Department of Electrical Engineering

IQRA National University Peshawar

Assignment: Advance Computer Networks

Topic Title:

Design of Single Micro Strip Antenna for 5G Wireless Application with enhanced Bandwidth

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Abstract:

A 5G is the 5th generation mobile network. It is a new global wireless standard after 1G, 2G, 3G, and 4G networks. 5G enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects, and devices.

In the design a rectangular antenna is designed that has high bandwidth stable radiation at 28GHz for future 5G applications. The FR-4 substrate having dimensions $(5.5 \times 4.35)^2$ with dielectric constant of 4.4 and thickness of the substrate of 1.6 mm with loss tangent of 0.002 is used. The design is simulated by HFSS(high frequency structure simulator) based on finite element method. The bandwidth achieved by the antenna design is about 3.7 GHz (26.40 GHz – 30.10 GHz)and has a return loss of about -31.68 dB, with a maximum gain of 4.3 dB.

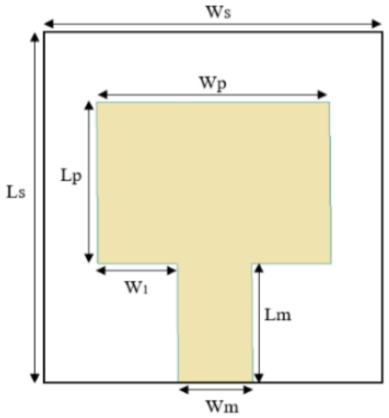
Basic Design:

In the basic design a simple rectangular micro strip patch antenna is design by using the formulae for Antenna parameters

Table 1. Dimension of the simple micro strip antenna

Parameters	Value (mm)
Ls	4.35
Ws	5.5
Lp	1.8
Wp	2.5
Lm	1.35
Wm	0.8
W1	0.7

Figure 1



Where, Ls is Length of Substrate,

Ws is Width of substrate,

Lp is Length of Patch,

Wp is Width of Patch,

Lm is Length of micro strip line,

Wm is Width of micro strip line,

And W1 is the width left and right side of the micro strip.

In the design first I draw the substrate with the above values with dielectric constant of FR-4 and thickness of 1.6mm shown in figure 2 the front view and in figure 3 the side view of the substrate.

Figure 2 Substrate front View

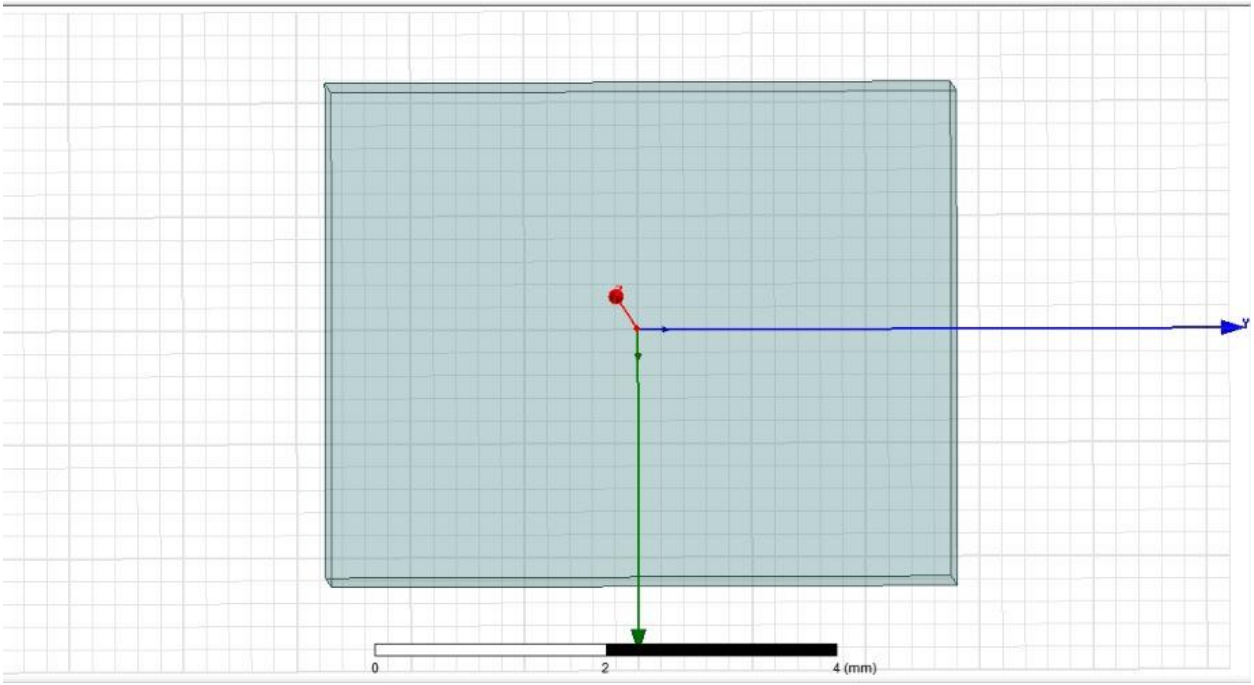
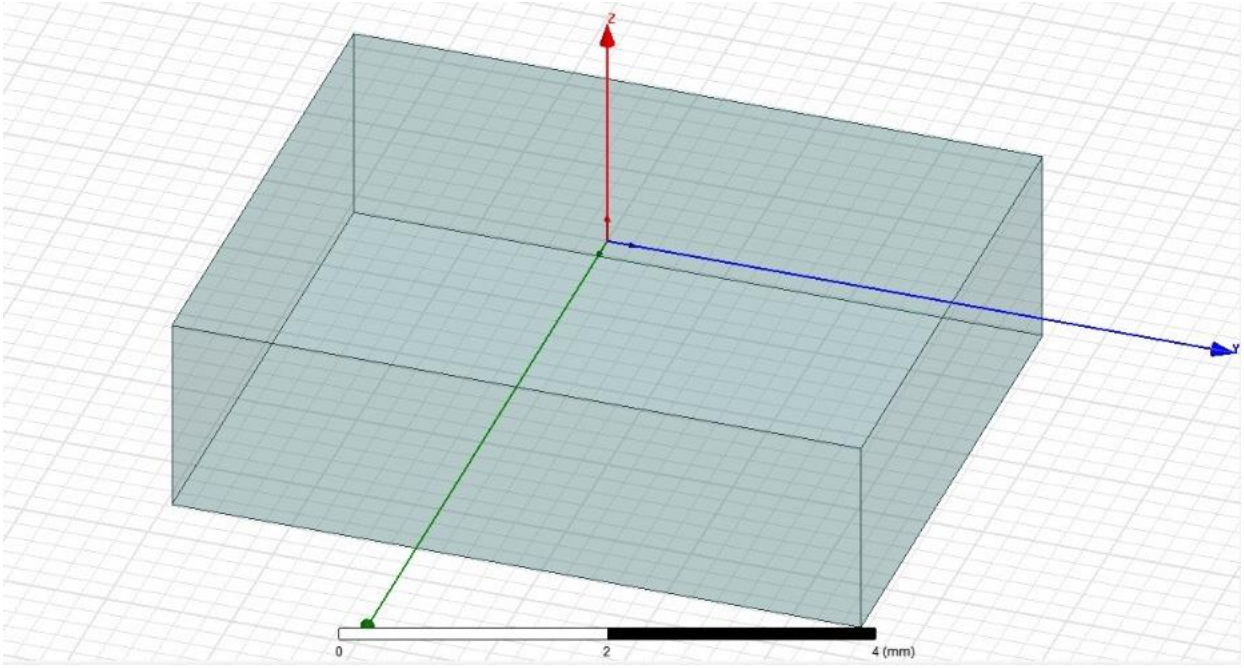
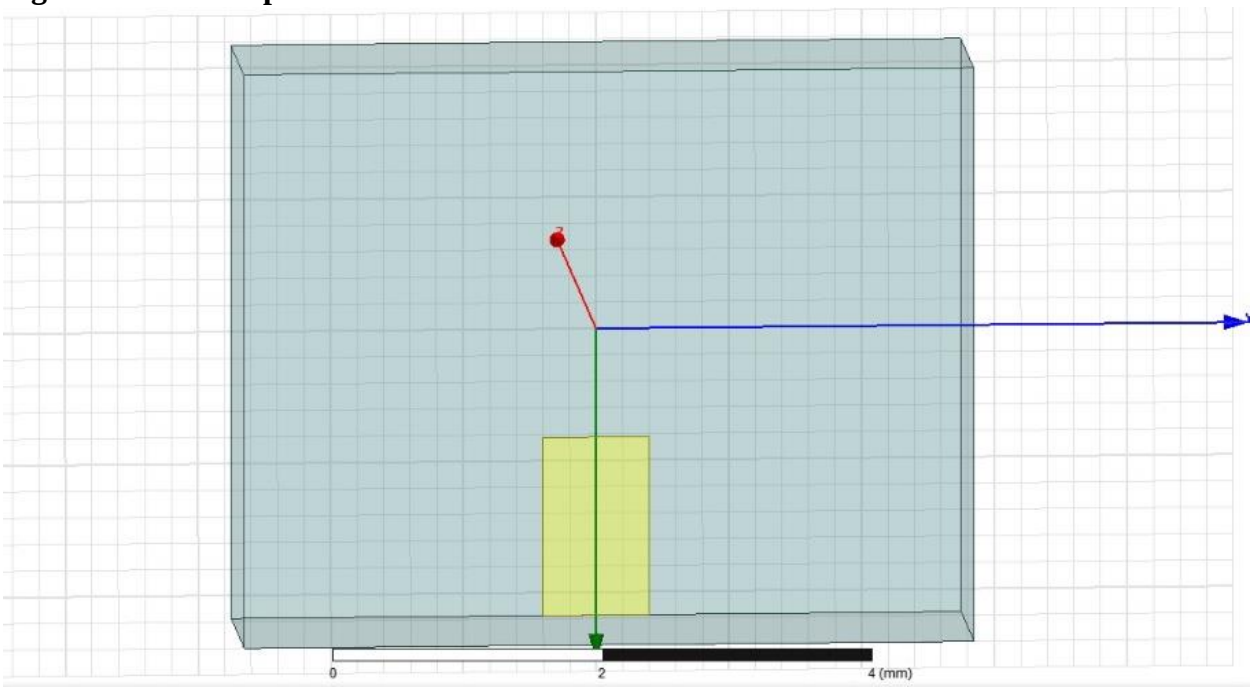


Figure 3 Side view of the substrate



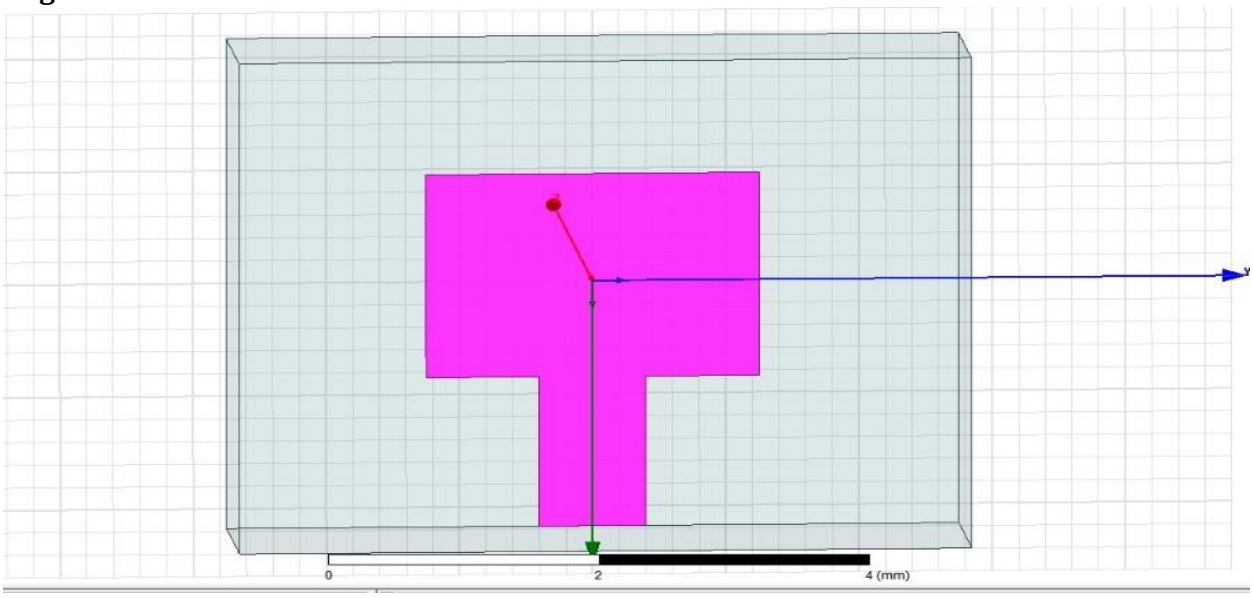
After substrate I draw the micro strip line having the value given in table 1 and shown in figure 4

Figure 4 Micro strip Line



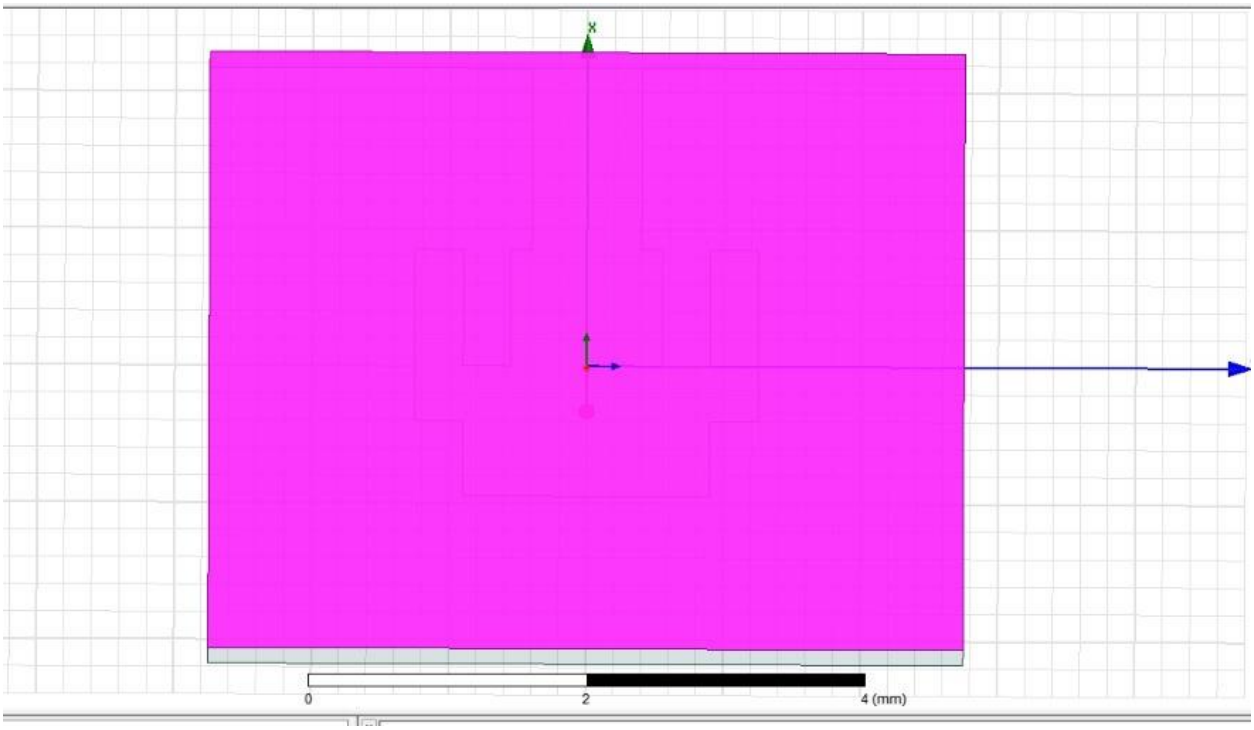
Drawing micro strip its Patch turn to be draw according to the table 1 values as shown in the figure 5 and also the patch is unite with the micro strip line

Figure 5 Patch



When the substrate and patch are done the third step is to draw the ground on the bottom of the substrate have the same dimensions as substrate as shown in figure 6 the highlighted pink is the ground plane

Figure 6 Ground Plane



Then assigning finite conductivity using copper material to ground and patch shown in figure 7 and giving radiation area where the antenna will radiate but when the simulation is run the results were not good so a technique is used named slotting technique in which some slots are made on patch in this case there are four slots made but the results are taken during each slot.

First slot is draw on the upper left side of the patch and subtracted from patch as shown in figure 8

Figure 7 Assigning Copper to ground and patch

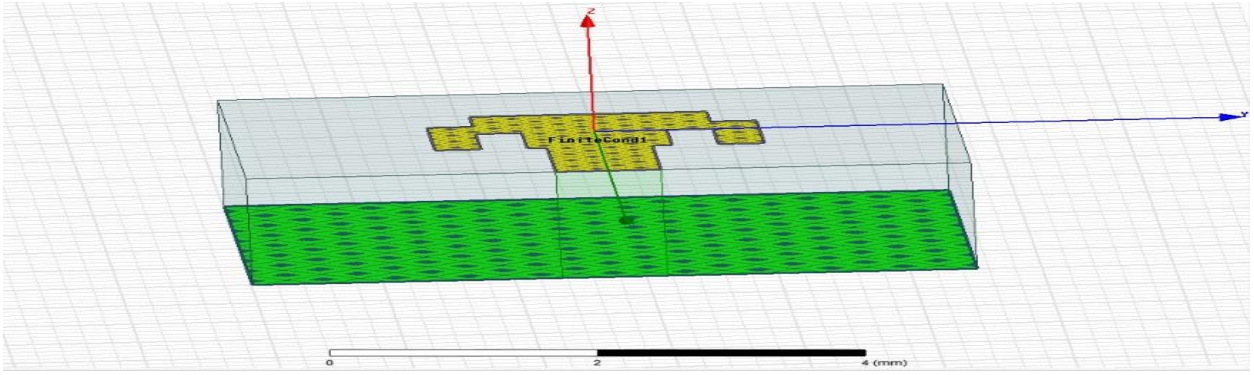
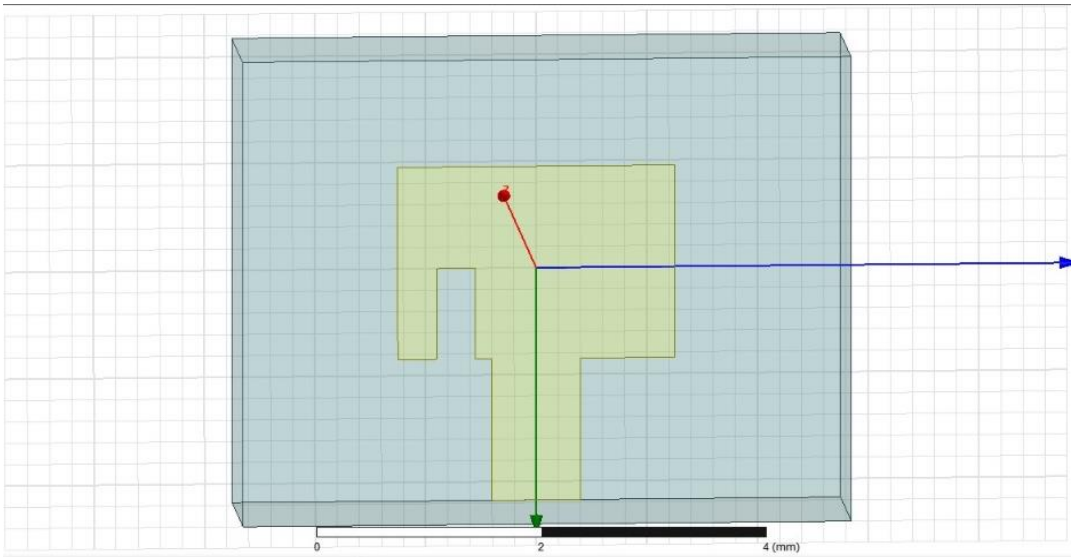
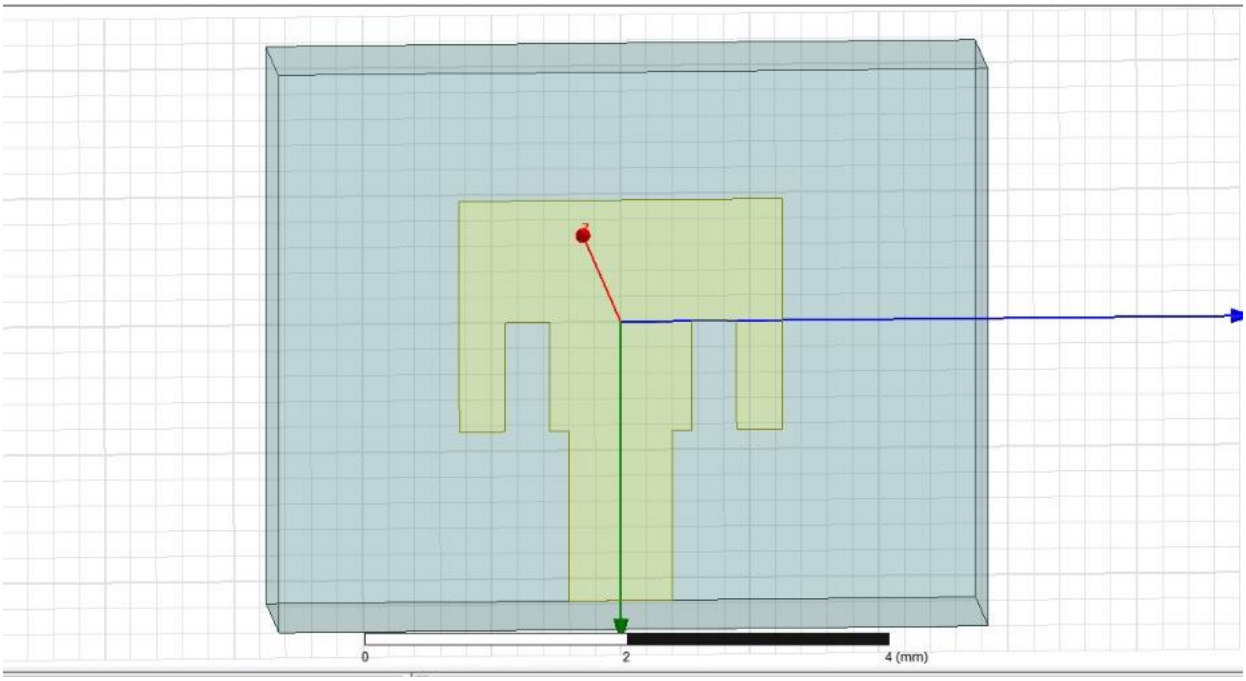


Figure 8 Slot 1 on patch



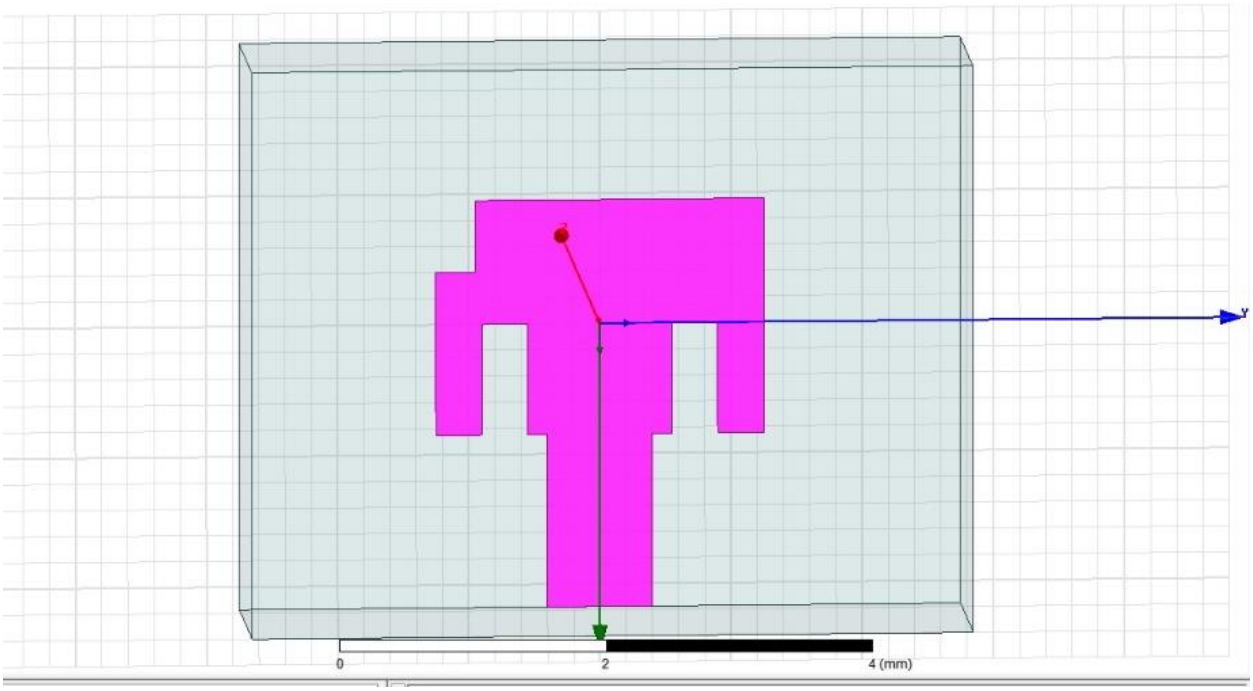
The slot 2 on the upper right side of the patch with same dimensions and subtracted from the patch as shown in figure 9

Figure 9 Slot 2 on patch



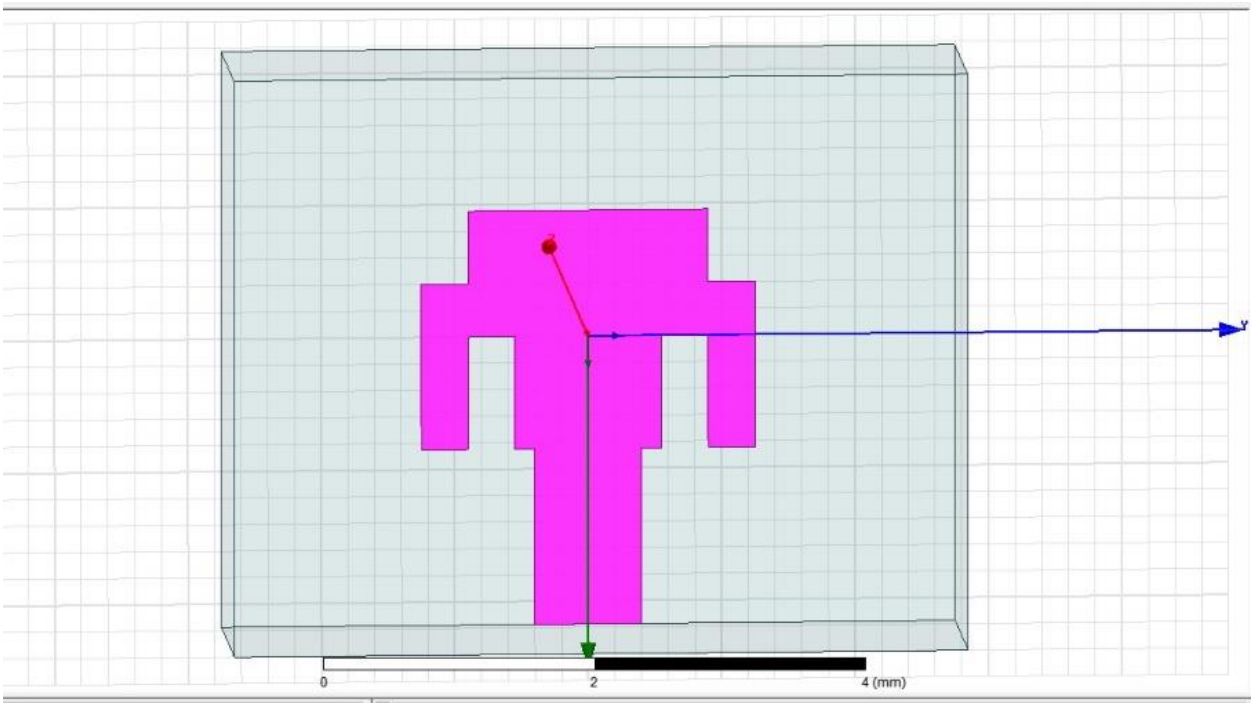
By doing the second slot the results were improved but the third slot is also made on the lower left side on the patch as shown in figure 10 for checking the results improving or not

Figure 10 3rd Slot on Patch



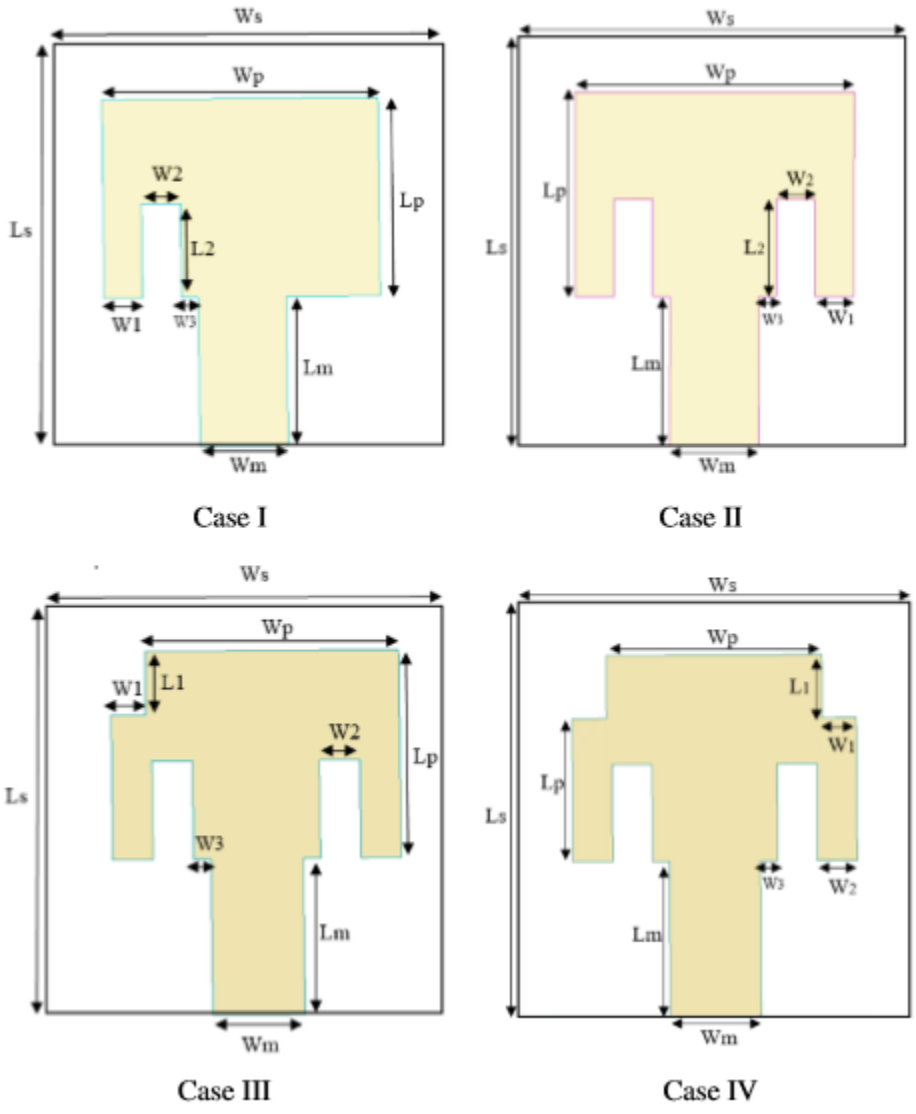
From the third slot the results goes toward the best side so another slot of same dimension is made against the 3rd slot as shown in figure 11 and a miracle in happen the results achieved is far better than the previous ones

Figure 11 4th Slot on Patch



Now the geometric evolutions of the slots are shown in the figure 12

Figure 12 Geometric evolutions of the antenna



Geometric parameters of the slot done on rectangular patch antenna for the four optimization steps in table 2

Table no 2

Parameters	Dimensions(mm)			
	Slot 1	Slot2	Slot3	Slot4
Ws	5.5	5.5	5.5	5.5
Ls	4.35	4.35	4.35	4.35
Wp	2.5	2.5	2.2	1.9
Lp	1.8	1.8	1.25	1.25
Wm	0.8	0.8	0.8	0.8
Lm	1.35	1.35	1.35	1.35
W1	0.35	0.35	0.3	0.3
W2	0.35	0.35	0.35	0.35
L2	0.85	0.85	0.85	0.85
W3	0.15	0.15	0.15	0.15
L1	-	-	0.55	0.55

Now the obtained result by drawing the four slots on patch are shown in table 3

Table 3 Obtained results

Optimization Slots	Frequency (GHz)	S_{11} (dB)	Bandwidth (GHz)
Slot 1	25.79	-22	2.43
Slot 2	26.44	-24	2.88
Slot 3	27.42	-27.96	3.08
Slot 4 (Proposed)	28.5	-31.68	3.7

Figure 13 bandwidth of the slotted antenna

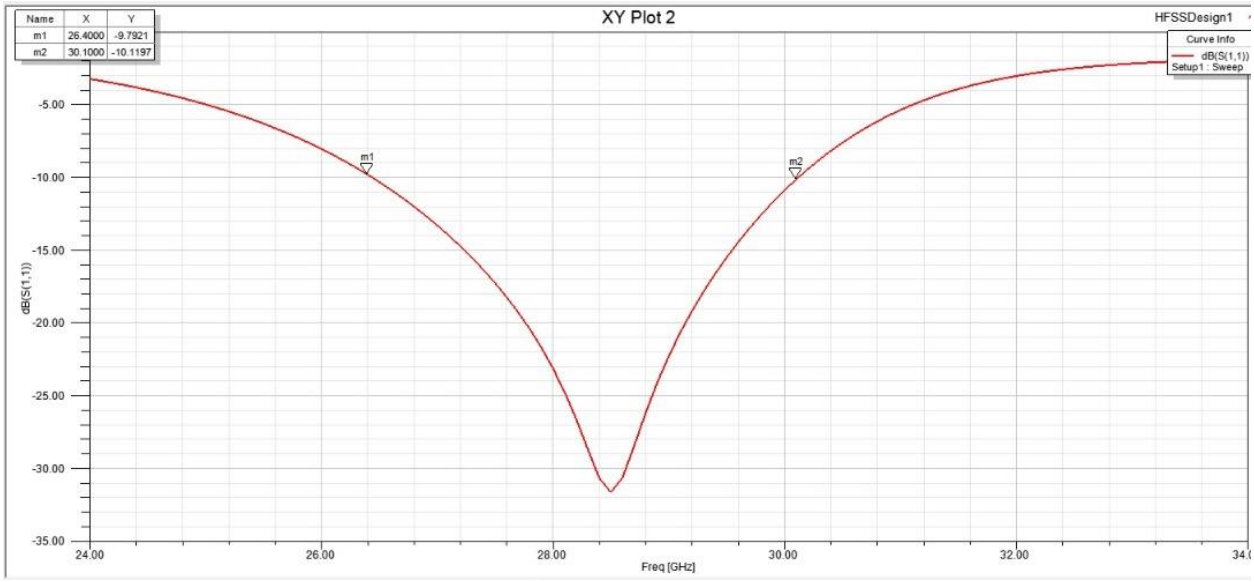


Figure 14 VSWR of the slotted antenna

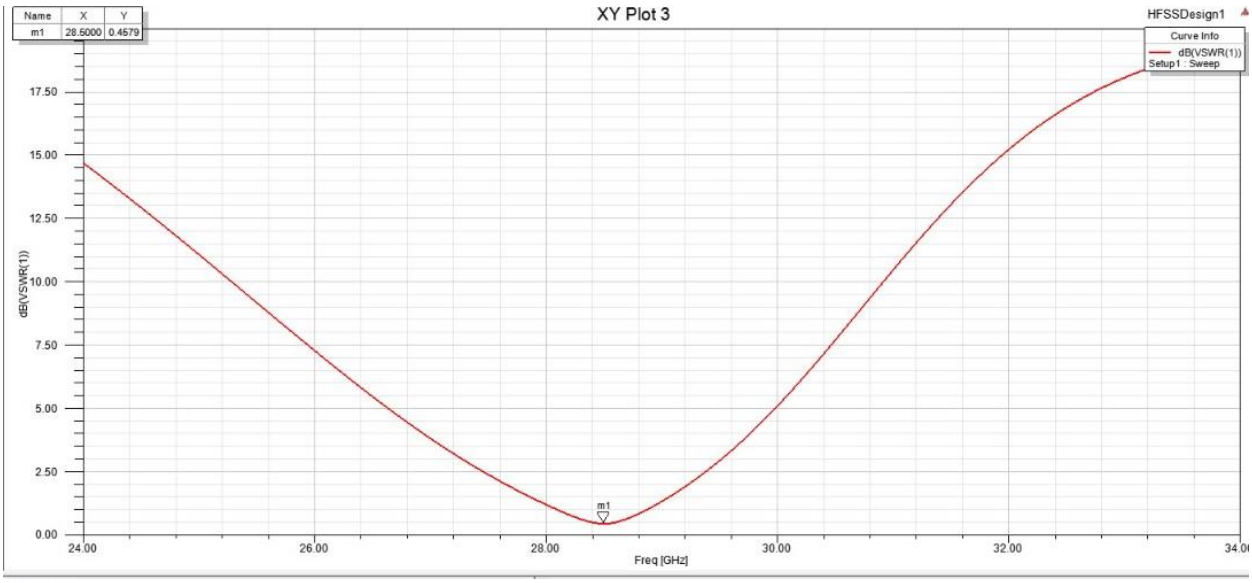


Figure 15 S11 return loss of the slotted antenna

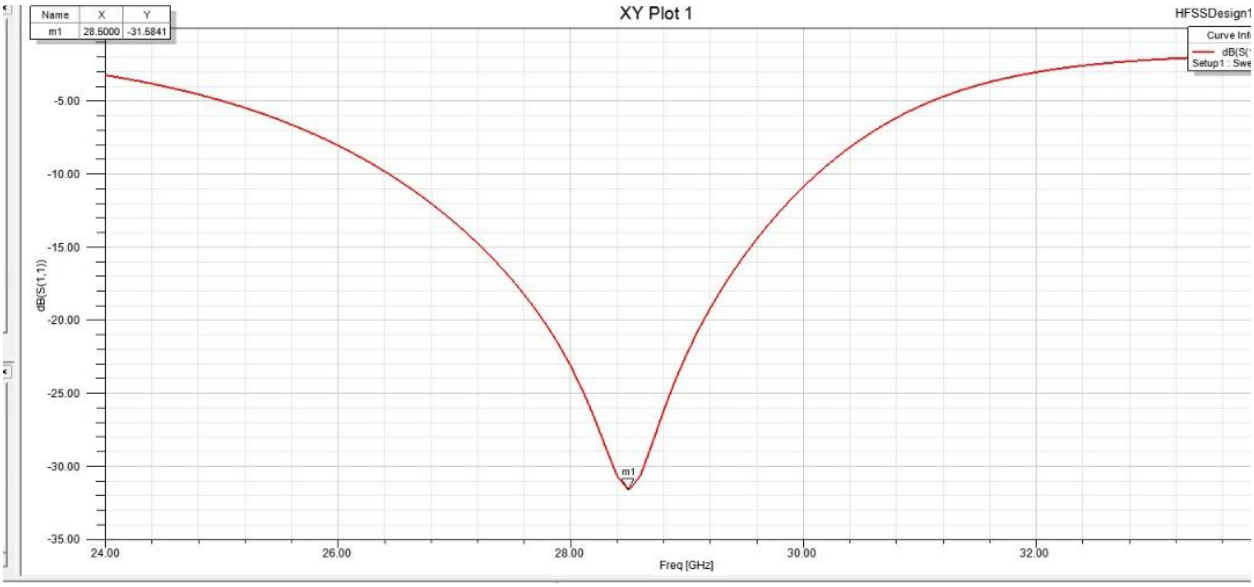


Figure 16 Total gain and radiation of the slotted antenna

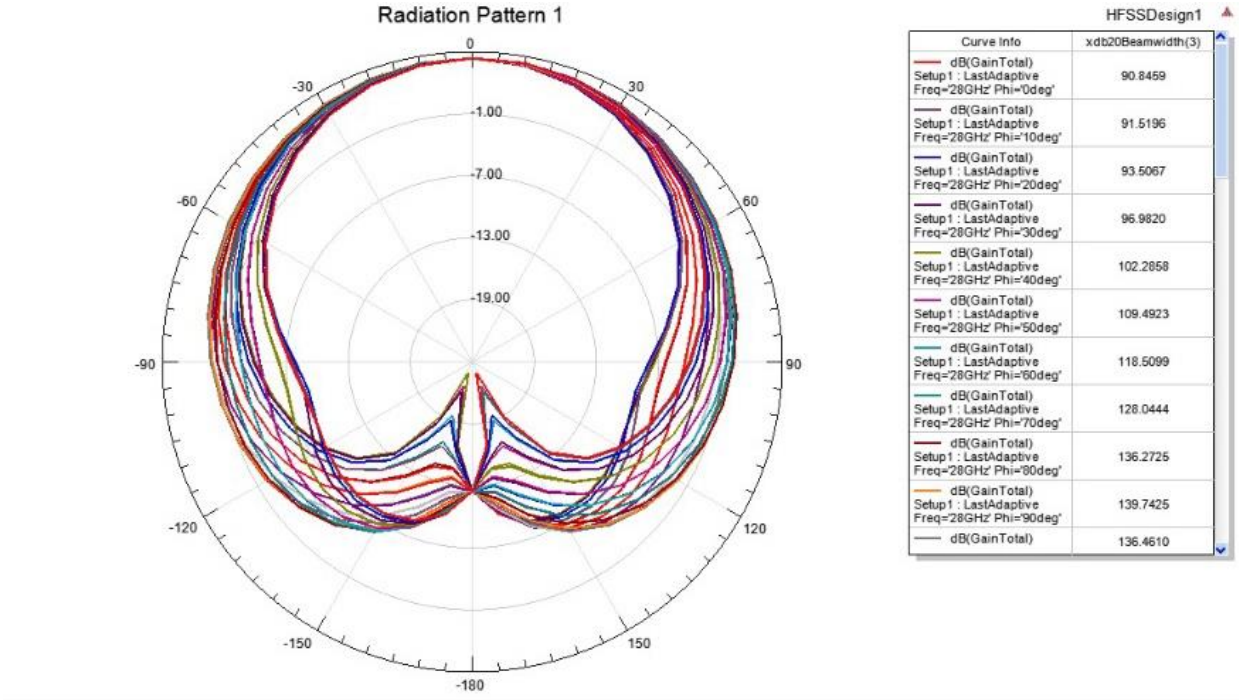
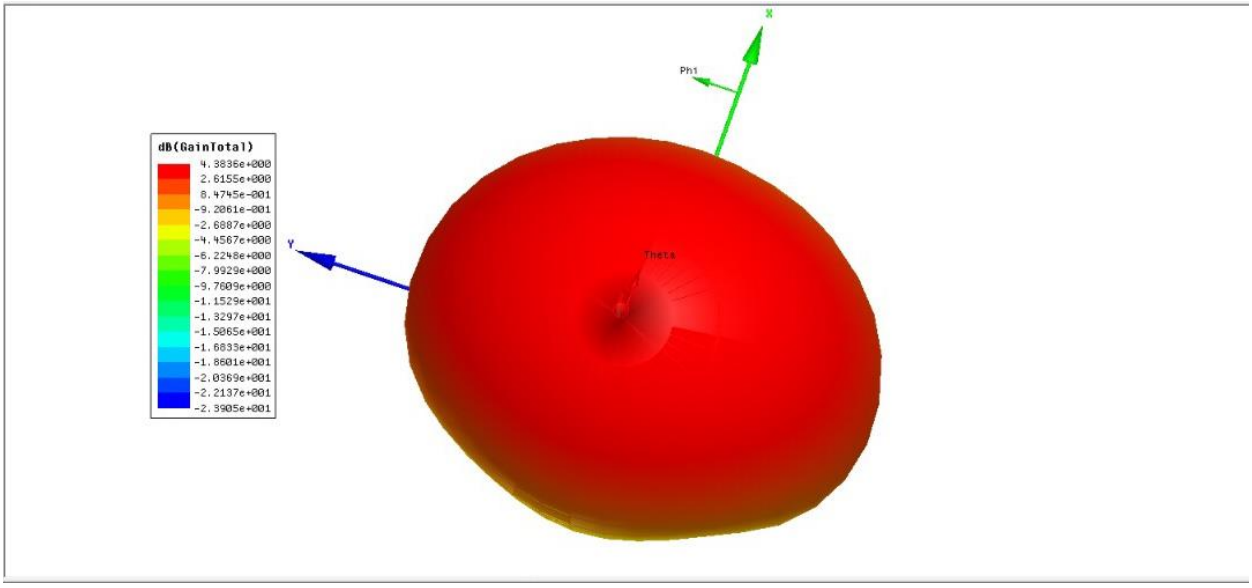


Figure 17 3D gain view



Performance Comparison of the with other antennas it is clear that the slotted antenna has small size and much higher bandwidth compare to other reference work as shown in table 4

Table 4 Performance comparasion of the slotted antenna with other antennas

References	Antennas Dimensions (mm^2)	Frequency (GHz)	Bandwidth (GHz)
1	5x5	28	1.44
2	55x110	28	1.06
3	19x19	28	1
4	3.2x3.2	28	2.8
5	5.3x5.35	28	0.47
6	3x7	28	3.34
7	11x5	28	0.82
8	6x6	28	1.3
9	10x10	28	2.94
10	12x14	28	2.55
This Work	**5.5x4.35**	**28**	**3.7**

References of the other antennas given in the Table 4

[1] W.A.Awan, A.Zaidiand A.Baghdad ,Patch antenna with improved performance using DGS for 28GHzapplications,IEEEInt.Conf.Wirel.Technol.Emb.Intell.Syst.2019(2019)1.

[2] H.M.Marzouk, M.I.Ahmed and A.A.Shaalan, Noveldual-band28/38 GHz MIMO antennas for 5G mobile applications, Prog.Electromagn.Res.C93(2019)103.

[3] Y.Jandi, F.Gharnati and A.O.Said, Design of a compact dualbands patch antenna for 5G applications, Int.Conf.Wirel.Technol.Emb.Intell.Syst.2017(2017)1.

[4] H.Jiang, L.Si, M.Xu, B.YangandX.Lv, Ahighgain 5G antenna with near zero refractive index superstrate, Int.Conf.Microw.MillimeterWaveTechnol.2018(2018)1.

[5] D.N.Arizaca-Cusicuna, J.L.Arizaca-Cusicuna and M.Clemente-Arenas, Highgain 4×4 rectangular patch antenna array at 28 GHz forfuture 5G applications, IEEEInt.Congr.Electron.Electric.Eng. Comput.2018(2018)1.

[6] W.Ahmad and W.T.Khan,Small form factor dualband (28/38GHz) PIFA antenna for 5G applications,IEEEMTT-SInt.Conf.Microw.Intell.Mobil.2017(2017)1.

[7] M.M.M.AliandA.-R.Sebak, Directive antennas for future 5Gmobile wireless communications, at General Assembly and Scientific Symposium of the International Union of Radio Science (URSI GASS), MontréalCanada(2017).

[8] M.I.Khattak, A.Sohail, U.Khan, Z.BarkiandG.Witjaksono, Elliptical slot circular patch antenna array with dualband behavior for future 5G mobile communication networks, Progr.Electromagn. Res.C89(2019)133.

[9] J. Sainiand S.K.Agarwal, T and L slotted patch antenna for future mobile and wireless communication, Int.Conf.Comput.Commun.Netw.Technol.2017(2017)1.

[10]M.N.Hasan, S.Bashir and SonChu, Dual band omni directional millimeter wave antenna for 5G communications, J.Electromagn.WavesAppl.33(2019)1581.