Novel Power Pattern Matching Technique for Clustered Phased Arrays: Focusing on Linear Arrays

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2024/11/29

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Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 32$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]
- Excitations set: $i = 1$

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

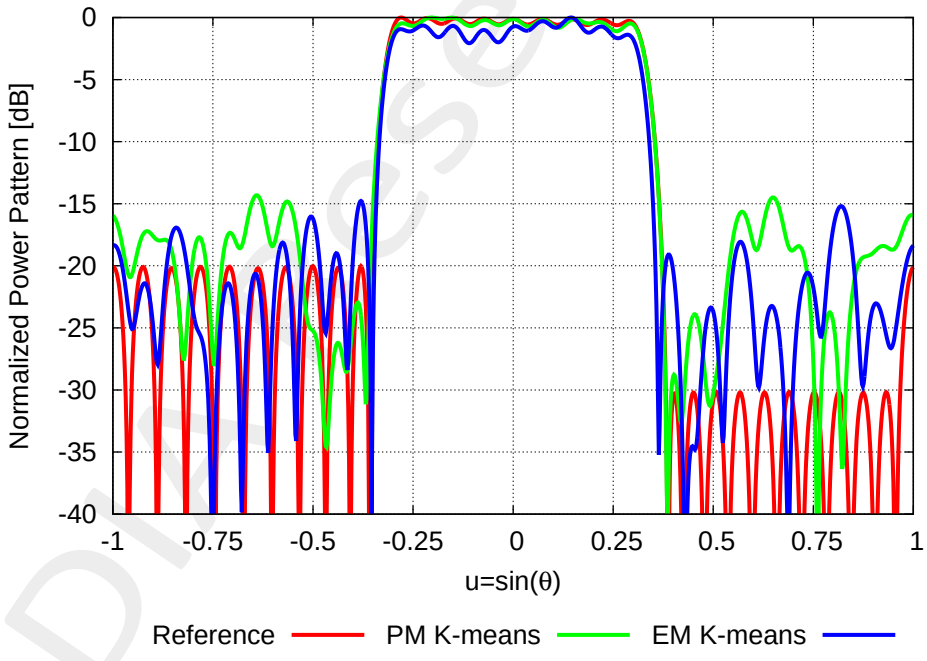

Figure 1: Power Pattern comparison PM K-means vs. EM K-means

Approach	**Pattern Matching**
PM K-means	6.13×10^{-2}
EM K-means	1.75×10^{-1}
Matching Improvement, R	0.65

Table I: Pattern Matching

1.1.2 $\mathbf{N = 32 - \ Q = N/2}$

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 32$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]
- Excitations set: $i = 1$

Sub-array generation

- number of clusters: $Q = 16$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

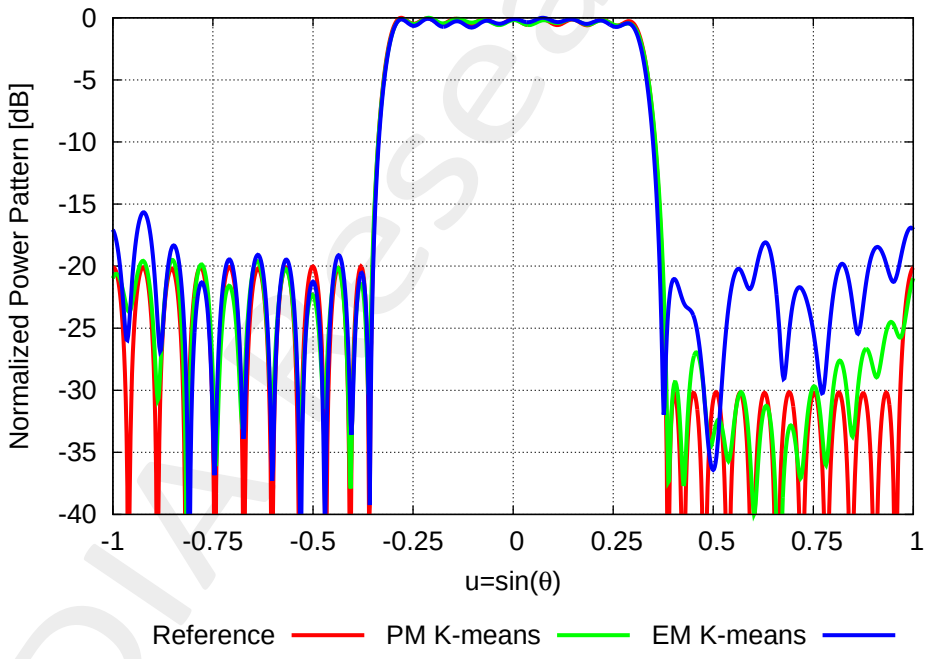

Figure 2: Power Pattern comparison PM K-means vs. EM K-means

Approach	**Pattern Matching**
PM K-means	1.94×10^{-2}
EM K-means	7.48×10^{-2}
Matching Improvement, R	0.74

Table II: Pattern Matching

1.1.3 $\mathbf{N = 32 - Q = \frac{3}{4}N}$

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 32$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]
- Excitations set: $i = 1$

Sub-array generation

- number of clusters: $Q = 24$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

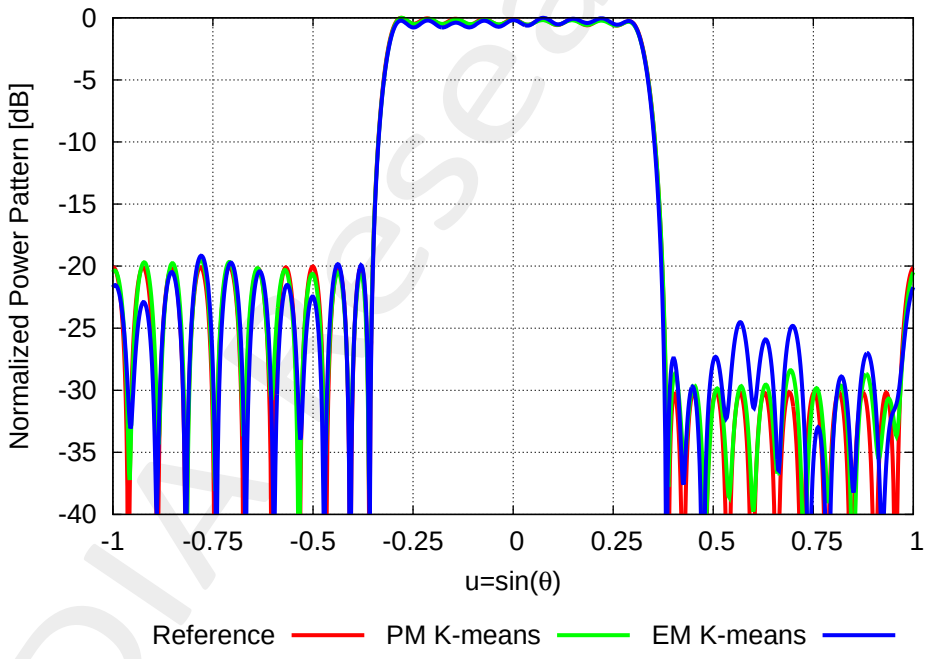

Figure 3: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	1.06×10^{-2}
EM K-means	3.69×10^{-2}
Matching Improvement, R	0.71

Table III: Pattern Matching

1.2 Asymmetric Flat Top, $\mathrm{SLL_1} = -20$ [dB] - $\mathrm{SLL_2} = -30$ [dB], Excitations Multiplicity, $\mathrm{N} = 16$ - $\mathrm{Q} = 8$

1.2.1 Excitations #1

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 16$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]
- Excitations set: $i = 1$

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

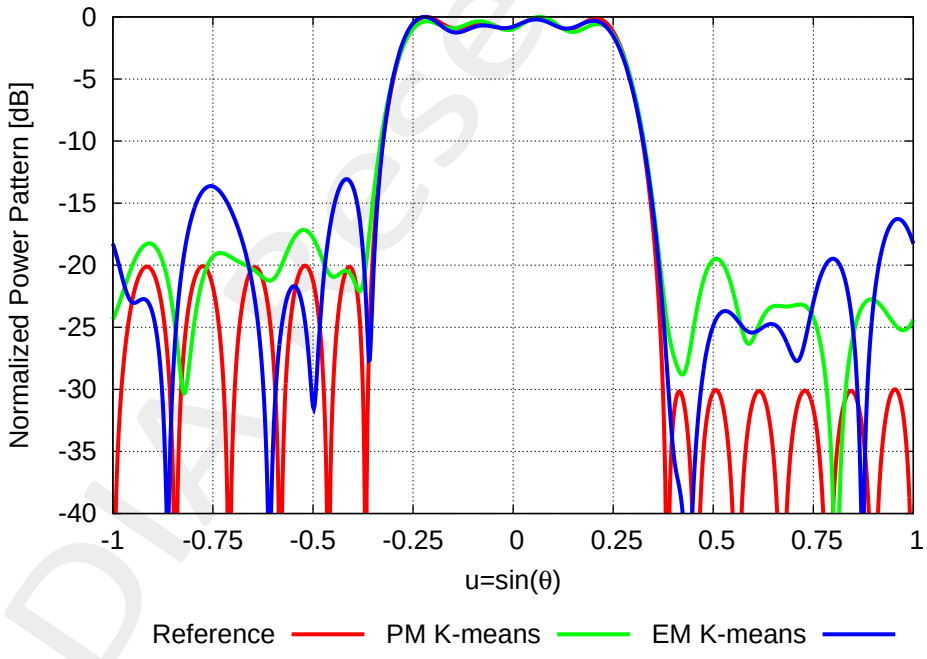

Figure 4: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	5.53×10^{-2}
EM K-means	5.96×10^{-2}

Table IV: Pattern Matching

1.2.2 Excitations #2

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 16$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]
- Excitations set: $i = 2$

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

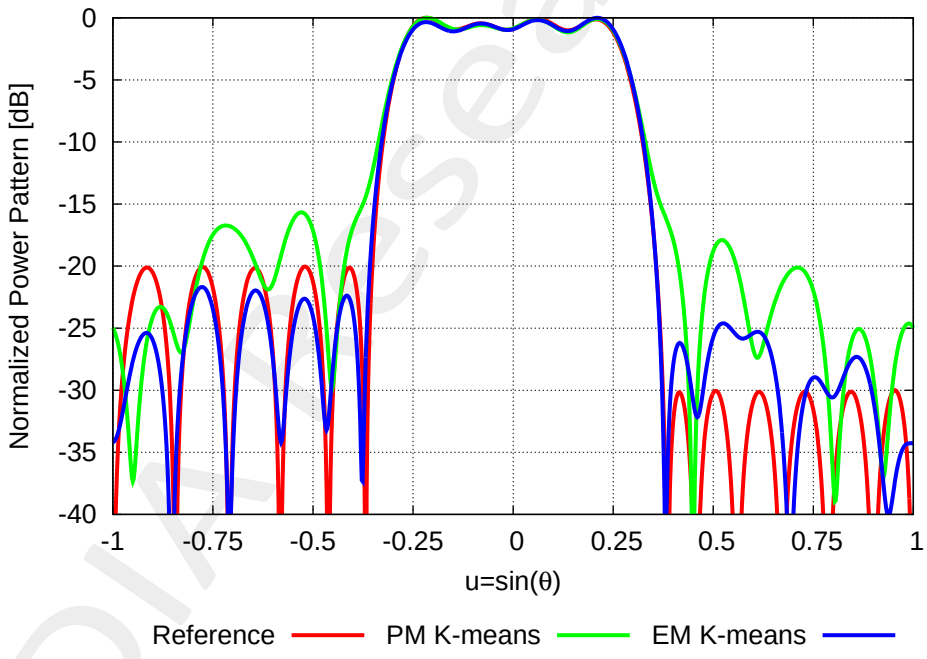

Figure 5: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	4.41×10^{-2}
EM K-means	3.56×10^{-2}

Table V: Pattern Matching

1.2.3 Excitations #3

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 16$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]
- Excitations set: $i = 3$

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

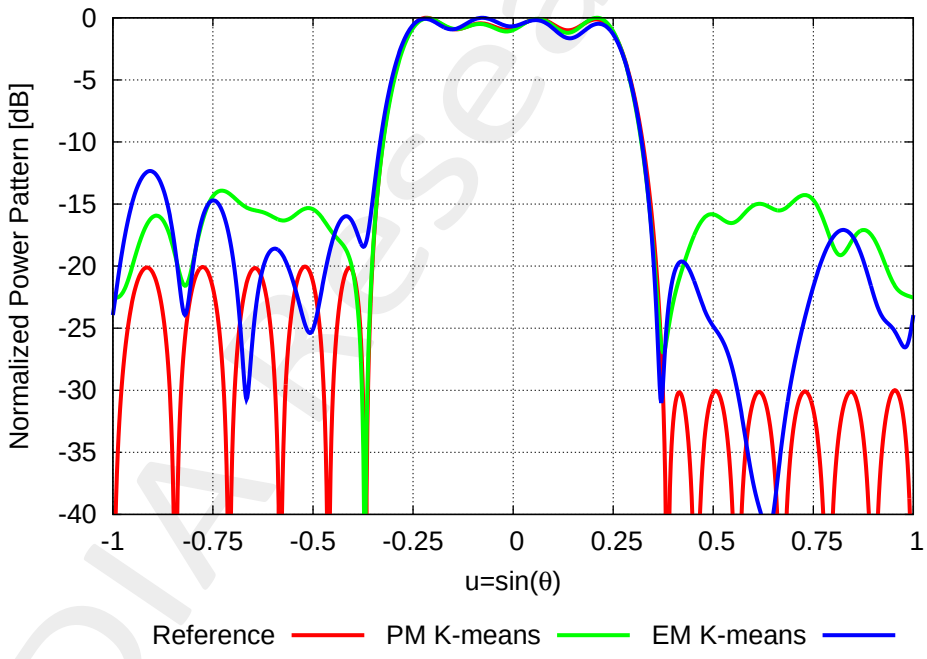

Figure 6: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	6.52×10^{-2}
EM K-means	9.03×10^{-2}

Table VI: Pattern Matching

1.2.4 Excitations #4

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 16$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]
- Excitations set: $i = 4$

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

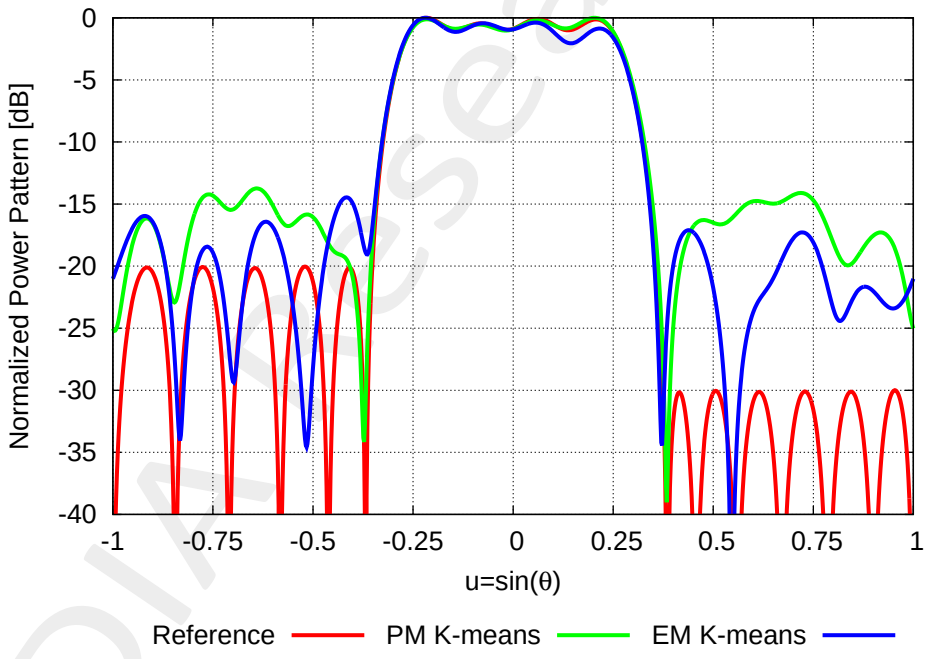

Figure 7: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	7.02×10^{-2}
EM K-means	9.28×10^{-2}

Table VII: Pattern Matching

1.2.5 Excitations #5

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 16$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]
- Excitations set: $i = 5$

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

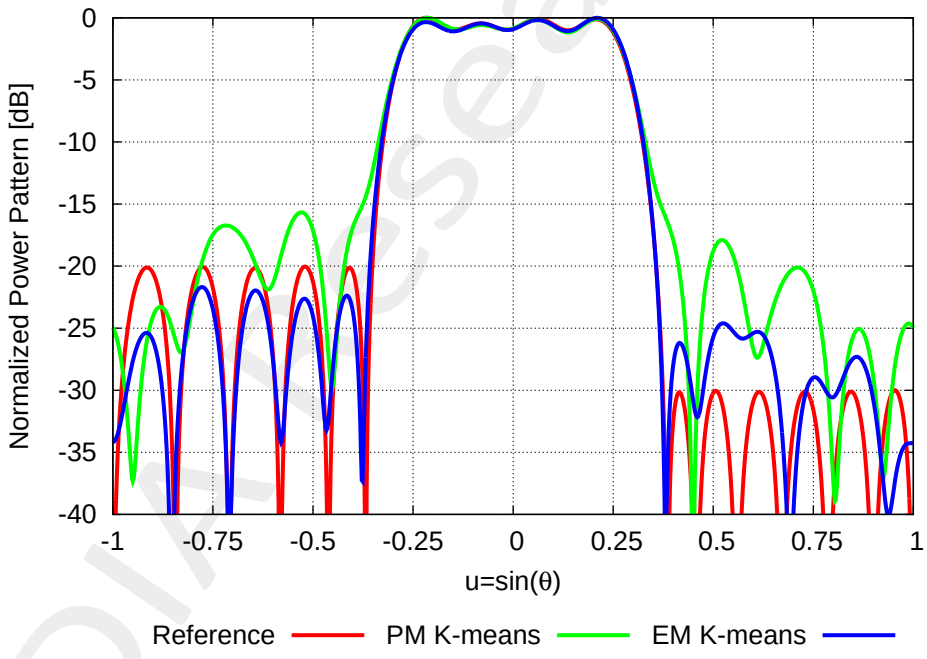

Figure 8: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	4.41×10^{-2}
EM K-means	3.56×10^{-2}

Table VIII: Pattern Matching

1.2.6 Excitations #6

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 16$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]
- Excitations set: $i = 6$

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

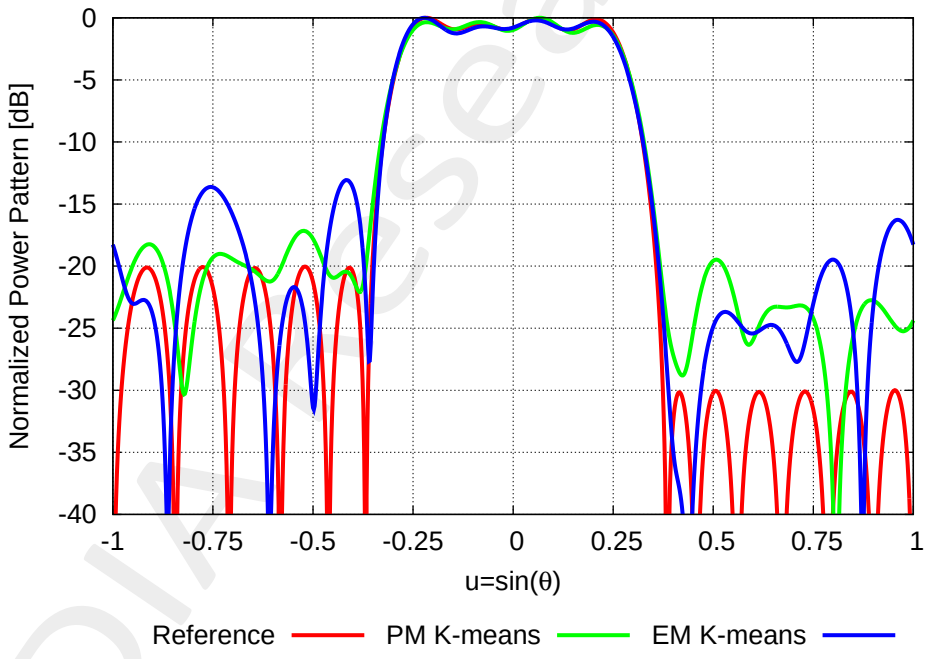

Figure 9: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	5.53×10^{-2}
EM K-means	5.96×10^{-2}

Table IX: Pattern Matching

1.2.7 Excitations #7

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 16$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]
- Excitations set: $i = 7$

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

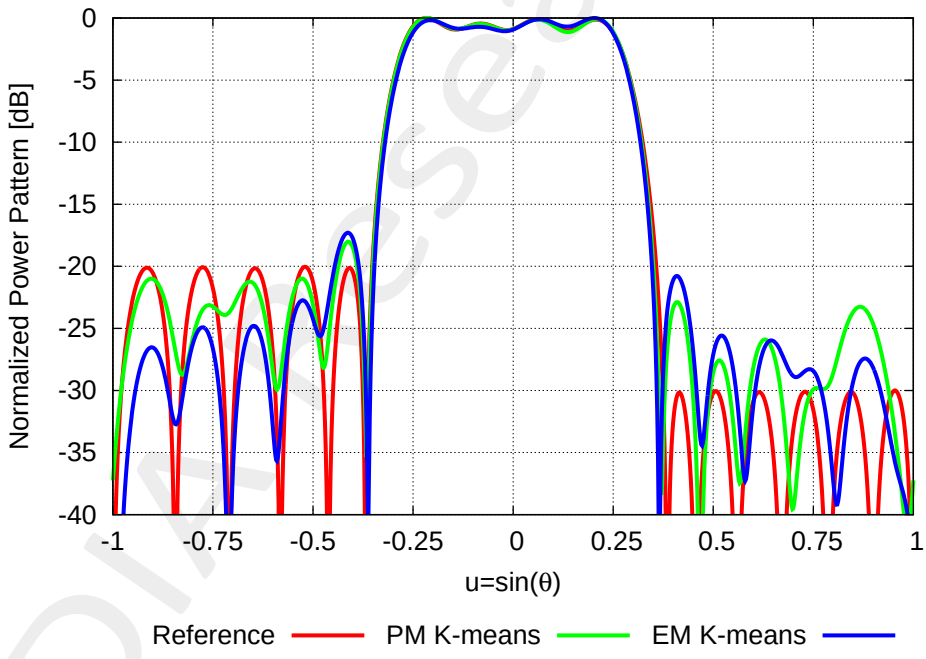

Figure 10: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	1.78×10^{-2}
EM K-means	5.23×10^{-2}

Table X: Pattern Matching

1.2.8 Excitations #8

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 16$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]
- Excitations set: $i = 8$

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

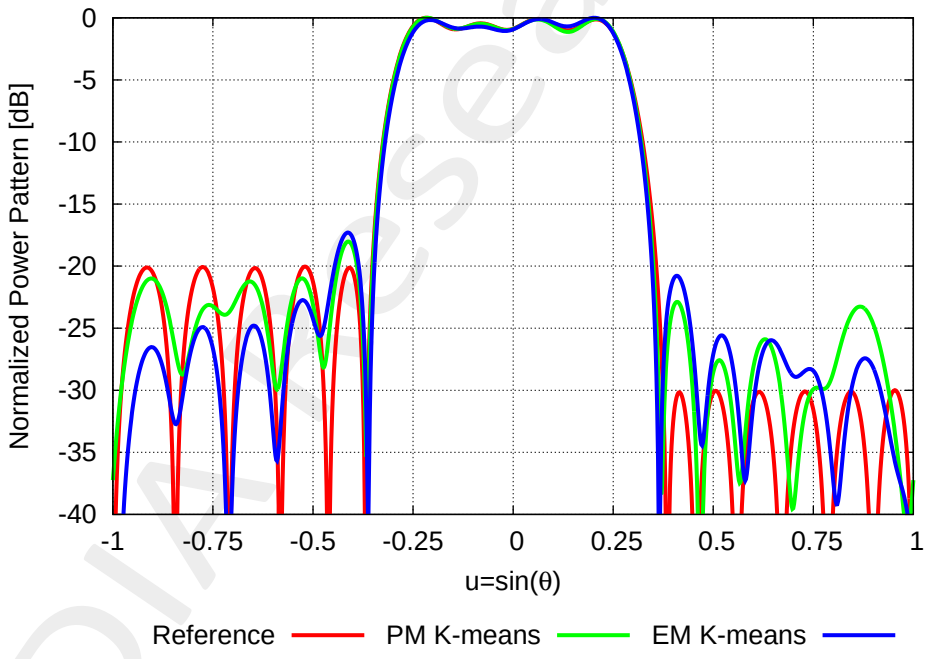

Figure 11: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	1.78×10^{-2}
EM K-means	5.23×10^{-2}

Table XI: Pattern Matching

1.2.9 Analysis vs. Excitations Multiplicity

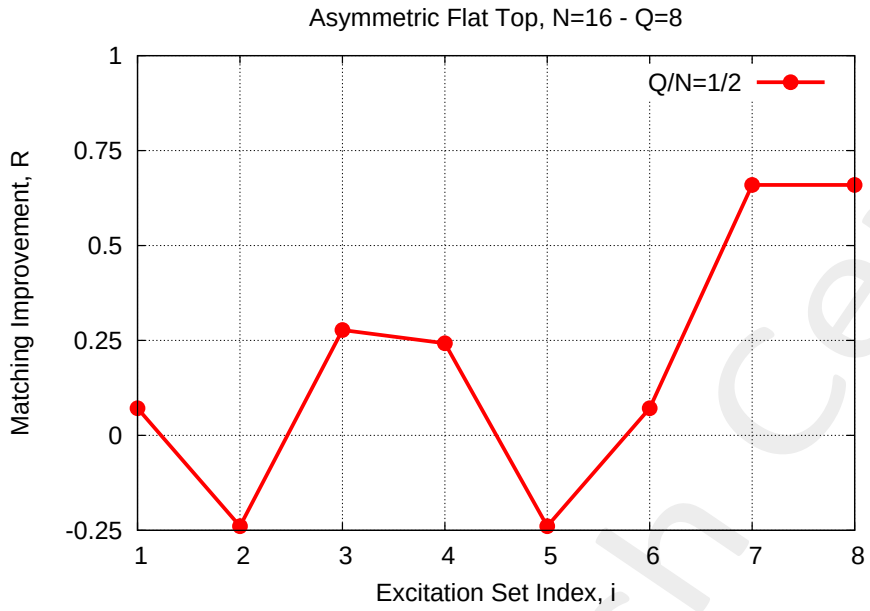

Figure 12: Analysis Matching Improvement vs. Excitations Multiplicity

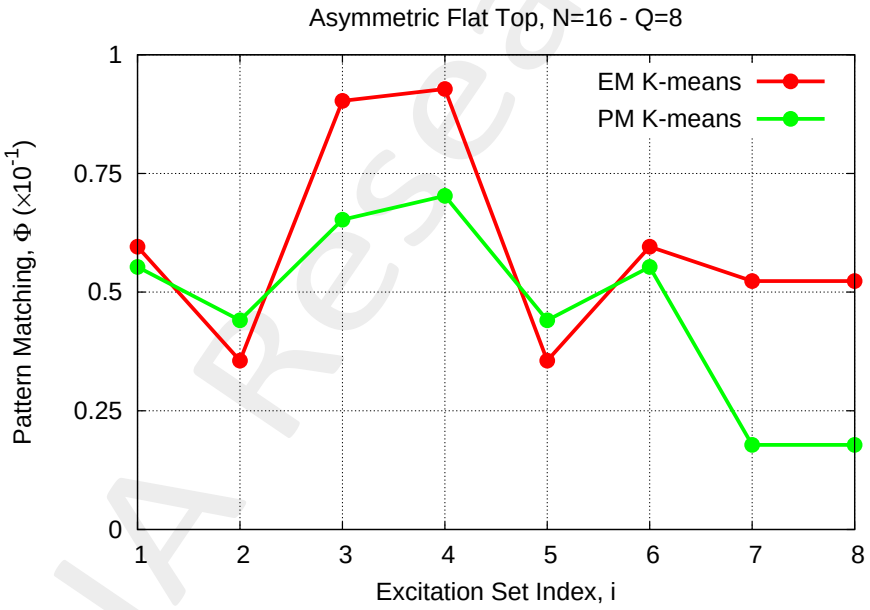

Figure 13: Pattern Matching comparison PM K-means vs. EM K-means for the different reference excitations available for $Q/N = 1/2$

Observations

- The PM K-means has been applied to all the possible excitations set, which allows to generate an asymmetric flat to pattern with $SLL_1 = -20$ [dB] and $SLL_2 = -30$ [dB] of an array with $N = 16$ elements and $Q = 8$ subarrays.
- It has been proved that the clustering depends on the excitations set considered.
- The multiplicity must be exploited to find the best subarray pattern.

1.3 Asymmetric Flat Top, $\mathrm{SLL}_1 = -20$ [dB] - Analysis SLL_2, $\mathrm{N} = 32$ - $\mathrm{Q} = \mathrm{N}/4$

1.3.1 $\mathrm{SLL}_2 = -20$ [dB]

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 32$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -20$ [dB]

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

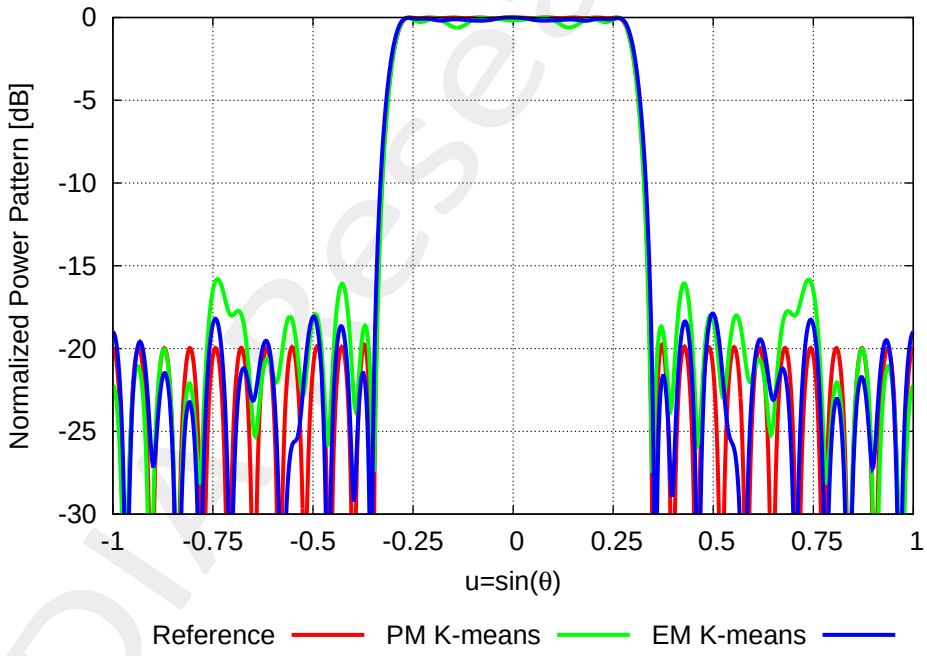

Figure 14: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	4.80×10^{-2}
EM K-means	3.62×10^{-2}

Table XII: Pattern Matching

1.3.2 $\mathbf{SLL_2 = -25}$ [dB]

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 32$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -25$ [dB]

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

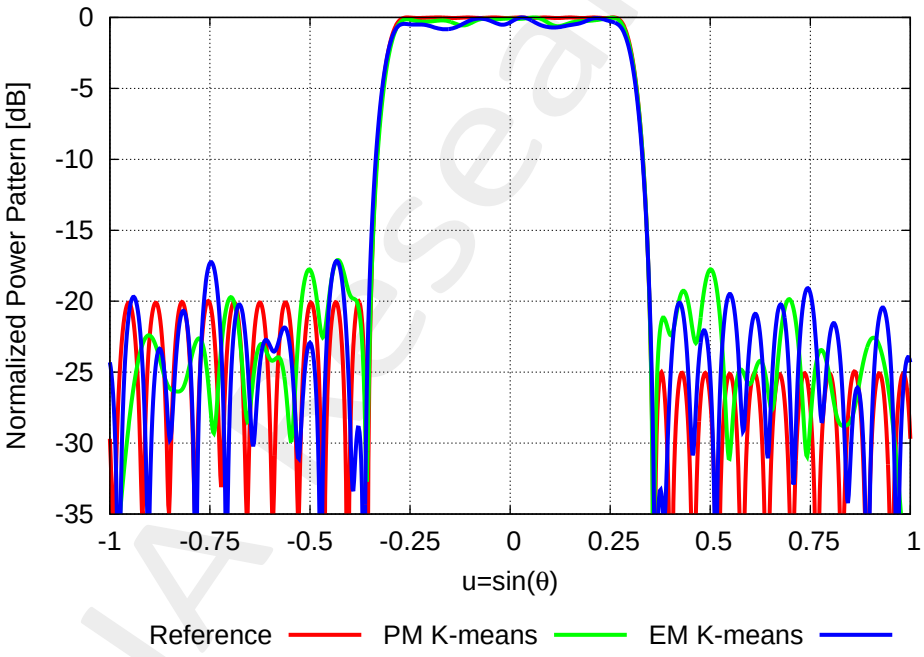

Figure 15: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	5.60×10^{-2}
EM K-means	9.04×10^{-2}

Table XIII: Pattern Matching

1.3.3 $\mathbf{SLL_2 = -30}$ [dB]

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 32$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -30$ [dB]

Sub-array generation

- number of clusters: $Q = 16$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

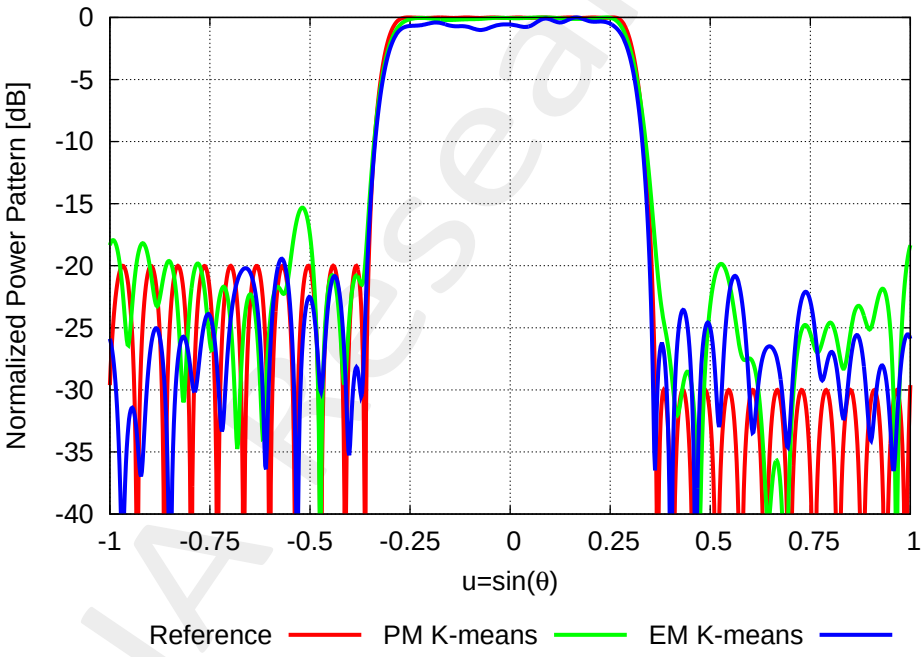

Figure 16: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	4.02×10^{-2}
EM K-means	1.30×10^{-1}

Table XIV: Pattern Matching

1.3.4 $\mathbf{SLL_2 = -35}$ [dB]

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 32$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -35$ [dB]

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

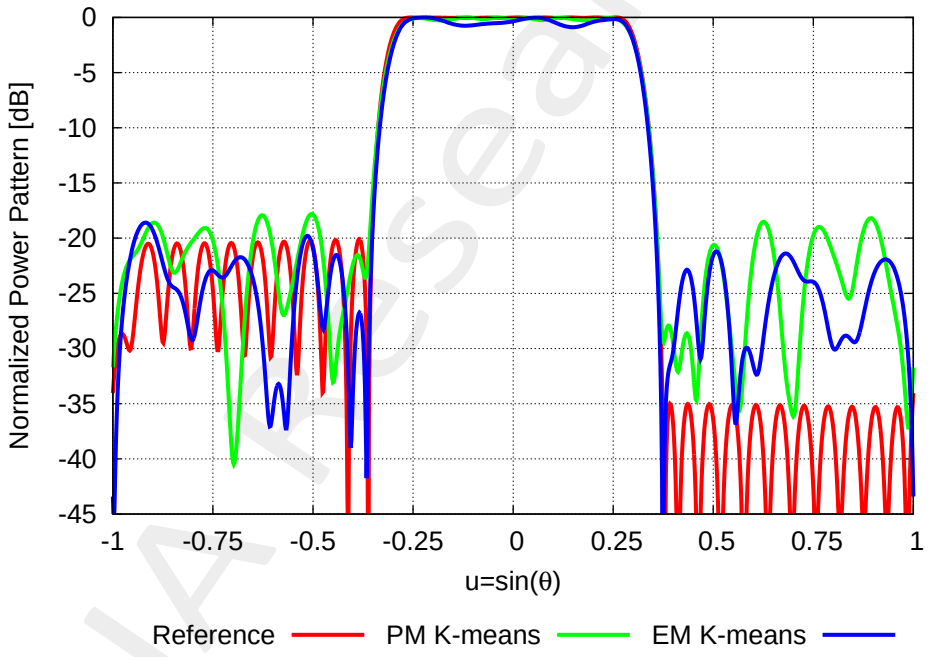

Figure 17: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	4.50×10^{-2}
EM K-means	9.37×10^{-2}

Table XV: Pattern Matching

1.3.5 $\mathbf{SLL_2 = -40}$ [dB]

Antenna configuration

- Isotropic Elements
- Number of Elements: $N = 32$
- Distance between Elements along x axis: $d_x = \lambda/2$

Target excitations

- Asymmetric Flat Top, $SLL_1 = -20$ [dB] - $SLL_2 = -40$ [dB]

Sub-array generation

- number of clusters: $Q = 8$
- excitation matching strategy: EM K-Means
- power matching strategy: PM K-means

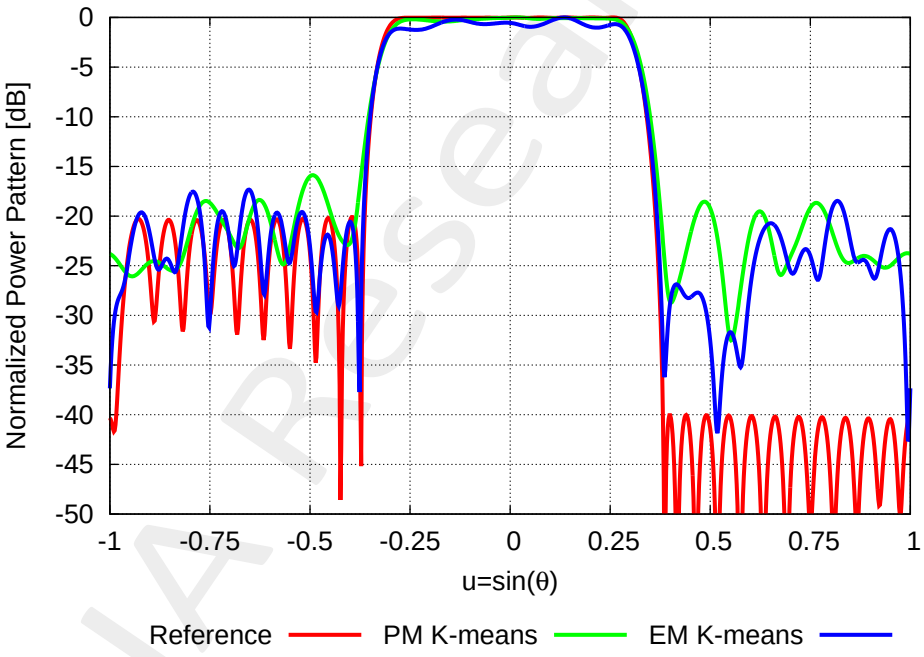

Figure 18: Power Pattern comparison PM K-means vs. EM K-means

Approach	Pattern Matching
PM K-means	5.48×10^{-2}
EM K-means	1.40×10^{-1}

Table XVI: Pattern Matching

1.3.6 Analysis vs. SLL

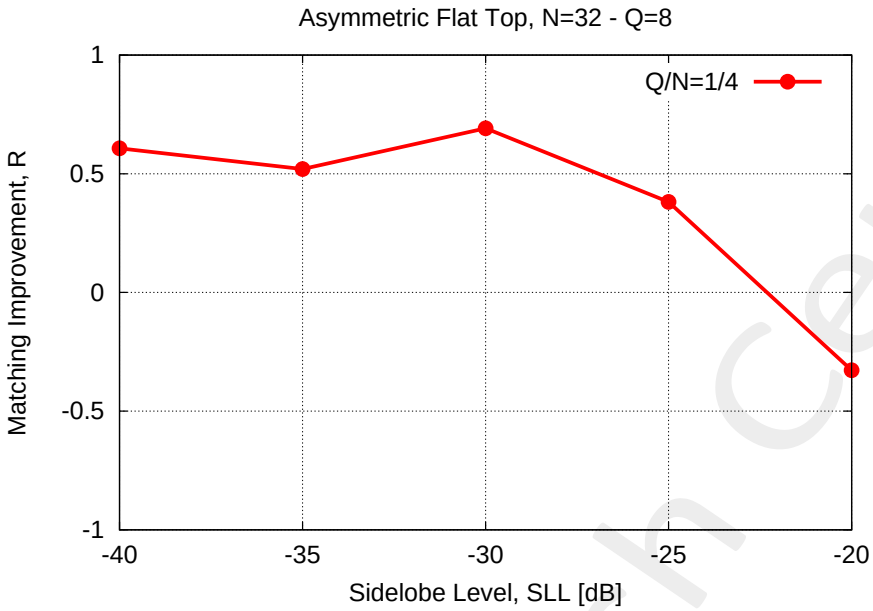

Figure 19: Analysis Matching Improvement vs. SLL

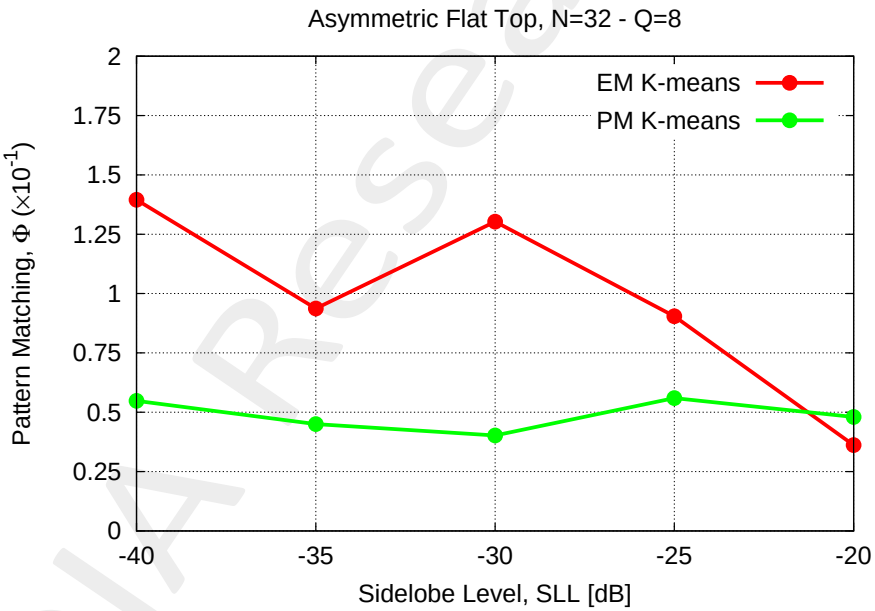

Figure 20: Pattern Matching comparison PM K-means vs. EM K-means for the different SLL for $Q/N = 1/4$

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

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