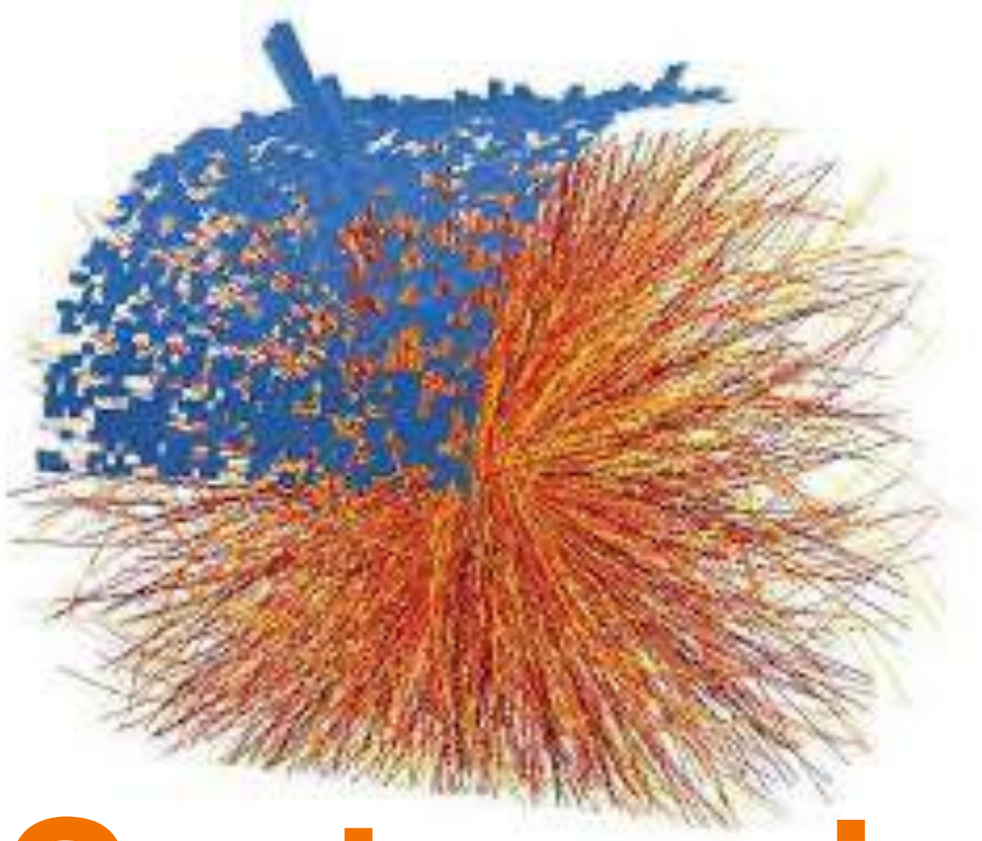

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System size dependence of quantities sensitive to parton energy loss measured with ALICE at the LHC

Seminario de Física de Altas Energías
ICN-IF, UNAM. 23/02/2021

Antonio Ortiz

Introduction

The ALICE Collaboration

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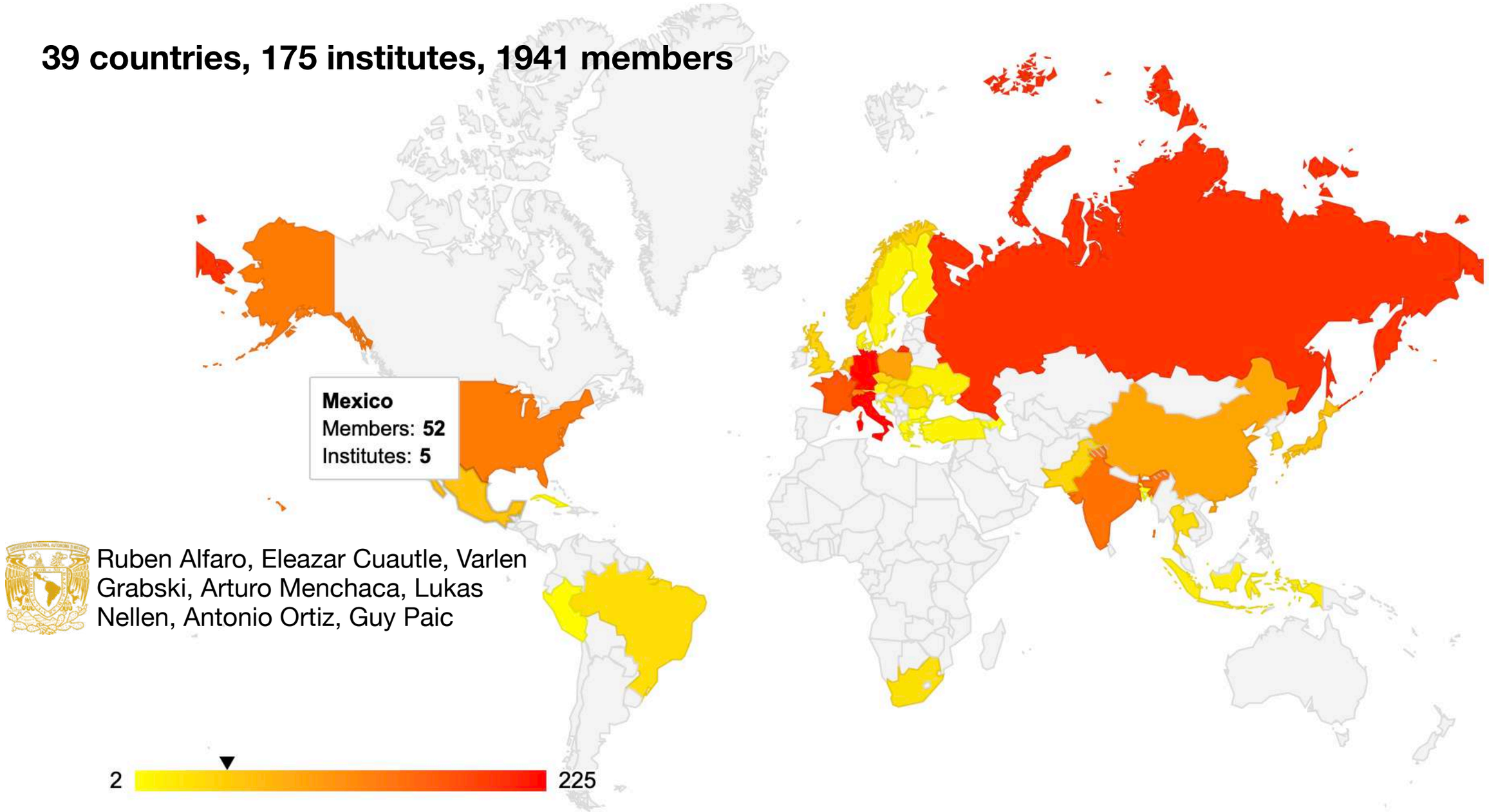
ALICE (A Large Ion Collider Experiment) is a major experiment at the Large Hadron Collider (LHC), which is optimized for the study of QCD matter created in high-energy collisions between lead nuclei

39 countries, 175 institutes, 1941 members



Ruben Alfaro, Eleazar Cuautle, Varlen Grabski, Arturo Menchaca, Lukas Nellen, Antonio Ortiz, Guy Paic

The ALICE detector (Run 2)

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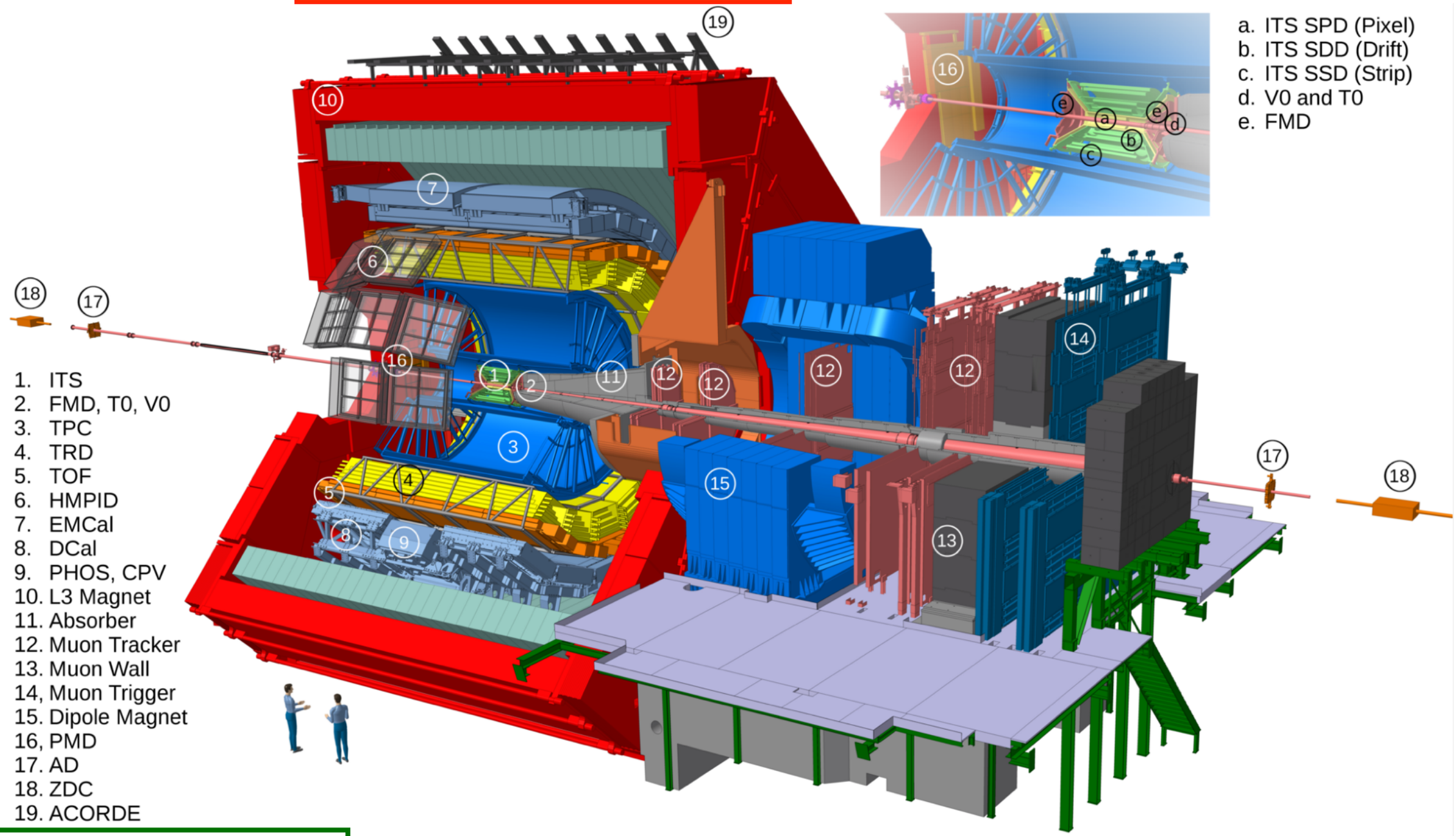
Central barrel $|\eta| < 0.9$
Tracking, PID, calorimetry,
mid-pseudorapidity multiplicity estimator (TPC+ITS)



Forward detectors, VZERO: event activity estimator

Muon spectrometer $-4 < \eta < -2.5$

Small systems

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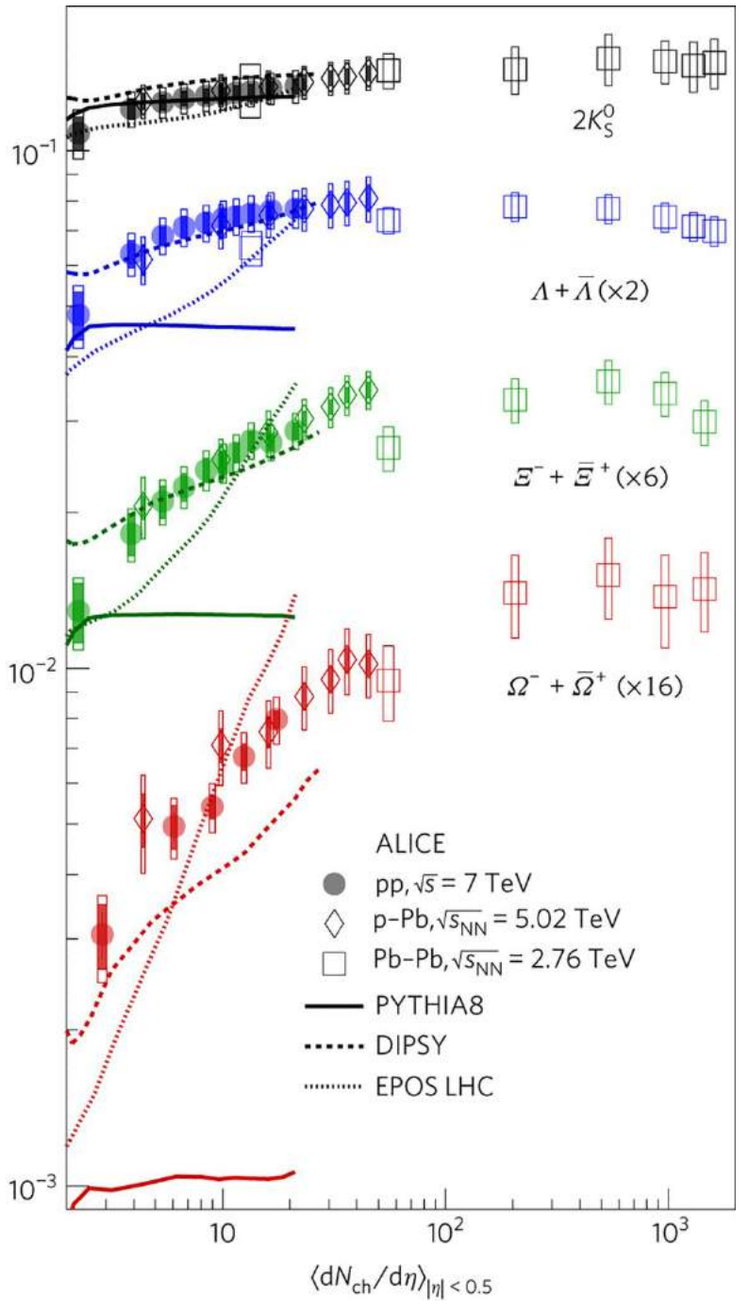
Striking similarities between numerous observables have been observed across different collision systems at both RHIC and LHC energies, when compared at similar multiplicity

Small systems



Strangeness enhancement

Striking similarities between numerous observables have been observed across different collision systems at both RHIC and LHC energies, when compared at similar multiplicity

Multiplicity reach ~$3 \times \left\langle \frac{dN_{ch}}{d\eta} \right\rangle$ (MB pp)

Small systems

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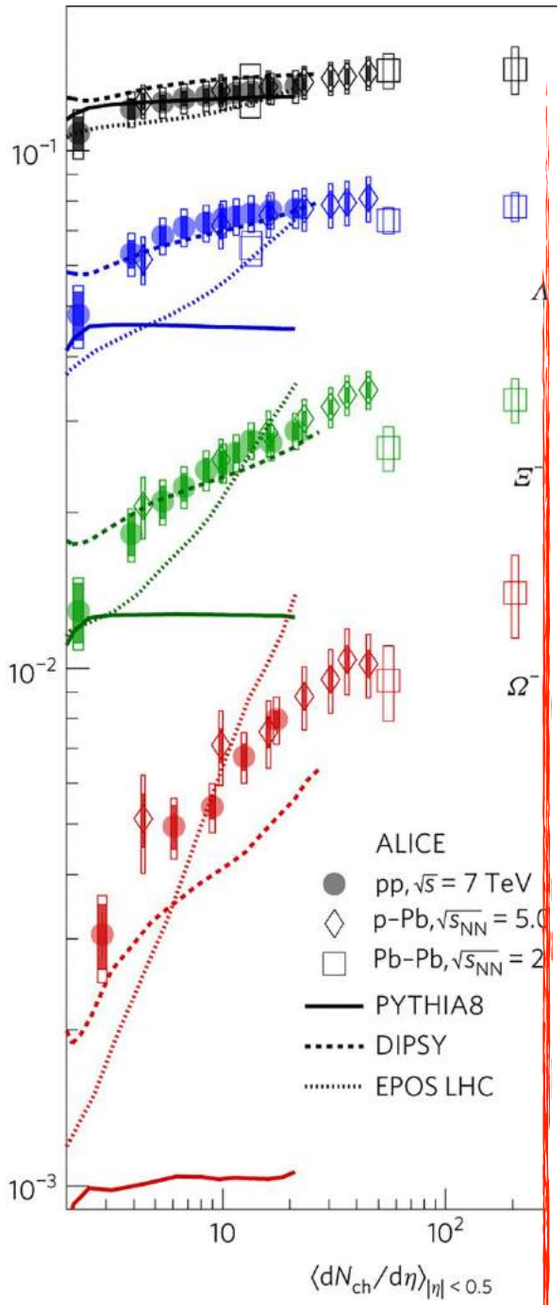
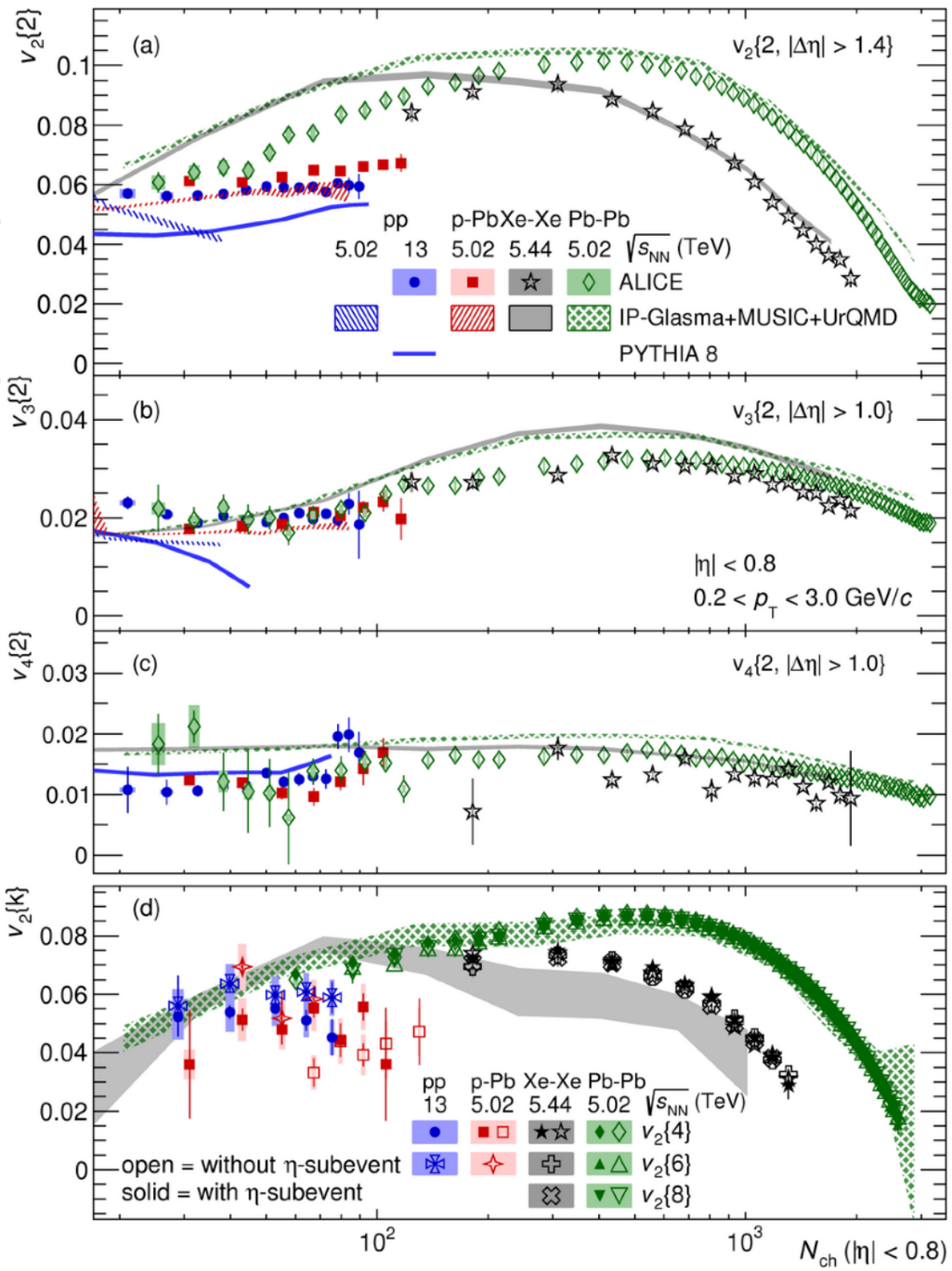
ALICE, Nat. Phys. 13, 535–539 (2017)



Strangene
enhanceme

ALICE, PRL 123, 142301 (2019)



Collectivity

Striking similarities between numerous observed across ems at both RHIC en compared at

Small systems

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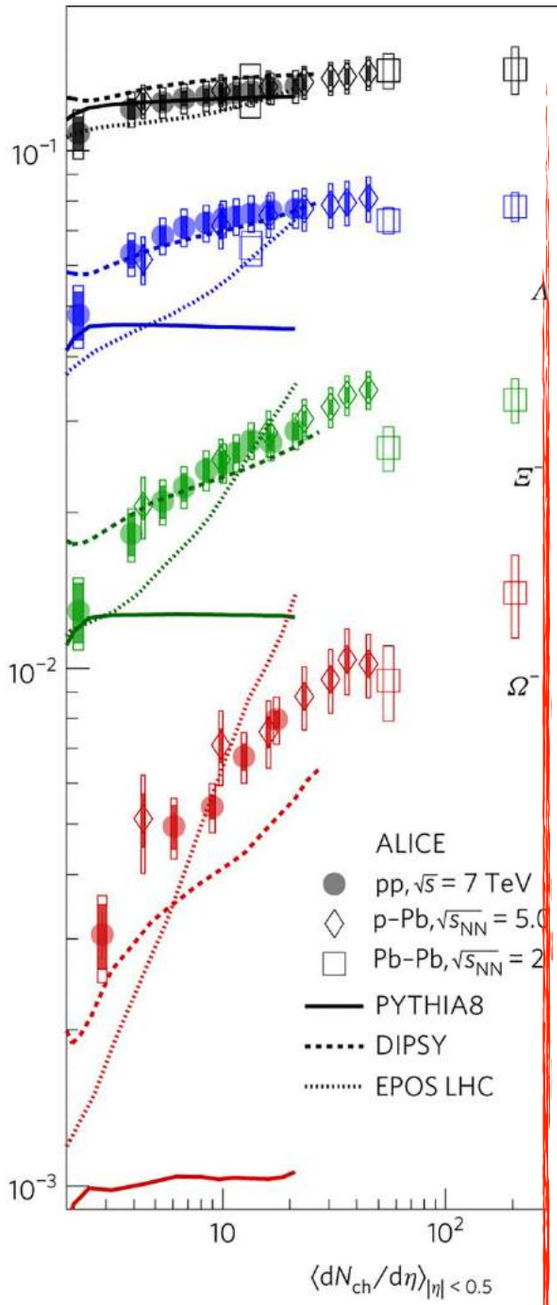
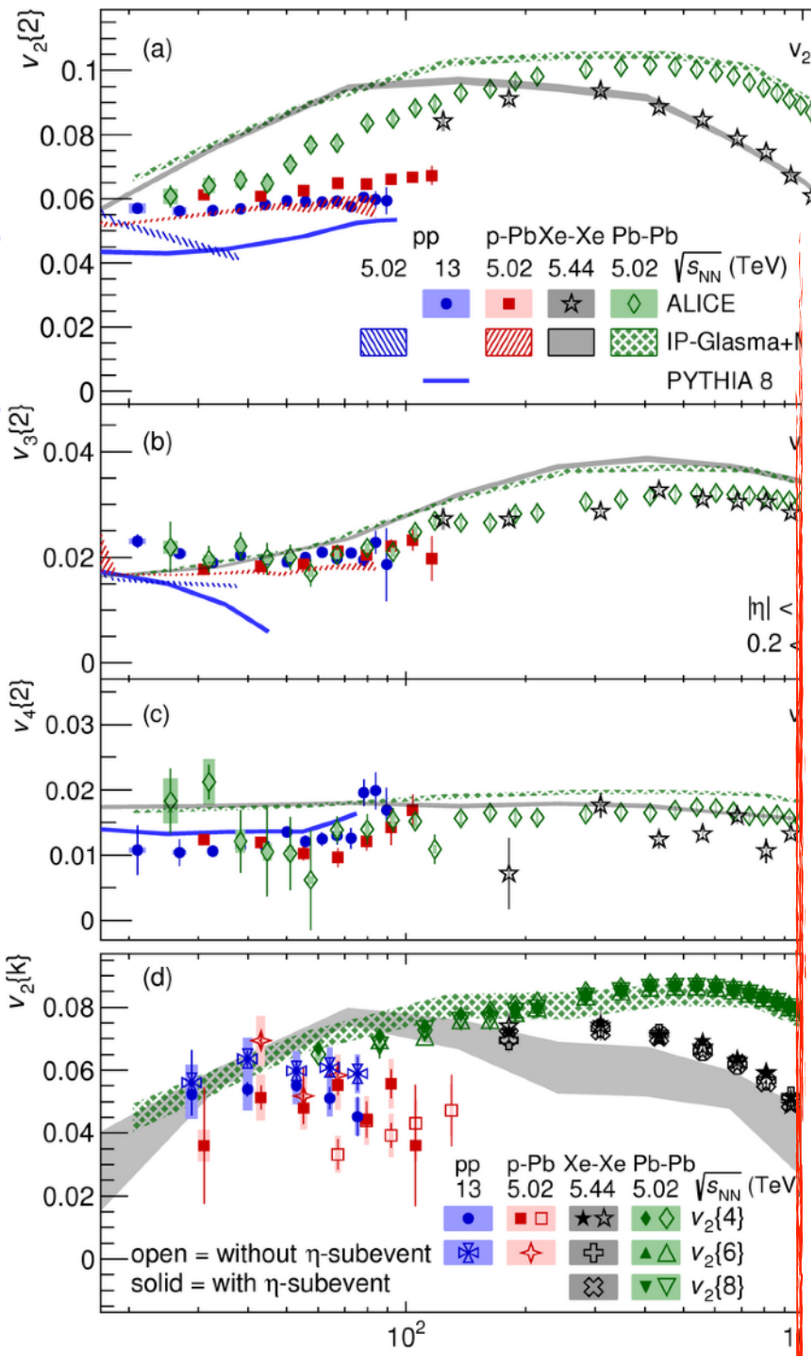
ALICE, Nat. Phys. 13, 535–539 (2017)



Strangene enhanceme

ALICE, PRL 123, 142301 (2019)



Collectivity

Striking similarities between numerous observables observed across systems at both RHIC

Strangeness enhancement as well as v_3 and v_4 (unlike v_2) show a continuous evolution across collision systems: pp<->p-Pb<->Pb-Pb

?

Jet quenching

Focus of this talk

Jet quenching in A-A collisions

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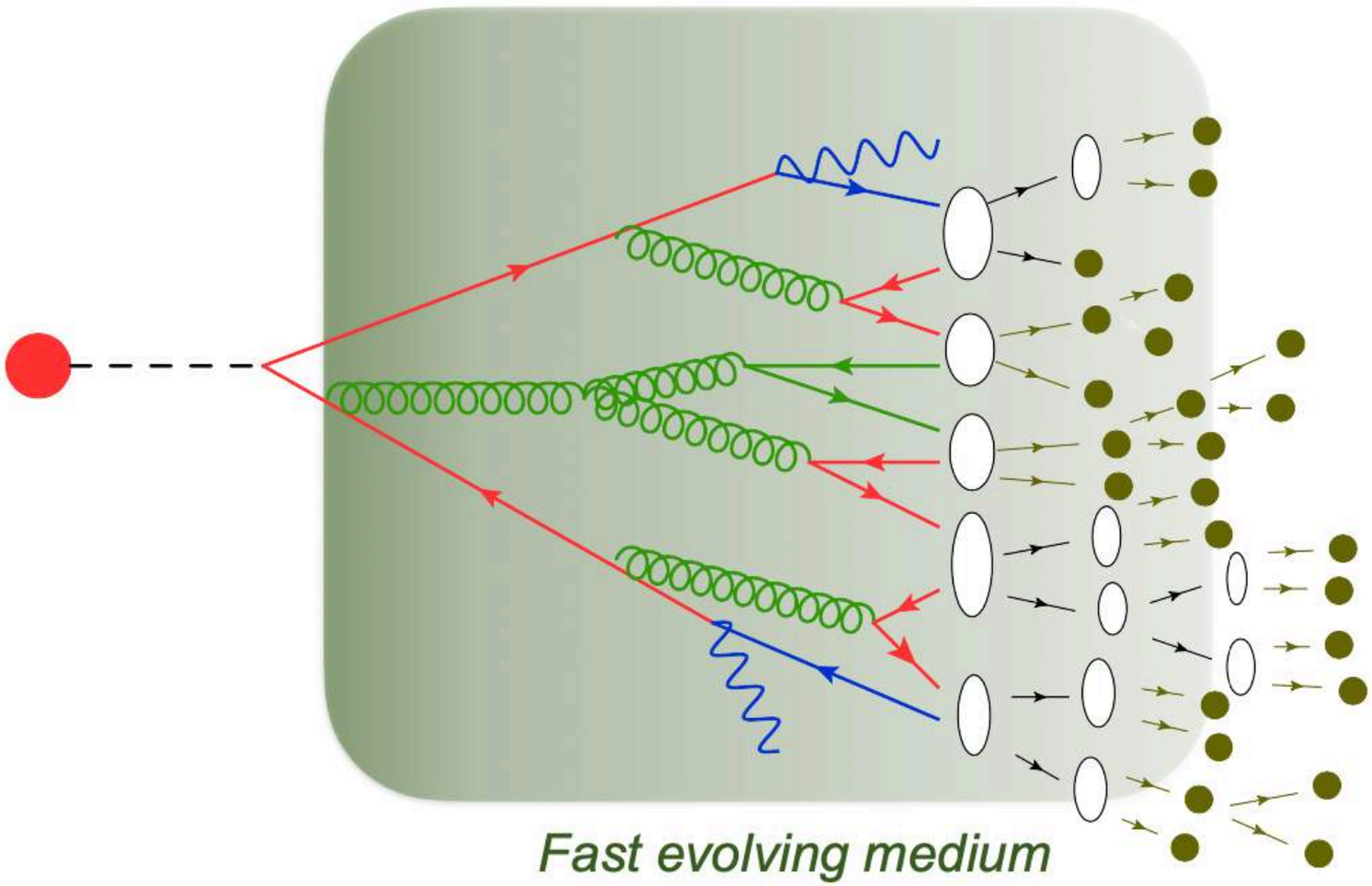
UNAM

Jet shower in the medium, superposition of:
vacuum shower



From L. Apolinário [2020 RHIC/AGS Jet Workshop]

Jet quenching in A-A collisions

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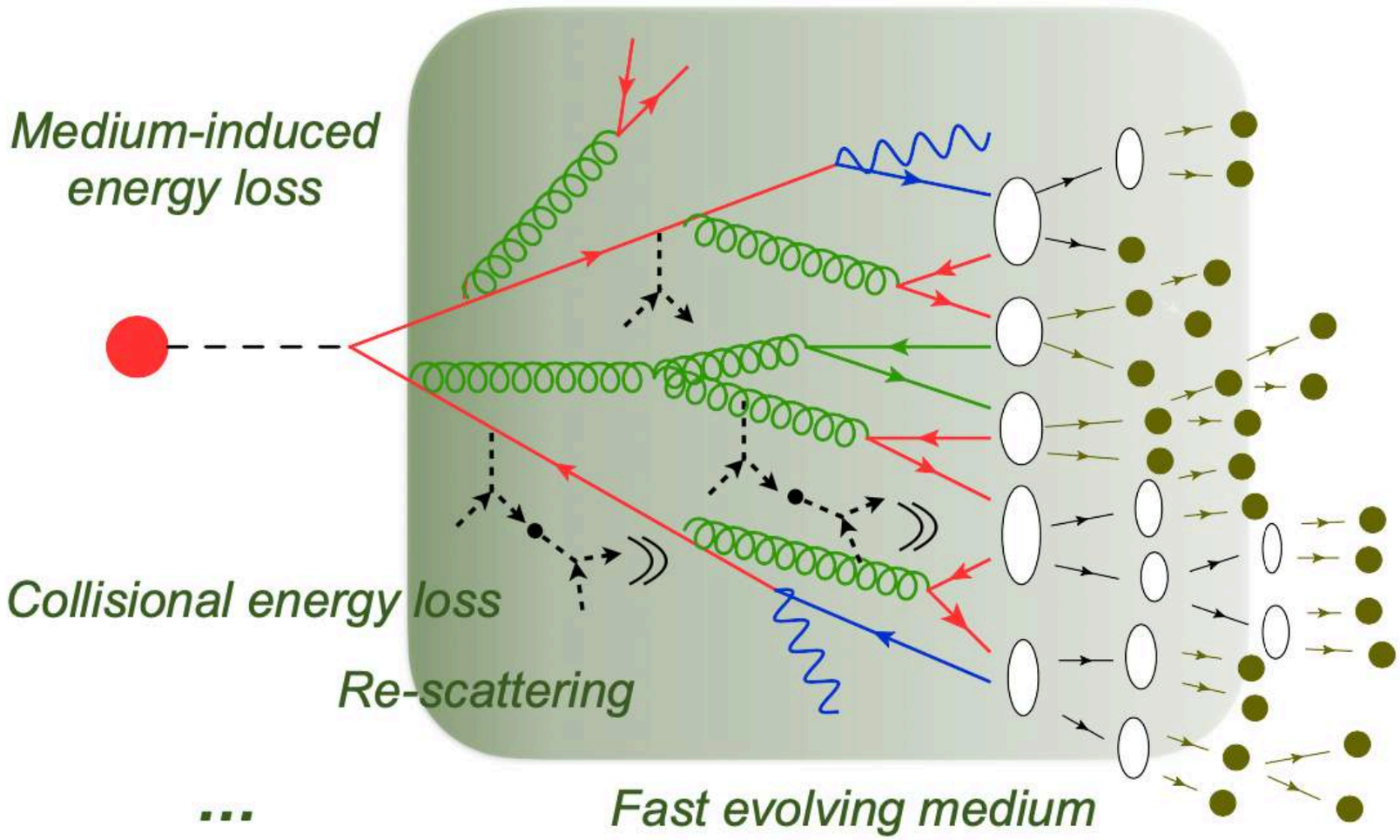
UNAM

Jet shower in the medium, superposition of:
medium-induced gluon emission



From L. Apolinário [2020 RHIC/AGS Jet Workshop]

These processes happen simultaneously and interfere

Jet quenching in A-A collisions

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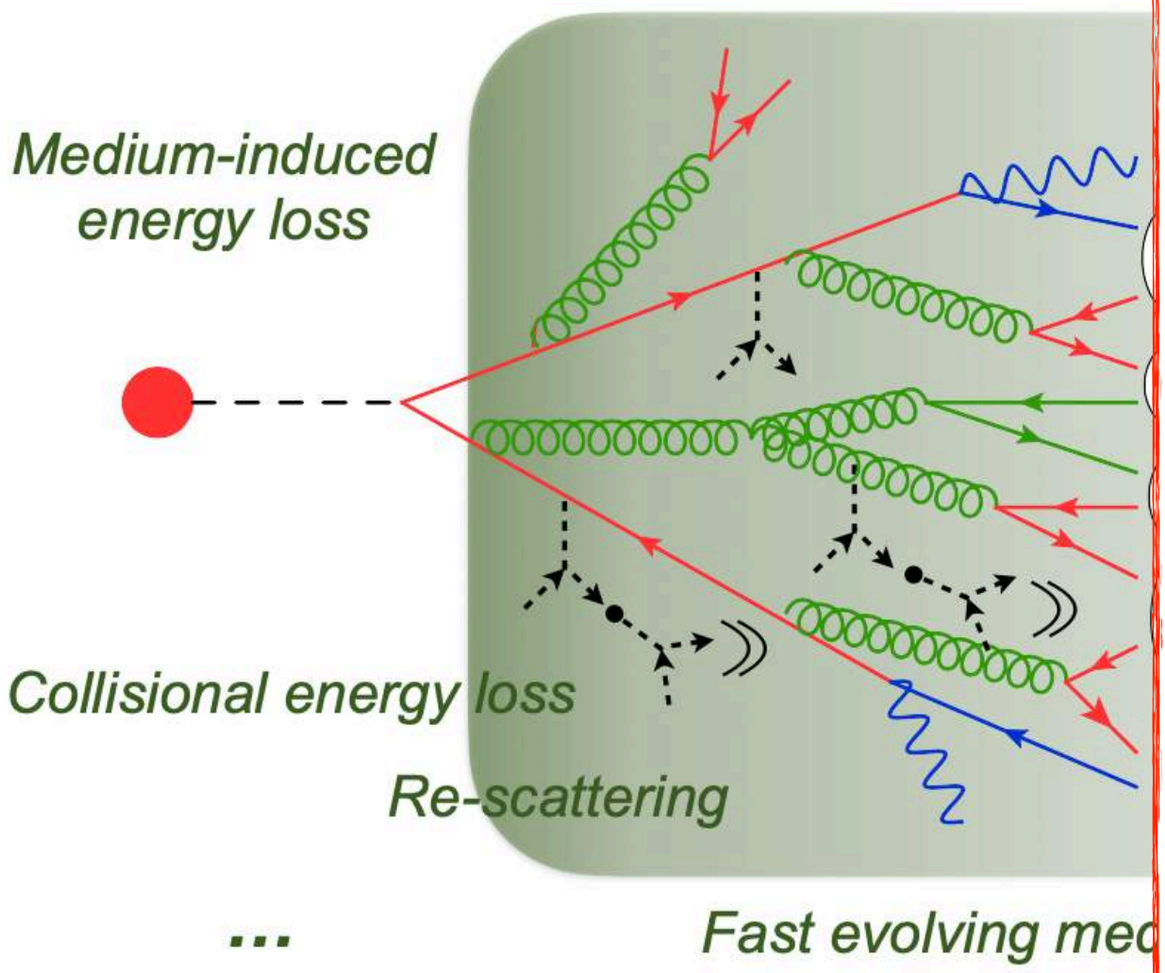
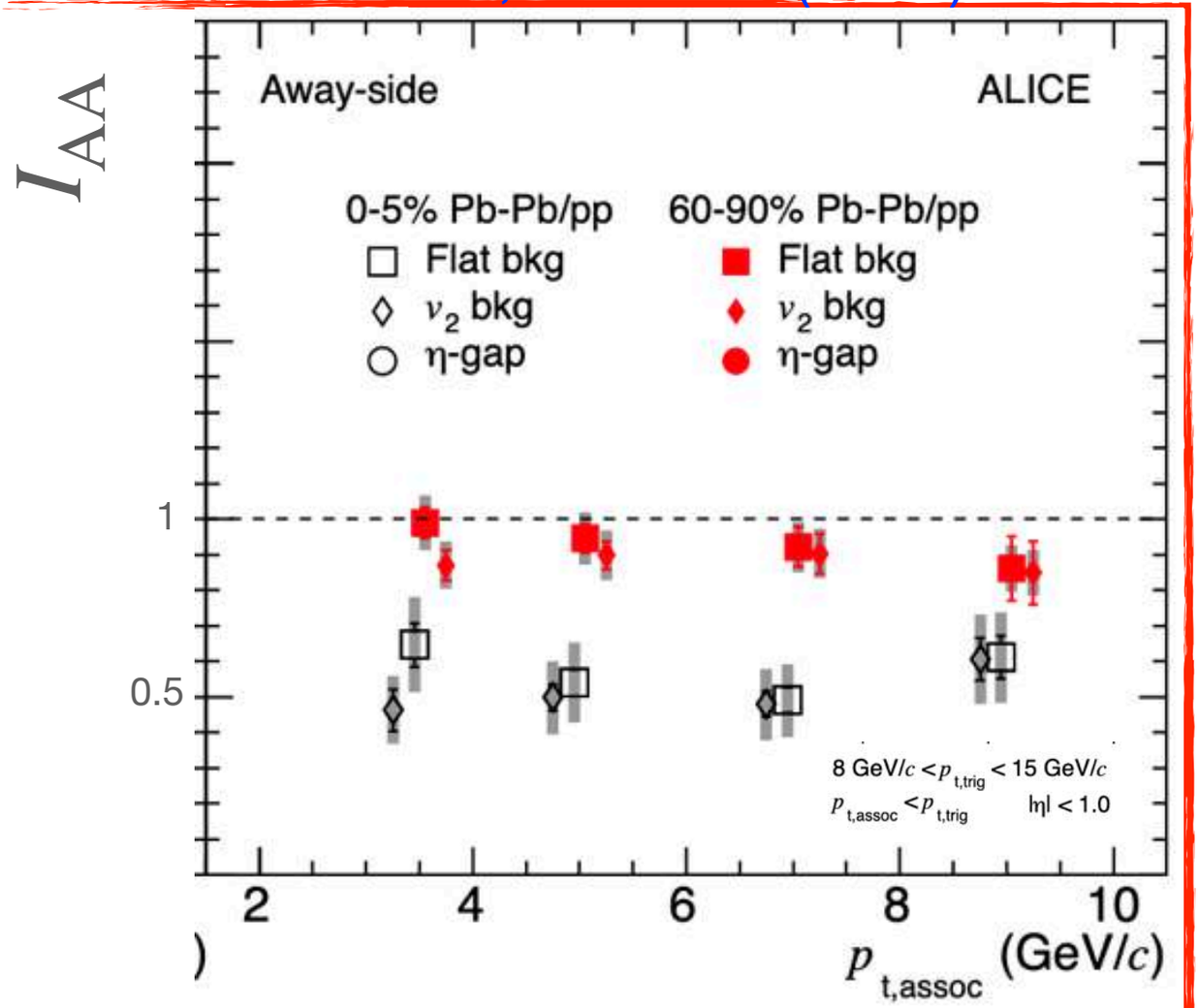
Jet shower in the medium, sup

medium-induced gluon emis



From L. Apolinário [2

ALICE, PRL 108 (2012) 092301



Suppression of jet-like yield of the away side of the di-hadrons correlations (A-A relative to MB pp)

These processes happ

Jet quenching in A-A collisions

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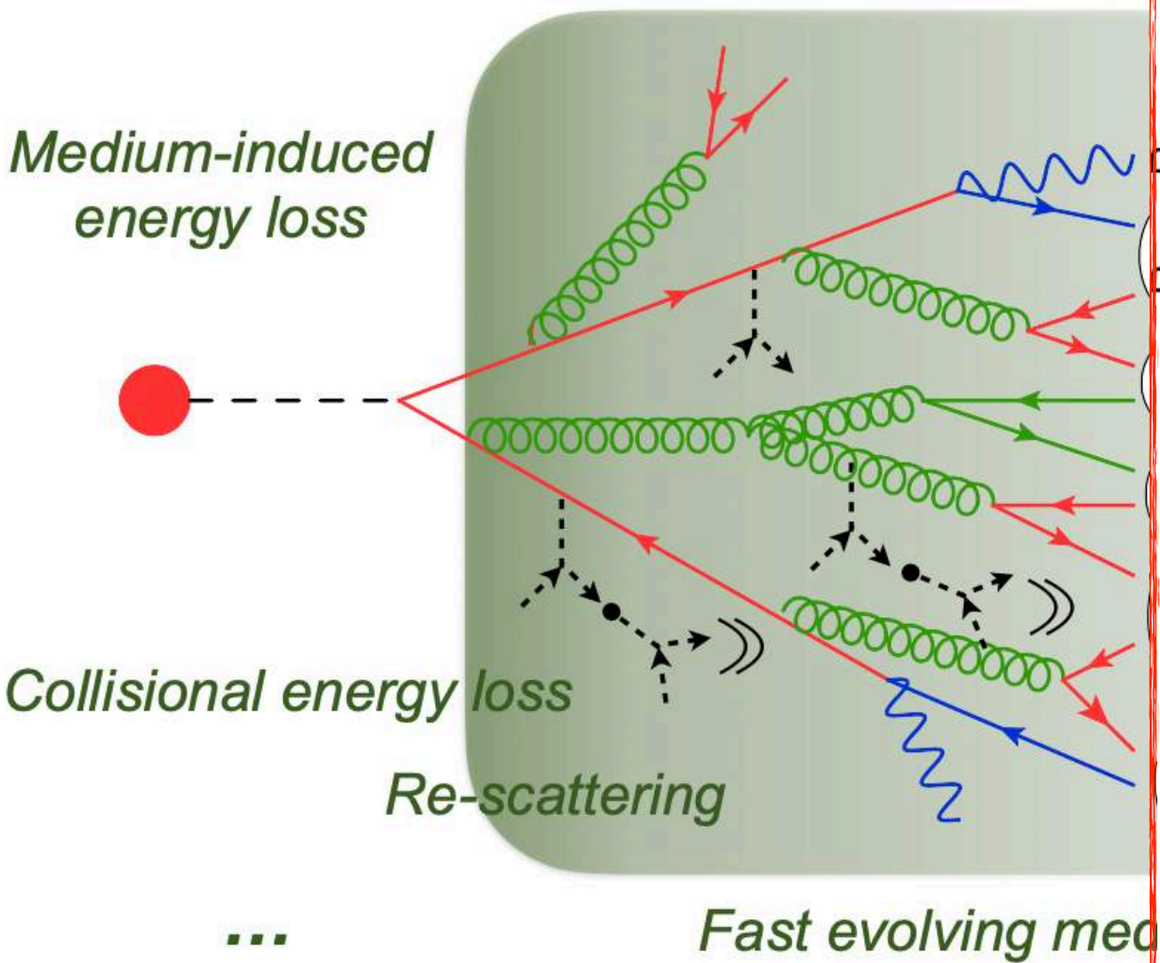
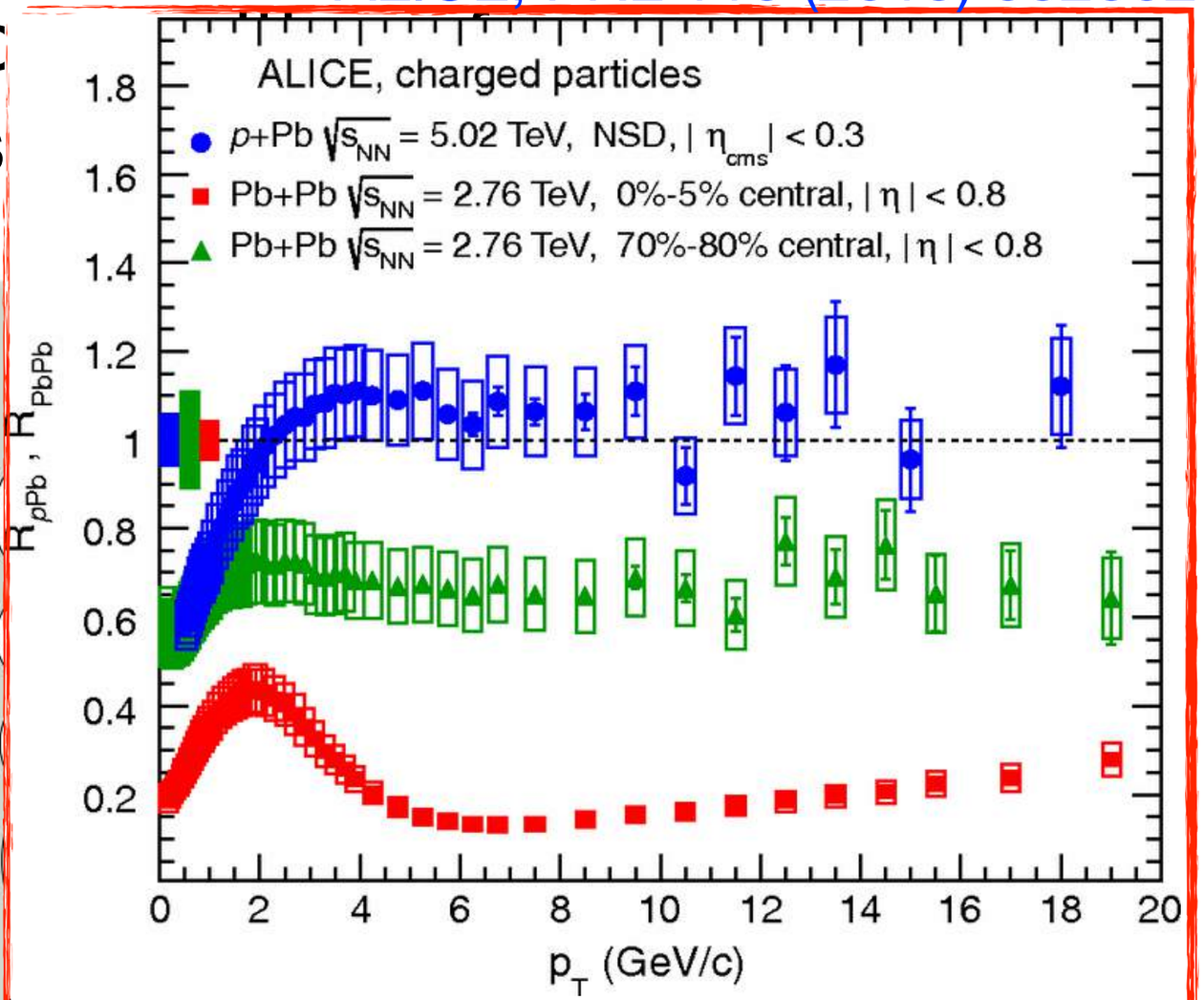
Jet shower in the medium, sup

medium-induced gluon emis



From L. Apolinário [2

ALICE, PRL 110 (2013) 082302



Suppression of the high p_T hadron yield in A-A relative to MB pp

Jet quenching in A-A collisions

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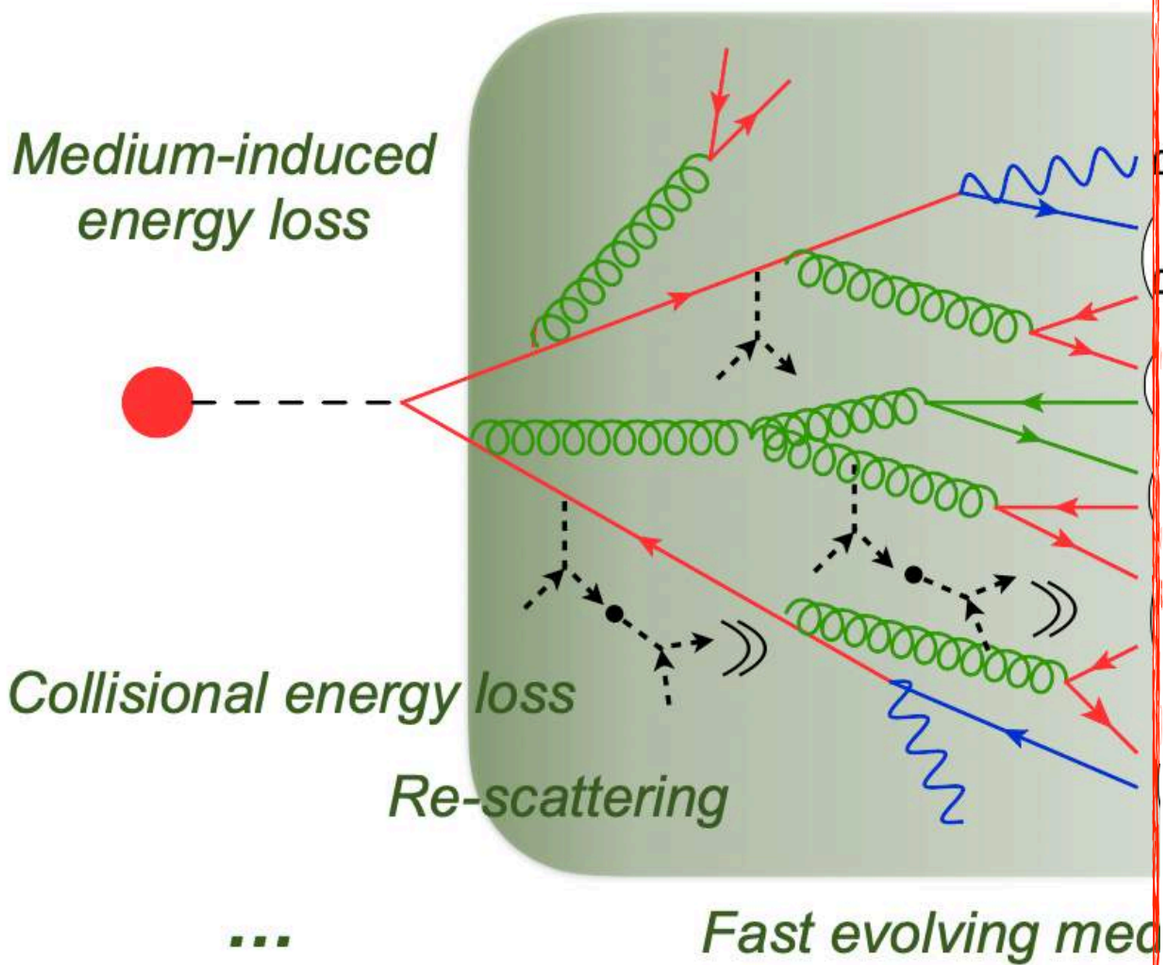
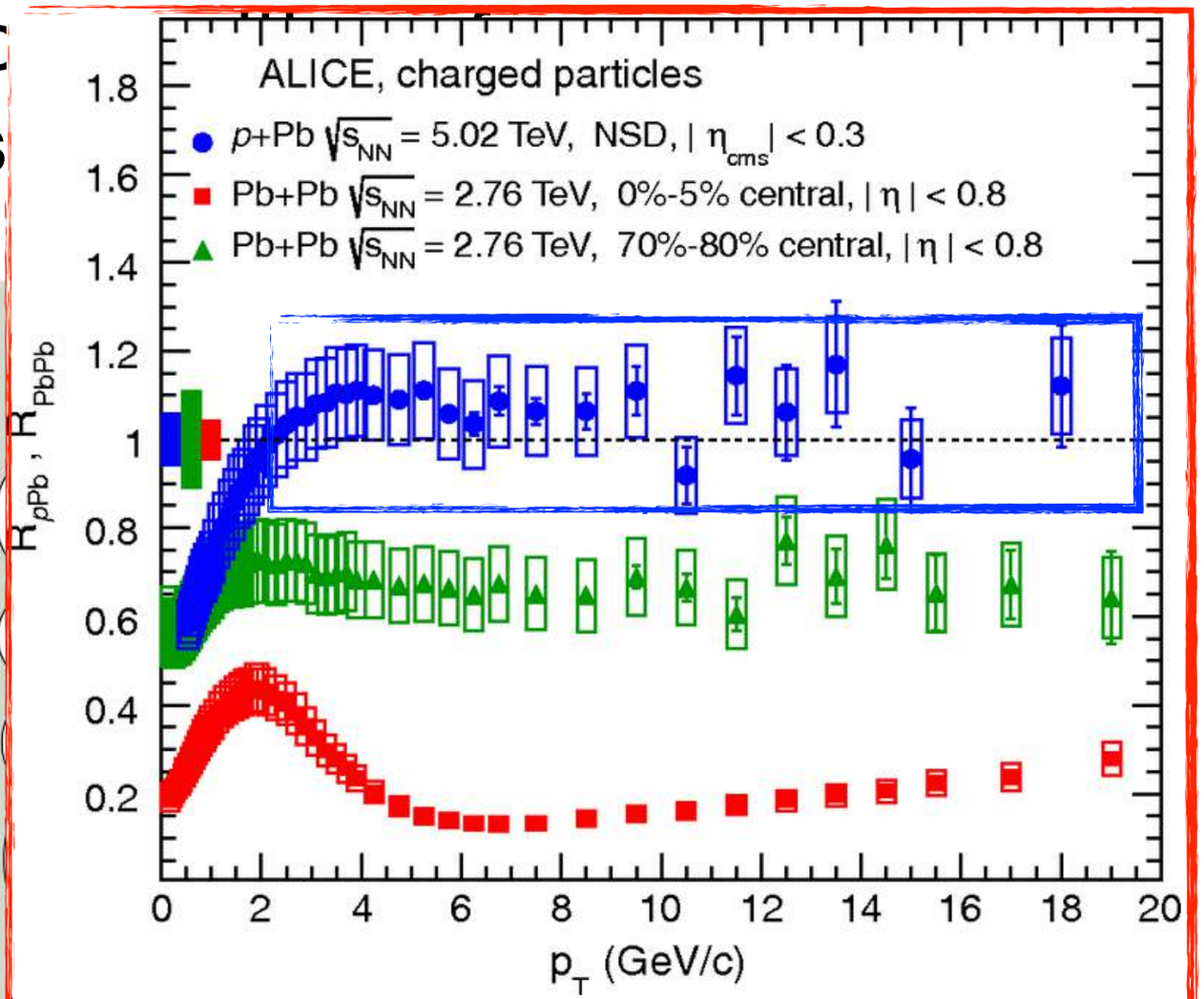
Jet shower in the medium, sup

medium-induced gluon emis



From L. Apolinário [2

Observed consequences, e.g. 2



Suppression of the high p_T hadron yield in A-A relative to MB pp

The effect (suppression = parton energy loss) is not seen in p-Pb collisions → **more studies are needed**

Motivation from spherXcity studies in pp collisions

Antonio Ortiz (23/02/2021)

First ALICE results on pp vs multiplicity

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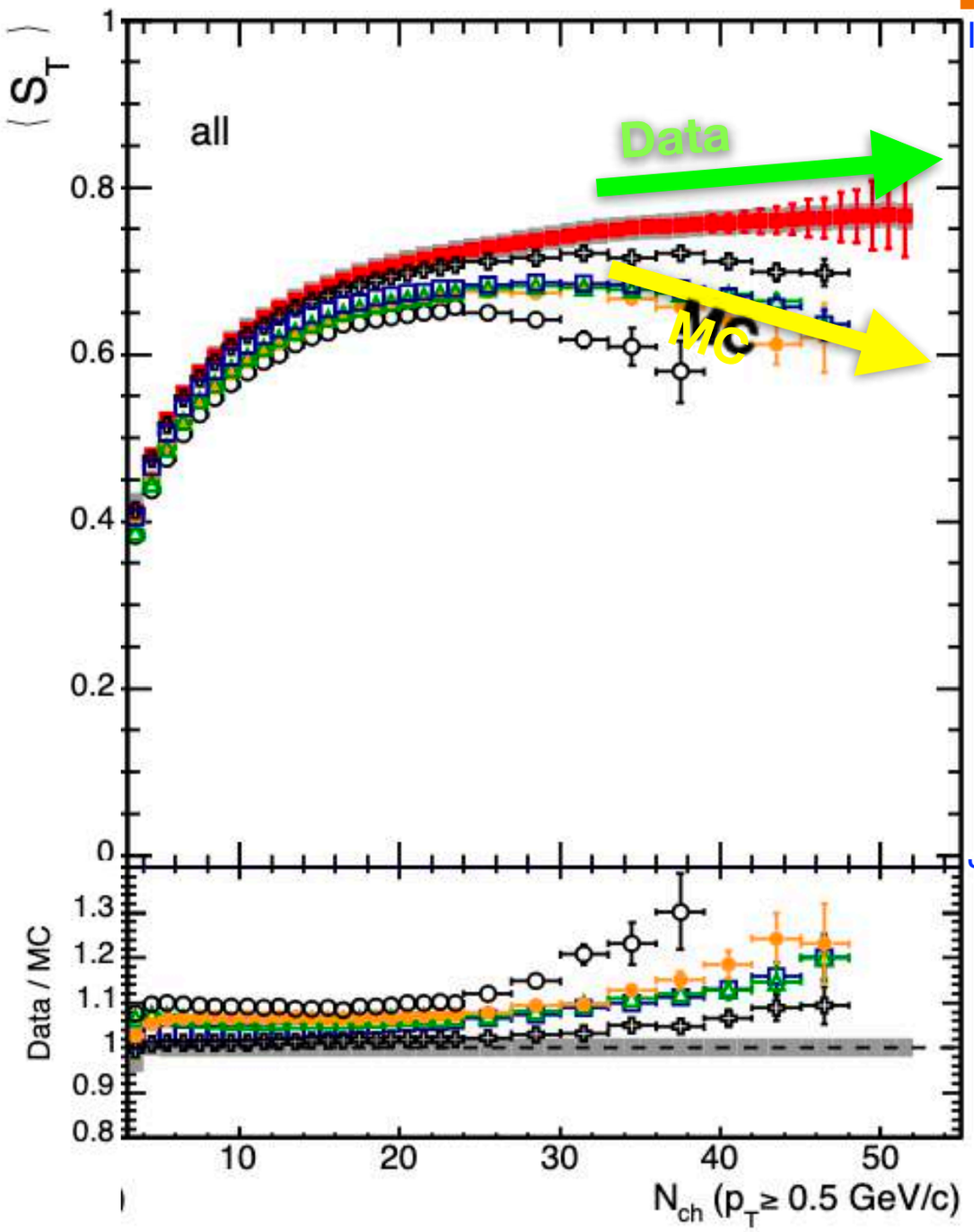

"Further insight and puzzles on large-Nch events… Events are generically more spherical, less jetty, than MC. Most of the discrepancy comes however from hard events, not soft ones… probe final state consistent with those of extreme Nch (>100) measured by ATLAS/CMS in a larger rapidity volume."
M. Mangano @ LHC Physics: present and future (2012)

Publications and Article Submissions

HOME ALICE COLLABORATION CONFERENCES PUBLIC & ANALYSIS NOTES

Transverse sphericity of primary charged particles in minimum bias proton-proton collisions at sqrt(s)=0.9, 2.76 and 7 TeV
- **Article reference:** Eur. Phys. J. C 72 (2012) 2124 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV , 2.76 TeV , 7 TeV **Publication date:** 31 August, 2012

18th ALICE publication
2n paper on characterisation of high multiplicity pp collisions

Measurement of charm production at central rapidity in proton-proton collisions at $\sqrt{s} = 2.76$ TeV
- **Article reference:** JHEP 1207 (2012) 191 Publication link arXiv HEPData
- **System:** p-p **Energy:** 2.76 TeV , 7 TeV **Publication date:** 30 July, 2012

Underlying Event measurements in pp collisions at $\sqrt{s}$ = 0.9 and 7 TeV with the ALICE experiment at the LHC
- **Article reference:** JHEP 07 (2012) 116 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV , 7 TeV **Publication date:** 17 July, 2012

Multi-strange baryon production in pp collisions at $\sqrt{s}$ = 7 TeV with ALICE
- **Article reference:** Phys. Lett. B 712 (2012) 309 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 11 June, 2012

J/psi Production as a Function of Charged Particle Multiplicity in pp Collisions at sqrt(s) = 7 TeV
- **Article reference:** Phys.Lett. B712 (2012) 165-175 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 5 June, 2012

Light vector meson production in pp collisions at $\sqrt{s}$ = 7 TeV
- **Article reference:** Phys. Lett. B 710 (2012) 557-568 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 2 April, 2012

Heavy flavour decay muon production at forward rapidity in proton--proton collisions at $\sqrt{s}$ = 7 TeV
- **Article reference:** Phys. Lett. B 708 (2012) 265 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 27 February, 2012

J/ψ polarization in pp collisions at $\sqrt{s} = 7$ TeV
- **Article reference:** Phys.Rev.Lett. 108 (2012) 082001 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 22 February, 2012

Measurement of charm production at central rapidity in proton-proton collisions at $\sqrt{s} = 7$ TeV
- **Article reference:** JHEP 01 (2012) 128 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 4 January, 2012

Femtoscopy of pp collisions at $\sqrt{s} = 0.9$ and 7 TeV at the LHC with two-pion Bose-Einstein correlations
- **Article reference:** Phys. Rev. D 84 (2011) 112004 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV , 7 TeV **Publication date:** 13 December, 2011

Strange particle production in proton-proton collisions at $\sqrt{s} = 0.9$ TeV with ALICE at the LHC
- **Article reference:** Eur. Phys. J. C 71 (2011) 1594 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV **Publication date:** 13 October, 2011

Production of pions, kaons and protons in pp collisions at $\sqrt{s} = 900$ GeV with ALICE at the LHC
- **Article reference:** Eur. Phys. J. C 71 (2011) 1655 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV **Publication date:** 14 June, 2011

Two-pion Bose-Einstein correlations in pp collisions at $\sqrt{s}$ =900 GeV
- **Article reference:** Phys. Rev. D 82 (2010) 052001 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV **Publication date:** 8 September, 2010

Transverse momentum spectra of charged particles in proton-proton collisions at $\sqrt{s} = 900$ GeV with ALICE at the LHC
- **Article reference:** Phys. Lett. B 693 (2010) 53-68 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV **Publication date:** 19 August, 2010

Charged-particle multiplicity measurement in proton-proton collisions at $\sqrt{s} = 7$ TeV with ALICE at LHC
- **Article reference:** Eur. Phys. J. C 68 (2010) 345-354 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 12 August, 2010

Charged-particle multiplicity measurement in proton-proton collisions at $\sqrt{s}$ = 0.9 and 2.36 TeV with ALICE at LHC
- **Article reference:** Eur. Phys. J. C 68 (2010) 89-108 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV , 2.36 TeV **Publication date:** 12 August, 2010

Midrapidity antiproton-to-proton ratio in pp collisions at $\sqrt{s} = 0.9$ and 7 TeV measured by the ALICE experiment

2nd ALICE publication

Transverse spherocity in ALICE

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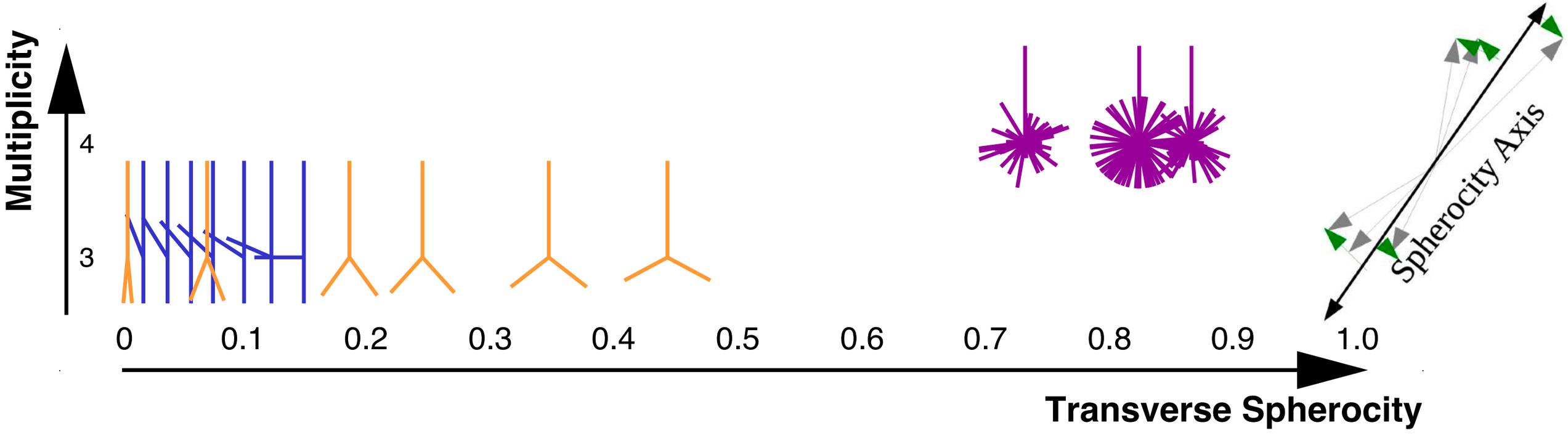
First time **transverse spherocity** (S_0) was presented to the community as a tool to select special pp collisions [link]

S_0 is better than S_T for the isolation of the most "central" pp collisions. Clean back-to-back jet structures can also be discriminated

$$S_0 = \min \frac{\pi^2}{4} \left(\frac{\sum_i |\vec{p}_{T,i} \times \hat{n}|}{\sum_i p_{T.i}} \right)^2$$



6 years later…

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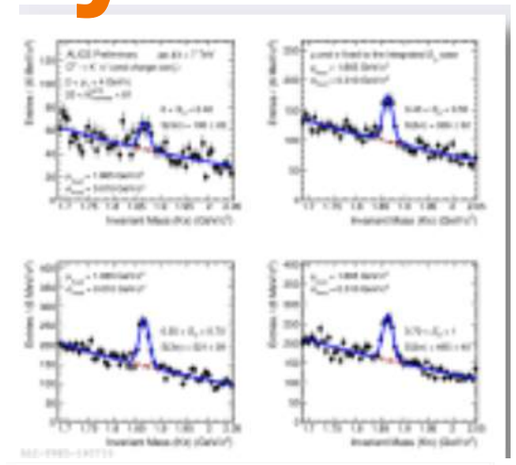

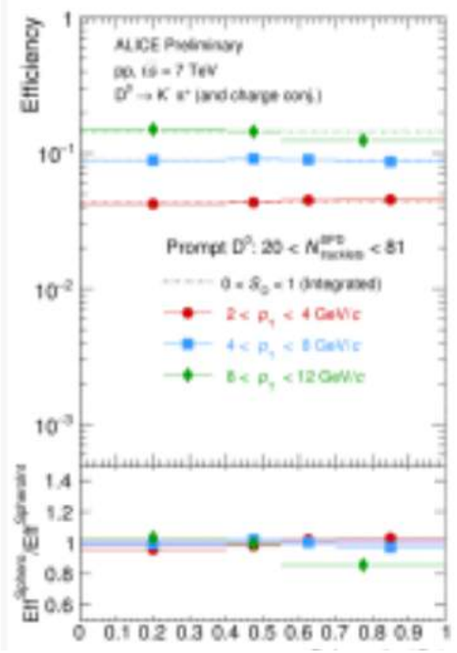

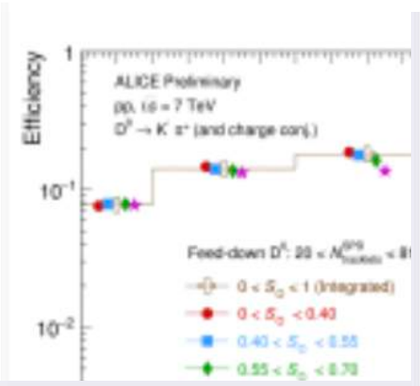

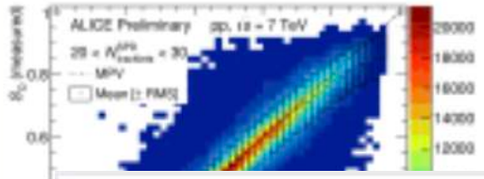

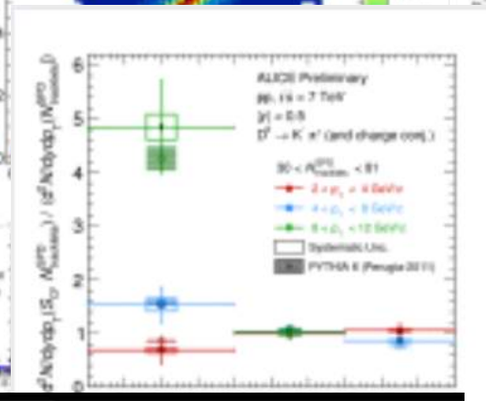

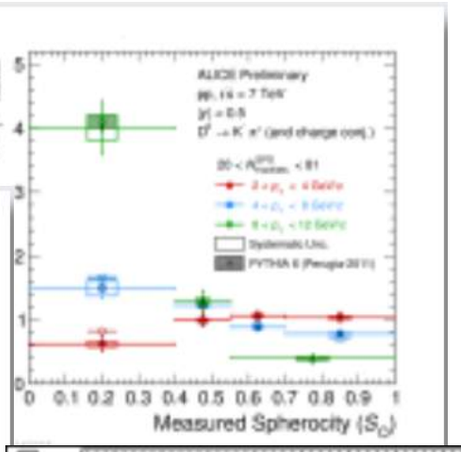

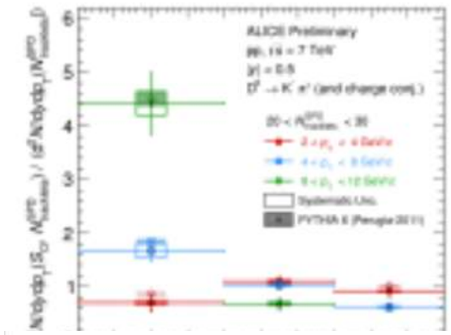

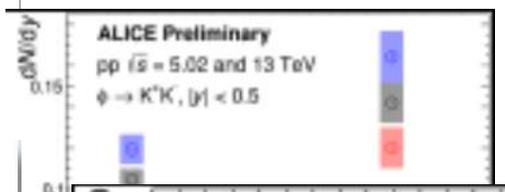

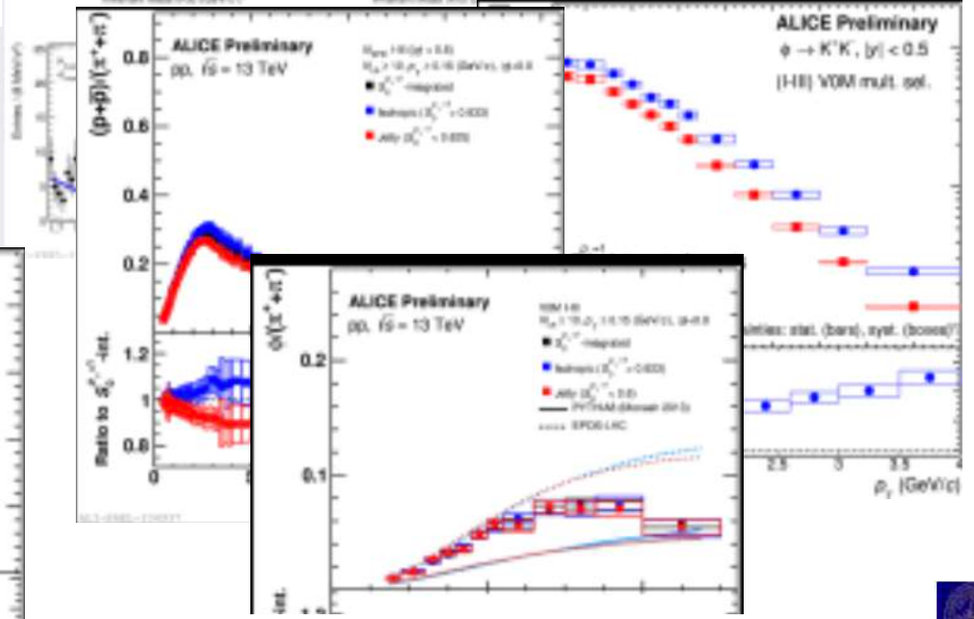

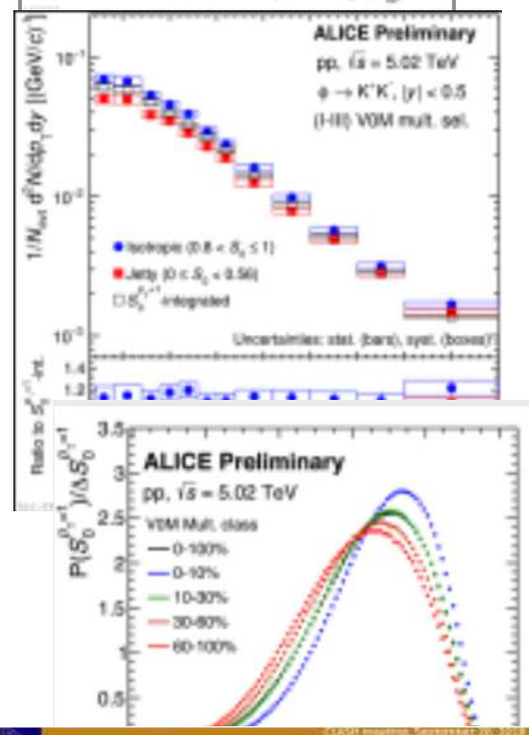

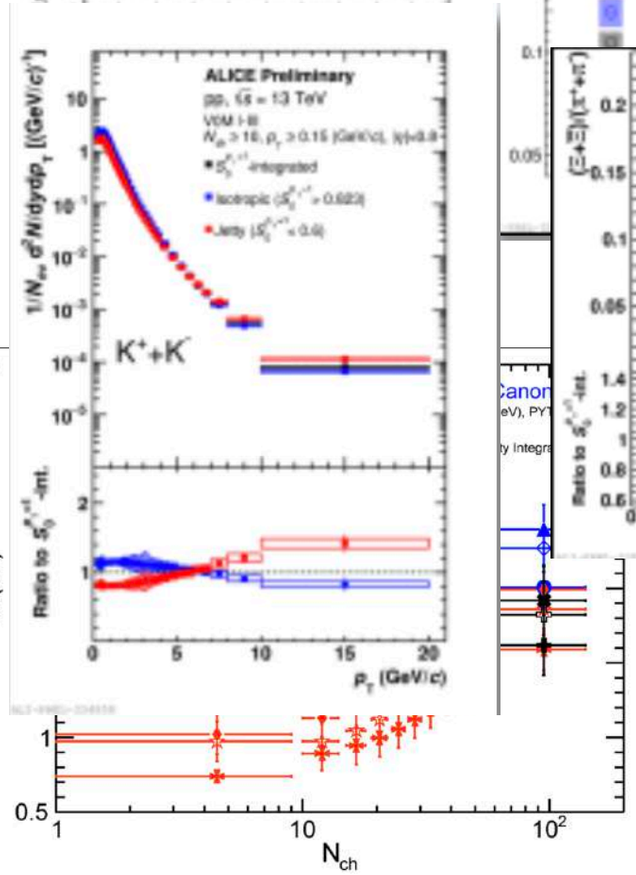

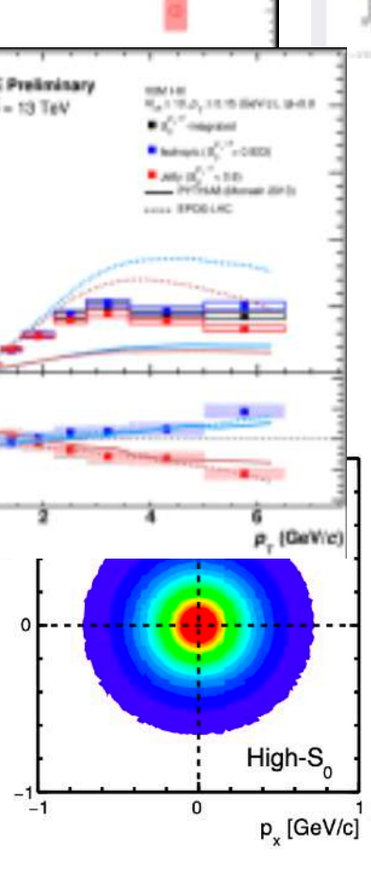

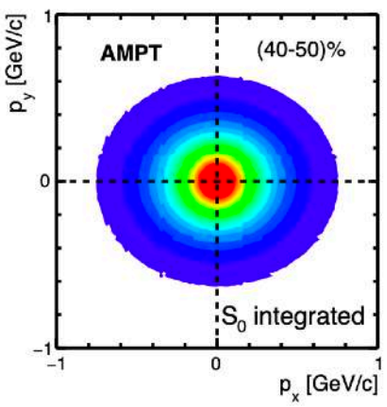

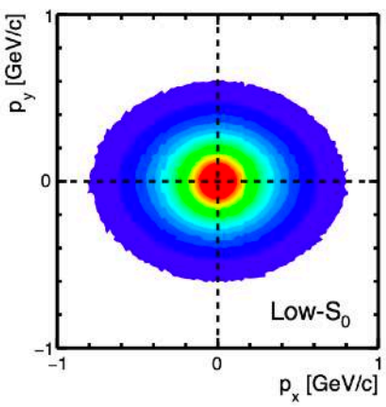

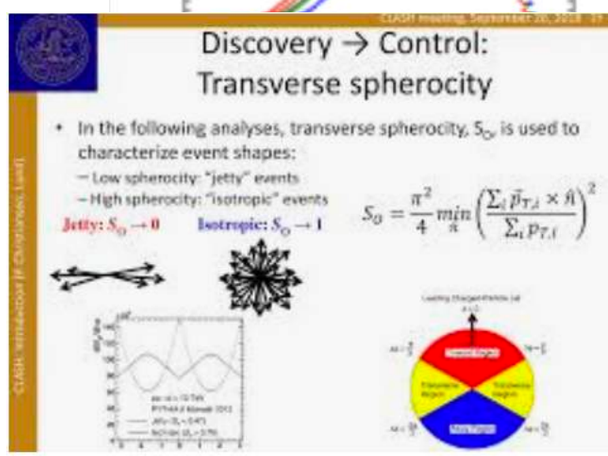

pillars of CLASH Practical ...

First scientific publication

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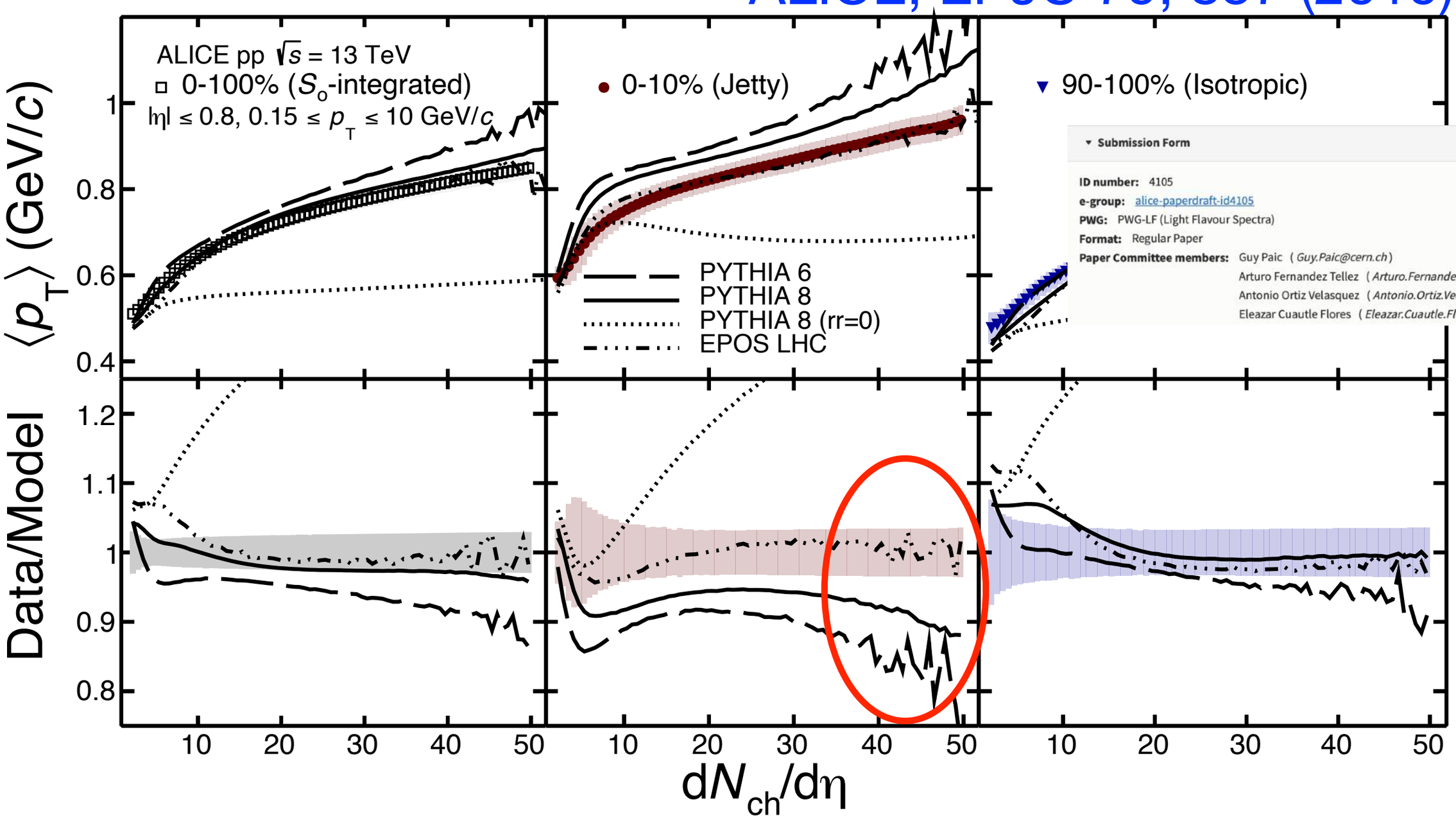
ALICE, EPJC 79, 857 (2019)



Submission Form

ID number: 4105
e-group: alice-paperdraft-id4105
PWG: PWG-LF (Light Flavour Spectra)
Format: Regular Paper
Paper Committee members: Guy Paic (*Guy.Paic@cern.ch*)
Arturo Fernandez Tellez (*Arturo.Fernandez.Tellez@cern.ch*)
Antonio Ortiz Velasquez (*Antonio.Ortiz.Velasquez@cern.ch*)
Eleazar Cuautle Flores (*Eleazar.Cuautle.Flores@cern.ch*)

PYTHIA predict a different behavior for high multiplicity jetty-like events: a third rise of $\langle p_T \rangle$ at $dN_{ch}/d\eta > 30$. This is a surprise because we know that PYTHIA describes better hard physics than EPOS, e.g. ALICE, PRD 99 (2019) no.1, 012016 and PLB 753 (2016) 319-329 **(WHY?)**

The origin of the effect in Pythia

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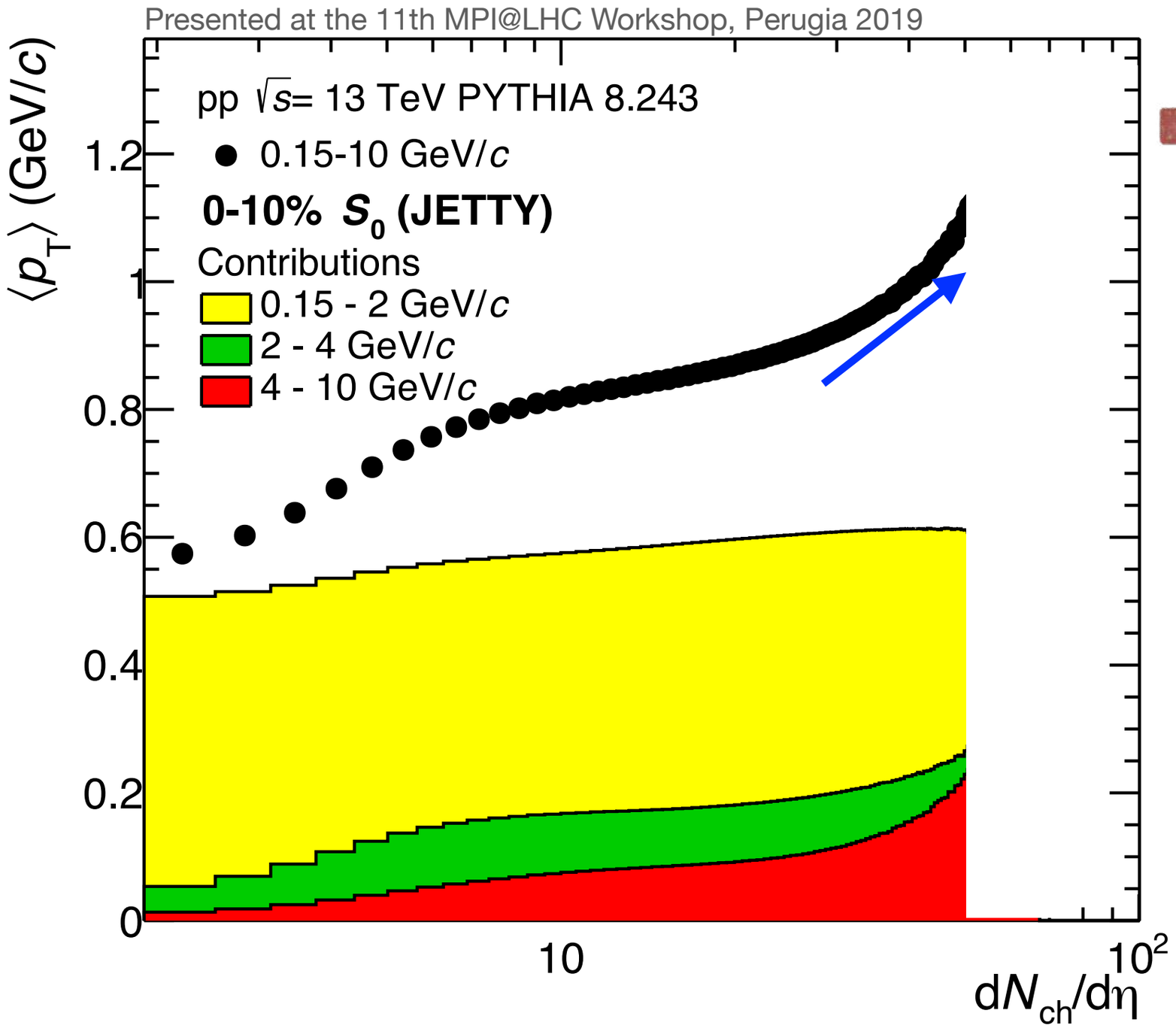

- The effect is produced by high-p_T particles [this agrees with the picture: low S_0->hard events]

The origin of the effect in Pythia

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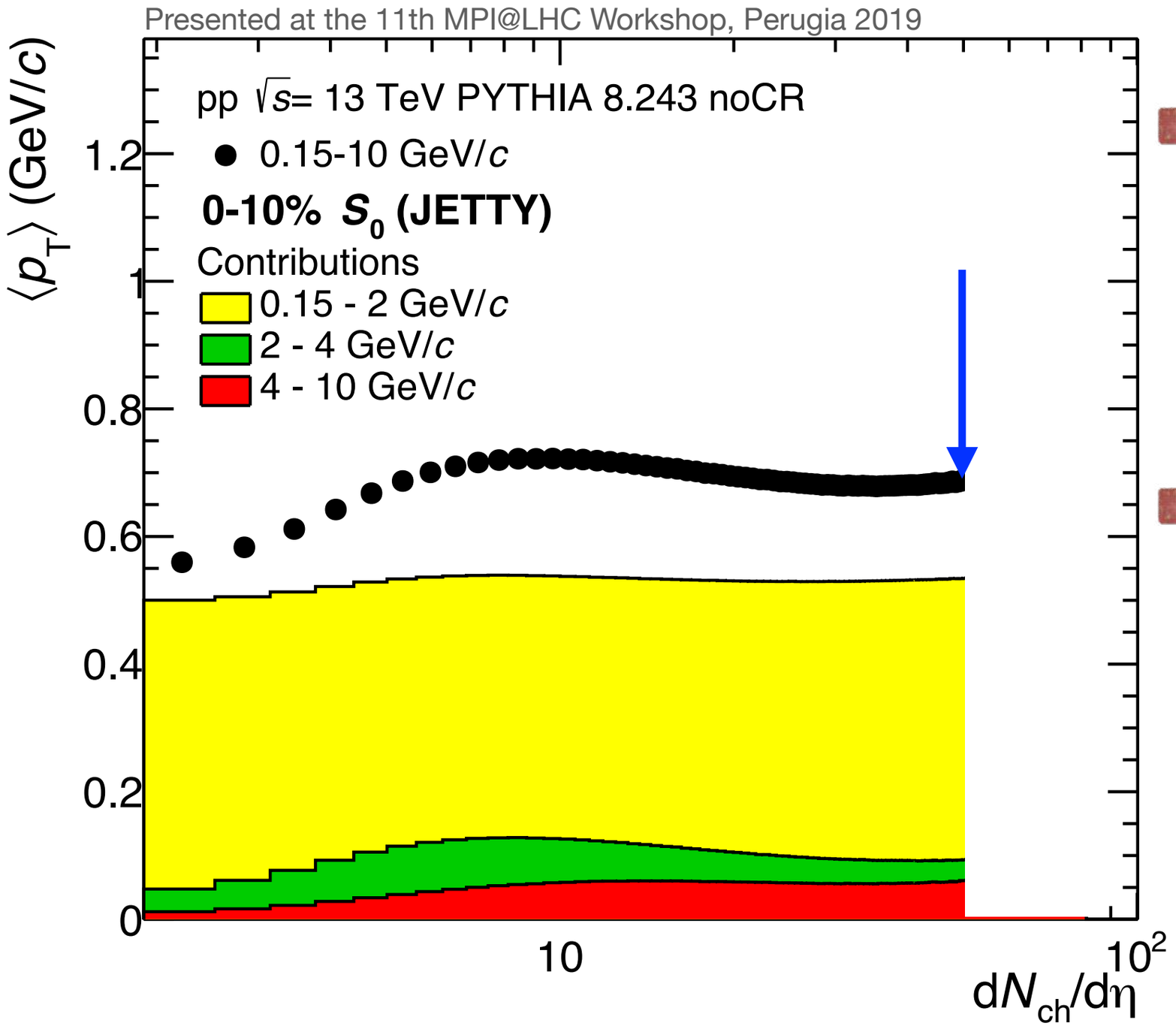
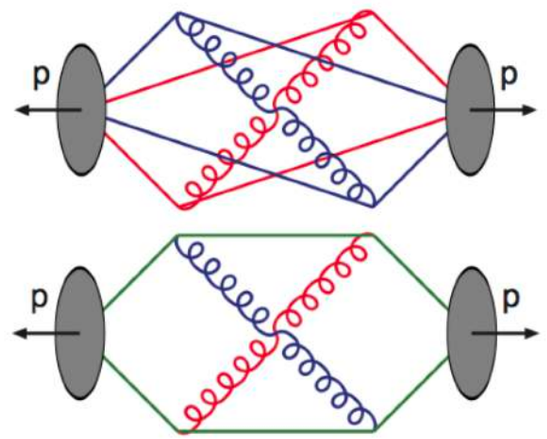


- The effect is produced by high-p_T particles [this agrees with the picture: low S_0->hard events]
- A significant amount of the effect is attributed to strong correlations between the Underlying Event (UE) and jets produced by Color Reconnection (CR)



CR enhances the particle production from intermediate to high-p_T. A. Ortiz, L. Valencia, PRD 99 (2019) 3, 034027

The origin of the effect in Pythia

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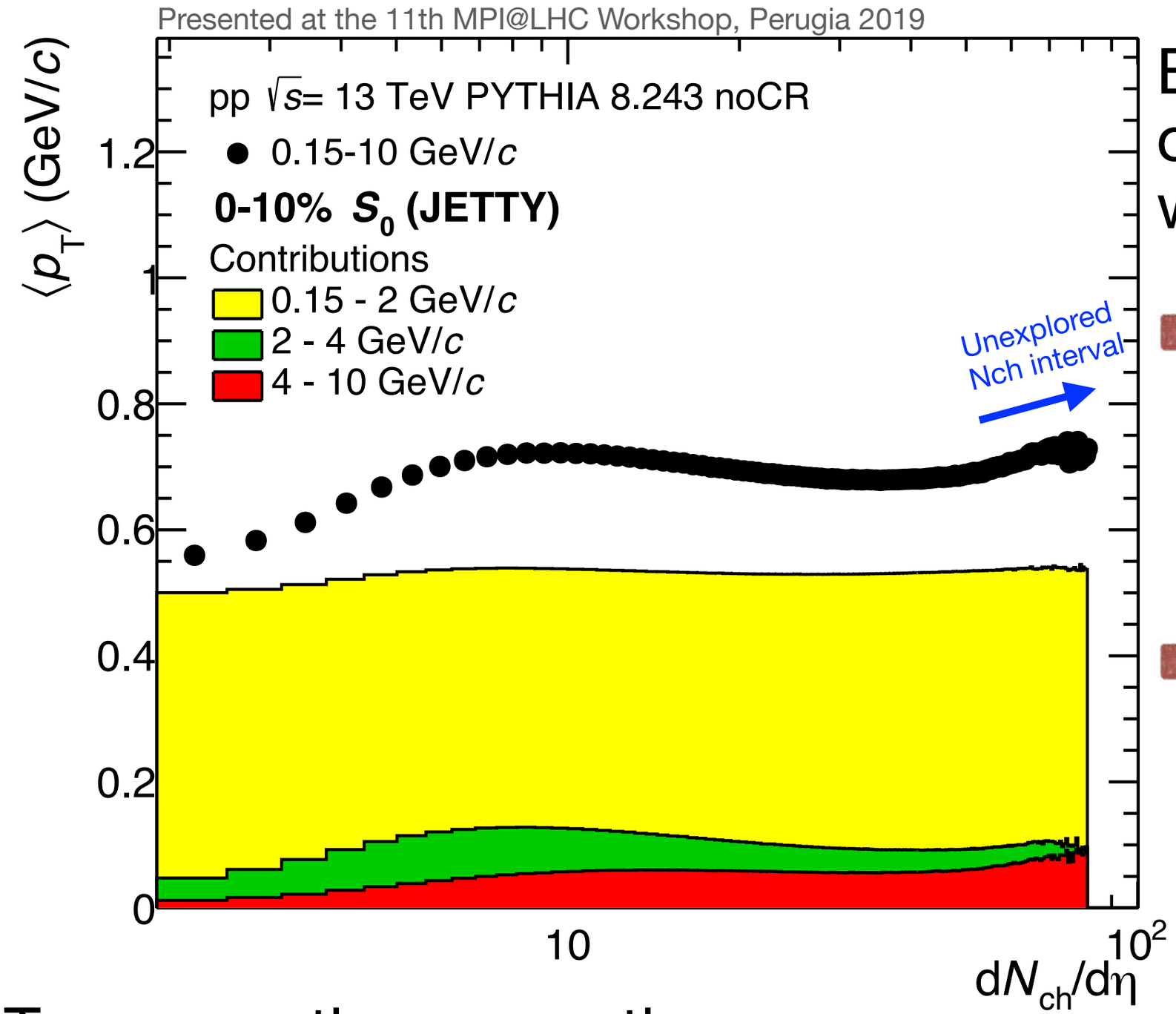


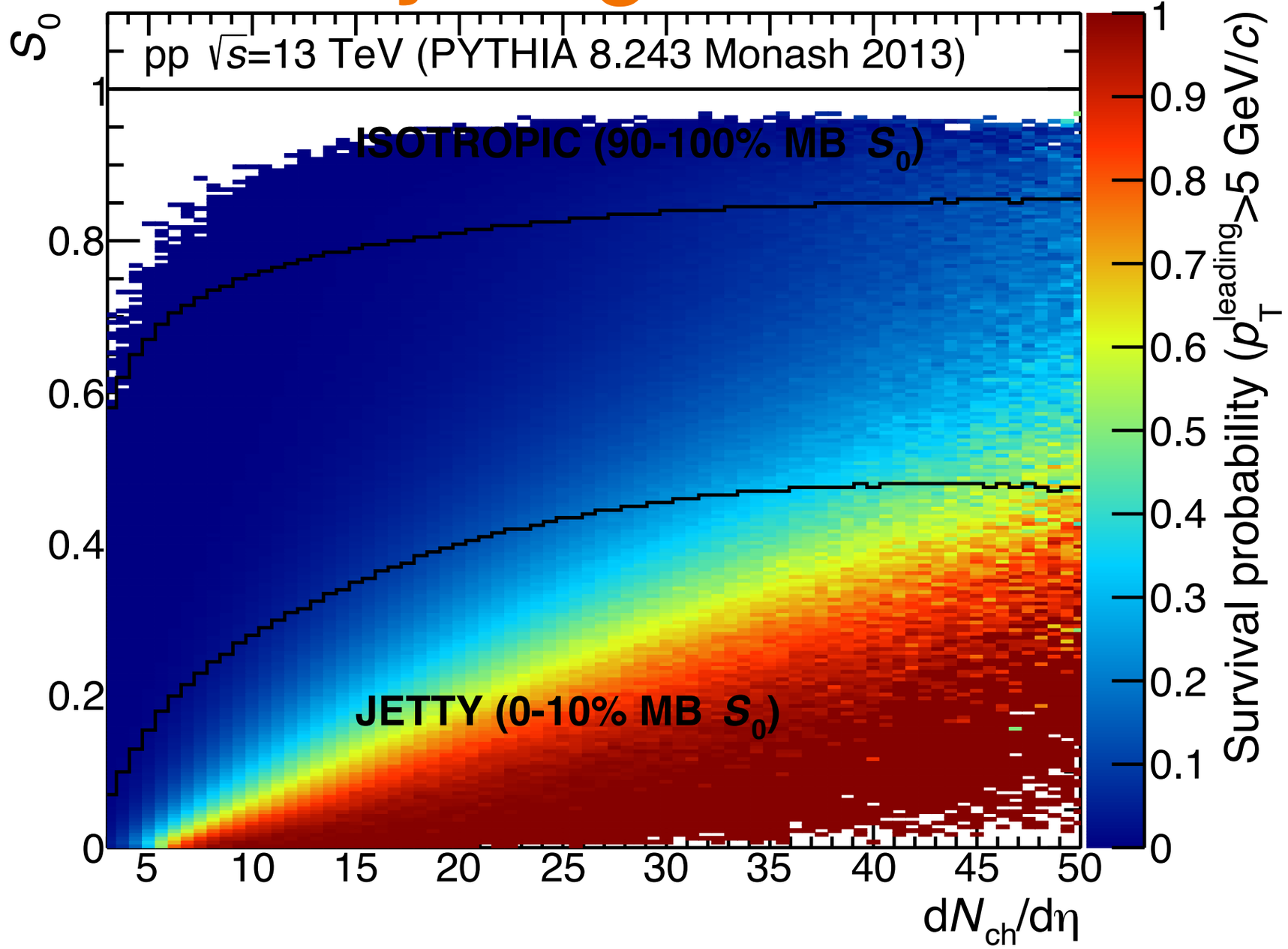
Even w/o CR we still observe a small effect which is not seen in data:

- Can PYTHIA improve the description of jetty-like events with a better CR model ? NO
- Is this an indication of jet quenching effects in pp data? which of course are not incorporated in the model

To answer these questions:

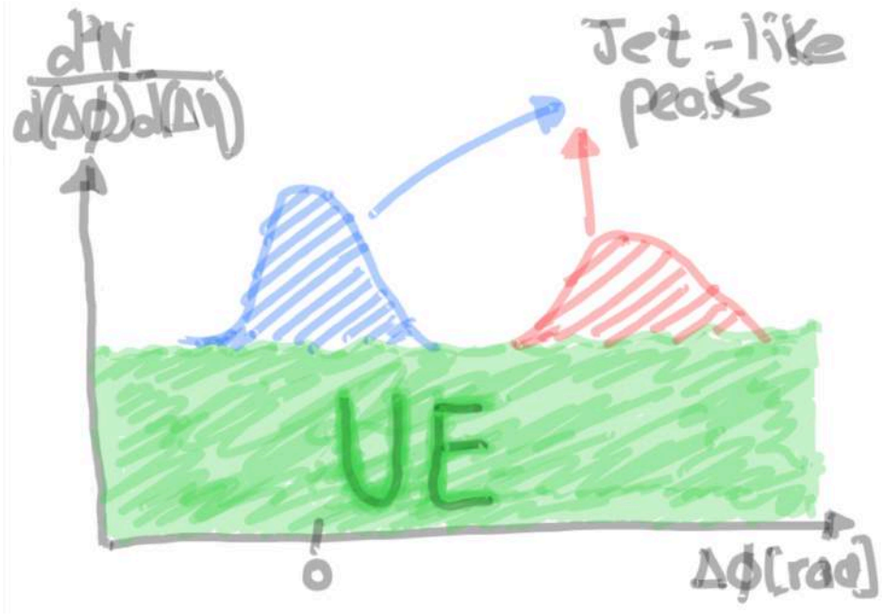
(I) Measurement of p_T spectra as a function of S_0 and N_{ch} [work in progress… David Romo, MS thesis]

(II) Isolation of the jet signal



The analysis requires events with at least one high-p_T track (e.g. $p_T^{leading}$>5 GeV/c). The figure above shows that most of the events which satisfy the $p_T^{leading}$ cut have low S_0!

Then, the jet-like signal is studied as a function of the event activity (different set of particle to reduce the selection biases)



Particle production in the jet-like yield as a function of $p_T^{leading}$

pp <-> p-Pb

Underlying-event observables

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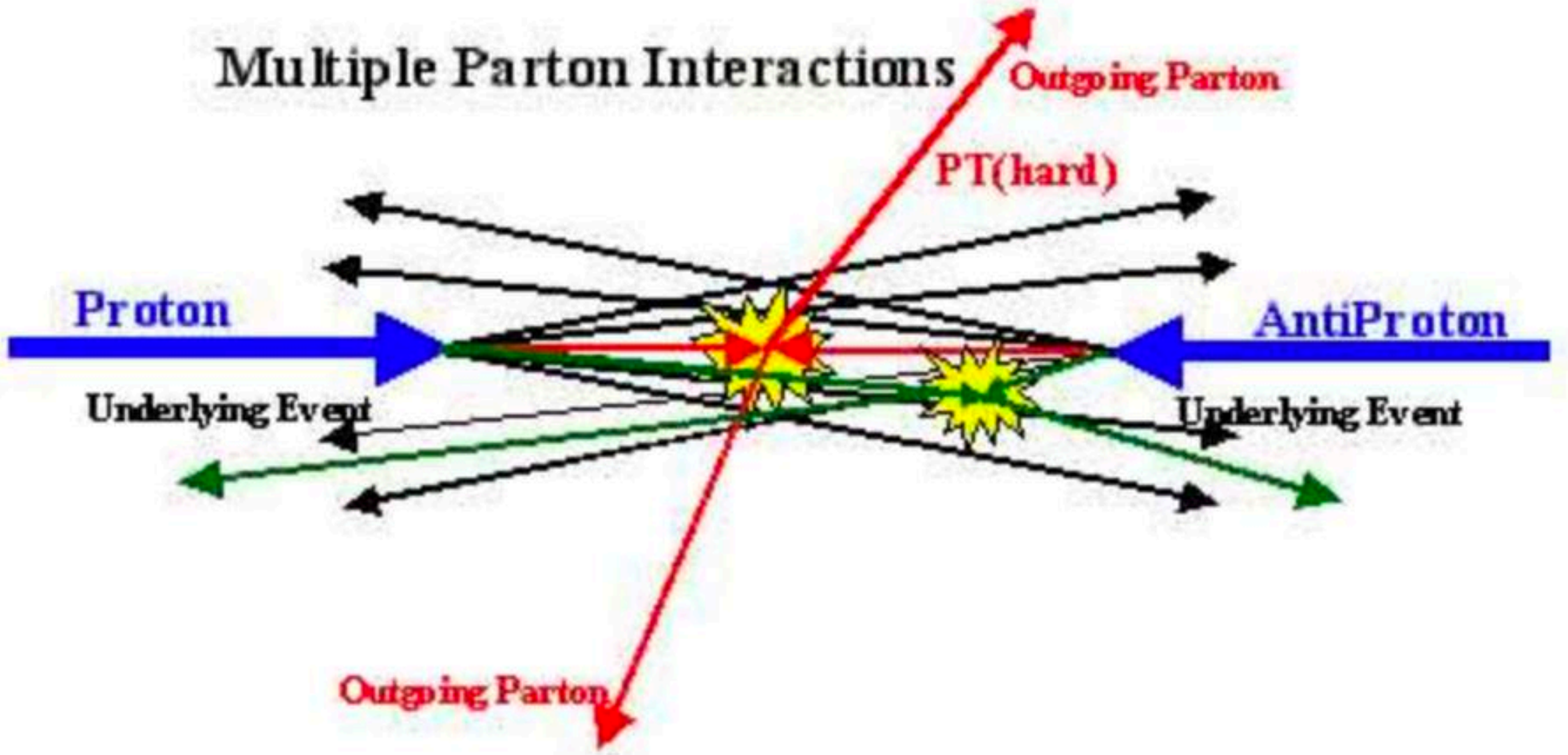
Figure taken from: https://www-cdf.fnal.gov/physics/new/qcd/ue_escan/



In high-energy pp interactions more than one parton-parton scattering can occur within the same collision (MPI), see e.g. A. Ortiz et al., PRD 102 (2020) 7,076014, arXiv:2101.10274 [Isaí Sotarriva BS thesis (2019), Erik Zepeda MS thesis]

Underlying-event observables

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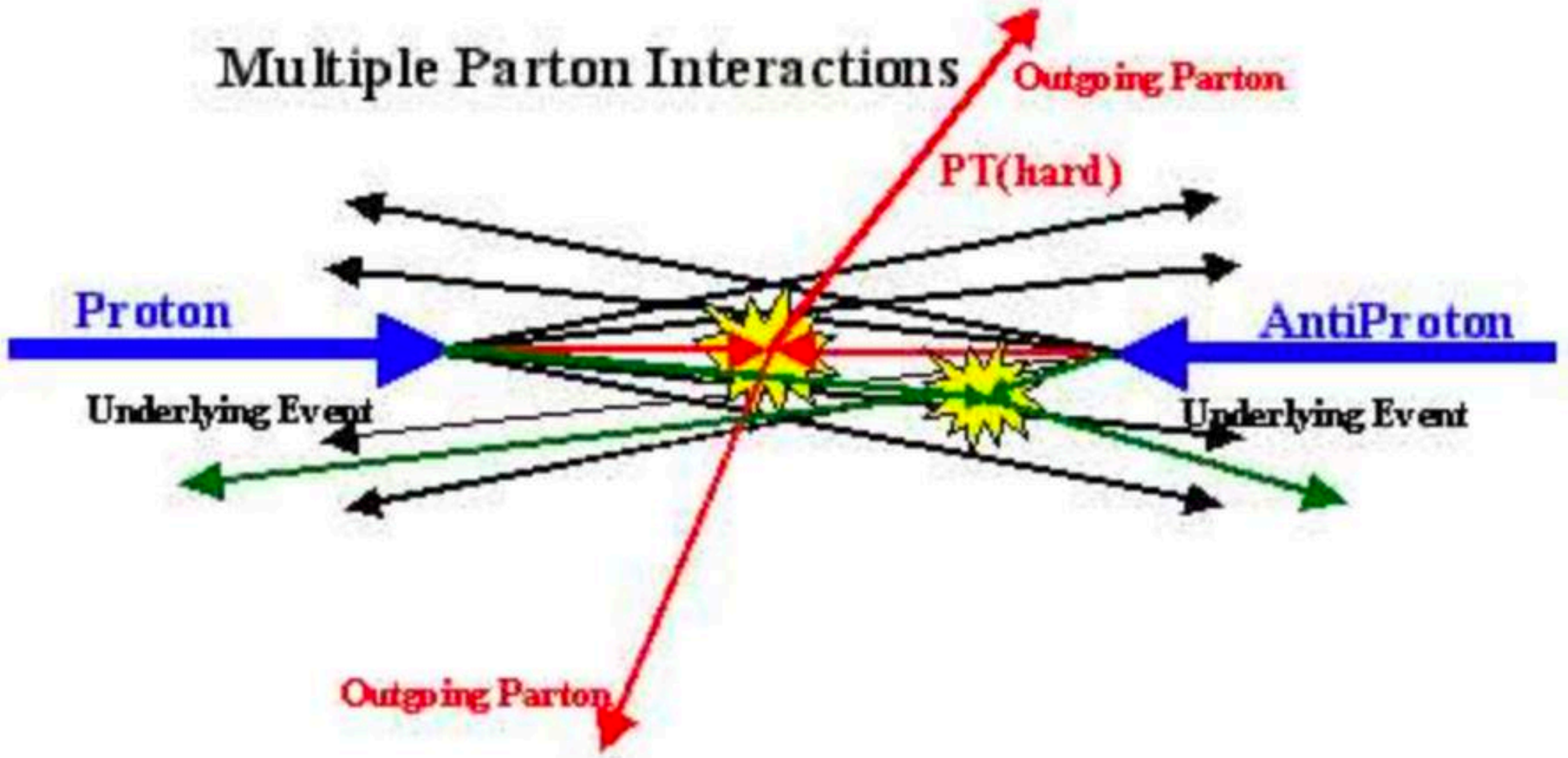
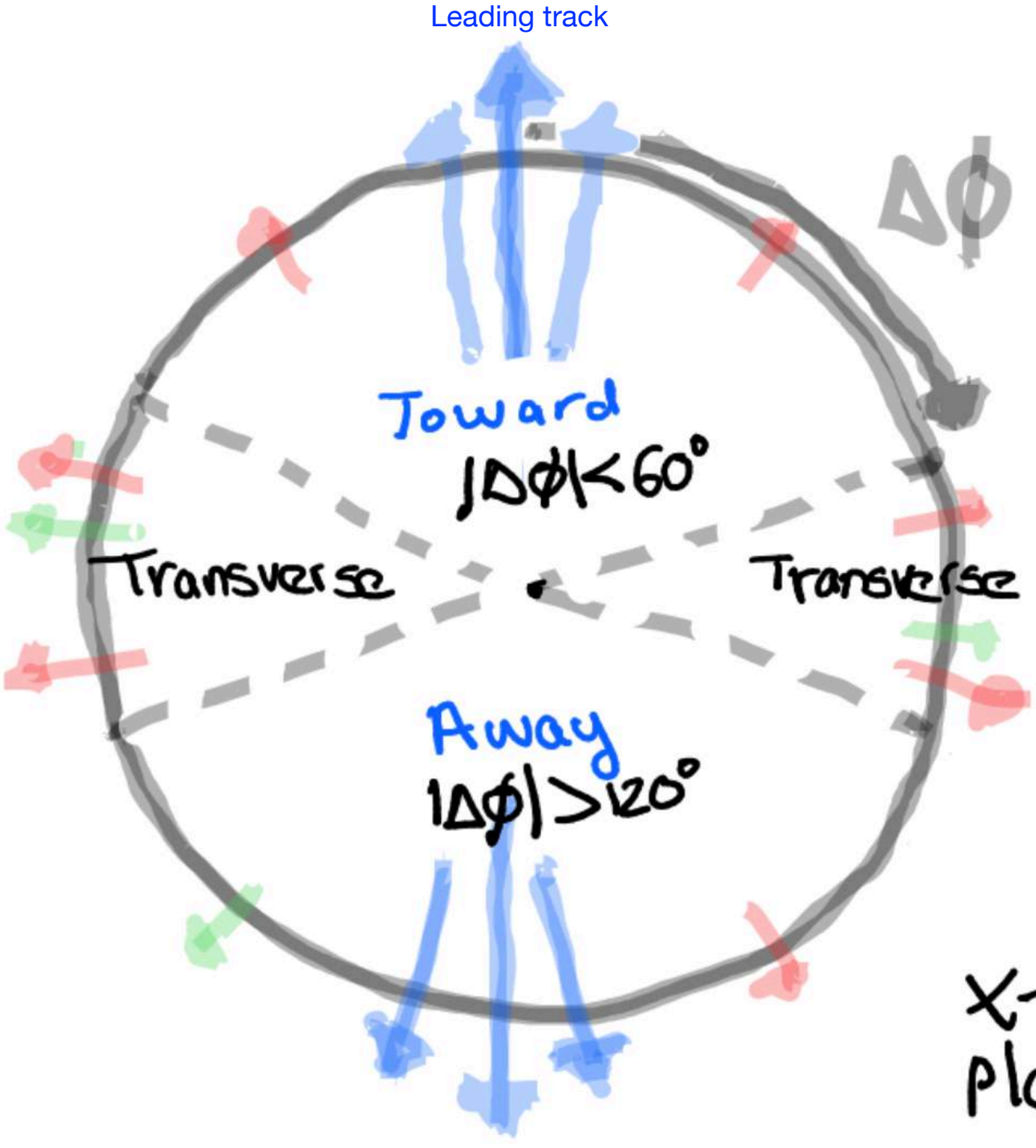
Figure taken from: https://www-cdf.fnal.gov/physics/new/qcd/ue_escan/



Everything which does not belong the main partonic scattering conforms the Underlying Event (UE)

Underlying-event observables



In MC event generators, UE has contributions from:

- beam remnants
- initial- and final-state radiation (ISR & FSR)
- MPI

Experimentally, UE properties can be extracted from the transverse side of the azimuthal correlations

x-y plane

Tradicional analysis using pp data

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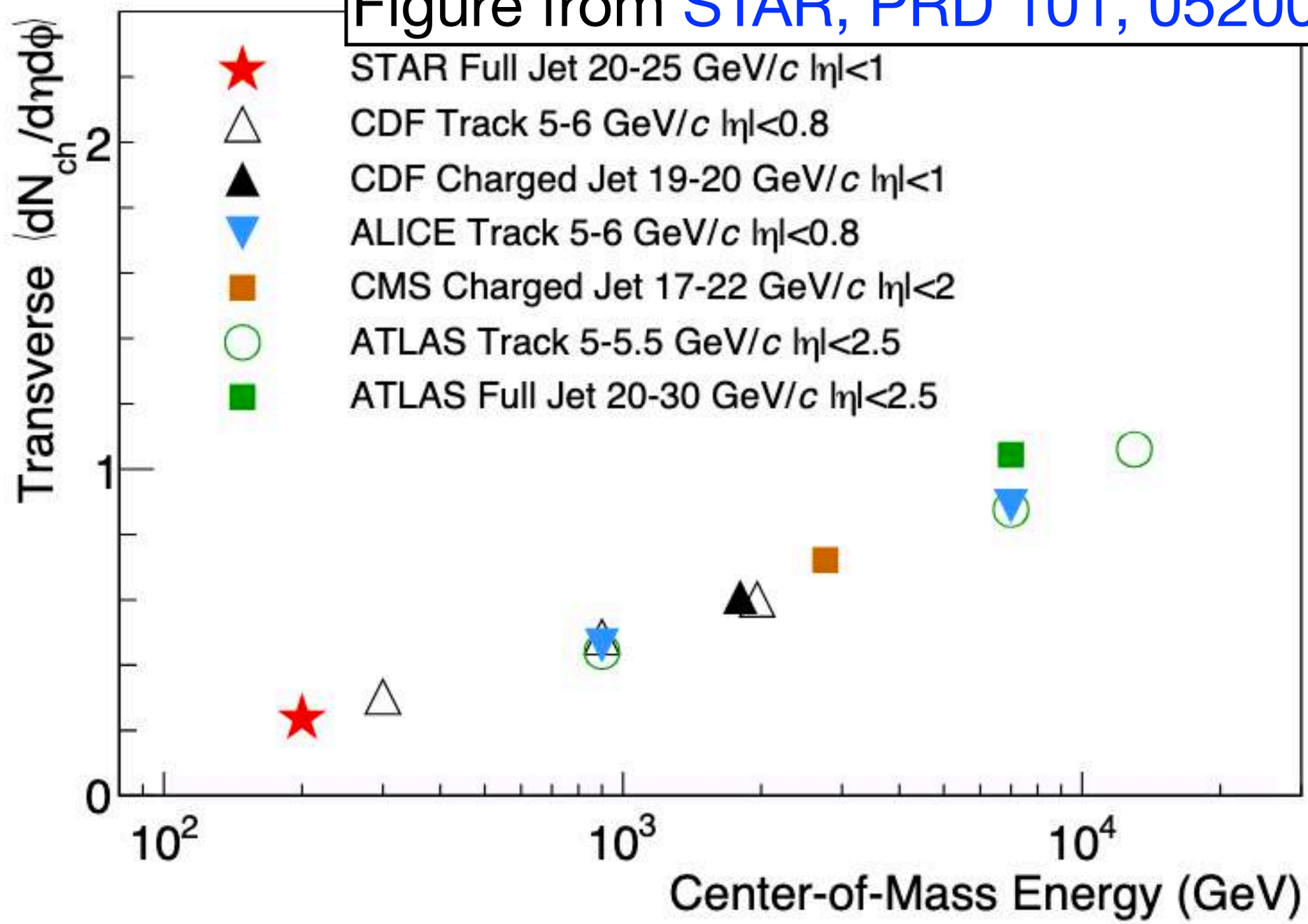
Figure from STAR, PRD 101, 052004 (2020)



The number density in the transverse side increases with increasing the center-of-mass energy (energy dependence of MPI, ISR & FSR).

Underlying event analysis in p-Pb

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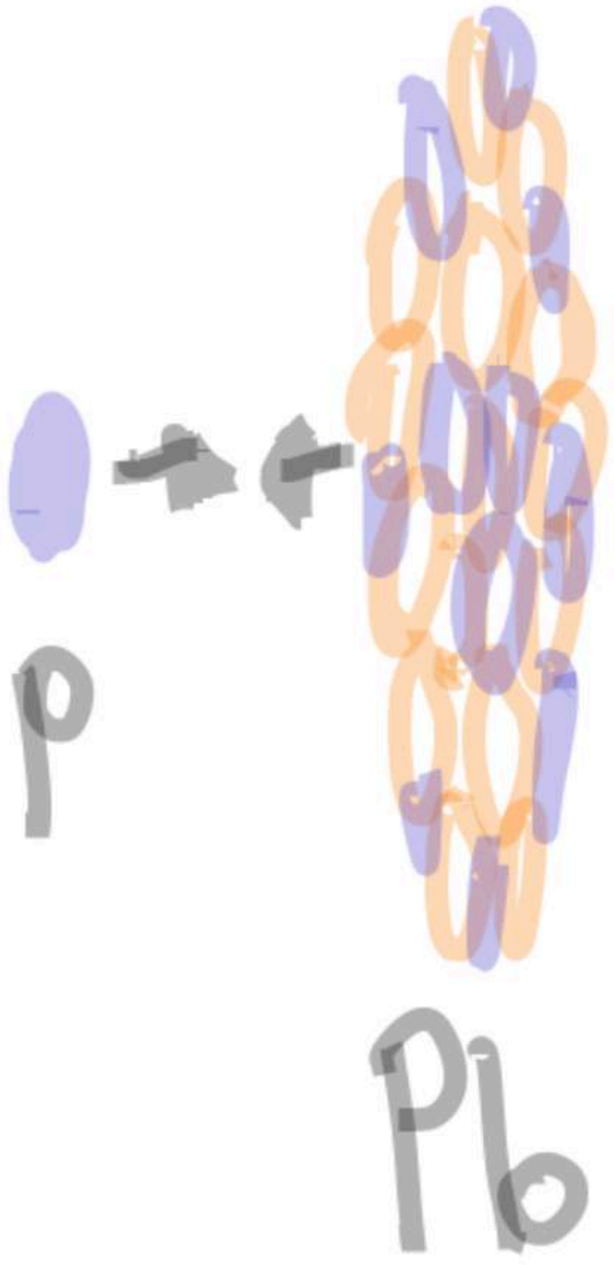
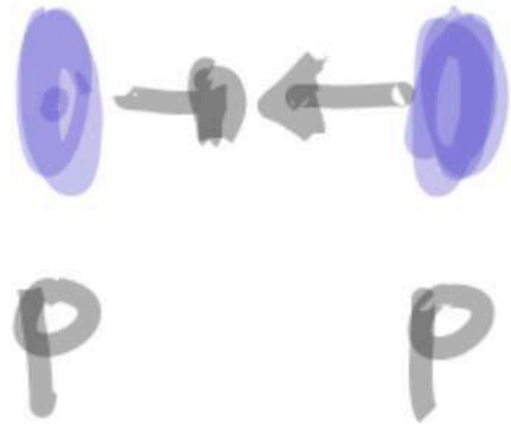
Goal: compare the particle production in pp and p-Pb collisions (same $\sqrt{s_{\mathrm{NN}}}$) in the the jet-like regions of the di-hadron correlations (towards and away sides) after the subtraction of UE (transverse side)



$\sqrt{s_{NN}} = 5.02\,TeV$

Vs.



$\sqrt{s} = 5.02\,TeV$

UE vs $p_T^{leading}$ (pp collisions @ 5.02 TeV)

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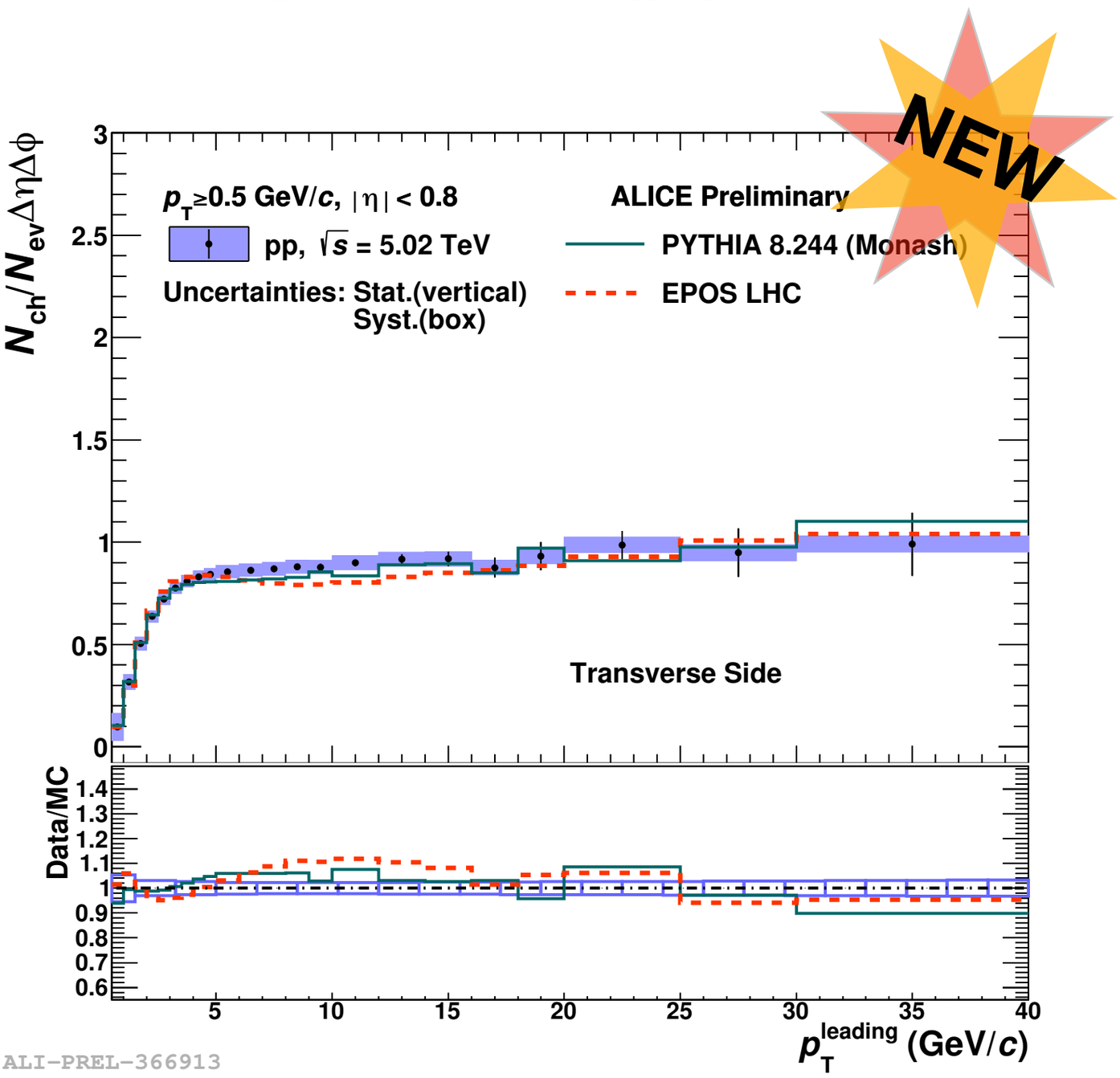

Ahsan Mehmood (CCNU-ICN)

$p_T^{leading} < 5$ GeV/c:

The number density exhibit a fast increase with increasing $p_T^{leading}$

$p_T^{leading} \geq 5$ GeV/c:

The UE activity saturates

The $p_T^{leading}$-dependence can be explained by MPI, which saturates in "central pp collisions" (events with $p_T^{leading} \geq 5$ GeV/c)

UE vs $p_T^{leading}$ (pp vs p-Pb)

Ahsan Mehmood (CCNU-ICN)

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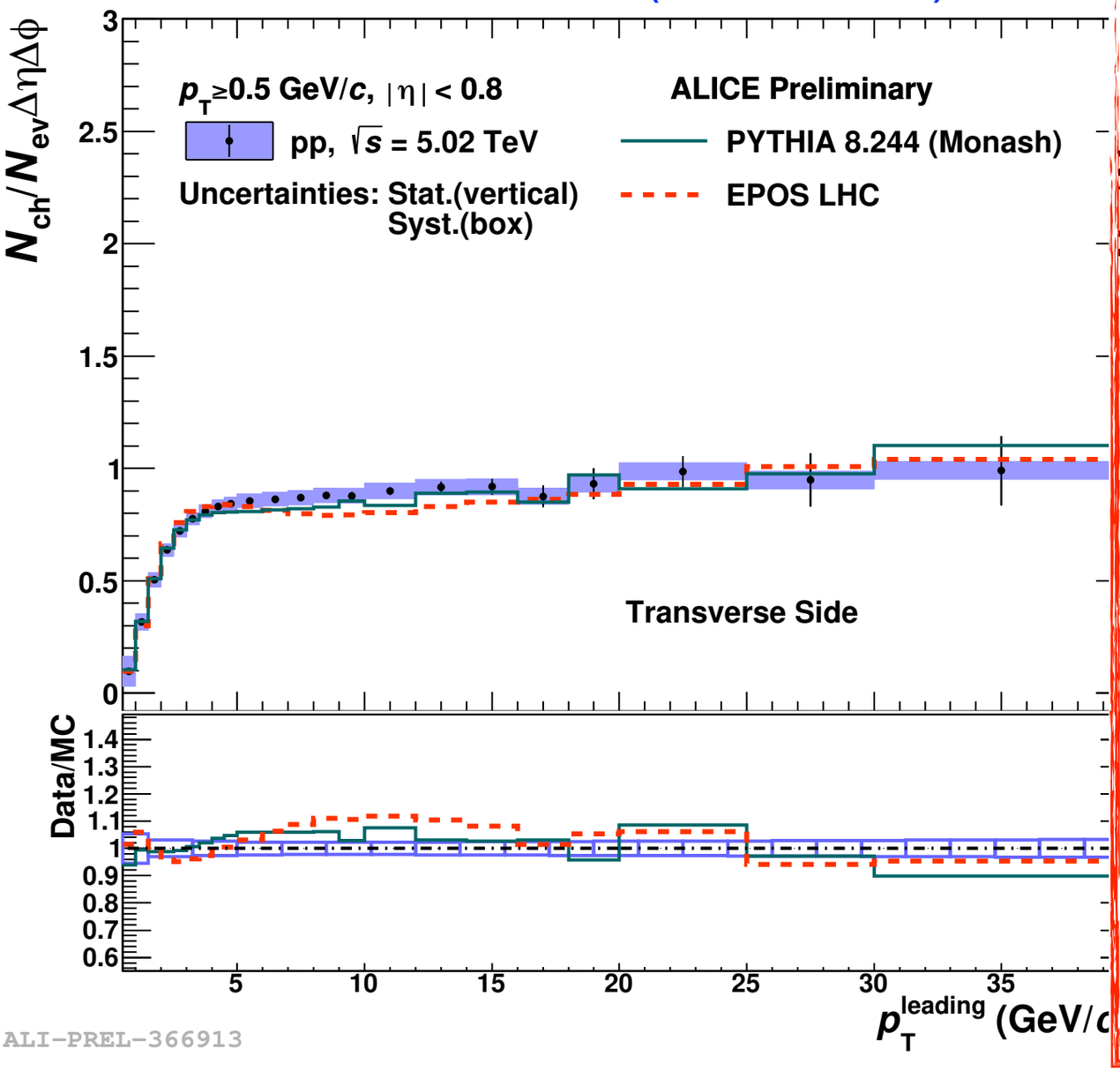
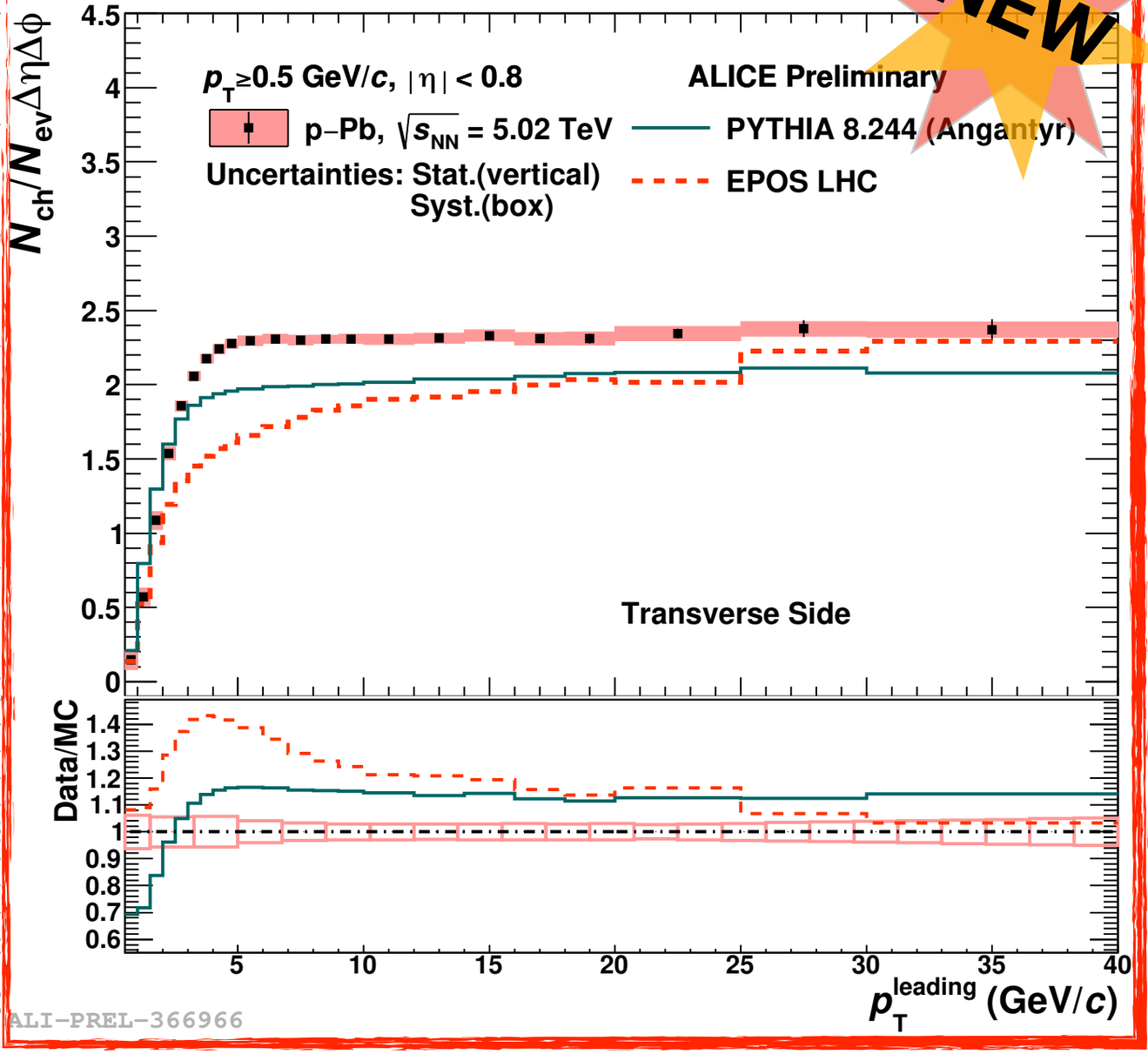


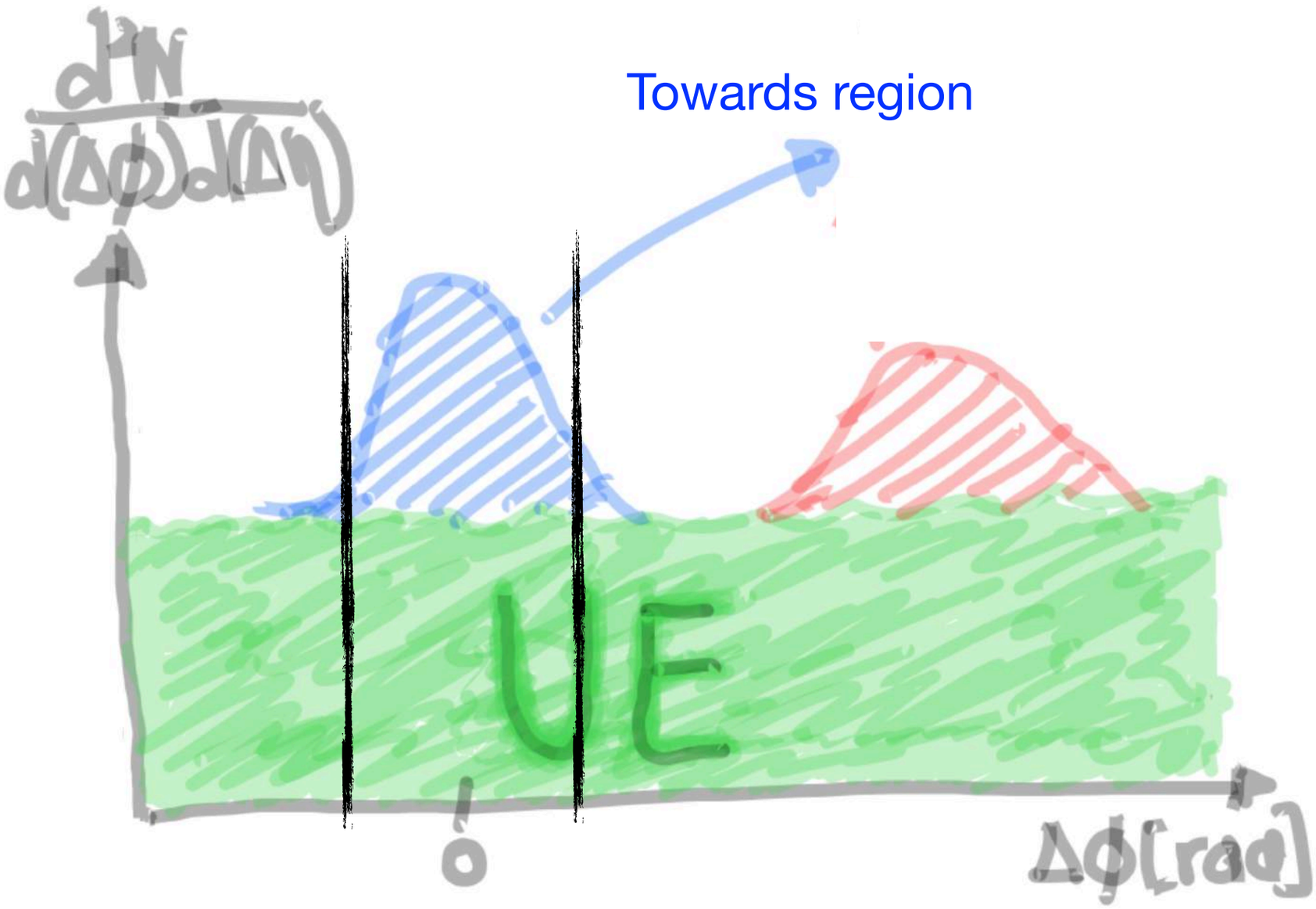
NEW



-The transverse side in p-Pb collisions exhibits the same behaviour as pp [SAME "UE structure" in both pp and p-Pb?]

-Models underestimate the "UE activity"

Toward region



Keep in mind that in the traditional analysis, the toward region contains both the jet and UE components

Toward region (pp collisions @ 5.02 TeV)

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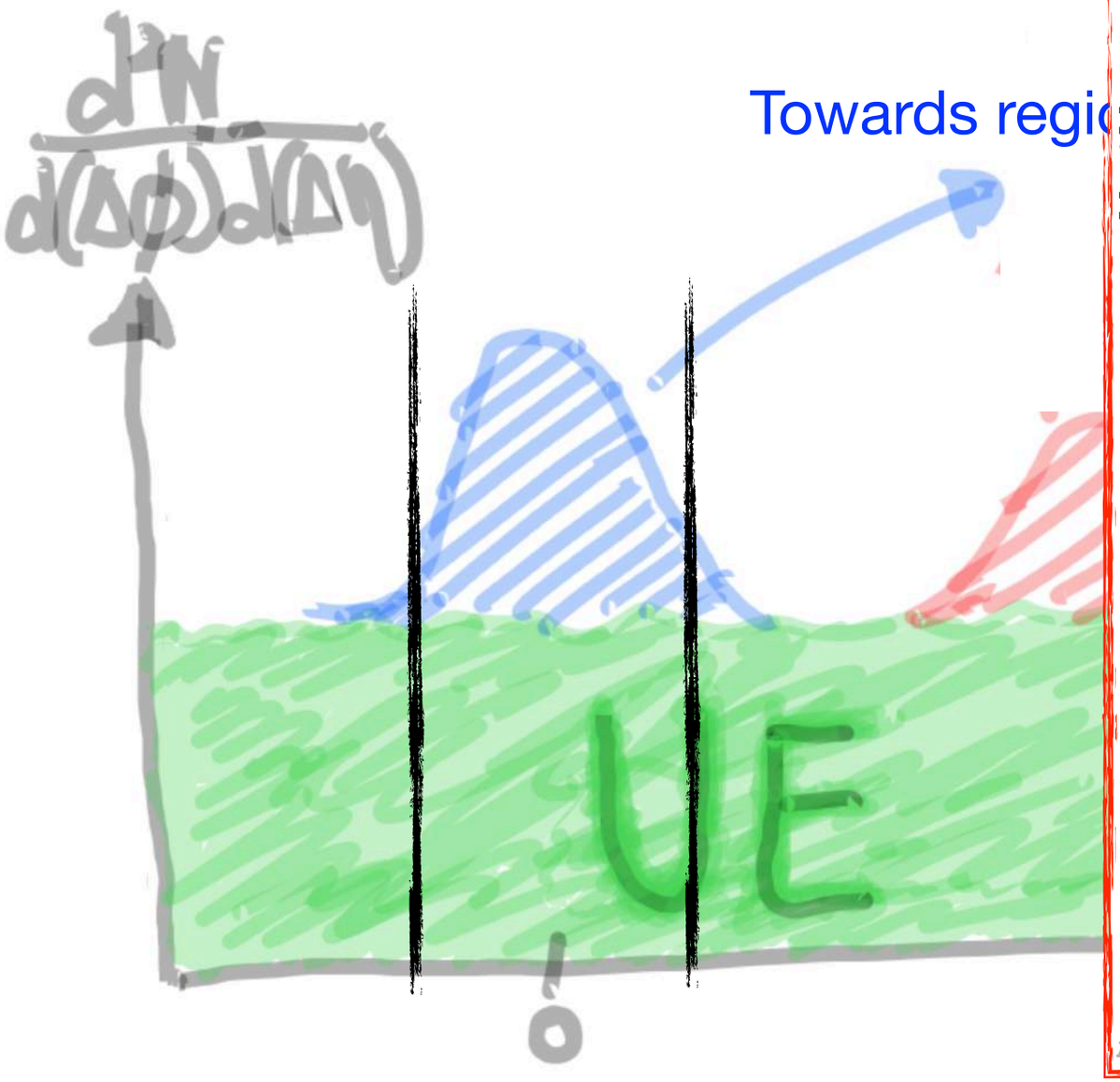

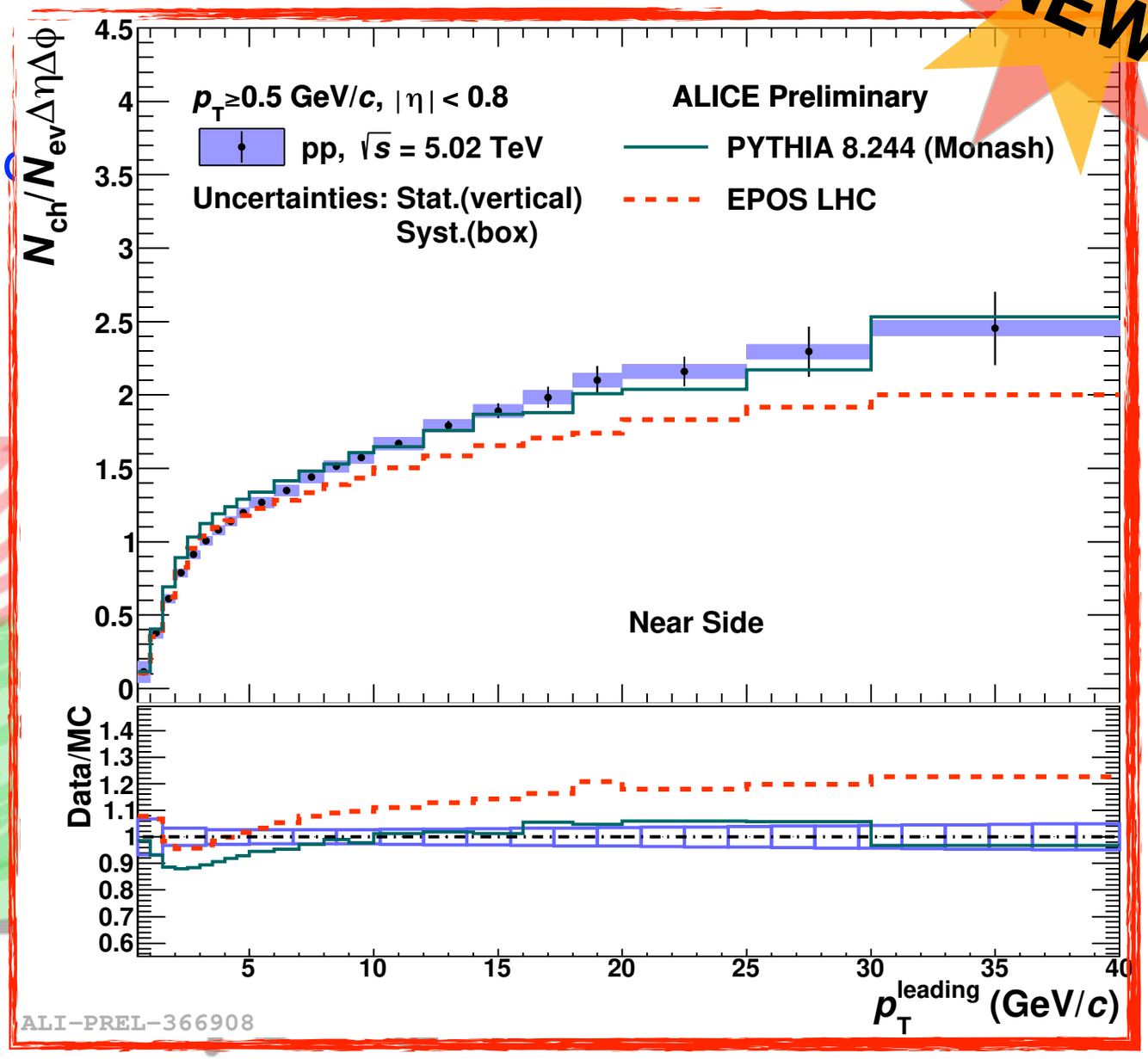

The number density as a function of $p_{\mathrm{T}}^{\mathrm{leading}}$ exhibits a change in the slope at 5 GeV/c, the effect can be attributed to UE

Isolation of the jet-like yield

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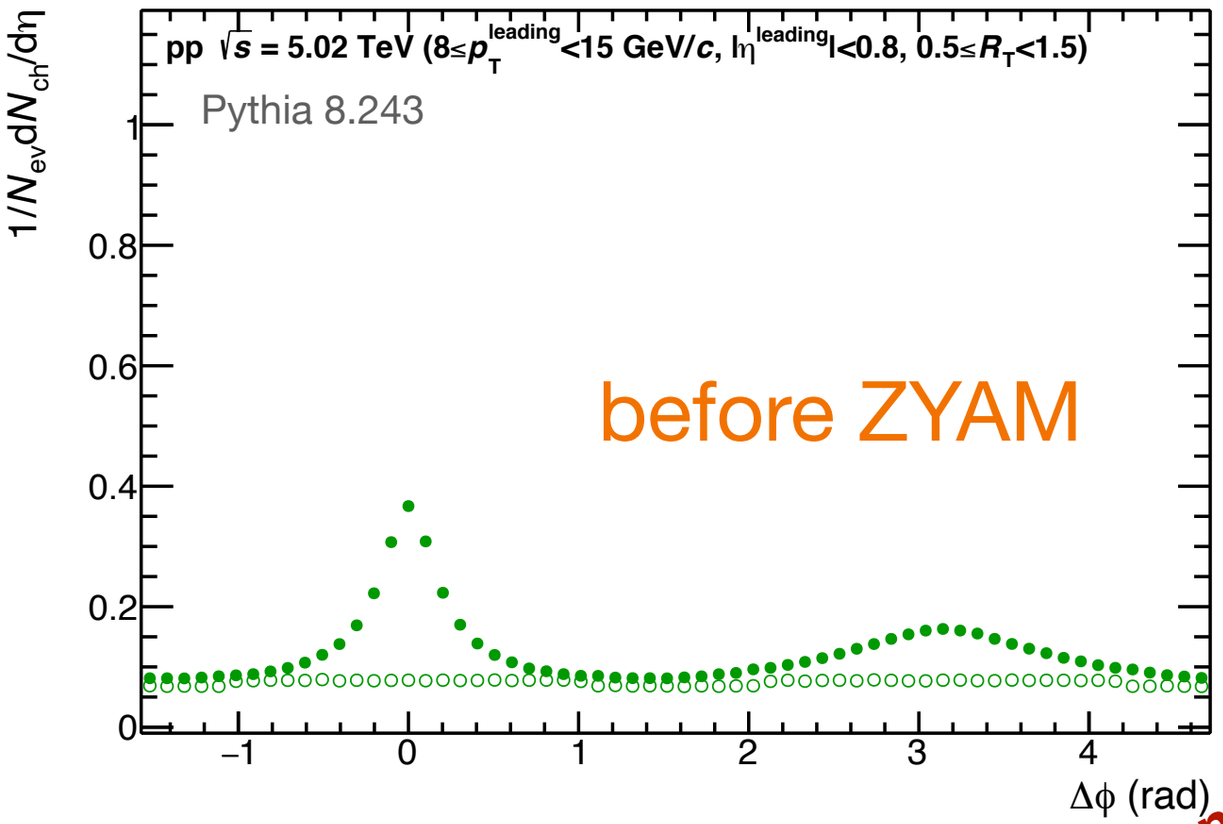
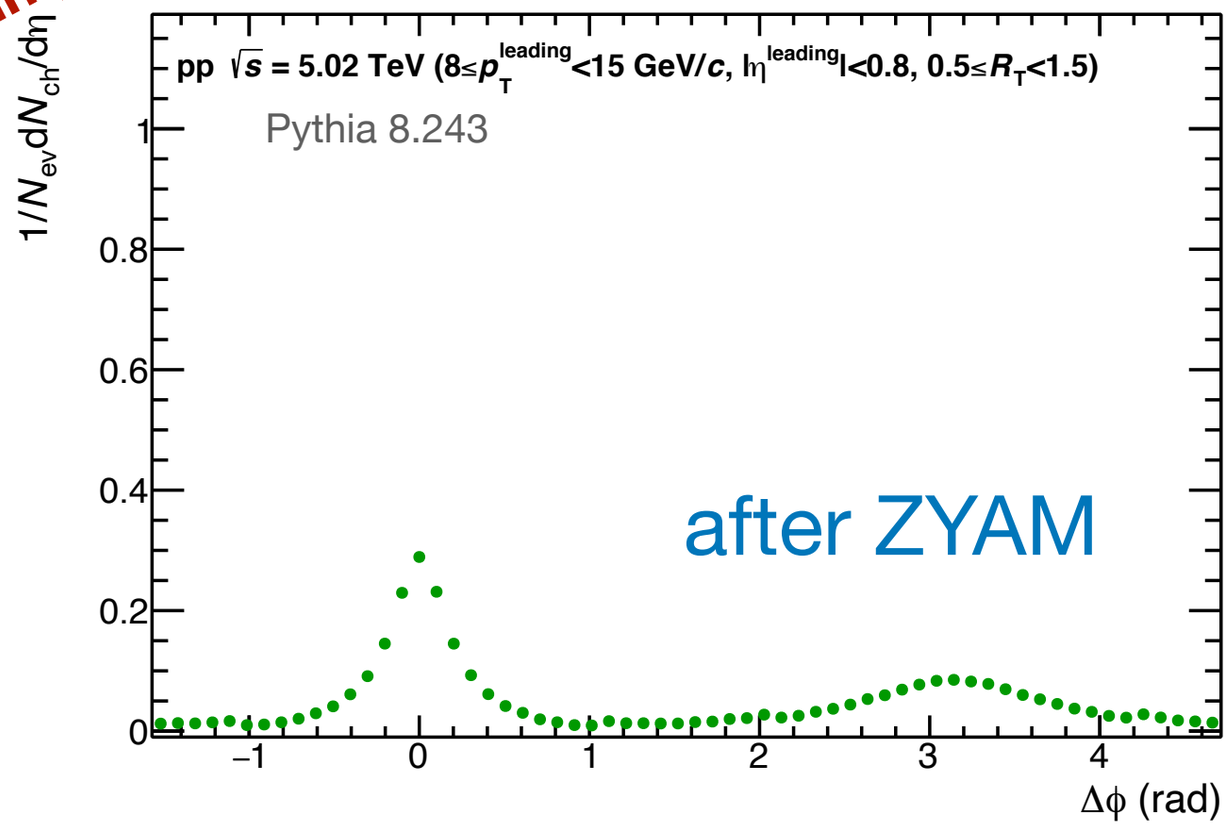
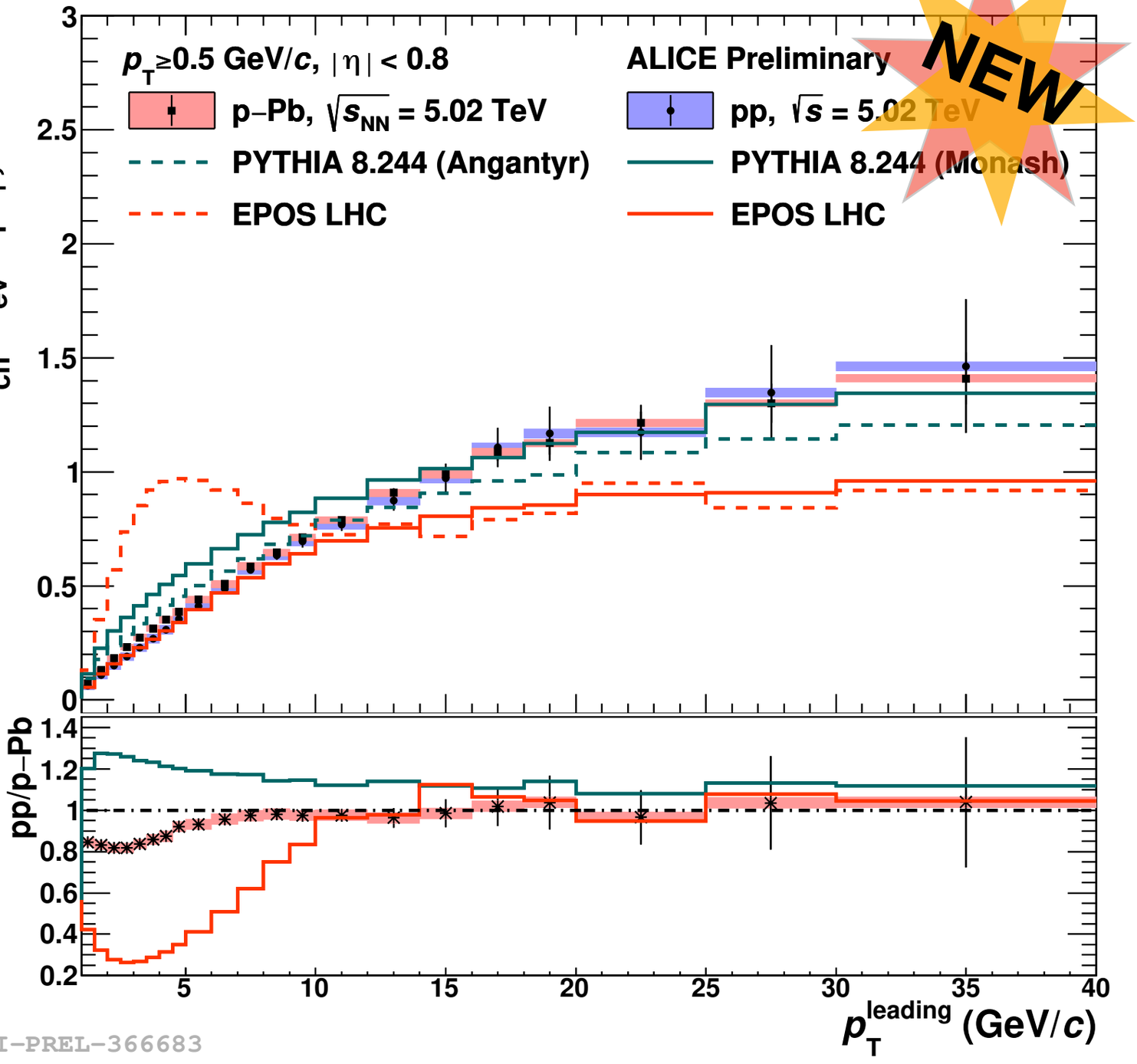


ZYAM (Zero Yield at Minimum) approach (UE is flat in DeltaPhi)



Toward - Transverse region

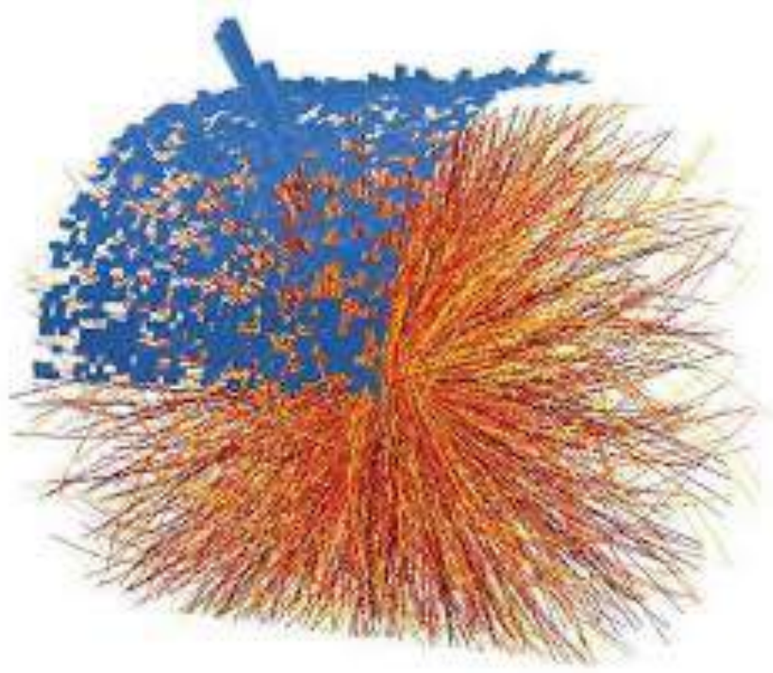


Ahsan Mehmood (CCNU-ICN)

Isolation of the particle production in the jet-like region:

- Number density is system size independent for $p_{\mathrm{T}}^{\mathrm{leading}} > 8\,\mathrm{GeV}/c$ **[fragmentation is not modified]**
- Number density smaller higher in p-Pb than in pp for $p_{\mathrm{T}}^{\mathrm{leading}} < 8\,\mathrm{GeV}/c$ **[flow effects]**

EPOS LHC fails for jet-like observables. "Too few jets in EPOS LHC" [Klaus Werner]



Particle production in the jet-like yield as a function of the event activity

pp <-> p-Pb <-> Pb-Pb

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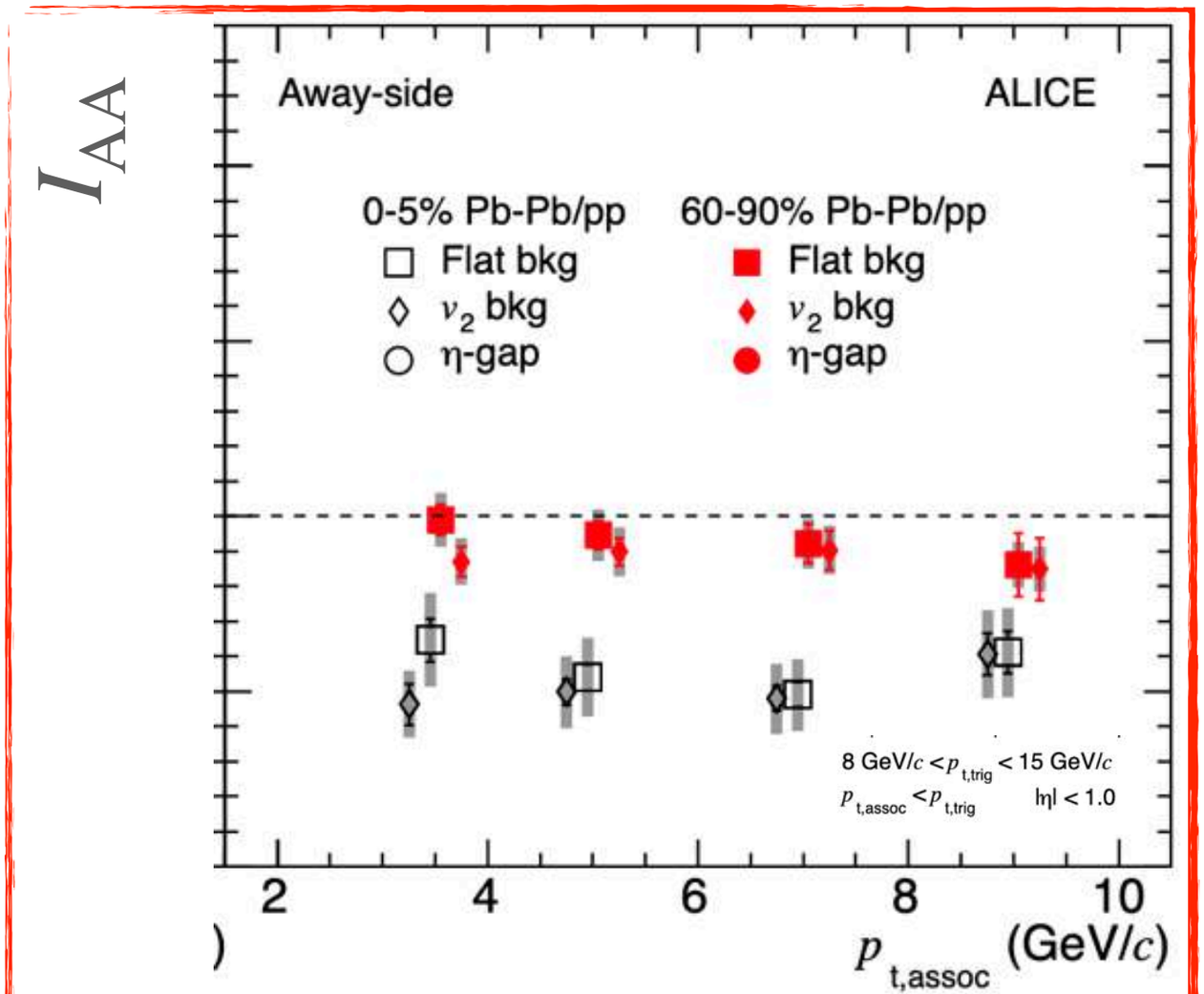
System size dependence of "I_{AA}":

- We analyse pp, p-Pb and Pb-Pb data at the same $\sqrt{s_{NN}}$
- For Pb-Pb we want to extend the measurement for more centrality classes
- Results are plotted as a function of the event activity which does not directly belong the jet (in pp collisions: Underlying Event)

Observed consequences, e.g. 2



Suppression of jet-like yield of the away side of the di-hadrons correlations (A-A relative to MB pp)

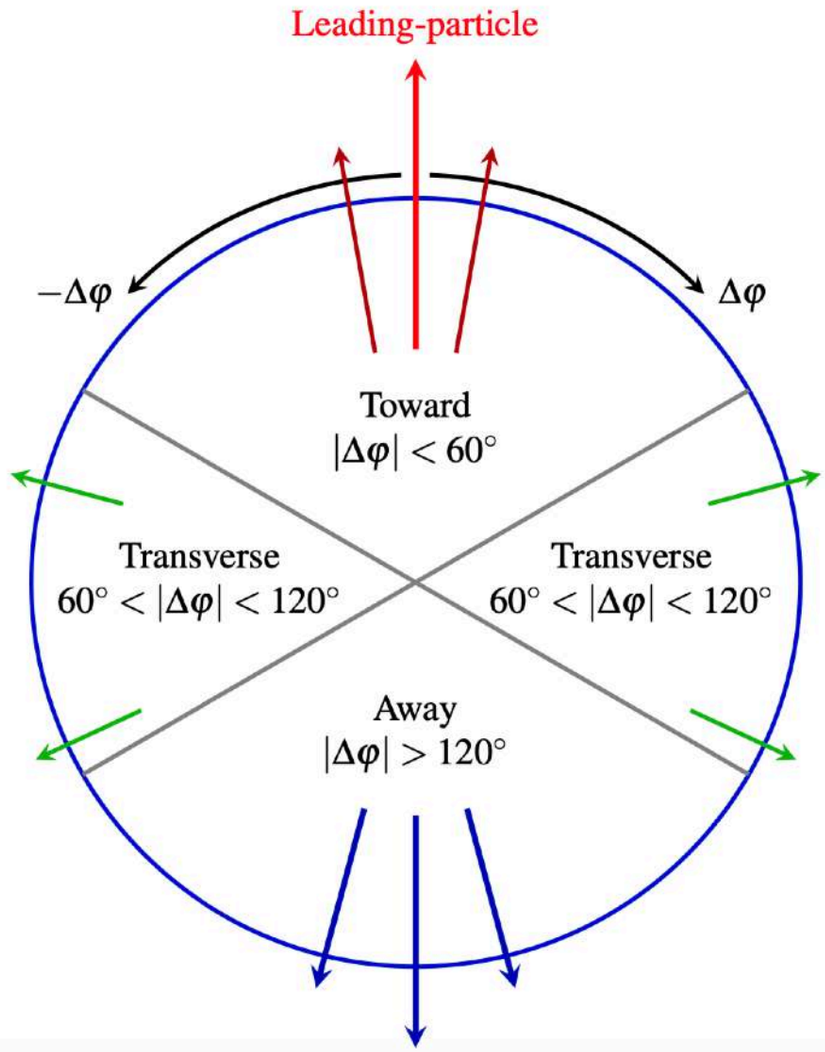
Analysis strategy

Event selection

- Multiplicity estimator: VZERO detector
- p_T trigger track: 8-15 GeV/c

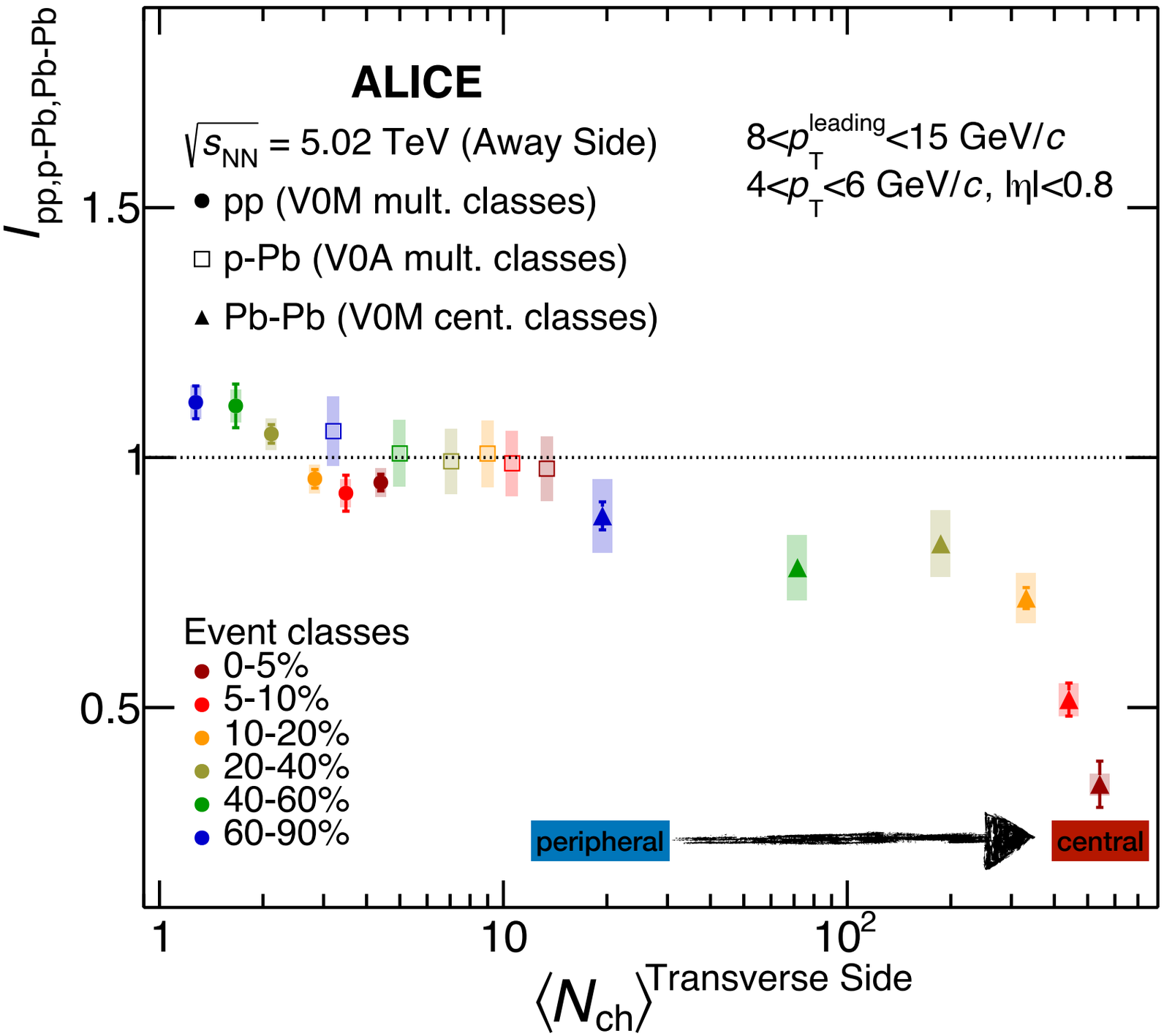
Three regions are studied: toward, away and transverse

- The p_T spectra of associated particles are extracted for each region. The p_T spectra are corrected for detector effects
- Multiplicity distributions in the transverse region are corrected using a Bayesian unfolding
- The p_T spectra in the transverse side is subtracted (ZYAM) from both the near and away sides (this gives the jet-like signal)



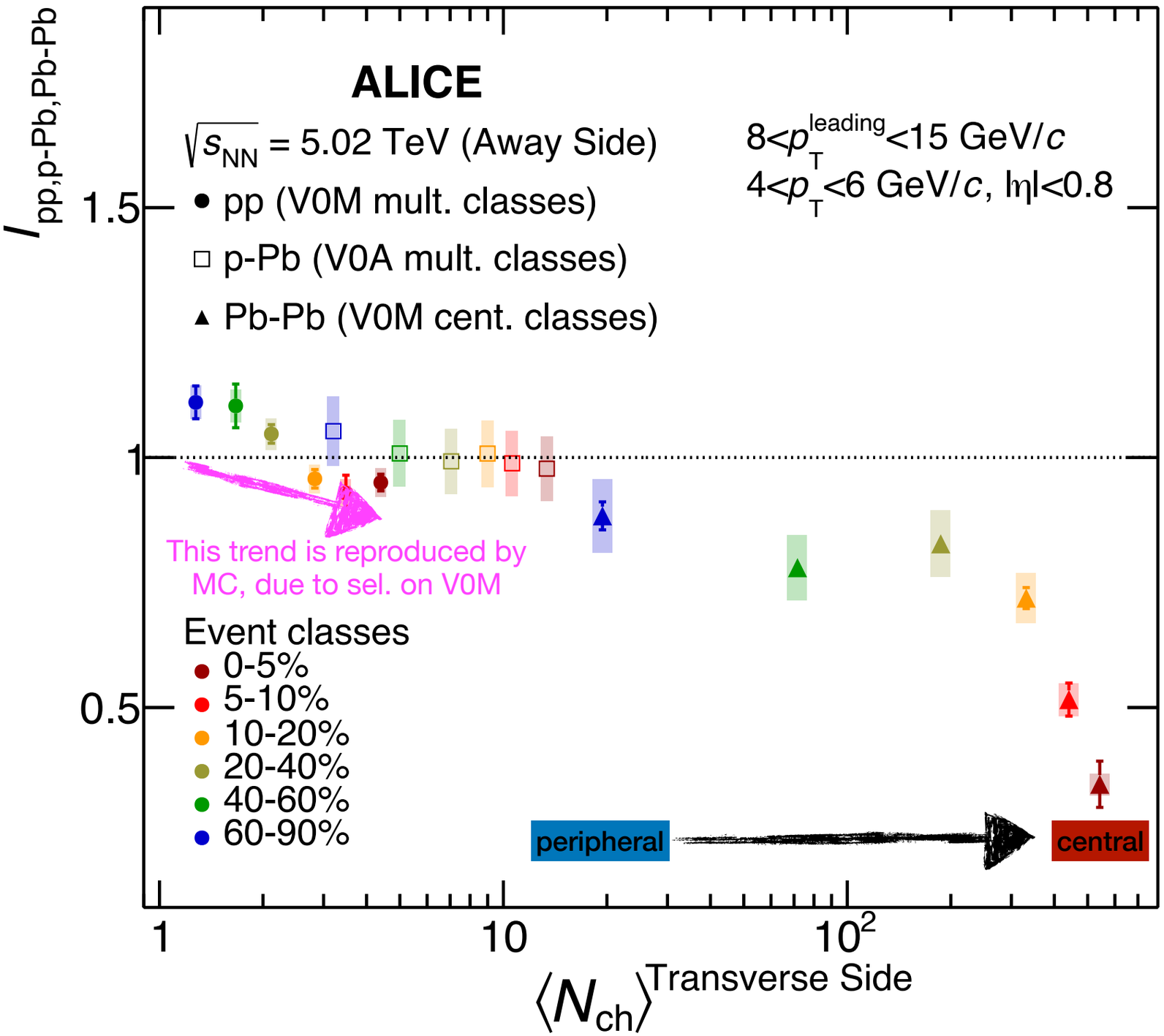
Analysis Note: A. Ortiz, S. Tripathy https://alice-notes.web.cern.ch/node/1092

I_{AA} vs $N_{ch}^{trans.}$ (away side)



- Suppression for central Pb-Pb collisions [Results are consistent with ALICE, PRL 108 (2012) 092301]
- Indication of medium effects and presence of jet-quenching effects in Pb-Pb
- No jet quenching effects are seen for small collision systems in the measured multiplicity ranges

I_{AA} vs $N_{ch}^{trans.}$ (away side)



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- No jet quenching effects are seen for small collision systems in the measured multiplicity ranges

Coming back to our intro.

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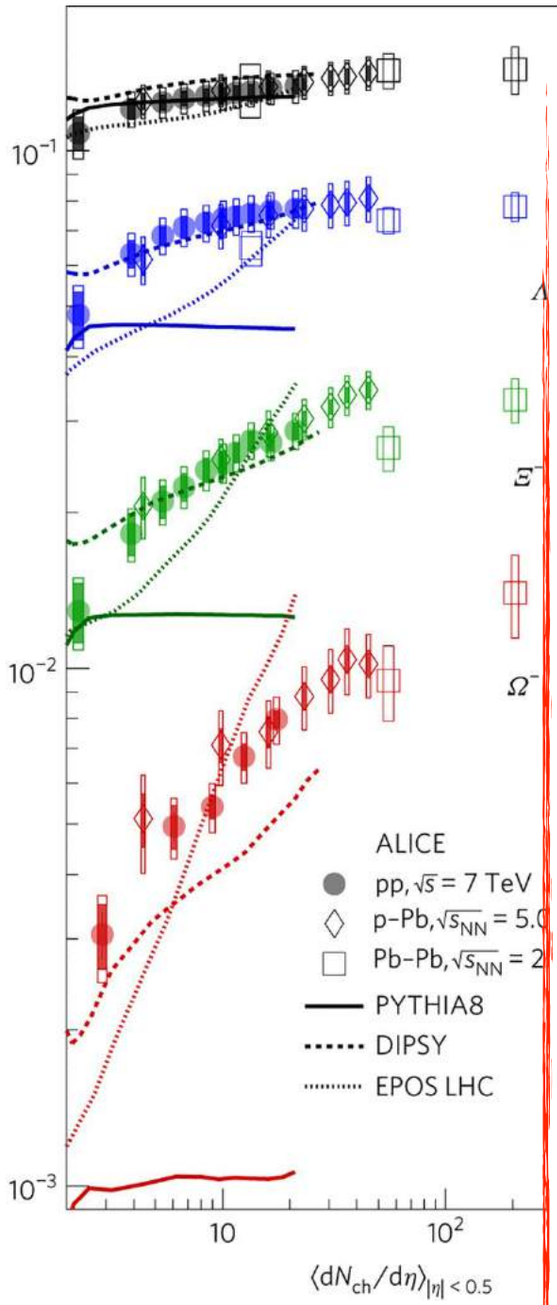
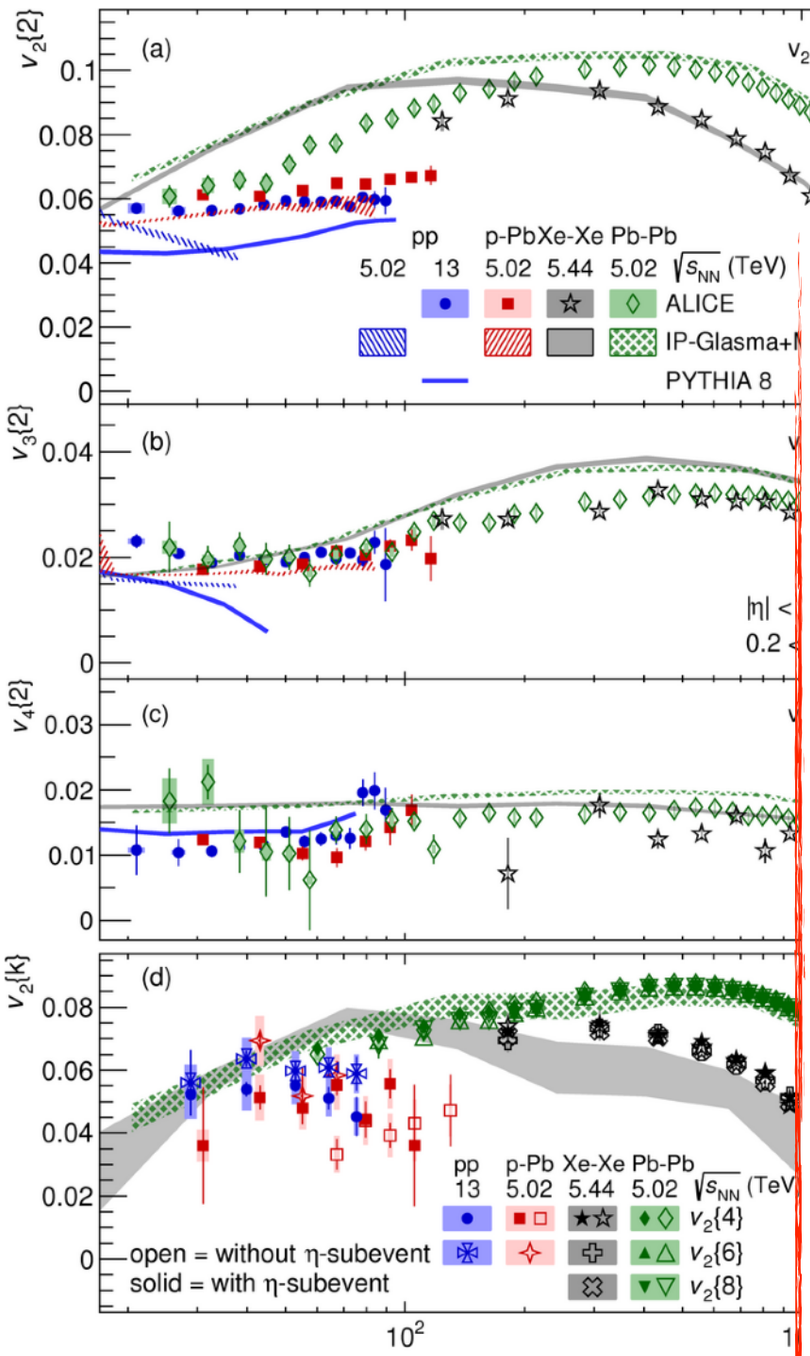
ALICE, Nat. Phys. 13, 535–539 (2017)



Strangene enhanceme

ALICE, PRL 123, 142301 (2019)



Collectivity

Striking similarities between numerous observables observed across systems at both RHIC

Strangeness enhancement as well as v_3 and v_4 (unlike v_2) show a continuous evolution across collision systems: pp<->p-Pb<->Pb-Pb

?

Jet quenching

Focus of this talk

A clear picture or more questions?

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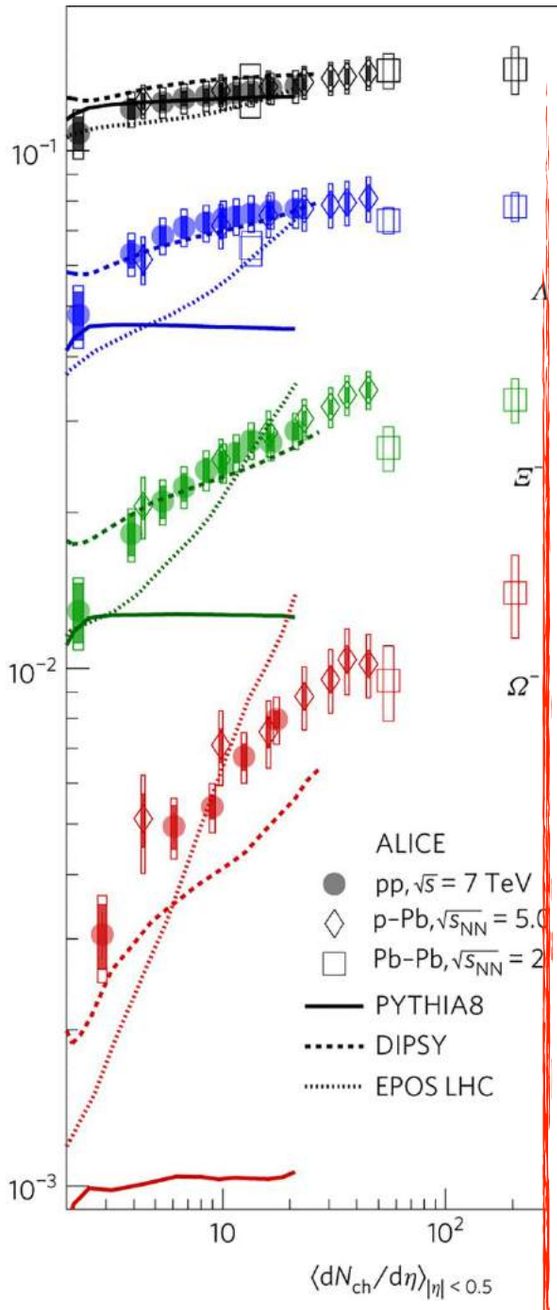
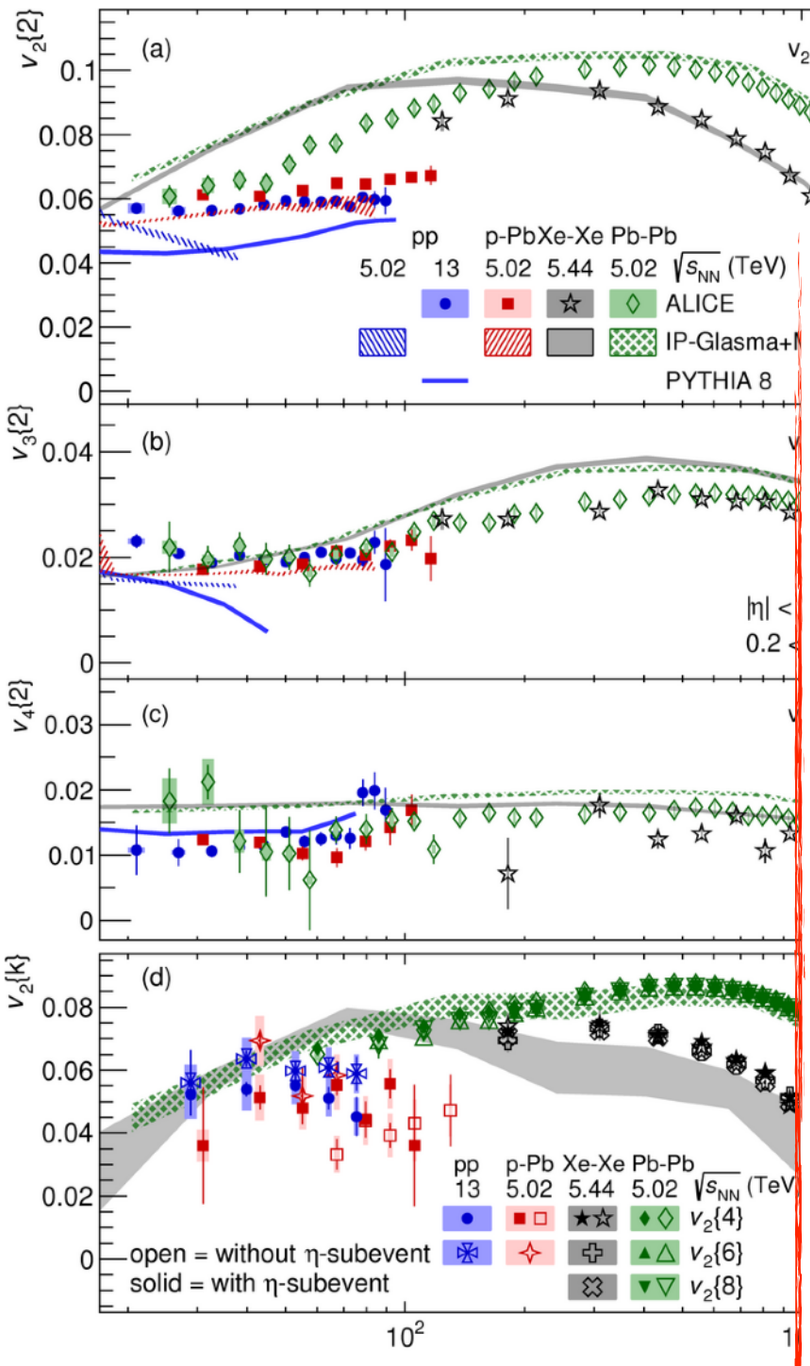
ALICE, Nat. Phys. 13, 535–539 (2017)



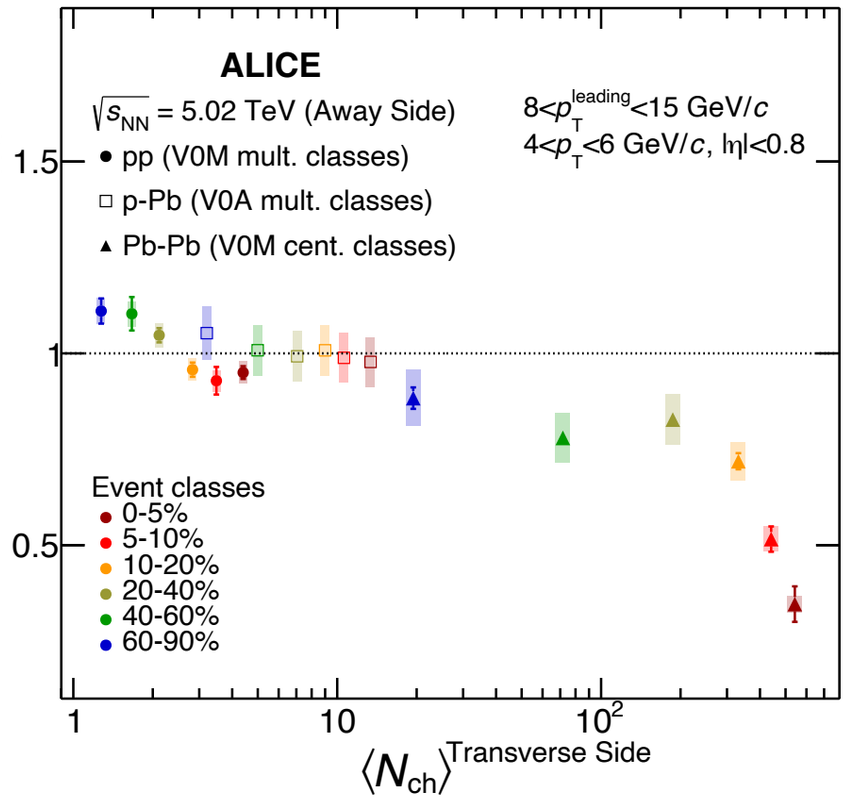
Strangene enhanceme

ALICE, PRL 123, 142301 (2019)



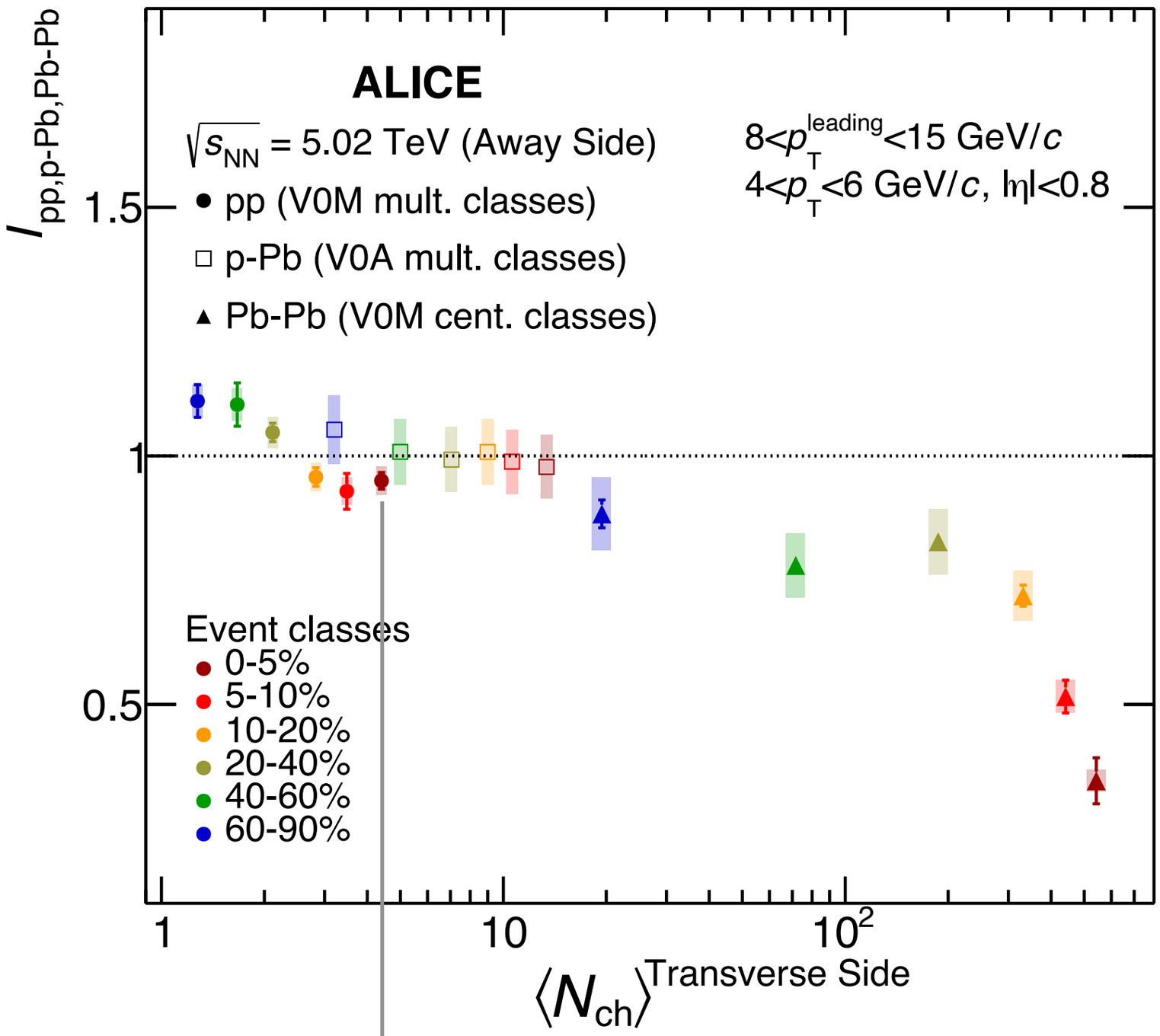
Collectivity

Jet quenching



Within the limited multiplicity reach, no jet quenching effects are seen in small systems

Very limited multiplicity reach in pp



$$\langle \mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \rangle \approx 2.7 \times \langle \mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \rangle^{\mathrm{MB}}$$

First extension of the analysis

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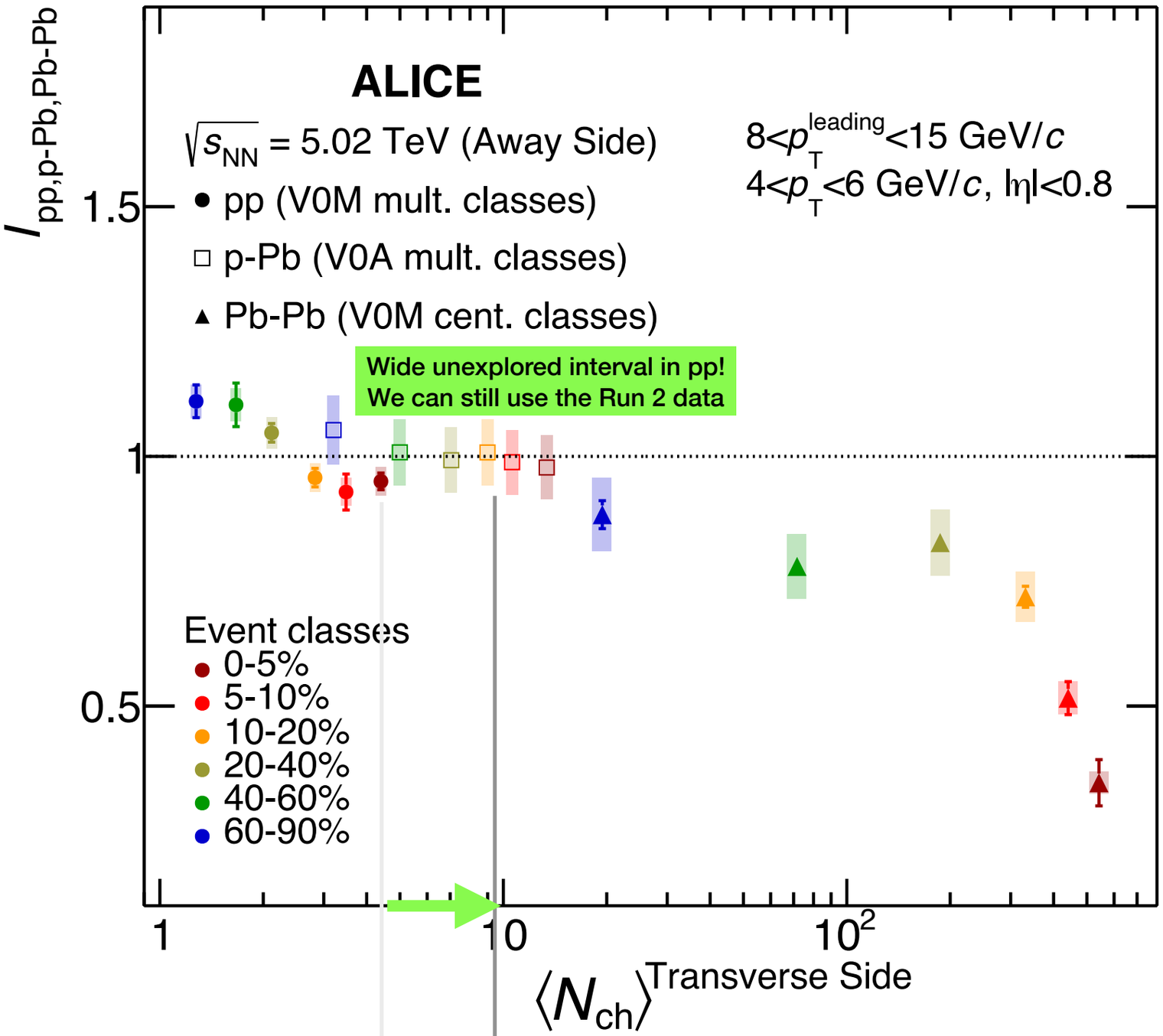

$$\langle \mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \rangle \approx 2.7 \times \langle \mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \rangle^{\mathrm{MB}}$$

$$\langle \mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \rangle \approx 5 \times \langle \mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \rangle^{\mathrm{MB}}$$

New developments R_T

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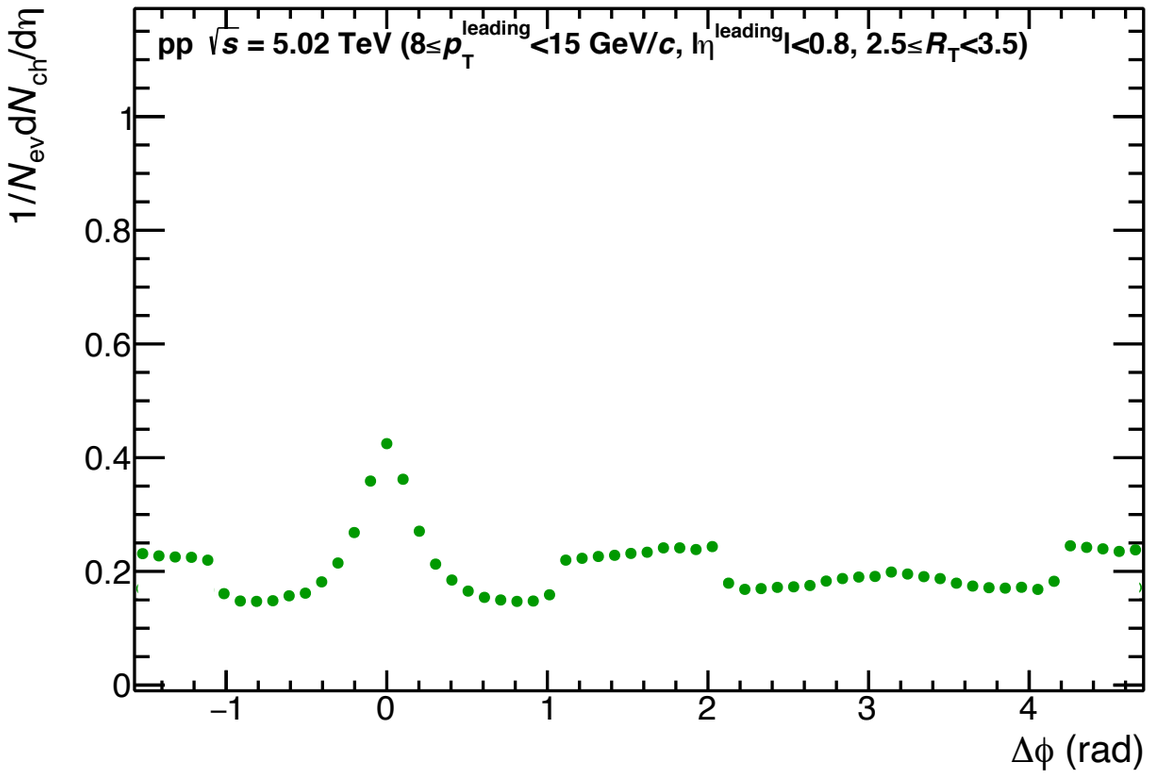
We can define R_T as follows: $$R_{\mathrm{T}} = \frac{N_{\mathrm{ch}}^{\mathrm{Transv.Side}}}{\langle N_{\mathrm{ch}}^{\mathrm{Transv.Side}} \rangle}$$

R_T allows the selection of events as a function of UE

T. Martin, P. Skands, S. Farrington, EPJC 76 (2016) 299

A. Ortiz and L. Valencia, PRD 96 (2017) 114019



In order to extend the analysis to higher R_T, we can use R_T as event classifier. However, we face one issue…

The ZYAM approach can not be used if we consider events with large R_T

The UE subtraction is not trivial

First preliminary results vs R_T do not consider the UE subtraction!

First preliminary p_T spectra vs R_T

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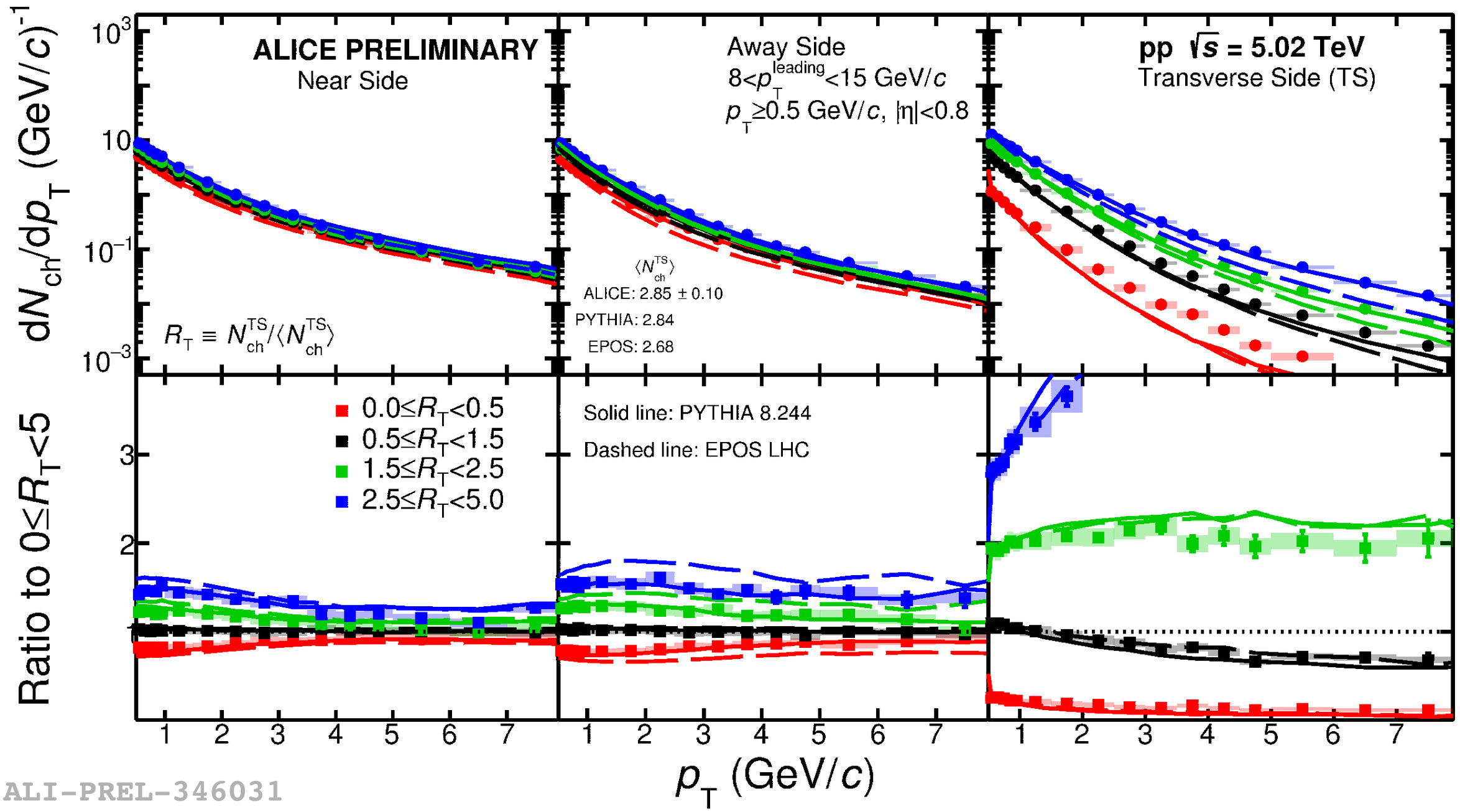

Analysis Note: A. Ortiz, S. Tripathy https://alice-notes.web.cern.ch/node/1031

Finalisation of the analysis: Luz Tiscareño (BS thesis)

First preliminary p_T spectra vs R_T

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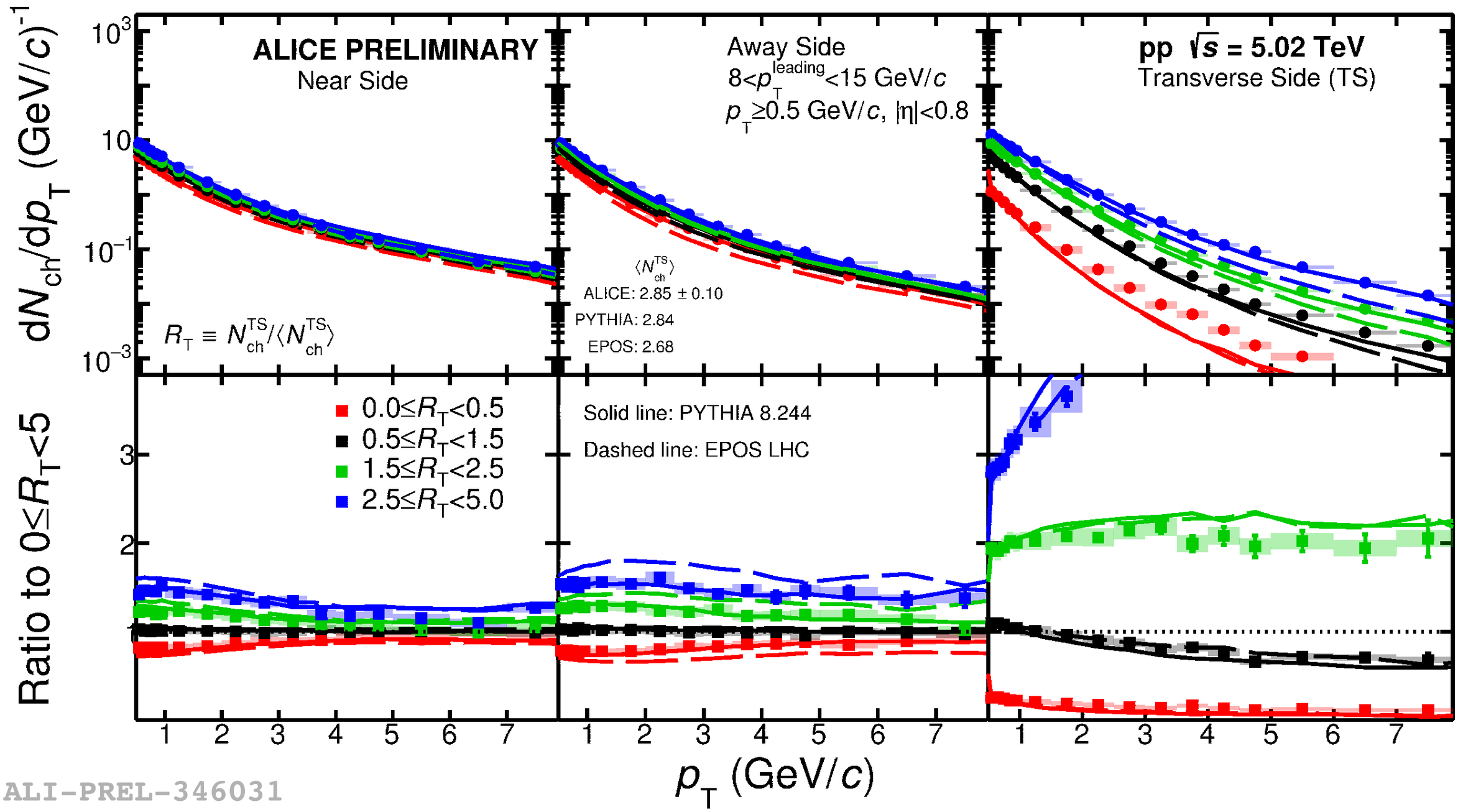

I_{AA} results are reported up to R_T~1.5 (we did not see a significant suppression)

The p_T spectra are now measured up to R_T~3 which is more or less

$\mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \approx 5 \times \langle \mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \rangle^{\mathrm{MB}}$: **the near and away side do not exhibit any deviation wrt MC (no hint of jet quenching)**

ALICE in Run 3

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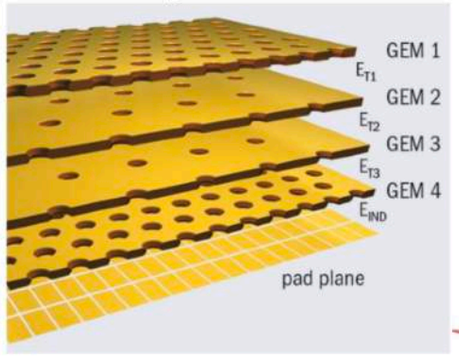
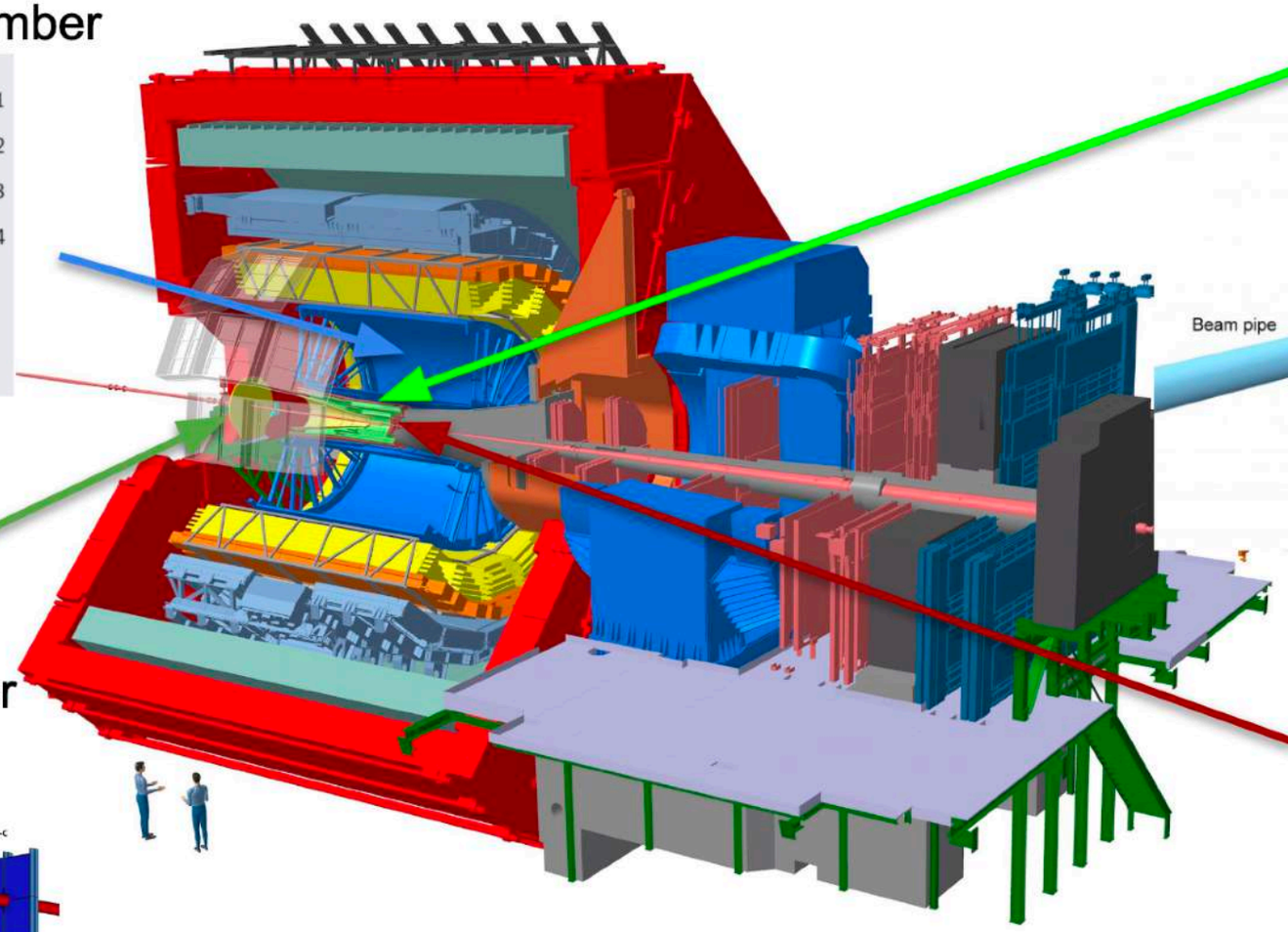
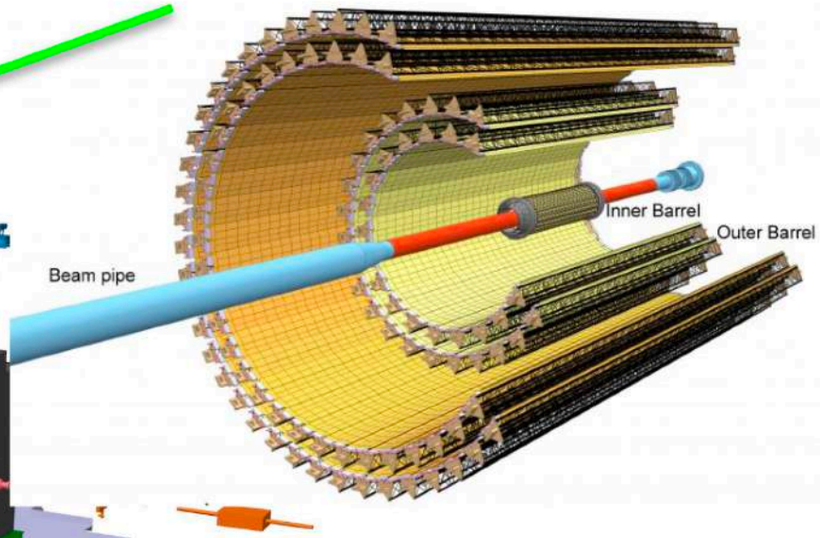
Time Projection Chamber

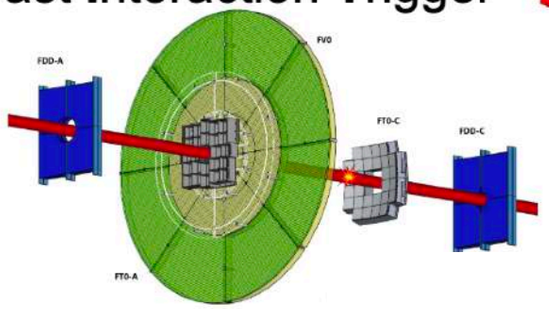




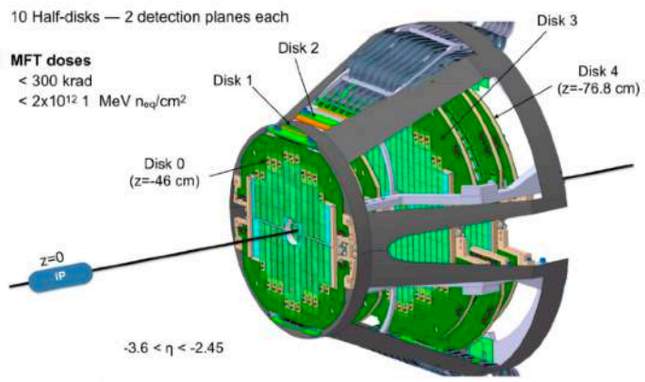
Inner Tracking System 2



Fast Interaction Trigger



Muon Forward Tracker



Upgraded data processing:

O^2 (Online-Offline processing)

Most of the detectors will operate in continuous readout mode

interaction rate: Pb-Pb (pp) 50 kHz (0.5-1 MHz)

Run 3 target luminosity:

pp: 200 pb^{-1} (rare events e.g. HM)

pp: 3 pb^{-1} (MB)

Pb-Pb: 6 nb^{-1}

p-Pb: 0.3 pb^{-1}

I_{AA} analysis in Run 3

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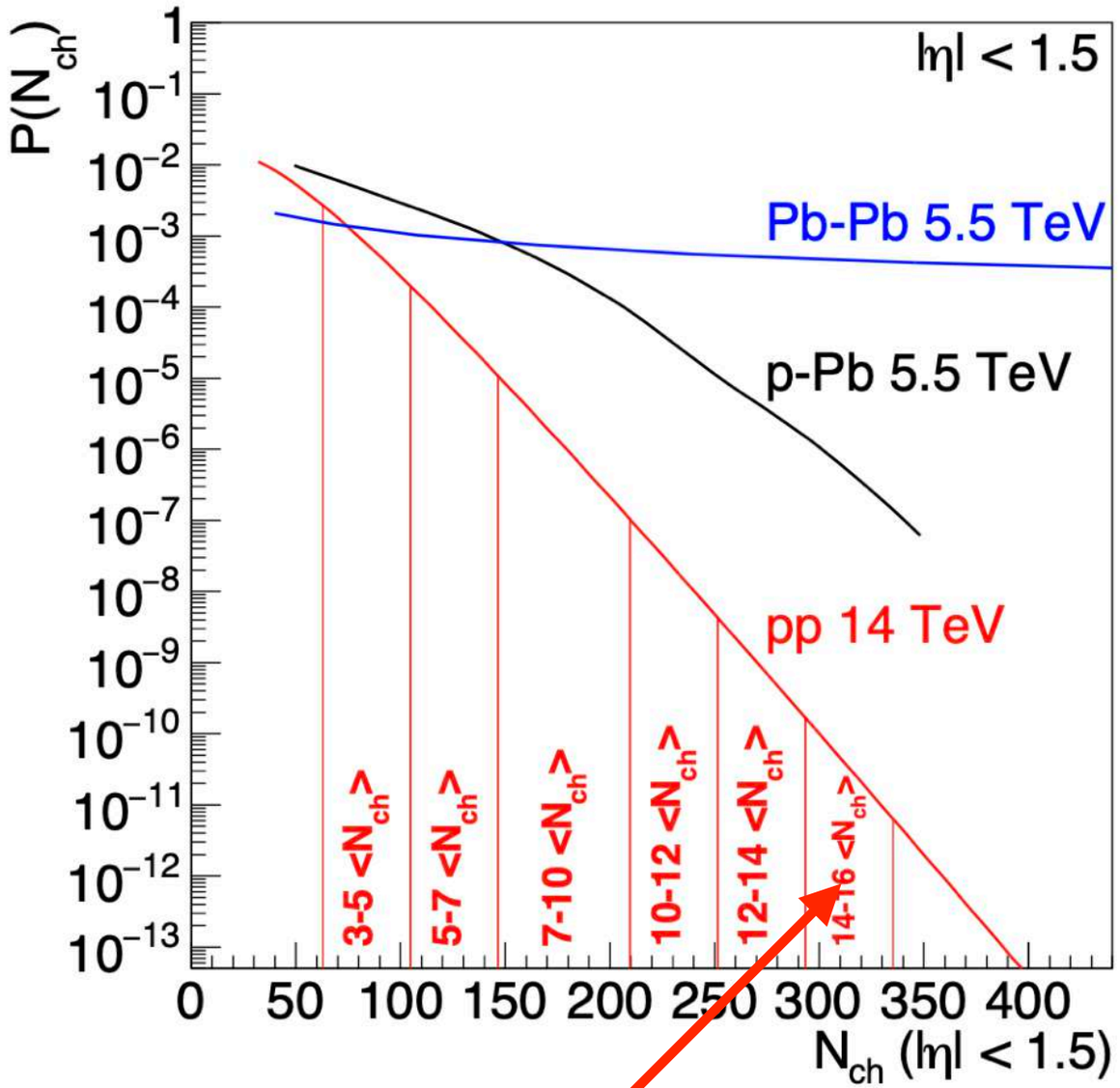
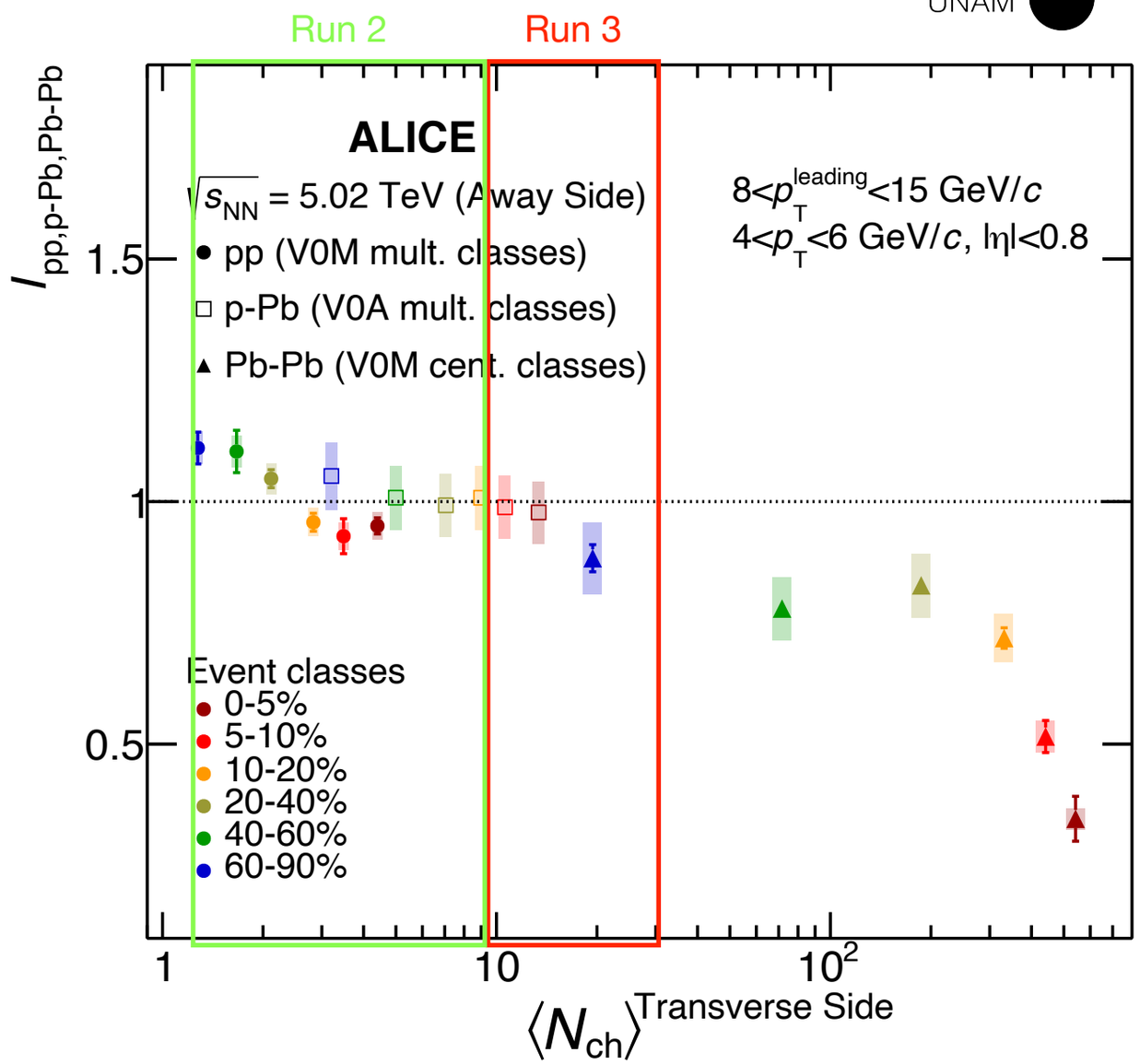


Very high multiplicity reach !



With Run 3 data, the jet quenching search in pp can be extended up to more than 14 times the MB multiplicity

Run 3 target luminosity:

- pp: 200 pb^{-1} (rare events e.g. HM)
- pp: 3 pb^{-1} (MB)
- Pb-Pb: 6 nb^{-1}
- p-Pb: 0.3 pb^{-1}

Preparation for the analysis of HM pp events: Paola Vargas (MS thesis)
Antonio Paz (PhD thesis)

Preparation for the analysis of pp events with very large R_T

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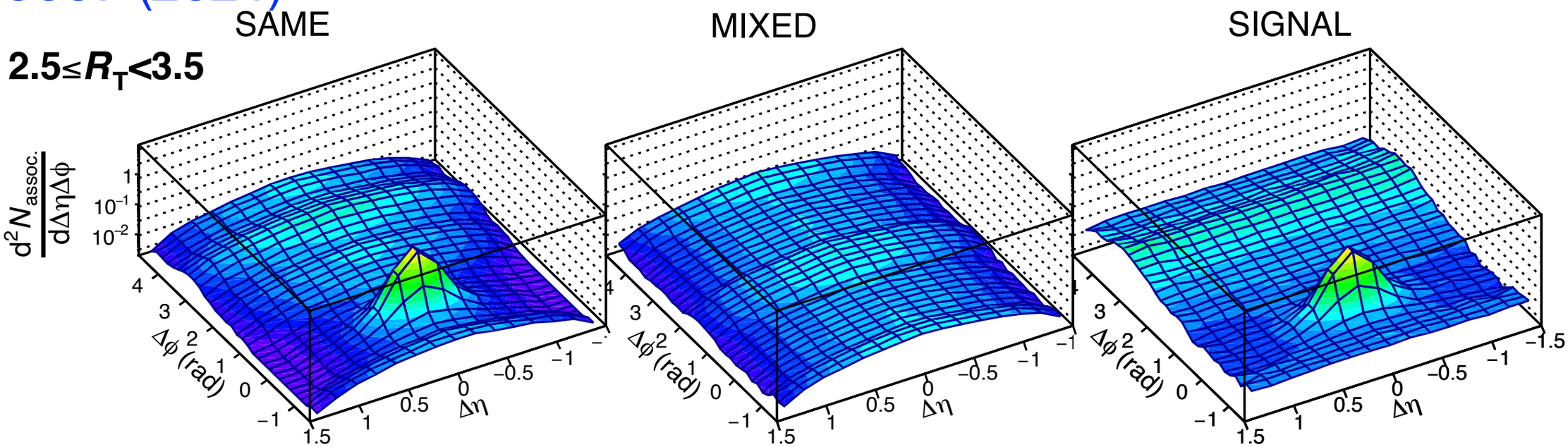
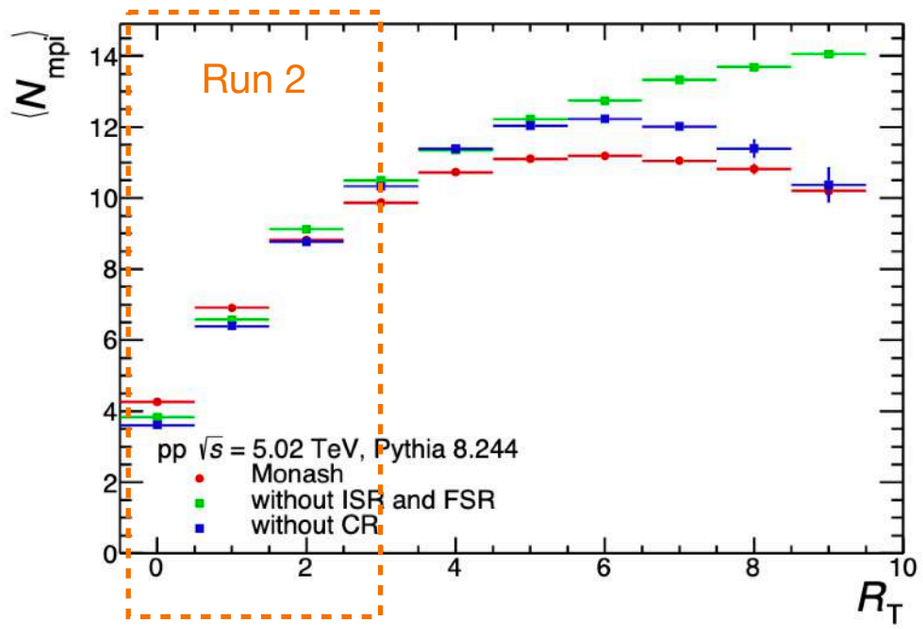
G. Bencédi, A. Ortiz and S. Tripathy, J. Phys. G: Nucl. Part. Phys. **48** 015007 (2021)



pp $\sqrt{s}$ = 5.02 TeV Pythia 8.244 (Monash), $8 \le p_T^{leading} < 15$ GeV/c, $4.0 \le p_T^{assoc} < 6.0$ GeV/c

We propose to use event mixing in order to model the selection bias (mixed events). Then, we can remove this contribution from the same distribution

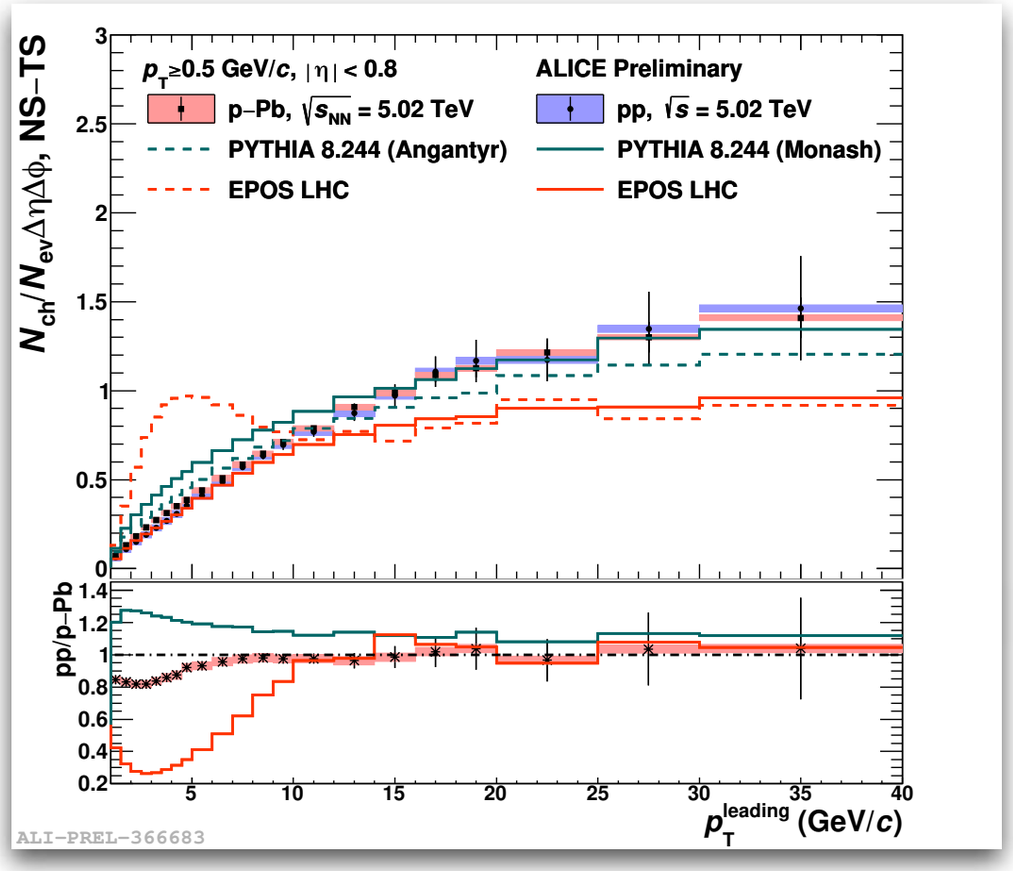


Summary

Underlying event analysis

[paper 1 under preparation]

- The transverse side in p-Pb collisions exhibits the same behaviour as pp. This suggests the SAME “UE structure” in both pp and p-Pb
- The jet-like yield in p-Pb and pp collisions is the same for $p_T^{leading} > 10$ GeV/c. At lower $p_T^{leading}$ medium effects seem to be present [investigation with JEWEL]



Summary

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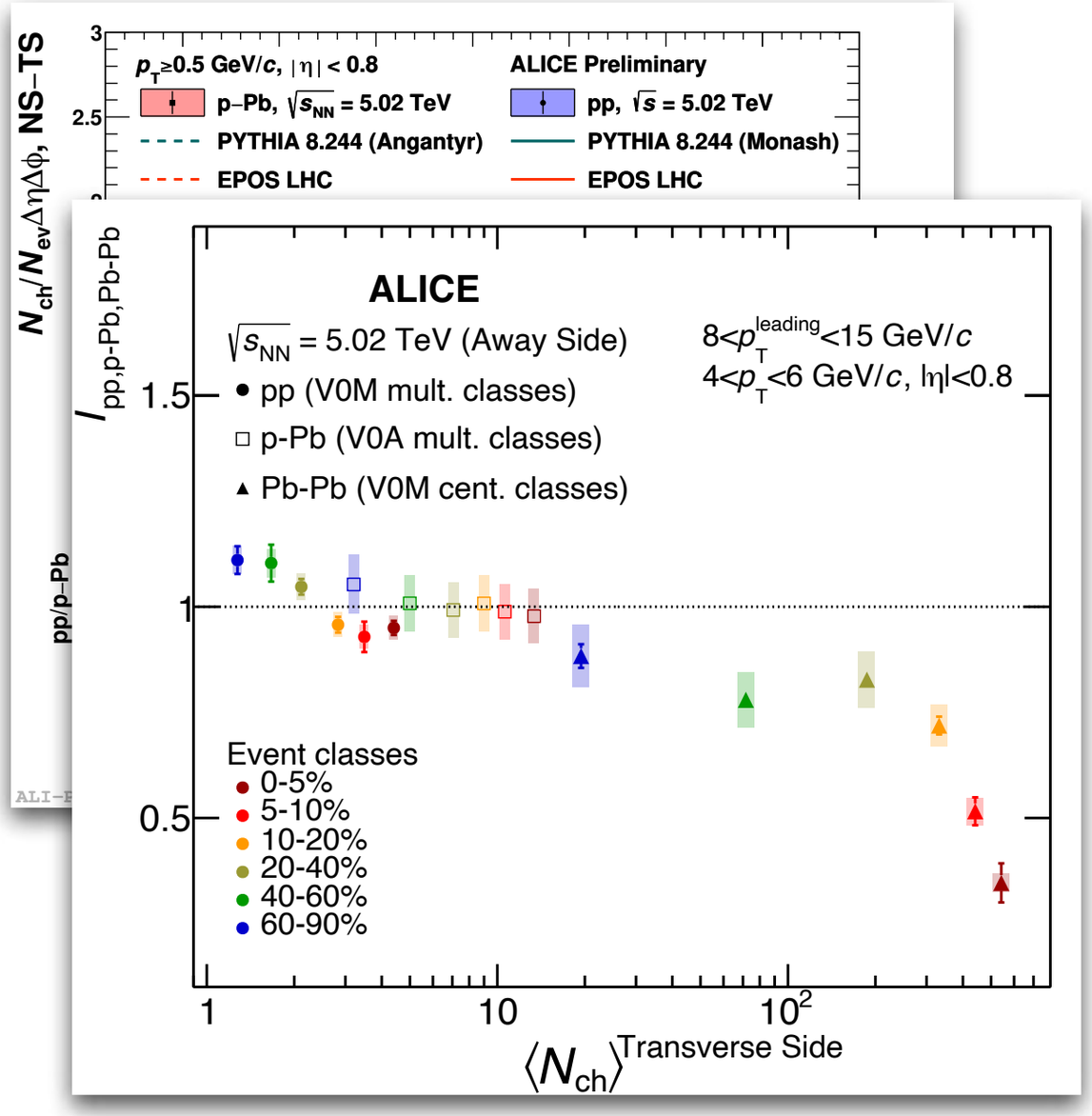
I_{AA} analysis

[a letter is under preparation]

- In contrast to central Pb-Pb collisions, little or no suppression of I_{AA} is seen in away region in pp and p-Pb collisions. Based on these results, no jet quenching is observed in small systems for the measured multiplicity ranges



pp:

$$\langle \mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \rangle \approx 2.7 \times \langle \mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \rangle^{\mathrm{MB}}$$

Summary

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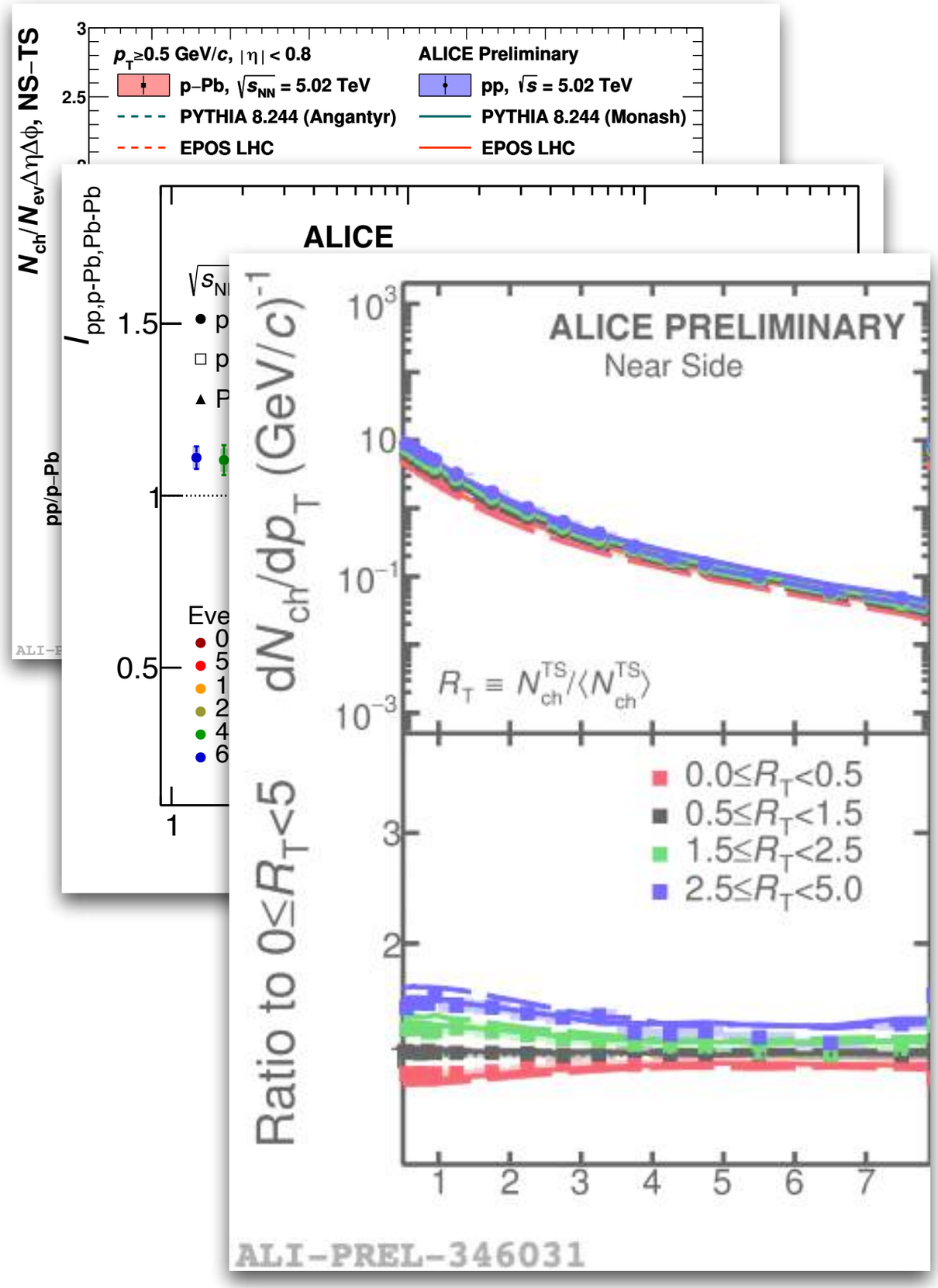
R_T analysis

[paper 3 under preparation]

- Using the UE tool, one can reduce the jet bias. In this way the pT spectra in the jet-like region can be measured up to $\langle dN_{ch}/d\eta \rangle \approx 5 \times \langle dN_{ch}/d\eta \rangle^{MB}$

We do not observe any deviation wrt Pythia predictions. Compatible with absence of jet quenching in pp



Summary

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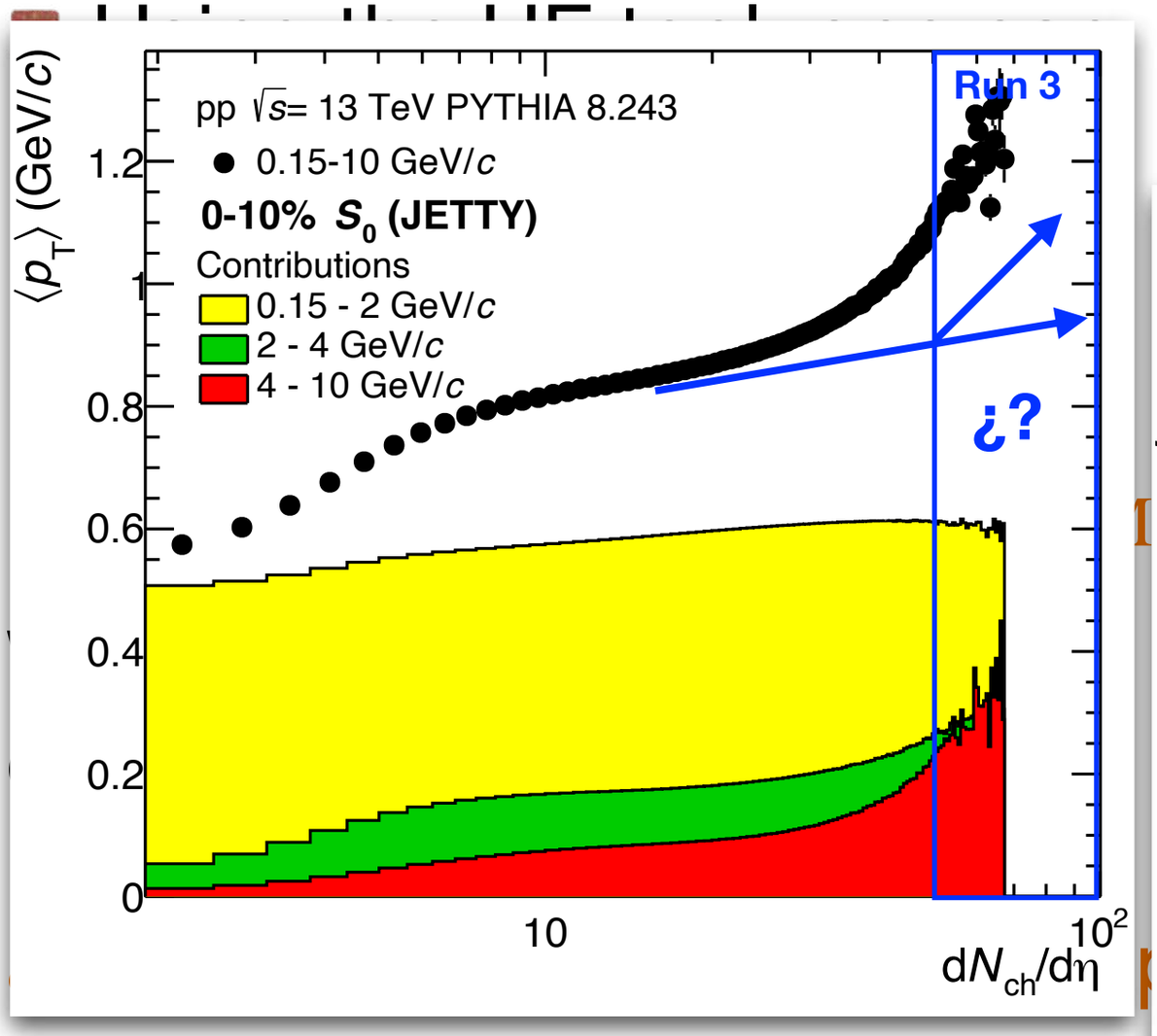
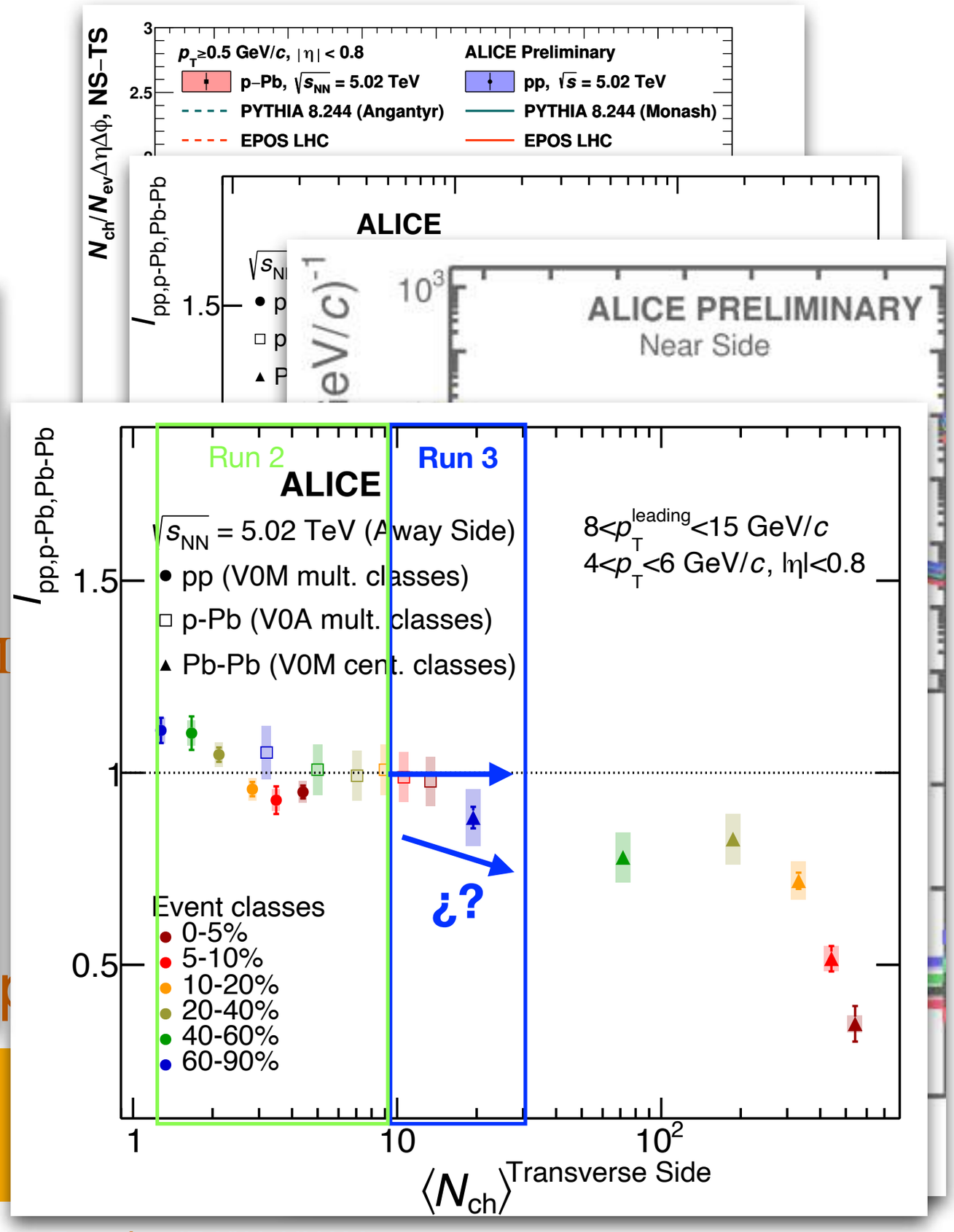
R_T analysis

[paper 3 under preparation]





Waiting for the Run 3 LHC data!

Instituto de Ciencias Nucleares UNAM

Our group is quite active, unfortunately I could not cover all the results

ICN-UNAM group meeting

Friday 12 Feb 2021, 09:00 → 11:20 America/Mexico_City

F209 (ICN, UNAM)

Antonio Ortiz Velasquez (Universidad Nacional Autonoma (MX))

Description

Registration *You are registered for this event.* Check details

Videoconference Rooms ICN-UNAM group meeting ▶ Join

There are minutes attached to this event. ***Show them.***

09:00 → 09:20 **Service work + MC study (RTmin and RTmax)**
Speaker: Gyula Bencedi (Universidad Nacional Autonoma (MX))
WeeklyICN_12feb20...

09:20 → 09:40 **Analysis update: ML studies**
Speaker: Erik Alfredo Zepeda Garcia (Universidad Nacional Autonoma (MX))
meeting1202.pdf

09:40 → 10:00 **Analysis update: UE vs Nch in MC**
Speaker: Ahsan Mehmood Khan (Central China Normal University CCNU (CN))
12Feb21ICN.pdf

10:00 → 10:20 **Analysis update: pT spectra vs centrality and multiplicity in Pb-Pb**
Speaker: Paola Vargas (ICN)
Adv2.pdf

10:20 → 10:40 **MC study: Pythia + FastJet**
Speaker: Luis Díaz-Calvo (UNAM)
slides.pdf

10:40 → 11:00 **Crosschecks: pT spectra vs RT**
Speaker: Luz Tiscareño (Universidad Politécnica de Aguascalientes)
E3_12022021.pdf

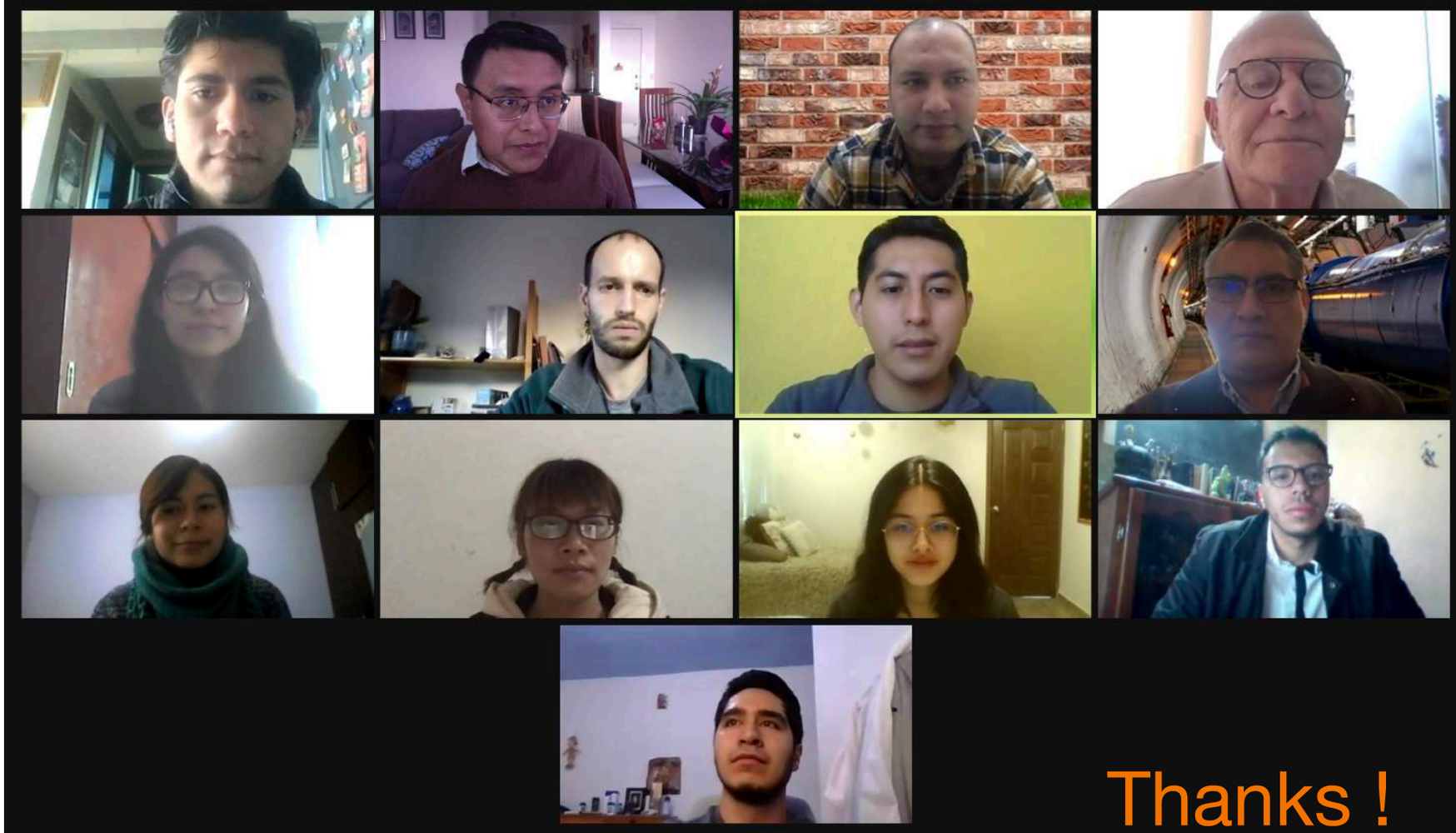
11:00 → 11:20 **Analysis update: 3D unfolding**
Speaker: Jose David Romo Lopez (Universidad Nacional Autonoma (MX))
11-09.pdf

11:00 → 11:20 **TMVA study**
Speaker: Arlette Melo (FC, UNAM)
Weekly_Report-Arlet...

11:00 → 11:20 **analysis update + service work**
Speaker: Antonio Paz
AnalysisUpdate_ICN...

Zoom Meeting

Photo from our last ALICE-ICN group meeting

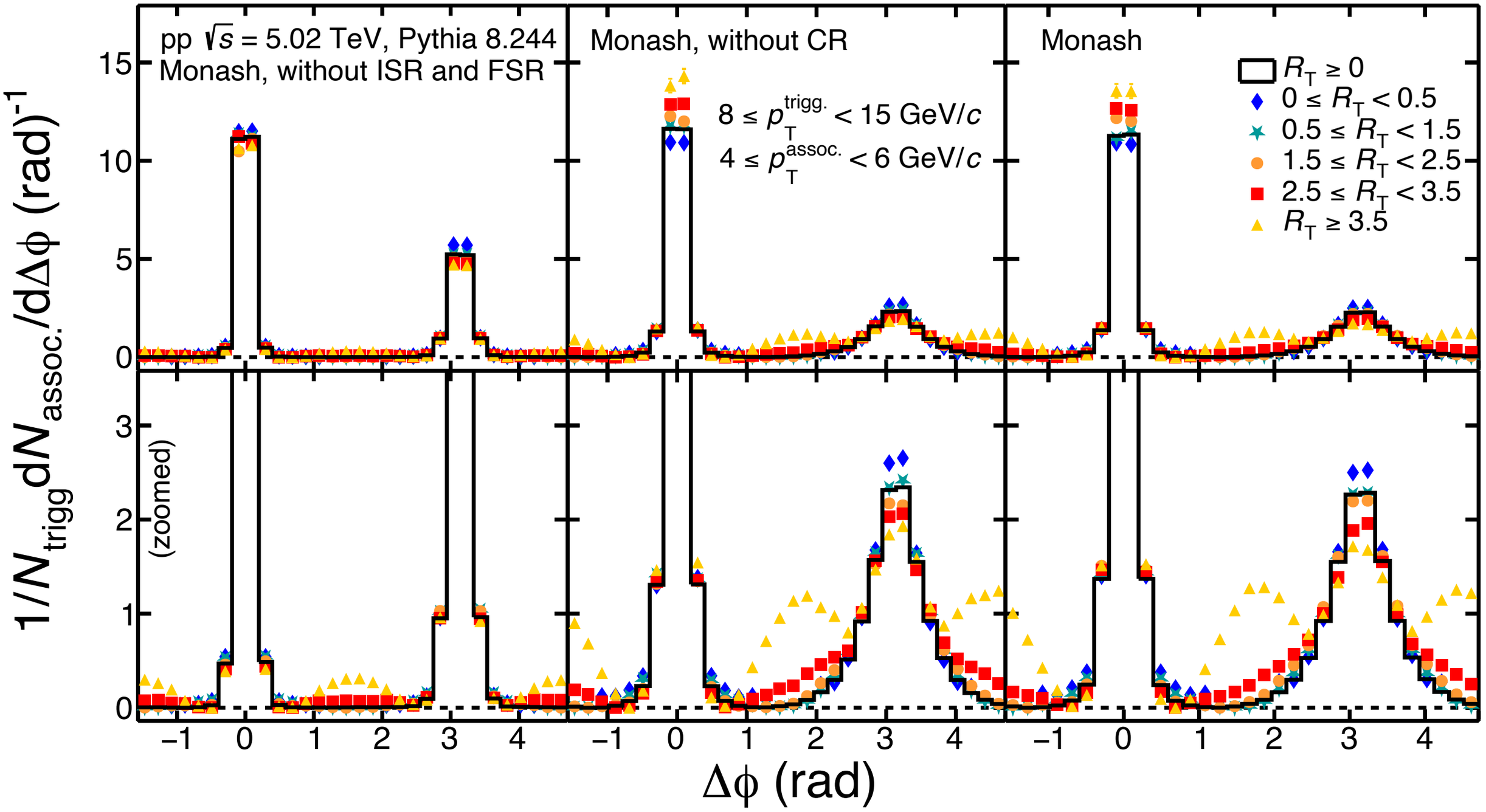


Thanks !

Backup

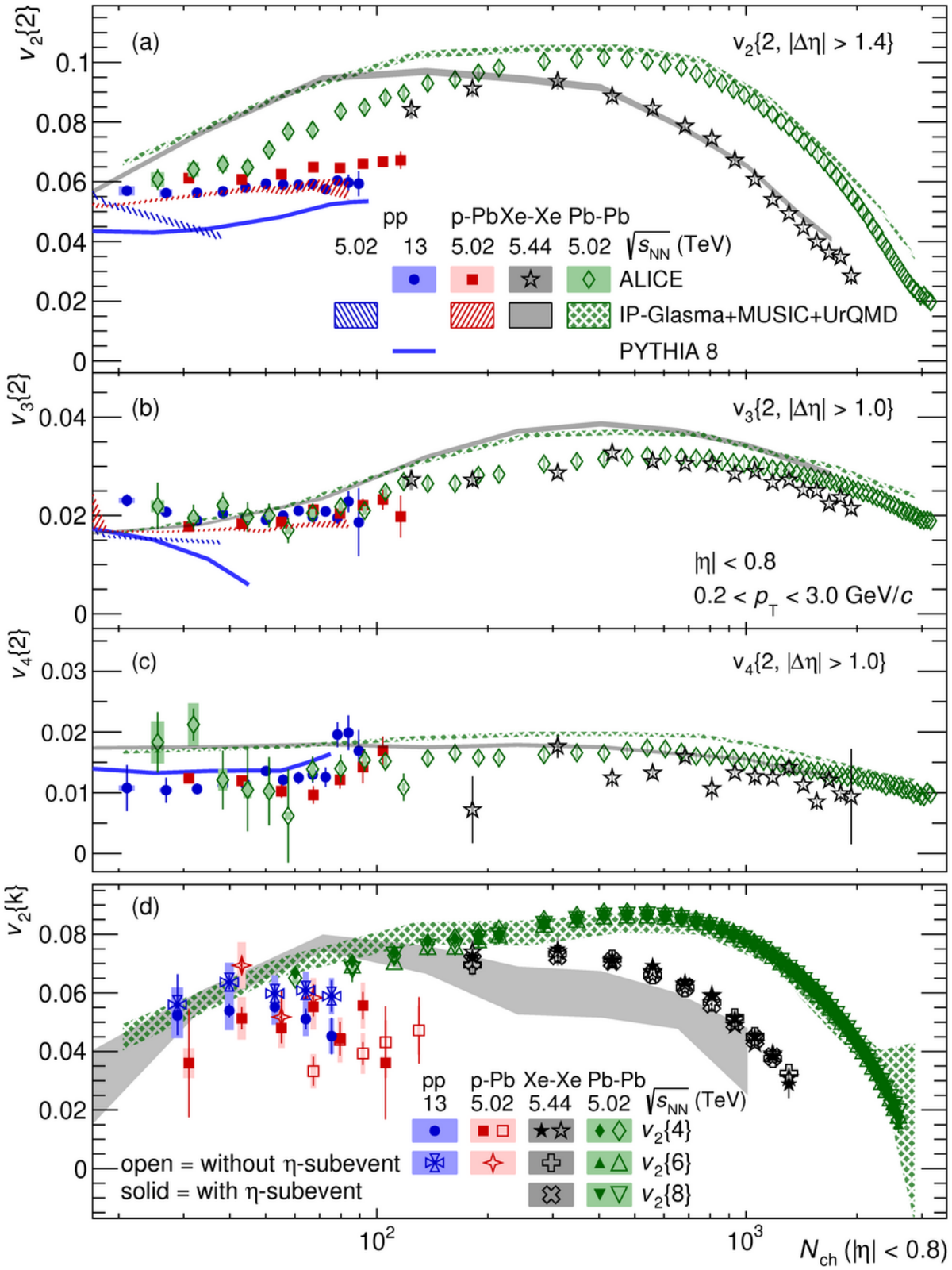
Di-hadron correlations

Instituto de Ciencias Nucleares UNAM



Collectivity in small systems

Instituto de Ciencias Nucleares UNAM



- Striking similarities between numerous observables have been observed across different collision systems at both RHIC and LHC energies, when compared at similar multiplicity
- Besides hydrodynamic description, calculations from transport models, hadronic re-scattering, Multi-Parton Interactions (MPI), string rope and shoving, as well as initial state effects have been investigated

e.g. ALICE, PRL 123, 142301 (2019)

I_{AA} vs $N_{ch}^{trans.}$ (near side)

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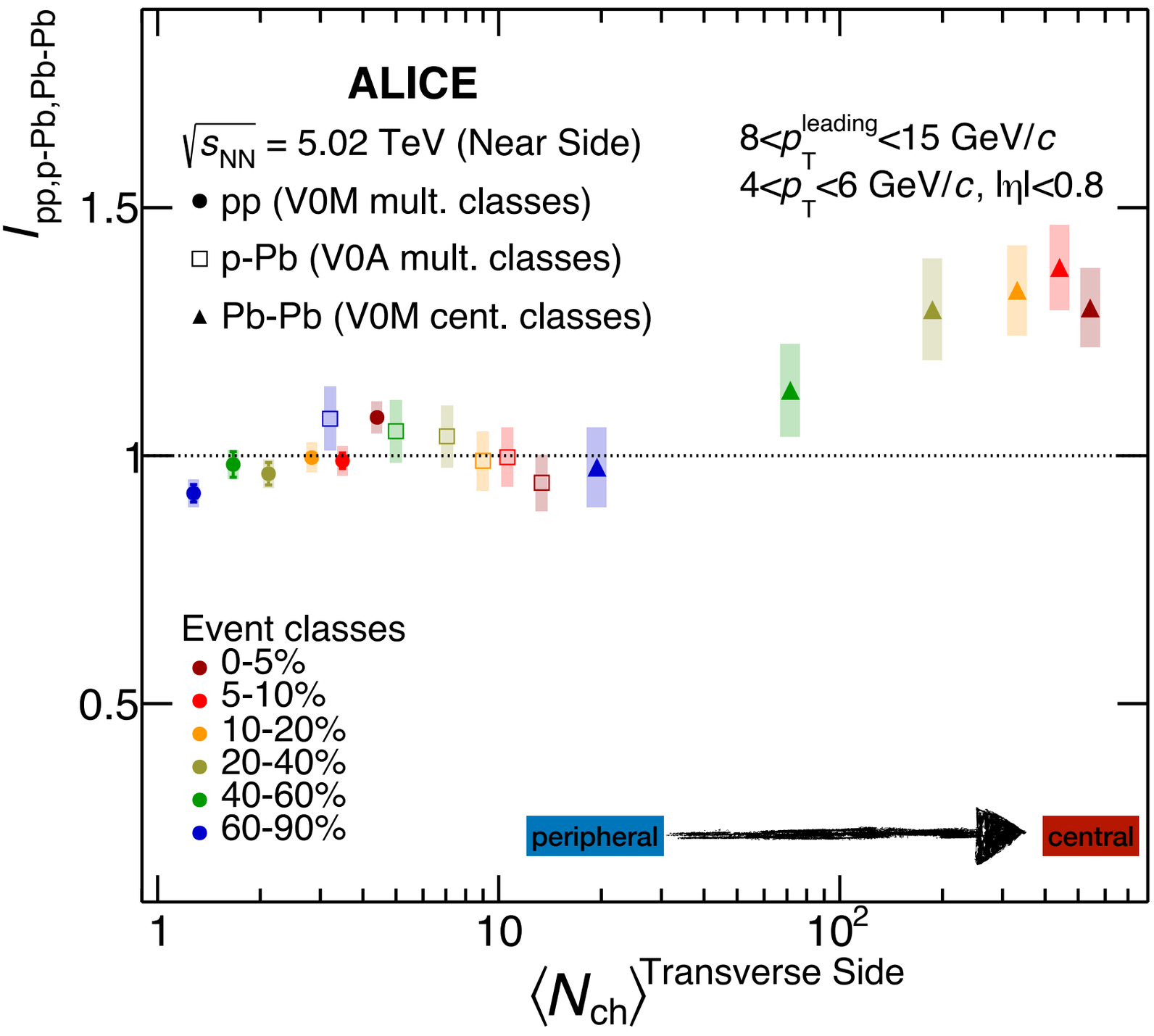

- 20-30% enhancement of IAA in central P-PB collisions [Results are consistent with ALICE, PRL 108 (2012) 092301]
- No significant enhancement is seen for small collision systems in the measured multiplicity ranges

First ALICE results on pp vs multiplicity

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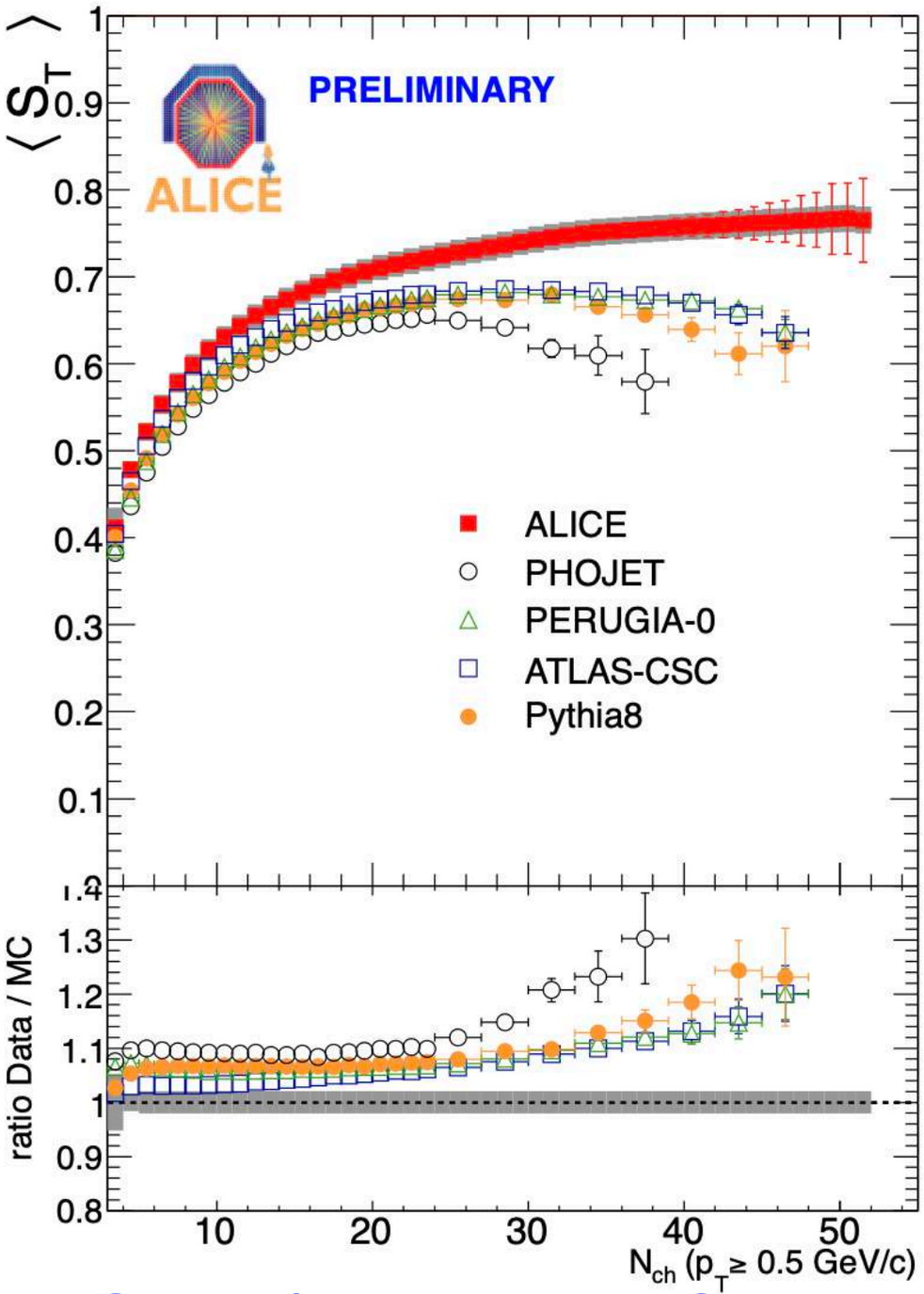
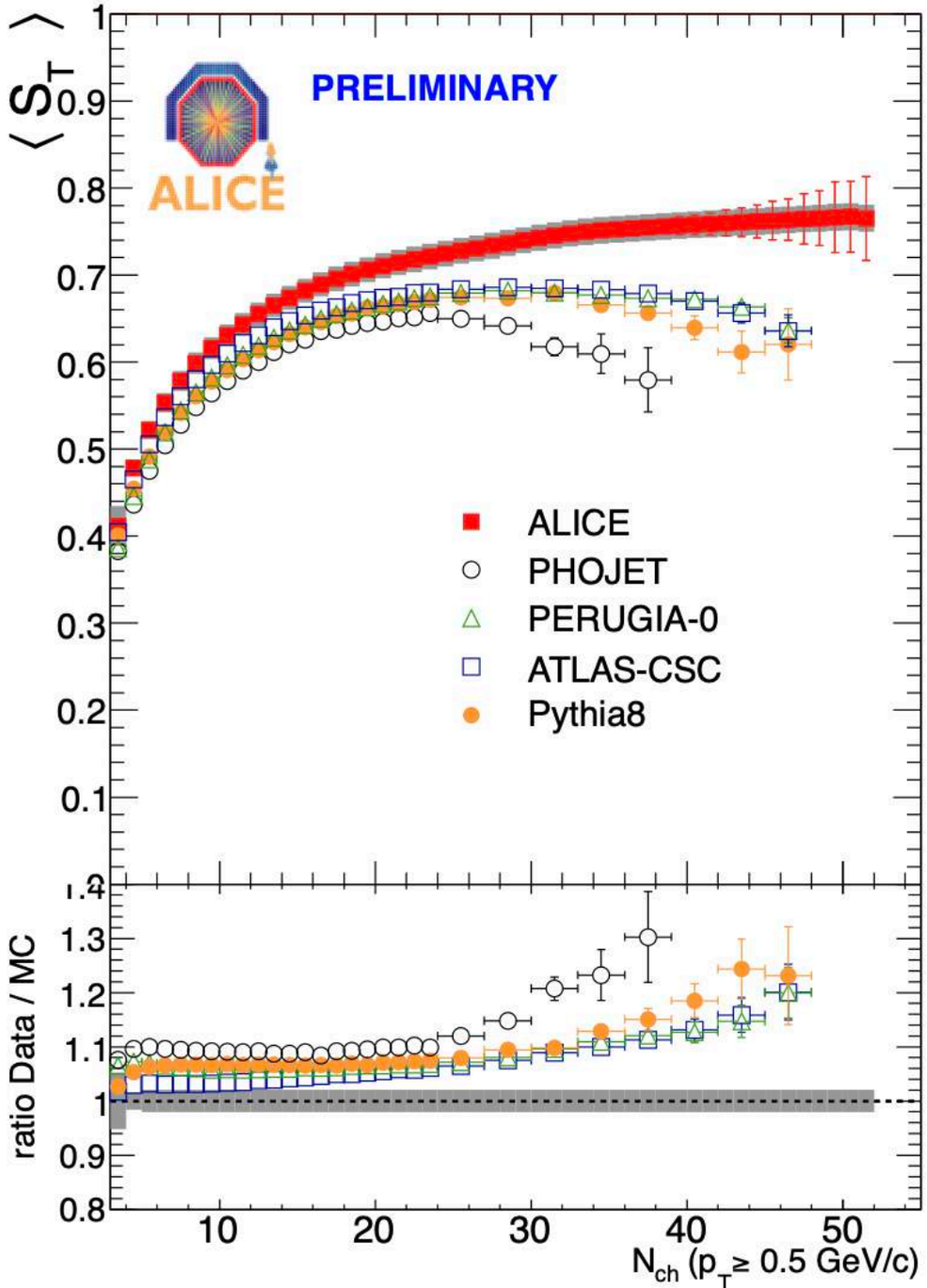


A. Ortiz (for the ALICE Collaboration), proceedings of the Physics at the LHC Conference 2011

First ALICE results on pp v



A. Ortiz (for the ALICE Collaboration), proceedings of the Physics at the LHC Conference 2011

Publications and Article Submissions

HOME ALICE COLLABORATION CONFERENCES PUBLIC & ANALYSIS NOTES

Transverse sphericity of primary charged particles in minimum bias proton-proton collisions at sqrt(s)=0.9, 2.76 and 7 TeV
- **Article reference:** Eur. Phys. J. C 72 (2012) 2124 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV , 2.76 TeV , 7 TeV **Publication date:** 31 August, 2012

Measurement of charm production at central rapidity in proton-proton collisions at $\sqrt{s} = 2.76$ TeV
- **Article reference:** JHEP 1207 (2012) 191 Publication link arXiv HEPData
- **System:** p-p **Energy:** 2.76 TeV , 7 TeV **Publication date:** 30 July, 2012

Underlying Event measurements in pp collisions at $\sqrt{s}$ = 0.9 and 7 TeV with the ALICE experiment at the LHC
- **Article reference:** JHEP 07 (2012) 116 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV , 7 TeV **Publication date:** 17 July, 2012

Multi-strange baryon production in pp collisions at $\sqrt{s}$ = 7 TeV with ALICE
- **Article reference:** Phys. Lett. B 712 (2012) 309 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 11 June, 2012

J/psi Production as a Function of Charged Particle Multiplicity in pp Collisions at sqrt(s) = 7 TeV
- **Article reference:** Phys.Lett. B712 (2012) 165-175 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 5 June, 2012

Light vector meson production in pp collisions at $\sqrt{s}$ = 7 TeV
- **Article reference:** Phys. Lett. B 710 (2012) 557-568 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 2 April, 2012

Heavy flavour decay muon production at forward rapidity in proton--proton collisions at $\sqrt{s}$ = 7 TeV
- **Article reference:** Phys. Lett. B 708 (2012) 265 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 27 February, 2012

J/ψ polarization in pp collisions at $\sqrt{s} = 7$ TeV
- **Article reference:** Phys.Rev.Lett. 108 (2012) 082001 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 22 February, 2012

Measurement of charm production at central rapidity in proton-proton collisions at $\sqrt{s} = 7$ TeV
- **Article reference:** JHEP 01 (2012) 128 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 4 January, 2012

Femtoscopy of pp collisions at $\sqrt{s} = 0.9$ and 7 TeV at the LHC with two-pion Bose-Einstein correlations
- **Article reference:** Phys. Rev. D 84 (2011) 112004 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV , 7 TeV **Publication date:** 13 December, 2011

Strange particle production in proton-proton collisions at $\sqrt{s} = 0.9$ TeV with ALICE at the LHC
- **Article reference:** Eur. Phys. J. C 71 (2011) 1594 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV **Publication date:** 13 October, 2011

Production of pions, kaons and protons in pp collisions at $\sqrt{s} = 900$ GeV with ALICE at the LHC
- **Article reference:** Eur. Phys. J. C 71 (2011) 1655 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV **Publication date:** 14 June, 2011

Two-pion Bose-Einstein correlations in pp collisions at $\sqrt{s}$ =900 GeV
- **Article reference:** Phys. Rev. D 82 (2010) 052001 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV **Publication date:** 8 September, 2010

Transverse momentum spectra of charged particles in proton-proton collisions at $\sqrt{s} = 900$ GeV with ALICE at the LHC
- **Article reference:** Phys. Lett. B 693 (2010) 53-68 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV **Publication date:** 19 August, 2010

Charged-particle multiplicity measurement in proton-proton collisions at $\sqrt{s} = 7$ TeV with ALICE at LHC
- **Article reference:** Eur. Phys. J. C 68 (2010) 345-354 Publication link arXiv HEPData
- **System:** p-p **Energy:** 7 TeV **Publication date:** 12 August, 2010

Charged-particle multiplicity measurement in proton-proton collisions at $\sqrt{s}$ = 0.9 and 2.36 TeV with ALICE at LHC
- **Article reference:** Eur. Phys. J. C 68 (2010) 89-108 Publication link arXiv HEPData
- **System:** p-p **Energy:** 900 GeV , 2.36 TeV **Publication date:** 12 August, 2010

Midrapidity antiproton-to-proton ratio in pp collisions at $\sqrt{s} = 0.9$ and 7 TeV measured by the ALICE experiment

Transverse spherocity in ALICE

Instituto de Ciencias Nucleares UNAM

First time **transverse spherocity** (S_0) was presented to the community as a tool to select special pp collisions [link]

Why study event shapes

- People use to look for kind of collectivity in high multiplicity pp events (argument: multiplicity measured in pp at 7 TeV is comparable to Cu-Cu collisions at RHIC)

K. Werner at al. Phys.Rev.C83:044915,2011
k. Werner at al. J.Phys.Conf.Ser.316:012012,2011

- However, high multiplicity events may have different event structures associated with the hardness of the event.

ALICE Collaboration, Eur. Phys. J. C (2012) 72:2124

How to isolate high multiplicity events, with isotropic distribution of transverse momentum and with a small contribution from multi-jet topologies?

Goal: Understand effects which are observed in Pb-Pb collisions and may be present in pp collisions.

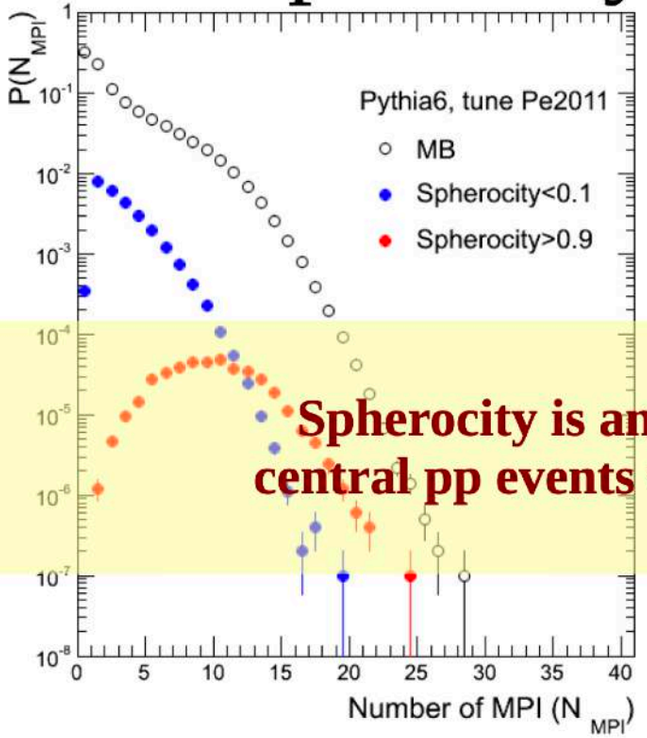
December 1st, 2012 A. Ortiz, (Symposium in honor of Guy Paic) 4

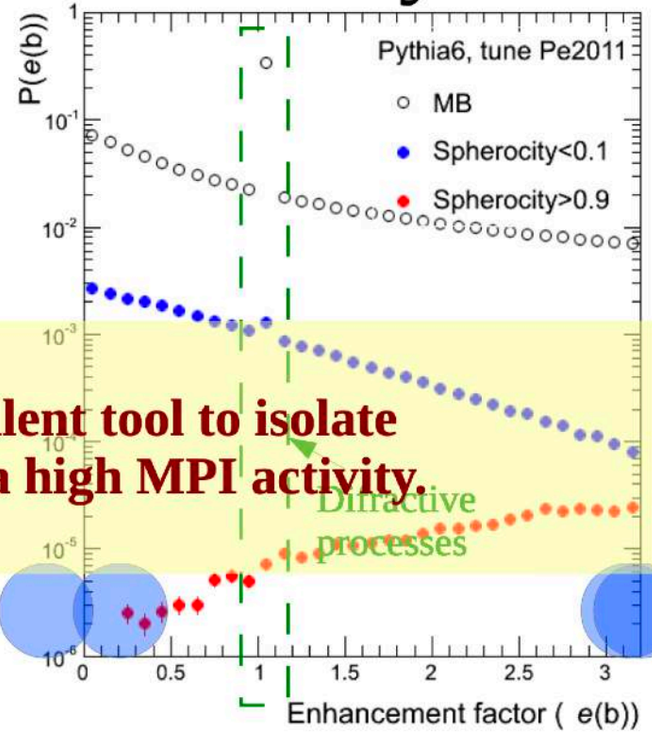
Transverse spherocity in ALICE

Instituto de Ciencias Nucleares UNAM

First time **transverse spherocity** (S_0) was presented to the community as a tool to select special pp collisions [link]

Spherocity and Centrality





Spherocity is an excellent tool to isolate central pp events with a high MPI activity.

December 1st, 2012 A. Ortiz, (Symposium in honor of Guy Paic) 18

...vent shapes

However, high multiplicity events may have different event structures associated with the hardness of the event.

...Collaboration, Eur. Phys. J. C (2012) 72:2124

How to isolate high multiplicity events, with isotropic distribution of transverse momentum and with a small contribution from multi-jet topologies?

...1

Goal: Understand effects which are observed in Pb-Pb collisions and may be present in pp collisions.

...onor of Guy Paic) 4

Di-hadron correlations [PYTHIA 8]

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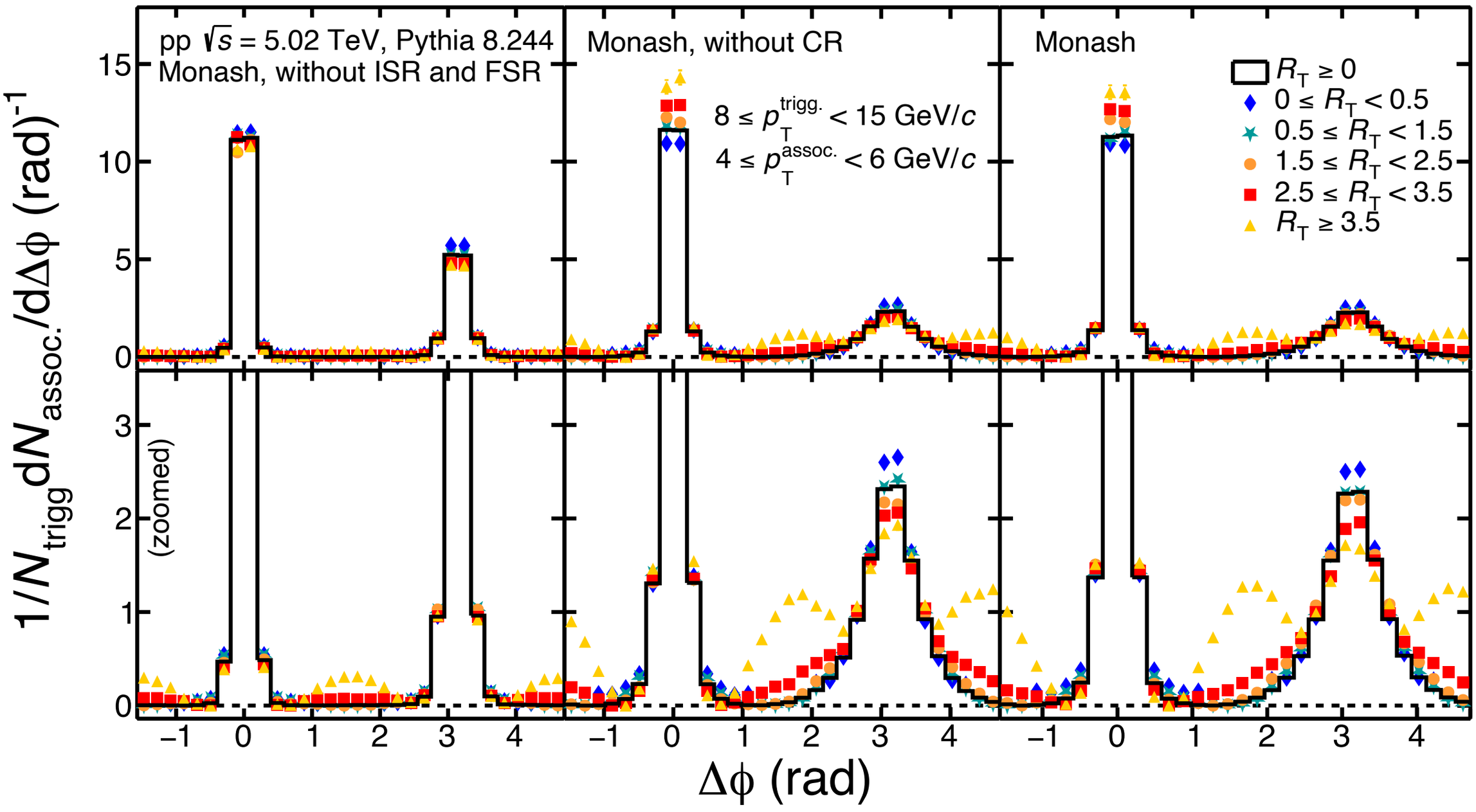

Apparent modification of the jet-like signal in events which includes ISR and FSR [the away side gets broader with increasing R_T]

I_{pp} up to R_T~3.5 [PYTHIA 8]

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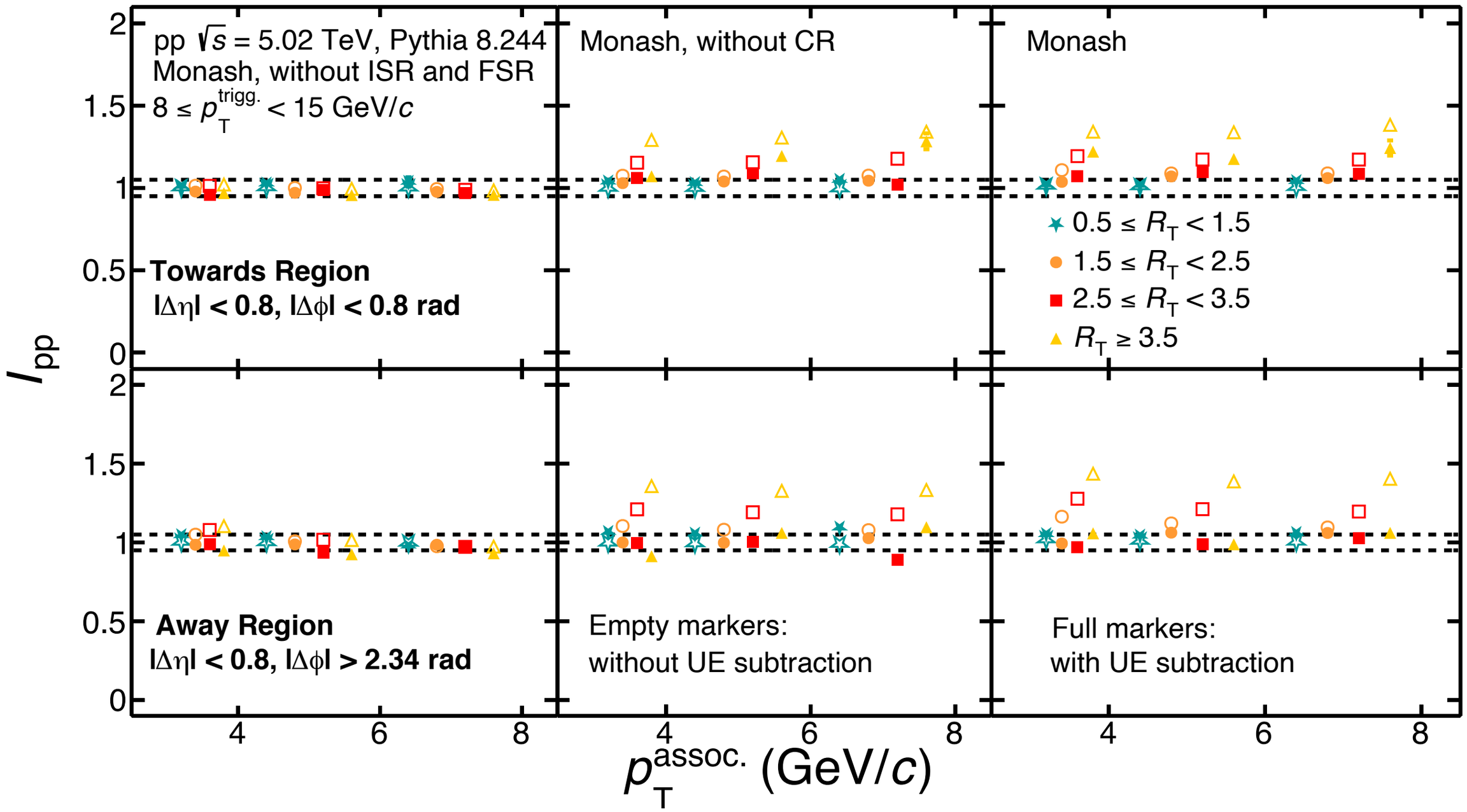
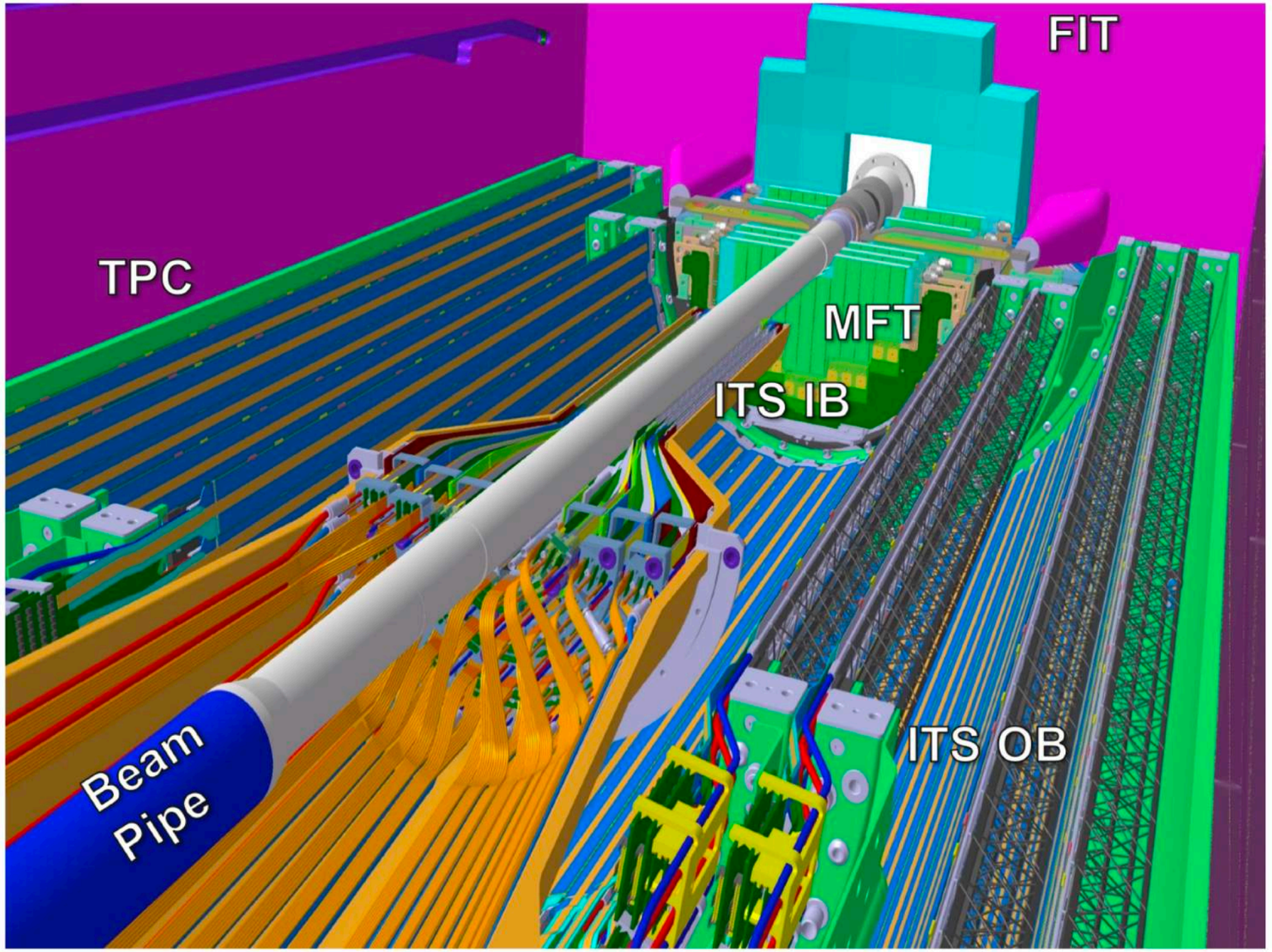


Near Side: Simulations which includes radiation gives a I_{pp} which increases with R_T (same feature observed in A-A data)

Away Side: seems to be independent of R_T [this observable is the best suited for jet quenching searches]

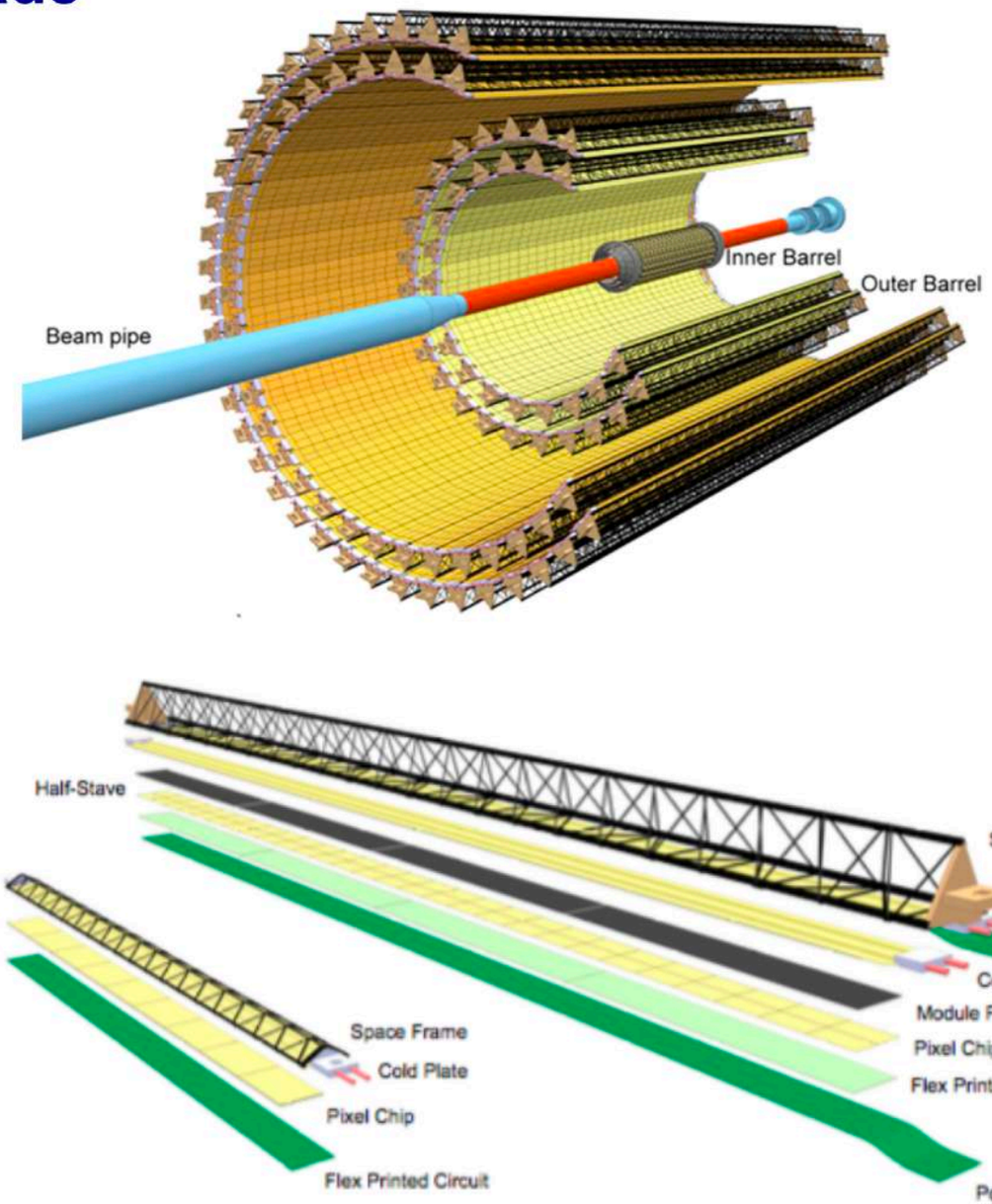
Inner central region upgrade



Inner tracking system (ITS) upgrade

Improving tracking performance at low p_T

- **Large area** (10 m^2) tracker made of **monolithic active silicon pixel sensors** ($|\eta|<1.22$)
- 7 layers from R=22 mm to R=400 mm Inner Barrel, Outer Barrel (Middle layers & Outer layers)
- **Spatial resolution O(5 μm)**
- First layer closer to IP (smaller beam pipe radius)
- **0.3%X_0 per layer** in the 3 inner most layers (light mechanical structure)



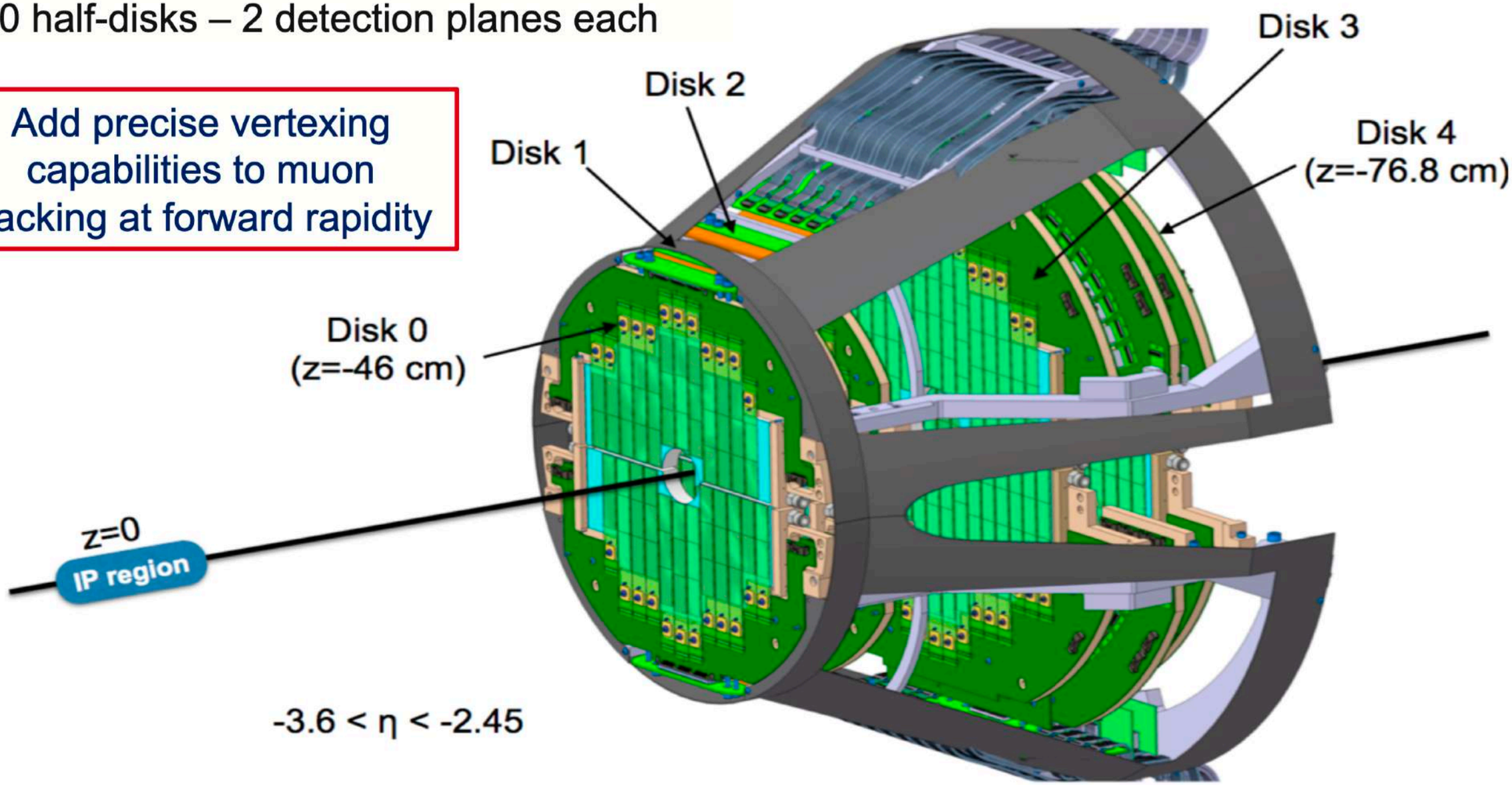
9

Muon Forward Tracker (MFT)

920 silicon pixel sensors (0.4 m²) on 280 ladders of 2 to 5 sensors each

10 half-disks – 2 detection planes each

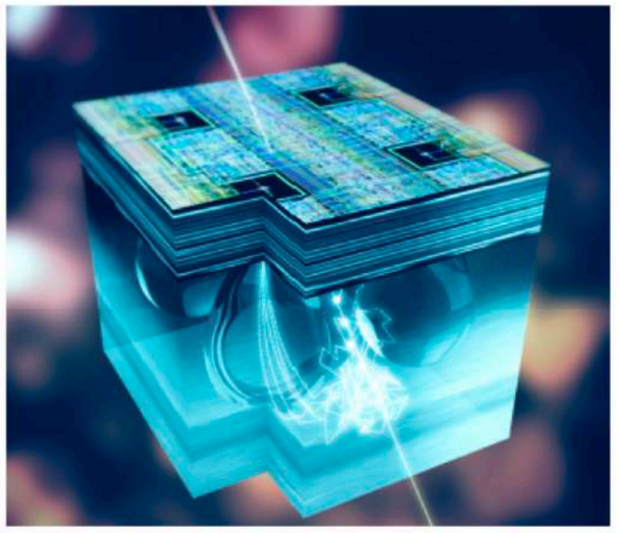
Add precise vertexing capabilities to muon tracking at forward rapidity

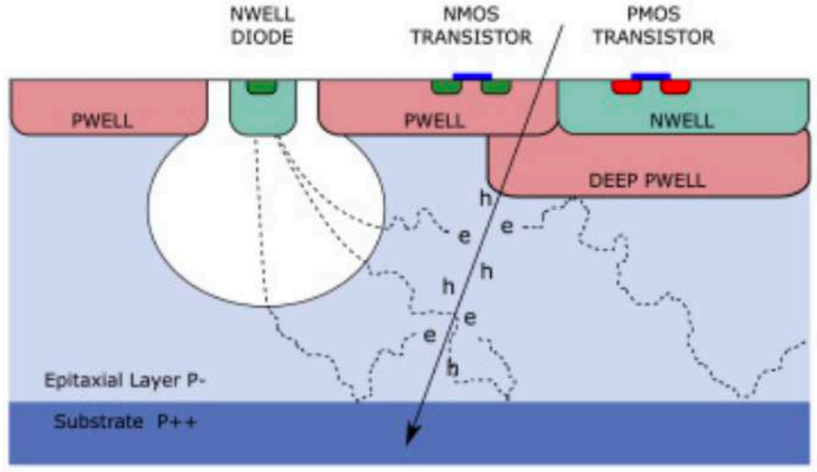


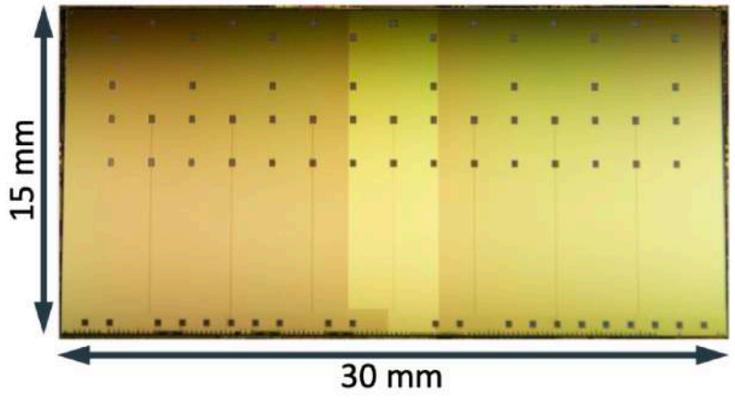
ALPIDE pixel sensor

CMOS Monolithic Active Sensors (MAPS), TowerJazz 0.18 μm technology

- **Developed for ITS and MFT**
- Thickness 50 μm (inner ITS and MFT) and 100 μm (outer ITS)
- **130 000 pixels/cm²**
  - Sensor size: 15 mm x 30 mm
  - Pixel size: 29 μm x 27 μm
- **Detection efficiency > 99%**
- Event-time resolution <4 μs
- **Space resolution: 5 μm**
- Max particle rate: 100 MHz/cm²
- Power consumption: ~40 mW/cm²
- **Radiation dose** (Run3+Run4): <300 krad, <2.0x10¹² 1MeV n_{eq}/cm²







Small systems

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Jet quenching searches in pp: one of the main topics for the LHC Run 3

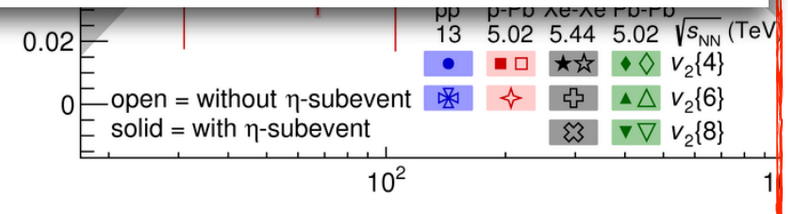
ALICE-PUBLIC-2020-005
CERN-LHCC-2020-018; LHCC-G-179

Future high-energy pp programme with ALICE

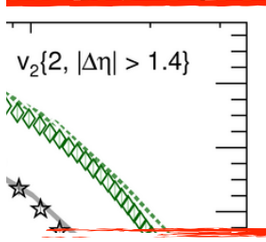
ALICE Collaboration *

– **High-density QCD effects and search for quark–gluon plasma in high-multiplicity pp collisions.** The discovery of heavy-ion-like phenomena —in particular, the long-range correlation structures (the *ridge*) and the increasing production of strangeness as a function of multiplicity— in the small collision systems, pp and p–Pb, has been a major outcome of the LHC programme so far, and one of the most unexpected. A data sample with selection of high-multiplicity events and an integrated luminosity of about 200 pb^{-1} would be larger by a factor of 10 with respect to the sample recorded during Run 2. Such increase would allow us to a) study pp collisions with a multiplicity of charged particles per unit of pseudorapidity $dN_{ch}/d\eta \approx 100$ as found in semi-peripheral Pb–Pb collisions and an estimated energy density $\varepsilon \sim 50$ GeV/fm^3 as found in central Pb–Pb collisions; b) search for jet quenching, one of the characterising quark–gluon plasma (QGP) signatures that has not been observed so far in small-system collisions, with a sensitivity to energy

Strangene enhanceme



Collectivity



tween numerous
n observed across
ems at both RHIC

Strangeness enhancement as well as v_3 and v_4 (unlike v_2) show a continuous evolution across collision systems: pp<->p-Pb<->Pb-Pb

?

Jet quenching

Focus of this talk