Azimuthal correlations of neutral pions and charged jets in pp collisions at √s = 7 TeV

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ALICE

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 possible jet structure modification or jet suppression.

Fig.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 GeV²/fm), the distribution follows the unbiased distribution of hard scatterings, whereas for a large $\hat{q}$ values and high energetic π^0s it is strongly biased towards short jet path lengths. 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 by the ALICE experiment at LHC.

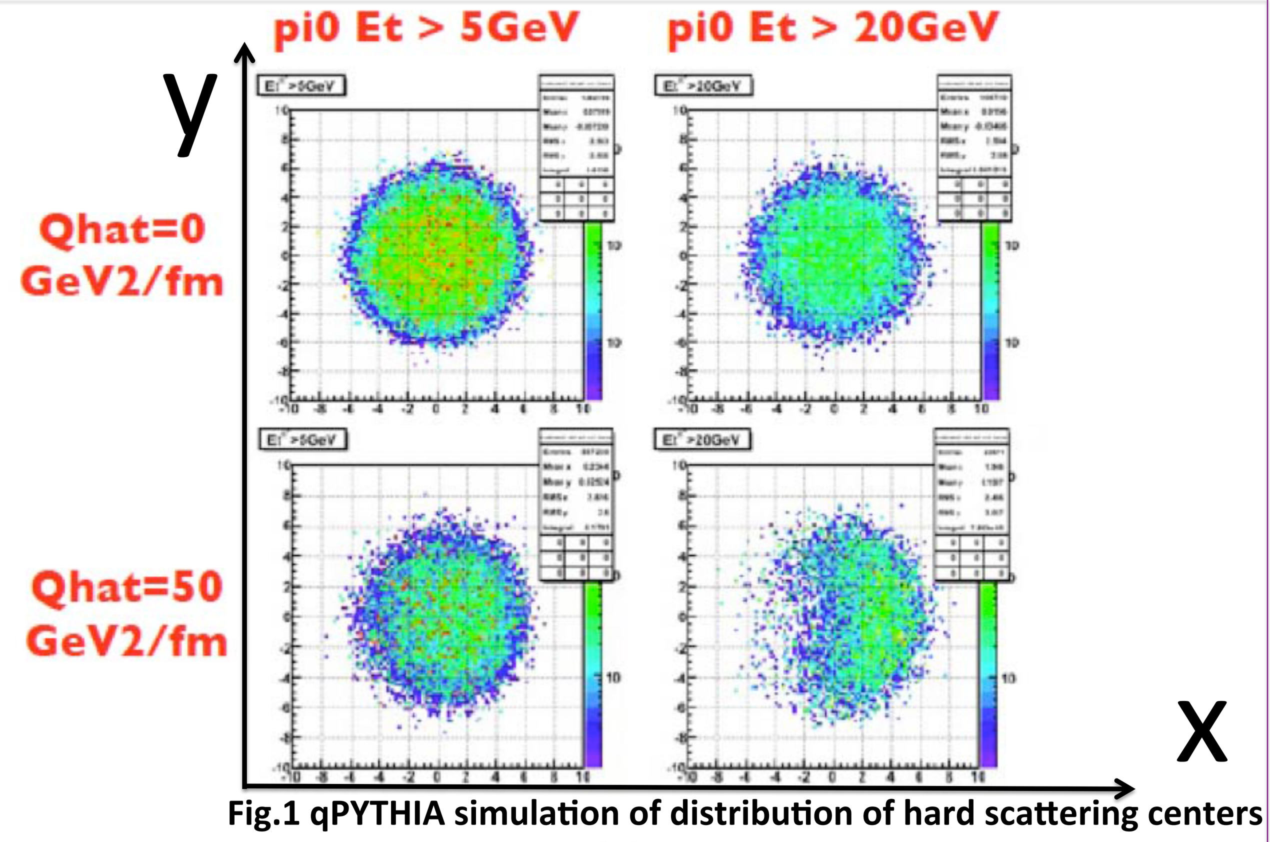

Fig.1 qPYTHIA simulation of distribution of hard scattering centers in the transverse plane [1].

ALICE experiment

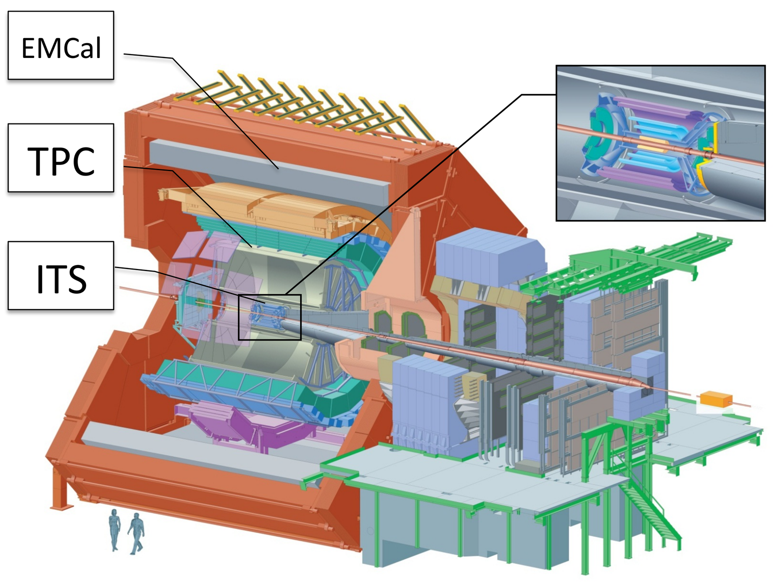

Fig.2 ALICE detector [2]

The ALICE detectors [2] were built to exploit the unique physics potential of nucleus-nucleus interaction at the LHC and are capable of studying jet quenching effects via particle identification and jet reconstruction. This analysis used two kinds of detectors, the central tracking devices, ITS and 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 the jets. We utilized the anti-k_T algorithm [3] from the FastJet package [4].

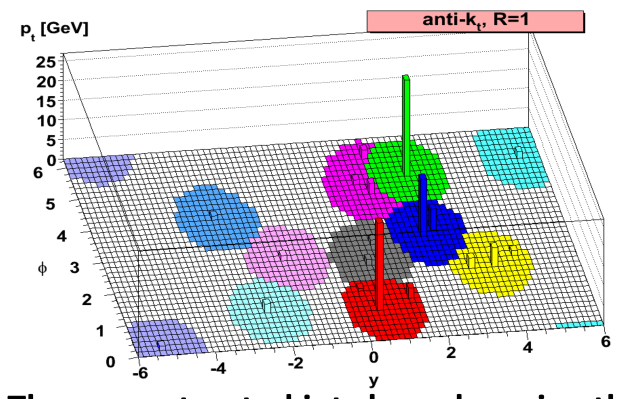

Fig.3 The reconstructed jet shape by using the anti-k_T algorithm [3].

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

Particles deposit their energy in several calorimeter cells forming a cluster with ellipsoidal shape. The opening angle of the neutral meson decay photons becomes smaller due to the Lorentz boost with increasing energy of the neutral meson.

In the EMCal, the two showers of the decay photons start to overlap when the π^0 energy is larger than 5 GeV.

Shower shape

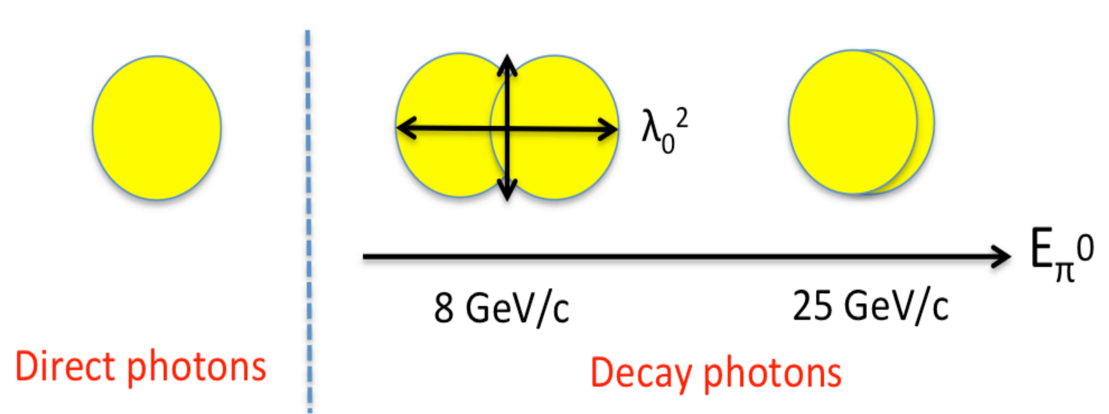

Fig.4 The shower shape geometries of direct photons and decay photons.

Shower shape parameter

The width along cluster main axis, λ_0^2, is used to separate merged photon clusters from single photon clusters and as seen in Fig.5 up to 20 GeV the separation is quite good.

$$\lambda^2_{0(1)} = 0.5(\delta_{\varphi\varphi}+\delta_{\eta\eta}) \pm \sqrt{0.25(\delta_{\varphi\varphi}-\delta_{\eta\eta})^2+\delta^2_{\varphi\eta}}$$

$$\delta_{xy} = \sum_i \frac{w_i X_i Y_i}{w_{tot}} - \sum_i \frac{w_i X_i}{w_{tot}} \sum_i \frac{w_i Y_i}{w_{tot}}, \quad (X,Y=\varphi,\eta)$$

$$w = Max\left(0, w_0 + \log\left(\frac{E_{cell}}{E_{cluster}}\right)\right), \quad w_0 = 4.5$$

where i is a cell of the cluster

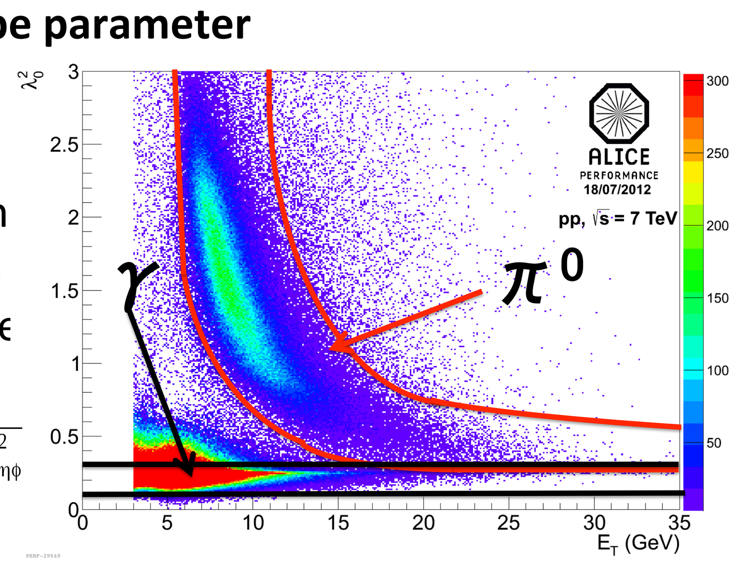

Fig.5 λ_0^2 vs E_T for neutral clusters.

Cluster splitting method

1. Select a neutral cluster with λ_0^2 > 0.3, track matching etc.
2. Find local maxima: cells inside the clusters with higher energy than adjacent cells. Used clusters with NLM <=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.

Cluster selection

- Cell with highest energy in a cluster must be 1 cell away from border of the calorimeter
- Clusters must contain at least 4 cells
- Removal of the cluster containing a bad channel and exotic clusters (high energy deposition in a single tower due to neutron/anti-neutrons)
- Timing cut : -25 < time < 20 ns
- Charged particle veto : track matching $\Delta\varphi$ > 0.03, $\Delta\eta$ > 0.25

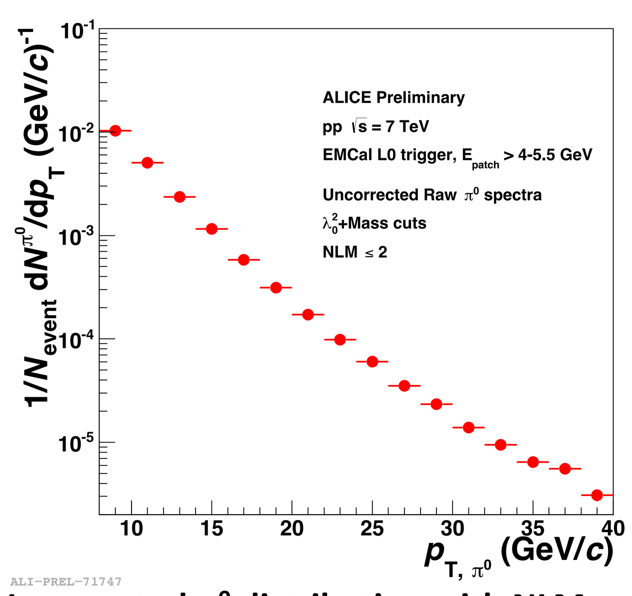

Fig.6 Uncorrected π^0 distribution with NLM <=2 and applied analysis cuts.

Results

π^0- charged jet azimuthal correlations

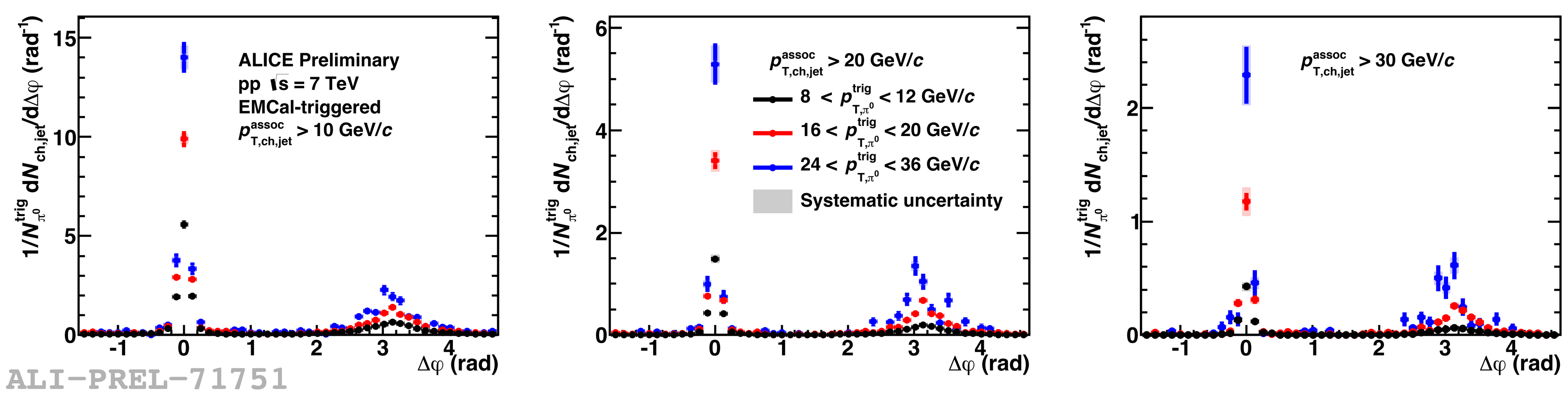

Fig.7 π^0-jet azimuthal correlations normalized by number of trigger π^0 for trigger π^0 p_T regions $8 < p_T^{trig} < 12$ GeV/c, $16 < p_T^{trig} < 20$ GeV/c, $24 < p_T^{trig} < 36$ GeV/c, and associated jet thresholds $p_T^{asso} > 10, 20, 30$ GeV/c.

Near and away-side width

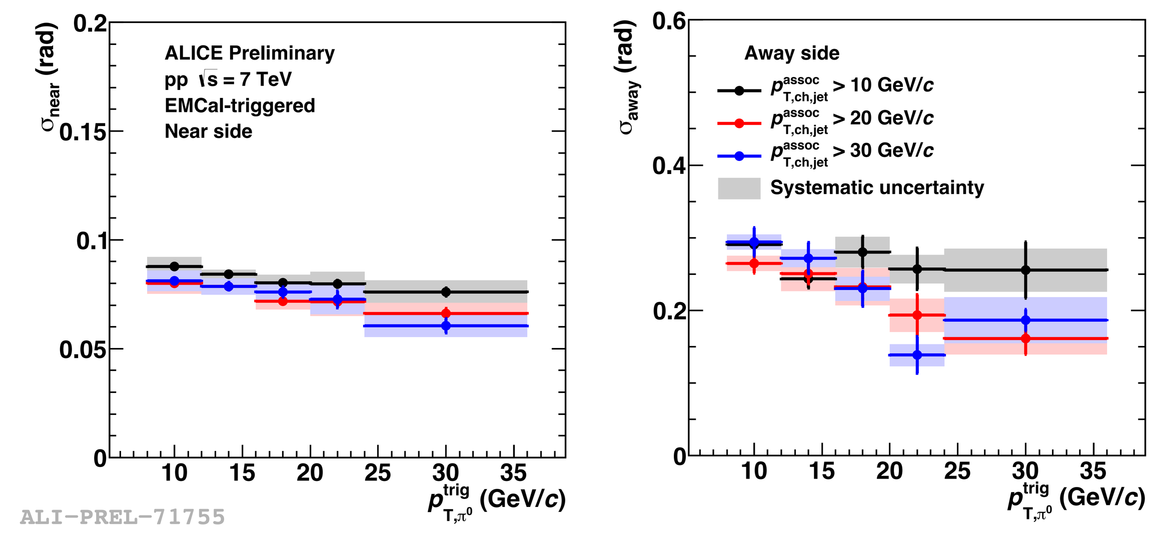

Fig.8 Near and away-side Gaussian widths as a function of trigger p_T for several charged jet p_T thresholds (p_T^{asso} > 10, 20, 30 GeV/c).

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
- This measurement provides an important baseline for Pb-Pb data

References

[1] ALICE Collaboration, J. Allen, et al, CERN-LHCC-2010-011, ALICE-TDR-014-ADD-1
[2] ALICE Collaboration, arXiv:1402.4476v2
[3] M. Cacciari, G. P. Salam and G. Soyez et al, JHEP 0804 (2008) 063
[4] M. Cacciari, G. P. Salam and G. Soyez et al, CERN-PH-TH/2011-297

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