Rapidity dependent efficiency estimation for strangeness enhancement studies

Nur Hussain

-with Pranjal and B. Bhattacharjee

Gauhati University

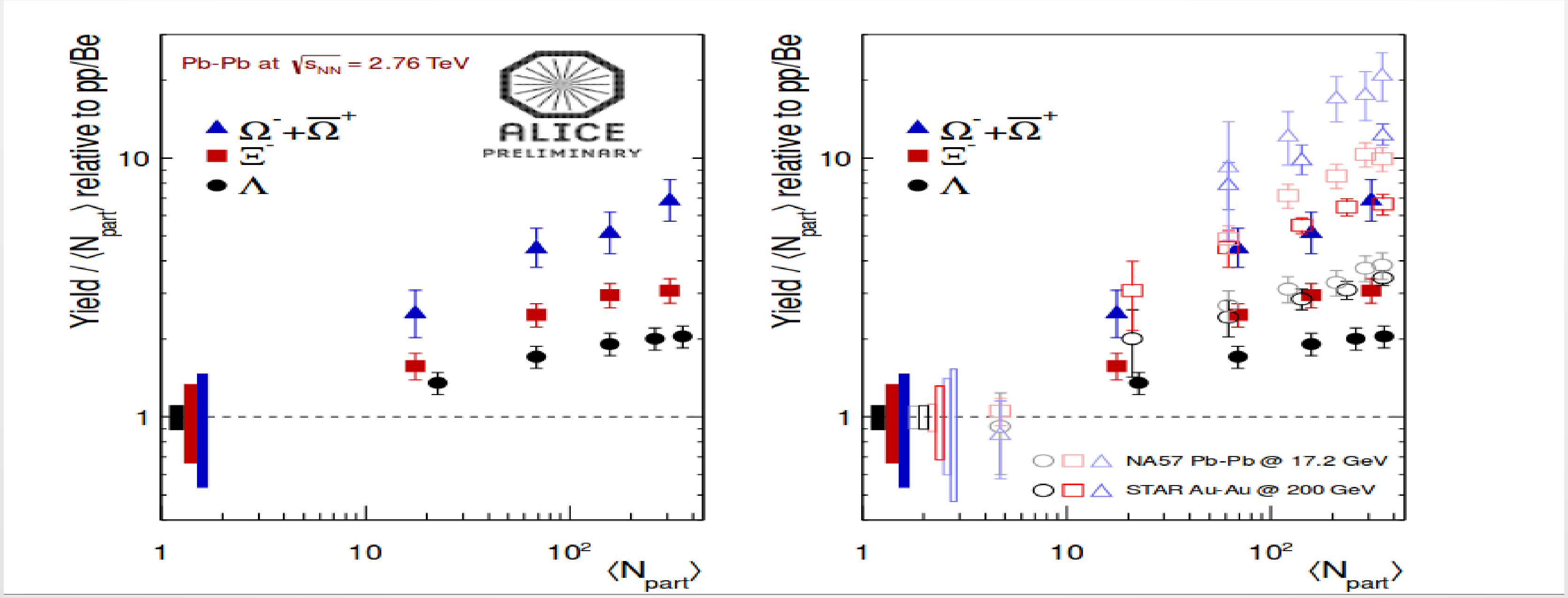
ALICE-India meeting February, 2016, SINP, Kolkata

Outline

- **Motivation : strangeness enhancement**
- **Analysis details**
- **One dimensional (1D) efficiency estimation**
- **Estimation of efficieny (2D) from y-p_T plot**
- **Comparison of 1D and 2D efficiencies**
- **Efficiency corrected plots**
- **Enhancement plot**
- **Summary and Future plan**

Strangeness enhancement in heavy ion collisions

- One of the major signature of QGP was proposed as strangeness enhancement (Phy.Rev.Lett. 48, 16 (1982)).
- Due to limitations of detector acceptance and assuming global conservation of strangeness, all the earlier and present enhancement studies were carried out at mid rapidity only. Hence, not much information is available on rapidity dependent starngeness enhancement.



P. Foka and M Janik, EPJ web of conferences 71, 00057 (2014).

- Recently, there are predictions that strangeness conservation may be violated locally. (J.Steinheimer et al. Phys. Lett. B676 (2009)).

- We, therefore have undertaken a work to study rapidity dependent strangeness enhancement with ALICE data.

- To start with, I started my analysis on K^+ and K^- as these are stable particles and from these we can get information on rapidity dependent k/pi ration as well.

Analysis details

$0.2 < p_T < 2.5$ (GeV/c), $|V_z| < 10$ cm

$|y| < 0.5$, Global track, TPC+TOF

Pb+Pb at $\sqrt{s_{NN}} = 2.76$ TeV

Data: LHC10h, pass2, AOD160	
138438, 138439, 138442, 138469, 138534, 138578, 138579, 138582, 138583, 138621, 138624, 138653, 139029, 139105, 139173, 13909, 139310	
Central event	1,66,118
Peripheral	3,59,593

MC: LHC11a10a_bis, AOD162	
38578, 138579, 138582, 138620, 138624, 138637, 138638, 138653, 138662, 138666, 138730, 138731, 138732, 138736, 138737, 138740, 139316, 139328, 139329, 139360, 139437, 139438, 139439, 139440, 139441, 139465, 139467, 139471, 139505, 139507, 139511, 139517	
Central event	8,854
Peripheral	41,862

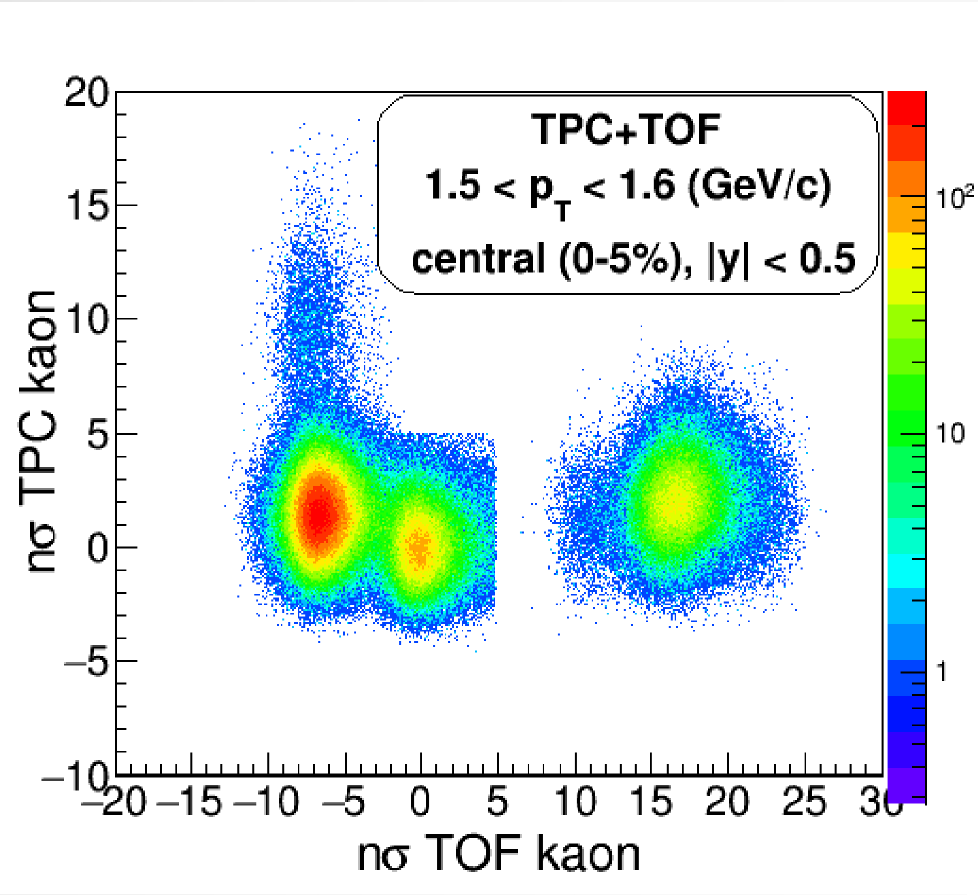
nSigma cut

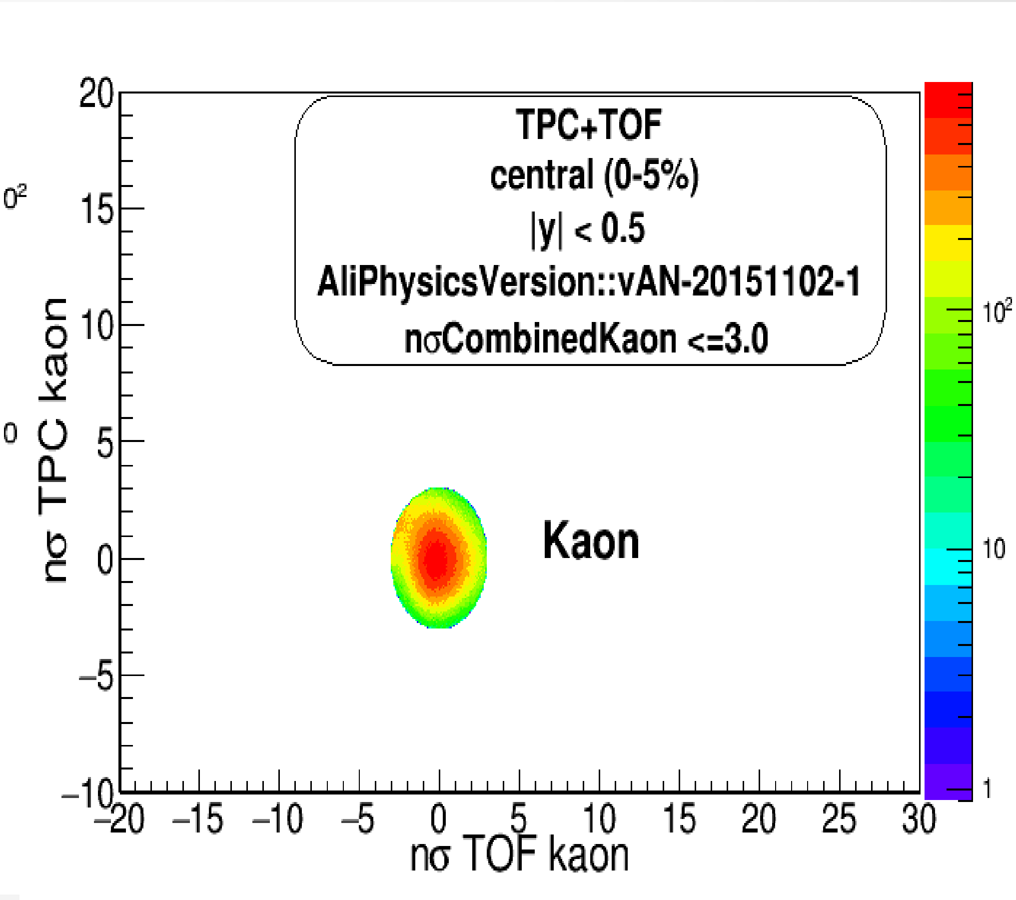
- **Combined nSigma (TPC+TOF) was calculated using the following relation:**

$$nSigmaCombinedKaon = \sqrt{(nSigmaTPCKaon)^2 + (nSigmaTOFKaon)^2}$$
$$nSigmaCombinedKaon \leqslant 3$$

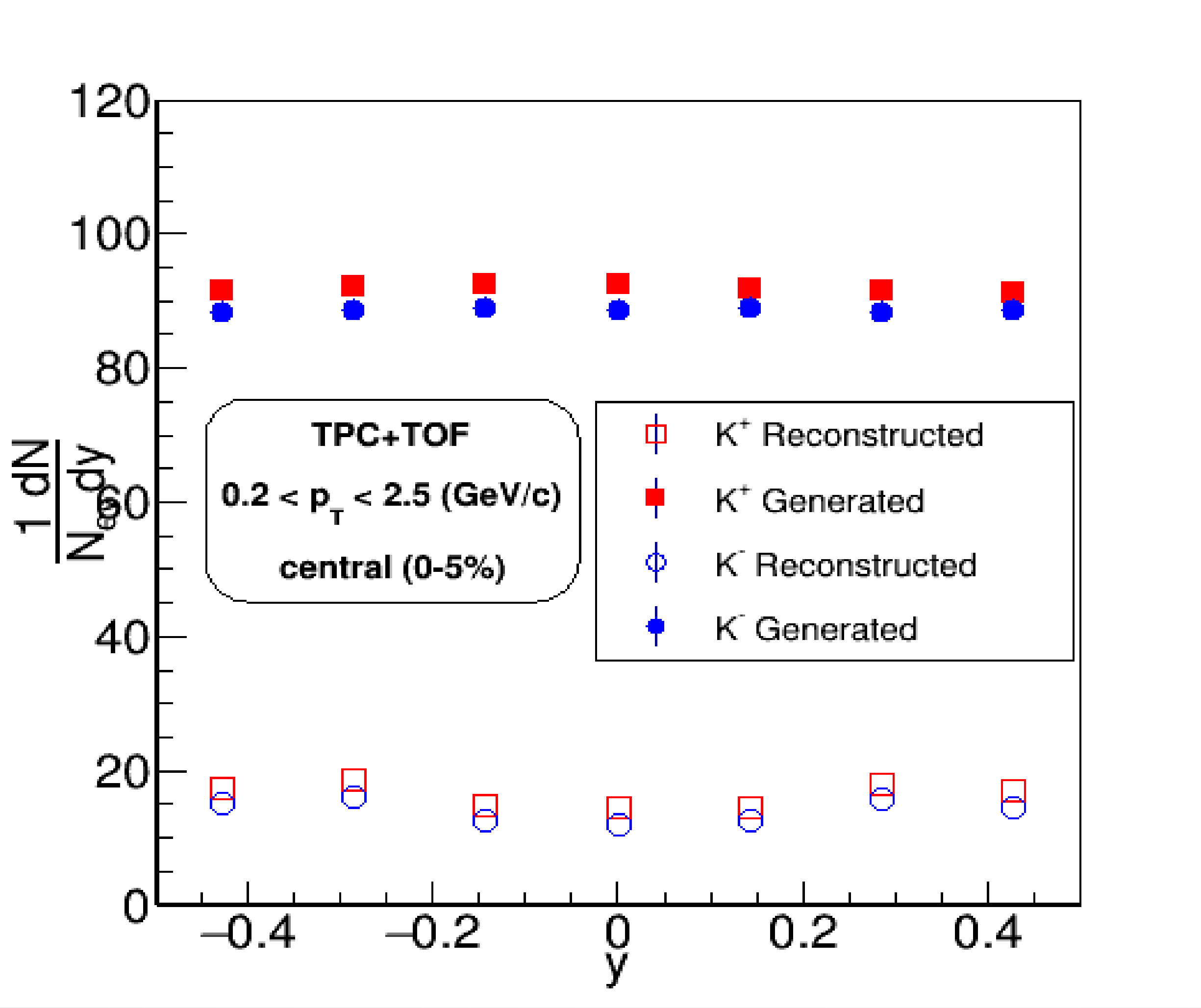
>> For MC reconstructed track, the same cuts are implemented as mentioned above.

nSigmaTPCKaon vs. nSigmaTOFKaon





Rapidity distribution MC generated and reconstructed of $K^{\pm}$



>> Rapidity distribution of generated particles is more or less flat.

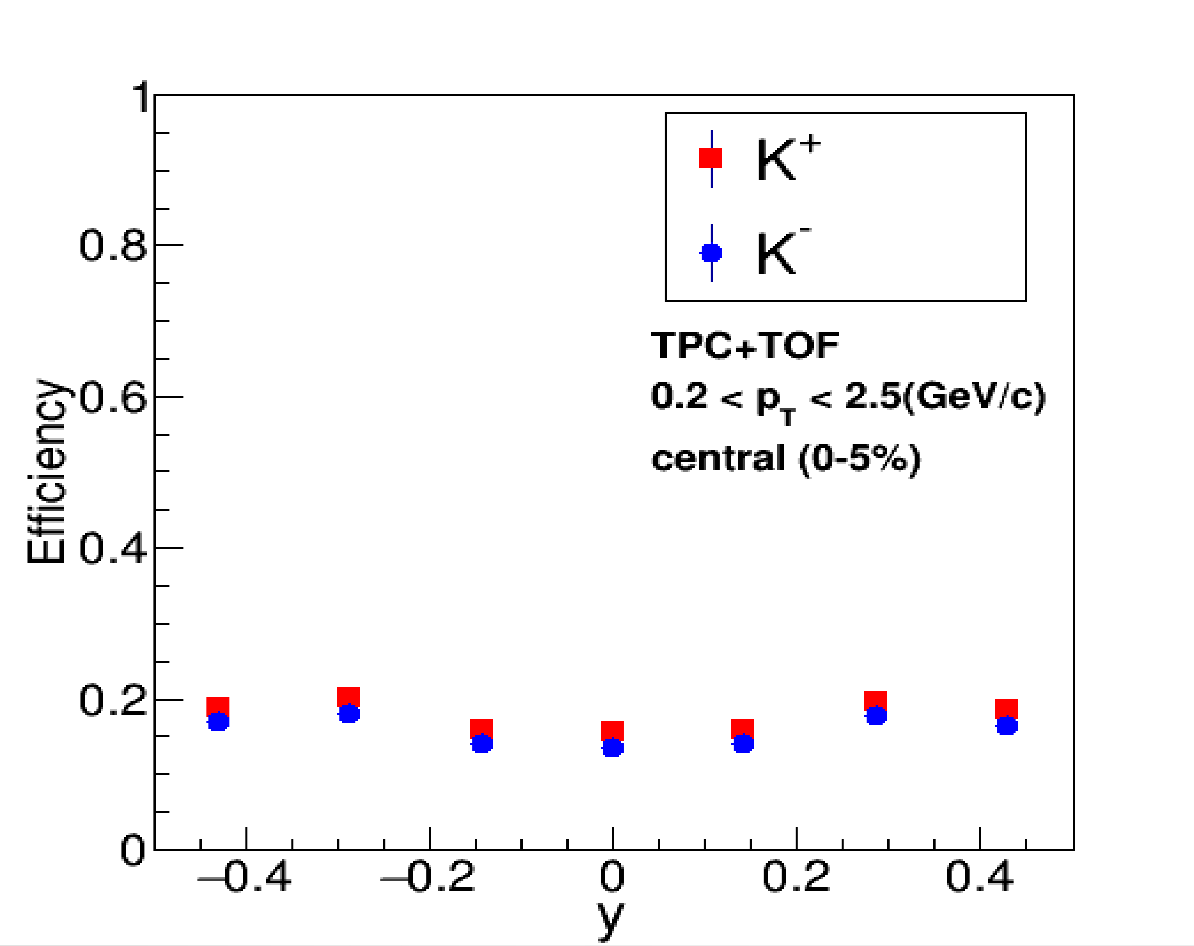
>>Reconstructed tracks show a pattern.

>> Issue is - is the pattern genuine ?

>> This pattern influences all the subsequent results.

Rapidity dependent 1D efficiency of $K^{\pm}$ for central collisions

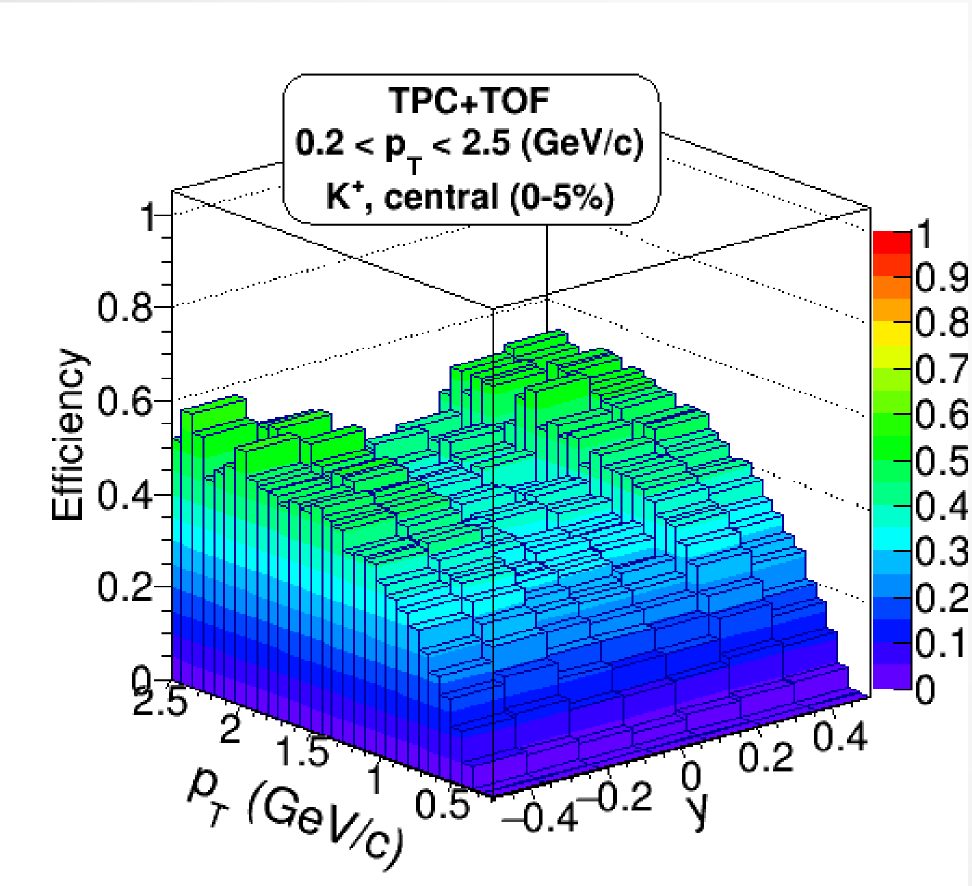
Efficiency (1D) = MC reconstructed / MC generated

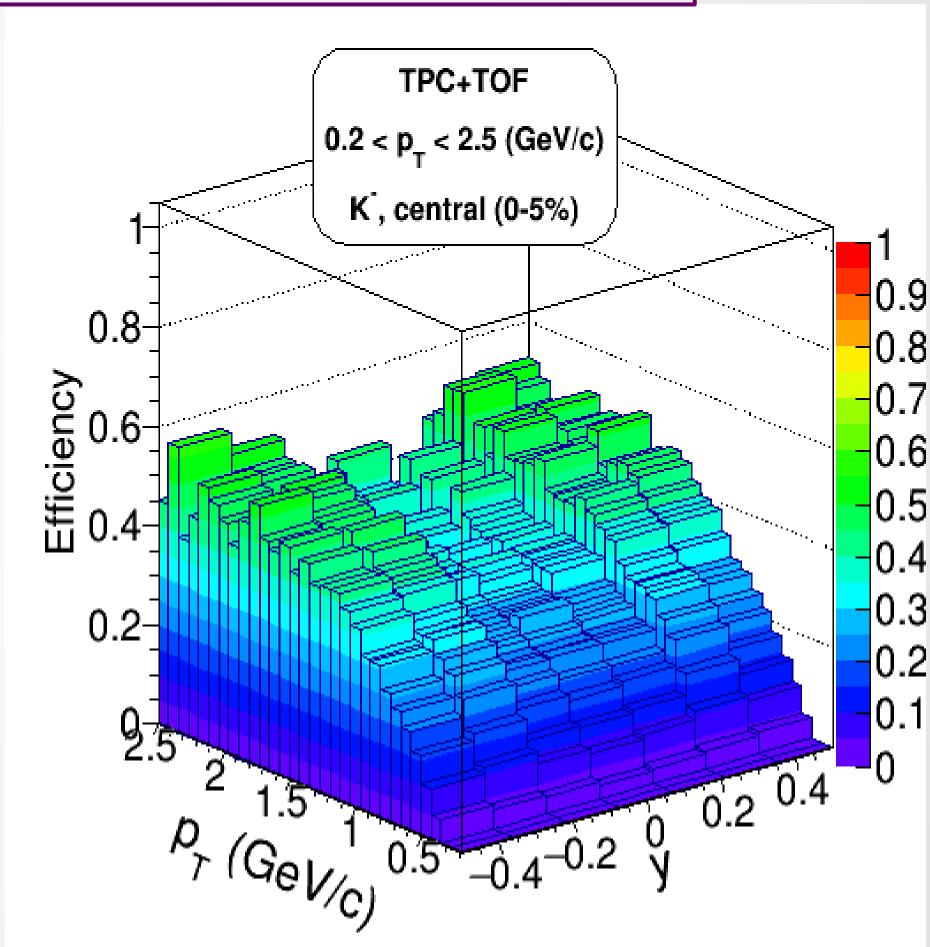


>> Same pattern persists as MC reconstructed.

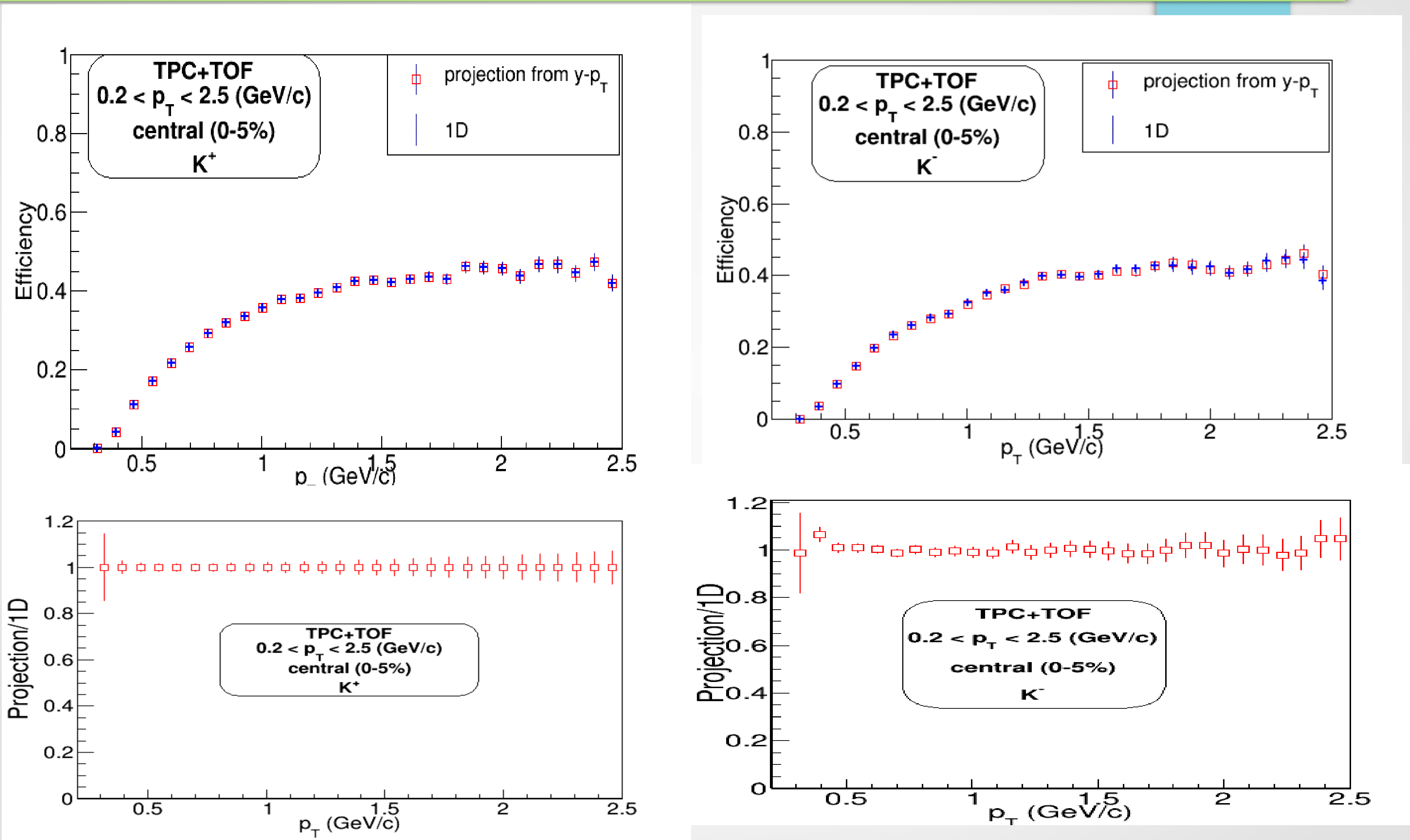
2D efficiency from y-p_T plot

2D efficiency = y-p_T reconstructed / y-p_T generated



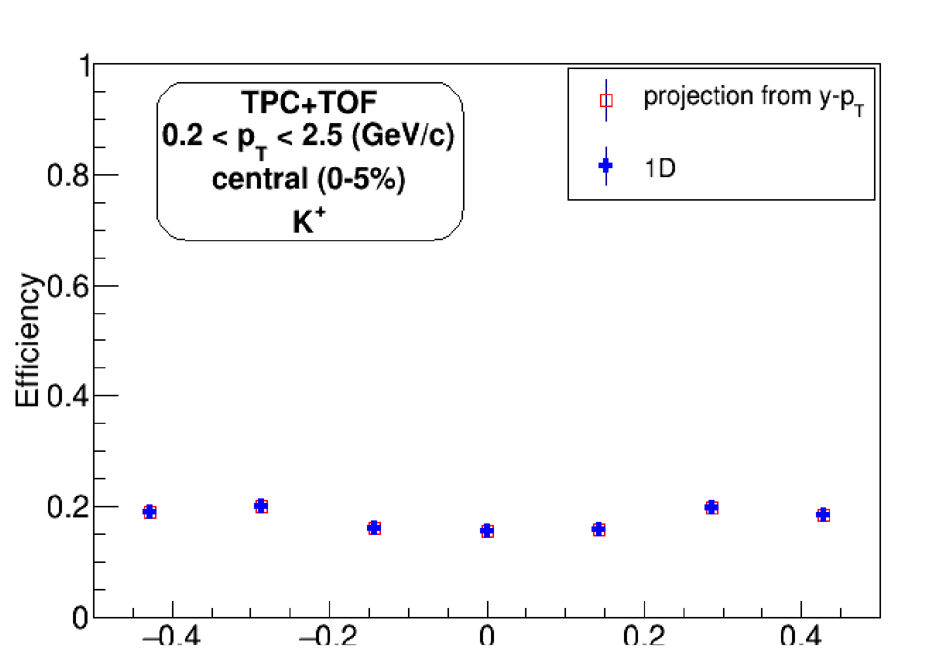


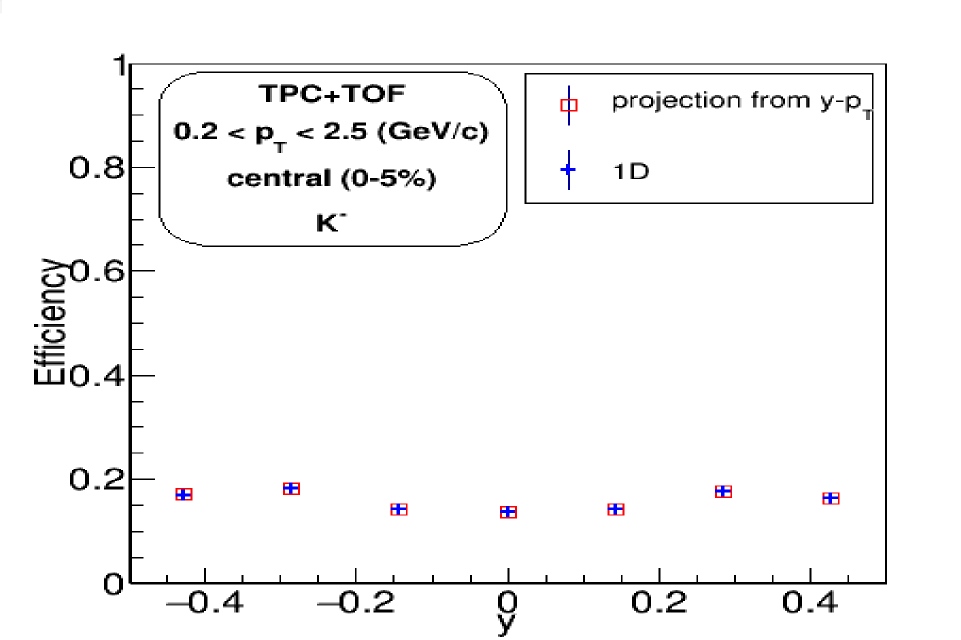
Comparison of p_T dependent 1D and 2D efficiencies

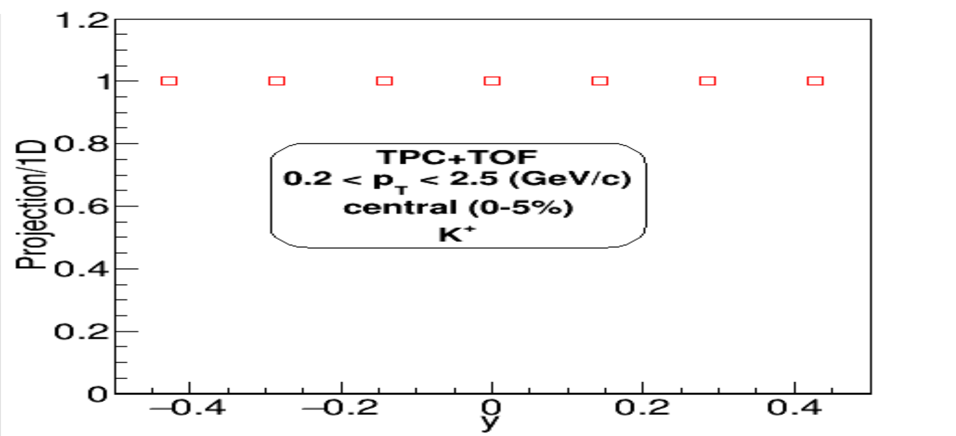


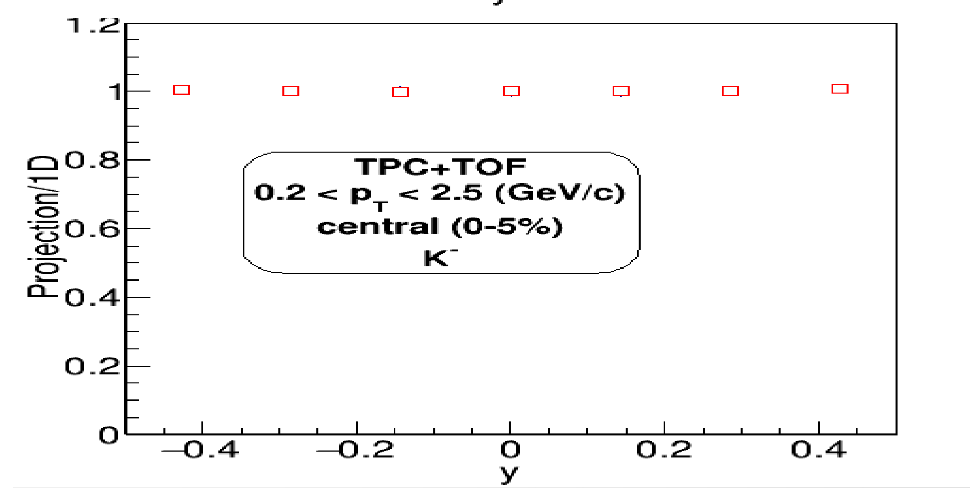
Observation: p_T dependent 1D efficiency agrees well with that of 2D efficiency.

Comparison of y dependent 1D and 2D efficiencies









Observation: 1D efficiency agrees well with that of 2D efficiency.

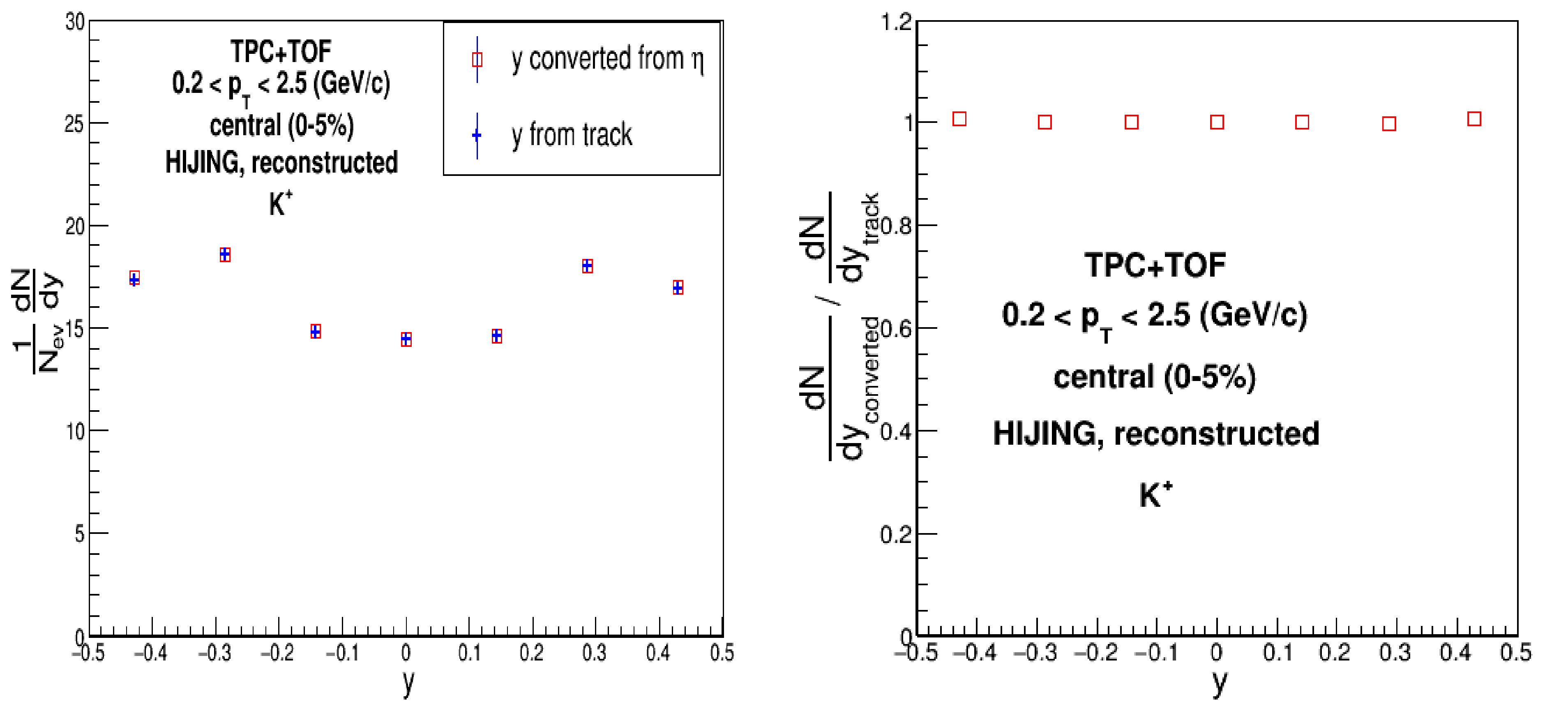
Calculation of rapidity from η

For each track η is calculated directly. Within the same loop rapidity is calculated using the following equation

$$y = \frac{1}{2} \ln \left[\frac{\sqrt{p_{\mathrm{T}}^2 \cosh^2 \eta + m^2} + p_{\mathrm{T}} \sinh \eta}{\sqrt{p_{\mathrm{T}}^2 \cosh^2 \eta + m^2} - p_{\mathrm{T}} \sinh \eta} \right]$$

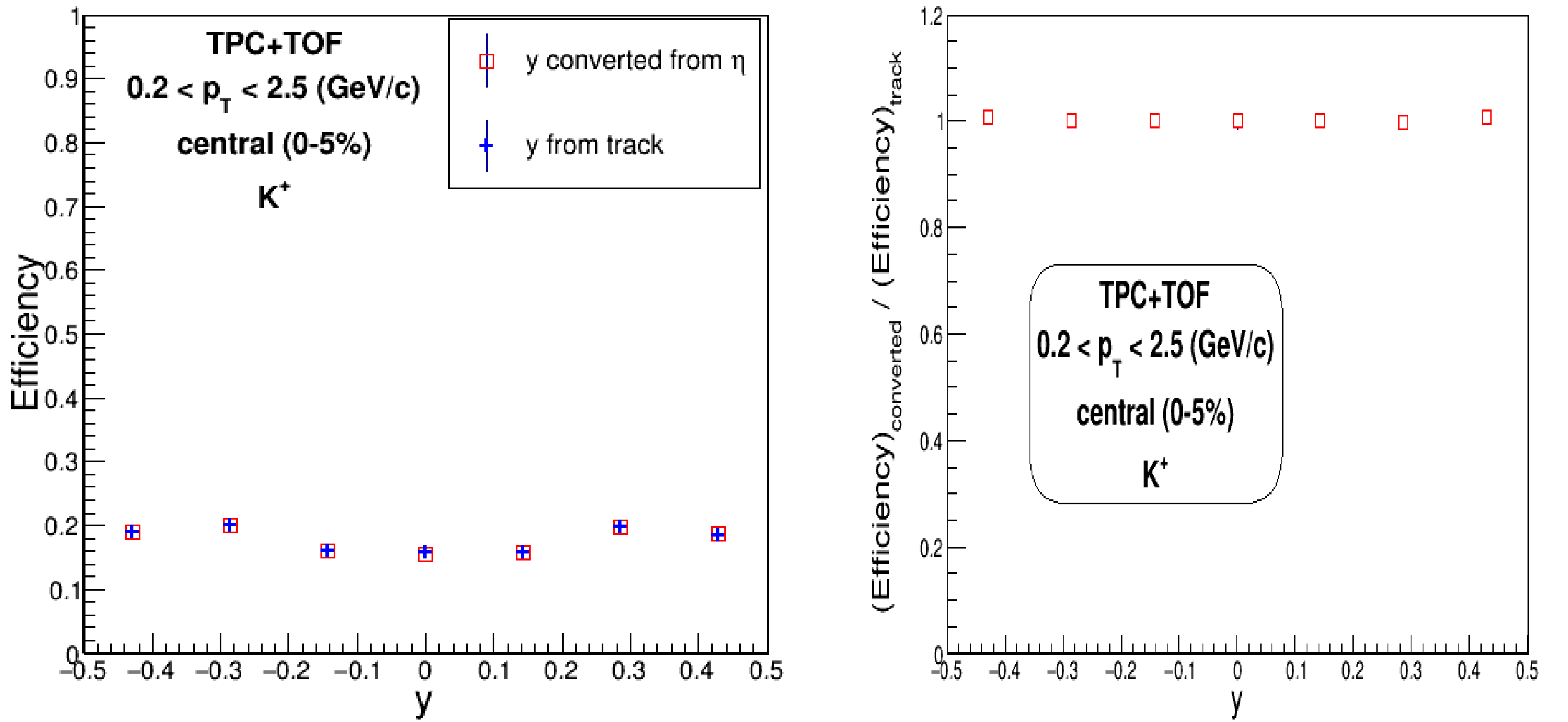
Nucl. Phys. **A** 941 (2015) 188–200

Comparison of rapidity distribution (y estimated from η vs. directly from track)



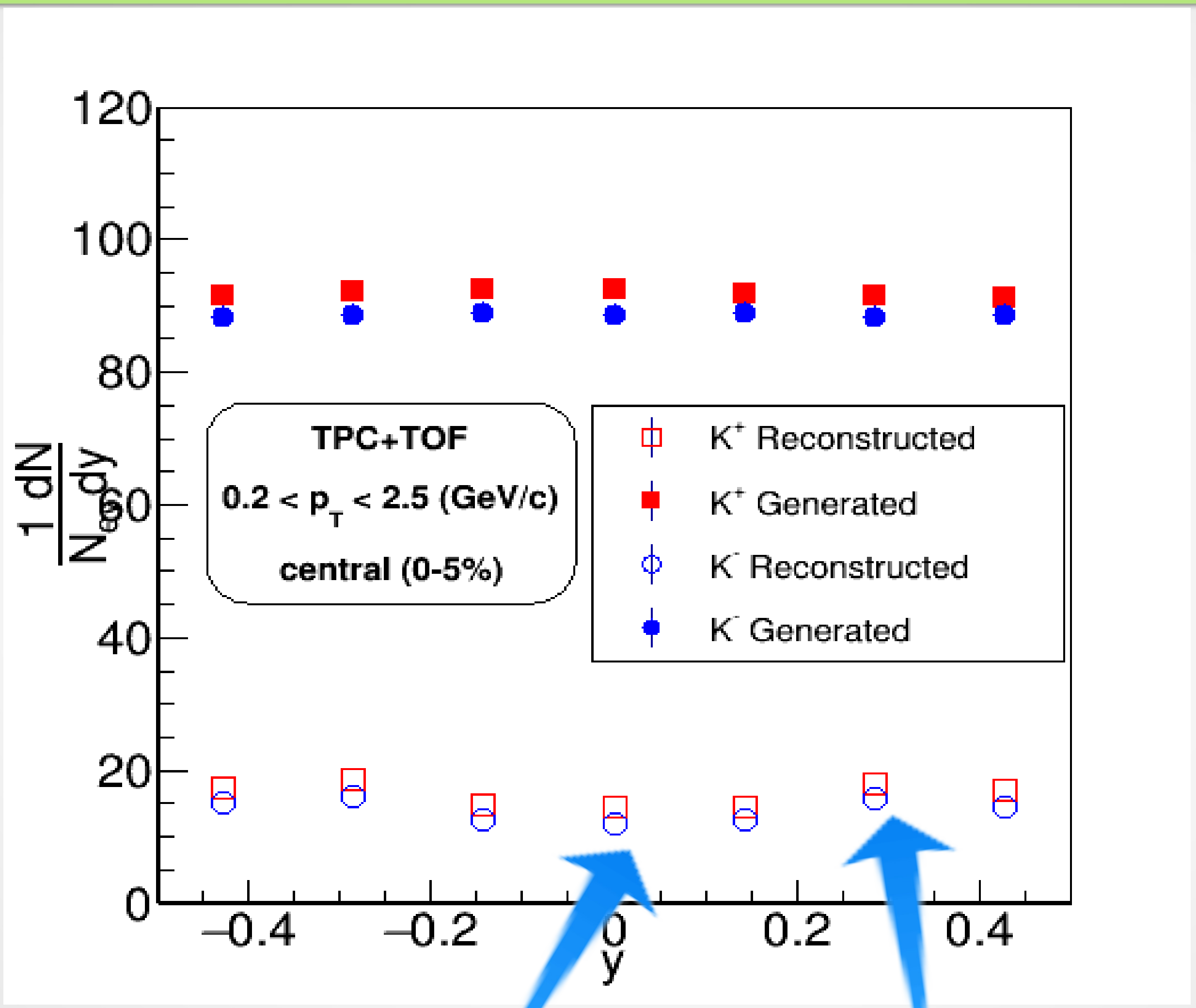
Observation: As expected, dN/dy (y calculated from Eta) gives the same as dN/dy (y taken from track directly)

Comparison of rapidity dependent efficiency (y converted from η vs. directly from track)



Observation: Both the plots give the same values

Why dip at the mid rapidity??



Dip at the mid rapidity!

Bump at 0.3!

Is TPC TOF track matching efficiency responsible for such shape?

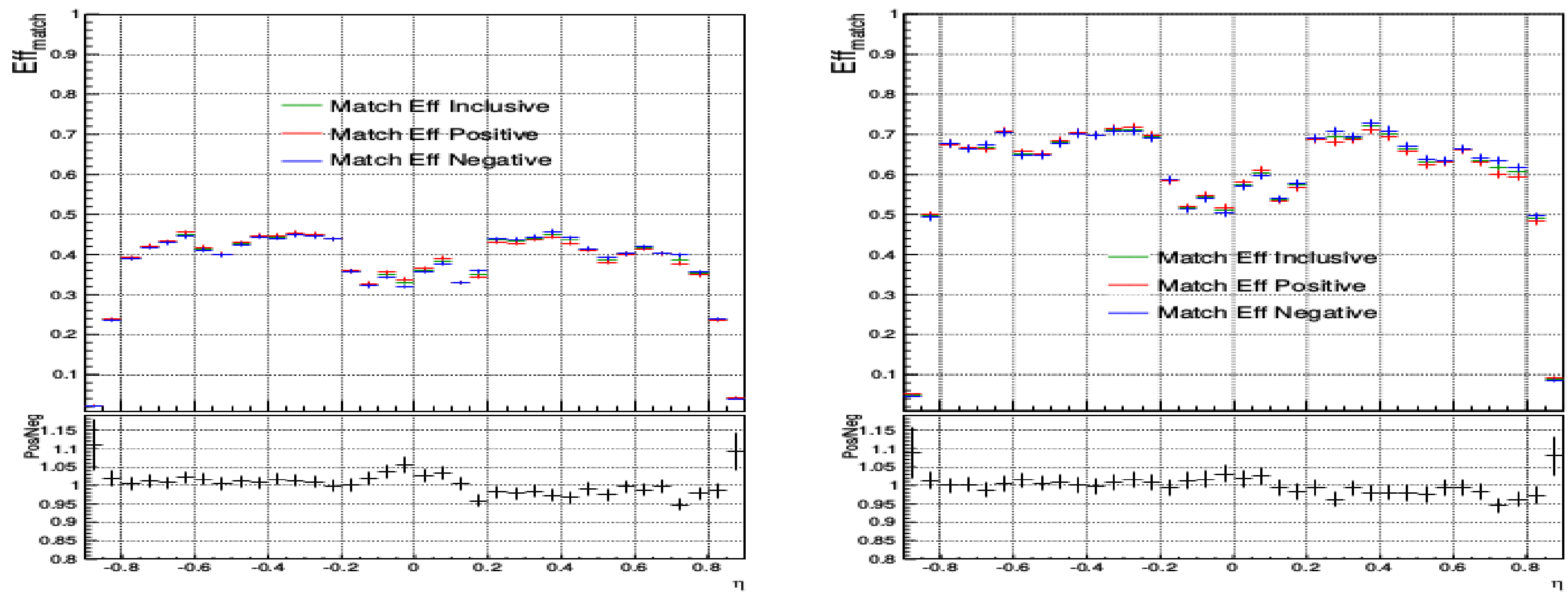


Figure 4.11: Eff_{match} as a function of η. The left panel includes all the tracks passing the quality cuts, while for the right panel, a cut on $p_t > 0.5\,\mathrm{GeV/c}$ was applied. In the bottom panels the ratios between the matching efficiency of positive and negative particles are shown.

Ref: http://www.infn.it/thesis/PDF/getfile.php?filename=7185-Guerzoni-dottorato.pdf (By Dr. Barbara Guerzoni).

Possible explanation for TPC TOF matching efficiency

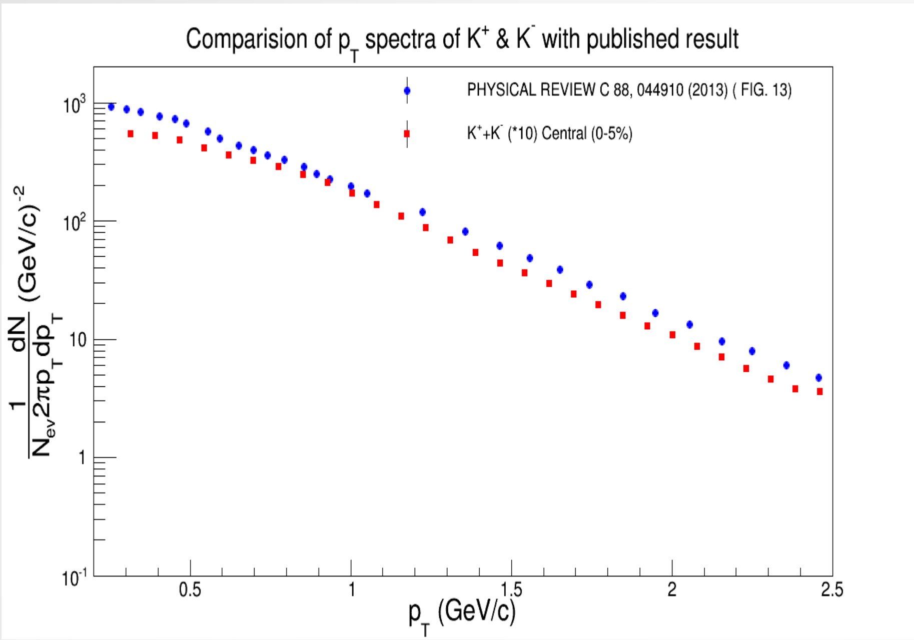
- **Dip of the TPC TOF matching efficiency at the mid eta region is due to the absence of three central TOF modules in front of PHOS spectrometer.**

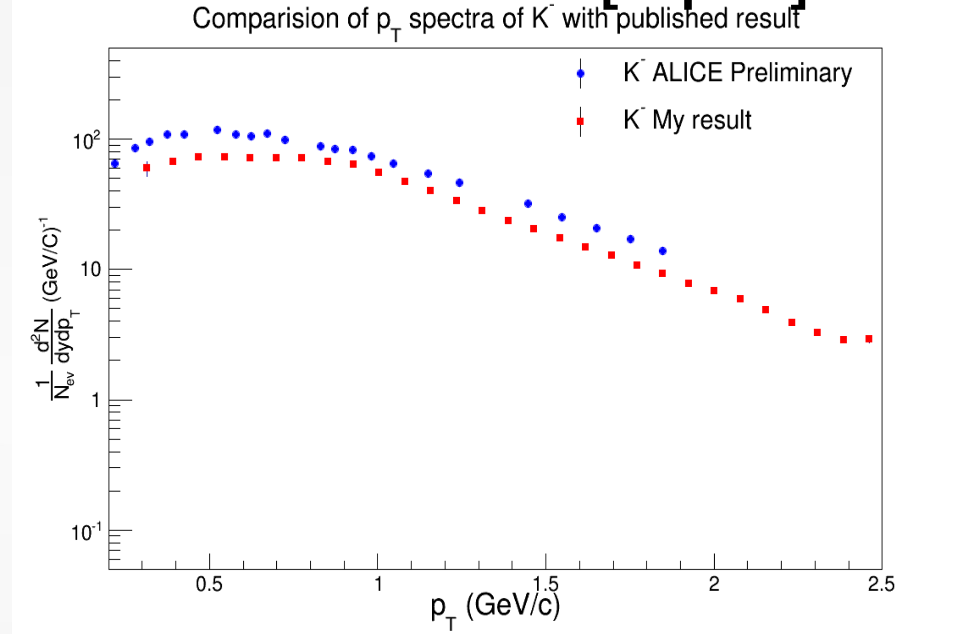
- **Minimum at higher eta is due to the barrel geometrical acceptance.(Chapter 4, page number 102 of the above mentioned link).**

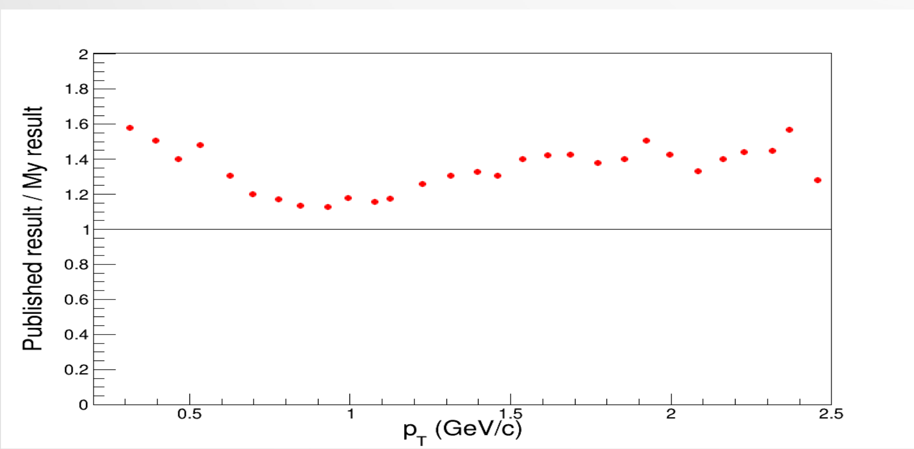
Comparison of p_T spectra

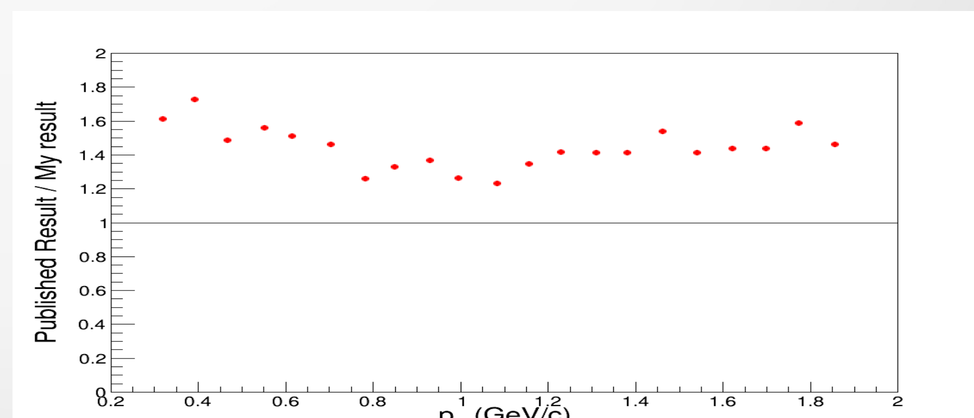
Phy. Rev. C 88, 044910 (2013)

ref: Roberto Preghenella, arXiv:1203.5904v1 [hep-ex]









Cuts used in my analysis and published results

Ref: Roberto Preghenella, arXiv:1203.5904v1 [hep-ex]

1. Detector used: ITS, TPC and TOF
2. Iy| < 0.5
3. 0.2 < p_T < 2.0 (GeV/c) for $K^{\pm}$

Ref:Phy. Rev. C 88, 044910 (2013)

1. Detector used: ITS, TPC, TOF and TRD
2. |y| < 0.5
3. Global tracks for ITS, TPC and TOF
4. nSigma TPC+TOF = 3 Sigma
5. |Vz| < 10 cm

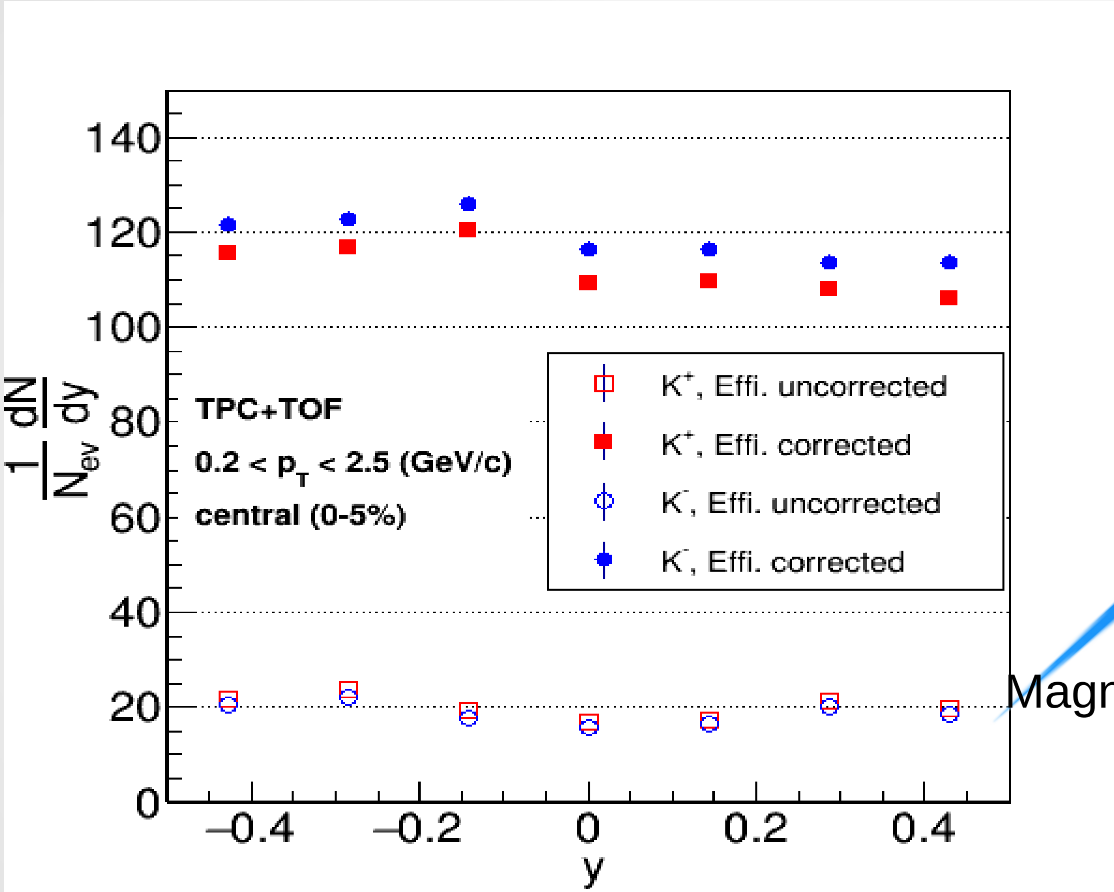
Analysis	π	K	p
ITS stand-alone	0.10–0.60	0.20–0.50	0.30–0.60
TPC/TOF	0.20–1.20	0.25–1.20	0.45–1.80
TOF fits	0.50–3.00	0.45–3.00	0.50–4.60

My analysis

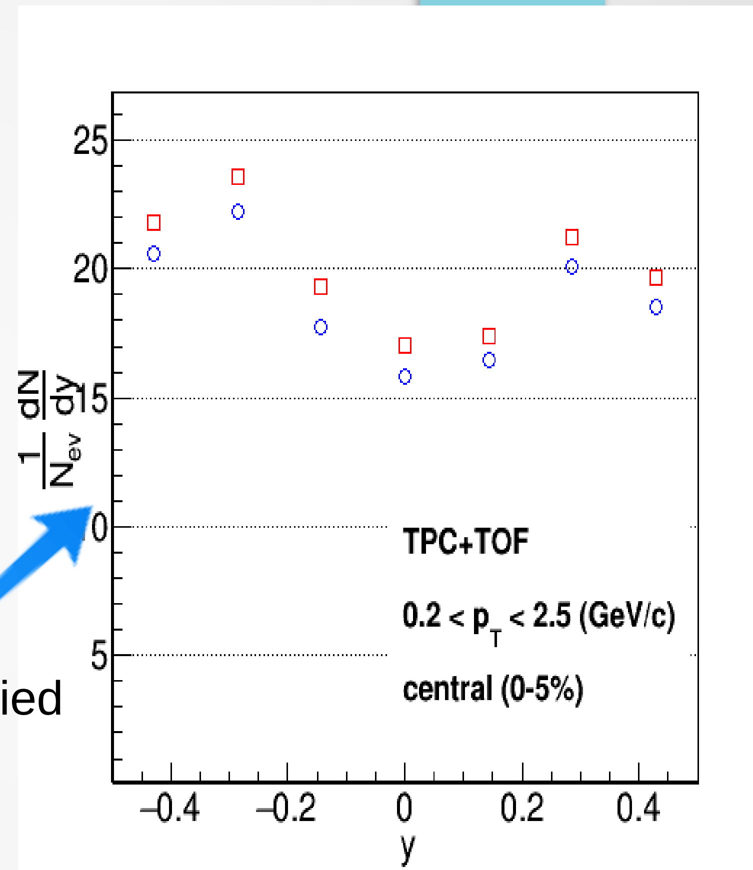
1. Detector used: TPC+TOF
2. |y| < 0.5
3. Global tracks
4. nSigma TPC+TOF ≤ 3 Sigma
5. 0.2 <p_T < 2.5 (GeV/c) for $K^{\pm}$
6. |Vz| <10 cm

>> Discripency in p_T spectra may arise due absence of ITS detector and slight different cut in my analysis.

Efficiency uncorrected and corrected rapidity distributions



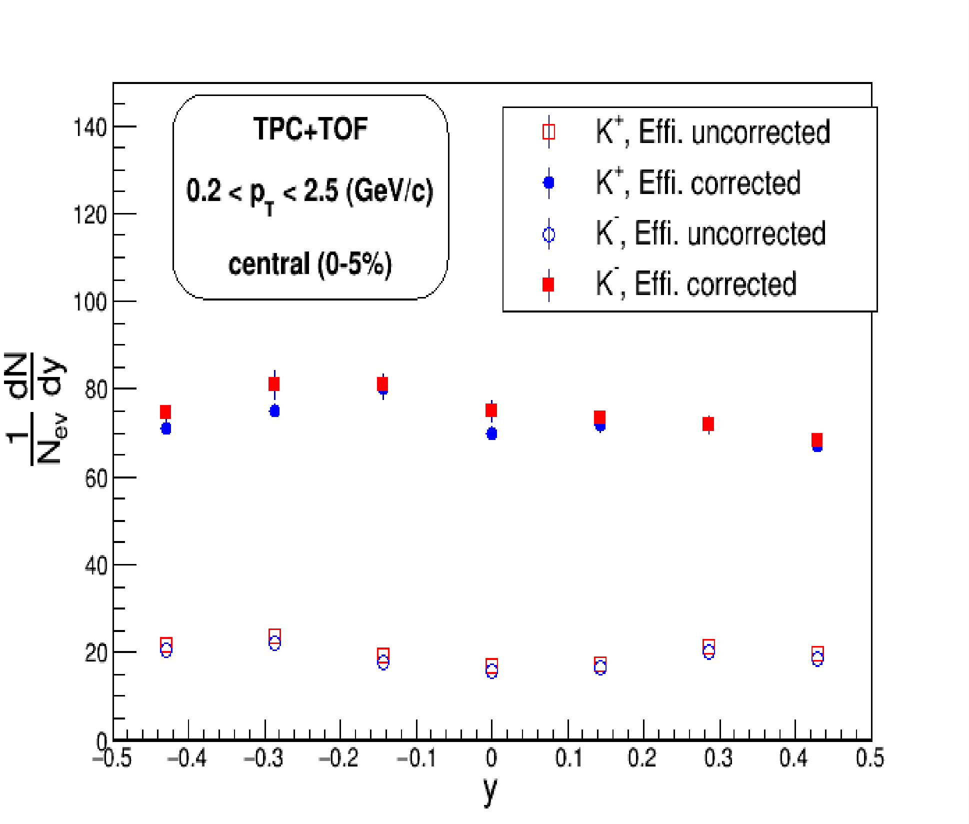
Magnified



1D plot

>> Asymmetry in both efficiency uncorrected and corrected plots

Efficiency uncorreted and corrected rapidity distributions (from projection)



Projection from 2D plot

>> Similar asymmetry persists

>> Whether the asymmetry is pT dependent??

Why this asymmetry?

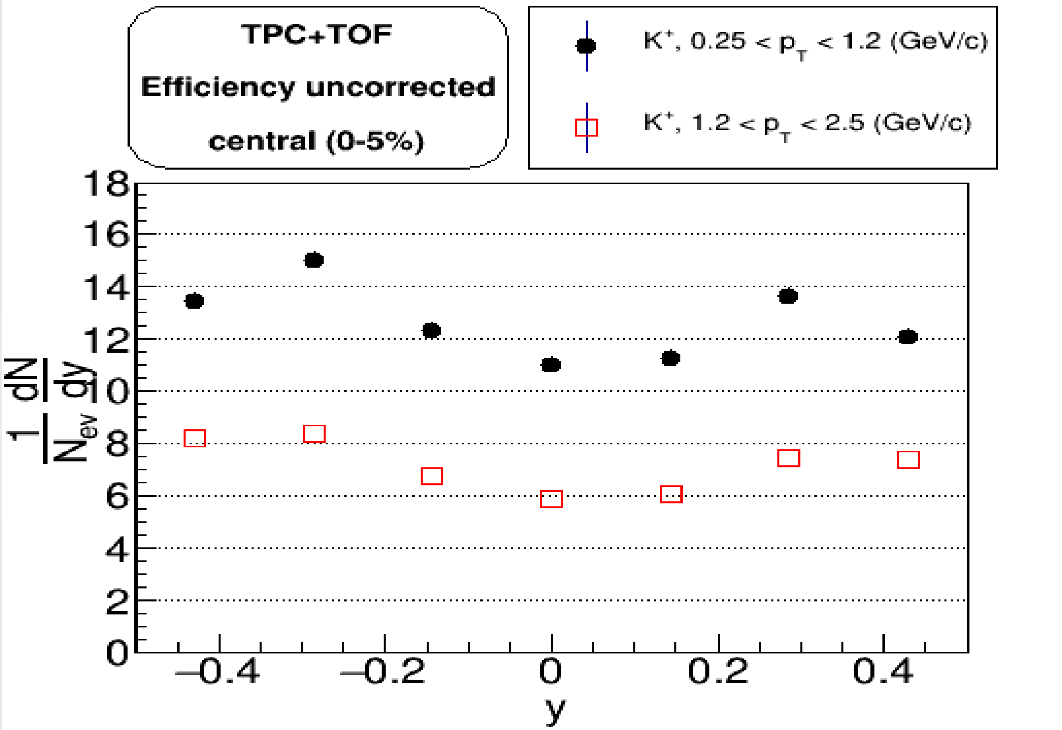
Mail from PAG

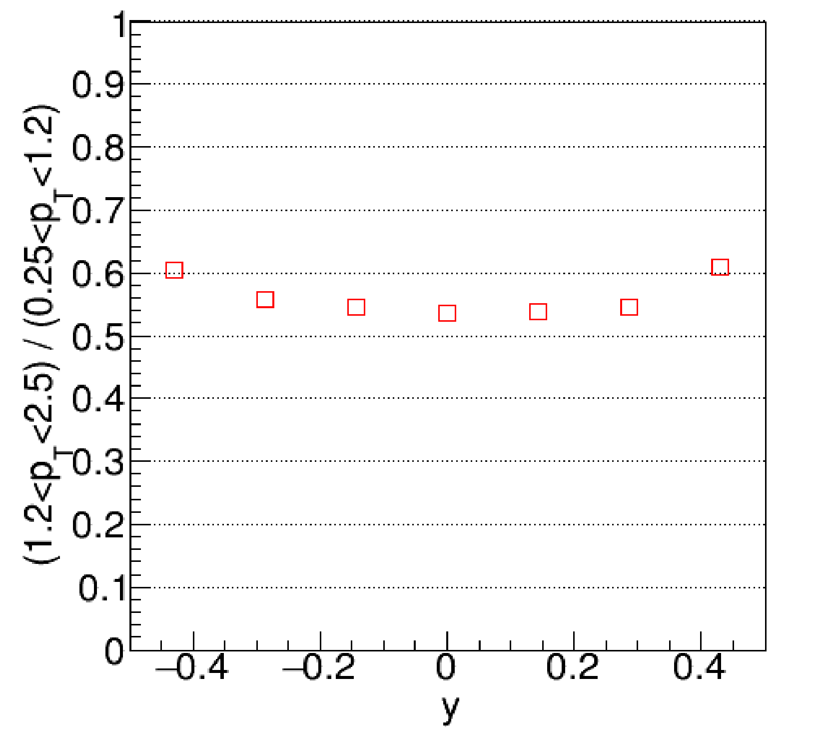
......
To summarize, it is confirmed that the decrease in the al/l ratio comes mainly from the negative eta and the decrease seems to be stronger at larger negative eta.

Being aware that there is also a second order effect due to the magnetic filed (positive) from what Simone and Michal have shown, we have now to think how we deal with this asymmetry for already published results and for results we are going to publish like the RAA at 2.76 TeV and the ab/b papers.
......

Mariella

Comparison of rapidity distribution of K^+ at different p_T



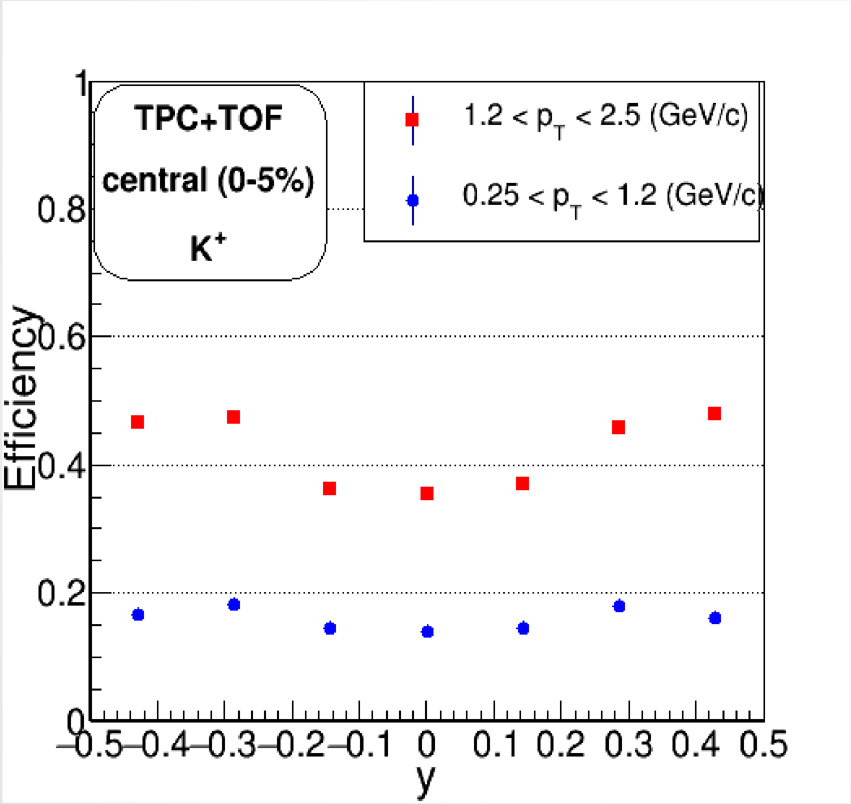


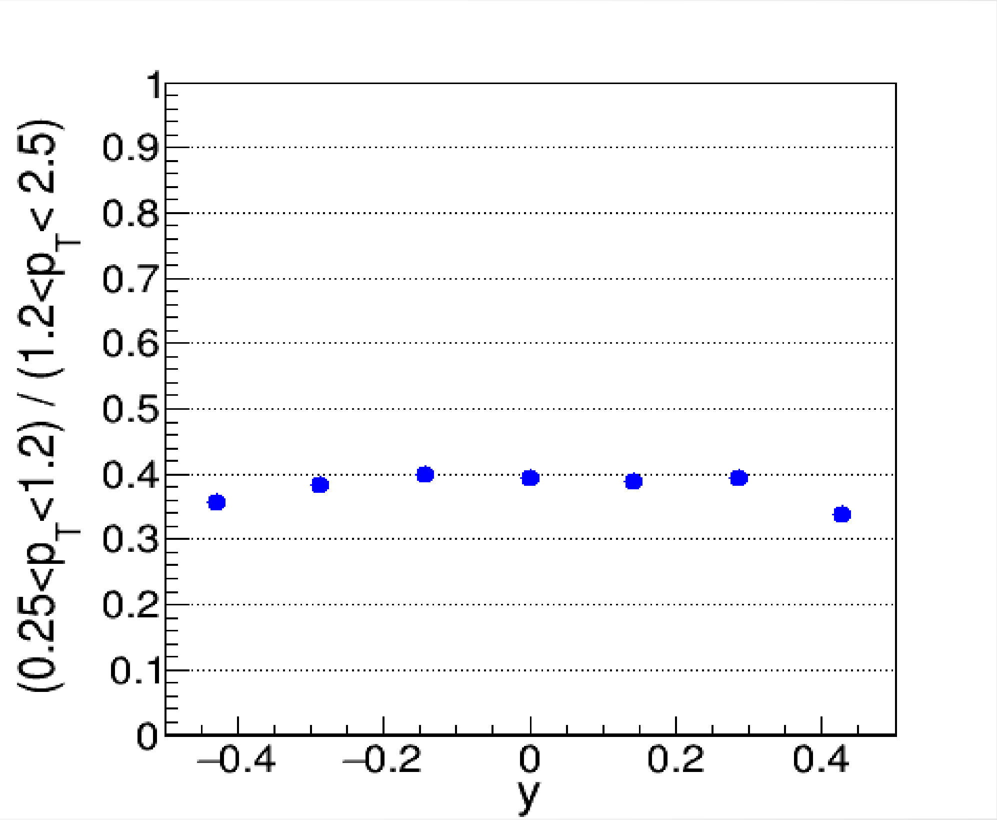
>>Asymmetries arise in both the p_T cuts.

>> Asymmetries are not same.

>> Asymmetry may be pT dependent.

Asymmetry is not there in efficiencies plots





Efficiency is not flat in y! Let's move on with enhancement estimation

Strangeness enhancement

Following S. Soff et al. (Phys Lett B, 471, 1999), the enhancement (E_s) is defined as,

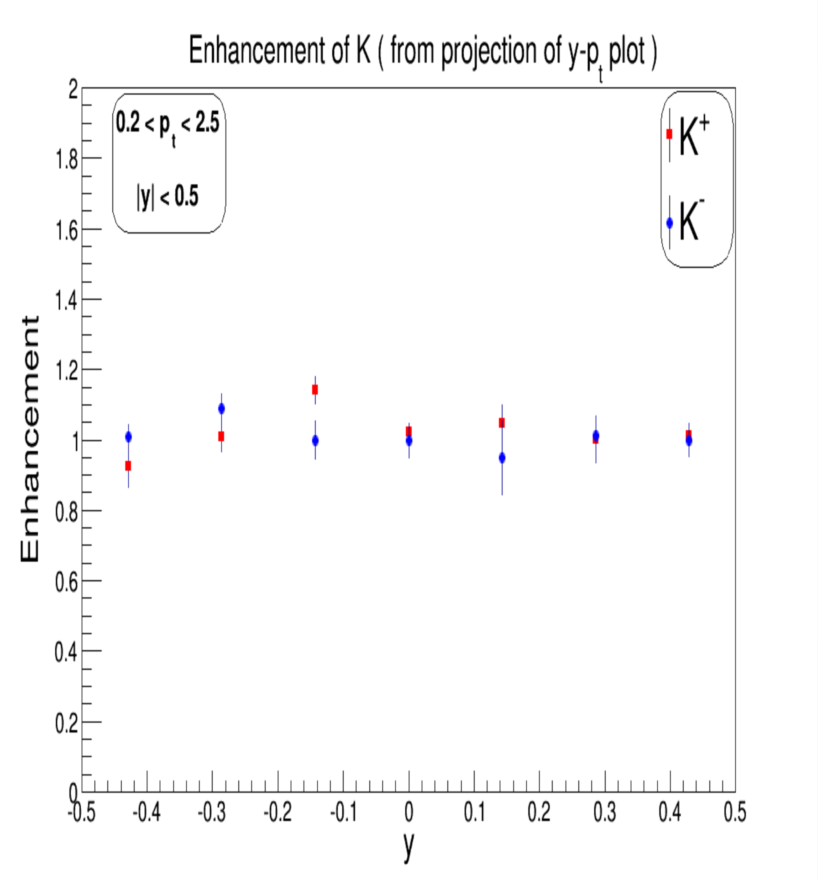
$$E_S = \left[\frac{(Yield)_{AA}}{< N_{\pi^-} >}\right]_{central} / \left[\frac{(Yield)_{AA}}{< N_{\pi^-} >}\right]_{peripheral}$$

I estimated enhancement as,

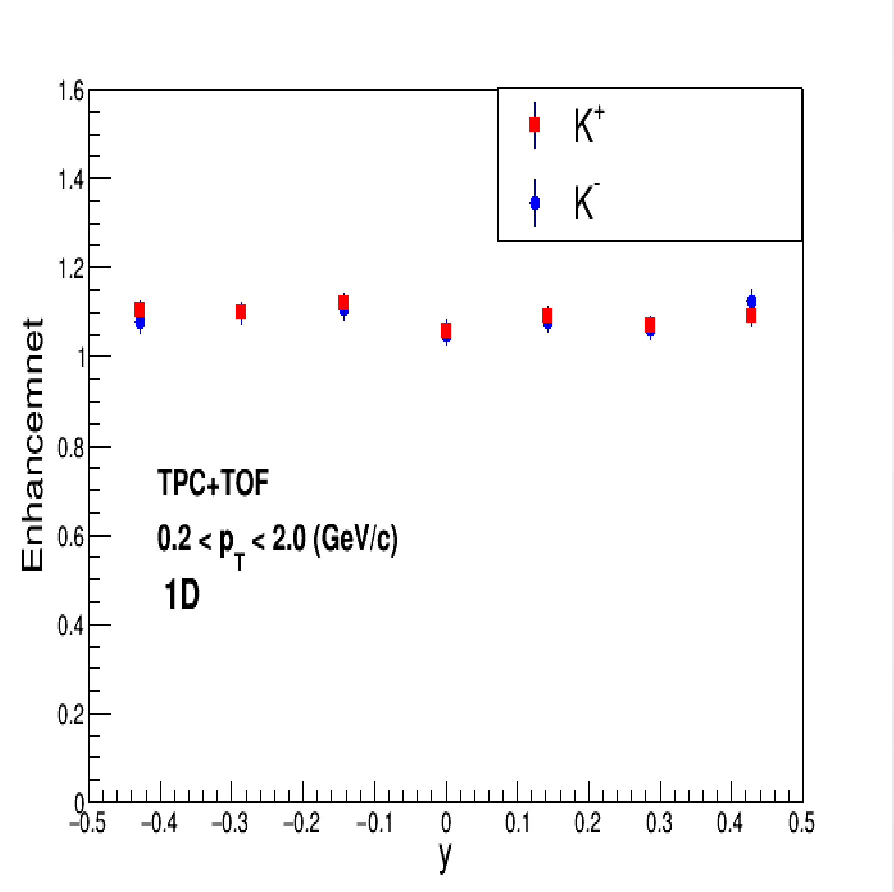
$$E_s = \frac{\left(\frac{1}{<N_{\pi^-}>}\frac{1}{N_{ev}}\frac{dN}{dy}\right)_{central}}{\left(\frac{1}{<N_{\pi^-}>}\frac{1}{N_{ev}}\frac{dN}{dy}\right)_{peripheral}}$$

Enhancement plot (preliminary)

From projection of y-p_T plot



From 1D rapidity distribution



Summary and future plan

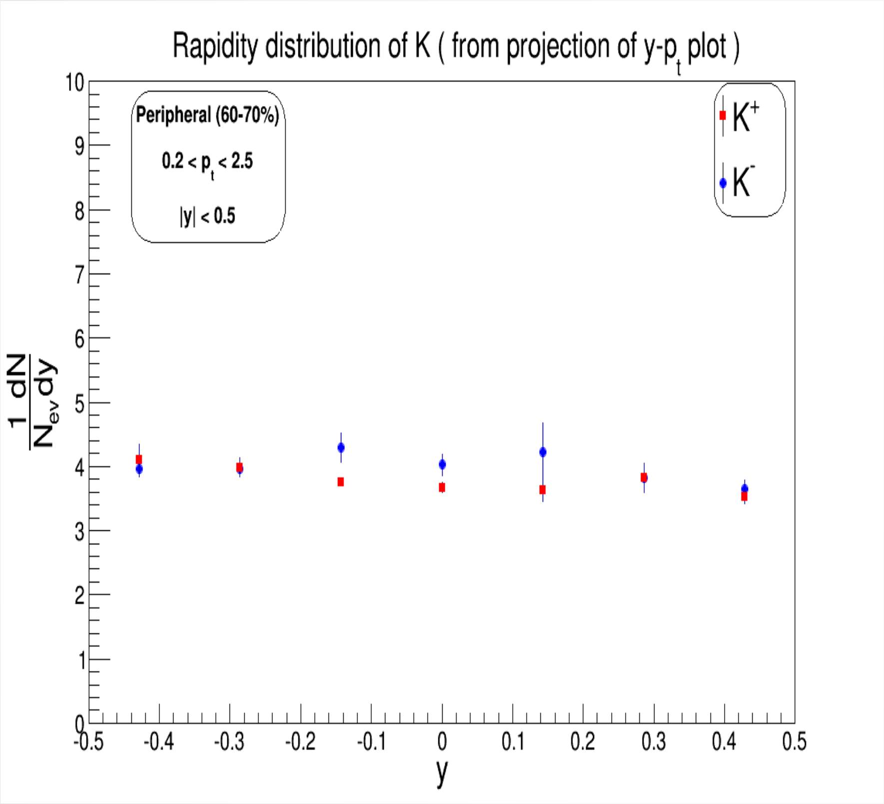
- We don’t have any published results with us on rapidity dependent efficiency estimation for comparison.
- p_T dependent efficieny looks fine.
- The dip at the mid rapidity region may arise due to the absence of three TOF module (PHOS hole).
- Asymmetry- It need to be discussed.
- Enhancement with rapidity is found to be more or less flat.
- Our future plan is to study rapidity dependent stangness enhancement with more particles.

Thank you....

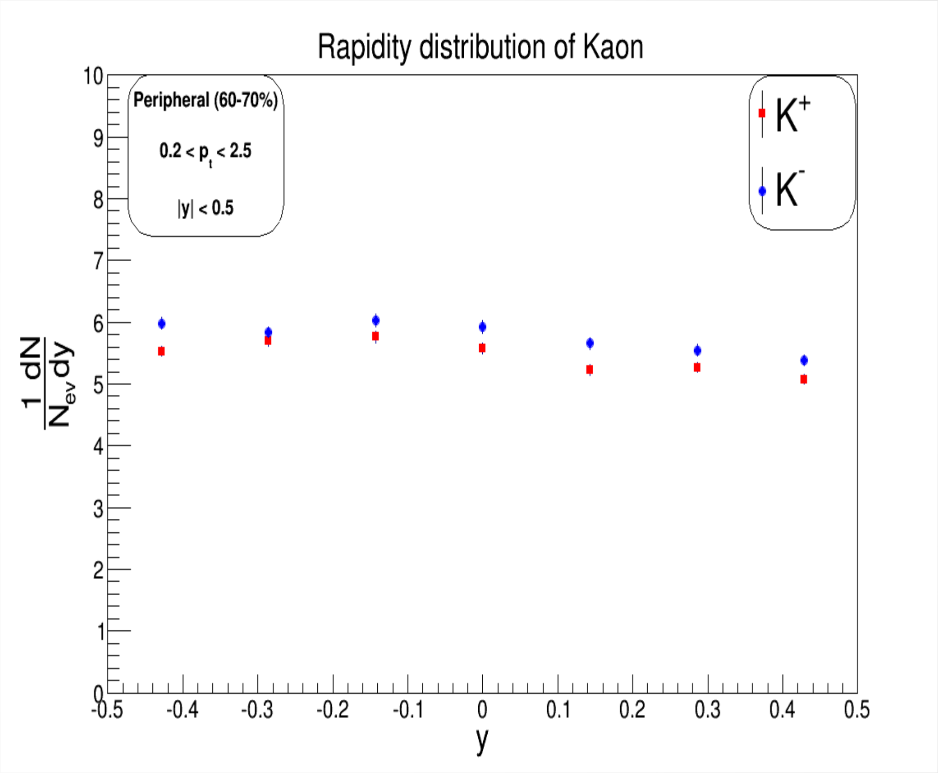
Back up

Efficiency corrected rapidity distribution of $K^{\pm}$ for Peripheral (60-70%) collisions

From projection of y-p_T plot



Rapidity distribution of $K^{\pm}$ (1D)



PID with old AliRoot version