# Probing medium response by measuring (anti-)proton to pion ratio and the radial profile of charged particles in jets in Pb-Pb and pp collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV

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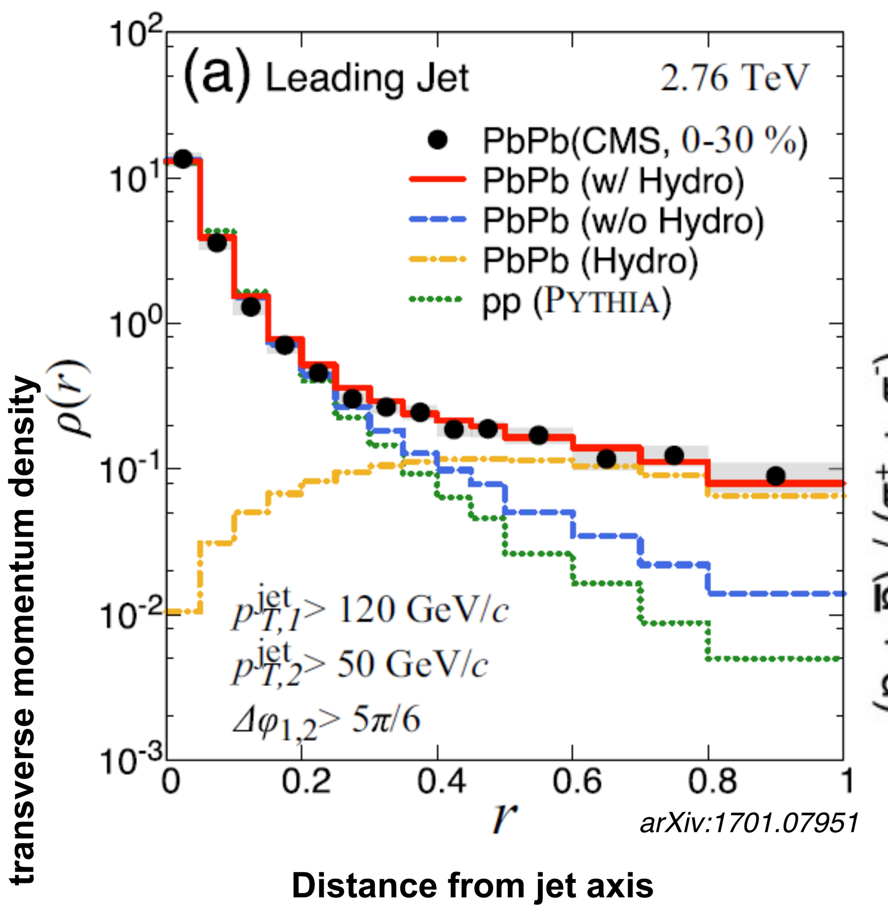
## Motivation

- **Hydrodynamic medium response**
  - The jet transfers energy to the medium, inducing a correlated excitation of the medium in the direction of the propagating jet
  - Increased soft particle production at **large distance with respect to jet** in heavy ion collision

- **Production of charged pions and (anti-)protons**
  - Does this production ratio differ in the medium response compared to the fragmentation in the jet
  - How does particle production change with distance from the jet axis?




Production of charged pions, kaons and (anti-)protons in Pb-Pb and pp collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV

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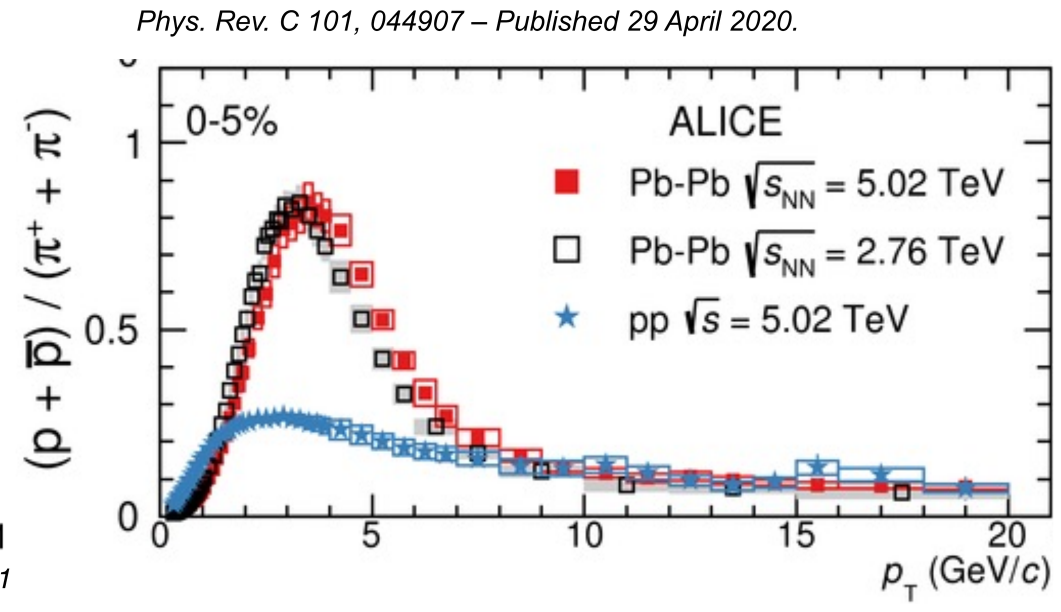



### ■Our study goals

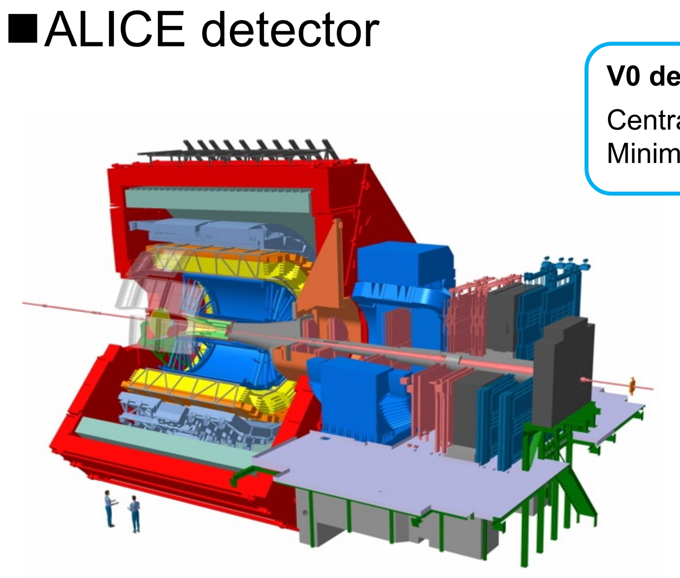
- Study proton-(anti-)pion production ratio as a function of distance from jet axis
- Compare production ratios in pp and Pb-Pb collisions and see changes due to medium response

## Data set and setup

### ■Data set

- $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV Pb-Pb collisions (Number of event:80M) , Central trigger ( Centrality 0-10%)
- $\sqrt{s}$ = 5.02 TeV pp collisions, Minimum bias trigger ( 3.10×$10^8$ events )

### ■ALICE detector

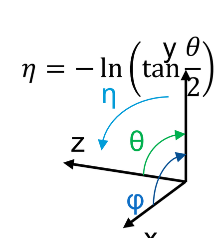


**V0 detector**
Centrality
Minimum bias trigger

**Inner Tracking System (ITS)**
Tracking and particle identification through ionisation energy
$|\eta| < 0.9$

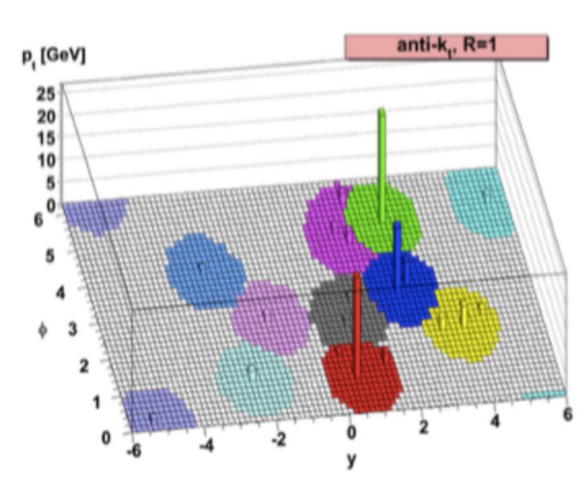
**Time Projection Chamber (TPC)**
Tracking and measure energy loss $(dE/dx)$ $|\eta| < 0.9$

**Time-of-Flight detector(TOF)**
Particle identification through time of flight
$|\eta| < 0.9$



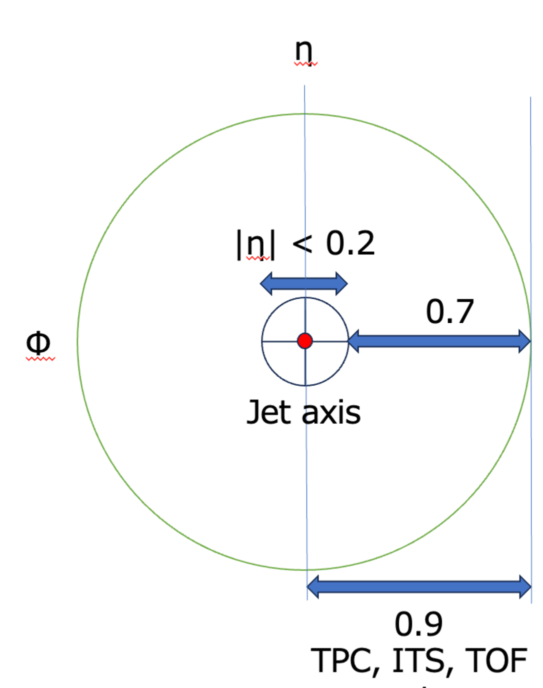

### ◆ Jet reconstruction

- Anti-$k_T$ algorithm
  - cluster around high transverse momentum particles
- Underlying event
  - estimate the density of the underlying event using $k_T$ algorithm in Pb-Pb collision




### ◆ Parameters

| Jet type | Charged jet (Leading jet) |
|---|---|
| Jet resolution parameter | 0.2, 0.3, 0.4 |
| Minimum jet $p_T$ | > 60 GeV/c |
| Minimum track $p_T$ | > 0.15 GeV/c |
| Jet axis range | \|η\| < 0.2 |
| Leading track $p_T$ | > 5 GeV/c |




## Particle Identification

### ◆PID using ITS, TPC, and TOF

$$N_{\sigma}^{i} = \frac{\langle signal\rangle^{\mathrm{mesurement}} - \langle signal\rangle_{i}^{expected}}{\sigma_i} \quad (i : \text{pion, kaon, proton})$$

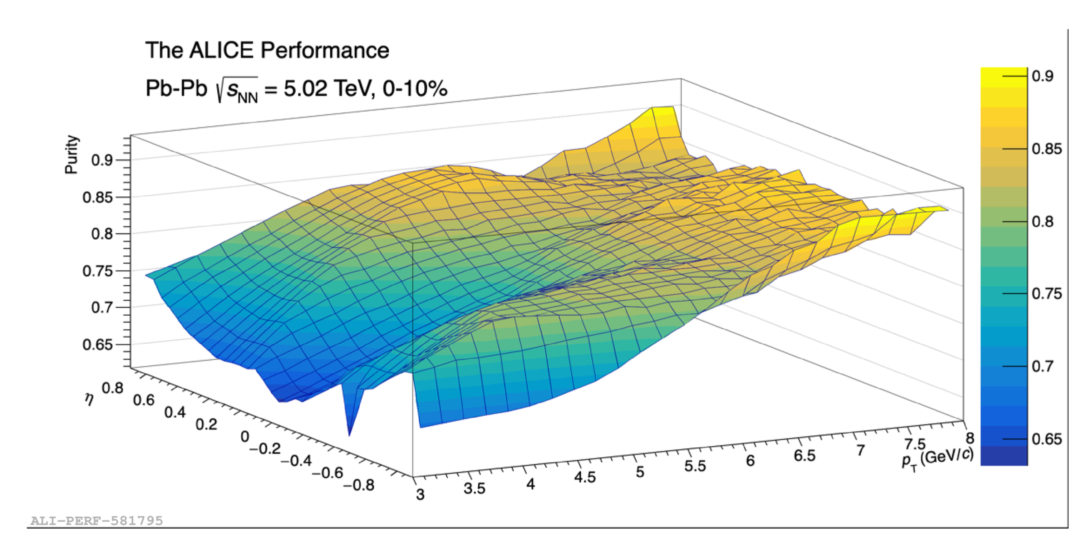
**1) $p_T$ < 3.0 GeV/c**

- ITS, TPC and TOF signal : PID selection $|N_{\sigma}^{i}| < 2$ of all detectors

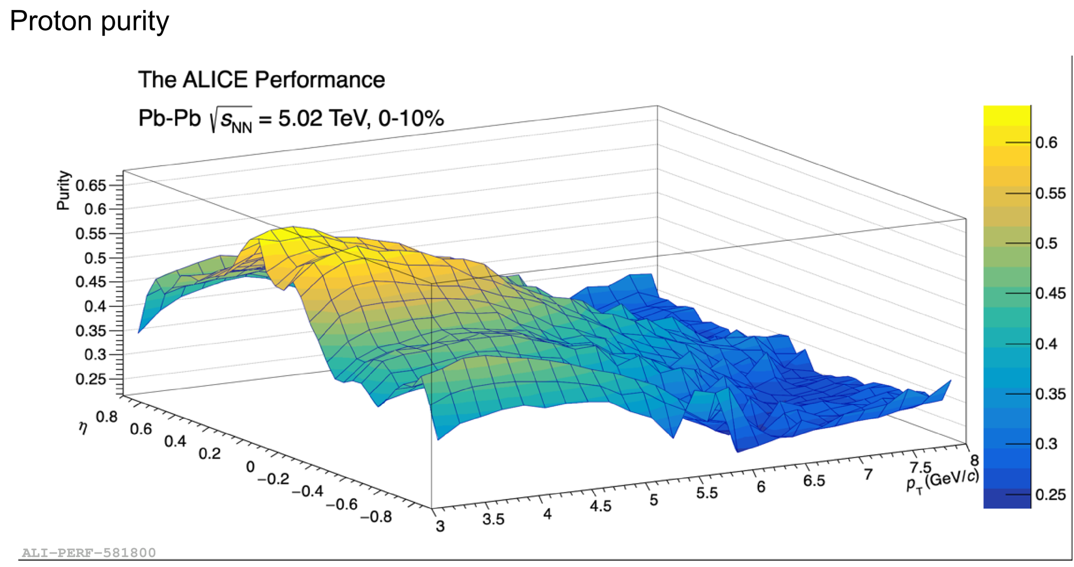
**2) $p_T$ > 3.0 GeV/c**

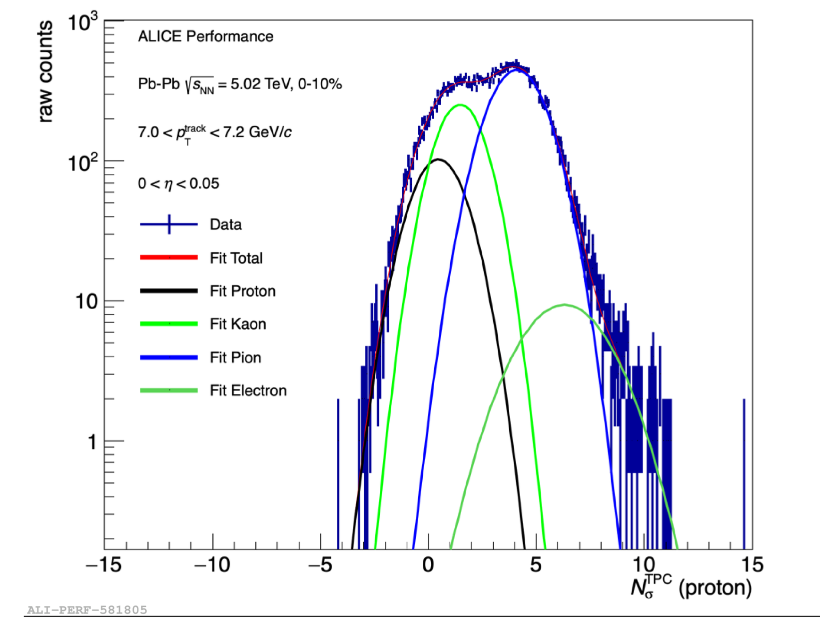
- TPC signal: $|N_{\sigma}^{i}| < 2$
- Fit the TPC $N_{\sigma}^{i}$ distribution with a Gaussian (Pion, Kaon, Proton, Electron)
- Change the range of $p_T$ and $\eta$ and fit : ex) 7.0 < $p_T$ < 7.2 GeV/*c*, *0* < $\eta$ <0.05
- From the fitting results, calculate the purity when $|N_{\sigma}^{i}|$ < 2
- And apply this purity to pion(proton) $p_T$ distribution

Pion purity

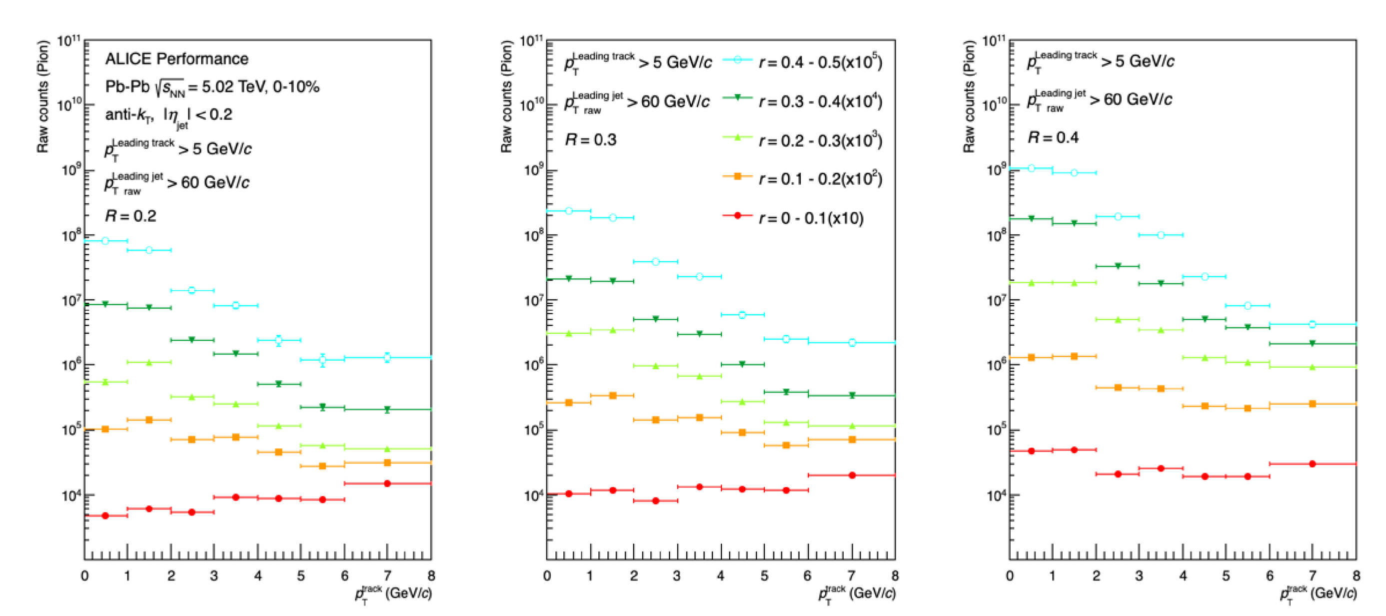



Proton purity




## Cone size (R) and distance from jet axis (r) dependence of pion and proton productions

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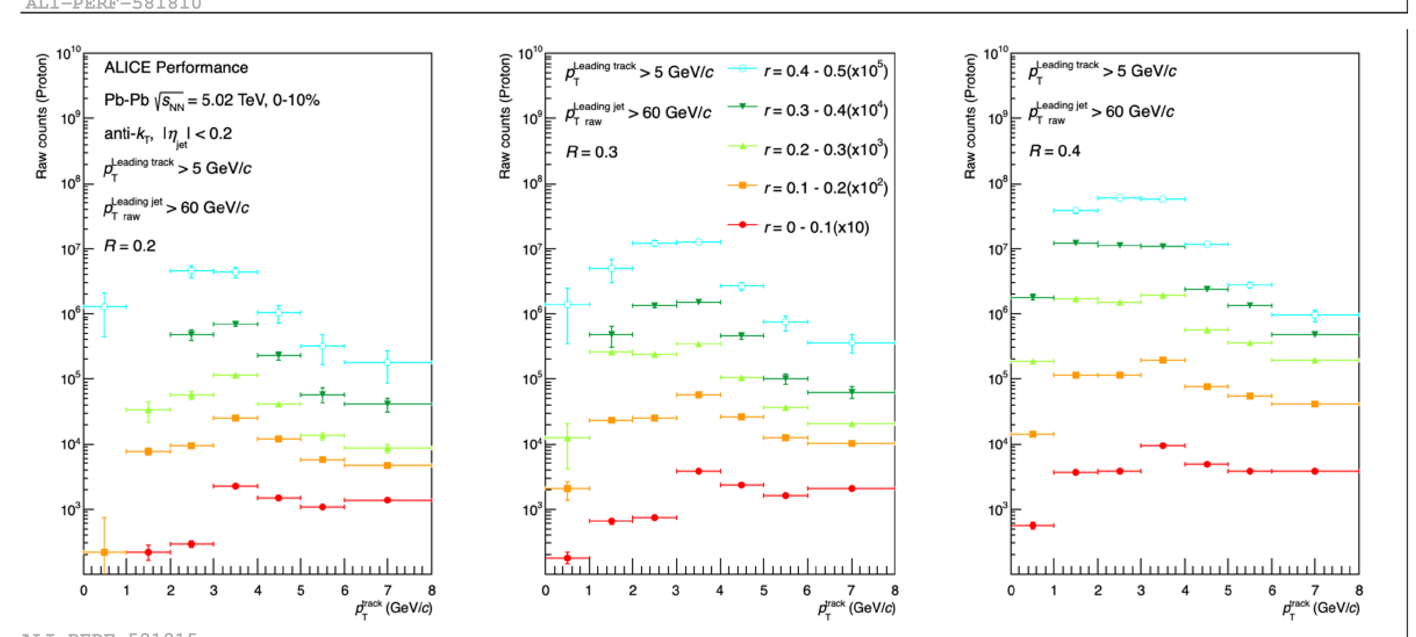


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◆*Jet radius dependence*
The overall yields of identified particles increase.

◆*Radial profile dependence*
The proportion of hard particles decreases, soft particles increase at large r

## Future Plans

◆Research of $r$ and $p_T$ dependence of Proton-Pion ratios
◆Unfold detector effects in jet shape measurements
◆Estimation of systematic uncertainties
◆Comparison of pp pPb, and PbPb collisions