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Direct charge digital readout of dual phase xenon Time Projection Chambers with GridPix

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Dual phase and high pressure noble gas Time Projection Chambers (TPC) are successfully employed in rare event experiments such as Dark Matter and neutrino-less double beta decay searches. The simultaneous measurement of the scintillation light and the ionisation electrons, converted to scintillation via the electroluminescence mechanism, allows for accurate 3D-reconstruction of the energy deposition and effective particle identification. An alternative method for the measurement of the ionisation channel is the direct detection of the electrons by equipping the TPC with a charge-sensitive device, such as GridPix. This is a Micro-Pattern Gaseous Detector consisting of a mesh stretched 50 micron above a pixelated readout chip. It is fabricated with wafer post-processing techniques with well defined materials, therefore ensuring high radio-purity and low outgassing. The high granularity of a pixel readout, the pixels'low noise and high detection efficiency for single electrons allow for the measurement of the ionisation signal by the amount and the pattern of the hit pixels. We evaluate here, for the case of a dual phase xenon TPC, the benefits in term of energy resolution as a function of constructive parameters such as the pixel pitch. Moreover we report on the R&D at Nikhef with current Gridpix devices, which utilise the Timepix chip readout with a 55 micron pixel pitch. The gain and the detection efficiency for single electrons have been measured for several pure and quenched, argon or xenon gas mixtures. The behaviour of the Timepix chip at liquid xenon temperature has been also studied.

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