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## Quantum Random Walk Simulator Using Ultrafast Optical Switches

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Quantum random walk processes have many intriguing applications in high energy physics including the simulation of parton shower evolution. We will present the design and initial results of a fiber loop time-bin quantum walk architecture using the hardware platform already in operation at the Fermilab Quantum Network in which the state of the photon is defined by its time-of-arrival. The fiber loop consists of an unbalanced Mach-Zehnder interferometer implemented using an ultrafast electro-optical switch. The input switch controls the photon path within the interferometer, while the output switch will direct the photon back into the interferometer or to single photon detectors to measure the probability distribution of arrival times. Depending on which path the photon takes each pass through the loop, its wave function will interfere on these optical switches similar to quantum interference on a beam splitter. This work is an important step towards utilizing real-world advantages of quantum information protocols to solve problems in high energy physics.

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