



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 39th cycle

Research Area n. 2 - Electronics

**THEMATIC Research Field: SPAD-BASED ARRAY DETECTORS FOR NEAR-INFRARED
PHOTON COUNTING**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

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

Non-Line-of-Sight (NLOS) imaging using time-of-flight information encoded in multiple scattered light can reconstruct images of objects hidden from the camera's direct line of sight. While first demonstrations were based on silicon SPAD arrays and pulsed lasers operating in the visible range, next generation NLOS imaging systems have to work in the near-infrared (NIR) or short-wave infrared (SWIR) wavelength ranges for reconstructing the hidden scene, neither harming people nor being detected. This research project aims to develop the first SWIR camera system based on InGaAs/InP SPAD (Single Photon Avalanche Diode) arrays specifically designed for eye-safe NLOS applications. The camera will include a new ROIC (read-out integrated circuit) dedicated to NLOS, able to gate the SPAD detectors with fast rising-edge and to detect the avalanche pulses with low timing-jitter. Additionally, the SPAD array chip will include Time-to-Digital Converters (TDCs) to time-stamps the incoming photons in the individual pixels with picosecond resolution.

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

The single-photon detectors will be based on SPAD arrays and their dedicated read-out electronics. The SPADs will be modeled and designed with TCAD simulations. The read-out integrated circuits (ROIC) will



	<p>be designed with electronic design automation tools. The SPAD chip and its ROIC will be assembled together inside a custom-made package onto a thermo-electric cooler. The PhD candidate will have to model and design the whole electro-opto-mechanical packaging system, and then will focus on the design of the camera system, where the packaged detector will be integrated with a stack of boards designed for: power supply, input/output of analog signals, and data download via FPGA (Field-Programmable Gate Array) and microcontrollers to a PC. To this aim, the PhD candidate will develop (by means of EDA tools) and program the full set of electronic boards (PCBs). Then, fabricated detectors will be fully characterized for assessing electrical and optical performance. Finally, the developed SPAD camera will be installed and exploited in NLOS setups for acquiring experimental data.</p>
<p>Educational objectives</p>	<p>The PhD student will learn how to model, simulate, design, prototype and characterize single-photon detection systems based on SPADs, with a special focus on the electronic systems (including electronic boards, microcontrollers, FPGAs, etc.). The PhD student will also develop applications and graphical-user-interfaces to enable users to manage and control the electronic instrumentation that will be developed during the PhD research. The doctorate activity will include attendance of academic courses, conferences, summer schools and workshops</p>
<p>Job opportunities</p>	<p>The PhD studies will allow to acquire all required skills and know-how to enable a swift transition to high-level R&D companies and institutes. The POLIMI's research group has already many contacts with R&D centers and end-users, which employed previous PhD students and post-docs, trained in the research group.</p>
<p>Composition of the research group</p>	<p>1 Full Professors 2 Associated Professors 0 Assistant Professors 6 PhD Students</p>
<p>Name of the research directors</p>	<p>Alberto Tosi, Franco Zappa, Federica Villa</p>



Contacts
E-mail: alberto.tosi@polimi.it Phone: +39-02-2399.6174
E-mail: franco.zappa@polimi.it Phone:+39-02-2399.6149
E-mail: federica.villa@polimi.it Phone:+39-02-2399.4003

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

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>Premiality: Premialities will be recognized to the PhD candidate:</p> <ul style="list-style-type: none"> i) up to 2,500.00 euro (gross amount) after completion of the I year, provided that she/he demonstrates a significant contribution to the growth of scientific excellence, the industrial valorization of the research, the networking and communication activities of the research group and of the Department; ii) up to 2,500.00 euro (gross amount), after completion of the II year, provided that she/he has published at least one paper on a scientific journal and demonstrates a continuous and significant contribution to the growth of scientific excellence, the industrial valorization of the research, the networking and communication activities of the research group and of the Department; iii) up to 2,500.00 euro (gross amount), after completion of the III year, provided that she/he has published at least two papers on a scientific journal and demonstrates a continuous and significant contribution to the growth of scientific excellence, the industrial valorization of the research, the networking and communication activities of the research group and of the Department. <p>EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student</p> <p>COMPUTER AVAILABILITY: individual use</p>



DESK AVAILABILITY: individual use