Homodyne Detection for Quantum Key Distribution: an Alternative to Photon Counting
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ABSTRACT. We present the principles and preliminary experimental results on a fiber optic QKD system at 1550 nm, that uses balanced homodyning for the detection of a differential QPSK signals.

Present QKD systems at 1550 nm based on APD photon counters suffer from low quantum efficiency and response time due to the quenching process [1]. On the other part, homodyne detection [2] is a promising technique that provides a mixing gain to overcome thermal noise using standard room temperature pin photodiodes with high quantum efficiency and high speed, and allows a variety of key encoding formats. A strong local oscillator is needed and carrier phase synchronization and polarization compensation are required.

In this work we generate a differential QPSK-modulated key interleaved with unmodulated strong pulses that constitute a carrier phase reference. Figure 1 is a diagram of our experimental set up: optical pulses are fed into an unbalanced interferometer: In its longer arm we produce Alice’s fainted QPSK signal with a two-electrode electrooptical modulator. Strong unmodulated pulses pass through the short arm, as shown in Figure 2(a). At Bob’s end, 2-state phase modulation is applied in a similar delayed configuration so that the weak modulated pulse beats with the strong reference pulse, then a balanced photodetection is performed. Figure 2(b) shows the Bob’s Detector 1 output after 11 km fiber propagation. Good detection performances were observed, even in the presence of an unavoidable slow phase drift of the set-up.

![Diagram of quantum cryptography setup](image)

Figure 1 Quantum Cryptography Setup: DQPSK Coherent Homodyne Detection

![Graphs showing QPSK signals](image)

Figure 2 QPSK Signal (a) Alice’s Output; (b) Bob’s Detected Signal