Measurement of jet radial profile through charged jet-hadron correlation in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV

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Abstract

The heavy-ion physics program of the ALICE experiment at the LHC aims to reveal the properties of strongly interacting QCD matter, the so-called Quark-Gluon Plasma (QGP), which is formed under extreme energy density conditions. Jets are well calibrated and established probes of the QGP properties. At the formation of QGP, initial energies of the hard scattered partons, which are the origin of jets, can be suppressed and re-distributed while traversing the QGP and then measured jet profiles are modified in comparison with the case of QCD vacuum. This phenomenon is known as 'jet quenching'. A jet-hadron correlation study is performed to explore jet quenching. We will present the ALICE measurements of the profiles of charged jet near-side peak through jet-hadron correlations in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV. We currently observed a slight modification of near-side jet peak w.r.t event plane which could be interpreted as a hint of path length dependence.

Physics motivation

- **Jets in heavy-ion collisions**
  - Jets are modified while traversing the QGP → Jet quenching effect
  - QGP properties can be probed by evaluating the quenching effect
  - Initial collision geometry can be controlled by selecting jet axis angle w.r.t event plane (EP)
  - Path length dependence of jet quenching and medium response can be studied in detail

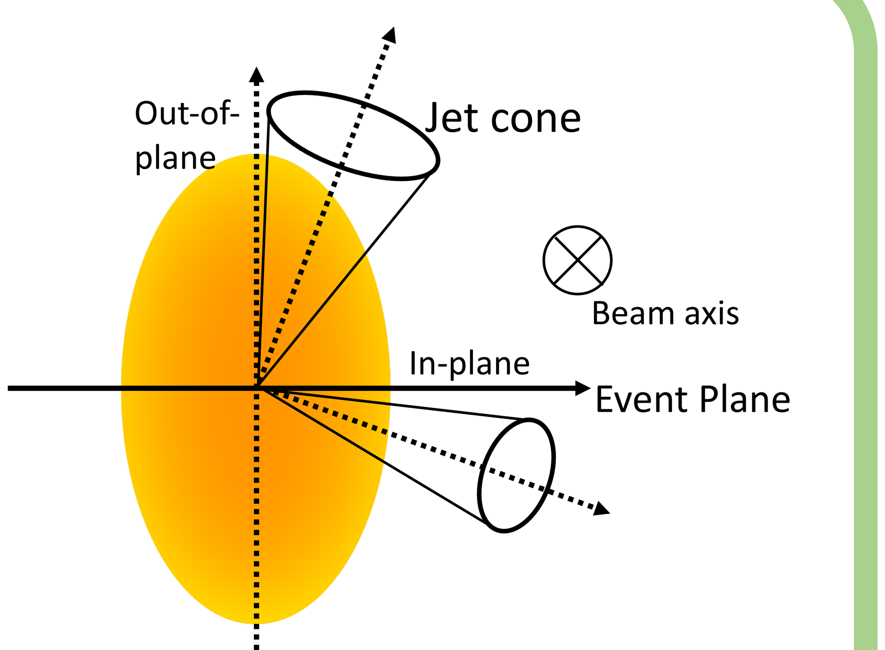

Fig.1: An image of collision geometry in heavy-ion collisions

ALICE Detector

The ALICE detector is a multipurpose detector dedicated to heavy ion physics at the LHC.

- Key detectors for measurement of charged jet-hadron correlations
  - Central barrel tracking system (ITS + TPC) for charged particle tracking
  - The V0 detector for triggering, centrality determination and event plane measurement.

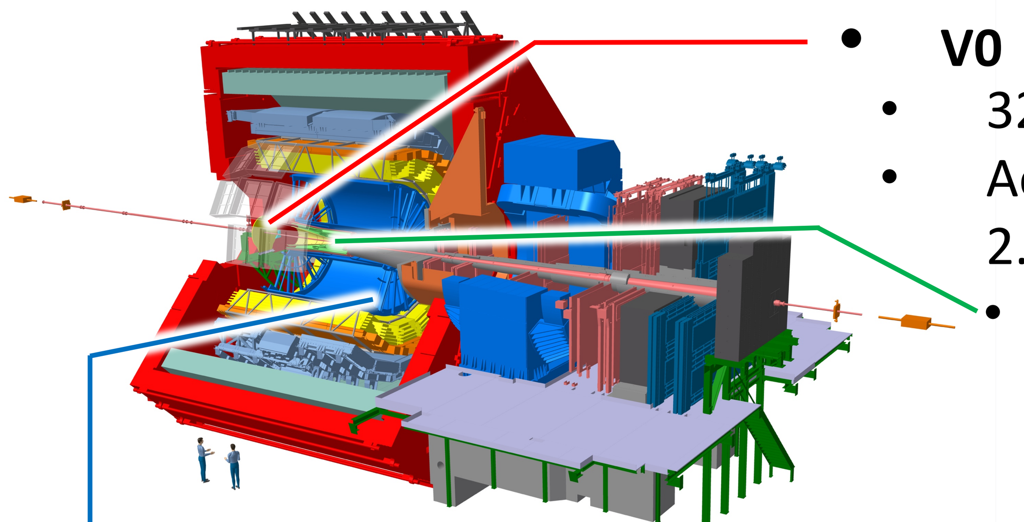

Fig.2 ALICE detector

- **V0**
  - 32+32 scintillators
  - Acceptance: 2.8<η<5.1 (V0A),−3.7<η<−1.7 (V0C)
- **ITS (Inner Tracking System)**
  - Consists of 3 type silicon detectors
    - SPD (Silicon Pixel Detector)
    - SDD (Silicon Drift Detector)
    - SSD (Silicon Strip Detector)
  - Acceptance: Full tracking w/ TPC: |η|<0.9
- **TPC (Time projection chamber)**
  - Filled with Ar-CO_2 (9:1)
  - Max drift time: 92 µs
  - Acceptance (Full tracking): |η|<0.9

Analysis details

- 14M 30-50% centrality minimum bias events
- 2nd order event plane (ψ_2) was measured with the V0C detector
- Trigger jets are reconstructed with the anti-k_T algorithm[1] with a jet cone resolution parameter R = 0.2.
  - Input p_T range: 0.15 < p_T < 100 GeV/c
- The even plane dependent background p_T estimation and subtraction for jets were performed similarly to the ALICE jet v_2 measurement[2]
- Jets were reconstructed including low p_T tracks down to 0.15 GeV/c and then jet axes were recalculated with constituents which have p_T > 4 GeV/c to suppress autocorrelation effect
- Currently, trigger jet p_T has not been corrected for detector effects (efficiency, resolution) and background fluctuation effect
- Charged jet-hadron correlation function

$$C(\Delta\varphi,\Delta\eta) = \frac{N_{mix}^{pair}}{N_{real}^{pair}}\left(\frac{d^2N_{real}}{d\Delta\eta d\Delta\varphi}\Big/\frac{d^2N_{mix}}{d\Delta\eta d\Delta\varphi}\right) \qquad \Delta\varphi = \varphi^{assoc} - \varphi^{trig} \quad \Delta\eta = \eta^{assoc} - \eta^{trig}$$

N_{real}, N_{mix} : Associated track yield in real and mix event

N_{real}^{pair}, N_{mix}^{pair} : Total jet-track pairs in real and mix event

- Flow background in jet-hadron correlations was estimated at large Δη region (Sideband : 1 < |Δη| < 1.5) of correlation function and then subtracted

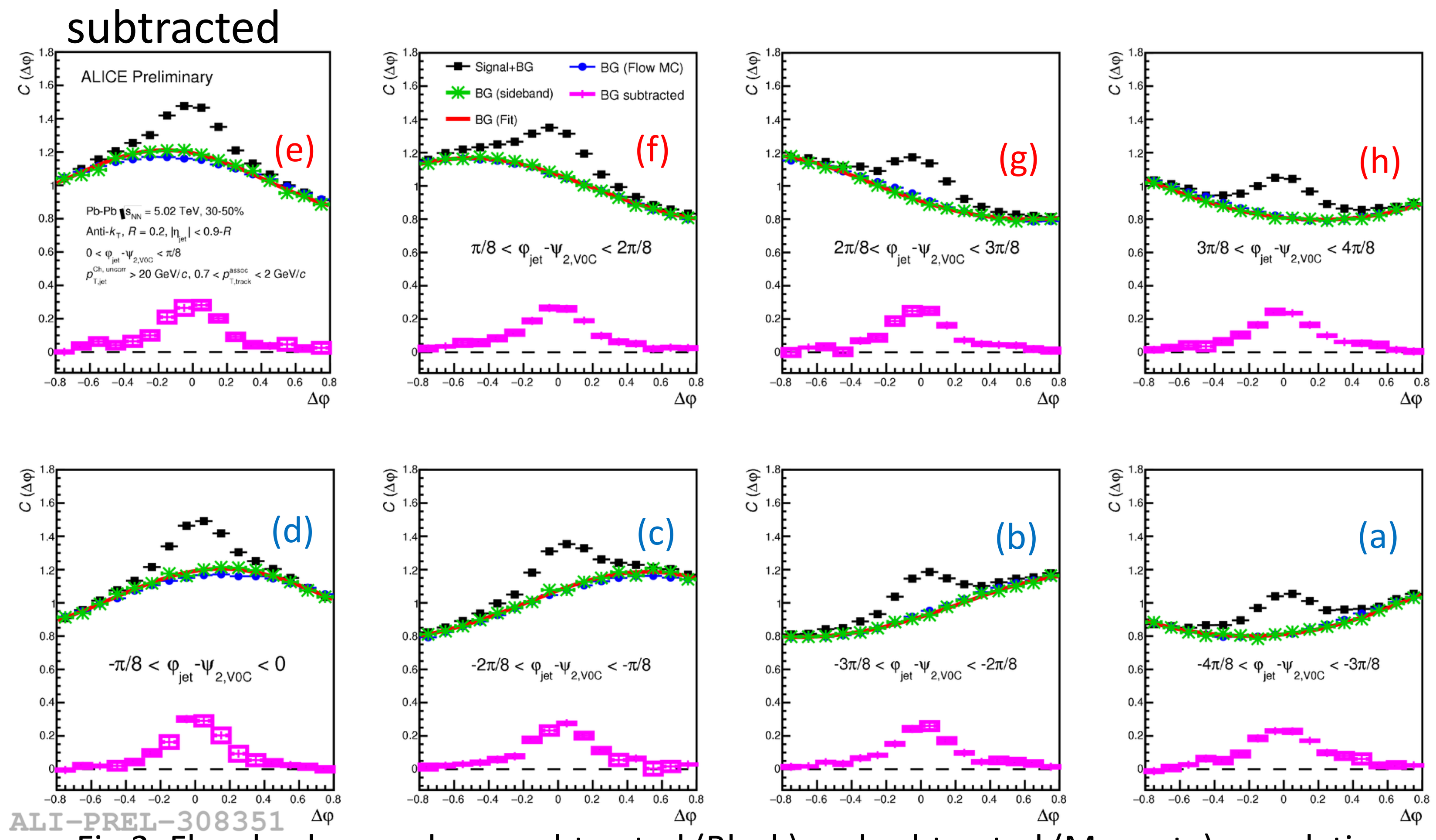

Fig.3: Flow background non-subtracted (Black) and subtracted (Magenta) correlation of the near-side jet peak. Flow MC study was performed as a systematic check of background estimation similarly to Ref [3]. (a)-(h) are corresponding to jet-ψ_2 angle illustrated in results section.

Results

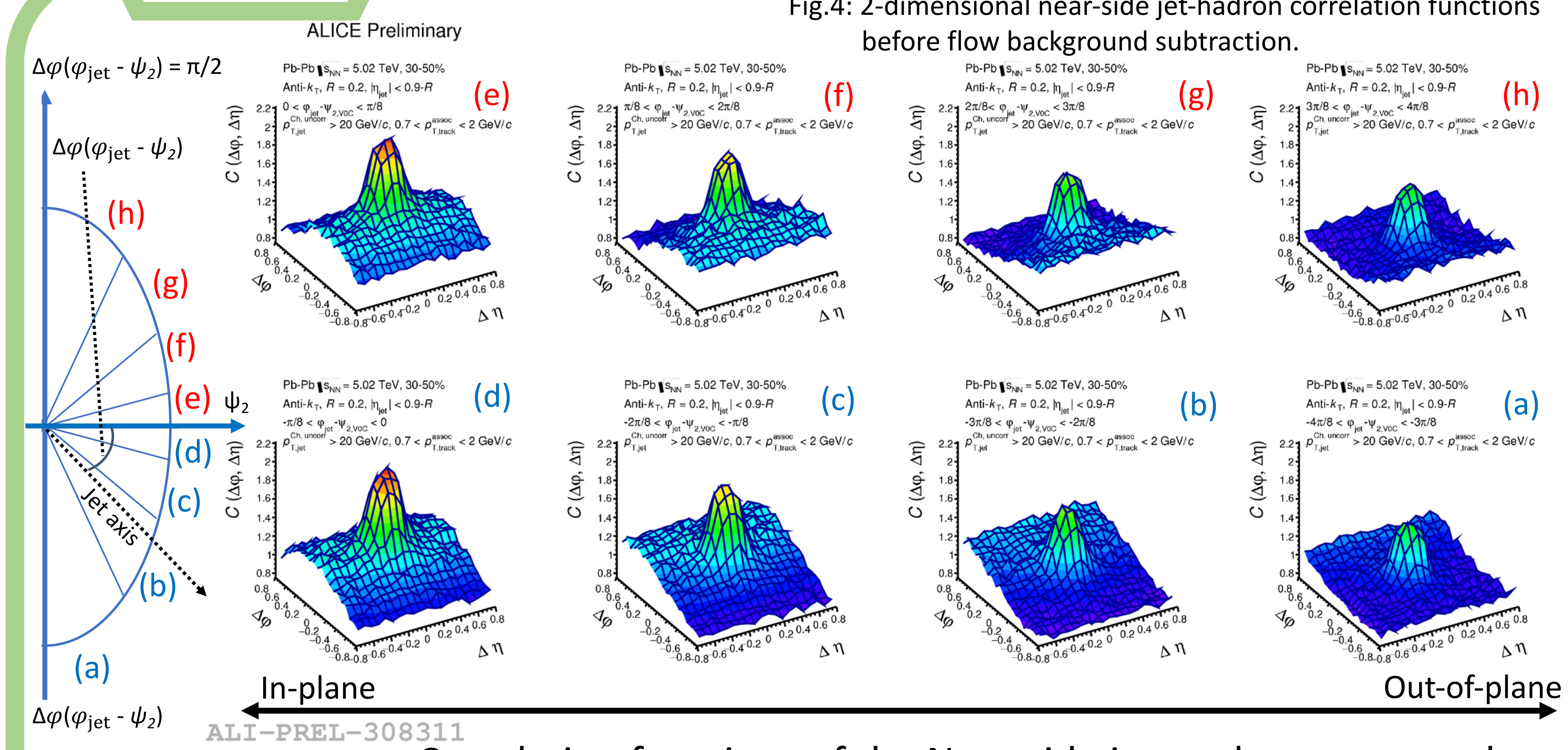

Fig.4: 2-dimensional near-side jet-hadron correlation functions before flow background subtraction.

- Correlation functions of the Near-side jet peak w.r.t event plane
  - Clear jet peak on top of the flow background
  - Clear EP dependence of flow background

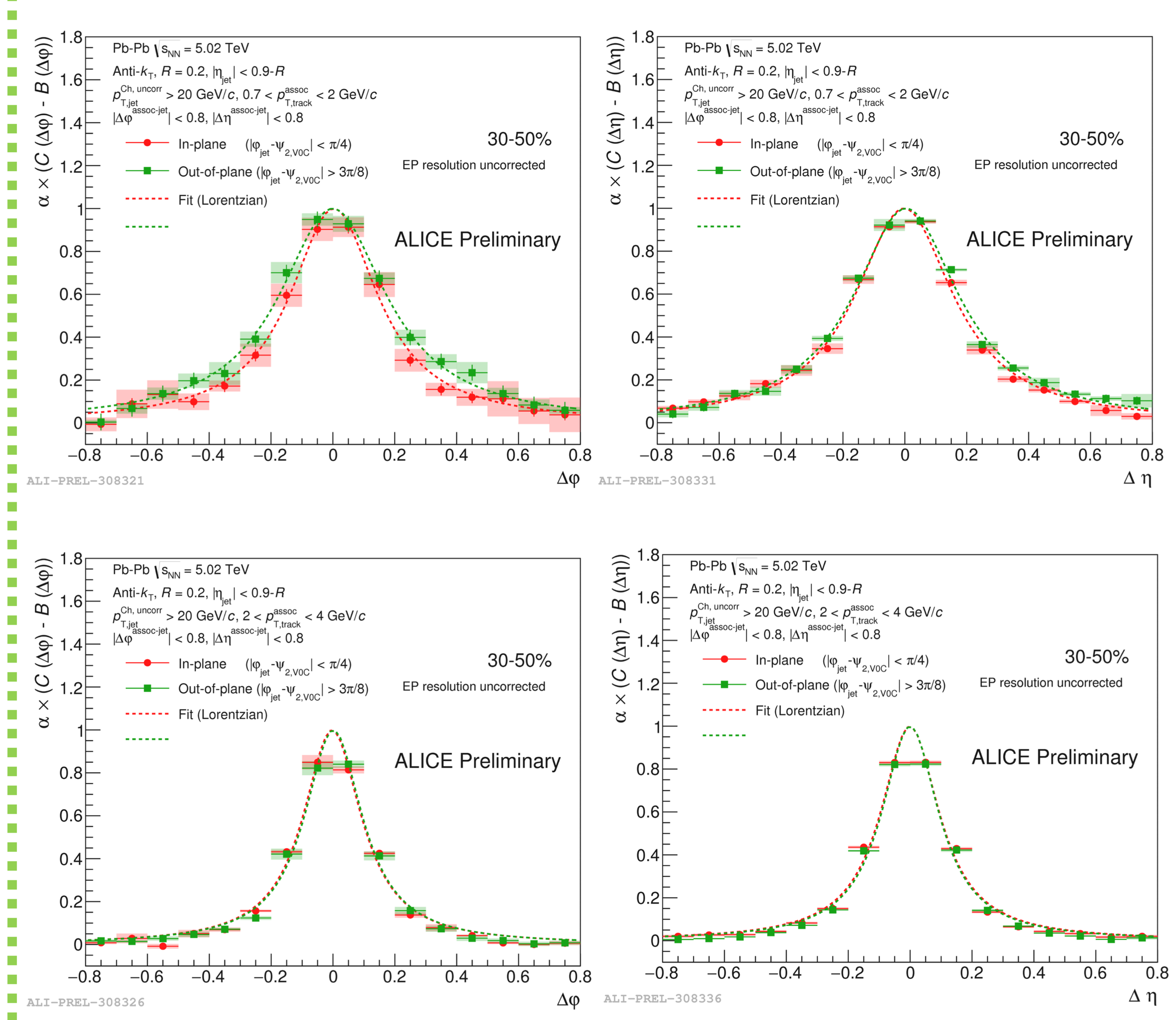

Fig.5: Background subtracted near-side jet-hadron correlation at in-plane (Red) and out-of-plane (Green). α is selected to the height become 1

B(Δφ), B(Δη) : Background distribution dominated by flow effect

A slight broadening of the out-of-plane distribution is observed for lower p_T associate tracks

The broadening effect was not observed for higher p_T associate tracks

Summary & Outlook

- Charged jet-hadron near-side correlation functions were measured in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV
  - **Hint of slight out-of-plane broadening for associate track p_T = 0.7-2 GeV/c**
  - **No broadening effect for associate track p_T = 2-4 GeV/c**
- Exploratory study of jet quenching path length dependence and medium response
- Outlook
  - R dependence study
  - Away side peak study
  - EP resolution correction
  - Refinement of systematics
  - Comparison to models

References

[1] Matteo Cacciari *et al.*, JHEP 0804:063, (2008)
[2] ALICE collaboration, Phys.Lett. B 753 (2016) 511-525
[3] PHENIX collaboration, arXiv:1803.01749 [hep-ex]

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