

EE4620 Spectral Domain Methods in EM

Lecture: Matlab Session on Connected Arrays

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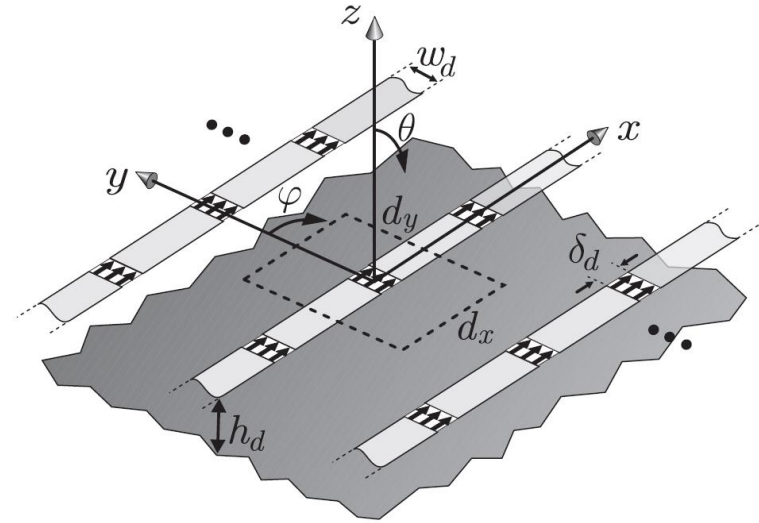
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Problem

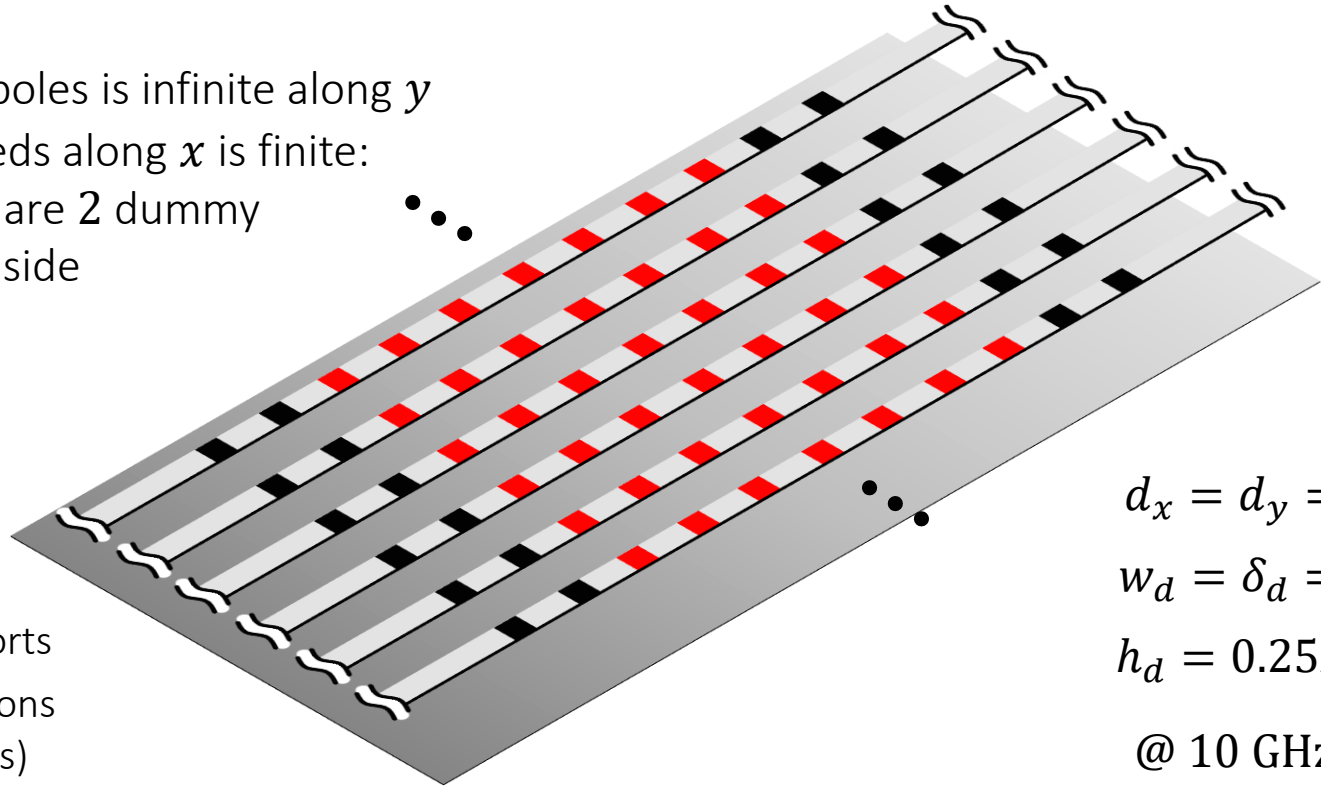
- Implement the active input impedance of the elements of a connected array of dipole with backing reflector
- Compare the finite Active Z_a and Γ with the infinite array for broadside and scanning to 45°



The number of dipoles is infinite along y

The number of feeds along x is finite:

$N_x = 7$ and there are 2 dummy elements on each side



■ Active feeding ports

■ Passive terminations
(dummy elements)

$$d_x = d_y = 0.5\lambda_0$$

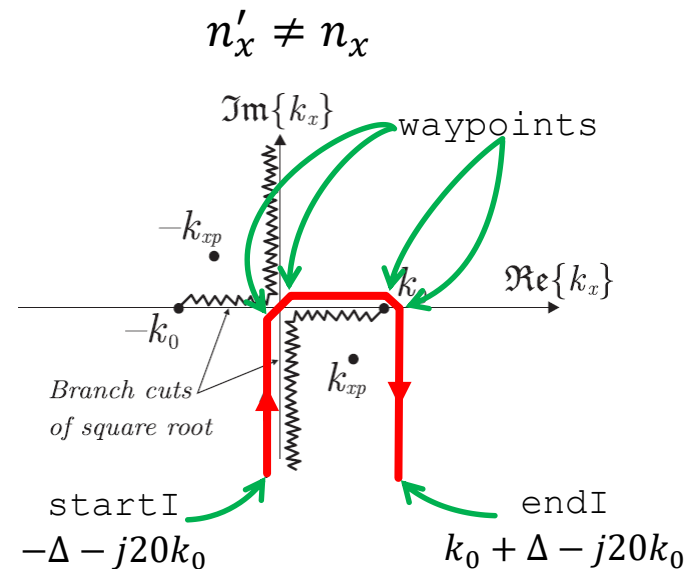
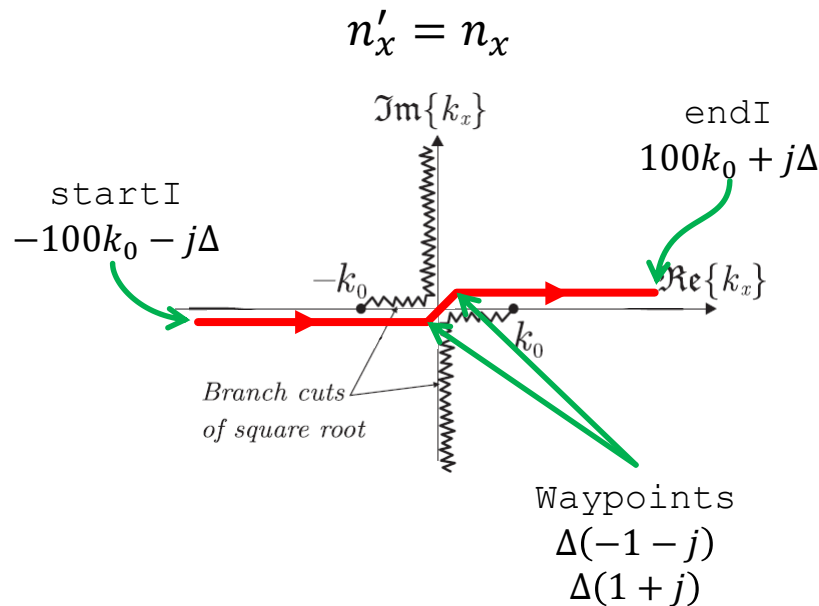
$$w_d = \delta_d = 0.2\lambda_0$$

$$h_d = 0.25\lambda_0$$

@ 10 GHz

How to Calculate the Admittance Matrix?

$$Y_{n_x, n'_x} = -\frac{1}{2\pi} \int_{-\infty}^{\infty} \frac{\text{sinc}^2(k_x \delta / 2)}{D(k_x)} e^{-jk_x |n'_x - n_x| d_x} dk_x$$



- integral
`Q = integral(fun, startI, endI, 'Waypoints', waypoints) ;`

`fun = @(kx) integrand(kx, ...)`

Integration variable
(not defined by you)

Array containing the points which
define the integration path

...Towards Z_{Act}

$$-\frac{1}{2\pi} \frac{\text{sinc}^2(k_x \delta/2)}{D(k_x)} e^{-jk_x (n_x-1) d_x} \xrightarrow{\text{Integrals}} Y_{1,n_x} \xrightarrow{\text{Toeplitz}} Y$$

Interaction between element 1 and n_x

- toeplitz

`Y = toeplitz(real(YRow))+1j*toeplitz(imag(YRow));`

$$\mathbf{i}_\delta = (\mathbf{Z} + \mathbf{Z}_l \mathbf{I})^{-1} \mathbf{v} \rightarrow \text{Excitation}$$

Unknowns $\mathbf{Z} = \mathbf{Y}^{-1}$ \mathbf{Z}_l : line \mathbf{I} : identity matrix (eye(Nx+4))

$$Z_{\text{Act},n} = \frac{v_n}{i_{\delta,n}} - Z_l$$

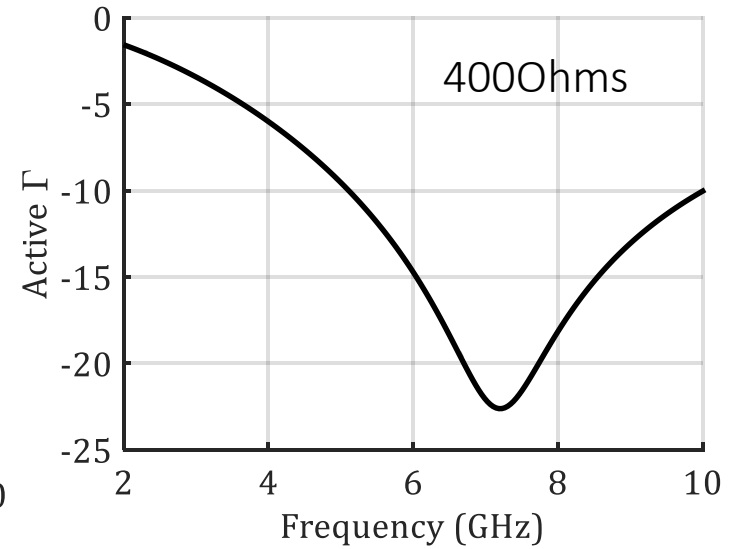
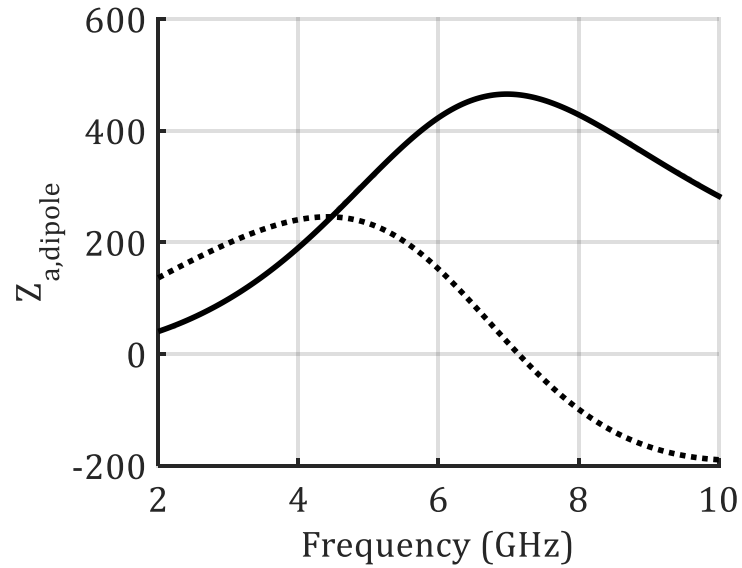
Dummy Elements

Active Elements (phase shift)

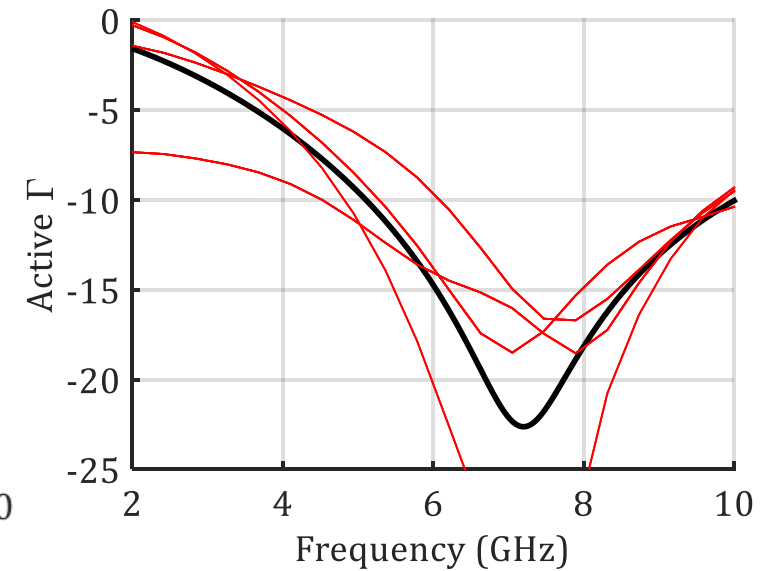
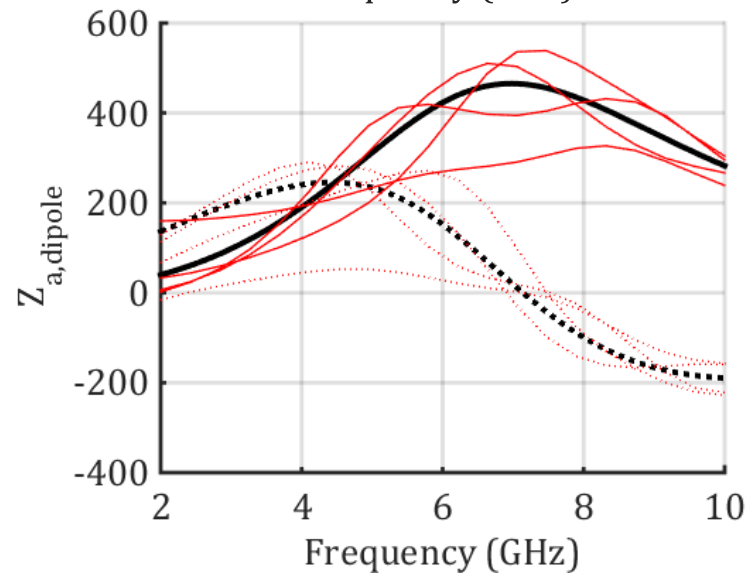
$$\mathbf{v} = \begin{bmatrix} 0 \\ 0 \\ v_1 \\ v_2 \\ \vdots \\ v_{N_x} \\ 0 \\ 0 \end{bmatrix} \quad v_n = e^{-jk_{x0} n d_x}$$

Broadside

Infinite array



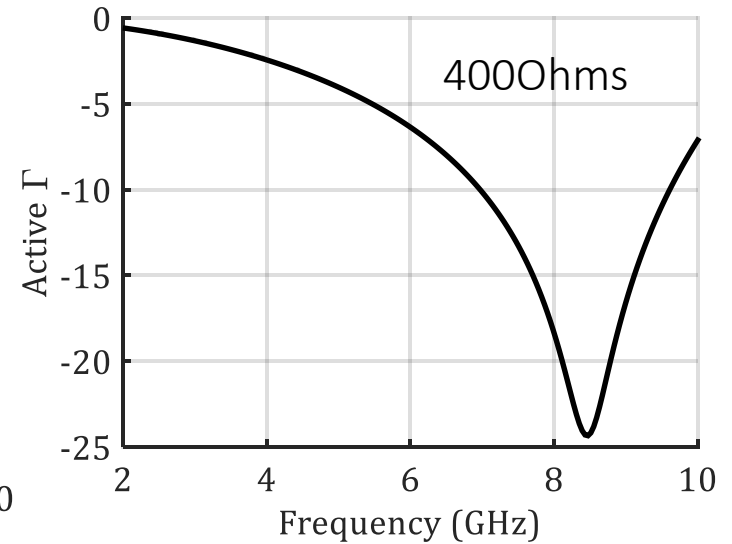
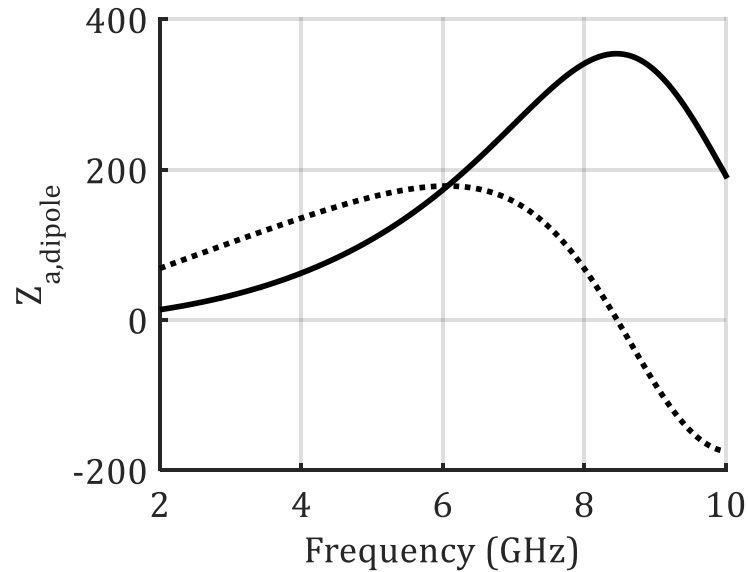
Finite array



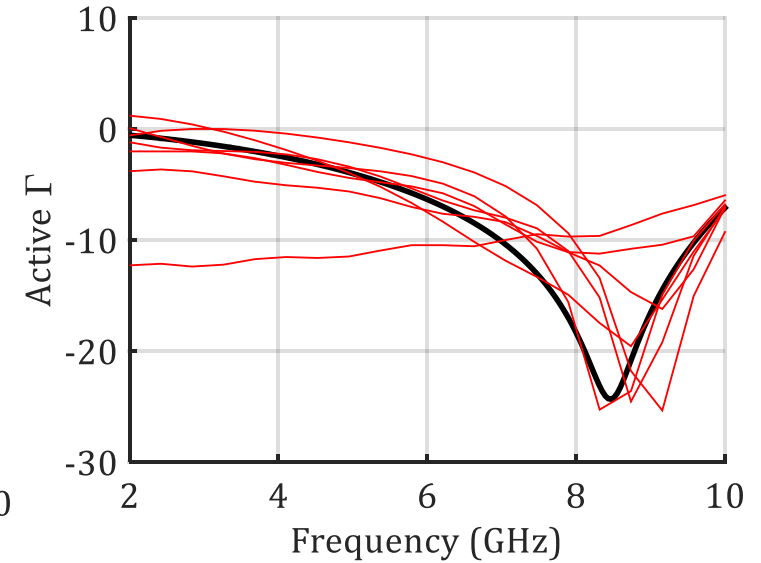
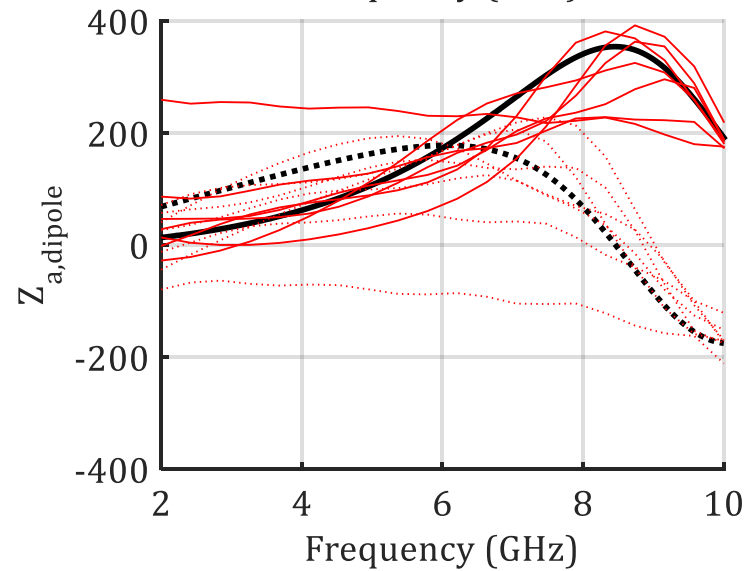
Matching is quite stable

Scanning to 45 degrees

Infinite array



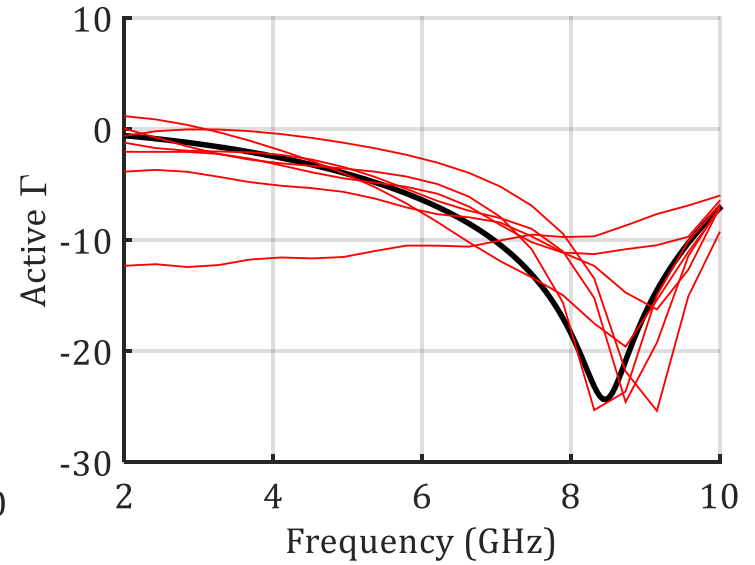
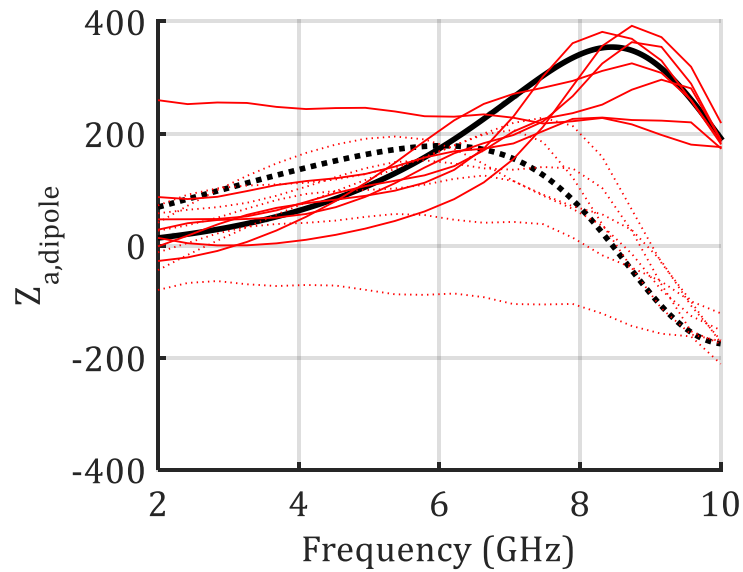
Finite array



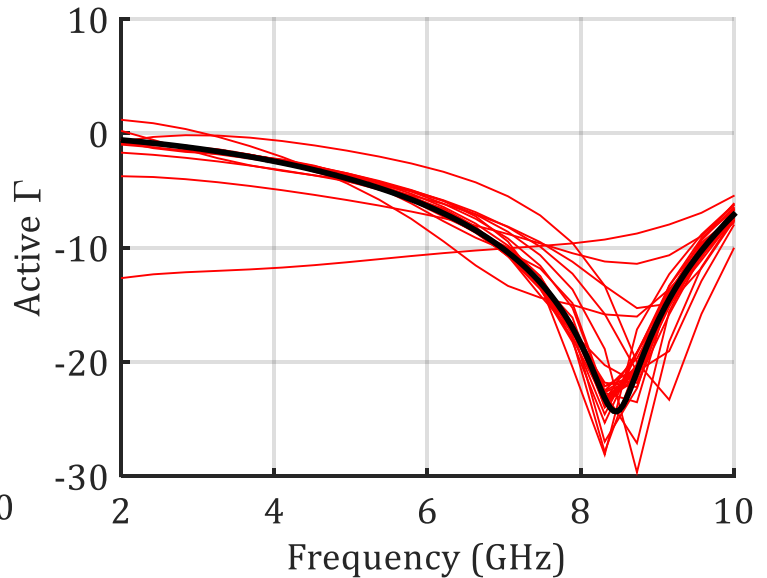
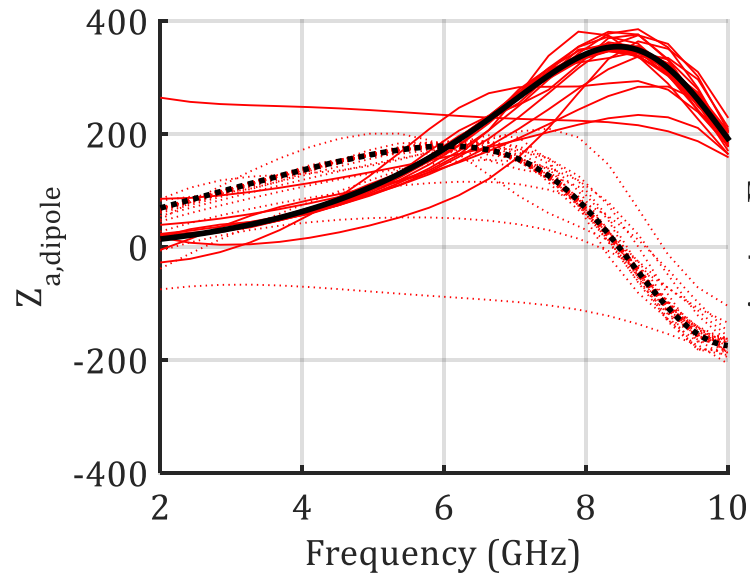
Edge effects worsen for scanning -> mismatch

Larger array

Finite array
7 elements



Finite array
30 elements



Larger array: elements are mostly matched except few at the edge (higher overall efficiency)