# Machine Learning Aided Carrier Recovery in Continuous-Variable Quantum Key Distribution

T Gehring[1], H-M Chin[1,2], N Jain[1], D Zibar[2], and U L Andersen[1]

[1]*Department of Physics, Technical University of Denmark, Lyngby, Denmark*
[2]*Department of Photonics, Technical University of Denmark, Lyngby, Denmark*
Contact Email: tobias.gehring@fysik.dtu.dk

Continuous-variable quantum key distribution (CV-QKD) makes use of in-phase and quadrature modulation and coherent detection to distribute secret keys between two parties for data encryption with future proof security. The secret key rate of such CV-QKD systems is limited by excess noise, which is attributed to an eavesdropper. A key issue typical to all modern CV-QKD systems implemented with a reference or pilot signal and an independent local oscillator is controlling the excess noise generated from the frequency and phase noise accrued by the transmitter and receiver. Therefore accurate phase estimation and compensation, so-called carrier recovery, is a critical subsystem of CV-QKD.

Here, we present the implementation of a machine learning framework based on Bayesian inference, namely an unscented Kalman filter (UKF), for estimation of phase noise and compare it to a standard reference method. Experimental results obtained over a 20 km fiber-optic link indicate that the UKF can ensure very low excess noise even at low pilot powers. The measurements exhibited low variance and high stability in excess noise over a wide range of pilot signal to noise ratios.

The machine learning framework may enable CV-QKD systems with low implementation complexity, which can seamlessly work on diverse transmission lines, and it may have applications in the implementation of other cryptographic protocols, cloud-based photonic quantum computing, as well as in quantum sensing.