Time-based reconstruction in the GEM Tracker

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Introduction

The GEM Tracker, a set of three planar Gaseous Electron Multiplier detectors, is a forward part of the central barrel of the PANDA experimental setup. Covering polar angles from 5 to 20 degrees it is responsible for track reconstruction. The charged particles are crossing two drift volumes (front and back) per each station and ionize the gas.The signal is detected on the double sided pad plane located in the centre of each station. Each side is equipped with sensitive pads that are connected into strips in two directions per pad plane. This results in recording particle trajectory position on each station in 4 different views. The paper presents the reconstruction chain of the time-based digitized data from the GEM Tracker, that was introduced in [1].

Implementation

The time-stamped digitized data from the GEM Tracker is stored in the time ordered buffer assuming PANDA goal event rate of 2×10^7 events per second. The reconstruction tasks request data from these filled buffers and obtain time slices of data, as presented in Figure 1. The time slices are defined by gaps in the data stream and thus are independent of the simulated events structure, often consisting of several events or spreading event data between different slices.

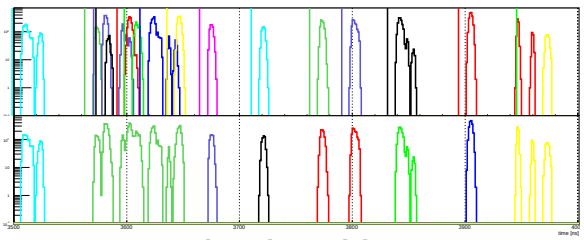

Figure 1: GEM Tracker's digitized data versus time. Top panel shows different simulated events in different colors (vertical line indicates the beginning of a corresponding event), in the bottom panel different colors represent different time slices.

The reconstruction chain include finding of clusters, hits and eventually tracks. The original idea was to operate on the data from individual time slices with the help of the previously developed algorithms that worked on events. However obtained results, specifically the low track finding efficiency of about 57% for the primary tracks from the DPM event generator, forced searching for new solutions. The first change was to use the time information when combining data, that was originally combined only geometrically. That increased the efficiency by few percent, but still well below the acceptable levels.

In many cases events are inseparably close in time, resulting in higher combinatorics and thus lowering track finding efficiency. The other sources of the tracking inefficiencies are the high occupancy in the GEM Tracker and relatively large strip dead time of 100 ns, resulting in up to 7% chance of any strip being hit again while being inactive. The original hit finding algorithm identified hits from intersections of strips on front (radial and concentric) or back (horizontal and vertical) readout planes. In case of the time-based reconstruction that resulted in hit finding inefficiencies of 10% with about 70% of the found hits being fake hits, stemming from combining signals from different particle trajectories.

In order to cope with these problems it was necessary to amend for the possible influence of previous events. To achieve this, for each reconstructed hit on front (or back) pad plane a confirmation in the form of fired strips on the back (or front) is required. The confirmation may come from the currently analyzed time slice, or from previous time slices. This information is stored in newly developed GEM Tracker Monitor, that gathers information about last activation of each strip.

This method reduced drastically the number of combinatorial fake hits, cutting only small number of real hits, and resulted in improving track finding efficiency to 87% for primary tracks with momentum larger than $1\ GeV/c$.

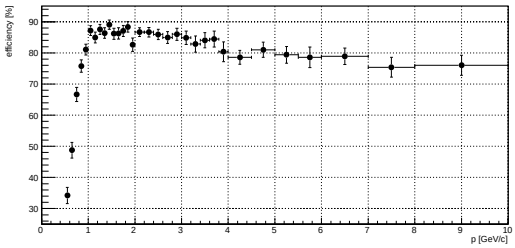

Figure 2: Track finding efficiency in the GEM Tracker as a function of momentum magnitude.

Summary

The current efforts in the PANDA computing community focus on the reconstruction of constant data stream from various detectors. In this report it has been shown that the data from the GEM Tracker can be analyzed with satisfactory results. Further improvements are still necessary to increase the tracking efficiency and reduce reconstruction time, which amounts today to about $50\ ms$ per simulated event.

References

[1] R. Karabowicz, "Panda GEM Tracker software status", GSI Scientific Report 2012 (2013) 301