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Microwave SQUID multiplexer for readout of optical TES array

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Optical Transition Edge Sensor (TES) detectors are highly desirable for two-dimensional single-photon multi-color imaging, especially in biology. Recently, we have demonstrated the single photon spectroscopic imaging with an optical TES [1]. It takes 20 to 40 minutes to obtain an image. To decrease the measurement time, multi-pixel detectors are necessary. A Microwave SQUID Multiplexer (MW-Mux) [2] which consists of superconducting resonators and rf-SQUID is a powerful device for readout of the optical TES array.
In previous work, we successfully measured output signals of an optical TES with MW-Mux. Fig. 1 shows the energy spectrum of faint light source with a wavelength of 1550 nm. The observed energy resolution of 0.42 eV for the single photon peak (= 0.8 eV) was worse than that measured with dc-SQUID (0.27 eV).
In this research, we considered the degradation of the energy resolution which is caused by the high-frequency cutoff. There are two main factors that limit the frequency band. The first one is a loss of waveform information due to a low sampling frequency compared with the inverse of time constant of the optical TES. The second one is a bandwidth of the resonator. We simulated the effect of the first one on the energy resolution. The sum of the intrinsic energy resolution (0.27 eV), readout noise (0.07 eV) and the simulated result (0.25 eV) was 0.37 eV. This is consistent with the experimental energy resolution. We will discuss the requirement of frequency band of MW-Mux to improve the energy resolution.

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References
[1] Niwa et al. Scientific Reports 7 (2017) 45660.
[2] J. A. B. Mates et al., Appl. Phys. Lett. 92, 023514 (2008).

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Less than 5 years of experience since completion of Ph.D

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