MultiQomm: Multi-Functional Platform for Secure Quantum Key Distribution Using Waveguide-Integrated SNSPDs

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Quantum key distribution (QKD) enables secure communication based on quantum mechanical principles; however, practical systems remain vulnerable to side-channel attacks. Detecting such attacks typically requires tailored countermeasures, yet current systems often employ detector arrays optimized for a single operating function. On-chip superconducting nanowire single-photon detectors (SNSPDs) offer high detection efficiency, low dark counts, and excellent timing resolution, and the potential to implement specific countermeasures to eavesdropper attacks.

Here we develop a scalable multifunctional platform within the MultiQomm project based on waveguide-integrated SNSPDs (WI-SNSPDs). Nanophotonic waveguides and detectors are monolithically integrated on a single chip to realise application-specific QKD blocks with dedicated security functionalities. A high-efficiency time-bin QKD [1] block targets detection efficiencies approaching 95%, while a long-distance distribution block aims for dark count rates below 1 Hz and timing jitter below 10 ps. An additional block employs an asymmetric multimode interferometer (MMI) to separate TE and TM modes for BB84 polarisation-basis detection. System security is ensured by a dedicated monitoring block using developed WI-SNSPDs to enable photon-number-resolving [2] and deterministic detection of intercept–resend blinding attacks, both of which are used for eavesdropper identification.

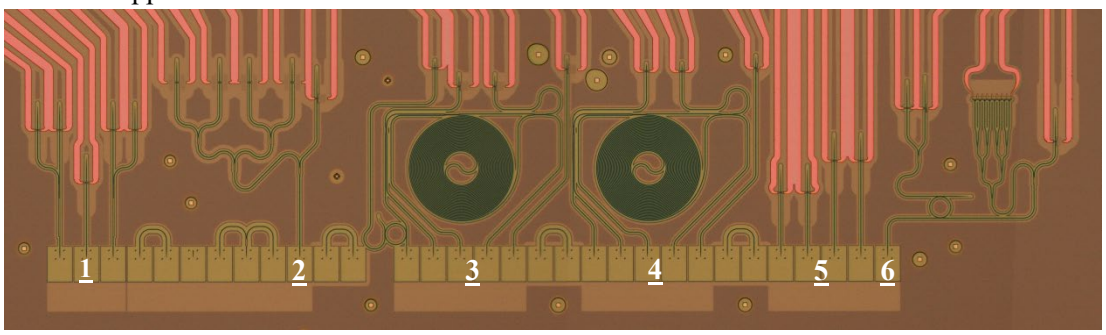

Fig. 1: *Optical microscopy of the fabricated MultiQomm chip showing the integrated functional blocks: (1) TE/TM mode discrimination, (2) primary hacking detection, (3) high-efficiency QKD, (4) long-distance-optimised QKD, (5) reference SNSPDs, and (6) secondary hacking detection.*

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References

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