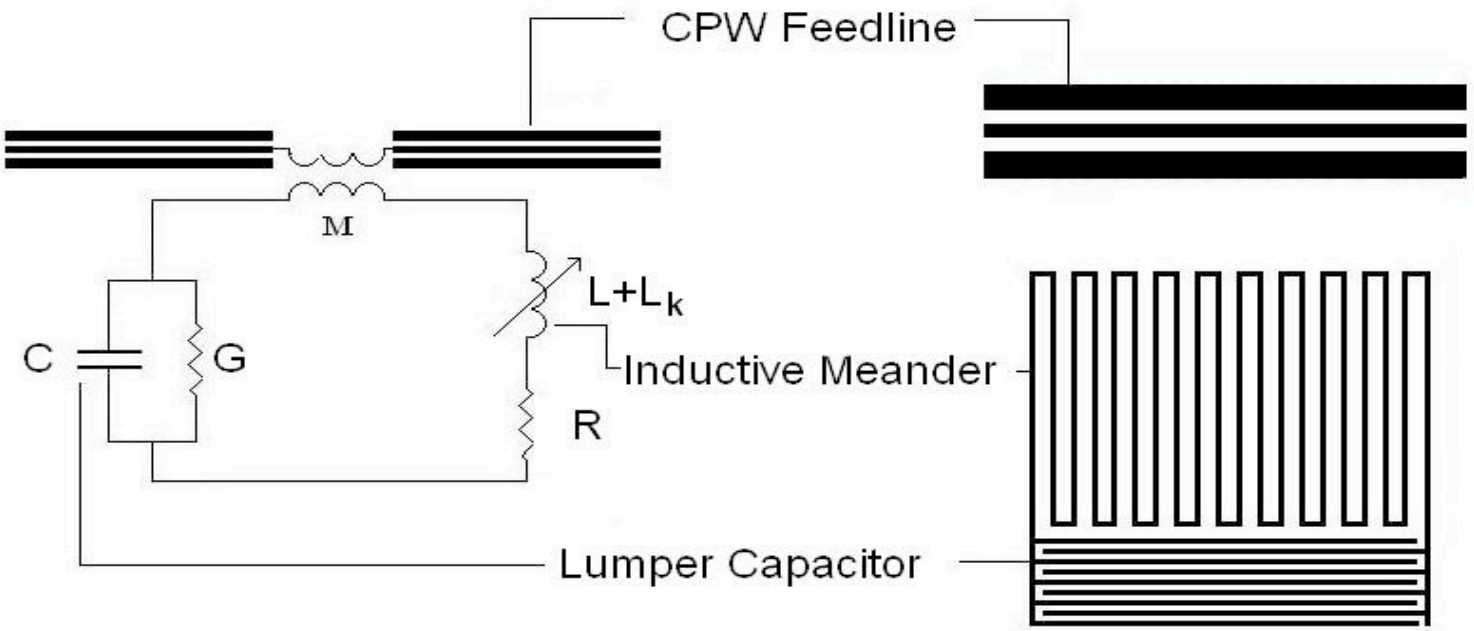
LEKID Optimisation

Phase noise of current LEKID design approaching cold amplifier noise

Gain in NEP achieved by greater responsivity or better power handling

Responsivity increased by increasing QL, increasing τ_{qp} under load, increasing $d\omega/dP$

Simulate LEKID using Mattis Bardeen and analytical model



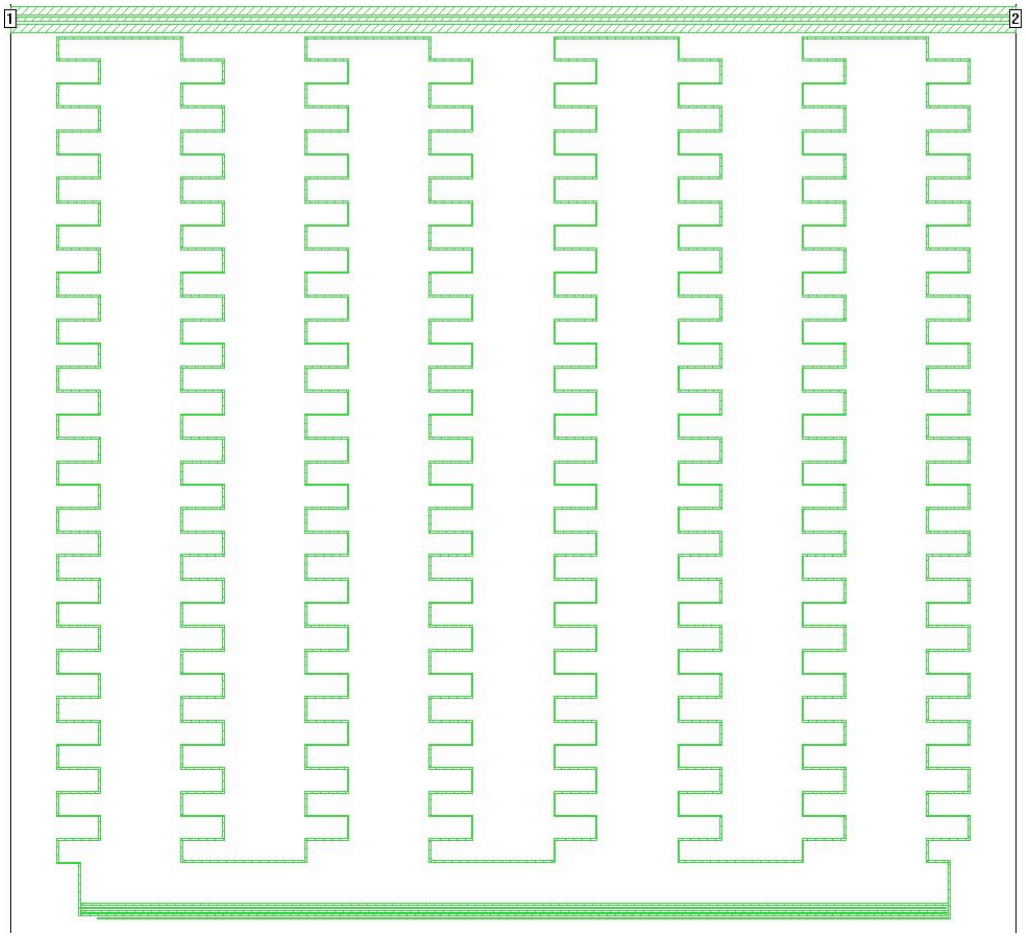
$$\frac{1}{\tau_{qp}} = \frac{\pi^{1/2}}{\tau_0}\left(\frac{2\Delta}{k_B T_c}\right)^{\frac{5}{2}}\left(\frac{T}{T_c}\right)^{\frac{1}{2}}\exp\left(\frac{-\Delta}{k_B T}\right)$$

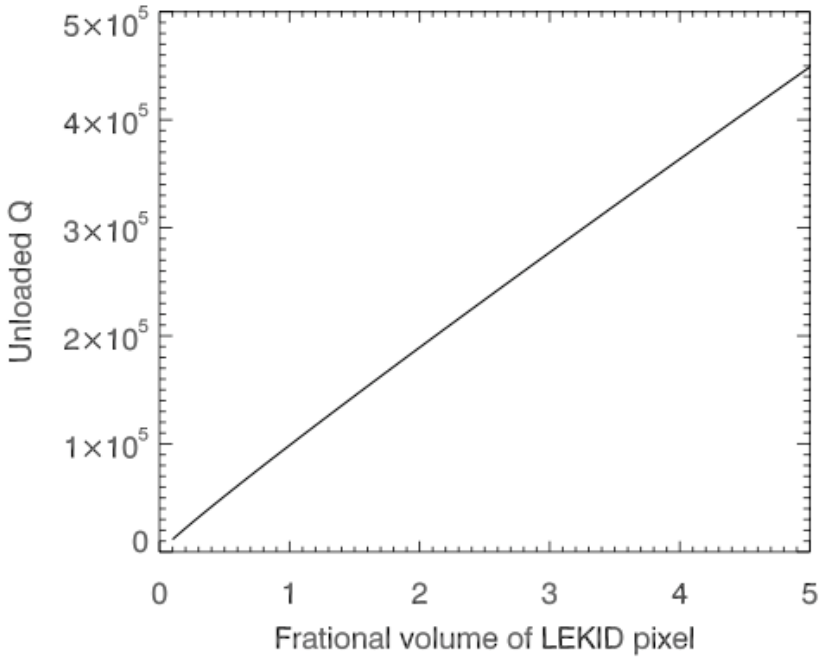
$$n_{qp} = 2N(0)\sqrt{2\pi k_B T\Delta(0)}\exp\left(\frac{-\Delta(0)}{k_B T}\right)$$

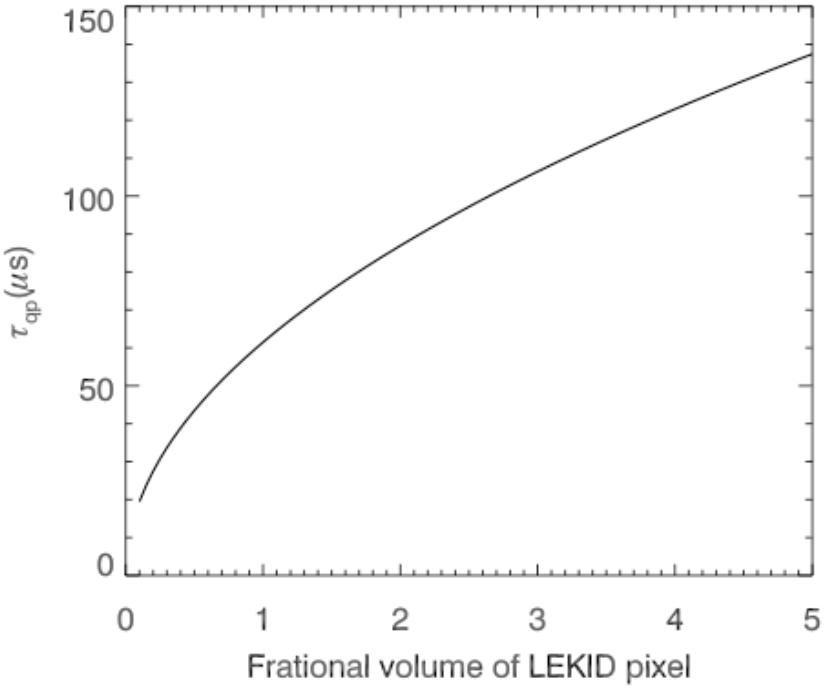
$$N_{xs} = \frac{P_{opt}\eta\tau_{qp}}{\Delta}$$

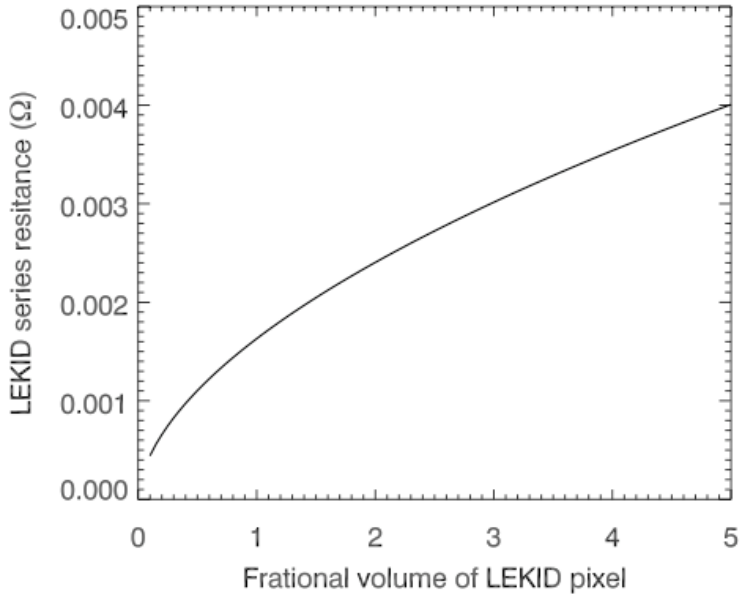
$$\mathrm{N_{QP\ Detector}(T)} - \mathrm{N_{xs}}(\tau_{qp}) = 0$$

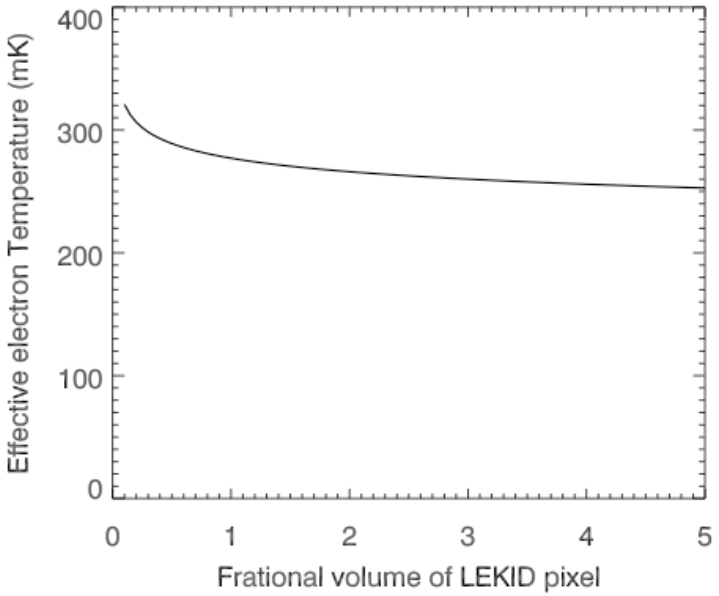
Adding Volume by squares




Unloaded Q
5×10^5
4×10^5
3×10^5
2×10^5
1×10^5
0
0
1
2
3
4
5
Frational volume of LEKID pixel

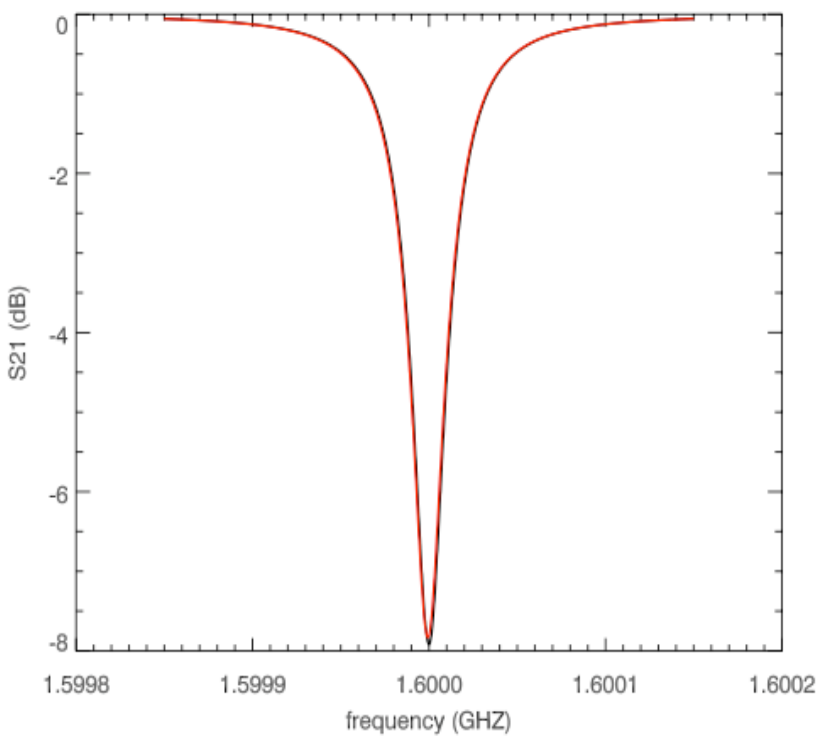

$\tau_{qp}(\mu s)$
150
100
50
0
0
1
2
3
4
5
Frational volume of LEKID pixel

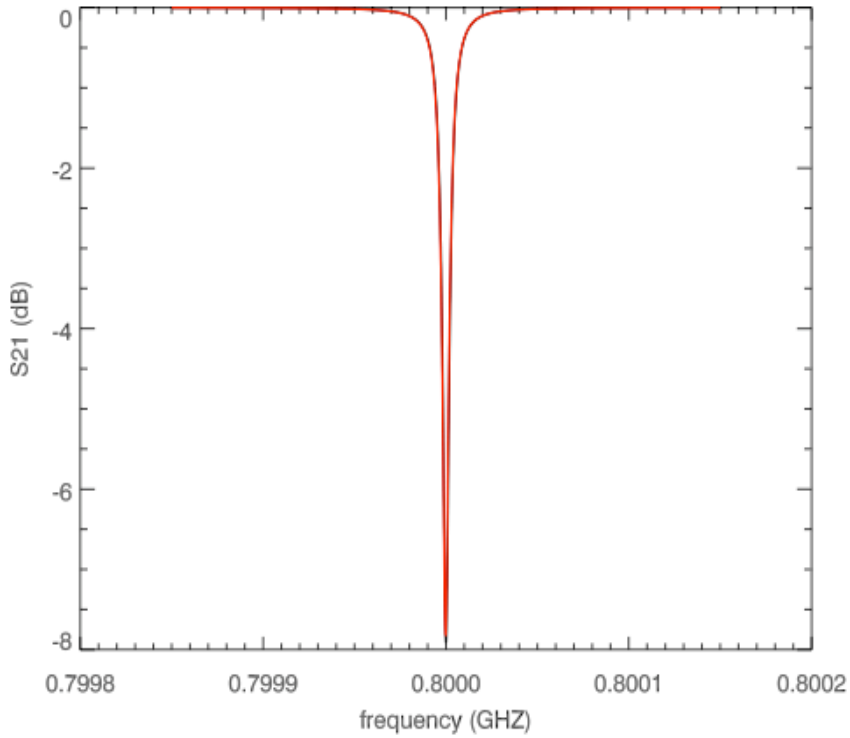

LEKID series resitance (Ω)
0.005
0.004
0.003
0.002
0.001
0.000
0
1
2
3
4
5
Frational volume of LEKID pixel


Effective electron Temperature (mK)
400
300
200
100
0
0
1
2
3
4
5
Frational volume of LEKID pixel

Adding Volume by squares

Factor 1.5 gain in response





Scale =1

Tau_QP = 60.273834 uS

Loaded Q = 42287.996

Unloaded Q =104154.19

Coupling = 49.0000pH

Response = 0.35441517 rads / pW

Scale =4

Tau_QP = 120.55185 uS

Loaded Q = 117048.47

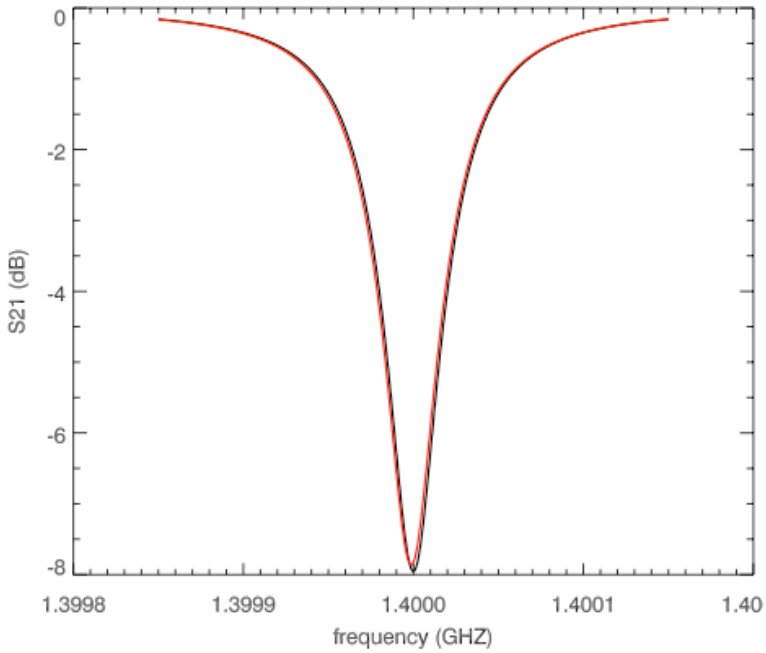
Unloaded Q =288253.50

Coupling = 83.3000pH

Response = 0.53806630 rads / pW

Reduction in line width

Factor of 1.8 gain in response



Scale =1

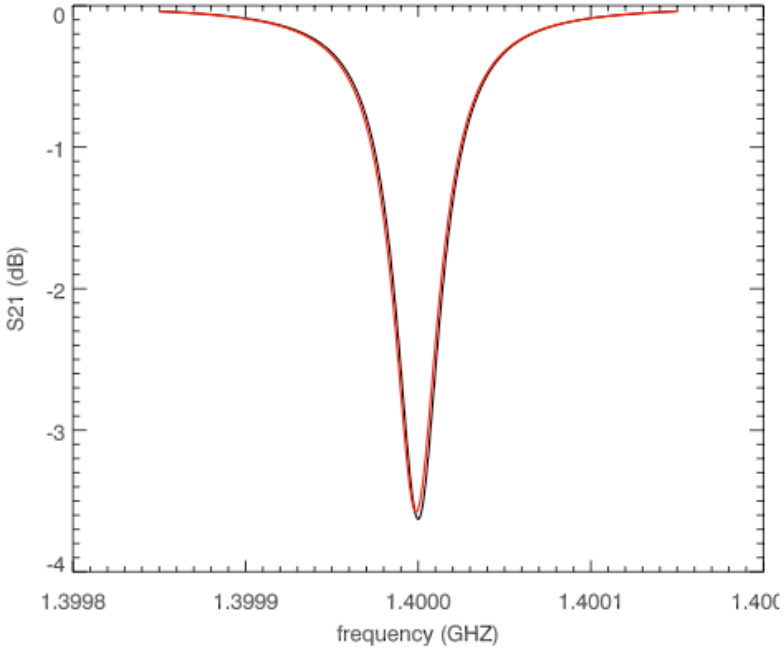
Tau_QP = 42.620517 uS

Loaded Q = 21829.667

Unloaded Q =53987.371

Coupling = 83.3000pH

Response = 0.39571412 rads / pW



Scale =1

Tau_QP = 42.620517 uS

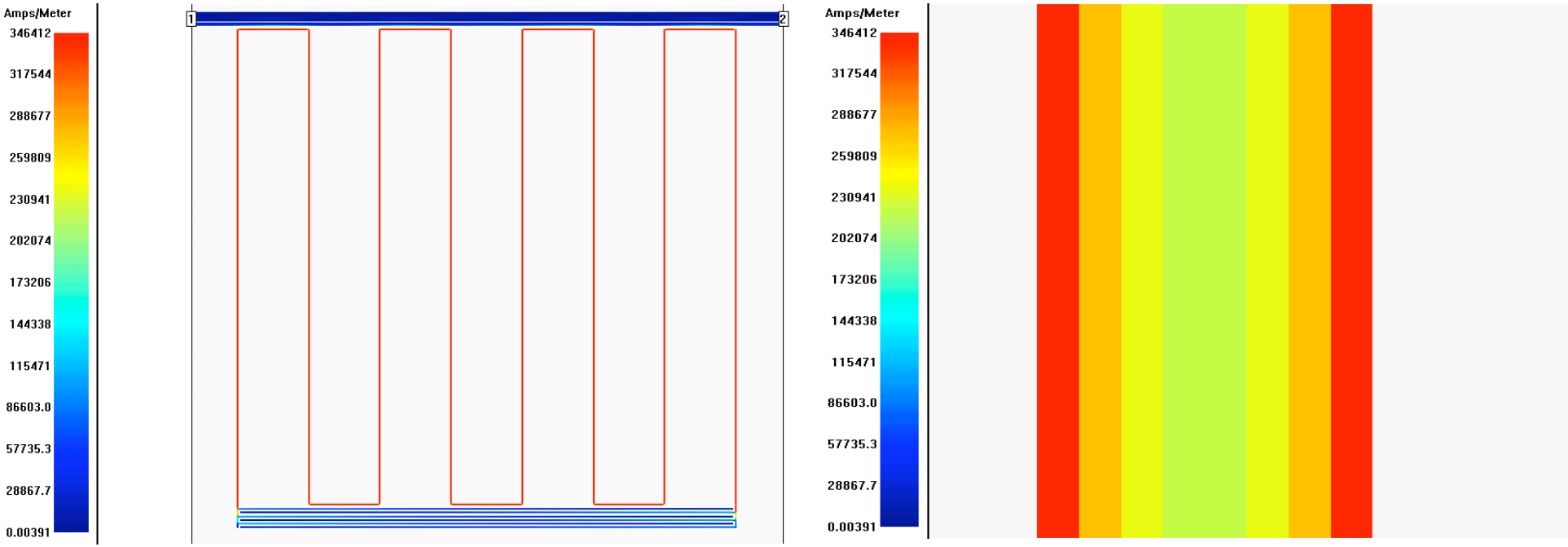
Loaded Q = 35759.625

Unloaded Q =53987.371

Coupling = 49.0000pH

Response = 0.64765846 rads / pW

Power Handling?



$$I_{res} = \frac{\omega M I_{feed}}{Z_{res}}$$

Conclusion so far…

- Need to control coupling in array
- Need to increase power handling
- Study required of LEKID power handling for various couplings and meander geometries.
- Study τ_{qp} as a function of volume and optical load + kill any excess loading from stray light.