

Measurement of charged hadron ratios using TPC dE/dx in ALICE in p+p at $\sqrt{s} = 2.76 \text{ TeV}$

Koichi Kihara

High Energy Nuclear Physics Group,
University of Tsukuba

Outline

1. Introduction

- Physics motivation
- The ALICE experiment
- PID in ALICE, TPC

2. Analysis

- TPC dE/dx
- Sigma momentum dependence
- Raw particle yield & ratio

3. Summary & Outlook

Abbreviations:

ALICE A Large Ion Collider Experiment

PID Particle IDentification

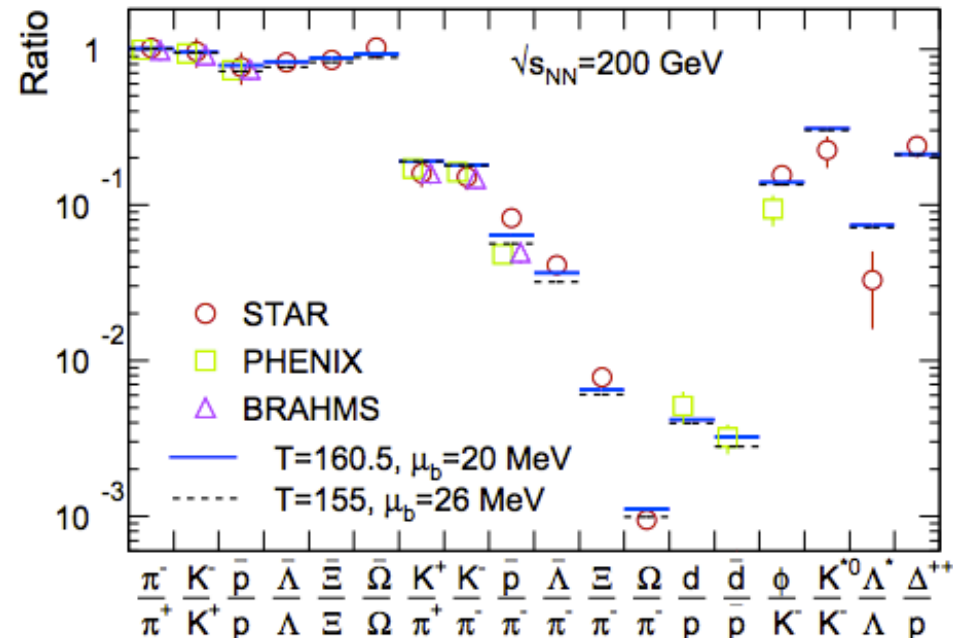
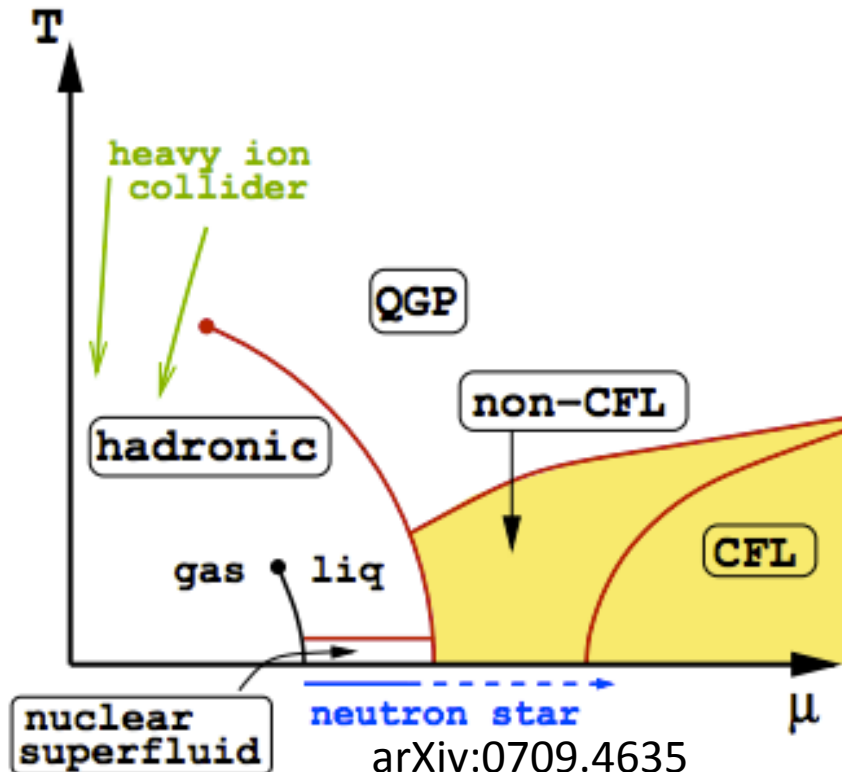
TPC Time Projection Chamber

1. Introduction

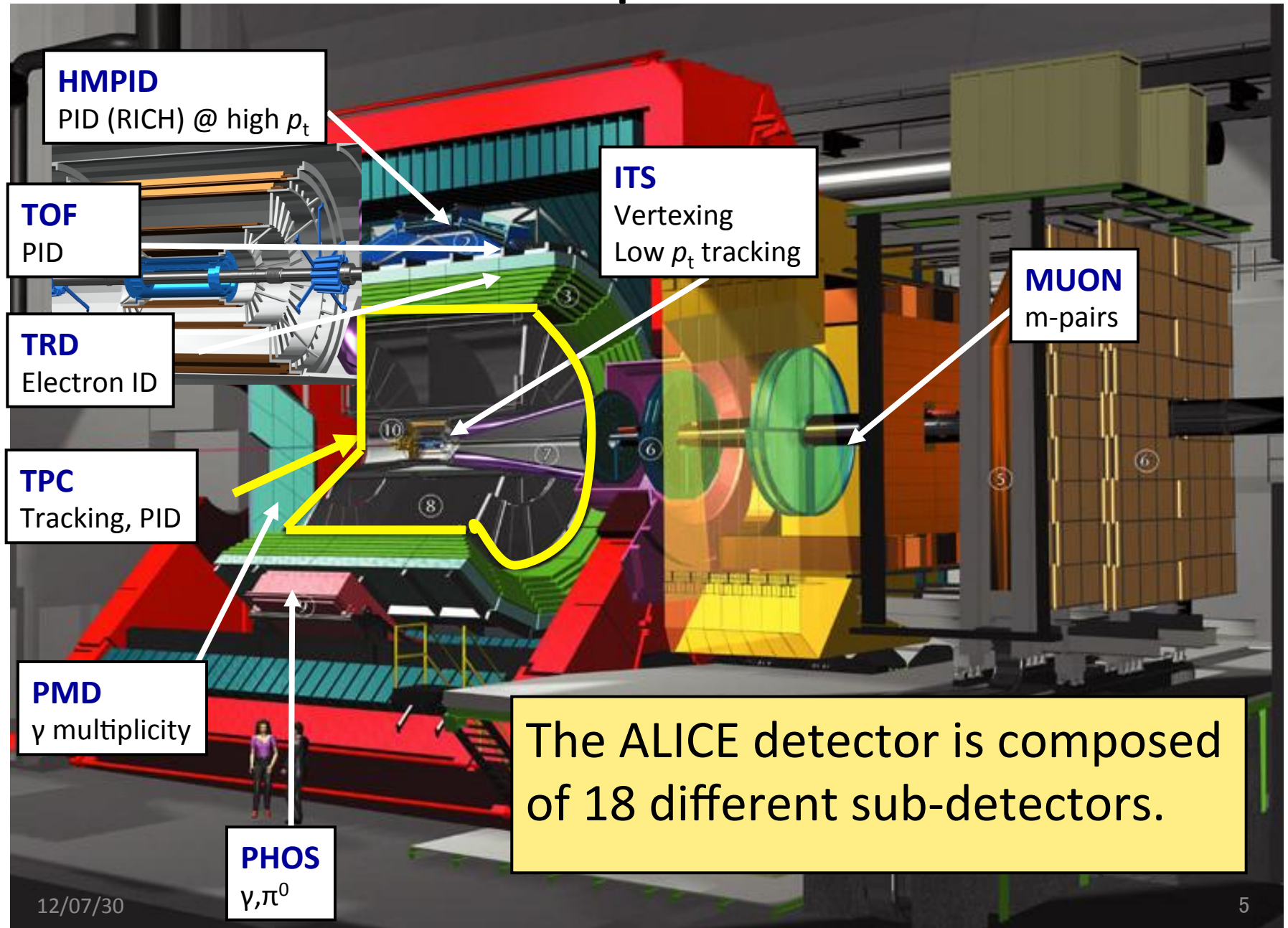
Physics motivation

- The phase diagram of QCD matter
- To study T and μ from the hadron yields

 Understanding from LHC p+p collisions

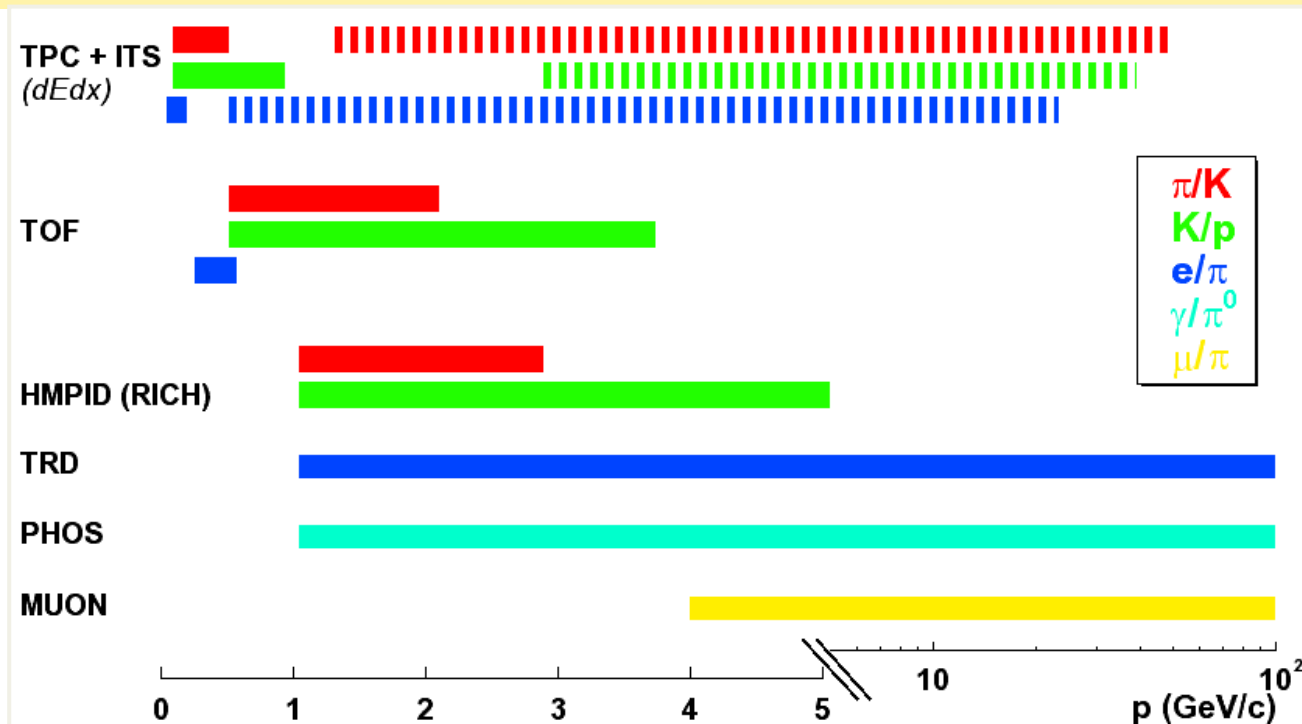


ALICE Experiment



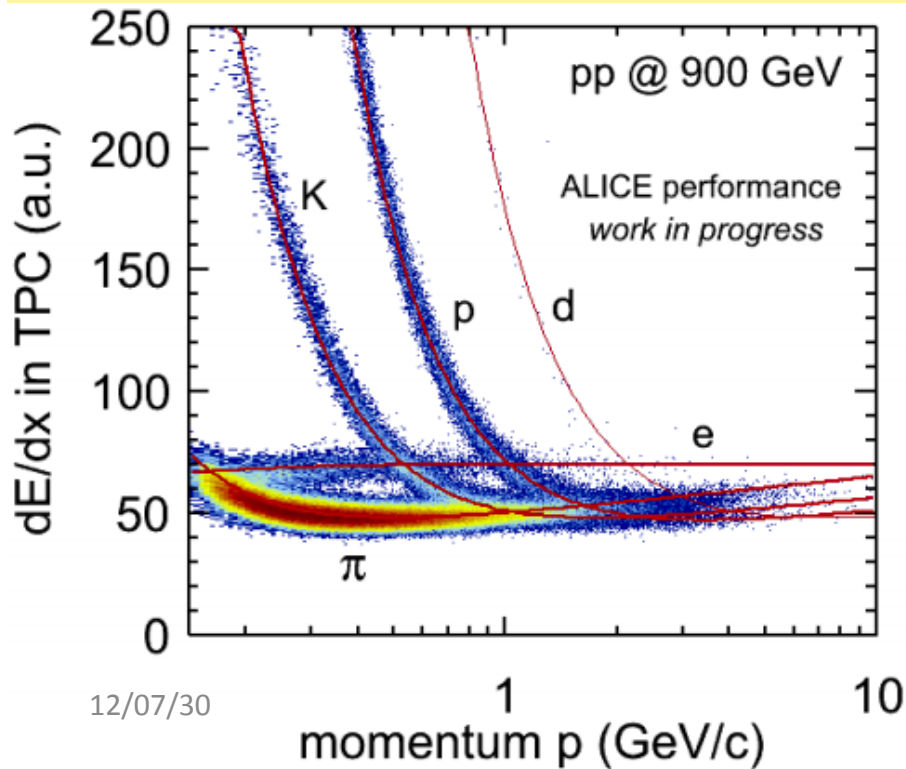
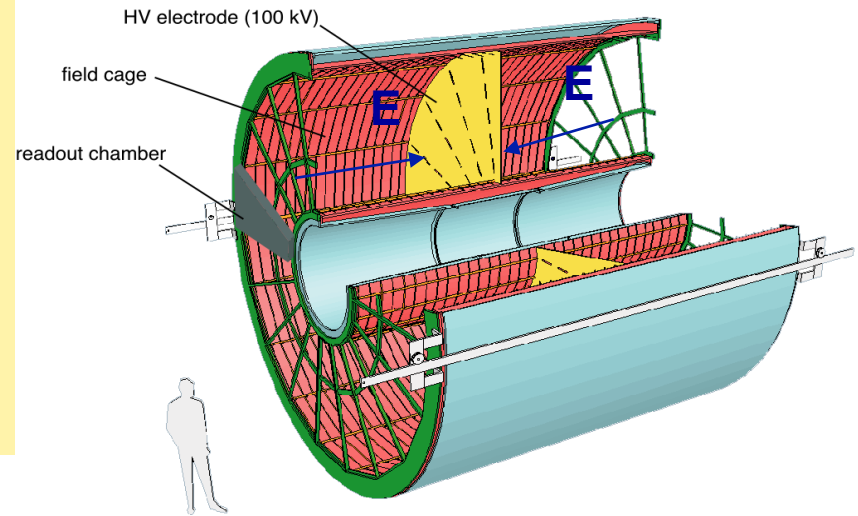
PID capabilities in ALICE

- ALICE has PID over large momentum range due to the exploiting of different types of detectors:
 - ITS + TPC : low p_T identification
 - TOF : covers intermediate p_T region
 - TRD : electrons identification
 - HMPID : high p_T region



TPC(Time Projection Chamber)

- PID at low momentum($p < 1 \text{ GeV}/c$)
- PID at mid momentum($3 \sim 50 \text{ GeV}/c$) if the resolution and/or calibration is sufficient



- Main tracking detector PID via dE/dx in gas up to 159 samples

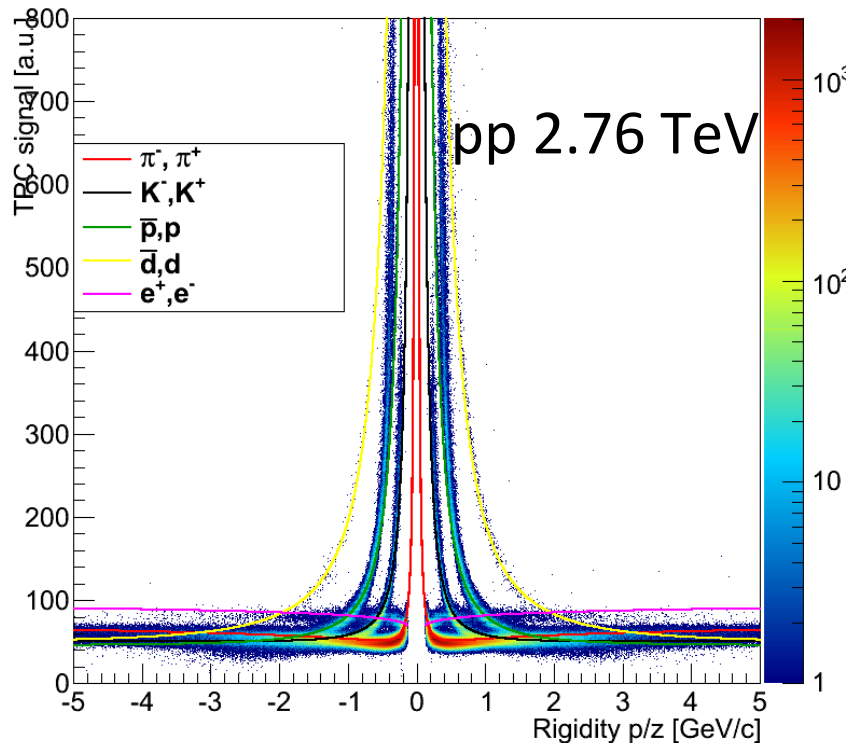
2. Analysis

Data set & track selection

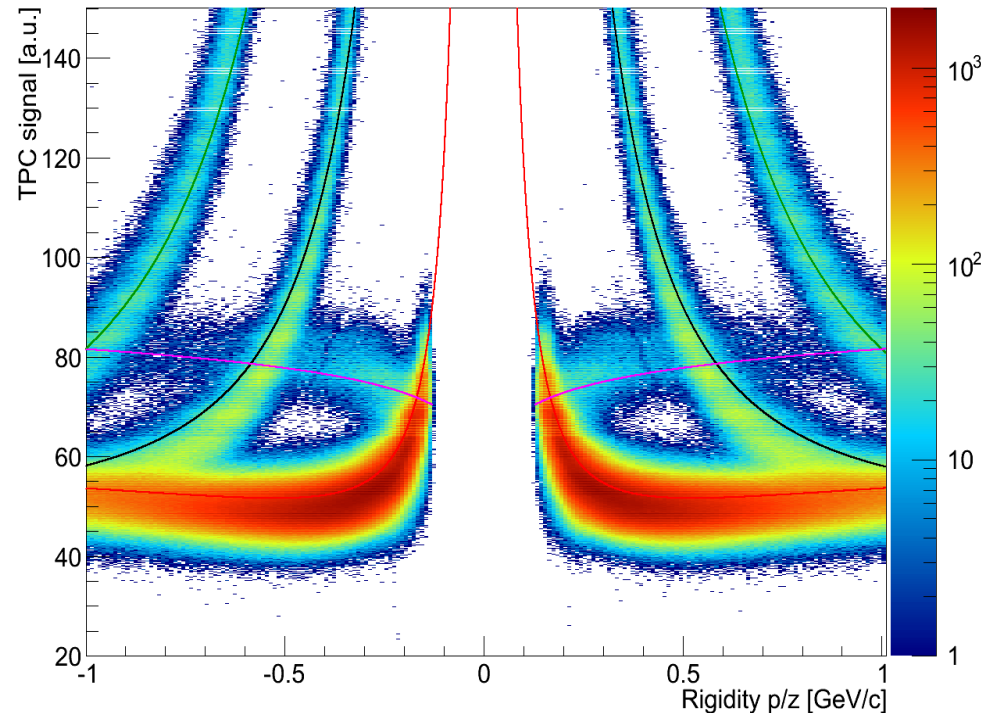
- Data & trigger
 - p+p 2.76 TeV
 - LHC11a pass1, ESD file, Run number 146804
 - # of event: 12.4 million
 - $|Z \text{ vertex}| < 10 \text{ cm}$
 - AliVEvent::kAnyINT
- TPC track selection
 - EtaRange: $|\eta| < 0.9$
 - MinNClustersTPC: 70
 - MaxChi2PerClusterTPC: 4.0
 - RequireTPCRefit(KTRUE)
 - MaxDCAToVertexXY: 1.0
 - MaxDCAToVertexZ: 3.0
 - DCAToVertex2D(kTRUE)
 - RequireSigmaToVertex(kFALSE)
 - AcceptKinkDaughters(kFALSE);

TPC dE/dx vs. Rigidity p/z

TPC dE/dx distribution



TPC dE/dx distribution



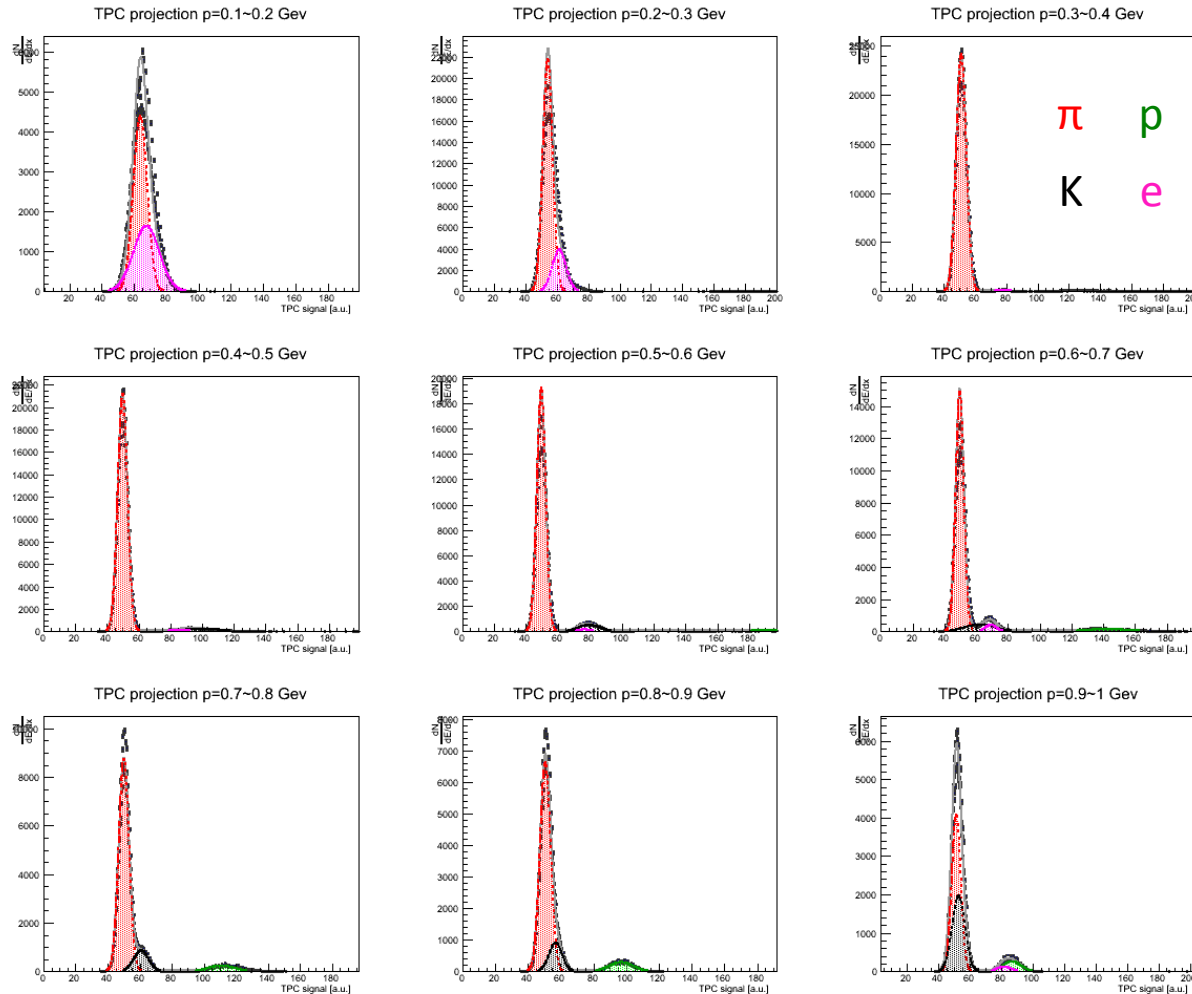
- Fitting function : Bethe-Bloch formula

$$-\frac{dE}{dx} = 2\pi N_a r_e^2 m_e c^2 \rho \frac{Z}{A} \frac{z^2}{\beta^2} \left[\ln \left(\frac{2m_e \gamma^2 v^2 W_{\max}}{I^2} \right) - 2\beta^2 - \delta - 2\frac{C}{Z} \right]$$

- π , K, p, e, (d) are clearly separated in low momentum.

dE/dx of TPC in rigidity slices

$p/z = -1.0 \sim 1.0 \text{ GeV}/c \rightarrow 20 \text{ segmentation}$



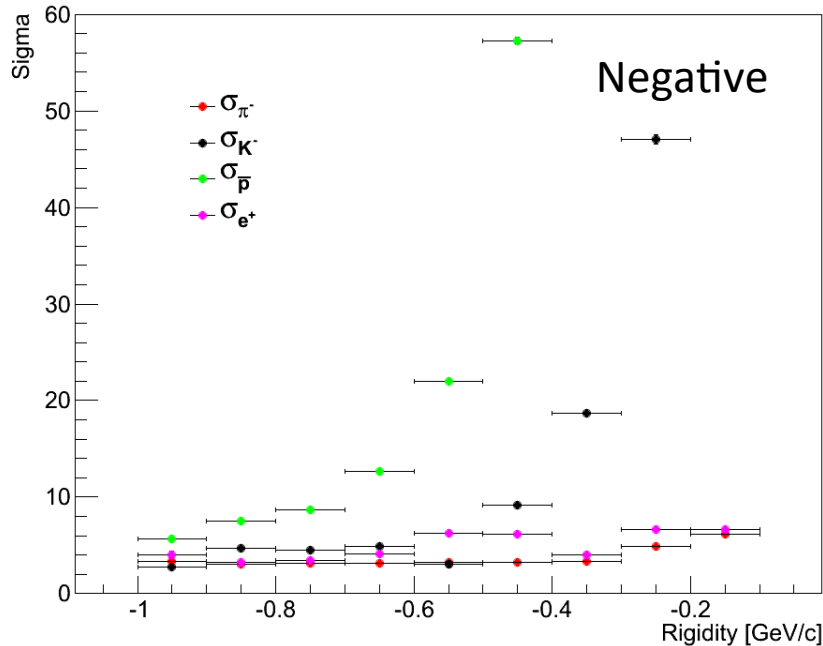
4 Gaussians fit
(π , K , p , e)



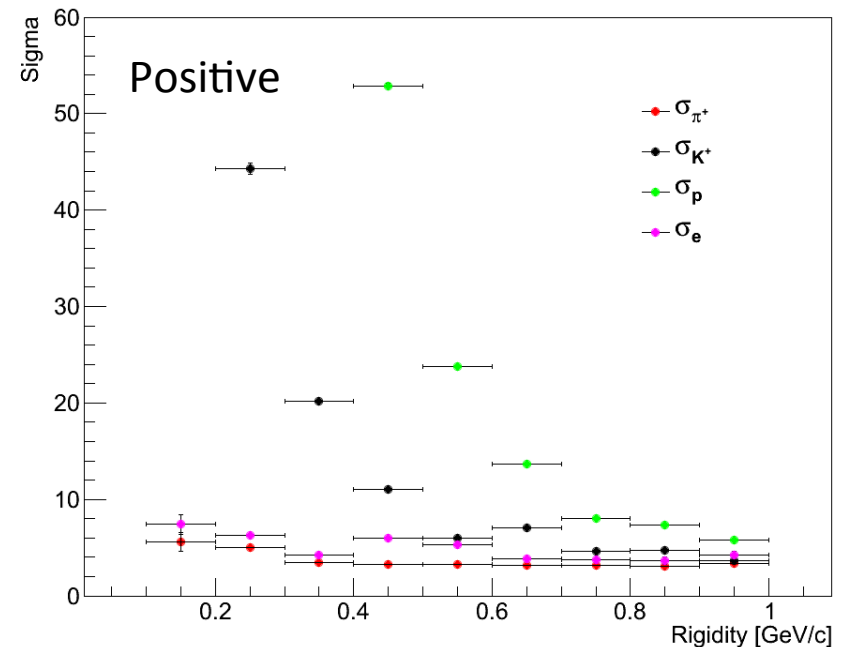
Estimated dE/dx's
sigma for each
particle species

Sigma in rigidity slices

Sigma vs. Rigidity



Sigma vs. Rigidity

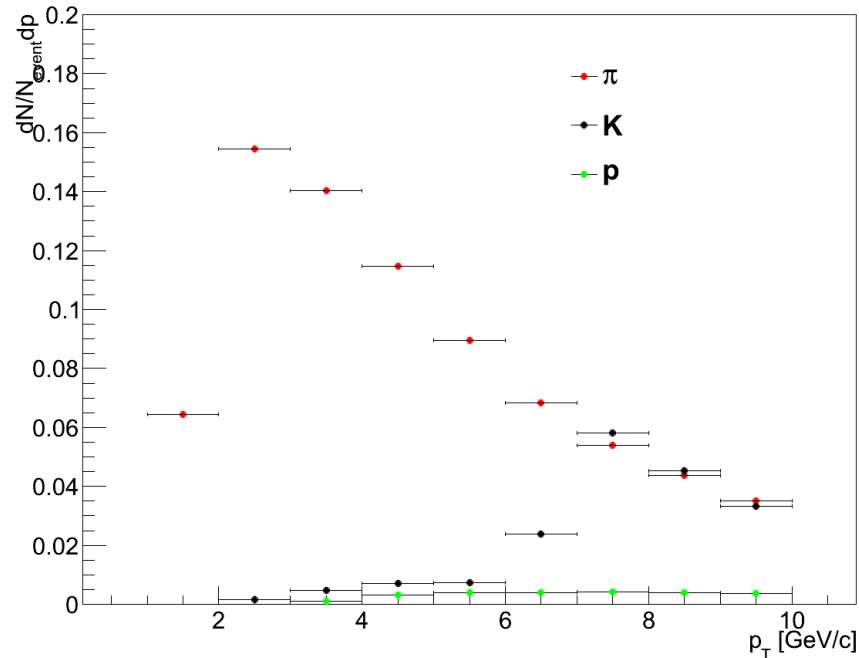


- Each sigma has momentum dependence.
- The higher momentum, the smaller sigma for all particles.
- Momentum dependent dE/dx cut on sigma.
 - > Charged hadron PID

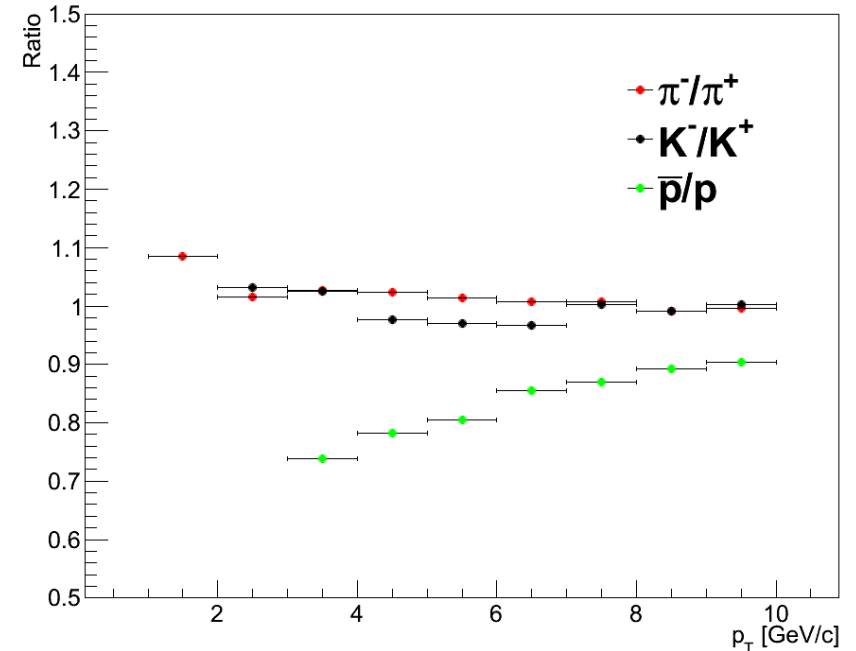
Raw particle yield & ratio

- Charged hadron yield from 3 sigma cut

Raw particle yield



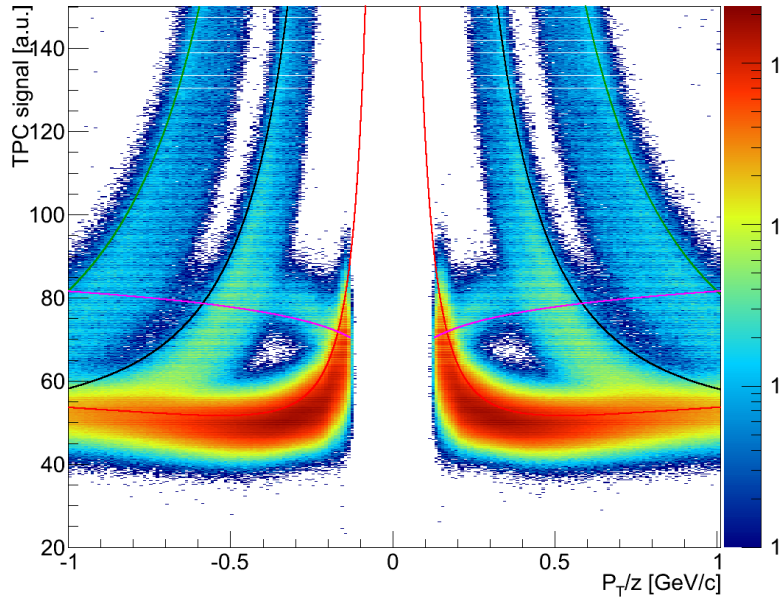
Raw particle ratio



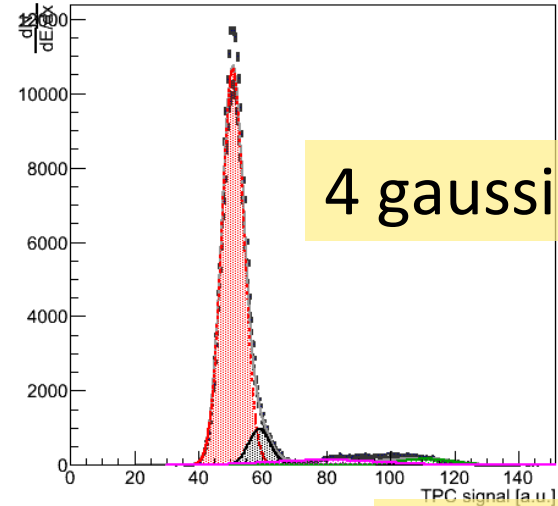
- The yield of K increases in $p_T > 0.6$ GeV/c region.
 - Included other particle(π, e)
- π^-/π^+ and K^-/K^+ are almost constant value(=1.0) .

TPC dE/dx vs. p_T/z

TPC dE/dx distribution



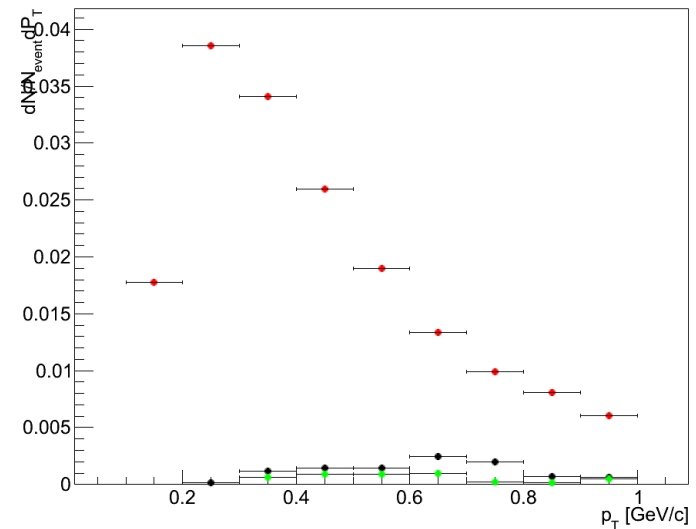
dE/dx
projection



4 gaussian fit

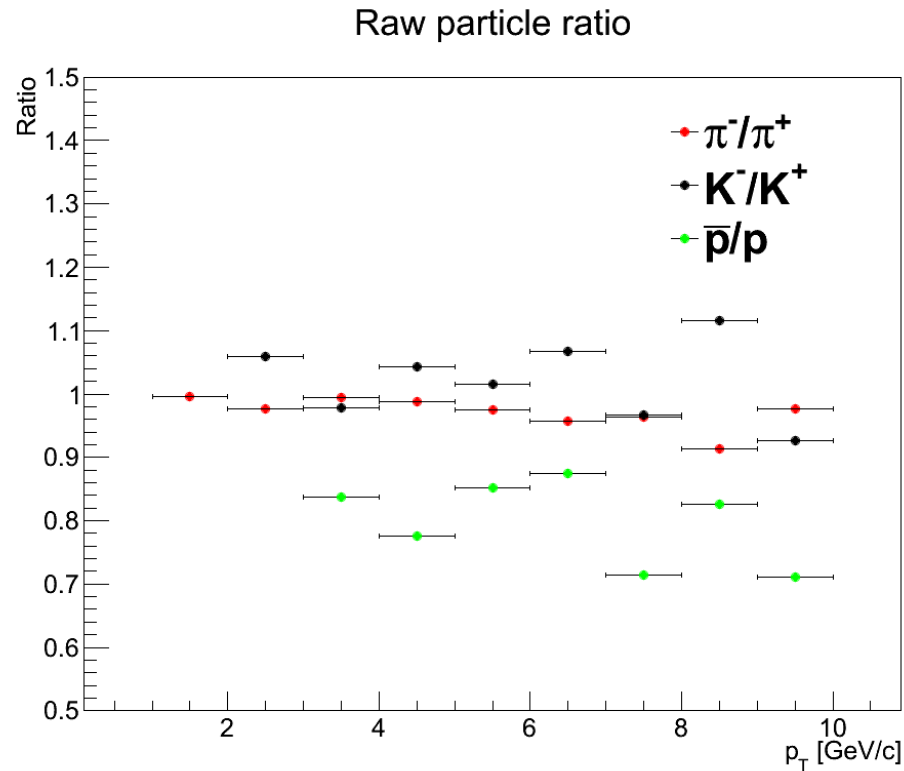
Integration

Raw charged hadron yield



Raw particle yield can be estimated by Gaussian integrals.

Raw particle ratio by p_T gaussian fit



- π^-/π^+ and K^-/K^+ are also constant value(=1.0) .
- \bar{p}/p is always less than 1.0 too.

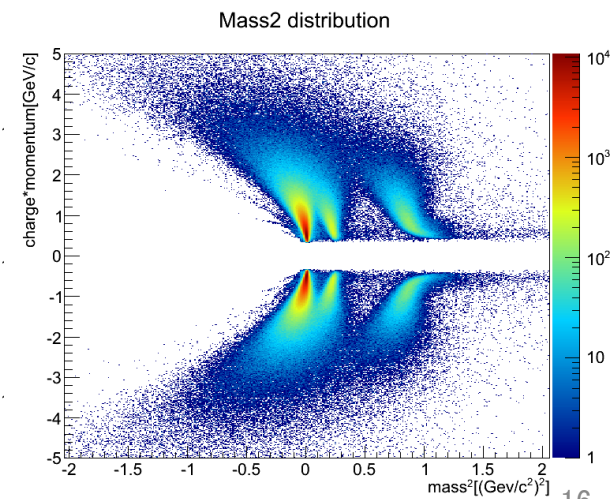
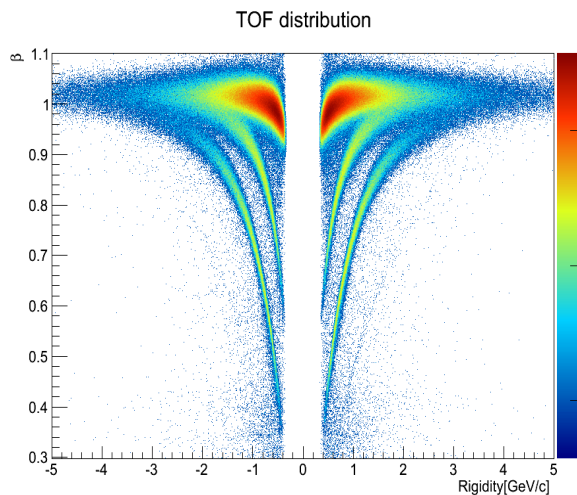
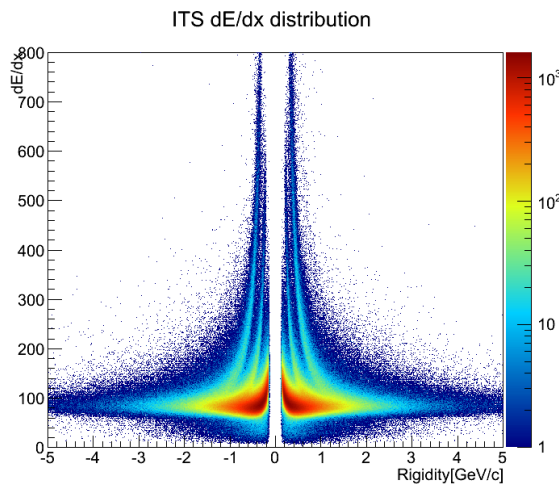
3. Summary & Outlook

Summary

- TPC has PID capability in low momentum.
- Measurement of the charged hadron ratios (π^-/π^+ , K^-/K^+ , \bar{p}/p) and their ratios are almost close to 1.0 except for \bar{p}/p .

Outlook

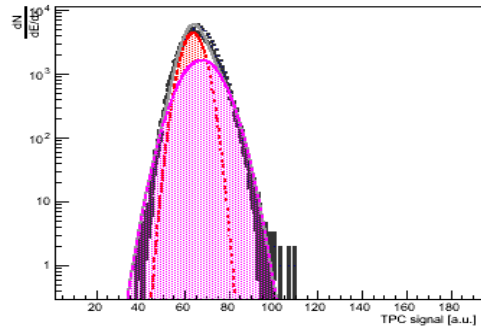
- To combine ITS and TOF information
- Detector effect (acceptance, decay...)
- To compare the theoretical thermal model (T, μ).



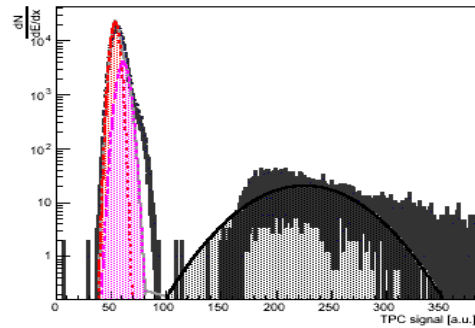
Back up

4 Gaussians fits of dE/dx of TPC in p slices Log scale

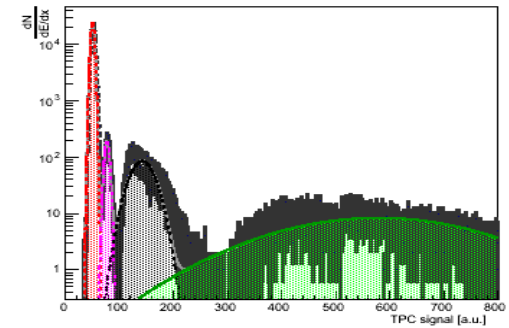
TPC projection p=0.1~0.2 Gev



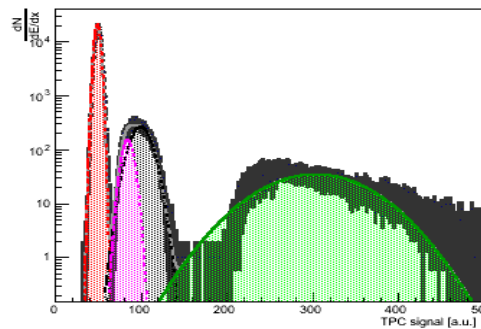
TPC projection p=0.2~0.3 Gev



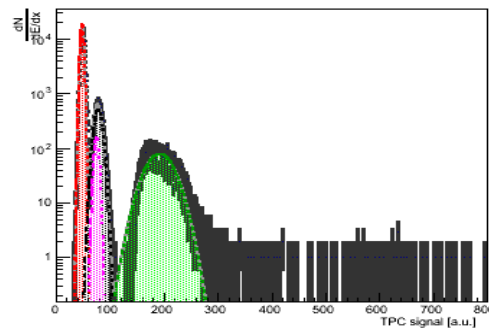
TPC projection p=0.3~0.4 Gev



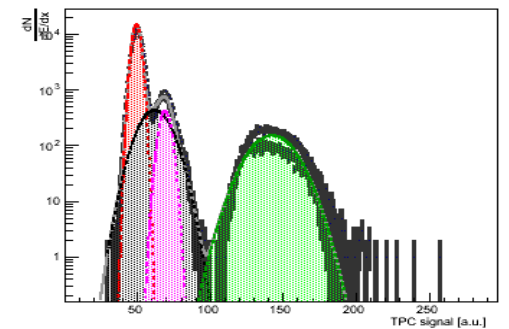
TPC projection p=0.4~0.5 Gev



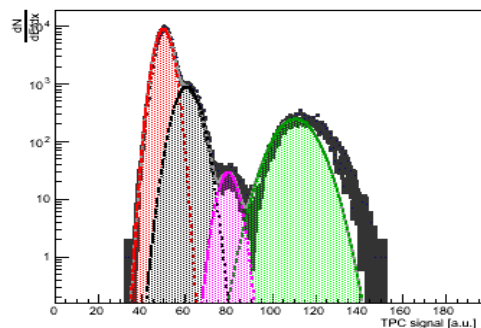
TPC projection p=0.5~0.6 Gev



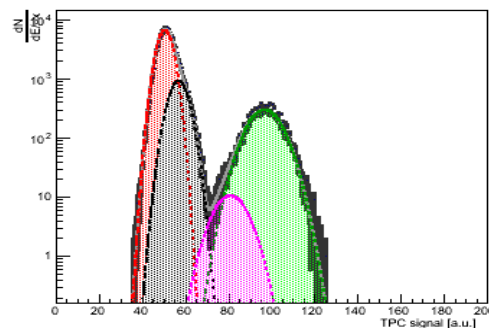
TPC projection p=0.6~0.7 Gev



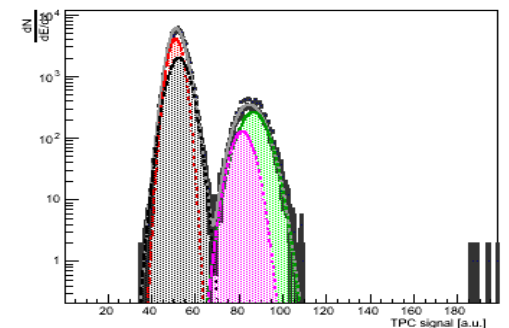
TPC projection p=0.7~0.8 Gev



TPC projection p=0.8~0.9 Gev

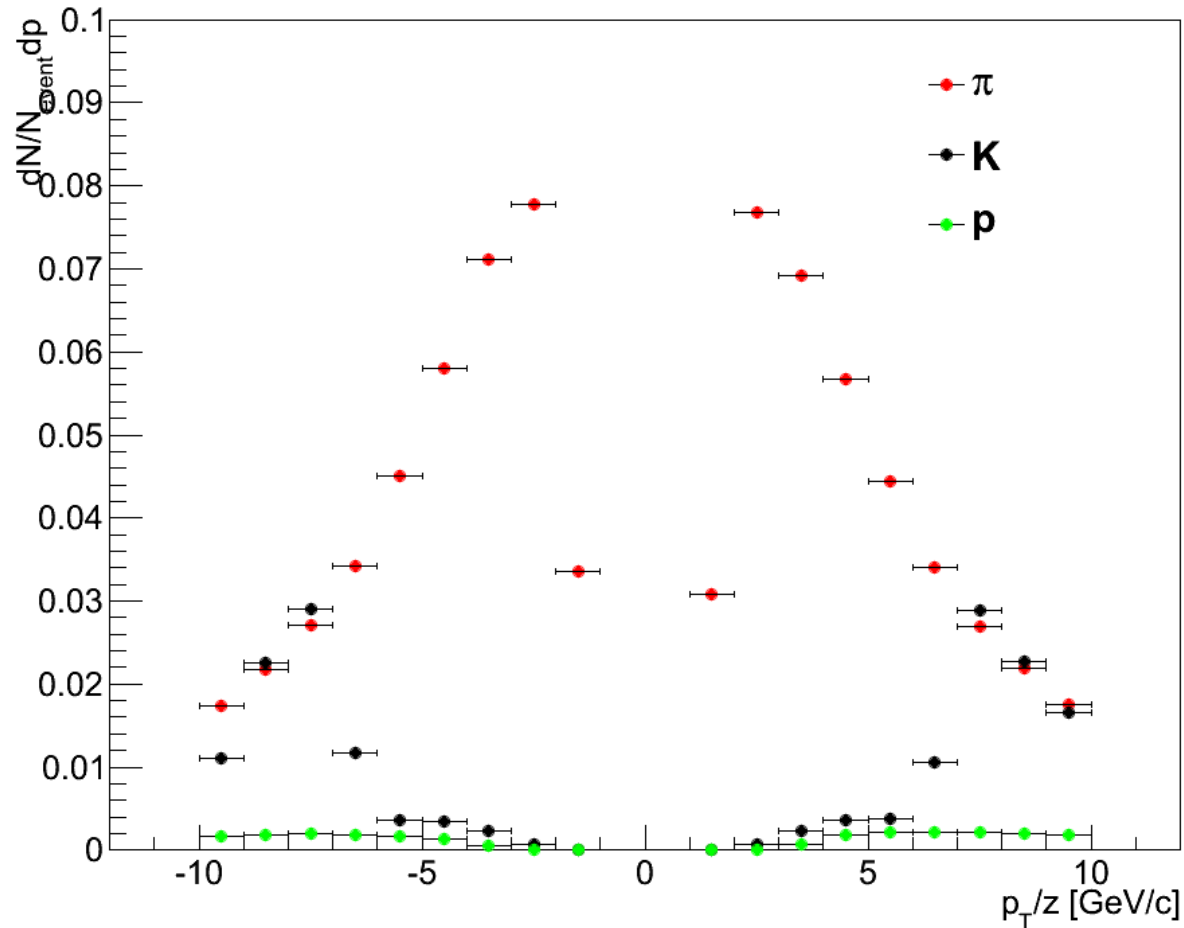


TPC projection p=0.9~1 Gev



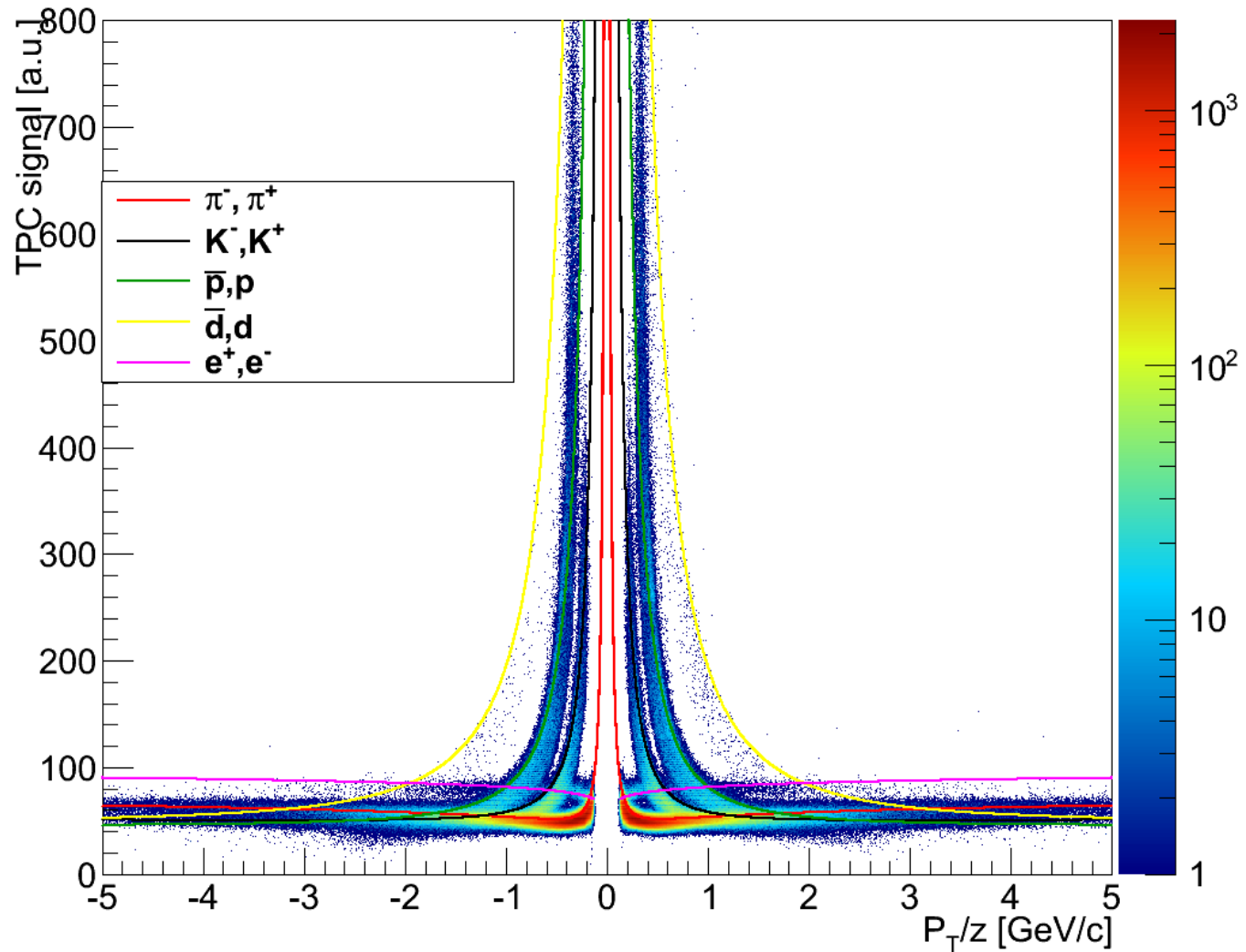
$dN/N_{\text{event}} dp_T$ vs. p_T/z

Particle yield



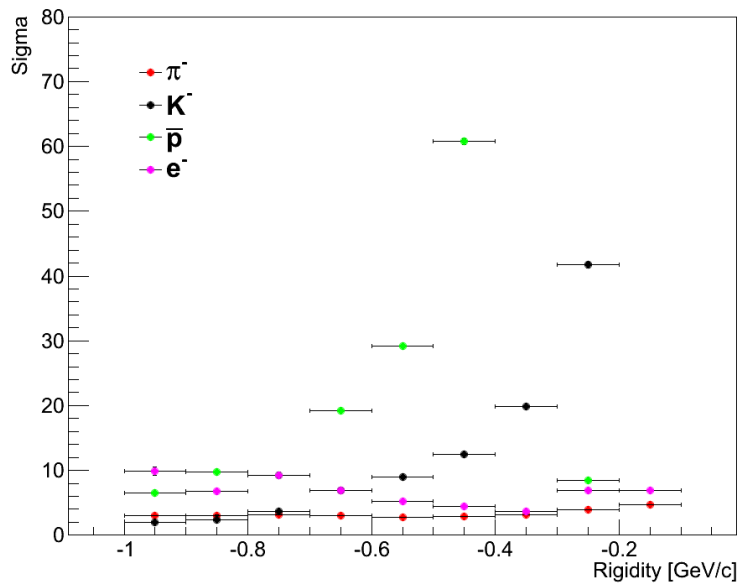
TPC dE/dx vs. p_T/z

TPC dE/dx distribution

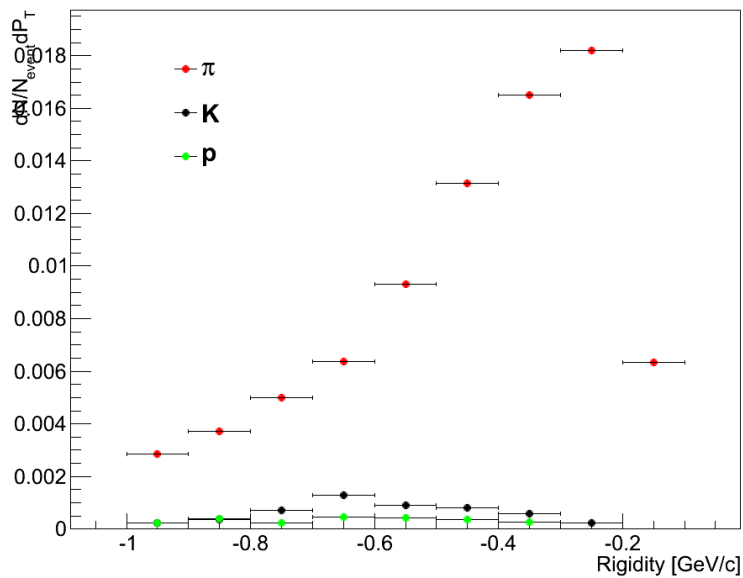


Sigma vs. p_T

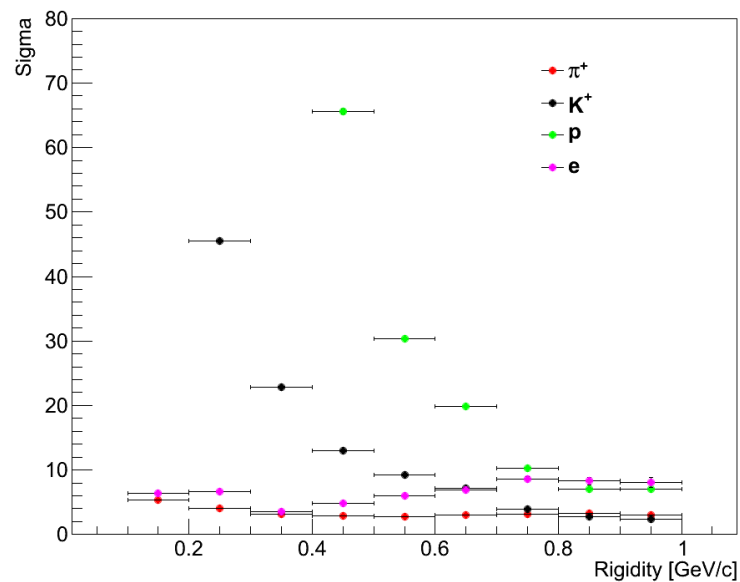
Sigma vs. Rigidity



Raw charged hadron yield



Sigma vs. Rigidity



Raw charged hadron yield

