Design of Mach-Zehnder Interferometer

Abstract

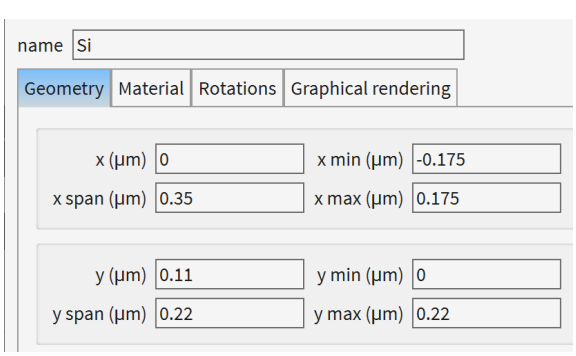
Designed a Mach-Zehnder Interferometer with an FSR of 25 GHz for a wavelength of 1310 nm. Created multiple designs in KLayout, and ran simulations in Lumerical Interconnect to see results.

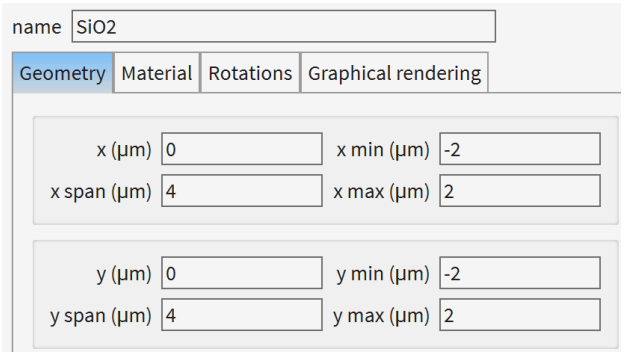
Introduction

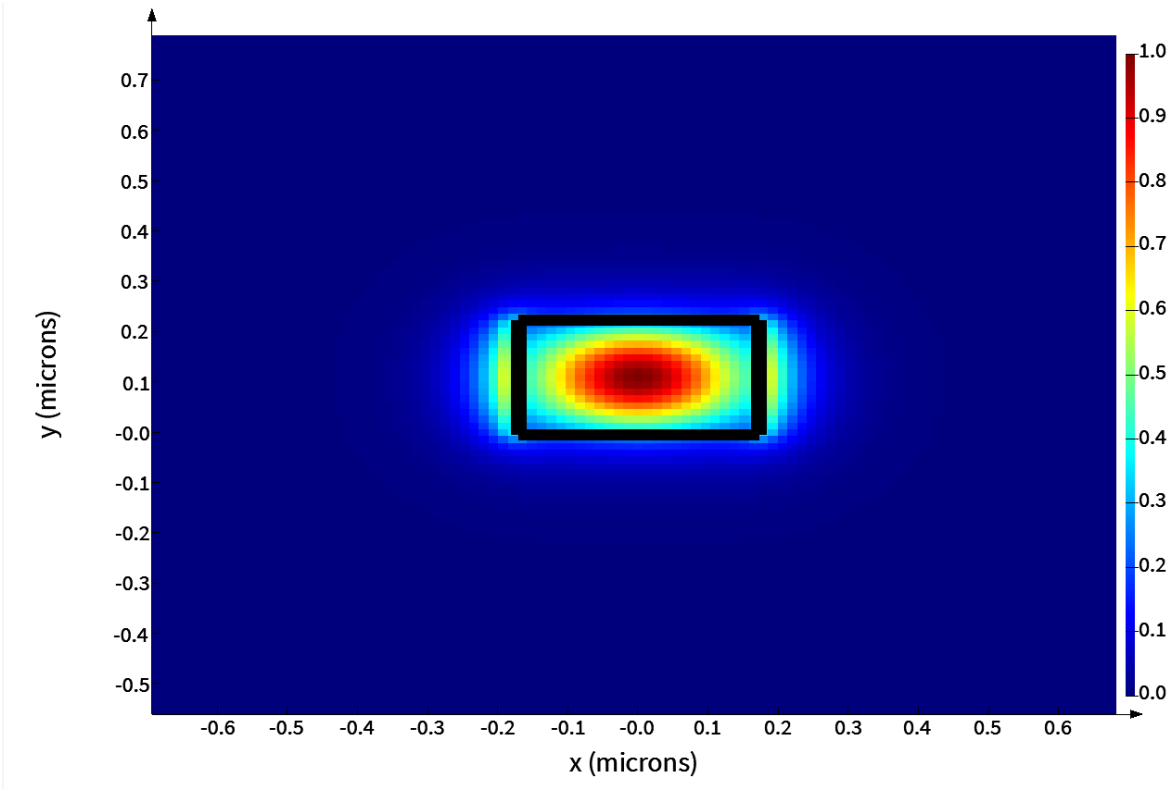
For this project, I am aiming to design a Mach-Zehnder Interferometer (MZI) with a Free Spectral Range (FSR) of 25 GHz, optimized for operation at a wavelength of 1310 nm. The waveguide width is set at 350 nm due to compatibility with other components in KLayout.

Method

My first goal was to find what the length difference between the waveguide paths should be. To know this, I needed to know the group index.
I created the waveguide in Lumerical Mode to find the group index at the given wavelength.







With a 350 nm waveguide, the resulting group index was ~4.5. **add manual calculation**

mode #	effective index	wavelength (μm)	loss (dB/cm)	group index	TE polarization fraction (Ex)
1	2.428375+1.580350e-09i	1.31	0.00065838	4.498421+3.725617e-09i	98

I used this value in the formula

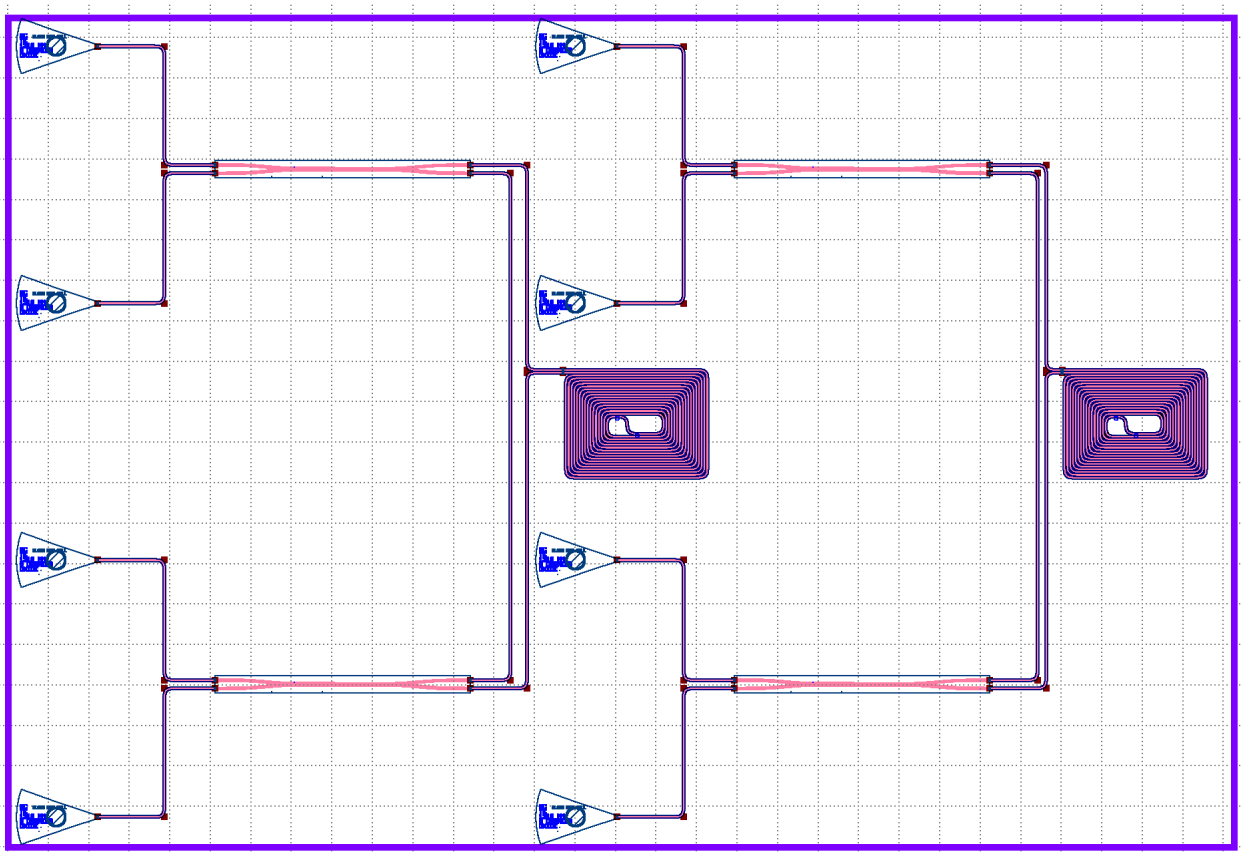
$\Delta\nu \approx -\frac{c\Delta\lambda}{\lambda^2}$ to solve for $\Delta\lambda \approx 2.6648\, mm$.

Next, I redid the design process with the added goal of accounting for fabrication biases. Waveguides shrink by approximately 15 nm, so I used a new width of 335 nm.

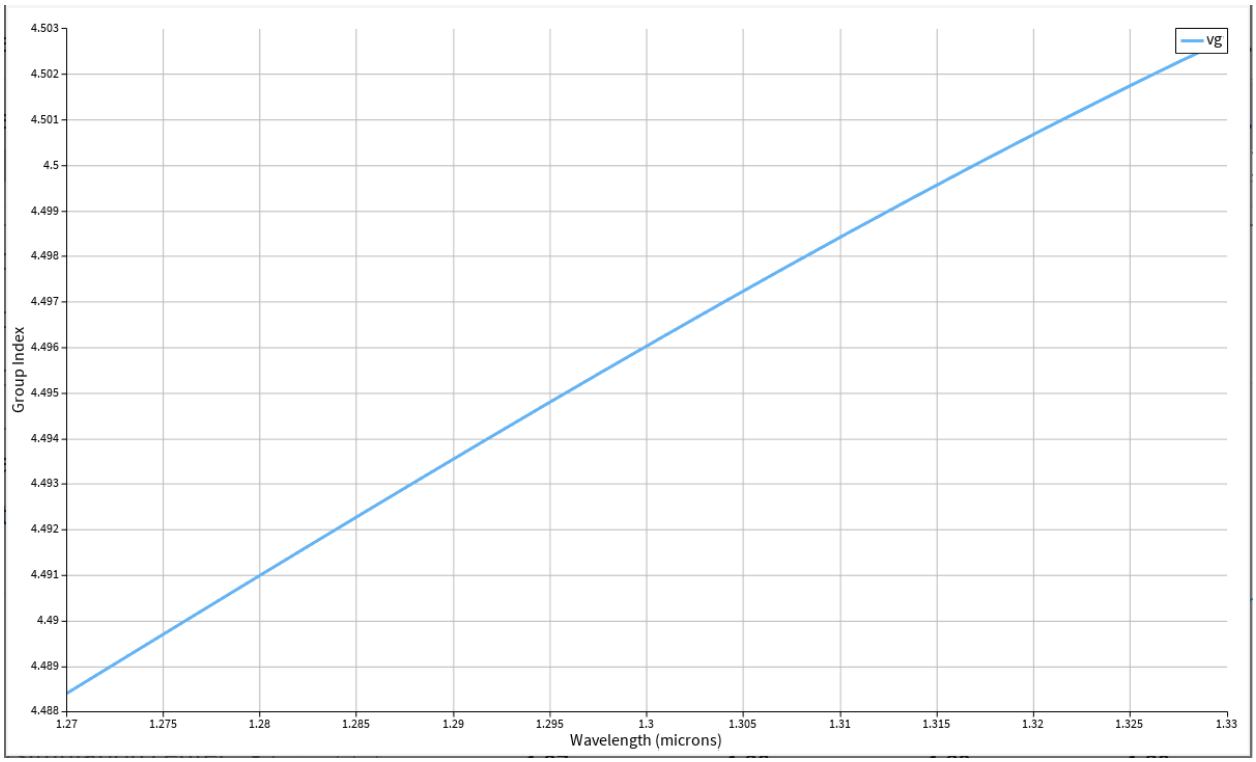
Using Lumerical Mode I found the new group index to be ~4.547.

mode #	effective index	wavelength (μm)	loss (dB/cm)	group index	TE polarization fraction (Ex)
1	2.379623+1.582468e-09i	1.31	0.00065926	4.547230+3.829000e-09i	97

This gave me a new length difference of $2.637\, mm$**.** I duplicated and edited my original design to reflect this, leaving me with my completed design in KLayout.



Next, simulate my design using interconnect **Could not get it to work with the components, to-do**.


vg
Group Index
4.503
4.502
4.501
4.5
4.499
4.498
4.497
4.496
4.495
4.494
4.493
4.492
4.491
4.49
4.489
4.488
1.27
1.275
1.28
1.285
1.29
1.295
1.3
1.305
1.31
1.315
1.32
1.325
1.33
Wavelength (microns)