64-channel Binary-Division Multiplexing of Heralded Photons for Enhanced Generation of Entanglement

Eun Chae Ha[1,2], Se Geon Oh[2], Kwang Yong Song[1,*], and Hee Su Park[2,*]

[1]*Chung-Ang University, Seoul 06974, Republic of Korea*

[2]*Korea Research Institute of Standard and Science, Daejeon 34113, Republic of Korea*

As photonic quantum technologies transition to real-world networking, efficient and scalable quantum light sources are essential to bridge the spectral gap between local nodes and transmission channels. Temporal multiplexing has emerged as a key strategy for generating large-scale photonic quantum states for quantum information processing [1,2]. We investigate a fiber-based binary-division multiplexing scheme, which has been proposed to offer superior loss scaling in high-dimensional systems compared to cavity-based architectures [3,4], for efficient heralded generation of photonic entangled states.

In this work, we implement a 64-channel binary-division multiplexing platform and evaluate its functional performance. Using double-path type-II SPDC processes, we generated two heralded pure-state photons at 1580 nm triggered by 760 nm detections under group velocity matching conditions [5]. These orthogonally polarized two photons are synchronized by a multiplexing network to coincide at a beam splitter for post-selected entanglement generation. The quality of the generated states is verified by quantum state tomography and entanglement measures. This study, despite current experimental loss limitation (~9 dB), provides a foundational framework for high-dimensional quantum state preparation in scalable photonic systems.

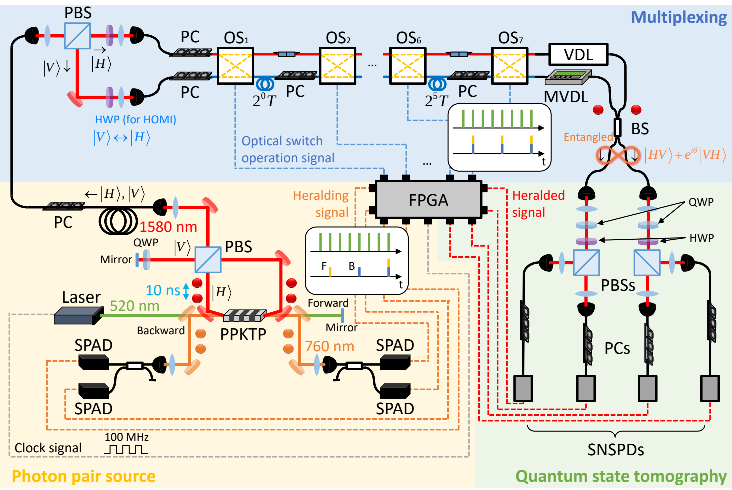

Fig. 1: *Experimental setup.*

Funding acknowledgement

This work supported by the National Research Foundation of Korea grant (2022M3K4A109477513) and the National Research Council of Science & Technology grant (GTL25011-000) by the Korea government (MSIT).

References

[1] F. Kaneda, B.G. Christensen, J.J. Wong, H.S. Park, K.T. McCusker, and P.G. Kwiat, Optica 2, 1010 (2015).
[2] H. Aghaee Rad et al., Nature 638, 912 (2025).
[3] J. Mower and D. Englund, Phys. Rev. A 84, 052326 (2011).
[4] E. Lee, S. M. Lee, and H. S. Park, Opt. Express 27, 24545 (2019).
[5] F. Kaneda, K. Garay-Palmett, A. B. U'Ren, and P. G. Kwiat, Opt. Express 24, 10733 (2016).