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Identified charged hadron production at high p_T with the ALICE experiment

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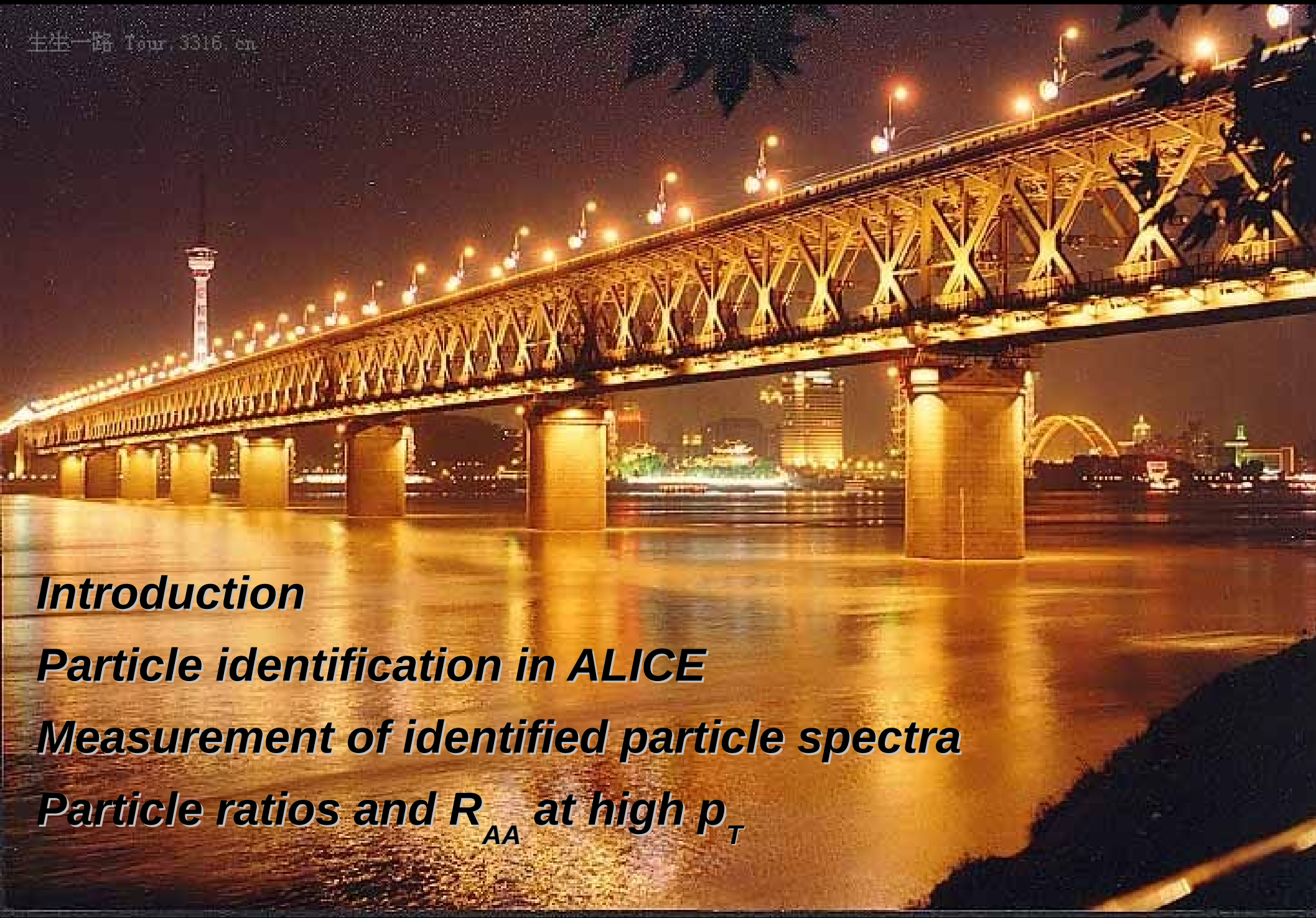


Introduction

Particle identification in ALICE

Measurement of identified particle spectra

Particle ratios and R_{AA} at high p_T

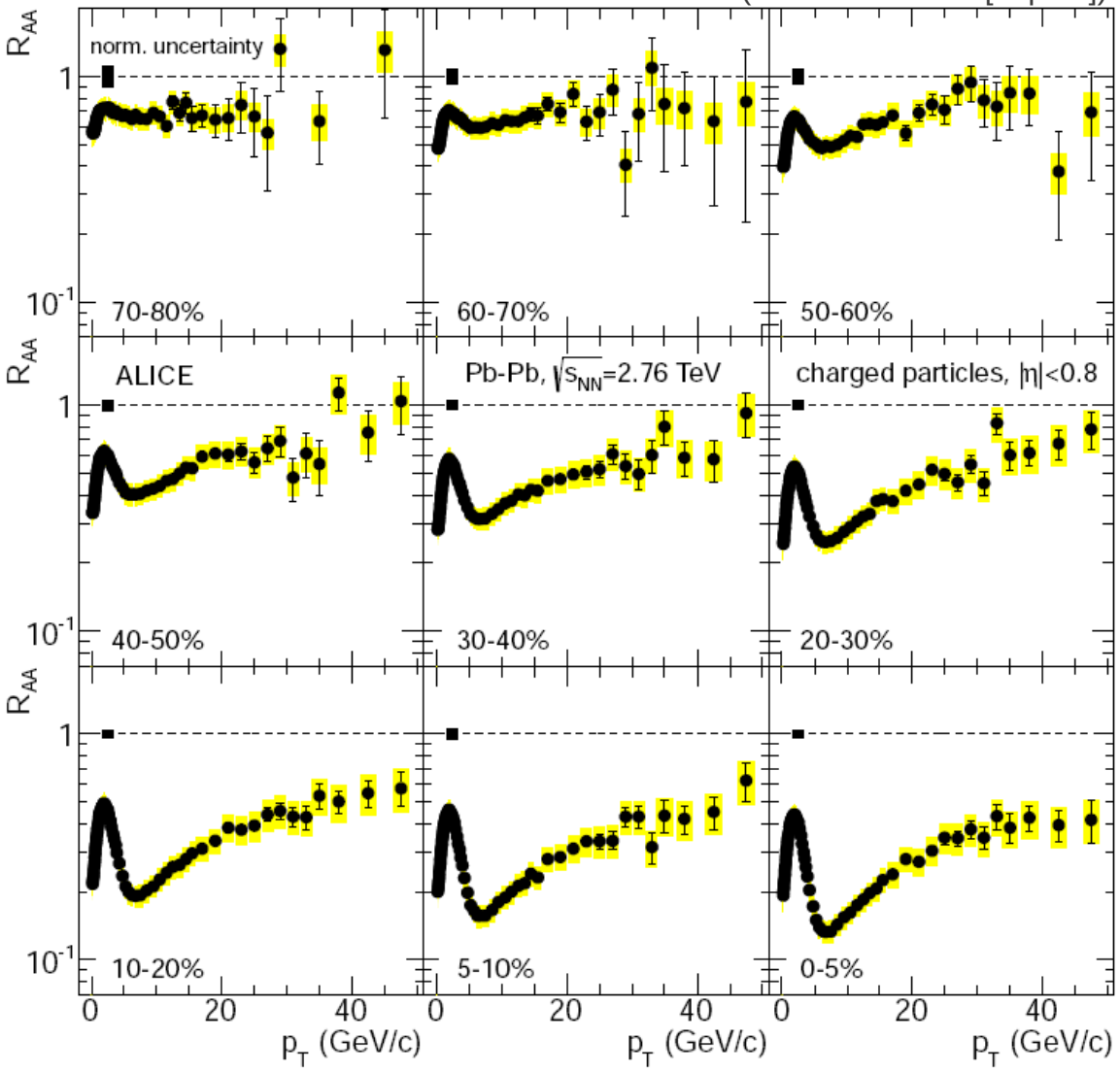
Image source: http://www.ch-go.com/uploadfile/profile/20071022183047433385.jpg

Introduction

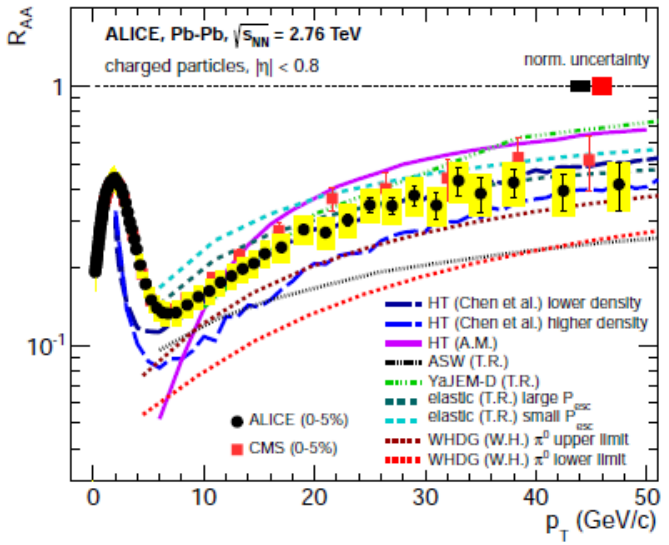
Our story starts with the charged particle R_{AA} measured by ALICE ...

$$R_{\mathrm{AA}}(p_{\mathrm{T}}) = \frac{\mathrm{d}^2 N_{\mathrm{ch}}^{\mathrm{AA}}/\mathrm{d}\eta\,\mathrm{d}p_{\mathrm{T}}}{\langle T_{\mathrm{AA}}\rangle \mathrm{d}^2\sigma_{ch}^{\mathrm{pp}}/\mathrm{d}\eta\,\mathrm{d}p_{\mathrm{T}}}$$

(arXiv:1208.2711 [hep-ex])



- Charged particle yield in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV, normalized to the pp reference at same coll. energy
- At high p_T (> 7GeV/c)
  - p_T dependence: almost flat in peripheral, pronounced dip followed by significant rise in central coll.
  - Rise less steep as p_T increases
  - Info about parton energy loss, medium density ...



Introduction

The story continues as ...

ALICE is able to identify the charged particle types and study ($\pi^+ + \pi^-$), ($K^+ + K^-$), (proton+anti-proton) production individually.

Info about particle production mechanism, partonic energy loss, jet fragmentation ...

Our measurement

$$\frac{\mathrm{d}^2 N_i}{\mathrm{d}y \mathrm{d}p_T} = \underbrace{\frac{\mathrm{d}^2 N_{\mathrm{ch}}}{\mathrm{d}\eta \mathrm{d}p_T} \frac{\Delta\eta}{\Delta y}}_{(2)} \underbrace{\frac{N_i^{\mathrm{uncor.}}}{N_{\mathrm{ch}}^{\mathrm{uncor.}}} \frac{\epsilon_{\mathrm{ch}}}{\epsilon_i}}_{(1)} \quad \text{(i=}\pi\text{, K, p)}$$

Extract particle fractions (π/K/p) in p_T bins, corrected for efficiency (1)

Multiply by charged particle spectra (2) used in charged particle R_{AA} measurement

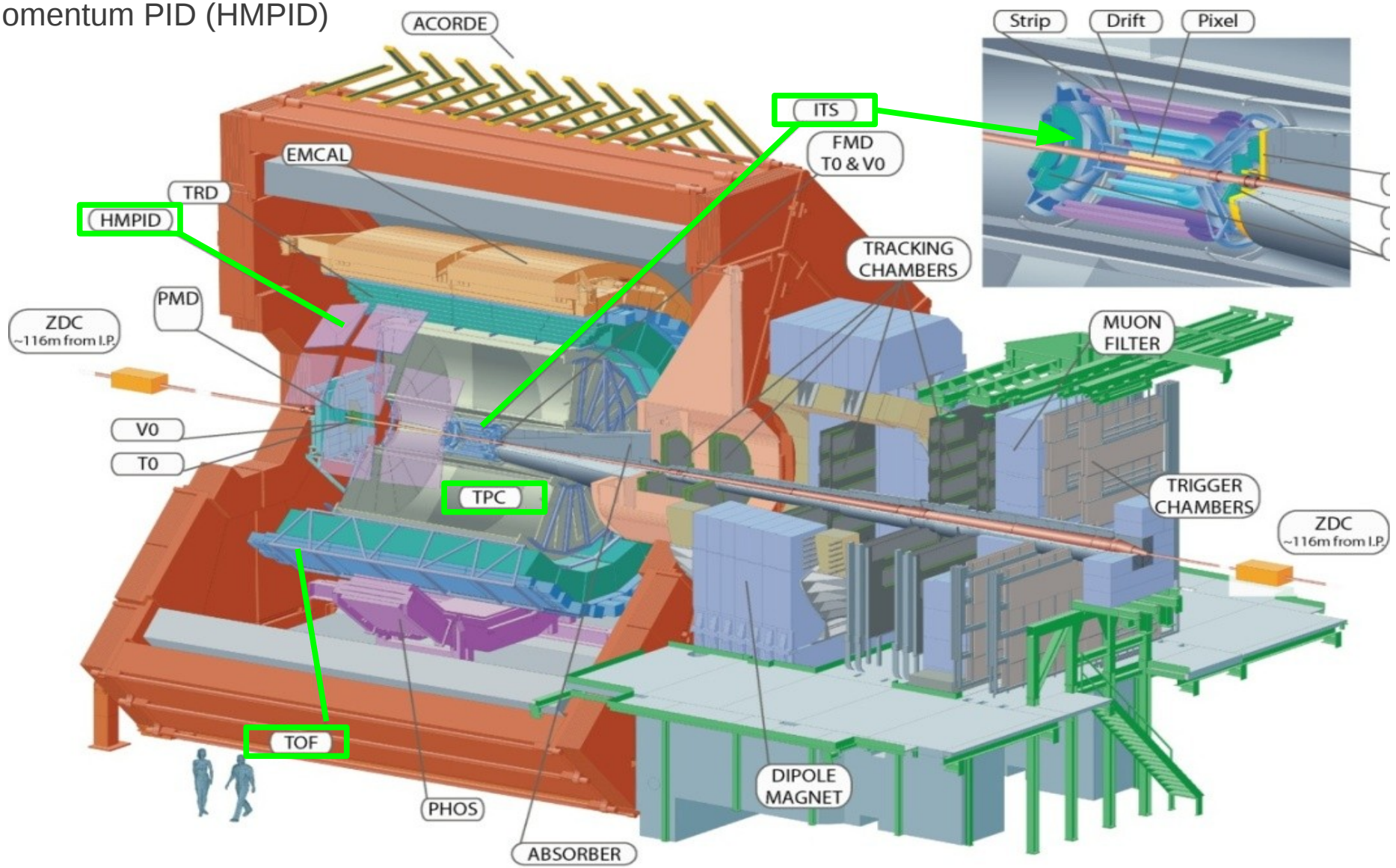
Jacobian dη/dy is taken into account.

Results: p_T spectra, ratios between particle types and R_{AA} for each type

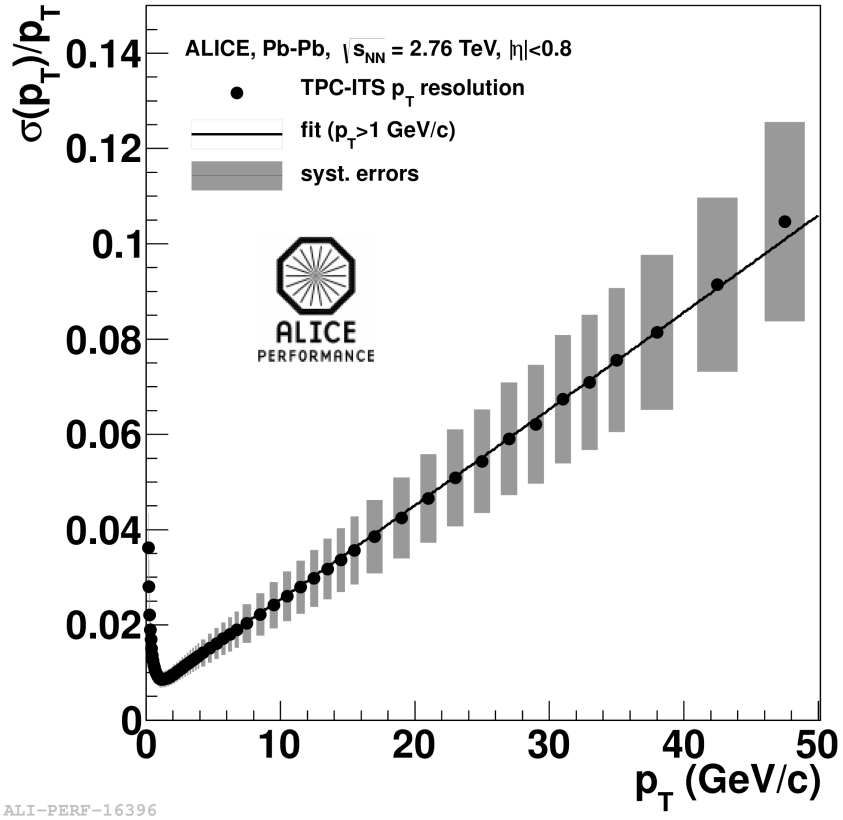
2010 Pb-Pb data sample, 12M minimum-bias events. Much more to come for 2011 data sample!

ALICE and its Central Detectors:

Inner Tracking System (ITS)
Time Projection Chamber (TPC)
Time-of-Flight (TOF)
High Momentum PID (HMPID)



TPC-ITS combined tracking



p_T resolution ~ 10% at 50 GeV/c

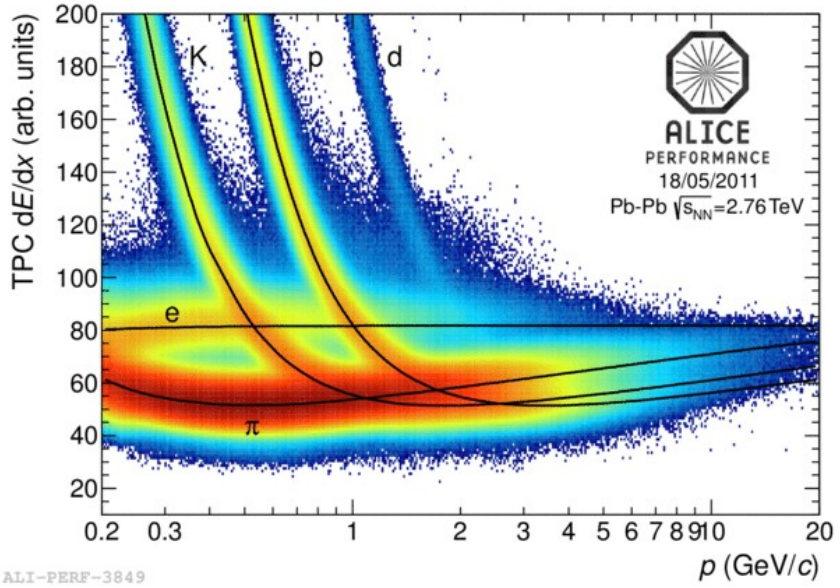
For new ongoing reconstruction production, ~ 5% at 50 GeV/c due to improved TPC-ITS matching

Small multiplicity dependence (around 10%)

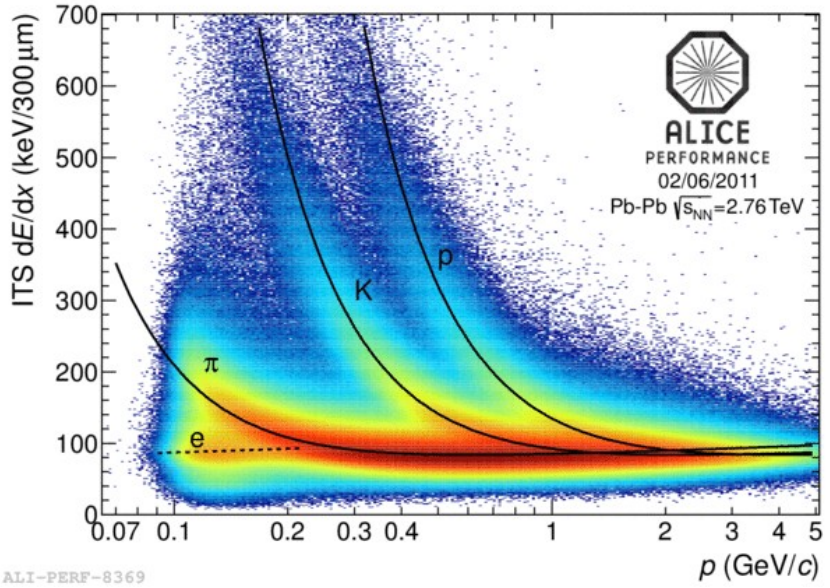
Verified using cosmic tracks and K_S^0 invariant mass distribution
→ relative systematic uncertainty: 20%

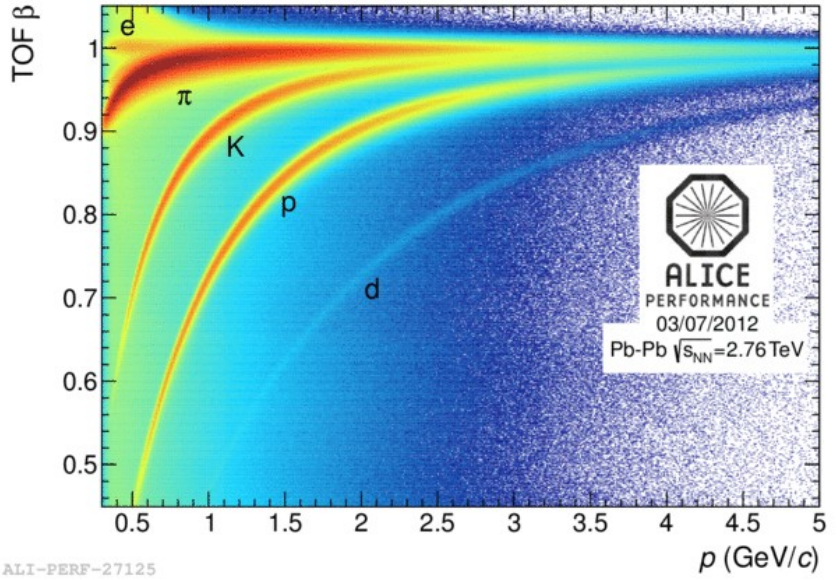
Particle identification (PID) with TPC, ITS, TOF and HMPID in this analysis

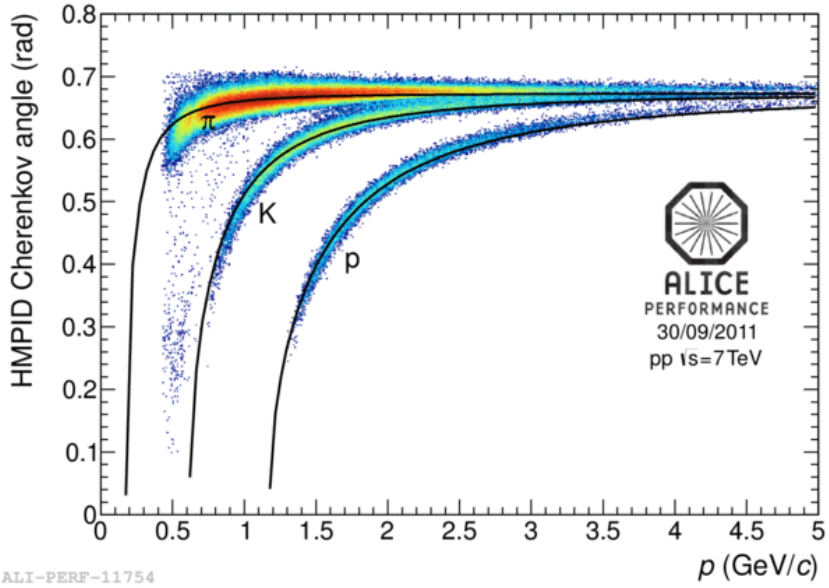
TPC dE/dx resolution pp: ~5%, Pb-Pb: ~7%



ITS dE/dx used for low p_T spectra analysis



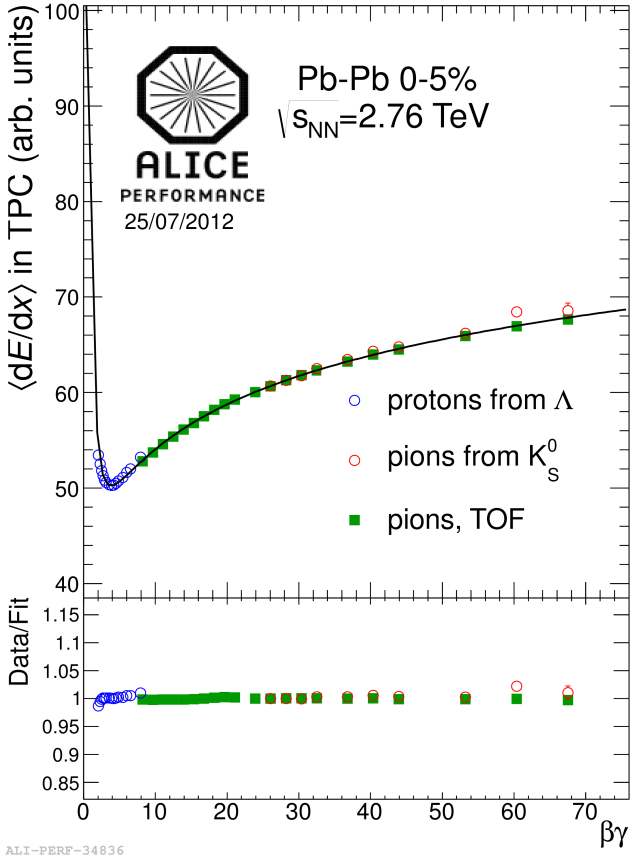




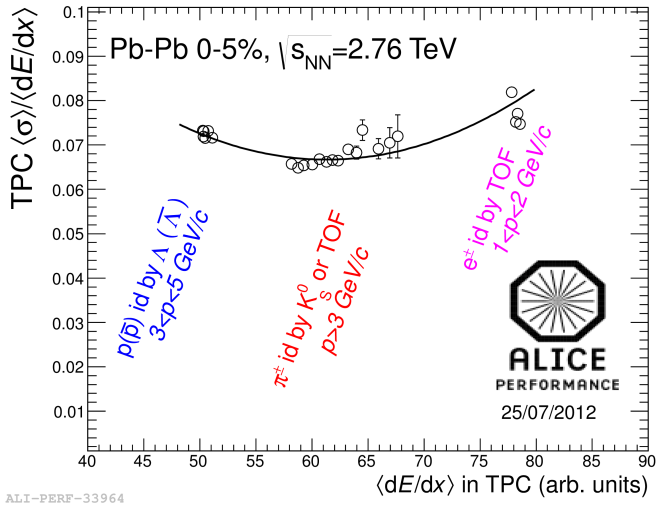
TOF, HMPID (cherenkov detector) as independent reference detectors to provide clean π/K/p sample

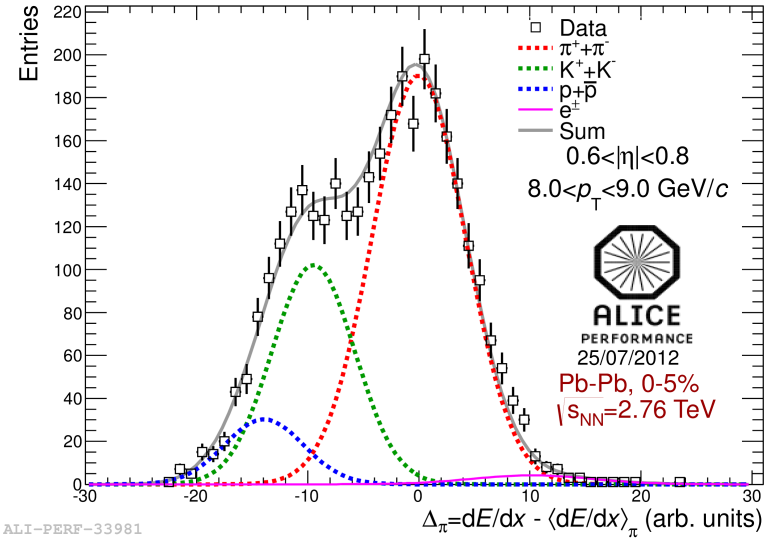
Measurement of π/K/p fractions with TPC dE/dx signal

Analysis oriented TPC calibration using reference detectors and Λ, K_S^0 decay products.



Models of <dE/dx> and dE/dx resolution fit (+corrections) with pre-identified particle. Deviation of <dE/dx> within 0.5 %.

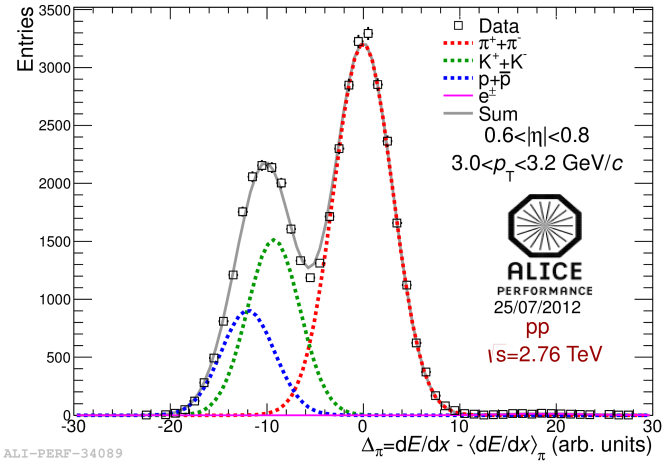


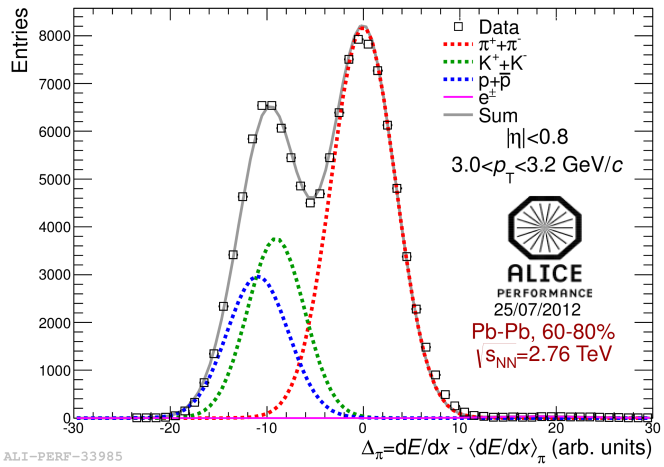


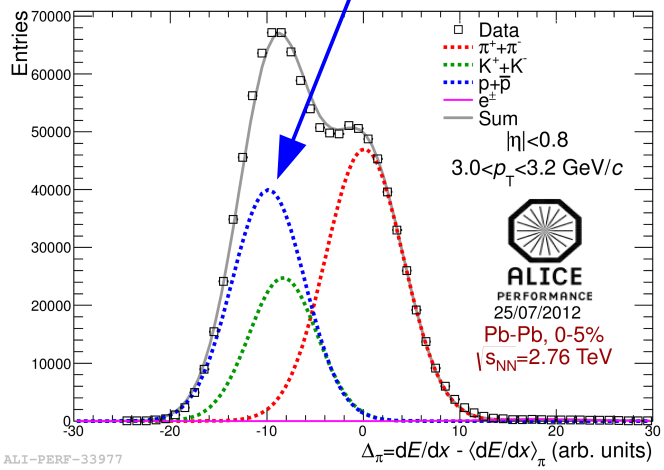
Fractions obtained using 4-Gaussian (including electrons) fits with fixed mean and width.

In central Pb-Pb collisions proton is enhanced in the intermediate p_T region.

$3.0 < p_T < 3.2$ GeV/c





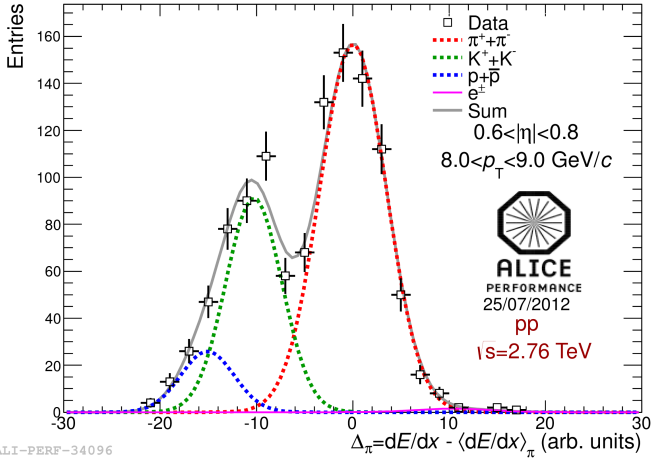


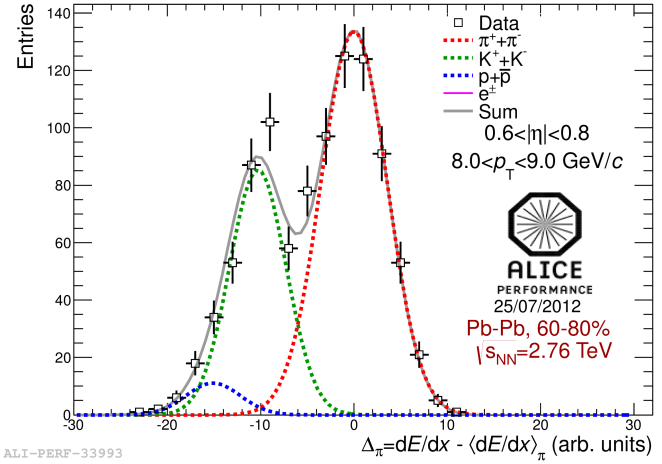
pp

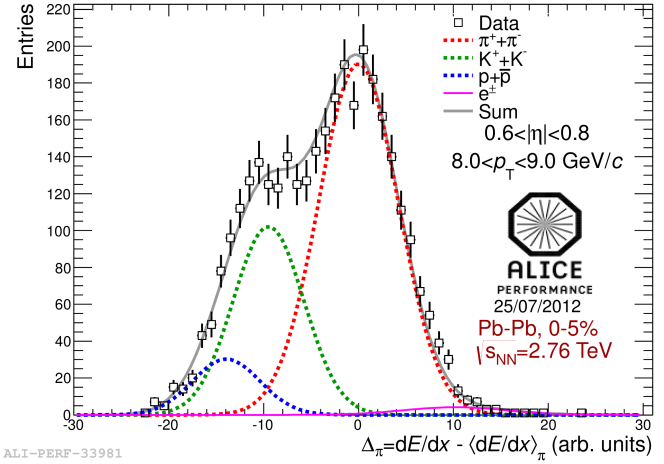
Pb-Pb peripheral (60-80 %)

Pb-Pb central (0-5%)

$8.0 < p_T < 9.0$ GeV/c

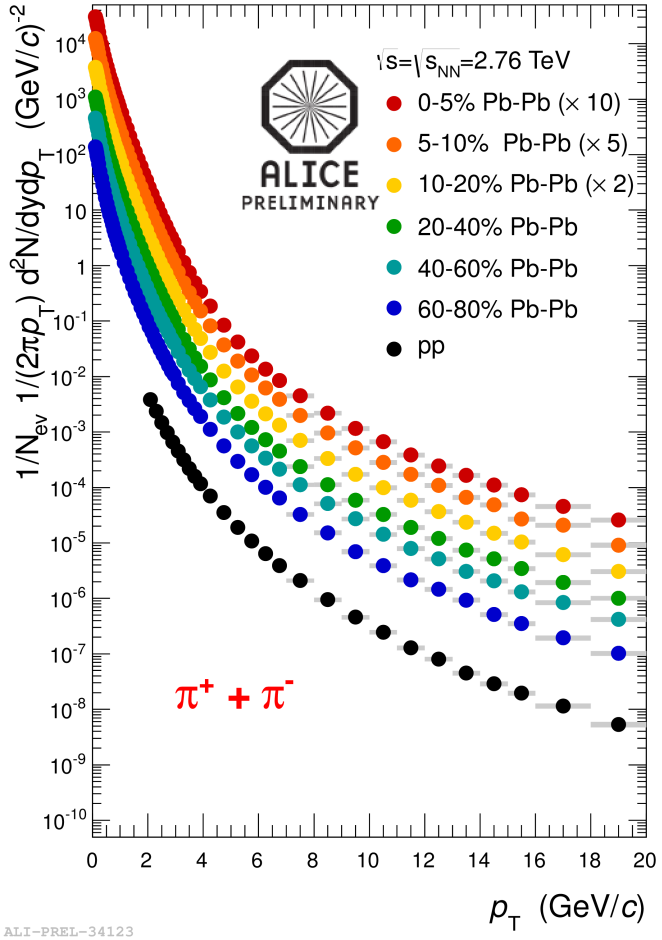


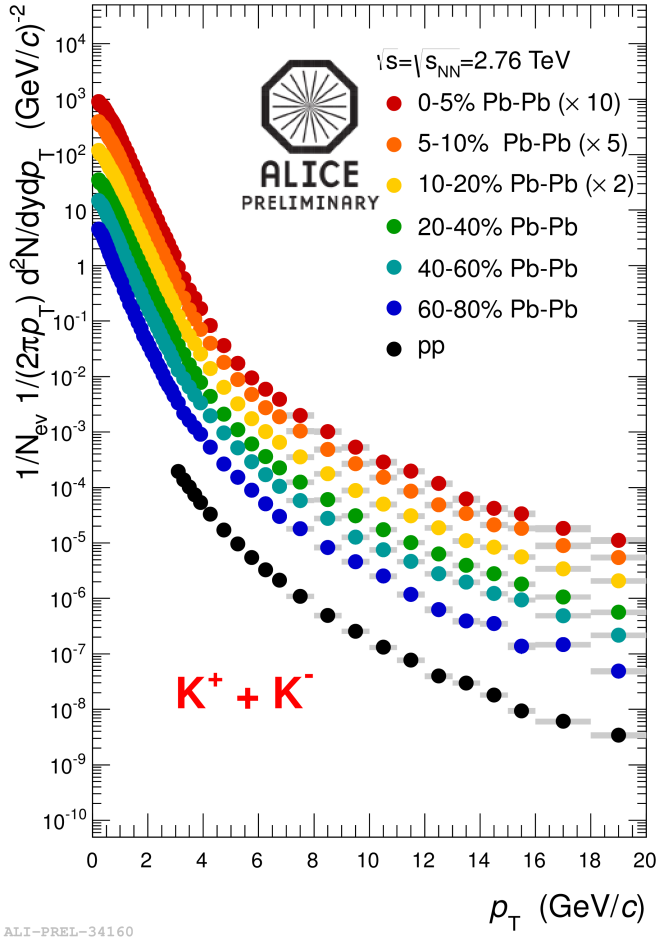


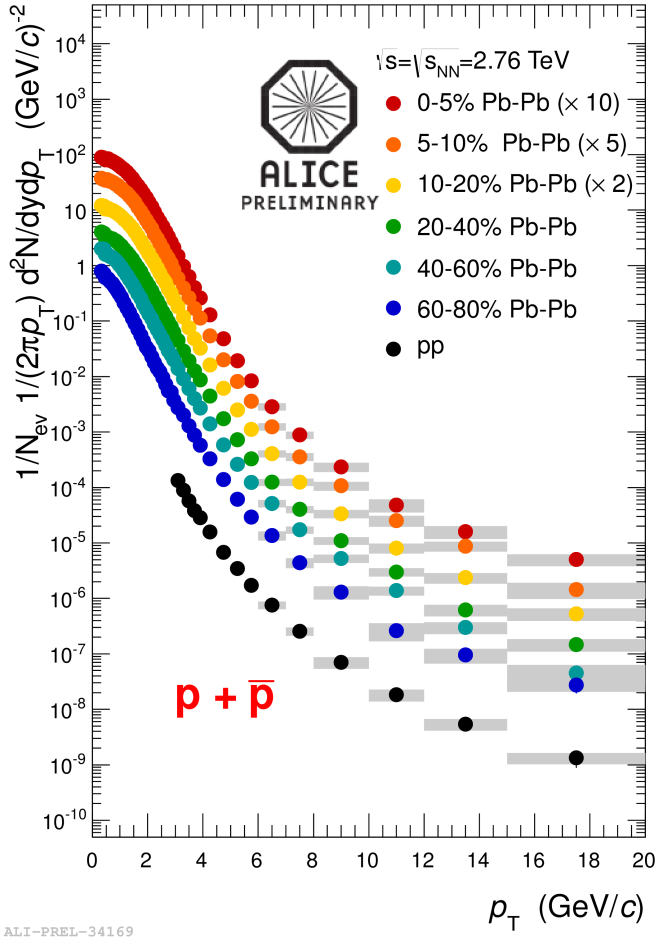


Identified particle spectra

$$\frac{\mathrm{d}^2 N_i}{\mathrm{d}y \mathrm{d}p_T} = \frac{\mathrm{d}^2 N_{\mathrm{ch}}}{\mathrm{d}\eta \mathrm{d}p_T} \frac{\Delta\eta}{\Delta y} \frac{N_i^{\mathrm{uncor.}}}{N_{\mathrm{ch}}^{\mathrm{uncor.}}} \frac{\epsilon_{\mathrm{ch}}}{\epsilon_i}$$



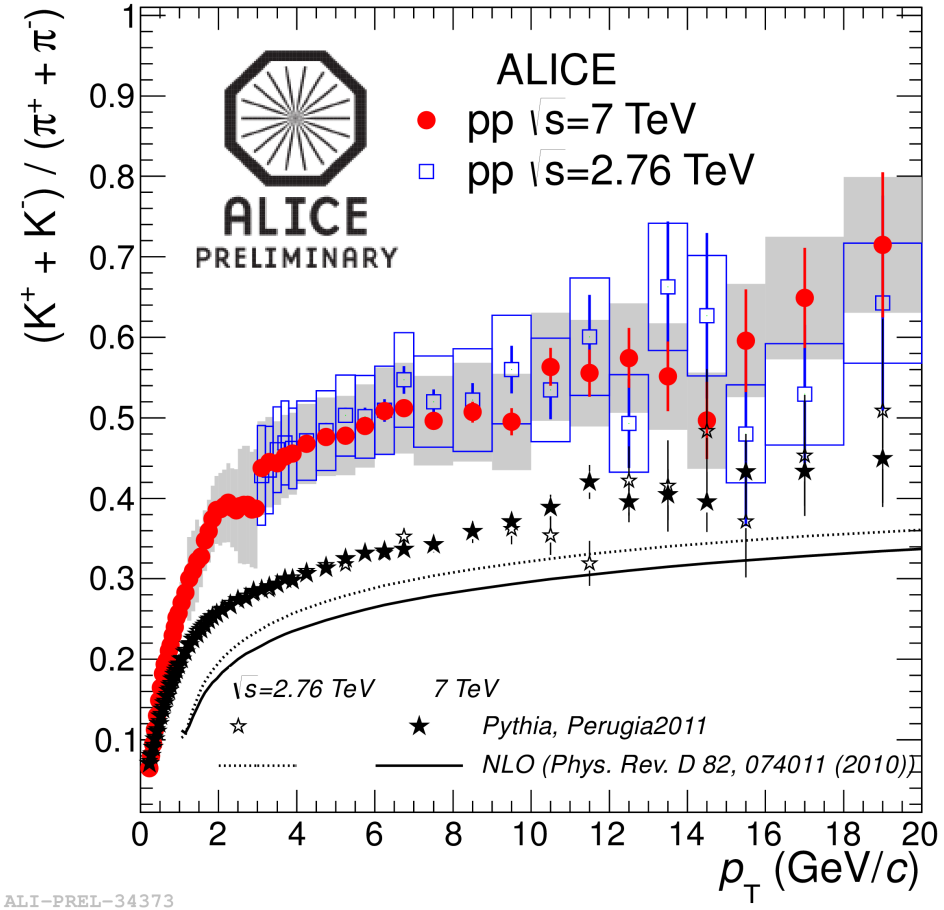


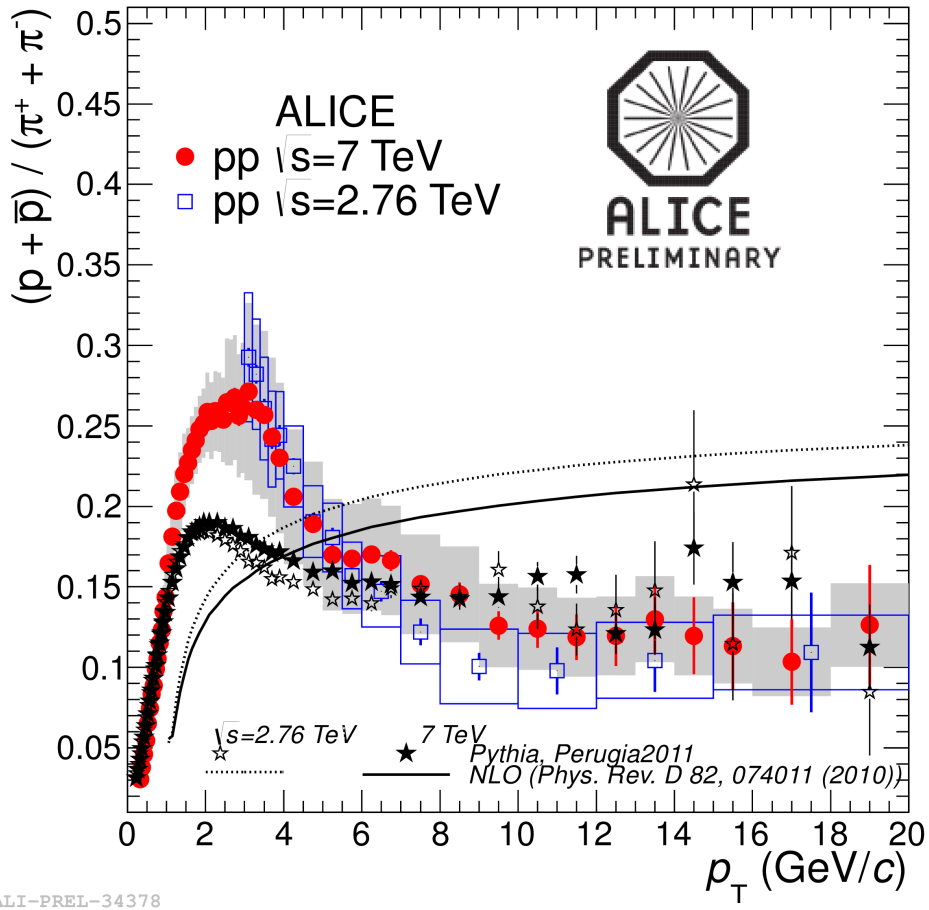


Low p_T spectra from other independent analysis (arXiv:1208.1974 [hep-ex]) using also ITS.

π spectra p_T > 2 GeV/c, K, p sepctra p_T > 3 GeV/c obtained with method described here.

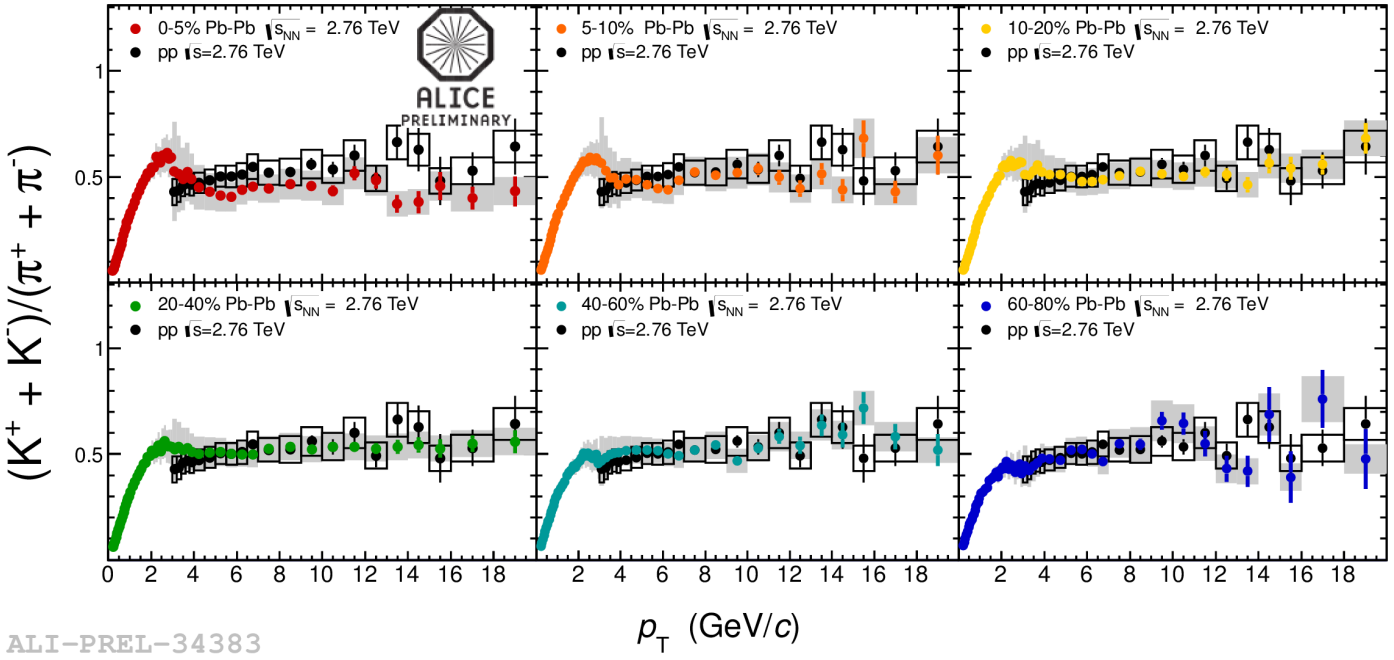
K/π, p/π ratio in pp compared to theory





- **No obvious energy dependence seen in data.**
- **Pythia Perugia2011 predicts well p/π ratio at low and high pT, but under-predicts at intermediate p_T.**
- **NLO calculation does not predict the data.**

p/π, K/π ratio in Pb-Pb compared to pp collisions



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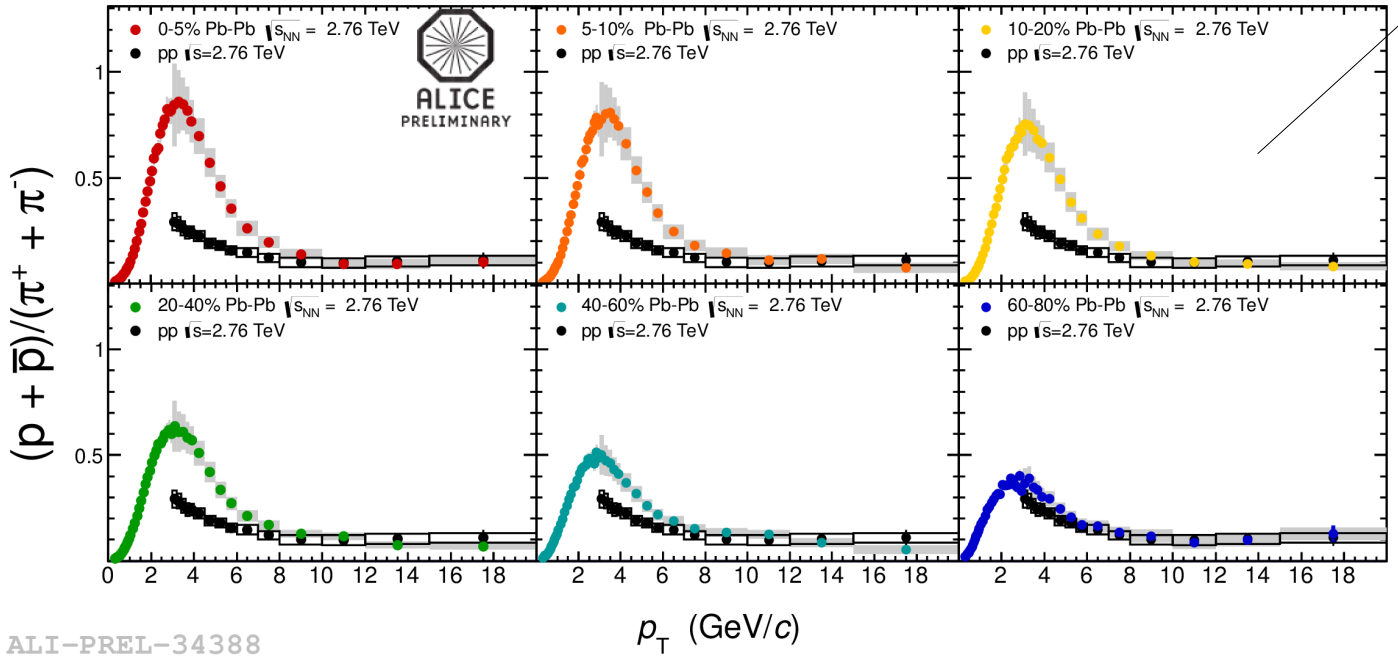

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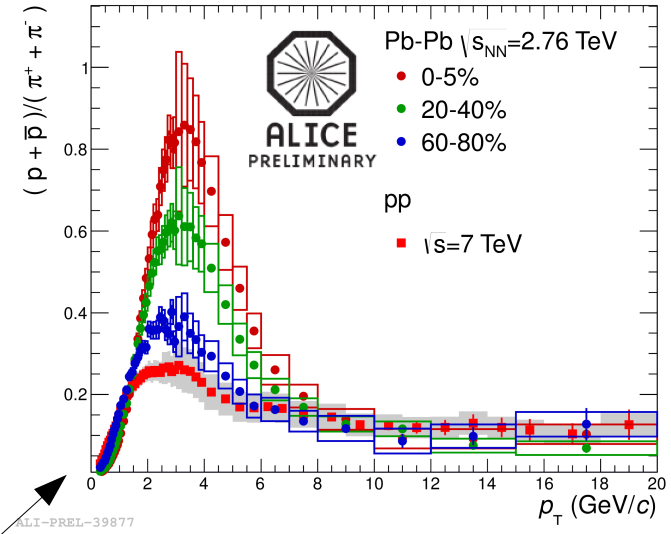


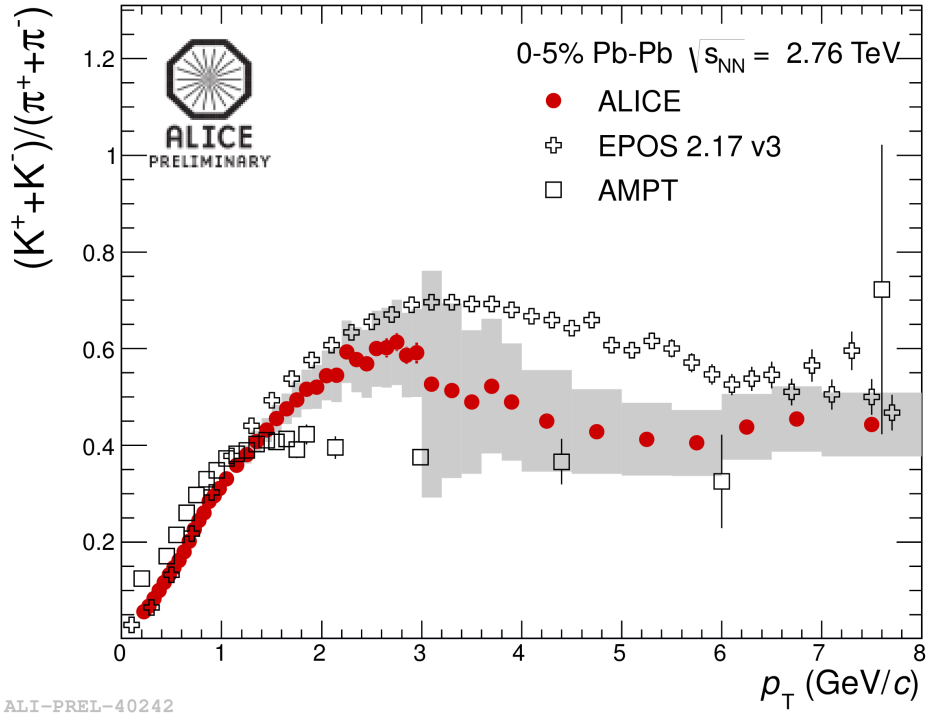
ALI-PREL-39877

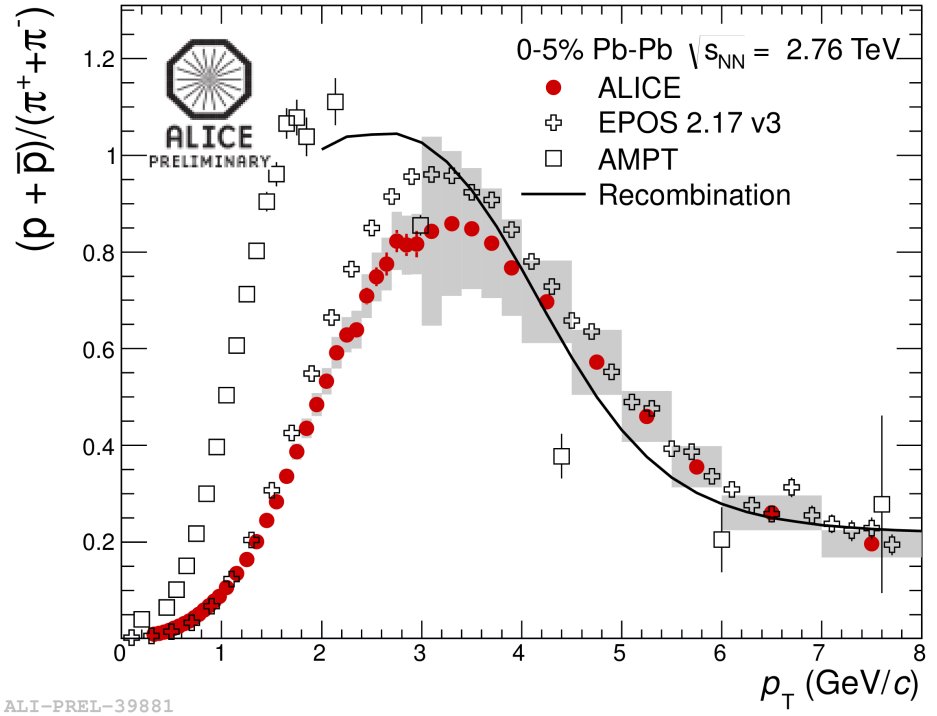
Centrality evolution of p/π ratio

At high p_T no centrality evolution is seen for p/π and K/π ratio

At intermediate p_T there is a strong enhancement of proton to pion ratios in central collisions.

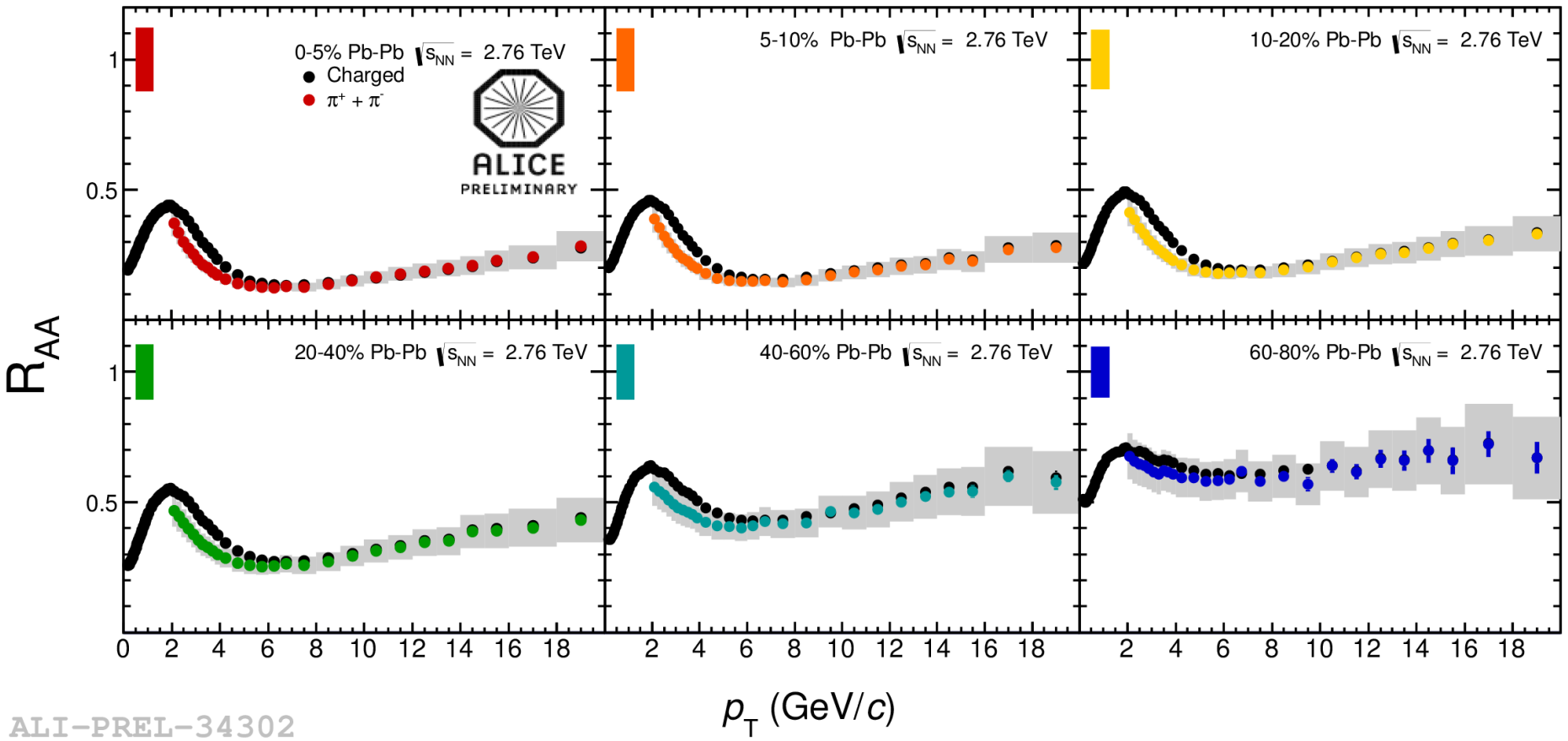
K/π, p/π ratio in Pb-Pb compared to theory





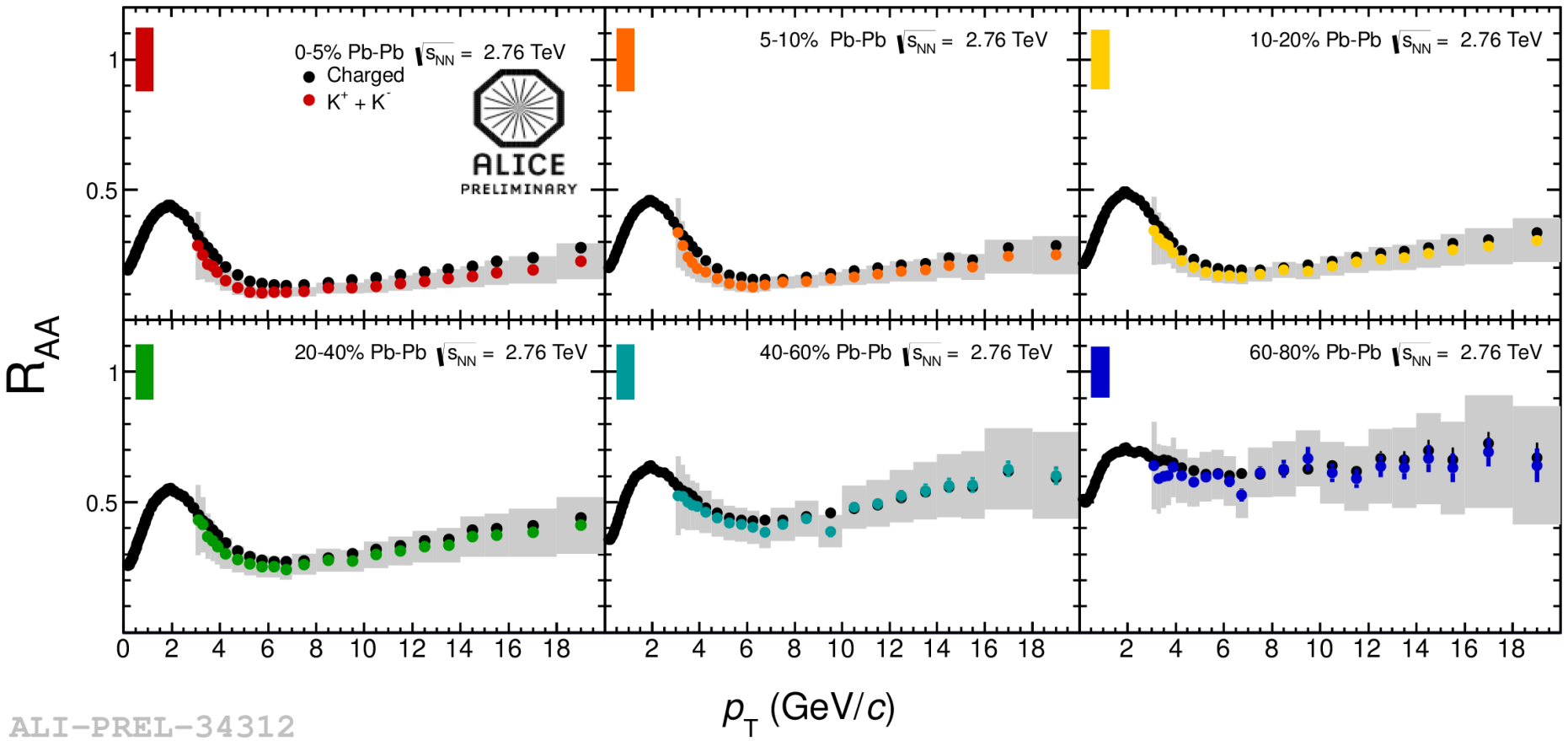
EPOS: Klaus Werner, arXiv:1204.1394, arXiv:1205.3379.
AMPT: Jun Xu and Che Ming Ko, Phys. Rev. C 83, 034904 (2011).
Recombination: R. J. Fries et al., Phys. Rev. Lett. 90, 202303 (2003) and private communication (one of the models explaining the baryon anomaly at RHIC)

Pion R_{AA} compared to charged particle R_{AA}



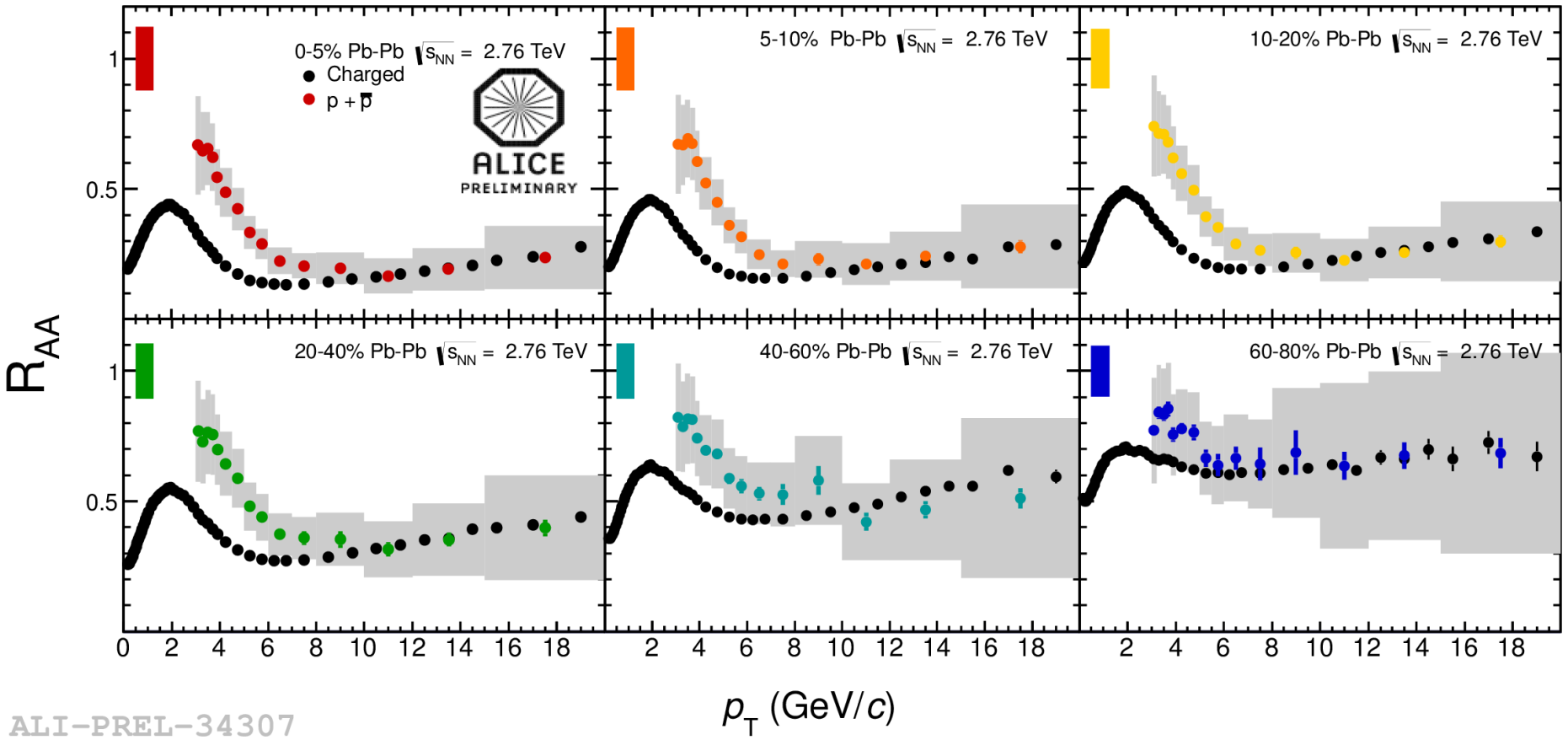
- **Stronger suppression at intermediate p_T**
- **Compatible at high p_T**

Kaon R_{AA} compared to charged particle R_{AA}



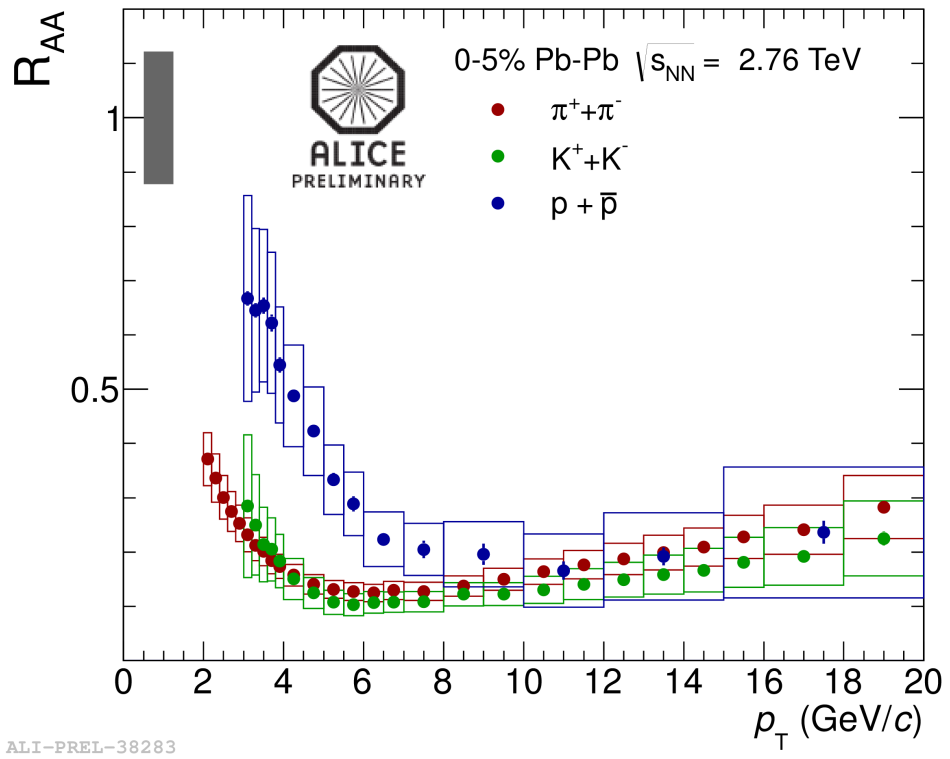
- **stronger suppression at intermediate p_T (but less suppressed than pions)**
- **Compatible at high p_T**

(Anti-)Proton R_{AA} compared to charged particle R_{AA}



- **Weaker suppression at intermediate p_T**
- **Compatible at high p_T**

Direct comparison of π/K/p R_{AA}



- **At high p_T, the suppression of yields are compatible for π/K/p**
  → no evidence of different energy loss for the partonic sources of ($\pi^+ + \pi^-$), ($K^+ + K^-$), and (proton+anti-proton)
  → suggest that fragmentation is not modified by the medium (within errors)
- **Both meson and baryon are strongly suppressed, compatible with charged particle results.**

Summary

- Measurement of charged π/K/p production up to 20 GeV/c at ALICE with centrality dependence.

- No evolution of p/π and K/π ratio with centralities at high p_T.
  → fragmentation is not modified by medium (within errors)
- π/K/p R_{AA} are compatible with charged particle R_{AA}, all strongly suppressed at high p_T.
  → no evidence (within errors) of different energy loss for the partonic sources of (π^++π^-), (K^++K^-), and (proton+anti-proton)
  → suggests that fragmentation is not modified by the medium (within errors)

BACKUP

END