4. Discussion

The triggered SPS in our experiment showed short photon duration, narrow linewidth and 50% polarization contrast, thus benefitting higher repetition rate and signal to noise ratio, and polarization encoding for QKD. The maximum recorded intensity of the triggered single photon source in this experiment reached 16.6 kcounts/s with an excitation laser repetition of 30 MHz. Since the excited state lifetime is short (1.3-1.7 ns), in principle it should support single-photon generation rates up to hundreds of MHz with pulsed excitation rates of GHz. However, these experiments were limited by the 20-ns deadtime of the single-photon detectors currently employed, therefore limiting the repetition rate of the pulsed excitation source to below 50 MHz in order to avoid missing photodetection events. But, with development of new generation single-photon detectors for QKD, a detector with shorter deadtime would be expected to allow high speed single-photon generation.

Modification of the SiV^- sample can be used to raise the collection efficiency and achieve higher photon count rates. By using SiV^- in nanodiamonds, fluorescence collection efficiency can be increased [6]. However, drawbacks include a longer excited state lifetime and wider ZPL emission band for SiV^- in nanodiamonds [6,14]. Another solution is to use solid-immersion lenses (SIL) which allow the collection efficiency to be enhanced 10 fold without ZPL broadening [16,18]. Surface plasmon resonance enhancement provides another solution for generation of brighter single photon sources [27,28]. Each of these solutions build upon the beneficial intrinsic properties of the SiV^- defect, demonstrated here, to enhance the intensity rate of triggered single photon sources.

Chromium-related color centers in diamond are also bright and of similar excitation state lifetime and its quantum yield shifts versus temperature. At cryogenic temperature, it can achieve almost unitary quantum yield, thus have great potential in making great single photon source [29,30]. And recently, a new single photon source in silicon carbide was investigated to be very bright, and is very promising for making excellent single photon source at different band from 648 nm to 677 nm too [31].

5. Conclusion

In conclusion, we achieved a triggered SPS with narrow linewidth, short photon-duration and very low noise using a single SiV- color center under high speed pulsed picosecond laser excitation. The photoluminescence properties of single SiV- promote the value of it for quantum key distribution as the following reasons. Firstly, with careful spectral filtering, the useful narrow spectral emission is easy to be selected from the stray light noise, providing a high signal to noise ratio. Secondly, due to the short photon emission lifetime, high repetition pulsed excitation could be employed to build a fast SPS for high speed QKD. Moreover, narrow time-window analysis on the detection is also compatible with such triggered SPS due to the short photon emission lifetime. Our experimental results promote the value of the SiV-color center for quantum key distribution, and its emergence as a true single-photon source for higher key rate and safety-level photon generation.

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