# Implementation of Relevant Sensing Protocols Based on Quantum Loss Channel Discrimination

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The Quantum reading protocol addresses the information retrieval from an optical memory, whose generic cell stores a bit of information in two values of the reflectance, modeled as loss channels [1,2]. Thus, it is described in the framework of quantum hypothesis testing and, in particular, quantum channel discrimination, where the final goal is to achieve a quantum advantage over all possible classical strategies. In [1], we have demonstrated theoretically and experimentally that quantum advantage is obtained by combining entangled two-mode squeezed vacuum transmitter and practical photon-counting measurements processed with a simple maximum-likelihood decision. Recently, we have extended the original quantum reading protocol to the case of imperfect encoding of the data [2] and, in general, whenever the loss parameter can be a random variable whose distributions can be eventually characterized. The problem can be reformulated as the task of discriminating between two convex combinations of lossy channels.

In this context, in [3] we introduce a protocol addressing the conformance test problem, which consists in determining whether a process under test conforms to a reference one. We consider a process to be characterized by the set of end-product it produces, which are generated according to a given probability distribution. A small subset of end-products is measured, and a decision on the production process is taken: either conform or defective. Such conformity tests frequently appear in many applications, one example being product safety testing.

More recently, we have investigated experimentally the general multi-cell scenario, where the relevant information can be stored/hidden in complex patterns rather the in each individual cell of memory or individual pixel of an image. Nevertheless, the quantum enhanced readout of the cells is expected to produce a more efficient classification of the patterns. We have considered the problem of handwritten digit classification with a supervised learning algorithm. The preliminary results show a significant experimental advantage in pattern classification.

In summarizing, our experimental findings demonstrate that bipartite quantum entanglement and simple measurements are able to enhance the readout of digital data and the monitoring of a production process. Besides those examples, our work has implications for the identification of patterns in a biological system, in spectrophotometry, and whenever the information can be extracted from a transmission/refection optical measurement.

## References

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