post-QM 2014 meeting @Nagoya

Soft region

A-A collisions

✓ Direct photon

✓ Shape engineering

p(d)-A collisions

✓ v_n measurement

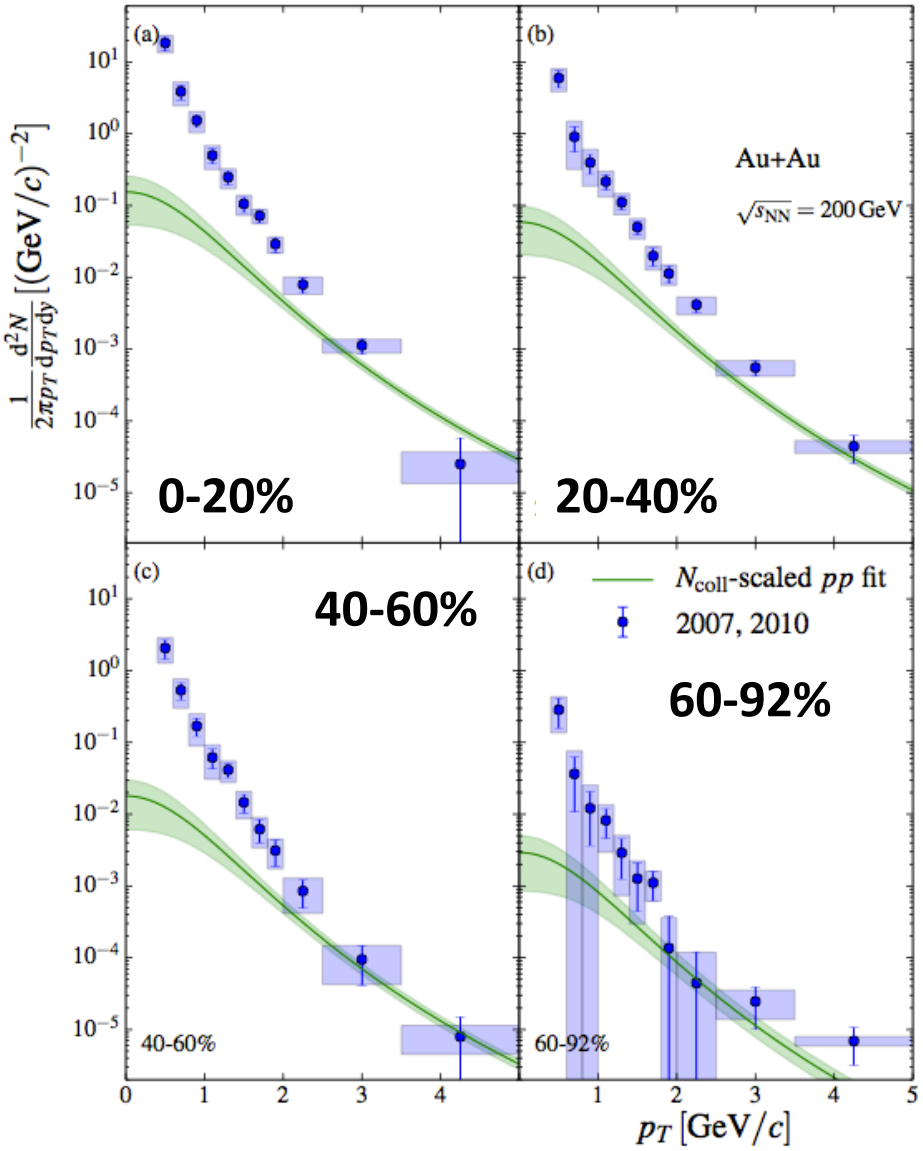
Sanshiro Mizuno

University of Tsukuba, RIKEN

06/06/2014

A-A collisions

Excess of Direct Photon Yield

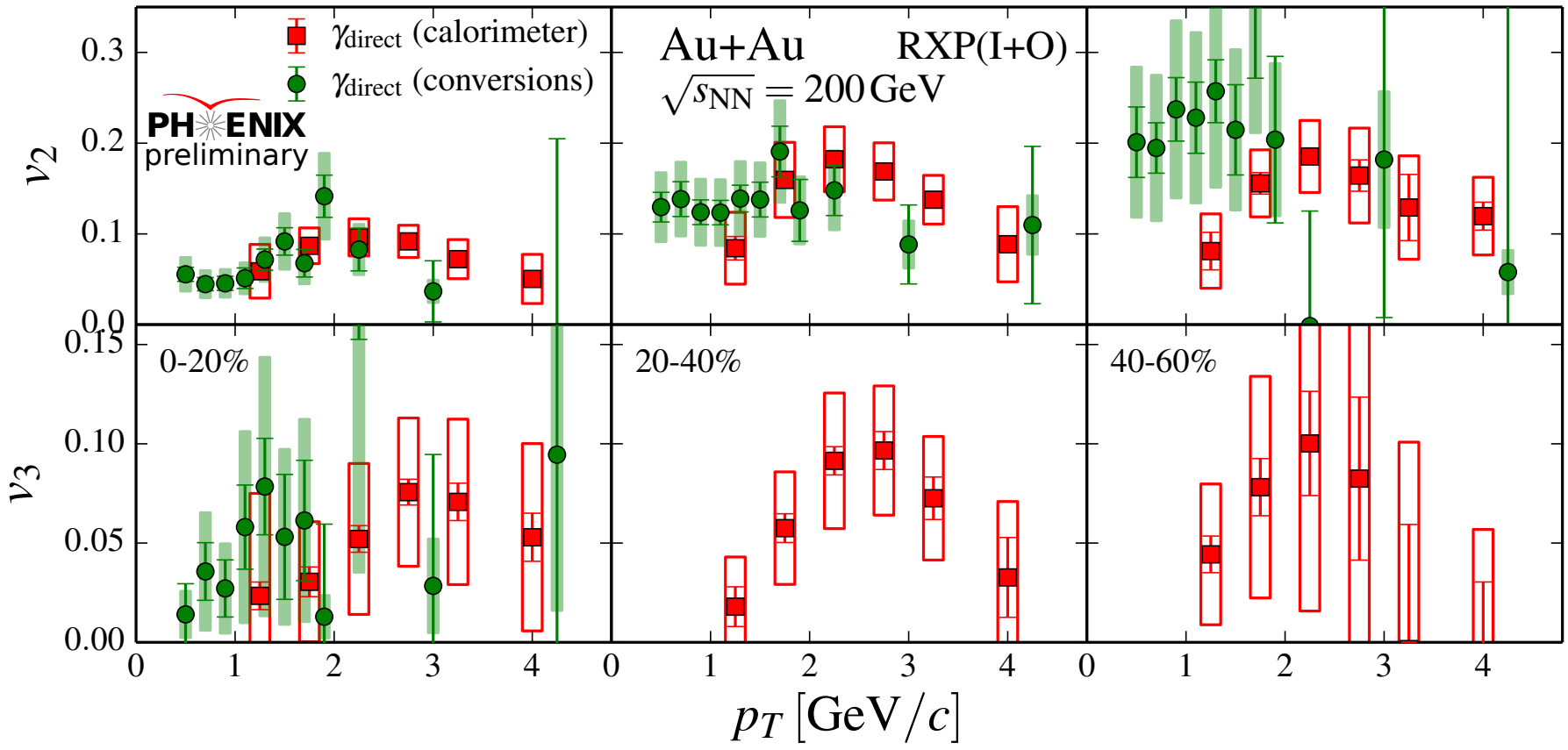


External photon conversion method achieved to measure 0.4-5.0 GeV/c and several centralities.
Lower p_T limit is extended.

Enhancements are observed.

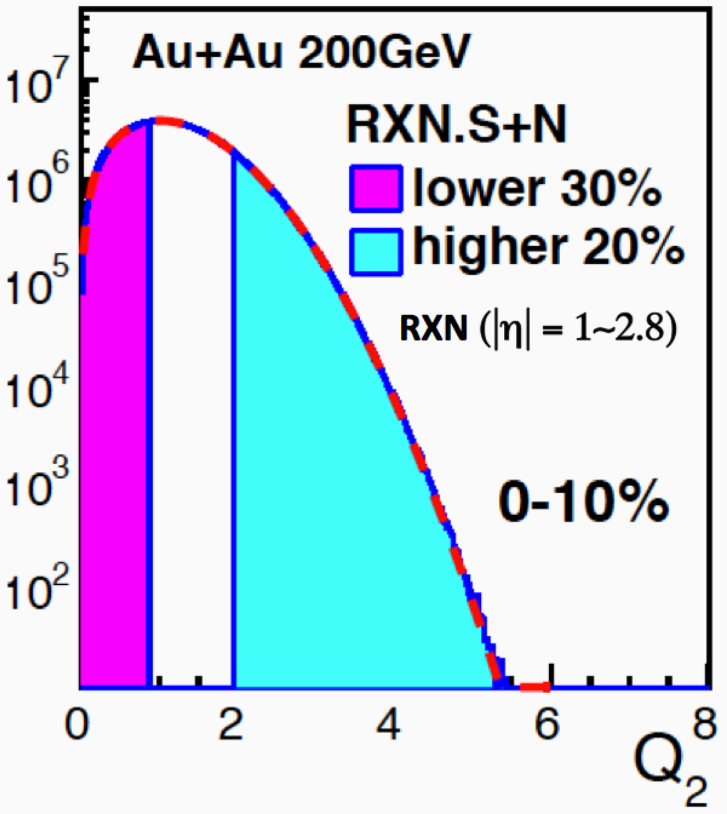
It is found that the shape of spectra in Au+Au doesn't depend on centrality.

Non-Zero Direct Photon v_3



Non-zero positive v_3 is observed in all centrality, as seen in v_2.
Their strengths are comparable with hadron.
They are expected to constrain photon production mechanism.

Event Shape Engineering 1



$$Q_{2,x} = \sum w_i cos(2\phi_i)$$

$$Q_{2,y} = \sum w_i sin(2\phi_i)$$

$$Q_{2,raw} = \sqrt{Q_{2,x}^2 + Q_{2,y}^2} / \sqrt{\sum w_i}$$

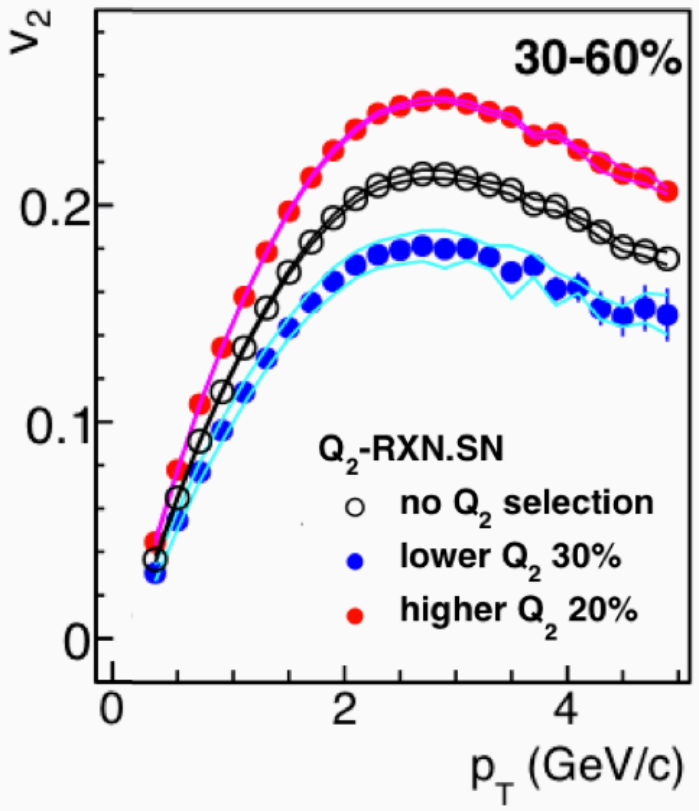
$$Q_2 \sim Q_{2,raw} / < Q_{2,raw} >$$

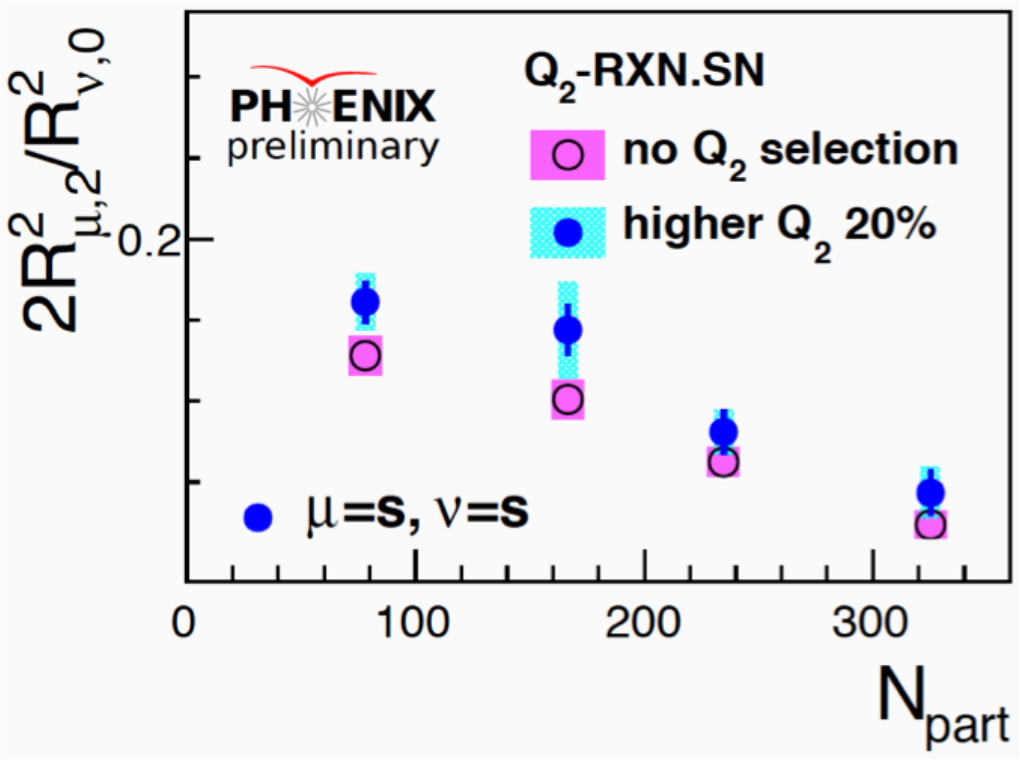
Q_2 is a sort of the strength of v_2 and selected in forward rapidity.
$|\eta|$ = 1~2.8

$\varepsilon_2^{ini.} \sim Q_2 \approx v_2 \sim \varepsilon_2^{fin.}$

Multiplicity and initial geometry are restricted in forward rapidity and v_2 and final eccentricity are measured in mid-rapidity.

v_2 and $\varepsilon_2^{fin.}$ in mid-rapidity ($|\eta|<0.35$)

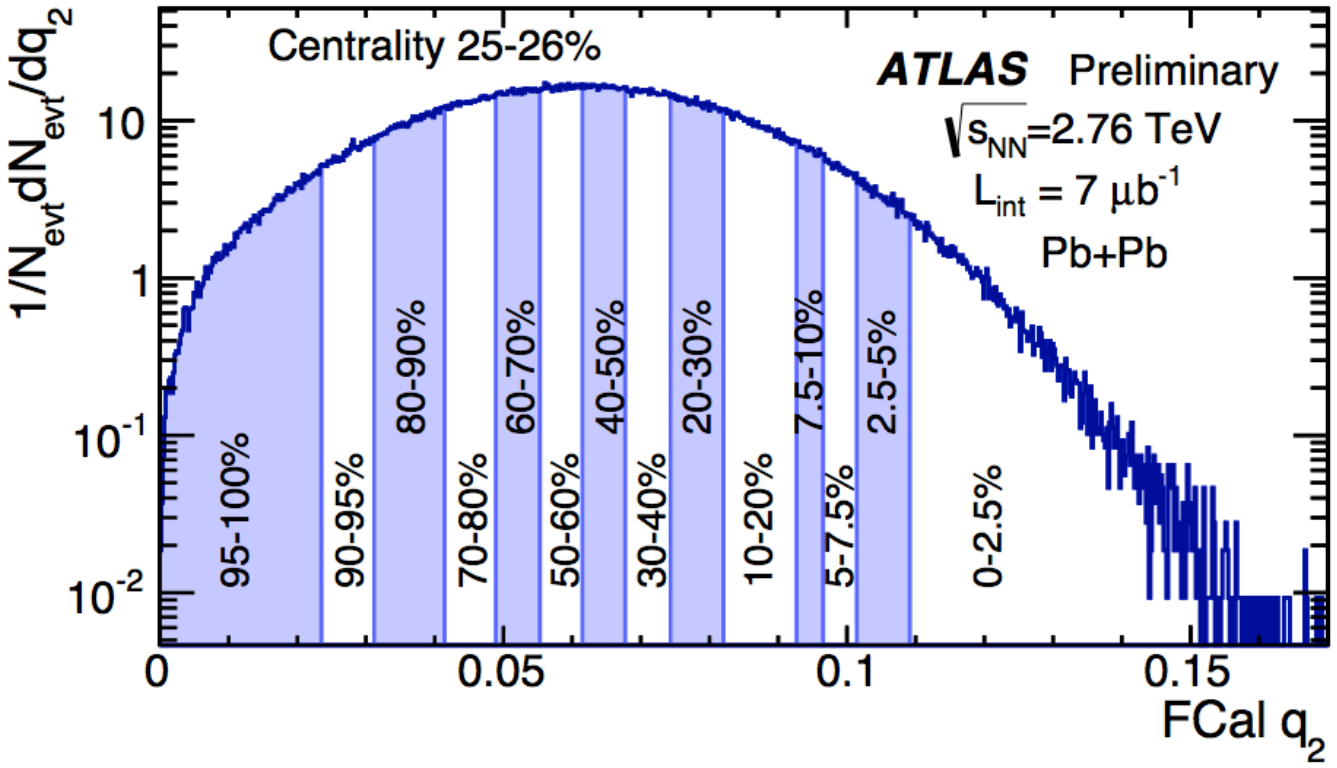




v_2 and final eccentricity($\varepsilon_2^{fin.}$) in mid-rapidity are changed with Q_2 selection in forward rapidity.

High Q_2 -> High v_2 & High $\varepsilon_2^{fin.}$ --- High $\varepsilon_2^{ini.}$?

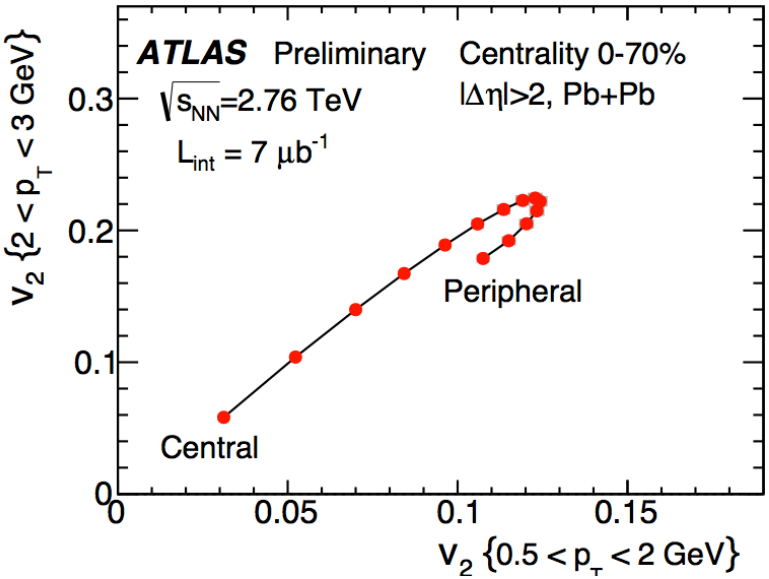
Event Shape Engineering 2



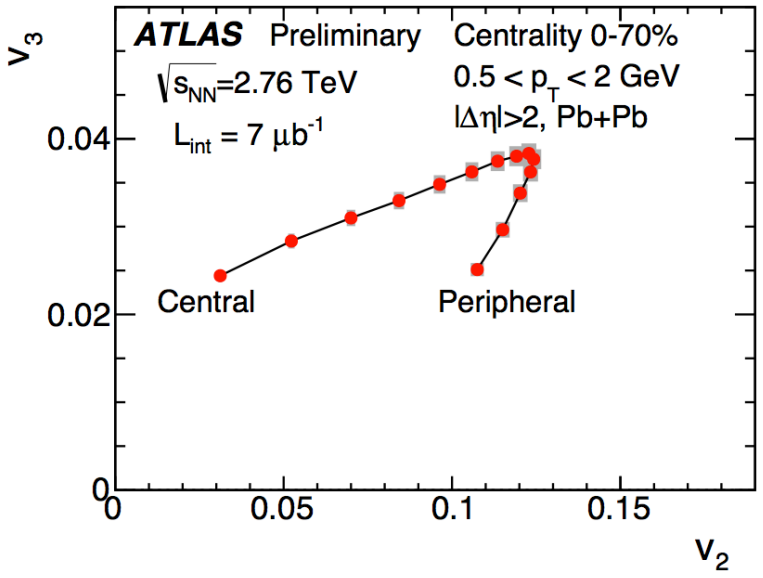
q_2 is observed v_2 in FCal ($3.2<|\eta|<4.9$).

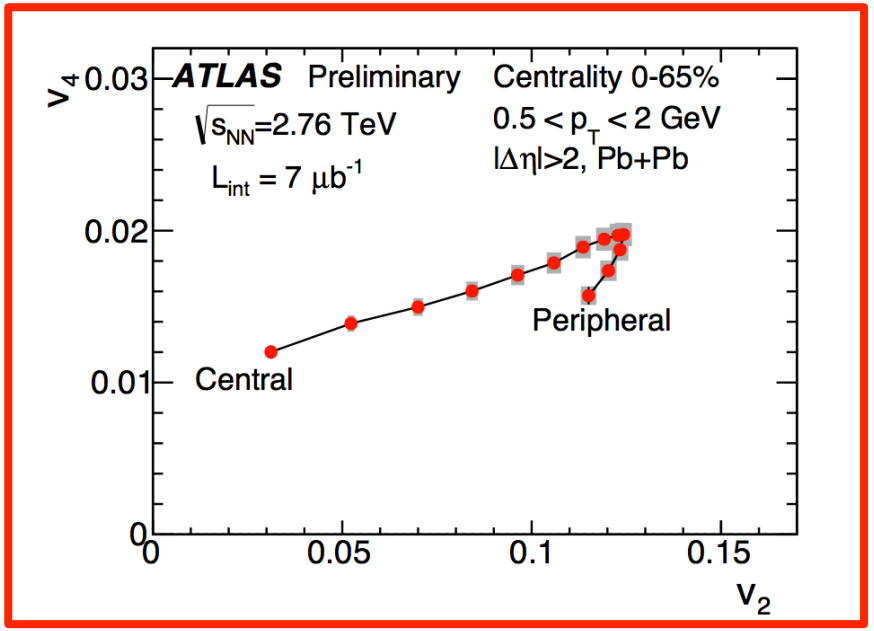
It is expected to reveal hidden initial geometry effect.

v_m-v_2 Correlation Without q_2 selection

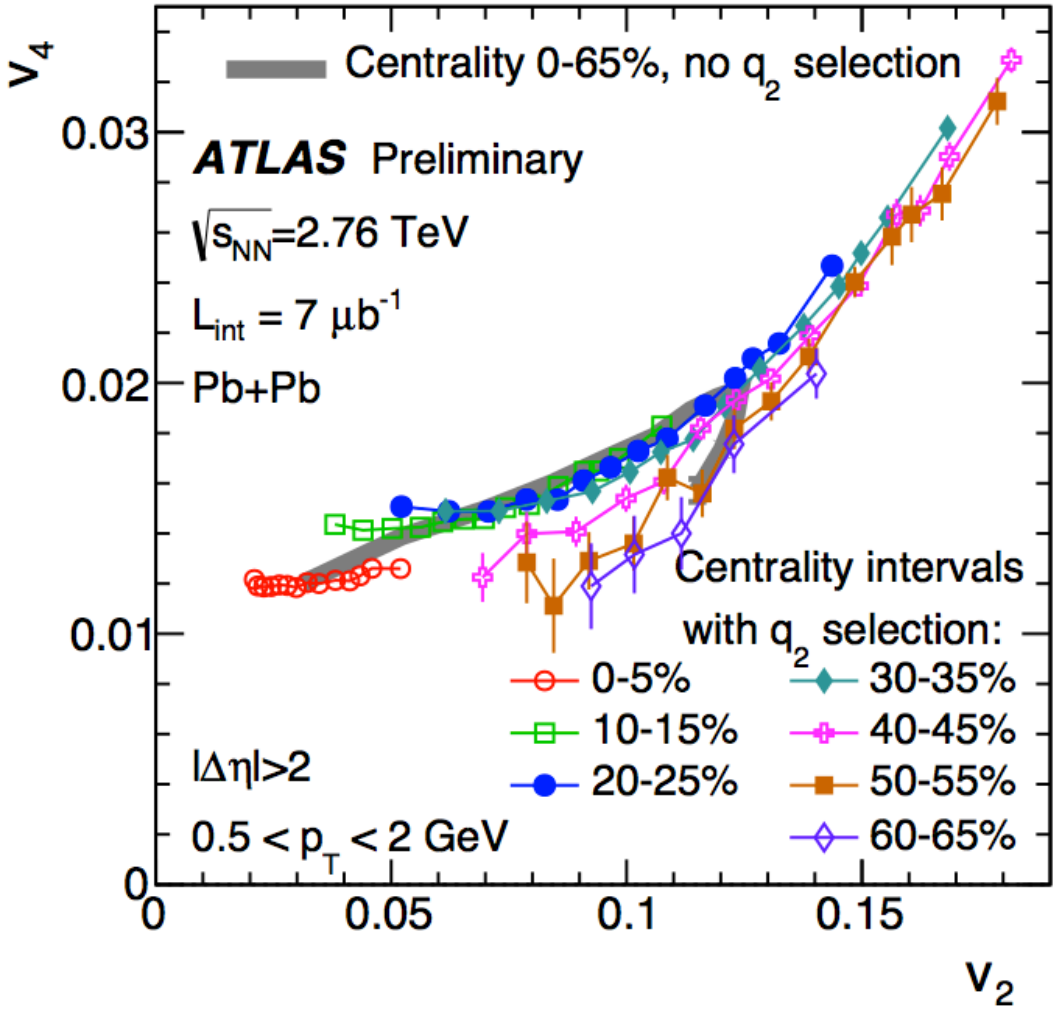


They have centrality dependence.





v_4-v_2 correlation with q_2 selection



Non-linear correlation is found.

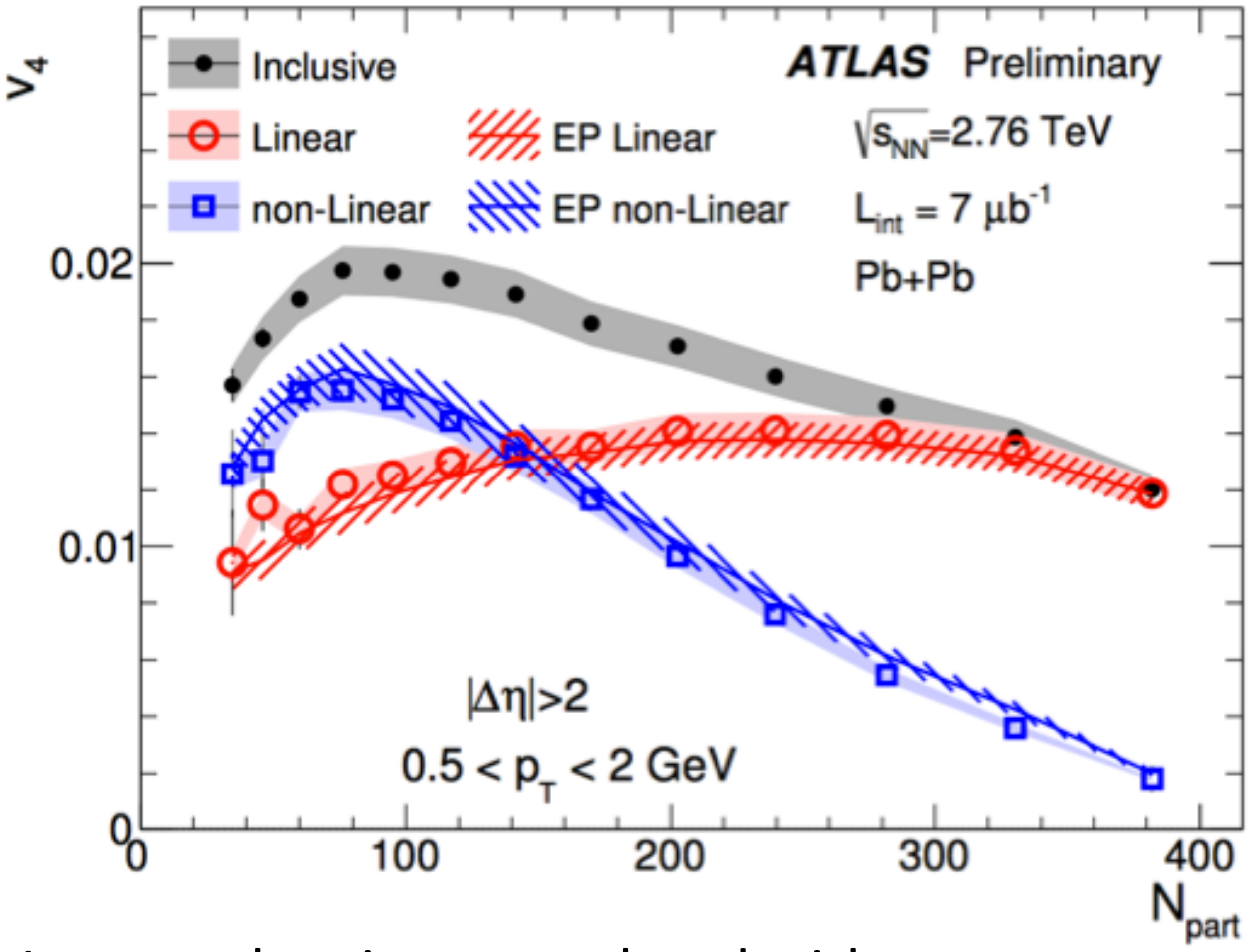
v_4 is divided into two components

- c_0 : independent on $v_2(\varepsilon_2)$
- c_1 : dependent on $v_2(\varepsilon_2)$

They are extracted by fitting.

$$v_4 = \sqrt{c_0^2 + c_1^2 v_2^4}$$

Non-Linear & Linear v_4 Component



$$v_4 = \sqrt{c_0^2 + c_1^2 v_2^4}$$

c_0 : Linear (ε_4)

$c_1 v_2^2$: non-Linear (ε_2)

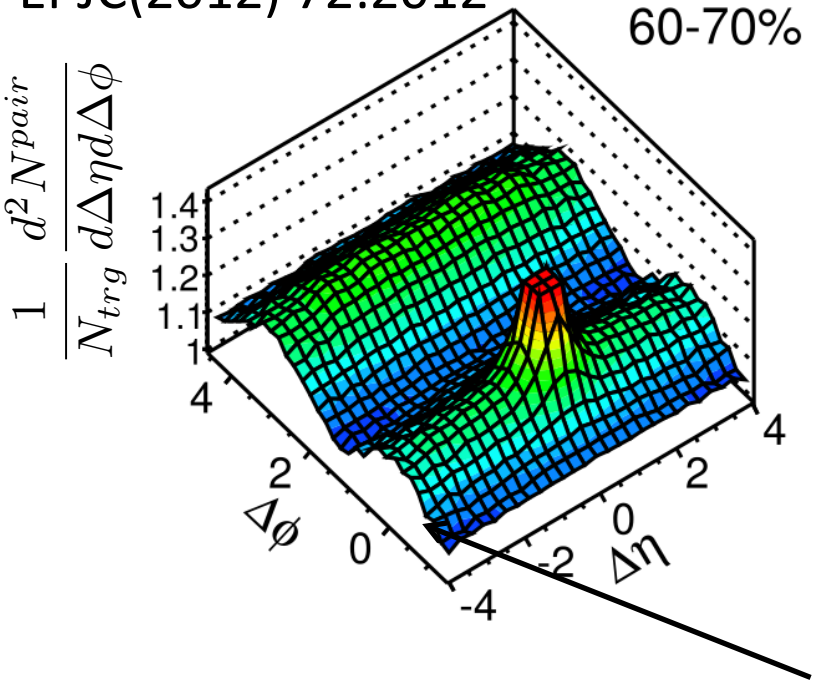
In central, v_4 is uncorrelated with v_2.

Correlated v_4 gradually increases and overtakes at around N_{part}~120.

p(d)-A collisions

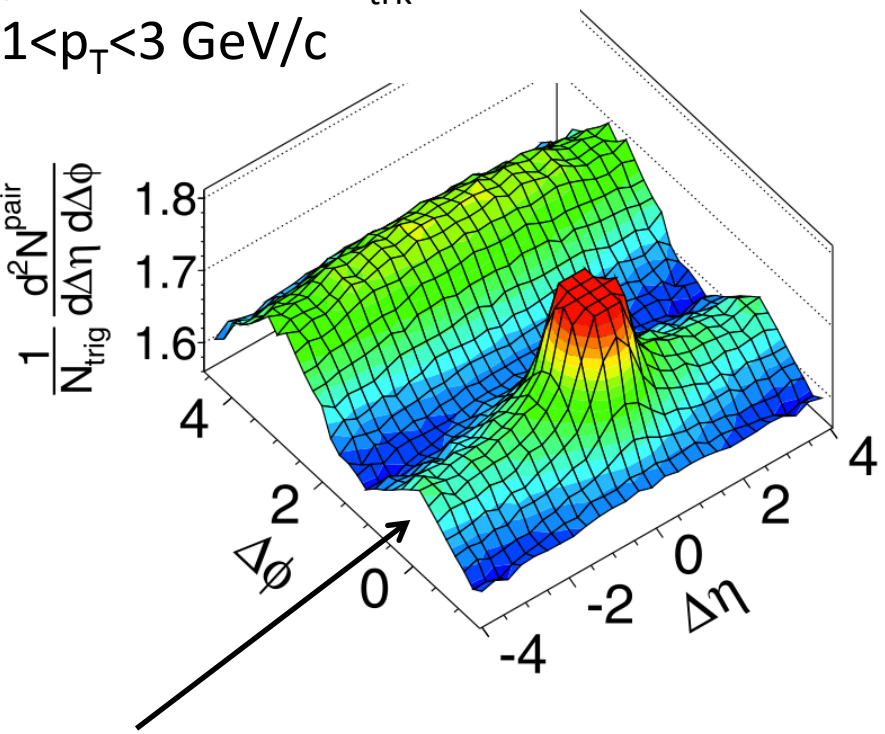
p(d)-A Collisions

PbPb 2.76TeV, $1<p_T<1.5$ GeV/c
EPJC(2012) 72:2012



pPb 5.02TeV, $N_{trk} \geq 110$
$1<p_T<3$ GeV/c

(b)

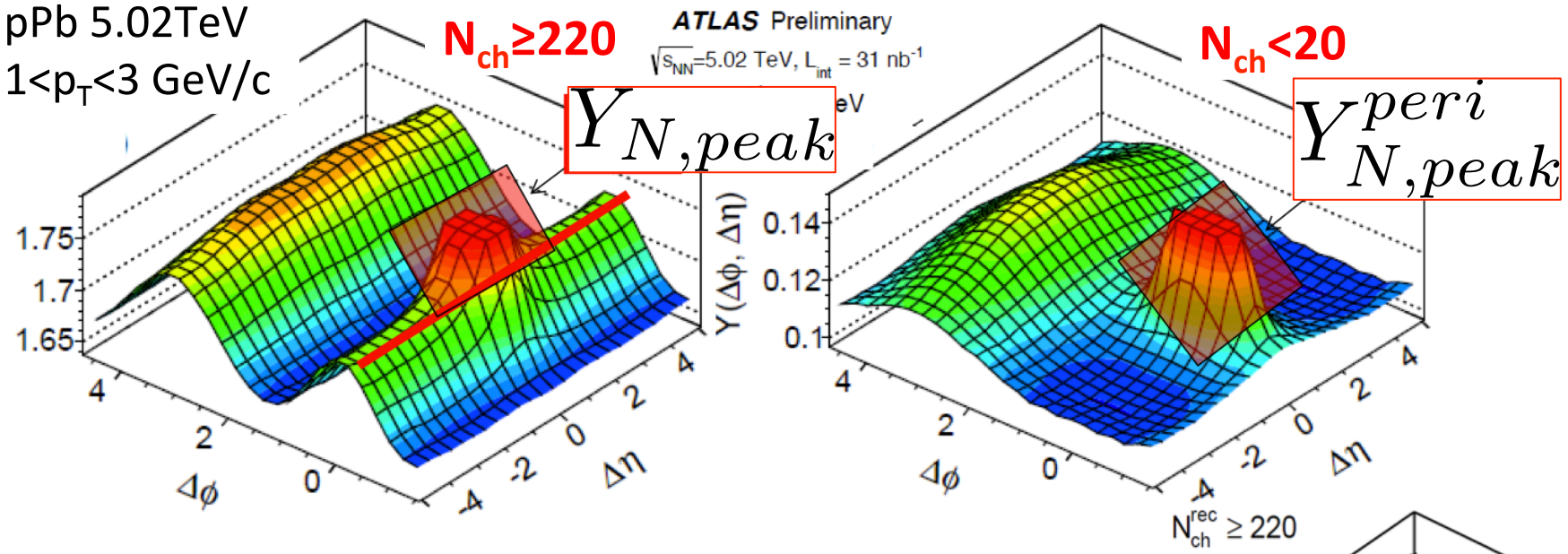


near side ridge

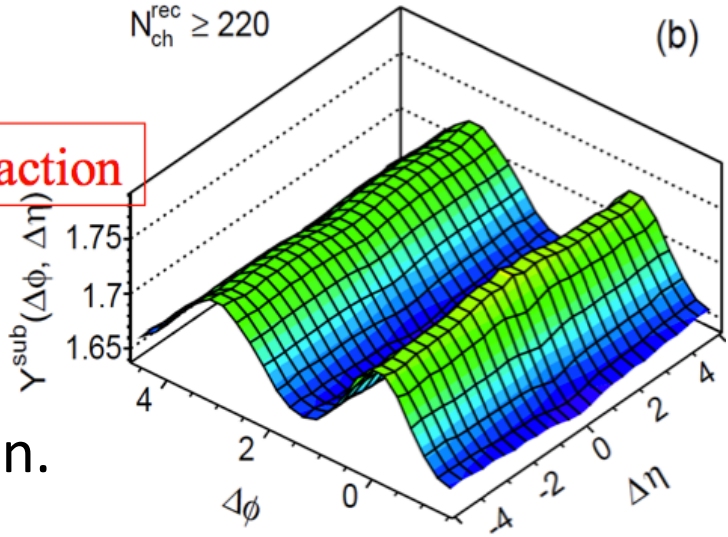
Long range near-side ($\Delta\phi \sim 0$) ridge have been observed in pPb.
v_n components are extracted.

Extraction v_n component

pPb 5.02TeV
$1<p_T<3$ GeV/c



After subtraction

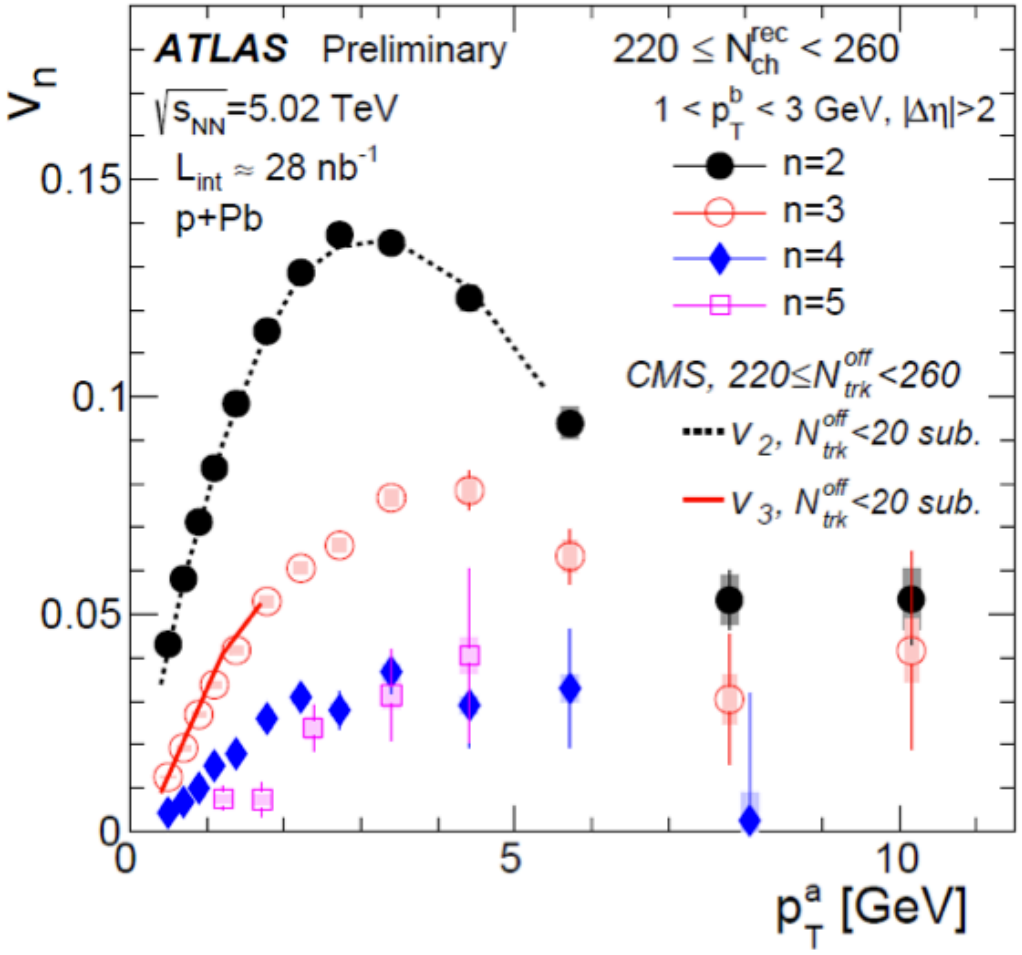


$$Y_{N,peak} = \alpha Y^{peri}_{N,peak}$$

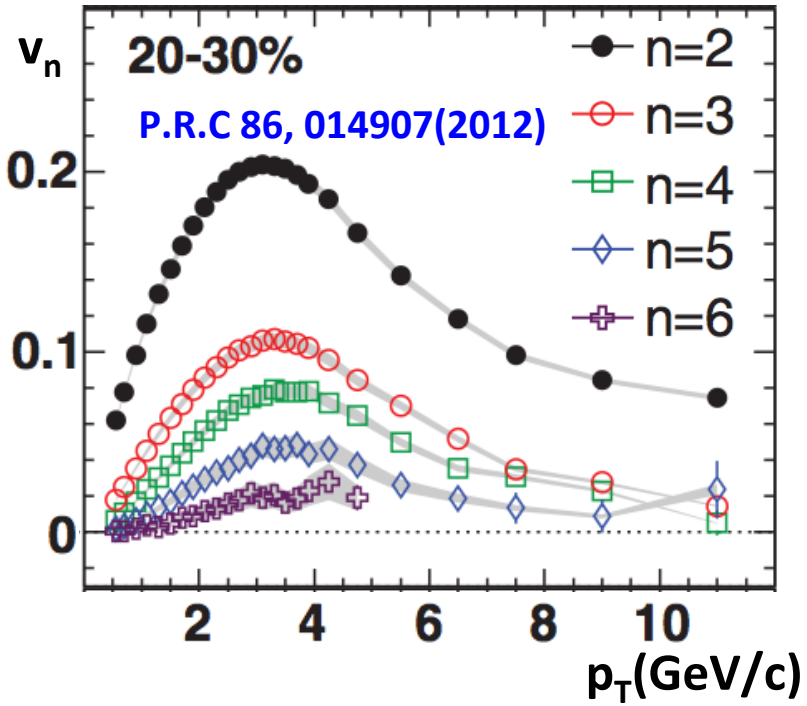
$$Y^{sub} = Y_{\{N_{ch}\leq 220\}} - \alpha Y_{\{N_{ch}<20\}}$$

Subtracted yield are fitted by Fourier function.

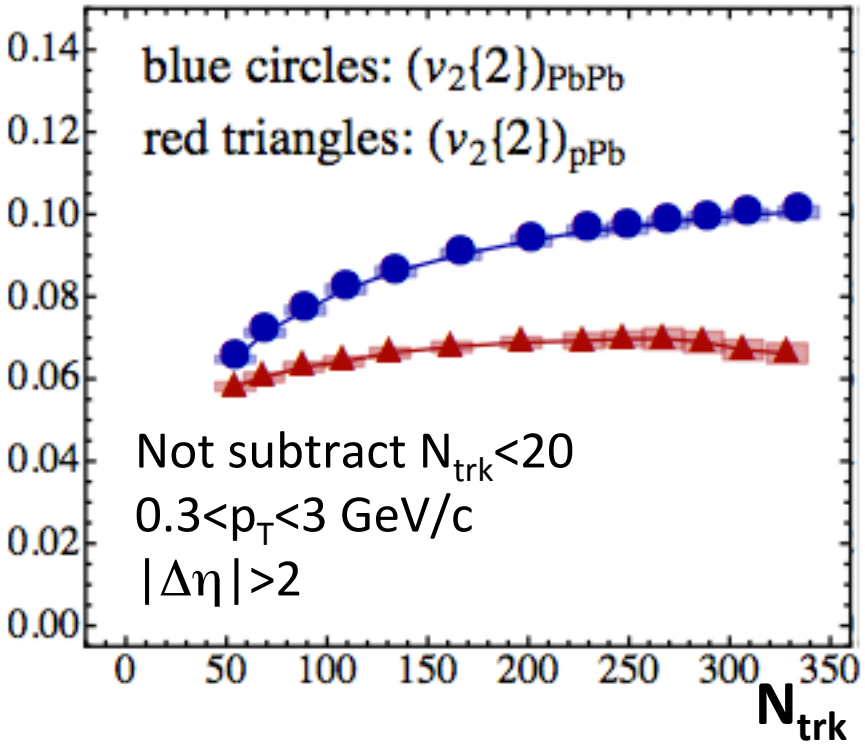
$v_{n(2-5)}$ measurement in pPb

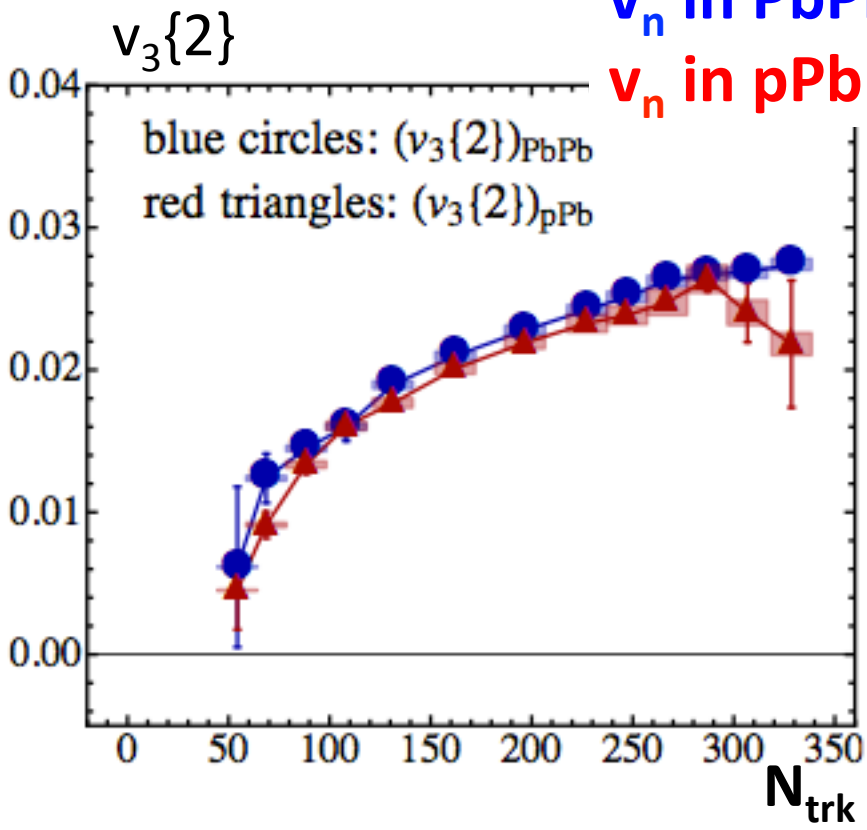


- Non-zero positive v_n are observed.
- Rise with p_T at low p_T and then decrease, it is similar to PbPb collisions.



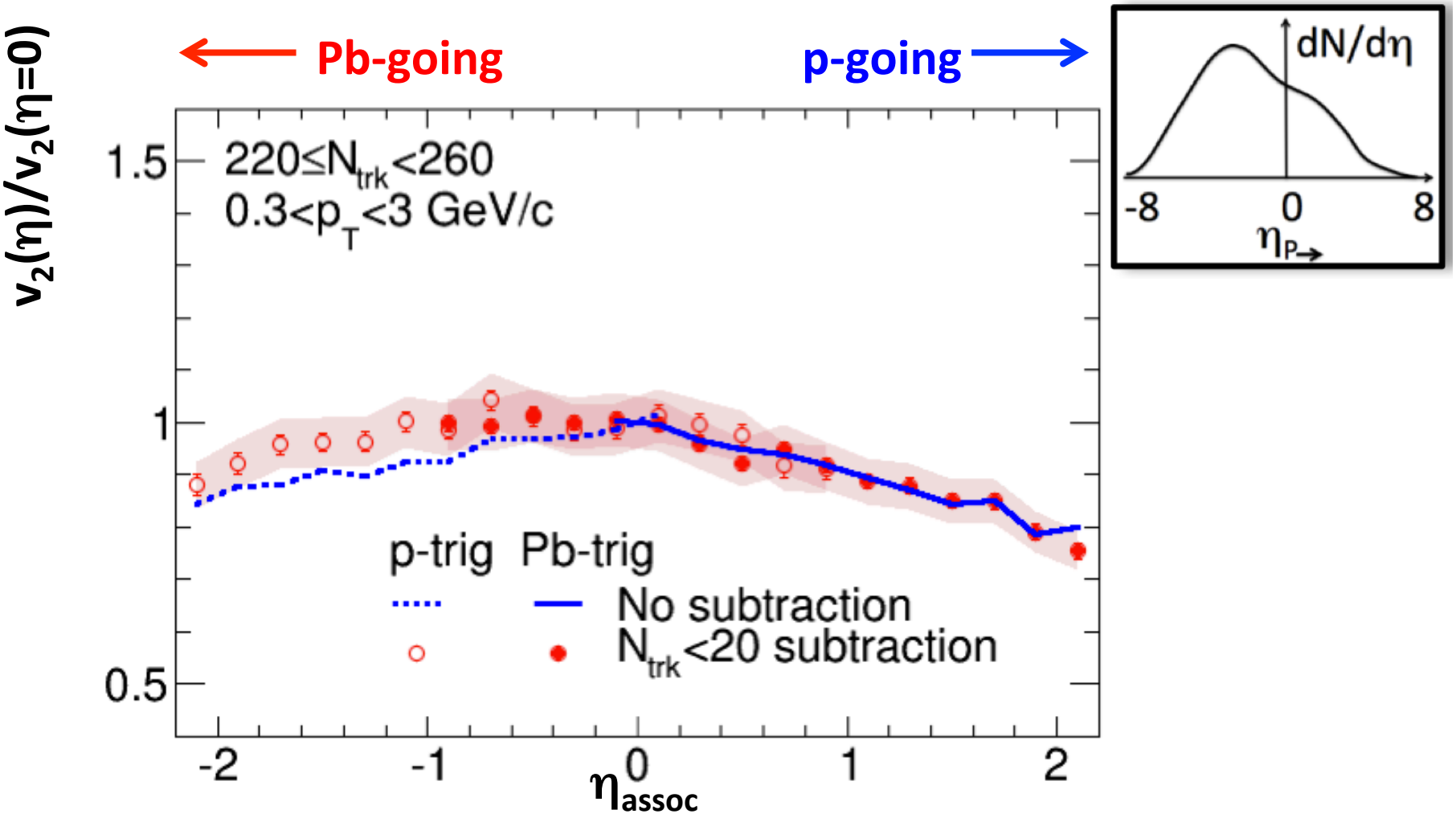
Comparison N_{part} Dependence





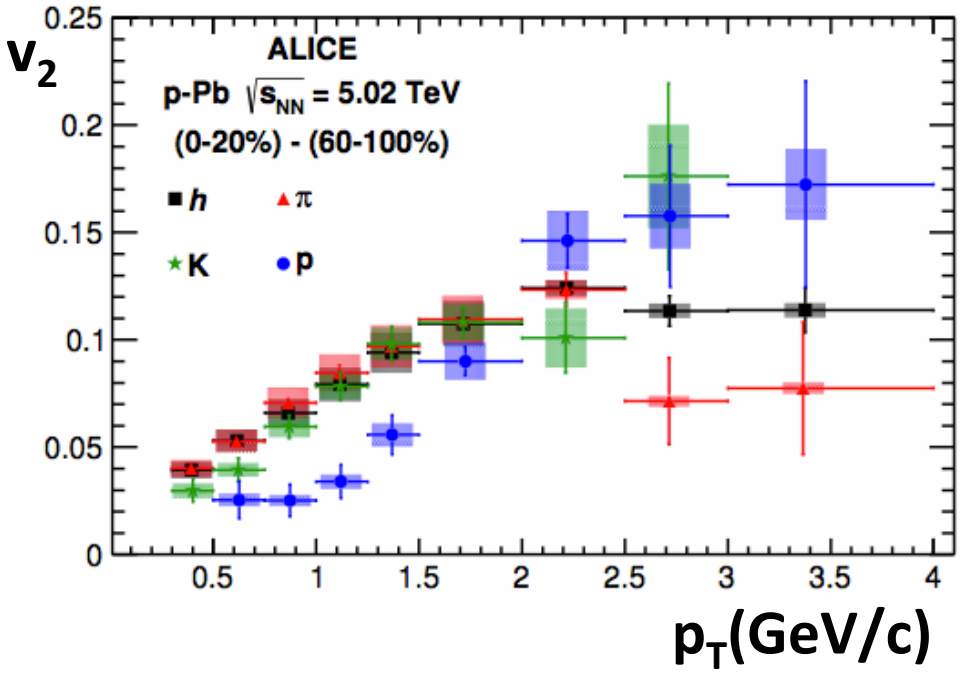
There are deviation in v_2 while v_3 are comparable.
Eccentricity and triangularity study are needed.

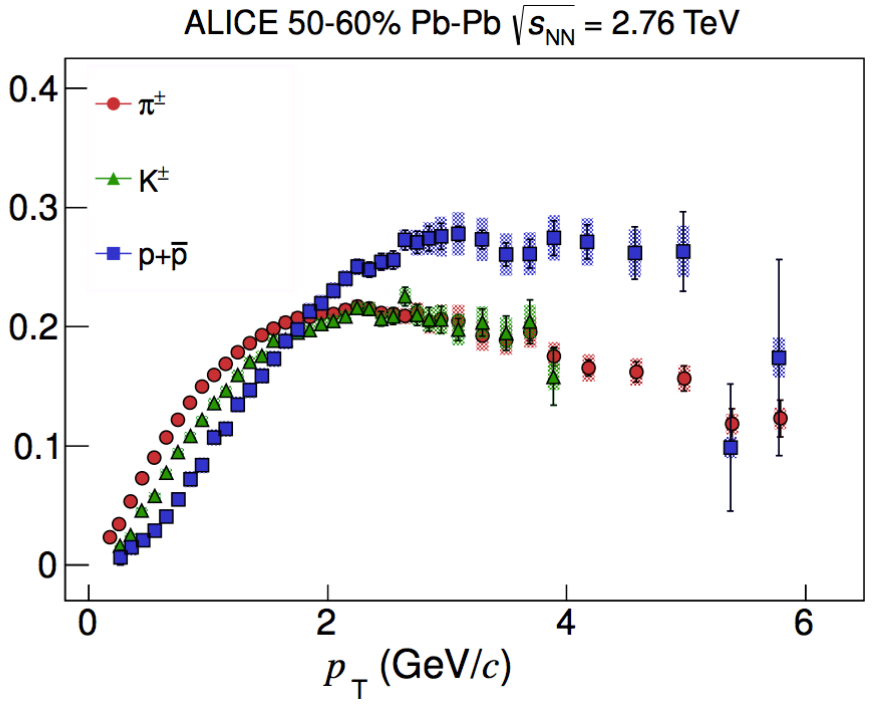
η Dependence In v_2



v_2 in Pb-going is slightly larger than v_2 in p-going.
This could be related with higher particle densities.

Collective Flow In pPb?



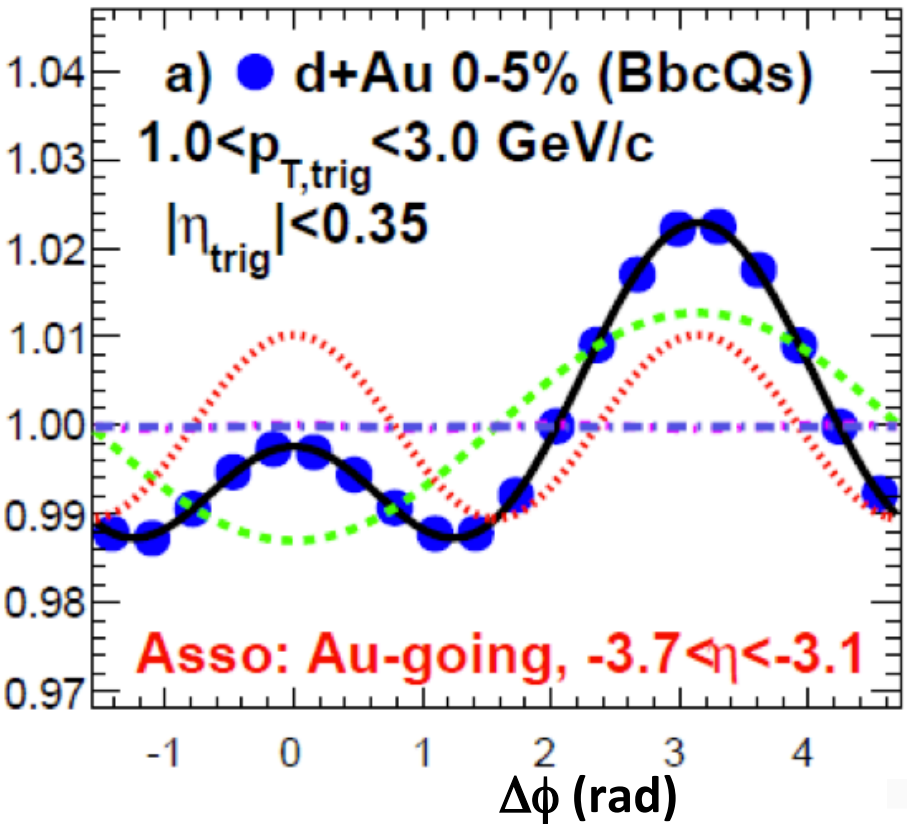


Mass ordering is observed in low p_T, it is similar to the trend in PbPb. Mesons and baryon cross at about 2GeV/c.

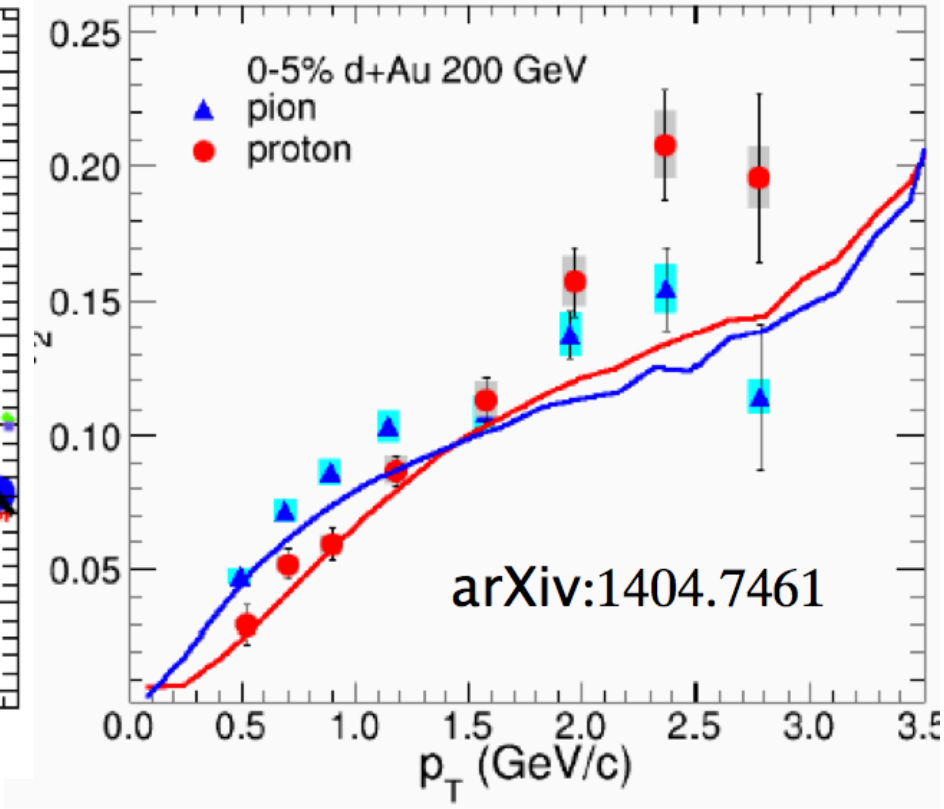
Collective flow exists?

Collective Flow In dAu?

C(Δϕ) : CNT-Forward(Augoing)



v_2

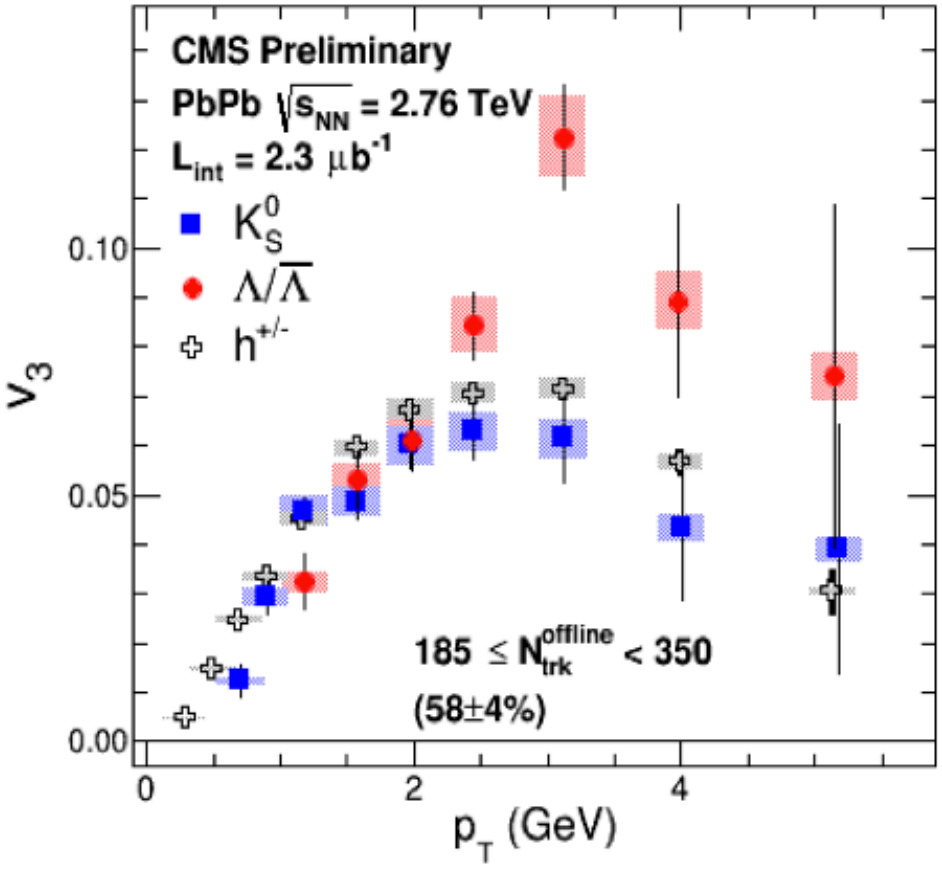


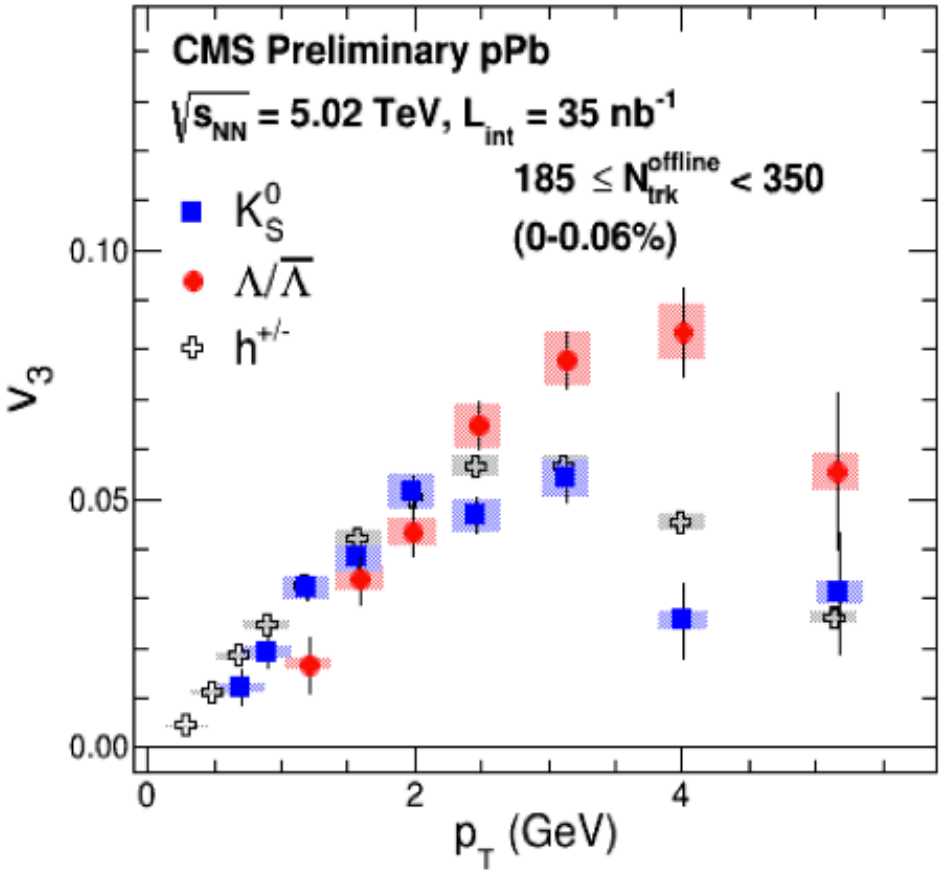
Ridge like structure is seen around Δϕ~0.

Mass ordering is observed in low p_T, and they cross at around 2GeV/c.

Collective flow exists??

Mass Ordering In v_3??

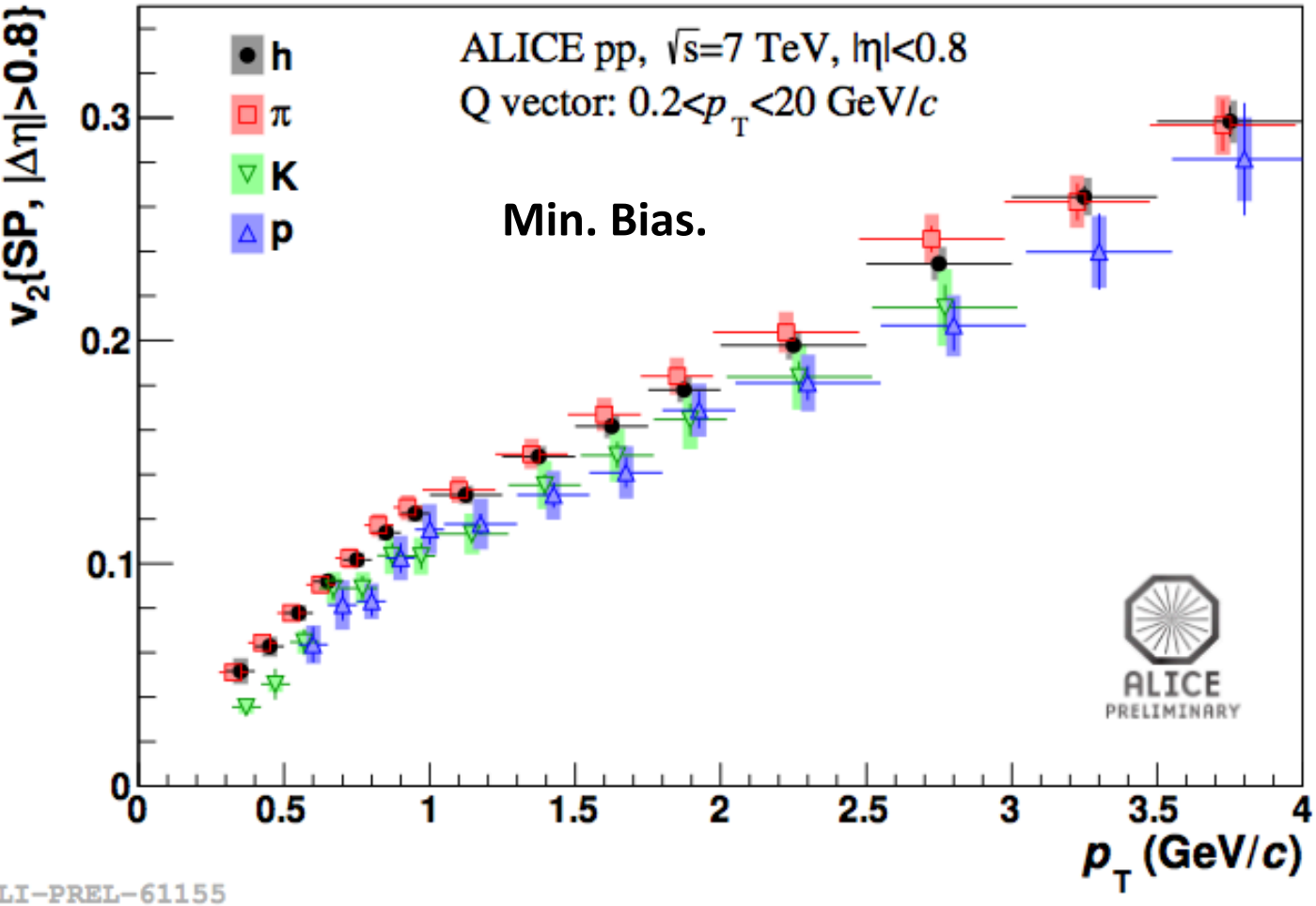




It is observed that v_3 has mass ordering in low p_T and they cross at around 2.0 GeV/c.

Collective flow exists???

Mass ordering in pp???



Non-flow dominates measurement
-- No ridge observed.

Mass ordering is observed in pp collisions, but they don't cross as it is found in PbPb and pPb collisions.

Mass ordering indicates that collective flow exists????

Summary

A-A collisions

- Direct photon study

  The shape of yield in AuAu doesn't depend on centrality.

  Non-zero v_3 is observed.

- Event shape engineering

  Q_2 selection helps to handle event selection.

  v_4 is divided into linear and non-linear components.

p(d)-A collisions

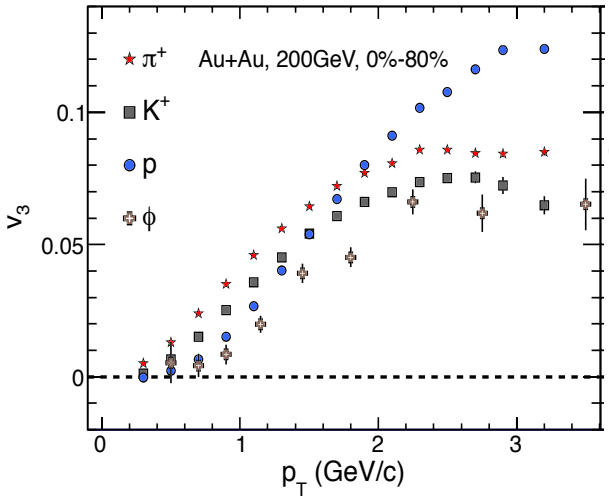
Near side ridge is studied by measuring v_n.

N_{part}, η and particle species dependence are measured.

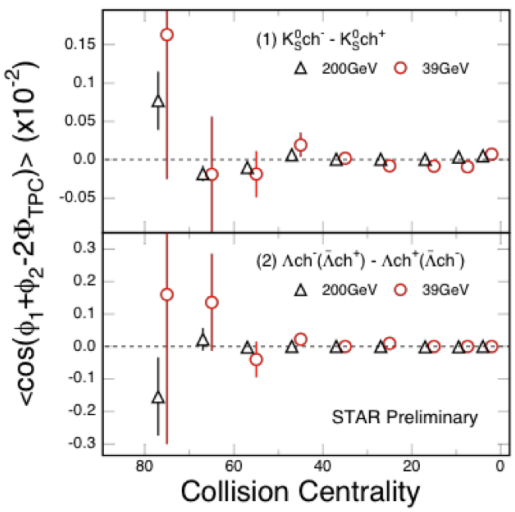
Mass ordering is observed in pPb and dAu.

Other Measurements

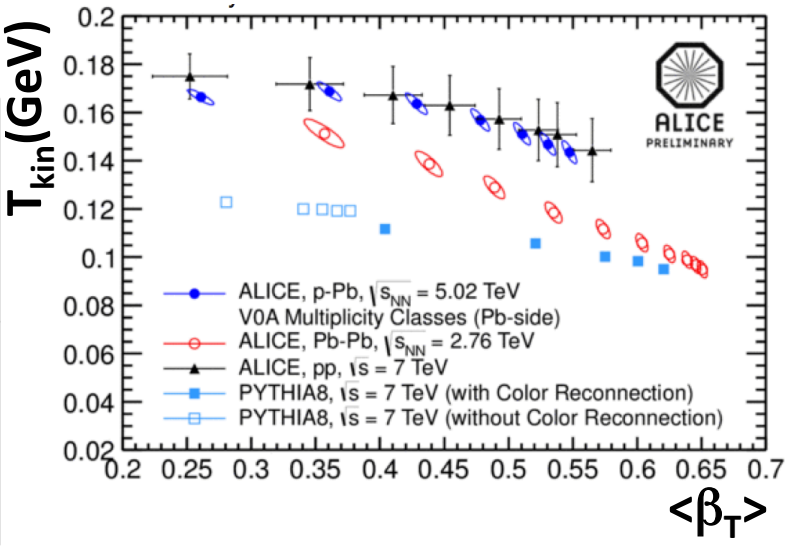
ϕ v_3 measurement @STAR



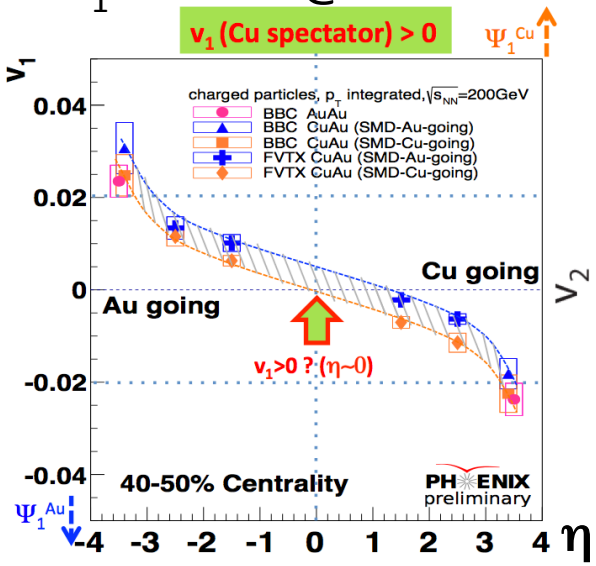
LPV @STAR



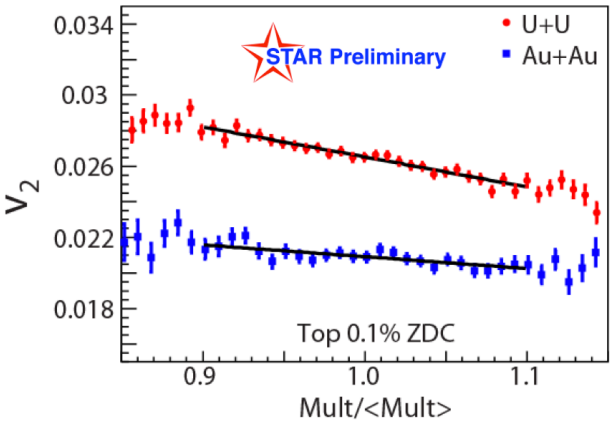
Blast Wave Parameterization @ALICE



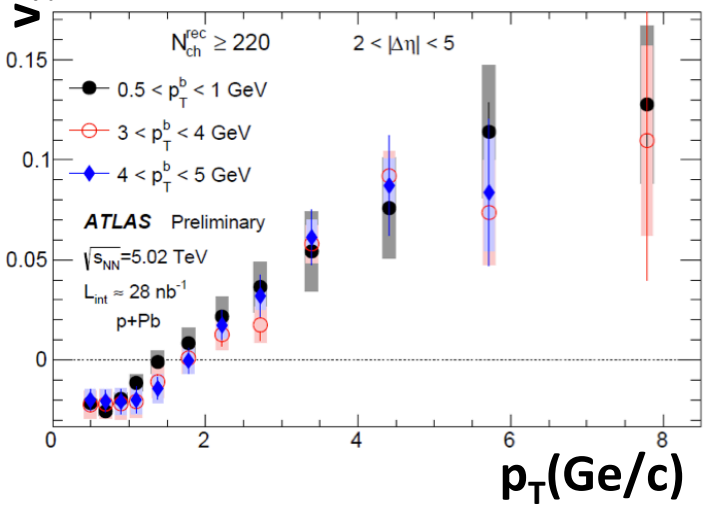
v_1 in CuAu @PHENIX



v_2 in UU @STAR



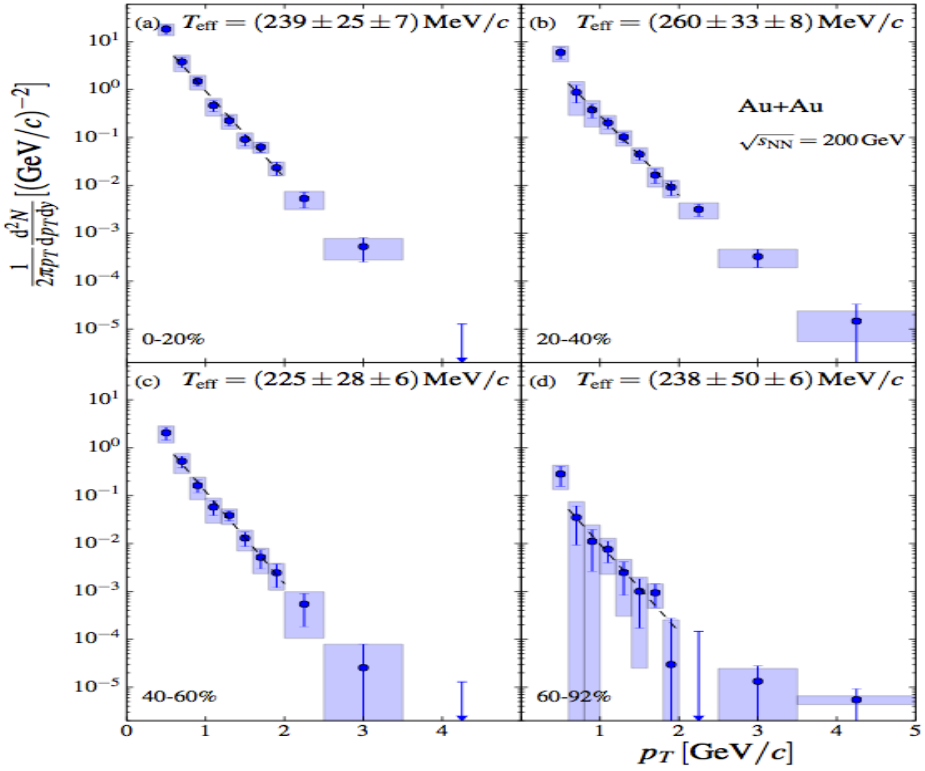
v_1 in pPb @ATLAS



Direct photon Excess Yield Study

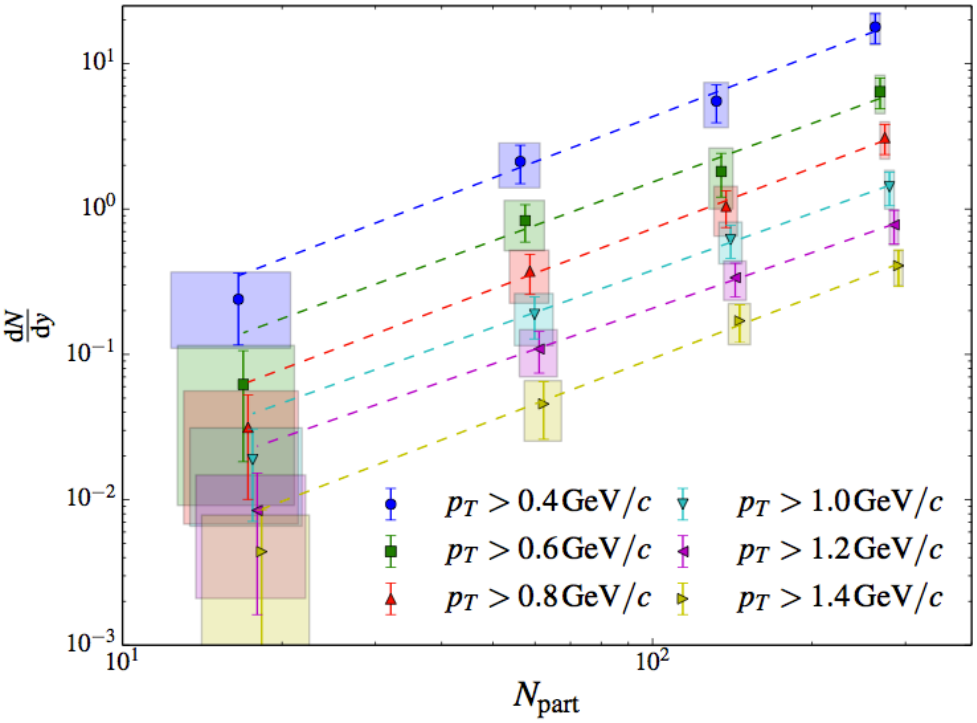
arXiv:1405.3940

Distribution After subtraction of yield in scaled pp from yield in AuAu



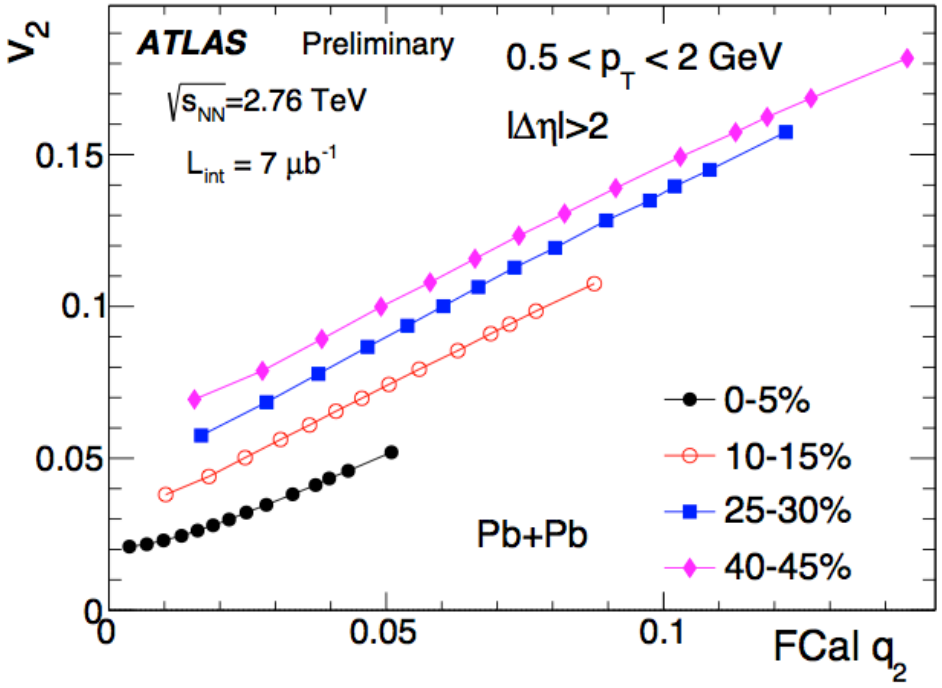
$$Ae^{-p_T/T_{eff}}$$

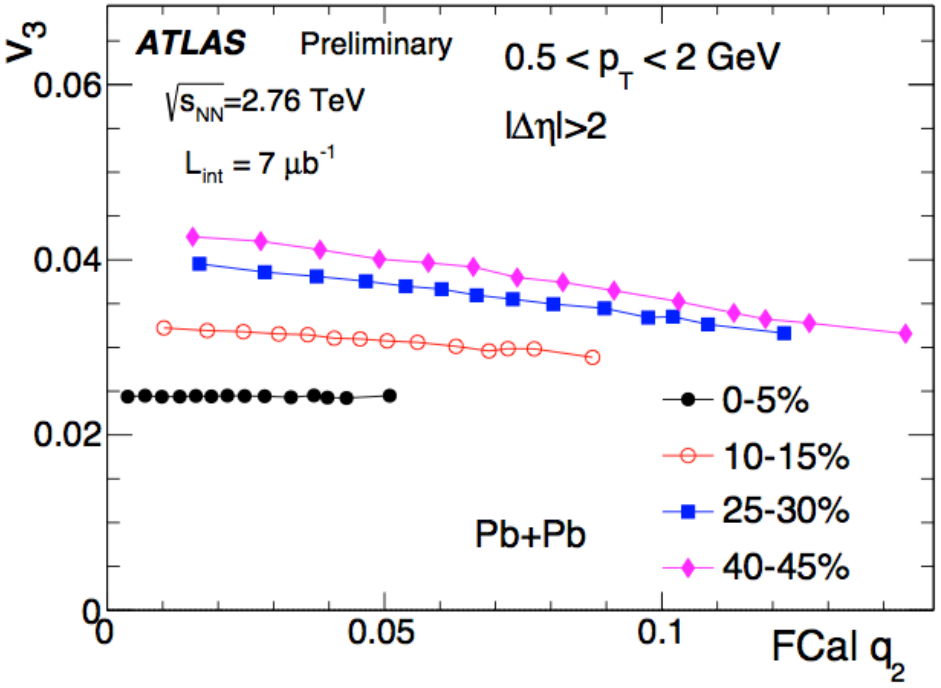
The amount of excess direct photon yield



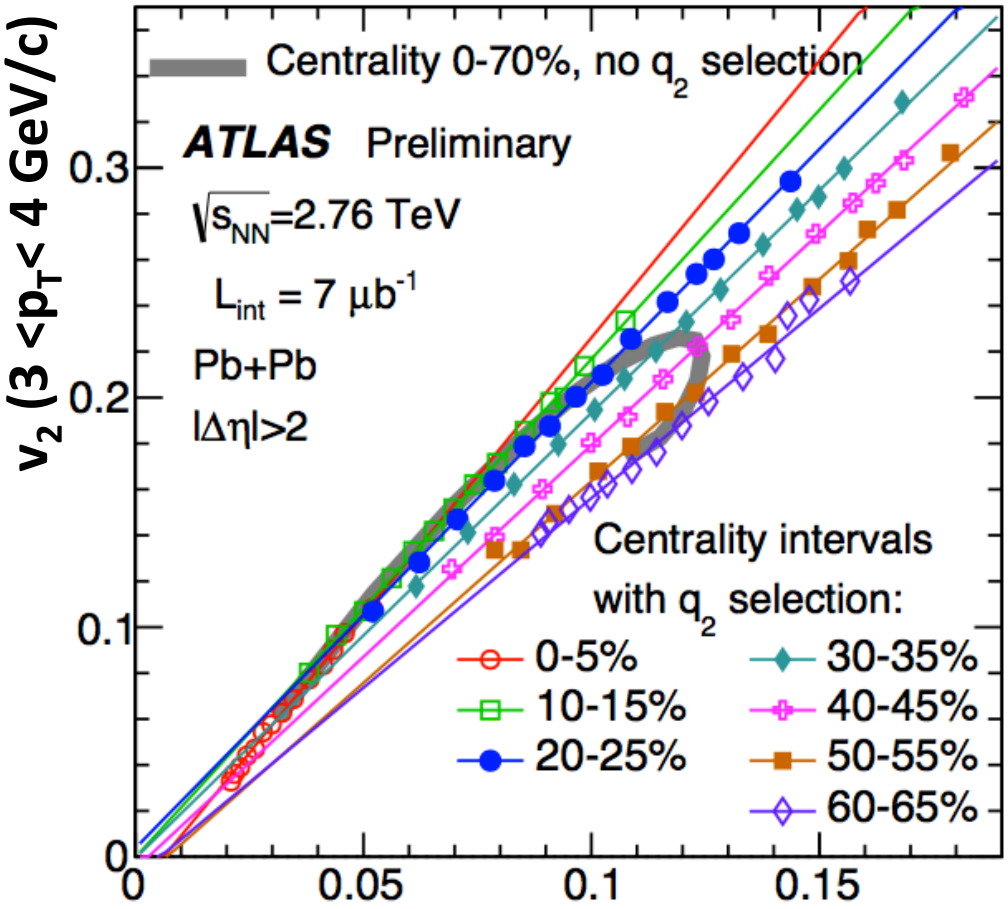
$$F = AN_{part}^{\alpha}$$

v_m-q_2 Correlation





v_2-v_2 Correlation with q_2 selection



$$v_2 e^{i2\Phi_2} \propto \epsilon_2 e^{i2\Phi_2}$$

$$v_2 e^{i2\Phi_2} = C\epsilon_2 e^{i2\Phi_2}$$

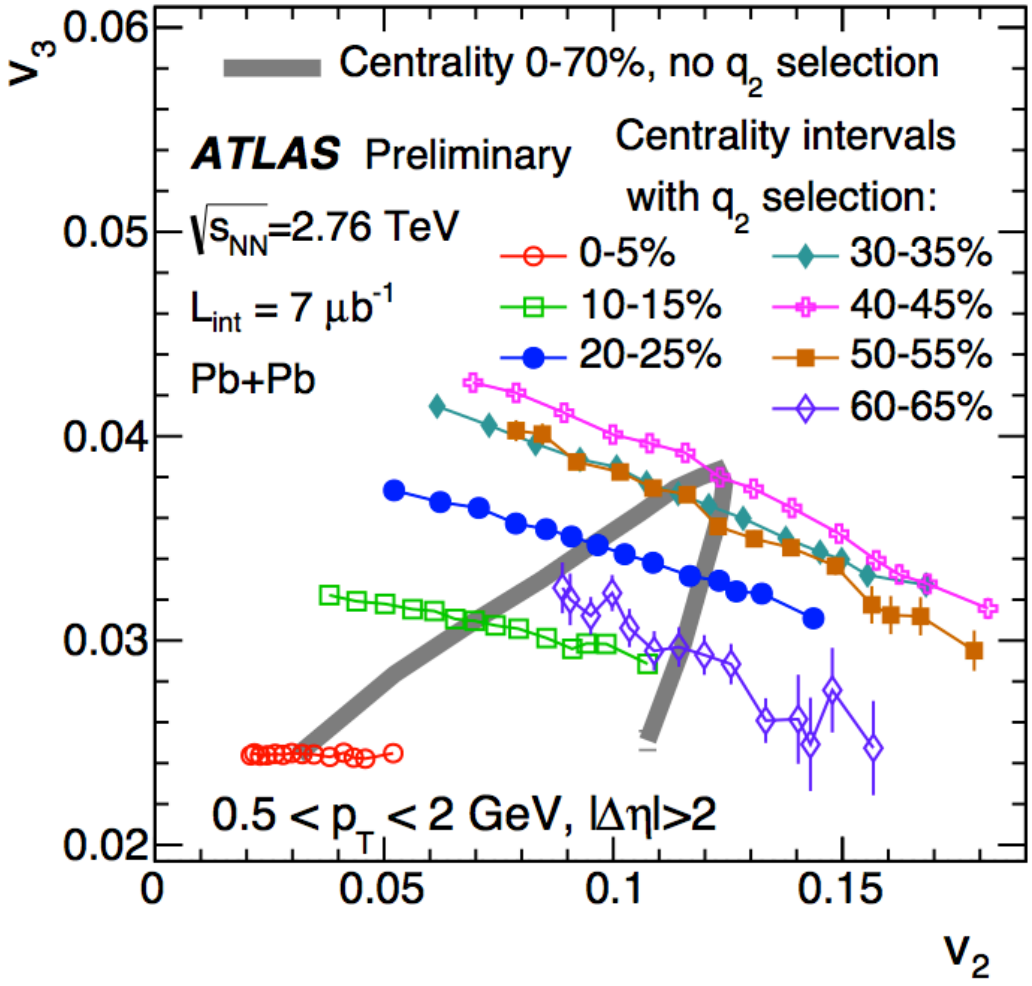
v_2 (0.5 <p_T< 2 GeV/c)

Non-trivial dependence with centrality (boomerang)

Linear dependence within one centrality

Indicates that viscous correction mostly controlled by size, not shape.

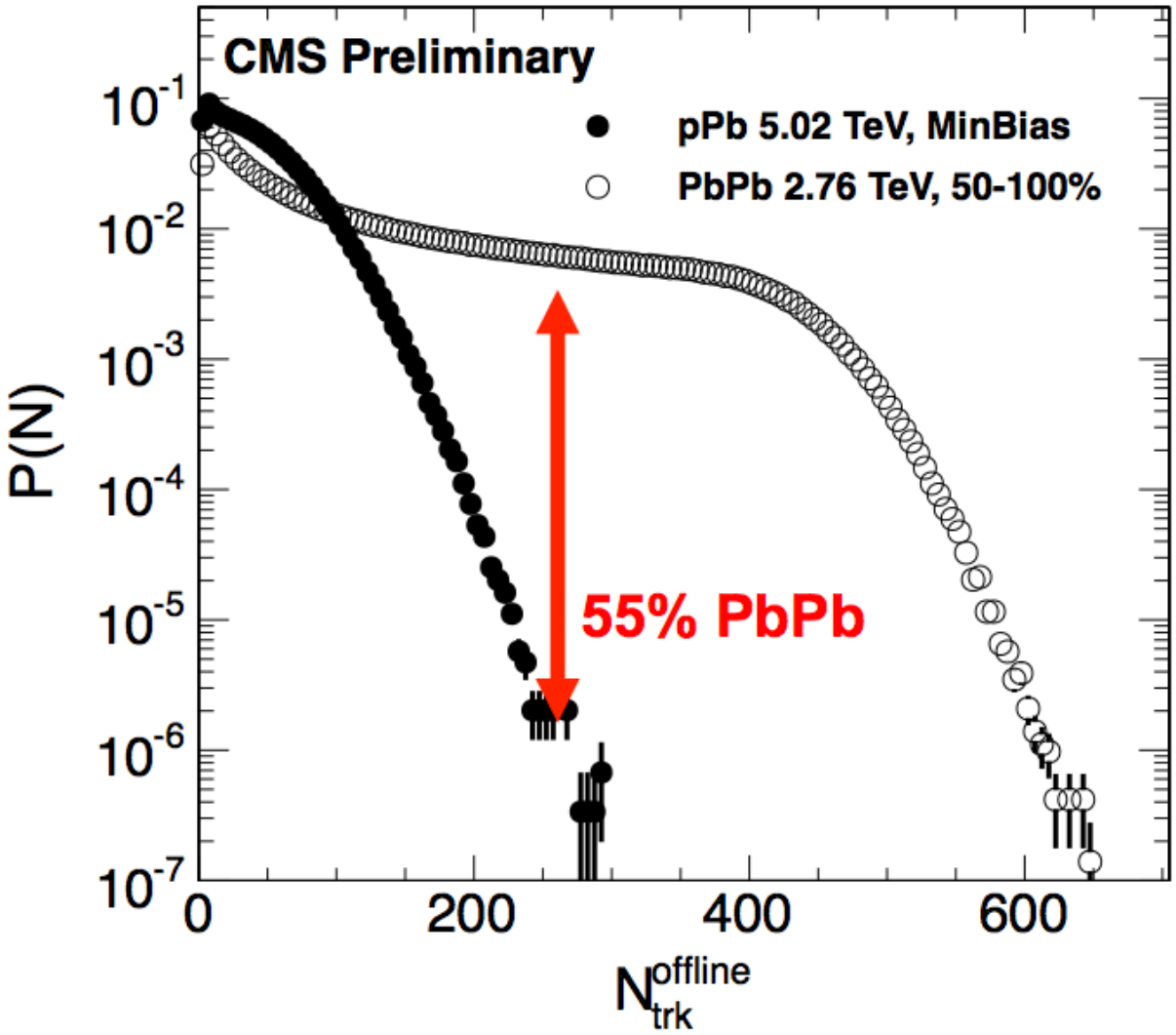
v_3-v_2 correlation with q_2 selection



$$v_3 = kv_2 + v_3^0$$

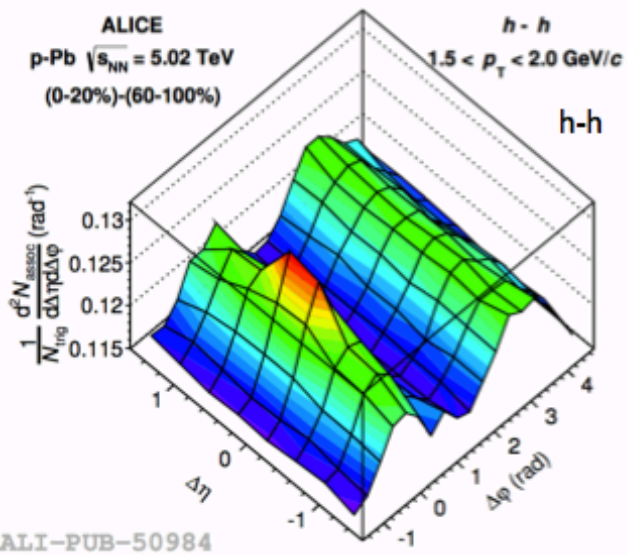
v_3 has linear and anti-correlation with v_2.
These measurement can constrain initial geometry models.

Multiplicity in PbPb and pPb

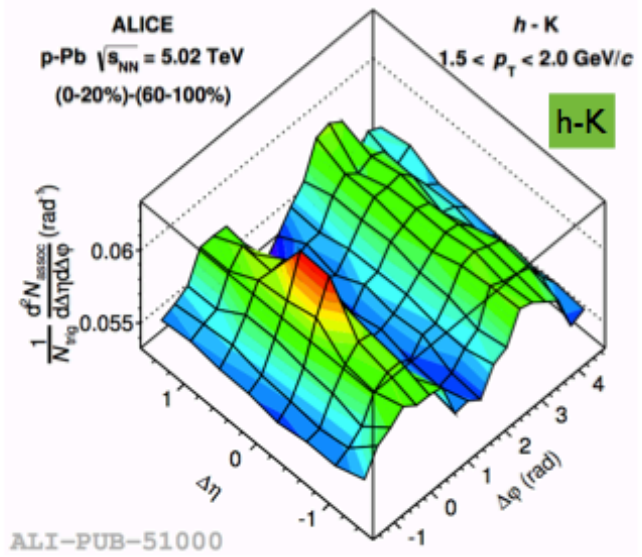


2PC distribution

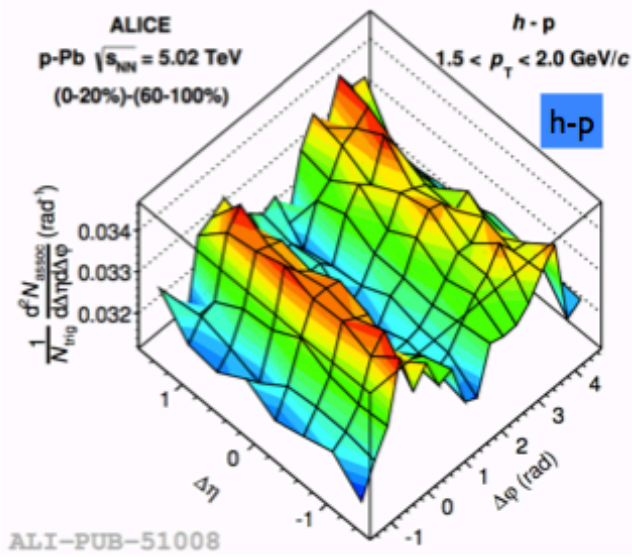
h - h



h - K



h - p



They are 2PC distribution after subtraction of distribution in peripheral. The region in $|\Delta\eta|>0.8$ are fitted and v_n are extracted.

$$v_n^h\{2PC\} = \sqrt{V_{n\Delta}^{h-h}} \qquad v_n^i\{2PC\} = V_{n\Delta}^{h-i}\sqrt{V_{n\Delta}^{h-h}}$$