

Progress Report

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Introduction

Objectives

- ▶ Study CV-QKD with 4 state discrete modulation.
- ▶ Both simulation and experimental results were obtained.
- ▶ Results were linked to theoretical expected values, not each other (missing detector information to compare simulation to experimental values).

Results in this Presentation

- ▶ Simulation results:
 - ▶ Noise characterization.
 - ▶ Secret key generation rate in function of transmission for two levels of excess noise.
- ▶ Experimental results:
 - ▶ Phase drift compensation.
 - ▶ Noise characterization experiment.
 - ▶ Key distribution experiment with secret key generation rate estimation.

Theoretical notes

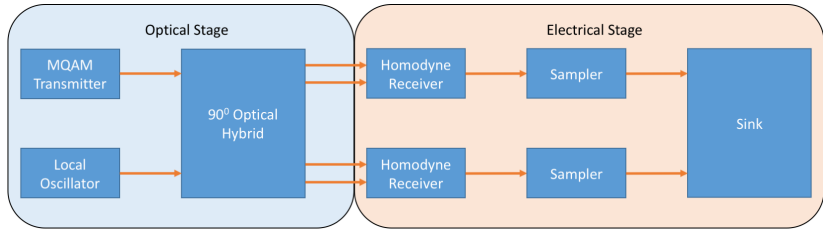
$$\begin{aligned} K &= \beta I(A : B) - S(B : A) = \beta \log_2(1 + \text{SNR}) - S(AB) + S(AB|B) \\ &= \beta \log_2(1 + \text{SNR}) - \sum_{k=1}^2 \left[(\bar{n}_k^{AB} + 1) \log_2(\bar{n}_k^{AB} + 1) - \bar{n}_k^{AB} \log_2 \bar{n}_k^{AB} \right] \\ &\quad + (\bar{n}^{AB|B} + 1) \log_2(\bar{n}^{AB|B} + 1) - \bar{n}^{AB|B} \log_2 \bar{n}^{AB|B} \end{aligned}$$

$$\gamma_{AB} = \begin{bmatrix} (1 + 2 \langle n \rangle) \mathbb{I}_2 & \sqrt{\frac{T}{2}} Z \sigma_Z \\ \sqrt{\frac{T}{2}} Z \sigma_Z & (T \langle n \rangle + 1 + \frac{T}{2} \epsilon) \mathbb{I}_2 \end{bmatrix}$$

$$\gamma_{AB|B} = \left[(1 + 2 \langle n \rangle) - \frac{\frac{T}{2} Z^2}{T \langle n \rangle + 2 + \frac{T}{2} \epsilon} \right] \mathbb{I}_2$$

Simulation

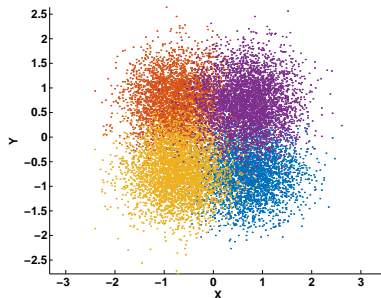
Block diagram



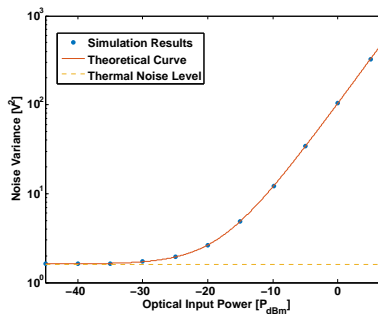
Simulation Parameters

Parameter	Symbol	Value
Detector Bandwidth	B	800 GHz
Symbol Period	T	20 ps
Optical Wavelength	λ	1550 nm
Detector Responsivity	ρ	1 A/W
Detector Gain	g	10^6
Signal Optical Power	P_{Si}	~ 51.26 nW
Local Oscillator Optical Power	P_{Lo}	1 mW
Thermal Noise Spectral Density	N_{Th}	1.610 V ²

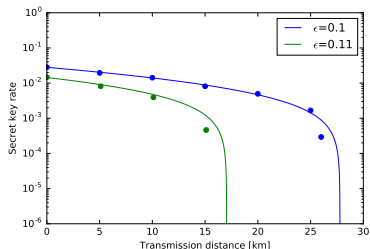
Simulation constellation



Noise characterization

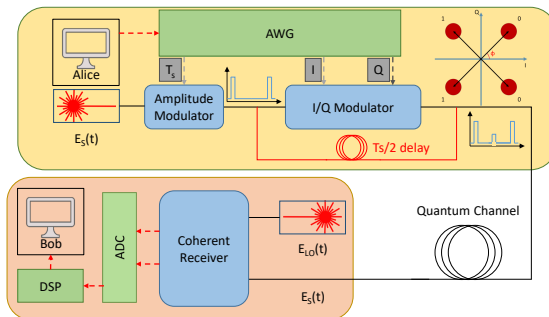


Simulation secret key generation rate



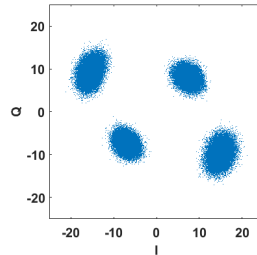
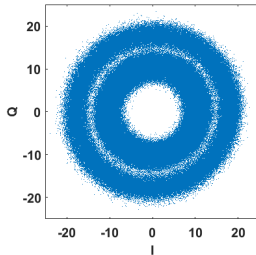
Experimental

Experimental setup

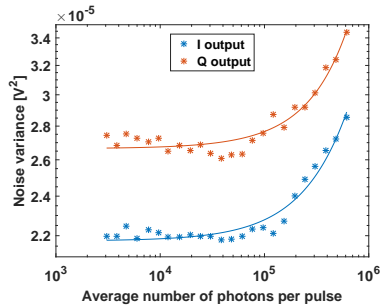


- Laser wavelength, repetition rate, etc.

Phase drift compensation



Detector noise variance characterization



Detector noise variance characterization

The values of these coefficients in the two presented fits are:

$$a_0 = 2.18 \times 10^{-5} \text{ V}^2,$$

$$a_1 = 1.01 \times 10^{-11} \text{ V}^2,$$

$$a_2 = 2.481 \times 10^{-18} \text{ V}^2,$$

for the I output of the coherent receiver and:

$$a_0 = 2.67 \times 10^{-5} \text{ V}^2,$$

$$a_1 = 9.68 \times 10^{-12} \text{ V}^2,$$

$$a_2 = 5.22 \times 10^{-18} \text{ V}^2,$$

Conclusion

