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Timepix2 with a 500 μm thick silicon sensor in adaptive gain mode as a dE/dX spectrometer for relativistic heavy ions

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Timepix2 [1] is a hybrid pixel detector developed by the Medipix2 collaboration as the successor to Timepix [2]. Its release introduced significant enhancements, including simultaneous measurement of Time-over-Threshold (ToT) and Time-of-Arrival (ToA), along with additional features such as adaptive gain mode and pixel disabling to reduce chip power consumption. These latter features, coupled with an occupancy trigger and compact size, enable the use of Timepix2 for space dosimetry applications, where high-energy heavy ions (such as Galactic Cosmic Rays) can deliver substantial radiation doses to humans and electronics, potentially causing upsets. The improved pixel-level energy measurements also facilitate dE/dX spectroscopy in space using Timepix2.

In this contribution, we present the study of the response of a Timepix2 (v1) detector (256 × 256 pixels, pixel pitch 55 μm) with a 500 μm thick silicon sensor in charged particle beams of relativistic ion fragments at the Super-Proton-Synchrotron at CERN. This mixed field was created by a 385 GeV/c primary lead beam interaction in a beryllium target The detector was configured in adaptive gain mode, providing a larger per-pixel energy range, and irradiated at different angles.

Prior to the testbeam campaign the Timepix2 detector was calibrated using previously developed methodology [3] using protons with energies in the range from 400 keV to 2 MeV and α -particles of 5.5 MeV from 241Am source. Measuring at different bias voltages allows for varying the energy deposition in single pixels. In contrast to the findings of the previous work, where Timepix2 saturated at ˜2.6 MeV [3], it was found that the Timepix2 chip (v1) studied in the present work shows a linear response at least up to 3 MeV deposited per pixel energy in adaptive gain mode. To further understand this issue, the temperature dependence of the Timepix2's energy response will be investigated and discussed.

We present and discuss energy deposition spectra for relativistic particles of different stopping power. The main goal of the deposited energy spectra analysis is investigation the capabilities of the Timepix2 detector for decomposing the mixed beam. Using spectrum stripping technique by iterative Landau curve fitting charge discrimination could be done up to Z = 13 (see figure 1) for impact angle of 70 degrees with respect to the sensor normal. Timepix3 results, for example, indicated sensitivity up to Z=7 [4]. Using the acquired test beam data, we will further refine the per-pixel energy response determined with above described methodology and compare it to the electronics design simulations from [1].

References:

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