Progress Report

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Introduction

Objectives

- Study CV-QKD with 4 state discrete modulation.
- Both simulation and experimental results where obtained.
- Results where 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

$$K = \beta I(A:B) - S(B:A) = \beta \log_2(1+\mathrm{SNR}) - S(AB) + S(AB|B)$$

$$= \beta \log_2(1+\mathrm{SNR}) - \sum_{k=1}^{2} \left[(\bar{n}_k^{AB}+1)\log_2(\bar{n}_k^{AB}+1) - \bar{n}_k^{AB}\log_2 \bar{n}_k^{AB} \right]$$

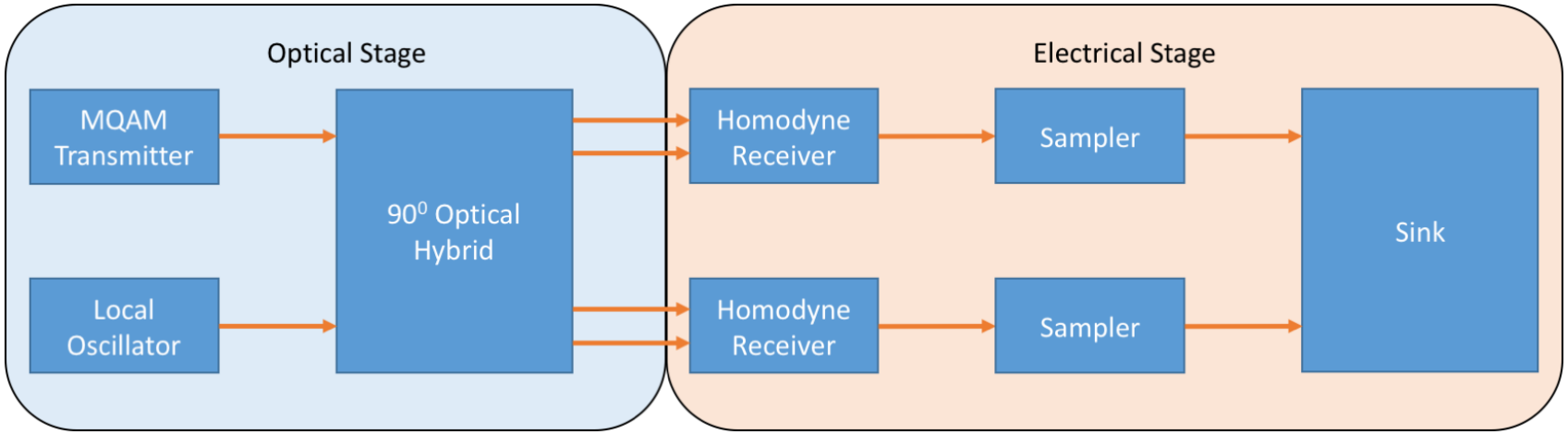
$$+ (\bar{n}^{AB|B}+1)\log_2(\bar{n}^{AB|B}+1) - \bar{n}^{AB|B}\log_2 \bar{n}^{AB|B}$$

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

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

Simulation

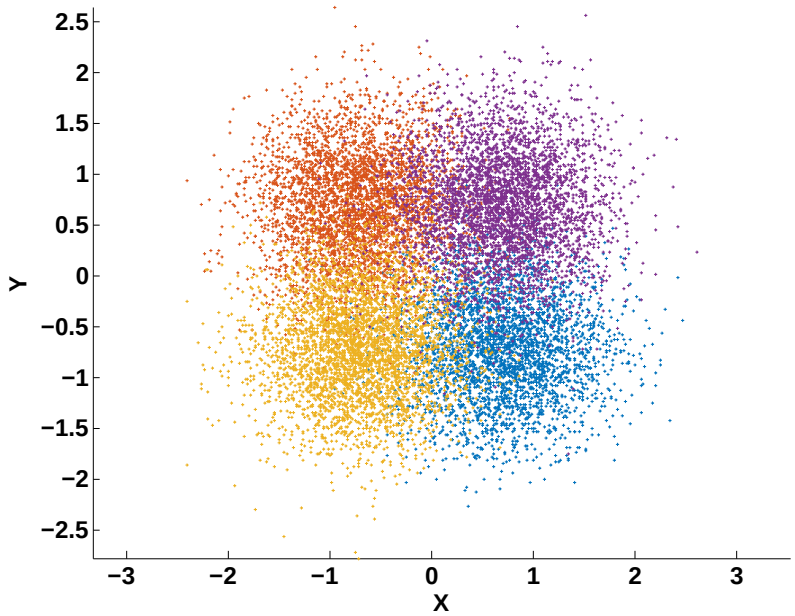
Block diagram



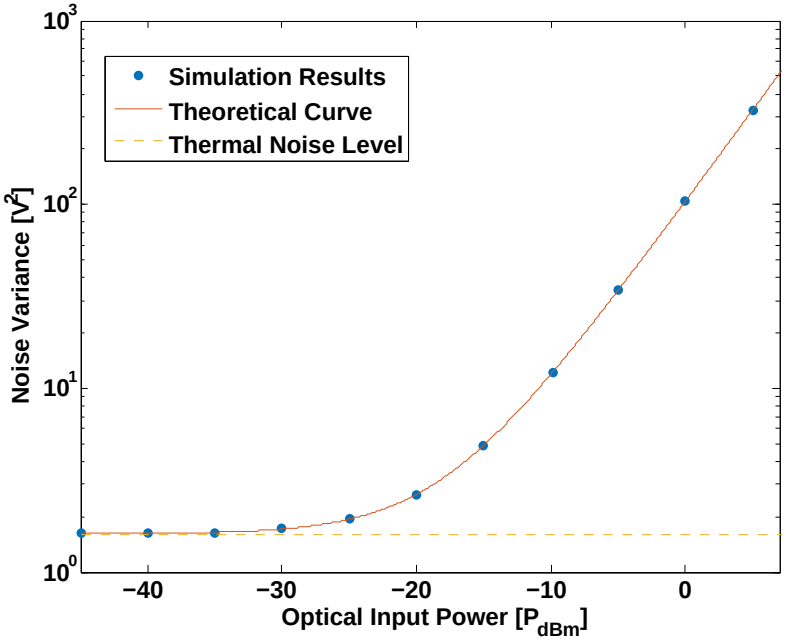
Simulation Parameters

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}	$\sim$ 51.26 nW
Local Oscillator Optical Power	P_{Lo}	1 mW
Thermal Noise Spectral Density	N_{Th}	1.610 V^2

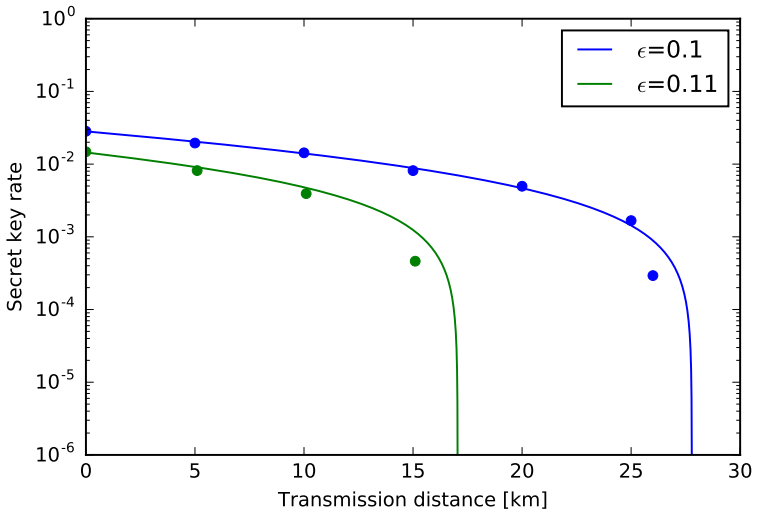
Simulation constellation



Noise characterization

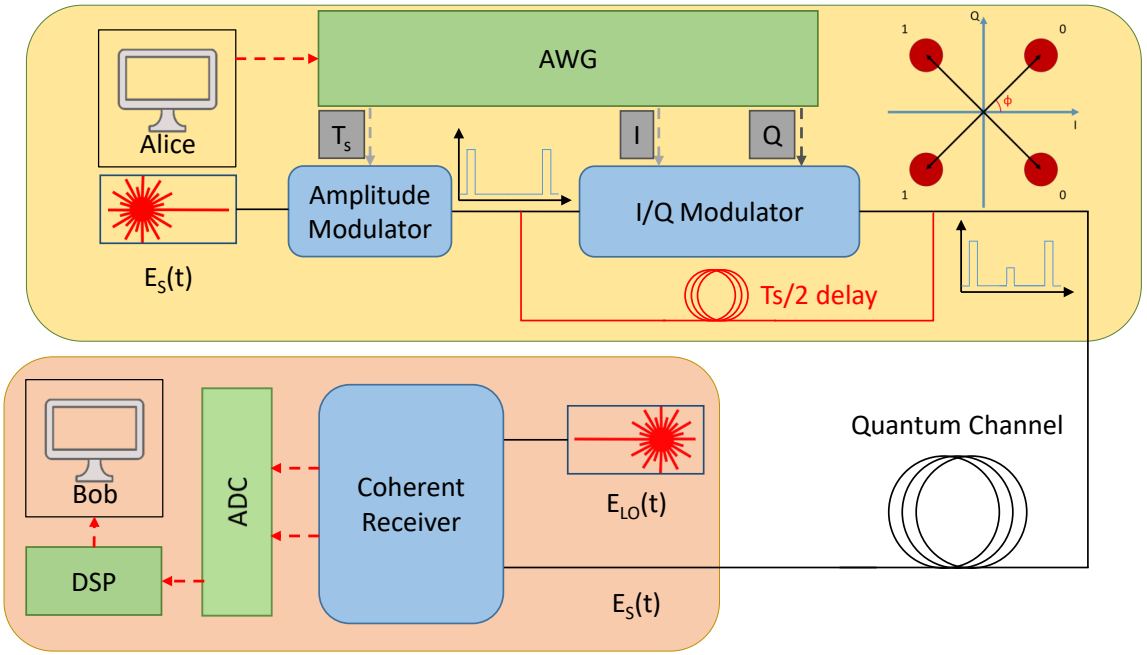


Simulation secret key generation rate



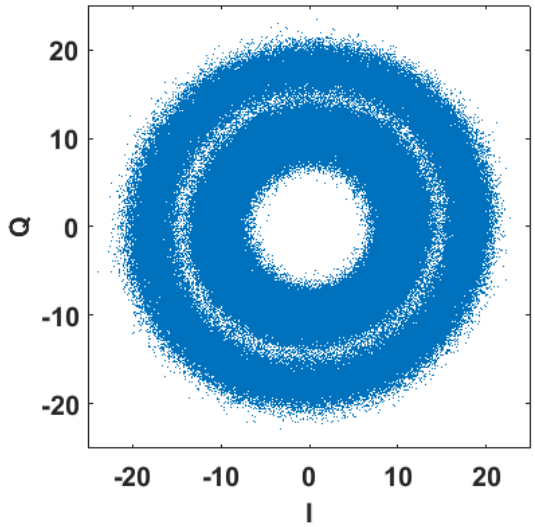
Experimental

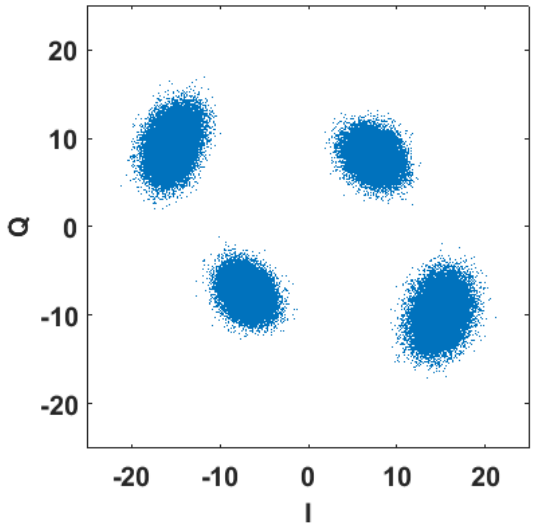
Experimental setup



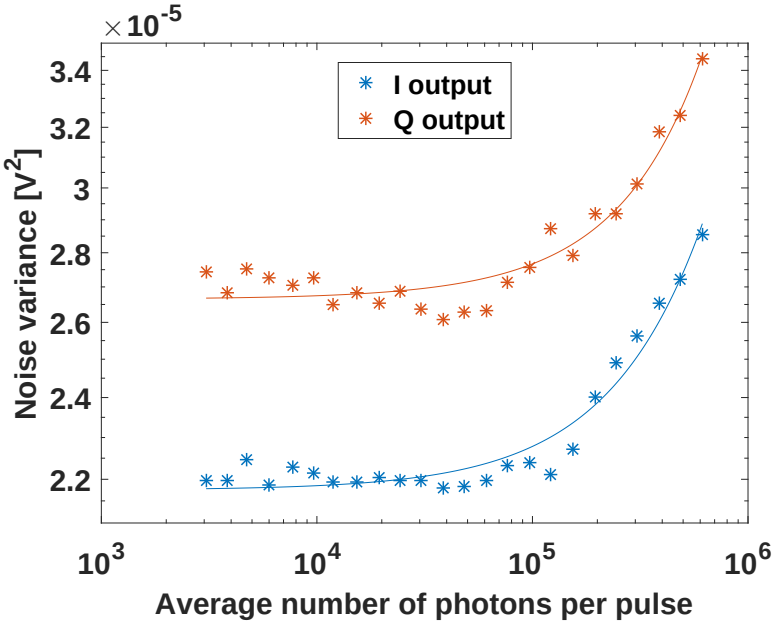
- Laser wavelength, repetition rate, etc.

Phase drift compensation





Detector noise variance characterization



Detector noise variance characterization

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

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

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

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

for the I output of the coherent receiver and:

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

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

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

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Conclusion

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