Azimuthal correlations of neutral pions and charged jets in pp collisions at 7 TeV and Pb-Pb collisions at 2.76 TeV

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Motivation

Jet measurements play a critical role in probing the hot and high energy-density matter created in heavy-ion collisions through parton energy loss via the observation of the jet structure modification or jet suppression.

Figure 1 shows the position of hard-scattering centers in the transverse plane generated in qPYTHIA. Assuming no in-medium energy loss per unit path length ($\hat{q}$ = 0 GeV^2/fm), the distribution follows the unbiased distribution of hard-scatterings, whereas for large $\hat{q}$ values and high energetic π^0s it is strongly biased towards short jet path lengths [1]. In fact, the same effect maximizes the path length for jet recoiling from a high transverse momentum trigger hadron that mainly comes from the surface of the medium.

In this poster, we report π^0- charged jet azimuthal correlations with high p_T neutral pion triggers measured in pp collisions at √s = 7 TeV and the π^0- charged hadron correlation results in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV as the forthcoming results of π^0- jet analysis in Pb-Pb collisions.

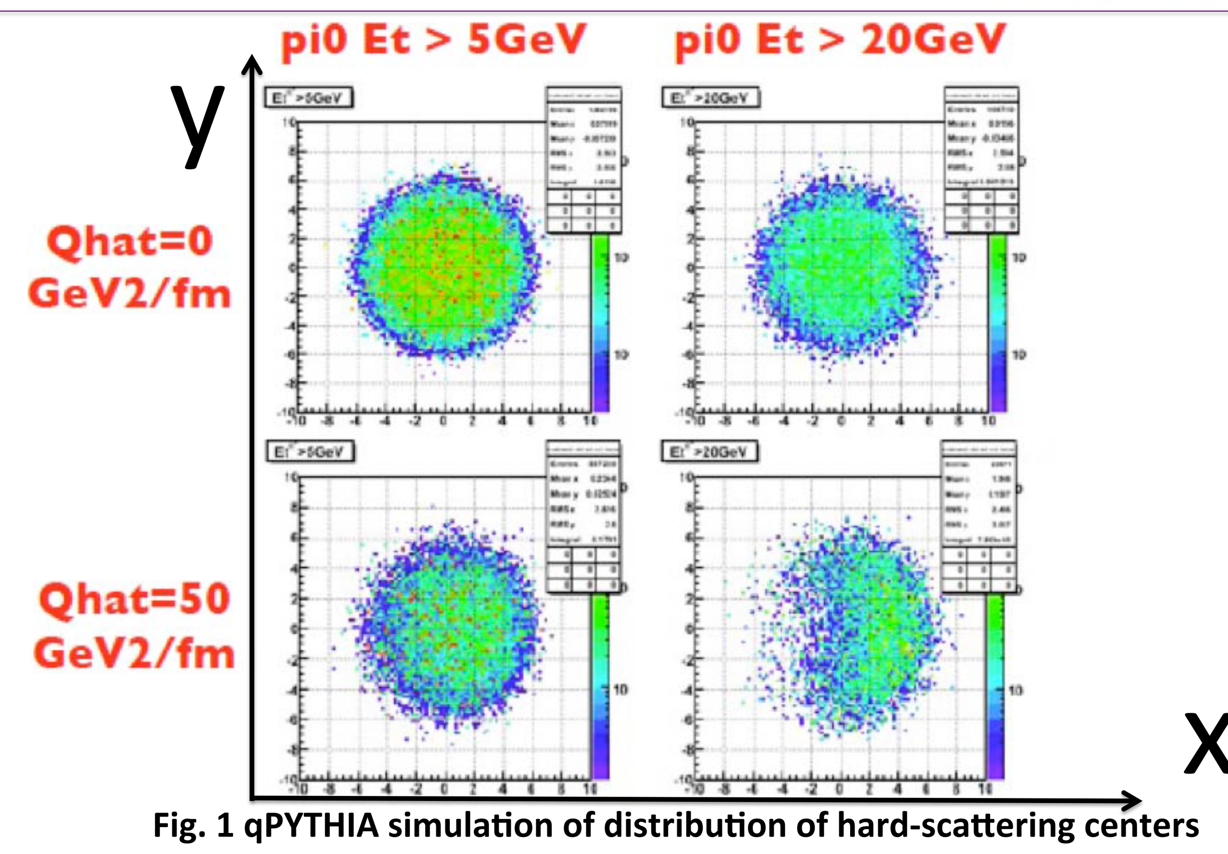

Fig. 1 qPYTHIA simulation of distribution of hard-scattering centers in the transverse plane [2].

ALICE experiment

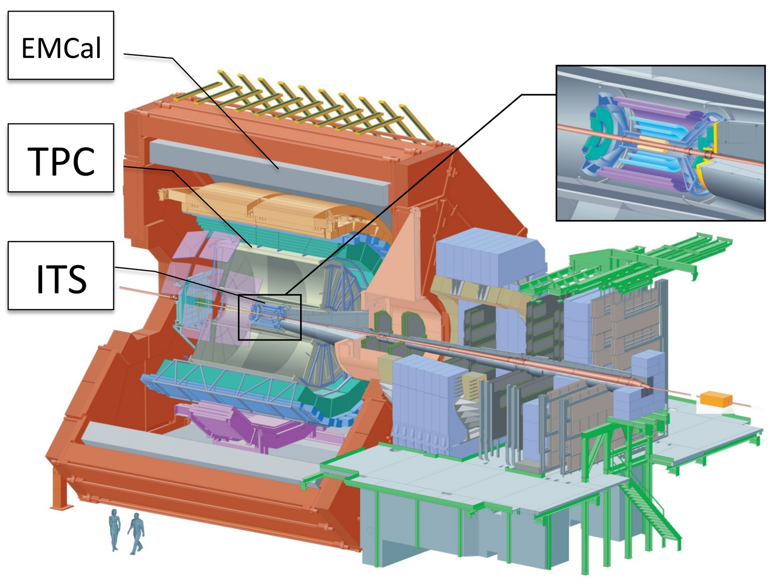

Fig. 2 ALICE detector [3]

The ALICE detector [3] was built to exploit the unique physics potential of nucleus-nucleus interaction at the LHC and is capable of studying jet quenching effects via particle identification and jet reconstruction. This analysis used two types of detectors, the central tracking devices, the inner tracking system ITS and time projection chamber TPC, for charged particle tracks measurement, and the electromagnetic calorimeter EMCal for π^0 measurements. The EMCal was also used as a trigger detector selecting events with energy depositions larger than 4 and 5.5 GeV (the threshold changed during data taking).

Jet reconstruction

Charged particles measured in the TPC and ITS were used to reconstruct jets. We utilized the anti-k_T algorithm [4] from the FastJet package [5].

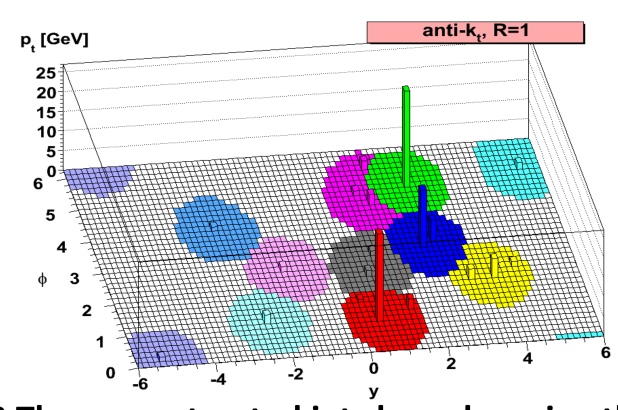

Fig. 3 The reconstructed jet shape by using the anti-k_T algorithm [4].

Jet selection criteria

- Anti-k_T algorithm
- Resolution parameter R = 0.4
- Minimum track p_T > 0.15 GeV/c
- Jet p_T > 10 GeV/c
- Jet pseudorapidity $|\eta_{jet}|$ < 0.5
- Reconstructed jet area A > 0.4

π^0 identification method

Cluster splitting method

1. Select a neutral cluster with λ_0^2 > 0.3, track matching etc. (λ_0: elliptical shower shape long axis)
2. Find local maxima: cells inside the clusters with higher energy than adjacent cells. Used clusters with NLM(Number of Local Maxima) <= 2.
3. Split the cluster in two new sub-clusters taking the two highest local maxima and aggregate all towers around them (form a 3x3 cluster).
4. Selected clusters with sub-clusters having an invariant mass at most 3 sigma from the π^0 mass.

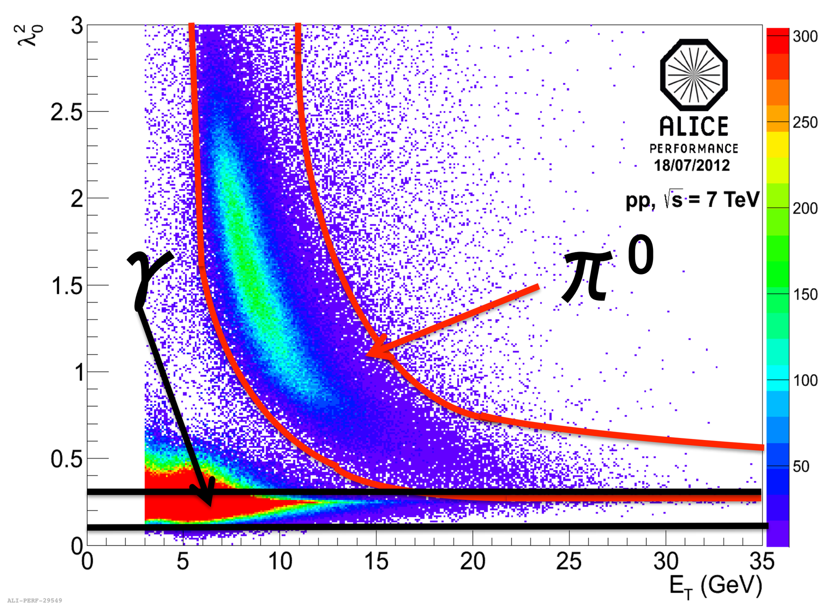

Fig. 4 λ_0^2 vs E_T for neutral clusters.

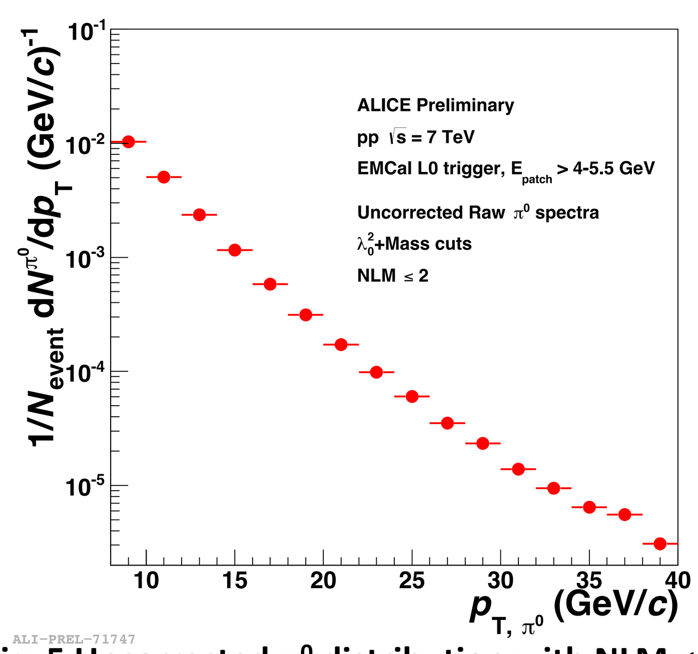

Fig. 5 Uncorrected π^0 distribution with NLM <=2 and applied analysis cuts.

π^0 – jet correlation results in pp 7 TeV

π^0- charged jet azimuthal correlations

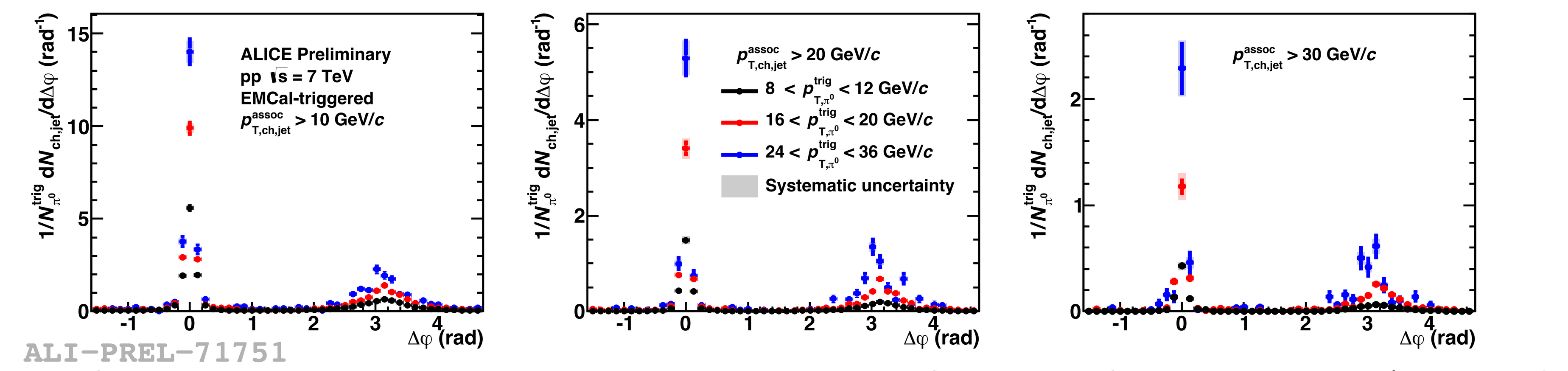

Fig. 6 π^0- jet azimuthal correlations normalized by number of trigger π^0 for trigger π^0 p_T regions 8 < $p_{T,\pi 0}^{trig}$ < 12 GeV/c, 16 < $p_{T,\pi 0}^{trig}$ < 20 GeV/c, 24 < $p_{T,\pi 0}^{trig}$ < 36 GeV/c, and associated jet thresholds $p_{T,ch,jet}^{asso}$ > 10, 20, 30 GeV/c.

Near and away-side width

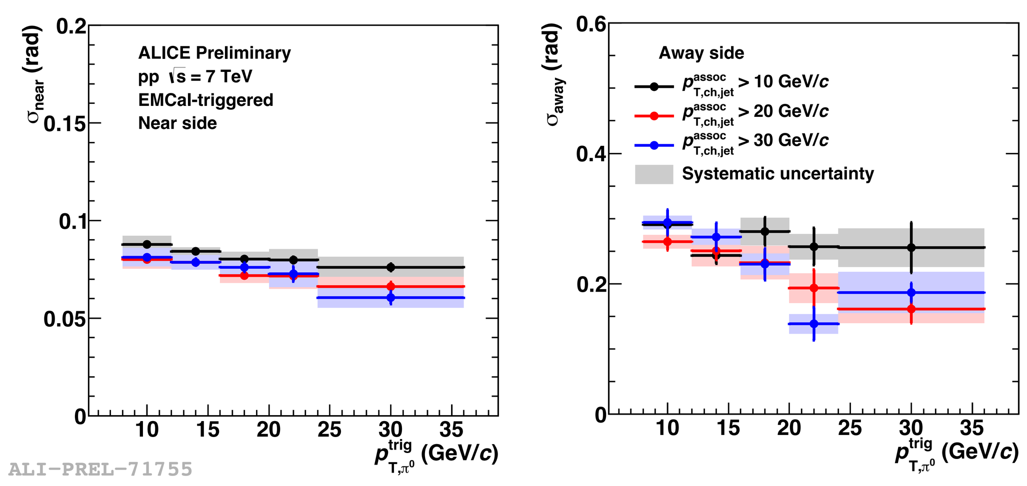

Fig. 7 Near and away-side Gaussian widths as a function of trigger p_T for several charged jet p_T thresholds ($p_{T,ch,jet}^{asso}$ > 10, 20, 30 GeV/c).

1. Azimuthal correlation: two clear jet-like peaks at near and away side of the trigger π^0 are observed in pp collisions.
2. Yields of jet-like peaks increase with increasing π^0 p_T.
3. The near and away-side Gaussian widths decrease moderately with increasing π^0 p_T.

π^0 – charged hadron correlation in Pb-Pb 2.76 TeV

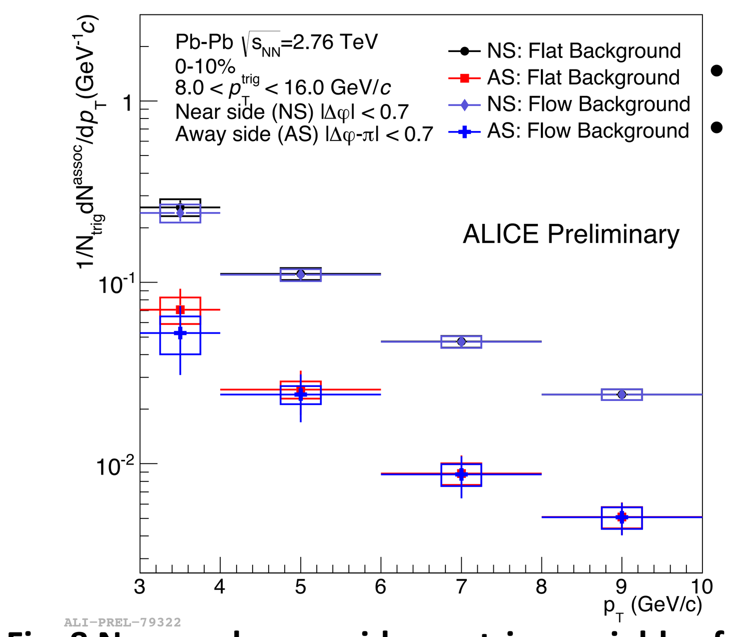

Fig. 8 Near and away-side per trigger yields of charged hadrons for π^0 triggers with 8 < $p_{T,\pi 0}^{trig}$ < 16 GeV/c.

- Flat background subtraction: ZYAM method [6]
- Flow background subtraction:

$$J(\Delta\varphi) = C(\Delta\varphi) - b_0\left(1+2\langle v_2^{trig} v_2^{assoc}\rangle \cos(2\Delta\varphi)\right)$$

- $C(\Delta\varphi)$: per trigger normalized measured azimuthal correlation function.
- $J(\Delta\varphi)$: per trigger normalized jet-like correlation after elliptic flow background subtraction.
- b_0 : background scale factor obtained from the ZYAM method [6].

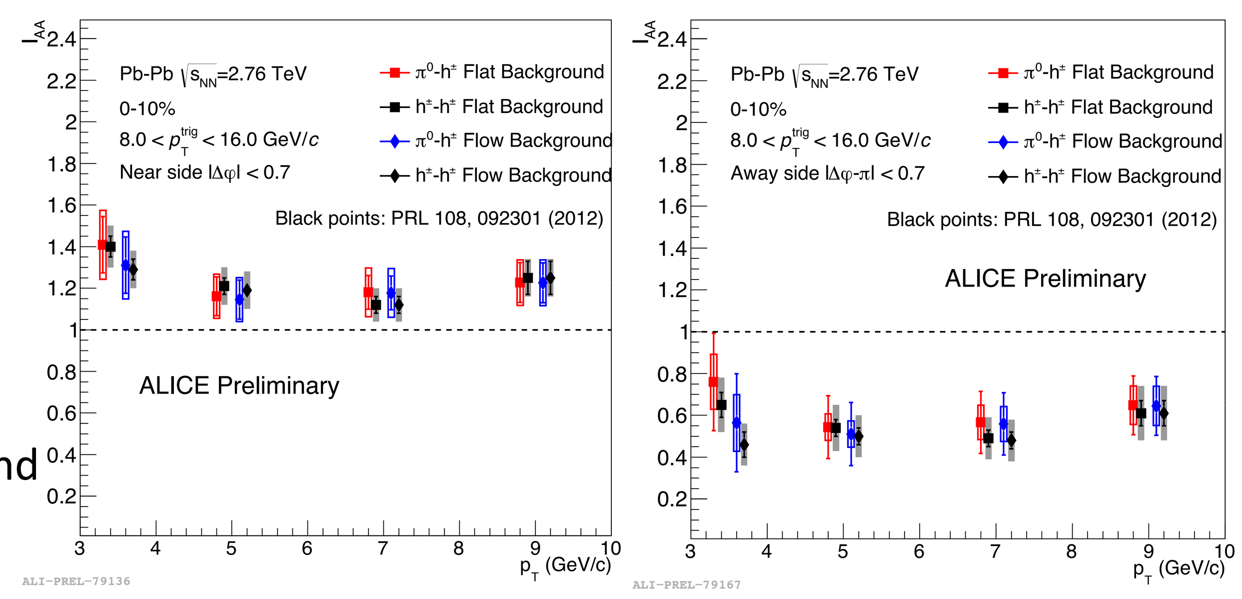

Fig. 9 Near and away-side ratio of per trigger yields of charged hadrons (I_{AA}) for π^0 triggers with 8 < $p_{T,\pi 0}^{trig}$ < 16 GeV/c.

The Ratio of per trigger yields I_{AA} is defined as

$$I_{AA}(p_T^{\pi^0}, p_T^{h^\pm}) = \frac{Y^{PbPb}(p_T^{\pi^0}, p_T^{h^\pm})}{Y^{pp}(p_T^{\pi^0}, p_T^{h^\pm})}$$

- Small enhancement of near-side and suppression of away-side yields observed in π^0-hadron analysis.

Summary

- π^0- jet correlations have been measured in pp collisions at √s = 7 TeV with cluster splitting method
- Two clear jet peaks are observed, indicating that high p_T production is correlated with jet production
- Both near and away-side widths are decreasing with increasing p_T of the trigger π^0. The decrease is stronger for the away-side correlation width
- Enhancement of near-side and suppression of away-side yields in Pb-Pb collisions in π^0- hadron correlation observed
- The next step is to extend the π^0-hadron analysis to π^0- jet analysis and measure the trigger π^0 p_T dependence of the ratio of per trigger jet yields I_{AA} in Pb-Pb at $\sqrt{s_{NN}}$ = 2.76 TeV

References

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