



# PhD in INGEGNERIA STRUTTURALE, SISMICA, GEOTECNICA / STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 38th cycle

**PARTENARIATO PNRR Research Field: DESIGN OF SMART MICROFLUIDICS THROUGH  
QUANTUM MACHINE LEARNING**

**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**

### **CN-HPC: CENTRO NAZIONALE PER HPC, BIG DATA E QUANTUM COMPUTING**

CUP D43C22001240001 – Decreto di concessione D.D.  
1031 del 17/06/2022

Bando D. D. 3138 del 12/16/2021 rettificato con D.D.  
3175 del 18/12/2021 “Avviso pubblico per presentazione  
Proposte di intervento per il Potenziamento di strutture di  
ricerca e creazione di “campioni nazionali” di R&S su  
alcune Key Enabling Technologies da finanziare  
nell'ambito del Piano Nazionale di Ripresa e Resilienza,  
Missione 4 Componente 2 Investimento 1.4

“Potenziamento strutture di ricerca e creazione di  
“campioni nazionali di R&S” su alcune Key Enabling  
Technologies” finanziato dall'Unione europea -  
NextGenerationEU”.

In recent years, machine learning (ML) tools have been  
applied to a variety of scientific fields, including  
computational fluid and solid mechanics. Referring to  
microfluidics, we focus on a morphing environment  
induced by the actuation of compliant channels, by  
reactive phenomena at the fluid/solid interface (e.g.,  
precipitation/dissolution processes) or by the flow of  
microparticles and/or in presence of multiple fluid phases.



<b>Methods and techniques that will be developed and used to carry out the research</b>	<p>Convolutional NN architectures have shown promising results in assessing the probability distribution function of parameters used for feeding Monte Carlo simulations. Starting from multi-fidelity datasets linked to experiments and simulations, a coarse-grained, data-driven surrogate would be adopted to avoid high computational costs. Powerful approaches have been recently proposed in this regard, resting on the so-called physics-informed NNs (PINNs) where model-based and data-driven approaches are integrated within a unique framework in a synergic way.</p> <p>As “Quantum systems produce atypical patterns that classical systems are thought not to produce efficiently”, results are therefore foreseen also regarding Quantum principal component analysis.</p>
<b>Educational objectives</b>	<p>The Ph.D. student will have to collect information on the behavior of microfluidic devices, for the analysis of the various phenomena under study. He/she will have to develop quantum machine learning models, based on what is evidenced by the experimental tests. The ability to perform analyses on quantum computers or to learn how to operate in this field is therefore going to be developed in detail.</p>
<b>Job opportunities</b>	<p>Quantum computing is still a niche in the field of fluid and solid mechanics, but is going to have a burst in the coming years as in any other field. The capability to operate with quantum computers will then provide to the student a unique opportunity regarding his/her future activities.</p>
<b>Composition of the research group</b>	<p>2 Full Professors 3 Associated Professors 0 Assistant Professors 3 PhD Students</p>
<b>Name of the research directors</b>	<p>Stefano Mariani and Martina Siena</p>

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**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	650.0 €
By number of months	6

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

Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:

- SYstèmes de COmmunication et Microsystèmes (ESYCOM), Université Gustave Eiffel, <https://esycom.cnrs.fr/>
- Fluid-o-Tech, <https://www.fluidotech.it/>

Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): The Ph.D. course supports the educational activities of its Ph.D. students with an additional funding equal to 10% of the scholarship, starting from the first year.

Teaching assistanship (availability of funding in recognition of support to teaching activities by the PhD student): Ph.D. students are encouraged to apply, upon prior authorization, to the calls to support teaching activities at the undergraduate and Master levels at Politecnico, being paid for that. The teaching assistantship will be limited up to about 80 hours, maximum half of them devoted to teaching and classroom activities and the rest to support classworks and exams.

Computer availability and desk availability: Each Ph.D. student has his/her own computer for individual use. Each Ph.D. student has his/her own desk, cabinet and locker.