



# PhD in BIOINGEGNERIA / BIOENGINEERING - 39th cycle

**PNRR 117 Research Field: DESIGN AND DEVELOPMENT OF INNOVATIVE HEAD-ECG AND EYEGLASS-EEG SOLUTIONS**

Monthly net income of PhDscholarship (max 36 months)
<b>€ 1400.0</b>

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
<b>Motivation and objectives of the research in this field</b>	The project will develop the concept and the tools for Head-ECG measurements able to monitor quantities related to health status, namely RR-Interval, Heart Rate, Hear Rate variability, Arrhythmias, to cite the most relevant, and daytime activities (step counting, calories consumption) from electrodes placed on a eyeglass or on its proximity. This is part of a long-term aim to develop concept and tools based on signal processing and AI methods to extract and monitor quantities related to heath status from eyeglasses with a level of accuracy enabled by smartwatches and app services and potentially with that of medical devices.
<b>Methods and techniques that will be developed and used to carry out the research</b>	The feasibility of recording cardiac rhythms from head and ear locations will be investigated. The best set of electrodes and positions will be designed to obtain robust measurements of an electric signal sensible to heart-beating (i.e. the timing of QRS-complexes on ECG) or brain Activity (EEG). The sensor positions will be studied on the base of theoretical considerations on electrocardiogram (ECG) or EEG recordings from head and ear/behind-ear locations. A minimal setting of sensors will be derived and setup to record the physiological measures of Head-ECG. Theoretical results will be confirmed by lab experiments to be performed on at least 25 normal subjects. Subjects will undergo simultaneous recordings from the designed sensors positions and from classical ECG/EEG leads, which will serve as reference.



	<p>classical ECG/EEG leads, which will serve as reference. Ergonomic evaluation will be performed to optimize recording locations, which ensure the best signal quality, taking also into account anthropometrical head structure variability. As far as, cardiovascular parameters are concerned, comparison between Head-ECG and standard ECG leads will be carried out to summarize ECG-quality indexes on local morphological quality parameter (kSQI, pSQI) or impacts on QRS detectors (bSQI). We also assess the accuracy of the derived RR-Interval variability indexes (Heart Rate, SDNN, RMSSD, LF and HF power, LF/HF ratio).</p>
<b>Educational objectives</b>	<p>The doctoral candidate will undergo comprehensive interdisciplinary training in cutting-edge hardware and software technologies for biosignal recording and processing using wearable devices. The candidate will acquire the skills necessary to proficiently develop integrated systems that leverage the latest advancements in wearable sensor design and application, deep learning methodologies, and biomedical signal processing tools. Throughout the duration of the PhD program, the candidate will actively participate in multidisciplinary courses offered by the Bioengineering PhD School at Politecnico di Milano. These courses will provide valuable knowledge and insights from various fields. Additionally, the candidate will have the opportunity to attend both national and international conferences, fostering collaboration and expanding their network within the research community.</p>
<b>Job opportunities</b>	<p>After the PhD, different job opportunities will be available as Post-Doc or Research Scientist in national or international institutions. Careers related to the development of sensorised, smart, wearable objects and to machine learning applied to biosignal analysis and denoising are recently evolving in many enterprise organizations and recently founded spin-off companies. Jobs as data scientists, big data engineers and machine learning engineers will be additional opportunities.</p>
<b>Composition of the research group</b>	<p>1 Full Professors 1 Associated Professors</p>



	2 Assistant Professors 0 PhD Students
<b>Name of the research directors</b>	PROF LUCA MAINARDI, PROF PIETRO CERVERI

#### Contacts

luca.mainardi@polimi.it  
 phone: 02-2399-3347 h  
<https://www.deib.polimi.it/eng/people/details/252284>

pietro.cerveri@polimi.it  
 phone: 02-2399-3352  
<https://www.deib.polimi.it/ita/personale/dettagli/139286>

#### Additional support - Financial aid per PhD student per year (gross amount)

<b>Housing - Foreign Students</b>	--
<b>Housing - Out-of-town residents (more than 80Km out of Milano)</b>	--

#### Scholarship Increase for a period abroad

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

#### National Operational Program for Research and Innovation

<b>Company where the candidate will attend the stage (name and brief description)</b>	L'azienda Luxottica S.r.l.
<b>By number of months at the company</b>	6
<b>Institution or company where the candidate will spend the period abroad (name and brief description)</b>	Georgia Tech & Emory University Atlanta, USA
<b>By number of months abroad</b>	6

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

**Educational activity:** The student will be encouraged to attend to courses at POLIMI or abroad in International Schools.

**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:** the student will be allowed to access facilities of the DEIB.