Superconducting Single Photon Detectors for quantum information Processing

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Photon based quantum technologies, such as quantum key distribution (QKD) or quantum computing, require single photon sources and single photon detectors [1,2]. In terms of detectors, Superconducting Nanowire Single Photon Detectors (SNSPDs) have demonstrated their superiority towards for example single-photon avalanche photodiodes (SPADs). These detectors exhibit near unity quantum efficiency, extreme low dark counts and timing jitter [3,4,5]. Continued progress in SNSPD development requires systematic investigation of device geometry, material integration, and detector architecture for performance optimisation of different applications.

In this work, we present a study of tungsten silicide (WSi) based SNSPD, integrated with a distributed Bragg reflector (DBR), where the focus lies on the influence of nanowire width and length, multipixel device layouts and the implementation of shunt bars.

This study explores the key detector characteristics, such as system detection efficiency (SDE), dark counts, and kinetic inductance in dependence of nanowire width and length. In parallel Multipixel SNSPD architectures are investigated, as a pathway for enhanced count rate capability and photon-number-resolving potential. In addition, superconducting shunt-bars are integrated as an approach to improve device recovery and on chip integration of an additional shunted current pathway.

Combining WSi as a well-established amorphous superconducting material used in combination with commercially available DBRs, this work aims to provide a broad experimental platform for understanding important trade-offs between optical absorption, electrical performance, and device scalability. The presented device set is intended to enable comparative studies across multiple SNSPD design parameters and to support future optimisation of single-photon detectors for fundamental and applied quantum photonic technologies.

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