Internship position

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On-chip pulse compression in the mid-IR wavelength range

Mid-infrared (mid-IR) spectroscopy is a universal way to identify chemical and biological substances. Indeed, when interacting with a light beam, most molecules are responsible for absorption at specific wavelengths in the mid-IR spectrum, allowing to detect and quantify small traces of substances. On-chip broadband light sources in the mid-IR are thus of significant interest for compact sensing devices.

In that regard, supercontinuum generation offers a mean to efficiently perform coherent light conversion over an ultrawide spectral range, in a single and compact device. This effect has been used previously in many waveguide platforms, and more specifically two-octave supercontinuum generation has been demonstrated, ranging from 3 to 13 µm , using Ge-rich graded index SiGe waveguides. [1]

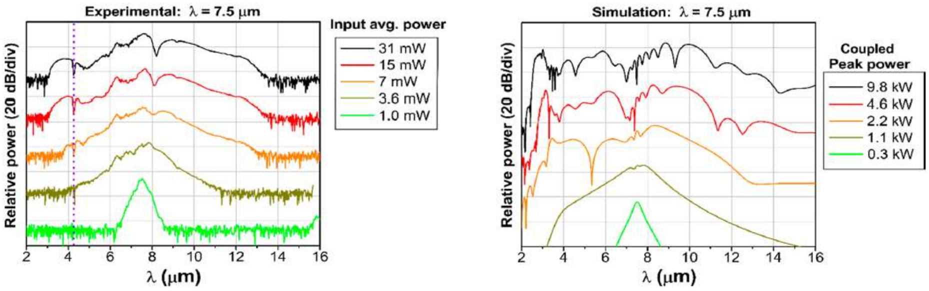

Figure 1: Supercontinuum generation in SiGe photonics circuits, from [1]

However, high input peak power of almost 10 kW is used in these demonstrations, which is only achievable with bulky tabletop laser systems operating in pulsed regime. The objective of the work is to demonstrate the possibility to achieve supercontinuum generation with compact Quantum Cascade Laser (QCL) sources. Indeed, recent works have shown the possibility for pulse generation with QCLs based on external pulse compression of the frequency modulated frequency comb [2]. In this demonstration, up to 10W peak power was reached at the output of the QCL, but again at the cost of a table size set-up.

In parallel, on-chip pulse compression has been demonstrated in the literature but only in the near-IR wavelength range [3-4].

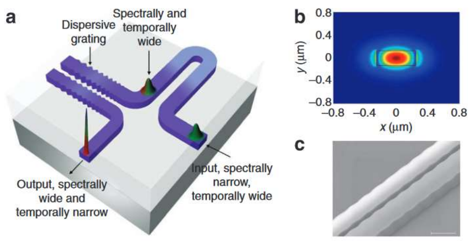

Figure 2: on-chip pulse compression, from [3]

In this context, the objective of the internship **is to develop the first mid-IR on chip pulse compressor**. The main objective is to be able to give rise to ultra-short high power sub-picosecond pulses, up to 1kW, from a frequency comb QCL.

The research activity will include:

- **theoretical study and optical simulations** (using commercial software) to study and optimize the optical devices. Different solutions will be investigated based on the use of dispersive gratings or on periodic structures.
- **definition of a fabrication process flow** to fabricate the photonic circuits
- **experimental characterizations** of devices, using a mid-IR optical bench existing in the group

The work is done in the framework of a collaboration with L-Ness lab (Politecnico di Milano)

BIBLIOGRAPHY RELATED TO THE TOPIC

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