Highly pure single photon source on a tuneable ring resonator

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Silicon photonics is believed to be a promising platform for quantum information processing. Single photon sources play a key role in this quest but limited photon quality often still degrades interference in these tasks, limiting operation fidelity. Ring resonators have recently drawn great attention in the domain of quantum photonics as they allow enhancement of pump fields that enables efficient photon generation with high brightness. However, for a single ring resonator, spectral purity is limited to 92% unless spectral filtering or careful device engineering are applied [1]. Recently, it has been shown theoretically that two linearly uncoupled ring resonators can generate single photons within the coupling region, where spontaneous four-wave-mixing can occur [2].

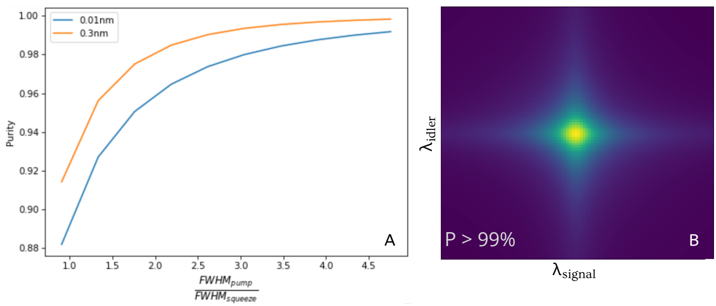

Fig. 1: Spectral purity enhancement in a ring resonator structure. (A) shows an increased spectral purity can be observed when increasing the spectral linewidth of the pump resonance with respect to the single photon generation resonance. The blue and orange lines correspond to pumping the ring resonator structure with a 0.01nm and 0.3nm width laser respectively. (B) Joint spectral intensity of signal and idler photons generated through the non-degenerate spontaneous four-wave-mixing process, yielding a >99% spectral purity.

Inspired by this theoretical proposal, we present a technique for generating single photons with high spectral purity using a fully tuneable add-drop coupled ring structure. This tuneability allows for controlling the coupling to the cavities, and so their spectral linewidths. Fig. 1 (A) shows that increasing the pump resonance linewidth with respect to the photon generation linewidth enables purity enhancement, which can be further increased with a wider pump laser width.

References

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