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Bose Institute, Kolkata

“ALICE-STAR-India Collaboration Meeting”

Study of Two Particle Azimuthal Correlation in pp and pPb Collisions at 5.02 TeV in ALICE

Mintu Haldar (JRF, Bose Institute)

Collaborators: Sanchari Thakur, Sidharth Kumar Prasad

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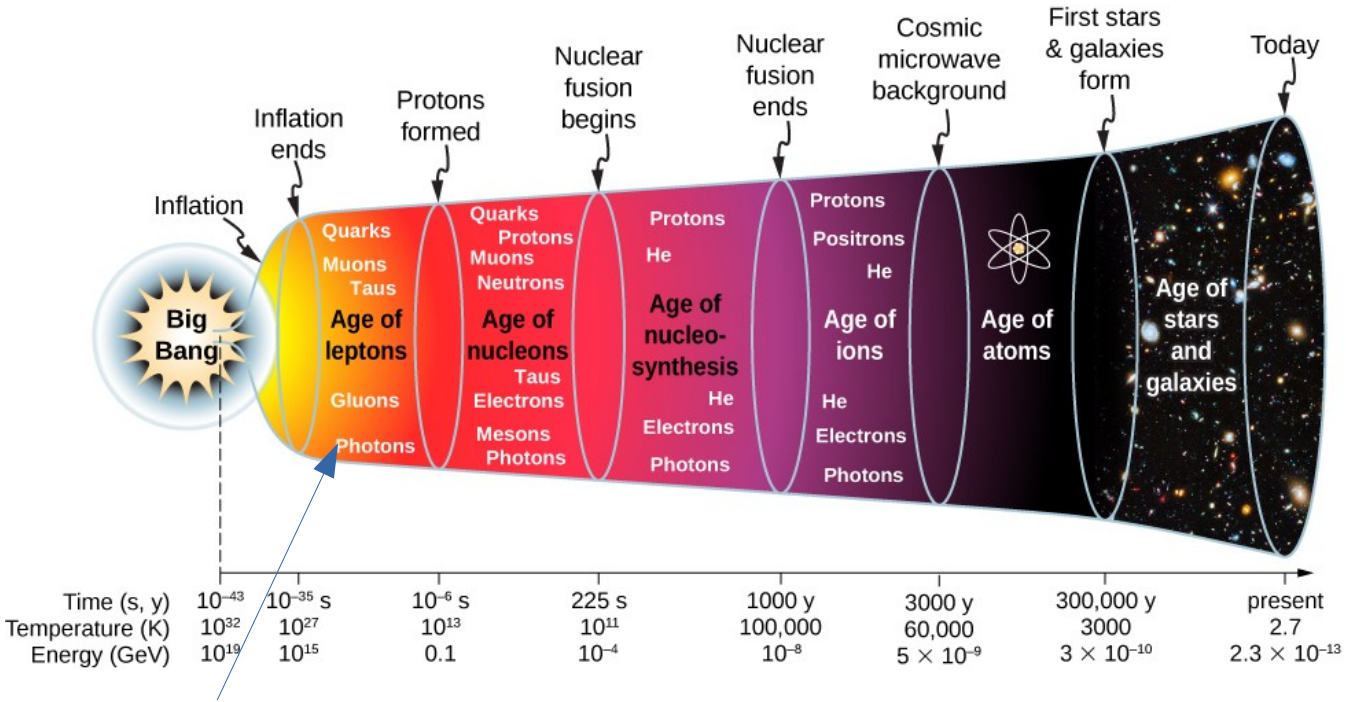
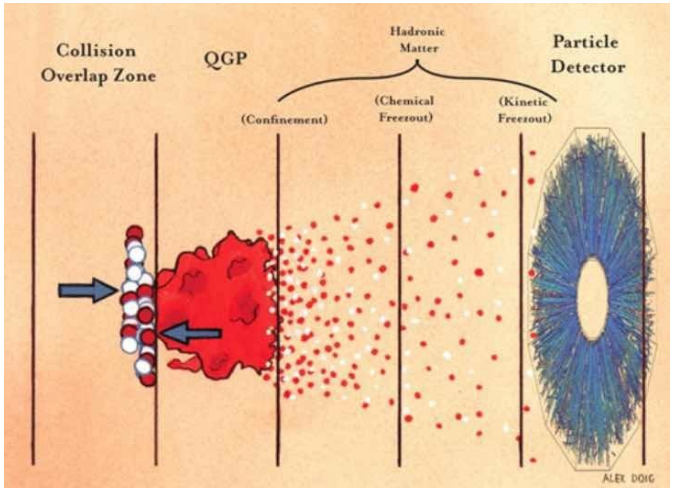
Outline

- Introduction
- Motivation
- Analysis Details
- Some Preliminary Results
- Future Plan
- Summary

Introduction



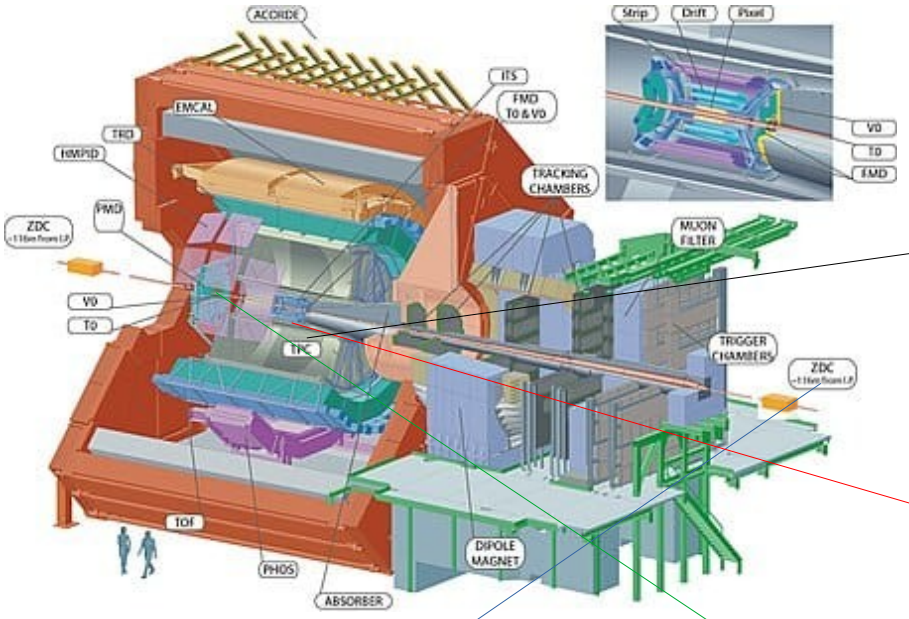


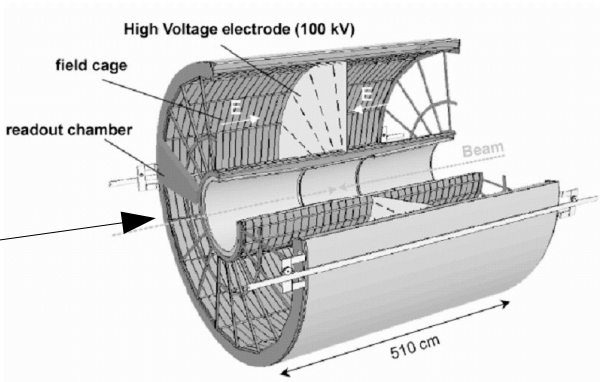
Quark Gluon Plasma (QGP):

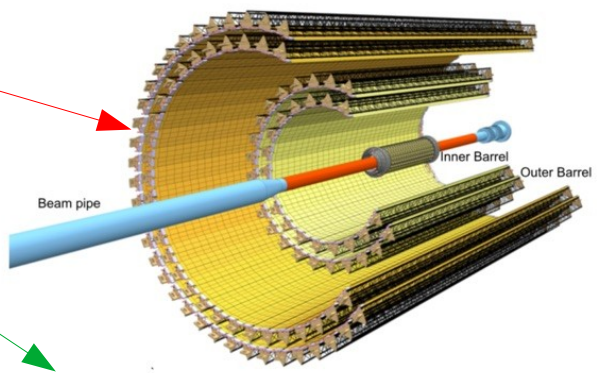
1. Deconfined state of quarks and gluons

2. Thermally equillibrated state of matter

A Large Ion Collider Experiment (ALICE)







- **Time Projection Chamber (TPC):**

It is a gas detector and used for particle identification and tracking through momentum and energy loss measurement

- **Inner Tracking System (ITS):**

ITS is silicon detector and used for-
1. Primary vertex reconstruction
2. Particle identification
3.Tracking and standalone reconstruction of low p_T particles

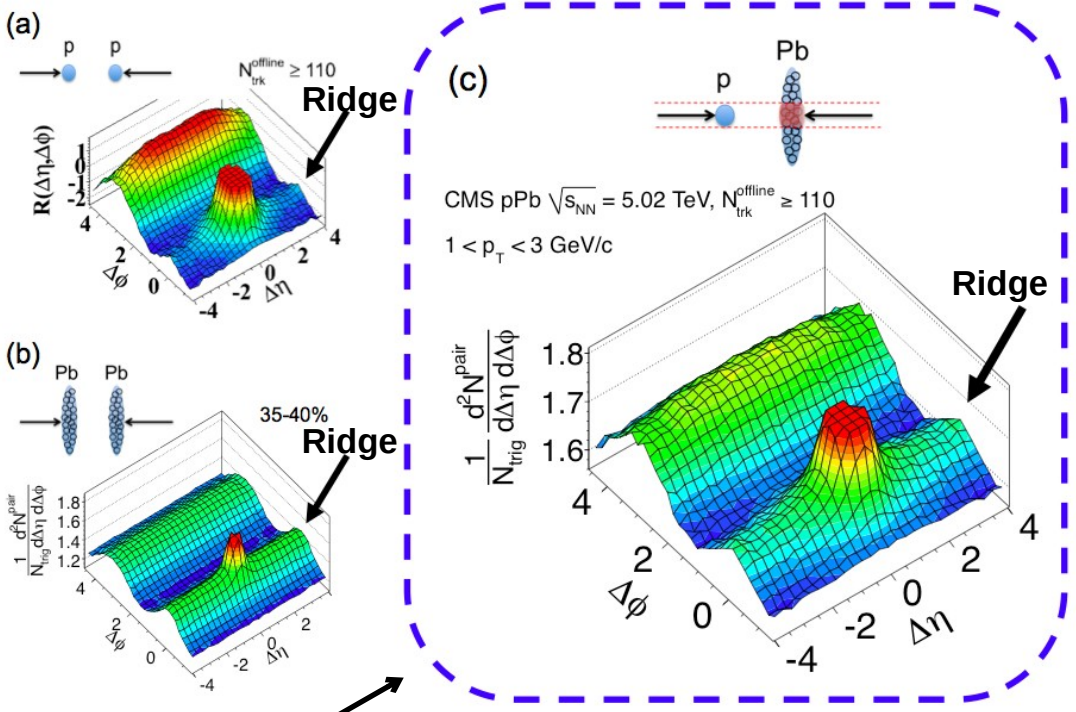
- **Zero Degree Calorimeter (ZDC):**

It is a Calorimeter and it is used for centrality estimation through deposited energy of spectators

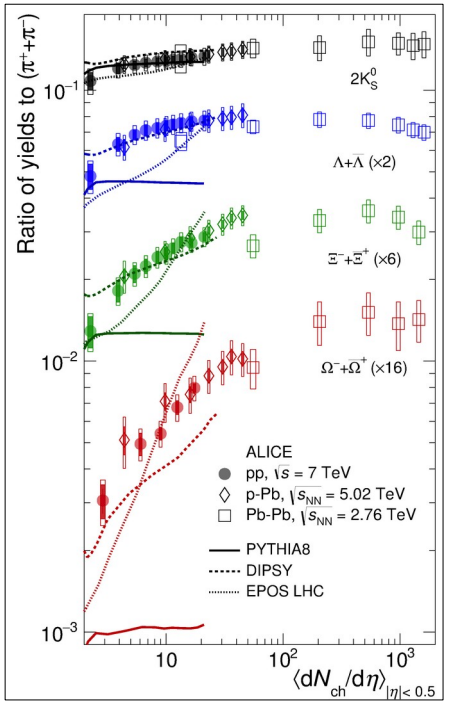
- **Vertex Zero (V0):**

It is a scintilator detector used for centrality estimation using produced particles

Motivation



QGP like behaviour in pPb



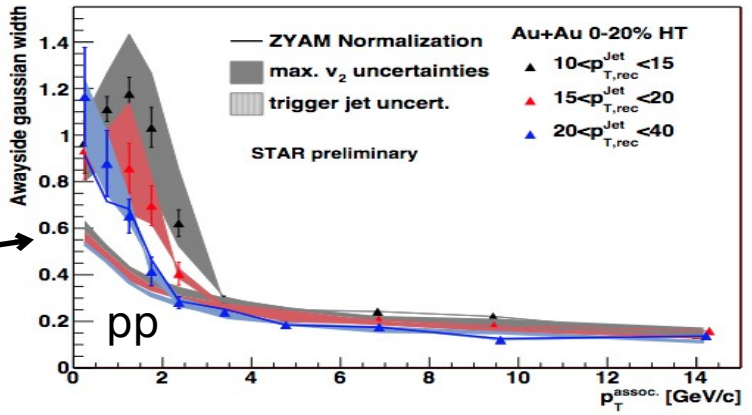
pPb (High Multiplicity) unexpectedly shows ridge like structure and strangeness enhancement similar to Pb-Pb in Run-1 and Run-2 LHC

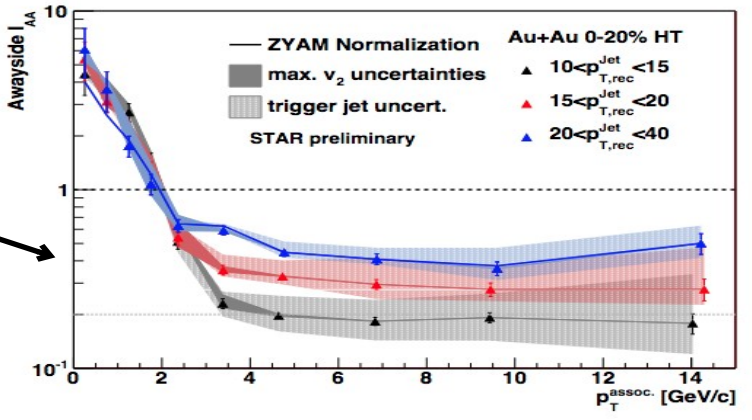
My main motivation is to investigate the mechanism of QGP like behaviour through hadron-hadron correlation in pp and pPb collisions

A. M. Sirunyan et al. (CMS Collaboration) https://doi.org/10.1103/PhysRevC.96.064902

J. Adam et al. [ALICE], Nature Phys. 13 (2017), 535-539 doi:10.1038/nphys4111 [arXiv:1606.07424 [nucl-ex]]

- We know, in heavy-ion collisions, partons lose energy in the medium
- What should we see in angular correlation studies? **Softer and broader distribution of hadrons around the jet axis than seen in pp**
- The widths of the heavy-ion jet appear broader
- Effect is more in awayside as the recoiled parton travels through a significant amount of the medium
- Significant softening of the awayside jets has been observed in heavy-ion





We are probing the modification of jet-like yields and widths in pp and pPb collisions

A. Ohlson [STAR], “Jet-hadron correlations in STAR,'' J. Phys. Conf. Ser. 316 (2011), 012015, arXiv:1106.6032 [nucl-ex]

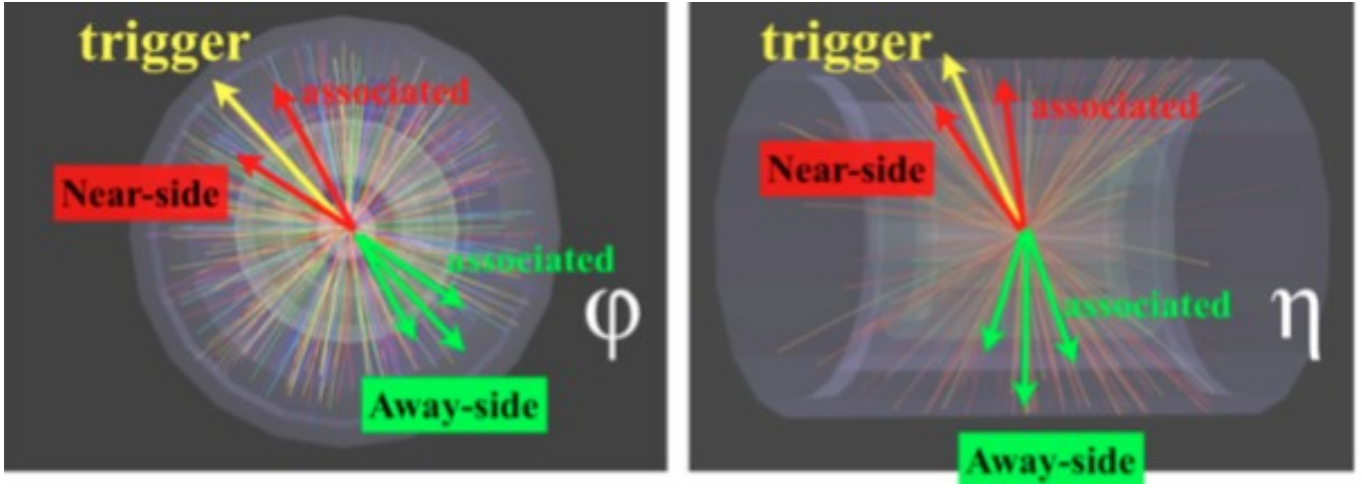
Measurement of correlation in data

- *What is Correlation ?* Given a particle (trigger), what is the probability of finding another particle (associated) at a relative angle

- Two particle correlation between pairs of triggers and associate hadrons in Δη-Δφ space is defined as,

$$C(\Delta\phi, \Delta\eta) = \frac{1}{N_{trigger}} \frac{d^2 N_{asso}}{d\Delta\phi d\Delta\eta}$$

$$\Delta\phi = \phi_{trig} - \phi_{asso}, \Delta\eta = \eta_{trig} - \eta_{asso}$$



The Same Event (SE):

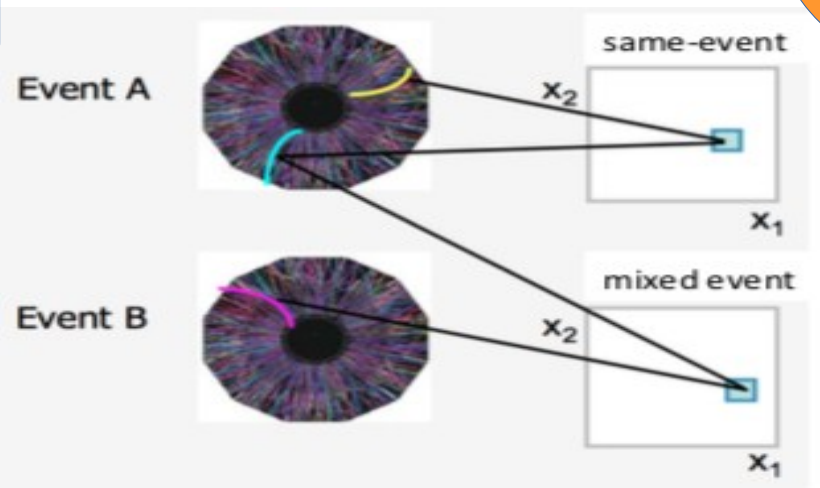
$$S(\Delta\phi,\Delta\eta)=\frac{1}{N_{trigger}}\frac{d^2N_{same}}{d\Delta\phi d\Delta\eta}$$

Physics correlation + finite detector acceptance effect + background due to uncorrelated pairs

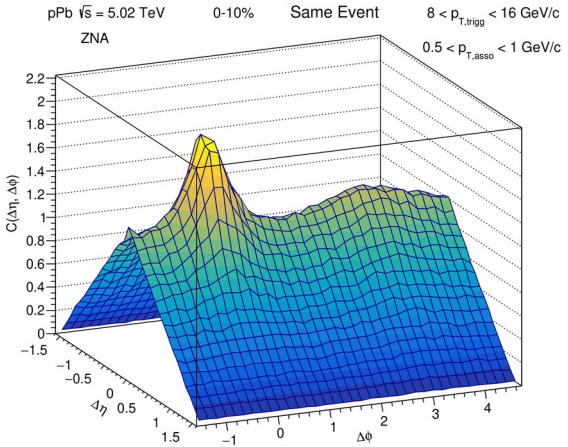
The Background (ME):

$$B(\Delta\phi,\Delta\eta)=\frac{d^2N_{mixed}}{d\Delta\phi d\Delta\eta}$$

No physics correlation - only finite detector acceptance effect + background due to uncorrelated pairs

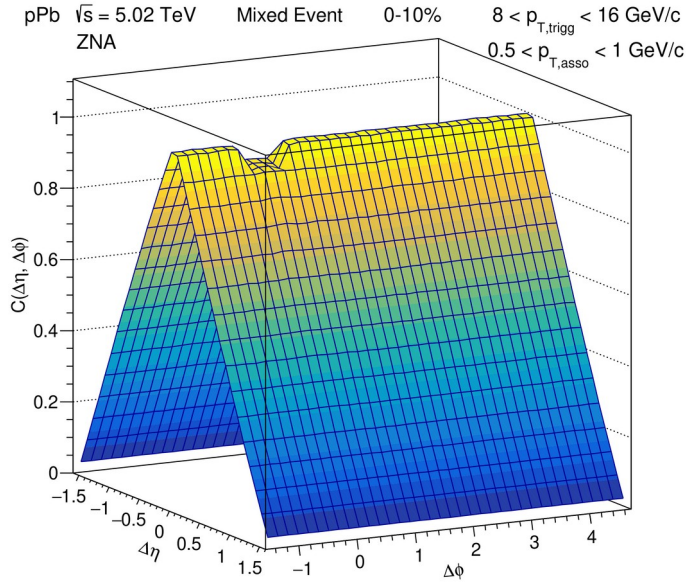


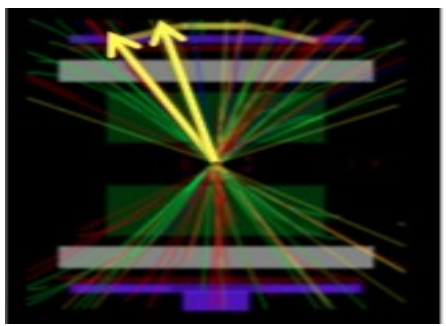
Same Event

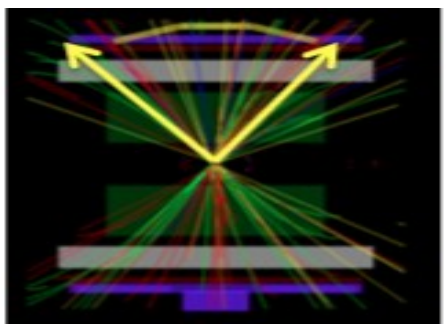


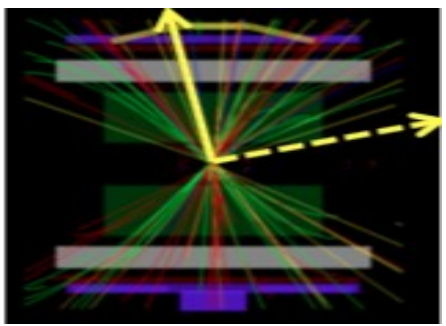
Due to the finite acceptance in η the probability of reconstructing pairs in small Δη is large (triangular shape) Pair acceptance

Mixed Event



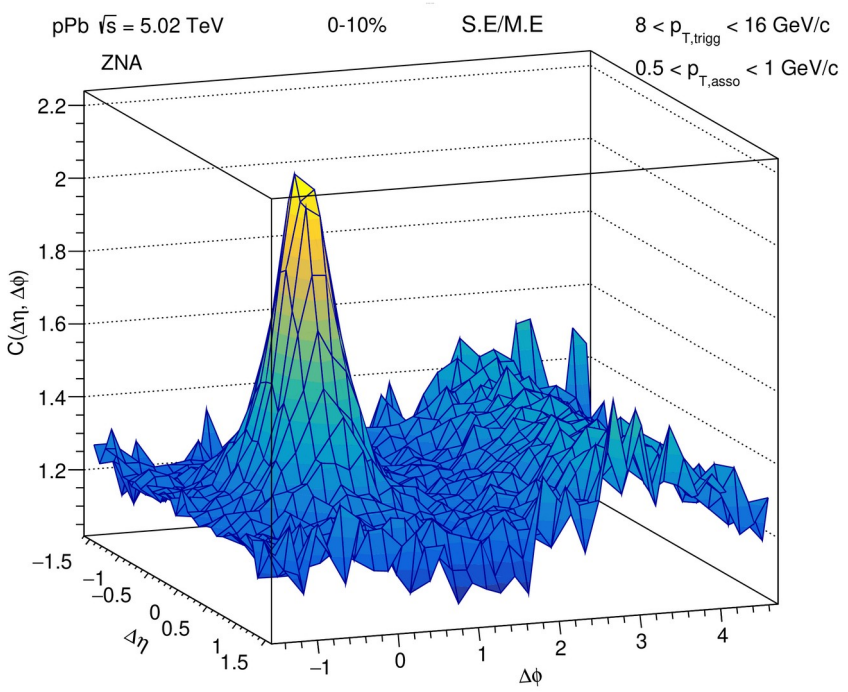






To correct for this pair acceptance and to remove background due to uncorrelated pairs : mixed event method is used

$$C(\Delta\eta,\Delta\phi)=B(0,\pi)\frac{S(\Delta\eta,\Delta\phi)}{B(\Delta\eta,\Delta\phi)}$$



- *We divide correlation functions of the Signal with mixed event to extract the physics correlation*
- The pair counts in the mixed event are normalized with the value at $(0,\pi)$ to make it 1

Analysis details

- Dataset : LHC16q pass2 dataset is used for pPb
  LHC17p_pass1 for pp

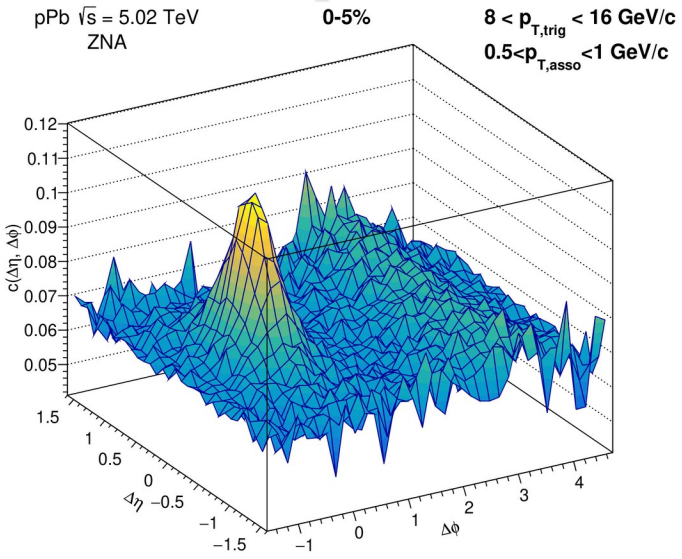
- Event cuts: Trigger kINT7 (V0AND, hit in both V0A and V0C): Minimum bias trigger and rejection of background events, |Z-Vertex| < 10 cm, Physics selection Task is used to select collision candidates in data and reject background and poor quality events

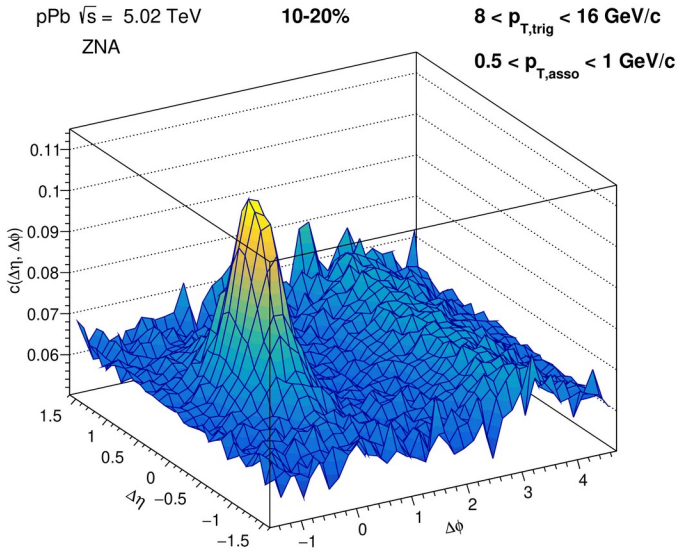
- Track cuts:
  - $|\eta| < 0.8$
  - Filterbit96
  - Trigger p_T : $8 < p_T < 16$ GeV/c,
  - Associate p_T : $0.15 < p_T < 8$ GeV/c
  - Track merging correction is included
  - Centrality estimator: V0A and ZNA are used for pPb

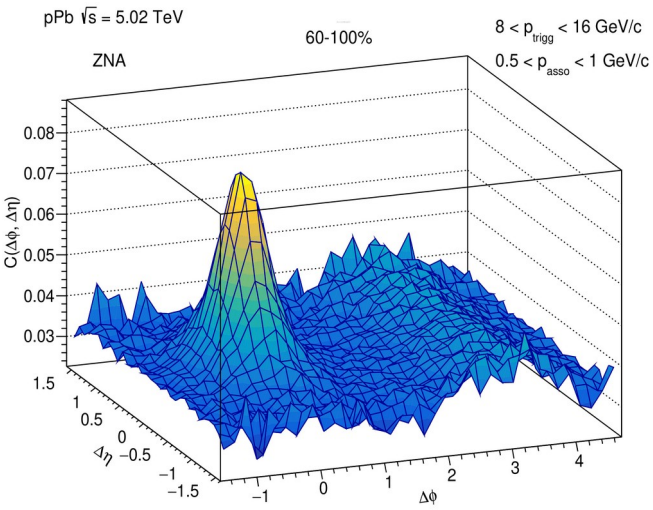
Preliminary Results

Raw correlation function

ZNA estimator







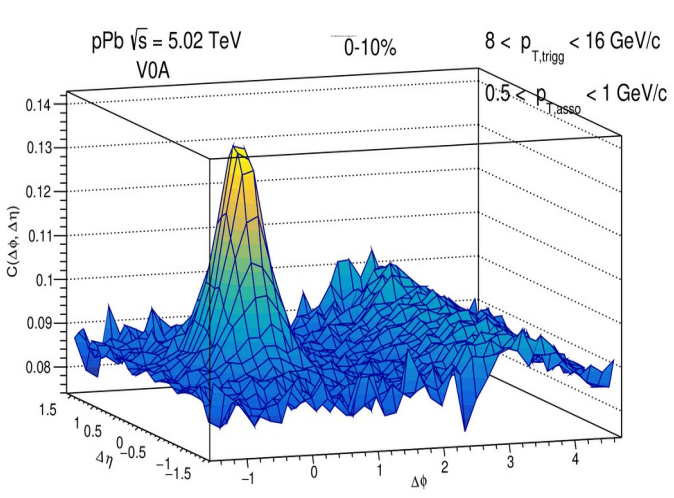
Number of pairs is increasing with increasing centrality

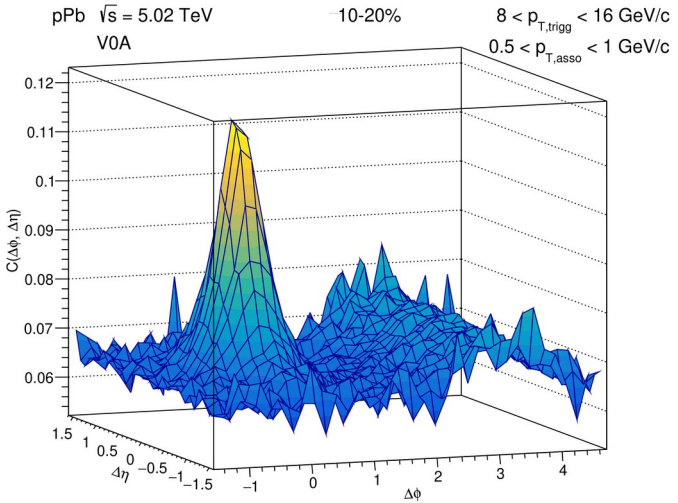
$8 < p_{T,trigg} < 16$ GeV/c

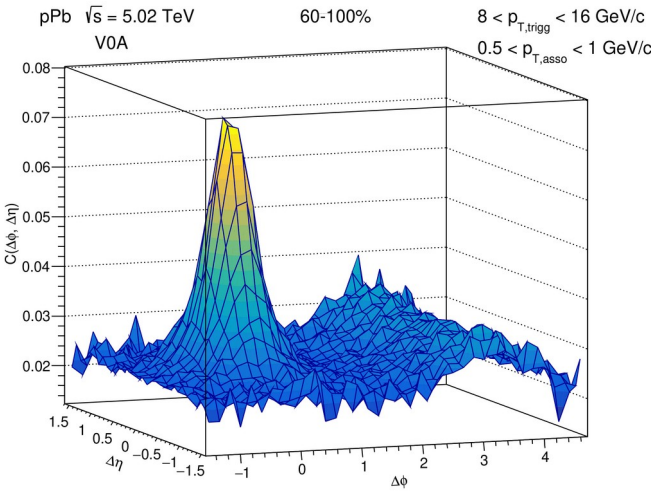
$0.15 < p_{T,asso} < 8$ GeV/c

Raw correlation function

V0A estimator







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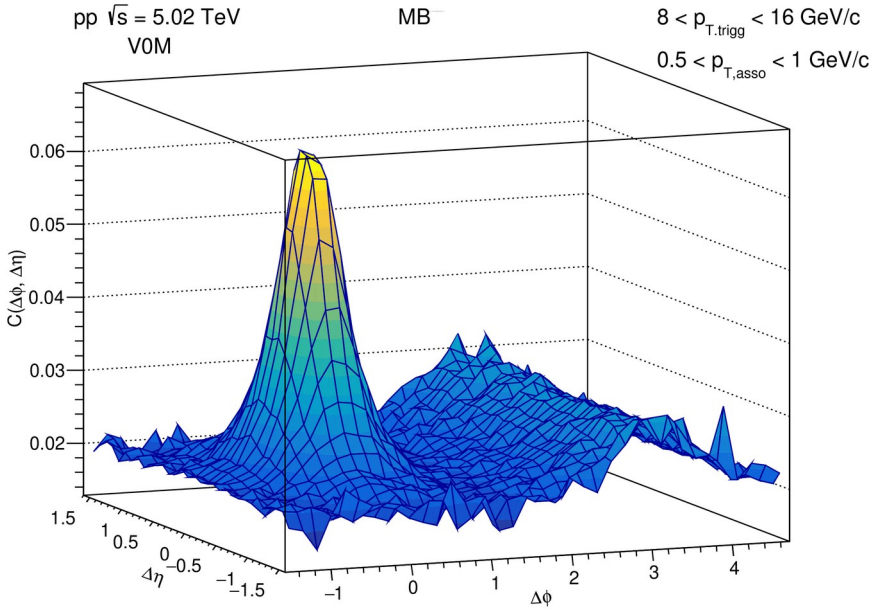
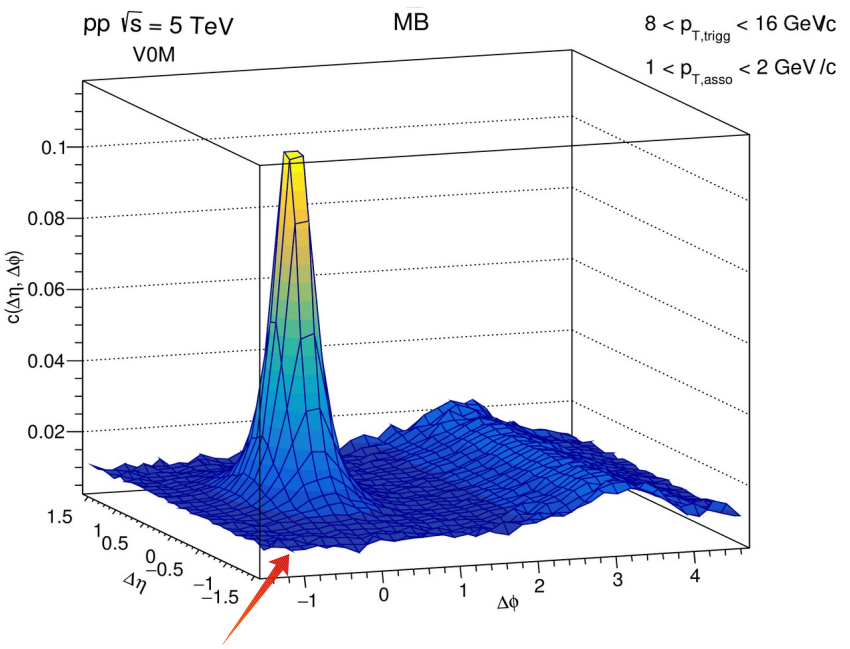
Raw correlation function

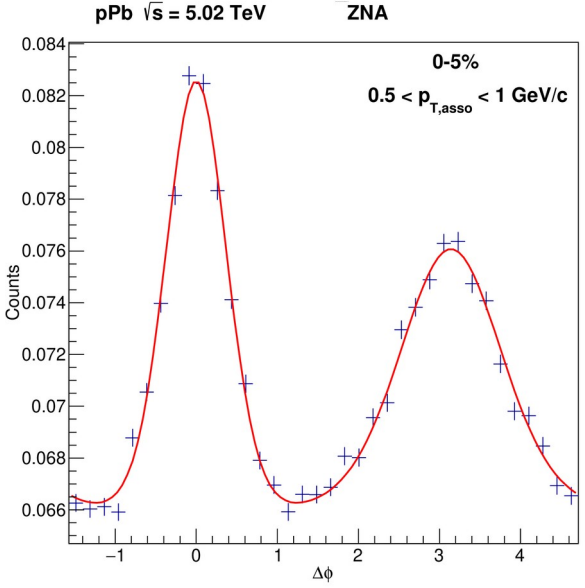


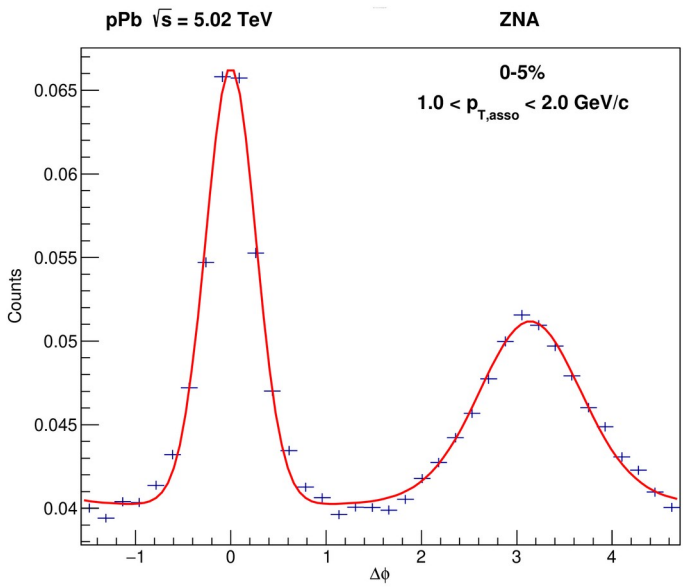
Number of pairs decreases with increasing the transverse momentum of associated particles

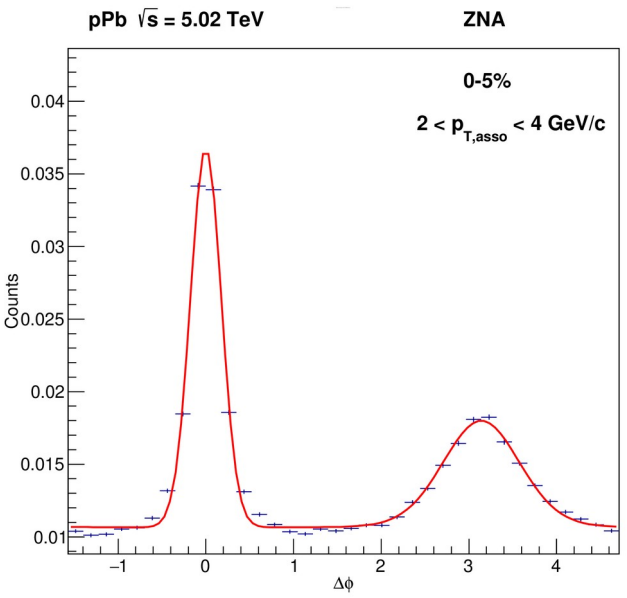


With the increase of associated transverse momentum width of the near-side peak is being decreased

Δϕ projection of correlation function

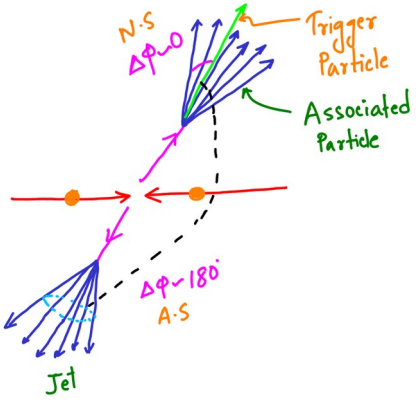






Generalized Gaus (NS) + Std. Gaus (AS)

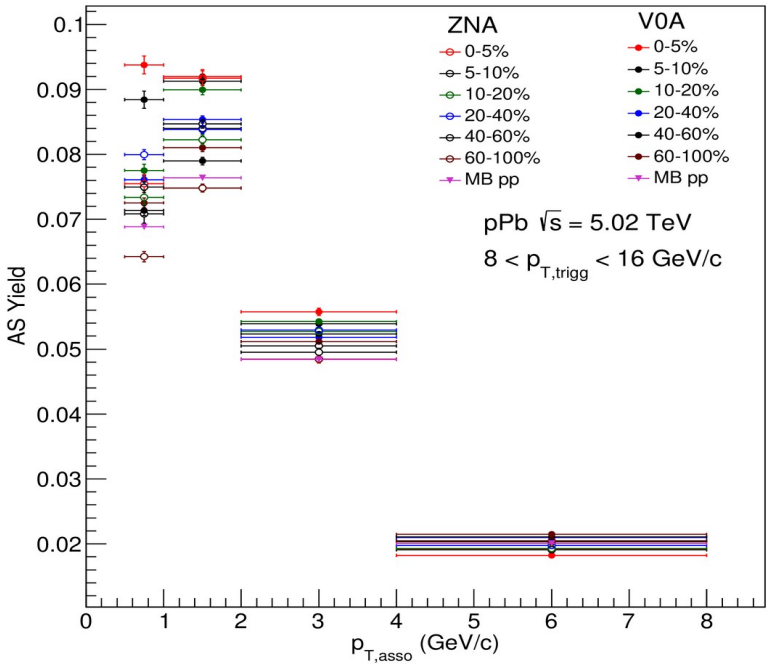
$$f = \frac{A}{2\sigma\Gamma(1/\alpha)} e^{-(\frac{x-\mu}{\sigma})^{\alpha}}$$



Awayside and Nearside Yield

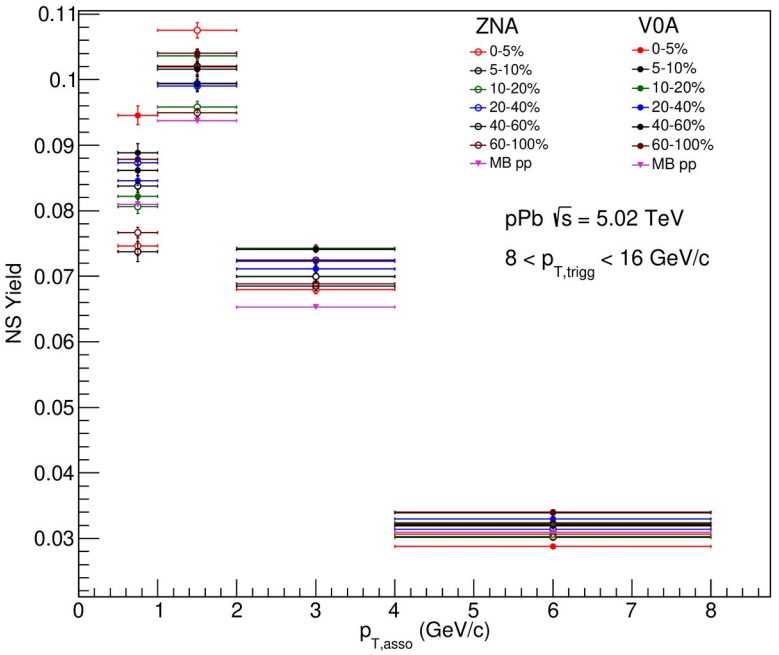
Raw Data

$1.8 \leqslant \Delta\phi \leqslant 4.5$



Yield is the area covered by the curve of certain range

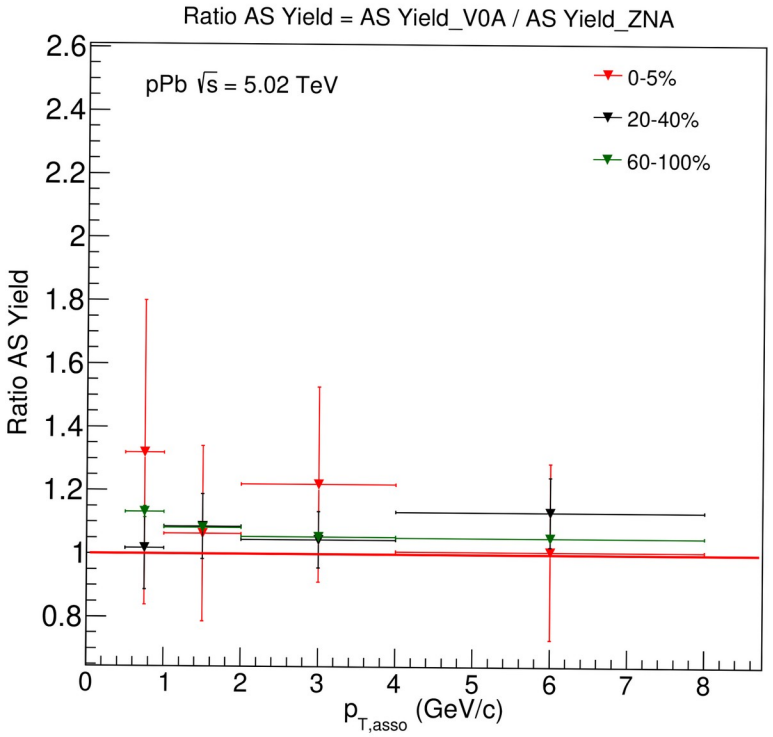
$-1.5 \leqslant \Delta\phi \leqslant 1.5$

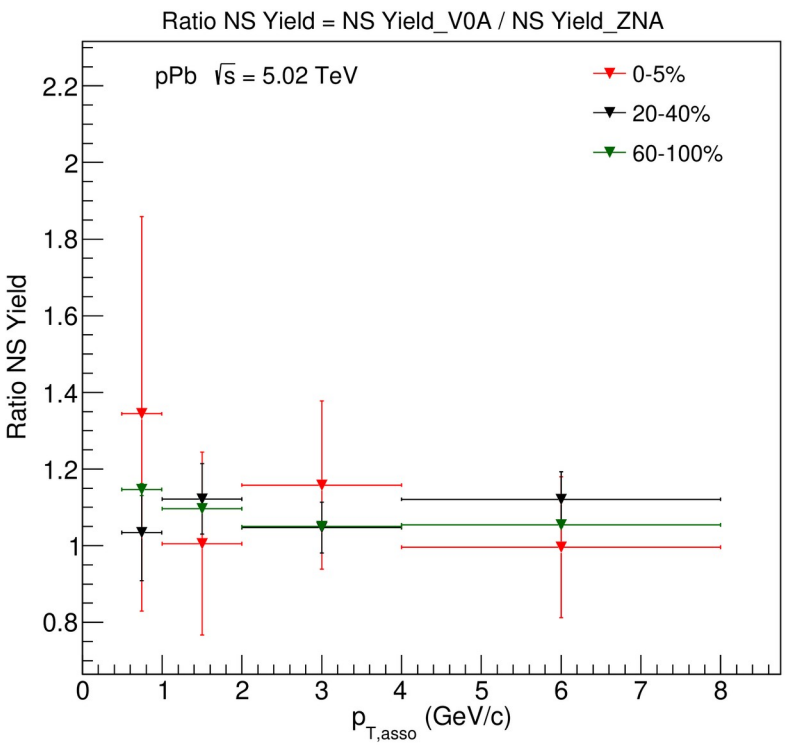


Near side and away side yields are decreasing with increasing associated p_T

Ratio of Yield

Raw Data

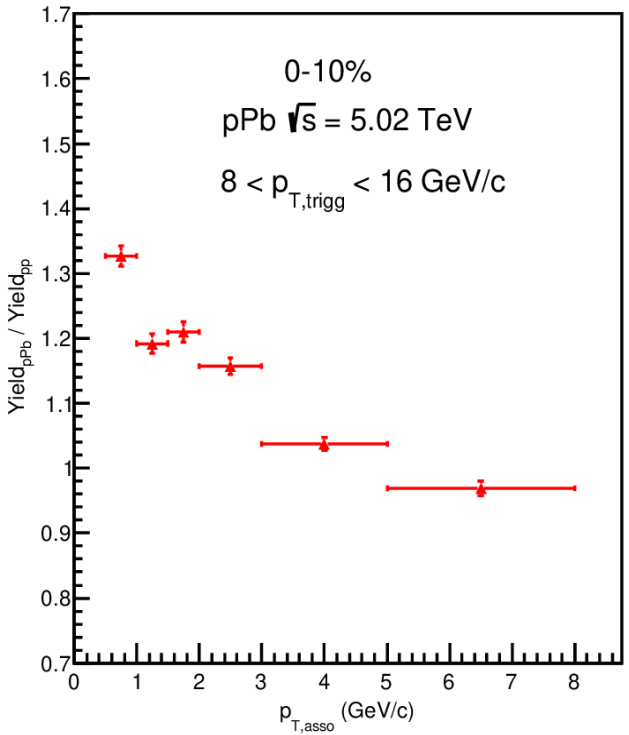


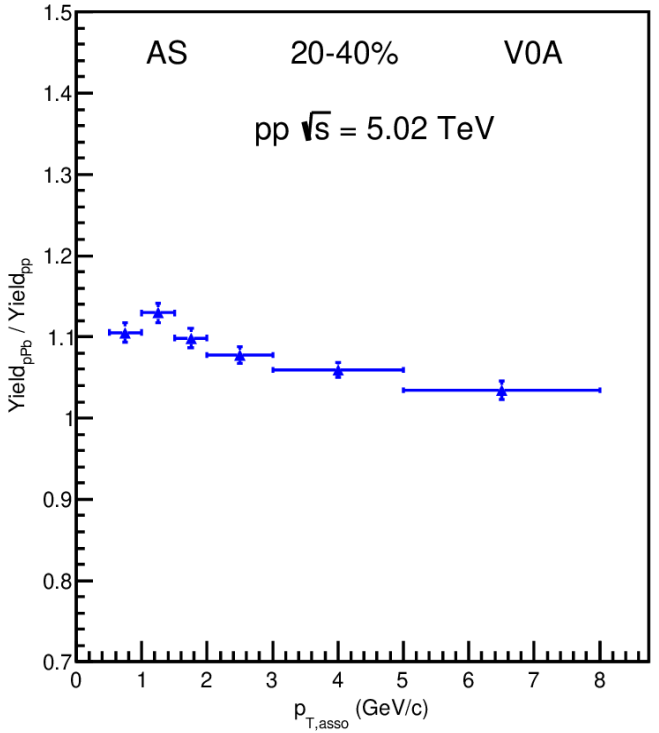


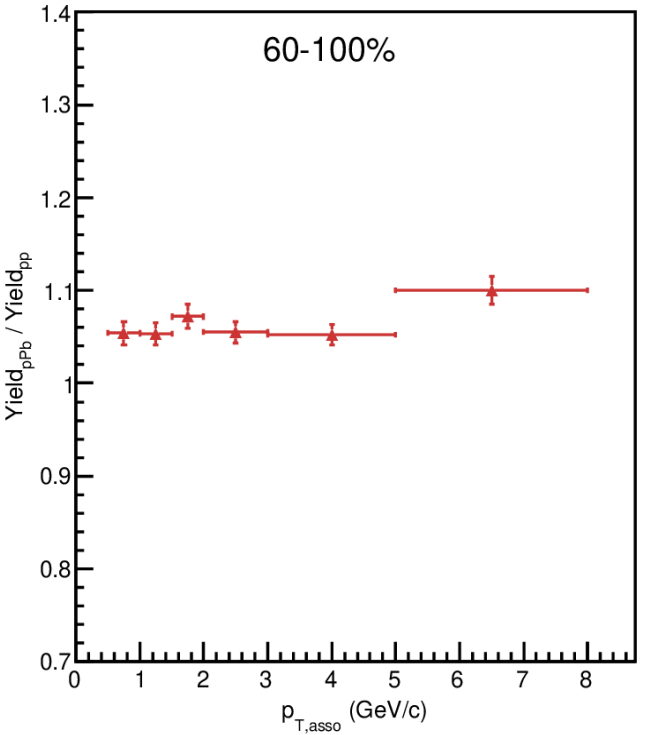
This ratio shows that both of the estimators can be used for centrality selection since the ratio becomes approximately 1

Ratio of Yield with pp

Raw Data

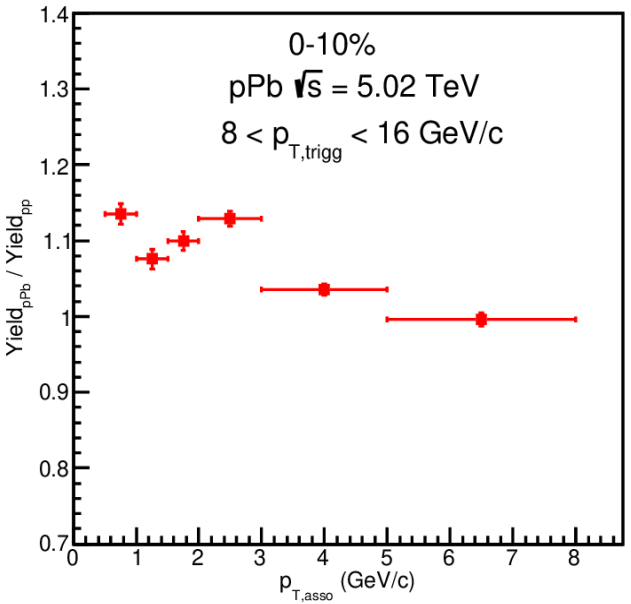


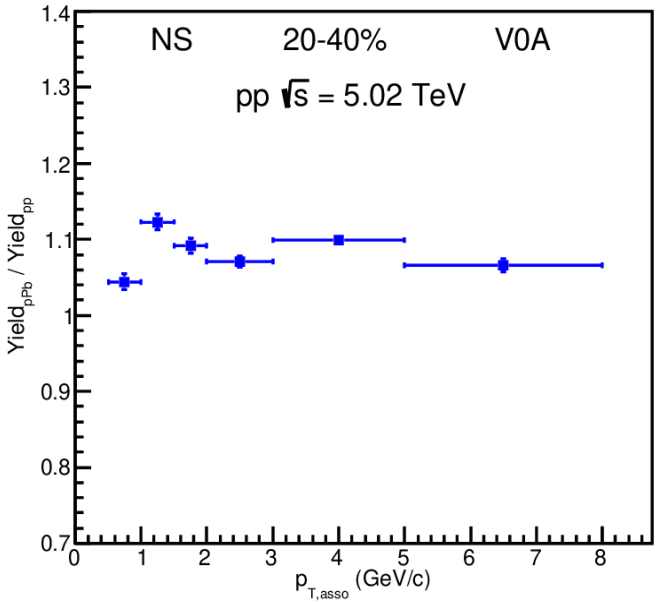


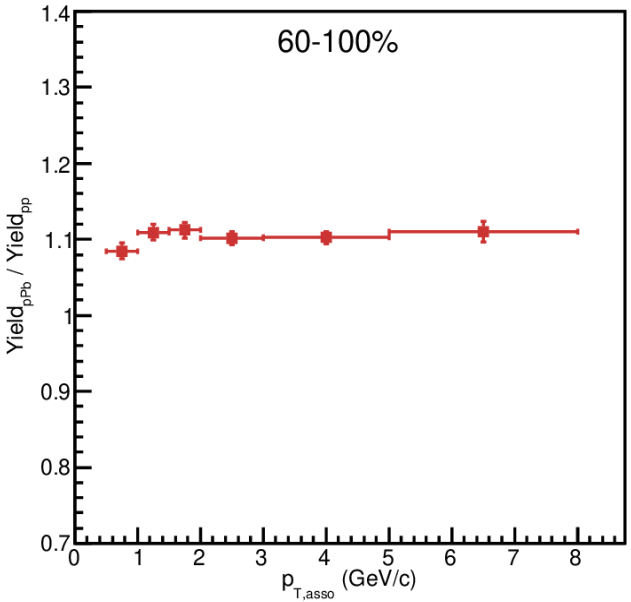


Ratio of Yield with pp

Raw Data

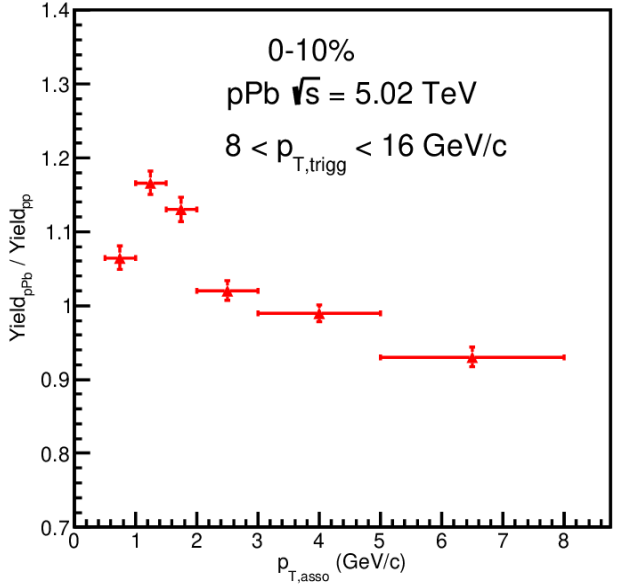


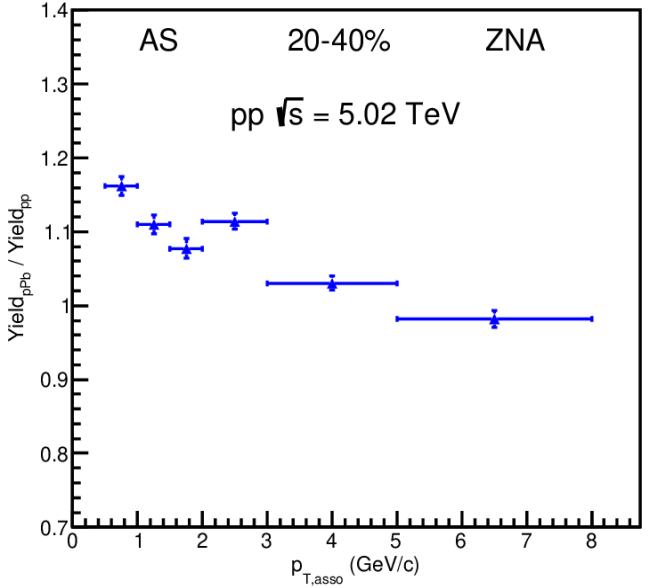


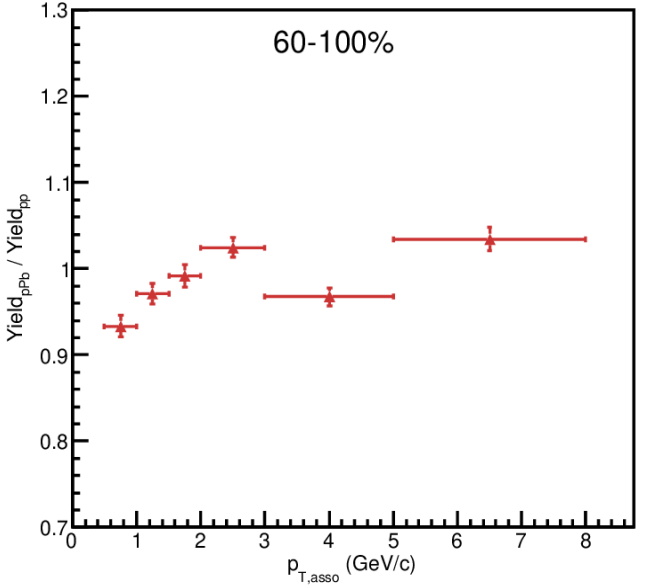


Ratio of Yield with pp

Raw Data

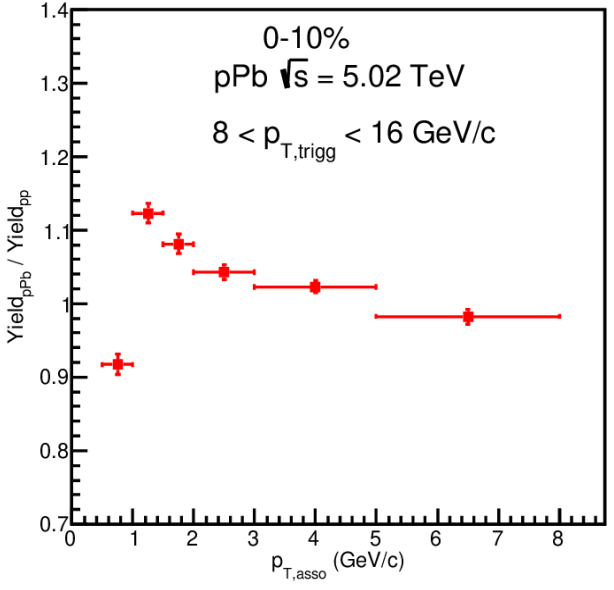


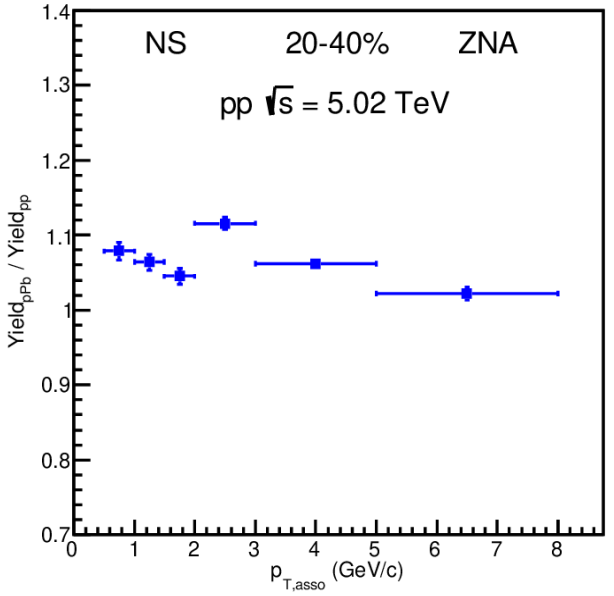


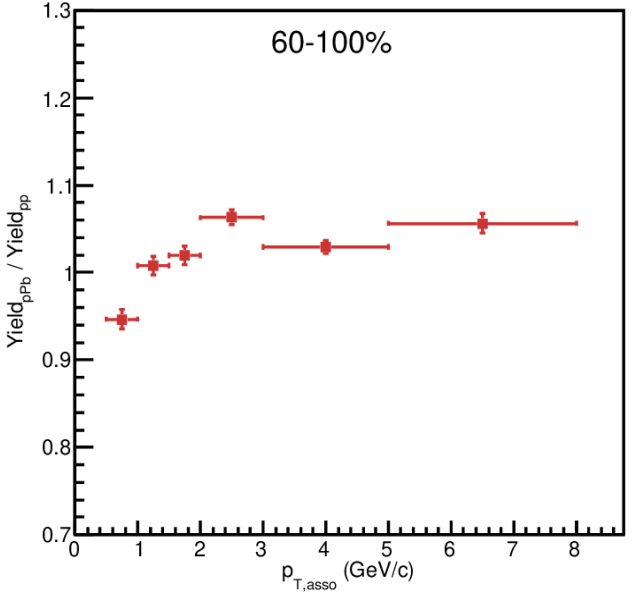


Ratio of Yield with pp

Raw Data







Summary

- Centrality dependence correlations between two hadrons for pPb collisions have been studied for V0A and ZNA estimators and for pp Minimum Bias (MB) as reference
- $\Delta\phi$ projection of correlation function shows that width of near side peak is being decreased with increasing associated transverse momentum
- Centrality dependence away-side and near-side yield have been studied for both V0A and ZNA estimators with associated transverse momentum
- Ratio of yields for different centrality classes has been measured using both of the estimators

Future Plan

- **Raw data has to be corrected using simulation.**
- **Efficiency and secondary contamination have to be determined using Monte Carlo (MC) simulation, correction factor is to be calculated.**
- **Efficiency correction procedure can be validated by the Closure test.**
- **Correction factor is to be used in raw data to estimate the corrected data.**

Acknowledgement

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- Dr. Saikat Biswas
- University Grants Commission (UGC)

Thank You