

PhD in Electrical, Electronic and Communications Engineering

Research Title: Low-power front-end circuits for X-ray imaging

Funded by

IHEP - Istituto Nazionale di Fisica Nucleare (INFN)

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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 determine their behaviour. 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 Cadium 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 main focus of this research activity is to develop compact and low power front-end electronics with embedded digitisation capability. The front-end electronics must fit in a very small area (25 μm x 25 μm or similar) and be capable of reading both silicon detectors and high-Z sensors. The power consumption has to be at the level of a few micro-watts, with 6-8 bits resolution.

The front-end will be first prototype in stand-alone and then embedded in a large ASIC together with the digital signal processor.

The final goal of the research work is to produced 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. The student is expected to have some background in analogue and mixed signal circuit design in CMOS technologies.