IS experimental summary

- Disclaimer: did not attend workshop (but nobody else volunteered)
  - Reflect what I know from ALICE and what I picked up from slides

- Outline:
  - Biased view: Analyses “close” to me from ALICE
  - Strangeness
  - Flow
  - Jets and jet quenching

Biased view: Analyses “close” to me in ALICE

- But the good thing is that it also means that comments and suggestions are more likely to propogate to the analyser

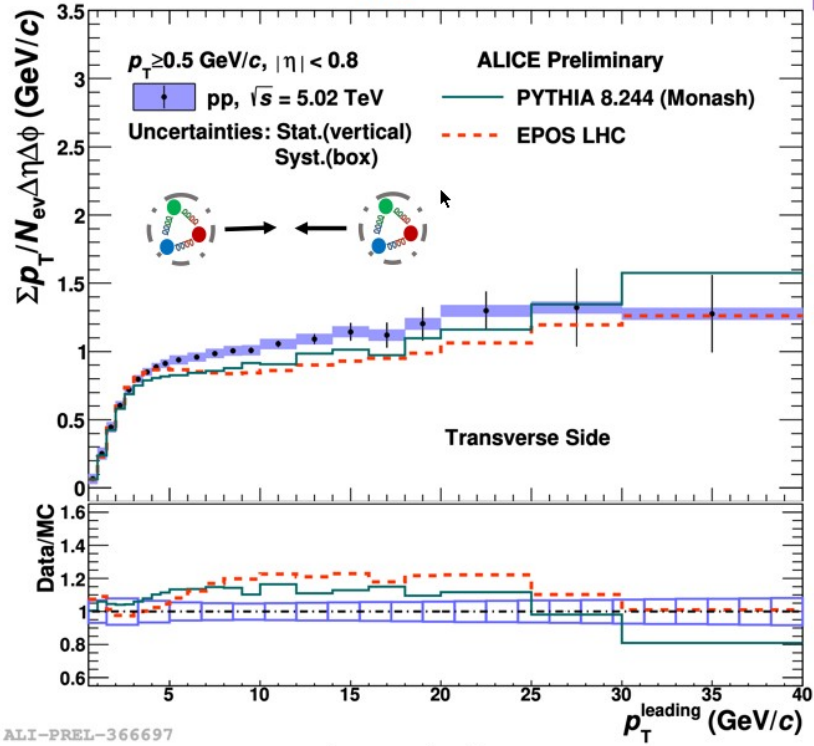
Traditional UE in p-Pb

Underlying-event characterisation (pp and p-Pb)

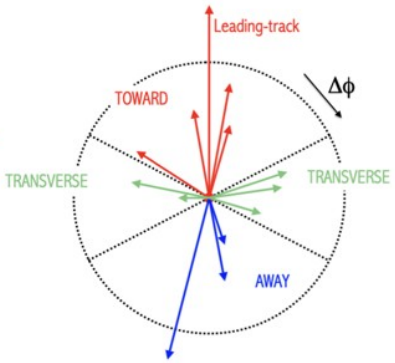
pp

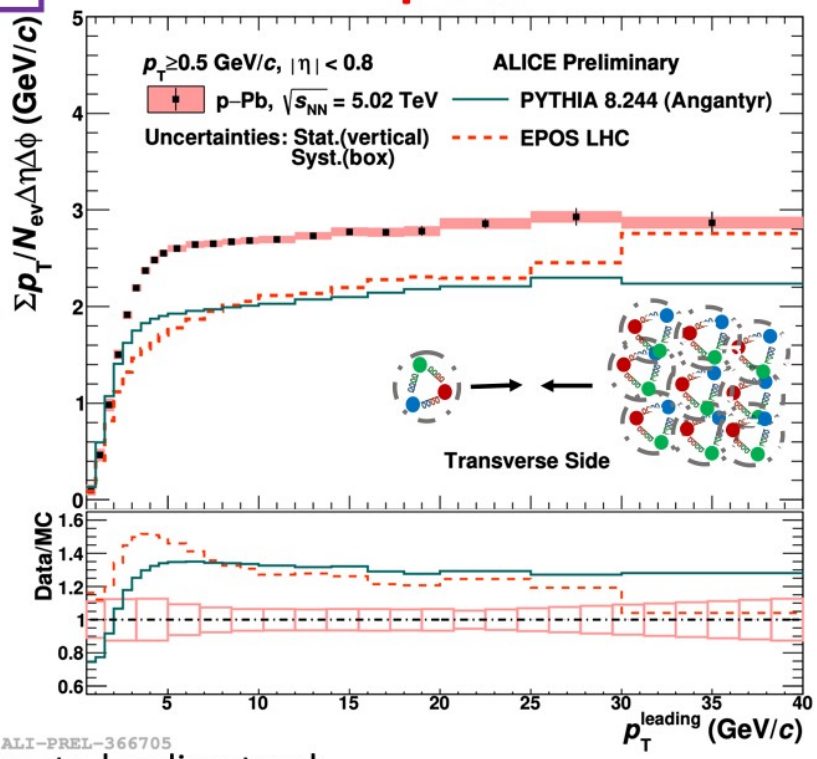
A. Mehmood's bullet talk

p-Pb



New

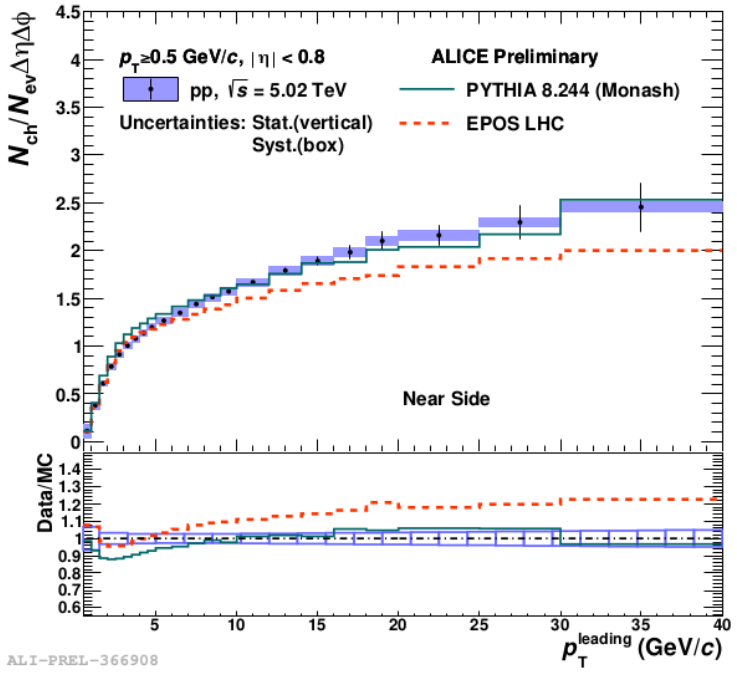


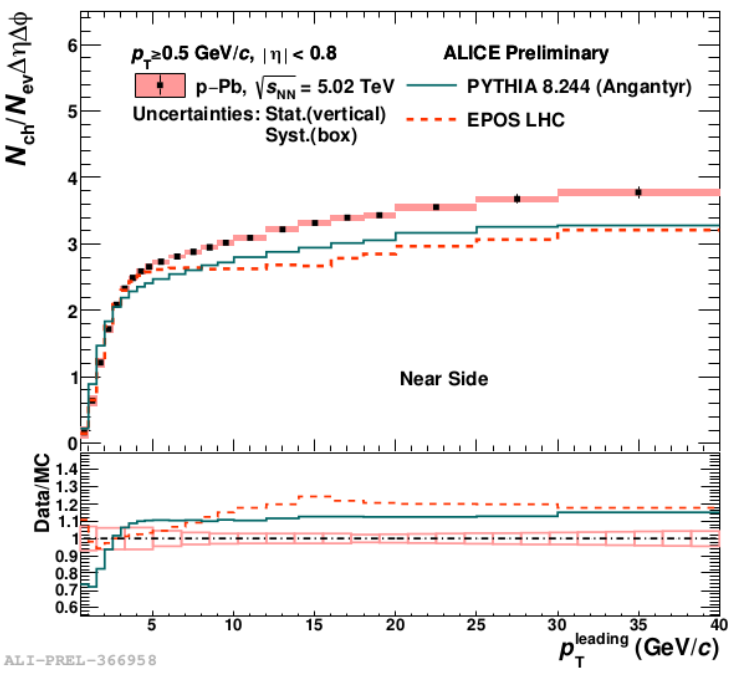


- Underlying event is measured in region transverse to leading track
- Flattening of $\sum p_T$ for $p_T^{leading} > 5$ GeV/c in p-Pb: due to multiple nucleonic interactions
- UE in pp is qualitatively similar to p-Pb – points to role of MPIs in pp

Toward region:

Number density for $p_T \geq 0.5$ GeV/c



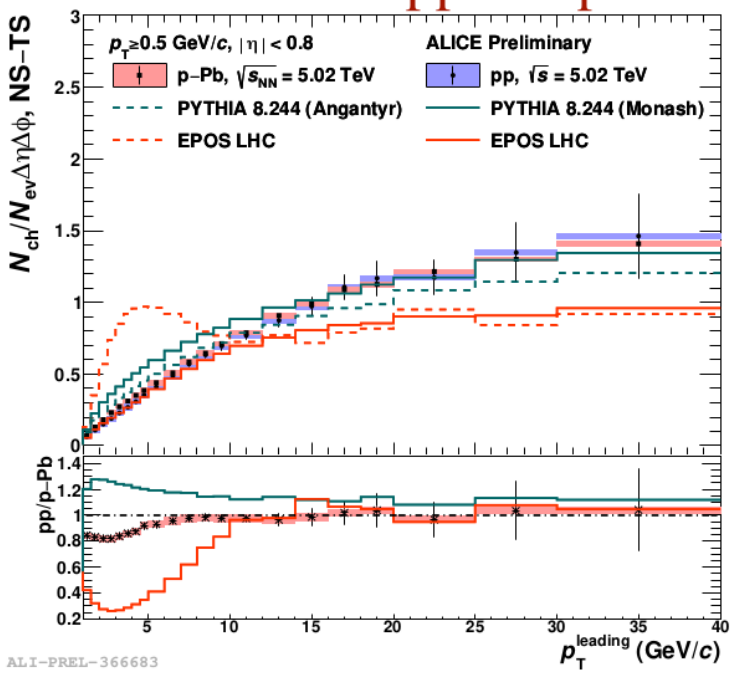


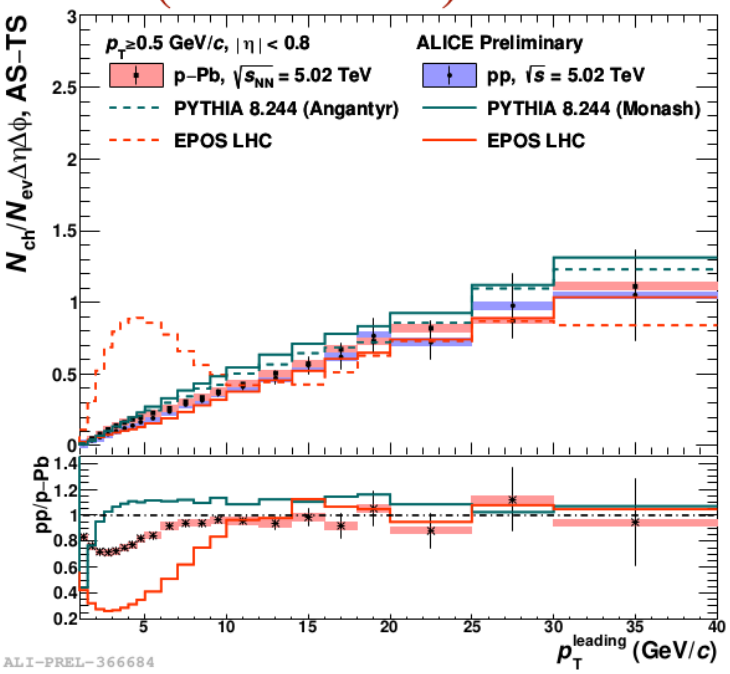
Near Side/towards region: The activity in pp increases faster with $p_T^{leading}$ than in p-Pb, because of the "UE activity" in p-Pb is higher than in pp.

For both collision systems EPOS LHC underestimates the trend at high $p_T^{leading}$, while for p-Pb collisions Pythia 8 underestimates (overestimates) the low (high) $p_T^{leading}$ part.

“Jet”=NS-TS and AS-TS

Number density NS-TS and AS-TS for $p_T \geq 0.5$ GeV/c for pp and p-Pb @ 5.02TeV (data vs MC)

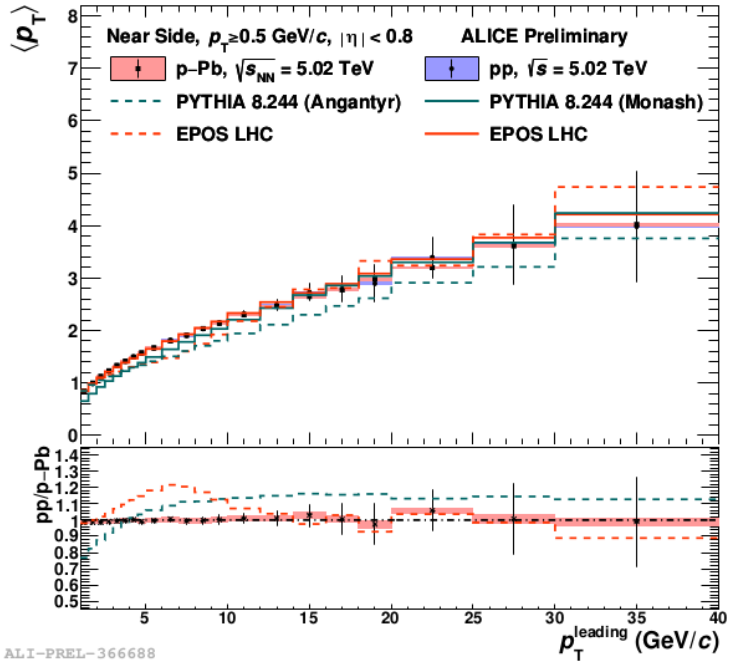


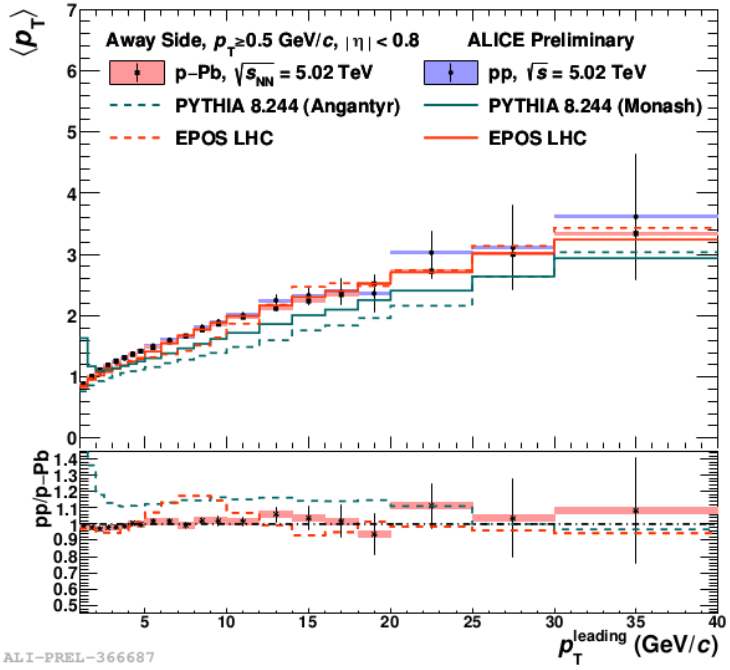


- The jet-like region is compared by subtracting the transverse side from the towards and away sides.
- At high $p_T^{leading}$ pp and p-Pb data agree with each other suggesting the absence of medium effects.
- This suggests that for $p_T^{leading}$ > 10 GeV/c the UE can be handled in much the same way in pp and p-Pb collisions.
- Useful for more advanced studies searching for jet quenching in small systems.

<p_T> of Jet

<p_T> near side and away side for $p_T \geq 0.5$ GeV/c for pp and p-Pb @ 5.02TeV (data vs MC)

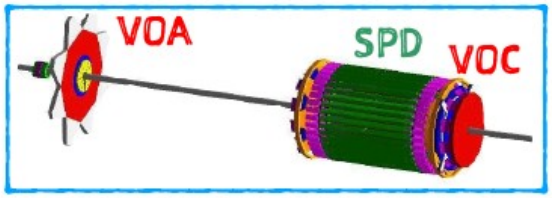




- We used the average sum p_T and the number density in order to derive the <p_T>.
- Results show the jet-like component give the same <p_T> for both pp and p-Pb collisions.
- Pythia underestimates (overestimates) the low $p_T^{leading}$ region for the <p_T> in the near (away) side.

ZDC vs mid-rapidity

ALICE detectors

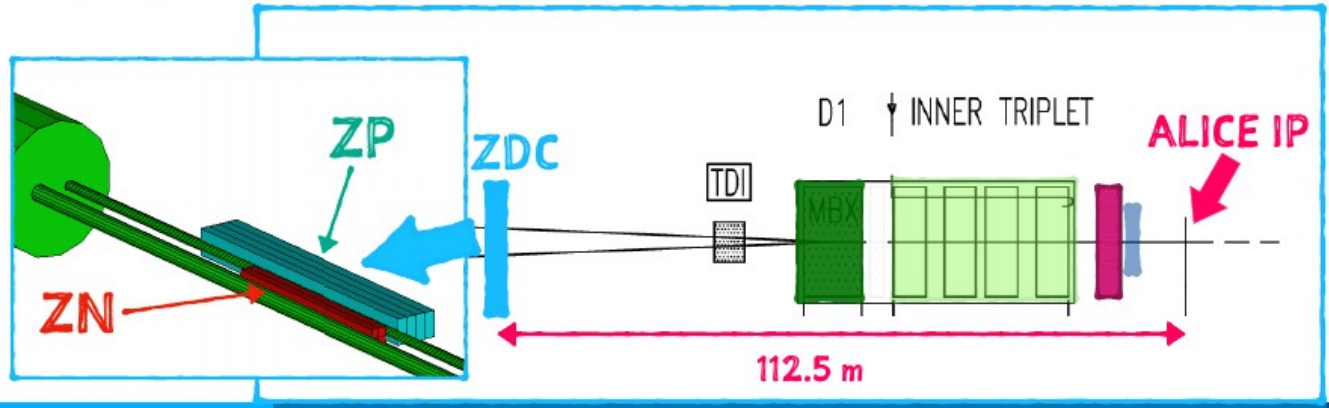


SPD ◗ 2 innermost layers of the ITS |η|<1.4 and |η|<2, used to measure charged-particle multiplicity

VZERO ◗ scintillator hodoscopes used for triggering, covering 2.8<η<5.1 (V0-A) -3.7<η<-1.7 (V0-C)

TPC ◗ main tracking detector, covering |η|<0.9
Charged particle tracks formed combining ITS hits and TPC reconstructed clusters

ZDC ◗ quartz fibre "spaghetti" calorimeters, 2 identical systems, 112.5 m from IP
ZN (|η|>8.8) for neutrons ZP (6.5<η<7.4) for protons



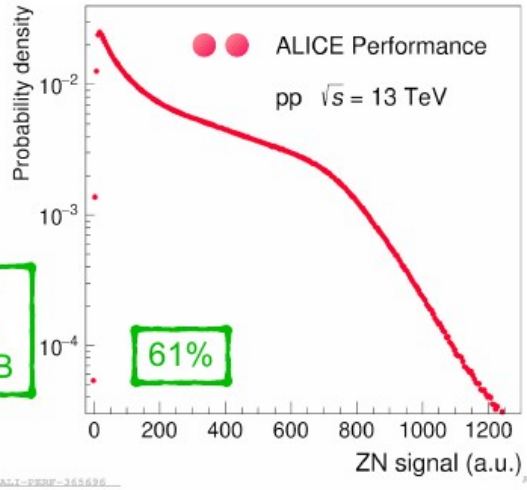
C. Oppedisano for the ALICE Collaboration — IS 2021, Weizmann Institute of Science — 3

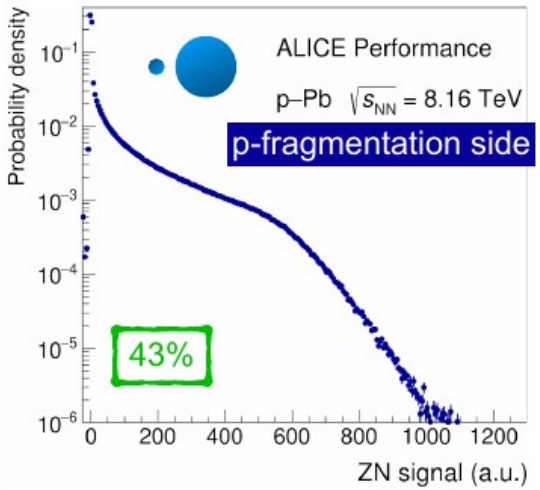
ZDC spectra

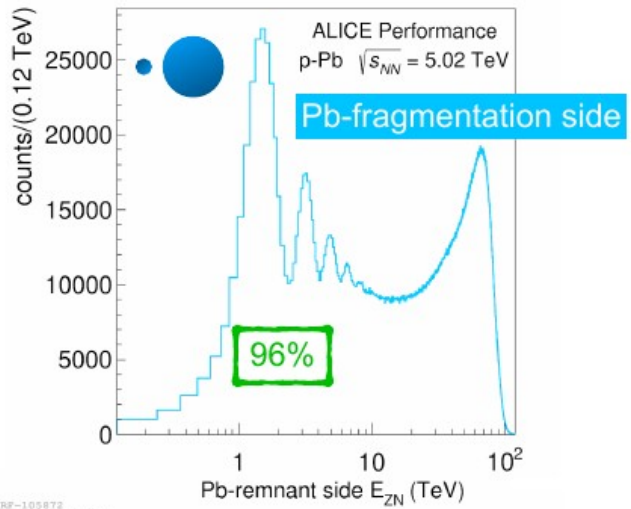
ZDC spectra in pp and p-Pb collisions

ZN

Fraction of events with ZN signal/MB

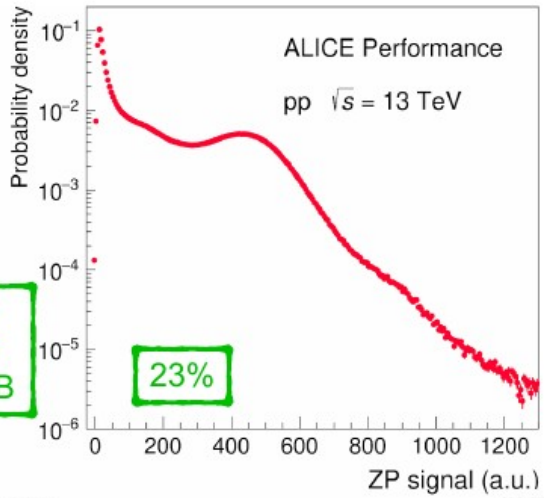


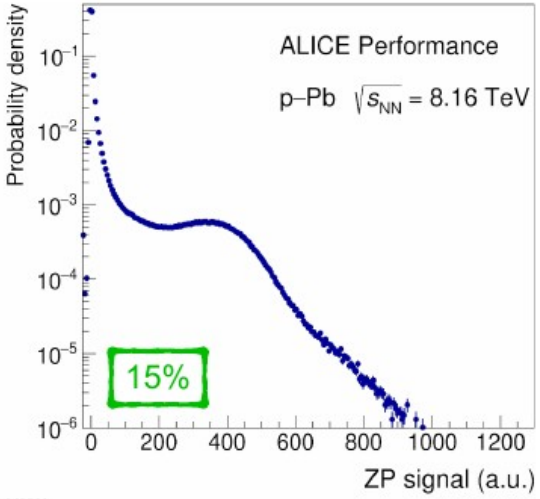


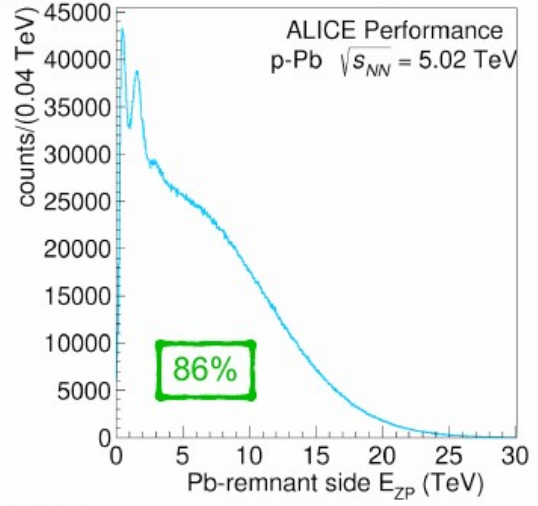


ZP

Fraction of events with ZN signal/MB





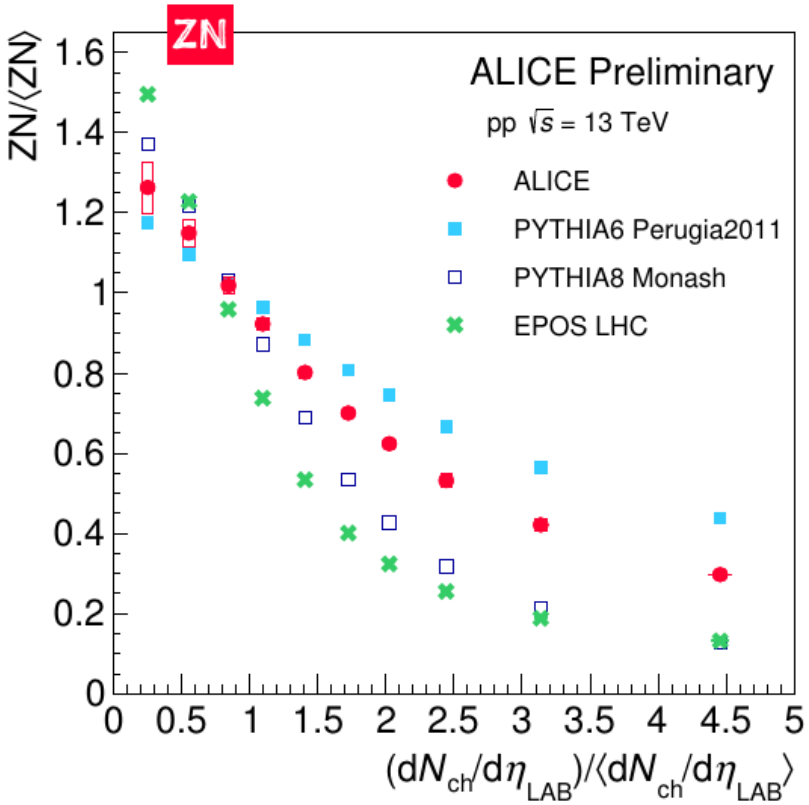


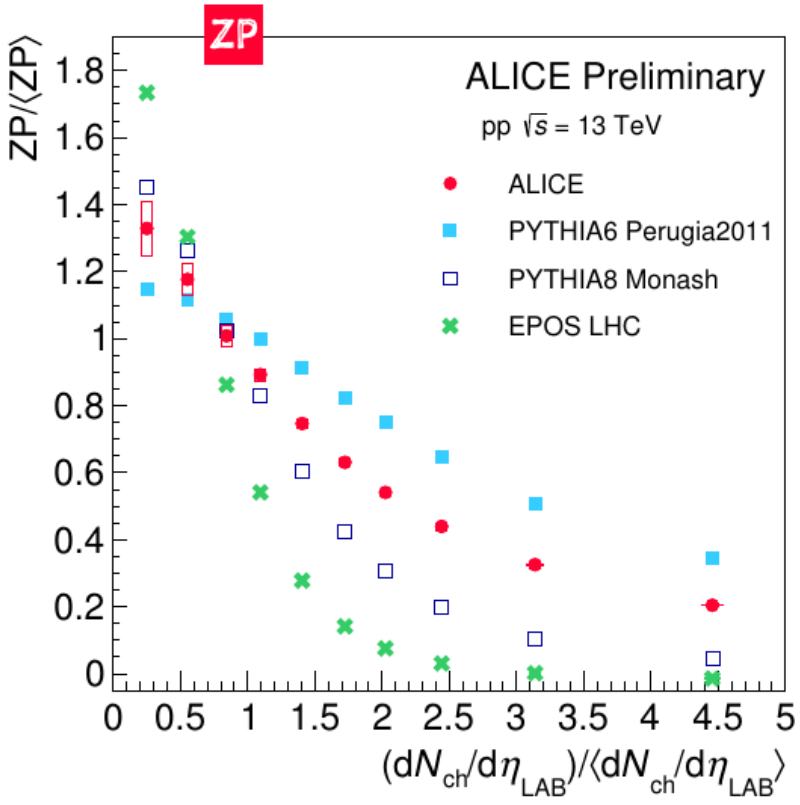
C. Oppedisano

4

ZDC vs mult in pp:

Forward energy vs. multiplicity in pp





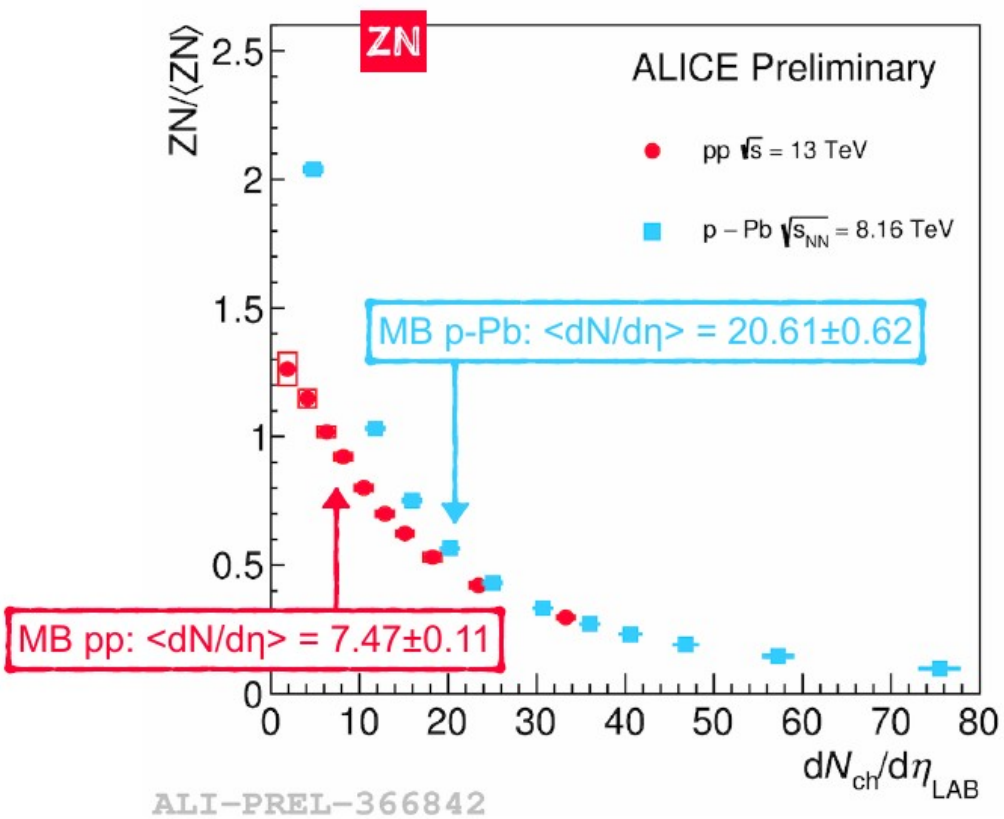
Forward energy decreases with increasing particle multiplicity at midrapidity

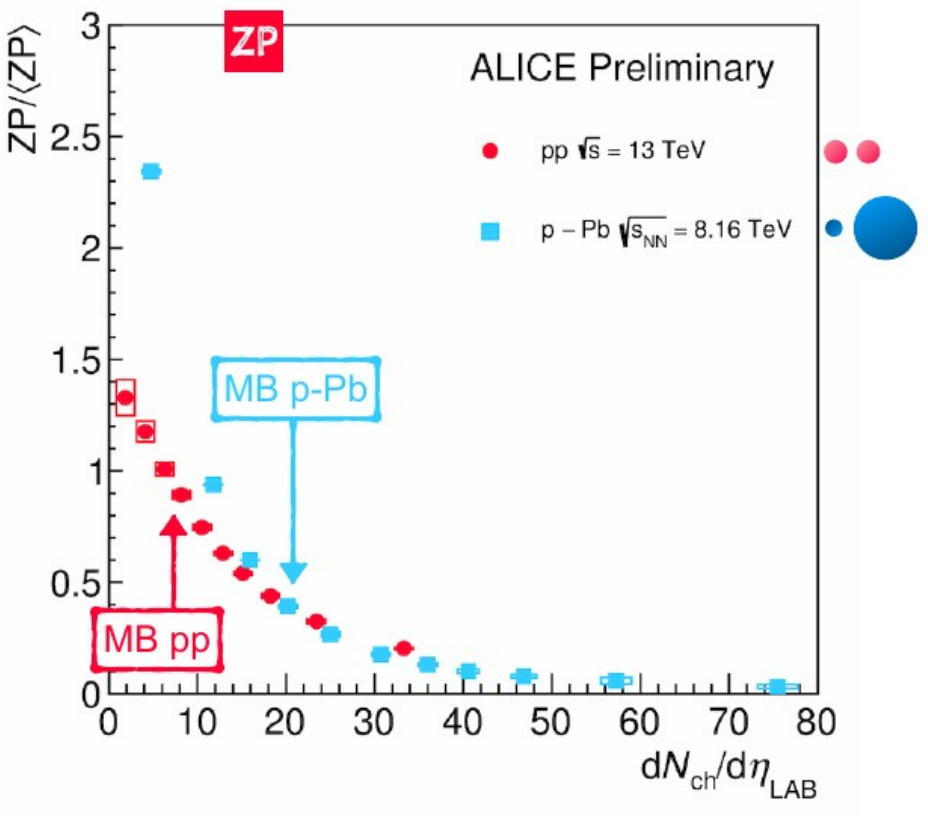
PYTHIA6 Perugia2011, PYTHIA8 Monash and EPOS-LHC predictions describe the overall pattern, but are not able to quantitatively reproduce experimental results in multiplicity bins.

Pp vs p-Pb:

Forward energy vs. multiplicity

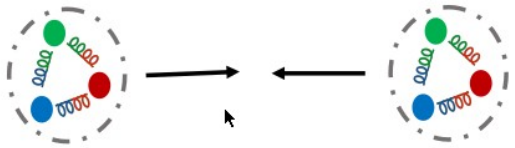
ZN, ZP energies normalized to MB values decreases rapidly with increasing multiplicity at midrapidity, both in pp and in in p-Pb interactions in the p-fragmentation region (same p beam energy)

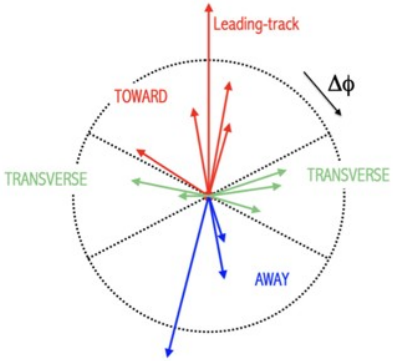




Relation to UE:

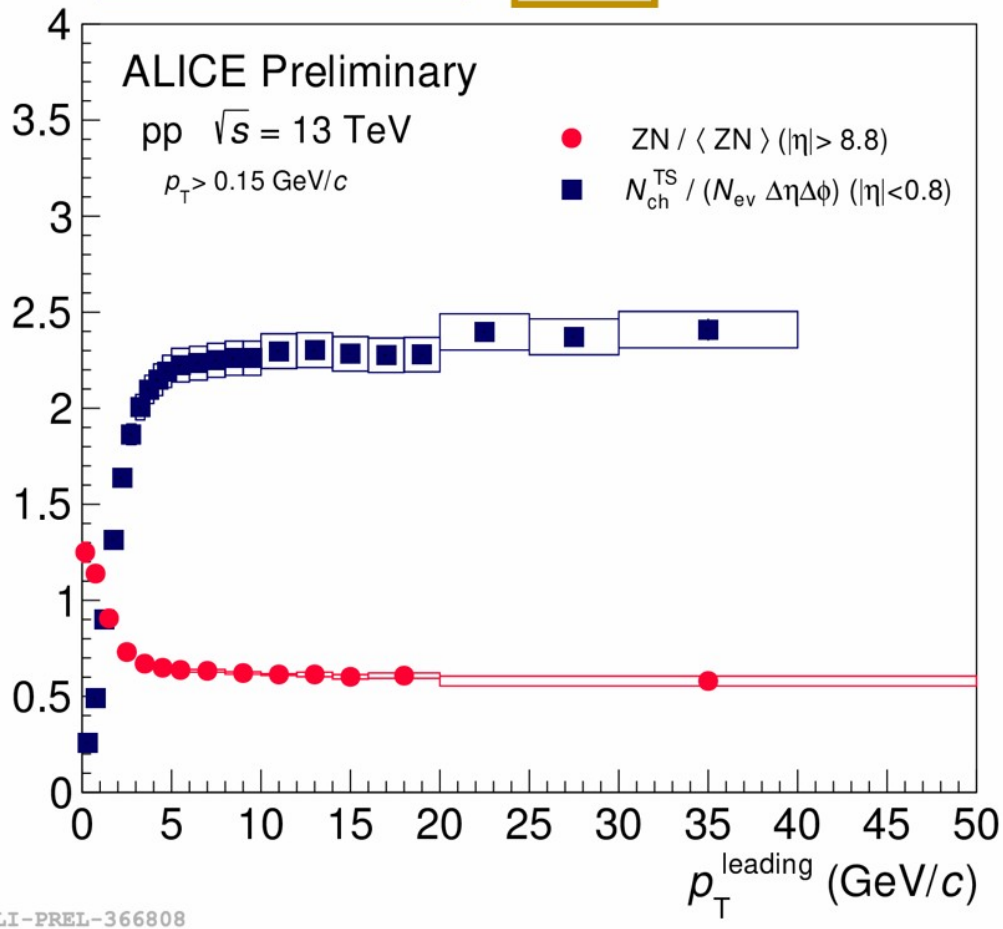
Correlation of zero-degree energy with transverse multiplicity (pp)





C. Oppedisano's talk

New

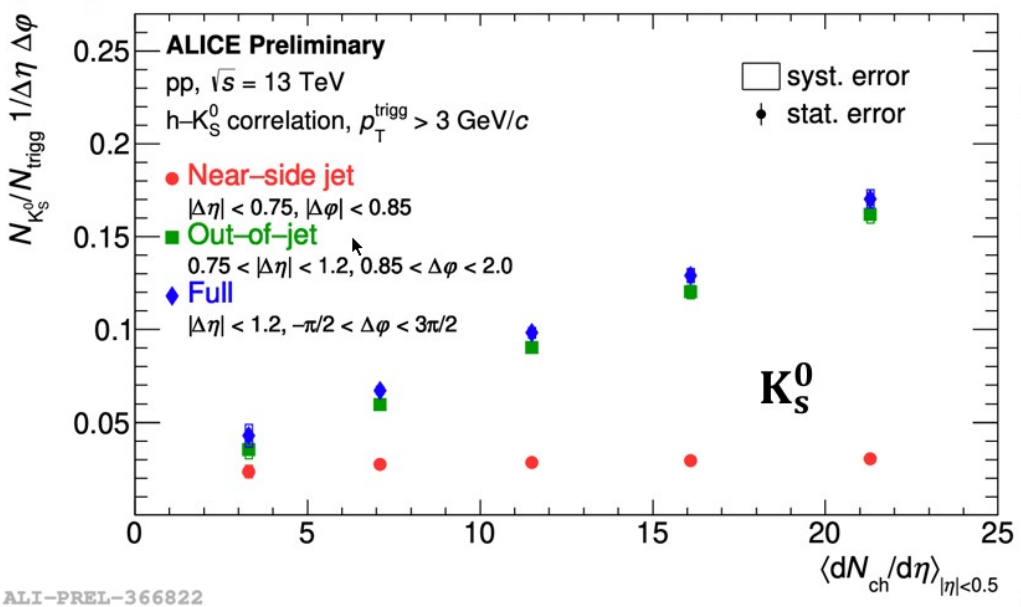


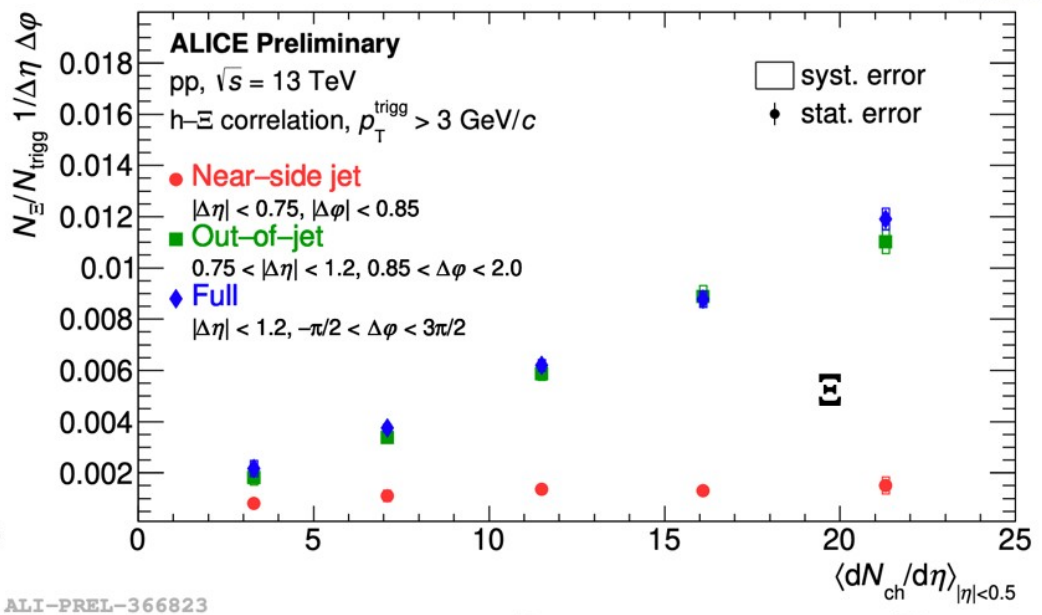
- Zero-degree energy decreases with increasing $p_T^{leading}$ at midrapidity
- Constant zero-degree energy and jet pedestal effect at $p_T^{leading} > 5$ GeV/c
- First measurement at the LHC with a gap of 9 η units
- Enhanced probability of partonic scatterings (MPI) when pp collisions are more overlapping

Strangeness

Xi and K0s assoc. production

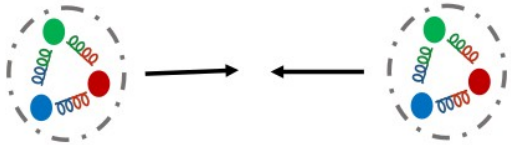
In and out of jet strangeness production (pp)





C. De Martin's talk

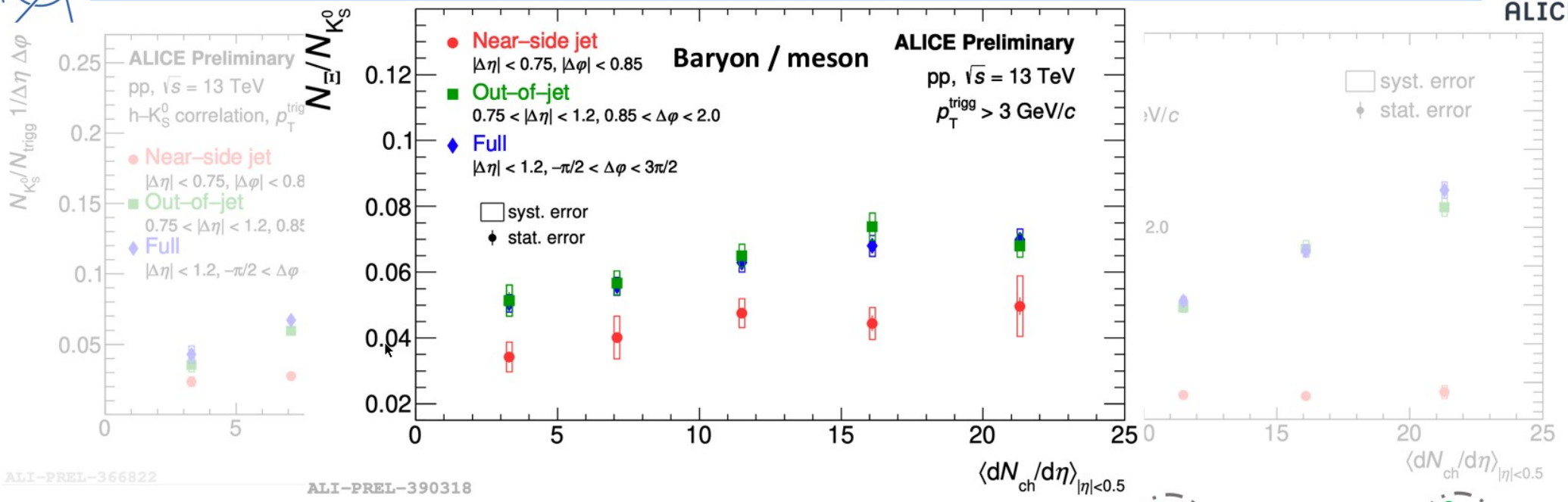
New



- In and out of jet production of strange hadrons measured – particles with p_T > 3 GeV/c used as jet proxy
- Out of jet production increases at a much faster rate with multiplicity than the in jet production
- Not directly comparable to inclusive yields in events without a jet bias

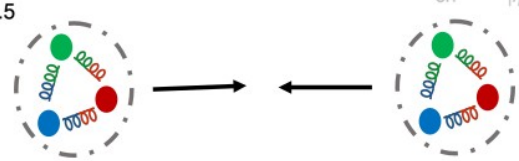
Xi/K0s assoc. ratio

In and out of jet strangeness enhancement (pp)



C. De Martin's talk

New

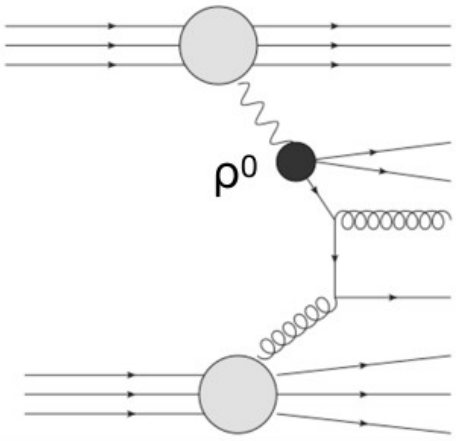


- Mild strangeness enhancement for both in and out of jet production
- Next step to repeat measurement with Ξ/π

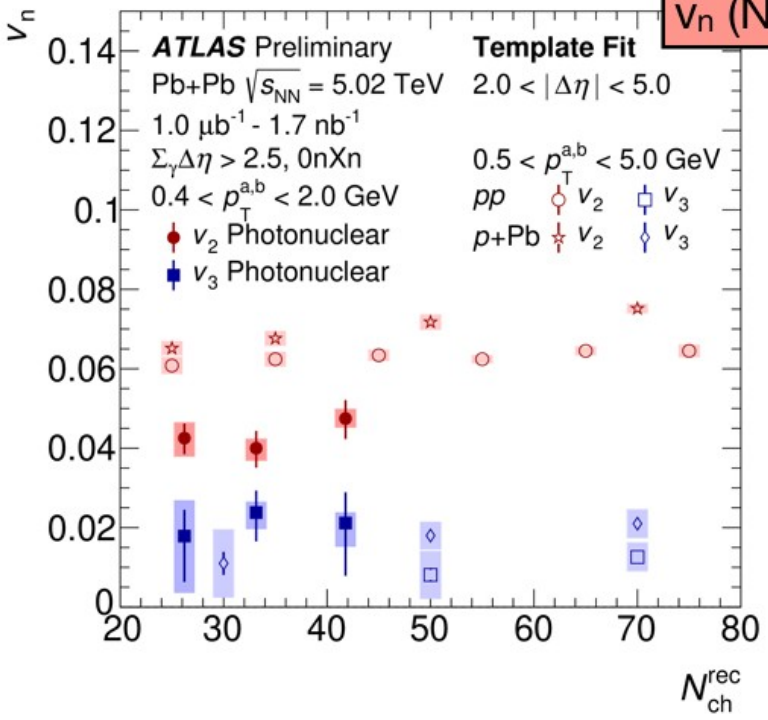
Flow

Flow in photo-nuclear UPC

UPC γ+Pb (p+Pb)

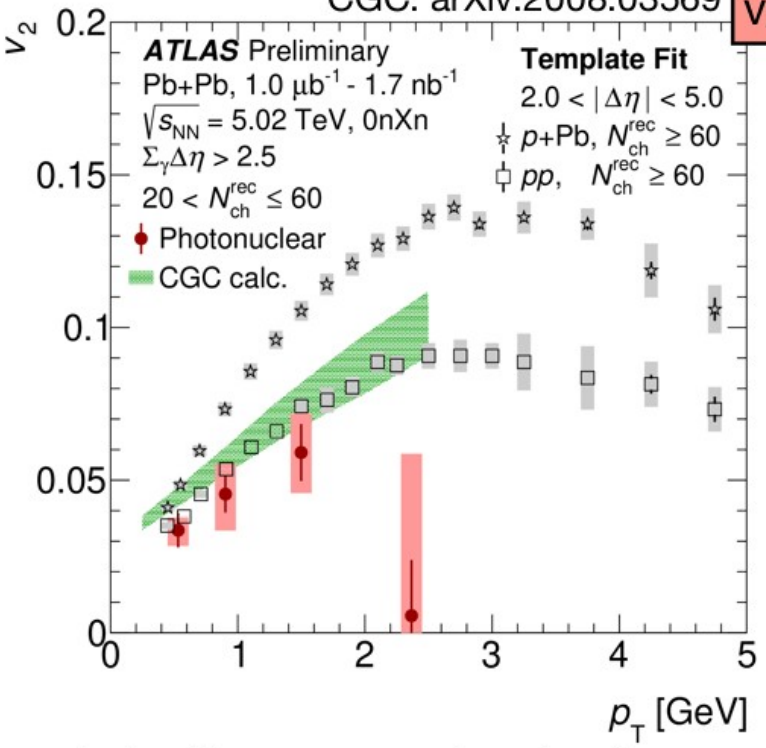


v_n (N_{ch})



CGC: arXiv:2008.03569

v_2 (p_T)



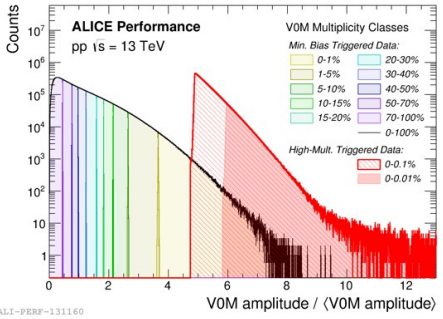
- Observed significant v_2 and v_3, in photo-nuclear collisions
  - v_2 smaller than *p*+Pb and *pp*
  - v_3 show similar size but large systematic uncertainties
- Trend in p_T model by CGC calculation (alone). It will be interesting to see hydro calculations!

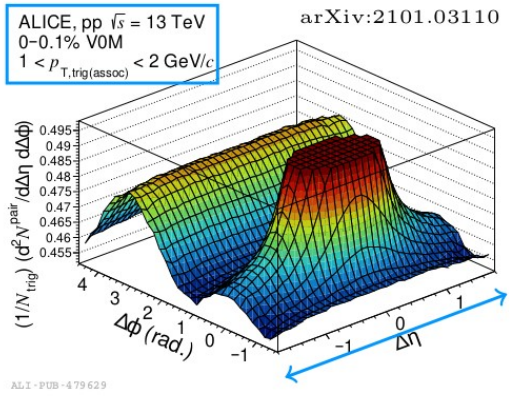
Blair Seidlitz on Wednesday 15:50

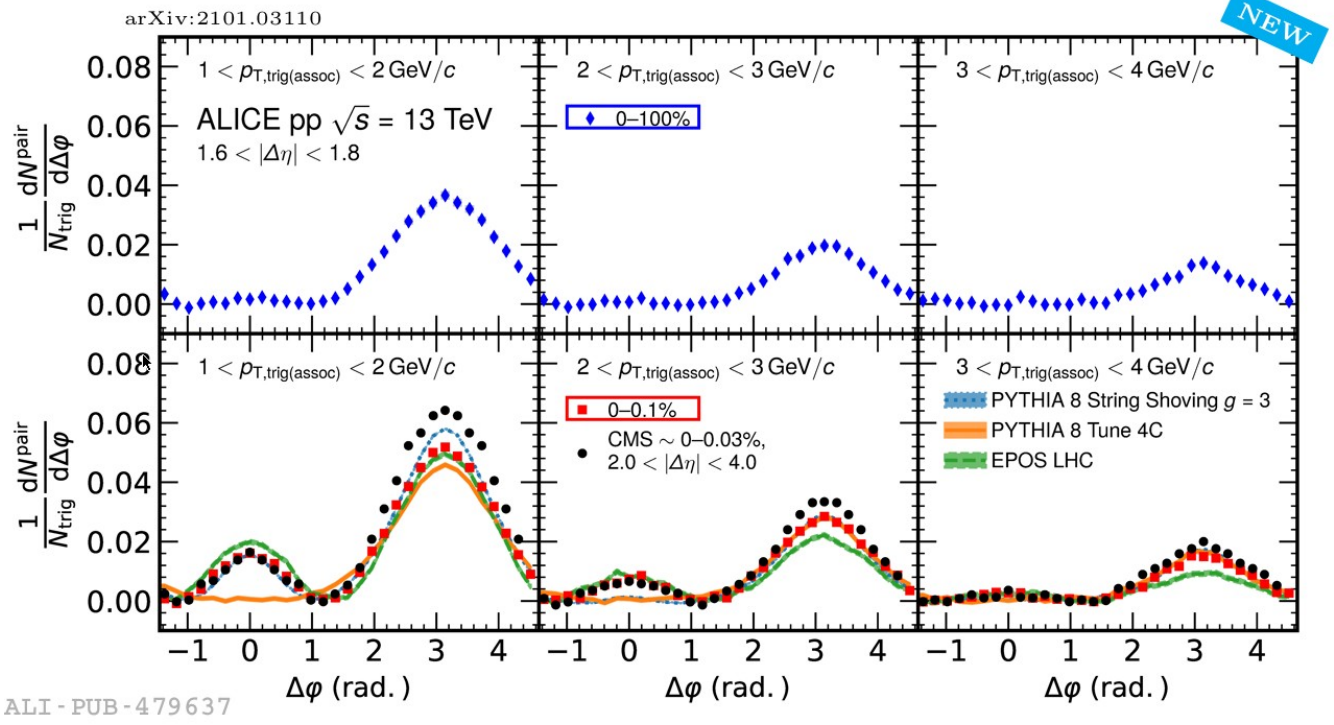
Jets and jet quenching

pp 13 TeV ridge in ALICE

Long-range $\Delta\varphi$ correlations (TPC-TPC)



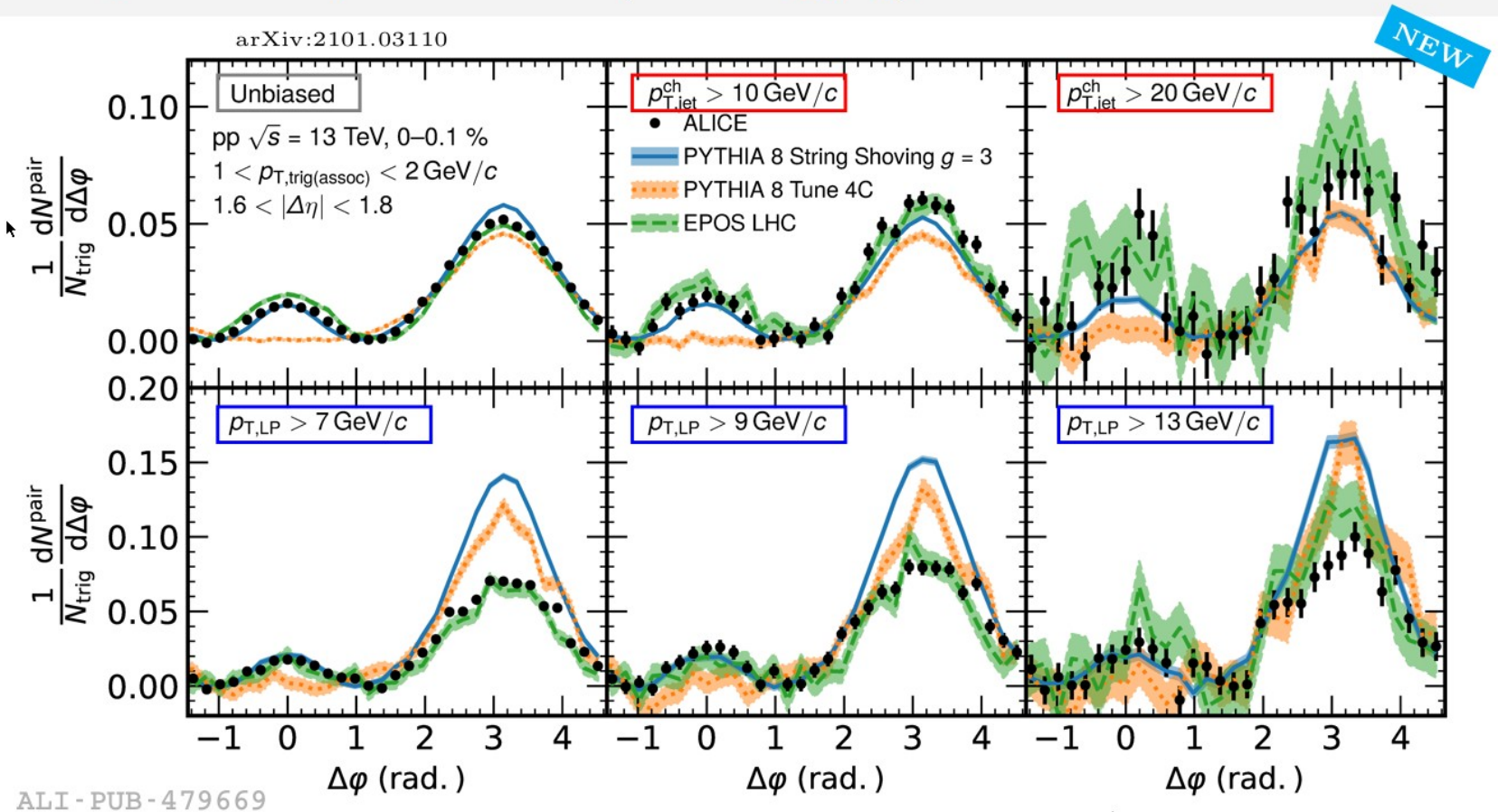




- Long-range ($1.6 < |\Delta\eta| < 1.8$) to avoid nonflow contribution
- **Clear ridge in high-multiplicity events, while no ridge in minimum bias events**

+ event scale selection

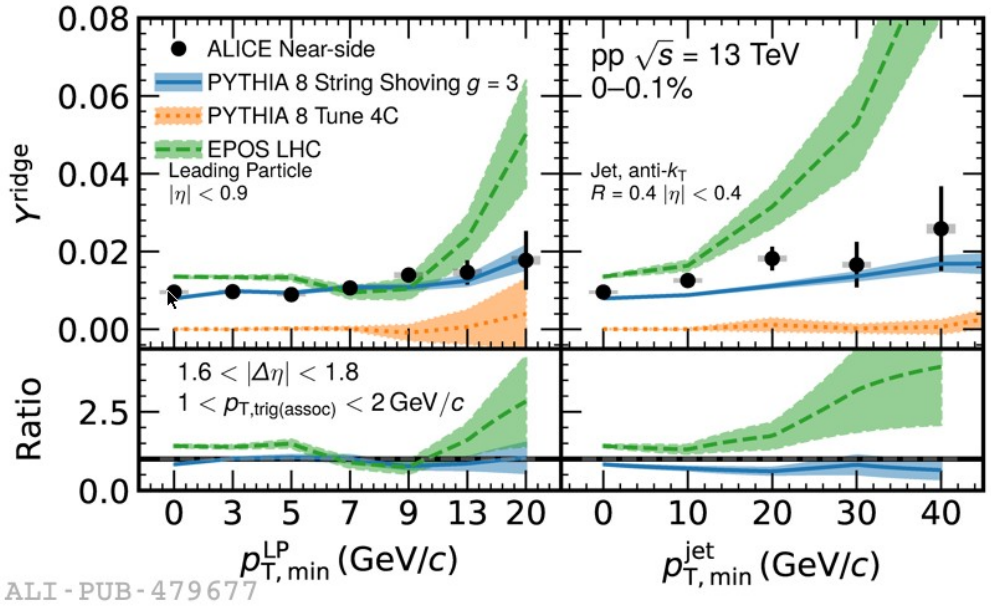
Event-scale dependent $\Delta\varphi$ correlations (event tagging)

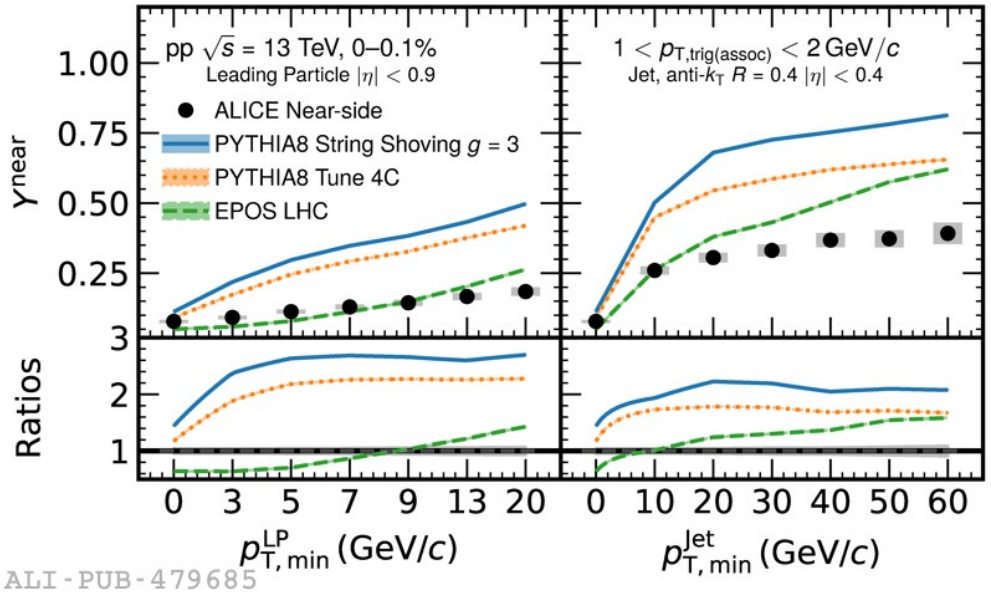


- Event-scale selection: requirement of the presence of a hard scattering (tagging by minimum p_T of reconstructed jet or leading particle)
- The ridge is still visible with event-scale selection

+ look at near-side correlation

Event-scale dependent ridge yield

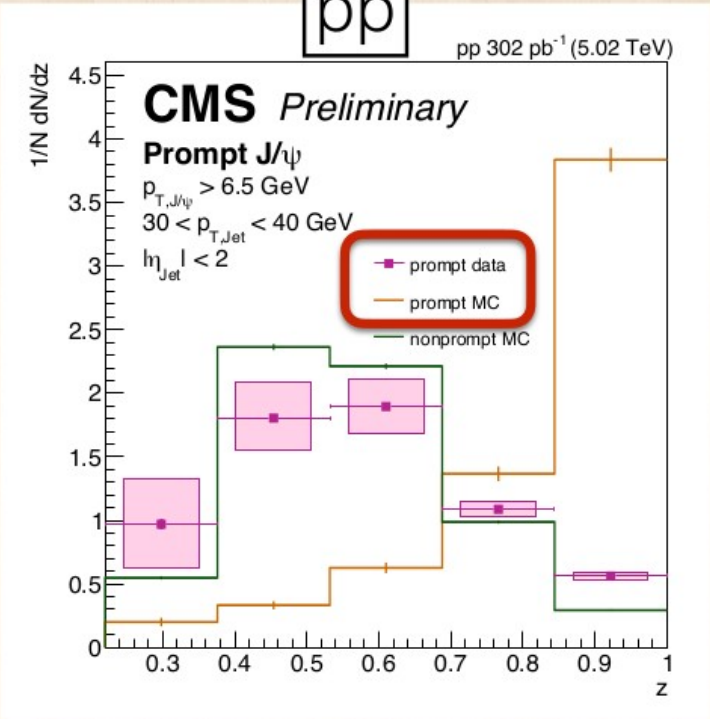




- The ridge yield tends to increase with increasing $p_{T,Lead}$ or $p_{T,Jet}$.
- The increase of the ridge yield is also visible for two models.
  - EPOS LHC largely overestimates the ridge yields while PYTHIA with string shoving underestimates them
  - PYTHIA with string shoving, in contrast, overshoots the jet fragmentation.

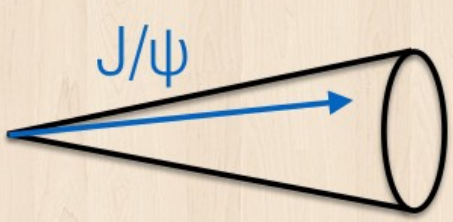
J/ψ in Jet

pp

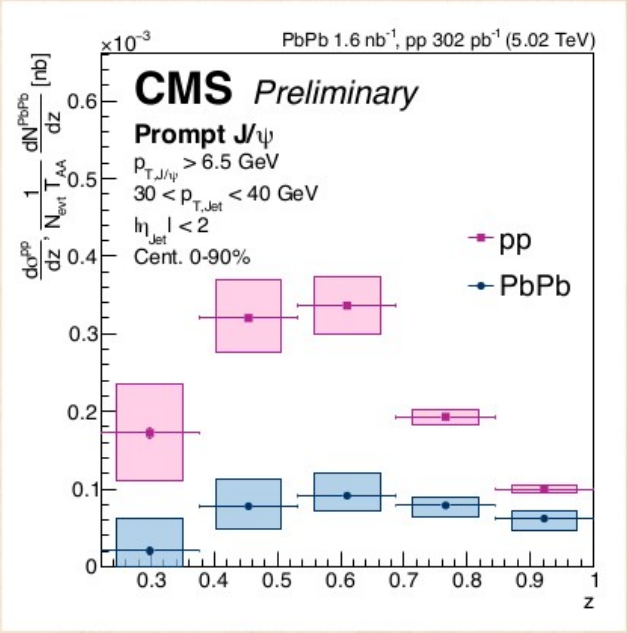


Not reproduced by generator!

Production mechanism

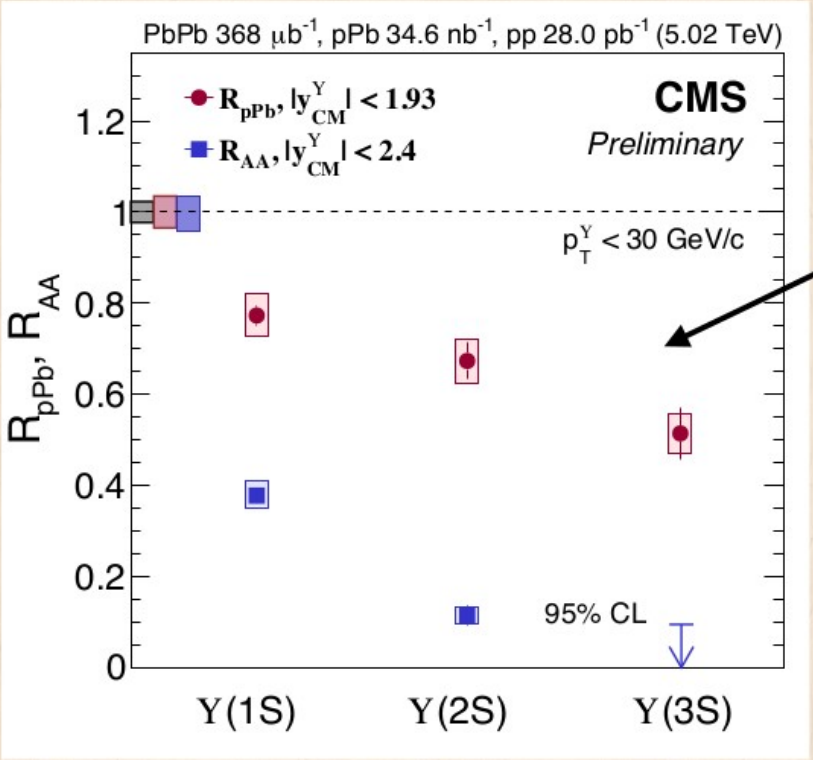


$$z = \frac{J/\psi}{\text{Jet}}$$



PbPb: connection to quenching & hot nuclear effect

Quarkonia suppression



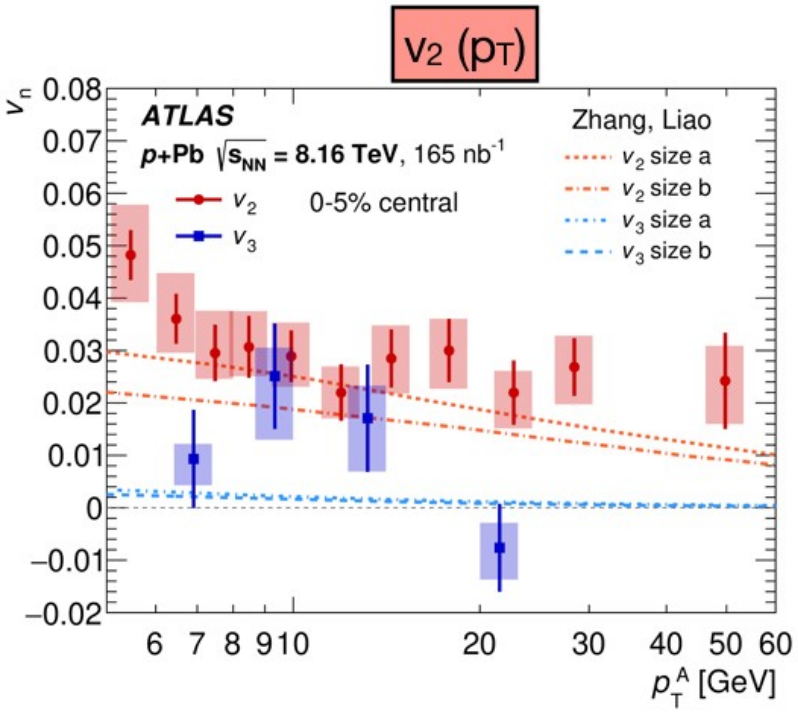
Ordering in pPb: suggest some final state effect

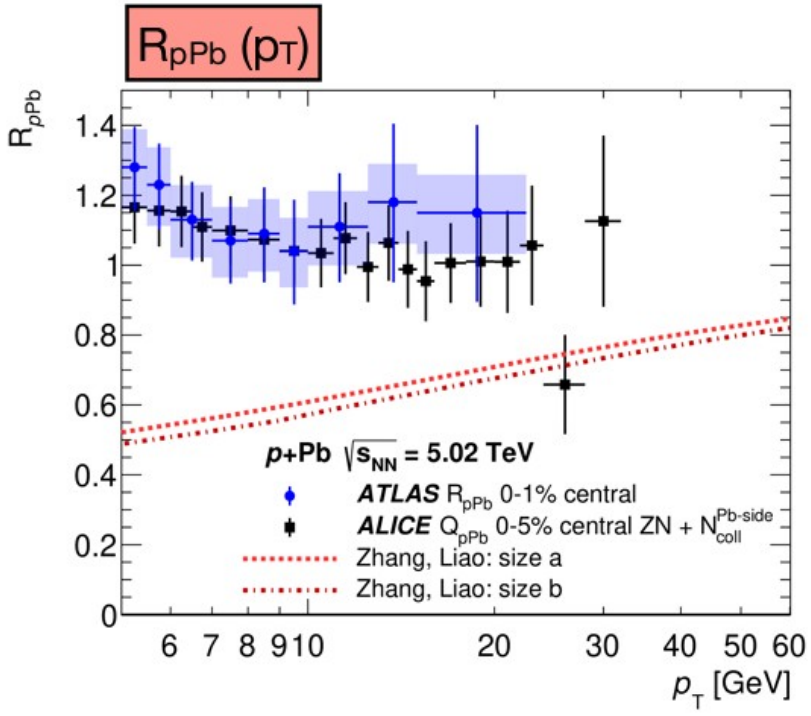
Large effect from hot nuclear effect

Helps disentangle cold nuclear effects and hot nuclear effects

V_n of high p_T hadrons in p+Pb

arXiv:1910.13978

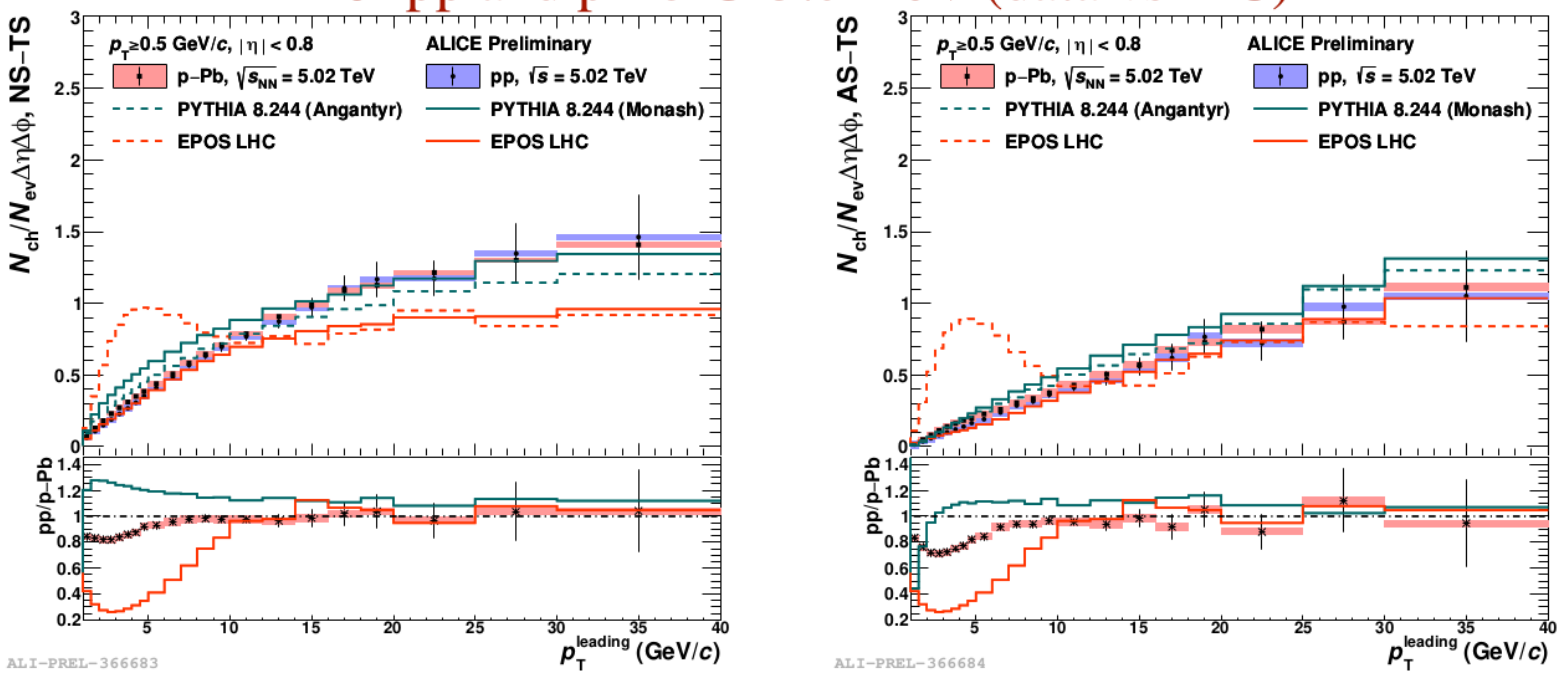




- Significant v_2 up to 50 GeV, but **R_{pPb} consistent with unity**
- Common interpretation in Pb+Pb collisions is that v_2 at high p_T is caused by energy loss, **Interesting tension**, significant v_2 without any measurable jet quenching in p+Pb

Soumya Mohapatra on Tuesday 17:40

Different (?) from UE results:



- The jet-like region is compared by subtracting the transverse side from the towards and away sides.
- At high $p_T^{leading}$ pp and p-Pb data agree with each other suggesting the absence of medium effects.
- This suggests that for $p_T^{leading}$ > 10 GeV/c the UE can be handled in much the same way in pp and p-Pb collisions.
- Useful for more advanced studies searching for jet quenching in small systems.