

# PhD in: Electrical, Electronics and Communication Engineering

## Research Title: Hybrid pixel sensors for X-ray imaging

**Funded by**

Istituto Nazionale di Fisica Nucleare (INFN)

**Supervisor**

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## Context of the research activity

The National Institute for Nuclear Physics (INFN), operating under the ministry of education and research (MIUR), is the Italian research agency in charge of studying the fundamental constituents of matter and the physical laws that govern them. To fulfil its mission, INFN needs to develop dedicated instrumentation, including many types of radiation sensors. Such devices find applications also in other domain of science, such as material science and medical imaging. INFN often pursues its research objectives in the context of international collaborations with other primary research institution. The purpose of the collaboration is to develop novel high performance systems for X-ray imaging, to be used mainly in the context of medical imaging. The sensor material can be either silicon or other materials with higher atomic number such as Cadmium Zinc Telluride. The front-end electronics have to be compatible with both. The design of such systems entail several issues. In order to achieve adequate spatial resolution the pixel size has in fact to be small. The charge sharing between adjacent pixels compromise the spectroscopy performance. To reduce the effect to a manageable level, state-of-the art systems employ analog charge summing scheme, which affect the signal-to-noise ratio. Due to space constraints, the energy discrimination is usually limited to a few levels. The present research activity will try to address the aforementioned issue through the use of fast and compact digitisation schemes combined with the use of smart digital signal processing algorithms directly embedded in the front-end electronics.

The proposed research activity is performed in the framework of the agreement between INFN and the Chinese Institute for High Energy Physics (IHEP). The fellowship is reserved to applicants with Chinese nationality.

## **Objectives**

The research activity will pursue three main objectives. The first objective is to deploy compact and very fast front-end electronics with a digitisation scheme that can increase the number of energy levels which can be discriminated by the system

The second objective is to study the replacement of conventional, analog-based charged summing schemes with digital-based more robust algorithms to overcome the deterioration in energy resolution introduced by charge sharing.

The final goal of the research work is to produce a full system demonstrator where a high-Z sensor is readout by a duly optimised front-end electronics.

## **Skills and competencies for the development of the activity**

The ideal candidate combines a good attitude to team activity with the capacity of working autonomously to identify novel solutions. In a first phase, the student will be involved in high-level modelling of the digital signal processing algorithms. Therefore familiarity with C/C++ and hardware description languages such as Verilog and VHDL is a plus. Knowledge analog design techniques is an asset, but it can be also acquired during the PhD studies.