Abstract

The gaseous QUAD pixel detector

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We have developed a gaseous pixel detector based on four Timepix3 chips that can serve as a building block for a large detector plane. To provide the required gas amplification a fine grid has been deposited on the chip surface by wafer postprocessing (GridPix technology). The precisely aligned grid holes and chip pixels having a pitch of 55 µm and the high time resolution of 1.56 ns of the Timepix3 chip enable the reconstruction of each individual ionization electron where the accuracy is dominated by diffusion. The QUAD was designed to have minimum electrical field inhomogenities and distortions, achieving a tracking precision in the pixel plane with systematics of better than 10 microns. Due to the high efficiency to detect the ionization electrons a precise measurement of the energy loss dEdx can be performed.

The QUAD detector has all services located under the detection surface. In this way multiple QUADs can be simply put together to create a detection surface of arbitrary dimensions. A possible application is in the readout modules of a large TPC.

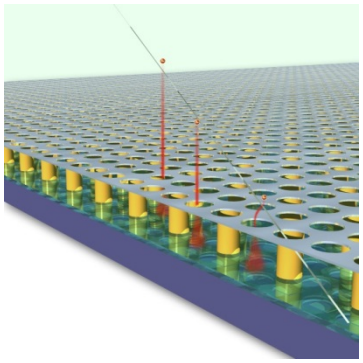
In the presentation we show details about the construction of the QUAD and the results from a recent test beam experiment performed at the ELSA electron beam in Bonn where a silicon telescope was used to provide accurate tracking.

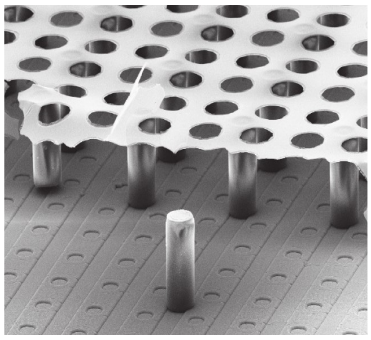
Summary

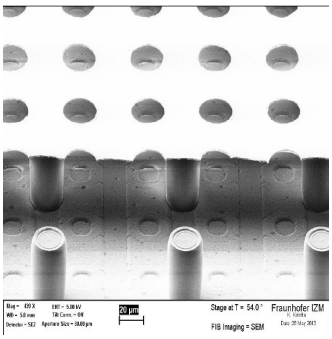
The development of the GridPix technology[1] has made a big step forward by the successful deposition of the grid to the TimePix-3 chip by wafer postprocessing. Recently, two 8" wafers were processed with almost no bad grids, indicating that the process is well under control. The construction of the QUAD where all services are located under the active surface, enables the creation of a large detection plane for a TPC. The QUAD building block is one of the candidates for the detection plane of a TPC at the future ILC, where up to 12000 single electrons on a full length track are expected to be detected.

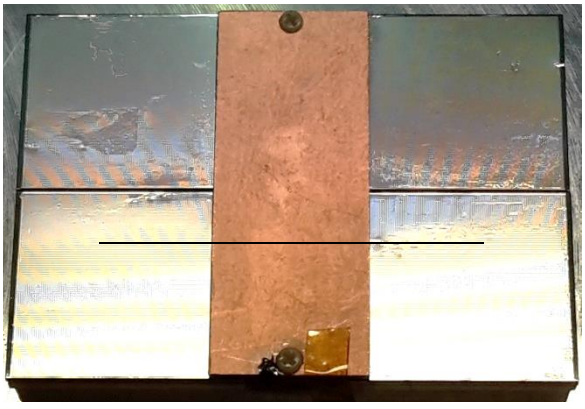
The large data set (30M tracks) taken at the test beam experiment in Bonn (October 2018) enables us to determine the position and dEdx resolution that can be achieved with this technology.

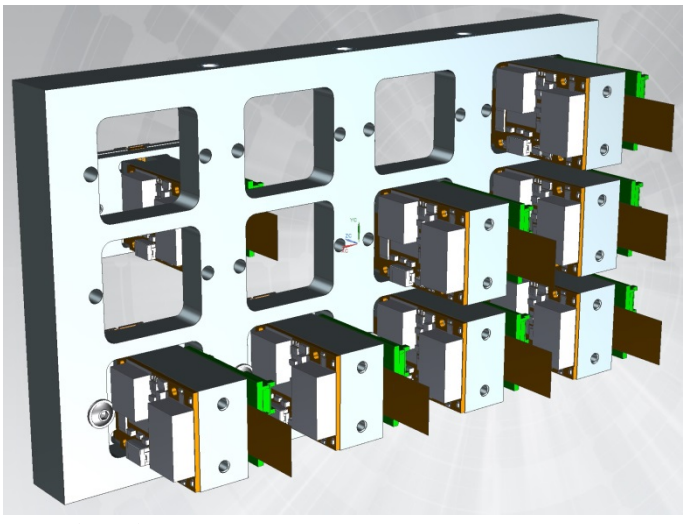
The results from a SINGLE chip Timepix3 detector[2] showed that the diffusion was the dominating error in the pixel and drift directions, while the systematic distortions in the pixel plane remained below 10 µm. In addition the energy loss (dE/dx) resolution using a truncated sum method was 4.1% for an effective track length of 1m.











[1] V. M. Blanco Carballo et al., Proceedings of ESSDERC 2006 (2006) 129.
[2] C. Ligtenberg et al., *Performance of a GridPix detector based on the Timepix3 chip*, NIMA 908 (2018) 18.