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**Title of the project: Broadband heterodyne interferometry**

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Laboratory / Department / Team : **Photonics / PRISM**

**Collaborations:**

## Summary:

Modern photonic technologies, from neuromorphic optical hardware to quantum photonics and environmental sensing, rely on materials whose optical properties change under intense light. Precisely measuring these nonlinear optical effects is therefore a key challenge for the development of next-generation photonic devices.

At the ICB laboratory, we recently developed a new measurement technique called nonlinear heterodyne interferometry ([Rogemont et al., 2025](#)). This method allows extremely sensitive measurements of light-induced nonlinearities in optical materials.

The goal of this project is to design and build a new broadband interferometer capable of characterizing nonlinear optical effects over a very wide spectral range: from the visible (400 nm) to the mid-infrared (10  $\mu\text{m}$ ).

Unlike previous setups in the laboratory that rely on fiber-optic components restricted to telecommunications wavelengths, the new instrument will use a free-space optical architecture. This approach has two major advantages: operation over a much broader wavelength range and reduced phase noise compared to fiber-based interferometers.

To enable sensitive detection in this configuration, the project will implement a pseudo-heterodyne detection scheme inspired by the technique developed by [Ocelic et al. \(2006\)](#).

During this project, the student will:

- Design and assemble a free-space interferometer,
- Implement frequency-modulated pseudo-heterodyne detection,
- Align and optimize a precision optical setup,
- Test the system using different laboratory laser sources (400 nm  $\rightarrow$  10  $\mu\text{m}$ ),
- Measure the nonlinear optical response of integrated photonic waveguides

**Type of project (theory/experiment): Experiments**

**Required skills: Free space optics, nonlinear dynamics, signal processing**