

Wavelength-switchable spatiotemporal mode-locked multimode fiber laser

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ABSTRACT

Wavelength-switchable spatiotemporal mode-locked multimode fiber laser:

Keywords: Nonlinear Kerr effect, wavelength dependent, self-cleaning

We propose and demonstrate a wavelength-switchable spatiotemporal mode-locked multimode fiber laser, which relies on spatial beam self-cleaning via the nonlinear Kerr effect to attain high pulse energy with near Gaussian output beam shape. Moreover, it is found that the wavelength-dependent self-cleaning behavior observed at different wavelengths has distinct threshold

RESULTS AND DISCUSSIONS

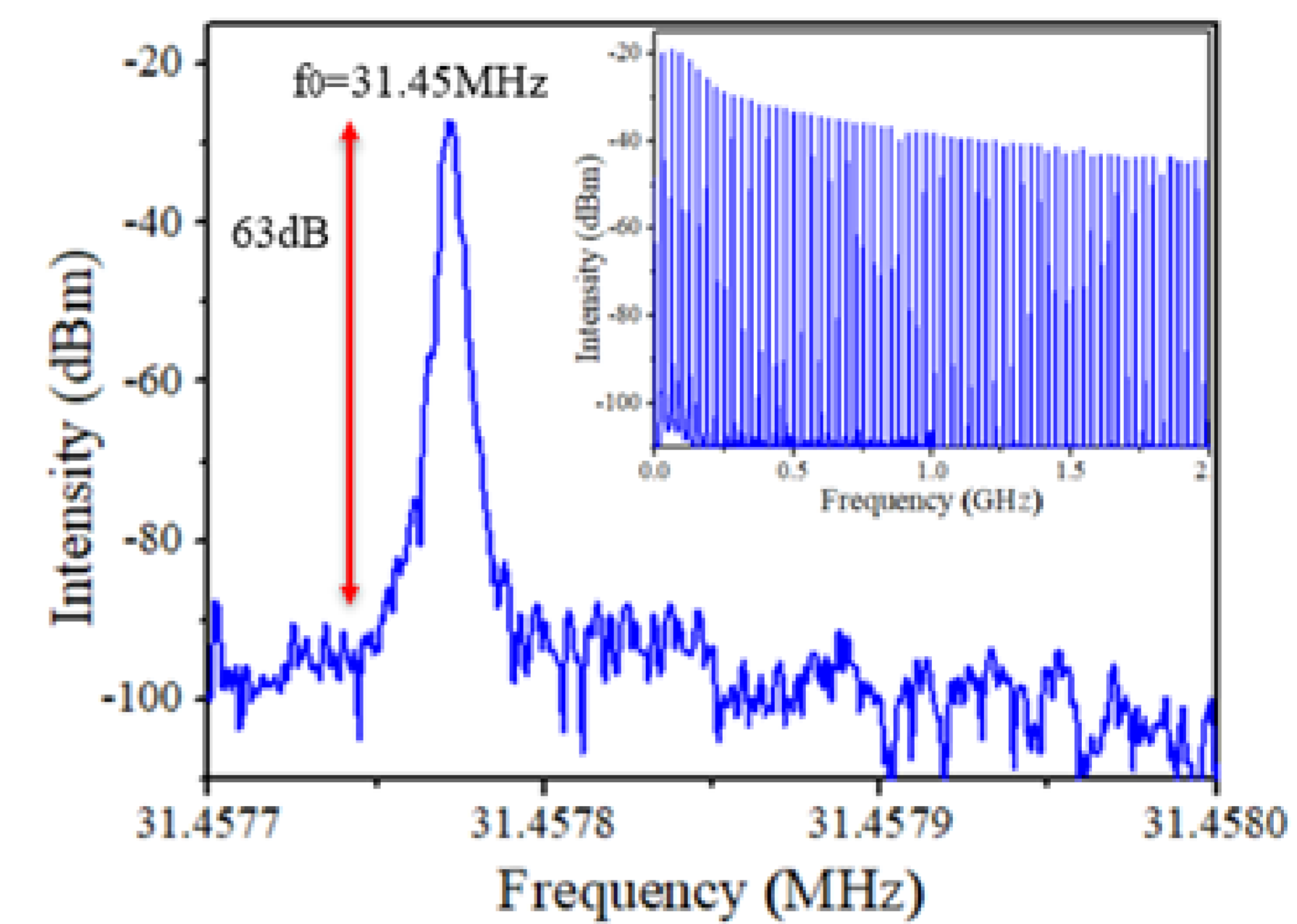
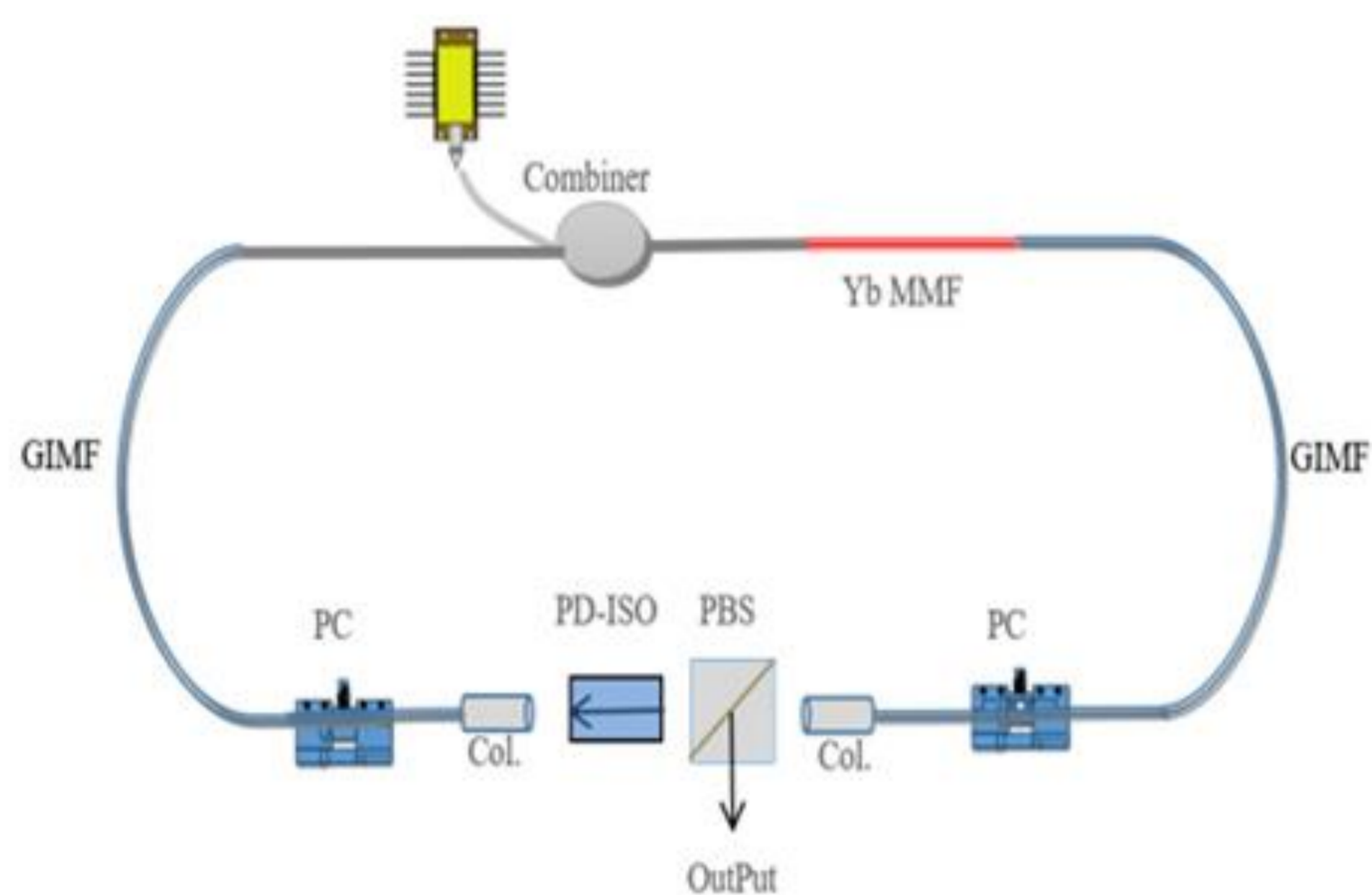


Fig.4. RF spectrum of the mode-locked pulses with 100 Hz frequency span (Inset: RF spectrum with 2 GHz span).

A signal-to-noise ratio of 63 dB is exhibited. The fundamental repetition rate is 31.45 MHz. The inset of Fig. 4 indicates good stability of the laser.

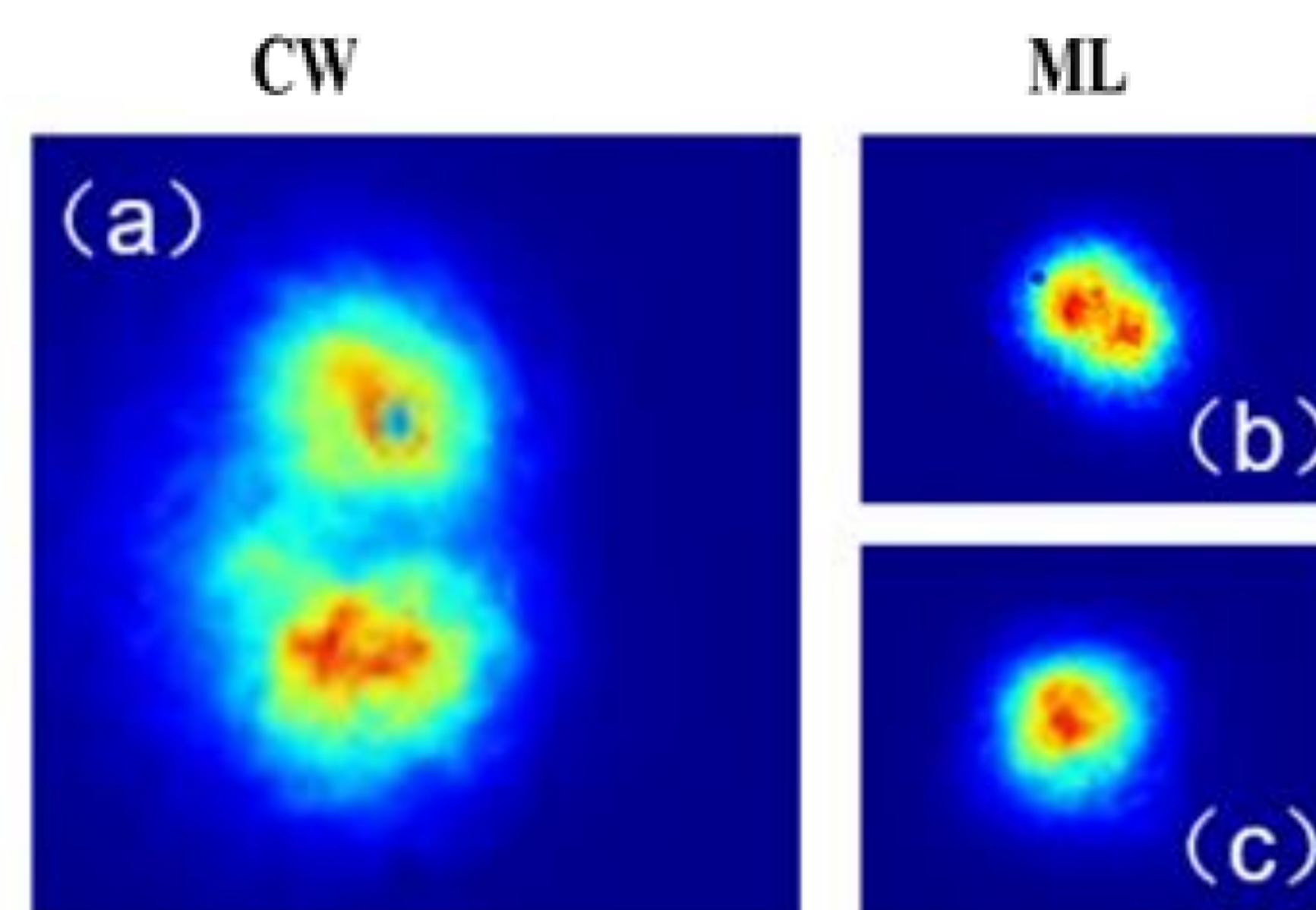
EXPERIMENTAL SETUP



It is an all-normal-dispersion cavity containing a 2.2 m GIMF with 50 μm core diameter, a double-cladding multimode gain fiber of 4.5m. A 915 nm laser diode with maximum output power of 7 W is used as the pump source.

Fig.1. Schematic of the laser cavity. Yb MMF: double cladding Yb-doped multimode fiber; GIMF: graded-index multimode fiber; PC: polarization controller; Col: collimator; PD-ISO: polarization-dependent isolator; PBS: polarization beam splitter.

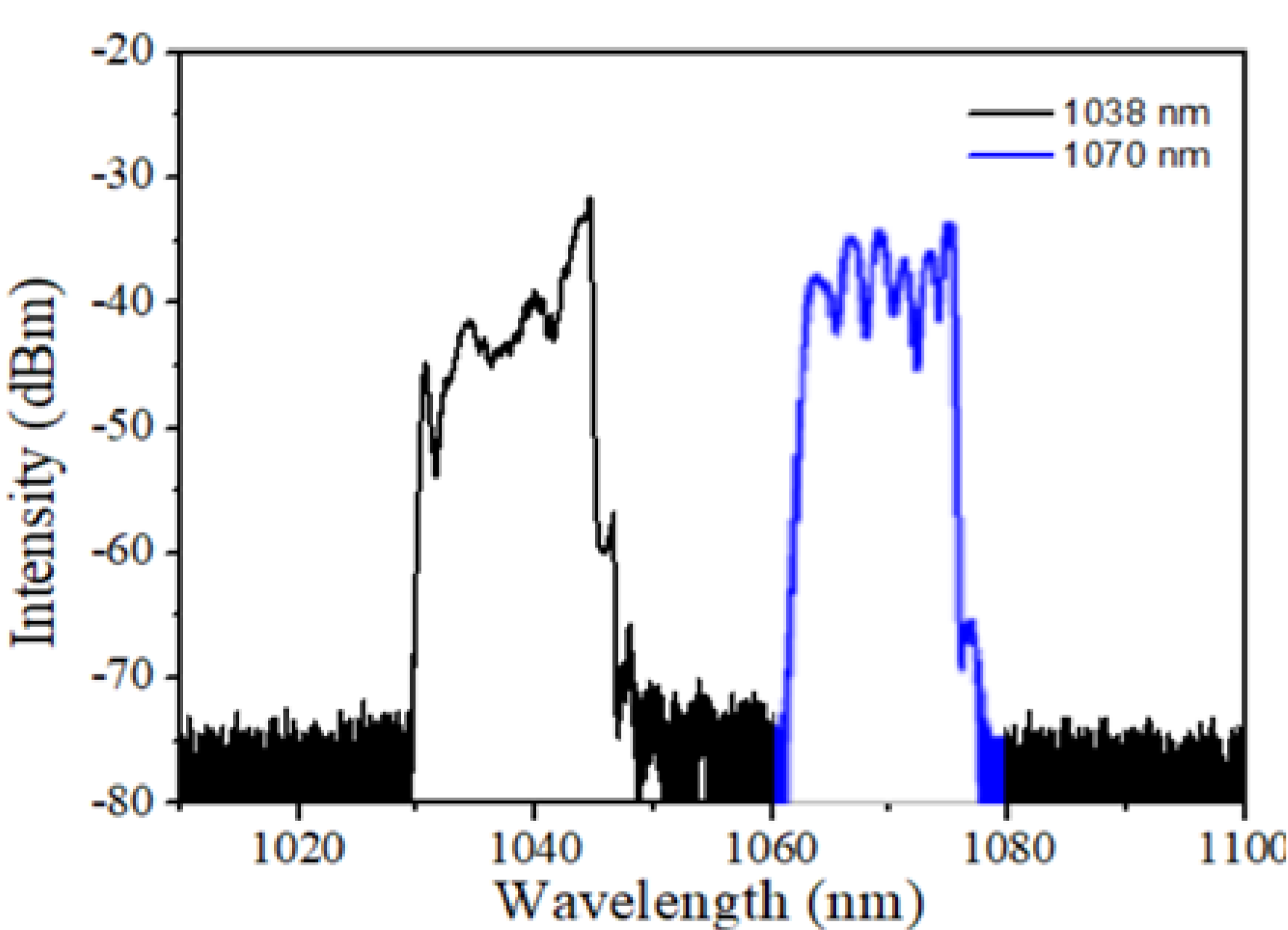
RESULTS AND DISCUSSIONS



When the pulse energy is 5nJ, the output beam is still a high-order mode beam. The output beam will not change to a nearly Gaussian beam profile until the pulse energy reaches 13 nJ.

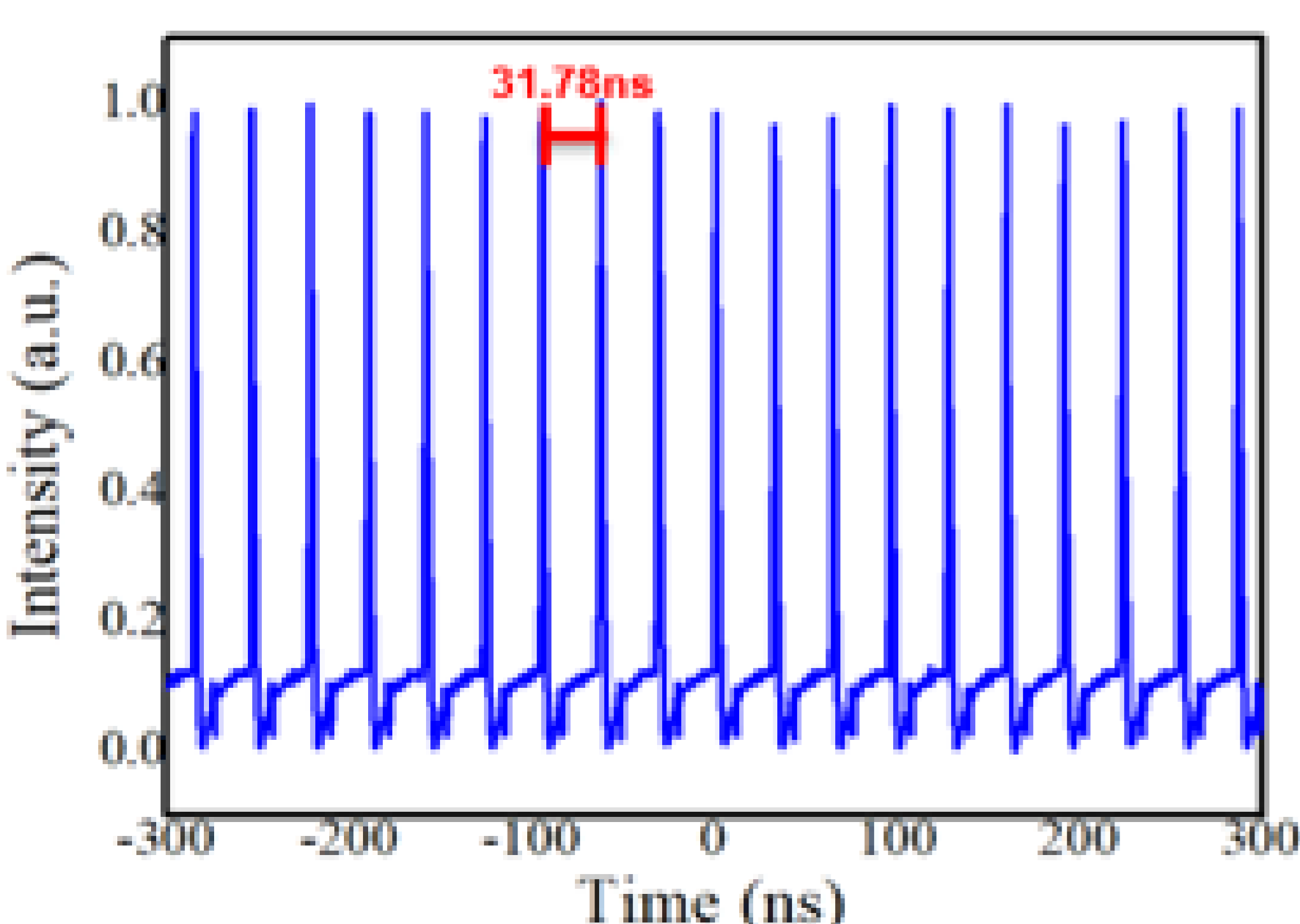
Fig.5. Beam profiles for different output pulse energies at 1038 nm: (a) continuous wave. Mode-locked: (b)pulse energy: 5 nJ; (c) pulse energy: 13 nJ.

RESULTS AND DISCUSSIONS



Self-start single pulse mode-locking can be readily achieved by increasing the pump power to 3.1 W and rotating the PCs in the cavity. The central wavelengths can be switched between two different wavelengths, which are 1038 nm, 1070nm, respectively.

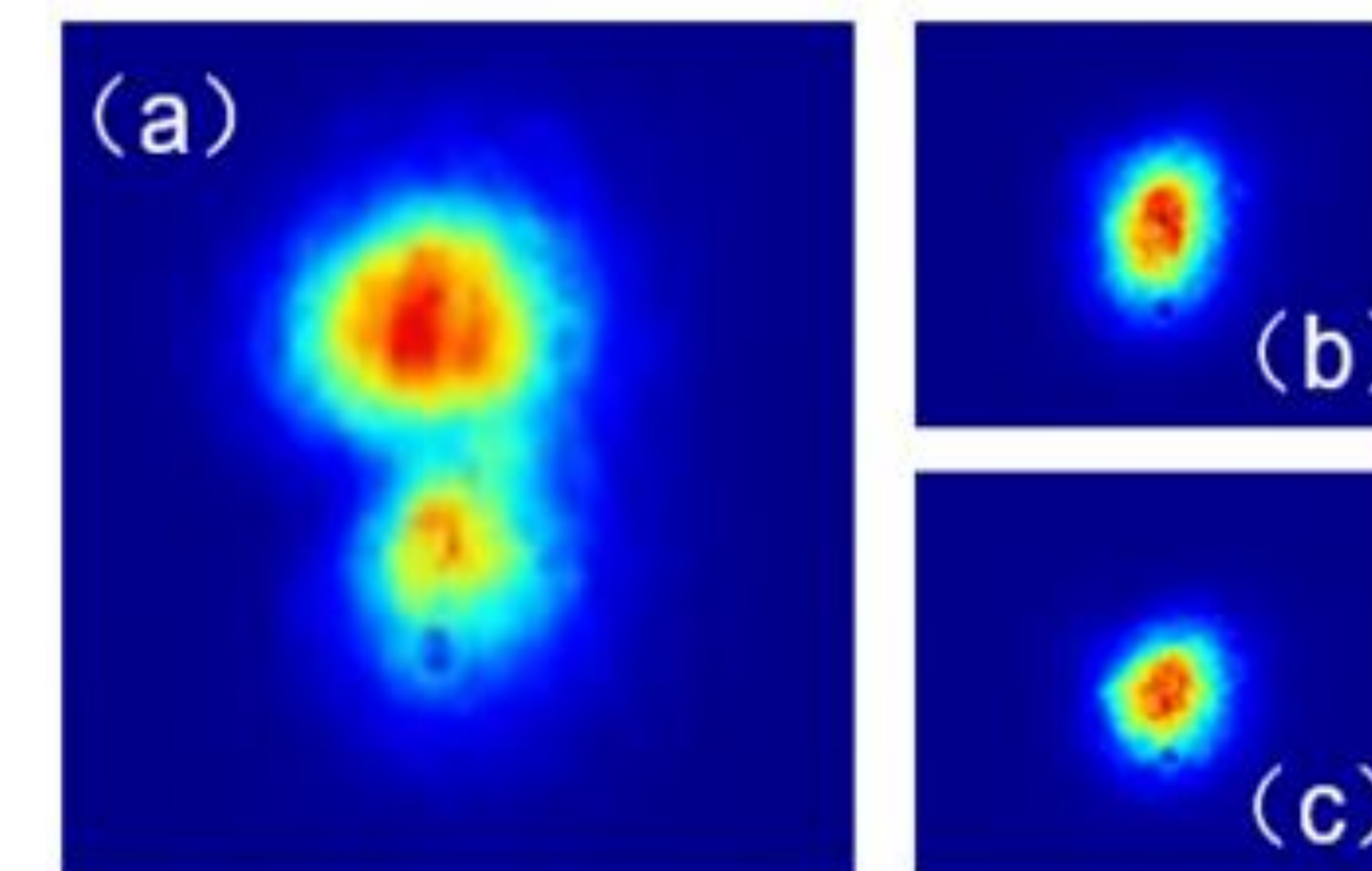
Fig.2. Output mode-locked optical spectra.



When a pump power is 3.1 W, the temporal behavior of the pulse train is shown in Fig. 3. The pulse period is measured to be 31.78 ns.

Fig.3. Output mode-locked pulse train

RESULTS AND DISCUSSIONS



When the pulse energy is 5nJ, the high-multimode beam profile at the continuous wave output is converted to the nearly Gaussian beam profile. the mode-locking output beam profile will be closer to Gaussian beam profile.

Fig.6. Beam profiles for different output pulse energies at 1070 nm; (a) continuous wave. Mode-locked: (b)pulse energy: 5 nJ; (c) pulse energy: 13 nJ

It means that the power threshold for realizing nonlinear Kerr beam cleaning effect is distinct under different wavebands.

CONCLUSION

We propose and demonstrate a multimode fiber laser with high energy and Gaussian-like output beam profile based on Kerr-induced self-beam cleaning. It is found that the pulse energy threshold and pump power required for achieving nonlinear Kerr beam cleaning effect (NL-KBC) is distinct with different wavelength STML.

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