



# PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 39th cycle

**THEMATIC Research Field: ROBUST SENSORS-DEVELOPING ECOSYSTEMS FOR  
REDUCING MEASUREMENT UNCERTAINTY IN MEMS-SENSOR BASED APPLICATIONS**

**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

The use of data-driven analysis approaches requires robust data generated by measurement sensors. In a technological context where the pervasiveness of information from sensors installed on platforms with differentiated targets (consumer, industrial, etc.) has increased exponentially, there is a need for a multi-competence approach that sees, in the union of mechanical, electronic, computer science and metrology aspects, the necessary means for the generation of strategies to ensure the robustness towards of data generated by these sensors.

The project aims at developing an ecosystem to reduce the uncertainty associated with measurements performed utilizing MEMS nodes by acting vertically on several levels.

Specifically, three levels are identified, with increasing degree of architectural complexity:

- 1) *Sensor-level*: the presence of Intelligent Sensor Processing Units (ISPU) in new sensors opens the door to the implementation of processing strategies directly at the sensor edge; a key factor to ensure robustness of data collected, especially for "data-driven" applications, is the ability for the sensor to self-verify its correct calibration (*self-calibration*) and self-diagnose (*self-diagnosis*) any of its malfunctioning;
- 2) *Node-level*: MEMS technology and its associated cost open up endless possibilities regarding the combination of multiple sensors on the same sensing node. It becomes



	<p>critical, therefore, to operate at both hardware and software levels to fully exploit the potential of a multi-sensor platform. While concepts such as <i>redundancy</i>, <i>sensor-fusion</i>, <i>synchronism</i>, gain relevance, proper mechanical design of the node envelope becomes also critical to avoid the introduction of mechanical performances negatively affecting the response of the individual/sensor pool;</p> <p>3) <i>Node-network-level</i>: the ability of multiple sensor nodes to communicate among each other, to exchange information related to their operating status, as well as autonomously manage the possible activation/deactivation of measurement positions upon specific requests (e.g., optimizing consumption, increasing capillarity of collected data, etc.) becomes crucial.</p> <p>The availability of software tools (Vespucci Tool) capable of enabling high-level, low-level code porting (sensor-level--&gt;ISPU; node-level--&gt;MCU) becomes a key element to enable the development of the strategies listed above, providing greater flexibility in identifying specific software solutions, including those based on artificial intelligence, for each level of investigation. It is clear, therefore, that the ecosystem that is being developed provides a unique opportunity for the creation of a toolchain aimed at the selection, design and deployment of MEMS-based monitoring systems and dense sensing.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The research is expected to develop strategies to enable a robust use of MEMS sensors. Metrology analyses and artificial intelligence will play key role in the activity, as one of the main targets of the research is providing the sensors/sensing nodes with self-diagnostic and self-calibration capabilities. A project-tuned sensing node is being designed to act as the platform for the development of those strategies and methods targeted to increase the robustness of MEMS-based measurements. The project plan has already been agreed with STMicroelectronics (ST), a worldwide semiconductor company. During the long long-lasting cooperation with ST, the experimentation of cross contamination among different researchers has already produced relevant results.</p>



<b>Educational objectives</b>	The Researcher is expected to develop multidisciplinary skills involving metrology science, mechanics, electronics and computer science. Such an approach will contribute to create a new professional figure combining different expertise.
<b>Job opportunities</b>	The PhD is perfectly aligned in the industrial need for new professional skills having a wide transverse education. Opportunities can be everywhere, from academia, to big industries, to service companies. STMicroelectronics (Dr. Diego Melpignano and Dr. Lisa Trollo) is cooperating in the research.
<b>Composition of the research group</b>	1 Full Professors 1 Associated Professors 1 Assistant Professors 2 PhD Students
<b>Name of the research directors</b>	Prof. Alfredo Cigada, Prof. Paolo Chiariotti

<b>Contacts</b>
<p>Prof. Alfredo Cigada - Politecnico di Milano</p> <p>Prof. Paolo Chiariotti - Politecnico di Milano</p> <p>Department of Mechanical Engineering, Via La Masa 1 - 20156, Milan</p> <p>For questions about scholarship/support, please contact <a href="mailto:phd-dmec@polimi.it">phd-dmec@polimi.it</a>.</p>

<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>	700.0 €
<b>By number of months</b>	6

<b>Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information</b>
Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 5.707,13.



Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 700 euro/month- net amount).

Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. 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.