Cavity-Enhanced Heralded Single-Photon Source

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Many quantum applications involving photons for distributing quantum information are sensitive to loss as well as photon indistinguishability. For many of these use cases, photon pair sources based on spontaneous parametric downconversion (SPDC) are employed, as the photons may be coupled efficiently into single mode fiber. However, high-efficiency fiber coupling requires large beam waists, which lead to low pair generation rates. One solution to this problem is to pump the nonlinear crystals with higher power. However, typical setups are limited by the available power of the pump lasers.

To address this challenge, we developed a singly resonant 775 nm build-up cavity to enable a high-brightness source for down-conversion using SPDC. With this source, we achieve 29.7 ± 0.8 times enhancement, yielding 1.67 ± 0.01 million coincidences per second measured with a 48.3 ± 0.1 % heralded efficiency as detected. This implies a source rate of 7.15 ± 0.07 million pairs per second. Daughter photons generated via SPDC and separated using a beamsplitter (see Figure. 1) yielded a spectral purity is 99.5 ± 0.1 % (Schmidt number of 1.0048 ± 0.0001) through joint spectral intensity measurements. These measurements imply an extremely high rate of indistinguishable single photons for existing and advanced quantum optical protocols.

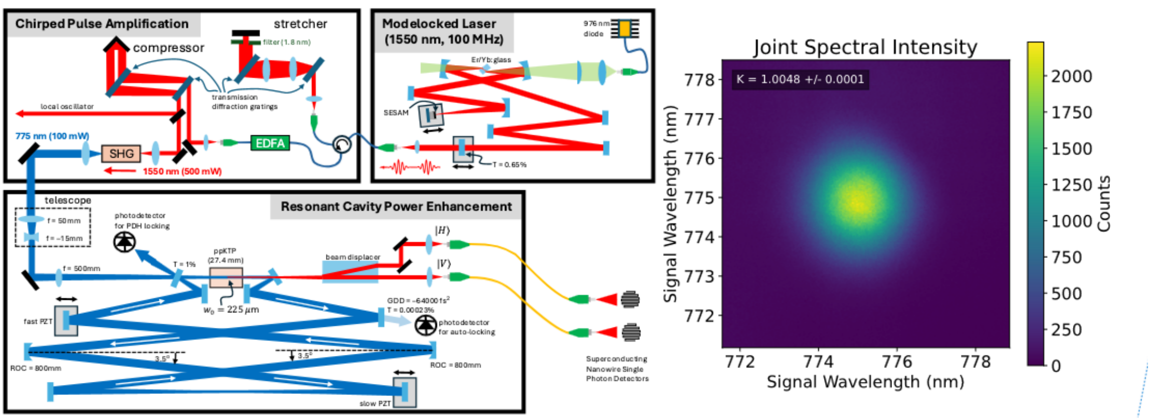

Fig. 1: a) *High-brightness cavity enhanced single photon source. A home-built telecom Er:Yb:glass mode-locker laser uses chirp pulse amplification for spectral filtering and pulse amplification. The output is doubled using a ppLN crystal to produce 75 mW of light at 775nm, which is resonantly coupled to a 775 nm build-up cavity with an intracavity ppKTP crystal to enable high efficiency spontaneous parametric down-conversion (SPDC).* ***b)*** *The joint spectralintensity is then used to assess the spectral correlation between signal-idler pairs produced via SPDC*

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