# Integrated Photonics for Quantum Repeaters

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A key component of quantum communication is the distribution of entanglement through networks. However, this comes with several challenges. One of the most significant is that direct transmission of quantum information between two nodes, via a standard fibre link, is unfeasible for transmission distances of more than a few hundred kilometres [1]. A solution is the 'quantum repeater' architecture, which distributes entanglement between two nodes via an intermediate repeater node [2].

Current state of the art experiments have recently implemented proof-of-principle, repeater-like networks with quantum memories [3]. However, such experiments often use highly complicated photon sources, which is impractical when moving towards a realistically implementable and scalable quantum network. Integrated photonics is a promising solution to this problem, allowing large numbers of components to be packaged together in a compact and stable manner. In particular, integrated micro-ring resonators (MRRs) have shown they are well-suited to the production of narrow-band photons, with bandwidths compatible with some rare-earth ion quantum memories [5].

This poster will demonstrate recent work at the University of Geneva, in collaboration with EPFL and Nokia Bell labs, on the design and development of MRRs which produce highly non-degenerate entangled photons, with one photon at 980nm and one at 1550nm, for realising quantum repeaters. The 980nm photon from our devices is designed to be resonant with a solid-state Ytterbium ion quantum memory [5], with the 1550nm photon for low-loss transmission through fibre. The atomic memory places very strict requirements on the wavelength, bandwidth, and frequency stability of the photon source, which is challenging to achieve in integrated photonics, with our work demonstrating solutions to these problems.

Our research explores several different material platforms for entangled photon generation, including silicon nitride (SiN), thin-film lithium niobate (TFLN), and thin-film lithium tantalate (TFLT). Preliminary results will show the production of photon pairs at 980nm and 1550nm from both SiN and TFLN devices. These abilities will be instrumental in enabling the creation of a quantum node based on such integrated sources interfaced with Ytterbium ion quantum memories for development of future quantum networks.

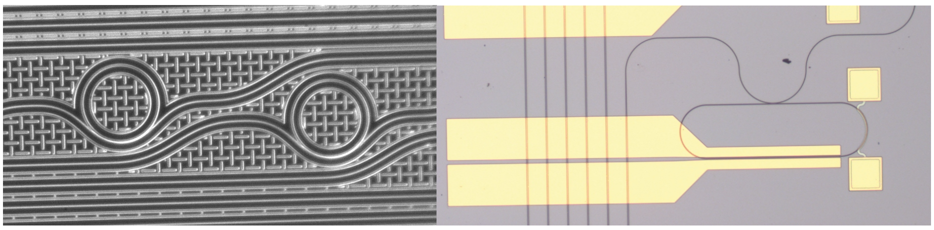

Fig. 1 Examples of the highly non-degenerate entangled photon pair sources which will be presented. **Left:** SiN device. **Right:** TFLN device.

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[4] T. Brydges et al., *Phys. Rev. A*, **107**, 052602 (2023)
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