High-speed quantum key distribution system

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While the theoretical security of various QKD protocols has been proven, practical side-channel attacks on implementations like Photon Number Splitting (PNS) and blinding attacks are well-known. Additionally, high secret key rates have to be achieved for QKD to be viable for large scale real world use. In the effort of implementing the Coherent One Way Protocol (COW) on Photonic Integrated Circuits (PIC), we are realizing wavelength-division multiplexed sender and receiver units with special focus on implementing defences and mitigation on chip [1]. Previously, a secret key rate of 12.17 Mbps at 10 dB channel attenuation was achieved using a scalable design utilizing Waveguide-Integrated Superconducting Nanowire Single-Photon Detectors (WI-SNSPDs), implementing COW on four wavelength channels simultaneously [2]. The current state, ongoing work and follow-up projects are presented. This includes the hybrid sender chip design and complex packaging scheme, the receiver design with on chip demultiplexing and hardware, post-processing software and remote monitoring preparations for a field test over a 20km dark fibre link.
The sender unit is comprised of two PICs. The first one uses the Indium Phosphide (InP) material platform for implementing 20 wavelength separated (1550nm-1570nm) and tunable (1nm) laser sources with integrated intensity modulation, while the second chip, based on Silicon Nitride (SiN), implements a multiplexer to provide a single fibre output port for all modulated laser channels. An ongoing project aims at enhancing the modulation extinction ratio by implementing high-speed modulators on the Thin Film Lithium Niobate (TFLN) platform on a separate PIC. The receiver is a SiN chip with a shared delay-line interferometer for coherence measurement (X basis), resonant rings for channel filtering and one WI-SNSPD per basis per channel.

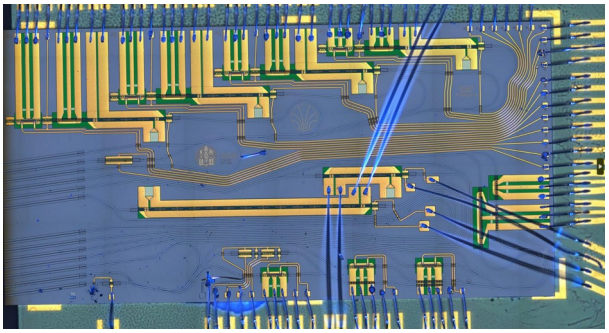

Fig. 1: *Four channel InP sender chip [1]*

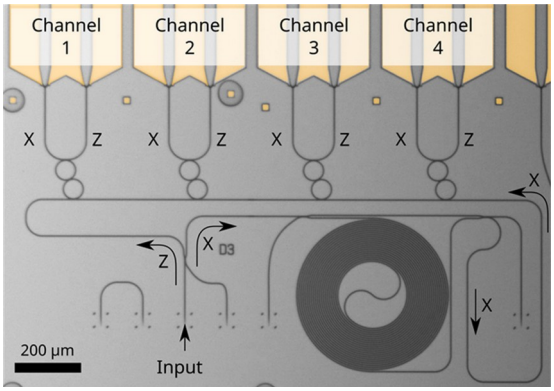

Fig. 2: *Four channel SiN receiver chip [2]*

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References

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[2] Beutel, F. et al., Optica 9, 1121 (2022).