Investigation of the temperature influence on the mode locked regime of the fiber resonator with dispersion Fourier transformation method

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Mode-locked fiber lasers based on the effect of nonlinear polarization rotation (NPR) are widely used in scientific laboratories as sources of ultrashort pulses [1]. A relatively simple implementation of a fiber laser resonator makes it possible to obtain a source of optical pulses with a duration of the femtosecond range. Unfortunately, the stability of the pulsed radiation of NPR-lasers is strongly influenced by the environment, which limits their use outside scientific laboratories.

A new wave of interest in NPR-lasers from the scientific community is associated with the development of machine learning algorithms that make it possible to effectively control the elements of a laser cavity to stabilize and optimize the parameters of pulsed radiation [2]. The key element of the laser system under the control of the machine learning algorithm is the feedback system, which determines the effect of the control elements on the parameters of the optical pulses.

To measure the stability of the operation of a fiber laser commonly devices are used that average the parameters of the output pulses, which leads to the loss of information of inter-pulse fluctuations. The ability to measure fluctuations of parameters from pulse to pulse will allow the development of laser-adaptive systems with an increased level of stability. The most attractive technique for solving this problem is dispersive Fourier transformation (DFT) of optical pulses, makes it possible to measure the optical spectrum of a single pulse [3].

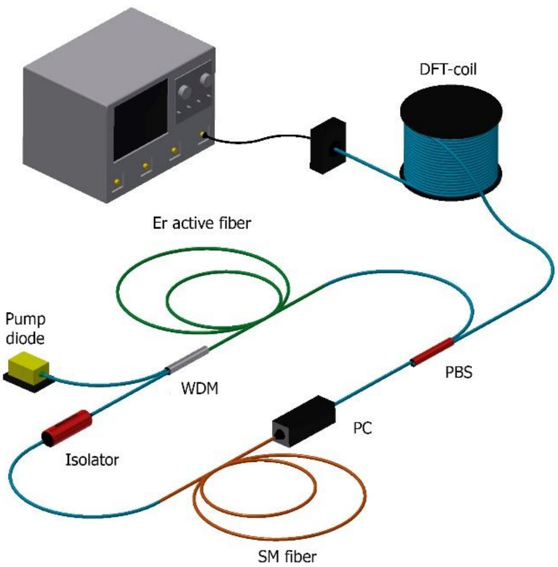

Fig.1. Experimental setup.

In this work, a fiber laser was investigated (Figure 1). An Er - doped fiber (80 cm) was used as an amplifying medium. Pumping is carried out by a laser diode at a wavelength of 980 nm via WDM.

The fiber laser cavity was placed on a heating plate that controlled the temperature of the laser cavity. In the mode of stable pulsed generation at a temperature of 30 ºC, DFT - spectra of optical pulses were measured successively with an increase in the cavity temperature to 41 ºC. (Figure 2) shows the most remarkable pulsed regimes that were established during heating.

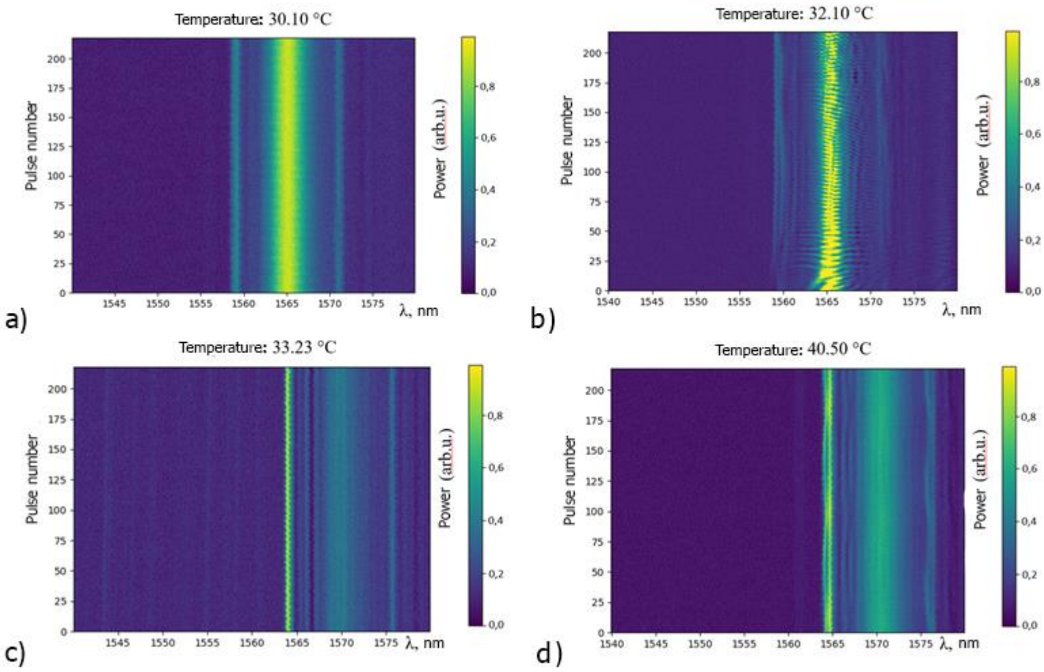

Fig.2. DFT - spectra of pulses versus the temperature of the laser cavity.

To determine the degree of fluctuation of the optical spectrum, the standard deviation of the error between the difference in the optical spectrum of the i-th and first pulses was calculated. The smallest standard deviation for the pulsed mode at 30.10 °C – 30e-3, the largest for the pulsed generation at a temperature of 40.50 °C – 112e-3 (Figure 2 a) and d)). In addition to fluctuations in the optical spectrum, the DFT technique allows one to determine the energy fluctuation from pulse to pulse. When the cavity was heated, the pulse energy varied in the range 1.2 - 2.6 pJ, and the pulse energy spread was from 0.1 - 0.4 pJ.

The results obtained demonstrate that the technique of measuring the dispersive Fourier transform of optical pulses makes it possible to determine the interpulse fluctuations of the energy and optical spectrum under temperature changes in the laser cavity.

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