Semiconductor Optical Amplifiers: Understanding and Modeling Electron-Photon Interaction

Name: Muhammad Farhan Abbasi

Lab: OCPN

Mentor: Vikrant Lal

Advisor: Prof. Daniel J. Blumenthal

Funding: DARPA – Chip Scale WDM

Program: INSET, UCSB, Santa Barbara

College: Mission College, Santa Clara

Transfer: UCSC, Santa Cruz (Fall 2003)

Major: Computer Science

Overview

- Background of Fiber Optic Networks
- Significance of SOA's in Wavelength Converters
- My Contribution in the Project : Simulations and Lab Experiments
- Future Applications
- Summary and Acknowledgement

Semiconductor Optical Amplifiers: Understanding and Modeling Electron-Photon Interaction

- Fiber Optic Technology and The Present Internet
- Wavelength Division Multiplexing (WDM)
- Fundamental Components of WDM
- Semiconductor Optical Amplifiers (SOA)
  - Building Blocks of the Wavelength Converter
- The Need of a Single Chip Integrated Wavelength Converter

The Objective

- Significance of an SOA in Wavelength Converters

- Understanding and Modeling an SOA to improve device design

LASER

Signal In

Signal Out

Wavelength Converter

SOA
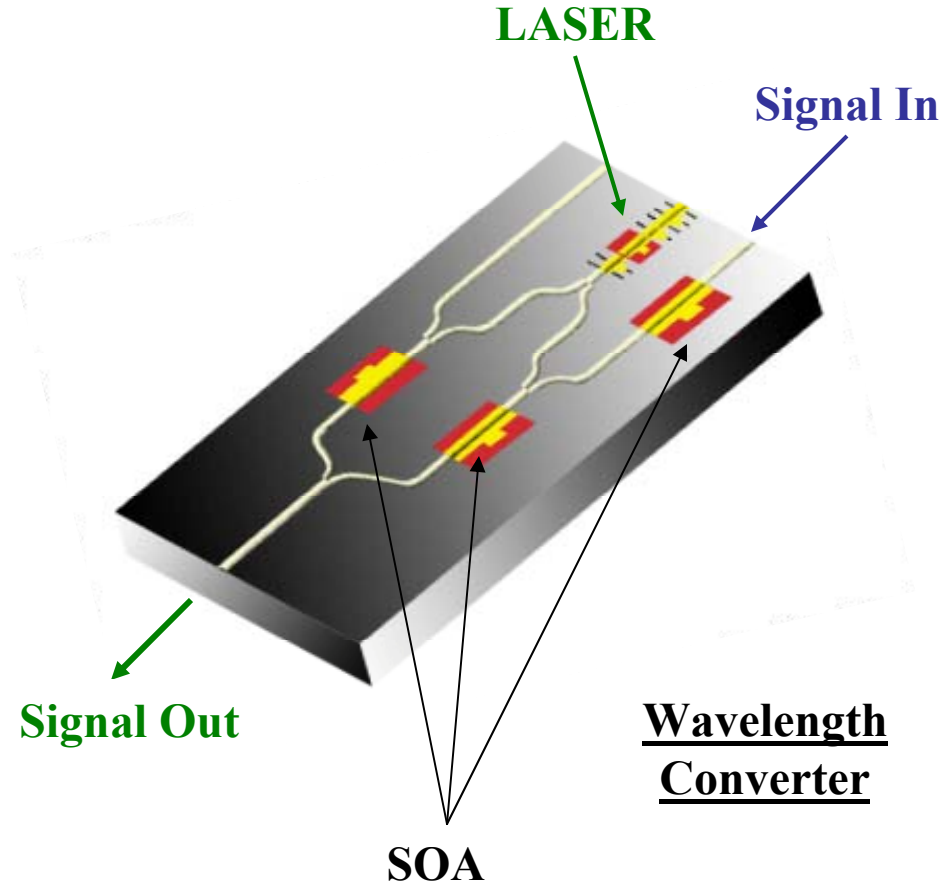
Part I : My Contribution in the Project

● **Coded a Simulation Regarding SOA's in C Language**

Reference Book : "Numerical Recipes in C" by Press, William H. et. all

Stage I :

➢ Reading Binary Files
➢ Computing Root of a Non-Linear Equation
➢ Solving Ordinary Differential Equation
   using Runge-Kutta method

Stage II :

➢ Integrating Smaller Parts to Formulate Simulation
➢ Running Simulation on Test Data

Stage III :

➢ Testing Simulation for Speed and Performance
➢ Comparing Results with Existing Simulation
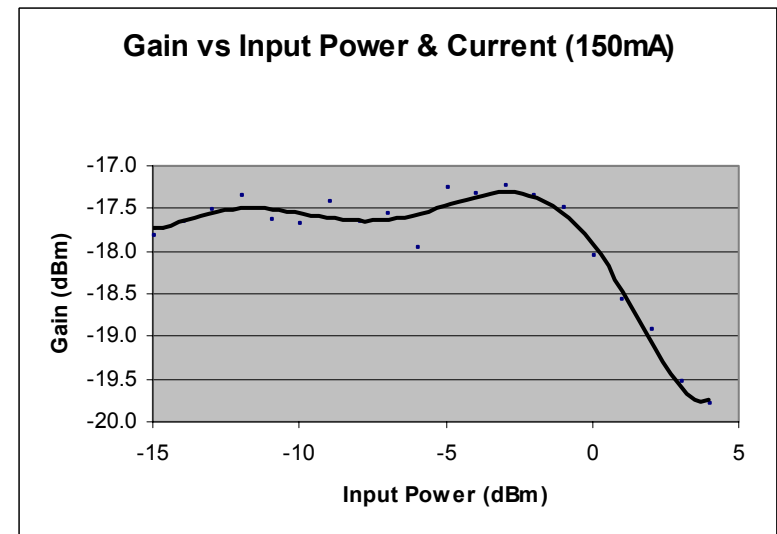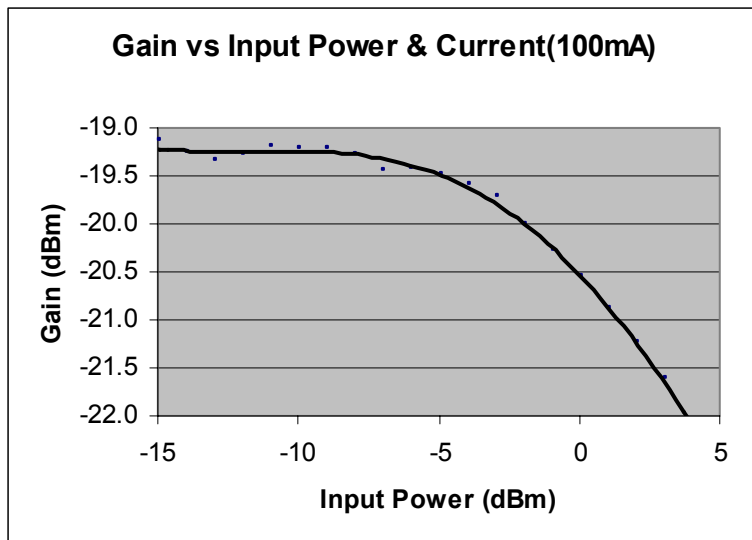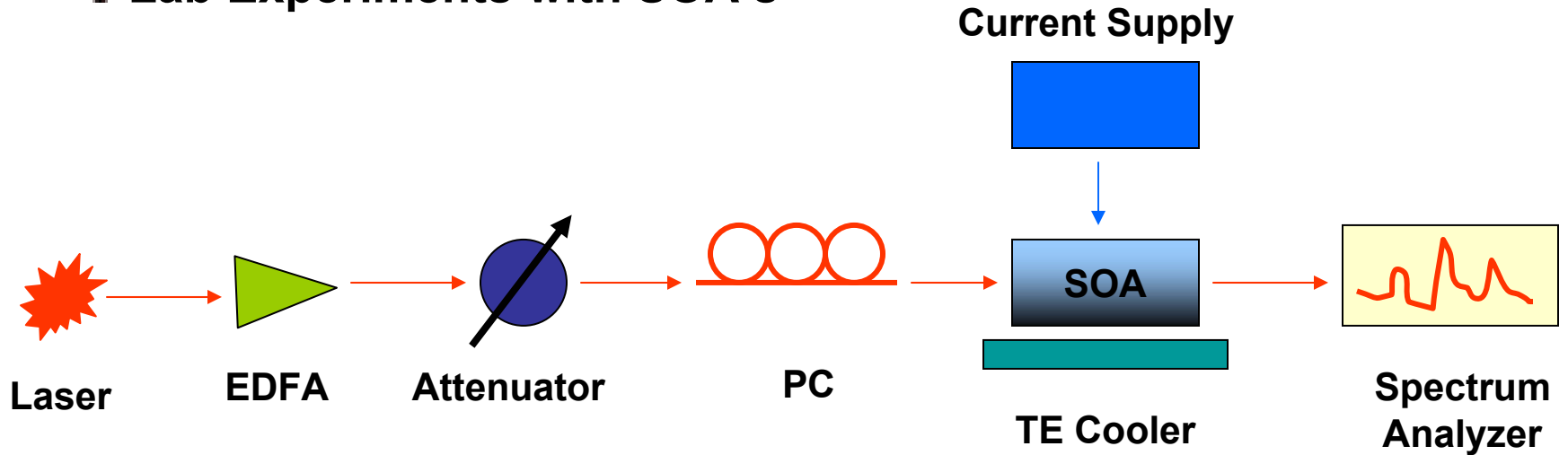
Gain, Input Power, & Applied Current

- As the Input Power increases, Gain Decreases (Why?)

  [Incoming Photons will take away more electrons from conduction band, hence, decreasing electron density]

- Gain curve drops much faster with higher Input Current

Gain vs. input Power and Current

I = 100mA

I = 60mA

Gain (dB)

Input Power (dBm)
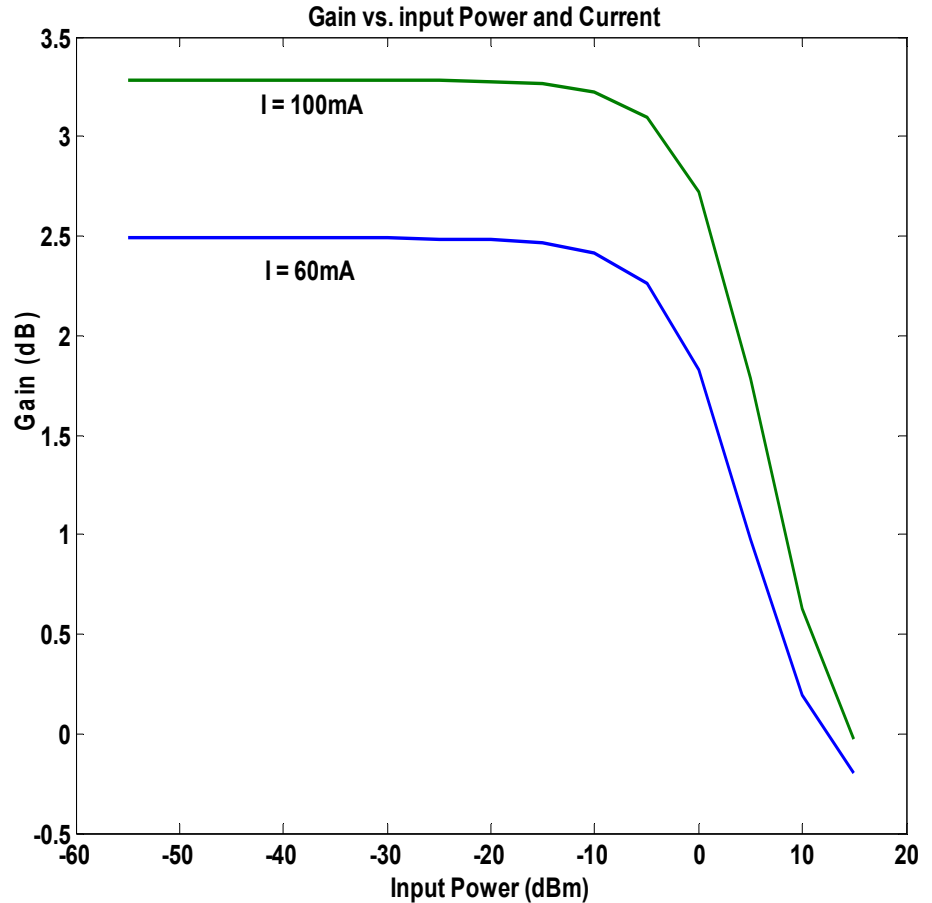
Data Plot Provided by Vikrant Lal, OCPN, UCSB

Part II : My Contribution in the Project

● **Lab Experiments with SOA's**

Laser → **EDFA** → **Attenuator** → **PC** → **SOA** (with **Current Supply**, **TE Cooler**) → **Spectrum Analyzer**

Gain vs Input Power & Current(100mA)

Gain vs Input Power & Current (150mA)

Future Applications

- This simulation will be helpful in improving the structure of the existing wavelength converter

- Understanding the working of SOAs in combinations would be easier with this simulator

- Various designs of wavelength converters and SOAs can be investigated in broader detail

Summary

- Present fiber optic networks will improve their performance by using such devices that overcome electronic speed

- Semiconductor optical amplifiers play a vital role in fiber optic networks

- Simulations are important tools for understanding semiconductor optical amplifiers and related devices like wavelength converters

Acknowledgement

I would like to thank

- University of California, Santa Barbara

- INSET

- Prof. Daniel J. Blumenthal & Vikrant Lal of the Department of Electrical & Computer Engineering & the OCPN team