Netgear 5G MHS Travel Router (FCC ID: PY319400469) RF Exposure Compliance Test Report

Part 0: SAR and Power Density Characterization

(PD Simulation & Comparison with Measurement)

Rev. A

May 22, 2020

Revision history

Revision	Date	Description
A	May 22 ,2020	Initial release

Contents

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Tables

1 Introduction

The equipment under test (EUT) is Netgear 5G MHS Travel Router (FCC ID: PY319400469). It contains the Qualcomm SDM8150 modem supporting 4G WWAN technologies and SDX55 modem supporting mmW 5G NR bands. Both modems are enabled with Qualcomm Smart Transmit feature to control and manage transmitting power in real time and to ensure at all times the time-averaged RF exposure is compliant to the FCC requirement.

For WWAN technology, this EUT supports LTE, Sub-6 and mmW 5G NR radios. In Part 0 report, the EUT SAR and power density (PD) are characterized for WWAN radios (Sub-6 and mmW NR) to determine the power limit that corresponds to the exposure design target after accounting for all device design related uncertainties, i.e., *SAR_design_target* (< FCC SAR limit) for sub-6 radio and *PD_design_target* (< FCC PD limit) for mmW radio. The SAR characterization and PD characterization are denoted as SAR Char and PD Char in this report.

SAR Char and PD Char will be used as input for Qualcomm Smart Transmit to operate. Both SAR Char and PD Char will be loaded and stored in the EUT via the Embedded File System (EFS), and cannot be accessed by end users.

The EUT supports WLAN radio as well but WLAN modem is not enabled with time-averaging algorithm. Refer to Part 1 report for WLAN SAR test report and for simultaneous transmission analysis.

2 SAR Characterization

SAR Char is generated to cover all WCDMA/LTE/5G Sub 6 bands and exposure scenarios that EUT supports.

2.1 Worst-case SAR determination

This EUT is a travel router. The body exposure condition is tested according to the hotspot SAR procedures specified in KDB 941225 D06. A test separation distance of 10 mm is used between the SAM flat phantom and all surfaces with a transmitting antenna within 25 mm from that surface. See Bureau Veritas Report No. SF191031C08: *FCC SAR Test Report* for details.

The worst-case SAR for each band is determined by taking the maximum SAR value among all applicable surfaces tested. Fig.2-1 shows all device antennas 1, 2, 3, 4 and 5 for WCDMA, LTE, Sub 6 NR and WLAN. Only Ant 1 and 2 are transmit for WCDMA/LTE/Sub 6 NR and Ant 3 and 4 are for WLAN transmit, so these are relevant for SAR testing.

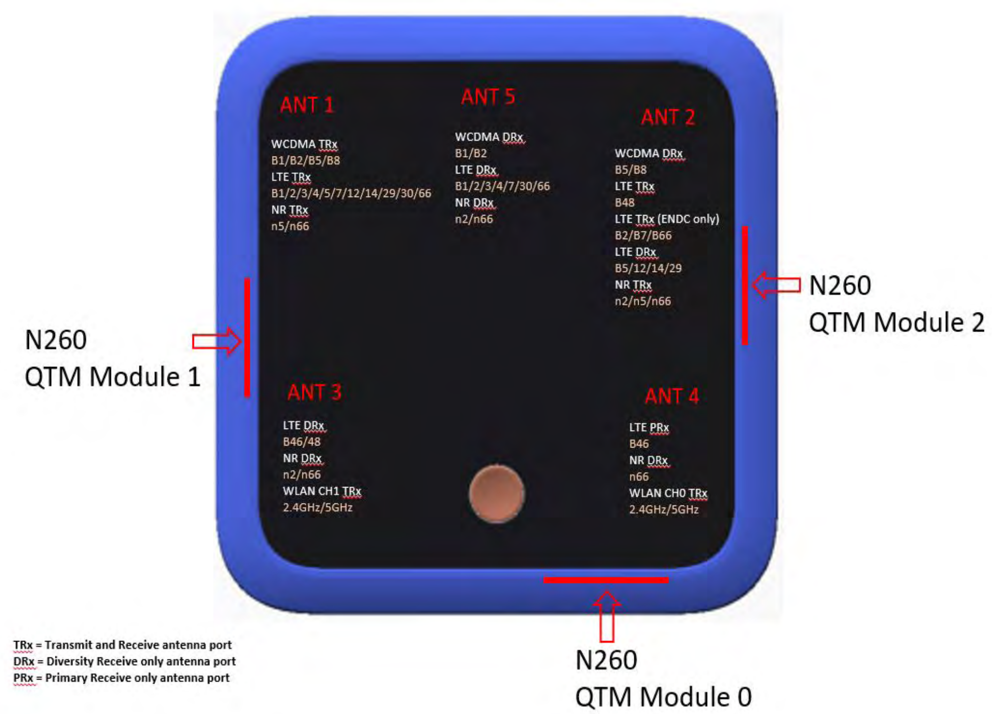


Figure 2-1: Netgear 5G MHS Travel Router (FCC ID: PY319400469) Antenna Block Diagram

2.2 SAR design target

The total device design related uncertainties of Netgear 5G MHS Travel Router (FCC ID: PY319400469) is 1dB (k=2), which includes TxAGC and device to device variation.

To account for the total uncertainty, *SAR_design_target* needs to be:

$$SAR\_design\_target < SAR_{regulatory\_limit} \times 10^{\frac{-total\ uncertainty}{10}}$$

For FCC SAR requirement of 1.6 W/kg for 1gSAR, the *SAR_design_target* for Netgear 5G MHS Travel Router (FCC ID: PY319400469) is determined as

$$SAR\_design\_target\ = 1.2W/kg\ for\ 1gSAR$$

2.3 SAR Char of Netgear 5G MHS Travel Router (FCC ID: PY319400469)

Referring to Bureau Veritas Report No. SF191031C08: *FCC SAR Test Report (Sec:4.7.2)*, the worst-case reported SAR for all WCDMA, LTE and Sub 6 supported bands for all relevant antenna paths in FTM mode at max tune up power is summarized in Table 2-1:

Table 2-1: Worst-case *reported* SAR (extracted from Bureau Veritas Report No. SF191031C08: *FCC SAR Test Report*)

Band	Antenna	Max tune up power P_{max} (dBm)	Reported SAR 1g (W/kg)
LTE 2	1	23	0.71
LTE 2	2	23	1.18
LTE 4	1	24	0.67
LTE 4	2	24	0.67
LTE 5	1	24	0.61
LTE 7	1	24	1.19
LTE 12	1	24	0.60
LTE 14	1	24	0.64
LTE 30	1	23	0.94
LTE 48	2	24	0.70
LTE 66	1	24	0.67
LTE 66	2	24	1.19
NR n2	2	23	0.76
NR n5	1	24	0.47
NR n5	2	24	0.87
NR n66	1	24	0.71
NR n66	2	24	0.90
WCDMA II	1	24	1.09
WCDMA V	1	24	0.8

With 1.2W/kg of SAR_design_target, the SAR Char for this EUT is determined and listed in Table 2-2.

Table 2-2: SAR Char of Netgear 5G MHS Travel Router (FCC ID: PY319400469)

Regulatory requirement	FCC
Reserve_power_margin	3dB
DSI	15
Tech/Band, Antenna	P_{limit} (dBm)
LTE 2, Ant 1	25.3
LTE 2, Ant 2	23.1
LTE 4, Ant 1	26.5
LTE 4, Ant 2	26.5
LTE 5, Ant 1	26.9
LTE 7, Ant 1	24.0
LTE 12, Ant 1	27.7
LTE 14, Ant 1	26.7
LTE 30, Ant 1	24.1
LTE 48, Ant 2	26.3
LTE 66, Ant 1	26.5
LTE 66, Ant 2	24.0
NR n2, Ant 2	25.0
NR n5, Ant 1	28.1
NR n5, Ant 2	25.4
NR n66, Ant 1	26.3
NR n66, Ant 2	25.3
WCDMA II, Ant 1	24.4
WCDMA V, Ant 1	25.8

Comparing maximum tune-up power, P_{max} in Table 2-1 to P_{limit} in Table 2-2 it can be seen that $P_{limit} > P_{max}$ for all WCDMA, LTE and NR bands for all relevant antennas. Therefore, for this EUT, Smart Transmit shall monitor Tx transmission but will not perform power enforcement when only WCDMA radio is active or only LTE radio is active.

3 Power Density Characterization

Netgear 5G MHS Travel Router (FCC ID: PY319400469) 5G mmW NR contains three Qualcomm QTM525-5 mmW antenna modules, denoted as QTM 0, 1 & 2 which are installed at three different locations as shown in Fig.3-1. These are referred to as "Module" or "Phasor" interchangeably throughout this report. Total 135 beams or antenna array configurations are supported. In this chapter, a hybrid approach using electromagnetic (EM) simulation in combination with measurement is taken to efficiently and conservatively characterize power density profile for Netgear 5G MHS Travel Router (FCC ID: PY319400469).

Figure 3-1: Netgear 5G MHS Travel Router (FCC ID: PY319400469) with three QTM525-5 mmW antenna modules

3.1 Exposure scenarios in PD evaluation

In general, for a device operating at frequencies > 6 GHz, the PD is required to be assessed for all antenna configurations (beams) from all mmW antenna modules that are installed inside the device. Furthermore, this PD evaluation should be performed at low, mid, and high channels for each supported mmW band.

For this EUT, the 4cm^2 spatially-averaged PD is evaluated along the surfaces (*S1, S2, S3, S4, S5, S6* as shown in Fig.3-2) of the EUT, and the worst-case PD is determined by taking the maximum PD among all PDs at the evaluated surfaces for each beam/band.

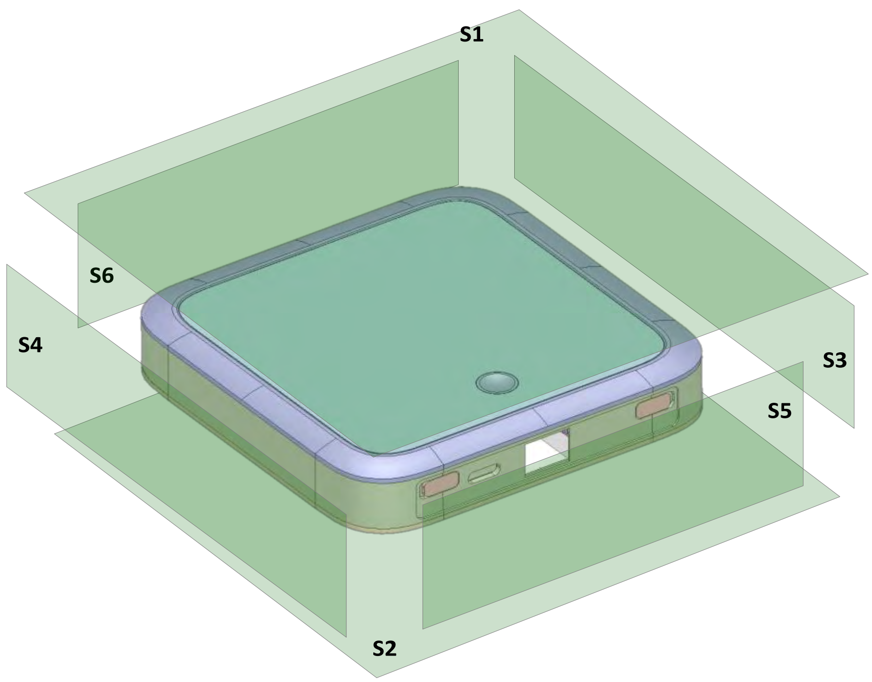


Figure 3-2: EUT surface definition: S1=front, S2=back, S3=right, S4=left, S5=bottom, S6=top

3.2 PD characterization overview

Parameters used in PD characterization:

- The EUT supports total 135 beams in n260 band, where 90 beams are single beams (SISO) and 45 are beam pairs (MIMO) where two single beams are excited at the same time.

- ***PD_design_target***: The design target for PD compliance as defined in the 80-W5567-3 Rev. A: *Compliance Summary Report*. It should be less than FCC PD limit to account for all device design related uncertainties.
- ***input.power.limit***: For a PD characterized wireless device, the input power level at antenna port(s) for each beam corresponding to *PD_design_target*.
- **PD Char**: the table that contains *input.power.limit* fed to antenna port(s) for all supported beams.

Figure 3-3 in the next page outlines the PD Char process.

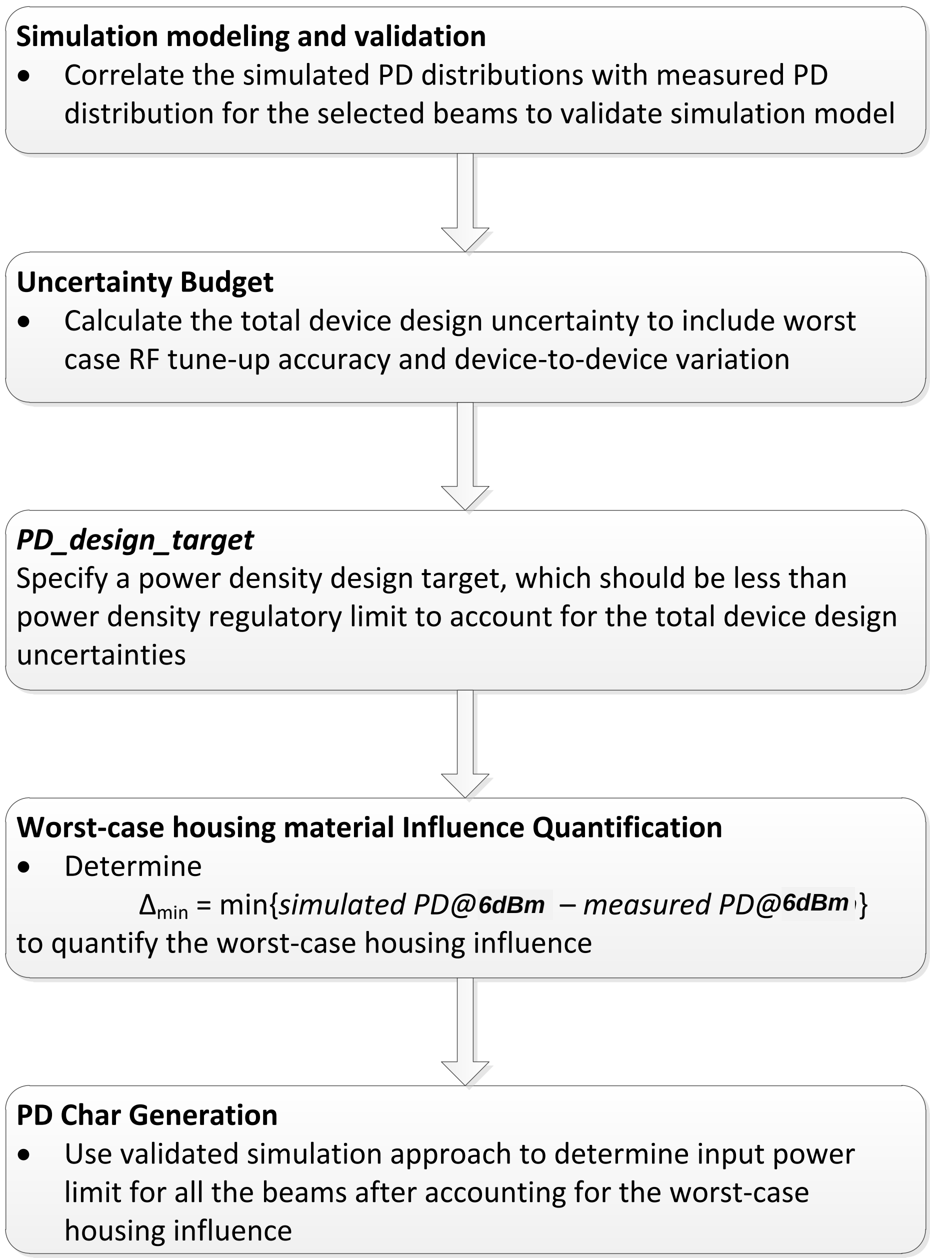


Figure 3-3 High level flow chart for power density characterization

3.3 Codebook for Netgear 5G MHS Travel Router (FCC ID: PY319400469)

In general, all the beams that the device supports are specified in the pre-defined codebook. The codebook contains a codeword for each beam in a defined set of beam pairs, which is a list of magnitude and phase weights applied to each active antenna element group's feeds to cause the desired beam to be formed. The codebook is device design specific and generated after evaluating radiation coverage from this specific device.

Table 3-1 shows all the beams and their relevant information in the codebook of Netgear 5G MHS Travel Router (FCC ID: PY319400469). There are three QTM mmW modules with module ID = 0, 1 and 2, respectively, as shown in Fig.3-1 & 3-2. The PD evaluation needs to be performed for all the beams listed in Table 3-1.

Table 3-1: Codebook of Netgear 5G MHS Travel Router (FCC ID: PY319400469)

(The single beams selected for modeling validation are highlighted in yellow)

Beam_ID	Module_ID	Ant_Type	No_active_elements	Paired_With
0	1	PATCH	1	128
1	0	PATCH	1	129
2	2	PATCH	1	130
3	1	PATCH	2	133
4	1	PATCH	2	132
5	1	PATCH	2	131
6	0	PATCH	2	134
7	0	PATCH	2	135
8	0	PATCH	2	136
9	2	PATCH	2	139
10	2	PATCH	2	138
11	2	PATCH	2	137
12	1	PATCH	2	140
13	1	PATCH	2	141
14	0	PATCH	2	143
15	0	PATCH	2	142
16	2	PATCH	2	145
17	2	PATCH	2	144
18	1	PATCH	4	146
19	1	PATCH	4	147
20	1	PATCH	4	148
21	1	PATCH	4	149
22	1	PATCH	4	150
23	0	PATCH	4	151
24	0	PATCH	4	153
25	0	PATCH	4	152
26	0	PATCH	4	155
27	0	PATCH	4	154
28	2	PATCH	4	160

29	2	PATCH	4	159
30	2	PATCH	4	158
31	2	PATCH	4	157
32	2	PATCH	4	156
33	1	PATCH	4	161
34	1	PATCH	4	162
35	1	PATCH	4	163
36	1	PATCH	4	164
37	0	PATCH	4	167
38	0	PATCH	4	165
39	0	PATCH	4	166
40	0	PATCH	4	168
41	2	PATCH	4	172
42	2	PATCH	4	171
43	2	PATCH	4	170
44	2	PATCH	4	169
128	1	PATCH	1	0
129	0	PATCH	1	1
130	2	PATCH	1	2
131	1	PATCH	2	5
132	1	PATCH	2	4
133	1	PATCH	2	3
134	0	PATCH	2	6
135	0	PATCH	2	7
136	0	PATCH	2	8
137	2	PATCH	2	11
138	2	PATCH	2	10
139	2	PATCH	2	9
140	1	PATCH	2	12
141	1	PATCH	2	13
142	0	PATCH	2	15
143	0	PATCH	2	14
144	2	PATCH	2	17
145	2	PATCH	2	16
146	1	PATCH	4	18
147	1	PATCH	4	19
148	1	PATCH	4	20
149	1	PATCH	4	21
150	1	PATCH	4	22
151	0	PATCH	4	23
152	0	PATCH	4	25
153	0	PATCH	4	24
154	0	PATCH	4	27
155	0	PATCH	4	26
156	2	PATCH	4	32
157	2	PATCH	4	31

158	2	PATCH	4	30
159	2	PATCH	4	29
160	2	PATCH	4	28
161	1	PATCH	4	33
162	1	PATCH	4	34
163	1	PATCH	4	35
164	1	PATCH	4	36
165	0	PATCH	4	38
166	0	PATCH	4	39
167	0	PATCH	4	37
168	0	PATCH	4	40
169	2	PATCH	4	44
170	2	PATCH	4	43
171	2	PATCH	4	42
172	2	PATCH	4	41

3.4 PD Simulation and Comparison with Measurement

3.4.1 Simulation Model

The EUT has three QTM525-5 mmW modules highlighted in (Fig.3-4), which contains only patch antenna arrays. The QTM525-5 is designed by Qualcomm, who have provided the encrypted simulation model of this module for EM simulation. The entire Netgear MHS is first modeled along with housing, mmW modules, all LTE/Sub-6 antennas, PCB, shields, LCD, flex cables, and battery etc. as shown below.

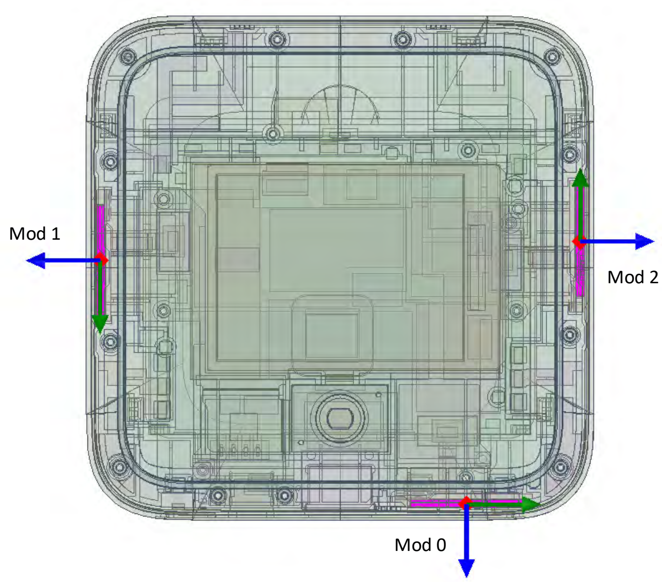
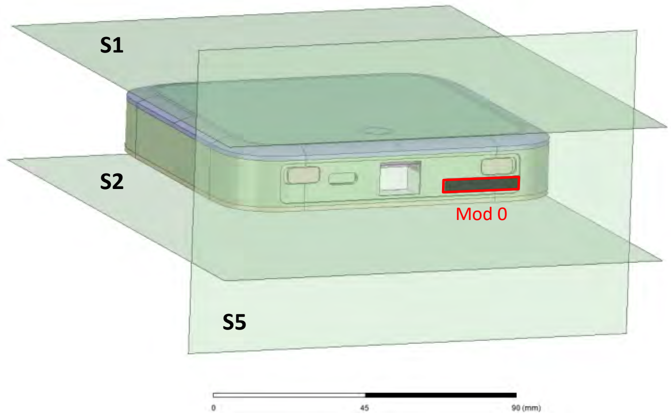
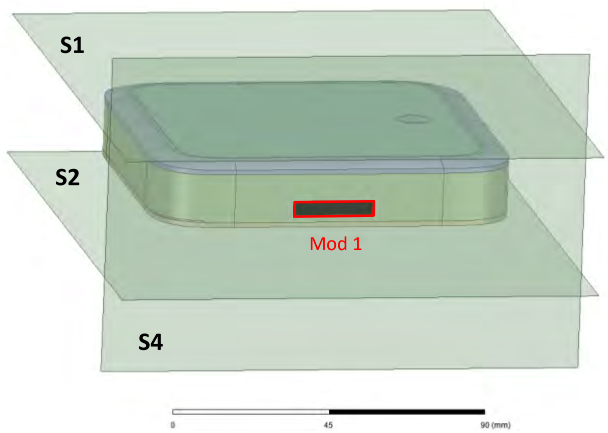


Figure 3-4: Netgear 5G travel router simulation model

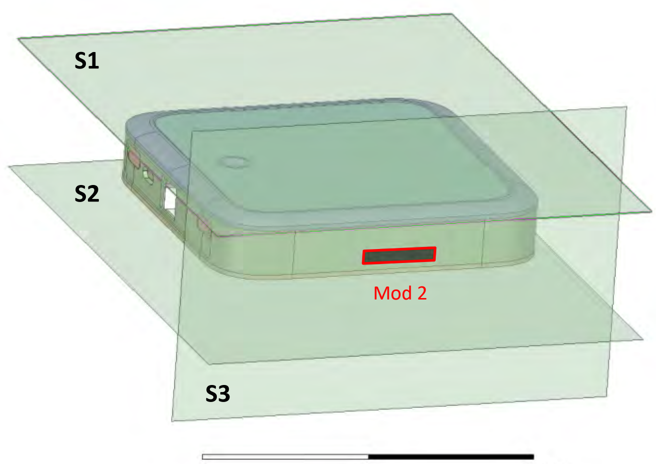
As shown in Fig.3-5, the EM simulation is conducted for Module 0, 1 and 2 separately with the relevant PD evaluation planes S1, S2, S3, S4 & S5 at d=10mm where the PD is dominant. More details on surface selection are in Sec. 3.4.4.



(a)



(b)



(c)

Figure 3-5: Simplified simulation model: (a) Module 0, (b) Module 1, (c) Module 2

These device level simulation models for PD assessment are constructed according to best engineering practices. However, to characterize the mm-wave PD behavior accurately all the important details within at least two wavelengths around each QTM module should be considered.

3.4.2 Simulation Setup

FEM simulations were performed to assess the power density of the EUT with QTM525-5 modules using ANSYS Electromagnetics Suite 2019.R2. The auto initial mesh defined “lambda refinement” (i.e., ANSYS refines the initial mesh based on the material-dependent wavelength) and 30% maximum refinement per pass are selected as adaptive options in the simulation setup.

The system (ANSYS Electromagnetics suite 2019R2) computes the error, and the iterative process (solve –> error analysis –> adaptive refinement) repeats until the convergence criteria is met with maximum magnitude of delta S less than 2% which is defined by the user. As long as convergence is reached, the converged results are accurate. Fig.3-6 shows the adaptive mesh setup over a cross section.

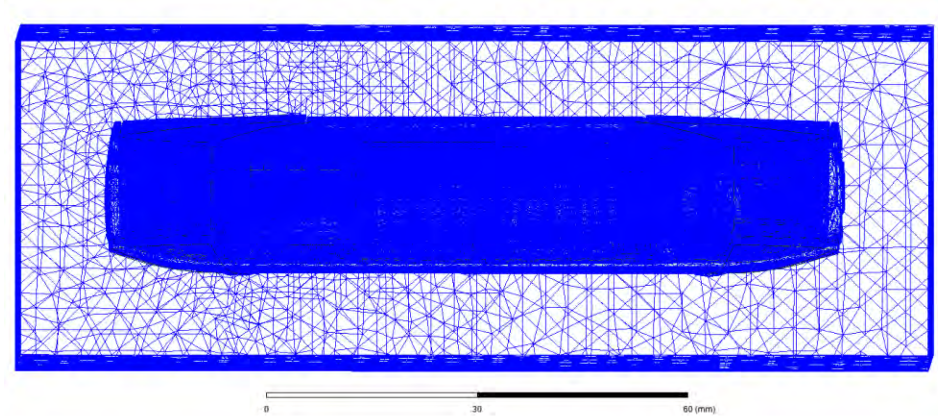


Figure 3-6 Simulation mesh setup

For radiation boundary, the 2nd order absorbing boundary condition (ABC) is used for all simulations in this report. This radiation boundary simulates an electrically open surface that allows waves to radiate infinitely far into space. The system absorbs the wave via the 2nd order radiation boundary condition, essentially ballooning the boundary infinitely far away from the structure and into space. The radiation boundaries may also be placed relatively close to a structure and can be of arbitrary shape.

Per ANSYS recommendations for their simulation tool, the radiation boundary plane must be located at least a quarter wavelength from strongly radiating structure, or at least a tenth of a wavelength from a weakly radiating structure. In this report, more than five wavelengths spacing (40mm) from the EUT in all directions are applied to ensure convergence (see Fig.3-7). This is enough to capture the PD hotspots at d=10mm which fall well within the simulation domain and have been verified later in Table 3-3.

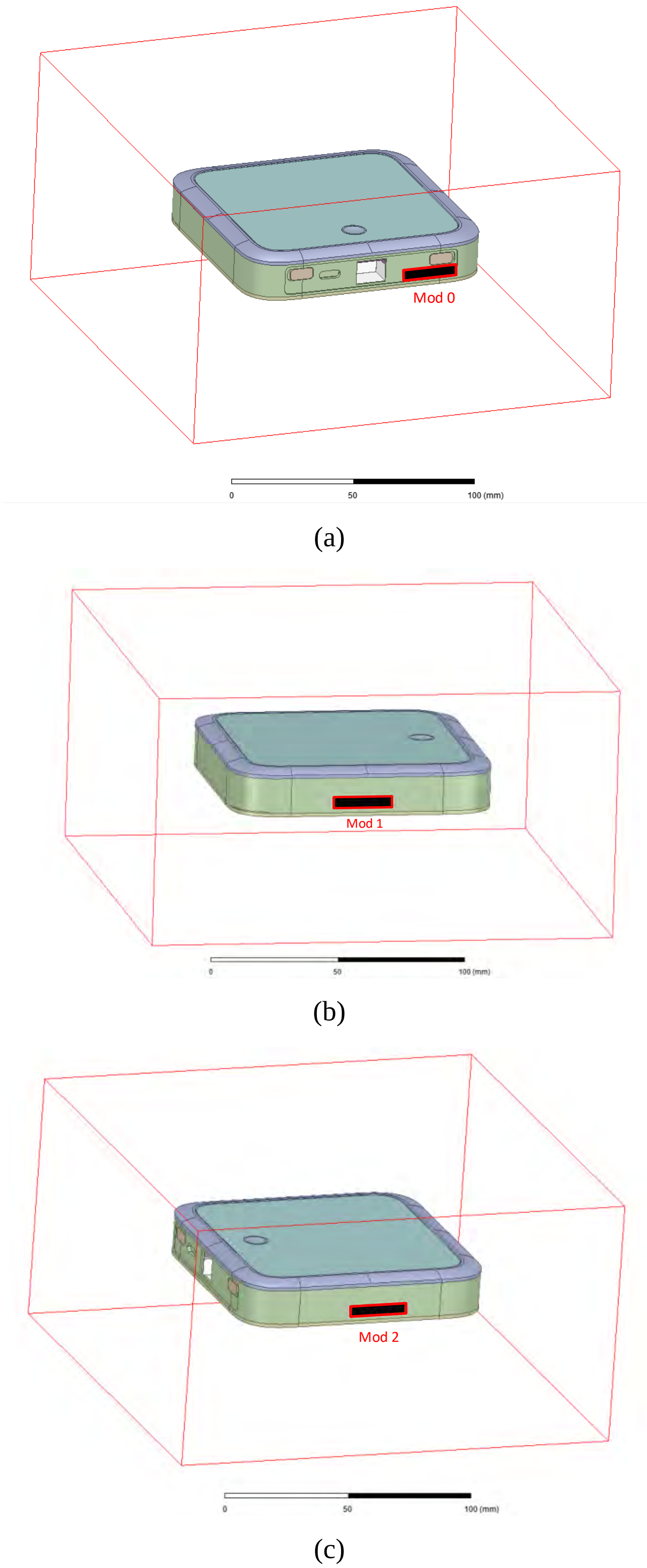


Figure 3-7 Radiation boundary for: (a) Module 0, (b) Module 1, (c) Module 2

Each antenna module 0, 1 & 2 are identical and has 16 ports. Out of these, 8 ports are for 1x4 patch array antennas for low band n258 (24.25-27.5 GHz) & n261 (27.5-28.35 GHz) and 8 ports are for 1x4 patch array antennas for high band n260 (37-40 GHz) respectively. The device currently only supports n260 band and simulation analysis is for high band ports only. Out of 8 ports of the patch array, 4 are for +45 deg (Pol 1) and 4 are for -45deg (Pol 2) polarization feeding respectively. With the encrypted QTM simulation model, the magnitude and phase information can be loaded for each port by using “Edit Sources” in ANSYS Electromagnetics suite 2019R2. Fig.3-8 shows the antenna port excitations.

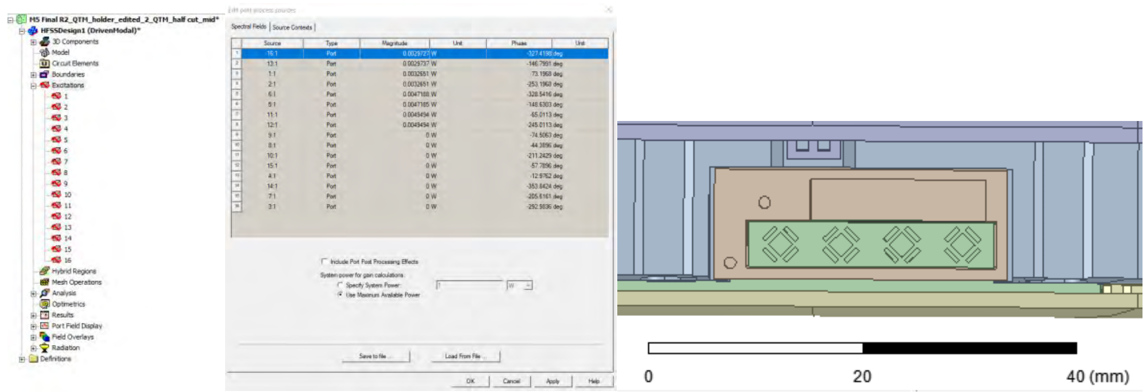


Figure 3-8 Antenna port excitations in ANSYS EM Suite 2019R2

After simulating the electric and magnetic (E & H) fields for a single beam formed by an array, the Poynting vector is calculated based on “peak” (i.e. non-RMS) field values in a grid with 0.95 mm step size, on the appropriate evaluation planes defined in Table 3-2. The Poynting vector at each spatial point is readily available in ANSYS Electromagnetics Suite 2019.R2 through the “Field Calculator” navigation option. The magnitude of the real part of the Poynting vector (all X, Y, Z components) at each spatial point i.e. the point power density is exported to do the averaging. The spatially averaged power density at each point on a given surface is then calculated by taking the average of the point power density over a 4 square cm area. Thus, the total power density (all X, Y, Z components) through any given surface is used to calculate the averaged power density

$$P_{avg} = \frac{1}{2A}\int_A \left|Re(\vec{E} \times \vec{H}^*)\right|.\, dS$$

The PD calculation from the simulated E & H fields for a dual or beam pair is given in Appendix A.

3.4.3 Modeling validation with PD measurements

To validate modeling and simulation the process below is followed:

1. Select at-least one beam (i.e., antenna array configuration) per antenna type (dipole and/or patch), per antenna polarization (if applicable) and per antenna module.

   This EUT contains three QTM525-5 mmW antenna modules (Mod 0, Mod 1 and Mod 2). Each module has only patch type antenna arrays. Therefore, the beam selection criteria for each mmW antenna are:

   a) Two beams (Pol 1 & Pol 2) from Module 0

b) Two beams (Pol 1 & Pol 2) from Module 1

c) Two beams (Pol 1 & Pol 2) from Module 2

Note: Since the relative phase between two single beams in a beam pair is uncontrolled and could vary from run to run, for the validation purpose, the selection is limited to the single beam antenna array configuration. Additionally, single beam containing a higher number of active antenna elements is selected. For example, a single beam with four active patches should be selected over beam with a single active patch antenna beam.

The single beams for modeling validation are already highlighted in yellow in Table 3-1.

2. For a given input power, perform both PD simulation and PD measurement to obtain the simulated PD distributions and measured PD distributions on the surface in front of the antenna array as well as the surfaces that are adjacent to the antenna array as they could potentially have strong radiating energy when considering the orientation of antenna array and type of antenna array (i.e., patch array).

3. Validate modeling and simulation by correlating the simulated PD distribution and measured PD distribution for all antenna array configurations selected in Step 1 and for all surfaces selected in Step 2.

   The modeling validation is performed through correlating the simulated point PD distribution to measured point PD distribution.

   The difference in 4cm^2-avg PD is not used for the purpose of validity of the modeling because the housing material property (for non-metal material) used in the simulation is an approximation (note that accurate material properties are not available at mmW frequencies). This discrepancy in PD magnitude will be used to determine the worst-case housing influence (due to non-metal material property uncertainty) later in Section 3.6. The worst-case housing influence will be accounted for in PD Char generation for conservative RF exposure assessment, see Section 3.7 for details.

Based on the selection criteria described in Step 1 and Step 2, the beams and surfaces selected for modeling validation of the EUT are listed in Table 3-2.

Table 3-2: Beams and surfaces selection for PD correlation

Band	**mmW Module**	**Polarization**	**Beam ID**	**Surface** (see Fig.3-3)
n260	0	Pol 1	39	S1,S2,S5
		Pol 2	166	S1,S2,S5
	1	Pol 1	20	S1,S2,S4
		Pol 2	148	S1,S2,S4
	2	Pol 1	30	S1,S2,S3
		Pol 2	158	S1,S2,S3

With an input power of 6 dBm for n260 band, PD measurement and PD simulation are conducted for all beams and surfaces listed in Table 3-2:

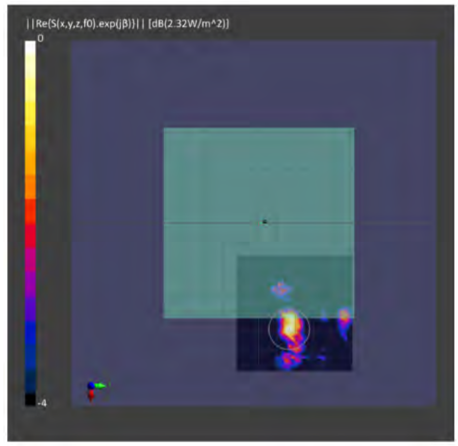
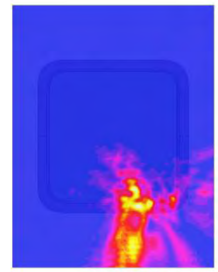
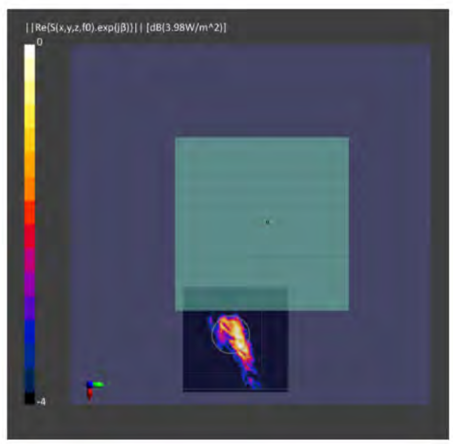
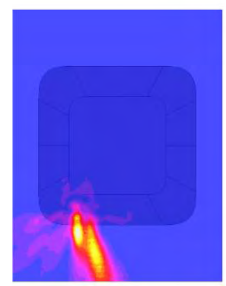
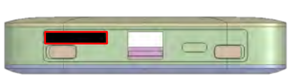
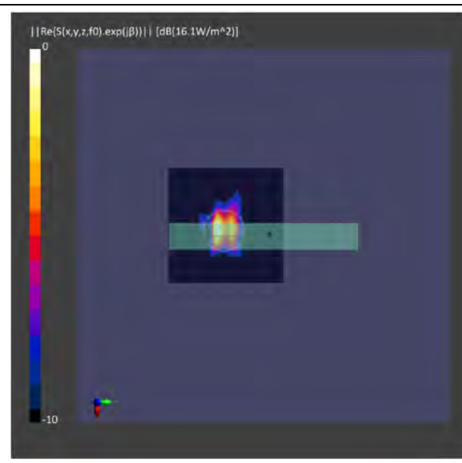
- PD distribution

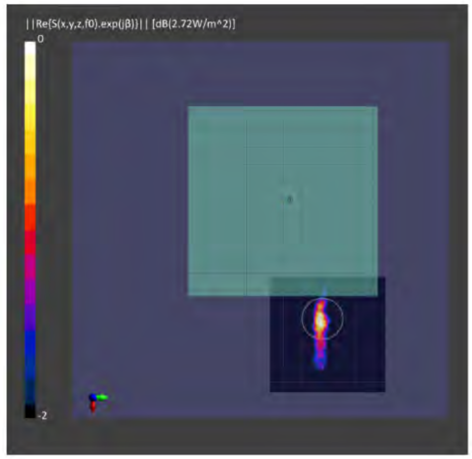
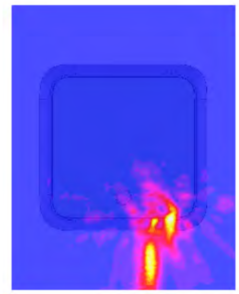
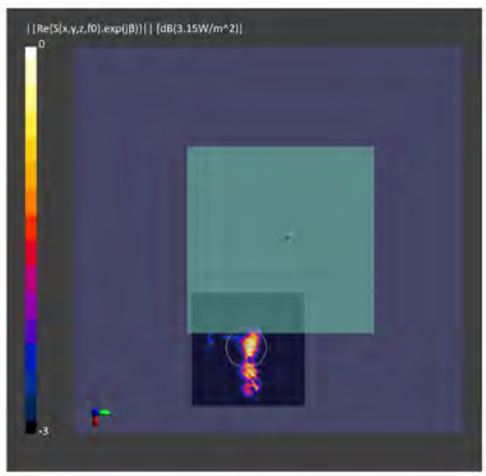
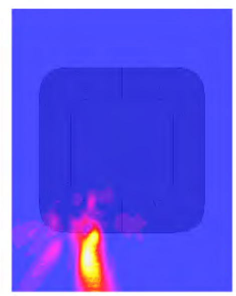
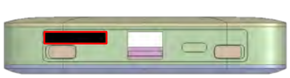
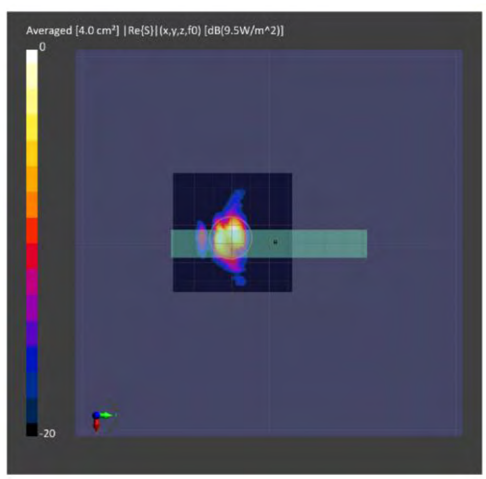
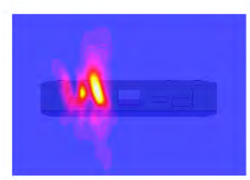
  Table 3-3 shows the measured and simulated point PD distributions for all selected beams and surfaces for n260 band. The "View" column depicts the orientation of the device and the antenna module location is outlined in red. As can be seen, the simulated PD distributions correlate well with the measured PD distributions for all selected beams on all identified surfaces of the EUT. This confirms that the modeling is a good representation of the actual mmW QTM modules installed in the EUT. The location of the peak PD hotspots on various planes in Sporton Report No. FA9N2723: *Power Density Measurement Report (Appendix B)* also match well with simulation. Therefore, the simulation model to be used for performing mmW NR RF exposure assessment is valid for this EUT.

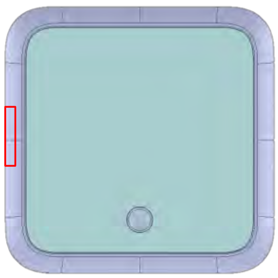
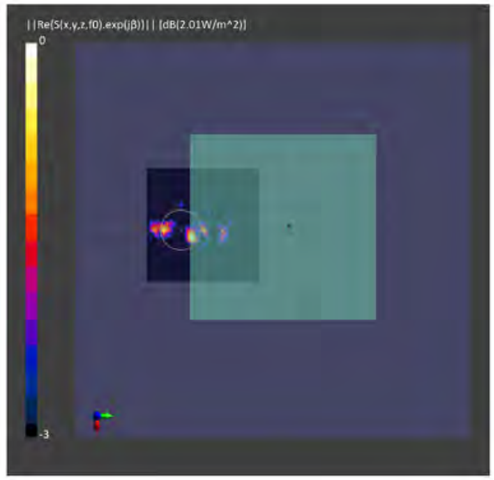
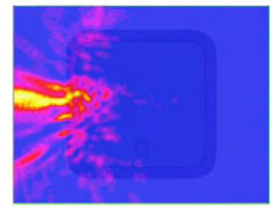
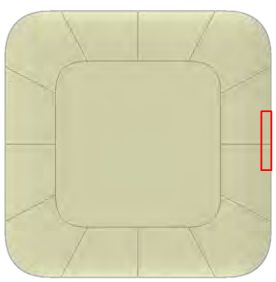
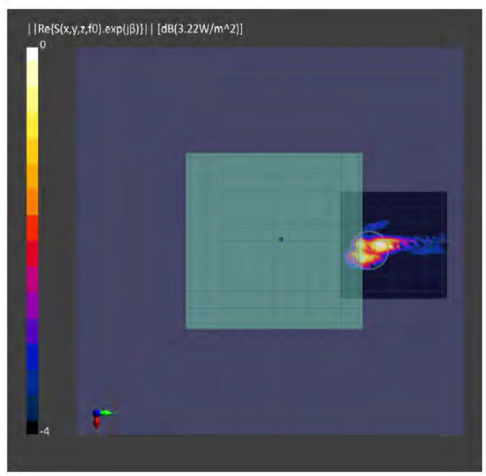
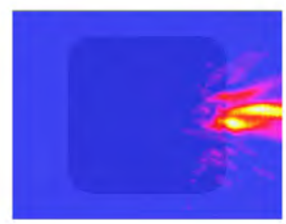
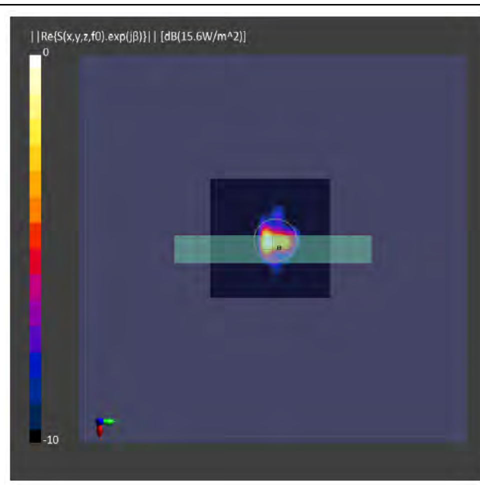
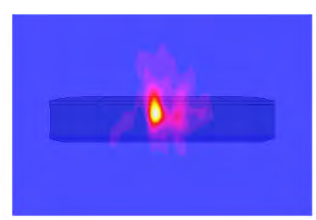
- 4cm^2-averaged PD value

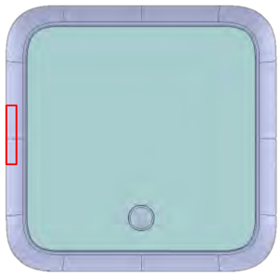
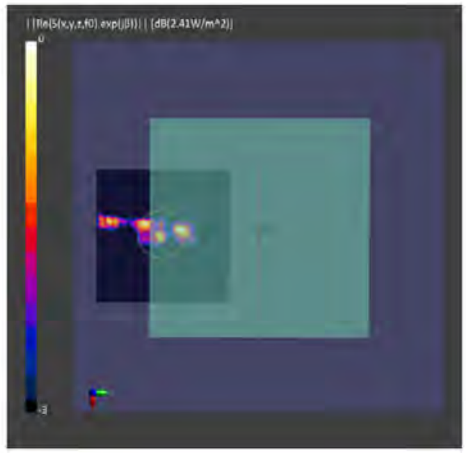
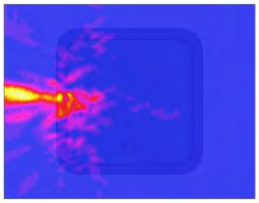
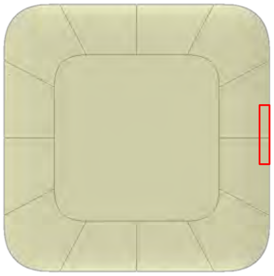
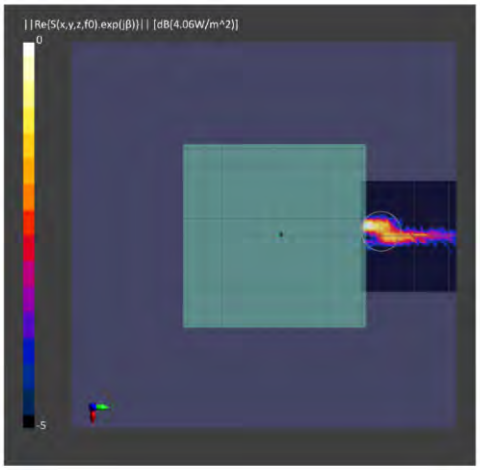
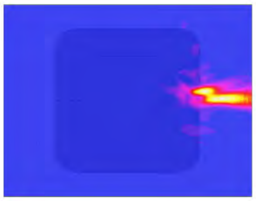
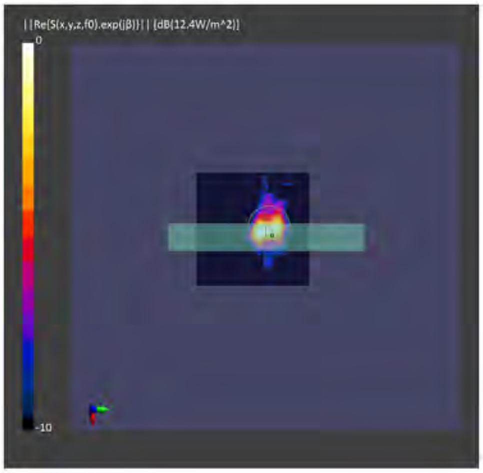
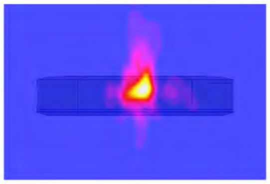
  Table 3-4 lists the measured 4cm^2-averaged PD and simulated 4cm^2-averaged PD for all selected beams and surfaces for n260 band. Refer to Sporton Report No. FA9N2723: *Power Density Measurement Report (Sec. 10)* for measurement details. The discrepancy between simulated and measured PD value will be used to determine worst-case housing influence for conservative assessment (see Section 3.6).

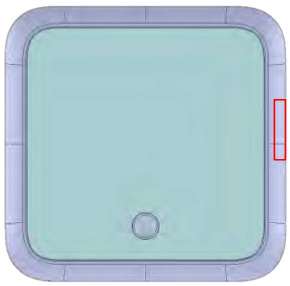
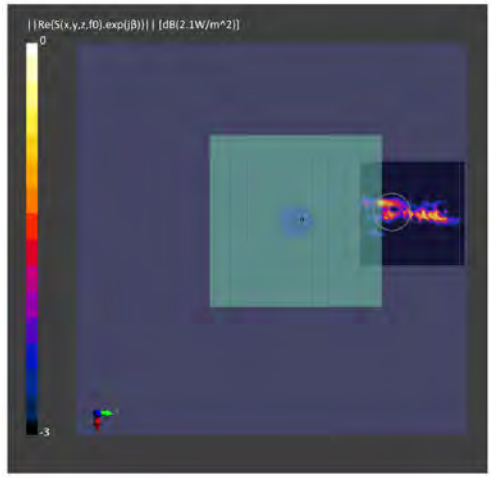
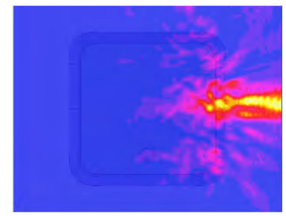
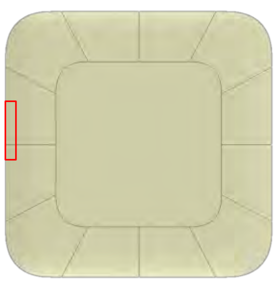
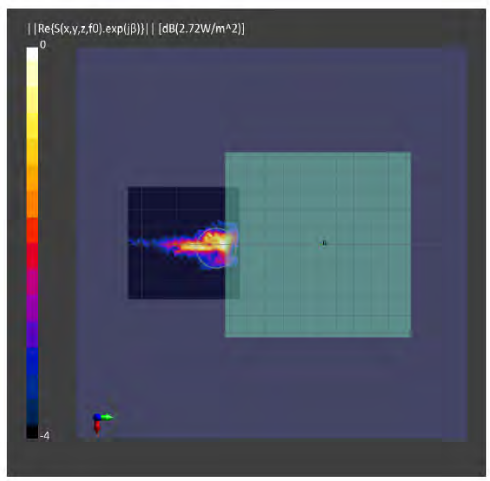
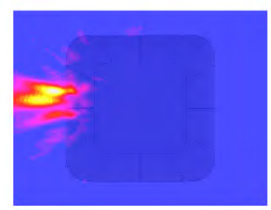
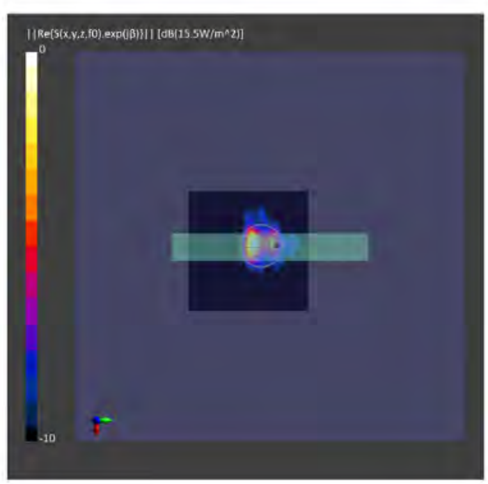
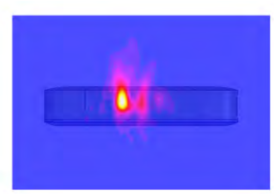
Table 3-3 Measured and simulated PD distributions for selected beams in n260 band

n260				
Beam ID	**Surface**	**View**	**Measured PD**	**Simulated PD**
39	S1			
	S2			
	S5			

<table>
<tr><th colspan="5">n260</th></tr>
<tr><th>Beam ID</th><th>Surface</th><th>View</th><th>Measured PD</th><th>Simulated PD</th></tr>
<tr><td rowspan="3">166</td><td>S1</td><td></td><td>
</td><td></td></tr>
<tr><td>S2</td><td></td><td>
</td><td></td></tr>
<tr><td>S5</td><td></td><td>
</td><td></td></tr>
</table>

n260				
Beam ID	**Surface**	**View**	**Measured PD**	**Simulated PD**
20	S1			
	S2			
	S4			

n260				
Beam ID	**Surface**	**View**	**Measured PD**	**Simulated PD**
148	S1			
	S2			
	S4			

n260				
Beam ID	Surface	View	Measured PD	Simulated PD
30	S1			
	S2			
	S3			

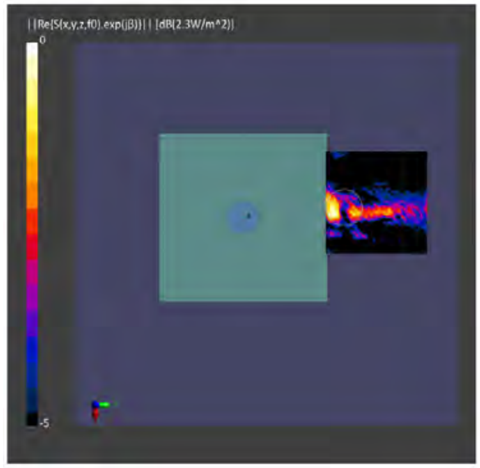
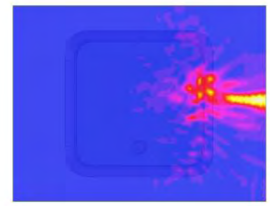
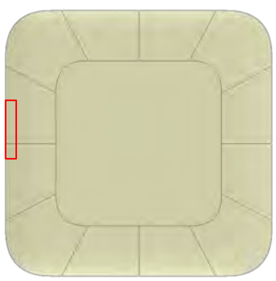
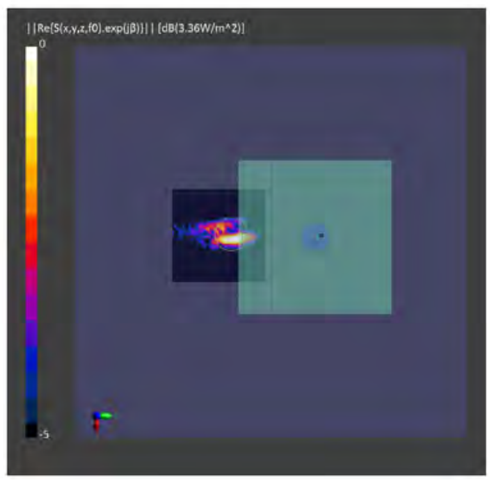
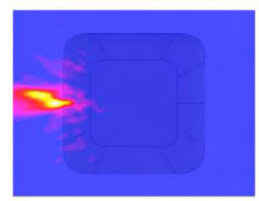
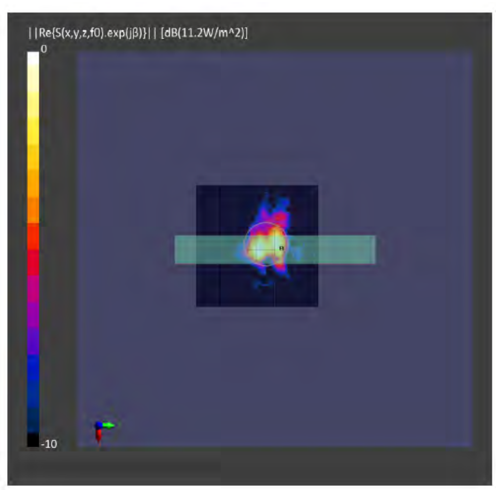
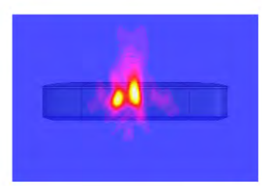
n260				
Beam ID	**Surface**	**View**	**Measured PD**	**Simulated PD**
158	S1			
	S2			
	S3			

Table 3-4 Measured and simulated 4cm^2 averaged PD for selected beams with 6 dBm input power with CW

Band	Ant Pol	Beam ID	Surface	4cm2 avg. PD (W/m2) Meas.	Sim	Delta = Sim. - Meas. (dB)
n260	Pol 1	39	S1	1.29	1.19	-0.35
			S2	2.45	2.75	0.50
			S5	5.79	7.35	1.04
	Pol 2	166	S1	1.72	1.43	-0.80
			S2	1.83	2.39	1.16
			S5	4.23	5.62	1.23
	Pol 1	20	S1	1.04	0.95	-0.39
			S2	2.12	2.14	0.04
			S4	5.24	6.37	0.85
	Pol 2	148	S1	1.37	1.02	-1.28
			S2	2.21	2.24	0.06
			S4	5.15	5.96	0.63
	Pol 1	30	S1	1.25	0.98	-1.06
			S2	1.75	2.3	1.19
			S3	4.86	6.43	1.22
	Pol 2	158	S1	1.25	0.98	-1.06
			S2	1.93	2.37	-0.89
			S3	4.97	6.11	0.90

3.4.4 Simulation of PD with validated model

The model is validated in Section 3.4.3 and the PD exposure of EUT can be reliably assessed using the validated simulation approach.

In general, all six surfaces of wireless device as shown in Fig. 3-2 should be assessed for RF exposure from mmW radio, and the worst-case PD should be determined by

$$\boldsymbol{PD}_{\boldsymbol{worst\text{-}case}} = \max\{PD_{s1}, PD_{s2}, PD_{s3}, PD_{s4}, PD_{s5}, PD_{s6}\} \qquad (1)$$

where $PD_{s1}, PD_{s2}, PD_{s3}, PD_{s4}, PD_{s5}, PD_{s6}$ are the highest 4cm^2-averaged PD on surface S1, S2, S3, S4, S5 and S6 of the device. respectively.

However, depending on the location of the mmW module and the antenna array orientation relative to the surface of the device, one or more surface(s) can be excluded for PD calculation as the PD value(s) on the excluded surface(s) will be undoubtedly lower when comparing to other surfaces, thus, the exclusion will have no impact for the worst-case PD determined using Equation 1.

For this EUT, based on the location of Mod 0, Mod 1 and Mod 2 shown in Figure 3-1, and type of antenna array (containing in each mmW Ant), the surface planes identified for PD evaluation to determine the worst-case PD are selected and listed in Table 3-5.

Table 3-5: PD evaluation plane

	FRONT S1	BACK S2	RIGHT S3	LEFT S4	BOTTOM S5	TOP S6
MOD 0	Yes	yes	no	no	yes	no
MOD 1	Yes	yes	no	yes	no	no
MOD 2	Yes	yes	yes	no	no	no

The EM simulation is performed to characterize PD at low, mid, and high channels for each supported band. The simulation setup (mesh, convergence criteria and radiation boundary settings) as described in Section 3.4.2, ensures the accurate and reliable result for PD simulation on the planes identified. Both point PD and 4cm^2-averaged PD distributions on all the surfaces relevant for each module are plotted for all 135 beams (single & pair) and provided in Appendix C to show that that all PD hotspots at d=10mm are captured in this analysis.

3.5 *PD_design_target*

The 2.1 dB of total uncertainty (k=2) provided by Qualcomm (please refer to document *80-W5693-2: SDX55/QTM525 Uncertainty Budget* for details) includes TxAGC (RF calibration) and IC/element level part to part variation. Tx_AGC uncertainty for 4-element patch at 6dBm input power with CW is +/-0.5dB.

To account for the total design related uncertainty, *PD_design_target* need to be:

$$PD\_design\_target < PD_{regulatory\_limit} \times 10^{\frac{-total\ uncertainty}{10}}$$

For FCC 4cm^2-averaged PD requirement of 10 W/m^2, the *PD_design_target* for Netgear 5G MHS Travel Router (FCC ID: PY319400469) is determined as

$$PD_{design_{target}} = 6.2W/\text{m}^2$$

3.6 Worst-case housing influence determination

For non-metal material, the material property cannot be accurately characterized at mmW frequencies to date. The estimated material property for the device housing used in the simulation model could influence the accuracy in simulation for PD amplitude quantification. Since the housing influence on PD could vary from surface to surface where the EM field propagates through, the most underestimated surface is used to quantify the worst-case housing influence for conservative assessment.

For this EUT, simulated 4cm^2-averaged PD and measured 4 cm^2-averaged PD are compared in Table 3-4. Surfaces S3, S4 and S5 are selected which always have the highest 4cm^2 averaged PD for the selected beams/all beams from the patch elements of the respective modules. Also, the worst value out of both polarizations on these selected surfaces are considered. The worst error introduced when using the estimated material property in the simulation is 1.04dB for Mod 0, 0.63dB for Mod 1 & 0.9dB for Mod 2 which are highlighted in Table 3-4. This worst-case housing influence, denoted as $\Delta_{min} = \text{Sim.PD} - \text{Meas.PD}$, represents the worst case where RF exposure is underestimated the most in simulation for each module when using the estimated material property for glass/plastics of the housing in the vicinity of the relevant module. For conservative assessment, Δ_{min} is used as the worst-case factor and applied to all the beams of a given QTM module to determine input power limits in PD char for compliance (see Section 3.7.3 for details).

3.7 PD Char of Netgear 5G MHS Travel Router (FCC ID: PY319400469)

This section describes the PD Char generation that complies with the *PD_design_target* determined in Section 3.5 and is compliant to the regulatory power density limit.

3.7.1 Scaling factor for single beams

To determine the input power limit at each antenna port, perform simulation at low, mid and high channel for each mmW band supported, with a given input power per active port (i.e., 6 dBm):

1. Obtain $PD_{surface}$ value (the worst PD among all identified surfaces of the EUT) at all three channels for all single beams specified in the codebook of Table 3-1.
2. Derive a scaling factor at low, mid and high channel, $s(i)_{low\_or\_mid\_or\_high}$, by using:

$$s(i)_{low\_or\_mid\_or\_high} = \frac{PD\ design\ target}{sim.PD_{surface}(i)},\ \ i \in single\ beams \qquad (2)$$

3. Determine the worst-case scaling factor, $\boldsymbol{s(i)}$, among low, mid and high channels:

$$\boldsymbol{s(i)} = min\{s_{low}(i), s_{mid}(i), s_{high}(i)\},\ \ i \in single\ beams \qquad (3)$$

and apply this scaling factor to the input power at each antenna port.

3.7.2 Scaling factor for beam pairs

The relative phase between beam pair is not controlled in QTM525 design and could vary from run to run. Therefore, for beam pair, based on the simulation results, the worst-case scaling factor needs to be determined mathematically to ensure the compliance.

For a beam pair, extract the E-fields and H-fields from the corresponding single beams at low, mid and high channel for each supported band and for all identified surfaces of the EUT.

For a given beam pair containing *beam_a* and *beam_b*, and for a given channel, let

relative phase between *beam_a* and *beam_b* = $\emptyset$,

the total PD of the beam pair can be expressed as

$$total\ PD\ (\emptyset) = \frac{1}{2}\sqrt{Re\{PD_x(\emptyset)\}^2 + Re\{PD_y(\emptyset)\}^2 + Re\{PD_z(\emptyset)\}^2}$$

$$= \frac{1}{2} Re\left\{\left(\overrightarrow{E_a} + \overrightarrow{E_b e^{j\omega\emptyset}}\right) \times \left(\overrightarrow{H_a} + \overrightarrow{H_b e^{j\omega\emptyset}}\right)^*\right\} \qquad (4)$$

where, $PD_x(\emptyset)$, $PD_y(\emptyset)$ and $PD_z(\emptyset)$ are the three components of the $total\ PD\ (\emptyset)$; E_a and H_a are the extracted E-fields and H-fields of *beam_a*, while E_b and H_b are the extracted E-fields and H-fields of *beam_b*.

Sweep $\emptyset$ with a 5° step from 0° to 360° to determine the worst-case $\emptyset_{worstcase}$ which results in the highest $total\ PD\ (\emptyset)$ among all identified surfaces for this beam pair at this channel. For details on worst case $total\ PD\ (\emptyset)$ derivation, see Appendix A.

Follow the above procedure to determine $\emptyset_{worstcase}$ for all three channels, and obtain the scaling factor given by the below equation for low, mid and high channels:

$$s(i)_{low\_or\_mid\_or\_high} = \frac{PD\ design\ target}{total\ PD\ (\emptyset(i)_{worstcase})}, i \in beam\ pairs \qquad (5)$$

The $\emptyset_{worstcase}$ varies with channel and beam pair, the lowest scaling factor among all three channels, $s(i)$, is determined for the beam pair *i*:

$$\boldsymbol{s(i)} = min\{s_{low}(i), s_{mid}(i), s_{high}(i)\},\ i \in beam\ pairs \qquad (6)$$

All the scaling factors for single and pair beams are given in Table B-1 in Appendix B. Also, the simulated 4cm^2 averaged PD values on all relevant surfaces for these beams are grouped per module and shown in Table B-2 in Appendix B for low, mid & high channels.

3.7.3 Input power limit

The PD Char specifies the limit of input power at any given antenna port that corresponds to *PD_design_target* for all the beams.

Ideally, if there is no uncertainty associated with hardware design, the input power limit, denoted as $input.power.limit(i)$, for beam *i* can be obtained after accounting for the housing influence (Δ_{min}) determined in Section 3.6, given by:

$$input.power.limit(i) = 6\ dBm + 10 * \log(s(i)) + \Delta_{min},\ i \in all\ beams \qquad (7)$$

where 6 dBm is the input power used in simulation; $s(i)$ is the scaling factor obtained from Eq. (3) or Eq. (6) for beam *i*; Δ_{min} is the worst-case housing influence factor (determined in Sec.3.6) for beam *i* for a module.

If simulation overestimates the housing influence, then Δ_{min} = (simulated PD – measured PD) is negative, which means that the measured PD would be higher than the simulated PD. The input power to antenna elements determined via simulation must be decreased for compliance.

Similarly, if simulation underestimates the loss, then Δ_{min} is positive (measured PD would be lower than the simulated value). Input power to antenna elements determined via simulation can be increased and still be PD compliant.

In reality, the hardware design has uncertainty which must be properly considered. In Section 3.6, the TxAGC uncertainty is embedded in the process of Δ_{min} determination. Since TxAGC uncertainty is already accounted for in *PD_design_target* (see Section 3.5), it needs to be removed to avoid double counting this uncertainty.

Thus, Equation 7 is modified to:

If -TxAGC uncertainty < Δ_{min} < TxAGC uncertainty,

$$input.power.limit(i) = 6\ dBm + 10 * \log(s(i)),\ i \in all\ beams \qquad (8)$$

else if Δ_{min} < -TxAGC uncertainty,

$$input.power.limit(i) = 6\ dBm + 10 * \log\big(s(i)\big) + \ (\Delta_{min} + \text{TxAGC uncertainty}),$$
$$i \in all\ beams \qquad (9)$$

else if Δ_{min} > TxAGC uncertainty,

$$input.power.limit(i) = 6\ dBm + 10 * \log\big(s(i)\big) + (\Delta_{min} - \text{TxAGC uncertainty}),$$
$$i \in all\ beams \qquad (10)$$

Following above logic, the *input.power.limit* for this EUT can be calculated using Equations (8), (9) and (10), i.e.,

Table 3-6: *input.power.limit* calculation

Band	**Module**	Δ_{min} **(dB)**	***Input.power.limit*** **(dBm) =**	**Notes**
n260	0	1.04	$6\ dBm + 10 * \log\big(s(i)\big)$+0.54	Using Eg. 10
	1	0.63	$6\ dBm + 10 * \log\big(s(i)\big)$+0.13	Using Eg. 10
	2	0.9	$6\ dBm + 10 * \log\big(s(i)\big)$+0.40	Using Eg. 10

Thus, the EUT PD Char for n260 is shown in Table 3-7.

Table 3-7: n260 mmW PD Char of Netgear 5G MHS Travel Router (FCC ID: PY319400469)

Pair with Beam_ID	Beam_ID	Module #	Input Power Limit (dBm)
	0	1	13.2
	1	0	11.3
	2	2	10.7
	3	1	8.9
	4	1	9.4
	5	1	8.8
	6	0	9.6
	7	0	9.8
	8	0	8.4
	9	2	8.9
	10	2	9.5
	11	2	8.0
	12	1	8.9
	13	1	8.0
	14	0	9.3
	15	0	10.0
	16	2	9.0
	17	2	9.8
	18	1	6.5
	19	1	5.4
	20	1	6.0
	21	1	5.2
	22	1	6.4
	23	0	7.5
	24	0	6.5
	25	0	6.1
	26	0	5.6
	27	0	7.1
	28	2	6.8
	29	2	6.3
	30	2	6.2
	31	2	5.5
	32	2	6.4
	33	1	5.7
	34	1	5.7
	35	1	5.6
	36	1	5.7
	37	0	7.2
	38	0	6.3

Pair with Beam_ID	Beam_ID	Module #	Input Power Limit (dBm)
	39	0	5.8
	40	0	6.5
	41	2	6.7
	42	2	5.8
	43	2	6.0
	44	2	5.5
	128	1	10.9
	129	0	13.5
	130	2	11.8
	131	1	9.0
	132	1	8.6
	133	1	8.9
	134	0	9.4
	135	0	8.6
	136	0	9.6
	137	2	9.3
	138	2	8.0
	139	2	10.4
	140	1	8.6
	141	1	8.6
	142	0	9.5
	143	0	9.5
	144	2	8.9
	145	2	8.8
	146	1	6.1
	147	1	6.0
	148	1	6.1
	149	1	5.9
	150	1	6.9
	151	0	7.6
	152	0	7.0
	153	0	6.8
	154	0	6.4
	155	0	7.3
	156	2	6.8
	157	2	6.5
	158	2	6.4
	159	2	6.1
	160	2	6.8
	161	1	6.1

Pair with Beam_ID	Beam_ID	Module #	Input Power Limit (dBm)
	162	1	6.1
	163	1	5.5
	164	1	6.6
	165	0	7.4
	166	0	6.9
	167	0	6.3
	168	0	7.8
	169	2	6.7
	170	2	5.9
	171	2	6.5
	172	2	6.6
0	128	1	8.4
1	129	0	8.7
2	130	2	8.0
3	133	1	4.8
4	132	1	5.4
5	131	1	5.7
6	134	0	5.4
7	135	0	5.5
8	136	0	5.4
9	139	2	6.0
10	138	2	5.2
11	137	2	5.3
12	140	1	5.0
13	141	1	5.2
14	143	0	6.1
15	142	0	6.1
16	145	2	5.0
17	144	2	5.6
18	146	1	3.0
19	147	1	2.2
20	148	1	2.9
21	149	1	2.4
22	150	1	3.0
23	151	0	4.1
24	153	0	2.9
25	152	0	2.9
26	155	0	2.9
27	154	0	3.8
28	160	2	3.2

Pair with Beam_ID	Beam_ID	Module #	Input Power Limit (dBm)
29	159	2	2.7
30	158	2	3.2
31	157	2	2.5
32	156	2	3.5
33	161	1	2.3
34	162	1	2.8
35	163	1	2.3
36	164	1	2.7
37	167	0	3.3
38	165	0	3.4
39	166	0	3.2
40	168	0	3.7
41	172	2	3.1
42	171	2	3.0
43	170	2	2.8
44	169	2	2.3

A Worst Phase Derivation for Beam Pair

For beam pairs, beam ID M+1 ~ N – since the relative phase between two beams is unknown – finding the worst-case PD by sweeping the relative phase for all possible angles is required for conservative assessment.

Assuming E-field and H-field of *beam_a* are {$Ex_{\_a}$, $Ey_{\_a}$, $Ez_{\_a}$} and {$Hx_{\_a}$, $Hy_{\_a}$, $Hz_{\_a}$}, respectively; E-field and H-field of *beam_b* are {$Ex_{\_b}$, $Ey_{\_b}$, $Ez_{\_b}$} and {$Hx_{\_b}$, $Hy_{\_b}$, $Hz_{\_b}$}, respectively; and the relative phase is ∅, for beam pair consisting of *beam_a* and *beam_b*, the combined E and H, {$Ex_{\_pair\_i}$, $Ey_{\_pair\_i}$, $Ez_{\_pair\_i}$} and {$Hx_{\_pair\_i}$, $Hy_{\_pair\_i}$, $Hz_{\_pair\_i}$}, can be expressed as:

$$Ex(\emptyset)_{\_pair\_i} = E_{x\_a} + E_{x\_b} \times e^{-j\omega\emptyset}$$

$$Ey(\emptyset)_{\_pair\_i} = E_{y\_a} + E_{y\_b} \times e^{-j\omega\emptyset}$$

$$Ez(\emptyset)_{\_pair\_i} = E_{z\_a} + E_{z\_b} \times e^{-j\omega\emptyset}$$

$$Hx(\emptyset)_{\_pair\_i} = H_{x\_a} + H_{x\_b} \times e^{-j\omega\emptyset}$$

$$Hy(\emptyset)_{\_pair\_i} = H_{y\_a} + H_{y\_b} \times e^{-j\omega\emptyset}$$

$$Hz(\emptyset)_{\_pair\_i} = H_{z\_a} + H_{z\_b} \times e^{-j\omega\emptyset}$$

The combined PD can then be calculated:

$$PDx(\emptyset)_{pair\_i} = Ey(\emptyset)_{\_pair\_i} \times Hz(\emptyset)^*_{pair\_i} - Ez(\emptyset)_{\_pair\_i} \times Hy(\emptyset)^*_{\_pair\_i}$$

$$PDy(\emptyset)_{\_pair\_i} = Ez(\emptyset)_{\_pair\_i} \times Hx(\emptyset)^*_{\_pair\_i} - Ex(\emptyset)_{\_pair\_i} \times Hz(\emptyset)^*_{\_pair\_i}$$

$$PDz(\emptyset)_{\_pair\_i} = Ex(\emptyset)_{\_pair\_i} \times Hy(\emptyset)^*_{\_pair\_i} - Ey(\emptyset)_{\_pair\_i} \times Hx(\emptyset)^*_{\_pair\_i}$$

$$PD(\emptyset) = \frac{1}{2}\sqrt{Re\{PDx(\emptyset)\}^2_{\_pair\_i} + Re\{PDy(\emptyset)\}^2_{\_pair\_i} + Re\{PDz(\emptyset)\}^2_{\_pair\_i}}$$

Sweep ∅ from 0 degree to 360 degree to find the highest PD (out of low, mid and high channel) and its corresponding ∅, $\emptyset_{worstcase}$, for all the beam pairs specified in the *codebook_sim*. The worst-case scaling factor *s(i)* for beam pair will be determined with $\emptyset(i)_{worstcase}$.

B Scaling Factor & Simulated 4cm^2 avg. PD

Table B-1 lists scaling factor S for all the beams that Netgear 5G MHS Travel Router (FCC ID: PY319400469) supports.

NOTE: *S* = min {*S_low*, *S_mid*, *S_high*}, where *S_low*, *S_mid*, *S_high* are the scaling factors for low, mid, and high channels, respectively.

Table B-1 Scaling factors

Pair with Beam_ID	Beam_ID	S_low	S_mid	S_high	S
	0	5.13385	5.170156	5.163023	5.13385
	1	3.781497	2.974256	2.987821	2.974256
	2	3.318262	2.719776	2.725721	2.719776
	3	1.912773	2.11887	2.158592	1.912773
	4	2.156936	2.129575	2.202342	2.129575
	5	1.849178	2.108436	2.217505	1.849178
	6	2.005466	2.205369	2.228001	2.005466
	7	2.110532	2.099972	2.16713	2.099972
	8	1.830243	1.536986	1.699458	1.536986
	9	2.156359	1.797571	1.876881	1.797571
	10	2.052072	2.160233	2.241729	2.052072
	11	1.64925	1.449957	1.497725	1.449957
	12	1.871256	2.099291	2.258782	1.871256
	13	1.835925	1.543282	1.540055	1.540055
	14	2.339842	2.008501	1.902834	1.902834
	15	2.713583	2.404268	2.214201	2.214201
	16	1.825654	2.139478	2.292073	1.825654
	17	2.434809	2.212049	2.166794	2.166794
	18	1.1909	1.117567	1.095928	1.095928
	19	0.934393	0.84599	0.984028	0.84599
	20	0.966303	0.968648	1.013944	0.966303
	21	0.884604	0.803987	0.835504	0.803987
	22	1.076265	1.112619	1.140995	1.076265
	23	1.342658	1.328765	1.251526	1.251526
	24	1.099908	0.999446	1.013325	0.999446
	25	1.02343	0.91291	0.906937	0.906937

	26	0.968153	0.81304	0.865533	0.81304
	27	1.255032	1.137118	1.299198	1.137118
	28	1.270069	1.143186	1.105824	1.105824
	29	0.980211	1.009386	1.024163	0.980211
	30	1.010848	0.959053	0.977138	0.959053
	31	0.893914	0.814315	0.829594	0.814315
	32	1.045609	0.996929	1.067627	0.996929
	33	0.936191	0.897761	1.006344	0.897761
	34	0.954631	0.903044	1.01378	0.903044
	35	0.990313	0.891754	0.876053	0.876053
	36	0.946507	0.905341	0.935478	0.905341
	37	1.311152	1.210425	1.161096	1.161096
	38	1.031949	0.953775	1.054599	0.953775
	39	0.96024	0.838496	0.86335	0.838496
	40	1.084051	0.999815	1.097673	0.999815
	41	1.145638	1.128641	1.079748	1.079748
	42	0.962074	0.878202	0.934311	0.878202
	43	0.982632	0.923491	0.907243	0.907243
	44	0.912216	0.810864	0.853564	0.810864
	128	3.456057	2.971102	3.019085	2.971102
	129	5.454857	5.016819	5.491979	5.016819
	130	3.870473	3.526831	3.477264	3.477264
	131	2.260625	1.918889	1.916491	1.916491
	132	1.826241	1.803131	1.76873	1.76873
	133	2.238383	1.979312	1.878531	1.878531
	134	2.01651	1.936452	1.966346	1.936452
	135	1.887748	1.652343	1.604667	1.604667
	136	2.549677	2.200608	2.029472	2.029472
	137	2.161875	1.937407	1.952242	1.937407
	138	1.634591	1.448267	1.4789	1.448267
	139	2.854615	2.55387	2.489207	2.489207
	140	1.766337	1.837677	1.793184	1.766337
	141	2.036266	1.849869	1.757112	1.757112
	142	2.114997	1.966949	1.966715	1.966715
	143	2.087508	1.978865	2.029933	1.978865
	144	1.886829	1.767313	1.819046	1.767313
	145	1.797319	1.877349	1.746617	1.746617
	146	1.078644	0.989409	0.999065	0.989409
	147	1.010057	0.986763	0.960198	0.960198
	148	0.991256	1.033893	1.083523	0.991256
	149	1.026756	0.938959	0.94335	0.938959

	150	1.365931	1.187818	1.205698	1.187818
	151	1.328093	1.297266	1.26245	1.26245
	152	1.218009	1.153586	1.120016	1.120016
	153	1.091677	1.067482	1.077333	1.067482
	154	1.034292	0.968735	1.066824	0.968735
	155	1.295969	1.254645	1.204281	1.204281
	156	1.158629	1.144878	1.085881	1.085881
	157	1.132905	1.042045	1.013965	1.013965
	158	1.06953	1.008547	1.054115	1.008547
	159	1.00153	0.958614	0.941527	0.941527
	160	1.195999	1.13523	1.103234	1.103234
	161	1.064378	0.994952	0.994424	0.994424
	162	0.986507	1.057659	1.051894	0.986507
	163	0.950365	0.873476	0.912226	0.873476
	164	1.263808	1.151508	1.115588	1.115588
	165	1.382448	1.298436	1.221636	1.221636
	166	1.147858	1.097237	1.090154	1.090154
	167	1.056574	0.968007	0.951545	0.951545
	168	1.511464	1.364107	1.344936	1.344936
	169	1.203833	1.082907	1.155914	1.082907
	170	0.999399	0.891891	0.933054	0.891891
	171	1.075422	1.026896	1.026361	1.026361
	172	1.094872	1.076192	1.040634	1.040634
0	128	1.871672	1.755104	1.693848	1.693848
1	129	1.928393	1.661516	1.718398	1.661516
2	130	1.698854	1.446889	1.466944	1.446889
3	133	0.837653	0.810895	0.740783	0.740783
4	132	0.902623	0.846577	0.901623	0.846577
5	131	0.917614	0.930174	0.910488	0.910488
6	134	0.803554	0.844079	0.763778	0.763778
7	135	0.923802	0.846043	0.781639	0.781639
8	136	0.946975	0.785418	0.771129	0.771129
9	139	1.1218	0.956121	0.911928	0.911928
10	138	0.846636	0.763768	0.77745	0.763768
11	137	0.928039	0.773726	0.828603	0.773726
12	140	0.772236	0.840409	0.790439	0.772236
13	141	0.957777	0.826826	0.816317	0.816317
14	143	1.013084	0.947942	0.89349	0.89349
15	142	1.109546	0.972592	0.895595	0.895595
16	145	0.719388	0.835662	0.757586	0.719388
17	144	1.007253	0.836786	0.852245	0.836786

18	146	0.534865	0.500984	0.490242	0.490242
19	147	0.437433	0.406812	0.43725	0.406812
20	148	0.47146	0.476233	0.486119	0.47146
21	149	0.433035	0.421484	0.431101	0.421484
22	150	0.489004	0.489605	0.543628	0.489004
23	151	0.596449	0.572794	0.581904	0.572794
24	153	0.50501	0.455244	0.436677	0.436677
25	152	0.495694	0.428388	0.429766	0.428388
26	155	0.526954	0.433057	0.442912	0.433057
27	154	0.577043	0.530657	0.537194	0.530657
28	160	0.567285	0.492824	0.47331	0.47331
29	159	0.439823	0.451752	0.43072	0.43072
30	158	0.508188	0.47542	0.496781	0.47542
31	157	0.456024	0.421832	0.406339	0.406339
32	156	0.532833	0.523767	0.509173	0.509173
33	161	0.437873	0.414941	0.430063	0.414941
34	162	0.483362	0.467487	0.499276	0.467487
35	163	0.434688	0.412241	0.4168	0.412241
36	164	0.456117	0.451507	0.472529	0.451507
37	167	0.5555	0.483922	0.477523	0.477523
38	165	0.559248	0.495988	0.48351	0.48351
39	166	0.489575	0.46079	0.469178	0.46079
40	168	0.614203	0.545576	0.525558	0.525558
41	172	0.496622	0.497999	0.464167	0.464167
42	171	0.485192	0.45511	0.478514	0.45511
43	170	0.45451	0.432235	0.442808	0.432235
44	169	0.436922	0.387479	0.41323	0.387479

Table B-2 Simulated 4cm² Avg PD in W/m² on surfaces S1, S2, S3, S4 & S5 with 6dBm input power for all beams

Beam ID		Module			Low channel		Mid channel		High channel		
			S1	S2	S5	S1	S2	S5	S1	S2	S5
	1	0	0.21	0.63	1.63	0.25	0.78	2.07	0.21	0.81	2.06
	6	0	0.53	0.94	3.07	0.83	0.75	2.80	0.94	0.96	2.77
	7	0	0.87	0.81	2.92	0.93	0.98	2.94	0.89	1.19	2.85
	8	0	0.55	1.02	3.37	0.52	1.39	4.01	0.43	1.50	3.63
	14	0	0.37	1.40	2.64	0.45	1.27	3.07	0.49	1.04	3.24
	15	0	0.64	0.69	2.27	0.84	0.75	2.56	0.87	0.96	2.78
	23	0	1.02	2.17	4.59	1.18	1.94	4.64	1.16	1.96	4.93
	24	0	1.03	2.69	5.61	1.37	2.43	6.17	1.33	2.35	6.08
	25	0	1.48	1.77	6.02	1.38	2.43	6.75	1.33	2.90	6.80
	26	0	0.85	2.50	6.37	1.08	2.98	7.58	1.13	2.83	7.12
	27	0	0.91	1.61	4.91	0.98	1.86	5.42	1.07	1.92	4.75
	37	0	1.06	2.27	4.70	1.36	2.08	5.09	1.27	1.82	5.31
	38	0	0.80	2.42	5.98	1.06	2.33	6.46	1.09	2.22	5.85
	39	0	1.16	2.13	6.42	1.19	2.75	7.35	1.17	2.99	7.14
	40	0	1.03	2.10	5.69	1.24	2.17	6.17	1.30	2.12	5.62
	129	0	0.18	0.25	1.13	0.22	0.24	1.23	0.19	0.27	1.12
	134	0	0.49	1.12	3.06	0.42	1.14	3.18	0.44	0.97	3.14
	135	0	0.52	1.05	3.27	0.72	1.04	3.73	0.84	1.01	3.84
	136	0	0.49	1.15	2.42	0.64	1.24	2.80	0.68	1.28	3.04
	142	0	0.60	1.04	2.92	0.87	1.05	3.13	0.97	0.81	3.14
	143	0	0.48	1.12	2.95	0.45	1.12	3.12	0.47	1.04	3.04
	151	0	1.41	1.94	4.64	1.33	1.89	4.75	1.25	1.81	4.88
	152	0	1.09	2.17	5.06	1.53	2.29	5.35	1.65	1.90	5.51
	153	0	1.13	1.52	5.65	1.35	1.84	5.78	1.15	1.74	5.72
	154	0	1.07	2.30	5.96	1.02	2.46	6.36	0.94	2.25	5.78
	155	0	1.66	1.78	4.76	1.91	2.03	4.91	1.73	1.98	5.12

Beam ID		Module			Low channel		Mid channel		High channel		
			S1	S2	S5	S1	S2	S5	S1	S2	S5
	165	0	1.52	1.88	4.46	1.67	1.91	4.75	1.51	1.83	5.05
	166	0	0.90	2.37	5.37	1.43	2.39	5.62	1.65	1.89	5.66
	167	0	1.03	1.81	5.84	0.95	2.51	6.37	1.04	2.66	6.48
	168	0	1.46	2.17	4.08	1.61	2.29	4.52	1.43	2.01	4.58
1	129	0	0.48	1.02	3.20	0.65	1.26	3.71	0.59	1.35	3.59
6	134	0	1.74	2.65	7.67	2.21	2.69	7.30	2.30	2.85	8.07
7	135	0	1.85	2.47	6.67	2.33	2.39	7.29	2.25	2.71	7.89
8	136	0	1.23	2.73	6.51	1.48	3.37	7.85	1.54	3.77	8.00
14	143	0	0.82	2.89	6.09	0.85	2.76	6.50	0.95	2.24	6.90
15	142	0	1.73	1.81	5.56	2.25	1.83	6.34	2.42	1.78	6.88
23	151	0	3.45	4.08	10.34	3.65	4.03	10.76	3.29	4.03	10.60
24	153	0	2.94	5.01	12.21	3.44	5.44	13.54	3.38	5.71	14.12
25	152	0	3.49	4.66	12.44	3.69	6.58	14.39	3.95	6.03	14.35
26	155	0	2.97	5.74	11.70	3.95	6.71	14.24	4.01	5.72	13.92
27	154	0	2.97	5.16	10.69	2.87	5.45	11.62	2.54	5.40	11.48
37	167	0	3.04	4.94	11.10	3.19	7.09	12.74	2.57	6.28	12.91
38	165	0	2.30	3.67	11.03	2.88	4.12	12.43	3.24	4.28	12.75
39	166	0	2.22	5.45	12.59	3.32	6.29	13.38	3.35	5.97	13.14
40	168	0	2.84	4.79	10.04	3.12	5.48	11.30	2.63	5.21	11.73

Beam ID		Module	Low channel			Mid channel			High channel		
			S1	S2	S4	S1	S2	S4	S1	S2	S4
	0	1	0.27	0.30	1.20	0.33	0.31	1.19	0.35	0.40	1.19
	3	1	0.49	0.67	3.22	0.77	0.72	2.91	0.70	0.97	2.86
	4	1	0.89	0.90	2.86	0.82	0.98	2.90	0.87	1.10	2.80
	5	1	0.55	0.79	3.33	0.71	0.81	2.92	0.55	1.00	2.78
	12	1	0.69	0.93	3.30	0.78	0.87	2.94	0.61	1.03	2.73
	13	1	0.40	1.22	3.36	0.36	1.71	4.00	0.32	1.66	4.00
	18	1	0.96	1.53	5.18	1.19	1.60	5.52	1.06	1.68	5.63
	19	1	0.99	2.76	6.60	1.22	3.22	7.29	1.44	2.26	6.27
	20	1	1.01	2.01	6.38	0.95	2.14	6.37	1.03	1.99	6.08
	21	1	0.78	2.12	6.97	1.07	2.62	7.67	0.92	2.81	7.38
	22	1	0.56	1.72	5.73	0.67	2.06	5.54	0.59	2.23	5.40
	33	1	1.14	2.40	6.59	1.44	3.11	6.87	1.41	2.45	6.13
	34	1	0.84	2.59	6.46	0.92	2.64	6.83	1.16	1.93	6.08
	35	1	1.14	1.82	6.23	1.15	2.82	6.91	1.16	3.07	7.04
	36	1	0.64	2.05	6.51	0.90	2.39	6.81	0.67	2.63	6.59
	128	1	0.15	0.61	1.78	0.14	0.76	2.08	0.18	0.64	2.04
	131	1	0.49	0.88	2.73	0.54	1.09	3.21	0.50	0.82	3.22
	132	1	0.49	1.55	3.38	0.37	1.77	3.42	0.50	1.40	3.49
	133	1	0.30	1.00	2.75	0.33	1.02	3.12	0.40	1.09	3.28
	140	1	0.46	1.12	3.49	0.36	1.27	3.36	0.40	1.09	3.44
	141	1	0.37	1.53	3.03	0.40	1.64	3.33	0.54	1.51	3.51
	146	1	0.69	2.03	5.72	0.60	2.23	6.23	0.65	1.95	6.17
	147	1	1.10	1.62	6.10	1.02	2.19	6.25	0.92	2.44	6.42
	148	1	1.28	2.22	6.22	1.02	2.24	5.96	1.22	1.66	5.69
	149	1	1.40	2.34	6.01	1.71	2.45	6.57	1.62	2.08	6.54
	150	1	0.97	1.85	4.51	0.92	1.66	5.19	0.94	1.45	5.11
	161	1	0.79	1.72	5.79	0.66	2.25	6.20	0.66	2.19	6.20
	162	1	1.39	1.66	6.25	1.04	1.74	5.83	0.98	1.89	5.86
	163	1	0.99	2.67	6.49	1.44	2.58	7.06	1.66	2.03	6.76
	164	1	1.29	1.60	4.88	1.32	1.84	5.35	1.20	1.89	5.53
0	128	1	0.61	1.11	3.29	0.66	1.14	3.51	0.80	1.08	3.64
3	133	1	1.11	1.94	7.36	1.68	2.39	7.60	1.85	2.70	8.32
4	132	1	1.79	3.69	6.83	1.71	3.90	7.28	1.92	3.71	6.84
5	131	1	1.47	2.08	6.72	1.80	2.49	6.63	1.44	2.44	6.77
12	140	1	1.32	2.89	7.98	1.34	3.37	7.34	1.30	3.14	7.80
13	141	1	0.94	3.09	6.44	1.06	3.73	7.46	0.98	3.07	7.55
18	146	1	2.40	4.57	11.53	2.46	4.98	12.31	2.35	4.71	12.58
19	147	1	2.57	5.28	14.10	2.91	7.50	15.16	2.72	6.00	14.10
20	148	1	2.90	4.93	13.08	2.75	4.84	12.95	2.94	4.26	12.68

Beam ID		Module	Low channel			Mid channel			High channel		
			S1	S2	S4	S1	S2	S4	S1	S2	S4
21	149	1	2.73	5.34	14.24	3.19	6.71	14.63	3.17	6.20	14.30
22	150	1	2.13	4.06	12.61	2.04	5.04	12.59	1.78	4.90	11.34
33	161	1	2.48	4.99	14.08	2.62	7.16	14.86	2.40	5.51	14.34
34	162	1	2.63	4.74	12.76	2.60	5.31	13.19	2.82	4.78	12.35
35	163	1	2.31	5.53	14.18	2.86	7.35	14.96	3.16	6.77	14.79
36	164	1	2.31	4.95	13.52	2.62	5.84	13.66	2.29	5.78	13.05

Beam ID		Module	Low channel			Mid channel			High channel		
			S1	S2	S3	S1	S2	S3	S1	S2	S3
	2	2	0.15	0.59	1.86	0.14	0.87	2.27	0.18	0.83	2.26
	9	2	0.45	0.96	2.86	0.45	1.32	3.43	0.51	1.18	3.29
	10	2	0.83	0.84	3.00	0.81	0.97	2.85	0.87	1.09	2.75
	11	2	0.54	0.97	3.74	0.44	1.57	4.25	0.39	1.69	4.12
	16	2	0.61	0.85	3.38	0.71	0.83	2.88	0.63	0.97	2.69
	17	2	0.82	0.64	2.53	0.84	0.87	2.79	0.96	1.02	2.85
	28	2	1.02	1.75	4.85	1.02	1.90	5.39	0.93	1.87	5.58
	29	2	1.05	2.03	6.29	1.24	2.32	6.11	1.25	1.91	6.02
	30	2	0.91	1.96	6.10	0.98	2.30	6.43	1.03	2.06	6.31
	31	2	0.91	2.06	6.90	1.10	2.73	7.57	0.97	2.72	7.43
	32	2	0.72	1.82	5.90	0.85	2.30	6.18	0.75	2.31	5.78
	41	2	1.01	1.57	5.38	1.07	1.86	5.46	1.07	1.75	5.71
	42	2	0.84	2.44	6.41	0.99	2.84	7.02	1.24	2.09	6.60
	43	2	1.38	1.46	6.27	1.21	2.34	6.68	1.12	2.77	6.80
	44	2	0.74	2.13	6.76	0.97	2.64	7.60	0.80	2.54	7.22
	130	2	0.33	0.24	1.59	0.37	0.28	1.75	0.38	0.29	1.77
	137	2	0.48	0.96	2.85	0.60	1.10	3.18	0.55	0.76	3.16
	138	2	0.45	1.00	3.77	0.51	1.23	4.26	0.73	0.94	4.17
	139	2	0.60	0.54	2.16	0.65	0.67	2.41	0.52	0.78	2.48
	144	2	0.51	1.11	3.27	0.69	1.24	3.49	0.73	0.81	3.39
	145	2	0.37	1.12	3.43	0.39	1.08	3.28	0.34	1.03	3.53
	156	2	0.61	1.85	5.32	0.65	1.78	5.39	0.70	1.70	5.68
	157	2	1.33	1.85	5.44	1.51	2.12	5.92	1.32	2.06	6.08
	158	2	0.95	2.09	5.77	0.98	2.37	6.11	1.21	1.61	5.85
	159	2	0.77	1.95	6.16	0.64	2.12	6.43	0.67	2.25	6.55
	160	2	1.30	1.82	5.16	1.43	2.10	5.43	1.14	2.05	5.59
	169	2	1.21	1.67	5.12	1.18	1.73	5.69	1.06	1.68	5.33
	170	2	0.84	2.40	6.17	1.29	2.67	6.91	1.49	2.02	6.61
	171	2	1.15	1.37	5.73	0.83	1.82	6.00	0.77	2.16	6.01
	172	2	0.78	2.16	5.63	0.76	2.05	5.73	0.80	1.88	5.93
2	130	2	0.54	1.23	3.63	0.61	1.59	4.26	0.72	1.44	4.20
9	139	2	1.28	1.92	5.50	1.35	2.36	6.45	1.57	2.43	6.76
10	138	2	1.53	2.42	7.28	1.53	2.47	8.07	1.93	2.43	7.93
11	137	2	1.39	2.56	6.64	1.45	3.94	7.97	1.33	3.24	7.44
16	145	2	1.16	2.53	8.57	1.29	2.91	7.38	1.21	3.03	8.14
17	144	2	1.54	2.05	6.12	1.77	2.32	7.37	2.12	2.12	7.23
28	160	2	2.57	4.47	10.87	3.11	5.37	12.51	2.85	4.96	13.03
29	159	2	2.22	4.86	14.02	2.09	5.81	13.65	2.44	4.95	14.32

Beam ID		Module	Low channel			Mid channel			High channel		
			S1	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
30	158	2	2.48	4.73	12.13	2.60	5.61	12.97	3.00	4.48	12.41
31	157	2	2.87	5.35	13.52	3.46	6.80	14.62	2.63	5.61	15.17
32	156	2	2.26	3.67	11.57	2.07	5.25	11.77	2.10	4.62	12.11
41	172	2	2.19	4.46	12.42	2.24	5.07	12.38	2.42	4.49	13.28
42	171	2	2.48	4.69	12.71	2.53	5.91	13.55	2.81	5.69	12.89
43	170	2	2.67	4.29	13.57	3.07	6.30	14.27	2.85	5.42	13.92
44	169	2	2.94	4.54	14.11	3.31	5.76	15.91	2.76	5.28	14.92

C Simulated PD Distribution Plots

The PD distributions for all 135 beams on all the three surfaces are provided in this Appendix:

- For Module 0, PD is displayed on S1(front), S2 (back) & S5 (bottom)
- For Module 1, PD is displayed on S1(front), S2 (back) and S4 (left)
- For Module 2, PD is displayed on S1(front), S2 (back) and S3 (right)

As shown in Fig.C-1, the PD simulations in this Appendix for the front side (S1) & back side (S2) should be both viewed from the front of the device and looking through the device (i.e., along negative z direction). The PD distributions for the bottom (S5) side should be viewed from the bottom side of the device and looking through the device (i.e., along negative y direction). The PD distributions for the left (S4) side should be viewed from the left side of the device and looking through the device (i.e., along negative x direction). Similarly, the PD distributions for the right (S3) side should be viewed from the right side of the device and looking through the device (i.e., along positive x direction). The views with device outlines (white) are shown in more detail in Fig. C-2, Fig C-3 & C-4 for different antenna modules or phasors.

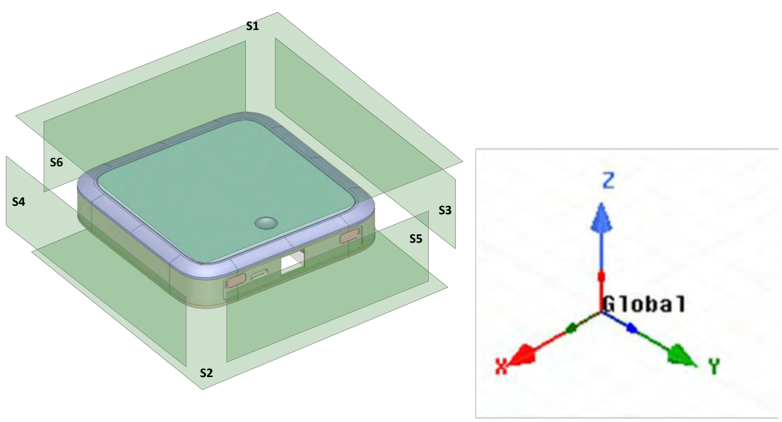


Figure C-1: EUT surface definition

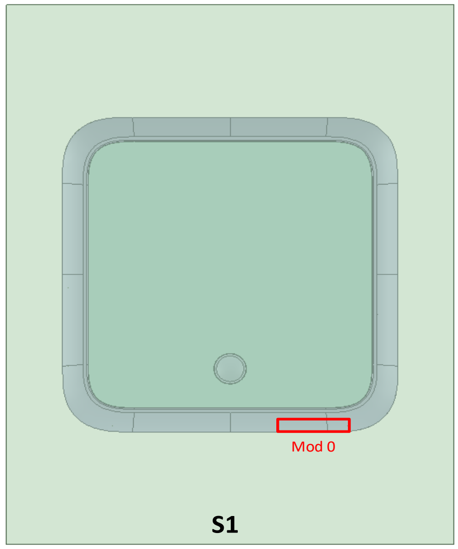
All PD distribution plots (Pages 51-455) are normalized to their own maximum value and plotted for only mid channel as the PD distribution for low, mid and high channels are similar.

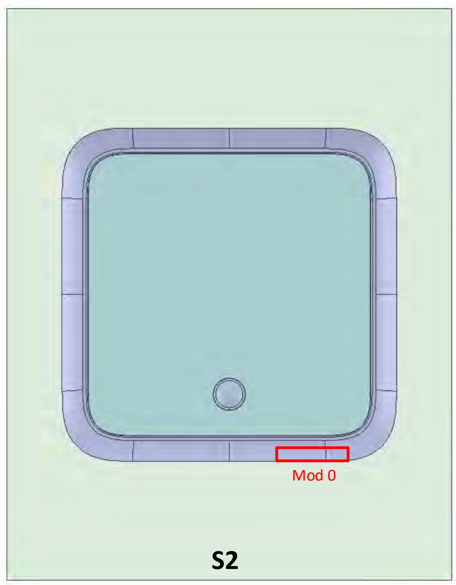
The plots are arranged as:

Mod 0 (Phasor 0): Point & 4cm^2 Avg. PD (Single Beam) → *Point & 4cm^2 Avg. PD (Dual Beam)*

Mod 1 (Phasor 1): Point & 4cm^2 Avg. PD (Single Beam) → *Point & 4cm^2 Avg. PD (Dual Beam)*

Mod 2 (Phasor 2): Point & 4cm^{2}Avg. PD (Single Beam) → *Point & 4cm^2 Avg. PD (Dual Beam)*





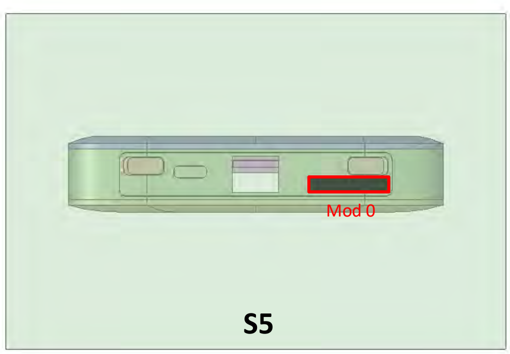
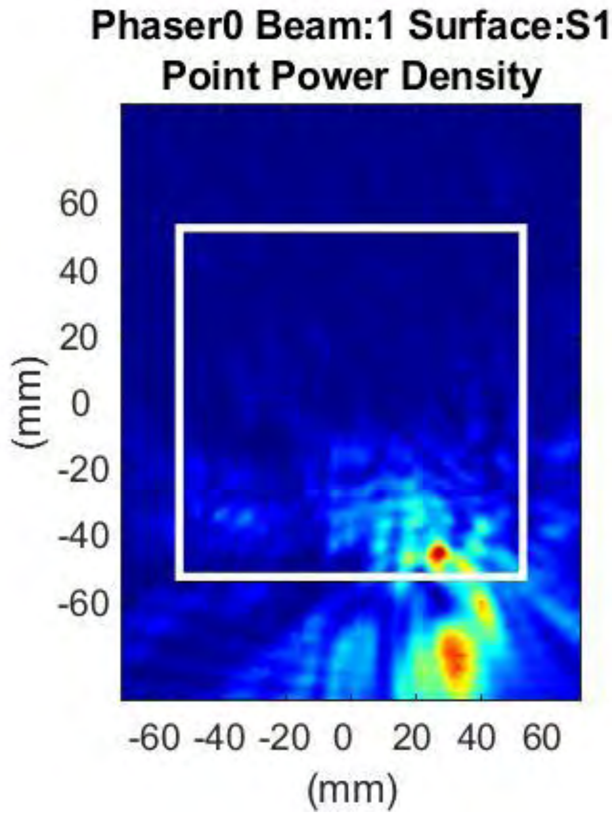


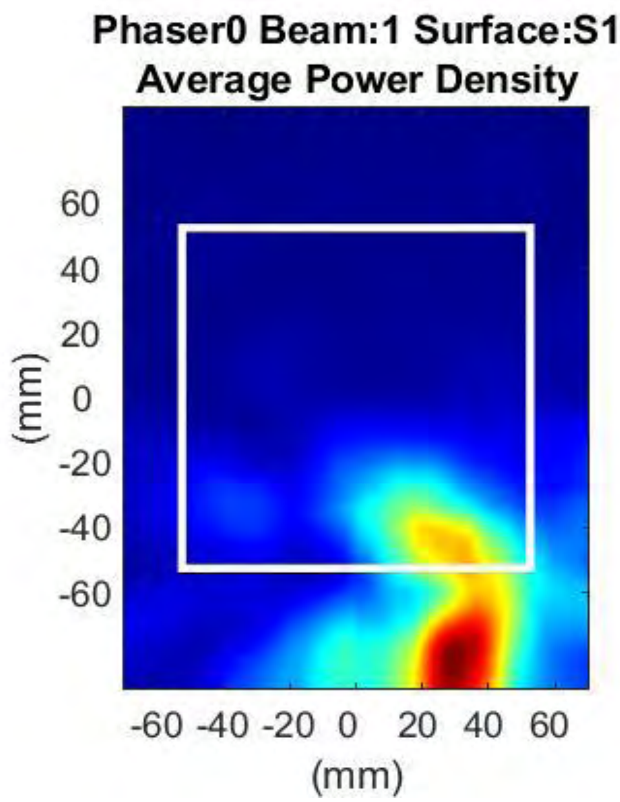
Figure C-2: Phasor 0 views for S1 (Front), S2 (Back) & S5 (Bottom)

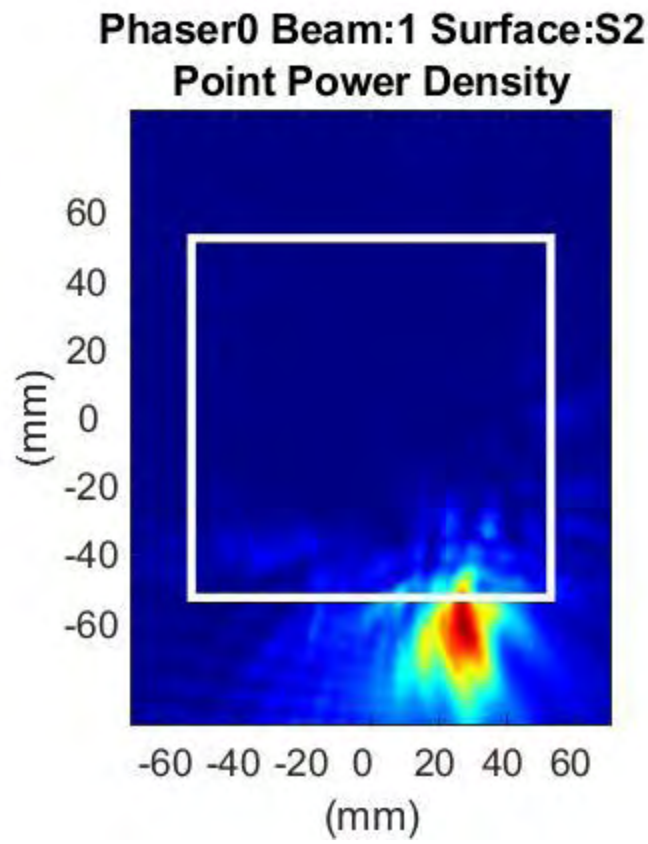
Figure C-3: Phasor 1 views for S1 (Front), S2 (Back) & S4 (Left)

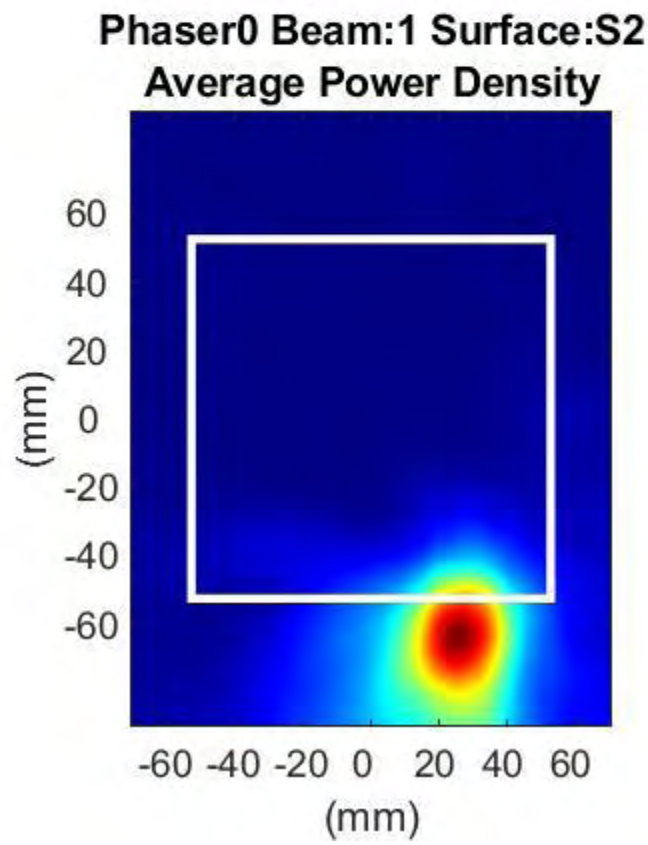
Figure C-4: Phasor 2 views for S1 (Front), S2 (Back) & S3 (Right)

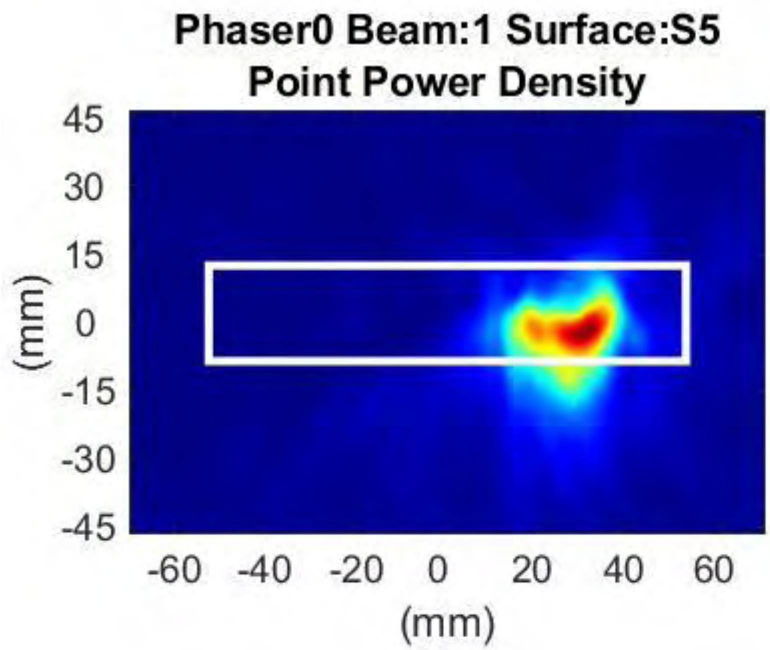
Plots of Point PD & Avg. PD for all Beams

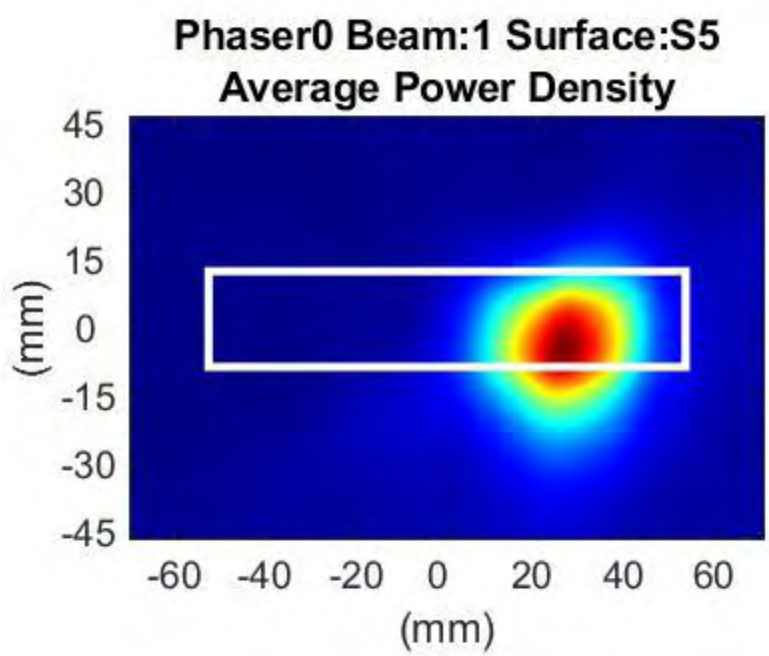


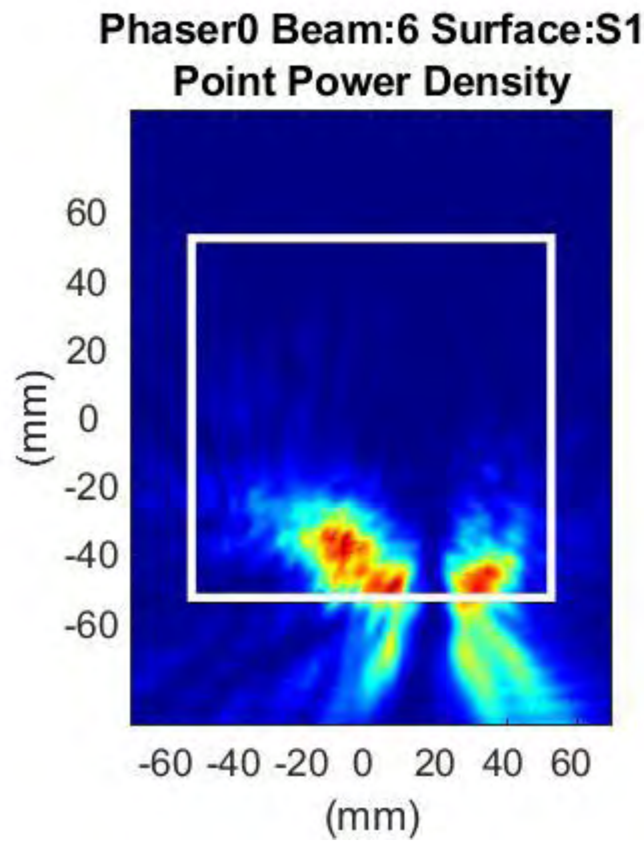


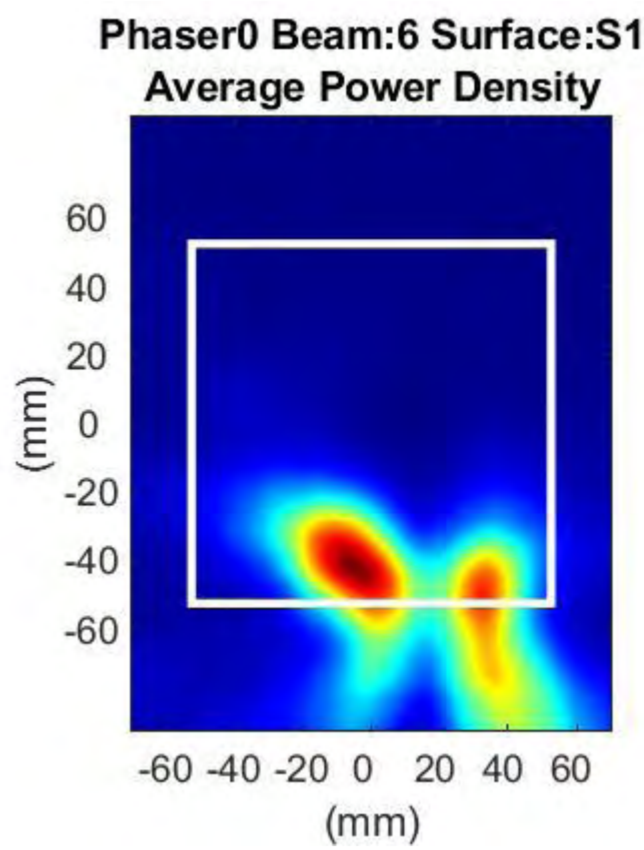

Phaser0 Beam:1 Surface:S2
Point Power Density
60
40
20
0
-20
-40
-60
(mm)
-60 -40 -20 0 20 40 60
(mm)


Phaser0 Beam:1 Surface:S2
Average Power Density
60
40
20
0
-20
-40
-60
(mm)
-60 -40 -20 0 20 40 60
(mm)

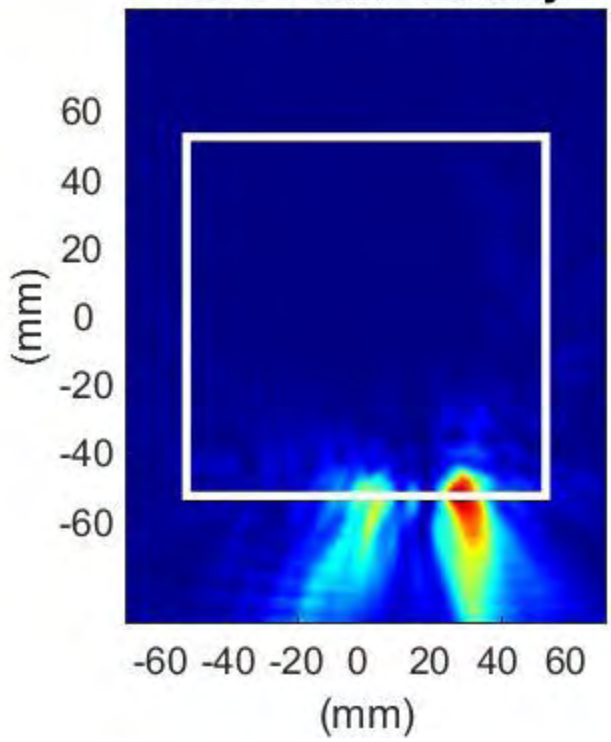

Phaser0 Beam:1 Surface:S5
Point Power Density
45
30
15
0
-15
-30
-45
(mm)
-60
-40
-20
0
20
40
60
(mm)


Phaser0 Beam:1 Surface:S5
Average Power Density
45
30
15
0
-15
-30
-45
(mm)
-60
-40
-20
0
20
40
60
(mm)

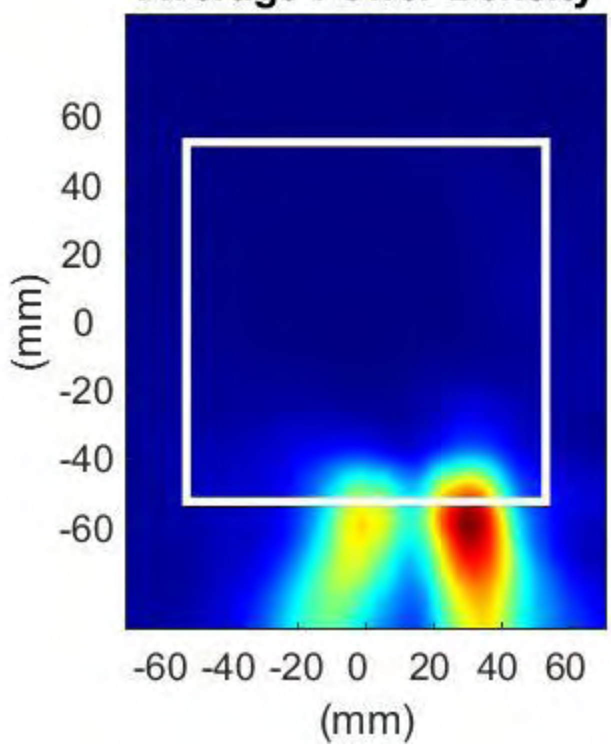

Phaser0 Beam:6 Surface:S1
Point Power Density
60
40
20
0
-20
-40
-60
(mm)
-60 -40 -20 0 20 40 60
(mm)

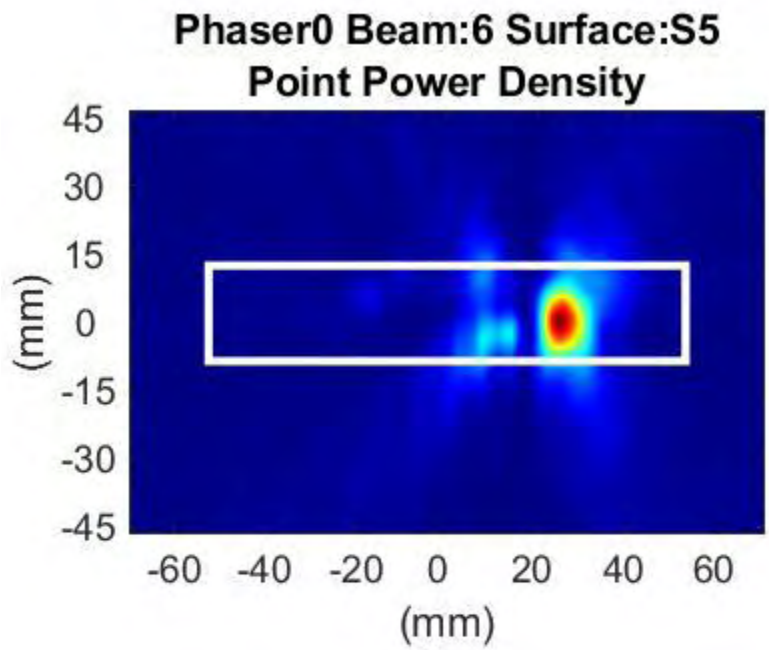

Phaser0 Beam:6 Surface:S1
Average Power Density
60
40
20
0
-20
-40
-60
(mm)
-60 -40 -20 0 20 40 60
(mm)

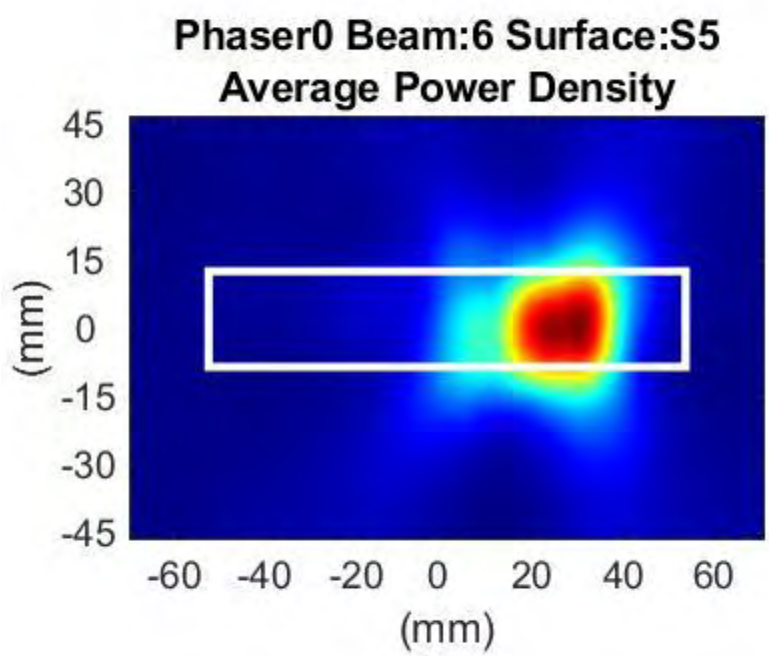
Phaser0 Beam:6 Surface:S2
Point Power Density



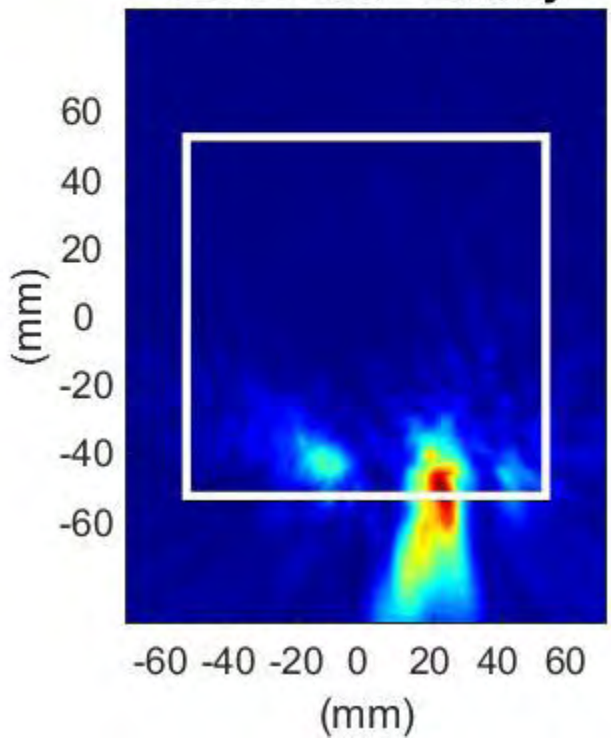
Phaser0 Beam:6 Surface:S2
Average Power Density



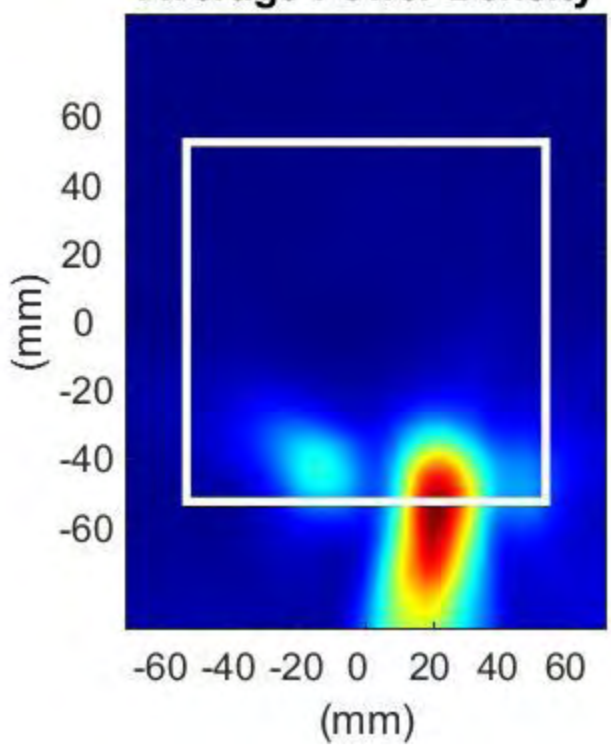

Phaser0 Beam:6 Surface:S5
Point Power Density
45
30
15
0
-15
-30
-45
(mm)
-60
-40
-20
0
20
40
60
(mm)

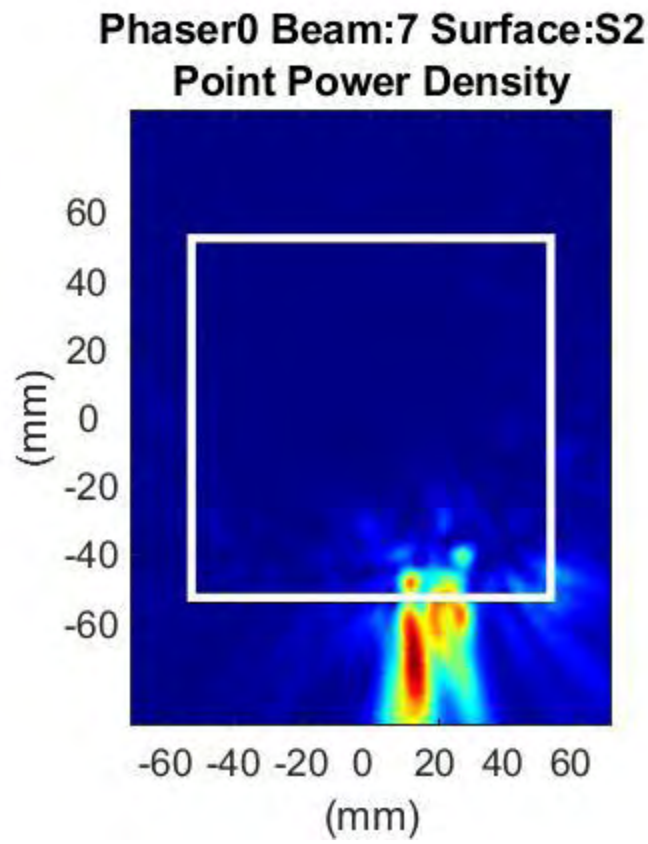

Phaser0 Beam:6 Surface:S5
Average Power Density
45
30
15
0
-15
-30
-45
(mm)
-60
-40
-20
0
20
40
60
(mm)

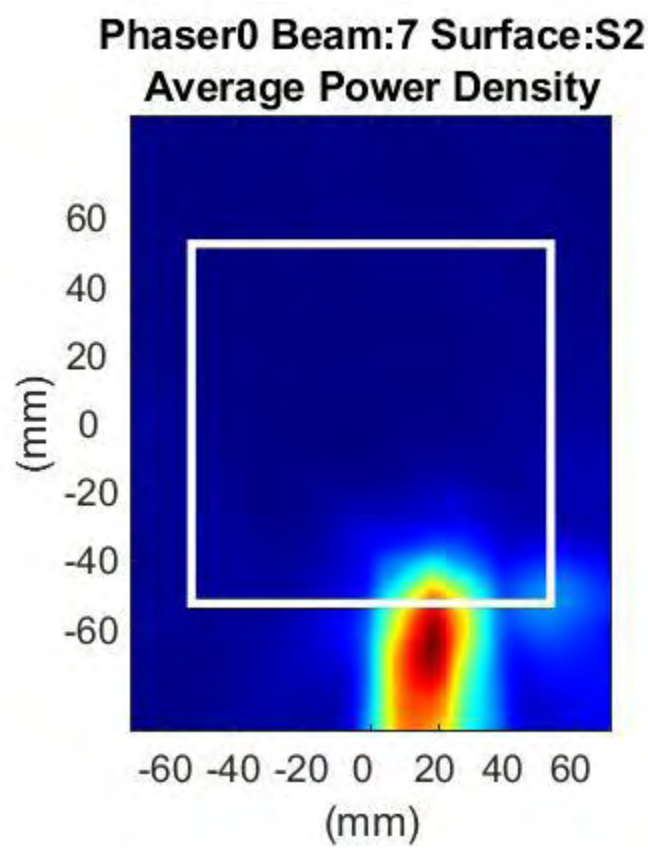
Phaser0 Beam:7 Surface:S1
Point Power Density

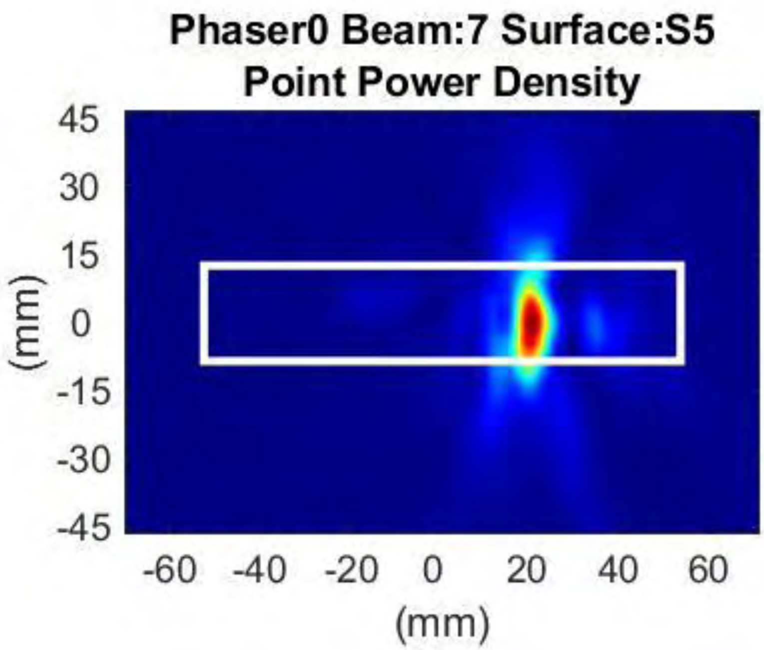


Phaser0 Beam:7 Surface:S1
Average Power Density




Phaser0 Beam:7 Surface:S2
Point Power Density
60
40
20
0
-20
-40
-60
(mm)
-60 -40 -20 0 20 40 60
(mm)


Phaser0 Beam:7 Surface:S2
Average Power Density
60
40
20
0
-20
-40
-60
(mm)
-60 -40 -20 0 20 40 60
(mm)


Phaser0 Beam:7 Surface:S5
Point Power Density
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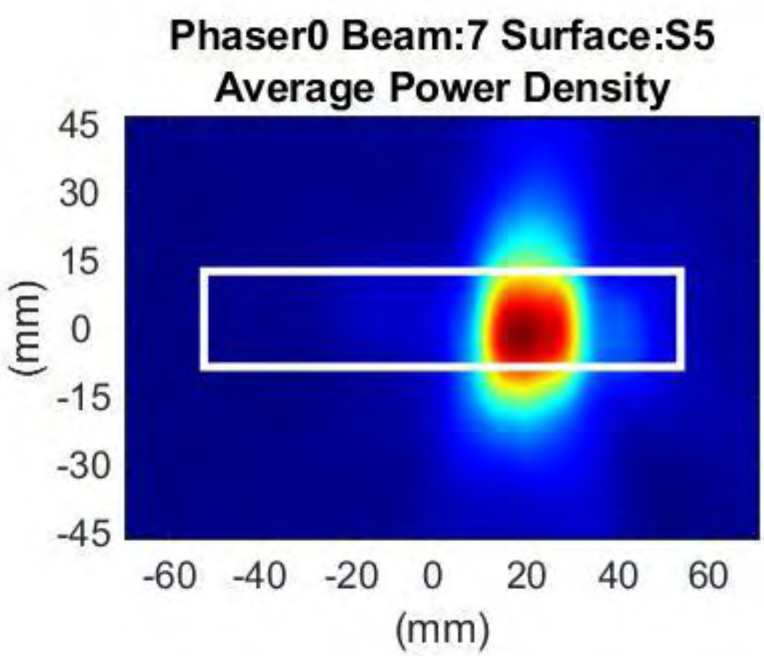
30
15
0
-15
-30
-45
(mm)
-60
-40
-20
0
20
40
60
(mm)


Phaser0 Beam:7 Surface:S5
Average Power Density
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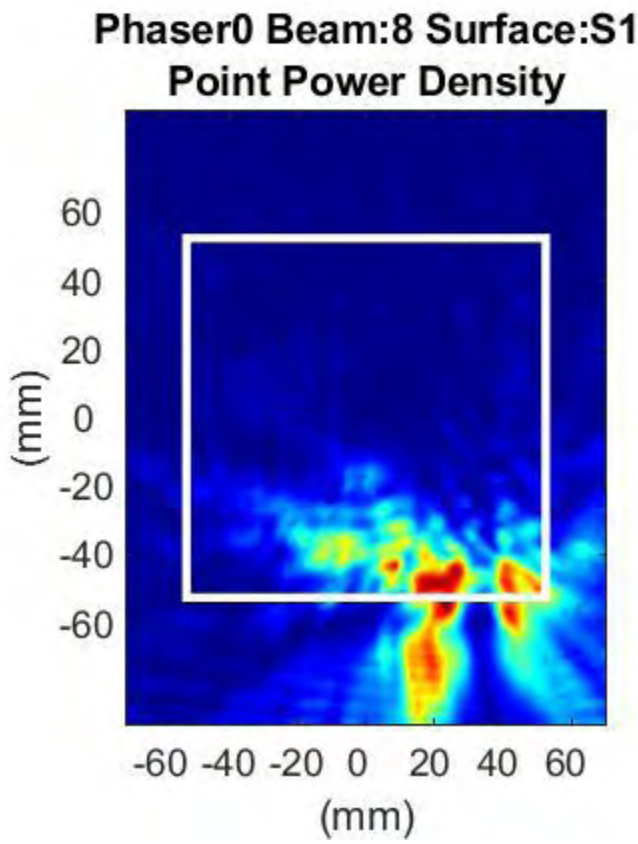
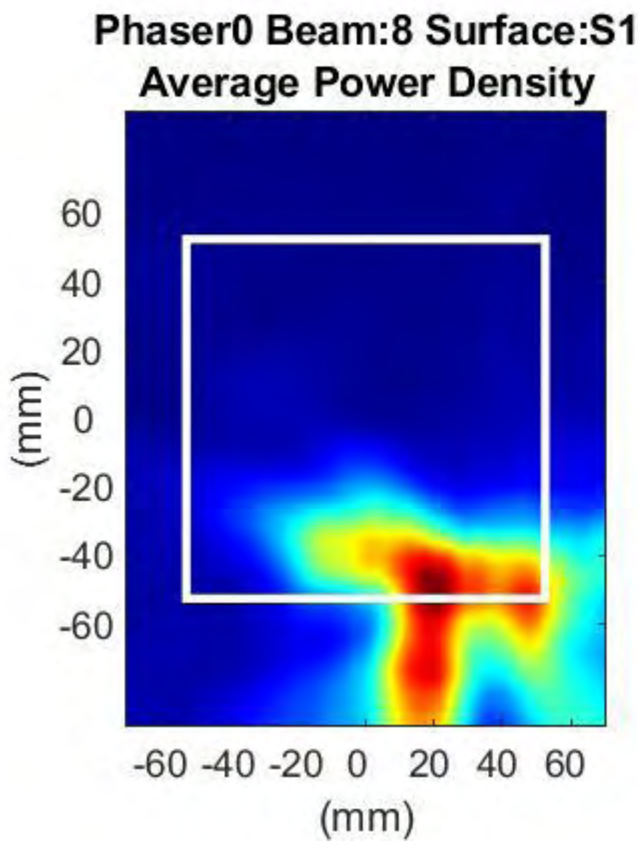
30
15
0
-15
-30
-45
(mm)
-60
-40
-20
0
20
40
60
(mm)


Phaser0 Beam:8 Surface:S1
Point Power Density
60
40
20
0
-20
-40
-60
(mm)
-60 -40 -20 0 20 40 60
(mm)


Phaser0 Beam:8 Surface:S1
Average Power Density
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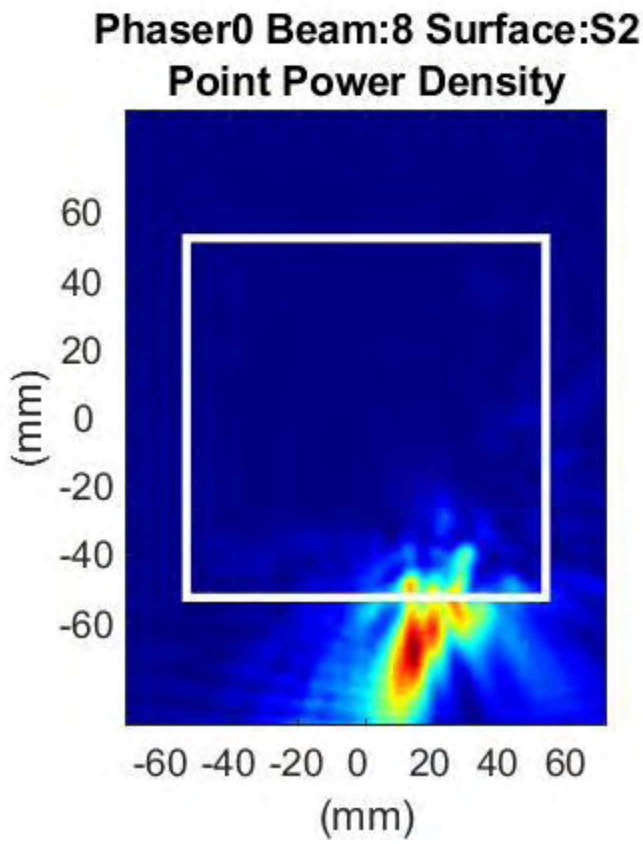
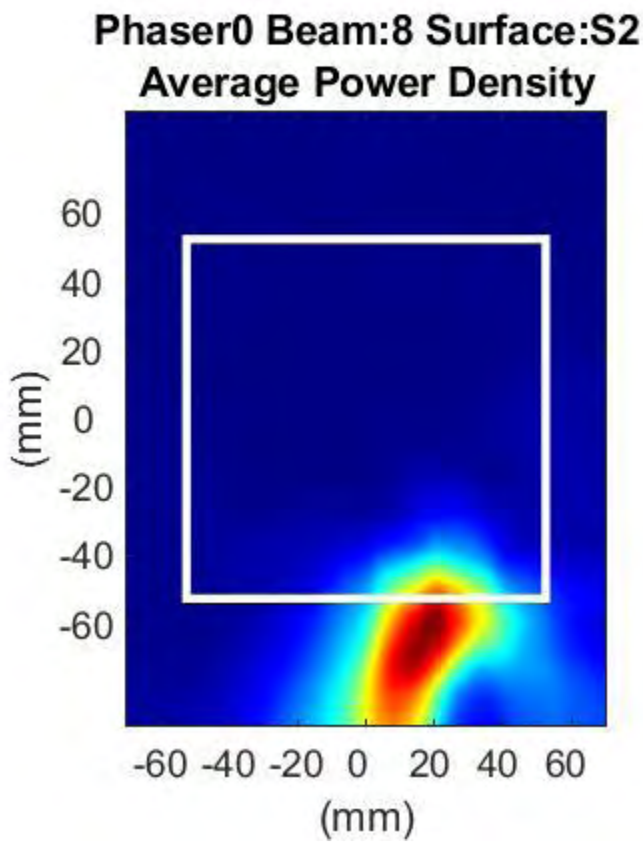
40
20
0
-20
-40
-60
(mm)
-60 -40 -20 0 20 40 60
(mm)


Phaser0 Beam:8 Surface:S2
Point Power Density
60
40
20
0
-20
-40
-60
(mm)
-60 -40 -20 0 20 40 60
(mm)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Average Power Density
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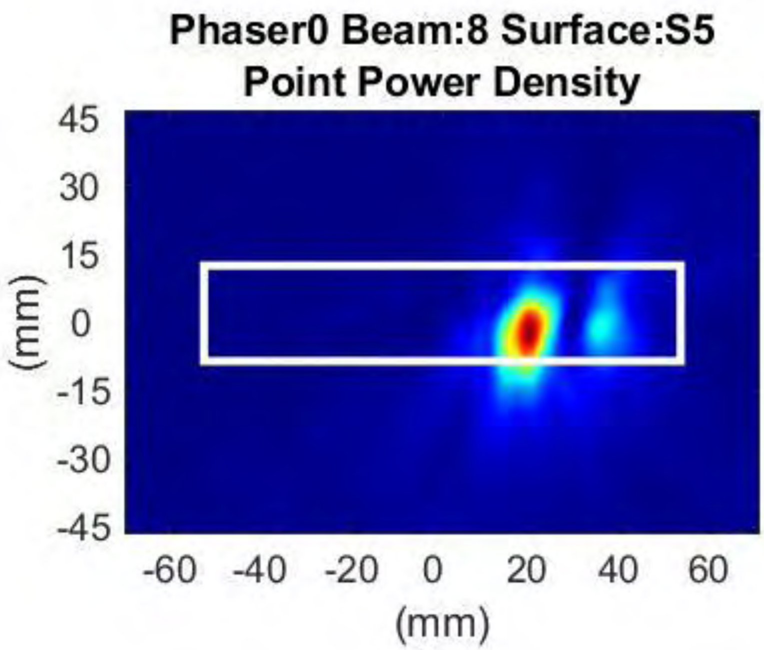
40
20
0
-20
-40
-60
(mm)
-60 -40 -20 0 20 40 60
(mm)


Phaser0 Beam:8 Surface:S5
Point Power Density
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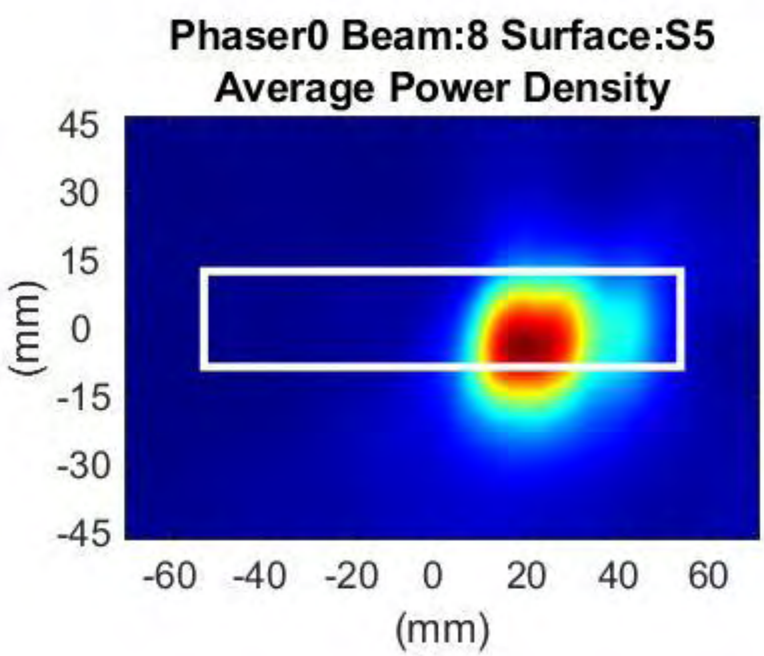
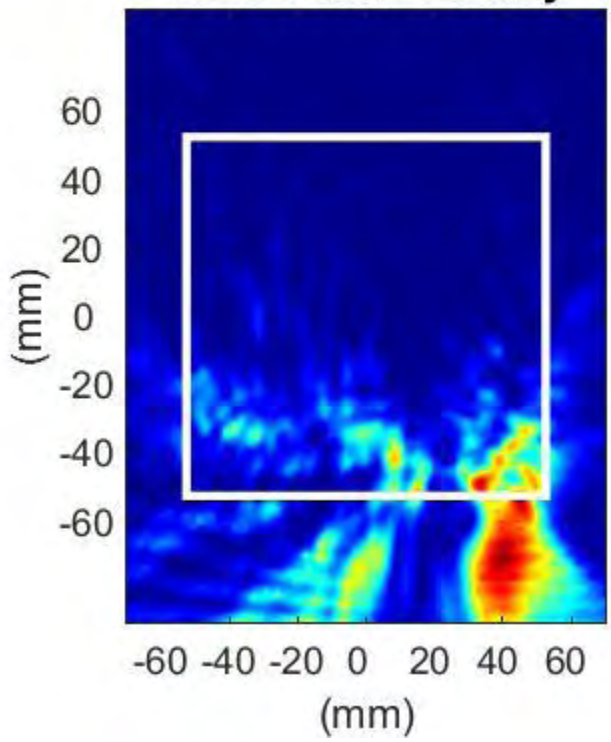
30
15
0
-15
-30
-45
(mm)
-60
-40
-20
0
20
40
60
(mm)


Phaser0 Beam:8 Surface:S5
Average Power Density
45
30
15
0
-15
-30
-45
(mm)
-60
-40
-20
0
20
40
60
(mm)

Phaser0 Beam:14 Surface:S1
Point Power Density



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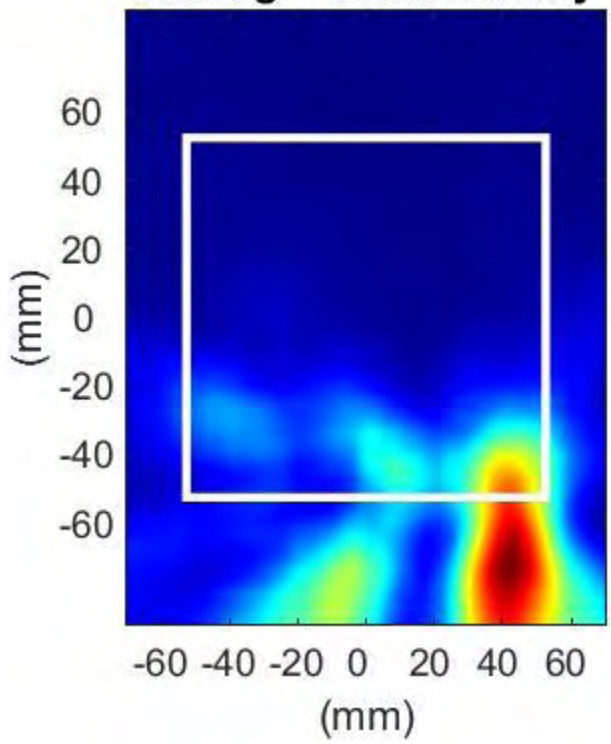

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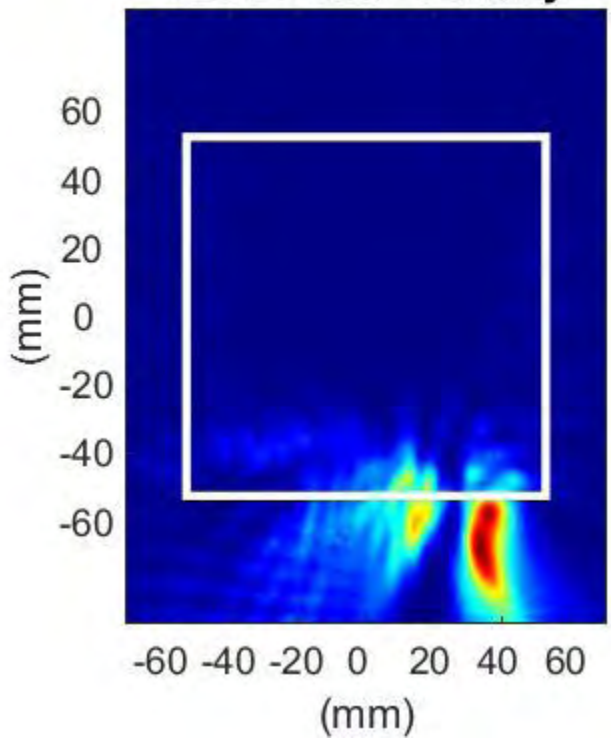

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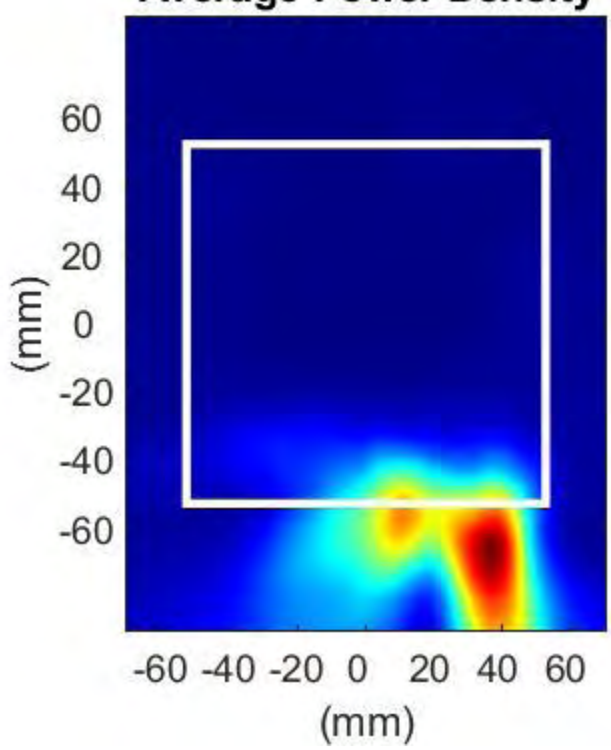

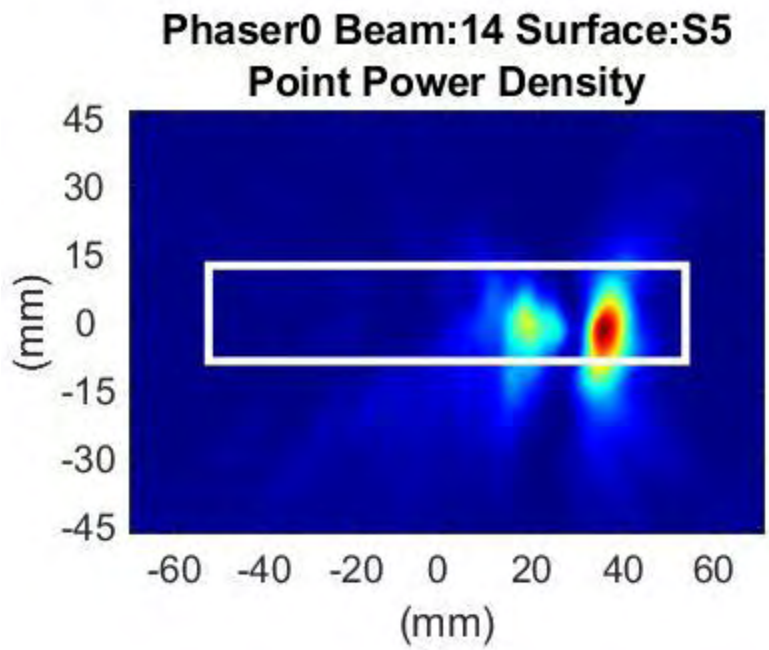
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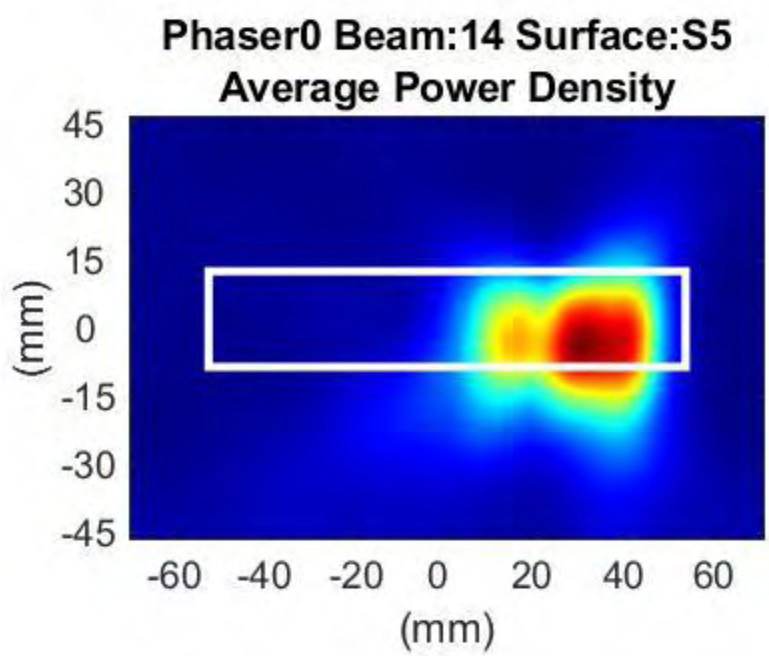
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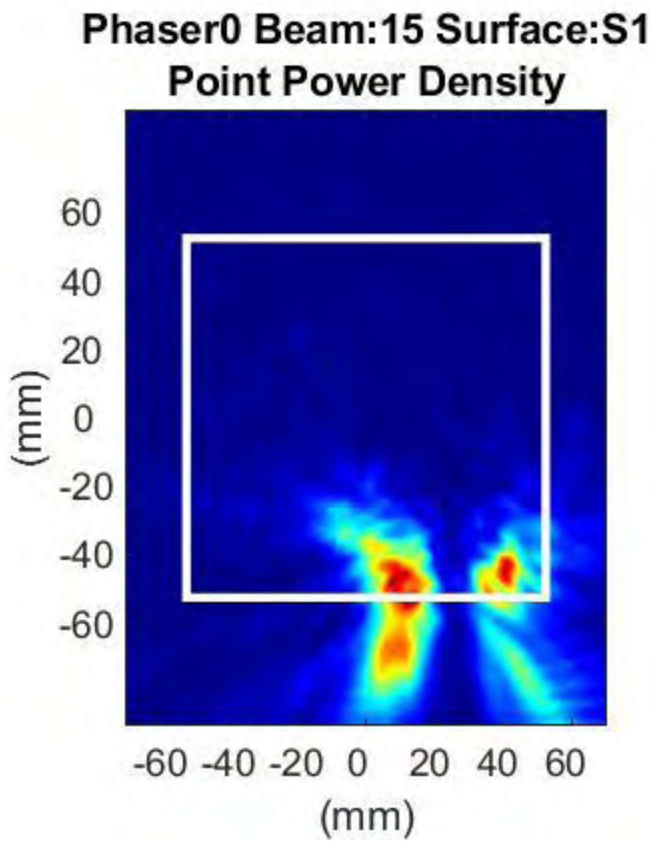
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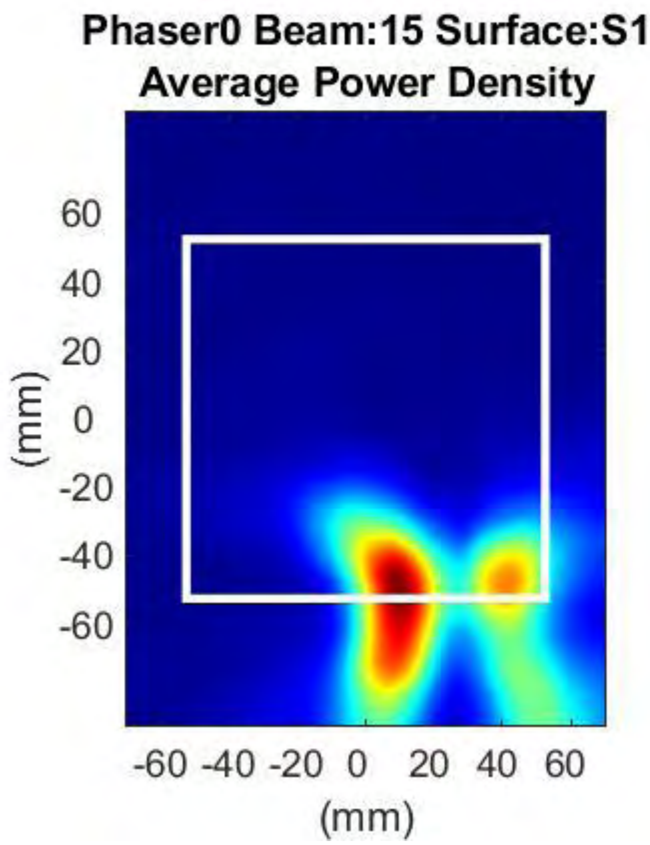
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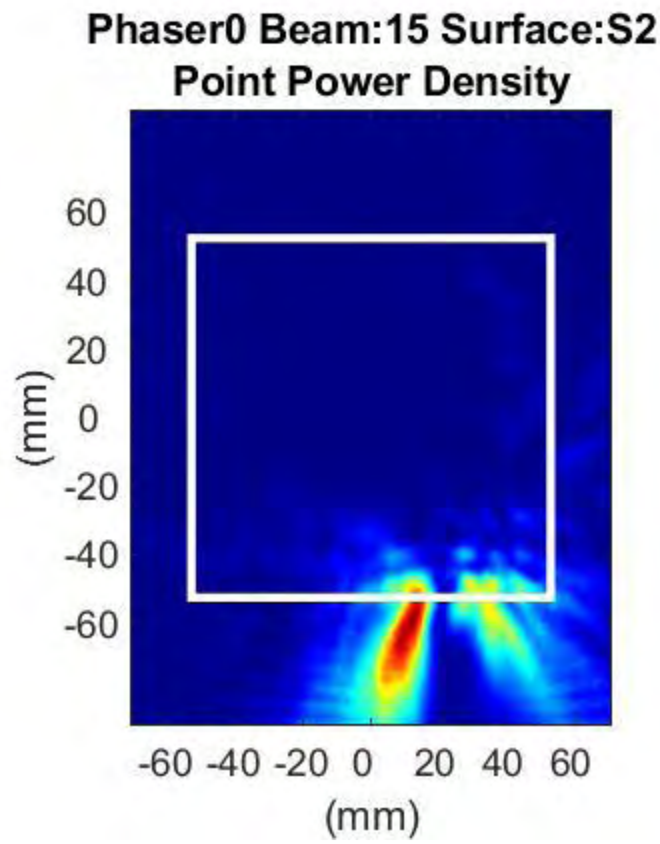
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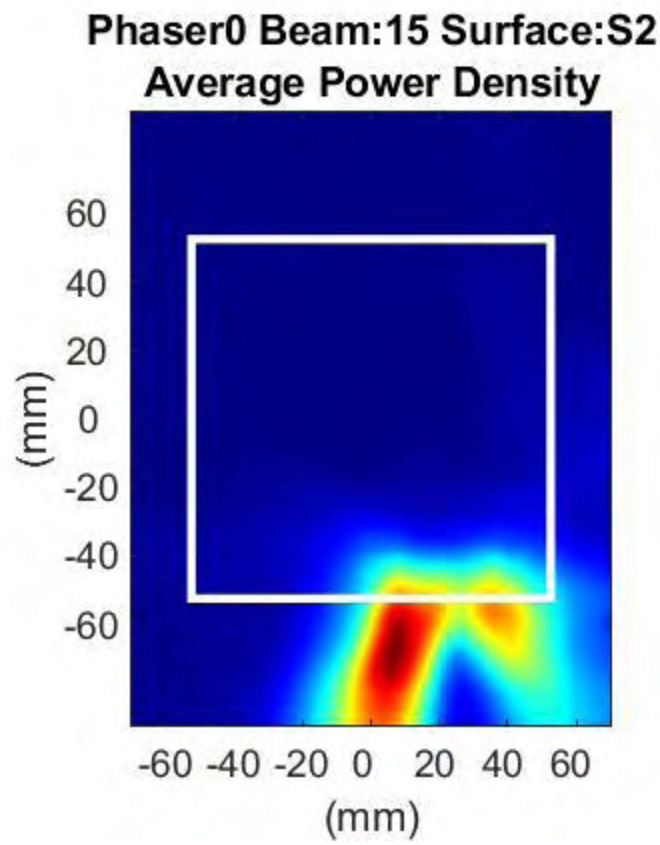
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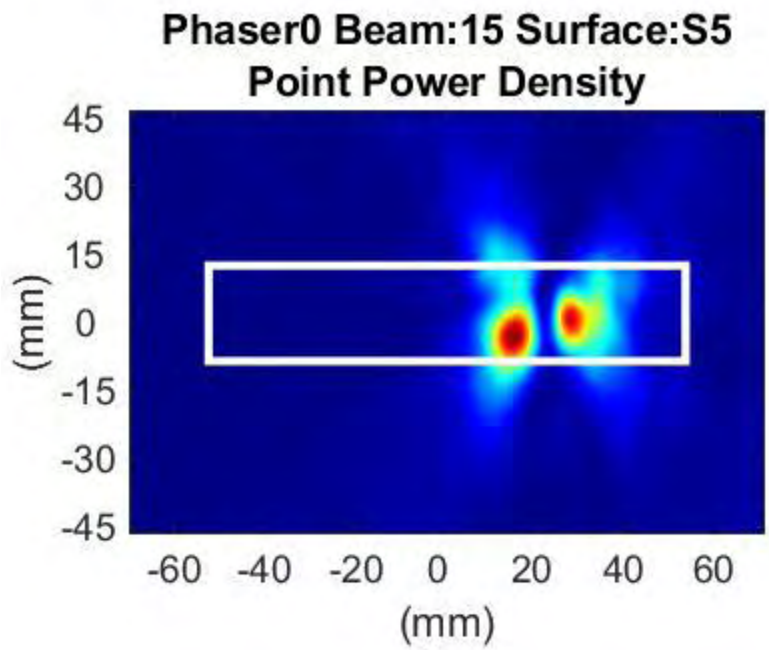
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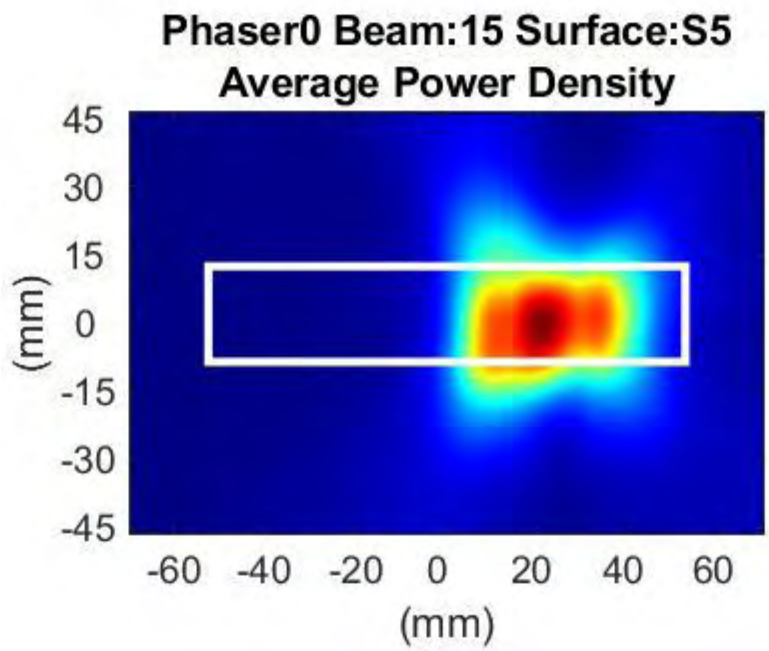
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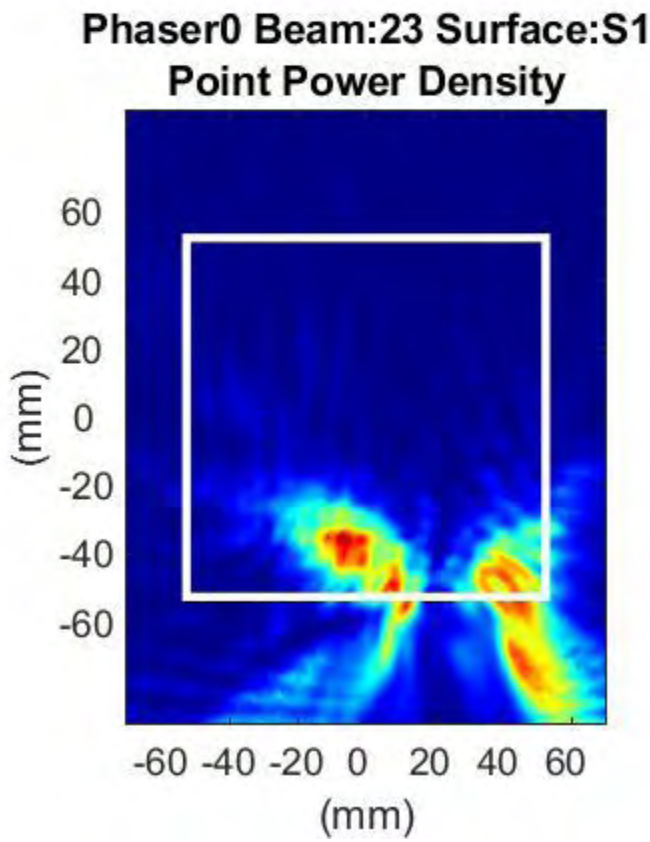
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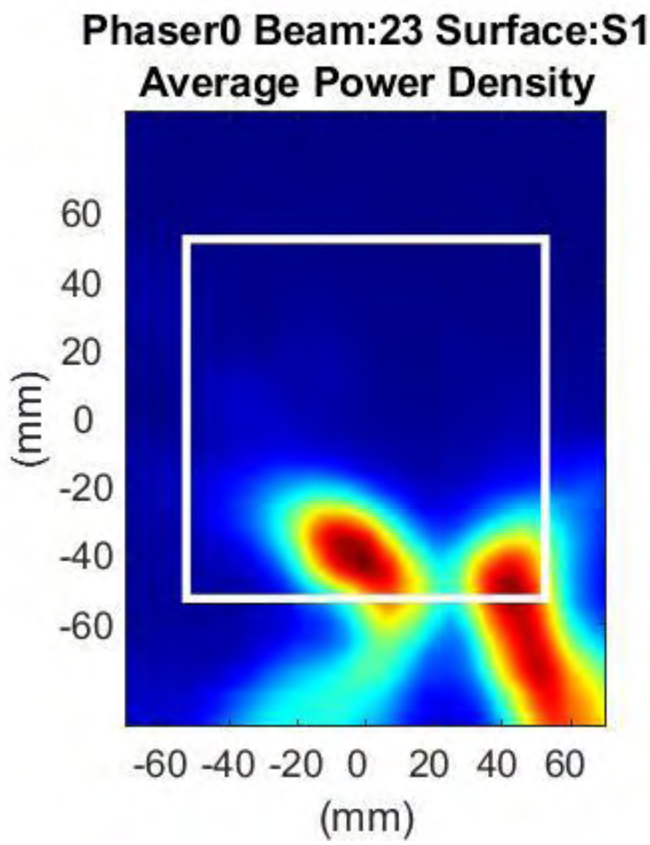
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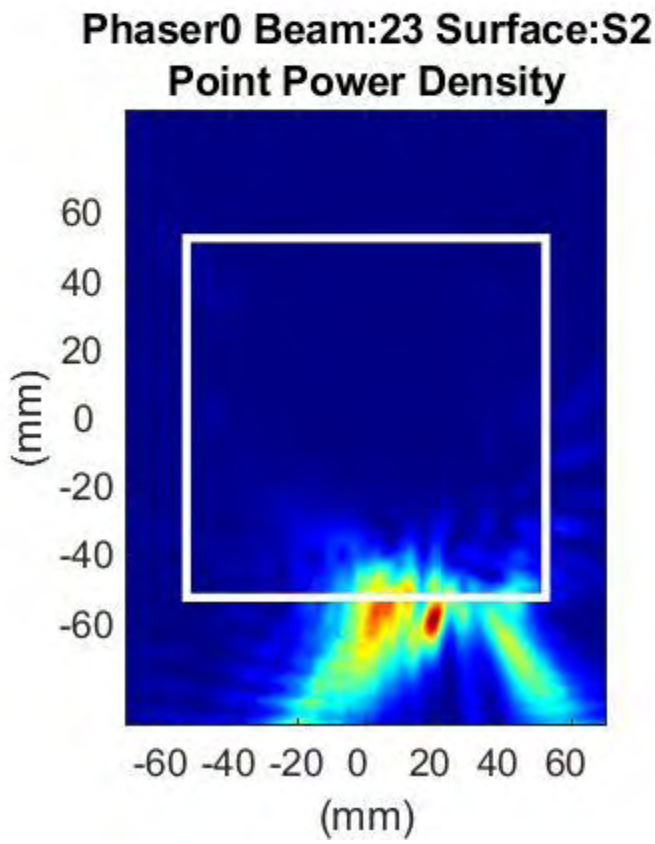
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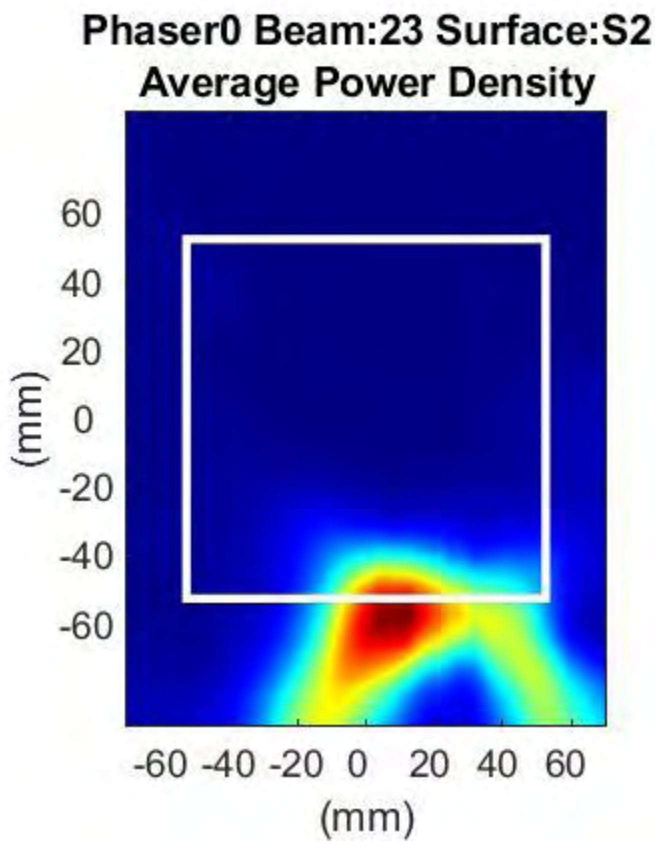
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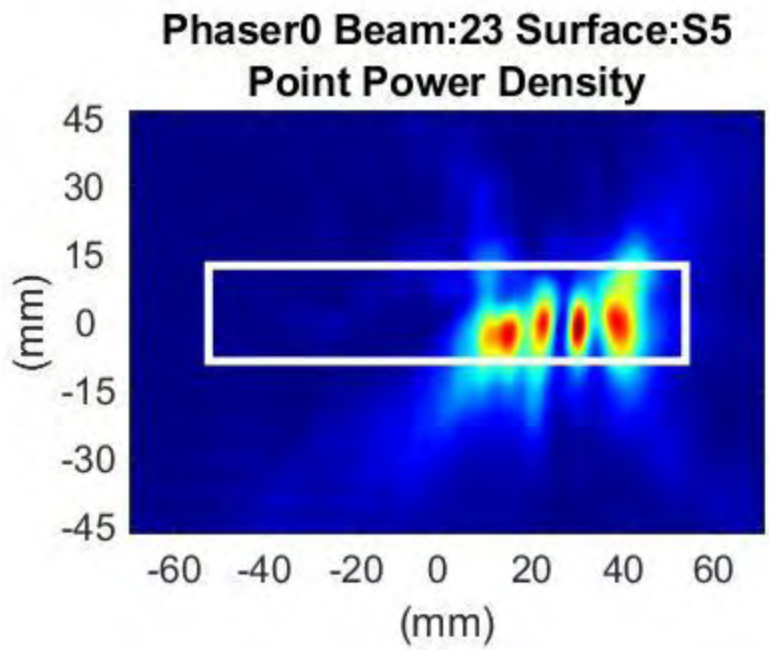
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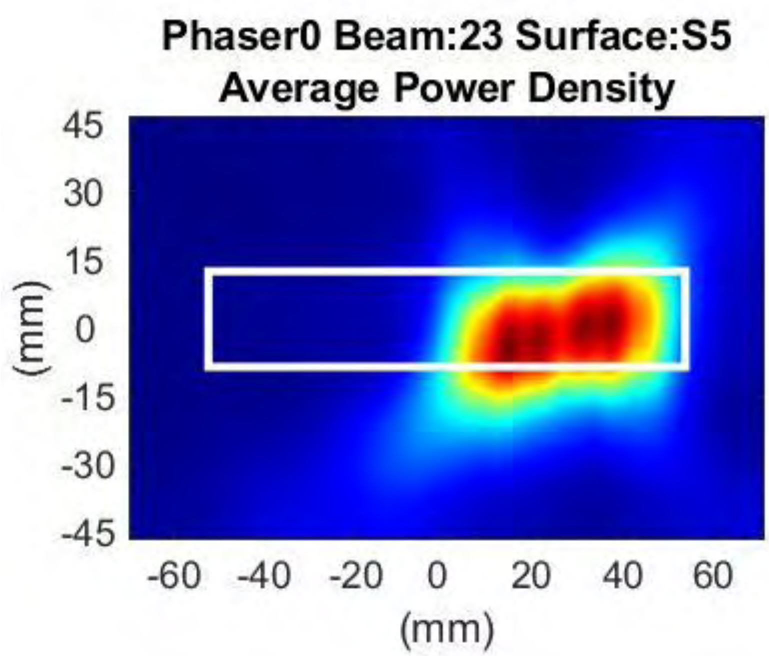
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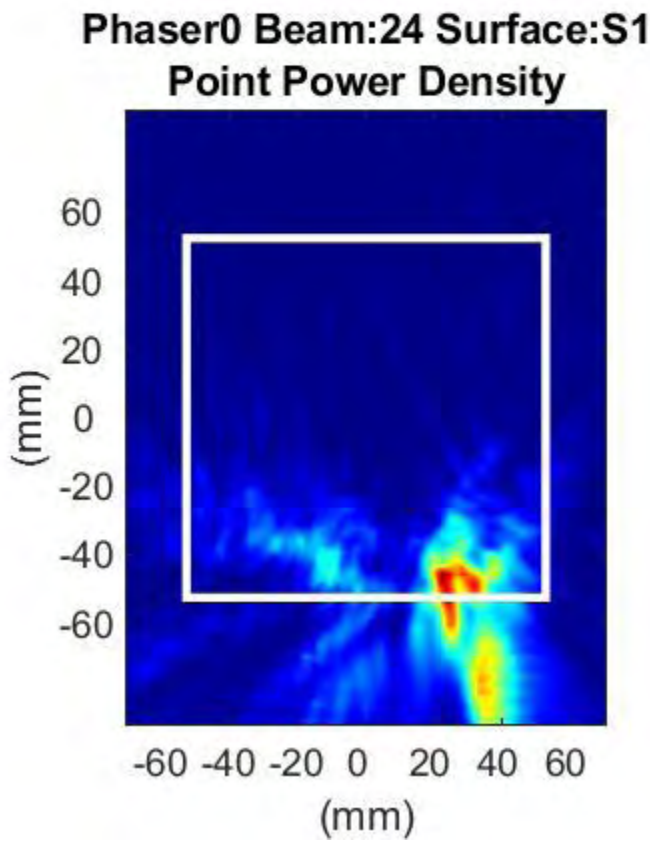
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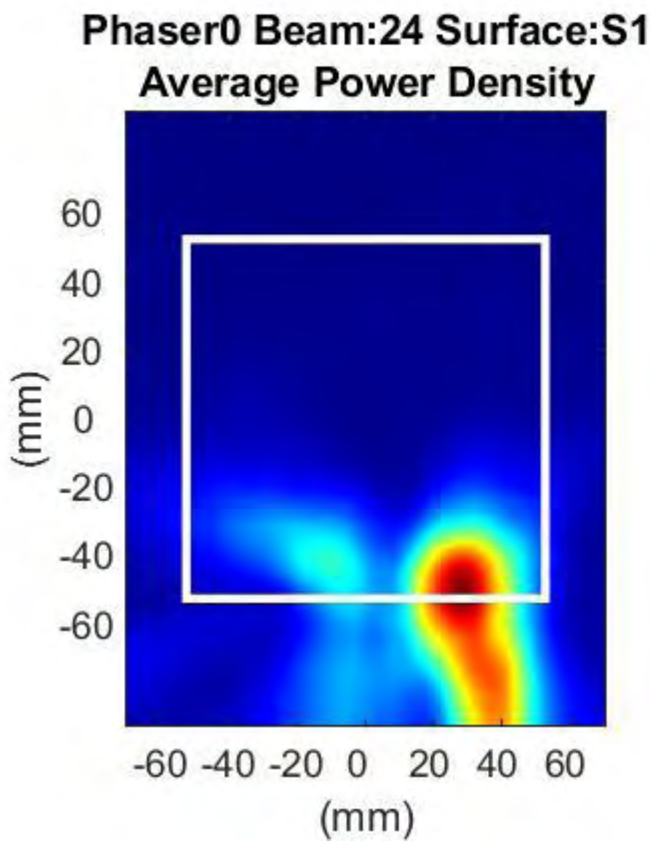
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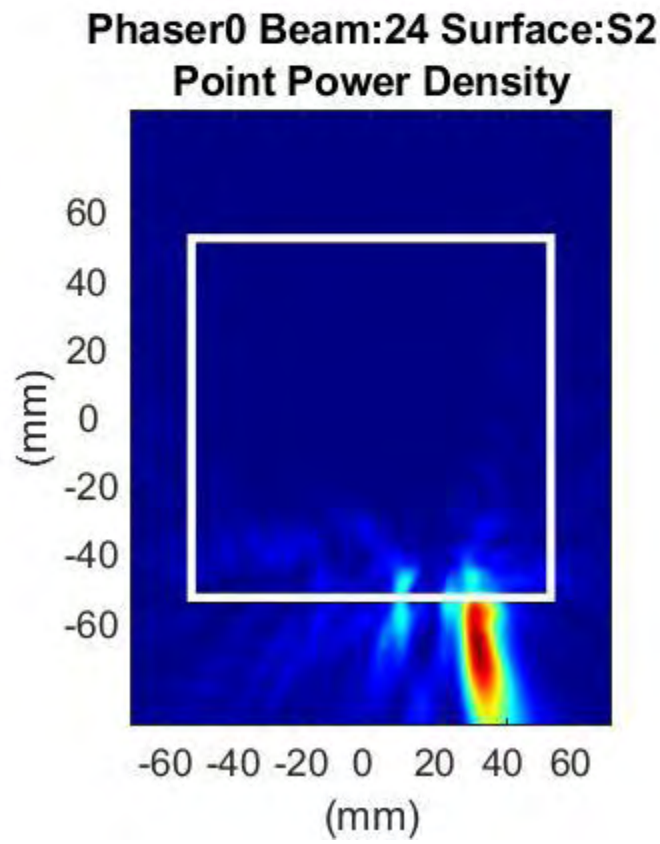
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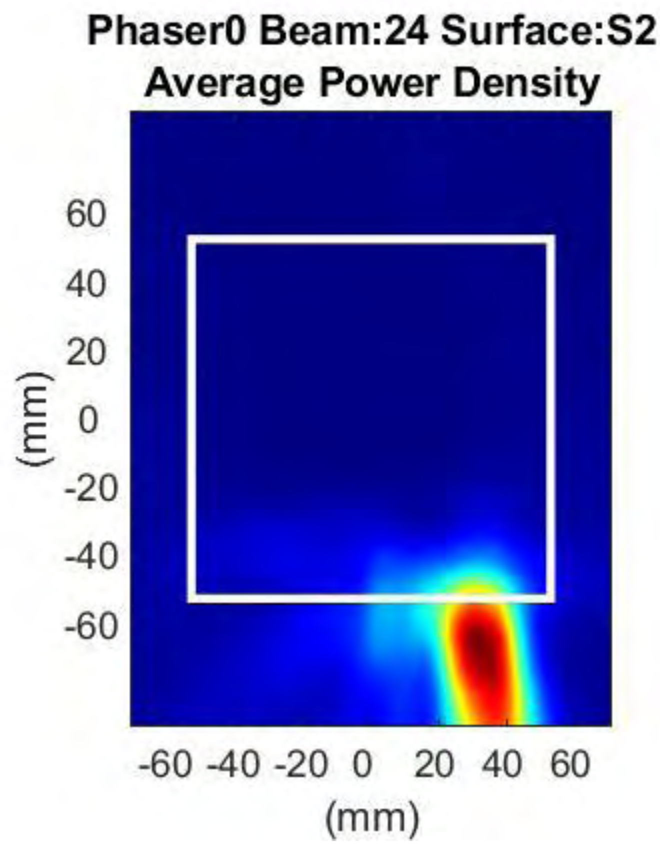
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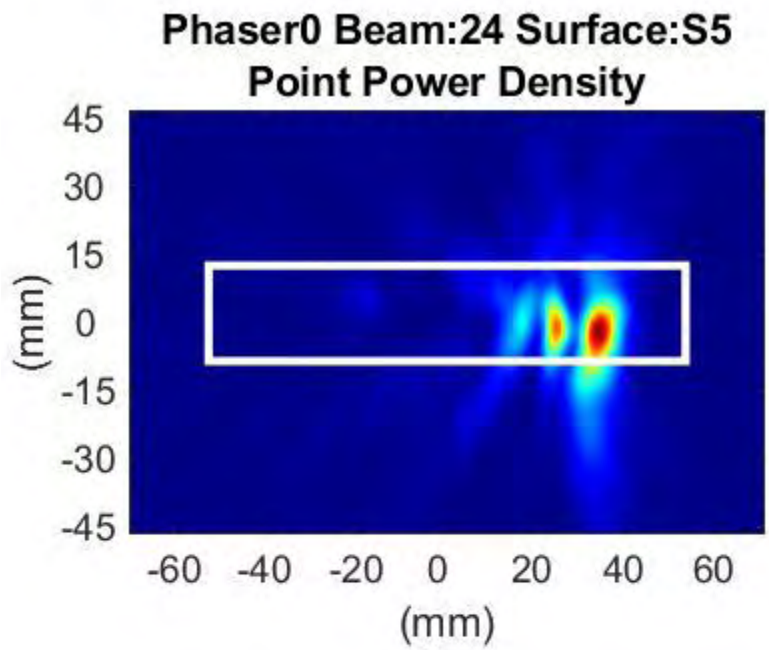
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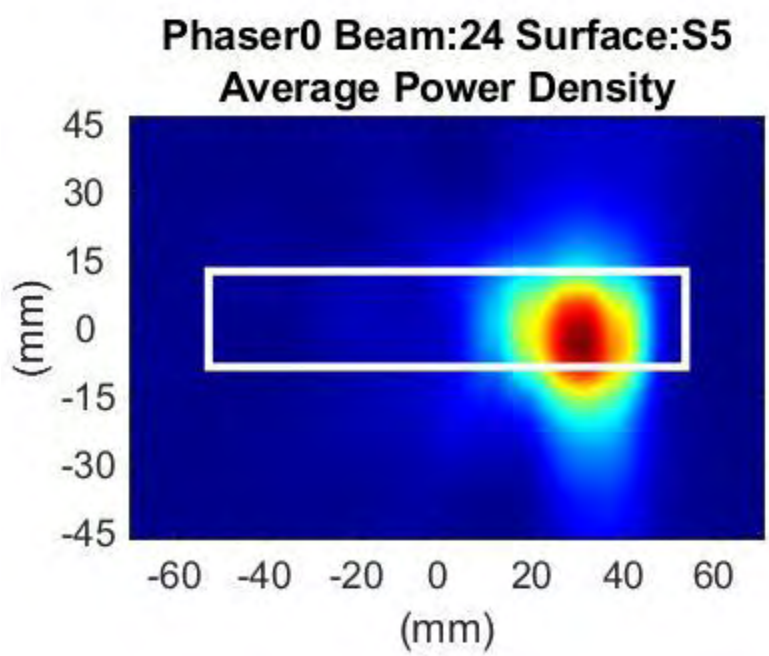
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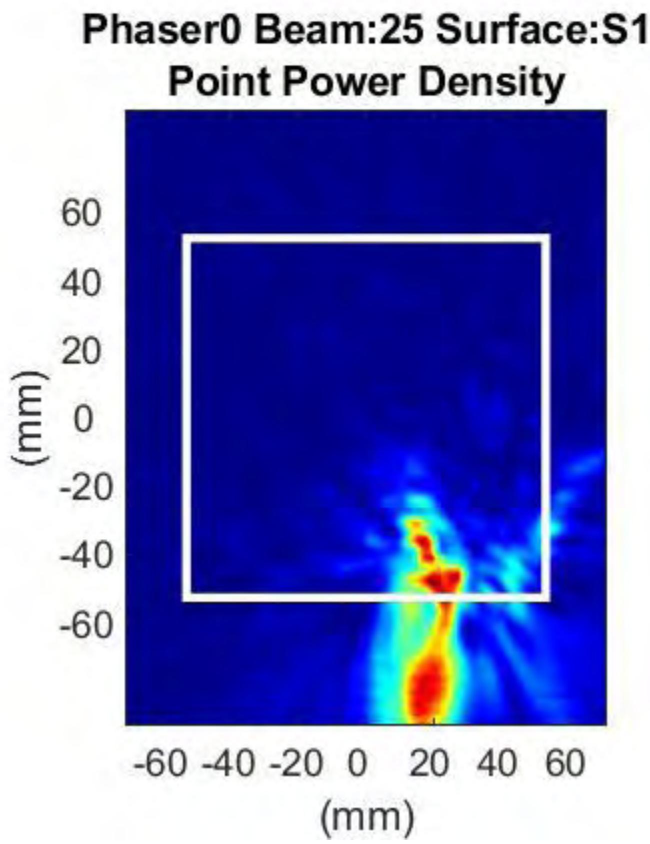
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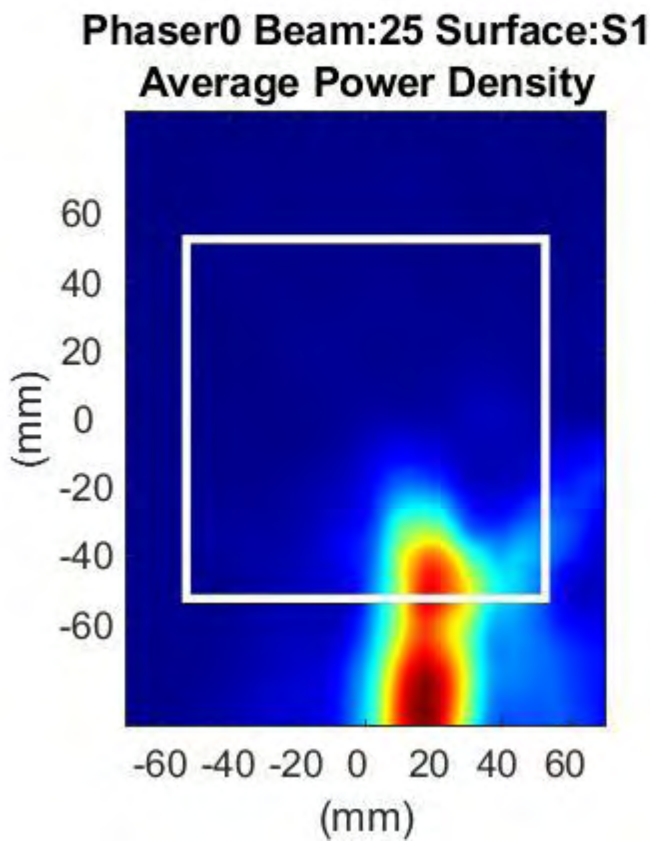
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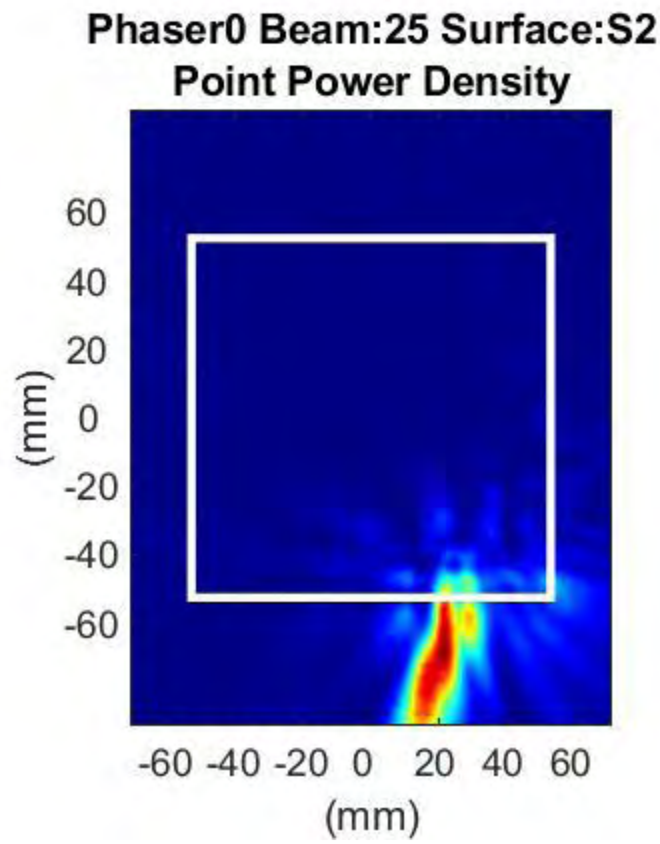
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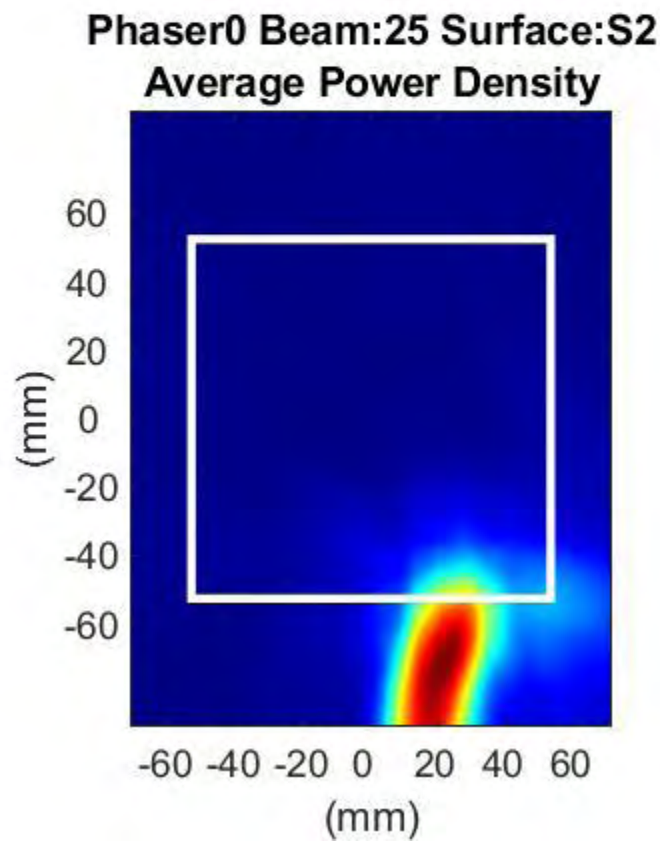
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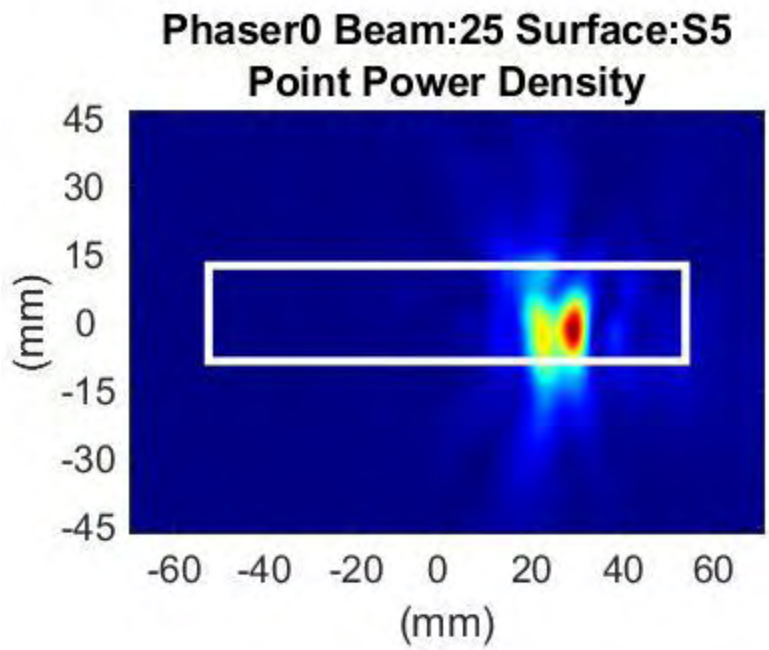
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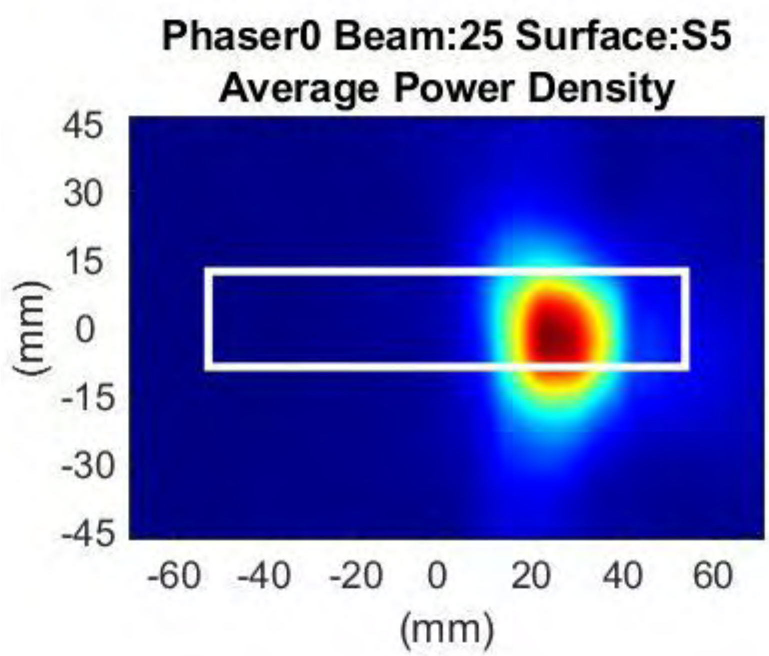
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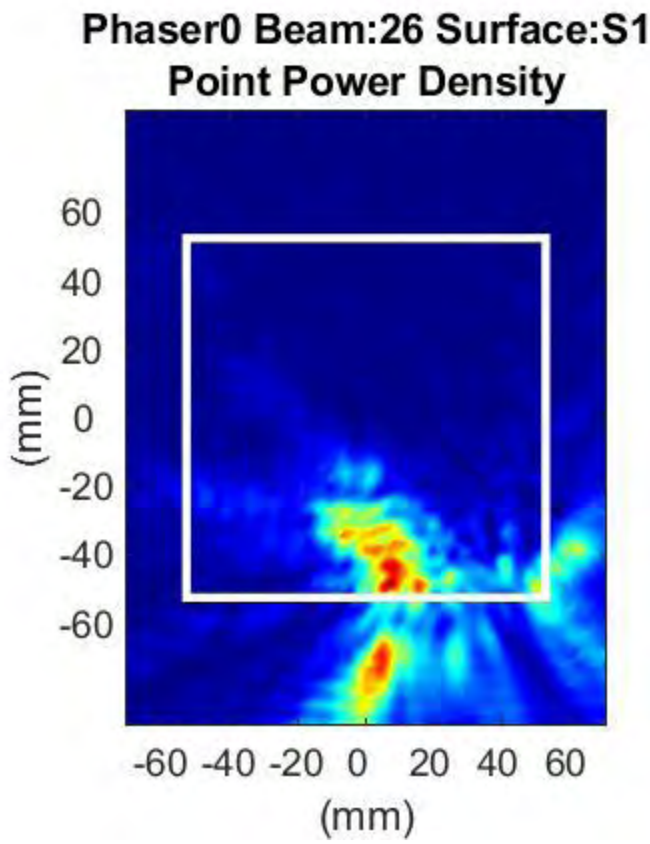
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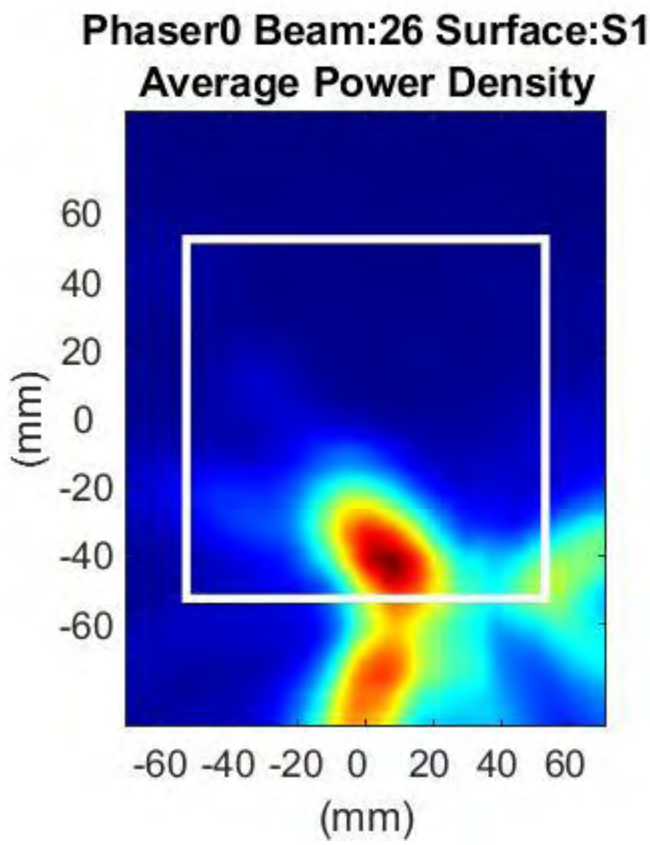
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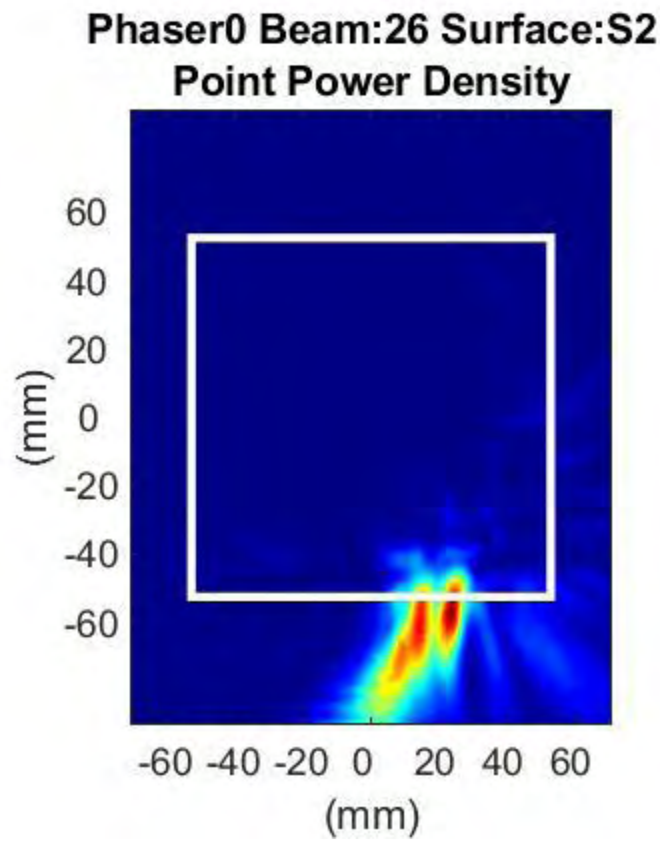
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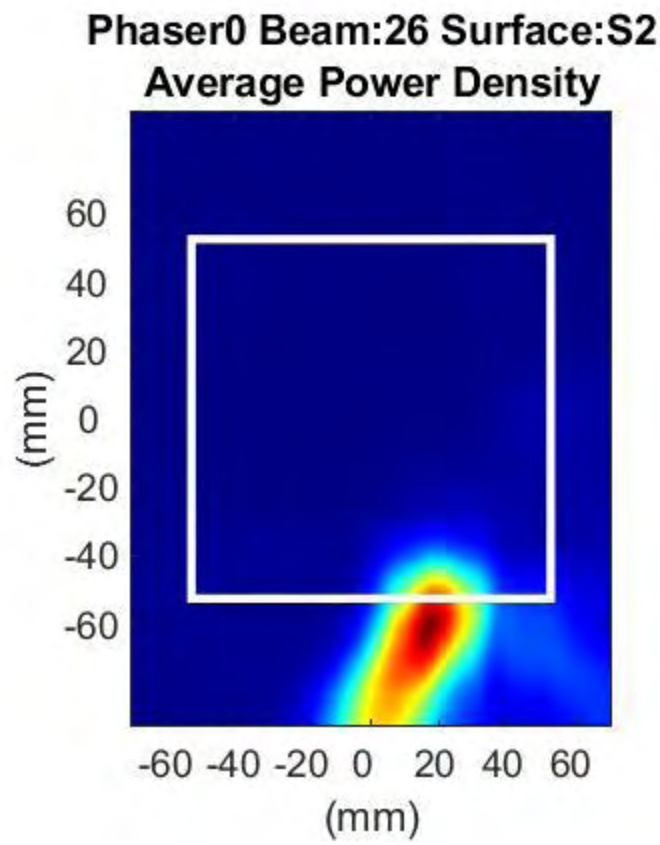
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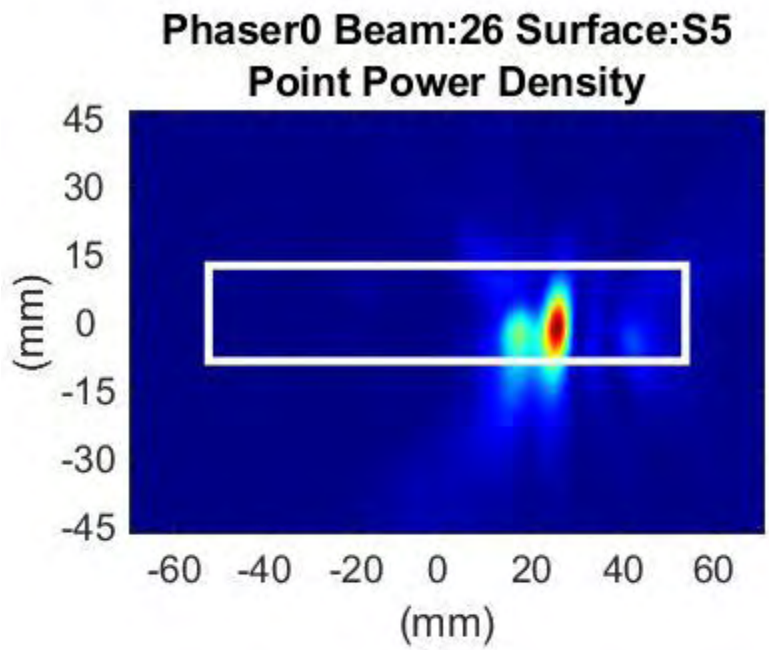
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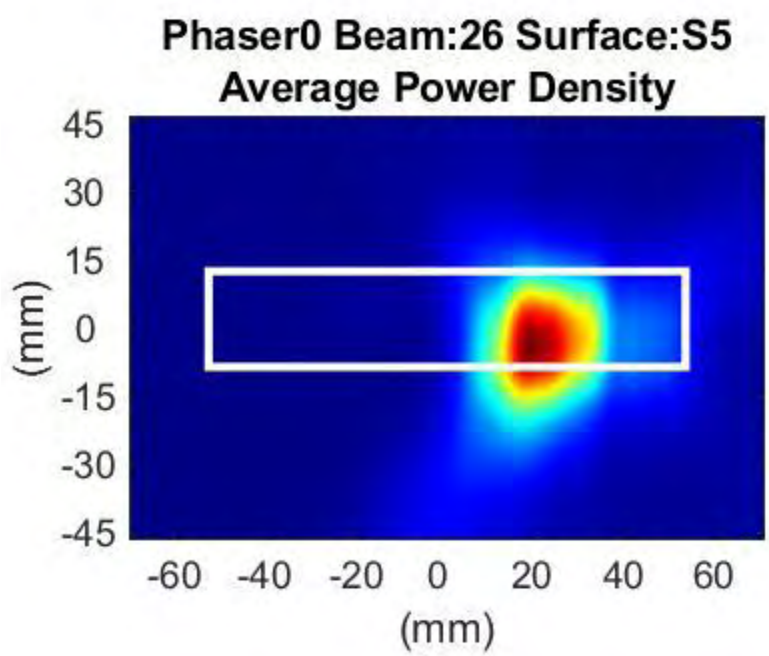
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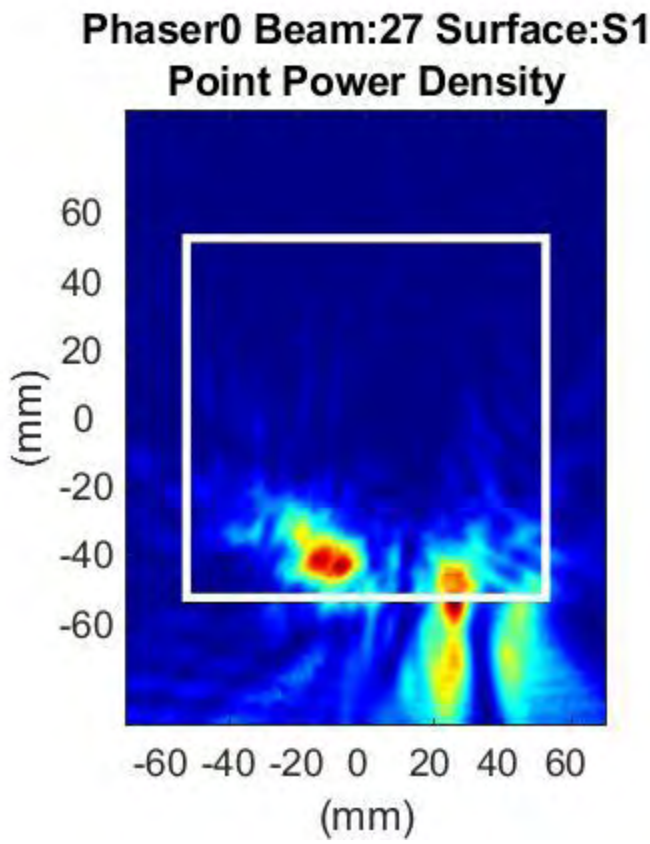
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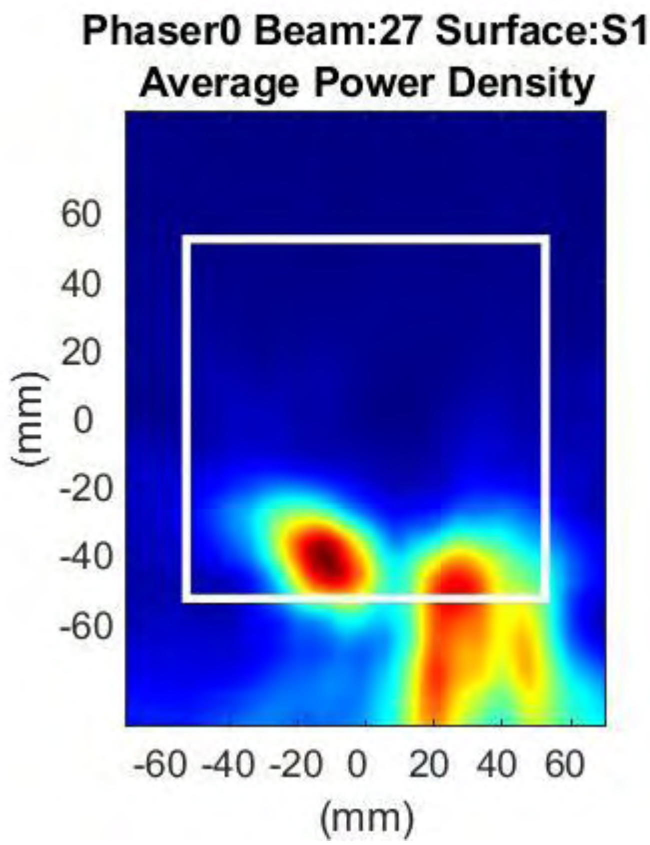
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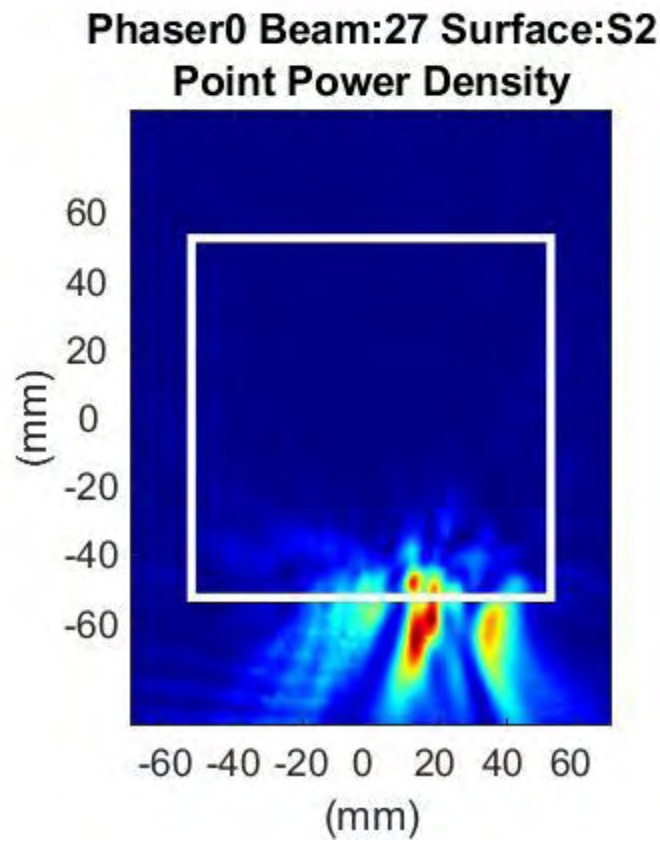
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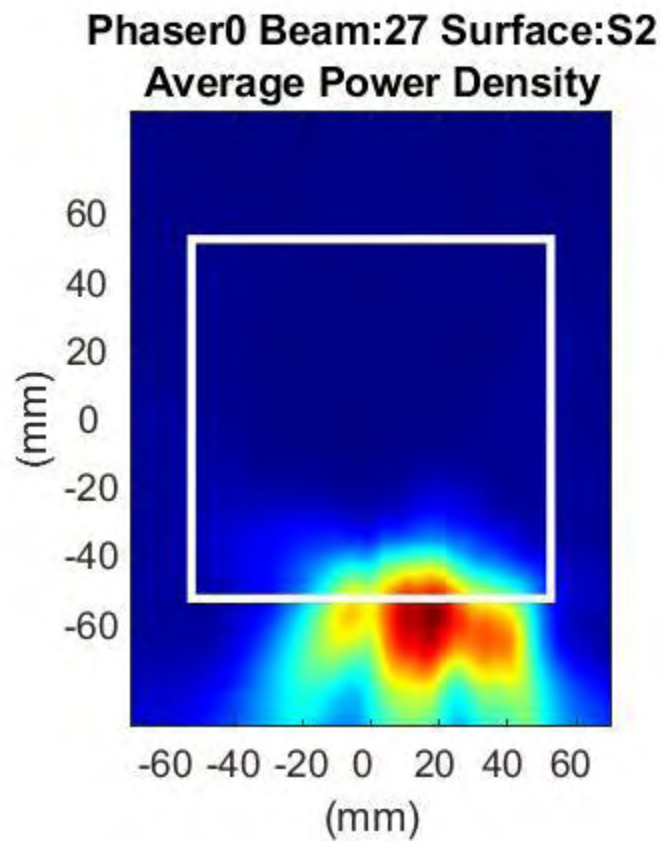
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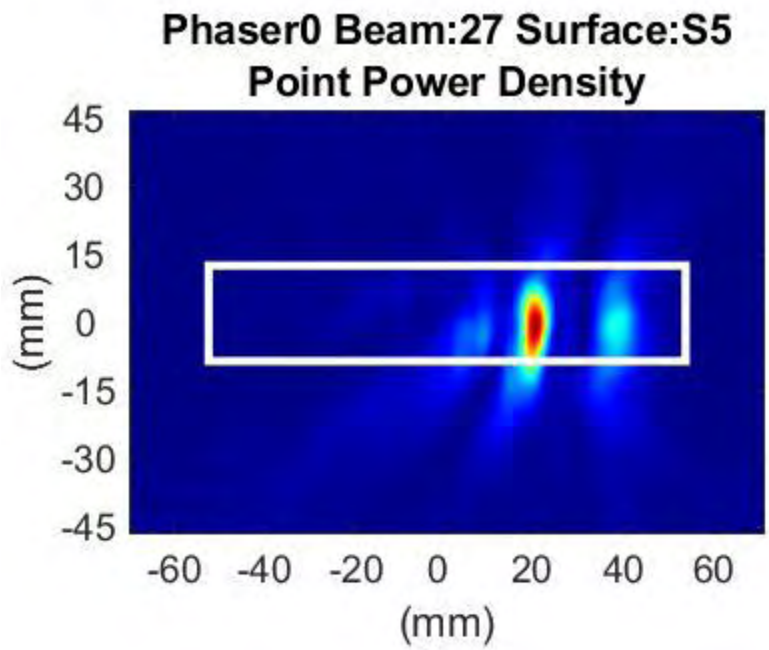
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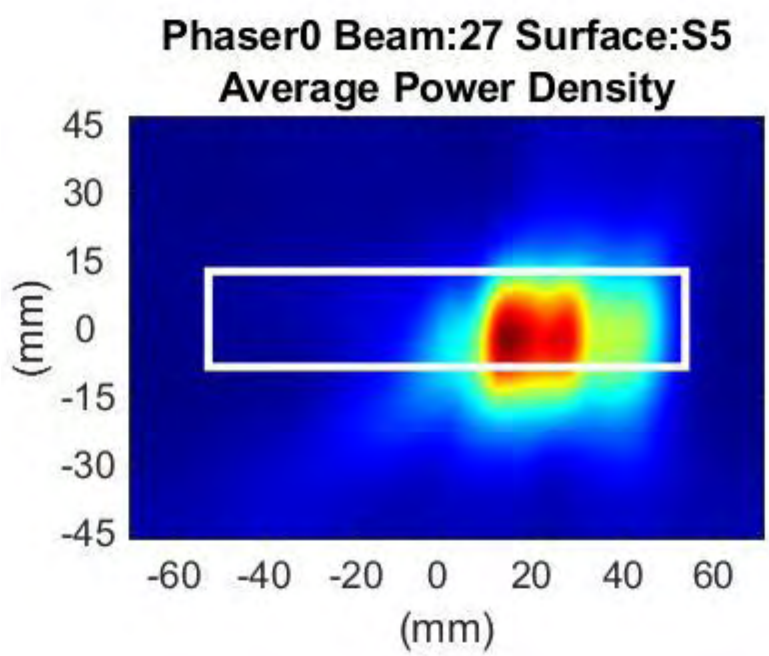
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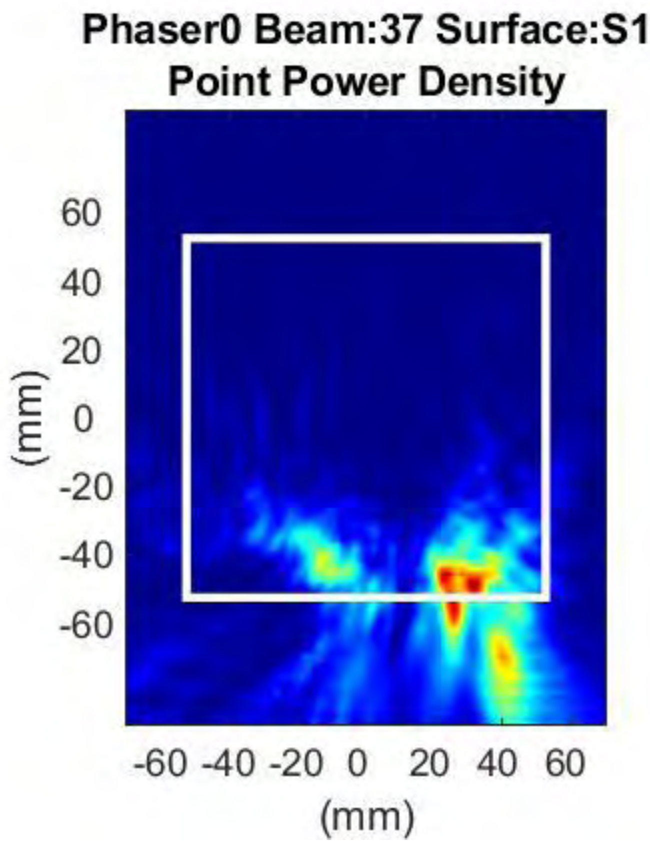
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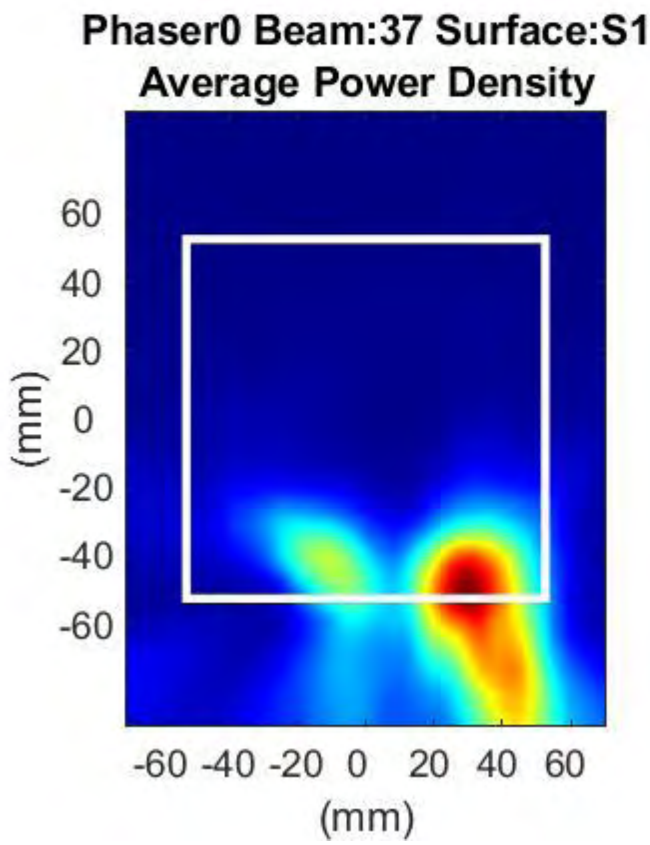
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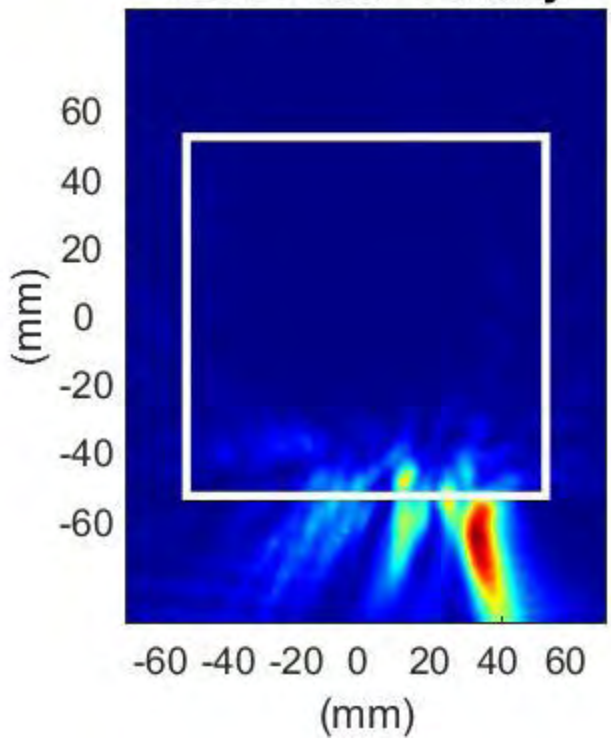

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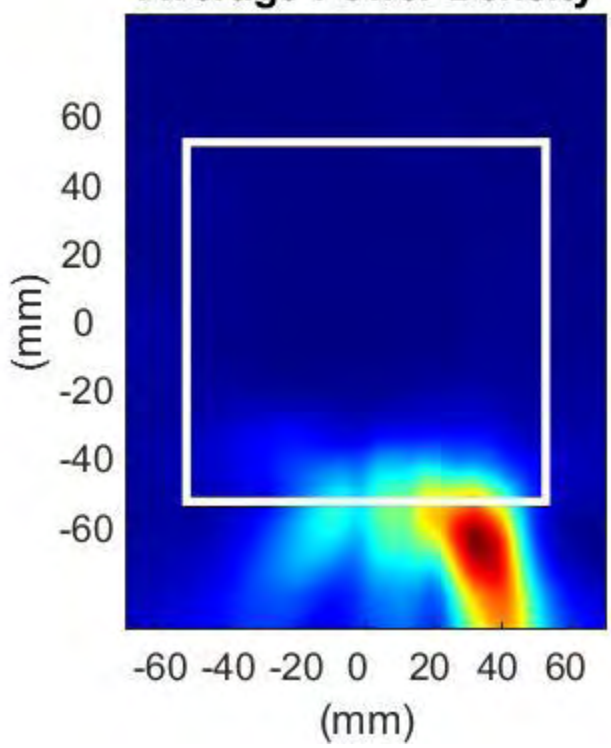

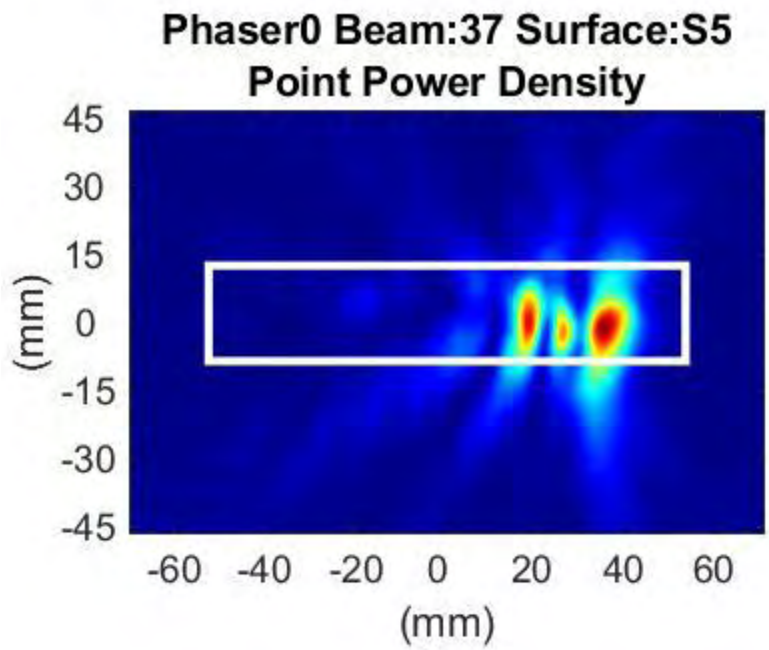
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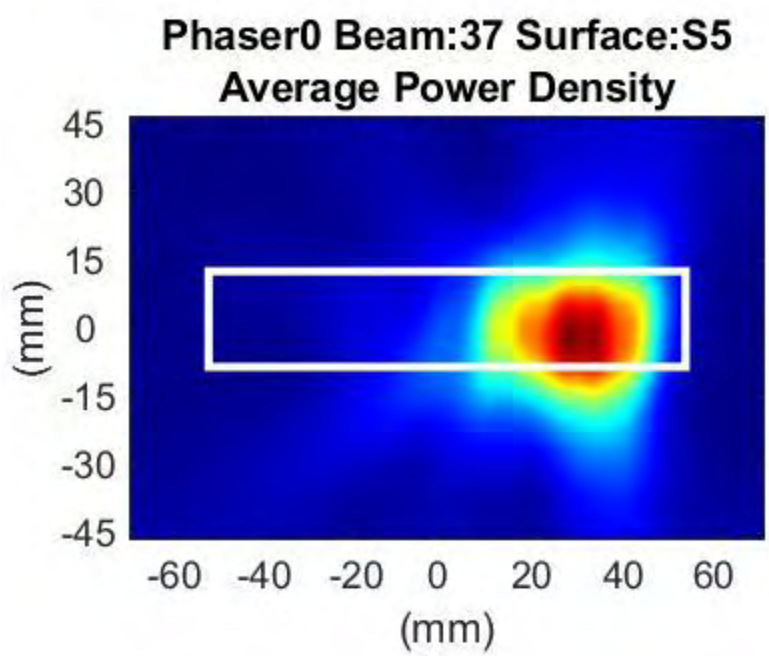
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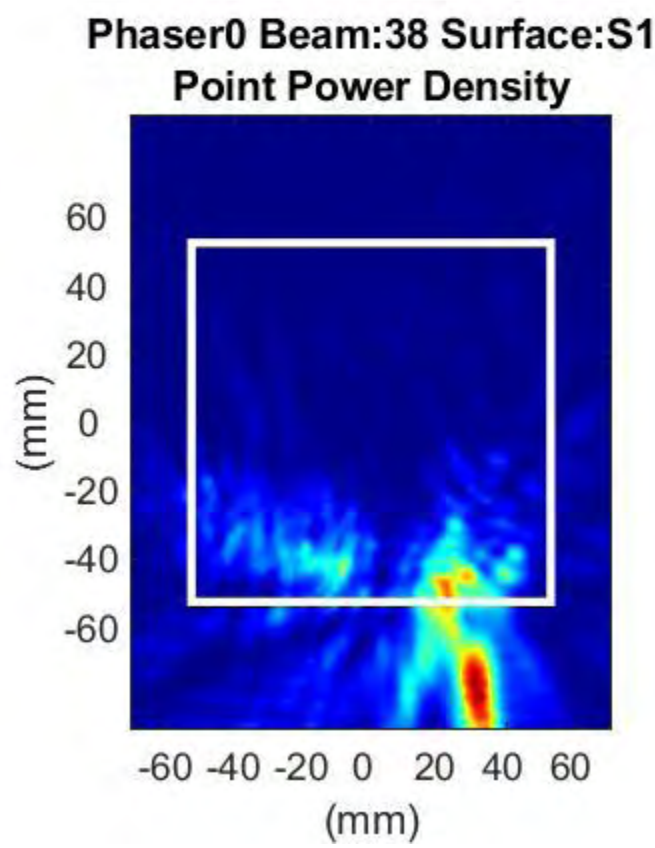
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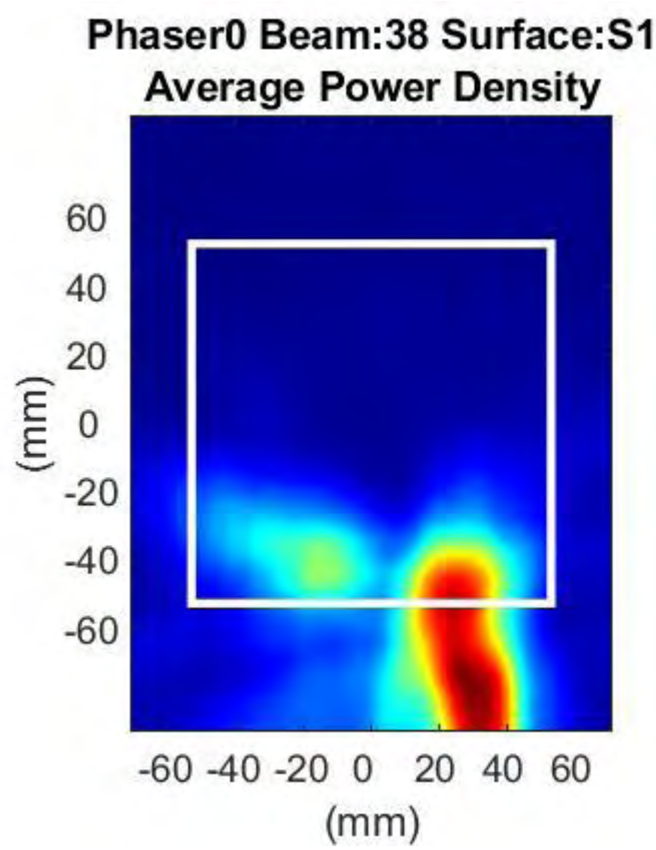
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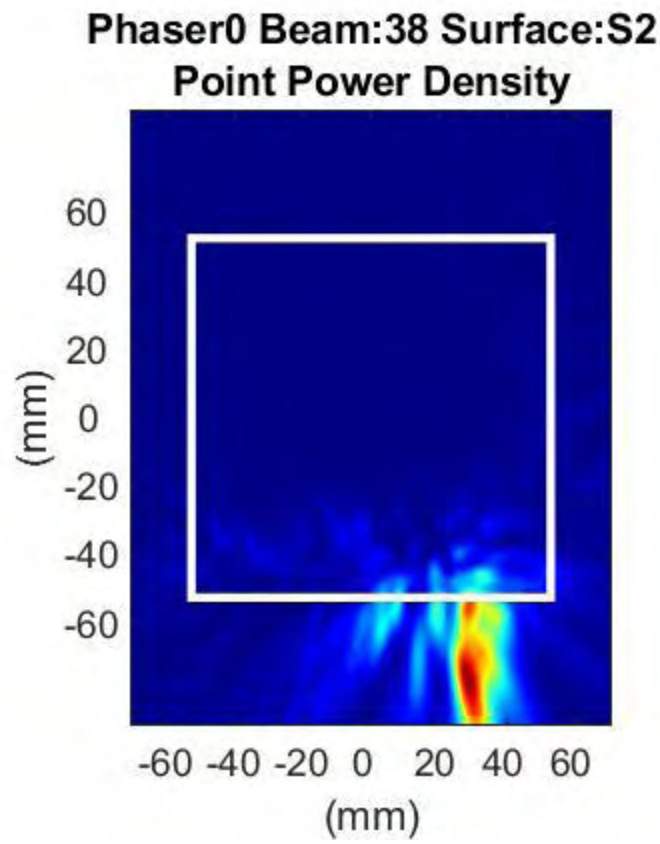
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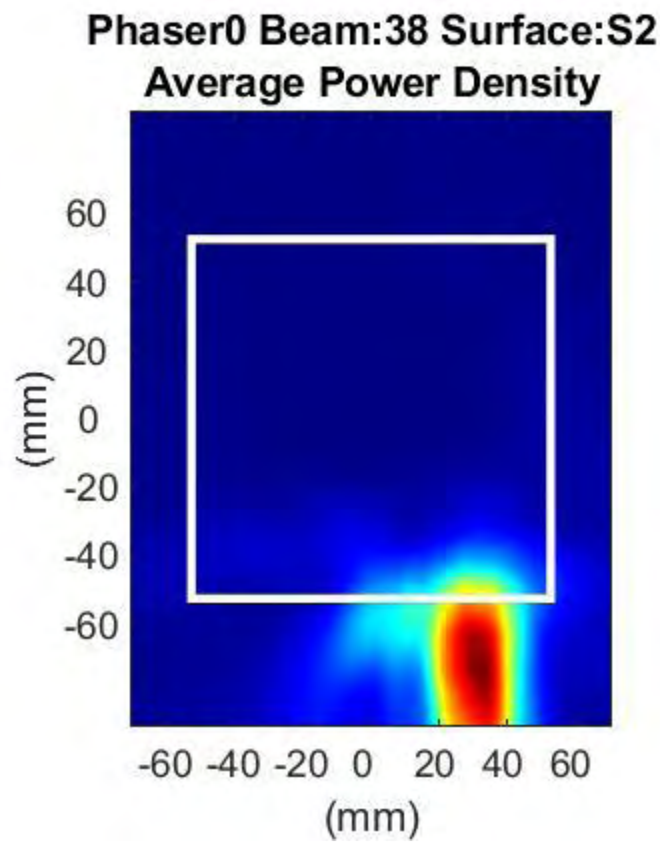
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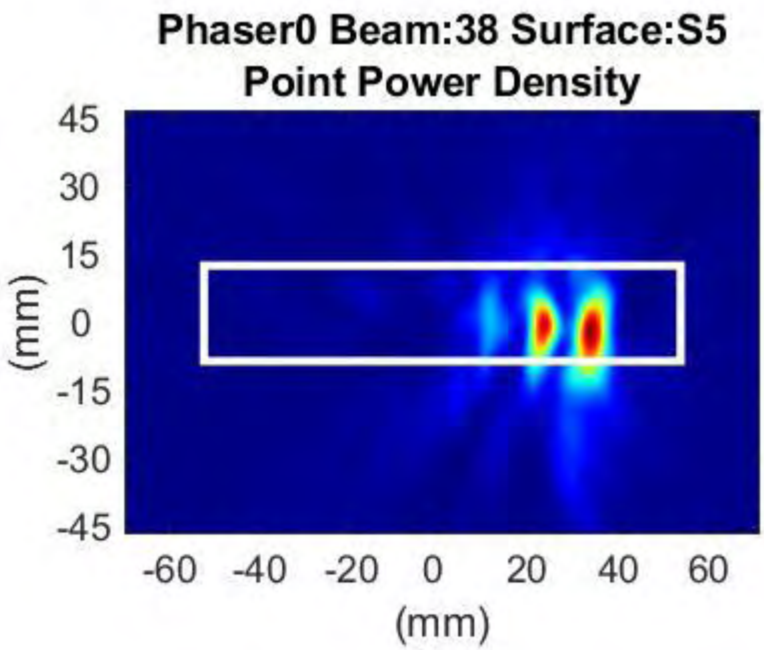
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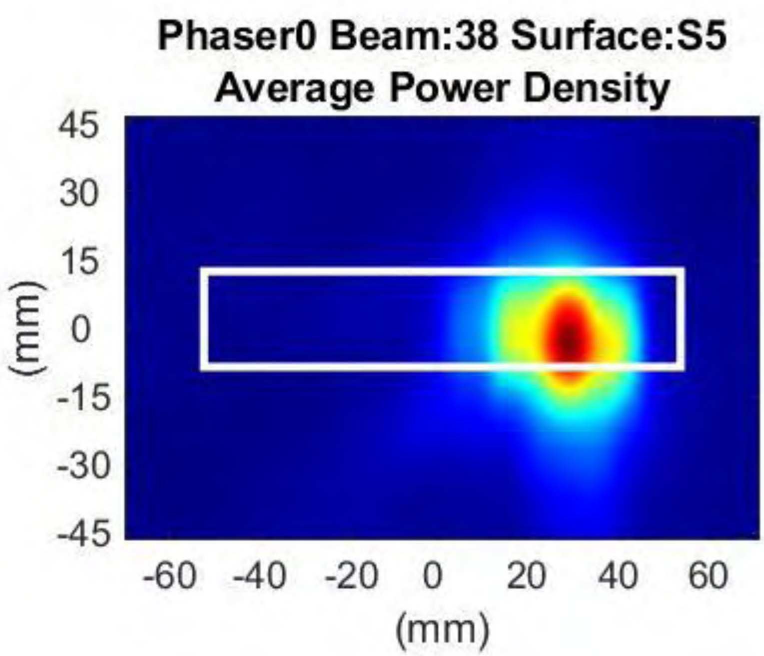
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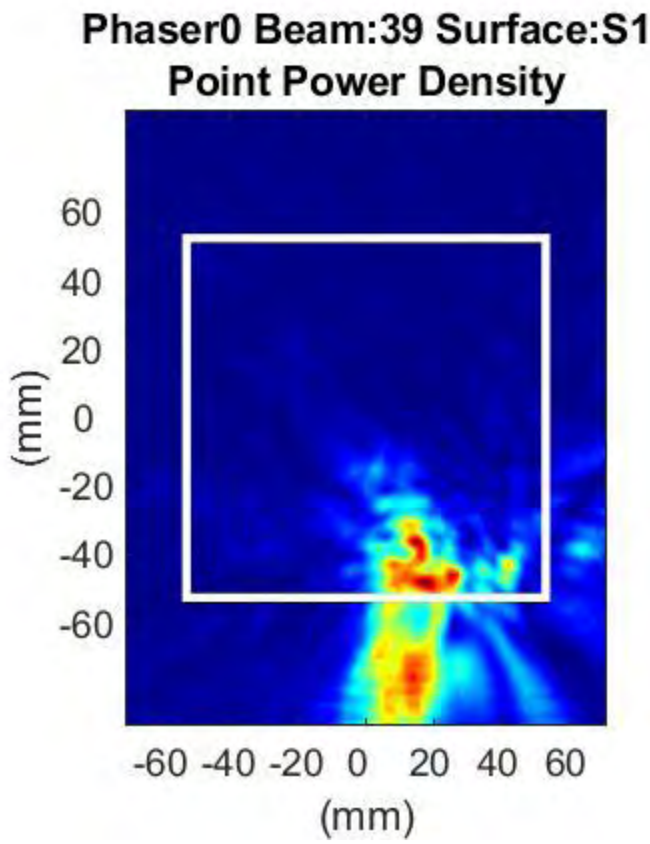
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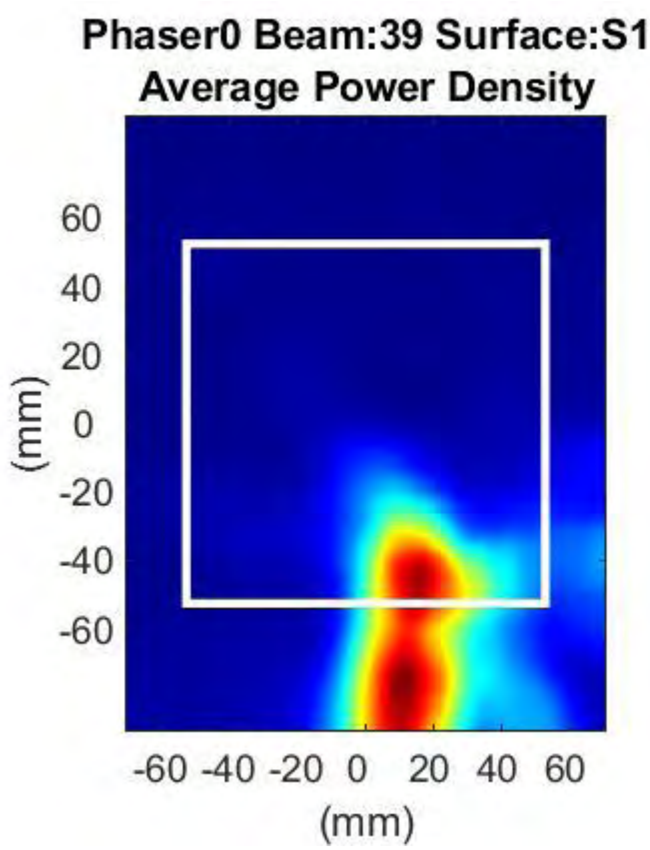
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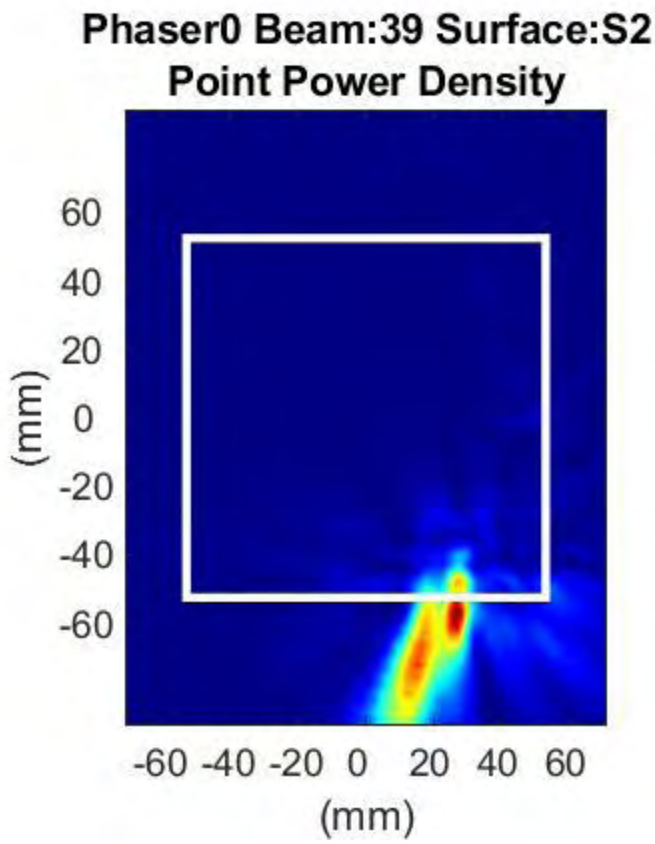
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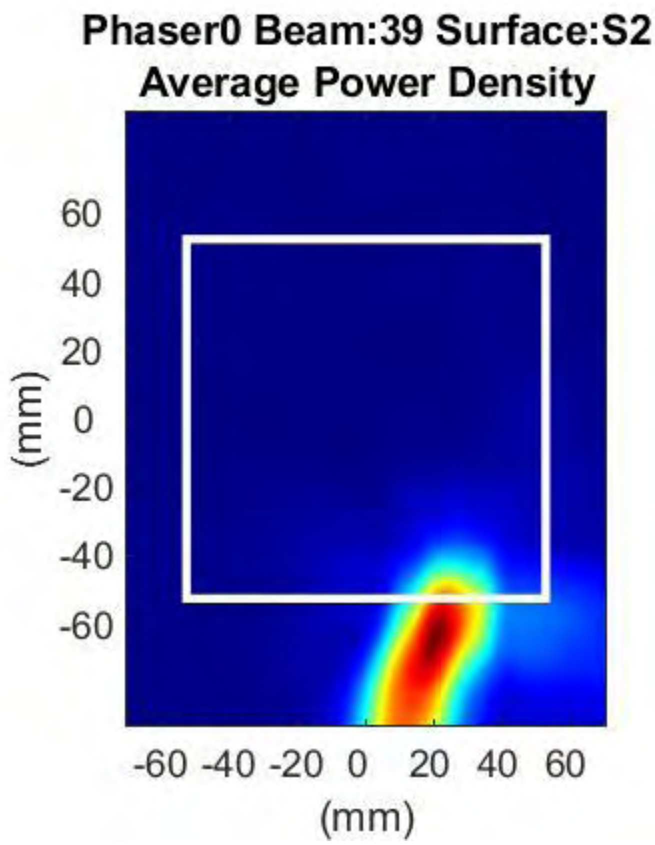
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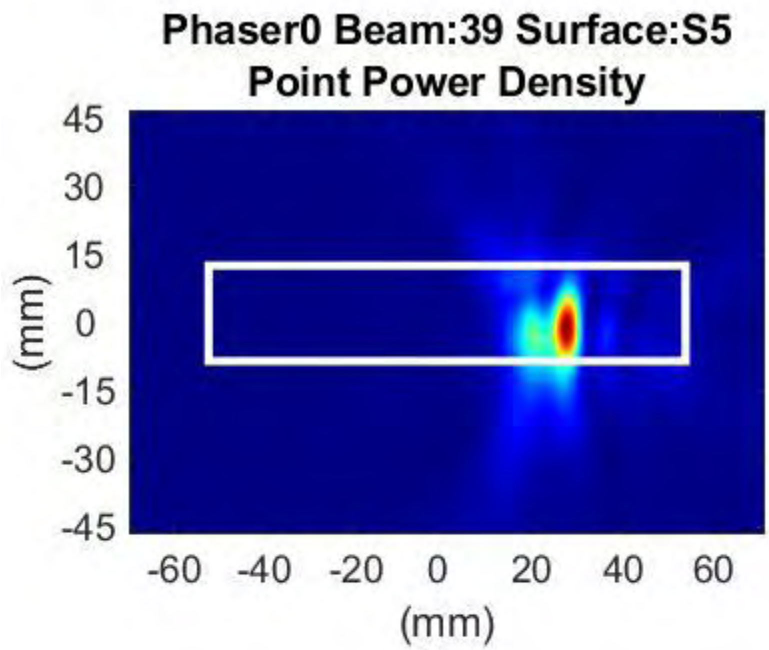
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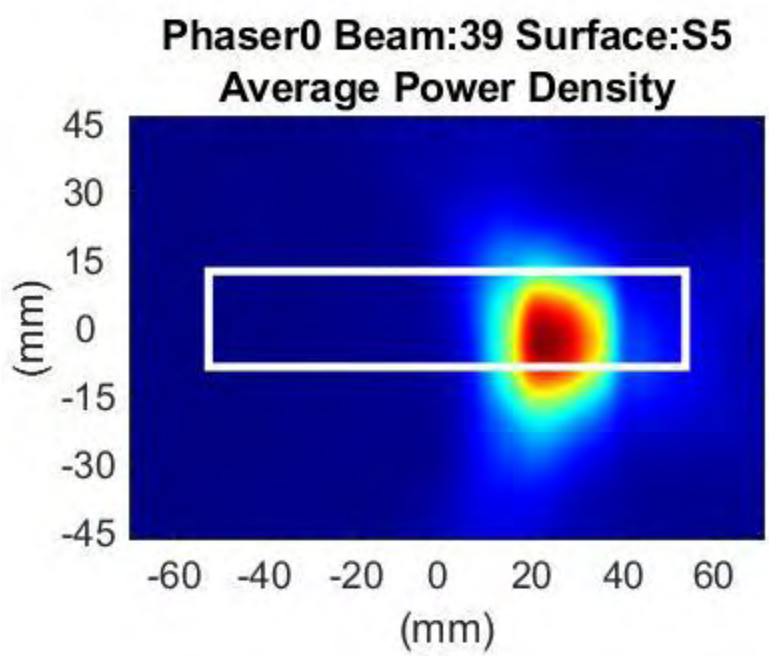
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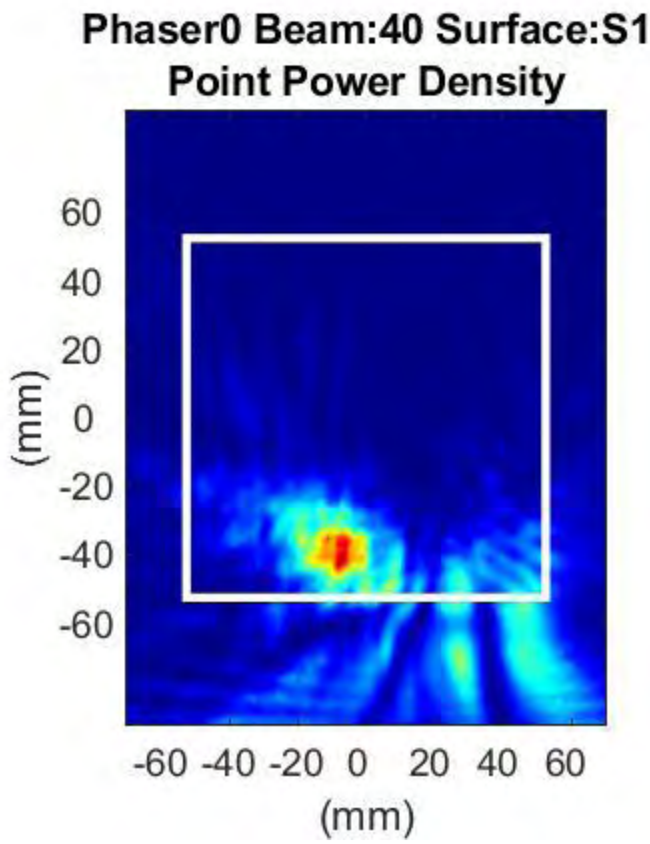
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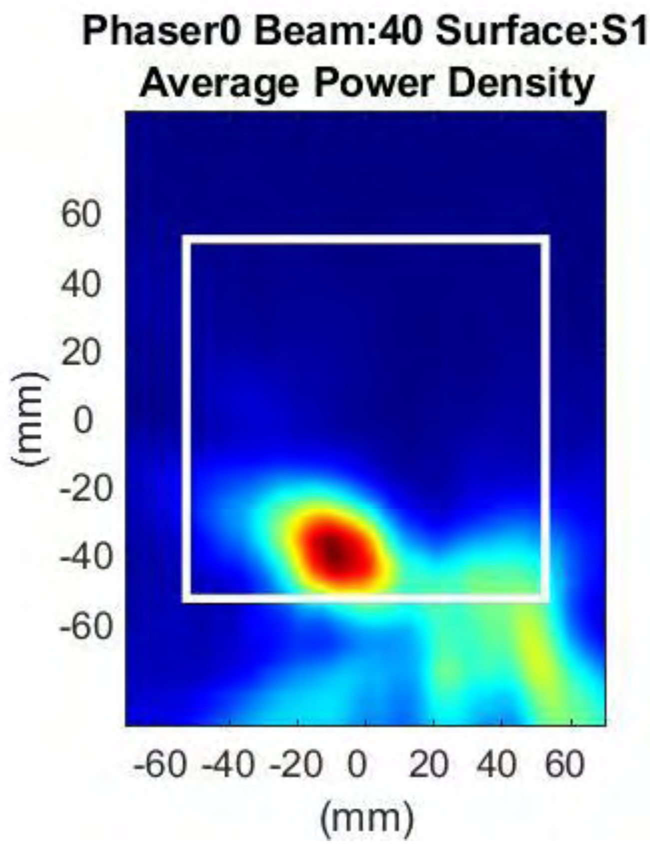
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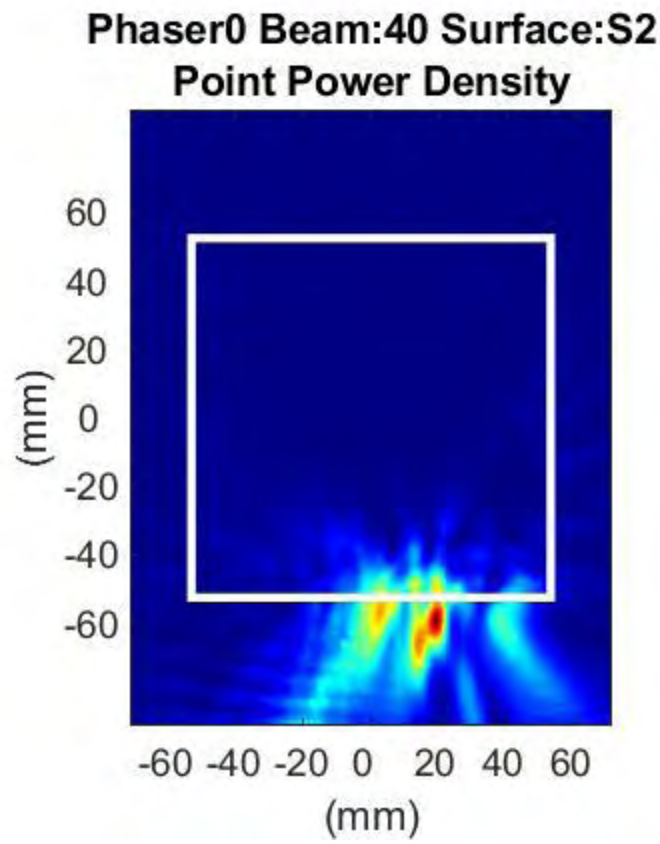
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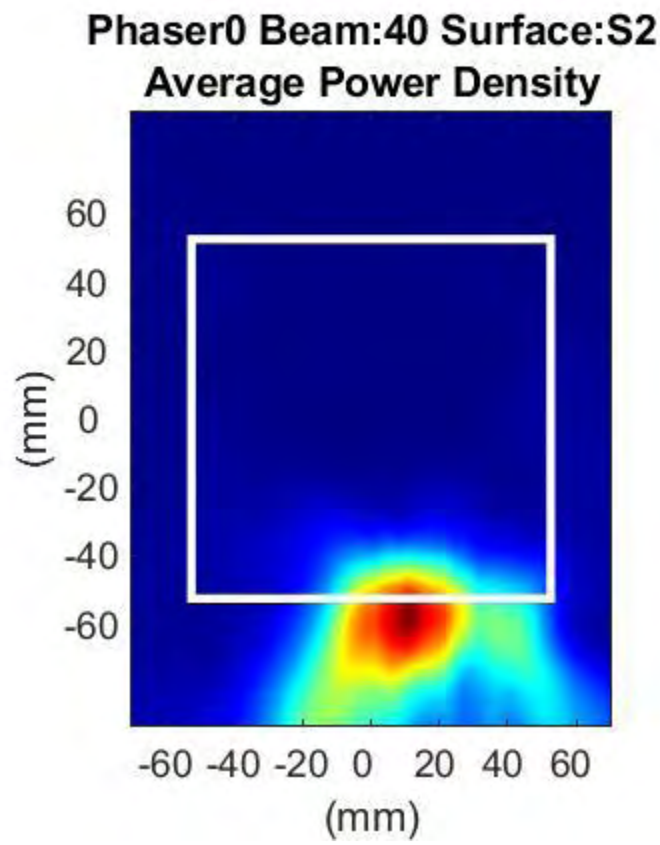
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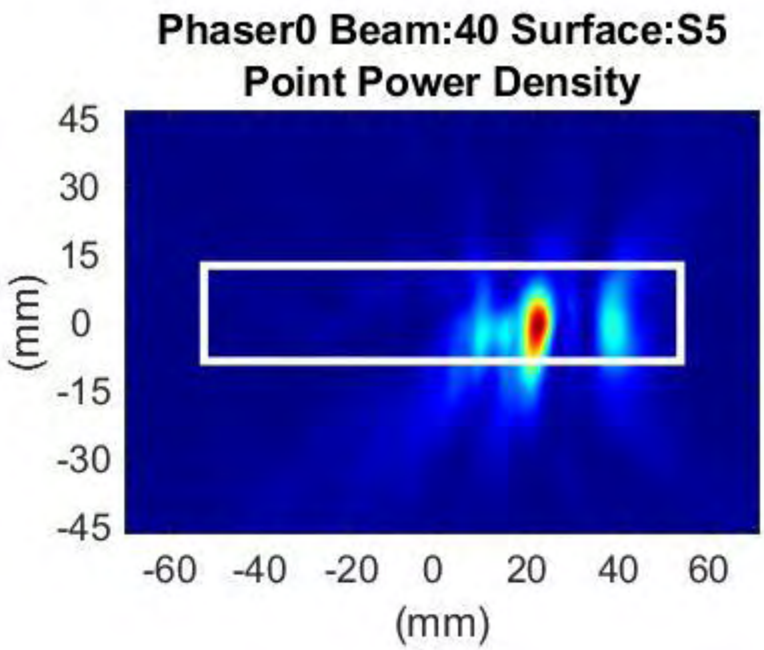

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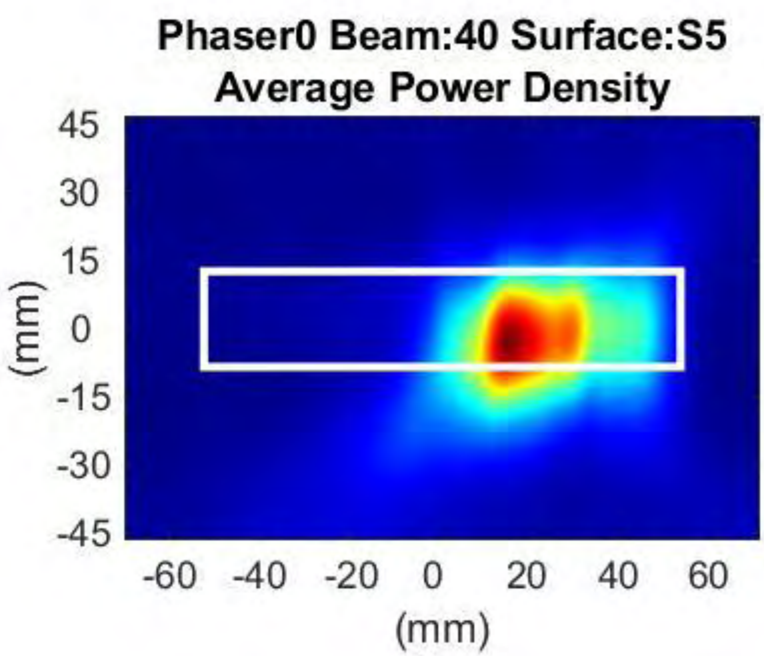

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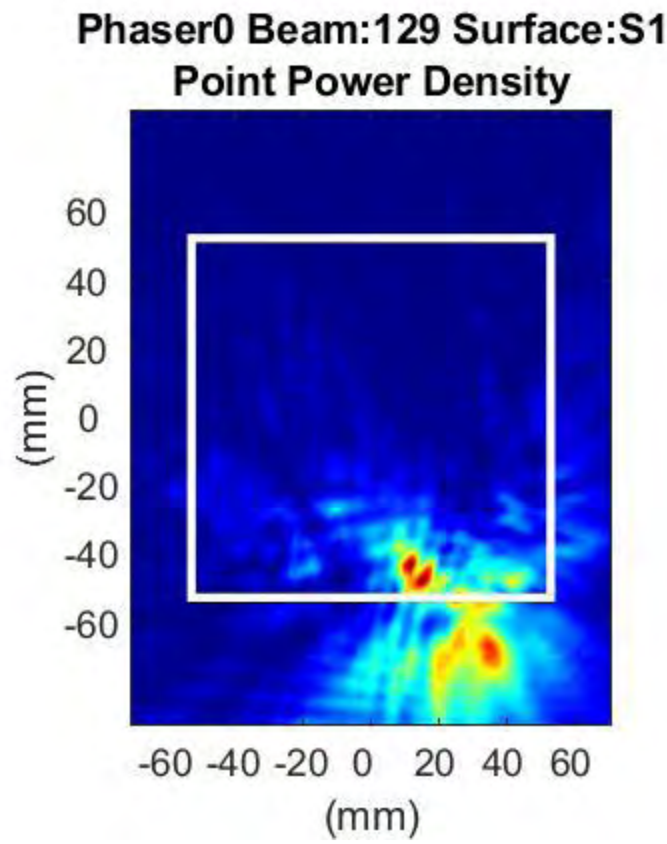
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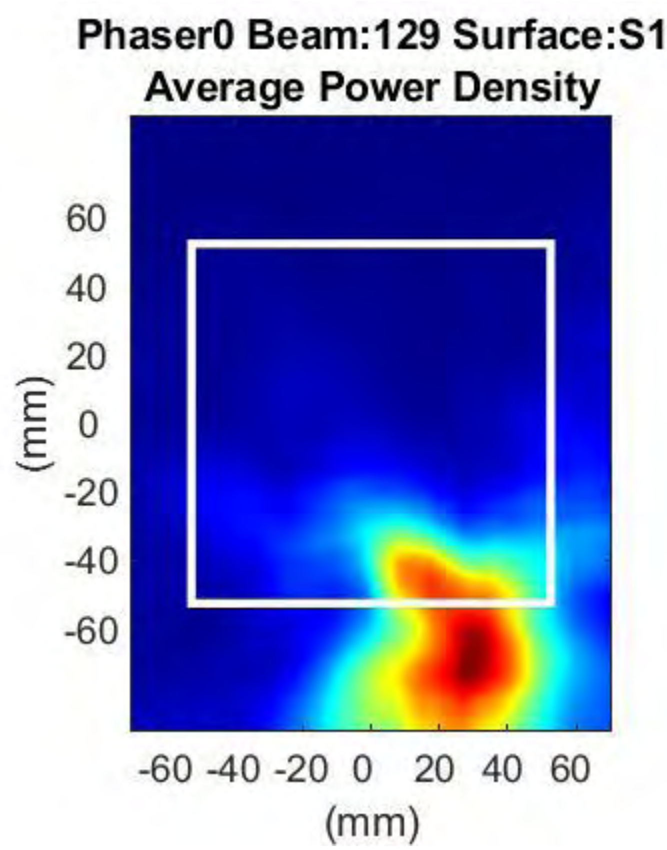
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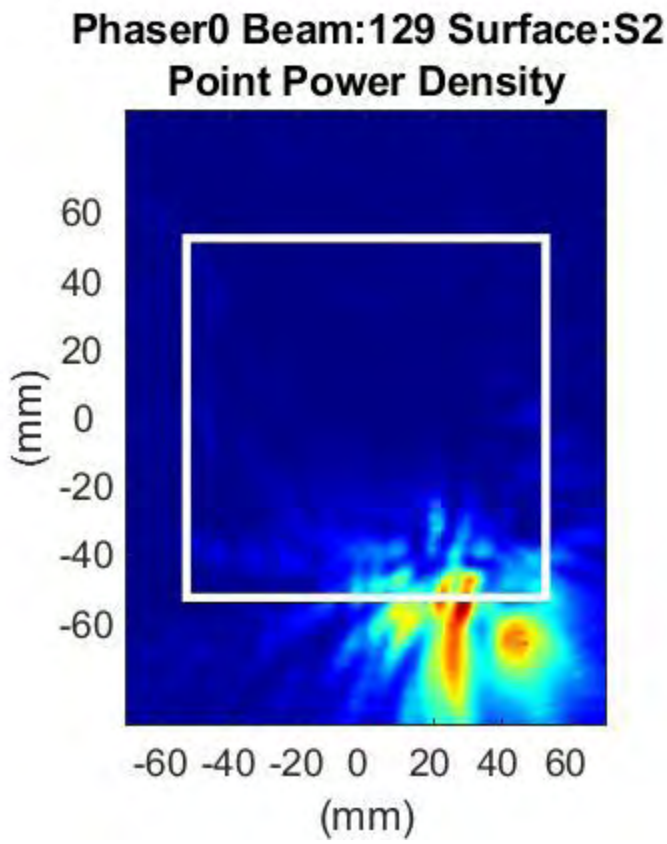
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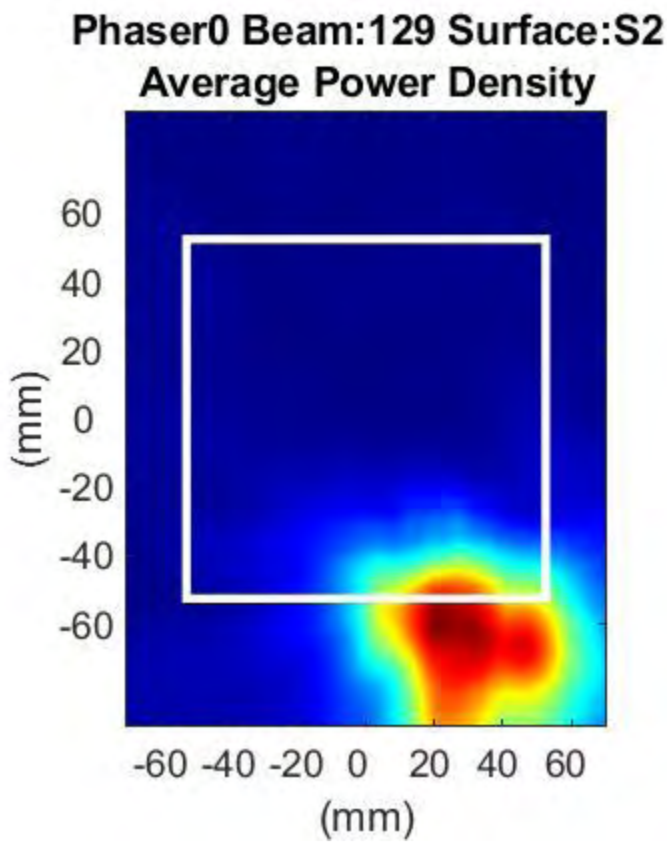
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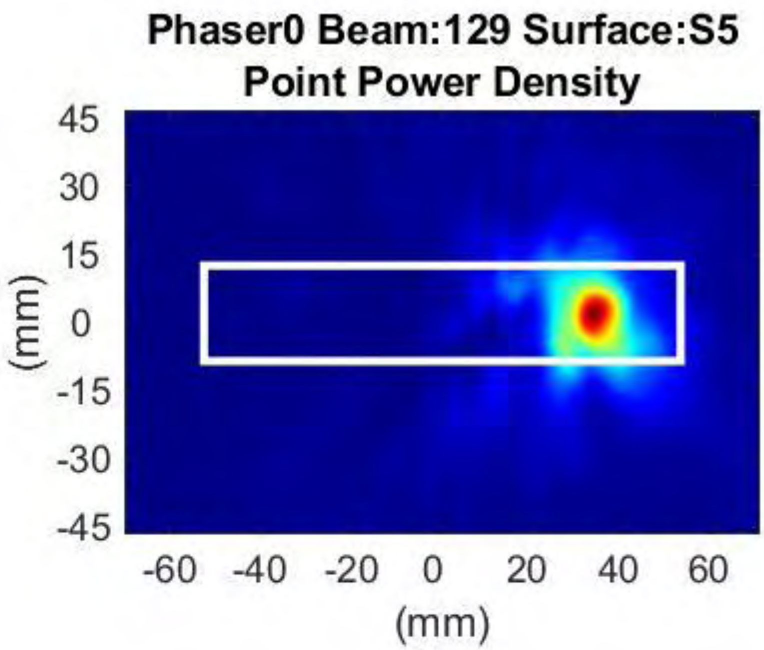
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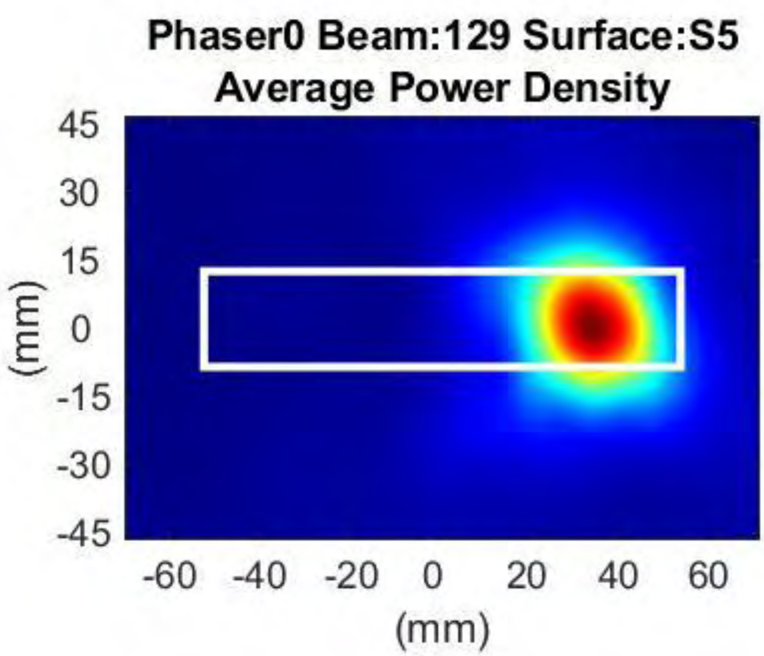
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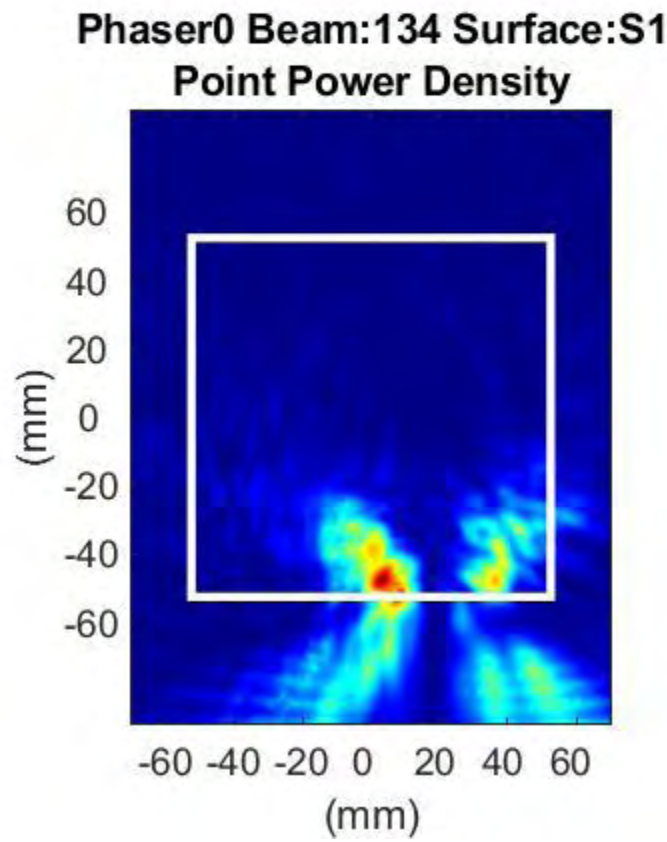
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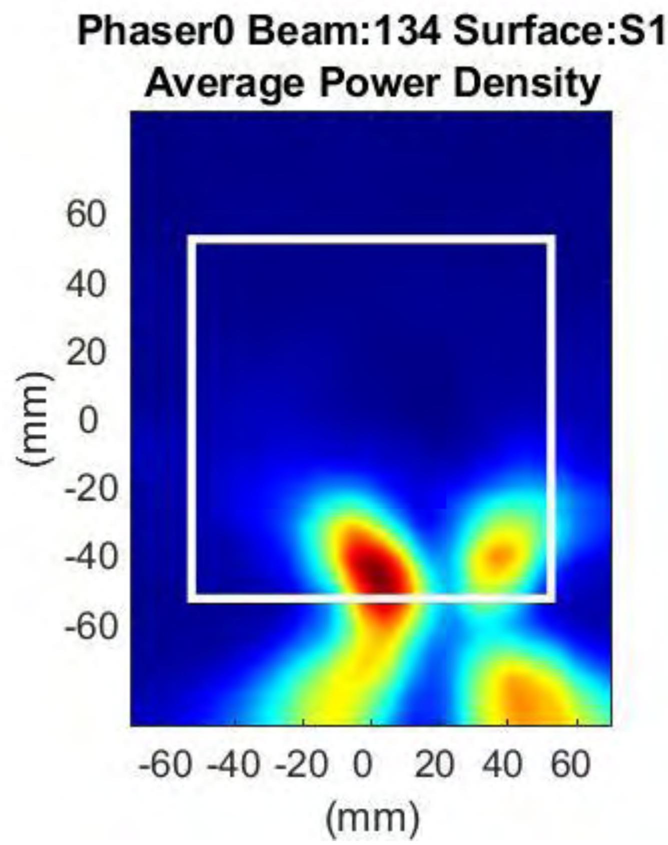
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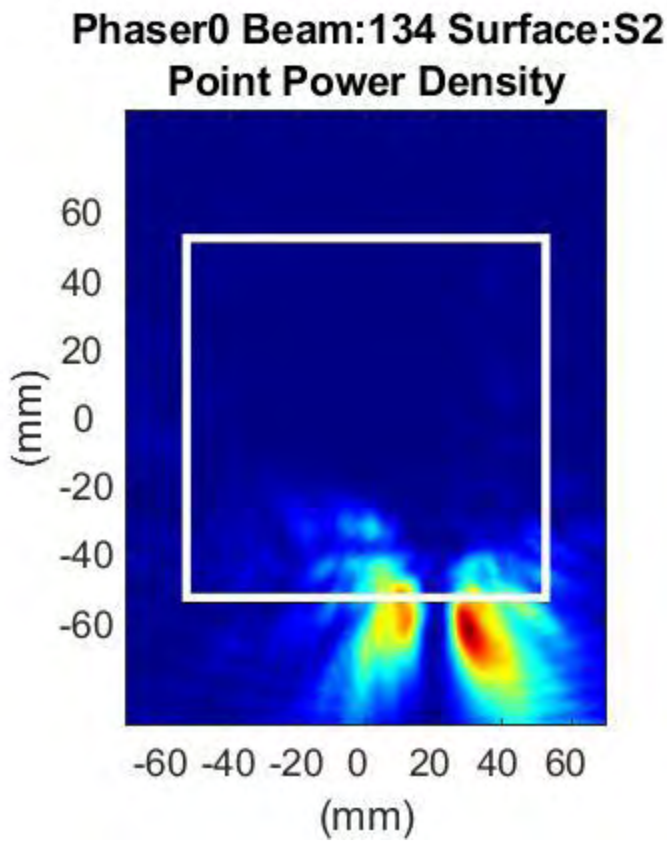
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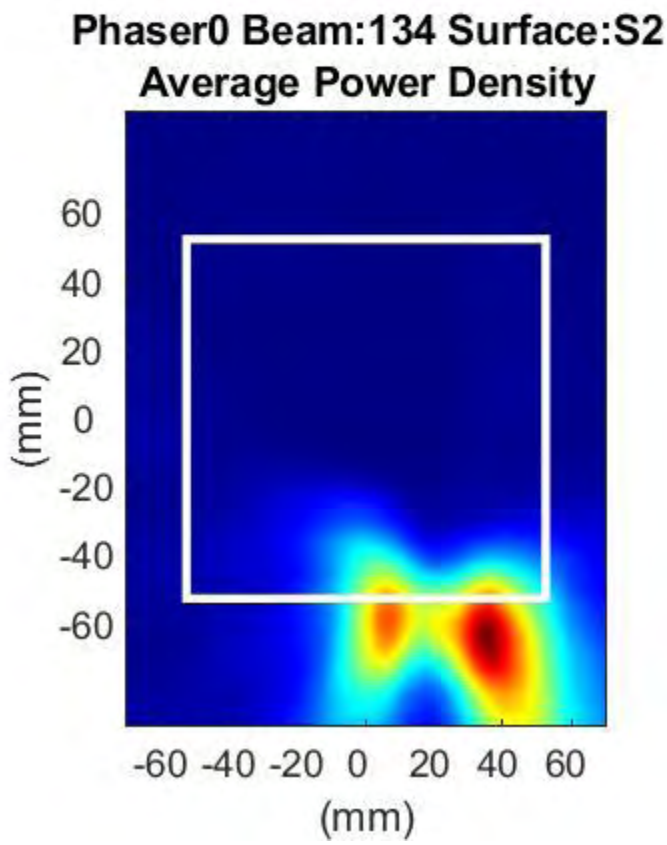
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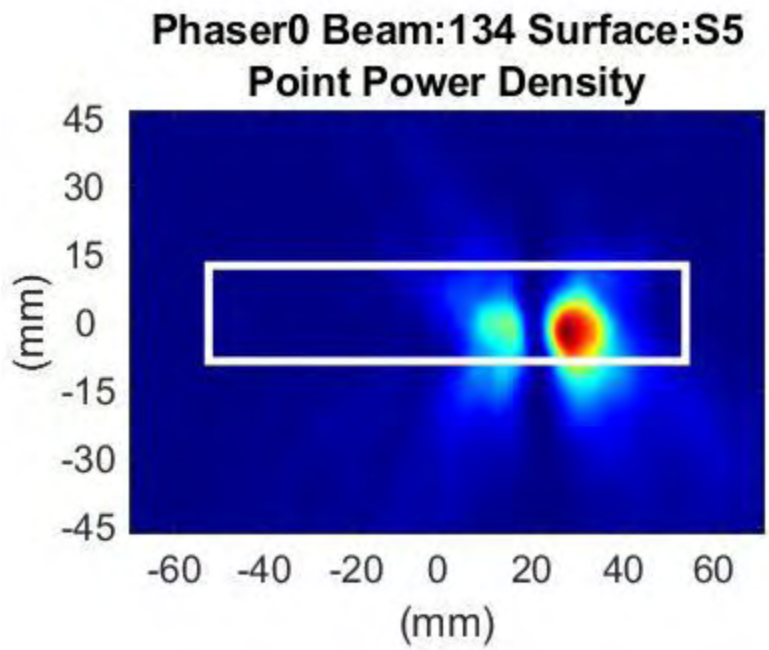
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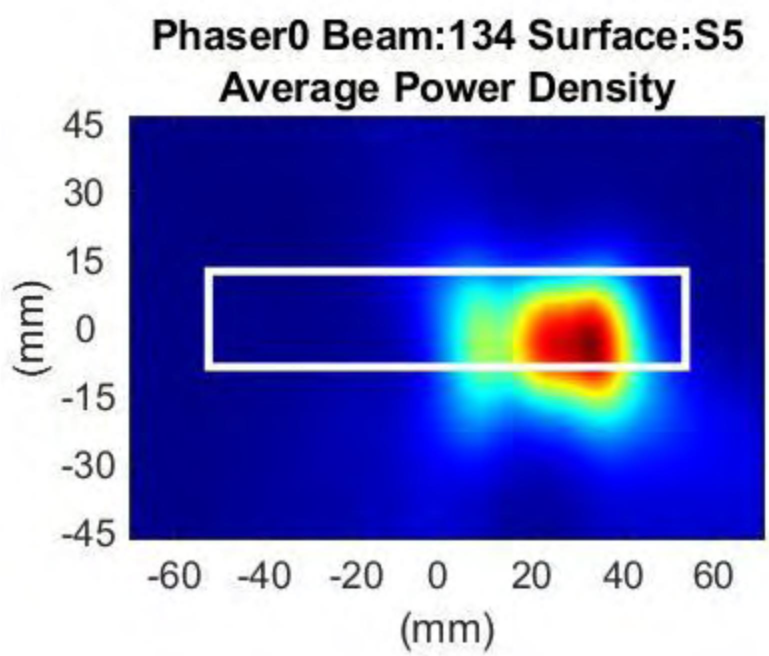
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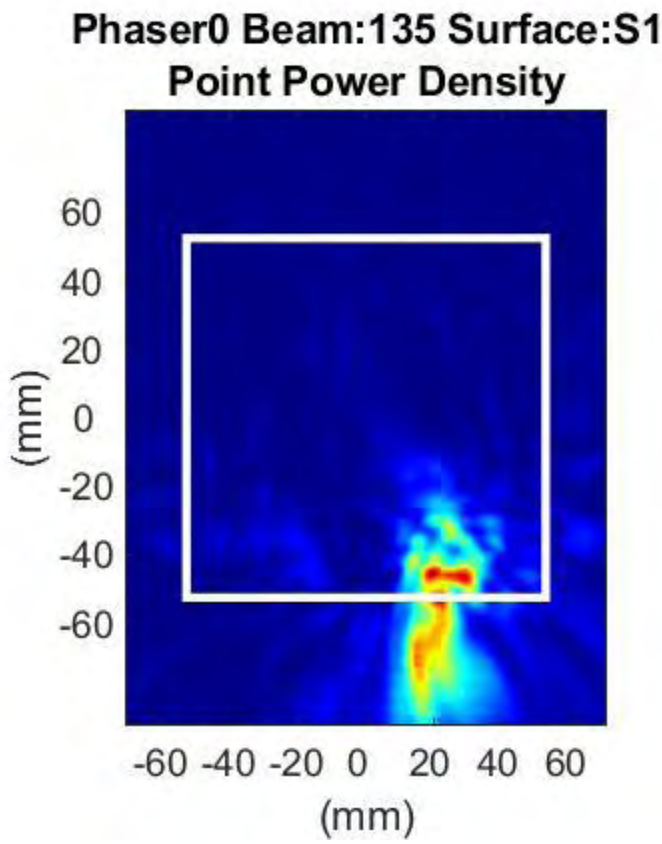
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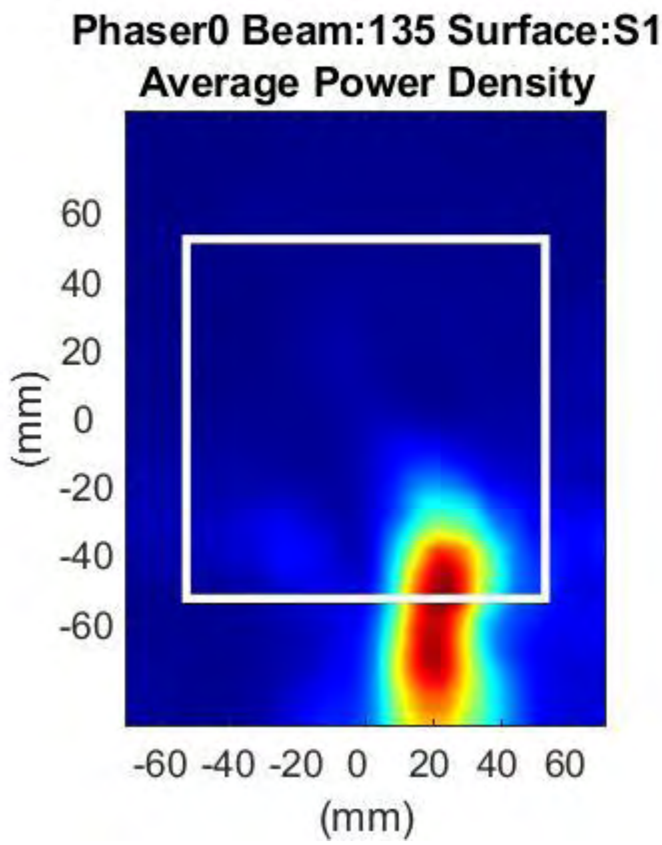
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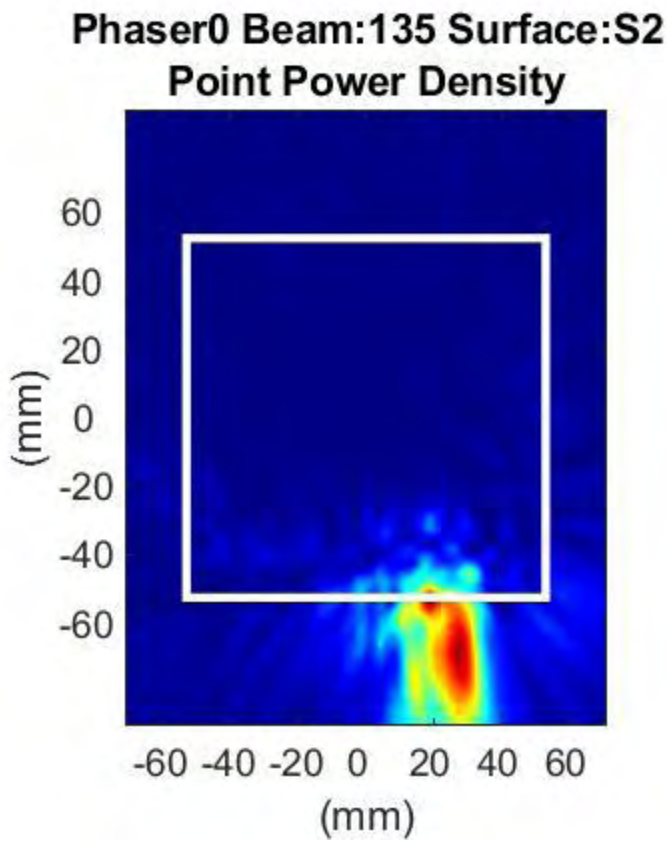
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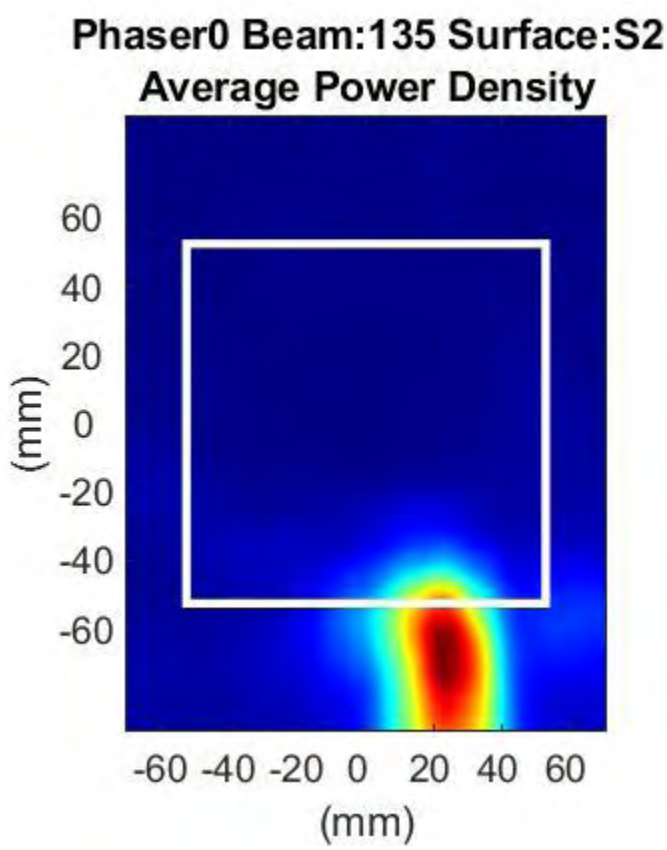
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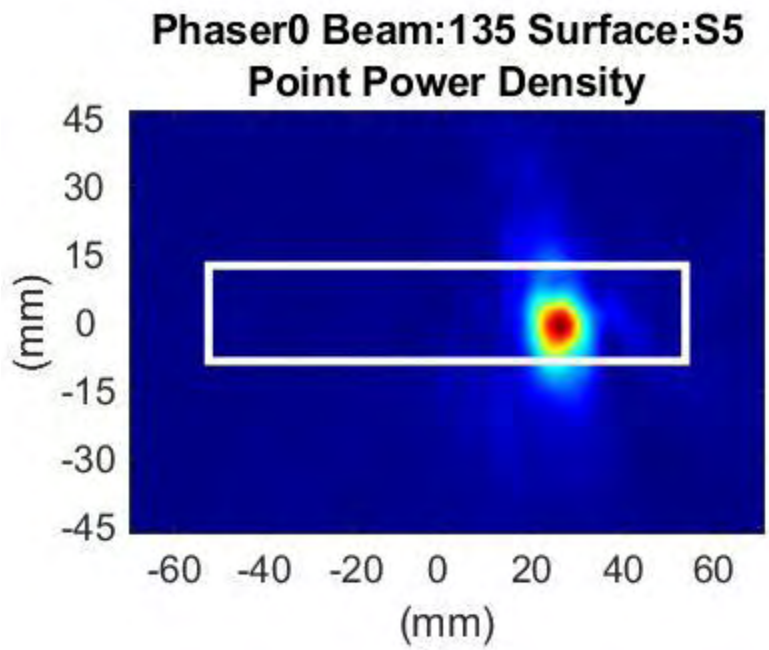
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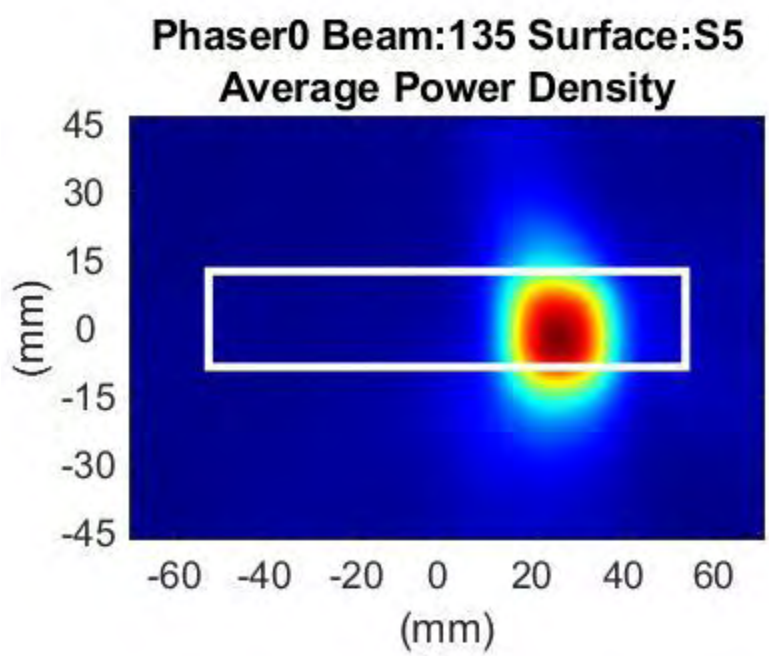
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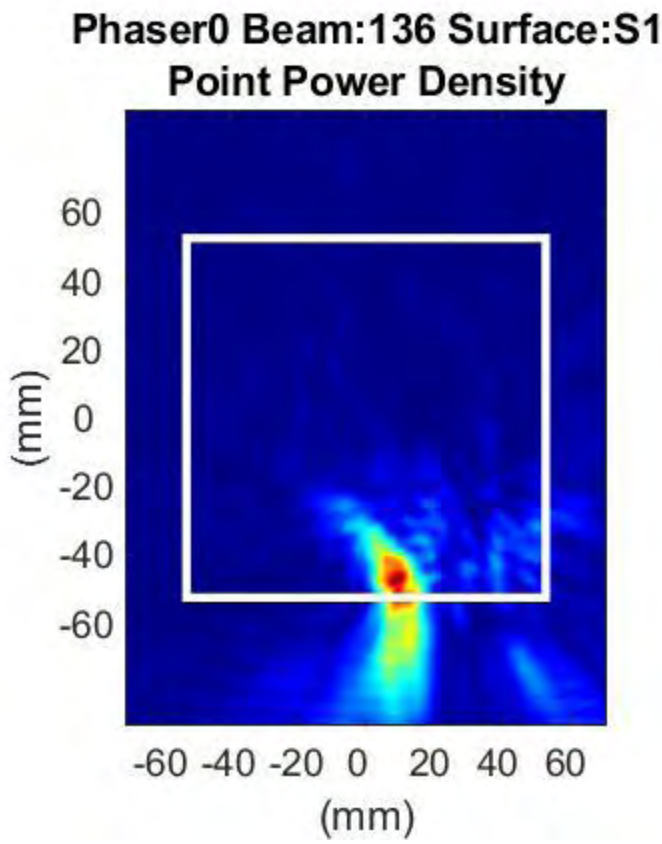
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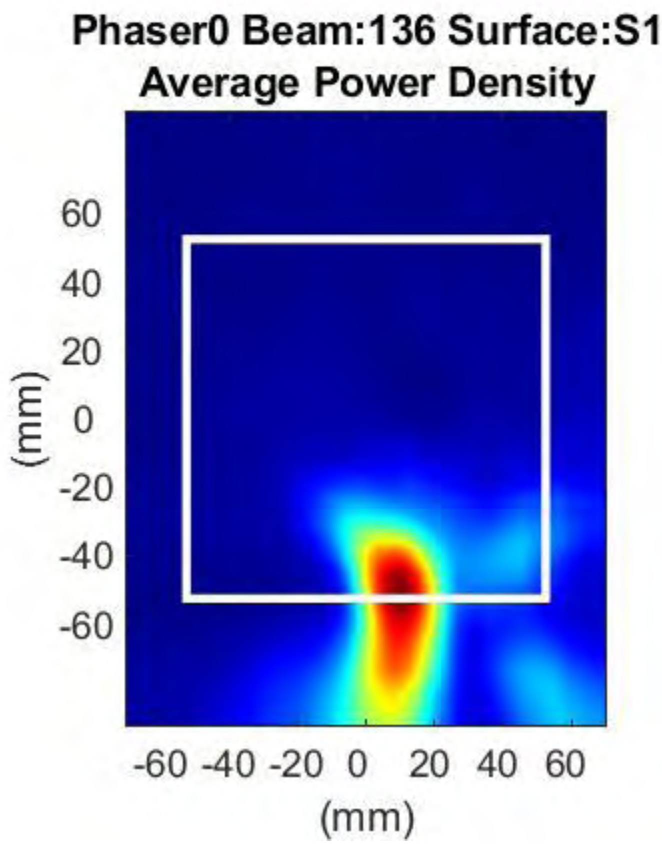
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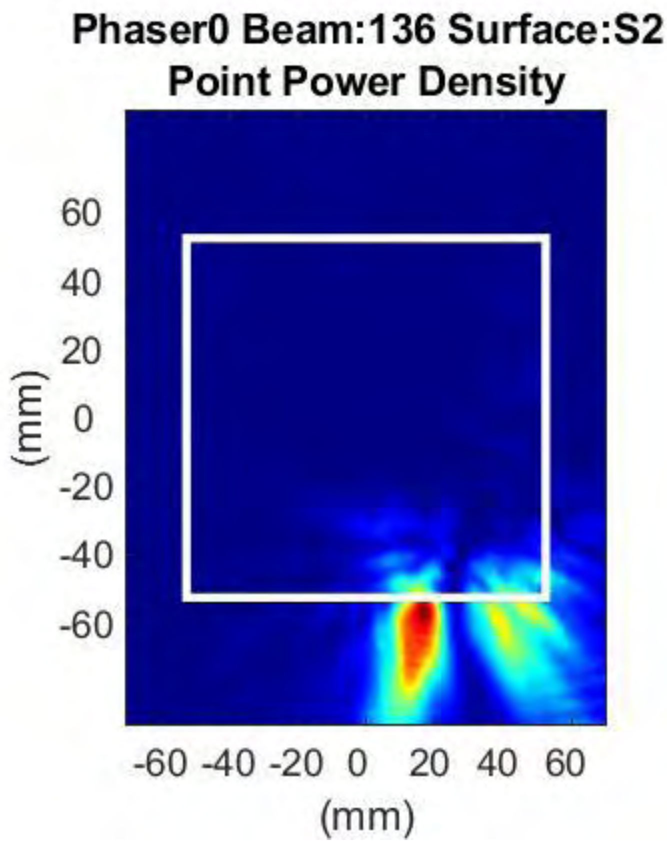
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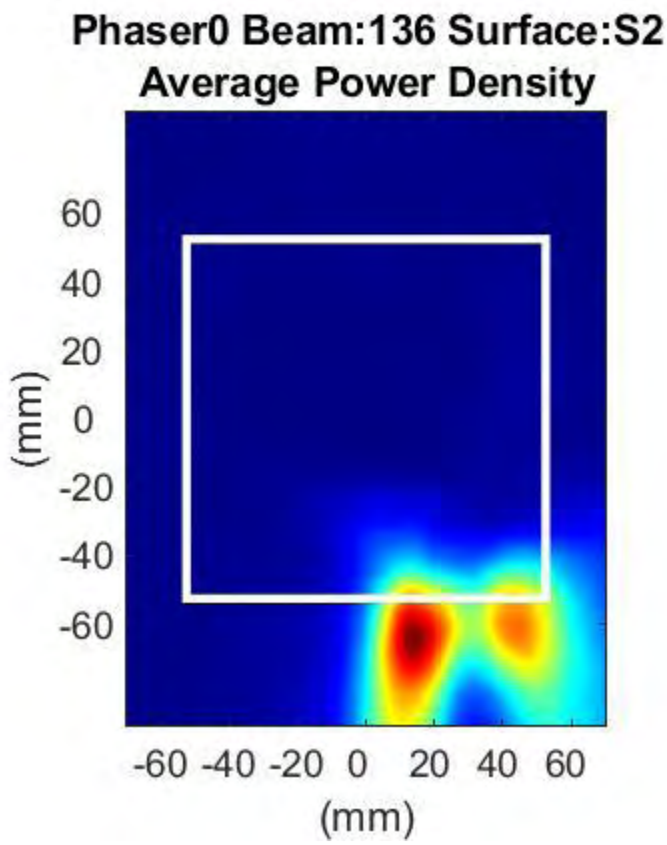
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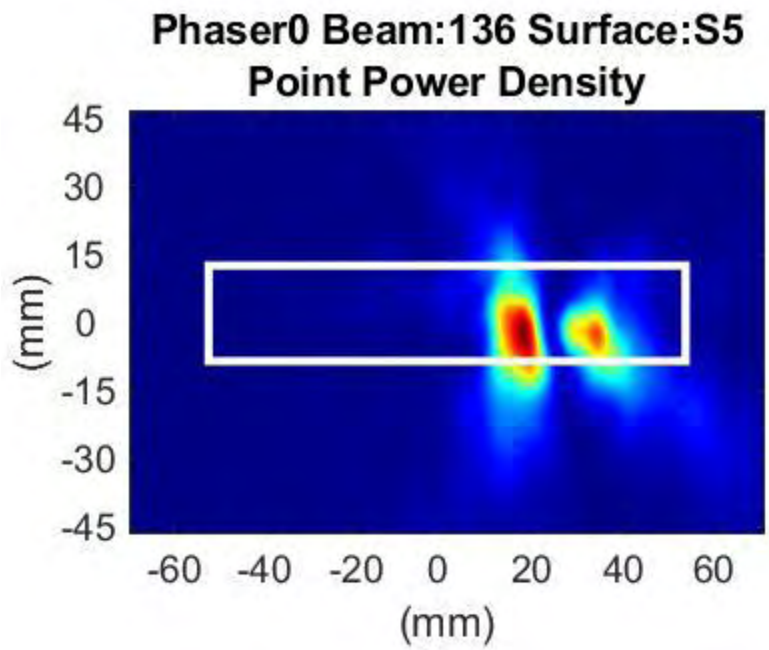
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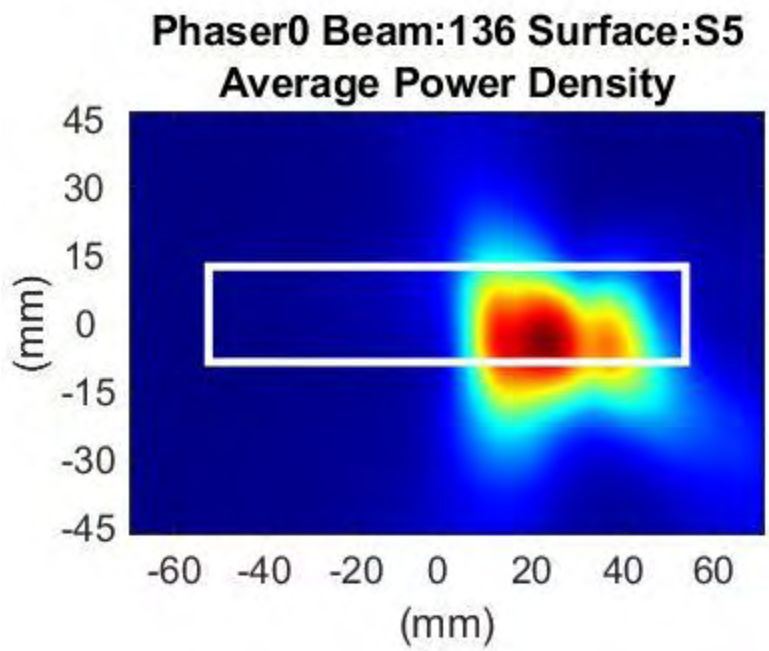
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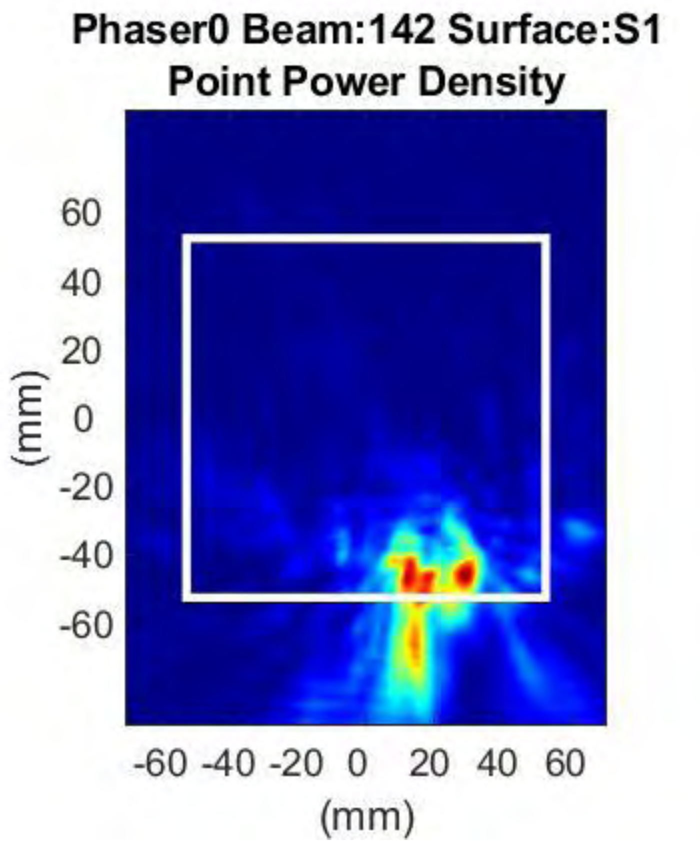
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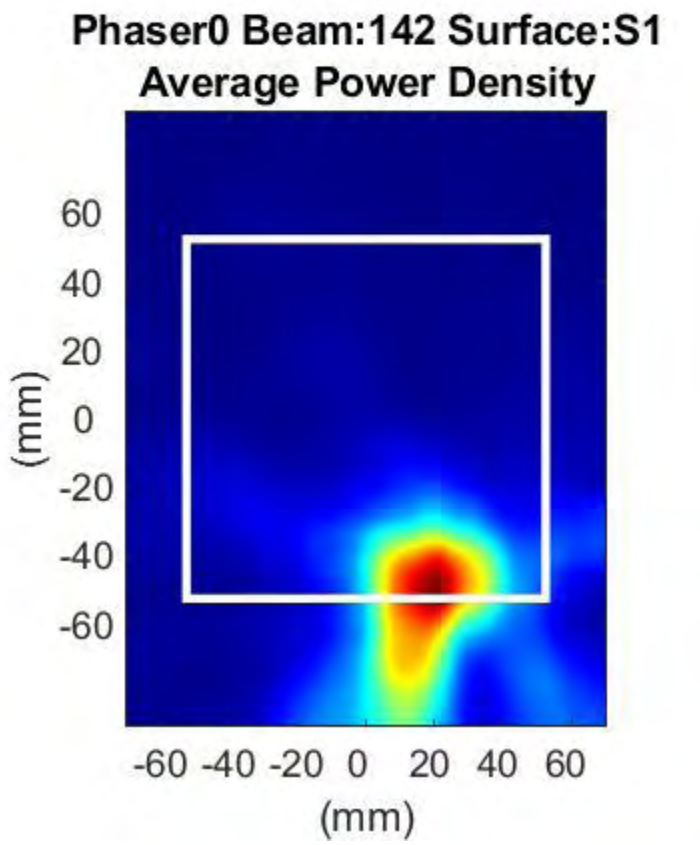
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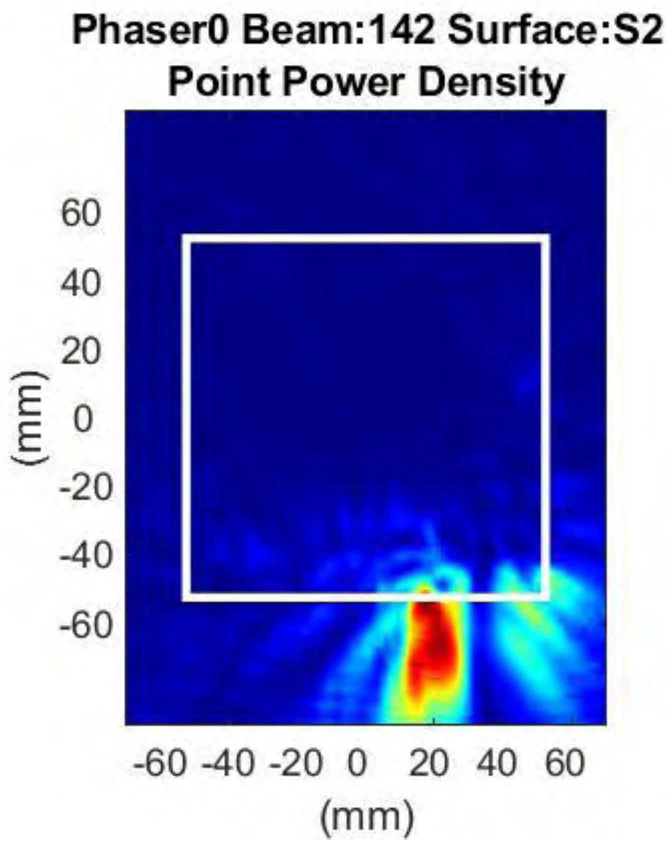
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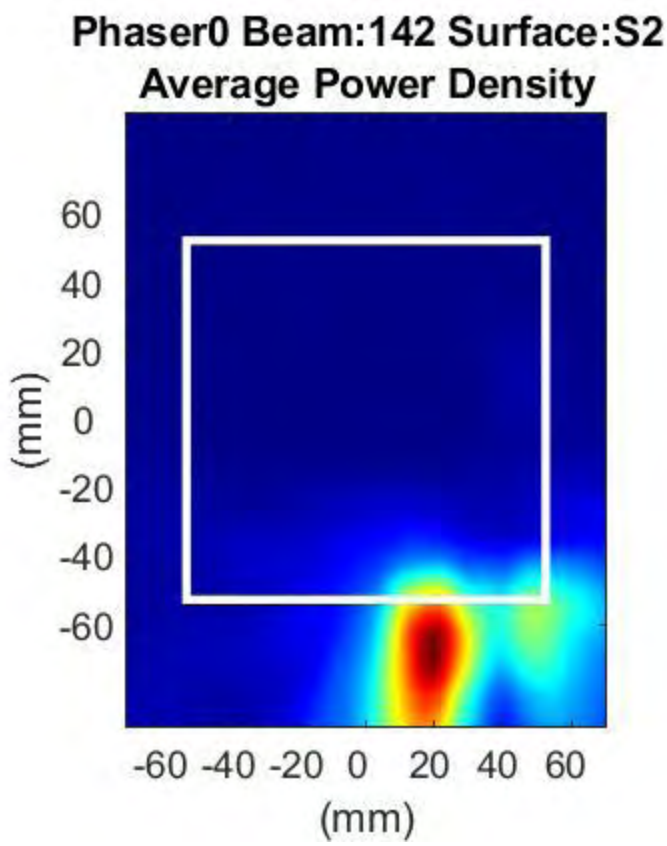
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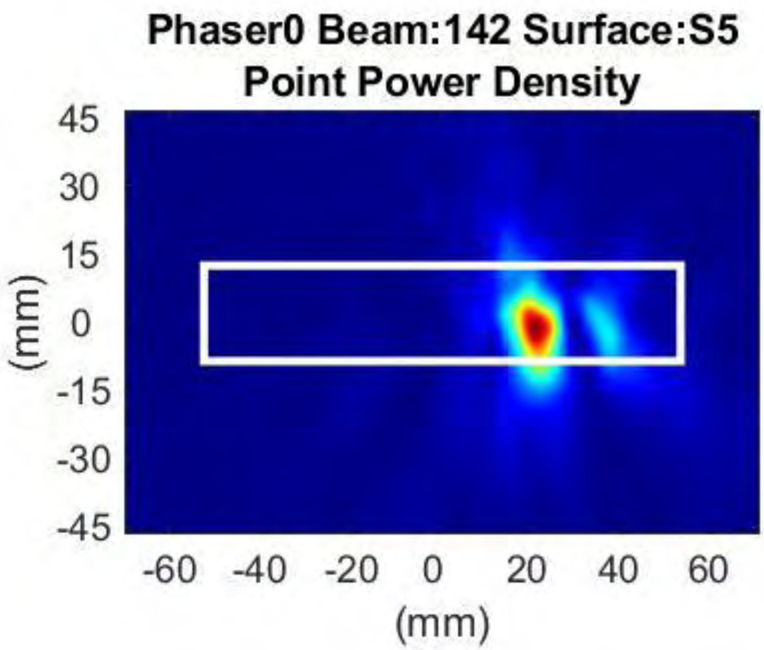
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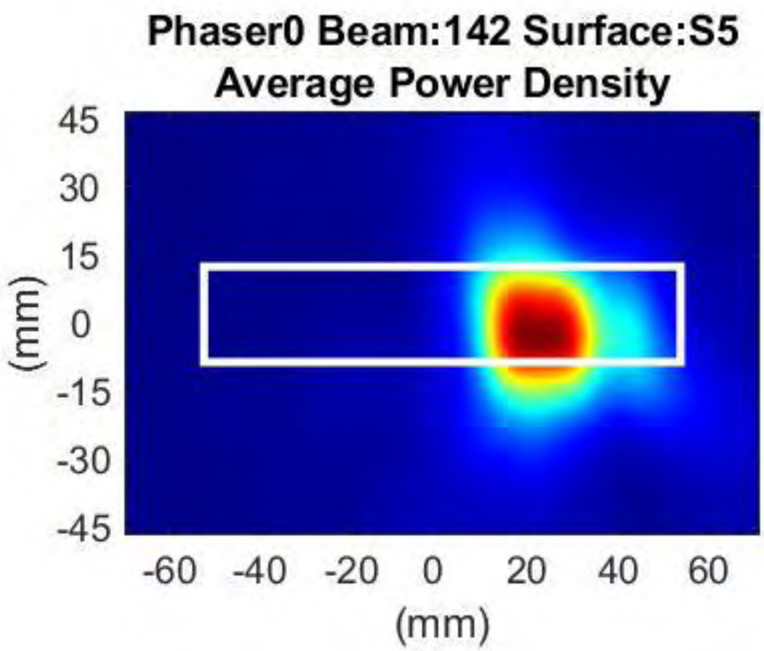
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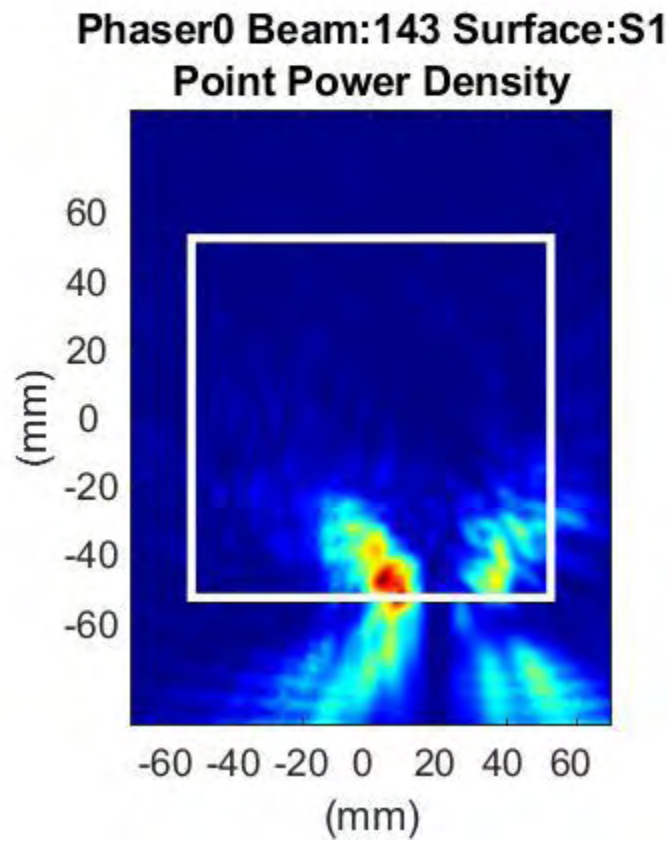
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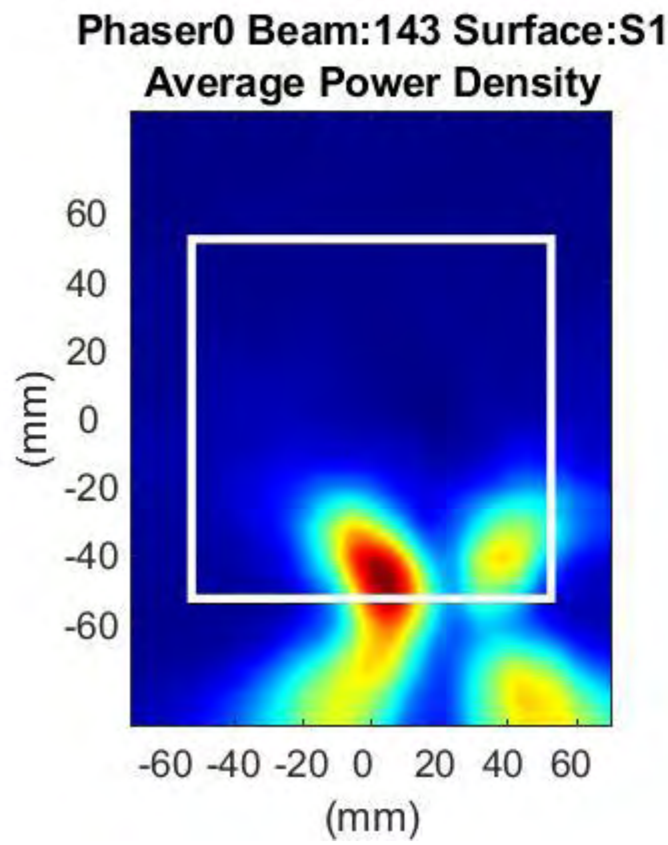
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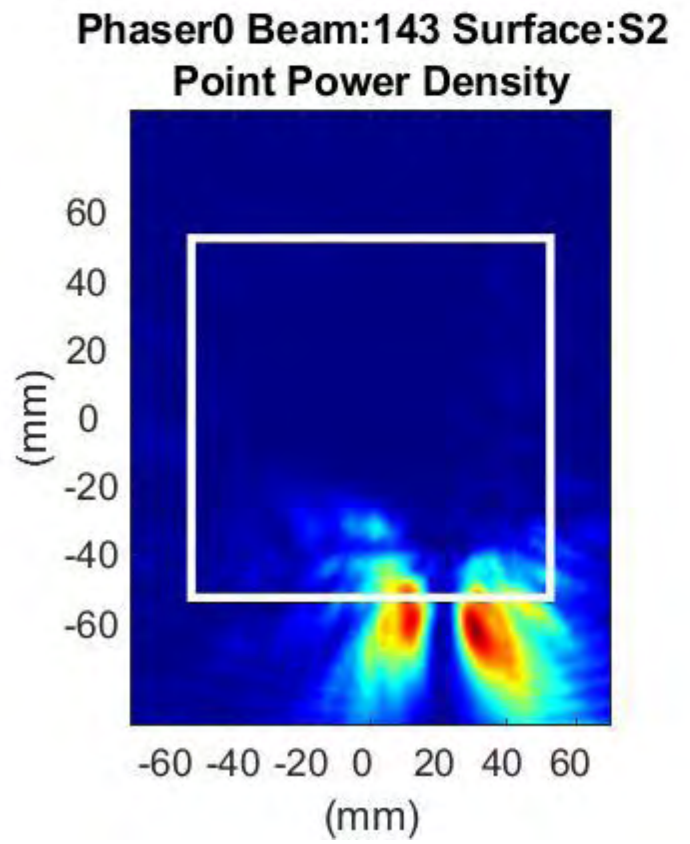
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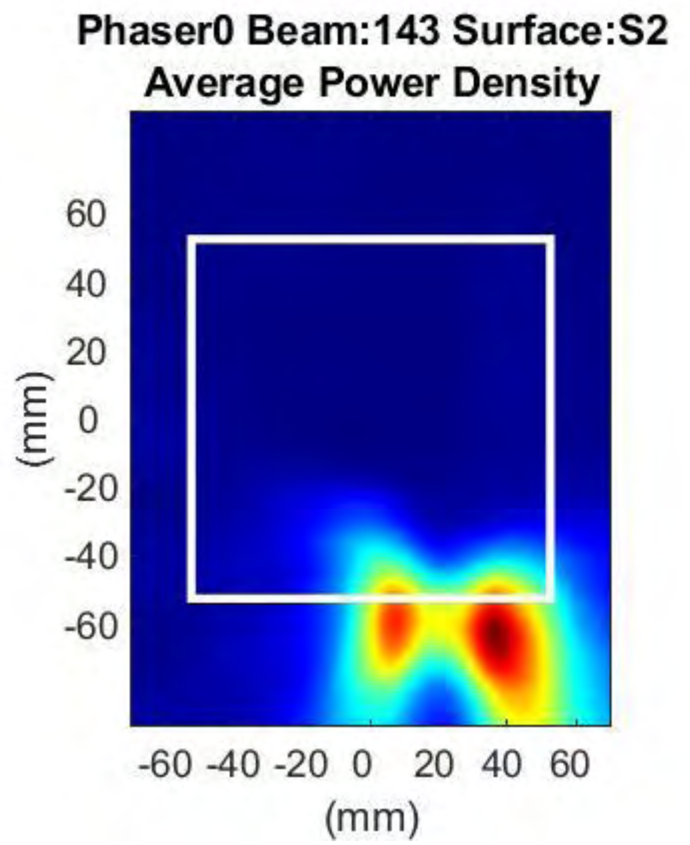
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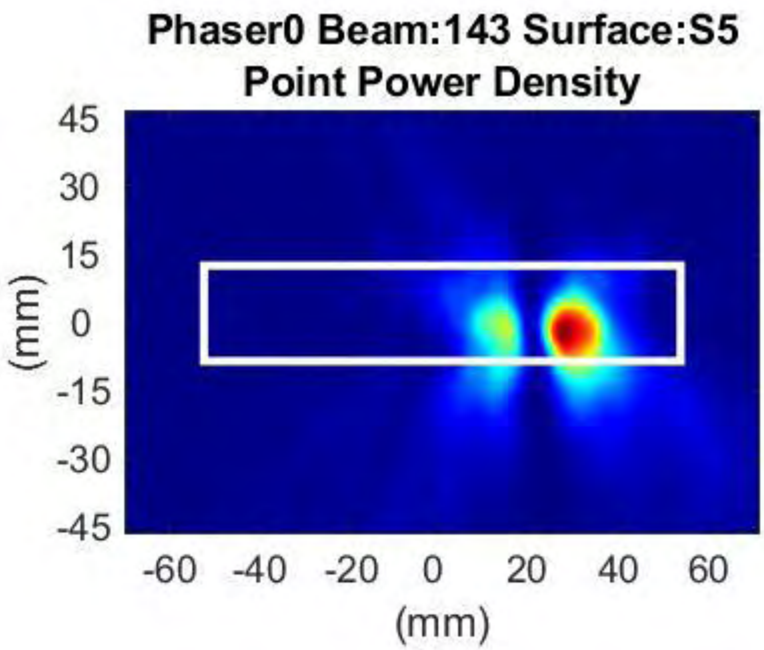
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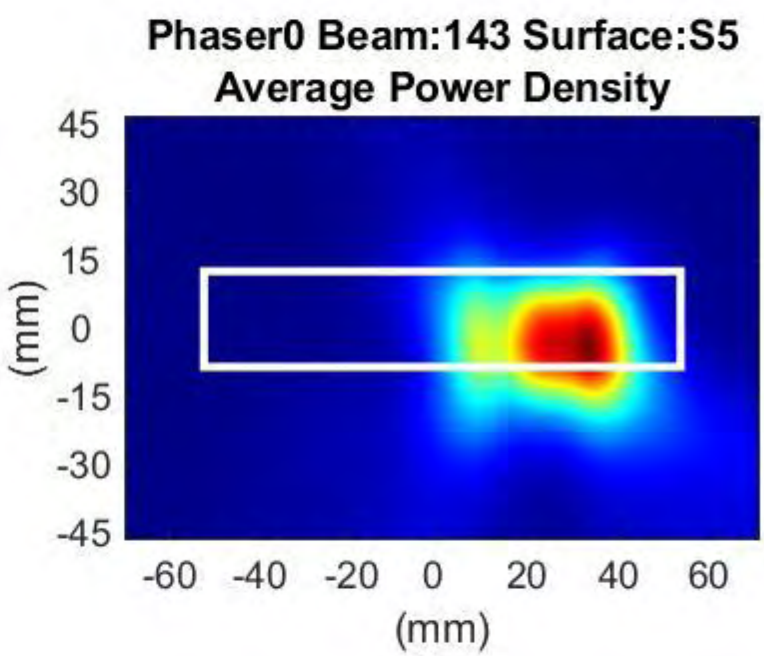
(mm)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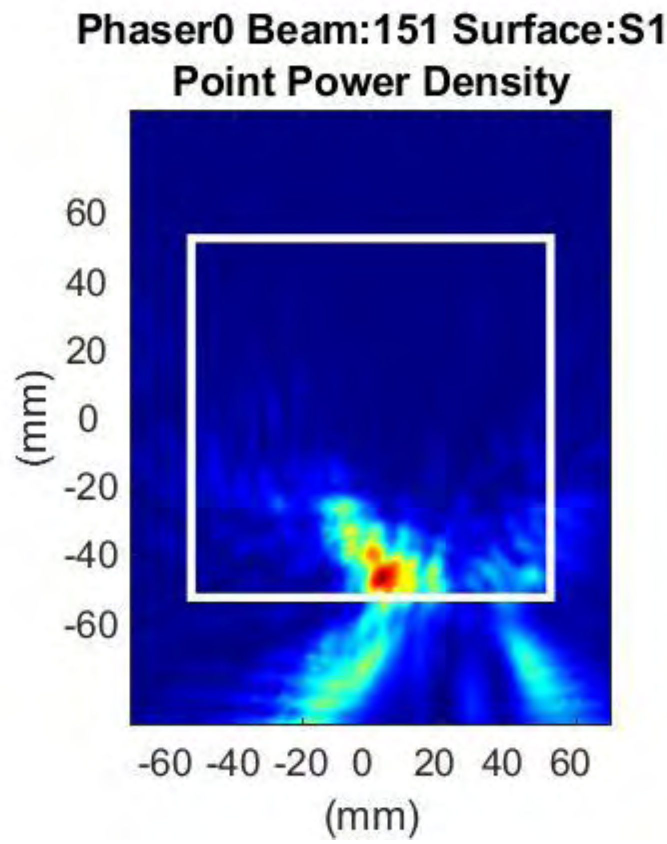
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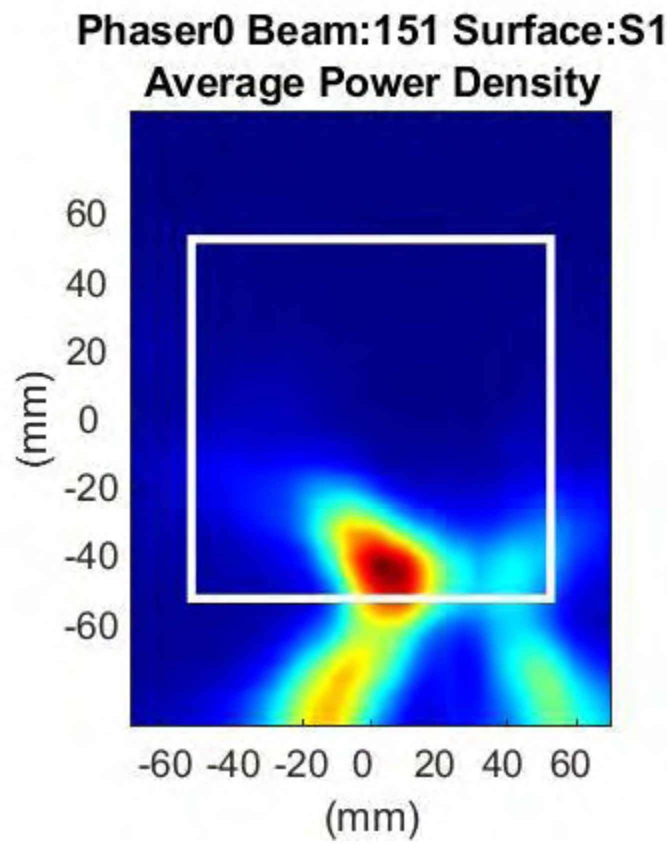
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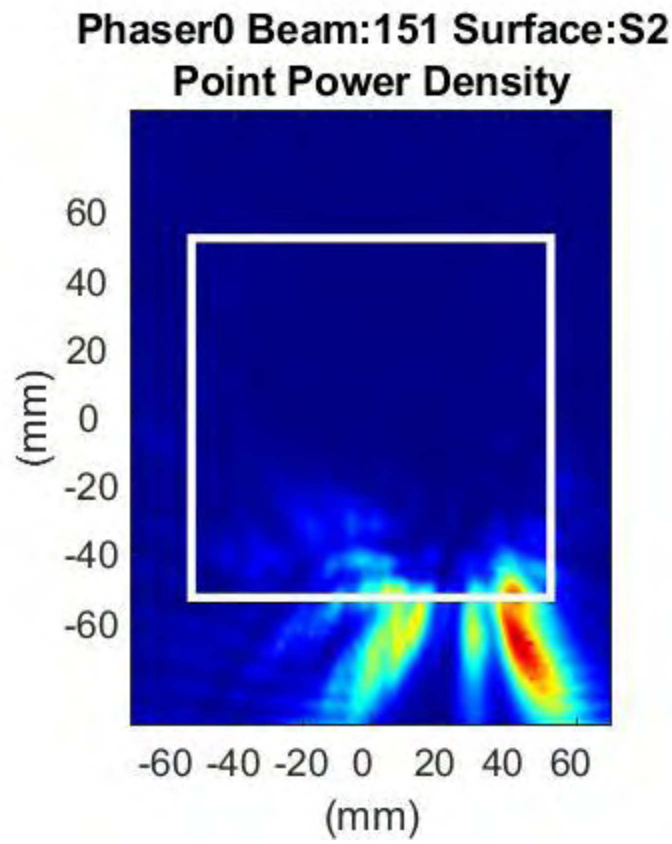
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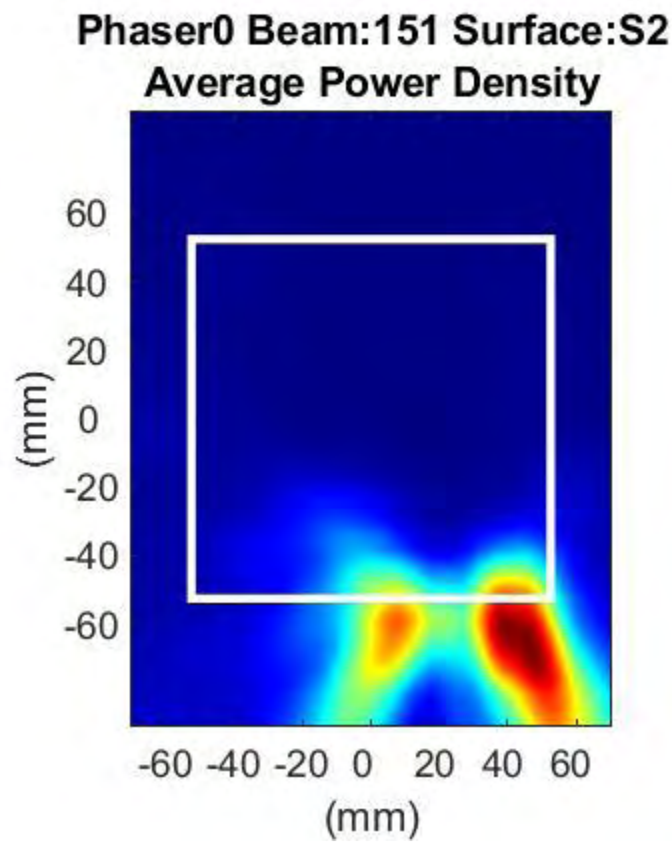
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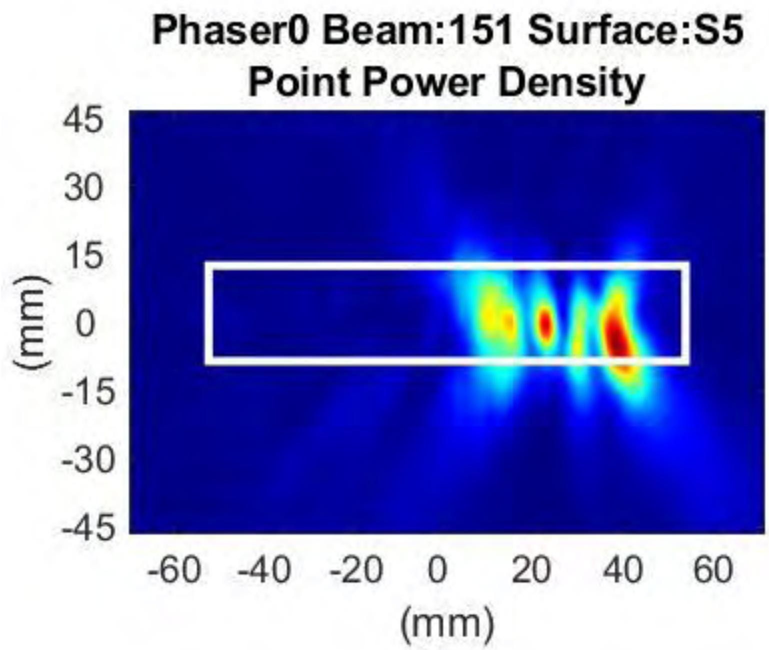
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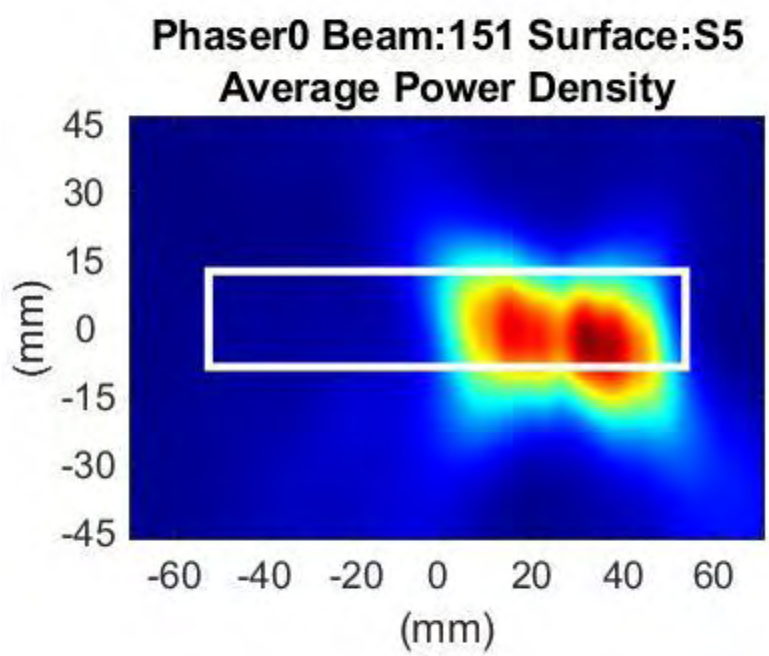
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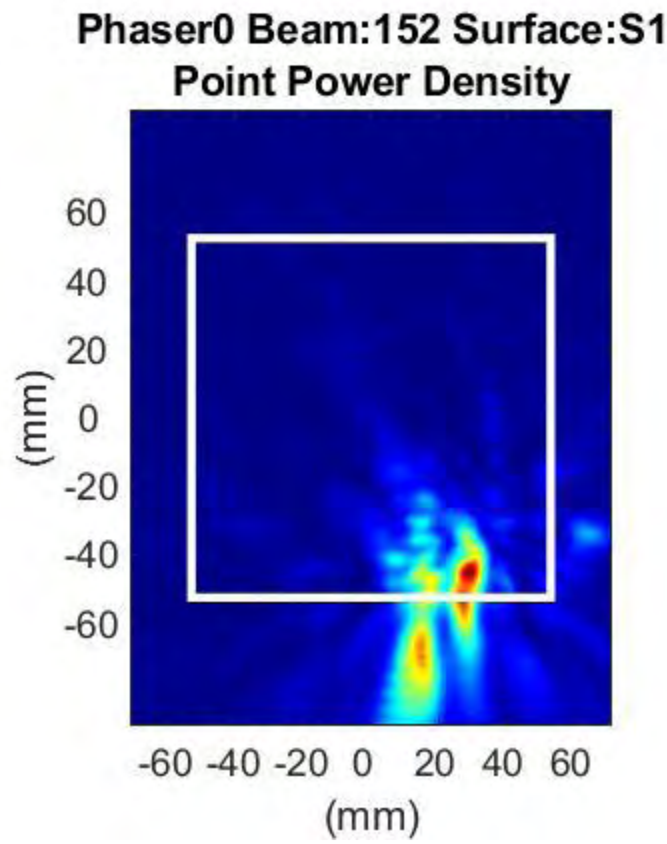
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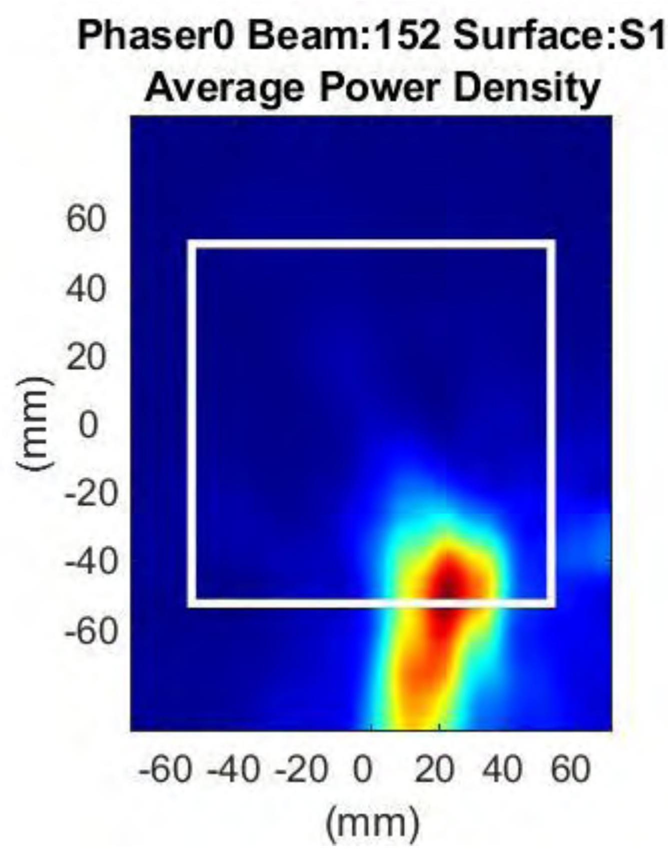
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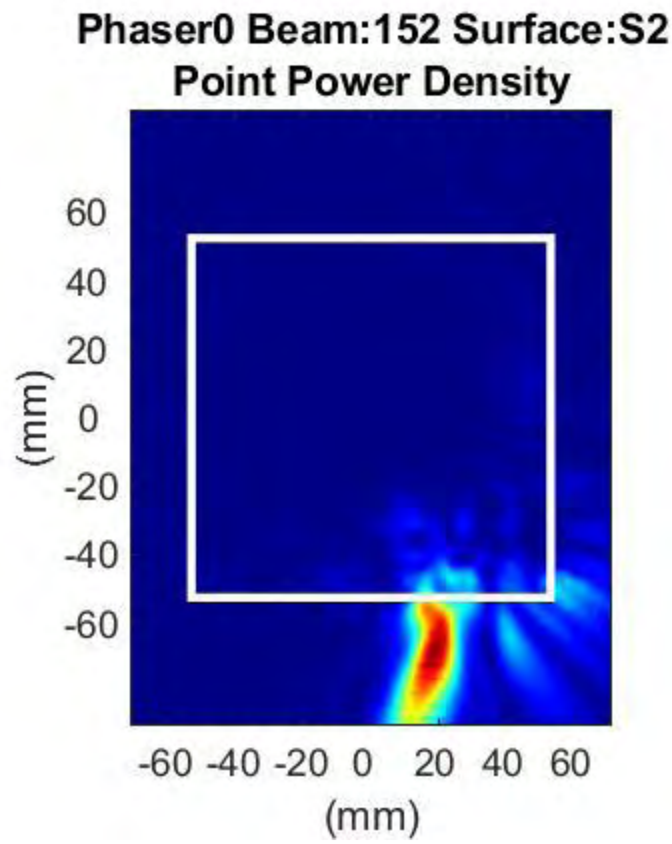
(mm)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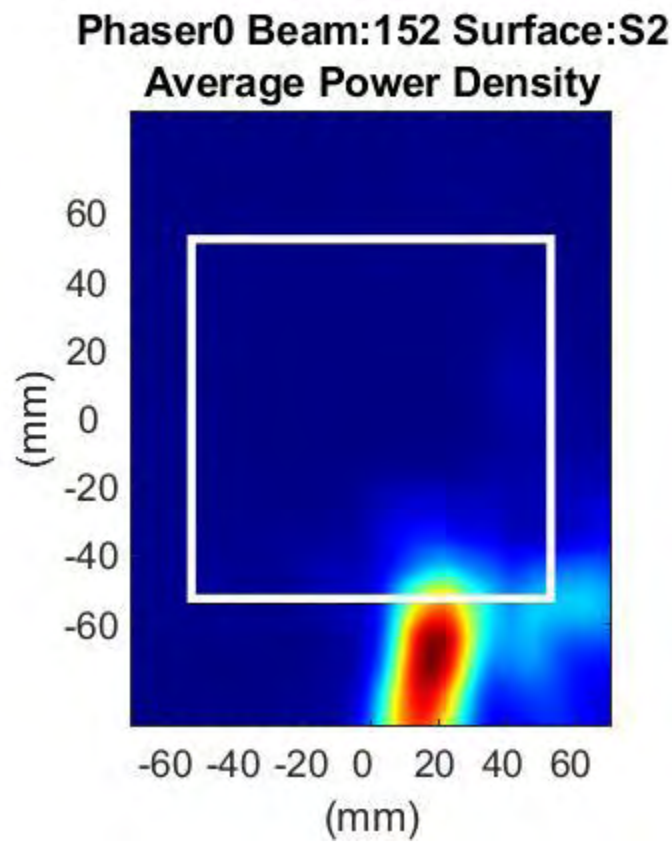
(mm)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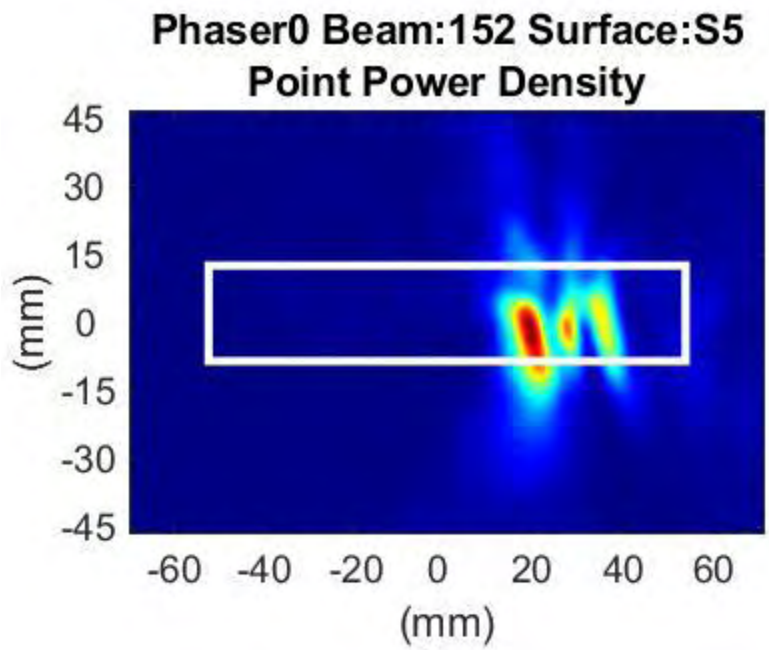
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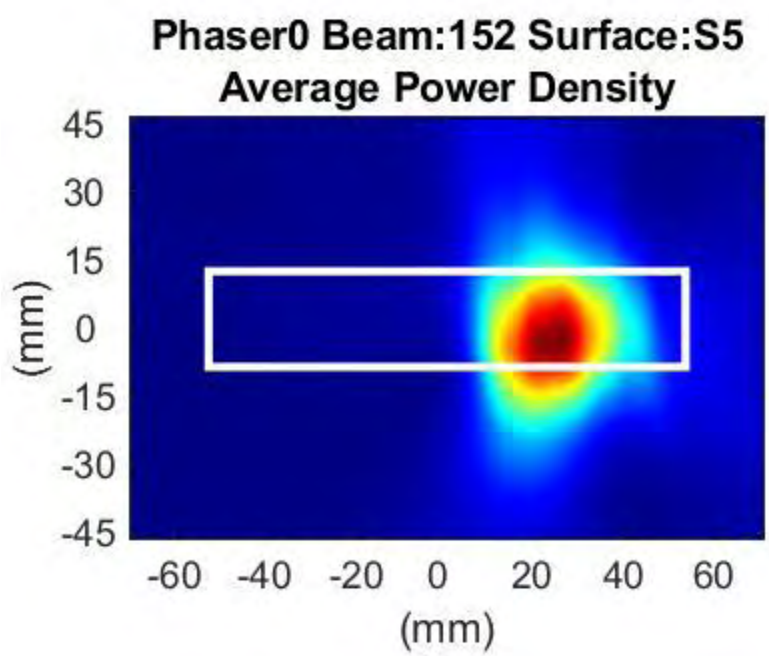
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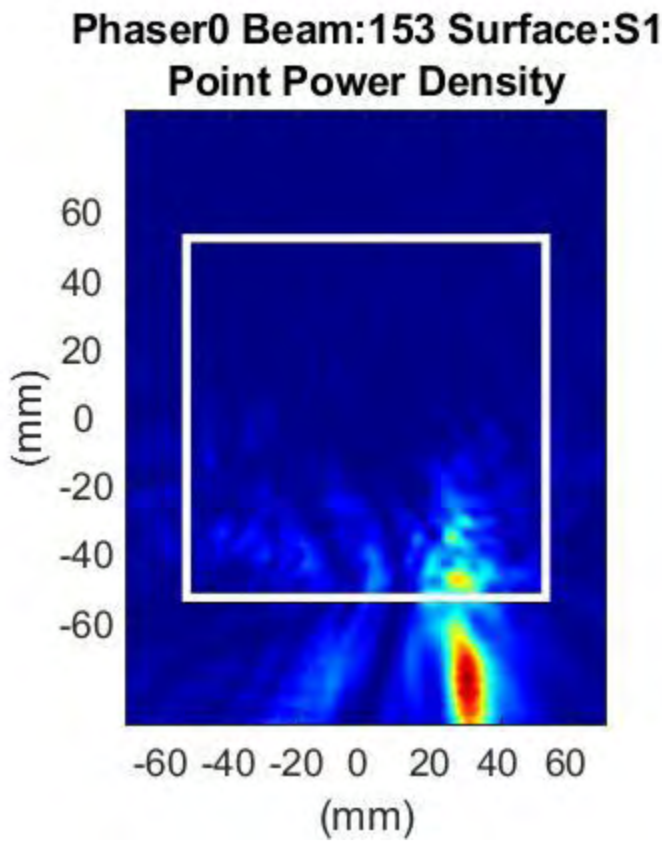
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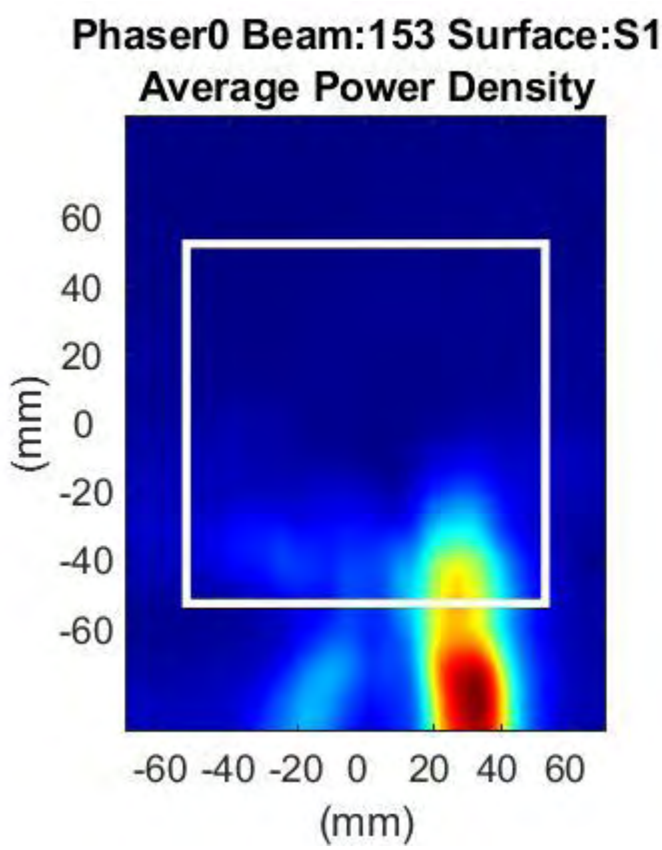
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