FCC ID: A3LSMN976V

Power Density Simulation Report

Revision A

July 3, 2019

SAMSUNG ELECTRONICS

1.1 Simulation tool

1.1.1 Tool description

For the simulation approach to calculating power density (PD) evaluation for mobile phone with mmWave antenna modules, ANSYS Electromagnetics suite version 19.2 (HFSS) is used. ANSYS HFSS is one of several commercial tools for 3D full-wave electromagnetic simulation used for antenna and RF structure design of high frequency component. ANSYS Electromagnetics suite version 19.2 (HFSS) is implemented based on Finite Element Method (FEM), which operates in the frequency domain.

1.1.2 Mesh and Convergence criteria

To solve the PD analysis using FEM, volume area containing simulated objects should be subdivided into electrically small parts that are called finite elements as the unknown functions. To subdivide system, the adaptive mesh technique in ANSYS Electromagnetics suite version 19.2 (HFSS) is used. ANSYS Electromagnetics suite version 19.2 (HFSS) starts to refine the initial mesh based on wavelength and calculate the error to iterative process for adaptive mesh refinement. The determination parameter of the number of iteration in ANSYS Electromagnetics suite version 19.2 (HFSS) is defined as convergence criteria, delta S, and the iterative adaptive mesh process repeats until the delta S is met. In ANSYS Electromagnetics suite version 19.2 (HFSS), the accuracy of converged results depends on the delta S. Figure 1 is an example of final adaptive mesh of the device (cross-section of top view).
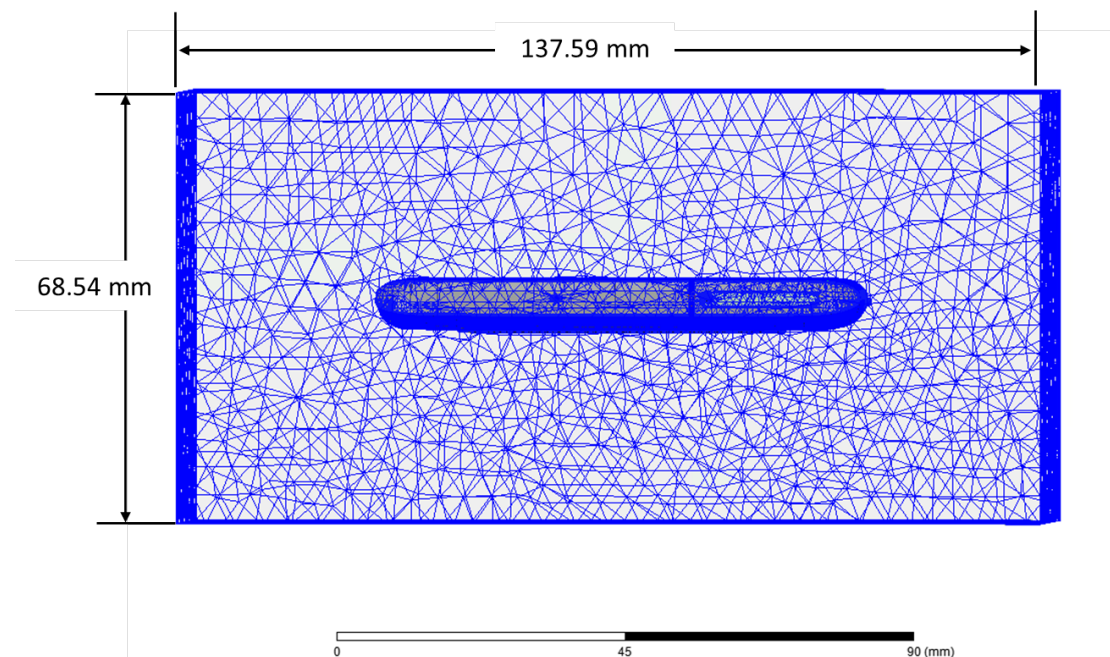

Figure 1 Example of the adaptive mesh technique (Top view)

1.1.3 Power density calculation

After solving 3D full-wave electromagnetic simulation, various kinds of physical quantities can be obtained. To calculate PD evaluation, two physical quantities, an electric field ($\vec{E}$) and a magnetic field ($\vec{H}$) are needed. The actual consumption power can be expressed as the real term of the Poynting vector ($\vec{S}$) from the cross product of $\vec{E}$ and complex conjugation of $\vec{H}$ as shown below:

$$\langle\vec{S}\rangle = \mathrm{Re}\left(\frac{1}{2}\vec{E} \times \vec{H}^*\right)$$

$\langle\vec{S}\rangle$ can be expressed as localized power density based on a peak value of each spatial point on mesh grids, and obtained directly from ANSYS Electromagnetics suite version 19.2 (HFSS).

From the localized power density $\langle\vec{S}\rangle$, the spatial-averaged power density (PD_{av}) on an evaluated area (A) can be derived as shown below:

$$PD_{av} = \frac{1}{A}\int_A \langle\vec{S}\rangle \cdot ds = \frac{1}{2A}\int_A \left|Re(\vec{E} \times \vec{H}^*)\right| \cdot ds$$

, where the spatial-averaged power density (PD_{av}) is total power density value considering on x, y and z components of localized power density $\langle\vec{S}\rangle$ and the evaluated area (A) is $4\mathrm{cm}^2$.

1.2 Simulation setup

1.2.1 3D modeling

Figure 2 shows the simulation model which is mounted three mmWave antenna modules. The simulation modeling includes most of the entire structure of device itself such as PCB, metal frame, battery, cables, and legacy antennas as well as mmWave antenna modules called as Ant J, Ant K and Ant L. On the back side view, Ant J is placed at the top side and antennas are facing the backside of the device. Ant K is placed on the left side and antennas are facing the left side, and Ant L is placed on the right side and antennas are facing the right side of the device.
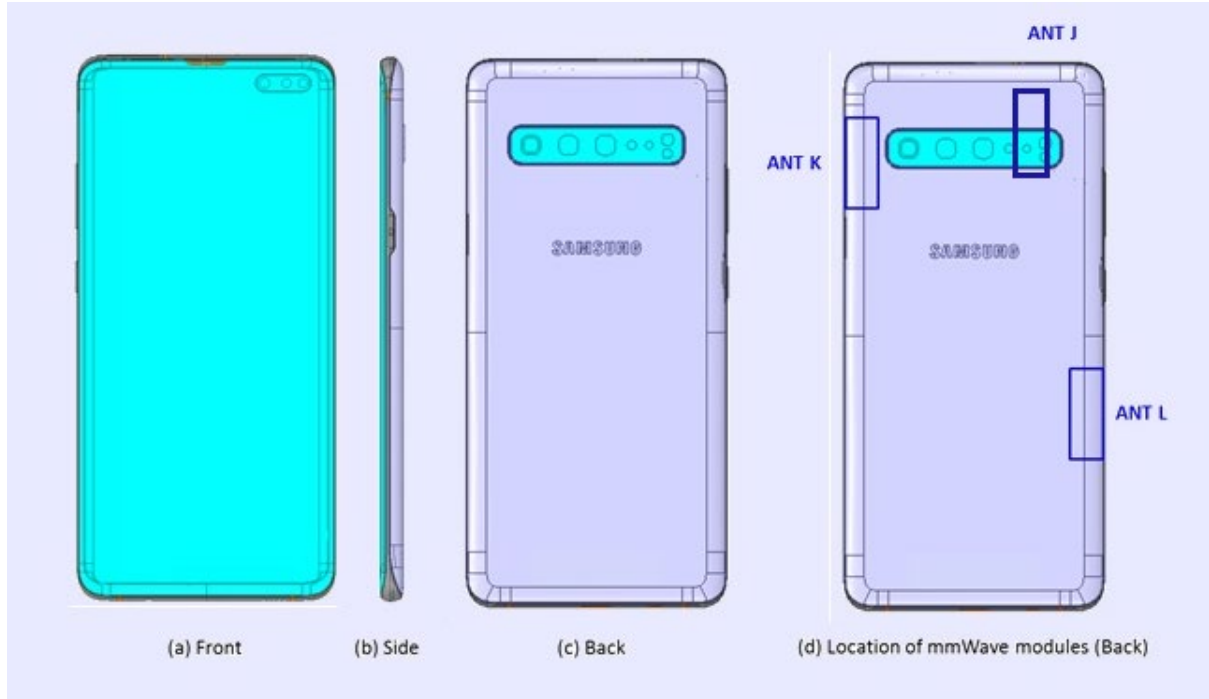
Figure 2 Simulation model which is mounted three mmWave antenna modules

1.2.2 PD evaluation planes

Table 1 shows the PD evaluation planes for each mmWave antenna module and Figure 3 shows the PD evaluation planes and truncation area of the simulation model to find worst case of beamforming cases. In Ant J and Ant K cases, five PD evaluation planes except bottom side are set up. Ant J and Ant K are placed at the upper of the device and the bottom side is excluded from the worst case because the distance from the bottom side is more than 10 lambda at 28GHz and 39 GHz. In Ant L case, five PD evaluation planes except top side are set up, Ant L is placed at the lower of the device and the top side is excluded from the worst case for the same reason as Ant J and Ant K.

Please note that the "right" and "left" edge of mentioned in this report are defined from the perspective of looking at the device from the back side.

Table 1. PD evaluation planes

	Front	Back	Left From Front View	Right From Front View	Top	Bottom
	S1	S2	S3	S4	S5	S6
Ant J	O	O	O	O	O	X
Ant K	O	O	O	O	O	X
Ant L	O	O	O	O	X	O
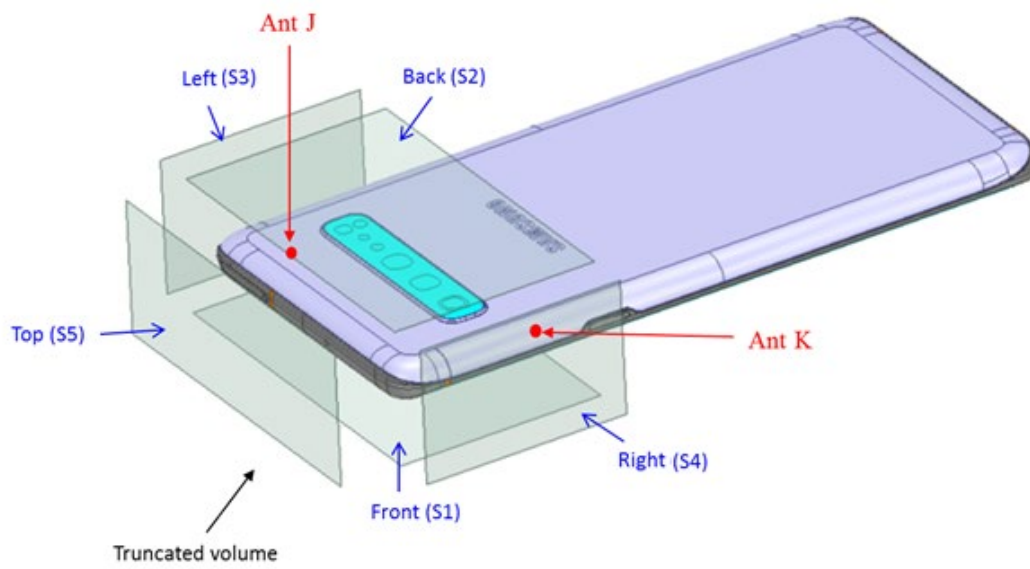
(a) Ant J and Ant K
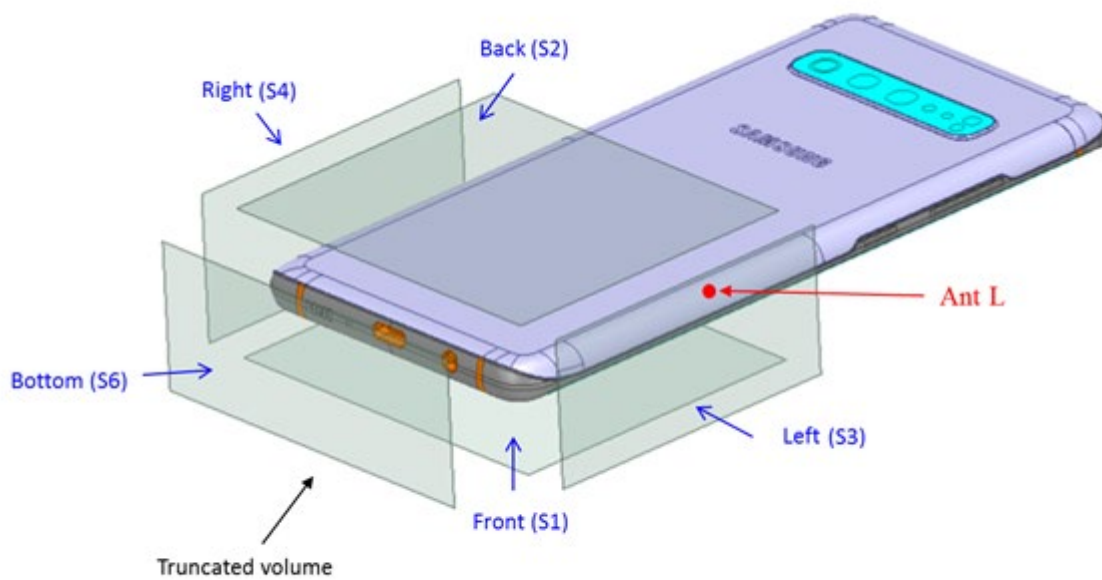
(b) Ant L

Figure 3. PD evaluation planes

1.2.3 Boundary condition

To simulate electromagnetic tool based on FEM, the boundary condition allows electromagnetic waves to be electrically open at the boundary and radiated far away without reflection. ANSYS Electromagnetics suite version 19.2 (HFSS) can support the absorbing boundary condition (ABC) for radiation boundary and make normally a quarter wave length from the radiating structure. In this report, to cover all beamforming cases of mmWave antenna modules, the three wavelength spacing from the device is used.

1.2.4 Source excitation condition

The number of antenna ports of ANT J, ANT K, and ANT L for source excitation consists of 16, 8, and 8, respectively. The antenna port of ANT J is divided into 8 ports for 1 x 4 patch array antennas and 8 ports for 1 x 4 dipole array antennas. In the 8 ports included in each patch antenna, 4 ports are divided into vertical polarization feeding, and the other 4 ports are divided into horizontal polarization feeding. The dipole array antennas consist of 4 antenna elements and each element uses two ports as a source excitation. All antenna ports of ANT K and ANT L are for patch array antennas and are similar to those of ANT J.

Figure 4 shows the ANT J module structure and surrounding structure. The ANT J module is encrypted in the ANSYS Electromagnetics suite (HFSS) and can only check the feeding position.
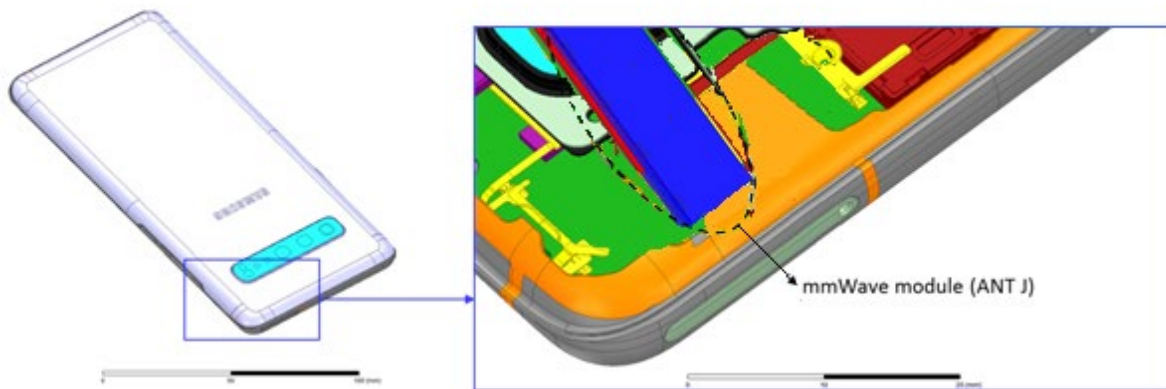
Figure 4. mmWave module (ANT J)

After finishing 3D full wave electromagnetic simulation of modeling structure, the magnitude and phase information can be loaded for each port by using "Edit Sources" function in ANSYS Electromagnetics suite (HFSS). Figure 5 shows an example of antenna port excitations.
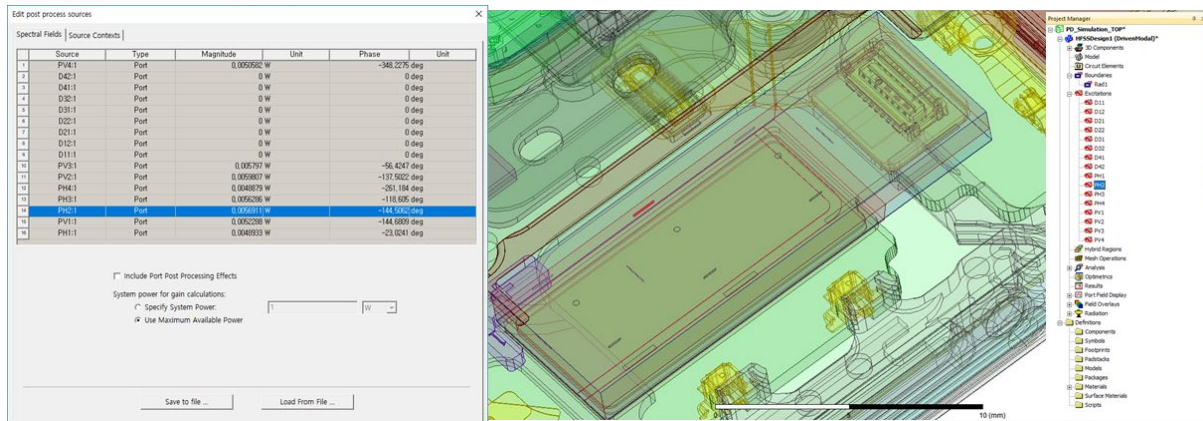
Figure 5. An example of port excitation (ANT J)

Since ANSYS Electromagnetics suite (HFSS) uses FEM solver based on frequency domain analysis method, the input source for the port excitation applies sinusoidal waveform for each frequency.

1.2.5 Condition of simulation completion

The simulation completion condition of ANSYS Electromagnetics suite (HFSS) is defined as delta S. The ANSYS Electromagnetics suite (HFSS) calculates the S-parameter for the mesh conditions of each step and determines whether to proceed with the operation of the next step by comparing the difference between the S-parameters in the previous step. A difference between the previous step and the current step of S-parameter is expressed as delta S, and the delta S generally sets 0.02. The simulation result of this report is the result of setting delta S to 0.02.

2. Simulation verification

2.1 Spatial-averaged power density

As mentioned in the previous chapter, the Poynting vector $(\vec{S})$ can be obtained through cross product of an electric field $(\vec{E})$ and complex conjugate of a magnetic field $(\vec{H})$. The real term of the Poynting vector can be described as the localized power density or peak power density. Using the localized power density, the spatial-averaged power density can be obtained by the integral of $4\ \mathrm{cm}^2$ at 2.5 mm intervals of the localized power density result. Figure 6 shows examples of the distribution plot of localized power density and the averaged power density.

(a) Localized power density   (b) Averaged power density
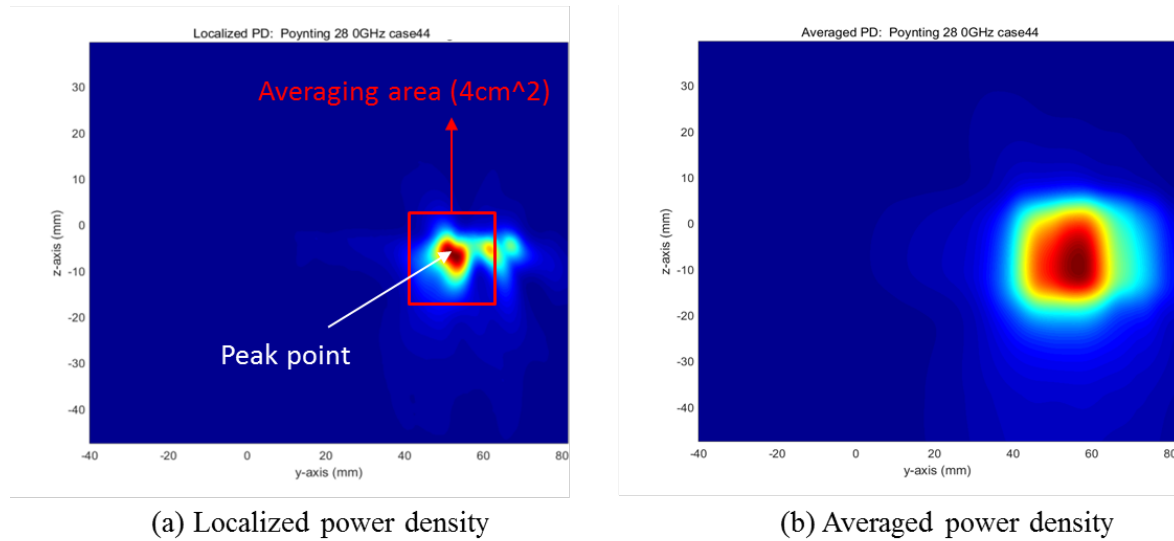
Figure 6. Power density distribution (Example)

2.2 Comparison between simulation and measurement

In this section, the simulated-power density distributions and measured-power density distributions are compared to each mmWave antenna.

Based on comparison of power density distributions, simulated power density and measured power density have a good correlation. Measurement uncertainty in mmWave frequency in measurement side and inaccuracy of material properties in mmWave frequency in the simulation side are considered as error factors.

The input powers per each active port are below for both Simulation and Measurement validation and power density characterization. For Simulation, these values were entered directly into HFSS model. For measurement, FTM S/W was used to input these values for each active port also.

Mode/Band	Antenna	Input Power(in dBm) SISO	Input Power(in dBm) MIMO
5G NR n261	J Dipole	8	8
	J Patch	8	8
	K Patch	8	8
	L Patch	8	8
5G NR n260	J Dipole	6.5	6.5
	J Patch	6.5	6.5
	K Patch	6.5	6.5
	L Patch	6.5	6.5

* The below simulation and measurement result were performed at 2mm Distance and 28GHz / 38.5GHz. PLimit was decided according to the Simulation results and the output power that will be used on the live network will be reported after calculation

Band	Beam ID	Antenna	Surface	Channel	4cm2 avg. PD (W/m2)	
					Meas.	Sim
n261	16	J (dipole)	Back (S2)	Mid	15.20	30.35
	133		Back (S2)	Mid	8.02	21.90
	24	J (patch)	Back (S2)	Mid	17.10	39.76
	154		Back (S2)	Mid	17.00	39.40
	30	K (patch)	Back (S2)	Mid	11.10	32.00
			Right (S4)	Mid	11.40	33.13
	173		Back (S2)	Mid	6.99	18.06
			Right (S4)	Mid	13.00	31.24
	37	L (patch)	Back (S2)	Mid	10.30	35.25
			Left (S3)	Mid	9.92	30.59
	177		Back (S2)	Mid	5.70	17.54
			Left (S3)	Mid	9.37	27.96
n260	6	J (dipole)	Back (S2)	Mid	7.28	14.16
	134		Back (S2)	Mid	4.94	9.93
	39	J (patch)	Back (S2)	Mid	5.09	17.89
	153		Back (S2)	Mid	5.03	19.55
	44	K (patch)	Back (S2)	Mid	6.44	18.09
			Right (S4)	Mid	7.31	19.94
	157		Back (S2)	Mid	3.32	6.90
			Right (S4)	Mid	10.70	14.21
	36	L (patch)	Back (S2)	Mid	8.09	22.11
			Left (S3)	Mid	7.51	20.89
	175		Back (S2)	Mid	4.00	5.38
			Left (S3)	Mid	8.48	12.72

- n261 ANT J-Dipole: Mid Channel, Beam ID:16, Back
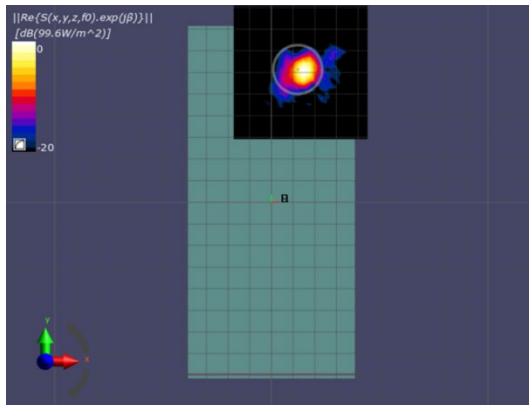
(a) measurement   (b) simulation
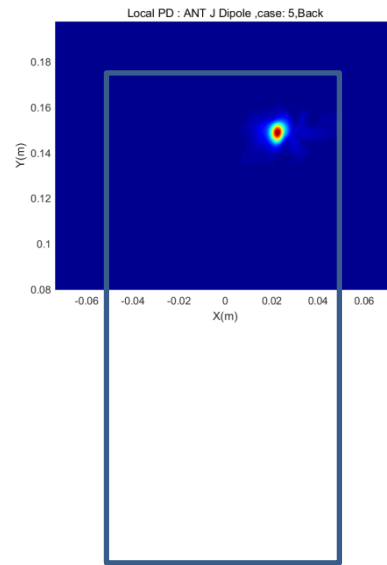
ANT J Dipole: Mid Channel, Localized power density

(a) measurement   (b) simulation

ANT J Dipole: Mid Channel, averaged power density

● n261 ANT J- Dipole : Mid Channel, Beam ID: 133, Back

(a) measurement   (b) simulation

ANT J- Dipole : Mid Channel, Localized power density

(a) measurement   (b) simulation

ANT J- Dipole : Mid Channel, averaged power density

- n261 ANT J-Patch: Mid Channel, Beam ID: 24, Back

(a) measurement

(b) simulation

ANT J-Patch: Mid Channel, Localized power density

(a) measurement

(b) simulation

ANT J-Patch: Mid Channel, averaged power density

- n261 ANT J-Patch: Mid Channel, Beam ID : 154, Back

(a) measurement

(b) simulation

ANT J-Patch: Mid Channel, Localized power density

(a) measurement

(b) simulation

ANT J-Patch: Mid Channel, averaged power density

- n261 ANT K-Patch: Mid Channel, Beam ID 30, Back

(a) measurement　　　　　　　　(b) simulation

ANT K-Patch: Mid Channel, Localized power density

(a) measurement　　　　　　　　(b) simulation

ANT K-Patch: Mid Channel, averaged power density

- n261 ANT K-Patch: Mid Channel, Beam ID 30, Right

(a) measurement (b) simulation

ANT K-Patch: Mid Channel, Localized power density

(a) measurement (b) simulation

ANT K-Patch: Mid Channel, averaged power density

● n261 ANT K-Patch: Mid Channel, Beam ID 173, Back

(a) measurement   (b) simulation

ANT K-Patch: Mid Channel, Localized power density

(a) measurement   (b) simulation

ANT K-Patch: Mid Channel, Averaged power density

● n261 ANT K-Patch: Mid Channel, Beam ID 173, Right

(a) measurement   (b) simulation
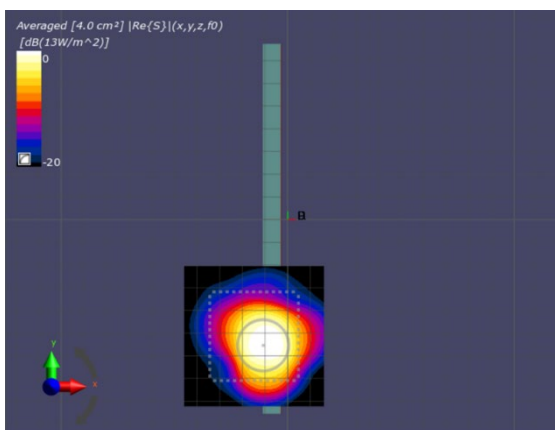
ANT K-Patch: Mid Channel, Localized power density
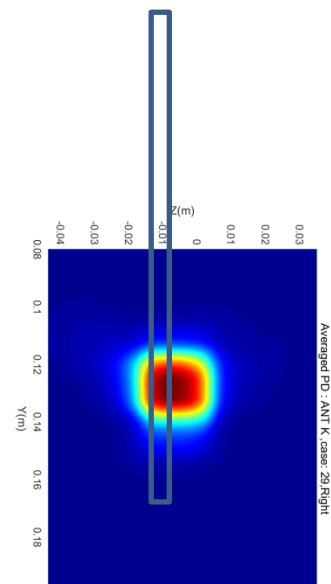
(a) measurement   (b) simulation

ANT K-Patch: Mid Channel, averaged power density

- n261 ANT L-Patch: Mid Channel, Beam ID 37, Back
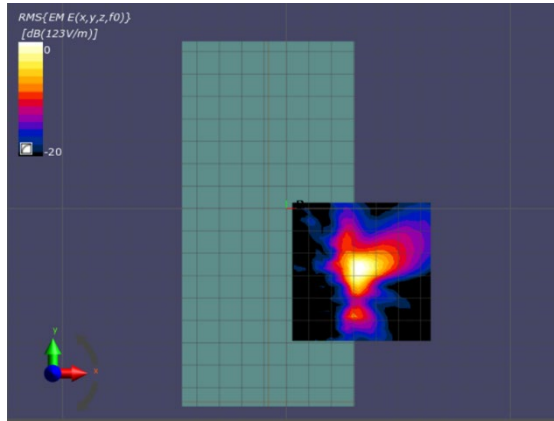
(a) measurement　　　　　　　　(b) simulation
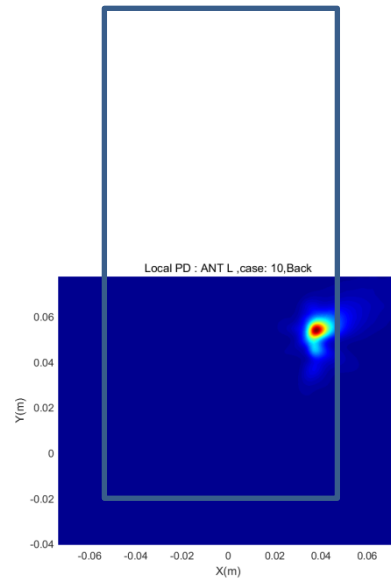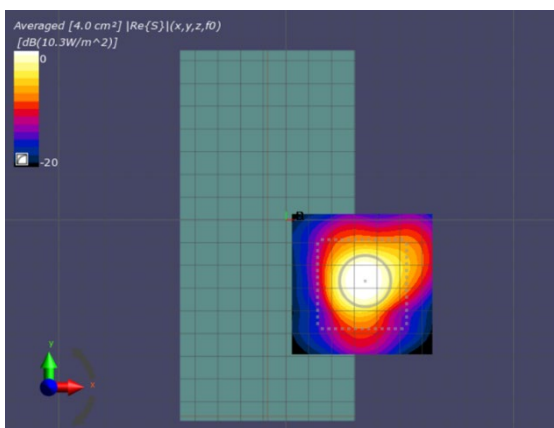
ANT L-Patch: Mid Channel, Localized power density
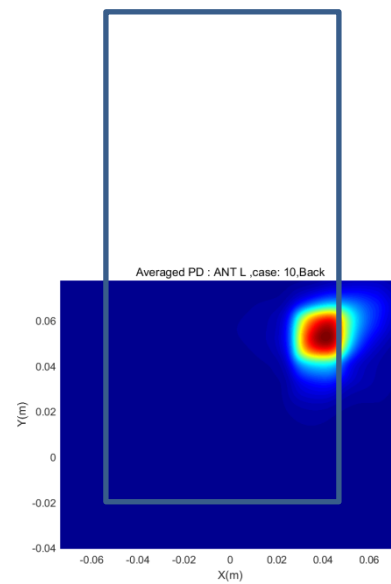
(a) measurement　　　　　　　　(b) simulation

ANT L-Patch: Mid Channel, averaged power density

- n261 ANT L-Patch: Mid Channel, Beam ID 37, Left
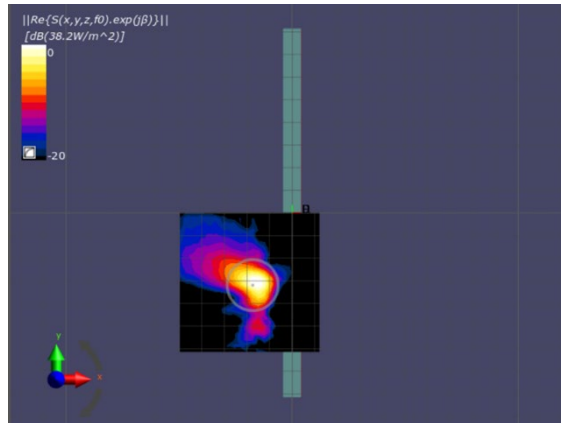
(a) measurement   (b) simulation
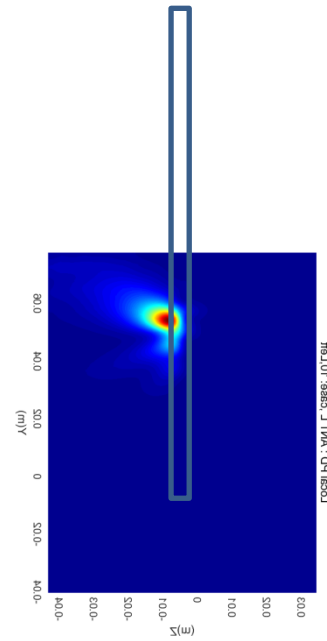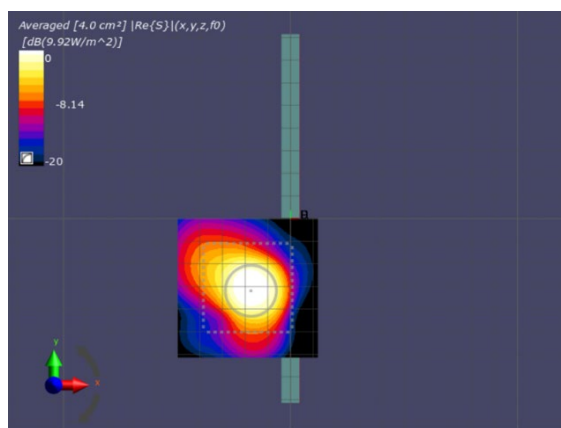
ANT L-Patch: Mid Channel, Localized power density
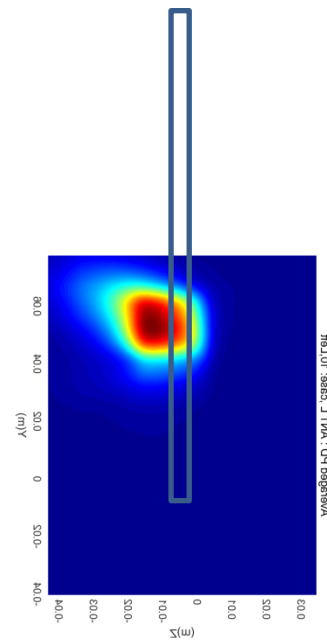
(a) measurement   (b) simulation

ANT L-Patch: Mid Channel, Averaged power density

● n261 ANT L-Patch: Mid Channel, Beam ID177, Back
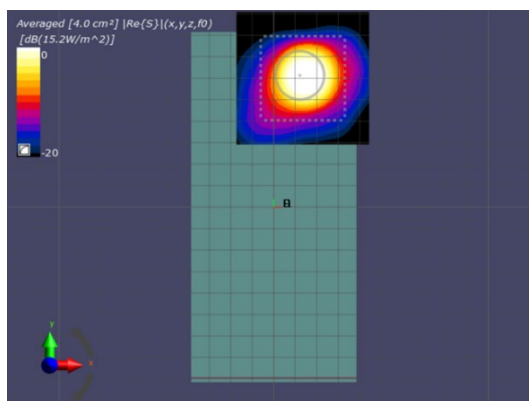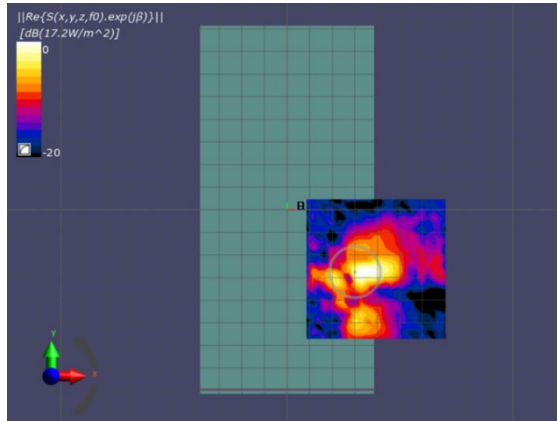
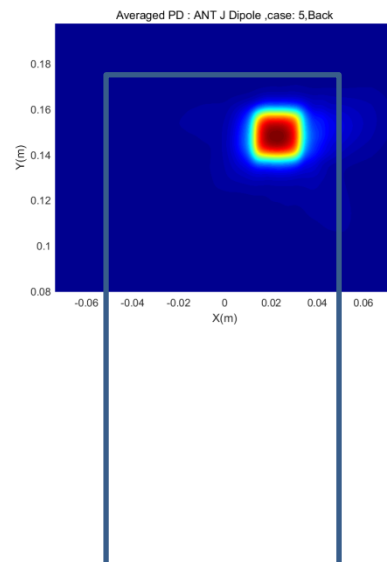

(a) measurement   (b) simulation
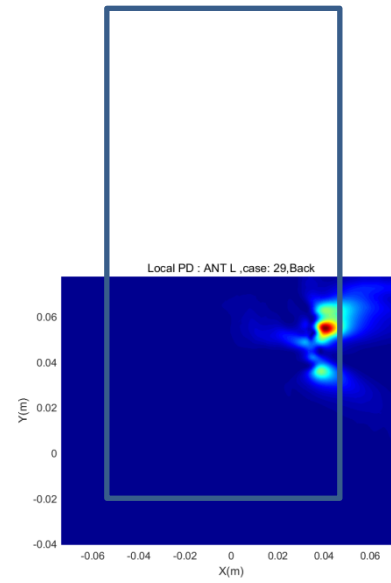
ANT L-Patch: Mid Channel, Localized power density
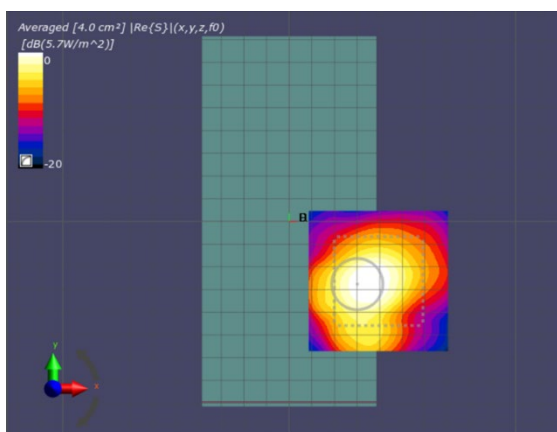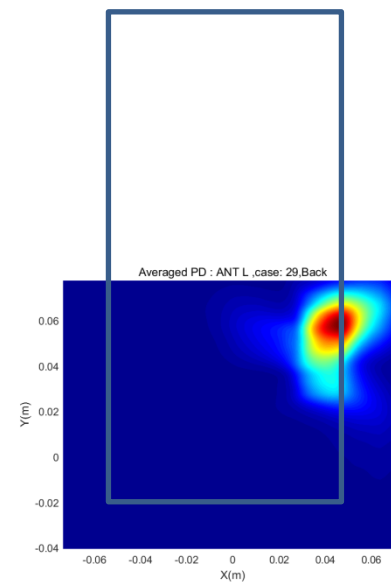
(a) measurement   (b) simulation

ANT L-Patch: Mid Channel, averaged power densit

● n261 ANT L-Patch: Mid Channel, Beam ID177, Left
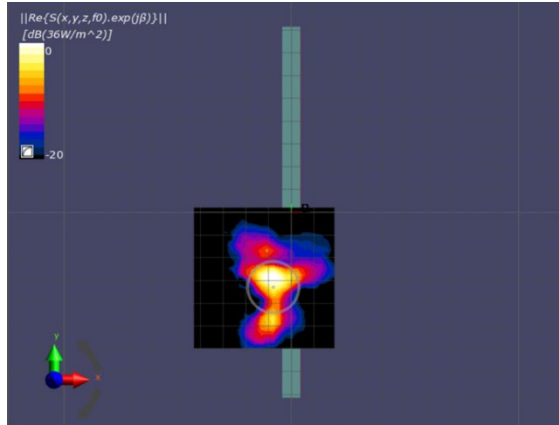
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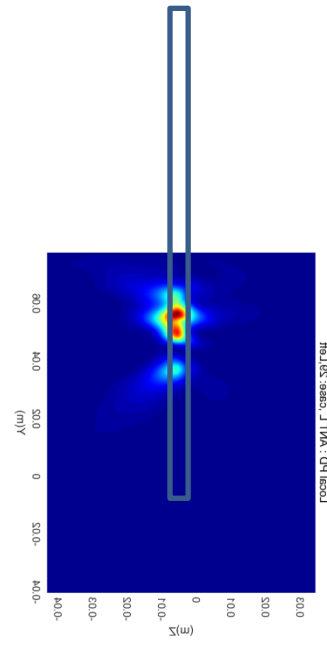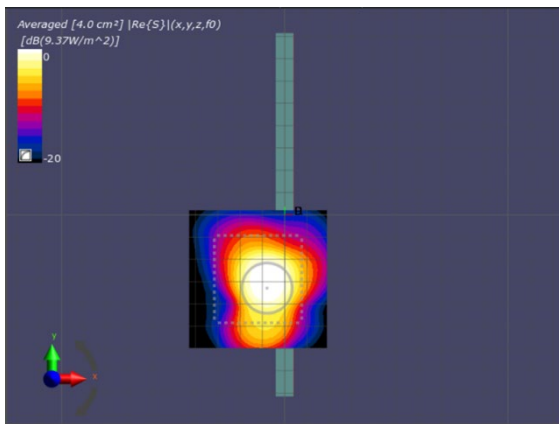
ANT L-Patch: Mid Channel, Localized power density
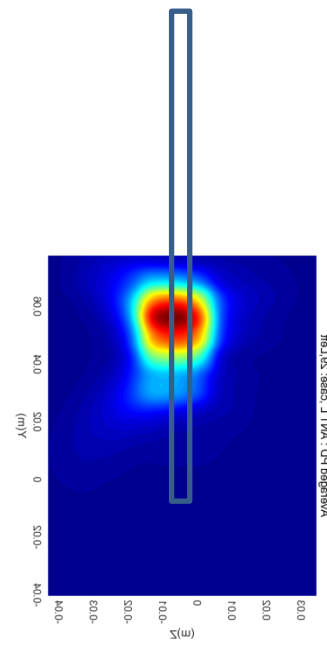
(a) measurement   (b) simulation

ANT L-Patch: Mid Channel, averaged power density

- n260 ANT J-Dipole: Mid Channel, Beam ID : 6, Back
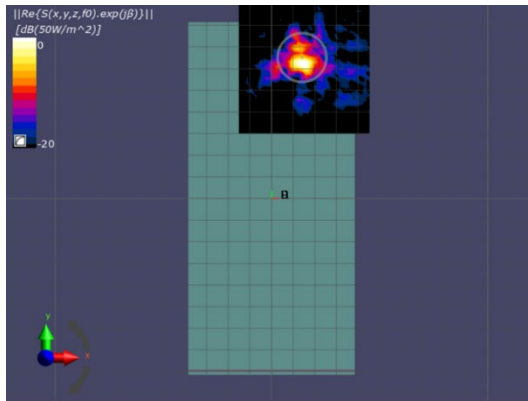
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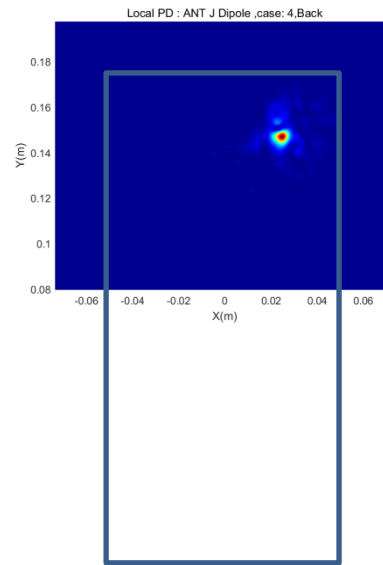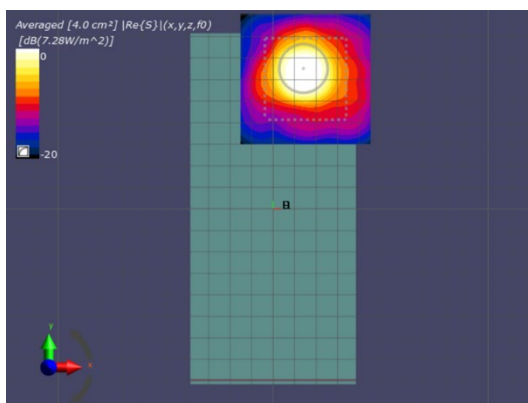
ANT J Dipole: Mid Channel, Localized power density
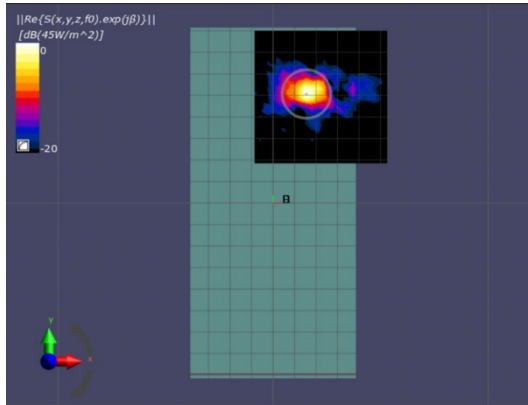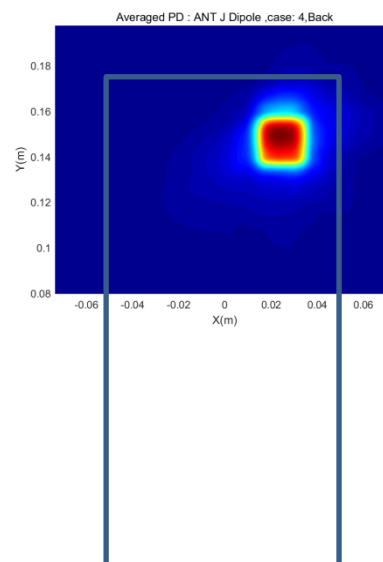

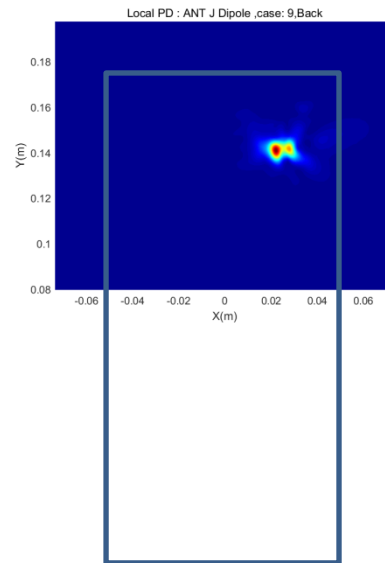(a) measurement   (b) simulation

ANT J Dipole: Mid Channel, averaged power density

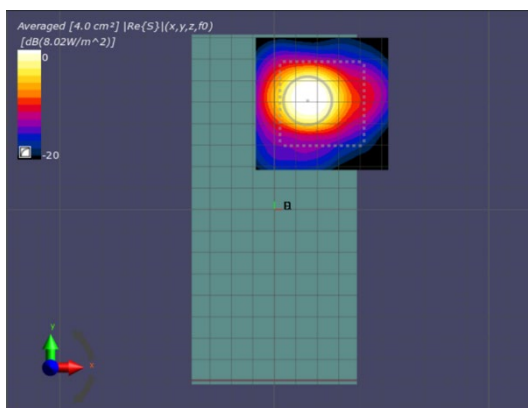● n260 ANT J- Dipole : Mid Channel, Beam ID: 134, Back
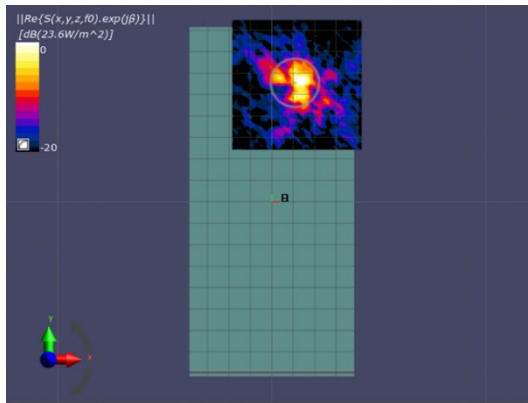
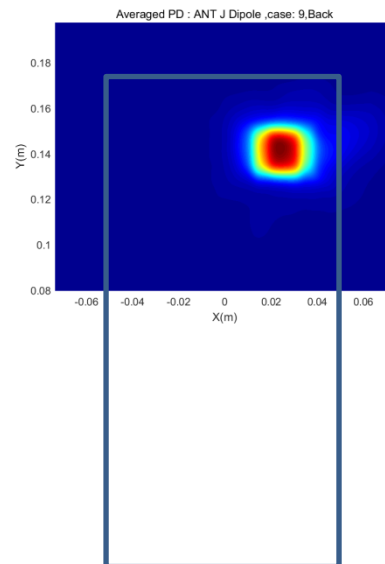(a) measurement   (b) simulation
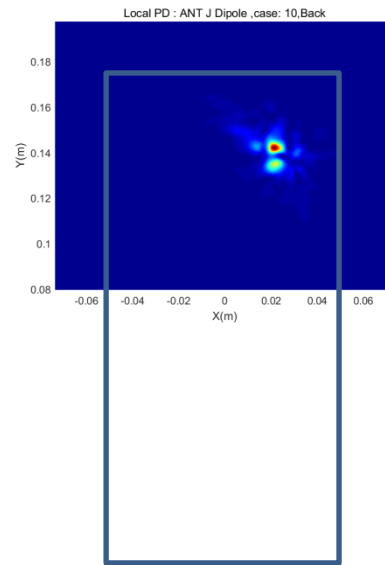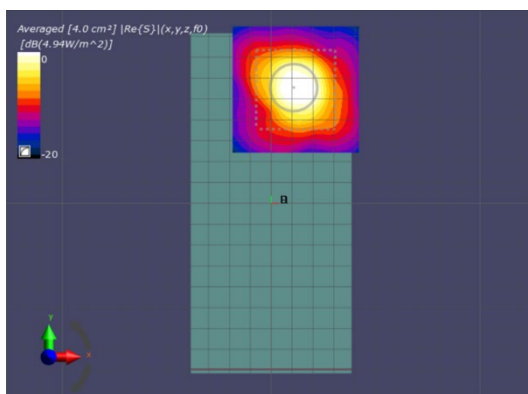
ANT J- Dipole : Mid Channel, Localized power density
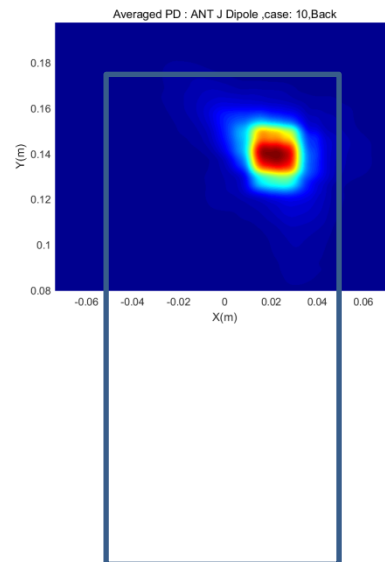
(a) measurement   (b) simulation

ANT J- Dipole : Mid Channel, averaged power density

● n260 ANT J-Patch: Mid Channel, Beam ID: 39, Back
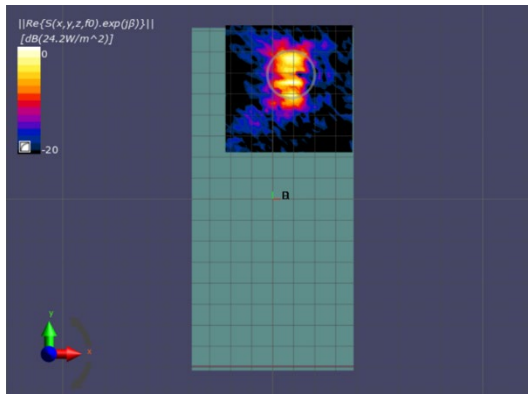
(a) measurement   (b) simulation
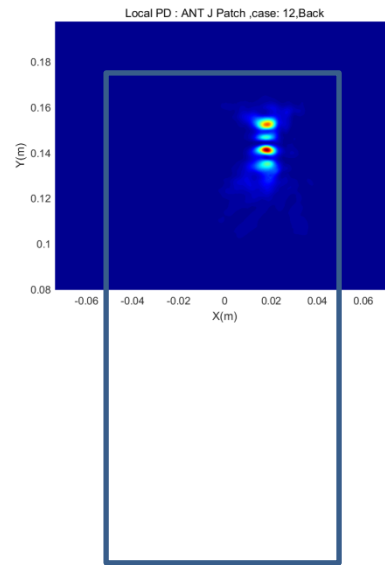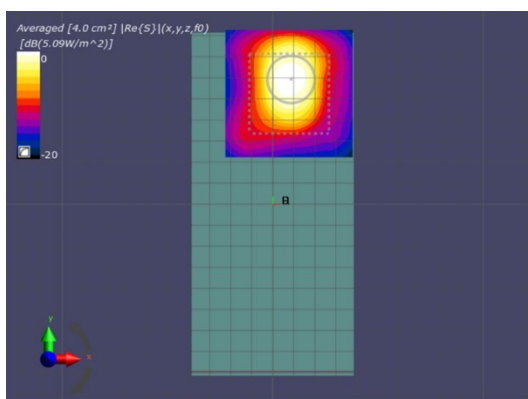
ANT J-Patch: Mid Channel, Localized power density
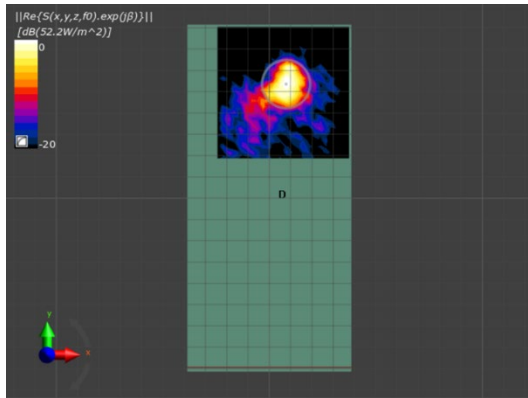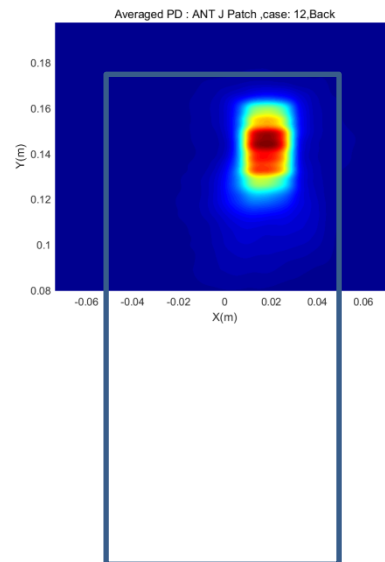

(a) measurement   (b) simulation

ANT J-Patch: Mid Channel, averaged power density

- n260 ANT J-Patch: Mid Channel, Beam ID : 153, Back
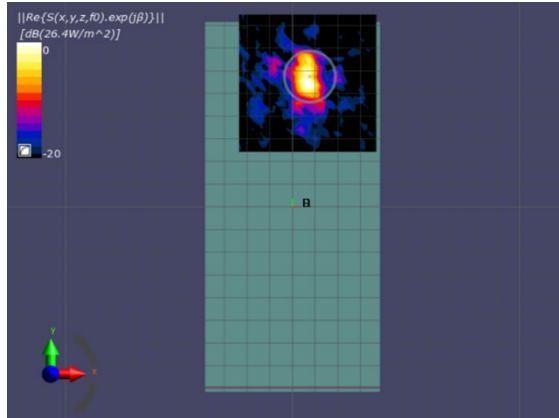
(a) measurement   (b) simulation
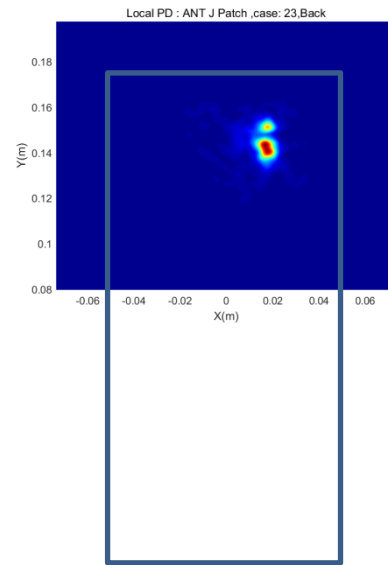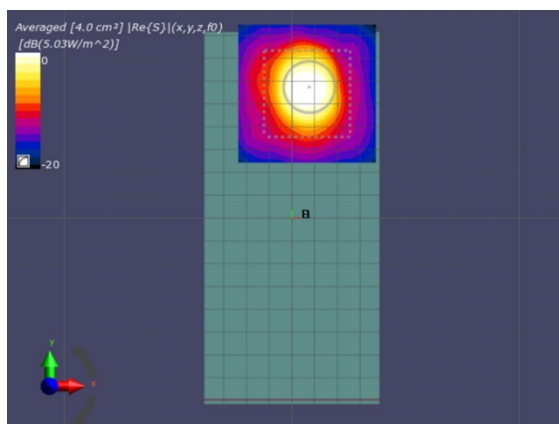
ANT J-Patch: Mid Channel, Localized power density
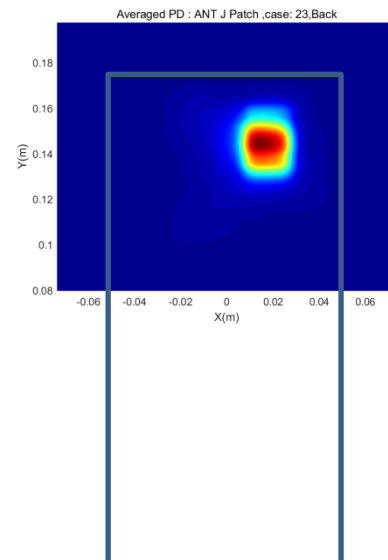
(a) measurement   (b) simulation
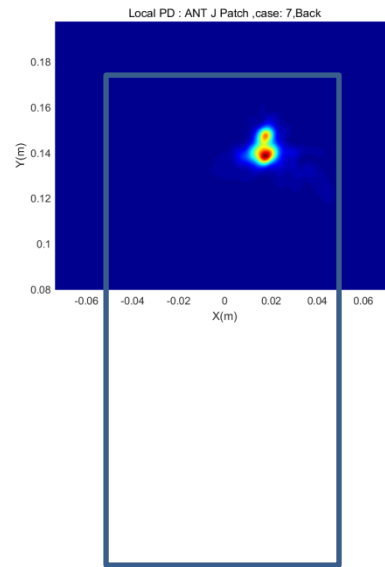
ANT J-Patch: Mid Channel, averaged power density

● n260 ANT K-Patch: Mid Channel, Beam ID 44, Back
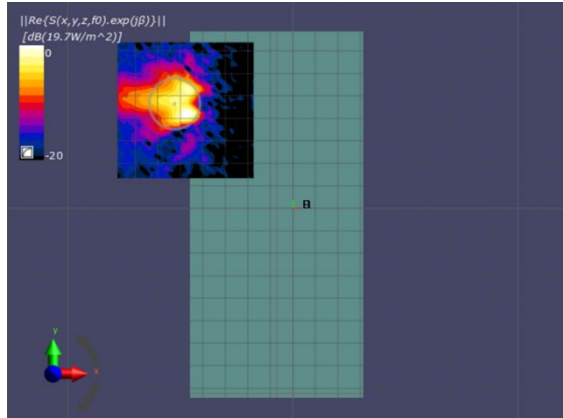
(a) measurement
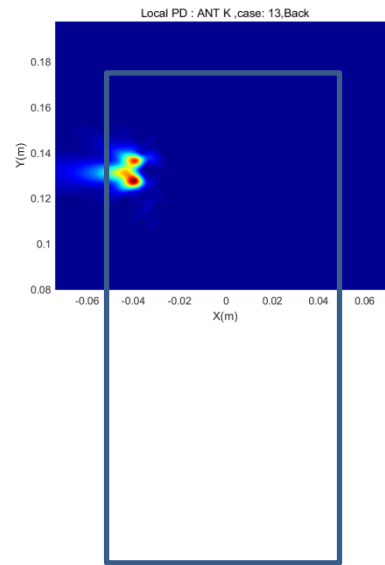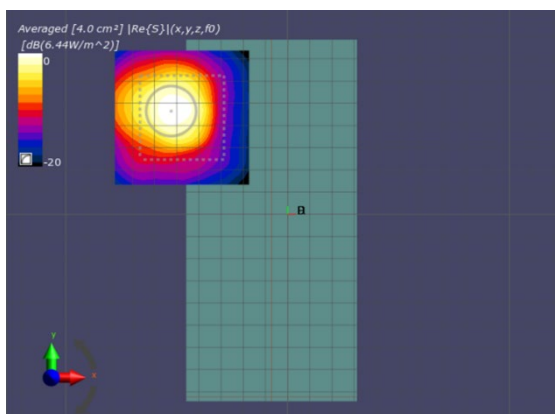
(b) simulation

ANT K-Patch: Mid Channel, Localized power density
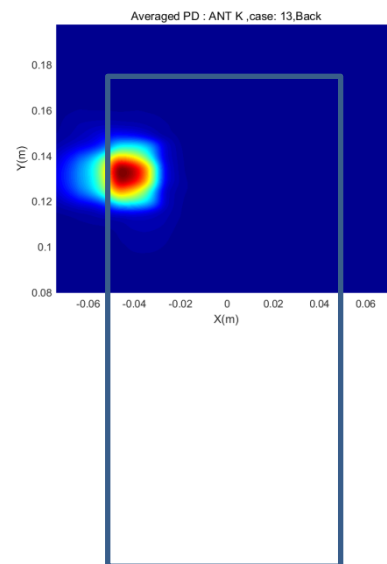
(a) measurement

(b) simulation

ANT K-Patch: Mid Channel, averaged power density

- n260 ANT K-Patch: Mid Channel, Beam ID 44, Right
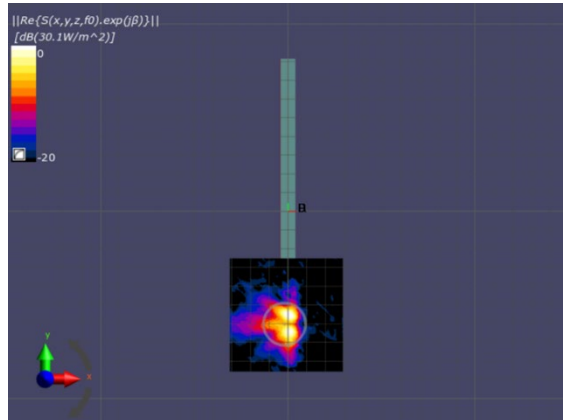
(a) measurement   (b) simulation
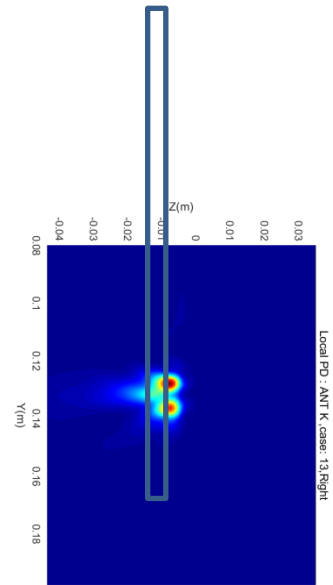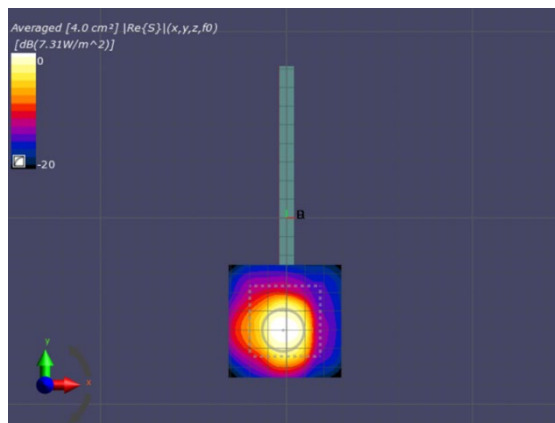
ANT K-Patch: Mid Channel, Localized power density
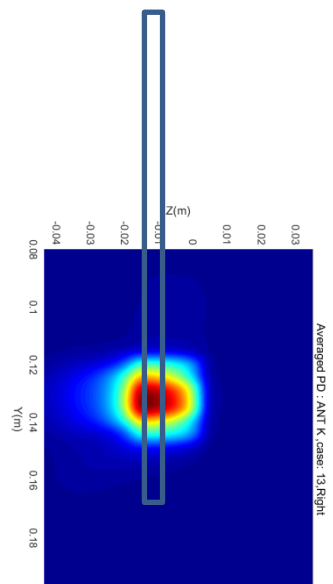
(a) measurement   (b) simulation

ANT K-Patch: Mid Channel, averaged power density
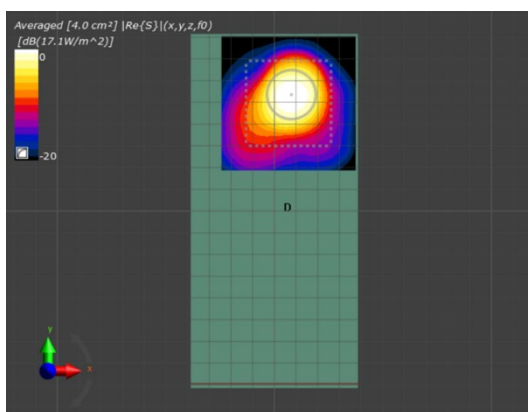
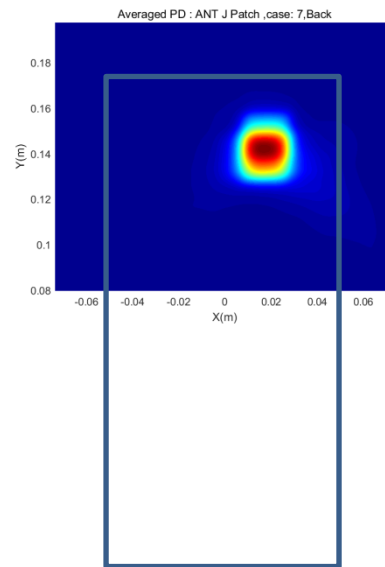● n260 ANT K-Patch: Mid Channel, Beam ID 157, Back
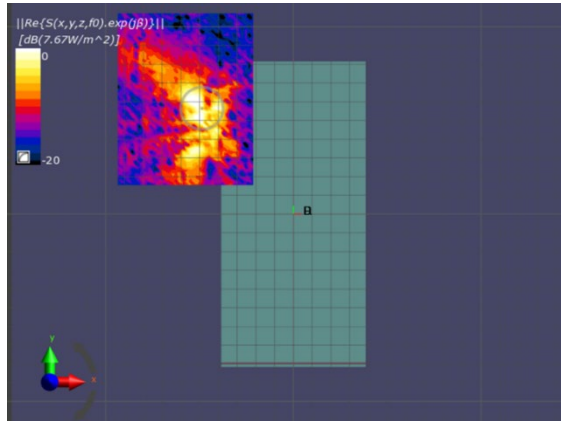
(a) measurement (b) simulation
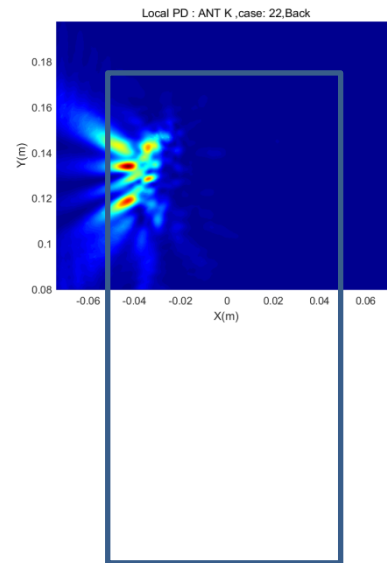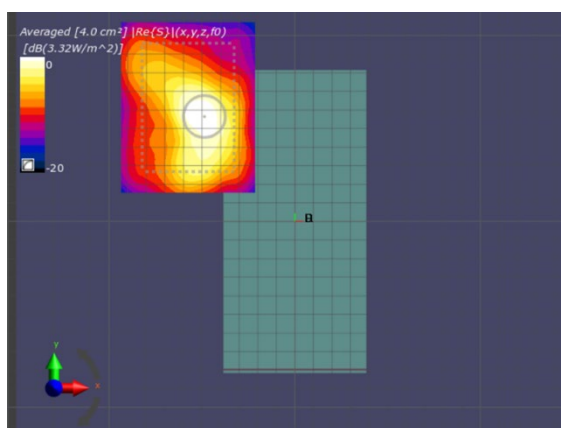
ANT K-Patch: Mid Channel, Localized power density
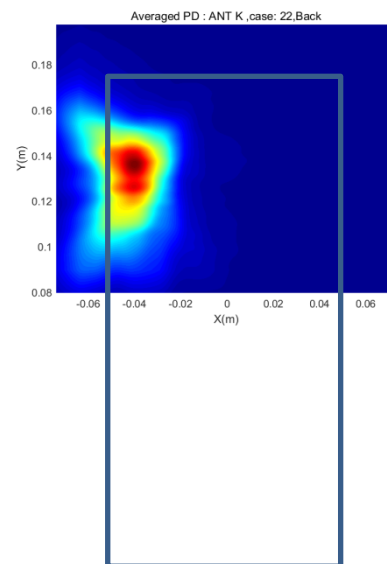
(a) measurement (b) simulation

ANT K-Patch: Mid Channel, Averaged power density

● n260 ANT K-Patch: Mid Channel, Beam ID 157, Right
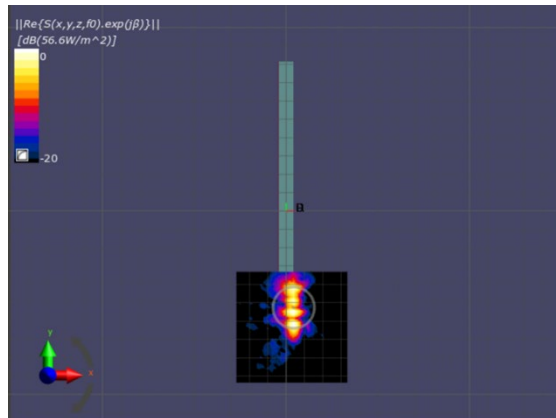
(a) measurement　　　　　　　　　(b) simulation
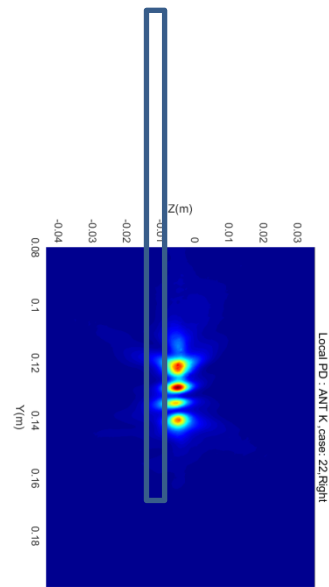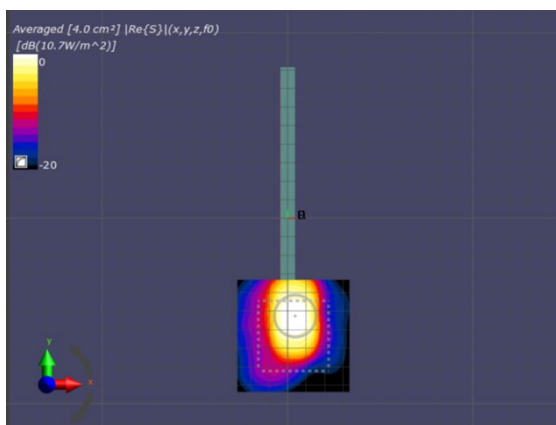
ANT K-Patch: Mid Channel, Localized power density
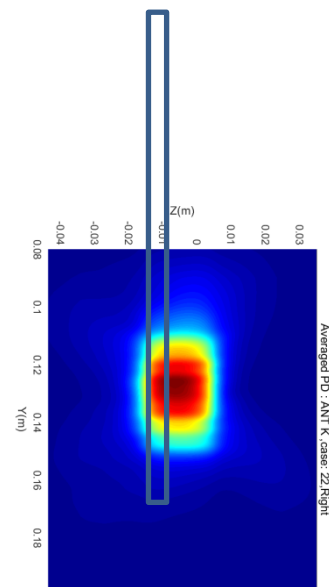
(a) measurement　　　　　　　　　(b) simulation

ANT K-Patch: Mid Channel, averaged power density

- n260 ANT L-Patch: Mid Channel, Beam ID 36, Back
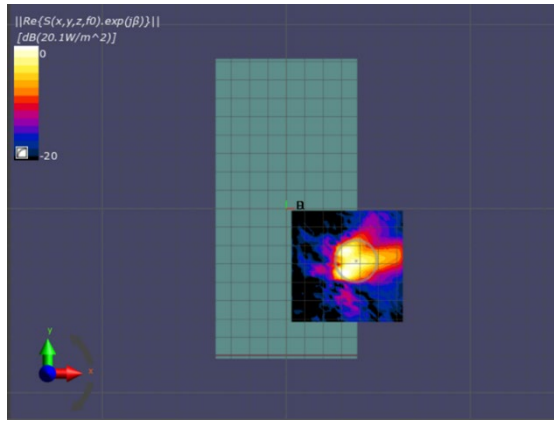
(a) measurement   (b) simulation
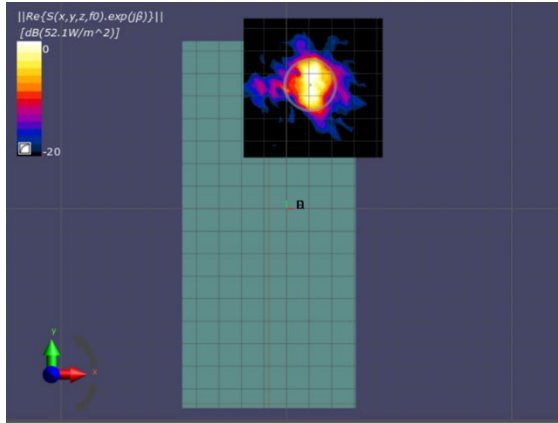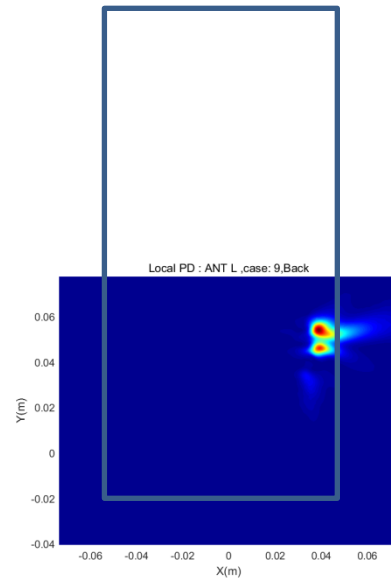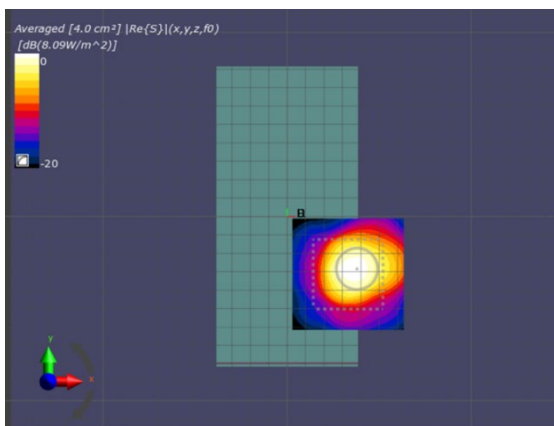
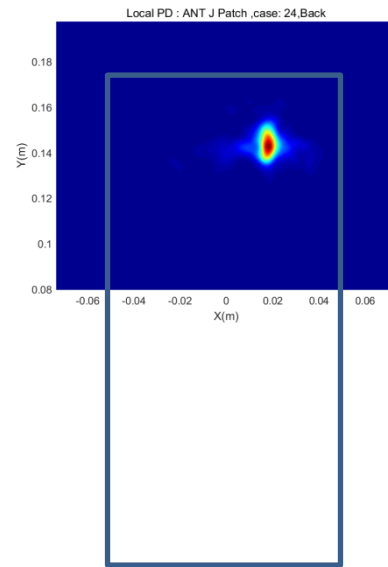ANT L-Patch: Mid Channel, Localized power density
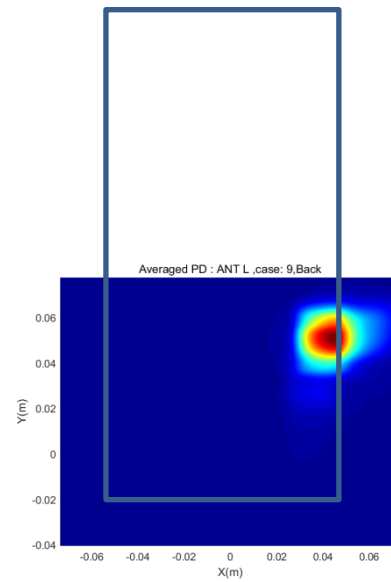
(a) measurement   (b) simulation

ANT L-Patch: Mid Channel, averaged power density

● n260 ANT L-Patch: Mid Channel, Beam ID 36, Left
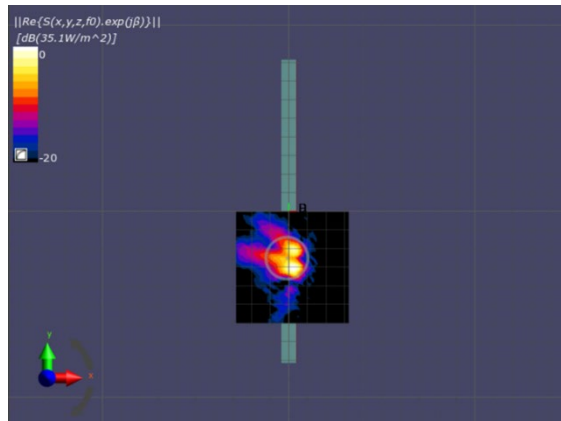
(a) measurement   (b) simulation
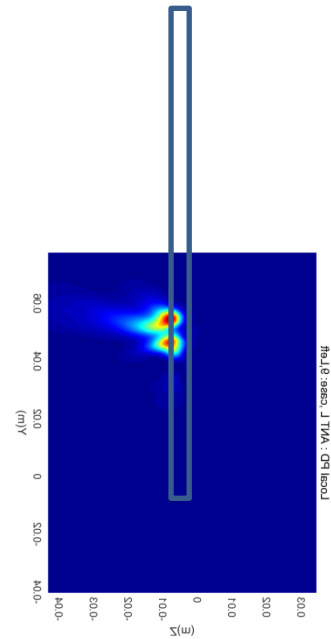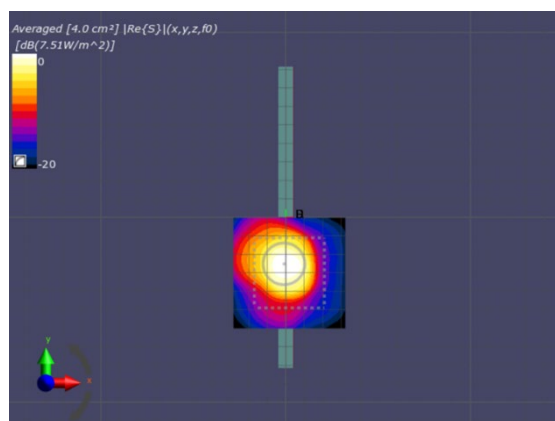
ANT L-Patch: Mid Channel, Localized power density
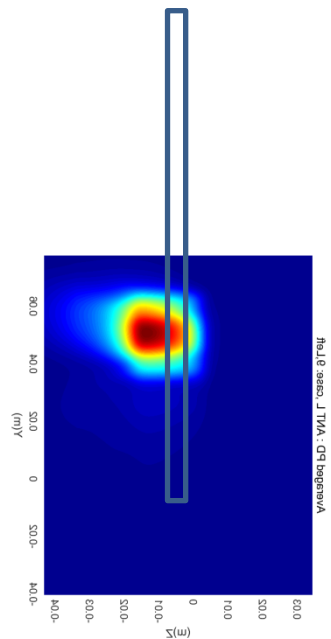
(a) measurement   (b) simulation

ANT L-Patch: Mid Channel, Averaged power density
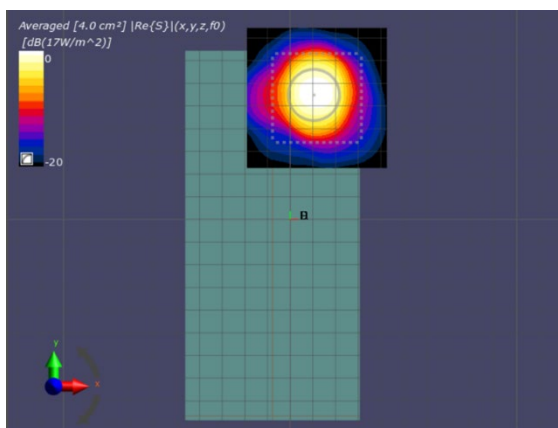
- n260 ANT L-Patch: Mid Channel, Beam ID175, Back
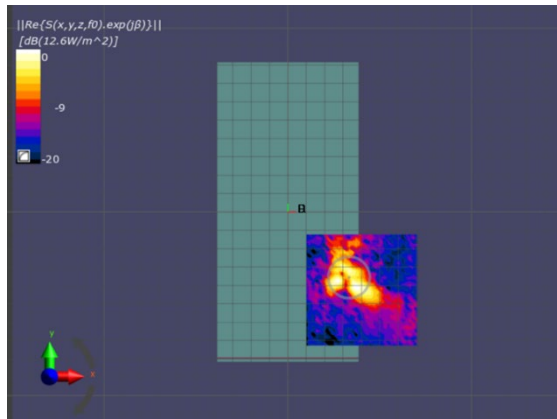
(a) measurement   (b) simulation
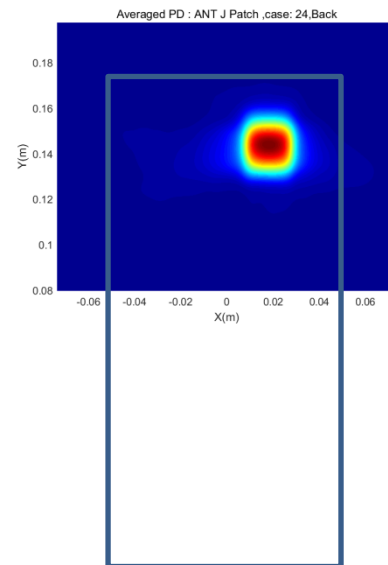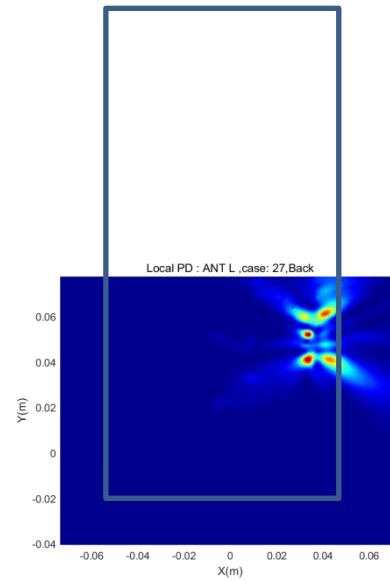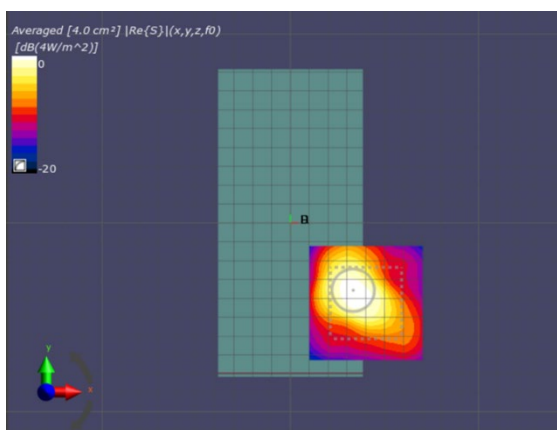
ANT L-Patch: Mid Channel, Localized power density
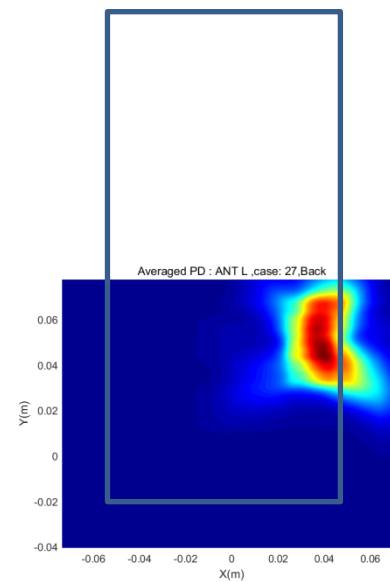
(a) measurement   (b) simulation

ANT L-Patch: Mid Channel, averaged power density

- n260 ANT L-Patch: Mid Channel, Beam ID175, Left
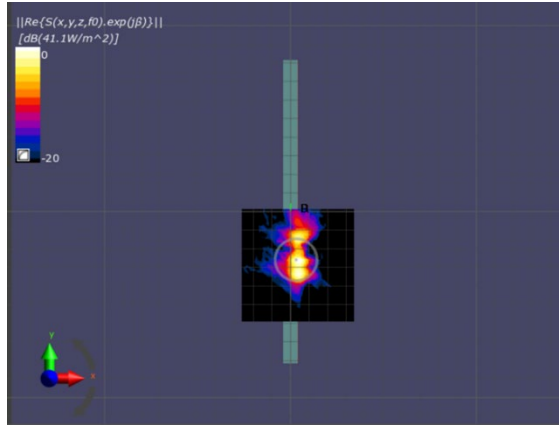
(a) measurement   (b) simulation
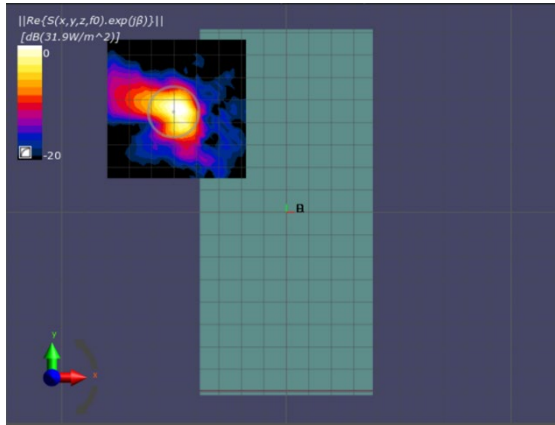
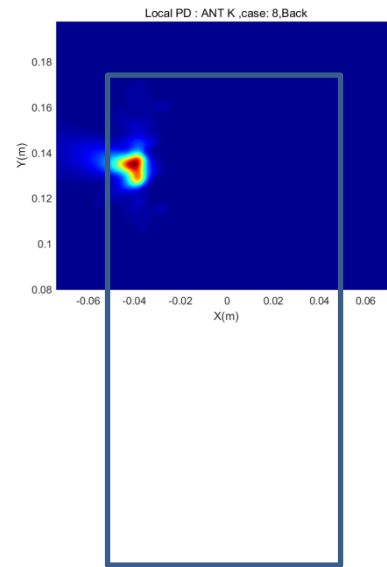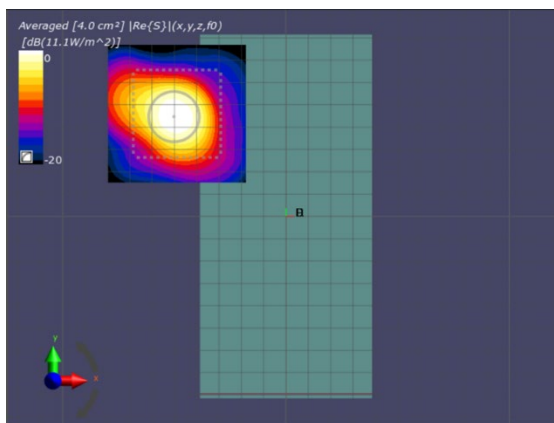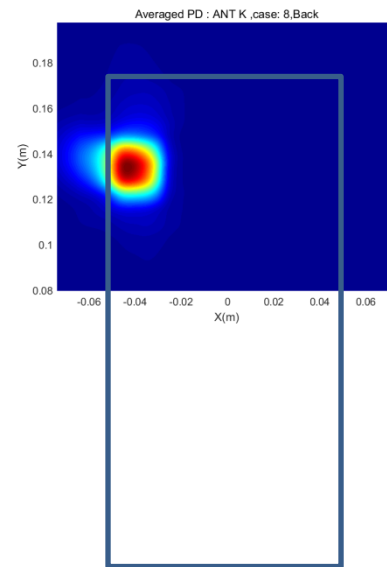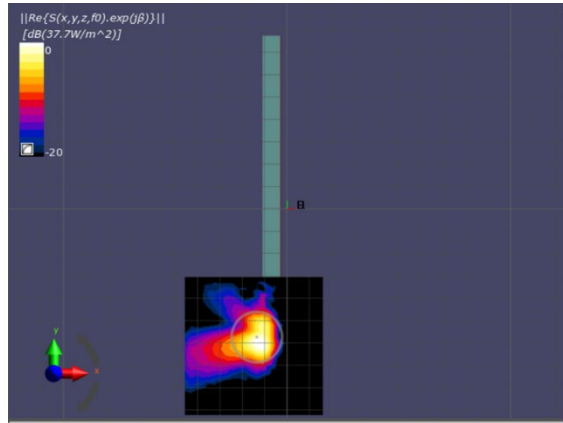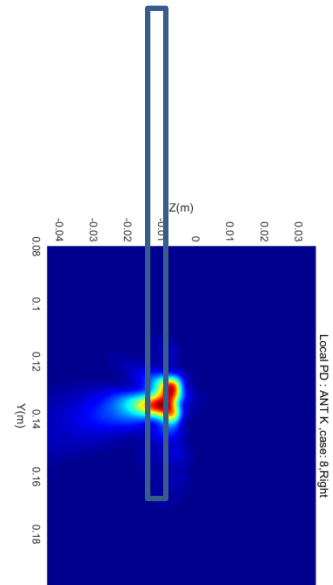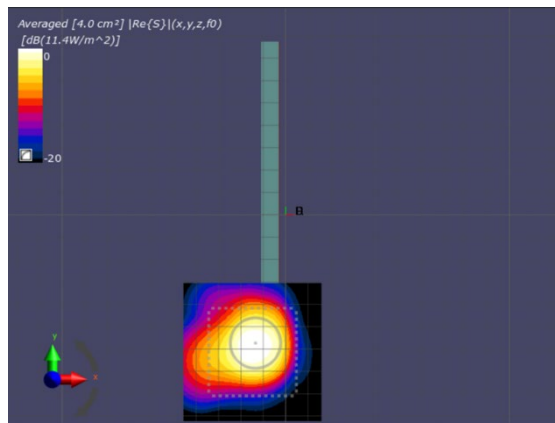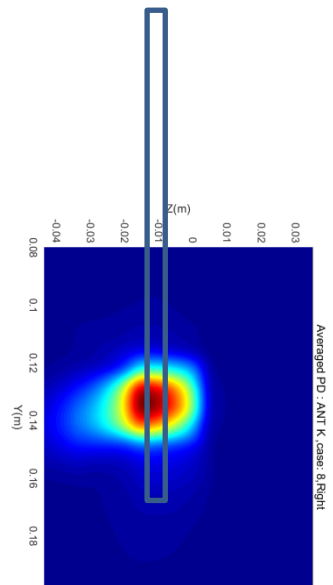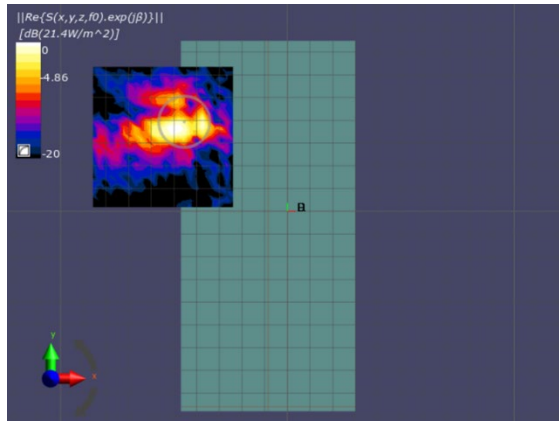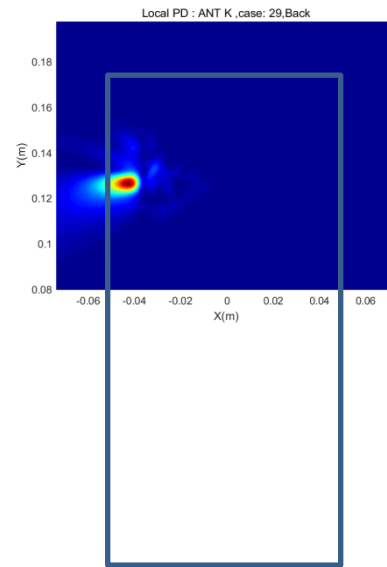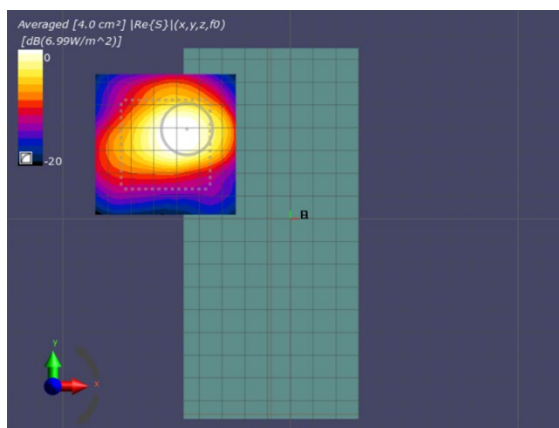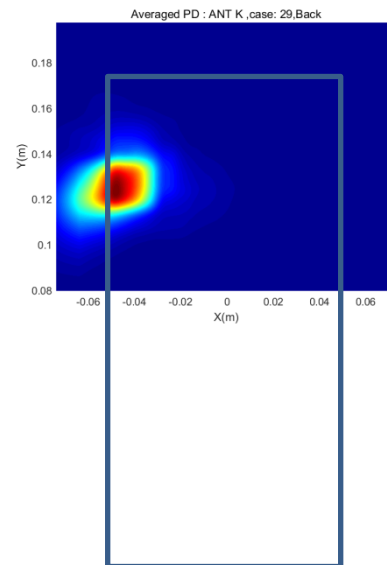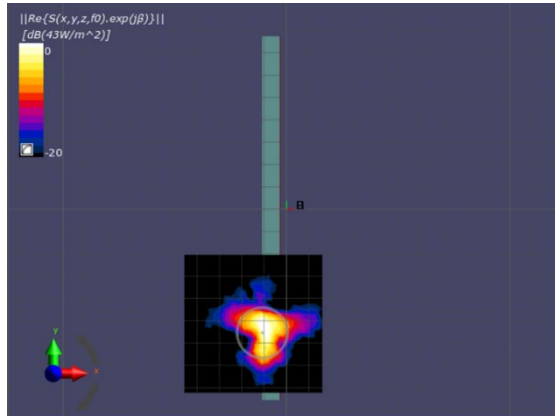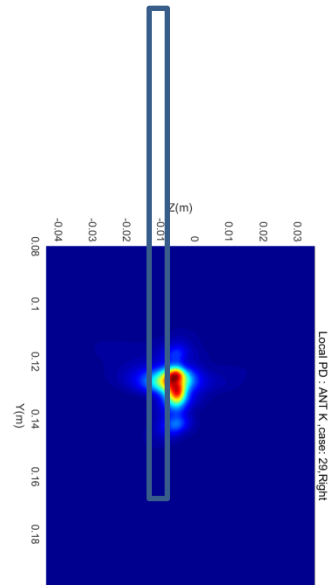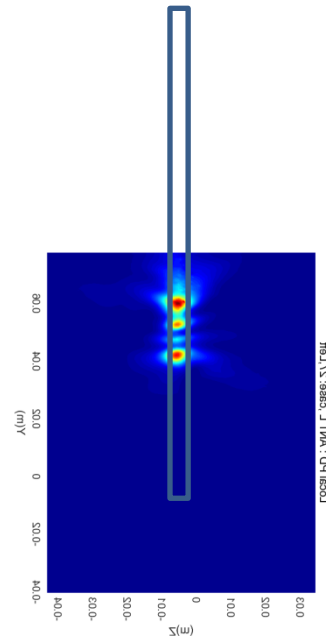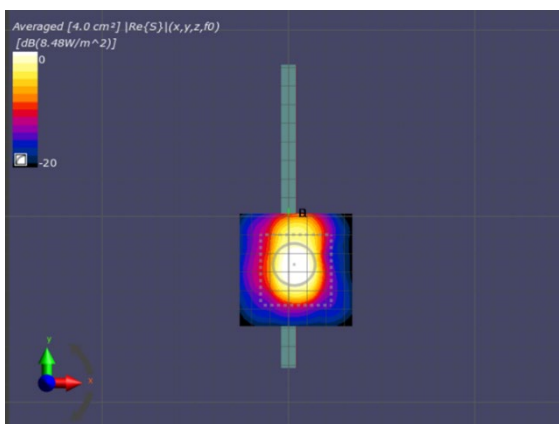ANT L-Patch: Mid Channel, Localized power density

(a) measurement   (b) simulation
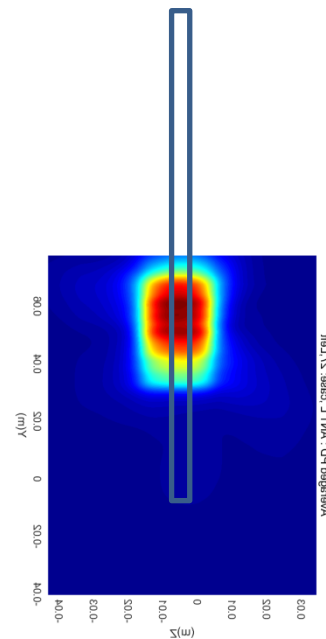
- ANT L-Patch: Mid Channel, averaged power density

3.1 PD for Low/Mid/High Channel at 28GHz / 39GHz

3.1.1 Ant J – Patch/Dipole Antenna

Table 2 & Table 3 show the PD simulation evaluation of Ant J patch/dipole antenna at 28GHz / 39GHz for each evaluation plane. The relative phase between beam pairs is not controlled in the chipset design. Therefore, the relative phase between each beam pair was considered mathematically to identify the worst case conditions. The below MIMO results represent the condition when the relative phase between each beam pair was at 0.° Section 3.2 includes the highest reported MIMO simulation results after sweeping across the relative phase between beams in a 5° step interval from 0° to 360.°

Table 2. PD of Ant J – dipole / patch antenna (28GHz)

- J–dipole Low CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
J	DIPOLE	0		1	0.04	1.83	0.48		0.20	*8.83*
		4		2	0.19	2.98	0.51		0.38	*29.52*
		5		2	0.09	2.90	0.53		0.18	*26.69*
		6		2	0.07	2.34	1.05		0.16	*20.59*
		16		2	0.15	3.10	0.45		0.36	*31.04*
		17		2	0.08	2.79	0.84		0.16	*22.81*
		128		1	0.05	2.01	0.16		0.01	*9.92*
		132		2	0.09	3.57	0.29		0.05	*16.09*
		133		2	0.07	3.15	0.20		0.05	*22.56*
		134		2	0.06	2.02	0.26		0.04	*17.63*
		144		2	0.07	3.71	0.20		0.05	*22.73*
		145		2	0.04	2.21	0.24		0.04	*19.14*
		0	128	2	0.21	2.64	0.29		0.12	7.63
		4	133	4	0.20	4.53	0.64		0.32	24.62
		5	132	4	0.08	2.85	1.07		0.17	22.16
		6	134	4	0.07	2.12	1.13		0.19	22.85
		16	144	4	0.19	4.62	0.51		0.30	23.72
		17	145	4	0.14	2.04	0.97		0.17	23.94

- J–dipole Mid CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
J	DIPOLE	0		1	0.06	1.99	0.31		0.20	*9.00*
		4		2	0.23	2.88	0.45		0.38	*28.85*
		5		2	0.10	3.44	0.88		0.25	*26.13*
		6		2	0.09	3.45	1.70		0.19	*20.16*
		16		2	0.18	2.94	0.36		0.40	*30.35*
		17		2	0.08	3.52	1.38		0.20	*22.45*
		128		1	0.05	2.12	0.17		0.02	*9.77*
		132		2	0.09	3.57	0.76		0.11	*18.34*
		133		2	0.04	3.24	0.23		0.05	*21.90*
		134		2	0.08	2.42	0.80		0.08	*20.40*
		144		2	0.04	3.70	0.20		0.04	*21.52*
		145		2	0.04	2.45	0.68		0.07	*21.28*
		0	128	2	0.16	2.69	0.38		0.12	7.98
		4	133	4	0.17	3.81	0.62		0.29	23.73
		5	132	4	0.14	3.62	1.06		0.25	24.78
		6	134	4	0.14	1.83	1.14		0.22	26.09
		16	144	4	0.16	3.93	0.49		0.29	23.04
		17	145	4	0.13	2.28	0.83		0.19	23.65

- J–dipole High CH

| Module | Type(P or D) | Beam ID_1 | Bema ID_2 | Feed no. | 4cm2 PD(W/m2) | | | | | |
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
J	DIPOLE	0		1	0.05	1.87	0.58		0.08	*9.13*
		4		2	0.20	2.89	0.79		0.25	*28.05*
		5		2	0.10	3.30	0.92		0.12	*26.36*
		6		2	0.09	3.06	1.61		0.10	*20.56*
		16		2	0.14	2.91	0.30		0.24	*29.86*
		17		2	0.10	3.33	1.35		0.10	*22.76*
		128		1	0.05	2.14	0.35		0.02	*9.51*
		132		2	0.09	3.57	0.68		0.08	*18.58*
		133		2	0.05	3.36	0.59		0.04	*20.51*
		134		2	0.06	1.30	0.92		0.07	*20.08*
		144		2	0.04	4.06	0.48		0.04	*20.22*
		145		2	0.06	2.45	0.88		0.06	*20.57*
		0	128	2	0.11	2.46	0.37		0.10	7.86
		4	133	4	0.14	3.82	0.54		0.16	23.67
		5	132	4	0.13	3.69	0.70		0.17	25.39
		6	134	4	0.13	2.36	0.76		0.15	26.28
		16	144	4	0.12	3.88	0.45		0.15	23.29
		17	145	4	0.09	2.16	0.64		0.14	23.41

- J–patch Low CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
J	PATCH	1		1	0.03	0.36	0.44		0.03	11.76
		7		2	0.10	0.25	0.39		0.06	21.45
		8		2	0.11	0.98	0.13		0.03	21.28
		9		2	0.09	0.26	1.14		0.10	18.03
		18		2	0.10	0.36	0.26		0.05	21.74
		19		2	0.11	1.21	1.17		0.08	21.78
		24		4	0.19	1.85	0.32		0.08	41.88
		25		4	0.13	0.99	0.21		0.03	37.93
		26		4	0.13	1.49	0.62		0.07	37.16
		27		4	0.16	2.19	2.54		0.16	41.28
		28		4	0.19	2.31	5.39		0.23	35.35
		39		4	0.14	1.40	0.24		0.05	41.24
		40		4	0.16	0.31	0.19		0.05	36.40
		41		4	0.12	1.58	0.76		0.10	40.98
		42		4	0.18	2.29	4.65		0.20	38.61
		129		1	0.20	0.18	0.48		0.04	9.18
		135		2	0.26	0.27	0.28		0.13	18.92
		136		2	0.24	1.22	0.10		0.09	20.12
		137		2	0.14	0.76	0.21		0.09	20.60
		146		2	0.22	0.69	1.88		0.08	20.56
		147		2	0.17	0.67	0.12		0.08	20.70
		152		4	0.51	0.35	3.25		0.11	38.36
		153		4	0.87	1.49	0.57		0.14	38.27
		154		4	0.42	0.42	0.61		0.10	39.82
		155		4	0.59	1.68	0.42		0.15	40.14
		156		4	0.47	1.67	0.52		0.16	37.19
		167		4	0.64	1.45	3.01		0.10	38.85
		168		4	0.84	1.17	0.44		0.17	37.18
		169		4	0.61	1.04	0.70		0.10	40.03
		170		4	0.49	1.77	0.46		0.15	39.13
		1	129	2	0.28	0.67	0.69		0.08	14.91
		7	137	4	0.24	0.85	0.17		0.12	33.22
		8	136	4	0.29	1.77	0.18		0.17	43.10
		9	135	4	0.34	1.78	0.88		0.18	32.17
		18	147	4	0.32	0.61	0.17		0.11	33.88
		19	146	4	0.26	0.82	0.82		0.12	34.41
		24	155	8	1.08	2.28	1.52		0.22	63.80
		25	156	8	0.81	1.91	0.59		0.23	61.20
		26	153	8	1.29	3.39	0.89		0.34	73.79
		27	152	8	0.64	4.06	1.47		0.21	86.06
		28	154	8	0.94	2.94	1.43		0.26	72.72
		39	170	8	0.97	2.22	1.50		0.23	62.97
		40	169	8	0.63	2.33	1.16		0.35	70.74
		41	167	8	0.74	3.77	1.29		0.16	81.69
		42	168	8	0.98	3.13	1.51		0.32	72.26

- J–patch Mid CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
J	PATCH	1		1	0.04	0.54	0.32		0.04	11.21
		7		2	0.05	0.37	0.43		0.04	20.73
		8		2	0.09	0.90	0.28		0.03	20.43
		9		2	0.13	0.67	0.93		0.08	17.33
		18		2	0.04	0.33	0.32		0.04	21.01
		19		2	0.09	1.21	1.01		0.06	20.57
		24		4	0.16	1.73	0.28		0.07	39.76
		25		4	0.13	1.36	0.20		0.04	36.31
		26		4	0.17	1.24	1.44		0.09	34.43
		27		4	0.17	2.11	2.03		0.16	39.67
		28		4	0.29	2.26	4.07		0.16	34.86
		39		4	0.16	1.25	0.29		0.05	38.93
		40		4	0.11	1.01	0.21		0.04	34.60
		41		4	0.14	1.37	0.91		0.13	38.92
		42		4	0.28	2.34	3.46		0.16	37.47
		129		1	0.11	0.21	1.21		0.08	8.71
		135		2	0.23	0.31	0.47		0.10	18.26
		136		2	0.25	0.88	0.19		0.08	19.92
		137		2	0.23	0.78	0.40		0.04	20.43
		146		2	0.18	0.75	1.58		0.12	19.90
		147		2	0.22	0.84	0.18		0.05	20.45
		152		4	0.42	1.15	2.39		0.18	38.91
		153		4	0.88	1.63	0.97		0.11	37.64
		154		4	0.44	1.63	0.56		0.16	39.40
		155		4	0.31	1.71	1.10		0.09	38.20
		156		4	0.42	1.84	0.70		0.13	35.49
		167		4	0.55	1.37	2.06		0.14	38.46
		168		4	0.76	1.51	1.25		0.20	36.96
		169		4	0.50	1.97	0.78		0.08	39.15
		170		4	0.38	1.89	1.25		0.11	37.63
		1	129	2	0.15	0.63	1.70		0.18	14.28
		7	137	4	0.32	0.86	0.42		0.08	32.04
		8	136	4	0.45	1.86	0.18		0.18	43.00
		9	135	4	0.33	1.28	0.92		0.23	30.64
		18	147	4	0.31	0.93	0.41		0.09	32.98
		19	146	4	0.19	1.12	2.81		0.15	33.11
		24	155	8	1.09	2.02	0.66		0.28	62.96
		25	156	8	0.84	1.73	0.51		0.29	59.74
		26	153	8	1.34	3.10	2.39		0.42	71.74
		27	152	8	0.57	2.99	4.98		0.55	80.54
		28	154	8	0.82	2.51	2.54		0.51	70.13
		39	170	8	0.96	1.96	0.53		0.28	62.07
		40	169	8	0.51	1.19	4.51		0.18	68.70
		41	167	8	0.64	2.46	1.29		0.46	79.20
		42	168	8	0.91	2.71	3.68		0.51	69.55

- J–patch High CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
J	PATCH	1		1	0.04	0.52	0.31		0.02	10.63
		7		2	0.04	0.42	0.36		0.04	19.60
		8		2	0.07	0.85	0.26		0.02	19.55
		9		2	0.12	0.45	1.49		0.05	15.87
		18		2	0.04	0.36	0.28		0.04	19.91
		19		2	0.08	0.97	0.96		0.03	19.02
		24		4	0.14	1.63	0.40		0.08	37.55
		25		4	0.10	1.27	0.17		0.03	34.68
		26		4	0.16	1.07	1.45		0.03	32.30
		27		4	0.19	1.69	1.69		0.08	36.16
		28		4	0.28	2.18	3.41		0.11	32.12
		39		4	0.13	1.05	0.24		0.05	37.01
		40		4	0.07	1.04	0.18		0.03	32.76
		41		4	0.11	1.08	0.60		0.04	36.54
		42		4	0.24	1.95	2.85		0.10	34.31
		129		1	0.08	0.23	1.21		0.06	8.32
		135		2	0.15	0.94	0.44		0.09	17.39
		136		2	0.17	0.82	0.18		0.06	19.64
		137		2	0.24	1.33	0.31		0.04	19.36
		146		2	0.18	0.65	1.14		0.08	19.23
		147		2	0.21	0.77	0.20		0.04	19.75
		152		4	0.30	1.23	1.83		0.16	38.39
		153		4	0.67	1.49	0.55		0.10	36.61
		154		4	0.37	1.53	0.67		0.17	37.35
		155		4	0.35	2.09	1.07		0.07	36.58
		156		4	0.47	1.88	1.26		0.13	33.62
		167		4	0.51	1.48	1.44		0.12	37.63
		168		4	0.52	0.37	1.11		0.17	35.43
		169		4	0.54	1.63	0.77		0.09	36.75
		170		4	0.43	1.82	1.15		0.09	36.05
		1	129	2	0.13	0.52	1.76		0.12	13.67
		7	137	4	0.28	0.99	0.45		0.09	31.35
		8	136	4	0.35	1.76	0.46		0.12	42.46
		9	135	4	0.23	1.18	2.43		0.12	29.65
		18	147	4	0.26	1.00	0.41		0.09	32.28
		19	146	4	0.21	1.24	2.54		0.14	30.38
		24	155	8	1.05	1.93	0.76		0.26	62.97
		25	156	8	0.86	1.63	0.77		0.30	59.27
		26	153	8	1.08	2.91	2.03		0.25	68.71
		27	152	8	0.39	2.56	4.26		0.41	76.04
		28	154	8	0.62	0.76	2.40		0.37	67.81
		39	170	8	0.96	1.86	0.81		0.28	61.65
		40	169	8	0.43	1.28	3.98		0.12	65.71
		41	167	8	0.53	2.24	1.43		0.38	75.44
		42	168	8	0.67	0.77	3.38		0.33	67.44

Table 3. PD of Ant J –dipole/patch antenna (39GHz)

- J–dipole Low CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
J	DIPOLE	0		2	0.03	1.33	0.51		0.05	*6.52*
		4		4	0.05	2.13	1.91		0.03	*14.61*
		5		4	0.06	2.29	1.37		0.10	*12.24*
		6		4	0.04	2.33	1.37		0.05	*15.29*
		16		4	0.04	2.23	0.97		0.09	*14.19*
		17		4	0.05	2.00	2.06		0.03	*13.96*
		128		2	0.02	0.48	0.15		0.01	*4.79*
		132		4	0.04	1.44	0.44		0.02	*8.32*
		133		4	0.03	1.29	0.50		0.02	*8.23*
		134		4	0.03	0.51	0.29		0.02	*10.60*
		144		4	0.02	1.11	0.57		0.02	*8.57*
		145		4	0.03	0.92	0.15		0.02	*10.37*
		0	128	2	0.03	0.88	0.12		0.05	3.88
		4	132	4	0.08	2.06	1.45		0.02	9.12
		5	134	4	0.02	1.92	0.68		0.07	10.48
		6	133	4	0.03	2.13	0.46		0.03	11.88
		16	144	4	0.03	2.15	0.43		0.07	9.77
		17	145	4	0.06	2.02	1.37		0.02	9.01

- J–dipole Mid CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
J	DIPOLE	0		2	0.03	1.47	0.55		0.03	*6.26*
		4		4	0.06	1.92	1.99		0.04	*13.77*
		5		4	0.03	2.85	1.01		0.05	*12.11*
		6		4	0.06	2.01	1.88		0.04	*14.16*
		16		4	0.05	2.32	1.11		0.05	*13.45*
		17		4	0.05	1.94	1.95		0.04	*13.40*
		128		2	0.02	0.68	0.16		0.02	*4.17*
		132		4	0.04	1.42	0.40		0.01	*7.80*
		133		4	0.04	1.42	0.38		0.02	*7.86*
		134		4	0.03	0.88	0.43		0.04	*9.93*
		144		4	0.04	1.23	0.54		0.03	*8.36*
		145		4	0.03	0.12	0.07		0.02	*9.49*
		0	128	2	0.01	1.18	0.06		0.03	4.20
		4	132	4	0.04	2.09	1.24		0.04	9.69
		5	134	4	0.04	2.10	0.62		0.05	8.92
		6	133	4	0.03	1.90	0.45		0.03	10.50
		16	144	4	0.04	2.12	0.50		0.05	8.80
		17	145	4	0.04	1.69	1.32		0.04	8.94

- J–dipole High CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
	DIPOLE	0		2	0.03	1.26	0.55		0.02	*5.70*
		4		4	0.07	1.96	1.05		0.03	*13.21*
		5		4	0.04	2.12	0.86		0.03	*11.97*
		6		4	0.07	1.72	0.88		0.03	*12.80*
		16		4	0.04	1.94	1.05		0.03	*12.12*
		17		4	0.05	2.04	1.07		0.04	*13.21*
		128		2	0.03	0.59	0.07		0.02	*4.10*
		132		4	0.01	1.24	0.28		0.03	*7.56*
		133		4	0.05	1.30	0.30		0.03	*7.53*
		134		4	0.04	0.85	0.37		0.02	*8.55*
		144		4	0.04	1.27	0.32		0.03	*7.64*
		145		4	0.03	0.85	0.18		0.02	*8.74*
		0	128	2	0.04	0.83	0.12		0.04	3.16
		4	132	4	0.05	1.92	0.85		0.03	9.26
		5	134	4	0.09	2.29	0.33		0.04	9.57
		6	133	4	0.04	1.66	0.76		0.03	9.59
		16	144	4	0.08	1.61	0.38		0.03	8.28
		17	145	4	0.03	1.93	1.01		0.03	9.08

- J–patch Low CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
J	PATCH	1		1	0.03	0.16	0.72		0.01	*5.48*
		7		2	0.04	0.08	0.15		0.02	*9.53*
		8		2	0.06	0.09	0.22		0.03	*9.43*
		9		2	0.03	0.30	0.36		0.02	*10.23*
		18		2	0.03	0.28	0.28		0.02	*9.54*
		19		2	0.04	0.19	0.60		0.03	*6.53*
		24		4	0.04	0.40	0.08		0.02	*16.70*
		25		4	0.03	0.38	0.39		0.07	*14.28*
		26		4	0.06	0.20	0.09		0.02	*17.24*
		27		4	0.04	0.49	0.33		0.05	*13.93*
		28		4	0.08	0.65	0.73		0.04	*12.40*
		39		4	0.03	0.43	0.35		0.04	*14.91*
		40		4	0.12	0.51	0.58		0.04	*13.76*
		41		4	0.07	0.39	0.46		0.10	*11.58*
		42		4	0.11	0.72	4.12		0.05	*14.50*
		129		1	0.03	0.09	0.20		0.01	*5.05*
		135		2	0.05	0.18	0.39		0.03	*9.09*
		136		2	0.08	0.08	0.10		0.01	*8.94*
		137		2	0.07	0.10	0.10		0.01	*9.30*
		146		2	0.07	0.13	0.06		0.02	*9.49*
		147		2	0.06	0.15	0.16		0.02	*8.68*
		152		4	0.13	0.45	0.35		0.07	*13.82*
		153		4	0.14	0.07	0.13		0.01	*16.26*
		154		4	0.15	0.46	0.79		0.02	*13.73*
		155		4	0.10	0.45	0.37		0.08	*11.28*
		156		4	0.16	0.08	0.14		0.02	*15.84*
		167		4	0.20	0.41	0.28		0.05	*14.46*
		168		4	0.19	0.08	0.14		0.02	*15.33*
		169		4	0.13	0.30	0.56		0.04	*12.59*
		170		4	0.14	0.14	0.27		0.03	*15.77*
		1	129	1	0.09	0.14	0.83		0.03	10.50
		7	136	2	0.10	0.11	0.96		0.04	14.44
		8	137	2	0.08	0.20	0.56		0.05	14.80
		9	135	2	0.10	0.17	1.52		0.04	16.31
		18	147	2	0.11	0.50	1.30		0.03	13.58
		19	146	2	0.10	0.29	0.95		0.04	14.67
		24	153	4	0.33	0.42	1.47		0.08	30.00
		25	154	4	0.42	0.83	2.98		0.10	27.92
		26	152	4	0.34	0.61	0.52		0.09	31.82
		27	155	4	0.31	0.46	2.97		0.09	30.46
		28	156	4	0.20	0.60	2.84		0.07	28.31
		39	167	4	0.20	0.79	0.51		0.11	30.06
		40	169	4	0.27	0.19	3.16		0.08	27.57
		41	168	4	0.21	0.21	0.43		0.06	31.30
		42	170	4	0.23	0.67	3.76		0.09	28.42

- J–patch Mid CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
		1		1	0.04	0.20	0.75		0.02	6.18
		7		2	0.04	0.23	0.35		0.02	9.98
		8		2	0.05	0.33	0.22		0.02	9.93
		9		2	0.03	0.40	1.67		0.03	11.56
		18		2	0.03	0.32	0.55		0.02	10.00
		19		2	0.04	0.13	0.73		0.03	7.25
		24		4	0.04	0.34	0.27		0.02	17.53
		25		4	0.08	0.18	2.35		0.03	15.19
		26		4	0.07	0.48	0.30		0.03	17.21
		27		4	0.05	0.76	1.95		0.06	16.53
		28		4	0.09	0.44	3.59		0.04	13.19
		39		4	0.05	0.75	1.77		0.04	17.89
		40		4	0.09	0.45	2.63		0.05	14.45
		41		4	0.06	0.69	0.53		0.07	15.19
		42		4	0.09	0.59	3.77		0.03	16.95
		129		1	0.03	0.14	0.08		0.01	5.76
		135		2	0.06	0.24	0.15		0.02	10.31
		136		2	0.10	0.19	0.09		0.02	9.80
		137		2	0.07	0.14	0.06		0.02	10.40
		146		2	0.08	0.18	0.06		0.02	10.59
		147		2	0.06	0.29	0.20		0.01	9.56
	PATCH	152		4	0.10	0.60	0.50		0.06	15.79
		153		4	0.15	0.10	0.20		0.04	19.55
		154		4	0.08	0.14	0.42		0.05	13.82
		155		4	0.08	0.47	0.55		0.05	13.90
		156		4	0.22	0.17	0.33		0.03	18.97
		167		4	0.18	0.69	0.53		0.06	14.68
		168		4	0.22	0.21	0.40		0.03	17.46
		169		4	0.18	0.67	0.56		0.04	13.67
		170		4	0.18	0.19	0.45		0.03	18.83
		1	129	1	0.07	0.35	0.65		0.03	10.89
		7	136	2	0.11	0.40	0.36		0.03	15.80
		8	137	2	0.09	0.51	0.58		0.04	16.20
		9	135	2	0.14	0.63	0.80		0.03	13.26
		18	147	2	0.13	0.49	0.41		0.03	14.57
		19	146	2	0.08	0.34	1.08		0.08	16.97
		24	153	4	0.26	0.79	1.53		0.08	30.73
		25	154	4	0.32	0.72	2.92		0.08	31.77
		26	152	4	0.28	0.90	1.55		0.11	33.29
		27	155	4	0.38	0.44	2.93		0.11	31.64
		28	156	4	0.37	0.43	3.28		0.07	29.75
		39	167	4	0.28	1.33	3.66		0.12	29.38
		40	169	4	0.28	0.63	3.99		0.07	30.29
		41	168	4	0.41	0.49	2.48		0.07	35.79
		42	170	4	0.38	0.53	3.76		0.07	29.80

- J-patch High CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
	PATCH	1		1	0.02	0.17	0.15		0.01	5.19
		7		2	0.04	0.33	0.29		0.02	7.55
		8		2	0.03	0.39	0.19		0.02	7.78
		9		2	0.02	0.30	0.40		0.02	9.42
		18		2	0.03	0.31	0.41		0.02	8.37
		19		2	0.04	0.09	0.57		0.02	6.84
		24		4	0.07	0.57	0.41		0.04	12.12
		25		4	0.06	0.51	0.67		0.03	15.13
		26		4	0.05	0.30	0.24		0.05	11.62
		27		4	0.10	0.31	0.27		0.04	16.11
		28		4	0.06	0.58	2.39		0.03	15.76
		39		4	0.09	0.29	0.97		0.04	17.08
		40		4	0.09	0.16	0.84		0.05	13.13
		41		4	0.05	0.24	0.36		0.03	15.28
		42		4	0.11	0.66	0.82		0.04	16.44
		129		1	0.02	0.02	0.13		0.01	5.00
		135		2	0.03	0.12	0.22		0.02	8.95
		136		2	0.04	0.11	0.08		0.01	8.68
		137		2	0.07	0.08	0.06		0.01	8.94
		146		2	0.06	0.11	0.08		0.02	9.08
		147		2	0.02	0.23	0.24		0.01	8.56
		152		4	0.08	0.31	0.22		0.06	13.92
		153		4	0.20	0.24	0.43		0.03	14.14
		154		4	0.09	0.44	0.28		0.02	13.21
		155		4	0.07	0.29	0.33		0.05	11.52
		156		4	0.19	0.18	0.18		0.03	18.02
		167		4	0.12	0.15	0.47		0.06	13.79
		168		4	0.19	0.19	0.21		0.03	17.54
		169		4	0.11	0.41	1.48		0.03	12.59
		170		4	0.15	0.14	0.16		0.02	17.09
		1	129	1	0.06	0.20	0.17		0.03	10.24
		7	136	2	0.06	0.46	0.36		0.03	13.04
		8	137	2	0.05	0.10	0.35		0.04	13.96
		9	135	2	0.05	0.47	0.38		0.05	14.72
		18	147	2	0.05	0.42	0.28		0.04	14.49
		19	146	2	0.09	0.31	0.88		0.05	14.41
		24	153	4	0.30	0.41	0.44		0.11	27.51
		25	154	4	0.23	0.40	1.59		0.08	35.61
		26	152	4	0.23	0.96	0.33		0.15	29.17
		27	155	4	0.28	0.37	1.75		0.14	28.81
		28	156	4	0.24	0.12	1.13		0.07	26.88
		39	167	4	0.18	0.34	2.63		0.10	31.08
		40	169	4	0.28	0.55	2.79		0.06	33.32
		41	168	4	0.23	0.61	1.76		0.09	34.20
		42	170	4	0.22	0.74	0.98		0.06	28.05

3.1.2 Ant K – Patch Antenna

Table 4 & Table 5 show the PD simulation evaluation of Ant K patch antenna at 28GHz / 39GHz for each evaluation plane. The relative phase between beam pairs is not controlled in the chipset design. Therefore, the relative phase between each beam pair was considered mathematically to identify the worst case conditions. The below MIMO results represent the condition when the relative phase between each beam pair was at 0.° Section 3.2 includes the highest reported MIMO simulation results after sweeping across the relative phase between beams in a 5° step interval from 0° to 360.°

Table 4. PD of Ant K – patch antenna (28GHz)

- K–patch Low CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	Patch	2		1	6.19	0.01	0.45		0.16	6.26
		10		2	11.47	0.03	1.45		0.77	12.18
		11		2	13.41	0.01	0.08		0.56	13.99
		12		2	10.48	0.04	0.34		0.26	11.35
		20		2	12.30	0.02	1.09		0.64	13.07
		21		2	12.22	0.02	0.33		0.50	12.89
		29		4	21.55	0.05	0.54		1.19	23.05
		30		4	26.42	0.03	0.98		1.05	25.75
		31		4	24.78	0.03	0.20		1.04	24.81
		32		4	25.37	0.06	0.19		1.31	26.04
		33		4	21.39	0.08	1.62		1.34	23.09
		43		4	24.37	0.03	0.79		1.12	24.87
		44		4	24.58	0.04	0.20		1.06	24.04
		45		4	25.29	0.02	0.19		1.38	25.79
		46		4	23.91	0.10	0.70		1.40	25.31
		130		1	6.76	0.03	0.30		1.23	3.11
		138		2	16.31	0.03	0.38		3.33	9.64
		139		2	16.04	0.06	0.11		3.85	8.78
		140		2	10.31	0.07	0.55		1.70	7.08
		148		2	17.18	0.03	0.11		3.62	9.80
		149		2	14.57	0.06	0.14		3.90	7.68
		157		4	20.45	0.06	0.19		4.85	11.48
		158		4	26.10	0.07	0.36		6.55	15.41
		159		4	33.98	0.16	0.35		7.92	19.53
		160		4	26.64	0.23	0.42		4.21	14.86
		161		4	16.02	0.12	1.22		6.04	8.53
		171		4	22.95	0.05	0.37		5.80	13.88
		172		4	30.41	0.11	0.40		7.26	17.98
		173		4	32.69	0.26	0.38		7.88	18.22
		174		4	19.29	0.19	0.64		5.54	12.46
		2	130	2	9.85	0.04	0.70		1.71	6.86
		10	138	4	21.35	0.04	0.62		4.04	17.88
		11	139	4	23.44	0.05	0.14		4.06	18.38
		12	140	4	20.59	0.12	0.26		3.54	20.10
		20	148	4	22.19	0.04	0.44		4.06	17.87
		21	149	4	24.06	0.07	0.19		4.34	17.56
		29	158	8	58.99	0.11	0.55		9.48	45.52
		30	157	8	42.73	0.20	1.62		6.63	31.67
		31	160	8	48.35	0.09	0.29		5.41	40.36
		32	161	8	36.91	0.12	0.57		5.14	32.93
		33	159	8	46.03	0.21	1.63		8.73	31.84
		43	172	8	57.59	0.12	0.49		9.12	43.04
		44	171	8	50.24	0.12	1.60		3.02	42.01
		45	173	8	57.50	0.09	0.49		8.23	42.82
		46	174	8	32.11	0.17	0.57		5.22	28.54

- K–patch Mid CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	Patch	2		1	7.79	0.01	0.53		0.16	7.89
		10		2	13.66	0.03	1.74		0.42	14.51
		11		2	16.36	0.01	0.13		0.67	16.52
		12		2	12.28	0.05	0.40		0.57	13.09
		20		2	14.78	0.02	1.30		0.65	15.51
		21		2	14.93	0.02	0.35		0.80	15.43
		29		4	25.35	0.04	0.82		1.58	25.70
		30		4	33.13	0.03	1.23		1.35	32.00
		31		4	30.83	0.03	0.22		1.34	30.45
		32		4	28.38	0.03	0.21		1.02	28.86
		33		4	26.26	0.11	2.25		0.96	28.36
		43		4	29.98	0.04	1.24		1.25	29.70
		44		4	30.31	0.03	0.11		1.39	29.44
		45		4	29.44	0.02	0.12		1.33	29.64
		46		4	27.57	0.07	1.05		1.10	28.97
		130		1	6.23	0.05	0.10		0.79	2.83
		138		2	14.48	0.07	0.18		3.08	8.04
		139		2	15.48	0.04	0.18		3.30	8.68
		140		2	9.84	0.04	0.40		1.21	6.32
		148		2	15.80	0.05	0.14		3.33	8.88
		149		2	14.67	0.07	0.20		3.14	8.13
		157		4	19.36	0.07	0.30		4.09	10.65
		158		4	17.57	0.07	0.34		6.18	9.29
		159		4	29.81	0.13	0.24		6.89	17.68
		160		4	28.29	0.11	0.46		5.27	15.56
		161		4	17.56	0.15	0.68		2.71	11.63
		171		4	20.07	0.04	0.33		5.03	12.15
		172		4	25.67	0.15	0.36		6.84	10.62
		173		4	31.24	0.12	0.18		6.62	18.06
		174		4	24.66	0.12	0.57		2.46	13.42
		2	130	2	10.09	0.05	0.78		1.11	8.94
		10	138	4	21.87	0.08	0.76		3.63	19.04
		11	139	4	22.94	0.05	0.13		3.26	20.61
		12	140	4	24.46	0.07	0.12		3.37	22.09
		20	148	4	21.77	0.06	0.47		3.44	19.49
		21	149	4	23.17	0.06	0.29		3.38	20.76
		29	158	8	57.63	0.15	0.37		9.67	48.54
		30	157	8	43.29	0.37	2.36		7.16	34.71
		31	160	8	50.31	0.10	0.44		5.79	41.69
		32	161	8	38.99	0.14	0.48		5.63	30.30
		33	159	8	42.10	0.32	2.82		8.66	31.72
		43	172	8	53.71	0.19	0.37		9.48	44.19
		44	171	8	49.35	0.16	0.94		6.55	44.30
		45	173	8	54.89	0.15	0.39		7.77	42.35
		46	174	8	27.15	0.19	1.72		4.79	30.07

- K–patch High CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	Patch	2		1	8.48	0.01	0.51		0.28	8.30
		10		2	14.17	0.03	1.76		0.92	15.14
		11		2	17.24	0.01	0.13		0.73	16.82
		12		2	12.95	0.05	0.41		0.49	13.47
		20		2	15.37	0.03	1.37		0.77	16.07
		21		2	16.23	0.02	0.20		0.91	15.92
		29		4	26.66	0.07	0.93		1.71	26.45
		30		4	29.13	0.04	1.13		1.39	32.78
		31		4	32.39	0.04	0.11		1.60	31.61
		32		4	30.67	0.03	0.17		1.95	29.93
		33		4	29.23	0.11	2.05		2.08	29.61
		43		4	30.46	0.05	1.14		1.38	29.98
		44		4	31.88	0.03	0.19		1.55	30.81
		45		4	30.88	0.02	0.11		1.44	30.27
		46		4	30.21	0.04	0.96		2.15	30.04
		130		1	7.11	0.03	0.05		1.09	2.75
		138		2	12.79	0.06	0.08		2.70	6.37
		139		2	14.42	0.06	0.10		2.92	7.65
		140		2	8.95	0.05	0.32		1.70	5.61
		148		2	14.02	0.04	0.08		2.89	7.36
		149		2	14.26	0.07	0.12		2.88	7.49
		157		4	20.33	0.06	0.17		4.49	10.78
		158		4	16.10	0.10	0.30		5.15	8.29
		159		4	26.06	0.12	0.20		5.81	14.76
		160		4	26.26	0.08	0.39		5.41	13.71
		161		4	21.70	0.15	0.57		3.03	10.15
		171		4	18.66	0.07	0.23		4.90	10.57
		172		4	21.84	0.14	0.27		5.60	8.20
		173		4	27.42	0.09	0.19		5.96	15.65
		174		4	24.22	0.11	0.48		4.73	11.79
		2	130	2	11.35	0.05	0.68		0.75	10.82
		10	138	4	20.74	0.08	0.98		3.10	19.10
		11	139	4	24.90	0.05	0.11		2.50	20.28
		12	140	4	23.27	0.06	0.11		3.08	21.03
		20	148	4	20.97	0.06	0.68		2.85	19.27
		21	149	4	22.55	0.06	0.13		2.92	21.10
		29	158	8	52.07	0.13	0.54		8.25	44.43
		30	157	8	42.91	0.31	2.59		6.29	35.35
		31	160	8	49.14	0.12	0.40		5.58	40.22
		32	161	8	39.76	0.22	0.43		5.51	30.95
		33	159	8	38.17	0.29	3.16		6.97	29.52
		43	172	8	48.86	0.12	0.62		7.97	40.55
		44	171	8	49.68	0.16	0.84		5.92	44.77
		45	173	8	53.31	0.16	0.39		6.26	40.80
		46	174	8	30.04	0.18	1.68		5.08	28.44

Table 5. PD of Ant K – patch antenna (39GHz)

- K–patch Low CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	Patch	2		1	5.44	0.01	0.16		0.17	4.53
		10		2	10.41	0.03	0.43		0.64	8.21
		11		2	12.46	0.01	0.25		0.57	11.36
		12		2	10.41	0.03	0.43		0.64	8.21
		20		2	11.74	0.02	0.15		0.63	9.96
		21		2	11.77	0.03	0.47		0.58	9.59
		29		4	16.26	0.06	0.11		1.35	13.78
		30		4	19.92	0.03	0.30		0.21	17.20
		31		4	22.80	0.05	0.35		1.06	21.64
		32		4	17.27	0.08	0.94		0.48	13.46
		33		4	17.61	0.04	0.06		0.98	15.50
		43		4	17.85	0.03	0.17		0.68	16.29
		44		4	20.19	0.02	0.13		0.81	17.89
		45		4	18.63	0.05	1.49		0.96	16.69
		46		4	17.07	0.07	0.12		1.28	13.18
		130		1	4.49	0.05	0.07		0.97	2.34
		138		2	8.45	0.10	0.39		2.00	3.44
		139		2	6.35	0.07	0.04		0.61	5.26
		140		2	6.48	0.07	0.07		1.82	3.85
		148		2	7.28	0.03	0.06		2.11	4.74
		149		2	7.00	0.07	0.07		1.87	3.89
		157		4	13.75	0.17	0.18		3.34	5.99
		158		4	12.35	0.06	0.06		3.11	9.41
		159		4	12.74	0.12	0.13		3.42	9.60
		160		4	11.64	0.12	0.20		4.18	8.32
		161		4	13.42	0.15	0.61		3.53	5.17
		171		4	10.07	0.15	0.14		2.50	5.41
		172		4	12.48	0.10	0.09		3.54	9.51
		173		4	11.44	0.14	0.18		3.51	8.87
		174		4	14.95	0.13	1.24		3.50	8.27
		2	130	1	9.46	0.07	0.48		1.50	6.30
		10	139	2	18.07	0.13	0.74		0.99	15.70
		11	140	2	19.41	0.04	0.30		2.66	15.98
		12	138	2	20.15	0.05	0.45		3.12	15.76
		20	148	2	17.87	0.04	0.03		2.53	14.49
		21	149	2	18.43	0.05	0.45		2.59	15.27
		29	157	4	34.90	0.09	0.39		5.28	29.03
		30	158	4	35.78	0.04	0.30		5.28	30.69
		31	159	4	28.86	0.08	0.54		4.97	27.41
		32	160	4	35.97	0.08	0.56		5.64	29.09
		33	161	4	31.62	0.15	1.10		4.58	24.18
		43	173	4	30.71	0.07	0.74		4.89	26.99
		44	172	4	32.93	0.17	0.41		4.10	31.13
		45	174	4	31.33	0.16	1.51		3.30	25.39
		46	171	4	31.54	0.15	0.50		4.10	29.89

- K–patch Mid CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	Patch	2		1	4.88	0.01	0.12		0.20	4.32
		10		2	10.46	0.03	0.45		0.50	8.72
		11		2	11.80	0.01	0.31		0.47	11.00
		12		2	10.46	0.03	0.45		0.50	8.72
		20		2	10.95	0.03	0.01		0.51	9.75
		21		2	11.41	0.02	0.44		0.36	9.74
		29		4	16.98	0.04	0.22		1.71	15.10
		30		4	19.69	0.04	0.03		0.79	16.71
		31		4	19.41	0.05	0.61		0.95	18.15
		32		4	17.90	0.03	0.71		1.28	13.81
		33		4	17.11	0.05	0.07		1.35	15.95
		43		4	17.51	0.04	0.17		0.96	14.93
		44		4	19.94	0.02	0.13		0.38	18.09
		45		4	15.20	0.04	1.17		1.08	14.81
		46		4	19.00	0.04	0.24		1.69	15.35
		130		1	3.95	0.02	0.27		0.63	2.12
		138		2	8.71	0.04	0.58		1.60	2.56
		139		2	7.58	0.02	0.20		1.35	5.34
		140		2	8.89	0.04	0.10		1.52	3.32
		148		2	7.43	0.04	0.05		2.01	4.04
		149		2	8.36	0.05	0.11		1.44	3.08
		157		4	14.21	0.08	0.35		2.95	6.90
		158		4	12.21	0.12	0.07		3.37	8.01
		159		4	13.22	0.05	0.36		2.70	7.92
		160		4	12.15	0.18	1.36		3.09	7.73
		161		4	14.00	0.08	0.15		3.23	6.41
		171		4	10.54	0.07	0.30		2.77	6.49
		172		4	11.88	0.09	0.18		2.15	7.80
		173		4	12.39	0.14	0.66		3.21	7.64
		174		4	13.21	0.06	1.28		3.55	7.35
		2	130	1	8.43	0.03	0.55		1.41	5.80
		10	139	2	18.47	0.05	0.53		1.73	15.54
		11	140	2	17.81	0.04	0.26		2.34	14.76
		12	138	2	18.66	0.11	0.37		2.66	15.65
		20	148	2	16.39	0.06	0.04		2.15	13.52
		21	149	2	17.56	0.05	0.37		2.36	14.80
		29	157	4	37.24	0.13	0.68		4.29	33.34
		30	158	4	33.85	0.12	0.34		4.87	27.58
		31	159	4	28.85	0.10	1.06		4.13	26.30
		32	160	4	35.94	0.11	0.81		5.21	29.47
		33	161	4	29.58	0.13	0.86		2.99	23.78
		43	173	4	30.34	0.17	1.01		3.57	26.11
		44	172	4	29.66	0.08	0.60		2.81	25.87
		45	174	4	30.69	0.11	1.09		2.47	25.90
		46	171	4	33.12	0.18	0.52		4.29	29.98

- K–patch High CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	Patch	2		1	4.74	0.01	0.11		0.23	4.07
		10		2	9.70	0.03	0.16		0.42	8.01
		11		2	10.59	0.01	0.20		0.60	9.24
		12		2	9.70	0.03	0.16		0.42	8.01
		20		2	10.60	0.03	0.08		0.46	9.28
		21		2	10.00	0.01	0.31		0.45	8.23
		29		4	16.51	0.05	0.12		1.59	14.29
		30		4	16.72	0.04	0.21		0.91	14.60
		31		4	16.03	0.03	0.70		0.19	14.23
		32		4	17.40	0.03	0.62		1.28	13.02
		33		4	16.74	0.04	0.14		1.36	15.39
		43		4	16.46	0.03	0.19		1.10	15.64
		44		4	18.18	0.04	0.14		0.87	15.28
		45		4	14.94	0.03	1.20		0.49	13.25
		46		4	17.94	0.05	0.13		1.53	14.36
		130		1	4.40	0.02	0.05		0.66	1.84
		138		2	8.10	0.03	0.50		1.53	3.69
		139		2	7.30	0.09	0.10		2.05	4.18
		140		2	8.38	0.03	0.09		1.32	3.18
		148		2	6.54	0.08	0.03		2.26	3.14
		149		2	8.45	0.04	0.12		1.78	2.74
		157		4	13.81	0.07	0.32		2.34	7.77
		158		4	11.12	0.22	0.08		4.19	5.44
		159		4	13.13	0.16	0.24		4.17	5.68
		160		4	12.48	0.09	1.27		2.67	8.01
		161		4	15.67	0.08	0.12		3.06	7.97
		171		4	10.44	0.08	0.05		2.75	6.46
		172		4	11.70	0.21	0.29		4.20	4.84
		173		4	12.01	0.11	0.28		3.89	6.16
		174		4	14.64	0.08	1.23		2.81	6.69
		2	130	1	8.86	0.03	0.40		1.02	5.87
		10	139	2	16.72	0.04	0.41		2.39	12.40
		11	140	2	16.89	0.08	0.24		2.43	13.64
		12	138	2	16.87	0.06	0.90		2.60	11.04
		20	148	2	14.89	0.07	0.06		2.83	12.17
		21	149	2	16.95	0.06	0.30		2.27	13.77
		29	157	4	35.17	0.07	0.41		4.59	26.67
		30	158	4	29.10	0.22	0.64		6.02	21.64
		31	159	4	25.92	0.23	1.07		4.94	20.04
		32	160	4	32.25	0.11	0.47		5.87	25.12
		33	161	4	26.07	0.12	1.00		3.33	21.02
		43	173	4	26.23	0.13	1.37		4.32	21.09
		44	172	4	27.01	0.15	0.41		4.44	21.58
		45	174	4	27.04	0.15	1.37		3.97	22.12
		46	171	4	30.59	0.18	0.55		4.86	24.17

3.1.3 Ant L – Patch Antenna

Table 6 & Table 7 show the PD simulation evaluation of Ant L patch antenna at 28GHz / 39GHz for each evaluation plane. The relative phase between beam pairs is not controlled in the chipset design. Therefore, the relative phase between each beam pair was considered mathematically to identify the worst case conditions. The below MIMO results represent the condition when the relative phase between each beam pair was at 0.° Section 3.2 includes the highest reported MIMO simulation results after sweeping across the relative phase between beams in a 5° step interval from 0° to 360.°

Table 6. PD of Ant L – patch antenna (28GHz)

- L–patch Low CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
L	Patch	3		1	0.02	7.17		0.35	0.15	8.08
		13		2	0.02	12.67		0.57	0.39	15.29
		14		2	0.01	12.70		0.03	0.47	15.33
		15		2	0.02	11.27		0.80	0.38	12.65
		22		2	0.04	14.03		0.63	0.33	17.05
		23		2	0.01	13.91		0.18	0.57	16.15
		34		4	0.04	25.87		0.88	1.05	31.40
		35		4	0.04	25.83		0.40	0.97	29.30
		36		4	0.02	25.53		0.04	0.90	28.53
		37		4	0.04	27.25		0.18	1.61	32.47
		38		4	0.04	19.53		1.38	1.86	26.60
		47		4	0.04	25.40		0.13	0.86	31.39
		48		4	0.03	26.20		0.41	0.89	28.91
		49		4	0.01	25.85		0.03	1.11	30.15
		50		4	0.05	25.33		0.39	1.44	31.29
		131		1	0.02	5.22		0.05	0.95	3.72
		141		2	0.11	12.13		0.04	3.06	8.03
		142		2	0.06	10.31		0.16	1.96	7.56
		143		2	0.05	9.14		0.17	1.24	5.03
		150		2	0.05	11.26		0.12	2.08	8.24
		151		2	0.06	7.81		0.22	1.79	5.66
		162		4	0.14	20.64		0.14	6.17	14.59
		163		4	0.11	27.28		0.40	6.22	19.15
		164		4	0.08	28.06		0.20	6.33	21.84
		165		4	0.08	16.57		0.17	2.32	10.62
		166		4	0.16	9.96		0.40	3.11	9.03
		175		4	0.14	22.73		0.22	5.77	15.85
		176		4	0.09	30.36		0.30	6.53	21.82
		177		4	0.06	22.94		0.19	4.44	16.59
		178		4	0.12	12.28		0.32	2.91	10.49
		3	131	2	0.06	10.19		0.48	1.44	9.45
		13	141	4	0.10	26.40		0.94	3.57	23.88
		14	142	4	0.10	18.95		0.12	3.47	21.54
		15	143	4	0.07	18.19		0.79	3.58	17.59
		22	150	4	0.06	28.69		0.24	3.63	26.52
		23	151	4	0.04	26.84		0.14	3.64	24.45
		34	163	8	0.12	56.83		0.37	7.75	50.23
		35	162	8	0.13	50.49		0.31	6.12	44.94
		36	164	8	0.14	54.91		0.17	8.29	47.49
		37	166	8	0.29	44.18		0.13	5.57	44.20
		38	165	8	0.14	29.87		0.85	2.23	34.76
		47	176	8	0.13	57.26		0.29	8.04	51.20
		48	175	8	0.17	54.84		0.40	7.73	46.18
		49	177	8	0.14	33.51		0.24	5.44	32.40
		50	178	8	0.13	36.57		0.19	2.50	36.83

- L–patch Mid CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
L	Patch	3		1	0.01	8.48		0.31	0.15	9.12
		13		2	0.02	15.63		0.45	0.80	17.63
		14		2	0.01	15.85		0.03	0.60	18.47
		15		2	0.02	12.66		0.68	0.74	13.67
		22		2	0.02	15.80		0.57	0.34	18.61
		23		2	0.02	15.73		0.14	0.67	17.64
		34		4	0.04	29.14		0.70	2.17	32.91
		35		4	0.04	31.64		0.46	1.17	35.06
		36		4	0.03	30.46		0.05	1.07	33.61
		37		4	0.03	30.59		0.09	1.71	35.25
		38		4	0.08	22.15		1.40	1.94	28.37
		47		4	0.05	29.38		0.07	1.46	33.86
		48		4	0.02	31.74		0.45	1.20	33.84
		49		4	0.02	30.01		0.03	1.27	34.81
		50		4	0.07	28.17		0.34	1.71	33.70
		131		1	0.03	5.95		0.07	1.11	3.46
		141		2	0.16	13.14		0.03	3.45	8.40
		142		2	0.07	12.33		0.18	3.58	8.27
		143		2	0.13	10.93		0.08	1.72	5.96
		150		2	0.08	13.37		0.14	4.01	8.72
		151		2	0.05	9.21		0.26	1.35	6.80
		162		4	0.42	22.29		0.05	7.20	14.79
		163		4	0.17	26.61		0.28	6.66	18.25
		164		4	0.14	27.75		0.08	7.22	19.41
		165		4	0.12	21.34		0.19	4.62	15.51
		166		4	0.21	12.80		0.52	3.68	7.37
		175		4	0.37	24.79		0.13	7.74	16.73
		176		4	0.15	28.31		0.12	6.69	19.51
		177		4	0.16	27.96		0.15	6.03	17.54
		178		4	0.15	16.62		0.40	2.18	9.05
		3	131	2	0.03	12.82		0.57	1.64	11.25
		13	141	4	0.15	31.04		0.88	5.12	27.35
		14	142	4	0.11	22.73		0.18	5.01	24.65
		15	143	4	0.14	20.30		0.73	3.88	18.31
		22	150	4	0.13	31.36		0.40	5.26	27.86
		23	151	4	0.07	30.96		0.16	4.94	26.41
		34	163	8	0.21	56.83		0.42	8.46	52.29
		35	162	8	0.17	57.85		0.22	8.30	50.82
		36	164	8	0.27	55.11		0.16	8.75	52.72
		37	166	8	0.30	44.16		0.12	3.43	35.19
		38	165	8	0.36	34.01		0.87	6.22	38.18
		47	176	8	0.25	56.39		0.17	8.34	52.12
		48	175	8	0.26	56.49		0.44	9.27	48.43
		49	177	8	0.24	38.96		0.47	7.65	36.65
		50	178	8	0.15	44.07		0.23	3.14	41.45

- L–patch High CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
L	Patch	3		1	0.01	8.68		0.29	0.16	*9.38*
		13		2	0.02	16.67		0.37	0.89	*18.32*
		14		2	0.01	16.76		0.02	0.67	*19.33*
		15		2	0.02	12.91		0.62	0.79	*13.31*
		22		2	0.02	15.88		0.53	0.32	*18.31*
		23		2	0.01	16.00		0.12	0.71	*17.44*
		34		4	0.04	28.45		0.47	1.69	*30.42*
		35		4	0.03	32.82		0.47	1.20	*36.01*
		36		4	0.03	31.53		0.04	1.23	*34.47*
		37		4	0.04	30.77		0.07	1.79	*34.95*
		38		4	0.08	22.47		1.53	0.92	*27.74*
		47		4	0.03	28.37		0.06	1.56	*31.58*
		48		4	0.02	32.91		0.41	1.33	*35.00*
		49		4	0.05	31.08		0.02	1.40	*35.87*
		50		4	0.06	28.02		0.41	1.76	*32.36*
		131		1	0.03	*5.58*		0.07	0.92	3.86
		141		2	0.13	*12.06*		0.07	2.58	8.09
		142		2	0.07	*11.86*		0.21	3.21	7.87
		143		2	0.14	*11.25*		0.16	1.77	5.52
		150		2	0.07	*12.68*		0.15	3.60	8.43
		151		2	0.07	*9.31*		0.33	1.45	6.17
		162		4	0.17	*19.93*		0.07	4.89	14.34
		163		4	0.16	*22.93*		0.30	6.63	15.85
		164		4	0.15	*26.85*		0.08	6.74	18.39
		165		4	0.14	*20.36*		0.24	4.78	14.87
		166		4	0.24	*13.48*		0.76	3.67	6.27
		175		4	0.28	*21.94*		0.05	6.38	16.17
		176		4	0.15	*24.80*		0.12	6.82	17.25
		177		4	0.15	*26.38*		0.14	5.54	17.22
		178		4	0.16	*16.59*		0.55	4.84	11.70
		3	131	2	0.02	*13.40*		0.54	1.37	11.38
		13	141	4	0.14	*30.66*		0.83	4.42	28.59
		14	142	4	0.10	*26.11*		0.16	4.76	24.97
		15	143	4	0.10	*20.53*		0.59	4.00	16.29
		22	150	4	0.08	*30.71*		0.37	4.85	28.60
		23	151	4	0.08	*31.90*		0.17	4.81	27.30
		34	163	8	0.25	*52.01*		0.29	8.65	49.66
		35	162	8	0.14	*56.78*		0.20	7.51	51.85
		36	164	8	0.27	54.41		0.14	8.81	55.40
		37	166	8	0.27	*40.28*		0.24	5.40	32.42
		38	165	8	0.33	37.46		0.73	5.41	37.92
		47	176	8	0.28	*52.95*		0.16	8.55	50.05
		48	175	8	0.21	*52.22*		0.35	8.90	48.77
		49	177	8	0.22	*41.39*		0.63	8.80	37.09
		50	178	8	0.24	*42.61*		0.43	3.17	39.31

Table 7. PD of Ant L – patch antenna (39GHz)

- L–patch Low CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
L	Patch	3		1	0.01	5.93		0.02	0.24	5.82
		13		2	0.02	10.52		0.10	0.57	9.72
		14		2	0.01	11.59		0.12	0.51	11.38
		15		2	0.02	9.22		0.05	0.48	9.68
		22		2	0.02	11.27		0.04	0.52	10.70
		23		2	0.01	10.37		0.29	0.21	9.91
		34		4	0.02	17.52		0.05	0.80	16.84
		35		4	0.03	19.26		0.02	0.89	18.22
		36		4	0.02	20.04		0.14	0.84	20.67
		37		4	0.07	16.19		0.55	0.75	16.16
		38		4	0.02	16.11		0.09	1.45	15.18
		47		4	0.02	18.79		0.04	0.94	18.33
		48		4	0.02	21.31		0.07	0.64	20.00
		49		4	0.03	20.20		0.46	0.96	20.00
		50		4	0.05	14.72		0.27	1.39	13.77
		131		1	0.03	3.62		0.02	1.02	2.63
		141		2	0.06	6.63		0.05	1.73	4.44
		142		2	0.06	6.26		0.03	2.67	4.44
		143		2	0.06	7.84		0.06	2.90	3.98
		150		2	0.08	6.81		0.03	2.42	4.83
		151		2	0.06	7.30		0.05	3.17	4.26
		162		4	0.10	11.78		0.09	4.31	6.94
		163		4	0.18	10.47		0.10	3.19	8.96
		164		4	0.14	9.89		0.05	3.30	8.21
		165		4	0.15	11.44		0.14	4.61	9.23
		166		4	0.12	12.89		0.09	3.94	7.22
		175		4	0.16	11.32		0.09	5.13	5.52
		176		4	0.18	10.16		0.05	3.33	7.82
		177		4	0.14	12.17		0.07	3.72	9.54
		178		4	0.13	11.40		0.12	4.48	8.39
		3	131	1	0.05	9.03		0.03	0.75	8.79
		13	141	2	0.08	14.93		0.21	1.82	11.21
		14	142	2	0.09	18.62		0.18	3.50	17.07
		15	143	2	0.09	14.42		0.12	2.42	13.34
		22	150	2	0.08	15.96		0.03	2.70	13.82
		23	151	2	0.08	18.27		0.38	2.51	14.03
		34	166	4	0.17	30.59		0.39	5.09	24.53
		35	163	4	0.18	30.95		0.02	5.84	29.43
		36	162	4	0.17	33.91		0.18	4.64	27.87
		37	165	4	0.21	25.50		0.70	2.40	25.50
		38	164	4	0.19	27.96		0.44	4.83	28.31
		47	175	4	0.23	27.25		0.22	5.87	23.22
		48	176	4	0.20	30.81		0.18	5.34	29.40
		49	177	4	0.22	27.21		0.47	3.79	27.08
		50	178	4	0.16	27.05		0.53	5.61	26.93

- L–patch Mid CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
L	Patch	3		1	0.01	6.38		0.02	0.26	6.37
		13		2	0.01	12.06		0.09	0.61	11.34
		14		2	0.01	10.89		0.19	0.12	10.82
		15		2	0.02	10.56		0.06	0.53	9.87
		22		2	0.02	12.23		0.03	0.54	11.68
		23		2	0.01	11.24		0.36	0.22	10.62
		34		4	0.03	19.01		0.06	1.07	18.48
		35		4	0.05	20.74		0.03	0.97	20.04
		36		4	0.03	20.89		0.17	0.93	22.11
		37		4	0.04	17.47		0.62	0.92	16.89
		38		4	0.02	18.41		0.07	1.36	17.44
		47		4	0.04	20.29		0.05	1.12	20.42
		48		4	0.03	18.56		0.12	0.13	18.34
		49		4	0.03	21.11		0.57	1.07	21.43
		50		4	0.03	18.53		0.24	1.70	14.26
		131		1	0.03	4.06		0.04	0.58	2.03
		141		2	0.10	7.14		0.06	1.69	3.72
		142		2	0.09	7.57		0.05	2.22	5.31
		143		2	0.11	8.29		0.17	1.77	5.01
		150		2	0.08	7.21		0.05	2.22	3.57
		151		2	0.14	8.17		0.09	2.44	5.29
		162		4	0.09	11.09		0.07	3.67	6.40
		163		4	0.20	10.83		0.14	4.23	5.13
		164		4	0.22	13.33		0.08	3.09	9.18
		165		4	0.18	11.82		0.38	3.21	7.87
		166		4	0.14	12.44		0.12	3.75	6.74
		175		4	0.17	12.72		0.12	3.80	5.38
		176		4	0.16	12.58		0.05	4.42	8.13
		177		4	0.19	12.77		0.22	3.61	8.53
		178		4	0.20	12.30		0.27	3.71	6.84
		3	131	1	0.04	9.70		0.04	0.55	7.20
		13	141	2	0.09	16.13		0.27	1.67	13.12
		14	142	2	0.12	20.17		0.33	2.87	16.37
		15	143	2	0.06	15.30		0.12	2.07	13.72
		22	150	2	0.12	17.67		0.08	2.84	15.68
		23	151	2	0.05	17.47		0.55	2.10	13.95
		34	166	4	0.14	33.67		0.42	4.03	27.10
		35	163	4	0.17	35.67		0.11	5.40	30.93
		36	162	4	0.15	36.59		0.26	4.60	30.03
		37	165	4	0.19	27.44		1.07	2.42	27.19
		38	164	4	0.17	35.08		0.41	5.50	31.45
		47	175	4	0.13	30.13		0.36	5.53	24.06
		48	176	4	0.23	34.87		0.37	5.59	28.49
		49	177	4	0.20	30.43		0.72	3.37	29.26
		50	178	4	0.14	31.26		0.54	4.48	30.03

- L–patch High CH

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)					
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
L	Patch	3		1	0.01	*6.05*		0.03	0.22	5.84
		13		2	0.01	*11.26*		0.05	0.42	11.15
		14		2	0.02	*10.52*		0.09	0.28	10.25
		15		2	0.02	*9.87*		0.10	0.59	8.89
		22		2	0.02	*11.69*		0.01	0.51	11.41
		23		2	0.02	*10.07*		0.18	0.54	9.71
		34		4	0.03	16.50		0.06	0.78	*17.17*
		35		4	0.05	*19.53*		0.01	1.03	18.26
		36		4	0.04	*20.85*		0.13	1.07	18.99
		37		4	0.03	*16.64*		0.46	0.77	15.71
		38		4	0.03	16.01		0.02	1.14	*16.43*
		47		4	0.04	18.09		0.06	0.88	*19.46*
		48		4	0.05	*18.03*		0.08	0.39	17.27
		49		4	0.03	17.40		0.47	0.91	*17.57*
		50		4	0.03	*17.50*		0.12	1.19	14.31
		131		1	0.03	*3.72*		0.03	0.90	1.88
		141		2	0.05	*7.15*		0.05	1.62	3.80
		142		2	0.07	*5.73*		0.11	1.49	2.65
		143		2	0.13	*7.72*		0.23	1.41	3.72
		150		2	0.07	*7.11*		0.03	1.30	4.44
		151		2	0.12	*6.85*		0.23	1.41	3.70
		162		4	0.14	*13.10*		0.11	3.96	7.92
		163		4	0.18	*10.18*		0.10	2.68	4.23
		164		4	0.18	*11.37*		0.14	3.19	4.14
		165		4	0.25	*9.75*		0.47	0.91	5.38
		166		4	0.16	*13.10*		0.17	3.89	7.92
		175		4	0.11	*12.13*		0.04	3.64	6.71
		176		4	0.19	*12.31*		0.09	3.34	7.30
		177		4	0.25	*9.00*		0.28	0.97	3.01
		178		4	0.20	*12.39*		0.39	2.90	5.91
		3	131	1	0.06	*8.72*		0.05	1.18	7.38
		13	141	2	0.12	*16.91*		0.16	1.73	14.20
		14	142	2	0.12	*17.52*		0.34	1.38	14.57
		15	143	2	0.07	*15.32*		0.15	1.91	13.05
		22	150	2	0.08	*18.21*		0.08	2.57	16.63
		23	151	2	0.10	*17.26*		0.32	2.66	12.97
		34	166	4	0.17	*31.48*		0.43	3.53	25.36
		35	163	4	0.24	*32.90*		0.23	5.40	29.31
		36	162	4	0.14	*32.76*		0.26	4.49	25.44
		37	165	4	0.33	*25.94*		0.97	3.31	20.92
		38	164	4	0.21	*31.49*		0.29	4.61	28.99
		47	175	4	0.20	*28.43*		0.49	4.43	24.18
		48	176	4	0.23	*32.05*		0.52	5.09	27.53
		49	177	4	0.36	*27.25*		0.68	3.65	22.08
		50	178	4	0.23	*29.71*		0.30	5.07	28.39

3.2 PD with MIMO Relative Phase for Low/Mid/High Channel at 28GHz / 39GHz

Table 8. PD with MIMO Relative Phase (28GHz_Low CH)

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)	Max_S.
					4cm2 PD(W/m2)						
J	Dipole	0	128	1	0.25196	3.835626	0.545439	0	0.240765	12.19743	12.20
		4	133	2	0.358521	7.352222	0.725677	0	0.339328	27.76188	27.76
		5	132	2	0.272903	5.211876	1.192037	0	0.236699	26.97517	26.98
		6	134	2	0.257533	4.834737	1.143774	0	0.228826	31.8856	31.89
		16	144	2	0.322454	7.273141	0.571297	0	0.328075	28.31557	28.32
		17	145	2	0.271115	4.644777	1.157078	0	0.239848	38.67247	38.67
J	PATCH	1	129	1	0.281423	0.801055	0.777338	0	0.084535	18.67767	18.68
		7	137	2	0.245056	0.859191	0.191693	0	0.129463	33.59426	33.59
		8	136	2	0.39929	1.947524	0.212707	0	0.17452	46.01224	46.01
		9	135	2	0.684753	1.777184	2.789628	0	0.200665	36.04385	36.04
		18	147	2	0.338959	0.666358	0.22908	0	0.109624	38.17029	38.17
		19	146	2	0.271899	0.826537	0.874251	0	0.11573	37.68978	37.69
		24	155	4	1.335577	2.612061	2.148835	0	0.257777	72.73819	72.74
		25	156	4	0.924183	1.928917	0.607389	0	0.234328	64.66565	64.67
		26	153	4	1.290226	3.429714	0.890573	0	0.35161	73.78609	73.79
		27	152	4	0.790506	4.657143	7.573468	0	0.254245	91.05644	91.06
		28	154	4	2.868512	3.126669	2.014846	0	0.312316	77.21295	77.21
		39	170	4	0.999799	2.324383	1.497134	0	0.235827	66.66249	66.66
		40	169	4	0.824803	2.406287	1.582769	0	0.35436	77.41464	77.41
		41	167	4	1.455109	3.937307	1.510205	0	0.163503	99.43603	99.44
		42	168	4	1.295952	3.171383	3.05664	0	0.324196	75.35225	75.35
K	PATCH	2	130	1	10.987	0.081082	0.705827	0	1.955217	7.723669	10.99
		10	138	2	21.57304	0.047106	0.629841	0	4.069983	18.69324	21.57
		11	139	2	23.43745	0.059779	0.166628	0	4.266608	18.38313	23.44
		12	140	2	22.53302	0.127627	0.478626	0	3.808562	22.03576	22.53
		20	148	2	22.22617	0.045486	0.461513	0	4.161622	18.15787	22.23
		21	149	1	24.05567	0.110067	0.244038	0	4.708643	17.65053	24.06
		29	158	4	59.33026	0.113075	0.649082	0	9.666721	45.81792	59.33
		30	157	4	44.30744	0.201415	1.7702	0	6.970046	32.67258	44.31
		31	160	4	52.11475	0.13011	0.4557	0	5.940865	42.05713	52.11
		32	161	4	37.13595	0.131493	0.80023	0	6.183133	33.21962	37.14
		33	159	4	46.40086	0.256011	3.201552	0	9.56669	31.8792	46.40
		43	172	4	59.48853	0.123823	0.543845	0	9.739491	44.73655	59.49
		44	171	4	51.08439	0.117944	1.643376	0	3.046242	42.36955	51.08
		45	173	4	61.09911	0.113367	0.499677	0	9.866651	45.70722	61.10
		46	174	4	34.89958	0.237245	0.588774	0	5.786057	30.6556	34.90
L	PATCH	3	131	1	0.063561	10.32016	0	0.625137	1.618661	10.05762	10.32
		13	141	2	0.102932	38.98274	0	1.155223	5.778889	25.19774	38.98
		14	142	2	0.106536	23.47943	0	0.135431	3.543313	22.76554	23.48
		15	143	2	0.117146	20.50879	0	0.792161	6.153132	17.79287	20.51
		22	150	2	0.062126	38.22352	0	0.453818	5.062262	27.88651	38.22
		23	151	2	0.076359	32.19567	0	0.160463	3.660047	24.74036	32.20
		34	163	4	0.122627	68.16984	0	0.406777	8.248005	51.86742	68.17
		35	162	4	0.178023	50.52503	0	0.317412	6.195782	45.09034	50.53
		36	164	4	0.16796	57.78659	0	0.227143	8.687134	49.74977	57.79
		37	166	4	0.299598	45.27909	0	0.187728	5.623758	45.99734	46.00
		38	165	4	0.233538	30.26798	0	0.869574	3.184528	34.78829	34.79
		47	176	4	0.131853	64.38267	0	0.365261	8.351849	52.9914	64.38
		48	175	4	0.188674	69.11127	0	0.473568	7.772903	47.57779	69.11
		49	177	4	0.204535	33.91939	0	0.242996	6.120441	33.48519	33.92
		50	178	4	0.181464	36.60201	0	0.215292	2.636466	37.23489	37.23489

Table 9. PD with MIMO Relative Phase (28GHz_Mid CH)

| Module | Type(P or D) | Beam ID_1 | Bema ID_2 | Feed no. | 4cm2 PD(W/m2) | | | | | | |
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)	Max_S.
J	Dipole	0	128	1	0.221696	4.146784	0.710743	0.000000	0.253255	13.320353	13.32
		4	133	2	0.288645	6.371794	0.744888	0	0.326518	27.42316	27.42
		5	132	2	0.393628	5.875844	1.321117	0	0.315957	27.09265	27.09
		6	134	2	0.34238	3.371785	1.158167	0	0.268986	32.30038	32.30
		16	144	2	0.242248	6.55914	0.58586	0	0.332977	27.89723	27.90
		17	145	2	0.261812	4.640991	1.140854	0	0.306197	37.61591	37.62
J	PATCH	1	129	1	0.146018	0.753549	1.907474	0	0.205752	17.8867	17.89
		7	137	2	0.328344	0.869131	0.466406	0	0.086681	32.40306	32.40
		8	136	2	0.627802	2.047937	0.213599	0	0.180429	45.90864	45.91
		9	135	2	0.656653	1.279047	2.916938	0	0.247036	34.32917	34.33
		18	147	2	0.326796	1.012846	0.574168	0	0.091741	37.16595	37.17
		19	146	2	0.195059	1.123468	3.005665	0	0.149936	36.26661	36.27
		24	155	4	1.346555	2.314297	0.929926	0	0.322883	71.77612	71.78
		25	156	4	0.951738	1.744201	0.526329	0	0.295459	63.12209	63.12
		26	153	4	1.34373	3.129939	2.402246	0	0.435084	71.74385	71.74
		27	152	4	0.704719	3.42845	25.7224	0	0.669313	85.21182	85.21
		28	154	4	2.498972	2.666779	3.564185	0	0.604723	74.45693	74.46
		39	170	4	0.985611	2.050791	0.530672	0	0.286766	65.70557	65.71
		40	169	4	0.668362	1.224591	6.162416	0	0.183248	75.17889	75.18
		41	167	4	1.258144	2.568186	1.508637	0	0.460428	96.4007	96.40
		42	168	4	1.196544	2.747843	7.436757	0	0.522711	72.528	72.53
K	PATCH	2	130	1	10.38185	0.109074	0.785229	0	1.367323	9.351689	10.38
		10	138	2	25.02771	0.083259	0.840351	0	3.933136	22.92081	25.03
		11	139	2	22.99312	0.071021	0.134787	0	4.109727	20.77481	22.99
		12	140	2	27.07797	0.109899	0.330543	0	3.580713	24.05541	27.08
		20	148	2	23.33543	0.06472	0.50863	0	3.952256	22.09202	23.34
		21	149	1	24.00343	0.106697	0.288377	0	4.457734	21.15828	24.00
		29	158	4	57.88021	0.152597	0.378453	0	9.67516	49.25956	57.88
		30	157	4	43.77038	0.406631	2.972336	0	7.364026	35.88495	43.77
		31	160	4	55.47328	0.143159	0.575705	0	6.35992	44.53971	55.47
		32	161	4	39.03988	0.16749	0.714493	0	5.650089	30.41077	39.04
		33	159	4	44.80432	0.348031	3.94234	0	8.74389	32.15912	44.80
		43	172	4	56.12653	0.202651	0.42071	0	9.934958	48.5164	56.13
		44	171	4	50.38814	0.15551	1.242466	0	7.409801	44.35954	50.39
		45	173	4	60.67032	0.231283	0.48623	0	10.02369	49.02495	60.67
		46	174	4	34.99561	0.24846	2.045648	0	6.051742	37.0419	37.04
L	PATCH	3	131	1	0.036216	13.54037	0	0.712535	1.865192	12.48017	13.54
		13	141	2	0.150684	49.59339	0	1.356238	6.436276	28.90498	49.59
		14	142	2	0.110422	29.94807	0	0.237199	5.115274	25.1852	29.95
		15	143	2	0.280757	27.69631	0	0.751995	5.227145	19.37346	27.70
		22	150	2	0.132101	45.39198	0	0.842478	6.085804	29.3143	45.39
		23	151	2	0.098091	31.01393	0	0.187678	5.607868	26.41647	31.01
		34	163	4	0.217216	60.58123	0	0.495033	9.259822	53.36603	60.58
		35	162	4	0.242659	57.92542	0	0.219477	8.323926	50.83268	57.93
		36	164	4	0.329011	58.71838	0	0.205101	8.791385	53.94727	58.72
		37	166	4	0.311954	44.29085	0	0.17099	3.532747	36.56112	44.29
		38	165	4	0.5906	35.06688	0	0.898161	7.009959	38.23059	38.23
		47	176	4	0.255929	58.29536	0	0.217213	8.897024	53.60028	58.30
		48	175	4	0.297401	65.72253	0	0.58126	9.51659	50.00939	65.72
		49	177	4	0.34227	39.12058	0	0.465522	7.867177	37.27847	39.12
		50	178	4	0.200231	44.26279	0	0.236318	3.158884	41.5526	44.26279

Table 10. PD with MIMO Relative Phase (28GHz_High CH)

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)						
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)	Max_S.
J	Dipole	0	128	1	0.140020	3.900028	0.630367		0.189952	13.238139	13.24
		4	133	2	0.210035	5.781446	0.667785		0.18475	27.58789	27.59
		5	132	2	0.230659	5.455451	1.099237		0.226199	27.31005	27.31
		6	134	2	0.206983	4.563314	0.798814		0.211555	32.27671	32.28
		16	144	2	0.162052	6.024515	0.557168		0.17371	28.3641	28.36
		17	145	2	0.181779	3.790256	0.996941		0.314862	35.77659	35.78
J	PATCH	1	129	1	0.134567	0.62253	1.970853		0.138291	17.11888	17.12
		7	137	2	0.291547	1.003623	0.491866		0.096167	31.70828	31.71
		8	136	2	0.478209	1.930363	0.55938		0.117784	45.32561	45.33
		9	135	2	0.460007	1.182056	7.701164		0.136826	33.22138	33.22
		18	147	2	0.275181	1.085331	0.570779		0.097219	36.37028	36.37
		19	146	2	0.219778	1.239872	2.716146		0.138396	33.27562	33.28
		24	155	4	1.300103	2.213793	1.078044		0.30318	71.78995	71.79
		25	156	4	0.980712	1.643415	0.78811		0.307371	62.62877	62.63
		26	153	4	1.082349	2.942861	2.041745		0.260881	68.70542	68.71
		27	152	4	0.477519	2.93786	21.97632		0.499164	80.45817	80.46
		28	154	4	1.89964	0.808128	3.369579		0.436886	71.99376	71.99
		39	170	4	0.984327	1.945894	0.814232		0.286427	65.26671	65.27
		40	169	4	0.573588	1.316825	5.442181		0.122716	71.91046	71.91
		41	167	4	1.055979	2.338916	1.673201		0.386798	91.82819	91.83
		42	168	4	0.880597	0.783363	6.825342		0.336424	70.32113	70.32
K	PATCH	2	130	1	11.39831	0.061015	0.76743	0	0.759218	10.97413	11.40
		10	138	2	23.02932	0.081791	1.21642	0	3.62388	21.22065	23.03
		11	139	2	24.90353	0.063823	0.125511	0	3.341888	20.27942	24.90
		12	140	2	25.24631	0.089791	0.345327	0	3.172436	22.57159	25.25
		20	148	2	21.96359	0.069746	0.970662	0	3.523662	20.53133	21.96
		21	149	1	22.91033	0.074044	0.158148	0	4.095249	21.61707	22.91
		29	158	4	52.2412	0.146325	0.563544	0	8.292695	45.01839	52.24
		30	157	4	43.08946	0.313216	3.059898	0	6.779446	38.33144	43.09
		31	160	4	53.47785	0.183203	0.60521	0	7.056552	43.44073	53.48
		32	161	4	39.75752	0.262684	0.611627	0	5.644303	31.06222	39.76
		33	159	4	41.84115	0.300465	3.821382	0	7.250939	29.80893	41.84
		43	172	4	50.22084	0.139025	0.798239	0	8.279192	44.16018	50.22
		44	171	4	49.75872	0.158296	1.143352	0	7.291764	45.01254	49.76
		45	173	4	56.75084	0.292351	0.800341	0	8.158128	45.39418	56.75
		46	174	4	38.59371	0.212822	2.017564	0	6.511828	36.6873	38.59
L	PATCH	3	131	1	0.028456	13.85276	0	0.669719	1.523029	12.57525	13.85
		13	141	2	0.151746	42.78614	0	0.95249	5.17223	29.56101	42.79
		14	142	2	0.100841	35.94034	0	0.205099	4.770433	25.17239	35.94
		15	143	2	0.236476	23.98839	0	0.59957	6.136422	17.78476	23.99
		22	150	2	0.087522	37.71047	0	0.543325	5.394774	29.54134	37.71
		23	151	2	0.132978	32.528	0	0.209601	6.175372	27.30055	32.53
		34	163	4	0.288859	57.19381	0	0.335285	8.937697	50.95334	57.19
		35	162	4	0.202592	56.94131	0	0.197162	7.516635	51.8597	56.94
		36	164	4	0.346173	57.29672	0	0.174463	9.014402	55.84217	57.30
		37	166	4	0.278182	41.17151	0	0.303187	5.424464	33.87766	41.17
		38	165	4	0.967687	38.2967	0	0.744447	6.78034	38.06654	38.30
		47	176	4	0.293378	56.56879	0	0.191959	8.727643	51.84752	56.57
		48	175	4	0.221023	56.2251	0	0.482166	8.962637	50.4484	56.23
		49	177	4	0.377262	41.56312	0	0.62644	9.38995	37.5287	41.56
		50	178	4	0.347438	42.68721	0	0.444107	3.217493	39.42353	42.68721

Table 11. PD with MIMO Relative Phase (39GHz_Low CH)

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)						
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)	Max_S.
J	Dipole	0	128	1	0.051246	1.326805	0.198655	0.000000	0.070538	5.703672	5.70
		4	132	2	0.165204	3.785694	1.564149	0	0.030529	10.96975	10.97
		5	134	2	0.028703	3.677698	1.165078	0	0.145009	16.14467	16.14
		6	133	2	0.062425	4.361263	0.890703	0	0.051358	22.00387	22.00
		16	144	2	0.057685	4.018982	0.640865	0	0.112313	15.96058	15.96
		17	145	2	0.141121	3.449971	1.476935	0	0.027939	12.38575	12.39
J	PATCH	1	129	1	0.088179	0.211167	0.945755	0	0.031323	10.51555	10.52
		7	136	2	0.10135	0.117121	1.003378	0	0.04128	14.75383	14.75
		8	137	2	0.107286	0.212092	0.588909	0	0.054658	15.29307	15.29
		9	135	2	0.136511	0.204653	1.884589	0	0.039467	16.33764	16.34
		18	147	2	0.114521	0.640961	1.519622	0	0.034974	13.71071	13.71
		19	146	2	0.114871	0.292881	1.029954	0	0.052552	17.44588	17.45
		24	153	4	0.408311	0.526848	1.476219	0	0.119744	32.23129	32.23
		25	154	4	0.422265	1.733041	3.10054	0	0.109304	29.40431	29.40
		26	152	4	0.401137	0.771624	0.535942	0	0.106275	32.80783	32.81
		27	155	4	0.311858	1.009905	3.248762	0	0.088428	31.1456	31.15
		28	156	4	0.220952	1.038968	2.888463	0	0.073917	29.798	29.80
		39	167	4	0.204638	0.805934	0.525129	0	0.140204	31.50905	31.51
		40	169	4	0.350389	0.23786	3.664712	0	0.08394	27.60893	27.61
		41	168	4	0.280979	0.388071	0.432295	0	0.061127	31.55836	31.56
		42	170	4	0.284617	1.363272	3.768177	0	0.08746	29.67214	29.67
K	PATCH	2	130	1	10.43155	0.072963	0.483762	0	1.530453	7.553985	10.43
		10	139	2	18.31366	0.13793	0.846644	0	1.145453	15.7889	18.31
		11	140	2	19.43321	0.07747	0.472139	0	2.655645	15.98472	19.43
		12	138	2	25.23478	0.08794	0.530804	0	3.458286	18.91845	25.23
		20	148	2	17.87818	0.071218	0.042132	0	2.52896	14.64337	17.88
		21	149	1	18.87231	0.096573	0.699374	0	2.608016	15.58383	18.87
		29	157	4	38.02763	0.159807	0.471905	0	5.845918	29.99416	38.03
		30	158	4	35.91855	0.094083	0.306898	0	5.391586	30.84573	35.92
		31	159	4	30.12437	0.130387	0.675122	0	5.053683	30.70811	30.71
		32	160	4	38.55671	0.108712	0.914216	0	5.775875	30.49495	38.56
		33	161	4	35.78543	0.215097	1.108463	0	5.036319	28.42012	35.79
		43	173	4	33.83894	0.124713	0.765517	0	4.992039	29.06309	33.84
		44	172	4	34.65939	0.168221	0.436966	0	5.339875	31.78242	34.66
		45	174	4	37.62039	0.220679	2.819814	0	4.523486	29.54437	37.62
		46	171	4	31.76012	0.154838	0.775411	0	5.046697	29.91241	31.76
L	PATCH	3	131	1	0.051808	10.11856	0	0.037005	1.211071	8.89814	10.12
		13	141	2	0.080455	15.20504	0	0.357211	2.625592	11.78058	15.21
		14	142	2	0.096147	18.88082	0	0.195628	3.53265	17.07387	18.88
		15	143	2	0.09589	14.51532	0	0.187633	2.648466	13.9793	14.52
		22	150	2	0.083868	16.9957	0	0.037551	2.795536	13.8761	17.00
		23	151	2	0.086181	19.65733	0	0.381417	2.723591	15.77908	19.66
		34	166	4	0.230482	33.87227	0	0.421281	5.273053	27.94149	33.87
		35	163	4	0.183942	31.72284	0	0.022144	5.848341	30.79058	31.72
		36	162	4	0.170753	33.95476	0	0.262388	4.706005	29.00702	33.95
		37	165	4	0.336273	28.45273	0	0.700749	3.456568	26.32845	28.45
		38	164	4	0.18667	29.51093	0	0.912499	4.988012	28.36709	29.51
		47	175	4	0.313629	29.17936	0	0.382392	6.016917	26.58384	29.18
		48	176	4	0.196623	32.06134	0	0.212905	5.367817	30.34067	32.06
		49	177	4	0.275563	29.32229	0	0.480506	5.147005	27.9529	29.32
		50	178	4	0.176048	30.02667	0	0.632111	5.774185	28.22913	30.02667

Table 12. PD with MIMO Relative Phase (39GHz_Mid CH)

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)						
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)	Max_S.
J	Dipole	0	128	1	0.150766	1.686634	1.208522	0.000000	0.468506	6.675237	6.68
		4	132	2	0.530572	4.218527	2.337537	0	0.984105	12.97586	12.98
		5	134	2	0.47103	5.589006	1.14122	0	0.799638	15.11698	15.12
		6	133	2	0.550855	5.157552	2.014797	0	0.913662	19.57659	19.58
		16	144	2	0.429595	4.838453	1.254763	0	0.697271	14.97737	14.98
		17	145	2	0.575284	3.371561	2.449427	0	0.811535	13.36268	13.36
J	PATCH	1	129	1	0.079329	0.631921	0.685654	0	0.035366	11.01374	11.01
		7	136	2	0.128949	0.419097	0.365407	0	0.037062	15.9025	15.90
		8	137	2	0.124291	0.528719	0.609895	0	0.047669	16.26624	16.27
		9	135	2	0.143322	0.927077	0.803688	0	0.034967	13.44516	13.45
		18	147	2	0.133833	0.673631	0.408698	0	0.028659	14.57348	14.57
		19	146	2	0.093466	0.342547	1.26845	0	0.114795	20.08387	20.08
		24	153	4	0.314277	1.018089	1.64668	0	0.091104	34.47903	34.48
		25	154	4	0.325399	1.227499	3.272922	0	0.079938	33.28862	33.29
		26	152	4	0.319616	1.298027	1.810502	0	0.113289	35.41109	35.41
		27	155	4	0.383006	1.000404	3.879781	0	0.114535	35.4096	35.41
		28	156	4	0.430461	0.586303	3.334678	0	0.070642	32.1998	32.20
		39	167	4	0.341582	1.372605	3.771742	0	0.147579	32.42965	32.43
		40	169	4	0.281038	0.710975	4.440317	0	0.075494	30.92819	30.93
		41	168	4	0.48166	0.687703	2.50481	0	0.069262	37.06574	37.07
		42	170	4	0.455369	0.859181	4.005478	0	0.074421	31.99664	32.00
K	PATCH	2	130	1	10.30846	0.044902	0.595377	0	1.420075	7.534849	10.31
		10	139	2	19.45044	0.066906	0.988684	0	1.984121	17.29792	19.45
		11	140	2	17.84005	0.052509	0.392213	0	2.344646	14.84973	17.84
		12	138	2	23.47952	0.133685	0.568171	0	3.140872	18.70597	23.48
		20	148	2	16.65404	0.09475	0.055623	0	2.17531	14.04017	16.65
		21	149	1	18.27594	0.049718	0.497954	0	2.360243	15.08688	18.28
		29	157	4	39.78287	0.156497	0.854642	0	4.521295	34.0284	39.78
		30	158	4	34.25878	0.216118	0.380736	0	4.95492	29.51484	34.26
		31	159	4	30.60594	0.112125	1.107977	0	4.309202	30.22827	30.61
		32	160	4	40.01906	0.11744	1.369	0	5.235107	32.16291	40.02
		33	161	4	31.47724	0.143732	1.097707	0	3.959607	24.12774	31.48
		43	173	4	33.65903	0.187169	1.462389	0	3.713226	27.60826	33.66
		44	172	4	32.80095	0.126726	0.728709	0	3.839027	27.34898	32.80
		45	174	4	37.58059	0.141767	2.530777	0	3.47039	28.14508	37.58
		46	171	4	33.14403	0.177046	0.876438	0	5.032418	30.11097	33.14
L	PATCH	3	131	1	0.049106	10.80535	0	0.076446	0.686987	7.732266	10.81
		13	141	2	0.177811	16.84591	0	0.5264	2.260845	13.59751	16.85
		14	142	2	0.166694	20.77951	0	0.337794	2.894185	17.63594	20.78
		15	143	2	0.067777	15.33857	0	0.217626	2.216237	13.94291	15.34
		22	150	2	0.115552	20.0033	0	0.112838	2.866088	16.80743	20.00
		23	151	2	0.058172	22.77407	0	0.648732	3.083462	17.50426	22.77
		34	166	4	0.331881	36.31825	0	0.459358	4.518266	28.24041	36.32
		35	163	4	0.187153	36.41387	0	0.135299	5.4338	31.57259	36.41
		36	162	4	0.256305	38.45622	0	0.283996	4.604591	33.4425	38.46
		37	165	4	0.274965	33.56156	0	1.115603	4.276864	29.27985	33.56
		38	164	4	0.356785	35.28553	0	0.63032	5.511686	31.548	35.29
		47	175	4	0.356822	30.47276	0	0.64935	5.580306	25.97071	30.47
		48	176	4	0.248828	35.00008	0	0.384214	5.623168	29.15924	35.00
		49	177	4	0.303559	35.72376	0	0.842091	5.622245	31.65085	35.72
		50	178	4	0.153933	35.30618	0	0.733864	5.130732	30.48045	35.30618

Table 13. PD with MIMO Relative Phase (39GHz_High CH)

Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	4cm2 PD(W/m2)						
					S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)	Max_S.
J	Dipole	0	128	1	0.046519	1.456961	0.152418		0.046597	5.022547	5.02
		4	132	2	0.075765	3.197719	0.878148		0.048239	11.02477	11.02
		5	134	2	0.155441	3.905488	0.411259		0.054857	14.94496	14.94
		6	133	2	0.077863	2.653221	1.465019		0.049362	16.44702	16.45
		16	144	2	0.186068	2.360585	0.45227		0.041391	13.2614	13.26
		17	145	2	0.045521	2.941232	1.04673		0.041198	11.05803	11.06
J	PATCH	1	129	1	0.061534	0.375646	0.20631	0	0.031038	10.246	10.25
		7	136	2	0.077238	0.641719	0.492033	0	0.038731	14.38109	14.38
		8	137	2	0.101587	0.112928	0.402265	0	0.038351	15.73197	15.73
		9	135	2	0.056071	0.830684	0.61403	0	0.067395	14.71785	14.72
		18	147	2	0.056406	0.832508	0.478145	0	0.053506	14.74447	14.74
		19	146	2	0.134533	0.313349	0.977207	0	0.059898	19.7199	19.72
		24	153	4	0.46819	0.668564	0.452672	0	0.117849	33.0106	33.01
		25	154	4	0.268746	0.78623	2.439427	0	0.105596	37.56823	37.57
		26	152	4	0.269122	1.811864	0.362754	0	0.15027	29.63737	29.64
		27	155	4	0.305348	0.967435	2.970929	0	0.138098	32.30115	32.30
		28	156	4	0.40626	0.154582	1.251399	0	0.08106	30.55952	30.56
		39	167	4	0.251811	0.43224	2.633576	0	0.183729	31.60014	31.60
		40	169	4	0.280985	0.602891	3.040704	0	0.122581	33.3188	33.32
		41	168	4	0.266284	0.720651	2.37249	0	0.141117	35.8454	35.85
		42	170	4	0.317393	1.001735	1.09475	0	0.075965	29.34377	29.34
K	PATCH	2	130	1	10.31651	0.032456	0.428408	0	1.162484	6.748601	10.32
		10	139	2	17.30247	0.055665	0.539694	0	2.5003	12.76451	17.30
		11	140	2	16.91363	0.091302	0.312517	0	2.479824	13.90434	16.91
		12	138	2	22.22605	0.067979	1.415438	0	3.037181	16.38798	22.23
		20	148	2	15.70087	0.083785	0.074766	0	2.973675	13.26742	15.70
		21	149	1	17.25373	0.079679	0.332016	0	2.294422	13.77342	17.25
		29	157	4	37.49459	0.155428	0.502518	0	4.667596	28.23925	37.49
		30	158	4	30.68508	0.335852	0.754635	0	6.050582	25.80272	30.69
		31	159	4	26.1876	0.260414	1.114546	0	5.745632	20.71526	26.19
		32	160	4	38.25187	0.178746	0.517704	0	5.887692	30.37331	38.25
		33	161	4	33.0504	0.168512	1.140117	0	4.092941	26.47409	33.05
		43	173	4	28.2618	0.199944	1.646036	0	4.375743	22.02019	28.26
		44	172	4	27.30105	0.282527	0.716228	0	5.294106	22.06262	27.30
		45	174	4	32.31832	0.248219	2.302938	0	4.805996	23.40119	32.32
		46	171	4	30.72361	0.322668	0.640394	0	5.635393	24.18819	30.72
L	PATCH	3	131	1	0.059277	11.08933	0	0.078345	1.189285	8.848138	11.09
		13	141	2	0.13573	16.93867	0	0.169372	2.264923	14.40267	16.94
		14	142	2	0.151773	19.80146	0	0.341771	1.434517	16.94186	19.80
		15	143	2	0.073727	15.3417	0	0.466233	2.704171	13.0571	15.34
		22	150	2	0.079531	19.85996	0	0.116898	2.56883	18.15975	19.86
		23	151	2	0.153587	21.7927	0	0.391225	3.075181	16.0772	21.79
		34	166	4	0.223178	36.25551	0	0.442381	4.163198	27.11971	36.26
		35	163	4	0.415396	33.22377	0	0.245218	5.402873	29.98634	33.22
		36	162	4	0.228411	34.85694	0	0.282448	4.58978	29.65291	34.86
		37	165	4	0.332636	31.82288	0	1.132692	4.355139	26.86491	31.82
		38	164	4	0.257255	31.71245	0	0.377484	4.728106	29.70113	31.71
		47	175	4	0.244578	29.23288	0	0.537954	4.434068	24.17527	29.23
		48	176	4	0.346645	32.06175	0	0.532188	5.186937	27.55481	32.06
		49	177	4	0.391711	32.83818	0	0.863178	4.686882	27.29511	32.84
		50	178	4	0.283114	30.46948	0	0.404432	5.396476	29.69201	30.46948

4. Uncertainty

The amplitude level of PD simulation is biased due to material property parameter configuration in device housing at high frequencies. Material property is difficult to model due to complexity of material and operating frequency. Therefore, it is not possible to assign an exact uncertainty for simulation result. However, for this RF exposure evaluation, simulation results were only used to select highest beam ID measurement. Power Density results for measurement and simulation showed similar trend to justify selection of Beam ID used for measurement. All final power density evaluation were performed on measurement system with uncertainty approximately 1.48dB.