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High-angular resolution tracking of energetic charged particles in wide field-of-view with compact tracker telescope MiniPIX Timepix3 1×2 Stack

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We developed a highly integrated particle telescope assembled from two Timepix3 ASIC chip detectors [1] operated and readout in sync with highly integrated MiniPIX readout interfaces. The pixel detectors are used as particle trackers stacked on top of each other (see Fig. 1a) being accommodated in close geometry. The small distance gap (about 10 mm) between the pixel detectors provides a wide field-of-view (FoV) of about 1/3 of the full 2π with high angular resolution (sub-degree). The remaining FoV, about 2/3 of full 2π, which corresponds to particles incident at large angles (>35°) to the plane of the sensors, can be covered by each of the detectors separate. The angular resolution in this remaining region is few degrees [2] and, in a narrow range, also sub-degree (for very large incident directions and grazing angles). This configuration also enables to register all energetic charged particles in full tracking mode i.e. with tracks having elongated morphology which allows performing high-resolution tracking. This enables to derive precise wide-range spectrometric and tracking information of individual particles e.g. precise LET and also provide enhanced particle-type resolving power of up to 8 event classes [3]. The device is controlled, operated and readout via two USB 2.0 connectors (each tracker detector is connected to a separate USB port). Communication and fast clock timing synchronization between both trackers is realized by the SPI ports. The coincidence timing window between both trackers is in the range 50 – 100 ns. Control, operation and data readout is performed on standard PC/laptop and the software package PIXET. Test measurements were performed with energetic i.e., penetrating charged particles, 5–25 MeV electrons (at the Microtron MT-25 electron accelerator) and 8–36 MeV protons – see Fig. 1, (at the cyclotron U–120M proton/light ion accelerator) both at the NPI-CAS in Rez near Prague. Future measurements and novel applications include space radiation studies in outer space, nuclear and cosmic ray physics and particle radiotherapy research.

[1] T. Poikela et al., Timepix3: a 65k channel hybrid pixel readout chip with simultaneous ToA/ToT and sparse readout, J. of Instrum. JINST 9 (2014) C05013
[2] C. Granja et al, Directional detection of charged particles and cosmic rays with the miniaturized radiation camera MiniPIX Timepix, Nucl. Instrum. and Meth. A 911 (2018) 142-152
[3] C. Granja et al., Resolving power of pixel detector Timepix for wide-range electron, proton and ion detection, Nucl. Instrum. Meth. A 908 (2018) 60-71

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