

Monte Carlo studies of identified two-particle correlations in p-p and Pb-Pb collisions at mid-rapidity

Gyula Bencedi,
(WIGNER RCP, Hungary)
Gergely G. Barnafoldi
(WIGNER RCP, Hungary),



Levente Molnar
(Institut Pluridisciplinaire Hubert Curien (FR)),

06/12/2013

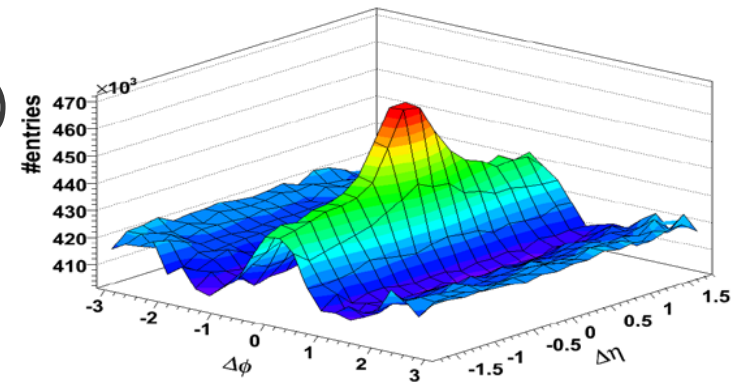
13. Zimányi WINTER SCHOOL ON HEAVY ION PHYSICS
Dec. 2. - Dec. 6., Budapest, Hungary

Outline

- 0, Motivation
- 1, Azimuthal particle correlations
- 2, Monte Carlo study of identified two-particle azimuthal correlations in p-p and Pb-Pb collisions at $|\eta| < 1$
 - PID associated spectra and ratios
 - $\Delta\varphi$ distributions with triggered PIDs
- Summary, outlook

Motivation

- Hadronization in QGP
 - High- p_T hadrons, particle ratios, collective effects
 - High- p_T factorization holds: PDF \times pQCD \times FF + jet quenching HI (PID?)
 - Intermediate p_T : recombination rises
- Fragmentation effects, including PID: recombination effects in intermediate p_T (RCP, RAA, B/M, v_2)
- Jet-like correlations: ridge (AuAu, dAu, pPb,)
 - PID could shed light on formation mechanism...



1, Identified two-particle azimuthal correlations

- Identified **triggers**, identified **associateds** integrated in mid-rapidity region

- Trigger $p_T > Assoc p_T$

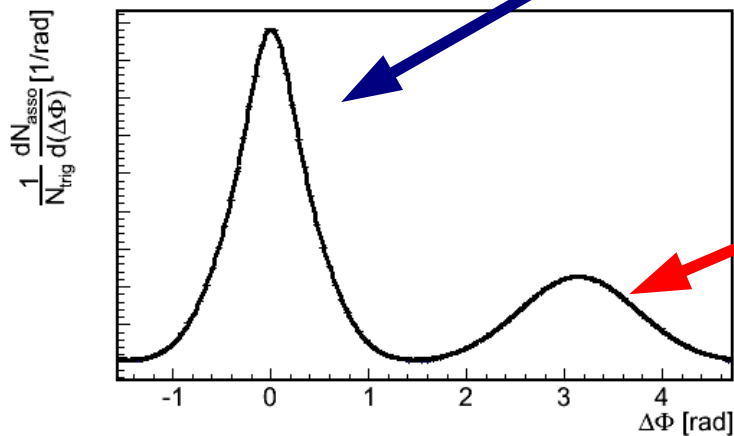
- $|Trigger, Assoc \eta| < 1$

- Trigger, Associated species selection both on near and away sides

$\pi^+, \pi^-, K^+, K^-, p^+, p^-, \dots$

near

away



Expectation: conservation of quantum numbers

π, K, p - momentum p , charge Q (+ K strangeness, + p baryon number)

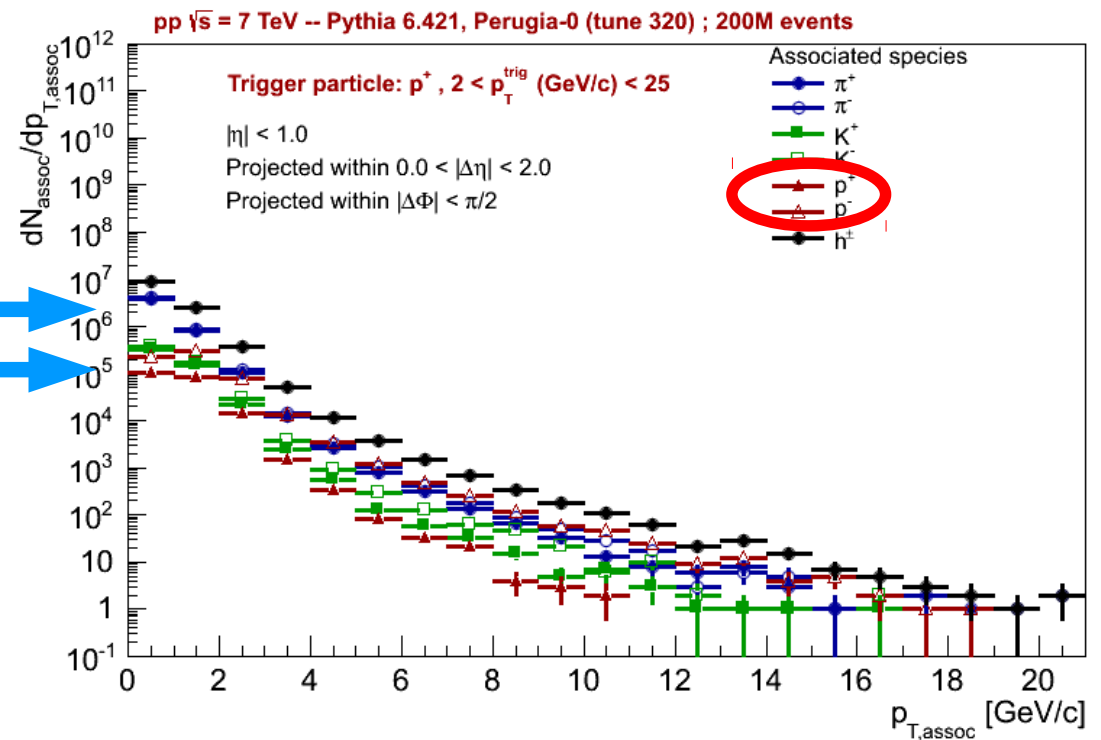
Fragmentation / hadronization for different particle flavours

Identified two-particle azimuthal correlations, Simulation settings

- **Pseudorapidity:** trigger particles $|\eta| < 0.5$, associated particles $|\eta| < 1.0$
- **Azimuthal angle:** no restriction
- **Azimuthal and pseudorapidity difference:** $\Delta\phi$, $|\Delta\eta| < 2$
- **Identified particles:** $\pi^+, \pi^-, K^+, K^-, p, p_{\text{bar}}$
 - **pp** : PYTHIA 6.4 perugia0 (tune 320)
 - **200M** events generated
 - **PbPb** : HIJING (w/ quenching, shadowing)
 - Focusing on centrality: **0-10% (4M)**

PID associated raw spectra

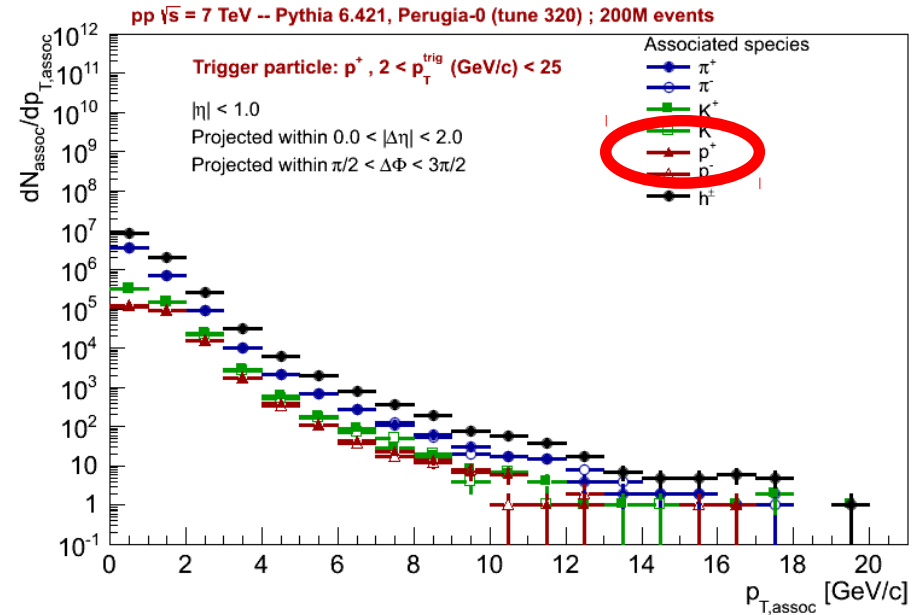
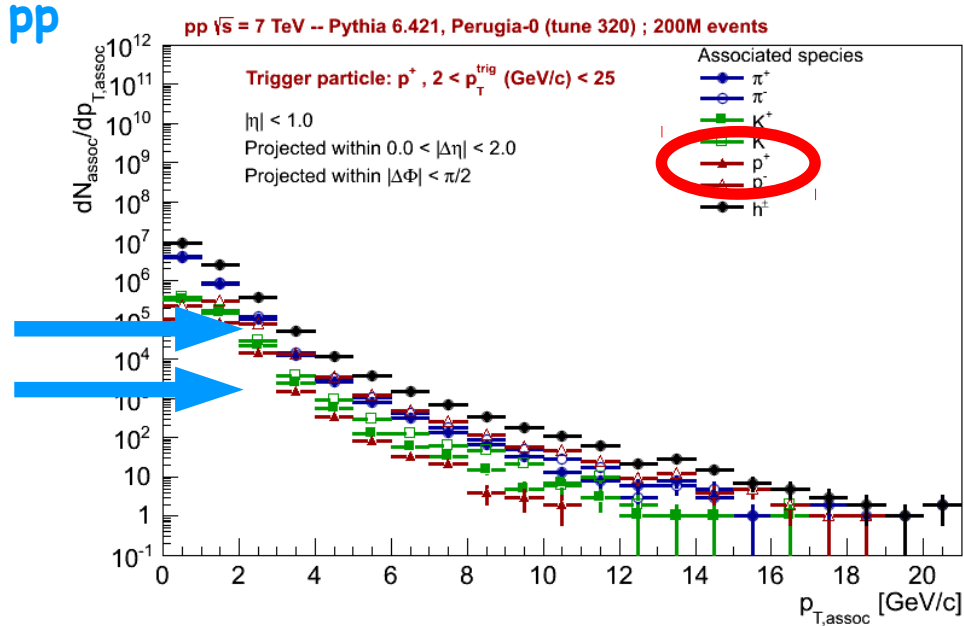
- PID-PID associated pT spectra up to high-pT
- p-p @ 7TeV, Pythia (tune320)
- Same side
- Trigger particle: **proton**
 - in $2 < p_{T, \text{trig}} < 25$
- Associateds: $\pi^+, \pi^-, K^+, K^-, p, pbar$
- Acceptance: $|\eta| < 1$.
- Observation: difference in the proton, anti-proton yields



PID associated spectra (p trigger)

Near side

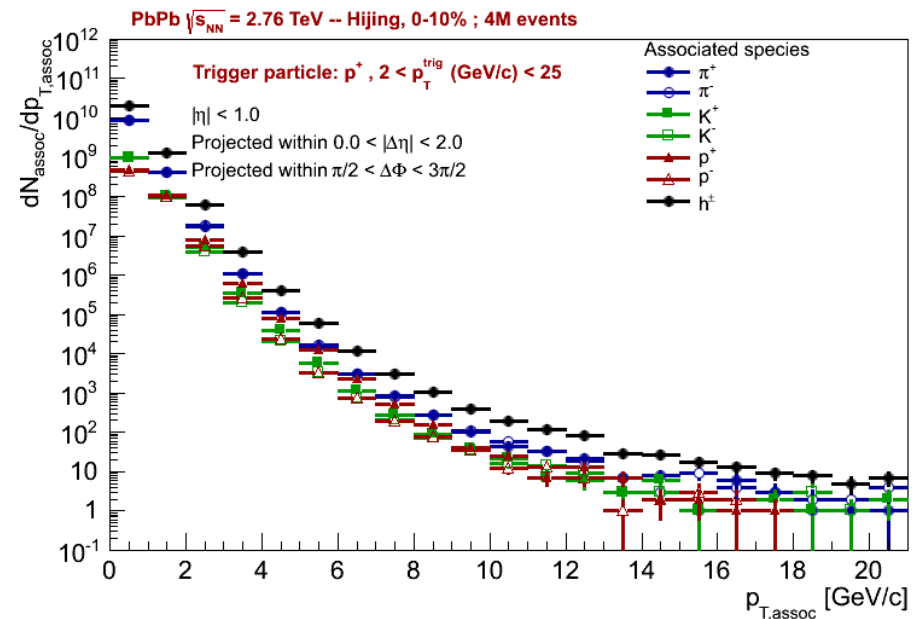
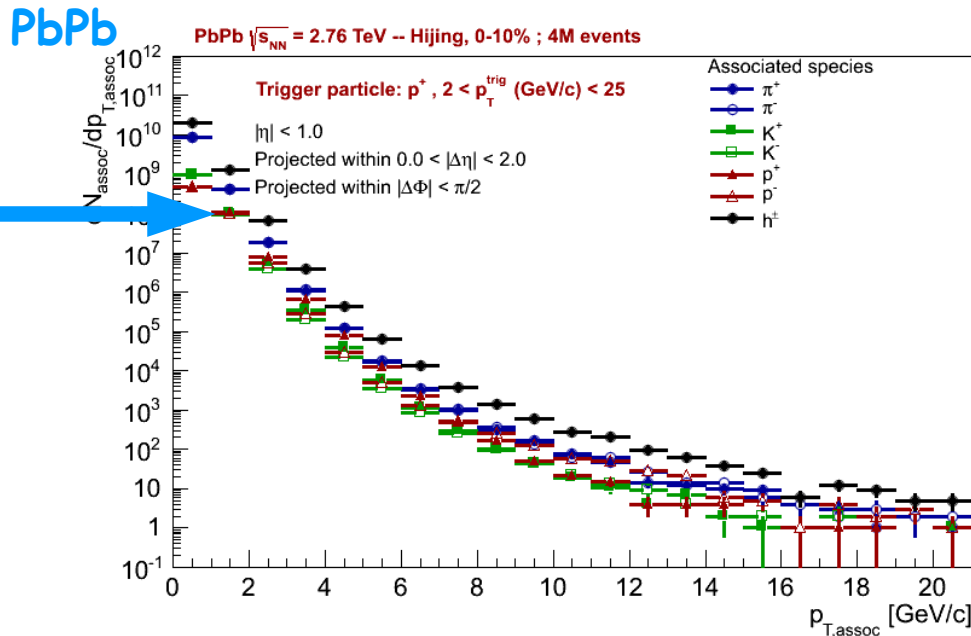
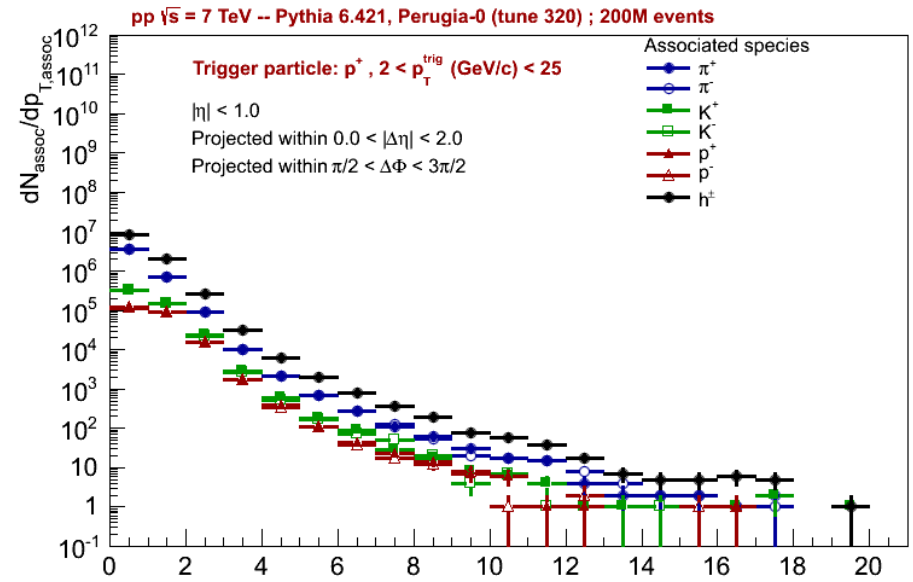
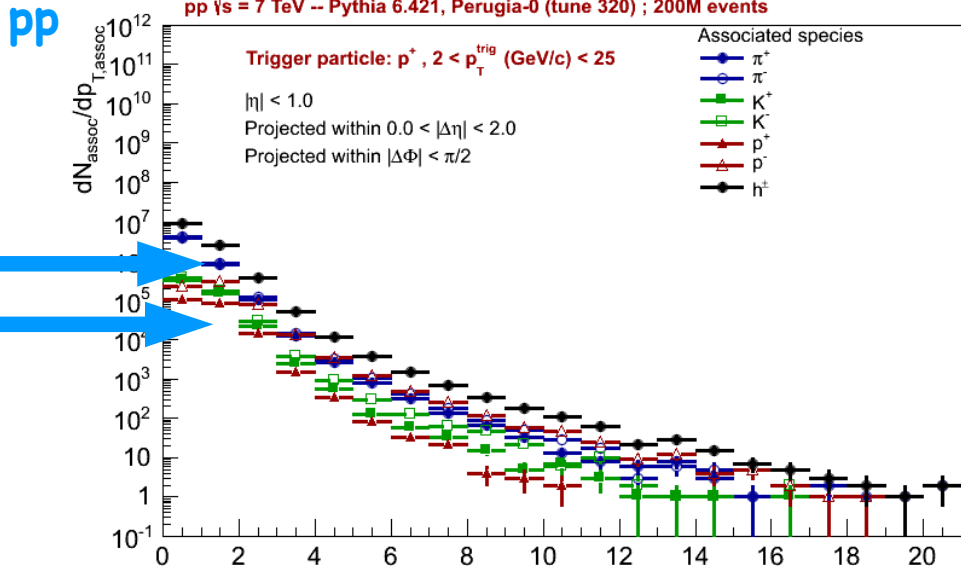
Away side



PID associated spectra (p trigger)

Near side

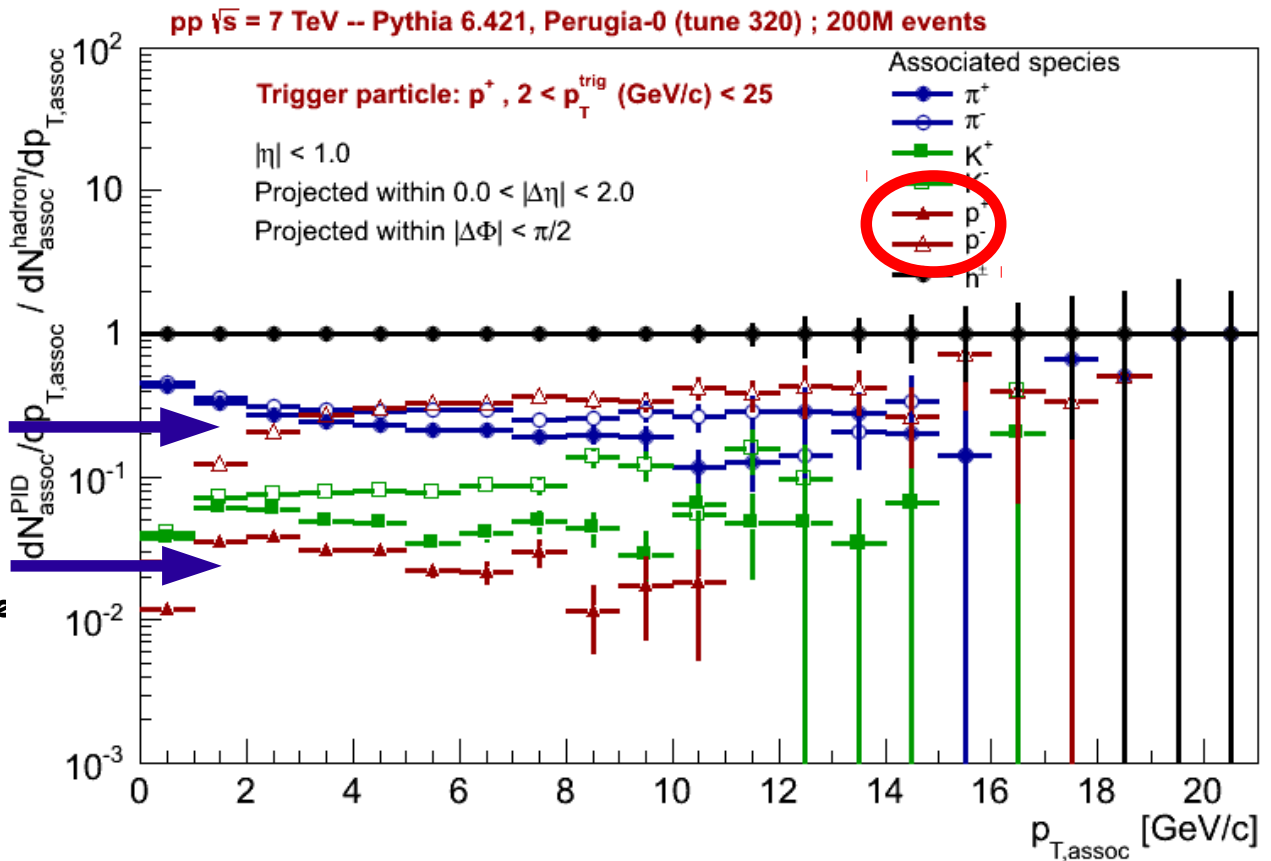
Away side



Identified particle ratios (p trigger)

$$R := \frac{\frac{1}{N_{trig}^i} \times \frac{dN_{assoc}}{dp_{T,assoc}}}{\frac{1}{N_{trig}^j} \times \frac{dN_{assoc}}{dp_{T,assoc}}}, \quad i \in \{\pi^\pm, K^\pm, p^\pm, h^\pm\}, \quad j \in \{h^\pm\}$$

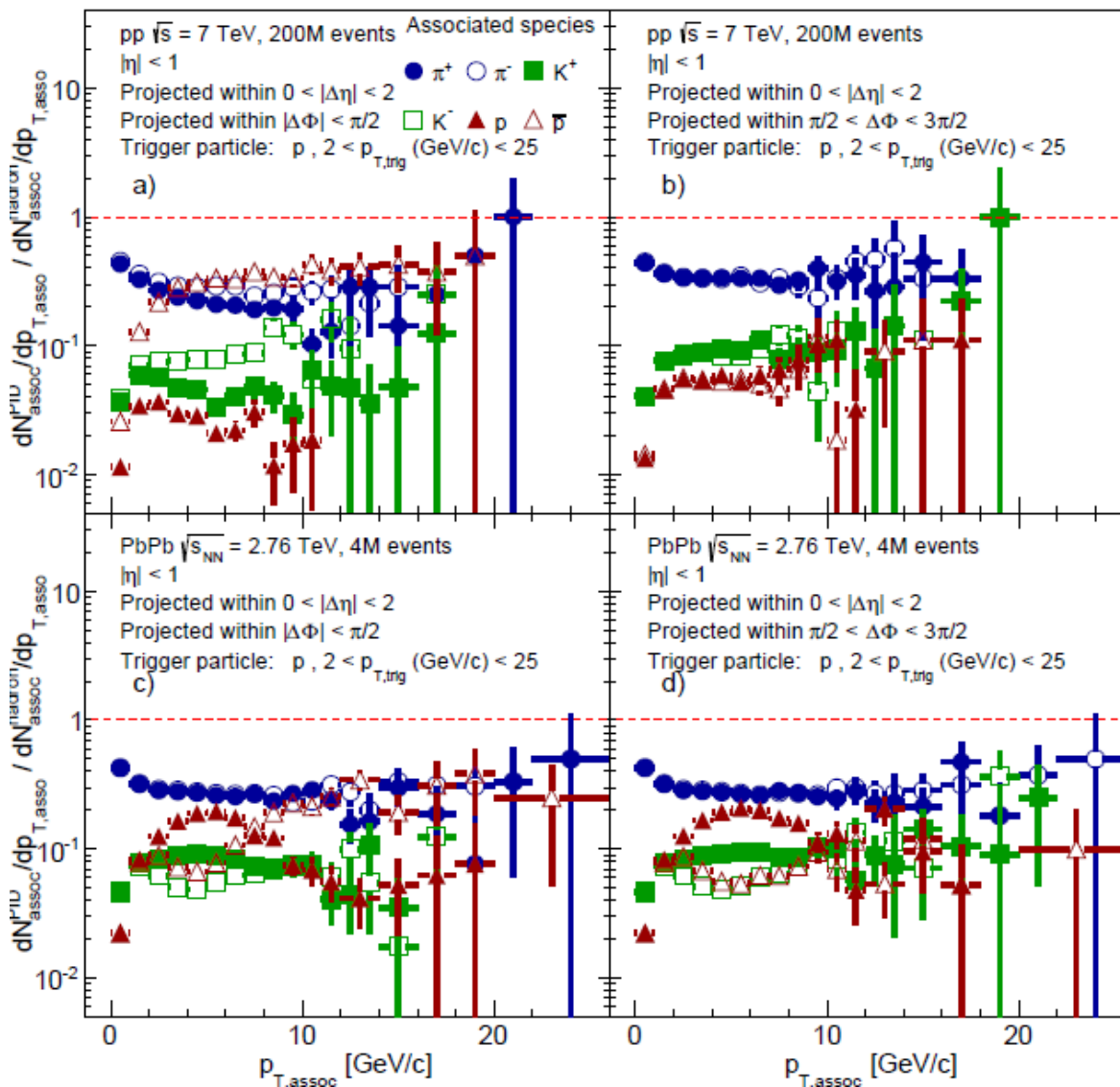
- Pp @ 7TeV, PYTHIA (tune 320)
- $|\Delta\phi| < \pi/2, |\Delta\eta| < 2$.
- Trigger particle: **proton**
 - in $2 < p_{T,assoc} < 25$
- Associateds: $\pi^+, \pi^-, K^+, K^-, p, pbar$
- Acceptance: $|\eta| < 1$
- In an unmodified fragmentation process the baryon number and charge is conserved and leads to highly correlated distributions in the same phase space
- Observation: splitting above $2\text{GeV}/c$ for the triggered protons



Identified particle ratios (p trigger)

Acceptance
 $|\eta| < 1$

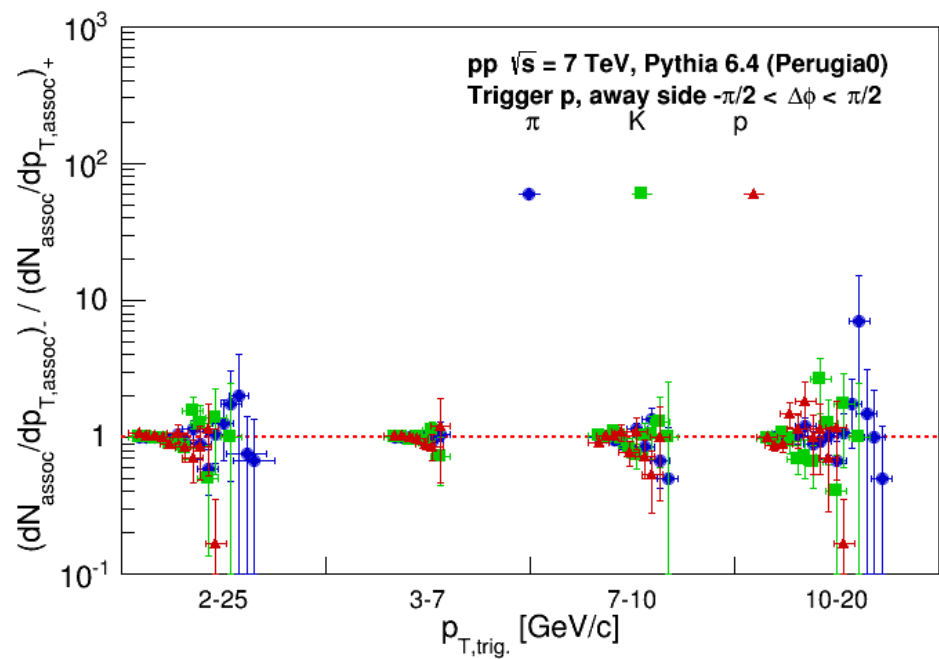
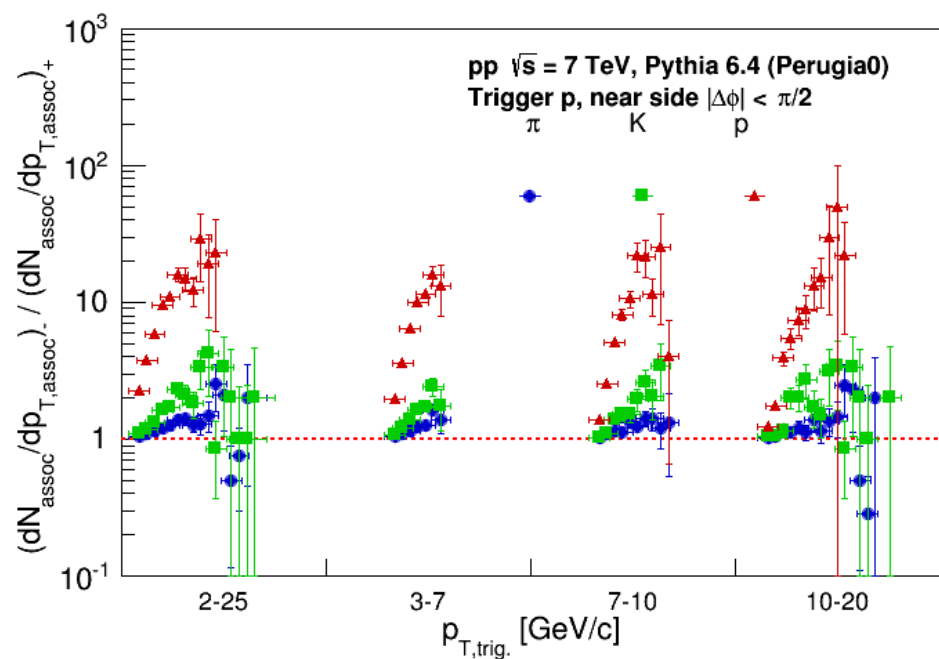
pp near side



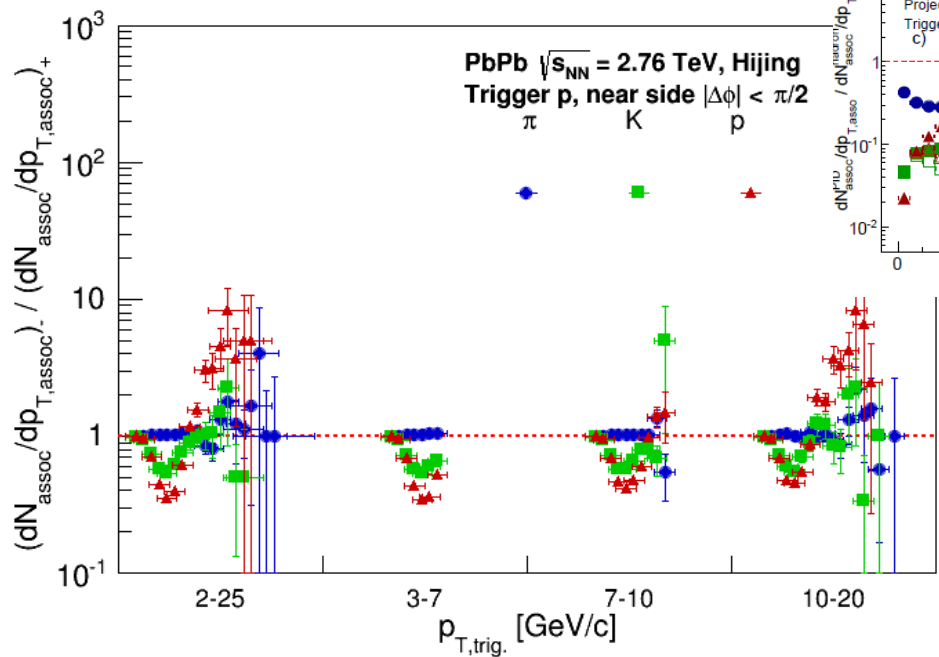
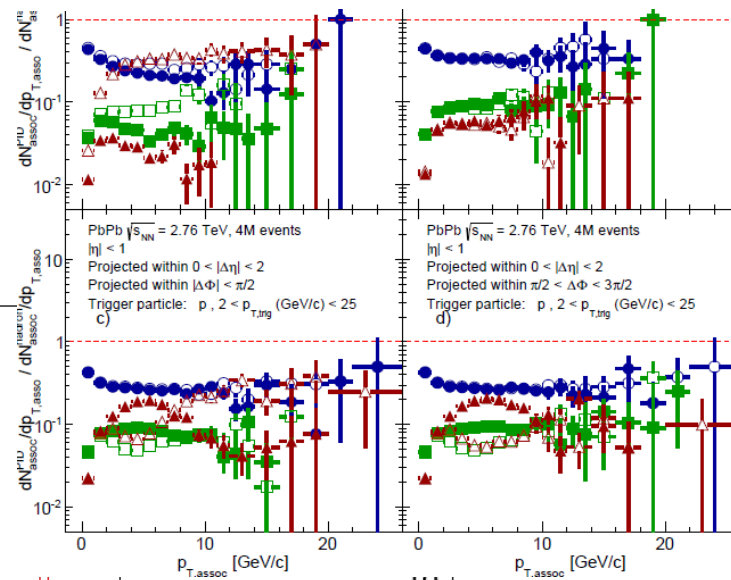
pp away side

PbPb near side

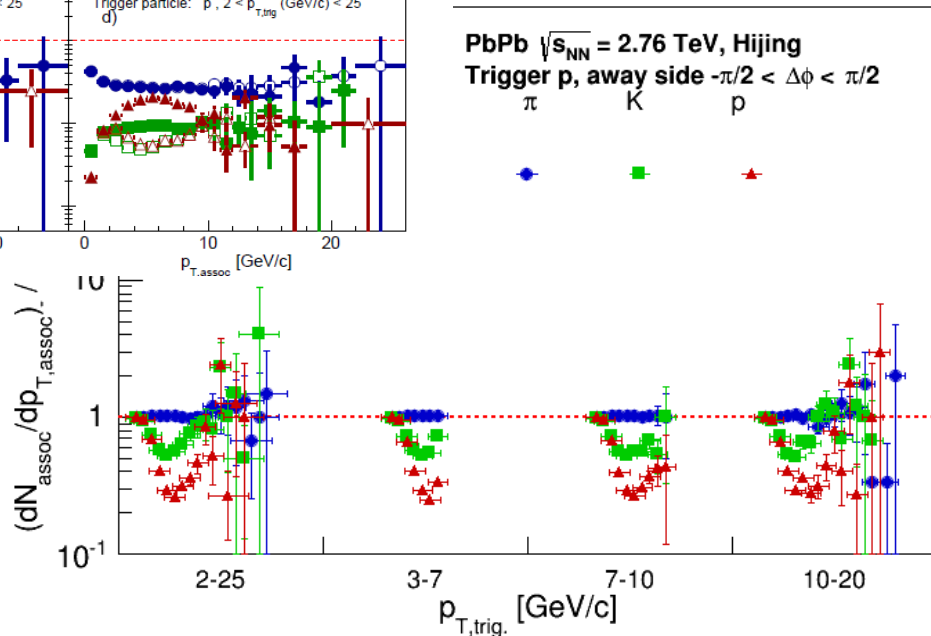
PbPb away side



PID (-)/(+) ratio vs $p_{T,\text{trig}}$

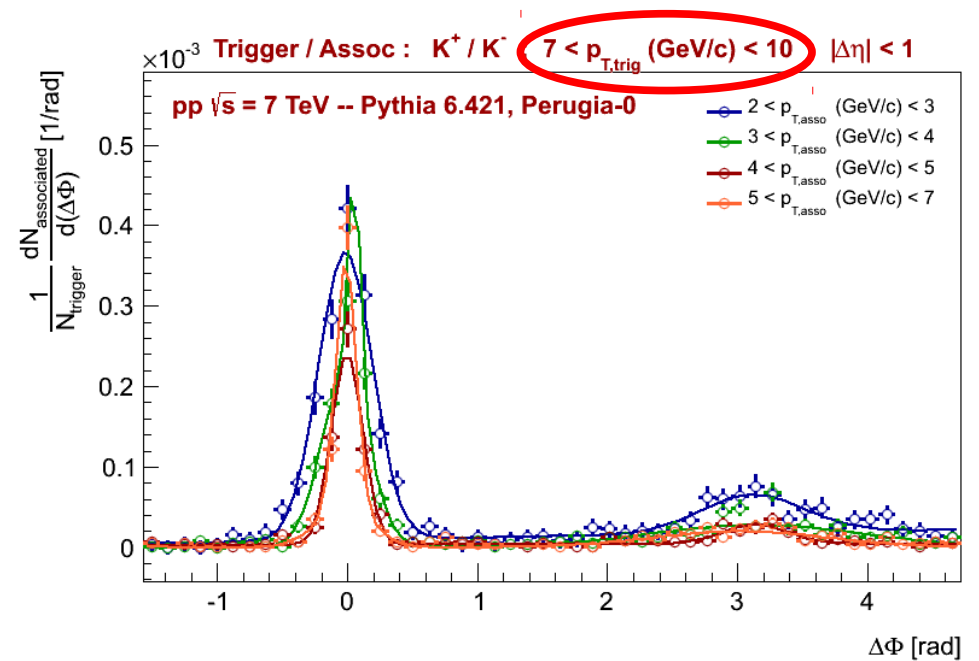
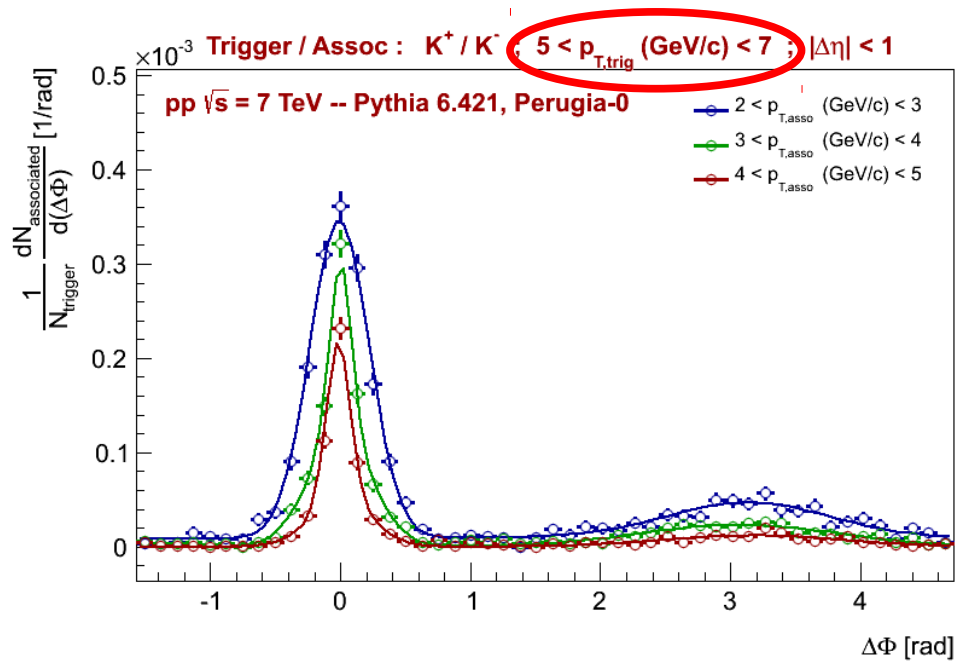


Wigner RCP



Dphi projections (flavour conservations, K)

pp



- Same side flavor and charge correlations decrease as a function of $p_{T, \text{assoc}}$ and $p_{T, \text{trig}}$ (the width narrows) compared to the away side correlations which stay roughly constant when the trigger particle momentum is increased

Trigger/Assoc

π^+/π^-

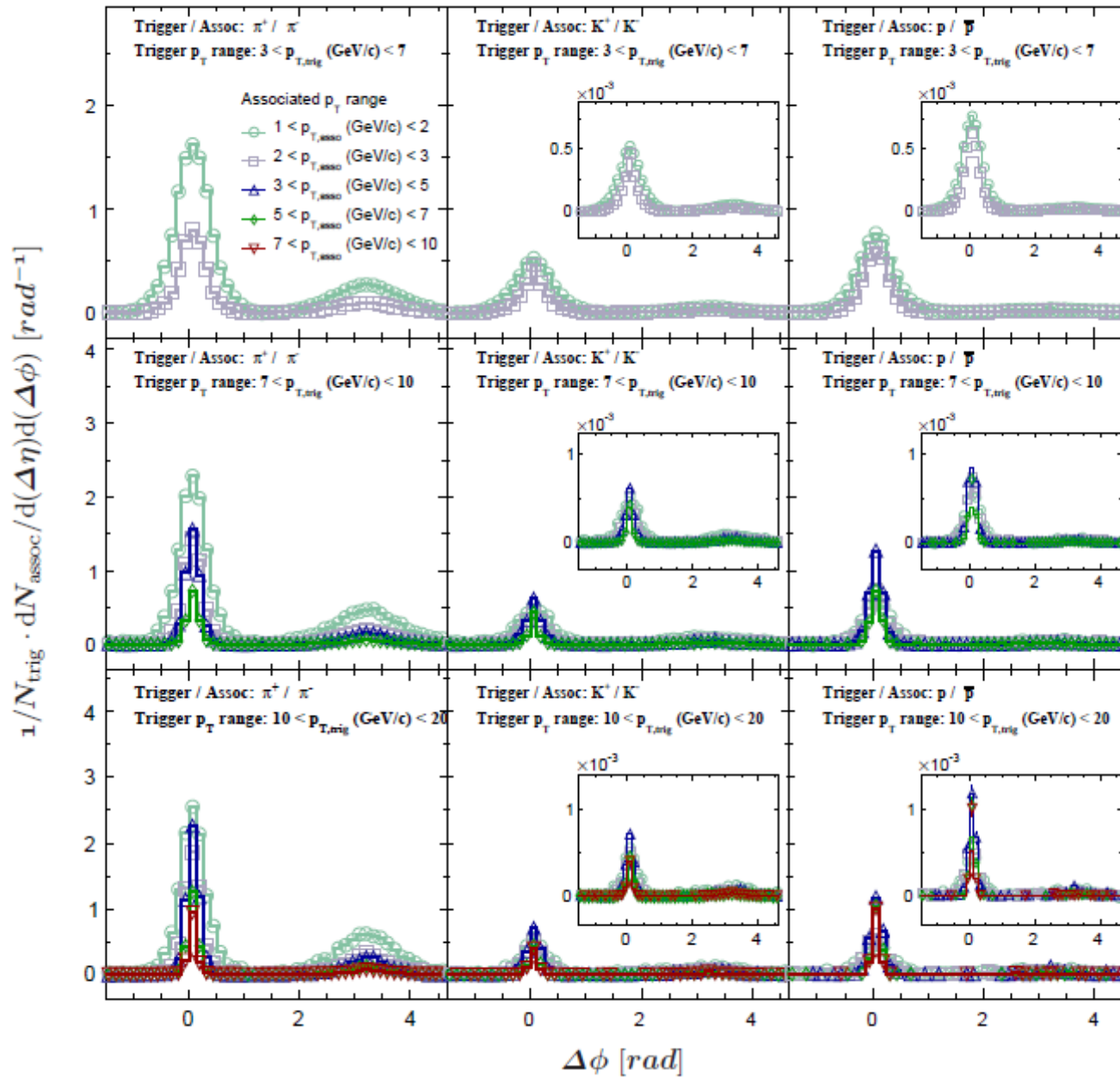
K^+/K^-

$p/pbar$

$\times 10^{-3}$

$p-p$ 7TeV,
PYTHIA
(Perugia0)

trigger
 p_T bins



Trigger/Assoc

π^+/π^-

K^+/K^-

p/\bar{p}

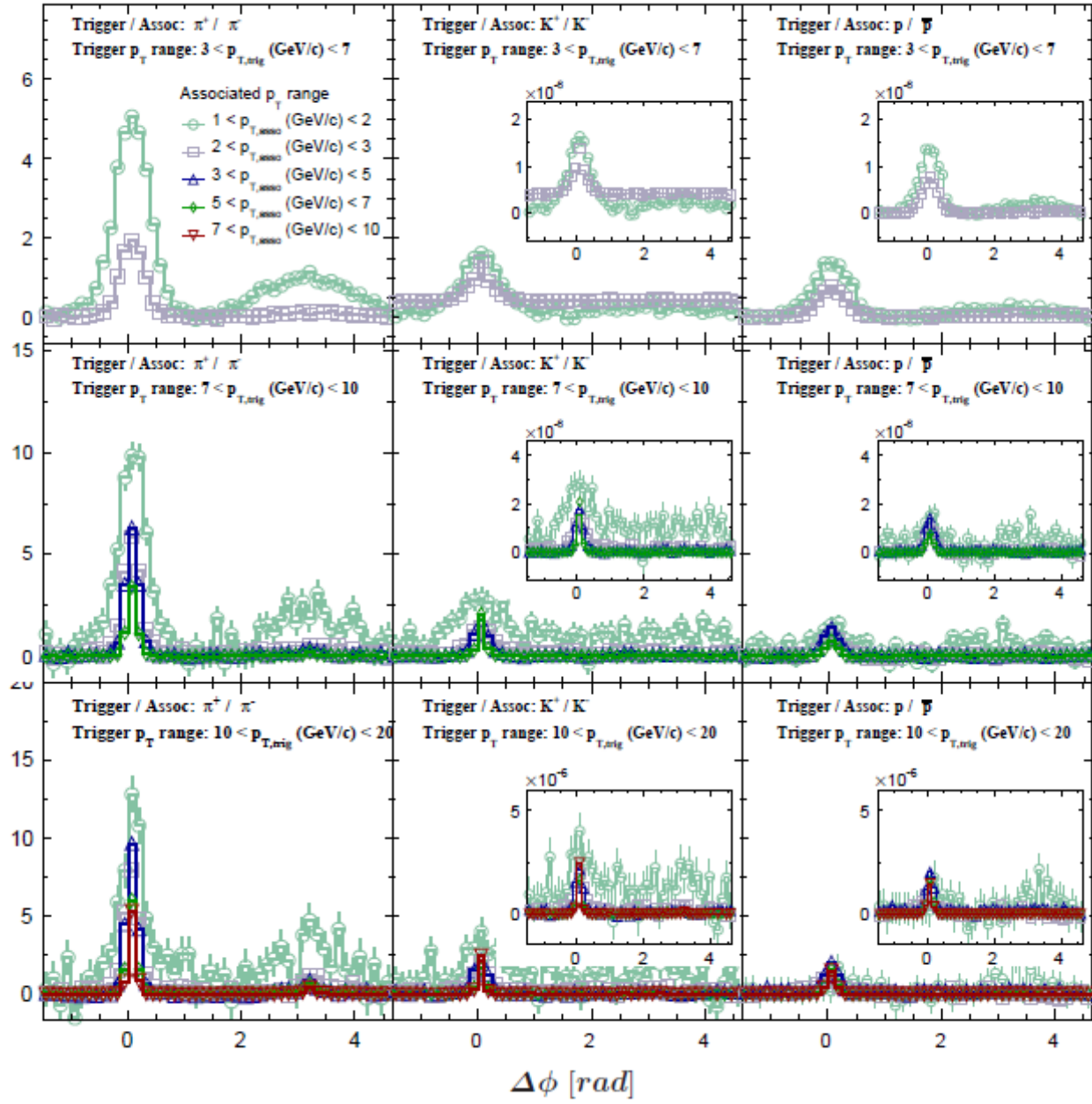
$\times 10^{-6}$

Pb-Pb 2.76TeV,
HIJING

trigger
 p_T bins



$1/N_{\text{trig}} \cdot dN_{\text{assoc}}/d(\Delta\eta)d(\Delta\phi) [\text{rad}^{-1}]$

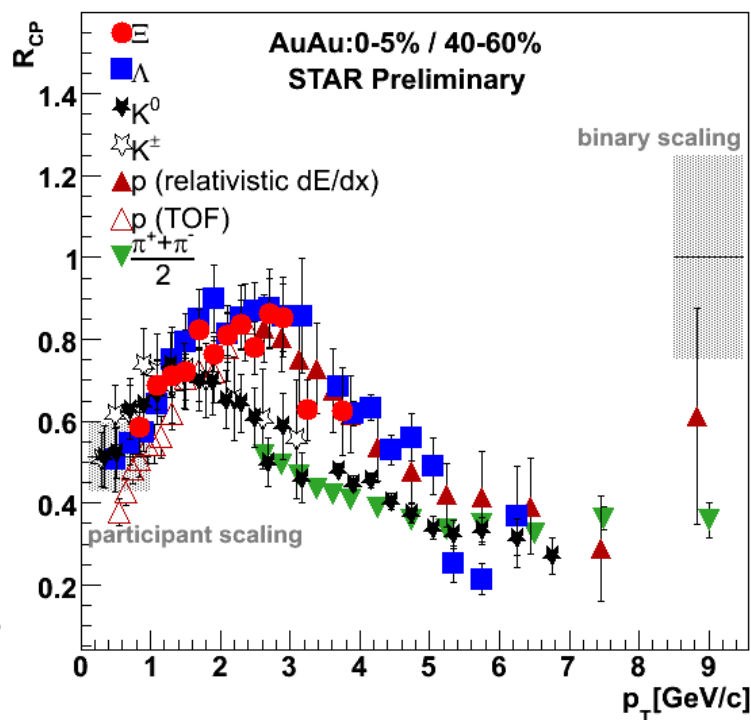
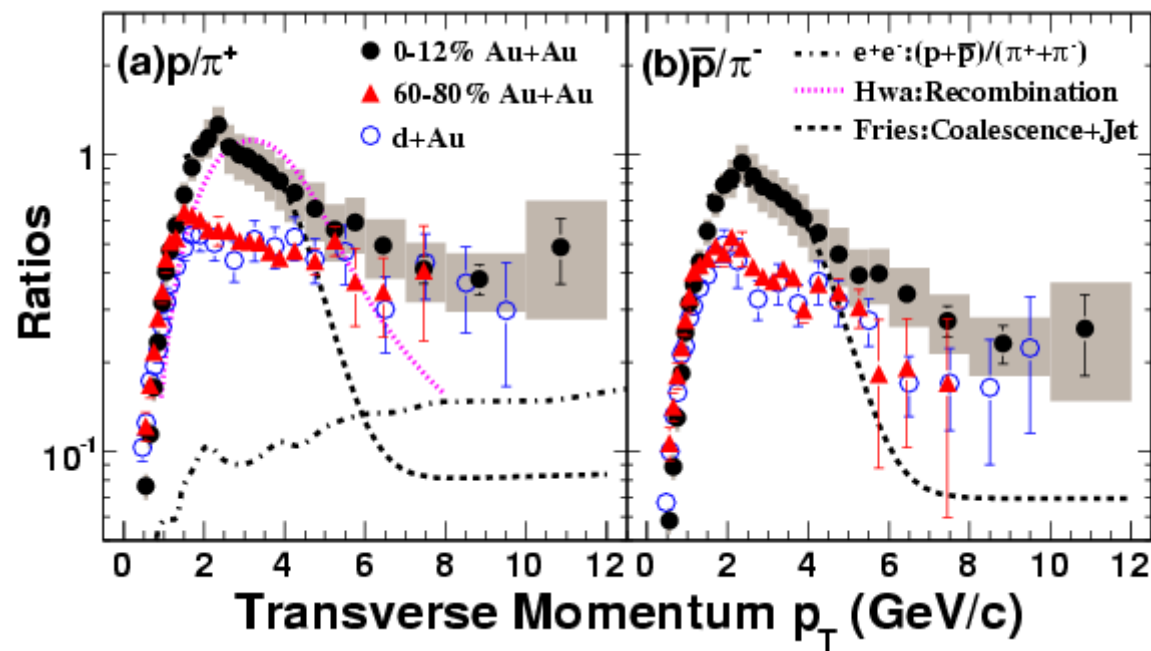
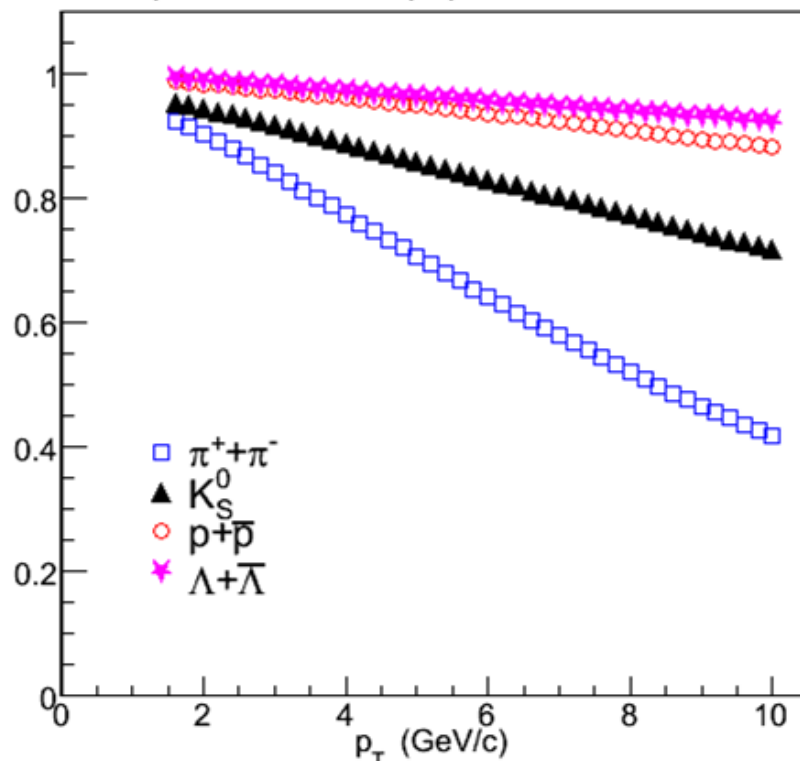


Summary and Outlook

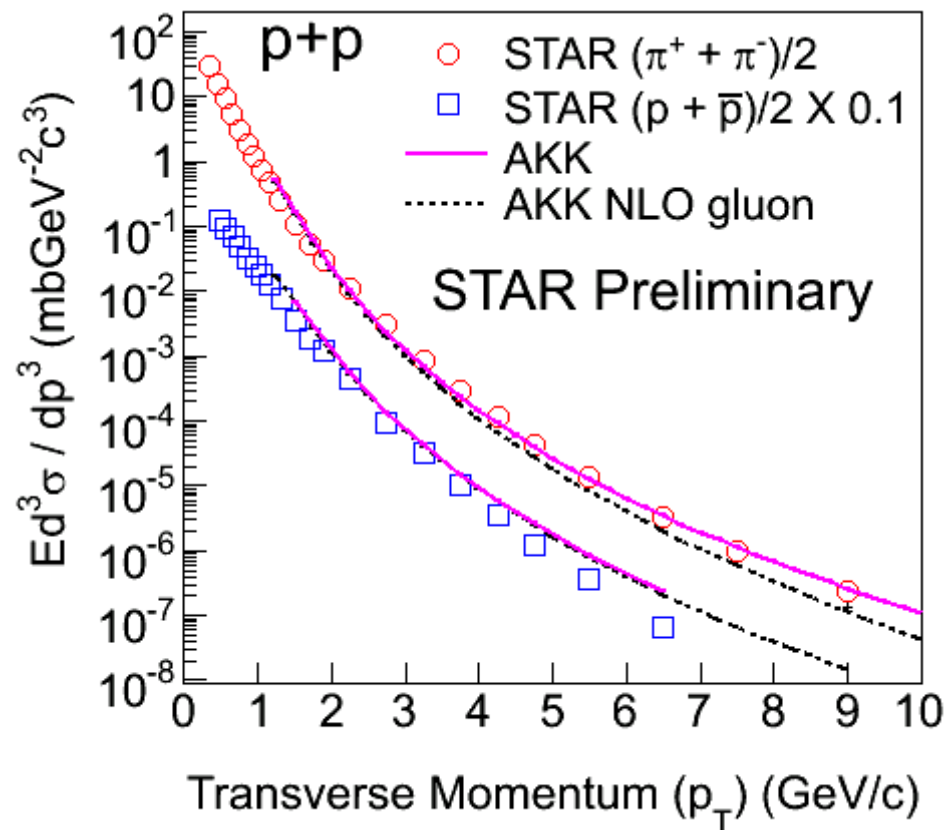
- MC simulations and analysis have been performed to study PID-PID azimuthal correlations at mid-rapidity
- MC shows interesting splitting in associated particle production (p-triggered to hadron-triggered ratios of the yields shows splitting: in pp on the near side and in PbPb on the near and away side as well)
- No experimental measurements to contrast with the observed MC analysis
 - Further Monte Carlo checks needed to have a better understanding...
- Analysis has been started to perform the same analysis exploiting the PID capabilities of ALICE at the LHC
- The observed interesting patterns can be measured at lower momentum in ALICE
 - In principle this can be done by the TPC, statistical method: relativistic dE/dx
 - Purity PID cuts

Backups...

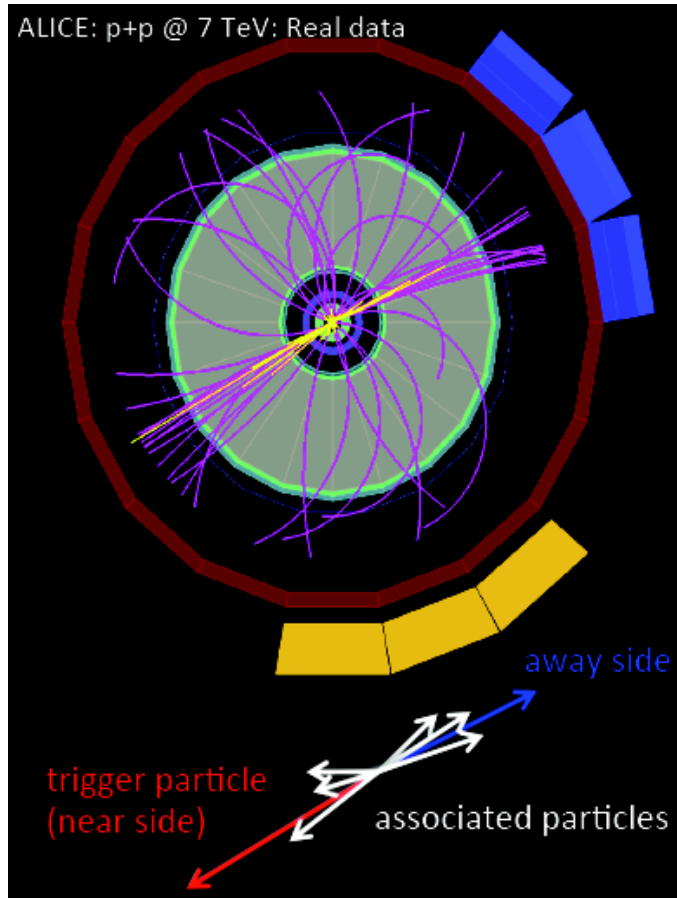
NLO pQCD AKK FF : p+p collisions at 200 GeV



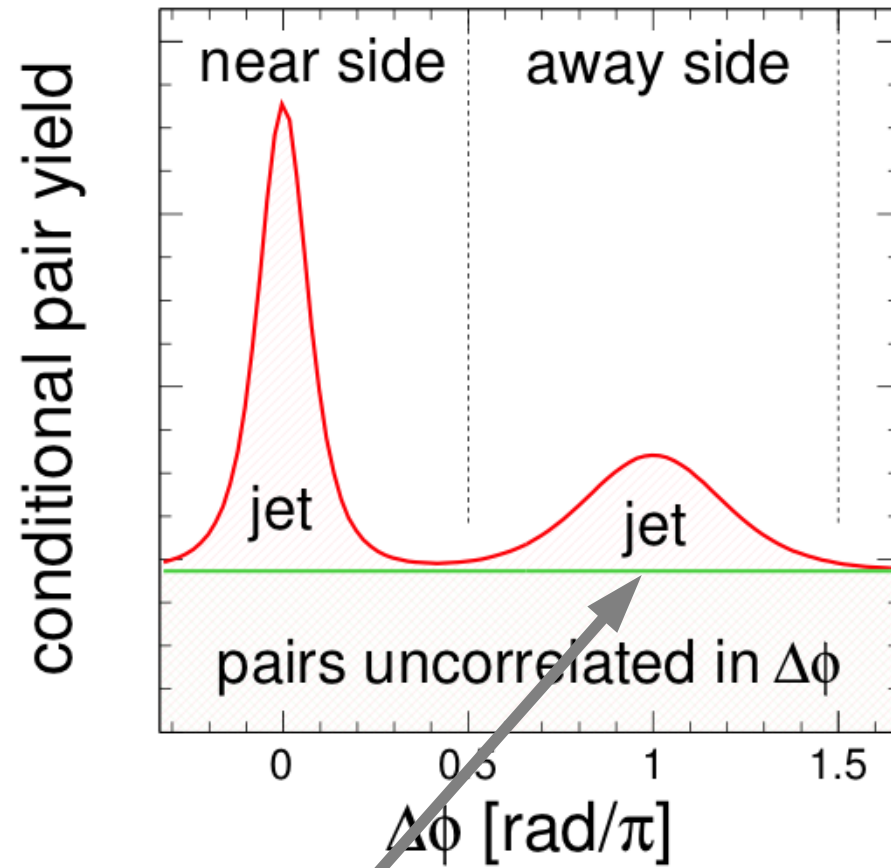
06/12/2013



Azimuthal correlations

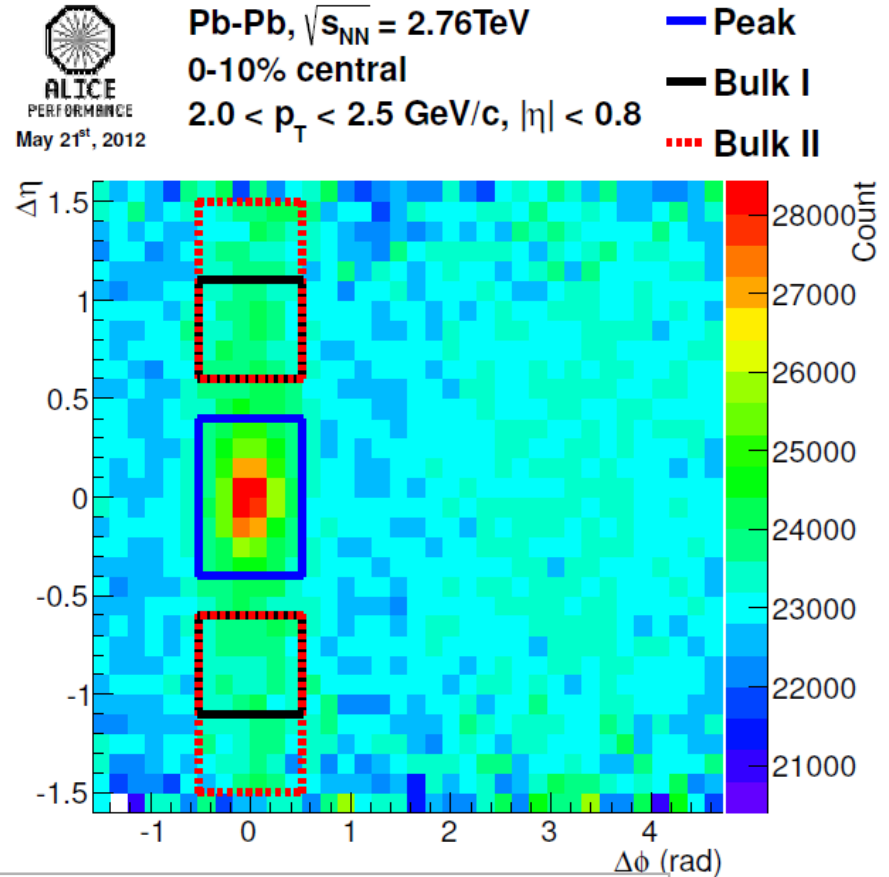


$$\Delta\phi = \phi_{\text{trigger}} - \phi_{\text{assoc}}, \quad \Delta\eta = \eta_{\text{trigger}} - \eta_{\text{assoc}}$$



ZYAM: Zero Yield At Minimum

Azimuthal correlations



Phys.Lett. B719 (2013) 29-41

arXiv:1208.1445v1 [nucl-ex] 7 Aug 2012