Final Year Projects – 2018

Integrated Photonics Group

Overview:

This year, a number of projects have been created where the student will work with researchers in the Integrated Photonics Group. The projects include a mixture of experimental and theoretical elements covering numerical simulations, optical and electrical test & characterisation, equipment development and photonic device design. While all projects are on offer, only a subset will be filled. Many can be either long or short projects, and are described accordingly. Please contact Frank to discuss any of these projects.

The 2018 Projects:

Project #1 Laser Measurements (with possible theory)

The purpose of this project is to build and demonstrate testing capabilities for semiconductor diodes lasers. This includes the electrical characterisation (light, current and voltage), but may also include more sophisticated measurements include laser parameter extraction (e.g. mirror reflectance and gain). As a supplement to the project, the student may be interested in developing laser simulations to better extract parameters from the test.

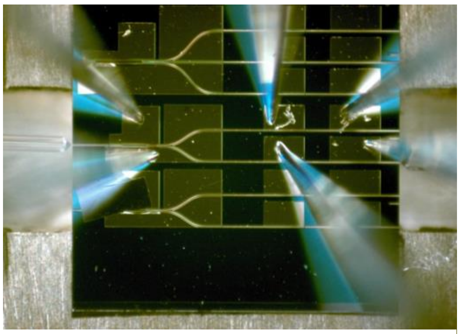


Figure 1 - multiple lasers under test

A possible alternative experimental project would be the measurements of injection locked laser demuliplexers.

Scope: Experimental with possible Theoretical extension (6 or 12 weeks)

The student will learn about the characterisation of semiconductor lasers.

Project #2 Laser Theory

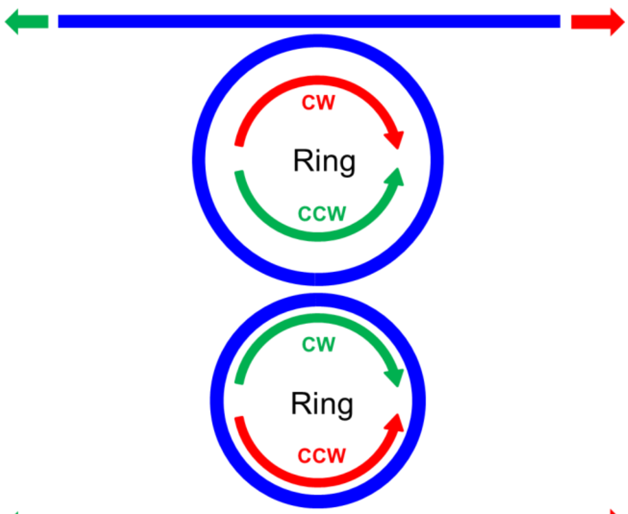


Figure 2 Schematic of a dual ring laser

In the Integrated Photonics Group, we design and make lasers. To ensure that the lasers have the characteristics we would like, it is useful to extensively model lasers in the design stage.

There are two areas of focus with laser modelling:

1) Laser cavity resonances: this uses the mathematics of optics to calculate the strength of all resonances in a laser cavity. For example, with the dual rings laser shown in Figure 2, what is the mathematical expression for the frequencies/wavelengths that resonate in the device?
2) Laser equations: this modelling considers the gain within a laser cavity, and solves the non-linear equations associated with these equations in order to predict the lasers performance.

Scope: Theoretical (6 or 12 weeks)

The student would learn about lasers, especially:
Focus 1) laser resonances, solved primarily by analytical calculations
Focus 2) laser dynamics, by solving non-linear equations using a computer

Project #3 Characterizing and modeling the effects of noise in the LC-RDSHI (loss compensated delayed self-heterodyne interferometer) for narrow laser linewidth measurements

Narrow linewidth lasers are needed in photonic integrated circuits (PICs) for telecommunication systems, especially as the spacing between adjacent communication channels becomes smaller. To make sure that the lasers developed for use in telecommunication systems a method to correctly characterize the linewidth is important. Many commercial high end optical spectrum analyzers only have resolutions of 0.01 nm (1.25 GHz near 1550 nm) to 0.005 nm (625 MHz near 1550 nm), however the linewidth of the lasers we are measuring are less than 500 kHz. One method for measuring narrow laser linewidth is using a LC-RDSHI. The measureable linewidth depends upon the delay time being longer than the coherence time of the laser.

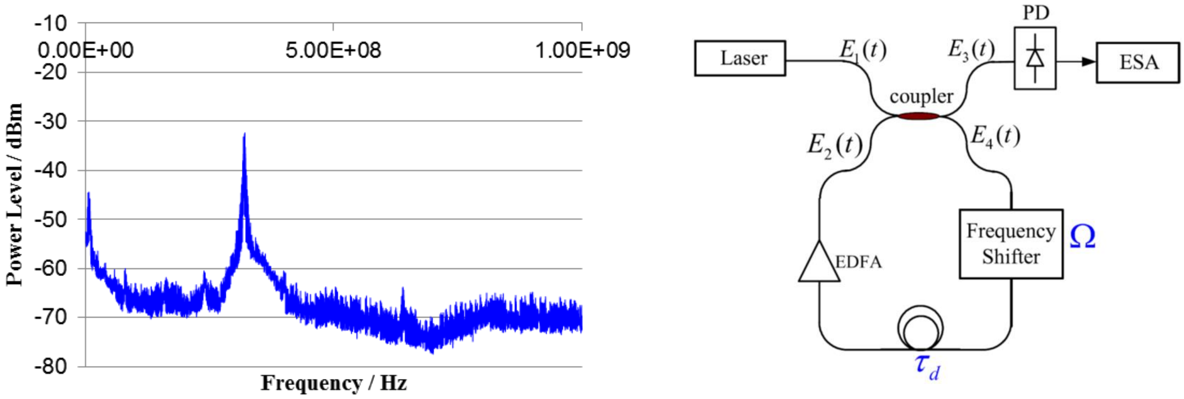


Figure 2 a. Measured electrical spectra of the laser using an LC-RDSHI with an optical switch placed after the laser. The spectra in Fig. 2 a. is measured using the LC-RDSHI setup shown in Fig. 2 b.

The scope of this project will focus on experimentally and theoretically analyzing the sources of noise in the LC-RDSHI setup in the laboratory to give recommendations on how to improve the system. Commercial and lasers built in house will be tested using the system. The work will build upon existing LabView code for controlling the system and analyzing the laser linewidth.

Scope: Theoretical and Experimental (6 or 12 weeks)

The student will learn about semiconductor lasers, and linewidth measurements

LineWidth Measurement: http://www.rp-photonics.com/self_heterodyne_linewidth_measurement.html

Project #4 Optical Device Simulations

There are multiple possible projects. Some require coding, while others would utilise existing code, which will be run. Please talk to Frank about possible subjects.

There are multiple theoretical project possibilities related to the injection locking of lasers, both master-slave (i.e. light only goes one direction), and mutually coupled (where light goes both directions) systems

Scope: Theoretical (6 or 12 weeks)

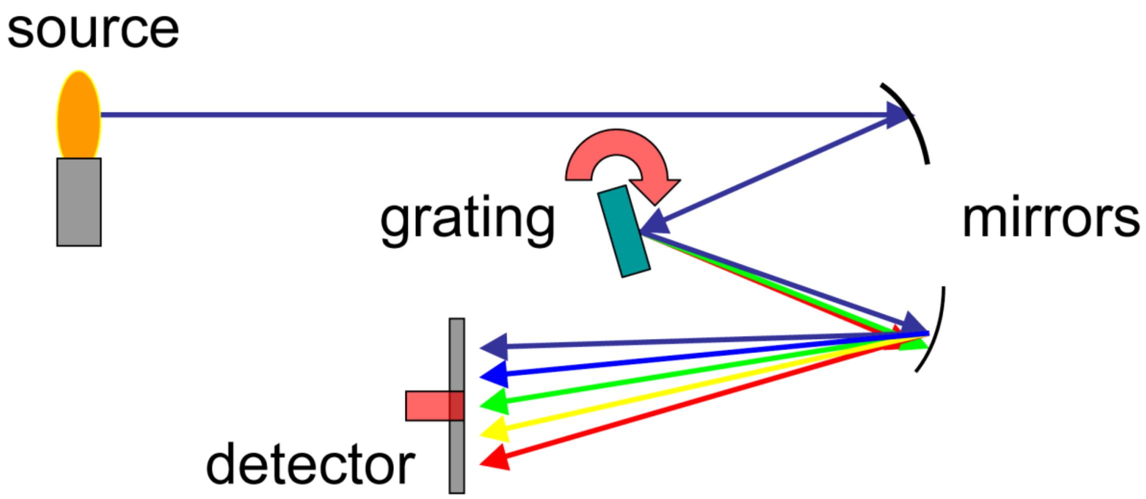
Project #5 Software development for Photonic Integrated Circuits

Within the Integrated Photonics Group, we have developed a software tool for the design and analysis of photonic integrated circuits, which has been licensed to a number of companies including Intel. There are additions that could and should be made to the tool. Thus, if a student was interested in a C++ based project, they should contact Frank Peters to discuss options.

Scope: Code based theoretical (6 or 12 weeks)

Project #6 Building Things

Finally, we are always building things in our research group: devices, circuits, equipment etc. If you are interested in getting your hands dirty, please talk to Frank about possibilities. One of many possible options for 2016/17 is to build and characterise a Czerny-Turner optical spectrometer. This project would be a collaborative effort between Prof. Peter and Dr. Cotter.



There are also numerous possible projects based on LabView and/or electronics, where new experiments would be developed. If this is of interest, please come by to discuss options.

Scope: Experimental (12 weeks)

Summary Matrix

		Experiment	Theory	Programming
1	Laser Measurements	Yes	possible	LabView
2	Laser Theory	No	Yes	likely
3	Laser Linewidth	Yes	Yes	LabView
4	Simulations	No	Yes	likely
5	Optical design tools	No	Yes	C++
6	Making things	Yes	?	?