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4H-Silicon carbide as particle detector for high-intensity ion beams

In ion cancer therapy high intensity ion beams are used to treat tumors by taking advantage of the Bragg-Peak [1]. Typical ion therapy centers use particle rates up to 10ˆ10 ions/second for treatment [2]. On the other hand, such intensities are often too high when using these beamlines for particle physic experiments or as a test-beam environment in general. The project presented here aims to develop a beam position and intensity monitor, to cover the full intensity spectrum from a few kHz up to GHz rates as used in clinical settings.

Silicon carbide has been chosen as detector material because it combines not only a high radiation hardness with a high bandgap [3], but also for its affordability. Additionally, the fast charge collection can help to mitigate pile-ups in the high-rate regime.

The readout electronics is developed completely from scratch, starting in discrete electronics for one channel. This will be expanded to multiple channels in discrete electronics first and later integrated into an ASIC. The electronics comprises a transimpedance and a voltage amplifier, a comparator, and an FPGA, which uses time over threshold measurements for robust pile-up detection.

In this presentation, the first measurements on a single channel SiC sample are shown in comparison to other common sensor materials like silicon and diamond. All these sensors were tested in the laboratory using radioactive sources and a readout prototype for a one channel sensor. Moreover, the prototype, which was successfully tested in MedAustron with a proton beam in a wide intensity range (kHz –GHz) and with different energies (60 –800 MeV), is presented (Figure 1, Figure 2).

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