ELEC 413 Project 2 Report

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Link to github fork:
https://github.com/aleximece/UBC-ELEC413-2025/blob/main/submissions/ELEC413_AlexMartin_Project2.gds

Introduction

This project aims to design a photonic circuit which connects a commercial DFB laser to a Mach-Zehnder interferometer with a 25 GHz channel spacing. The system operates within a wavelength range of 1270 to 1330 nm. The interferometer circuit is designed using KLayout and simulated numerically using Lumerical MODE and Lumerical INTERCONNECT to assess its performance and functionality.

Modeling and Simulation

A silicon waveguide with air cladding was simulated in Lumerical MODE using the following parameters: thickness of 220 nm and width of 350 nm. The simulation results provided key metrics, including the effective index, group index, loss, and dispersion.

Table 1: Lumerical Mode Numerical Simulation Values for a 350nm Waveguide

Effective Index	2.319786
Group Index	4.84834
Dispersion	6971.63 ps/nm/km
Loss	6.68917e-4 dB/cm

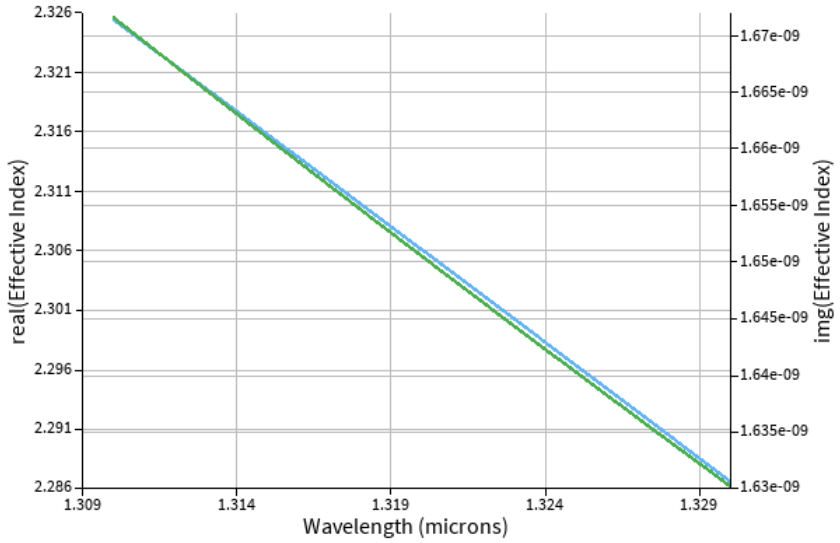

Figure 1: Lumerical MODE Effective Index

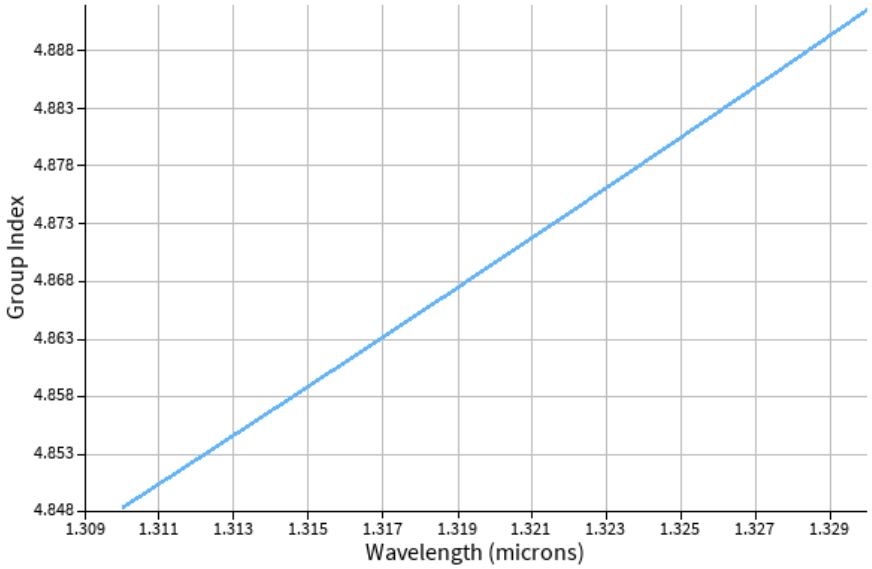

Figure 2: Lumerical MODE Group Index

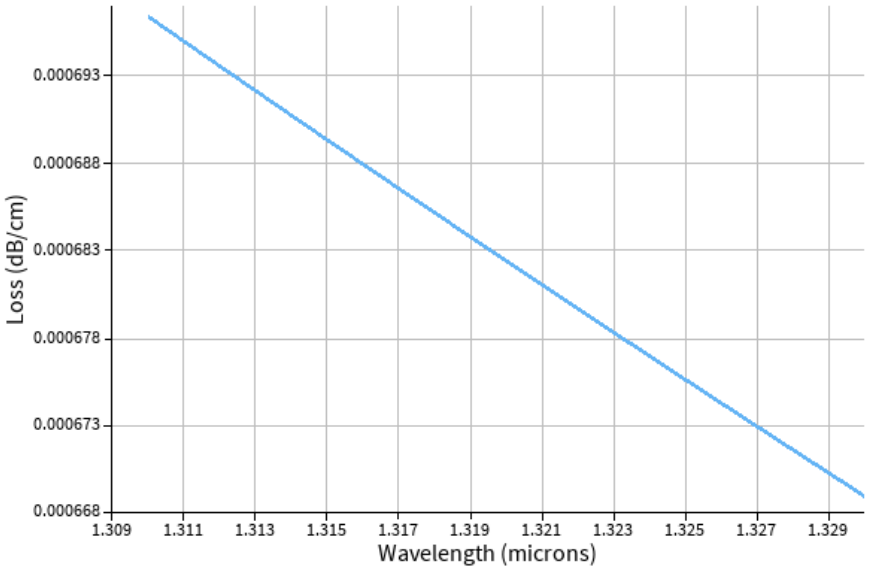

Figure 3: Lumerical MODE Loss Index

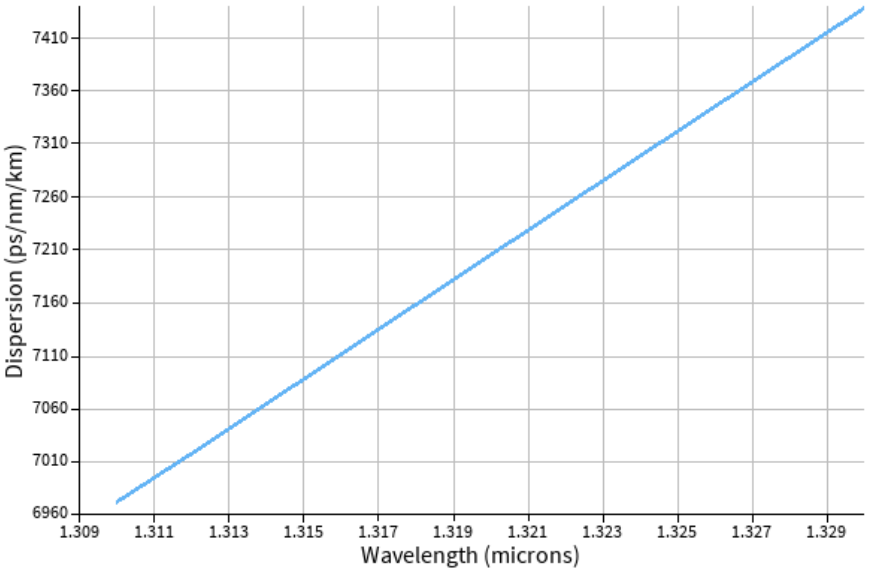

Figure 4: Lumerical MODE Dispersion Index

Layout

The circuit layout was created in KLayout using the SiEPIC compact model library components.

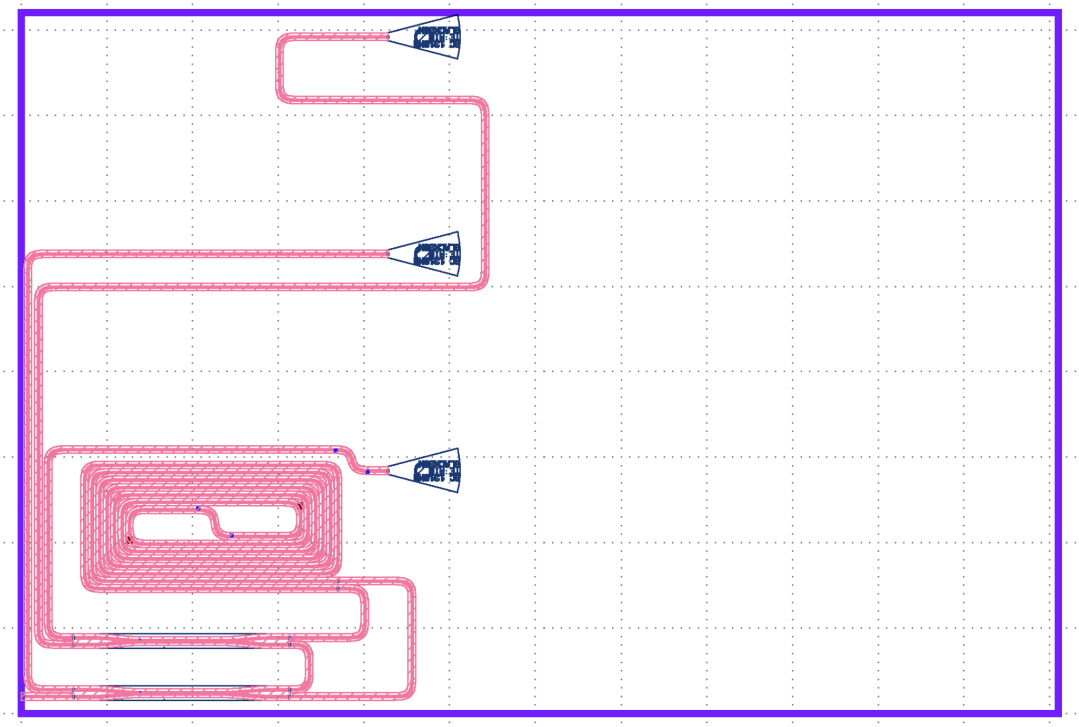

Figure 6: Circuit

Using the following equation, ΔL was determined analytically to be ΔL = 2.473362 mm.

$FSR = \frac{c}{ng \cdot \Delta L}$

Where FSR = 25 GHz, c = 299792458 m/s, ng = 4.84834

This ΔL value was used to guide the layout of the circuit. L1 = 43.401um and L2 = 2516.742um, giving a ΔL = 2.473341 mm. This value is 20.67 nm smaller than the ΔL determined analytically.

The design consists of two 1310nm 50-50 ultra-broad band splitter, a 1310nm 3 loop spiral paperclip, and 1310nm waveguides.

Circuit Simulation

Circuit simulation will be performed using Lumerical INTERCONNECT once component models are updated for air cladding. $\Delta\lambda$ was determined analytically to be $\Delta\lambda$=143.1pm using the following formula:

$\Delta\lambda = \frac{\lambda^2 \Delta f}{c}$

Where λ = 1310nm, f = 25GHz, c = 299792458 m/s