# Laser-damage attack on QKD systems using 1061-nm pulsed laser


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A full characterization of quantum key distribution (QKD) system is required to guarantee the secure key generation. However, an eavesdropper might also conduct the laser-damage attack [1] by injecting into a system a high-power laser emission which changes optical or electro-optical characteristics of system components, making QKD system insecure. To date, several countermeasures against the laser-damage attack [2, 3] have been experimentally studied only with a 1550-nm high-power continuous-wave laser. At the same time, the mechanisms and nature of damage to optical materials significantly depend on the parameters of the exposing emission: exposure time, emission wavelength, lasing regime (continuous-wave or pulsed), and in the case of the pulsed laser – on the pulse duration, the number of pulses in a train, pulse/train repetition rate [4]. Here, we develop methodology of QKD testing to the laser-damage attack by a 1061-nm pulsed laser (PL) emission and show its operation on the example of fiber-optic isolators, widely used as QKD source protective components.

We developed an easy-to-modified fiber laser system that provides high average powers up to 1400 mW with sub-nanosecond pulse duration and up to 17 mW average power with picosecond duration. The main characteristics of this two PL regimes are in Fig. 1, a and b. Figure 1, c shows the scheme for samples testing. It enables simultaneous exposing of a sample to a 1061-nm laser pulses and measuring of insertion loss or isolation at QKD operating wavelength of 1550 nm.

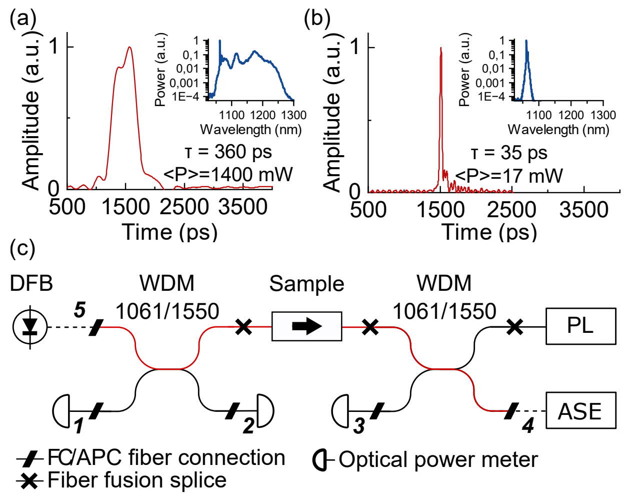


Figure 1: The experimental setup: PL characteristics with sub-nanosecond (a) and picosecond (b) pulse durations; scheme of QKD samples testing (c). ASE, amplified spontaneous emission source; DFB, distributed-feedback laser; WDM, wavelength-division multiplexer; PL, pulsed laser. (Light directions with minimal loss at 1550 nm in the setup are in red).

Several samples of fiber-optic isolators are tested in the experimental setup. We show that while fiber-optic isolator remains still effective against the laser-damage attack by a sub-nanosecond pulsed laser, picosecond laser pulses might harm security of QKD system. With illumination by 35-ps pulses, an average power of only about 17 mW is enough to temporary decrease isolation at 1550 nm by 20 dB. This power might reach and affect the isolator behind the last isolation component if the input PL power is just about 270 − 540 mW and the sample isolation at PL operating wavelength is between 12 − 15 dB. Finally, our study shows that to guarantee security of QKD, it should be experimentally tested under exposure to a wide range of high-intensity lasers. This work was funded from World-Class Research Center Photonics (grant 075-15-2022-315).


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