Abstract—Single-photon detectors are a key enabling technology for optical quantum information processing. A major challenge is integrating new detector technologies with photonic systems. This paper demonstrates enhanced efficiency in practical fibre coupled infrared superconducting single photon detectors through the integration of an optical cavity.

Single-photon detectors are a key enabling technology for optical quantum information processing (QIP). A new type of single-photon detector based on a superconducting nanowire holds particular promise, offering infrared single-photon sensitivity with low dark counts and excellent timing resolution, at an operating temperature of 4 K. These detectors have been integrated into practical closed-cycle refrigerator systems and have been successfully employed in a succession of QIP experiments, including characterisation of single and entangled photon sources and quantum key distribution over 200 Km of optical fibre.

Current work on Superconducting Nanowire Single Photon Detectors (SNSPDs) is focused towards improving Detector Efficiency (DE) at telecommunications wavelengths, whilst exploiting low dark count rates and picosecond timing resolution. Devices fabricated in a new material, NbTiN, offer improved signal to noise characteristics. In this work we present high efficiency measurements of practically fibre coupled NbTiN SNSPDs at telecoms wavelengths. Efficiency is significantly enhanced as the SNSPDs have been fabricated on silicon substrates with a 225nm thermally grown SiO₂ layer directly underneath the active device layer. The reflection at the SiO₂ – Si interface increases absorption in the NbTiN layer yielding practical efficiencies in excess of 20% at 1310 nm and 7% at 1510 nm, at dark count rates ~1 kHz. The efficiency drop off at lower bias current is slight, yielding 10% efficiency with only 20Hz dark counts at 1310nm.

Figure 1. Frontside fibre coupling to device.
Figure 2. Top - Experimental setup. Bottom – Experimental dependence of DE with varying wavelength at 1.7 kHz dark count rate. Inset red line is simulated device efficiency plotted with the same scale as the experimental data. Black dashed line marks the designed adsorption maximum from the device layer cavity structure.

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REFERENCES


