

# Progress Report

Daniel Pereira

# Index

Introduction

Theoretical notes

Simulation

Experimental

Conclusion

# 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

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

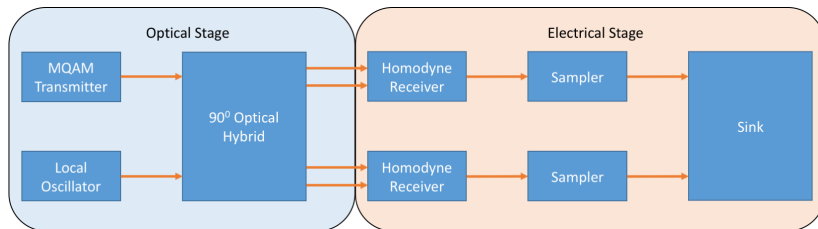
$$\gamma_{AB} = \begin{bmatrix} (1 + 2 \langle n \rangle) \mathbb{I}_2 & \sqrt{\frac{T}{2}} Z \sigma_Z \\ \sqrt{\frac{T}{2}} Z \sigma_Z & (T \langle n \rangle + 1 + \frac{T}{2} \epsilon) \mathbb{I}_2 \end{bmatrix}$$

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



# Simulation

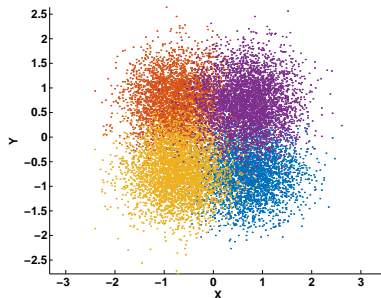
# Block diagram



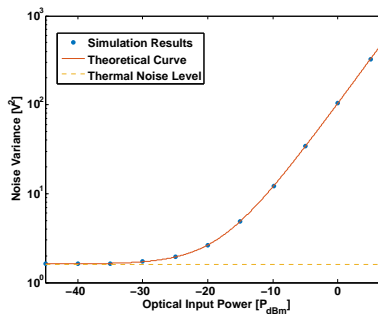
# Simulation Parameters

Parameter	Symbol	Value
Detector Bandwidth	$B$	800 GHz
Symbol Period	$T$	20 ps
Optical Wavelength	$\lambda$	1550 nm
Detector Responsivity	$\rho$	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 <sup>2</sup>

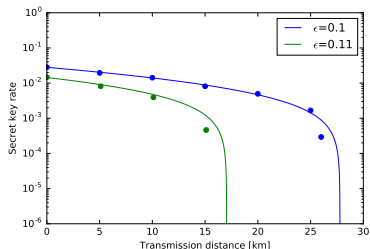
# Simulation constellation



# Noise characterization

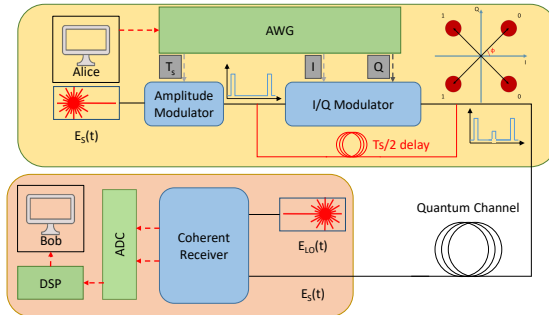


# Simulation secret key generation rate



# Experimental

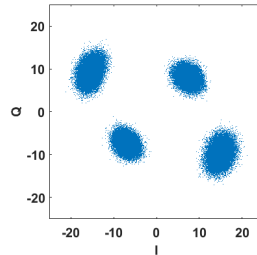
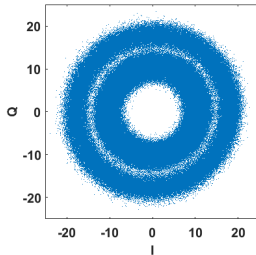
# Experimental setup



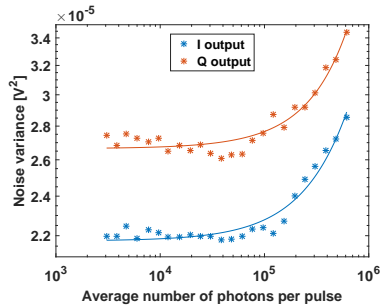
- Laser wavelength, repetition rate, etc.



# 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~~

