# Design of Bragg Grating Fabry-Perot Laser centered at 1310 nm with an FSR below 0.2nm

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***Abstract*—This document details the process of designing a Fabry-Perot laser resonator centered at 1310nm, with the goal of getting the FSR below 0.2nm**

## I. Introduction

The goal of this project is to create a Fabry-Perot cavity with a central wavelength of 1310nm that is powered by an on-chip laser. The laser can only tune in 0.2nm increments so to ensure the cavity works the FSR must be lower than 0.2nm.

## II. Theory

[TBD ran out of time]

## III. Modelling and Simulation

A strip waveguide was used with a width of 350nm and a thickness of 220nm. Modeling was done using a width of 335nm to account for shrinking in the fabrication process.

Lumerical Mode was used to create this heat map of the first TE polarized mode profile

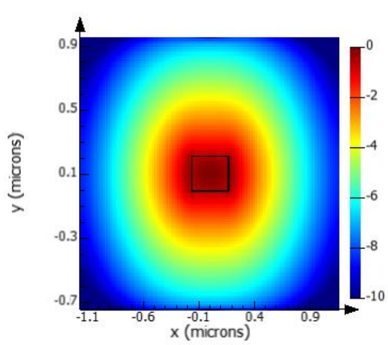


Fig. 1: First TE Mode Profile

Mode simulations also demonstrated the following wavelength dependency for $n_{eff}$:

$$n_{eff}(\lambda) = 2.38 - 1.67(\lambda - \lambda_0) + 0.00554(\lambda - \lambda_0)^2 \quad (1)$$

In addition, the following graphs were created to demonstrate the wavelengths effect of $n_{eff}$ and $n_g$

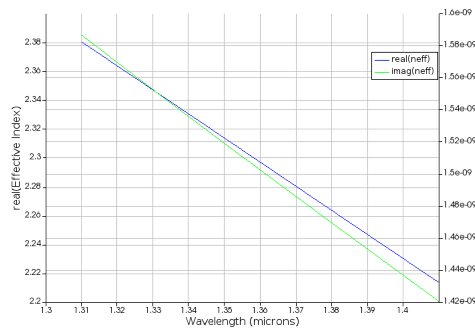


Fig. 2: $n_{eff}$ vs $\lambda$

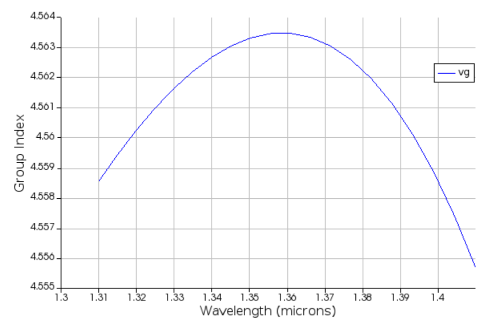


Fig. 3: $n_g$ vs $\lambda$

Following that the period was determined using

$$Period = \frac{\lambda}{2n_{eff}} \quad (2)$$

These parameters were then used in Lumerical FDTD to determine tentative values for kappa, bandwidth, and central wavelength. Still left to be done is to sweep the values for different dW and periods to generate graphs that determine the optimal value for these parameters. A full list of parameters can be found in table 1.

TABLE I: Parameters used in the model

| Parameter | $\Delta w$ [nm] |
|---|---|
| Width (nm) | 350 |
| $n_{eff}$ | 2.38 |
| Period (nm) | 275.17 |
| dW (nm) | 50 |
| kappa | 151930 |
| Number of periods | 30 |
| Cavity length (mm) | 1.2 |

To try and minimize FSR, the cavity length was made very large, 1.2mm, while the number of periods became 30. This resulted in a very fine response.

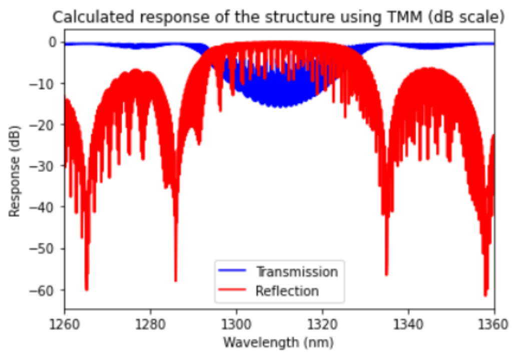


Fig. 4: Reflection and Transmission Spectrum

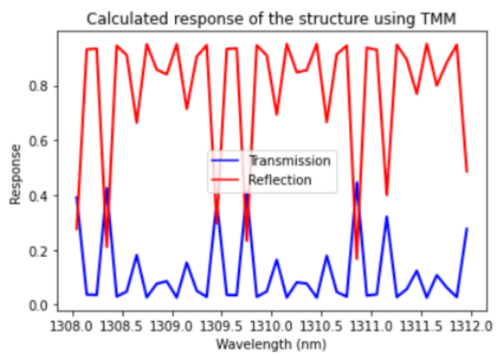


Fig. 5: Zoomed in Reflection and Transmission Spectrum

This spectrum has an FSR very close to 0.2nm, but is still slightly over. In addition, the Transmission never reaches the -20 line in Figure 4. This could pose a problem if there is a significant loss in the 20db range and could result in the cavity failing outright.

## IV. Fabrication

## V. Experiment Data

## VI. Analysis

## VII. Conclusion

Currently, the chosen parameters have resulted in a cavity that nearly reaches the desired performance, but falls short. In addition, there is a substantial risk that the cavity could fail due to significant loss.

In the coming days, I hope to resolve these issues by exploring different parameters, primarily experimenting with longer cavity lengths in the 1.5-2mm range to try and combat these issues.

## VIII. References