A single photon source for long distance quantum communication

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Satellite links have a potential to extend the range of quantum communication to a global scale. One of the basic block to achieve this goal is a source of photons which would minimize the negative effects related to imperfect detection techniques and atmospheric turbulences [1]. Photons from the visible spectral range are optimal for this type of communication. On the other hand a fiber based communication requires infrared photons for optimal performance. Therefore, a spontaneous parametric down conversion (SPDC) photon source, which can emit pairs where one photon is in visible and the other in infrared spectral range [2] can be used to connect this two technologies. We present here the SPDC source based on PPKTP crystal, which is designed to produce pairs of photons with wavelengths 532 nm and 1550 nm.

The experimental setup depicted in Fig. 1 consists of two parts: the second harmonic generation (SHG) and the SPDC source. The laser beam of 792 nm wavelength passes through half-wave plate and polarizing beam splitter and it is frequency doubled in BiBO nonlinear crystal. Then the lens L3 focuses 396 nm light inside the PPKTP crystal, which produces 532 nm and 1550nm photons. Next, a dichroic mirror DM separates paths of those photons. The spatial modes are collimated using lens L4. The 532 nm photon is focused by the lens L5 on the plane monitored by a single photon detector (MPD PD-050-CTE) placed onto a XYZ translation stage. A set of bandpass filters (Chroma and Semrock) reflect the unwanted pump beam photons.

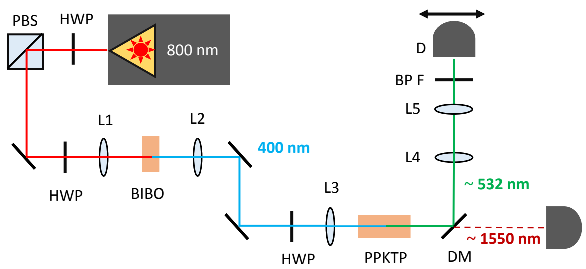

FIG. 1. Experimental setup.

A spatial mode profile of a green photon was characterized by scanning with MPD detector in XY direction. Data points are depicted in Fig. 2(a) (blue dots, error bars smaller than markers' size). As a result gaussian function fitting we obtained the beam waist of green photon beam, which is equal to $w = 123(2)\ \mu$m. The result is consistent with the theoretical predictions and allows for apropriate choise of optics for the best singe mode fiber coupling.

Next, the fiber coupled photons were measured using single-photon-sensitive Triax 320 spectrometer. In this experiment the temperature dependence was examined. The PPKTP crystal was heated in the range from 300K to 340K. The acquired data and the best linear fit is presented in Fig. 2(b). As a result we can clearly see that the temperature change by 1K results in 0.062(1) nm change in green photons wavelength. This value was confirmed by theoretical calculations.

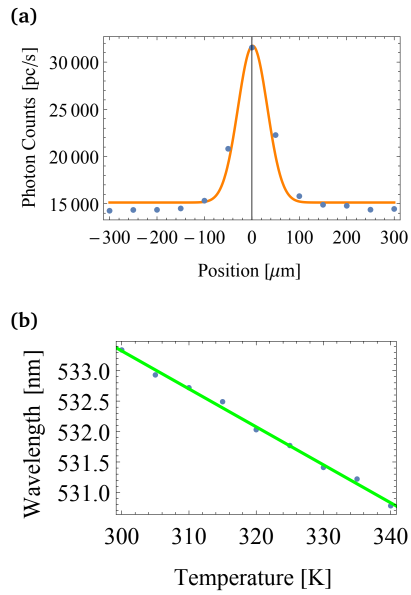

FIG. 2. (a) Measured spatial mode profile and (b) central frequency temperature dependence of the visible range photon.

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