Antennas

Antenna types

Antennas

End Fires

Loops

Dipoles

Monopole

Apertures

Slots

Patches

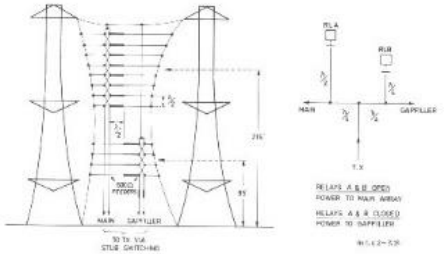
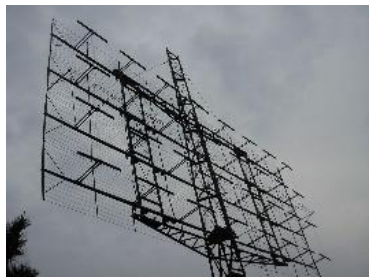
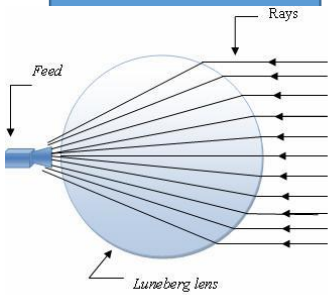
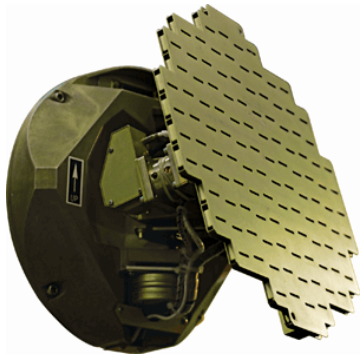
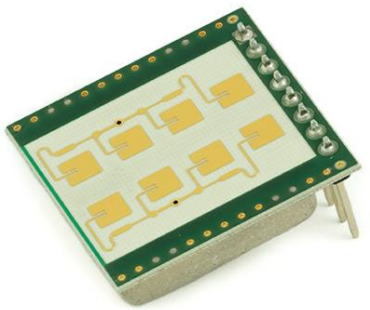


Fig. 3. (a) CH transmitter array (b) stub switching





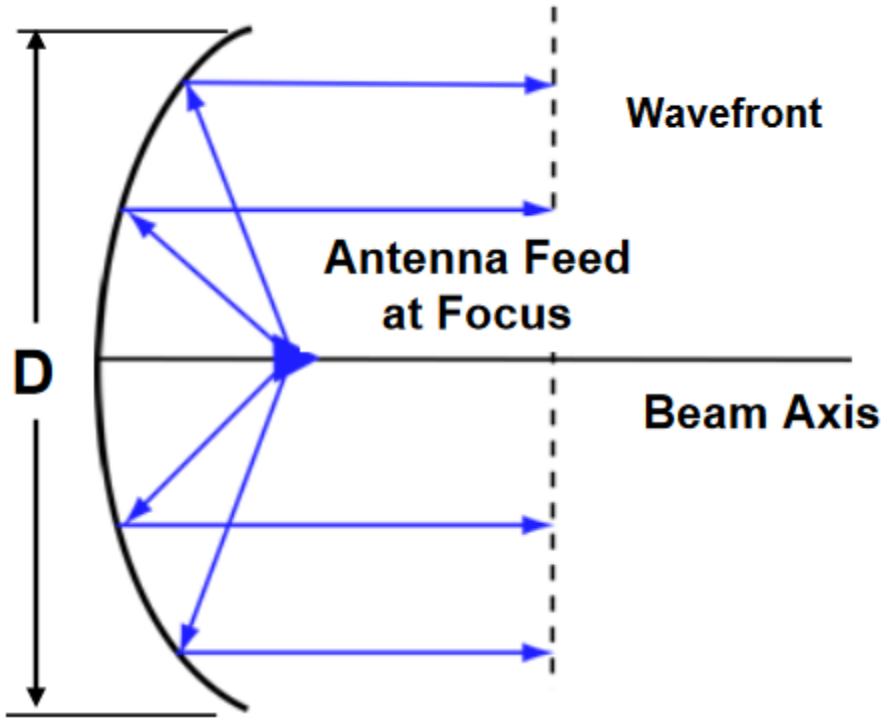




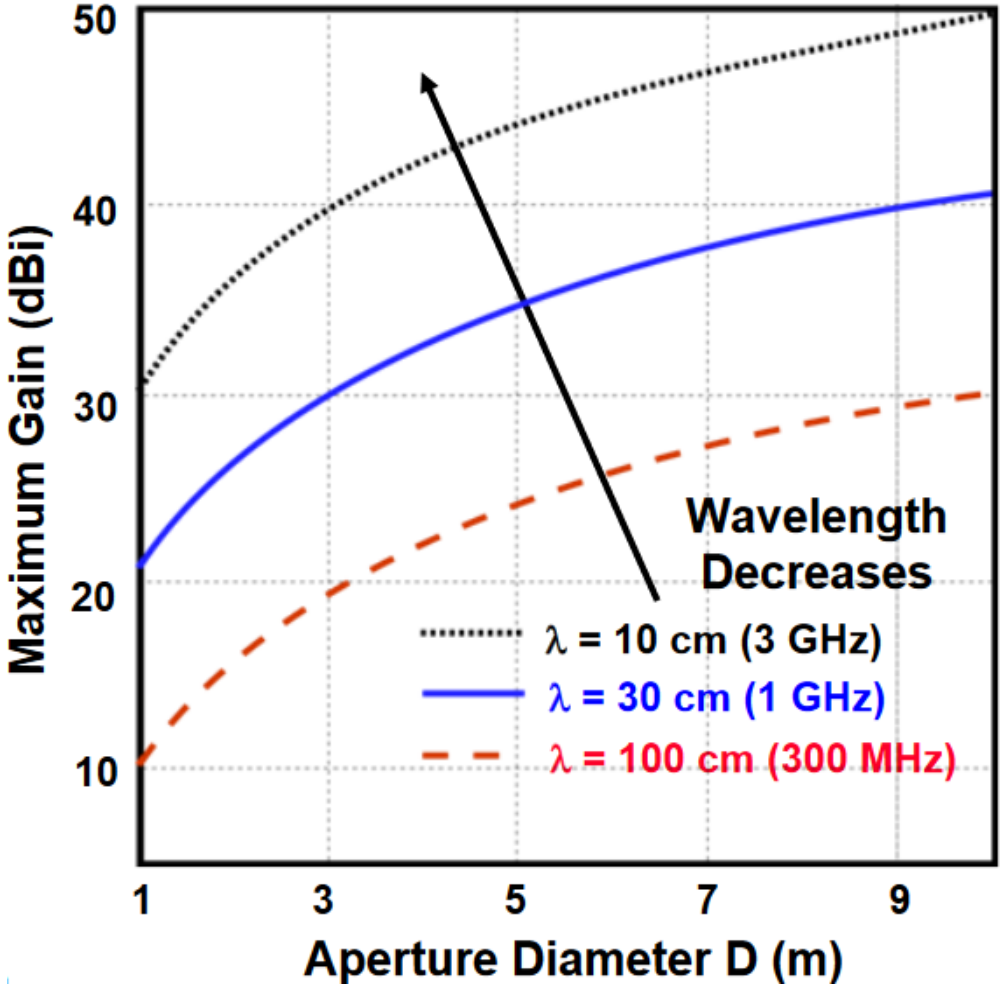
Antenna parameters

- Radiation pattern
  - Horizontal plane $f(\phi)$ ….(approximation for SLS ≤ 25 dB)… $\phi_{-3dB} = 65 \cdot \frac{\lambda}{D}$
  - Vertical plane $f(\theta)$ ….(approximation for SLS ≤ 25 dB)… $\theta_{-3dB} = 65 \cdot \frac{\lambda}{D}$
  - 3D $f(\phi, \theta)$
- Gain ….(approximation for good illumination)… $G = \frac{26000}{\theta_{-3dB} \cdot \phi_{-3dB}}$
- HPBW – Half Power BeamWidth
- FBR – Front to Back Ratio
- SLS – Side Lobe Suppression
- Input impedance
- Bandwidth

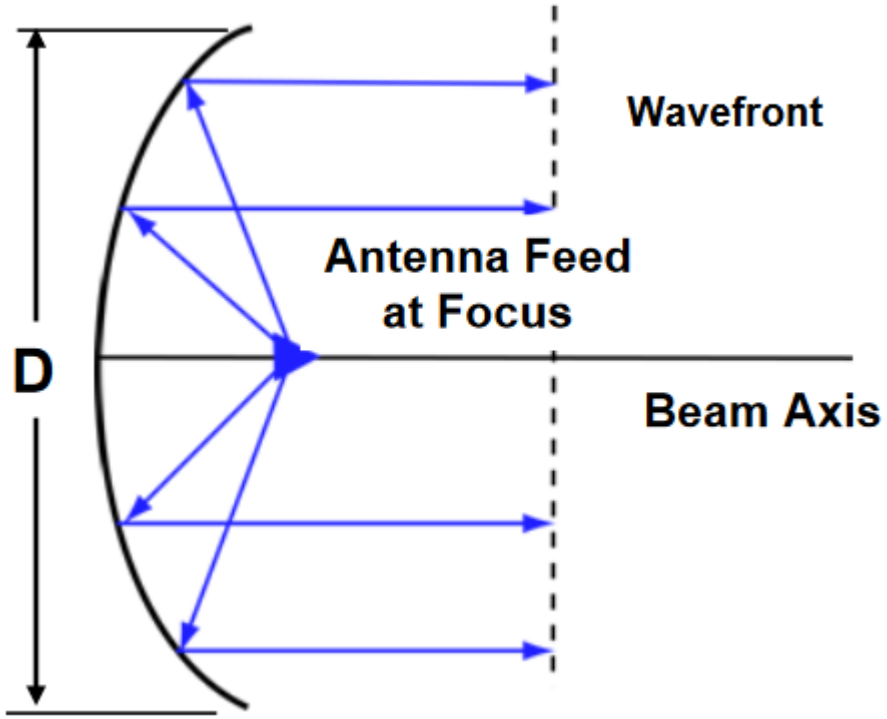
Reflector antennas - feeds



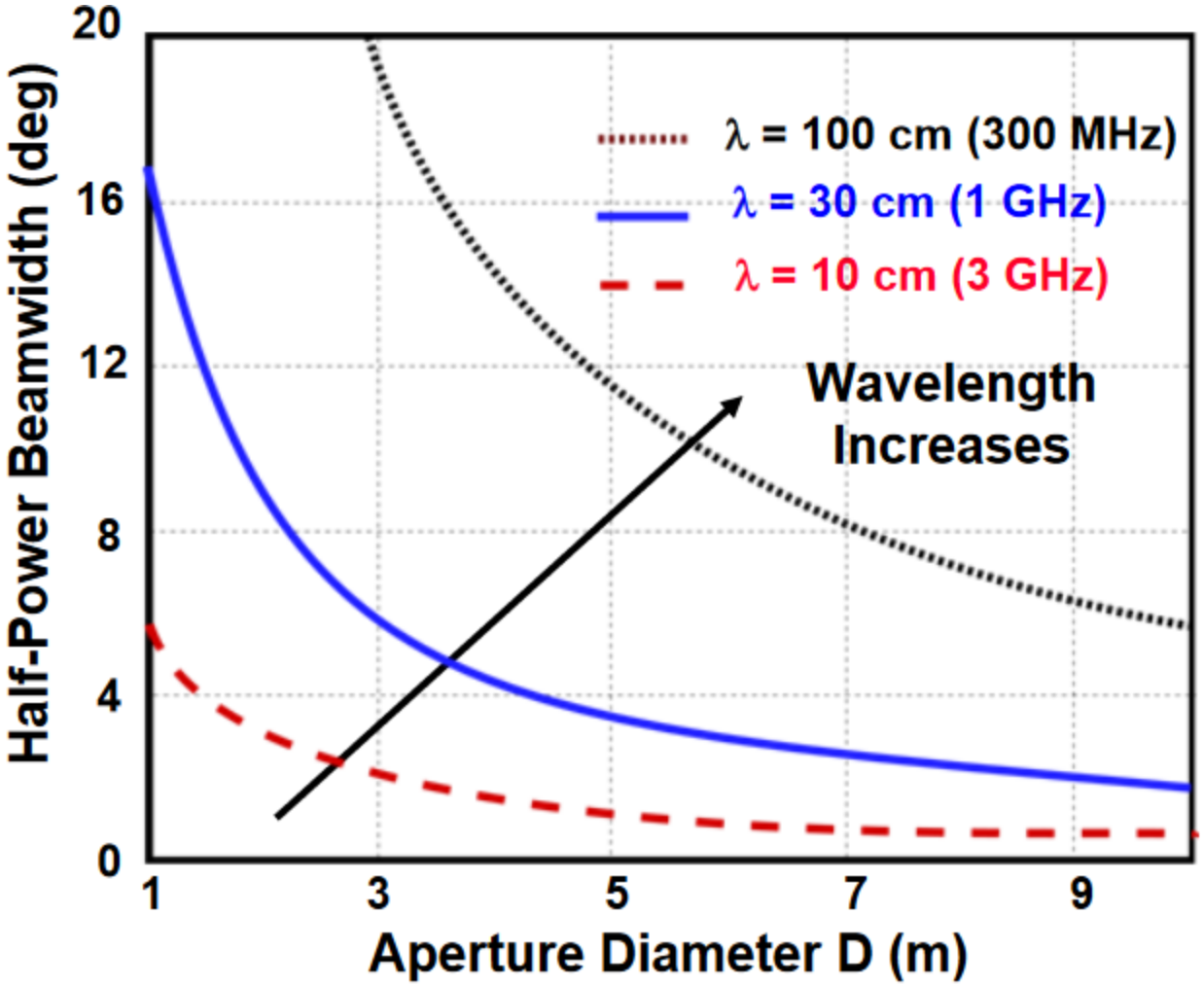
$$G = \frac{4\pi A_{ef}}{\lambda^2} = \eta A \frac{4\pi}{\lambda^2} \cong \left(\frac{\pi D}{\lambda}\right)^2$$



Reflector antennas - feeds

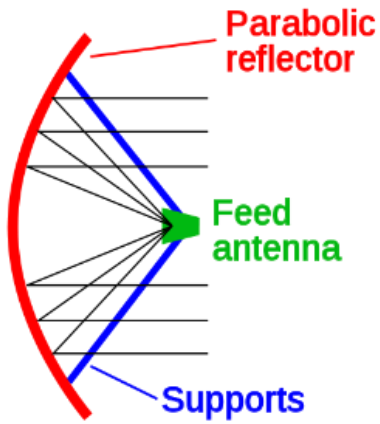


$$\text{Beamwidth (deg)} \cong \frac{180\lambda}{\pi D}$$

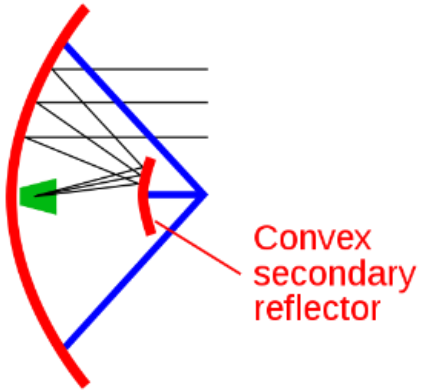


Reflector antennas - feeds

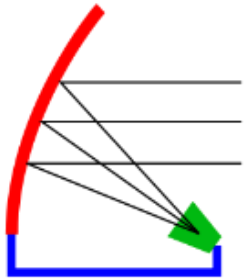
Axial or
Front feed



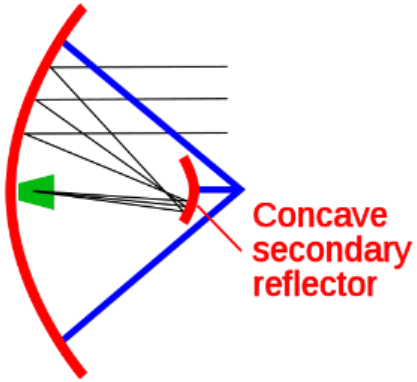
Cassegrain



Off-axis or
Offset feed

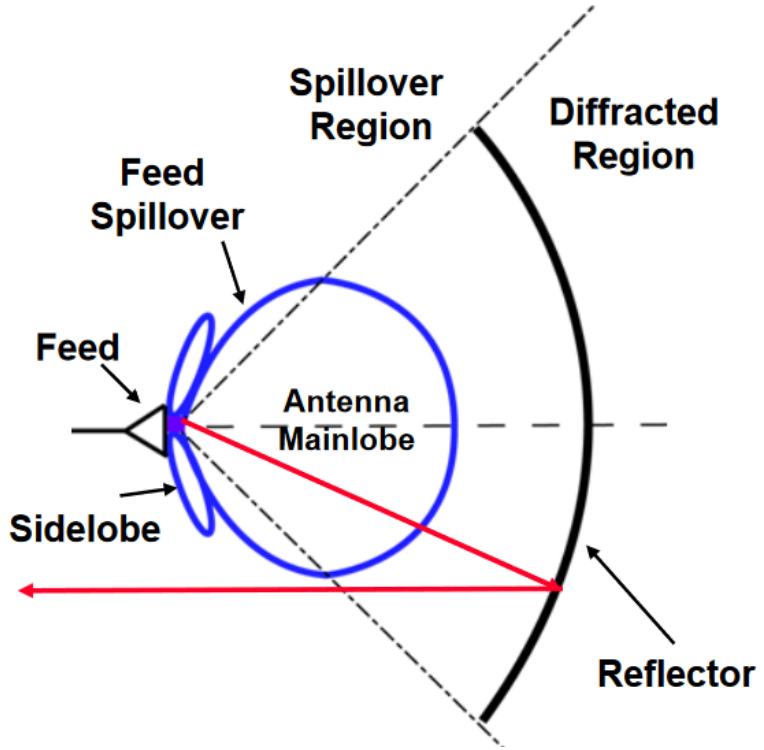


Gregorian

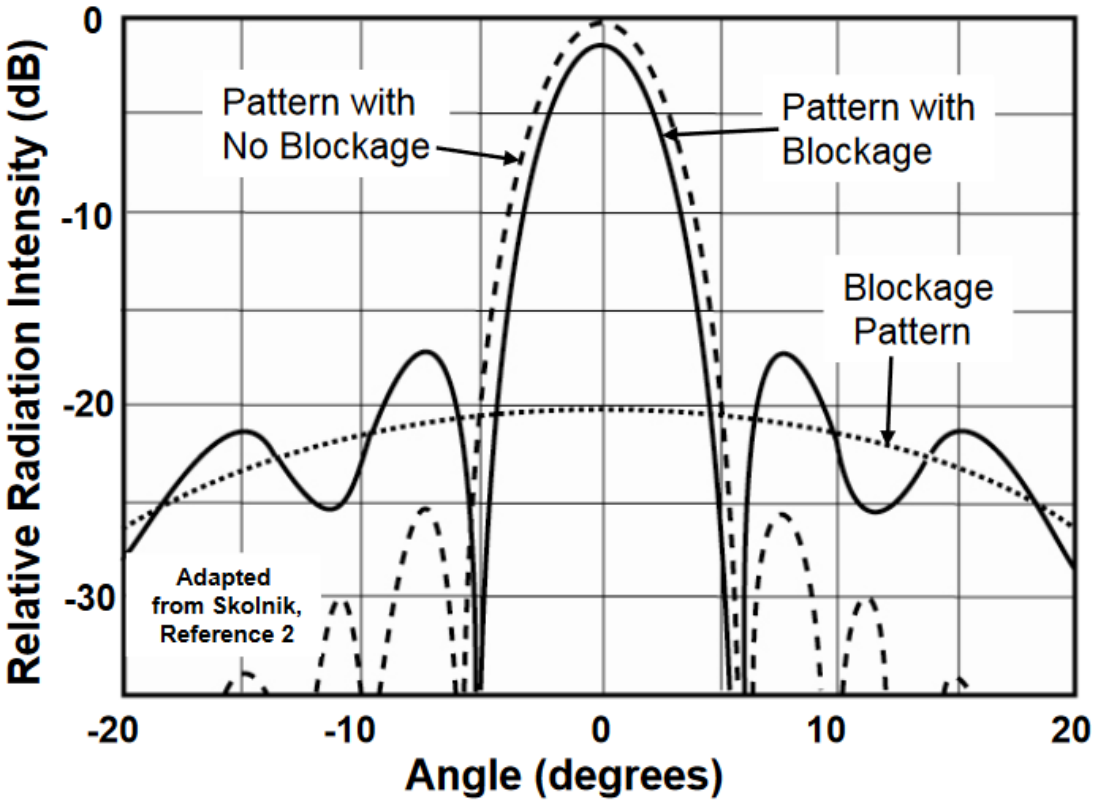


Antenna spillover and aperture blocking

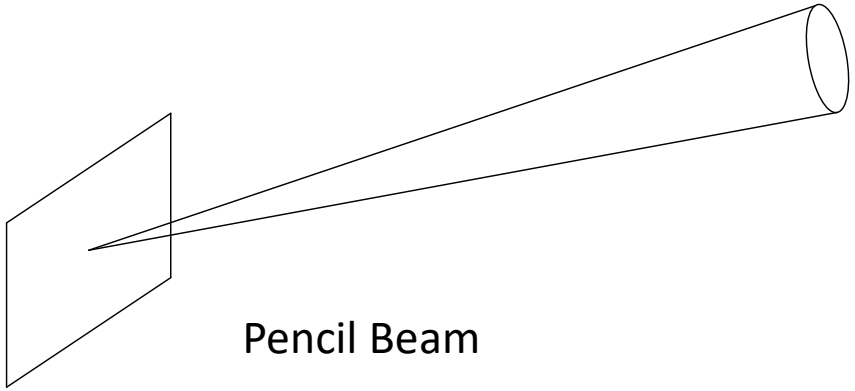
Spillover



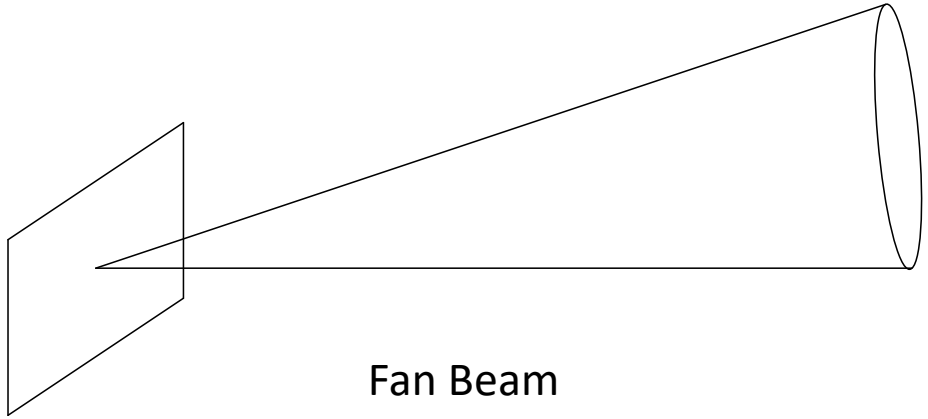
Aperture blocking



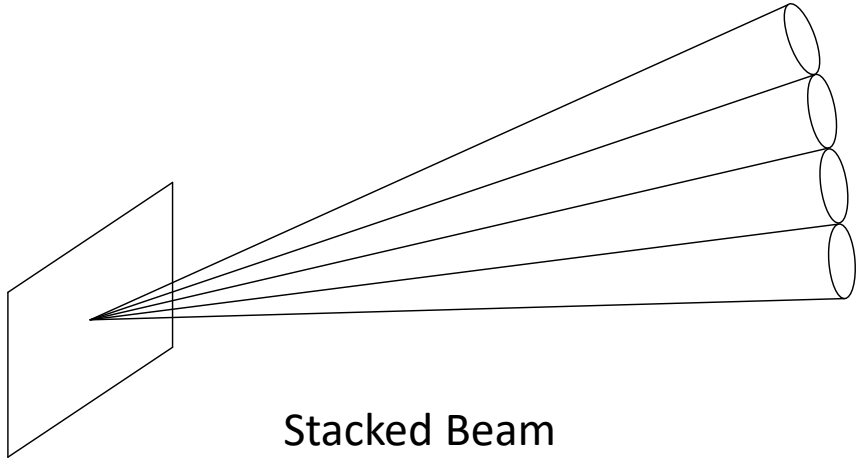
Types of radar beams



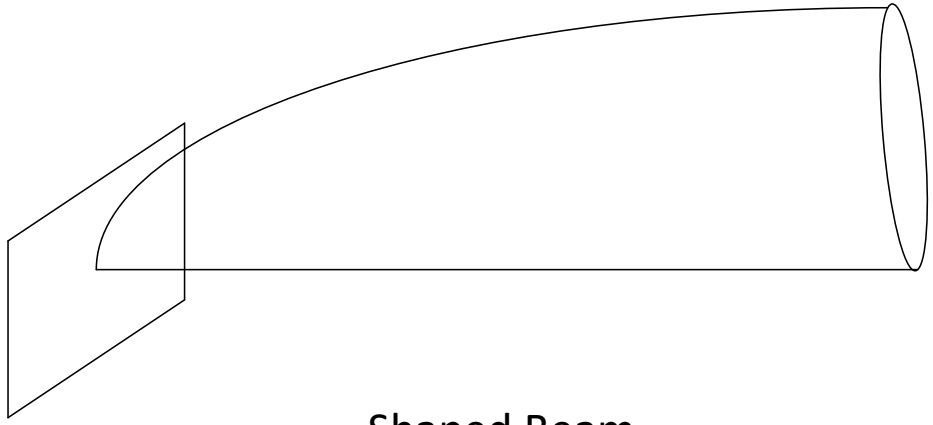
Pencil Beam



Fan Beam



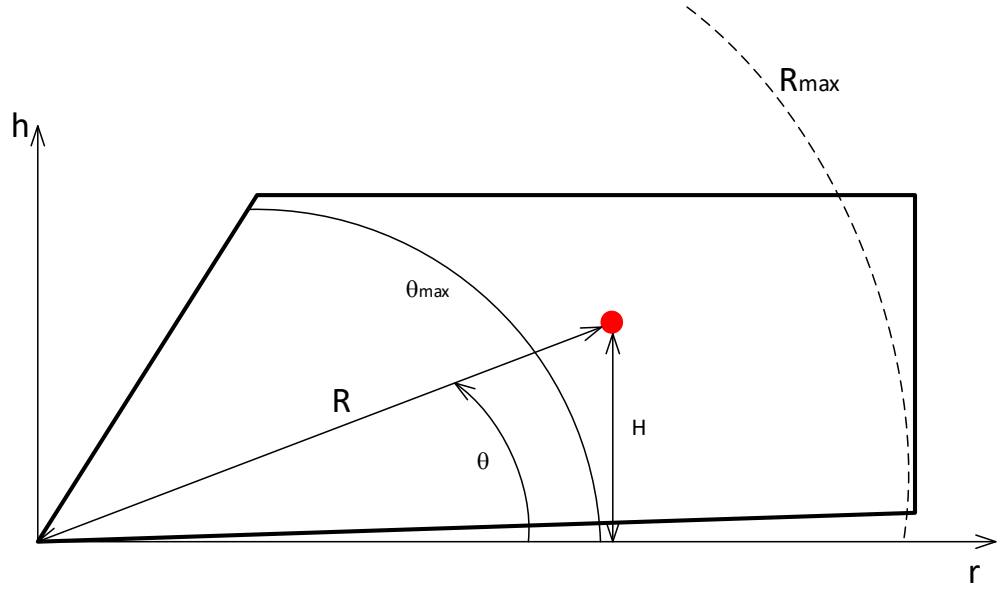
Stacked Beam



Shaped Beam

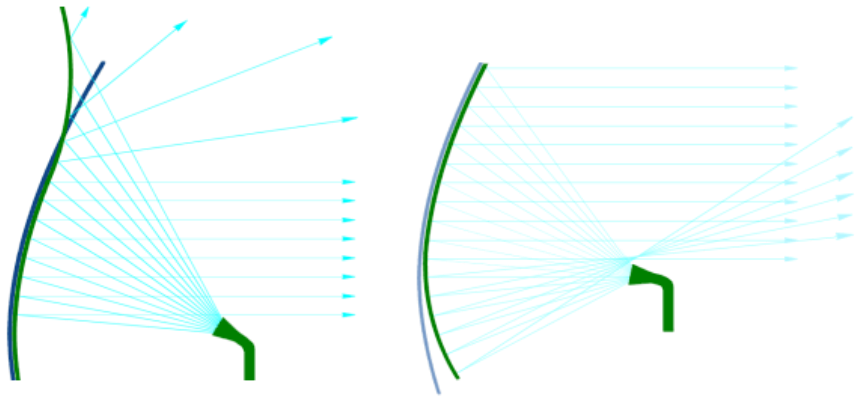
Cosecant-Squared antenna pattern

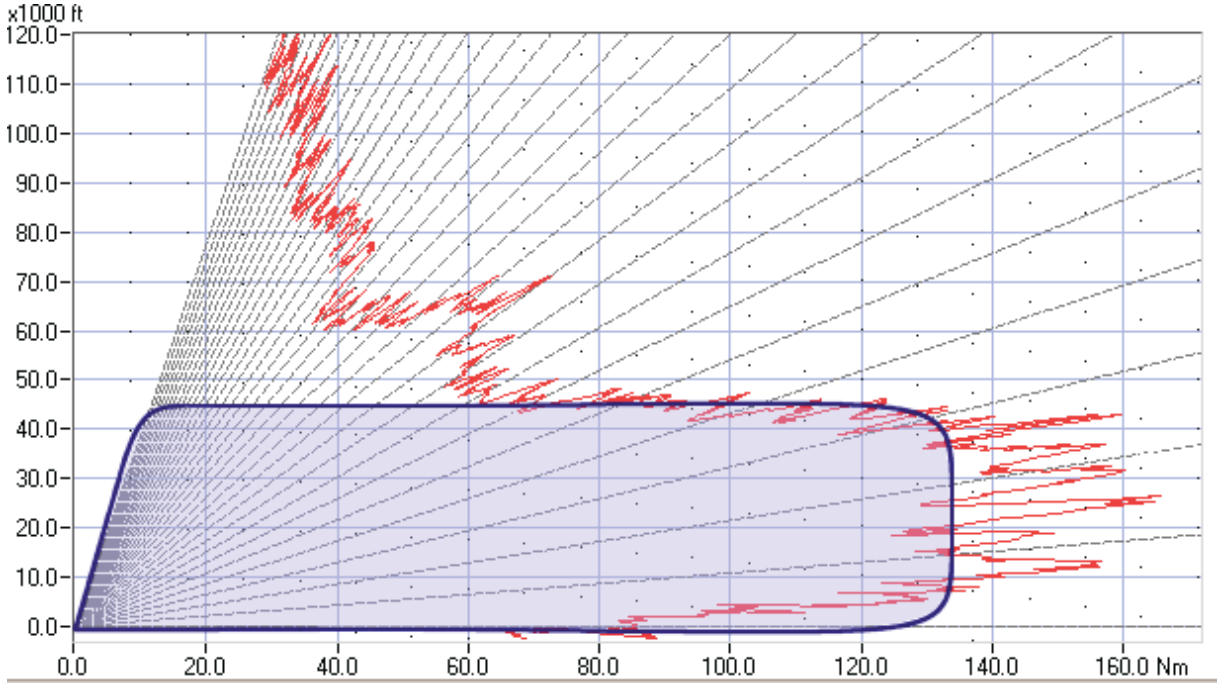
- Slant range $R = \frac{H}{\sin\theta}$
- For monostatic radar…(for directional pattern D_t=D_r)
  - $\frac{P_r}{P_t} = \frac{D^2\lambda^2\sigma}{(4\pi)^3 R^4} = \frac{D^2\lambda^2\sigma}{(4\pi)^3} \cdot \frac{sin^4\theta}{H^4}$
- $D^2 \cdot sin^4\theta$ = const.
- $\boldsymbol{D(\theta) = const \cdot \frac{1}{sin^2\theta} = const \cdot cosec^2\theta}$



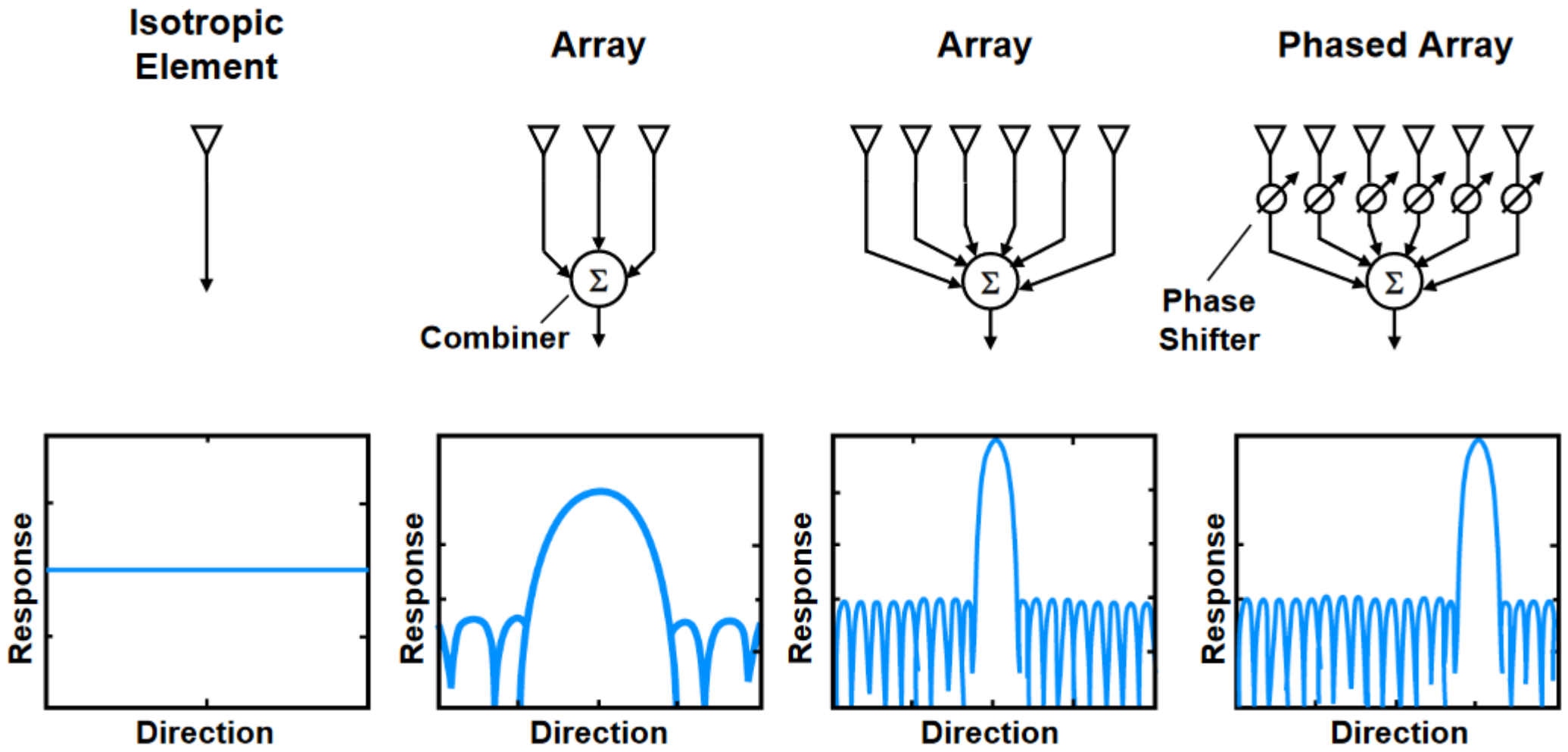
Cosecant-Squared antenna pattern

- Deformation of a parabolic reflector
- Stacked beam by more horns feeding a parabolic reflector





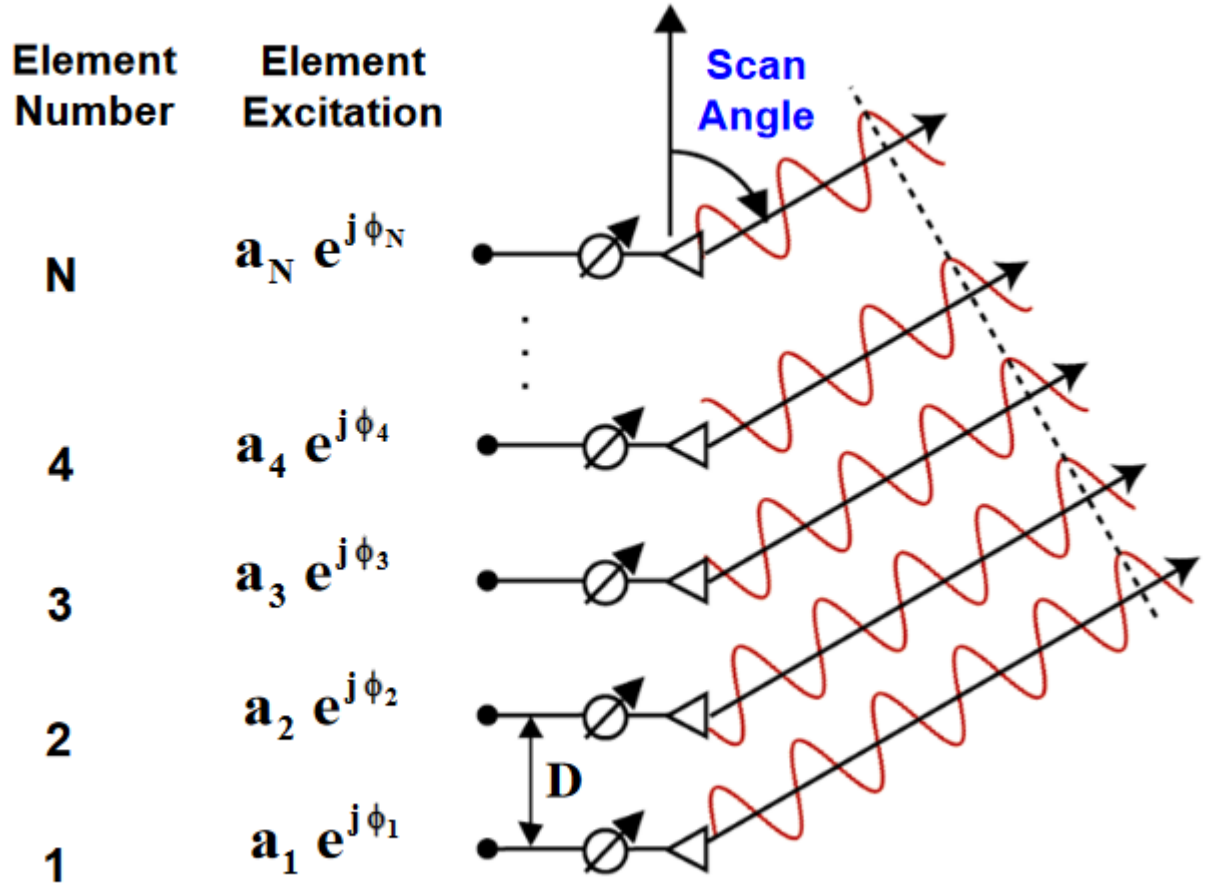
Antenna Arrays



Antenna Arrays

- Geometrical configuration

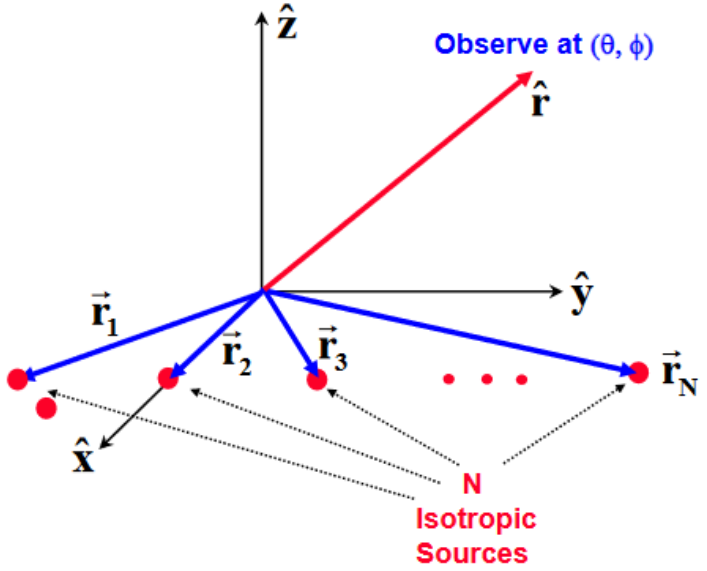
- Number of elements **N**
- Separation **D**
- Excitation phase shifts ϕ
- Excitation amplitudes **a**



Antenna Arrays – Array Factor

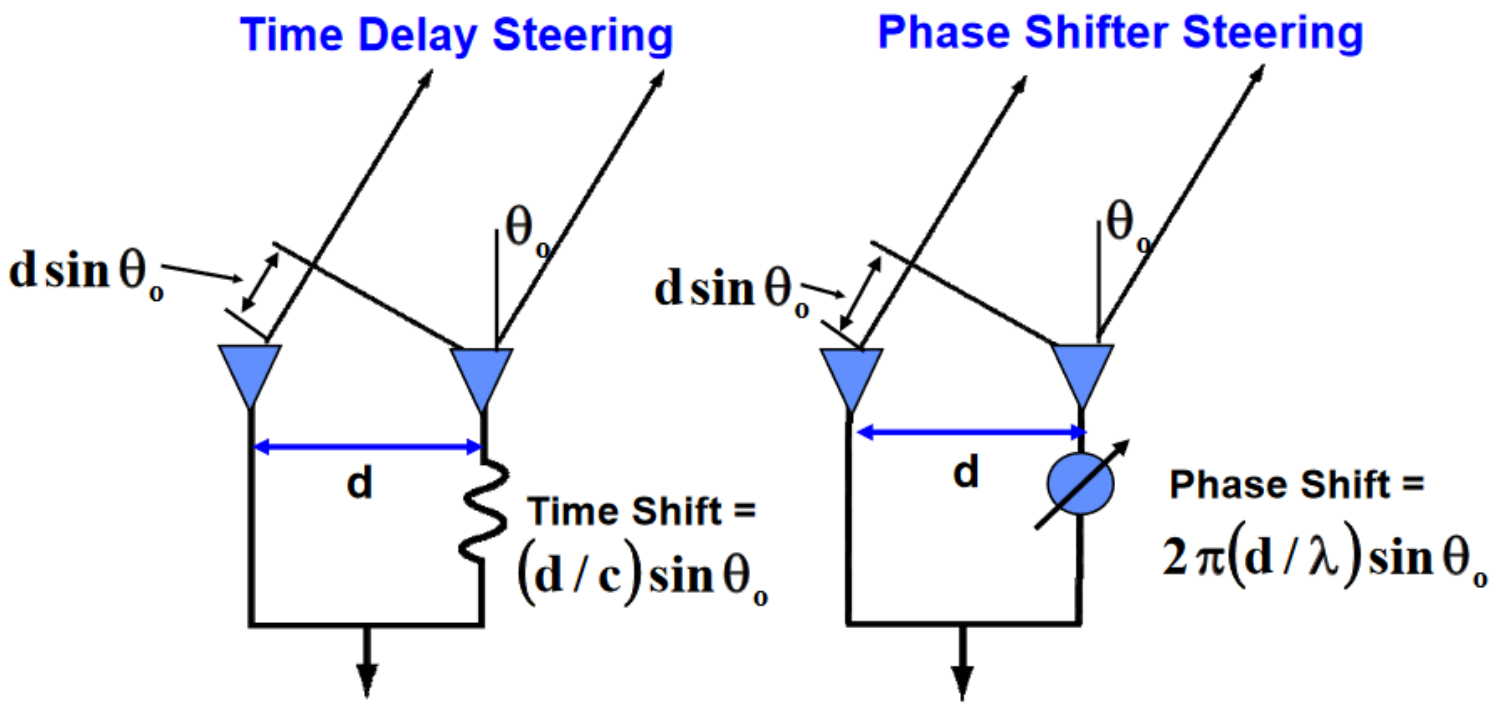
- The “Array Factor” AF, is the normalized radiation pattern of an array of isotropic point-source elements

$$AF(\theta,\phi) = \sum_{n=1}^{N} a_n \, e^{j\phi_n} e^{j k \vec{r}_n \cdot \hat{r}}$$

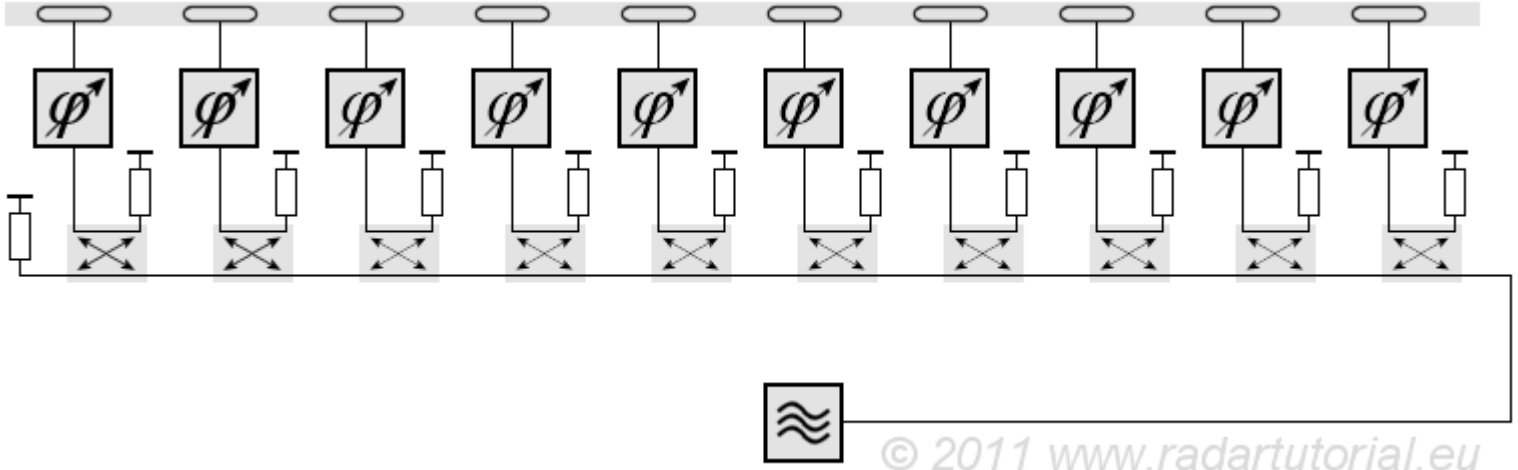


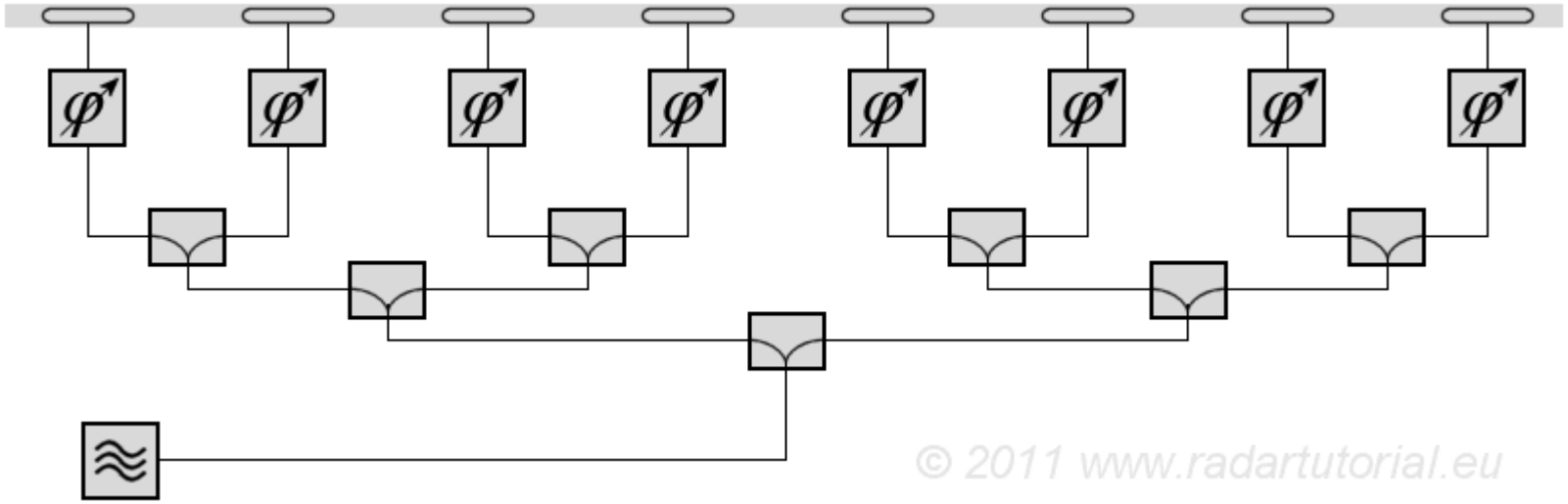
Array radiation = element radiation X array factor

Phase shifters / time delay



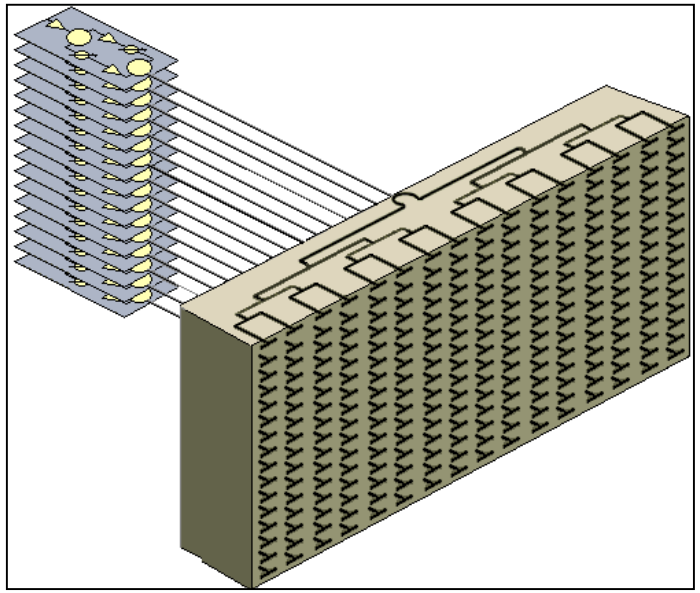
Constrained feeding



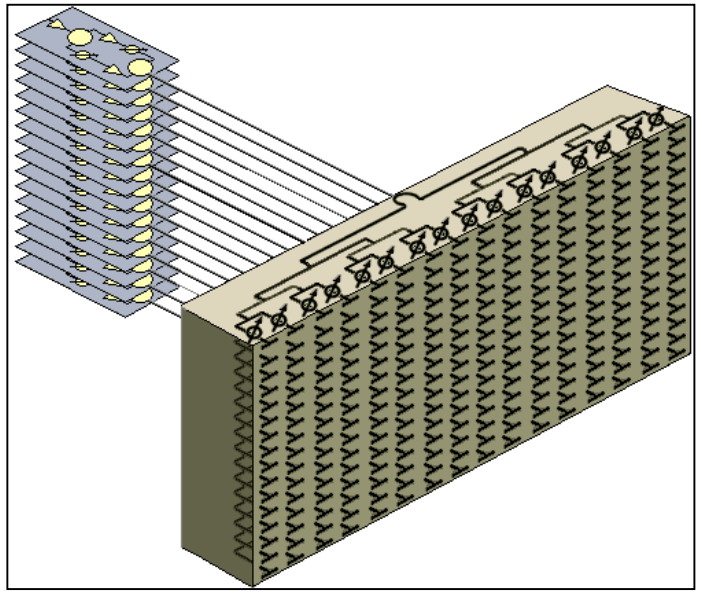


Antenna Arrays

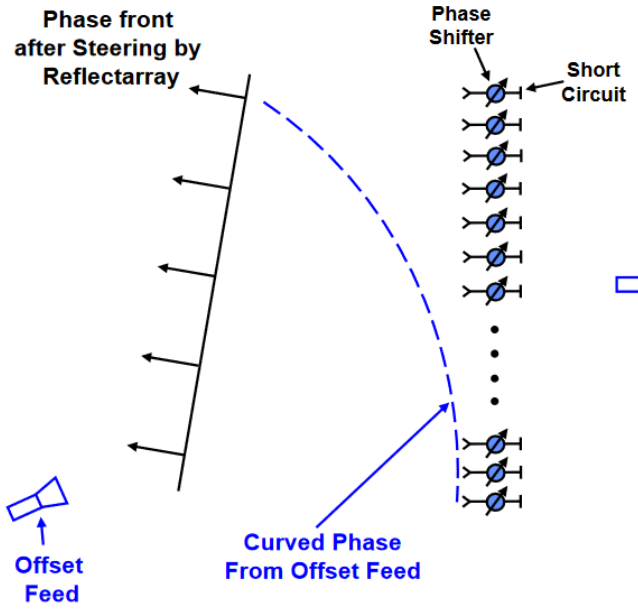
1-D beamforming



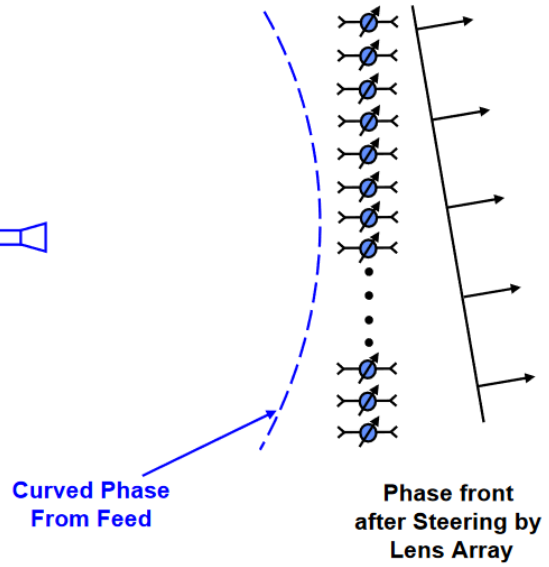
2-D beamforming



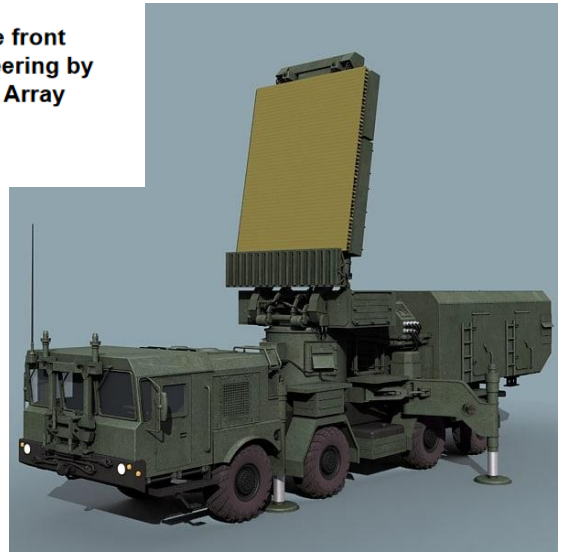
Space feeding



Reflectarray Configuration



Lens Array Configuration



Monopulse antenna