A high brightness source of polarization entangled photons

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Summary
We present a simple but highly efficient source of polarization entangled photons based on SPDC in bulk PPKTP. Utilizing the highest available nonlinear coefficient in a type 0 collinear configuration, as well as an optimized geometry of the setup, we expect to exceed the brightness achieved in current schemes by at least an order of magnitude.

Motivation
While the use of polarization entangled photons is currently mostly limited to quantum optics laboratories, a commercial implementation of communication protocols utilizing entangled photons may well be possible in the foreseeable future. Many obstacles must be overcome in the pursuit of a global scale quantum optical communication network; one of these is the engineering of sources of entangled photons with sufficient brightness and entanglement visibility.

Entangled photon source
We report on our progress in engineering a compact, high brightness source of polarization entangled photons based on collinear non-degenerate down-conversion emission from crossed type-0 crystals as demonstrated in [1]. With respect to [1], utilizing beta-BaB₂O₄ (BBO), we make use of periodically poled KTiOPO₄ (PPKTP). The proposed crossed crystal geometry allows accessing the largest nonlinear coefficient in PPKTP which is almost an order of magnitude larger than that utilized in previous schemes, such as the type II Sagnac configuration [2]. Using 2x12mm crossed PPKTP crystals and single frequency laser pumping, brightness and visibility in excess of 5 MHz/mW and 95% respectively, have already been achieved. We consider also the option of multimode (free running) laser diode pumping and discuss the consequences for spectrum and achievable brightness. Finally, by combining the larger interaction length of 2x20mm PPKTP crystals with an optimally designed geometric setup, we expect to further improve upon these values and achieve unprecedented brightness, especially valuable to long distance quantum communication links in fiber and free-space.

Fig. 2. (left): Brightness (cps/mW) observed utilizing free running laser diode pump. (right) Brightness (cps/mW) observed with single frequency pump laser diode.

References
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