Design and simulation of photonic integrated circuits for multiprotocol and high-dimensional QKD

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Abstract

Quantum integrated photonics (QIP) has arisen as an important platform to implement quantum key distribution (QKD) due to miniaturization and easy interactivity between components [1]. More interestingly, the use of photonic integrated circuits (PICs) as QKD transceivers opens new interesting possibilities for quantum cryptography. On one side, QIP facilitates the implementation of new protocols, such as high-dimensional (HD-)QKD [2], which guarantees a higher level of security while ensuring higher transmission rates. On the other side, PICs support multiprotocol QKD [3], enabling capabilities of operation among different protocols, and allowing simple reconfiguration to adjust to different conditions and scenarios.

In this work, we present the design and development of different photonic integrated QKD terminals for the implementation of both HD-KD [4] and multiprotocol QKD. Additionally, we present and analyse different components required in these devices such as on-chip path-polarization interconverts and modulators. We simulate the behaviour of the proposed circuits and components and establish a security framework analysis for their implementation in real networks.

References

[1] Wang, J., Sciarrino, et al. (2020). Nature Photonics, 14(5), 273-284.
[2] Cozzolino, D., et al. (2019). Advanced Quantum Technologies, 2(12), 1900038.
[3] De Marco, I., et al. (2021). Optica, 8(6), 911-915.
[4] Balado, D., et al. (2019). JOSA B, 36(10), 2793-2803.

Figures

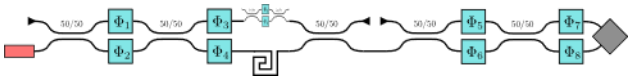

Figure 1: Scheme of a multiprotocol transmitter.

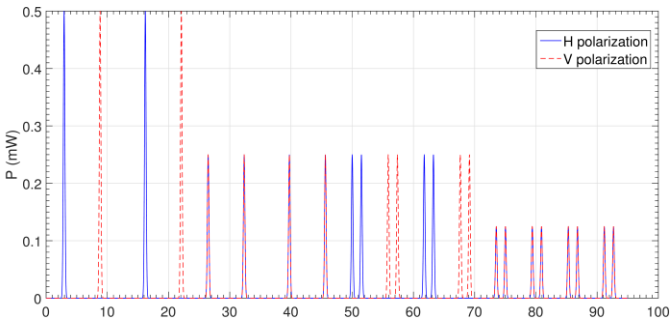

Figure 2: Simulation of emitted states.

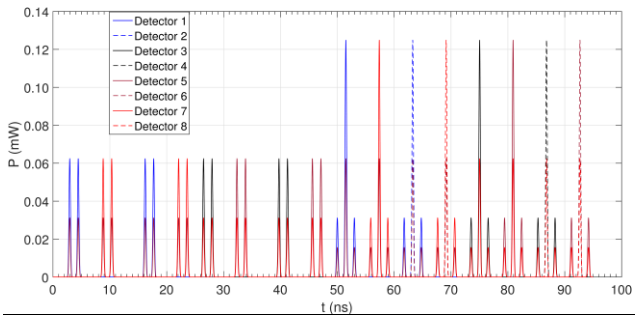

Figure 3: Simulation of detected states.