On-chip directly phase-modulated laser source for QKD applications

by Pablo Vilar Gómez and Francisco Díaz Otero

2018 WORKSHOP PhD STUDENT PROGRESS

Motivation of the work

Indium Phosphide (InP) photonics offers a significant advantage when compared to Silicon Photonics, it allows the integration of active elements. This gives us the ability to add laser sources to Photonic Integrated Circuits (PIC).

This proposal will develop will develop an on-chip directly phase-modulated laser source for Quantum Key Distribution (QKD) applications.

Thesis objectives

- Development of a direct modulation system for a Distributed Bragg Reflector (DBR) laser with random phase modulation for QKD communication systems
- Development of a DBR laser
- Development of the modulator
- Joining together the modulator and laser, manufacturing and characterization

Research plan

	2018			2019				2020			
Literature review											
Design of the photonic directly phase-modulated transmitter prototype											
Manufacturing and characterization of the transmitter											
Design and implementation of interfaces between photonic and RF equipment											
Experimental results and comparison with theoretical predictions											

Next year planning

The next year planning includes the following tasks:

- Design of the photonic directly phase-modulated transmitter prototype
- Manufacturing and characterization of the transmitter
- Design and implementation of interfaces between photonic and RF equipment

Results & discussions

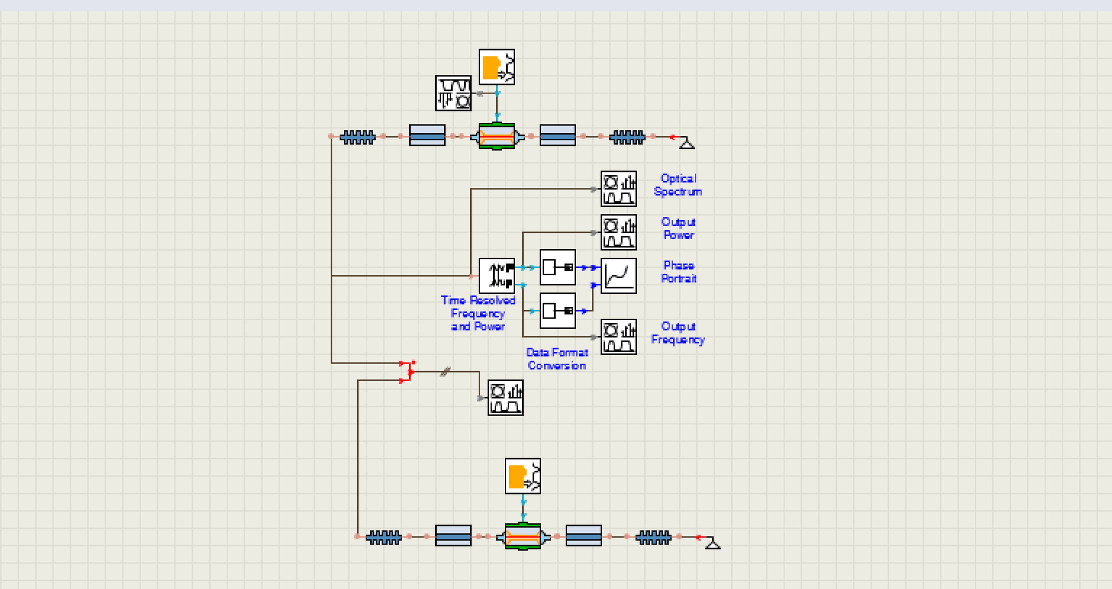

Figure 1. Laser design schematic

The DBR laser is composed by a Semiconductor Optical Amplifier (SOA) and two gratings.
The gratings are designed to reflect light at a specific bandwidth. One has is highly reflective and the other has low reflectivity.
The parameters of the gratings determine the laser's peak frequency and bandwidth.

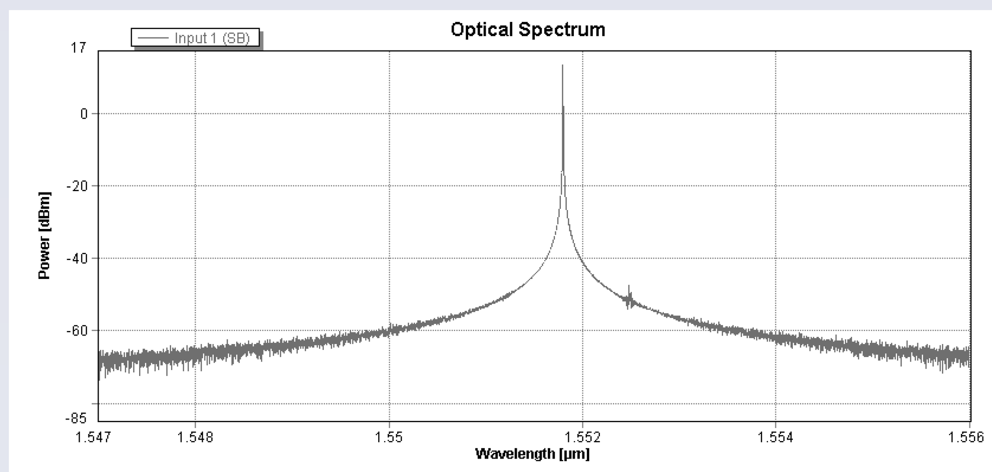

Figure 3. Simulated laser spectrum

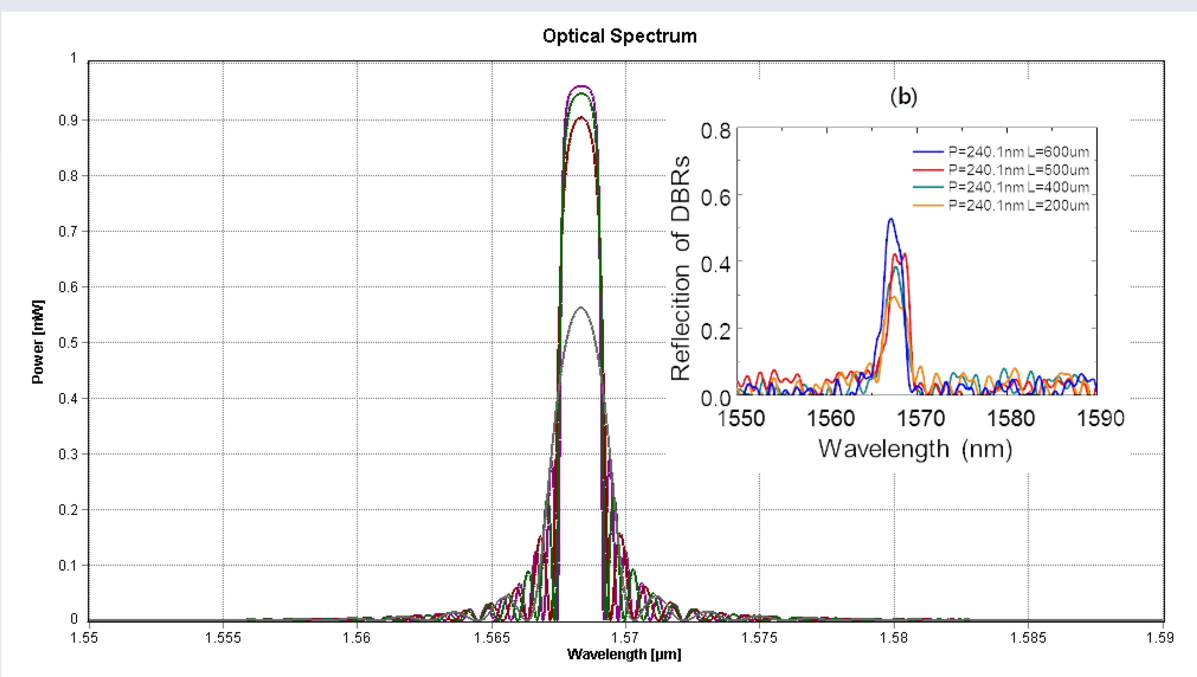

Figure 2. Simulated and measured gratings

The differences between the simulation results and the measured data can be considerable. The differences are caused by changes small in some parameters during manufacturing like, for example, the effective index of the gratings, which shifts the peak frequency significantly.

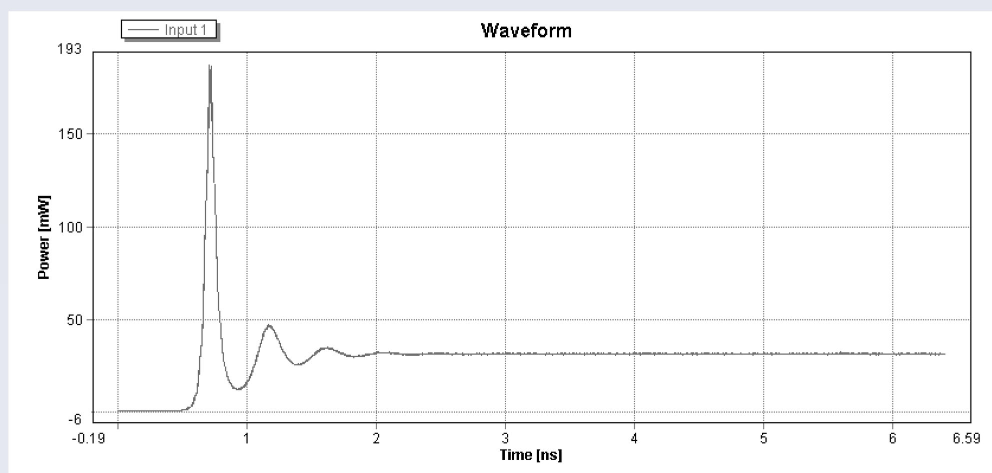

Figure 4. Time domain simulation

References

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2.Zhao, D., Augustin, L. M., Pustakhod, D., Williams, K. A., & Leijtens, X. J. M, *Design of uniform and non-uniform DBR Gratings using transfer-matrix method,* Proceedings of the 20th Annual Symposium of the IEEE Photonics Benelux Chapter, 26-27 November 2015, Brussels, Belgium (pp. 87-90). Brussels: OPERA-photonics, Brussels School of Engineering
3.Zhao, D., Augustin, L. M., Bolk, J., Pustakhod, D., Williams, K. A., & Leijtens, X. J. M., *Distributed Bragg reflectors on InP platform fabricated with deep-UV technology*, Proceedings of the 21st Annual Symposium of the IEEE Photonics Society Benelux Chapter, November 17-18, 2016, Gent, Belgium (pp. 231-234). Gent: Universiteit Gent.