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Microcontroller-Based Readout System for Spectroscopic Applications

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This work presents a novel signal readout and data processing system based on a 32-bit ARM microcontroller for spectroscopic applications.

Previous attempts to develop microcontroller-based spectroscopy systems have often struggled with limitations such as low performance and high dead time, making them impractical for real-world use. This work introduces a highly customizable, full-stack solution that leverages modern microcontrollers to overcome these challenges while maintaining simplicity, flexibility, and low power consumption.

Although microcontroller-based solutions offer advantages such as reduced component count and ease of customization, they typically have lower performance compared to FPGA-based systems, which can limit certain capabilities. To address this, we present a readout system designed for a silicon drift detector (SDD) array, demonstrating key performance metrics achievable with a modern microcontroller.

In the presented implementation, a single microcontroller processes signals from two independent silicon sensors, requiring only four external components per channel. The system operates with a power consumption below 20 mA per channel and achieves zero dead time. It supports a throughput of up to 700k events/second per microcontroller, or 500k events/second per channel.

With its compact design and efficient performance, this microcontroller-based system is well-suited for portable detectors, embedded systems, and scalable front-end electronics in high-channel-count applications.

Primary author: DEMENEV, Evgeny (Fondazione Bruno Kessler)

Co-authors: TOSATO, Pietro (Fondazione Bruno Kessler); PEPPONI, Giancarlo (Fondazione Bruno Kessler, Istituto Nazionale di Fisica Nucleare); FERRARIO, Lorenza (Istituto Nazionale di Fisica Nucleare)

Presenter: DEMENEV, Evgeny (Fondazione Bruno Kessler)

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