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Characterization of Microwave SQUID Multiplexers for the RICOCHET Experiment

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The RICOCHET experiment measures the spectrum of coherent elastic neutrino-nuclear scattering (CEνNS) of reactor neutrinos to search for physics beyond the Standard Model. In RICOCHET's Q-Array detector, recoil energy deposited in an array of superconducting crystals is transferred to transition-edge sensors (TES). TESes convert the heat signals into current signals, which then get amplified and read out through a microwave SQUID multiplexer (μMUX). Compared to more traditional multiplexing techniques such as time and code division multiplexing, a frequency-division multiplexer made with high Q superconducting resonators allows for faster pulse response, higher multiplexing factor, and lower power dissipation.

Together with Lincoln Laboratory, we designed, fabricated, and characterized the aluminum μMUX. In this poster, we present the characterization results of a 6-channel device. When flux biased at the sensitive point, the μMUX is limited by 1/f noise at low frequencies and the amplifier noise at high frequencies. The amplifier noise from the HEMT is around 1-2 $\mu\Phi_0\sqrt{\text{Hz}}$. Adding a travelling wave parametric amplifier (TWPA) before the HEMT lowers the amplifier noise floor by a factor of 2-3. Flux ramping modulation reduces the amount of 1/f noise from the resonators. At high frequencies, it's mainly limited by amplifier noise, which we measure to be around 3-4 $\mu\Phi_0\sqrt{\text{Hz}}$.

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