Master projects at the Ultrafast Photonics laboratory, 2020

Laboratory description

At the ultrafast photonics laboratory, we develop laser frequency comb technology on a chip scale. Laser frequency combs were conceived at the beginning of the 21st century, motivated by the need of measuring optical frequencies with great precision and accuracy [1]. Today laser frequency combs are commercially available and can measure frequencies with 20 digits of precision! However, they remain bulky and expensive, and only a bunch of laboratories around the world, including ours, can afford using them. Integrated, chip-scale frequency comb sources would not only facilitate their use outside the laboratory environment, but also enable new applications, from spectroscopy to optical communications [2].

Why a Master thesis with us?

We work with chip-scale microresonator frequency combs and do research in all aspects: nanofabrication, physical modeling, characterization and practical applications. There is a master thesis topic for you in any of the above areas, depending on your interests.

You will get trained in advanced software tools for modeling photonic devices (Lumerical, COMSOL) and/or get hands-on experience with state-of-the-art laser systems.

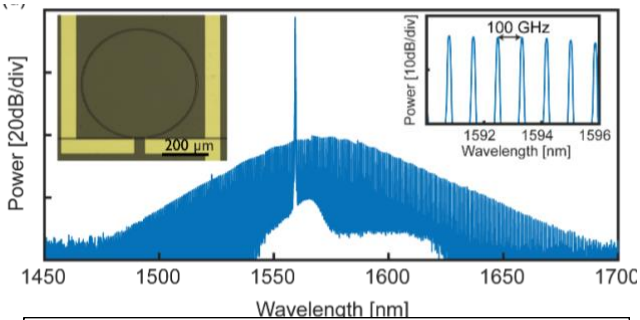

Figure. Spectrum of an integrated frequency comb. The left inset shows the microfabricated device with thermo-optic heaters on top. The right inset is a zoom in of the spectrum, showing the comb teeth, spaced in frequency by 100 GHz.

You will have a senior student or postdoc as main supervisor and Victor Torres-Company as examiner. The master thesis period is typically around 6 months, starting in January 2020, with some flexibility. Depending on the results, this could result in a scientific publication.

Current opportunities

Project 1. Comb-based swept-wavelength interferometry. The project is mainly experimental. The purpose is to develop a novel method to characterize integrated photonics devices fabricated at the cleanroom with a laser frequency comb. Contact us for further information.

Project 2. Laser cooling of microcombs. This project is mainly experimental. We use continuous-wave lasers to pump our integrated photonic devices. The laser has a power of just a few tens of mW, but this is enough to observe interesting thermal dynamics that, in some cases, can disrupt the formation of our chip-scale frequency combs. The idea to be investigated in this project is whether the thermal dynamics effects can be counteracted with the use of yet another laser, whose frequency is carefully adjusted far away from the pump wavelength. There can be drawn very interesting physical analogies to laser cooling of atoms. Contact us for further information.

Contact information: Assoc. Professor Victor Torres-Company (torresv@chalmers.se)

References

[1] Th. Udem et al., *Nature* **416**, 233 (2003).
[2] A. L. Gaeta et al., *Nature Photon.* **13**, 158 (2019).