Abstract—A compact, robust, turnkey femtosecond fiber chirped pulse amplification system is presented. 400-fs pulses are obtained in the broad range of repetition rates and pulse energies up to 10 microjoules at 1.55 micron wavelength.

Keywords—femtosecond fiber laser; chirped pulse amplification; micromachining

I. INTRODUCTION

Fiber lasers continue to replace other laser technologies in many applications. In recent years they also became very popular seed sources of ultrashort pulses. However fiber lasers have fundamental limitations with respect to achievable peak powers and pulse energies. Use of chirped pulse amplification approach mitigates the requirements for fiber nonlinearity.

II. OPTICAL SCHEMATICS

In this work we present femtosecond fiber laser system operating at 1.55 micron wavelength. Optical schematics is shown on Fig. 1 (see also [1,2]).

Radiation from a mode-locked femtosecond seed laser (based on polarization rotation) goes through the circulator and then through the VBG (chirped volume Bragg grating) acting both as a pulse stretcher and compressor. After VBG pulse gets strong positive chirp and pulse duration of approximately 500 ps. Then it goes through Erbium-doped preamplifier A1 and booster A2 (LMA double clad fiber with core diameter 40 μm, both amplifiers are on polarization maintaining fiber), which is pumped by a multimode pump diode through a dichroic mirror M1. Between them an acousto-optical modulator is installed which acts as a pulse picker lowering pulse repetition frequency from ~ 30 MHz to 100-1000 kHz. AOM driver is synchronized with the seed laser. After amplification pulses enter polarization beamsplitter cube. Input polarization is adjusted in such a way as to reflect input radiation again to the VBG through the quarter-waveplate which converts linear input polarization to the circular polarization. Upon reflection from VBG and passing again through the waveplate the radiation is polarized linearly and perpendicular to the input, so it is transmitted to the output by the polarization beamsplitter cube.

Total dispersion of fiber amplifiers is adjusted to be zero to get minimum output pulse duration. This can be done fairly easy because at 1.55 micron fibers with both positive and negative dispersion are freely available.

III. RESULTS

Mode-locked seed laser emits ultrashort pulses with transform-limited duration of 200 fs and spectrum centered at 1560 nm. Peak power of the stretched pulse after the booster was up to 50 kW. After the compressor we obtained 400-fs pulses with energies of up to 10 microjoules at pulse repetition rates from 100 to 1000 kHz. Output beam was nearly single-mode. We attribute the fact that we could not get initial transform limited duration because of VBG having some group delay ripple, and also to the higher order dispersion of the fibers. In energy we were limited by the onset of nonlinearities in the booster fiber. The whole system is packaged in an OEM laser module with remote head and is ready for integration into industrial systems.

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REFERENCES