In Focal Plane Multiplexing Circuitry for Next-Generation TES Arrays

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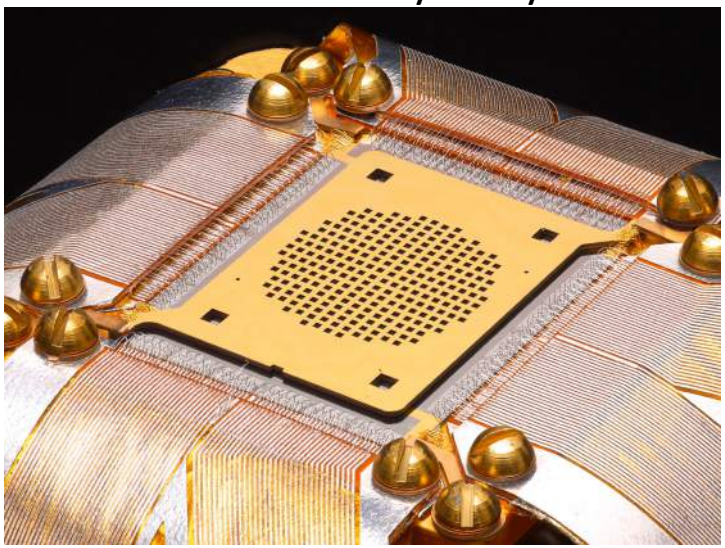
Scaling Problems with Current Multiplexing Techniques

- Scientific applications demands larger arrays
- Existing multiplexing = 2 wires/TES at focal plane
- Required space for bond pads
- Kilopixel array:
  - Active region : 16 x 16 mm
  - Bond pads : 50 x 50 mm
  - 10 % active area
- Power dissipation
  - Voltage bias requires shunt resistor
  - ~10x more power than the TESs
  - ~1 pW for typical NIST x-ray TESs

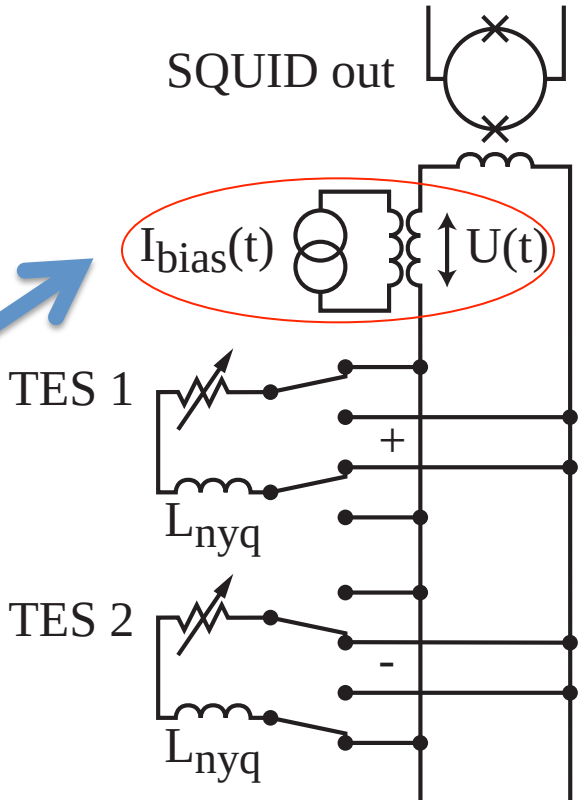
NIST AR14 240 pixel array
6 keV x-ray array



How do we Readout Larger Arrays?

- Integrate multiplexing into detector focal plane
- Current steered – CDM
- Switch as fundamental element
- Benefits
  - Compact
  - Low power
  - Binary addressing

TES bias achieved inductively instead of resistively

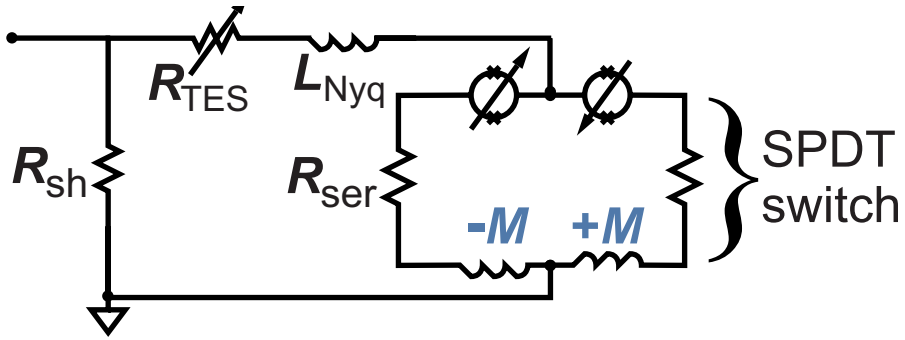


I-CDM Circuit Schematic

Switches for I-CDM

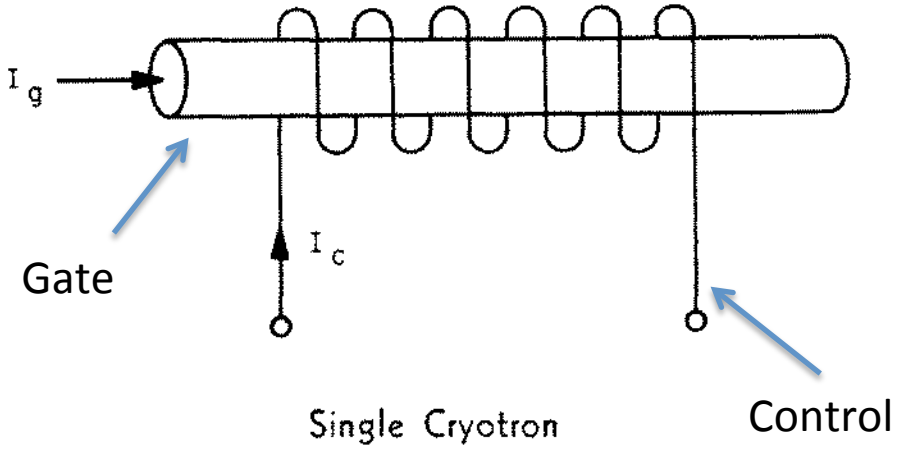
Two approaches at NIST

SQUID based switch
(magnetic flux actuated)



Niemack, M. D., et al. "Code-division SQUID multiplexing." *Applied Physics Letters* 96.16 (2010): 163509.

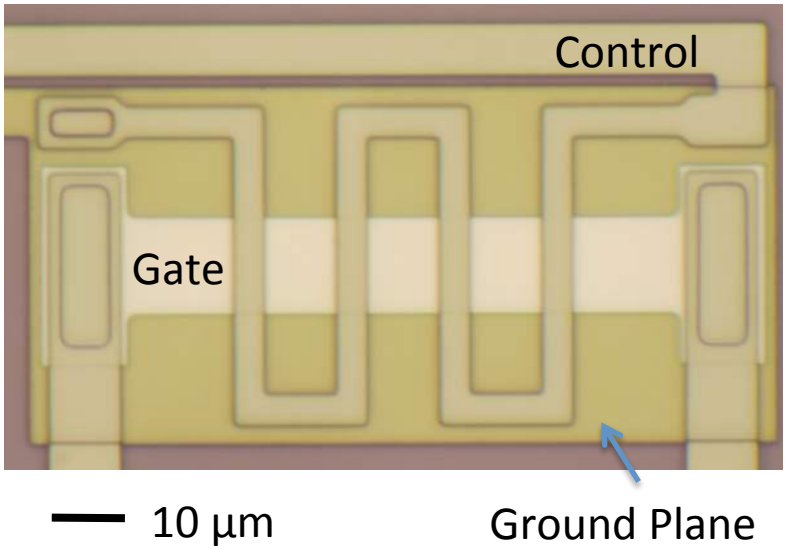
Cryotron
(magnetic field actuated)

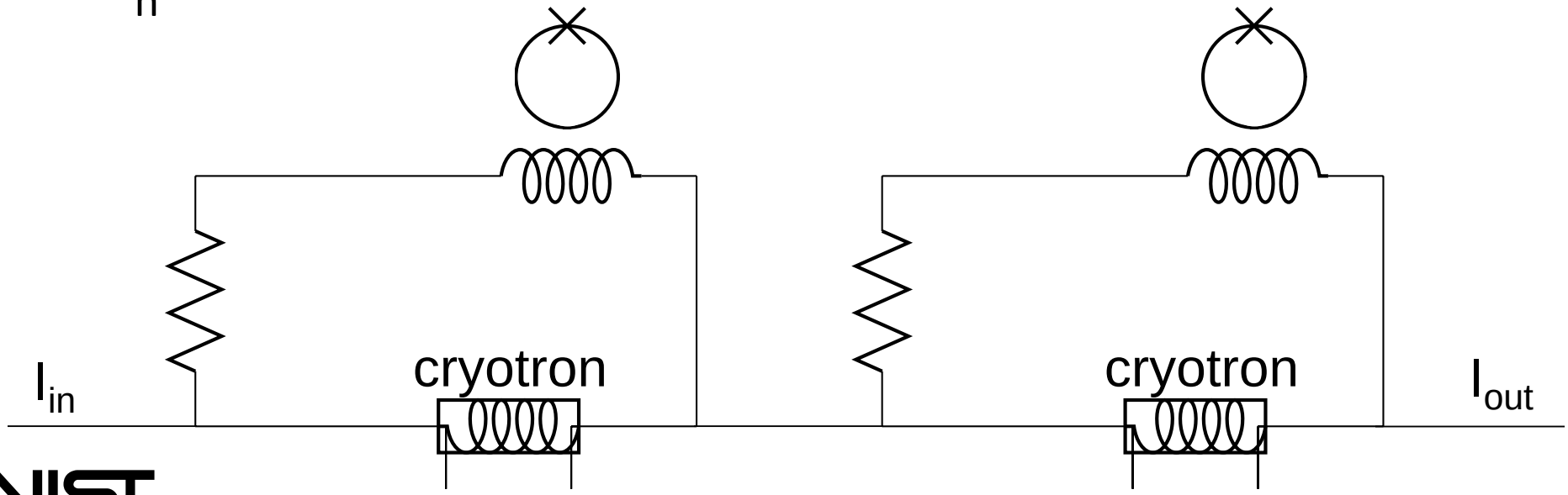


Buck, Dudley A. "The Cryotron-a superconductive computer component." Proceedings of the IRE 44, no. 4 (1956): 482-493.

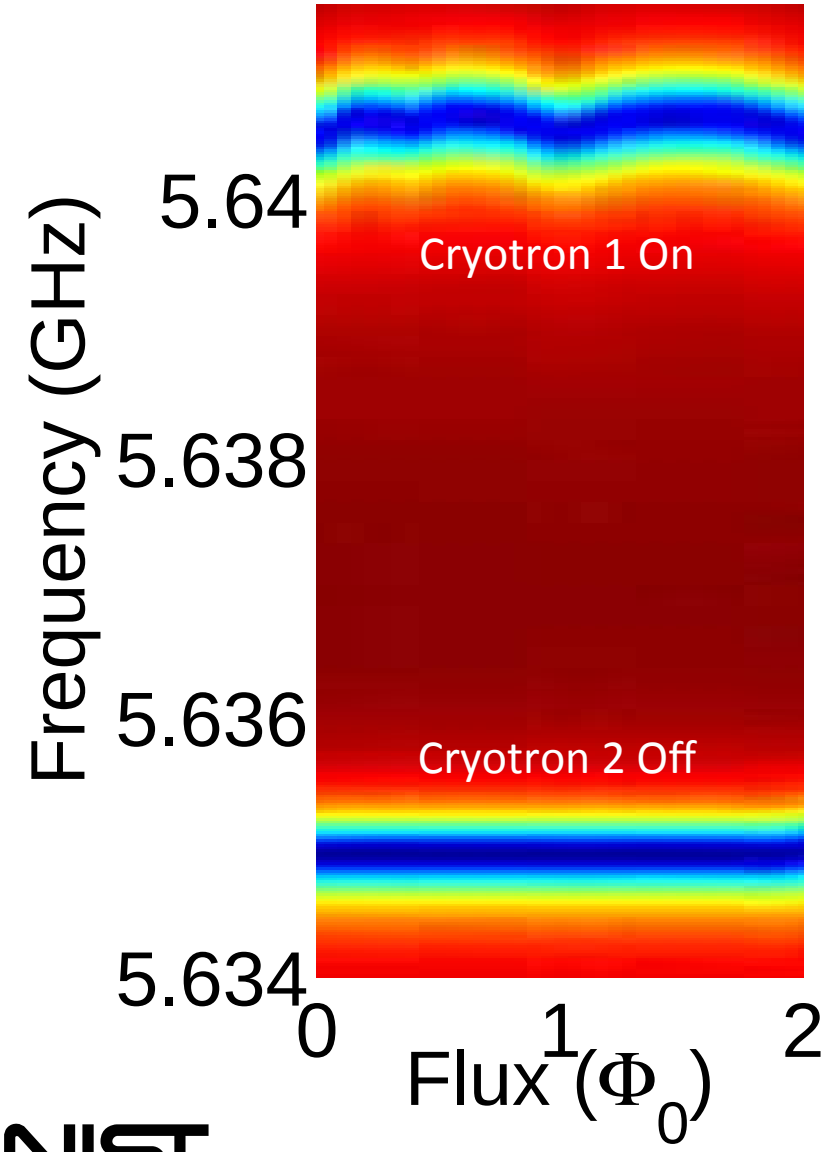
Our Cryotron

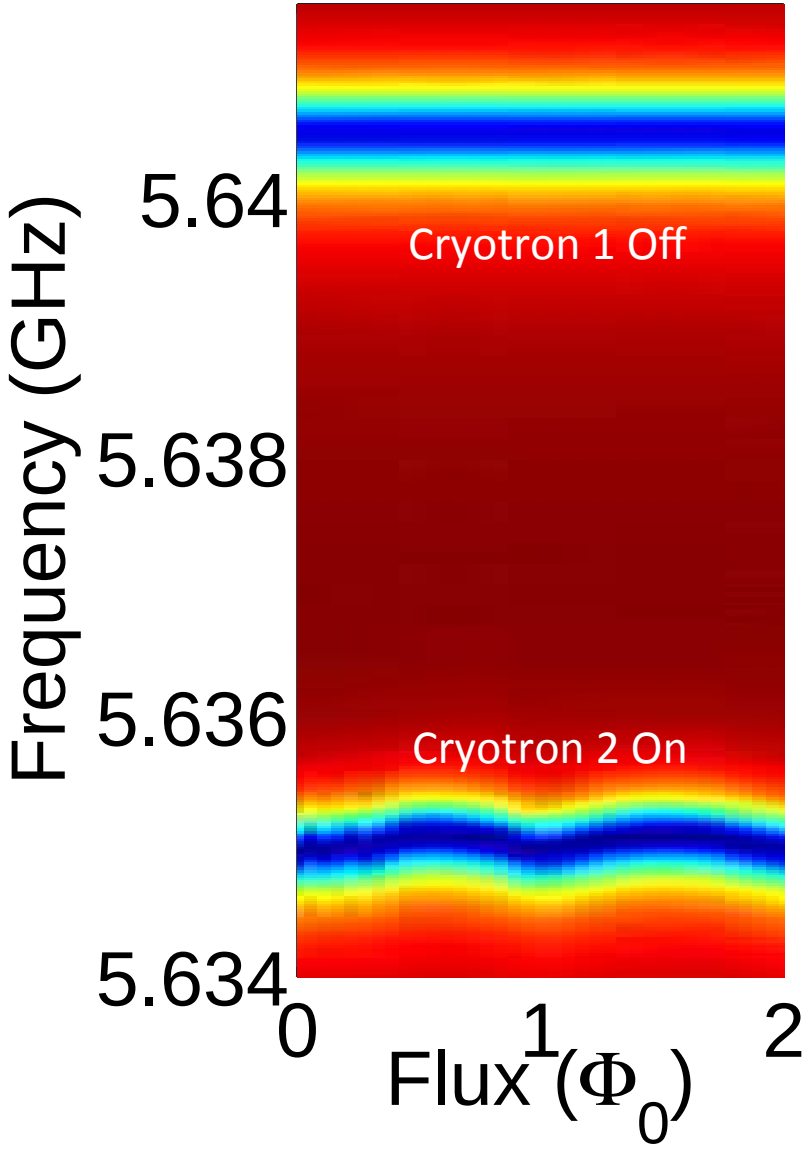
- Nb control wire creates B field perpendicular to the AlMn gate (Tunable T_c)
- T_c of Gate ≈ 550 mK
- R_n of Gate ≈ 3 Ω





SQUID Response with Cryotrons





Conclusion

- We have fabricated and measured prototype devices
- Come to my poster (G2.44) for more information