ECE558 Course Project Photonic Testbed for E-O-E Neuron Characterization

Instructor: Prof. Paul Prucnal, Mentor: Josh Lederman

Mihir Kavishwar

First Year PhD Student Electrical and Computer Engineering Princeton University

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Outline

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- 4 Measurement Results
 - THRU Port Measurements
 - DROP Port Measurements
 - Combined Results

5 Conclusion & Future Work

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Introduction & Motivation



Figure: Neural Network example

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• Photonic systems have the following advantages over electrical systems:

- High operational bandwidth
- Lower cross-talk between multiplexed channels
- Lower power dissipation
- This motivates research into photonic integrated circuits for performing neural network computations

Photonic Neural Networks



Figure: Optical broadcast and weight network

A. N. Tait, M. A. Nahmias, B. J. Shastri and P. R. Prucnal, "Broadcast and Weight: An Integrated Network For Scalable Photonic Spike Processing," in Journal of Lightwave Technology, vol. 32, no. 21, pp. 4029-4041, 1 Nov.1, 2014, doi: 10.1109/JLT.2014.2345652.

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Photonic Neural Networks



Figure: Microring Resonators (MRR) used as tunable spectral filters in an optical broadcast and weight network

A. N. Tait et al., "Microring Weight Banks," in IEEE Journal of Selected Topics in Quantum Electronics, vol. 22, no. 6, pp. 312-325, Nov.-Dec. 2016, Art no. 5900214, doi: 10.1109/JSTQE.2016.2573583.

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Photos/lr_layout.PNG

Figure: Layout of Lionrock chip designed by Lightwave Lab

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Photos/lr_layout_annotated.png

Figure: Layout of Lionrock chip designed by Lightwave Lab

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Photos/heater_mods.png

Figure: *MRR*₂ with heater modulator

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Figure: Test setup for E-O-E Neuron Characterization

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Figure: Test setup side view



Figure: Test setup top view

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Figure: Complete test setup

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THRU Port Measurements



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THRU Port Measurements



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THRU Port Measurements



MRR Weight Bank THRU spectrum

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DROP Port Measurements



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DROP Port Measurements



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DROP Port Measurements



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Best fit curve for the data

 $\lambda_0 \; (\textit{nm}) pprox 1548.99 + 4.945 imes 10^{-8} imes (i \; (\mu A))^2$

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Predicted MRR₂ (THRU-DROP) spectrum at different input currents

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Measured MRR₂ (THRU-DROP) spectrum at different input currents

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MRR₂ (THRU-DROP) power as a function of current for $\lambda_{in} = 1548.99$ nm

Fixing $\lambda = 1548.99nm$ and sweeping over the input current to vary λ_0 (and thus control $P(\lambda, \lambda_0)$). This represents the weighting performance of E-O-E heater modulators.

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• Weighting performance of E-O-E heater modulators was characterized by setting up the photonic testbed

- Future work includes:
 - Characterize the weighting performance of E-O-E PN modulators
 - Determine the frequency performance of both modulators
 - Determine the noise figure of both the modulators
 - ► Enable remote operation of OSA with GPIB Ethernet controller

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