POLARBEAR KT7 Comb A Detectors

This document reports noise results. There is one page per detector that describes the parameters used, the noise calculation and a plot of the timestream used and its power spectrum. Also, one plot per comb is shown showing measured and predicted noise as a function of bias frequency.

The demodulator gain and frequency, the carrier gain and amplitude, the nuller gain and amplitude and the SQUID feedback loop, flux bias and current bias are parameters read from the DfMUX and SQUID controller boards. Values of -1 indicates that the value was not known at the time and other values can be wrong (do not trust calculated numbers if a -1 is present).

The voltage bias is calculated using the transfer function (refer to the DfMUXTransferFunctionsMemo memo). R normal is obtained from the width of the peaks in the network analysis. R is assumed to be x×R_n for a bolometer in transition where x is the position in the transition (0.8 for 80% in transition for example). The leadlag resistance is assumed to be 20Ω. The optical loading is approximated by subtracting the power at turnaround when bolometers were tuned from the power at turnaround when bolometers were tuned dark. T_c is a measured value and the bath temperature is simply the temperature the detectors are heatsunk to. The average thermal conductance is obtained from the bolometer tuning dark and the dynamical G is calculated from it (refer to the BoloNoiseMemo memo).

The list of operations done to the data is also listed. Each of the components of the calculated noise are listed. The predicted noise as well as the measured average noise between two given frequencies with its variance and the ratio of measured over predicted noise are finally listed. The frequencies between which the PSD is averaged are quoted as well.

b153-w0-c0

Removing gradient
Applying Hanning window
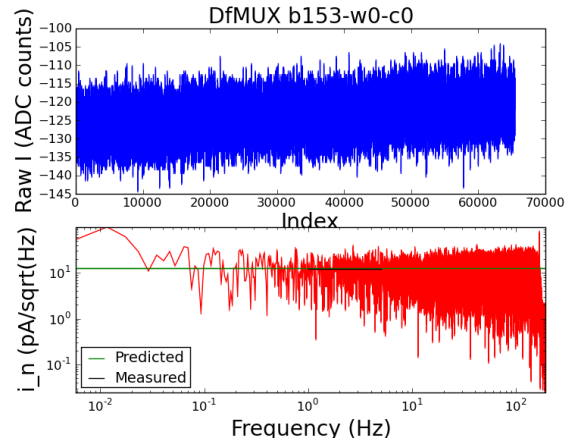Correcting PSD for Hanning window

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Measured I increased by 5% for DMFD imperfections.

Measured value is the average between 1.0 and 5.0Hz.

Demod gain is : 2
Demod frequency is : 273510 Hz
Carrier gain is : 2
Carrier amplitude : 1.7
Nuller gain is : 2
Nuller amplitude : 0.625
Voltage bias is : 9.0508 uV_RMS
R normal is : 0.99 ohm
R is   : 0.99 ohm
SQUID feedback loop: 10000 ohm
SQUID flux bias : -0.260864257812 V
SQUID current bias : 4.04962158203 V
Leadlag R : 20 ohm
Optical loading : 0.0 pW
Frequency band : 0 GHz
Tc is : 0.51 K
T_bath is : 0.235 K
G is guessed : 219.708538413 pW/K

Dark bolo overbiased
SQUID noise : 3.53553390593 pA/sqrt(Hz)
SQUID ctrl 1st stage noise : 2.88623946429 pA/sqrt(Hz)
20 ohms noise : 1.65958769197 pA/sqrt(Hz)
Feedback resistor noise : 1.81971212009 pA/sqrt(Hz)
SQUID ctrl 2nd stage noise : 0.183847763109 pA/sqrt(Hz)
Flux bias 50kOhm noise : 0.820243866176 pA/sqrt(Hz)
Flux bias shot noise : 1.82743865989 pA/sqrt(Hz)
Flux bias shot noise : 3.2845221202 pA/sqrt(Hz)
Demod digitization stage noise : 0.00810783178394 pA/sqrt(Hz)
Carrier 1st stage noise : 1.76776695297 pA/sqrt(Hz)
Carrier 2nd stage noise : 0.459572267319 pA/sqrt(Hz)
50 Ohm bolo termination noise : 0.735391052434 pA/sqrt(Hz)
30mOhm resistor noise : 3.76695067068 pA/sqrt(Hz)
Carrier shot noise : 3.42061243458 pA/sqrt(Hz)
Carrier digitization noise : 0.444882064419 pA/sqrt(Hz)
Nuller 1st stage noise : 3.59302226213 pA/sqrt(Hz)
Nuller 2nd stage noise : 0.934185788153 pA/sqrt(Hz)
4x820 Ohm resitors noise : 3.11126983722 pA/sqrt(Hz)
Nuller shot noise : 2.97445120989 pA/sqrt(Hz)
Nuller digitization noise : 0.895291465886 pA/sqrt(Hz)
Johnson noise : 7.54140088264 pA/sqrt(Hz)

Predicted noise : 12.715338169 pA/sqrt(Hz)
Measured noise : 12.1240680161 pA/sqrt(Hz)
Standard deviation : 6.81094977162 pA/sqrt(Hz)
Measured/predicted : 0.953499455146

DfMUX b153-w0-c0

b153-w0-c1

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Removing gradient
Applying Hanning window
Correcting PSD for Hanning window
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Measured I increased by 5% for DMFD imperfections.
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Measured value is the average between 1.0 and 5.0Hz.
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Demod gain is : 2
Demod frequency is : 334719 Hz
Carrier gain is : 2
Carrier amplitude : 1.17
Nuller gain is : 2
Nuller amplitude : 0.501
Voltage bias is : 6.22908 uV_RMS
R normal is : 1.03 ohm
R is   : 0.927 ohm
SQUID feedback loop: 10000 ohm
SQUID flux bias : -0.260864257812 V
SQUID current bias : 4.04962158203 V
Leadlag R : 20 ohm
Optical loading : 0.0 pW
Frequency band : 0 GHz
Tc is : 0.51 K
T_bath is : 0.235 K
G is guessed : 207.79910362 pW/K
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Dark bolo in transition
SQUID noise : 3.53553390593 pA/sqrt(Hz)
SQUID ctrl 1st stage noise : 2.91453343414 pA/sqrt(Hz)
20 ohms noise : 1.67585672463 pA/sqrt(Hz)
Feedback resistor noise : 1.81971212009 pA/sqrt(Hz)
SQUID ctrl 2nd stage noise : 0.183847763109 pA/sqrt(Hz)
Flux bias 50kOhm noise : 0.820243866176 pA/sqrt(Hz)
Flux bias shot noise : 1.82743865989 pA/sqrt(Hz)
Flux bias shot noise : 3.31672047761 pA/sqrt(Hz)
Demod digitization stage noise : 0.00810783178394 pA/sqrt(Hz)
Carrier 1st stage noise : 1.76776695297 pA/sqrt(Hz)
Carrier 2nd stage noise : 0.459572267319 pA/sqrt(Hz)
50 Ohm bolo termination noise : 0.735391052434 pA/sqrt(Hz)
30mOhm resistor noise : 4.02295702694 pA/sqrt(Hz)
Carrier shot noise : 2.93258136507 pA/sqrt(Hz)
Carrier digitization noise : 0.475116767826 pA/sqrt(Hz)
Nuller 1st stage noise : 3.59302226213 pA/sqrt(Hz)
Nuller 2nd stage noise : 0.934185788153 pA/sqrt(Hz)
4x820 Ohm resitors noise : 3.11126983722 pA/sqrt(Hz)
Nuller shot noise : 2.66308914158 pA/sqrt(Hz)
Nuller digitization noise : 0.895291465886 pA/sqrt(Hz)
Johnson noise : 7.79345007539 pA/sqrt(Hz)
Phonon noise : 6.1880286062 pA/sqrt(Hz)
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Predicted noise : 14.1927379209 pA/sqrt(Hz)
Measured noise : 12.5380274163 pA/sqrt(Hz)
Standard deviation : 6.88955500641 pA/sqrt(Hz)
Measured/predicted : 0.883411466211
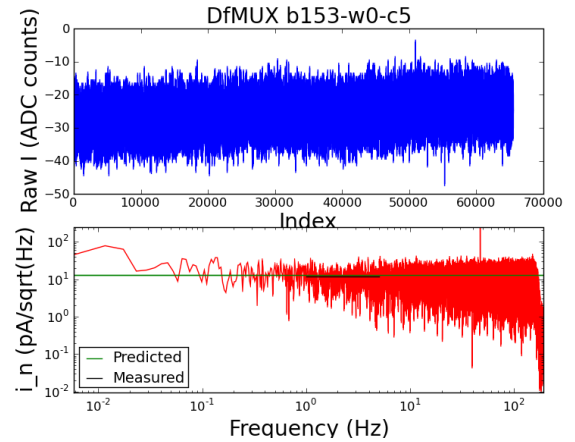
b153-w0-c2

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Removing gradient
Applying Hanning window
Correcting PSD for Hanning window

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Measured I increased by 5% for DMFD imperfections.

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Measured value is the average between 1.0 and 5.0Hz.

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Demod gain is : 2
Demod frequency is : 399777 Hz
Carrier gain is : 2
Carrier amplitude : 1.7
Nuller gain is : 2
Nuller amplitude : 0.627
Voltage bias is : 9.0508 uV_RMS
R normal is : 1.0 ohm
R is   : 1.0 ohm
SQUID feedback loop: 10000 ohm
SQUID flux bias : -0.260864257812 V
SQUID current bias : 4.04962158203 V
Leadlag R : 20 ohm
Optical loading : 0.0 pW
Frequency band : 0 GHz
Tc is : 0.51 K
T_bath is : 0.235 K
G is guessed : 195.478998662 pW/K

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Dark bolo overbiased
SQUID noise : 3.53553390593 pA/sqrt(Hz)
SQUID ctrl 1st stage noise : 2.9504043216 pA/sqrt(Hz)
20 ohms noise : 1.69648248492 pA/sqrt(Hz)
Feedback resistor noise : 1.81971212009 pA/sqrt(Hz)
SQUID ctrl 2nd stage noise : 0.183847763109 pA/sqrt(Hz)
Flux bias 50kOhm noise : 0.820243866176 pA/sqrt(Hz)
Flux bias shot noise : 1.82743865989 pA/sqrt(Hz)
Flux bias shot noise : 3.35754131898 pA/sqrt(Hz)
Demod digitization stage noise : 0.00810783178394 pA/sqrt(Hz)
Carrier 1st stage noise : 1.76776695297 pA/sqrt(Hz)
Carrier 2nd stage noise : 0.459572267319 pA/sqrt(Hz)
50 Ohm bolo termination noise : 0.735391052434 pA/sqrt(Hz)
30mOhm resistor noise : 3.72928116398 pA/sqrt(Hz)
Carrier shot noise : 3.40346639962 pA/sqrt(Hz)
Carrier digitization noise : 0.440433243775 pA/sqrt(Hz)
Nuller 1st stage noise : 3.59302226213 pA/sqrt(Hz)
Nuller 2nd stage noise : 0.934185788153 pA/sqrt(Hz)
4x820 Ohm resitors noise : 3.11126983722 pA/sqrt(Hz)
Nuller shot noise : 2.97920653061 pA/sqrt(Hz)
Nuller digitization noise : 0.895291465886 pA/sqrt(Hz)
Johnson noise : 7.50359913641 pA/sqrt(Hz)

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Predicted noise : 12.7168947567 pA/sqrt(Hz)
Measured noise : 12.2030202704 pA/sqrt(Hz)
Standard deviation : 6.4017284665 pA/sqrt(Hz)
Measured/predicted : 0.959591197683

DfMUX b153-w0-c4
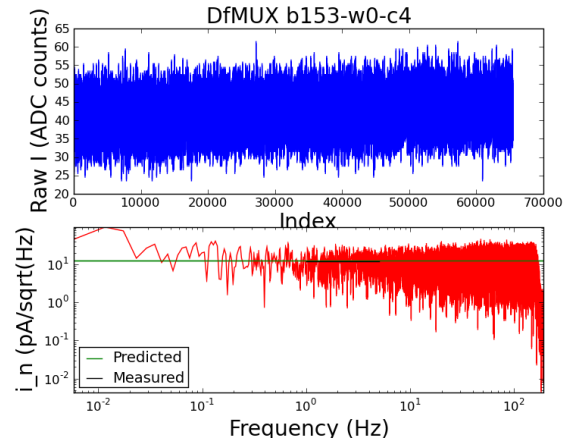
b153-w0-c3

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Removing gradient
Applying Hanning window
Correcting PSD for Hanning window

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Measured I increased by 5% for DMFD imperfections.

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Measured value is the average between 1.0 and 5.0Hz.

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Demod gain is : 2
Demod frequency is : 457305 Hz
Carrier gain is : 2
Carrier amplitude : 1.7
Nuller gain is : 2
Nuller amplitude : 0.609
Voltage bias is : 9.0508 uV_RMS
R normal is : 1.0 ohm
R is   : 1.0 ohm
SQUID feedback loop: 10000 ohm
SQUID flux bias : -0.260864257812 V
SQUID current bias : 4.04962158203 V
Leadlag R : 20 ohm
Optical loading : 0.0 pW
Frequency band : 0 GHz
Tc is : 0.51 K
T_bath is : 0.235 K
G is guessed : 193.754183968 pW/K

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Dark bolo overbiased
SQUID noise : 3.53553390593 pA/sqrt(Hz)
SQUID ctrl 1st stage noise : 2.98691020006 pA/sqrt(Hz)
20 ohms noise : 1.71747336504 pA/sqrt(Hz)
Feedback resistor noise : 1.81971212009 pA/sqrt(Hz)
SQUID ctrl 2nd stage noise : 0.183847763109 pA/sqrt(Hz)
Flux bias 50kOhm noise : 0.820243866176 pA/sqrt(Hz)
Flux bias shot noise : 1.82743865989 pA/sqrt(Hz)
Flux bias shot noise : 3.39908477607 pA/sqrt(Hz)
Demod digitization stage noise : 0.00810783178394 pA/sqrt(Hz)
Carrier 1st stage noise : 1.76776695297 pA/sqrt(Hz)
Carrier 2nd stage noise : 0.459572267319 pA/sqrt(Hz)
50 Ohm bolo termination noise : 0.735391052434 pA/sqrt(Hz)
30mOhm resistor noise : 3.72928116398 pA/sqrt(Hz)
Carrier shot noise : 3.40346639962 pA/sqrt(Hz)
Carrier digitization noise : 0.440433243775 pA/sqrt(Hz)
Nuller 1st stage noise : 3.59302226213 pA/sqrt(Hz)
Nuller 2nd stage noise : 0.934185788153 pA/sqrt(Hz)
4x820 Ohm resitors noise : 3.11126983722 pA/sqrt(Hz)
Nuller shot noise : 2.9361313976 pA/sqrt(Hz)
Nuller digitization noise : 0.895291465886 pA/sqrt(Hz)
Johnson noise : 7.50359913641 pA/sqrt(Hz)

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Predicted noise : 12.7292462743 pA/sqrt(Hz)
Measured noise : 12.0458064586 pA/sqrt(Hz)
Standard deviation : 6.43882506003 pA/sqrt(Hz)
Measured/predicted : 0.94630948283
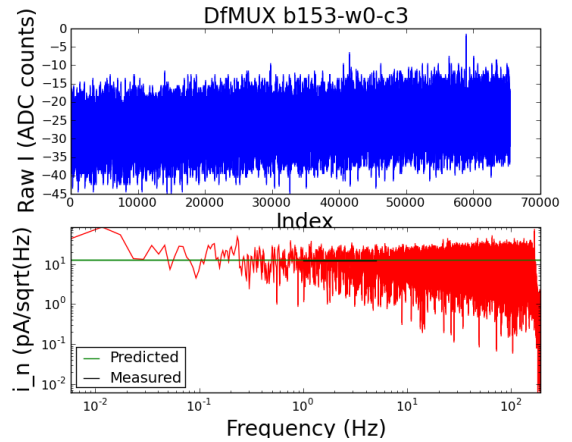
b153-w0-c4

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Measured I increased by 5% for DMFD imperfections.

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Measured value is the average between 1.0 and 5.0Hz.

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Demod gain is : 2
Demod frequency is : 515133 Hz
Carrier gain is : 2
Carrier amplitude : 1.7
Nuller gain is : 2
Nuller amplitude : 0.608
Voltage bias is : 9.0508 uV_RMS
R normal is : 0.99 ohm
R is   : 0.99 ohm
SQUID feedback loop: 10000 ohm
SQUID flux bias : -0.260864257812 V
SQUID current bias : 4.04962158203 V
Leadlag R : 20 ohm
Optical loading : 0.0 pW
Frequency band : 0 GHz
Tc is : 0.51 K
T_bath is : 0.235 K
G is guessed : 184.801574366 pW/K

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Dark bolo overbiased
SQUID noise : 3.53553390593 pA/sqrt(Hz)
SQUID ctrl 1st stage noise : 3.02794053513 pA/sqrt(Hz)
20 ohms noise : 1.7410658077 pA/sqrt(Hz)
Feedback resistor noise : 1.81971212009 pA/sqrt(Hz)
SQUID ctrl 2nd stage noise : 0.183847763109 pA/sqrt(Hz)
Flux bias 50kOhm noise : 0.820243866176 pA/sqrt(Hz)
Flux bias shot noise : 1.82743865989 pA/sqrt(Hz)
Flux bias shot noise : 3.44577703595 pA/sqrt(Hz)
Demod digitization stage noise : 0.00810783178394 pA/sqrt(Hz)
Carrier 1st stage noise : 1.76776695297 pA/sqrt(Hz)
Carrier 2nd stage noise : 0.459572267319 pA/sqrt(Hz)
50 Ohm bolo termination noise : 0.735391052434 pA/sqrt(Hz)
30mOhm resistor noise : 3.76695067068 pA/sqrt(Hz)
Carrier shot noise : 3.42061243458 pA/sqrt(Hz)
Carrier digitization noise : 0.444882064419 pA/sqrt(Hz)
Nuller 1st stage noise : 3.59302226213 pA/sqrt(Hz)
Nuller 2nd stage noise : 0.934185788153 pA/sqrt(Hz)
4x820 Ohm resitors noise : 3.11126983722 pA/sqrt(Hz)
Nuller shot noise : 2.9337197903 pA/sqrt(Hz)
Nuller digitization noise : 0.895291465886 pA/sqrt(Hz)
Johnson noise : 7.54140088264 pA/sqrt(Hz)

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Predicted noise : 12.7921692789 pA/sqrt(Hz)
Measured noise : 12.3677499818 pA/sqrt(Hz)
Standard deviation : 6.57048810008 pA/sqrt(Hz)
Measured/predicted : 0.966821944903

DfMUX b153-w0-c2
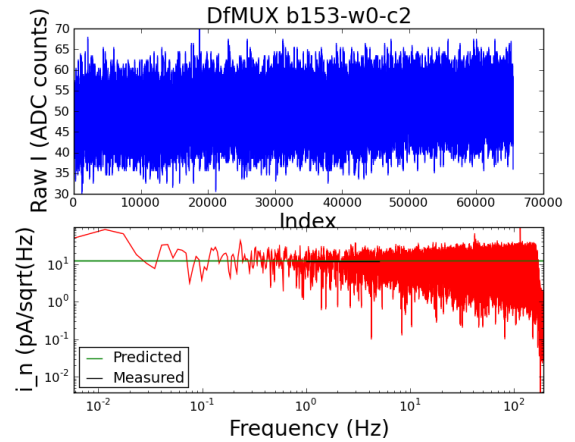
b153-w0-c5

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Removing gradient
Applying Hanning window
Correcting PSD for Hanning window

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Measured I increased by 5% for DMFD imperfections.

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Measured value is the average between 1.0 and 5.0Hz.

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Demod gain is : 2
Demod frequency is : 568581 Hz
Carrier gain is : 2
Carrier amplitude : 1.7
Nuller gain is : 2
Nuller amplitude : 0.569
Voltage bias is : 9.0508 uV_RMS
R normal is : 1.01 ohm
R is   : 1.01 ohm
SQUID feedback loop: 10000 ohm
SQUID flux bias : -0.260864257812 V
SQUID current bias : 4.04962158203 V
Leadlag R : 20 ohm
Optical loading : 0.0 pW
Frequency band : 0 GHz
Tc is : 0.51 K
T_bath is : 0.235 K
G is guessed : 190.058152481 pW/K

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Dark bolo overbiased
SQUID noise : 3.53553390593 pA/sqrt(Hz)
SQUID ctrl 1st stage noise : 3.06955505154 pA/sqrt(Hz)
20 ohms noise : 1.76499415463 pA/sqrt(Hz)
Feedback resistor noise : 1.81971212009 pA/sqrt(Hz)
SQUID ctrl 2nd stage noise : 0.183847763109 pA/sqrt(Hz)
Flux bias 50kOhm noise : 0.820243866176 pA/sqrt(Hz)
Flux bias shot noise : 1.82743865989 pA/sqrt(Hz)
Flux bias shot noise : 3.49313409046 pA/sqrt(Hz)
Demod digitization stage noise : 0.00810783178394 pA/sqrt(Hz)
Carrier 1st stage noise : 1.76776695297 pA/sqrt(Hz)
Carrier 2nd stage noise : 0.459572267319 pA/sqrt(Hz)
50 Ohm bolo termination noise : 0.735391052434 pA/sqrt(Hz)
30mOhm resistor noise : 3.6923575881 pA/sqrt(Hz)
Carrier shot noise : 3.38657564325 pA/sqrt(Hz)
Carrier digitization noise : 0.436072518589 pA/sqrt(Hz)
Nuller 1st stage noise : 3.59302226213 pA/sqrt(Hz)
Nuller 2nd stage noise : 0.934185788153 pA/sqrt(Hz)
4x820 Ohm resitors noise : 3.11126983722 pA/sqrt(Hz)
Nuller shot noise : 2.83806915772 pA/sqrt(Hz)
Nuller digitization noise : 0.895291465886 pA/sqrt(Hz)
Johnson noise : 7.46636020116 pA/sqrt(Hz)

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Predicted noise : 12.7213090314 pA/sqrt(Hz)
Measured noise : 11.8678377832 pA/sqrt(Hz)
Standard deviation : 6.41229107766 pA/sqrt(Hz)
Measured/predicted : 0.932910108065

DfMUX b153-w0-c7
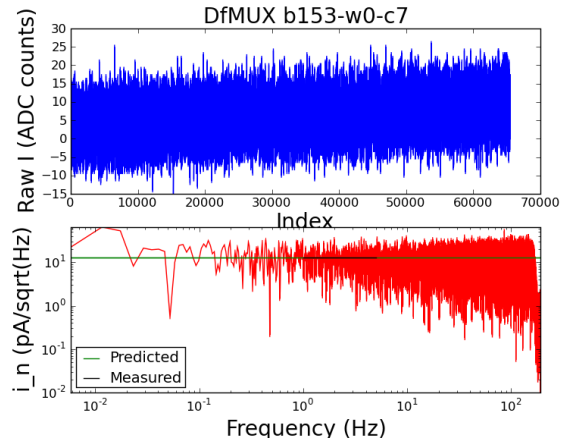
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Removing gradient
Applying Hanning window
Correcting PSD for Hanning window

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Measured I increased by 5% for DMFD imperfections.

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Measured value is the average between 1.0 and 5.0Hz.

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Demod gain is : 2
Demod frequency is : 631419 Hz
Carrier gain is : 2
Carrier amplitude : 1.7
Nuller gain is : 2
Nuller amplitude : 0.545
Voltage bias is : 9.0508 uV_RMS
R normal is : 0.99 ohm
R is   : 0.99 ohm
SQUID feedback loop: 10000 ohm
SQUID flux bias : -0.260864257812 V
SQUID current bias : 4.04962158203 V
Leadlag R : 20 ohm
Optical loading : 0.0 pW
Frequency band : 0 GHz
Tc is : 0.51 K
T_bath is : 0.235 K
G is guessed : 192.440039439 pW/K

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Dark bolo overbiased
SQUID noise : 3.53553390593 pA/sqrt(Hz)
SQUID ctrl 1st stage noise : 3.12278905327 pA/sqrt(Hz)
20 ohms noise : 1.79560370563 pA/sqrt(Hz)
Feedback resistor noise : 1.81971212009 pA/sqrt(Hz)
SQUID ctrl 2nd stage noise : 0.183847763109 pA/sqrt(Hz)
Flux bias 50kOhm noise : 0.820243866176 pA/sqrt(Hz)
Flux bias shot noise : 1.82743865989 pA/sqrt(Hz)
Flux bias shot noise : 3.55371404524 pA/sqrt(Hz)
Demod digitization stage noise : 0.00810783178394 pA/sqrt(Hz)
Carrier 1st stage noise : 1.76776695297 pA/sqrt(Hz)
Carrier 2nd stage noise : 0.459572267319 pA/sqrt(Hz)
50 Ohm bolo termination noise : 0.735391052434 pA/sqrt(Hz)
30mOhm resistor noise : 3.76695067068 pA/sqrt(Hz)
Carrier shot noise : 3.42061243458 pA/sqrt(Hz)
Carrier digitization noise : 0.444882064419 pA/sqrt(Hz)
Nuller 1st stage noise : 3.59302226213 pA/sqrt(Hz)
Nuller 2nd stage noise : 0.934185788153 pA/sqrt(Hz)
4x820 Ohm resitors noise : 3.11126983722 pA/sqrt(Hz)
Nuller shot noise : 2.77757050676 pA/sqrt(Hz)
Nuller digitization noise : 0.895291465886 pA/sqrt(Hz)
Johnson noise : 7.54140088264 pA/sqrt(Hz)

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Predicted noise : 12.8171586248 pA/sqrt(Hz)
Measured noise : 11.9559253106 pA/sqrt(Hz)
Standard deviation : 6.12535171521 pA/sqrt(Hz)
Measured/predicted : 0.932806221766

DfMUX b153-w0-c1

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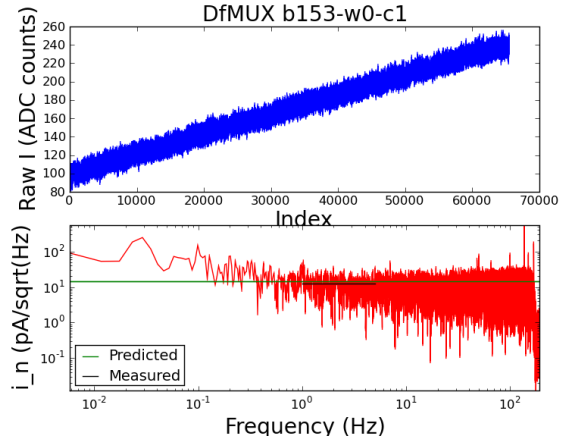
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Removing gradient
Applying Hanning window
Correcting PSD for Hanning window
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Measured I increased by 5% for DMFD imperfections.
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Measured value is the average between 1.0 and 5.0Hz.
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Demod gain is : 2
Demod frequency is : 719946 Hz
Carrier gain is : 2
Carrier amplitude : 1.7
Nuller gain is : 2
Nuller amplitude : 0.553
Voltage bias is : 9.0508 uV_RMS
R normal is : 0.95 ohm
R is   : 0.95 ohm
SQUID feedback loop: 10000 ohm
SQUID flux bias : -0.260864257812 V
SQUID current bias : 4.04962158203 V
Leadlag R : 20 ohm
Optical loading : 0.0 pW
Frequency band : 0 GHz
Tc is : 0.51 K
T_bath is : 0.235 K
G is guessed : 182.091151275 pW/K
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Dark bolo overbiased
SQUID noise : 3.53553390593 pA/sqrt(Hz)
SQUID ctrl 1st stage noise : 3.20518307298 pA/sqrt(Hz)
20 ohms noise : 1.84298026696 pA/sqrt(Hz)
Feedback resistor noise : 1.81971212009 pA/sqrt(Hz)
SQUID ctrl 2nd stage noise : 0.183847763109 pA/sqrt(Hz)
Flux bias 50kOhm noise : 0.820243866176 pA/sqrt(Hz)
Flux bias shot noise : 1.82743865989 pA/sqrt(Hz)
Flux bias shot noise : 3.64747791469 pA/sqrt(Hz)
Demod digitization stage noise : 0.00810783178394 pA/sqrt(Hz)
Carrier 1st stage noise : 1.76776695297 pA/sqrt(Hz)
Carrier 2nd stage noise : 0.459572267319 pA/sqrt(Hz)
50 Ohm bolo termination noise : 0.735391052434 pA/sqrt(Hz)
30mOhm resistor noise : 3.92555911998 pA/sqrt(Hz)
Carrier shot noise : 3.49188284806 pA/sqrt(Hz)
Carrier digitization noise : 0.463613940816 pA/sqrt(Hz)
Nuller 1st stage noise : 3.59302226213 pA/sqrt(Hz)
Nuller 2nd stage noise : 0.934185788153 pA/sqrt(Hz)
4x820 Ohm resitors noise : 3.11126983722 pA/sqrt(Hz)
Nuller shot noise : 2.797882079 pA/sqrt(Hz)
Nuller digitization noise : 0.895291465886 pA/sqrt(Hz)
Johnson noise : 7.69853027669 pA/sqrt(Hz)
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Predicted noise : 13.0340399006 pA/sqrt(Hz)
Measured noise : 12.7344402786 pA/sqrt(Hz)
Standard deviation : 6.59147973639 pA/sqrt(Hz)
Measured/predicted : 0.977014062845

DfMUX b153-w0-c6

b153-w0