Towards integrated platforms for quantum communications based on Hong-Ou-Mandel interference

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Introduction

In our society the exchange of sensitive data requires high and reliable security protocols. Unconditionally secure communication can be achieved with quantum key distribution (QKD) [1]. Most of implemented QKD systems make use of bulky and expensive devices, which prevent scalability and integration with the existing communication networks. Photonic integrated circuits (PICs) provide an excellent solution in terms of scalability, compactness and optical stability. Integrated point-to-point QKD schemes have been demonstrated [2, 3], but they are vulnerable to detector side channel attacks [4]. Measurement device independent (MDI) protocols can successfully counteract this problem [5]. Both Alice and Bob, the two users, send quantum states to a third untrusted party, Charlie, which correlates the received states performing a Bell's state measurement. To realize it, a high Hong-Ou-Mandel (HOM) dip visibility is required.

Setup and results

The setup is reported in Figure 1 on the left. We use, as transmitters, two different III-V lasers on silicon waveguide, controlled with two temperature controllers (TC), operating at telecom wavelength with spectra around 1534.5 nm and 400 pm width [6]. The lasers are independently probed and operated in gain-switching mode, obtaining short pulses of 145 ps full width half maximum (FWHM), each with random phase, at a repetition rate of 100 MHz. Light is then coupled to two optical fibres, filtered with band pass tunable filters (BPTF) and attenuated with variable optical attenuators (VOA) to reach the desired photon number per pulse. An optical delay line (ODL), in one of the two paths, is used to match the time of arrivals and to scan the HOM dip. Polarization controllers (PC) are then used to align the polarization of the two pulses and finally a 50/50 beam splitter (BS) combines them. Two gated avalanched single photon detectors (SPDs) are used to collect the photons and a time-to-digital converter (TDC) counts coincidences among the two outputs of the BS [7]. The obtained HOM dip is shown in Figure 1 (right), where the g^2 intensity-intensity correlation function, i.e. the normalized coincidence rate, is reported. In this work we experimentally achieved HOM interference, with a visibility of 47±1%, between two integrated silicon chips. This result represents the first milestone towards MDI-QKD protocols with photonic platforms, paving the way for an integrated quantum network.

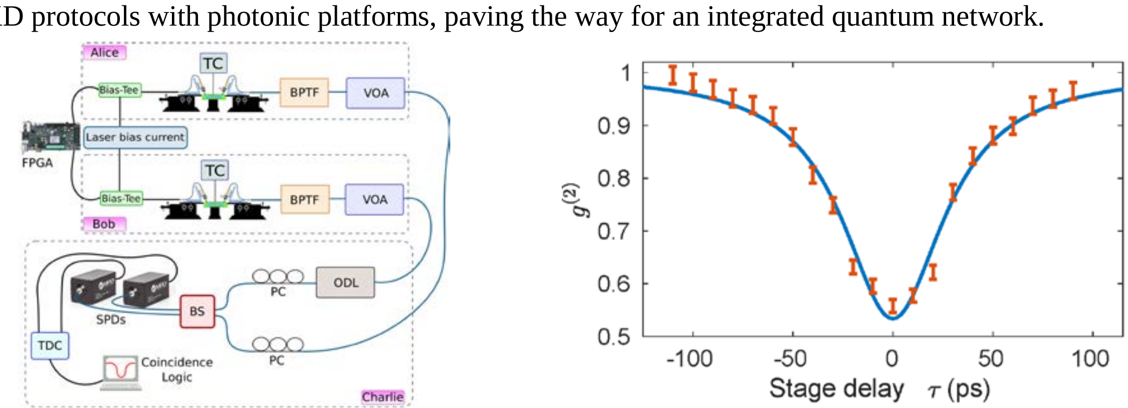

Figure 1: On the left side we show the experimental setup; on the right, the measured HOM dip.

References

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