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Pulse Shape Discrimination for Online Data Acquisition in Water Cherenkov Detectors Based on FPGA/SoC

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Discrimination of secondary particles produced in extensive air showers is needed to study the composition of primary cosmic rays. High speed data acquisition and the increase in resources in modern FPGAs with the addition of a microprocessor in System-on-Chip (SoC) technologies allow to implement complex algorithms for digital signal analysis. Pulse Shape Discrimination (PSD) can be carried out in real-time on the digital front-end of the detector. Online data analysis leads to save computational resources in post-processing and transmission bandwidth. We describe two methods for PSD, the first based on artificial neural network (ANN) using the novel hls4ml, and the other based on a correlation approach using finite impulse response (FIR) filters. Both methods were implemented and tested on Xilinx FPGA SoC devices ZU9EG Zynq Ultrascale+ and ZC7Z020 Zynq. Data from a Water Cherenkov Detector (WCD) were acquired with a 500 Mhz, 8 bits high speed analog to digital converter acquisition system. Experimental results obtained with both methods are presented along with accuracy, resources utilization and power consumption analysis.

Keywords

FPGA, SoC, WCD, neural network , FIR, pulse shape discrimination.

Collaboration

other (fill field below)

other Collaboration

LAGO

Subcategory

Experimental Methods & Instrumentation

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