Nanooptics and photonics

Integrated quantum correlation counter based on multi-element superconducting nanowire single photon detector

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The development of efficient single photon sources and single photon detectors [1] for telecom wavelength bands (1310-1550 nm) are crucial for optical quantum information applications. Quantum correlation (QC) measurements are important diagnostic tool for characterization of such single photon sources [2]. Up to now, implementation of quantum correlation measurements (often in Hanbury Brown - Twiss interferometer geometry) required the use of bulky optical components such as beam splitters, lenses, discrete single photon detectors and measurements of QCs higher than 2nd order are very complicated due to increased amount of necessary equipment and possible artifacts due to misalignment. The detectors commonly used in such experiments are semiconducting avalanche photodiodes with low timing resolution and limited quantum efficiencies. Here we present a new concept of integrated QC counter that requires neither alignment nor additional optical components. The developed counter is based on multi-element superconducting nanowire single photon detector made of ultrathin NbTiN film. The detector is self-aligned to single-mode optical fiber and each detector element is biased and readout independently. The detector has overall system quantum detection efficiency of 28 % at 1310 nm, a system dark count rate around 100 Hz and FWHM timing jitter of 32 ps when operated in closed-cycle refrigerator with a base temperature of 2.5 K. Using the developed integrated quantum correlation counter we measured the second-order intensity correlation function $g^2(\tau)$ of infrared nanowire quantum dot single photon source and observed characteristic photon antibunching statistics. This work was supported by European Research Council via the Proof of Concept Grant “Integrated quantum correlation counter”.

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2. *Migdall A., Polyakov S., Fan J., Bienfang J.* // Single-Photon Generation and Detection: Physics and Applications (Academic Press, 2013).