Solid State Noise Source Calibration

using cryogenically cooled thermal noise generators

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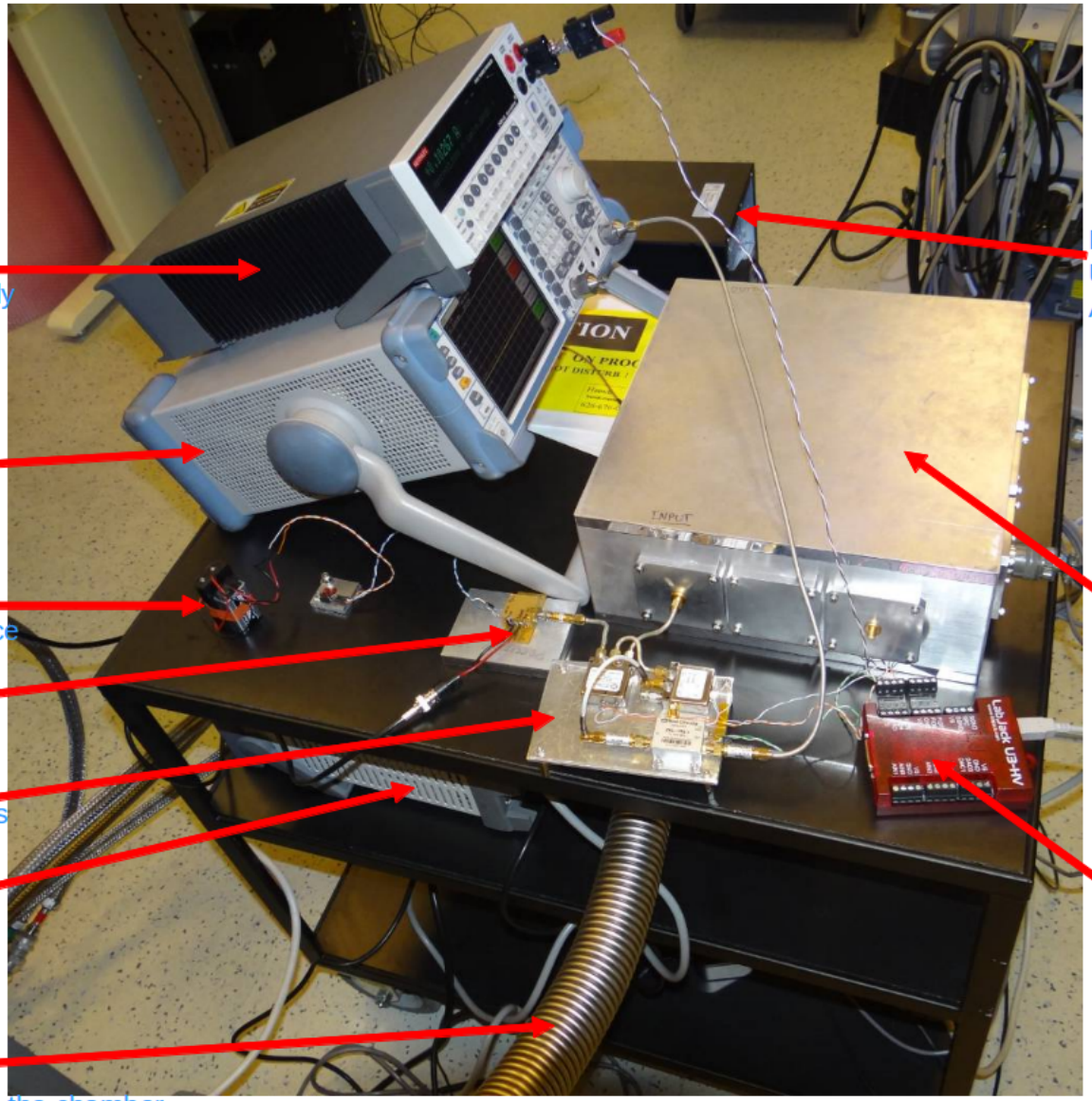
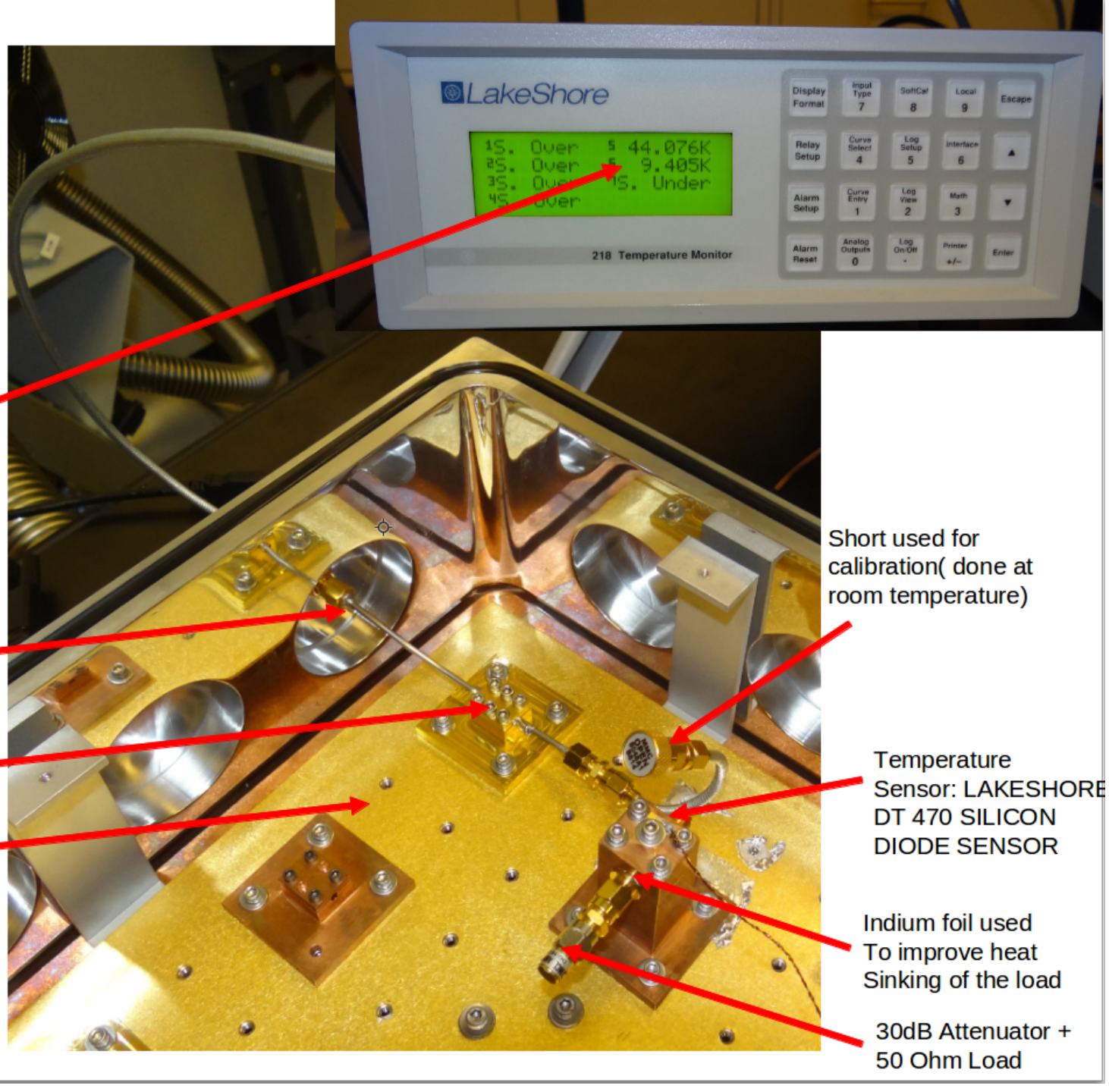
02/17/2013

SETUP USED TO COOL A 50 OHM LOAD TO 9.4K AND CALIBRATE THE DOLID STATE NOISE SOURCE



View of the Cold Load inside the Vacuum chamber



Temperature of the Cold load: 9.4K Measured very close To the load

Output Cable

Cable heat sink

Cold plate of the cryostat 9.4K

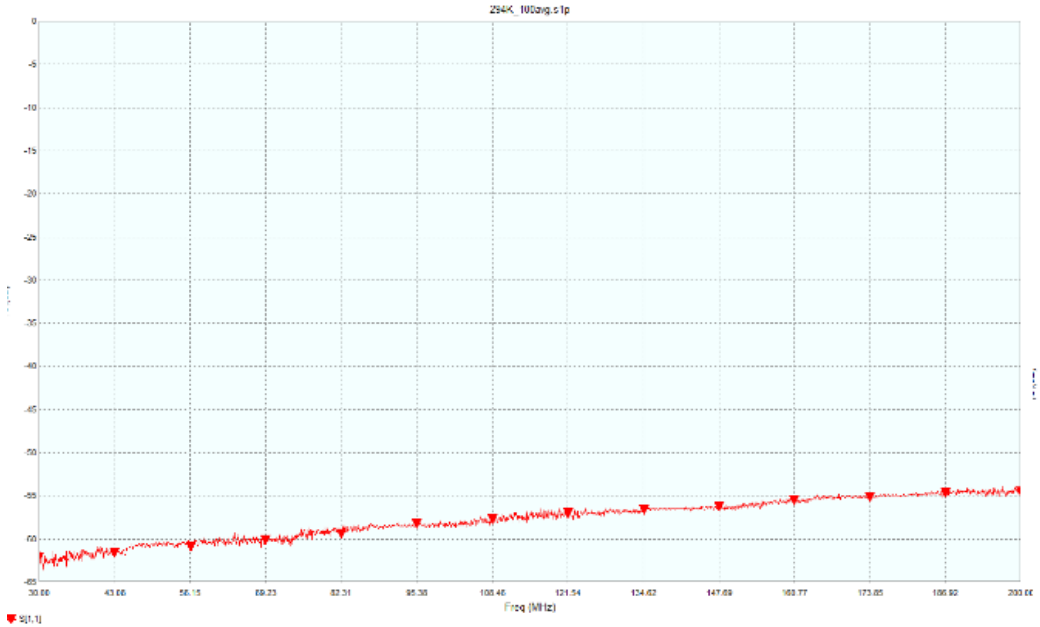
Short used for calibration(done at room temperature)

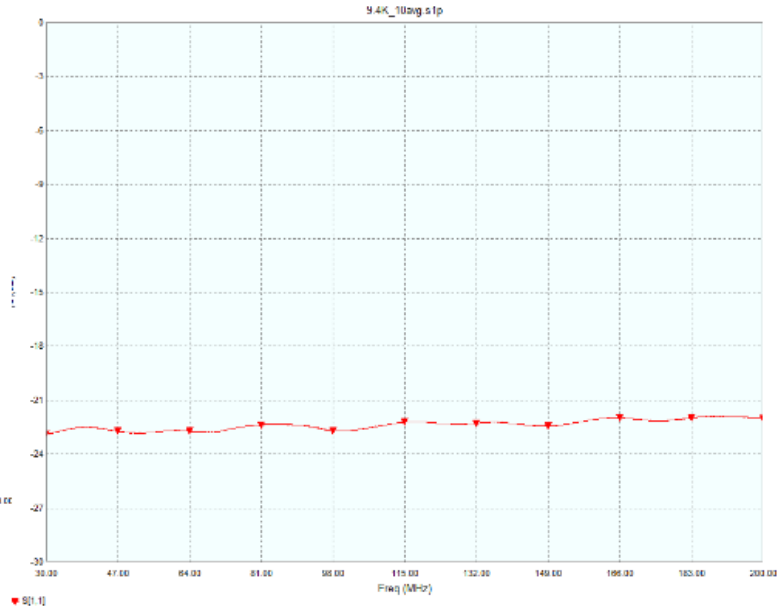
Temperature Sensor: LAKESHORE DT 470 SILICON DIODE SENSOR

Indium foil used To improve heat Sinking of the load

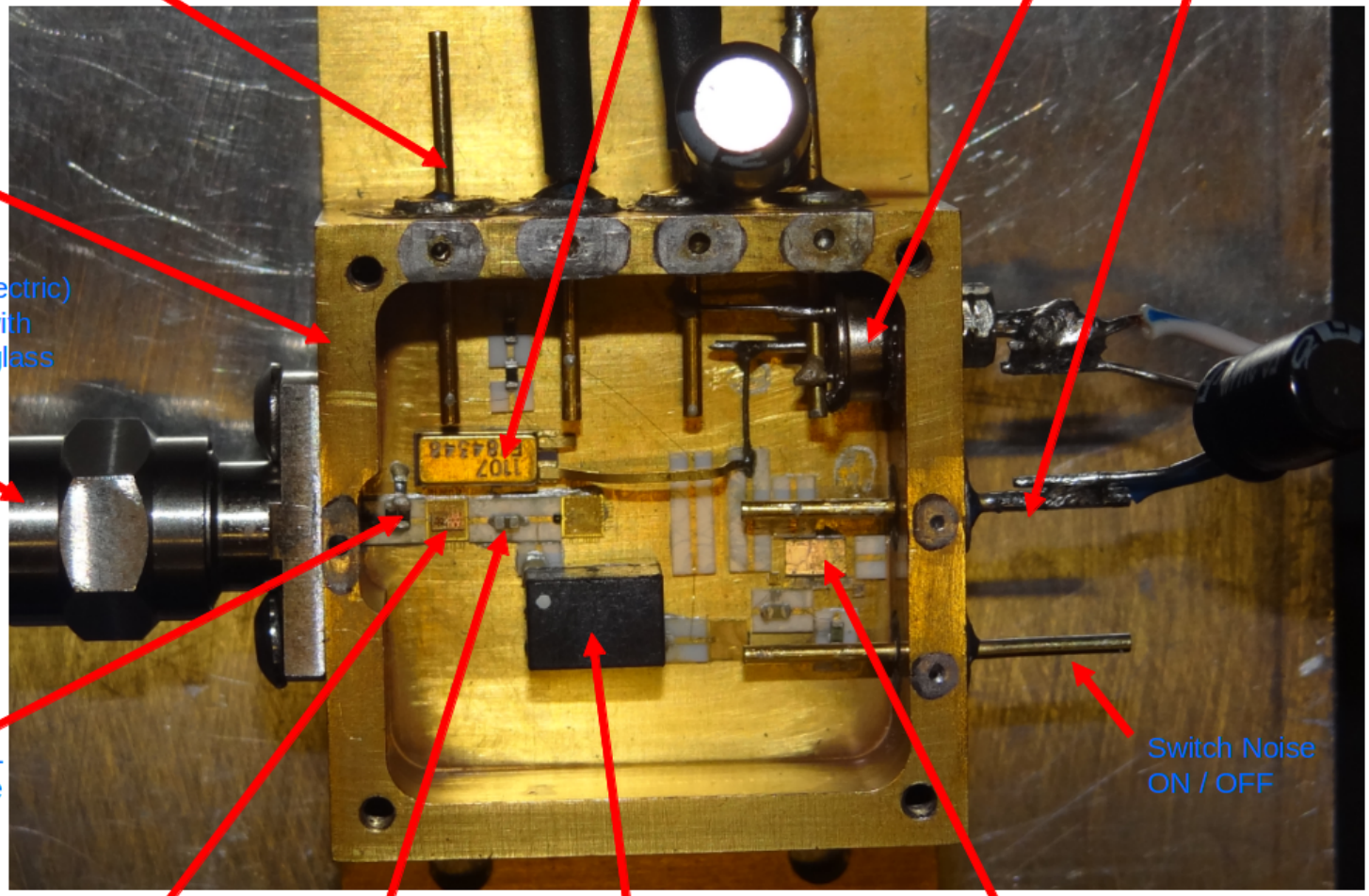
30dB Attenuator + 50 Ohm Load

DEGRADATION OF THE RETURN LOSS OF THE 50 Ohm load when cooled from 300K to 9.4K





A better 50 ohm load needs to be used



Capacitive DC feed through connectors
Soldered hermetically to the package

Precision temperature sensor
Soldered next to noise diode

Precision constant current Source
Attached to the package for heat sinking

Input voltage from Battery

Custom designed
RFI tight, compact
Package made of
Aluminum

Precision 2.9mm
Connector(air Dielectric)
Field replaceable with
Hermetic 50 Ohm glass
Bead

Matching network
To improve the S11
Of the noise source

Switch Noise
ON / OFF

Thin film attenuator Chips with good
Power match and low temperature
coefficient used here to set the level
and improve the impedance match

Wideband, Low loss
DC blocking capacitor
With smooth freq response
Mounted on an Alumina
50 ohm microstrip line

Wideband RF choke
Conical inductor with
Smooth freq response

Ultra low noise voltage Regulator
in Die form soldered to the package for
better heat sinking. Gold bond wires
are used to connect it to the circuit

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Span;170000000.000000;Hz
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Start;30000000.000000;Hz
Stop;200000000.000000;Hz
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Level Offset;0.000000;dB
Ref Position;100.000000;%
y-Axis;LOG;
Level Range;20.000000;dB
Rf Att;0.000000;dB
RBW;100000.000000;Hz
VBW;300.000000;Hz
SWT;11.500000;s
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Detector;AVERAGE;
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y-Unit;dBpW;
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Transducer;OFF;
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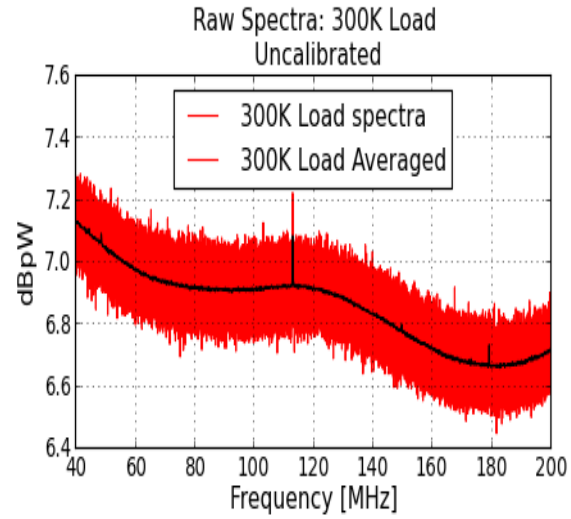
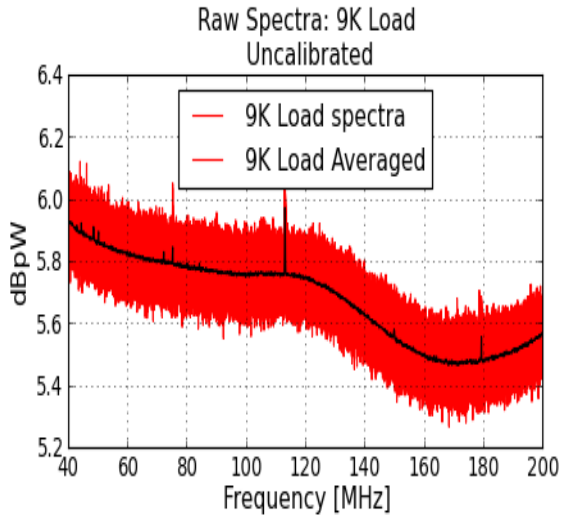
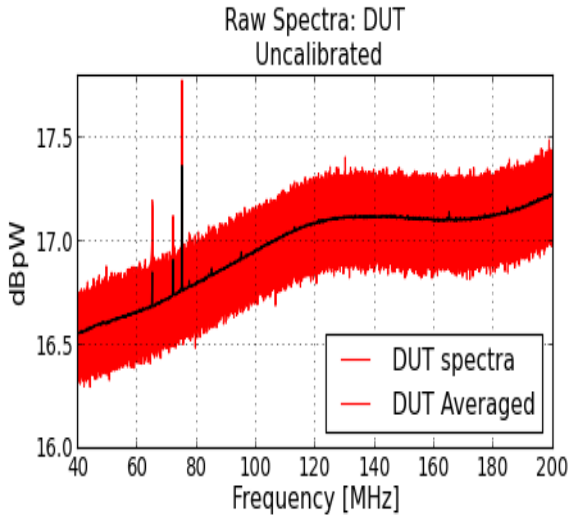
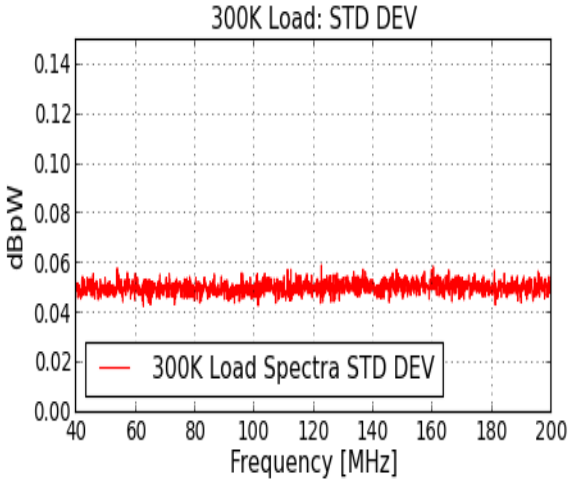
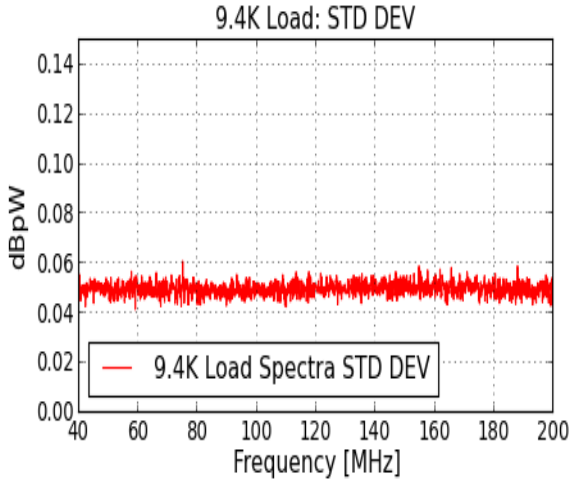
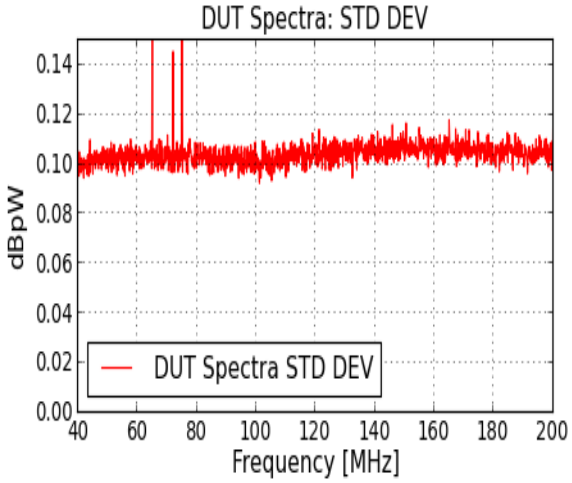

Raw Spectra: 300K Load
Uncalibrated
300K Load spectra
300K Load Averaged
dBpW
Frequency [MHz]

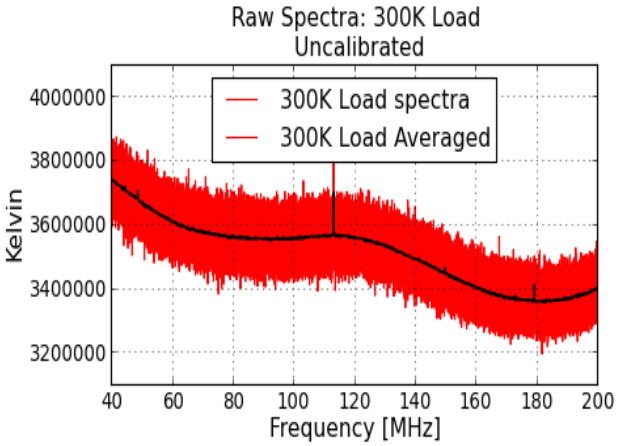

Raw Spectra: 9K Load
Uncalibrated
9K Load spectra
9K Load Averaged
dBpW
Frequency [MHz]

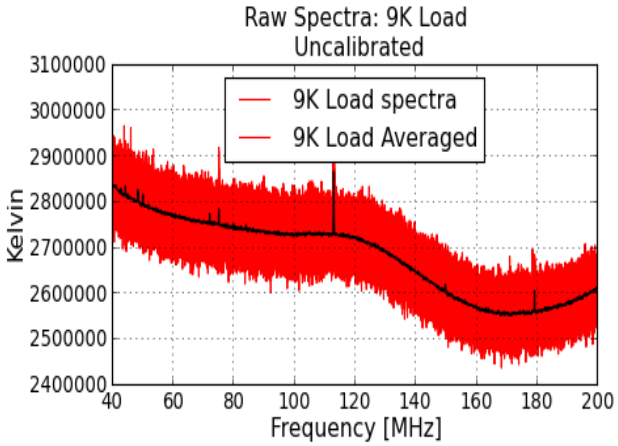

Raw Spectra: DUT
Uncalibrated
DUT spectra
DUT Averaged
dBpW
Frequency [MHz]

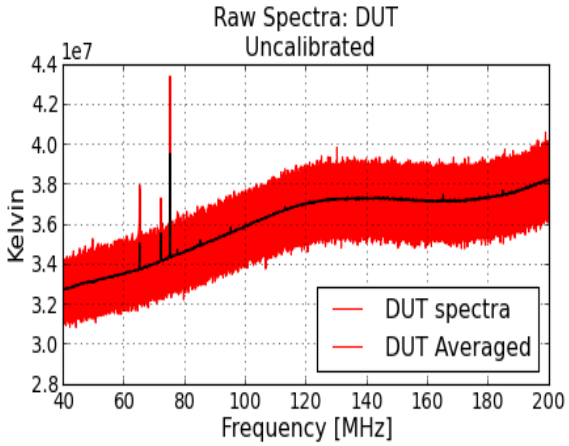

300K Load: STD DEV
300K Load Spectra STD DEV
dBpW
Frequency [MHz]

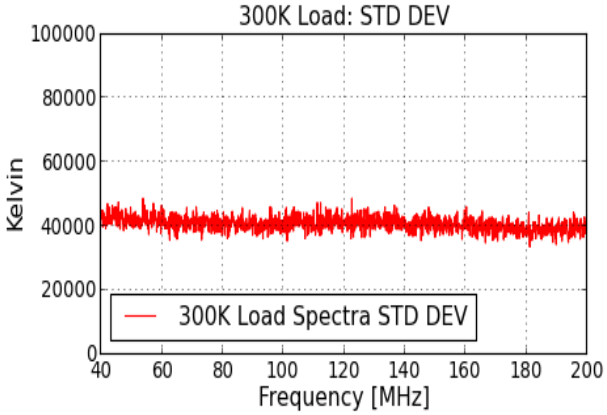

9.4K Load: STD DEV
9.4K Load Spectra STD DEV
dBpW
Frequency [MHz]

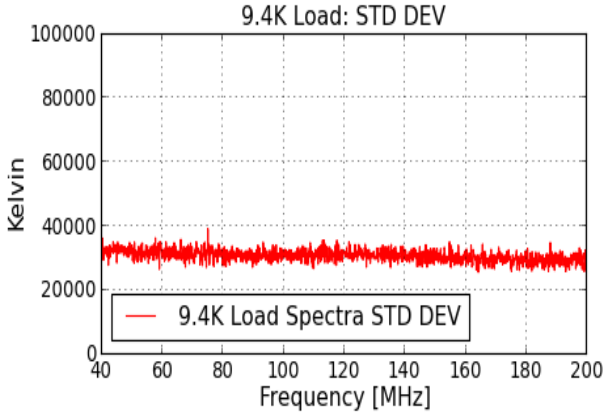

DUT Spectra: STD DEV
DUT Spectra STD DEV
dBpW
Frequency [MHz]

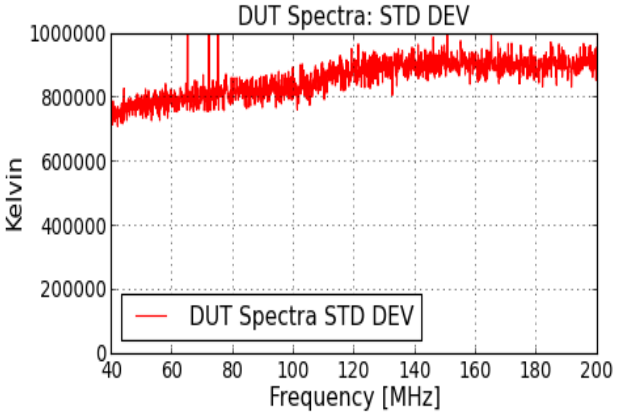

Raw Spectra: 300K Load
Uncalibrated
300K Load spectra
300K Load Averaged
Kelvin
Frequency [MHz]

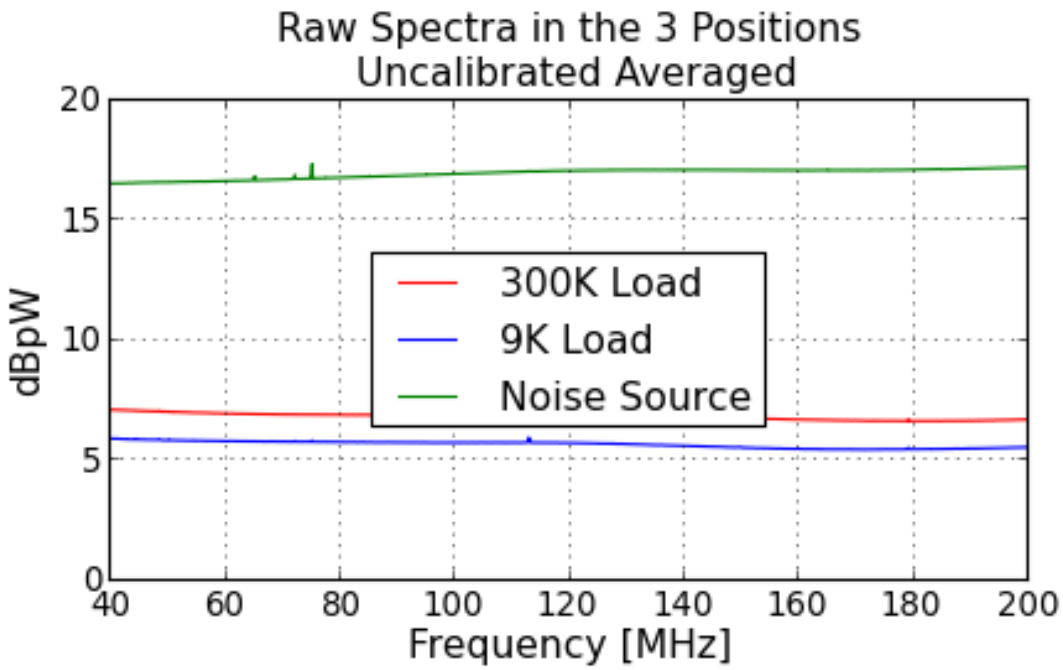

Raw Spectra: 9K Load
Uncalibrated
9K Load spectra
9K Load Averaged
Kelvin
Frequency [MHz]

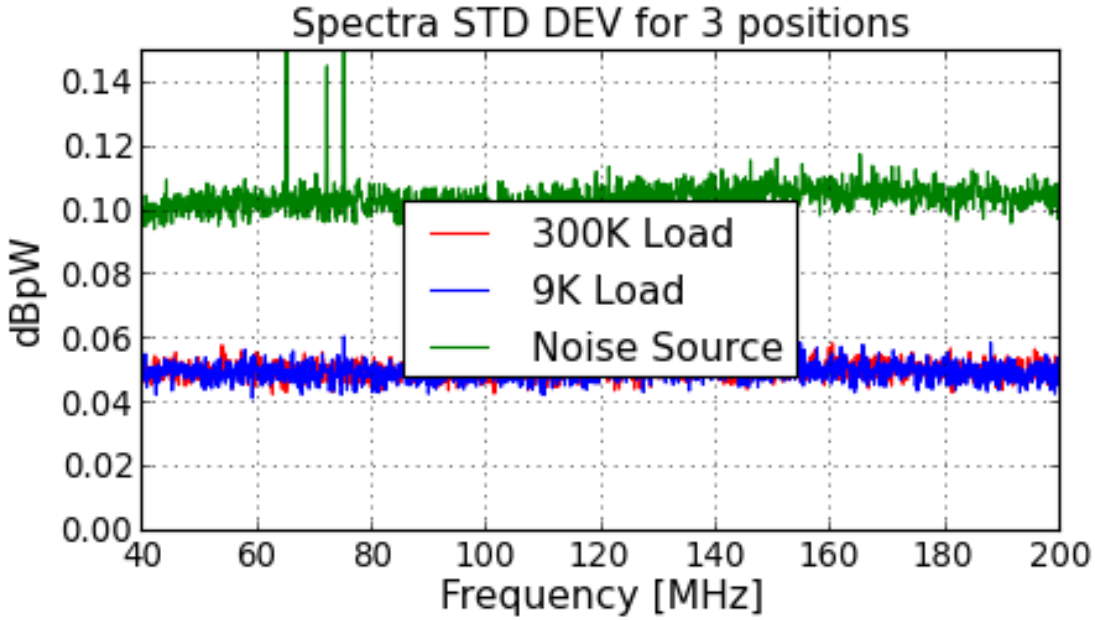

Raw Spectra: DUT
Uncalibrated
1e7
DUT spectra
DUT Averaged
Kelvin
Frequency [MHz]

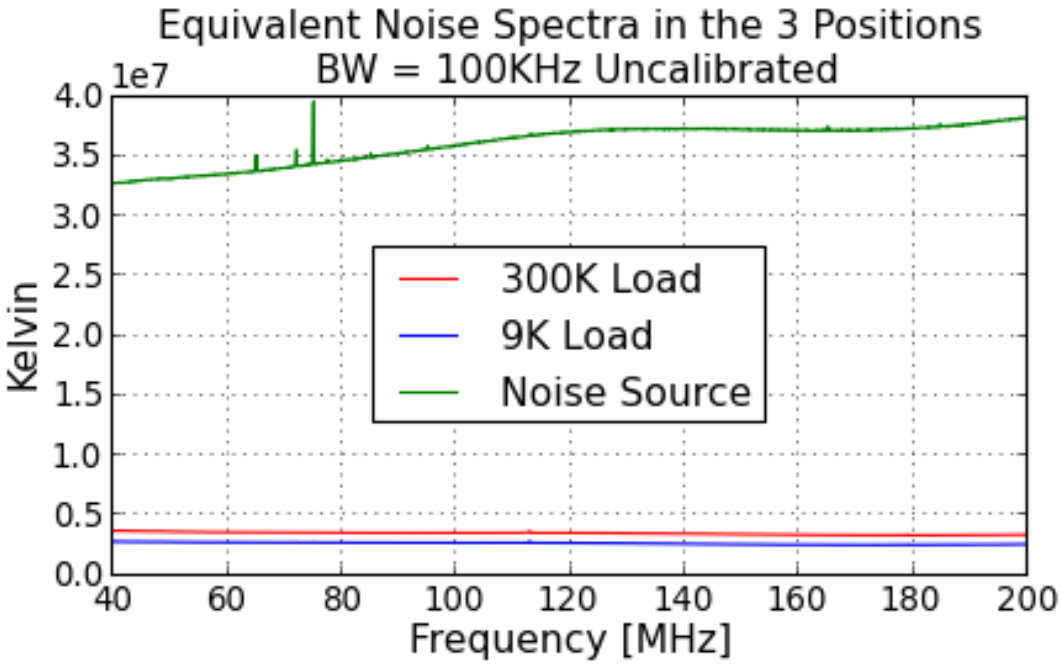

300K Load: STD DEV
300K Load Spectra STD DEV
Kelvin
Frequency [MHz]

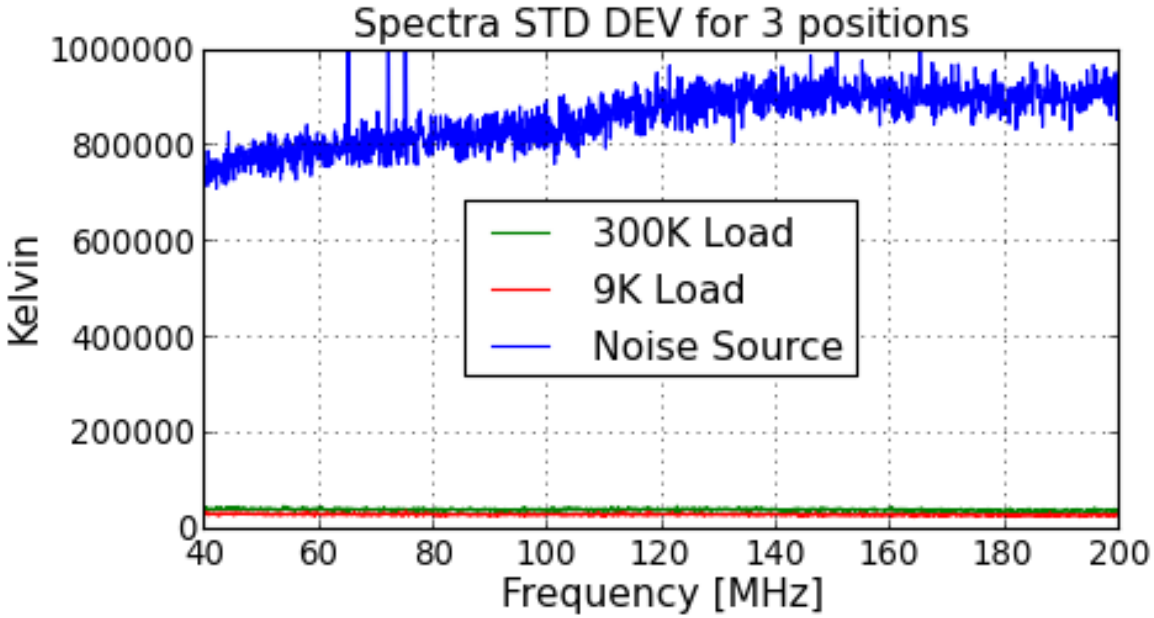

9.4K Load: STD DEV
9.4K Load Spectra STD DEV
Kelvin
Frequency [MHz]

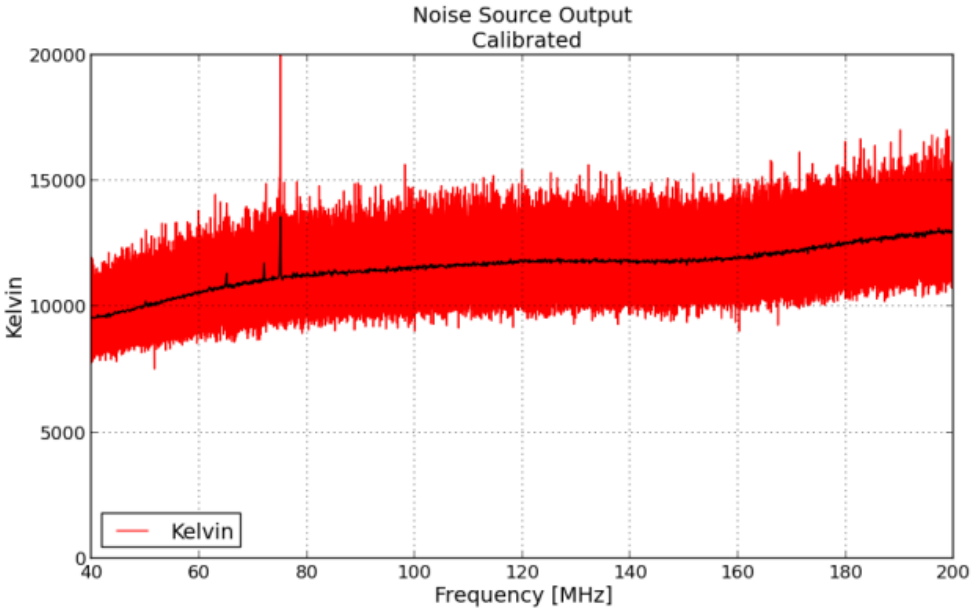

DUT Spectra: STD DEV
DUT Spectra STD DEV
Kelvin
Frequency [MHz]

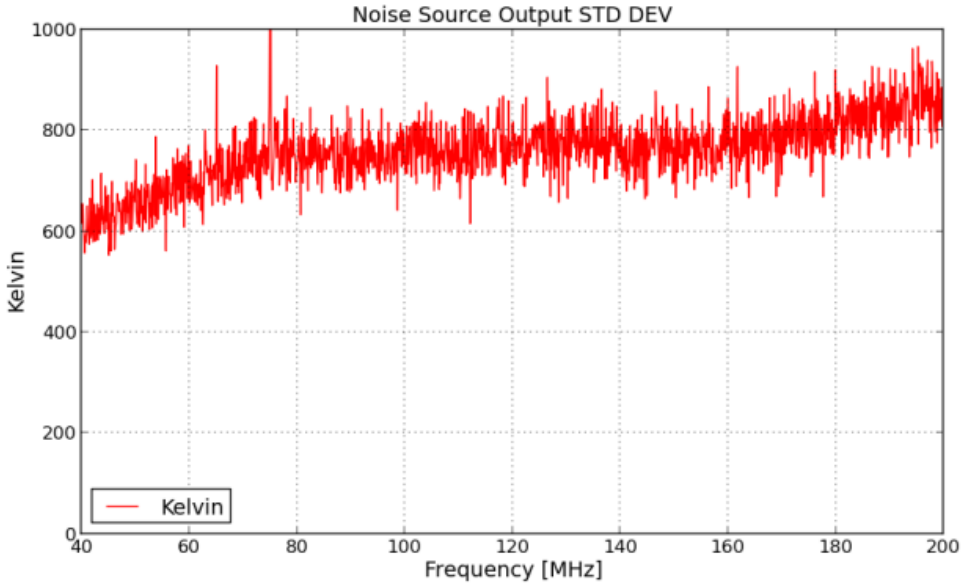

Raw Spectra in the 3 Positions
Uncalibrated Averaged
dBpW
Frequency [MHz]
300K Load
9K Load
Noise Source
0
5
10
15
20
40
60
80
100
120
140
160
180
200

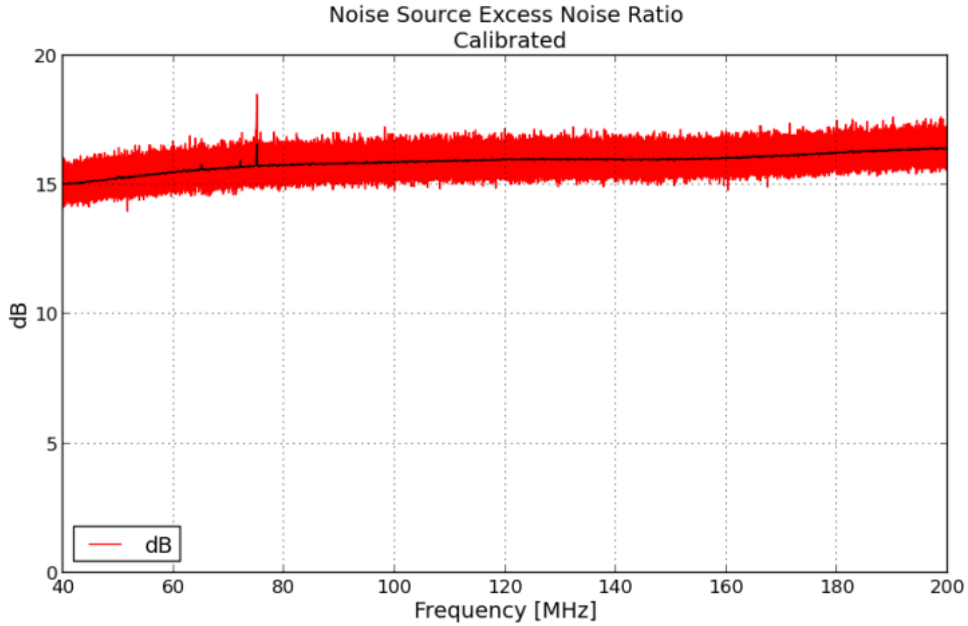

Spectra STD DEV for 3 positions
dBpW
Frequency [MHz]
300K Load
9K Load
Noise Source
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
40
60
80
100
120
140
160
180
200


Equivalent Noise Spectra in the 3 Positions
BW = 100KHz Uncalibrated
1e7
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Kelvin
300K Load
9K Load
Noise Source
40
60
80
100
120
140
160
180
200
Frequency [MHz]


Spectra STD DEV for 3 positions
1000000
800000
600000
400000
200000
0
Kelvin
300K Load
9K Load
Noise Source
40
60
80
100
120
140
160
180
200
Frequency [MHz]


Noise Source Output
Calibrated
20000
15000
10000
5000
0
Kelvin
Kelvin
40
60
80
100
120
140
160
180
200
Frequency [MHz]


Noise Source Output STD DEV
1000
800
600
400
200
0
Kelvin
Kelvin
40
60
80
100
120
140
160
180
200
Frequency [MHz]


Noise Source Excess Noise Ratio
Calibrated
dB
Frequency [MHz]
dB
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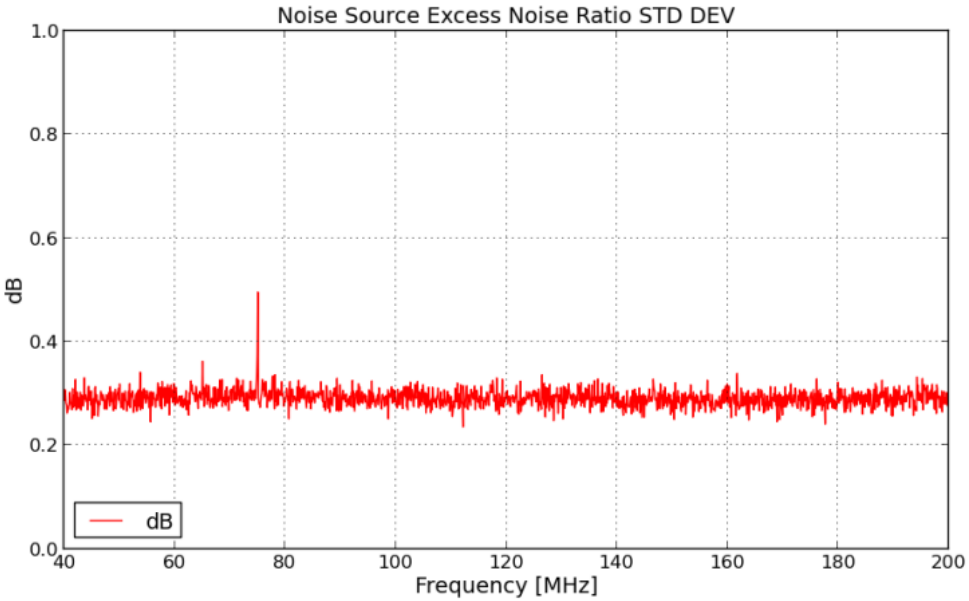
5
10
15
20
40
60
80
100
120
140
160
180
200


Noise Source Excess Noise Ratio STD DEV
dB
Frequency [MHz]
dB
0.0
0.2
0.4
0.6
0.8
1.0
40
60
80
100
120
140
160
180
200

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Stop;200000000.000000;Hz
Ref Level;20.000000;dBpW
Level Offset;0.000000;dB
Ref Position;100.000000;%
y-Axis;LOG;
Level Range;20.000000;dB
Rf Att;0.000000;dB
RBW;100000.000000;Hz
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SWT;11.500000;s
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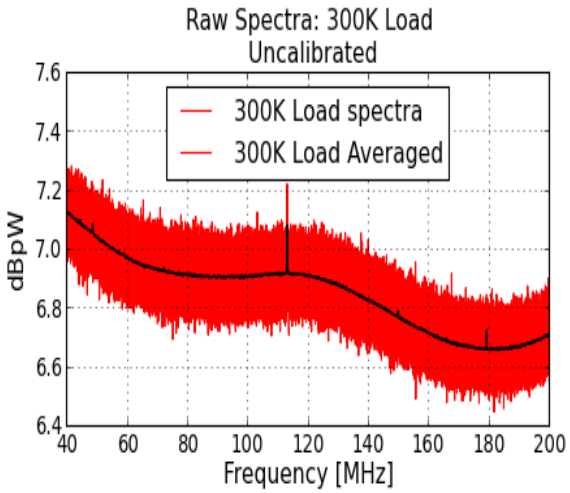
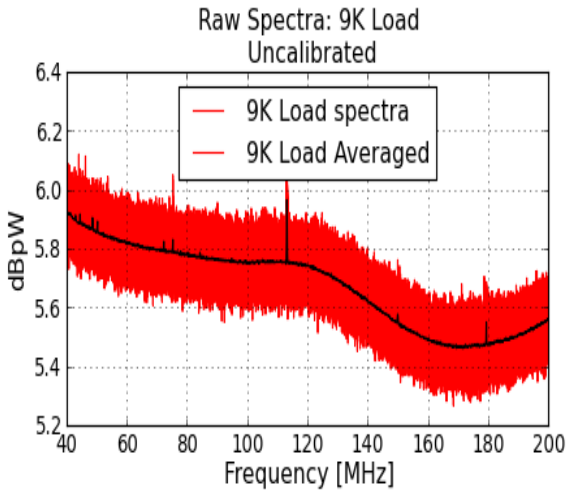
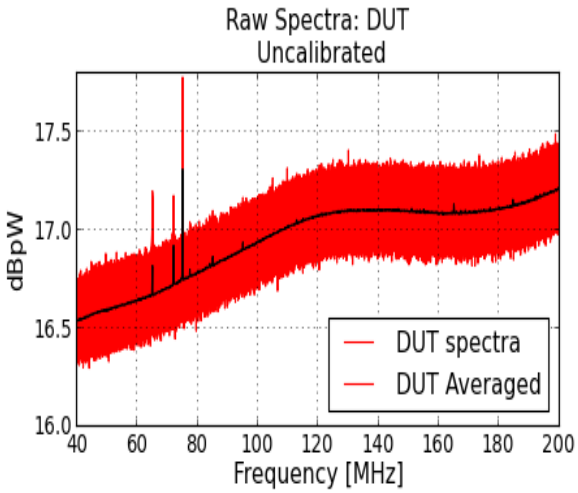

Raw Spectra: 300K Load
Uncalibrated
300K Load spectra
300K Load Averaged
dBpW
Frequency [MHz]


Raw Spectra: 9K Load
Uncalibrated
9K Load spectra
9K Load Averaged
dBpW
Frequency [MHz]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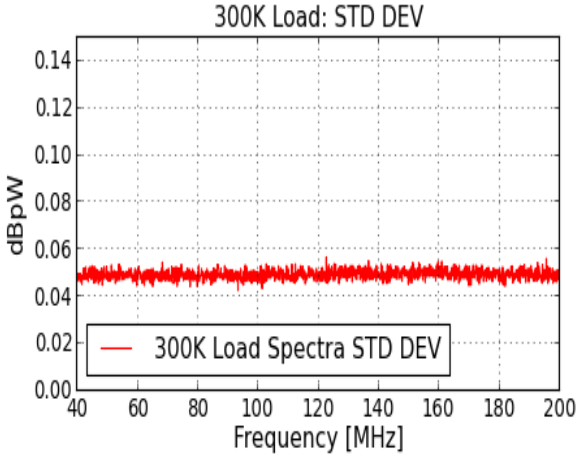
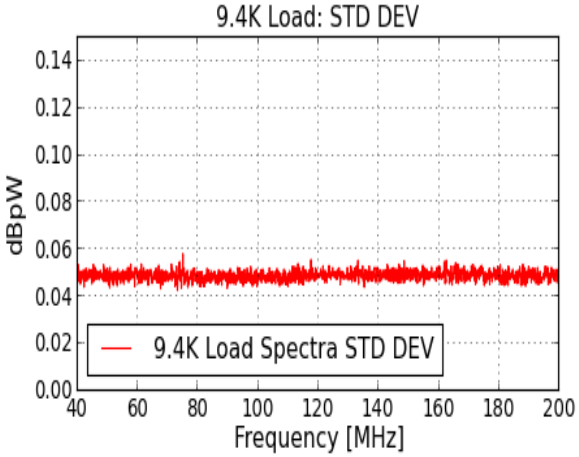
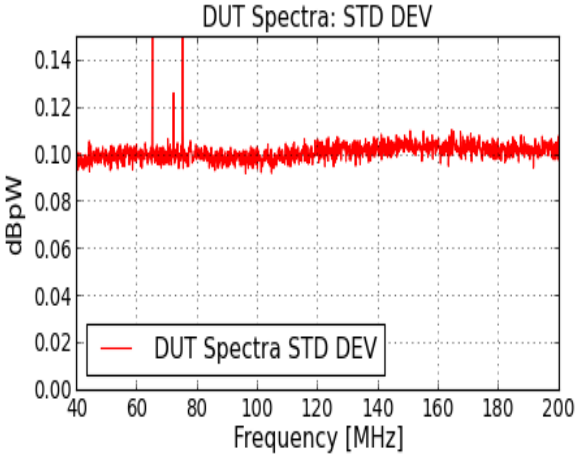
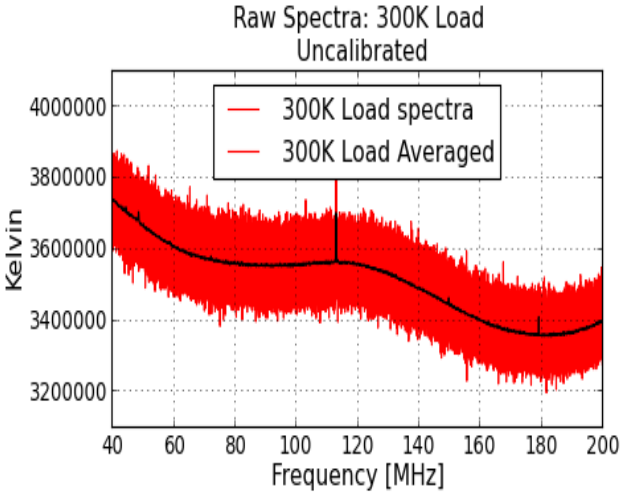
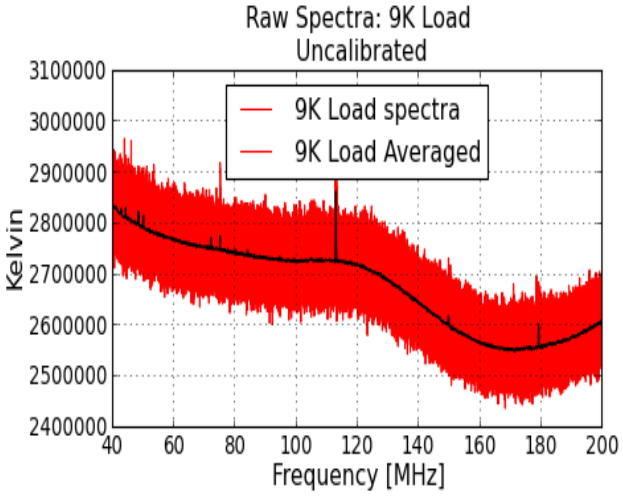
Uncalibrated
DUT spectra
DUT Averaged
dBpW
Frequency [MHz]

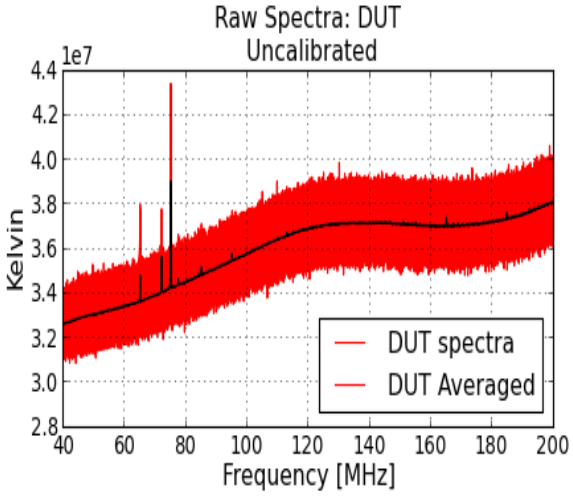

300K Load: STD DEV
300K Load Spectra STD DEV
dBpW
Frequency [MHz]

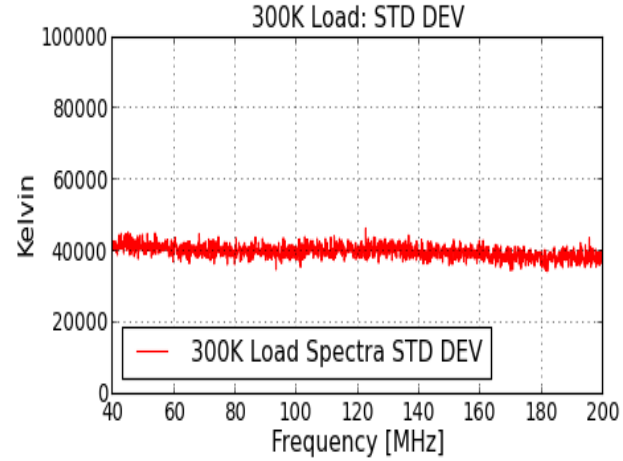

9.4K Load: STD DEV
9.4K Load Spectra STD DEV
dBpW
Frequency [MHz]

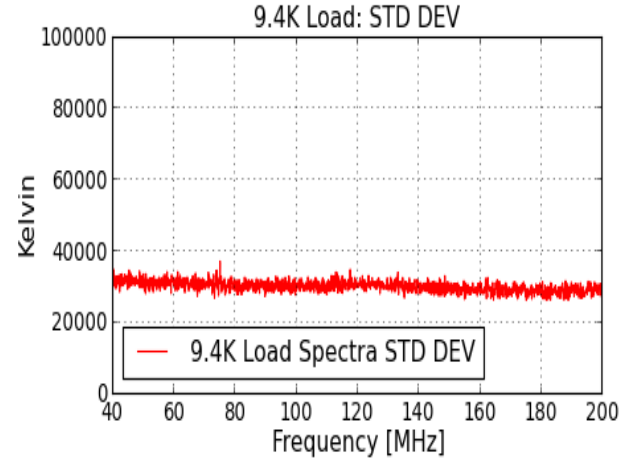

DUT Spectra: STD DEV
DUT Spectra STD DEV
dBpW
Frequency [MHz]

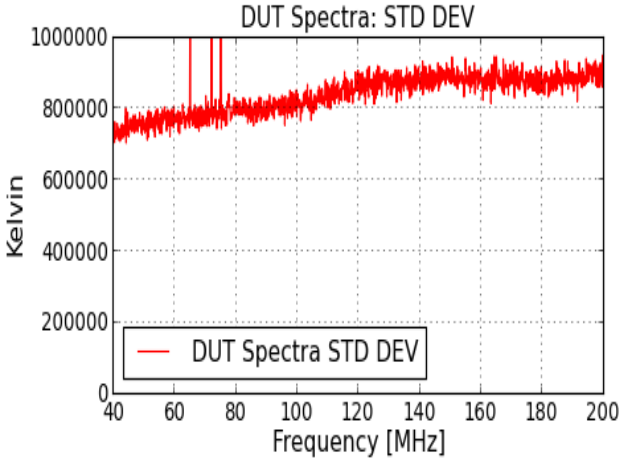

Raw Spectra: 300K Load
Uncalibrated
300K Load spectra
300K Load Averaged
Kelvin
Frequency [MHz]

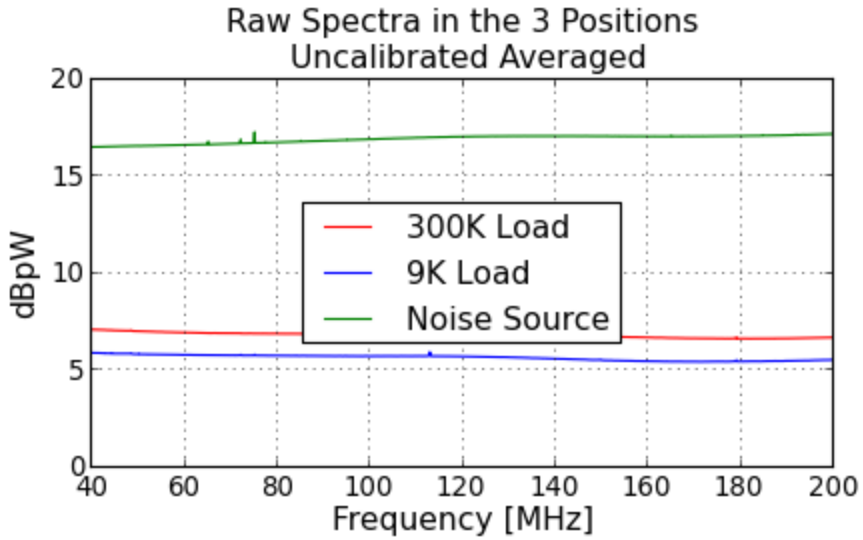

Raw Spectra: 9K Load
Uncalibrated
9K Load spectra
9K Load Averaged
Kelvin
Frequency [MHz]

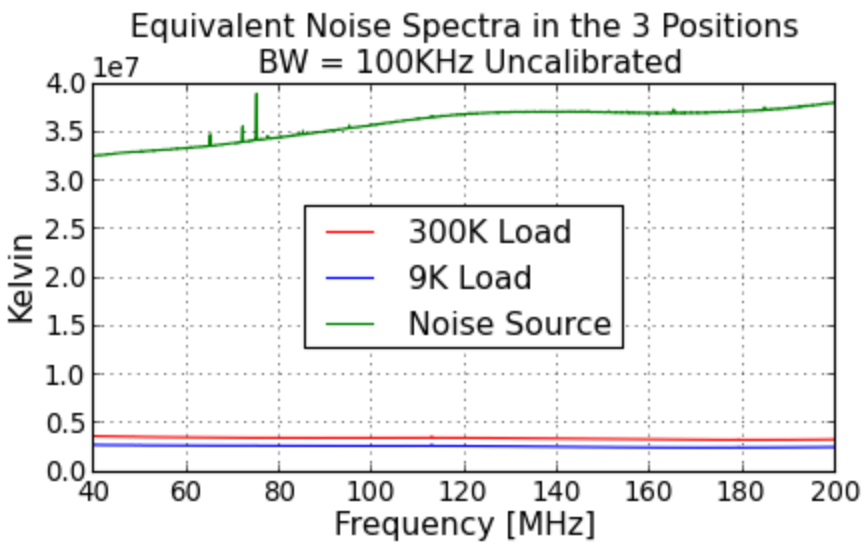

Raw Spectra: DUT
Uncalibrated
1e7
DUT spectra
DUT Averaged
Kelvin
Frequency [MHz]

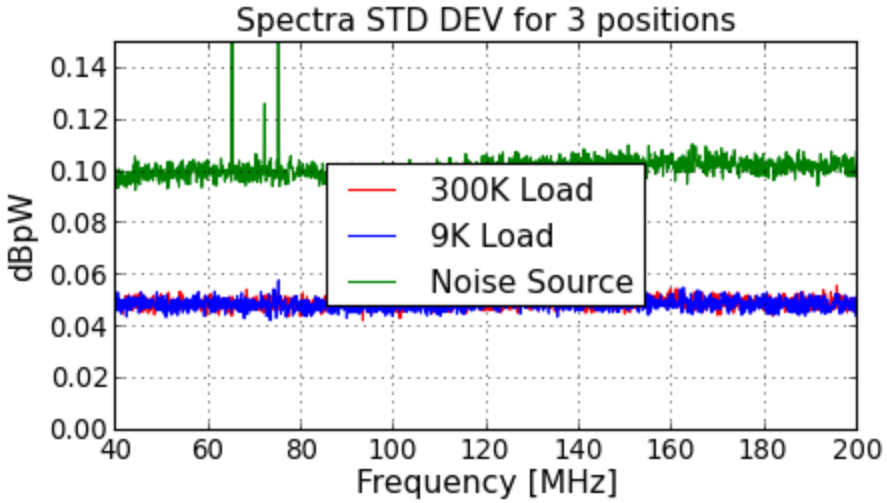

300K Load: STD DEV
300K Load Spectra STD DEV
Kelvin
Frequency [MHz]

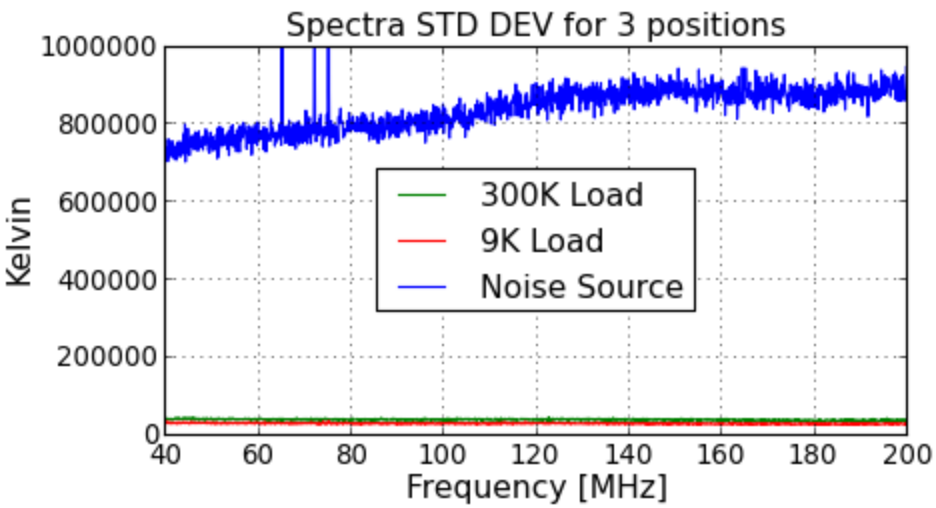

9.4K Load: STD DEV
9.4K Load Spectra STD DEV
Kelvin
Frequency [MHz]

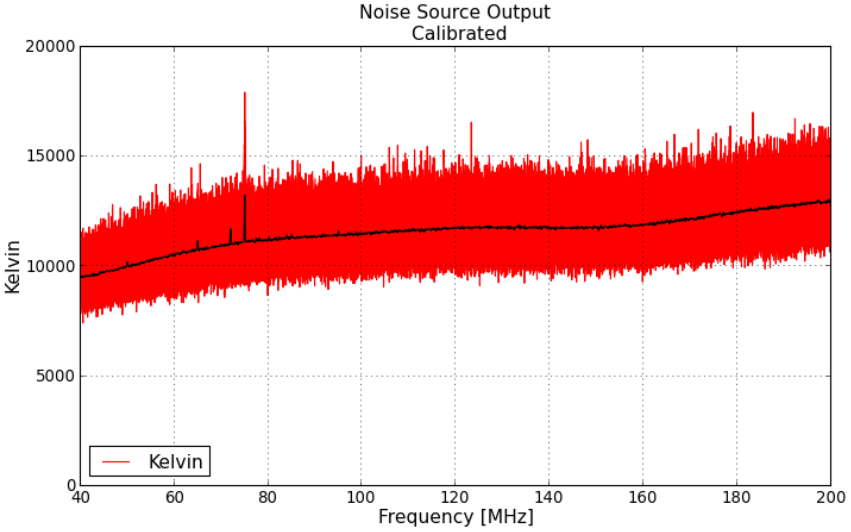

DUT Spectra: STD DEV
DUT Spectra STD DEV
Kelvin
Frequency [MHz]

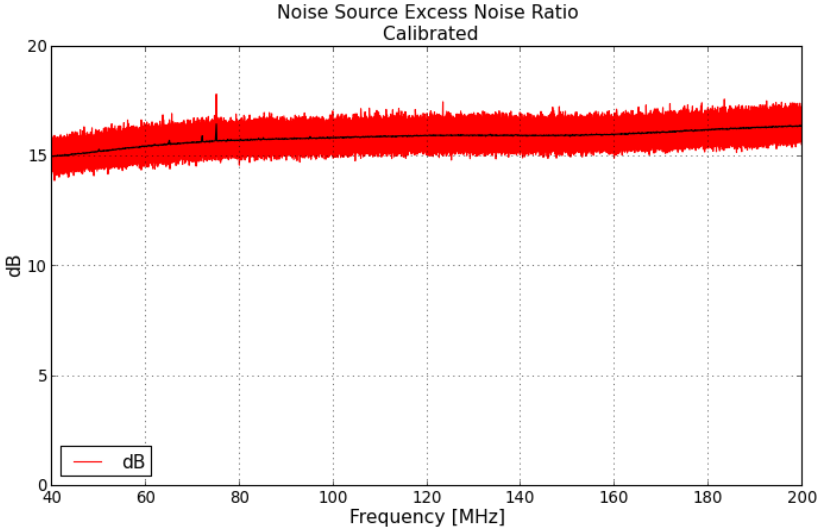

Raw Spectra in the 3 Positions
Uncalibrated Averaged
dBpW
Frequency [MHz]
300K Load
9K Load
Noise Source

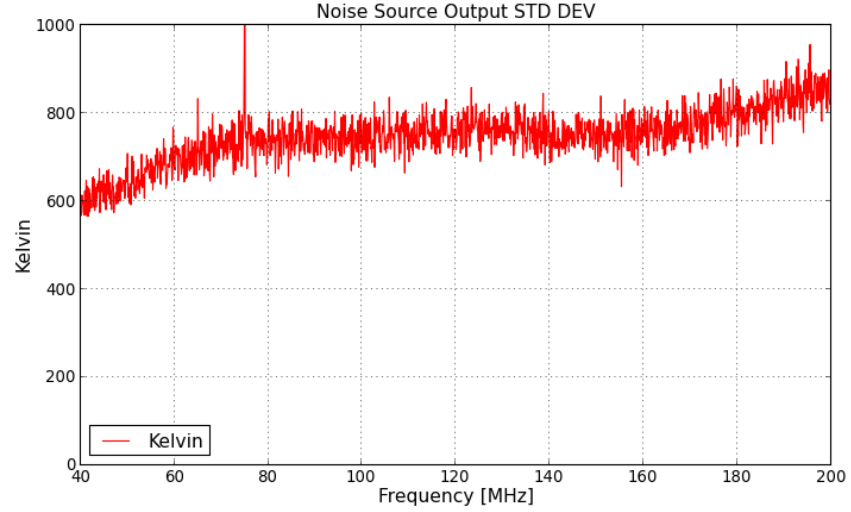

Equivalent Noise Spectra in the 3 Positions
BW = 100KHz Uncalibrated
1e7
Kelvin
Frequency [MHz]
300K Load
9K Load
Noise Source

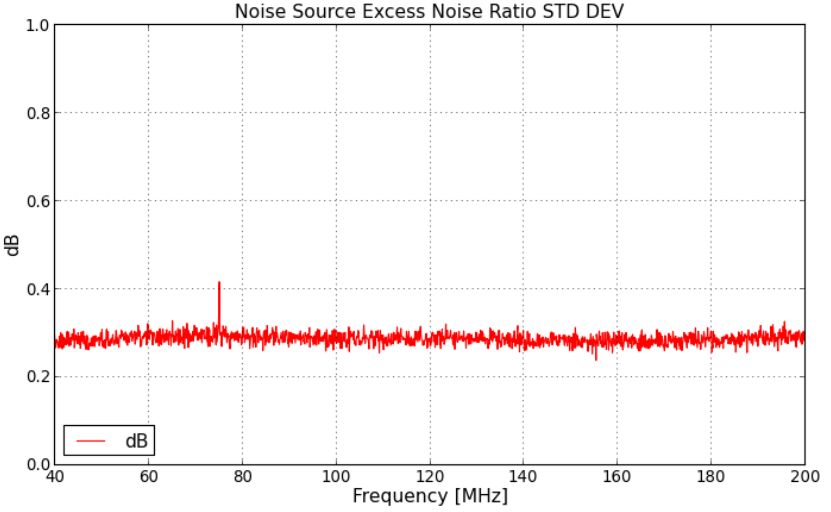

Spectra STD DEV for 3 positions
dBpW
Frequency [MHz]
300K Load
9K Load
Noise Source


Spectra STD DEV for 3 positions
Kelvin
Frequency [MHz]
300K Load
9K Load
Noise Source


Noise Source Output
Calibrated
Kelvin
Frequency [MHz]
Kelvin


Noise Source Excess Noise Ratio
Calibrated
dB
Frequency [MHz]
dB


Noise Source Output STD DEV
Kelvin
Frequency [MHz]
Kelvin


Noise Source Excess Noise Ratio STD DEV
dB
Frequency [MHz]
dB

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Freq Offset;0.000000;Hz
Span;40000000.000000;Hz
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Start;40000000.000000;Hz
Stop;80000000.000000;Hz
Ref Level;30.000000;dBpW
Level Offset;0.000000;dB
Ref Position;100.000000;%
y-Axis;LOG;
Level Range;15.000000;dB
Rf Att;0.000000;dB
RBW;1000000.000000;Hz
VBW;1.000000;Hz
SWT;80.000000;s
Trace Mode;AVERAGE;
Detector;AVERAGE;
Sweep Count;0;
Trace 1:;;
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y-Unit;dBpW;
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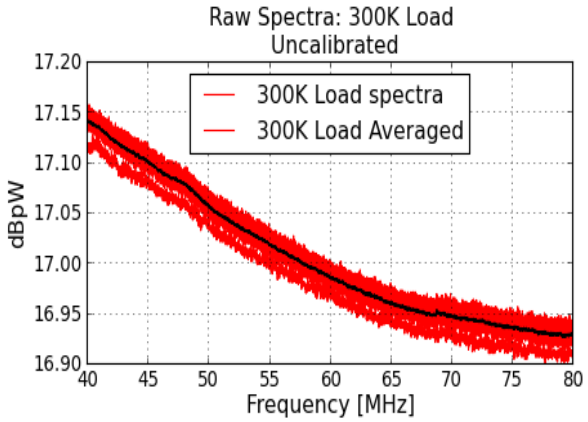
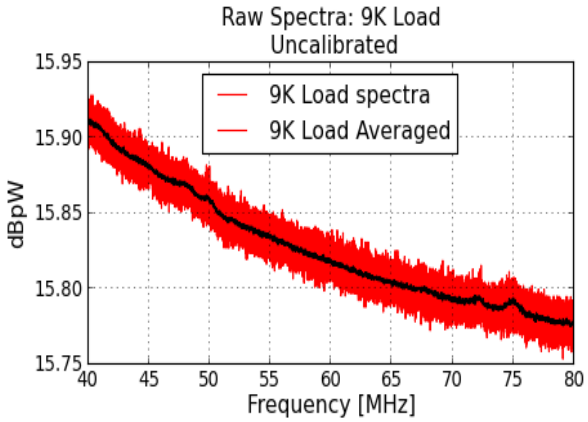
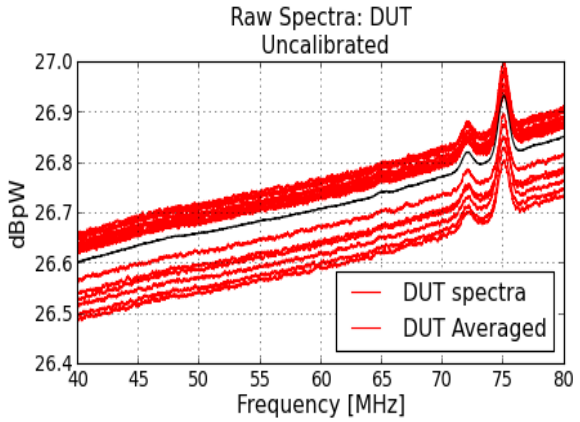
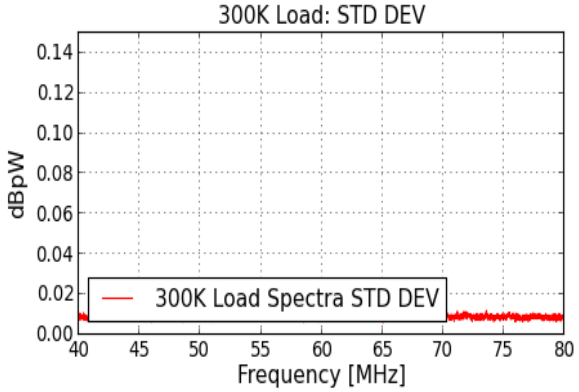
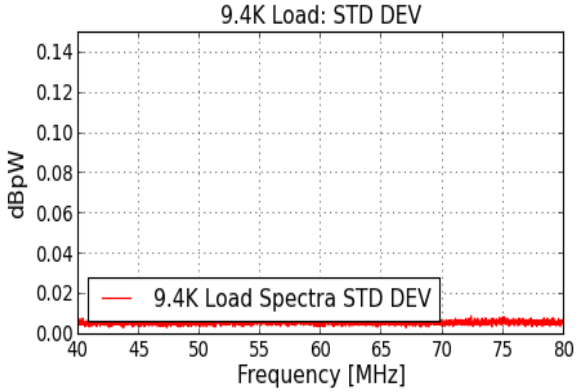
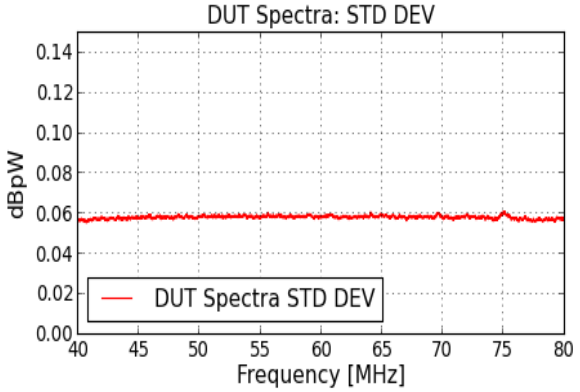

Raw Spectra: 300K Load
Uncalibrated
300K Load spectra
300K Load Averaged
dBpW
Frequency [MHz]

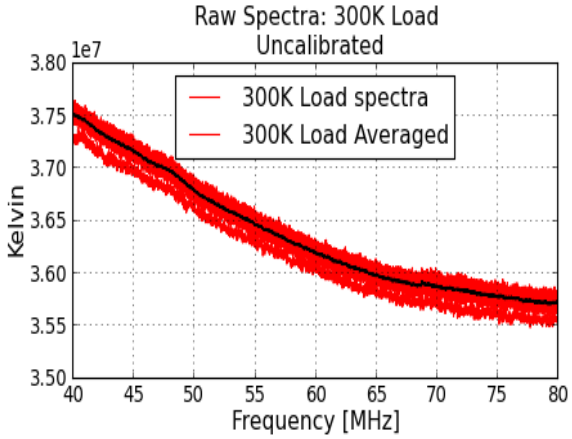

Raw Spectra: 9K Load
Uncalibrated
9K Load spectra
9K Load Averaged
dBpW
Frequency [MHz]

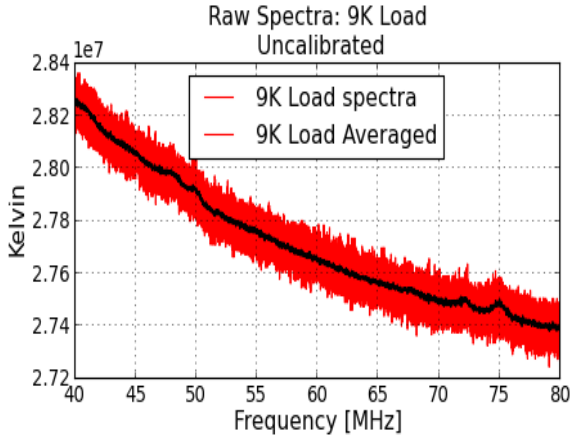

Raw Spectra: DUT
Uncalibrated
DUT spectra
DUT Averaged
dBpW
Frequency [MHz]

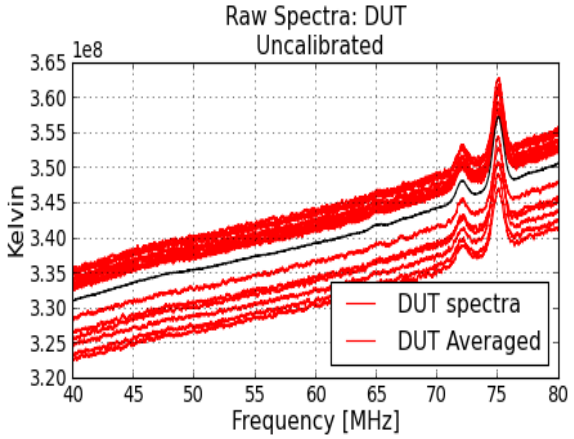

300K Load: STD DEV
300K Load Spectra STD DEV
dBpW
Frequency [MHz]

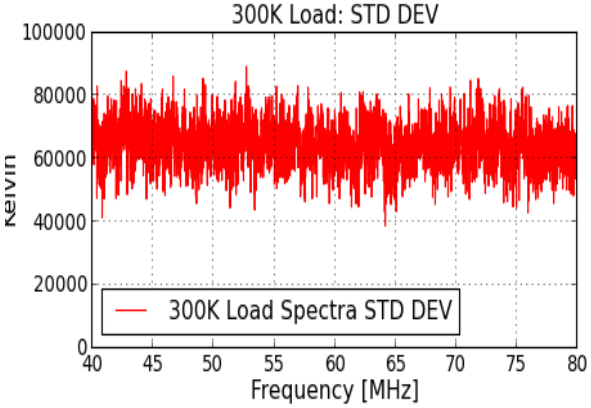

9.4K Load: STD DEV
9.4K Load Spectra STD DEV
dBpW
Frequency [MHz]

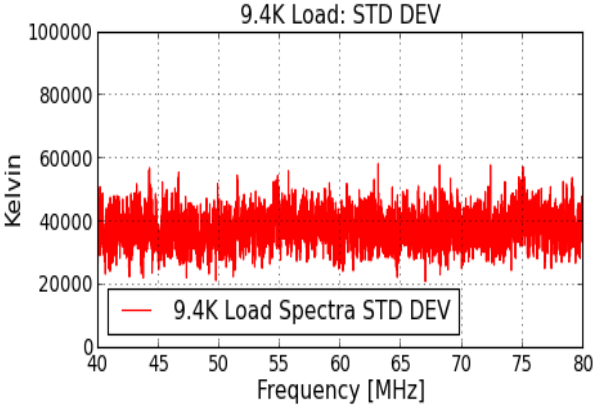

DUT Spectra: STD DEV
DUT Spectra STD DEV
dBpW
Frequency [MHz]

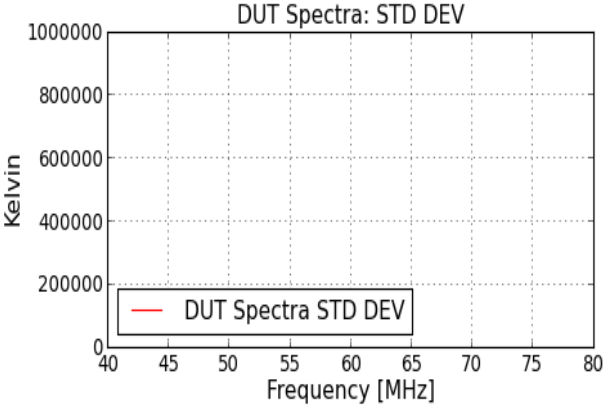

Raw Spectra: 300K Load
Uncalibrated
1e7
3.80
3.75
3.70
3.65
3.60
3.55
3.50
Kelvin
300K Load spectra
300K Load Averaged
40
45
50
55
60
65
70
75
80
Frequency [MHz]

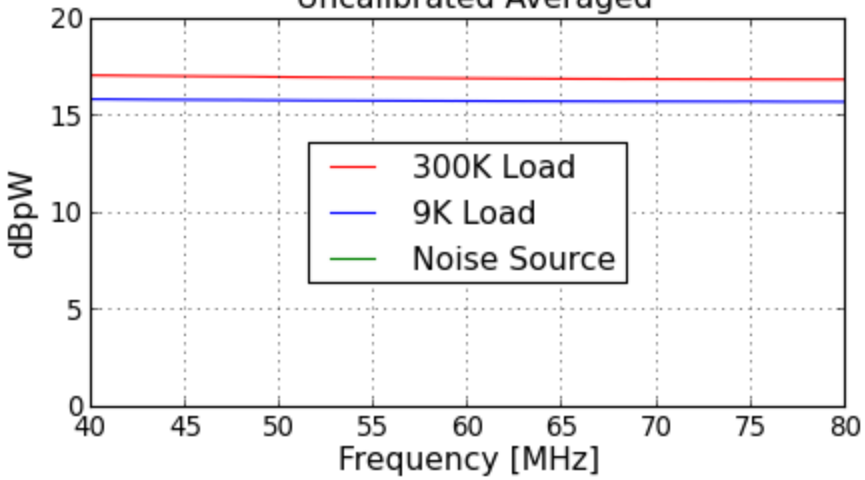

Raw Spectra: 9K Load
Uncalibrated
1e7
2.84
2.82
2.80
2.78
2.76
2.74
2.72
Kelvin
9K Load spectra
9K Load Averaged
40
45
50
55
60
65
70
75
80
Frequency [MHz]

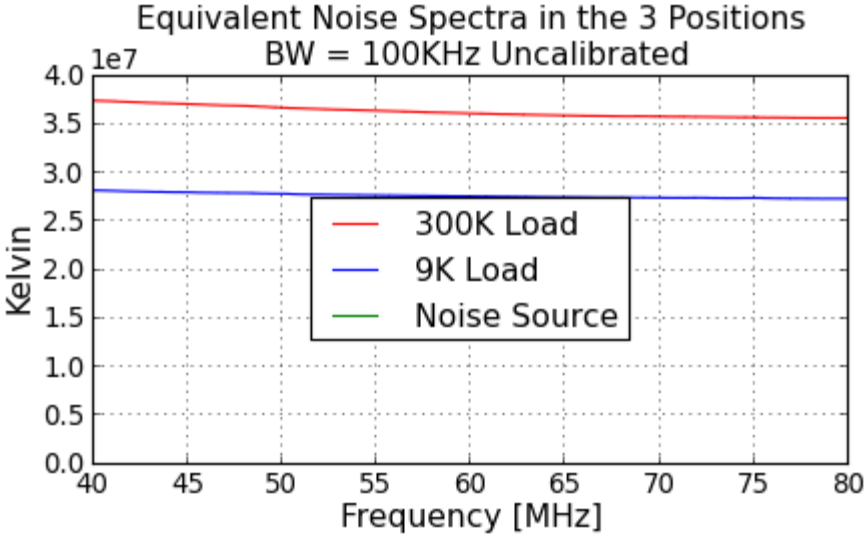

Raw Spectra: DUT
Uncalibrated
1e8
3.65
3.60
3.55
3.50
3.45
3.40
3.35
3.30
3.25
3.20
Kelvin
DUT spectra
DUT Averaged
40
45
50
55
60
65
70
75
80
Frequency [MHz]

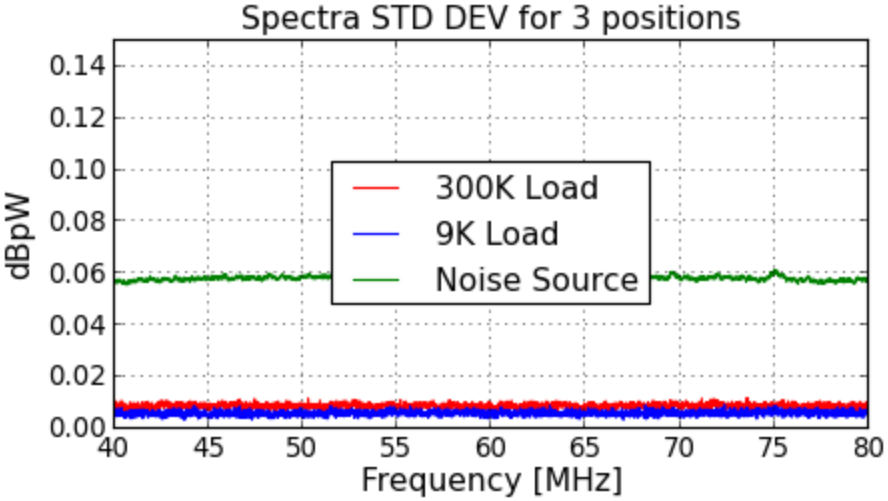

300K Load: STD DEV
100000
80000
60000
40000
20000
0
Kelvin
300K Load Spectra STD DEV
40
45
50
55
60
65
70
75
80
Frequency [MHz]

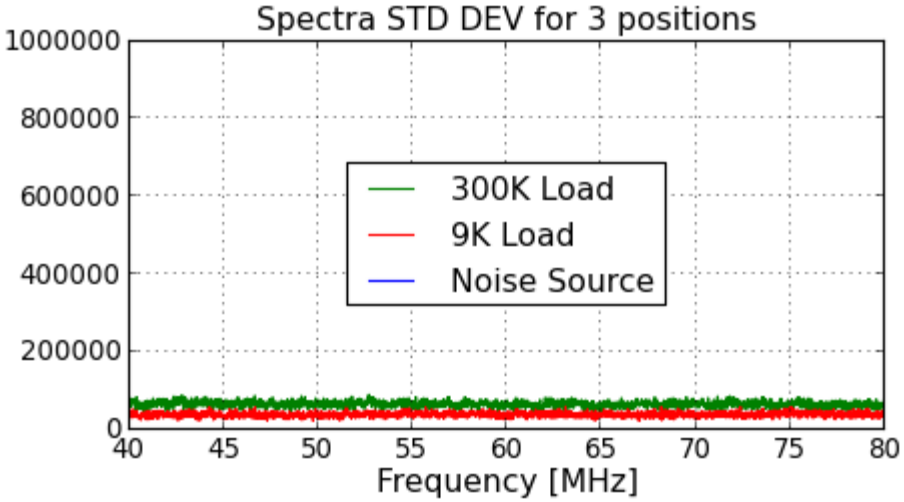

9.4K Load: STD DEV
100000
80000
60000
40000
20000
0
Kelvin
9.4K Load Spectra STD DEV
40
45
50
55
60
65
70
75
80
Frequency [MHz]

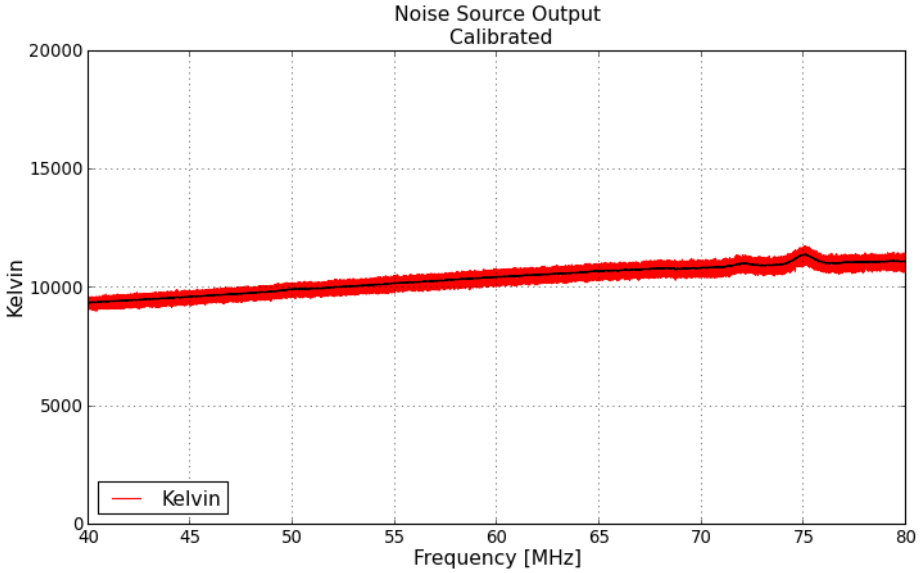

DUT Spectra: STD DEV
1000000
800000
600000
400000
200000
0
Kelvin
DUT Spectra STD DEV
40
45
50
55
60
65
70
75
80
Frequency [MHz]

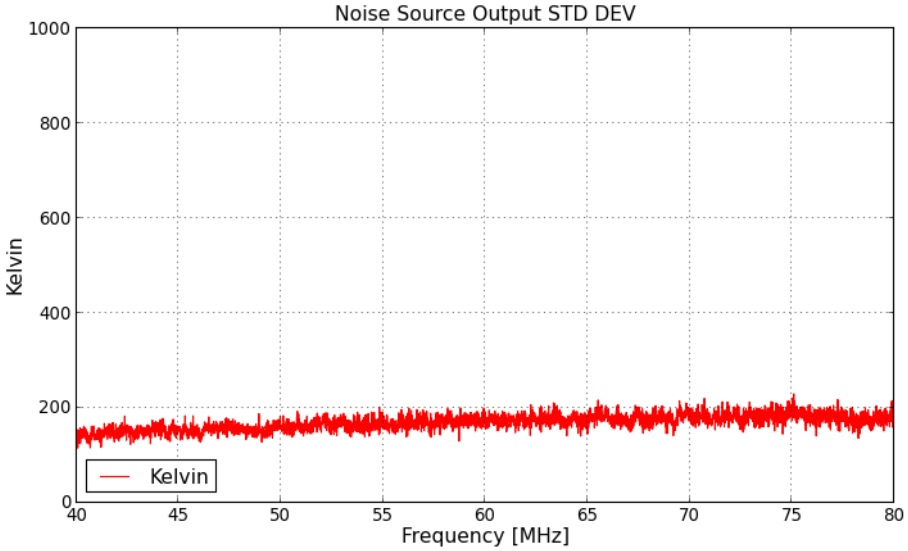

Raw Spectra in the 3 Positions
Uncalibrated Averaged
dBpW
Frequency [MHz]
300K Load
9K Load
Noise Source

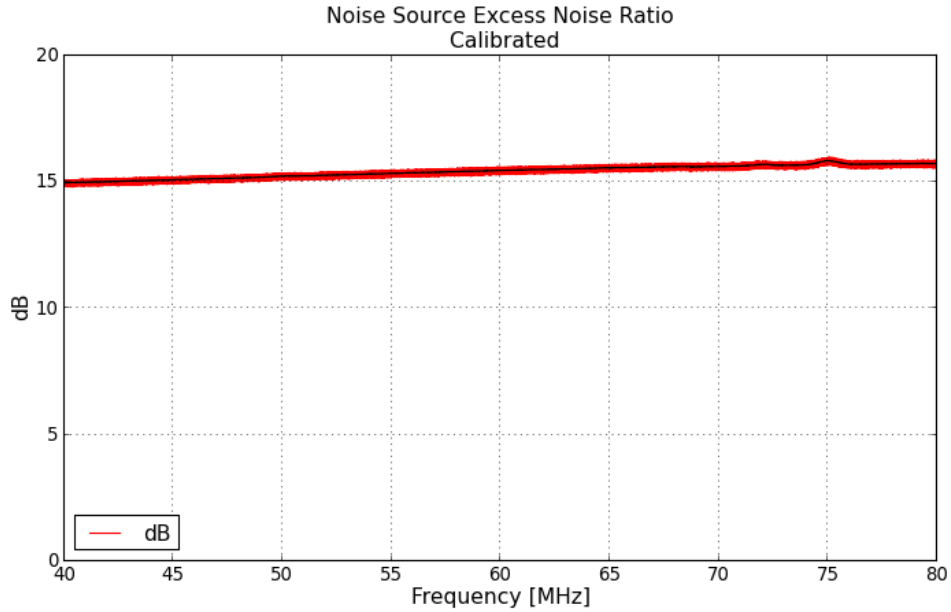

Equivalent Noise Spectra in the 3 Positions
BW = 100KHz Uncalibrated
1e7
Kelvin
Frequency [MHz]
300K Load
9K Load
Noise Source

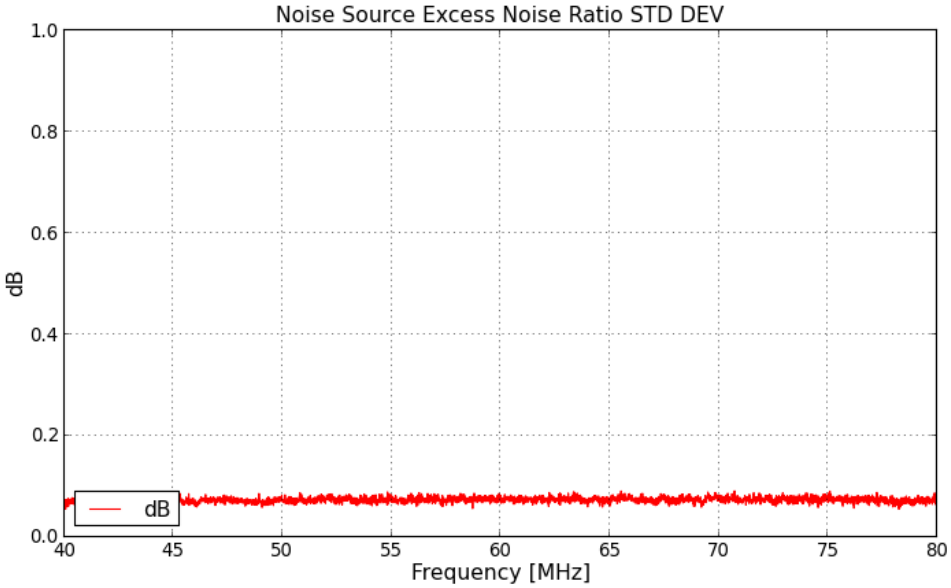

Spectra STD DEV for 3 positions
dBpW
Frequency [MHz]
300K Load
9K Load
Noise Source


Spectra STD DEV for 3 positions
Frequency [MHz]
300K Load
9K Load
Noise Source


Noise Source Output
Calibrated
20000
15000
10000
5000
0
Kelvin
Kelvin
40
45
50
55
60
65
70
75
80
Frequency [MHz]


Noise Source Output STD DEV
1000
800
600
400
200
0
Kelvin
Kelvin
40
45
50
55
60
65
70
75
80
Frequency [MHz]


Noise Source Excess Noise Ratio
Calibrated
dB
Frequency [MHz]
dB


Noise Source Excess Noise Ratio STD DEV
dB
Frequency [MHz]
dB