



COMSOL® Design Tool: Week 6: Simulations of Optical Components

Group Projects

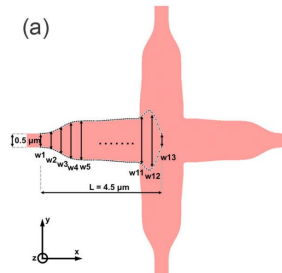
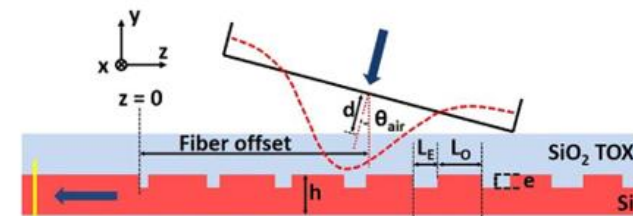
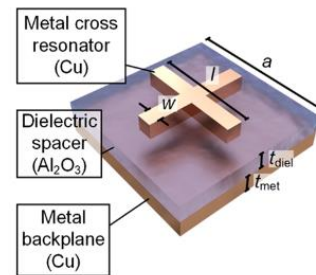
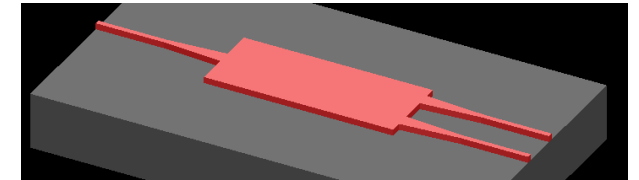
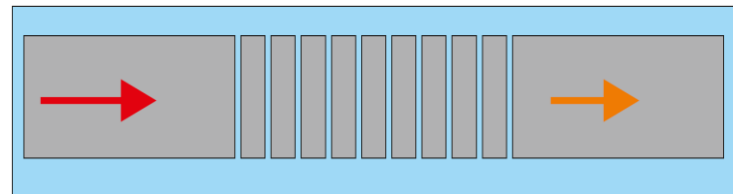
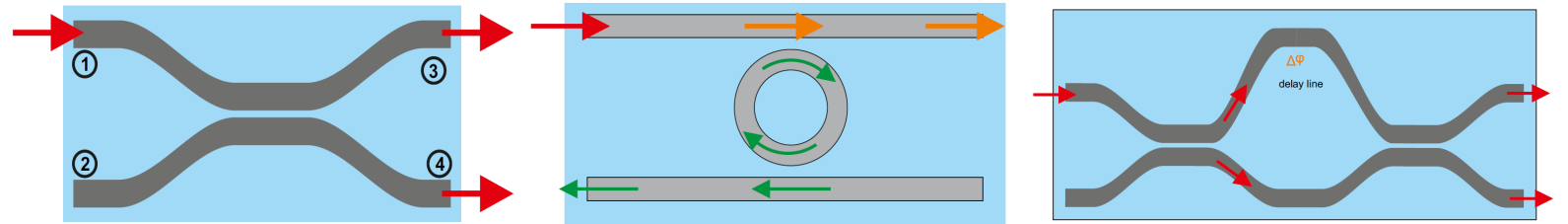
Manuel Kohli, Raphael Schwanninger

Projects – Outline

Date	Content
10.04.2023	Easter Break
17.04.2023	Sechseläuten
24.04.2023	Individual work on projects
01.05.2023	Individual work on projects
08.05.2023	Individual work on projects
15.05.2023	Individual work on projects
22.05.2023	Individual work on projects
29.05.2023	Presentations
05.06.2023	Deadline Reports

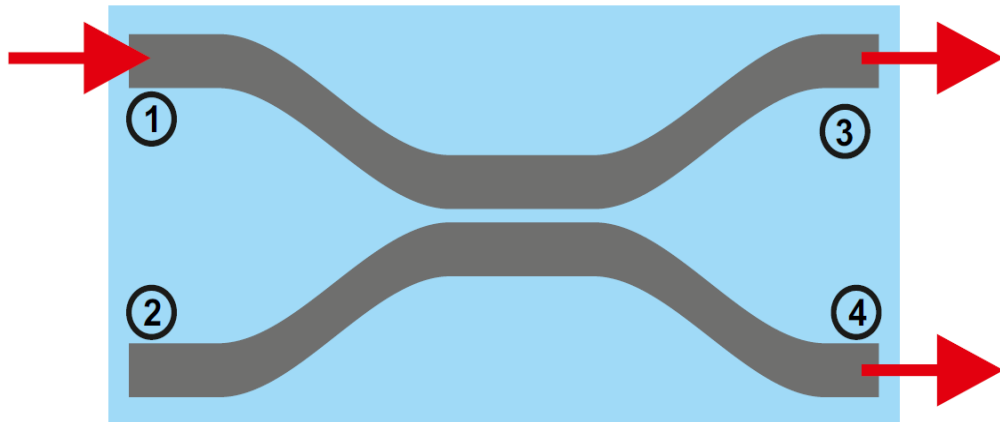
Project Overview

- Project descriptions
 - Directional coupler
 - Ring resonator
 - Delay line interferometer
 - Bragg mirror
 - Multi-mode interferometer (MMI)
 - Grating coupler
 - Optical Metamaterial
 - Waveguide crossing



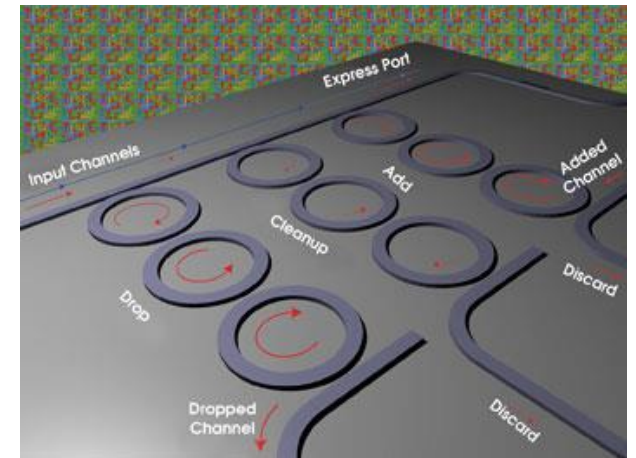
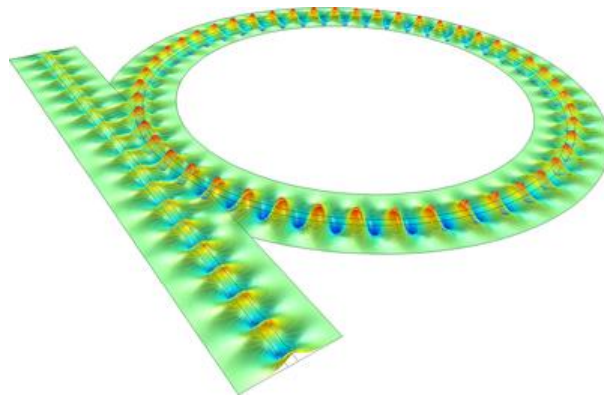
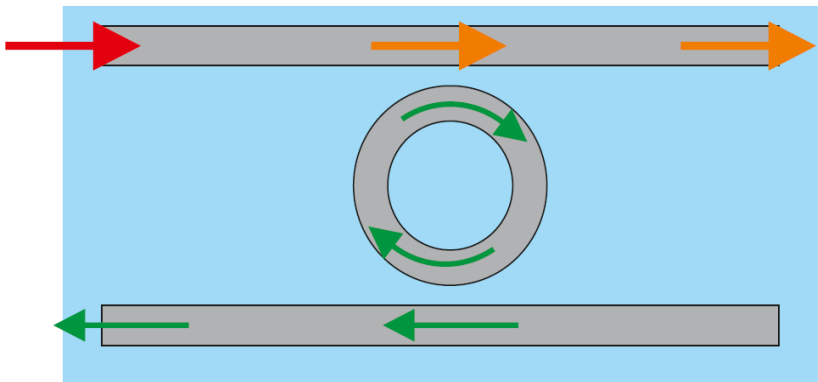
Directional Coupler

- 2-3 students
- Goal
 - Analyze the Mode in 1D and 2D, discuss the difference
 - Wavelength: 1550 nm (C-Band)
 - Fix power ratio (to 50/50 **and** 90/10)
 - Minimize bending losses



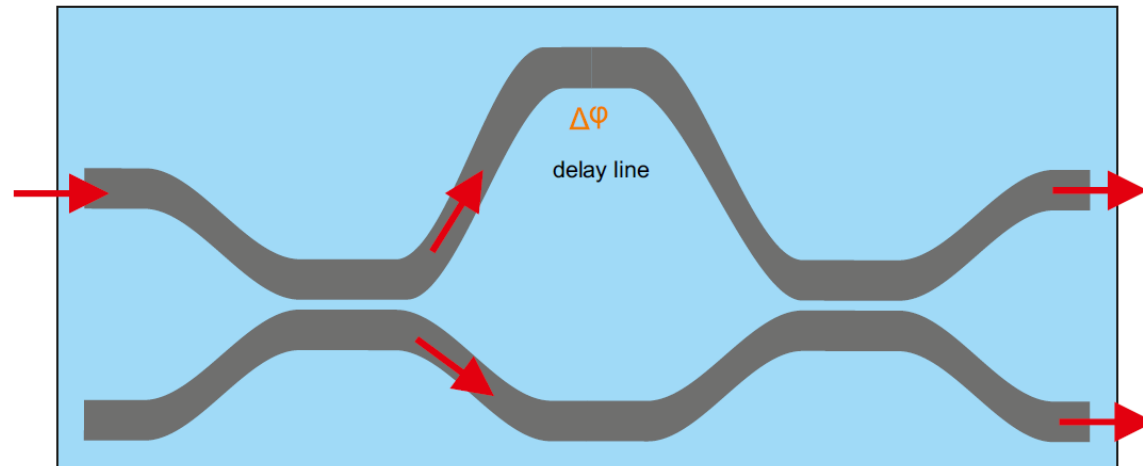
Ring Resonator

- 2-3 students
- Goal
 - Find the resonant behavior at 1310 nm
 - Maximize Q factor and minimize losses
 - >30 dB ER
 - Q factor $\sim 10'000$
 - FSR 10 nm
- Task 2
 - Cascaded rings
 - Wavelength = 1310 nm
 - 50:50 output



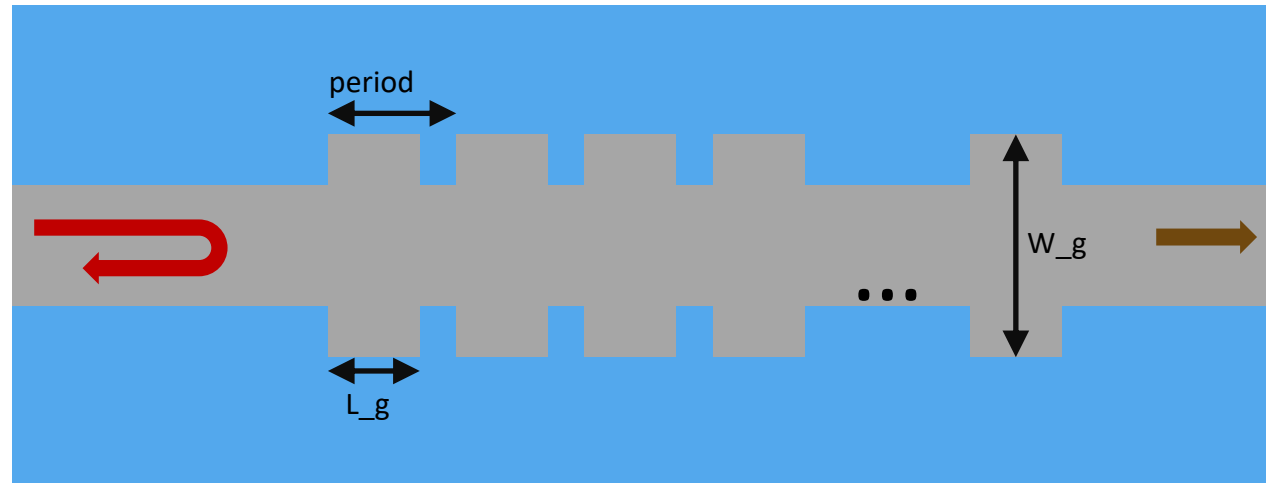
Delay Interferometer

- 3 students
- Goal
 - Wavelength = 1550 nm
 - Minimize bending losses
 - Find delay line for a $\frac{\pi}{2}$, π , 2π phase shift
 - Coupling 50:50
- Things to consider
 - Thermal control of phase shift?
 - MMI output coupling
 - 20 dB extinction ratio



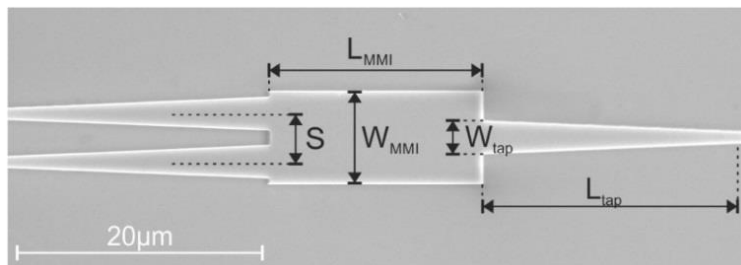
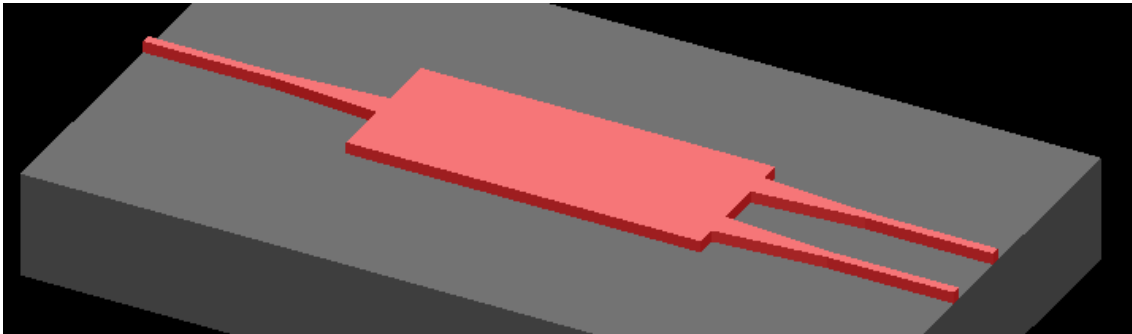
Bragg Mirror

- 2-3 students
- Goal
 - Operating wavelength: 1550 nm
 - Incoming wave should be reflected, $R > 0.9$ at 1550 nm
 - Reflection coefficient > 3 dB for 1450-1650 nm



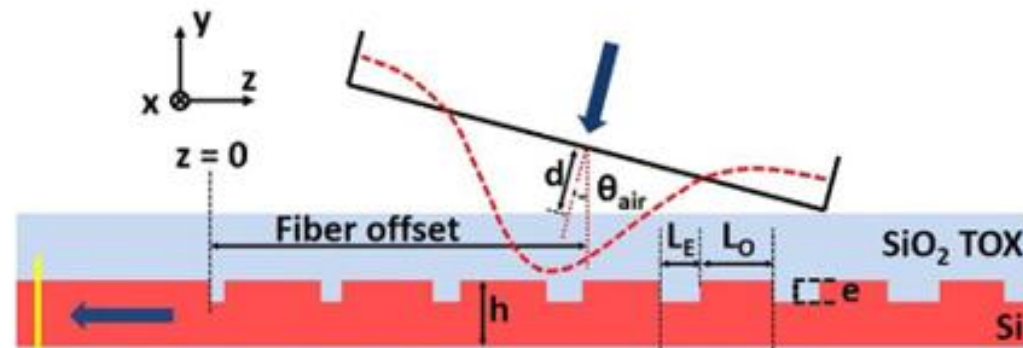
Multimode Interferometer

- 2-3 students
- Goal
 - Wavelength 1550 nm
 - Find geometry such that output ratio is 50/50 and also 10/90



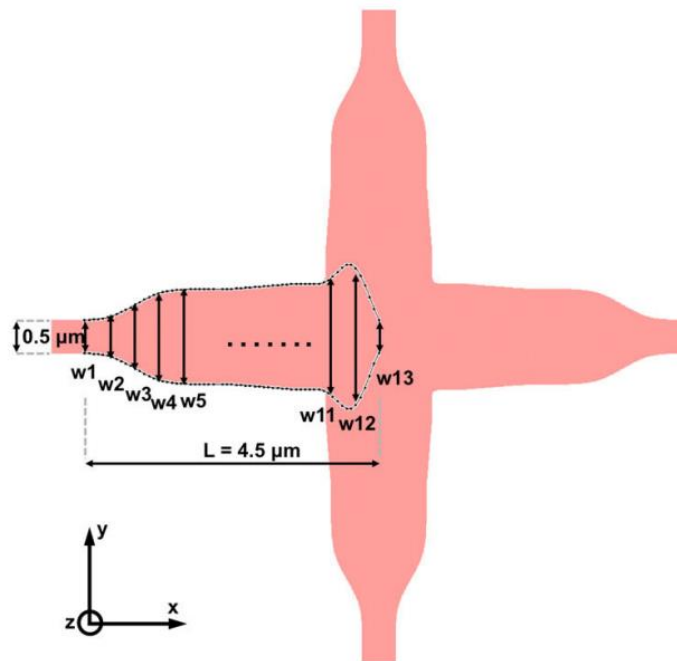
Grating Coupler

- 3 students
- Goal
 - Analyze the effective index dependent on the etching depth
 - Simulate a grating coupler using the Bragg condition for a fiber incident angle of 10° .
 - Operating wavelength: 1550 nm
- Coupling Efficiency loss < 3 dB
- Reflection < -20 dB

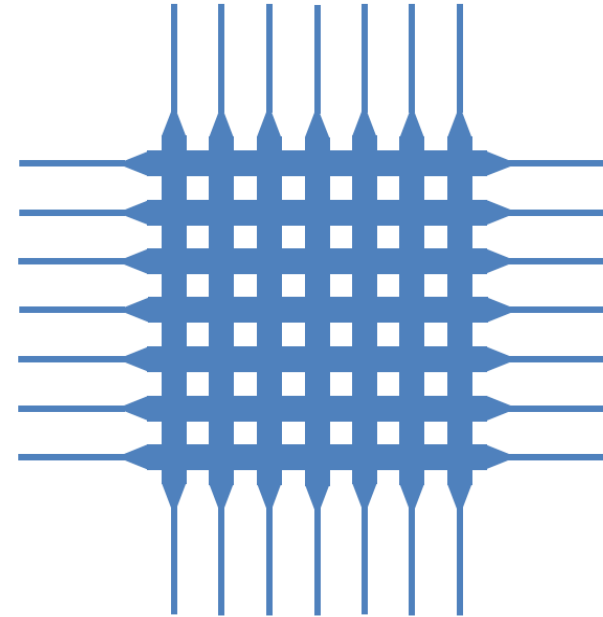


Waveguide Crossings

- 2 – 3 students
- Goal
 - Minimize transmission losses
 - Total losses < 0.3 dB



- Things to consider:
 - Expanding crossing
 - Many junctions!



Optical Metamaterial

- 2 – 3 students
- Goal
 - Design a perfect absorber metamaterial based on the metal-insulator-metal layer stack.
 - a. Analyze the absorption spectra with respect to the peak position and FWHM
 - b. Analyze the polarization dependence
 - Operating wavelength: 2700 nm

