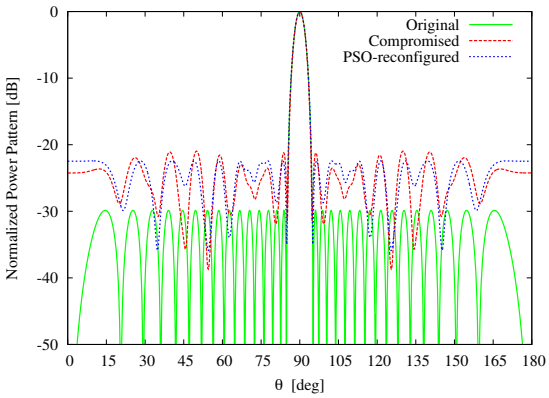

Fig. 78 - SBL - Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-29.86	3.88	11.53	-12.29	23.95
$Compromised$	-20.97	3.84	11.26	-11.99	24.44
$PSO-reconfigured$	-22.43	3.95	11.29	-12.85	21.90

Tab. IX - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 3.a - $N = 30$, Single Failure (External Pulse)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: Number of Elements $N = 32$; Failures occured at the element $n = 2$, 29
- Current: Number of Elements $N = 30$; Failure occured at the elements $n = 28$

Description

- Number of Elements $N = 30$
- Elements Spacing: $d = 0.7\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: Optimized to synthesize a pattern with $SLL = -20\,dB$ with minimum SR
- Failure occured at the element $n = 28$

Optimization Approach: PSO [1]

- Number of Variables: $X = 30$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 1$, SR weight: $w_{SR} = 1$

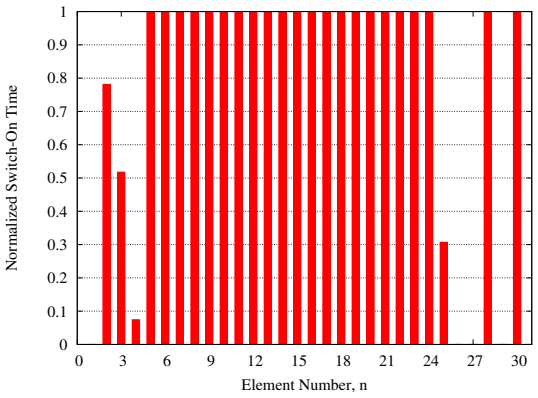

Fig. 79 - Pulse Sequence - Original

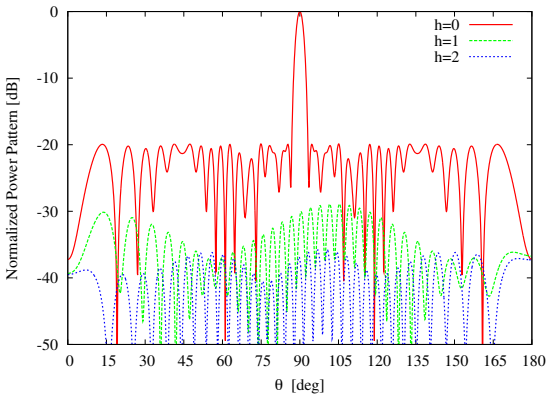

Fig. 80 - Patterns - Original

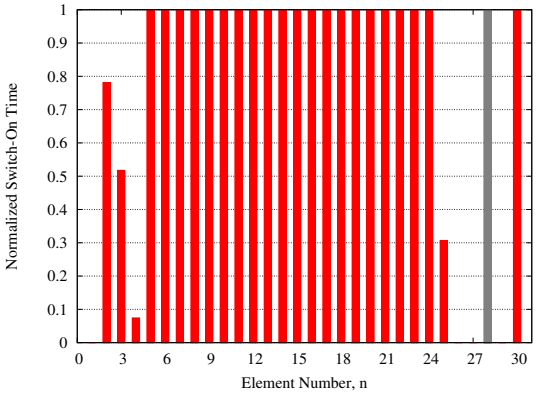

Fig. 81 - Pulse Sequence - Compromised

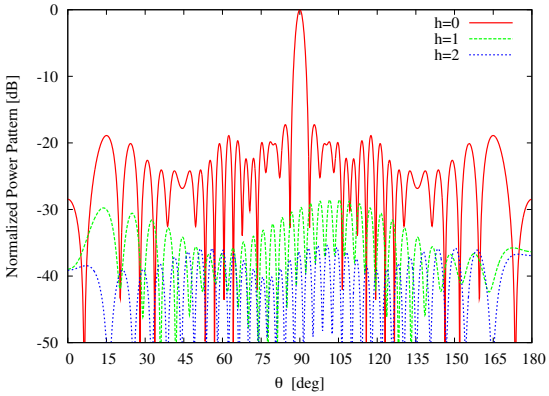

Fig. 82 - Patterns - Compromised

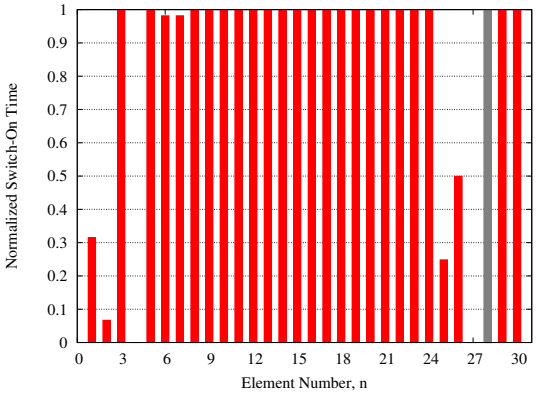

Fig. 83 - Pulse Sequence - PSO-reconfigured

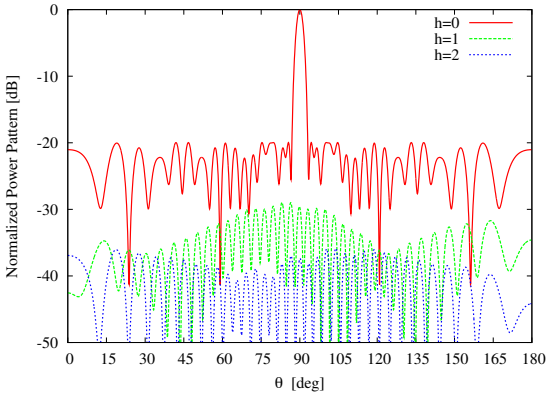

Fig. 84 - Patterns - PSO-reconfigured

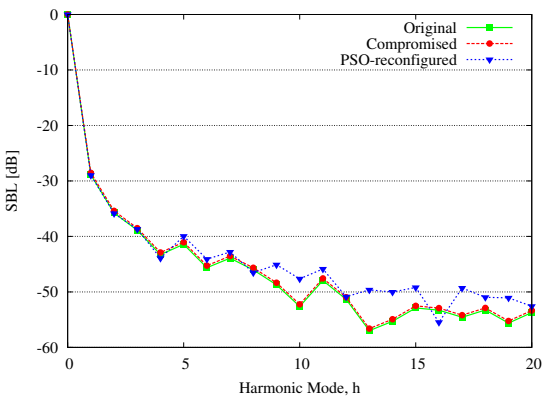

Fig. 85 - SBL - Comparison

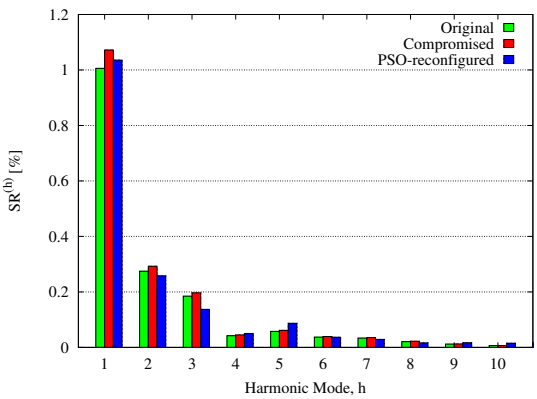

Fig. 86 - SR - Comparison

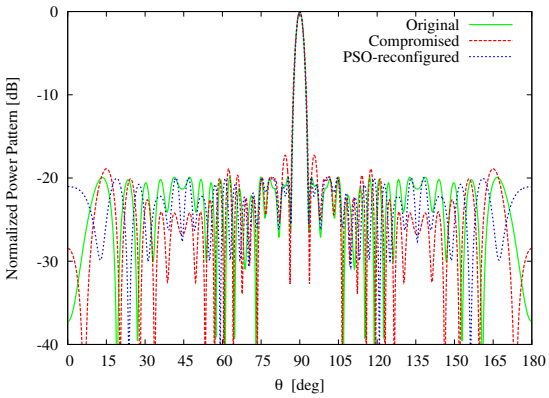

Fig. 87 - SBL - Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-19.88	2.84	13.91	-28.91	3.57
$Compromised$	-17.26	2.99	13.77	-28.54	3.81
$PSO-reconfigured$	-19.97	2.78	14.25	28.97	3.68

Tab. X - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 3.b - $N = 30$, Double Failure (External/Semi-External Pulses)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: Failure occured at the element $n = 28$
- Current: Failures occured at the elements $n = 7, 28$

Description

- Number of Elements $N = 30$
- Elements Spacing: $d = 0.7\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: Optimized to synthesize a pattern with $SLL = -20\,dB$ with minimum SR
- Failures occured at the elements $n = 7, 28$

Optimization Approach: PSO [1]

- Number of Variables: $X = 30$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 1$, SR weight: $w_{SR} = 1$

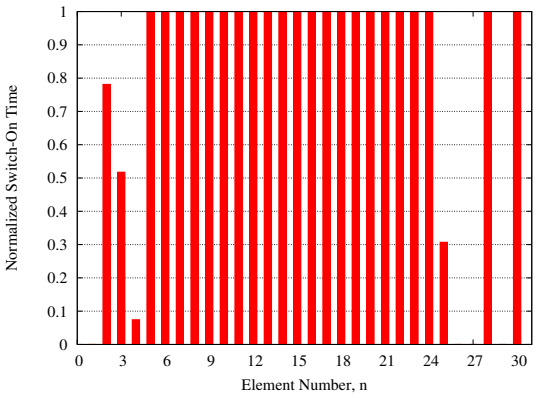

Fig. 88 - Pulse Sequence - Original

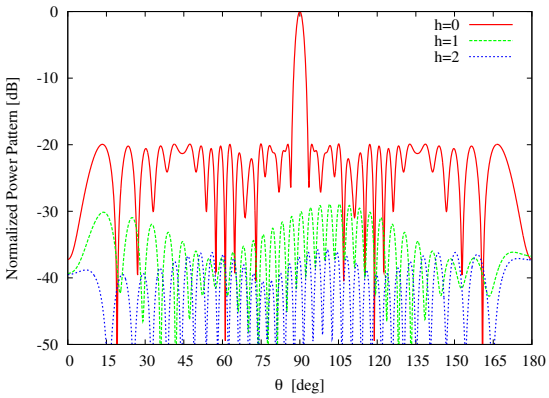

Fig. 89 - Patterns - Original

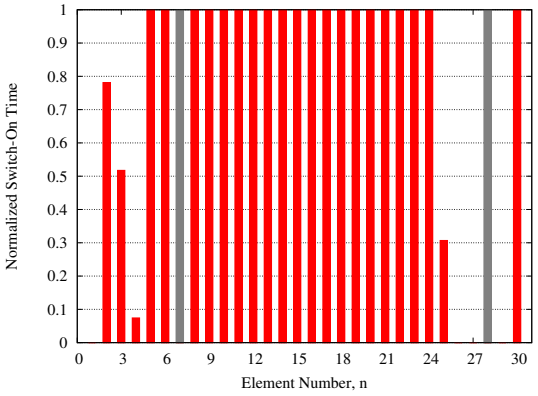

Fig. 90 - Pulse Sequence - Compromised

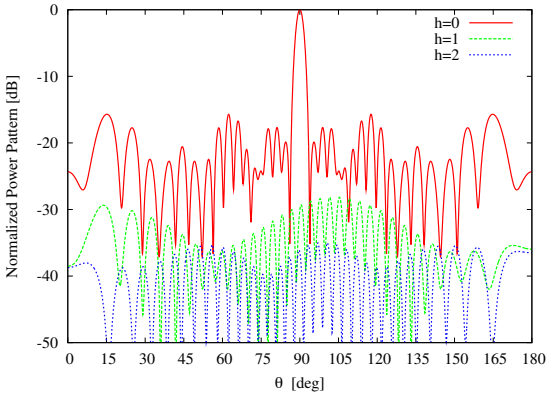

Fig. 91 - Patterns - Compromised

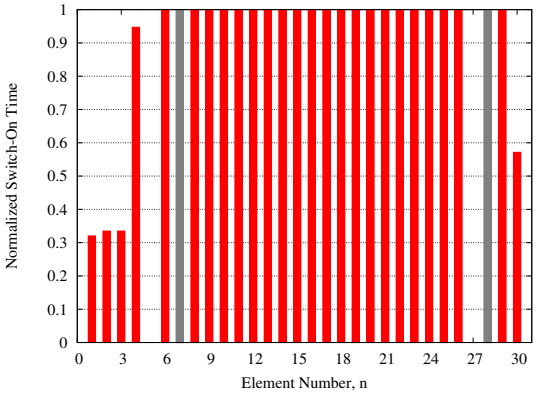

Fig. 92 - Pulse Sequence - PSO-reconfigured

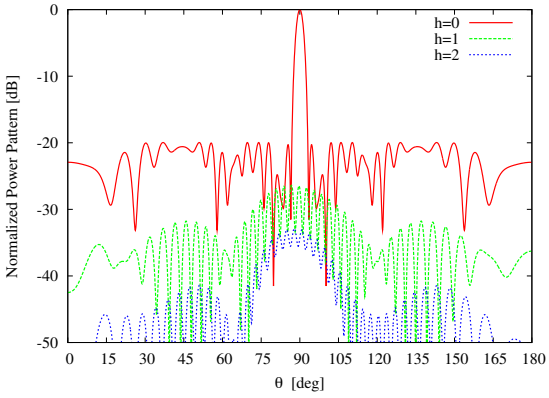

Fig. 93 - Patterns - PSO-reconfigured

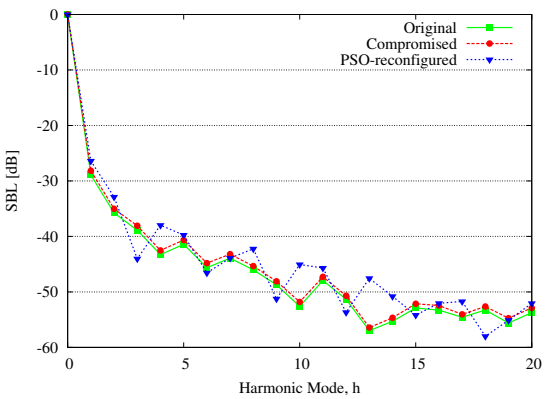

Fig. 94 - SBL - Comparison

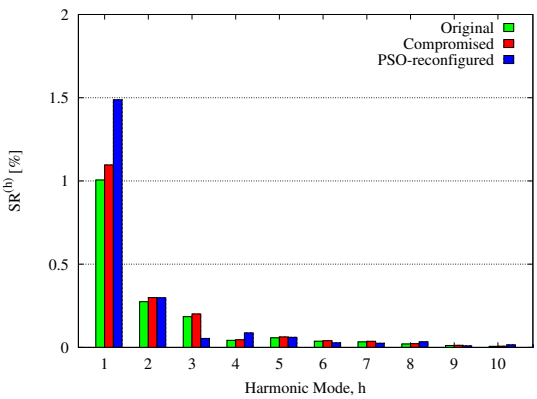

Fig. 95 - SR - Comparison

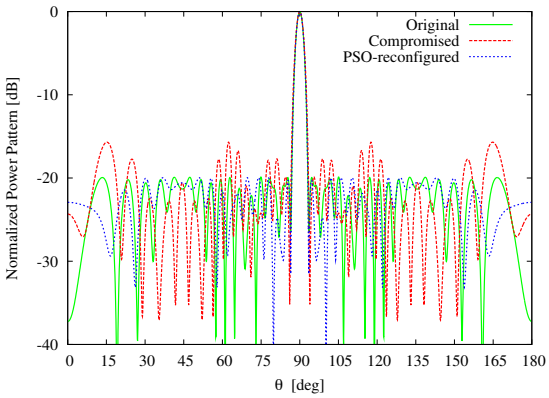

Fig. 96 - SBL - Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-19.88	2.84	13.91	-28.91	3.57
$Compromised$	-15.70	3.01	13.43	-28.16	3.89
$PSO-reconfigured$	-19.96	2.84	14.15	-26.40	4.45

Tab. XI - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 3.c - $N = 30$, Triple Failure (External/External/Semi-External Pulses)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: Failures occured at the elements $n = 7$, 28
- Current: Failures occured at the elements $n = 2$, 7, 28

Description

- Number of Elements $N = 30$
- Elements Spacing: $d = 0.7\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: Optimized to synthesize a pattern with $SLL = -20\,dB$ with minimum SR
- Failures occured at the element $n = 2$, 7, 28

Optimization Approach: PSO [1]

- Number of Variables: $X = 30$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 1$, SR weight: $w_{SR} = 1$

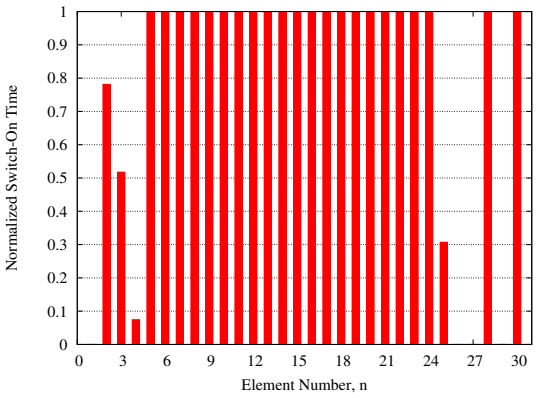

Fig. 97 - Pulse Sequence - Original

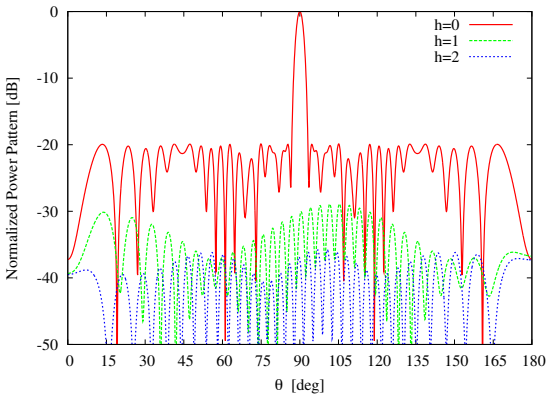

Fig. 98 - Patterns - Original

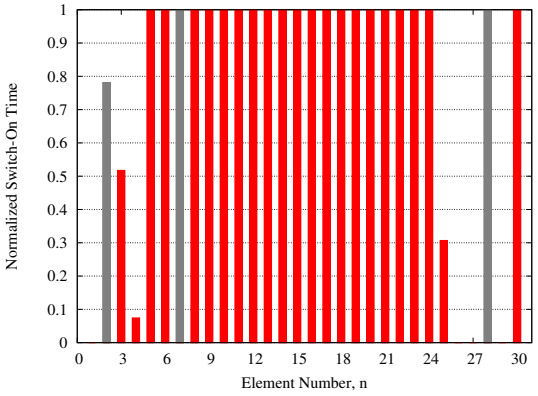

Fig. 99 - Pulse Sequence - Compromised

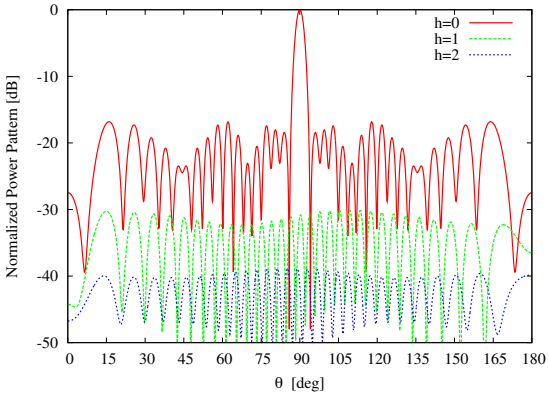

Fig. 100 - Patterns - Compromised

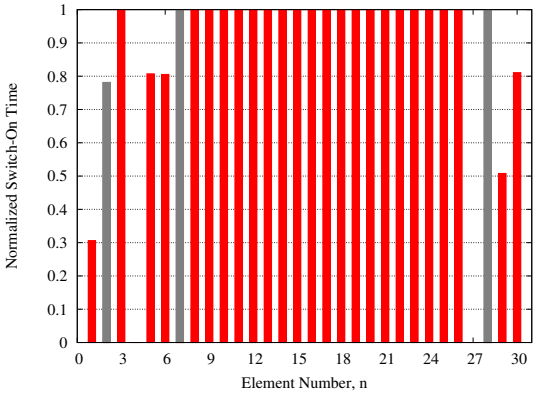

Fig. 101 - Pulse Sequence - PSO-reconfigured

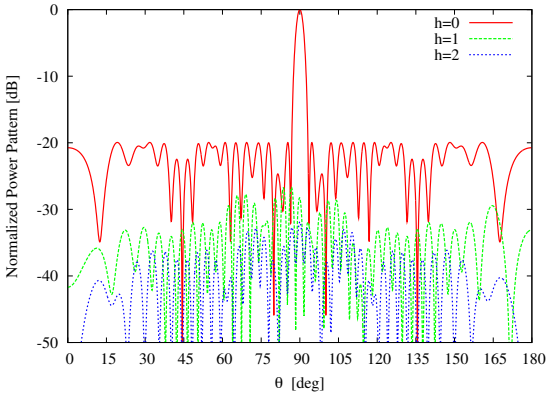

Fig. 102 - Patterns - PSO-reconfigured

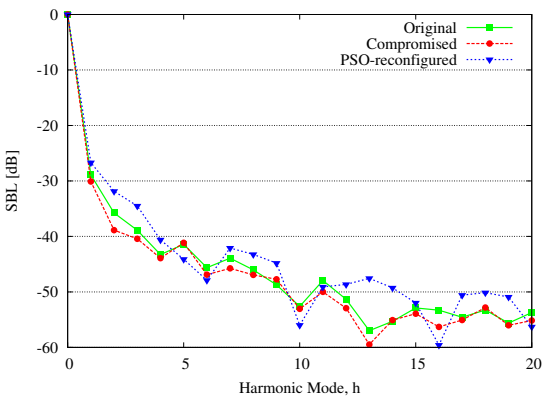

Fig. 103 - SBL - Comparison

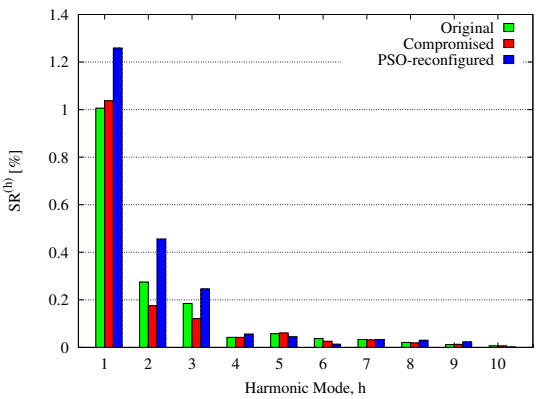

Fig. 104 - SR - Comparison

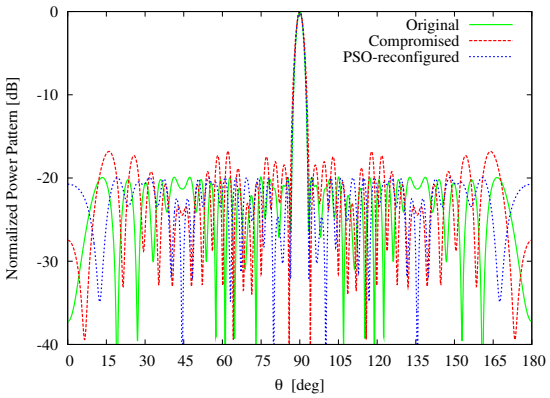

Fig. 105 - SBL - Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-19.88	2.84	13.91	-28.91	3.57
$Compromised$	-16.82	3.16	13.27	-30.11	3.24
$PSO-reconfigured$	-19.95	2.88	14.20	-26.70	4.58

Tab. XII - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

TEST CASE 3.d - $N = 30$, Triple Failure (External/Semi-External/Internal Pulses)

Goal

Reconfigure the radiated pattern through a *PSO*-based optimization strategy according to the feature of the pattern before the failure occured to the *RF* switches.

Differences wrt previous test case

- Previous: Failures occured at the elements $n = 2, 7, 28$
- Current: Failures occured at the elements $n = 7, 20, 28$

Description

- Number of Elements $N = 30$
- Elements Spacing: $d = 0.7\lambda$
- Static Array Excitations: Uniform, $I_n = 1, \ \ n = 1, \ \ , N$
- Averaged Time-Modulated Array Excitations: Optimized to synthesize a pattern with $SLL = -20\,dB$
- Failures occured at the element $n = 7, 20, 28$

Optimization Approach: PSO [1]

- Number of Variables: $X = 30$ (τ_n, $n = 1, ..., N$)
- Number of Particles: $S = N$
- Number of Iterations: $M = 1000$
- Inertial Weight: $I_w = 0.4$
- Cost Function: SLL weight: $w_{SLL} = 100$, BW weight: $w_{BW} = 1$, SR weight: $w_{SR} = 1$

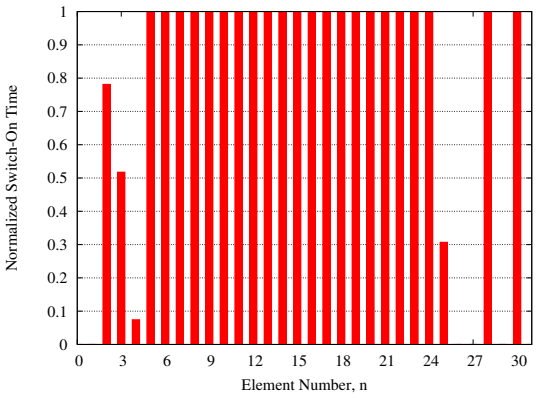

Fig. 106 - Pulse Sequence - Original

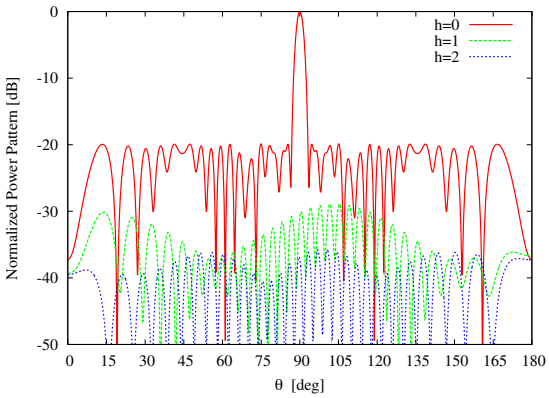

Fig. 107 - Patterns - Original

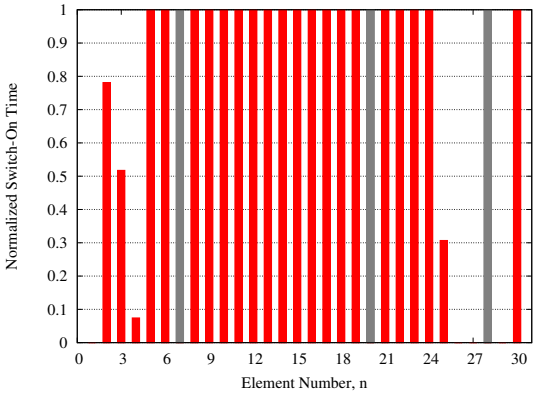

Fig. 108 - Pulse Sequence - Compromised

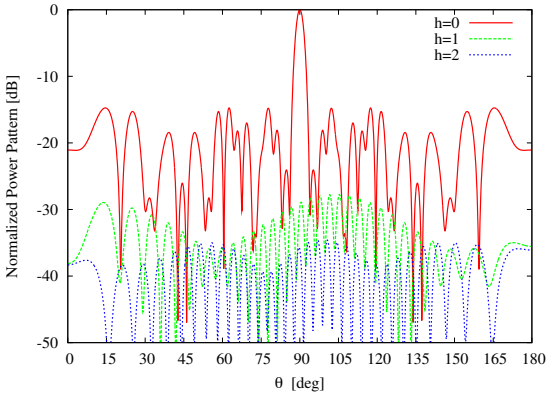

Fig. 109 - Patterns - Compromised

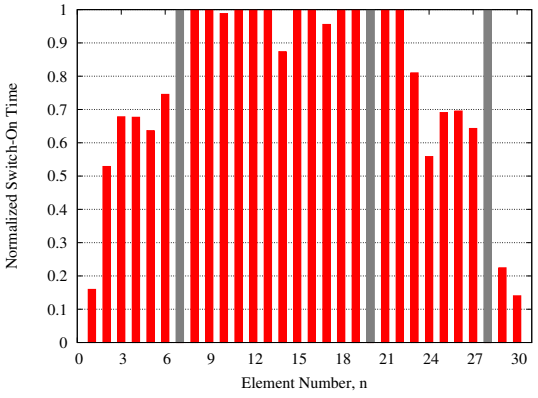

Fig. 110 - Pulse Sequence - PSO-reconfigured

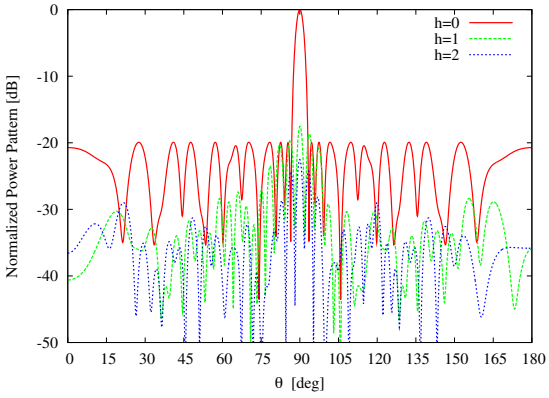

Fig. 111 - Patterns - PSO-reconfigured

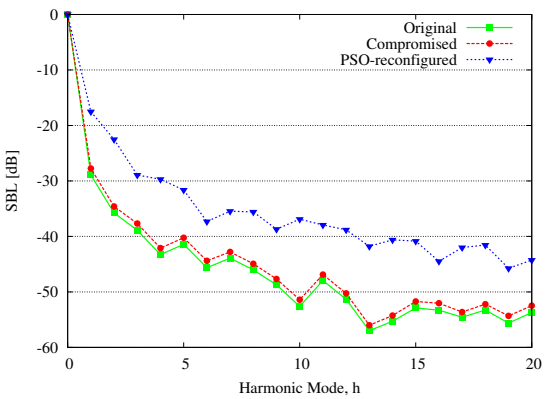

Fig. 112 - SBL - Comparison

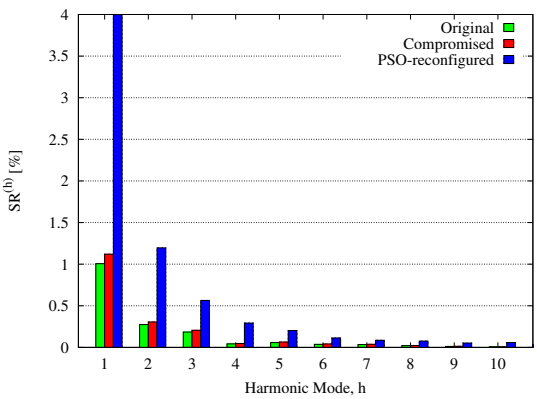

Fig. 113 - SR - Comparison

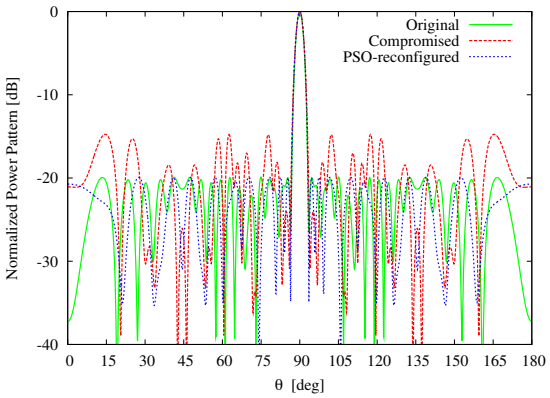

Fig. 114 - SBL - Comparison

	$SLL\,[dB]$	$BW\,[deg]$	$D\,[dB]$	$SBL\,[dB]$	$SR\,[\%]$
$Original$	-19.88	2.84	13.91	-28.91	3.57
$Compromised$	-14.74	2.98	13.07	-27.75	3.97
$PSO-reconfigured$	-19.92	2.91	13.35	-17.51	14.23

Tab. XIII - Patterns features: Sidelobe Level (SLL), -3dB Beamwidth (BW), Directivity (D), Sideband Level (SBL) and Sideband Radiation (SR)

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