mmWave MPE (Averaged Power Density) Simulation

1 Introduction 2
2 MPE Simulation Methodology 2
3 MPE Measurements 3
4 MPE Simulations 4
5 Uncertainty Budget for Simulation 8
6 Simulation versus Measurement 9
Appendix A: Worst Phase Derivation for Beam Pair 22
Appendix B: 4 cm^2 Averaged PD and Scaling Factor 23
Appendix C: Additional Verifications for GEN 2 49
References 65

1 Introduction

This document provides an overview of the methodology used for Maximum Permissible Exposure (MPE) compliance of the 5G mmWave radios on next generation iPad BCGA2764. In the mmWave regime that this product will cover, the MPE is best represented by peak spatial-average power density (psPD).

Due to the presence of multiple antenna arrays and multiple antenna beams for each antenna array, we propose to use a combination of simulations and measurements to demonstrate MPE compliance. At a high level, the discussion is grouped into the following topics:

- Brief introduction to MPE simulation methodologies
- Explanation of the approach to demonstrate MPE (psPD) compliance in a device using measurements
- Brief review of the device configuration and operation, and detailed description of the simulation methodology and results

2 MPE Simulation Methodology

3D full-wave simulation is used to evaluate MPE for each antenna array module's beam. Each beam is created by invoking a pre-defined codebook that has the proper array elements' excitation (i.e., magnitude and phase) to create the beam.
The following steps are taken to verify the validity of the model used for MPE simulations and then the verified model is used for the MPE calculations:

1) **EM Simulation:**
    - Import a CAD model that represents the actual product in the simulation tool
    - Define material properties inside the product based on vendor's inputs
    - Perform mesh seeding and solve
2) **Compile Fields and Codebook:**
    - Extract field data from solved model and arrange in format required by Qualcomm Module Group (MG) Script [1]
    - Input PD char codebook generated by Qualcomm Webchar tool
3) **MPE Calculations:**
    - Set averaging area to 4cm^2 using MG Script configuration xml file
    - Run MG script to generate MPE and power limit tables for each beam ID in codebook
4) **Validate Simulation Model:**
    - Measure MPE
    - Compare measurement vs simulation
    - Once a correlation is established, and model's accuracy is verified, this model will be used for computational MPE assessments

5) Run Additional Verifications:
- Use verification data generated by MG Script
- Measure MPE for worst case beams given by MG Script
- Use EM tools, MG Script to complete additional verifications

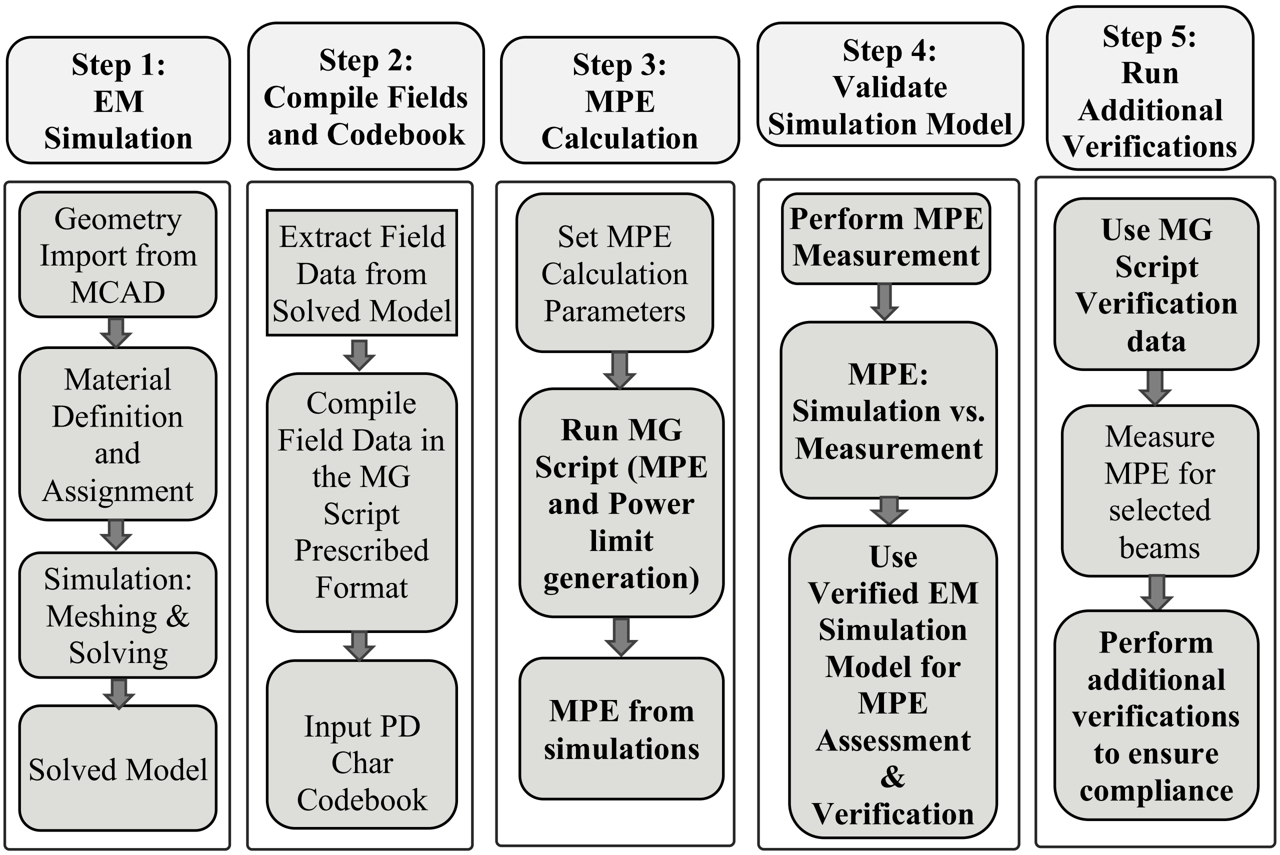


Figure 1. Model validation workflow for MPE simulation and evaluation

3 MPE Measurements

A mmWave DAE SN 1411 module from SPEAG is used to measure the MPE above the DUT. Figure 2 shows a typical measurement setup. The mmWave E-field probe is used to measure the electric field above DUT. The near-field magnetic field and MPE are further obtained using this setup. For more detail about the measurement algorithm, please refer to [2].

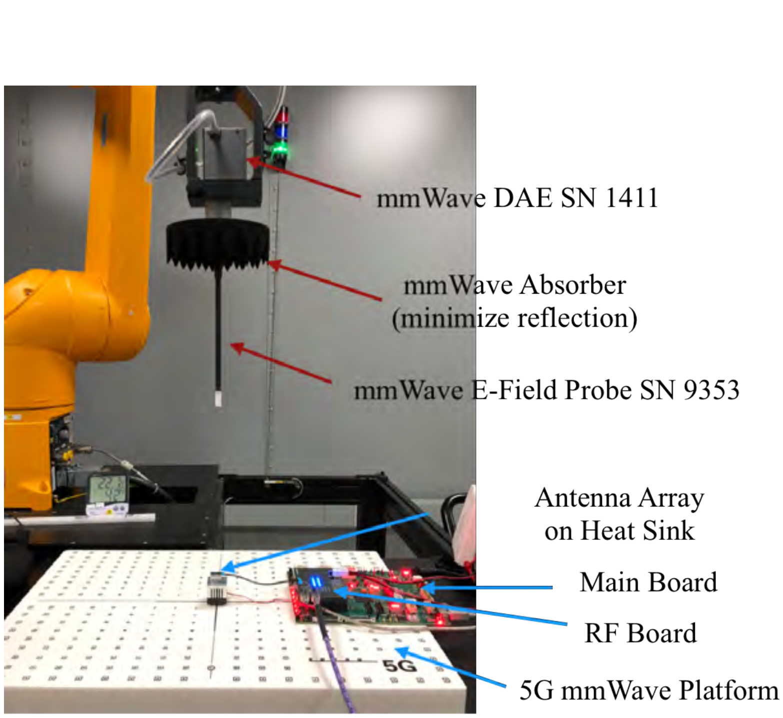


Figure 2. MPE measurement setup

The distance from the probe sensor tip to the edge of the housing is 1.5 mm, and there is 0.5 mm gap between the probe tip and the DUT surface to prevent any mechanical damages. Therefore, the closest distance that the setup can measure is 2 mm as shown below in Figure 3.

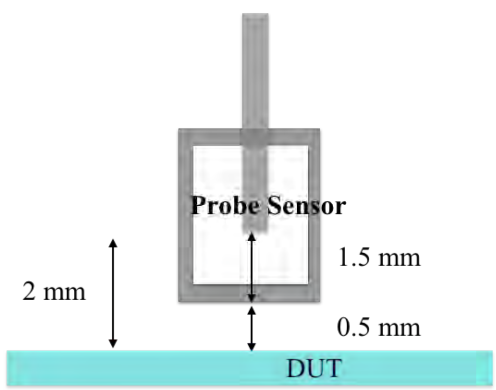


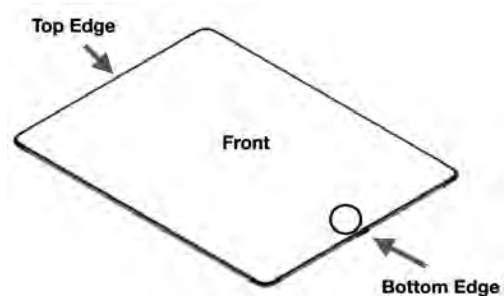
Figure 3. Schematic view of the probe showing that the minimum measurable distance is 2 mm

4 MPE Simulations

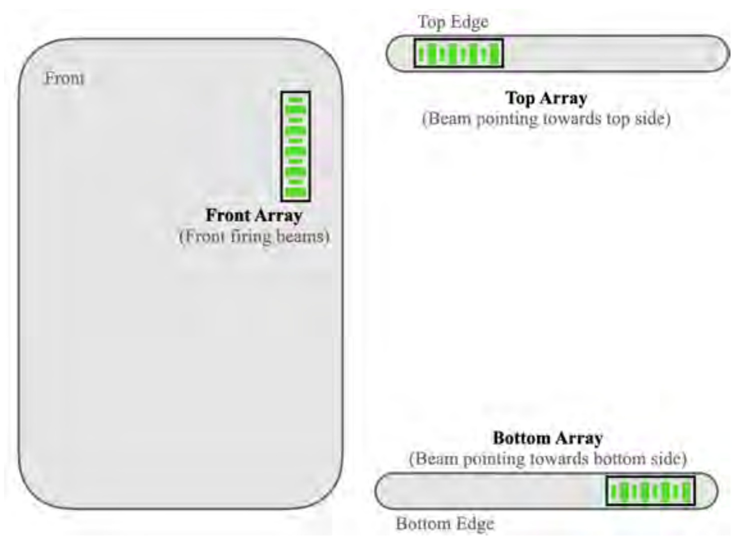
In 5G, array antennas are designed to direct the beam to specific directions to improve link budgets. Most arrays can be configured by using the codebook with each code resulting in a different exposure. The number of codes in the codebook can be very large and measurements of all possible configurations have been shown to be impractical. Therefore, simulation is used to determine the configurations that result in the highest MPE.

Simulation Models

Figure 4 shows a schematic view of the iPad. There are three antenna arrays located at the top left corner, bottom right corner, and front.



(a)



(b)

Figure 4. iPad schematic view (a) full view, (b) 5G arrays placement

The measurements and simulations are correlated across different evaluation surfaces 2 mm away from each DUT surface, as shown in Fig. 5 (drawing not to scale). Six surfaces will be evaluated, respectively: front (S1), back (S2), left (S3), right (S4), top (S5), and bottom (S6). As Table 1 shows, for the three antenna modules, only the 3 most significant PD evaluation planes within 2.5 cm from the edges of the antenna modules will be considered. This does not apply to the front-to-back condition since the fields from the front module will be blocked at the back plane by the metal parts (such as battery, MLB) in between.

The "left" and "right" edges in the report are defined relative to the front of the device.

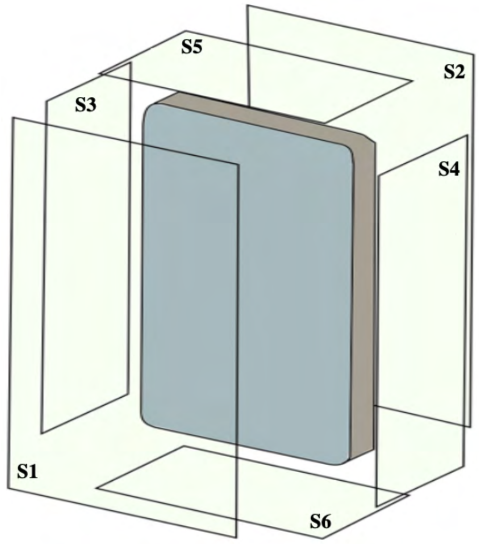


Figure 5. Evaluation surfaces for MPE (PD)

Table 1. PD evaluation planes (any distance less than 1 cm is reported as 0 cm)

	Front (S1)	Rear (S2)	Left from Front View (S3)	Right from Front View (S4)	Top (S5)	Bottom (S6)
Top Module	**Yes (0 cm)**	**Yes (0 cm)**	No (0 cm)	No (19 cm)	**Yes (0 cm)**	No (28 cm)
Bottom Module	**Yes (0 cm)**	**Yes (0 cm)**	No (19 cm)	No (0 cm)	No (28 cm)	**Yes (0 cm)**
Front Module	**Yes (0 cm)**	**Yes* (0 cm)**	No (19 cm)	**Yes (0 cm)**	No (7cm)	No (20 cm)

**MPE is reported but its value is very small because of the internal metallic objects' blockage.*

Peak Spatial-Average Power Density Definition

After solving the 3D full-wave electromagnetic simulation, first, electric field $\vec{E}$ and magnetic field $\vec{H}$ are extracted. To evaluate peak spatial-average power density, Poynting vector can be defined as:

$$\vec{S} = \frac{1}{2}\vec{E} \times \vec{H}^*$$

The peak spatial-average power density (psPD) on an evaluation area (A) can be calculated by performing an averaging as described, below:

$$\text{psPD} = \frac{1}{A}\int_A ||Re(\vec{S}) \cdot d\vec{A}|| = \frac{1}{2A}\int_A ||\text{Re}(\vec{E} \times \vec{H}^*) \cdot d\vec{A}||$$

Where ||.|| is the norm operation. The evaluated area A is 4 cm^2. To capture the worst-case conditions (i.e., highest psPD), simulations and measurements were performed assuming a 100% duty cycle. The quantities described in this section are evaluated using Qualcomm MG Script. Please refer to Appendix A for worst case total power density derivation.

Simulation Methodology:
A time domain 3D Full-Wave Electromagnetic Simulation is performed using CST Studio Suite. The solver calculates electric and magnetic fields at discrete locations and time samples. To achieve high accuracy at all locations, the total electromagnetic energy inside the calculation domain is used as a convergence criterion. The solvers terminate when the normalized energy is decayed to -40 dB ensuring high accuracy of simulation output.

Boundary Conditions:
The boundary condition for simulating electromagnetic behavior in CST is to allow the electromagnetic waves to be electrically open at the boundary and radiated far away without reflection. CST can support the absorption boundary condition (ABC) for radiation boundary and normally requires a quarter-wavelength separation from the structure.

Source Excitation and Example Codebook:
Figure 6 shows an example of the codebook for the antenna modules. The third column of the codebook is the beam ID. The other notable columns are "Amplitude" and "Phase" columns which are the excitation amplitude and phase for each antenna element. Each beam has a "Paired_with" beam for concurrent MIMO streams. The last column is the index of the beam which is paired with the index shown in the second column. The "Amplitude" is in dBm, and "Phase" is in degrees.

Band	Shared_Bands	Beam_ID	Module	Ant_Group	Subarray	Ant_Type	Ant_Feed	Amplitude	Phase	Paired_With
257	261	0	0	0	7	PATCH	11	0	0	128
257	261	1	1	0	9	PATCH	11	0	0	129
257	261	2	2	0	11	PATCH	15	0	0	130
257	261	3	0	0	7	PATCH	12	0	0	131
257	261	4	1	0	9	PATCH	12	0	0	132
257	261	5	2	0	11	PATCH	14	0	0	133
257	261	6	0	0	7	PATCH	13	0	0	134
257	261	7	1	0	9	PATCH	13	0	0	135
257	261	8	2	0	11	PATCH	13	0	0	136
257	261	9	0	0	7	PATCH	14	0	0	137
257	261	10	1	0	9	PATCH	14	0	0	138
257	261	11	2	0	11	PATCH	12	0	0	139
257	261	12	2	0	11	PATCH	11	0	0	140
257	261	13	0	0	7	PATCH	11;12	0;0	348.75;146.2	141
257	261	14	0	0	7	PATCH	11;12	0;0	292.5;0	142
257	261	15	0	0	7	PATCH	11;12	0;0	11.25;348.75	143
257	261	16	0	0	7	PATCH	11;12	0;0	67.5;0	144

Figure 6. An example version of the antenna codebook

Averaging the Power Density for MPE:
Qualcomm MG script performs spatial averaging is needed to determine the MPE values from the power density simulation results over the 4 cm^2 area required by the FCC.

5 Uncertainty Budget for Simulation

Below is a table summarizing the budget of the uncertainty contributions of the numerical algorithm and of the rendering of the simulation setup. The table was filled using the IEC 62704-1 ED1 [3].

Table 2 – Preliminary budget of the uncertainty contributions of the numerical algorithm

Uncertainty component	Probability distribution	Divisor f(d, h)[1]	Ci^2	Uncertainty %
Mesh resolution	Normal	1	1	1.45
ABC	Normal	1	1	0.209
Power budget	Normal	1	1	0.342
Model Truncation				0.0715
Convergence	Rectangular	1.73	1	0.01
DUT dielectrics	Normal	1	1	4.63
Lossy conductors	Rectangular	1.73	1	0.87
Combined standard uncertainty (k = 1)				7.59

Note 1: The divisor is a function of the probability distribution and degrees of freedom (v_i and v_{eff}).
Note 2: c_i is the sensitivity coefficient that is applied to convert the variability of the uncertainty component into a variability of psPD.

6 Simulation versus Measurement

To validate the accuracy of the model, measured MPE and simulated MPE values for n258 are summarized below in Table 3, with unit W/m^2. The difference between simulated and measured MPE values is in dB. Please be noted due to timeline, the simulation and measurement comparison is not obtained using the final version of codebook.

Table 3 - Simulated and measured n258 MPE (PD) at 2 mm away from DUT

a) Top Array, n258

Beam ID	Ant Pol	Simulation (W/m^2)	Measurement (W/m^2)	Delta = Sim – Meas. (dB)
		S5	S5	S5
34	V	19.08	12.5	1.83668357
35	V	19.13	15	1.05623711
49	V	19.44	12.9	1.7810655
162	H	15.28	14.7	0.16806019
177	H	15.28	15	0.08032095
180	H	16.12	13.3	0.83513397

b) Bottom Array, n258

Beam ID	Ant Pol	Simulation (W/m^2)	Measurement (W/m^2)	Delta = Sim – Meas. (dB)
		S6	S6	S6
39	V	22.48	12.9	2.41206597
42	V	22.08	14.8	1.73737354
53	V	21.06	15.1	1.4448142
167	H	16.46	15.8	0.17772744
181	H	14.95	12.9	0.64051482
184	H	15.96	14.2	0.50744543

c) Front Array 2, n258

Beam ID	Ant Pol	Simulation (W/m^2)	Measurement (W/m^2)	Delta = Sim – Meas. (dB)
		S1	S1	S1
45	V	25.43	19.9	1.06493284
47	V	29.28	26.7	0.40059811
58	V	26.26	22.3	0.70989859

172	H	31.28	22.1	1.50874471
174	H	29.75	26.2	0.55185679
185	H	30.44	24.5	0.94278564

To validate the accuracy of the model, measured point PD patterns for the three arrays were compared to simulated point PD patterns for different beams for n258, as is shown in Figure 7. The plotted point PD pattern are normalized to its own maximum value, respectively. Please be noted due to timeline, the simulation and measurement comparison is not obtained using the final version of codebook.

a) Top Array, n258

<table>
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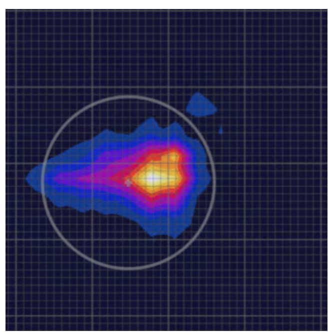
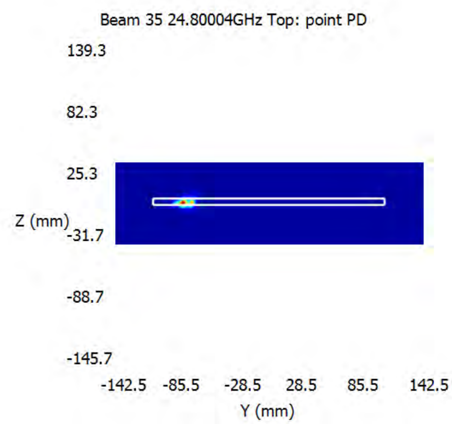
<tr><td rowspan="2">35</td><td>S5</td><td></td><td>
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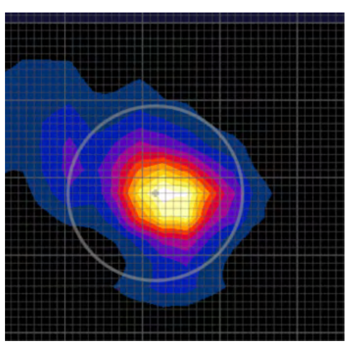
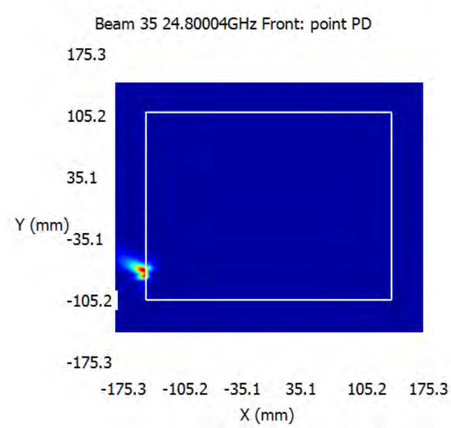
<tr><td>S1</td><td></td><td>
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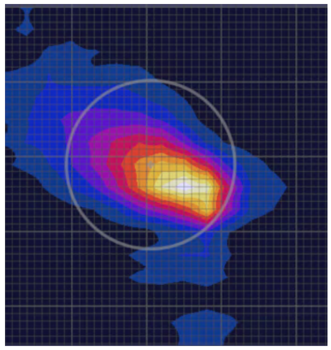
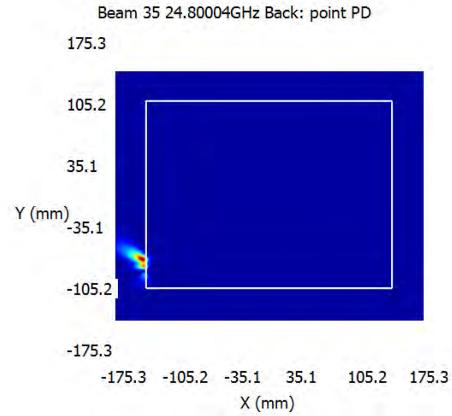
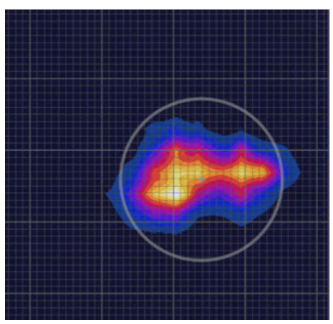
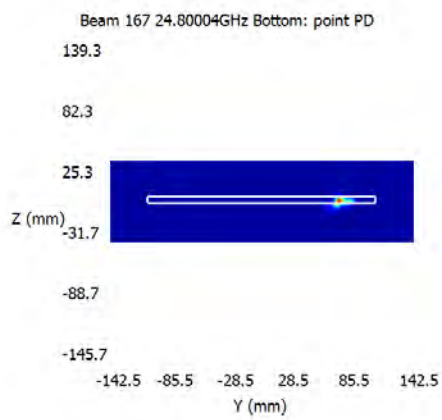
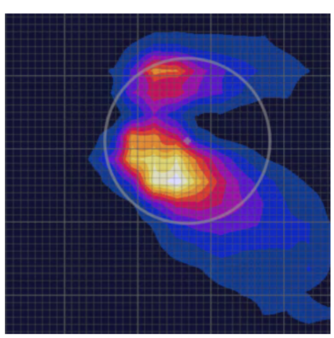
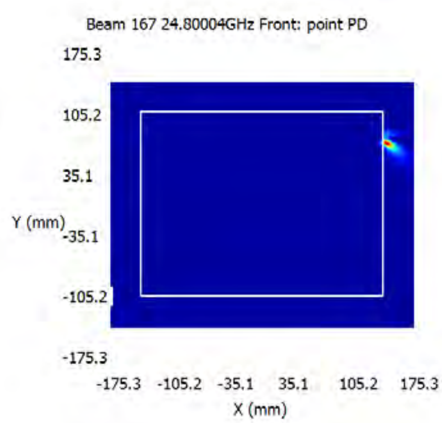
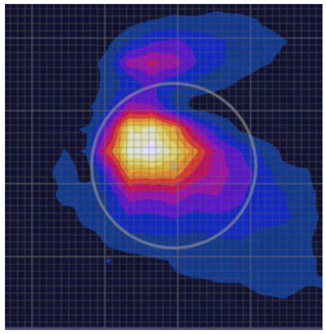
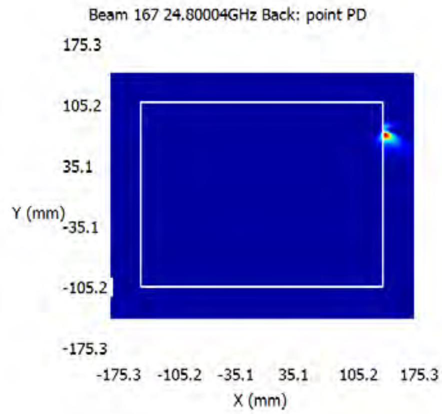
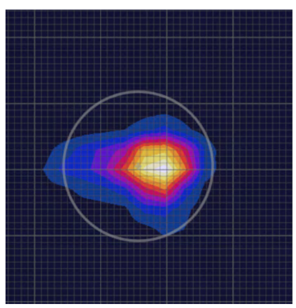
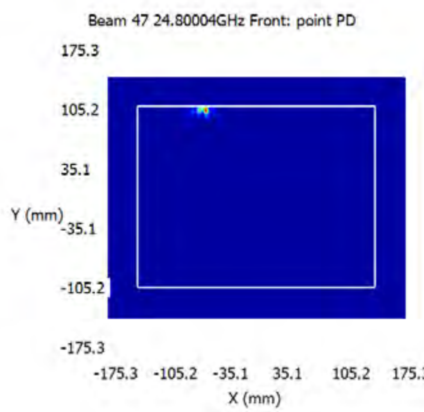
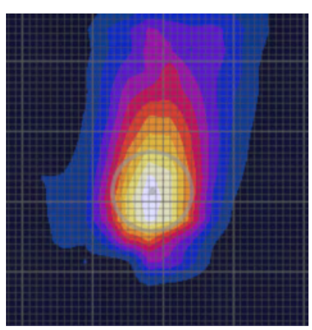
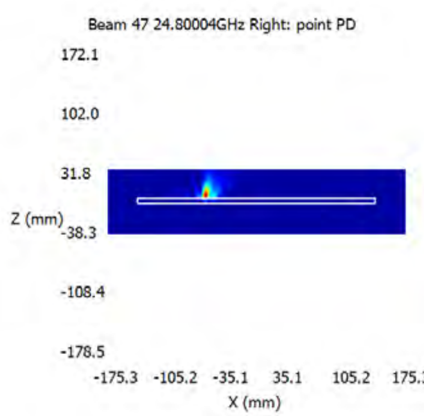
	S2		

b) Bottom Array,

Beam ID	**Surface**	**Measured Point PD**	**Simulated Point PD**
167	**S6**		
	S1		

	S2		

c) Front Array, n258

Beam ID	Surface	Measured Point PD	Simulated Point PD
47	**S1**		
	S4		

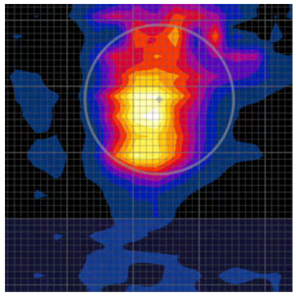
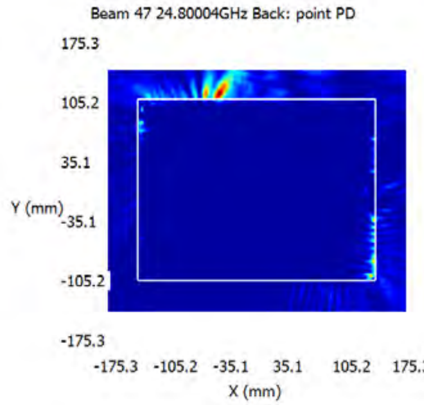
	S2		

Figure 7. Simulated and measured point PD for different beams for n258

To validate the accuracy of the model, measured MPE and simulated MPE values for n261 are summarized below in Table 4, with unit W/m^2. The difference between simulated and measured MPE values is in dB. Please be noted due to timeline, the simulation and measurement comparison is not obtained using the final version of codebook.

Table 4 - Simulated and measured n261 MPE (PD) at 2 mm away from DUT

a) Top Array, n261

Beam ID	Ant Pol	Simulation (W/m^2)	Measurement (W/m^2)	Delta = Sim – Meas. (dB)
		S5	S5	S5
37	V	18.87	16	0.71651918
38	V	19.83	14.8	1.27060999
52	V	20.85	16.4	1.04262211
165	H	20.97	16.6	1.01490342
179	H	18.83	15.6	0.81725722
180	H	19.82	16.9	0.69216946

b) Bottom Array, n261

Beam ID	Ant Pol	Simulation (W/m^2)	Measurement (W/m^2)	Delta = Sim – Meas. (dB)
		S6	S6	S6
43	V	21.9	15.5	1.50112417
53	V	19.92	19	0.20535733
56	V	21.31	14.7	1.61266115

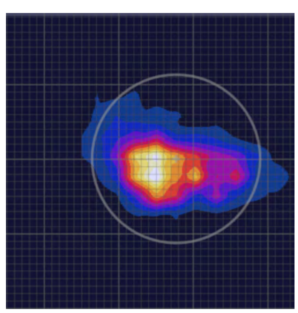
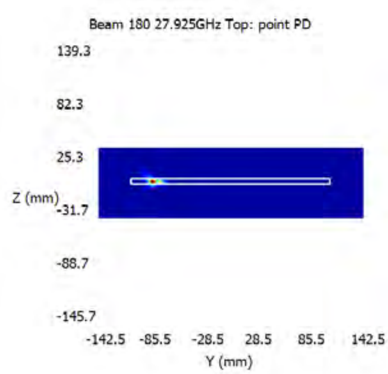
170	H	17.87	15.7	0.562249
171	H	18.03	16.8	0.30686445
184	H	20.17	16.2	0.95190884

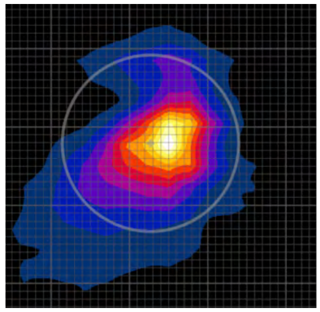
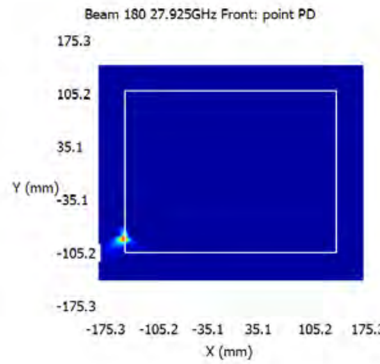
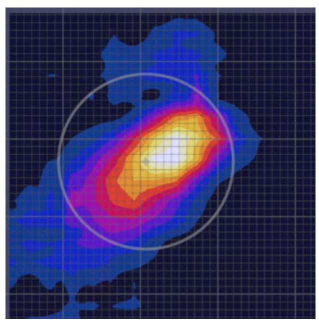
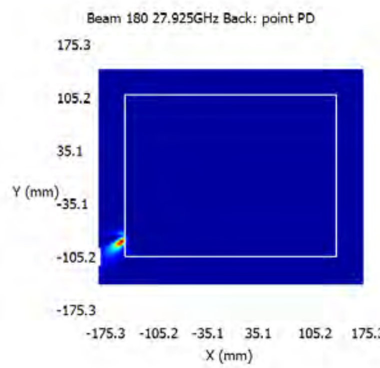
c) Front Array, n261

Beam ID	Ant Pol	Simulation (W/m^2)	Measurement (W/m^2)	Delta = Sim – Meas. (dB)
		S1	S1	S1
46	V	33.64	20.3	2.19359949
47	V	32.82	20.9	1.95992291
59	V	35.39	22.2	2.02527588
173	H	34.53	20.1	2.35000521
185	H	32.87	21.4	1.86385931
186	H	35.71	21.2	2.26453989

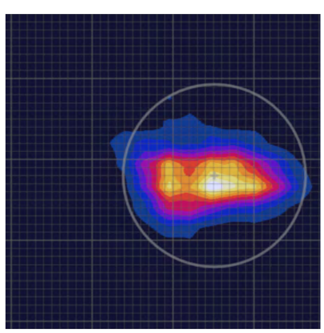
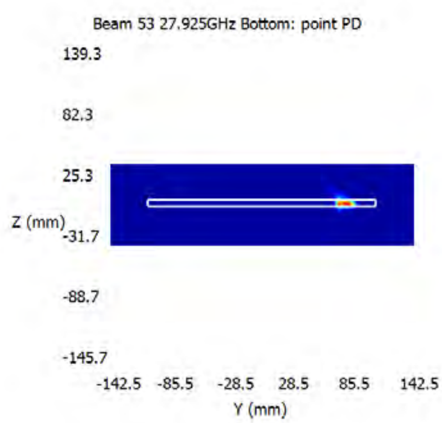
To validate the accuracy of the model, measured point PD patterns for the three arrays were compared to simulated point PD patterns for different beams for n261, as is shown in Figure 8. The plotted point PD pattern are normalized to its own maximum value, respectively. Please be noted due to timeline, the simulation and measurement comparison is not obtained using the final version of codebook.

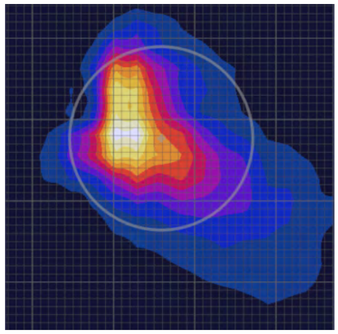
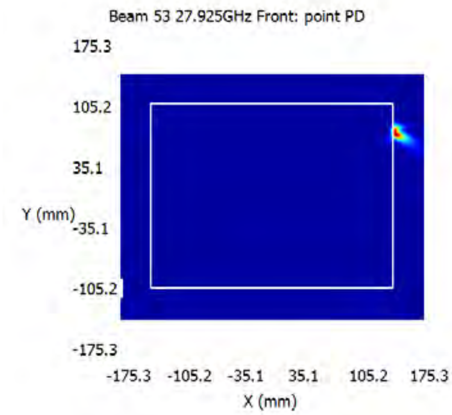
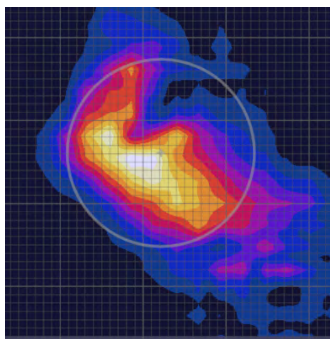
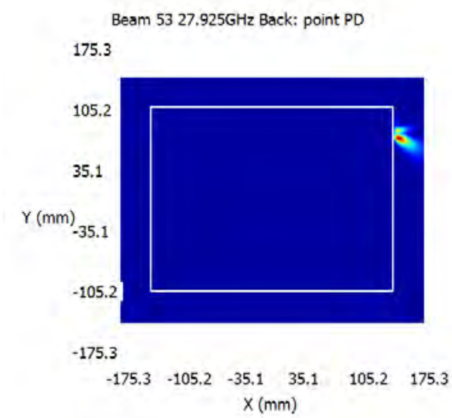
a) Top Array, n261

Beam ID	**Surface**	**Measured Point PD**	**Simulated Point PD**
180	**S5**		

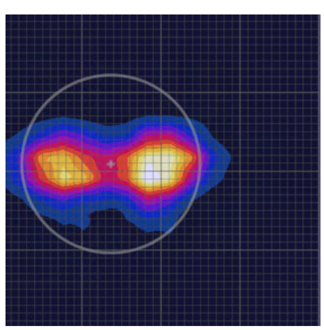
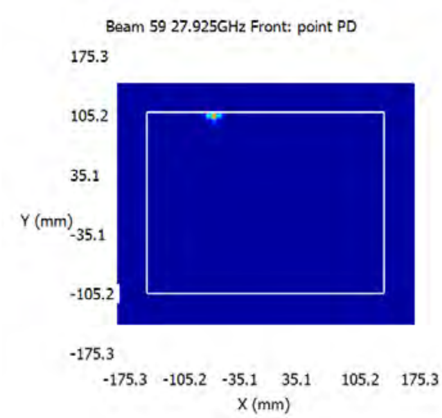
	S1		
	S2		

b) Bottom Array, n261

Beam ID	**Surface**	**Measured Point PD**	**Simulated Point PD**
53	**S6**		

	S1		
	S2		

c) Front Array, n261

Beam ID	Surface	Measured Point PD	Simulated Point PD
59	**S1**		

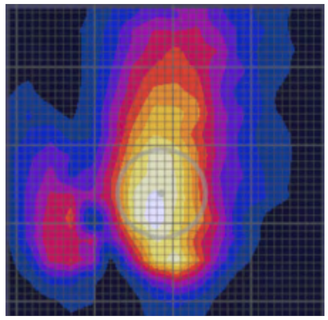
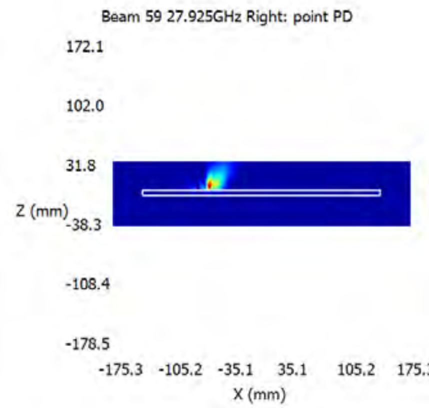
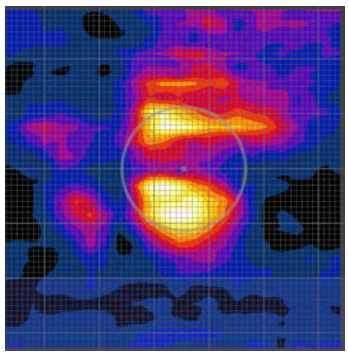
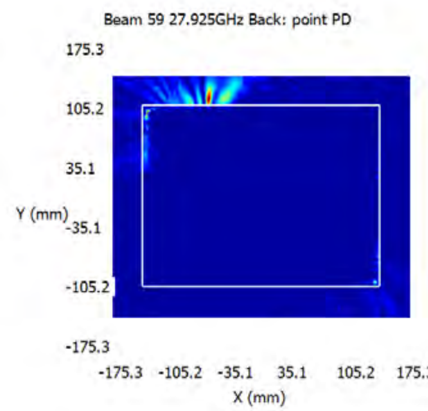
	S4		
	S2		

Figure 8. Simulated and measured point PD for different beams for n261

To validate the accuracy of the model, measured MPE and simulated MPE values for n260 are summarized below in Table 5, with unit W/m^2. The difference between simulated and measured MPE values is in dB. Please be noted due to timeline, the simulation and measurement comparison is not obtained using the final version of codebook.

Table 5 - Simulated and measured n260 MPE (PD) at 2 mm away from DUT

a) Top Array, n260

Beam ID	Ant Pol	Simulation (W/m^2)	Measurement (W/m^2)	Delta = Sim – Meas. (dB)
		S5	S5	S5
35	V	20.3	14	1.61368002
36	V	20.7	13.4	1.88865547
50	V	20.26	13.7	1.69918874
164	H	19.04	13.9	1.36652144

165	H	18.98	12.3	1.88391097
179	H	20.62	13.7	1.77568094

b) Bottom Array, n260

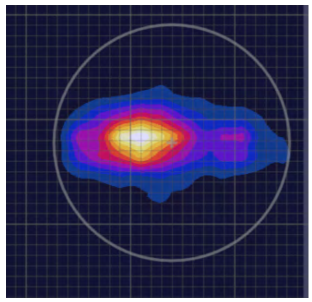
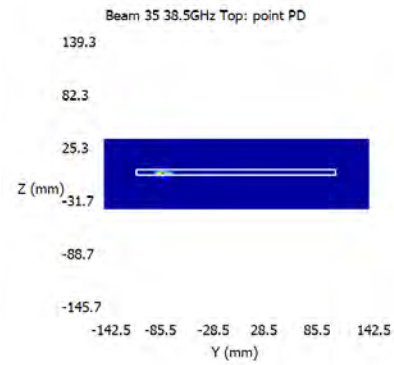
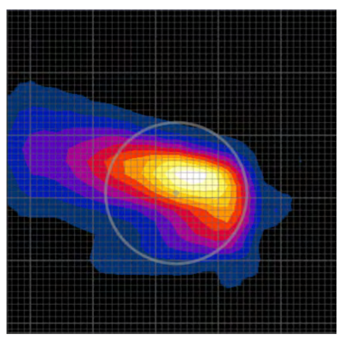
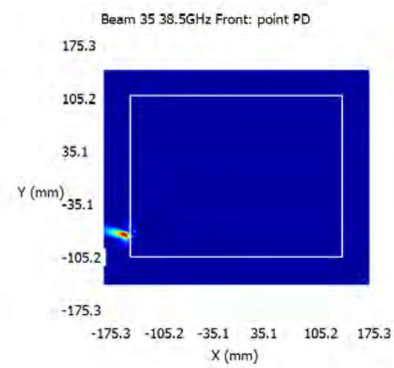
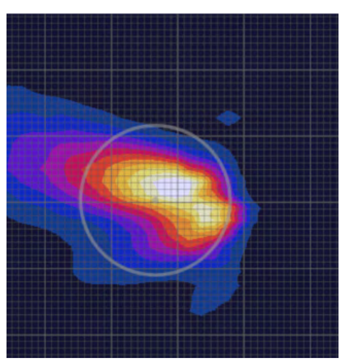
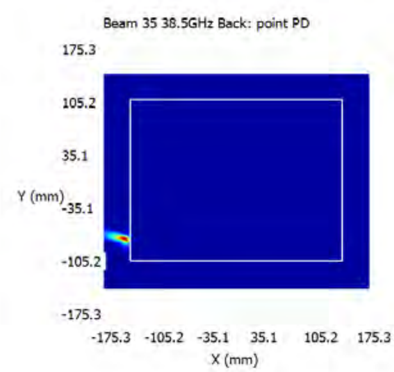
Beam ID	Ant Pol	Simulation (W/m^2)	Measurement (W/m^2)	Delta = Sim – Meas. (dB)
		S6	S6	S6
41	V	20.8	13.9	1.75048535
43	V	19.66	13.1	1.76312218
54	V	20.42	14.2	1.57767393
169	H	19.77	13.9	1.52991869
170	H	19.21	15.3	0.98835934
183	H	21.25	14.5	1.65990932

c) Front Array 2, n260

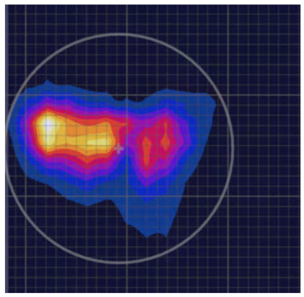
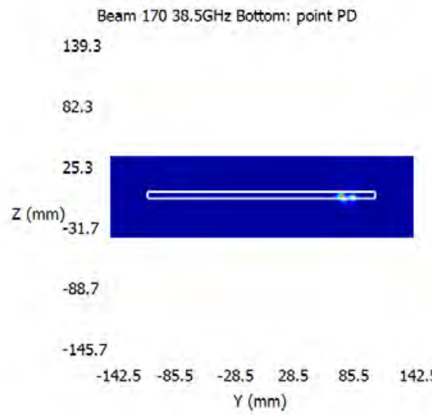
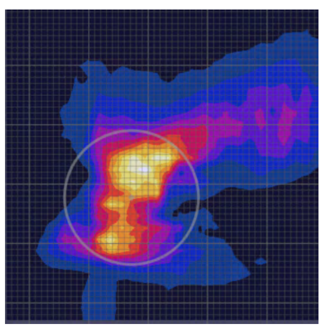
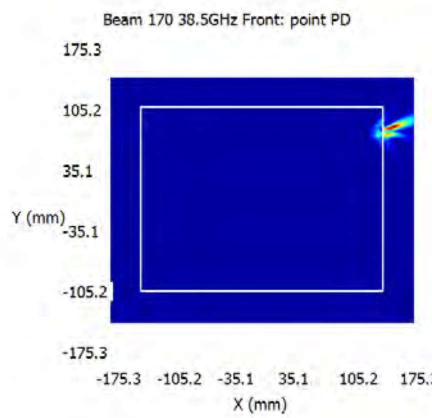
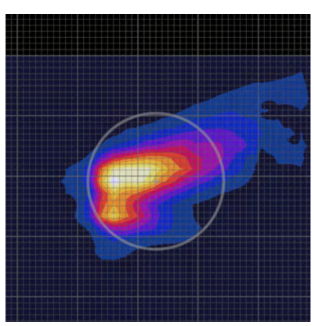
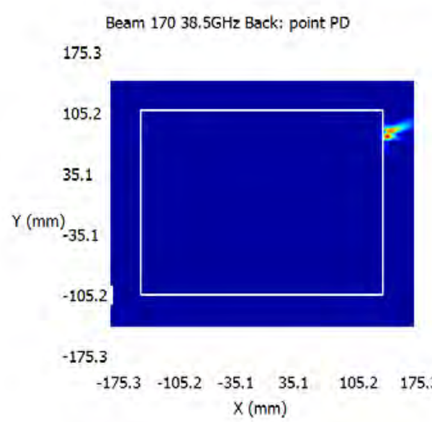
Beam ID	Ant Pol	Simulation (W/m^2)	Measurement (W/m^2)	Delta = Sim – Meas. (dB)
		S1	S1	S1
44	V	16.74	7.79	3.32217996
45	V	21.86	5.9	5.68798146
58	V	15.76	5.47	4.59568887
173	H	13.98	4.35	5.07017914
174	H	15.91	4.45	5.53310169
185	H	13.85	4.32	5.05966027

To validate the accuracy of the model, measured point PD patterns for the three arrays were compared to simulated point PD patterns for different beams for n260, as is shown in Figure 9. The plotted point PD pattern are normalized to its own maximum value, respectively. Please be noted due to timeline, the simulation and measurement comparison is not obtained using the final version of codebook.

a) Top Array, n260

<table>
<tr><th>Beam ID</th><th>Surface</th><th>Measured Point PD</th><th>Simulated Point PD</th></tr>
<tr><td rowspan="3">35</td><td>S5</td><td></td><td>
</td></tr>
<tr><td>S1</td><td></td><td>
</td></tr>
<tr><td>S2</td><td></td><td>
</td></tr>
</table>

b) Bottom Array, n260

Beam ID	Surface	Measured Point PD	Simulated Point PD
170	**S6**		
	S1		
	S2		

c) Front Array, n260

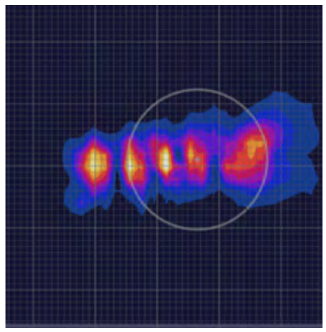
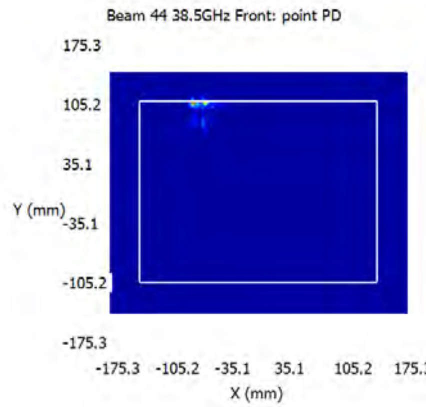
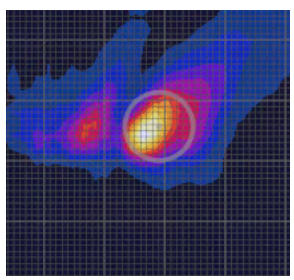
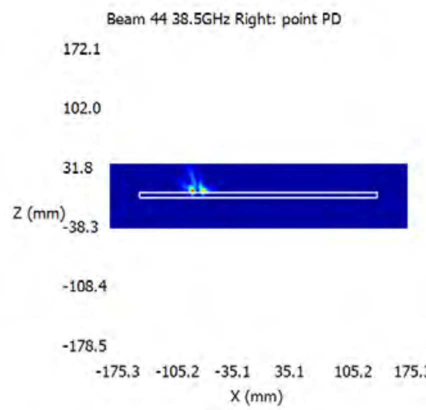
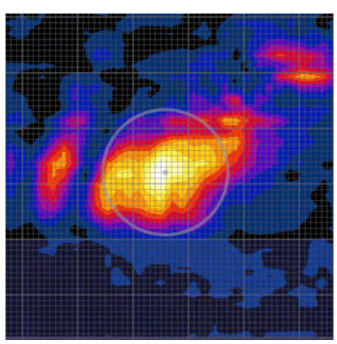
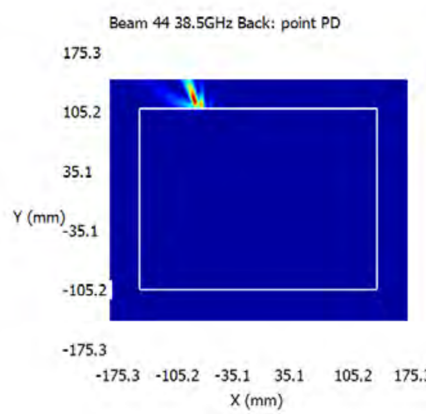
Beam ID	Surface	Measured Point PD	Simulated Point PD
44	**S1**		
	S4		
	S2		

Figure 9. Simulated and measured point PD for different beams for n260.

Appendix A: Worst Phase Derivation for Beam Pair

For beam pairs, since the relative phase between two beams is unknown, so finding the worst-case power density by sweeping the relative phase for all possible angles is required for conservative assessments.

Assuming E-field and H-field for beam ID a are {Ex_a, Ey_a,Ez_a} and {Hx_a,Hy_a,Hz_a}, respectively; for beam pair which is ID b is {Ex_b,Ey_b,Ez_b} and {Hx_b,Hy_b,Hz_b}, respectively. The relative phase between beam a and b is θ, the combined E and H field after beam pairing is:

$$Ex\_pair\_i(\theta) = Ex\_a + Ex\_b \times e^{-j\omega\theta}$$
$$Ey\_pair\_i(\theta) = Ey\_a + Ey\_b \times e^{-j\omega\theta}$$
$$Ez\_pair\_i(\theta) = Ez\_a + Ez\_b \times e^{-j\omega\theta}$$

$$Hx\_pair\_i(\theta) = Hx\_a + Hx\_b \times e^{-j\omega\theta}$$
$$Hy\_pair\_i(\theta) = Hy\_a + Hy\_b \times e^{-j\omega\theta}$$
$$Hz\_pair\_i(\theta) = Hz\_a + Hz\_b \times e^{-j\omega\theta}$$

The beam pair Poynting vector can be calculated as:

$$Sx\_pair\_i(\theta) = 0.5 \times Ey\_pair\_i(\theta) \times Hz\_pair\_i(\theta)^* - 0.5 \times Ez\_pair\_i(\theta) \times Hy\_pair\_i(\theta)^*$$
$$Sy\_pair\_i(\theta) = 0.5 \times Ez\_pair\_i(\theta) \times Hx\_pair\_i(\theta)^* - 0.5 \times Ex\_pair\_i(\theta) \times Hz\_pair\_i(\theta)^*$$
$$Sz\_pair\_i(\theta) = 0.5 \times Ex\_pair\_i(\theta) \times Hy\_pair\_i(\theta)^* - 0.5 \times Ey\_pair\_i(\theta) \times Hx\_pair\_i(\theta)^*$$

The local power density per gird point (PD) for the beam pair can be calculated as:

$$PD(\theta) = [Re(Sx\_pair\_i(\theta)))^2 + (Re(Sy\_pair\_i(\theta)))^2 + (Re(Sz\_pair\_i(\theta)))^2]^{1/2}$$

θ can be swept from 0 to 360 degrees to find the worst-case situation (highest PD). For more details, please refer to [4].

Appendix B: 4 cm^2 Averaged PD and Scaling Factor

4 cm^2 Averaging PD: The following tables show the simulated PD results for all three different arrays, at both band n258, n261 and band n260. Table a), b), and c) show the results for n258, for top array, bottom array and front array, respectively; table d), e), and f) show the results for n261, for top array, bottom array and front array, respectively and table g), h) and i) show the results for n260, for top array, bottom array and front array, respectively. Please be noted due to timeline, following results are not obtained using the final version of codebook.

a) *Simulated PD (W/m^2) at 4 cm^2 averaging for top array at n258*

			4 cm^2 PD (W/m^2) at 6 dBm per port, n258								
Module ID	Beam ID 1	Beam ID 2	LB			MB			HB		
0			S1	S2	S5	S1	S2	S5	S1	S2	S5
Top Array	0		2.42	2.11	6.13	2.42	2.21	6.41	2.06	1.66	5.54
	3		1.49	1.28	4.27	1.4	1.18	3.92	1.29	1.03	3.45
	6		0.99	0.85	2.74	0.86	0.68	2.41	1.48	1.19	3.77
	9		1.37	1.43	4.02	1.57	1.39	4.49	1.61	1.28	4.2
	13		2.54	1.97	5.74	2.41	1.93	6.75	2.48	1.97	7.34
	14		3.44	3.05	8.21	2.87	2.54	6.82	3.38	2.75	7.18
	15		4.53	4.57	10.34	4.15	4.36	9.73	3.68	3.46	8.1
	16		3.09	3.52	8.34	3.03	3.17	8.13	2.93	2.72	8.08
	25		4.76	3.01	10.49	4.8	3.32	11.09	4.27	2.93	9.9
	26		4.81	4.38	11.18	4.5	4.48	11.07	3.57	3.43	8.65
	27		1.44	1.65	5.05	1.67	1.57	5.11	2.06	2	6.34
	34		9.96	6.05	19.73	9.66	5.73	19.08	10.39	5.65	19.52
	35		9.59	7.53	19.88	9.08	7.24	19.13	8.66	6.58	17.86
	36		7.02	6.78	14.71	5.49	5.87	13.05	6.32	5.37	14.1
	37		7.66	7.72	18.54	7.53	6.34	16.54	6.55	5.41	14.6
	38		3.04	4.79	10.51	4.01	5.41	11.95	4.73	5.54	14.26
	49		10.11	6.38	20.09	9.73	6.04	19.44	10.3	5.87	19.6
	50		7.25	7.25	15.87	6.81	7.02	15.33	6.26	6.07	13.3
	51		7.38	6.32	16.26	6.16	5.24	14.07	6.19	4.97	14.53
	52		5.48	8.19	17.51	6.89	7.77	18.17	6.78	6.52	16.89
	128		1.33	1.25	3.85	1.22	1.16	3.59	1.18	0.97	3.07
	131		0.78	0.84	2.57	1.32	1.1	3.77	1.85	1.42	5.1
	134		1.07	0.85	2.92	0.92	0.59	2.48	1.46	1.12	3.7
	137		1.14	0.95	2.96	1.37	1.13	3.51	1.8	1.45	4.43
	141		2.46	2.93	6.99	2.61	2.97	7.41	2.66	3.03	7.59
	142		2.6	2.68	6.33	2.73	2.88	6.77	2.85	2.87	6.94
	143		2.38	2.05	5.47	2.61	1.92	5.43	3.83	2.52	7.44
	144		2.47	1.83	5.41	3.22	2.12	6.77	4.02	1.98	8.02
	153		2.28	2.35	5.42	2.2	2.35	5.54	2.44	3.43	7.28
	154		2.69	2.49	6.11	2.41	2.25	5.57	3.4	3.37	7.65
	155		1.68	1.41	5.54	2.57	1.69	7.01	3.72	2.04	8.86

	162		5.31	6.49	14.68	5.55	6.46	15.28	6.3	8.49	18.49
	163		5.25	5.67	13.36	5.25	5.48	13.48	6.15	7.11	16.32
	164		3.81	3.61	9.95	3.91	3.4	10.5	6.04	5.06	14.25
	165		6.35	5.06	13.54	6.68	4.88	13.59	8.49	5.66	16.16
	166		5.12	2.52	9.69	7.8	3.53	14.3	10.86	3.87	18.1
	177		5.31	6.49	14.68	5.55	6.46	15.28	6.3	8.49	18.49
	178		4.37	4.11	10.53	4.2	3.87	10.45	5.42	5.12	13.11
	179		4.12	3.93	9.52	4.28	3.74	9.53	6.83	5.55	13.74
	180		6.55	3.88	12.93	8.65	4.5	16.12	11.18	4.63	19.31
	0	128	5.72	4.91	14.06	4.96	4.48	12.42	3.77	2.97	9.43
	3	131	3.19	3.19	9.94	3.82	3.07	10.21	3.97	3.01	9.94
	6	134	2.99	2.34	7.79	2.32	1.38	5	3.71	2.23	8.17
	9	137	3.95	3.66	10.25	4.33	3.41	10.62	4.7	3.49	11.08
	13	141	5.18	6.37	14.48	4.92	6.03	14.06	5.32	5.96	14.41
	14	142	5.89	8.35	17.49	5.56	7.64	15.71	6.45	7.46	14.61
	15	143	10.1	7.23	18.75	9.68	6.37	17.32	10.99	5.6	18.38
	16	144	8.46	6.92	17.06	9.3	6.45	17.43	10.83	4.66	18.94
	25	153	9.73	5.75	18.34	9.42	5.49	17.66	9.03	6.77	17.28
	26	154	8.11	6.18	16.65	7.23	6.12	15.85	6.98	6.18	15.29
	27	155	4.25	4.54	10.73	6.4	4.7	13.46	8.01	5.22	16.84
	34	162	24.27	19.96	48.09	23.68	18.35	42.51	24.73	20.87	41.08
	35	163	24.04	20.59	47.65	22.15	18.43	40.51	22.18	18.96	36.81
	36	164	14.83	14.9	31.57	11.16	11.52	24.88	14.61	12.32	30.53
	37	165	21.7	19.93	44.3	21.94	15.31	38.63	22.67	13.1	37.6
	38	166	10.8	10.84	25.56	18.13	12.4	30.34	25.09	11.54	43.05
	49	177	24.64	20.44	48.76	23.79	18.74	42.74	24.64	21.04	40.89
	50	178	17.57	16.54	36.36	14.6	14.18	30.43	14.96	13.39	27.59
	51	179	15.99	15.3	33.35	13.58	11.49	26.35	16.43	12.51	30.63
	52	180	17.78	18.24	38.8	24.7	17.26	42.55	29.42	13.52	47.32

b) *Simulated PD (W/m^2) at 4 cm^2 averaging for bottom array at n258.*

			4 cm^2 PD (W/m^2) at 6 dBm per port, n258								
Module ID	Beam ID 1	Beam ID 2	LB			MB			HB		
1			S1	S2	S6	S1	S2	S6	S1	S2	S6
Bottom Array	1		2.37	2.21	6.37	2.52	2.38	6.96	2.27	2.23	6.51
	4		1.49	1.37	4.53	1.34	1.25	4.22	1.41	1.35	4.29
	7		1.03	0.93	2.97	1.1	1.02	3.37	1.15	1	3.47
	10		1.35	1.49	4.08	1.56	1.67	4.9	1.33	1.32	4.17
	17		4.84	2.97	11.07	4.95	3.33	12.07	4.76	3.33	11.51
	18		3.17	2.85	6.82	3.22	2.87	7.05	3.08	2.51	6.53
	19		1.98	2.5	6.04	2.29	2.72	6.93	2.75	2.97	7.8
	20		3.48	4.36	9.28	3.18	4.02	8.87	3.04	3.99	8.8
	28		3.68	2.97	8.56	3.31	2.77	7.84	3.24	2.59	7.51
	29		4.68	4.62	11.4	4.59	4.85	11.65	4.26	4.77	10.97
	30		4.04	4.83	10.19	3.73	4.56	9.68	3.53	4.47	9.4
	39		10.52	6.64	21.42	10.55	7.03	22.48	10.41	6.36	21.25

	40		7.7	7.65	17.15	7.47	7.88	17.44	7.06	7.49	16.31
	41		7.68	7.05	17.06	7.49	6.99	17.36	6.29	6.24	15.4
	42		6.77	9.29	19.76	8.12	9.59	22.08	7.86	8.44	19.94
	43		2.54	3.95	9.52	2.92	5.48	11.76	3.86	6.87	14.45
	53		9.76	7.57	20.55	9.48	7.92	21.06	9.12	7.24	19.57
	54		7.2	7.33	15.6	6.74	7.22	15.73	6.03	6.91	14.86
	55		7.51	8	18.71	8.28	8.17	19.87	7.22	7.04	17.17
	56		4.57	8.25	16.71	5.79	9.68	20.46	6.9	9.72	21.32
	129		1.17	1.19	3.61	1.1	1.12	3.41	1.25	1.21	3.63
	132		0.76	0.91	2.61	1.12	1.13	3.69	1.6	1.28	4.78
	135		1	0.89	2.94	0.99	0.86	3.11	1.04	0.85	3.26
	138		1.02	0.9	2.78	1.14	1.04	3.24	1.56	1.49	4.33
	145		1.38	2.08	4.92	1.68	2.51	6.63	2.01	2.58	8.3
	146		2.51	2.54	5.94	2.39	2.42	5.77	2.5	2.89	6.48
	147		2.1	1.74	5.33	2.95	2.19	6.87	4.36	2.95	9.4
	148		1.39	1.62	5.32	2.11	1.66	6.45	3.52	2.01	8.52
	156		2.38	2.72	6.36	2.41	2.88	6.77	2.54	3.05	7.25
	157		2.47	2.22	5.78	3.21	2.67	7.23	4.35	3.35	9.43
	158		2.08	1.04	4.85	2.53	1.33	6.24	3.31	1.7	8.04
	167		4.6	6.63	14.58	4.88	7.69	16.46	5.03	8.58	18.31
	168		4.1	4.15	10.96	4.27	4.32	11.83	4.78	5.03	13.67
	169		3.35	3.42	8.4	3.69	3.71	9.56	5	4.65	12.48
	170		6.27	4.5	13.06	6.96	4.95	14.54	7.81	5.13	15.81
	171		4.32	2.07	8.81	6.84	3.19	13.58	10.31	4.67	19.64
	181		4.78	5.96	13.71	4.91	6.55	14.95	5.15	7.37	16.72
	182		3.51	3.46	9.99	4.16	3.64	11.54	5.45	4.49	14.44
	183		4.25	3.99	9.73	4.38	4.24	10.1	5.3	4.87	11.79
	184		6.01	3.48	12.33	8.03	4.48	15.96	10.31	5.25	19.21
	1	129	5.31	4.96	14.08	4.82	4.64	12.96	4.36	4.39	11.86
	4	132	3.13	3.41	10.28	3.17	3.23	10.44	3.81	3.04	10.44
	7	135	2.96	2.53	8.2	2.7	2.23	7.99	2.66	2.07	6.92
	10	138	3.67	3.63	10.02	3.89	3.48	10.41	3.96	3.27	10.63
	17	145	8.83	6.63	18.83	9.41	7.56	20.76	9.59	7.25	20.07
	18	146	8.64	8.38	18.17	7.17	7.19	14.85	6.71	6.6	13.64
	19	147	5.32	6.68	13.79	6.85	7.17	15.4	9.49	8.07	17.91
	20	148	6.02	7.52	17.35	7.11	7.01	17.33	9.49	7.61	19.14
	28	156	6.07	8.61	18.36	5.54	8.37	17.48	6.05	7.97	16.56
	29	157	7.65	9.05	18.43	8.77	9.18	19.43	10.02	9.5	21.53
	30	158	8.24	6.28	16.65	8.26	5.72	16.81	8.51	5.87	17.89
	39	167	23.62	20.24	49.95	23.05	21.84	48.52	22.71	21.26	42.62
	40	168	17.55	16.68	37.72	15.96	16.32	35.41	14.99	15.97	32.85
	41	169	15.12	15.28	32.83	14.03	14.09	30.42	13.66	12.86	30.07
	42	170	19.66	20.8	44.27	23.03	20.8	45.51	24.33	17.13	43.8
	43	171	8.28	8.24	21.3	12.86	11.89	28.65	21.41	14.99	39.98
	53	181	22.99	20.5	48.34	21.56	21.25	45.62	20.83	20.48	39.9
	54	182	14.96	15.33	32.88	13.44	14.17	30.83	12.68	13.69	30.77
	55	183	17.61	17.81	38.49	17.98	16.75	36.46	17.63	14.2	33.59
	56	184	14.6	16.9	35.19	20.63	19.66	41.97	27.1	18.84	48.46

c) Simulated PD (W/m^2) at 4 cm^2 averaging for front array at n258.

			4 cm^2 PD (W/m^2) at 6 dBm per port, n258								
Module ID	Beam ID 1	Beam ID 2	LB			MB			HB		
2			S1	S2	S4	S1	S2	S4	S1	S2	S4
Front Array	2		3.73	0.06	1.03	5.08	0.05	1.39	4.64	0.07	1.25
	5		4.37	0.03	1.2	4.46	0.03	1.26	4.39	0.04	1.24
	8		4.16	0.03	1.15	4.73	0.03	1.3	4.49	0.03	1.27
	11		4.66	0.05	1.42	5.34	0.05	1.43	5.31	0.05	1.44
	12		3.82	0.04	1.01	5.12	0.06	1.4	5.33	0.08	1.56
	21		11.77	0.11	3.99	13.5	0.13	4.36	13.58	0.12	4.46
	22		10.59	0.11	3.19	10.07	0.09	3.12	8.92	0.09	2.65
	23		7.23	0.08	2.28	10.28	0.08	3.13	10.52	0.1	3.13
	24		8.23	0.09	2.8	10.43	0.08	3.34	10.87	0.08	3.38
	31		11.19	0.11	3.99	13.57	0.13	4.39	13.89	0.13	4.57
	32		9.03	0.12	3.44	11.65	0.13	3.81	12.09	0.12	3.9
	33		5.41	0.08	1.77	8.04	0.08	2.28	7.98	0.09	2.26
	44		19.18	0.29	6.05	21.28	0.34	6.94	22.51	0.38	7.71
	45		19.48	0.16	5.57	25.43	0.25	7.79	23.87	0.28	7.06
	46		18.95	0.15	6.32	22.2	0.23	7.03	23.23	0.28	7.06
	47		19.61	0.28	6.15	29.28	0.31	8.57	28.11	0.27	8.32
	48		13.3	0.27	4.19	16.36	0.19	3.95	15.17	0.18	3.76
	57		16.38	0.31	5.23	17.96	0.38	5.99	19.49	0.4	6.53
	58		20.48	0.17	6.81	26.26	0.24	8.79	24.25	0.3	7.38
	59		17.83	0.2	5.55	21.4	0.26	6.76	23.28	0.25	7.53
	60		14.12	0.27	4.77	25.26	0.28	6.08	20.43	0.22	4.91
	130		4.36	0.09	1.54	5.86	0.09	1.83	5.73	0.07	1.62
	133		5.32	0.11	2.05	5.37	0.14	2.06	5.53	0.15	2.15
	136		4.81	0.1	1.63	5.72	0.11	1.99	5.68	0.12	1.97
	139		4.92	0.11	1.68	5.93	0.11	1.93	5.88	0.12	2
	140		4.27	0.08	1.48	5.46	0.09	1.81	5.57	0.09	1.8
	149		11.22	0.27	4.75	12.63	0.37	5.28	13.55	0.4	5.84
	150		13.22	0.37	5.66	15.25	0.42	6.41	15.61	0.39	6.34
	151		12.86	0.34	5.36	13.74	0.38	5.42	13.4	0.33	4.97
	152		8.11	0.21	3.04	8.5	0.2	2.71	7.87	0.16	2.4
	159		13.41	0.37	5.72	15.23	0.42	6.33	15.46	0.39	6.2
	160		13.2	0.36	5.54	14.29	0.4	5.72	14.1	0.35	5.35
	161		11.28	0.29	4.56	13.11	0.33	5.49	14.32	0.33	5.79
	172		24.05	0.54	8.62	31.28	0.75	10.71	30.02	0.69	10.6
	173		25.76	0.66	10.27	29.28	0.83	11.91	32.1	0.87	13.07
	174		27.52	0.63	9.81	29.75	0.78	11.27	27.76	0.74	10.99
	175		19.83	0.56	7.38	22.39	0.6	8.24	20.07	0.53	7.59
	176		20.17	0.78	8.5	19.12	0.61	7.16	17.54	0.58	6.34
	185		26.03	0.61	9.98	30.44	0.81	11.57	31.09	0.78	11.98
	186		26.47	0.65	9.82	29.63	0.78	11.48	29.81	0.78	11.77
	187		24.02	0.5	8.29	25.46	0.6	8.98	22.71	0.6	8.7

	188		22.57	0.89	10.04	22.58	0.72	9.37	19.65	0.57	7.7
	2	130	11.88	0.22	3.74	13.56	0.23	4.2	13.72	0.22	3.87
	5	133	11.5	0.23	3.72	12.94	0.24	4.1	13.6	0.24	4
	8	136	11.1	0.22	3.55	13.69	0.24	4.41	13.7	0.23	4.04
	11	139	11.63	0.25	3.83	13.65	0.28	4.43	14.18	0.29	4.46
	12	140	9.49	0.2	3.19	11.58	0.25	3.96	13.24	0.29	4.42
	21	149	24.41	0.5	8.28	28.39	0.66	9.33	29.27	0.63	9.74
	22	150	26.87	0.7	10.1	30.14	0.78	11.39	29.22	0.59	10.64
	23	151	24.74	0.64	9.68	27.86	0.67	10.66	27.2	0.63	9.6
	24	152	18.57	0.54	7.59	20.35	0.48	8.29	20.8	0.43	8.12
	31	159	22.96	0.49	8.54	26.43	0.6	8.82	24.85	0.51	7.63
	32	160	21.23	0.51	7.86	24.13	0.52	8.49	22.91	0.42	7.64
	33	161	16.67	0.41	5.8	20.62	0.41	7.47	20.83	0.45	7.3
	44	172	42.77	1.06	16.26	51.26	1.29	18.23	51.83	1.19	17.43
	45	173	46.46	1.13	18.35	56.15	1.51	22.12	59.28	1.49	21.77
	46	174	48.41	1	17.13	56.25	1.3	20.13	57.11	1.38	21.6
	47	175	46.46	1.12	17.24	60.79	1.42	22.6	58.05	1.28	20.75
	48	176	36.39	1.58	17.36	38.75	1.19	15.84	36.34	1.32	15.28
	57	185	43.34	1.17	17.87	50.83	1.45	20.19	52.6	1.27	19.47
	58	186	50.43	1.15	18.92	59.12	1.54	21.85	60.24	1.41	22.53
	59	187	46.98	1.05	16.97	57.33	1.3	21.69	59.33	1.33	22.75
	60	188	41.77	1.54	18.69	52.41	1.18	20.48	42.89	0.87	15.97

d) Simulated PD (W/m^2) at 4 cm^2 averaging for top array at n261

			4 cm^2 PD (W/m^2) at 6 dBm per port, n261								
Module ID	Beam ID 1	Beam ID 2	LB			MB			HB		
0			S1	S2	S5	S1	S2	S5	S1	S2	S5
Top Array	0		2.35	1.9	5.49	1.99	1.68	4.9	2.56	2.18	6.09
	3		1.86	1.46	4.53	2.04	1.55	4.91	1.98	1.41	4.65
	6		1.97	1.24	4.04	1.84	1.29	4.07	2.13	1.38	4.55
	9		1.88	1.42	4.52	1.95	1.51	4.61	1.74	1.29	4.17
	13		5.29	2.51	9.03	5.01	2.49	8.71	5.98	3.11	10.76
	14		5.22	3.76	9.9	5.02	3.89	9.92	5.41	3.94	10.24
	15		4.26	5.15	10.96	4.03	4.94	10.88	4.25	5.02	10.63
	16		3.18	4.69	9.95	2.86	4.24	9.73	3.29	4.66	10.08
	25		5.38	2.95	9.28	5.09	2.95	9.02	5.99	3.49	10.68
	26		4.79	4.84	10.94	4.62	4.85	11.01	4.74	4.72	10.58
	27		3.18	3.22	8.02	2.53	3.46	7.49	3.86	3.11	8.9
	34		10.06	3.86	16.68	10.63	4.19	17.91	11.08	4.58	19.28
	35		9.64	6.13	17.68	9.36	6.02	17.53	10	6.81	18.91
	36		8.57	6.84	17.17	9.21	7.51	18.08	7.57	6.58	16.17
	37		8.67	8.29	18.87	8.04	8.66	18.75	8.31	8.07	18.15
	38		6.53	9.06	19.83	5.01	8.84	18.26	7.03	8.7	19.43
	49		10.49	5.65	18.57	10.83	5.82	19.15	11.16	6.48	20.48
	50		8.8	6.32	17.51	8.81	6.37	17.7	8.77	6.65	17.87

	51		8.65	7.48	17.21	8.75	8.05	17.73	7.89	7.24	16.37
	52		7.81	9.33	20.85	6.49	9.43	19.97	7.96	8.88	20.03
	128		2.25	1.47	4.7	2.46	1.81	5.54	2.05	1.67	4.95
	131		2	1.4	4.3	1.87	1.75	4.81	2.2	1.57	4.85
	134		1.84	1.14	3.9	1.65	1.17	3.85	1.98	1.18	4.24
	137		1.64	1.44	4.2	1.6	1.36	4.05	1.33	1.29	3.46
	141		2.75	2.07	7.09	3.01	4.03	10.44	2.89	3.13	8.49
	142		4.68	4.02	9.71	4.94	4.53	10.66	4.69	4.54	10.35
	143		4.93	2.76	8.92	4.75	2.52	8.76	5.32	3.04	9.76
	144		4.22	1.77	7.7	4.15	2.36	9.32	4.32	2.14	8.4
	153		3.26	3.08	7.24	3.05	4.07	8.22	3.46	3.16	8.01
	154		5.6	4.02	10.24	5.39	3.8	9.82	5.47	4.21	10.24
	155		4.35	2.08	8.28	3.93	1.82	7.86	4.77	2.54	9.74
	162		4.52	6.42	14.16	4.96	9.39	18.87	4.58	7.36	15.84
	163		6.76	6.62	14.99	7.41	7.8	16.67	7.36	7.54	16.44
	164		9.17	6.36	16.26	9.17	6.76	16.55	8.72	6.26	16.01
	165		12.1	6.9	20.97	11.73	6.27	20.21	10.75	6.46	18.85
	166		9.96	3.88	16.21	8.44	2.96	14.39	10.35	4.9	17.95
	177		5.52	6.94	15.7	6.15	9.14	18.91	6.12	8.54	17.84
	178		7.7	6.49	14.89	8.09	7.3	15.99	7.99	6.95	15.54
	179		11	6.79	18.83	11.1	6.88	18.99	9.98	6.3	17.4
	180		11.59	5.28	19.82	10.61	4.21	18.3	10.87	5.7	19.05
	0	128	5.47	4.17	12.64	5.2	3.85	11.59	5.74	4.78	14.12
	3	131	4.73	3.06	10.62	4.63	3.44	11.39	5.32	3.4	12.03
	6	134	5.76	3.08	10.67	4.96	3.24	10.72	5.01	2.88	8.76
	9	137	4.39	3.67	11.32	4.22	3.08	9.52	3.93	3.61	10.92
	13	141	10.49	5.65	19.78	10.38	8.31	21.41	10.99	8.19	21.62
	14	142	12.43	8.68	23.02	11.86	9.38	22.92	12.61	9.28	23.76
	15	143	13.25	8.21	23.46	12.64	7.6	23.78	13.44	8.73	23.75
	16	144	9.85	8.77	19.43	9.47	8.25	22.06	10.14	9.13	20.39
	25	153	12.15	6.38	20.59	10.9	7.09	20.1	12.82	7.52	21.58
	26	154	13.65	9.9	24.68	13.07	9.39	24.45	12.92	10.34	23.81
	27	155	11.89	6.67	20.13	9.72	6.12	18.67	13.69	6.69	22.4
	34	162	23.08	12.42	38.6	22.69	16.98	41.86	23.77	16.38	38.88
	35	163	21.88	15.93	38.61	22.09	17.59	40.77	22.05	18.98	39.84
	36	164	24.25	14.95	39.67	25.05	16.69	41.92	20.36	13.32	35.32
	37	165	31.18	18.89	47.49	29.75	18.66	48.57	27.17	17.47	42.02
	38	166	24.67	18.4	39.26	19.81	16.09	37.21	26.64	19.33	44.13
	49	177	23.55	16.03	41.78	23.52	19.49	45.38	24.04	20.73	42.5
	50	178	21.33	15.5	38.86	21.65	16.51	39.77	20.27	16.69	38.32
	51	179	28.43	16.69	43.35	28.9	18.32	45.98	24.12	14.77	38
	52	180	29.76	19.59	46.05	25.92	17.65	45.36	28.27	19.49	44.33

e) Simulated PD (W/m²) at 4 cm² averaging for bottom array at n261

			4 cm² PD (W/m²) at 6 dBm per port, n261								
Module ID	Beam ID 1	Beam ID 2	LB			MB			HB		
1			S1	S2	S6	S1	S2	S6	S1	S2	S6
Bottom Array	1		2.17	1.89	5.47	1.93	1.62	4.84	2.39	2.15	6.02
	4		1.92	1.67	5.02	2.18	1.58	5.15	1.81	1.71	4.9
	7		1.91	1.52	4.49	1.72	1.28	3.93	2.01	1.54	4.79
	10		1.83	1.45	4.58	1.91	1.42	4.41	1.69	1.3	4.15
	17		5.17	2.54	9.44	5.29	2.46	9.25	5.46	2.75	10.24
	18		5.18	3.93	10.21	5.2	3.9	10.21	5.22	4	10.25
	19		4.28	5.43	11.48	4.06	4.89	10.88	4.23	5.66	11.47
	20		3.57	5.3	10.95	3.25	4.53	10.08	3.6	5.74	11.24
	28		5.36	3.08	9.77	5.42	2.99	9.66	5.62	3.29	10.32
	29		4.87	4.8	11.08	4.84	4.63	10.94	4.78	4.83	10.87
	30		4.07	5.46	11.38	3.81	4.83	10.67	4.05	5.76	11.47
	39		11.07	4.78	19.21	11.86	4.39	19.55	11.5	4.74	20
	40		10.62	6.71	19.87	11.11	6.22	19.83	10.66	6.66	19.83
	41		8.96	7.61	18.08	9.51	7.67	18.19	8.33	7.44	17.38
	42		8.66	8.39	18.55	7.79	7.71	16.89	7.97	8.08	17.35
	43		6.61	10.61	21.9	5.14	9.12	18.54	6.8	11.03	22.11
	53		10.98	5.66	19.92	11.74	5.22	20.24	11.2	5.54	20.17
	54		9.46	7.11	18.57	9.66	6.71	18.16	9.45	7.31	18.73
	55		8.82	7.92	17.77	8.99	7.83	17.5	7.75	7.39	16.44
	56		8.15	9.88	21.31	6.57	8.62	18.42	7.95	9.87	20.55
	129		2.04	1.5	4.78	2.24	1.79	5.33	1.86	1.39	4.31
	132		1.98	1.7	4.87	1.71	1.61	4.45	1.9	1.38	4.18
	135		1.63	1.04	3.72	1.31	0.96	3.16	1.78	1.19	4.01
	138		1.5	1.45	4.11	1.38	1.06	3.36	1.29	1.42	3.64
	145		2.78	3.71	9.53	2.99	4.5	10.62	2.36	2.35	6.81
	146		4.25	4.3	9.92	4.5	4.49	10.37	3.76	3.96	8.99
	147		5.04	3.18	9.06	4.96	2.96	8.64	5.06	3.58	9.36
	148		3.62	2.14	8.46	2.85	1.81	6.97	3.4	1.95	7.63
	156		3.34	4.2	9.95	3.75	4.8	10.91	2.58	3.18	7.73
	157		4.77	3.94	9.41	4.82	3.8	9.27	4.66	4.16	9.64
	158		4.32	2.2	8.66	3.55	1.57	6.96	3.97	2.18	7.93
	167		4.4	8.68	17.57	4.3	8.75	17.71	3.63	6.34	13.15
	168		6.29	6.7	15.01	6.32	7.18	15.3	6.01	7.03	15.03
	169		7.67	5.87	14.12	7.83	6.12	14.16	7.72	6.27	14.76
	170		10.19	6.44	17.87	9.97	5.98	16.68	9.44	6.2	16.83
	171		10.21	3.91	18.03	8	2.71	13.9	9.91	4.34	17.52
	181		5.62	8.21	17.51	5.47	8.6	17.76	5.08	7.5	15.69
	182		6.87	6.12	13.83	7.07	6.58	14.18	6.75	6.49	14.03
	183		8.6	6.06	15.25	8.89	6.21	15.16	8.29	6.19	15.43
	184		11.5	5.79	20.17	10.18	4.44	17.09	10.66	5.92	18.87
	1	129	4.79	4.02	12.37	4.89	3.7	10.9	4.98	4.5	13.49

	4	132	4.78	3.72	12.48	4.62	3.24	11.4	4.45	3.4	11.2
	7	135	4.97	3.29	10.25	4.22	3.16	9.81	4.45	2.89	8.87
	10	138	3.97	3.65	11.35	3.97	2.84	9.26	3.57	3.55	10.7
	17	145	10.18	7.99	21.34	10.83	8.37	22.35	9.95	6.06	20.5
	18	146	11.73	9.64	23.91	11.59	9.44	22.98	10.93	8.75	22.16
	19	147	12.26	9.62	23.9	12.67	8.08	24.64	11.42	10.72	22.31
	20	148	8.97	7.05	19.54	8.15	5.45	17.75	8.14	7.83	19.16
	28	156	11.39	8.99	22.67	11.9	9.15	23.56	10.85	7.53	21.05
	29	157	11.96	10	24.14	12.07	9.2	23.79	11.22	10.09	23.49
	30	158	9.99	7.04	20.52	9.41	6.05	19.29	8.96	7.63	19.54
	39	167	21.32	17.12	40.74	22.7	15.15	43.57	21.93	13.54	38.61
	40	168	22.76	17.72	42.03	23.25	17.11	42.73	22.13	17.85	38.23
	41	169	21.61	15.62	37.78	23.28	16.45	39.25	18.68	14.83	34.82
	42	170	27.58	17.36	44.24	27.01	16	43.56	23.81	15.78	39.25
	43	171	24.6	19.5	46.25	19.5	14.91	38.92	23.83	21.18	46.67
	53	181	23.26	18.45	44.58	24.04	17.11	46.24	23.49	16.81	40.91
	54	182	21.09	16.35	38.73	21.68	16.31	38.44	19.44	16.81	36.16
	55	183	23.94	16.07	39.75	25.35	16.77	41.12	20.01	13.97	35.09
	56	184	29.61	19.59	49.48	26.18	15.19	45.55	26.68	19.98	44.66

f) Simulated PD (W/m^2) at 4 cm^2 averaging for front array at n261

			4 cm^2 PD (W/m^2) at 6 dBm per port, n261								
Module ID	Beam ID 1	Beam ID 2	LB			MB			HB		
2			S1	S2	S4	S1	S2	S4	S1	S2	S4
Front Array	2		7.51	0.09	1.96	7.19	0.08	1.8	7.59	0.08	2.07
	5		6.9	0.09	1.68	6.81	0.09	1.68	6.94	0.09	1.72
	8		6.84	0.09	1.61	6.88	0.09	1.66	6.82	0.1	1.66
	11		7.12	0.07	2	6.5	0.06	1.79	7.15	0.06	2.06
	12		5.84	0.13	2.04	6.37	0.15	2.21	5.24	0.11	1.92
	21		11.8	0.13	4.24	11.74	0.15	4.27	11.57	0.12	4.26
	22		15.9	0.2	5.02	15.78	0.19	4.95	15.29	0.14	4.96
	23		14.1	0.12	3.85	14.31	0.12	4.07	14.01	0.11	3.85
	24		12.12	0.26	3.53	11.23	0.24	3.17	12.61	0.27	3.9
	31		14.8	0.32	5.03	14.53	0.31	4.84	14.68	0.31	5.21
	32		11.95	0.29	3.47	11.72	0.29	3.28	11.42	0.24	3.19
	33		11.28	0.18	2.44	10.32	0.17	2.13	11.91	0.21	2.77
	44		26.18	0.56	9.3	25.27	0.55	8.44	26.43	0.57	9.82
	45		31.08	0.61	10.69	30.32	0.63	10.54	30.55	0.46	10.7
	46		33.64	0.37	11.17	35.18	0.4	11.68	31.68	0.28	10.56
	47		32.82	0.46	10.22	33.21	0.44	10.53	31.9	0.47	9.78
	48		21.51	0.37	5.86	19.9	0.37	5.34	22.68	0.4	6.35
	57		29.26	0.69	10.57	28.27	0.71	9.99	29.34	0.62	11.05
	58		32.16	0.44	11.4	32.74	0.43	11.64	30.67	0.32	10.94
	59		35.39	0.3	11.74	36.99	0.39	12.5	33.52	0.28	11.08
	60		25.48	0.36	6.81	24.29	0.33	6.53	25.46	0.34	6.96
	130		7.51	0.18	2.47	7.29	0.18	2.49	7.63	0.15	2.51

	133		6.73	0.12	1.95	6.57	0.11	2	6.82	0.11	1.98
	136		6.33	0.12	1.89	6.28	0.11	1.95	6.37	0.11	1.86
	139		6.24	0.12	1.98	6.24	0.12	2	6.17	0.11	1.99
	140		5.62	0.07	1.32	6.08	0.06	1.54	5.3	0.06	1.24
	149		9.59	0.3	3.6	9.25	0.3	3.4	9.9	0.3	3.75
	150		14.43	0.25	4.64	15.57	0.2	5.09	13.37	0.2	4.47
	151		11.99	0.33	4.29	12.38	0.3	4.42	11.8	0.28	4.44
	152		13.27	0.14	4.34	12.93	0.15	4.49	13.59	0.14	4.23
	159		15.57	0.21	5.13	15.79	0.22	5.49	15.38	0.16	4.94
	160		13.67	0.16	4.47	13.68	0.17	4.66	13.66	0.15	4.4
	161		9.55	0.25	2.79	8.79	0.23	2.39	10.14	0.25	3.05
	172		30.56	0.41	10.49	31.34	0.49	11.15	30.02	0.35	10.44
	173		34.53	0.52	11.9	36.43	0.44	12.87	32.84	0.37	11.11
	174		30.16	0.9	12	31.29	0.83	12.76	29.34	0.73	12.14
	175		25.13	0.92	9.96	23.98	0.84	9.36	26.03	0.86	10.32
	176		19.76	0.61	7.05	18.27	0.57	7.07	21.09	0.54	7.23
	185		32.87	0.47	11.08	34.34	0.48	12.1	31.71	0.32	10.84
	186		35.71	0.64	12.87	36.98	0.69	13.41	34.15	0.63	12.34
	187		23.55	0.79	9.38	23.4	0.7	9.48	24.04	0.67	10.15
	188		21.09	0.82	7.93	19.72	0.74	7.43	22.3	0.71	8.23
	2	130	15.71	0.4	5	15.07	0.36	4.75	15.99	0.32	5.21
	5	133	14.01	0.3	3.94	13.64	0.28	3.98	14.32	0.24	4.18
	8	136	13.22	0.32	4.02	13.35	0.3	4.16	13.4	0.26	4.12
	11	139	13.77	0.31	4.19	13.56	0.26	4.02	14.03	0.24	4.4
	12	140	13.83	0.35	4.4	14.31	0.33	4.54	13.4	0.3	4.61
	21	149	20.93	0.73	10.02	20.62	0.77	9.84	22.41	0.72	10.64
	22	150	32.89	0.72	11.13	34.59	0.54	11.81	31.26	0.5	10.26
	23	151	29.59	0.49	8.79	29.13	0.47	9.43	30.08	0.41	8.99
	24	152	25.61	0.64	10.14	24.58	0.67	10.12	26.42	0.61	10.37
	31	159	32.22	0.88	12.04	32.34	0.9	12.04	32.2	0.77	12.02
	32	160	25.07	0.79	9.62	25.17	0.8	9.56	24.74	0.7	9.24
	33	161	22.65	0.53	6.84	21.44	0.49	6.07	24.06	0.54	7.49
	44	172	55.99	1.72	22.66	55.98	1.89	22.49	56.26	1.63	23.64
	45	173	66.79	1.82	24.92	67.53	1.79	26.67	65.4	1.27	23.7
	46	174	67.28	1.97	26.15	70.94	1.87	26.82	66.13	1.51	26.6
	47	175	58.96	1.78	23.9	58.99	1.69	23.08	59.66	1.58	24.06
	48	176	46.4	1.4	17.47	44.49	1.51	17.01	48.87	1.39	18.04
	57	185	62.37	1.95	24.41	62.77	2.11	25.64	62.87	1.53	24.92
	58	186	71.25	1.61	24.74	73.29	1.72	25.69	67.4	1.35	24.2
	59	187	63.92	1.73	24.77	63.69	1.75	24.57	64.06	1.49	25.94
	60	188	47.66	1.72	18.06	46.62	1.6	17.34	47.29	1.48	18.45

g) Simulated PD (W/m^2) at 4 cm^2 averaging for top array at n260

			4 cm^2 PD (W/m^2) at 6 dBm per port, n260								
Module ID	Beam ID 1	Beam ID 2	LB			MB			HB		
0			S1	S2	S5	S1	S2	S5	S1	S2	S5
Top Array	0		2.09	1.86	5.44	2.63	2.15	6.3	2.43	2.04	5.69
	3		2.27	2.01	6.24	2.24	2.24	5.98	1.67	1.6	4.16
	6		2.2	2.18	5.92	2.03	1.86	5.1	1.61	1.4	3.67
	9		1.7	1.7	4.3	1.94	1.86	4.99	1.67	1.62	4.39
	13		3.46	3.44	10.26	3.22	2.92	8.73	2.6	2.36	7.2
	14		5.53	4.55	11.25	4.78	4.7	10.8	4.21	3.69	9.24
	15		3.43	3.59	9.78	4.77	3.74	10.87	3.58	2.99	8.89
	16		2.91	3	10.86	4.35	3.52	12.46	3.47	2.85	9.33
	25		5.35	4.48	11.85	4.85	4.67	12.16	4.14	3.61	9.58
	26		4.66	4.07	10.28	4.9	4.46	10.19	3.96	3.44	8.95
	27		2.81	3.09	10.28	4.44	3.41	11.79	3.45	2.78	9.09
	34		9.87	9.2	21.67	7.76	7.71	18.7	5.04	5.41	13.91
	35		9.58	9.35	19.08	9.52	9.45	20.3	7.07	5.58	14.4
	36		8.72	7.75	18	10.07	9.4	20.7	7.32	6.81	15.9
	37		7.08	6.95	15.48	8.53	7.85	18.47	6.63	6.05	16.06
	38		7.8	7.42	20.25	7.62	6.36	18.23	6.88	5.58	14.34
	49		9.72	9.17	20.13	8.78	8.86	19.31	5.45	5.09	12.66
	50		9.33	8.93	18.74	9.73	9.19	20.26	7.5	6.45	15.64
	51		7.44	6.87	16.06	9.32	8.63	19.8	6.91	6.23	16.07
	52		6.99	7.36	16.23	7.51	6.84	16.76	6.4	5.97	15.24
	128		1.72	2.8	4.84	1.8	2.59	5.5	1.45	3.12	5.35
	131		1.02	2.67	4.51	0.86	3.26	5.45	1.08	2.27	4.6
	134		1.18	3.11	5.52	1.06	2.57	4.56	1.23	1.89	3.36
	137		1.43	2.46	4.7	0.96	2.48	3.93	1.1	1.8	3.44
	141		2.04	5.29	10.7	1.51	4.38	9.5	2.11	3.65	8.04
	142		3.22	6.98	9.63	2.81	6.81	9.63	2.97	5.75	9.09
	143		3.15	6.89	11.15	2.71	6.22	9.55	2.29	4.15	6.62
	144		2.34	4.08	8.26	2.5	4.77	10.94	2.51	5.22	10.67
	153		3.2	6.65	9.29	2.51	6.43	9.69	2.46	5.84	10.16
	154		2.9	6.45	9.69	3.02	6.59	10.03	2.87	5.19	8.17
	155		2.13	4.18	8.51	2.96	4.94	11.12	2.69	4.66	9.12
	162		4.57	7.77	16.18	3.5	9.06	16.32	3.96	7.23	15.79
	163		5.61	12.38	18.3	4.6	9.43	14.06	4.01	8.21	13.63
	164		4.48	12.25	18.13	4.89	13.16	19.04	6.6	10.26	17.05
	165		6.41	11.12	19.11	5.86	11.2	18.98	3.97	7.1	11.76
	166		3.61	8.69	16.52	3.8	9.76	18.63	4.3	7.99	15.93
	177		5.82	11.47	18.91	3.4	7.17	11.86	4.3	7.49	13.18
	178		4.79	12.06	17.49	4.92	13.26	18.88	5.92	9.77	16.79
	179		4.9	12.83	19.18	5.45	13.9	20.62	5.72	9.73	16.25
	180		4.52	9.89	17.81	4.14	7.74	16.86	4.6	7.65	13.56
	0	128	4.6	5.45	12.02	5.58	5.92	13.13	5.43	6.9	12.04

	3	131	4.37	5.72	12.6	3.67	6.83	11.82	3.6	5.2	9.03
	6	134	4.12	5.8	12.83	3.97	5.73	9.84	3.27	4.37	8.04
	9	137	3.84	4.81	10	3.93	5.7	9.91	3.54	4.3	8.25
	13	141	5.96	11.9	24.54	5.49	10.46	21.71	5.53	8.19	17.68
	14	142	9.09	12.45	22.5	8.8	12.43	22.58	9.06	12.24	20.35
	15	143	6.58	10.82	20.13	6.84	10.95	20.28	6.03	7.54	14.98
	16	144	5.44	9.91	21.73	8.23	10.96	25.44	7.58	10.34	22.68
	25	153	8.77	13.85	24.38	8.74	12.39	23.44	9.13	12.89	22.31
	26	154	8.33	12.36	23.29	9.45	12.55	22.39	7.68	9.35	17.9
	27	155	5.69	10.42	22.35	9.26	10.07	24.8	7.43	10.17	21.36
	34	162	15.52	24.09	45.1	11.99	23.93	41.8	10.86	17.31	34.91
	35	163	16.65	26.62	42.95	16.65	20.93	36.37	13.24	17.78	31.2
	36	164	15.25	20.25	38.37	16.58	23.37	40.69	14.94	18.57	34.92
	37	165	14.69	23.91	40.99	17.92	23.19	42.63	12.21	18.09	32.57
	38	166	13.53	25.84	46.2	15.54	20.67	43.72	13.4	17.98	35.15
	49	177	17.87	27.53	45.3	14.63	19.72	36.07	10.43	16.36	30.74
	50	178	14.75	22.44	38.58	18.08	24.13	43.2	16.27	19.81	34.64
	51	179	13.62	23.25	39.95	18.09	24.25	45.95	15.75	20.1	35.51
	52	180	12.46	24.4	42.48	13.82	20.16	42.08	12.05	18.05	33.42

h) Simulated PD (W/m^2) at 4 cm^2 averaging for bottom array at n260

			4 cm^2 PD (W/m^2) at 6 dBm per port, n260								
Module ID	Beam ID 1	Beam ID 2	LB			MB			HB		
1			S1	S2	S6	S1	S2	S6	S1	S2	S6
	1		2.13	1.91	5.56	2.61	2.09	6.2	2.44	2.1	5.75
	4		2.28	2.01	6.18	2.28	2.25	5.93	1.6	1.59	4.02
	7		2.18	2.15	5.83	2.02	1.86	4.99	1.62	1.4	3.64
	10		1.76	1.75	4.46	1.99	1.88	4.98	1.71	1.63	4.45
	17		3.11	2.52	9.97	3.04	2.55	9.01	3.08	2.94	8.18
	18		5.6	4.6	11.78	4.73	4.62	11.38	4.23	3.7	9.43
	19		3.57	3.72	9.74	5.02	3.92	10.8	3.51	3.1	8.77
	20		3.84	3.52	11.54	4.38	3.82	12.63	3.45	3.15	9.37
	28		5.03	4.3	11.99	4.75	4.4	12.32	3.9	3.53	9.53
	29		4.64	4.05	10.26	5.03	4.47	10.25	3.96	3.46	8.94
Bottom Array	30		2.82	3.04	10.7	4.33	3.4	12.17	3.32	2.87	9.04
	39		7.51	6.86	19.96	6.92	6.49	19.59	6.26	6.07	15.85
	40		9.28	8.95	19.27	8.8	8.91	18.86	5.79	5.11	12.64
	41		9.27	8.55	18.7	10.12	9.6	20.8	7.72	6.89	16.14
	42		7.06	7.52	16.39	7.69	6.97	16.85	6.35	5.98	15.29
	43		7.58	5.75	21.01	6.7	5.5	19.66	6.63	5.9	15.59
	53		9.49	9.02	21	7.23	7.42	17.59	5.24	5.65	14.21
	54		9.53	9.28	19.07	9.67	9.61	20.42	6.97	5.51	14.21
	55		8.04	7.25	16.9	9.27	8.73	19.4	7.03	6.26	15.91
	56		7.57	7.5	20.09	7.93	6.45	18.06	6.48	5.59	14.14
	129		1.72	2.83	4.83	1.91	2.56	5.55	1.49	3.23	5.5
	132		0.94	2.73	4.51	0.89	3.23	5.47	1.09	2.28	4.49

	135		1.19	3.07	5.44	0.98	2.65	4.38	1.16	1.86	3.32
	138		1.43	2.47	4.69	0.96	2.45	3.98	1.14	1.82	3.46
	145		2.31	3.74	9.23	1.65	4.1	7.34	1.83	2.98	6.13
	146		2.91	5.57	9.11	1.62	4.29	6.69	2.53	3.45	6.77
	147		2.39	5.39	9.28	3.35	5.81	10.79	2.68	4.95	8.28
	148		2.09	4.07	8.38	2.77	4.64	11.06	2.6	5	10.11
	156		2.14	5.41	10.34	1.72	4.55	9.19	2.16	3.76	7.68
	157		2.84	6.57	9.58	3.47	6.65	10.18	2.89	5.6	8.54
	158		2.01	5.59	11.16	1.6	4.49	9.45	2.05	3.43	7.34
	167		3.22	8.49	16.57	4.18	8.86	18.35	4.62	7.83	15.6
	168		5.69	12.43	18.38	4.92	8.35	13.23	4.05	8.16	13.36
	169		4.54	12.72	18.37	4.74	13.8	19.77	7.34	10.82	18.16
	170		6.58	12.05	20.27	6.11	11.47	19.21	3.59	7.32	11.77
	171		3.11	7.1	15.92	3.75	9.19	17.96	4.44	7.47	16.24
	181		4.69	8.2	16.31	3.06	8.15	14.95	4.38	6.79	15.81
	182		4.57	12.22	17.53	4.97	13.44	19.11	6.69	10.5	17.99
	183		5.13	12.88	19.43	6.31	14.11	21.25	5.71	9.56	15.96
	184		4.91	10.2	18.35	4.71	7.71	16.69	4.73	7.56	12.4
	1	129	4.6	5.54	12.21	5.64	5.65	13.37	5.46	7.14	12.25
	4	132	4.42	5.93	12.69	3.71	6.88	11.88	3.49	5.19	8.75
	7	135	4.16	5.82	12.64	3.78	5.73	9.74	3.43	4.38	7.98
	10	138	3.91	4.9	9.96	3.99	5.76	9.94	3.58	4.34	8.34
	17	145	6.67	9.23	23.01	5.22	8.04	19.38	5.35	8.21	17.77
	18	146	10.32	11.51	21.12	7.54	9.7	19.59	6.75	7.61	17.34
	19	147	7.01	12.5	23.34	10.47	11.91	23.7	7.37	9.71	18.99
	20	148	6.43	10.19	22.74	8.22	11.22	25.93	6.93	9.46	21.7
	28	156	9.02	11.18	25.46	7.12	12.07	24.22	7.55	7.45	18.19
	29	157	8.31	12.58	23.31	9.81	12.82	22.65	7.61	10.03	18.24
	30	158	5.38	12.37	25.06	6.88	10.01	24.19	6.18	9.2	17.63
	39	167	12.17	20.93	41.69	13.4	26.15	46.36	12.69	16.05	36.58
	40	168	17.49	27.49	44.32	16.19	20.15	36.77	11.2	17.07	30.51
	41	169	16.69	21.77	39.69	16.69	23.94	41.35	16.9	20.02	36.84
	42	170	15.02	27.56	45.58	16.93	23.47	42.4	12.29	17.63	31.92
	43	171	13.69	22.34	46.58	14.58	23.62	45.01	14.28	16.26	36.92
	53	181	15.35	25.83	45.38	11.39	22.62	40.42	11.62	16.93	35.45
	54	182	14.54	22.06	38.38	16.34	25.36	43.76	17.13	19.97	34.73
	55	183	14.66	24.48	41.13	18.58	25.3	46.34	15.19	19.17	34.42
	56	184	14.01	28.16	49.09	15.18	21.37	44.06	12.59	16.72	32.48

i) Simulated PD (W/m^2) at 4 cm^2 averaging for front array at n260

			4 cm^2 PD (W/m^2) at 6 dBm per port, n260								
Module ID	Beam ID 1	Beam ID 2	LB			MB			HB		
2			S1	S2	S4	S1	S2	S4	S1	S2	S4
Front Array	2		2.41	0.06	1.03	3.33	0.11	1.31	3.81	0.08	1.26
	5		2.48	0.08	1.14	3.12	0.11	1.3	3.4	0.07	1.39

	8		2.62	0.08	1.2	2.76	0.09	1.14	3.4	0.08	1.37
	11		2.15	0.04	0.78	2.79	0.1	1.36	3.22	0.07	1.38
	12		4.35	0.06	1.23	4.88	0.12	1.84	5.52	0.12	2.13
	21		5.71	0.19	2.97	7.49	0.33	3.99	8.01	0.25	3.89
	22		4.57	0.08	1.39	5.67	0.19	2.44	6.38	0.14	2.09
	23		3.72	0.14	2.07	4.15	0.17	1.74	4.42	0.12	2.48
	24		5.04	0.18	2.77	7.21	0.35	3.41	7.52	0.18	3.14
	31		6.93	0.16	2.85	9.21	0.32	4.64	9.31	0.2	3.77
	32		5.56	0.21	2.69	7.01	0.25	3.3	8.34	0.26	3.39
	33		4.29	0.16	2.31	5.2	0.23	2.12	5.73	0.14	2.48
	44		12.14	0.35	5.61	16.74	0.97	8.99	14.83	0.36	6.72
	45		16.44	0.7	8.63	21.86	1.04	11.77	21.45	0.86	10.38
	46		9.21	0.16	2.55	9.71	0.18	2.33	11.65	0.18	4.8
	47		11.01	0.44	5.63	9.47	0.2	2.71	8.92	0.26	4.5
	48		10.58	0.23	4.12	14.1	0.62	6.44	14.71	0.41	6.68
	57		13.9	0.49	6.88	15.76	0.9	8.58	16.03	0.59	7.85
	58		10.46	0.25	4.38	15.22	0.6	6.96	18.33	0.51	6.76
	59		9.41	0.3	4.55	10.57	0.38	3.61	9.92	0.32	4.87
	60		11.78	0.32	5.28	14.22	0.52	6.01	13.11	0.42	6.17
	130		3.52	0.15	1.66	4.03	0.13	1.69	3.92	0.1	1.3
	133		2.95	0.12	1.52	3.74	0.1	1.45	3.81	0.06	1.1
	136		3.02	0.14	1.6	3.44	0.09	1.28	3.61	0.06	1.02
	139		3.36	0.14	1.78	3.49	0.1	1.29	3.58	0.05	0.97
	140		3.9	0.1	1.77	3.42	0.07	1.11	3.2	0.07	1.25
	149		6.12	0.18	2.92	6.35	0.14	2.16	6.92	0.12	1.91
	150		6.9	0.3	3.77	7.72	0.25	3.22	6.91	0.17	2.03
	151		6.27	0.26	3.62	6.35	0.19	2.71	5.96	0.09	1.83
	152		5.89	0.32	3.67	6.88	0.24	3.07	6.65	0.1	1.85
	159		7.16	0.28	3.17	7.11	0.19	2.01	6.53	0.15	1.85
	160		6.41	0.19	2.16	7.97	0.31	3.17	9.01	0.28	2.98
	161		5.99	0.37	4.09	6.82	0.26	3.09	6.34	0.1	1.81
	172		13.5	0.64	8.09	11.1	0.43	5.09	12.03	0.21	3.96
	173		15.01	0.97	9.92	13.98	0.64	7.34	12.25	0.23	3.32
	174		12.34	0.46	6.28	15.91	0.63	5.99	15.05	0.58	5.79
	175		12.63	0.37	5.05	12.91	0.59	5.5	15.56	0.57	6.1
	176		15.13	0.8	9.85	11.98	0.5	5.38	12.47	0.23	3.78
	185		13.94	0.76	9.09	12.42	0.56	5.95	12.6	0.28	4.01
	186		15.55	0.92	10.53	13.85	0.56	6.98	11.96	0.22	3.93
	187		13.82	0.33	5.79	12.64	0.32	4.46	13.99	0.31	4.29
	188		12.54	0.62	7.17	12.52	0.56	5.69	13.09	0.33	4.67
	2	130	6.95	0.25	3.97	8.45	0.23	3.06	8.75	0.2	2.8
	5	133	6.92	0.27	3.96	7.7	0.29	3.12	8.31	0.17	3.13
	8	136	6.89	0.25	3.75	7.29	0.2	2.71	8.22	0.17	3.06
	11	139	7.04	0.28	3.85	7.67	0.21	3.12	7.99	0.13	3.02
	12	140	10.6	0.25	3.97	8.84	0.25	3.74	9.72	0.25	4.59
	21	149	13.44	0.44	7.86	15.79	0.59	7.95	16.97	0.53	6.74
	22	150	10.82	0.53	5.62	9.96	0.38	4.26	9.2	0.24	3.19
	23	151	13.29	0.68	9.3	13.85	0.55	6.57	14.45	0.38	6.96
	24	152	12.86	0.62	8.17	17.29	0.57	6.57	16.99	0.31	6.23
	31	159	19.45	0.44	6.23	19.55	0.44	7.23	18.3	0.47	7.71

	32	160	12.81	0.31	4.75	14.63	0.38	5.57	16.33	0.53	5.63
	33	161	13.71	0.81	9.88	13.88	0.56	5.97	13	0.31	5.6
	44	172	29.73	1.12	15.34	31.54	1.77	15.95	31.96	0.79	13.86
	45	173	33.24	1.28	15.51	34.93	1.18	14.94	33.84	1.16	15.45
	46	174	25.36	0.88	12.04	30.31	0.87	10.81	33.41	0.65	12.68
	47	175	26.4	1.04	12.7	24.77	0.64	7.37	26.27	0.84	10.39
	48	176	31.29	1.47	19.32	30.03	1.25	13.81	34.06	0.94	13.43
	57	185	31.52	1.19	14.93	32.88	1.23	13.77	33.95	0.79	11.72
	58	186	30.55	1.56	19.41	26.94	0.85	11.32	31.6	0.79	12.37
	59	187	25.9	0.89	13.64	28.4	1.22	12.1	27.22	1	12.72
	60	188	30.66	1.18	15.58	29.63	0.76	10.91	29.38	0.84	12.29

Scaling factor calculation: The following tables show the scaling factor results for all three different modules, at n258, n261 and n260 bands. The scaling factor is defined as the MPE internal design limit (4.5 W/m^2) divided by the simulated peak spatial average power density. The data is provided for both single polarization beams and paired beams. Please be noted due to timeline, following results are not obtained using the final version of codebook.

In the tables below, the values reported represent the scaled factors for low-band, mid-band and high-band results (S_LB, S_MB, and S_HB, respectively) and the scaling factor SF is the most restrictive of the three band-specific values.

a) *Scaling factor for top array n258*

Beam ID 1	Beam ID 2	S_LB	S_MB	S_HB	S
0		0.734094617	0.702028081	0.812274368	0.702028081
3		1.053864169	1.147959184	1.304347826	1.053864169
6		1.642335766	1.867219917	1.193633952	1.193633952
9		1.119402985	1.002227171	1.071428571	1.002227171
13		0.783972125	0.666666667	0.613079019	0.613079019
14		0.548112058	0.659824047	0.626740947	0.548112058
15		0.435203095	0.462487153	0.555555556	0.435203095
16		0.539568345	0.553505535	0.556930693	0.539568345
25		0.428979981	0.405770965	0.454545455	0.405770965
26		0.402504472	0.406504065	0.520231214	0.402504472
27		0.891089109	0.880626223	0.70977918	0.70977918
34		0.228079067	0.235849057	0.230532787	0.228079067
35		0.226358149	0.235232619	0.251959686	0.226358149
36		0.305914344	0.344827586	0.319148936	0.305914344
37		0.242718447	0.272067715	0.308219178	0.242718447
38		0.428163654	0.376569038	0.315568022	0.315568022
49		0.223992036	0.231481481	0.229591837	0.223992036
50		0.283553875	0.293542074	0.338345865	0.283553875
51		0.276752768	0.319829424	0.309704061	0.276752768
52		0.256996002	0.24766098	0.26642984	0.24766098
128		1.168831169	1.253481894	1.465798046	1.168831169
131		1.750972763	1.193633952	0.882352941	0.882352941
134		1.54109589	1.814516129	1.216216216	1.216216216

137		1.52027027	1.282051282	1.015801354	1.015801354
141		0.643776824	0.607287449	0.592885375	0.592885375
142		0.710900474	0.664697194	0.648414986	0.648414986
143		0.822669104	0.828729282	0.60483871	0.60483871
144		0.831792976	0.664697194	0.561097257	0.561097257
153		0.830258303	0.812274368	0.618131868	0.618131868
154		0.736497545	0.807899461	0.588235294	0.588235294
155		0.812274368	0.641940086	0.507900677	0.507900677
162		0.30653951	0.294502618	0.243374797	0.243374797
163		0.336826347	0.333827893	0.275735294	0.275735294
164		0.452261307	0.428571429	0.315789474	0.315789474
165		0.332348597	0.331125828	0.278465347	0.278465347
166		0.464396285	0.314685315	0.248618785	0.248618785
177		0.30653951	0.294502618	0.243374797	0.243374797
178		0.427350427	0.43062201	0.343249428	0.343249428
179		0.472689076	0.472193075	0.327510917	0.327510917
180		0.348027842	0.279156328	0.233039876	0.233039876
0	128	0.320056899	0.362318841	0.477200424	0.320056899
3	131	0.452716298	0.440744368	0.452716298	0.440744368
6	134	0.577663671	0.9	0.550795594	0.550795594
9	137	0.43902439	0.423728814	0.406137184	0.406137184
13	141	0.310773481	0.320056899	0.312283137	0.310773481
14	142	0.25728988	0.286441757	0.308008214	0.25728988
15	143	0.24	0.259815242	0.244831338	0.24
16	144	0.263774912	0.258175559	0.237592397	0.237592397
25	153	0.245365322	0.254813137	0.260416667	0.245365322
26	154	0.27027027	0.283911672	0.294310007	0.27027027
27	155	0.419384902	0.334323923	0.267220903	0.267220903
34	162	0.093574548	0.105857445	0.109542356	0.093574548
35	163	0.094438615	0.111083683	0.122249389	0.094438615
36	164	0.142540386	0.180868167	0.147396004	0.142540386
37	165	0.101580135	0.116489775	0.119680851	0.101580135
38	166	0.176056338	0.148319051	0.104529617	0.104529617
49	177	0.092288761	0.105287787	0.110051357	0.092288761
50	178	0.123762376	0.147880381	0.163102573	0.123762376
51	179	0.134932534	0.170777989	0.146914789	0.134932534
52	180	0.115979381	0.105757932	0.09509721	0.09509721

b) *Scaling factor for bottom array n258*

Beam ID 1	Beam ID 2	S_LB	S_MB	S_HB	S
1		0.706436421	0.646551724	0.69124424	0.646551724
4		0.993377483	1.066350711	1.048951049	0.993377483
7		1.515151515	1.335311573	1.296829971	1.296829971
10		1.102941176	0.918367347	1.079136691	0.918367347
17		0.406504065	0.372825186	0.390964379	0.372825186
18		0.659824047	0.638297872	0.689127106	0.638297872
19		0.745033113	0.649350649	0.576923077	0.576923077
20		0.484913793	0.507328072	0.511363636	0.484913793

28		0.525700935	0.573979592	0.599201065	0.525700935
29		0.394736842	0.386266094	0.410209663	0.386266094
30		0.441609421	0.464876033	0.478723404	0.441609421
39		0.210084034	0.200177936	0.211764706	0.200177936
40		0.262390671	0.258027523	0.275904353	0.258027523
41		0.263774912	0.25921659	0.292207792	0.25921659
42		0.227732794	0.203804348	0.225677031	0.203804348
43		0.472689076	0.382653061	0.311418685	0.311418685
53		0.218978102	0.213675214	0.229943792	0.213675214
54		0.288461538	0.286077559	0.30282638	0.286077559
55		0.240513095	0.226472068	0.262085032	0.226472068
56		0.26929982	0.219941349	0.211069418	0.211069418
129		1.246537396	1.319648094	1.239669421	1.239669421
132		1.724137931	1.219512195	0.941422594	0.941422594
135		1.530612245	1.446945338	1.380368098	1.380368098
138		1.618705036	1.388888889	1.03926097	1.03926097
145		0.914634146	0.678733032	0.542168675	0.542168675
146		0.757575758	0.779896014	0.694444444	0.694444444
147		0.844277674	0.655021834	0.478723404	0.478723404
148		0.845864662	0.697674419	0.528169014	0.528169014
156		0.70754717	0.664697194	0.620689655	0.620689655
157		0.778546713	0.622406639	0.477200424	0.477200424
158		0.927835052	0.721153846	0.559701493	0.559701493
167		0.308641975	0.273390036	0.24576734	0.24576734
168		0.410583942	0.380388842	0.329188003	0.329188003
169		0.535714286	0.470711297	0.360576923	0.360576923
170		0.344563553	0.309491059	0.284629981	0.284629981
171		0.510783201	0.331369661	0.229124236	0.229124236
181		0.328227571	0.301003344	0.269138756	0.269138756
182		0.45045045	0.389948007	0.311634349	0.311634349
183		0.462487153	0.445544554	0.381679389	0.381679389
184		0.364963504	0.281954887	0.234252993	0.234252993
1	129	0.319602273	0.347222222	0.379426644	0.319602273
4	132	0.437743191	0.431034483	0.431034483	0.431034483
7	135	0.548780488	0.563204005	0.650289017	0.548780488
10	138	0.449101796	0.432276657	0.423330198	0.423330198
17	145	0.238980351	0.216763006	0.224215247	0.216763006
18	146	0.24766098	0.303030303	0.329912023	0.24766098
19	147	0.326323423	0.292207792	0.251256281	0.251256281
20	148	0.259365994	0.25966532	0.235109718	0.235109718
28	156	0.245098039	0.257437071	0.27173913	0.245098039
29	157	0.244167119	0.231600618	0.209010683	0.209010683
30	158	0.27027027	0.267697799	0.251537172	0.251537172
39	167	0.09009009	0.09274526	0.105584233	0.09009009
40	168	0.119300106	0.127082745	0.136986301	0.119300106
41	169	0.137069753	0.147928994	0.149650815	0.137069753
42	170	0.101648972	0.098879367	0.102739726	0.098879367
43	171	0.211267606	0.157068063	0.112556278	0.112556278
53	181	0.093090608	0.098640947	0.112781955	0.093090608

54	182	0.136861314	0.145961726	0.146246344	0.136861314
55	183	0.116913484	0.123422929	0.133968443	0.116913484
56	184	0.127877238	0.107219442	0.092860091	0.092860091

c) *Scaling factor for front array n258*

Beam ID 1	Beam ID 2	S_LB	S_MB	S_HB	S
2		1.206434316	0.885826772	0.969827586	0.885826772
5		1.029748284	1.00896861	1.025056948	1.00896861
8		1.081730769	0.951374207	1.002227171	0.951374207
11		0.965665236	0.842696629	0.847457627	0.842696629
12		1.178010471	0.87890625	0.844277674	0.844277674
21		0.382327952	0.333333333	0.331369661	0.331369661
22		0.424929178	0.446871897	0.504484305	0.424929178
23		0.622406639	0.437743191	0.427756654	0.427756654
24		0.546780073	0.431447747	0.413983441	0.413983441
31		0.402144772	0.331613854	0.323974082	0.323974082
32		0.49833887	0.386266094	0.372208437	0.372208437
33		0.831792976	0.559701493	0.563909774	0.559701493
44		0.234619395	0.211466165	0.199911151	0.199911151
45		0.23100616	0.176956351	0.188521156	0.176956351
46		0.237467018	0.202702703	0.193715024	0.193715024
47		0.229474758	0.153688525	0.160085379	0.153688525
48		0.338345865	0.275061125	0.296638102	0.275061125
57		0.274725275	0.250556793	0.230887635	0.230887635
58		0.219726563	0.17136329	0.18556701	0.17136329
59		0.252383623	0.210280374	0.193298969	0.193298969
60		0.318696884	0.178147268	0.220264317	0.178147268
130		1.032110092	0.767918089	0.785340314	0.767918089
133		0.845864662	0.837988827	0.813743219	0.813743219
136		0.935550936	0.786713287	0.792253521	0.786713287
139		0.914634146	0.758853288	0.765306122	0.758853288
140		1.053864169	0.824175824	0.807899461	0.807899461
149		0.401069519	0.356294537	0.332103321	0.332103321
150		0.340393343	0.295081967	0.288276746	0.288276746
151		0.34992224	0.327510917	0.335820896	0.327510917
152		0.55487053	0.529411765	0.571791614	0.529411765
159		0.33557047	0.295469468	0.291073739	0.291073739
160		0.340909091	0.314905528	0.319148936	0.314905528
161		0.39893617	0.343249428	0.31424581	0.31424581
172		0.187110187	0.143861893	0.149900067	0.143861893
173		0.174689441	0.153688525	0.140186916	0.140186916
174		0.163517442	0.151260504	0.162103746	0.151260504
175		0.226928896	0.200982582	0.224215247	0.200982582
176		0.223103619	0.235355649	0.256556442	0.223103619
185		0.172877449	0.1478318	0.144741074	0.144741074
186		0.170003778	0.151873102	0.150956055	0.150956055
187		0.18734388	0.17674784	0.198150594	0.17674784

188		0.199379708	0.199291408	0.229007634	0.199291408
2	130	0.378787879	0.331858407	0.327988338	0.327988338
5	133	0.391304348	0.347758887	0.330882353	0.330882353
8	136	0.405405405	0.328707085	0.328467153	0.328467153
11	139	0.386930353	0.32967033	0.317348378	0.317348378
12	140	0.474183351	0.388601036	0.339879154	0.339879154
21	149	0.184350676	0.158506516	0.153741032	0.153741032
22	150	0.167473018	0.149303251	0.154004107	0.149303251
23	151	0.181891673	0.161521895	0.165441176	0.161521895
24	152	0.242326333	0.221130221	0.216346154	0.216346154
31	159	0.195993031	0.170261067	0.181086519	0.170261067
32	160	0.211964202	0.186489847	0.196420777	0.186489847
33	161	0.269946011	0.218234724	0.216034566	0.216034566
44	172	0.105213935	0.087787749	0.086822304	0.086822304
45	173	0.096857512	0.080142476	0.075910931	0.075910931
46	174	0.092956001	0.08	0.078795307	0.078795307
47	175	0.096857512	0.074025333	0.07751938	0.074025333
48	176	0.123660346	0.116129032	0.12383049	0.116129032
57	185	0.10383018	0.088530395	0.085551331	0.085551331
58	186	0.0892326	0.076116373	0.074701195	0.074701195
59	187	0.095785441	0.078492936	0.075846958	0.075846958
60	188	0.107732823	0.085861477	0.104919562	0.085861477

d) Scaling factor for top array n261

Beam ID 1	Beam ID 2	S_LB	S_MB	S_HB	S
0		0.819672131	0.918367347	0.738916256	0.738916256
3		0.993377483	0.916496945	0.967741935	0.916496945
6		1.113861386	1.105651106	0.989010989	0.989010989
9		0.995575221	0.976138829	1.079136691	0.976138829
13		0.49833887	0.516647532	0.418215613	0.418215613
14		0.454545455	0.453629032	0.439453125	0.439453125
15		0.410583942	0.413602941	0.423330198	0.410583942
16		0.452261307	0.462487153	0.446428571	0.446428571
25		0.484913793	0.498891353	0.421348315	0.421348315
26		0.411334552	0.408719346	0.425330813	0.408719346
27		0.561097257	0.600801068	0.505617978	0.505617978
34		0.269784173	0.251256281	0.23340249	0.23340249
35		0.254524887	0.256702795	0.237969328	0.237969328
36		0.262085032	0.248893805	0.278293135	0.248893805
37		0.238473768	0.24	0.247933884	0.238473768
38		0.226928896	0.246440307	0.231600618	0.226928896
49		0.242326333	0.234986945	0.219726563	0.219726563
50		0.256996002	0.254237288	0.251818691	0.251818691
51		0.261475886	0.253807107	0.274893097	0.253807107
52		0.215827338	0.225338007	0.224663005	0.215827338
128		0.957446809	0.812274368	0.909090909	0.812274368
131		1.046511628	0.935550936	0.927835052	0.927835052

134		1.153846154	1.168831169	1.061320755	1.061320755
137		1.071428571	1.111111111	1.300578035	1.071428571
141		0.634696756	0.431034483	0.530035336	0.431034483
142		0.463439753	0.422138837	0.434782609	0.422138837
143		0.504484305	0.51369863	0.461065574	0.461065574
144		0.584415584	0.482832618	0.535714286	0.482832618
153		0.621546961	0.547445255	0.561797753	0.547445255
154		0.439453125	0.458248473	0.439453125	0.439453125
155		0.543478261	0.572519084	0.46201232	0.46201232
162		0.31779661	0.238473768	0.284090909	0.238473768
163		0.300200133	0.269946011	0.273722628	0.269946011
164		0.276752768	0.271903323	0.281074329	0.271903323
165		0.214592275	0.222662048	0.23872679	0.214592275
166		0.277606416	0.312717165	0.250696379	0.250696379
177		0.286624204	0.237969328	0.252242152	0.237969328
178		0.302216253	0.281425891	0.28957529	0.281425891
179		0.238980351	0.236966825	0.25862069	0.236966825
180		0.227043391	0.245901639	0.236220472	0.227043391
0	128	0.356012658	0.388265746	0.318696884	0.318696884
3	131	0.423728814	0.395083406	0.374064838	0.374064838
6	134	0.421743205	0.419776119	0.51369863	0.419776119
9	137	0.397526502	0.472689076	0.412087912	0.397526502
13	141	0.227502528	0.210182158	0.208140611	0.208140611
14	142	0.195482189	0.196335079	0.189393939	0.189393939
15	143	0.191815857	0.189234651	0.189473684	0.189234651
16	144	0.231600618	0.203989121	0.22069642	0.203989121
25	153	0.218552695	0.223880597	0.208526413	0.208526413
26	154	0.182333874	0.18404908	0.18899622	0.182333874
27	155	0.223546945	0.241028388	0.200892857	0.200892857
34	162	0.116580311	0.107501194	0.115740741	0.107501194
35	163	0.116550117	0.110375276	0.112951807	0.110375276
36	164	0.113435846	0.107347328	0.127406569	0.107347328
37	165	0.094756791	0.092649784	0.107091861	0.092649784
38	166	0.114620479	0.120935232	0.101971448	0.101971448
49	177	0.107707037	0.099162627	0.105882353	0.099162627
50	178	0.115800309	0.113150616	0.11743215	0.113150616
51	179	0.103806228	0.097868639	0.118421053	0.097868639
52	180	0.09771987	0.099206349	0.101511392	0.09771987

e) *Scaling factor for bottom array n261*

Beam ID 1	Beam ID 2	S_LB	S_MB	S_HB	S
1		0.822669104	0.929752066	0.747508306	0.747508306
4		0.896414343	0.873786408	0.918367347	0.873786408
7		1.002227171	1.145038168	0.939457203	0.939457203
10		0.982532751	1.020408163	1.084337349	0.982532751
17		0.476694915	0.486486486	0.439453125	0.439453125
18		0.440744368	0.440744368	0.43902439	0.43902439
19		0.391986063	0.413602941	0.392327812	0.391986063

20		0.410958904	0.446428571	0.400355872	0.400355872
28		0.460593654	0.465838509	0.436046512	0.436046512
29		0.406137184	0.411334552	0.413983441	0.406137184
30		0.39543058	0.421743205	0.392327812	0.392327812
39		0.234252993	0.230179028	0.225	0.225
40		0.226472068	0.226928896	0.226928896	0.226472068
41		0.248893805	0.247388675	0.258918297	0.247388675
42		0.242587601	0.26642984	0.259365994	0.242587601
43		0.205479452	0.242718447	0.203527815	0.203527815
53		0.225903614	0.222332016	0.223103619	0.222332016
54		0.242326333	0.247797357	0.240256273	0.240256273
55		0.253235791	0.257142857	0.273722628	0.253235791
56		0.211168466	0.244299674	0.218978102	0.211168466
129		0.941422594	0.844277674	1.044083527	0.844277674
132		0.924024641	1.011235955	1.076555024	0.924024641
135		1.209677419	1.424050633	1.122194514	1.122194514
138		1.094890511	1.339285714	1.236263736	1.094890511
145		0.472193075	0.423728814	0.660792952	0.423728814
146		0.453629032	0.433944069	0.500556174	0.433944069
147		0.496688742	0.520833333	0.480769231	0.480769231
148		0.531914894	0.645624103	0.589777195	0.531914894
156		0.452261307	0.412465628	0.582147477	0.412465628
157		0.478214665	0.485436893	0.466804979	0.466804979
158		0.519630485	0.646551724	0.567465322	0.519630485
167		0.256118384	0.254093732	0.342205323	0.254093732
168		0.299800133	0.294117647	0.299401198	0.294117647
169		0.318696884	0.31779661	0.304878049	0.304878049
170		0.251818691	0.269784173	0.267379679	0.251818691
171		0.249584027	0.323741007	0.256849315	0.249584027
181		0.256996002	0.253378378	0.286806883	0.253378378
182		0.32537961	0.317348378	0.320741269	0.317348378
183		0.295081967	0.296833773	0.291639663	0.291639663
184		0.223103619	0.263311878	0.238473768	0.223103619
1	129	0.363783347	0.412844037	0.33358043	0.33358043
4	132	0.360576923	0.394736842	0.401785714	0.360576923
7	135	0.43902439	0.458715596	0.507328072	0.43902439
10	138	0.396475771	0.485961123	0.420560748	0.396475771
17	145	0.210871603	0.201342282	0.219512195	0.201342282
18	146	0.188205772	0.195822454	0.203068592	0.188205772
19	147	0.188284519	0.18262987	0.201703272	0.18262987
20	148	0.230296827	0.253521127	0.234864301	0.230296827
28	156	0.198500221	0.191001698	0.213776722	0.191001698
29	157	0.186412593	0.189155107	0.191570881	0.186412593
30	158	0.219298246	0.233281493	0.230296827	0.219298246
39	167	0.110456554	0.103282075	0.116550117	0.103282075
40	168	0.107066381	0.105312427	0.117708606	0.105312427
41	169	0.119110641	0.114649682	0.129236071	0.114649682
42	170	0.101717902	0.103305785	0.114649682	0.101717902
43	171	0.097297297	0.115621788	0.096421684	0.096421684

53	181	0.100942127	0.097318339	0.109997556	0.097318339
54	182	0.116189001	0.117065557	0.124446903	0.116189001
55	183	0.113207547	0.109435798	0.128241664	0.109435798
56	184	0.090945837	0.098792536	0.100761308	0.090945837

f) Scaling factor for front array n261

Beam ID 1	Beam ID 2	S_LB	S_MB	S_HB	S
2		0.599201065	0.625869263	0.592885375	0.592885375
5		0.652173913	0.660792952	0.648414986	0.648414986
8		0.657894737	0.654069767	0.659824047	0.654069767
11		0.632022472	0.692307692	0.629370629	0.629370629
12		0.770547945	0.706436421	0.858778626	0.706436421
21		0.381355932	0.38330494	0.388936906	0.381355932
22		0.283018868	0.285171103	0.294310007	0.283018868
23		0.319148936	0.314465409	0.321199143	0.314465409
24		0.371287129	0.400712378	0.356859635	0.356859635
31		0.304054054	0.309704061	0.30653951	0.304054054
32		0.376569038	0.383959044	0.394045534	0.376569038
33		0.39893617	0.436046512	0.377833753	0.377833753
44		0.171886937	0.178076771	0.170261067	0.170261067
45		0.144787645	0.148416887	0.147299509	0.144787645
46		0.133769322	0.127913587	0.142045455	0.127913587
47		0.137111517	0.135501355	0.141065831	0.135501355
48		0.209205021	0.226130653	0.198412698	0.198412698
57		0.153793575	0.159179342	0.153374233	0.153374233
58		0.139925373	0.137446549	0.146723182	0.137446549
59		0.127154563	0.121654501	0.13424821	0.121654501
60		0.176609105	0.185261424	0.17674784	0.176609105
130		0.599201065	0.617283951	0.589777195	0.589777195
133		0.668647845	0.684931507	0.659824047	0.659824047
136		0.710900474	0.71656051	0.706436421	0.706436421
139		0.721153846	0.721153846	0.729335494	0.721153846
140		0.800711744	0.740131579	0.849056604	0.740131579
149		0.46923879	0.486486486	0.454545455	0.454545455
150		0.311850312	0.289017341	0.33657442	0.289017341
151		0.375312761	0.363489499	0.381355932	0.363489499
152		0.339110776	0.348027842	0.331125828	0.331125828
159		0.289017341	0.2849905	0.292587776	0.2849905
160		0.329188003	0.328947368	0.32942899	0.328947368
161		0.471204188	0.511945392	0.443786982	0.443786982
172		0.147251309	0.143586471	0.149900067	0.143586471
173		0.13032146	0.123524568	0.137028015	0.123524568
174		0.149204244	0.143815916	0.153374233	0.143815916
175		0.179068842	0.18765638	0.172877449	0.172877449
176		0.227732794	0.246305419	0.213371266	0.213371266
185		0.136902951	0.131042516	0.141911069	0.131042516
186		0.126015122	0.121687399	0.131771596	0.121687399

187		0.191082803	0.192307692	0.18718802	0.18718802
188		0.213371266	0.228194726	0.201793722	0.201793722
2	130	0.286441757	0.298606503	0.281425891	0.281425891
5	133	0.321199143	0.329912023	0.31424581	0.31424581
8	136	0.340393343	0.337078652	0.335820896	0.335820896
11	139	0.326797386	0.331858407	0.320741269	0.320741269
12	140	0.32537961	0.314465409	0.335820896	0.314465409
21	149	0.215002389	0.218234724	0.200803213	0.200803213
22	150	0.136819702	0.130095403	0.143953935	0.130095403
23	151	0.152078405	0.154479918	0.149601064	0.149601064
24	152	0.175712612	0.183075671	0.170325511	0.170325511
31	159	0.139664804	0.139146568	0.139751553	0.139146568
32	160	0.179497407	0.178784267	0.181891673	0.178784267
33	161	0.198675497	0.20988806	0.187032419	0.187032419
44	172	0.080371495	0.080385852	0.07998578	0.07998578
45	173	0.067375356	0.06663705	0.068807339	0.06663705
46	174	0.066884661	0.063433888	0.068047785	0.063433888
47	175	0.076322931	0.076284116	0.075427422	0.075427422
48	176	0.096982759	0.101146325	0.092081031	0.092081031
57	185	0.072150072	0.071690298	0.071576268	0.071576268
58	186	0.063157895	0.061399918	0.066765579	0.061399918
59	187	0.070400501	0.070654734	0.070246644	0.070246644
60	188	0.0944188	0.096525097	0.095157539	0.0944188

g) Scaling factor for top array n260

Beam ID 1	Beam ID 2	S_LB	S_MB	S_HB	S
0		0.827205882	0.714285714	0.79086116	0.714285714
3		0.721153846	0.752508361	1.081730769	0.721153846
6		0.760135135	0.882352941	1.226158038	0.760135135
9		1.046511628	0.901803607	1.025056948	0.901803607
13		0.438596491	0.515463918	0.625	0.438596491
14		0.4	0.416666667	0.487012987	0.4
15		0.460122699	0.413983441	0.506186727	0.413983441
16		0.414364641	0.361155698	0.482315113	0.361155698
25		0.379746835	0.370065789	0.469728601	0.370065789
26		0.437743191	0.441609421	0.502793296	0.437743191
27		0.437743191	0.381679389	0.495049505	0.381679389
34		0.20766036	0.240641711	0.323508267	0.20766036
35		0.235849057	0.221674877	0.3125	0.221674877
36		0.25	0.217391304	0.283018868	0.217391304
37		0.290697674	0.243638332	0.280199253	0.243638332
38		0.222222222	0.246845858	0.313807531	0.222222222
49		0.223546945	0.233039876	0.355450237	0.223546945
50		0.240128068	0.222112537	0.287723785	0.222112537
51		0.280199253	0.227272727	0.280024891	0.227272727
52		0.277264325	0.26849642	0.295275591	0.26849642
128		0.929752066	0.818181818	0.841121495	0.818181818

131		0.997782705	0.825688073	0.97826087	0.825688073
134		0.815217391	0.986842105	1.339285714	0.815217391
137		0.957446809	1.145038168	1.308139535	0.957446809
141		0.420560748	0.473684211	0.559701493	0.420560748
142		0.46728972	0.46728972	0.495049505	0.46728972
143		0.403587444	0.471204188	0.679758308	0.403587444
144		0.544794189	0.411334552	0.421743205	0.411334552
153		0.484391819	0.464396285	0.442913386	0.442913386
154		0.464396285	0.448654038	0.550795594	0.448654038
155		0.528789659	0.404676259	0.493421053	0.404676259
162		0.278121137	0.275735294	0.2849905	0.275735294
163		0.245901639	0.320056899	0.330154072	0.245901639
164		0.248207391	0.236344538	0.263929619	0.236344538
165		0.235478807	0.237091675	0.382653061	0.235478807
166		0.272397094	0.241545894	0.282485876	0.241545894
177		0.237969328	0.379426644	0.341426404	0.237969328
178		0.25728988	0.238347458	0.268016677	0.238347458
179		0.234619395	0.218234724	0.276923077	0.218234724
180		0.252667041	0.266903915	0.331858407	0.252667041
0	128	0.37437604	0.34272658	0.373754153	0.34272658
3	131	0.357142857	0.38071066	0.49833887	0.357142857
6	134	0.350740452	0.457317073	0.559701493	0.350740452
9	137	0.45	0.454086781	0.545454545	0.45
13	141	0.183374083	0.207277752	0.254524887	0.183374083
14	142	0.2	0.199291408	0.221130221	0.199291408
15	143	0.223546945	0.221893491	0.300400534	0.221893491
16	144	0.207086977	0.176886792	0.198412698	0.176886792
25	153	0.184577523	0.191979522	0.201703272	0.184577523
26	154	0.193215973	0.200982582	0.251396648	0.193215973
27	155	0.201342282	0.181451613	0.210674157	0.181451613
34	162	0.099778271	0.107655502	0.128902893	0.099778271
35	163	0.104772992	0.123728348	0.144230769	0.104772992
36	164	0.117279124	0.110592283	0.128865979	0.110592283
37	165	0.109782874	0.105559465	0.138163955	0.105559465
38	166	0.097402597	0.102927722	0.12802276	0.097402597
49	177	0.099337748	0.124757416	0.14638907	0.099337748
50	178	0.116640747	0.104166667	0.129907621	0.104166667
51	179	0.112640801	0.097932535	0.126724866	0.097932535
52	180	0.105932203	0.106939163	0.13464991	0.105932203

h) Scaling factor for bottom array n260

Beam ID 1	Beam ID 2	S_LB	S_MB	S_HB	S
1		0.809352518	0.725806452	0.782608696	0.725806452
4		0.72815534	0.758853288	1.119402985	0.72815534
7		0.77186964	0.901803607	1.236263736	0.77186964
10		1.00896861	0.903614458	1.011235955	0.903614458
17		0.451354062	0.499445061	0.550122249	0.451354062
18		0.382003396	0.39543058	0.477200424	0.382003396

19		0.46201232	0.416666667	0.513112885	0.416666667
20		0.389948007	0.356294537	0.480256137	0.356294537
28		0.375312761	0.36525974	0.472193075	0.36525974
29		0.438596491	0.43902439	0.503355705	0.438596491
30		0.420560748	0.369761709	0.497787611	0.369761709
39		0.225450902	0.229709035	0.283911672	0.225450902
40		0.233523612	0.238600212	0.356012658	0.233523612
41		0.240641711	0.216346154	0.278810409	0.216346154
42		0.274557657	0.267062315	0.294310007	0.267062315
43		0.214183722	0.22889115	0.288646568	0.214183722
53		0.214285714	0.255827175	0.316678395	0.214285714
54		0.235972732	0.220372184	0.316678395	0.220372184
55		0.266272189	0.231958763	0.282840981	0.231958763
56		0.223992036	0.249169435	0.31824611	0.223992036
129		0.931677019	0.810810811	0.818181818	0.810810811
132		0.997782705	0.822669104	1.002227171	0.822669104
135		0.827205882	1.02739726	1.355421687	0.827205882
138		0.959488273	1.130653266	1.300578035	0.959488273
145		0.487540628	0.613079019	0.734094617	0.487540628
146		0.493962678	0.67264574	0.664697194	0.493962678
147		0.484913793	0.417052827	0.543478261	0.417052827
148		0.53699284	0.406871609	0.445103858	0.406871609
156		0.435203095	0.489662677	0.5859375	0.435203095
157		0.469728601	0.442043222	0.526932084	0.442043222
158		0.403225806	0.476190476	0.613079019	0.403225806
167		0.271575136	0.245231608	0.288461538	0.245231608
168		0.244831338	0.340136054	0.336826347	0.244831338
169		0.244964616	0.227617602	0.247797357	0.227617602
170		0.22200296	0.234252993	0.382327952	0.22200296
171		0.282663317	0.250556793	0.277093596	0.250556793
181		0.275904353	0.301003344	0.284629981	0.275904353
182		0.256702795	0.235478807	0.250138966	0.235478807
183		0.231600618	0.211764706	0.281954887	0.211764706
184		0.245231608	0.269622528	0.362903226	0.245231608
1	129	0.368550369	0.33657442	0.367346939	0.33657442
4	132	0.354609929	0.378787879	0.514285714	0.354609929
7	135	0.356012658	0.46201232	0.563909774	0.356012658
10	138	0.451807229	0.452716298	0.539568345	0.451807229
17	145	0.195567145	0.232198142	0.253235791	0.195567145
18	146	0.213068182	0.229709035	0.259515571	0.213068182
19	147	0.192802057	0.189873418	0.236966825	0.189873418
20	148	0.197889182	0.173544157	0.207373272	0.173544157
28	156	0.17674784	0.185796862	0.247388675	0.17674784
29	157	0.193050193	0.198675497	0.246710526	0.193050193
30	158	0.179569034	0.186027284	0.255246739	0.179569034
39	167	0.107939554	0.097066437	0.123018043	0.097066437
40	168	0.101534296	0.122382377	0.147492625	0.101534296
41	169	0.113378685	0.108827086	0.122149837	0.108827086
42	170	0.098727512	0.106132075	0.140977444	0.098727512

43	171	0.096607986	0.099977783	0.121885157	0.096607986
53	181	0.099162627	0.111331024	0.126939351	0.099162627
54	182	0.117248567	0.102833638	0.129570976	0.102833638
55	183	0.10940919	0.09710833	0.130737943	0.09710833
56	184	0.091668364	0.102133454	0.138546798	0.091668364

i) Scaling factor for front array n260

Beam ID 1	Beam ID 2	S_LB	S_MB	S_HB	S
2		1.867219917	1.351351351	1.181102362	1.181102362
5		1.814516129	1.442307692	1.323529412	1.323529412
8		1.717557252	1.630434783	1.323529412	1.323529412
11		2.093023256	1.612903226	1.397515528	1.397515528
12		1.034482759	0.922131148	0.815217391	0.815217391
21		0.788091068	0.600801068	0.561797753	0.561797753
22		0.984682713	0.793650794	0.705329154	0.705329154
23		1.209677419	1.084337349	1.018099548	1.018099548
24		0.892857143	0.624133148	0.598404255	0.598404255
31		0.649350649	0.488599349	0.483351235	0.483351235
32		0.809352518	0.641940086	0.539568345	0.539568345
33		1.048951049	0.865384615	0.785340314	0.785340314
44		0.370675453	0.268817204	0.303438975	0.268817204
45		0.273722628	0.205855444	0.20979021	0.205855444
46		0.488599349	0.463439753	0.386266094	0.386266094
47		0.408719346	0.475184794	0.504484305	0.408719346
48		0.425330813	0.319148936	0.305914344	0.305914344
57		0.323741007	0.285532995	0.280723643	0.280723643
58		0.430210325	0.295663601	0.245499182	0.245499182
59		0.478214665	0.425733207	0.453629032	0.425733207
60		0.382003396	0.316455696	0.343249428	0.316455696
130		1.278409091	1.11662531	1.147959184	1.11662531
133		1.525423729	1.203208556	1.181102362	1.181102362
136		1.490066225	1.308139535	1.246537396	1.246537396
139		1.339285714	1.289398281	1.25698324	1.25698324
140		1.153846154	1.315789474	1.40625	1.153846154
149		0.735294118	0.708661417	0.650289017	0.650289017
150		0.652173913	0.582901554	0.651230101	0.582901554
151		0.717703349	0.708661417	0.755033557	0.708661417
152		0.764006791	0.654069767	0.676691729	0.654069767
159		0.62849162	0.632911392	0.689127106	0.62849162
160		0.702028081	0.564617315	0.499445061	0.499445061
161		0.751252087	0.659824047	0.70977918	0.659824047
172		0.333333333	0.405405405	0.374064838	0.333333333
173		0.299800133	0.321888412	0.367346939	0.299800133
174		0.364667747	0.282840981	0.299003322	0.282840981
175		0.356294537	0.348567002	0.289203085	0.289203085
176		0.29742234	0.375626043	0.360866079	0.29742234
185		0.322812052	0.362318841	0.357142857	0.322812052

186		0.289389068	0.324909747	0.376254181	0.289389068
187		0.325615051	0.356012658	0.321658327	0.321658327
188		0.358851675	0.35942492	0.343773873	0.343773873
2	130	0.647482014	0.532544379	0.514285714	0.514285714
5	133	0.650289017	0.584415584	0.541516245	0.541516245
8	136	0.653120464	0.617283951	0.547445255	0.547445255
11	139	0.639204545	0.586701434	0.563204005	0.563204005
12	140	0.424528302	0.509049774	0.462962963	0.424528302
21	149	0.334821429	0.2849905	0.265173836	0.265173836
22	150	0.415896488	0.451807229	0.489130435	0.415896488
23	151	0.338600451	0.324909747	0.311418685	0.311418685
24	152	0.34992224	0.26026605	0.264861683	0.26026605
31	159	0.231362468	0.230179028	0.245901639	0.230179028
32	160	0.351288056	0.30758715	0.275566442	0.275566442
33	161	0.328227571	0.324207493	0.346153846	0.324207493
44	172	0.15136226	0.142675967	0.140801001	0.140801001
45	173	0.135379061	0.128829087	0.132978723	0.128829087
46	174	0.177444795	0.148465853	0.134690213	0.134690213
47	175	0.170454545	0.181671377	0.171298059	0.170454545
48	176	0.143815916	0.14985015	0.132119789	0.132119789
57	185	0.142766497	0.136861314	0.132547865	0.132547865
58	186	0.147299509	0.167037862	0.142405063	0.142405063
59	187	0.173745174	0.158450704	0.165319618	0.158450704
60	188	0.146771037	0.151873102	0.153165419	0.146771037

Appendix C: Additional Verifications for GEN 2

The PD for GEN2 cannot be finalized until the additional verifications described in this section are performed and passed. The below steps are followed for verifications in the mid channel [4]. Please be noted due to timeline, the verifications are not performed using the final version of codebook.

VERIFICATION 1: Use "Qualcomm MG script" to print the PD plots for all the beams selected and evaluated for model validation. Compare the printed PD plot to the corresponding simulated/measured PD, the printed PD distributions should match the simulated PD distributions as shown in Table C.1, C.4 and C.7 verify that "Qualcomm MG script" is properly used.

VERIFICATION 2: "Qualcomm MG script" identifies the worst-case $4cm^2$ PD and its location (x,y,z). This worst-case $4cm^2$ PD is maximum $4cm^2$ PD value out of all exposure surfaces when assuming the worst beam from each of the antenna modules are active. The script will then identify the worst beam from each module that contributes the most to the worst $4cm^2$ PD and print their contribution factor, as well as the worst surface corresponding to the worst-case $4cm^2$ PD, backoff value for each antenna module and *verification.sim.powerlimit* (before backoff) value for each identified beams.

Use HFSS (or other EM simulation tool) to calculate the simulated contribution factor for the identified beams. The simulated contribution factor, $c_{simulated}(i,j)$, for beam i from QTM j can be computed by

$$csimulated\ (i, j) = 4cm^2\ PD\ at\ (x, y, z)\ at\ verification.\ sim.\ power\ limit\ /\ PD\_design\_target$$

Verify:

1. the printed contribution factor, $c(i,j)$, matches the simulated contribution factor, $c_{simulated}(i,j)$, obtained from HFSS (or other EM simulation tool) within 2% of numerical tolerance.
2. the normalized *combined PD* does not exceed 1.0, i.e., *normalized combined PD* = $\sum(b_j * c(i,j)) \leq 1.0$

   where *combined PD* = PD from current antenna module + PD contributions from other antenna modules; b_j = backoff value for antenna module j, j = antenna module #; $c(i,j)$ = contribution factor of beam i from antenna module j to the worst $4cm^2$ PD. Both bj and $c(i,j)$ are printed from "Qualcomm MG script".

VERIFICATION 3: Measure power density for the beams identified by "Qualcomm MG script" on their corresponding worst surfaces printed from the script. Set the device in FTM mode, the PD measurement should be performed at the reference power level with CW modulation. Scale the measured PD to obtain $4cm^2$ PD(i,j) for beam i from antenna module j at their *input.power.limit*. Demonstrate that the *combined PD* (i.e., $\sum[c(i,j)*PD(i,j)]$) is less than or equal to *PD_design_target* within the uncertainty at reference power level, i.e., *combined PD* = $\sum[c(i,j)*measured\ 4cm^2\ PD(i,j)] \leq PD\_design\_target$ + uncertainty **at reference power level.**

As an example of one of the iPad programs, which contains 3 antenna modules (top, bottom and front), the following verifications are for n258, n261 and n260, respectively.

1) Band n258

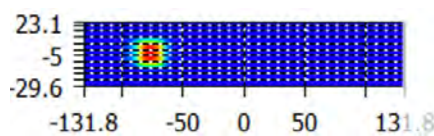
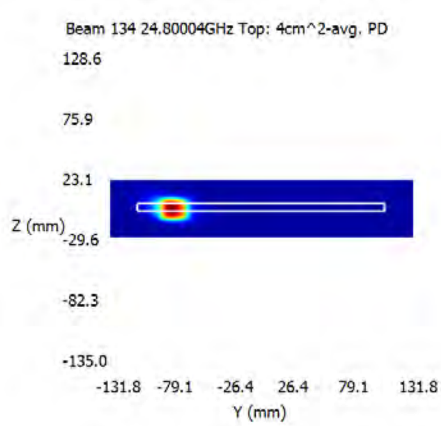
"Qualcomm MG script" identifies worst beam for module 0 is 134, worst beam for module 1 is 169 and for module 2 is 46. The script prints below information corresponding to the identified worst-case 4cm^2 PD:

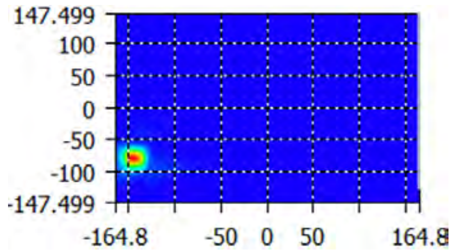
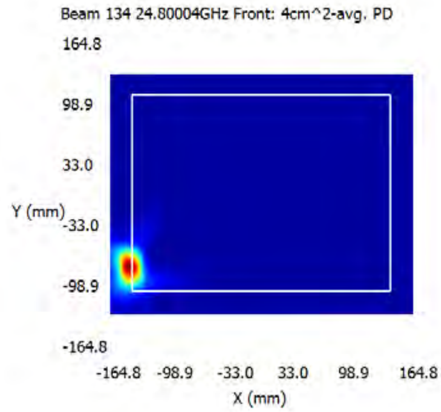
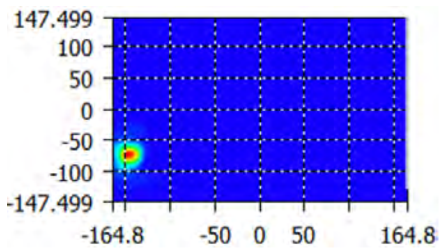
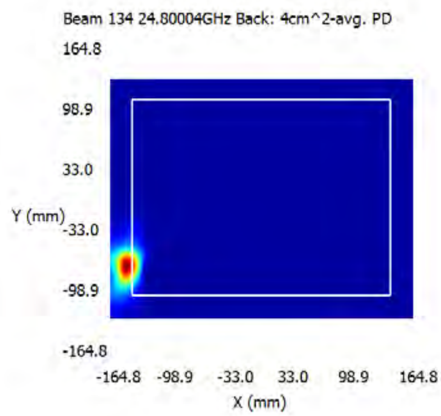
- the backoff values (in linear) for Module 0, Module 1 and Module 2: b_0 = 0.9772; b_1 = 0.9772; b_2 = 0.9772
- the worst location coordinates (*x, y, z*) in meter are (-0.06233, 0.09850, 0.00200)
- the worst-surface = S1(front surface, see Table C.1)
- the verification.sim.power limit (before backoff) for the beams for module 0, beam 134 is 8.59 dBm, for module 1, beam 169 is 2.73 dBm and for module 2, beam 46 is -0.93 dBm
- worst surface for Module 0 is S5 (top); worst surface for Module 1 is S6 (bottom); worst surface for Module 2 is S1 (front); the contribution factors *c*(134*, 0*) = 0.0032, *c*(*169, 1*) = 0.0031 and *c*(*46, 2*) = 1.0000 at the worst-case 4cm^2 PD location (-0.06233, 0.09850, 0.00200)

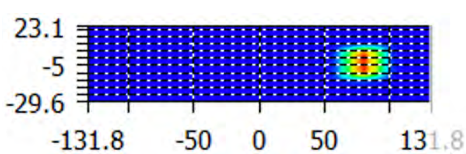
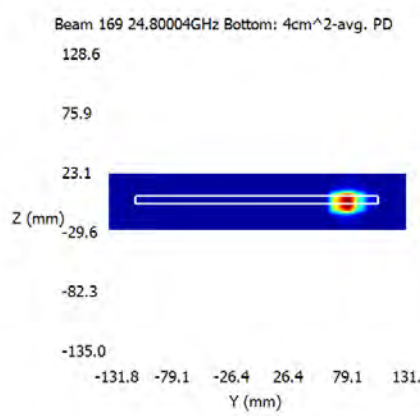
As shown in Table C.2, the printed contribution factor matches the simulated contribution factor within ~2%, and the *normalized combined PD* is less than 1.0. Thus, the verification 2 is completed for this program.

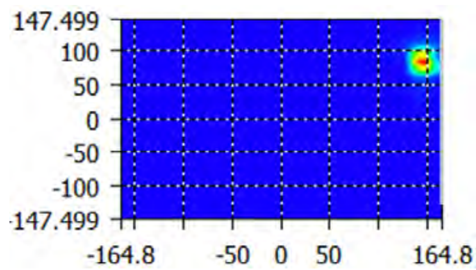
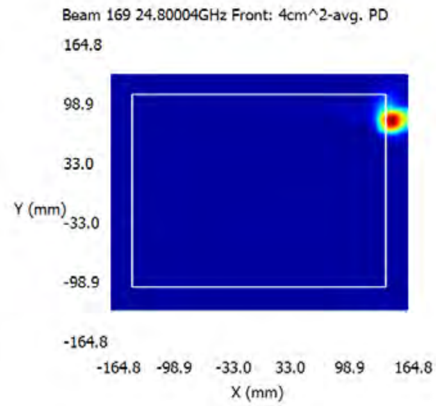
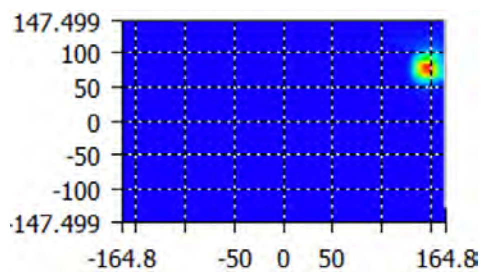
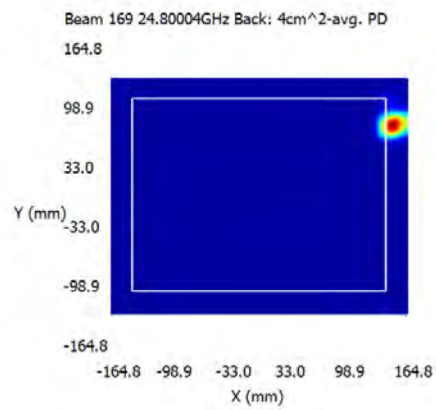
As shown in Table C.3, the *combined* measured *PD* at the worst location ≤ *PD_design_target* uncertainty at reference power level. Thus, the verification 3 is competed for this program.

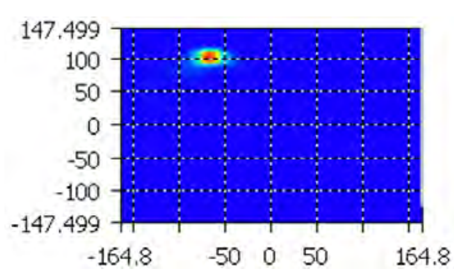
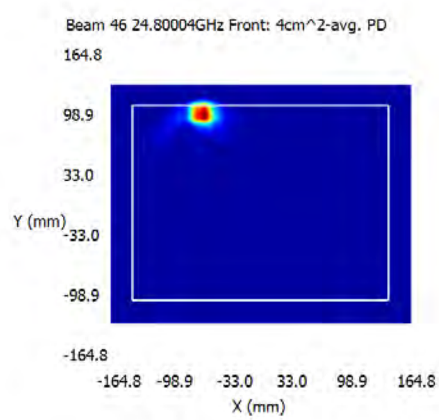
Table C.1 - Simulated PD distributions for selected beams

Beam ID	Surface	Simulated Point PD (from CST Studio Suite)	Simulated Point PD (from MG Script)
134	**S5**		

	S1		
	S2		

Beam ID	Surface	Simulated Point PD (from CST Studio Suite)	Simulated Point PD (from MG Script)
169	**S6**		

	S1		
	S2		

Beam ID	**Surface**	**Simulated Point PD (from CST Studio Suite)**	**Simulated Point PD (from MG Script)**
46	**S1**		

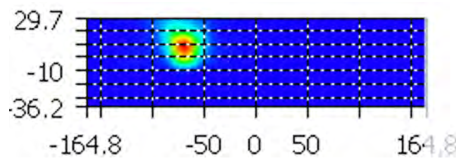
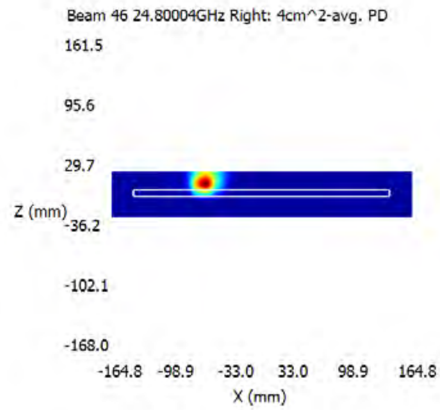
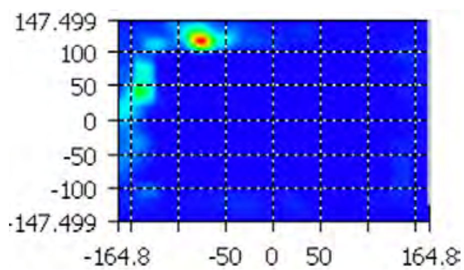
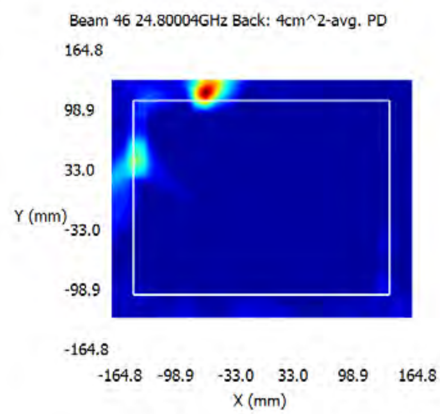
	S4		
	S2		

Table C.2 - Contribution factors from Qualcomm MG script and from CST Studio Suite for selected beams, and normalized combined PD verification, for device with 3 antenna modules

Worse-case surface					S1 (front surface)	
Worst-case location *(x,y,z)* in meters					(-0.06233, 0.09850, 0.00200)	
PD_design_target (W/m²)					4.5	
Value printed by MG Script					Value by EM tool	
Module #	Beam ID	*c(i ,j), i*=beam ID, *j*=module #	Backoff factor b_j	$verification.sim.power_{limit}$ (before backoffs) [dBm]	Simulated 4cm² PD at (-0.06233, 0.09850, 0.00200) with $verification.sim.power_{limit}$ on S1 (W/m²)	$c_{simulated}(i\ ,j)$
0	134	0.0032	0.9772	8.59	0.0147	0.0147/4.5 = 0.0032

1	169	0.0031	0.9772	2.73	0.0151	0.0151/4.5= 0.0033
2	46	1.0000	0.9772	-0.93	4.2625	4.2625/4.5= 0.947
Verify 1	$c(i,j) = c_{simulated}(i,j)$, i = 134, 169, 46 ; j = 0, 1, 2					
Verify 2	$b_0 \times c(134,0) + b_1 \times c(169,1) + b_2 \times c(46,2)$ = 0.9772 x 0.0032+ 0.9772 x 0.0031+0.9772 x 1.0000 = 0.9833 ≤ 1					

Table C.3: Measured 4cm^2 PD on worst surface and combined PD at worst-case location for device with 3 antenna modules.

Module#	Beam ID	Dominant Surface	Measured 4cm^2 PD at input.power.limit on dominant surface (W/m^2)
0	134	S5	5.95
1	169	S6	4.99
2	46	S1	5.39
combined PD at the worst-case location (*x,y,z*)			*c(134,0)* x meas.4cm^{2}PD*(134,0)* + *c(169,1)* x meas.4cm^{2}PD*(169,1)* + *c(46,2)* x meas.4cm^{2}PD*(46,2)* = 0.0032x 5.95+ 0.0031x 4.99+ 1.0000x 5.39 =5.42 W/m^2
PD_design_target + uncertainty at reference power level of 1 dB			= 4.5*10$^{(+1/10)}$ = 5.66 W/m^2
Verify			combined PD < PD_design_target + uncertainty at reference power level

Note *c(i,j)* is obtained from Table C.2.

2) Band n261

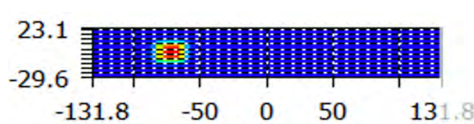
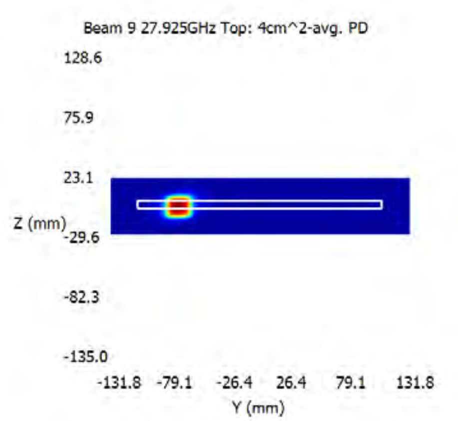
“Qualcomm MG script” identifies worst beam for module 0 is 9, worst beam for module 1 is 145 and for module 2 is 44. The script prints below information corresponding to the identified worst-case 4cm^2 PD:

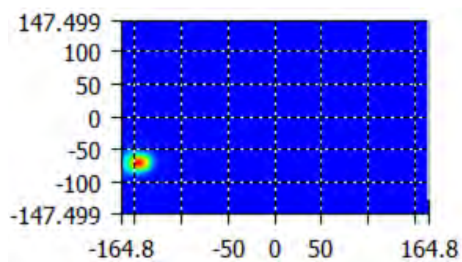
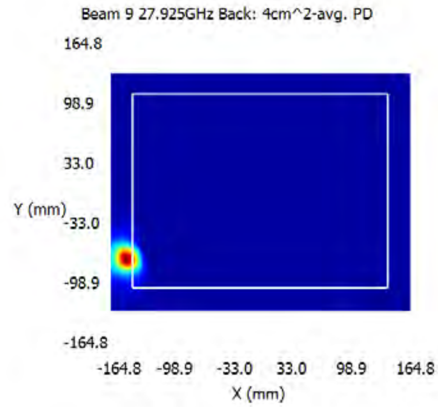
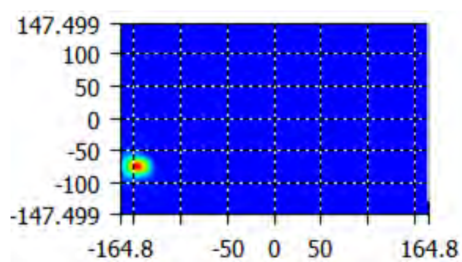
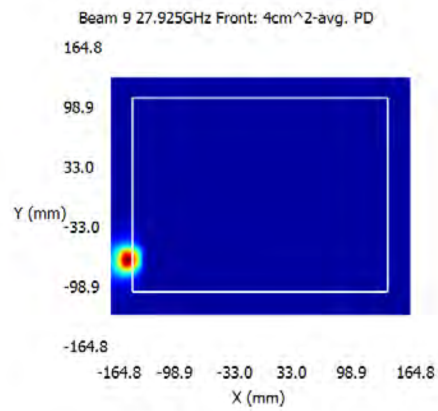
- the backoff values (in linear) for Module 0, Module 1 and Module 2: b_0 = 0.9772; b_1 = 0.9772; b_2 = 0.9772
- the worst location coordinates (*x, y, z*) in meter are (-0.14233, -0.07250, -0.00244) the worst-surface = S5 (Top surface, see Table C.4)
- the verification.sim.power limit (before backoff) for the beams for module 0, beam 9 is 5.98 dBm, for module 1, beam 145 is 2.74 dBm and for module 2, beam 44 is -1.65 dBm
- worst surface for Module 0 is S5 (top); worst surface for Module 1 is S6 (bottom); worst surface for Module 2 is S5 (front); the contribution factors *c*(9, *0*) = 1.0000, *c*(*145, 1*) = 0.0003 and *c*(*44,2*) = 0.0063 at the worst-case 4cm^2 PD location (-0.14233, -0.07250, -0.00244)

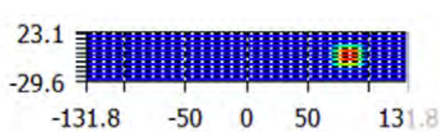
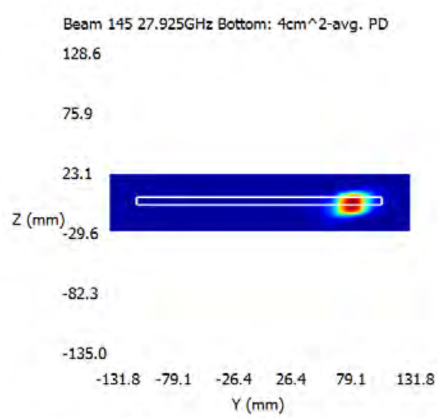
As shown in Table C.5, the printed contribution factor matches the simulated contribution factor within ~2%, and the *normalized combined PD* is less than 1.0. Thus, the verification 2 is completed for this program.

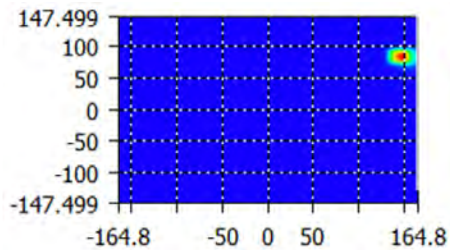
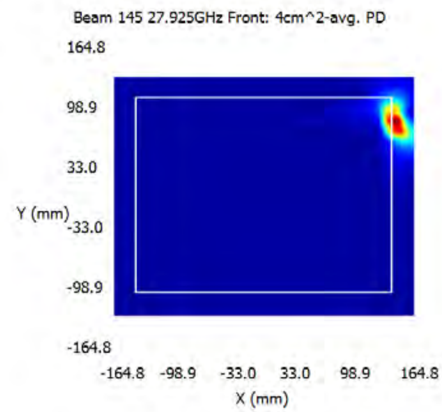
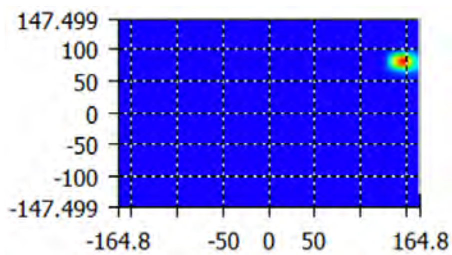
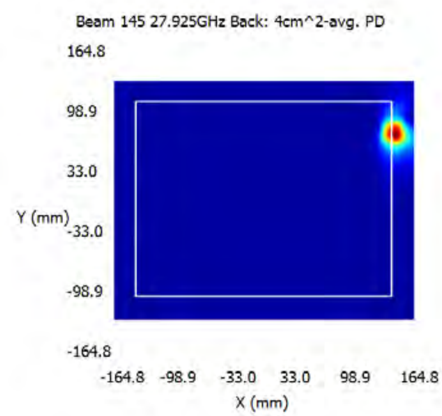
As shown in Table C.6, the *combined* measured *PD* at the worst location ≤ *PD_design_target* uncertainty at reference power level. Thus, the verification 3 is competed for this program.

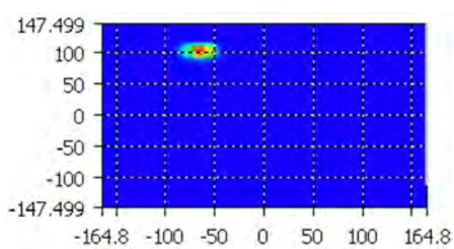
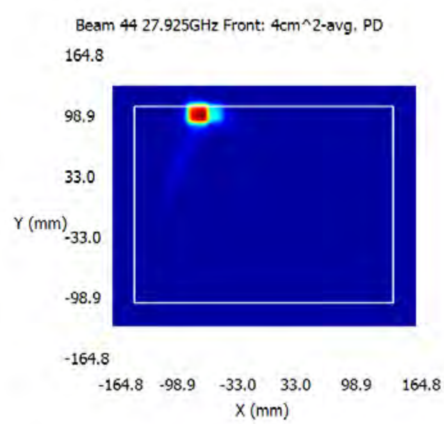
Table C.4 - Simulated PD distributions for selected beams

Beam ID	Surface	Simulated Point PD (from CST Studio Suite)	Simulated Point PD (from MG Script)
9	**S5**		

	S1		
	S2		

Beam ID	**Surface**	**Simulated Point PD (from CST Studio Suite)**	**Simulated Point PD (from MG Script)**
145	**S6**		

	S1		
	S2		

Beam ID	Surface	Simulated Point PD (from CST Studio Suite)	Simulated Point PD (from MG Script)
44	**S1**		

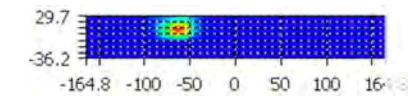
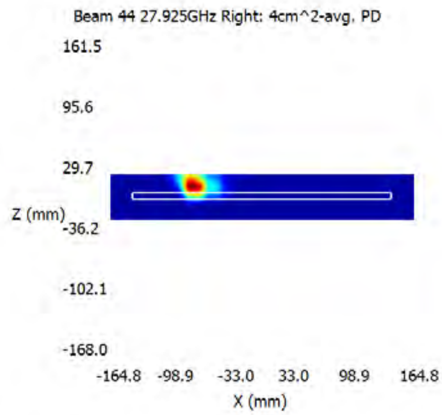
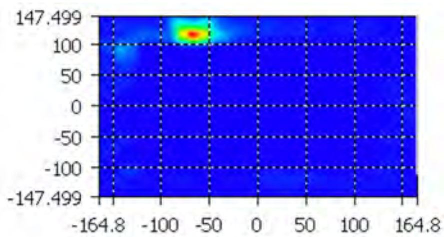
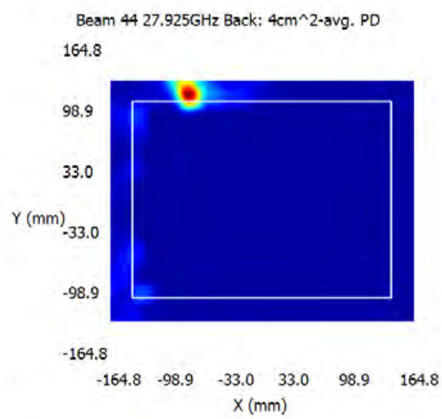
	S4		
	S2		

Table C.5 - Contribution factors from Qualcomm MG script and from HFSS for selected beams, and normalized combined PD verification, for device with 3 antenna modules

Worse-case surface					S5 (top surface)	
Worst-case location *(x,y,z)* in meters					(-0.14233, -0.07250, -0.00244)	
PD_design_target (W/m^2)					4.5	
Value printed by MG Script					Value by EM tool	
Module #	Beam ID	*c(i ,j), i*=beam ID, *j*=module #	Backoff factor b_j	$verification.sim.power_{limit}$ (before backoffs) [dBm]	Simulated 4cm^2 PD at (-0.14233, -0.07250, -0.00244) with $verification.sim.power_{limit}$ on S5 (W/m^2)	$c_{simulated}(i, j)$
0	9	1.0000	0.9772	5.98	4.4568	4.4568/4.5= 0.9904

1	145	0.0003	0.9772	2.74	0.0026	0.0026/4.5 = 0.0005
2	44	0.0063	0.9772	-1.65	0.0299	0.0299/4.5= 0.0066
Verify 1	$c(i,j)=c_{simulated}(i,j)$, i = 9, 145, 44; j = 0, 1, 2					
Verify 2	b_0 x $c(9,0)$ + b_1 x $c(145,1)$ + b_2 x $c(44,2)$ = 0.9772 x 1.0000 + 0.9772 x 0.0003+ 0.9772 x 0.0063 = 0.9836 ≤ 1					

Table C.6: Measured 4cm^2 PD on worst surface and combined PD at worst-case location for device with 3 antenna modules

Module#	Beam ID	Dominant Surface	Measured 4cm^2 PD at input.power.limit on dominant surface (W/m^2)
0	9	S5	3.13
1	145	S6	4.57
2	44	S1	1.66
combined PD at the worst-case location (*x,y,z*)			*c(9,0)* x meas.4cm^{2}PD*(9,0)* + *c(145,1)* x meas.4cm^{2}PD*(145,1)* + *c(44,2)* x meas.4cm^{2}PD*(44,2)* = 1.0000 x 3.13 + 0.0003x 3.13 + 0.0063 x 1.66 = 3.14 W/m^2
PD_design_target + uncertainty at reference power level of 1 dB			= 4.5*10$^{(+1/10)}$ = 5.66 W/m^2
Verify			combined PD < PD_design_target + uncertainty at reference power level

Note *c(i,j)* is obtained from Table C.5.

3) Band n260

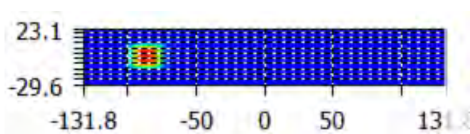
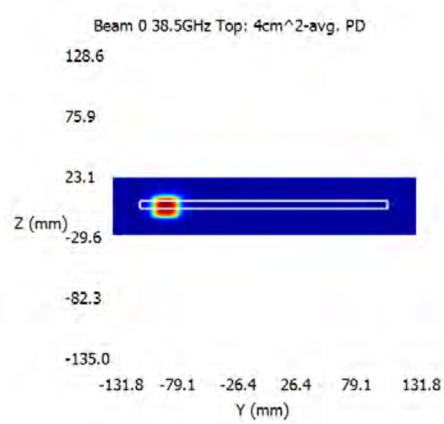
"Qualcomm MG script" identifies worst beam for module 0 is 0, worst beam for module 1 is 181 and for module 2 is 187. The script prints below information corresponding to the identified worst-case $4cm^2$ PD:

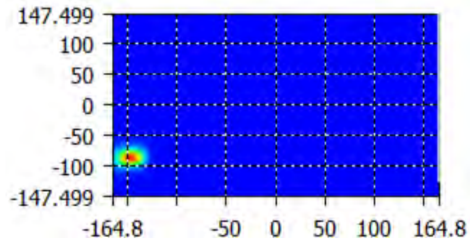
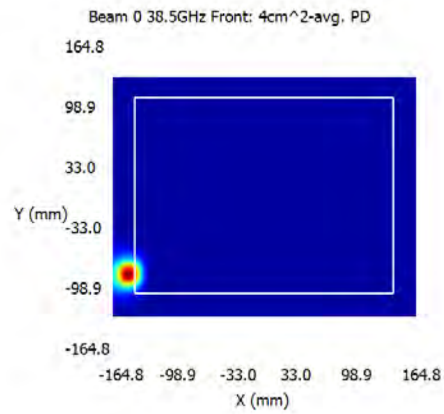
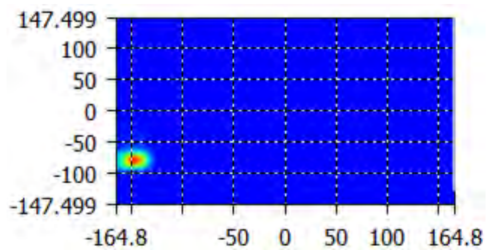
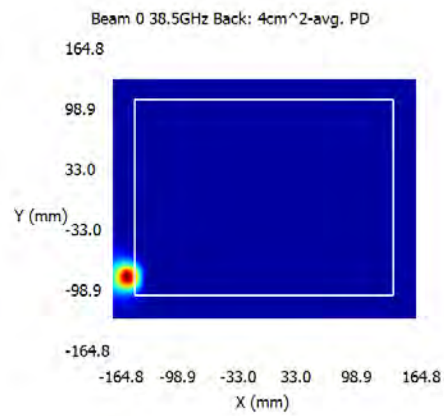
- the backoff values (in linear) for Module 0, Module 1 and Module 2: b_0 = 0.9772; b_1 = 0.9772; b_2 = 0.9772
- the worst location coordinates (*x, y, z*) in meter are (-0.14233, -0.08550, -0.00144)
- the worst-surface = S5 (top surface, see Table C.7)
- the verification.sim.power limit (before backoff) for the beams for module 0, beam 0 is 4.54 dBm, for module 1, beam 181 is 0.79 dBm and for module 2, beam 187 is 1.51 dBm
- worst surface for Module 0 is S5 (top); worst surface for Module 1 is S6 (bottom); worst surface for Module 2 is S1 (front); the contribution factors *c(0, 0)* = 1.0000, *c*(*181, 1*) = 0.0005 and *c*(*187, 2*) = 0.0090 at the worst-case $4cm^2$ PD location (-0.14233, -0.08550, -0.00144)

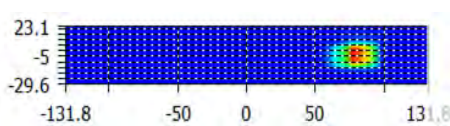
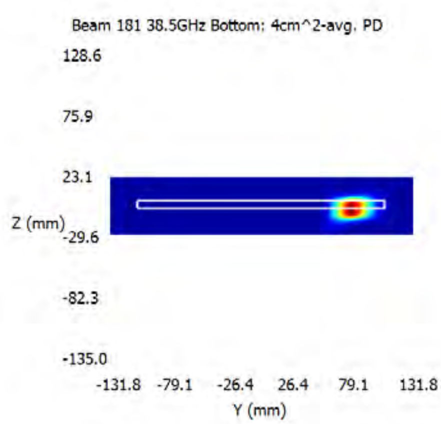
As shown in Table C.8, the printed contribution factor matches the simulated contribution factor within ~2%, and the *normalized combined PD* is less than 1.0. Thus, the verification 2 is completed for this program.

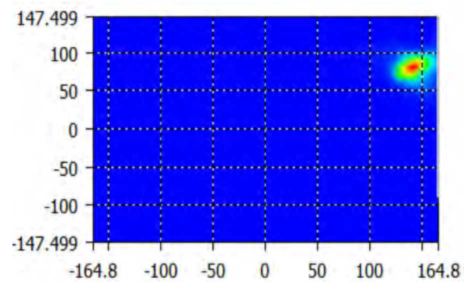
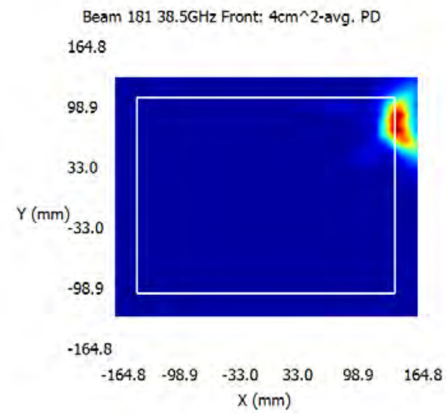
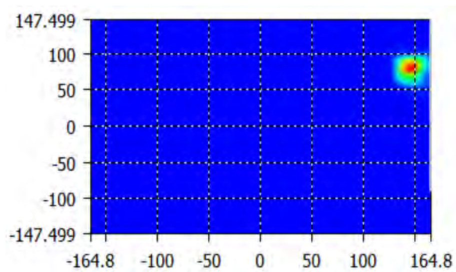
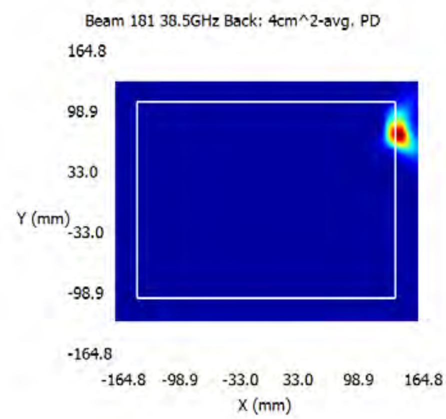
As shown in Table C.9, the *combined* measured *PD* at the worst location ≤ *PD_design_target* uncertainty at reference power level. Thus, the verification 3 is competed for this program.

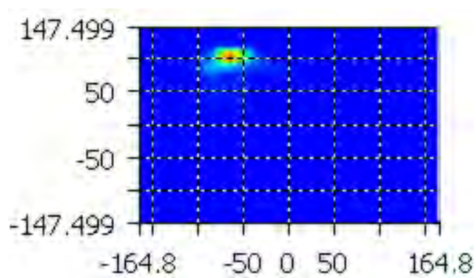
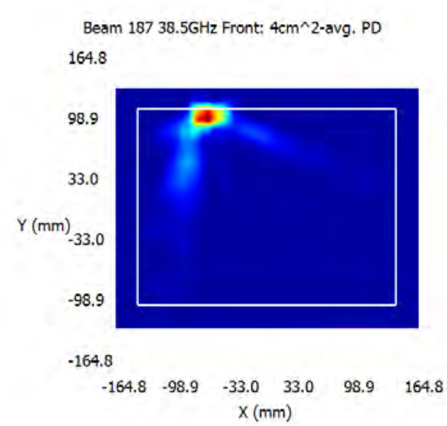
Table C.7 - Simulated PD distributions for selected beams

Beam ID	Surface	Simulated Point PD (from CST Studio Suite)	Simulated Point PD (from MG Script)
0	**S5**		

	S1		
	S2		

Beam ID	Surface	Simulated Point PD (from CST Studio Suite)	Simulated Point PD (from MG Script)
181	**S6**		

	S1		
	S2		

Beam ID	Surface	Simulated Point PD (from CST Studio Suite)	Simulated Point PD (from MG Script)
187	**S1**		

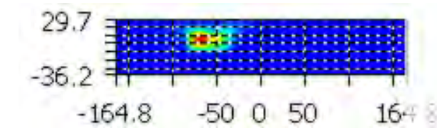
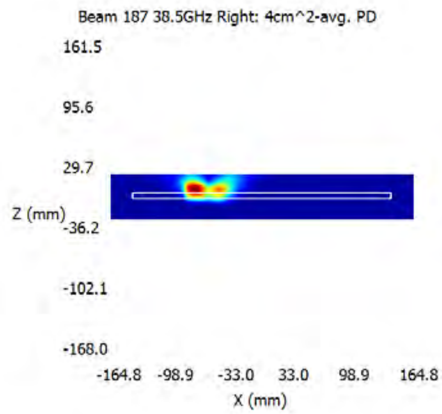
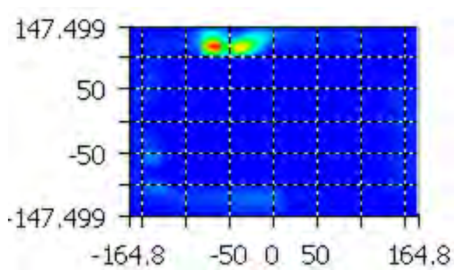
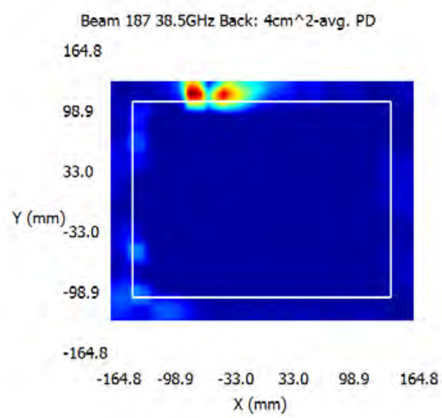
	S4		
	S2		

Table C.8 - Contribution factors from Qualcomm MG script and from CST Studio Suite for selected beams, and normalized combined PD verification, for device with 3 antenna modules

Worse-case surface					S5(top surface)	
Worst-case location *(x,y,z)* in meters					(-0.14233, -0.08550, -0.00144)	
PD_design_target (W/m^2)					4.5	
Value printed by MG Script					Value by EM tool	
Module #	Beam ID	*c(i ,j)*, *i*=beam ID, *j*=module #	Backoff factor b_j	$verification.sim.power_{limit}$ (before backoffs) [dBm]	Simulated 4cm^2 PD at (-0.14233, -0.08550, -0.00144) with $verification.sim.power_{limit}$ on S5 (W/m^2)	$c_{simulated}(i\ ,j)$
0	0	1.0000	0.9772	4.54	4.6771	4.6771/4.5 = 1.03

1	181	0.0005	0.9772	0.79	0.0021	0.0021/4.5 = 0.00047
2	187	0.0090	0.9772	1.51	0.0408	0.0408/4.5 = 0.0090
Verify 1	$c(i,j)=c_{simulated}(i,j)$, i = 0, 181, 187; j = 0, 1, 2					
Verify 2	b_0 x $c(0,0)$ + b_1 x $c(181,1)$ + b_2 x $c(187,2)$ = 0.9772 x 1.0000 + 0.9772 x 0.0005+ 0.9772 x 0.0090 = 0.9865≤ 1					

Table C.9: Measured 4cm^2 PD on worst surface and combined PD at worst-case location for device with 3 antenna modules

Module#	Beam ID	Dominant Surface	Measured 4cm^2 PD at input.power.limit on dominant surface (W/m^2)
0	0	S5	3.16
1	181	S6	3.64
2	187	S1	2.13
combined PD at the worst-case location (x,y,z)			$c(0,0)$ x meas.4cm^{2}PD$(0,0)$ + $c(181,1)$ x meas.4cm^{2}PD$(181,1)$ + $c(187,2)$ x meas.4cm^{2}PD$(187,2)$ = 1.0000x 3.16+ 0.0005 x 3.64+ 0.0090x 2.13= 3.18 W/m^2
PD_design_target + uncertainty at reference power level of 1 dB			= 4.5*10$^{(+1/10)}$ = 5.66 W/m^2
Verify			combined PD < PD_design_target + uncertainty at reference power level

Note $c(i,j)$ is obtained from Table C.8.

References

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