Rectangular wave biased superconducting wide strip photon detectors for high-speed operation

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Superconducting wide-strip photon detectors (SWSPDs) [1] are expected to be an alternative detection technology to superconducting nanostrip photon detectors (SNSPDs), because they have comparable detection efficiency, no polarization dependence, and can be fabricated using conventional photolithography techniques, allowing high production yield and low fabrication cost. A primary issue is that the response speed is slower than that of an SNSPD, which stems from the need to insert a parallel resistor and a series inductance to achieve stable SWSPD operation under a DC bias. One approach to address this issue is gated-bias operation, which is expected to shorten the output pulse width and hence improve the operation speed. In this work, we report the operation of an SWSPD with rectangular-wave biasing, which is one of the simplest gated-bias operation schemes. The SWSPD device consists of a 10-μm-wide, 20-μm-long, and 5.5-nm-thick NbTiN strip without an optical cavity, for confirmation of the rectangular-wave bias operation. The application of bias current and the extraction of the output signal are separated into different lines. A 1260-Ω resistor is inserted in series on the bias current line to prevent output-signal leakage to the bias line.

A rectangular-wave bias with a pulse width of 10 ns was applied through the bias line. The incident photons were provided by a pulsed-laser source synchronized with the rectangular-wave bias, and the timing was adjusted so that the incident photons arrived at the center of the bias time window. Figure 1 shows the output waveforms of the SWSPD under both DC-bias and rectangular-wave-bias operation. Under rectangular-wave-bias operation, we confirmed that the device operates stably without the insertion of the series inductance and shunt resistor required for DC-bias operation, and we also found that the pulse width of the output waveform can be significantly reduced.

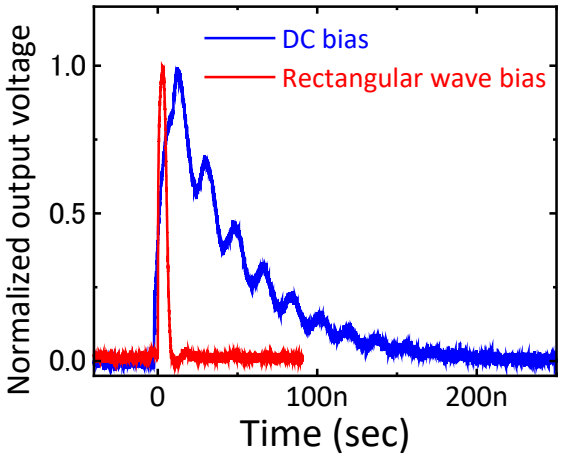

Fig. 1 Output waveform from SWSPD with DC and rectangular wave biasing operation.

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References

[1] M. Yabuno et al., Optica Quantum 1, 26 (2023).