DEVELOPMENT & CHARACTERIZATION OF SILICON DRIFT DETECTOR ARRAYS & INTEGRATED READOUT ELECTRONICS FOR X-RAY DETECTION APPLICATIONS

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The aim of this doctoral activity has been the modelling, design and characterization of X-ray detection systems based on silicon drift detectors (SDDs) and a low-noise integrated multichannel readout front-end for solid-state detectors signal processing in the field of nuclear electronics.

This PhD research activity is concluded on two main subjects: First part is dedicated to SIDDHARTA experiment. This experiment is an upgrade of the first one held in 2009 in Frascati (Rome) and both are meant to provide a deeper knowledge of the strong-interaction inside atoms, which is not completely defined due to the absence of experimental data. To gain new information, the experiment needs to measure as accurate as possible the shift and the amplitude of the K-alpha emission line of the Kaonic Hydrogen, an exotic atom. Both the detectors and readout electronics have been improved to match the background noise requirements, so they have to be fully characterized before using them in final experiment. Installation of Silicon Drift detectors (SDD), development of the acquisition chain, and post-processing of the acquired data to analyze the functionality of the detectors and readout electronics, beside some developments in the low-noise integrated multichannel readout front-end electronics have been done.

Second part of this research activity is dedicated to HTRS ASIC. HTRS is a front-end ASIC for the readout of multi-elements Silicon Drift Detectors specifically designed for high count-rate X-ray spectroscopy applications. HTRS is going to be used in eXTP (enhanced X-ray Timing and Polarimetry) mission, a scientific space mission designed to study the state of matter under extreme conditions of density, gravity and magnetism. Primary goals are the determination of the equation of state of matter at supra-nuclear density, the measurement of QED effects in the radiation emerging from highly magnetized stars, and the study of matter dynamics in the strong-field regime of gravity. The eXTP mission will revolutionize these areas of fundamental research by high precision X-ray measurements of NSs (Neutron Star) across the magnetic field scale and BHs (Black Hole) across the mass scale. Covering and solving the issues occurred during the HTRS ASIC installation and redesigning the ASIC carrier board and test setup have been done during this research activity.