Isolated Photon-Hadron Correlations in pp and p—Pb Collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5 TeV in ALICE

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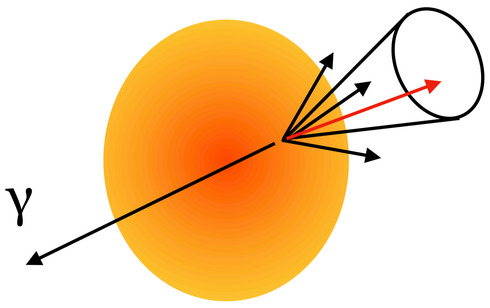
Motivation

Isolated high-p_{T} Photons (γ^{iso})

- Direct photons produced at leading order in hard scattering process ($qg \rightarrow q\gamma$)
- Direct photons constrain the parton kinematics from the initial hard scattering
- First study of Isolated γ-tagged fragmentation in p—Pb at the LHC



Away-side hadrons

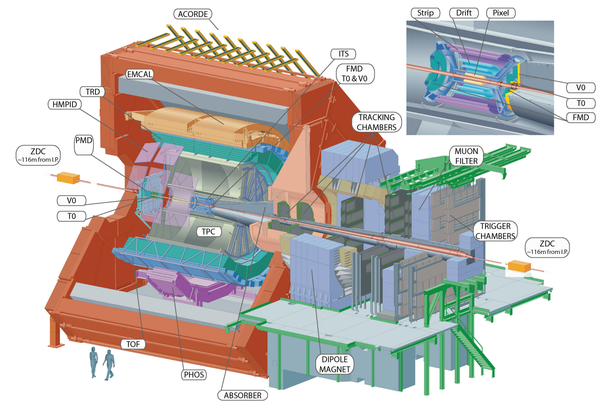
- Low $z_{\mathrm{T}} \equiv p_{\mathrm{T}}^{\mathrm{hadron}}/p_{\mathrm{T}}^{\gamma}$ hadrons are sensitive to the parton fragmentation
- Hadron z_{T} range of 0.12 < z_{T} < 0.65

Goal:
Measure the parton fragmentation in pp and p—Pb & constrain cold nuclear matter effects

ALICE Detector & Datasets

ALICE Detector at LHC

- Inner Tracking System (ITS) $|\eta| < 0.9$
- EMCal: $|\eta| < 0.67$, $80° < \varphi < 187°$
- DCal: $|\eta| < 0.7$, $320° < \varphi < 327°$
  $0.22 < |\eta| < 0.67$, $260° < \varphi < 320°$



Dataset

- pp & p—Pb Collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV
  pp: 400K EMCal Triggered Events
  p—Pb: 1M EMCal Triggered Events

ITS Only Charged Particle Tracking

- Charged hadrons measured by the ITS: $0.5 < p_{\mathrm{T}}^{\mathrm{track}} < 10$ GeV/c
- Consistent with performance of standard ALICE tracking (ITS+TPC)

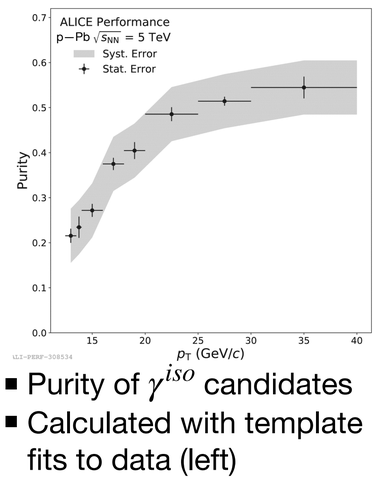
$\Delta\varphi$ Correlations of Isolated Photons and Charged Hadrons

Photon Selection

- $12 < p_{\mathrm{T}}^{\mathrm{Cluster}} < 40$ GeV/c
- Isolation: $\sum_{\mathrm{track}\ \in \Delta R<0.4} p_{\mathrm{T}}^{\mathrm{track}} - \rho_{\mathrm{UE}} \times \pi(0.4)^2 < 1.5$ GeV/c
- EMCal Cluster Shower shape: $\sigma^2_{\mathrm{long}} < 0.3$
  - square of larger eigenvalue of the energy distribution in the $\eta - \varphi$ plane

γ^{decay} Background

- **Purity** measures fraction of non-decay photons after isolation / σ^2_{long} cuts



- Purity of γ^{iso} candidates
- Calculated with template fits to data (left)

$$\mathrm{Data} = N \cdot f \cdot template_{\mathrm{SIGNAL}} + N \cdot (1-f) \cdot template_{\mathrm{BACKGROUND}}$$

See Alwina Liu's Poster on "Photon identification in the ALICE EMCal using a neural network and template fit"

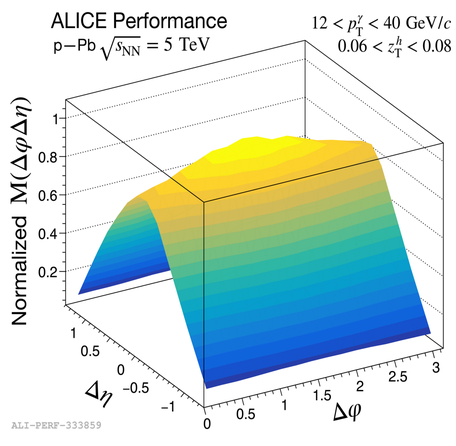
$$S(\Delta\varphi, \Delta\eta) = \frac{1}{N_{\mathrm{trig}}} \frac{d^2 N_{\mathrm{same}}}{d\Delta\varphi d\Delta\eta}$$

$$M(\Delta\varphi, \Delta\eta) = \alpha \frac{d^2 N_{\mathrm{mixed}}}{d\Delta\varphi d\Delta\eta} \qquad \max[M(\Delta\varphi\Delta\eta)] = 1/\alpha$$

$$C(\Delta\varphi, \Delta\eta) = \frac{S(\Delta\varphi, \Delta\eta)}{M(\Delta\varphi, \Delta\eta)}$$

Event Mixing

- Clusters mixed with tracks form minimum bias events
- Events paired with according to z-vertex and multiplicity
- **First use of stable matching algorithm in event-pairing**
  - Mixed according to v_{z} & multiplicity with no binning required



Subtracting γ^{decay} Contribution

- Measurement of γ^{decay}-hadron correlation (C_{BR})
- Scaled by 1-Purity and subtracted from γ^{iso}-hadron correlations (C_{SR})
- Correlation functions (C) measured in bins of $z_{\mathrm{T}} \equiv p_{\mathrm{T}}^{\mathrm{hadron}}/p_{\mathrm{T}}^{\gamma}$
- Each cluster and track in correlation function weighted at fill time

$$C_{\mathrm{S}} = \left(\frac{(C_{\mathrm{SR}}) - (1-\mathrm{P}) \cdot (C_{\mathrm{BR}})}{\mathrm{P}} \right)$$

$$C = \mathrm{P}(p_{\mathrm{T}}^{\gamma}) \cdot w^{\mathrm{track}}(p_{\mathrm{T}}) \cdot \Delta\eta\Delta\phi$$

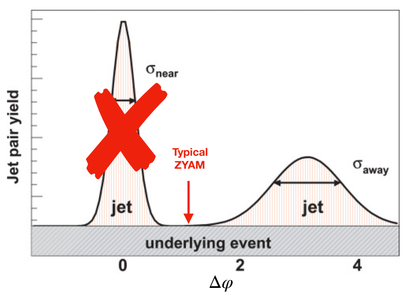
$$w^{\mathrm{track}}(p_{\mathrm{T}}) = \epsilon \cdot (1-f) \cdot b$$

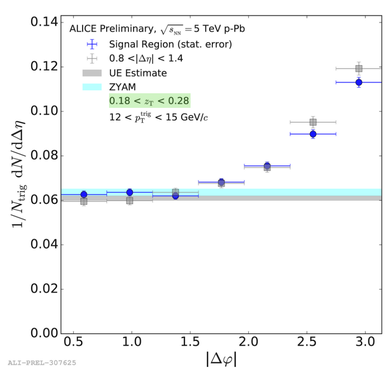
ϵ = efficiency, f = fake rate, b = p_{T} smearing

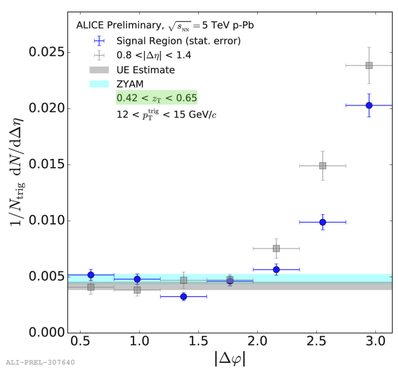
Final Subtraction & Results

Underlying Event Subtraction

- Substantial uncorrelated background remains after γ^{decay} subtraction: $U_{\mathrm{rem.}} = \frac{U_{\mathrm{SR}} - (1-P) \cdot U_{\mathrm{BR}}}{P}$
- γ^{iso}—charged hadron correlations lack near-side jet peak
- ZYAM can be averaged over a larger range: $0.4 < \Delta\varphi < \pi/2$



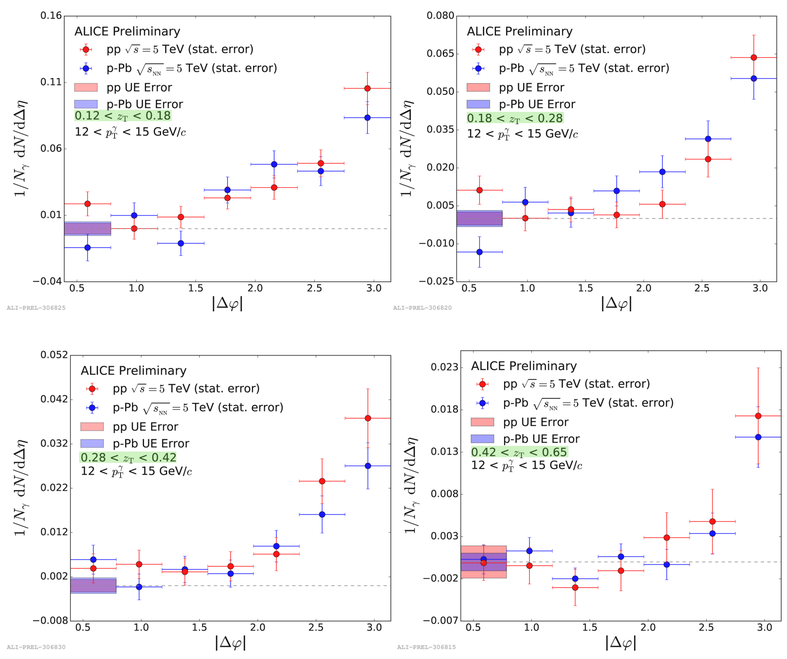




- Fully subtracted correlation function in two z_{T} - bins
- After γ^{decay} and underlying event subtraction, pp and p—Pb correlation function show good agreement

Final Correlation Functions

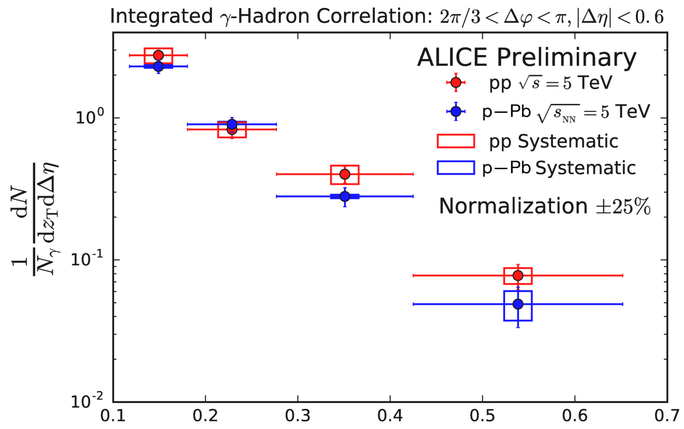
- Final correlation functions in pp and p—Pb in four z_{T}-bins:

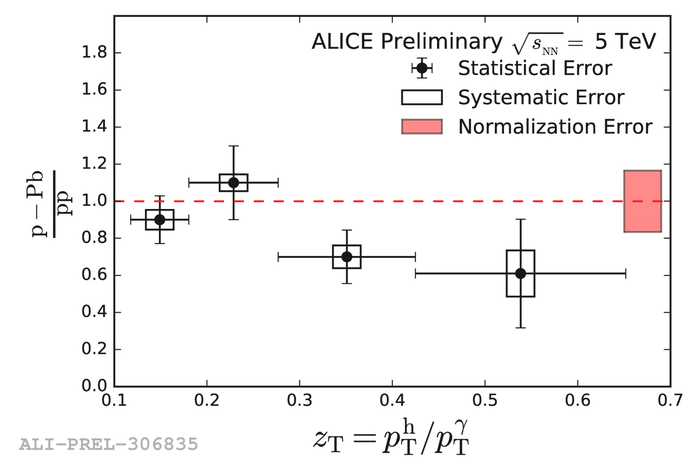


- Correlation functions integrated in region of $|\Delta\varphi| < 2\pi/3$

Ratio of away-side yields indicate no significant difference between parton fragmentation in pp and p—Pb collisions

Parton Fragmentation in pp and p—Pb





Summary

- Direct photons constrain the parton kinematics from the initial hard scattering and final state away side hadrons at low z_{T} are sensitive to the parton fragmentation process
- No significant difference is observed between pp and p-Pb measurements. Any modification to the z_{T} distributions observed in Pb—Pb must be a hot nuclear matter effect