Recent Results on Jets and high-p_T Hadrons From ALICE

Eliane Epple
for the ALICE collaboration

Tu, 12.6.2018

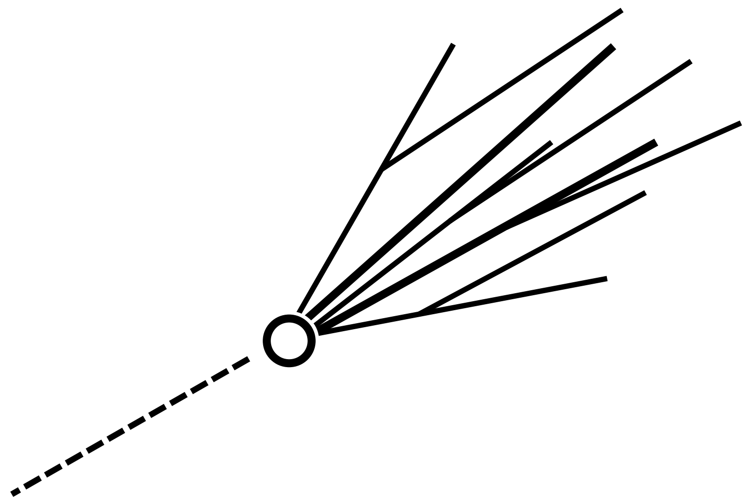
ALICE
A JOURNEY OF DISCOVERY

LUX ET VERITAS
Yale

Jet Physics in the Medium

Jet in Vacuum

created in a hard scattering event
back-to-back with parton/γ/Z-Boson
highly virtual parton fragmenting
and then hadronizing into measurable
particles



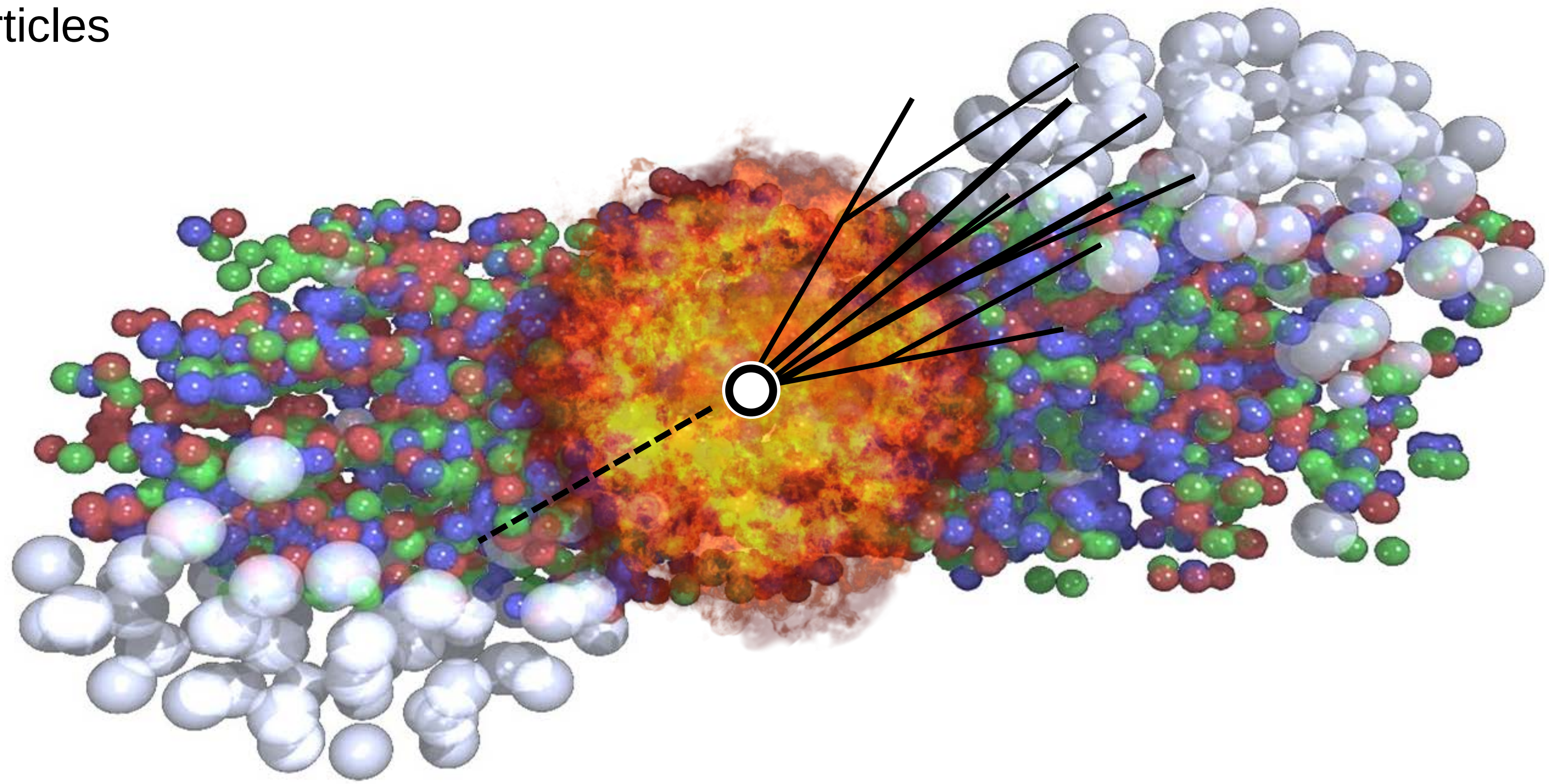
Jet Physics in the Medium

Jet in Vacuum

created in a hard scattering event
back-to-back with parton/γ/Z-Boson
highly virtual parton fragmenting
and then hadronizing into measurable
particles

Jet in Medium

- modification of recoil angle
- modification of energy profile of the jet. Softening/broadening?
- collisional/radiative parton energy loss



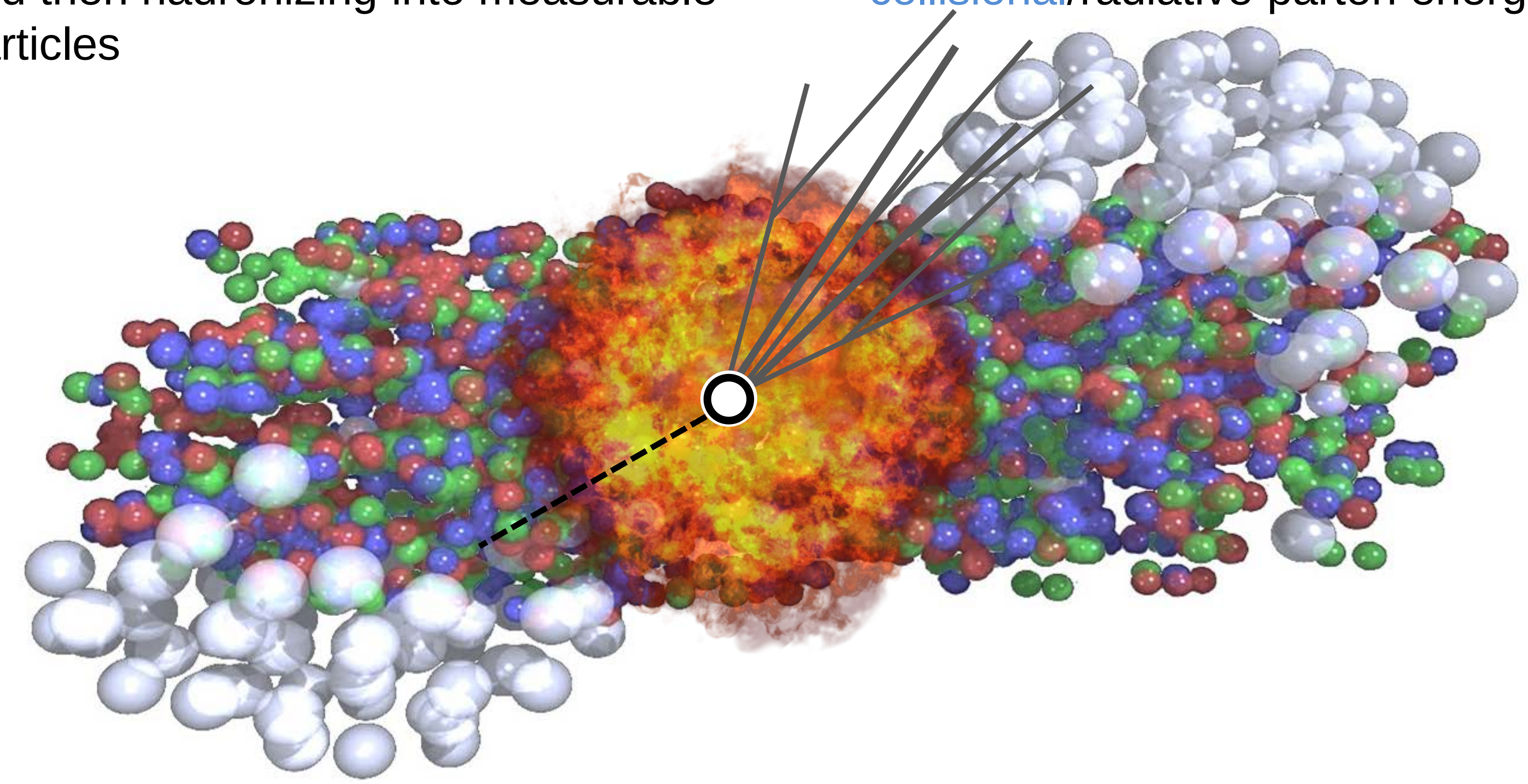
Jet Physics in the Medium

Jet in Vacuum

created in a hard scattering event
back-to-back with parton/γ/Z-Boson
highly virtual parton fragmenting
and then hadronizing into measurable
particles

Jet in Medium

- modification of recoil angle
- modification of energy profile of the jet. Softening/broadening?
- collisional/radiative parton energy loss



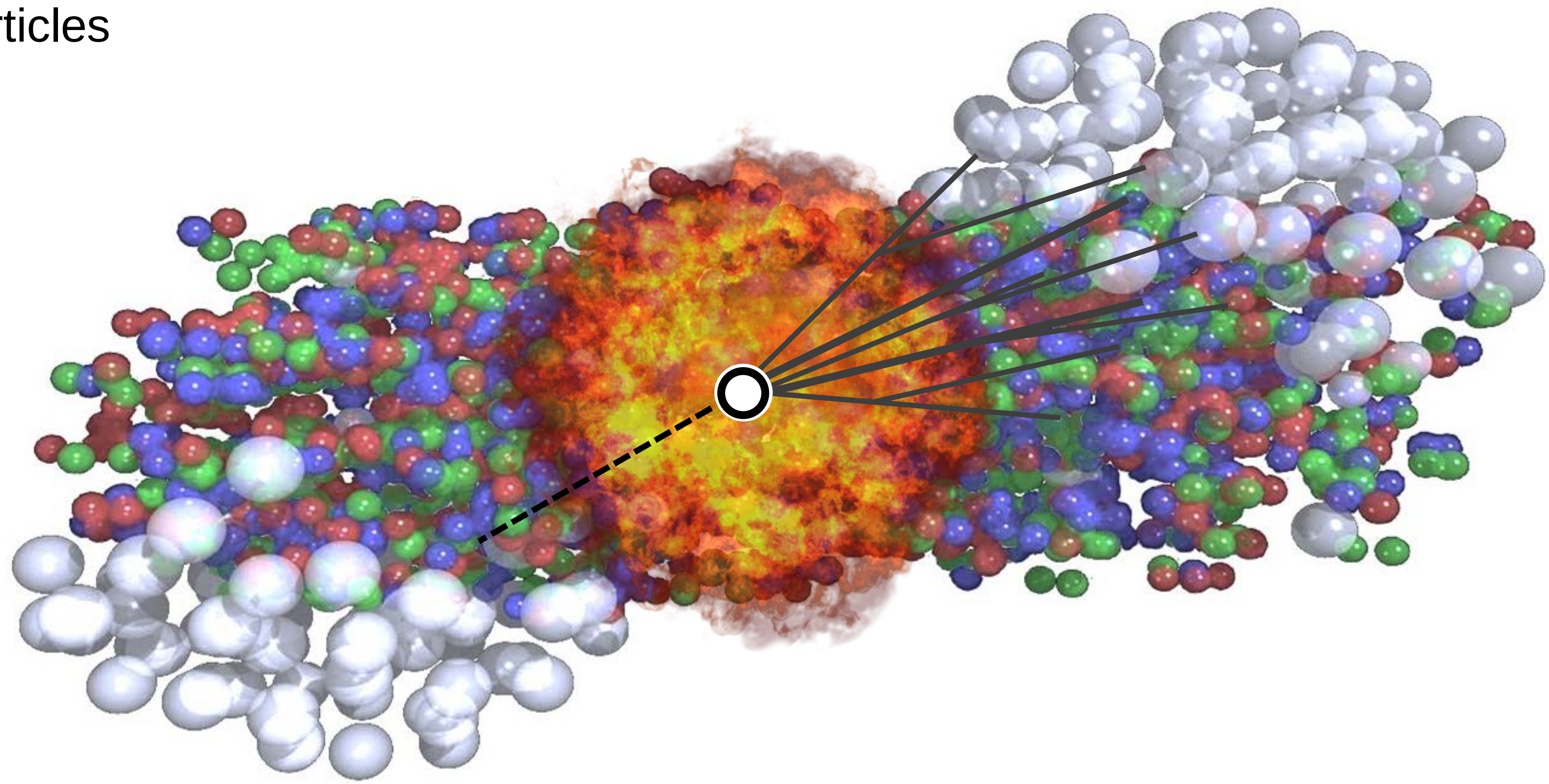
Jet Physics in the Medium

Jet in Vacuum

created in a hard scattering event
back-to-back with parton/γ/Z-Boson
highly virtual parton fragmenting
and then hadronizing into measurable particles

Jet in Medium

- modification of recoil angle
- modification of energy profile of the jet. Softening/broadening?
- collisional/radiative parton energy loss



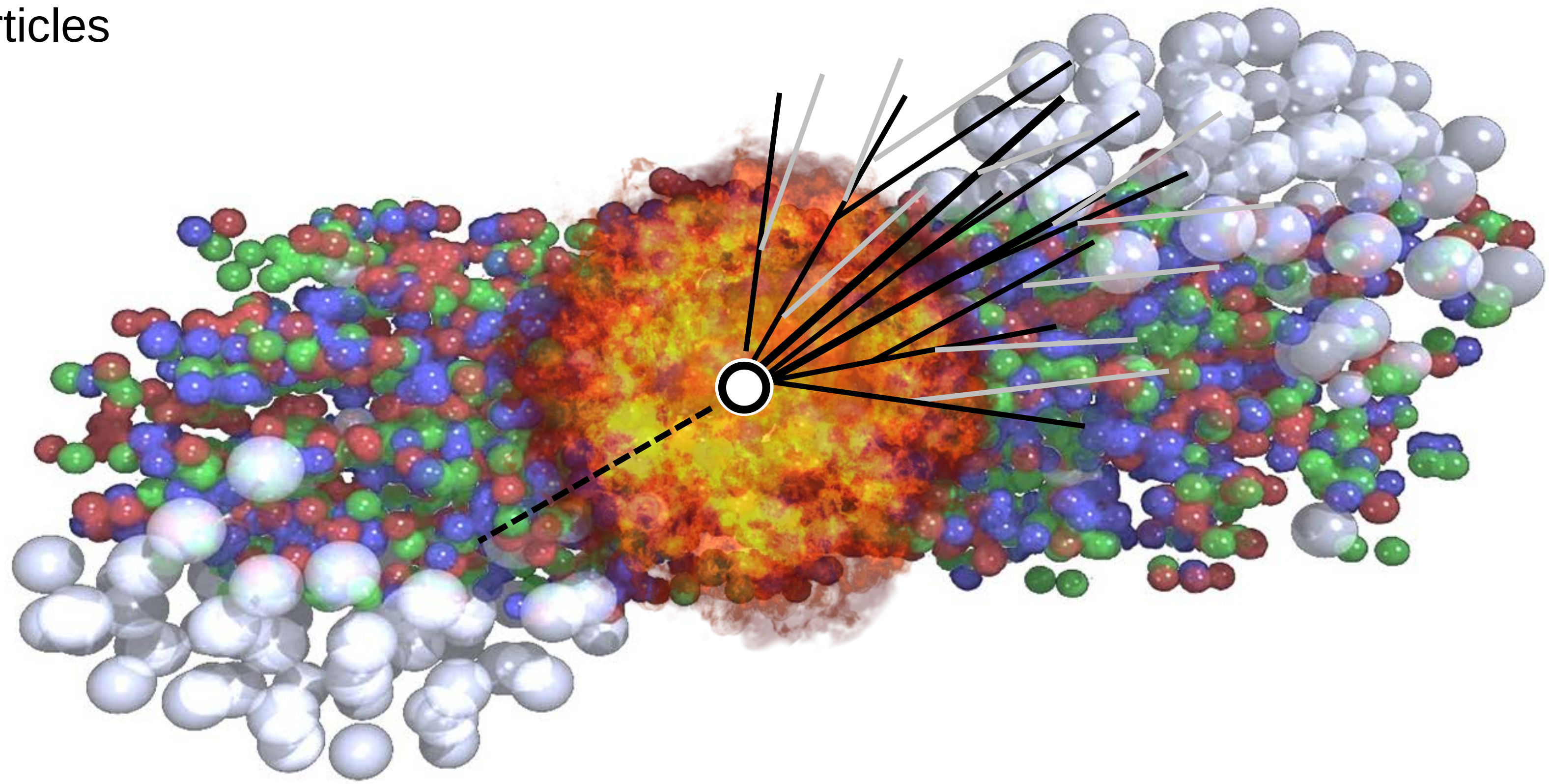
Jet Physics in the Medium

Jet in Vacuum

created in a hard scattering event
back-to-back with parton/γ/Z-Boson
highly virtual parton fragmenting
and then hadronizing into measurable
particles

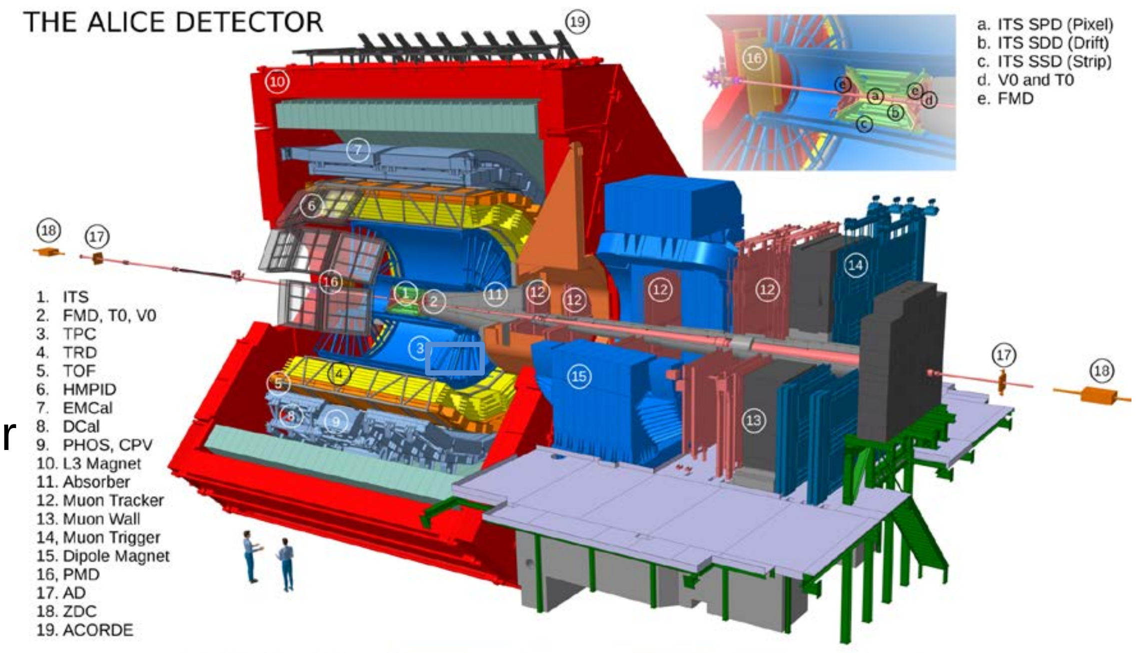
Jet in Medium

- modification of recoil angle
- modification of energy profile of the jet. Softening/broadening?
- collisional/radiative parton energy loss

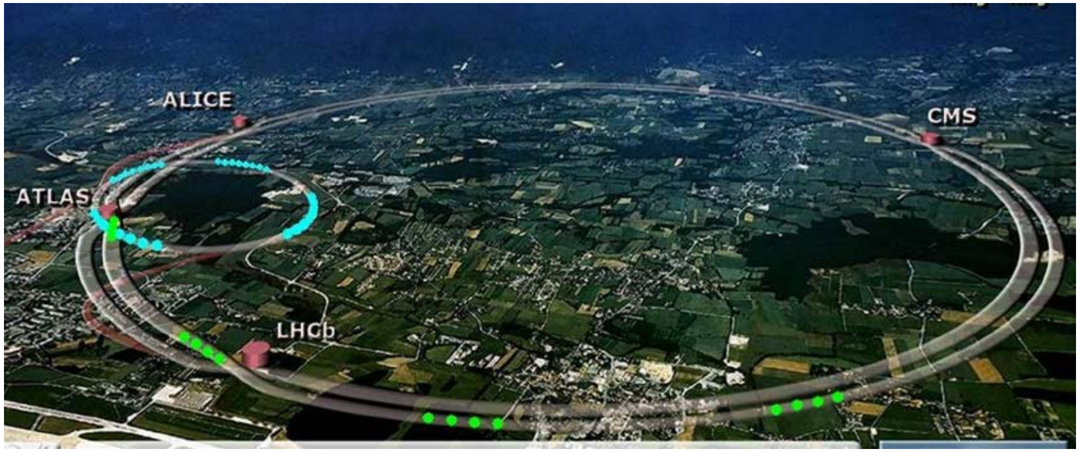


Experiment

TPC (Time projection chamber)
3D gas drift chamber
ITS (Inner Tracking System)
Si pixel, drift, and strip detectors
EMCal
Pb-scintillator sampling calorimeter



Measured Systems
p-Pb at 5.02 TeV
pp at 0.9, 2.76, 5.02, 7, 8, 13 TeV
Pb-Pb 2.76, 5.02 TeV
Xe-Xe 5.44 TeV



Results I Will Focus on

R_{AA} of inclusive and identified hadrons

How are inclusive hadron yields useful for determining the medium transport coefficient $\hat{q}$?

π^0 p_T spectra at several collision energies

How such measurements constrain the gluon to pion fragmentation.

Jet shape measurement in pp and Pb-Pb

How are the cores of jets modified in the medium?

Splitting of groomed jets

How does the medium influence the jet splitting distribution?

Results I Will Focus on

R_{AA} of inclusive and identified hadrons

How are inclusive hadron yields useful for determining the medium transport coefficient $\hat{q}$?

π^0 p_T spectra at several collision energies

How such measurements constrain the gluon to pion fragmentation.

Jet shape measurement in pp and Pb-Pb

How are the cores of jets modified in the medium?

Splitting of groomed jets

How does the medium influence the jet splitting distribution?

from hadrons

to partons

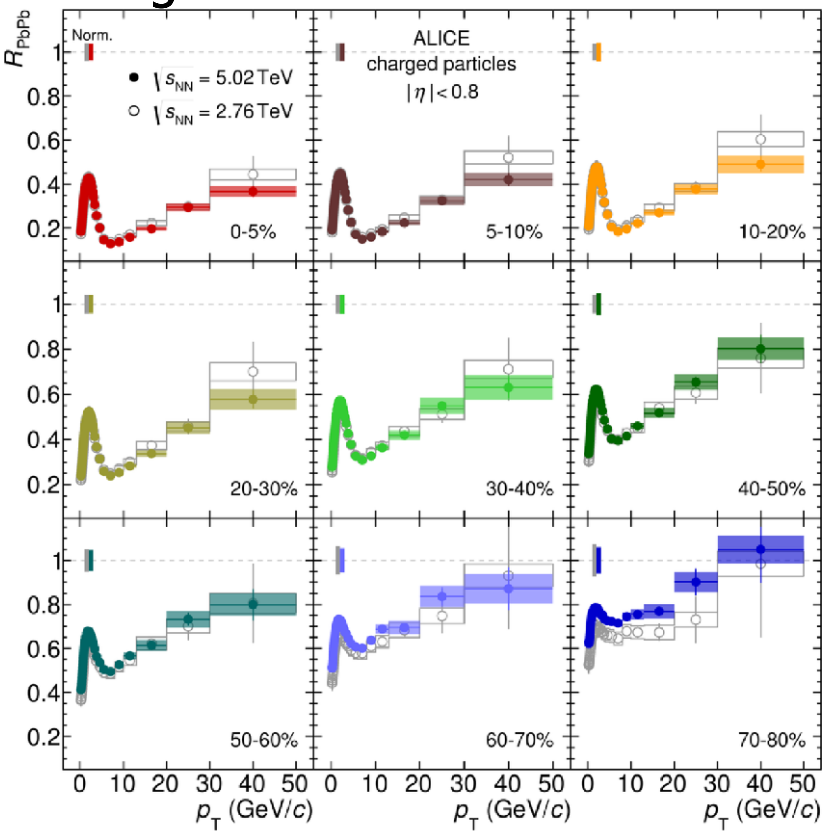
High p_T particles Pb-Pb spectra

- Understanding jet energy loss -

R_{AA} of hadrons

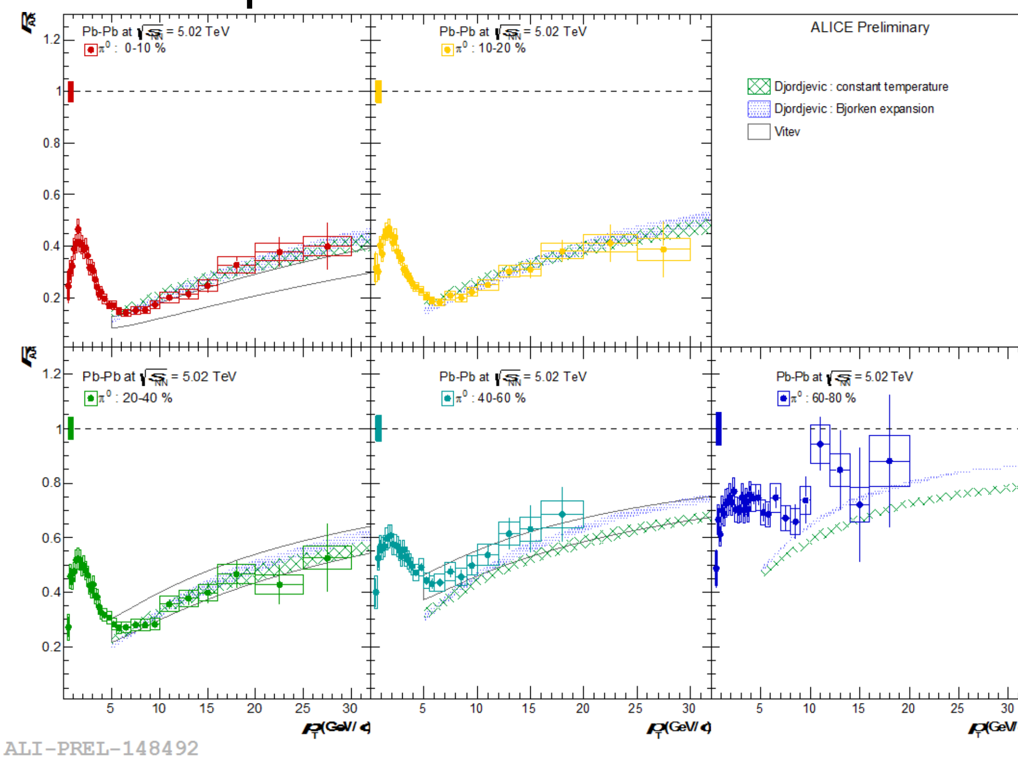
Charged hadrons

ALICE collaboration
arXiv:1802.09145



Neutral pions

ALICE collaboration
arXiv:1803.05490



new data: Pb-Pb at 5.02 TeV
re-analysed data: Pb-Pb at 2.75 TeV

$$R_{AA} = \frac{\mathrm{d}N^{AA}/\mathrm{d}p_T}{\langle N_{coll}\rangle \mathrm{d}N^{pp}/\mathrm{d}p_T} = \frac{\mathrm{d}N^{AA}/\mathrm{d}p_T}{\langle T_{AA}\rangle \mathrm{d}\sigma^{pp}/\mathrm{d}p_T}$$

Understanding jet energy loss

JET collaboration, K. Burke et al.,
Phys. Rev. C 90 (2014) 014909

Jet Collaboration used data from 2013.
Charged hadrons 0-5%, Pb-Pb 2.76 TeV

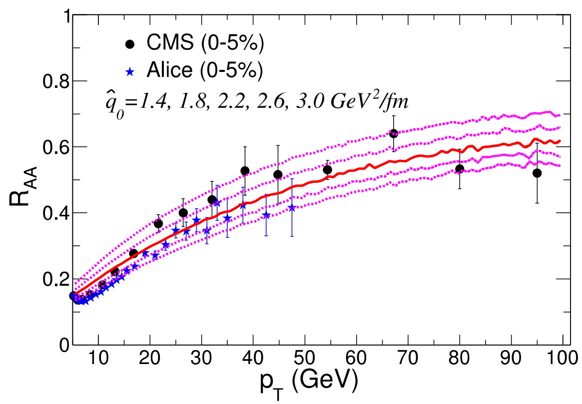
ALICE collaboration, B. Abelev et al.,
Phys. Lett. B 720 (2013) 52

for 10 GeV quark-jet

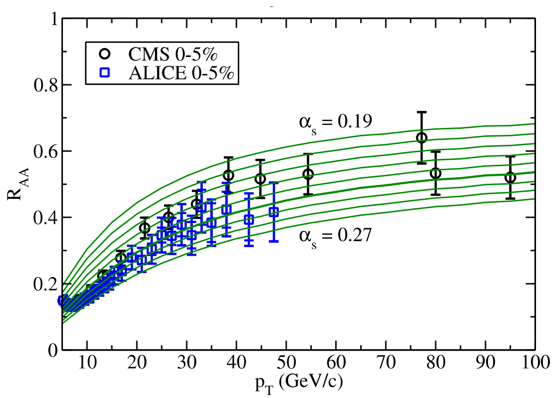
$$\hat{q} \approx \left\{ \begin{array}{ll} 1.2 \pm 0.3 & \\ 1.9 \pm 0.7 & \end{array} \right. \mathrm{GeV}^2/\mathrm{fm} \ \ \mathrm{at} \ \ \begin{array}{l} \mathrm{T{=}370\ MeV,} \\ \mathrm{T{=}470\ MeV,} \end{array}$$

Higher-Twist-Majumder Model (HT-M)

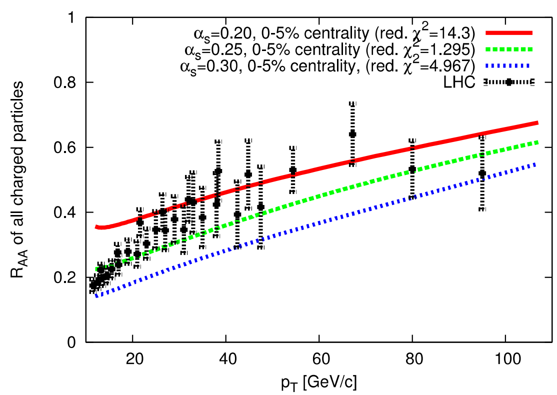
Higher-Twist-Berkeley-Wuhan Model (HT-BW)



McGill-AMYmodel



Martini Model



Understanding jet energy loss

JET collaboration, K. Burke et al.,
Phys. Rev. C 90 (2014) 014909

Jet Collaboration used data from 2013.
Charged hadrons 0-5%, Pb-Pb 2.76 TeV

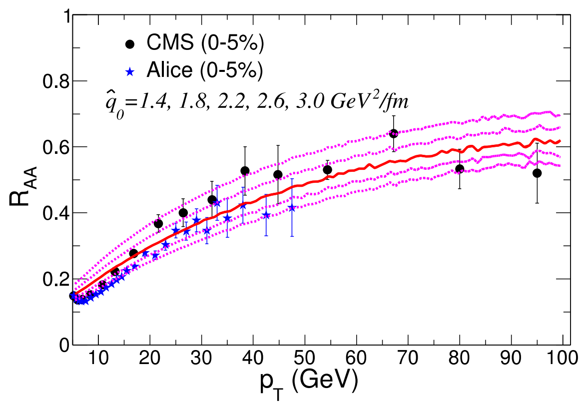
ALICE collaboration, B. Abelev et al.,
Phys. Lett. B 720 (2013) 52

for 10 GeV quark-jet

$$\hat{q} \approx \begin{cases} 1.2 \pm 0.3 \\ 1.9 \pm 0.7 \end{cases} \mathrm{GeV}^2/\mathrm{fm} \ \ \text{at} \ \ \begin{matrix} \mathrm{T{=}370\ MeV}, \\ \mathrm{T{=}470\ MeV}, \end{matrix}$$

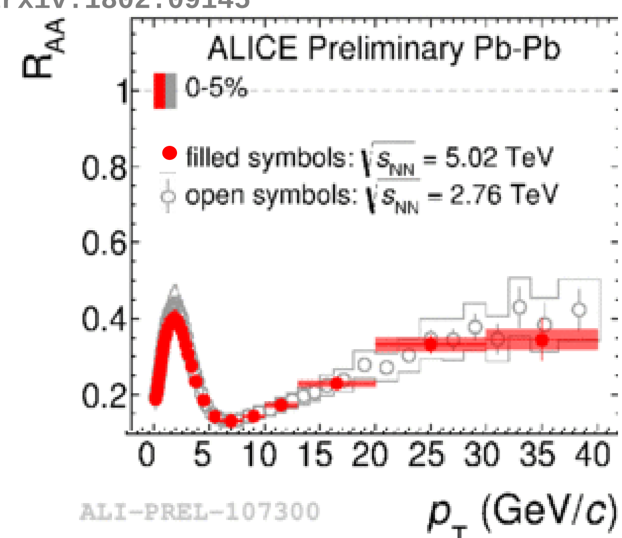
Higher-Twist-Majumder Model (HT-M)

Higher-Twist-Berkeley-Wuhan Model (HT-BW)

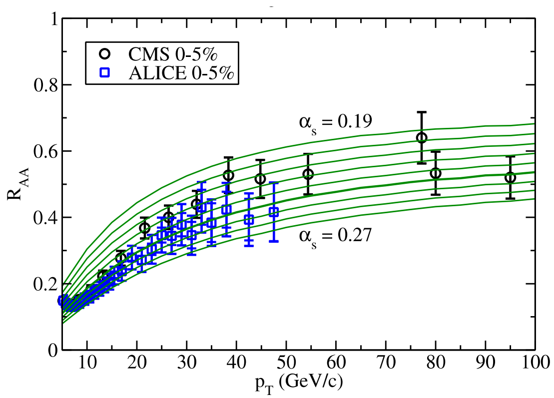


The new and re-analized data have significantly reduced errors (factor ~2)! Will help constrain transport coefficient.

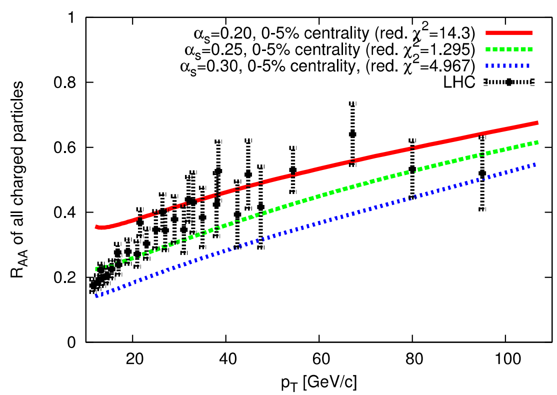
ALICE collaboration, S. Acharya et al.,
arxiv:1802.09145



McGill-AMYmodel



Martini Model



High p_T particles pp spectra

- Understanding jet fragmentation -

Identified high p_T hadrons

Test of pQCD predictions for particle yields produced in hard scattering events.

Ingredients: PDFs and FF

MSTW DSS14

NLO

Identified high p_T hadrons

Test of pQCD predictions for particle yields produced in hard scattering events.

Ingredients: PDFs and FF

MSTW DSS14

NLO

LHC data are ideal to improve the gluon to hadron FF functions.

Identified high p_T hadrons

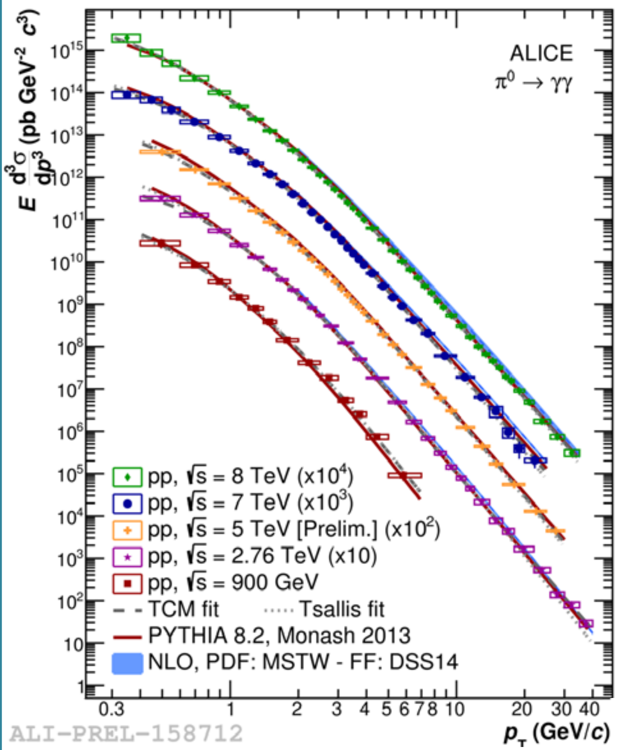
Test of pQCD predictions for particle yields produced in hard scattering events.

Ingredients: PDFs and FF

MSTW DSS14

NLO

LHC data are ideal to improve the gluon to hadron FF functions.



8 TeV - ALICE Collaboration, *Eur. Phys. J., C 78, (2018) 263*

2.76 TeV - ALICE Collaboration, *Eur. Phys. J., C 77, (2017) 339*

7 and 0.9 TeV - ALICE collaboration, Phys. Lett. B 717 (2012) 162-172

5 TeV - ALICE collaboration, PRELIMINARY

Identified high p_T hadrons

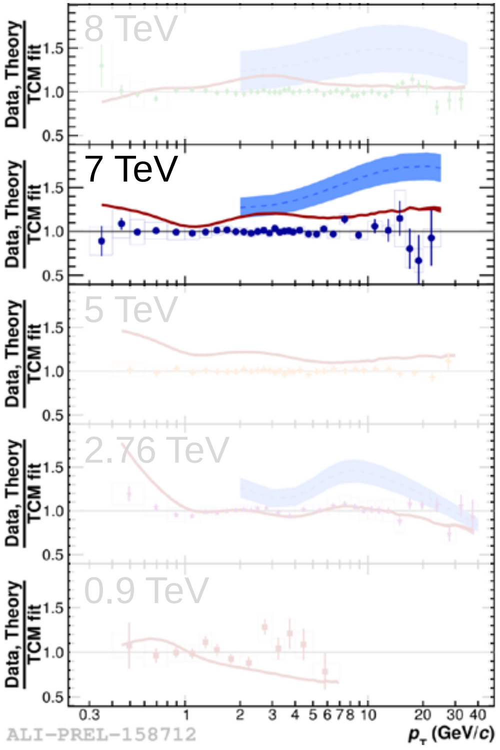
Test of pQCD predictions for particle yields produced in hard scattering events.

Ingredients: PDFs and FF

MSTW DSS14

NLO

LHC data are ideal to improve the gluon to hadron FF functions.



8 TeV - ALICE Collaboration, Eur. Phys. J., C 78, (2018) 263
2.76 TeV - ALICE Collaboration, Eur. Phys. J., C 77, (2017) 339
7 and 0.9 TeV - ALICE collaboration, Phys. Lett. B 717 (2012) 162-172
5 TeV - ALICE collaboration, PRELIMINARY

Identified high p_T hadrons

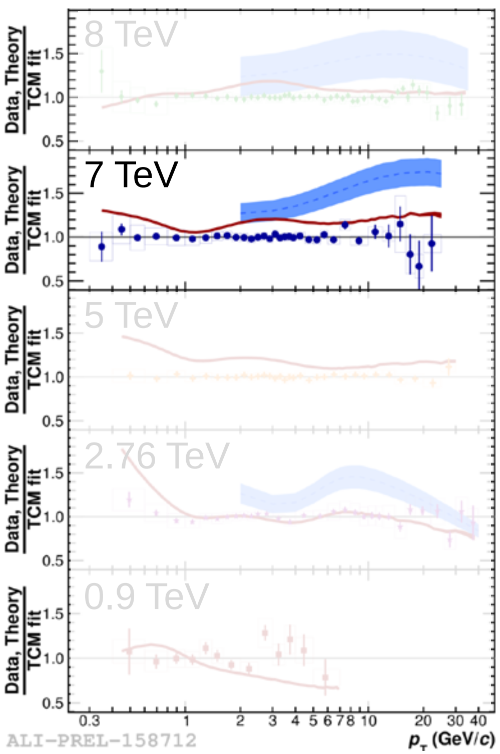
Test of pQCD predictions for particle yields produced in hard scattering events.

Ingredients: PDFs and FF

MSTW DSS14

NLO

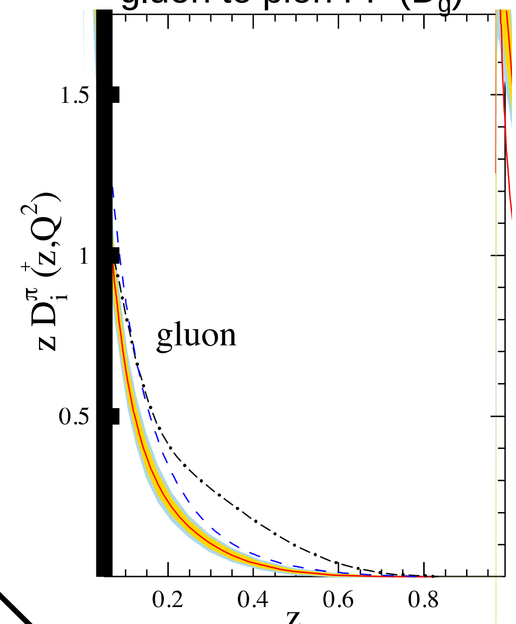
LHC data are ideal to improve the gluon to hadron FF functions.

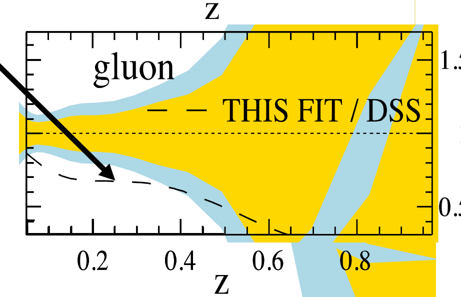


Including ALICE data in fit:
Strong preference for less pions from gluon fragmentation.

8 TeV - ALICE Collaboration, *Eur. Phys. J., C 78, (2018) 263*
2.76 TeV - ALICE Collaboration, *Eur. Phys. J., C 77, (2017) 339*
7 and 0.9 TeV - ALICE collaboration, Phys. Lett. B 717 (2012) 162-172
5 TeV - ALICE collaboration, PRELIMINARY

gluon to pion FF ($D_g^{\pi^0}$)





D. de Florian et al. Phys. Rev. D 91 (2015)

Identified high p_T hadrons

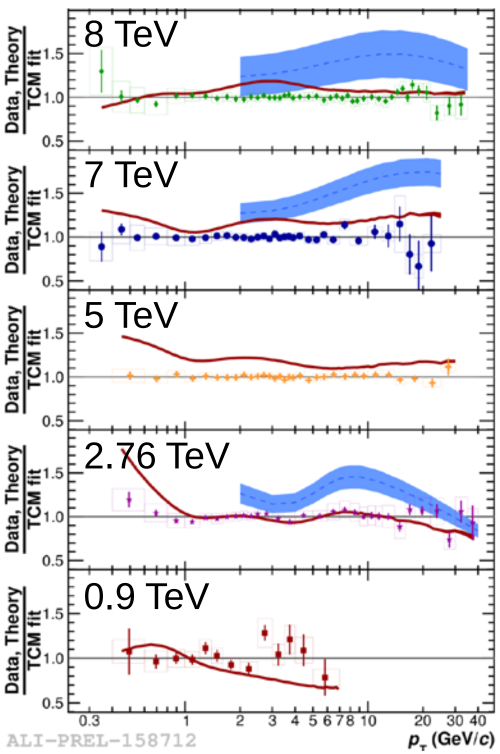
Test of pQCD predictions for particle yields produced in hard scattering events.

Ingredients: PDFs and FF

MSTW DSS14

NLO

LHC data are ideal to improve the gluon to hadron FF functions.

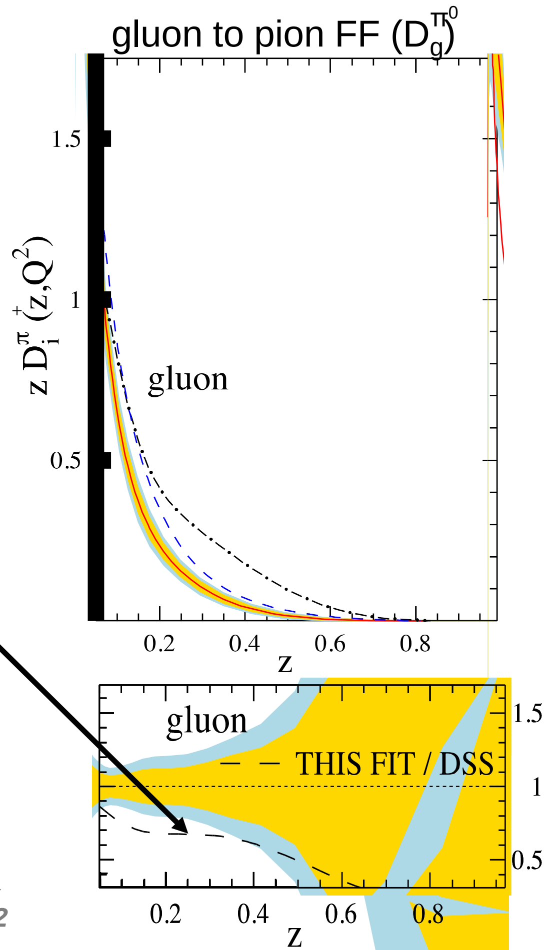


Including ALICE data in fit:
Strong preference for less pions from gluon fragmentation.

Lots of new data available to improve gluon FF further!

8 TeV - ALICE Collaboration, *Eur. Phys. J., C 78, (2018) 263*
2.76 TeV - ALICE Collaboration, *Eur. Phys. J., C 77, (2017) 339*
7 and 0.9 TeV - ALICE collaboration, Phys. Lett. B 717 (2012) 162-172
5 TeV - ALICE collaboration, PRELIMINARY

gluon to pion FF ($D_g^{\pi^0}$)



D. de Florian et al. Phys. Rev. D 91 (2015)

Part 2
Substructure of Jets

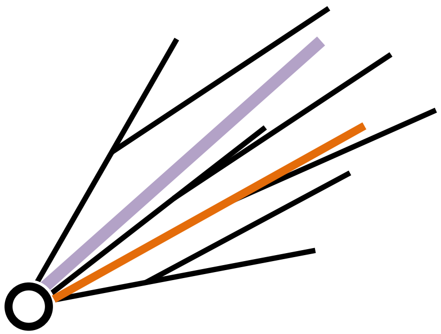
- How does the medium modify it? -

Jet Shapes of Small Jets

difference between leading and sub-leading track momentum

LeSub

$$LeSub = p_{\mathrm{T,track}}^{lead} - p_{\mathrm{T,track}}^{sublead}.$$

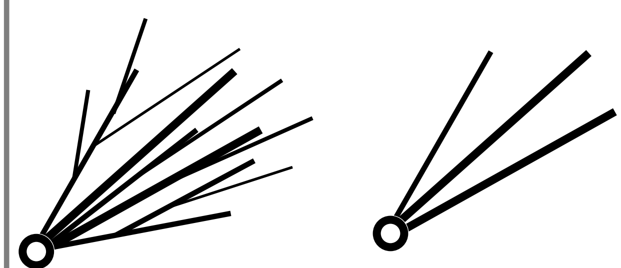


momentum dispersion

$p_T D$

$$p_T D = \frac{\sqrt{\sum_{i \in jet} p_{\mathrm{T,i}}^2}}{\sum_{i \in jet} p_{\mathrm{T,i}}}.$$

A measure for the hardness of the fragmentation.
Small value for many constituents. Large value for fewer constituents



$p_T D \sim 0$ $p_T D \sim 1$

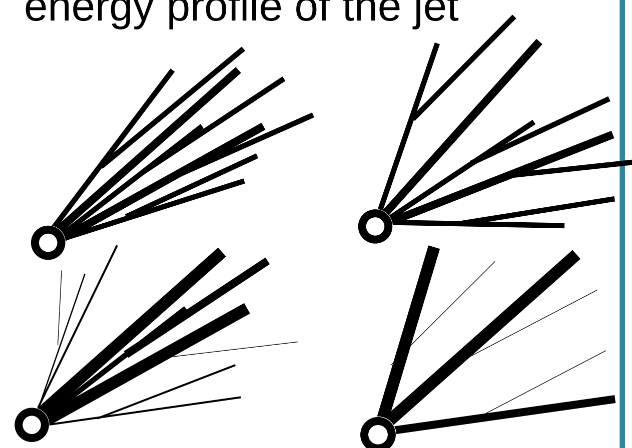
first radial moment or angularity

g

$$g = \sum_{i \in jet} \frac{p_{\mathrm{T}}^{\mathrm{i}}}{p_{\mathrm{T,jet}}} |\Delta R_{\mathrm{i,jet}}|$$

use momentum and distance to jet axis of each constituent

A measure for the radial energy profile of the jet



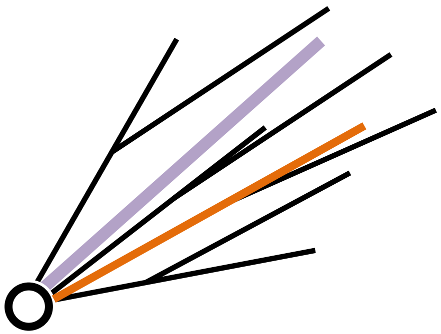
small g large g

Jet Shapes of Small Jets

difference between leading and sub-leading track momentum

LeSub

$$LeSub = p_{\mathrm{T,track}}^{lead} - p_{\mathrm{T,track}}^{sublead}.$$



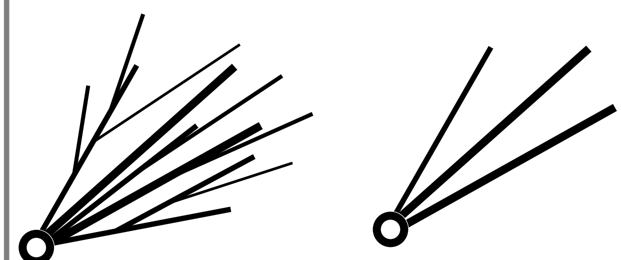
We measure:
pp 7 TeV, Pb-Pb 2.76 TeV
Anti-k_T jet algorithm,
resolution param. R = 0.2
$|\eta_{jet}| < 0.7$,
p_T = 40 - 60 GeV/*c*

momentum dispersion

$p_T D$

$$p_T D = \frac{\sqrt{\sum_{i\in jet} p_{\mathrm{T,i}}^2}}{\sum_{i\in jet} p_{\mathrm{T,i}}}.$$

A measure for the hardness of the fragmentation.
Small value for many constituents. Large value for fewer constituents



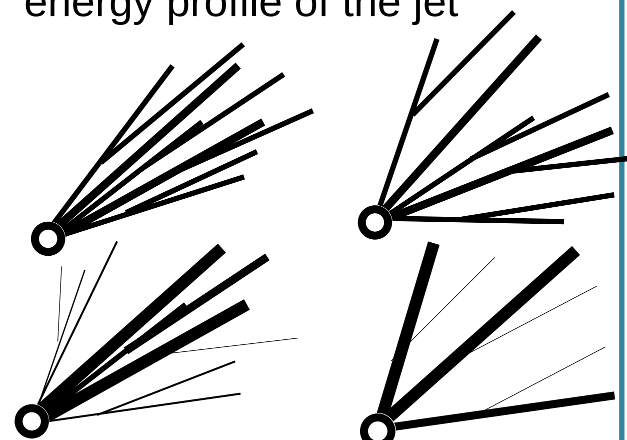
first radial moment or angularity

g

$$g = \sum_{i\in jet} \frac{p_{\mathrm{T}}^{\mathrm{i}}}{p_{\mathrm{T,jet}}} |\Delta R_{\mathrm{i,jet}}|$$

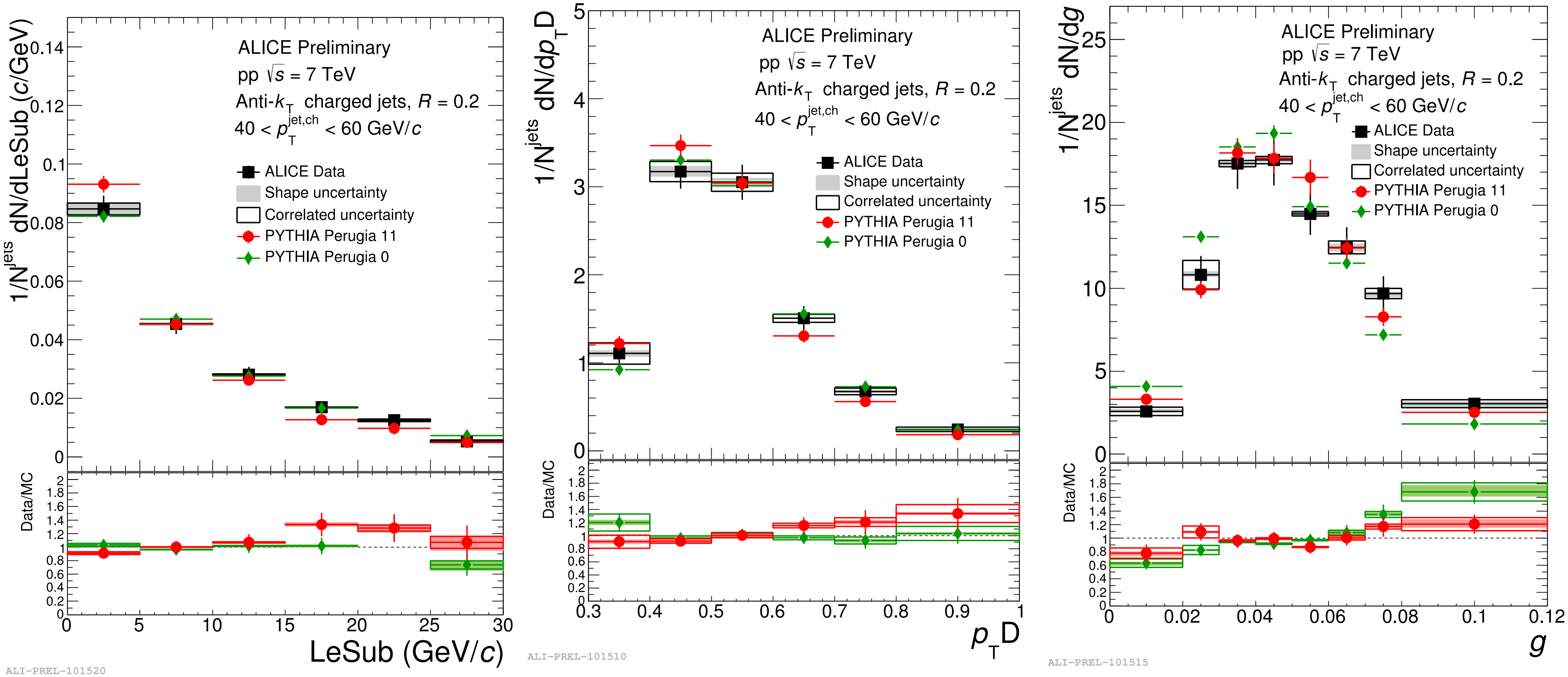
use momentum and distance to jet axis of each constituent

A measure for the radial energy profile of the jet



Jet Shapes of Small Jets

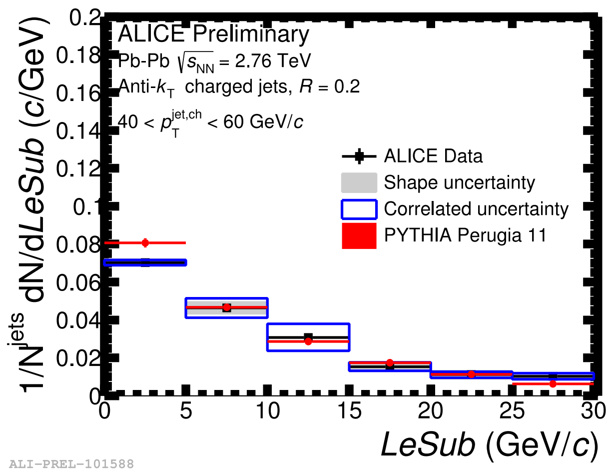
pp collisions

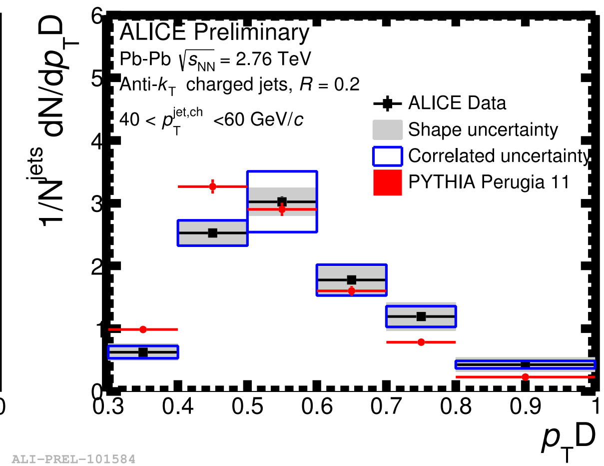


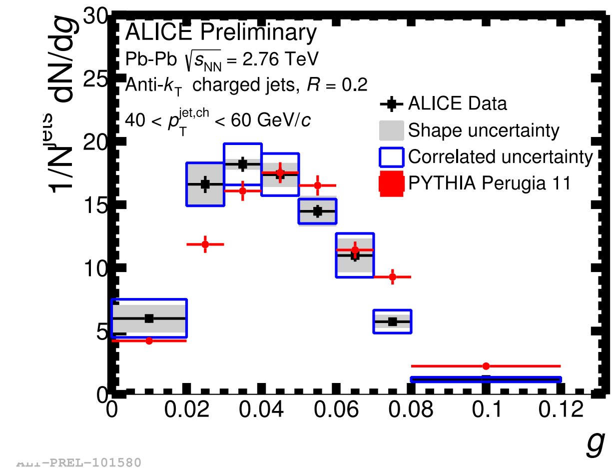
PYTHIA in agreement with data within 20%

Jet Shapes of Small Jets

Pb-Pb collisions







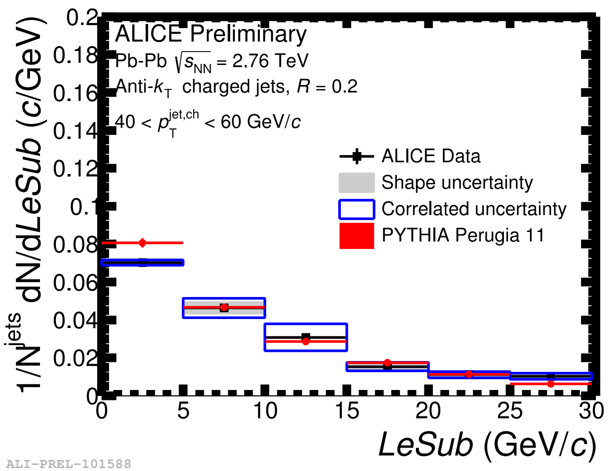
no significant modification

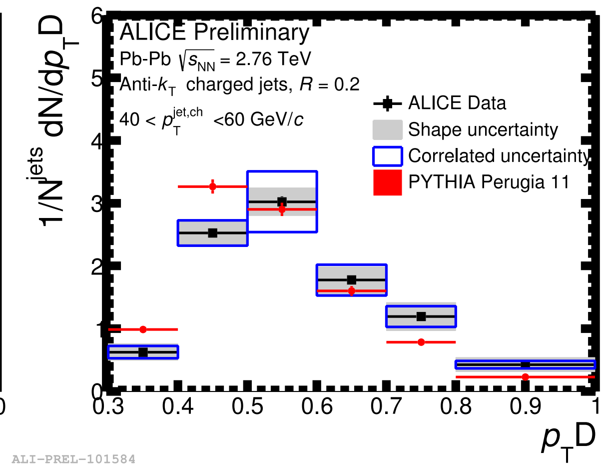
momentum dispersion is shifted to higher values

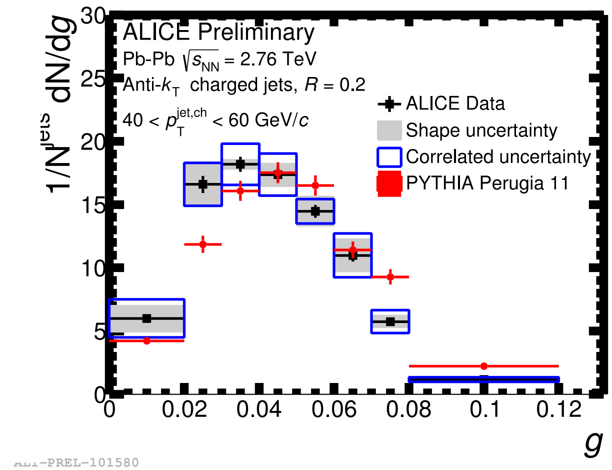
radial moment is shifted to lower values

Jet Shapes of Small Jets

Pb-Pb collisions







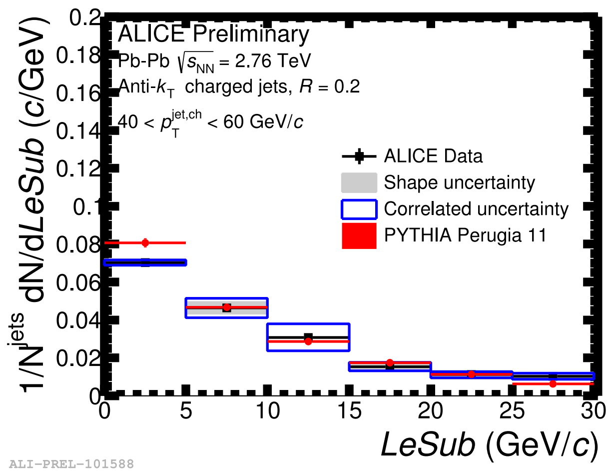
no significant modification

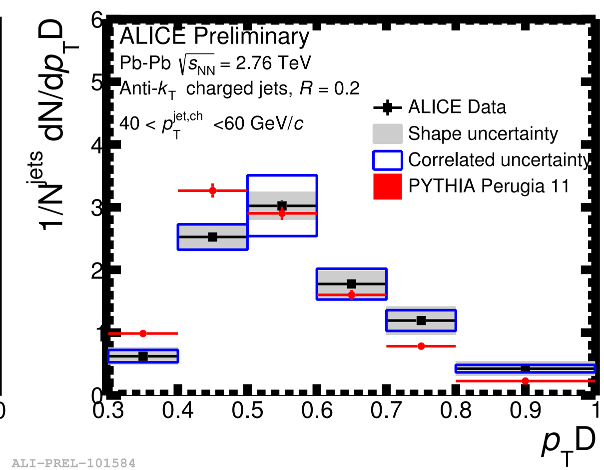
momentum dispersion is shifted to higher values

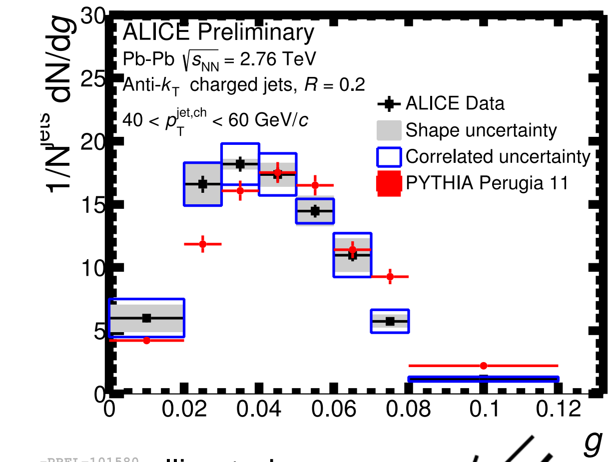
radial moment is shifted to lower values

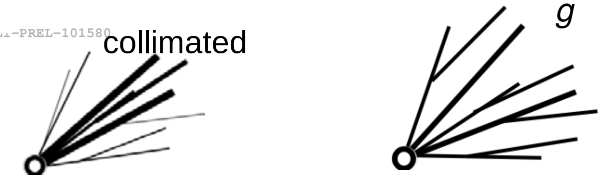
Jet Shapes of Small Jets

Pb-Pb collisions









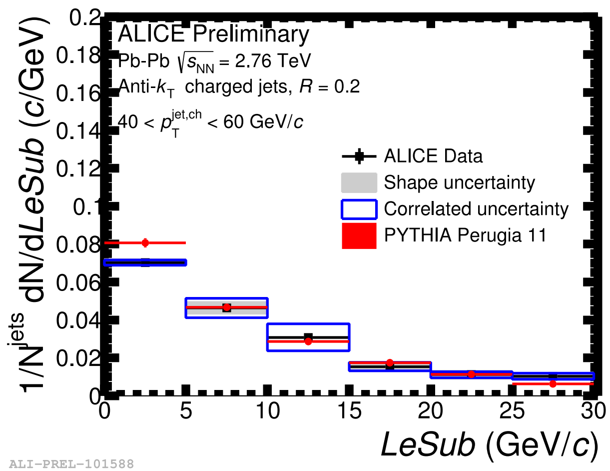
no significant modification

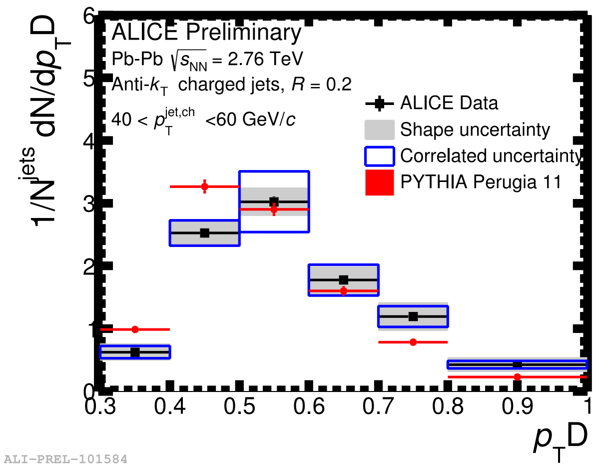
momentum dispersion is shifted to higher values

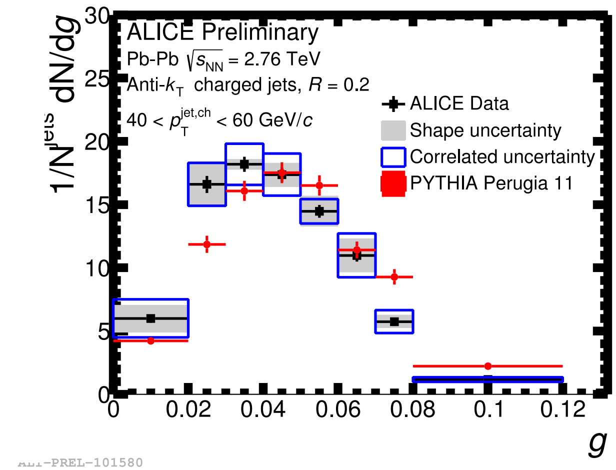
radial moment is shifted to lower values

Jet Shapes of Small Jets

Pb-Pb collisions







no significant modification

momentum dispersion is shifted to higher values

radial moment is shifted to lower values

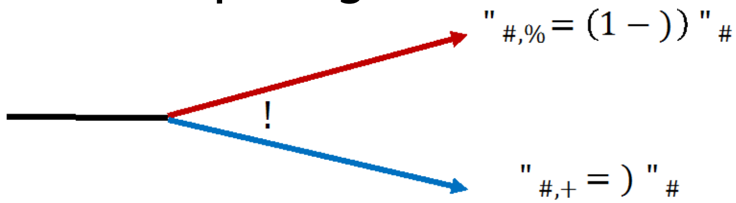
The results of R=0.2 jet shapes indicate that jet cores in Pb–Pb are more collimated and harder than those in PYTHIA at the same energy.
Soft particles emitted outside R=0.2

Arriving at the parton level

- Classifying parton splittings in jets -

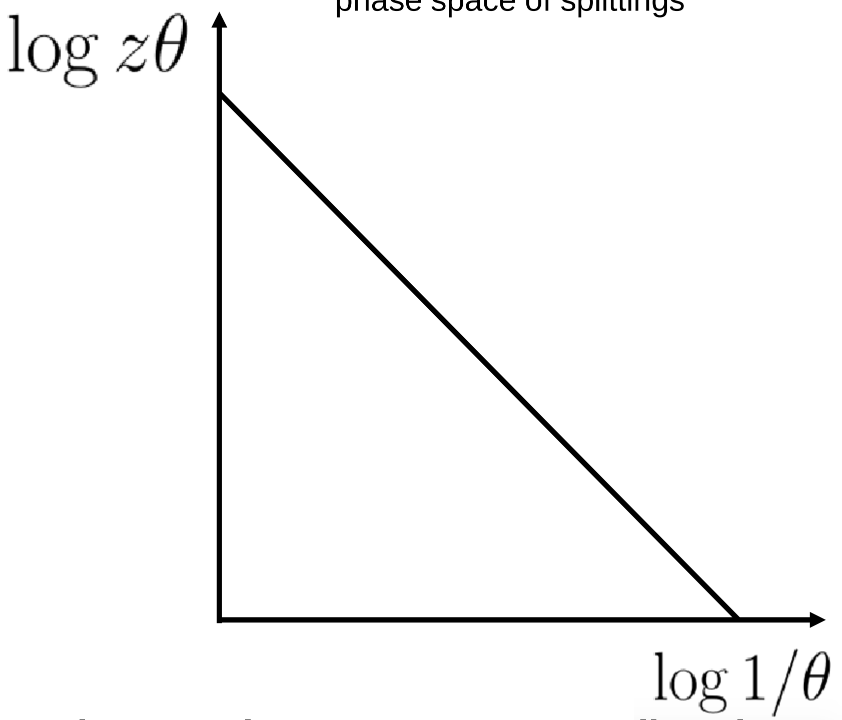
Classifying parton splittings

Parton splittings



Lund Diagram

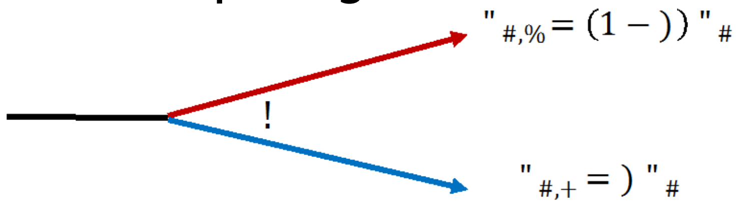
phase space of splittings



large angles **small angles**

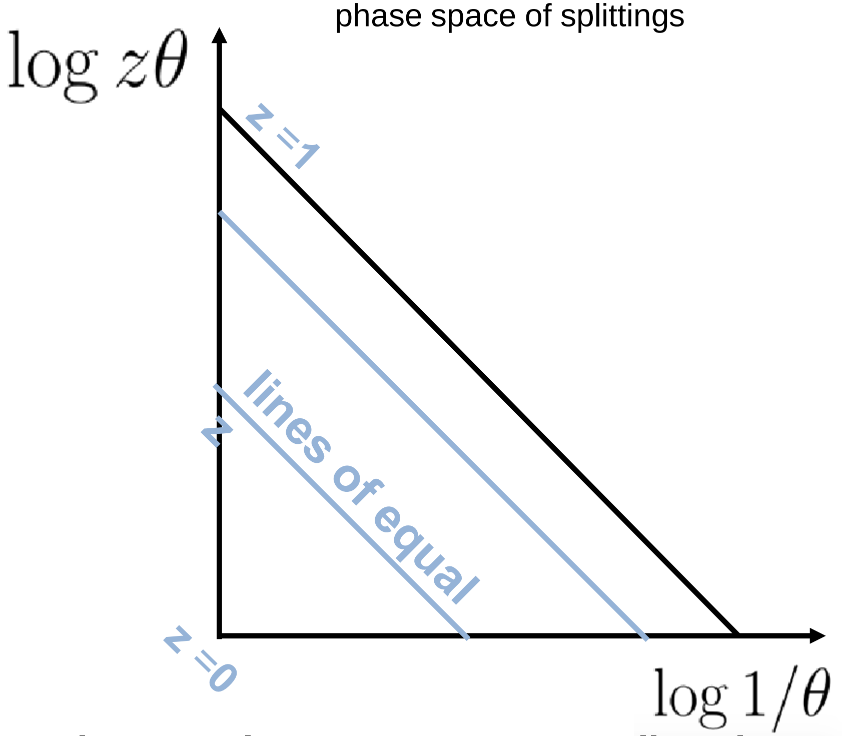
Classifying parton splittings

Parton splittings



Lund Diagram

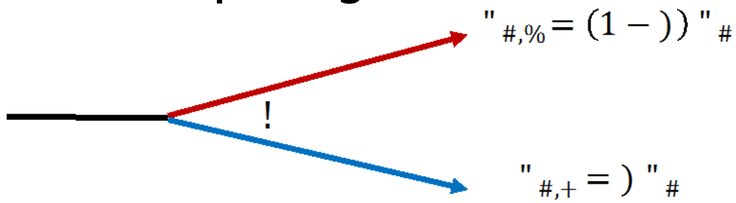
phase space of splittings



large angles **small angles**

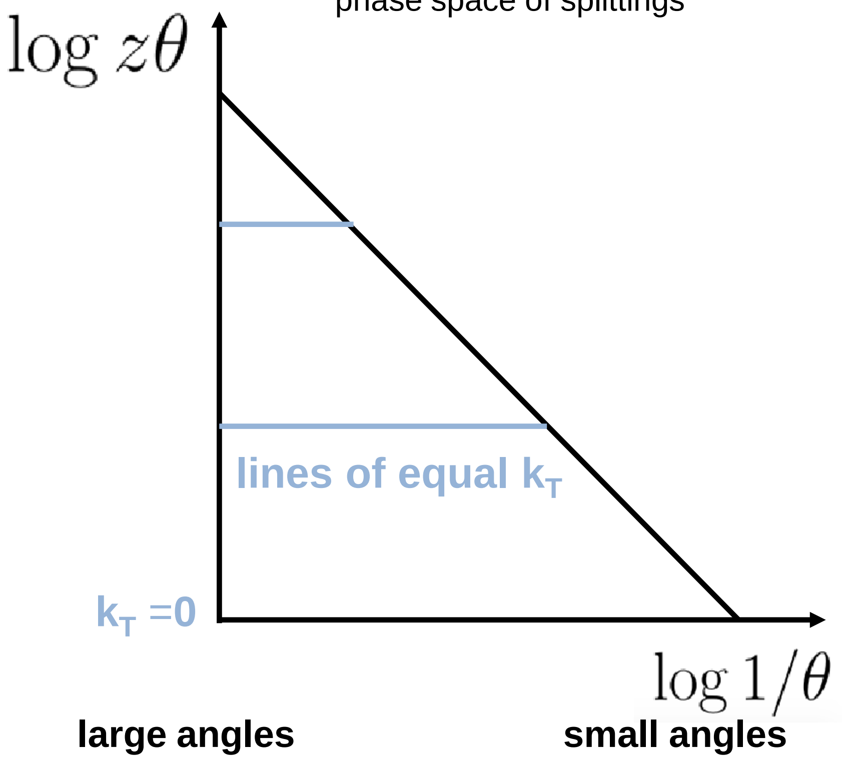
Classifying parton splittings

Parton splittings



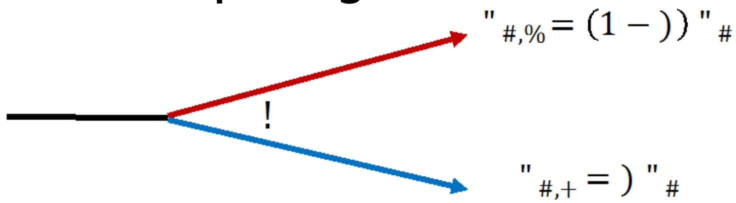
Lund Diagram

phase space of splittings



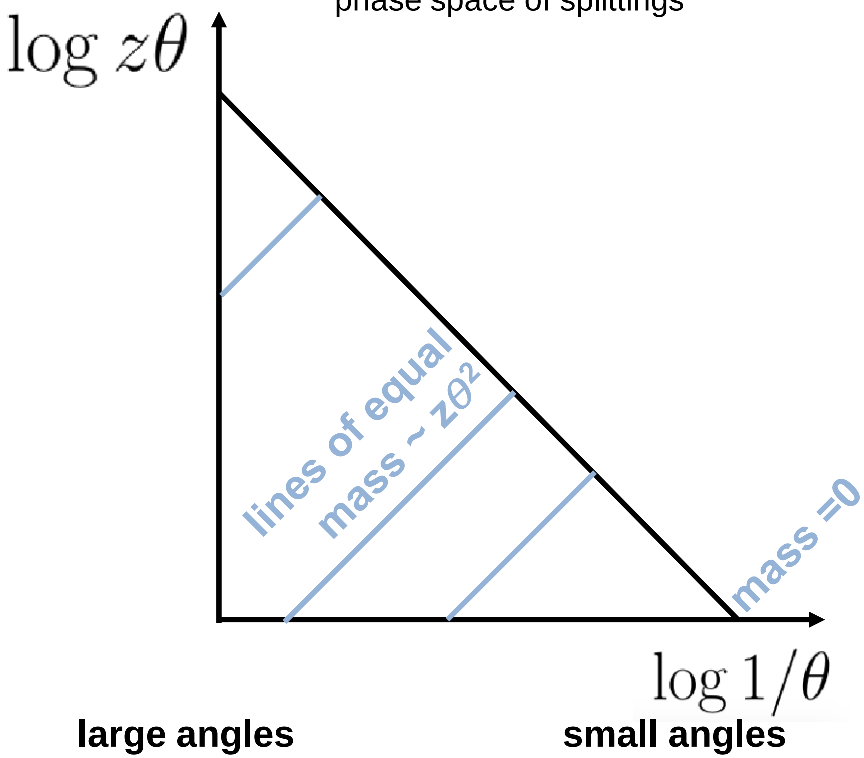
Classifying parton splittings

Parton splittings



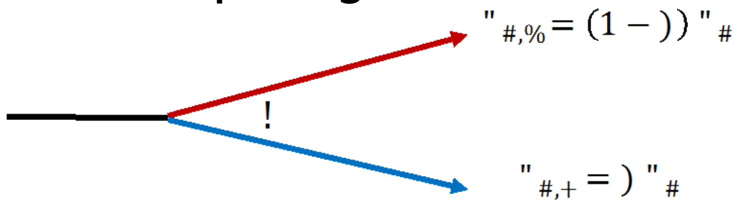
Lund Diagram

phase space of splittings



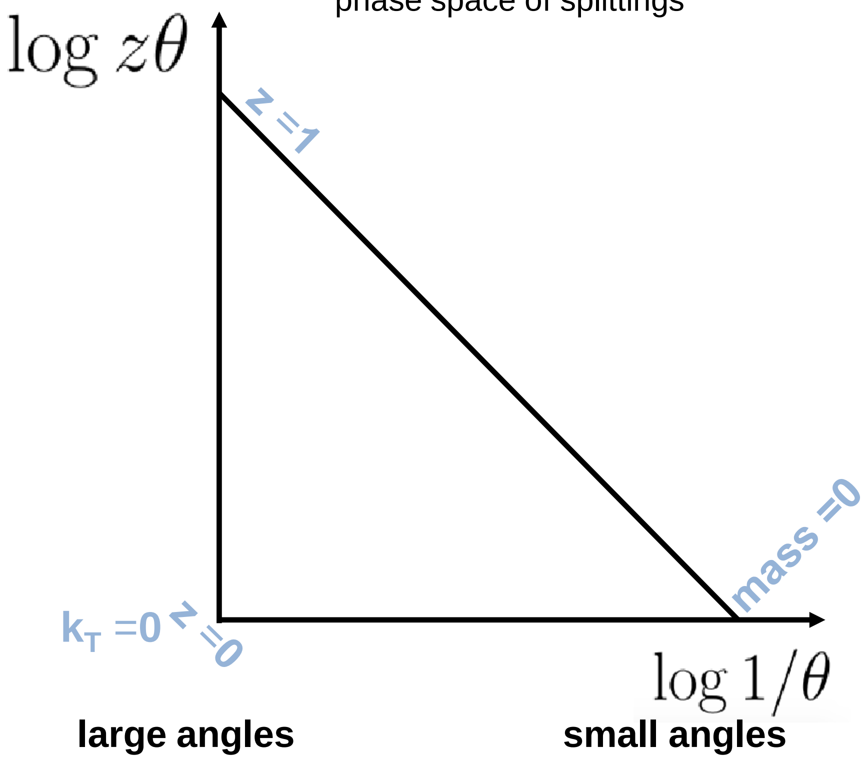
Classifying parton splittings

Parton splittings



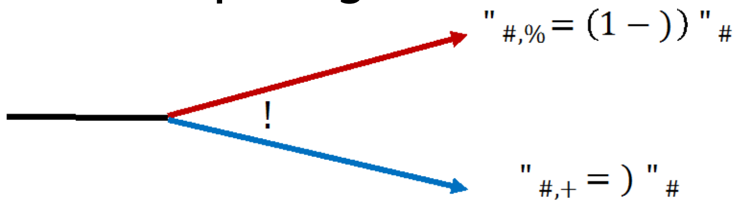
Lund Diagram

phase space of splittings



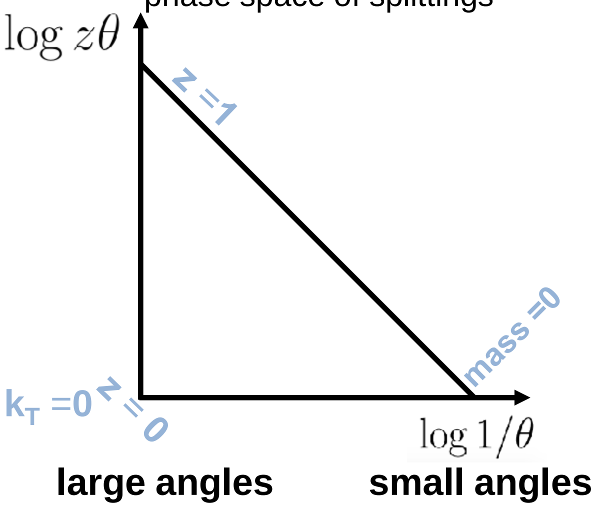
Classifying parton splittings

Parton splittings



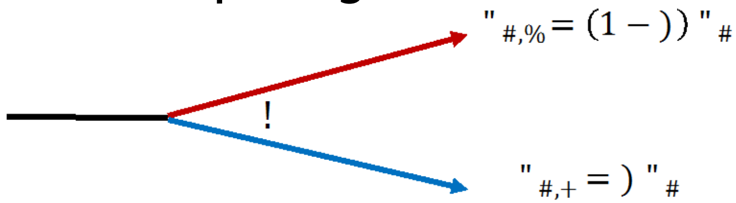
Lund Diagram

phase space of splittings



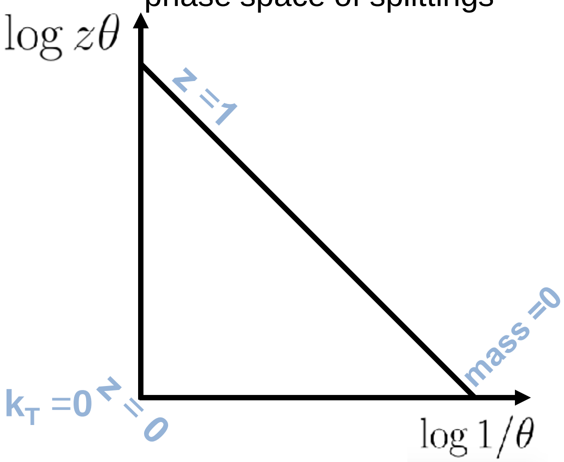
Classifying parton splittings

Parton splittings

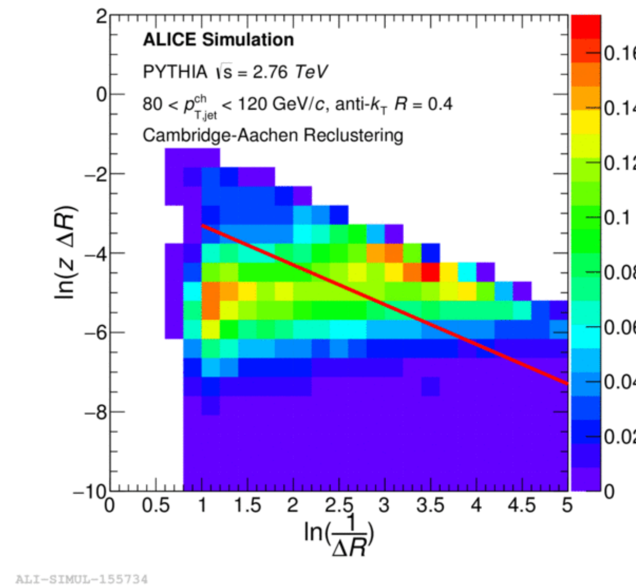


Lund Diagram

phase space of splittings



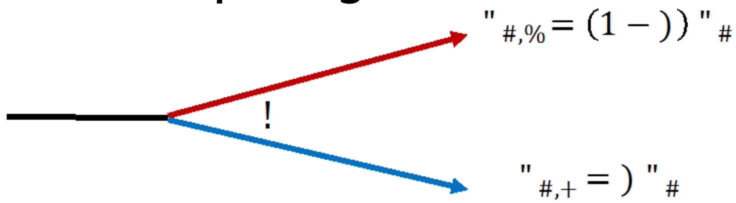
large angles **small angles**



We measure:
Pb-Pb 2.76 TeV, Anti-k_T jet algorithm,
R = 0.4, $|\eta_{jet}| < 0.5$, p_T = 80 - 120 GeV/*c*
Recluster found jets with C/A to unwind splitting

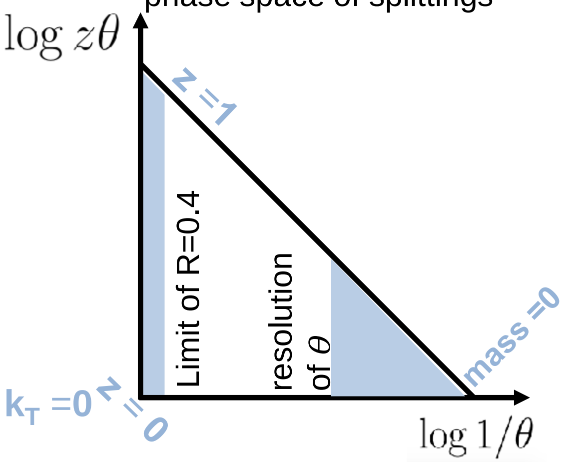
Classifying parton splittings

Parton splittings

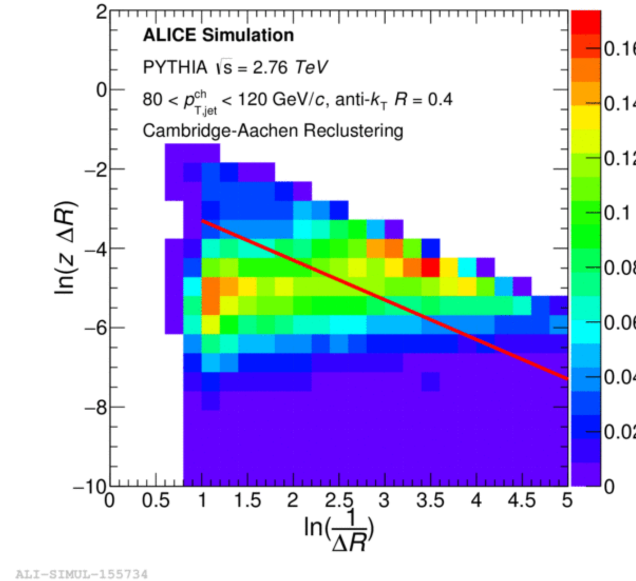


Lund Diagram

phase space of splittings



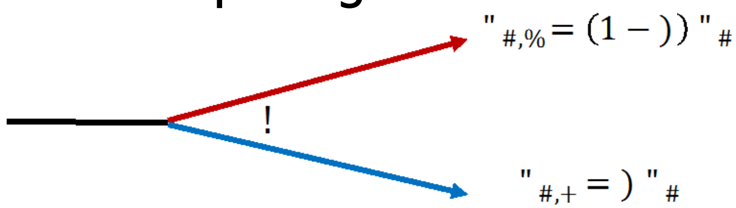
large angles **small angles**



We measure:
Pb-Pb 2.76 TeV, Anti-k_T jet algorithm,
R = 0.4, $|\eta_{jet}| < 0.5$, p_T = 80 - 120 GeV/*c*
Recluster found jets with C/A to unwind splitting

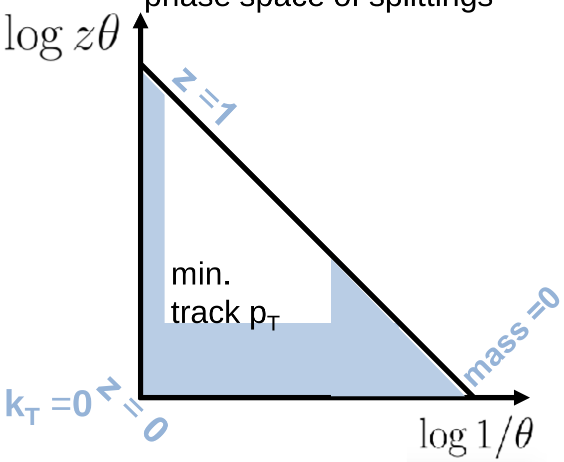
Classifying parton splittings

Parton splittings



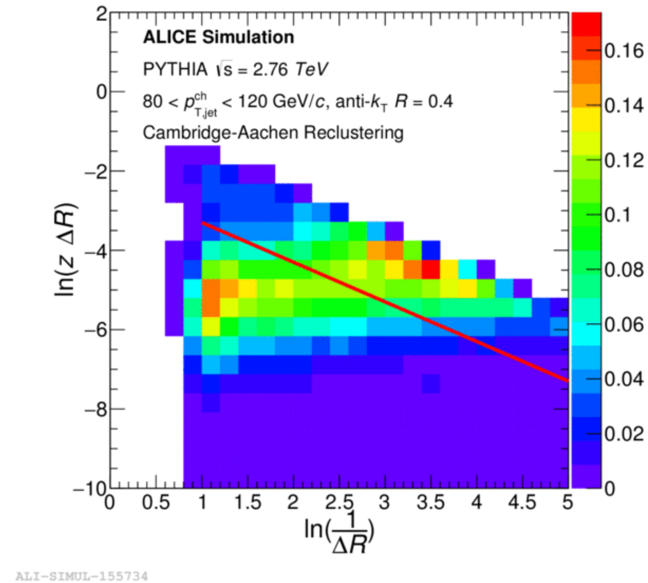
Lund Diagram

phase space of splittings



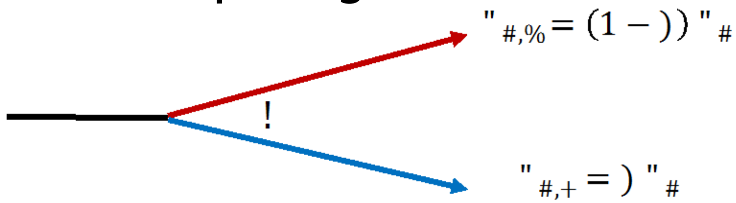
large angles **small angles**

We measure:
Pb-Pb 2.76 TeV, Anti-k_T jet algorithm,
R = 0.4, $|\eta_{jet}| < 0.5$, p_T = 80 - 120 GeV/c
Recluster found jets with C/A to unwind splitting



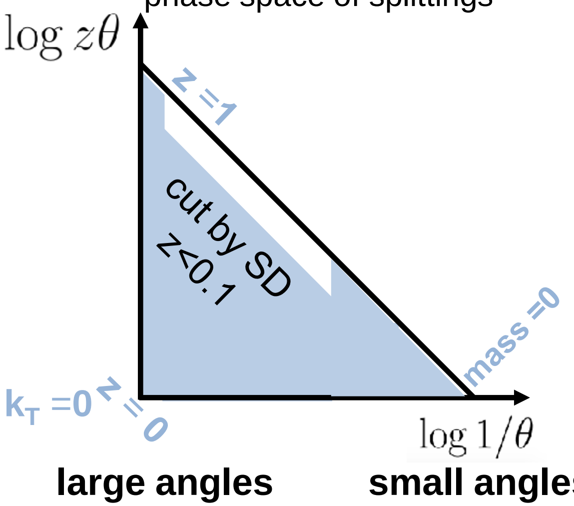
Classifying parton splittings

Parton splittings



Lund Diagram

phase space of splittings

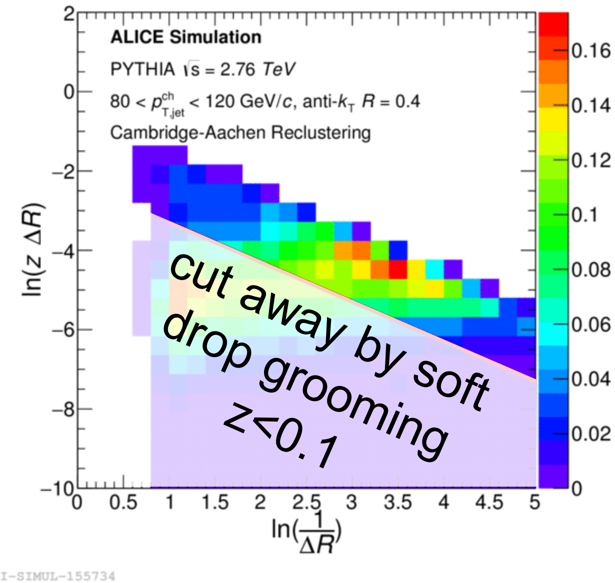


Soft Drop

Cut soft parton splittings

$z > z_{cut}\theta^{\beta}$

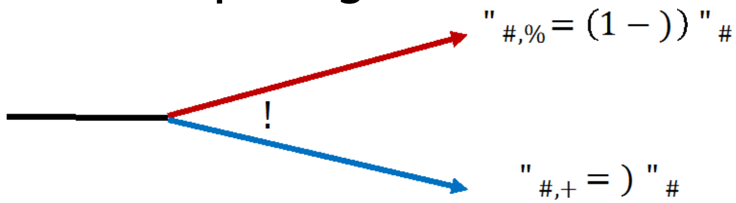
Impose phase space cuts to enhance regions of interest



We measure:
Pb-Pb 2.76 TeV, Anti-k_T jet algorithm,
R = 0.4, $|\eta_{jet}| < 0.5$, p_T = 80 - 120 GeV/*c*
Recluster found jets with C/A to unwind splitting

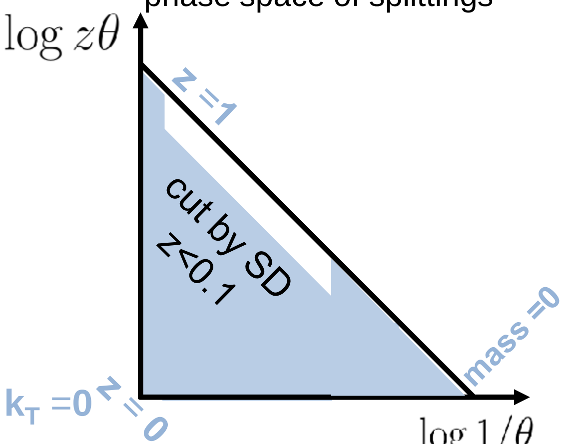
Classifying parton splittings

Parton splittings



Lund Diagram

phase space of splittings



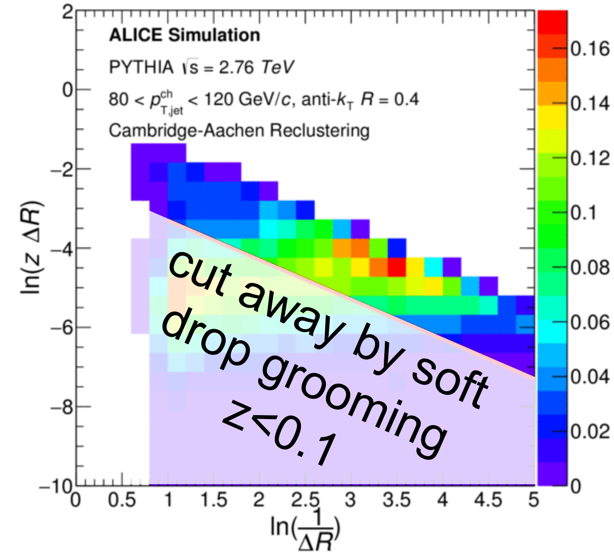
large angles **small angles**

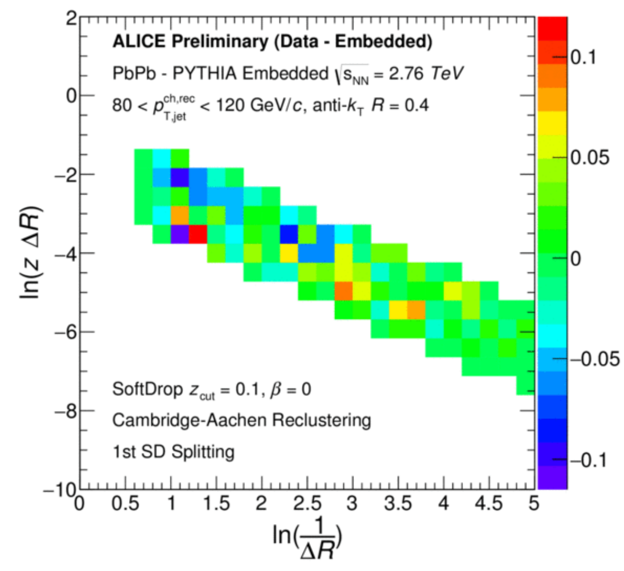
Soft Drop

Cut soft parton splittings

$z>z_{cut}\theta^{\beta}$

Impose phase space cuts to enhance regions of interest

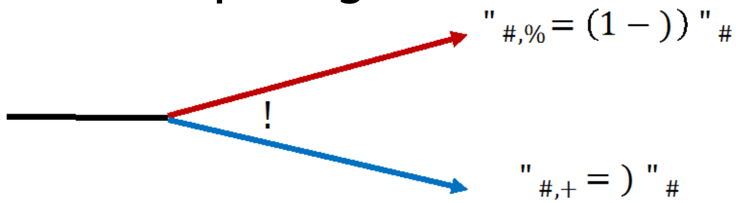




We measure:
Pb-Pb 2.76 TeV, Anti-k_T jet algorithm,
R = 0.4, $|\eta_{jet}| < 0.5$, p_T = 80 - 120 GeV/c
Recluster found jets with C/A to unwind splitting

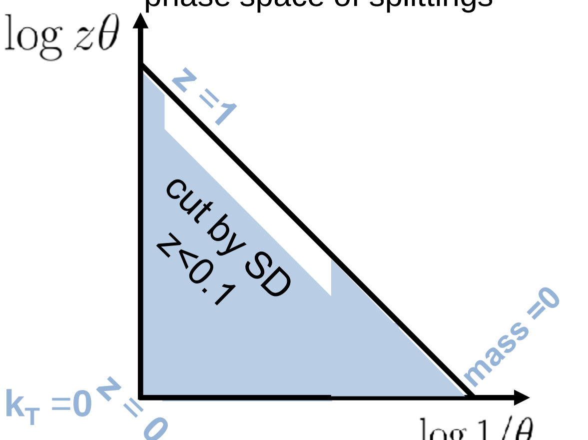
Classifying parton splittings

Parton splittings



Lund Diagram

phase space of splittings



large angles **small angles**

Soft Drop

Cut soft parton splittings

$z > z_{cut}\theta^{\beta}$

Impose phase space cuts to enhance regions of interest

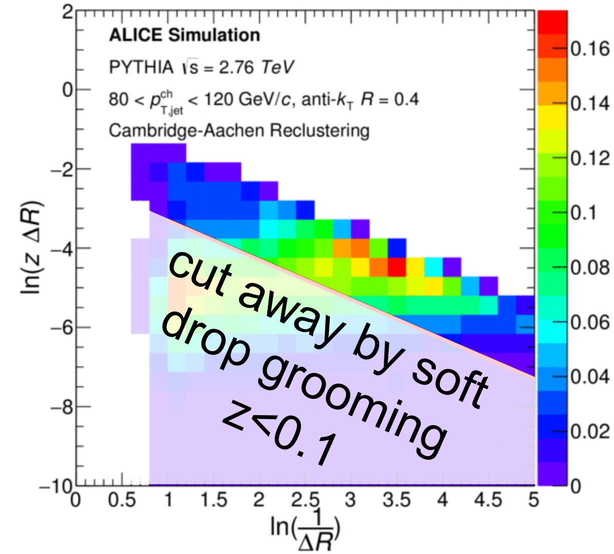
Hint for a depletion of large angle first-splittings in Pb-Pb collissons

We measure:

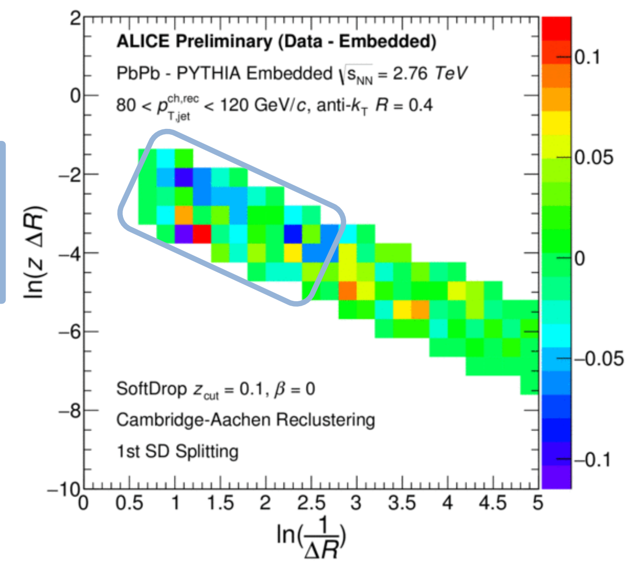
Pb-Pb 2.76 TeV, Anti-k_T jet algorithm,

R = 0.4, $|\eta_{jet}| < 0.5$, p_T = 80 - 120 GeV/*c*

Recluster found jets with C/A to unwind splitting



ALI-SIMUL-155734

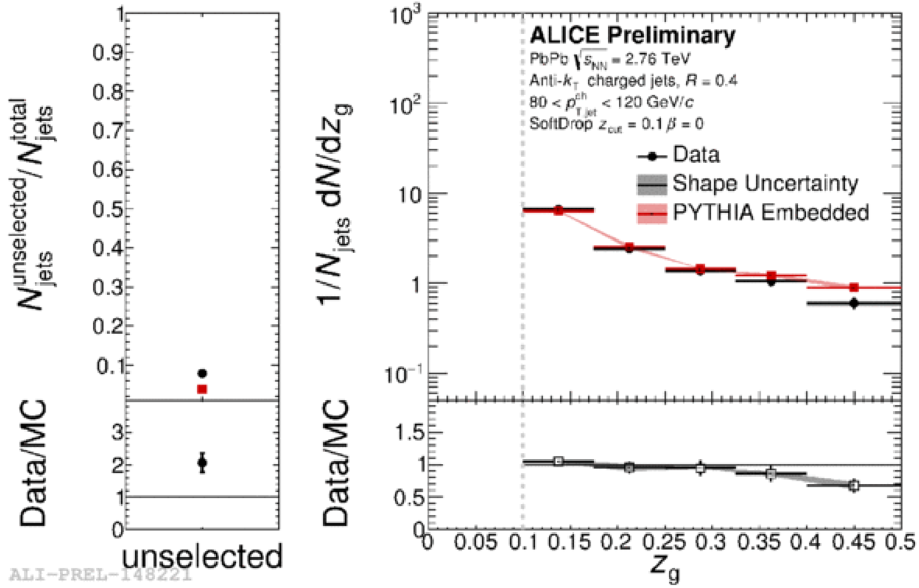


ALI-PREL-148246

A closer look into depleted splittings

z_g is the shared momentum fraction of the first groomed splitting

$$z_g = \frac{\min(p_{T,1}, p_{T,2})}{p_{T,1} + p_{T,2}},$$

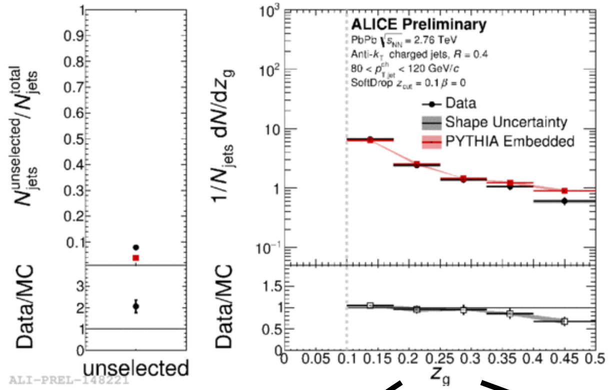


Lund diagram showed: large angles contain the biggest difference

A closer look into depleted splittings

z_g is the shared momentum fraction of the first groomed splitting

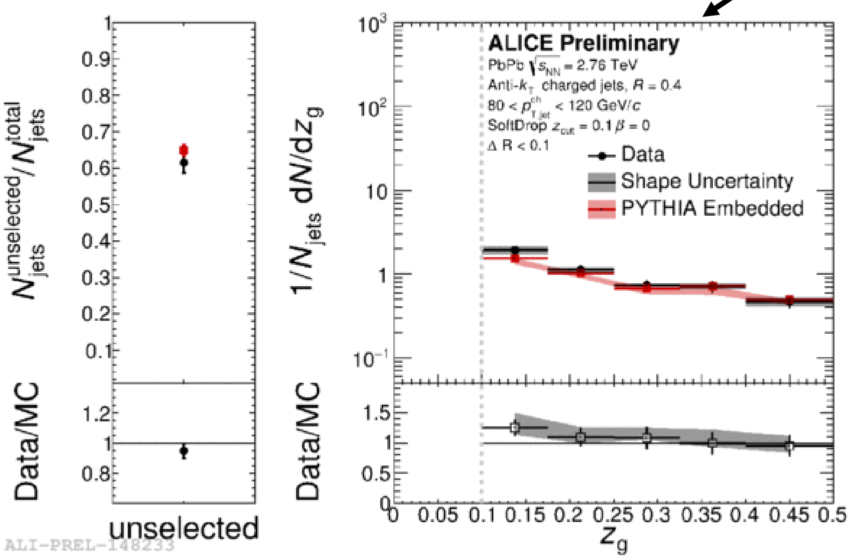
$$z_g = \frac{\min(p_{T,1}, p_{T,2})}{p_{T,1} + p_{T,2}},$$

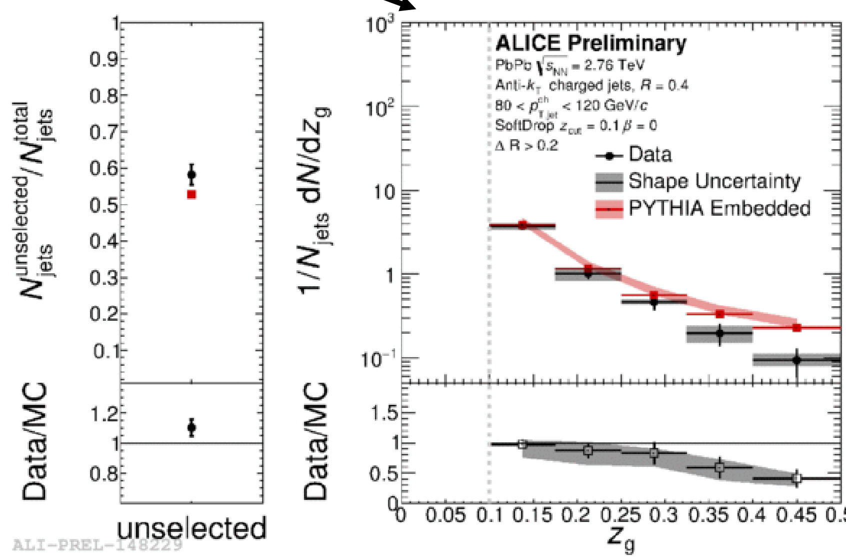


split groomed jets into two subsamples

R<0.1

R>0.2





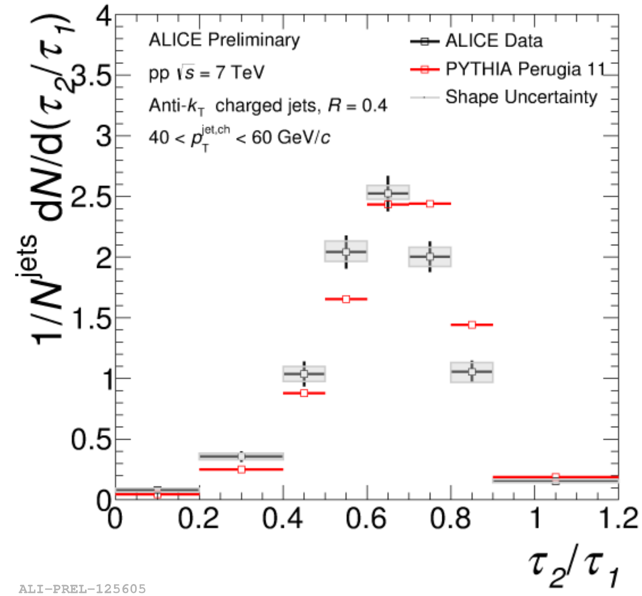
Slight enhancement of collinear first-splittings

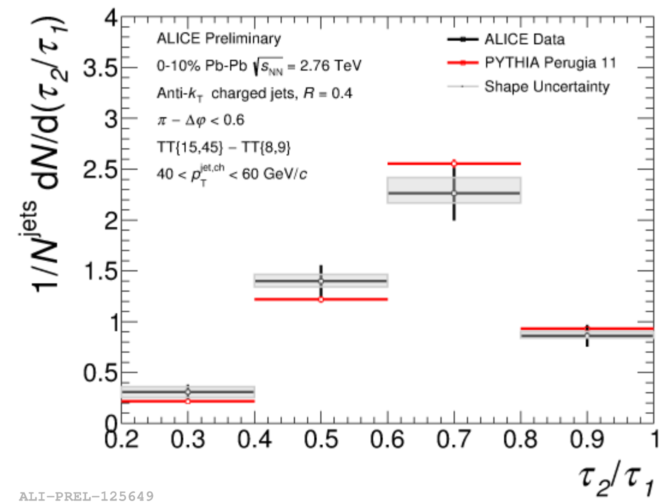
Depletion of large-angle first-splittings but no low z_g enhancement. Sensitivity to color coherence?

More jet shape results

Nsubjetiness of jets in Pb-Pb collisions
Ratio of 2-Subjettiness to 1-Subjettiness (τ_2/τ_1)
measures two-prongness of the jet

Interpretation
τ_N ~0, N or fewer cores
τ_N ~1, N+1 or more cores
Thus:
τ_2/τ_1 tells us about 2-cores
If τ_2/τ_1 ~0 parton has split into two resolvable subjets





We measure:
Pb-Pb 2.76 TeV
Anti-k_T jet algorithm,
resolution parameter R = 0.4,
$|\eta_{jet}| < 0.5$,
p_T = 40 - 60 GeV/c

consistent with PYTHIA

Summary

R_{AA} of inclusive and identified hadrons

Improved statistic and errors of inclusive and identified hadron measurements. Will help constrain medium transport properties.

New measurements with increased precision of incl. and identified hadron spectra and R_{AA} have clear potential to improve understanding of jet transport coefficients and gluon fragmentation functions.

π^0 p_T spectra at several collision energies

Improve understanding of gluon to pion fragmentation.

Jet shape measurement in pp and Pb-Pb

How are the cores of jets modified in the medium?

The results of R=0.2 jet shapes indicate that jet cores in Pb–Pb are more collimated and harder than those in PYTHIA at the same energy.

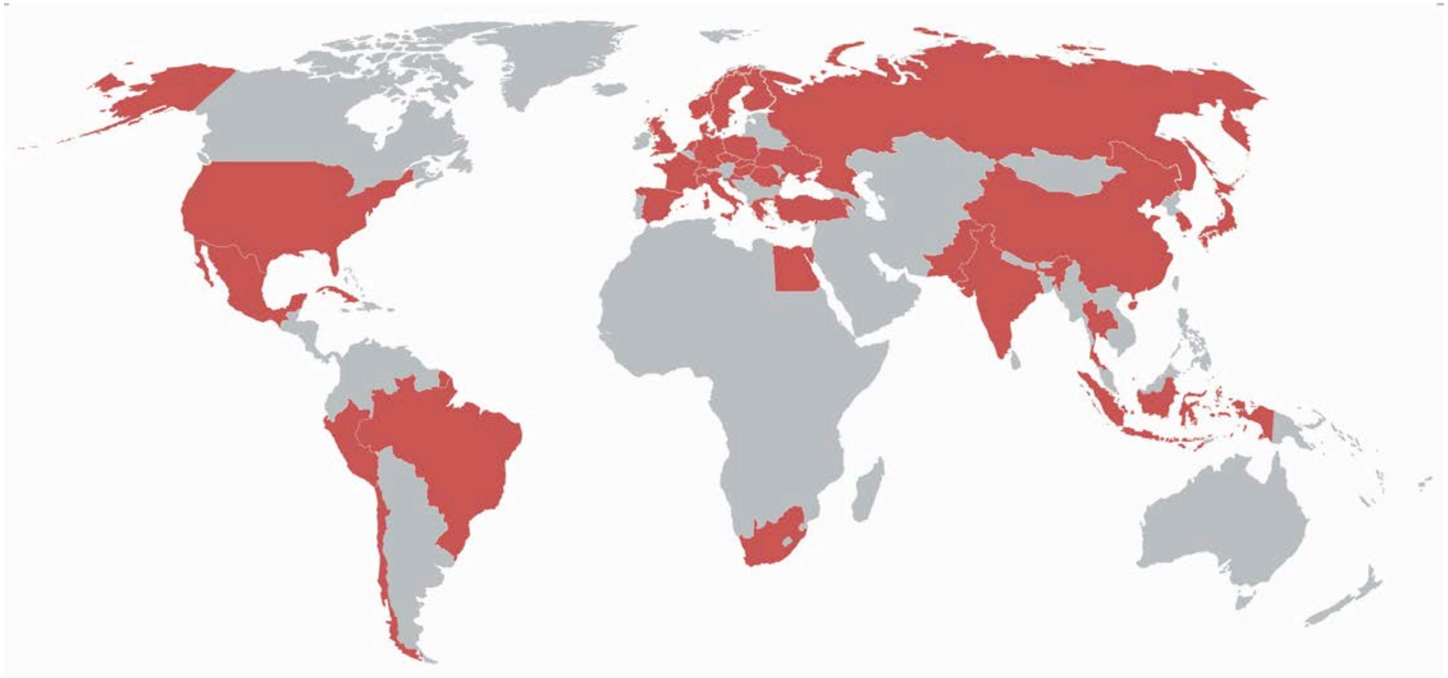
Splitting of groomed jets

How does the medium influence the jet splitting distribution?

Large-angle splitting is suppressed for groomed jets in PbPb.

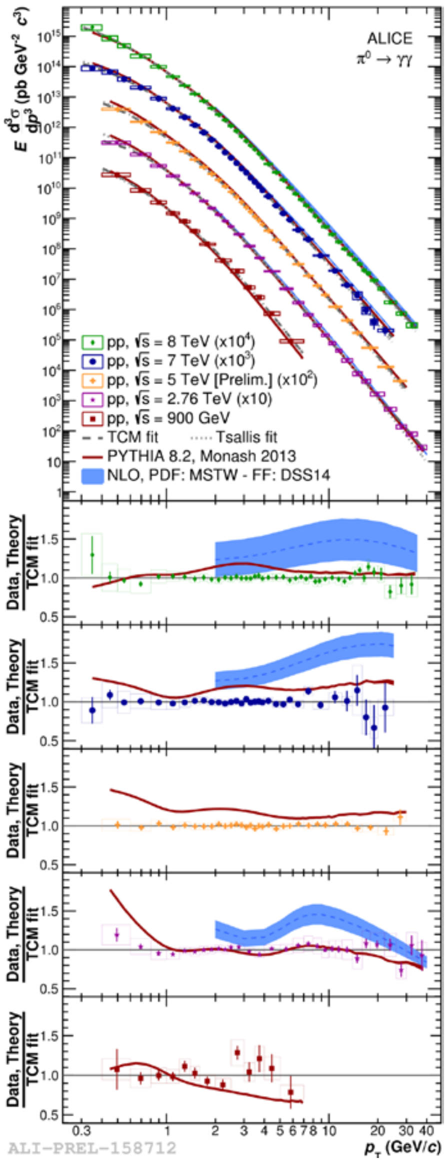
Thanks to the ALICE Collaboration

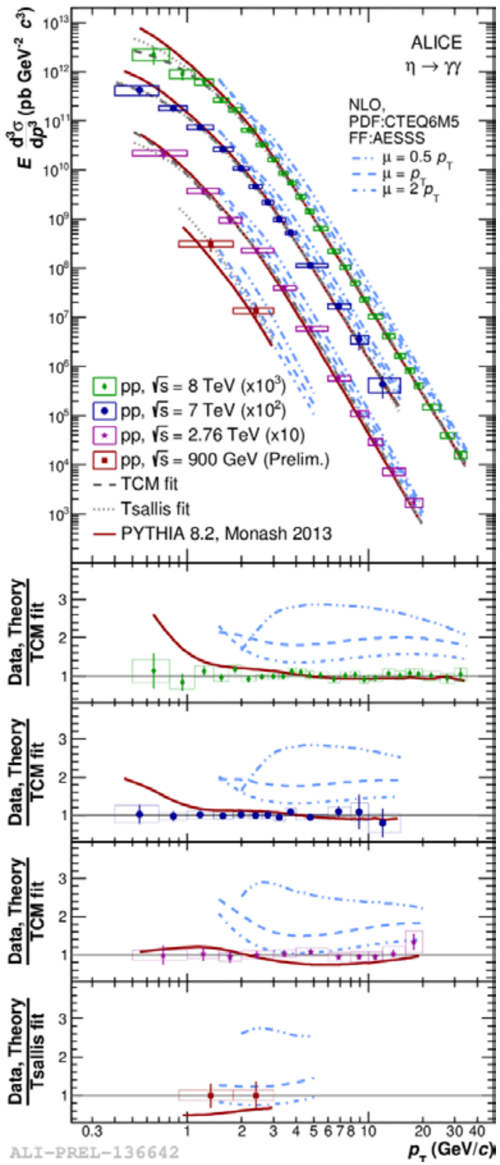
37 Countries, 154 Institutes and over 1500 members



Special thanks to the **Jet working group** and **Gamma working group** with about 30 members each.

Backup





Here, the measurement of the π_0 production cross section at LHC energies provides constraints on the gluon to pion fragmentation [8] in a new energy regime. In addition, the strange quark content of the η meson makes the comparison to pQCD relevant for possible differences of fragmentation functions with and without strange quarks [9].

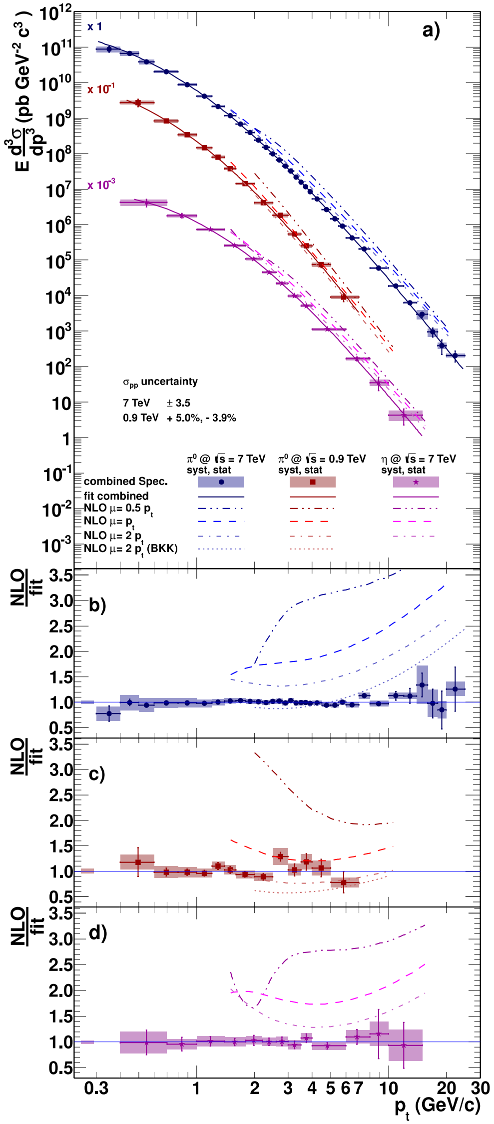
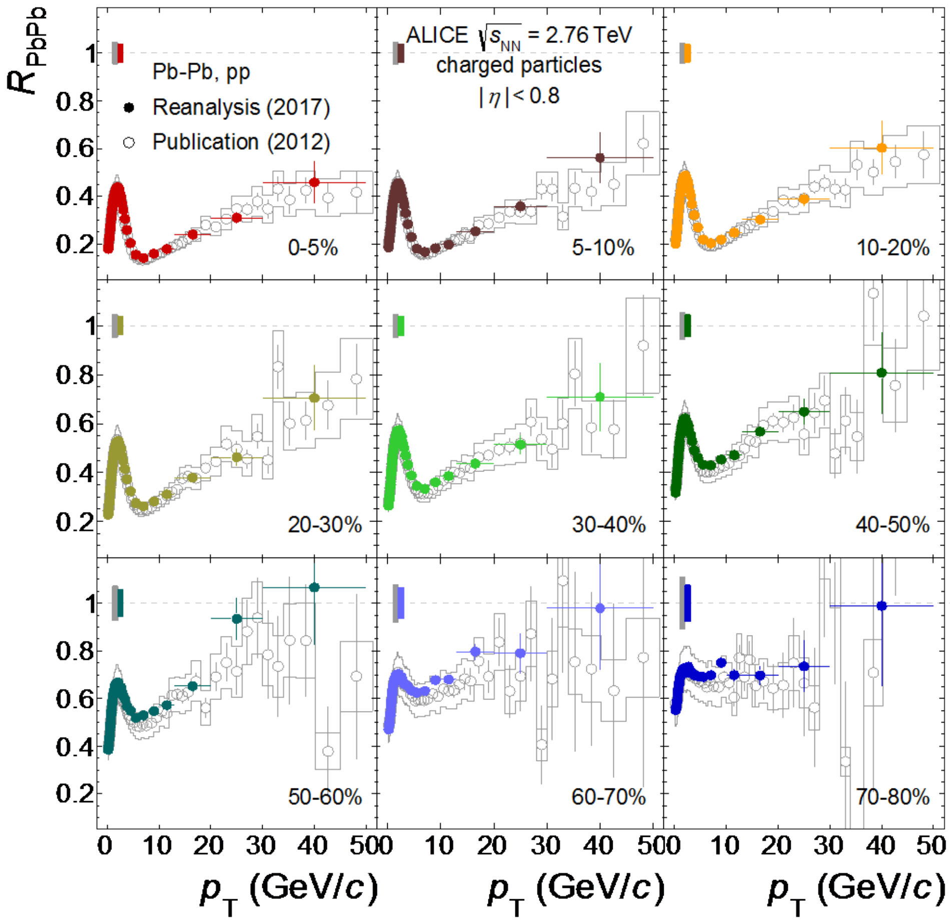


Fig. 3: a) Differential invariant cross section of π^0 production in pp collisions at $\sqrt{s} = 7$ TeV (circles) and 0.9 TeV (squares) and of η meson production at $\sqrt{s} = 7$ TeV (stars). The lines and the boxes represent the statistical and systematic error of the combined measurement respectively. The uncertainty on the pp cross section is not included. NLO pQCD calculations using the CTEQ6M5 PDF and the DSS (AESS for η mesons) FF for three scales $\mu = 0.5p_t$, $1p_t$ and $2p_t$ are shown. Dotted lines in panels b) and c) correspond to the ratios using the BKK FF. Ratio of the NLO calculations to the data parametrisations are shown in panels b), c) and d). The full boxes represent the uncertainty on the pp cross sections.

7 and 0.9 TeV - ALICE collaboration,
B.Abelev et al.,
Phys. Lett. B 717 (2012) 162-172

Improved analysis for 2.76 TeV data



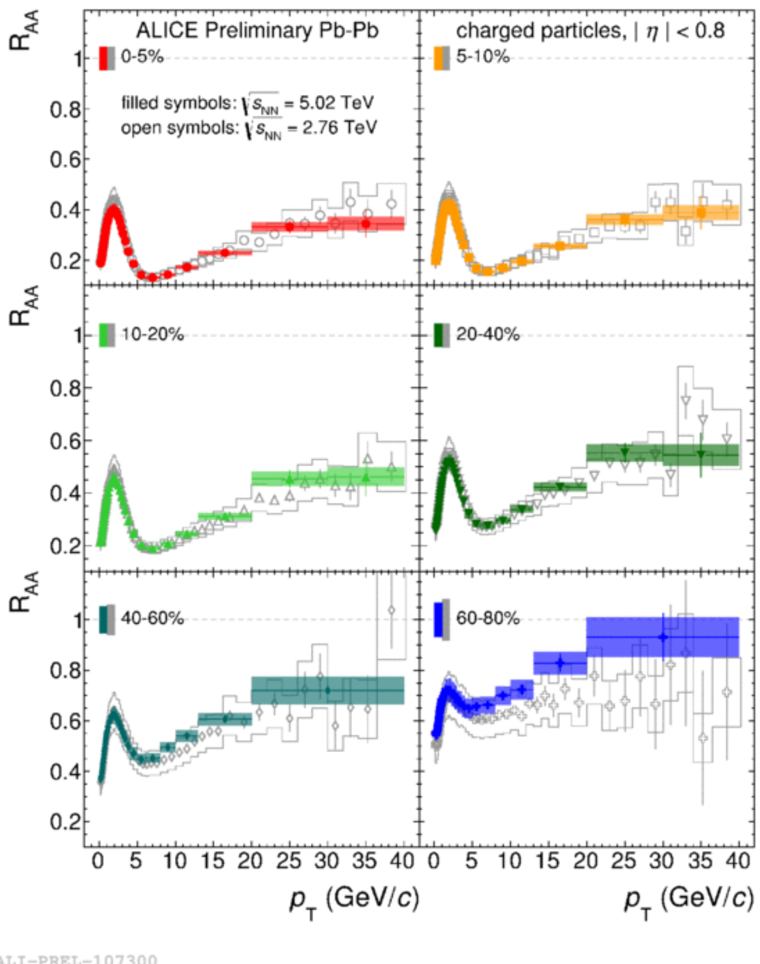
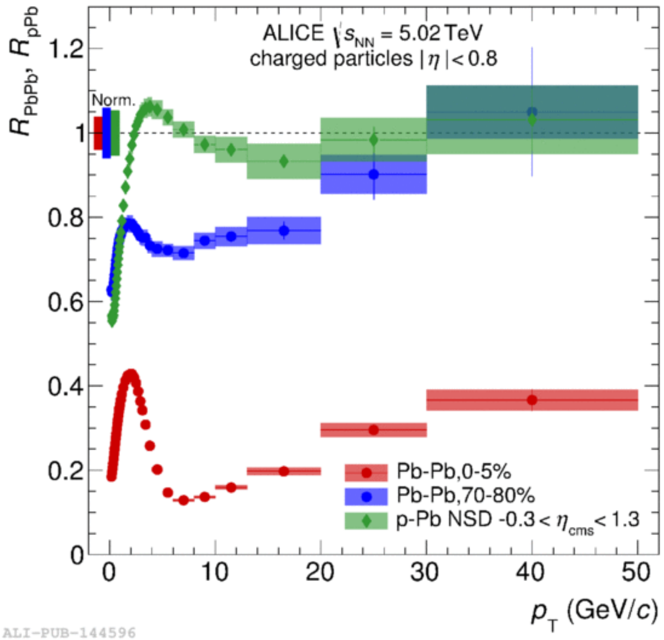


Fig. 51: R_{AA} for six different centrality classes. The open symboles represent the R_{AA} as measured in 2.75TeV 2010 data [8].

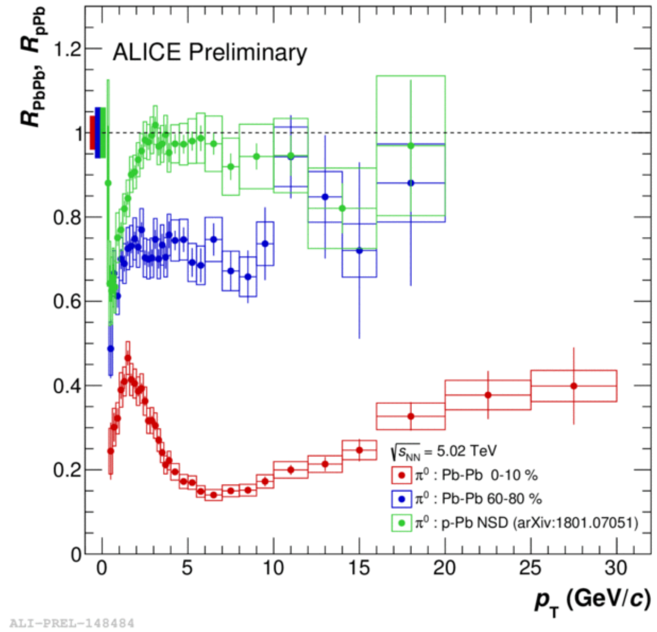
R_{AA} in different systems and centr.

Charged hadrons

ALICE collaboration
arXiv:1802.09145



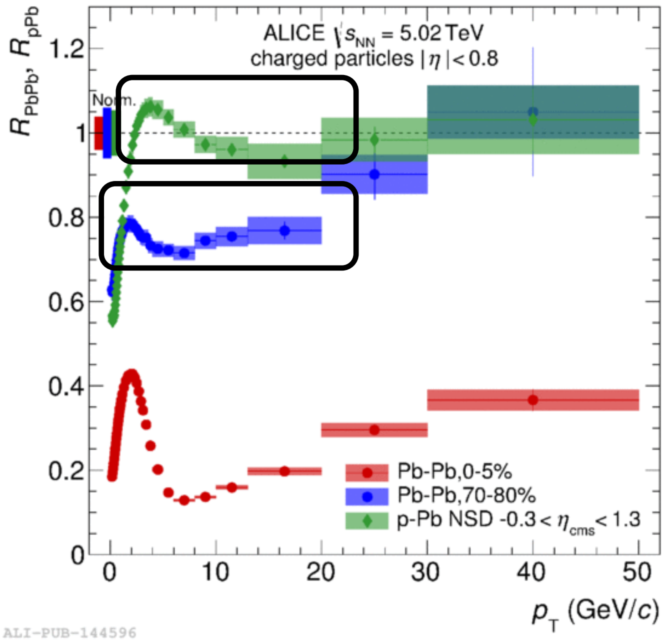
Neutral pions



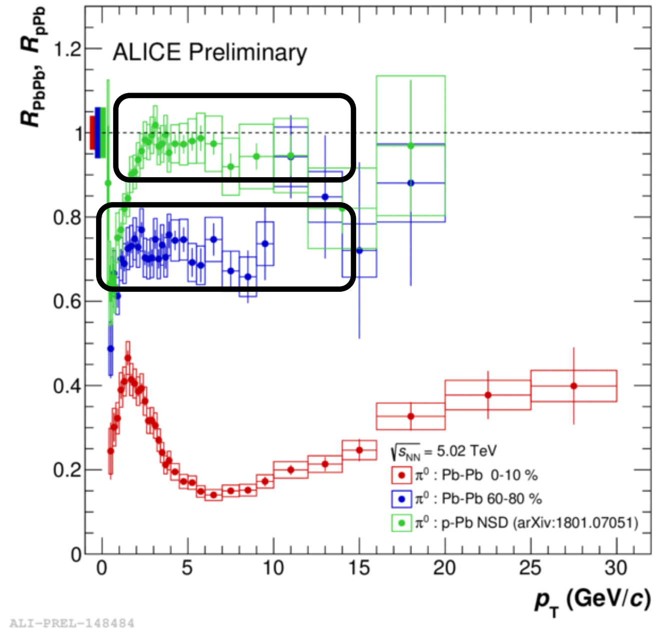
R_{AA} in different systems and centr.

Charged hadrons

ALICE collaboration
arXiv:1802.09145



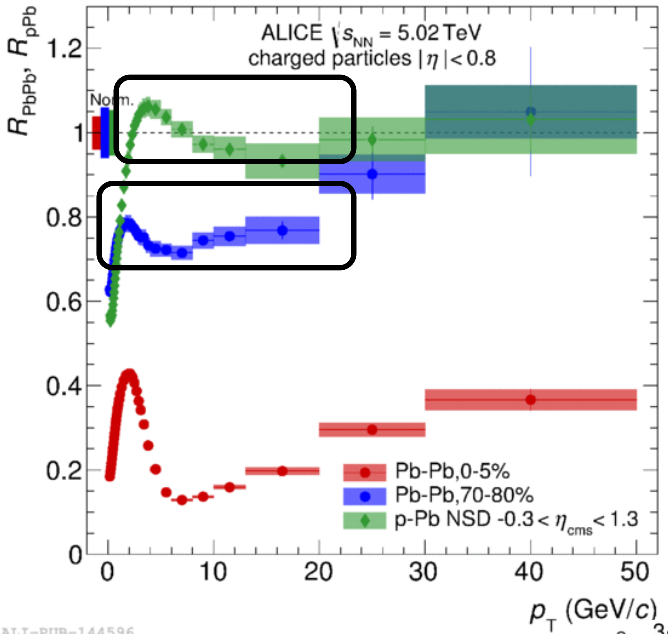
Neutral pions



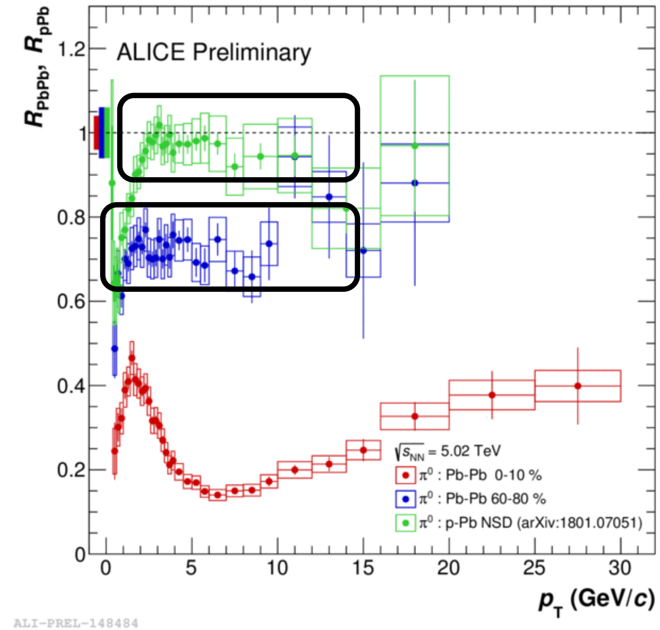
R_{AA} in different systems and centr.

Charged hadrons

ALICE collaboration
arXiv:1802.09145

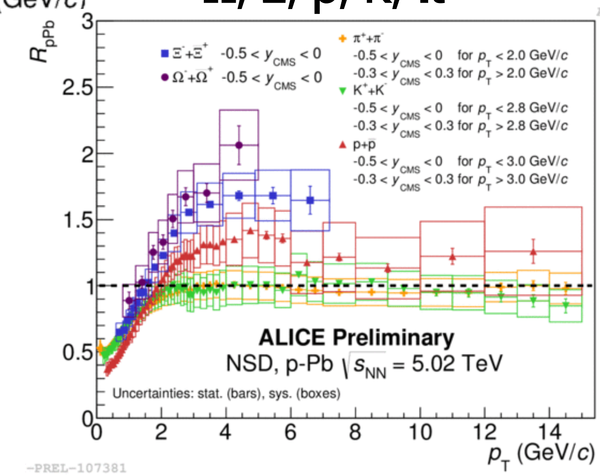


Neutral pions



Heavier particles account for the difference in R_{PbPb} and R_{pPb} between inclusive hadron and pion results.

Ω, Ξ, p, K, π

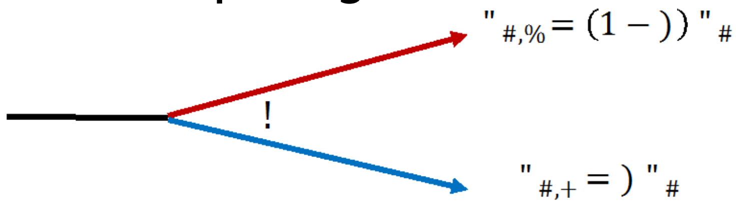


R_{pPb} and peripheral R_{AA} for high p_T particles approach unity.

Depleated R_{AA} not an initial state effect.

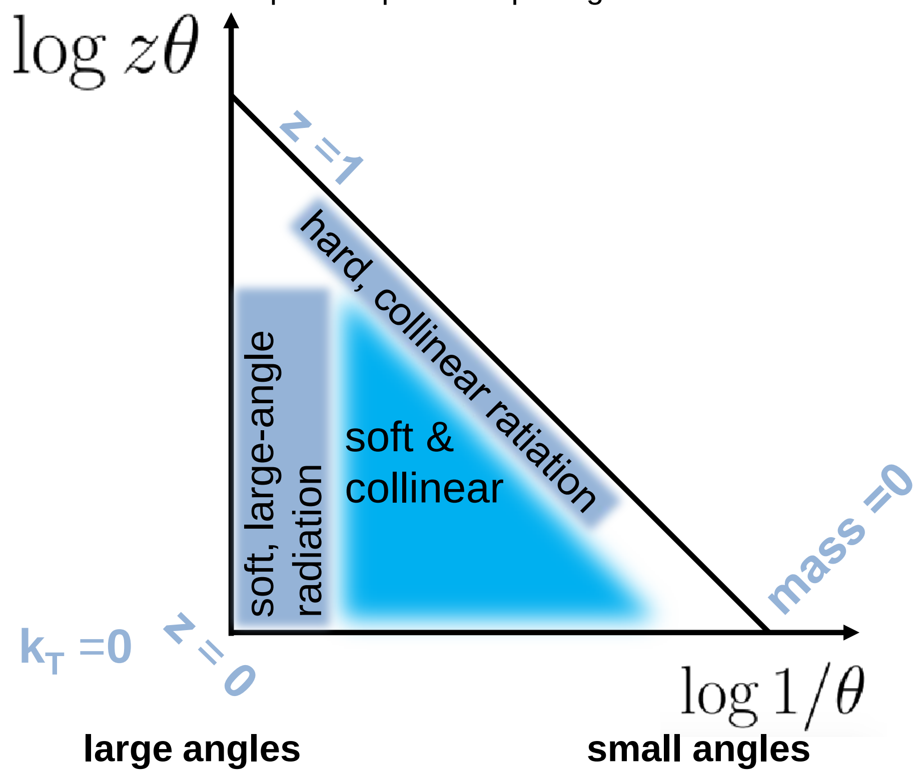
Regions of interest

Parton splittings

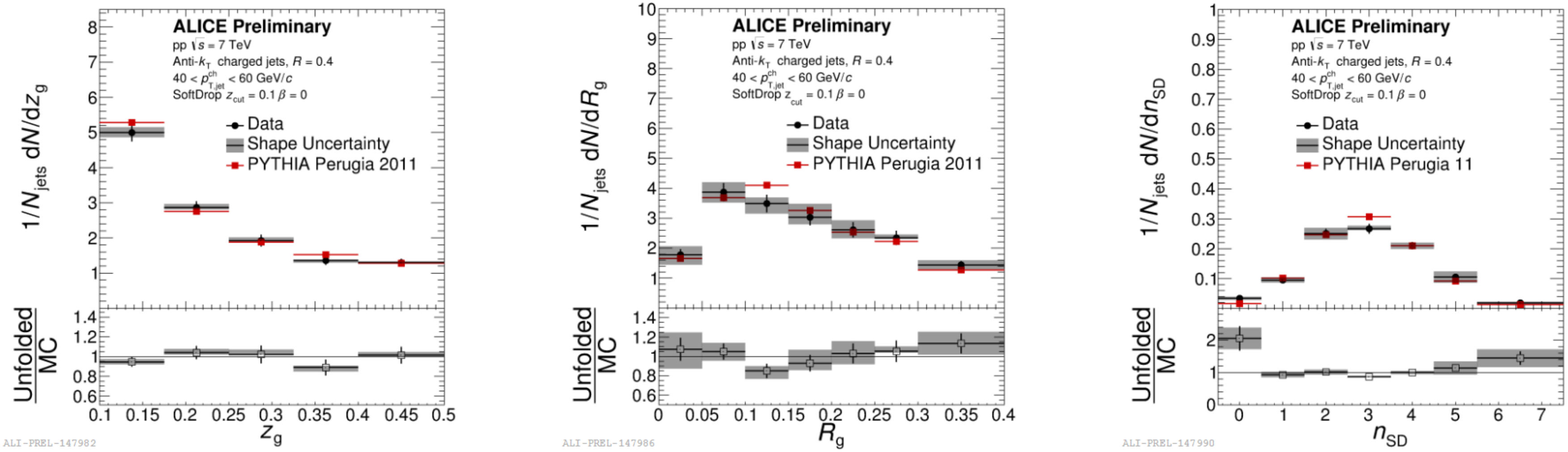


Lund Diagram

phase space of splittings



pp Substructure Results



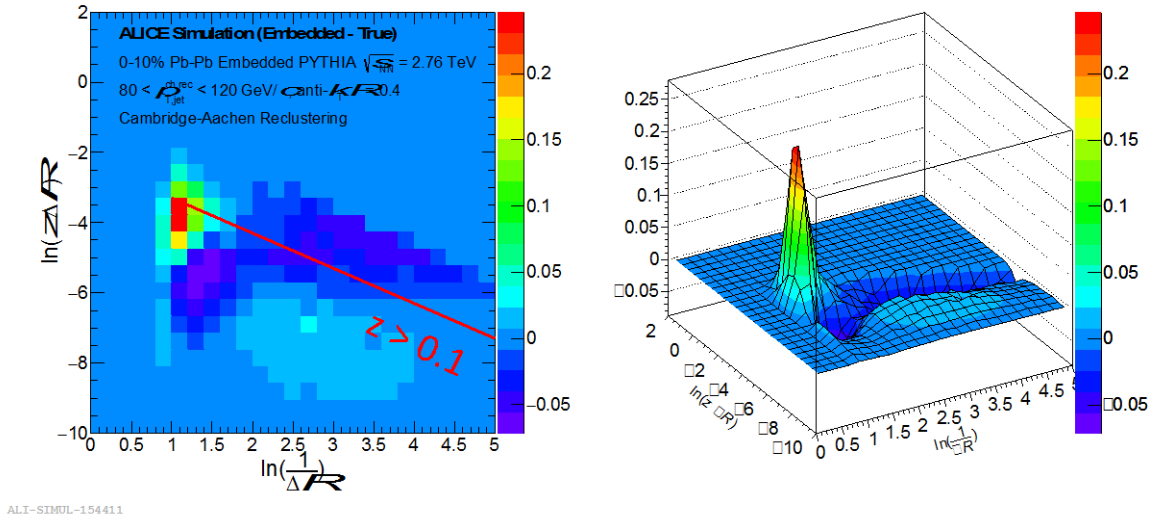
❖Jets satisfying $z > z_{cut} = 0.1$:

1. Data 97.3(0.5)%
2. PYTHIA 98.9(0.1)%

❖Good agreement observed between data and PYTHIA Perugia 2011

Background Response and Fake Subjets

Splittings map for difference of embedded and true PYTHIA



❖Compare Lund diagrams of two populations:

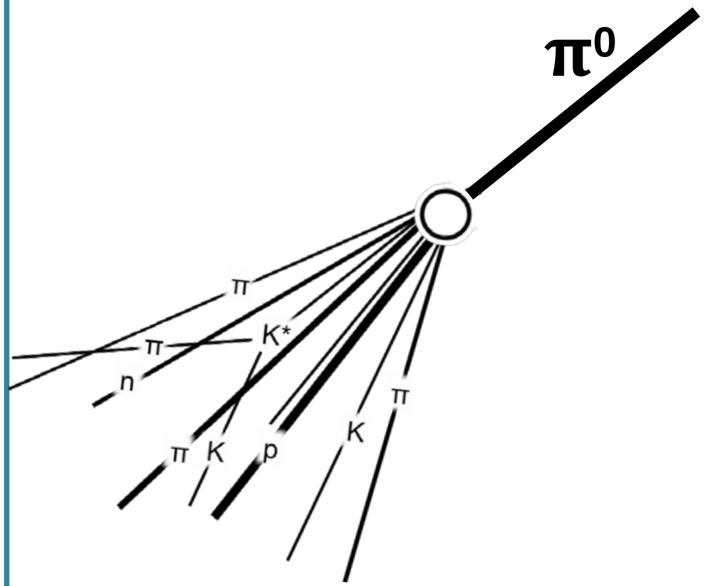
1. PYTHIA jets in vacuum
2. PYTHIA jets embedded into central PbPb

❖Observe a clear enhancement of splittings at large angular separation: purely a background effect, not physical

π^0-hadron correlations pp and PbPb

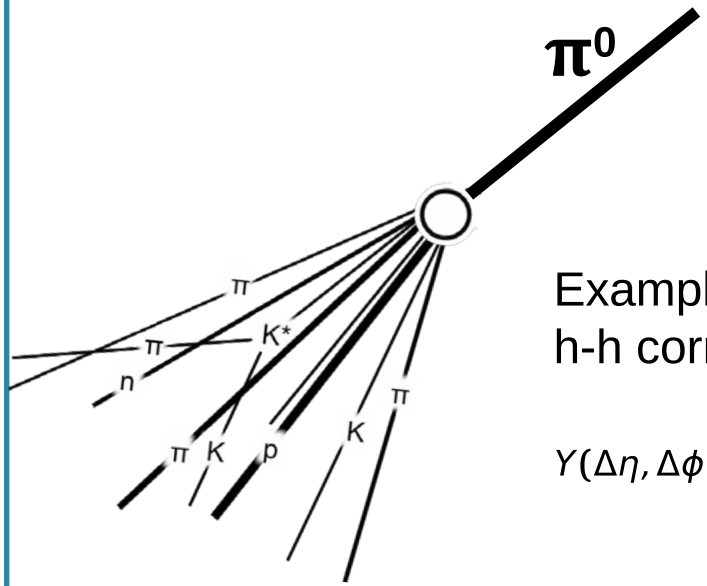
ALICE Collaboration, J. Adam et al.,
***Phys. Lett., B* 763, (2016) 238**

π^0-hadron Correlations



We measure:
pp & Pb-Pb 2.76 TeV
8 < p^{trig} < 16 GeV/c
0.5 < p^{assoc} < 10 GeV/c

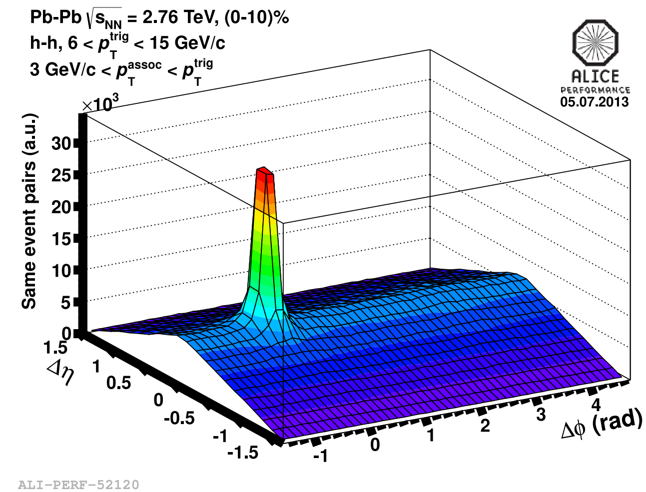
π^0-hadron Correlations

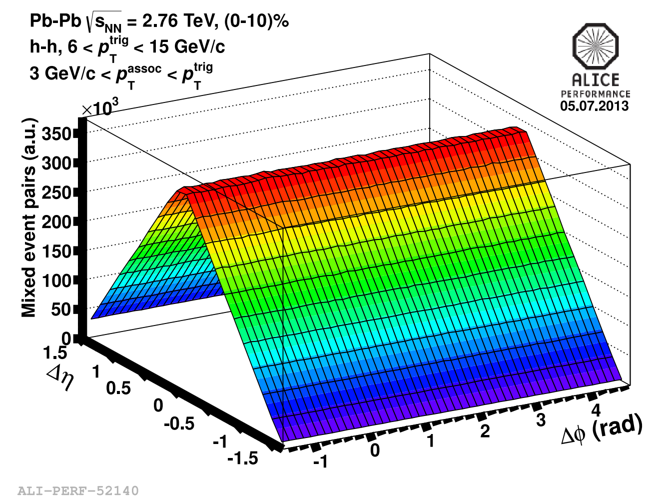


Example from
h-h correlations

$$Y(\Delta\eta,\Delta\phi) = \frac{1}{N^{trig.}}\frac{d^2N^{trig.-h}}{d\Delta\eta d\Delta\phi}$$

$$C(\Delta\phi,\Delta\eta) = \frac{1}{N_{trig.}}\frac{d^2N^{\gamma-h}_{same}/d\Delta\phi d\Delta\eta}{d^2N^{\gamma-h}_{mix}/d\Delta\phi d\Delta\eta}\cdot\alpha$$

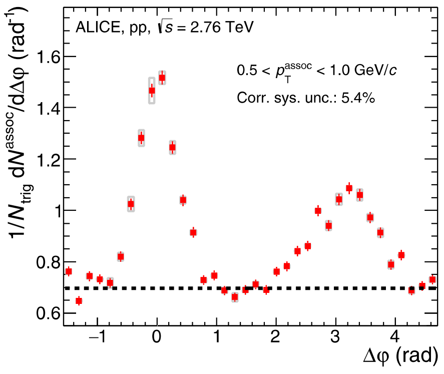




We measure:
pp & Pb-Pb 2.76 TeV
$8 < p^{trig} < 16$ GeV/c
$0.5 < p^{assoc} < 10$ GeV/c

π^0-hadron Correlations

pp

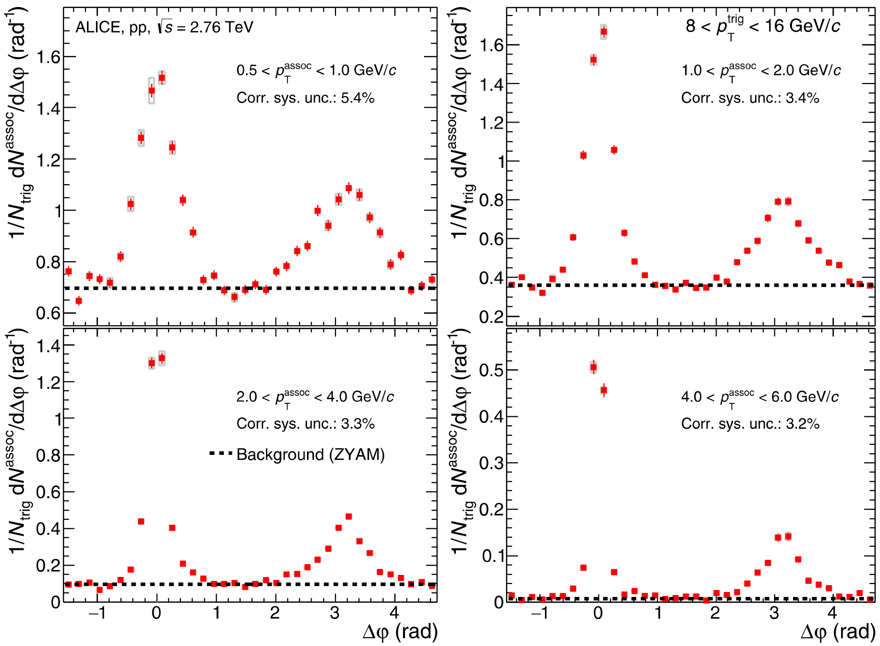


$8 < p^{trig} < 16$ GeV/c

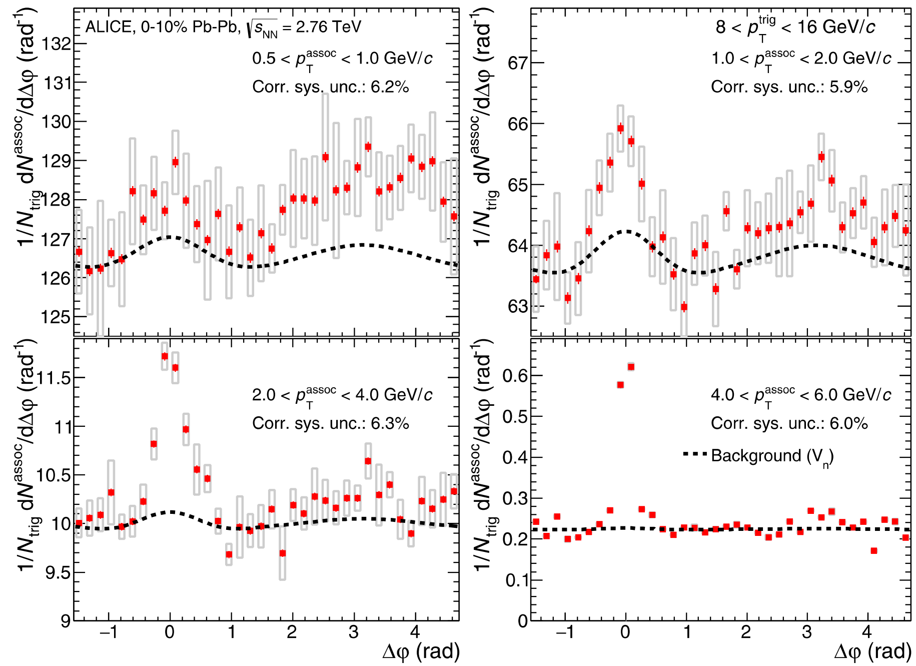
ALICE Collaboration, J. Adam et al.,
***Phys. Lett., B* 763, (2016) 238**

π^0-hadron Correlations

pp



0-10% Pb-Pb

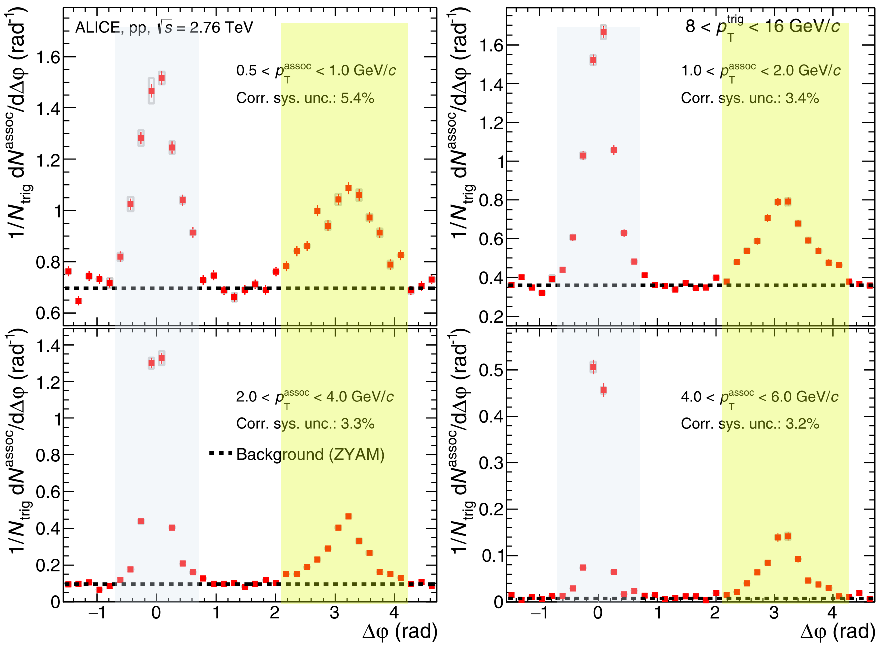


$8 < p^{trig} < 16$ GeV/c

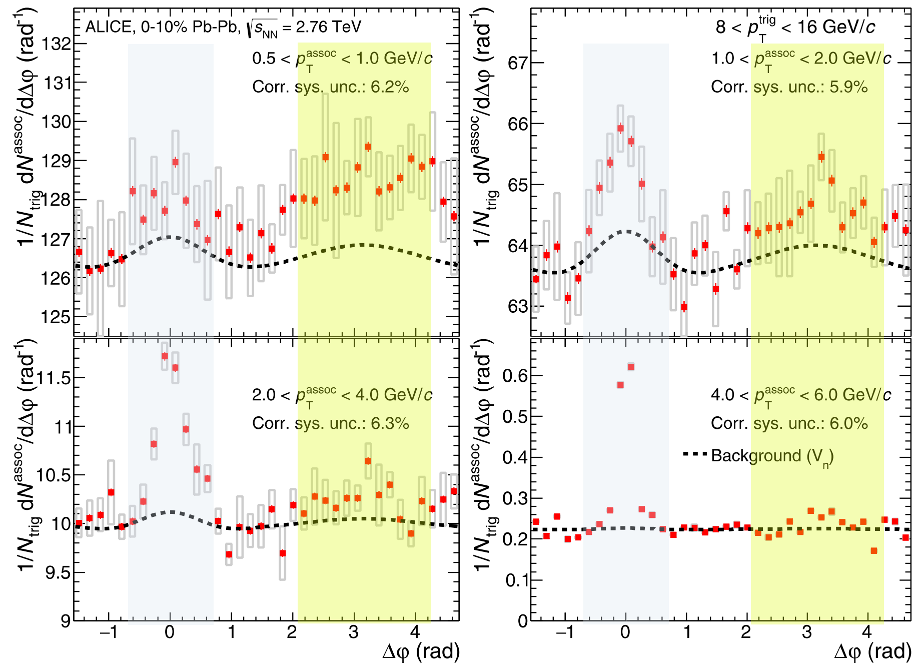
ALICE Collaboration, J. Adam et al., *Phys. Lett., B* 763, (2016) 238

π^0-hadron Correlations

pp



0-10% Pb-Pb



$8 < p^{trig} < 16$ GeV/c

Near Side Signal

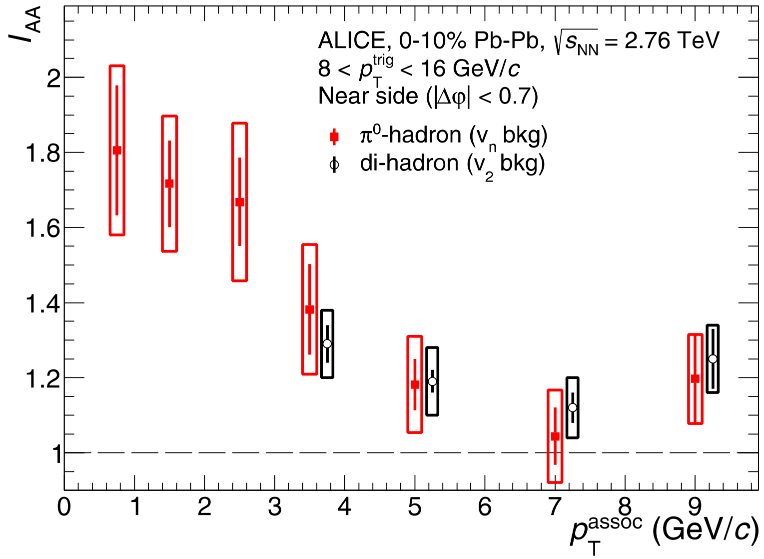
Away Side Signal

ALICE Collaboration, J. Adam et al., *Phys. Lett., B* 763, (2016) 238

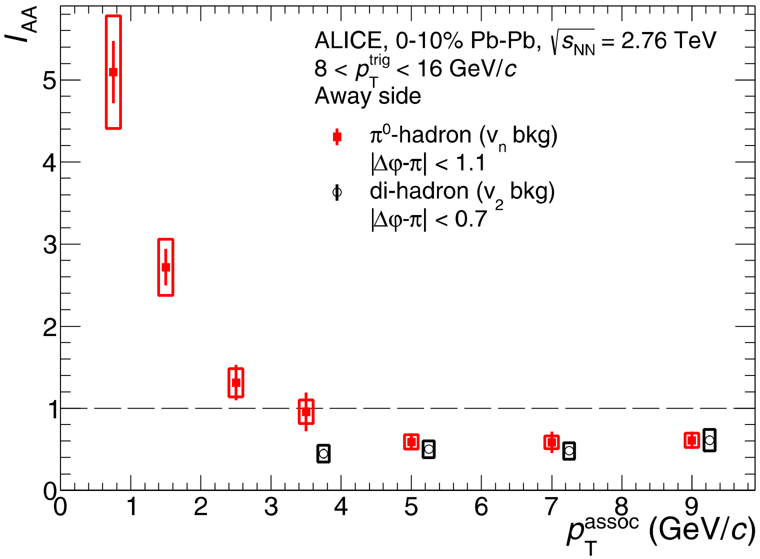
Associated Hadron Yield

ALICE Collaboration, J. Adam et al., *Phys. Lett., B* 763, (2016) 238

Near Side Signal



Away Side Signal

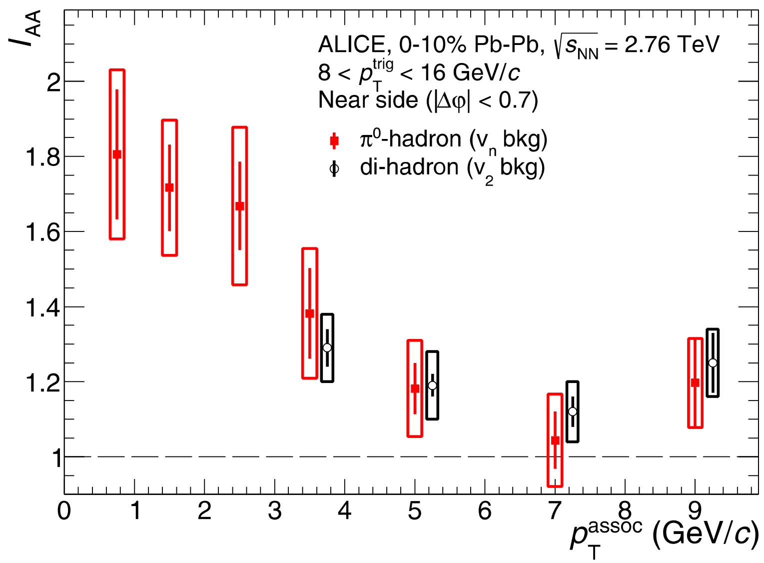


$$I_{AA} = \int_X J_{AA}(\Delta\varphi)\mathrm{d}\Delta\varphi \Big/ \int_X J_{pp}(\Delta\varphi)\mathrm{d}\Delta\varphi \,,$$

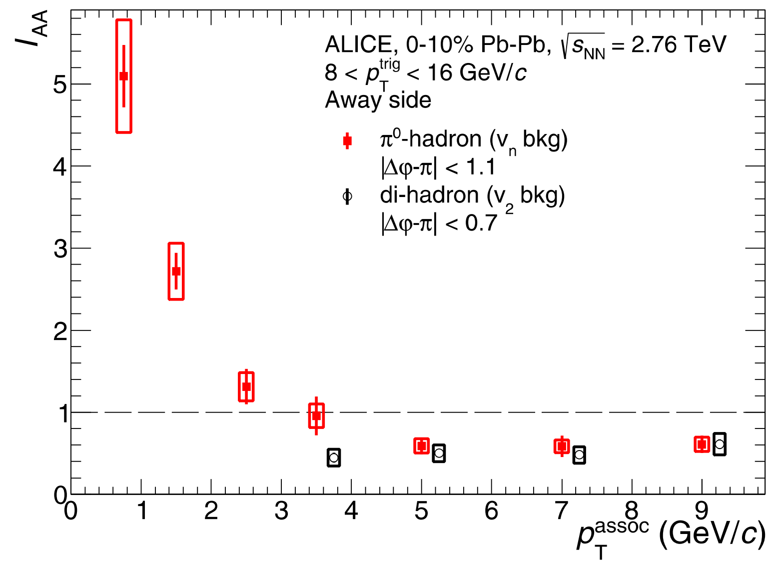
Associated Hadron Yield

ALICE Collaboration, J. Adam et al., *Phys. Lett., B 763, (2016) 238*

Near Side Signal



Away Side Signal



$$I_{AA} = \int_X J_{AA}(\Delta\varphi)\mathrm{d}\Delta\varphi \Big/ \int_X J_{pp}(\Delta\varphi)\mathrm{d}\Delta\varphi\,,$$

Enhancement at the **near side** in Pb-Pb
- Medium response to the jet
- Modified fragmentation function?
- Change of q/g jet fraction?

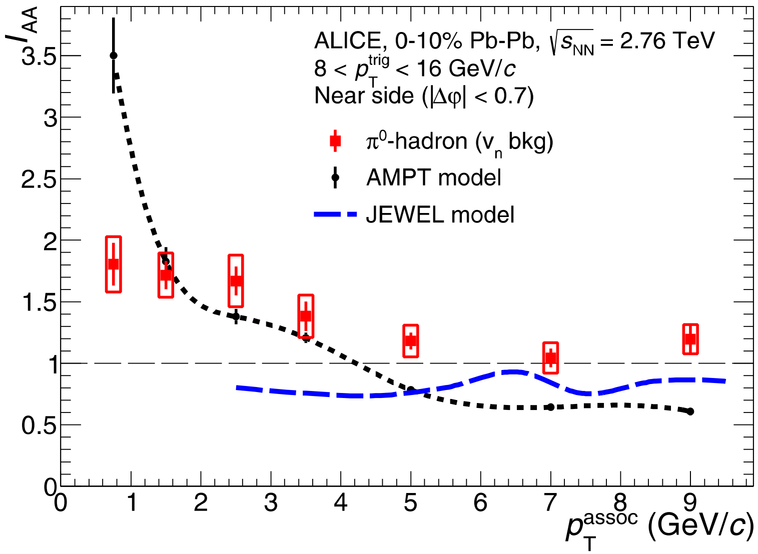
High-p_T suppression at the **away side**
- parton energy loss in-medium

Low-p_T enhancement at the **away side**
- Soft gluon radiation/medium response

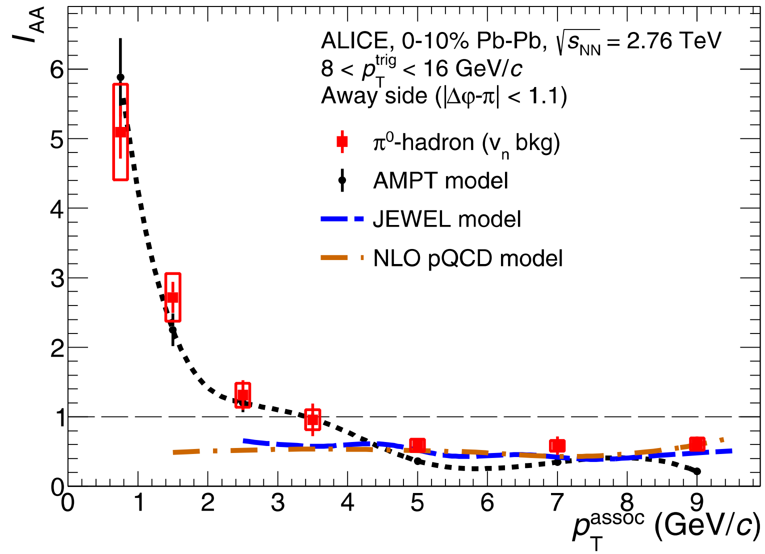
Associated Hadron Yield

ALICE Collaboration, J. Adam et al., *Phys. Lett., B* 763, (2016) 238

Near Side Signal



Away Side Signal

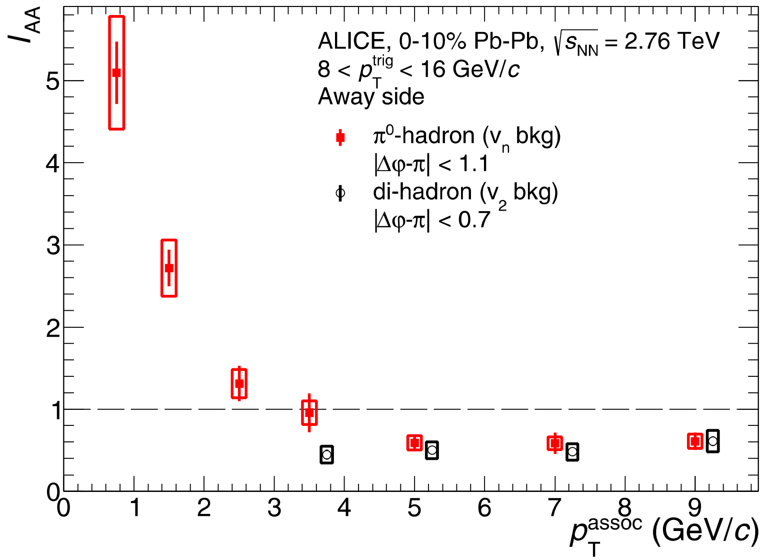


$$I_{AA} = \int_X J_{AA}(\Delta\varphi)\mathrm{d}\Delta\varphi \Big/ \int_X J_{pp}(\Delta\varphi)\mathrm{d}\Delta\varphi\,,$$

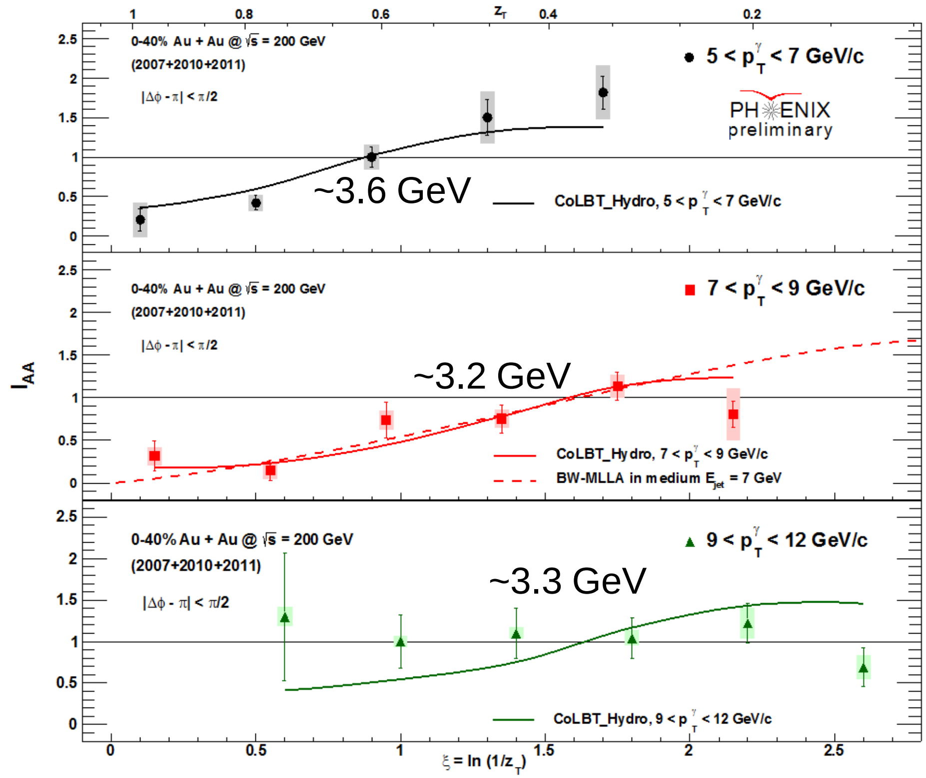
All models can describe the suppression at high p_T for the away side.
The increase at low p_T is only described by **AMPT**.
For **AMPT**, however, the suppression at the near and away side is much too strong.

In Context

ALICE Collaboration, J. Adam et al.,
Phys. Lett., B 763, (2016) 238



PHENIX Collaboration, J. Osborn et al.,
Nuclear Physics A 00 (2017) 1–4



Low-p_T enhancement also seen by PHENIX.
Enhancement there also starts at about 3.5 GeV
Same p_T region where ALICE sees the enhancement.

$$z_T = \frac{p_T^h}{p_T^{Trigger}}$$

Intra-jet Distributions I

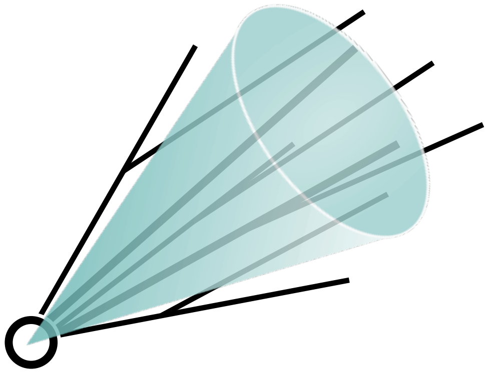
Jet Mass

ALICE Collaboration, S. Acharya et al.,
Phys. Lett., B 776,* (2018) *249

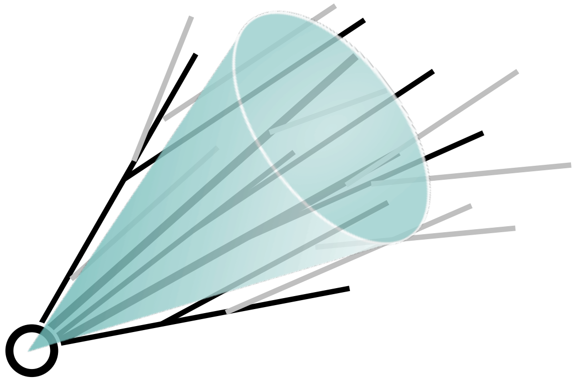
Jet Mass

Jet mass is a measure of the spread of the jet and is linked to the virtuality of the initial parton

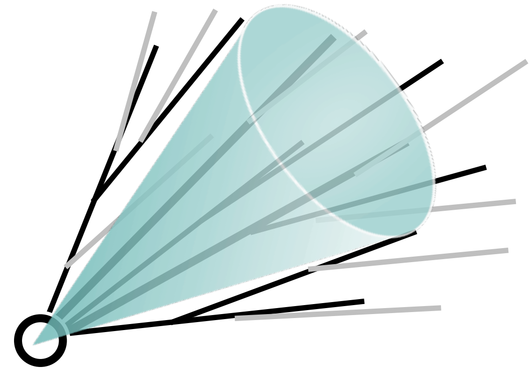
$$M = \sqrt{E^2 - p^2}$$



Measure jet mass in a given cone R



In Medium
If the profile broadens due to soft gluon radiation measured mass will increase

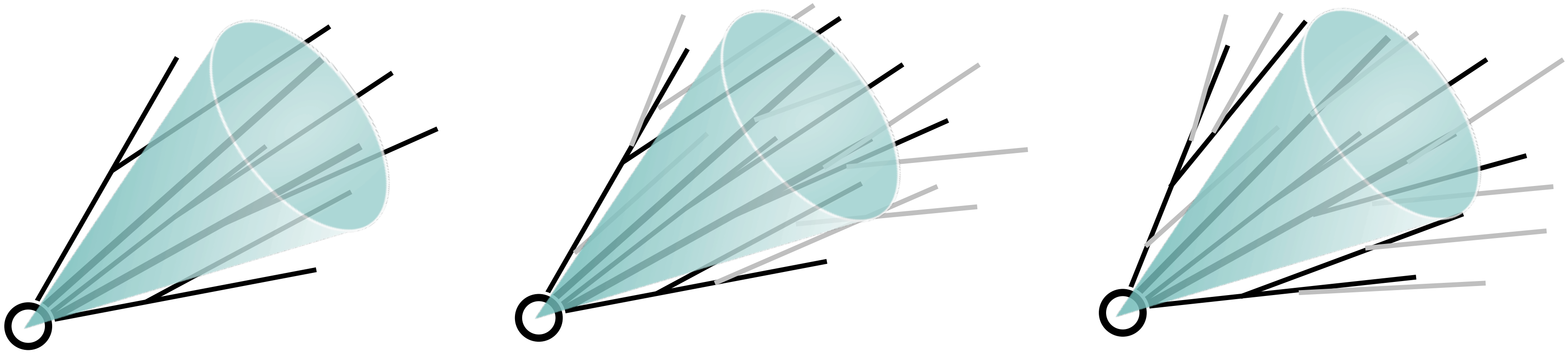


In Medium
If the profile broadens so much that large fraction of radiation is outside the cone, mass as well as p_T will decrease

Jet Mass

Jet mass is a measure of the spread of the jet and is linked to the virtuality of the initial parton

$$M = \sqrt{E^2 - p^2}$$



Measure jet mass in a given cone R

In Medium
If the profile broadens due to soft gluon radiation measured mass will increase

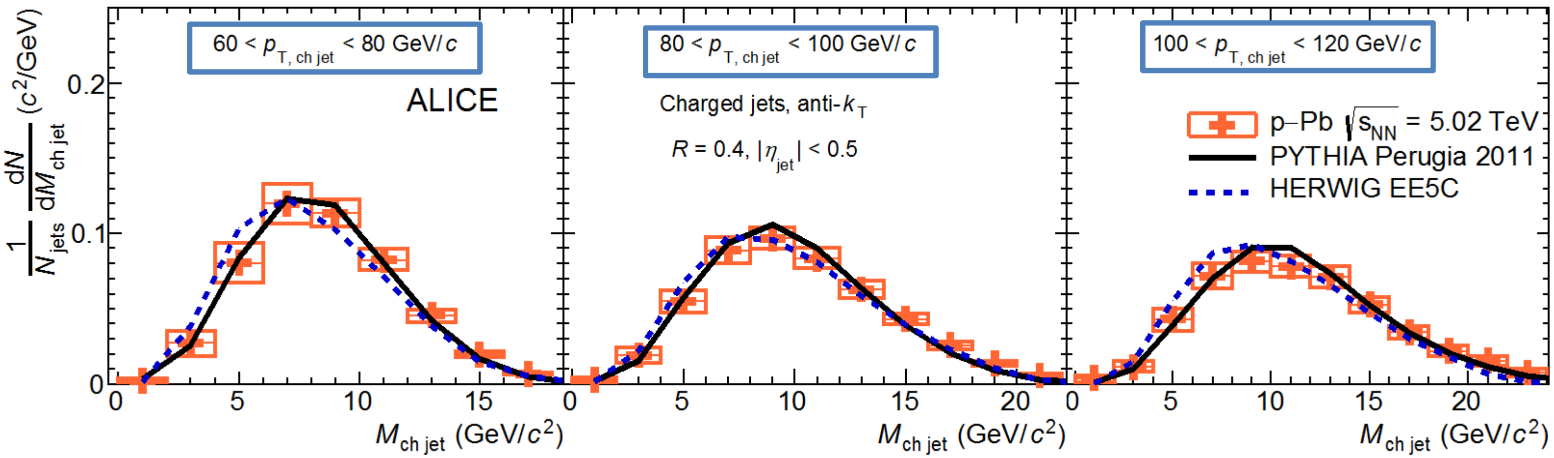
In Medium
If the profile broadens so much that large fraction of radiation is outside the cone, mass as well as p_T will decrease

We measure:
p-Pb 5.02, Pb-Pb 2.76 TeV
Anti-k_T jet algorithm,
resolution parameter R = 0.4,
$|\eta_{jet}| < 0.5$,
p_T = 60 - 120 GeV/*c*

Jet Mass Results

ALICE Collaboration, S. Acharya et al., *Phys. Lett., B 776*, (2018) *249*

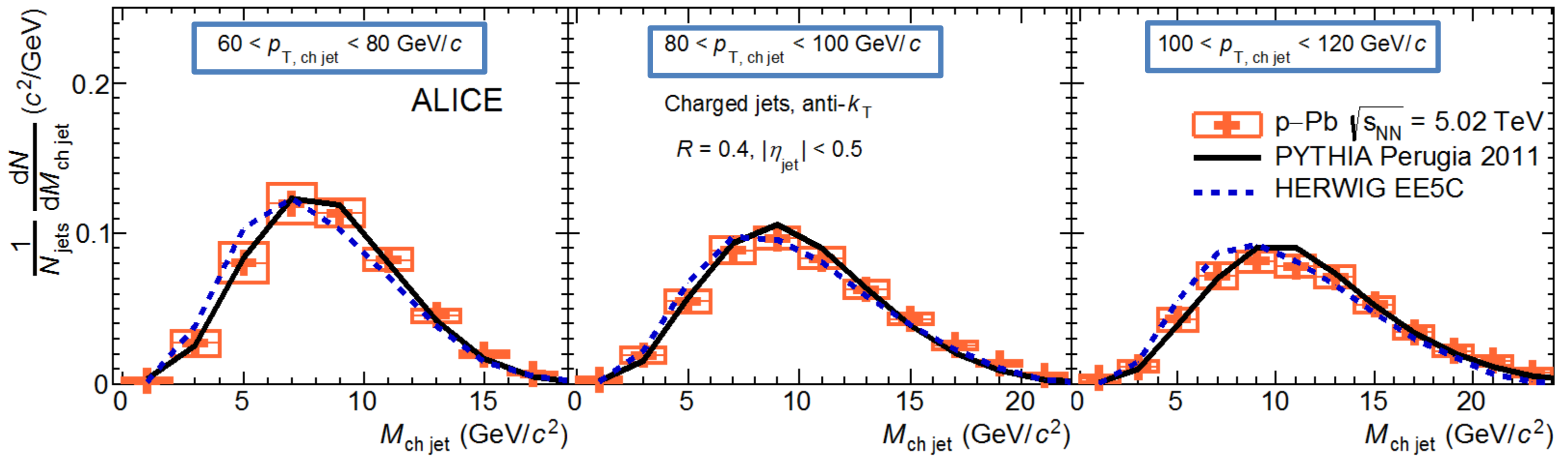
p-Pb, 5.02 TeV



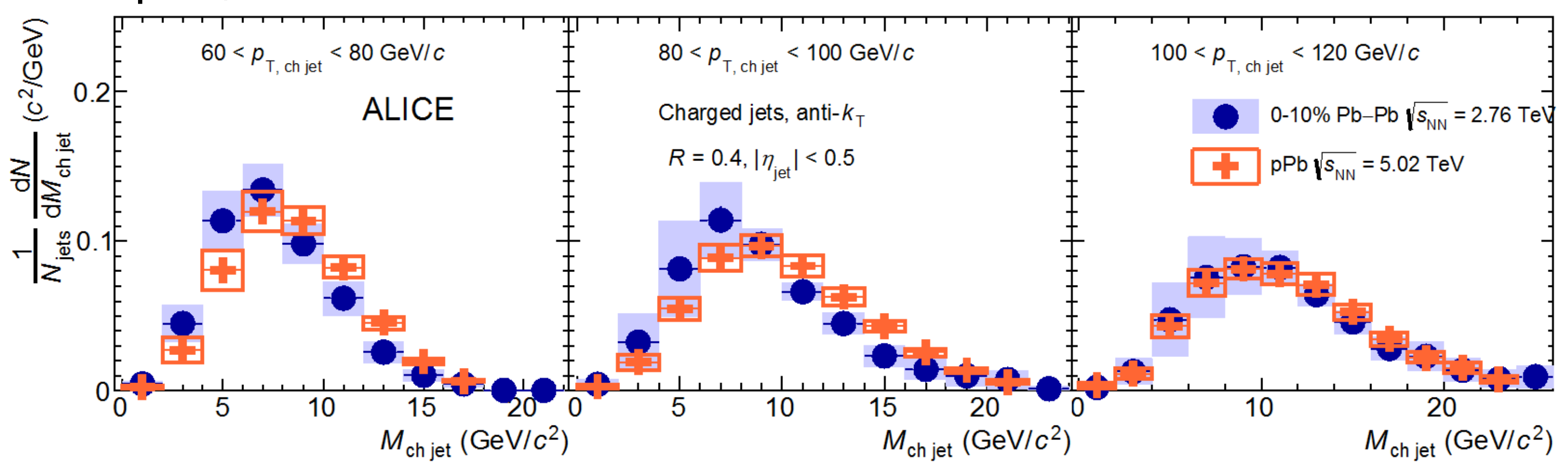
Jet Mass Results

ALICE Collaboration, S. Acharya et al., *Phys. Lett., B 776, (2018) 249*

p-Pb, 5.02 TeV



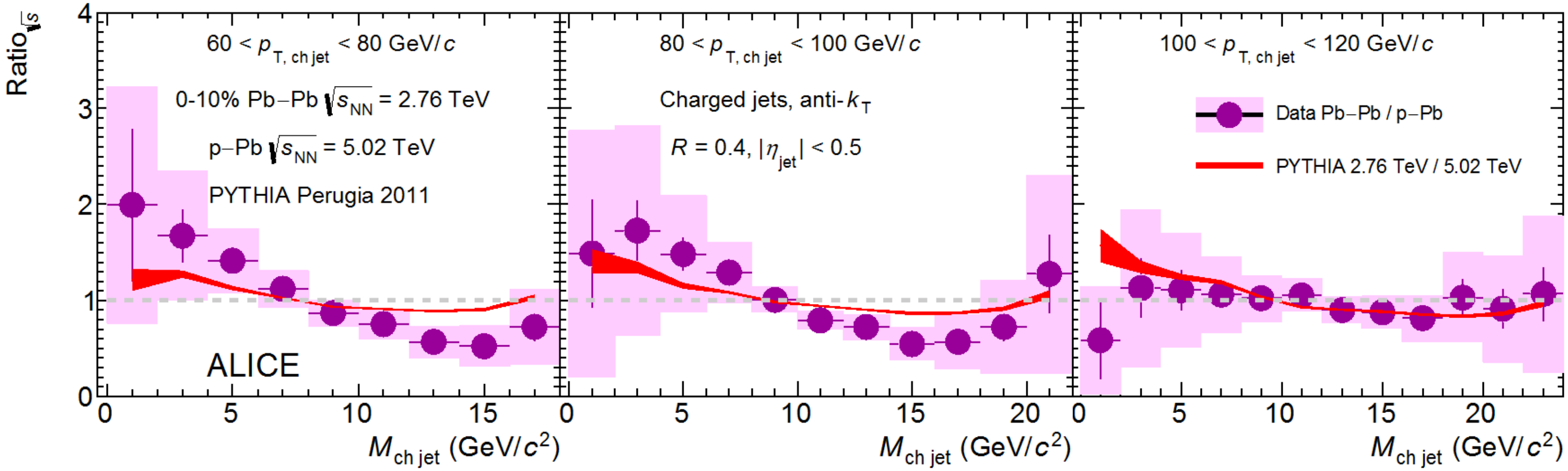
pPb, 5.02 TeV and PbPb 2.76 TeV



Jet mass in PbPb seems shifted to slighty lower values compared to pPb

Jet Mass Interpretation

ALICE Collaboration, S. Acharya et al., *Phys. Lett., B 776, (2018) 249*



To see effects of:
- different q/g ratio at different collision energies
- effect of different shapes of the underlying jet p_T spectrum

The PYTHIA ratio is compared to the Pb-Pb/p-Pb ratio

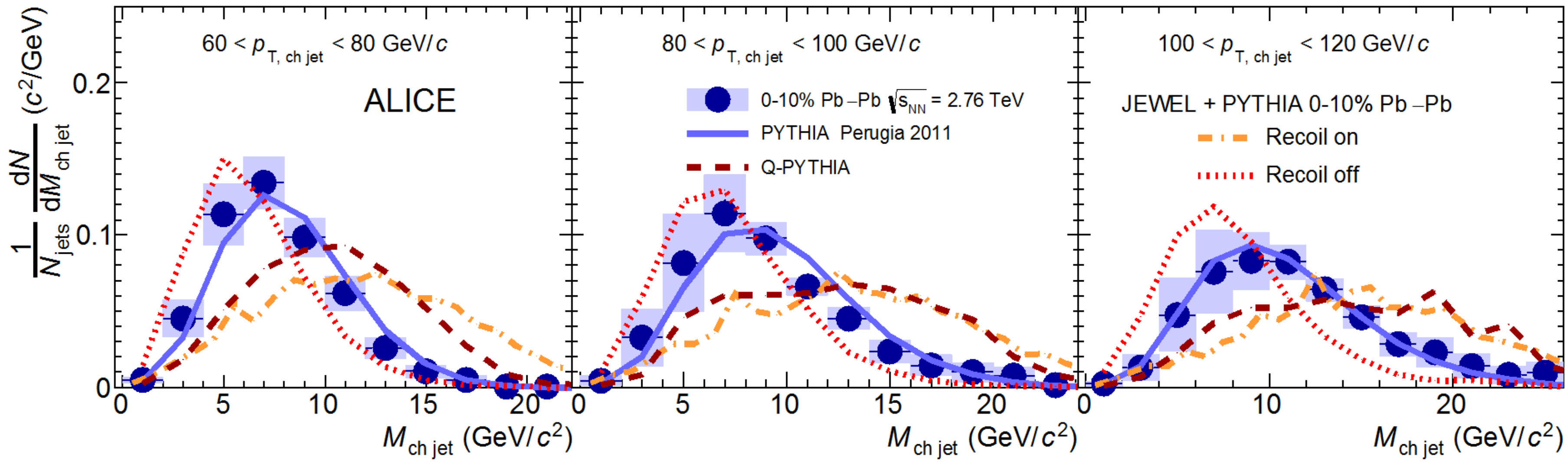
Observed effect is compatible with PYTHIA, no significant shift observed due to medium.
The soft radiation outside the cone doesn't alter the relation between p_T and mass of the parton

Jet Mass Interpretation

ALICE Collaboration, S. Acharya et al., *Phys. Lett., B 776*, (2018) *249*

Pb-Pb results compared to models

How well do they describe the in medium shower shape evolution?



PYTHIA result without jet quenching

Q-PYTHIA modifies the splitting functions of PYTHIA resulting in medium-induced gluon radiation following the multiple soft scattering approximation

JEWEL computation of scattering of leading parton with medium constituents. Gives a microscopic description of the transport coefficient $\hat{q}$

"Recoil on" keeps additional track of momenta of recoiling scattering centers

Quenching models do not describe measured jet mass