# Master thesis proposal

*CNRS UMR 7588*
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*Director: Massimiliano Marangolo*

**Title**: **Tailoring Ultrasonic Waves through Phase-Controlled Optical Generation**

**Keywords**: *lasers, acoustic waves, nanostructures, spectroscopy*

**Scientific description**: The aim of this master's level internship is to advance a picosecond ultrasonics setup by incorporating a Spatial Light Modulator (SLM) into the optical excitation pathway. This novel integration will allow the precise generation and control of Surface Acoustic Waves (SAWs) on unstructured, flat surfaces by modulating the phase of ultrafast laser pulses. The project offers a unique opportunity for the intern to work at the intersection of ultrafast optics, acoustics, and photonics, contributing to cutting-edge advancements in acoustic signal processing, materials characterization, and wavefront engineering.

**Background:** Surface Acoustic Waves (SAWs) are critical in a wide range of applications, from sensors and non-destructive testing to advanced communication technologies. Traditional methods for generating SAWs involve the use of custom-fabricated nanostructures to define specific wavefronts and spatial distributions. However, these methods are rigid, labor-intensive, and costly. By introducing phase modulation through a Spatial Light Modulator (SLM), it is now possible to generate reconfigurable, complex SAW patterns without the need for physically altering the sample surface. This new approach enables dynamic control over the spatial and spectral characteristics of the SAWs, allowing for more flexible and efficient testing of material properties.

**Project Scope.** During the internship, the student will engage in the following tasks:

1. **System Integration**: The intern will integrate the SLM into an existing picosecond ultrasonics setup, optimizing the alignment and phase modulation parameters for precise control over the laser-induced SAWs.
2. **Phase Pattern Design**: Using optical modeling software, the intern will design phase patterns to be encoded on the SLM. These patterns will control the spatial distribution of the laser excitation, enabling the generation of tailored SAW wavefronts, point sources, and complex displacement maps.
3. **Experimental Testing**: The intern will conduct experiments to generate and characterize SAWs on various flat, unstructured surfaces. Through this work, the student will explore different wavevector configurations to study SAW dispersion relations in test samples.

**Applicant skills**: Strong Foundation in Optics and Photonics, experience with computational tools such as MATLAB, Python

**Industrial partnership**: N **Possibility for a Doctoral thesis**: y

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