Design and Evaluation of Air-Cladded Photonic Integrated Circuits with DFB Laser Integration

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Abstract

Introduction

The objective of this project is to design, simulate, and test an air-cladded photonic integrated circuit (PIC) that connects a commercial Distributed Feedback (DFB) laser to a Mach-Zehnder Interferometer (MZI) or similar photonic circuit. The focus is on characterizing the laser and its interaction with the interferometer in an air-cladded environment, which reduces optical confinement losses and enhances performance. The design aims to achieve a 25 GHz Free Spectral Range (FSR) at 1310 nm, with optimized laser performance and minimal waveguide losses. This report outlines the design intentions, calculations, simulations, and expected outcomes.

Theoretical Calculations

Effective Index (n_eff)

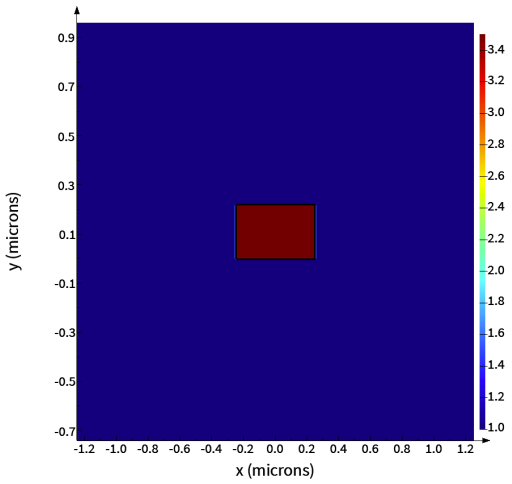
Group Index (n_g)

Free Spectral Range (FSR)

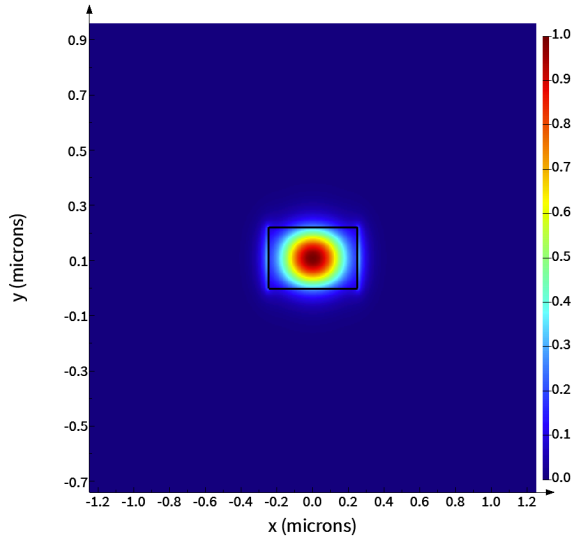
Simulation Approach

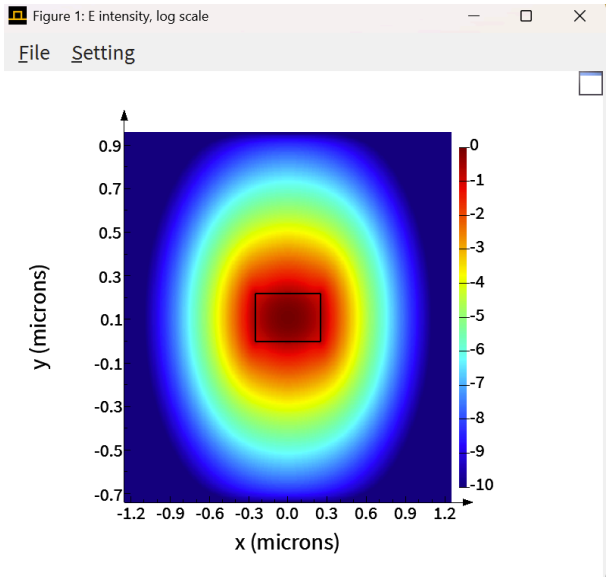
Simulations were conducted using Lumerical INTERCONNECT to validate theoretical predictions and refine the design.

- Lumerical MODE



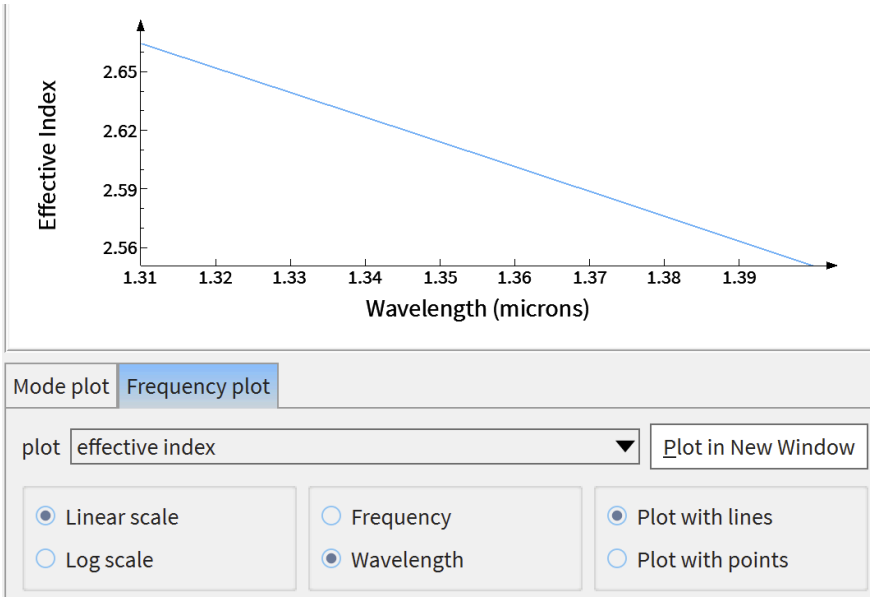
Mesh structure



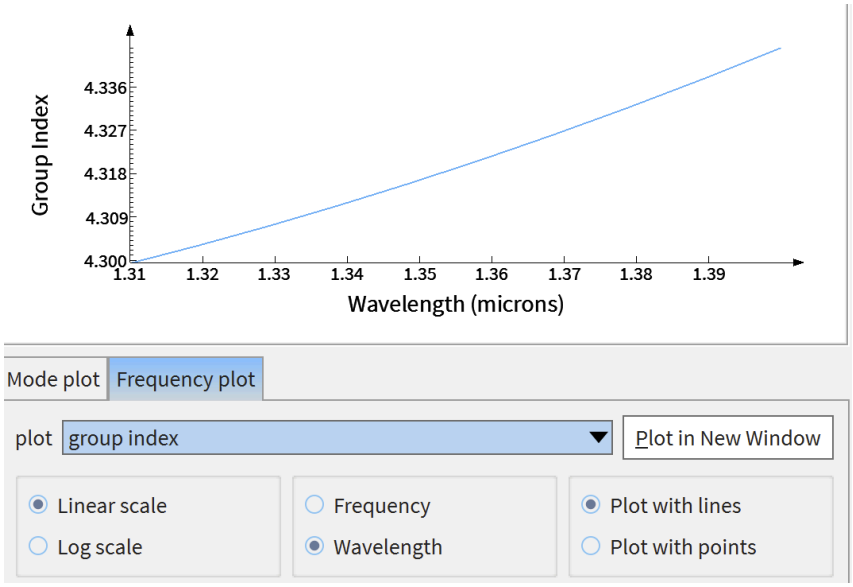


E intensity

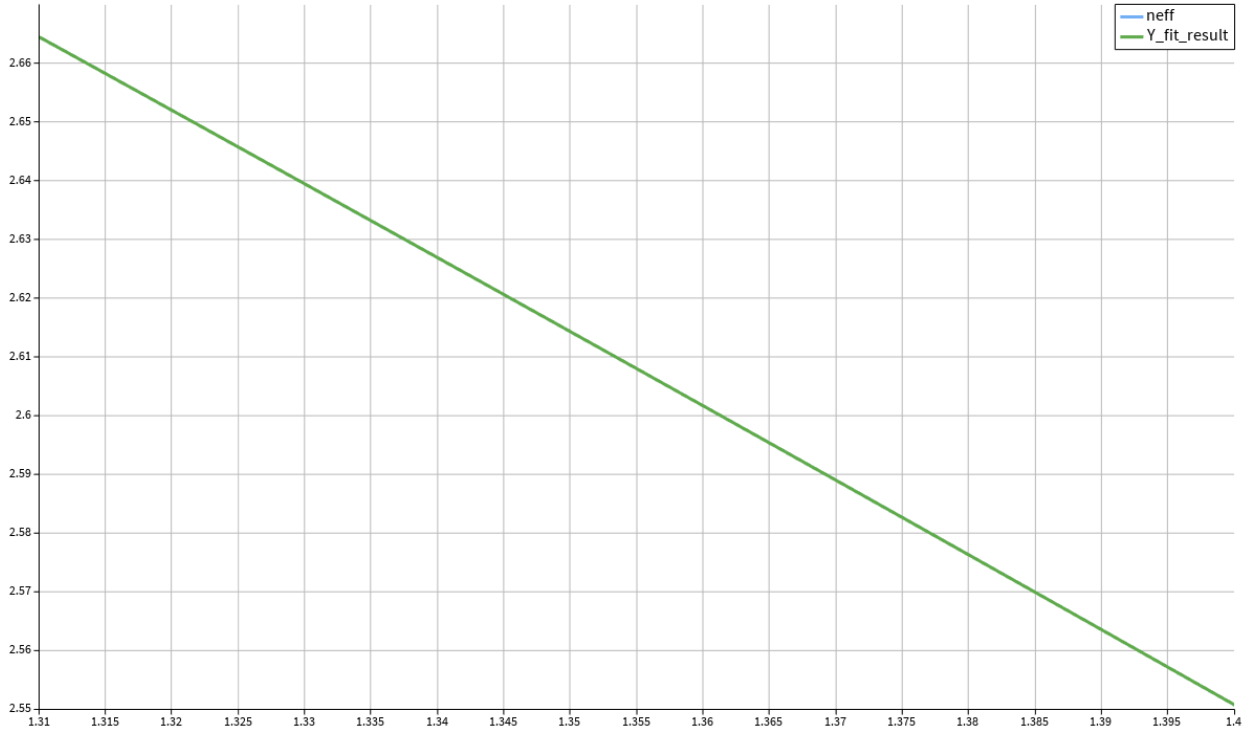
mode #	effective index	wavelength (μm)	loss (dB/cm)	group index	
1	2.664459+1.600338e-09i	1.31	0.00066671	4.299504+3.398442e-09i	9
2	1.848209+1.981577e-09i	1.31	0.00082553	5.959238+5.026053e-09i	6
3	1.531741+2.096643e-09i	1.31	0.00087347	6.146973+9.373624e-09i	8



Effective index



Group index

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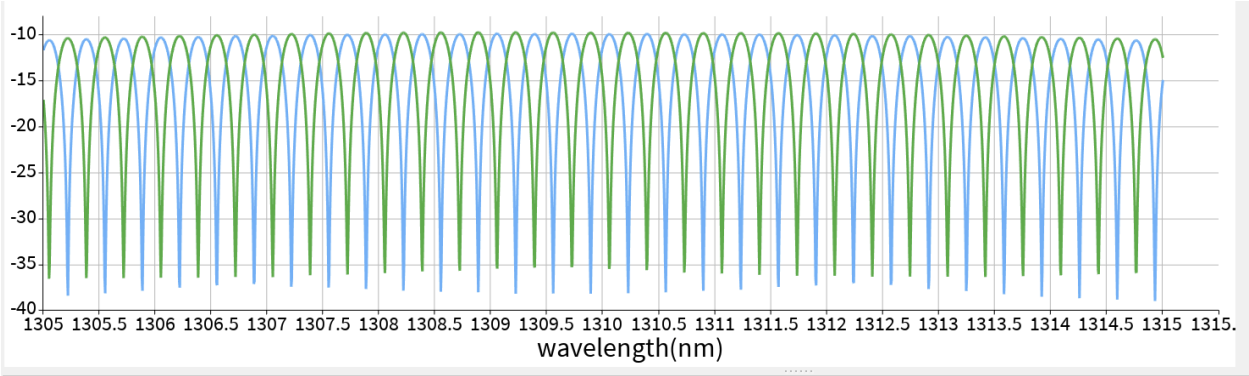
result:
2.66445
-1.2468
-0.182739
```

- Lumerical INTERCONNECT



Results and Discussion

Conclusion

References

Appendix