Strangeness production associated to a high-p_T particle in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV with ALICE

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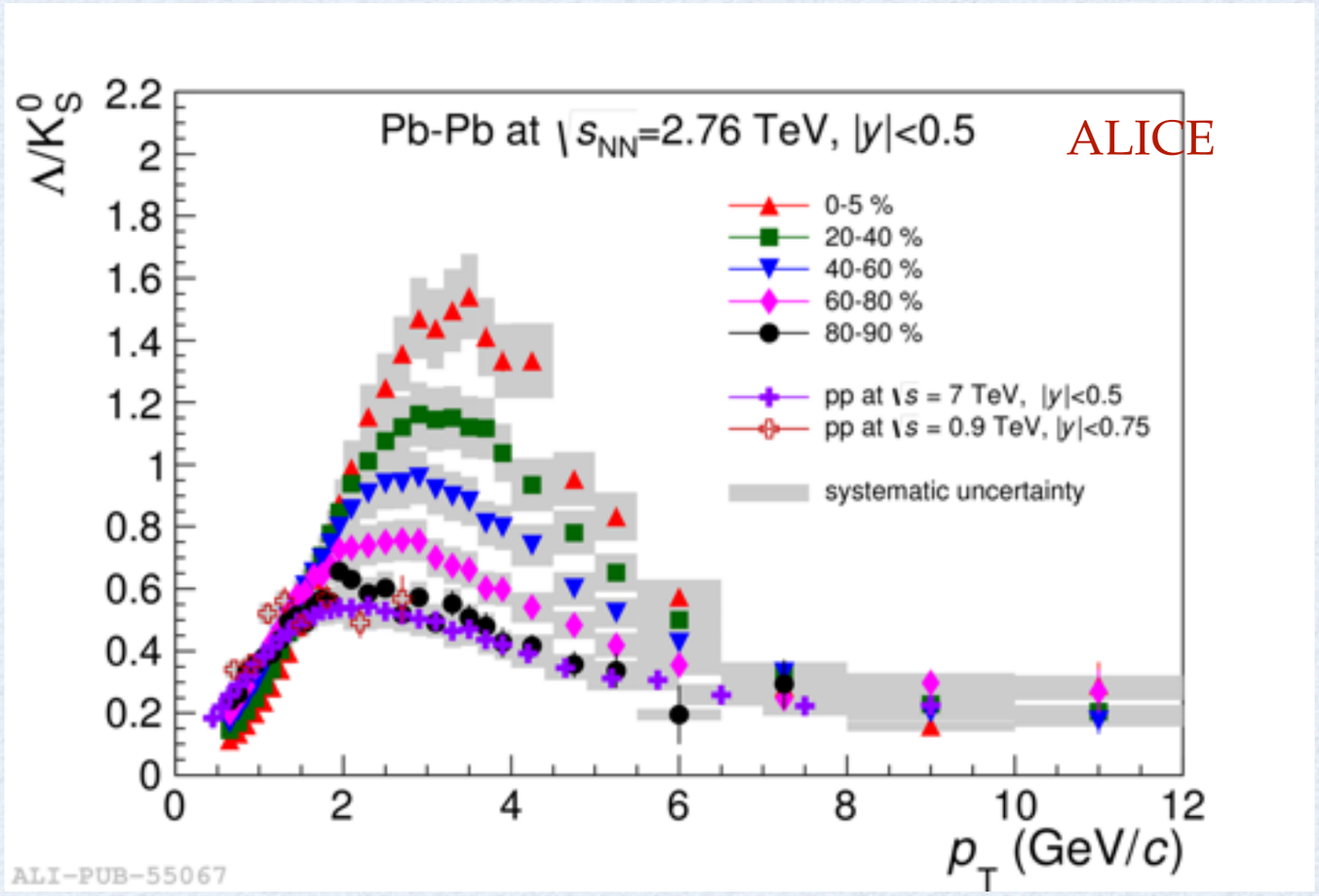
9th International Workshop on
High-p_T Physics at LHC
27th of September, 2013

Outline

- Motivation: Hadronization mechanisms
- ALICE
- Strangeness production
- Two-hadron correlations:
  - V0-hadron: quark and gluon jets
  - Hadron-V0: Λ /K^0_S
- Prospects

Motivation

- Is the baryon/meson enhancement a consequence of parton coalescence? (or/and radial flow?)



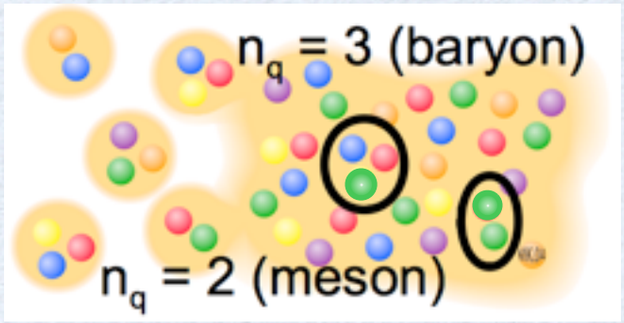
arXiv:1307.5530 [nucl-ex]

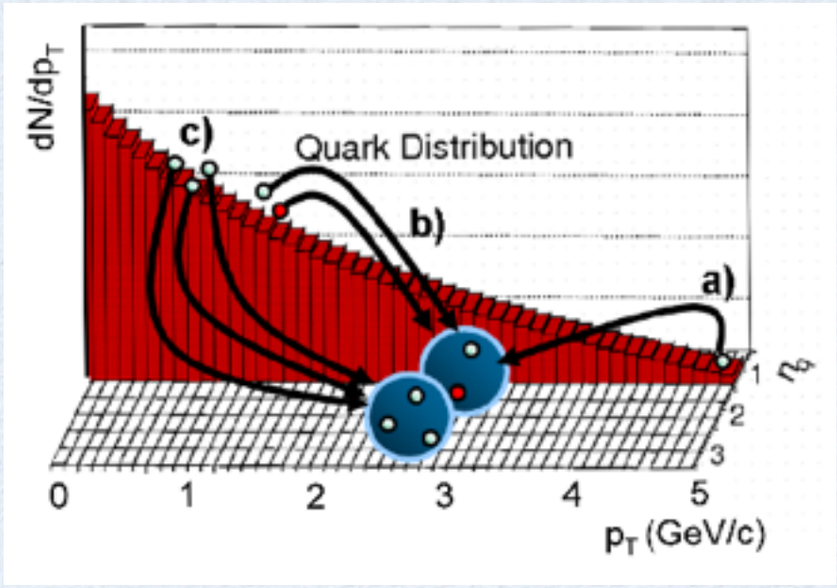
Hadronization mechanisms

Low p_T

Parton coalescence

- The hadronization by coalescence requires that two (three) partons from the QGP are close in phase-space to form a meson (baryon).

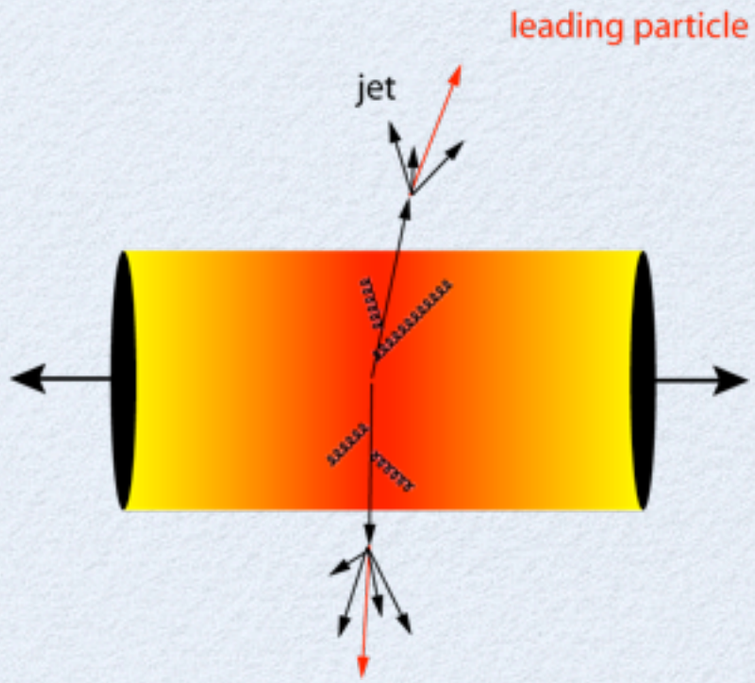




Parton fragmentation

High p_T

- At high values of p_T, partons are produced from initial hard processes.



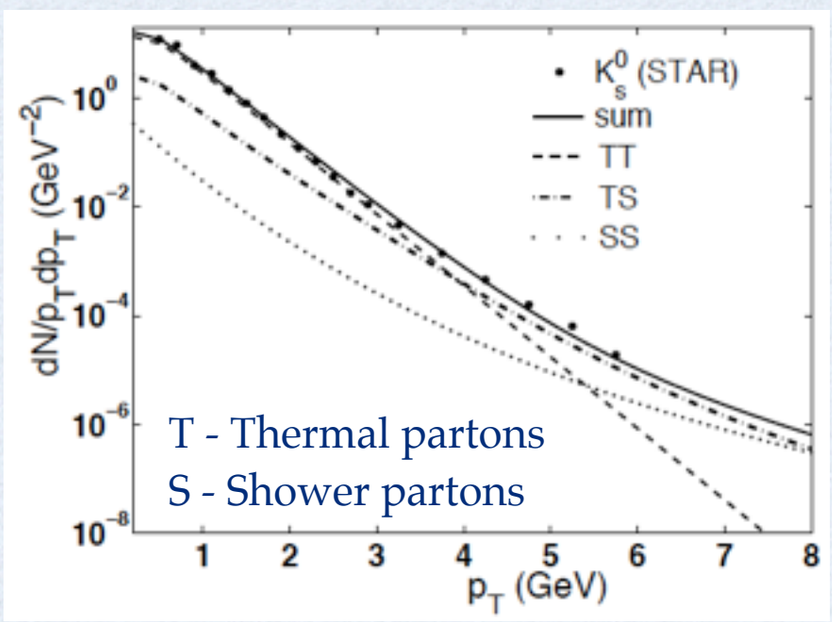
More hadronization mechanisms

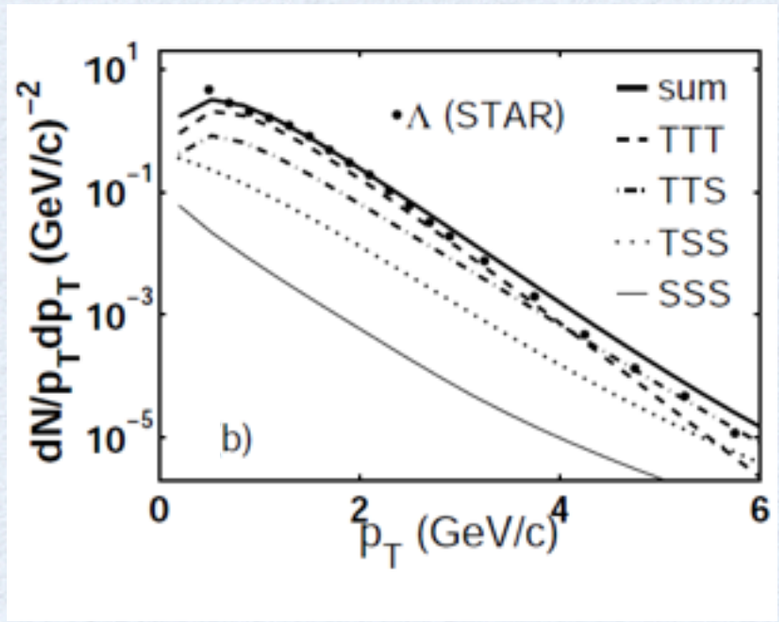
At intermediate p_T:

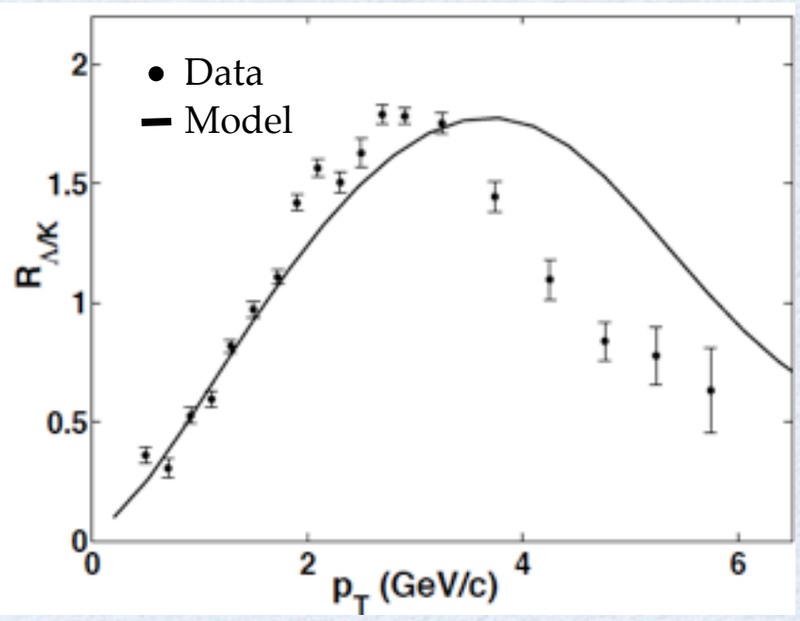
A more advanced model of coalescence allows
for the recombination between partons from jets
with partons from the thermalized bulk.

[PRL 90, 202302 (2003), Phys.Rev. C73 (2006) 064904 , Phys.Rev. C75 (2007) 054904]

Au-Au collisions at $\sqrt{s_{NN}}$ = 200 GeV







Phys.Rev. C75 (2007) 054904

More hadronization mechanisms

Does the baryon/meson enhancement at intermediate p_T have a contribution from in-medium modification of jet fragmentation?

More hadronization mechanisms

With high-p_T particles we have access to other physics studies:

- The two-particle correlations are sensitive to jet quenching and modification of jet fragmentation.

- It is possible to distinguish between quark and gluon jets due to their associated-hadron production and width [PRL 107, 172001 (2011)]

- There might be a difference between baryon and meson content in quark and gluon jets [OPAL, Eur.Phys.J.C8:241-254,1999]

ALICE

VZERO

-Trigger

-Centrality

ITS

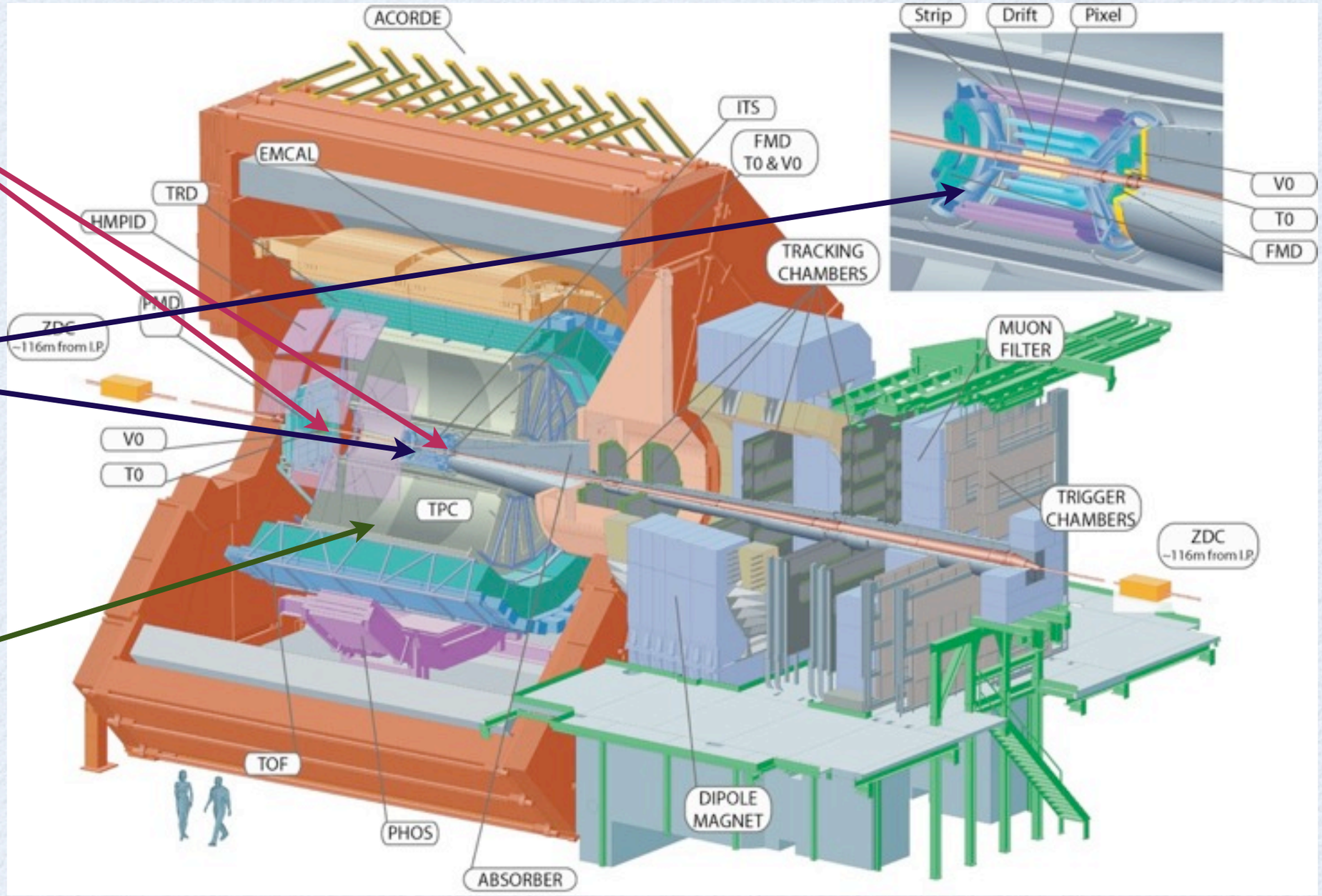
-Vertexing

-Tracking

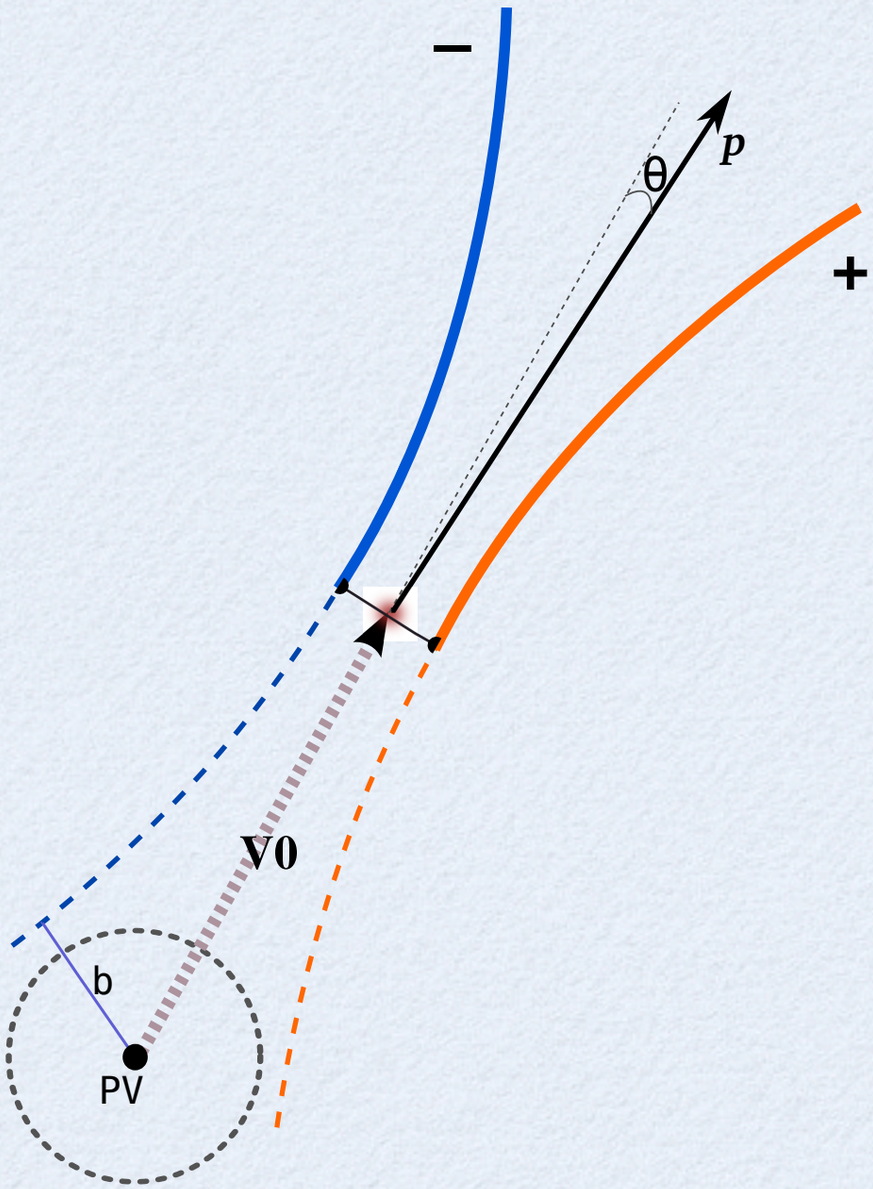
TPC

-Vertexing

-Tracking



Strangeness in ALICE

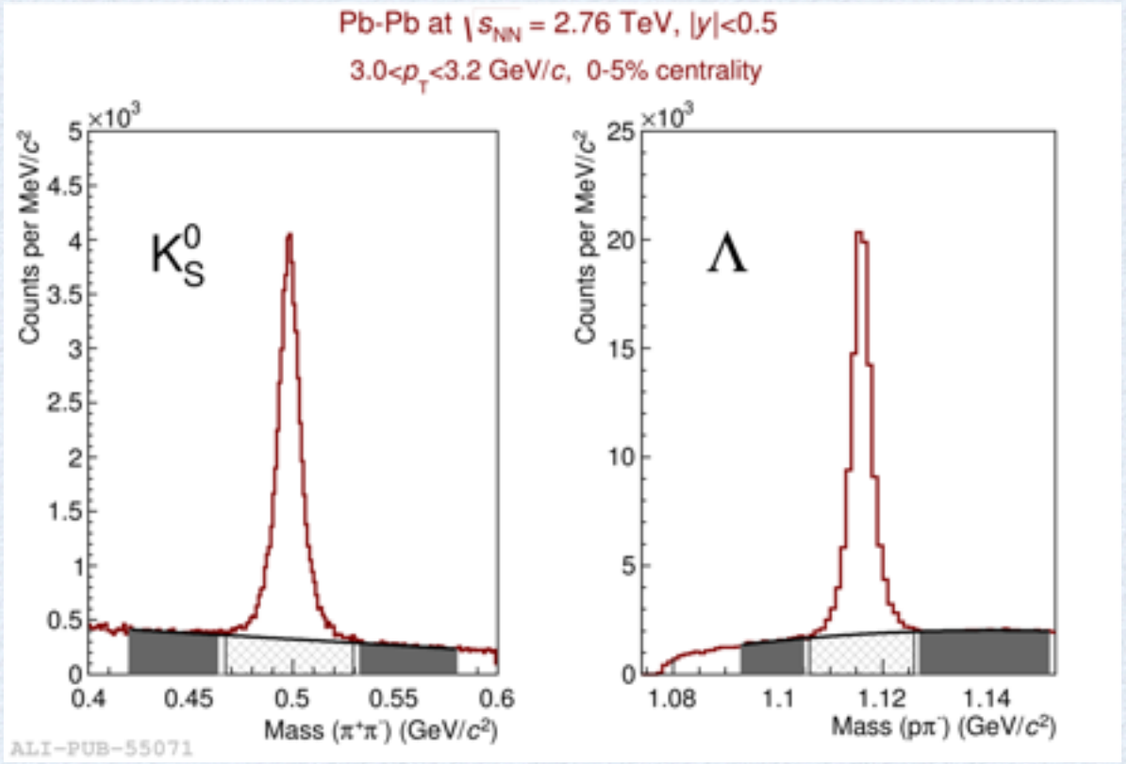


The neutral strange hadrons (K^0_S, Λ) are reconstructed using the kinematical and topological properties of their decays products.

$K^0_S \rightarrow \pi^+\pi^-$ (B.R. 69.2%)
$\Lambda \rightarrow p\,\pi^-$ (B.R. 63.9%)

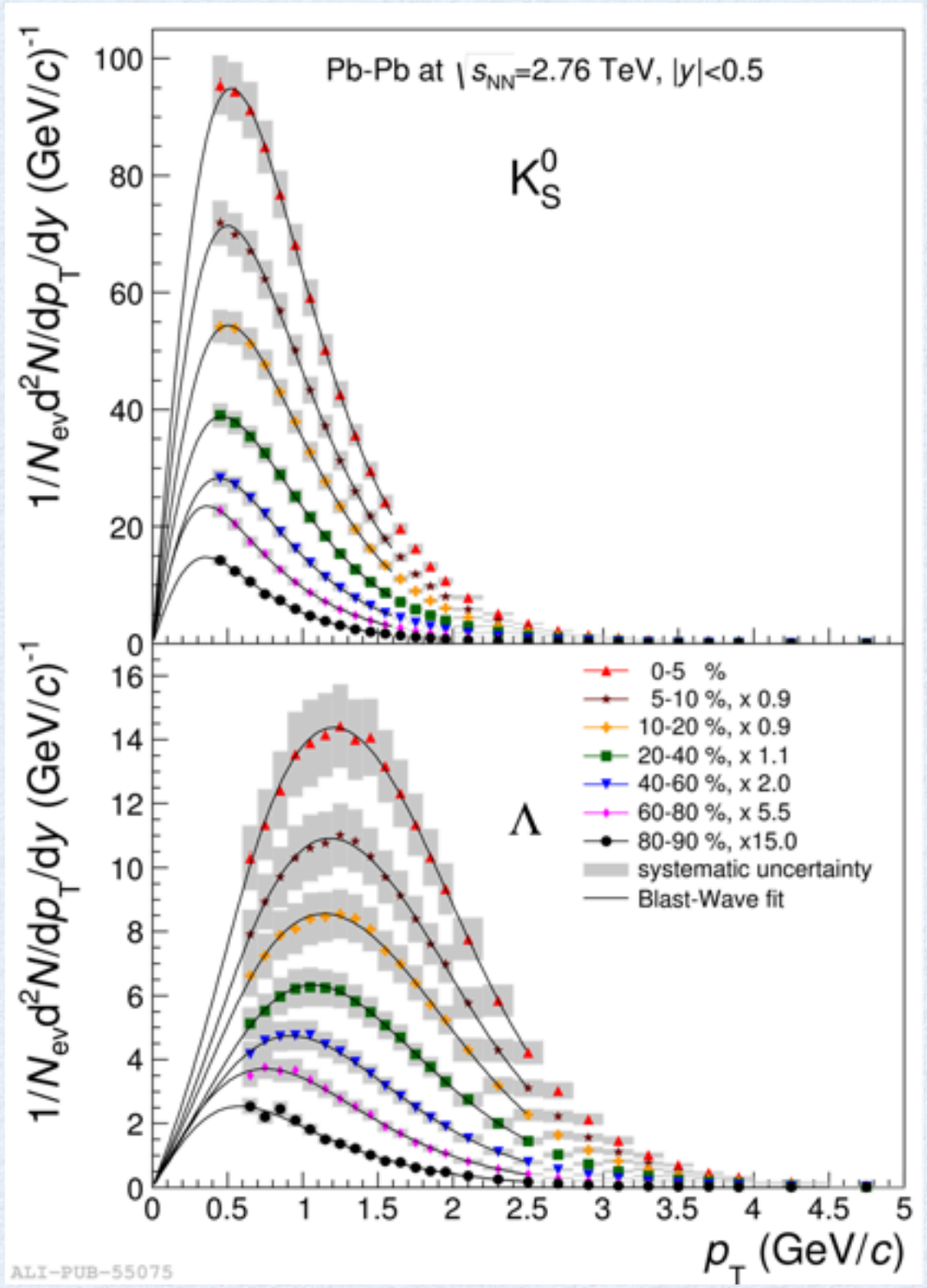
Single reconstruction technique allows for:

- Reconstruction of both strange mesons and baryons
- Wide transverse momentum range
- Good control of systematic uncertainties



arXiv:1307.5530 [nucl-ex]

Strangeness in ALICE



arXiv:1307.5530 [nucl-ex]

The spectra were fitted using a blast-wave function, up to:

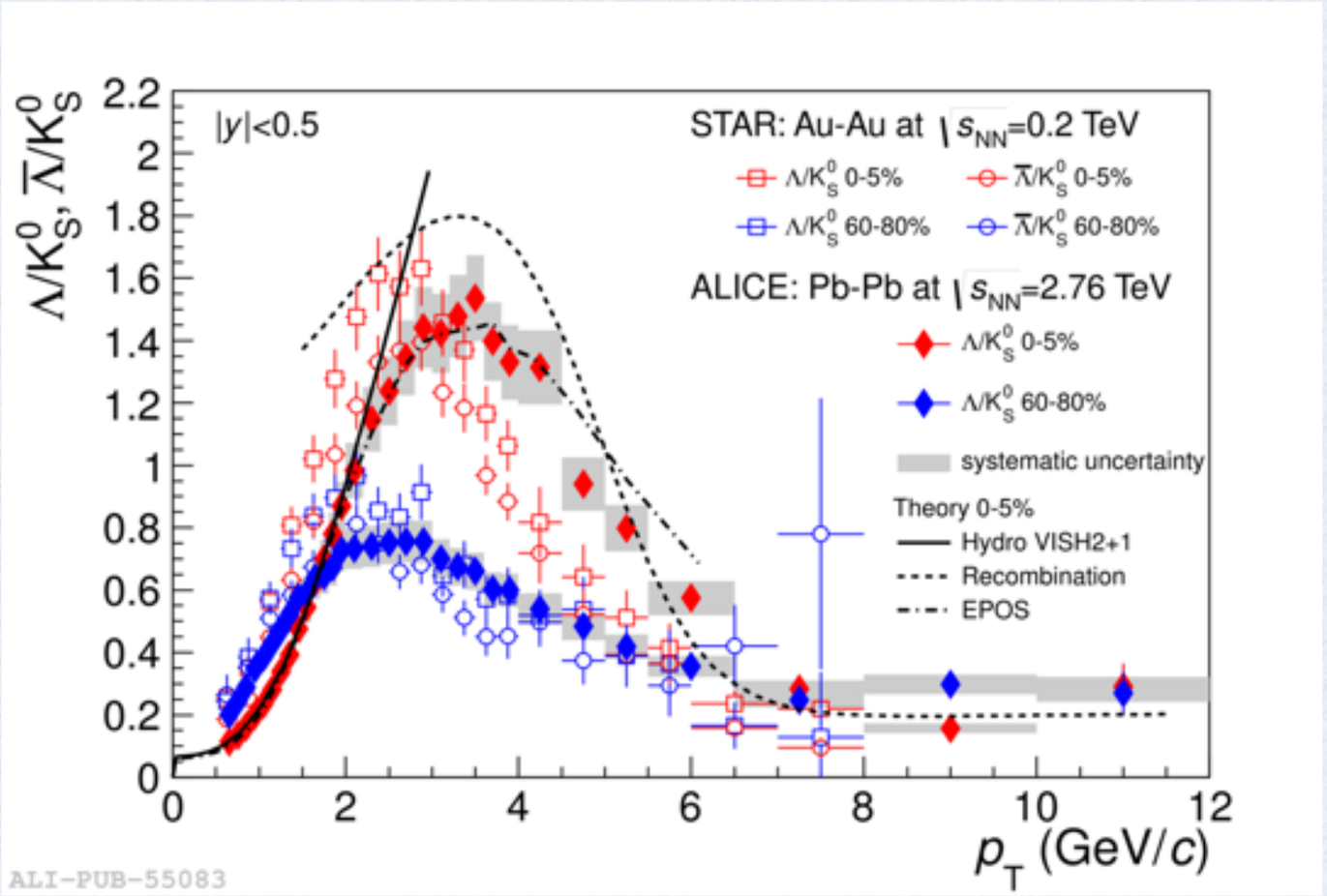
- 1.6 GeV/c for K^0_S
- 2.5 GeV/c for Λ

The ratio of the integrated Λ and K^0_S yields does not change with centrality

		0–5%	40–60%
Λ	dN/dy	26 ± 3	3.8 ± 0.4
	$p_T < 0.6$ GeV/c frac.	10%	18%
K^0_S	dN/dy	110 ± 10	14 ± 1
	$p_T < 0.4$ GeV/c frac.	20%	25%
	Ratio dN/dy Λ/K^0_S	0.24 ± 0.02	0.26 ± 0.03

arXiv:1307.5530 [nucl-ex]

More about Λ/K^0_S



arXiv:1307.5530 [nucl-ex]

-Low p_T

-Described by Hydrodynamical model calculation (up to 2 GeV/c) C. Shen, U. Heinz, P. Huovinen and H. Song, Phys. Rev. C 84, 044903 (2011).

- Intermediate p_T

-Recombination model

Overestimates the Λ/K^0_S enhancement. V. Greco, C. M. Ko, and I. Vitev, Phys. Rev. C 71 041901 (2005).

-EPOS

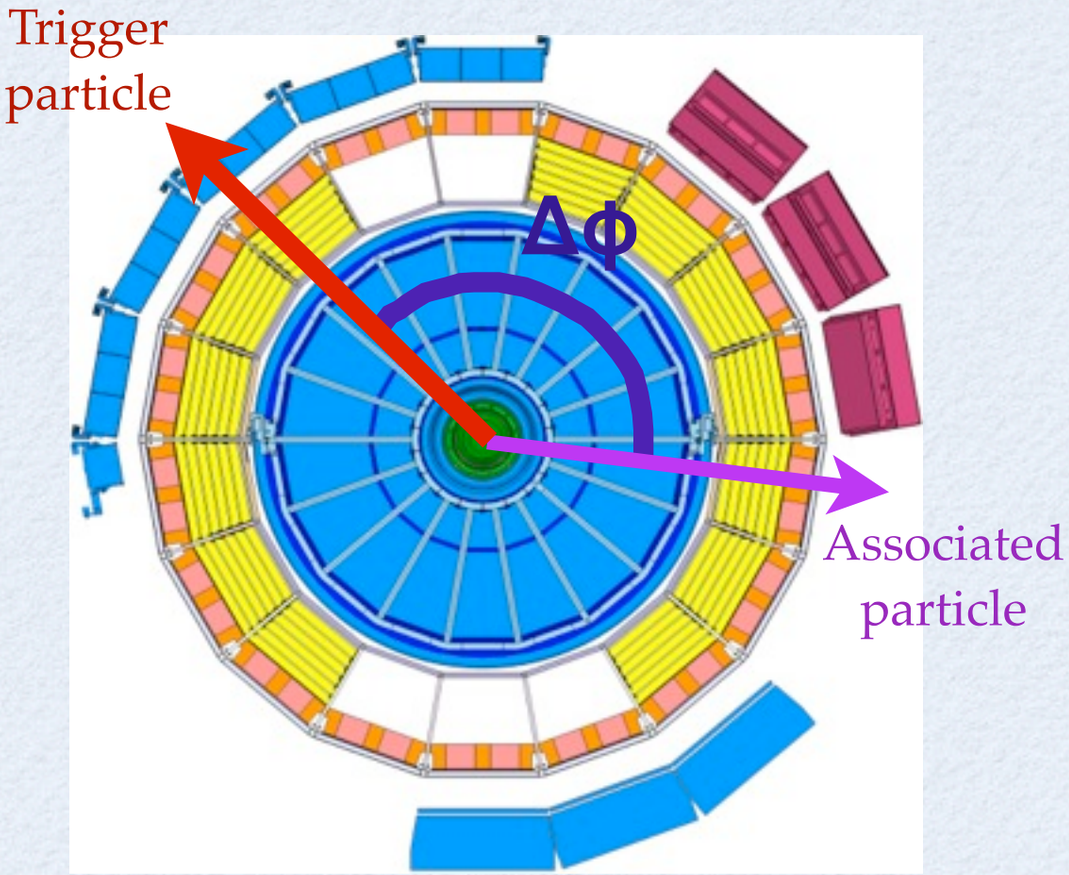
Interaction between jets and a hydrodynamical expansion of the system.
Qualitatively ok, it reproduces the maximum. K. Werner, Phys. Rev. Lett. 109, 102301 (2012).

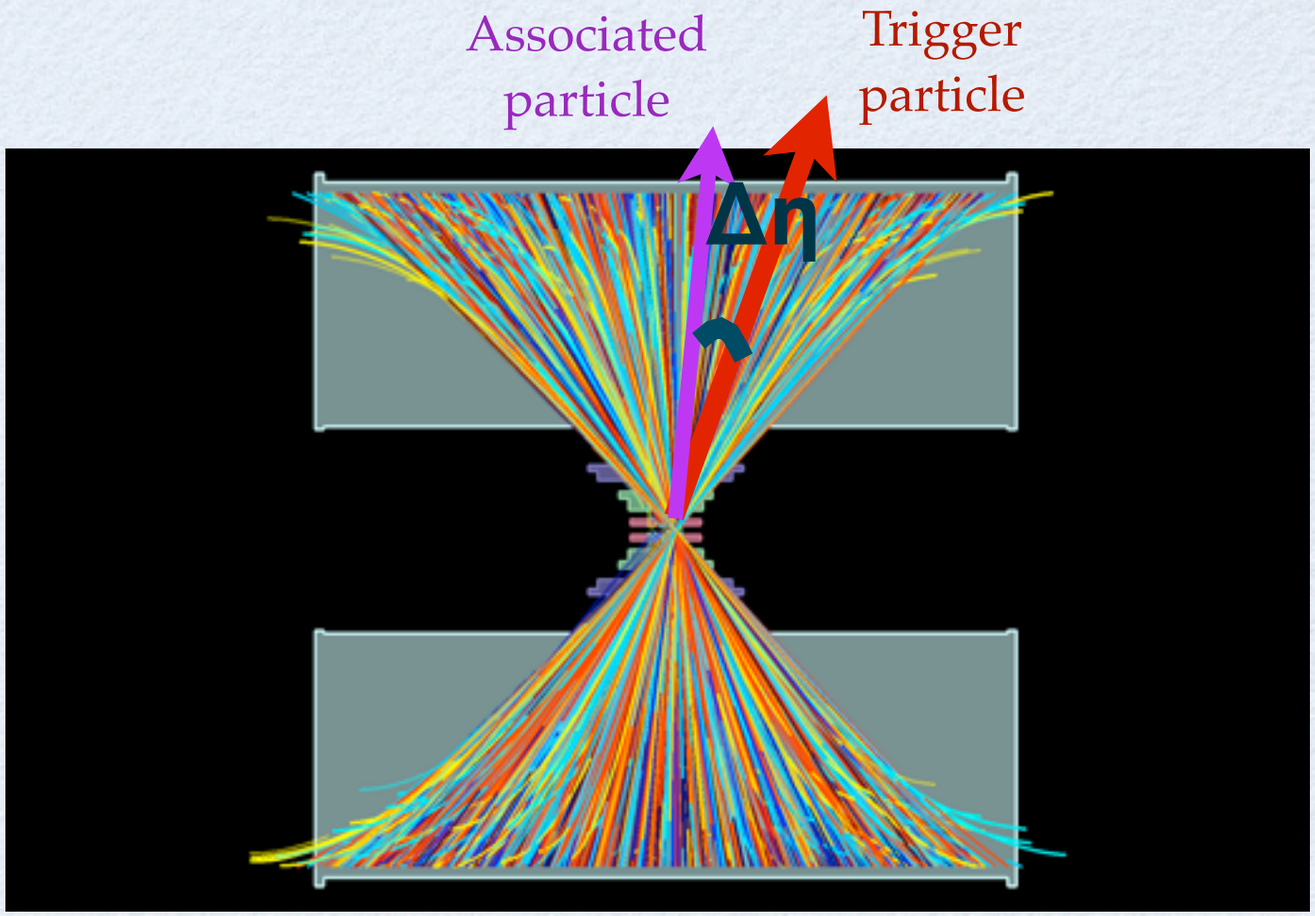
- High p_T

-Parton fragmentation regime

Values are similar to the ones in proton-proton collisions

Two-hadron correlations





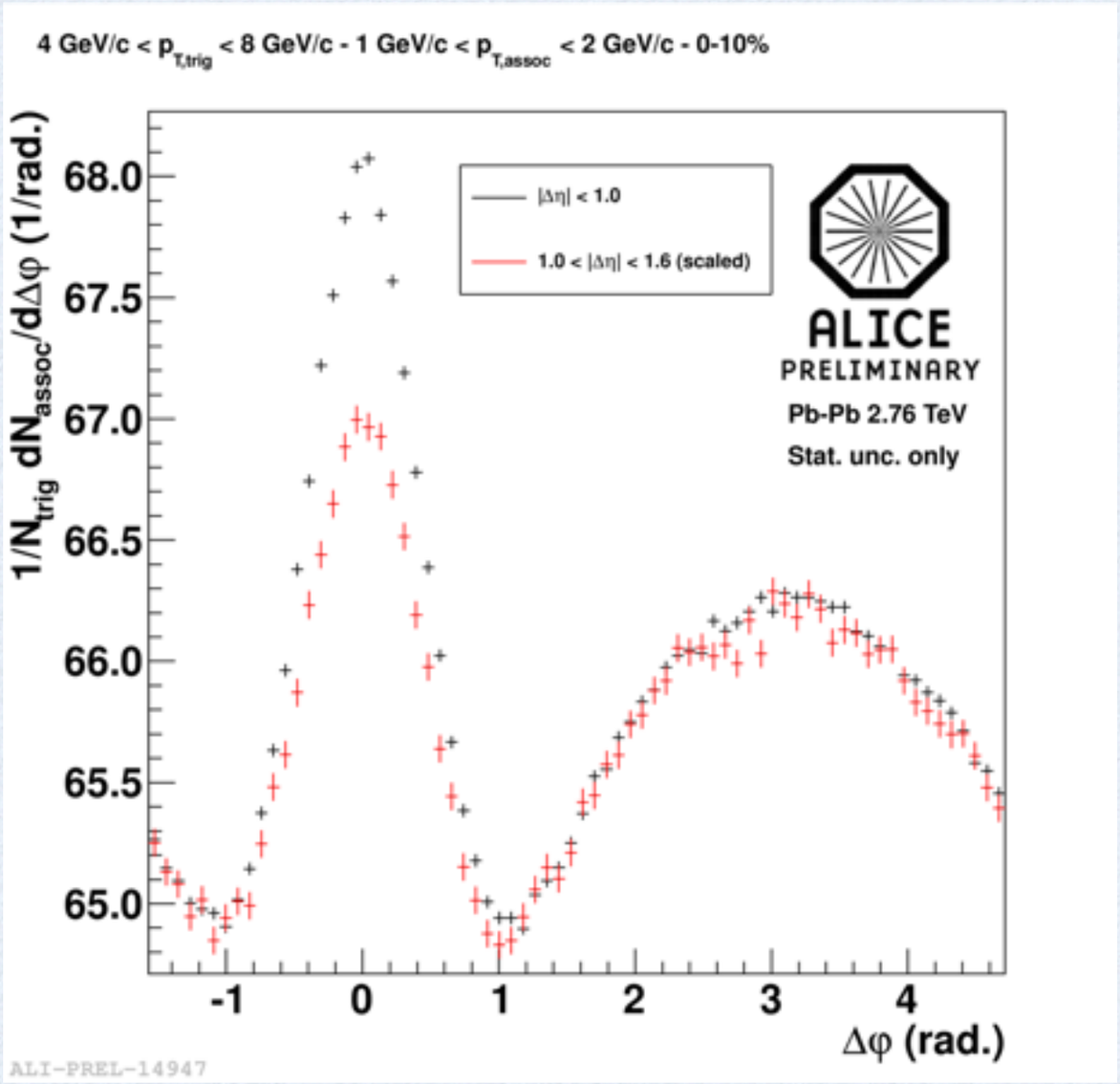
Transverse plane XY

$\Delta\varphi = \varphi_{Trig} - \varphi_{Assoc}$

Longitudinal direction Z

$\Delta\eta = \eta_{Trig} - \eta_{Assoc}$

Near-side yield extraction



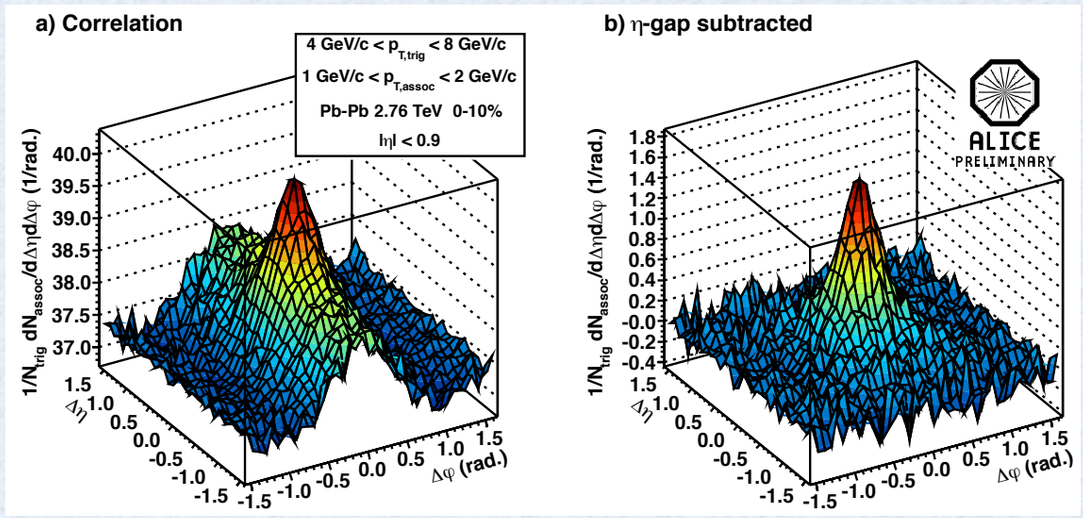
arXiv:1207.7187 [nucl-ex]

Flow modulated background subtraction:

The production associated to a high-p_T particle can be extracted by subtracting long-range correlations.

η-gap method: selecting the correlated particles in the range of $1.0 < |\Delta\eta| < 1.6$

Assumptions: flow is independent of $\Delta\eta$ and the jet does not contribute to $|\Delta\eta| > 1.0$



V0-hadron correlations

At high-p_T values:

The baryon production in gluon jets is enhanced with respect to quark jets.

Dividing V0-hadron correlations into two samples, K^0_S -hadron (*leading meson*) and (anti-Λ) Λ-hadron (*leading baryon*) we might be able to study:

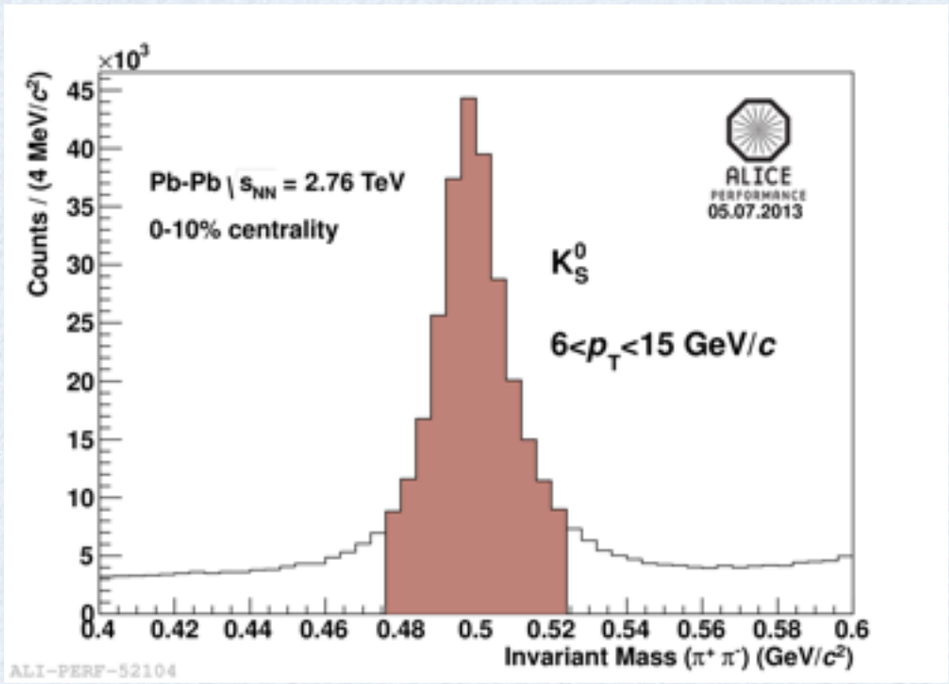
- gluon jet enriched sample via (anti)Λ-hadron correlations
- quark/gluon jet sample via K^0_S-hadron correlations

K^0_S–hadron correlations

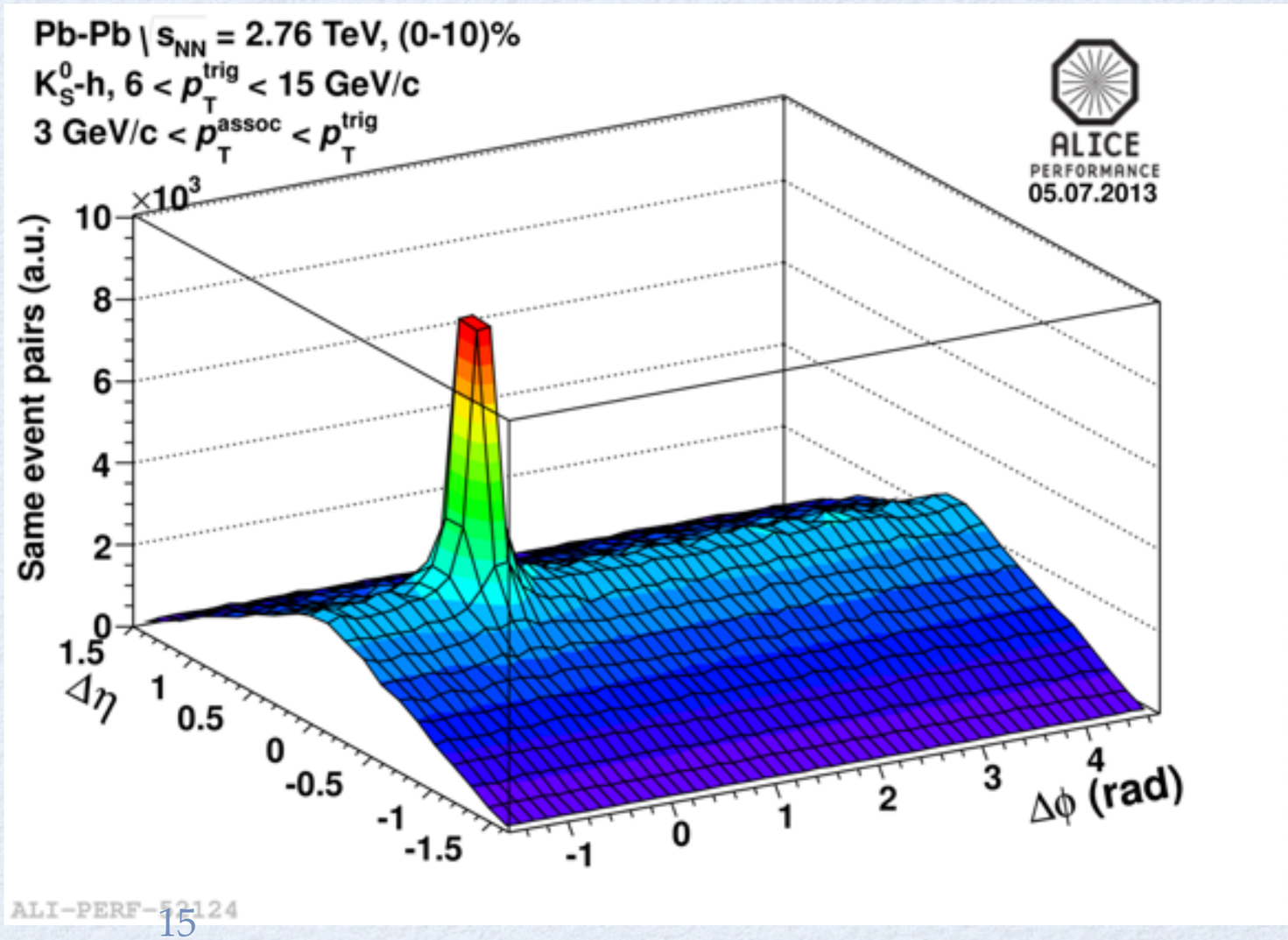
Trigger particle (K^0_S): $6 < p_{T,Trig} < 15$ GeV/c

Associated particle (charged hadrons): $3 < p_T < p_{T,Trig}$

2011 data



Production associated to high-p_T K^0_S



Raw correlation in
the invariant mass window

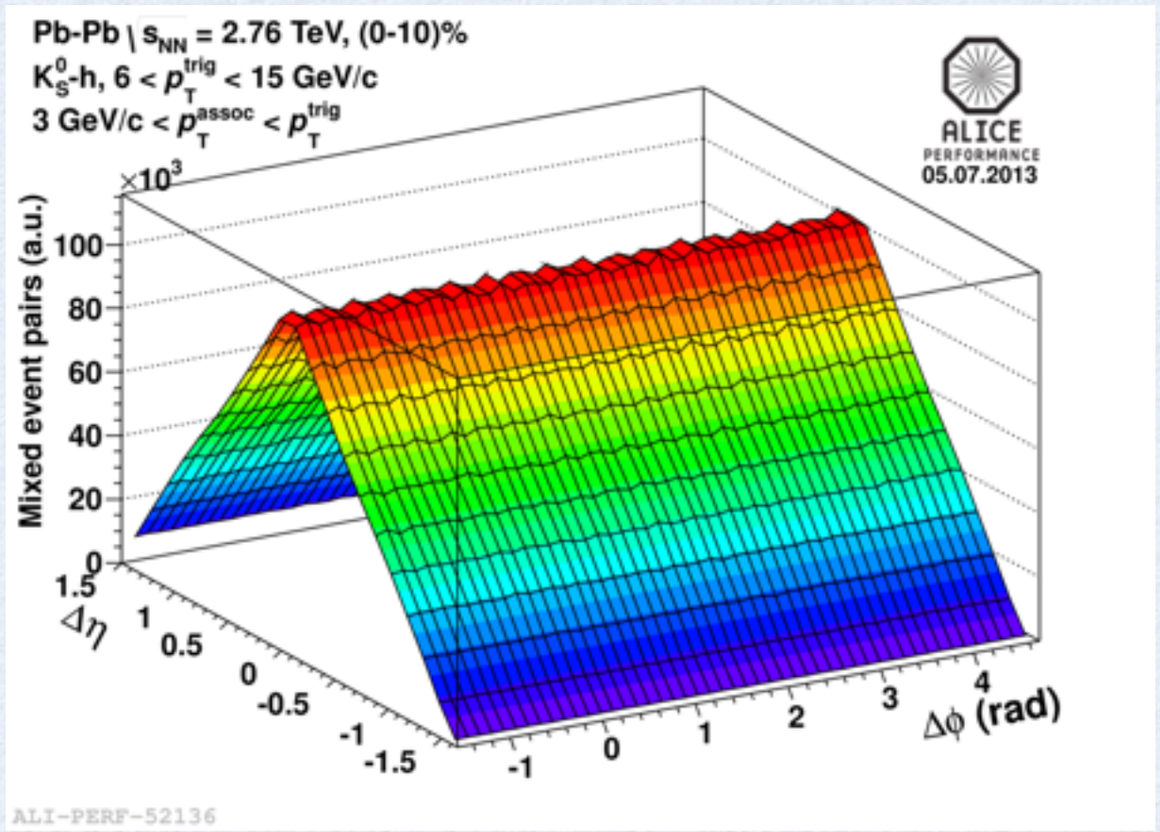
Mixed events

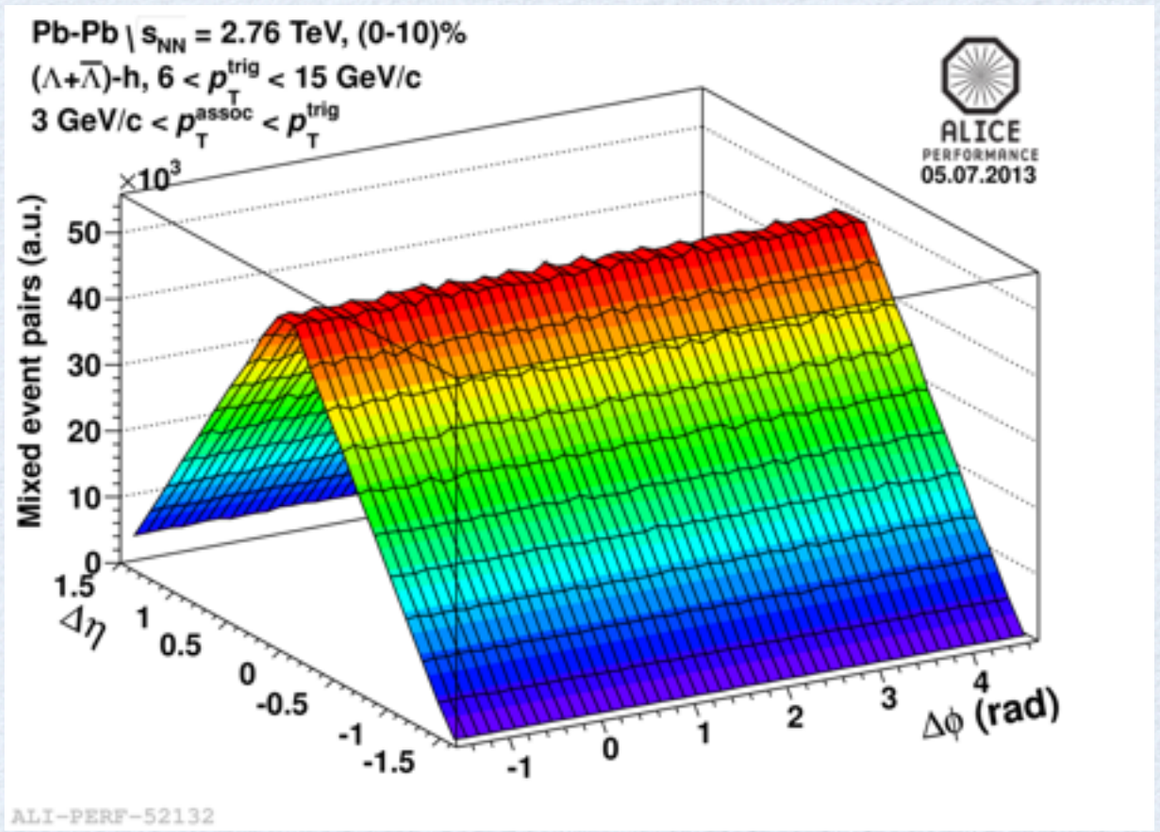
Trigger particle (K^0_S, Λ): $6 < p_{T,Trig} < 15$ GeV/c

Associated particle (charged hadrons): $3 < p_T < p_{T,Trig}$

2011 data

Detector acceptance is taken into account in the **mixed event correction.**





The triangular shape in $\Delta\eta$ is due to the limited η acceptance in the detector

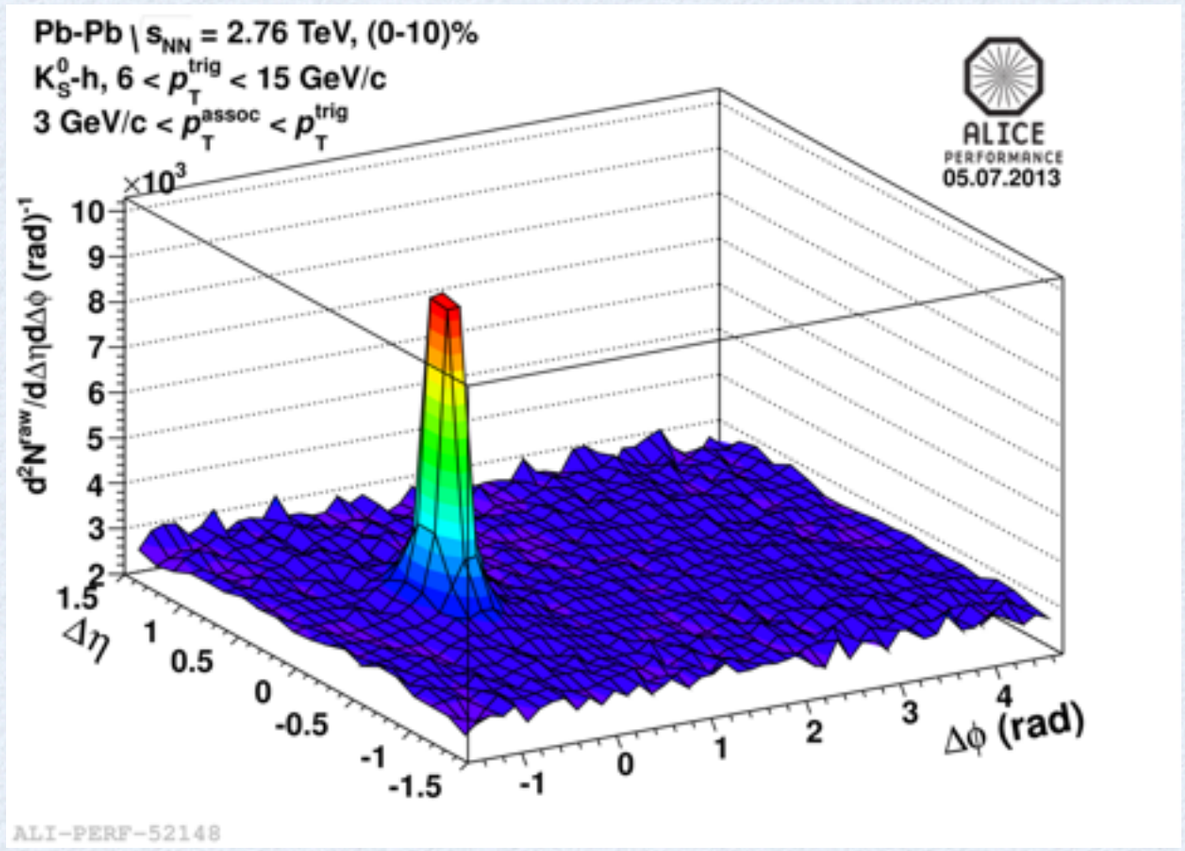
Outlook on V0-hadron correlations

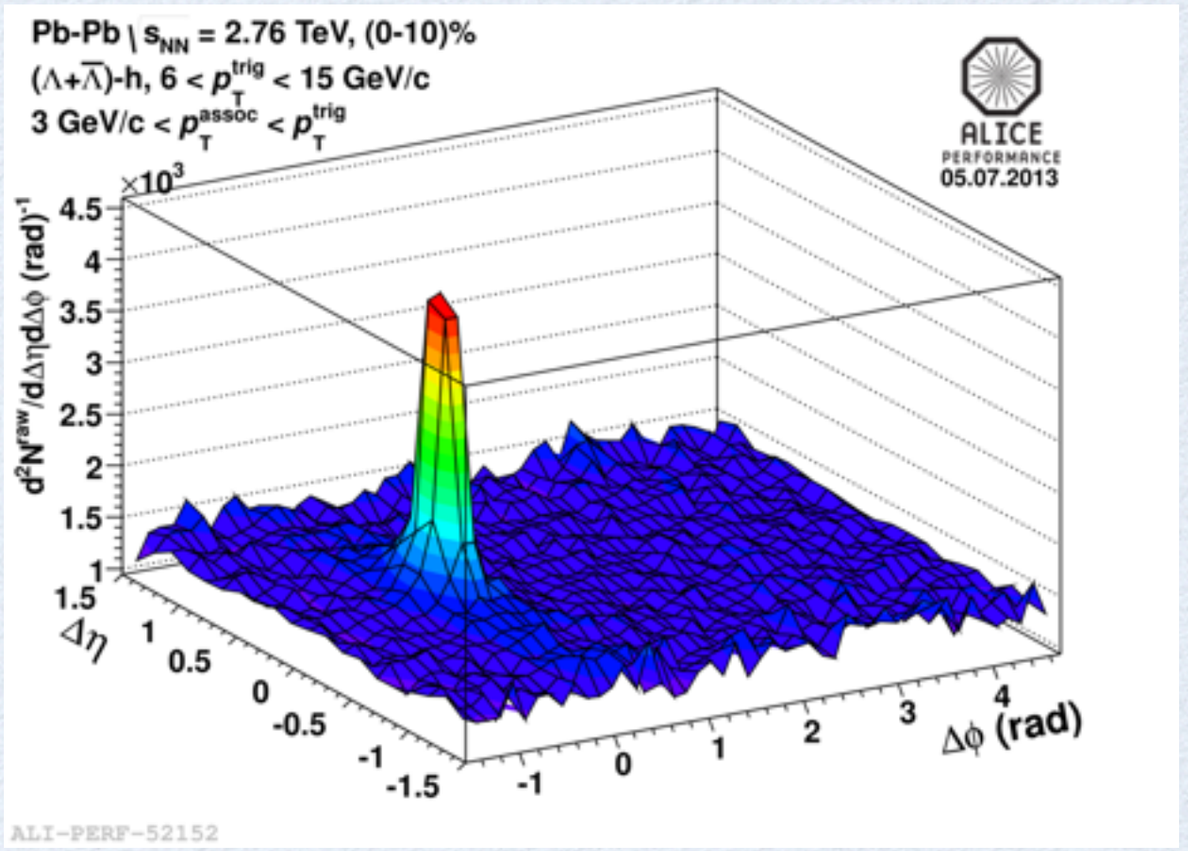
Trigger particle (K^0_S, Λ): $6 < p_{T,Trig} < 15$ GeV/c

Associated particle (charged hadrons): $3 < p_T < p_{T,Trig}$

2011 data

After acceptance correction:

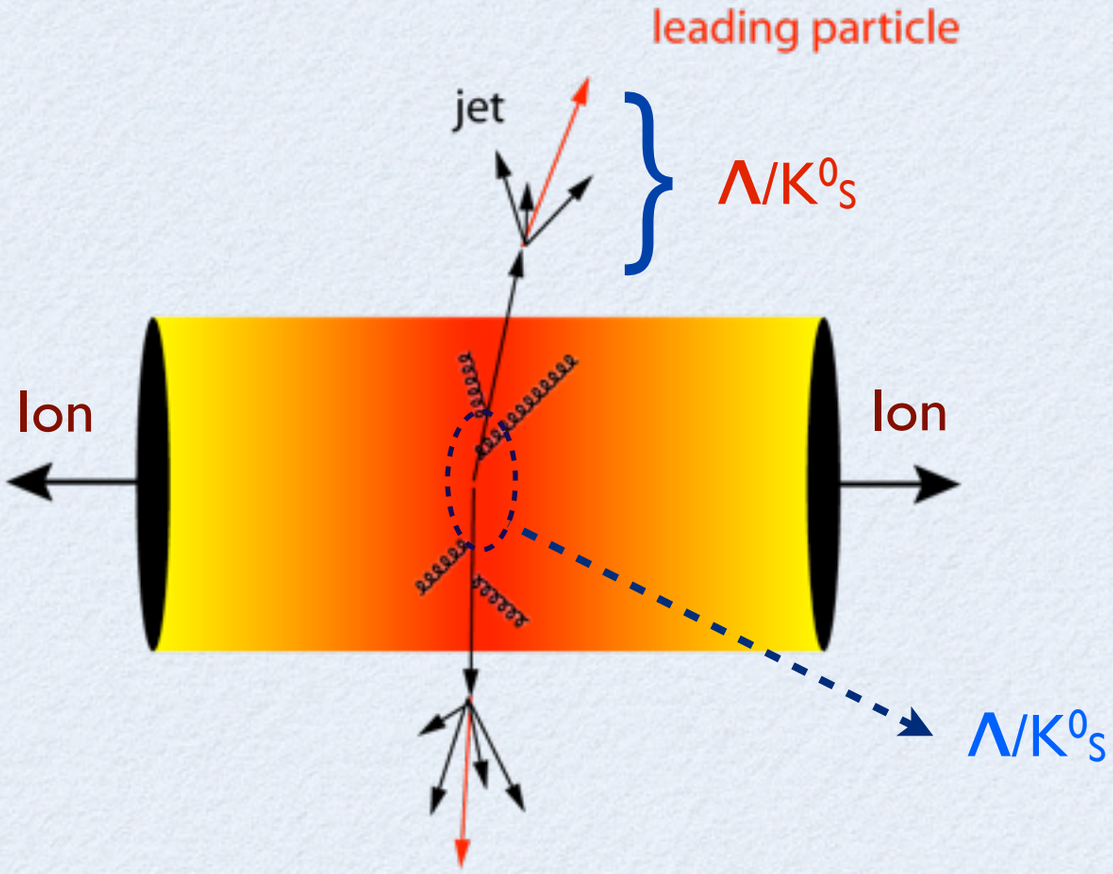




Still to be applied: Corrections for single track efficiencies, contamination (from secondary particles), track merging and track splitting.

New topic: Hadron–V0 correlations

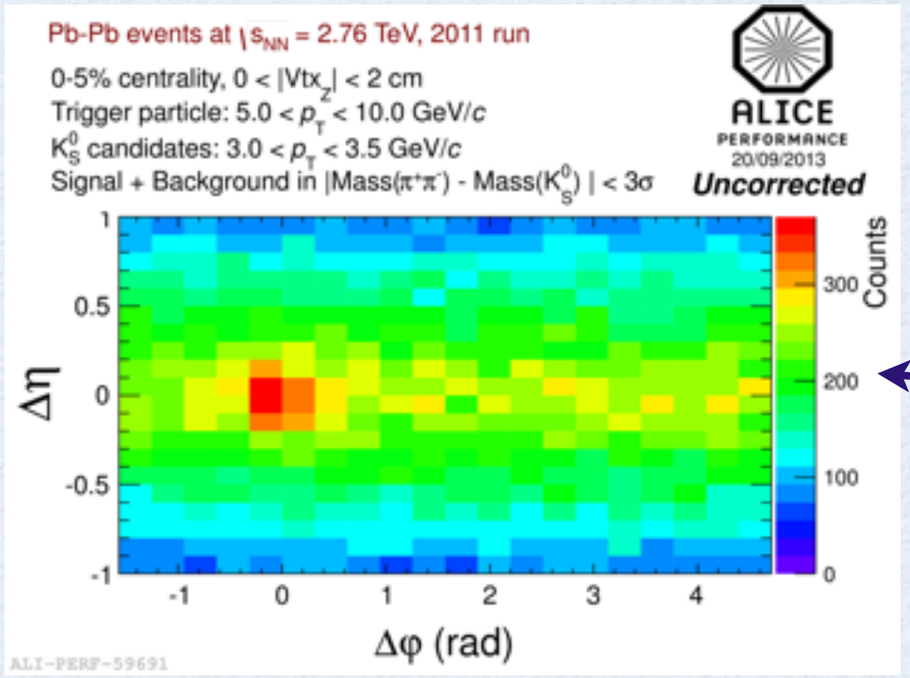
We want to understand the origin of the Λ/K^0_S enhancement by separating these hadrons produced in correlation with a high-p_T particle from their production in the thermalized bulk.



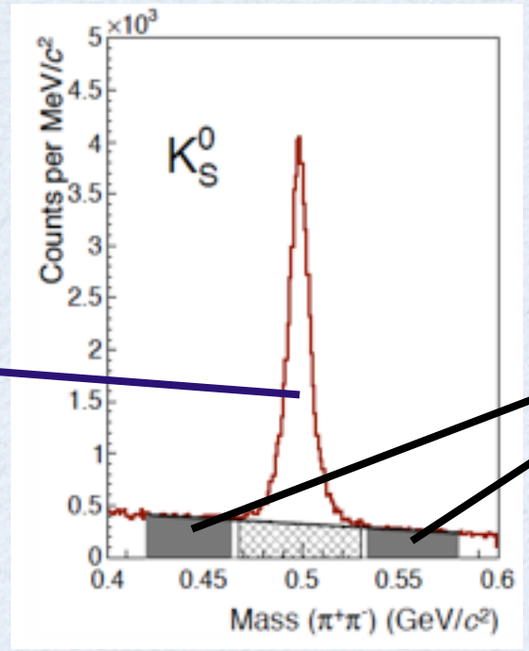
Is the baryon/meson enhancement related to the hadronization mechanisms in the plasma phase or is there also an effect due to jet fragmentation modification in the medium?

Hadron–V0 correlation

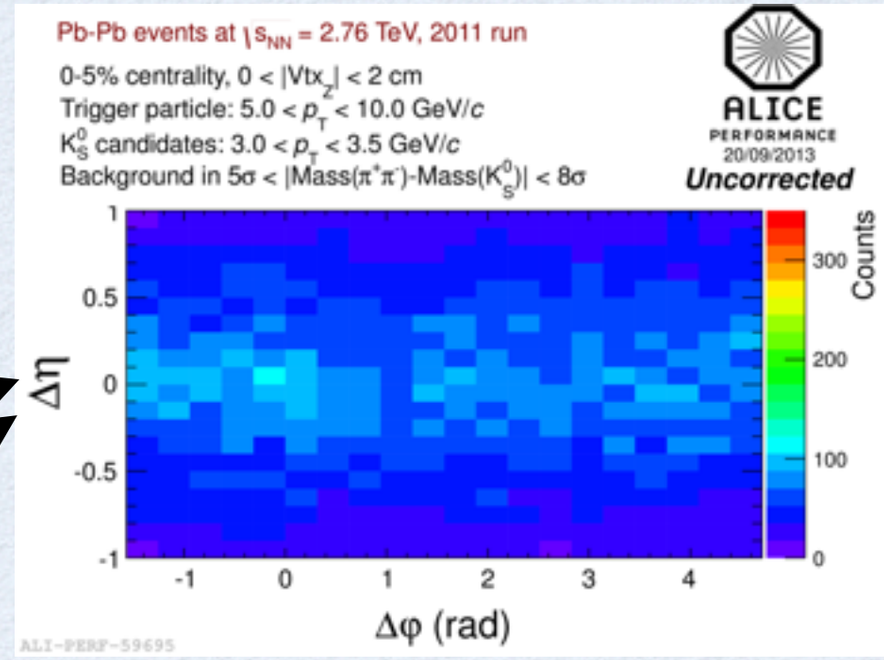
Signal + Background



arXiv:1307.5530 [nucl-ex]



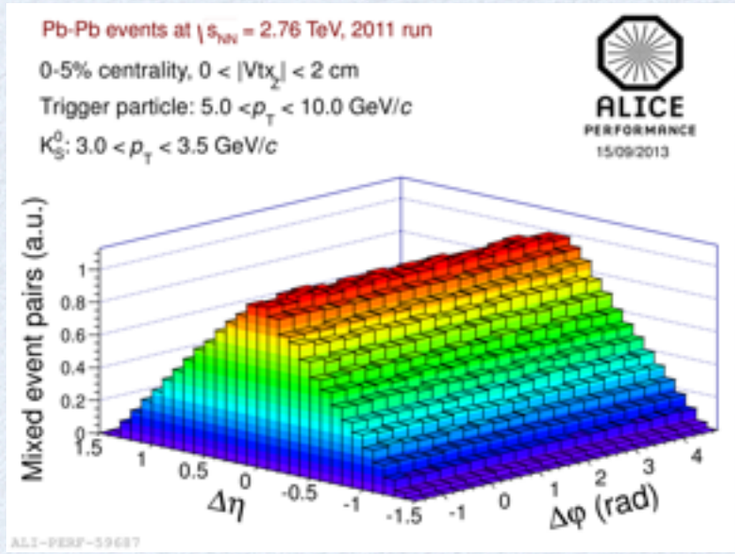
Background



Trigger particle:
all charged particles within
$5 < p_T < 10$ GeV/c

Associated particle:
K^0_S and Λ in the range
$2 < p_T < 7$ GeV/c

Detector acceptance is taken into account in the **mixed event correction.**



Hadron–V0: bulk and jet

Trigger particle (charged hadrons): $5 < p_{T,Trig} < 10$ GeV/c

Associated particle (K^0_S): $3 < p_T < 3.5$ GeV/c

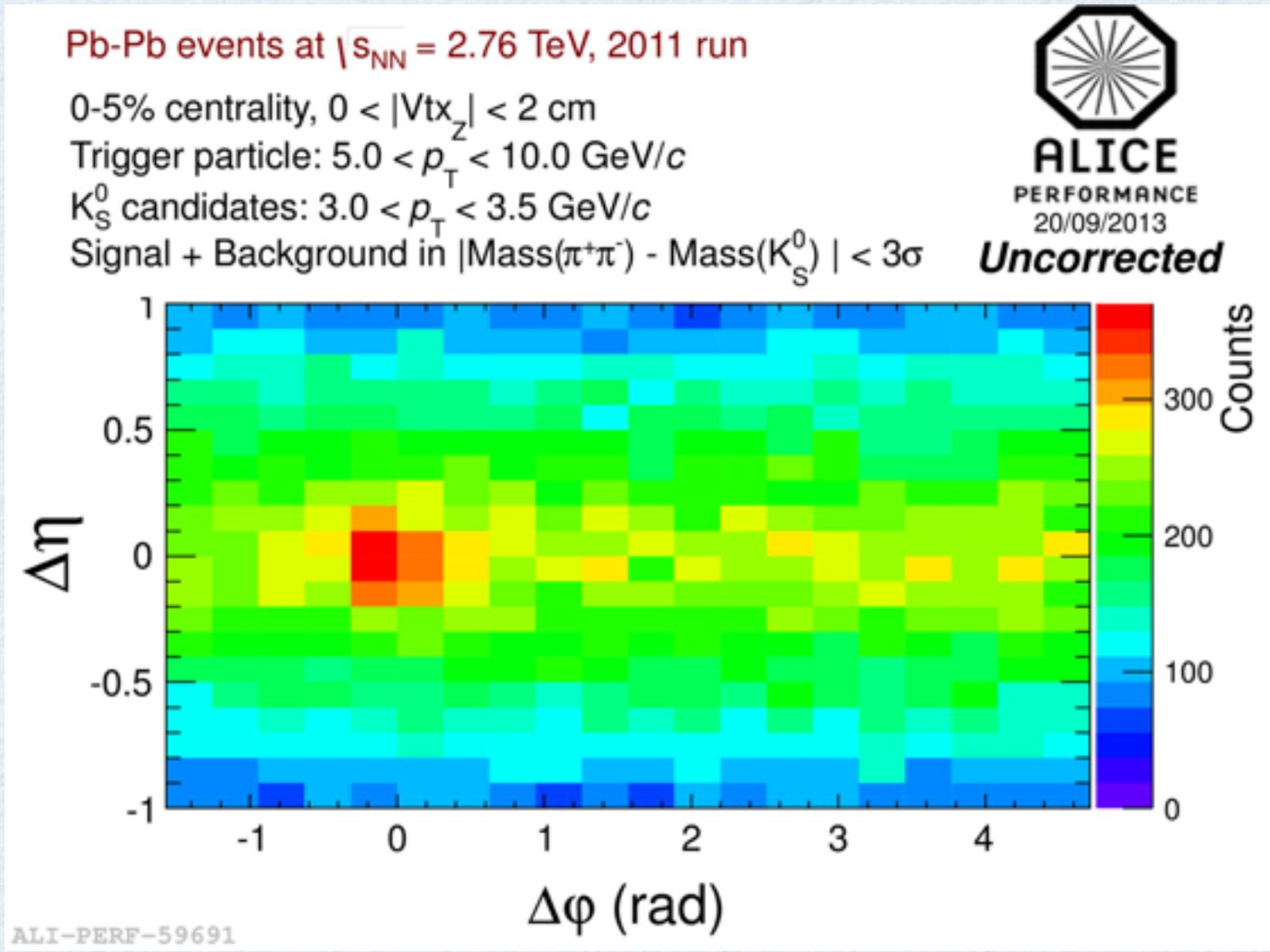
After all corrections we aim to study:

Jet production:

1) Projection in $\Delta\eta$
2) Projection in $\Delta\varphi$

Bulk production:

We can test several samples according to the physics involved: ridge, away-side area.



Prospects

- V0 - charged hadron correlations
  - Allows studying the origin of leading K0s and Lambdas.
  - Could enable the study of charge dependent energy loss via tagging of gluon and quark jets on a statistical basis.
  - First results (not fully corrected) are encouraging.

- Charged hadron - V0 correlations
  - It is possible to compare the **Λ/K^0_S** computed with particles **in the bulk** and the **Λ/K^0_S** obtained with particles **associated** in principle **to a jet**.
  - This study can help to understand better the origin of the baryon/meson enhancement.
  - Analysis is ongoing: results expected soon.

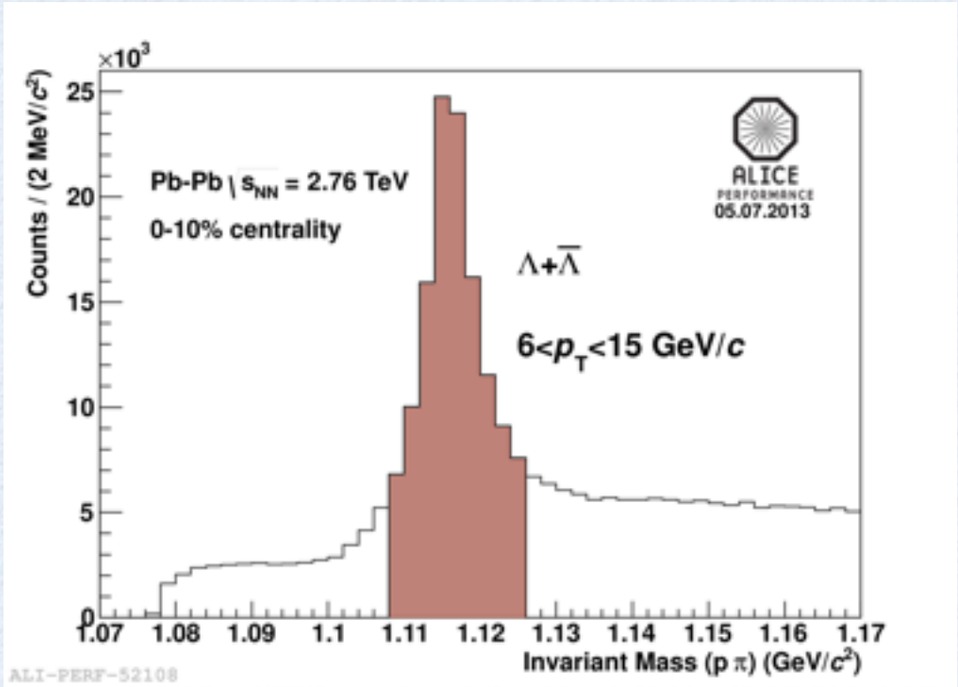
Back Up

Outlook on V0-hadron correlations

Trigger particle (K^0_S, Λ): $6 < p_{T,Trig} < 15$ GeV/c

Associated particle (charged hadrons): $3 < p_T < p_{T,Trig}$

2011 data



Raw correlation in
the invariant mass window

Production associated to high-p_T Λ