
# Florence labs visits

On May 19 you will have the chance to visit 4 laboratories of UniFi and Lens, based on your preferences. We will do our best to match your choices, but please note that you may be assigned to one or two labs outside your top 4. Kindly rank the labs from the one you're most interested in, to the one you're least interested in, in the form LoT25 - Florence lab visits.
The laboratories are color coded based on the main area of interest, but this is just for better readability.
on the right you can find a few links to articles and websites related to the labs.

Biomedical appl. | Photonic materials | Ultracold atoms

## A) Lab 9 Lens – Scattering

In Lab 9, we investigate how light propagates through opaque and optically complex media, focusing on systems where traditional models of light transport fail. Our research combines experimental optics and computational simulations to explore how disorder, anisotropy, and absorption affect the diffusion and scattering of light. These studies have a wide range of applications, including the development of advanced diagnostic techniques using infrared light, the design of photonic systems for secure information transfer in cybersecurity, and the implementation of compact, efficient photonic circuits for integrated optical technologies. Through a deeper understanding of light-matter interactions in complex environments, we aim to contribute to both fundamental science and applied photonics.

bioRxiv, 2025.04.02.646745

10.1103/PhysRevResearch.6

scholar.google.pini


## B) Lab 10 Lens – Photonic crystals

In lab 10 we investigate the light transport and confinement properties of peculiar nanostructures (nanocavities, quasi-2d topologically engineered surfaces, disordered engineered quasi-2d photonic crystals). The aim is to control the light-matter interaction at the nanoscale. Experimentally, we take advantage of a near field optical microscope in order to reconstruct the electric field intensity spatial distributions with sub-diffraction resolution.

Francesca-Intonti

## C) Lab 20 Lens – Random lasers

We study soft materials relevant to biomedicine and the food industry, focusing on self-assembling proteins like amyloid fibrils, which are linked to diseases such as Alzheimer's and type II diabetes. The dynamic evolution of such materials is explored using time-resolved laser spectroscopy, where the sample is impulsively excited, allowing us to monitor the material's response over a broad range of timescales, from femtoseconds to milliseconds.

Alice-Boschetti

## E) Lab 43 Lens – Single molecule microscopy

In our lab, we apply concepts from physics and photonics to develop optical microscopy techniques for studying biological systems at the nanoscale. Using approaches such as inclined light sheet microscopy and precise particle localization methods, we achieve high-resolution, stable 3D imaging. Our work aims to reveal the spatial organization and molecular dynamics of complex systems, including the distribution of proteins in bacterial biofilms, by integrating advanced optical design with quantitative physical analysis.

Marco-Capitanio


## D) Lab 45 Lens – Dysprosium Lab

At the Dy Lab, we investigate quantum many-body phenomena in ultracold gases of highly magnetic dysprosium atoms, where dipolar interactions dominate. Our work focuses on low-dimensional systems and exotic phases of matter, such as dipolar supersolids with both superfluid and crystalline properties. Through precision measurements like Josephson oscillations, we explore the collective dynamics of these systems, advancing quantum simulation with strongly interacting atomic gases.

Dy_quantumgases

## F) Lab 12 UniFi – Optical resonators

In the quantum optomechanics Lab, we study the interaction between light and mechanical systems using high-finesse optical cavities and mechanical resonators like membranes and levitated nanoparticles. Our goal is to explore quantum effects in macroscopic systems, such as squeezed motion and quantum non-demolition measurements, with applications in precision sensing and fundamental tests of quantum mechanics.

Francesco-Marin
Francesco-Marino

## G) Lab 21 UniFi – Light-sheet microscope

In our lab we developed advanced two-photon light-sheet microscopy for high-resolution, whole-brain imaging in zebrafish larvae with minimal visual interference. This enables real-time studies of neural activity during sleep and seizures, revealing brain regions involved in pathological dynamics. We also use optogenetic stimulation to modulate circuits, showing improved recovery in brain injury models via combined stimulation and motor training. This integrated approach enables precise studies of brain dynamics and plasticity.

Lapo-Turrini


## H) Lab 29 UniFi – Potassium/Rubidium Lab

K_Rb_quantumgases

In the K-Rb experiment, we study the physics of multicomponent superfluids, by using an atomic gas of ultracold 87Rb and 41K, which are both bosons. While each of species is a superfluid by itself, the peculiarity is that the interactions between the two can be tuned by an external magnetic field, thanks to the phenomenon of a Feshbach Resonance. In this way, we can explore the whole of the mixture phase diagram, ranging from the immiscible regime, to the collapse region, where the attraction would make the cloud collapse on itself. In this latter regime, in particular, we have explored the quantum-droplet phase, where the collapse is stabilized by the quantum fluctuations: because of this fluctuations, the ultra-dilute gas acquires characteristics of liquids, such as incompressibility and surface tension, and opens up the possibility of exploring a little known state of superfluids.

## I) Lab 31 UniFi – Hyperspectral imaging

HyperProbe

In this lab, we are developing a hyperspectral imaging system, called HyperProbe, that integrates broadband spectroscopy with wide-field microscopy to study brain tissue, in particular brain tumors such as gliomas and meningiomas. The setup combines a supercontinuum laser, acousto-optic tunable filters, and a scientific CMOS camera to acquire high-resolution spatio-spectral maps. Our aim is to detect and quantify biochemical markers during neurosurgery and cortical stimulation. Students joining the lab will gain experience in photonics, optical system design, and data analysis at the interface between physics, imaging, and neuroscience.


## J) Lab 69 UniFi – Hytterbium Lab

Yb_quantumgases

The Yb Lab explores ultracold quantum gases using ytterbium atoms, cooled near absolute zero to create Bose-Einstein condensates and degenerate Fermi gases. Ytterbium's unique atomic structure, with metastable states and ultranarrow optical clock transitions, allows precise control of SU(N) symmetric fermionic systems. This enables quantum simulations of complex many-body systems, topological phases, and strongly correlated materials. Recent breakthroughs include the first direct measurement of Hall voltage and resistance in a neutral-atom quantum simulator, flavor-selective localization via SU(3) symmetry breaking, and coherent control of orbital Feshbach molecules for applications in quantum information and simulation.

## K) Lab 86 UniFi – Strontium Lab

Sr-Rydberg

In our lab, we are developing the first Italian platform for quantum technologies based on programmable arrays of neutral strontium atoms trapped in optical tweezers. Strontium's long-lived excited states and state-selective transitions enable precise control and readout, making it ideal for quantum simulation and computation. We have successfully trapped individual atoms in a one-dimensional array, achieving single-atom occupancy through light-assisted collisions. This milestone lays the groundwork for defect-free atomic arrays essential for scalable quantum systems. Our advancements in laser cooling techniques, including the integration of 679 nm and 707 nm repumper lasers, have significantly increased atom density, facilitating further progress in our optical tweezer experiments.