Circular Transmitting/Receiving Radar Array

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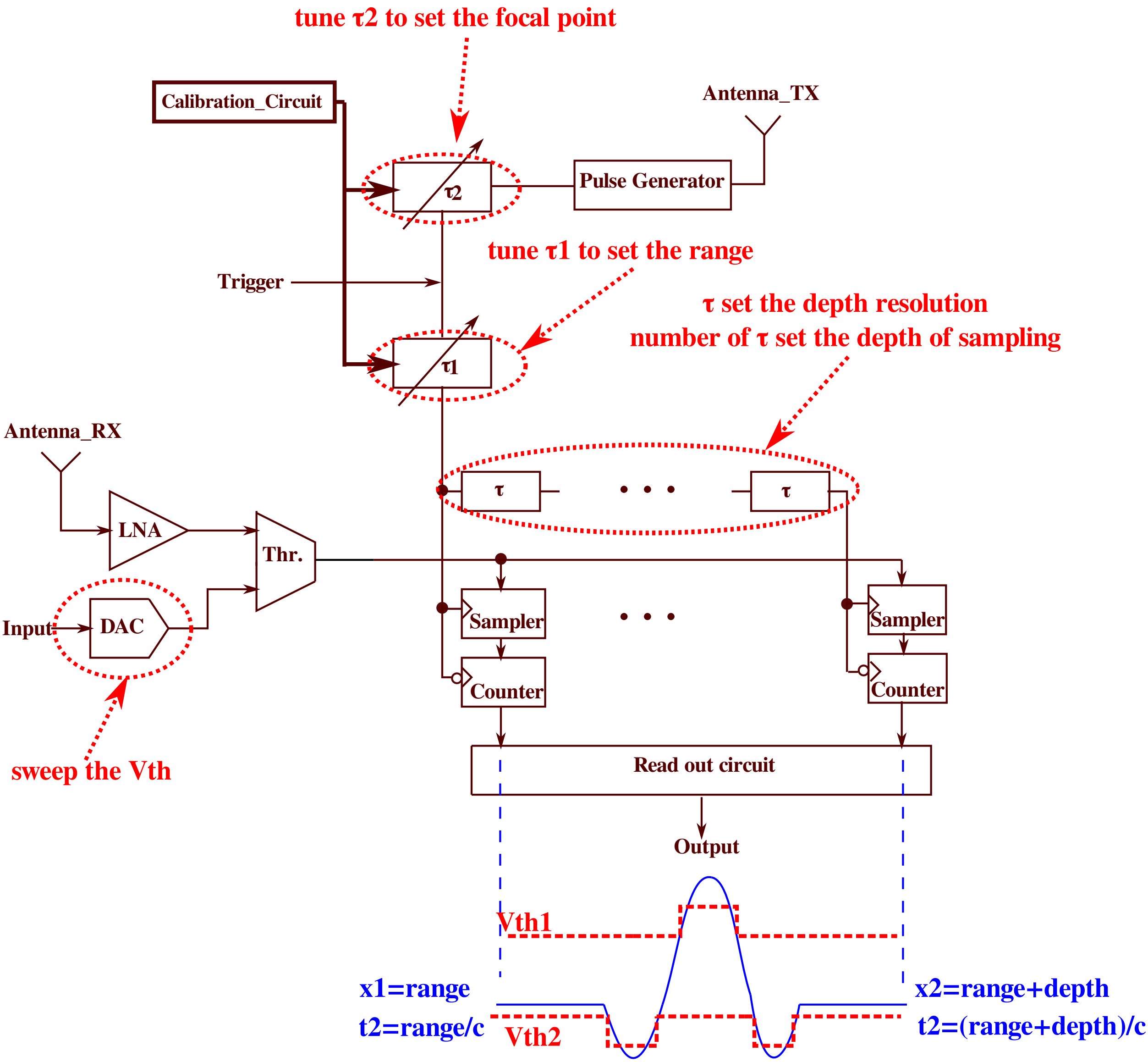
Outline

- introduction
- Beamformer array
  - Circuit description
  - Circular array
- Modeling
  - MATLAB simulation results

introduction

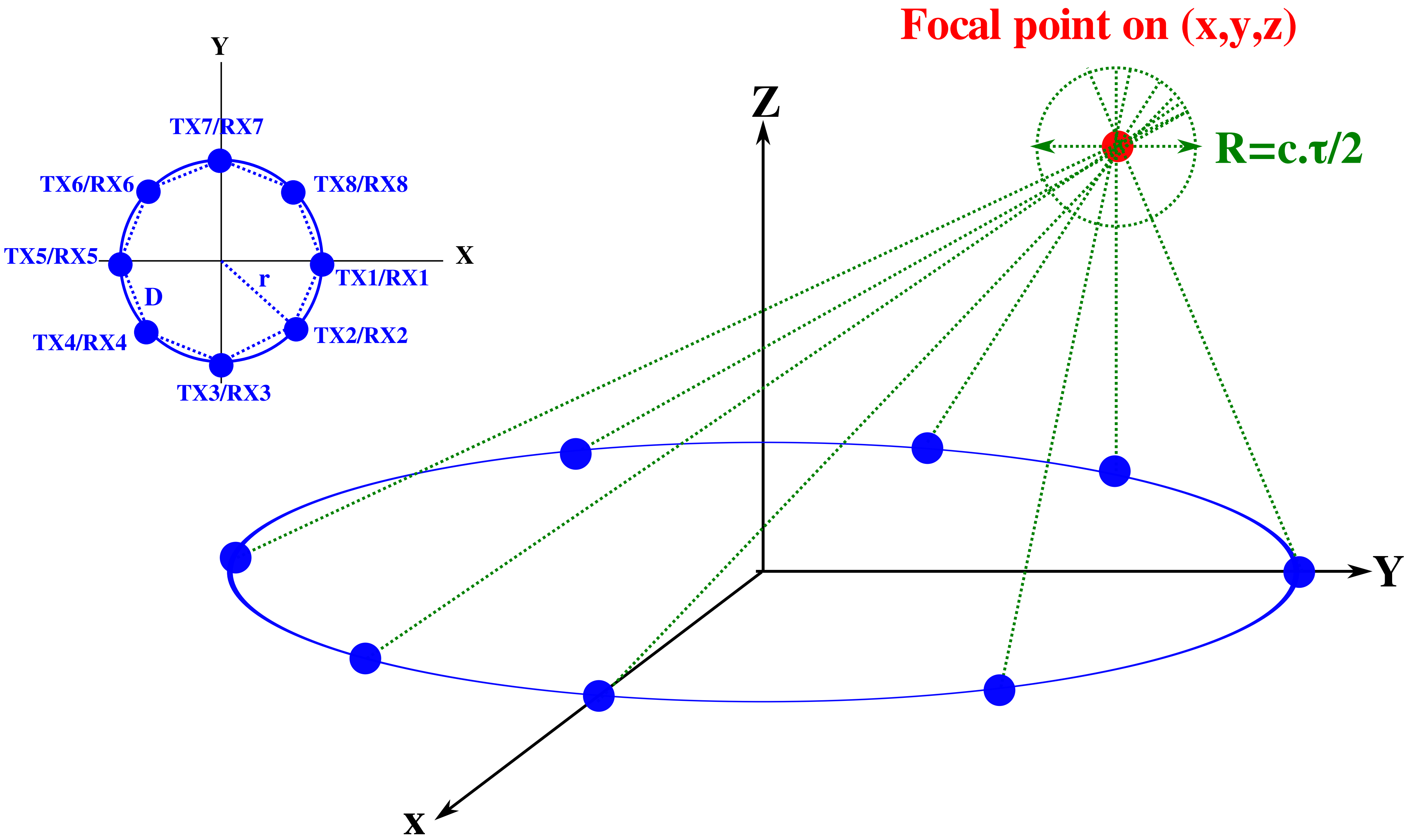
- Beamformnig:
  - Transmitting array: delaying transmitted waves to reach at focal point simultaneously.
  - Receiving array: delaying received waves to have constructive interference at the desired direction.
- Beam pattern depends on:
  - Array geometry
    - 1D structure → 2D image
    - 2D structure : rectangular, circular, … → 3D image
  - Number of elements
    - The more element the higher main-lobe peak and more side-lobe
  - Element weight
    - Set the location of nulls at the beam pattern
  - Element spacing
    - Beam width $\propto \lambda/D$ in Narrow-band array and $\propto c.T/D$ in UWB array
    - The larger element spacing the narrower beam (Narrow-band array : element spacing > one wavelength → grating lobe)

Beamformer Circuit



Circular Transmitting/Receiving Array

- A uniform Transmitting/Receiving Circular array with element spacing of D.
- Antenna polarization should be considered to have constructive interference.
- 8 transmitted signals are delayed to reach on point (x,y,z) simultaneously.
- Each receiver with "n" delay element of τ has a sampling frame with length of "n.τ.c/2".
- All receivers are delayed in a way that their frame at their center point crossed each other on focal point.
- All data from 8 receivers are processed in the software to construct a 3D image.

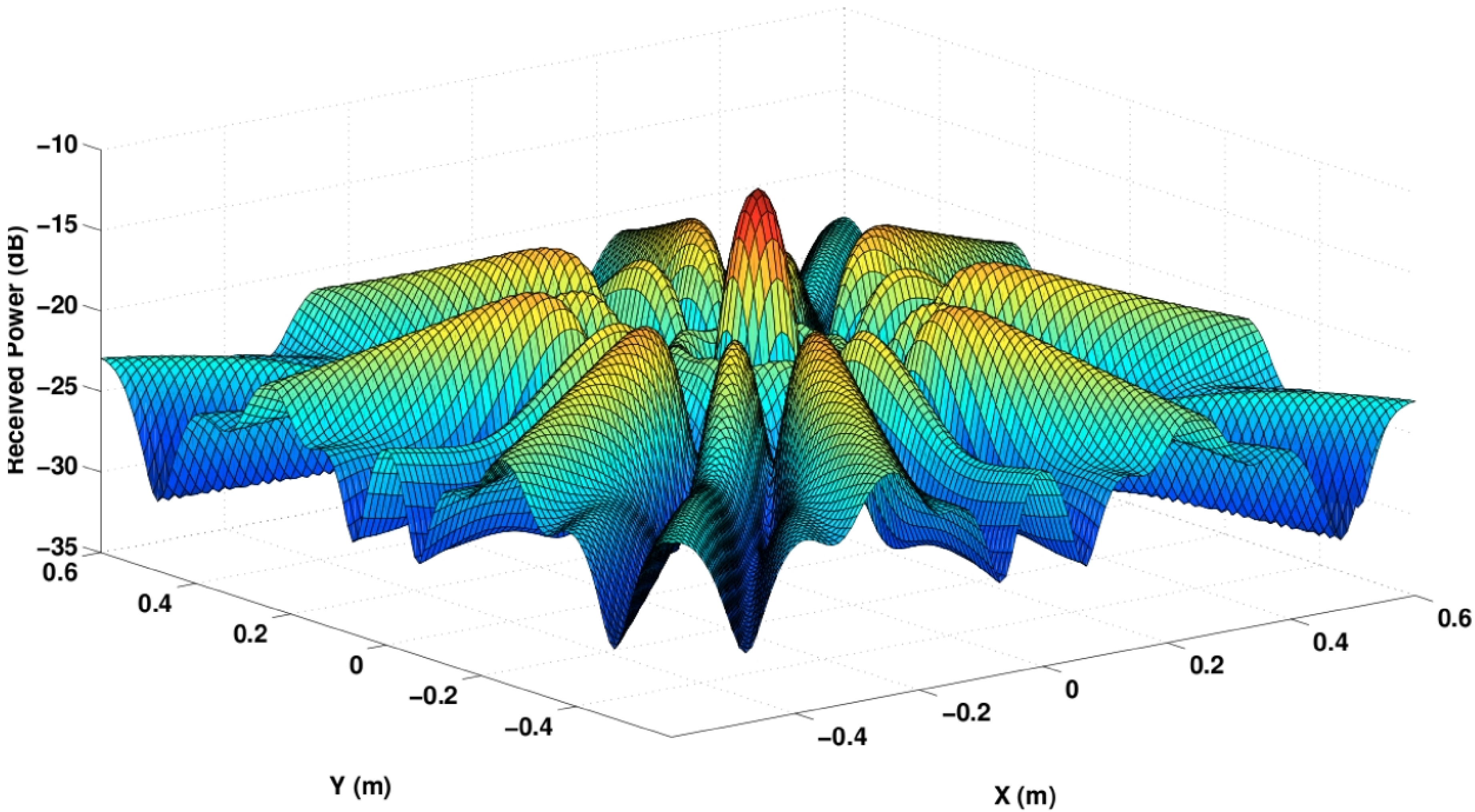


Modeling

- Friis equation : $$\frac{P_r}{P_t} = G_r \cdot G_r \left(\frac{\lambda}{4\pi R} \right)^2$$
  - P_t / P_r : Transmitted/Received power
  - G_t / G_t : Transmitted/Received Antenna gain
  - λ : wavelength and, R : distance
- Simulation:
  - FCC constraint
  - transmitted pulse is a multiplication of sinusoidal waveform with Gaussian pulse
  - Ominidirectional antenna
  - 8 elements
  - Element spacing of 10 cm → radius is 13 cm

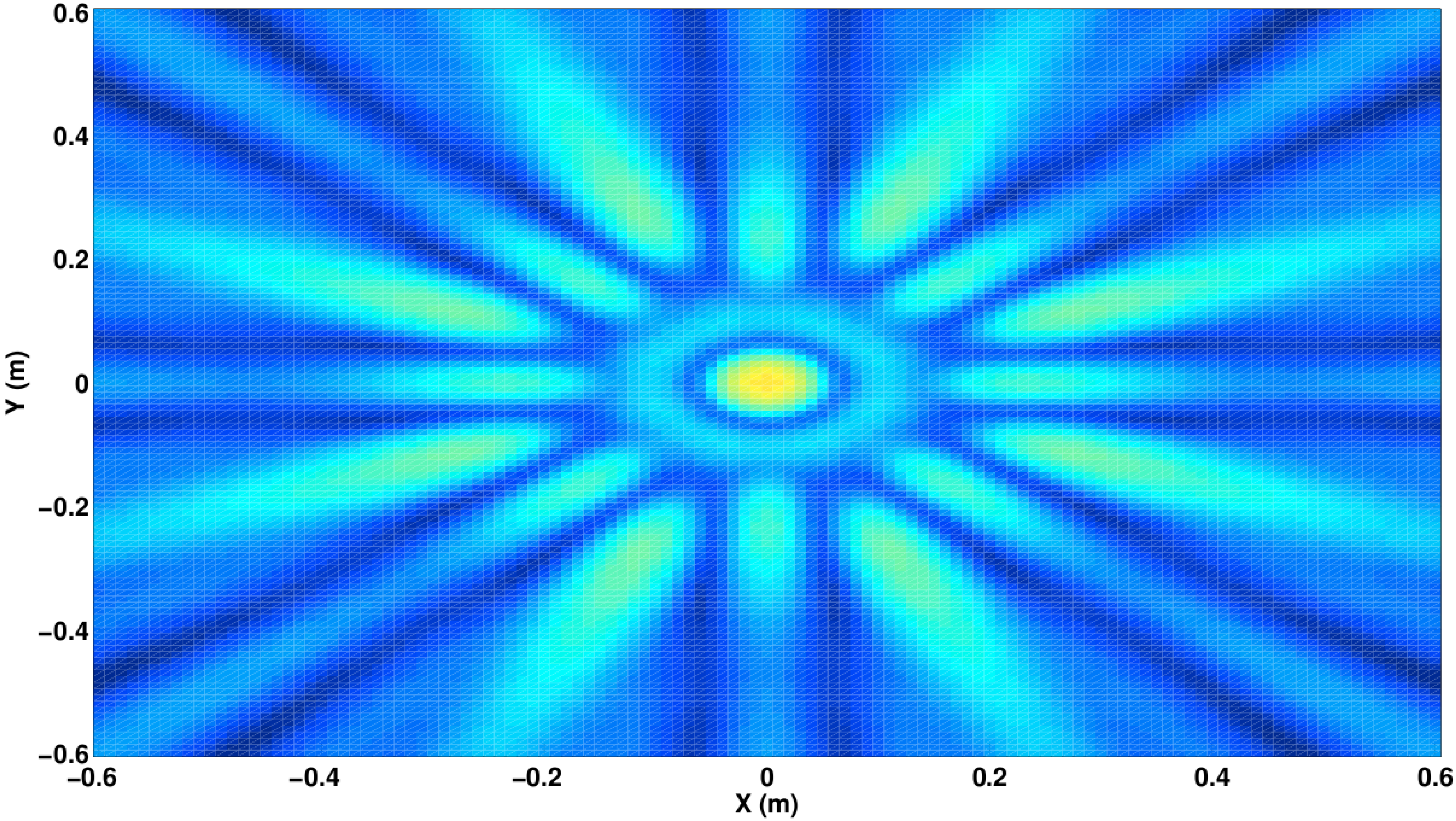
MATLAB Simulation Result (1)

- Focal point on (0 cm, 0 cm, 50 cm)
- Received power at the depth of 50 cm in XY plane



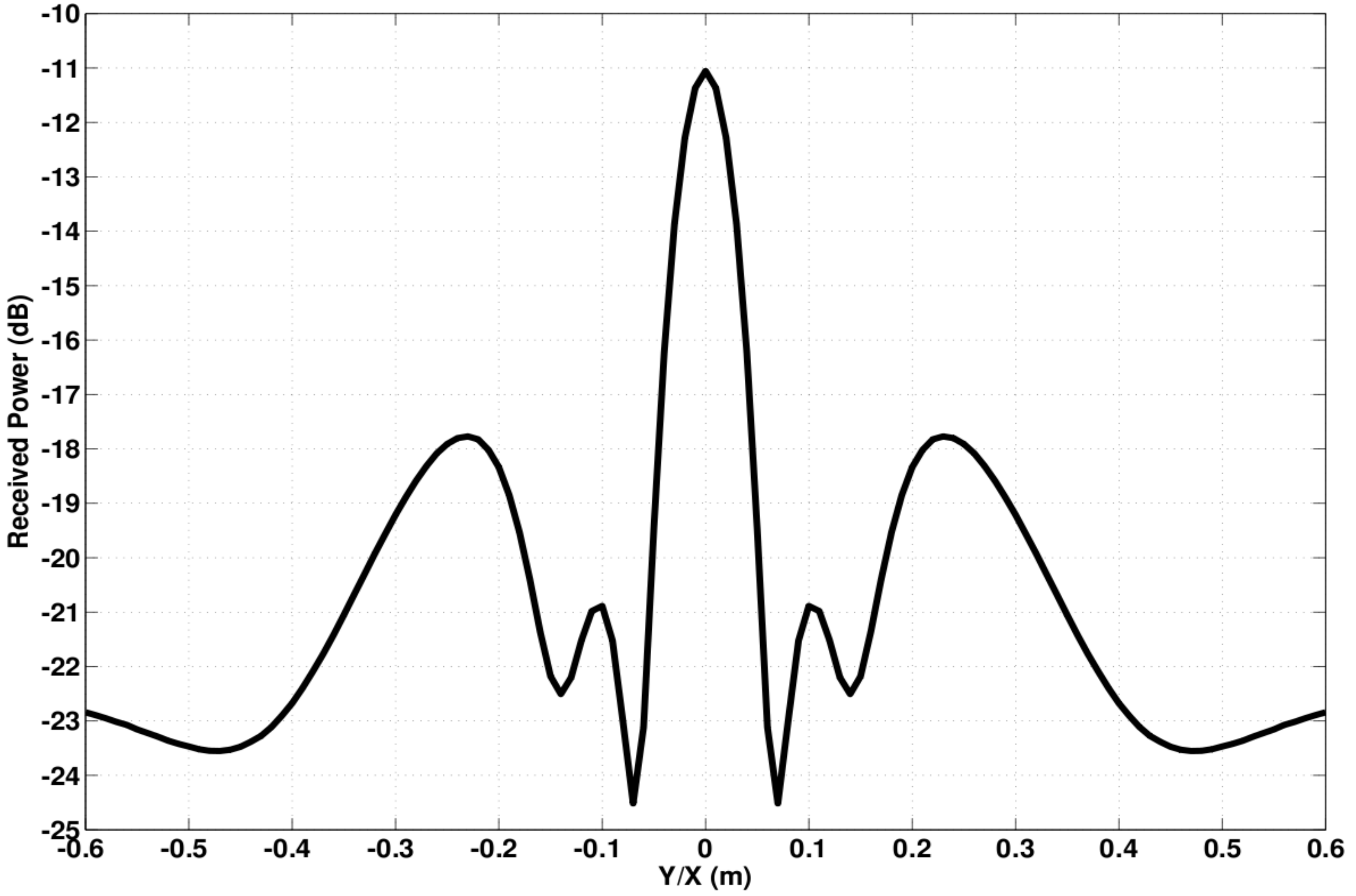
MATLAB Simulation Result (2)

- Focal point on (0 cm, 0 cm, 50 cm)



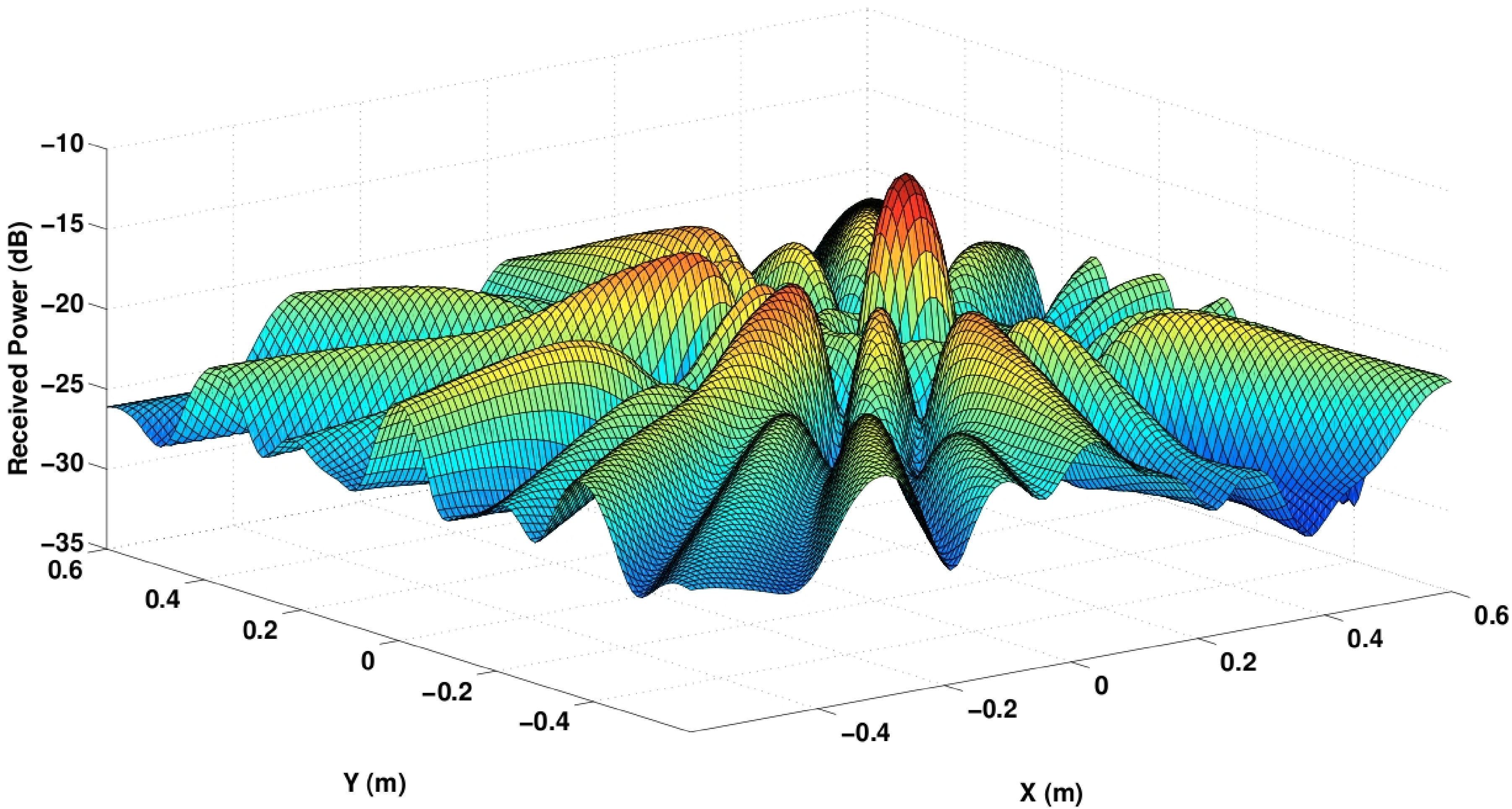
MATLAB Simulation Result (3)

- Focusing on center line → radiation pattern and resolution is the same at X and Y direction



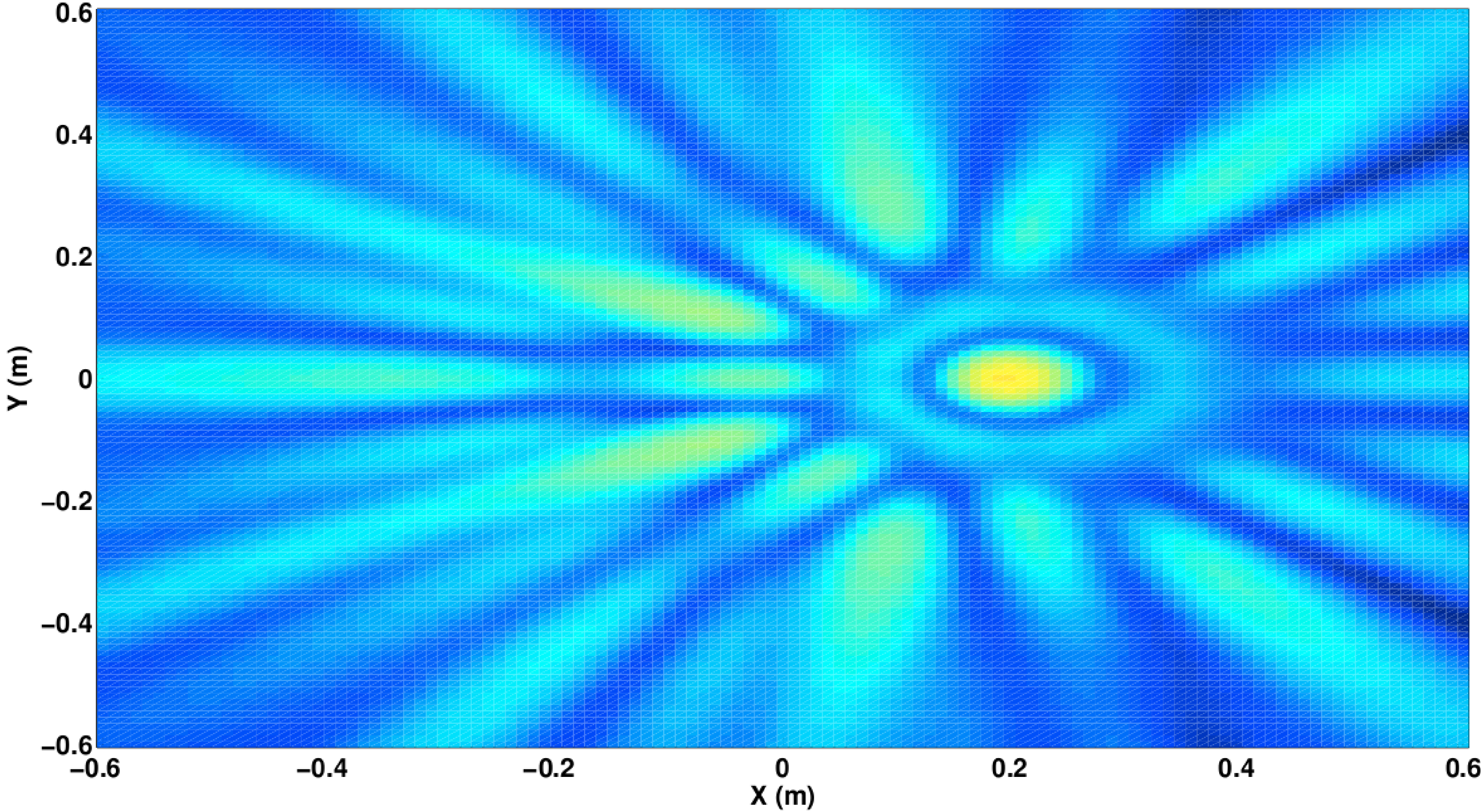
MATLAB Simulation Result (4)

- Focal point on (20 cm, 0 cm, 50 cm)
- Received power at the depth of 50 cm in XY plane



MATLAB Simulation Result (5)

- Focal point on (20 cm, 0 cm, 50 cm)



MATLAB Simulation Result (6)

- Focusing off center → different radiation pattern and resolution at X and Y direction