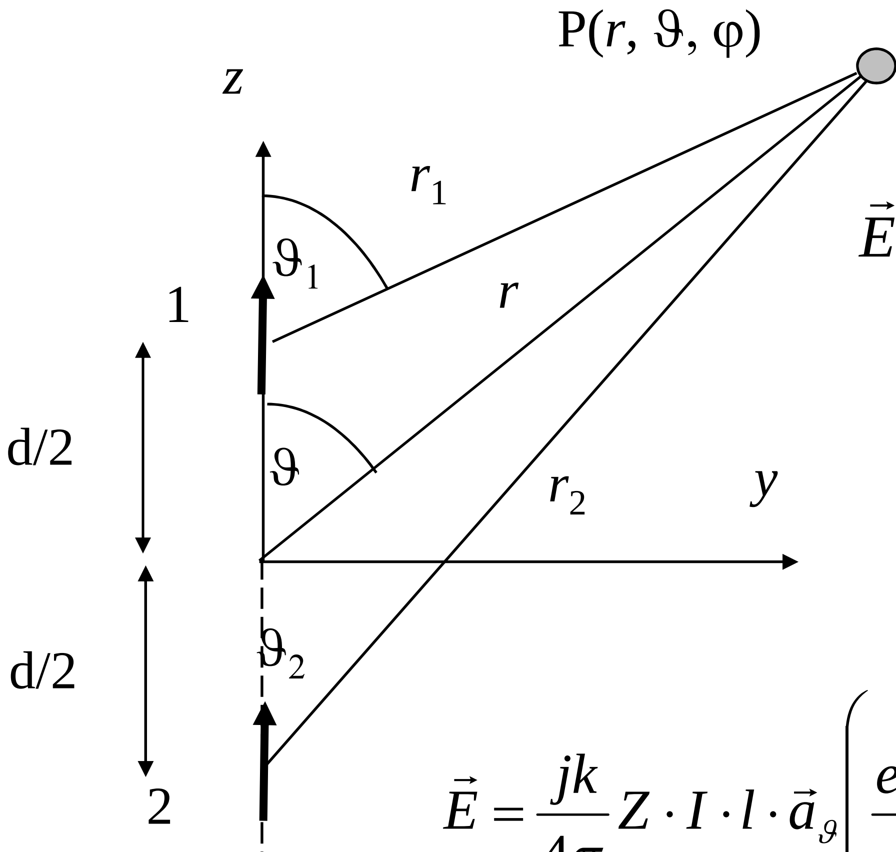
Array adalah sekumpulan antena (yang biasanya sejenis)

Array akan menghasilkan diagram radiasi yang direktif

Lima parameter pengontrol diagram radiasi:

1. Konfigurasi geometris array
2. Jarak antar elemen
3. Amplitudo arus/tegangan feeding
4. Phase pada feeding
5. Diagram radiasi masing-masing elemen

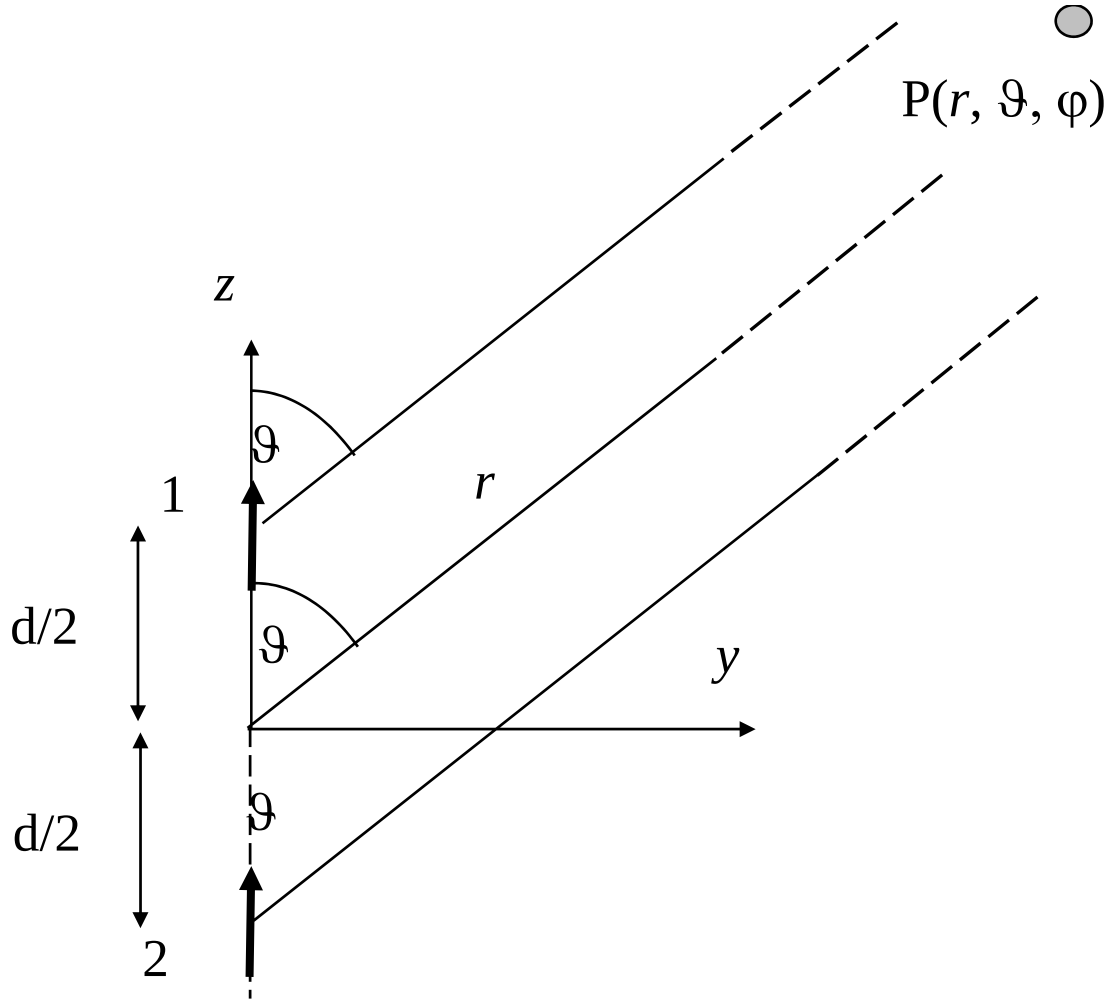
Array dua Antena



$$\vec{E}_{dipol\ Hertz} = \frac{jk}{4\pi} Z \cdot I \cdot l \cdot \frac{e^{-jkr}}{r} \cdot \sin\vartheta \cdot \vec{a}_\vartheta$$

$$I_1 = I \cdot e^{j\frac{\beta}{2}} \qquad I_2 = I \cdot e^{-j\frac{\beta}{2}}$$

$$\vec{E} = \frac{jk}{4\pi} Z \cdot I \cdot l \cdot \vec{a}_\vartheta \left(\frac{e^{-j\left(k r_1 - \frac{\beta}{2}\right)}}{r_1} \cdot \sin\vartheta_1 + \frac{e^{-j\left(k r_2 + \frac{\beta}{2}\right)}}{r_2} \cdot \sin\vartheta_2 \right)$$



$$\vartheta_1 \approx \vartheta_2 \approx \vartheta$$

Untuk phasa

$$r_1 \approx r - \frac{d}{2}\cos\vartheta$$

$$r_2 \approx r + \frac{d}{2}\cos\vartheta$$

Untuk amplitudo $r_1 \approx r_2 \approx r$

$$\vec{E} = \frac{jk}{4\pi} Z \cdot I \cdot l \cdot \vec{a}_\vartheta \left(\frac{e^{-j\left(kr - k\frac{d}{2}\cos\vartheta - \frac{\beta}{2}\right)}}{r} \cdot \sin\vartheta + \frac{e^{-j\left(kr + k\frac{d}{2}\cos\vartheta + \frac{\beta}{2}\right)}}{r} \cdot \sin\vartheta \right)$$

$$\vec{E} = \frac{jk}{4\pi} Z \cdot I \cdot l \cdot \frac{e^{-jkr}}{r} \cdot \sin\vartheta \cdot \vec{a}_\vartheta \left(e^{j\left(k\frac{d}{2}\cos\vartheta + \frac{\beta}{2}\right)} + e^{-j\left(k\frac{d}{2}\cos\vartheta + \frac{\beta}{2}\right)} \right)$$

$$\vec{E} = \frac{jk}{4\pi} Z \cdot I \cdot l \cdot \frac{e^{-jkr}}{r} \cdot \sin\vartheta \cdot \vec{a}_\vartheta \cdot 2\cos\frac{1}{2}\left(kd\cos\vartheta + \beta\right)$$

$$\vec{E} = \vec{E}_{dipol\ Hertz} \cdot AF$$

$$AF = 2\cos\left(\pi \cdot \frac{d}{\lambda}\cos\vartheta + \frac{\beta}{2}\right)$$

Jadi *AF* merupakan fungsi dari jarak kedua dipol satu dengan lainnya (geometri dari array) dan fungsi dari phasa arus pembangkit pancaran.

Contoh:

$$d = \frac{\lambda}{4}$$

Dan phasa masing-masing $\beta = 0$ $\beta = \pi / 2$ $\beta = -\pi / 2$

tentukanlah posisi nol medan listrik total

Jawab:
Medan total bisa nol, jika $E_{dipolHertz}$ = 0, atau AF = 0

$$\vec{E}_{dipol\ Hertz} = 0 \quad \Rightarrow \quad \vartheta = 0^o \qquad \vartheta = 180^o$$

dan

$$AF = 2\cos\left(\pi \cdot \frac{d}{\lambda}\cos\vartheta + \frac{\beta}{2}\right) = 0$$ dengan $d = \frac{\lambda}{4}$

$$AF = 2\cos\left(\frac{\pi}{4}\cos\vartheta + \frac{\beta}{2}\right) = 0$$

cosinus nol pada titik titik $\left(n+\frac{1}{2}\right)\pi$ dengan n = ..-2, -1, 0, 1, 2….

Maka $\frac{\pi}{4}\cos\vartheta+\frac{\beta}{2}=\left(n+\frac{1}{2}\right)\pi$

a. $\beta=0:$ $\cos\vartheta=4\left(n+\frac{1}{2}\right)$

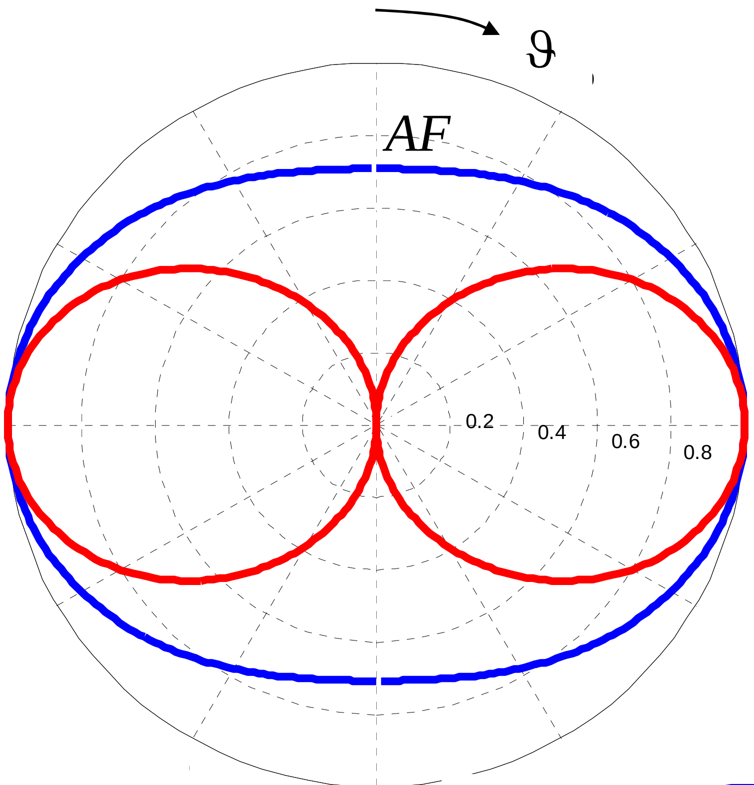
di sini untuk n = .., -2, -1, 0, 1, 2, … $\cos\vartheta>1$ atau $\cos\vartheta<-1$

b. $\beta=\frac{\pi}{2}:$ $\cos\vartheta+1=4\left(n+\frac{1}{2}\right)$ $\Rightarrow\cos\vartheta=4n+1$

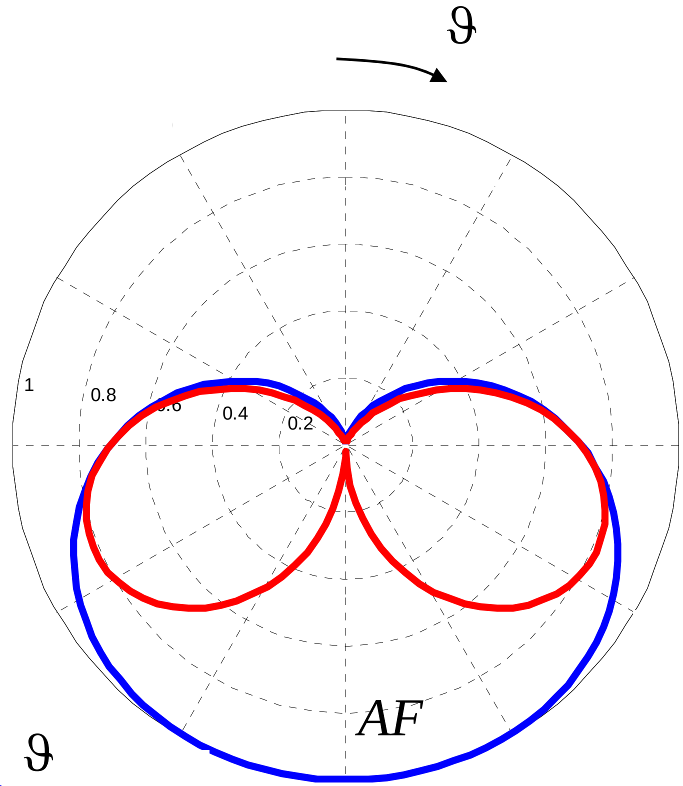
Solusi hanya untuk n = 0 $\cos\vartheta=1 \quad\Rightarrow\quad \vartheta=0$

c. $\beta=-\frac{\pi}{2}:$ $\cos\vartheta-1=4\left(n+\frac{1}{2}\right)$ $\Rightarrow\cos\vartheta=4n+3$

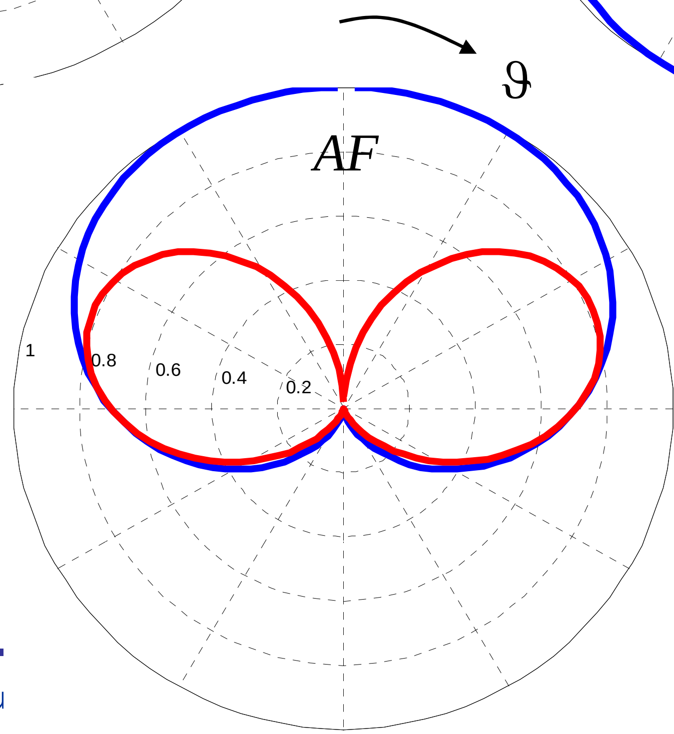
Solusi hanya untuk n = -1 $\cos\vartheta=-1 \quad\Rightarrow\quad \vartheta=180$



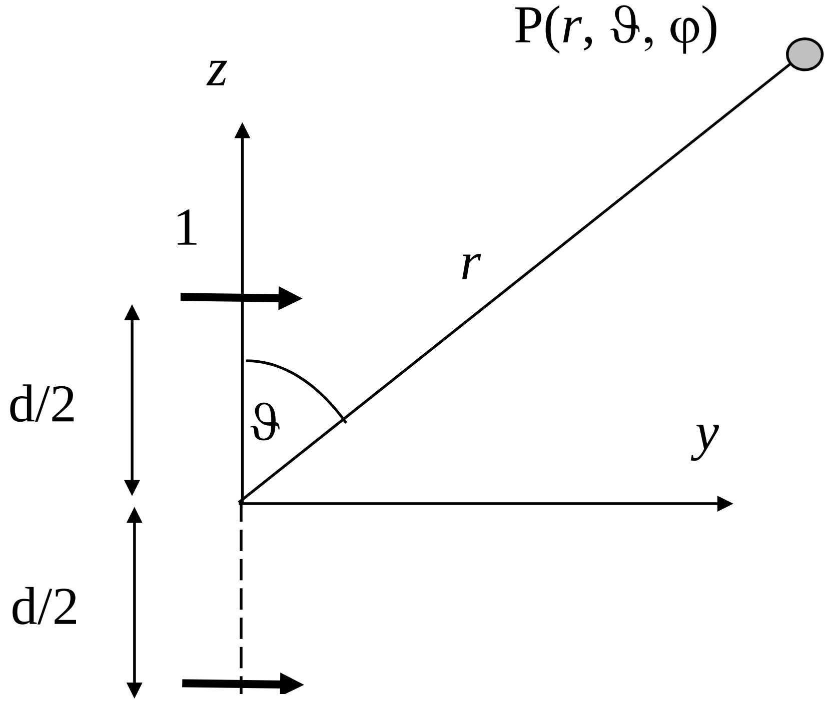
$\beta = 0$

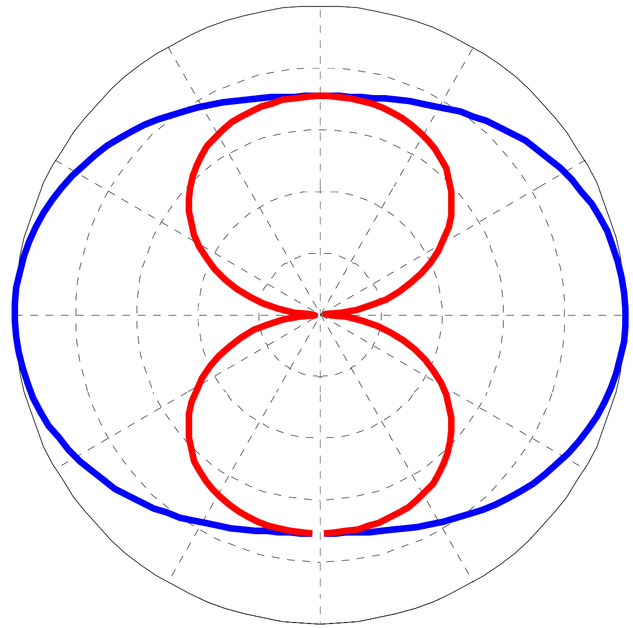


$\beta = \pi/2$

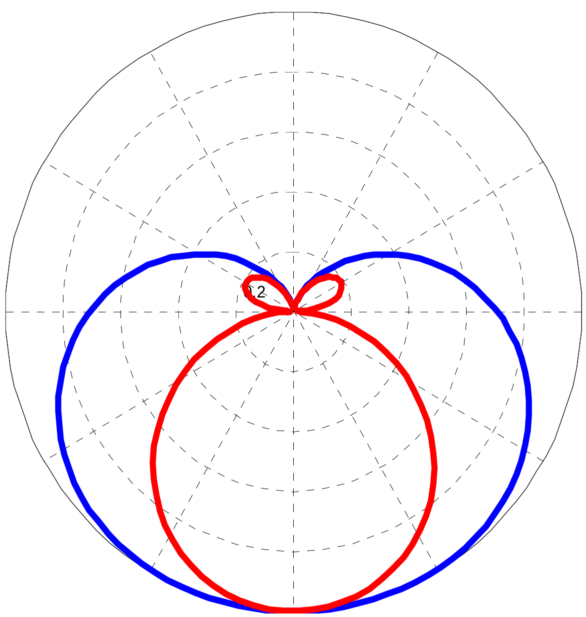


$\beta = -\pi/2$

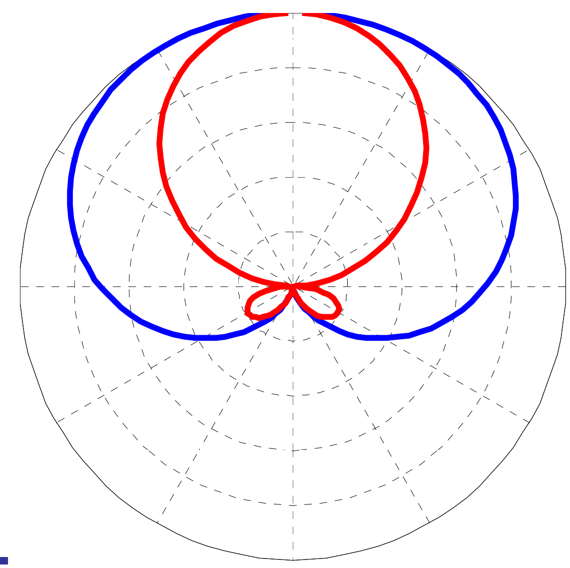




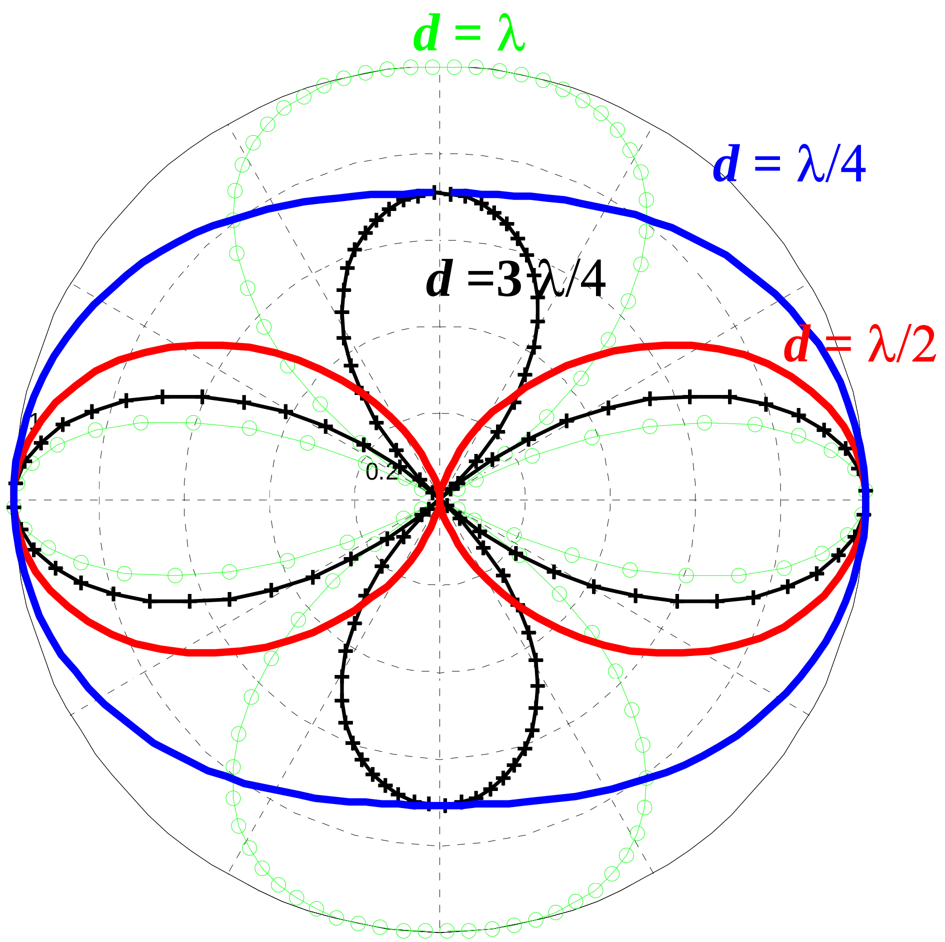
$\beta = 0$



$\beta = \pi/2$

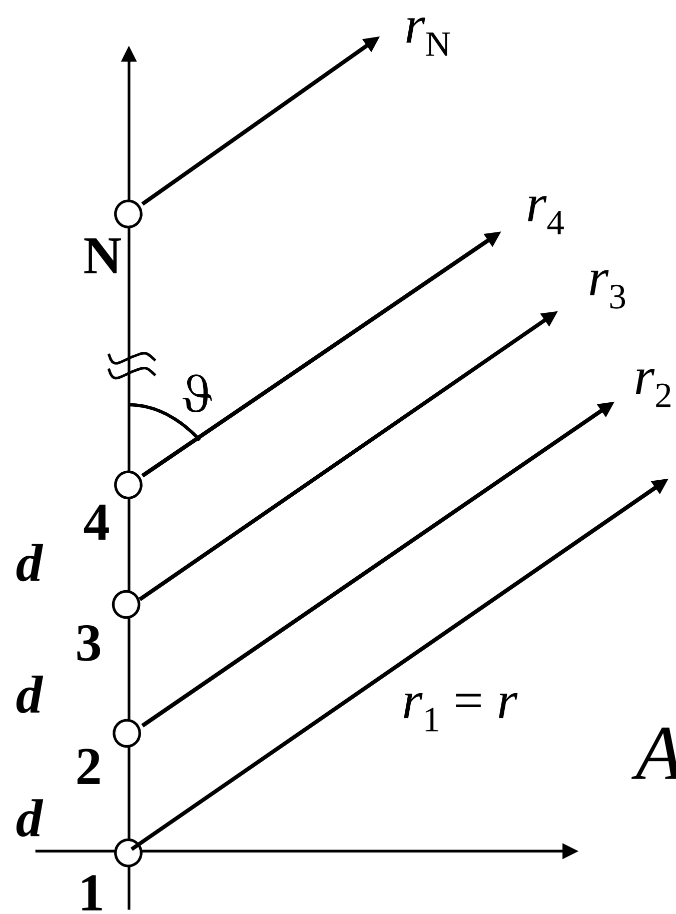


$\beta = -\pi/2$



d = λ
d = λ/4
d =3 λ/4
d = λ/2
1
0.2

Array Linier N Antena



$$I_1 = I$$
$$I_2 = I \cdot e^{j\beta}$$
$$I_3 = I \cdot e^{j2\beta}$$
$$I_n = I \cdot e^{j(n-1)\beta}$$

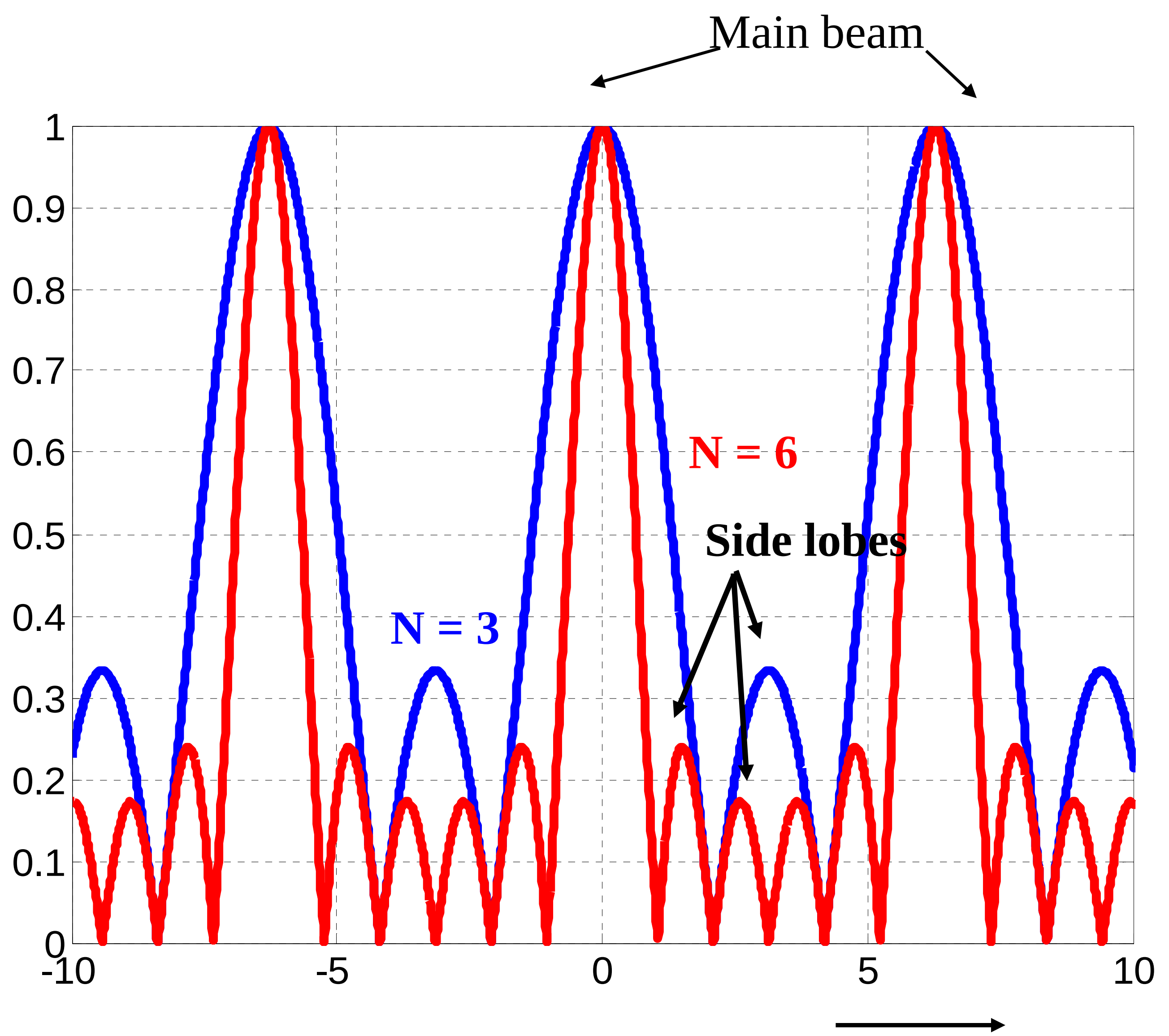
$$AF = 1 + e^{j(kd\cos\vartheta+\beta)} + e^{j2(kd\cos\vartheta+\beta)} + e^{j3(kd\cos\vartheta+\beta)} + \cdots + e^{j(N-1)(kd\cos\vartheta+\beta)}$$

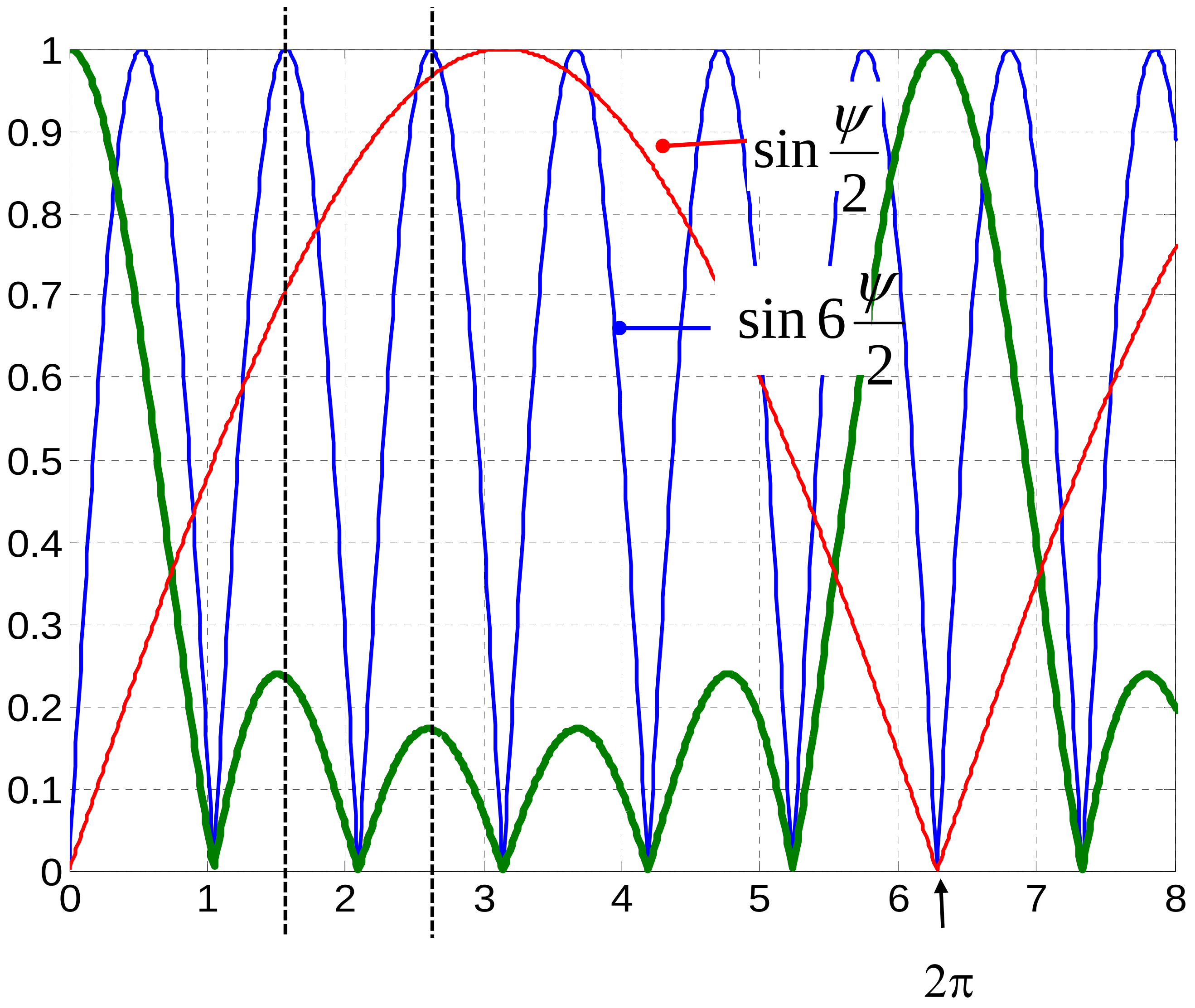
dengan $\psi = kd\cos\vartheta + \beta$

$$AF = 1 + e^{j\psi} + e^{j2\psi} + e^{j3\psi} + \cdots + e^{j(N-1)\psi}$$

$$AF = e^{j(N-1)\frac{\psi}{2}} \frac{\sin\left(\frac{N\psi}{2}\right)}{\sin\left(\frac{\psi}{2}\right)} \Rightarrow AF = \frac{\sin\left(\frac{N\psi}{2}\right)}{\sin\left(\frac{\psi}{2}\right)}$$

Di-norm $$AF_N = \frac{1}{N}\frac{\sin\left(\frac{N\psi}{2}\right)}{\sin\left(\frac{\psi}{2}\right)}$$


Main beam
N = 6
Side lobes
N = 3
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-10
-5
0
5
10



1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
6
7
8
$\sin\frac{\psi}{2}$
$\sin 6\frac{\psi}{2}$
2π

Posisi Nol Array N Antenna

$$AF_N = \frac{1}{N}\frac{\sin\left(\frac{N\psi}{2}\right)}{\sin\left(\frac{\psi}{2}\right)} = 0$$

$$\sin\left(\frac{N\psi}{2}\right) = 0 \qquad \text{syarat} \qquad \sin\left(\frac{\psi}{2}\right) \neq 0$$

$$\frac{N}{2}\left(kd\cos\vartheta + \beta\right) = \pm n \cdot \pi \qquad n \neq 0,\ N,\ 2N,\ \ldots$$

Untuk N = 6: $\psi = \frac{1}{3}\pi, \frac{2}{3}\pi, \pi, \frac{4}{3}\pi$ dan $\frac{5}{3}\pi$

Posisi Nilai Maksimum Faktor Array N Antenna

Pada saat $\frac{\sin(0)}{0}$

$$\vartheta_{\max} = \arccos\left[\frac{\lambda}{2\pi\, d}\left(\pm\, 2m \cdot \pi - \beta\right)\right]$$ *m* = 0, 1, 2, …..

Untuk contoh N = 6, pada saat $\psi = 0$ dan $\psi = 2\pi$

Maksimum Lokal : Side Lobes

Posisi nilai maksimum ini secara aproksimatif bisa diketahui dengan menentukan nilai maksimum dari fungsi sinus di pembilang dengan pengecualian nilai maksimum yang pertama dan terakhir dalam interval $0 \le \psi \le 2\pi$

Maksimum dari $\sin\left(\frac{N\psi}{2}\right)$ terjadi pada $\frac{N\psi}{2} = \left(\frac{1}{2} + n\right)\pi \Rightarrow \psi = (1 + 2n)\frac{1}{N}\pi$

Untuk N = 6:

$$\psi_1 = \frac{1}{6}\pi$$

Nilai pertama, jadi bukan side lobe

$$\psi_2 = \frac{1}{2}\pi = 1{,}571$$

Secara eksak 1,5125

$$\psi_3 = \frac{5}{6}\pi = 2{,}618$$

2,6027

$$\psi_4 = \frac{7}{6}\pi = 3{,}6652$$

3,6805

$$\psi_5 = \frac{3}{2}\pi = 4{,}7124$$

4,7707

$$\psi_6 = \frac{11}{6}\pi$$

Nilai terakhir, jadi bukan side lobe

Posisi approks.	Peredaman app.	Posisi eksak	Peredaman eksak
1,571	0,2357 = -12.55dB	1,5125	0.2392 = -12.43dB
2,618	0,1725 = -15.262dB	2, 6027	0.1727 = -15.25dB
3,665	0,1725 = -15.262dB	3,6805	0.1727 = -15.25dB
4,712	0,2357 = -12.55dB	4,7707	0.2392 = -12.43dB

Beam Width Array

Untuk nilai ψ yang sangat kecil, AF bisa diaproksimasikan menjadi

$$AF_N = \frac{1}{N}\frac{\sin\left(\frac{N\psi}{2}\right)}{\sin\left(\frac{\psi}{2}\right)} \approx \frac{1}{N}\frac{\sin\left(\frac{N\psi}{2}\right)}{\frac{\psi}{2}} = si\left(\frac{N\psi}{2}\right)$$

tabel si seperti di modul 6

$$\frac{N\psi}{2} \approx \pm 1{,}391$$

Untuk N = 6, pendekatan ini menghasilkan 0,4637.