Optimising Four-Wave Mixing with Temporal Pulse Shaping

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The development of next-generation heralded single photon sources is critical for achieving practical quantum technologies [1]. Spectral purity and brightness are key parameters, but standard sources struggle to optimise both simultaneously. For micro-ring resonator sources on integrated photonic platforms, temporal pump pulse shaping has shown to improve spectral purity above the single pulse limit [2]. Here, we investigate the effect of increasingly complicated pulse regimes formed from two, three, or four interfering pulses on four-wave mixing.

A simulation is used to explore the parameter space of more complex pulse shapes, indicating regions where both spectral purity and relative brightness (relative to a single pulse) are optimised, and also regions with significant improvements to relative brightness. This model informs parameter values for a pulse shaper chip, where spectral purity and relative brightness are measured using stimulated emission tomography [3]. Simulation and experimental data are given in Fig. 1. Current experimental results for the dual pulse case have some deviation from the model but follow the predicted trend.

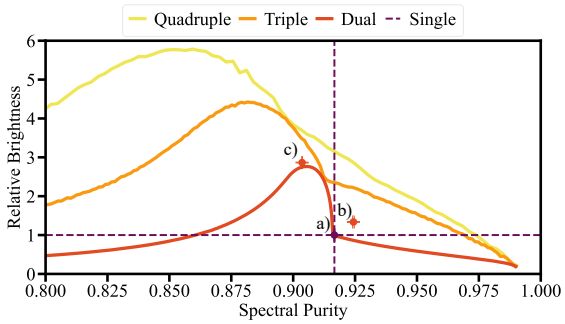

Fig. 1: *Simulation results (solid lines) of the maximum relative brightness for a given spectral purity for various pulse regimes. Single pulse spectral purity and brightness limits are given as dashed lines. Experimental data points are for the single a) and dual pulse b), c), where b) used model parameters for maximised spectral purity at a relative brightness of unity, and c) used model parameters for maximised relative brightness.*

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