

# NOVA I4H – Thesis Proposal

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**Title:**

Functional Near Infrared Spectroscopy sensing – Research on novel Instrumentation and applications methods

**Objectives** (recommended length: 2000-3000 char):

The thesis is focused on the creation of a Functional Near Infrared Spectroscopy (fNIRS) device for multi-source data acquisition, processing, and classification.

Monitoring physiological mechanisms via instrumentation of physical measures in the electrical, mechanical and optical dimensions have provided an increased number of biosignals to use in many biomedical applications. Functional near-infrared spectroscopy sensing has appeared as novel instrument to extract information from physiological mechanisms. This sensing technique started to be used in sports performance tasks to evaluate the local oxygenation of the muscles and on cognitive psychology and neurology research tasks to evaluate the cognitive process in the brain.

In this context, this thesis will focus on the integral development of the instrumentation, signal processing and classification of a multi-channel fNIRS medical device. The scope of application of fNIRS has been increasing, and there is a need to find a technical solution to enable the spread and accessibility of multi-channel fNIRS applications. For this purpose, the base instrumentation mechanisms will be studied to allow for a cost conservative design of a multi-channel fNIRS.

The challenges with signal processing of fNIRS physiological changes, coming from light interference, placement difficulty among other problems will request technical advances embedded electronics and wireless synchronization mechanisms. The signal collected will need novel algorithms for information extraction. The data extracted will need classification methods adapted to the contexts of usage and test on deep learning classification techniques applied to the multi-signal time series with spatial relation.

Two uses cases will be created in the areas of sports performance and cognitive psychology to demonstrate and document novel applications of fNIRS. The developed algorithms for the application scenarios will be shared with the scientific community via mature publications and by placing the code and documentation in open source repositories.

**Framework** (recommended length: 500-2000 char):

Established in 2007, PLUX creates innovative products for industry, clinicians and researchers, by developing advanced biosignals monitoring platforms that integrates wearable body sensors combined with wireless connectivity, algorithms and software applications. PLUX has a strong background on research collaboration with Universidade Nova de Lisboa. In the context of this thesis the research on a novel fNIRS device will enable the continuous introduction of biosignals modalities and providing cost accessible system to support the growth of biosignals monitoring.

This project will be developed in collaboration with the laboratory of Biomedical Instrumentation Lab – LIBPhys of Universidade Nova de Lisboa and will be supported by a company/faculty PhD grant assigned by FCT.

**Tasks** (recommended length: 1000-3000 char):

The candidate should investigate the current state of the art in functional infrared spectroscopy. The core developments will be on electronic development to create a multi-channel, wireless and synchronized fNIRS device, with all the design and development documentation. The device will be validated against functional tests and by comparison with other devices. Two uses case will be implemented with dedicated signal processing and classification algorithms. The intermediate results of the PhD should be presented in conferences and published in journals with known impact factor, on the areas of biomedical engineering. During the innovation process, careful attention should be given to identify ideas that can be part of intellectual property protection.

**Venue:**

This project will take place in the Biomedical Instrumentation Lab of FCT/UNL, as well as in PLUX Wireless Biosignals.

**Candidate profile:**

Considering that this project focuses heavily in instrumentation and signal the candidate should have expertise on electrical engineering, biomedical engineering or physics engineering. The candidate should have experience on designing embedded electronics and analog and digital signal processing.

The capacity to innovate, and develop new techniques for sensing systems along with the physical design devices, as well as the necessary critical aptitude towards all the procedures that he/she might be involved.

In addition, since this collaboration is between a faculty and an enterprise, the candidate must be prepared to develop his/her activity in an industrial environment, when necessary.

**Supervisor**

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