For research article

Response to Reviewer 2 Comments

1. Summary

Thank you very much for taking the time to review this manuscript. All of us authors have carefully read the comments that you have given us, and have discussed and revised each of these issues. The following is my list of revisions. In addition, we have resubmitted a new manuscript in the revised state, with the revisions highlighted in red. If there are any incorrect answers or questions in the manuscript, please do not hesitate to let us know.

2. Point-by-point response to Comments and Suggestions for Authors

Comments 1: In response to Comment #13, the authors claim that the spectrum of the system, which only includes the SOA chip inside the cavity, is identical to the spectrum of the individual SOA chip: "The first experiment involved having an external cavity without an FP etalon. The final spectrum was almost identical to the lasing spectrum of the SOA chip". However, these spectra cannot be identical given the maximum resolution of the spectrometer of 0.02 nm, as the external cavity acts as a filter.

The authors have not provided the spectrum of the system, which includes only the SOA chip inside the cavity, with a resolution of 0.02 nm. At the same time, the authors mention a cavity length of 55 mm, indicating that this spectrum would reveal lines with an intermode spacing of approximately 0.02 nm corresponding to the longitudinal modes of the whole cavity.

Response 1:

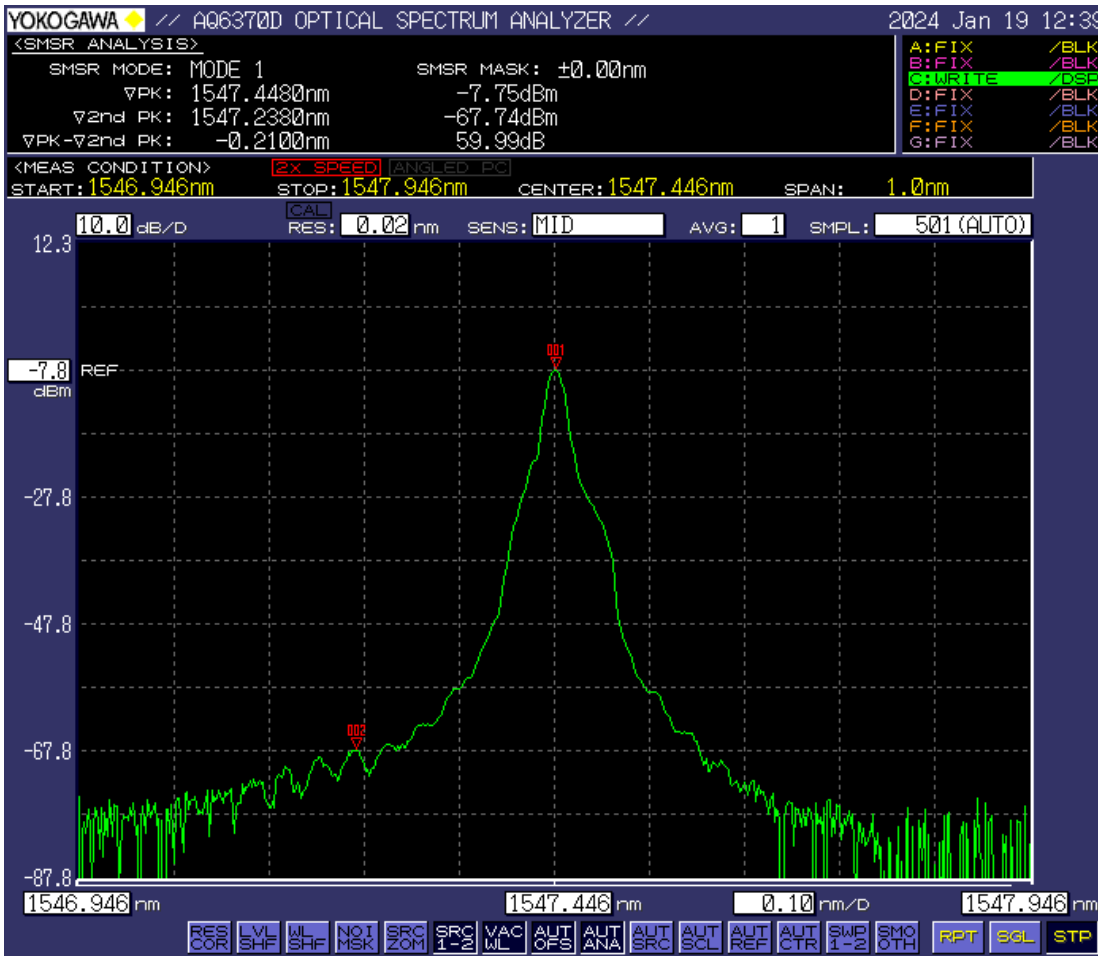
Regrettably, due to operational errors in the last experiment, there are significant issues with the experimental conclusions for the part where the FP etalon was missing. A detailed explanation of this matter will be provided later, aiming to address any misunderstandings.

We selected a filter with a central wavelength of 1549.72nm. In the entire system, excluding the FP etalon, we obtained the final spectral chart under the conditions of 150mA injection current and 25℃ temperature, as shown below:

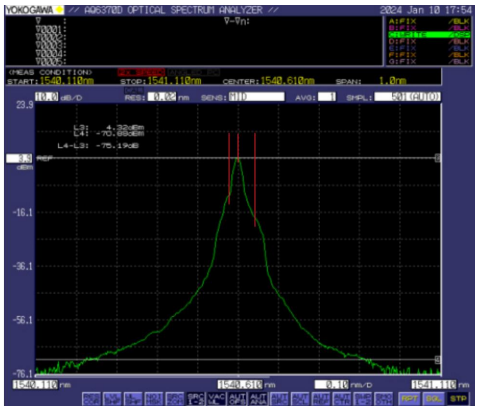


Due to the absence of the FP etalon for preliminary frequency selection and longitudinal mode suppression, the situation with multiple longitudinal modes exists in the absence of the FP etalon. The theoretical longitudinal mode spacing, calculated based on the cavity length, is approximately 0.2115 nm. However, the actual analysis using a spectrum analyzer reveals an interval of 0.034 nm between the '001' and '002' labeled points corresponding to the SMSR at this time. Based on the lines labeled 1 and 2, the calculated longitudinal mode spacing is approximately 0.0352 nm. Considering the inherent errors introduced by various device parameters and real-world conditions, the actual longitudinal mode spacing is deemed to be consistent with the theoretical calculation. At this point, the SMSR is only 0.04dB.

Moreover, when we continuously change its operating temperature through the TEC, it results in various spectral changes. The following figure illustrates the spectrum obtained when continuously adjusting the control temperature to achieve the best effect. Although, at this point, the SMSR obtained through spectral analysis is approximately 60 dB, it is evident that there are multiple modes to the left of the '002' marker. In addition, in a system without an FP etalon, the presence of multiple longitudinal modes persists, and even subtle temperature fluctuations can lead to a sharp change in SMSR, demonstrating poor actual performance and failing to meet the expected requirements.



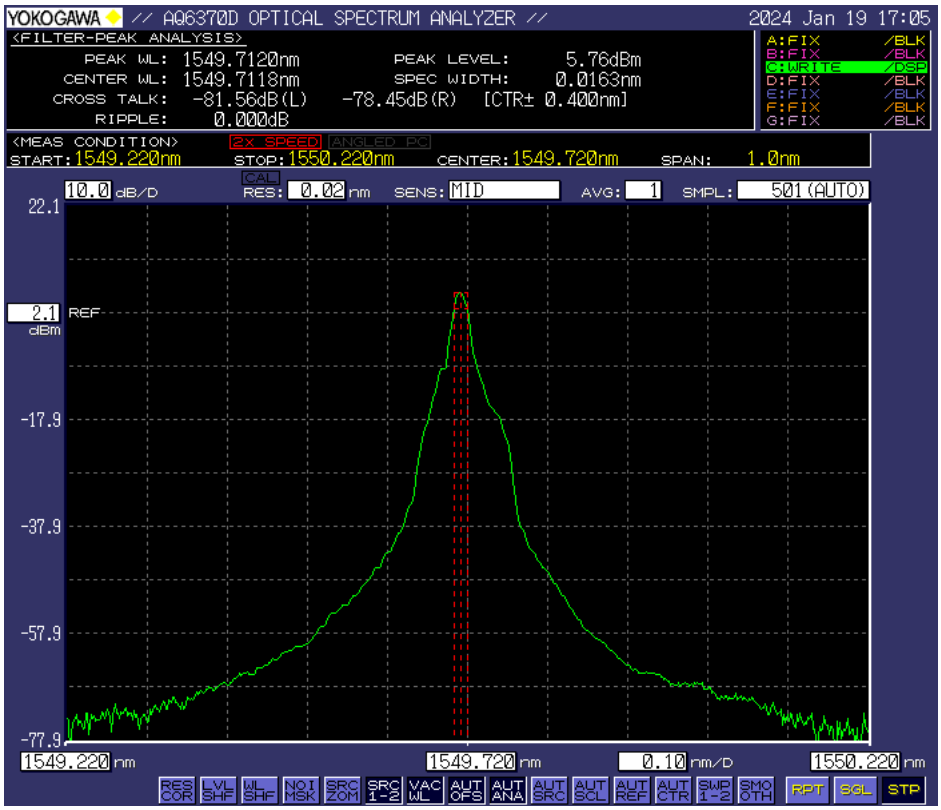
Comments 2: In response to Comment #13, the authors presented the resulting spectrum of the entire system, including the etalon and filter, with a resolution of 0.02 nm. In this high-resolution spectrum, the longitudinal modes are visible, indicating that the SMSR is around 12 dB, not 70 dB as stated in the abstract. Furthermore, the authors do not provide this high-resolution spectrum in the revised version of the manuscript.



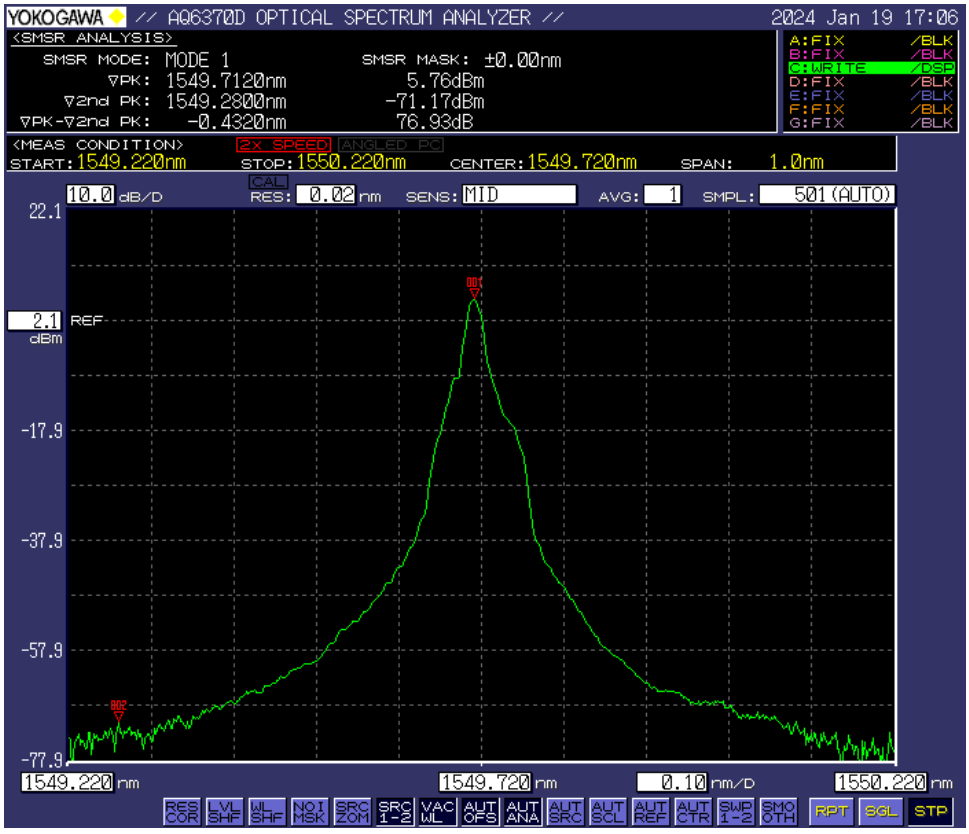
Response 2:

Firstly, this spectrum represents the lasing spectrum of the final system, with an SMSR far exceeding 12 dB, approximately 75dB in actuality. To substantiate this, we retested using an FP-ECDL with a central wavelength of 1549.72 nm. Under conditions of 150 mA injection current, operating temperature of 25°C, and a wavelength resolution of 0.02 nm with a 1 nm

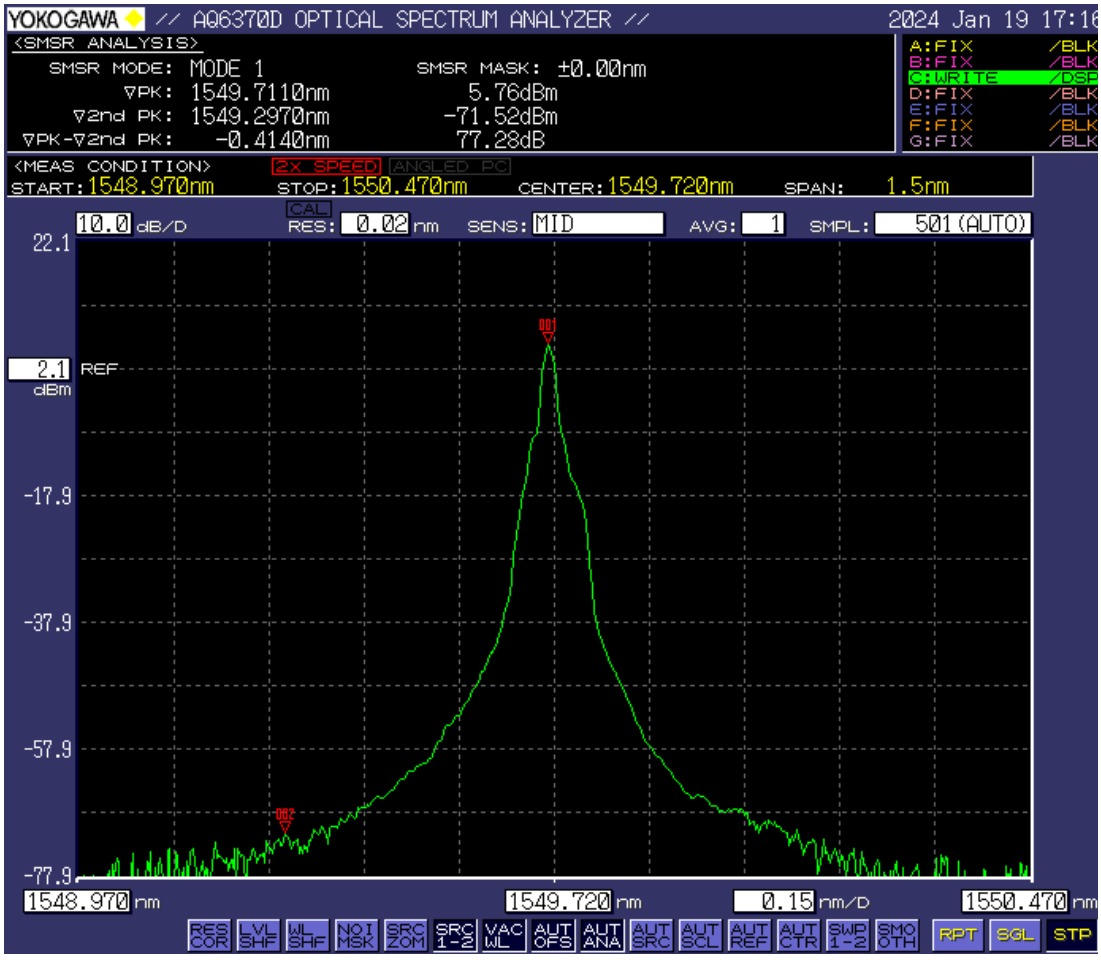
SPAN on the spectrum analyzer, the resulting lasing spectrum is as follows:



The SMSR is defined as the energy level difference between the main peak and the highest side peak. Through spectral analysis using a spectrum analyzer, the SMSR is determined to be 76.93 dB, as shown in the figure below:

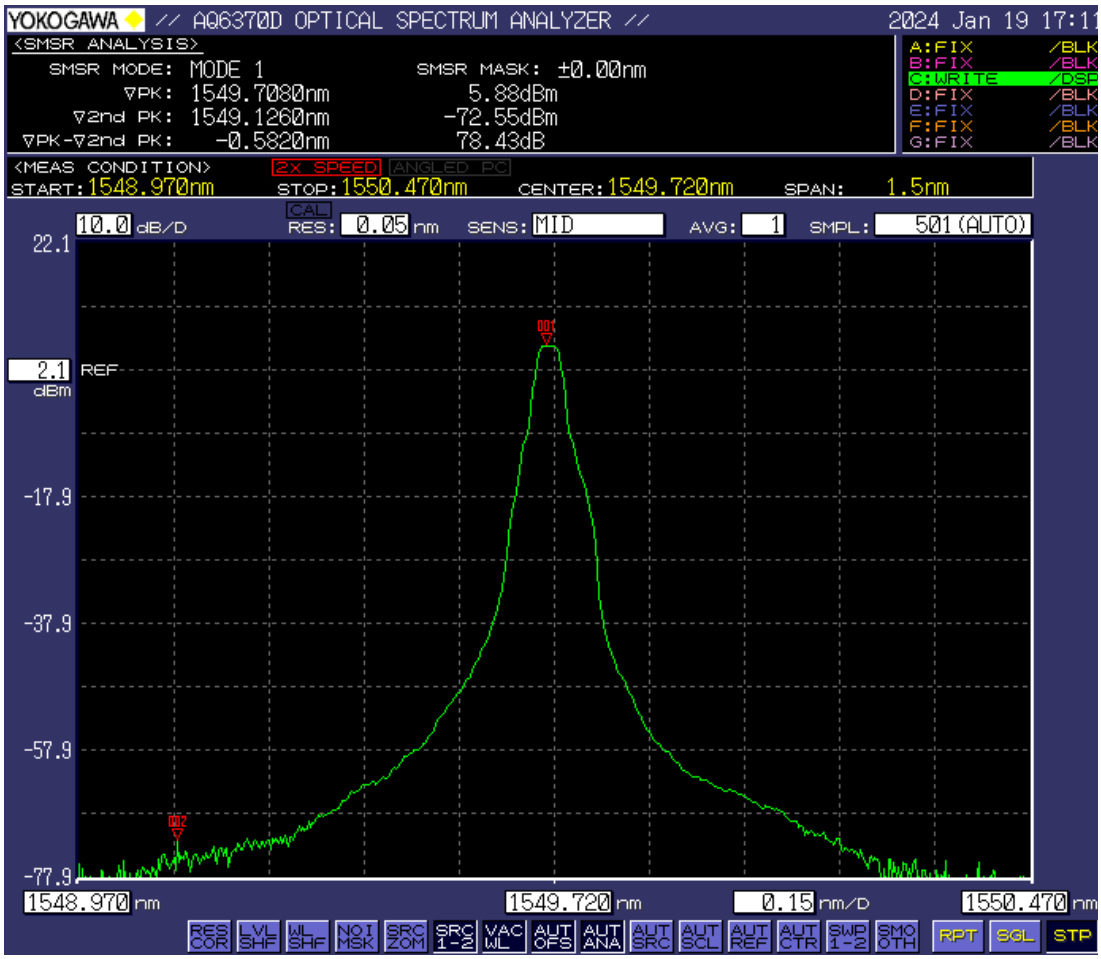


The reason for considering the visual error that the highest side peak in the above figure appears close to the main peak is due to visual perception and is related to the SPAN range. For easier observation, the figure below has only changed the SPAN from 1nm to 1.5nm while keeping the other parameters unchanged. It can be observed that near the so-called 'longitudinal modes,' the waveform does not exhibit an upward and downward change but rather an overall decrease. This indicates that this is not the maximum side peak, and the SMSR is far from 12dB. Additionally, we have confirmed this by examining the actual test data. The small range of slope reduction is related to the original gain chip and the quality of various devices in the system. However, this does not affect the performance of the final FP-ECDL.

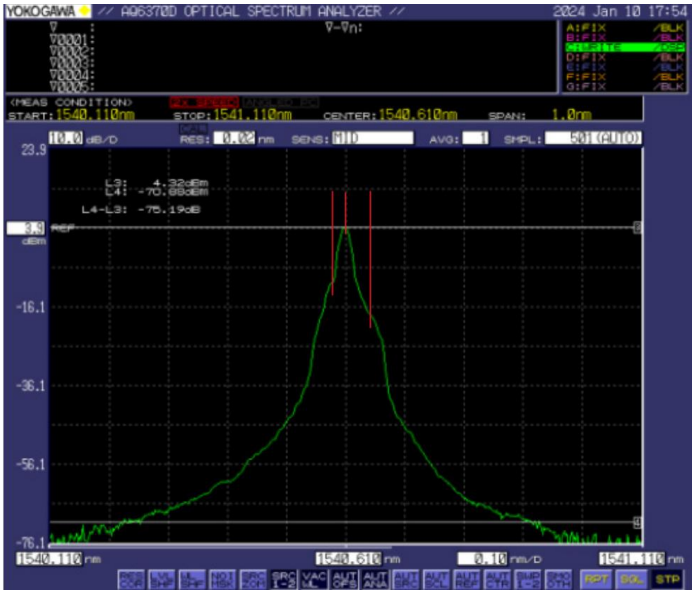


Increasing the resolution from 0.02nm to 0.05nm, as shown in the figure below, does not change the overall trend of the waveform. Furthermore, if the SMSR at this point is 12dB, it indicates the presence of multiple modes, and there is intense mode competition. Therefore, when changing the temperature, the variation of the highest side peak is very noticeable and does not remain stable. This is inconsistent with our measured results. Additionally, an SMSR of 12dB at this point implies that the FP-ECDL does not exhibit good wavelength stability and does not achieve a linewidth on the order of 5kHz. Therefore, from this perspective, an SMSR of 12dB is also inconsistent with the actual performance of the FP-ECDL. The absence of longitudinal mode lines at approximately 0.02nm from the main peak in the final emission spectrum is due to the appropriate selection of parameters. By combining the FP etalon with a narrow-band filter, it is possible to suppress longitudinal

modes outside the target wavelength with significant losses, ensuring that the final emission only contains the longitudinal mode corresponding to the center wavelength of the filter.



Comments 3: In the figure below, I have marked the approximate positions of several longitudinal modes in the spectrum with red lines. It is essential to include this variant of the spectrum in the final version of the manuscript.



Response 3:

Firstly, this spectrum represents the final emission spectrum, and there are no other longitudinal modes near the main peak, indicating effective suppression, as thoroughly explained and demonstrated in points 1 and 2 above.

In the paper, we have sequentially presented the spectra of the gain chip after collimation, the transmission spectrum of the FP etalon, and the final emission spectrum after passing through the narrow-band filter and mirror. Additionally, we have explained the principles behind the formation of a single longitudinal mode. Therefore, there is no need to display spectra with multiple longitudinal modes, as observed in experiments where elements such as the etalon are removed. The main reasons for this decision are as follows:

1、Sequential addition of corresponding components results in a single longitudinal mode, and the SMSR of the final generated single-mode spectrum typically exceeds 70dB. Any doubts regarding SMSR have been thoroughly addressed and demonstrated in points 1 and 2 above. During the actual fabrication process, components are added in sequence, and subsequent adjustments are made based on the results of the previous steps to achieve the desired final outcome, without any deviation in the order. In the beginning of Chapter 3 of the paper, we have already explained and illustrated the spectra and principles of the relevant sections in this order.

2、The impact of FP etalons with different coating reflectivities on various macroscopic indicators of the final FP-ECDL, as well as the method of selecting the optimal operating point through bidirectional temperature scanning, constitute the main focus of the paper. If various experiments demonstrating an SMSR of 70 dB are included in the final revised manuscript, it would require a separate section for explanation, which may appear abrupt. This is because the observation of an SMSR greater than 70 dB is the final result, and the principles explaining this result have already been systematically presented in order. Conversely, proving the result within the paper would be redundant, as it is inherently true.

Finally, to ensure that readers have a clearer view of the ultimate lasing spectrum without any potential misunderstanding, Figure 3-4 of the FP-ECDL final lasing spectrum in the original manuscript has been replaced with a high-resolution final lasing spectrum (Figure 3-4 in the revised manuscript) with a wavelength resolution of 0.02 nm and a SPAN of 1.5 nm. The SMSR values are also annotated in the modified text and images below:

In Figure 3-4, the spectrometer measured an SMSR greater than 70dB, with an exact value of 77.28dB, for the FP-ECDL laser spectrum operating in continuous-wave lasing mode.

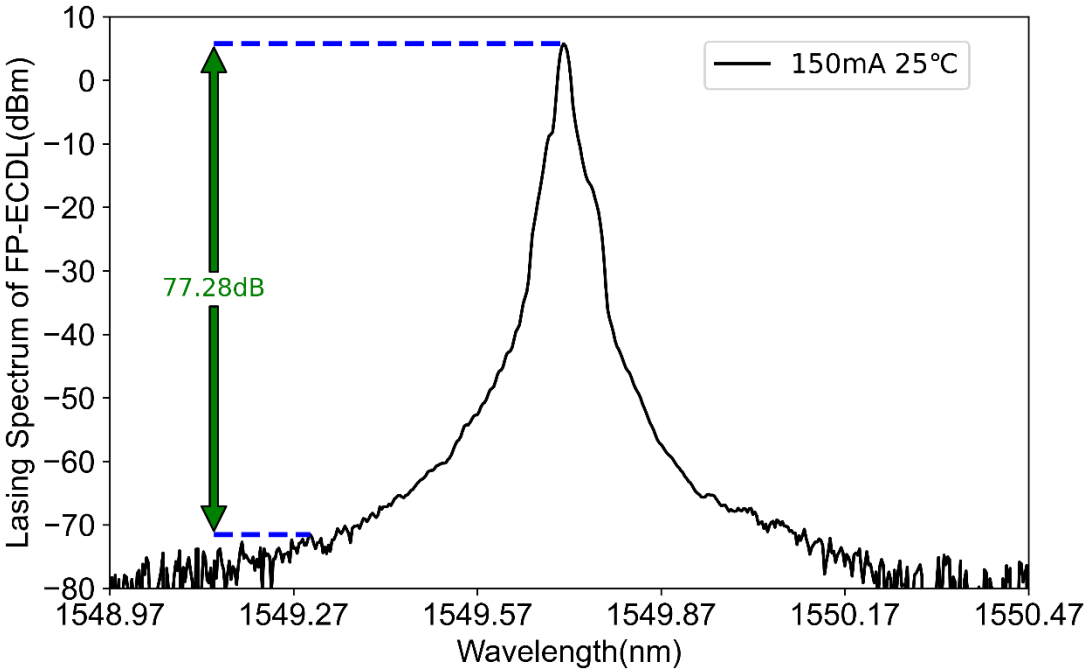


Figure 3-4: FP-ECDL Laser Spectrum

Thank you for your review.