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Display of specific ionization versus particle momentum in the sPHENIX TPC

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Abstract

This note details the first look at a non calibrated specific ionization (dE/dx) versus particle momentum using magnet-on data taken with the TPC in $p+p$ collisions.

Note on the tracking performance

We emphasise strongly that the data was reconstructed from the first field-on collisions of 2024. No efficiency or distortion corrections were applied, alignment procedures or matching with the silicon detectors. Hence, the plots here show a very preliminary look at the detector performance and are not reflective of our final performance. There are various parameters in the tracking that need to be understood so this note does not demonstrate the physics potential of sPHENIX.

1 Introduction

The sPHENIX magnet was ramped on Friday May 10th 2024 to its full current. The detector took data with all trackers for 2 hours after this and collected over 210,000 events across various runs. The complete ACTS tracking chain was performed on the runs to reconstruct tracks using only information from the TPC. As the alignment between the TPC and silicon was not known at the time of starting this study, the INTT and MVTX were excluded from the track reconstruction.

The runs used in this analysis are given in Table 1.

Run	Max. events
41989+41990	10791

Table 1: Run list used and number of events.

2 Event reconstruction and selection

The Event reconstruction for this analysis is performed using the Fun4All framework running the standard Fun4All_FieldOnAllTrackers.C macro. Events are written out to root ntuples using the TrkrNtuplizer for data rendering.

No event selection was applied

3 Track reconstruction and selection

To reconstruct charged particle trajectories the default local pattern reconstruction (seeding) in the TPC is used. The seeding is performed using the PHCSeeding class in the Fun4All framework. The pattern recognition is performed without corrections of apparent distortions in the TPC. The extraction and parametrization of the sizable visible distortions in the TPC is ongoing, but no validated distortion correction is available to this date. Hence the charged particle reconstruction efficiency is not known or understood yet. A significant difference in reconstruction efficiency for different charge signs of the particles is observed, likely due to the observed tearing effects at the radial sector boundaries which cause different residual step and inefficiencies depending on p_T

and bending direction. The results presented are not show differential in particle charge. Particle trajectories are selected that are composed of 30 or more clusters. No further selection criteria a applied.

4 Results

4.1 dEdx

The measurement of specific ionisation as a proxy for the energy loss (dE/dx) of the particle in the chamber gas is determined based on a truncated mean of the cluster charge (ADC sum) distribution for each given track. Each cluster charge is corrected for the thickness of the layer was recorded in to estimate the path length traversed, but no correction of local incident angle of the particle trajectory with respect to the readout layer was applied. The truncated mean as estimator of the post probable energy loss is realized by sorting the layer thickness corrected clusters charges in ascending order and rejecting the highest the highest 30% of the cluster charges before calculating the mean ionization. No attempt has been made to optimize the truncation parameters. The use of the simple truncated mean used here is a long established standard procedure in analysis of TPC data to provide a simple but robust estimator the the most probable energy loss of a given reconstructed particle. Despite the non calibrated input data and the very preliminary gain balancing between the various TPC readout sectors a clear separation between different particle masses is aparent.

The distribution of dEdX versus the logarithm of total momentum of the reconstructed particles is shown in Figure 1.

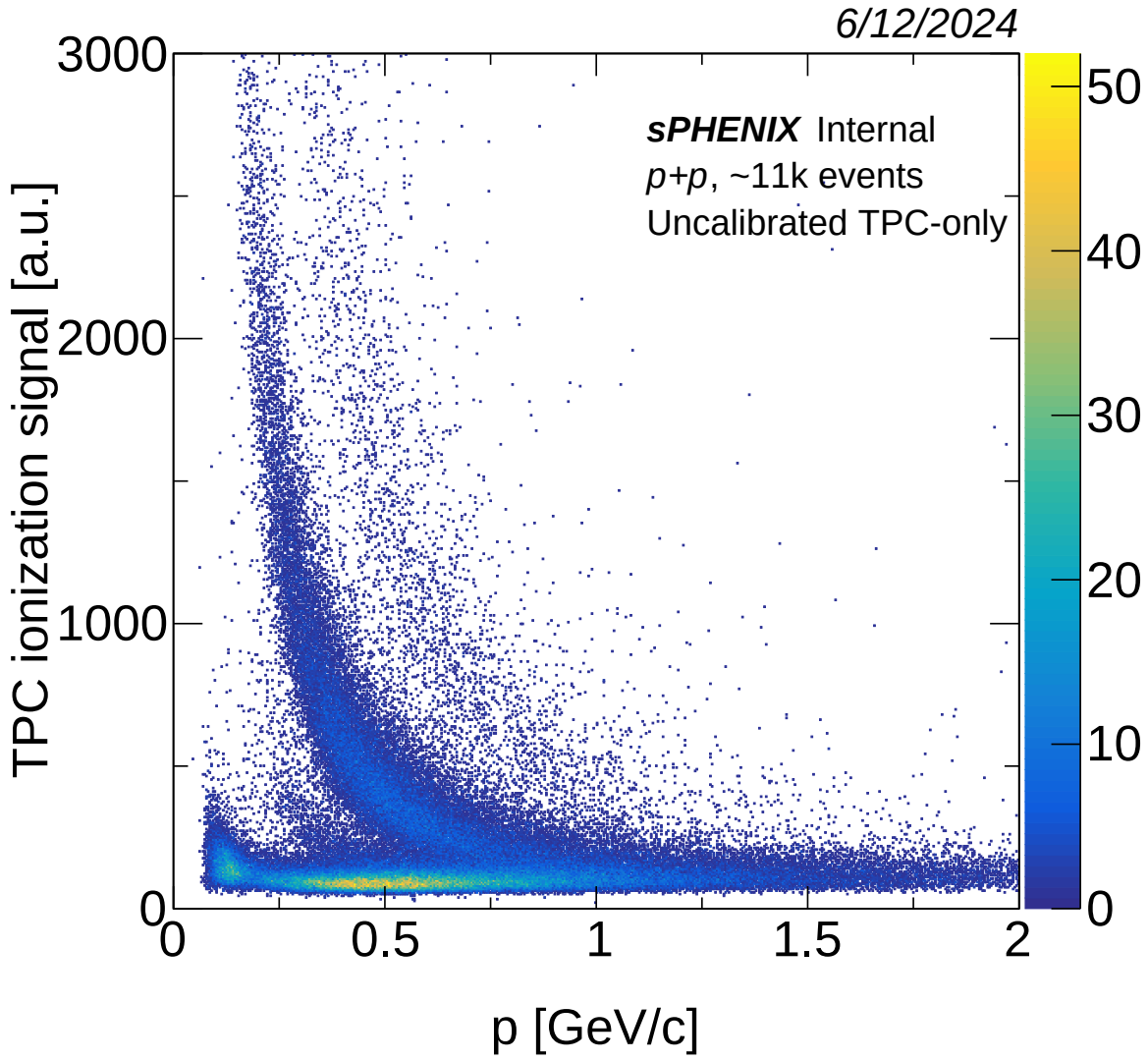

Figure 1: dE/dx