Contribution ID: **57** Type: **Poster**

SiC based beam monitoring system for particle rates from kHz to GHz

Tuesday 3 October 2023 15:00 (20 minutes)

The extremely low dark current of silicon carbide (SiC) detectors, even after high-fluence irradiation, is utilized to develop a beam monitoring system for a wide range of particle range, i.e., from the kHz to the GHz regime. The system is completely built from off-the-shelve components and is focused on compactness and simple deployment. Beam tests on a 50 um thick SiC detector reveal, that even single particles of a 62.4 MeV proton beam (equivalent to 5.03 MIP) can be detected. Overall accurate results can be achieved up to a particle rate of 10^9 particles per second.

Summary (500 words)

SiC is, due to its intrinsic material properties, an attractive detector material. On the one hand the, compared to silicon, very high displacement energy results in a potentially increased resilience against radiation damage. The low leakage current, on the other hand, allows to deploy SiC detectors without any dark current compensation, even when the particle flux is measured in DC coupled mode. The fact that the leakage current does not even increase for samples irradiated at up to 10^{16} $\frac{n_{eq}}{cm^2}$ 1 MeV neutron equivalent flux is another big advantage. Overall, these properties make SiC a very interesting material for beam monitors measuring fluxes which have to be distinguished from single particles monitors but still provide the possibility to detect the latter.

In this work we report on a beam monitoring system which is based on 4H-SiC strip detectors. The system was designed for particle rates ranging from the kHz to the GHz regime. In the kHz regime, the system operates in single particle counting mode. At particle rates in the GHz regime, the DC current through the detector is measured, which is proportional to the particle flux. We designed the system using only commercial off the shelve (COTS) components, omitting the long and expensive development of a front-end application specific integrated circuit(ASIC). At the core of the system, a commercial X-Ray thin film transistor (TFT) front-end chip is utilized for sensor readout. A 14 bit analog digital converter (ADC) provides accurate current measurements while a freely programmable gate array (FPGA) with built-in central processing unit (CPU) is responsible for data read-out and transmission to the host computer.

Emphasis was put onto making the system compact and easy to integrate. A single Ethernet port is used for both, controlling the system and data transfer. Only a single high voltage supply for the detector and an unregulated low-voltage is required to supply the system.

Beam test using a 50um thick 4H-SiC pad detector prove our system sufficient to count single particles when subjected to a 62.4 MeV proton beam 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 proton beam of the MedAustron facility. The system can sample 128 strips at a rate of 37 kHz. It works at beam rate up to 10^9 particles per second, with intensity peaks being up to an order of magnitude larger.

Author: WAID, Simon Emanuel (Austrian Academy of Sciences (AT))

Co-authors: GSPONER, Andreas (Austrian Academy of Sciences (AT)); MAIER, Jürgen (Austrian Academy of Sciences (AT)); GAGGL, Philipp (Austrian Academy of Sciences (AT)); THALMEIER, Richard; BERGAUER, Thomas (Austrian Academy of Sciences (AT))

Presenter: WAID, Simon Emanuel (Austrian Academy of Sciences (AT))

Session Classification: Tuesday posters session

Track Classification: Radiation-Tolerant Components and Systems