# Realization of a Highly Efficient Quantum Pulse Gate in Thin-Film Lithium Niobate

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Photonic quantum information science is an active field of research. Temporal modes (TMs) of quantum light, which encode information in the spectral degree of freedom, have been identified as a promising framework for applications [1]. An outstanding challenge is the efficient manipulation of TMs, which can, in principle, be overcome with the quantum pulse gate (QPG) [2]. The QPG is a device that implements projections onto user-chosen TM superpositions through dispersion-engineered sum-frequency generation. So far, demonstrations were based on traditional lithium niobate waveguides, which yielded low conversion efficiency per pump power. To address this challenge, we implement a QPG in thin-film lithium niobate which leads to an increased efficiency with a lower footprint due to the high-index-contrast waveguides. We benchmark the TM selective operation of our device when acting on the first five Hermite-Gauss TMs and obtain a modal contrast of (96.8±1.7) % (Fig. 1 a)), in line with traditional QPGs. At the same time, we find conversion efficiencies of (89.7±0.1) % for moderate pump powers of 45mW (Fig.1 b)) and see clear evidence of time ordering effects [3], a regime that has been out of reach until now due to the required efficiency. These results open the possibility of large-scale implementation of QPGs in highly sophisticated quantum experiments.

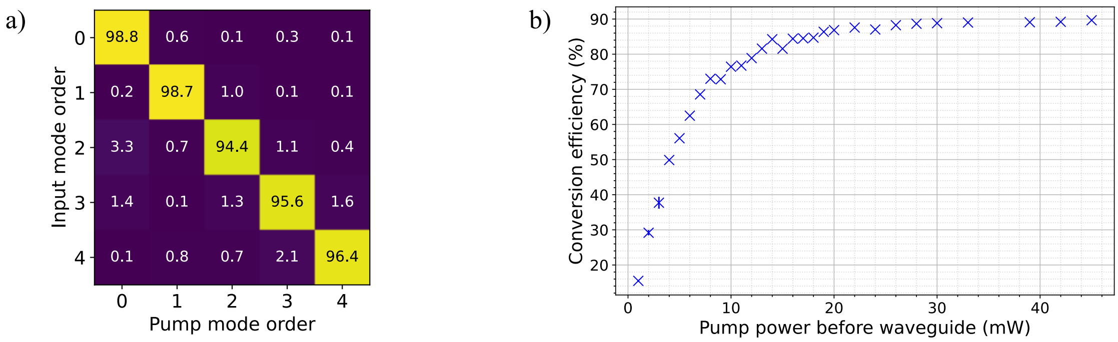


**Fig. 1:** *a) Measured modal contrast. b) Conversion efficiency as a function of the pump power before the waveguide.*

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**References**

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