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A low cost, high dynamic range readout system for SiC strip detectors

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The semiconductor industry is currently adopting SiC as a replacement for silicon in power devices. Compared to Si, SiC offers several advantages which make it an attractive detector material. Among them is the higher displacement energy as compared to silicon, which makes SiC potentially more radiation hard. The very low leakage currents do not increase even for highly irradiated samples. Both properties promise to make the material particularly suitable for use in high-radiation environments.

Apart from studying SiC as replacement for Si-based HEP detectors, we are also developing a beam monitoring system using SiC strip sensors. This beam monitor is intended to work at a ion cancer therapy center, where particle rates from the kHz to the GHz regime occur. While in the kHz regime, single particles are counted, in the GHz regime, counting is unfeasible, and the integrated detector current is measured.
The system is based on components off the shelve (COTS), omitting the long and expensive development of a front-end ASIC. Instead, we employed a commercial X-Ray TFT front-end chip for sensor readout, connected to an ADC and a subsequent FPGA for data processing.
The output data is transmitted via a TCP stream, which can also be used to control and configure the FE system.

Beam tests show that using a 50 µm thick SiC pad detector, our system can count single particles in a 62.4 MeV proton beam (particle energy equivalent to 5.03 minimum ionizing particles, MIP).
Using a Si Strip detector, the setup was employed to reveal the time structure of the particle beam of the MedAustron facility. The system enables a sampling rate of 37 kHz and works at beam fluences up to 10^9 particles per second, with intensity peaks being an order of magnitude larger.

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