High-Dimension and Sequential Time-Bin Entanglement using SiN Microring Resonator Photon-Pair Sources

F. Samara, A. Martin, C. Autebert, F. Bussières, H. Zbinden, R. Thew

Group of Applied Physics, University of Geneva, CH-1211 Geneva 4, Switzerland

Photonic sources represent a key building block for quantum communication. As systems move towards more complex quantum networks or more practical, low-cost, schemes, integrated photonics will play an important role. In the case of photon pairs, the platform of choice has been silicon (Si) due to the mature Si-Photonics technology. However, Si suffers from linear and nonlinear losses, such as Two Photon Absorption (TPA), which limits the achievable photon-pair generation rates in such devices. An alternative solution is silicon nitride (Si_3N_4), which does not suffer from TPA and where significant progress has been made in fabrication techniques [1] as well as loss reduction [2]. To demonstrate the maturity and flexibility of this technology we exploit Si_3N_4 microring-resonators (MRR) in an entanglement generation scheme to realise sequential time-bin entanglement [3] as well as the generation and certification of high-dimensional time-bin entanglement.

In our experiment, sequential time-bin entanglement is investigated using a folded franson interferometer set-up giving rise to interference fringes with raw visibility up to 95%. The free spectral range is adapted to match the standard telecom C-band channel spacing, thus permitting us to exploit low loss commercial telecom filters. This, togther with photon detection using state of the art superconducting single photon detectors that we have developed [4], permited us to detect coincidence counts of up to 75 kHz with further room for improvment. MRR devices with a moderate Q-factor ($2x10^5$) was chosen to allow us to operate with a 1 GHz pulsed pump rate. We also present several techniques that we have incorporated to mitigate noise while improving pump rejection and channel selection.

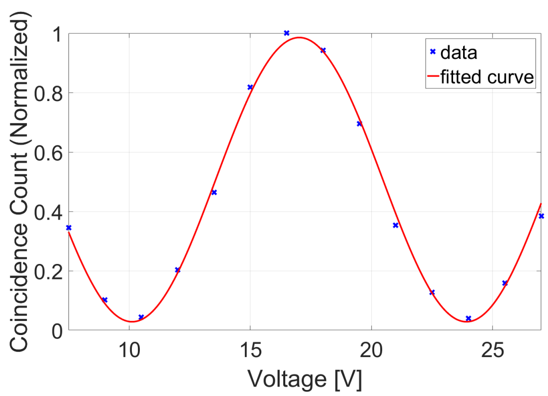

Figure 1: Normalized coincidence count as a function of the voltage applied on a piezo to control the phase.

References

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