Instalight

-Real-time Simulation of PIC

Junhe Zhang

Department of Electrical Engineering, Columbia University, New York, NY

COLUMBIA ENGINEERING
The Fu Foundation School of Engineering and Applied Science

Outline

- Motivation
- Fundamental building blocks
- Live demo
- Outlook
- Reference & Appendix

Why Instalight?

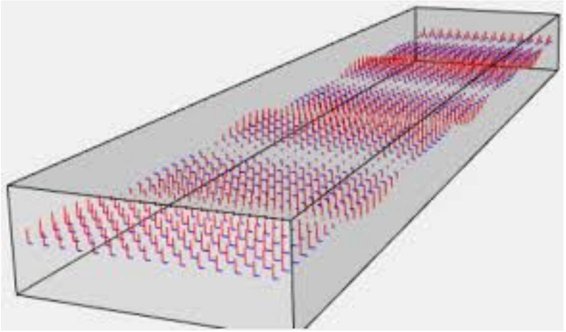
Lumerical Interconnect

- Time-consuming
- "Black box"
- Rigid

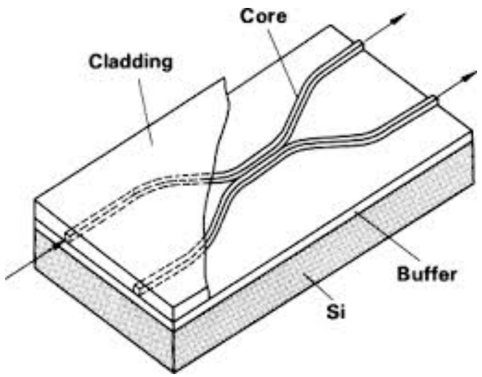
Instalight

- Real-time parameter tuning
- Easy to assemble
- Flexible

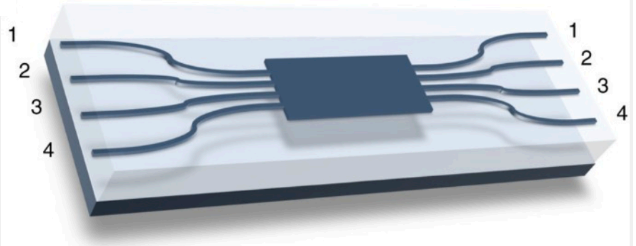
Fundamental Building Blocks



Waveguide



Directional Coupler



Multimode Interferometer (MMI)

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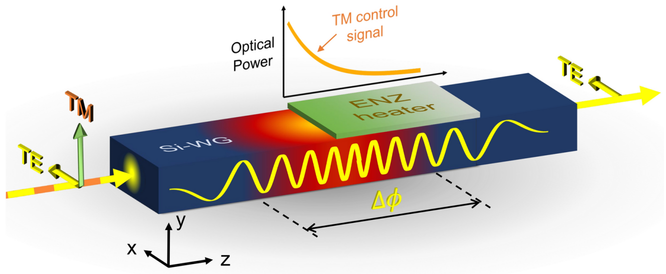
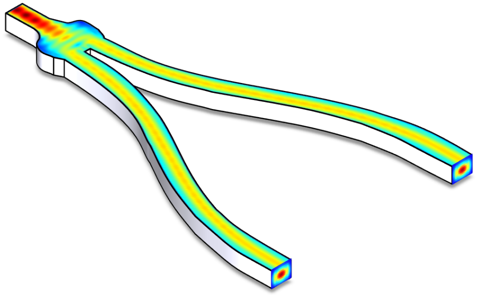
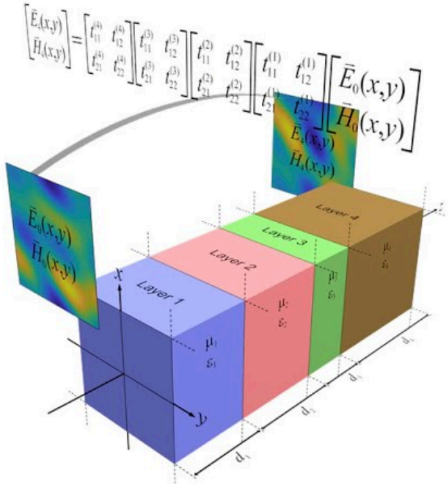


Phase Shifter



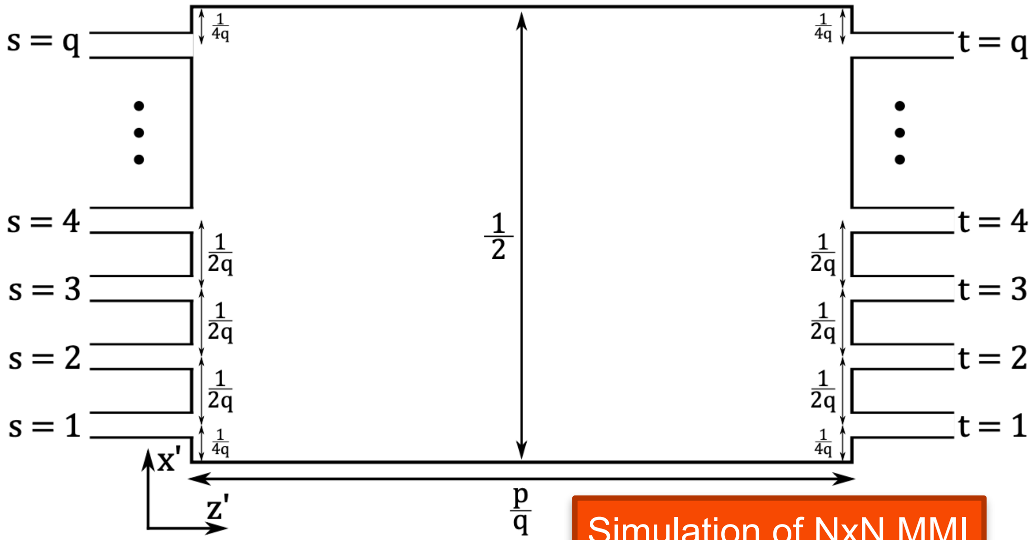
Y-Branch



Transfer Matrices

Live Demo

Outlooks



Simulation of NxN MMI

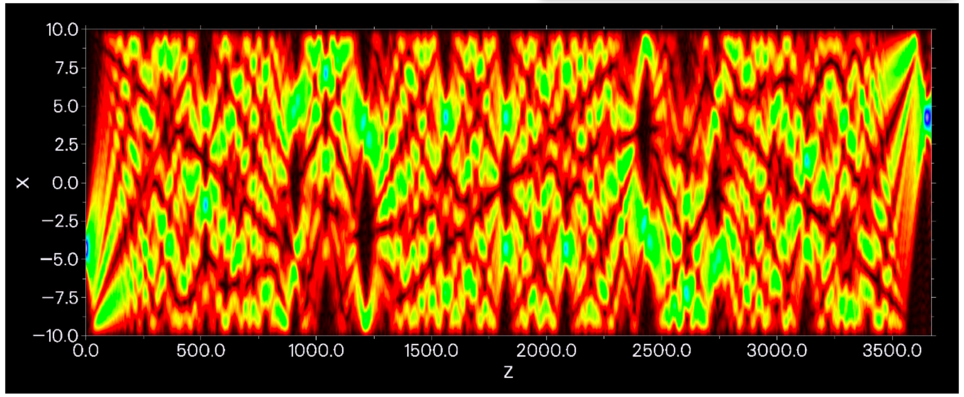
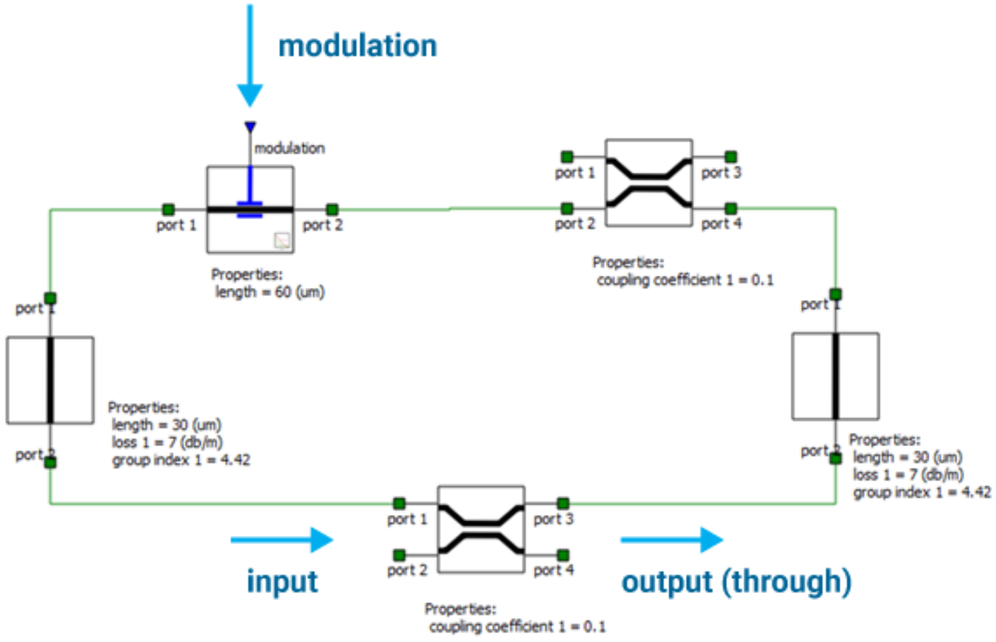


Fig. 3. A single image.



Graphical User Interface (GUI)

Reference

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- Mathuranathan. “QPSK Modulation & Demodulation (MATLAB and Python).” GaussianWaves, 7 Nov. 2020, www.gaussianwaves.com/2010/10/qpsk-modulation-and-demodulation-2/.
- “How to Demodulate Digital Phase Modulation: Radio Frequency Demodulation: Electronics Textbook.” All About Circuits, www.allaboutcircuits.com/textbook/radio-frequency-analysis-design/radio-frequency-demodulation/how-to-demodulate-digital-phase-modulation/. Accessed 12 July 2023.
- Hang Guan et al., "Compact and low loss 90° optical hybrid on a silicon-on-insulator platform," Opt. Express 25, 28957-28968 (2017)
- Kieran Cooney and Frank H. Peters, "Analysis of multimode interferometers," Opt. Express 24, 22481-22515 (2016)

Appendix

Let $\mathbf{S}(t)$ and $\mathbf{R}$ denote the two inputs to the optical hybrid and $\mathbf{S}(t)+\mathbf{R}\exp[j(\frac{\pi}{2}n)]$, with $n = 0, 1, 2$ and 3, represent the four outputs from it. Using the PSK modulation and phase-diversity homodyne receiver as an illustration, one can write the following expression for the signal power to be received by the four detectors:

$$P_n(t) \propto P_S + P_R + 2\sqrt{P_S P_R}\cos[\theta_S(t)+\theta_C(t)-\frac{\pi}{2}n],\quad n = 0, \ldots 3;$$

where P_S and P_R are the signal and reference power, respectively, $\theta_S(t)$ the signal phase modulation, and $\theta_C(t)$ the carrier phase relative to the LO phase. With proper subtractions, the two photocurrents fed to the TIA's can be expressed as

$$I_{BD1} \propto \sqrt{P_S P_R}\cos[\theta_S(t)+\theta_C(t)];$$

$$I_{BD2} \propto \sqrt{P_S P_R}\sin[\theta_S(t)+\theta_C(t)];$$