Continuous variable measurement-device-independent quantum communication scheme based on subcarrier waves

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***Abstract*—In this work, we combine the achievements in terms of coherent detection based on the subcarrier wave method and measurement-device-independent approach. For such a scheme we provide a proof-of-principle experiment.**

***Index Terms*—measurement-device-independent, coherent detection, subcarrier wave, continuous variables**

I. Introduction

The need for research in the field of measurement-device-independent quantum key distribution (MDI QKD) is primarily due to noticeable progress in the field of engineering implementation of such systems. However, many questions regarding the practical implementation of the latter remain open. The concept of subcarrier wave (SCW) continuous variable QKD (CV-QKD) studied in this paper is in the context of encoding information at the sidebands of modulated radiation. Such systems can be implemented both in fiber and in free space, on discrete and continuous variables.

II. Description of the optical setup

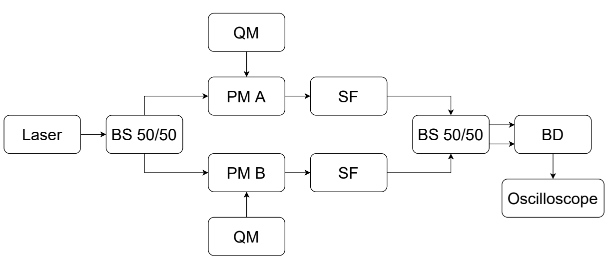

Fig. 1. Optical scheme of the experimental setup. BS is a beam splitter, QM is a quadrature modulator, PM is a phase modulator, SF is a spectral filter, BD is a balanced detector.

The optical scheme of the setup for the experiment is shown in the figure 1. The continuous radiation from the laser is split into a Y (1:2) beam splitter (BS), after which each of the branches (Alice's and Bob's) is subjected to electro-optical phase modulation with a given modulation frequency of 4.8 GHz (a combination of quadrature (QM) and phase modulator (PM)). In this case, the phases in the branches are chosen independently and randomly, as if it were in a QKD protocol. In this experiment, it was decided to fix one of the phases, while discretely or almost continuously changing the second. That is, it is assumed that the phase set by Alice on the "PM A" modulator remains unchanged. Further, the resulting radiation in both branches pass spectral filtering (SF) and, after mixing on a 50/50 beam splitter, go to the arms of a balanced detector (BD).

III. Results

The experiment can be described as follows. Alice sends 4 different states by applying different phase shifts $\{0, \pi/2, \pi, 3\pi/2\}$. Duration of these states is 80 ns and frequency of phase shifting is 100 MHz. On the other hand, Bob chooses only one state with zero phase shift. Interference between signals from Alice and Bob is detected by BD. Also BDs can replace two avalanche single photon detectors that are used in MDI schemes. The output of it is shown in Figure 2. This waveform demonstrates that the outcome voltage has a dependence of phase shifts chosen by Alice and Bob. In cases where the output of balanced detectors is fluctuating around zero, the basis of Alice does not match Bob's one and those results should be extracted from key in QKD protocol by using analog-to-digital converter.

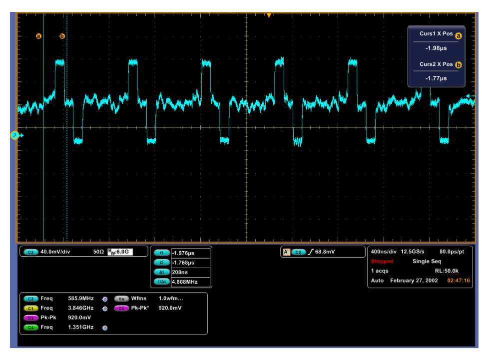

Fig. 2. Outcome waveform from balanced detector with 4 states encoding.

IV. Conclusion

In this work, we have demonstrated the principal possibility of implementing the MDI CV-QKD scheme based on SCW method. Further research will be aimed at assembling a complete scheme of the QKD protocol.

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