Neutral pion and jet measurements in Pb-Pb collisions $\sqrt{s_{NN}}$ = 2.76 TeV

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Outline

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  - Jet analysis in heavy-ion collisions
  - Physics motivation of π^0 – jet correlation measurements
- Analysis procedure
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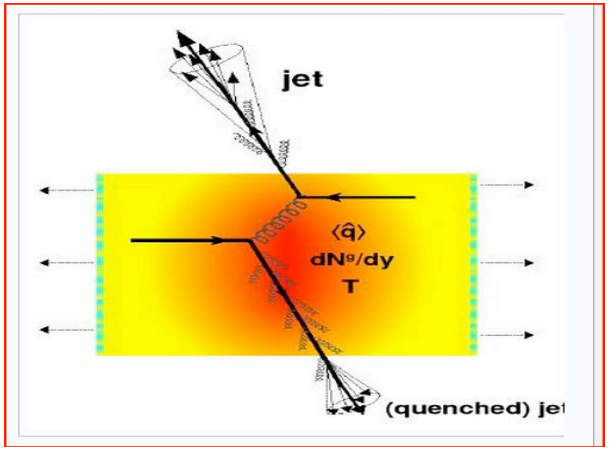
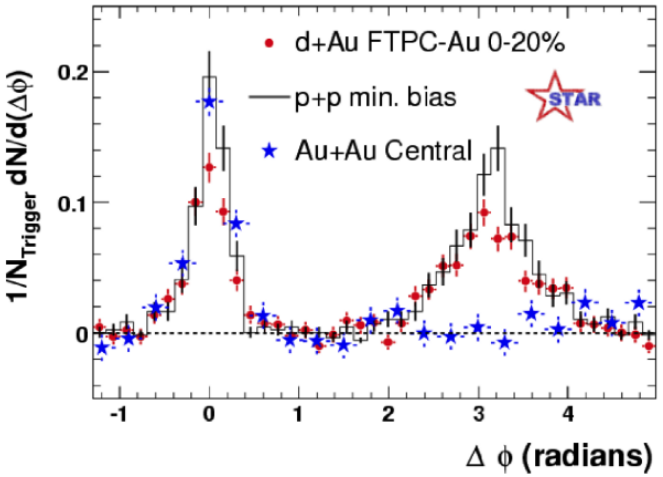
- Summary

Jet analysis in heavy-ion collisions

- Jet quenching
  - disappearance of away side jet ($\Delta\phi = \pi$).
  - energy loss of hard scattered parton in QGP.

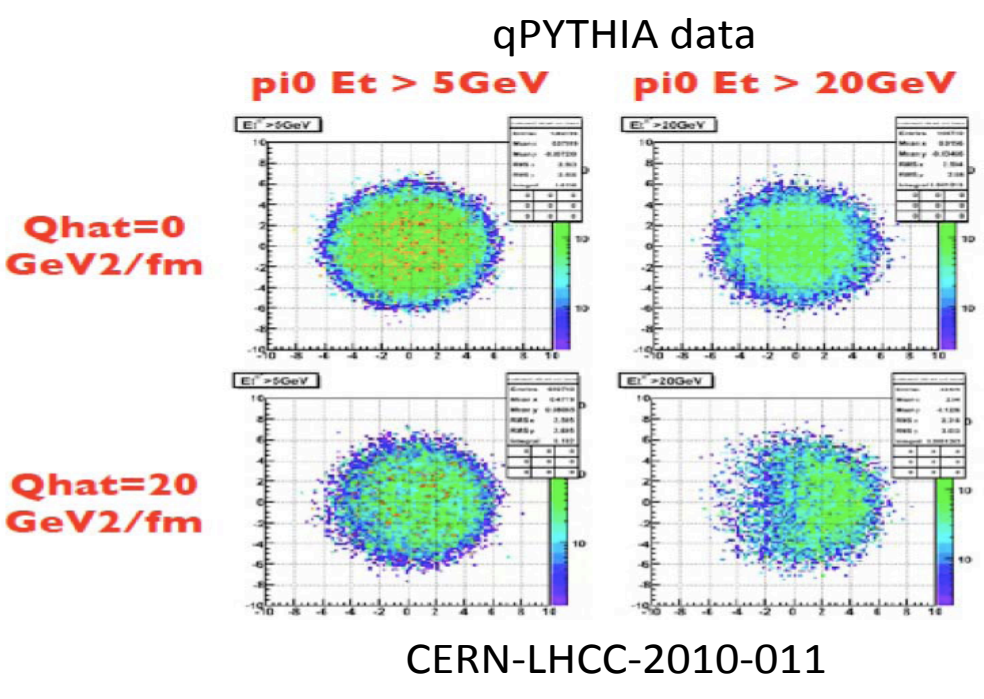
- Hadron-hadron correlation
  - biased towards a surface of the matter due to strong quenching.



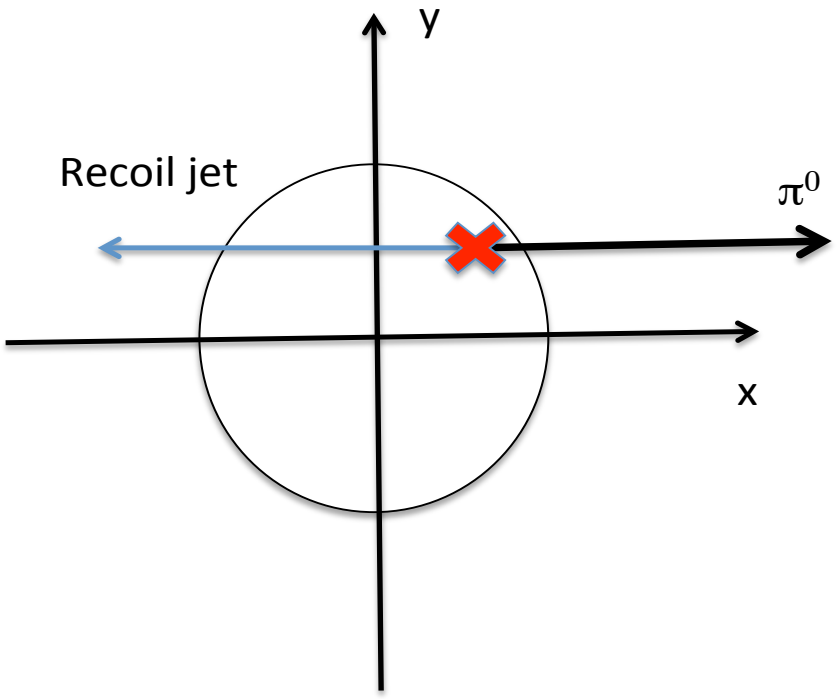


Two particle correlation
Phys. Rev. LeY. 91, 072304 (2003)

π^0 – jet correlation

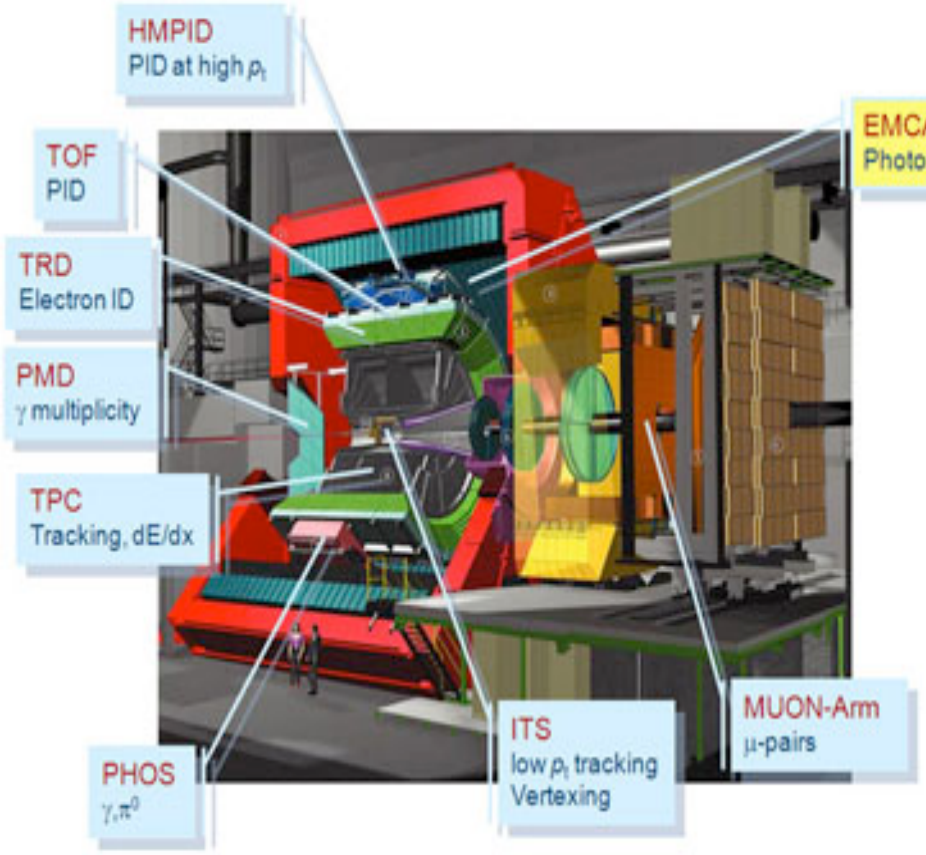


CERN-LHCC-2010-011



- Can control path length by tagging a recoil jet with triggered π^0 and changing p_T for π^0.
- If π^0 p_T is high, path length of recoil jets is long.
- If π^0 p_T is low, path length of recoil jets is short.
- Direct measurement of path length dependence of "jet" quenching, not by hadron.

ALICE experiment



- Data taking
  - 2009 : pp 900 GeV
  - 2010 : pp 7TeV, Pb-Pb 2.76TeV
  - 2011 : pp 2.76TeV 7TeV, Pb-Pb 2.76TeV
  - 2012 : pp 7TeV 8TeV, p-Pb 5.02TeV

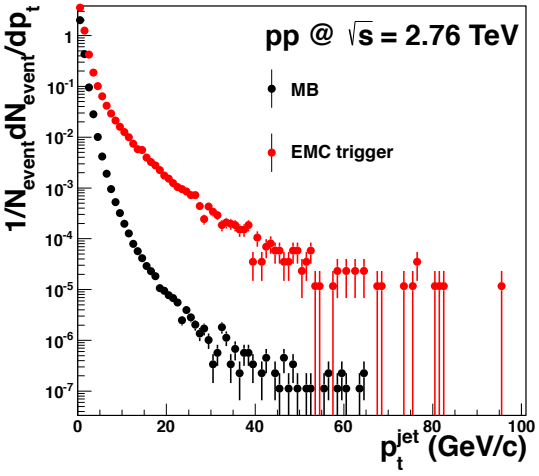
- V0 detector
  - centrality determination
- ITS+TPC
  - charged particle reconstruction
  - jet reconstruction
- EMCAL
  - π^0 reconstruction

Data set and analysis cuts

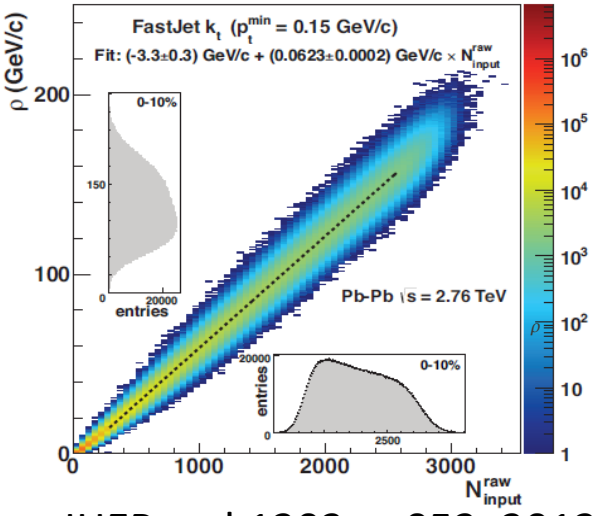
- Data:
  - pp collisions $\sqrt{s}$ = 2.76 TeV (run 11)
  - Pb-Pb collisions $\sqrt{s_{NN}}$ = 2.76 TeV (run 11)
- Event selection
  - vertex Z < 10 cm
  - pp analysis
    EMC photon trigger events (0.4M)
  - Pb-Pb analysis
    minimum bias events (18M)
    EMC photon trigger events (18M)
- Track selection
  - hybrid track cuts with ITS refit

Jet reconstruction

- Jet reconstruction(pp,Pb-Pb)
  - anti_k_T algorithm
  - cone radius : 0.4
  - input minimum track : p_T > 0.15 (GeV/c)
  - jet area : A > 0.4



- Estimated BKG density(Pb-Pb)
  - k_T algorithm
  - cone radius : 0.4
  - input minimum track : p_T > 0.15 (GeV/c)



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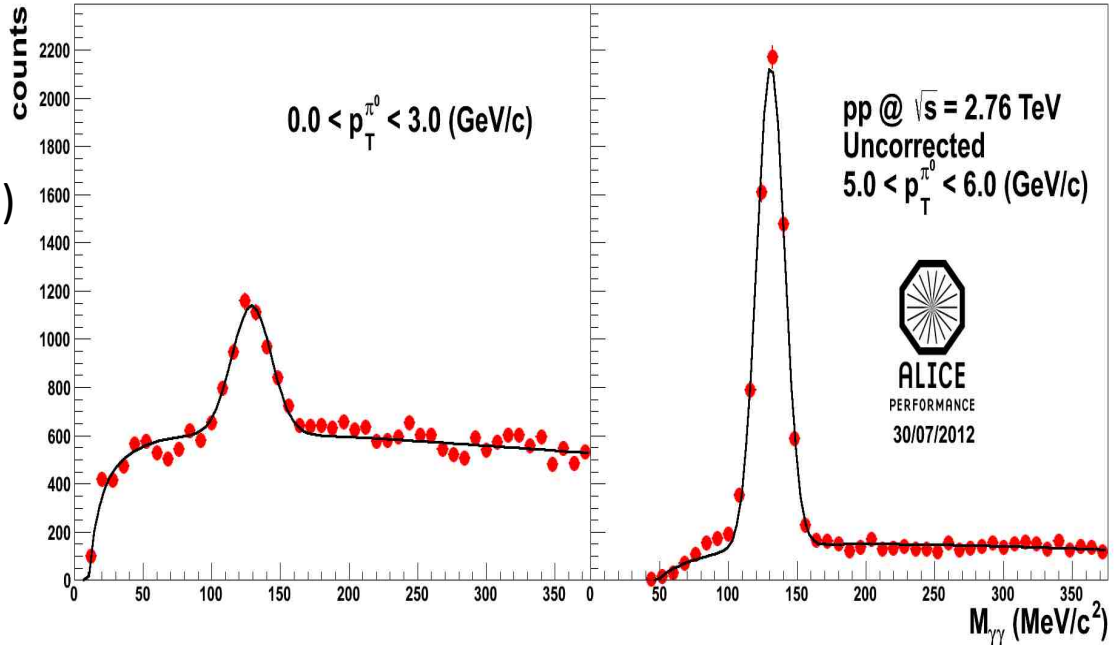
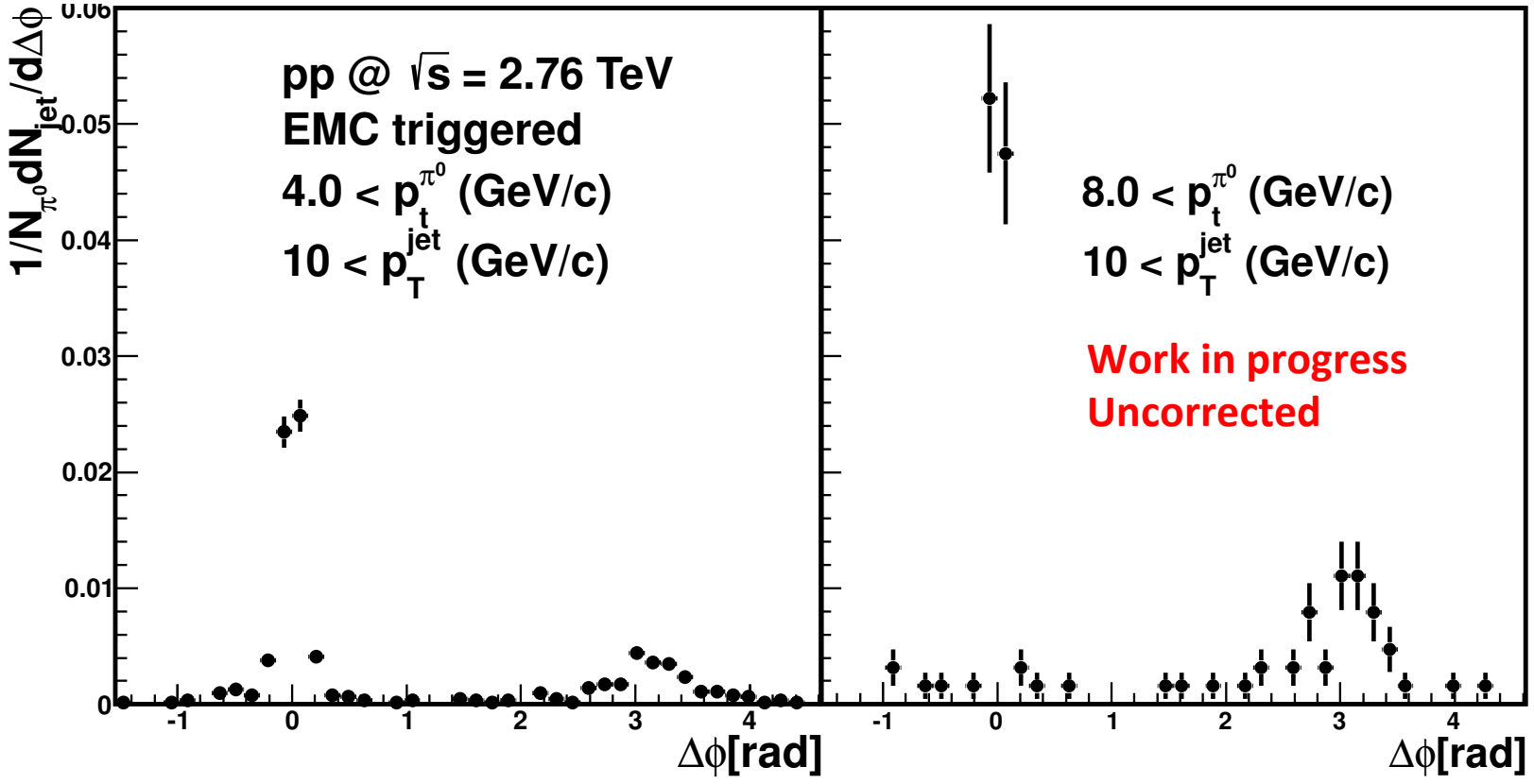
π^0 reconstruction

- Cut
  - track matching ($|\Delta\phi| < 0.03$, $|\Delta\eta| < 0.015$)
  - $M_{02} < 0.4$
  - # of cell in cluster > 2
  - min cluster energy > 0.5 GeV
  - energy asymmetry < 0.7
  - rejected bad channels and exotic clusters



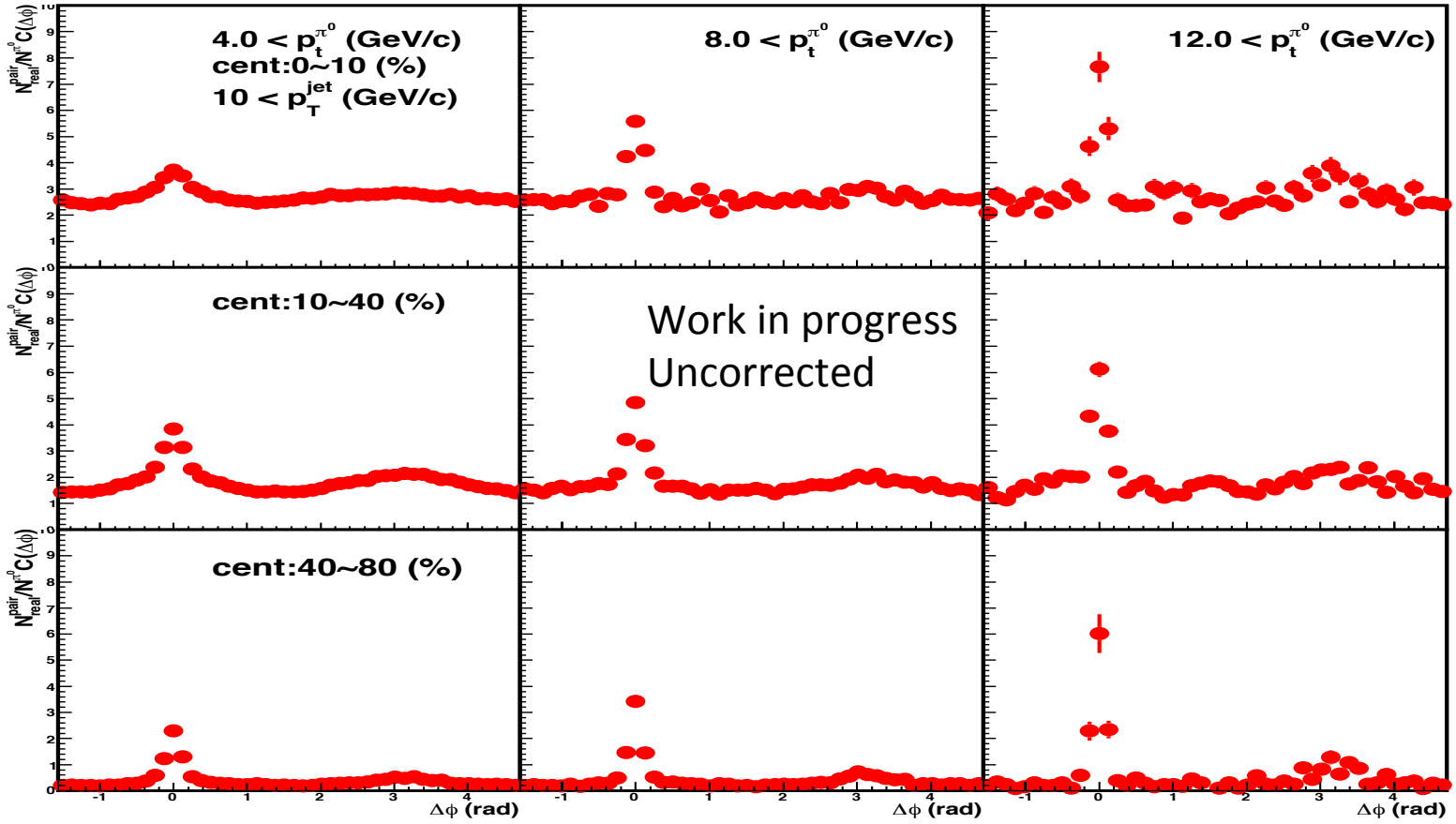
- Veto clusters generated by charged particles.
- Rejected exotic clusters and bad channels.
- BKG level decreases with increasing p_T region.

π^0 – jet correlations in pp collisions



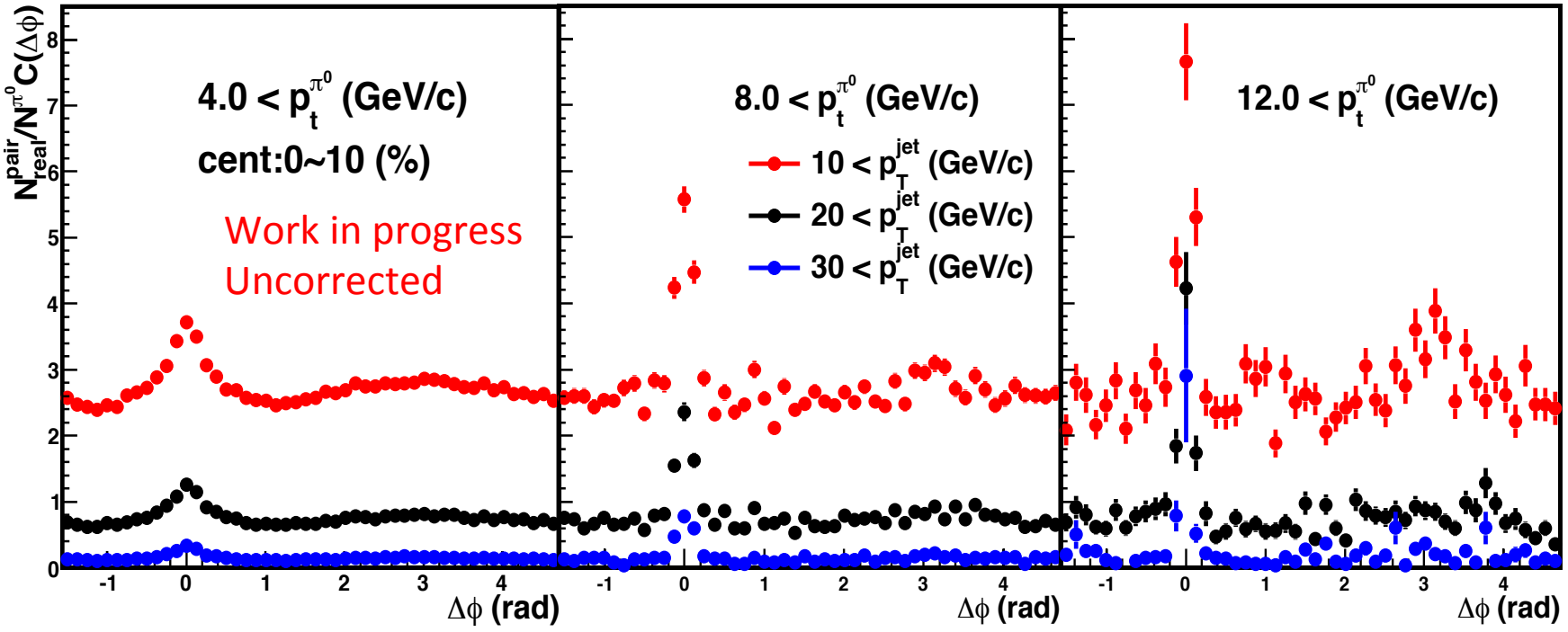
- Two clear jet peaks are observed, indicating that high p_T π^0 production is related to jet production.

π^0 – jet azimuthal correlations in Pb-Pb collisions



- Observed higher near and away side peaks on the BKG, by increasing trigger π^0 $p_{T.}$
- BKG level decreases from central to peripheral.

Jet p_T dep. Of π^0 - jet azimuthal correlations



- BKG level decreases with increasing jet p_T
  - decreasing the combinatorial background
  - can select signal jets by increasing jet p_T region

Summary

- π^0 – jet correlations have been measured in pp collisions and Pb-Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV in ALICE.
- pp collisions

  -Clear back-to-back jets with high p_T π^0 are seen for pp collisions.
- Pb-Pb collisions

  - Near and away side peaks are more higher as against BKG level at high p_T region.

  - BKG level decrease with going to peripheral collisions and increase jet p_T.
- Next to do

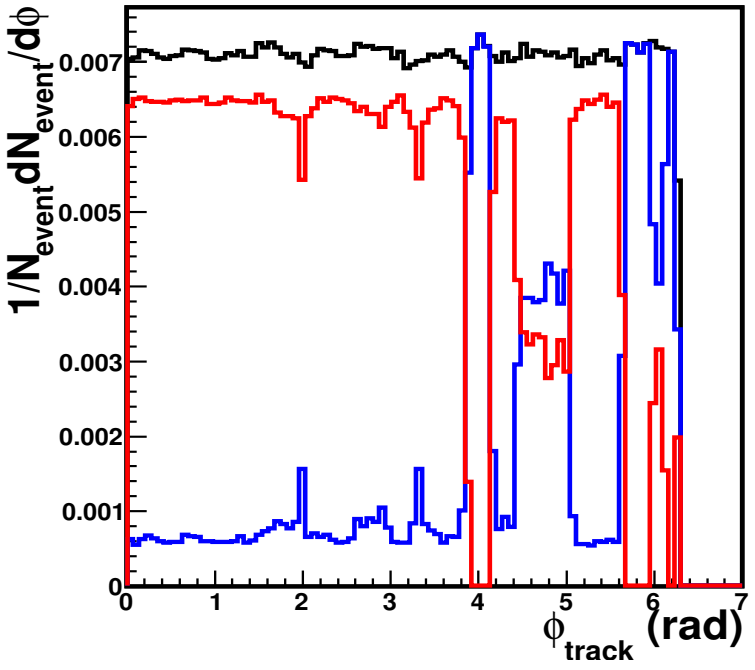
  - Will start shower shape analysis of EMCAL to get high p_T π^0(30 GeV ~).

Back up

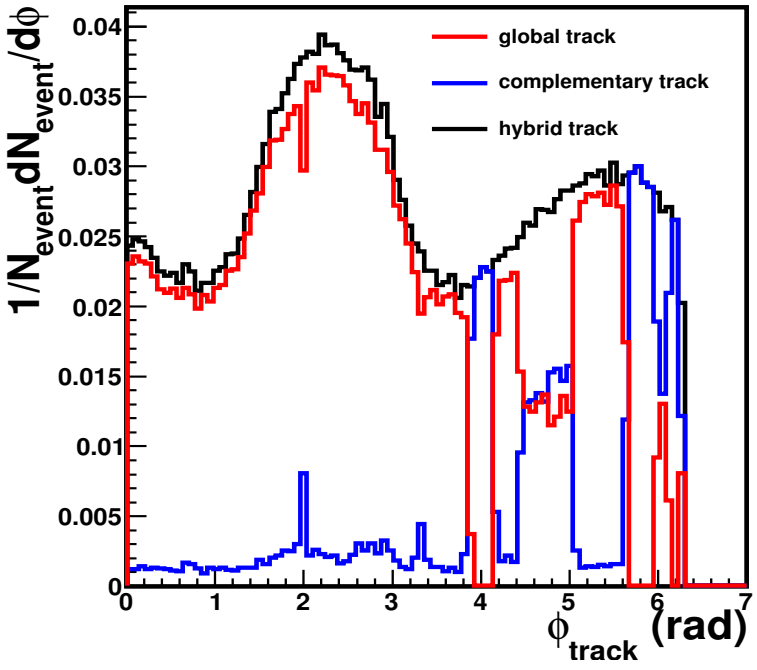
Charged particle reconstruction

- Hybrid track cut : constructed by a combination two track classes
  - Global track : used SPD hits
  - Complementary track : used collision vertex instead of SPD hits

Minimum bias trigger



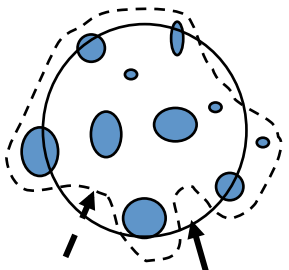
EMCAL photon trigger



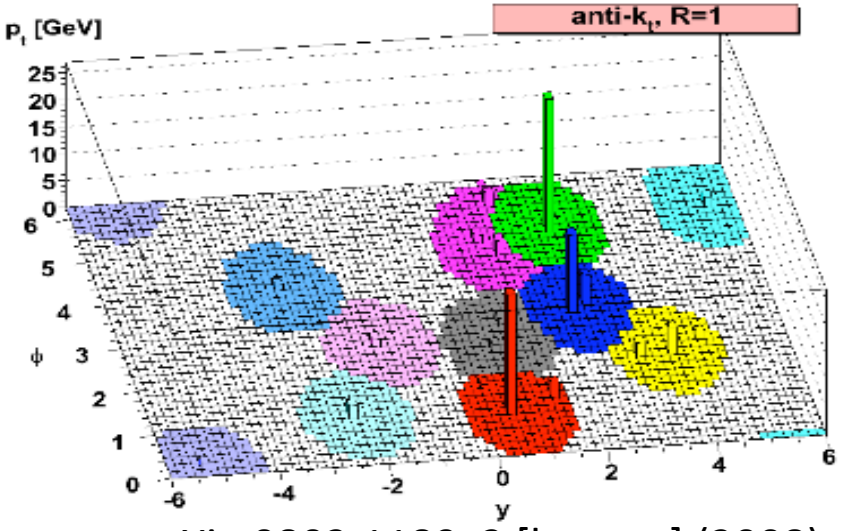
Jet Reconstruction (FASTJET)

$$d_{ij} = \min(k_{ti}^{2p}, k_{tj}^{2p}) \frac{\Delta R^2}{R^2} \begin{cases} p = 1 \\ p = 0 \\ p = -1 \end{cases}$$

k_T algorithm
Cambridge / Aachen algorithm
anti-k_T algorithm

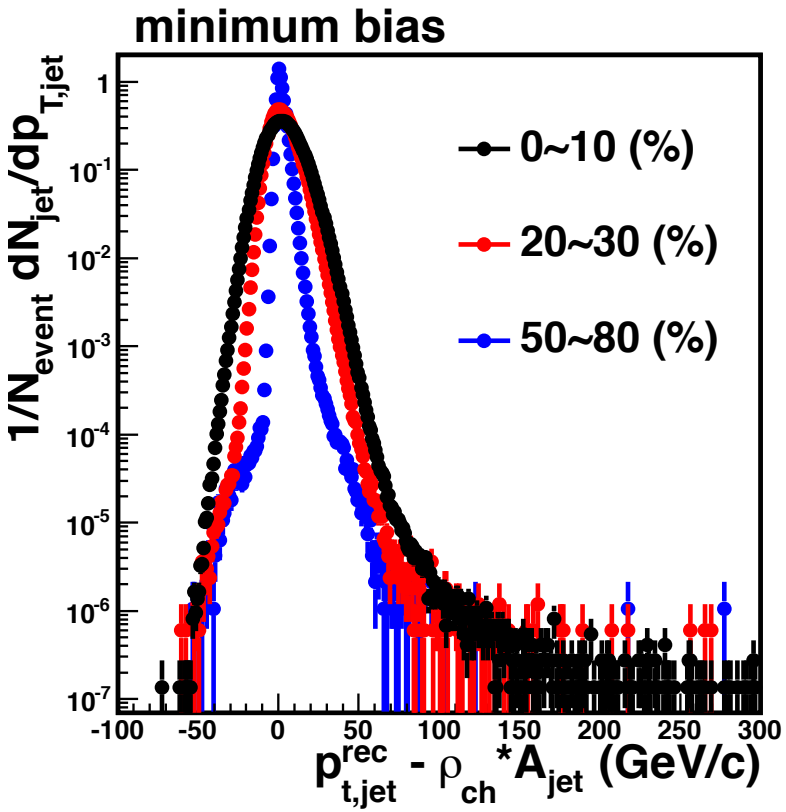


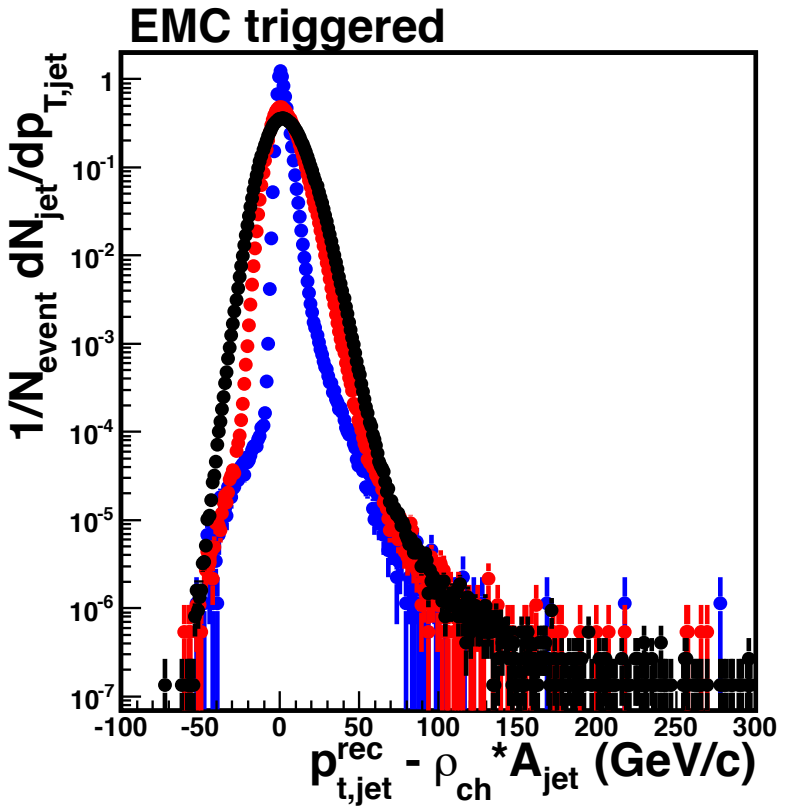
- Procedure of jet finding
  1. Calculate particle distance : d_{ij}
  2. Calculate Beam distance : d_{iB}
  3. Find smallest distance : d_{ij} or d_{iB}
  4. If d_{ij} is smallest combine particles
     If d_{iB} is smallest and
     the cluster momentum
     larger than threshold
     call the cluster a jet
- Parameter
  - anti-k_T algorithm
  - cone radius : 0.4
  - input track p_T > 0.15 (GeV)
  - jet area > 0.4



arXiv:0802.1189v2 [hep-pn] (2008)

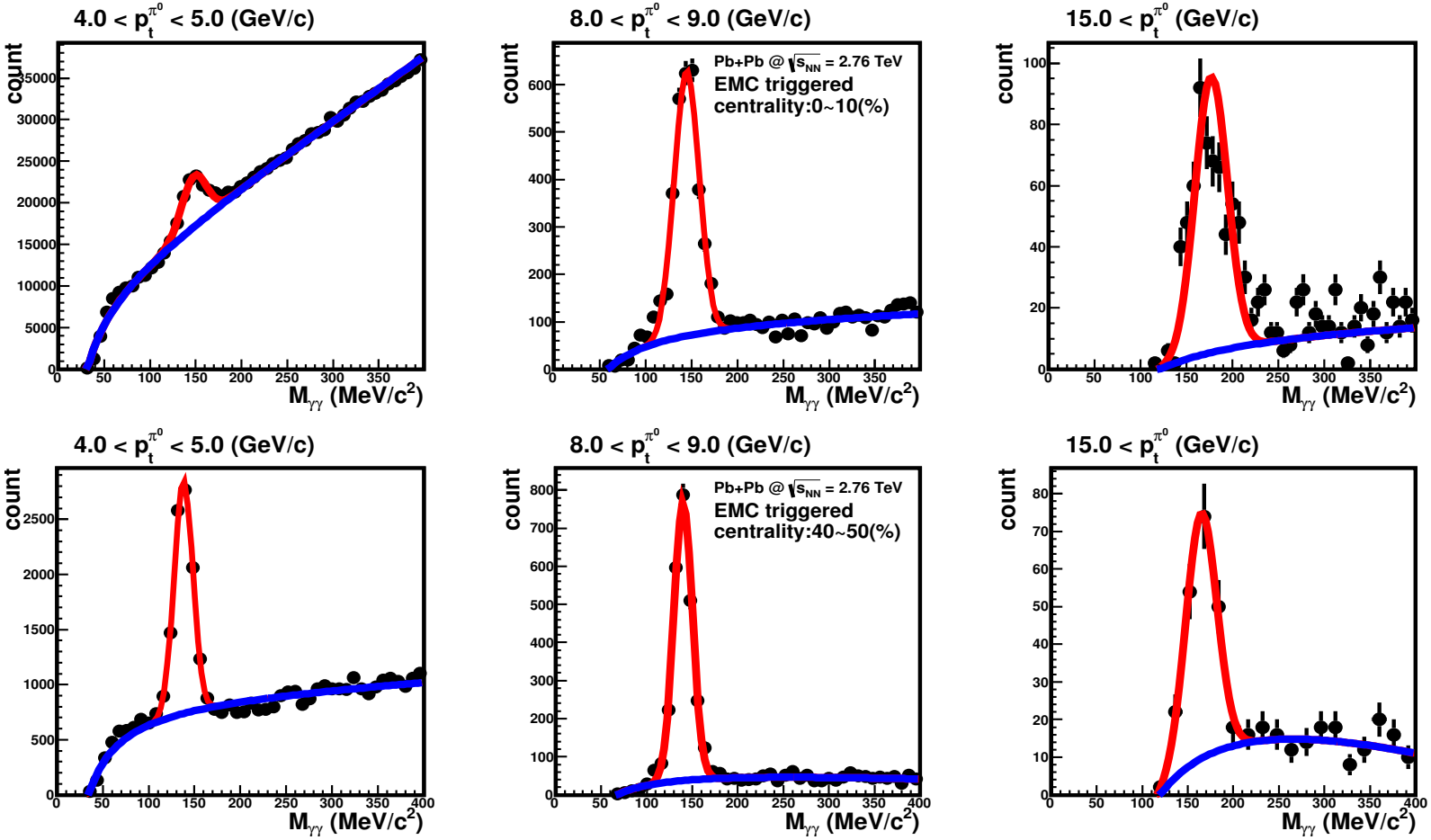
Subtraction of BKG energy





- Large fluctuation at low p_T region
- Can reconstruct signal jet greater than 50 GeV

Invariant mass distribution in Pb-Pb collisions



- Consistent with pp collisions at peripherral collisions.
- This analysis used as π^0 within 3sigma from each mean points.

Event mixing

- Event mixing
  - divided centrality 0~100% and vertex z ±10cm evenly into 10 parts
  - used as mix event same with centrality and vertex z of real event