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Development and characterization of a micro-controller based two photon correlation interferometer

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Quantum properties of light are usually characterized by the measurement of the first and second order correlation functions. These correlation functions are estimated from measurements of difference in arrival times of photons striking two single photon detectors. In this presentation, we describe the design, implementation and results of such a correlation interferometer. The device is capable of measuring time difference between the arrival of photons with a resolution of 110ps or smaller. The two photon correlator discussed here was built using two 16 bit micro-controllers, each having an analogue charge-time-measurement unit. The charge-time-measurement unit is an analogue circuitry within the micro-controller that charges a capacitor for a time period. A pulse from one photon detector starts the capacitor charging while a pulse from the other detector stops the charging. The voltage on the capacitor then is proportional to the charging time, in this case the time between arrival of the start and stop pulses. Our system provides the following features: (1) performs a measurement of time differences via the charge-time-measurement unit and produces a histogram of time differences, (2) counts the number of individual photons detected by each single photon detector, (3) detects coincidence events, i.e. photons arriving at the detectors simultaneously, using additional logic gates and (4) provides an interface between the micro-controllers and a user PC running a dedicated software. The system was tested in a lab using fabricated signals simulating classical chaotic light, single photons and light from a coherent source. The system was also tested using photons from a live quantum entanglement experiment where our system was compared to a commercial product. Measurements of the histograms of difference in photon arrival times are presented for both cases. From these histograms the first and second order correlation functions are extracted. Also presented are measurements of coincidence rates.

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