



PhD in FISICA / PHYSICS - 40th cycle

Number of scholarship offered	1
Department	DIPARTIMENTO DI FISICA

Description of the PhD Programme

The PhD Program aims at providing engineers and physicists with a general education in the basic areas of applied physics and specific knowledge in condensed matter physics, optics, lasers and photonics. To develop a research-oriented mind-set, the PhD students are guided to acquire problem-solving capabilities in a complex context, including in-depth problem analysis, identification of original solutions and capability of evaluating their applicability in given contexts. These skills will provide future doctors with major opportunities for their activities both in the academic field and in public and private companies and organizations.

The education contents are strictly related to the research activities carried out in the advanced experimental laboratories at the Department of Physics. In particular, 5 research lines can be identified:

- Ultrafast optics and spectroscopy: i) development of new nonlinear optics-based methods to generate broadly tunable pulses, from the infrared to the extreme-ultraviolet, with duration down to single optical cycle limit (from a few femtoseconds to attoseconds); ii) application to the study of primary photoinduced processes in atoms, molecules and solid state materials.
- Solid state lasers and photonic devices: i) development of ultra-broad band solid-state lasers and amplifiers for optical frequency combs; ii) femtosecond laser micromachining of transparent materials for novel optofluidic devices and integrated quantum optical circuits; iii) theoretical investigation and design of optical nanostructures for sensing applications.
- Photonics for health, food and cultural heritage. Development of innovative photonic systems and techniques and application in interdisciplinary fields relying on non-invasiveness and high diagnostic potential of optical means (e.g., fluorescence or photon migration). Projects involve theoretical investigations and simulations as well as extensive experimental work, including development of advanced laboratory set-ups and dedicated prototypes for use in real settings.
- Epitaxial growth and nanostructure fabrication (Milano-Leonardo and Como): i) synthesis of artificial materials for microelectronics, optoelectronics, plasmonics and spintronics; ii) optical and electron beam lithography; iii) spectroscopy and microscopy; iv) SiGe/Si heterostructures; v) graphene nanoelectronic devices; vi) magnetic thin films, oxide thin films.
- Electronic, optical and magnetic properties of low-dimensional systems (Milano-Leonardo and international synchrotron radiation facilities): i) x-ray spectroscopies with synchrotron radiation; ii)



ultrafast magnetic and electronic phenomena; iii) positron annihilation spectroscopy, antimatter production (at CERN); iv) nano-optics and plasmonics.

The specific research subject will be assigned within the first months of the PhD activity, with the agreement of the candidate and the Board of Professors of the PhD Program.

Most research is integrated with the activities of the Institute of Photonics and Nanotechnologies of the National Research Council (IFN-CNR) and with the Interuniversity Center LNESS (Laboratory of Epitaxial Nanostructures on Silicon and for Spintronics). Collaboration is also active with the IIT (Istituto Italiano di Tecnologia) Center for Nano Science and Technology. Several collaborations are on-going with high-level international institutions, both universities and advanced research centers (e.g., University of Cambridge, Massachusetts Institute of Technology, Stanford University, University College London, Harvard University). Students enrolled in our PhD Program will therefore have a real opportunity to gain experience also in prestigious laboratories abroad.

The Department of Physics is home to the PhD Program. Further information on the PhD Program and related research activities can be found at: www.fisi.polimi.it



PhD in FISICA / PHYSICS - 40th cycle

THEMATIC Research Field: DEVELOPMENT AND VALIDATION OF A MULTI-FUNCTIONAL OPTICAL TOMOGRAPH BASED ON SUPERCONDUCTING NANOWIRE SINGLE-PHOTON CAMERA

Monthly net income of PhDscholarship (max 36 months)

€ 1300.0

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 aim of this PhD project, in the framework of the fastMOT European pathfinder-open project (CUP D43C23000130006), is the development of an advanced workstation for non-invasive multi-functional spectroscopy and tomography based on a fast-gated single-photon camera with thousands of nanowire detectors. The goal of this research is to push biomedical photonic techniques beyond the state-of-the-art by developing and validating both on phantoms and in-vivo a unique instrumentation with top-class performances.
For more information: <https://fastmot.eu/>.

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

The PhD candidate will:

- i) perform preliminary time-domain near-infrared spectroscopy (TD-NIRS) and time-domain speckle contrast optical spectroscopy (TD-SCOS) investigations by using a state-of-the-art exploratory workstation already available at Politecnico di Milano that has been developed in the initial stage of the project for pilot studies;
- ii) integrate the new components developed by different partners in the framework of the fastMOT project into a novel workstation (i.e., the multi-functional tomograph) with boosted performances as compared with the state-of-the-art;
- iii) demonstrate the advancement by validating both on phantoms and in-vivo the new workstation. All this will be done in close collaboration with an international and interdisciplinary team of researchers.



Educational objectives	The PhD candidate will receive a multidisciplinary training in topics including lasers, detection techniques at the single-photon level, optical microscopy and tomography, study of photon migration through biological tissues, image reconstruction and analysis of biological signals. He/she will be exposed to the steps required for the development, validation and use of complex photonics instrumentation for next-generation biomedical diagnostic techniques.
Job opportunities	The candidate will be exposed both to the greatly growing field of health technologies and to the vibrant area of photonics with strong multidisciplinary attitude, well apt to find job opportunities in high-tech industries. In addition, he/she will be well positioned for a career in university or research center.
Composition of the research group	5 Full Professors 7 Associated Professors 9 Assistant Professors 20 PhD Students
Name of the research directors	A. Dalla Mora, L. Di Sieno, A.Pifferi

Contacts
<p><i>alberto.dallamora@polimi.it</i></p> <p><i>laura.disieno@polimi.it</i></p> <p><i>antonio.pifferi@polimi.it</i></p> <p><i>https://www.fisi.polimi.it/en/research-lines#photonics-for-health-food-and-cultural-heritage</i></p>

Additional support - Financial aid per PhD student per year (gross amount)			
	1st year	2nd year	3rd year
Housing - Foreign Students	1000.0 € per student	1000.0 € per student	1000.0 € per student
Housing - Out-of-town residents (more than 80Km out of Milano)	max number of financial aid available: 1, given in order of merit (only for students with scholarship)..		
	--		



Scholarship Increase for a period abroad	
Amount monthly	650.0 €
By number of months	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 5300,25 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