Arrow Patch-Slot Antenna for 5G Lower Frequency Band Communications

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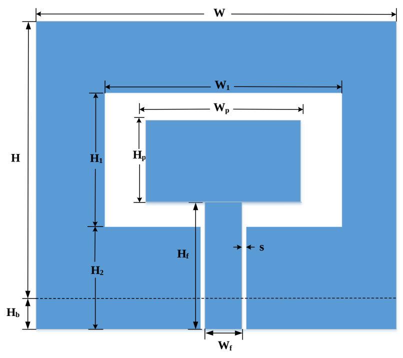
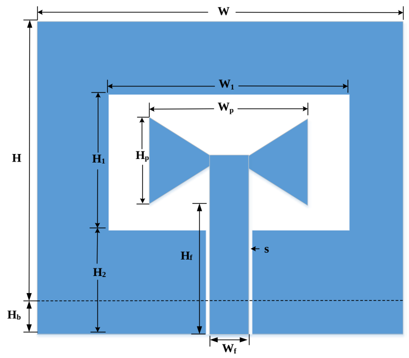
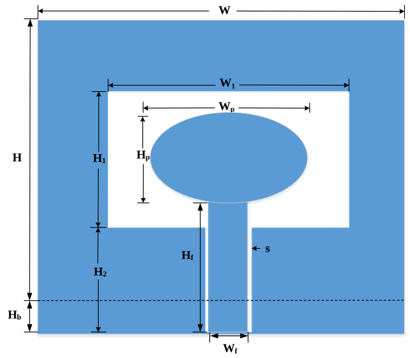
Single Element Design



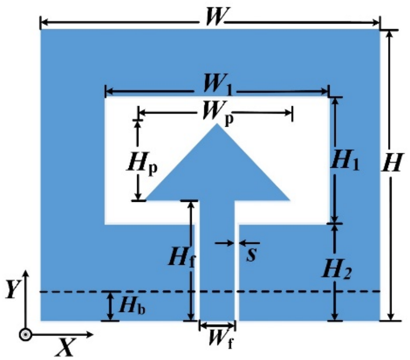
- (a) Rectangle Patch Single Element



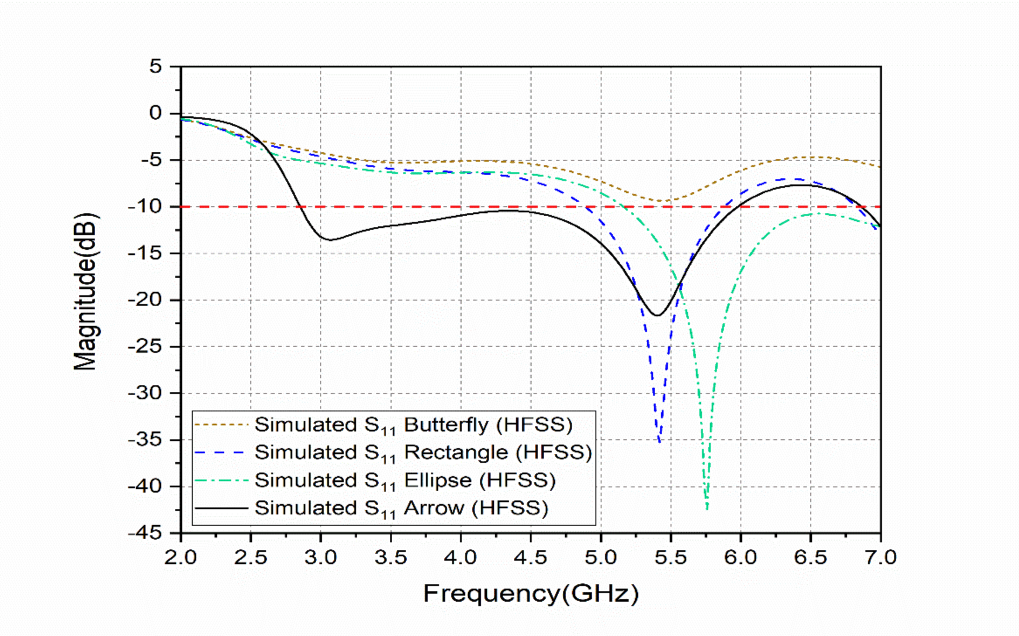
- (b) Butterfly Patch Single Element



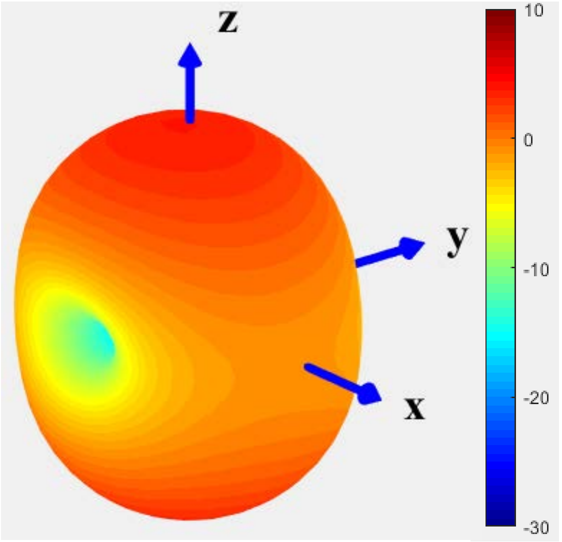
- (c) Ellipse Patch Single Element



- (d) Arrow Patch Single Element



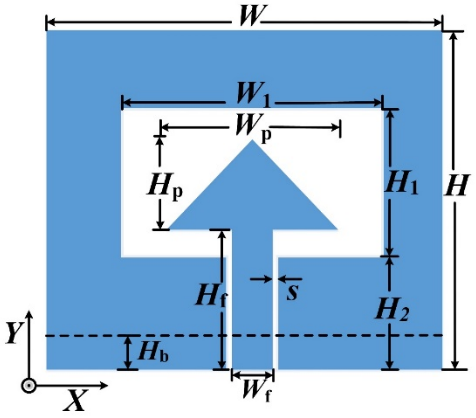
(e) S Parameter of 4 Structures Patch Single Element.



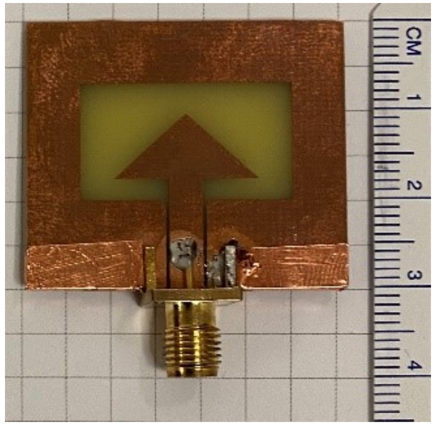
(f) Radiation Pattern at 3.7 GHz

The FCC's proposed US 5G spectrum is divided into three parts: Low-band, Mid-band and High-band, our antenna is also designed for these two low frequency bands the 3.55-3.7 GHz and 3.7- 4.2 GHz.

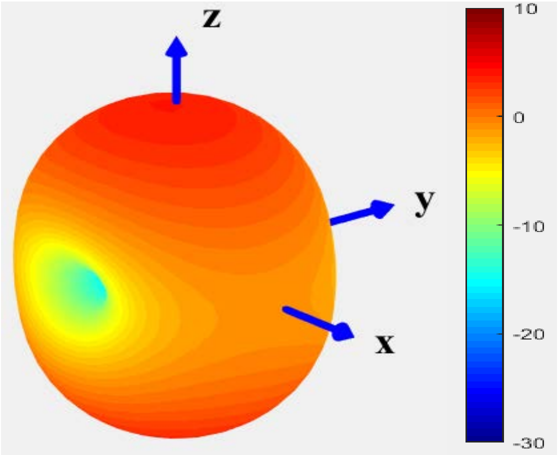
Single Element Antenna Simulation & Measured Result



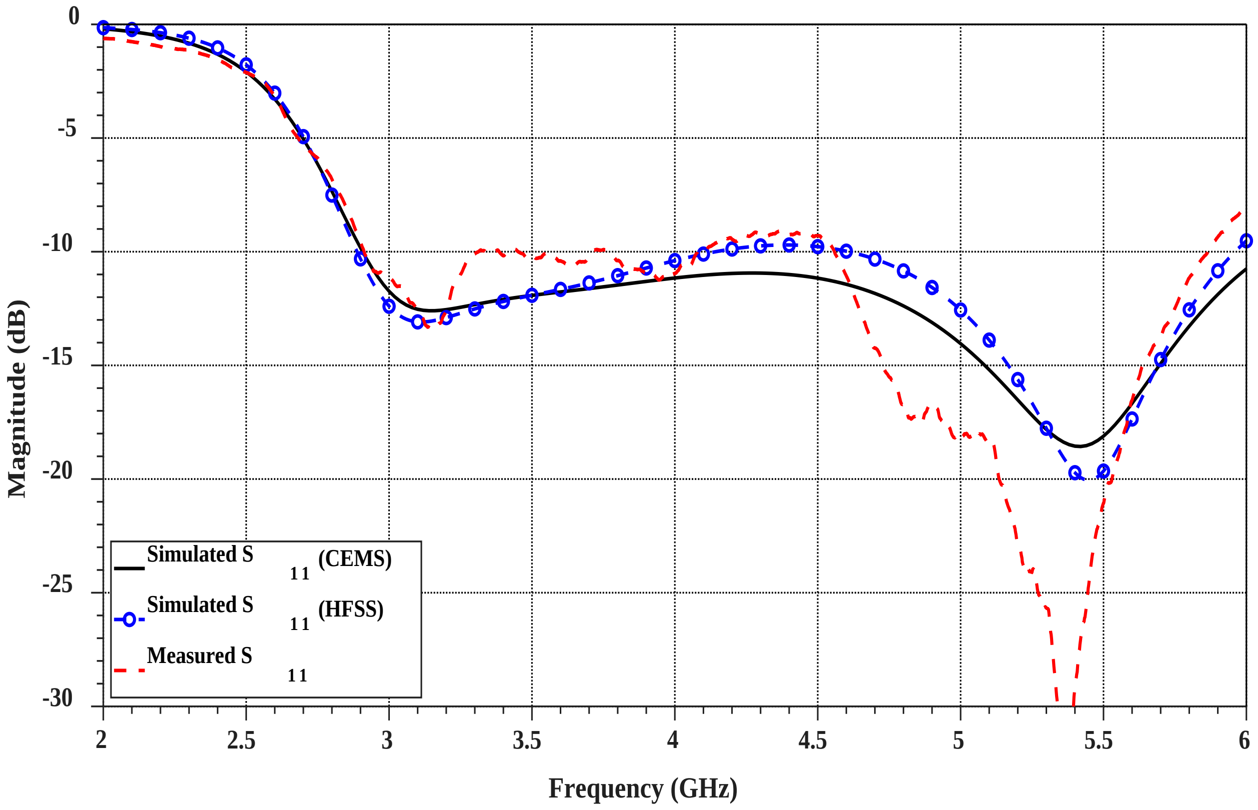
(a) Simulation parameters



(b) Fabricated antenna



(c) Radiation Pattern at 3.7 GHz



(d) S Parameter of Single Element

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Antenna Array Configurations

- 5-elements linear arrays
- 15-elements linear arrays
- General equations for a linear array

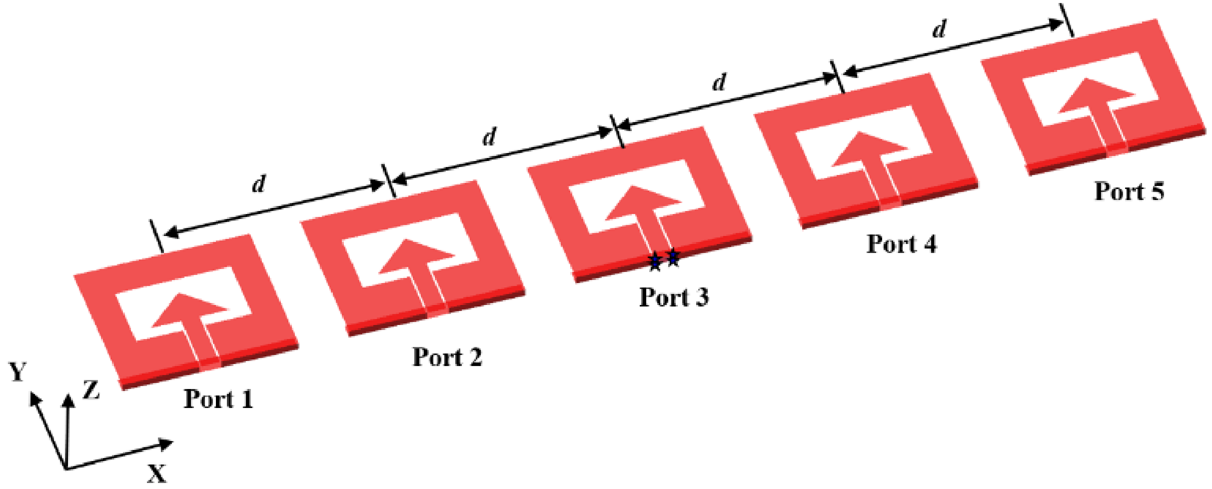
$$AF_{linear}(\theta,\varphi)=\sum_{n=1}^{N}\alpha_n\cdot e^{j\cdot(\beta_n+k\cdot d\cdot n\cdot\sin\theta)}$$

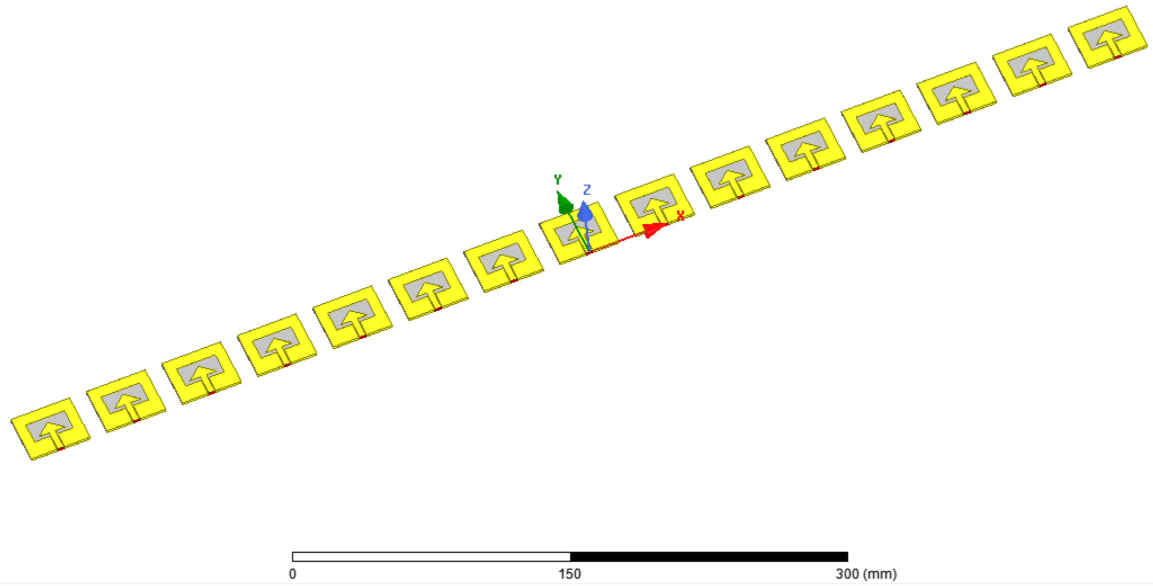
$$\Delta\beta(\theta_0)=-k\cdot d\cdot\sin\theta_0$$

$$\beta(\theta_0)=-k\cdot d\cdot n\cdot\sin\theta_0$$

$$\left|AF_{linear}(\theta,\theta_0)\right|=\left|\frac{\sin(\frac{N}{2}\cdot k\cdot d\cdot(\sin\theta-\sin\theta_0))}{\sin(\frac{k\cdot d\cdot(\sin\theta-\sin\theta_0)}{2})}\right|$$

- k is the wave number, d is the equal distance between the center lines of two adjacent elements, N is the total linear element number, θ_0 is the desired scanned angle.





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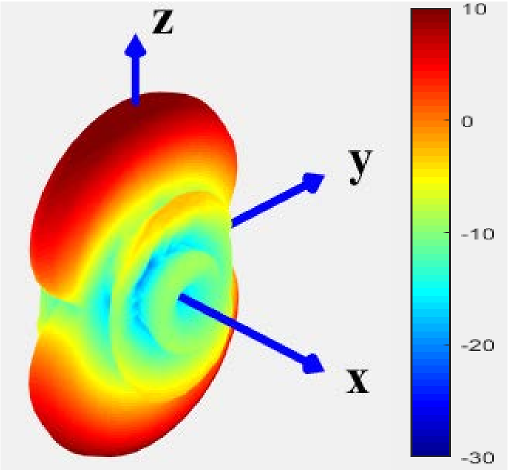
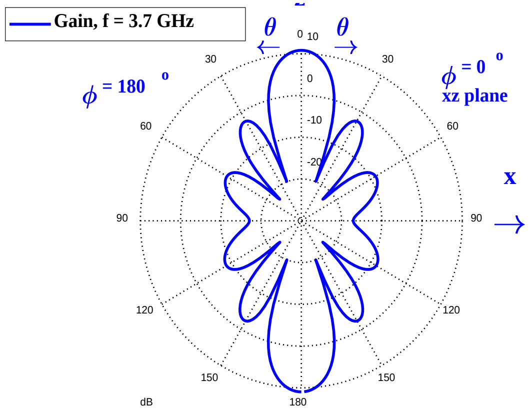
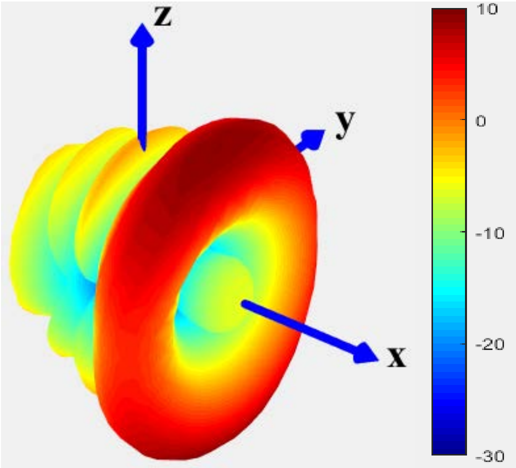
Simulation Result of 1x5 Linear Array

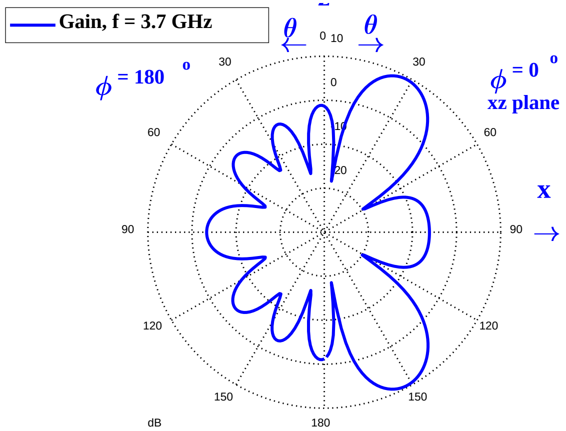
- Radiation Pattern at 3.7 GHz, uniform excitation with 0˚main beam directions.





- Radiation Pattern at 3.7 GHz, phased excitation with 30˚main beam directions.





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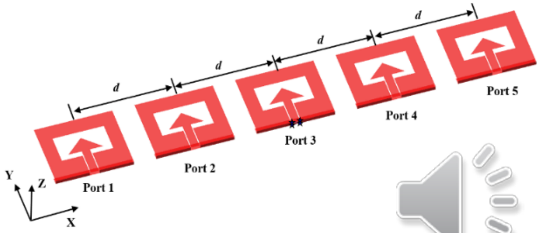

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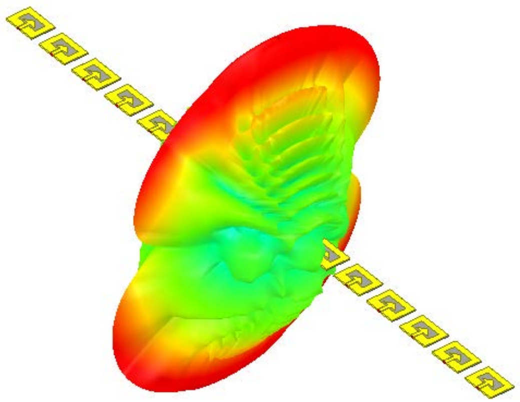
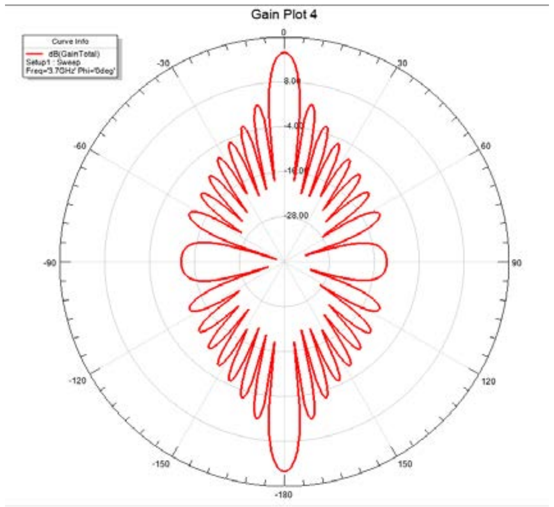
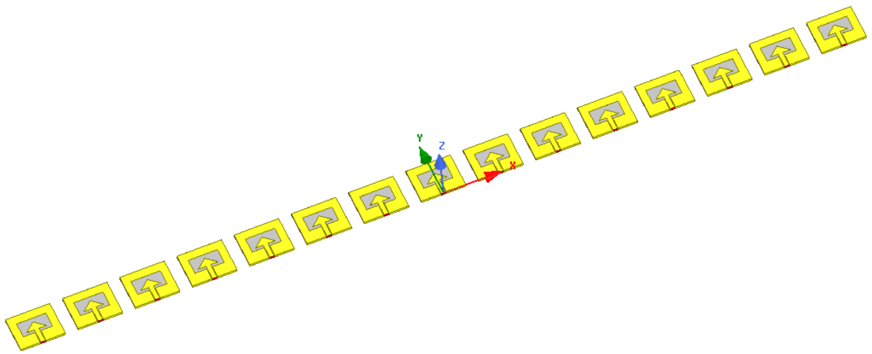
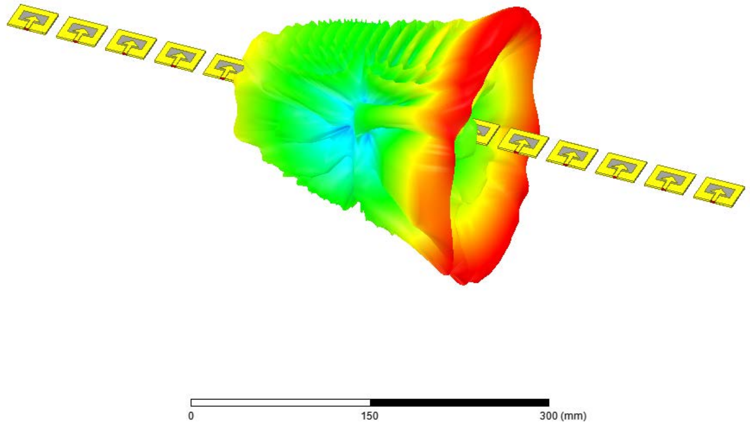
Simulation Result of 1x15 Linear Array

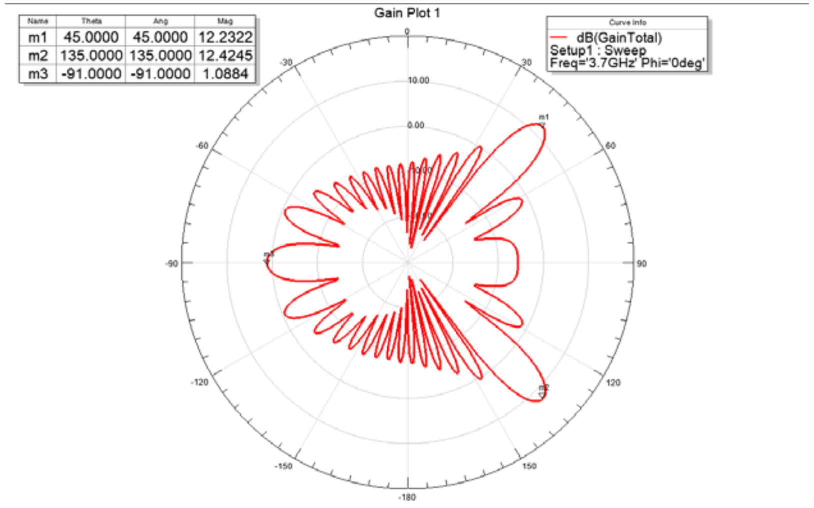
- Radiation Pattern at 3.7 GHz, uniform excitation with 0˚main beam directions.
- Radiation Pattern at 3.7 GHz, phase excitation with 45˚main beam directions.











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Conclusion & Future Work

- A miniaturized, low-cost design of patch/slot antenna element and the corresponding linear arrays supporting the sub 6 GHz frequency bands for 5G communications is presented.
- Higher gains and larger scanning range are achieved with the increase of number of elements in the linear array configuration without obvious deterioration in S-parameters or far-field characteristics.
- Future work, will focus on the development of 2D planar array with scanning in two perpendicular planes.

Reference

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- The FCC's 5G FAST Plan. (2018, January 10). Retrieved from https://www.fcc.gov/5G
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