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Spectral tracking of protons by the Timepix3 detector with GaAs, CdTe and Si sensors

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Position and directional-sensitive spectrometry of energetic charged particles can be performed with high resolution and wide dynamic range with the hybrid semiconductor pixel detectors Timepix/Timepix3 [1]. The choice of semiconductor sensor material, thickness and properties such as the reverse bias voltage greatly determined the sensitivity and resolving power for spectrometry and particle tracking (see Fig. 1). We investigated and evaluated the spectral-tracking resolving power such including deposited energy and linear-energy-transfer (LET) spectra (see Fig. 2 and Fig. 3) with the Timepix3 detector with different semiconductor sensors using well-defined radiation sources in terms of radiation type (protons, also alpha particles, X rays), energy and incident direction to the detector sensor. Measurements of particle incident direction in wide range were performed with collimated mono-energetic proton beams of various energies in the range 8 – 31 MeV at the U120-M cyclotron at the NPI CAS Rez near Prague. All detectors were per-pixel calibrated. The results will include correction for the per-pixel high-energy distortion [2]. This work enables to examine and perform detailed study of charge sharing and charge collection efficiency in semiconductor sensors. The results serve to optimize the detector chip-sensor assembly configuration for measurements especially with high-LET particles in ion radiotherapy and outer space. Work underway includes evaluation of newly refined GaAs sensors [3] as well as enhanced rad hard semiconductor sensors SiC.

[1] C Granja et al., NIM-A 908 (2018), 60-71
[2] M. Sommer, et al., NIM-A 1022 (2022) 165957
[3] B Zatko et al., JINST 15 (2020) C04004

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