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Collective effects in small systems, Hydro vs Color Reconnection

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EPOS3 Simulations by G. Bencedi

Motivations

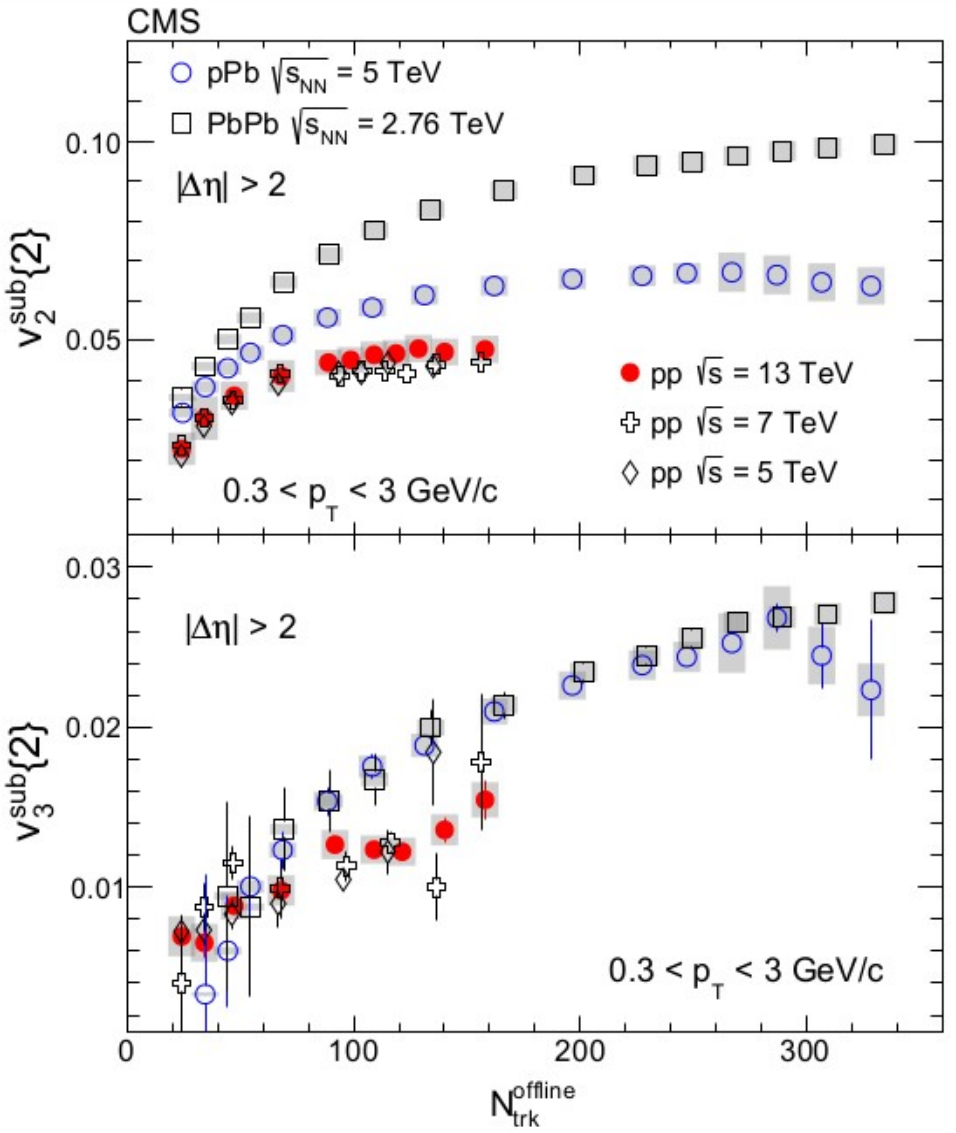
Recent results of flow in pp

Collective effects in are A-A well known, p-p and p-A under discussion.

CMS experiment has measured **v_2 and v_3** Fourier coefficients associated to **elliptic and triangular flow** respectively in long range di-hadron correlations in function of multiplicity in **pp collisions**.

Results show the same behavior observed in p-Pb and Pb-Pb

Higher mult → higher flow-associated coefficient for the three systems !



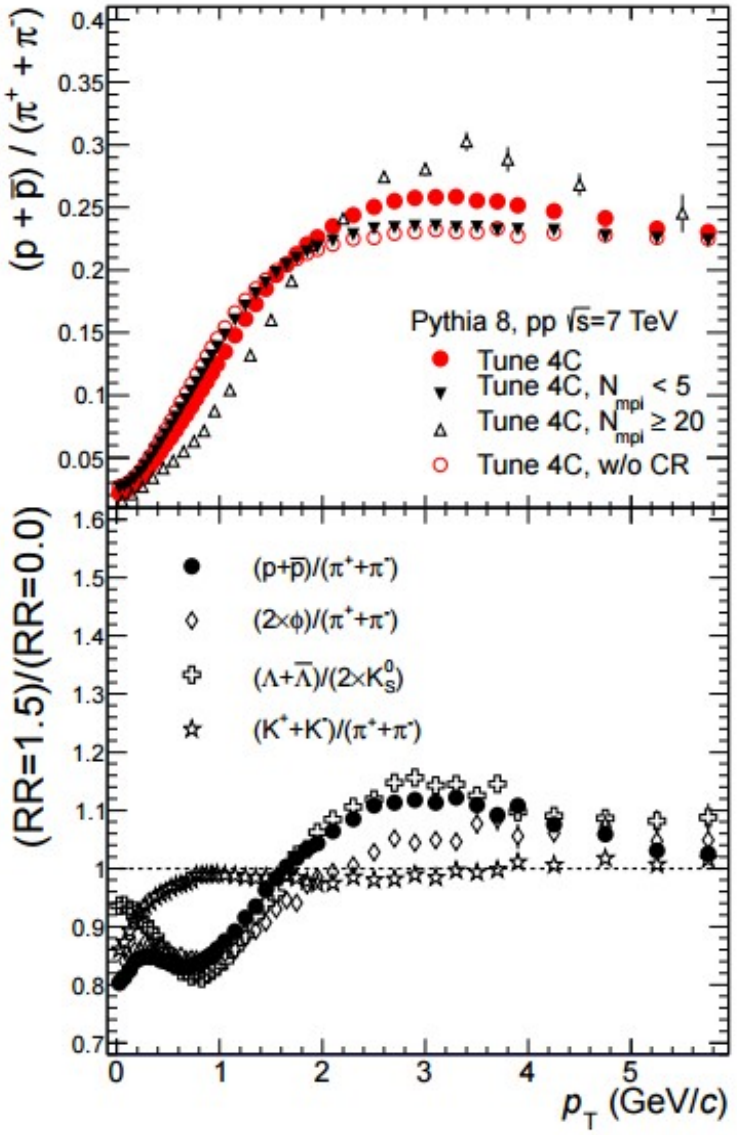
arXiv:1606.06198 [nucl-ex]

Models of CR included in Pythia 8

- **The original PYTHIA (mode 0)**
  - The partons of a lower-p_T MPI system are merged with the ones in a higher-p_T MPI
- **New scheme (mode 1)**
  - The QCD color rules are incorporated in the color reconnection, and determine the probability that a reconnection is allowed
- **Gluon motion (mode 2)**
  - Partons can be moved from one location to another so as to reduce the total string length

http://home.thep.lu.se/Pythia/pythia82html/ColourReconnection.html

CR shows flow-like patterns with CR mode0



The probability of two MPI systems to reconnect is given by

$P(CR) = (p_{T0} \times CRR)^2 / ((p_{T0} \times CRR)^2 + p_T^2)$

$\mathbf{p_{T0}}$ is energy dependence parameter

CRR is the CR Range, parameter that you can choose between 0(No CR) and 10(Highest CR probability)

And $\mathbf{p_T}$ is the transverse momentum of the MPI system that wants to reconnect

http://home.thep.lu.se/Pythia/pythia82html/ColourReconnection.html

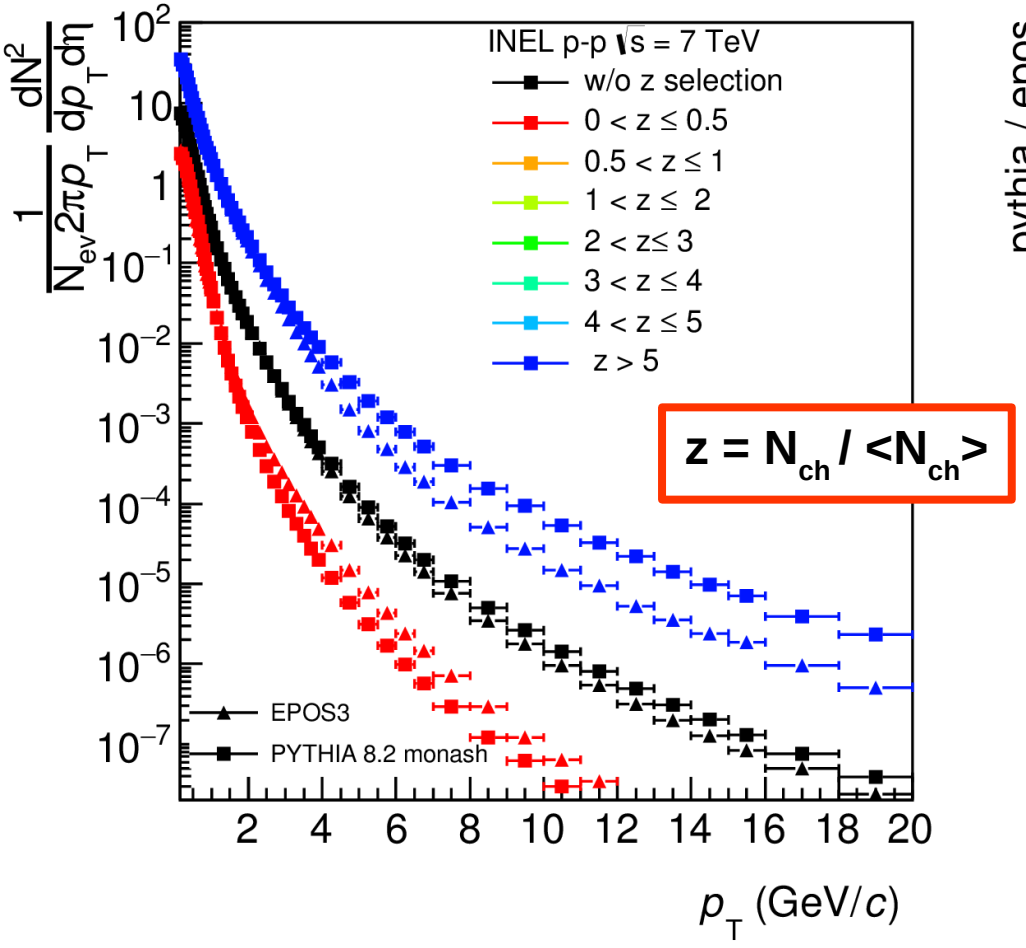
Higher nMPIs events shows a shift of the max value of p to pi ratio, more nMPIs leads to more CR effects.

10.1103/PhysRevLett.111.042001

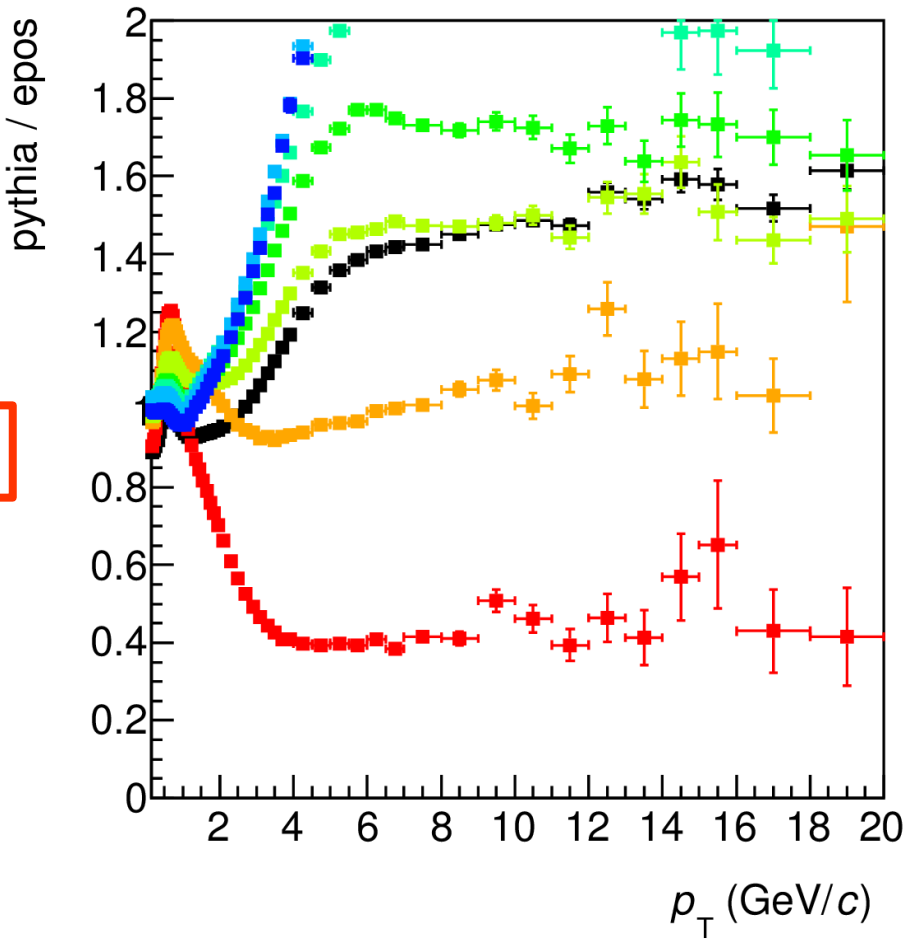
Is it necessary to use hydro to explain the evolution of small systems ?

Comparison between Hydro (EPOS3) and CR (PYTHIA8) models

The p_T spectra: Hydro vs CR

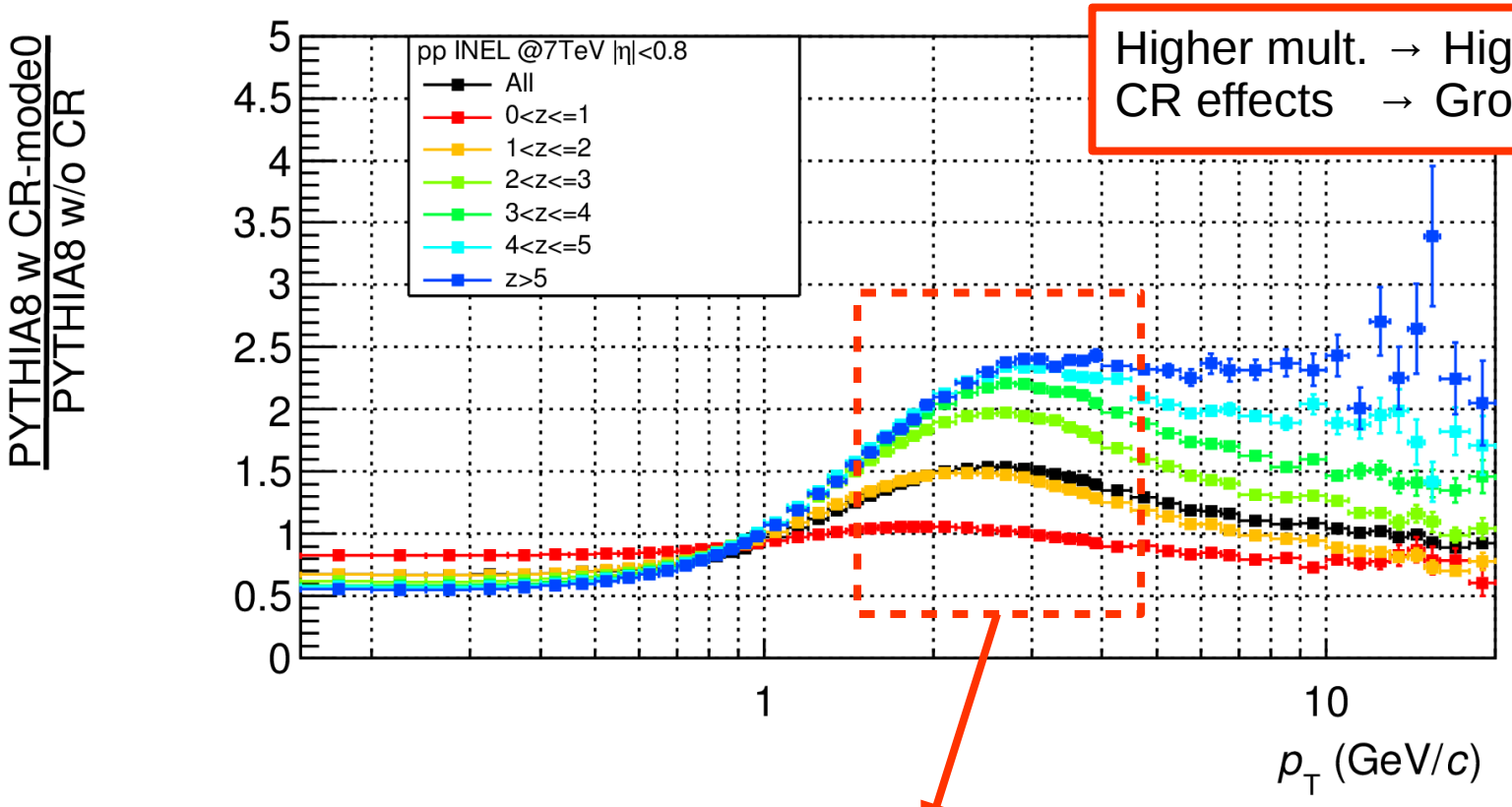


$z = N_{ch} / \langle N_{ch} \rangle$



PYTHIA8(Defaul CR mode0) harder than EPOS3 → **high mult** and **MB**, opposite in **low mult**

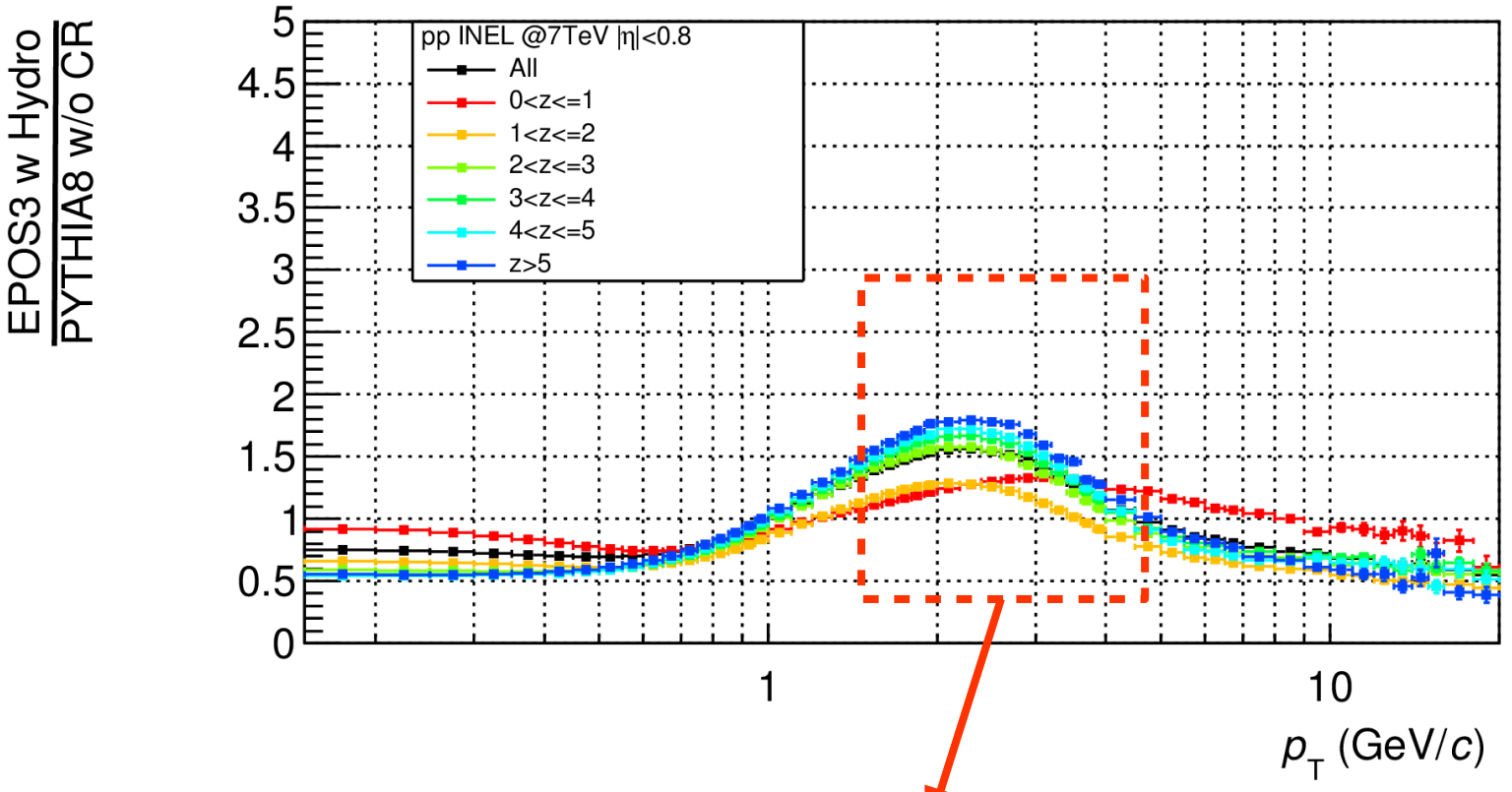
Multiplicity dependence of CR effects on p_T spectra



Higher mult. → Higher nMPIs
CR effects → Grow with mult. and p_T

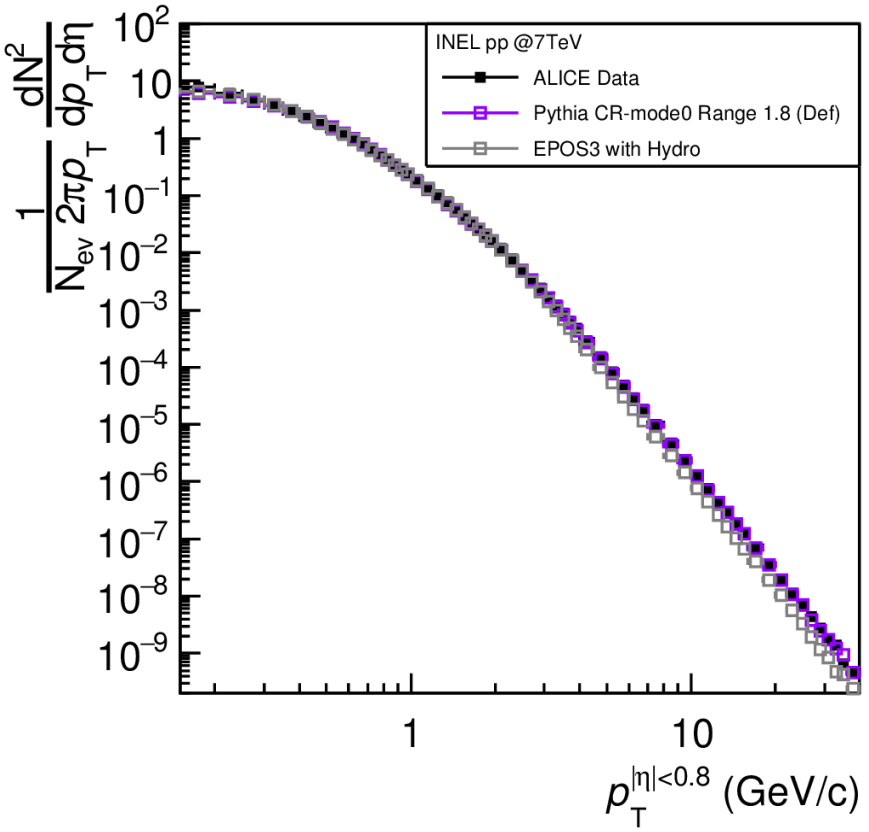
Bump around ~2.5GeV/c
Seems to saturate for the highest mult. bin

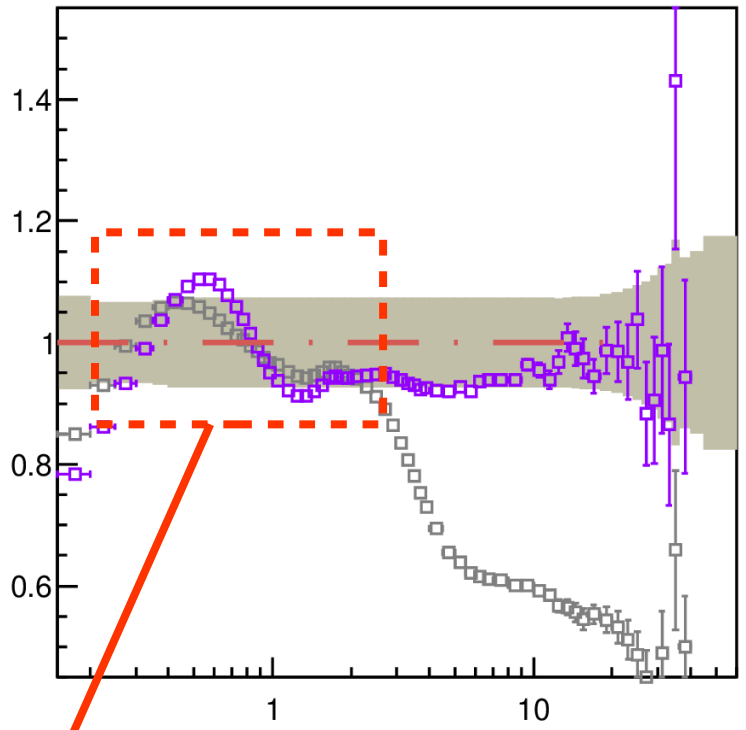
Multiplicity dependence of Hydro effects on p_T spectra



Bump around ~2.5GeV/c too !!
The effect diminishes at higher p_T with hydro but not with CR

p_T spectra: Data vs models

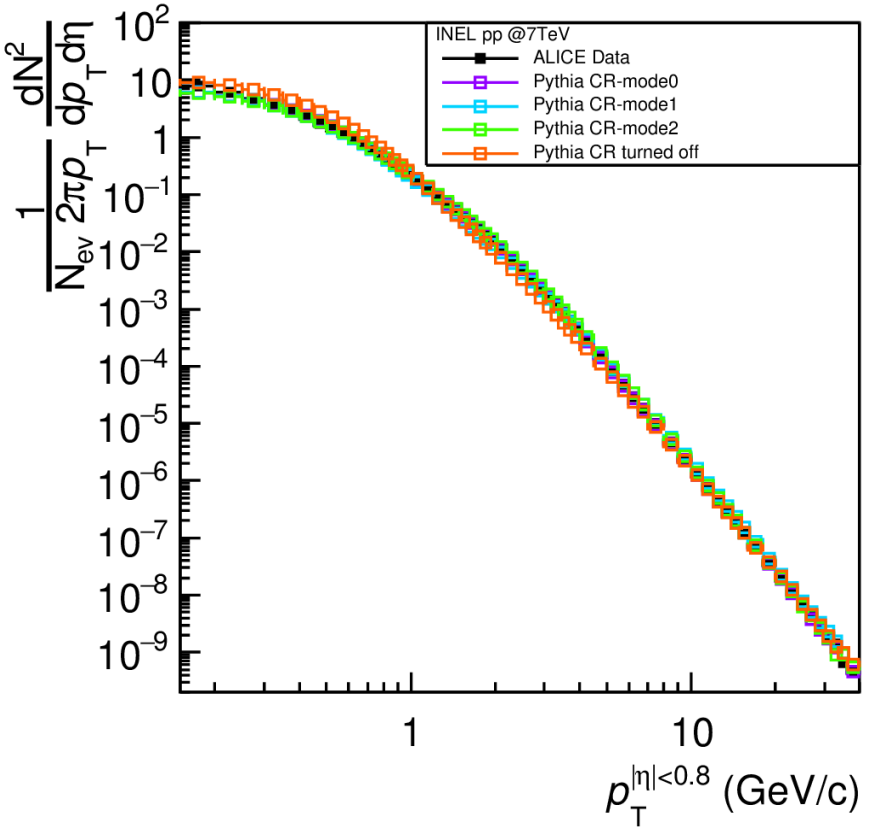


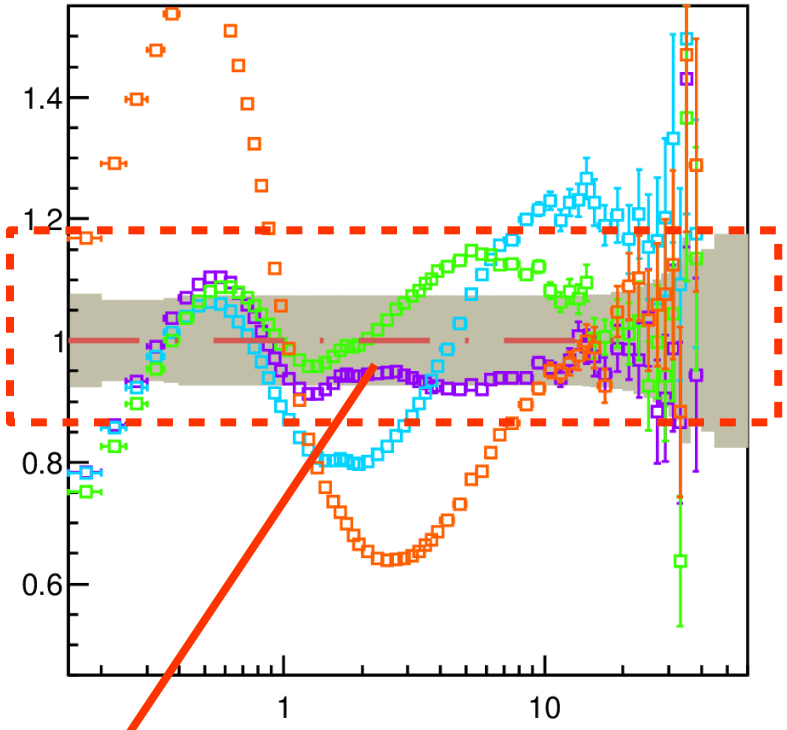


Data from 10.1140/epjc/s10052-013-2662-9

Hydro and **CR** describes well low p_T region.
Effects of **hydro** diminish at p_T higher than ~2.5GeV, **CR** still survives and seem to describes well the data inside the systematics

p_T spectra: Data vs CR models

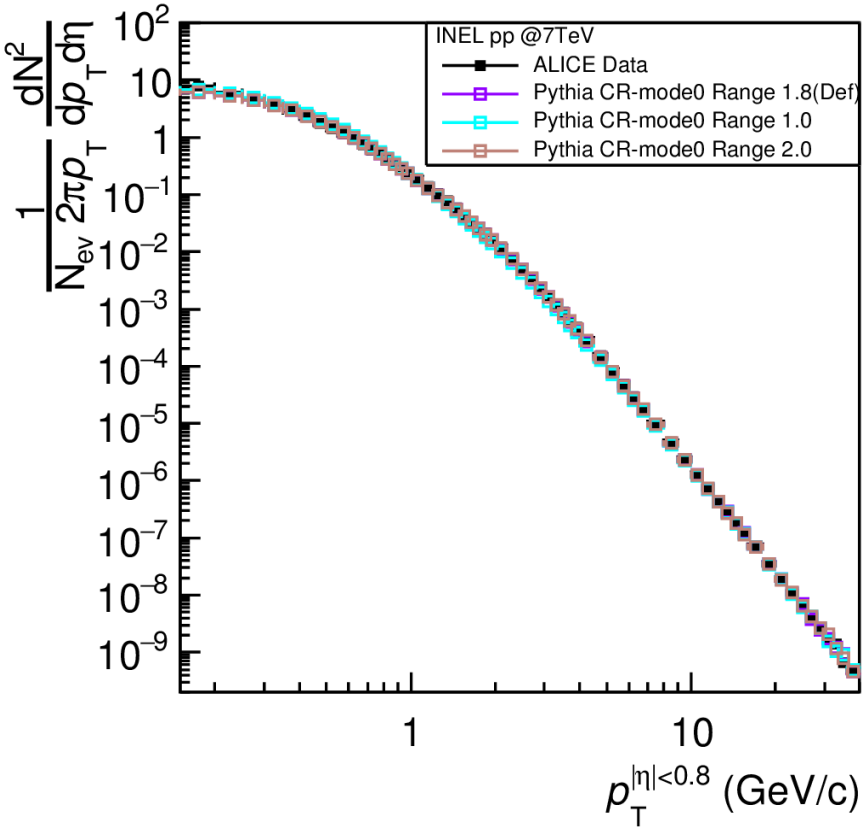




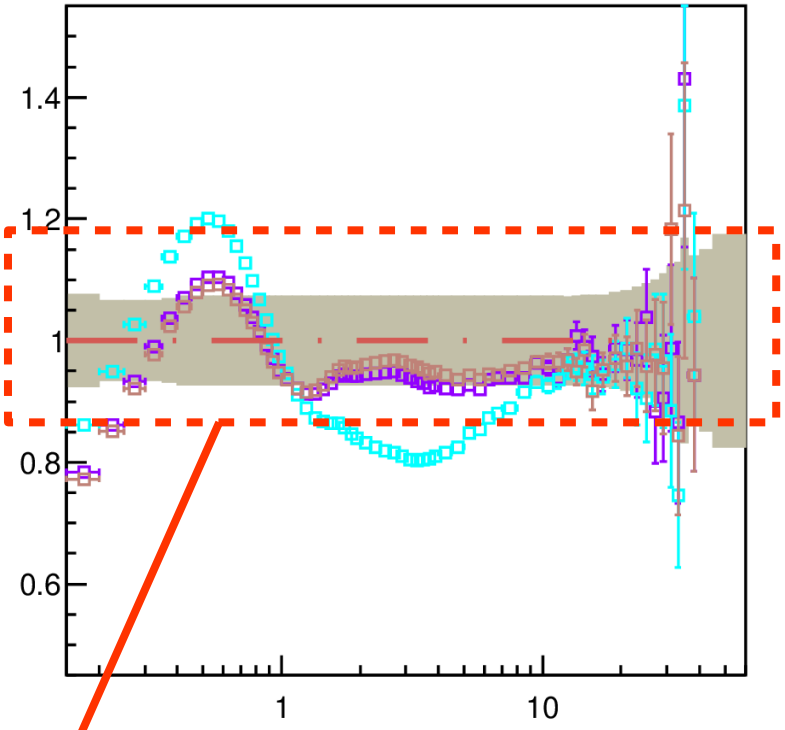
Data from 10.1140/epjc/s10052-013-2662-9

We can see that CR mode0 (Default) is the best describing the data

p_T spectra: Data vs CR Ranges

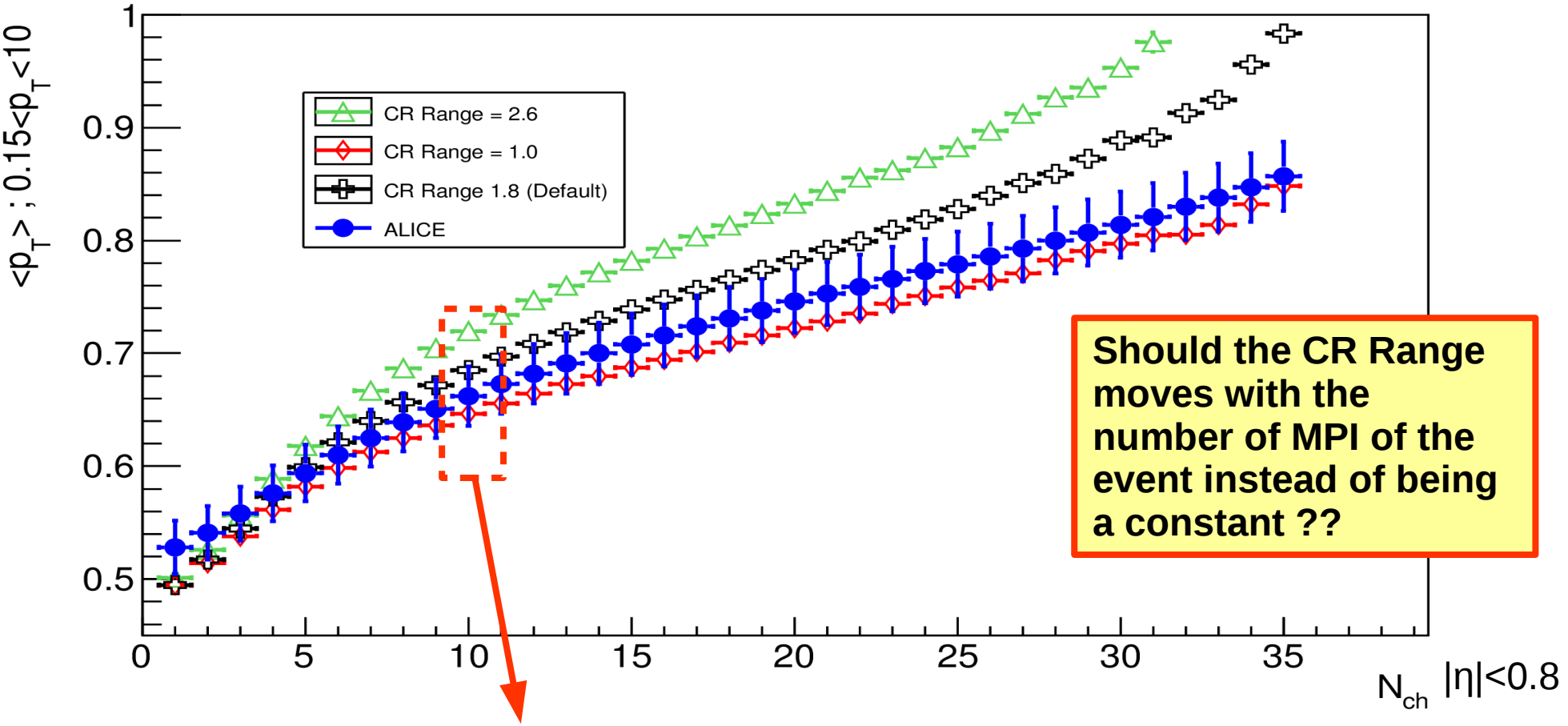


Data from 10.1140/epjc/s10052-013-2662-9



With CR-mode0 (Default) but changing the CR Range to a slightly higher value than the default fits better the data

$\langle p_T \rangle$ vs N_{ch}



Should the CR Range moves with the number of MPI of the event instead of being a constant ??

CR Range 1.0 fits the data inside the systematics in all N_{ch} region but the default value fits arround <Nch> Region

EPOS LHC seems to fit very well this observable

10.1016/j.physletb.2013.10.054

Summary

- We show that two very different approaches, hydro and CR, give almost the same results at p_T lower than ~3 GeV/c
- At higher p_T the QCD approach describes better the data complemented with a single final state parameter (CR)
- The default mode of CR is clearly favored compared with other models
- The possibility to modify the CR Range in function of the number of MPI (less for high nMPI, more for low nMPI) could improve the model.

THE QUESTION

What changes from p-p to Pb-Pb ?

Thank you !

Enjoy Chiapas