Response to Reviewer 1 Comments

The manuscript describes and characterizes a single-mode Yb fiber laser.

The experimental setup is clearly described and some simulations are included. The results are clearly detailed. The manuscript may be useful for a small community, but the applications are really interesting.

Response : Thank you very much reviewers for your comments.

Response to Reviewer 2 Comments

The authors of the manuscript (MS) “Single longitudinal mode ytterbium-doped fiber laser with ultra-narrow linewidth and high OSNR using a double-ring passive subcavity” report the results of experimental characterization of an ultra-narrow linewidth single-longitudinal mode ytterbium doped fiber laser based on narrowband fiber Bragg grating and dual-ring passive subcavity. I believe that this MS can be suitable for publication in MDPI photonics after major revision. My comments on the matter are given below.

Point 1:

Section 1. Introduction:

The authors should improve the abstract by including a discussion on operation regimes of single-frequency fiber lasers: CW, gain-switch, and Q-switch operation modes. The following paper can be cited as an example of Q-switch operation: “Transform-limited pulses generated by an actively Q-switched distributed fiber laser”, Opt. Lett 33 (22), pp. 2590-2592 (2008).

Response 1: We are very grateful to Reviewer for reviewing the paper so carefully. We have made improvements in the abstract and discussed the operating modes of the laser, on line 17, which operates under continuous-wave state. And this reference is cited in line 33 of the article.

Point 2:

Section 2. Experimental setup and principles:

The authors should include the FBG reflection spectrum in this section of MS and also its FWHM in picometers.

Response 2: We have carefully considered the suggestion of Reviewer and make some changes. Figure 1 shows the reflection spectrum of NB-FBG with an FWHM of 101 pm. We inserted the FBG reflection spectrum in line 110 of the manuscript, and labeled FWHM in pico meters.

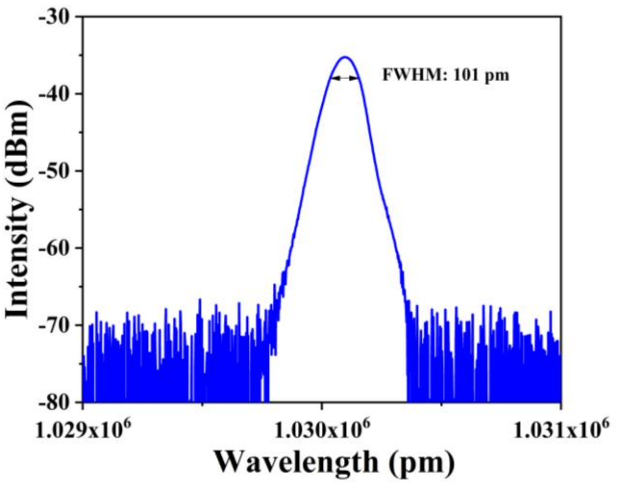

Fig. 1 Reflection Spectra of NB-FBG.

Point 3:

Section 2. Experimental setup and principles:

The authors should discuss the reason of election the laser wavelength 1030 nm.

Response 3: Thank you very much for your suggestions. 1030 nm is a widely used and well-established wavelength in the field of fiber lasers Lasers with 1030 nm wavelengths can be used in the field of spectral synthesis to broaden the spectral range of spectral synthesis. In the field of lidar, it is more suitable as a light source for radar because of its high response coefficient compared to traditional bands. It can also be used for cutting and drilling a wide range of materials, such as metals, plastics, and ceramics.

Point 4:

Section 2. Experimental setup and principles:

The authors should discuss the laser output power vs. pump power and present the correspondent graph.

Response 4: We have carefully considered the suggestion of Reviewer. We discussed the laser output power vs. pump power, and show in Fig. 2. The main reason for the low slope efficiency is the insertion loss of intracavity devices and the fusion loss caused by excessive fusion points.

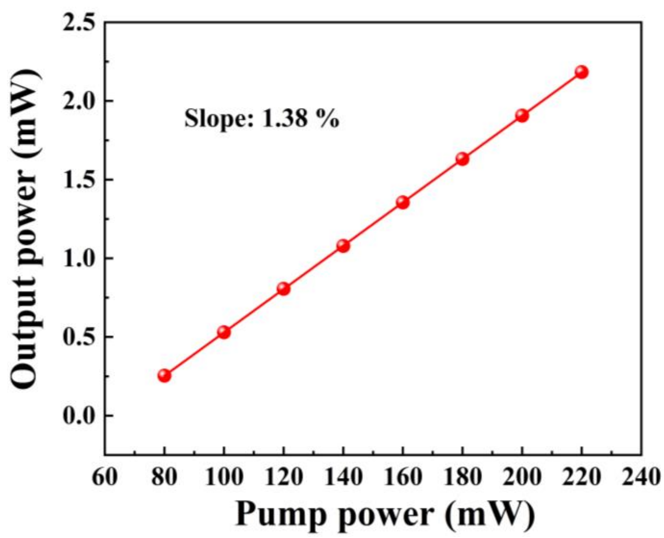

Fig. 2 Laser output power vs. pump power.

Point 5:

Section 2. Experimental setup and principles:

The authors should discuss the laser cavity Q-factor (this parameter was mentioned in the Abstract).

Response 5: Thank you very much for your comments. The laser cavity Q-factor, also known as the quality factor, is an important parameter that characterizes the quality of a laser resonator. A high Q-factor indicates a high degree of energy storage and a low rate of energy loss, which results in a narrow linewidth and high coherence of the laser output. On the other hand, a low Q-factor

indicates a low degree of energy storage and a high rate of energy loss, which results in a broad linewidth and low coherence of the laser output.The fiber laser with short cavity structure limits the energy storage of the gain fiber in the cavity, which is not conducive to obtaining high output power, and the resonant cavity quality factor (cavity Q value) is difficult to improve, so that the linewidth of the laser under free operation is generally above kHz. By using a ring cavity with a relatively long cavity length, the Q value of the resonant cavity of the fiber laser can be increased, which will facilitate the acquisition of narrower free-running laser linewidth. Therefore, optimizing the laser cavity Q-factor is an important consideration in the development of high-performance lasers.

Point 6:

Section 2. Experimental setup and principles:

The authors should discuss polarization effects that can influence the laser operation.

Response 6: We are very grateful to Reviewer for reviewing the paper so carefully. The polarization state of the optical signal is changed by adjusting the PC. The degree of polarization rotation of laser signals with different wavelengths or frequencies after passing through the optical path in the ring cavity is different, so the effect of frequency/mode selection is achieved, while the loss of other longitudinal mode and mode hopping positions increases, which better suppresses MLM and mode hopping at other positions. Due to laboratory conditions, there is no polarization analyzer to measure the polarization state of the laser, so the measurement cannot be performed.

Point 7:

Section 3. Experimental results and discussion:

The paragraph below Fig. 5: The OSA resolution of 20 pm is in the Erbium window only, in the ytterbium window it is about 34 pm, see the OSA manual.

Response 7: We are very grateful to Reviewer for reviewing the paper so carefully. Thank you very much for your comments, we have already marked them in the article. Revised on line 221 of the manuscript.

Point 8:

Section 3. Experimental results and discussion:

The paragraph below Fig. 8: the authors should present the setup of the delayed self-heterodyne used for measuring the laser bandwidth and include some reference on the matter, for instance, “On the delayed self-heterodyne interferometric technique for determining the linewidth of fiber lasers,” Opt. Exp. 14(9), pp. 3923–3928 (2006).

Response 8: We are very grateful to Reviewer for reviewing the paper so carefully. The delayed self-heterodyne device we use is shown in Fig. 3. The laser output linewidth was measured using this device. We refer to this reference in line 253 of the article.

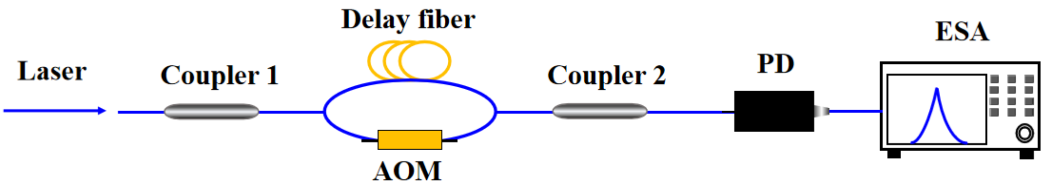

Fig. 3 Schematic diagram of delayed autoheterodyne device.

Point 9: Ref. [21]: the publication year is 1991, not 199.

Response 9: We are very grateful to Reviewer for reviewing the paper so carefully. Due to line breaks, it is not displayed completely. In lines 338-339 in the original text.

Response to Reviewer 3 Comments

The authors reported experimental and theoretical results on an ultra-narrow linewidth single-longitudinal mode ytterbium doped fiber laser based on narrowband fiber Bragg grating and dual-ring passive subcavity. The principle of the proposed scheme are explained and theoretically analyzed. The experimental laser scheme was implemented. The optical signal to-noise ratio is as high as 73 dB and the linewidth is as narrow as 355 Hz at the central wavelength of about 1030 nm. The good long-term stability is measured. I believe that the results are solid and interesting. I have only a few comments and suggestions for the authors.

Point 1: With power scaling, is excellent laser performance expected to be maintained, or is performance expected to degrade?

Response 1: Thank you very much for your questions. With power scaling, the output performance of the laser can be maintained in a good state of operation.

Point 2: What is the achieved slope efficiency?

Response 2: We have carefully considered the suggestion of Reviewer. We discussed the relationship between pump power and output power, and show in Fig. 1. The slope efficiency of the laser is approximately 1.38%.

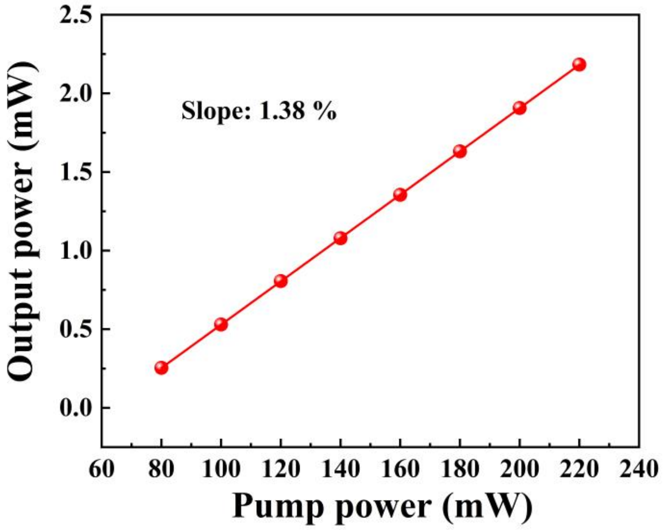

Fig.1 Laser output power vs. pump power.

Point 3: The authors report the lengths of the fiber pieces in the experimental scheme without discussing why such values were chosen and whether they are optimal. I suggest adding a brief explanation.

Response 3: Thank you very much for your comments. The reflection bandwidth of the NB-FBG used in the resonator is about 28.27 GHz at the wavelength of 1030 nm. This requires that the effective FSR formed by the two sub ring cavities be greater than the reflection bandwidth of the FBG, so that a dominant pass band can appear within the reflection bandwidth of the FBG. Through simulation calculation, the cavity lengths of the two sub rings are determined to be 0.49 m and 1.47 m, respectively. In addition, the transmission peak formed by the interference of the long subring cavity satisfies the requirement that the longitudinal mode spacing of the main cavity is greater than one time, and less than twice the longitudinal mode spacing of the main cavity.

Point 4: The authors wrote the OSA resolution is 0.02 nm. So, it is not clear why some values are given with higher accuracy. For example, the central wavelength of 1030.052 nm; or in lines 240-241 "The fluctuation range of the output wavelength and power of the laser is in the range of 0.008 nm m and 0.19 dB…"

Response 4: We have carefully considered the suggestion of Reviewer. This is mainly due to errors caused by OSA resolution. The second is caused by fluctuations in the laboratory environment. Due to laboratory conditions, there is no more precise wavelength testing device for measurement.

Point 5: Some values are given several times. For instance, lines 130-131 and 162-163 duplicates the information that c = 3 10^8 m/s and n=1.47.

Response 5: We are very grateful to Reviewer for reviewing the paper so carefully. We deleted the duplicate parameters in lines 167-168 of the original text.

Response to Reviewer 4 Comments

The authors claim as original a SLM Fiber laser approach that has never been demonstrated before (so far). Assuming that this triply-filtered by a FBG and two nested interferometers is original of them; and in spite of the obvious complexity, that they claim not to exist, as well as the also obvious low conversion efficiency, that they should mention and describe; the results are interesting and useful for future higher power systems.

I recommend a major revision of some sections of the manuscript before a final recommendation regarding its publication. Here my comments:

Point 1: The description of the (three) methods for realizing SLM Fiber lasers are no clear. Two of them are described with too much non-precise and confusing details. Please re-write with clarity. In particular the first one, the linear cavity, is extremely confusing. The third one that is supposed to be described within the same paragraph, is described in the next paragraph.

Response 1: We agree with the reviewer's assessment. Accordingly, throughout the manuscript, We have modified the introduction as follows:

Currently, there are three main categories of cavity structures used to achieve SLM fiber lasers: linear cavity, ring cavity, and composite cavity [5-7]. The linear cavity structure mainly consists of two single-frequency short cavity structures, distributed Bragg reflection (DBR), and distributed feedback (DFB). Linear cavities are favored for their structural stability, high resistance to external interference, and low tendency to mode hopping. However, their use of a short resonant cavity structure limits energy storage in the cavity, resulting in difficulties in increasing the cavity's Q value, which usually leads to output laser linewidths above kHz [8-9]. The ring cavity single-frequency fiber laser is more flexible and convenient in inserting filter elements into the resonator to realize SLM oscillation. Moreover, the longer cavity can improve the Q value of the fiber laser resonator to obtain single-frequency laser output with a narrower linewidth.

Based on your suggestion, we have modified lines 29-40 of the original text.

Point 2: The system that the authors are proposing, clearly is quite inefficient and has a lot of intracavity lossy components and a certain degree of complexity; then, please do not mention that it is simple. As a matter of fact, it is complex and the optical-to-optical efficiency probably is not higher than 1%, taking into account the total insertion loss of all the devices: WDM, CIR, FBG, PC, OC1(90 to 10%), OC2((90 to 10%) and OC3(also 90:10). In the best scenario, the system is providing some milliwatts of average power, while pumping with some hundreds of milliwatts. It is important to know this data, since it is not mentioned within the manuscript.

Response 2: We have carefully considered the suggestion of Reviewer. We discussed the relationship between pump power and output power, and show in Fig. 1. The slope efficiency is

about 1.38%. The main reason for the low slope efficiency is the insertion loss of intracavity devices and the fusion loss caused by excessive fusion points.

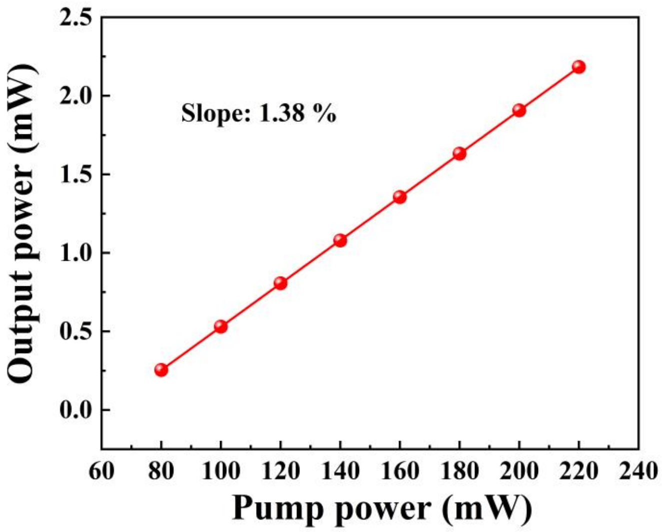

Fig.1 Laser output power vs. pump power.

Point 3: On the other hand, YbDFLS tend to oscillate naturally at 1035 nm. Before these, the Nd:YAGs and Nd:YVO4s crystal lasers established the 1064-nm wavelength as the more efficient and used in the one-micron band. Hence, when Yb doped materials were used to develop lasers, due to the higher efficiency, the were "forced" to oscillate out of their natural oscillations, 10 64 nm, the 1035 that is only 29 nm below was not useful for the uses of 1064; anyway, 1035 do not specially offers any advantage over 1064 nm. Please also do not highlight 1035 nm as a special wavelength that has been ignored, unless there is a strong argument other that being just different (Line 72: "Lasers with 1030 nm wavelengths can be used in the field of spectral synthesis to broaden the spectral range of spectral synthesis"?????; Line 75-78: "However, high OSNR and ultra-narrow linewidth single-frequency fiber lasers at this wavelength are rarely reported. The stable single longitudinal mode laser source at about 1030 nm is indispensable in the above applications. Therefore, it is of great significance to realize SLM YDFL with high performance at 1030 nm wave-length." ????).

Response 3: We agree with the reviewer's assessment. Accordingly, throughout the manuscript, We have modified the introduction as follows:

However, for SLM YDFL with a high-light signal-to-noise ratio (OSNR) and narrow linewidth at 1 μm band, most studies have focused on single-frequency oscillation output at a variety of wavelengths such as 976 nm, 1064 nm, and 1080 nm. The ring cavity single-frequency fiber laser at 1030 nm wavelength is rarely reported. Lasers with a wavelength of 1030 nm can be used in the field of spectral synthesis to broaden the spectral range of spectral synthesis. In the area of lidar, due to its higher response coefficient compared with the traditional band, it is more suitable as a radar light source [17-18]. Therefore, realizing a single-frequency fiber laser with high OSNR, ultra-narrow linewidth, and stable output at this wavelength is of great practical significance.

Based on your suggestion, we have modified lines 71-79 of the original text.

Point 4: The **Discussion** section is redundant as discussions were included in the Experimental-results one. Besides, it reads as **Conclusions**.

Response 4: We have carefully considered the suggestion of Reviewer. Change the title of this section to "Conclusion"， we have modified lines 270 of the original text.