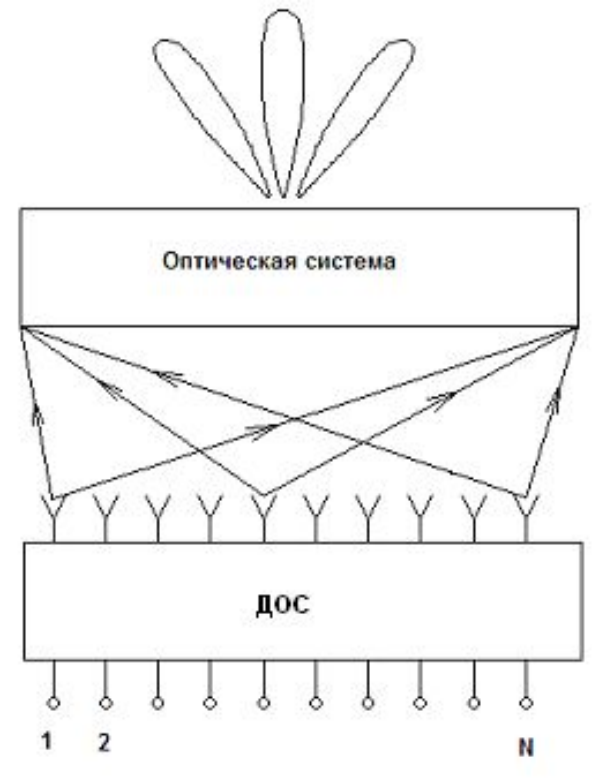
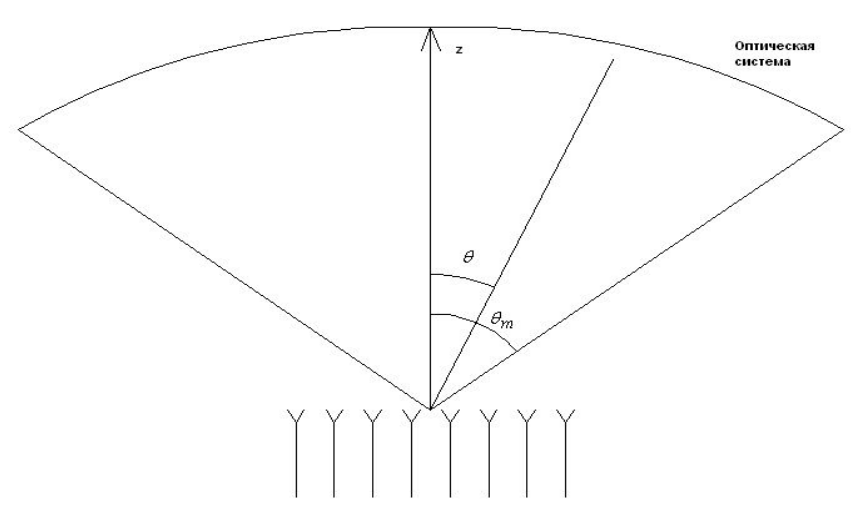
Одномерные и двумерные диаграммообразующие схемы многолучевых антенн на связанных волноводах

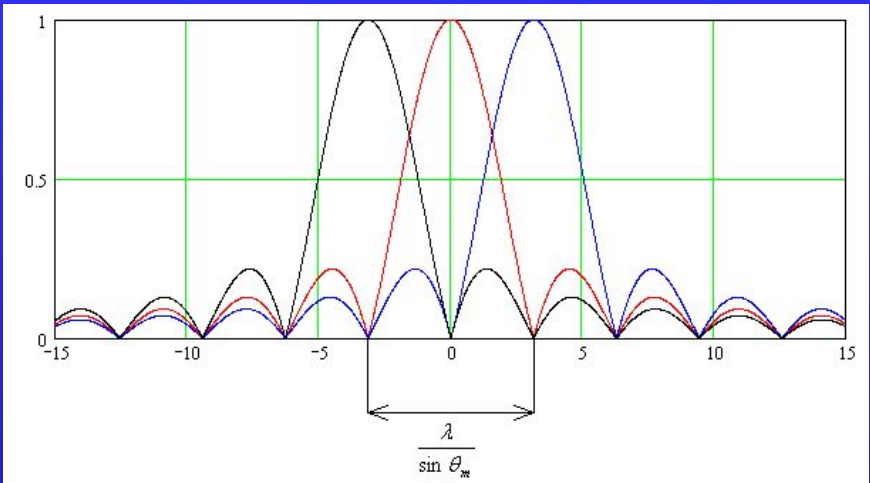
БАНКОВ С.Е.
ИРЭ РАН

Постановка задачи

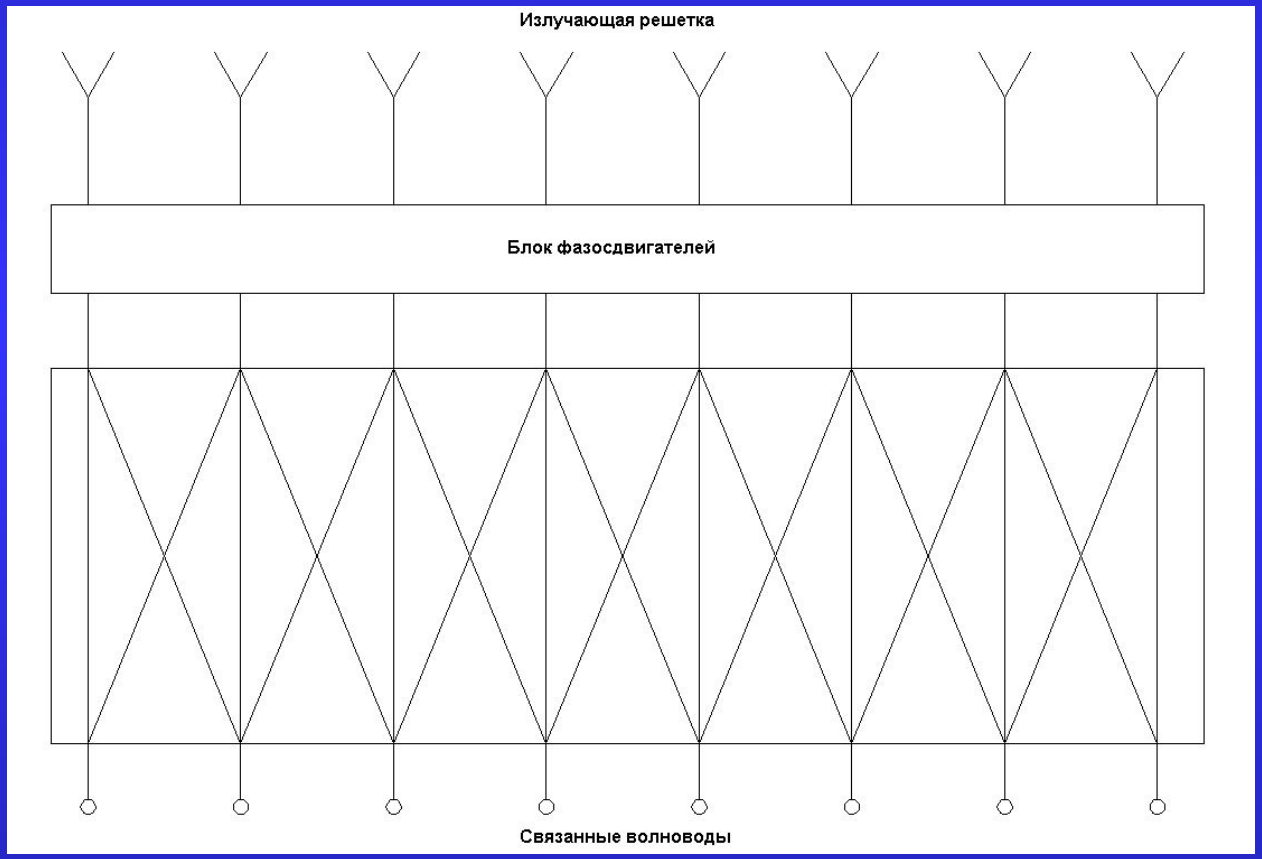




$КПД \approx 75\%$



Структура одномерной ДОС с фазосдвигателями



Теория связанных волн. Периодический режим

Исходная СДУ

$$\frac{dU_{-1}}{dz} + i\beta_0 U_{-1} + iCU_0 + iCU_{-2} = 0$$

$$\frac{dU_0}{dz} + i\beta_0 U_0 + iCU_1 + iCU_{-1} = 0$$

$$\frac{dU_1}{dz} + i\beta_0 U_1 + iCU_2 + iCU_0 = 0$$

Условие периодичности

$$U_n = U_0 e^{-i\beta nP}$$

Диф. ур-ие на периоде

$$\frac{dU_0}{dz} + i\beta_0 U_0 + 2iCU_0 \cos\beta P = 0$$

$$\gamma(\beta) = \beta_0 + 2C\cos(\beta P)$$

Постоянная распространения

$$U_n = A(\beta) e^{-i\beta nP - i\gamma(\beta)z}$$

Амплитуды волн в каналах

Возбуждение одного канала

$$U_n = \begin{cases} 1, \mathrm{n} = 0 \\ 0, \mathrm{n} \neq 0 \end{cases}$$

Условия в начале участка связи при z=0

$$\int_{-\frac{\pi}{P}}^{\frac{\pi}{P}} A(\beta) e^{-i\beta nP} d\beta = \begin{cases} 1, \mathrm{n} = 0 \\ 0, \mathrm{n} \neq 0 \end{cases}$$

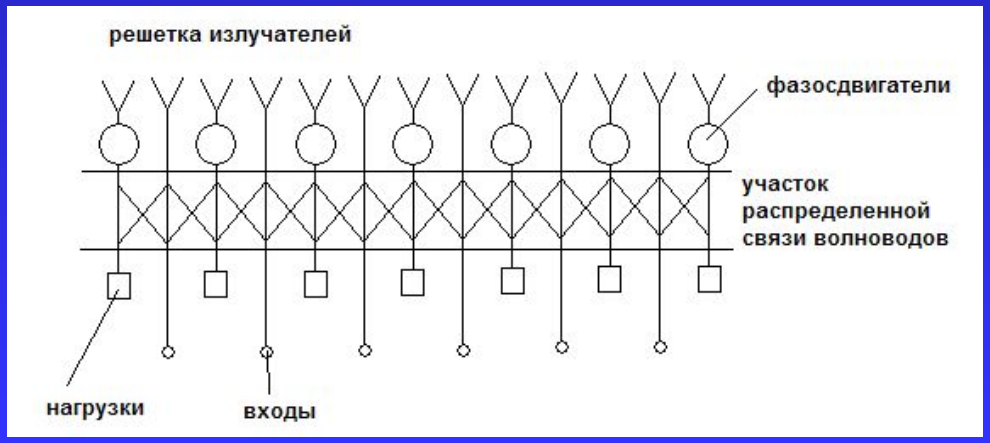
$$A(\beta) = \begin{cases} \dfrac{P}{2\pi}, |\beta| < \dfrac{\pi}{P} \\ 0, |\beta| > \dfrac{\pi}{P} \end{cases}$$

Решение для спектральной плотности

$$U_n = (-i)^n J_n(2CL)$$

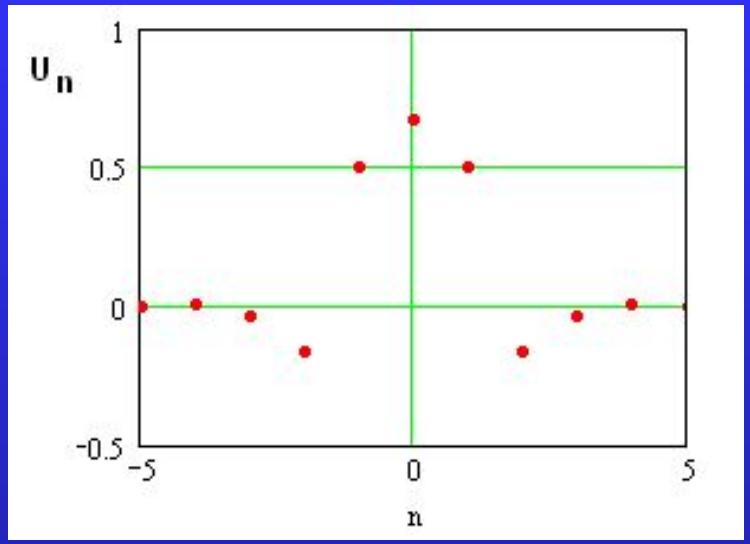
Решение для амплитуд волн

Блок фазосдвигателей



$$\Delta\varphi_n = \begin{cases} -\frac{\pi}{2}, \text{при } n \text{ четных} \\ 0, \text{при } n \text{ нечетных} \end{cases}$$

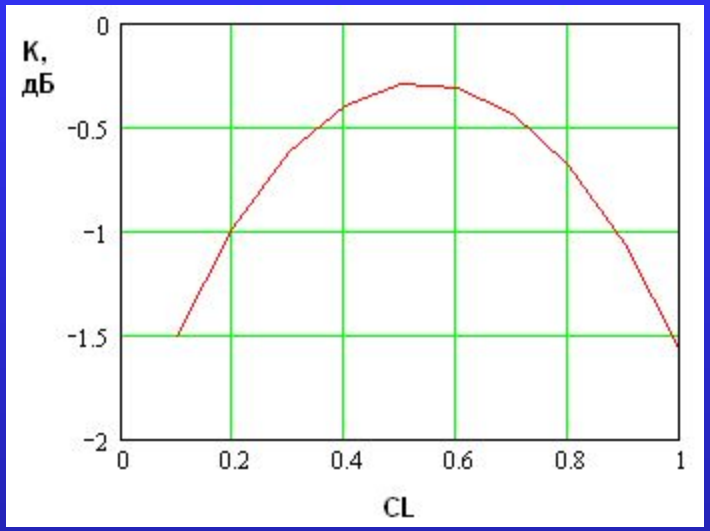
Амплитудно-фазовое распределение на выходе блока фазосдвигателей

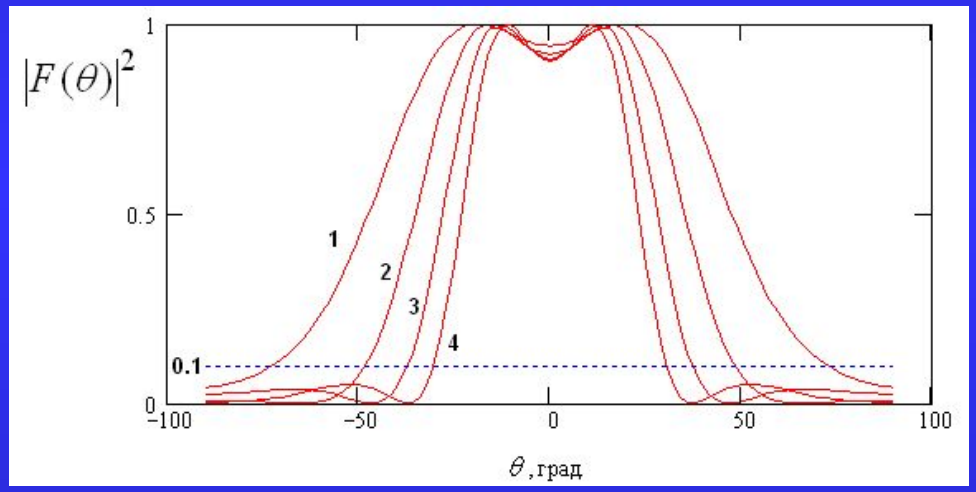


Характеристики излучения

$$F(\theta) = \frac{\cos(2CL\cos(kP\sin(\theta))) + \sin(2CL\cos(kP\sin(\theta)))}{\cos(2CL) + \sin(2CL)} F_e(\theta)$$

$$КИП = \frac{\left| \int_{-\theta_m}^{\theta_m} F(\theta) d\theta \right|^2}{2\theta_m \int_{-\theta_m}^{\theta_m} |F(\theta)|^2 d\theta}$$

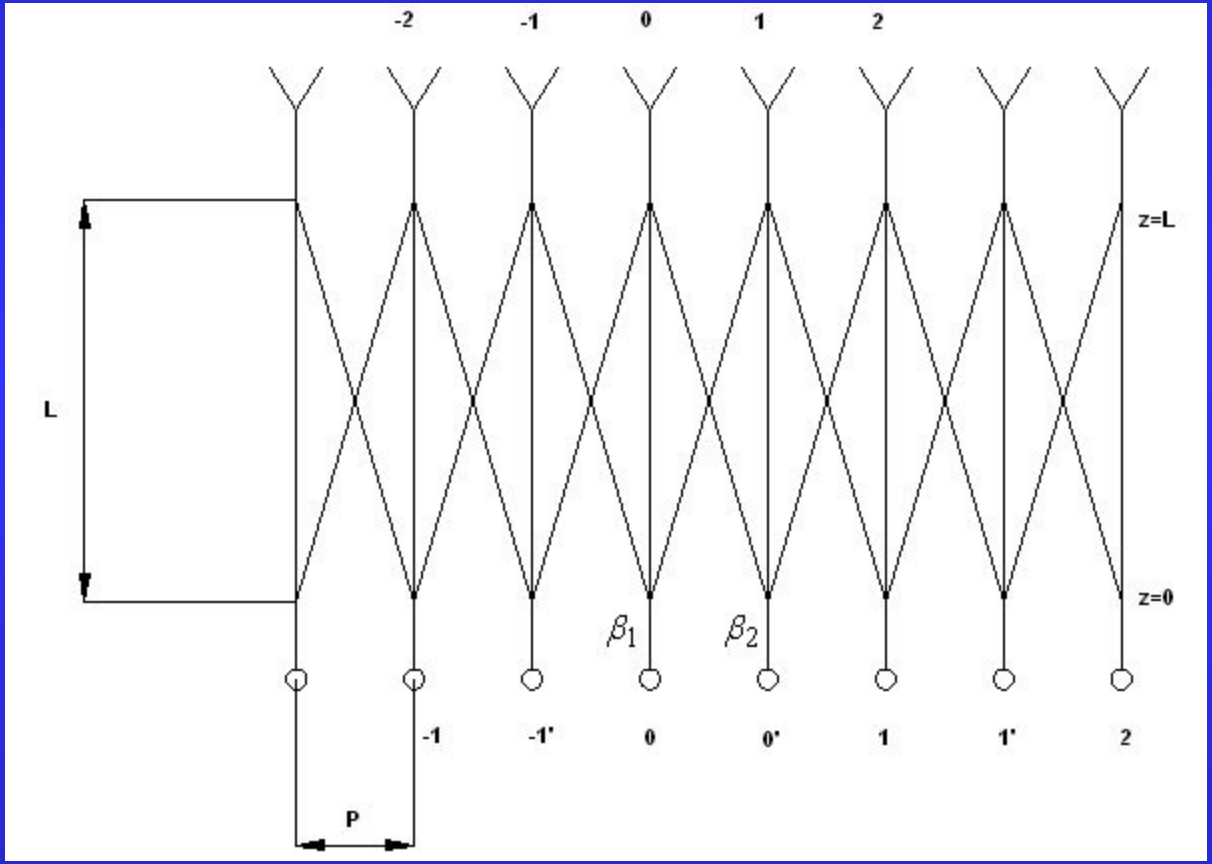




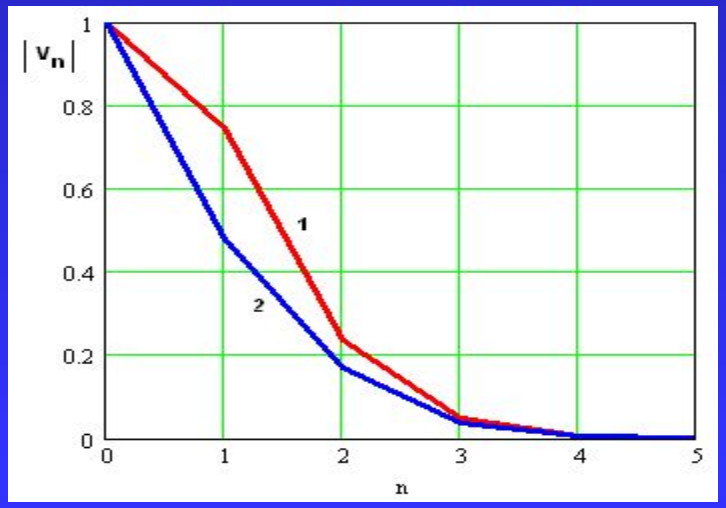
$$\frac{b}{\lambda} = 0.3, 0.4, 0.5, 0.6$$

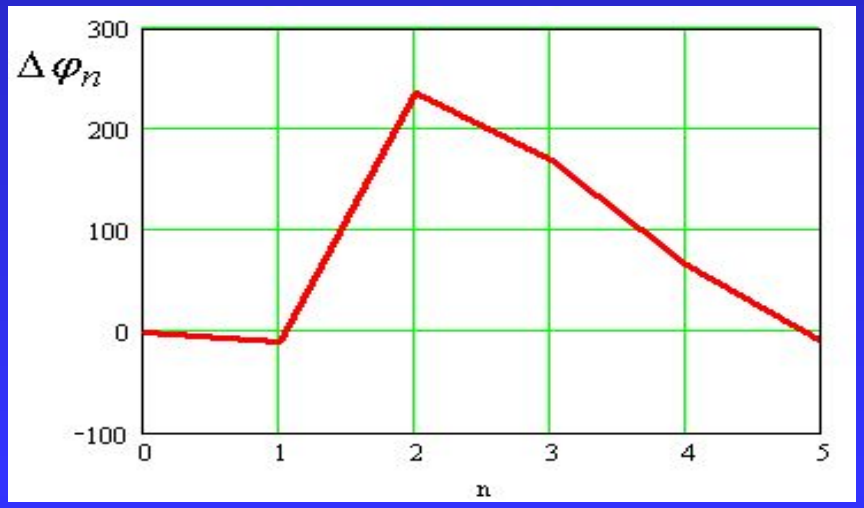
$$CL = 0.6$$

Одномерная ДОС на неодинаковых волноводах



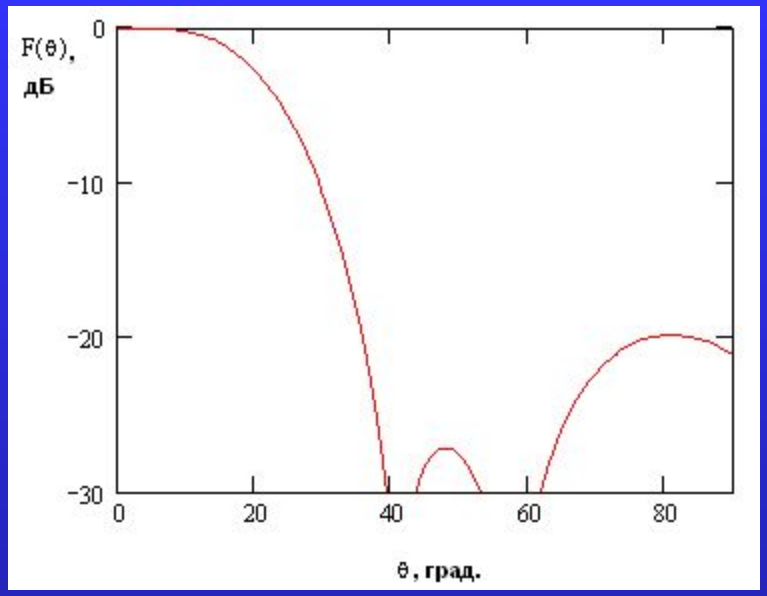
Характеристики ДОС на разных волноводах





$CL = 0.6$

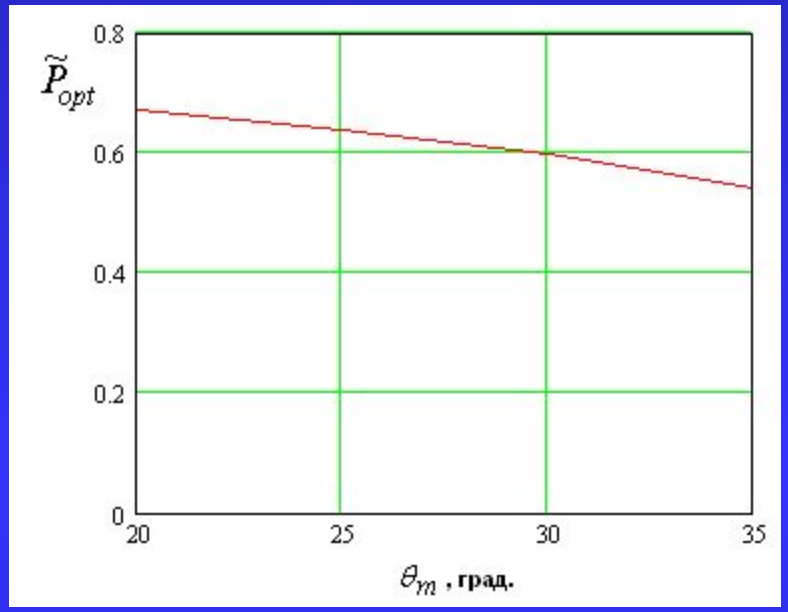
$\Delta\beta L = 1.15$

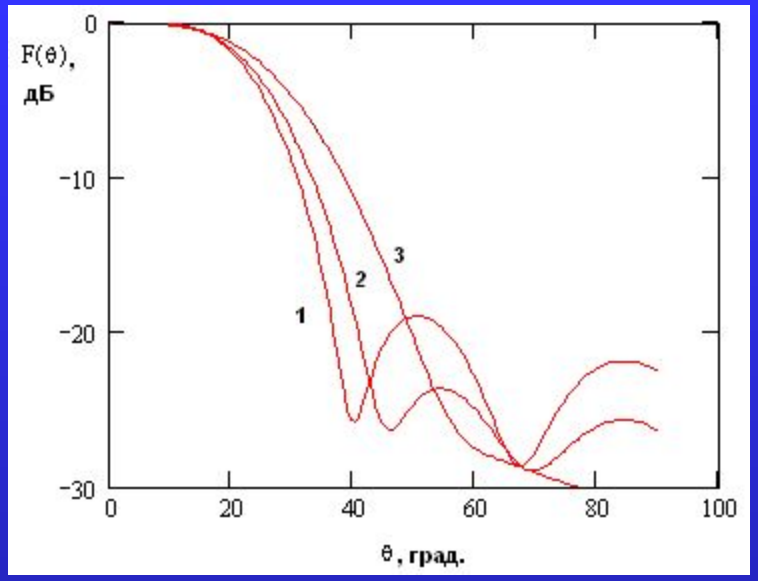


Оптимизация ДОС на Н-плоскостных волноводах

$\tilde{C}_{opt} = 0.6$

$\Delta\tilde{\beta}_{opt} = 1.25$

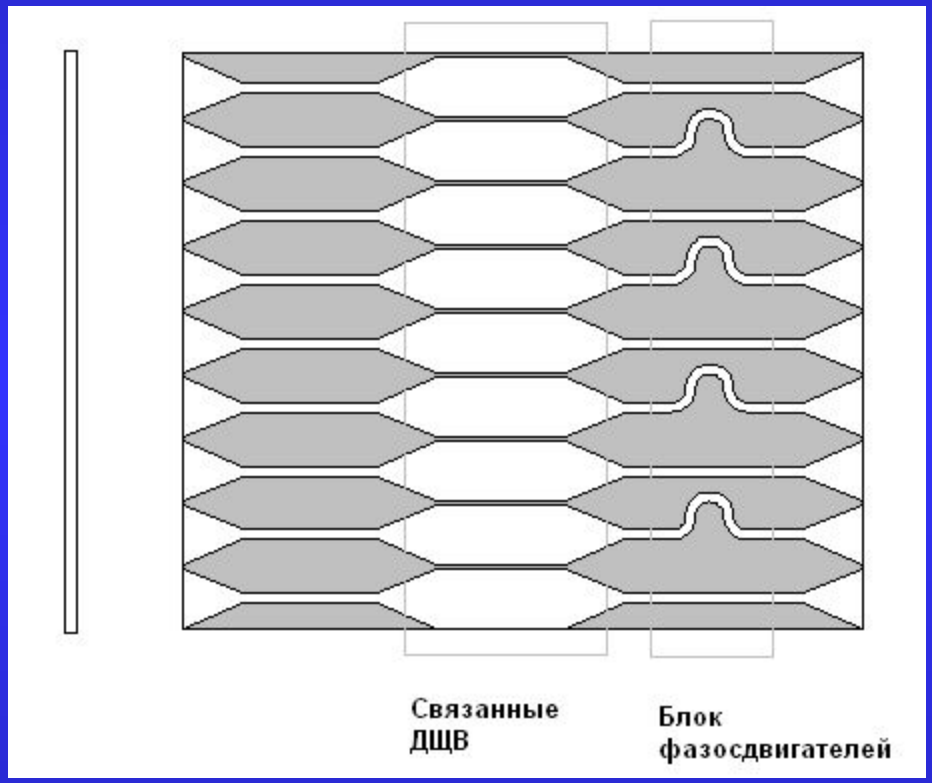


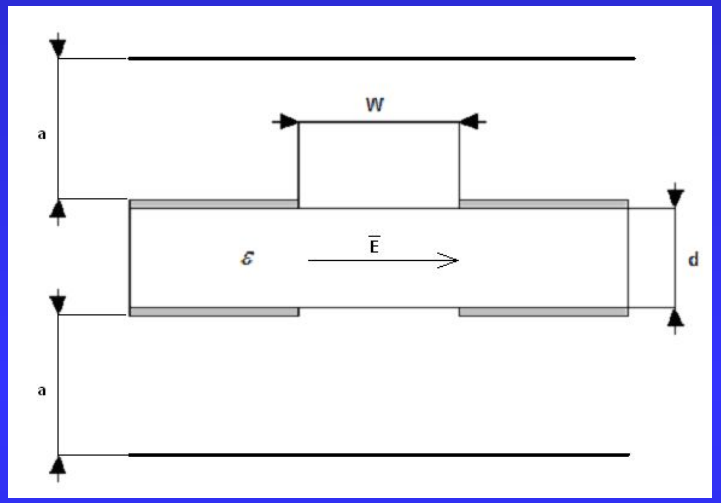


КИП $_{opt}$ = 0.5 дБ

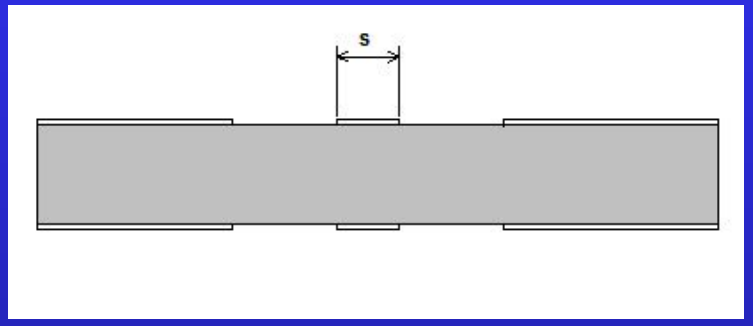
$\theta_m = 25,30,35$

ДОС на двусторонних щелевых волноводах

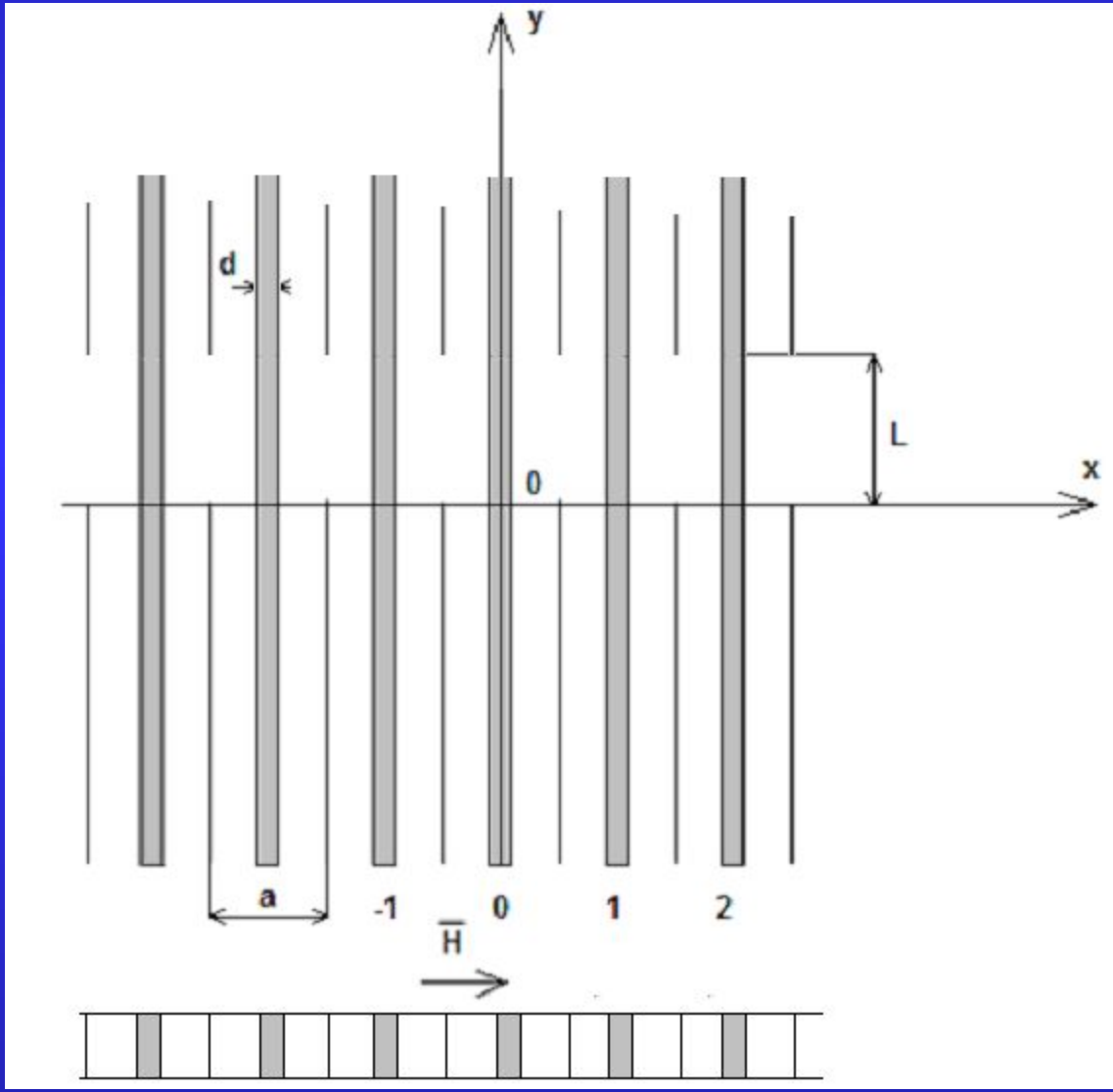




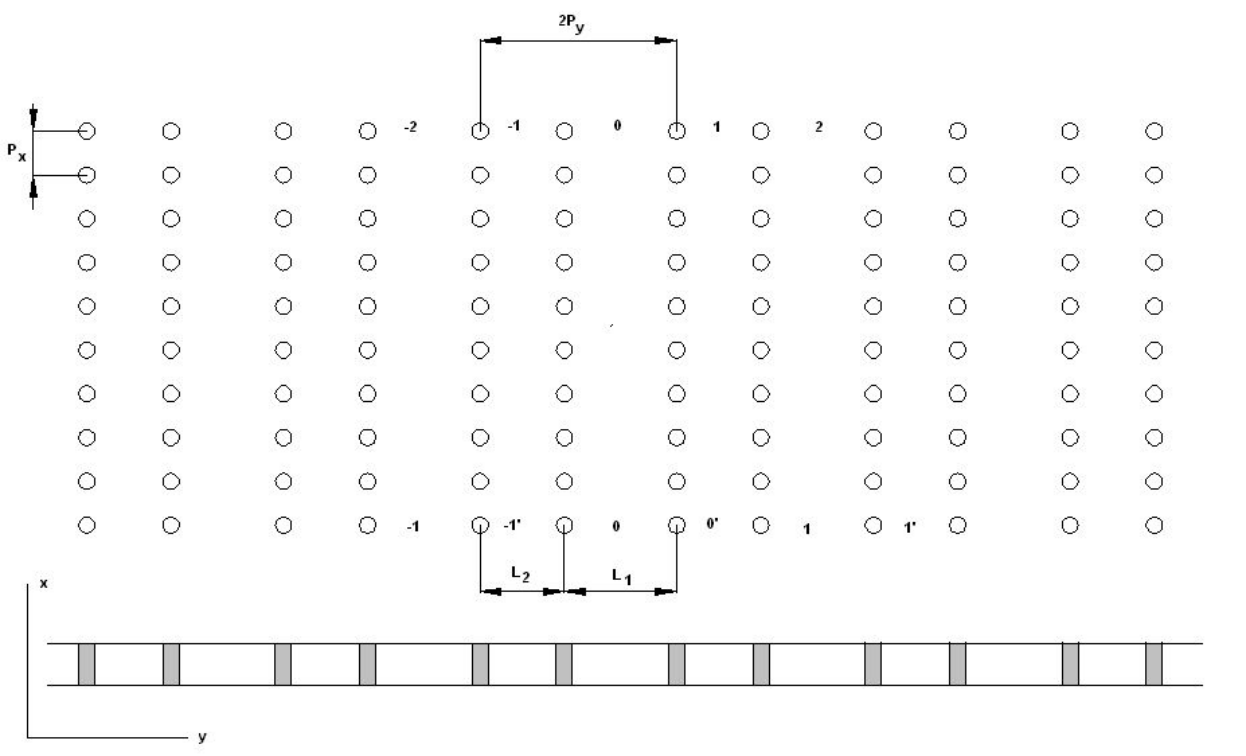
f=36 ГГц,
Поликор, d=0.5



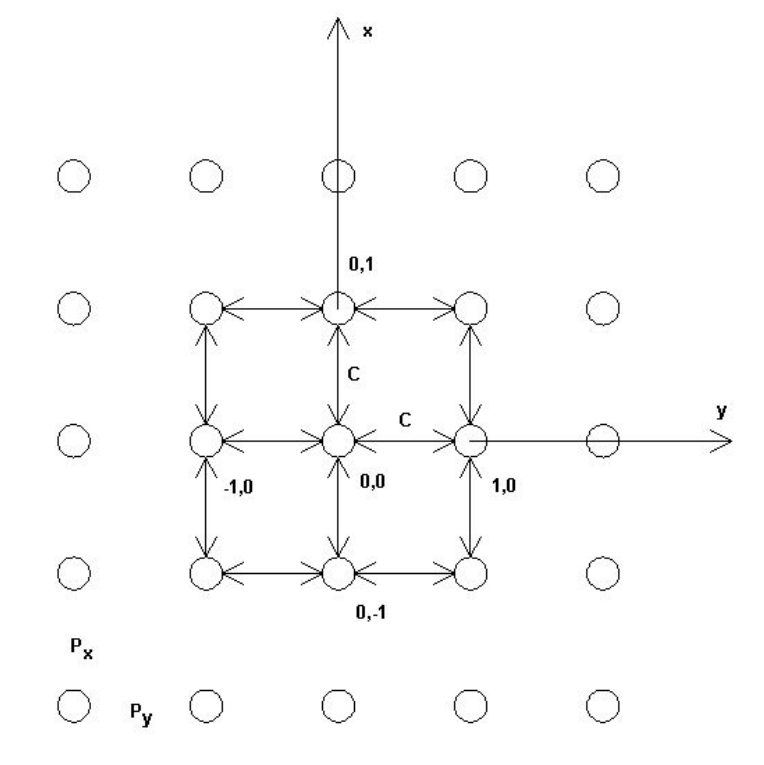
ДОС на Н-образных ДВ



ДОС на EBG волноводах



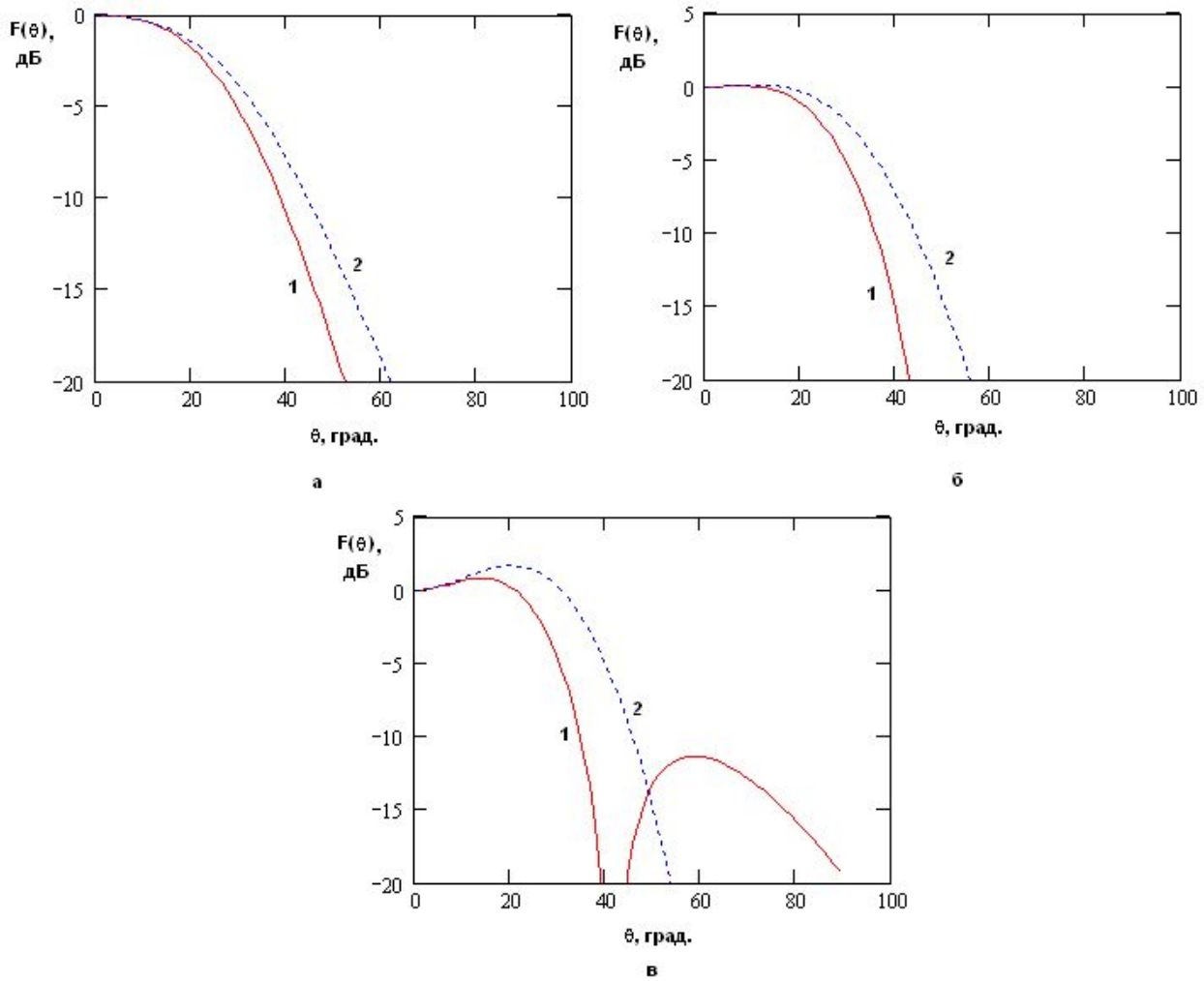
Двумерная ДОС с фазосдвигателями



-1.571	0	-1.571	0	-1.571
0	1.571	0	1.571	0
-1.571	0	-1.571	0	-1.571
0	1.571	0	1.571	0
-1.571	0	-1.571	0	-1.571

$$\Phi_{n,m} = 1 - (1+i)\cos^2\left(\frac{\pi n}{2}\right)\cos^2\left(\frac{\pi m}{2}\right) - (1-i)\sin^2\left(\frac{\pi n}{2}\right)\sin^2\left(\frac{\pi m}{2}\right)$$

Характеристики излучения ДОС



$$CL = 0.35,0.5,0.65$$

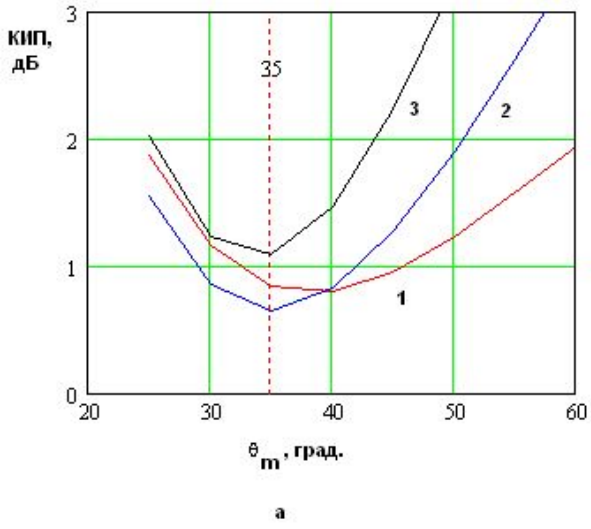
$$a_{x,y} = P_{x,y} = 20$$

$$\varphi = 0,45$$

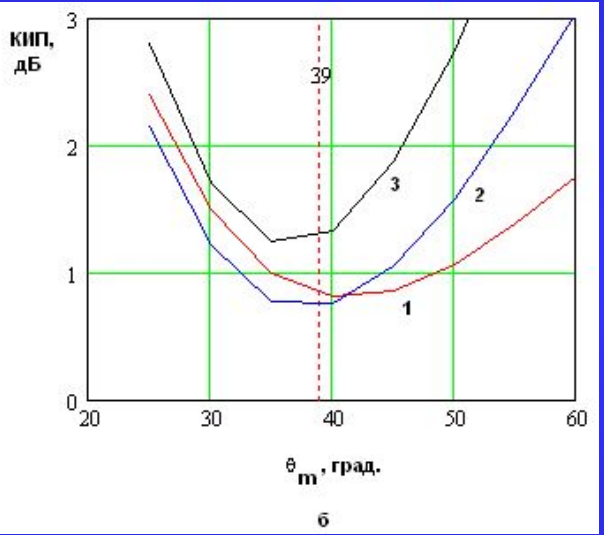
$$f = 8$$

Оптимизация ДОС

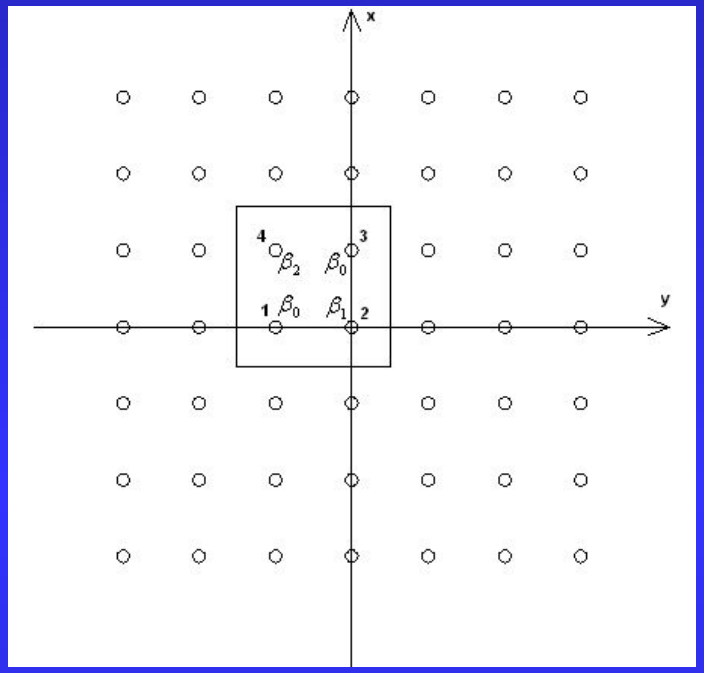
Квадратная ОС



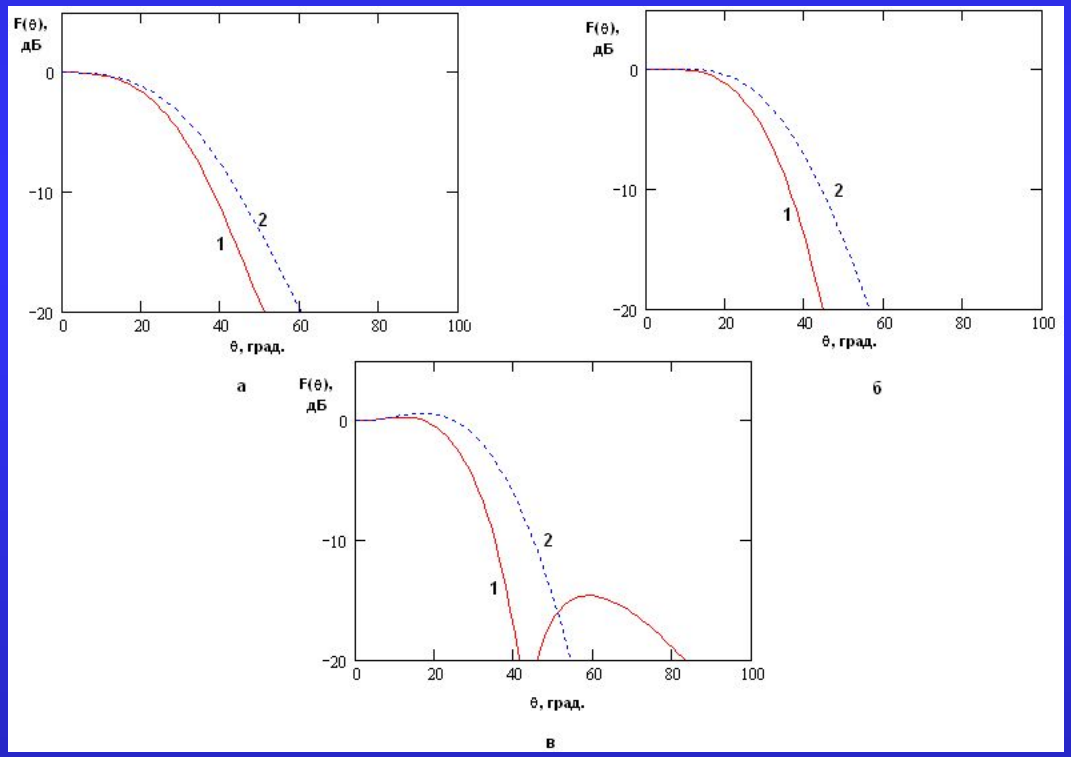
Круглая ОС



Двумерная ДОС на разных волноводах



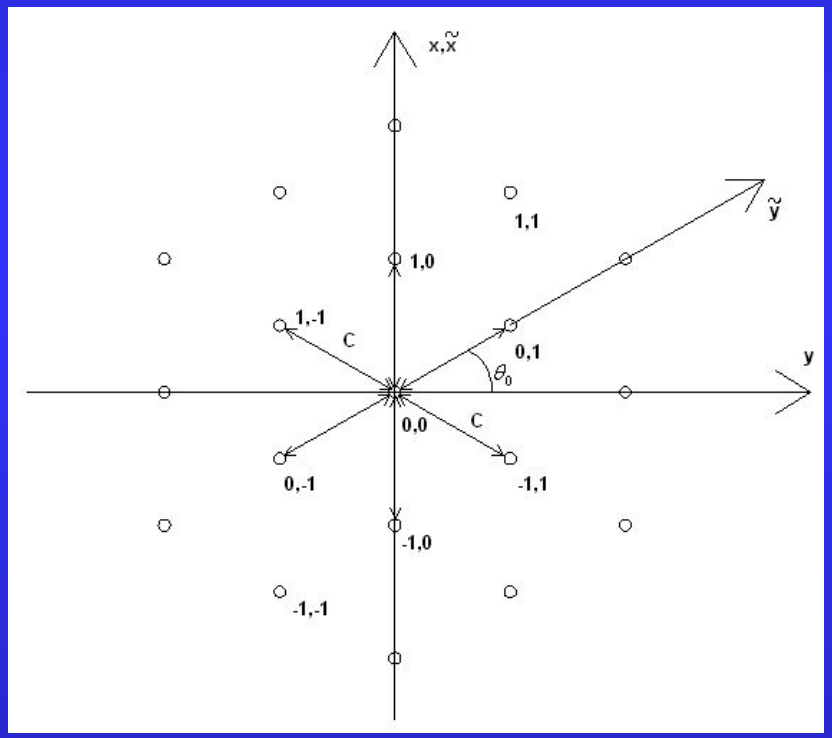
$$CL = 0.55, 0.7, 0.85$$

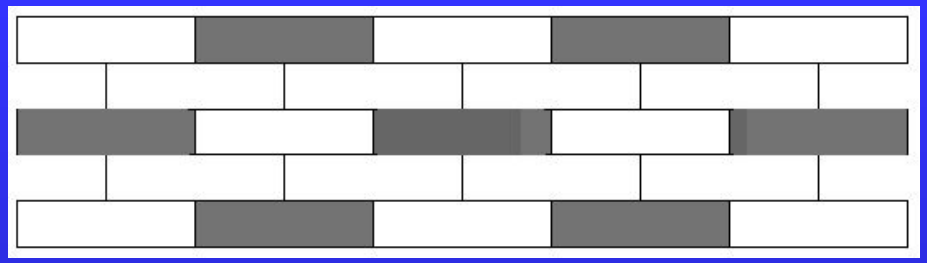


$$\Delta\beta L = 1.9$$

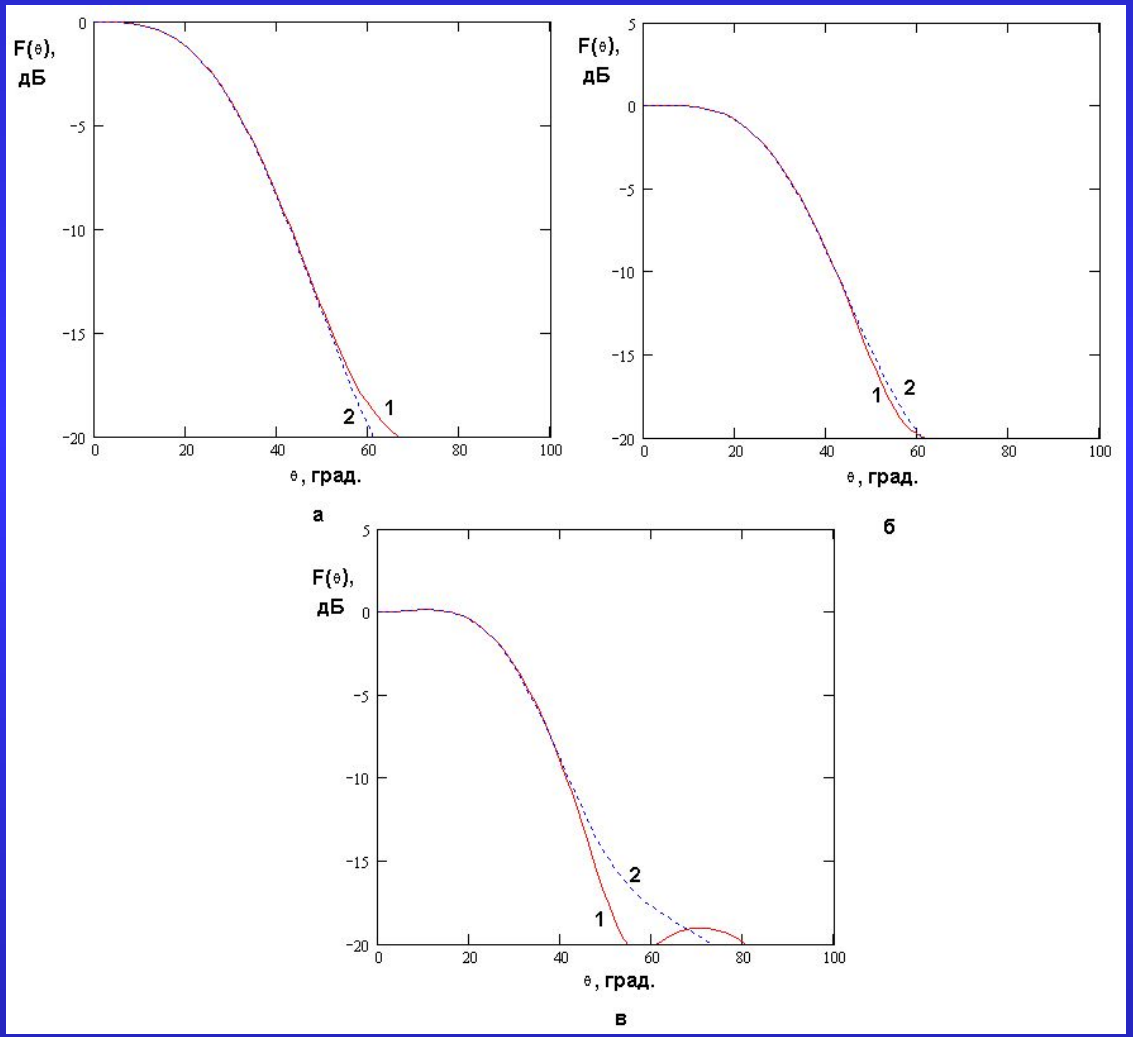
$$\beta_{1,2} = \beta_0 \pm \Delta\beta$$

Двумерная ДОС. Фазосдвигатели. Гексагональная сетка





Характеристики излучения



$$CL = 0.3, 0.35, 0.4$$

$$\varphi = 0, \pi/6$$

$$f = 8$$

$$P = 20$$

$$CL_{opt} = 0.35$$