High-Suppression of temporally filtered excitations by a ns-gated SNSPD

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Superconducting nanowire single-photon detectors (SNSPDs) offer exceptional detection efficiency and timing performance, but experiments involving strong optical excitation often require isolating weak photon signals from intense preceding pulses. Time-gated operation provides a promising approach by restricting the detector sensitivity to well-defined temporal windows. However, the effectiveness of this method depends on how quickly the detector can transition into the single-photon-sensitive regime.

Here we show a fast gated operation of standard fiber-coupled SNSPDs with sub-nanosecond turn-on times, enabling precise temporal control of the detector sensitivity. By employing a bias modulation scheme that rapidly drives the nanowire current into the efficiency maximum, the detector becomes fully sensitive within approximately one nanosecond after the gate sets on. This fast activation allows detection windows to be placed in close temporal proximity to strong excitation pulses while maintaining high detection efficiency.

What is critical to know for many application is the suppression ratio of the excitation signal reaching the SNSPD, ensuring normal operation while it is turned on. Therefore, using a pulsed excitation source combined with weak continuous illumination, we investigate the detector response under realistic experimental conditions. Thermally induced detection events are observed during the active gate due to excitation-induced heating of the nanowire, despite the detector being turned off when the excitation pulse reaches the device. Such thermally induced detections decay on a nanosecond timescale. Across a wide range of excitation pulse powers, the gated detector achieves an average suppression ratio of ~50 dB while preserving its internal detection efficiency during the active gate.

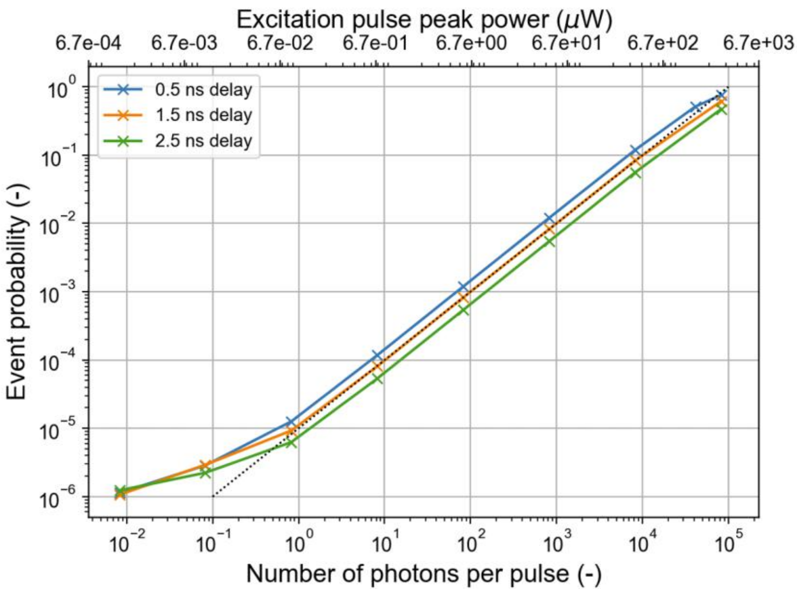

Fig. 1: *False event probability as function of the excitation pulse peak power and delay.*

These results show that ultrafast bias-controlled gating enables effective temporal filtering of strong optical backgrounds, allowing SNSPDs to operate reliably in experiments where weak photon signals must be detected in close temporal proximity to intense excitation pulses.