Introduction

The technology for creation of single photons is attracting sustained attention because of possible applications in quantum cryptography and computation, as well as experiments on the foundations of quantum optics. Several schemes to produce single photons on demand have been proposed ranging from faint laser pulses to optically excited impurities in solids and quantum dots. Single quantum systems show important advantages in comparison with attenuated classical (Poissonian) sources because of the complete suppression of multiple-photon emission events. When a photon is emitted by, for example, a single molecule, the system is projected into the ground electronic state: hence the simultaneous emission of a second photon is impossible. In the recent past, several of such systems have been proposed as single-photon emitters. First attempts have been carried out on single molecules at low temperature [Brunel 1999] as well as under ambient condition [Lounis 2000]; in the latter case, a major drawback is the limited photostability of organic dye molecules at room temperature, whereas in the first case, liquid-helium temperatures are prohibitive for most practical applications. Alternatively, quantum dots have been proposed as emitters: in this case, electrical and optical pumping of single-photon emission has been shown [Yuan 2002; Micheler 2000]; a certain disadvantage is the limited emission wavelength and the requirement of low-temperature operation. One of the few photostable single-photon source at room temperature reported so far is the nitrogen-vacancy defect centre in diamond [Kurstifer 2000]. A serious disadvantage of the N–V defect is its spectrally broad emission band and also the emission wavelength, which is around 640 nm. It is known that certain types of defects in diamond show a much narrower emission range [Zaitzev 2000]: recently, many emitters in the near-infrared have been reported [Steinmets 2011; Aharonovich 2010; Aharonovich 2009; Simpson 2009; Wu 2006], they are interesting for several reasons: the narrow emission line of those colour centres complies a very strong requirement for a good single photon source; the excited state lifetime is shorter with respect to NV centres (1~2 ns compared to 12 ns), allowing a ten-fold photon emission rate upon saturation, moreover a totally polarized emission is observed, which is not the case for NV centres.

In order to observe and extract emission light of this colour centres in diamond a confocal optical microscope must be used. In this communication the realization of such experimental setup in addition to first measures is reported.

Theory: second-order correlation function

The second-order time correlation function, named as $g^{(2)}(t)$ is the most important measure that can be made with this setup. Not only is the clearest signature of single photon emitting behaviour, but is a fast method to known part of the level structure of the colour centre under investigation and obtain the decay rates.

The second-order auto correlation function for an electromagnetic wave is:

$$g^{(2)}(t) \equiv \frac{\langle I(t_0 + t) \cdot I(t_0) \rangle}{\langle I \rangle^2}$$

Considering that the electromagnetic intensity is emitted in photons, intensities can be substituted by emission probabilities: let n_1 and n_2 be the probability of finding the system on the ground or excited state respectively.

$I(t_0+t) = n_2(t)$, because the emission of the first photon (detected by the Start APD) prepares the colour centre on the ground state: $n_2(t)$ is the probability of emitting one photon after the system was prepared on the ground state at time t_0.

$I(t_0) = k\, n_2(\infty)$, because the system starts to count the delay time after the detection of one photon on the Start APD, and the detection of one photon not correlated with time is proportional to the probability of finding the system on the excited level, never minding when the system was