Investigation Patch Array Antenna Pattern Degradation

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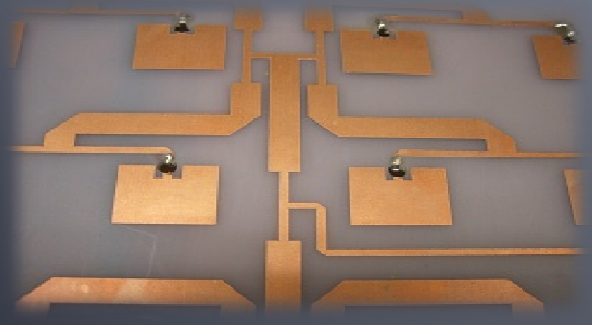

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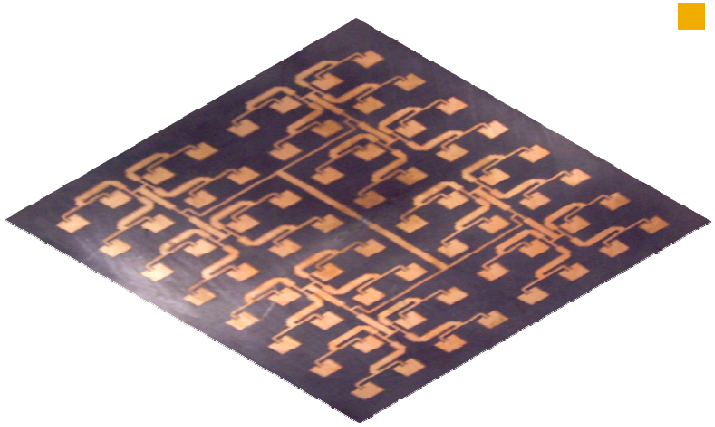
Motivation

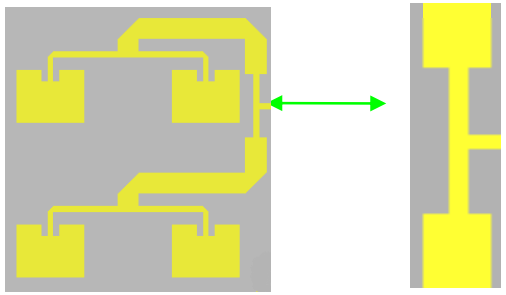


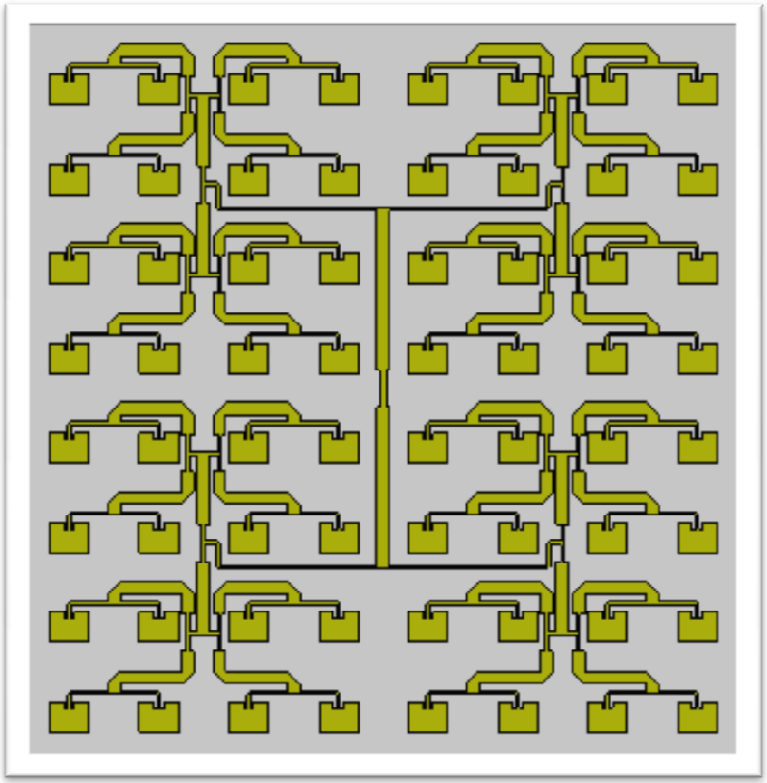
- Investigation of spurious network radiation and element excitation errors as the sources of pattern degradation

Outline

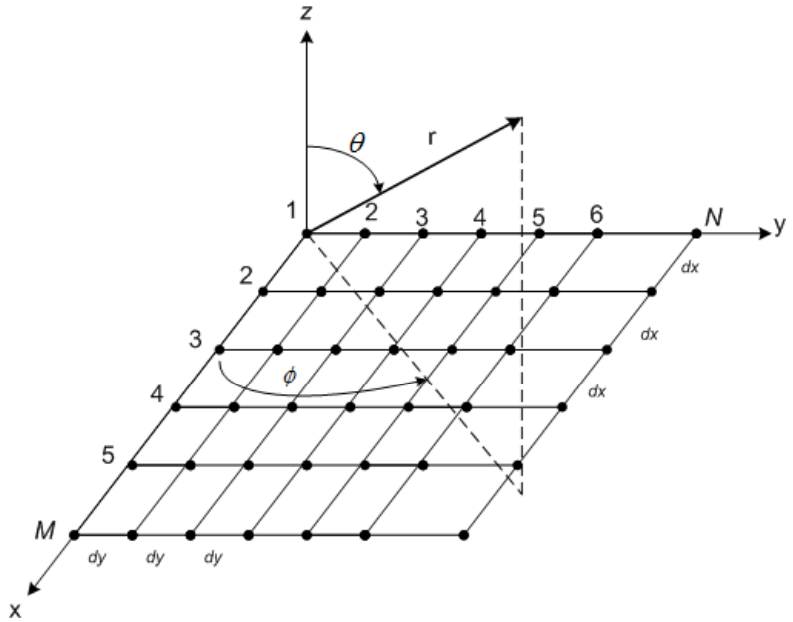
- Design of 8 x 8 Planar Array Antenna
- Investigation of Spurious Feed Network Radiation
- Investigation of Element Excitation Errors
- Pattern Improvement

Design of 8 X 8 Planar Array Antenna





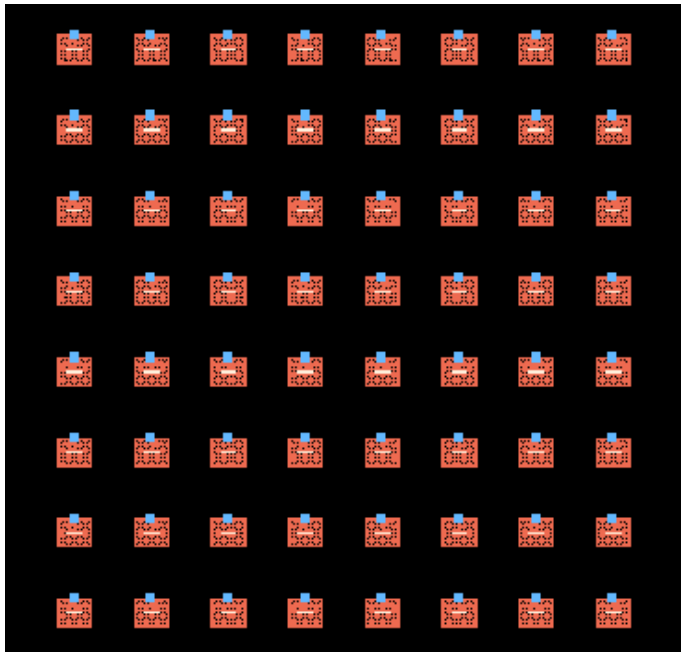
Planar Array, Uniform Distribution



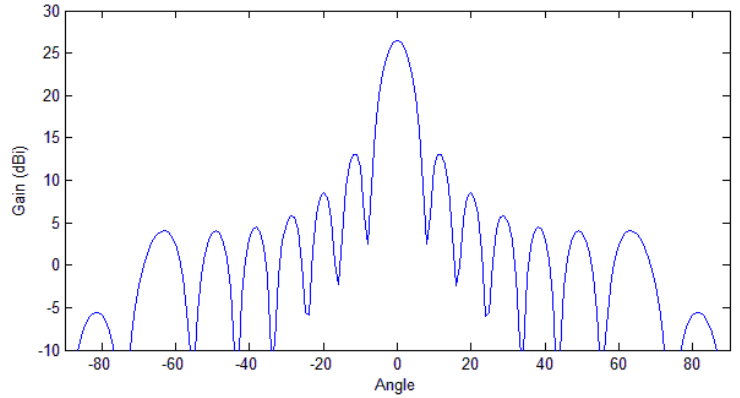
***E**(total) = [**E**(single elements at reference point)] x [array factor]*

$$AF = \sum_{n=1}^{N} I_{1n} \left[\sum_{m=1}^{M} I_{m1} e^{j(m-1)(kd_x \sin\theta \ \cos\phi + \beta_x)} \right] e^{j(n-1)(kd_y \sin\theta \ \sin\phi + \beta_y)}$$

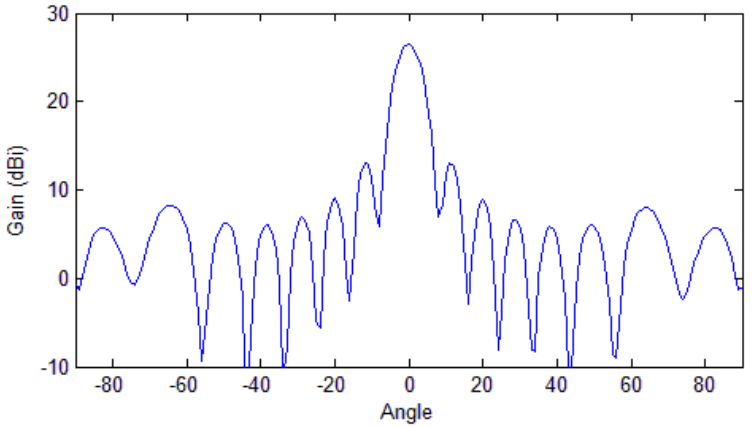
Planar Array, Uniform Distribution



- Uniform amplitude and phase
- 13 dB first side lobe level below the main lobe
- Symmetrical radiation pattern



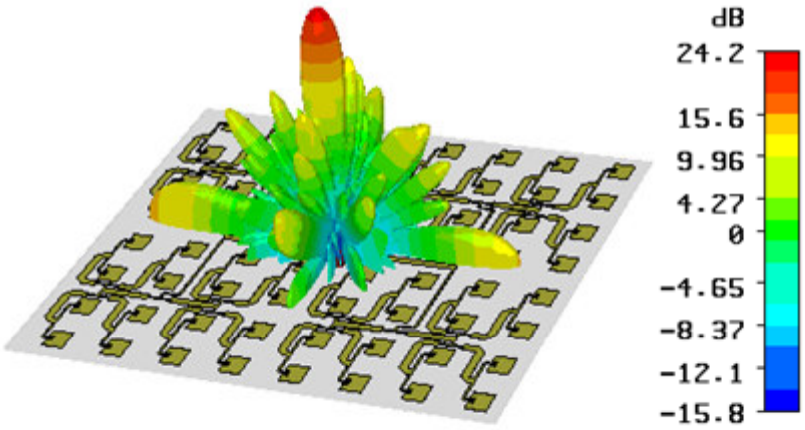
H-Plane



E-Plane

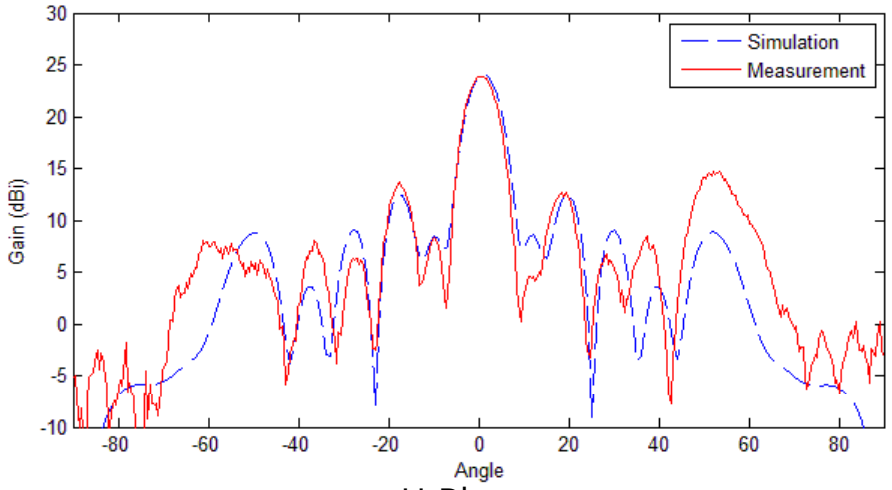
Radiation pattern of antenna without feed network, uniform distribution, simulated in ADS

Antenna Simulation and Measurement

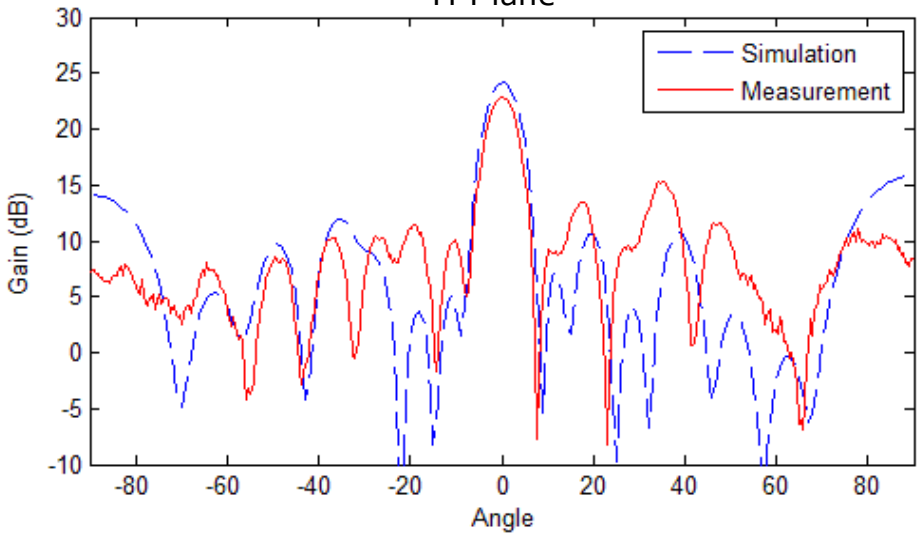


Patch Array Antenna, modeled in CST Microwave Studio
Substrate: RT Duroid 5880 , 0.5 mm

Pattern degradation
- Side lobe level -11 dB
- Non-symmetrical
- Irregular side lobe

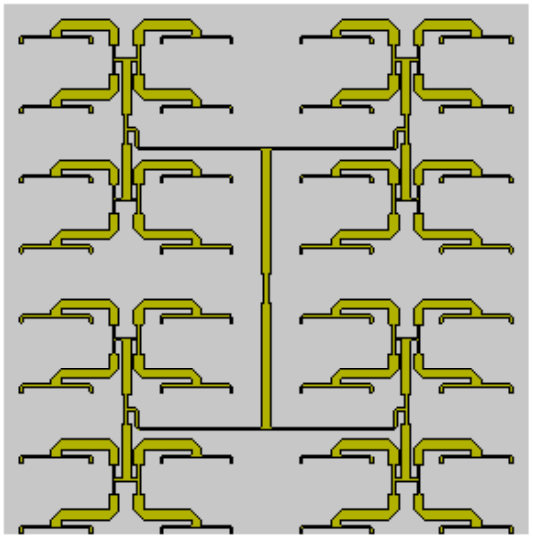


H-Plane

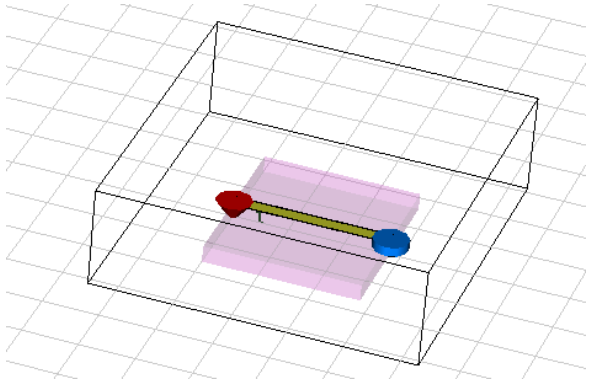


E-Plane

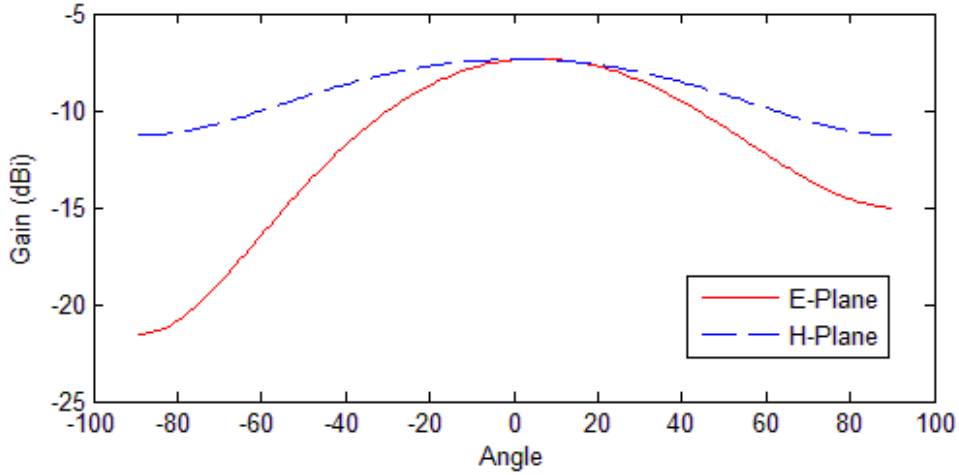
Spurious Radiation of Feed Network



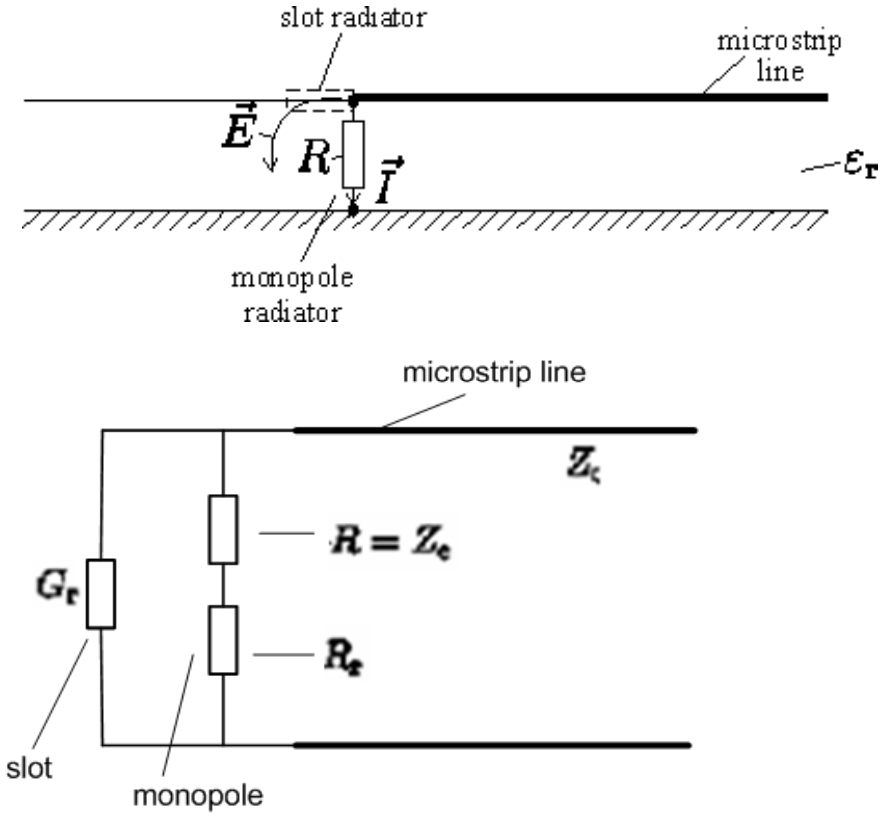
Antenna feed network



Half wavelength microstrip, modeled in CST Microwave Studio

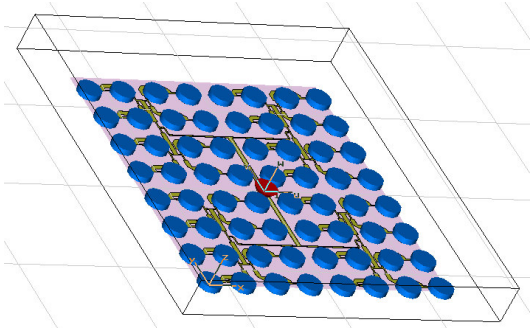


Spurious Radiation of Feed Network

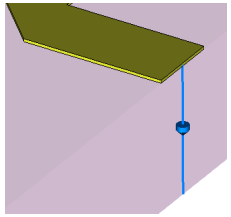


Concept of radiation source of discrete resistance termination

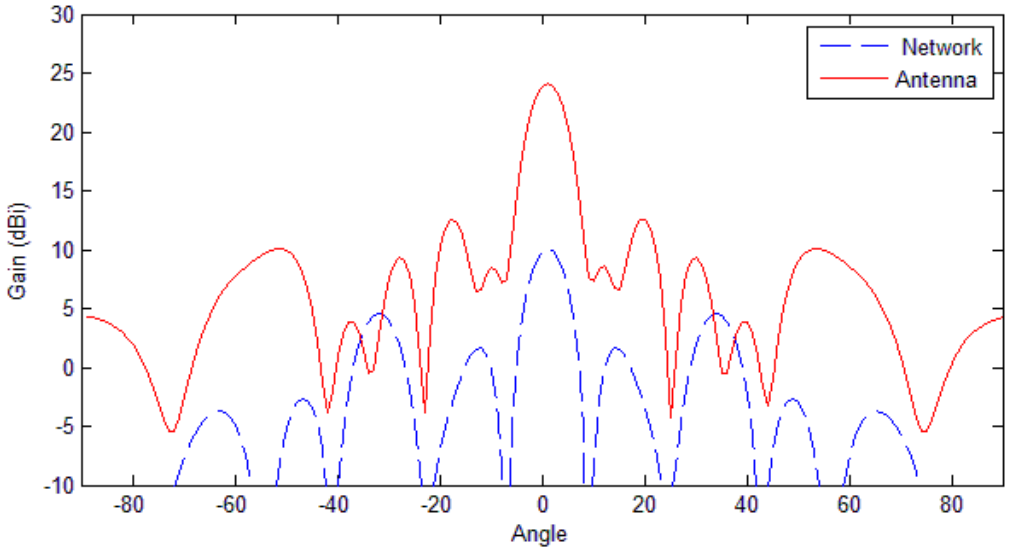
Spurious Radiation of Feed Network



Feed network terminated by resistance, modeled in CST Microwave Studio

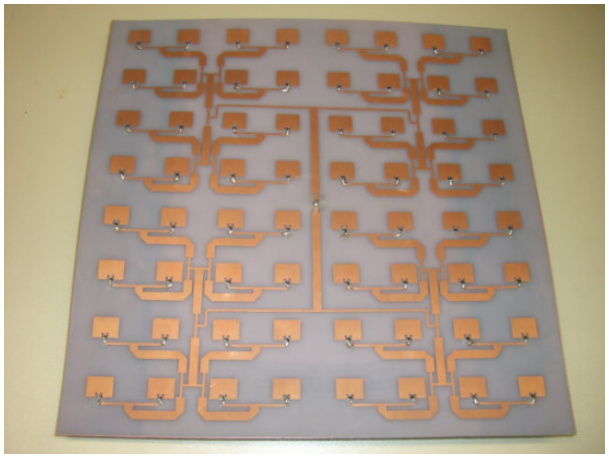


Blow up network terminated by resistance

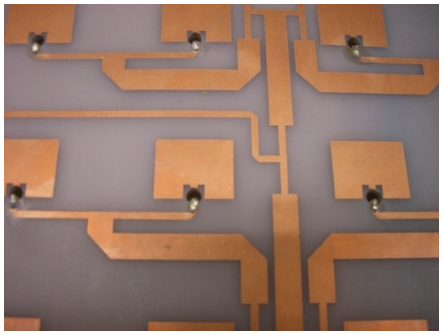


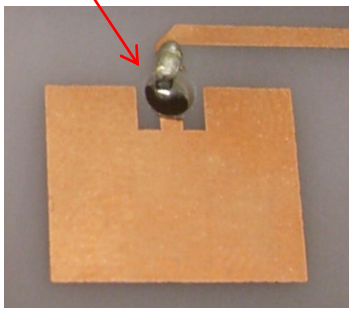
H-Plane radiation pattern of antenna and feed network

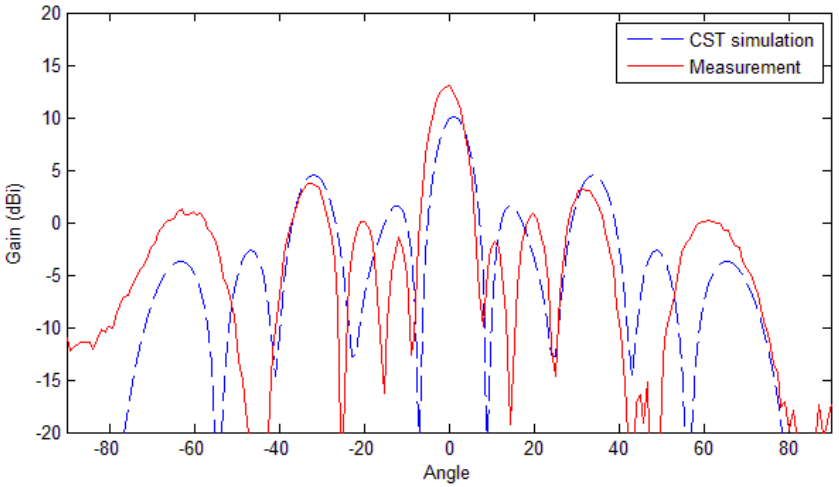
Spurious Radiation of Feed Network

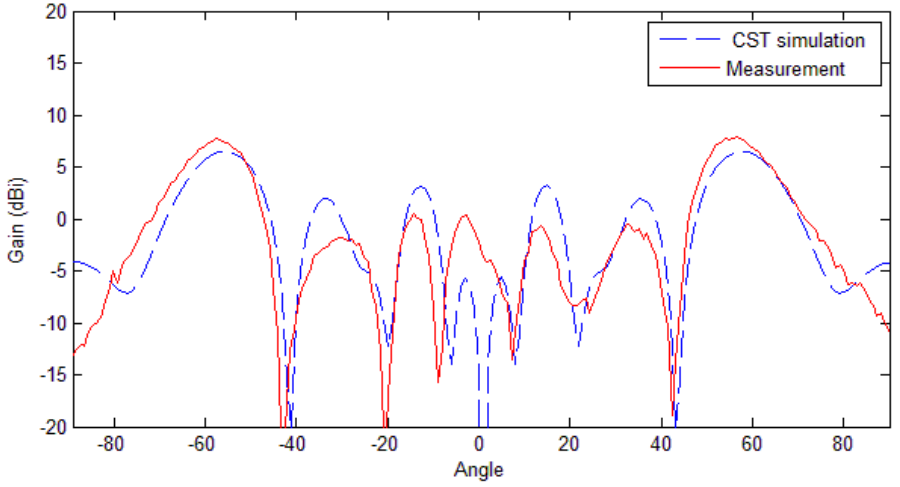


Drilled hole and 100 ohm resistor



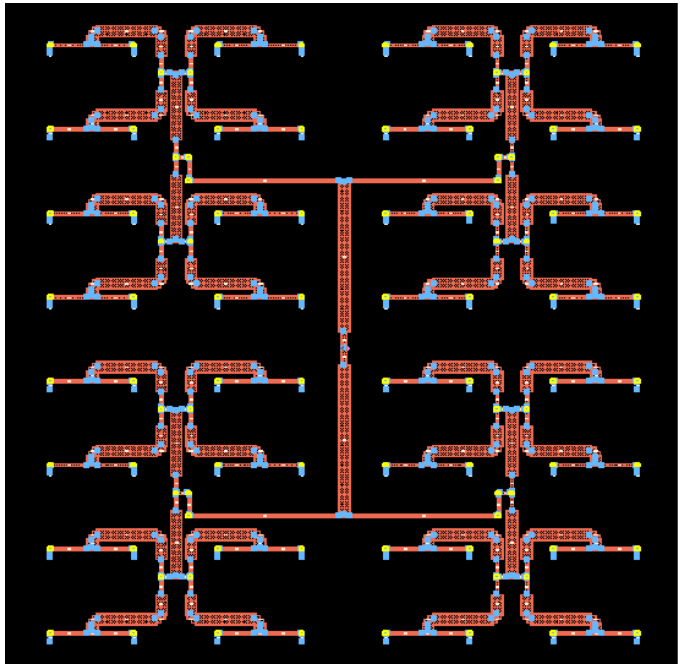




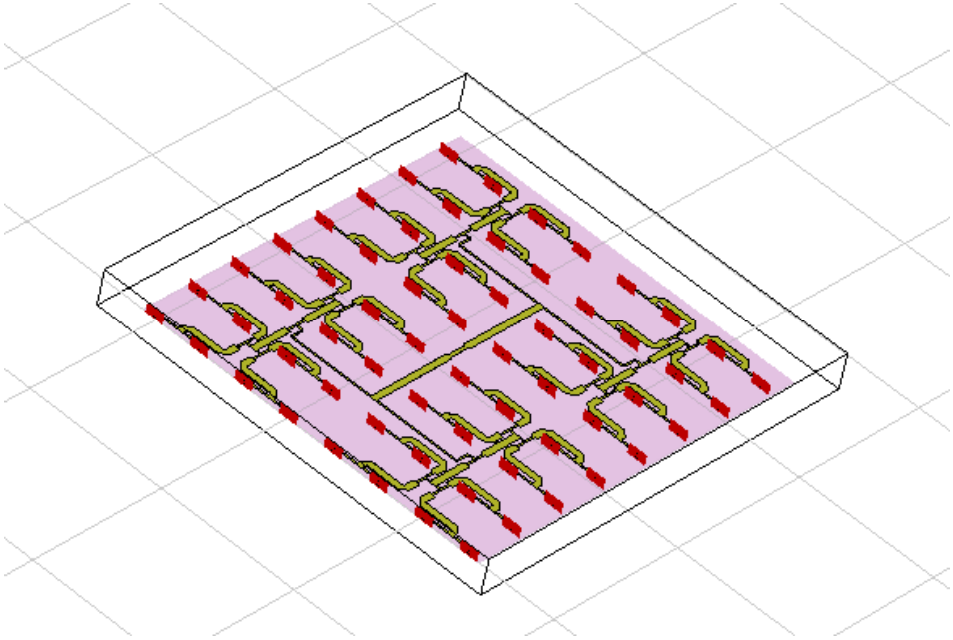


H-Plane co-polarization pattern (left) and cross polarization pattern (right) of the feed network

Element Excitation Errors

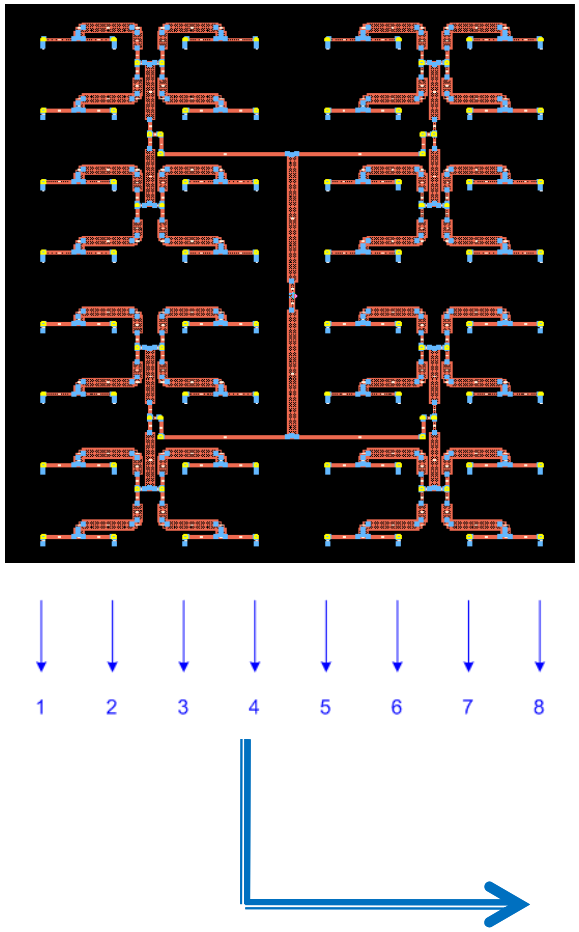


Feed network terminated by 64 ports, modeled in ADS

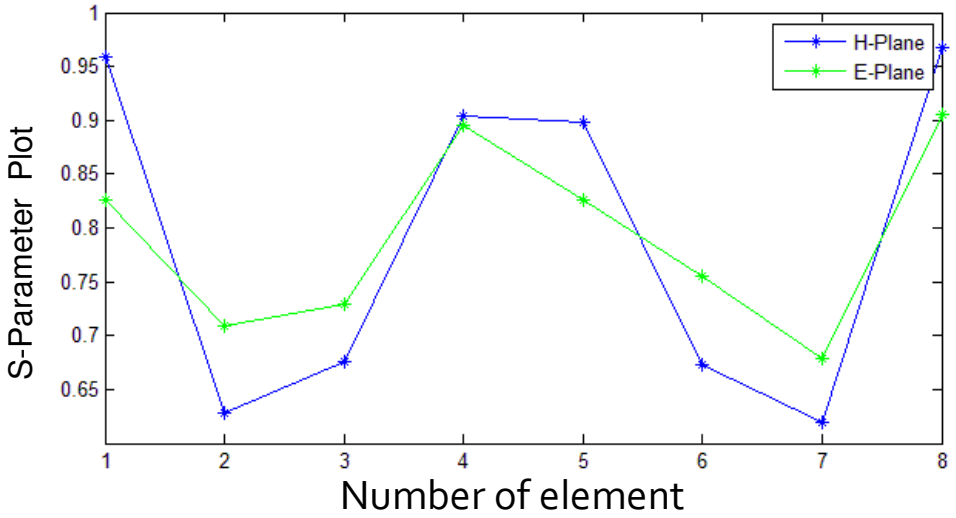


Feed network terminated by 64 ports, modeled in CST Microwave Studio

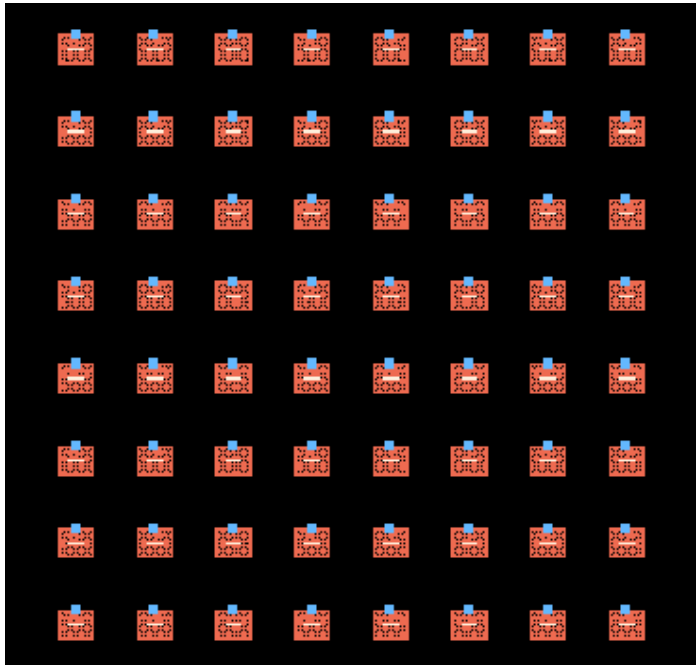
Element Excitation Errors



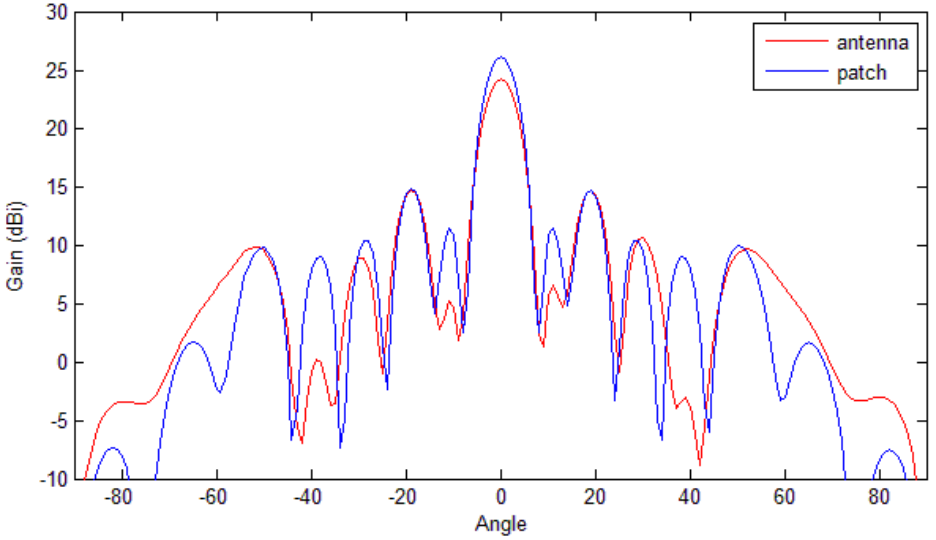
"Collapsed" distribution errors



Element Excitation Errors

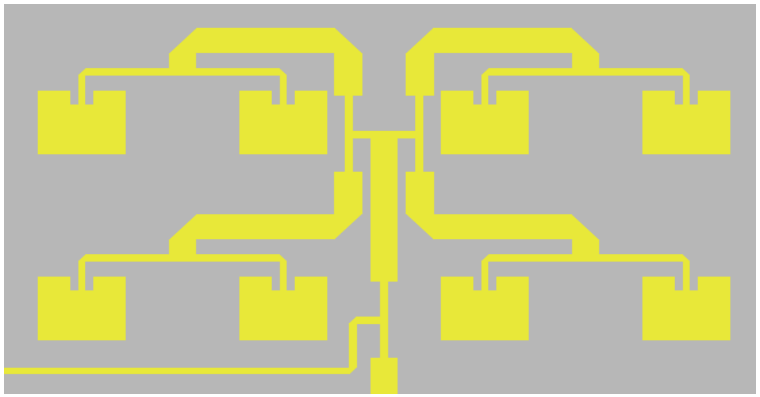


Patch array without feed network, excitation included error,modeled in ADS

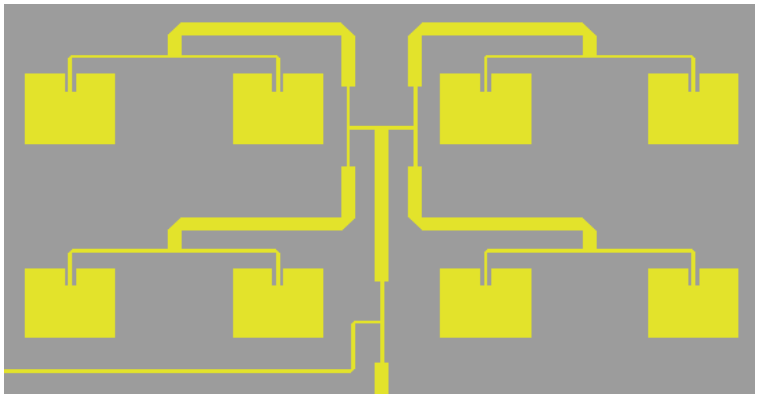


Radiation pattern of the antenna and patch array without feed network

Element Excitation Errors

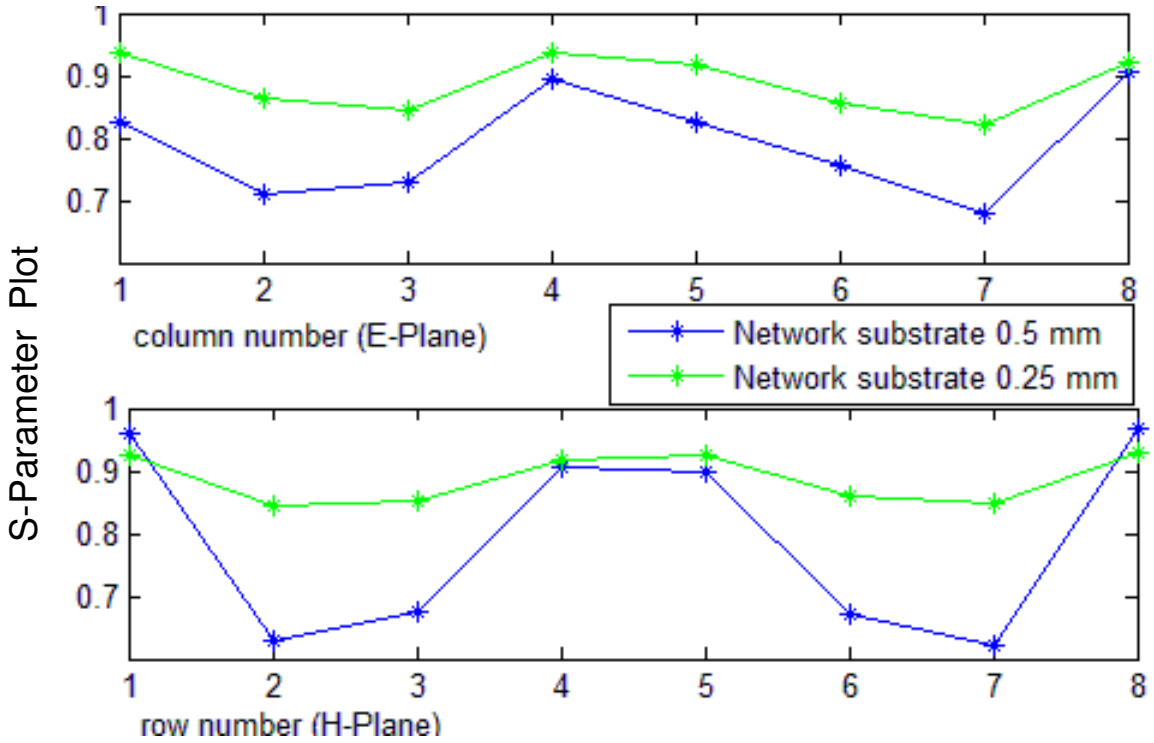


Antenna substrate 0.5 mm



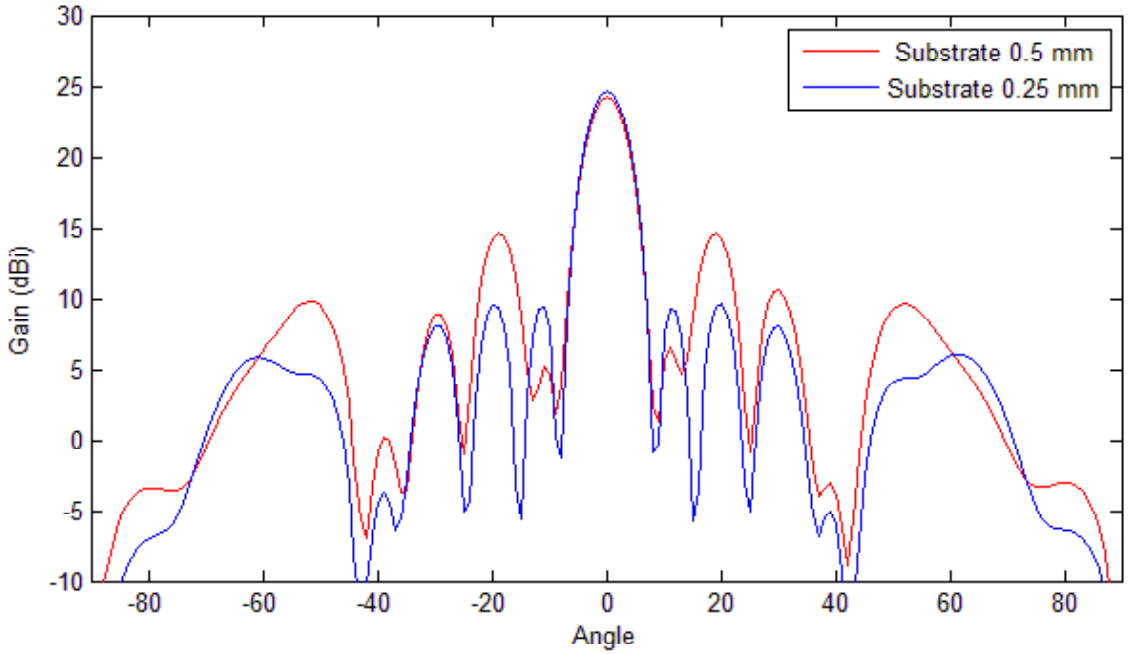
Antenna substrate 0.25 mm

Pattern Improvement



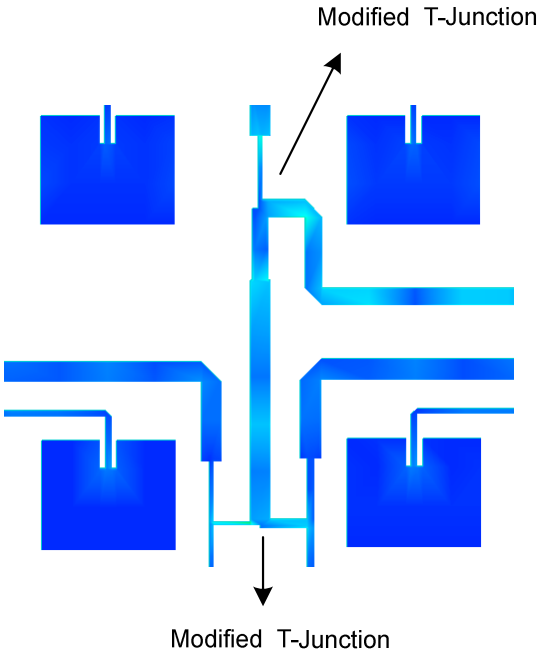
"*Collapsed* " amplitude distribution of the feed network of substrate 0.5 mm and substrate 0.25 mm

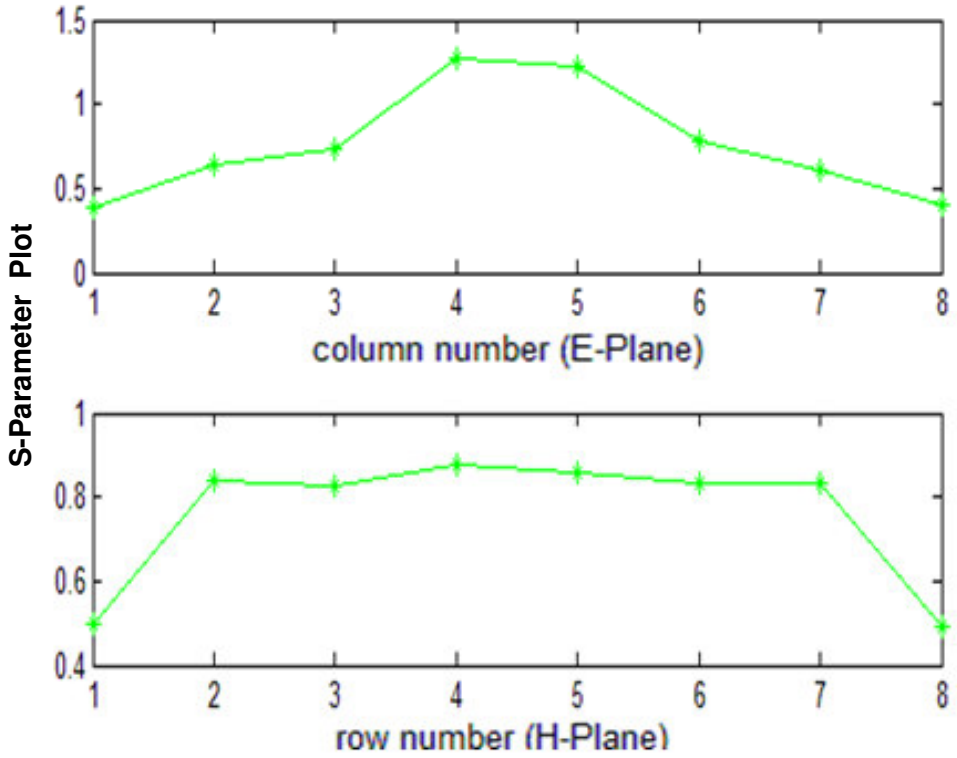
Pattern Improvement



H-Plane radiation pattern of the antenna on substrate 0.5 mm and substrate 0.25 mm

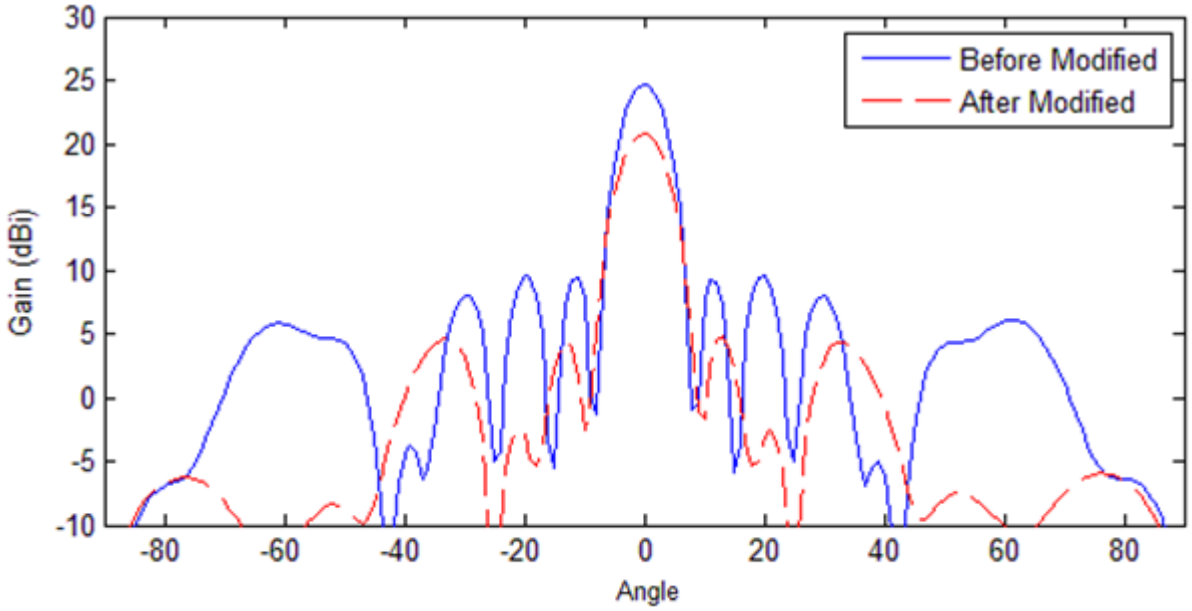
Pattern Improvement





Modification of current distribution

Pattern Improvement



H-Plane radiation pattern of the antenna after modification of current distribution

Conclusion

1. Separation of the major sources of pattern degradation :
   - Element excitation errors (more dominant in our case).
   - Spurious radiation from the feed network .
2. Improvement,verified with simulations and experiments , can be done by:
   - Reduction of line width.
   - Reduction of substrate thickness.

" *To be the best scientist, let us focus our attention like radiation of high gain antenna* "

Thank you

12nd March 2008
Hamburg, Germany