UBC Phot1x Course – Design Proposal Draft

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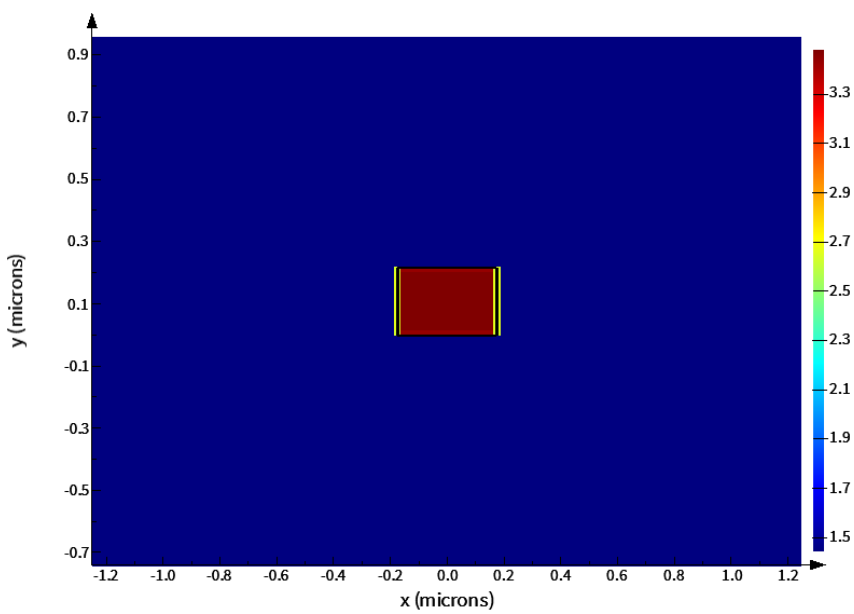
Design Goals: (minimum) use 3 path length variations of MZI to meet the requirements of the course analysis, with several repeats of one of these to observe process variation, (stretch 1) 3 different straight waveguide sections to extract loss from fabrication imperfections, (stretch 2) 3 waveguide bends at different radius to compare bend loss to simulation. All waveguides will be at the same width of 350 nm.

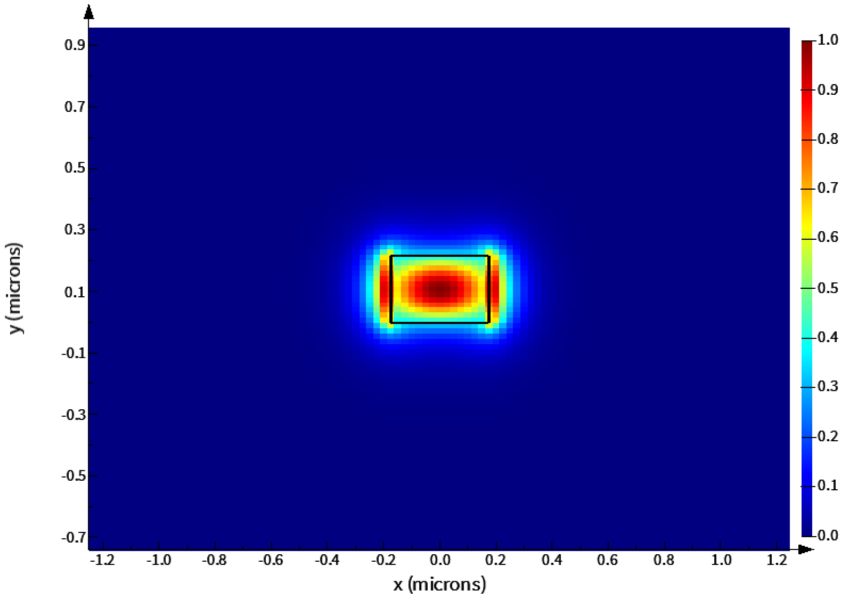
Simulation for TE mode of 350 nm wide and 220 nm tall strip waveguide:

mode #	effective index	wavelength (µm)	loss (dB/cm)	group index	TE polarization fraction (Ex)	waveguide TE/TM fraction (%)	effective area (µm^2)
1	2.132134+1.297152e-09i	1.5	0.00047195	4.488506+3.482913e-09i	96	66.5 / 82.79	0.20872

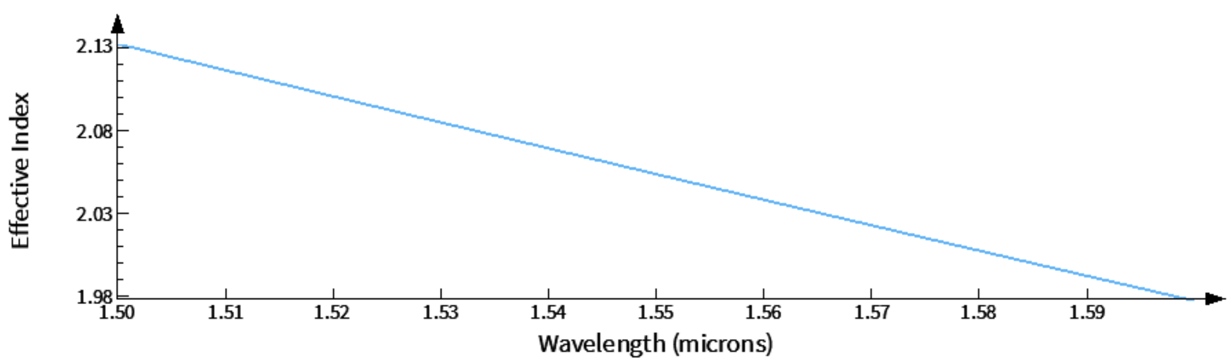
Index (x) distribution:



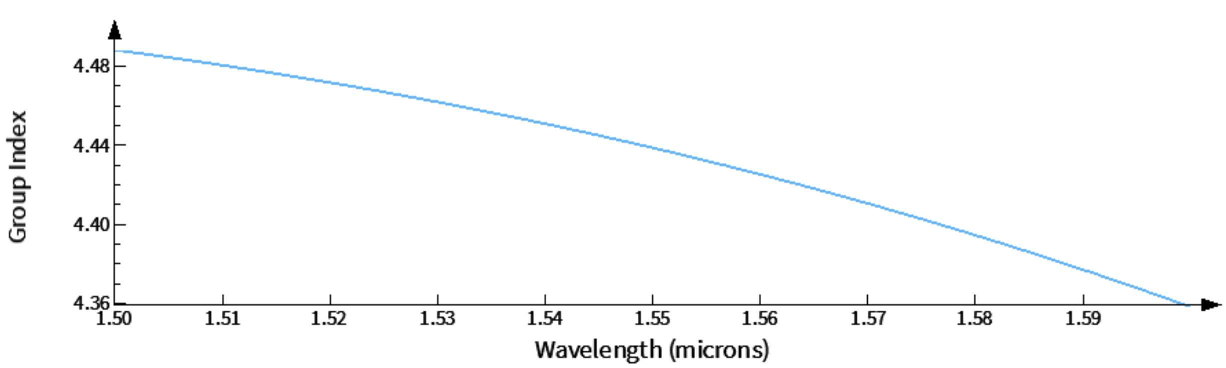
E intensity profile:



Effective index, 1.5-1.6 um wavelength:



Group index, 1.5-1.6 um wavelength:



Compact model:

Model parameters extracted using Lumerical script provided in section “Passive Photonic Components > Waveguide Modeling – Lumerical MODE > Waveguide Compact Model”

$$n_1 = 2.05432$$

$$n_2 = -1.53665$$

$$n_3 = 0.412216$$

$$n_{eff}(\lambda) = 2.05432 - 1.53665(\lambda - \lambda_0) + 0.412216(\lambda - \lambda_0)^2;\ \lambda_0 = 1.55\ \mu m$$

Interferometer transfer function:

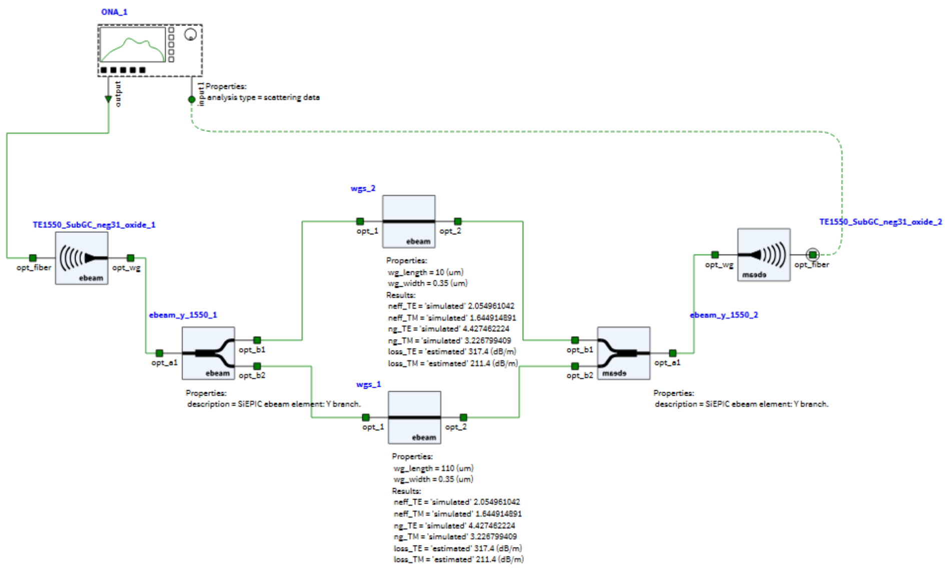
$$I_o(\lambda) = \frac{I_i}{2}[1 + \cos\left(\frac{2\pi n_{\mathrm{eff}}(\lambda)}{\lambda}\,\Delta L\right)$$

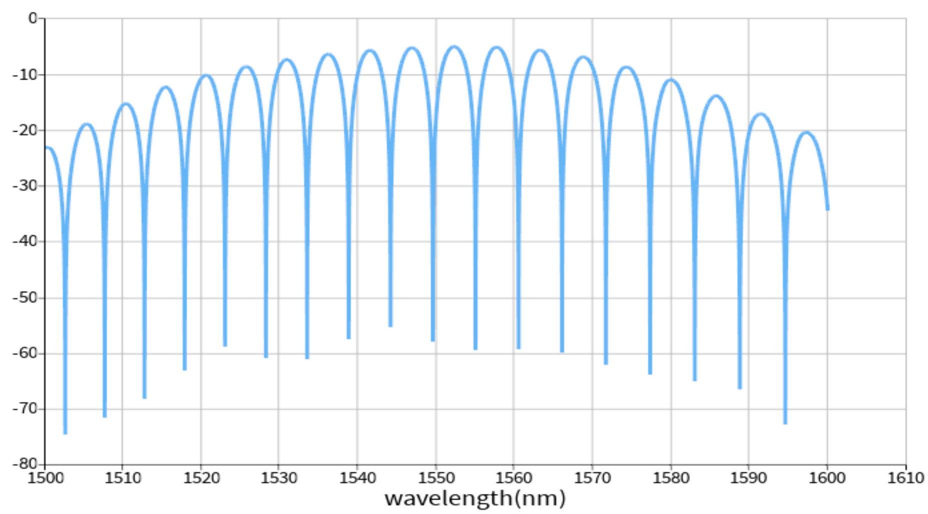
Anticipated parameter variations:

Device Variation	Waveguide Width (nm)	n_{eff} @ 1550 nm	n_g@ 1550 nm	L_0 (μm)	ΔL (μm)	FSR (nm)
MZI 1	350	2.0543	4.4392	10	25	21.65
MZI 2					100	5.412
MZI 3					1000	0.5412

In addition, I will design waveguides with straight section lengths 25, 100, and 1000 microns between grating couplers to analyze excess loss, and bend radius 3, 25, and 100 to compare bend loss to simulation.

Transmission spectrum of MZI variation #2:





▼ Attributes

Data set	Attribute	Vector operation	Scalar
ONA_1:input 1/mode 1/…	TE gain (dB)	Not Applicable	Re

Group index calculation from FSR:

$$FSR = \quad \Delta\lambda = \frac{\lambda^2}{\Delta L\, n_g}$$

$$\Rightarrow \boldsymbol{n_g} = \frac{\boldsymbol{\lambda^2}}{\boldsymbol{\Delta L\, \Delta\lambda}}$$