

Updates on π , K & p production for ALICE RUN 3 pp data

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ALICE-STAR INDIA collaboration meeting,

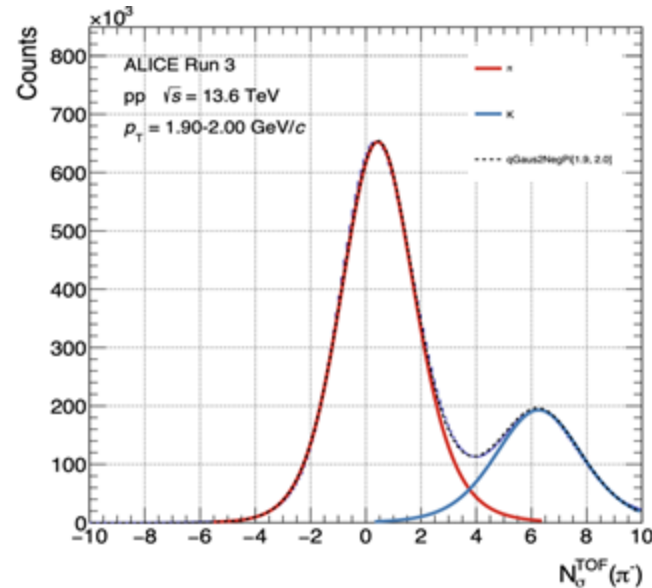
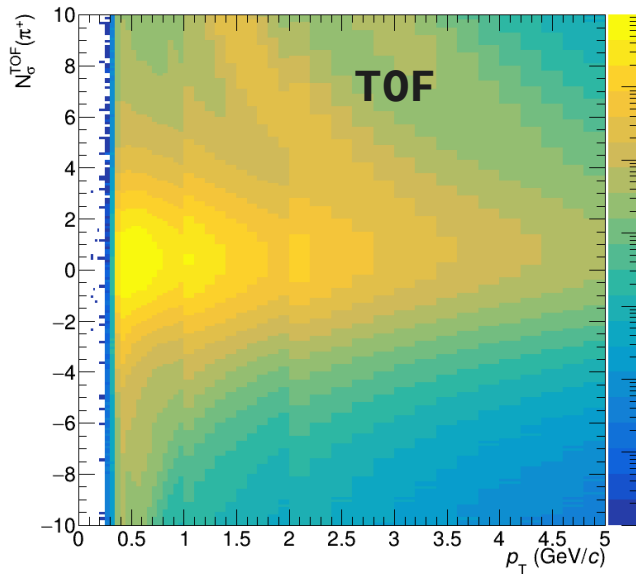
1 - 4 July, 2025

Variable Energy Cyclotron Centre, India

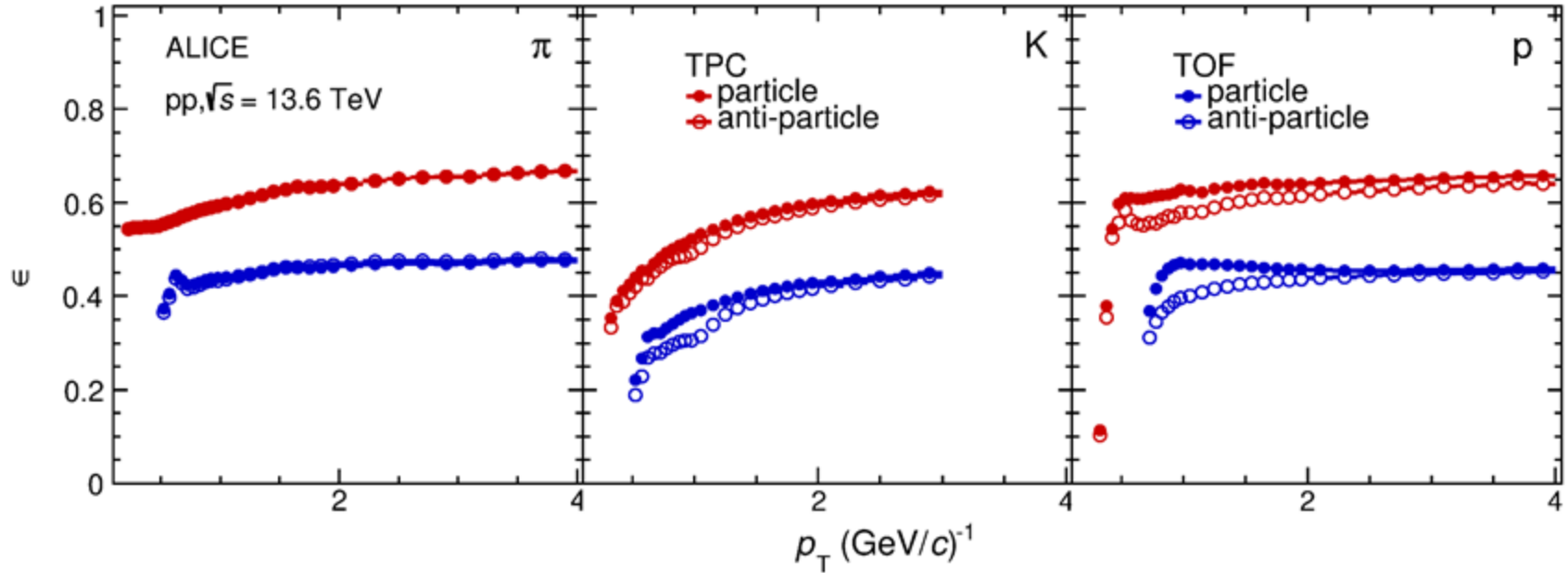


- Introduction
- Analysis Details
- Results
- Summary

- Prime objective of **ALICE** is to study the deconfined phase of QCD matter termed as **Quark Gluon Plasma (QGP)**.
- In this context, $dN_{ch}/d\eta$ – dependent K/π and p/π ratios are important in understanding how particle production scales with multiplicity across different systems. These ratios reveal whether strange and baryonic particle production increases smoothly from small to large systems or exhibits sharp transitions, providing hints about collective behaviour and the underlying production mechanisms.
- With RUN 3 upgrades of ALICE detector, it is now feasible to measure K and p to π yield ratios as functions of transverse momentum (p_T) and charged particle multiplicity density $dN_{ch}/d\eta$ with improved statistical precision.



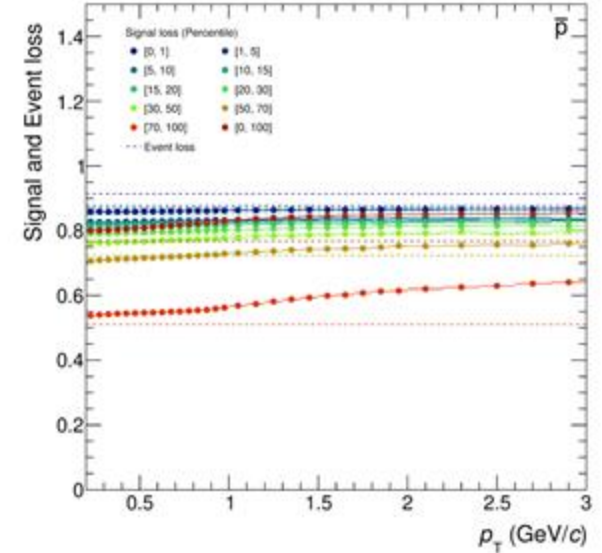
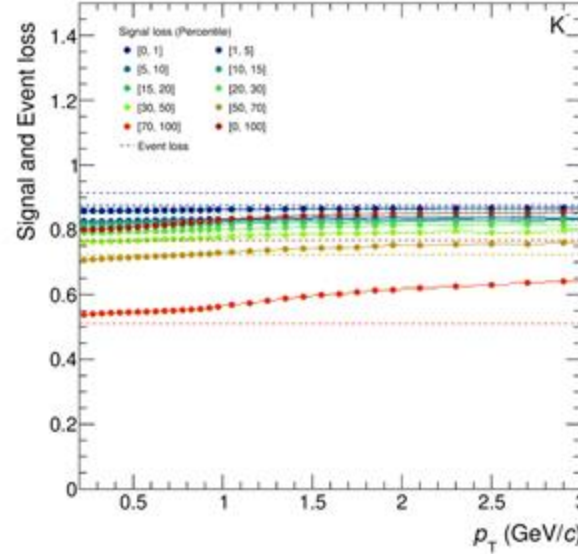
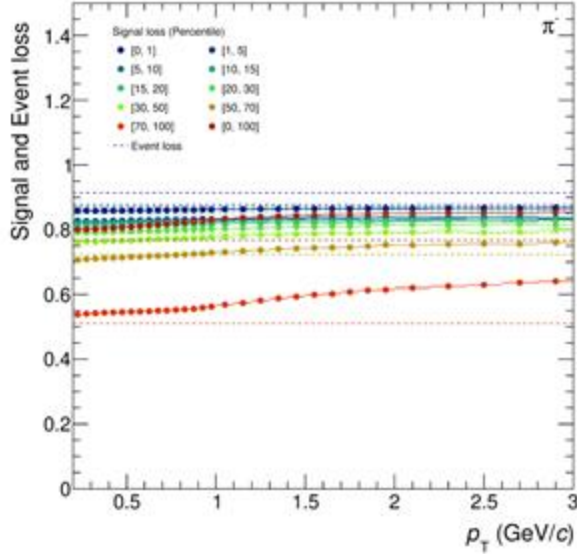
- Raw Yield extracted for each pT bins with unfolding of NSigma distribution
- Fitted with Gaussian+Expo tail
- Correction : Efficiency + Event loss + signal loss+ Primary fraction



$$\epsilon_{track} = \frac{\text{Reconstructed track}}{\text{Generated track}}$$

$$\epsilon_{mat} = \frac{\text{Reconstructed track with TOF}}{\text{Reconstructed track}}$$

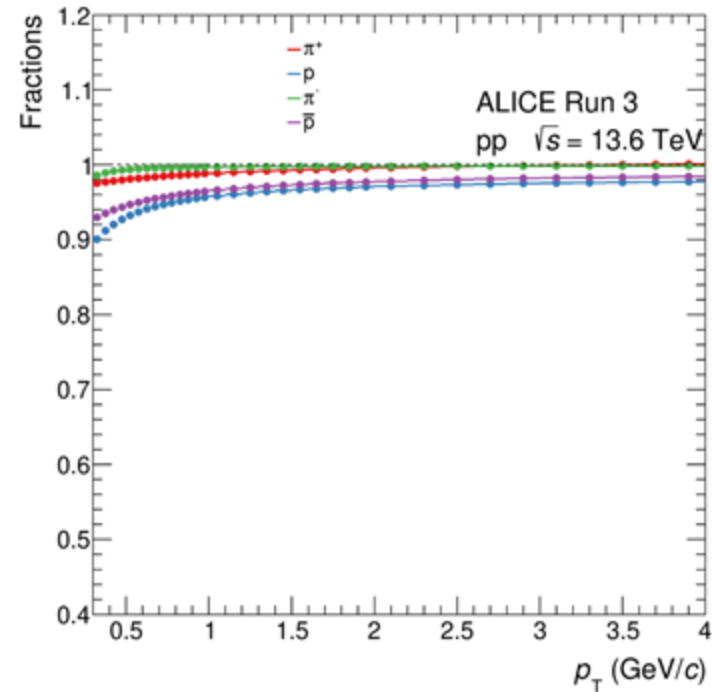
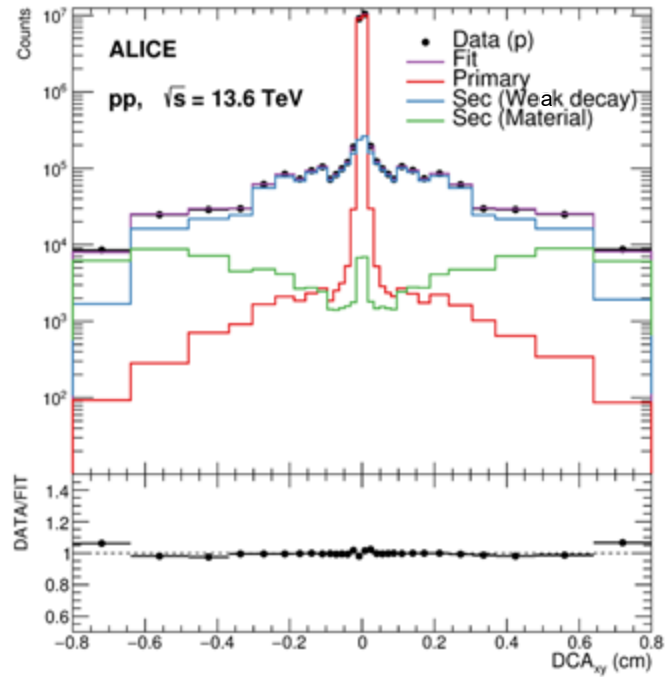
Event loss and signal loss



$$Event\ loss = \frac{Reconstructed\ Event}{Generated\ Events}$$

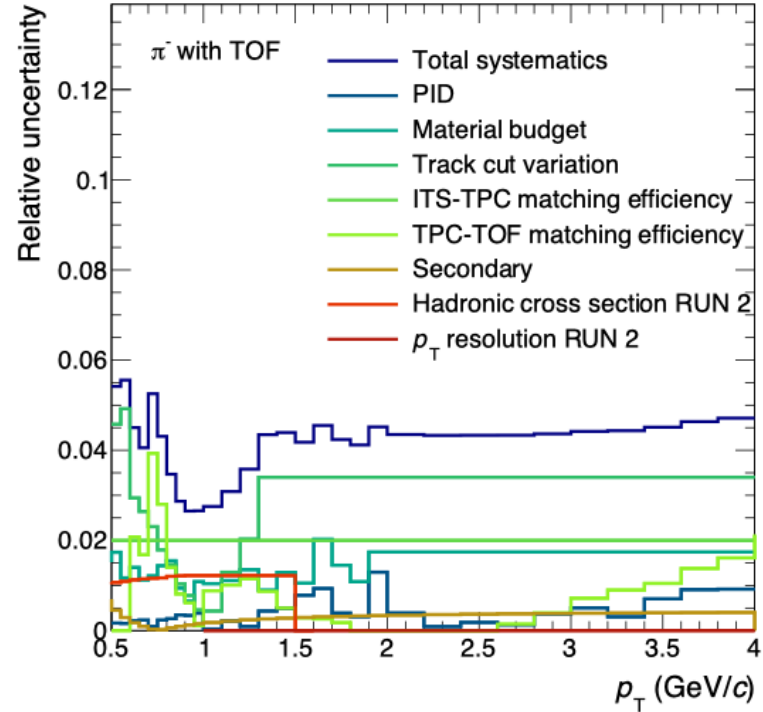
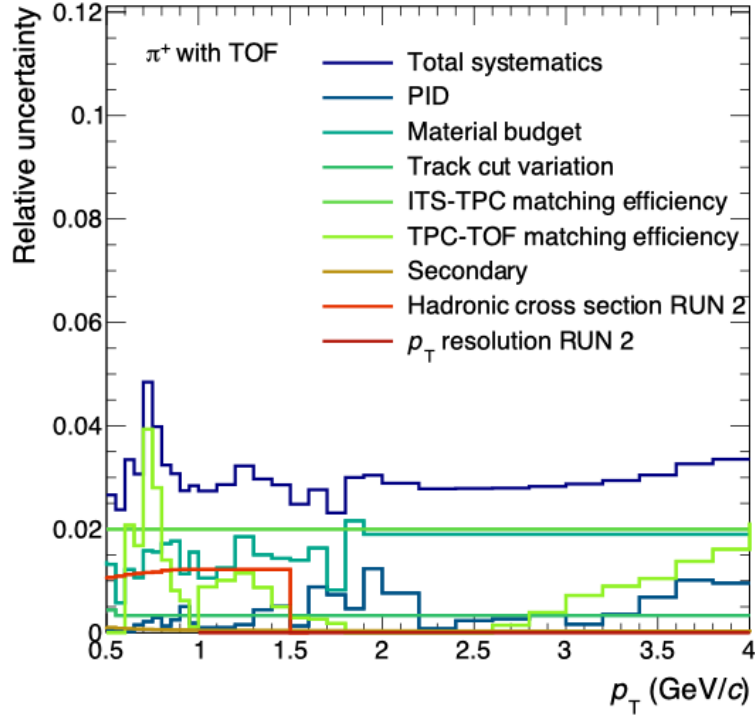
$$Sig.\ loss = \frac{Generated\ particle\ in\ Reco\ event}{Generated\ particle}$$

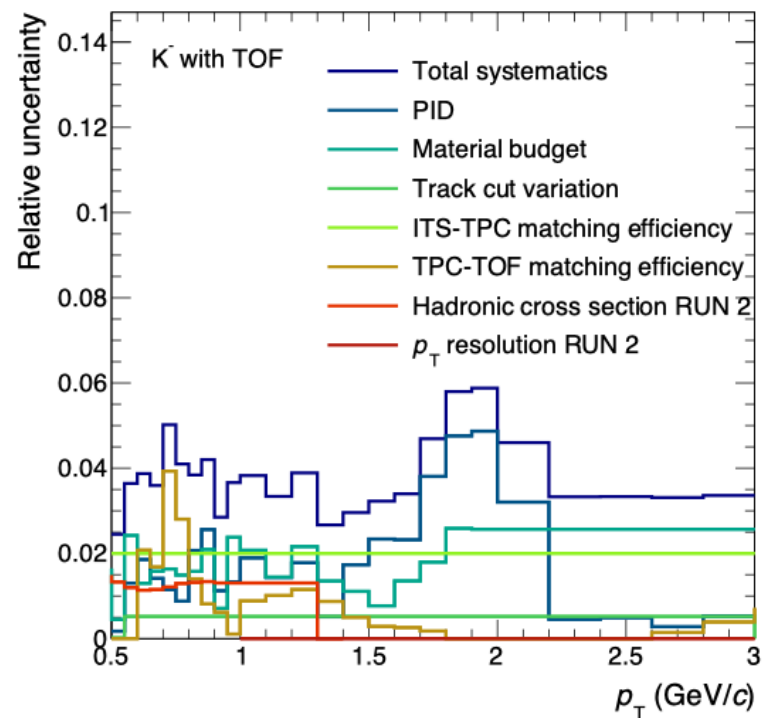
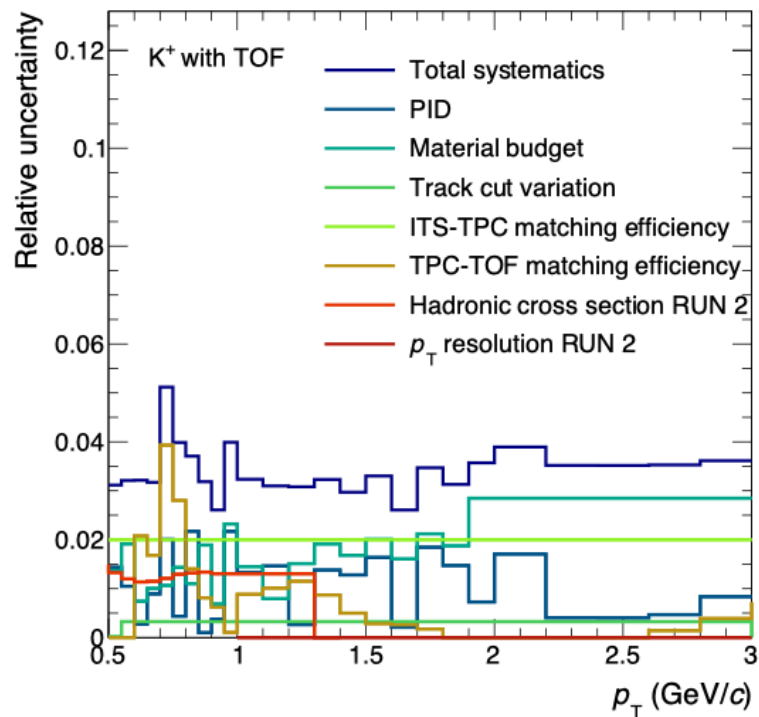
Primary fraction

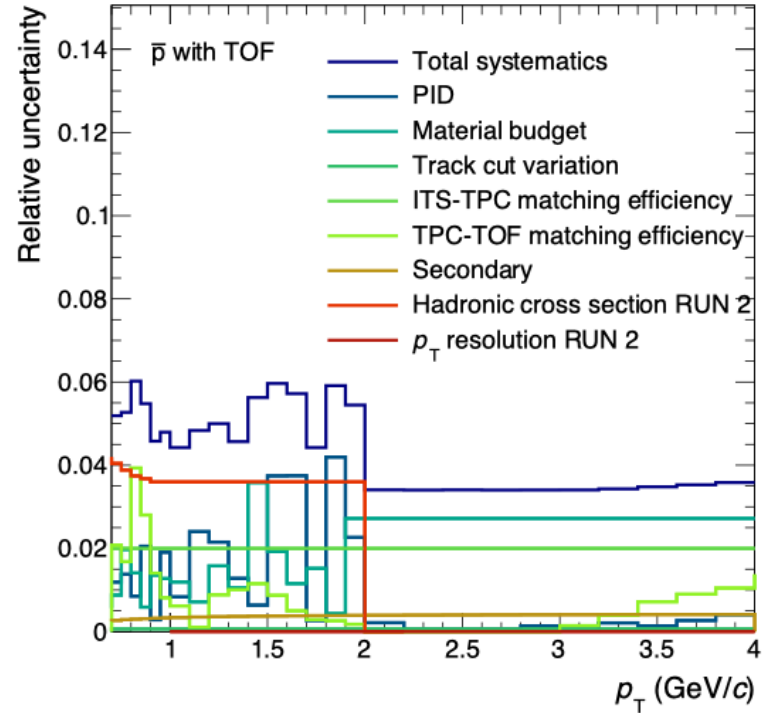
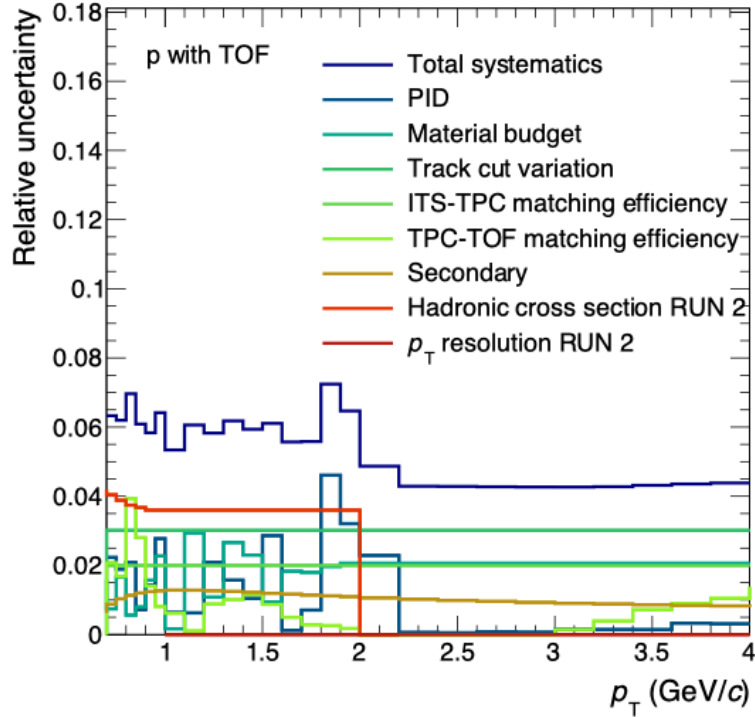


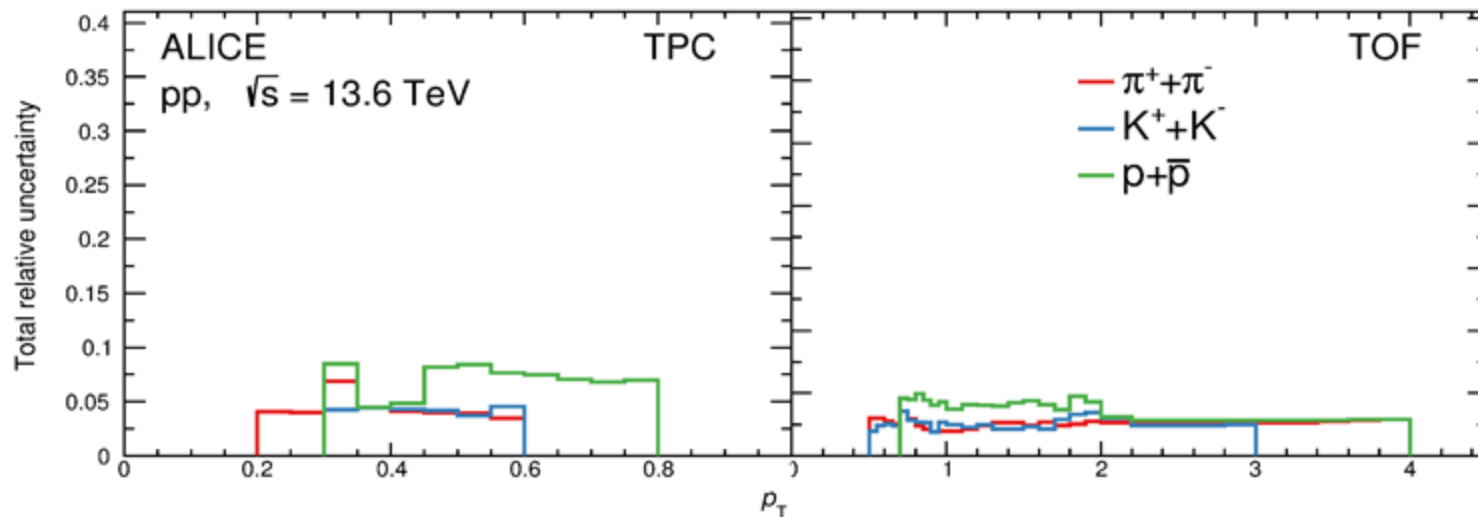
- Primary fraction is taken account for correcting the raw spectra.
- Used TFF for calculation to PF.

- ❖ Track cut variation:-
 - maxChi2PerClusterITS: 30 & 40 (standard = 36)
 - maxChi2PerClusterTPC: 3 & 5 (standard = 4)
 - maxDcaZ: 1 & 3 (standard = 2)
 - minNCrossedRowsOverFindableClustersTPC: 0.75 & 0.85 (standard = 0.8)
 - minNCrossRowsTPC: 60 & 80 (standard = 70)
- ❖ PID Technique:
 - Integral from the Template Fit
 - Bin counting
- ❖ Secondary:
 - Standard calculation technique : TFractionFitter, variation : RooFit
- ❖ Material Budget: (<https://its.cern.ch/jira/browse/O2-5700>)
 - Standard : LHC24f4d Variation : LHC25a9_Plus10 and LHC25a9_Minus10
- ❖ ITS-TPC Matching Efficiency:
 - Flat 2% for all pT (taken from slide 13 of [HF analysis](#))
- ❖ TPC-TOF Matching Efficiency:
 - Computed DATA/MC ratio of matching of global track with TOF





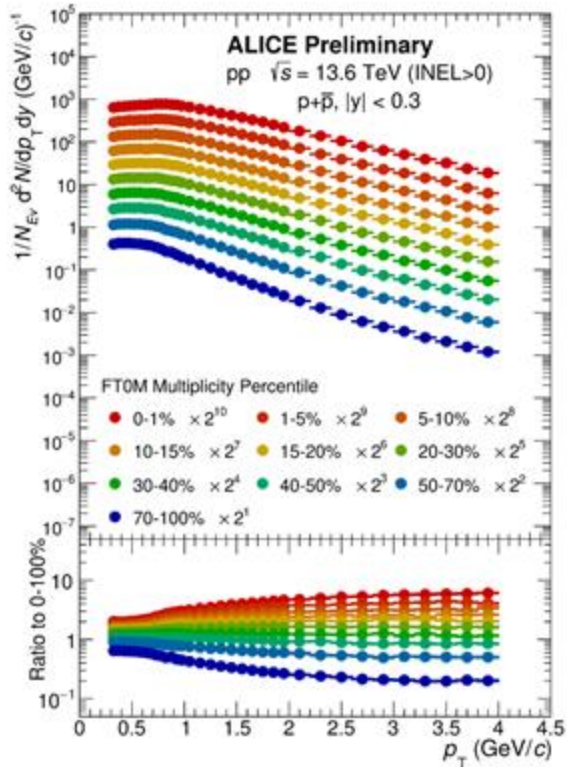
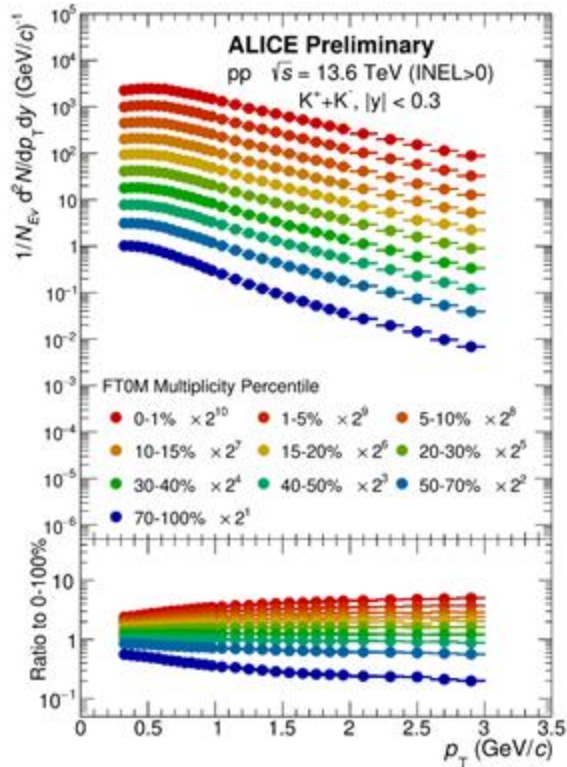
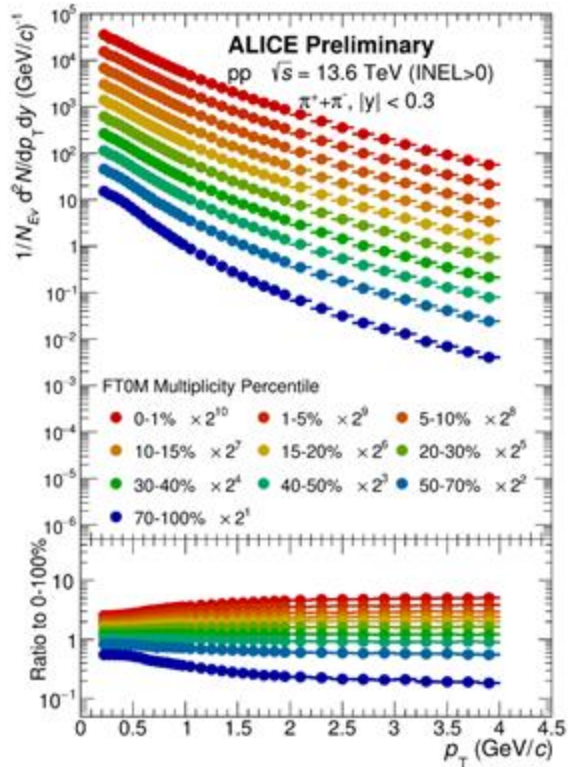




Combined Spectra

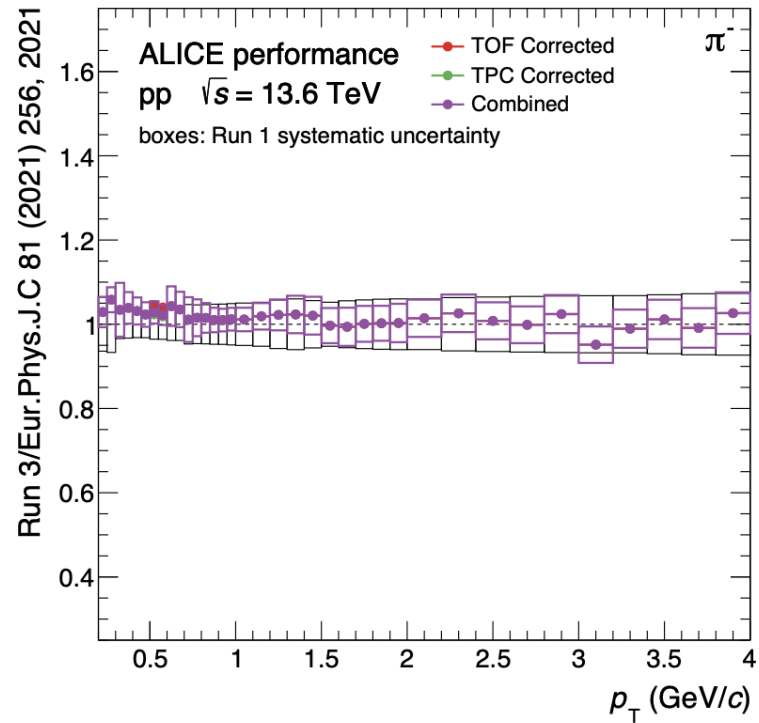
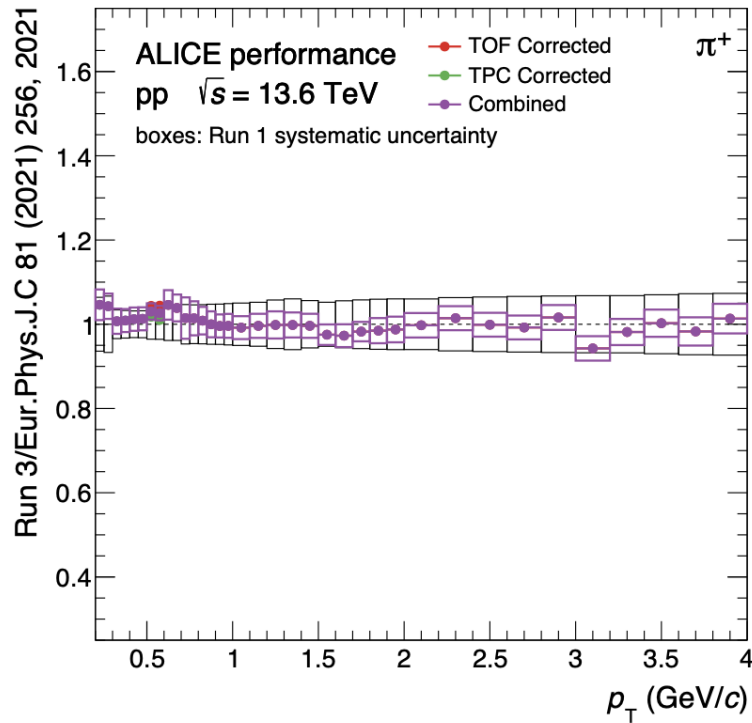


ALICE

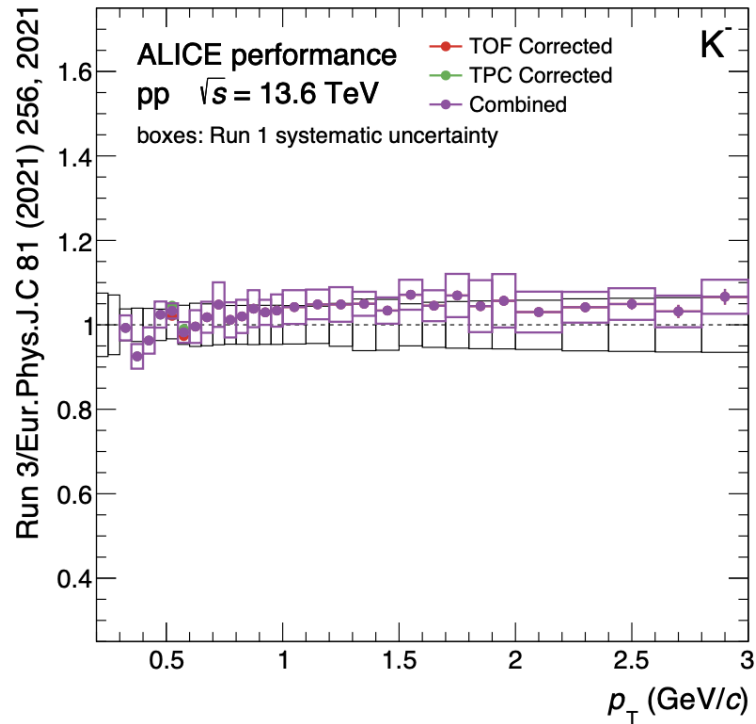
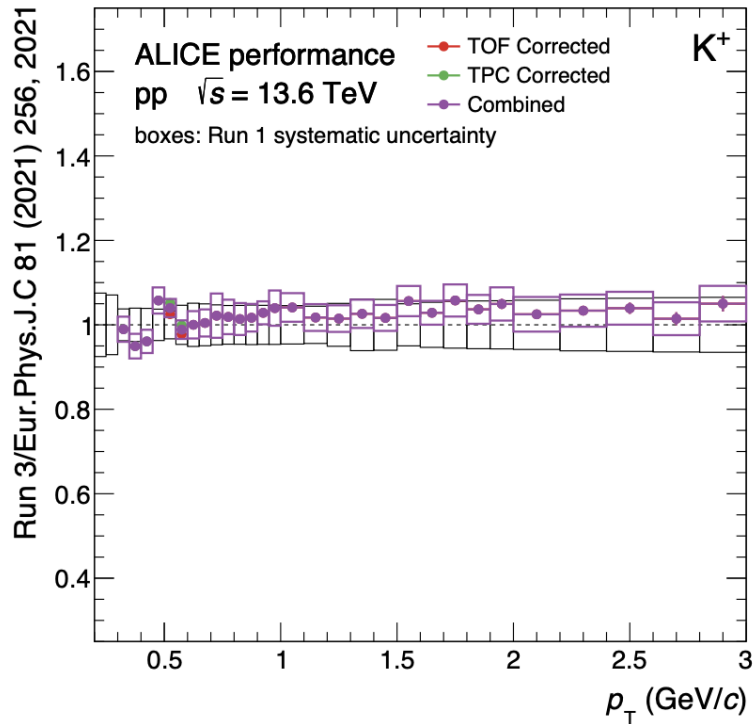


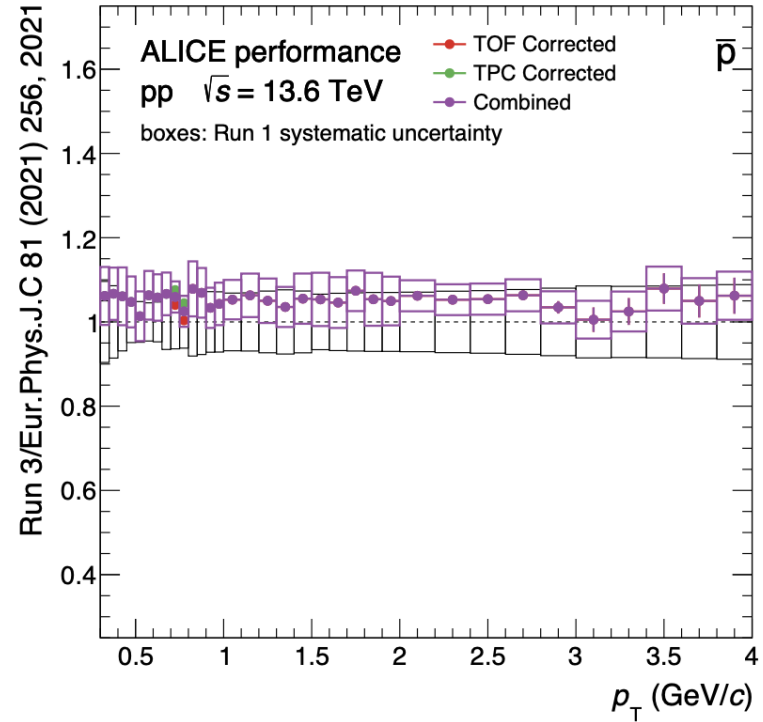
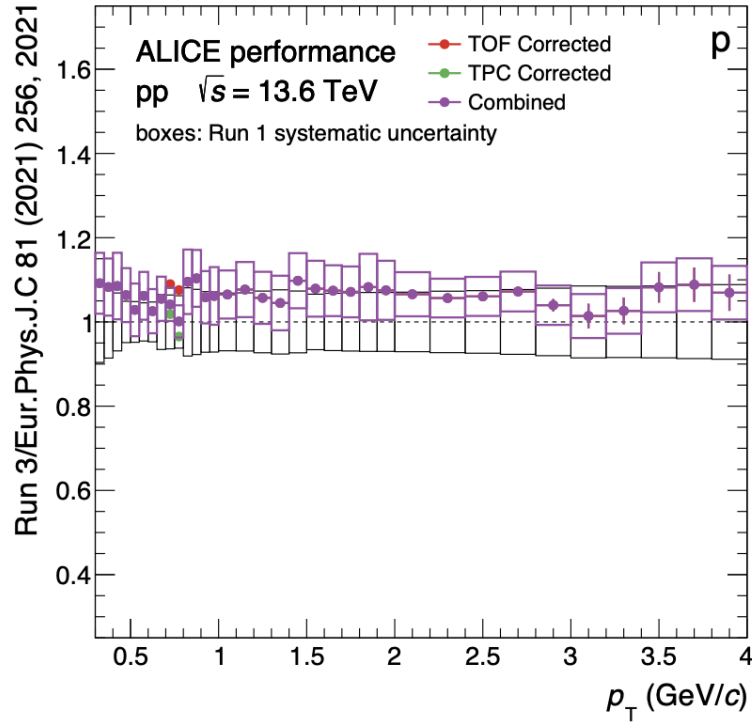
Measured p_T spectra become harder with increasing $\langle dNch/d\eta \rangle$ and the effect is more pronounced for proton

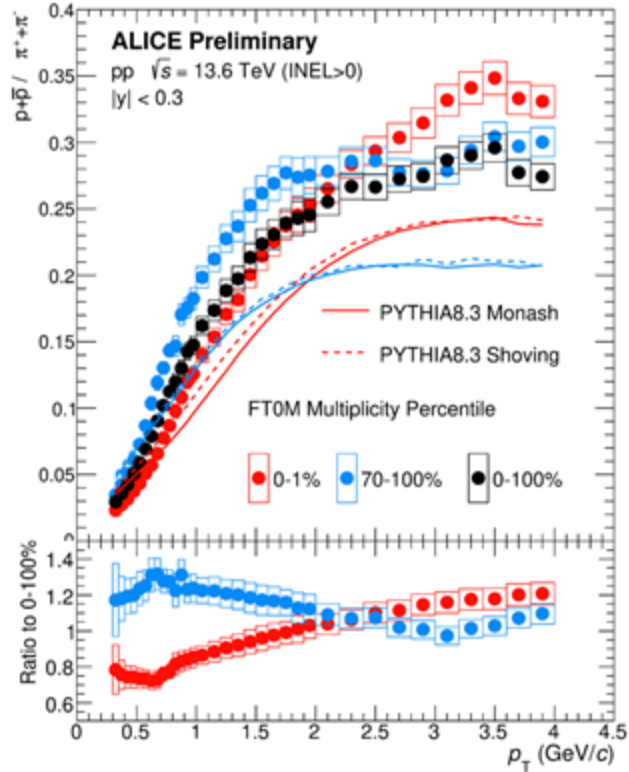
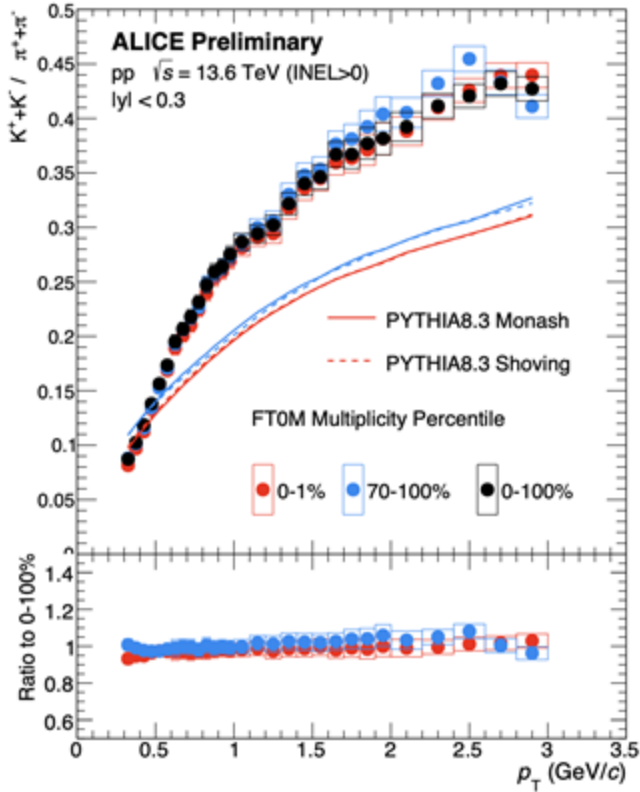
Comparison with RUN 2 INEL spectra



Comparison with RUN 2 INEL spectra

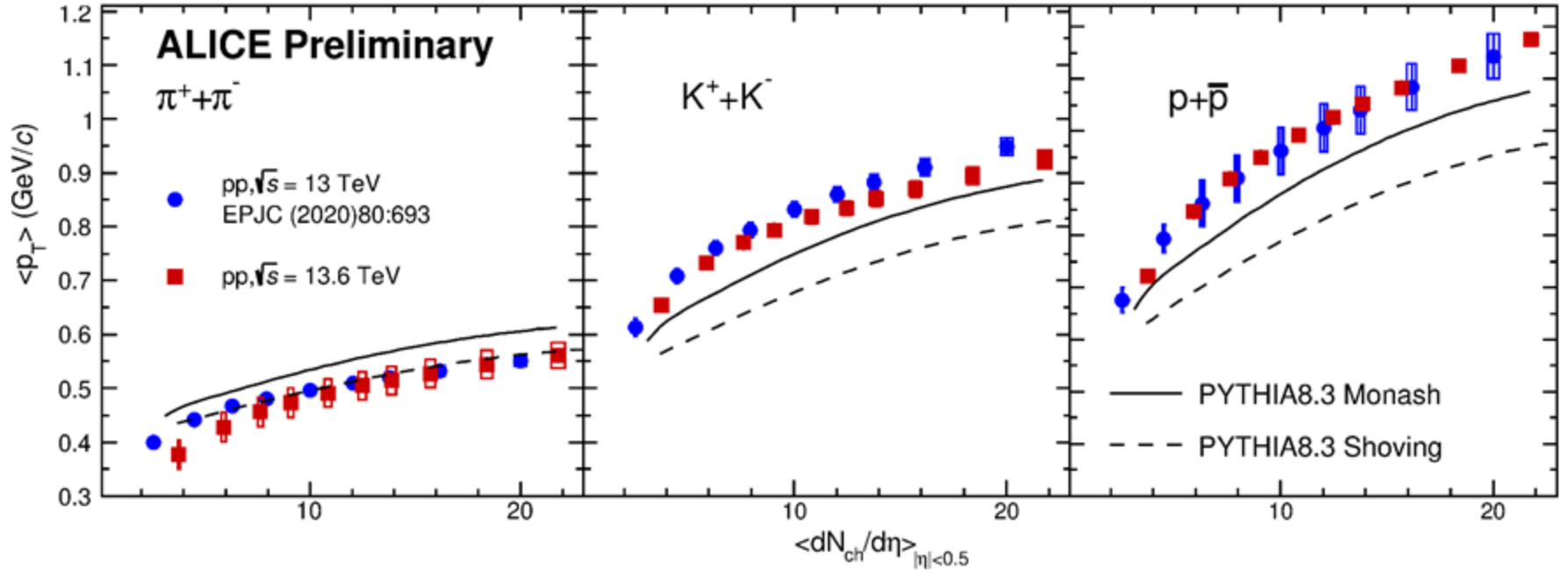






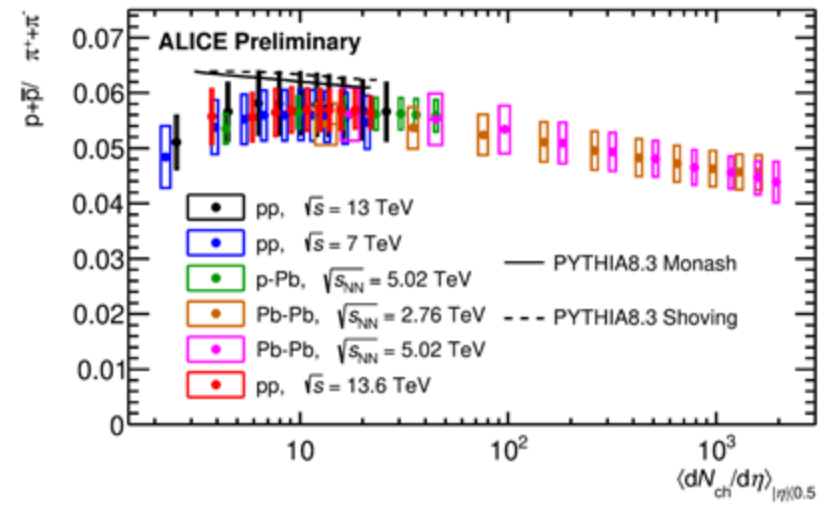
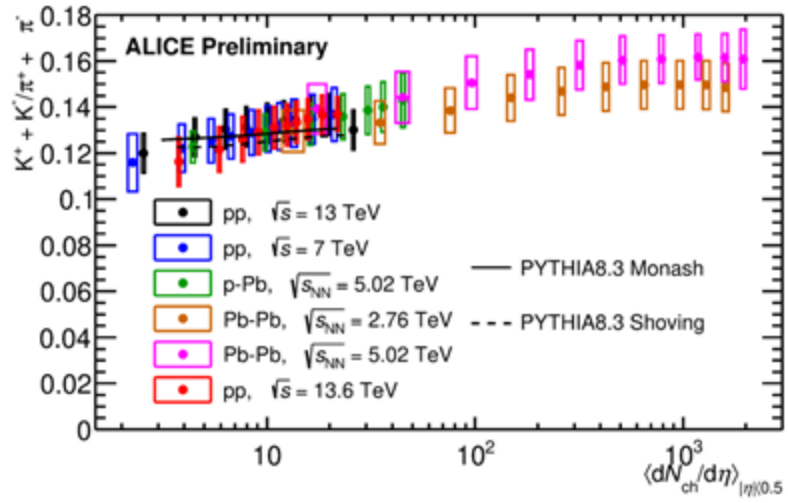
- ★ no significant variation in the p_T -differential k/π ratio is observed with multiplicity
- ★ Enhancement of p/π ratio is observed at intermediate p_T for higher multiplicity class.

$\langle p_T \rangle$ vs multiplicity



[Used updated multiplicity value](#)

Distinct mass ordering pattern is observed in the average transverse momentum ($\langle p_T \rangle$) among the various particle species studies



GOOD AGREEMENT WITH RUN2

Used updated multiplicity value

- Increasing trend in the (K/π) ratios -> support interpretation of strangeness enhancement
- Decrease in the p/π ratio -> effects of antibaryon-baryon annihilation

- Analysis is redone with new 24_pass1 pp dataset.
- With new MC, helps to evaluate the feed down correction.
- The p_T -spectra of the particle species are measured for each centrality classes.
- The corrected p_T -spectra shows a good agreement with RUN 2 spectra, which also shows a validation of the upgraded detector and analysis framework in RUN 3.
- Model comparison is done with various tunes of PYTHIA8.



First draft of the paper is ready

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH



CERN-EP-To be specified-To be specified
To be specified To be specified

Production of π^\pm , K^\pm , and p (\bar{p}) in pp collisions at $\sqrt{s} = 13.6$ TeV

Abstract

In this paper, the ALICE Collaboration presents its first measurement in proton-proton collisions using LHC Run 3 data. The study focuses on the production of light-flavour charged particles π , K , and p at $\sqrt{s} = 13.6$ TeV, using the upgraded ALICE detector and the new data processing framework, thereby validating the performance of the recent Run 3 upgrade of the ALICE experiment. The measured transverse momentum (p_T) spectra show clear multiplicity-dependent modifications, including spectral hardening and mass ordering of the mean transverse momentum ($\langle p_T \rangle$). These trends, consistent with observations in larger collision systems, point to the emergence of collective-like effects in small systems. Comparisons with model predictions offer further insights into particle production mechanisms. The results provide new constraints on the dynamics of high-multiplicity pp collisions at the highest LHC energies.

- I want to acknowledge, Department of Science and Technology, govt. of India for financial assistance through a project entitled “Indian Participation in the ALICE Experiment at CERN” by No. SR/MF/PS-02/2021-GU (E-37122).
- I want to acknowledge organisers of VECC for organising ALICE-STAR India Collaboration meeting.

Thank
You