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Pulse height analysis techniques for radiation detectors

Most radiation detectors require pulse (or signal) processing electronics so that energy or time information involved with radiation interactions can be properly extracted. The objective of this work is to develop and compare various pulse processing techniques for x-ray and Gamma ray spectrometers which can be used for future scientific missions.

A preamplifier is the first component in a signal processing chain of a radiation detector which has a main function to extract the signal from the detector without significantly degrading the intrinsic signal-to-noise ratio. Preamplifier does not act as an amplifier but it collects charge created within a detector. Charge sensitive pre-amplifier (CSPA) output is a pulse, carrying the information of interacted photon energy. CSPA output signal is given to pulse height analyzer for energy spectroscopy. The pulse height analyzer performs several essential functions. Its primary role is to magnify the amplitude of the preamplifier output pulse from the mV range into the 0.1 ~ 5 V range which is proportional to incident photon energy.

To make a comparative study we are developing various pulse height analysis techniques like, pulse height analysis using constant pulse discharge, Pulse width modulation technique, Digital pulse processing technique and pulse height measurement using peak detector & successive approximation ADC. This comparative study will help to identify the proper processing technique for various radiation detection instruments. By this study, proper pulse processing method can be selected based on instrument specifications like number of detectors, total incoming photon count rate, spectral resolution, size, mass and power.

Above said pulse processing methods were implemented on hardware and tested with x-ray detector (silicon drift detector-SDD). Performance of processing techniques is compared based on achieved spectral resolution, count rate handling, power consumption and total component requirement. Each technique has its own advantage and disadvantages will be presented in the symposium.

Autore principale: Sig. ARPIT, Arpit (Physical research laboratory, Ahmedabad)

Relatore: Sig. ARPIT, Arpit (Physical research laboratory, Ahmedabad)