Master Thesis

Control and Prediction of Scan Blindness Effects in Printed Planar Antenna Systems

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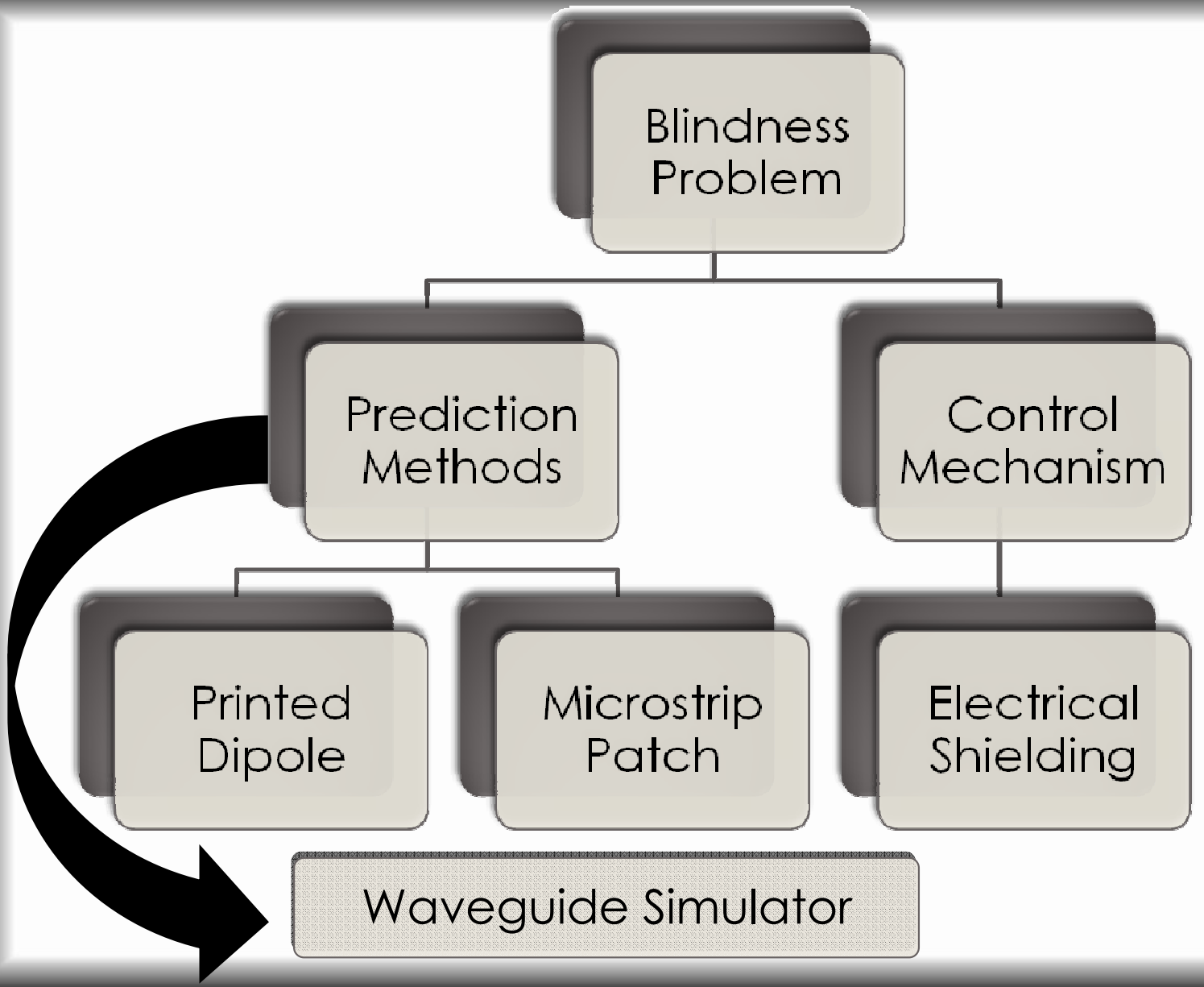
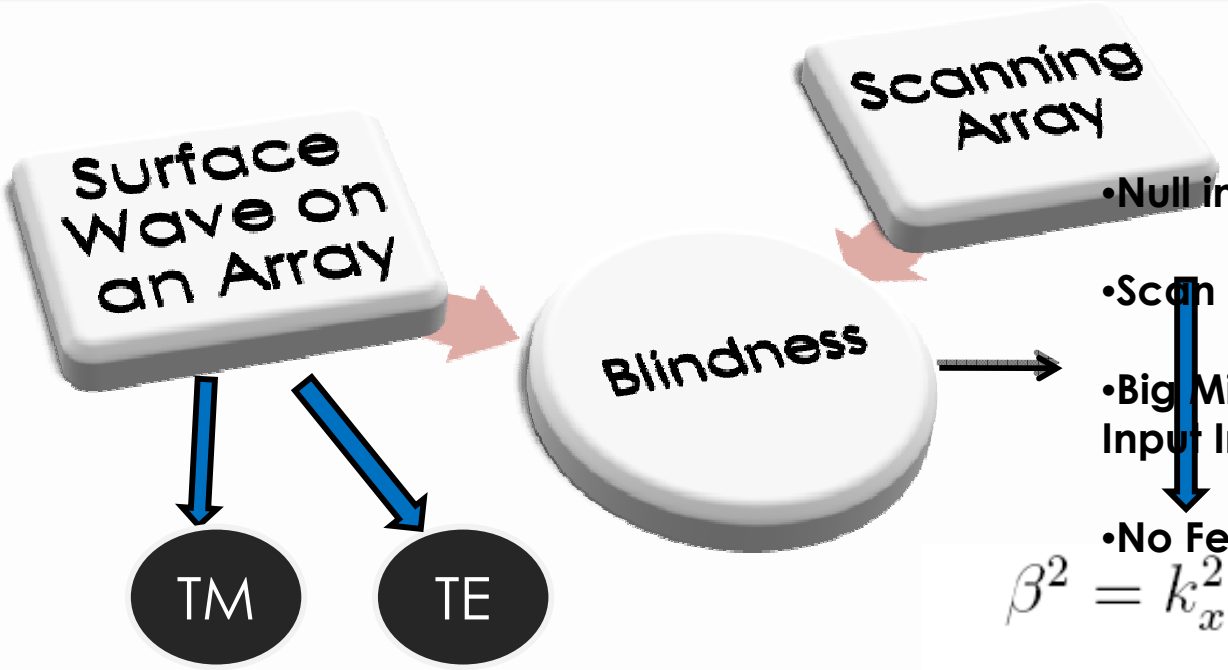
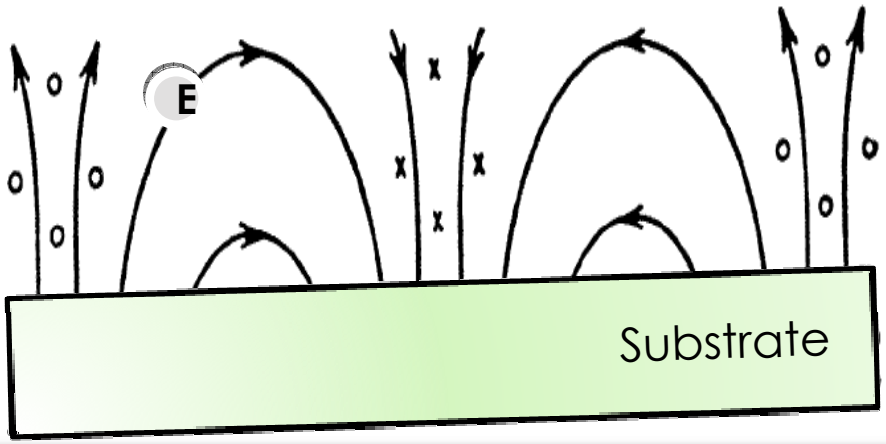
Presentation Outline



Blindness Concept



$$\beta^2 = k_x^2 + k_y^2$$

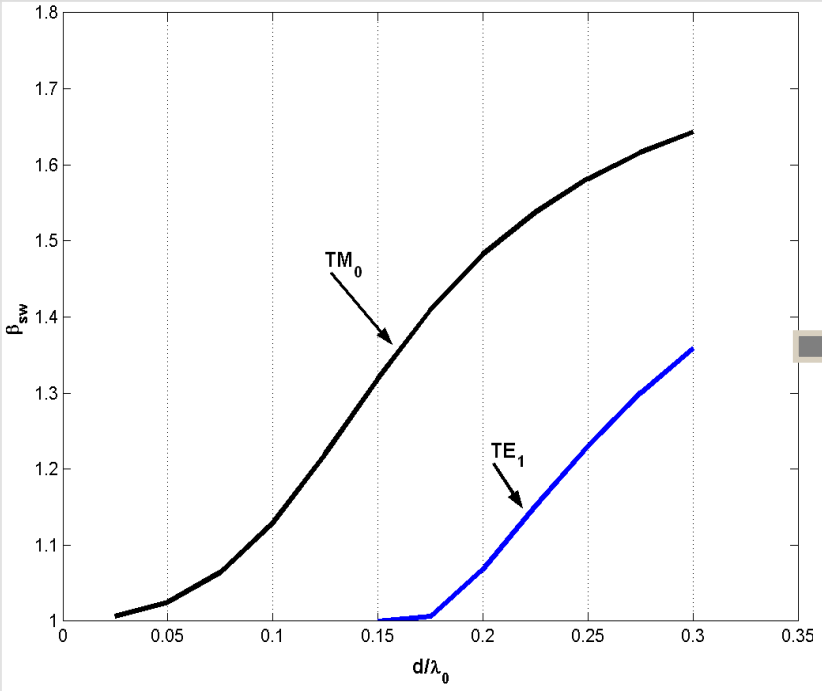


$$k_x = (\frac{2\pi m}{a} + k_0 u)$$

$$k_y = (\frac{2\pi n}{b} + k_0 v)$$

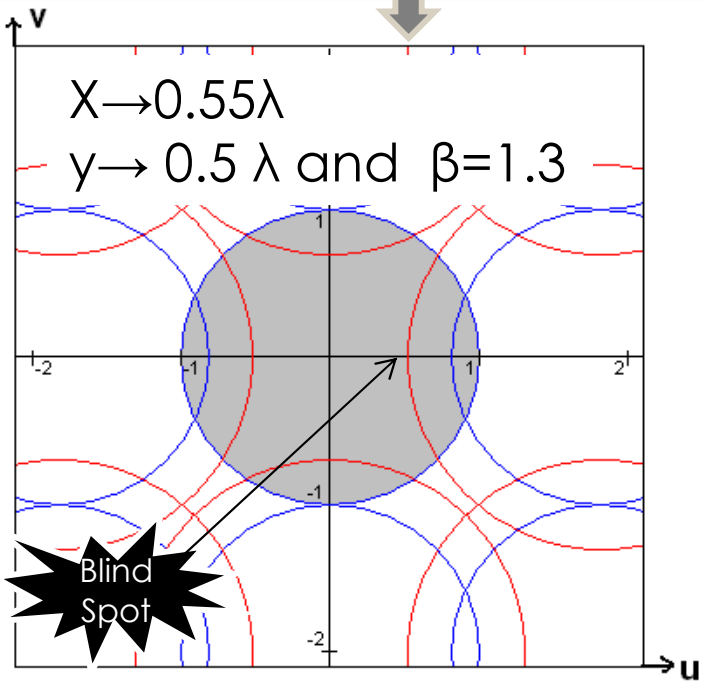
u=sin θ cos Φ

Surface Wave Circle Diagram



Scanning Part

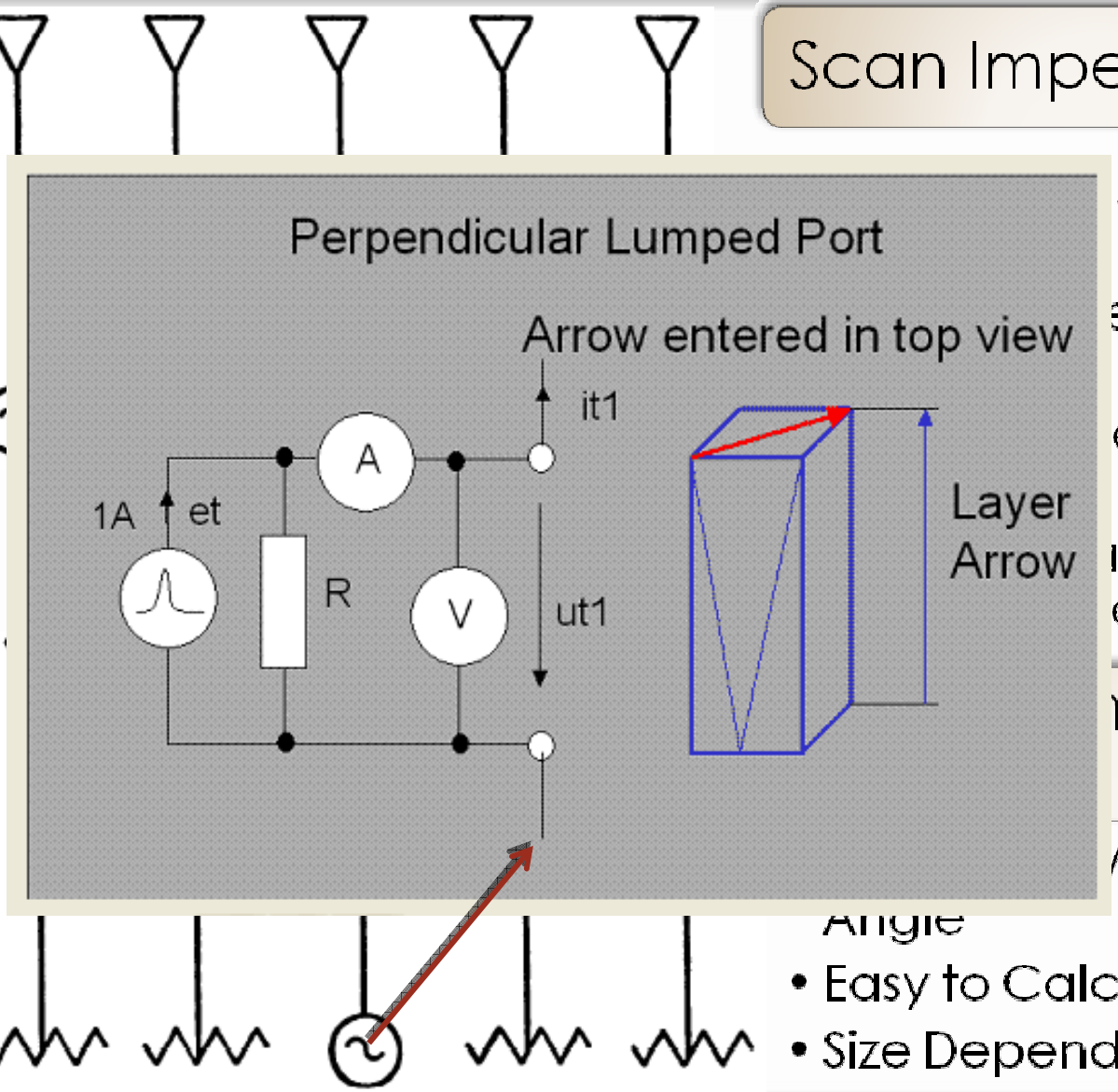
$$\beta_{sw}^2 = (\frac{m}{d_x/\lambda} + u)^2 + (\frac{n}{d_y/\lambda} + v)^2$$



Grid Spacing → Blindness in Visible Space

Polarization Match → TM (TE) mode excitation

Scan Impedance Method and SEP



Scan Impedance

Should be

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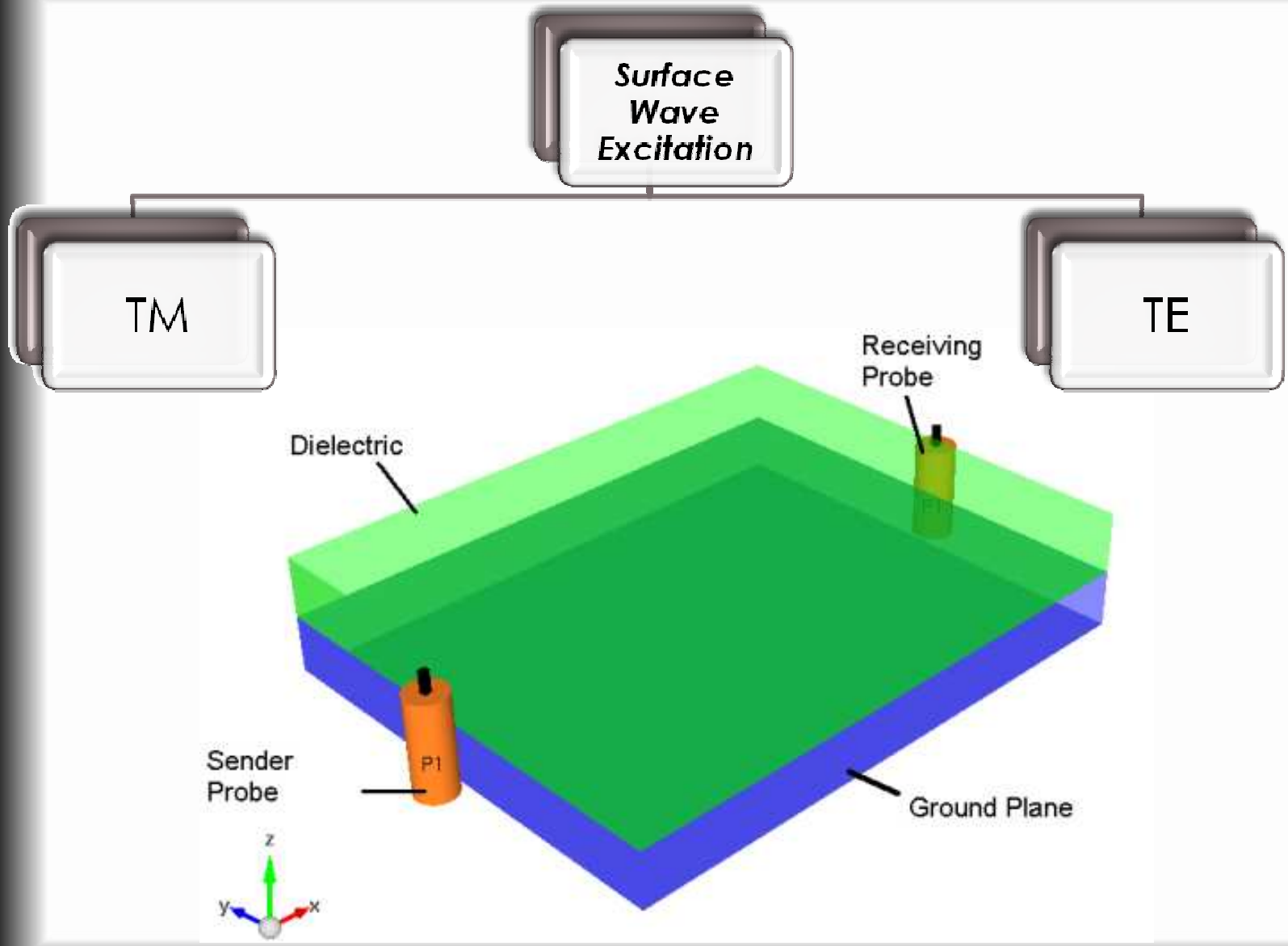
Angle

- Easy to Calculate
- Size Dependent

Effective Propagation Constant

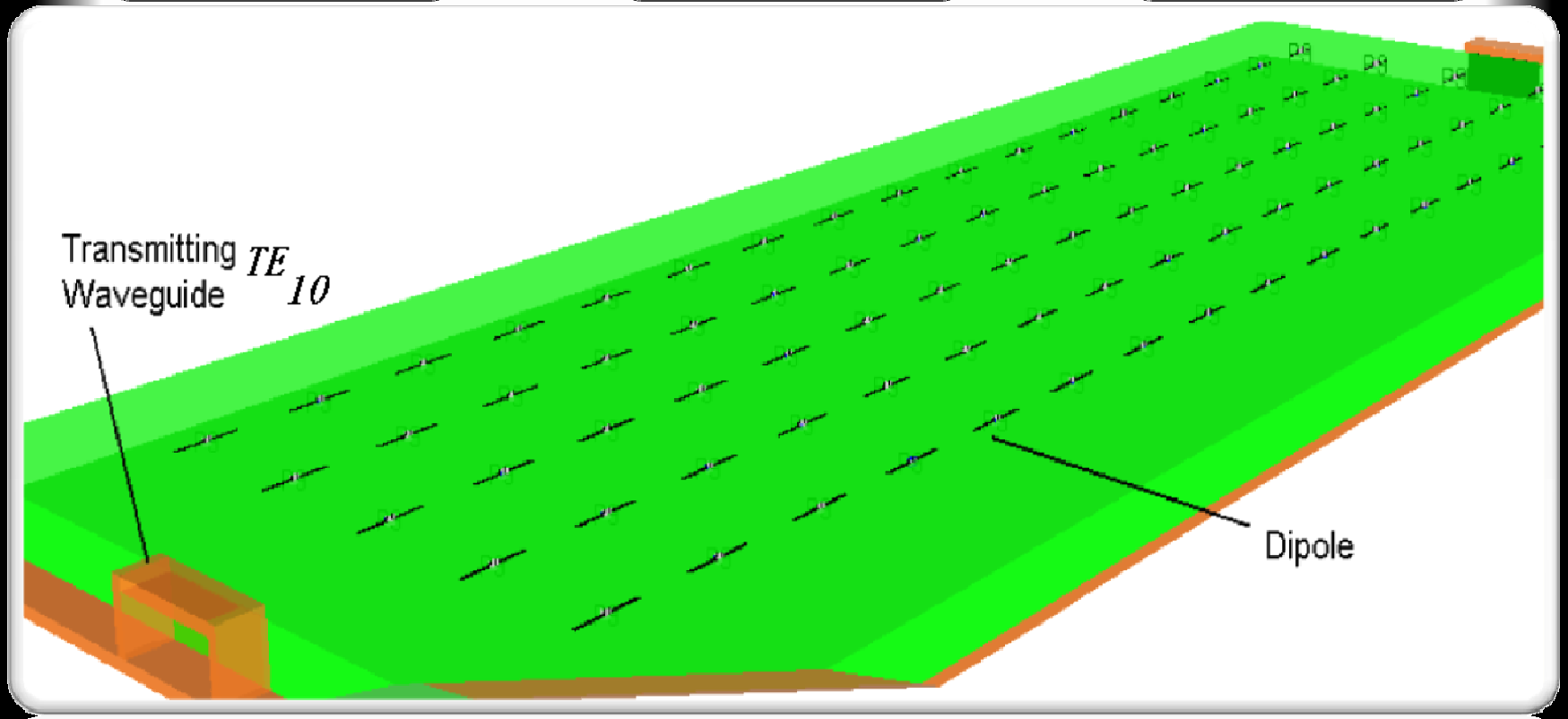


TM Mode β Calculation

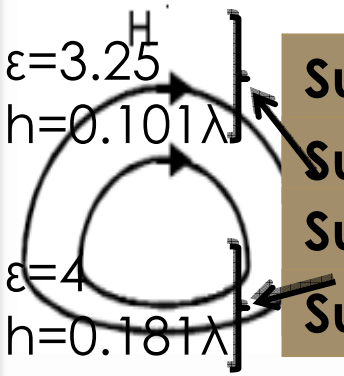
The first mode is excited on the waveguide port

Two simulations are needed two calculate β

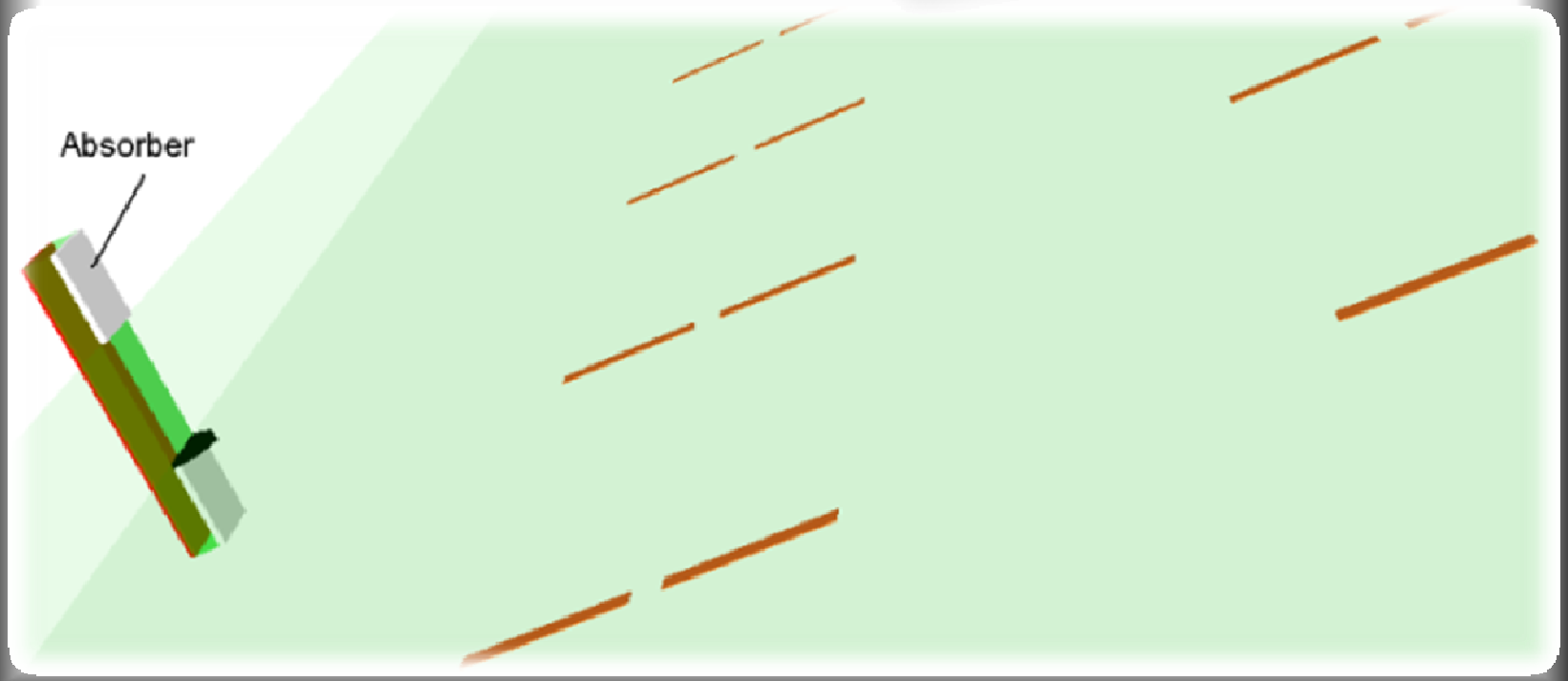
Blind spot is predicted with new effective β using classical method



TE Mode β Calculation



Substrate	Mode	Ideal β	Calculated
Substrate1	TM	1.1349	1.145
Substrate2	TM	1.6168	1.597
Substrate2	TE	1.1316	1.109



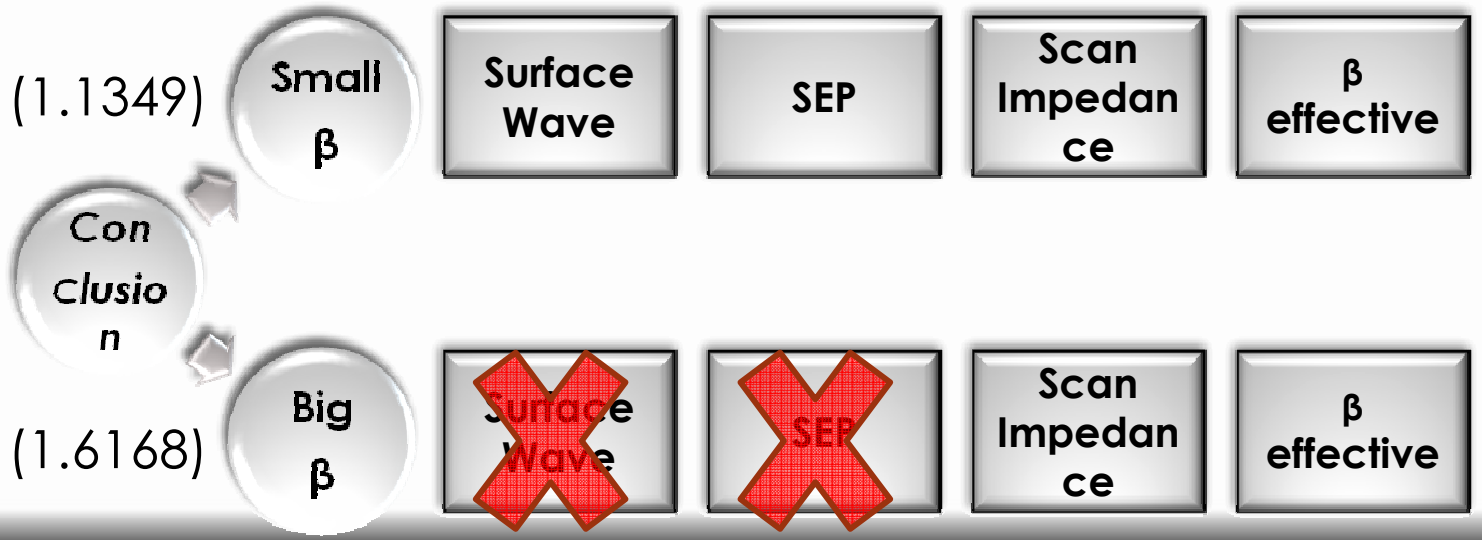
Printed Dipole

Scan Element Pattern

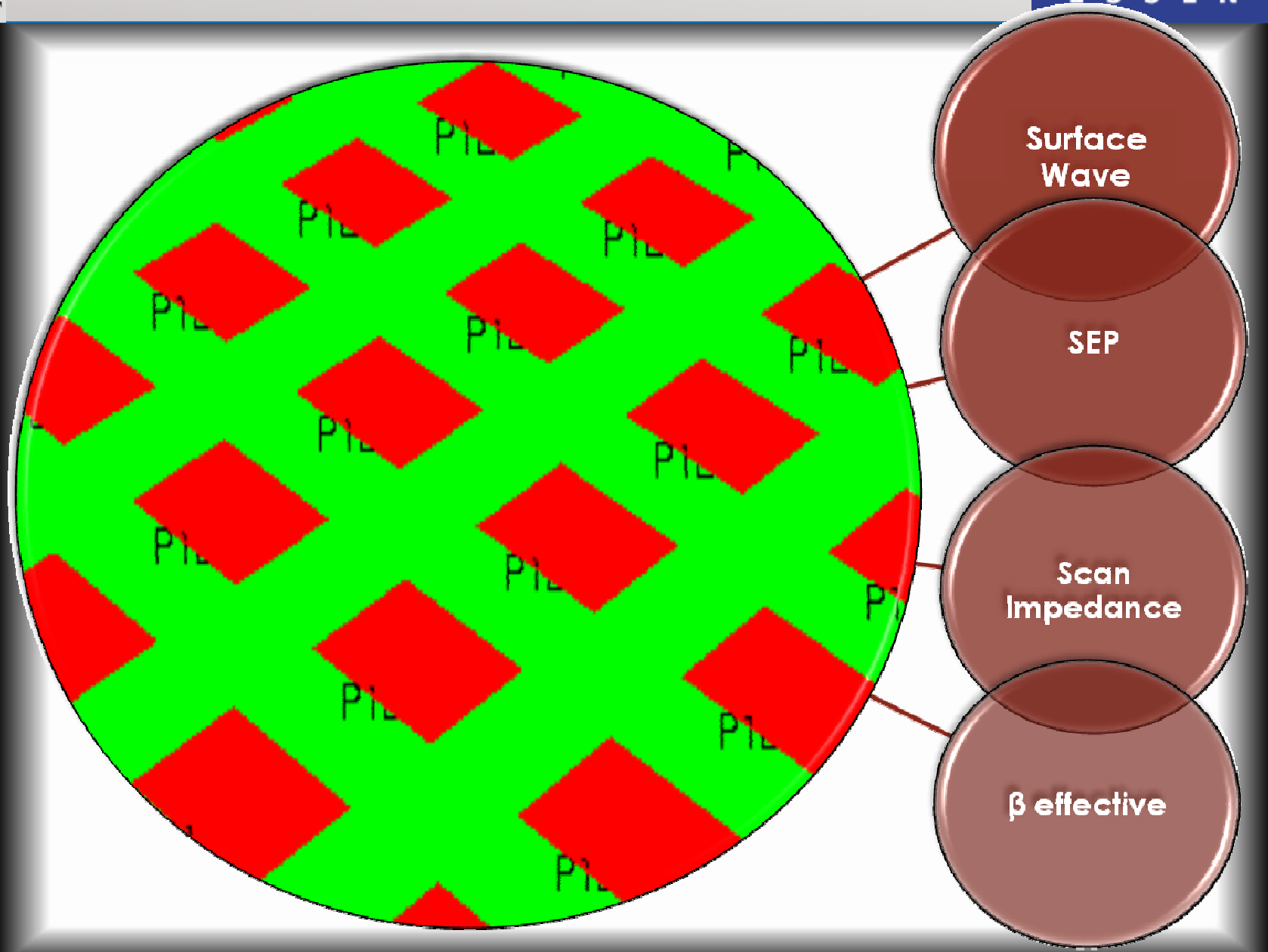
Scan Impedance Method

Method Comparison for Dipole

Spacing	Substrate	Surface Wave	SEP	Scan Impedance	β Effective
0.49λ , E	Substrate1	64	63	71	66
0.7λ , E	Substrate1	17	17	23	18
0.49λ , E	Substrate2	25	24	38	40
0.49λ , H	Substrate2	65	66	51	58
0.6λ , E	Substrate2	3.5	3	14	15.5
0.6λ , H	Substrate2	32.4	31	27	29



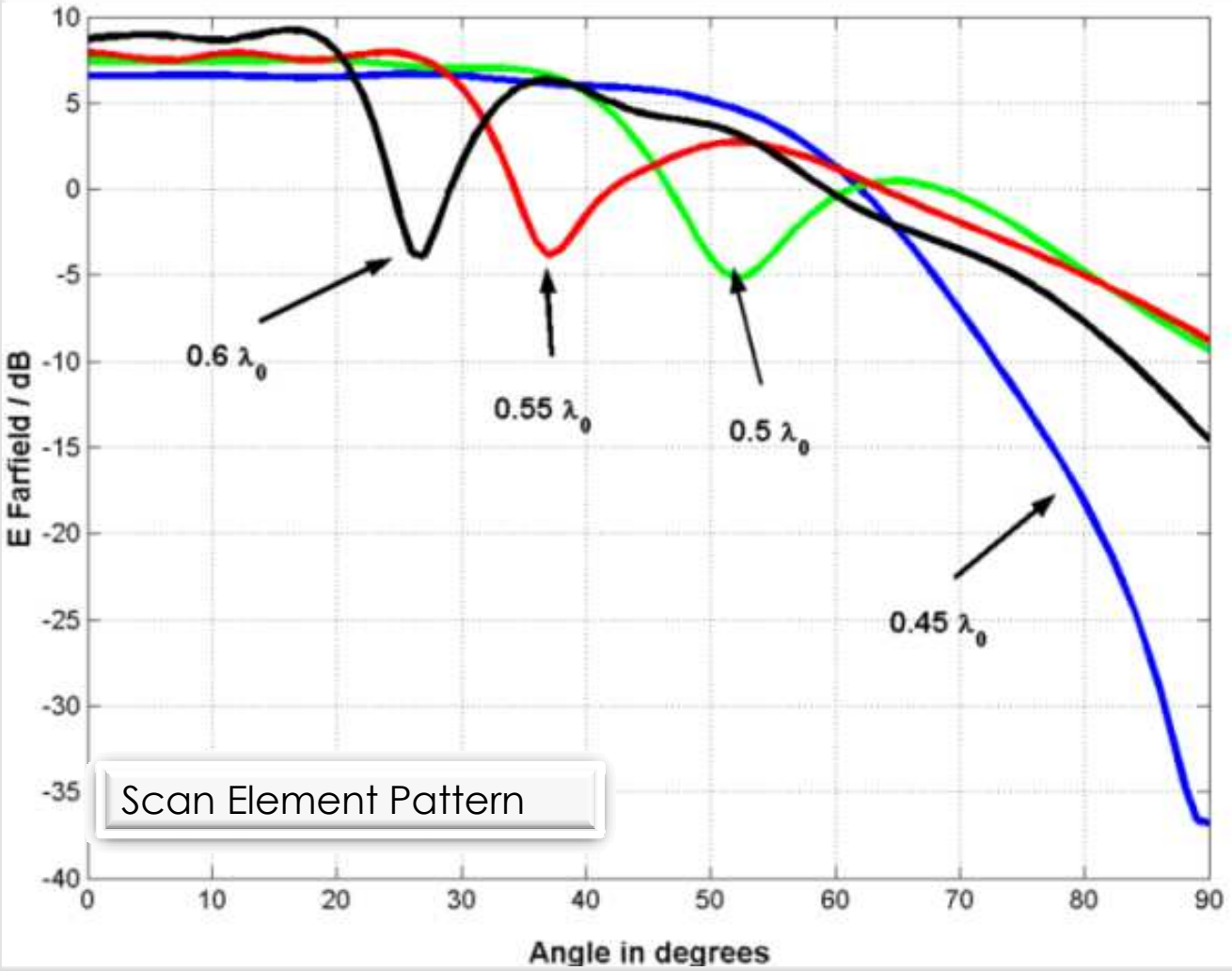
Patch Array



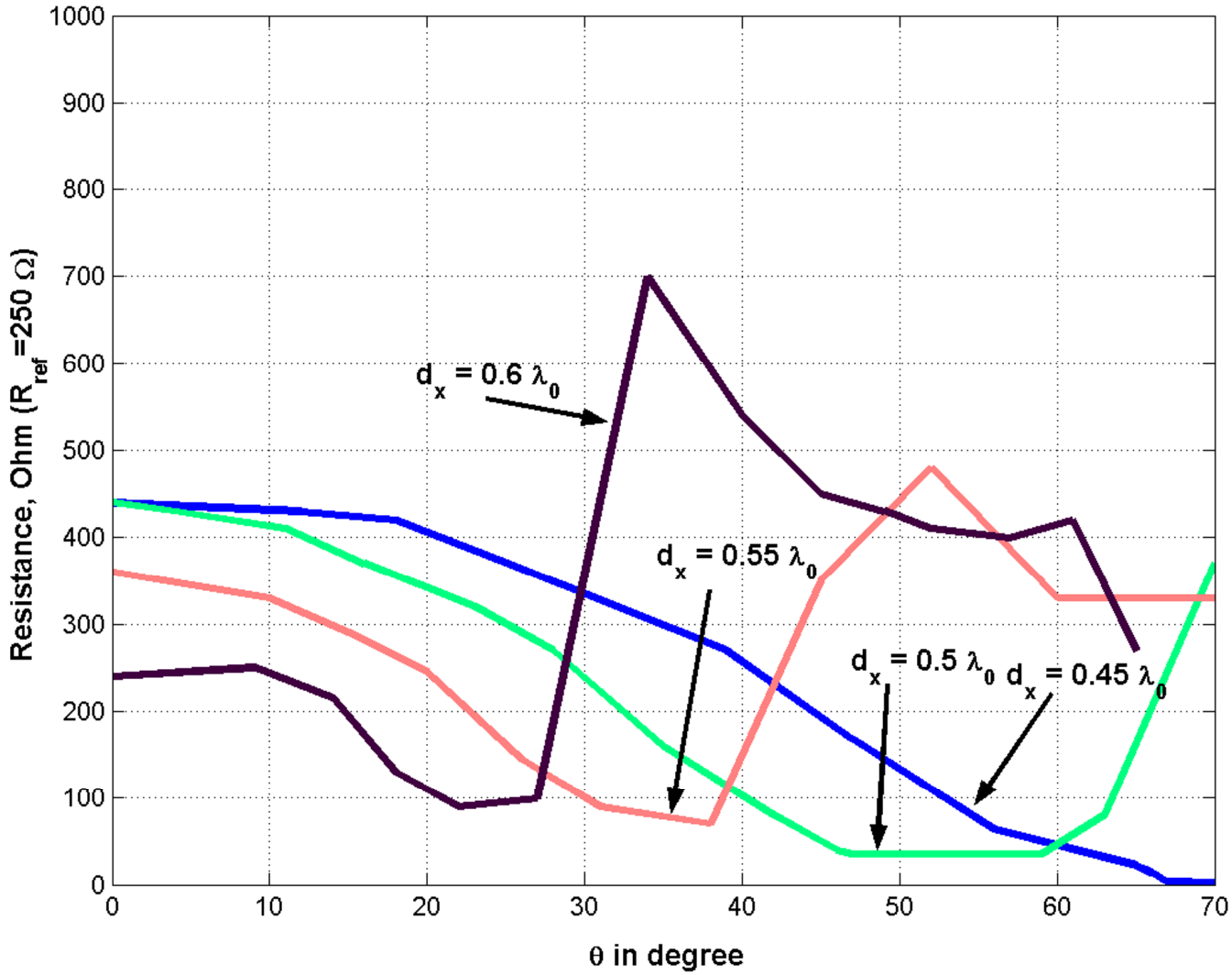
Arrays of Microstrip Patches

ε=3.48
h=0.121λ

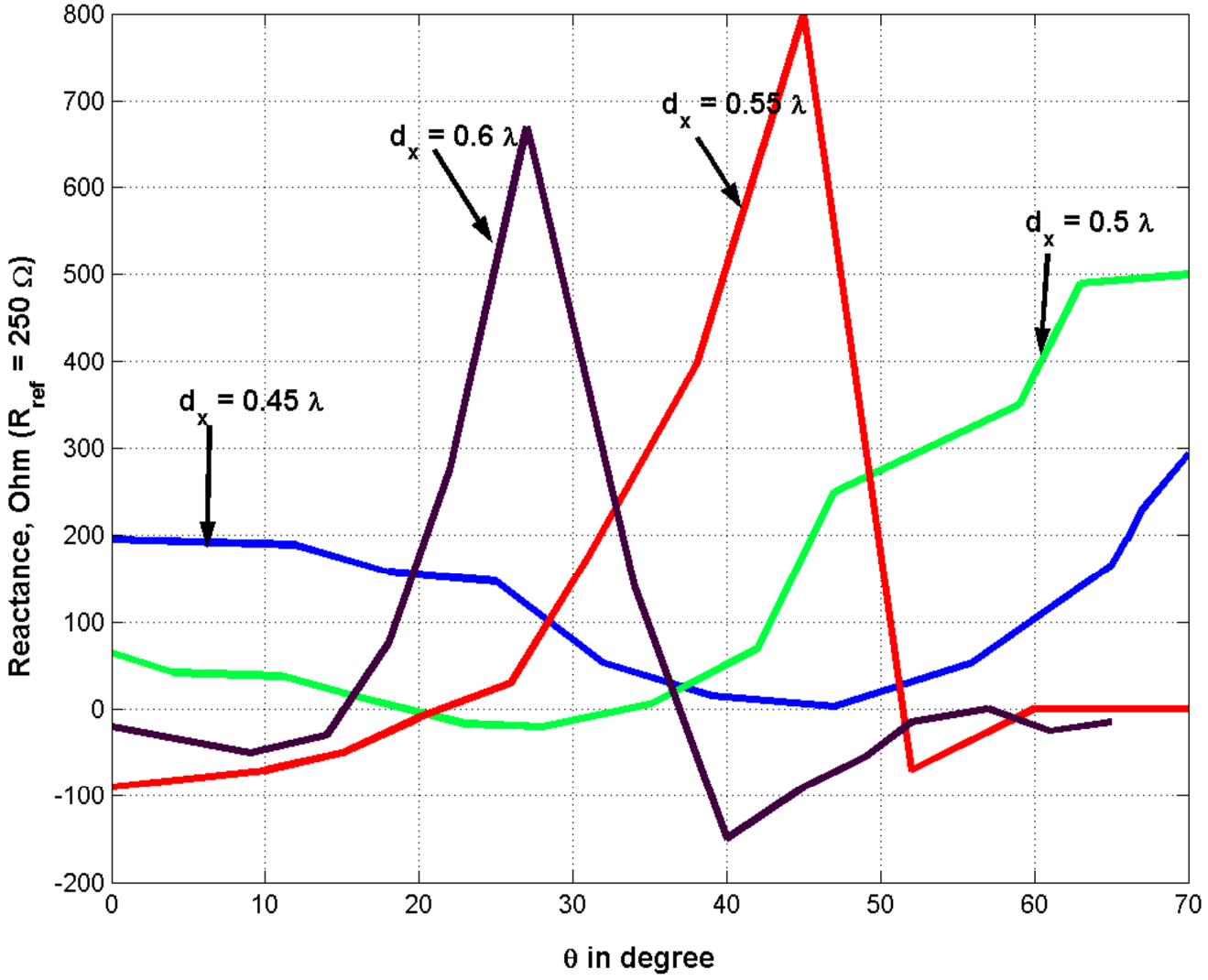
β=1.2383



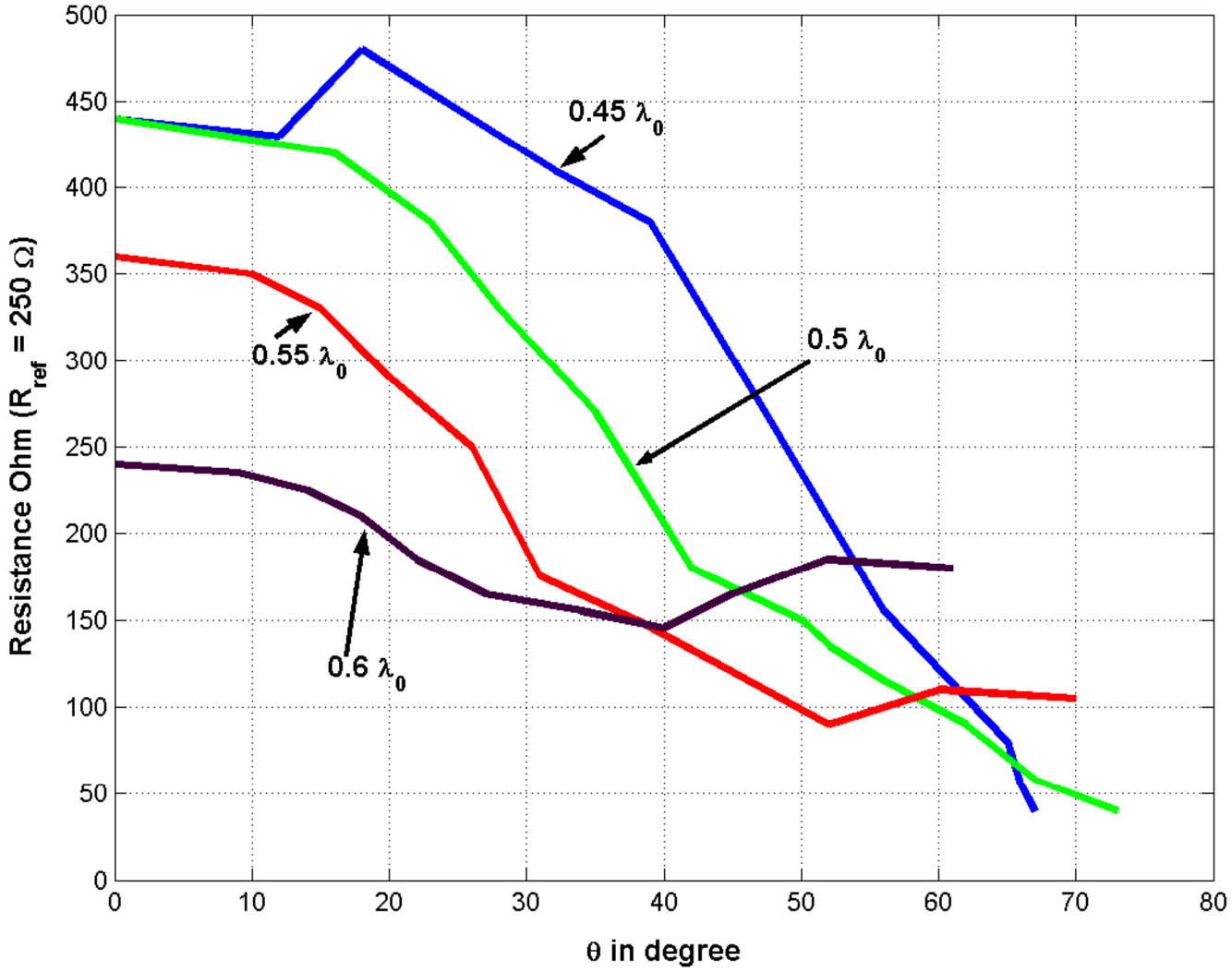
Scan Resistance, E-plane



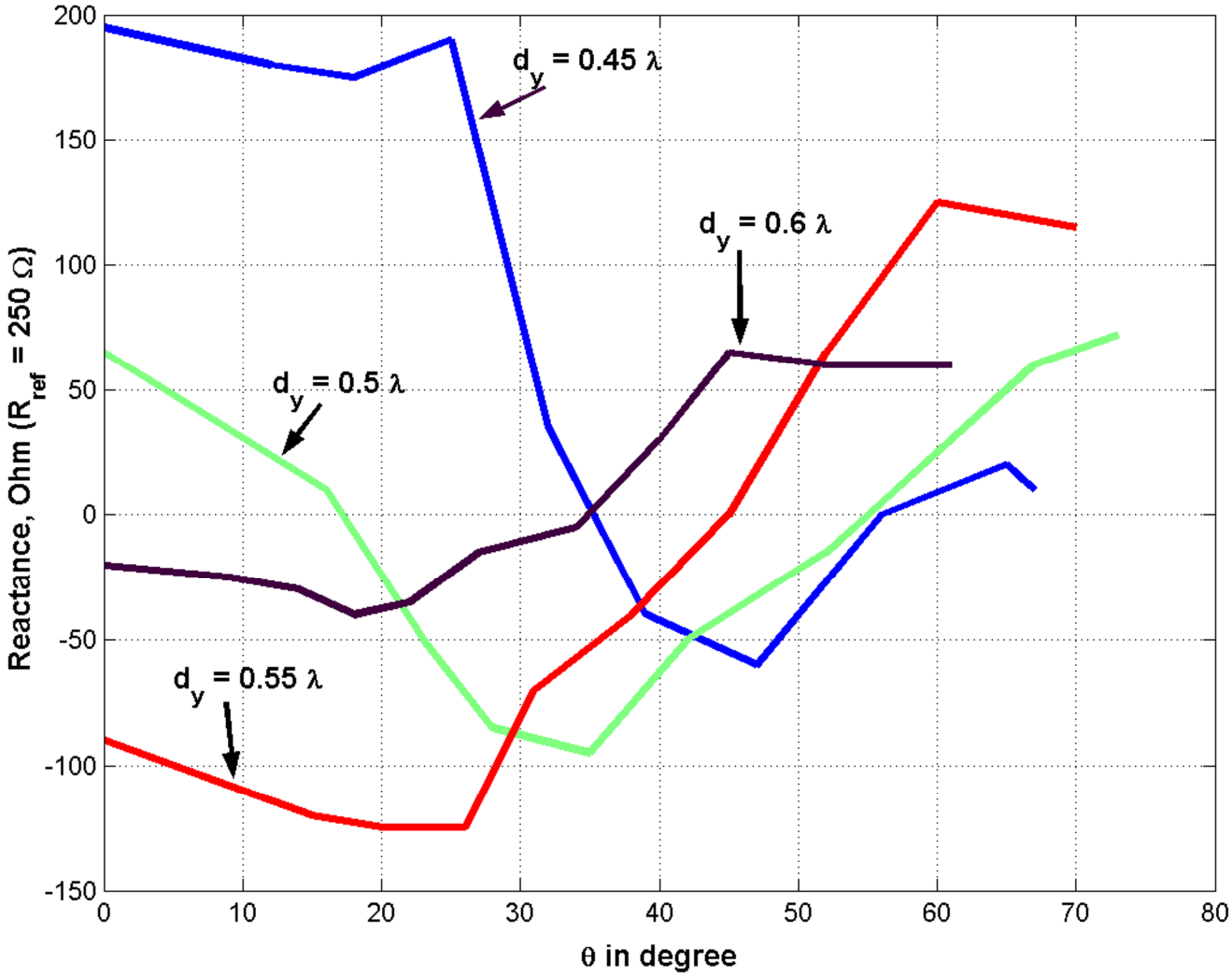
Scan Reactance, E-plane



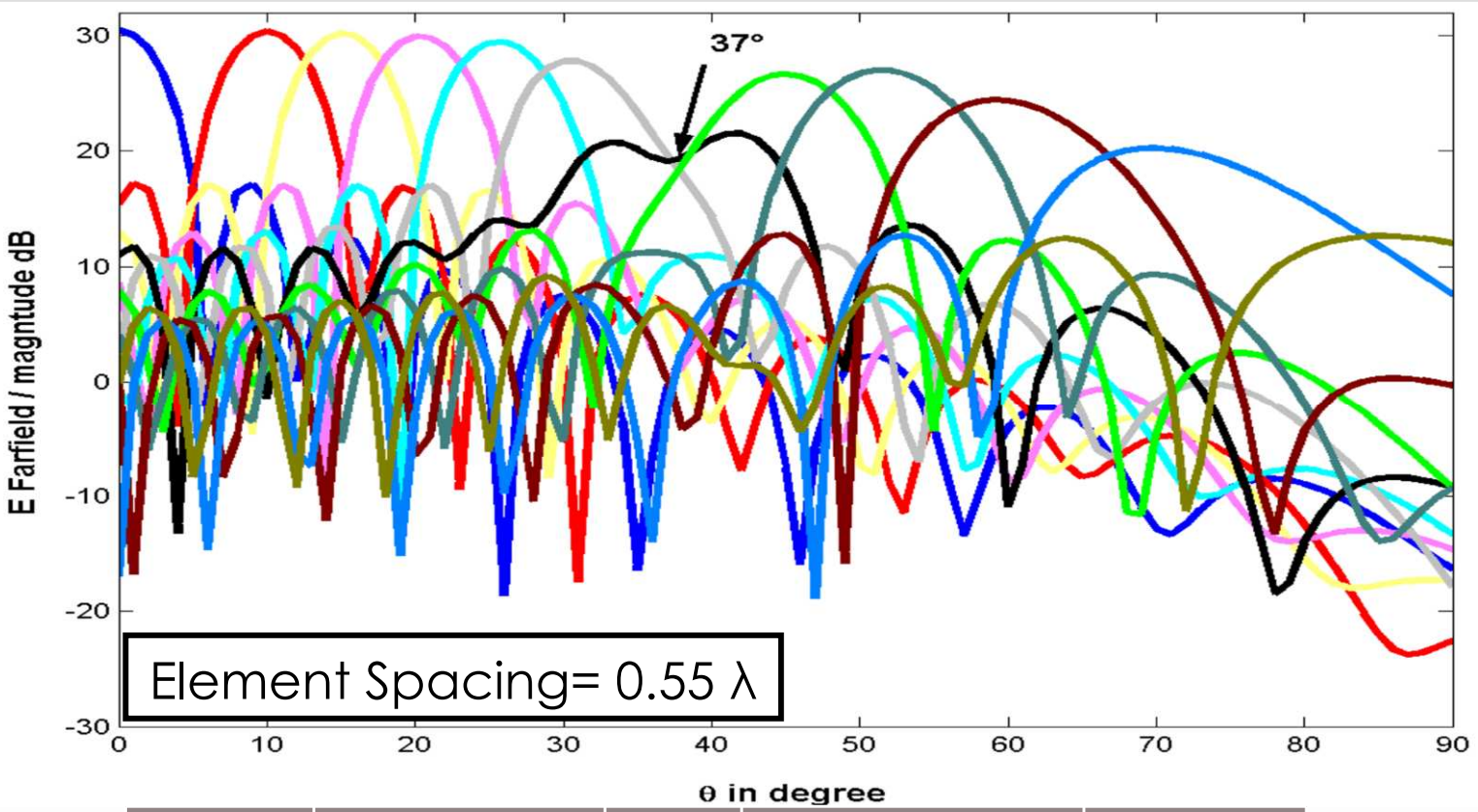
Scan Resistance, H-plane



Scan Reactance, H-plane



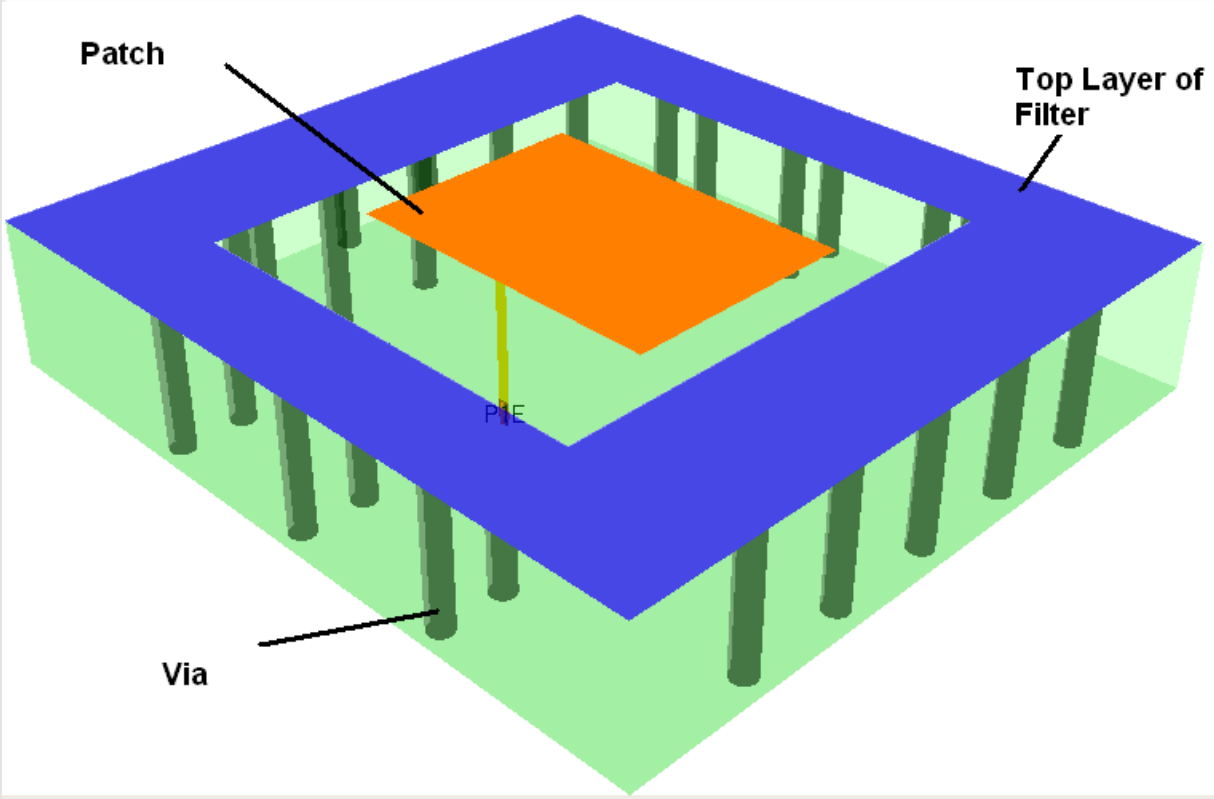
E-plane Farfield and Comparison



Spacing	Surface Wave	SEP	Scan Impedance	β effective
0.5λ	50	52	53	51
0.55λ	35	37	37	37
0.6λ	25	27	28	26.5

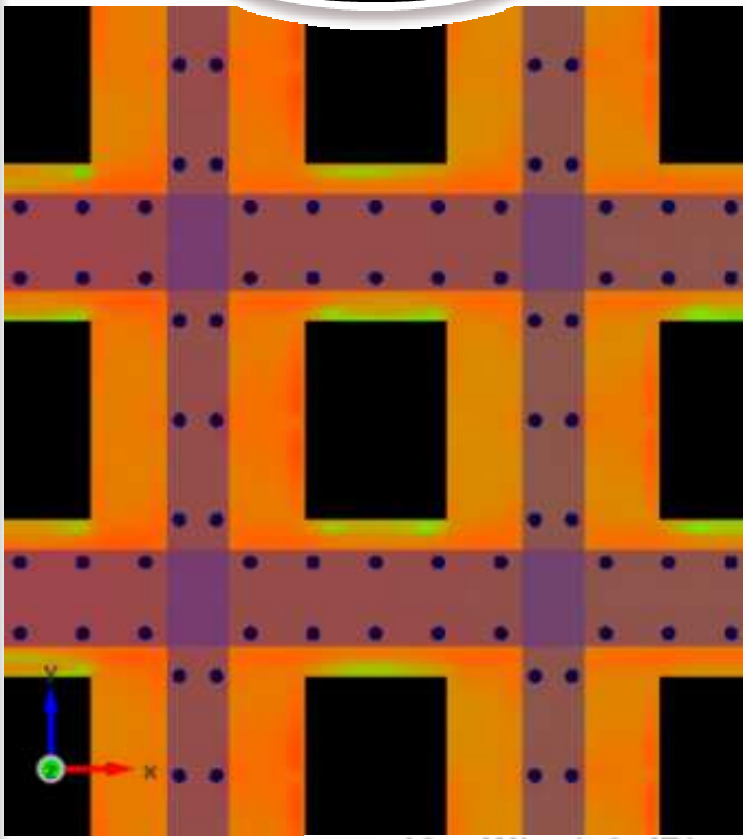
Blindness Control

Surface Wave Suppression → Perturbing and PBG Idea → Electrical Wall + Via



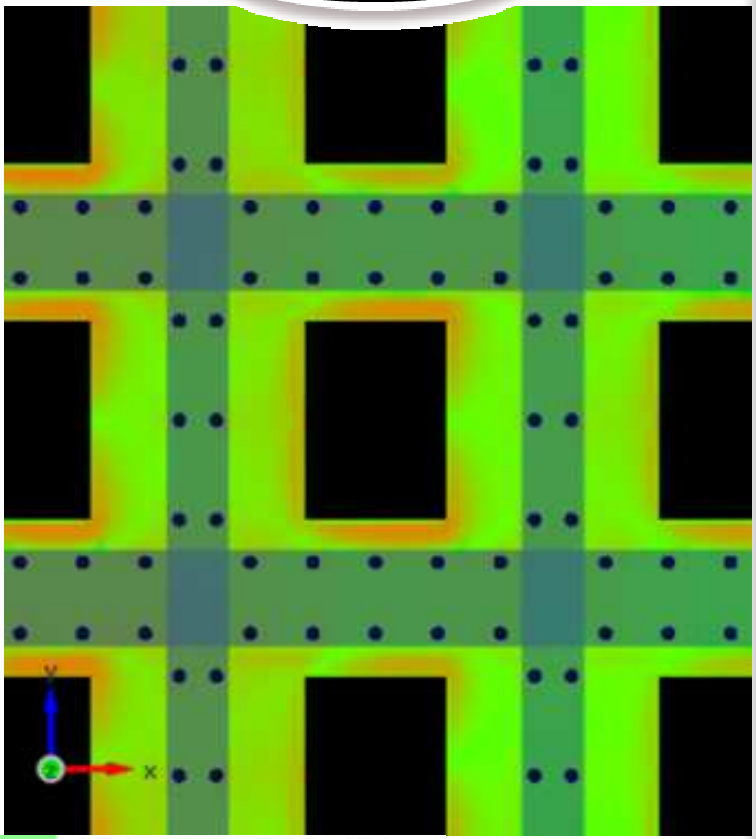
Wall's Functionality

18 GHz



10 mW/m (+0 dB)
1.996 mW/m (-7 dB)
398 uW/m (-14 dB)
79.44 uW/m (-14 dB)
15.84 uw/m (-28 dB)
3.162 uw/m (-35 dB)

24 GHz

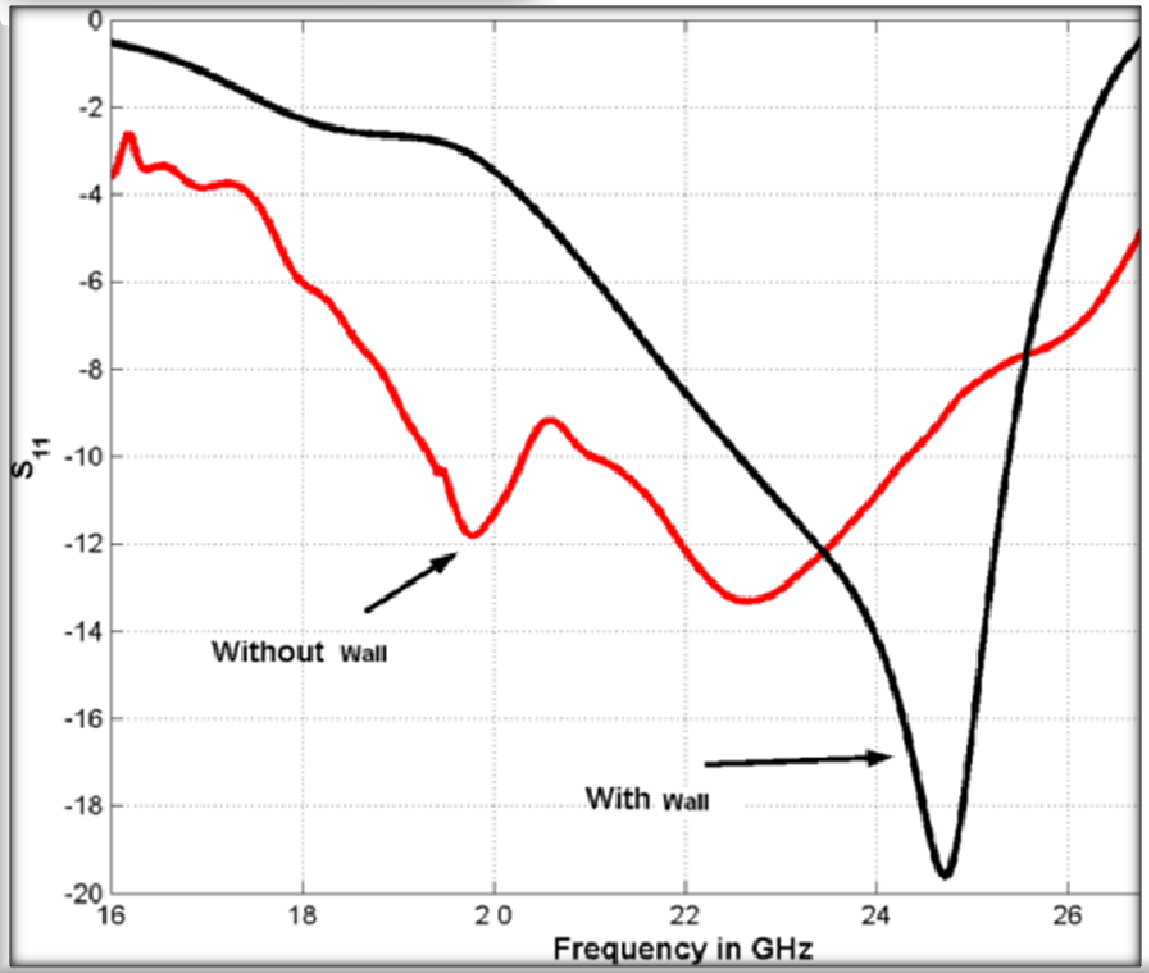


631 nw/m (-42 dB)
125.8 nW/m (-42 dB)
25.12 nW/m (-56 dB)
5.012 nW/m (-63 dB)
1000 pW/m (-70 dB)

Effect of Wall on Resonant Frequency

Near Field Interference

Frequency Up-shift → ***Single Element Tuning***

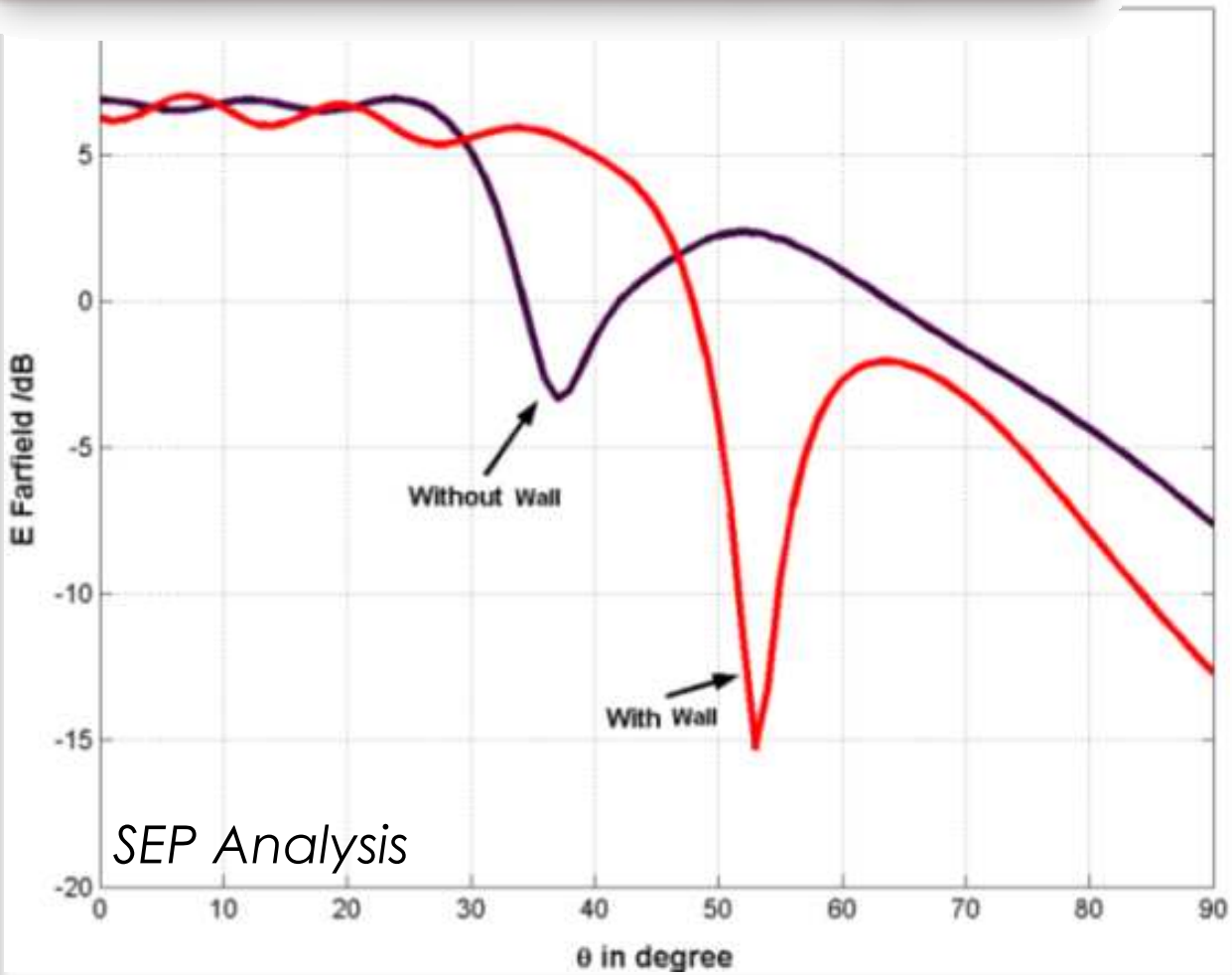


Match Improvement from Suppressed Surface Wave

Wall Effect on Blindness

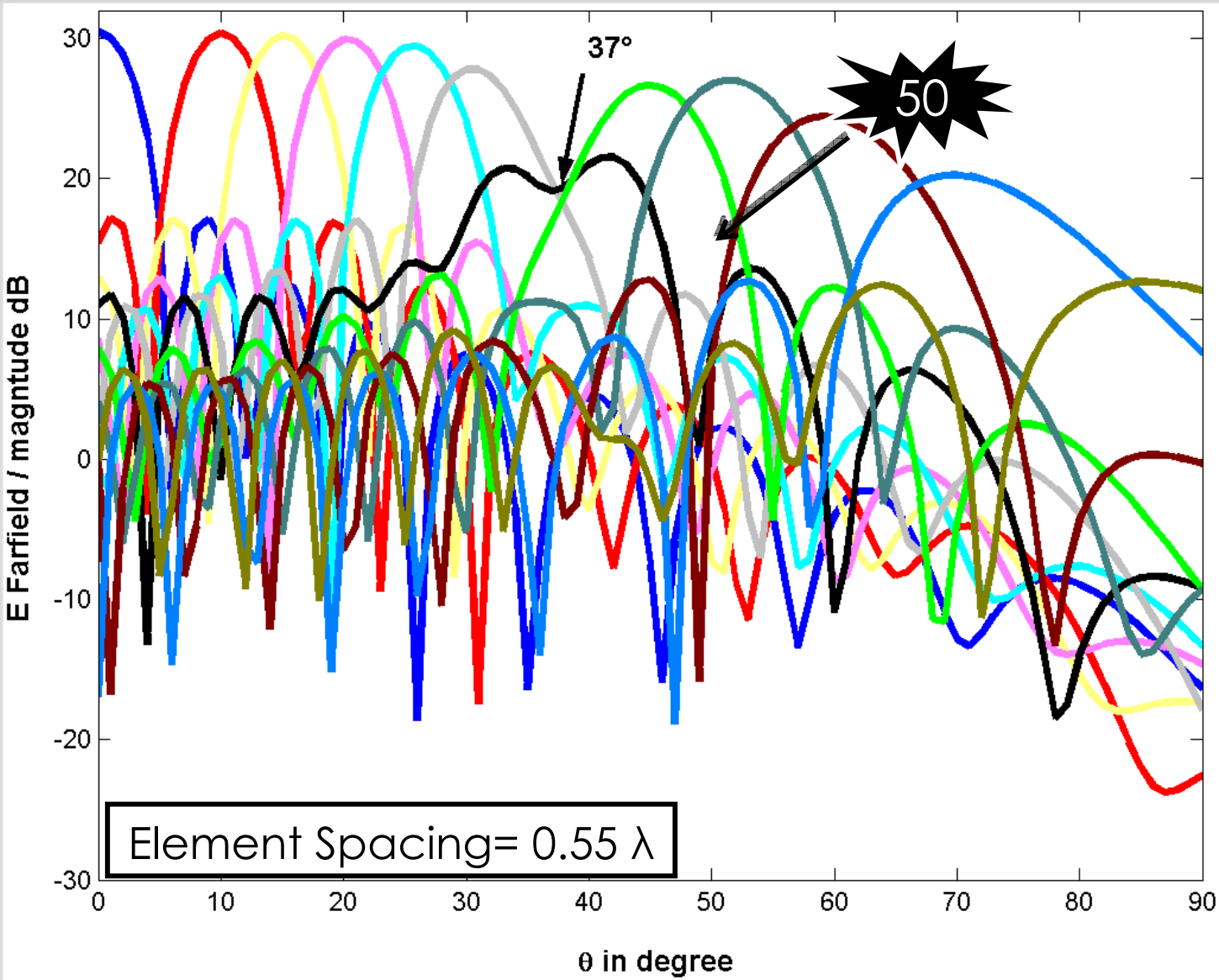
Element Spacing= 0.55 λ → ***Grating Lobe at 55***

Blind spot is moved toward grating lobe. → ***β close to 1***



Surface Wave is Suppressed

Farfield Comparison



Waveguide Simulator

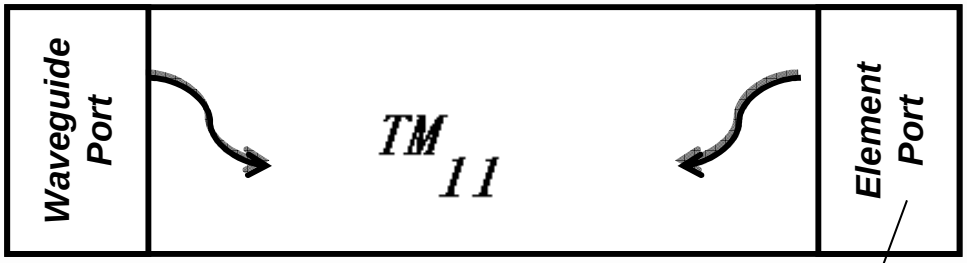
Waveguide Mode

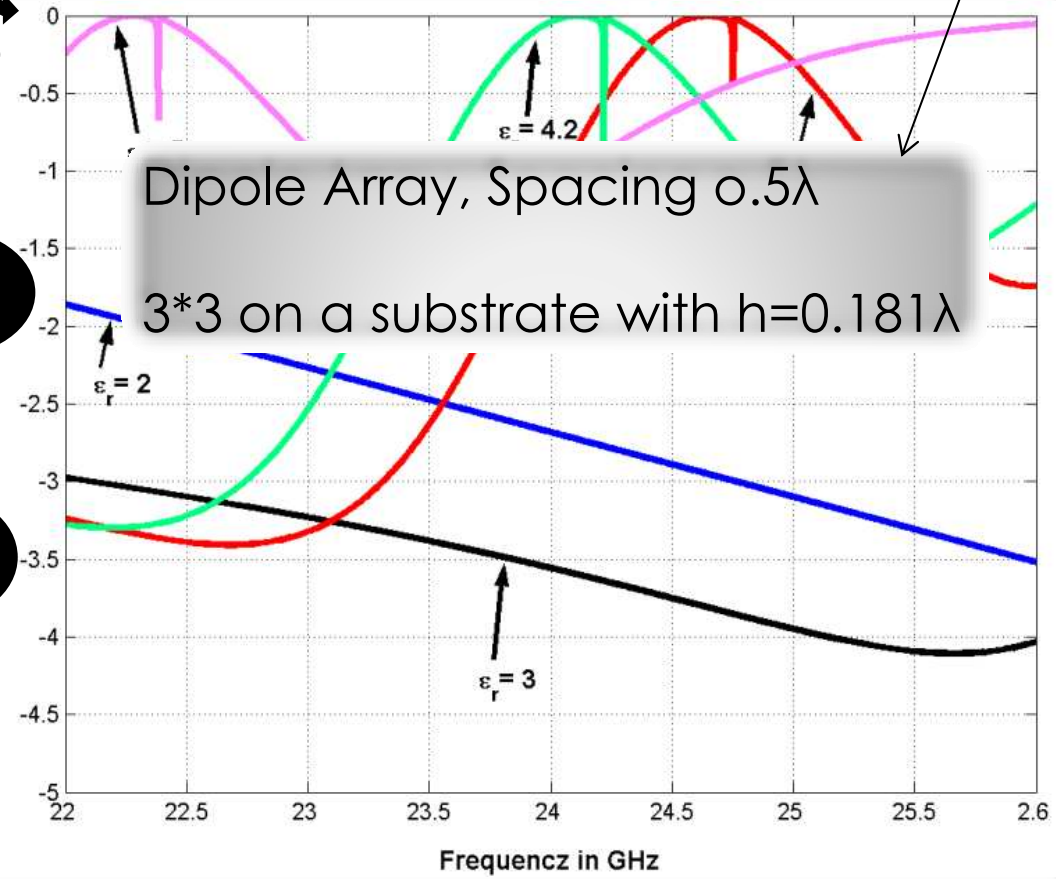
Plane Wave with Specific Angle — 28°

One Polarization — E-plane

One Frequency — 24 GHz

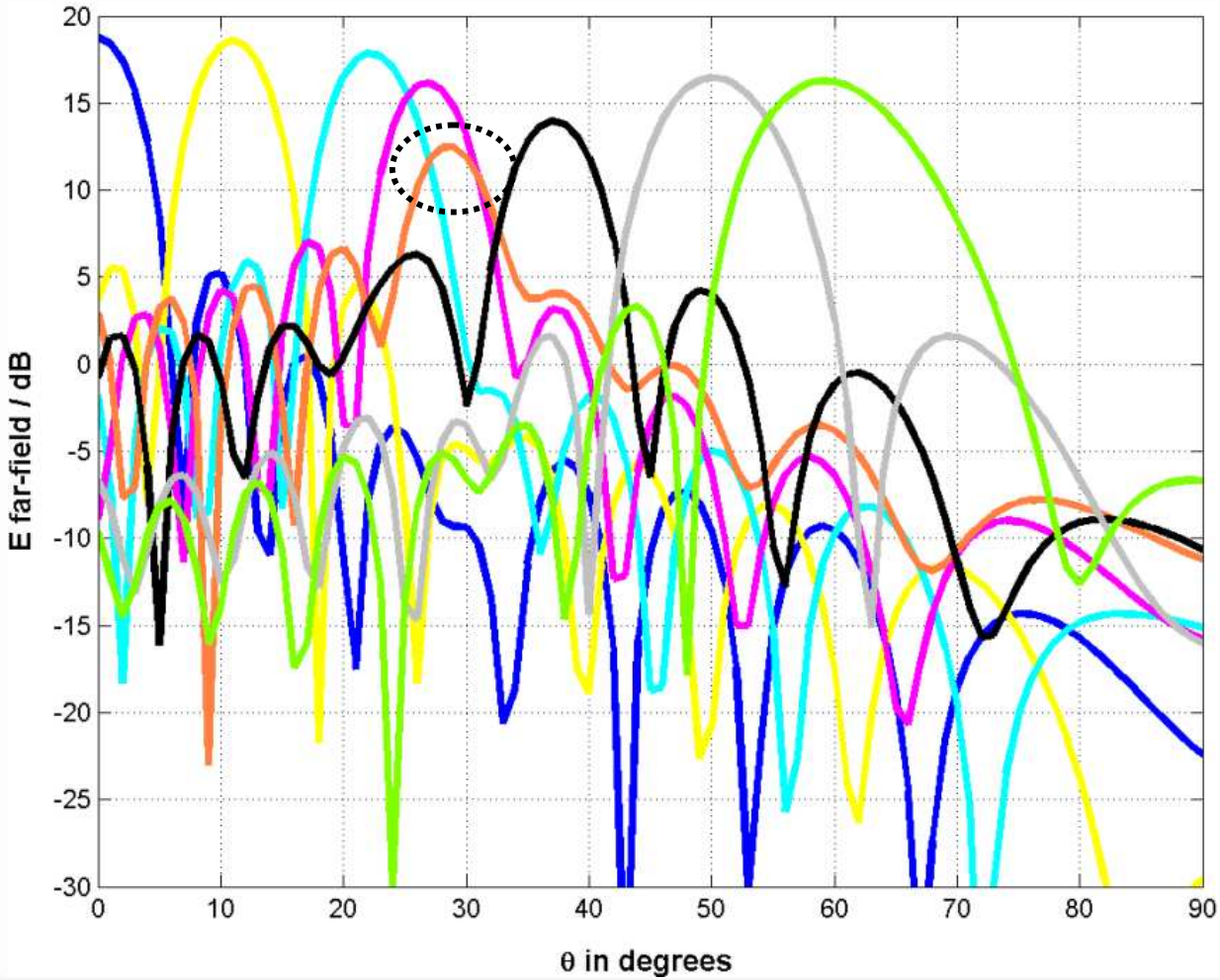
Null Positions, Array Symmetry Plane





Farfield

Farfield pattern of a 1inear array of 17 dipoles on a substrate with ε=4.2 from Scan Impedance Method



Conclusion and Future Work

- *Blindness prediction for dipoles and patches*
- *New method based on β calculations*
- *Blindness control*
- *Waveguide simulation as comparison*
- *β calculations for other single elements*
- *Optimized feeding network*
- *Another suppressing structures*

Thank you for your attention!

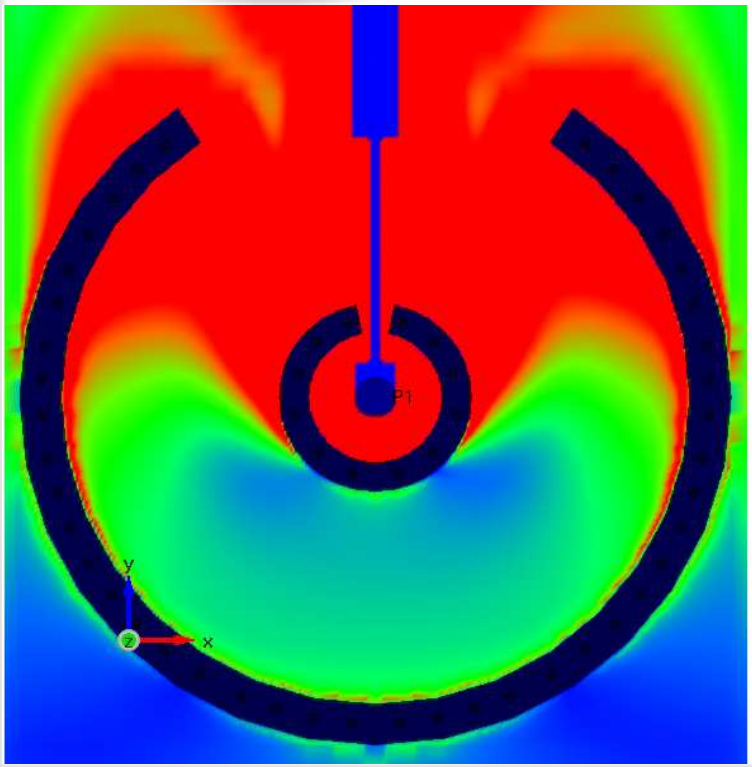
Patch Serial Feeding

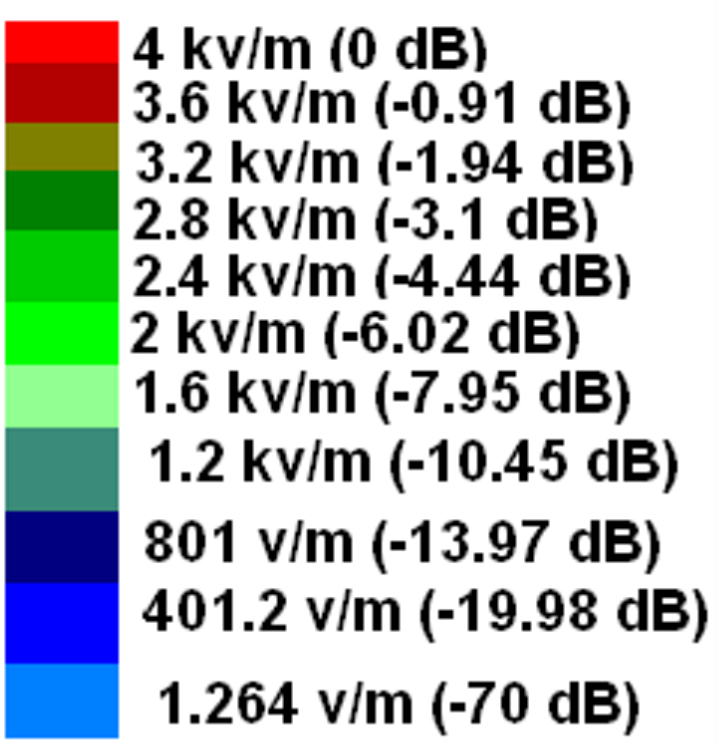
Why?

- Simple Feeding Network
- Easy to introduce phase shifters

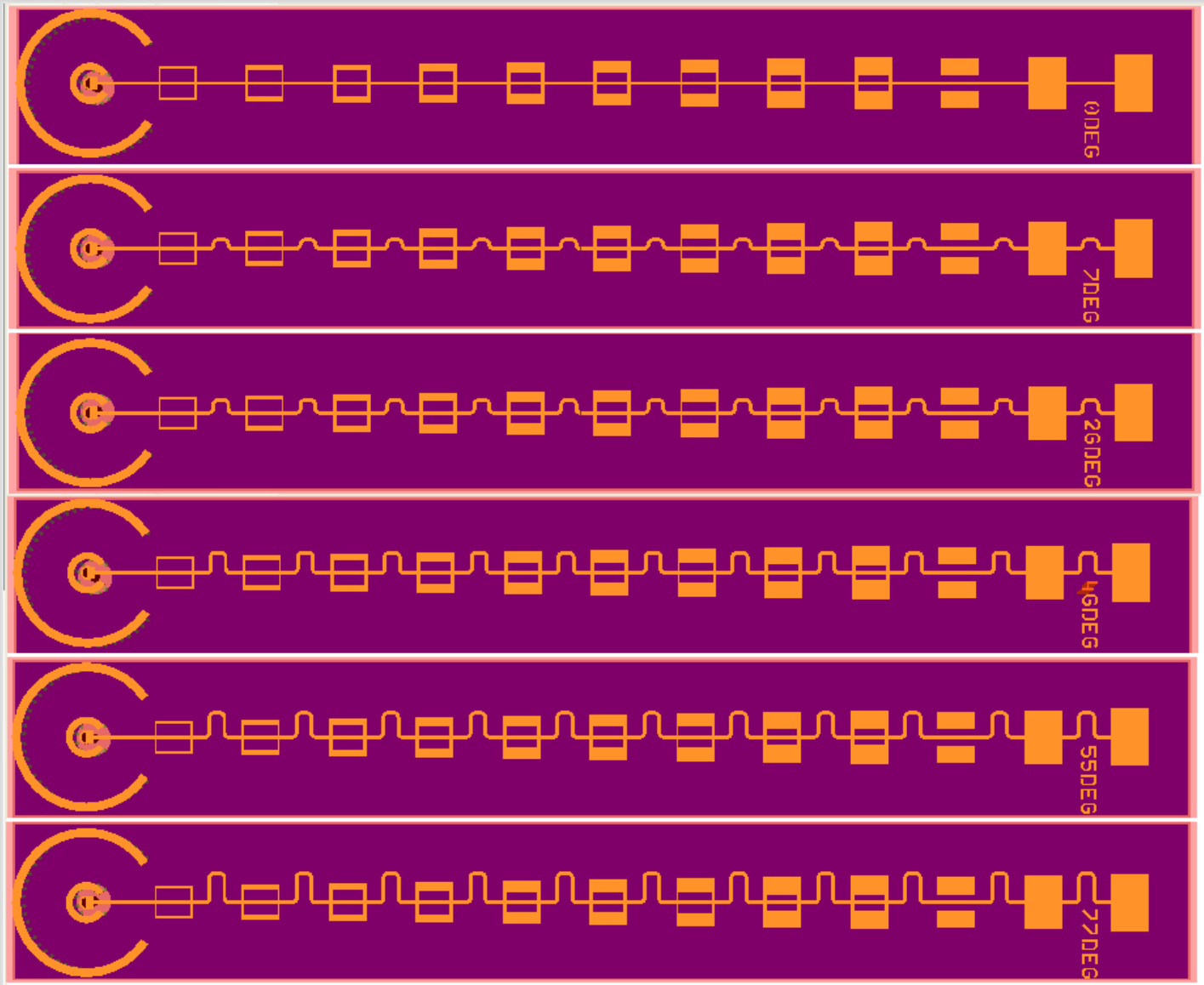
Disadvantages

- Pin's Spurious Radiation
- Amplitude Distribution





Amplitude Distribution and Layout



Farfield of Series Patches