

Bachelor / Master Thesis: Ultrafast optical ranging using mode-locked laser diodes

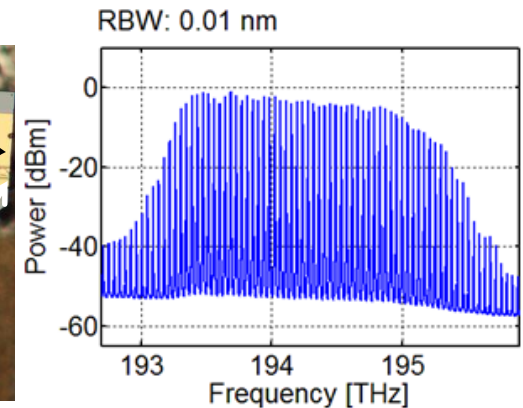
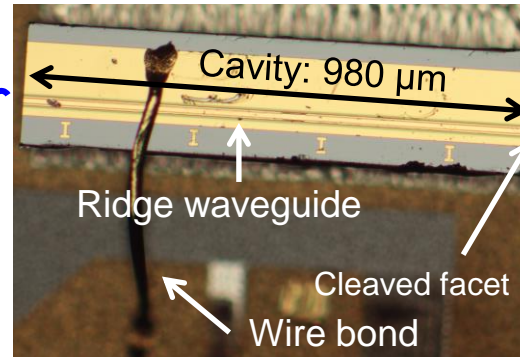
Introduction

Contactless optical distance measurements (ODM) are used in a wide range of scientific and industrial applications¹. So far, typical ODM systems achieve up to kHz-sampling rates while maintaining an application-specific required precision. In our experiments², we have used frequency combs to overcome typical parameter regimes and achieve world-record sampling rates of 100 MHz while maintaining a sub- μm precision. In this experiment, we investigate the applicability of a simple to operate frequency comb source not used so far for optical ranging: Quantum-dash mode-locked laser diodes³. These devices feature a frequency comb with an overall range of ~ 2 THz at an output power of ~ 10 mW, which makes them suitable for e.g. optical communications⁴.

Research interest

First tests indicate that sampling rates in the order of GHz may be possible while still having a reasonable precision, which has to be further explored. Also ranging towards targets close to possible real-life applications and at high target speed in the order of the speed of sound has to be performed. Finally, advanced digital signal processing techniques that may extend the measurement range should be investigated, which is so far inherently limited due to the phase periodicity of electromagnetic waves.

Top-view of QD-MLLD



Your tasks

- Laboratory work: Operate the experimental setup and record data for further evaluation. Perform changes in the setup (fiber-based as well as free-spaced parts) depending on target requirements
- Digital signal processing: Implement DSP blocks in the existing code, evaluate recorded

Interested? More detailed information here:

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[1] Bergovic, G.; Shafir, E. : **Optical methods for distance and displacement measurements**. *Advances in Optics and Photonics*, 4, 441–471 (2012)

[2] Trocha et al.: **Ultrafast optical ranging using microresonator soliton frequency combs**. *Science*, 359(6378), 887–891 (2018)

[3] Rafailov et al.: **Mode-locked quantum-dot lasers**. *Nature Photonics*, 1, 395–401 (2007)

[4] Marin et al.: **8.32 Tbit/s Coherent Transmission Using a Quantum-Dash Mode-Locked Laser Diode**, *Conference on Lasers and Electro-Optics (CLEO)*, paper STh1F.1, (2016)