Diamond Light Source Ltd
Beam Diagnostics Group

Date: July 20, 2017

BPM Test Report

This is a LaTeXtest report for the, beam profile monitor electronics that are used at Diamond. In this document the different tests will be recorded in their own individual section. along with the specific parameters that are being tested and the test method used.

Contents

List of Figures

1 Beam position equidistant grid raster scan test

Moves the beam position to -5 to 5 in the XY plane and recods beam position. The calc_x_pos and calc_y_pos functions are used to measure the theoretical beam position values. A set of ABCD values are created that will move the beam position from -5 to 5 in both the X and Y plane. This is then converted into attenuation values to put into the attenuator. A fixed RF frequency and power is used while the attenuator values are changed. Finally the predicted values are compared with the measured values of position.

Args:
RFObject (RFSignalGenerator Obj): Object to interface with the RF hardware.
BPMObject (BPMDevice Obj): Object to interface with the BPM hardware.
ProgAttenObject (Prog_Atten Obj): Object to interface with programmable attenuator hardware
rf_power (float): Output power of the RF system throughout the test, in dBm
rf_frequency (float): Frequency output of the RF throughout the test, in MHz
nominal_attenuation (float): starting attenuation values of each attenuator, in dB
x_points (int): number of samples in the X plane
y_points (int) number of samples in the Y plane
settling_time (float): time in seconds to wait between changing an attenuator value and taking a reading from the BPM.
ReportObject (LaTeX Report Obj): Specific report that the test results will be recorded to. If no report is sent to the test then it will just display the results in a graph.
sub_directory (str): String that can change where the graphs will be saved to

Returns:
float array: measured X values of position
float array: measured Y values of position
float array: predicted X values of position
float array: predicted Y values of position

The devices used for this test are:

RF Source Rigol Technologies,DSG3030,DSG3B174500308,00.01.06
Libera BPM with the Epics ID "libera:signals:fa" and the MAC Address "00:26:32:46:30:00"
Programmable Attenuator RC4DAT-6G-95

The parameters used in this test are:

Fixed RF Output Power: -40dBm
Fixed Rf Output Frequency: 499.6817682MHz
Nominal Attenuation: 10dB
Number of X points: 3
Nunber of Y points: 3
Settling time: 0s

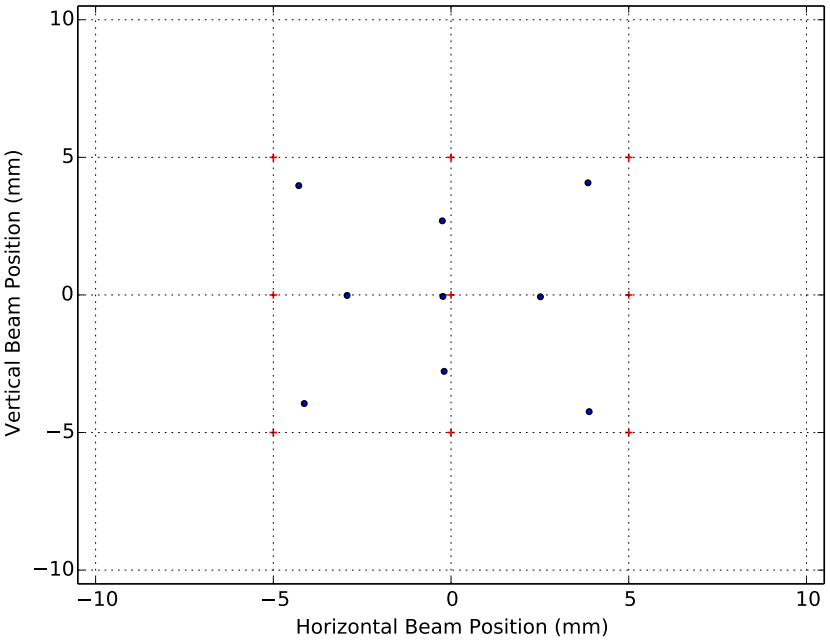

Vertical Beam Position (mm)
Horizontal Beam Position (mm)
10
5
0
−5
−10
−10
−5
0
5
10

Figure 1:

2 beam_position_attenuation_permutation

"Moves the beam position by changing the attenuator values with a series of different permutations. The calc_x_pos and calc_y_pos functions are used to measure the theoretical beam position values. The attenuator_max, attenuator_min and attenuator_steps are used to create a series of different combinations of attenuator values. A linear space will be made from the min to the max value of attenuation. These values will then be put into all possible permutations with four values. Each permutation will be fed to the four attenuators, and the BPM position recoded after each attenuation change.

Args:
RFObject (RFSignalGenerator Obj): Object to interface with the RF hardware.
BPMObject (BPMDevice Obj): Object to interface with the BPM hardware.
ProgAttenObject (Prog_Atten Obj): Object to interface with programmable attenuator hardware
rf_power (float): Output power of the RF system throughout the test, in dBm
rf_frequency (float): Frequency output of the RF throughout the test, in MHz
attenuator_max (float): max value for the attenuators
attenuator_min (float): min value for the attenuators
attenuator_steps (float): steps between the min and max values
settling_time (float): time in seconds to wait between changing an attenuator value and taking a reading from the BPM.
ReportObject (LaTeX Report Obj): Specific report that the test results will be recorded to. If no report is sent to the test then it will just display the results in a graph.
sub_directory (str): String that can change where the graphs will be saved to

Returns:
float array: measured X values of position
float array: measured Y values of position
float array: predicted X values of position
float array: predicted Y values of position

The devices used for this test are:

RF Source Rigol Technologies,DSG3030,DSG3B174500308,00.01.06
Libera BPM with the Epics ID "libera:signals:fa" and the MAC Address "00:26:32:46:30:00"
Programmable Attenuator RC4DAT-6G-95

The parameters used in this test are:

Fixed RF Output Power: -40 dBm
Fixed Rf Output Frequency: 499.6817682 MHz
Maximum Attenuation: 50dB
Minimum Attenuation: 10dB
Steps between min and max attenuations: 2
Settling time: 0s

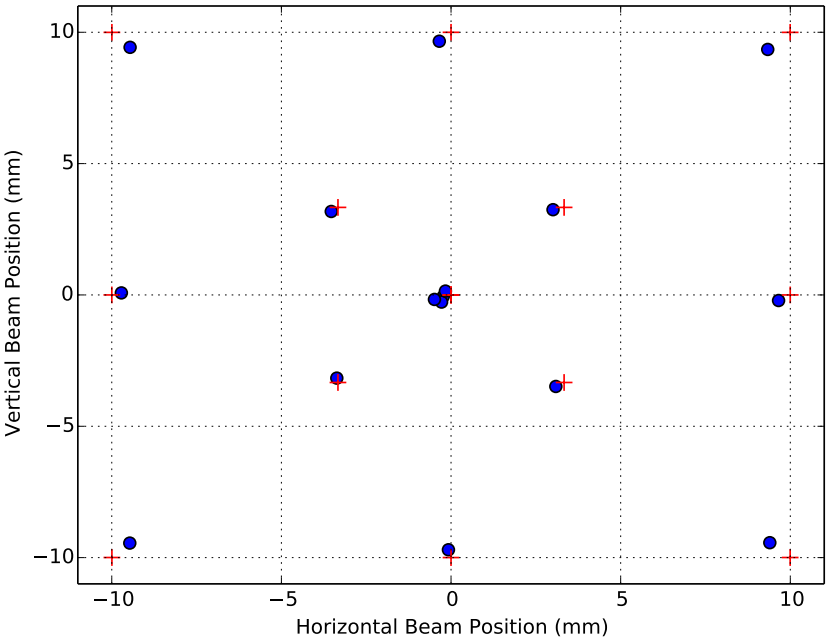

10
5
0
−5
−10
−10
−5
0
5
10
Vertical Beam Position (mm)
Horizontal Beam Position (mm)

Figure 2:

3 Beam Power Dependence

Tests the relationship between RF output power and values read from the BPM. An RF signal is output, and then different parameters are measured from the BPM. The signal is linearly ramped up in dBm at a single frequency. The number of samples to take, and settling time between each measurement can be decided using the arguments.

Args:
RFObject (RFSignalGenerator Obj): Object to interface with the RF hardware.
BPMObject (BPMDevice Obj): Object to interface with the BPM hardware.
frequency (float): Output frequency for the tests, set as a float that will use the assumed units of MHz.
start_power (float): Starting output power for the tests, default value is -100 dBm. The input values are floats and dBm is assumed.
end_power (float): Final output power for the tests, default value is 0 dBm. The input values are floats and dBm assumed.
samples (int): Number of samples take is this value + 1.
settling_time (float): Time in seconds, that the program will wait in between setting an output power on the RF, and reading the values of the BPM.
ReportObject (LaTeX Report Obj): Specific report that the test results will be recorded to. If no report is sent to the test then it will just display the results in a graph.
sub_directory (str): String that can change where the graphs will be saved to.

Returns:
float array: Power output from the RF
float array: Power read at the BPM
float array: Beam Current read at the BPM
float array: X Positions read from the BPM
float array: Y Positions read from the BPM

The devices used for this test are:

RF Source Rigol Technologies,DSG3030,DSG3B174500308,00.01.06
Libera BPM with the Epics ID "libera:signals:fa" and the MAC Address "00:26:32:46:30:00"

The parameters used in this test are:

Frequency: 499.6817682MHz
Starting output power: -100dBm
Final output power: -40dBm
Samples: 10
Settling time: 0s

Figure 3: Beam Power Dependence Results

Output Power (dBm)	Input Power (dBm)	BPM Current (mA)	X Position (mm)	Y Position (mm)	ADC Sum (Counts)
-100.0	7577.25	7577.25	-0.47	-0.19	7577.0
-93.33	8175.31	8175.31	-0.49	-0.18	8175.0
-86.67	10632.24	10632.24	-0.52	-0.19	10632.0
-80.0	19537.5	19537.5	-0.43	-0.11	19538.0
-73.33	42674.75	42674.75	-0.26	-0.05	42675.0
-66.67	90940.13	90943.44	-0.25	-0.03	90940.0
-60.0	198669.31	198669.31	-0.24	-0.03	198669.0
-53.33	428047.32	428058.2	-0.22	-0.03	428047.0
-46.67	911908.81	911908.81	-0.21	-0.03	911909.0
-40.0	1964355.22	1964481.03	-0.19	-0.0	1964355.0

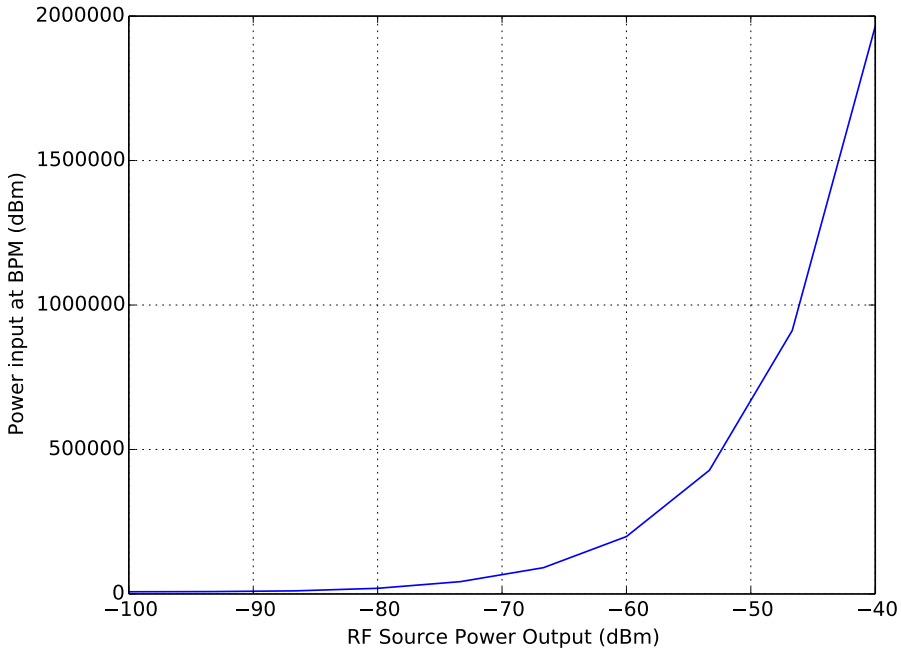


Figure 4:

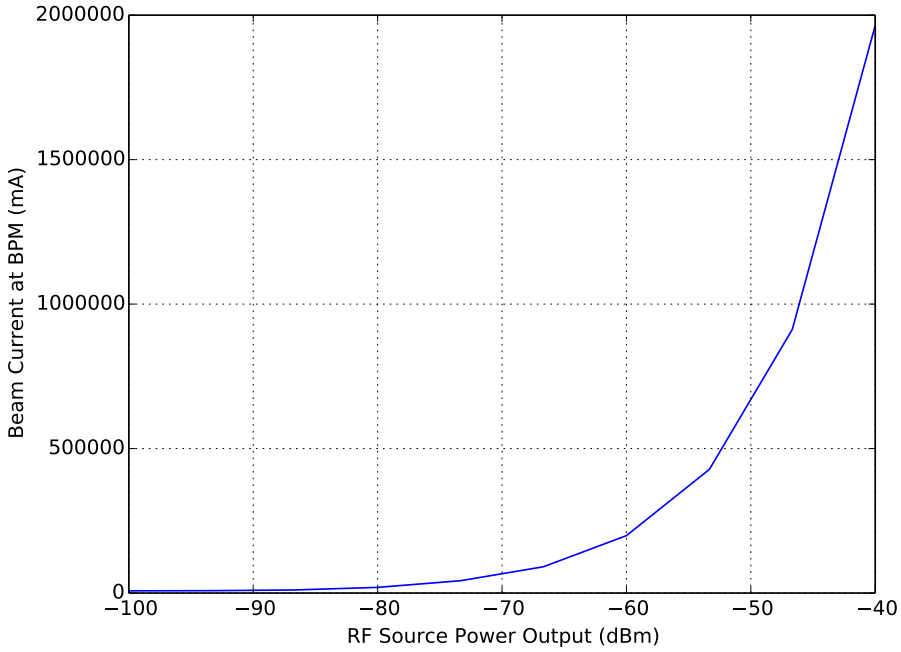


Figure 5:

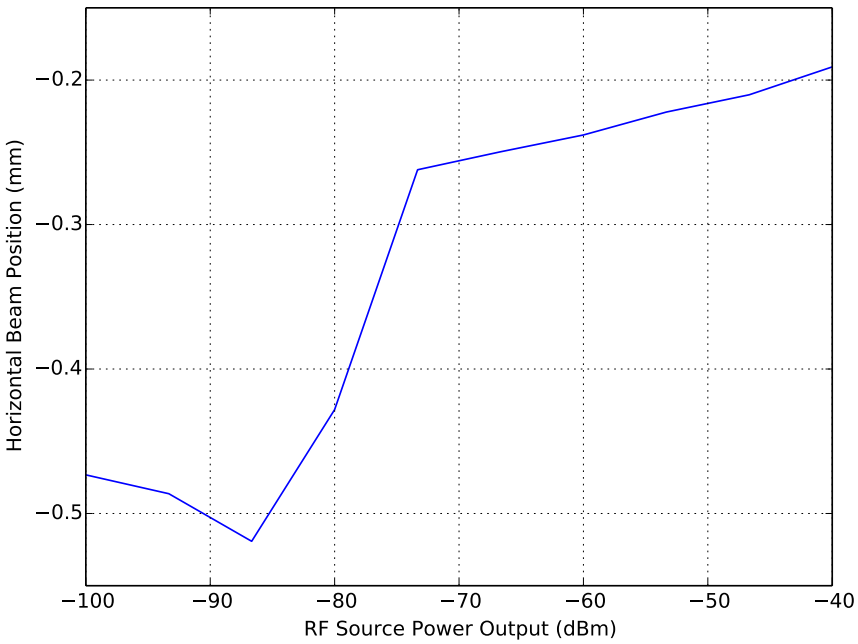


Figure 6:

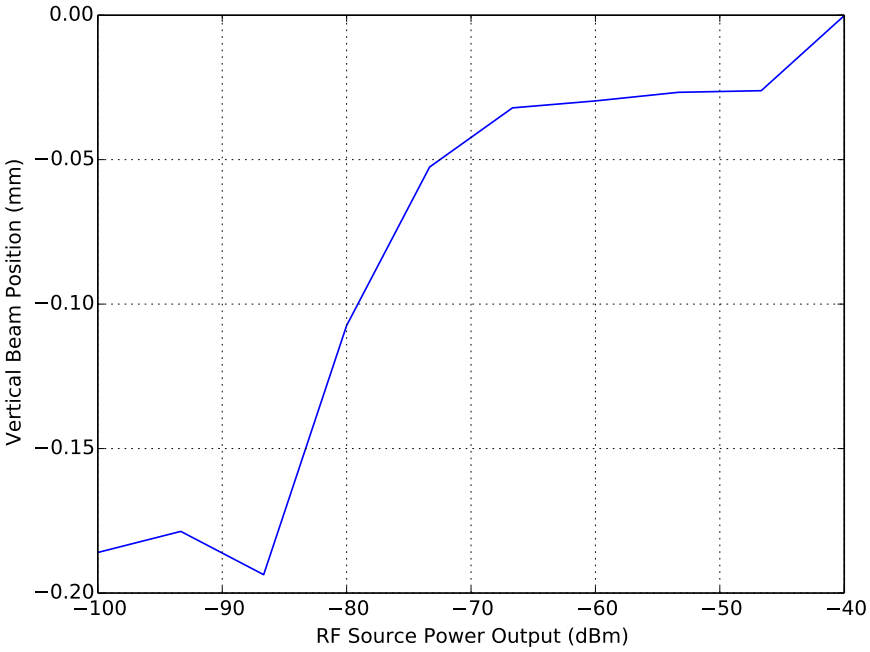


Figure 7:

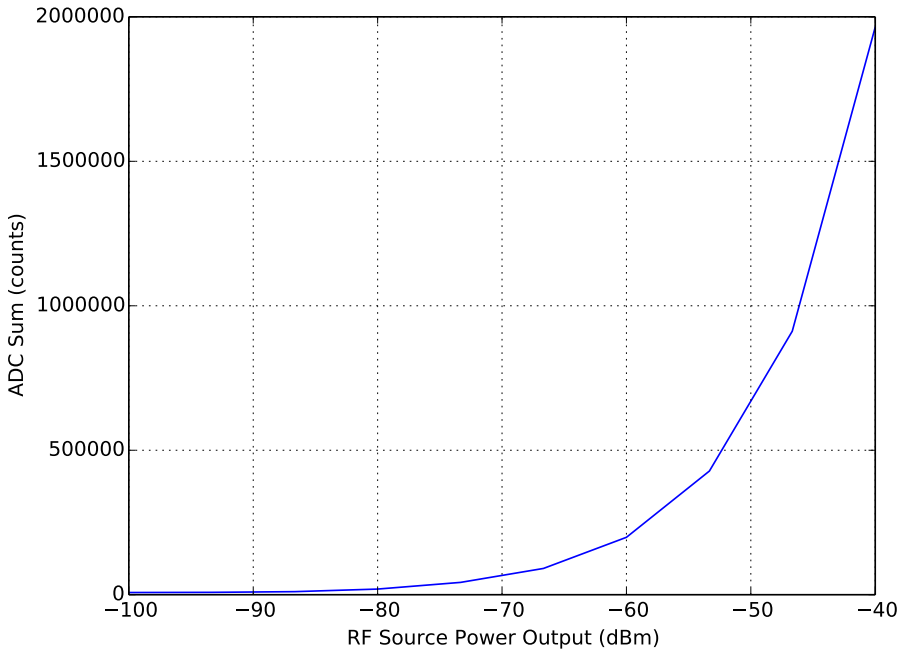


Figure 8:

4 Fixed voltage amplitude fill pattern test

This test imitates a fill pattern by modulation the RF signal with a square wave. The up time of the square wave represents when a bunch goes passed, and the downtime the gaps between the bunches. This test will take the pulse length in micro seconds, and then linearly step up the duty cycle of the pulse, from 0.1 to 1. Readings on the BPM are then recorded as the duty cycle is changed. While the duty cycle is increased, the peak RF voltage stays fixed, meaning that the average power will change with duty cycle.

Args:
RFObject (RFSignalGenerator Obj): Object to interface with the RF hardware.
BPMObject (BPMDevice Obj): Object to interface with the BPM hardware.
GateSourceObject: (GateSource Obj): Object used to interface with the gate source hardware.
frequency (float/str): Output frequency for the tests, set as a float that will use the assumed units of MHz.
power (float): Starting output power for the tests, default value is -100 dBm. The input values are floats and dBm is assumed.
samples (int): Number of samples take is this value + 1.
pulse_period (float): The pulse period for the modulation signal, i.e. the bunch length, this is a float that is in micro seconds.
settling_time (float): Time in seconds, that the program will wait in between setting an output power on the RF, and reading the values of the BPM.
ReportObject (LaTeX Report Obj): Specific report that the test results will be recorded to. If no report is sent to the test then it will just display the results in a graph.
sub_directory (str): String that can change where the graphs will be saved to

Returns:
float array: duty cycle of the modulation signal
float array: power read from the BPM
float array: current read from the BPM
float array: X position read from the BPM
float array: Y position read from the BPM

The devices used for this test are:

RF Source Rigol Technologies,DSG3030,DSG3B174500308,00.01.06
Gating Device Rigol Technologies,DSG3030,DSG3B174500308,00.01.06
Libera BPM with the Epics ID "libera:signals:fa" and the MAC Address "00:26:32:46:30:00"

The parameters used in this test are:

Frequency: 499.681 768 20MHz
Output Power: -40.00DBM
Pulse Period: 1.873us
Samples: 10
Settling time: 0s

Figure 9: Changing gate duty cycle, with fixed RF amplitude

Duty Cycle (0-1)	Input Power (dBm)	BPM Current (mA)	X Position (mm)	Y Position (mm)	ADC Sum (Counts)
0.1	180729.27	180729.27	-0.2	-0.0	180729.0
0.2	349612.32	349612.32	-0.2	-0.0	349612.0
0.3	529796.19	529796.19	-0.2	-0.0	529796.0
0.4	746680.18	746680.18	-0.19	-0.0	746680.0
0.5	898853.89	898853.89	-0.19	-0.0	898854.0
0.6	1132196.85	1132196.85	-0.19	-0.0	1132197.0
0.7	1315659.39	1315659.39	-0.19	-0.0	1315659.0
0.8	1510125.18	1510125.18	-0.19	-0.0	1510125.0
0.9	1707575.84	1707575.84	-0.19	-0.0	1707576.0
0.99	1911350.15	1911350.15	-0.19	-0.0	1911350.0

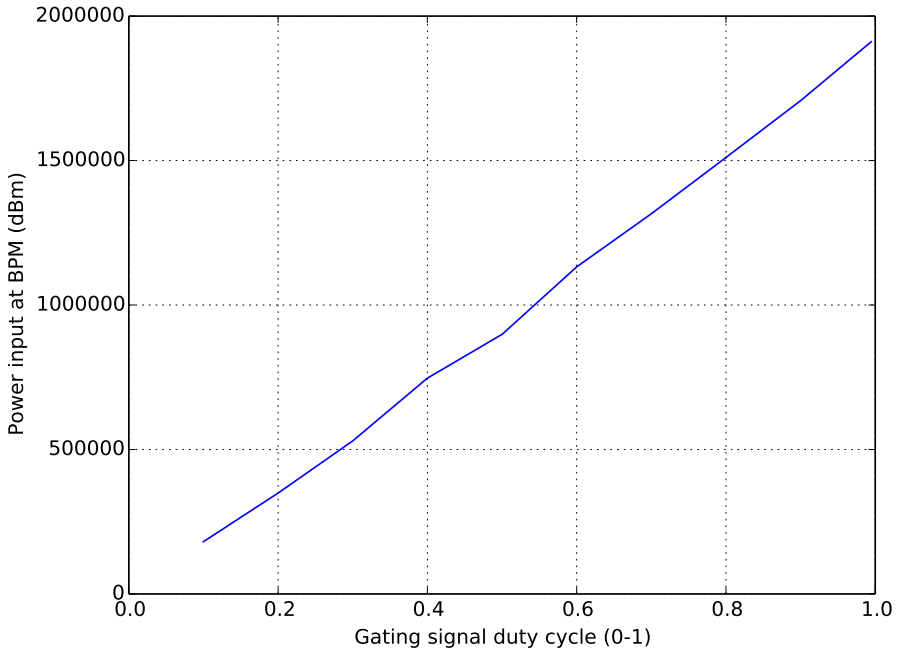
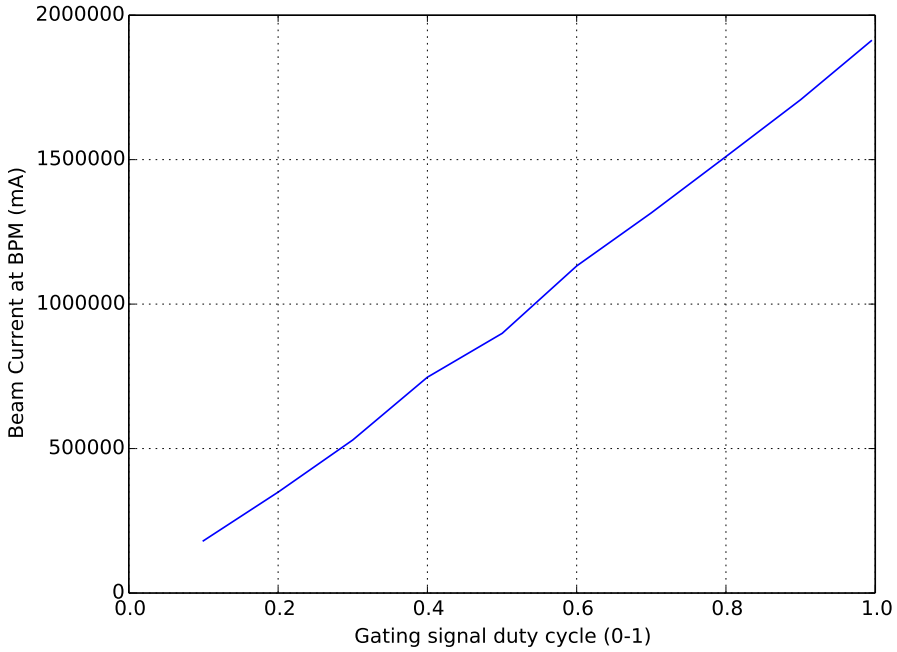


Figure 10:



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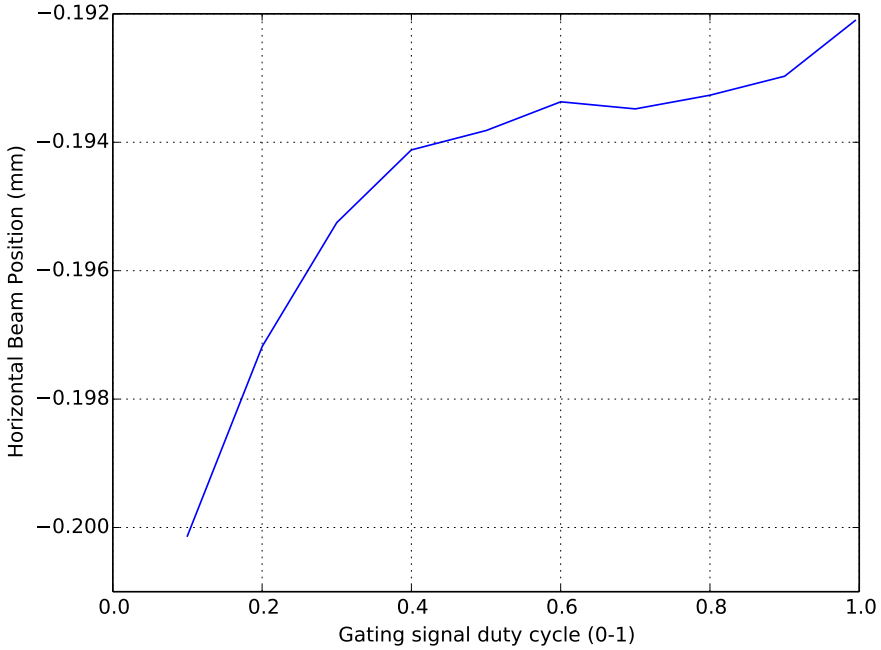

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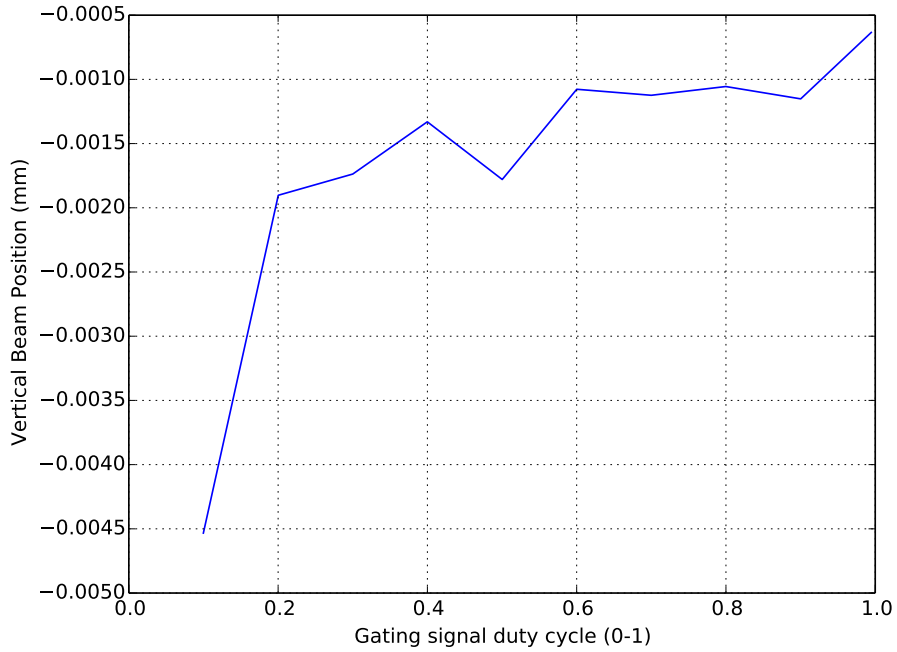

Figure 13:

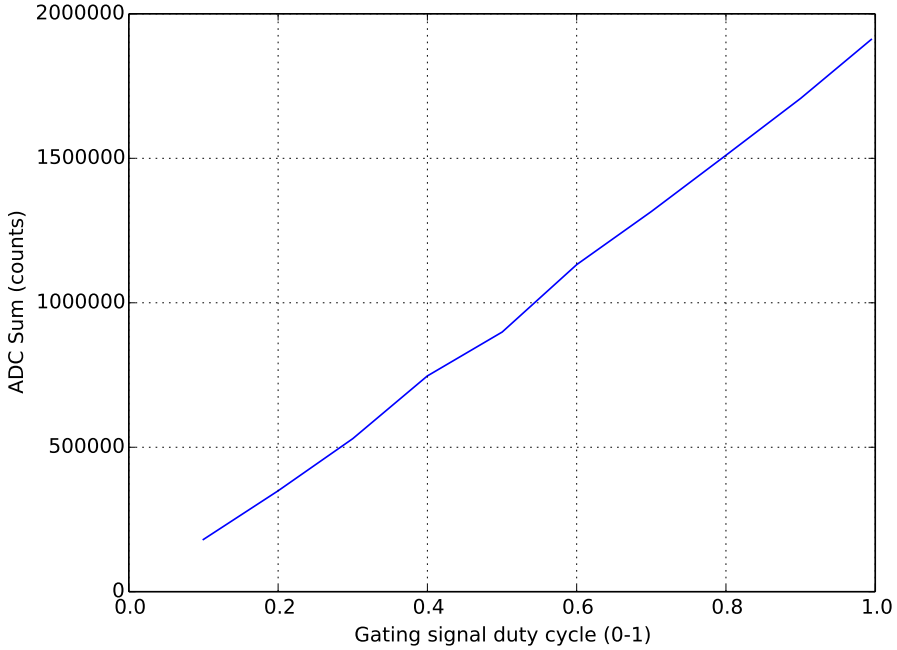

Figure 14:

5 Scaled voltage amplitude fill pattern test

This test imitates a fill pattern by modulation the RF signal with a square wave. The up time of the square wave represents when a bunch goes passed, and the downtime the gaps between the bunches. This test will take the pulse length in micro seconds, and then linearly step up the duty cycle of the pulse, from 0.1 to 1. Readings on the BPM are then recorded as the duty cycle is changed. While the duty cycle is increased, the peak RF voltage increases, meaning that the average power will be constant with duty cycle change.

Args:
RFObject (RFSignalGenerator Obj): Object to interface with the RF hardware.
BPMObject (BPMDevice Obj): Object to interface with the BPM hardware.
GateSourceObject: (GateSource Obj): Object used to interface with the gate source hardware.
frequency (float/str): Output frequency for the tests, set as a float that will use the assumed units of MHz.
desired_power (float): Starting output power for the tests, default value is -40 dBm. The input values are floats and dBm is assumed.
samples (int): Number of samples take is this value + 1.
pulse_period (float): The pulse period for the modulation signal, i.e. the bunch length, this is a float that is in micro seconds.
settling_time (float): Time in seconds, that the program will wait in between setting an output power on the RF, and reading the values of the BPM.
ReportObject (LaTeX Report Obj): Specific report that the test results will be recorded to. If no report is sent to the test then it will just display the results in a graph.
sub_directory (str): String that can change where the graphs will be saved to

Returns:
float array: duty cycle of the modulation signal
float array: power set at the rf output
float array: power read from the BPM
float array: current read fro mthe BPM
float array: X position read from the BPM
float array: Y position read from the BPM

The devices used for this test are:

RF Source Rigol Technologies,DSG3030,DSG3B174500308,00.01.06
Gating Device Rigol Technologies,DSG3030,DSG3B174500308,00.01.06
Libera BPM with the Epics ID "libera:signals:fa" and the MAC Address "00:26:32:46:30:00"

The parameters used in this test are:

Frequency: 499.681 768 20MHz
Desired Power: -70dBm
Pulse Period: 1.873us
Samples: 10
Settling time: 0s

Figure 15: Changing gate duty cycle, with fixed RF amplitude

Duty Cycle (0-1)	Output Power (dBm)	Input Power (dBm)	BPM Current (mA)	X Position (mm)	Y Position (mm)	ADC Sum (Counts)
0.1	-49.99	58212.21	58212.21	-0.24	-0.03	58212.0
0.2	-56.03	55711.45	55711.45	-0.24	-0.03	55711.0
0.3	-59.54	59849.3	59849.3	-0.25	-0.03	59849.0
0.4	-62.04	59979.63	59979.63	-0.24	-0.03	59980.0
0.5	-63.98	61537.69	61537.69	-0.25	-0.03	61538.0
0.6	-65.56	60742.03	60742.03	-0.25	-0.03	60742.0
0.7	-66.9	60549.45	60549.45	-0.23	-0.03	60549.0
0.8	-68.06	60596.73	60596.73	-0.24	-0.03	60597.0
0.9	-69.09	57493.16	57493.16	-0.24	-0.03	57493.0
0.99	-69.95	57467.12	57467.12	-0.24	-0.03	57467.0

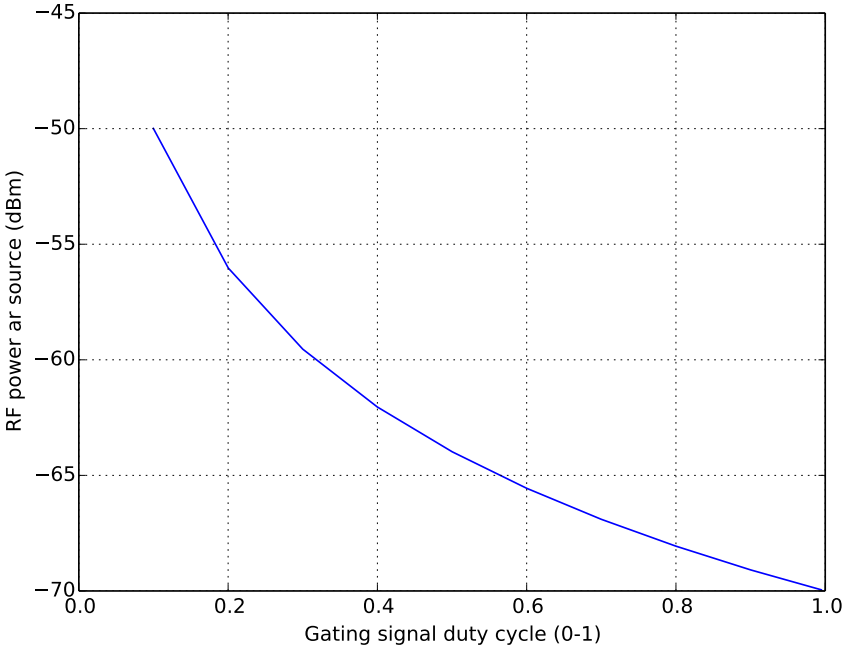

Figure 16:

Figure 17:

Figure 18:

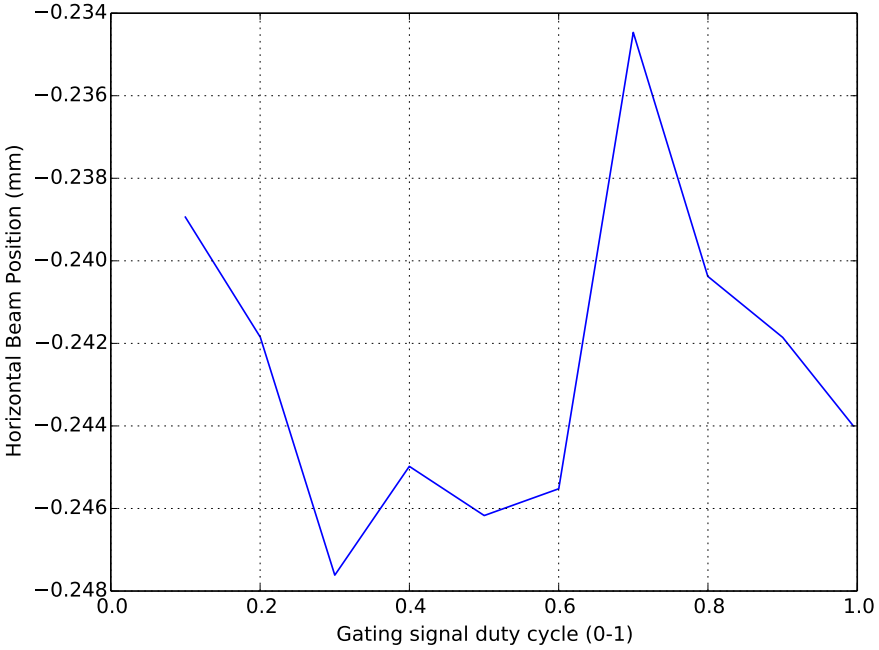

Figure 19:

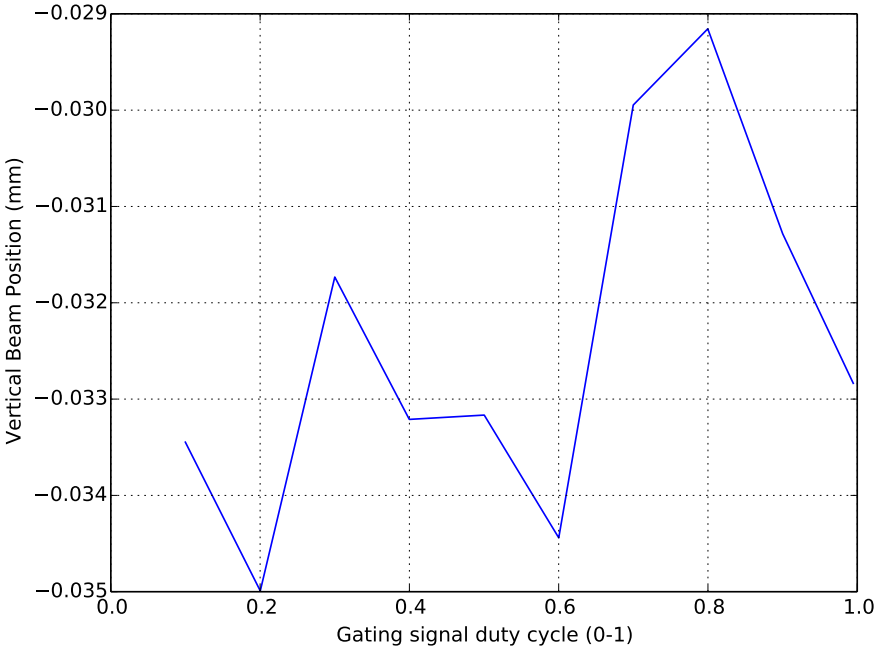

Figure 20:

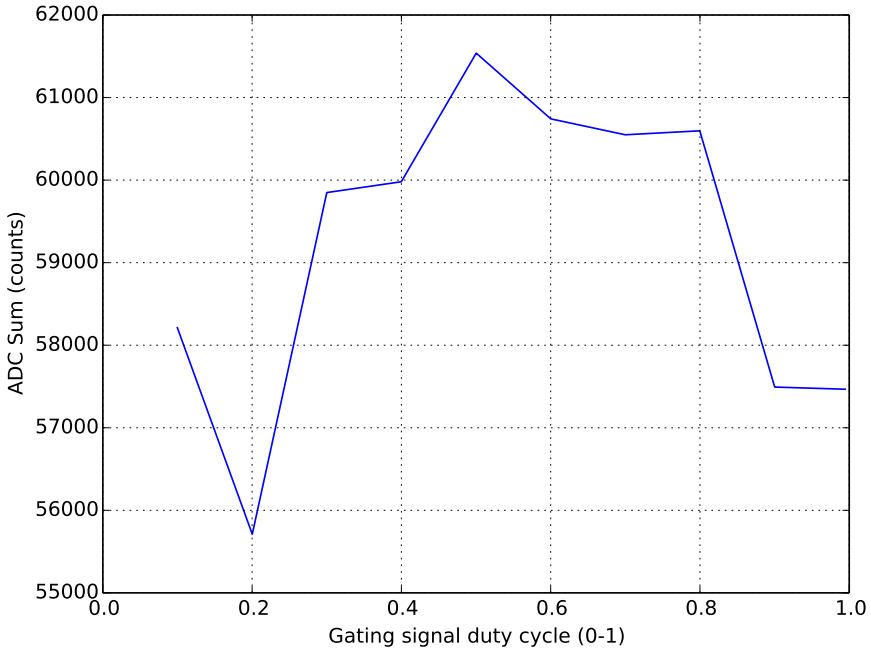
62000
61000
60000
59000
58000
57000
56000
55000
ADC Sum (counts)
0.0
0.2
0.4
0.6
0.8
1.0
Gating signal duty cycle (0-1)

Figure 21: