



## PhD in FISICA / PHYSICS - 38th cycle

**PNRR\_352 Research Field: ULTRAFAST NEAR- AND MID-INFRARED FIBER LASER FOR  
HYPERSPETRAL VIBRATIONAL MICROSCOPY APPLIED TO HISTOPATHOLOGY AND  
PRECISION MEDICINE**

**Monthly net income of PhDscholarship (max 36 months)**

**€ 1195.5**

In case of a change of the welfare rates during the three-year period, the amount could be modified.

### Context of the research activity

**Motivation and objectives of the research  
in this field**

The main goal of this project is the development of innovative laser sources generating ultra-short pulses in the spectral region between 1 and 3  $\mu\text{m}$  with all-fiber-laser technology for applications to vibrational hyperspectral microscopy for medical diagnostics. Microscopy is a crucial tool in the biological field and in medical diagnostics. For the analysis of biological tissues, microscopy requires preparatory activities on the samples, such as labeling, to allow their functional characterization, at the expense of irreversible sample degradation. The possibility of carrying out a functional microscopy on untreated, label-free samples, would allow to speed up tissue analysis and would open the possibility of real-time investigation of live samples and fragile biological systems. In this context, vibrational spectroscopy is widely recognized as a universal tool for the identification of molecular compounds in chemical and biological samples based on their selective response to light. The hyperspectral techniques that will be investigated within this project are direct vibrational spectroscopy methods (based on the use of fiber lasers in the mid infrared) and non-linear coherent Raman microscopy (through the use of two-color synchronized all-fiber lasers in the near-infrared).

**Methods and techniques that will be  
developed and used to carry out the  
research**

In collaboration with the start-up company CRI s.r.l., a spin-off of Politecnico di Milano, the scholar will develop ultrafast optical techniques (design, construction and



	characterization of ultrafast fiber-lasers working in the near- and mid-infrared) as well as mid-infrared spectroscopy techniques and nonlinear microscopy techniques (stimulated Raman scattering, second-harmonic generation and two-photo-excited microscopy).
<b>Educational objectives</b>	The scholar will receive a multidisciplinary training in topics including laser physics, nonlinear optics, vibrational spectroscopy, biomedical optics and microscopy. He/she will be exposed to steps required for the industrial development of a deep-tech instrument such as the coherent Raman microscope by the company CRI s.r.l..
<b>Job opportunities</b>	Due to the multidisciplinary training in cutting edge techniques of optics and photonics as well as vibrational spectroscopy and biomedical optics, the scholar will have excellent job opportunities in high-tech industries. In addition, he/she will be well positioned for an academic career.
<b>Composition of the research group</b>	2 Full Professors 2 Associated Professors 2 Assistant Professors 5 PhD Students
<b>Name of the research directors</b>	Gianluca Galzerano; Giulio Cerullo

<b>Contacts</b>	
gianluca.galzerano@polimi.it giulio.cerullo@polimi.it +39-02-23996164;+39-02-23996185; <a href="http://www.fisi.polimi.it/en/people/galzerano">http://www.fisi.polimi.it/en/people/galzerano</a> ; <a href="http://www.fisi.polimi.it/en/people/cerullo">http://www.fisi.polimi.it/en/people/cerullo</a> .	

<b>Additional support - Financial aid per PhD student per year (gross amount)</b>	
<b>Housing - Foreign Students</b>	--
<b>Housing - Out-of-town residents (more than 80Km out of Milano)</b>	--

<b>Scholarship Increase for a period abroad</b>	
<b>Amount monthly</b>	597.75 €
<b>By number of months</b>	6



National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Cambridge Raman Imaging (CRI)
By number of months at the company	18
Institution or company where the candidate will spend the period abroad (name and brief description)	
By number of months abroad	6

**Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information**

**Educational activities :**

Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): financial aid per PhD student per 3 years: max 4.872,90 euros per student.

**Teaching assistantship:**

There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

**Computer availability:** individual use

**Desk availability:** shared use

**Other information about Industrial Partner:**

Cambridge Raman Imaging srl

CRI is developing ultrafast and inherently synchronised fiber lasers based on graphene/carbon-nanotubes. These lasers will drastically simplify Coherent Raman Scattering systems enabling rapid and low-cost label free imaging. This technology enables new applications in medical technology where speed, ease of use and low cost are essential.