GHz Harmonic Mode-Locking from a Yb-Doped Fiber Laser with Consistently High SMSR

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***Abstract*—We built a mode-locked laser with a base frequency of 150 MHz, which can achieve 7th harmonic mode-locking up to 1.05 GHz by fine-tuning the polarization device in the cavity with high super mode suppression ratio over 70 dB.**

Keywords—high repetition rate; GHz, harmonic Mode-Locking, fiber laser

I. Introduction

Methods for generating GHz repetition rate laser oscillators can be generally categorized into harmonic mode-locking, semiconductor saturable absorber mirrors, and Kerr-lens mode-locking. Among these, harmonic mode-locking is achieved through soliton splitting. When the pulse energy exceeds a certain threshold, it undergoes a process of splitting to form higher-order solitons [1]. In a mode-locked laser, the repetition rate of these higher-order solitons becomes a multiple of the fundamental frequency. Consequently, the repetition rate of the oscillator is not constrained by the length of the resonator.

II. Experiment and Results

Here, we present a laser oscillator with a fundamental repetition rate of 150 MHz and a pump power of 3 Watts. By adjusting the angle of the polarizer within the resonator, we can observe harmonic mode-locking. Remarkably, a super mode suppression ratio (SMSR) of over 70 dB can be consistently maintained from a fundamental mode-locking to the 6th harmonic mode-locking.

The radio frequency spectrum depicting various orders of mode-locked harmonics is presented in Fig. 1, revealing distinct and progressively increasing repetition rates. We can observe an excellent SMSR up to the 6th mode locking. The Fig. 2 shows RF spectrum of the 6th harmonic mode-locking, where the SMSR is greater than 70 dB.

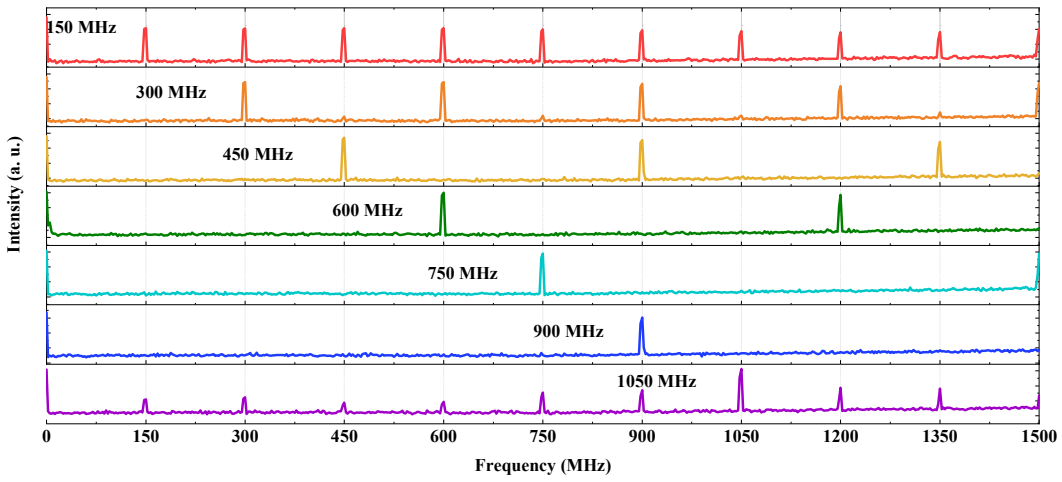

Fig. 1. Radio frequency spectrum of the harmonic mode-locking laser.

This work was partially supported by National Natural Science Foundation of China (61735001, U2031208, 91436210) and BUPT Excellent Ph.D. Students Foundation (CX2023141).

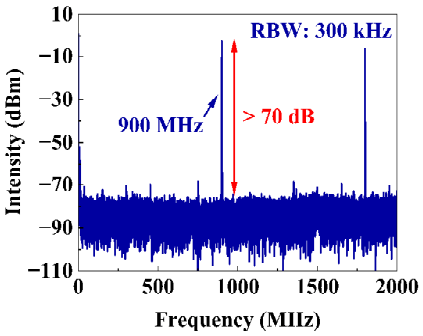

Fig. 2 RF spectrum ranging from 0 to 2 GHz with a resolution bandwidth of 300 kHz.

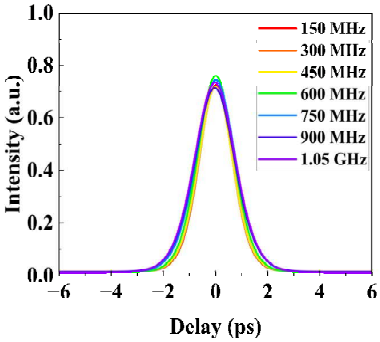

Fig. 3 Autocorrelation traces of different orders of harmonic mode-locking.

As we can see, the seventh harmonic mode locking faces challenges in achieving a suffi cient SMSR due to limited pump power. We be lieve that this constraint may similarly impede the realization of higher-order mode-locking. The pulse width also remains approximately 980 fs, showing a slight increase with higher orders. The repetition rate is expected to be further promoted to several GHz level by increasing pump power, and a shorter pulse width can be ob tained by optimizing the intracavity net dispersion.

REFERENCES

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