Optimizing the Process of Single Photons Coupling into Single-Mode Fibers by Using a Genetic Algorithm and Spatial Light Modulation

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The purpose of the experiment was optimizing the process of coupling single photons into single-mode fibers. The reason I chose polarization-entangled photons was that they are widely used in quantum Physics. They are produced within Spontaneous Parametric Down Conversion type II. Coupling photons into fibers is very challenging due to many variables which impact propagation paths. I decided to optimize the process by modulating the paths by using a Spatial Light Modulator (SLM). The major difficulty was to optimize diffraction patterns displayed on the SLM. To achieve that I chose a genetic algorithm because it requires little knowledge about experimental setup and despite that it is highly efficient. No other algorithm would be so universal. My research shows this algorithm is suitable for all kinds of single-photons optimizing applications. Having done numerous experiments I obtained about 9000 detected single photons/second coupled into the fiber, starting from about 3400 detected single photons/second coupled into the fiber, after running my algorithm for about 2 hours. That confirms the algorithm is time-efficient and increases the number of coupled photons by about 2.5 times. Moreover, it significantly stabilizes the signal. To conclude, the genetic algorithm can be very useful in all types of quantum laboratories using photonic qubits as well as quantum systems using photons, as it lowers operating expenses and saves time. Specialists’ visits will no longer be needed. Automatization of optimizing processes could also increase commercial use of quantum devices. Therefore I intend to continue working on a fully-integral FPGA device.

Awards Won:
Third Award of $1,000