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Experimental study of the adaptive gain feature for improved position sensitive ion spectroscopy with Timepix2

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Timepix2 [1] is a hybrid pixel detector developed in the Medipix2 collaboration as the successor of Timepix. It separates the sensor attached to the ASIC into a square matrix of 256 x 256 pixels at a pixel pitch of 55 µm. Similar to Timepix [2], it relies on a frame-based readout scheme. However, it comes with valuable additional features such as an occupancy trigger allowing to force the frame termination if a preset number of columns received entries. Moreover, it prevents the frame shutter from cutting ToT signals at the end of the frames and allows to reduce power consumption by reducing the sensitive area (pixel masking).

While the aforementioned improvements have already been studied [3,4], in this contribution, we investigate the behaviour of the per-pixel energy measurement with the adaptive gain mode, which was implemented to allow for an extended per pixel energy range.
A Timepix2 detector with a 300 µm thick silicon sensor was calibrated using x- and gamma-rays in the energy range up to 60 keV. An energy resolution of 1.62 keV (FWHM: 3.8 keV) is achieved for 59.5 keV gamma-rays. To study the high energy response, the device was further irradiated with alpha particles from a 241Am source, whereby the per-pixel energy depositions were varied by changing the applied reverse bias and the distance from the source to the sensor top (utilizing the alphas particle energy loss in air). For completeness, measurements were done in vacuum.
For each measurement, the energies measured in the alpha tracks are compared with the expected energy calculated by SRIM. While at greater distances (where the maximal per pixel energy is below 650 keV) the expectation and measurement are in good agreement, an underestimation of the alpha energy is found at shorter distances. Assuming correct per-pixel energy measurement up to 650 keV and using the topology of the alpha particle tracks, we can relate the energy measured in the central pixels of the track (Emeas) to the energy required to obtain the predicted alpha particle energy (Eexpected). The scatter plot of Emeas vs Eexp is shown in Figure 1. The observed behaviour is modelled with a bilinear function and used to correct the per-pixel energy calibration curve. Energy spectra at different distances to the alpha-source are shown in Figure 2 after applying the correction function. The energy resolution was determined by fitting Gaussian distributions. We find ~110 keV (FWHM: 260 keV) at 0.9 MeV and ~300 keV (FWHM: 706 keV) at 5.5 MeV. It will be shown that energies up to ~850 ke- (i.e. 3.2 MeV in silicon) can be measured in a single pixel, outperforming the other chip of the Timepix family currently used.
References:
[1] W.S. Wong et al., Radiation Measurements, Vol. 131, 106230 (2020).
[2] X. Llopart et al., NIM A, Vol. 581, Issues 1–2, 485-494 (2007).
[3] P. Burian et al., JINST 15, C01037 (2020).
[4] S. George et al., NIM A, Vol. 958, 162725 (2020).

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