PAR detector array 2

This is intended to be brief and to the point. Data is available in other files

1: What is right, what is wrong.

- 1a: Detector aliveness and readout
- 1b: T_C – values, spread and alpha
- 1c: Normal and bias resistors & cross talk
- 1d: NEP measurements
- 1e: Time Constants
- 1f: Z-Omega plots and what they mean

This is intended as a short summery of our results. The data is in many spreadsheets and is over 1GB so if people want anything it would be better to ask. More details for many things can be found in the documents Phil wrote and which are posted, under SQUIDS & electronics on the GBT website: chile1.physics.upenn.edu/GBT

Other system tests have been carried out (response to tilt) but they will be left out of this report.

1a: Detector aliveness.

- Muxs – these were unscreened.

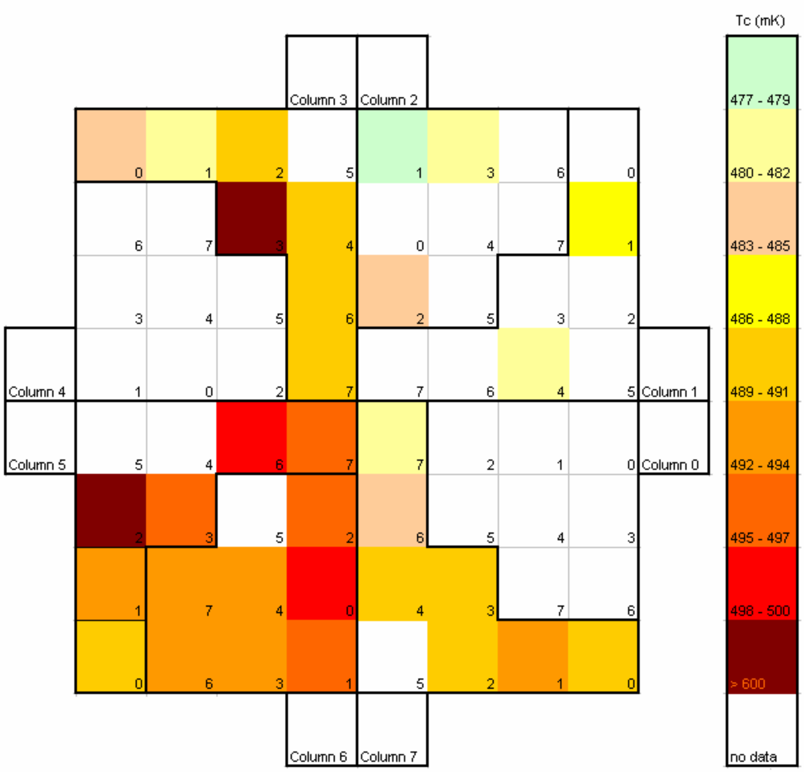
Col 0: DEAD second stage SQUID, behaves like a resistor.
Col 1: Working
Col 2: 4 dead first stage SQUIDs, r0,4,6,7.
Col 3: Working
Col 4: DEAD second stage SQUID, behaves like a resistor.
Col 5: Working
Col 6: Reads out BUT first stage feedback loop heats array.
Col 7: Working

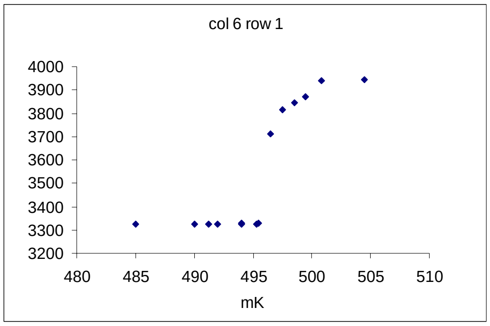
  - ALSO r5 in all mux has bad 1^{st} stage curve (flat top)

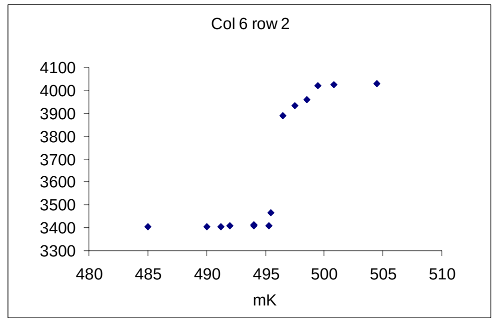
- TES – pixels c1r2 and c5r4 no response to bias. Rows 5 ignored
- Firmware – Bad mapping still exists
- Software – Much work in IRC needed, but basic DAQ and tuning works. Analysis software need much more.

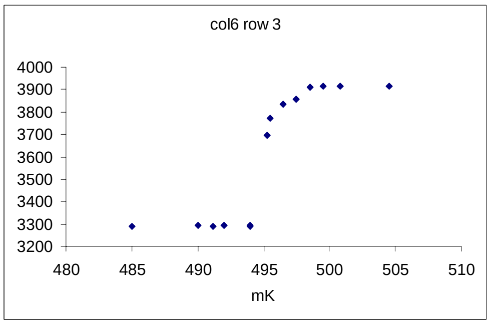
1b: T_C

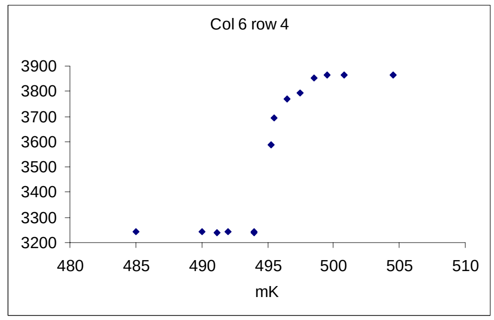
- 477mK to 500mK scatter, pixels c4r3 & c5r2 possible superconducting short
- trend with location hard to spot
- T_C measured with 1μA bias current – (<< 1×10^{-15} W dissipation)
- Steep part of transition ~1mK wide – values of alpha 400 - 500







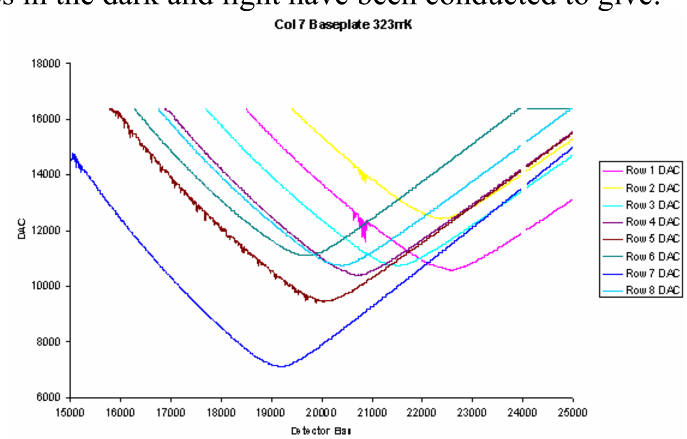




Q: Why are these values off and what can we learn?

1c: Bias curves, resistances + more

A huge number of bias curves in the dark and light have been conducted to give:

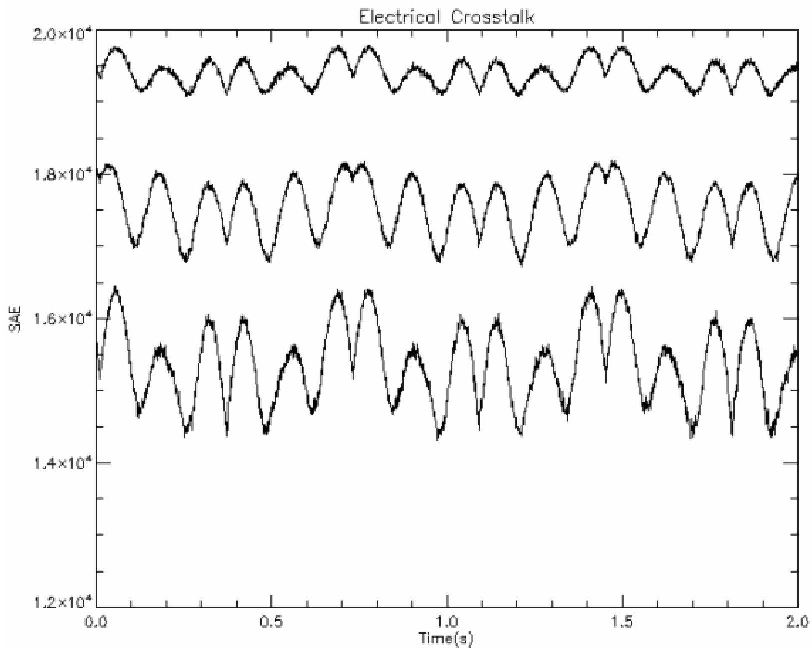


- Scatter in bias points:
- Ratios of normal to superconducting resistances (from down ramps), bias resistor from noise and normal detector resistance from ratio for col 7:

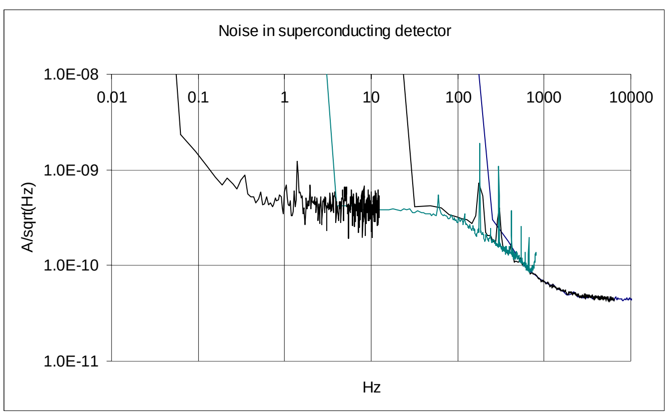
Row	0	1	2	3	4	5	6	7
LN2 ratio	18.36	17.75	17.91	17.36	17.28	16.59	15.94	17.21
300K ratio	17.54	17.36	17.47	16.95	16.81	16.19	15.62	16.70
bias resistance	0.72mΩ	0.65mΩ	0.72mΩ	0.59mΩ	0.84mΩ		0.77mΩ	0.77mΩ
normal resistance	12.52mΩ	10.87mΩ	12.21mΩ	9.67mΩ	13.68mΩ		11.44mΩ	12.55mΩ
saturation power	2.4E-11W	2.2E-11W	2.2E-11W	1.8E-11W	2.4E-11W		2.1E-11W	2.3E-11W

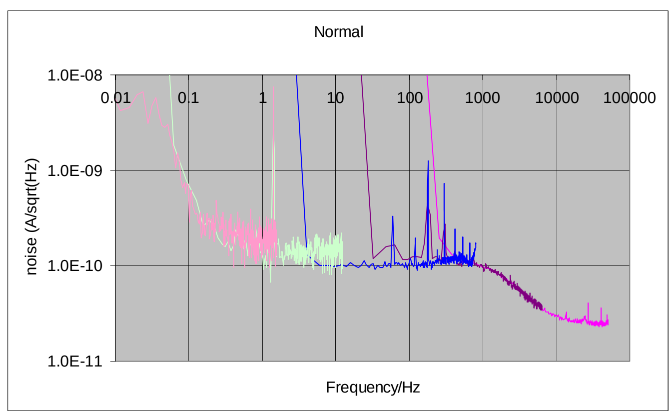
CROSS TALK in 1st stages is seen:

- Put all but one DFB card in signal generator mode
- Look at output of this card – cross talk at a 4% level:
- Putting just one DFB card in sig.gen. mode affects channels the same



1d: Noise measurements:

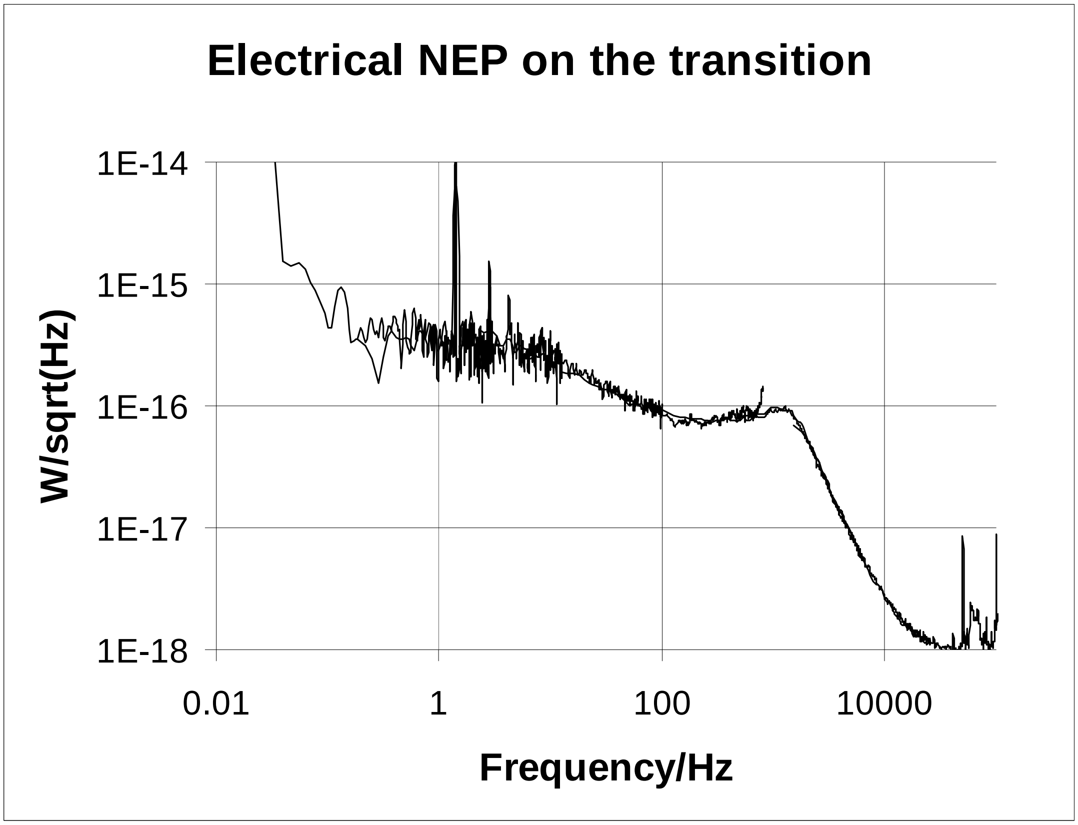


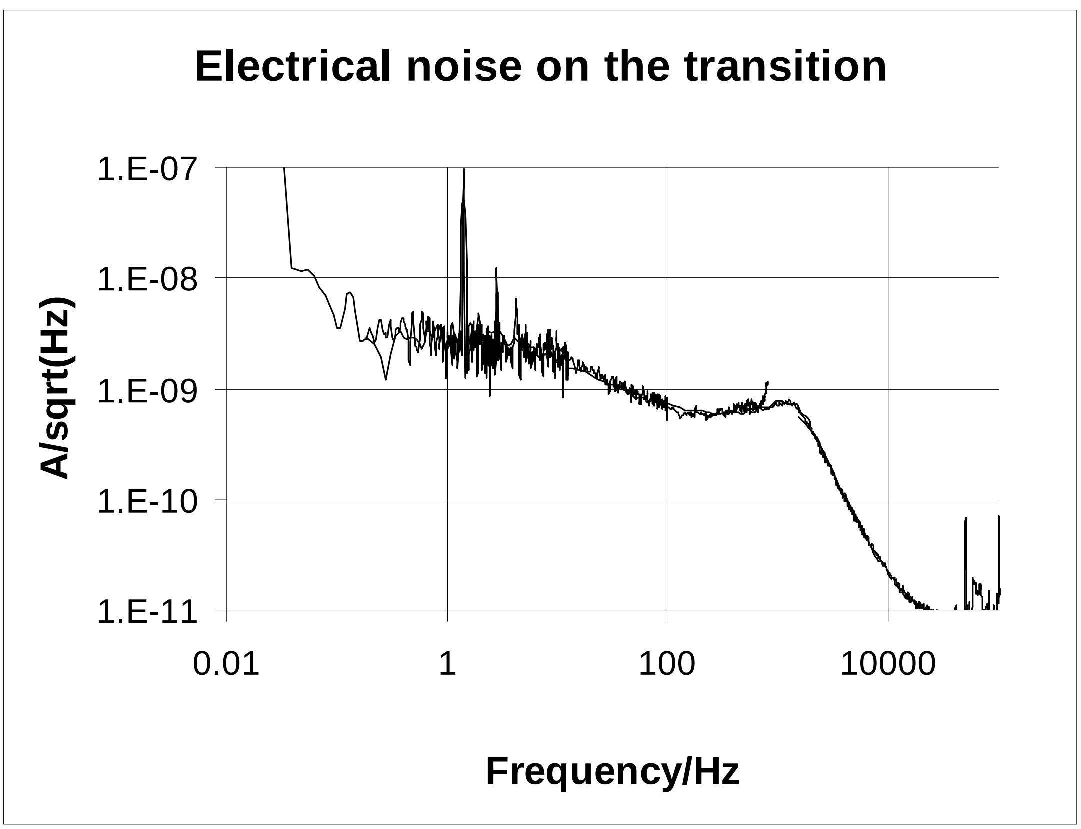


- Noise level at 10Hz matches ratio of superconduction/normal resistance – Johnston current noise.
- 3dB roll of frequencies : 200Hz (superconducting), 5000Hz Normal (predicted 160Hz and 3000)

- On the transition we get more noise than either of the above states (when looking at 300K) – phonon noise limited (Photon noise is calculated to be less)
- Also there is a feature at 1.4 Hz – due to temperature fluctuations in the pt405\
- **The detectors are also unstable – current oscillations > tens of μA occur and increase as you move to lower detector bias and lower baseplate temperatures. At normal (280mK) baseplate temperatures only the top 10% or so of the transition can be used, and to use the array requires heating the baseplate to over 350mK . Typical oscillation frequencies are 2-3.5kHz**

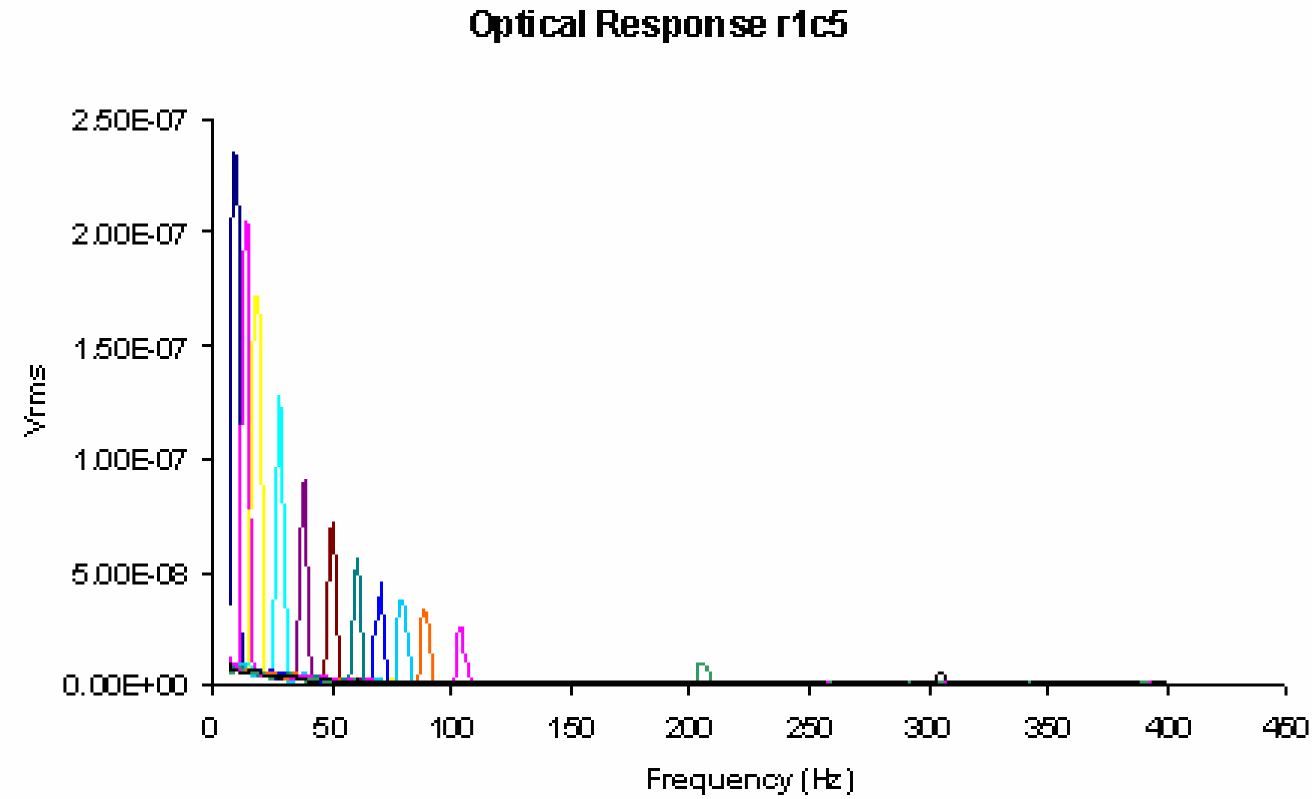
These graphs are the noise on a pixel when looking at 300K.





1e: Time constants

First the response to a chopped optical source:



- A very slow response that would be a problem on the GBT
- Slower than exp(-τt) fall-off – drops 3dB from 10 to 25 Hz, yet only 6db 100-200Hz

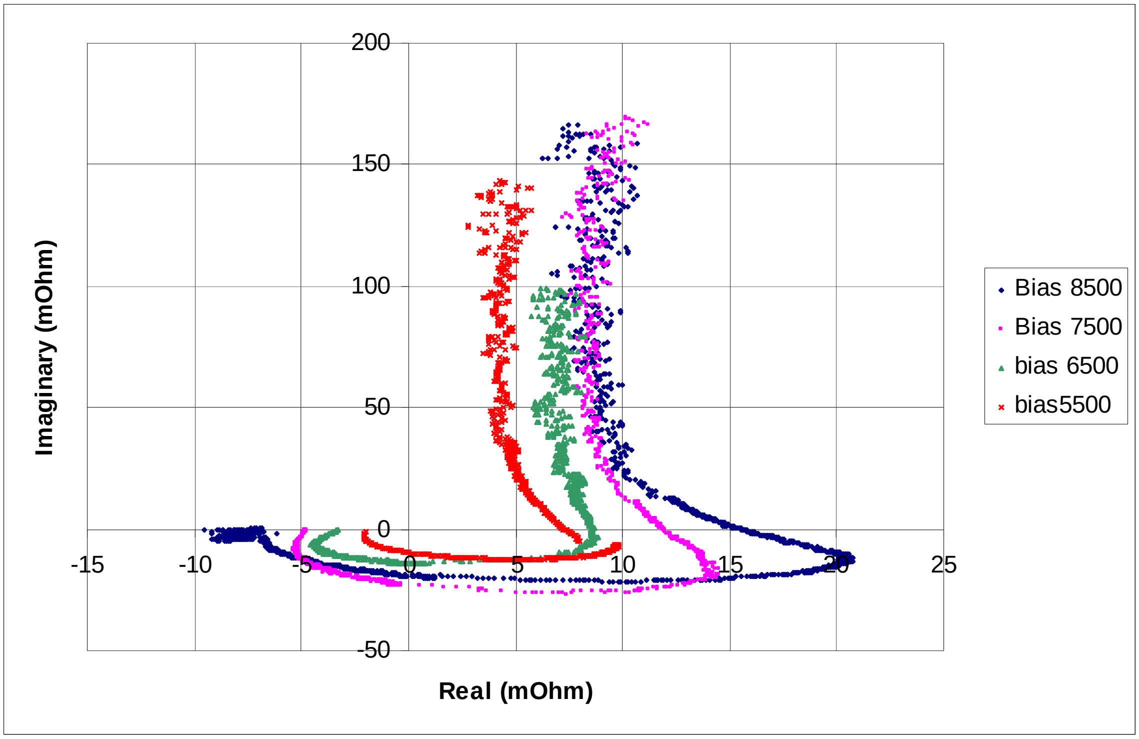
Time constants were also measured by step changes in the detector bias

- Between 2 superconducting points the time constant was exp(-531t) which matches the L/R time constant assuming L=1200nH.
- Between 2 normal points the time constant was exp(-10940 t) which matches the L/R roll-off assuming the same L
- Both these time constants are much faster than the optical one so it is not the electronics that slows the system down.

1f: Z-Omega

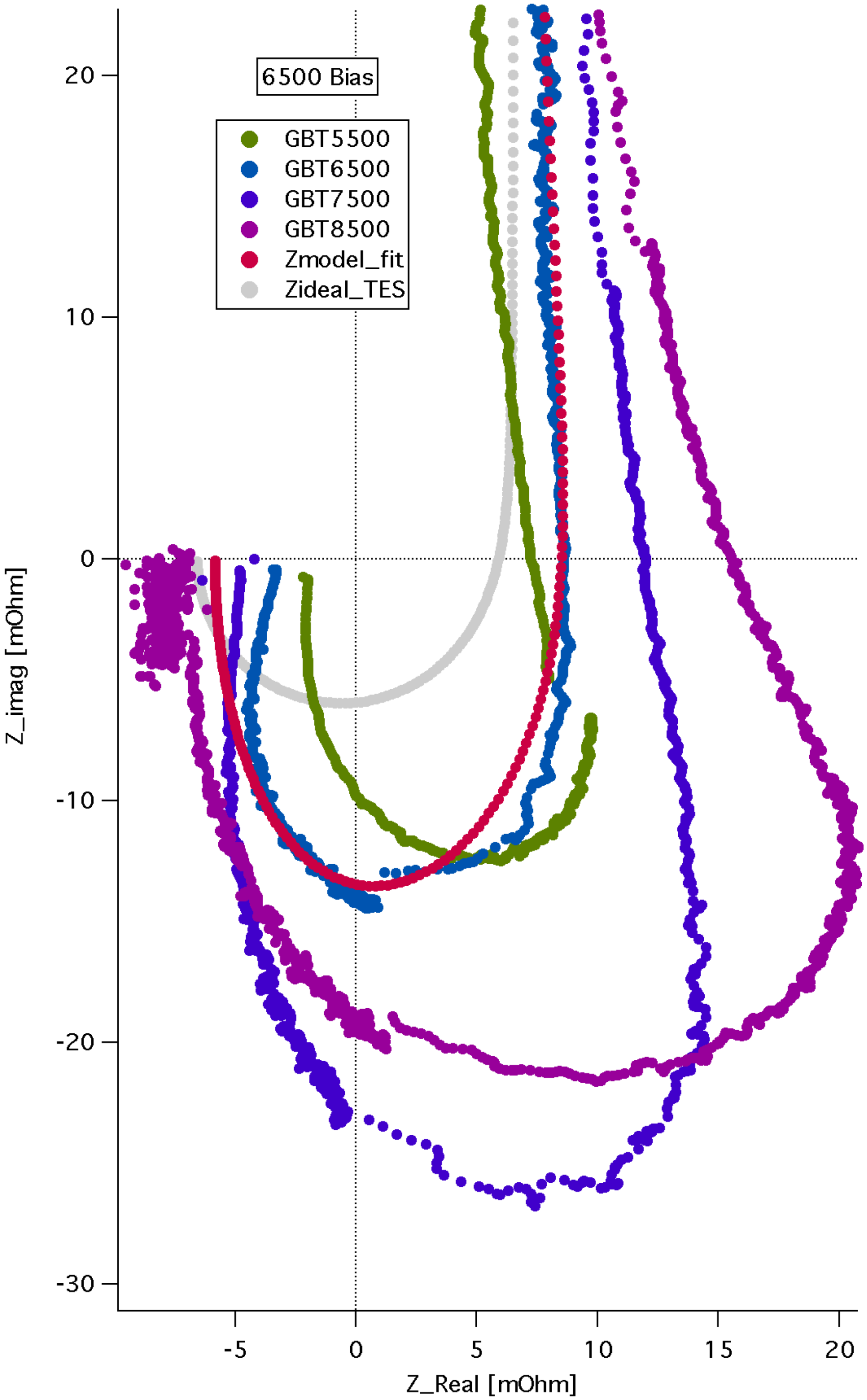
These data were taken using the analogue parts of the system only (and a power spectrum analyzer).

- The data do not fit the ideal TES model
- Enectali Figueroa fit a model that has a distributed hanging heat capacity this works.
- Calculations by Harvey Mosley show that this could be a problem with the bismuth layer (1000Å) on top of the 1.4 micron Si membrane.



200
150
100
50
0
-50
-15
-10
-5
0
5
10
15
20
25
Imaginary (mOhm)
Real (mOhm)
Bias 8500
Bias 7500
bias 6500
bias5500

The data



An example fit (red) to the 6500 count bias line.

Point	GBTpar55_close.l	GBTpar55_close	GBTpar65_close	GBTpar75_close	GBTpar85_close
0	DebugParameter	-999	-999	-999	-999
1					
2	Non-Linear Parameters:				
3					
4	Heat Transfer Parameters:				
5	C01_a [J/K]	5.79744e-12	2.73235e-13	3.71241e-13	5e-13
6	C01_e [J/K]	1e-13	1.25982e-13	1.24309e-13	2e-13
7	gamma_a [n/a]	0	0	0	0
8	gamma_e [n/a]	0	0	0	0
9	Gaa01 [W/K]	1.03357e-07	6.9696e-09	6.8056e-09	8.08636e-09
10	Gae01 [W/K]	1.03357e-07	6.9696e-09	6.8056e-09	8.08636e-09
11	Gab01 [W/K]	0	0	1e-17	0
12	Geb01 [W/K]	1.08117e-11	3.66726e-12	1.53427e-12	1.52451e-12
13	Baa [n/a]	0	0	0	0
14	Bae [n/a]	0	0	0	0
15	Bab [n/a]	3	3	3	3
16	Beb [n/a]	2.5	2.5	2.5	2.5
17	Tb [K]	0.39	0.39	0.39	0.39
18	Stray Power [W]	0	0	0	0
19					
20	Circuit Parameters:				
21	RvsT Func Type [n/a]	4	4	4	4
22	Rn [Ohm]	0.012	0.012	0.012	0.012
23	Rp [Ohm]	1e-06	1e-06	1e-06	1e-06
24	Tc_A [K]	0.45	0.45	0.45	0.45
25	Tc_B [K]	0.45	0.45	0.45	0.45
26	alpha0_A [n/a]	219.77	71.7266	369.924	500
27	alpha0_B [n/a]	75	75	75	75
28	Ce/C_betai [n/a]	1	1	1	1
29	R/Rn_A [%]	33.2697	47.0464	78.7756	89.3046
30	R/Rn_B [%]	- 1	- 1	- 1	- 1
31					
32	Calculated Parameters:				
33	Vb_A [V]	4.87246e-07	3.16928e-07	2.63753e-07	2.79296e-07
34	Vb_B [V]	0	0	0	0
35	Getf [W/K]	1.6305e-08	1.89065e-09	1.84983e-09	1.5957e-09
36	Tau_eff [s]	0.00236801	0.000984921	0.00143753	0.00225946
37	Integrated Pulse A [eV]	6065.51	4662.74	4734.54	4142.89
38	Integrated Pulse B [eV]	0	0	0	0
39	FWHM [eV]	123.243	24.6086	25.4087	93.7276
40					
41	Linear Parameters:				
42					
43	Heat Transfer Parameters:				
44	Ca1 [J/K]	5.79744e-12	2.73235e-13	3.71241e-13	5e-13
45	Ce_A [J/K]	1e-13	1.25982e-13	1.24309e-13	2e-13
46	Ge_Ab(Te_A) [W/K]	4.60746e-10	1.56852e-10	6.61028e-11	6.5757e-11