

TWO PARTICLE CORRELATIONS IN p-A WITH IDENTIFIED AND UNIDENTIFIED TRIGGER PARTICLES



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MOTIVATION

- ◆ CMS has observed a near side ridge in high-multiplicity pp and p-Pb collisions
- ◆ ALICE has observed “Double-Ridge” in p-Pb collisions.
- ◆ Yield associated with Unidentified trigger has contribution from both baryon and meson triggers.
- ◆ Our goal is to study identified trigger dependence of ridge & jet cone yield in p-A & p-p.

LONG RANGE CORRELATION—INITIAL STAGE EFFECT

arXiv:0804.3858v1

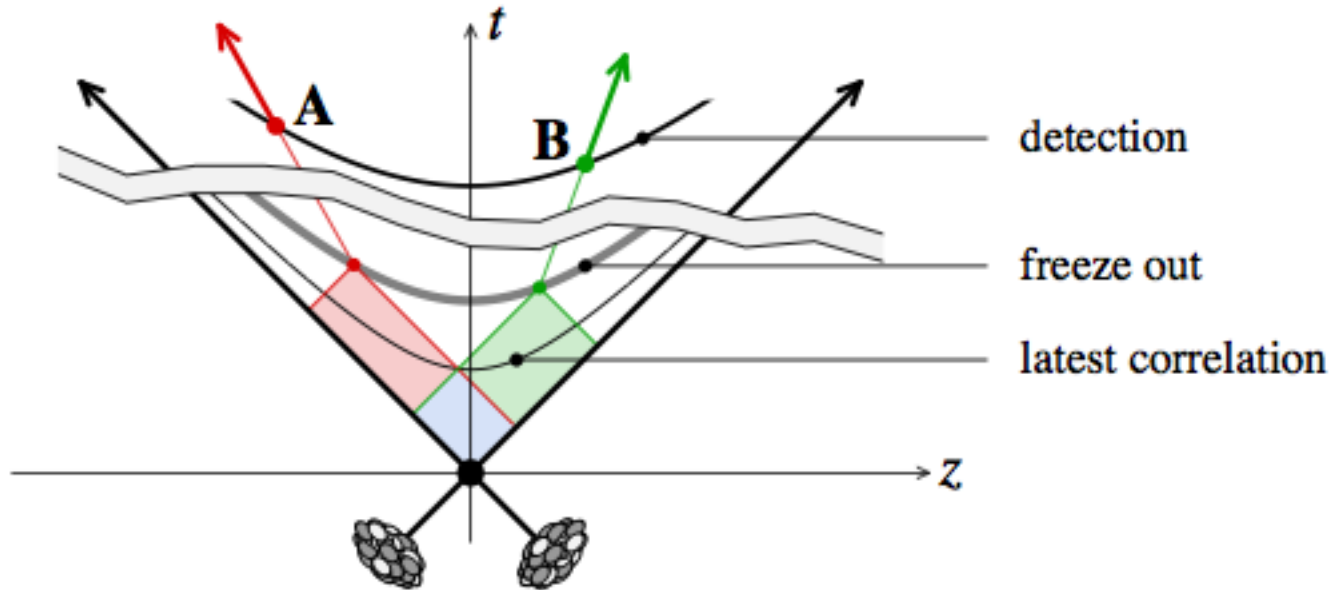


Figure 1: The red and green cones are the location of the events in causal relationship with the particles A and B respectively. Their intersection is the location in space-time of the events that may correlate the particles A and B .

If there is no medium formation due to the collision, the correlation between two correlated particles separated by large pseudorapidity difference must be originated at an earlier time. (carrying some signature of initial stage effect)

Data, Events and Tracks selection

◆ DATA:p-A at $\sqrt{s_{NN}} = 5.02$ TeV

/alice/data/2013/LHC13c/pass1/AOD

◆ Monte Carlo: p-A ,DPMJET anchored to LHC13b

/alice/data/2013/LHC13b/AOD

◆ EVENTS: kINT7 triggered events with $|z_{\text{vertex}}| < 10$ cm.

◆ TRACK CUTS:

1.Filterbit->768(Hybrid tracks)

2.Tracks passed-> AliAODTrack::kPrimary

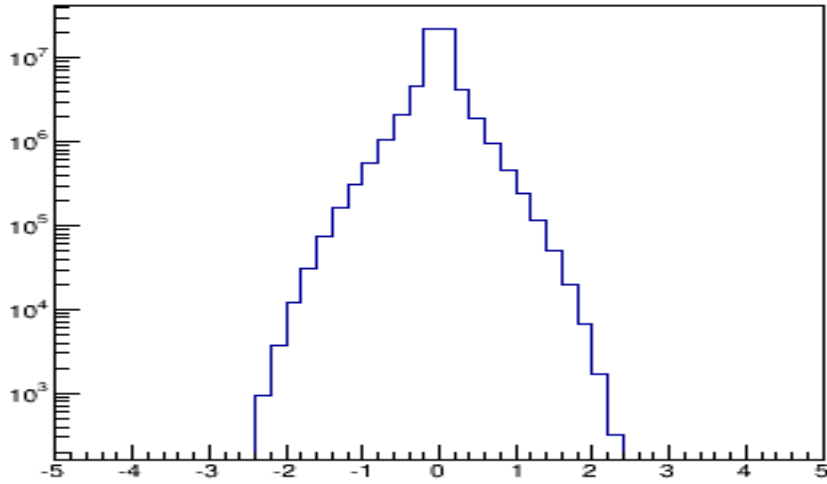
2.Pt >0.2 GeV.

3.-0.9< η <0.9.

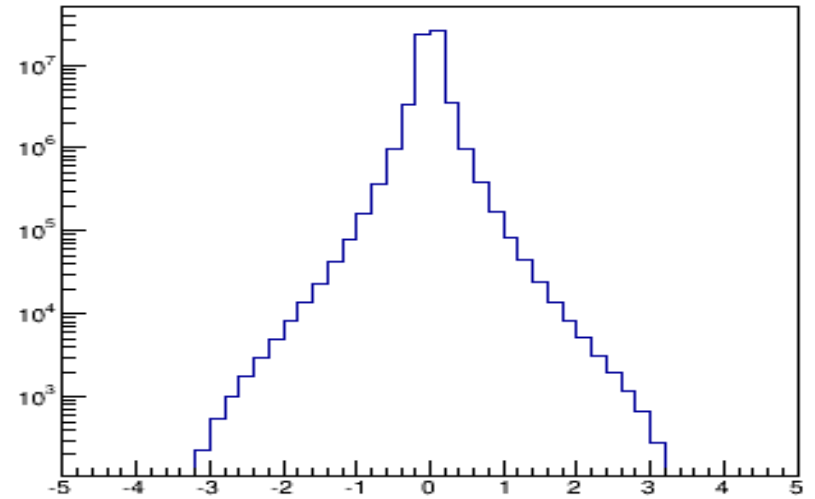
4. No of TPC Clusters>70.

5.ChiSq/ndf ≤ 4.0

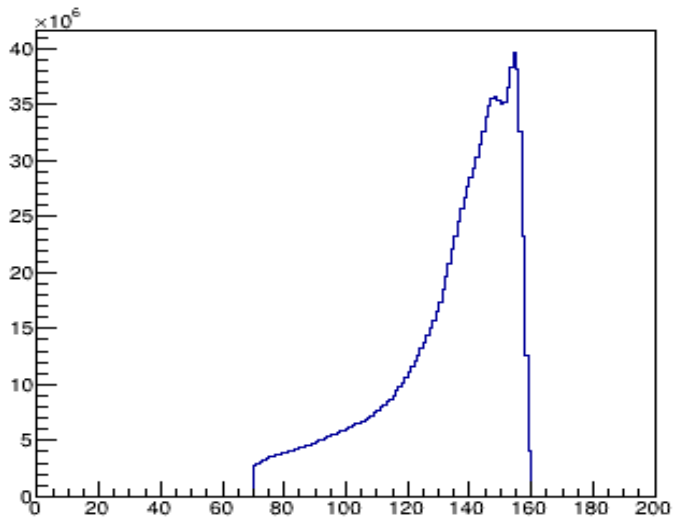
Basic QA Plots



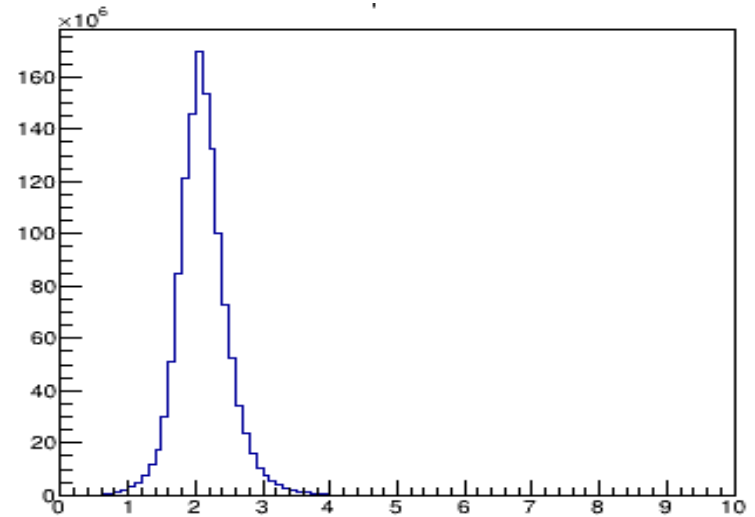
DCAxy<2.4



DCAz<3.2



No. of TPC clusters>70



Chi2/ndf<4

Two-Particle Correlations

- Correlation between a trigger and an associated particle in certain p_T intervals ($p_{T,assoc} < p_{T,trig}$)

$$\frac{1}{N_{trig}} \frac{d^2 N_{assoc}}{d\Delta\phi d\Delta\eta} = \frac{S(\Delta\phi, \Delta\eta)}{B(\Delta\phi, \Delta\eta)}$$

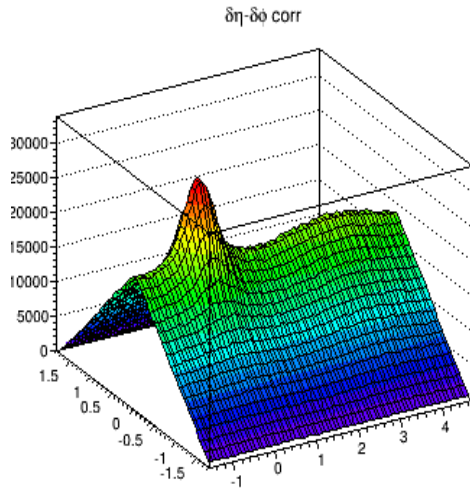
- Signal distribution S contains correlation within the same event

$$S(\Delta\phi, \Delta\eta) = \left(\frac{1}{N_{trig}} \frac{d^2 N_{assoc}}{d\Delta\phi d\Delta\eta} \right)_{same}$$

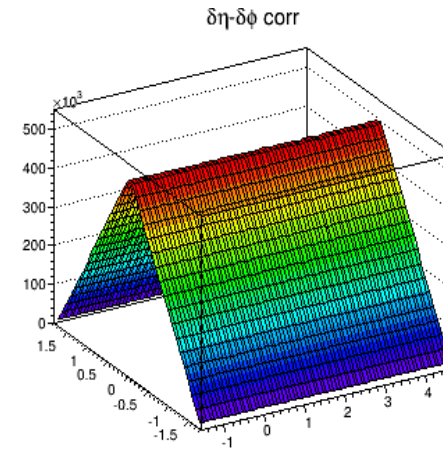
- Background B contains "correlation" between different events

$$B(\Delta\phi, \Delta\eta) = \alpha \left(\frac{d^2 N_{assoc}}{d\Delta\phi d\Delta\eta} \right)_{mixed}$$

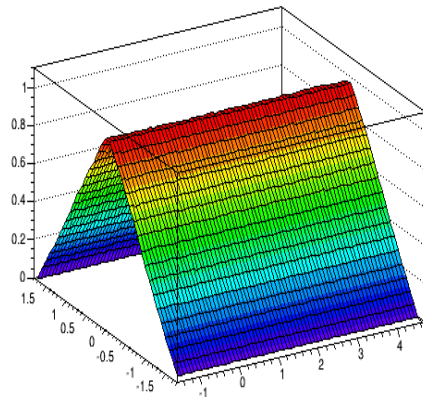
- Background Corrects for pair acceptance & pair efficiency
- Normalized such that it is unity around $(\Delta\eta, \Delta\phi) = (0, 0)$



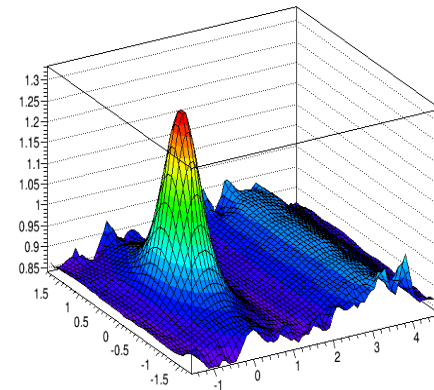
SAME EVENT



MIXED EVENT



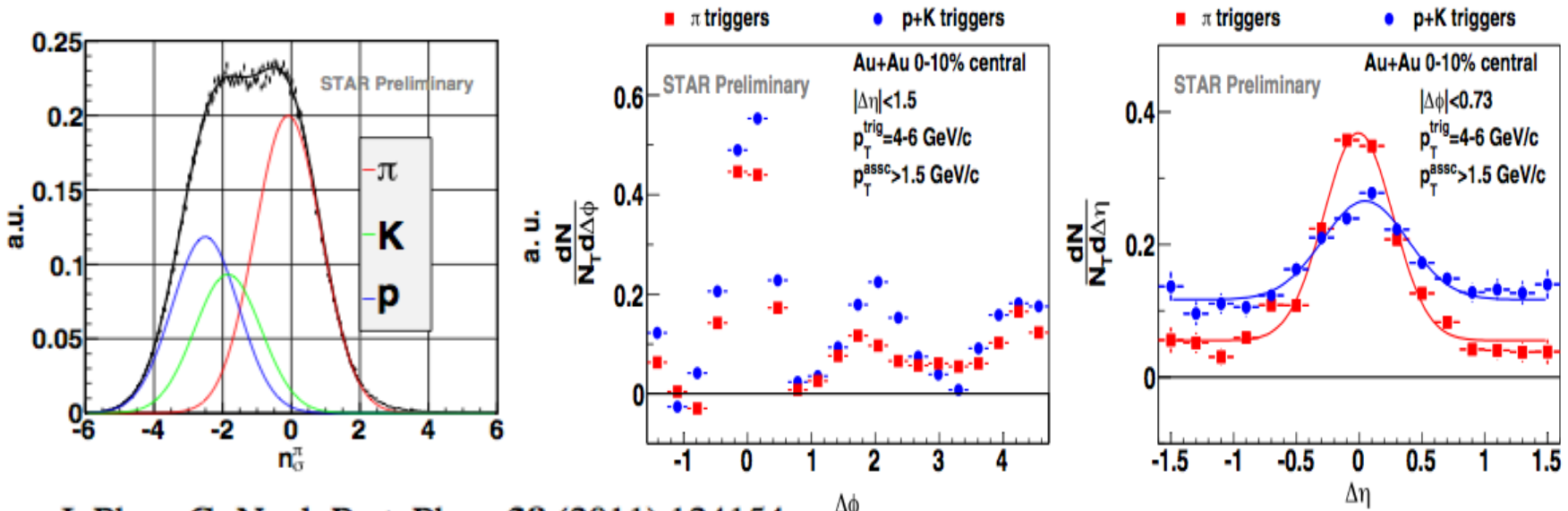
Mixed event normalized to unity



Signal/Background

STAR Results

- Trigger particles are divided into two classes(only TPC is used): a) Pions
b)Protons+kaons
- $n\sigma^\pi$ variable \rightarrow the number of standard deviations of the particular track's dE/dx value from the Bethe–Bloch expectation for a charged pion.



J. Phys. G: Nucl. Part. Phys. **38** (2011) 124154

Near side correlation structures are projected on $\Delta\eta$ for pion triggered(**red**) and p +k triggered(**blue**) events in Au+Au(left) and d+Au(right)

Trigger PID	Au+Au		d+Au		Au+Au
	Cone yield		Cone width		Ridge yield
π	0.22 ± 0.01	0.19 ± 0.01	0.34 ± 0.03	0.28 ± 0.03	0.057 ± 0.005
p+K	0.12 ± 0.01	0.14 ± 0.02	0.27 ± 0.01	0.22 ± 0.01	0.118 ± 0.007

Particle Identification In ALICE

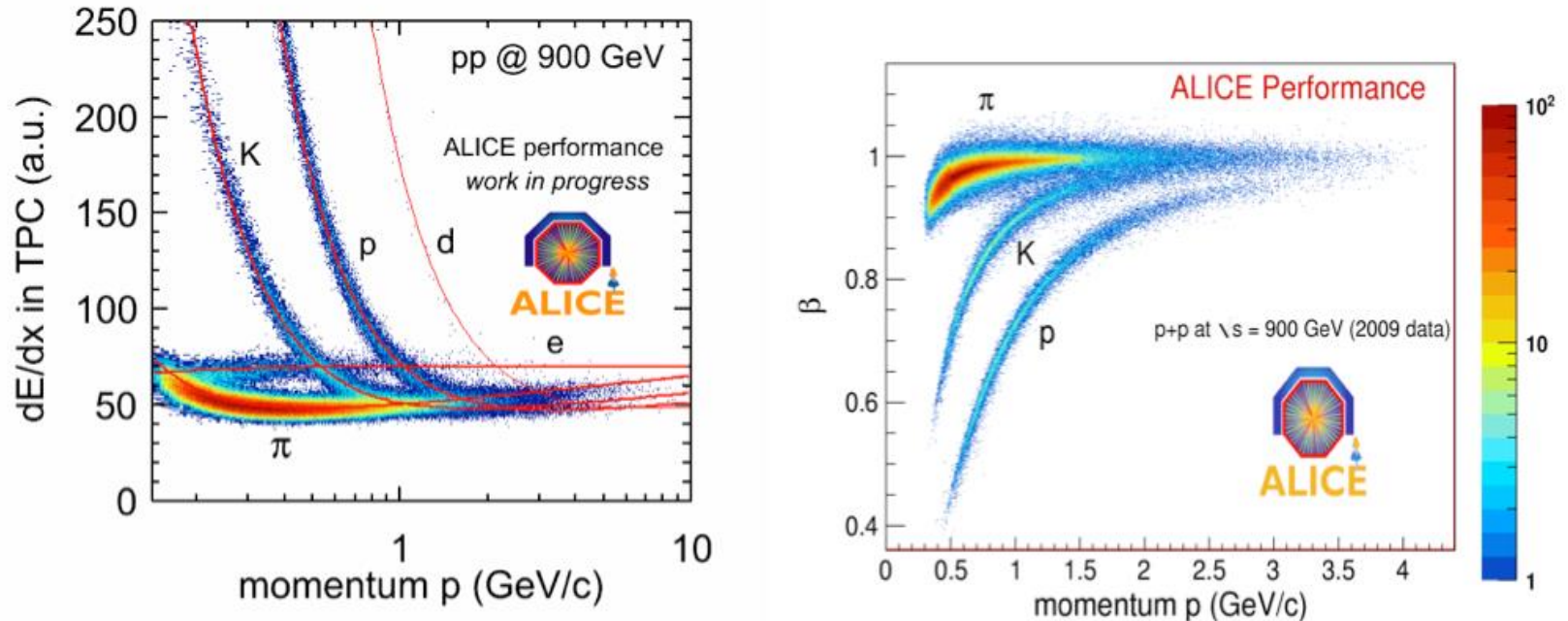
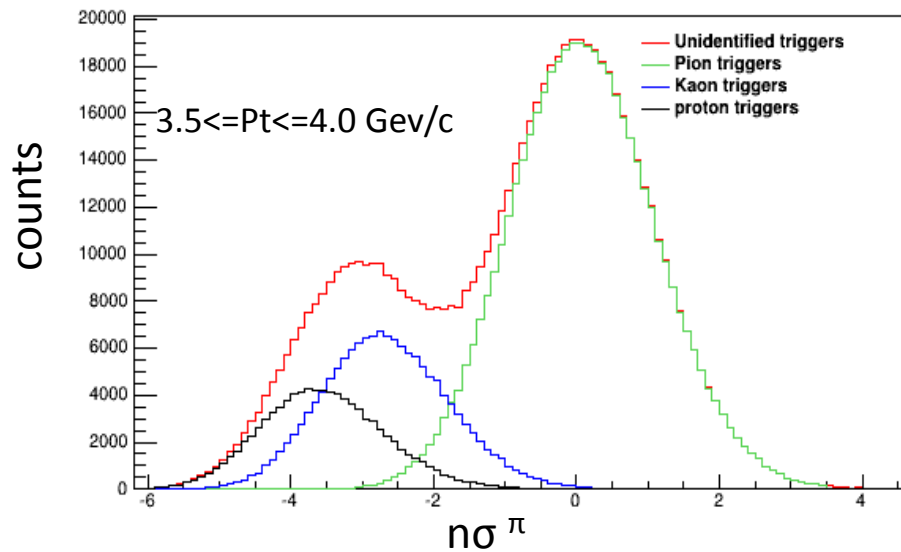
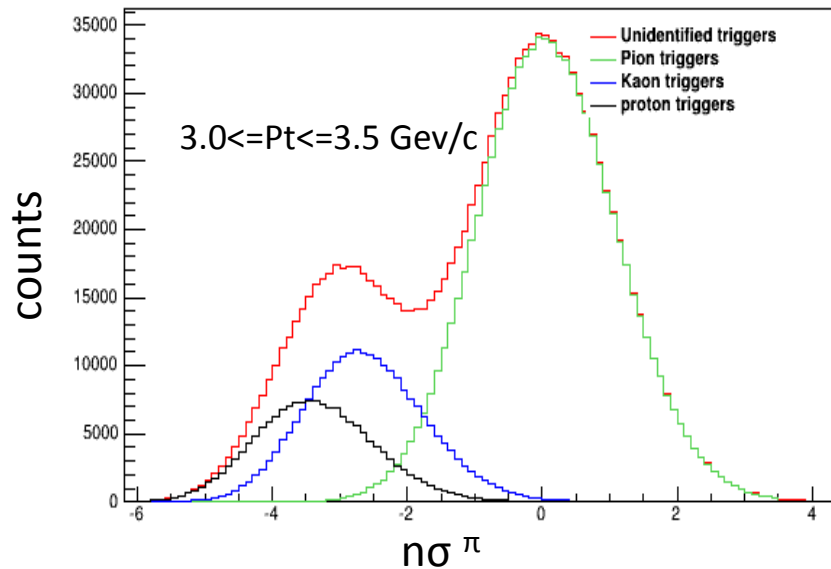
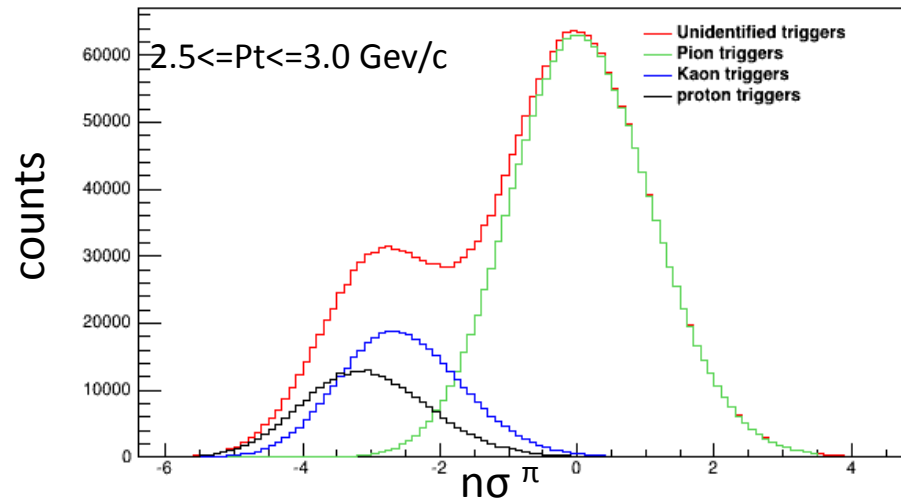
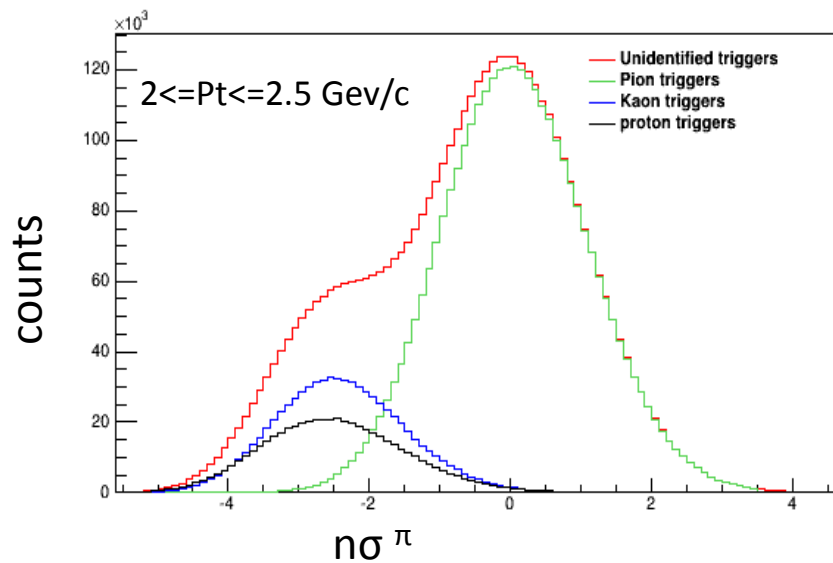


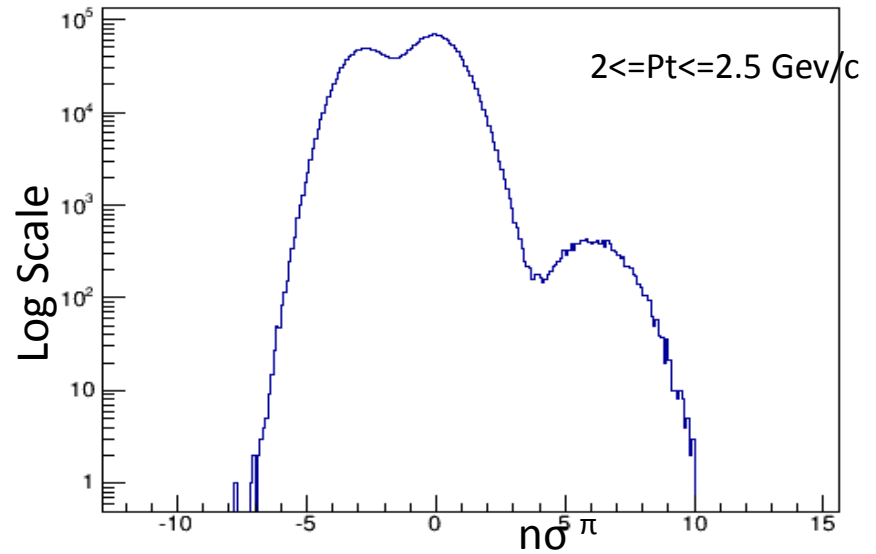
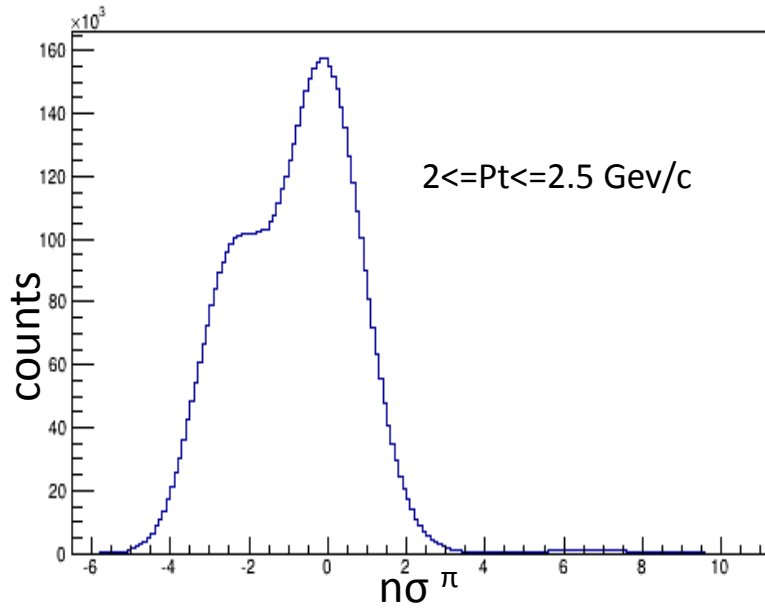
Figure 2: Left: Specific energy loss dE/dx in the TPC together with Bethe-Bloch curves for the different particle species (red curves). Right: Velocity $\beta = L/(ct)$, where L is the flight path of the track, versus particle momentum measured with the TPC.

- In this analysis both TPC & TOF are used for identification of trigger particles ($2.0 \leq p_t \leq 4.0$ GeV/c)

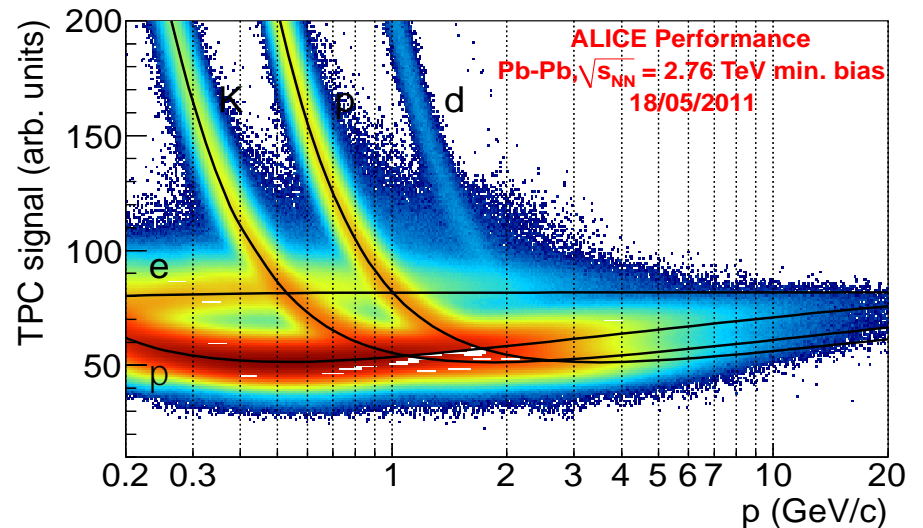
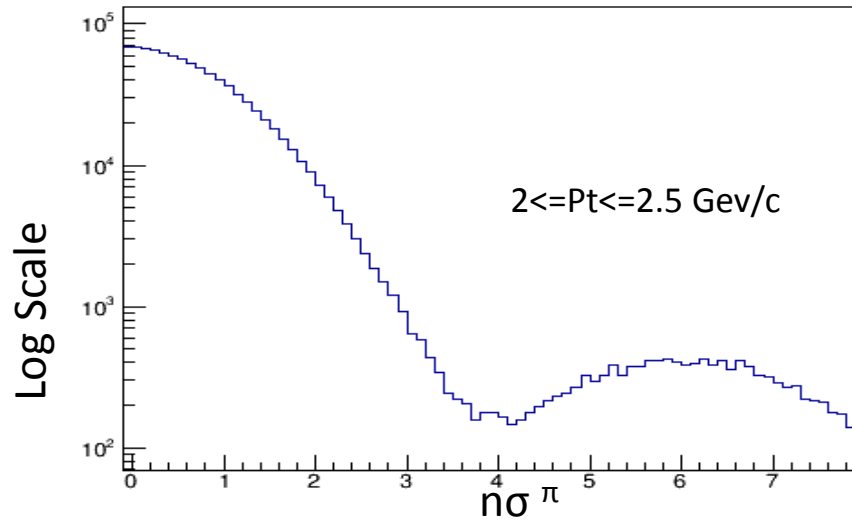
nSigma TPC MC



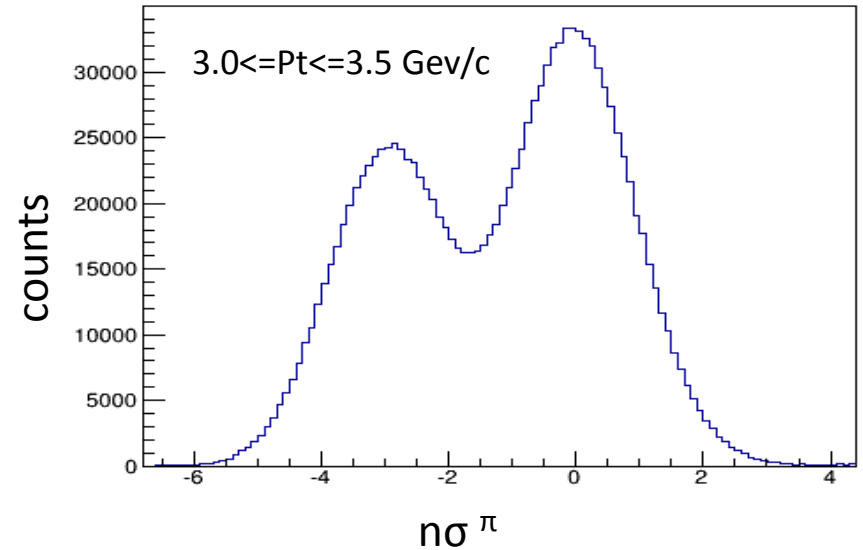
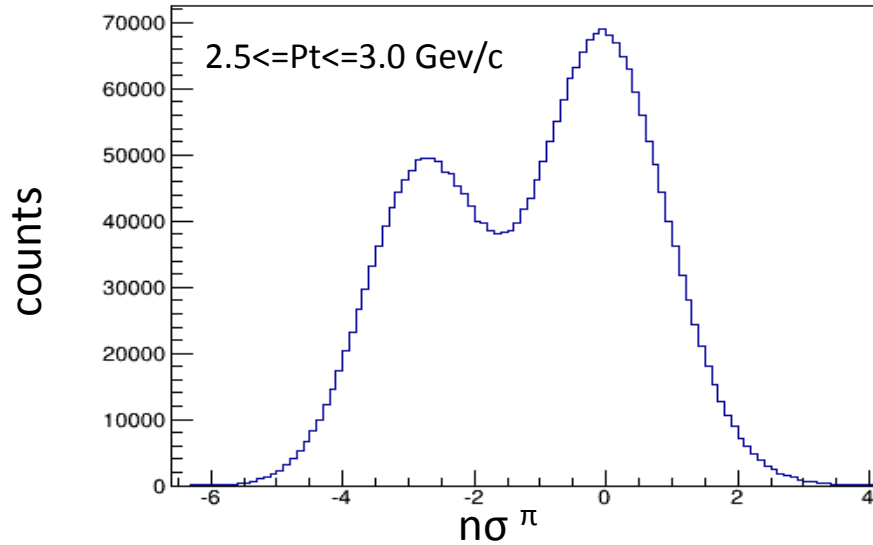
nSigma TPC DATA



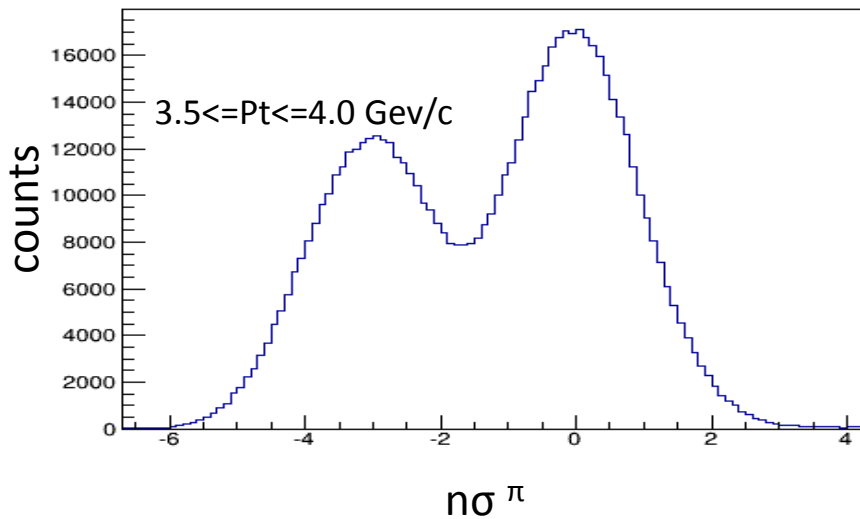
To avoid contribution from electrons neglect particles with $n\sigma^\pi \geq 3.5$



nSigma TPC DATA

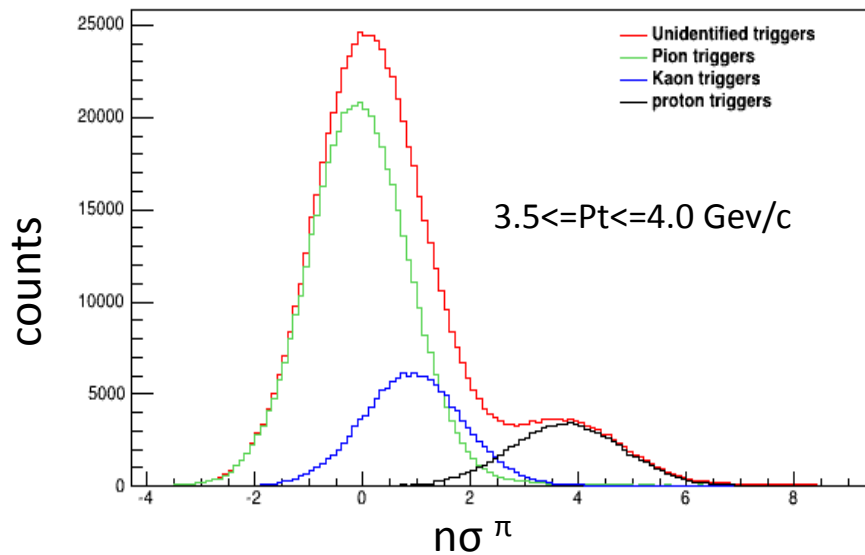
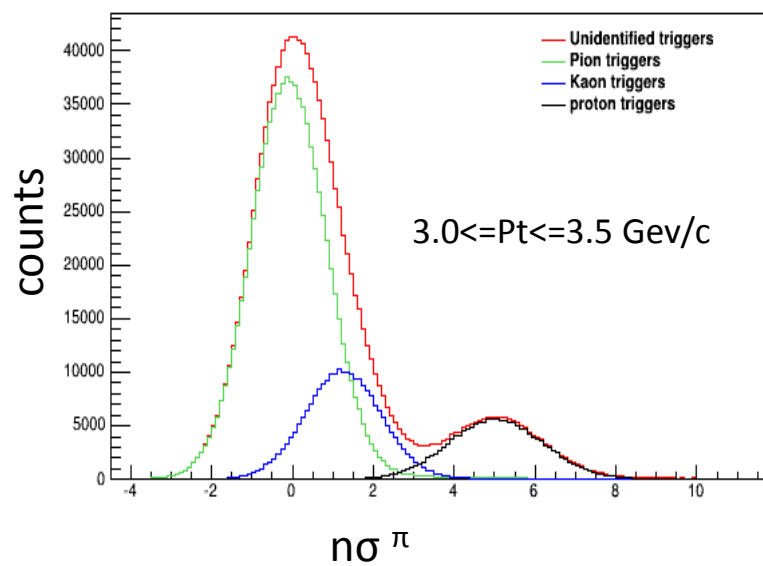
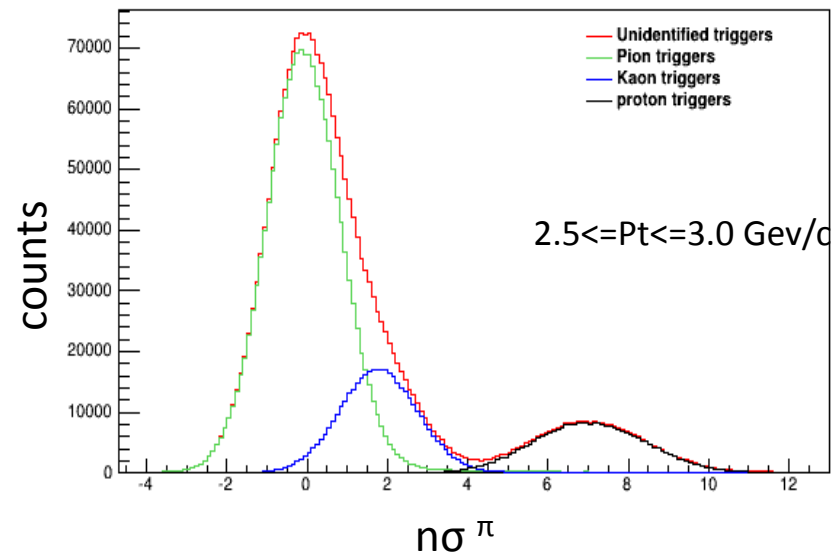
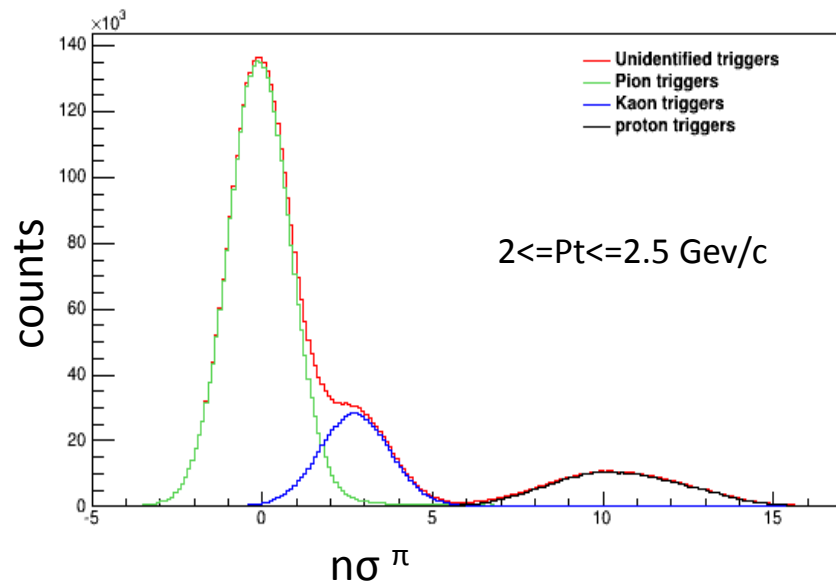


The $n\sigma^\pi$ distribution of the trigger tracks has to be fitted with the sum of three Gaussians.

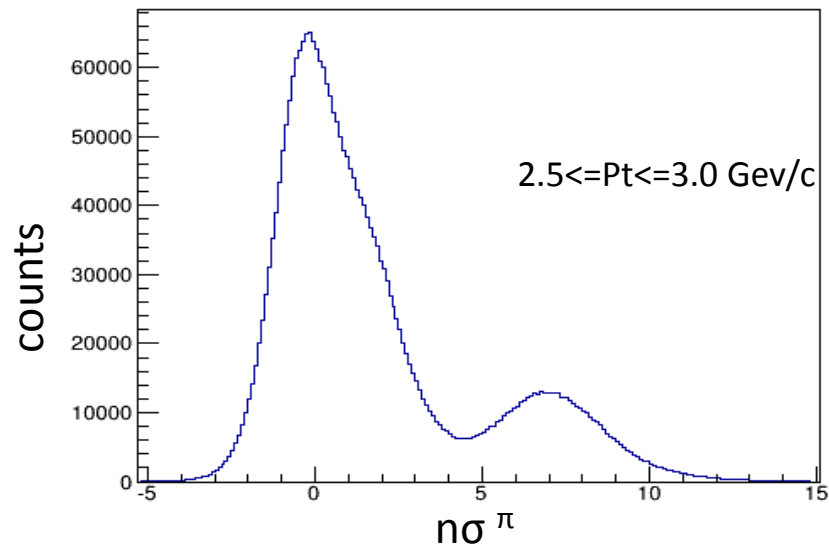
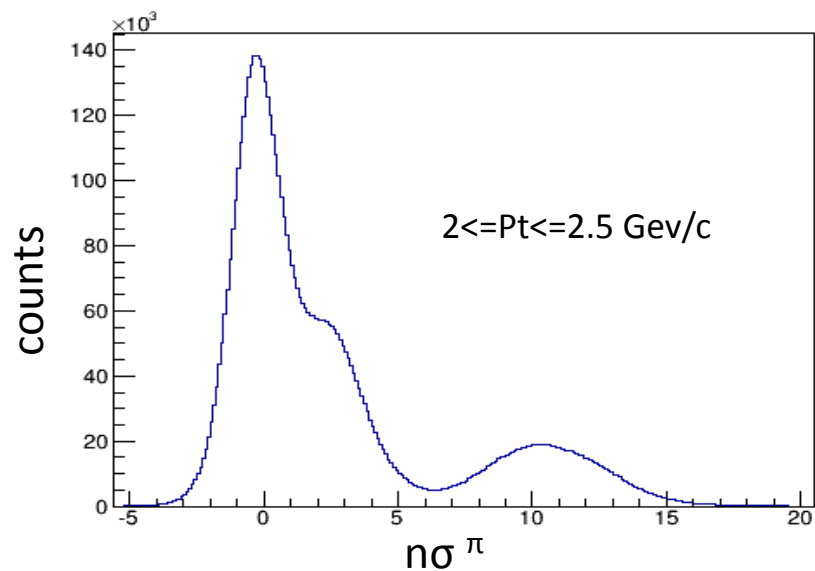


- Pions:
 $3.5 > TPC n\sigma^\pi > 0.0$. AND $0.0 > TOF n\sigma^\pi > -4.0$
- Pions+Kaons+Protons:
 $TPC n\sigma^\pi < 0.0$. AND $TOF n\sigma^\pi > 0.0$

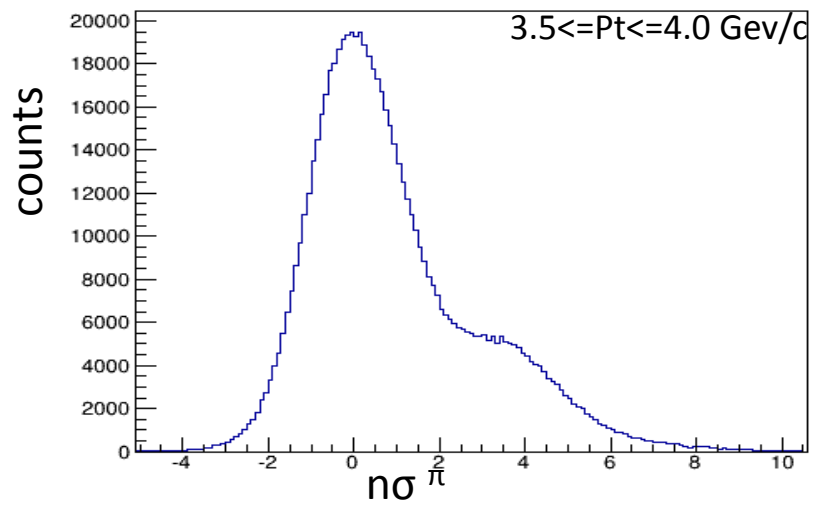
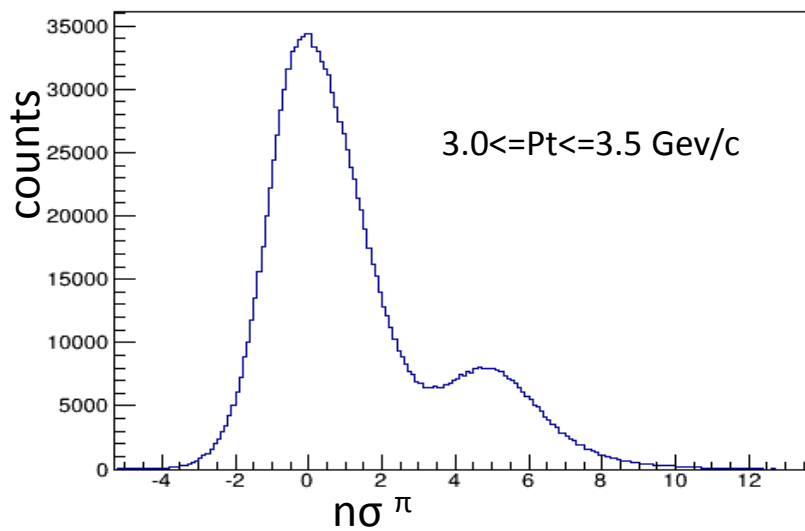
nSigma TOF MC



nSigma TOF DATA



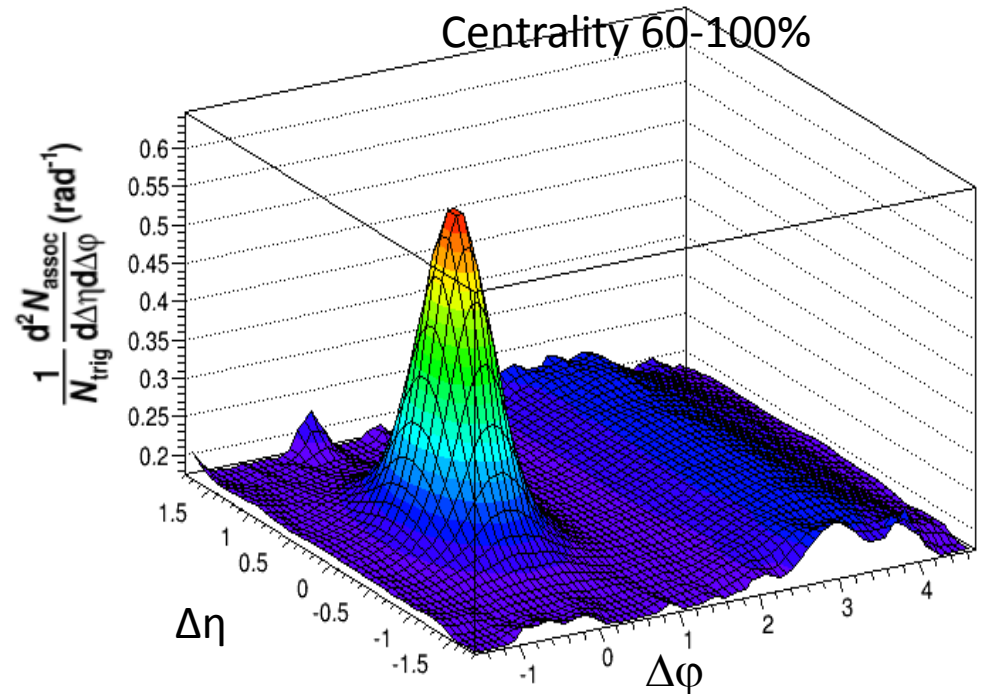
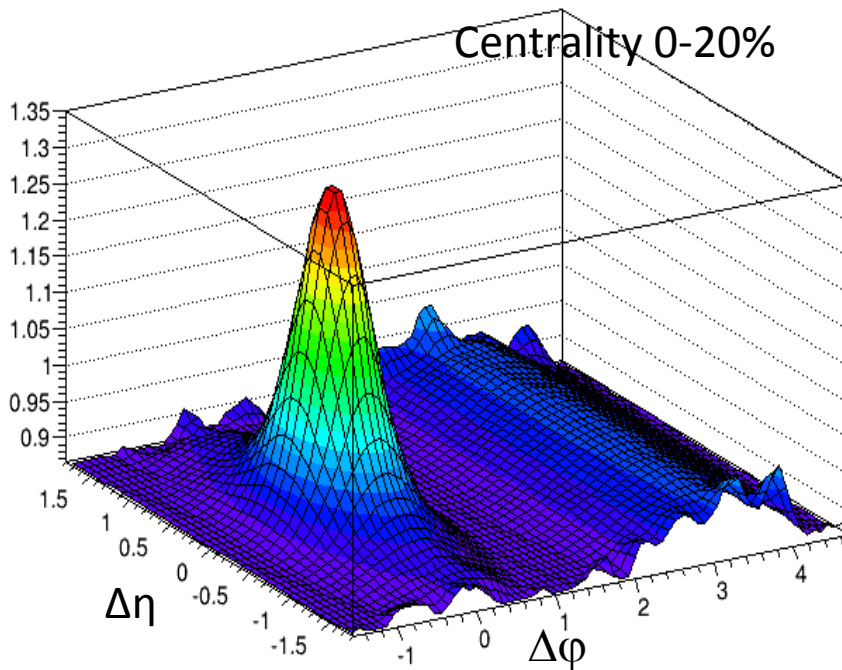
The $n\sigma^\pi$ distribution of the trigger tracks has to be fitted with the sum of three Gaussians.



Ratio of Signal to Mixed to get the Correlation function

Trigger $2 \leq p_t \leq 4$ GeV/c

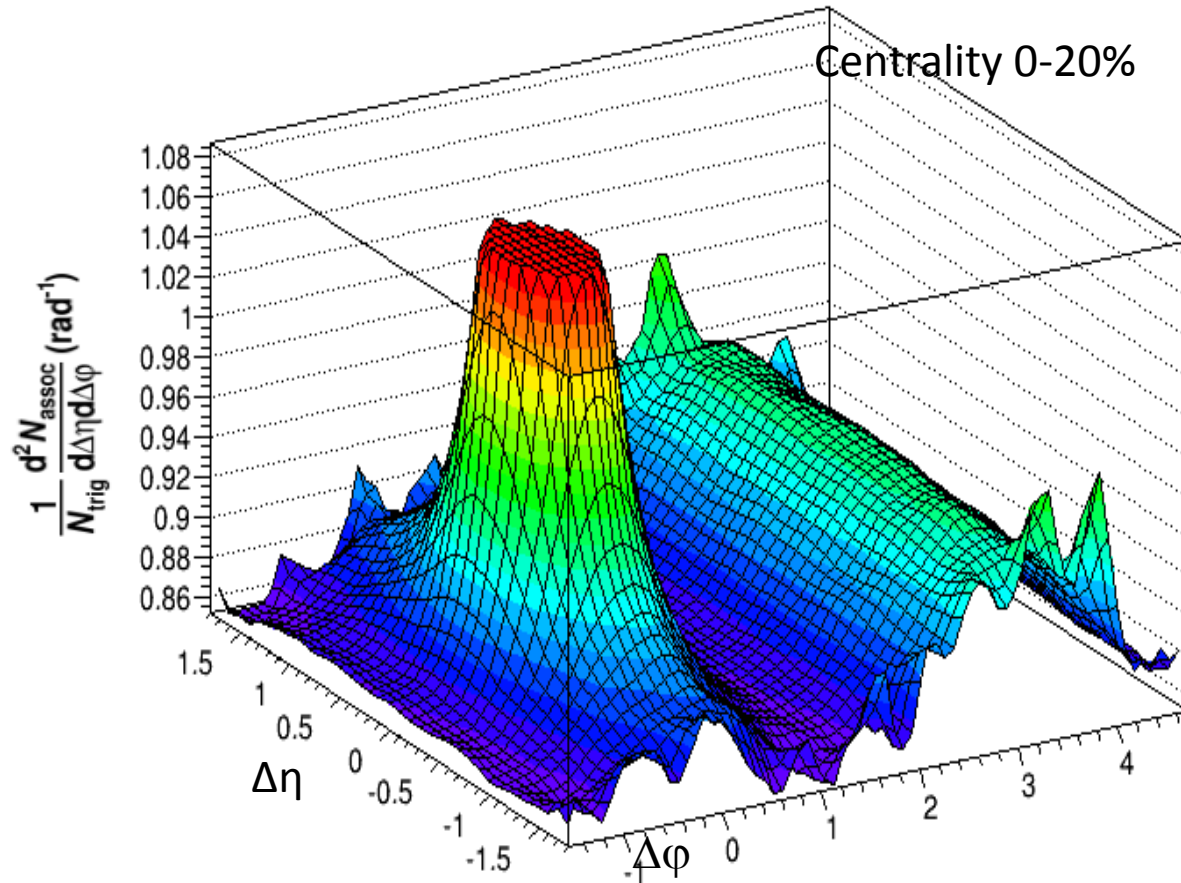
Associated $1 \leq p_t \leq 2$ GeV/c



➤ per trigger(**Unidentified**) 2D correlation plot

The near-side long-range ridge observed by CMS in pp and p-Pb can also be seen with ALICE [JHEP 09 (2010) 091, PLB718 (2013) 795]

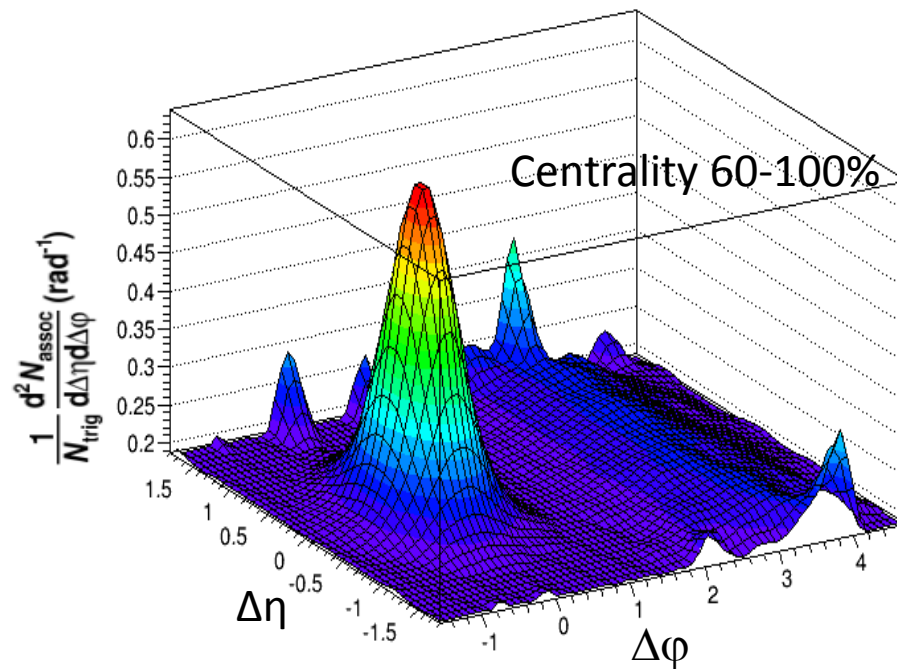
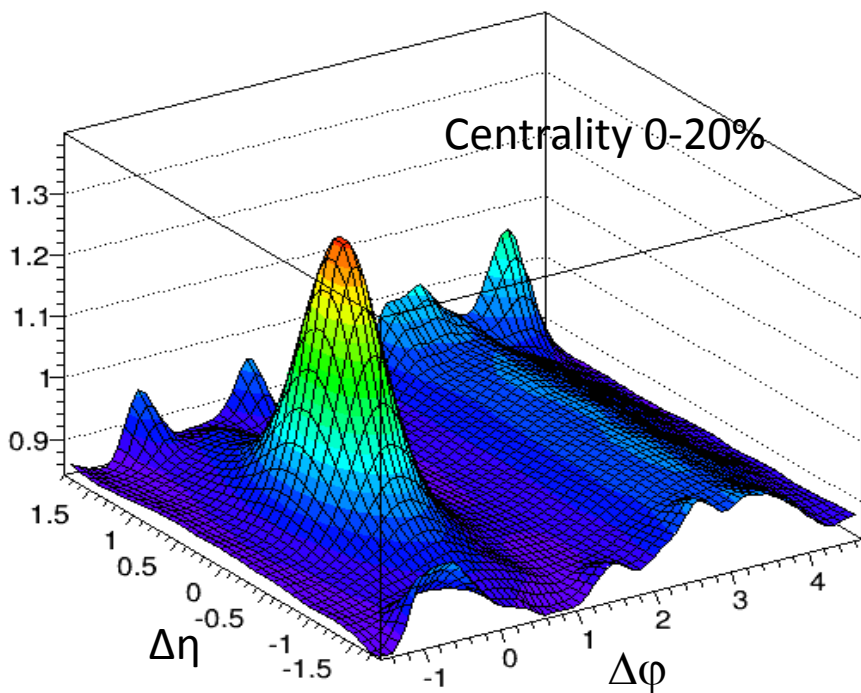
RIDGE



The near-side long-range ridge observed by CMS in pp and p-Pb can also be seen with ALICE [JHEP 09 (2010) 091, PLB718 (2013) 795]

Correlation Function For Identified Triggers

Trigger $2 \leq p_t \leq 4$ GeV/c
Associated $1 \leq p_t \leq 2$ GeV/c

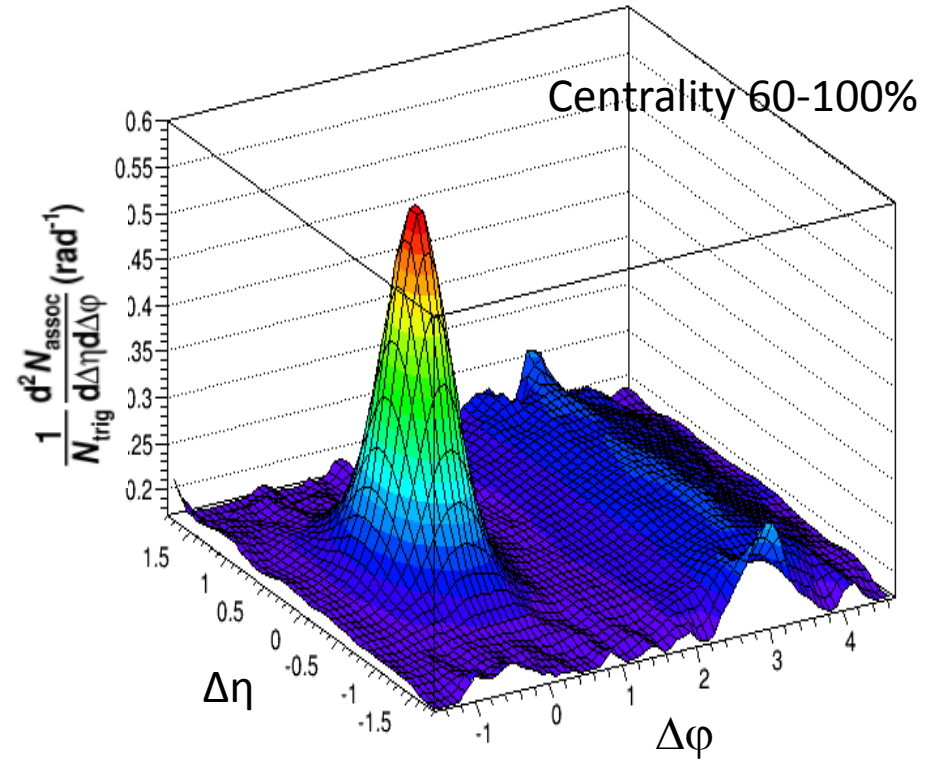
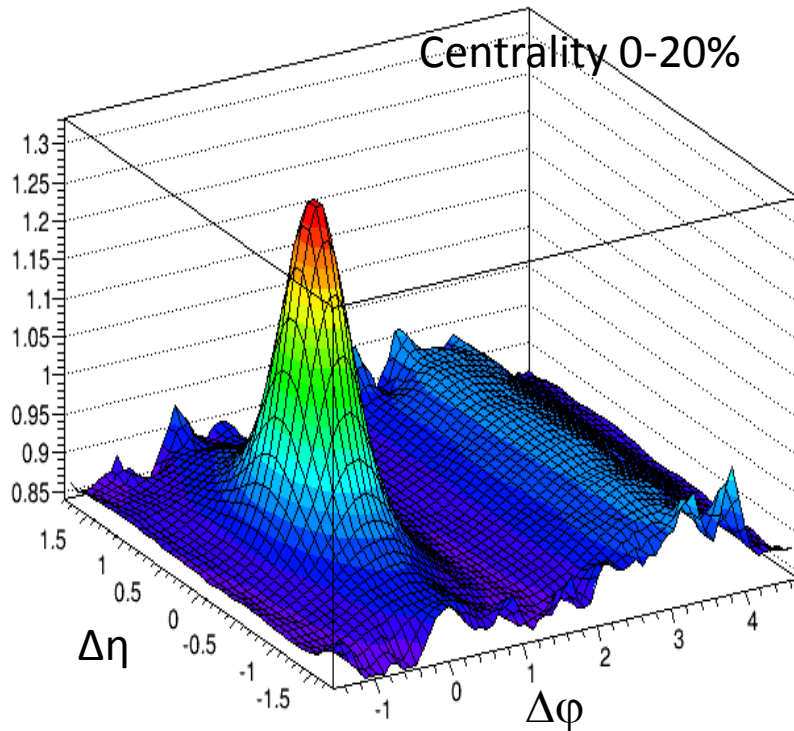


➤ Pion triggered (per trigger)
2D correlation plot

Is there any Identified trigger dependence
on the correlation(Jet + Ridge)?

Correlation Function For Identified Triggers

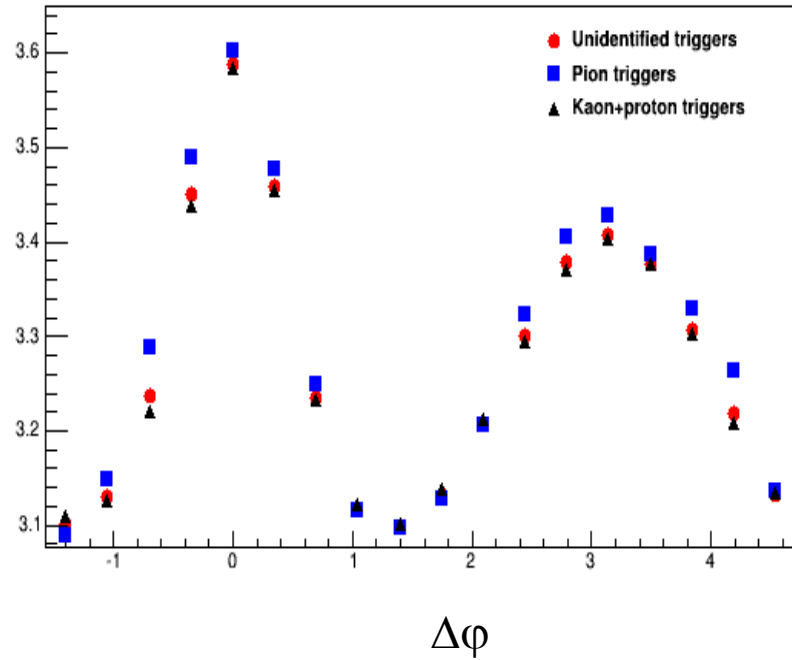
Trigger $2 \leq p_t \leq 4$ GeV/c
Associated $1 \leq p_t \leq 2$ GeV/c



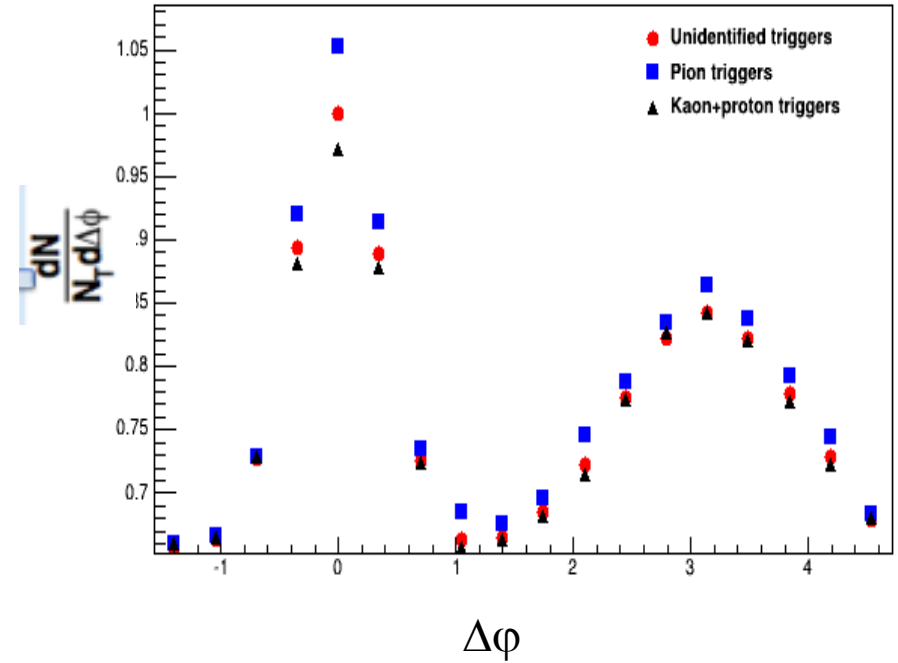
➤ Proton+Kaon triggered (per trigger)
2D correlation plot

Projections to $\Delta\phi$

0-20% centrality



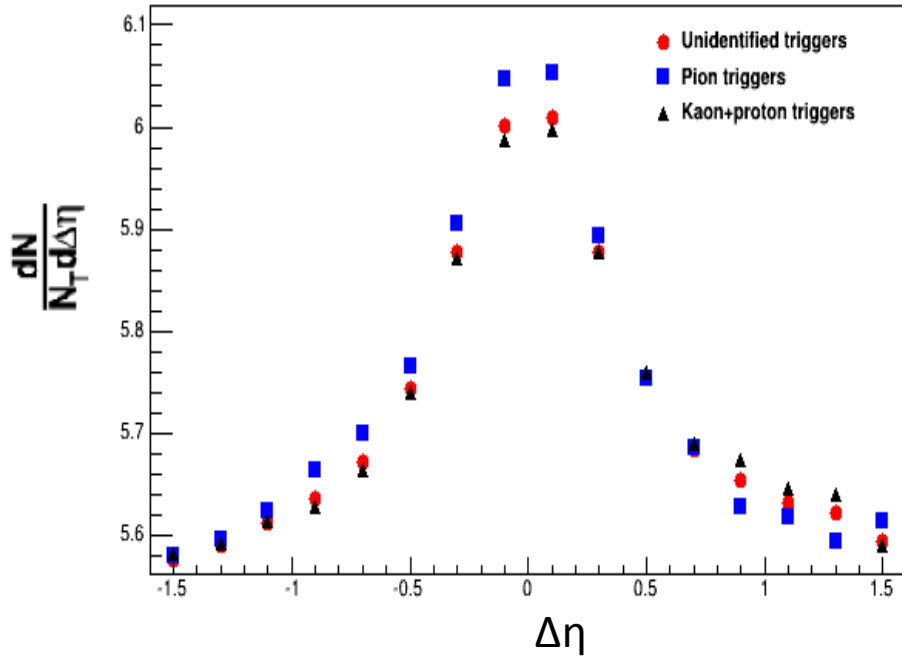
60-100% centrality



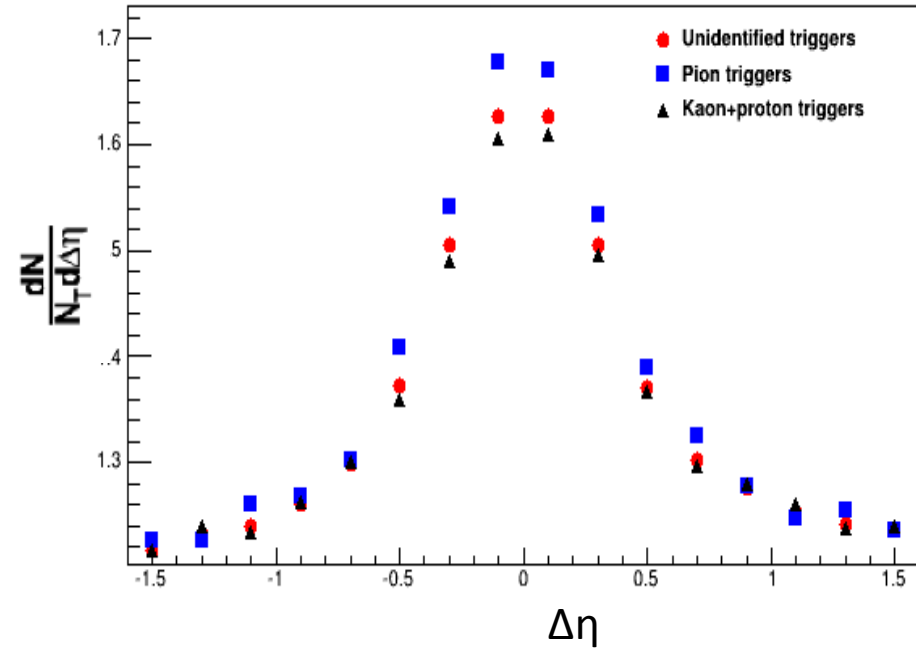
➤ Raw Correlation projected onto $\Delta\phi$ averaged over $|\Delta\eta| < 1.8$ on the near side & away side

Projections to $\Delta\eta$

0-20% centrality



60-100% centrality

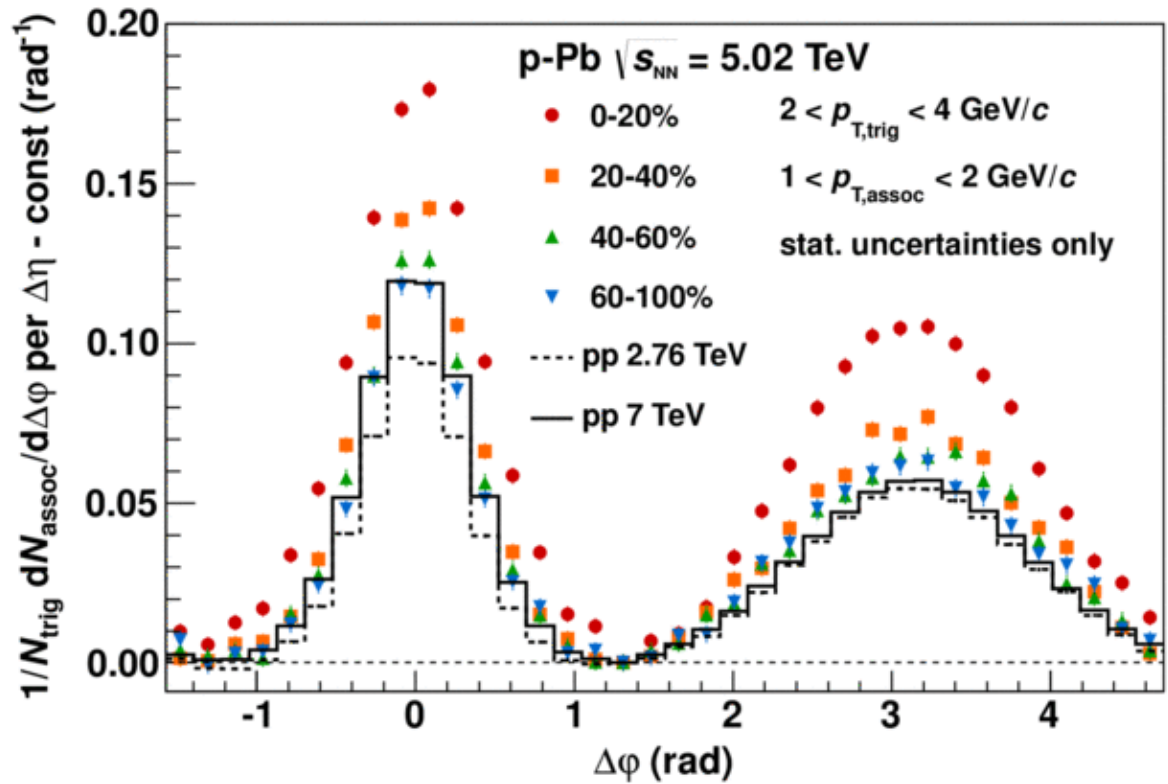


Raw Correlation projected onto $-1.8 \leq \Delta\eta \leq 1.8$ for 0-20% & 60-100% centrality events

- Can we separate the jet and ridge components?
 - No ridge seen in 60-100% and similar to pp
 - what remains if we subtract 60-100%?

● arXiv:1212.2001v1

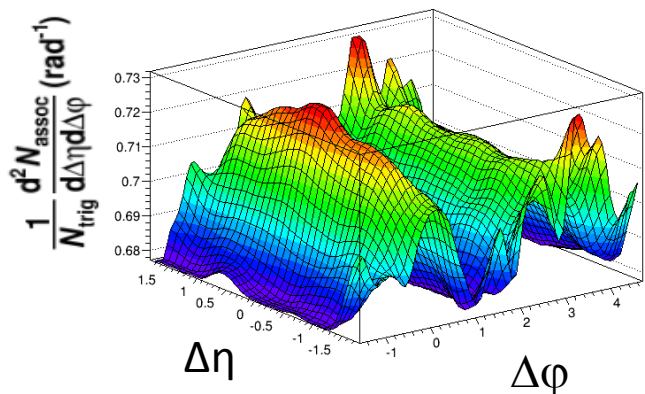
Shifted to same baseline by subtracting the value at $\Delta\phi = 1.3$



➤ Low multiplicity class agrees with results from pp collisions

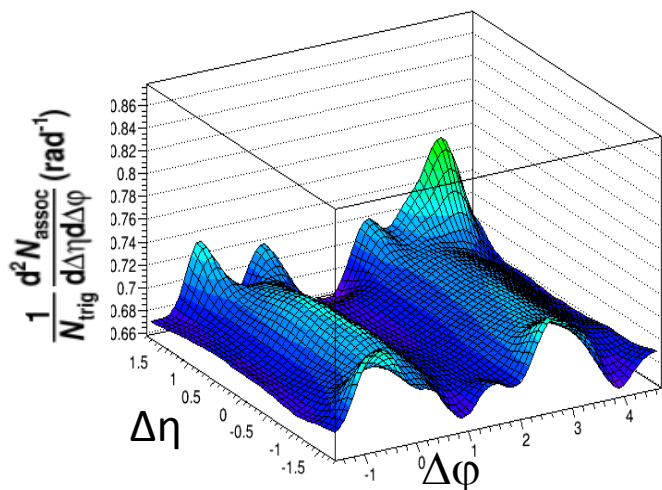
Ridge

- ◆ Associated yield per trigger particle for the 0–20% centrality class, after subtraction of the associated yield obtained in the 60–100% centrality class.

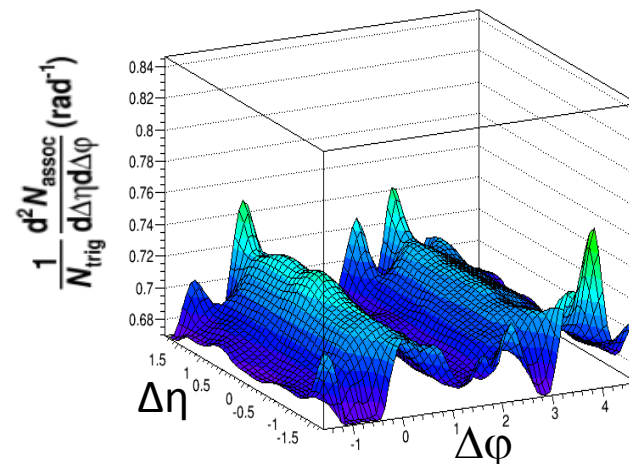


- Associated yield per trigger particle (unidentified) in $\Delta\phi$ and $\Delta\eta$

(0-20%)-(60-100%)



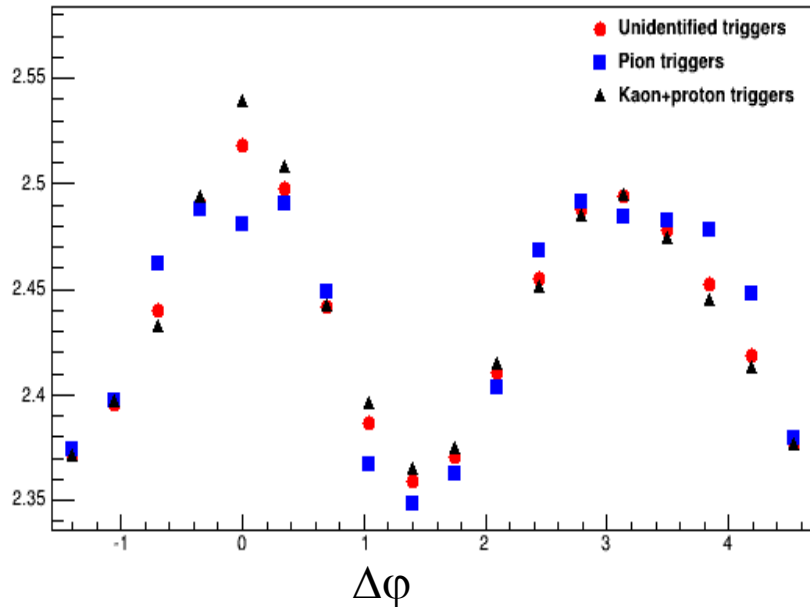
- Associated yield per trigger particle (PION) in $\Delta\phi$ and $\Delta\eta$



- Associated yield per trigger particle (Proton+Kaon) in $\Delta\phi$ and $\Delta\eta$

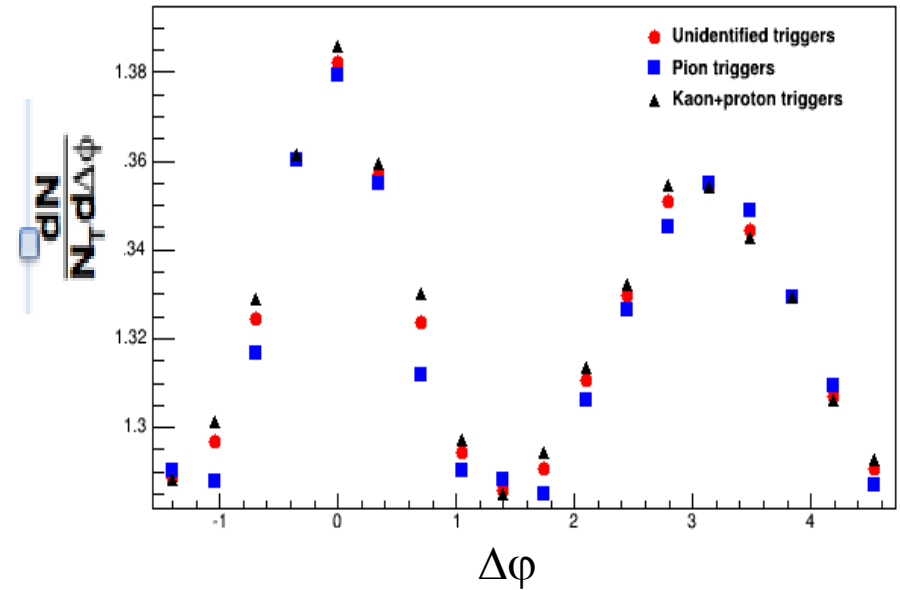
Projections to $\Delta\phi$

(0-20%)-(60-100%)



✧ Raw Correlation projected onto $\Delta\phi$ averaged over $|\Delta\eta| < 1.8$ cm on the near side & away side

(0-20%)-(60-100%)



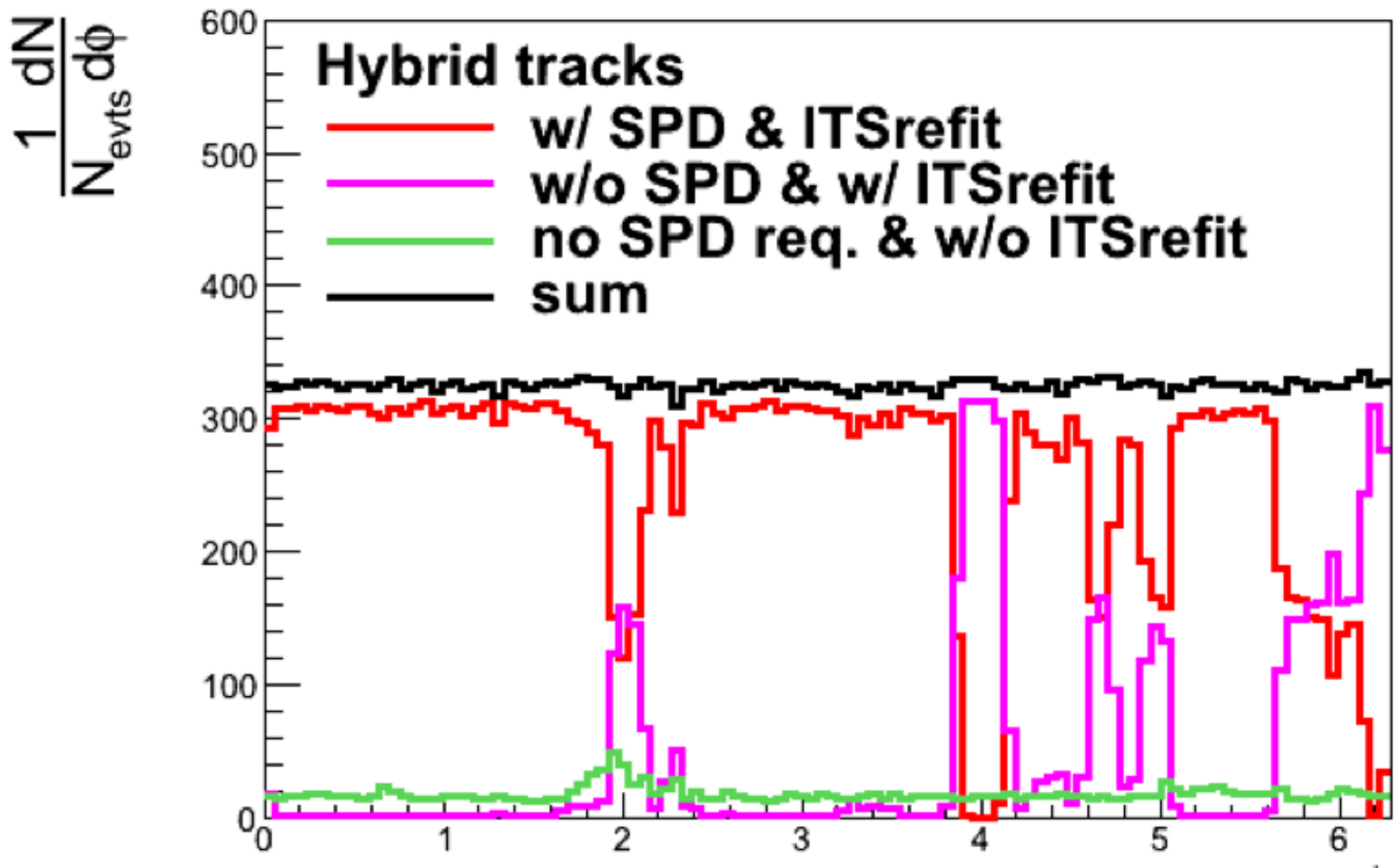
✧ Raw Correlation projected onto $\Delta\phi$ averaged over $|\Delta\eta| < 0.9$ cm on the near side & away side

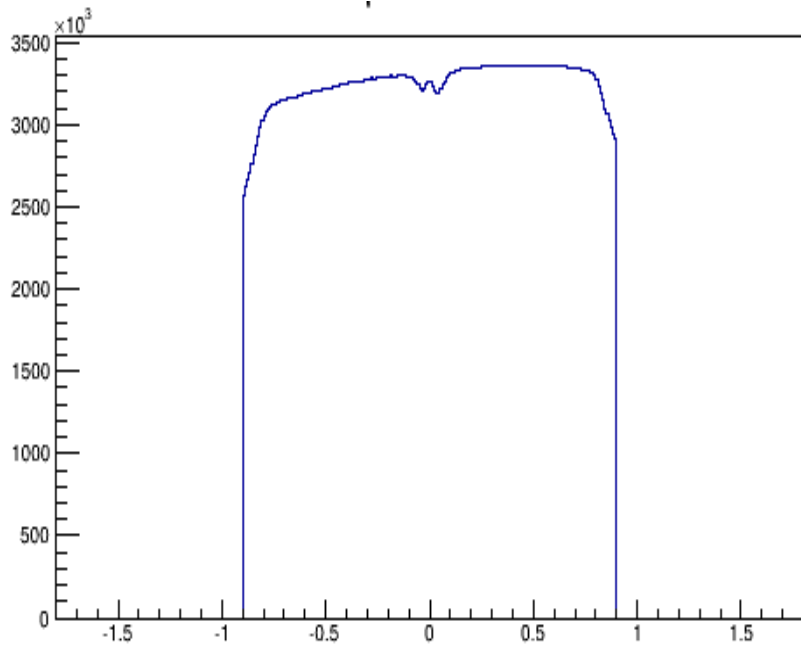
- TODO:
- We observe small difference in pion and proton+kaon triggered yield in different $\Delta\eta$ and $\Delta\phi$ regions . It need to be checked rigorously.
- Need to check purity of the trigger sample and also to repeat the study with separation of proton & kaon triggers.
- Need to repeat this analysis with identified associated to know the chemistry in jet & ridge regions.
- Do the same for pp & and PbPb2.76 TeV

Thank You

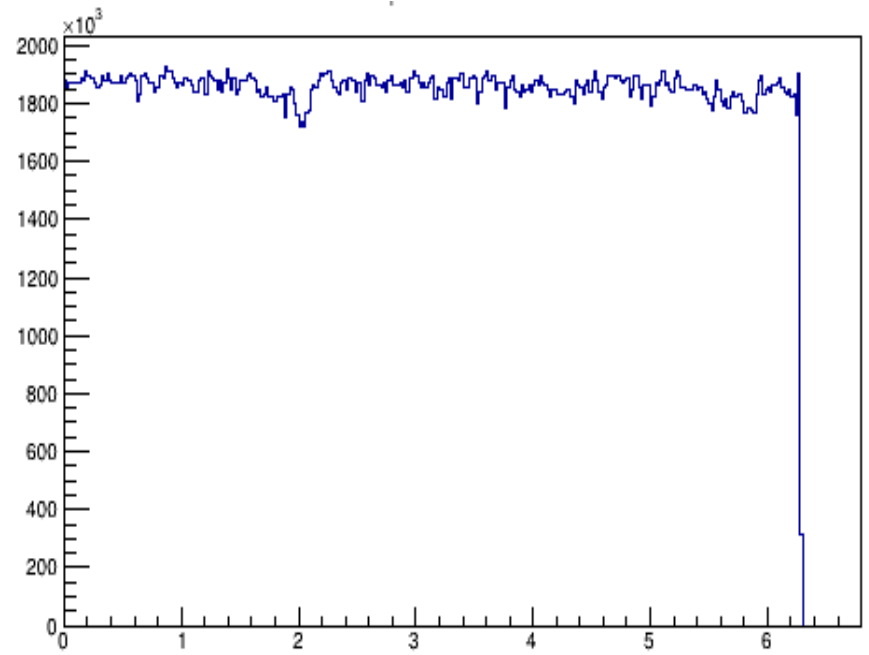
BACKUP

Since some parts of the SPD were switched off during many run periods, inefficient regions for common track reconstruction are apparent. To **ensure uniform distributions** in the (η, ϕ) plane, an approach of hybrid tracks of following types is used:



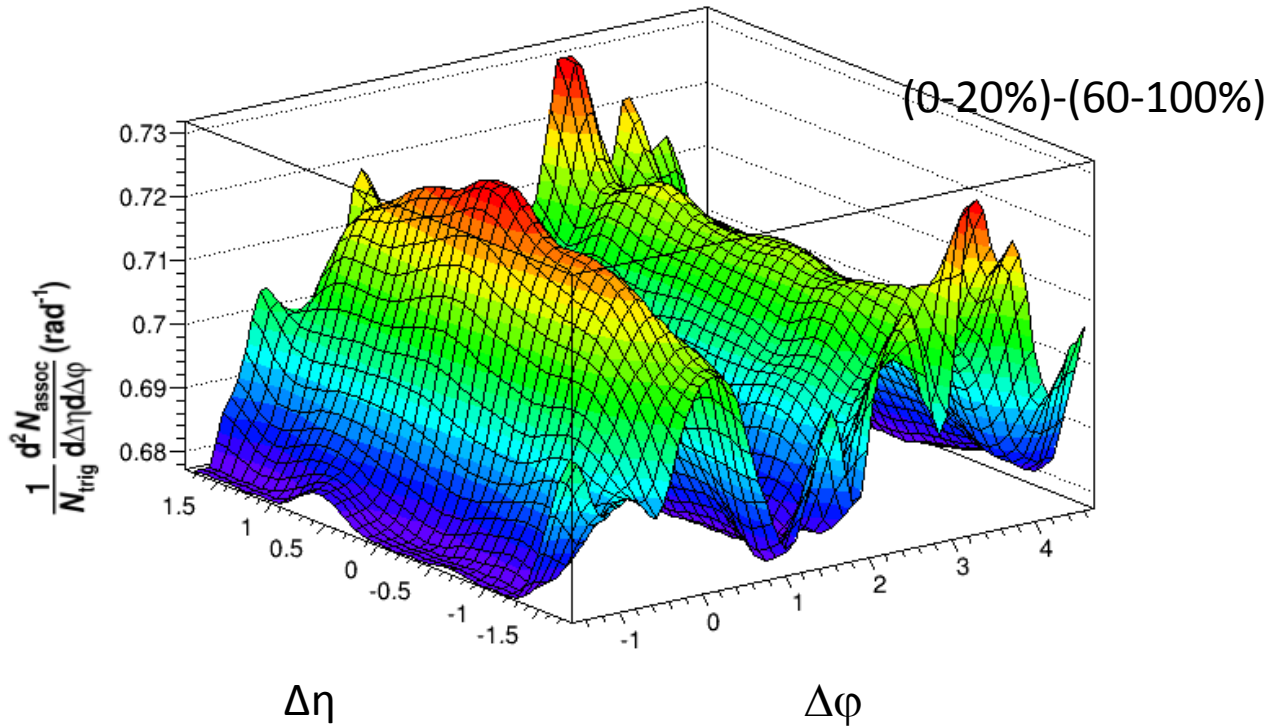


Eta distribution



Phi distribution

Ridge



Associated yield per trigger particle (**unidentified**) in $\Delta\phi$ and $\Delta\eta$ for pairs of charged particles with $2 < p_{T,\text{trig}} < 4$ GeV/c and $1 < p_{T,\text{assoc}} < 2$ GeV/c in p–Pb collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV for the 0–20% multiplicity class, after subtraction of the associated yield obtained in the 60–100% event class.

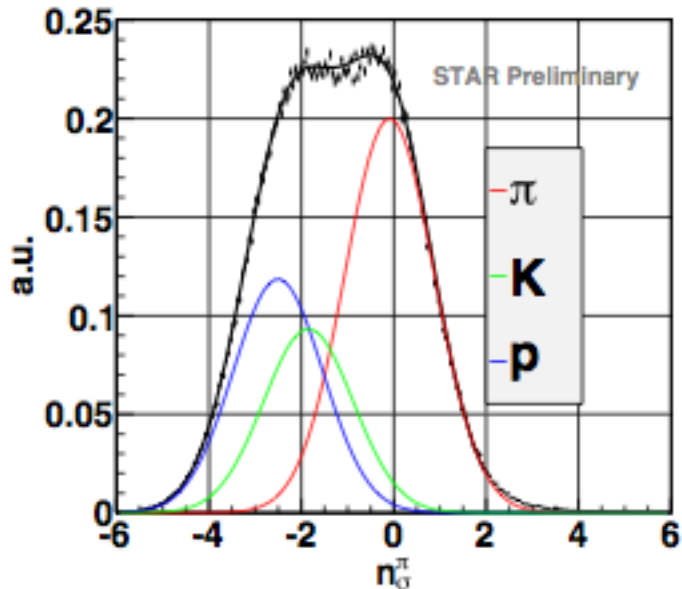
Particle Identification

Triggers are identified as Pions or (protons+Kaons) track by track depending on $n\sigma$ cuts on TPC and TOFs:

$3.5 > \text{TPC}n\sigma^\pi > 0.0$. AND $0.0 > \text{TOF}n\sigma^\pi > -4.0$

Kaons+Protons:

$\text{TPC}n\sigma^\pi < 0.0$. AND $\text{TOF}n\sigma^\pi > 0.0$

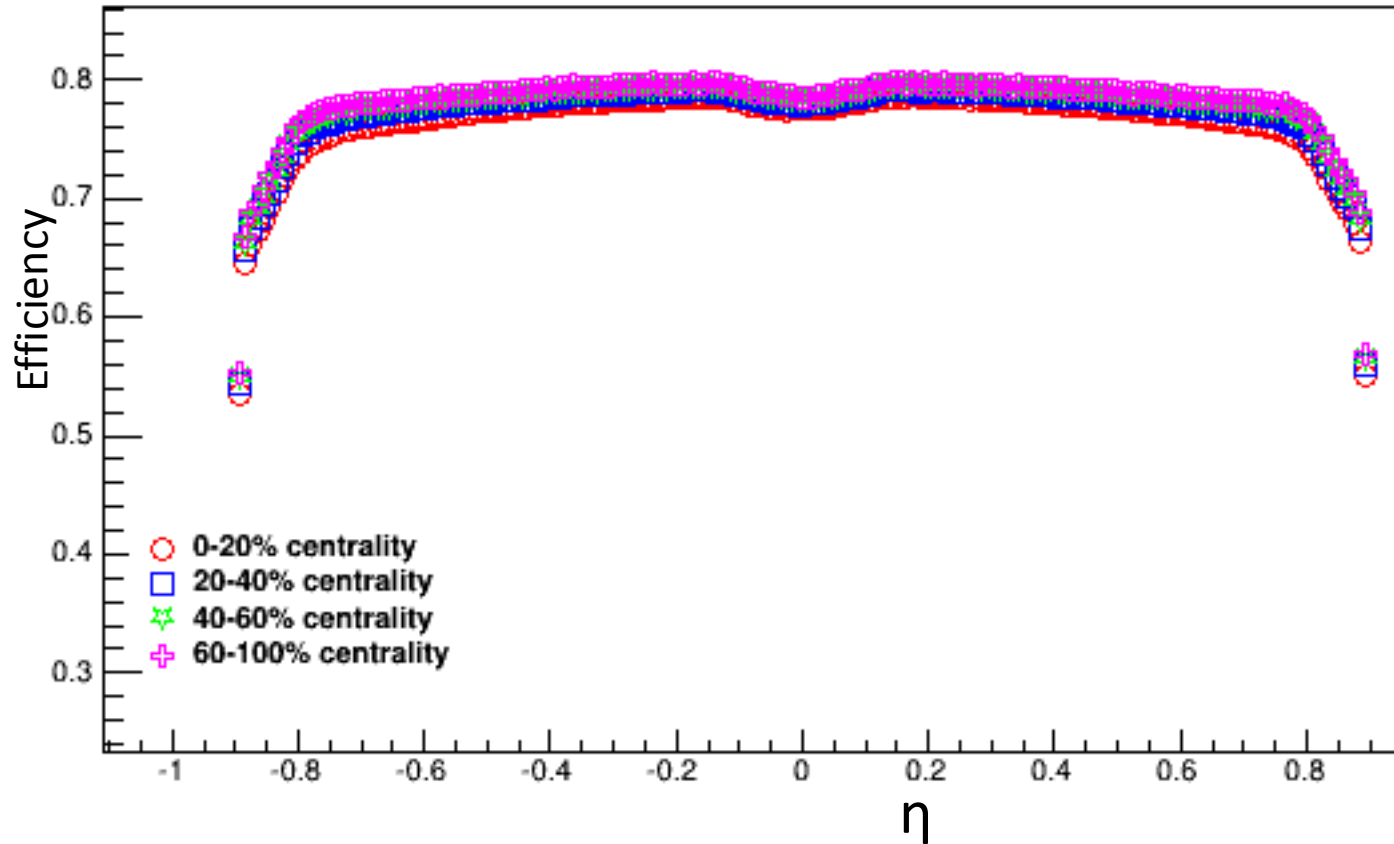


Baryon/Meson enhancement has been observed in central collisions compared to peripheral.

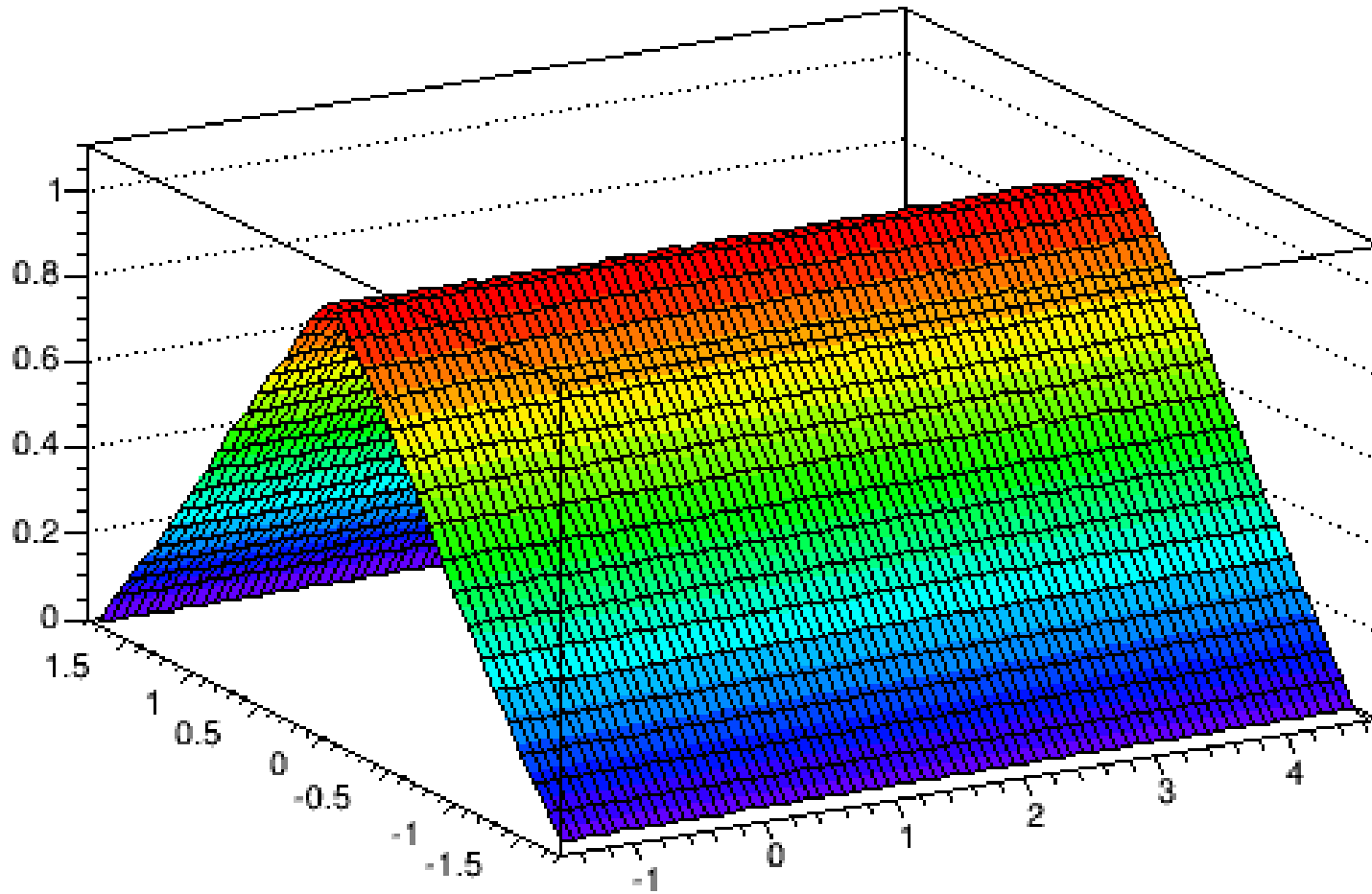
a.u. Recombination Model predicts at intermediate PT there will be more baryons oppose to mesons.

TRACKING EFFICIENCY CORRECTION

Efficiency with Eta



→ Normalized such that it is unity around $(\Delta\eta, \Delta\phi) = (0, 0)$



Mixed event normalized to unity