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Microwave SQUID multiplexing of magnetic microcalorimeters

Magnetic microcalorimeters (MMCs) are energy dispersive, low-temperature particle detectors that combine an intrinsically fast signal rise time, an excellent energy resolution, a huge dynamic range, a quantum efficiency close to 100% as well as an almost ideal linear response. For these reasons, MMCs are nowadays actively used in a wide field of applications. But although microfabrication technologies are technically mature and meanwhile allow producing large-scale detector arrays with virtually identical detectors, the readout of such arrays remains ambitious using established technologies that had been developed for single-channel readout in most cases. As a consequence, multiplexing techniques are currently under active development, whereas microwave SQUID multiplexing appears to be most promising.

In this contribution, we present the design and the performance of the most recent version of our lumped element microwave SQUID multiplexer (LEMUX), which will consist of 400 readout channels in the frequency range between 4 GHz and 8 GHz in the final stage. Each LEMUX channel consists of a superconducting lumped element microwave resonator with a bandwidth of 1 MHz and a power consumption below 10 pW. The non-hysteretic rf-SQUID, which is inductively coupled to the resonator, is based on four washers building a first-order parallel gradiometer and is impedance matched for optimal detector readout. The characterization of the LEMUX shows a very good agreement between measured data and multiplexer model, as well as device parameters very close to design values. Using this LEMUX device, we demonstrate a reliable post-processing method for fine-adjusting the resonator resonance frequencies, which ultimately allows for a resonance frequency spacing of 10 MHz within the system bandwidth of 4 GHz.

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