



Frequency-Domain Multiplexing for Bolometer Arrays

LTD-10

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Outline

- Motivation for Multiplexed Readout
- Voltage Summing MUX
- Current Summing MUX
- Conclusion and Future Work

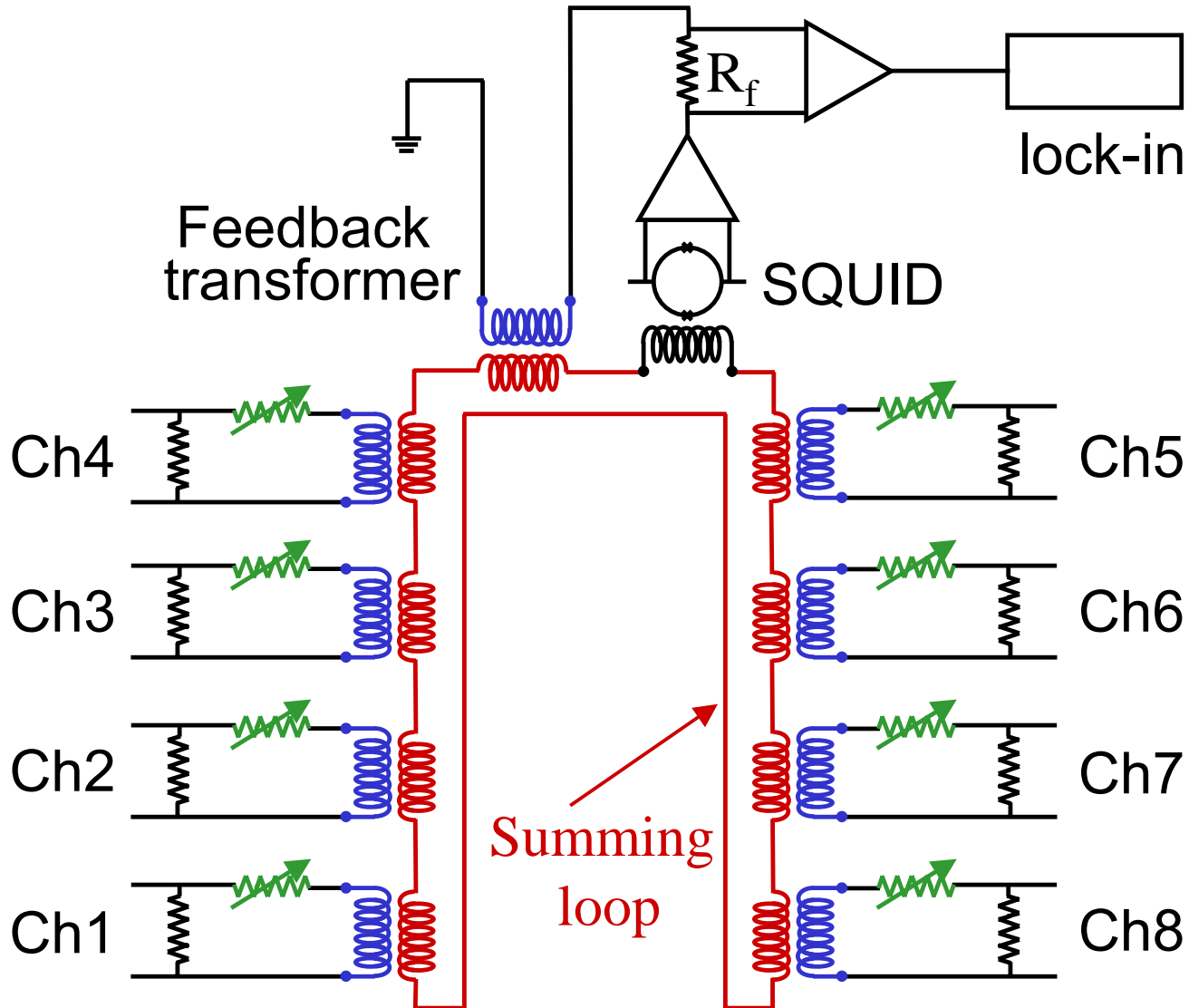


Motivation for Multiplexed Readout

- Large-format bolometer arrays for mm waves (10^3 to 10^4 elements)
- Next generation of Cosmic Microwave Background experiments
 - CMB temperature, polarization (POLAR BEAR)
 - Sunyaev-Zel'dovich cluster surveys (APEX SZ, SPT)
- Multiplexing reduces heat load from wiring, reduces readout complexity at low temperatures

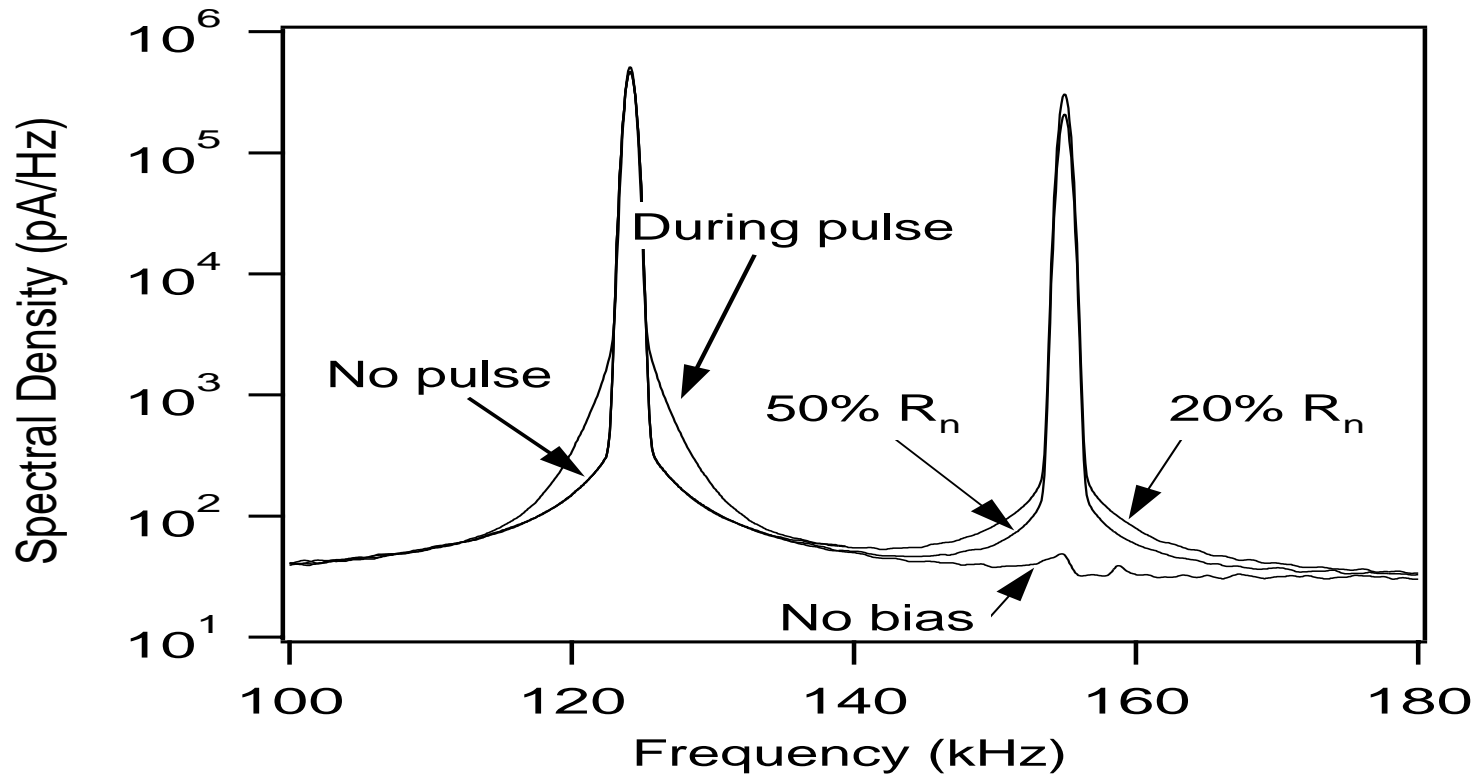


Voltage summing MUX - Design





Voltage Summing MUX - Testing

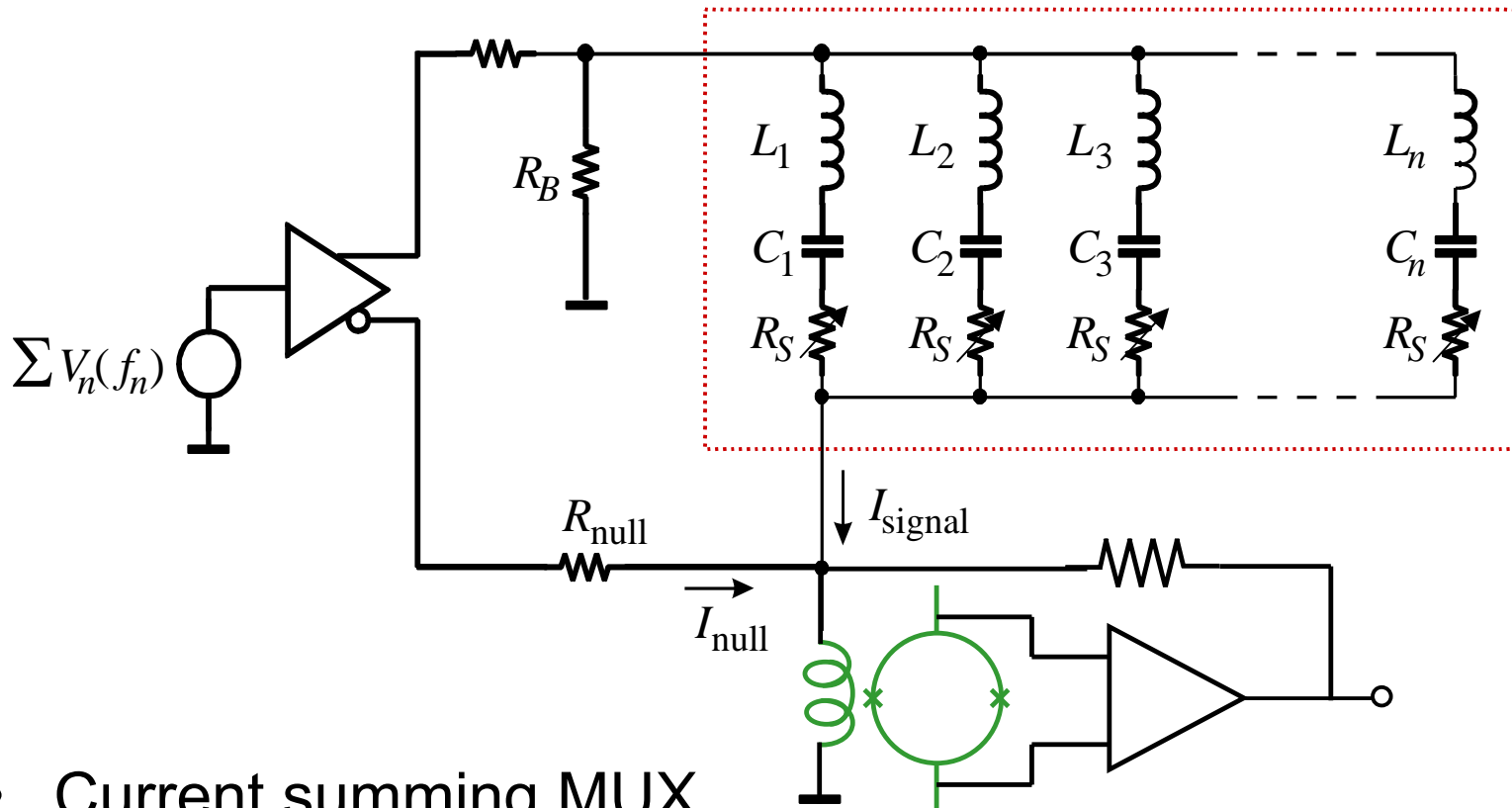


- 2-channel MUX demonstrated
- TES μ -calorimeters and γ rays
- MUXed sensor, single pixel energy resolution same

Cunningham *et al.*, APL, 81, 1 (2002)



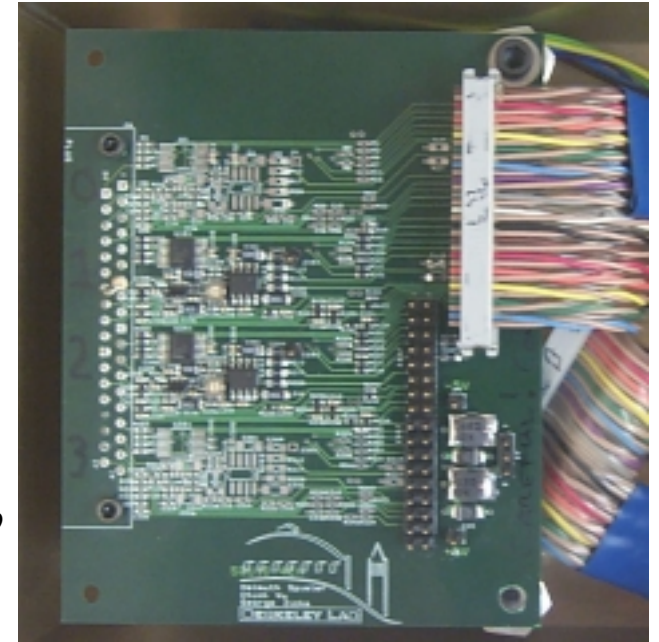
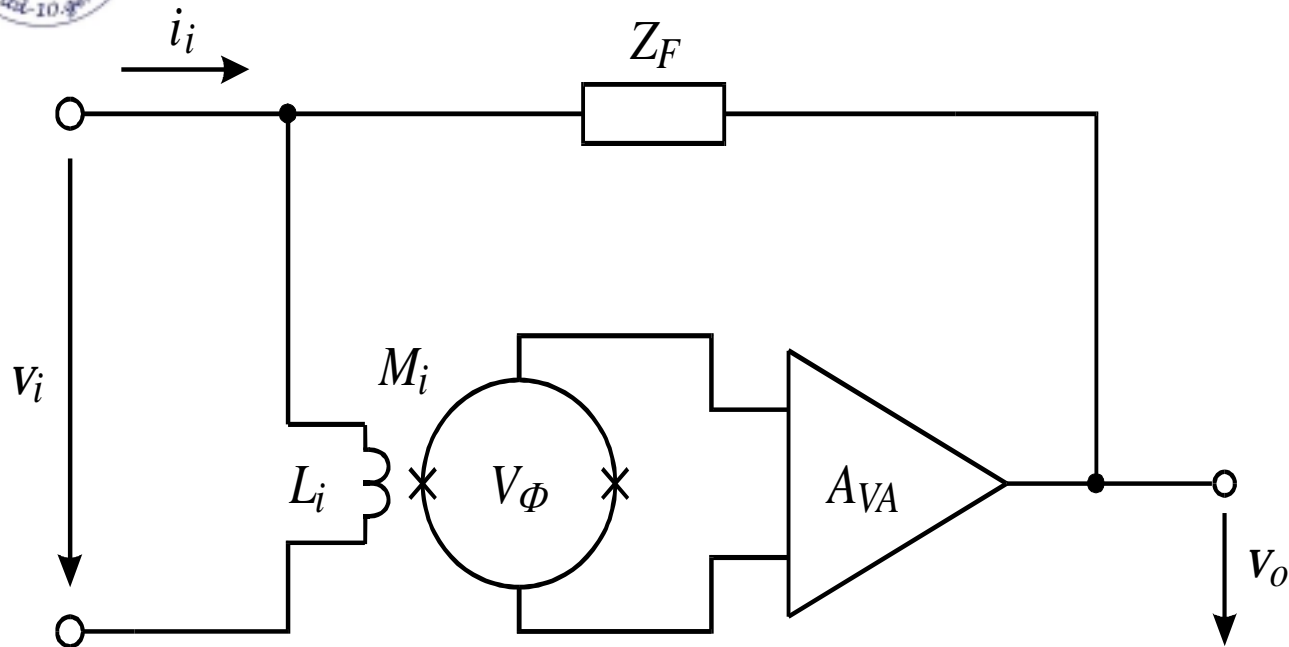
Current Summing MUX



- Current summing MUX
- Simpler design (no transformers)
- AC bias row of sensors with “comb” of frequencies
- Crosstalk determined by Q of LC resonance (design < 1%)



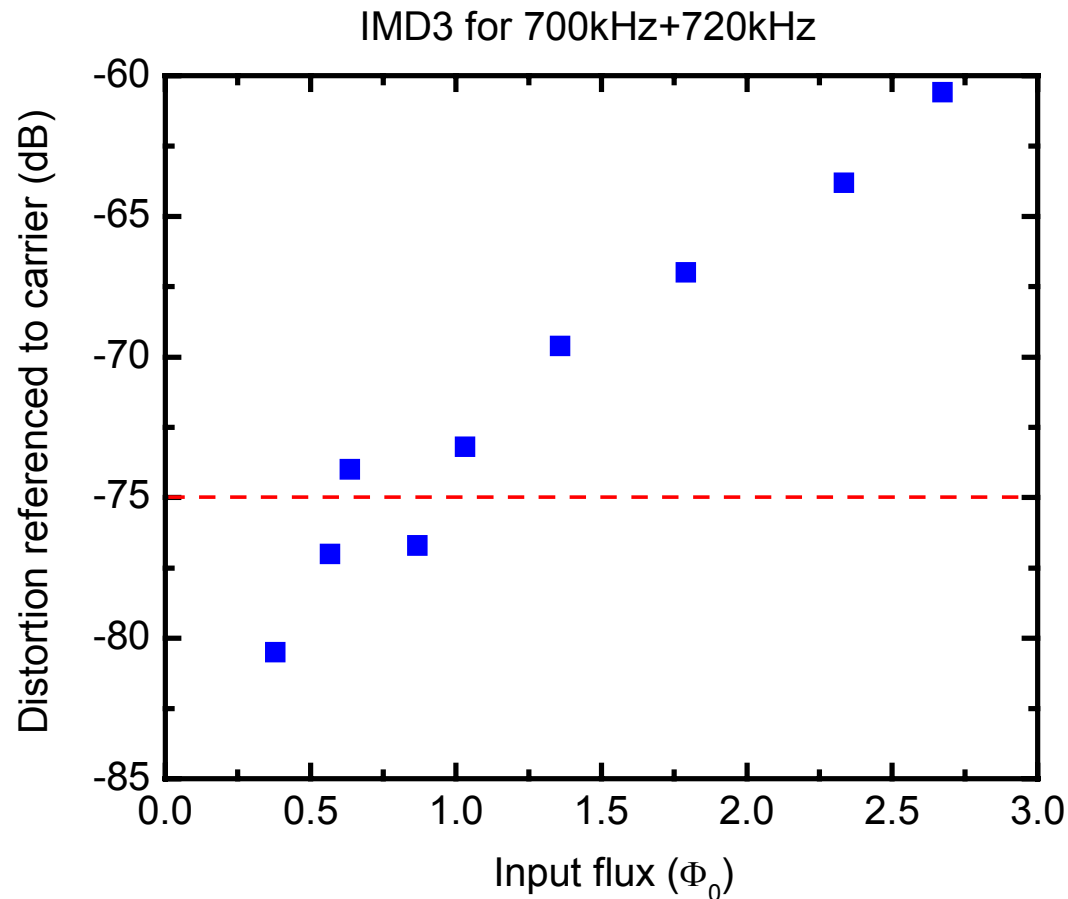
SQUID Controller – Overview



- Slew rate of $10^7 \Phi_0/s$ at 1MHz (SEIKO array)
- Single-pole roll-off controls stability of feedback
- ~10cm wiring to 4K
- Shunt feedback lowers input impedance



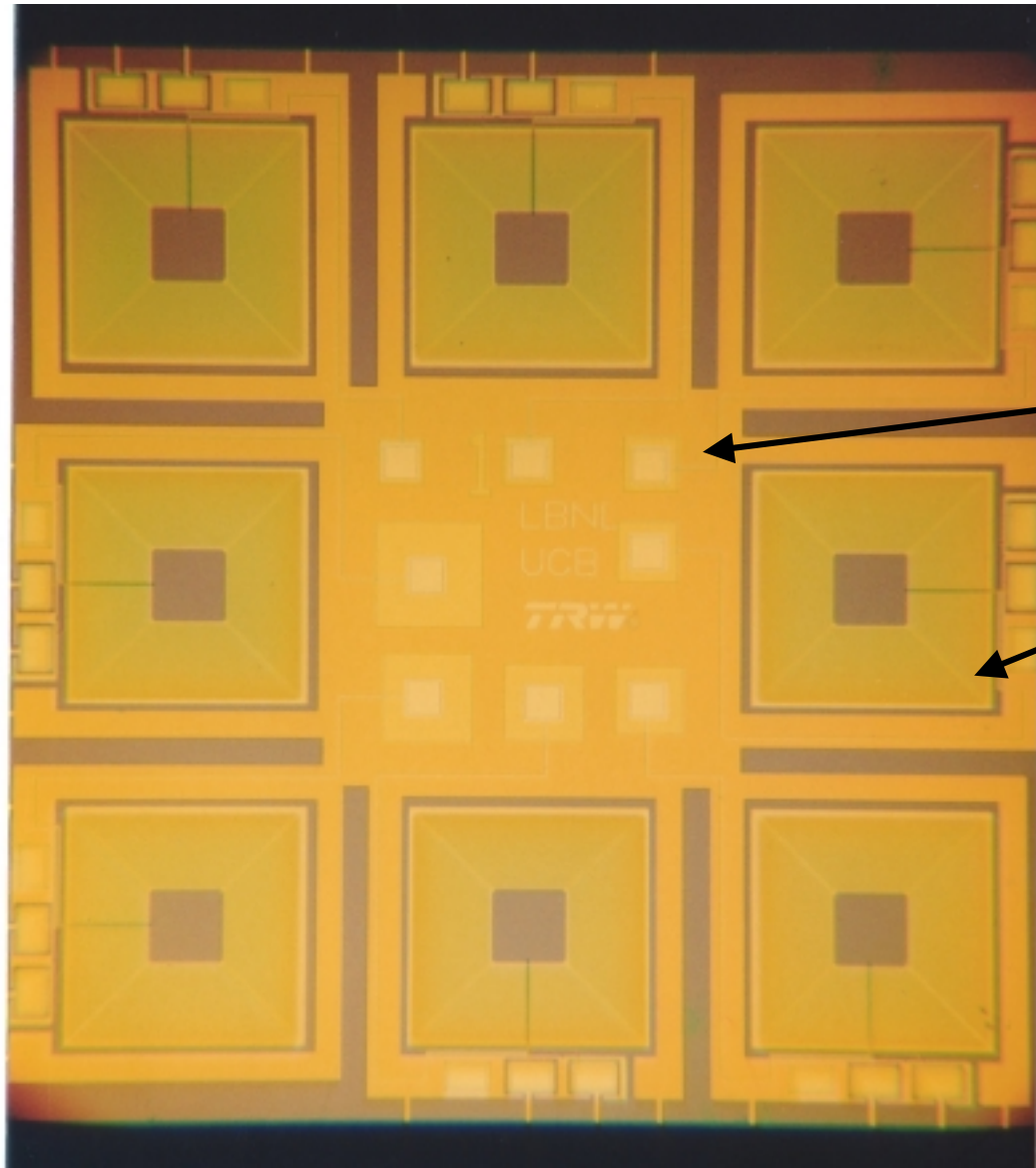
SQUID Controller – Linearity



- Harmonic distortion, intermodulation distortion
- Carrier nulling → estimate 32 channels with nulling



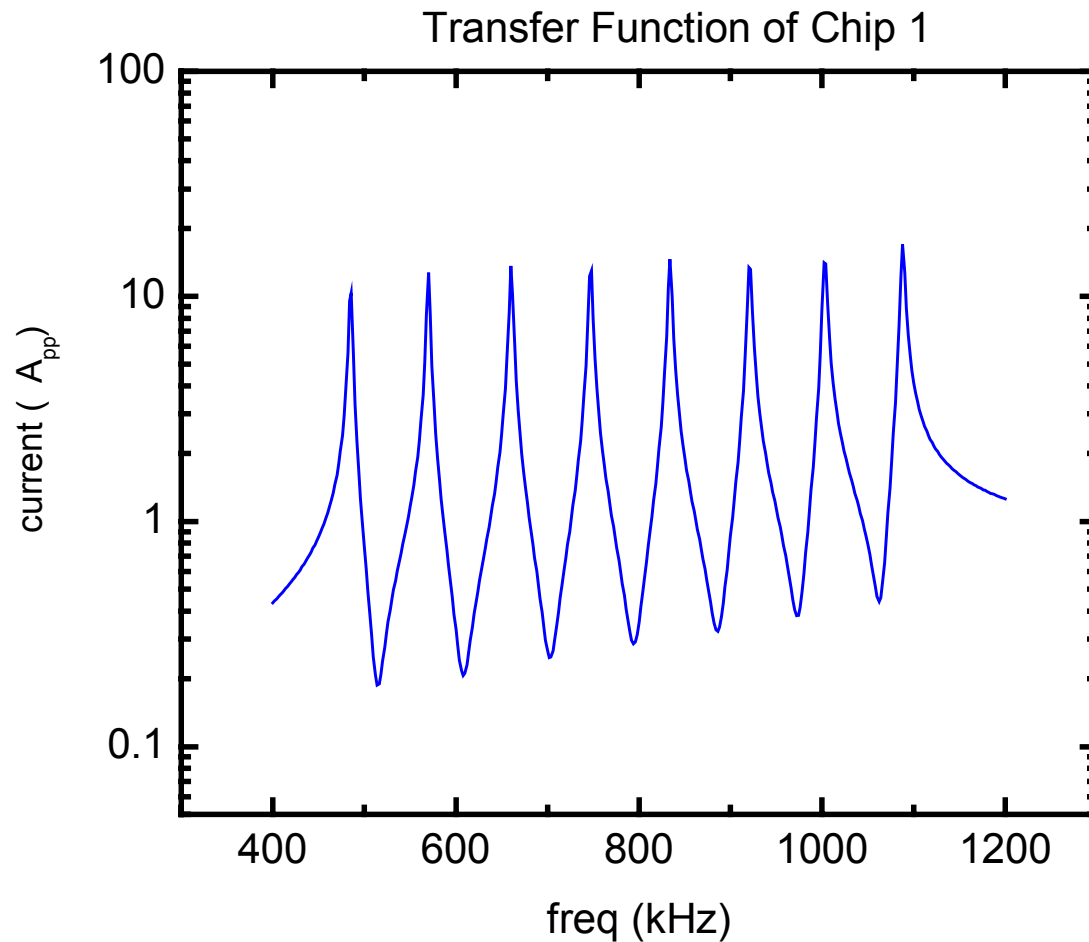
LC Filter Chip



- fabricated at TRW
- capacitors and inductors on chip
- $L = 40\mu\text{H}$
- $C = 630$ to 3300pF



Characterizing LC Filters

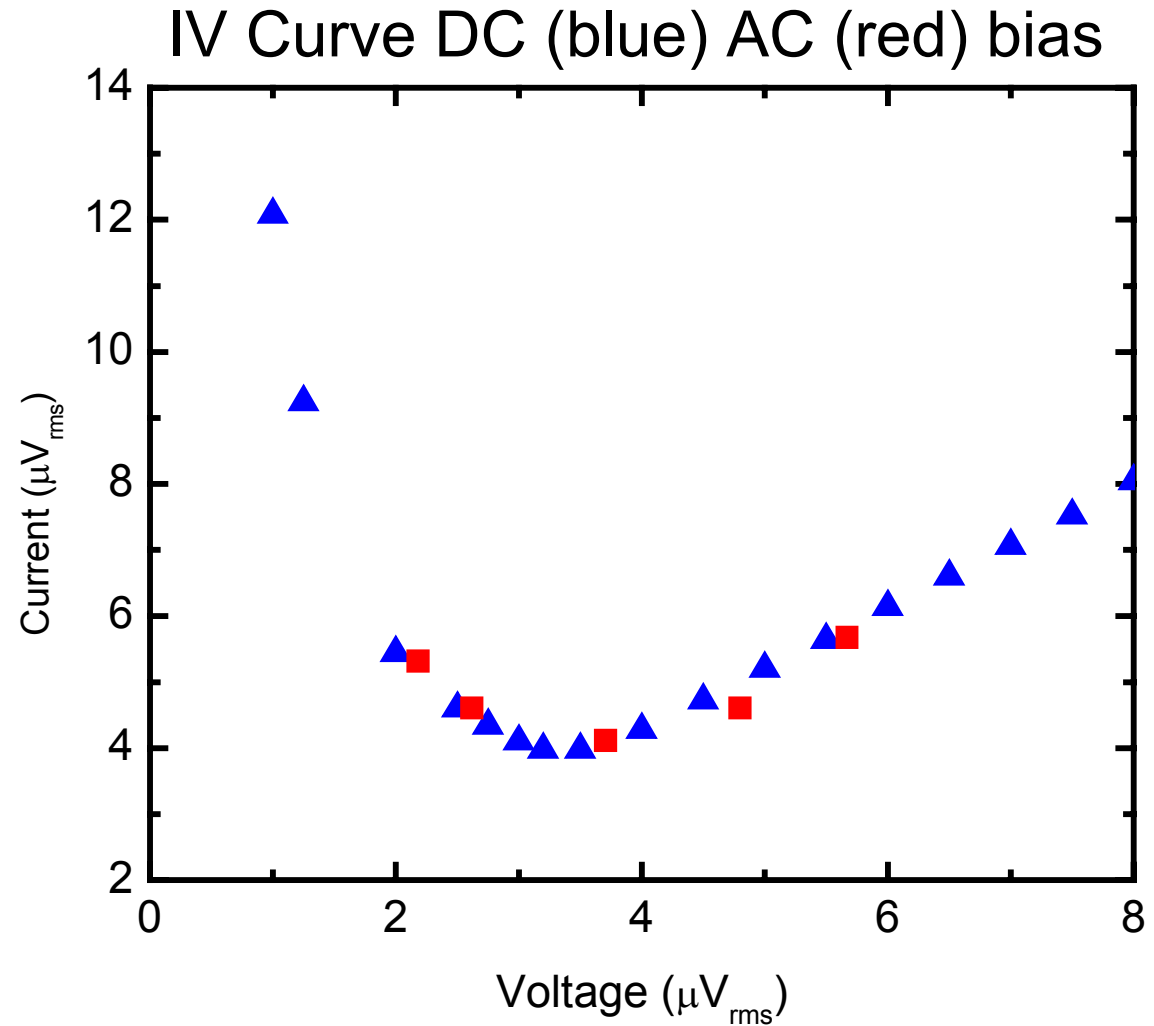


- Measured frequencies higher than design by 9%
- Dielectric losses high ($\delta \sim 0.003$): $\text{Nb}_2\text{O}_5 \rightarrow \text{SiO}_2$



Testing MUX with TES

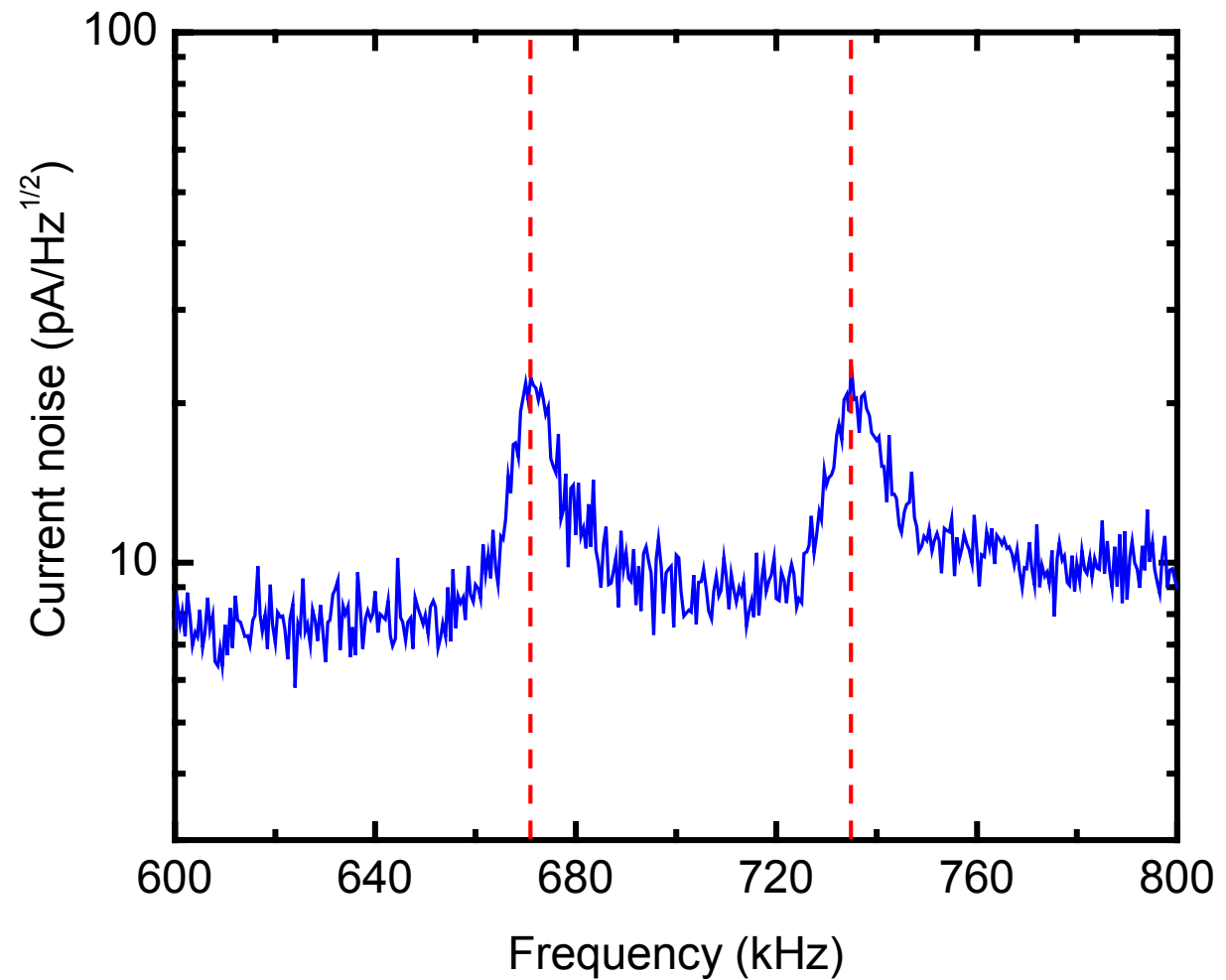
- AC, DC bias





Testing MUX with TES

- Operated two sensors (671kHz, 735kHz)
- See demodulated signals





Conclusions

- Two-channel voltage-summing frequency domain MUX demonstrated
- Two-channel current-summing frequency domain MUX demonstrated

Future Work

- Characterize sensor noise in operation
- Cross-talk measurement with cold, pulsed LED
- 8, 16, 32 channels
- Deploy 1000 element multiplexed array 2006 (SPT)