LHCC Students Poster Session
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Measurement of D-hadron azimuthal correlations in pp and p-Pb collisions with ALICE

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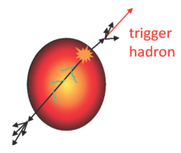
Introduction

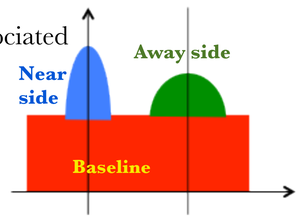
Azimuthal correlations in heavy-ion collisions

Azimuthal correlations of (high p_T) trigger hadrons with other hadrons produced in heavy-ion collisions are sensitive to



➡ in medium partonic energy loss:
- path-length dependence of energy loss
  - surface bias (due to high p_T selection for trigger particle).
  - away-side suppression.

➡ possible modification of jet formation (modified parton shower and fragmentation):
- modification of near and away side associated yields and correlation peak widths.



Interest of azimuthal correlations with heavy flavours

Due to their large masses, heavy quarks (charm and beauty) are predominantly produced via hard scatterings in the initial phase of the collision.

➡ They experience the full evolution of the system, losing energy while interacting with the medium.

➡ Energy loss predicted to be different for gluons, light quarks and heavy quarks:
- Dead cone effect.
- Casimir factor.

$\Delta E_g > \Delta E_{(u,d,s)} > \Delta E_c > \Delta E_b$

➡ Harder fragmentation relative to light quarks and gluons: experimen-tally accessible meson kinematics closer to parton kinematics.

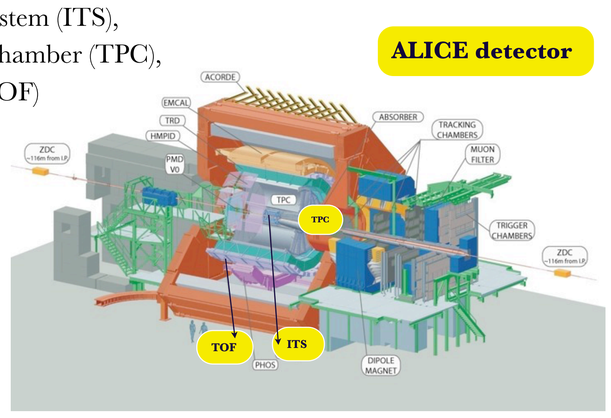
➡ Azimuthal correlations of D-mesons with charged particles produced in the collision is important to:
- Study the path-length dependence of heavy-quark energy loss.
- Extract information about a potential heavy-quark jet modification in A-A interaction relative to pp interaction.

pp collision: ✓ reference for p-Pb and Pb-Pb collisions.
✓ information on different charm production mechanisms

Experimental Setup

ALICE (A Large Ion Collider Experiment) is specifically optimized for the study of heavy-ion collisions at the LHC.
The main detectors of ALICE, used in this analysis are the:

➡ Inner Tracking System (ITS),
➡ Time Projection Chamber (TPC),
➡ Time Of Flight (TOF)



Track reconstruction: with ITS and TPC in $\eta < |0.9|$

Particle identification with TPC and TOF via the measurement of the specific energy loss dE/dx and of the time of flight

➡ separate pions and kaons up to 1.5(2) GeV/c in pp(p-Pb) collisions

Analysis Methods

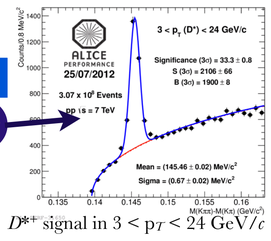
D-meson signal extraction

Decay Channel	Branching Ratio
$D^+ \to K^-\pi^+\pi^+$	9.13 ± 0.19%
$D^0 \to K^-\pi^+$	3.88 ± 0.05%
$D^{*+} \to K^-\pi^+\pi^+$	2.62 ± 0.10%

➡ Invariant mass analysis of D-meson decay products.
➡ Displaced vertices selected via topological cuts.

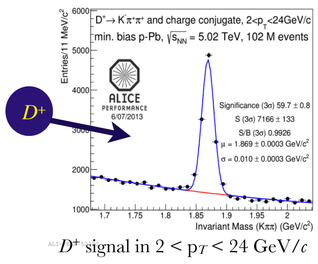
➡ D-meson invariant mass plots in

pp at 7 TeV

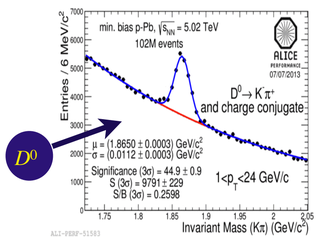


D^{*+} signal in $3 < p_T < 24$ GeV/c

p-Pb at 5.02 TeV



D^+ signal in $2 < p_T < 24$ GeV/c



D^0 signal in $1 < p_T < 24$ GeV/c

Azimuthal correlations

➡ Each selected D-meson is correlated with charged tracks produced in the event (excluding the D-meson daughter particles).

➡ Correlation $(\Delta\eta, \Delta\varphi)$ distribution is calculated in $5 \le p_T(D) \le 16$ GeV/c range and for hadron $p_T > 0.3$ GeV/c in the invariant mass region of the D signal.

Background subtraction:
The contribution to the azimuthal correlation due to background under the D-meson signal peak (**Fig. 1a**) is subtracted using the azimuthal correlation distribution of candidates in the **side-bands (Fig. 1b)** of the D-meson invariant mass distribution.

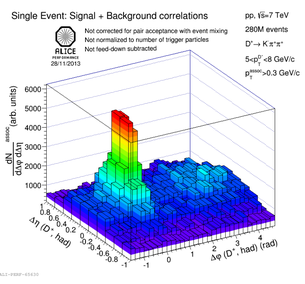


Fig. 1a.

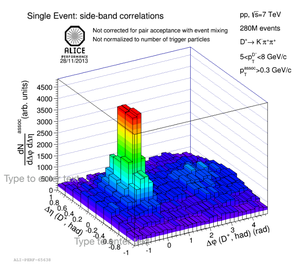
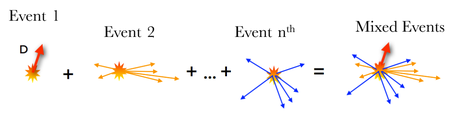


Fig. 1b.

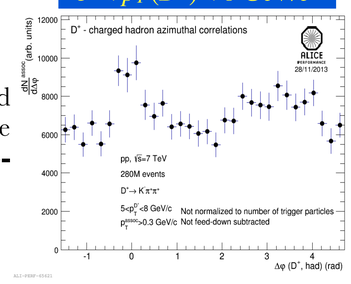
Corrections

➡ **Mixed event** (ME) technique is used to correct for limited detector acceptance and inhomogeneities.

$$\frac{d^2N^{MEcorr}(\Delta\varphi,\Delta\eta)}{d\varphi d\eta} = \frac{d^2N^{ME}(0,0)}{d\varphi d\eta}\,\frac{\frac{d^2N^{SE}(\Delta\varphi,\Delta\eta)}{d\varphi d\eta}}{\frac{d^2N^{ME}(\Delta\varphi,\Delta\eta)}{d\varphi d\eta}}$$



$5 < p_T(D^+) < 8$ GeV/c



pp

p-Pb

$5 < p_T(D^0) < 8$ GeV/c

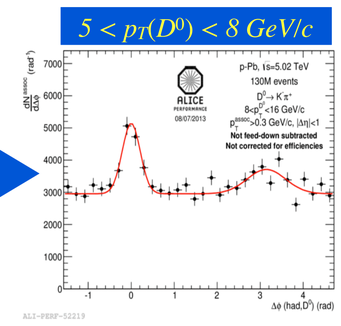


Fig. 2. **Background subtracted and ME corrected only** "Δφ correlations"

➡ **Efficiency corrections**
- D-meson efficiency correction.
- Track efficiency correction.

➡ **Beauty feed-down**

Systematic Uncertainties (main sources)
- D meson yield (10%) and background subtraction (5%)
- MC correction for associated track efficiency $^{+10\%}_{-5\%}$ and secondary track contamination (5%)
- Fit of azimuthal correlation distribution (up to 30%)

Results

Correlation results in pp collision

- ☑ About 3.1 ×10⁸ minimum bias events from pp collisions at √s = 7 TeV are analyzed.
- ☑ Correlations for average $D(D^{*+}, D^0)$ - hadron in intermediate ($5 < p_T < 8$ GeV/c) and high ($8 < p_T < 16$ GeV/c) D transverse momenta with hadron $p_T > 0.3$ GeV/c are shown in Fig. 3.
- ☑ Comparison to correlation distributions obtained from simulations with different Pythia tunes. Fig. 4.
- ☑ Study of "correlation baseline" and "yield and width of near side peak" vs p_T is shown in Fig. 5, 6, 7.

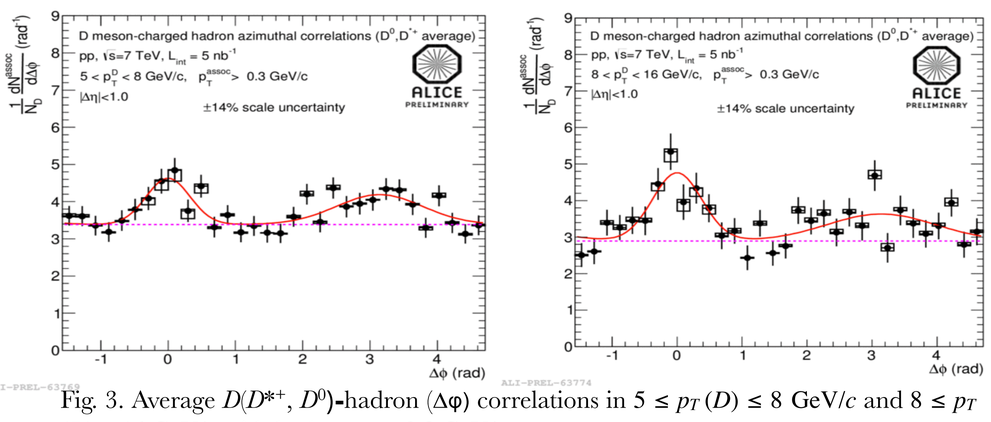


Fig. 3. Average $D(D^{*+}, D^0)$-hadron ($\Delta\varphi$) correlations in $5 \le p_T(D) \le 8$ GeV/c and $8 \le p_T(D) \le 16$ GeV/c with hadron $p_T > 0.3$ GeV/c.

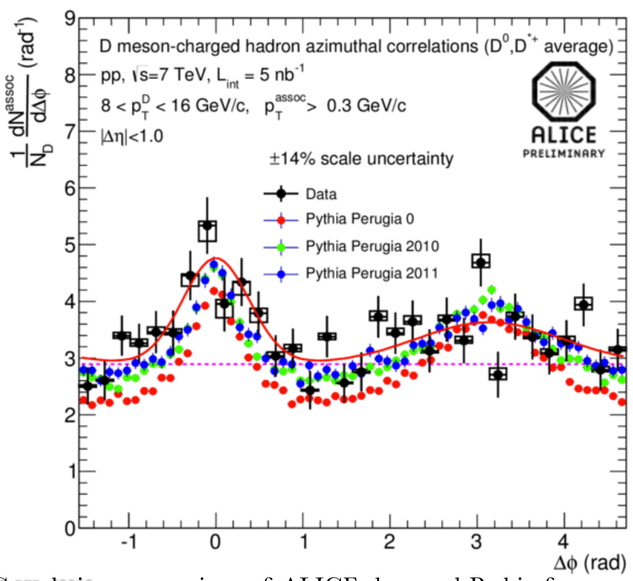


Fig. 4. Correlation comparison of ALICE data and Pythia for average D (D^{*+}, D^0) in $8 \le p_T(D) \le 16$ GeV/c with hadron $p_T > 0.3$ GeV/c.

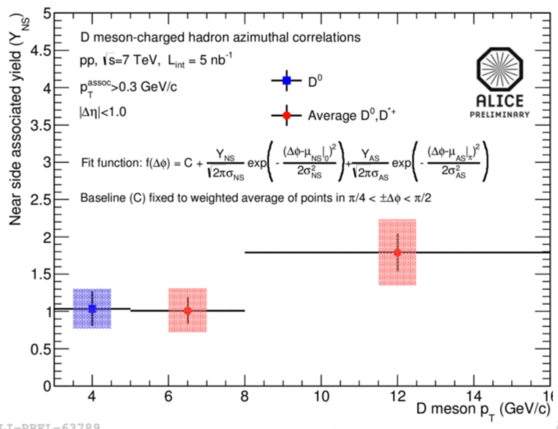


Fig. 5. Near side yield vs p_T

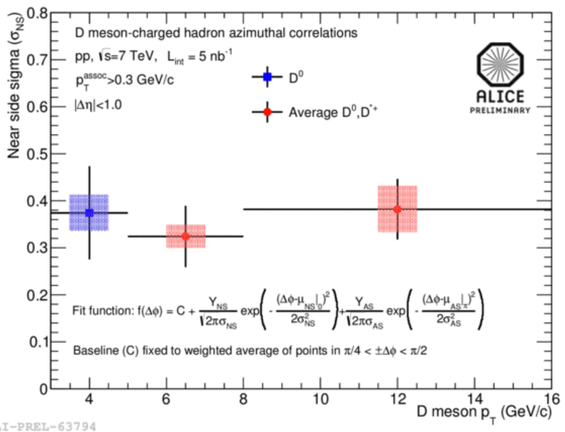


Fig. 6. Near side width vs p_T

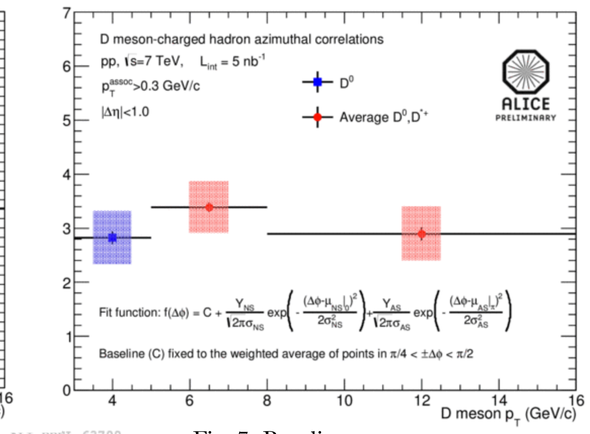


Fig. 7. Baseline vs p_T

Summary

- ☑ This is the first measurement of D-hadron azimuthal correlations in pp and p-Pb collisions with ALICE.
- ☑ Current status of the analysis of correlations between D mesons in $5 < p_T(D) < 16$ GeV/c with hadrons ($p_T > 0.3$ GeV/c) is presented.
- ☑ Near side ($\Delta\varphi \sim 0$) and away side ($\Delta\varphi \sim \pi$) peaks are clearly visible in the $\Delta\varphi$ correlation plots both at intermediate ($5 < p_T < 8$ GeV/c) and high ($8 < p_T < 16$ GeV/c) D-meson transverse momenta.
- ☑ Results of average $D(D^{*+}, D^0)$ in $8 < p_T(D) < 16$ GeV/c are in agreement with Pythia within large statistical and systematic uncertainties.
- ☑ The analysis of p-Pb data is ongoing: this might allow us to verify whether long range correlations, observed in correlations between light hadrons and between electrons from heavy flavour hadron decays and charged hadrons are present also in D meson-charged hadron correlations.
- ☑ The measurement with Pb-Pb data is challenging with the current statistics.

with ALICE Upgrade (after LS2)

Upgraded ITS will provide
➡ Better spatial resolution

Higher Integrated Luminosity
$L_{int(Pb\text{-}Pb)} = 10\ nb^{-1}$

From continuous readout of min. bias interaction at 50KHz

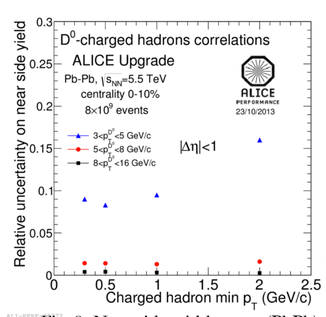


Fig. 8. Near side width vs p_T (PbPb)

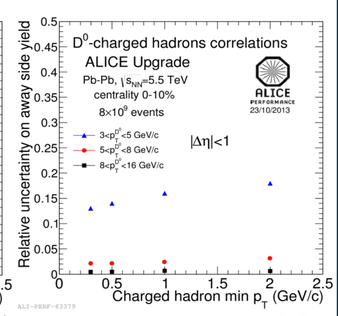


Fig. 9. Away side width vs p_T (PbPb)

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