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Particle Detectors with Arduino-based Frontend Electronics

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With the Arduino open hardware electronics platform microcontrollers have become a comparably easy-to-use tool for rapid prototyping and implementing innovative solutions. Their stability especially qualifies them to be used for slow control units. Yet, running at 16 MHz, the capabilities can be extended to data taking and signal analysis at decent rates. Such devices in combination with dedicated frontend electronics can offer low cost alternatives for student projects and independently operating small-scale instrumentation. We present two projects: the readout of proportional counters using helium-3 and boron-10 and a trigger unit for reading out scintillators or wavelength shifting fibers with Silicon Photomultipliers.
The nCatcher combines commercially available analog electronics and the Arduino nano enabling pulse shape analysis for proportional counters. The frontend integrates and shapes pulses to microseconds in order to use the Arduino's signal analysis capabilities - time over threshold measurement and a 10-bit analog to digital converter. Combining these two parameters allows for effective discrimination between different radiation types by estimating the total deposited energy (E) of incoming radiation as well as the mean energy loss per distance (dE/dx). This makes the device suitable for low to medium rate environments, where a good signal noise is a crucial.
With the SiPMTrigger we have realized a small scale design for triggering or vetoing. It consists of a custom mixed signal frontend board featuring signal amplification, discrimination and a coincidence unit. An Arduino MEGA digitally adjusts the thresholds of both channels and measures the trigger rate up to 200 kHz.

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