POLITECNICO DI MILANO

PhD in FISICA / PHYSICS - 38th cycle

THEMATIC Research Field: INTEGRATION OF QUANTUM SENSORS IN MICROSYSTEMS

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	Quantum Sensors represent the ultimate frontier in sensing applications, enabling extreme sensitivity and stability provided by quantum phenomena. A promising approach for quantum sensing applications is based on color centers like nitrogen-vacancy (NV) centers in diamond. NV-based sensors feature high magnetic sensitivityat room temperature, with large dynamic range and high spatial resolution [1,2]. Interestingly the same system can be used to measure temperature [3], electric fields [4], and pressure. Furthermore, this technology platform has been proposed for implementing quantum gyroscopes, which hold potential to reach performances required for autonomous driving [5]. The PhD candidate will develop novel solutions for the integration of quantum sensors in microsystems. This field is still in its infancy and there is plenty of room for the development of innovative solutions to move from laboratory proof of concept to integrated devices. In particular, the focus of this work will be on NV-based quantum sensors for detection of magnetic fields and for demonstration of quantum gyroscopes. [1] J.M. Taylor, P. Cappellaro, L. Childress, L. Jiang, D. Budker, P. R. Hemmer,A. Yacoby, R. Walsworth, M. D. Lukin, Nat. Phys. 2008, 4, 810. [2] T. Wolf, P. Neumann, K. Nakamura, H. Sumiya, T. Ohshima, J. Isoya,J. Wrachtrup, Phys. Rev. X 2015, 5, 041001. [3] P. Neumann, I. Jakobi, F. Dolde, C. Burk, R. Reuter, G. Waldherr, J.Honert, T. Wolf, A. Brunner, J. H. Shim, D. Suter, H. Sumiya, J. Isoya,J. Wrachtrup, Nano Lett. 2013,

	13, 2738. [4] F. Dolde, H. Fedder, M. W. Doherty, T. N.bauer, F. Rempp, G. Balasubramanian, T.Wolf, F. Reinhard, L. C. L.Hollenberg, F. Jelezko, Nat.Phys. 2011, 7, 459. [5] M. P. Ledbetter, K. Jensen, R. Fischer, A. Jarmola, and D. Budker, PHYSICAL REVIEW A 86, 052116 (2012)
Methods and techniques that will be developed and used to carry out the research	The PhD will carry out the following activities: -Design, fabrication and characterization of miniaturized quantum sensor prototypes - Fabrication of related components in the cleanroom of Politecnico di Milano (www.polifab.polimi.it) -Femtosecond laser fabrication of optical circuits in bulk diamond and their integration with NV centers (https://www.lasiondef.eu/) at IFN-CNR at the Department of Physics, Politecnico di Milano The activity will be carried out in the framework of the Joint Research Center STEAM between Politecnico di Milano and STMicroelectronics.
Educational objectives	Development of interdisciplinary knowledge at the boundary between physics, femtosecond lasers, microfabrication technology, optics, signal processing and electronics.
Job opportunities	The PhD will work in a team involved in the Joint Research Center of STM and Politecnico di Milano (STEAM), in strong connection with the world of MEMS development and production. This PhD will provide a solid basis for careers both in academia and in the semiconductor industry.
Composition of the research group	1 Full Professors 3 Associated Professors 3 Assistant Professors 6 PhD Students
Name of the research directors	Andrea Cattoni, Shane Eaton, Riccardo Bertacco

Contacts
http://nabis.fisi.polimi.it In collaboration with the Polifab staff: www.polifab.polimi.it

Shane.eaton@gmail.com
Tel 0039 02 2399 6063
Cel 0039 3200921952
https://www.fisi.polimi.it/en/user/118

andrea.cattoni@polimi.it

riccardo.bertacco@polimi.it
tel. 0039 02 2399 9663;
https://www.fisi.polimi.it/en/people/bertacco

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

Educational activitiesEducational activities (purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences): financial aid for the PhD student for 3 years: max euros 5.707,13.
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 and desk availability: individual use