Improving Classical Communication Systems Using Quantum Technologies

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Quantum communications apply fundamental laws of quantum physics to encode, transmit, store and process information. The ability to control quantum systems can trigger a completely new generation of communication systems. By using single or few photons we can address two important challenges in nowadays communication networks: security and capacity.

Over the last few years the Instituto de Telecomunicações (IT) has been actively involved in addressing issues related with quantum communications, through several research projects. In the framework of those projects, we succeeded to implement single and entangled photon sources for cryptographic applications. We are using the four-wave mixing process to obtain heralded single photon sources and polarization entangled photon sources. Entanglement is a non-classical phenomenon, in which two photons behave like one single object even though they are physically apart. Entangled states highlight the nonlocality and non-separability of the quantum world.

After encoding single photons in two non-orthogonal polarization states we implemented a long distance optical fiber quantum bit commitment protocol. That protocol has particular interest for applications such as commercial binding, and user authentication, since it allows solving trust issues when people are not closed to each other. Nevertheless, due to random evolution of the polarization states of the photons inside the fiber, a continuous compensation of those polarizations rotations is needed. We develop a real-time non-intrusive method to compensate for those random rotations. With that, we are able to extract the information encoded in the photons polarization, after they travel in the fiber for several kilometers.

Although security is the most obvious application of single or few photon sources, the use of very low-energy optical signals in optical networks can lead to an increase on the fiber capacity. We are engineering few photon transmission systems to pursue that goal, by increasing the number of bits carried per photon. We should note that nowadays we are using 10^{-5} bit/photon, which is several orders of magnitude below the 1.44 bit/photon pointed out as the fundamental limit.

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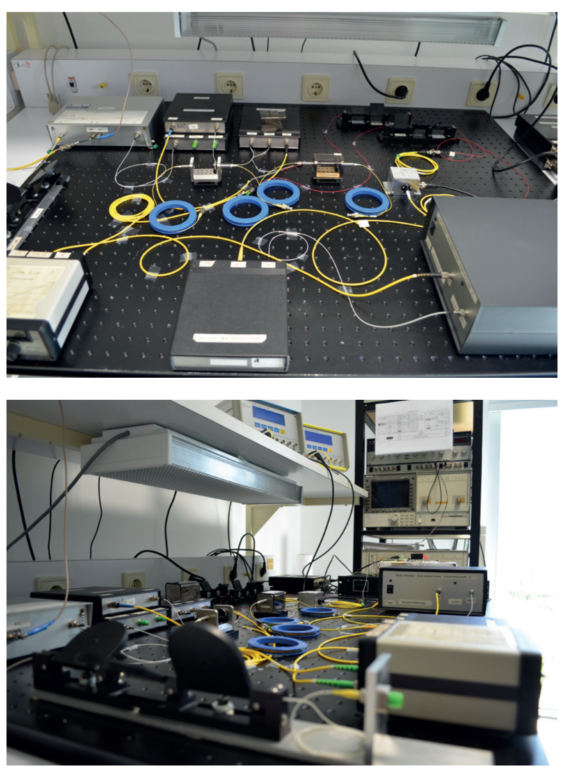

FIGURE 1
Laboratory implementation of the quantum bit commitment protocol.