A single photon source using parametric down conversion

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Abstract

The photon number distribution of the gated ` single photon pulses' using several types of detectors is discussed. We found that a photon source with CW pump laser to generate only one photon in a pulse with up to 100% probability when the ratio of the shutter opening time to the pulse width is maintained to 0.001. We also report a high speed (25ns FWMH) high transparency (80%) optical shutter circuit and a optical delay circuit. As a result, we have obtained up to 60% collection efficiency, which have never achieved so far.

Single photon sources will be very important tools for the high-bit-rate quantum cryptography and also for the quantum computers using photons. There have been very active researches to realize single photon sources using small light-emitters like quantum dots, single molecules. Some difficulties, however, may exist in these schemes. One is the difficulty to correct the emitted photons, and another is the wavelength tunability.

A single photon source using parametric down conversion may be an alternative candidate which overcomes these difficulties. We have recently reported a new method to generate parametric fluorescence into two small spots [1]. Because the generated twins are concentrated to the spots, we observed a high single count rate and coincidence count rate per pump power. We also observed that the ratio of coincidence count rate to single count rate was 80%, where the loss at filters and the quantum efficiency of detectors were compensated. This result is important for the application of this method to the single photon generator because we may be able to find a single photon in a gated pulse with up to 80% probability.

In this paper, we discuss the photon number distribution of the gated ` single photon pulses' [2] using several types of detectors including our high-quantum efficiency multi-photon detectors [3]. We found that a photon source with CW pump laser will is possible to generate only one photon in a pulse with up to 100% probability when the ratio of the shutter opening time to the pulse width is maintained to 0.001.

We also report our recent progress of constructing the single photon generation experiment. A high speed (25ns FWMH) high transparency (80%) optical shutter circuit and a optical delay circuit of 300ns with total insertion loss less than 1 dB are examples. As a result, we have obtained up to 60% collection efficiency, which have never achieved so far.

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