Towards a Quantum Network Testbed

Rong Xue, Christopher J. Chunnilall

National Physical Laboratory, TW11 0LW, Teddington, United Kingdom

Introduction: Quantum networks, leveraging the laws of quantum mechanics, have advantages over classical networks in applications such as secure communication and distributed quantum computing [1]. Here, we implemented an entanglement distribution network and verified entanglement properties of the distributed photon pairs among users.

Experiment: Based on the entangled photon source (EPS) from our previous work [2], the generated energy-time entangled photons with high coincidence-to-accidental ratio and high photon pair generation rate were distributed to multiple users in a quantum network. As shown in Fig. 1, a 3-user entanglement distribution network were demonstrated, where any two of the users share a pair of entangled photons. 6 ITU channels were demultiplexed from the broadband spectrum, corresponding to 3 different wavelength-correlated photon pairs. After wavelength multiplex, photons were transmitted over deployed fibres or fibre spools, before detection at the user nodes. The unbalanced Mach-Zehnder interferometers (UMZIs) were used to verify entanglement though violation of the Clauser-Horne-Shimony-Holt inequality [3]. Transmission through a 3-km deployed fibre loop via the IQST Building to each user introduced losses of 3.9 dB, 4.2 dB and 3.4 dB to Alice, Bob and Charlie respectively, with the visibilities of interference fringes exceeding 91.6% for all user pairs. Transmission through a 10-km fibre spool to Bob and a 25-km fibre spool to Charlie introduced losses of 1.9 dB and 5.5 dB respectively, with the visibilities exceeding 92.7% for all user pairs. All visibilities exceed 70.7% [4], verifying the distributed photon pairs are energy-time entangled.

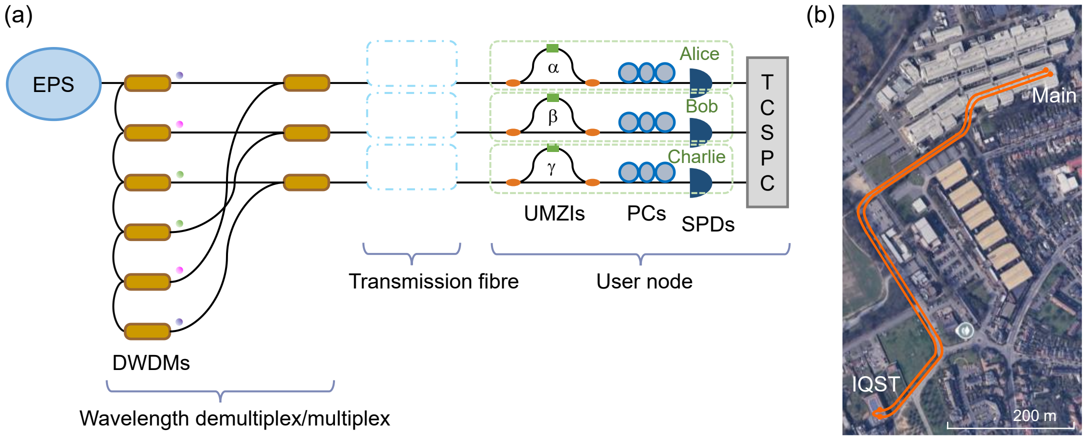

Fig. 1: *Schematic of the experimental setup. (a) Entanglement distribution network of 3 users, located at the Main Building. (b) Deployed fibres across the NPL site (Imagery from Google Maps). DWDM, dense wavelength division multiplexer; PC, polarisation controller; SPD, single-photon detector; TCSPC, time-correlated single-photon counter.*

Outlook: We will move the user nodes to different labs at NPL and apply White Rabbit technology for time synchronisation. Our final goal is achieving a fully functioning, characterised and scalable quantum network evaluation testbed.

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References

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