Flattenicity: a new event classifier to study pp collisions

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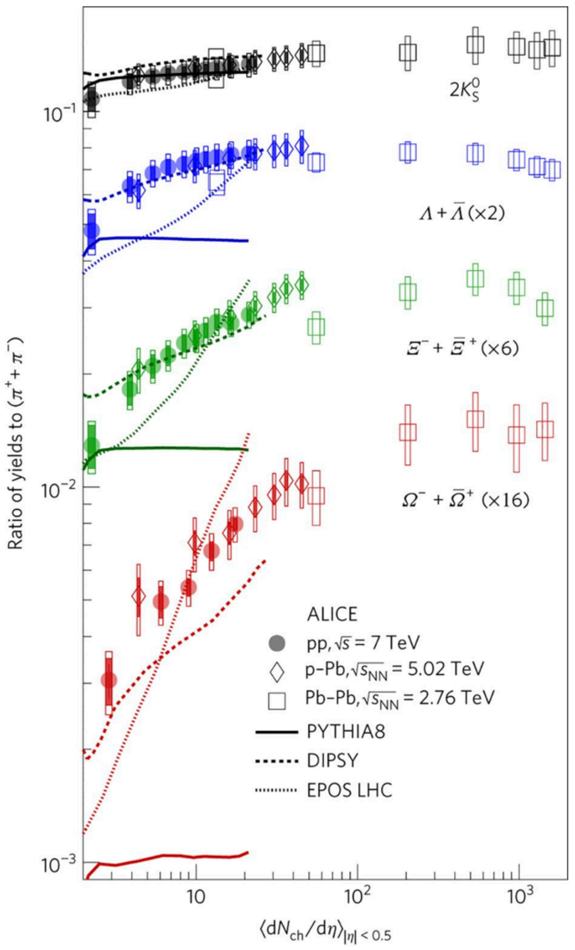
Theoretical Physics Seminar,
Wigner Research Centre for Physics
26/08/2022

Introduction

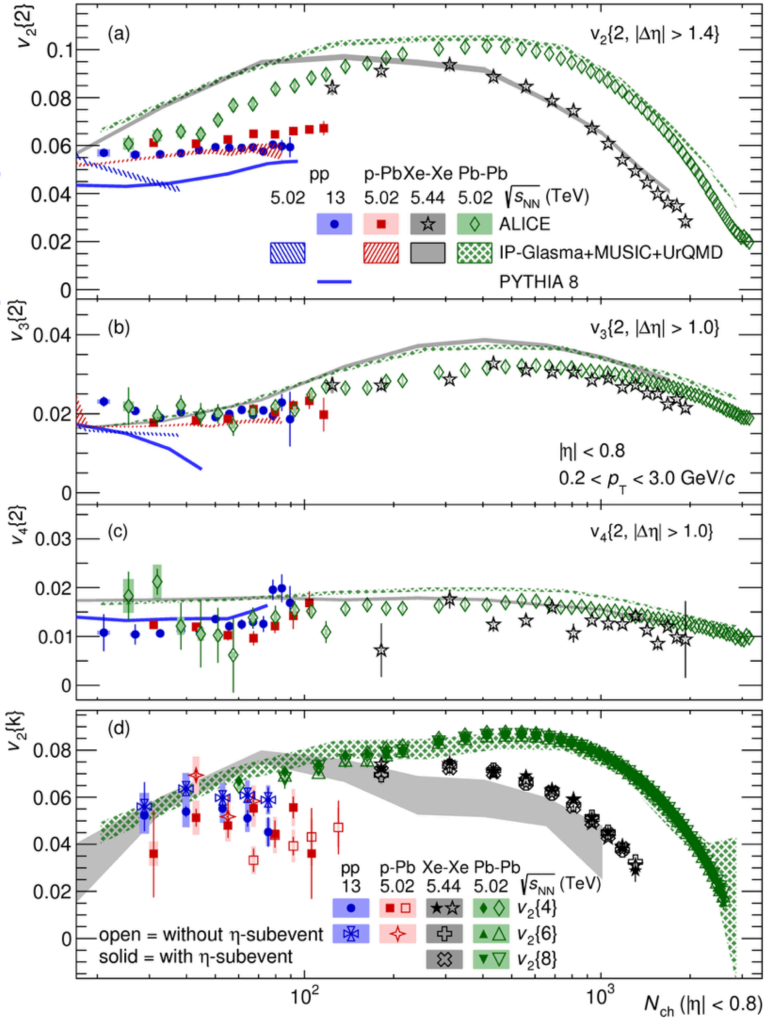
Small collision systems

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



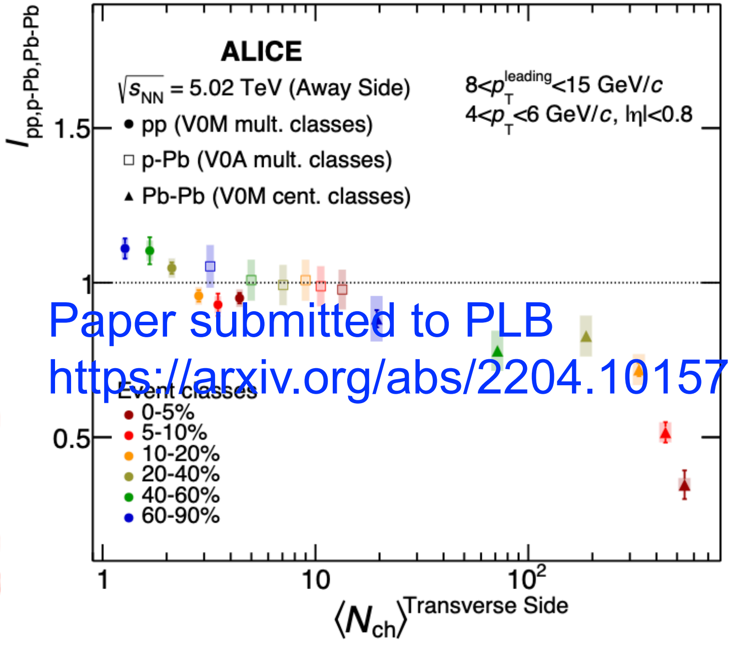
Strangeness enhancement

ALICE, PRL 123, 142301 (2019)



Collectivity

Effects at high p_T

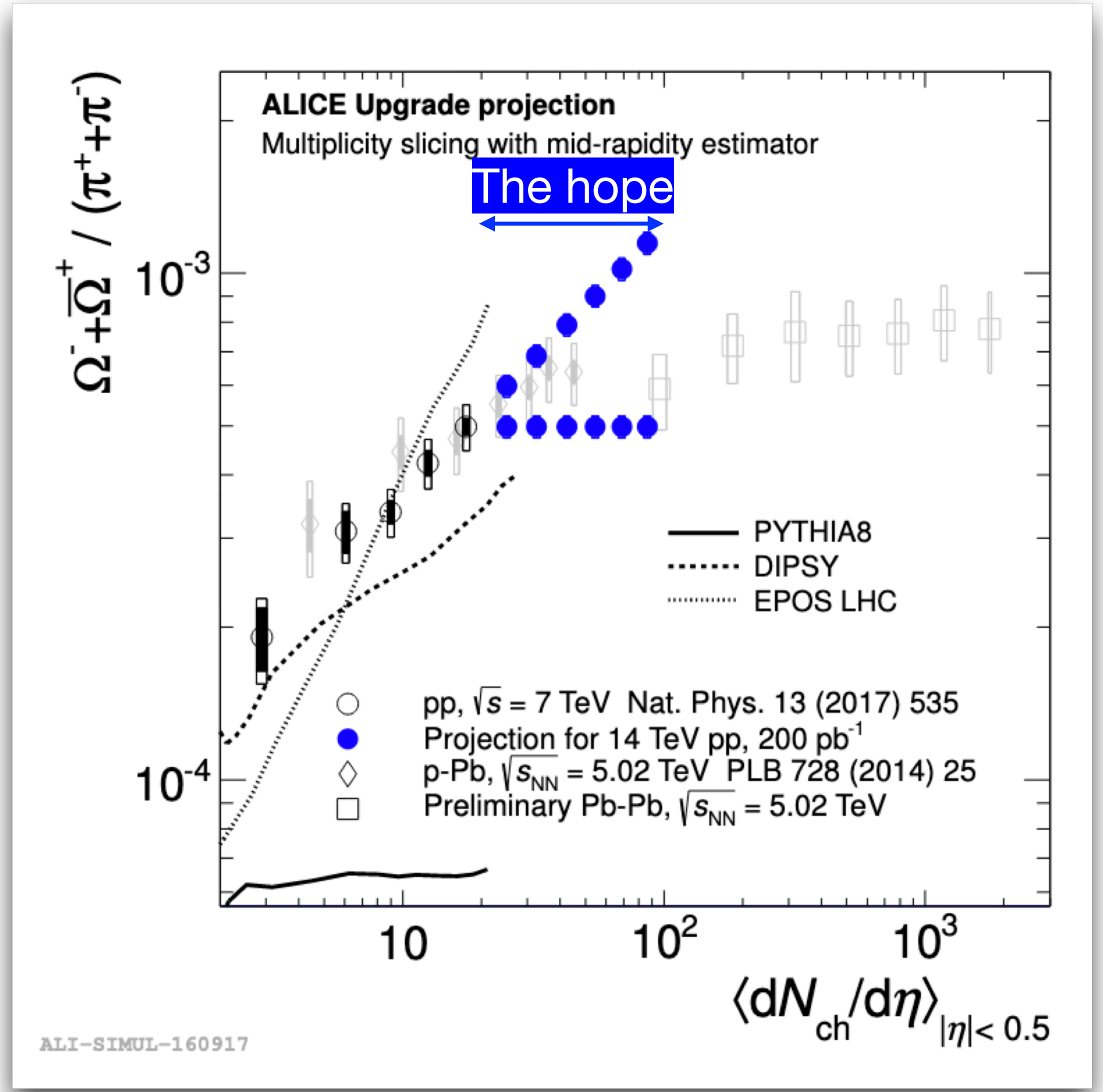


Paper submitted to PLB
https://arxiv.org/abs/2204.10157

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

ALICE plans for runs 3 and 4

- Study pp collisions with $\mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \approx 100$ (estimated energy density $\epsilon \approx 50\ \mathrm{GeV/fm^3}$ as found in central Pb–Pb collisions)
- Search for jet quenching effects
- Check whether the Ω/π ratio reaches or exceeds the thermal limit

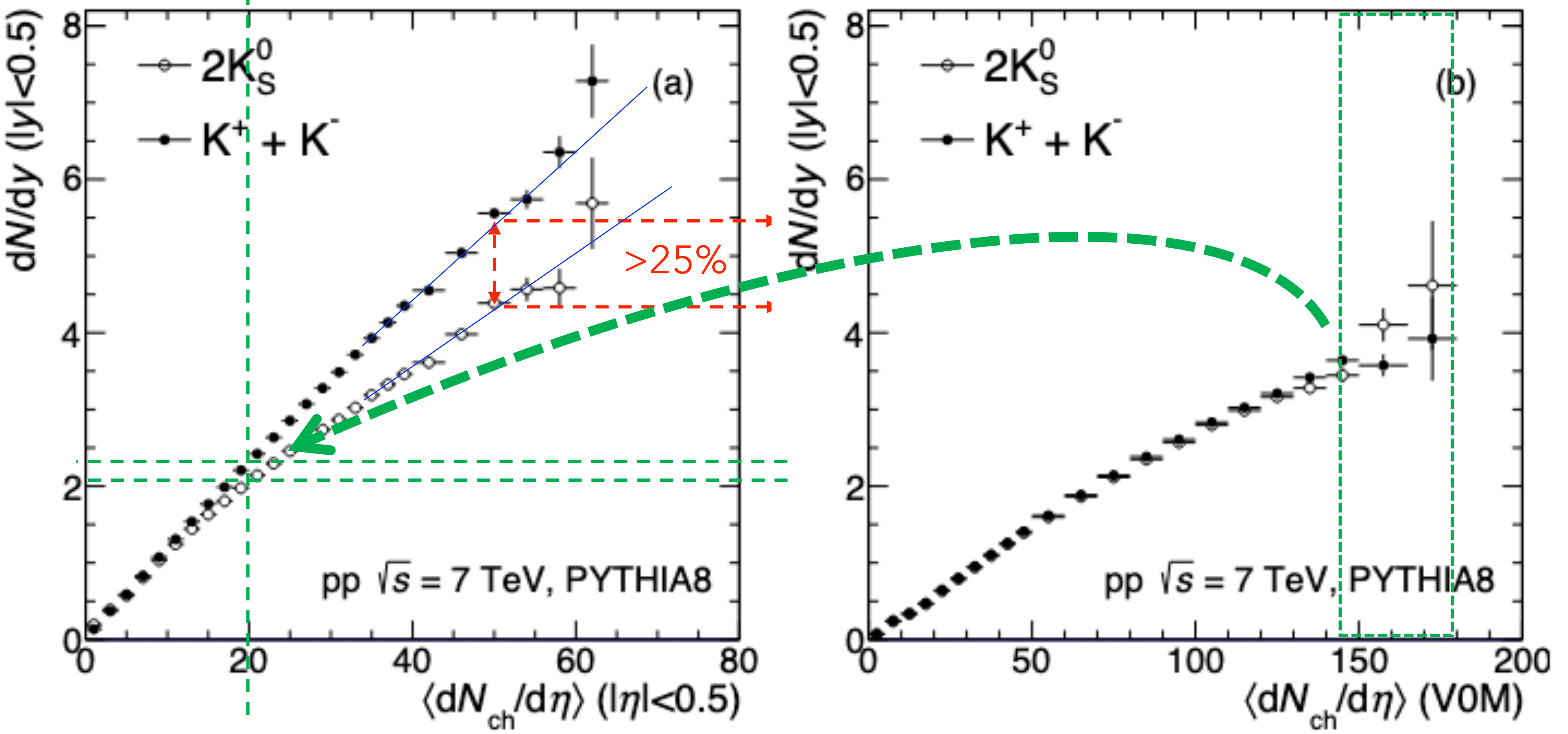


ALICE-PUBLIC-2020-005

Expected issues for very HM pp collisions

ALICE, Phys. Rev. C 99, 024906 (2019)

$dN_{ch}/ d\eta \approx 20$



- Charged particles bias

- Better control of the biases when the multiplicity is measured in the V0 detector, but at the cost of a lower multiplicity reach ($|\eta| < 0.5$)

Selection biases II

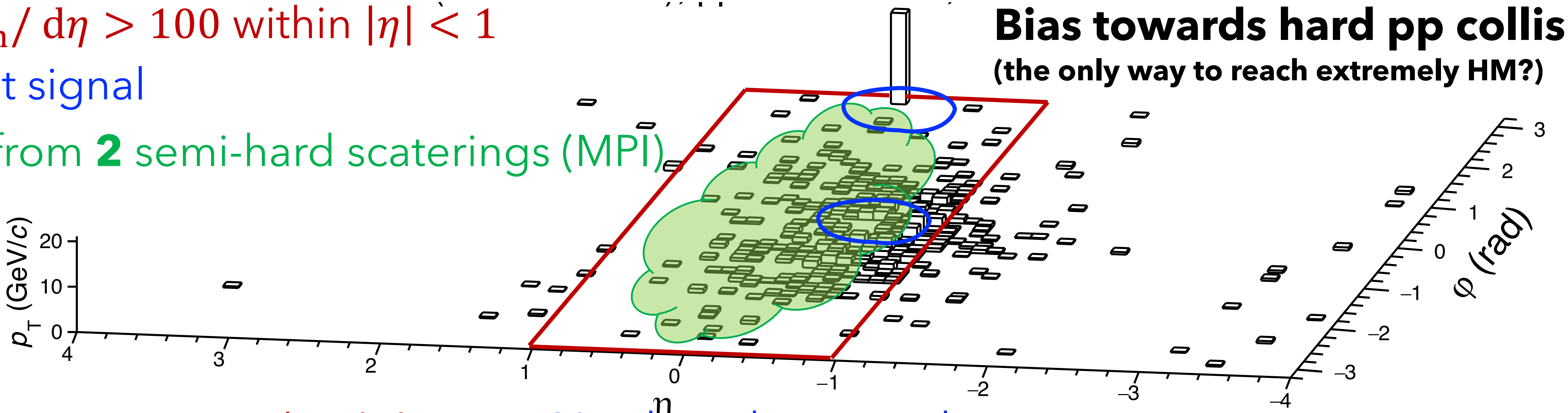
$\mathrm{d}N_{\mathrm{ch}}/\,\mathrm{d}\eta > 100$ within $|\eta| < 1$

Dijet signal

UE from **2** semi-hard scaterings (MPI)

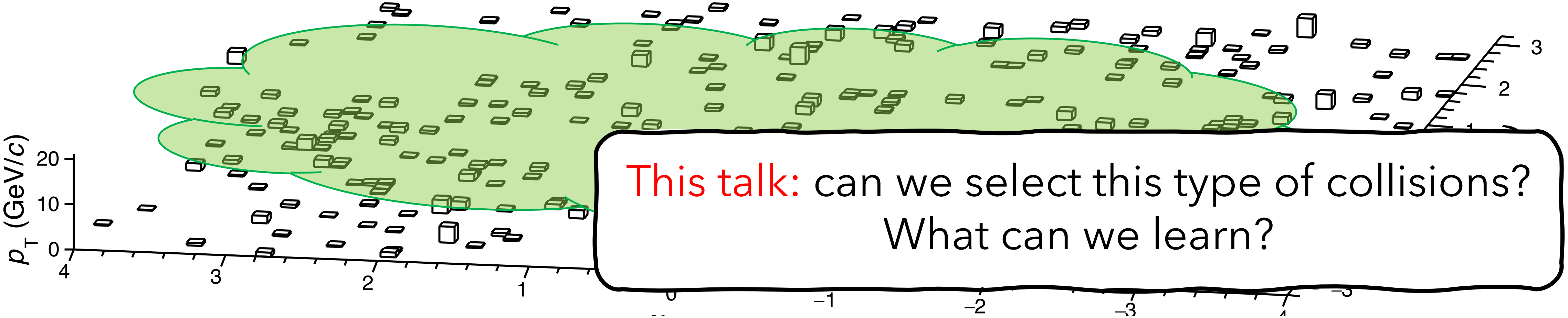
Bias towards hard pp collisions

(the only way to reach extremely HM?)



$\mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta \approx 50$ within $|\eta| < 1$

No clear dijet signal



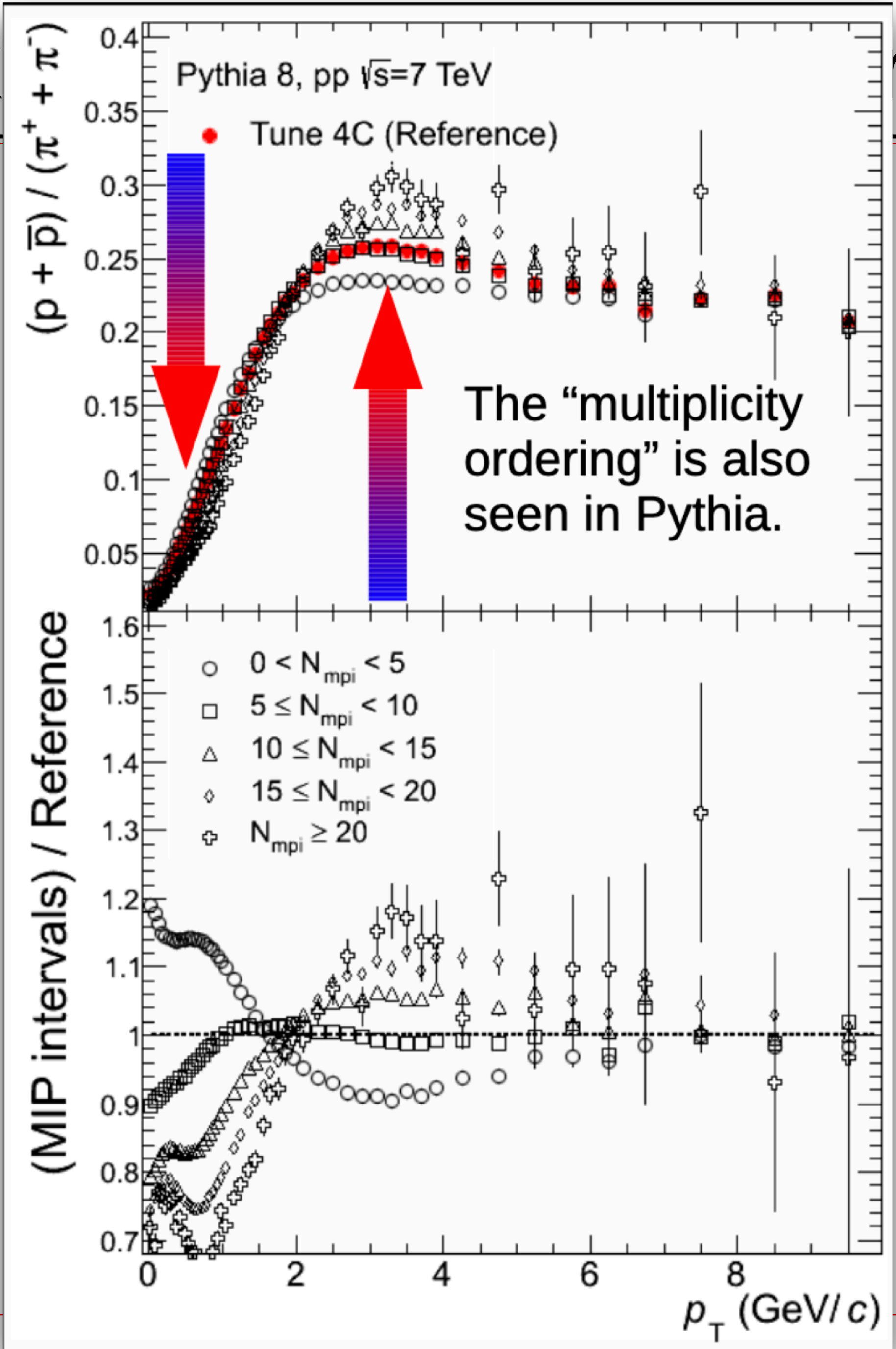
This talk: can we select this type of collisions?
What can we learn?

Isotropic pp collisions ("only UE")

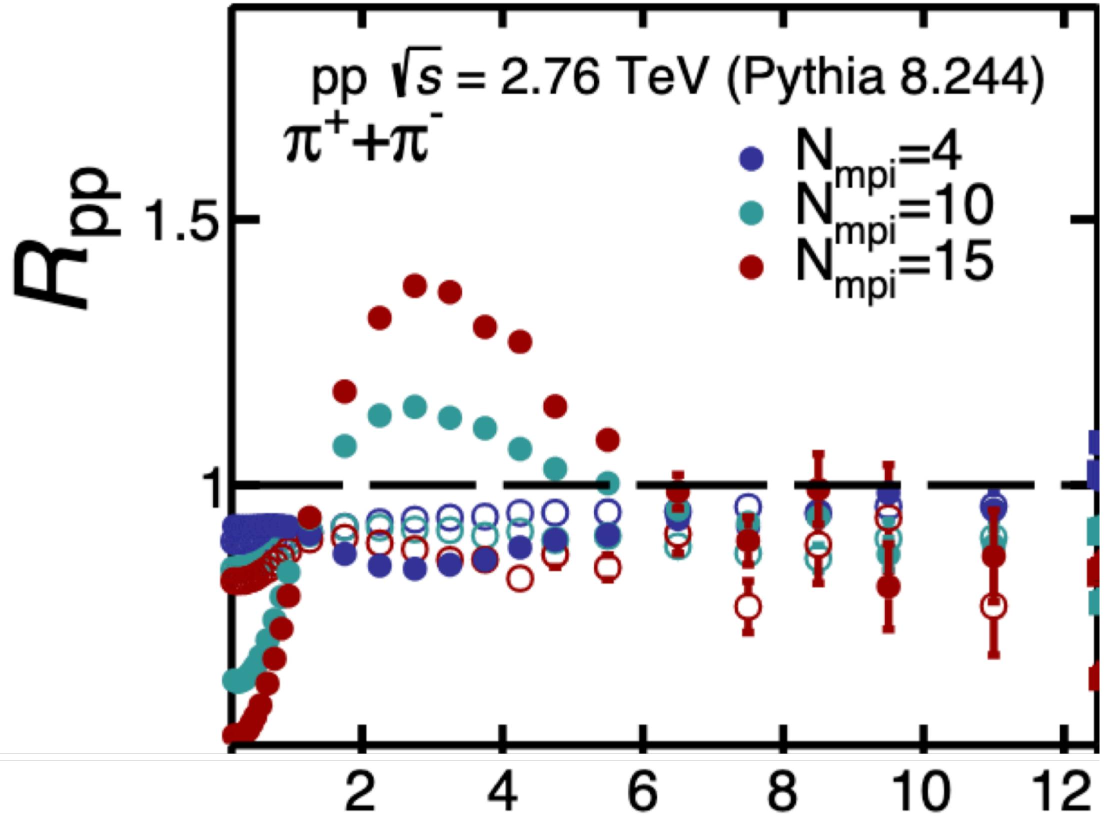
(interesting: several scaterred partons in the same collision, they must interact before the hadronization)

Ex... nts with active MPI

Phys. Rev. Lett. 111, 042001 (2013)



Phys. Rev.D 102 (2020) 7, 076014



$$R_{\rm pp} = \frac{{\rm d}^2 N_{\rm ch}^{\rm mpi}/(\langle N_{\rm mpi}\rangle {\rm d}\eta {\rm d}p_{\rm T})}{{\rm d}^2 N_{\rm ch}^{\rm MB}/(\langle N_{\rm mpi}^{\rm MB}\rangle {\rm d}\eta {\rm d}p_{\rm T})}$$

First attempts to classify the events

Using sphericity we found that the system created in pp collisions are more isotropic than predicted by models. The minijet analysis supports the picture of MPI in pp collisions

ALICE, EPJC 72 (2012) 2124 / JHEP 09 (2013)

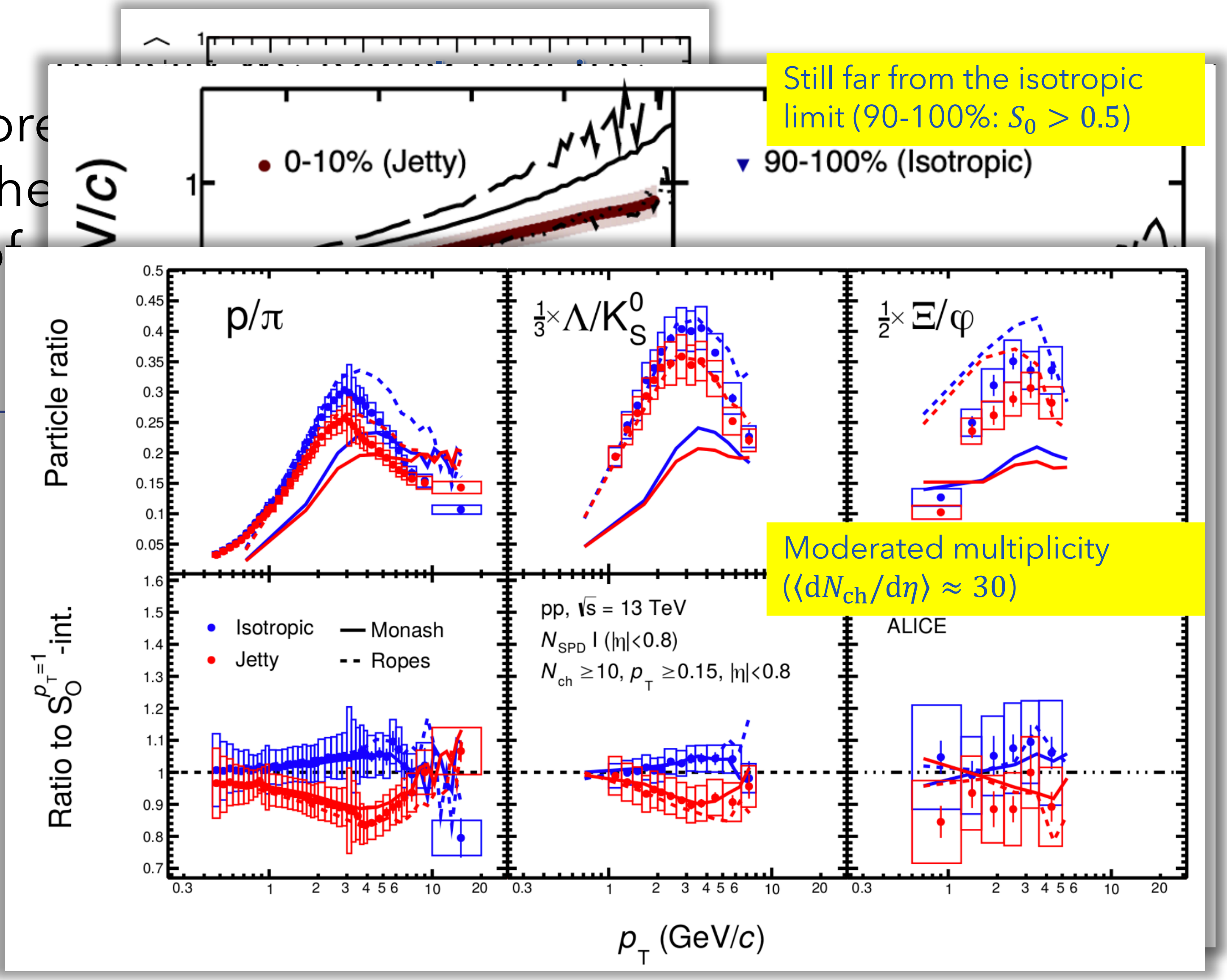
Bigger $\langle p_{\mathrm{T}} \rangle$ in jetty than in isotropic events, models face difficulties to reproduce the data

ALICE, EPJC 79 (2019) no.10, 857

ID hadron production is different in jetty vs isotropic events

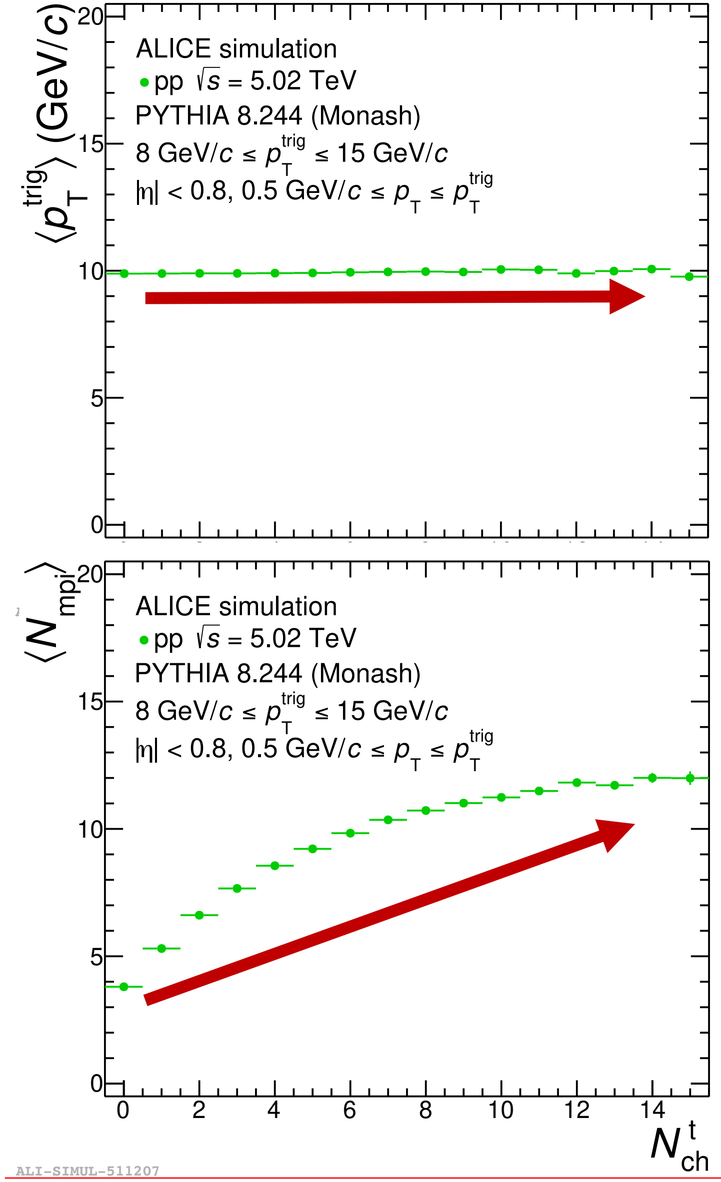
Still far from the isotropic limit (90-100%: $S_0 > 0.5$)

Moderated multiplicity ($\langle dN_{ch}/d\eta \rangle \approx 30$)



Still far from selecting pp collisions from several MPI

Extremes of UE from a different perspective

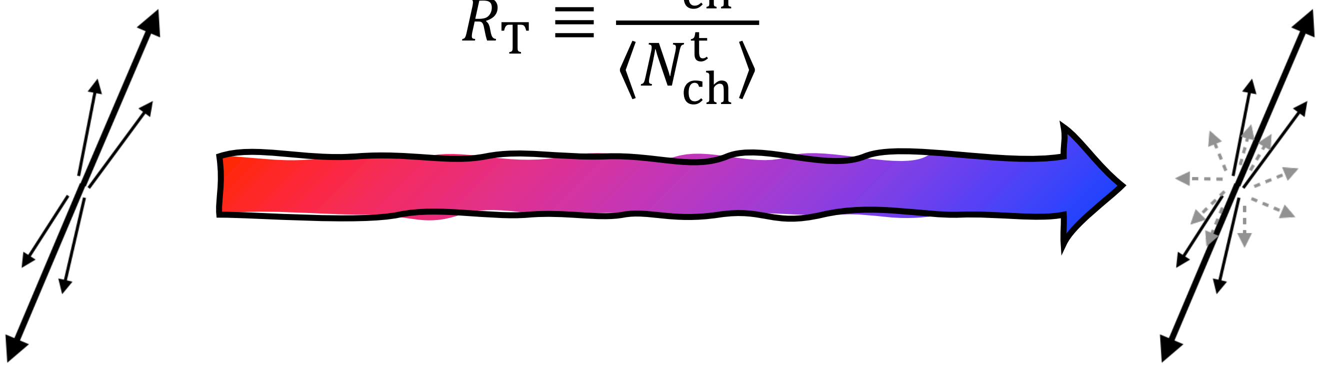


$N_{\rm ch}^{\rm t}$: multiplicity in the transvere region of the di-hadron correlations at the plateau (i.e., the $p_{\rm T}^{\rm trig}$-region where the average UE activity saturates, $p_{\rm T}^{\rm trig} > 5$ GeV/c)

The jet-like signal is $N_{\rm ch}^{\rm t}$ independent / UE increases with $N_{\rm ch}^{\rm t}$

To exprerimentaly control the UE activity, we define the self-normalized $N_{\rm ch}^{\rm t}$:

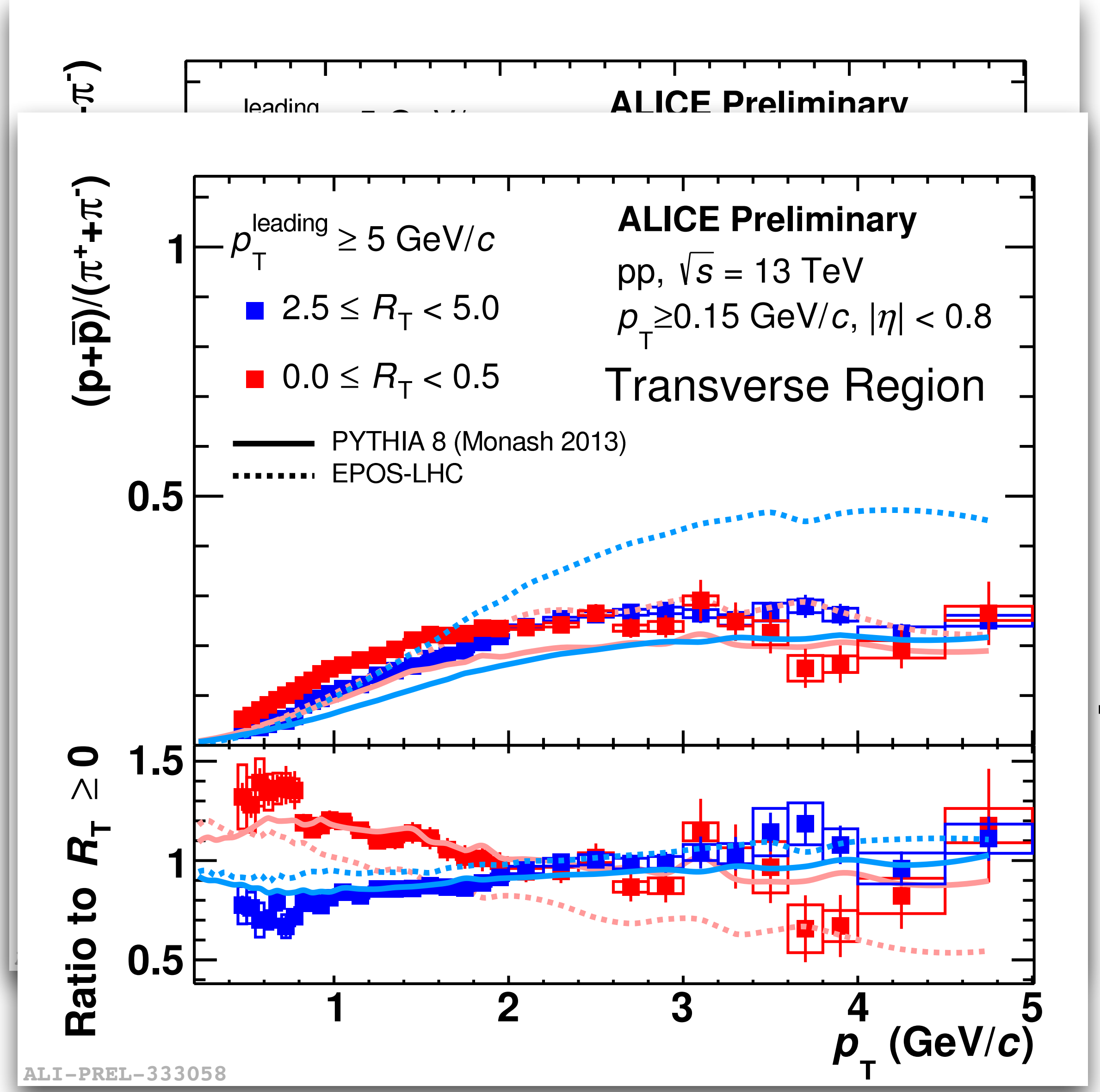
$$R_{\rm T} \equiv \frac{N_{\rm ch}^{\rm t}}{\langle N_{\rm ch}^{\rm t} \rangle}$$

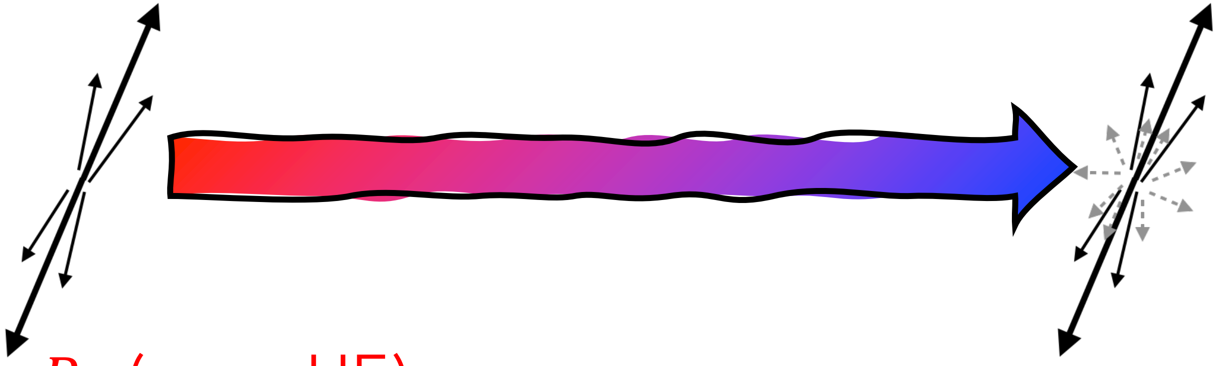


Low $R_{\rm T}$ (poor UE)

High $R_{\rm T}$ (large UE)

Particle ratios vs R_T





Low R_T (poor UE)

Toward region: not a surprise because we compare jet vs (jet+UE)

Transverse region: An enhancement of the particle ratio at intermediate pT is expected (high RT relative to low RT). We do not see it probably due to hard ISR&FSR:

[PRD 104 (2021) 1, 016017](PRD 104 (2021) 1, 016017)

Is there any way to improve the multiplicity estimator (small selection biases & high Nch reach)?

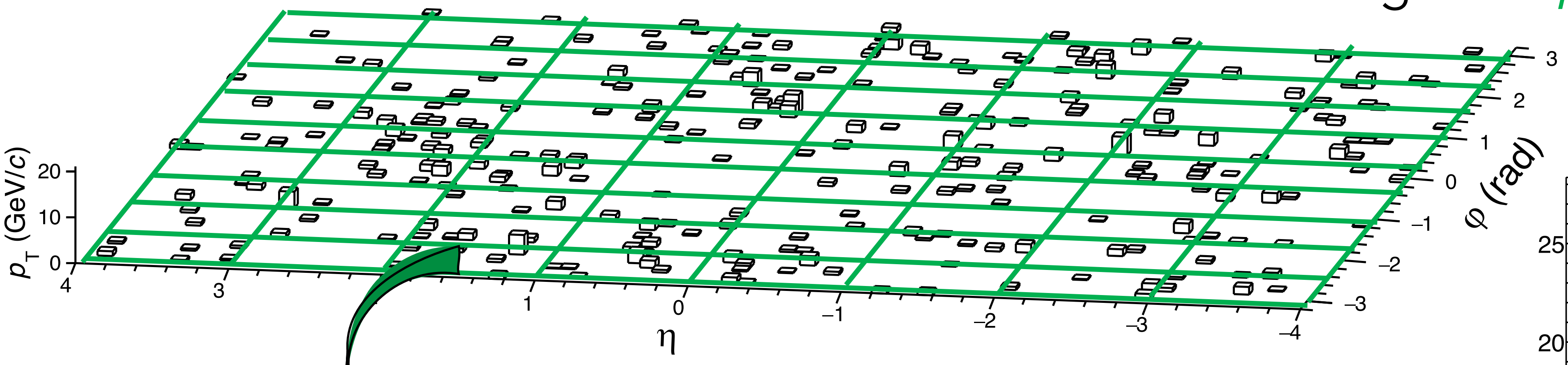
Flattenicity

CERN Instituto de Ciencias Nucleares UNAM ALICE

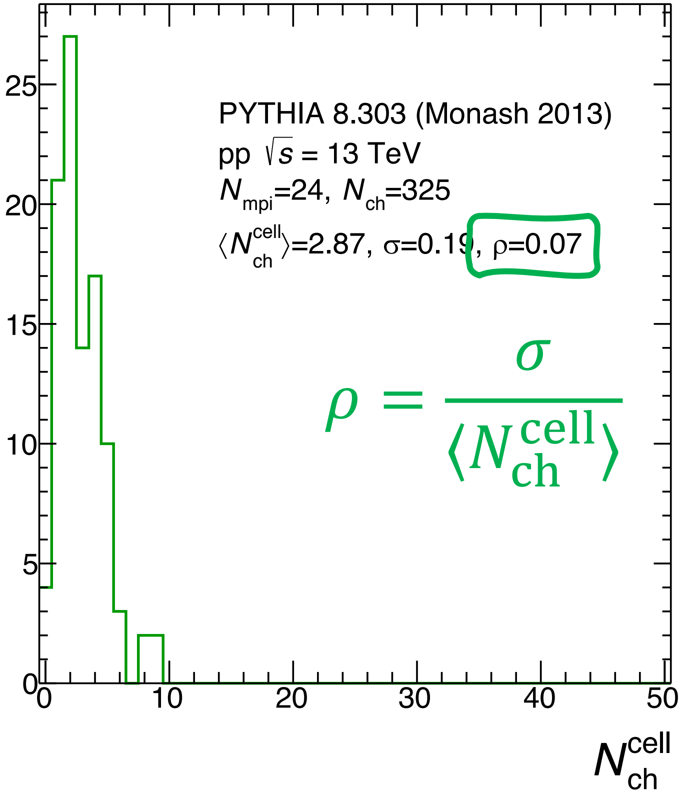
PYTHIA 8.303 (Monash 2013), pp $\sqrt{s}$ = 13 TeV, N_{mpi}=24, N_{ch}=325

A. O. and Guy Paic, 2204.13733

A grid in $\varphi - \eta$ is built: 10×8



In each cell, the charged particle multiplicity is computed: N_{ch}^{cell}



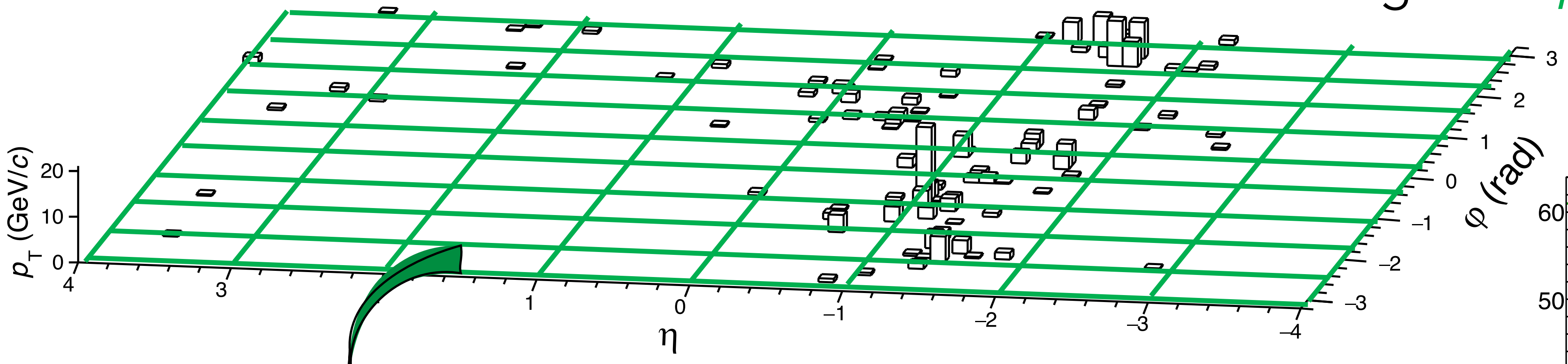
EbE the N_{ch}^{cell} distribution is obtained

Events with isotropic distribution of particles (very active MPI) are expected to have small ρ values

Flattenicity

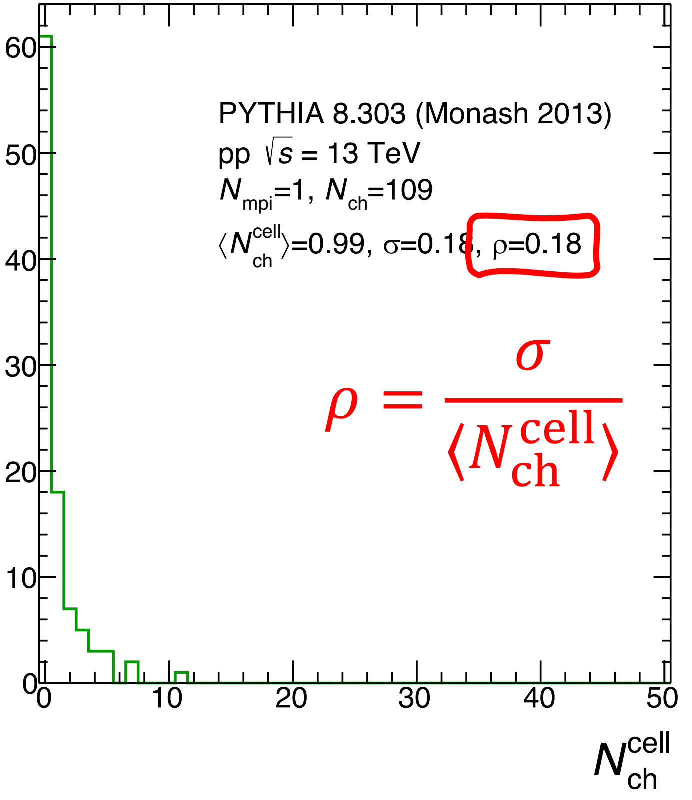
[A. O. and Guy Paic, 2204.13733](https://arxiv.org/abs/2204.13733)

PYTHIA 8.303 (Monash 2013), pp $\sqrt{s}$ = 13 TeV, N_{mpi}=1, N_{ch}=109



A grid in $\varphi - \eta$ is built: $10{\times}8$

In each cell, the charged particle multiplicity is computed: $N_{\mathrm{ch}}^{\mathrm{cell}}$

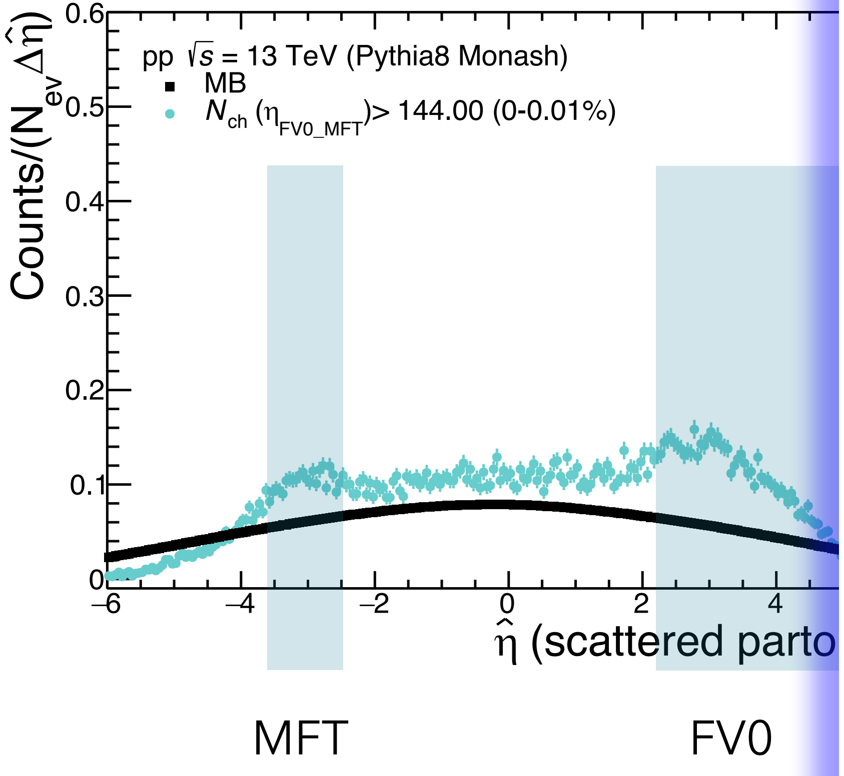


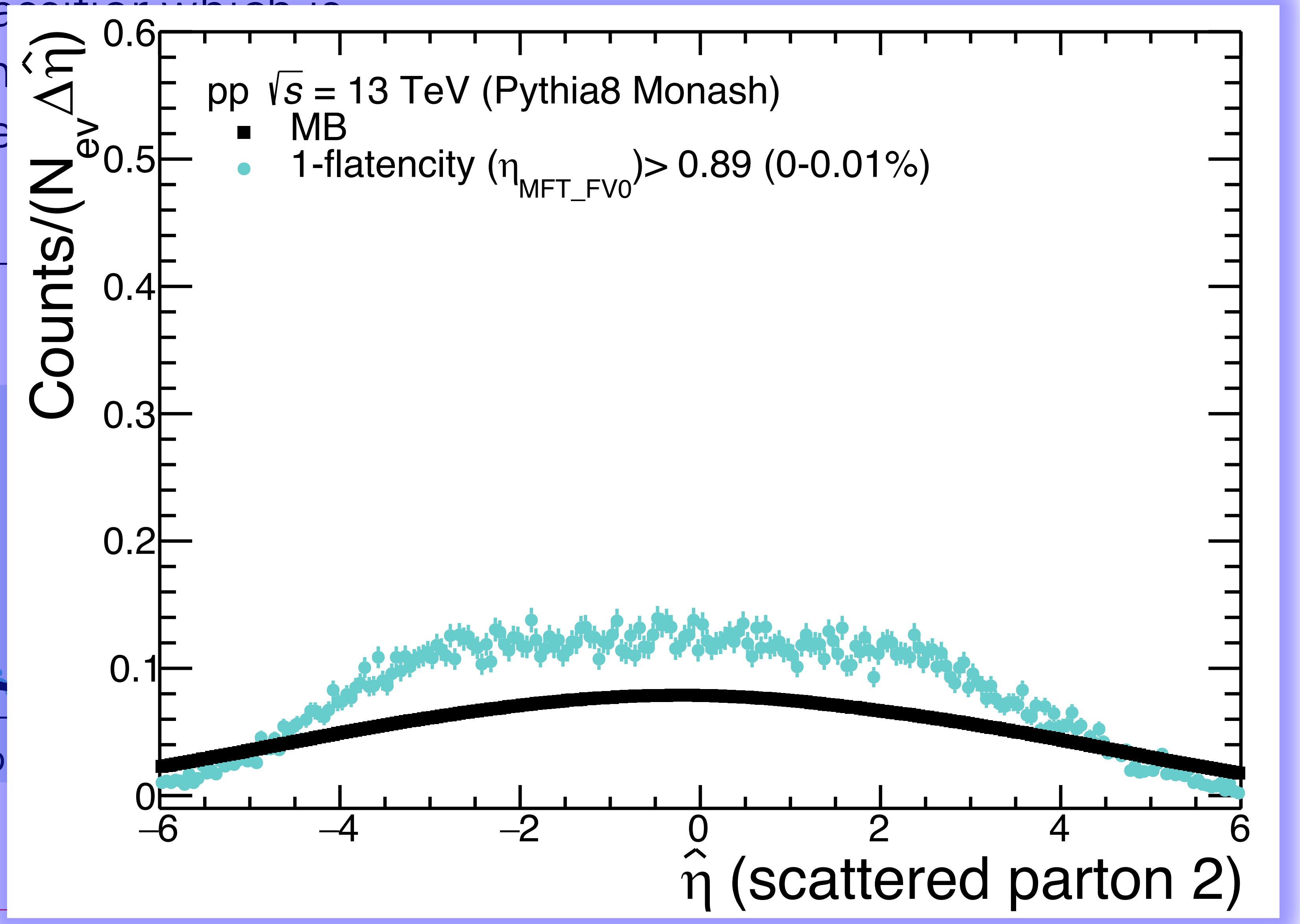
$$\rho = \frac{\sigma}{\langle N_{\mathrm{ch}}^{\mathrm{cell}} \rangle}$$

EbE the $N_{\mathrm{ch}}^{\mathrm{cell}}$ distribution is obtained

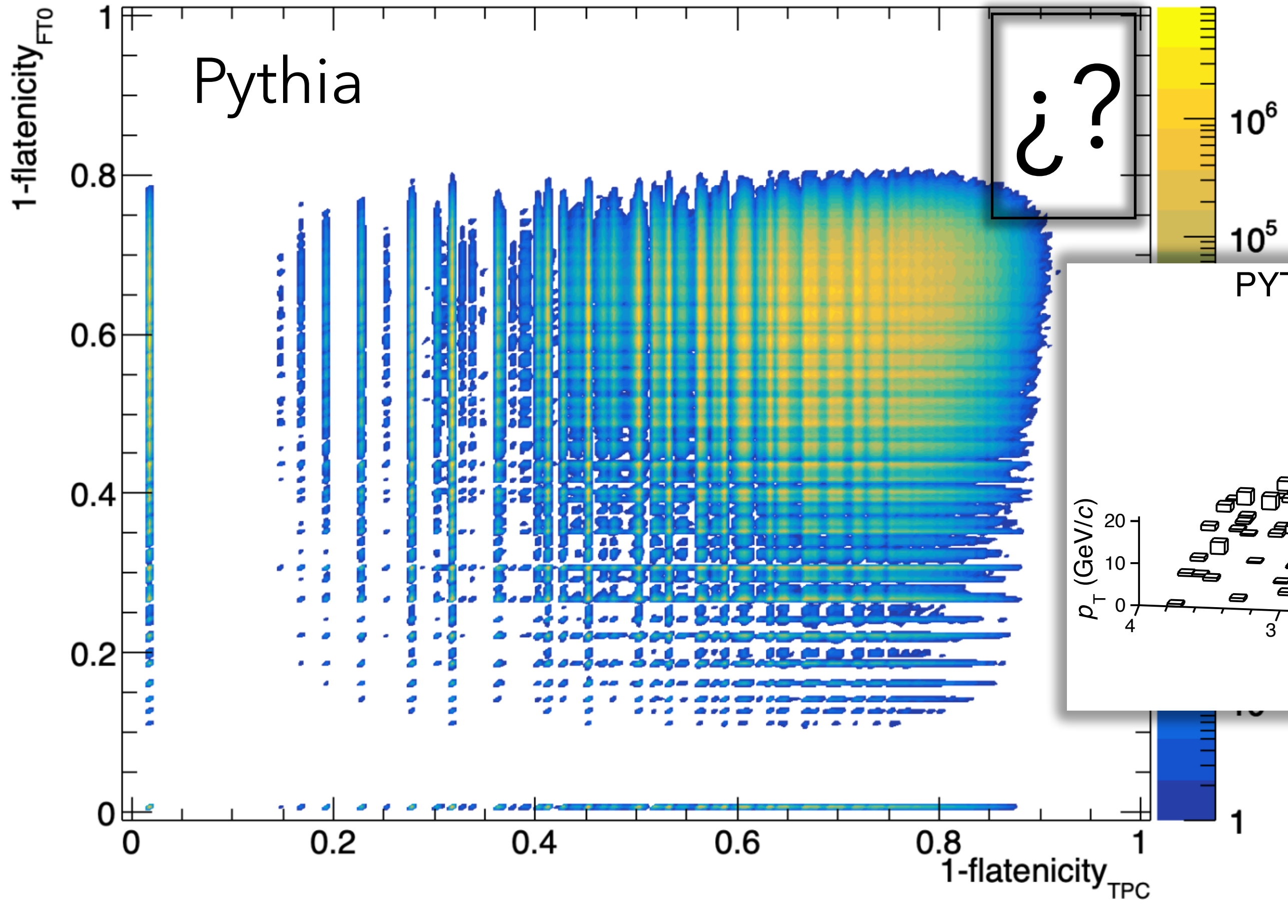
Events with jet structures are expected to have large ρ values

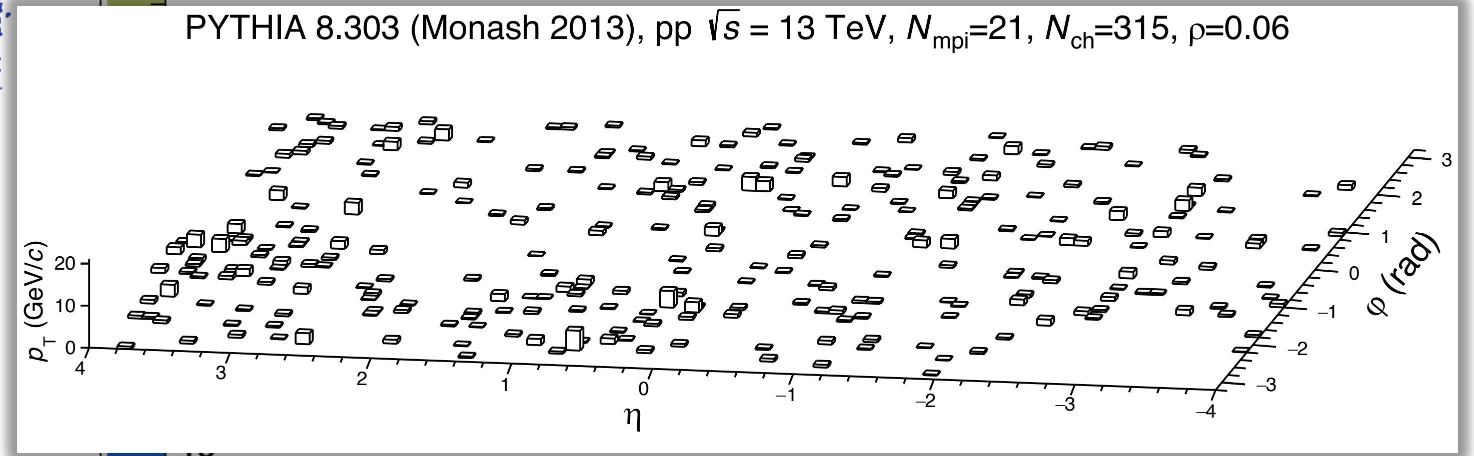
- Flattenicity is a new event cla… more global than V0M, it can… unwanted biases, it is very se…





Summary II





First pi/K/p pT spectra analysis is ongoing (Omar Vázquez and Gyula Bencédi)

Backup