Overview of flow results from ALICE experiment

ShinIchi Esumi for the ALICE collaboration
Inst. of Physics, Univ. of Tsukuba

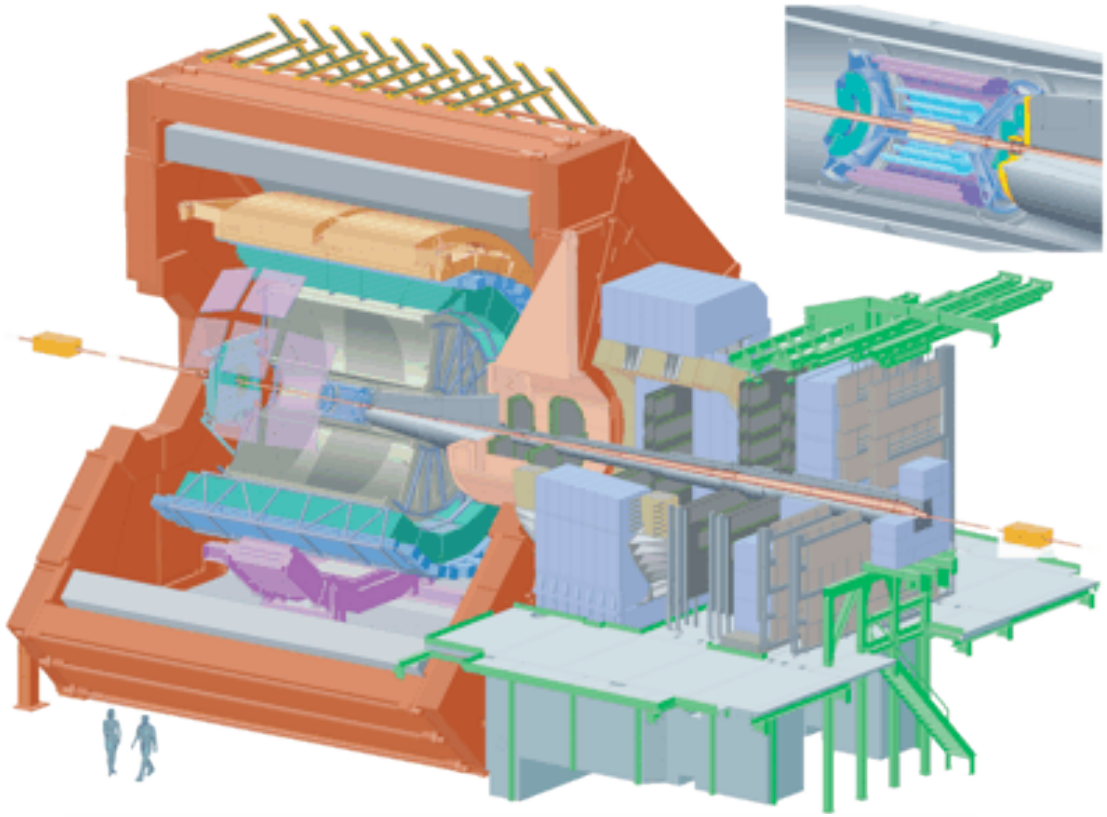
A Large Ion Collider Experiment

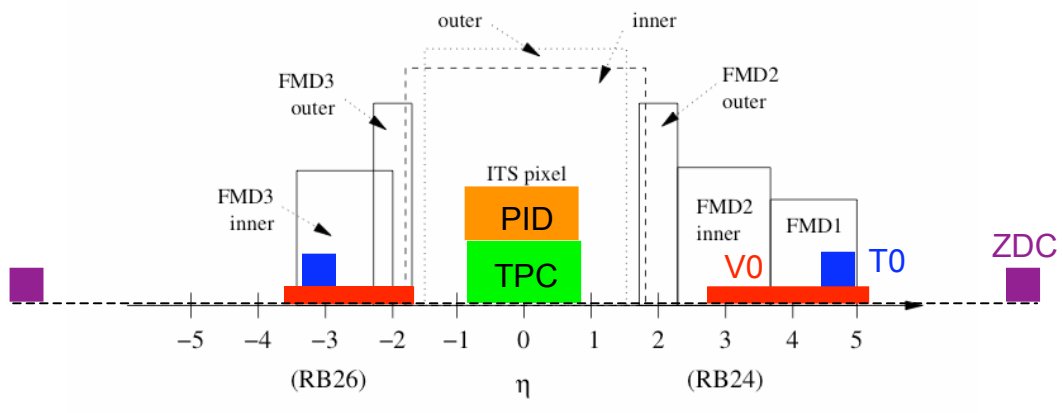
European Organisation for Nuclear Research

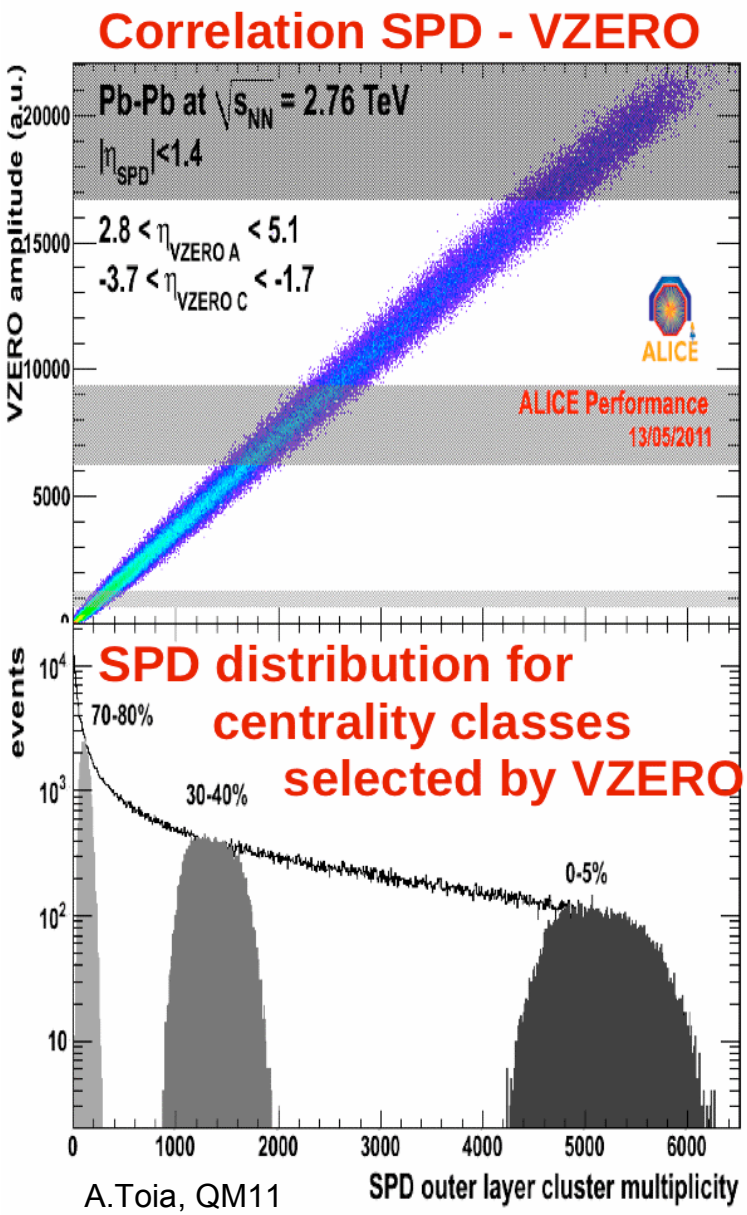
筑波大学
University of Tsukuba

contents

Multiplicity and transverse momentum distribution
Source size measurement from HBT
Elliptic and higher order collective flow
Correlation and higher p_T



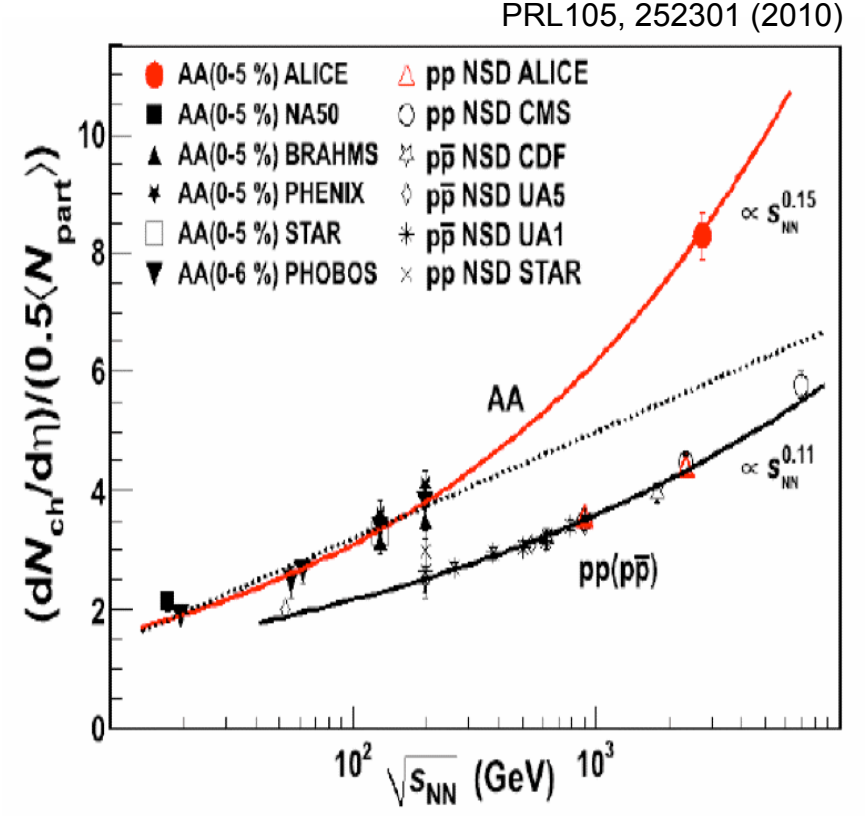

outer
inner
FMD3
outer
FMD2
outer
ITS pixel
FMD3
inner
PID
TPC
FMD2
inner
FMD1
V0
T0
ZDC
−5 −4 −3 −2 −1 0 1 2 3 4 5
(RB26)
η
(RB24)

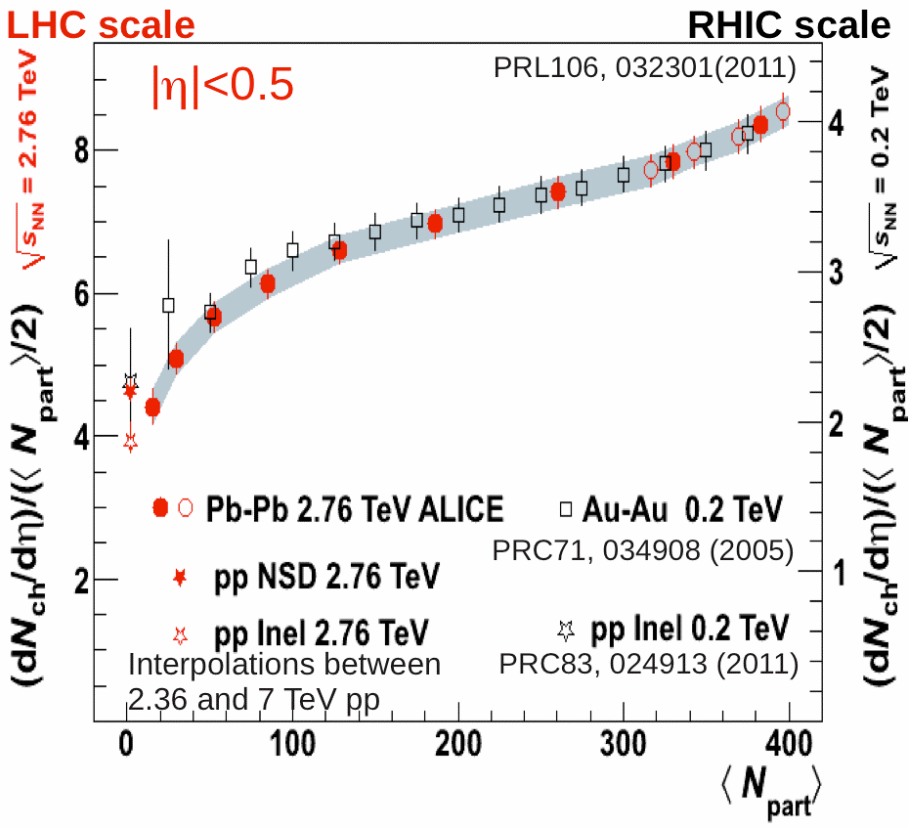

Correlation SPD - VZERO
Pb-Pb at √sNN = 2.76 TeV
|ηSPD|<1.4
2.8 < ηVZERO A < 5.1
-3.7 < ηVZERO C < -1.7
ALICE
ALICE Performance
13/05/2011
VZERO amplitude (a.u.)
20000
15000
10000
5000
SPD distribution for
centrality classes
selected by VZERO
events
70-80%
30-40%
0-5%
10^4
10^3
10^2
10
0 1000 2000 3000 4000 5000 6000
SPD outer layer cluster multiplicity

A.Toia, QM11

Multiplicity in A+A at the highest possible energy

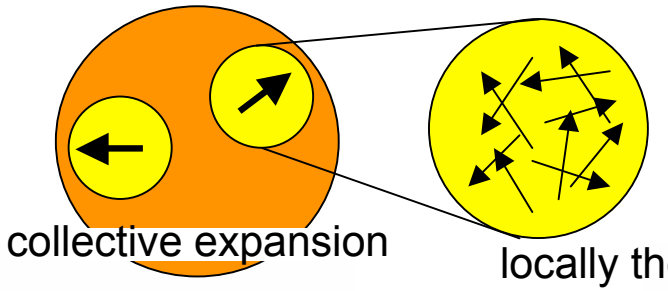
PRL105, 252301 (2010)

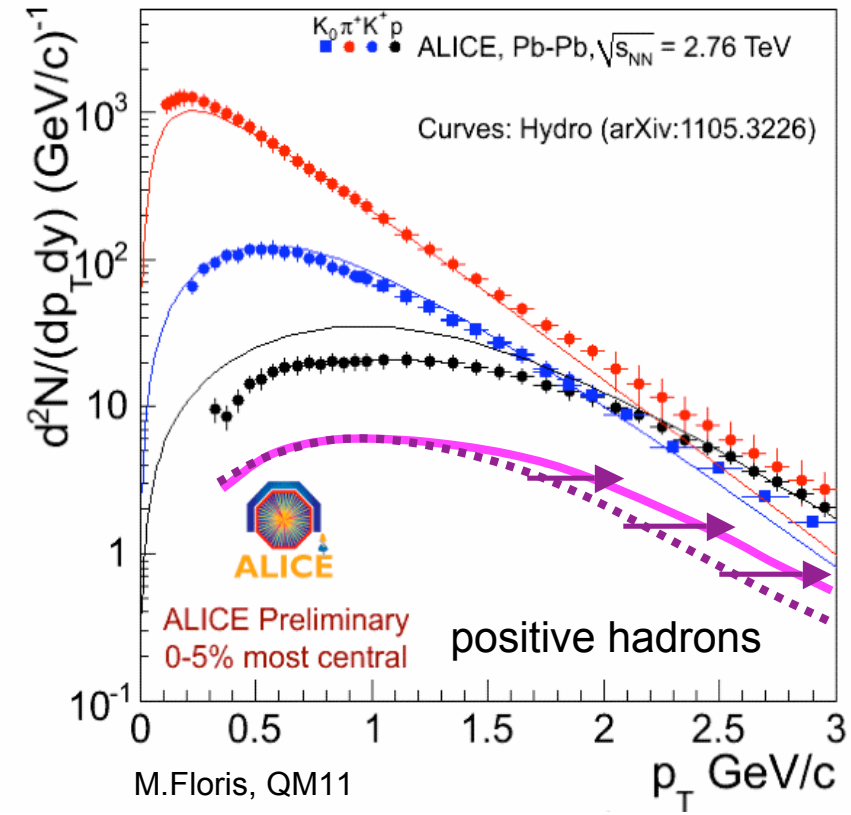


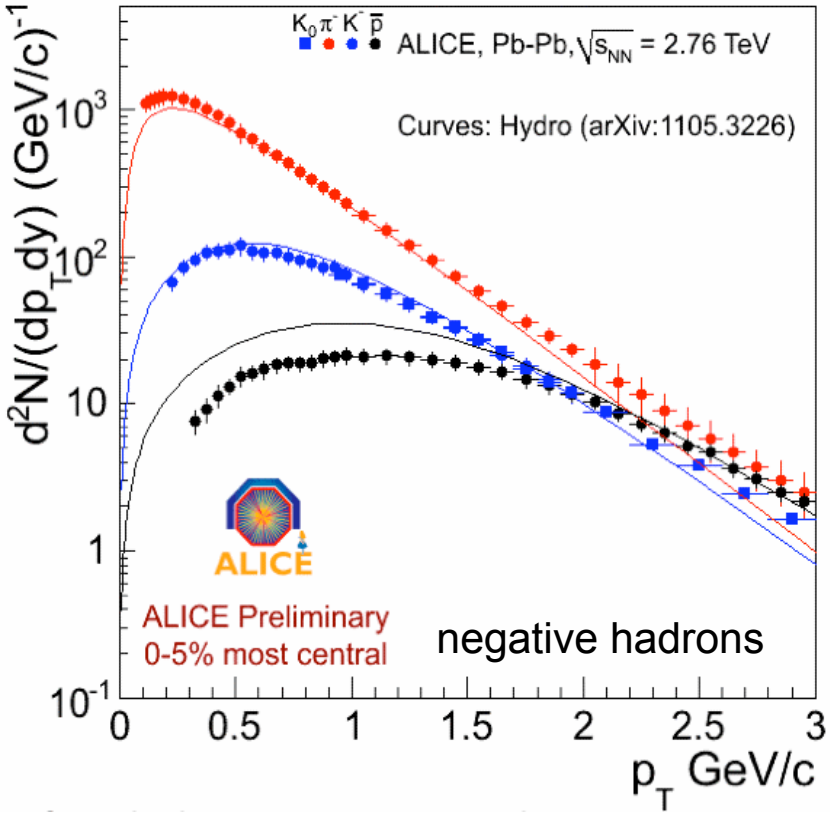


factor of ~2 increase with similar N_{part} dependence

Identified particle p_T distribution



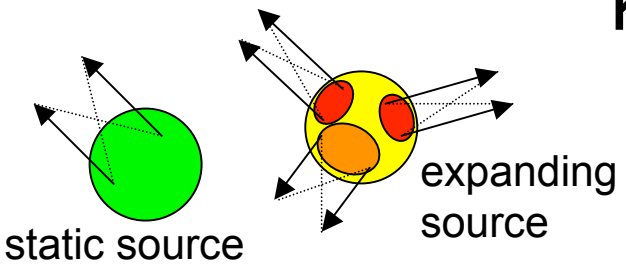


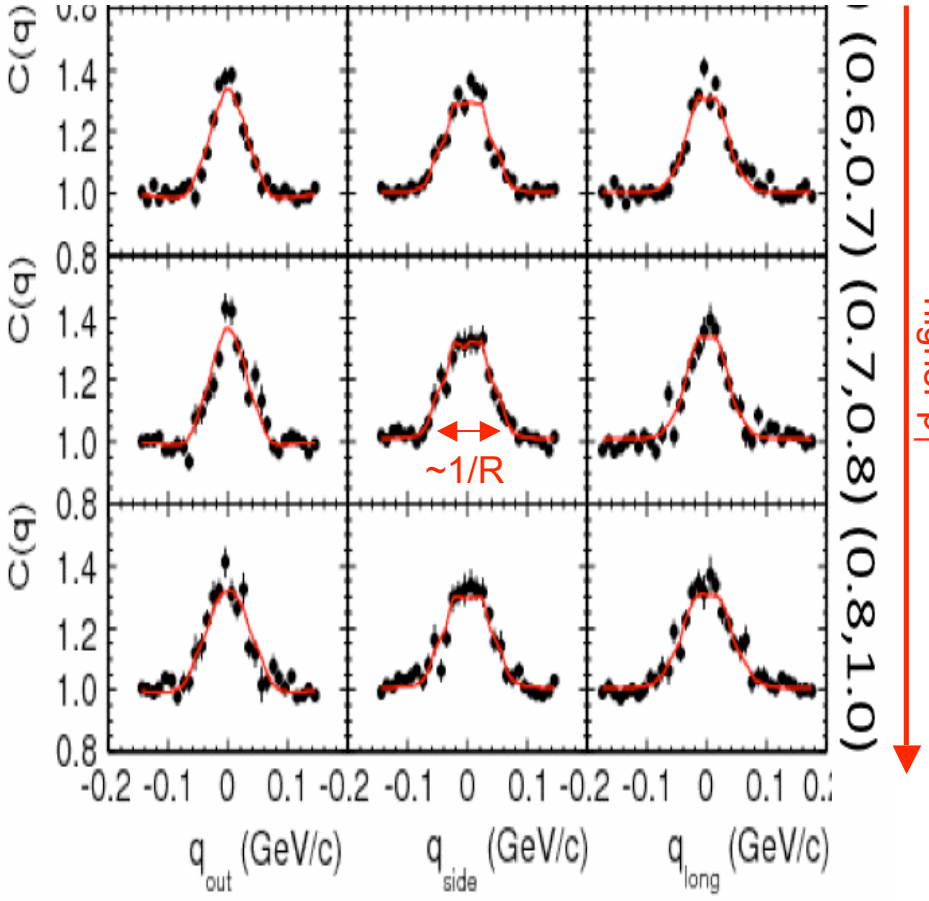


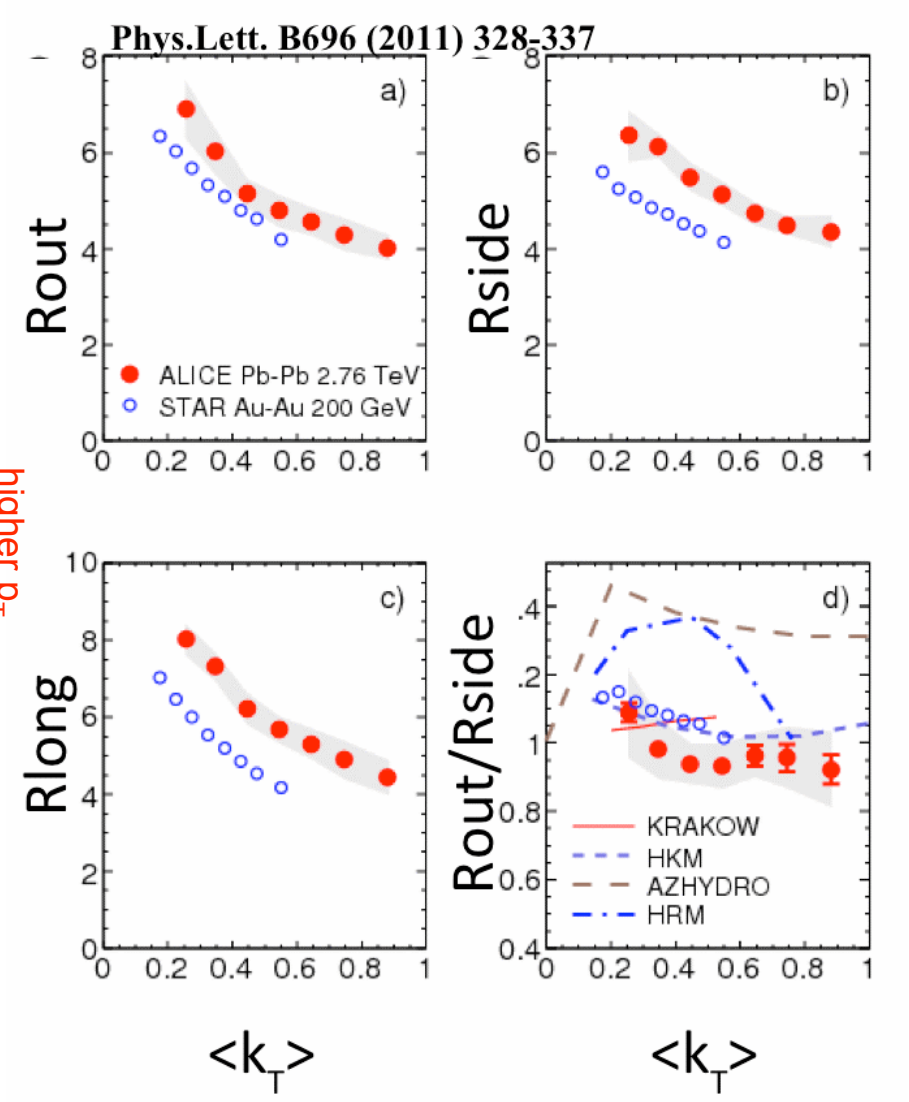
larger p_T shift for heavier particles
larger radial flow than in this hydro model

k_T dependence of HBT radii

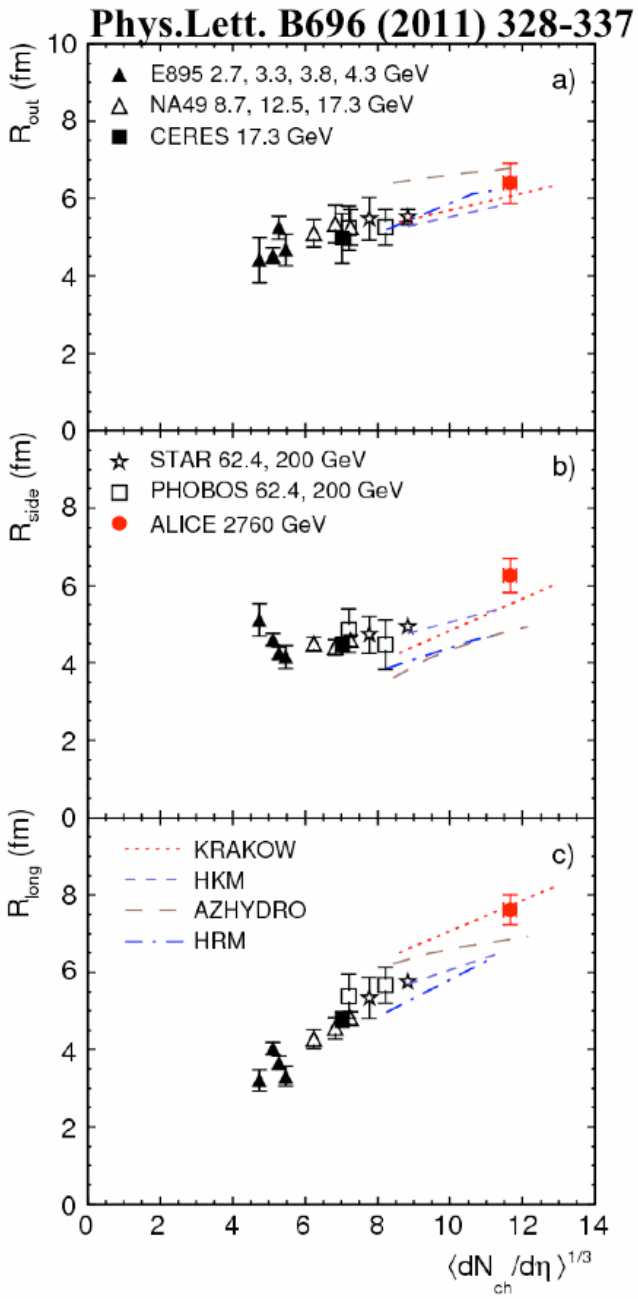
--- from extended and expanding source ---

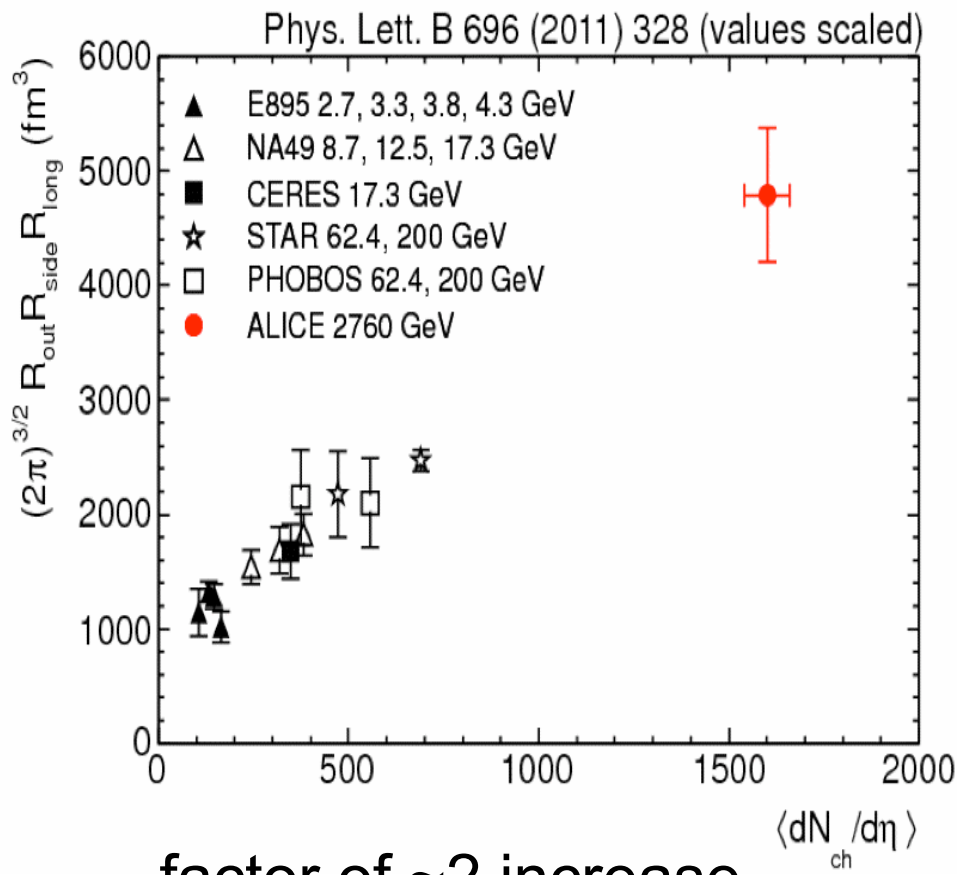






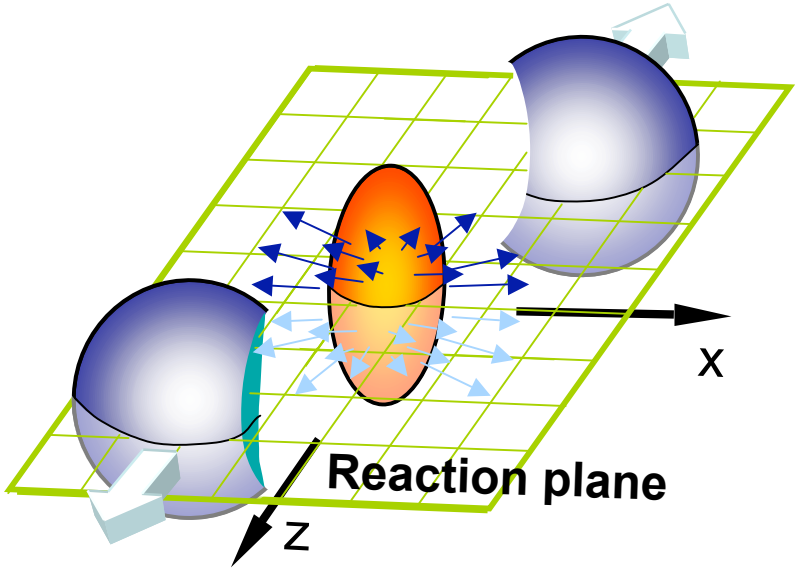
Beam energy dependence of 3D source size



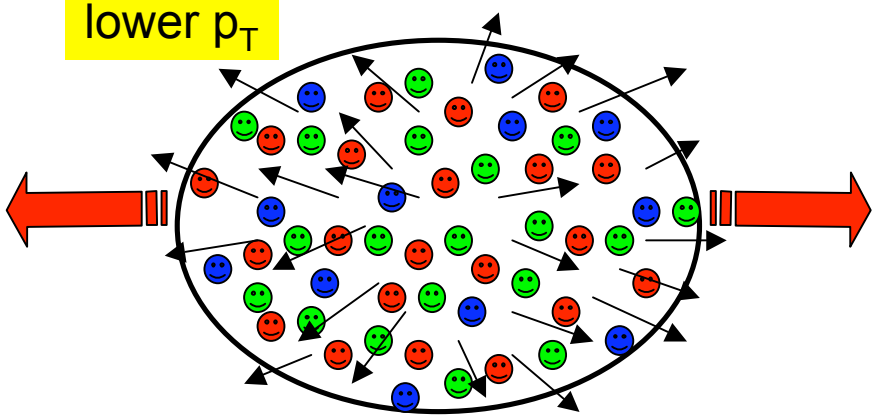


factor of ~2 increase in source volume

Elliptic flow (elliptic event anisotropy) : v_2

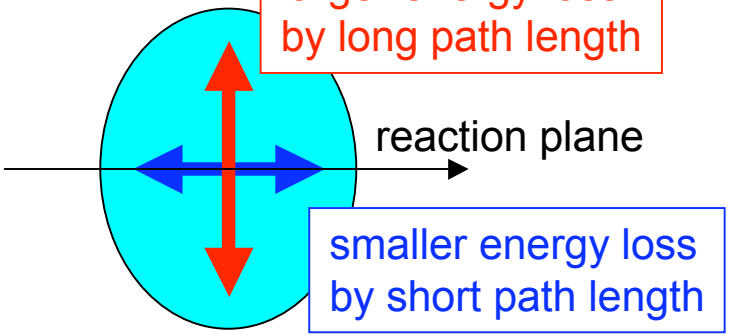


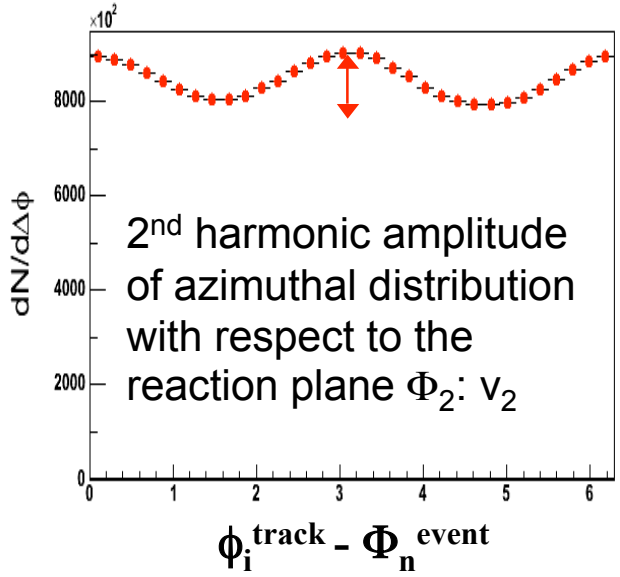
lower p_T



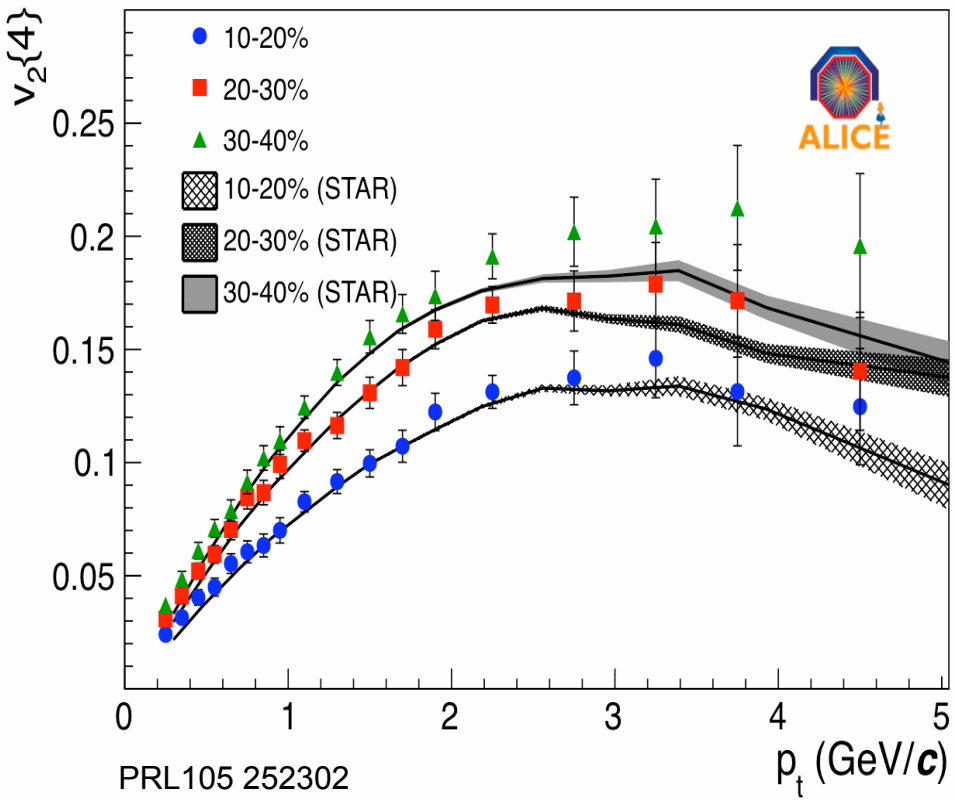
Hydro-dynamical expansion

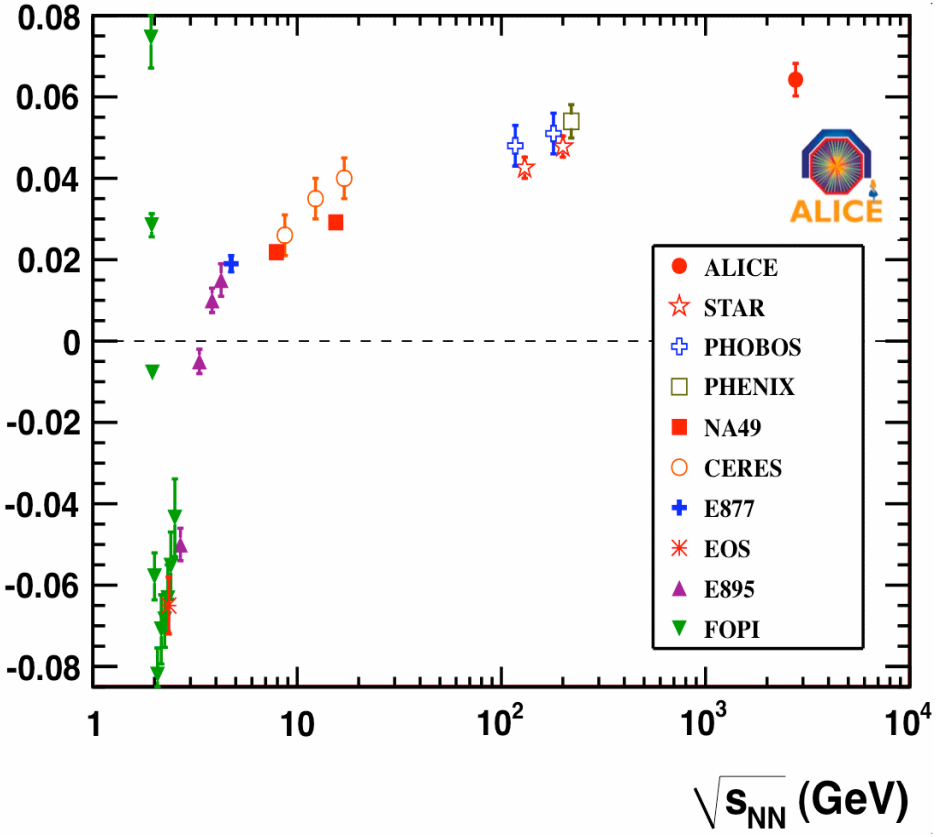
higher p_T





$v_2(p_T)$, $\langle v_2 \rangle$ comparison between RHIC and LHC



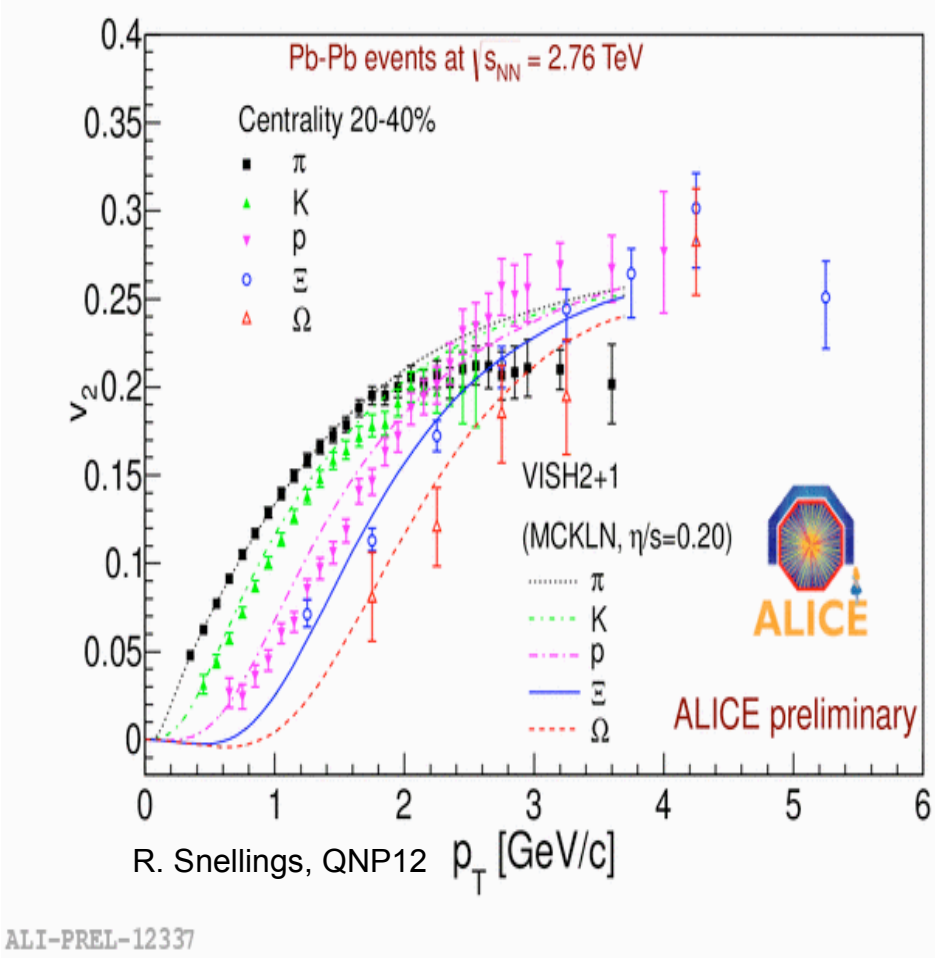


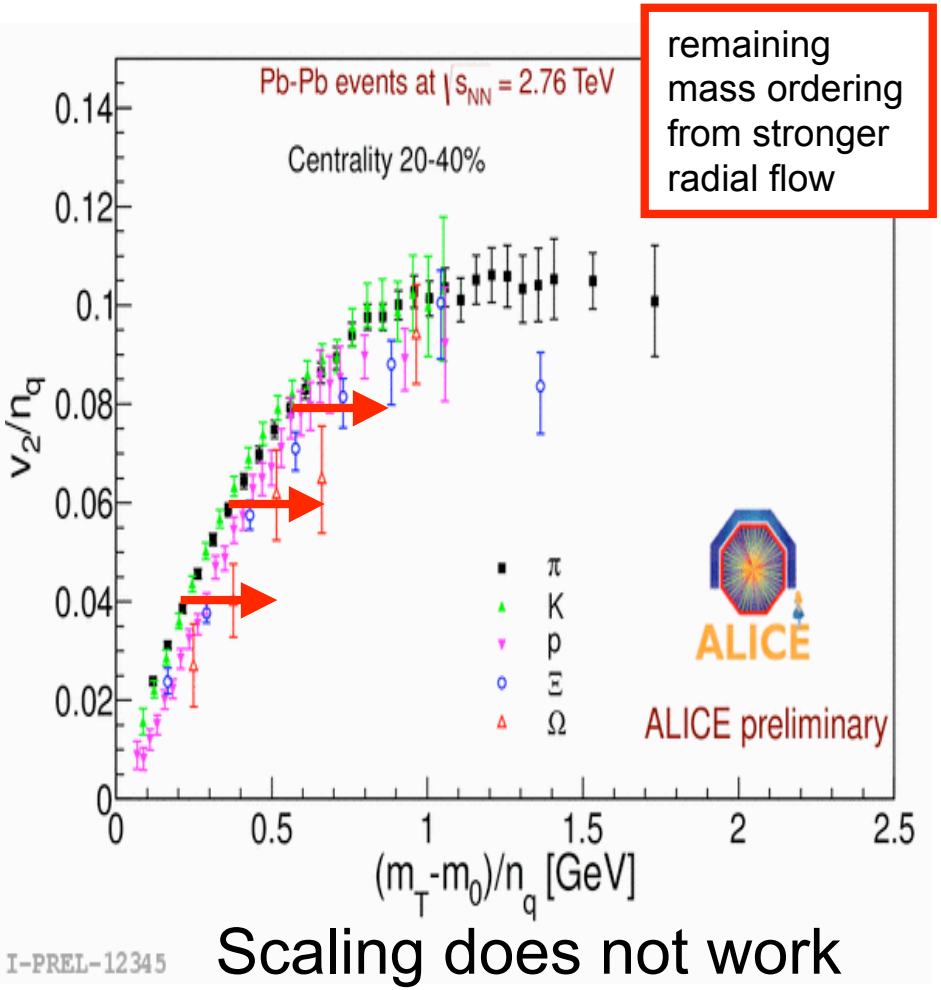
similar hydro properties

$\langle v_2 \rangle$ still increases with $\langle p_T \rangle$

Identified particle v_2 and $(m_T-m_0)/n_{quark}$ scaling

--- including strangeness/heavy baryons ---



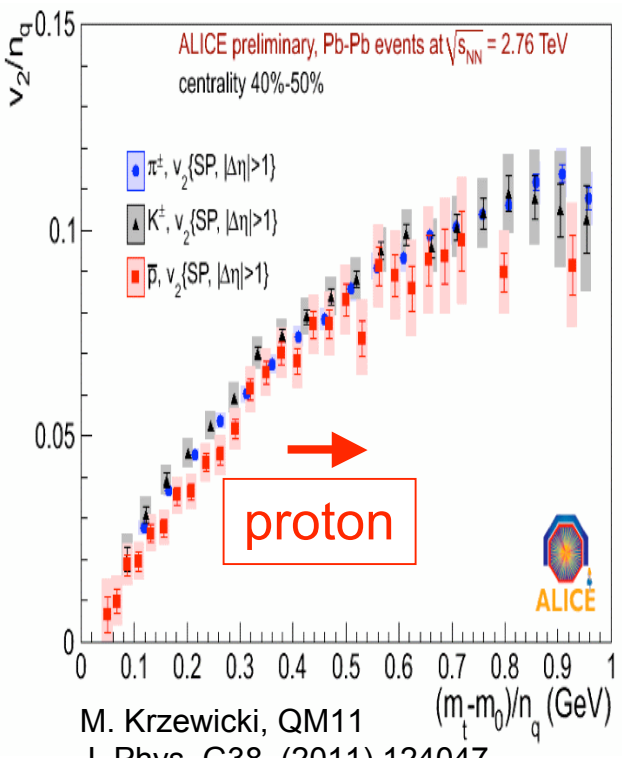


remaining mass ordering from stronger radial flow

Scaling does not work as good as at RHIC

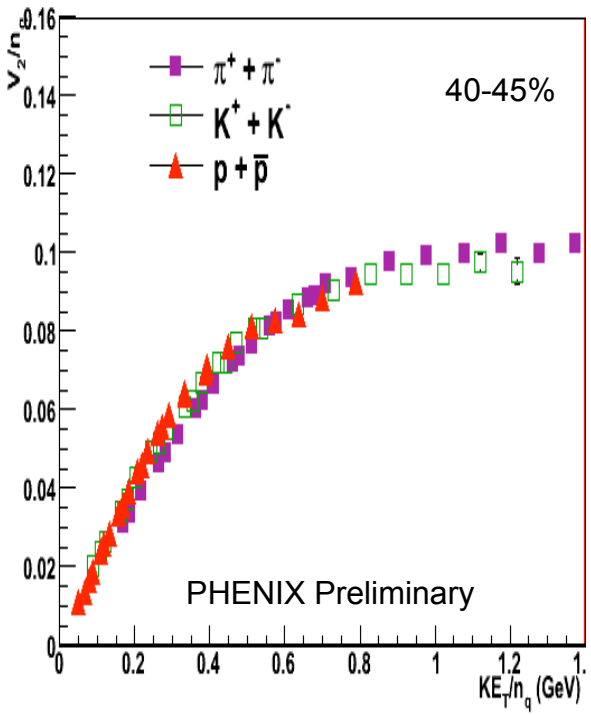
Small deviations in $(m_T-m_0)/n_q$ scaled v_2

Pb+Pb 2.76TeV

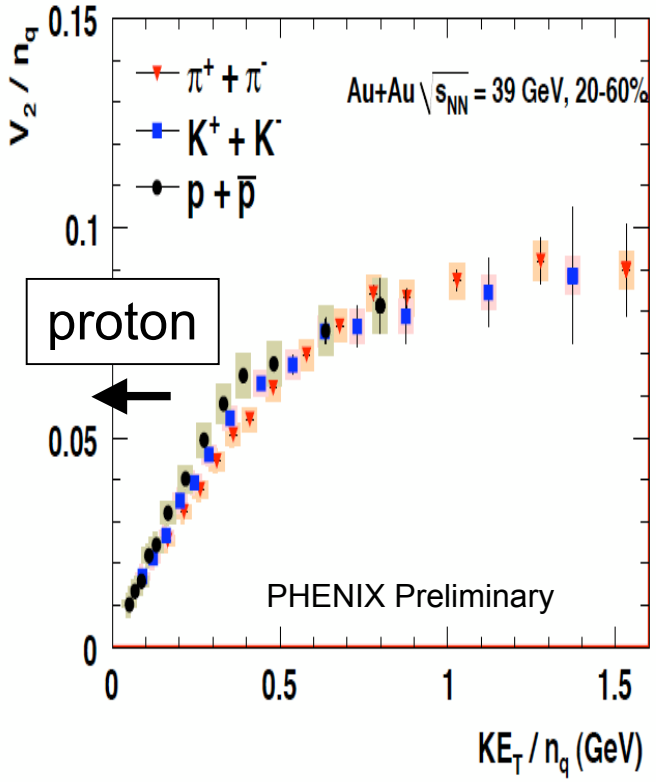


M. Krzewicki, QM11
J. Phys. G38, (2011) 124047

Au+Au 200GeV

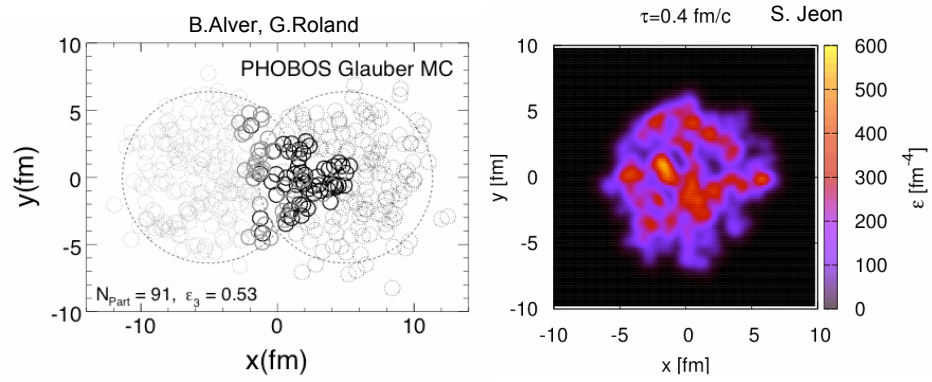


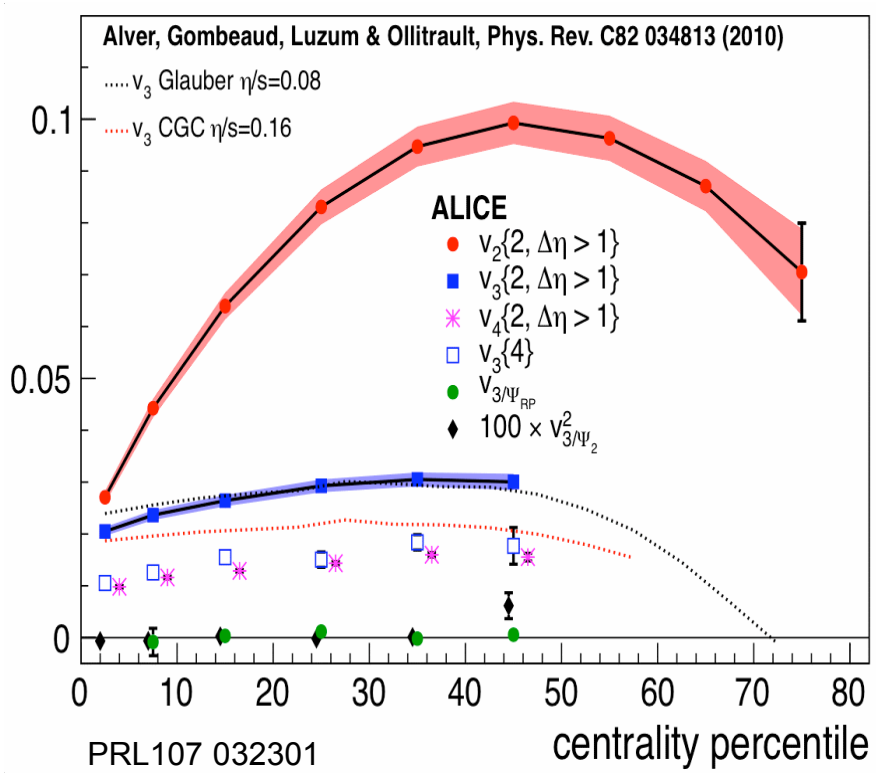
Au+Au 39GeV

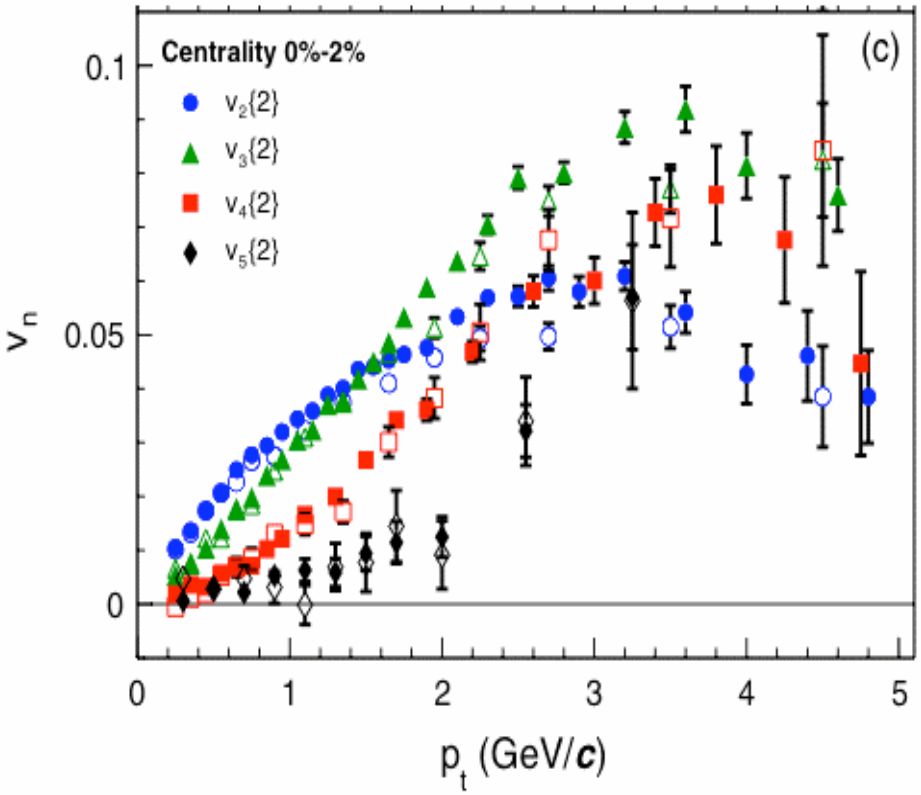


roughly $(m_T-m_0)/n_q$ scaled for all energies
larger p_T shift for heavier particles
radial flow increases with energy

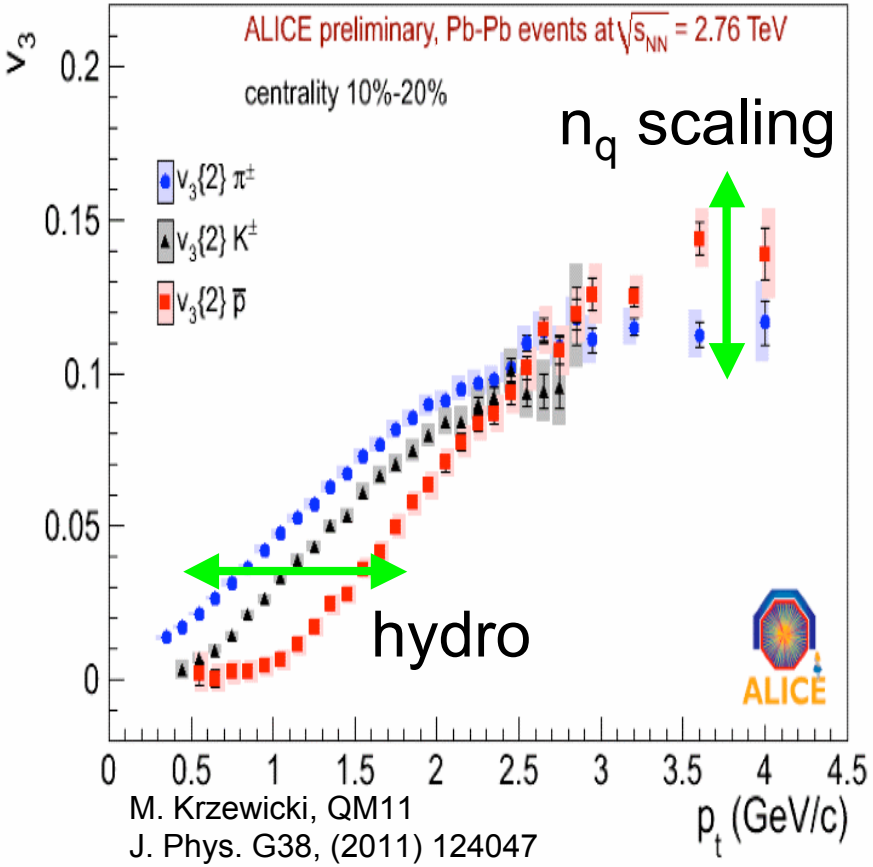
Initial geometrical fluctuation & Higher harmonic anisotropy v_n

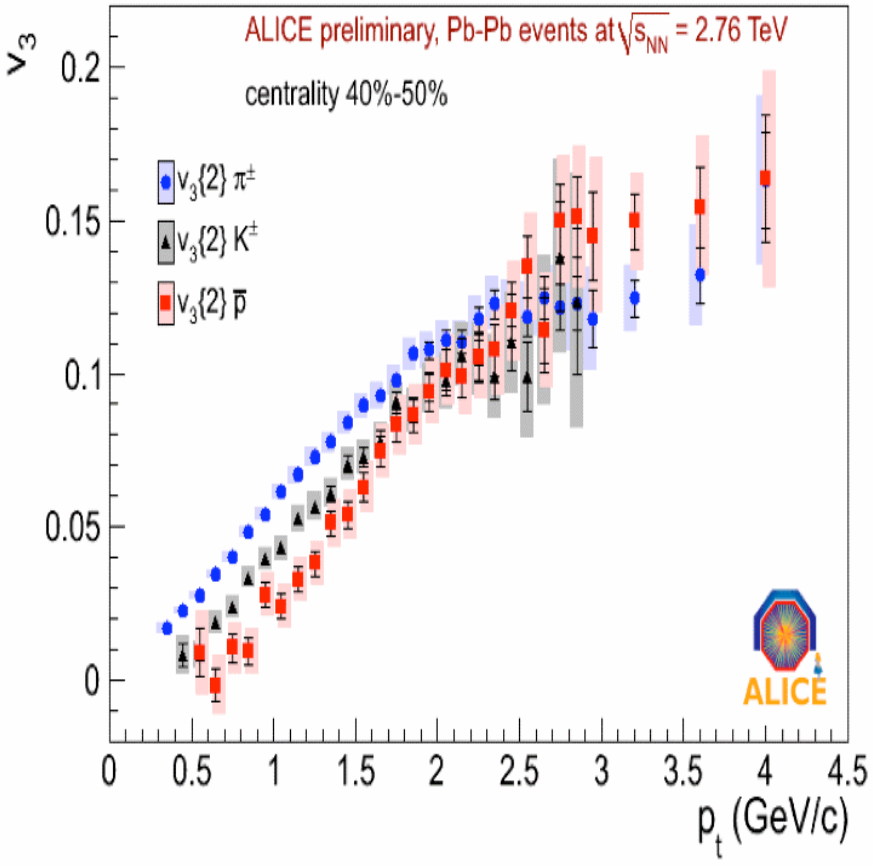






Identified particle v_3





M. Krzewicki, QM11
J. Phys. G38, (2011) 124047

hydro : similar mass-splitting at lower p_T

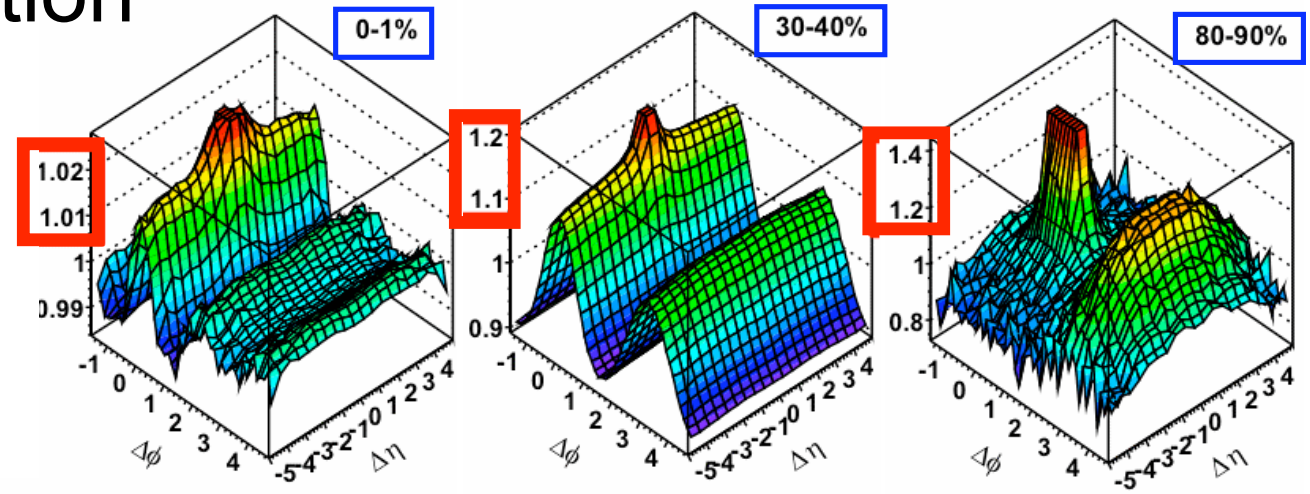
n_q scaling : similar Baryon / Meson difference at higher p_T

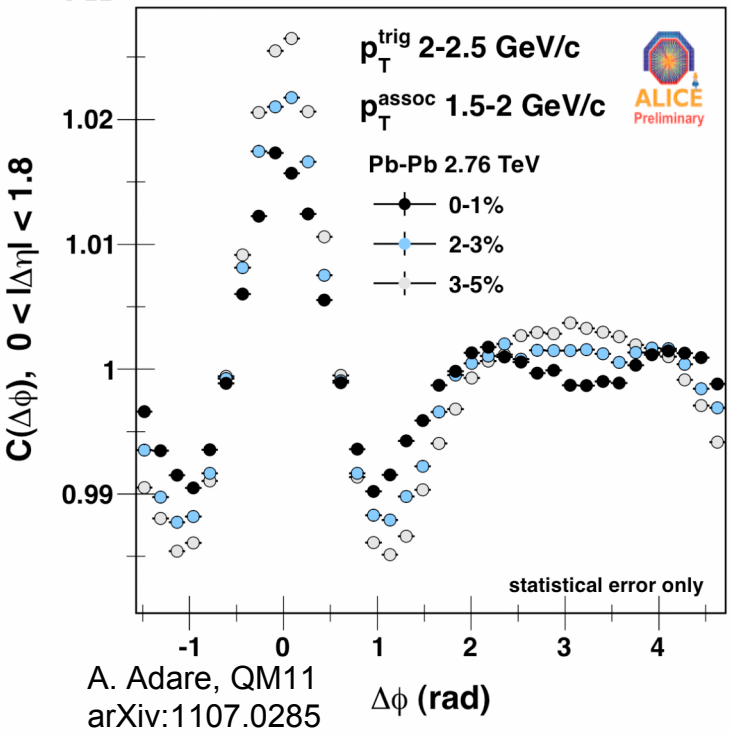
The KE_T/n_q scaling for v_3 is also not as good as for v_2

2-part. correlation in $\Delta\phi$ vs $\Delta\eta$

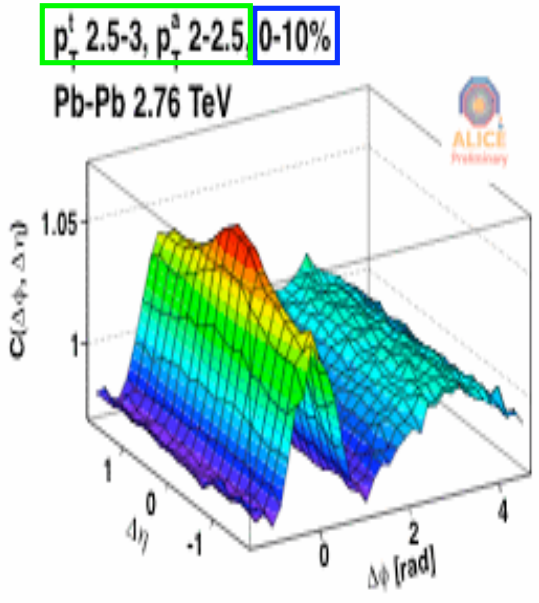
--- another way to measure v_n and to describe ridge and mach-cone ---

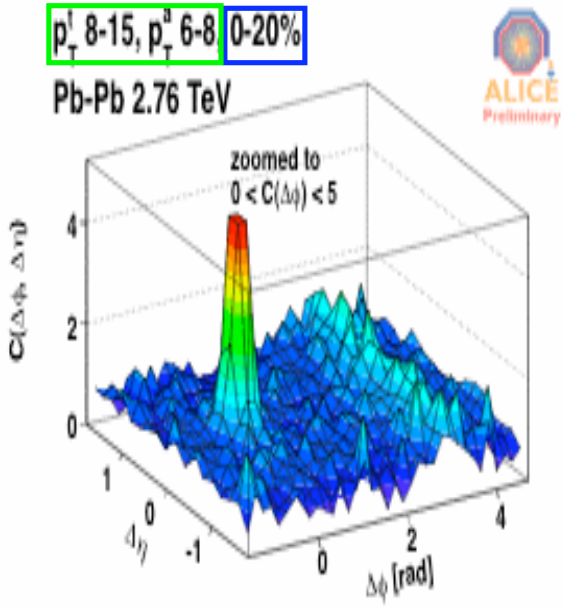
Pb-Pb 2.76TeV, 2~3GeV/c, J. Jia (ATLAS), QM11





A. Adare, QM11
arXiv:1107.0285

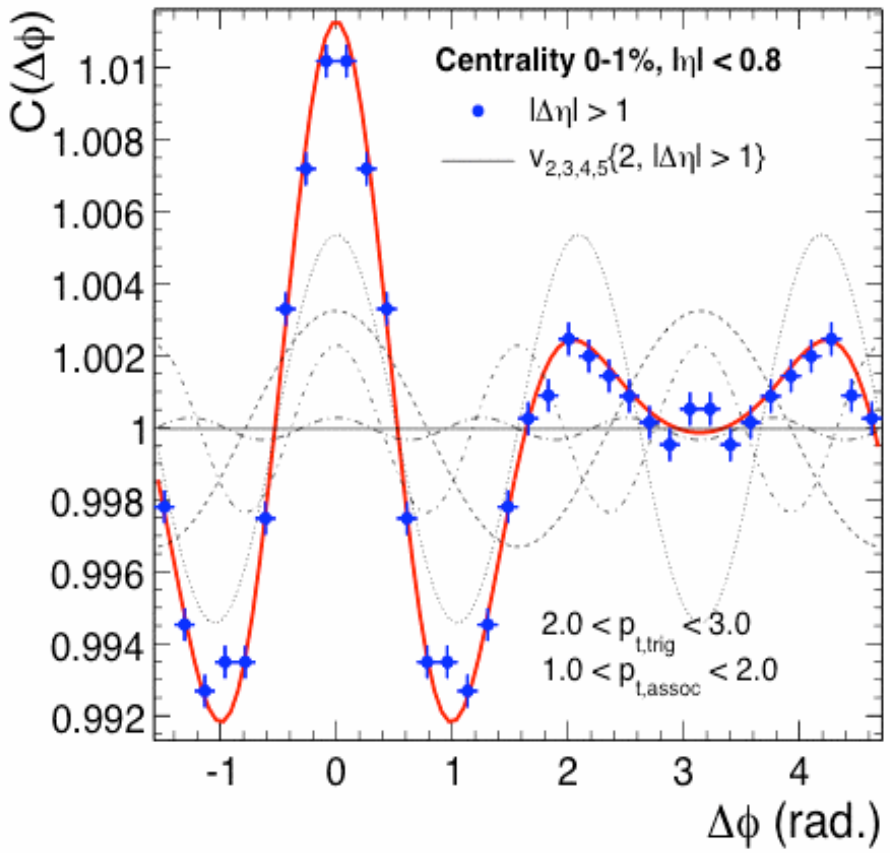




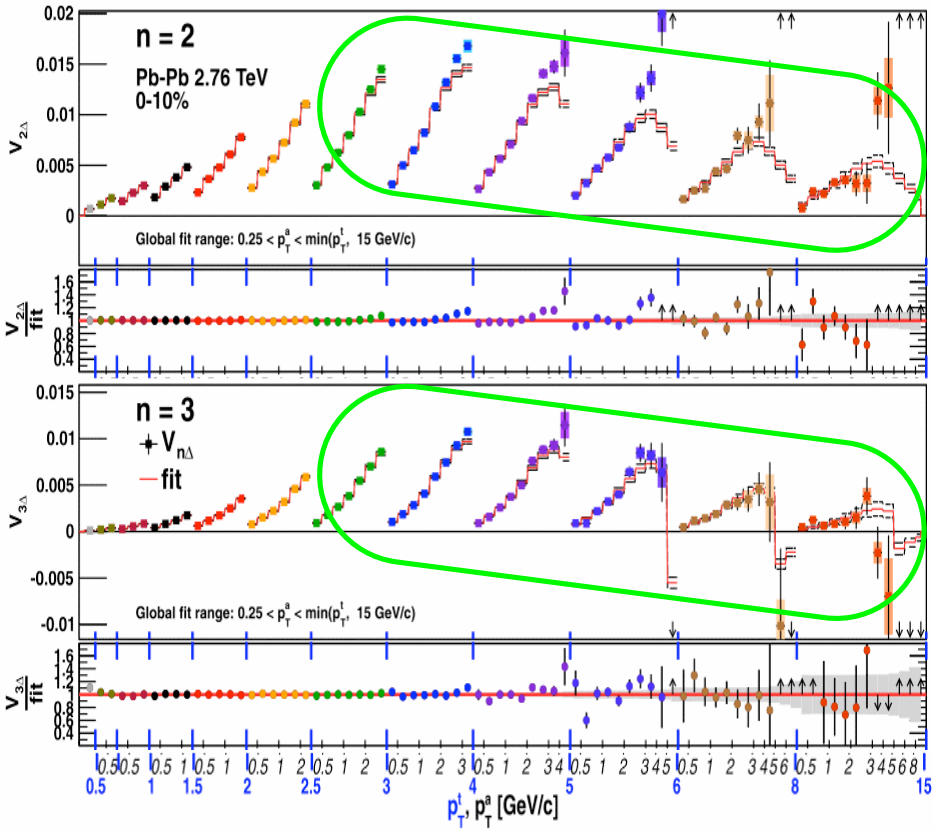
2-particle azimuthal correlation function

--- flow un-subtracted C_2 ---

PRL107 032301



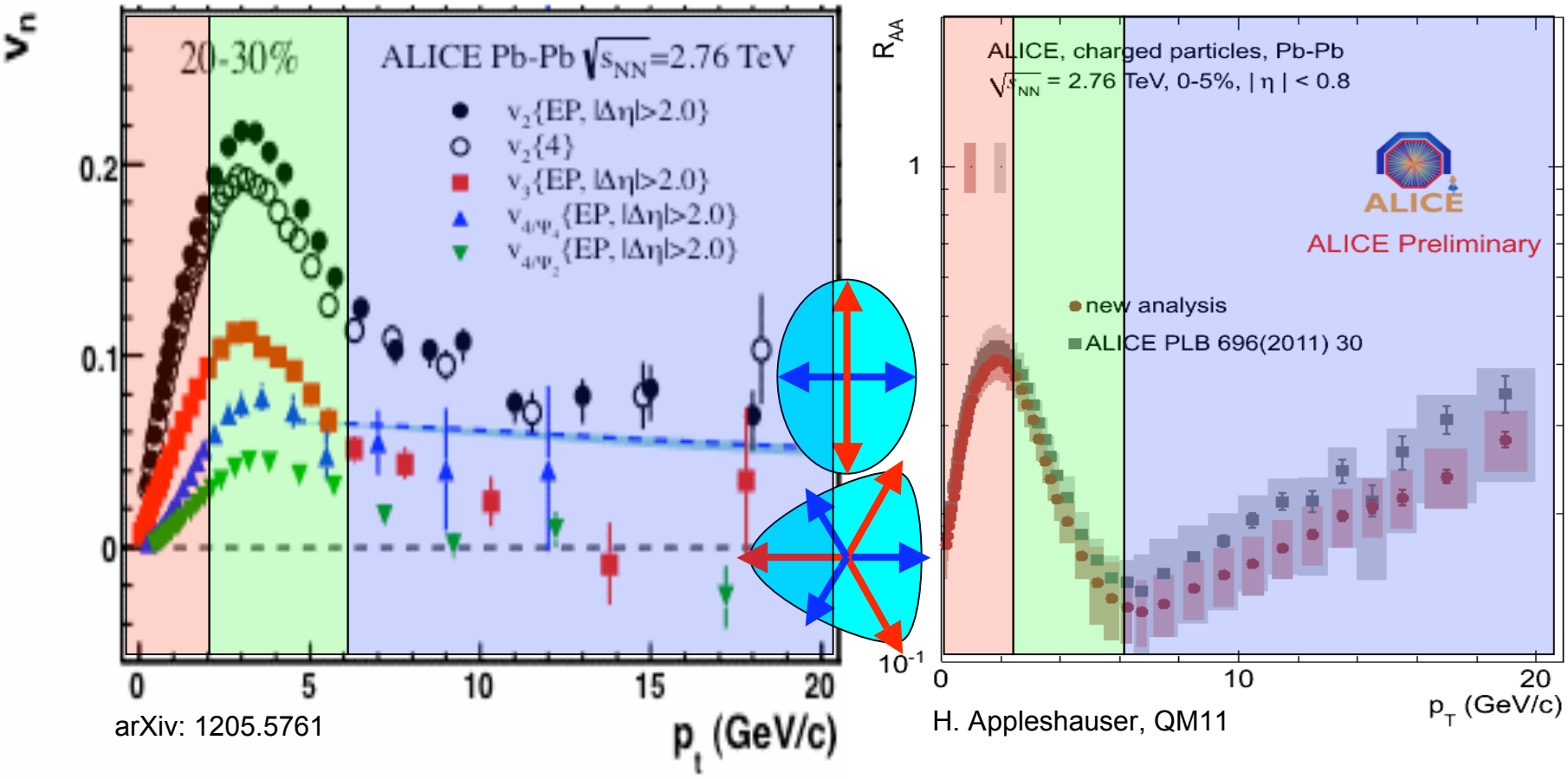
PLB708 249-264



rapidity separated C_2 is well described by $v_{2,3,4,5}$ as naturally expected because of $v_n\{2, |\Delta\eta|>1\}$

The small deviation gives the soft-hard interplay…

v_n and R_{AA} at low/mid/high p_T region

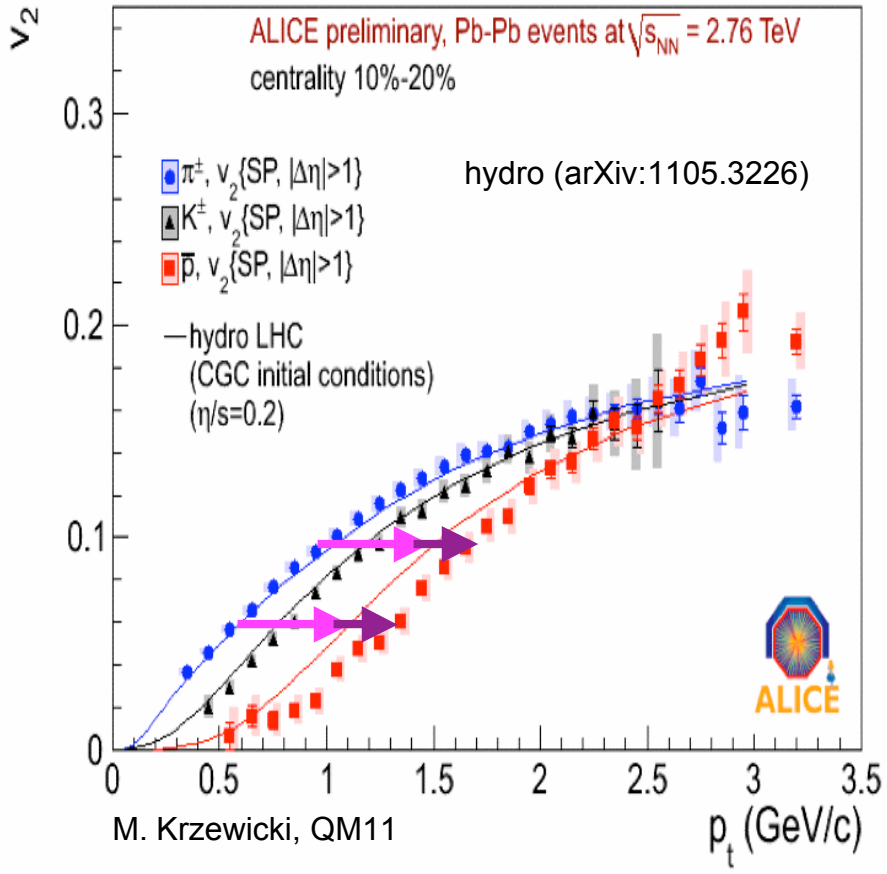


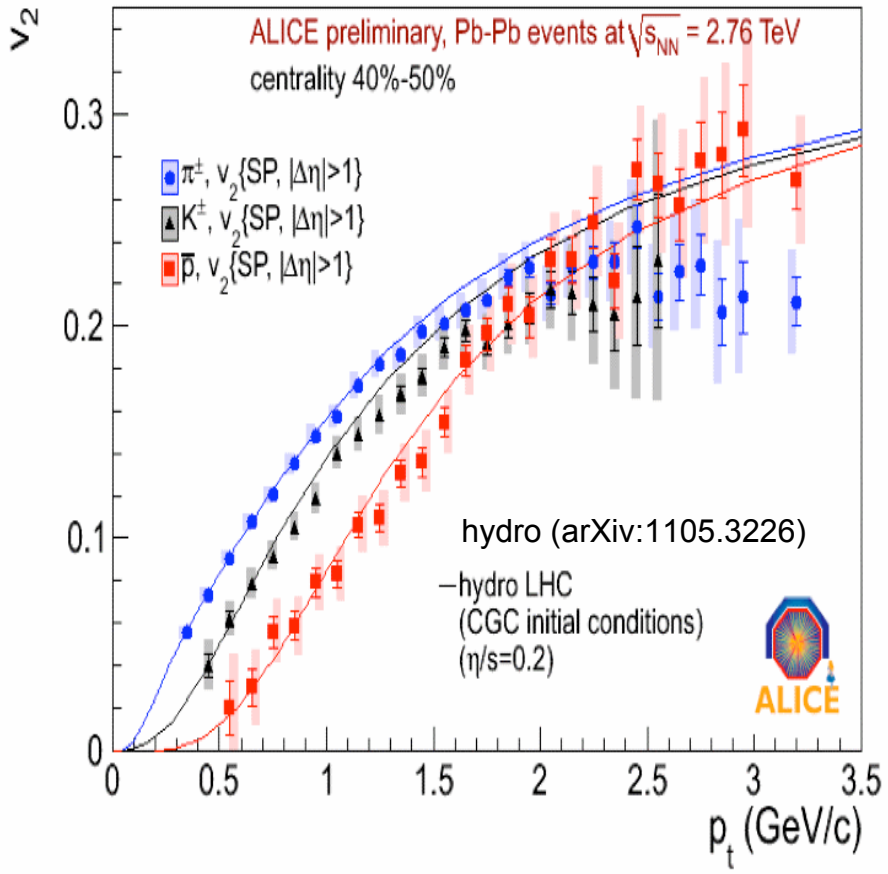
v_n at high p_T from suppression dominance given by path length transition from low(soft) to high(hard) p_T region

Summary and outlook

- 2.76TeV Pb+Pb collisions at LHC-ALICE
- factor of 2 in charged particle multiplicity $dN_{ch}/d\eta$
- factor of 2 in freeze-out volume from HBT
- increased and pronounced radial flow
- similar hydro properties compared with RHIC
- initial fluctuation and expansion drive the v_n
- soft-hard interplay

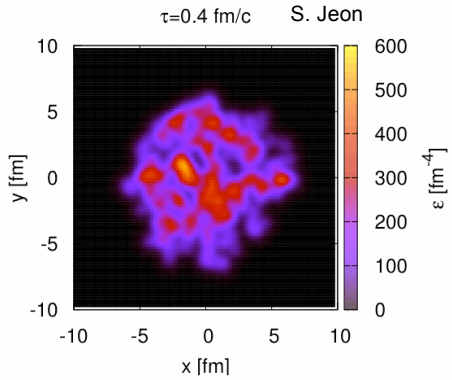
Identified particle v_2

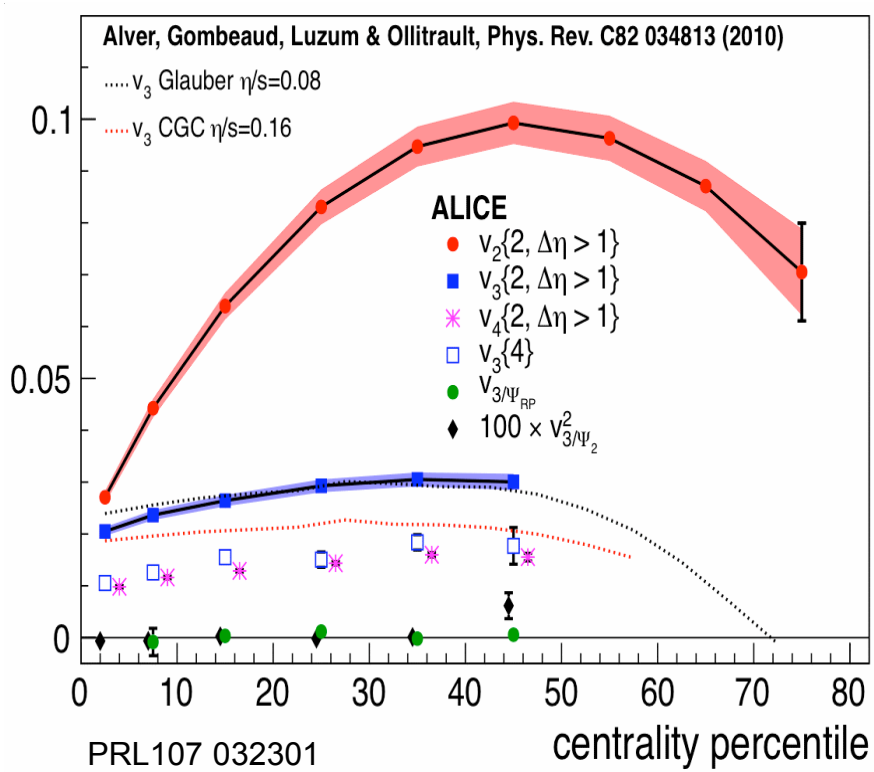


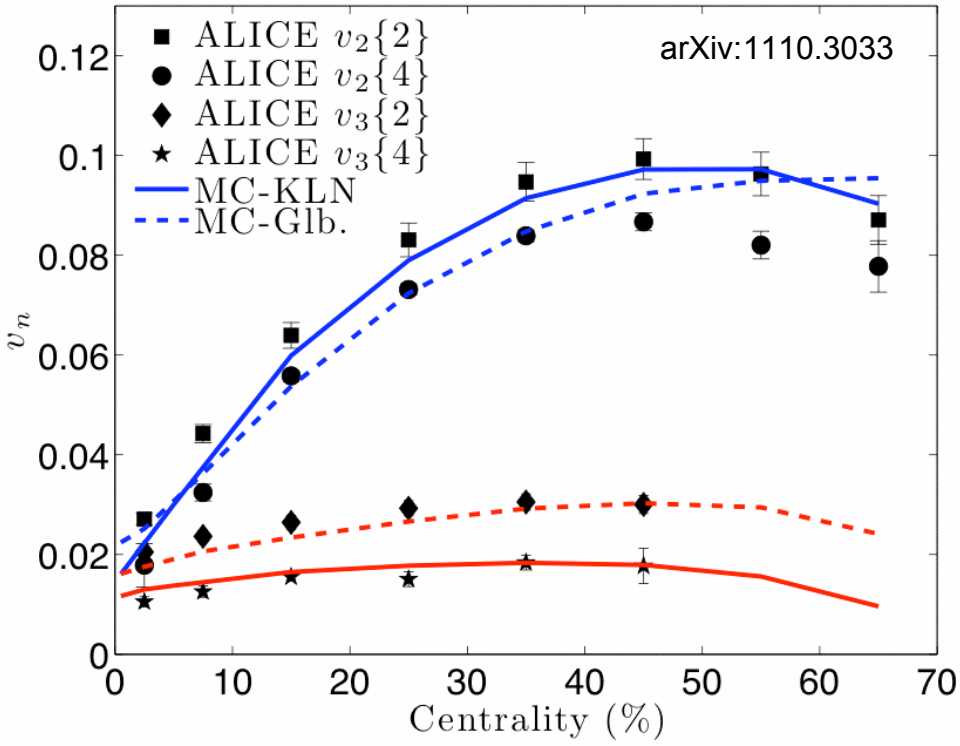


larger mass-splitting + familiar Baryon/Meson difference
larger radial flow in central collisions than in this hydro model

Initial geometrical fluctuation & Higher harmonic anisotropy v_n



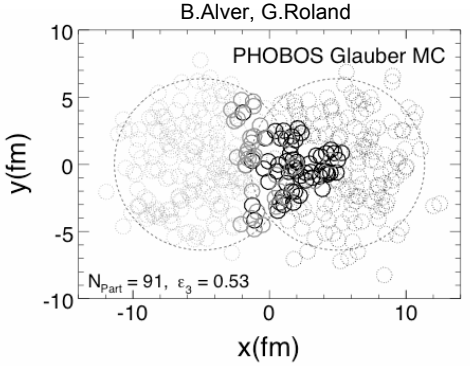




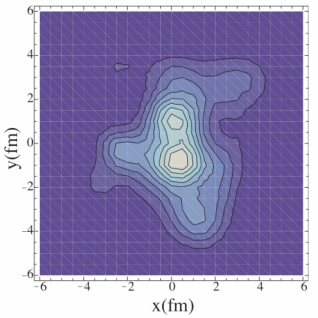
Fluctuation of v_2

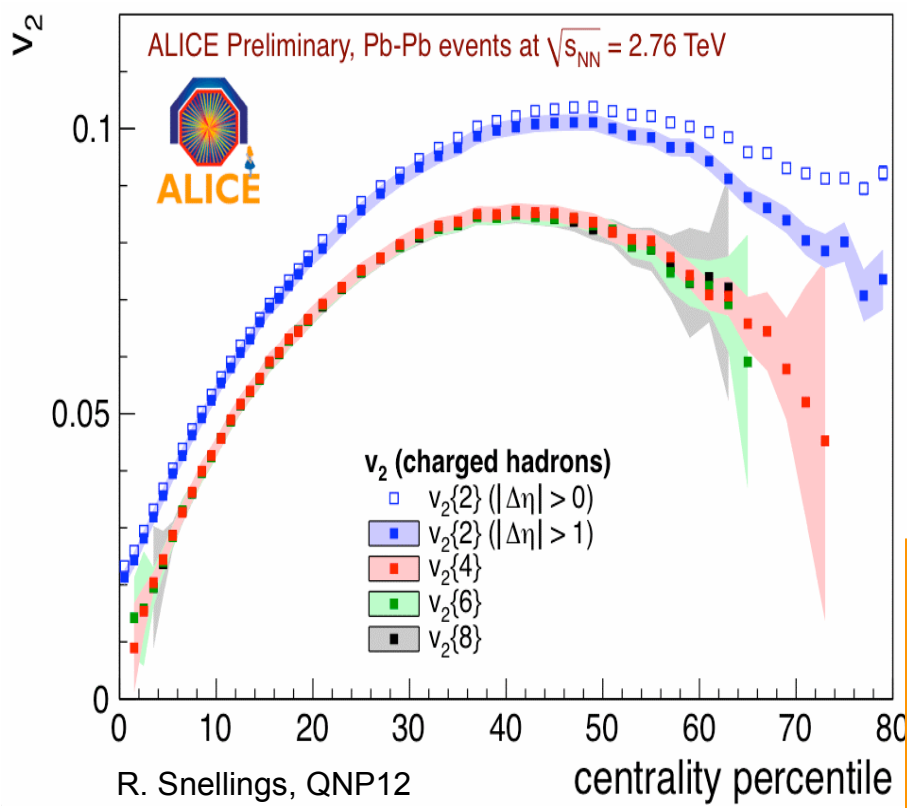
--- indirect measurement via $v_2\{2\}$ and $v_2\{4\}$ difference ---

B.Alver, G.Roland

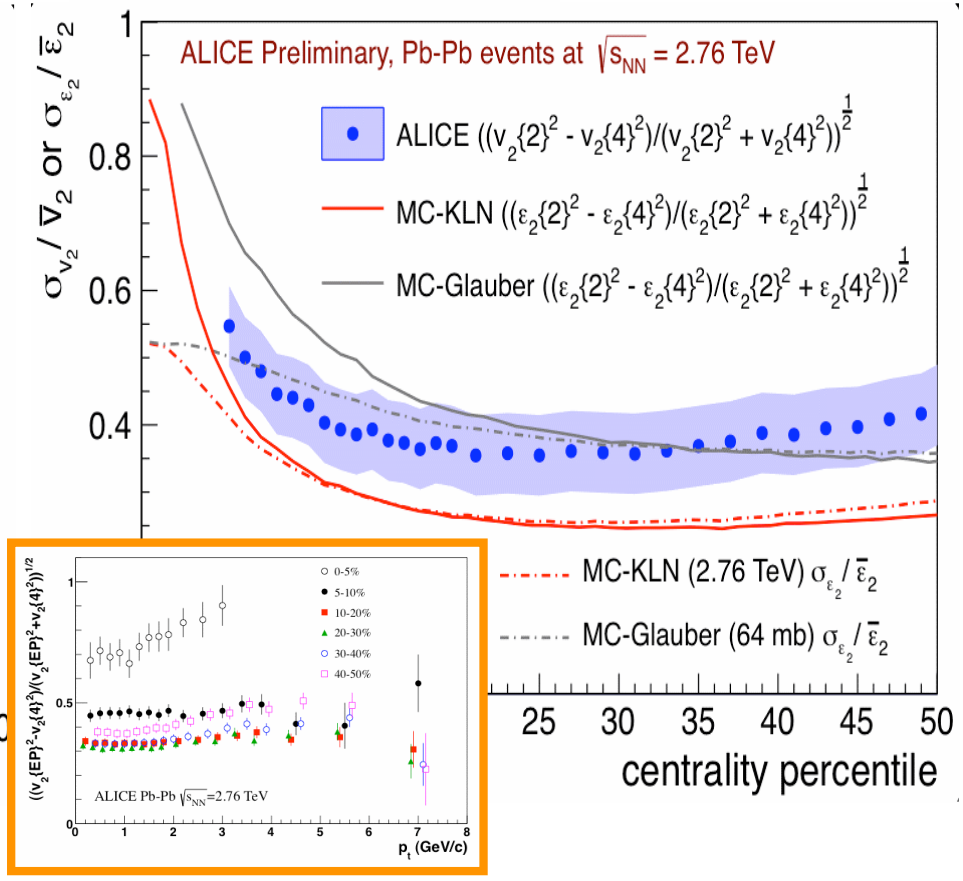


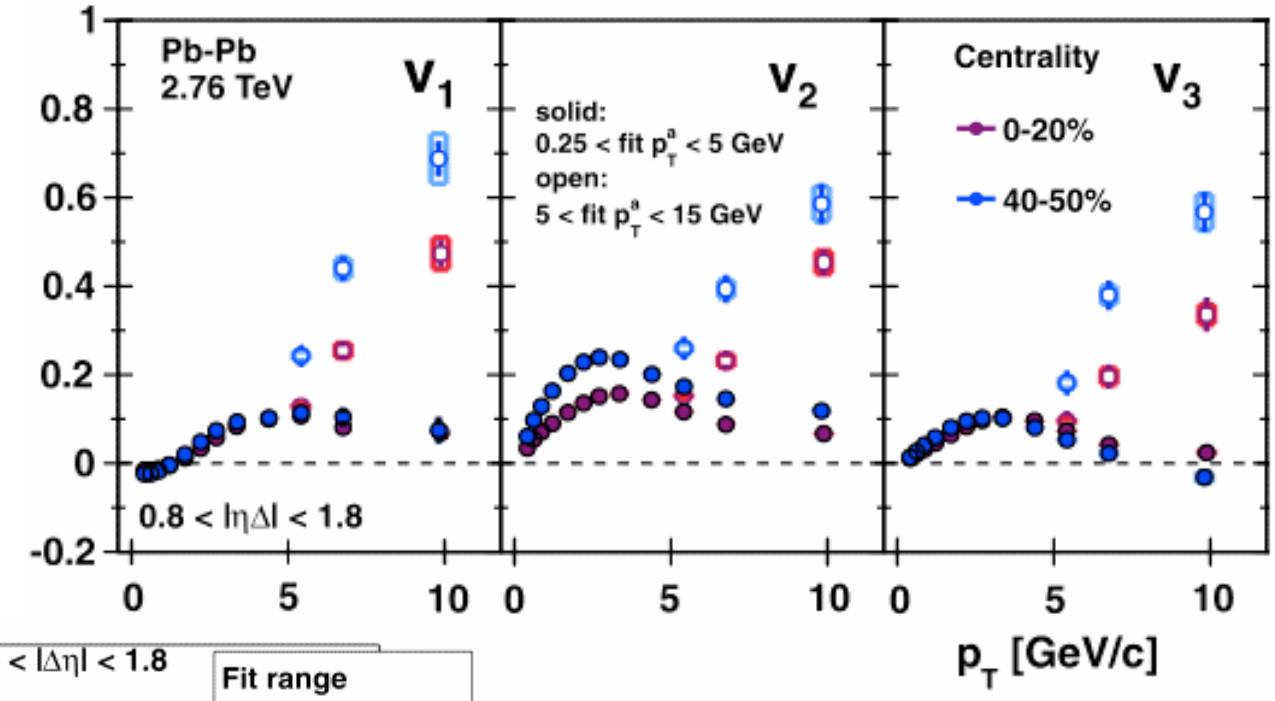
G. Qin, H. Petersen, S. Bass, and B. Muller

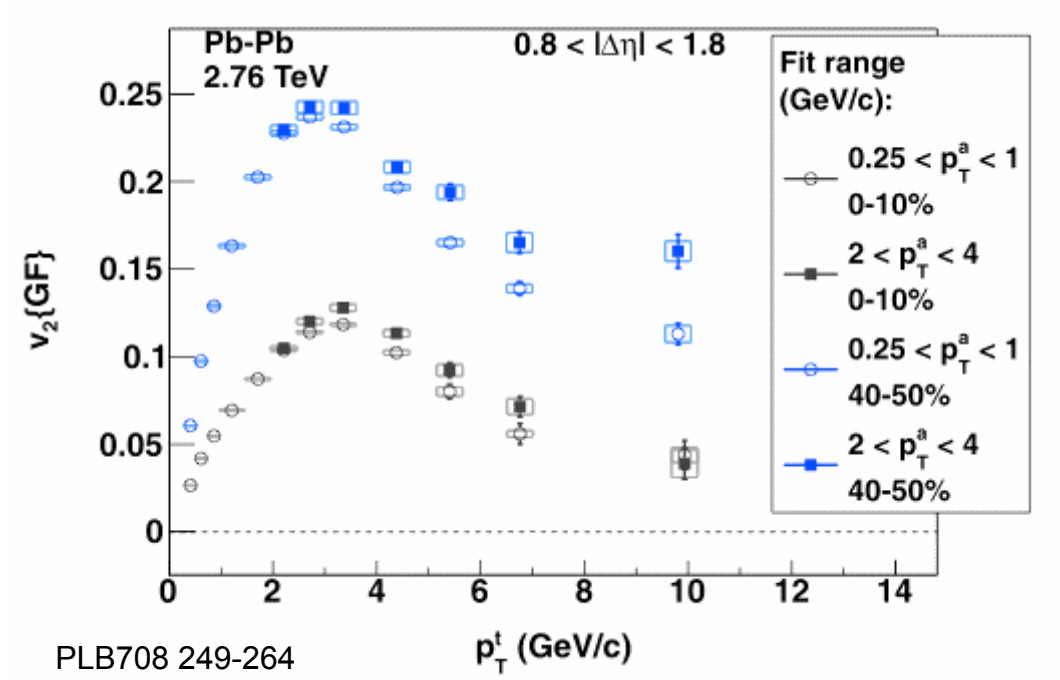




R. Snellings, QNP12





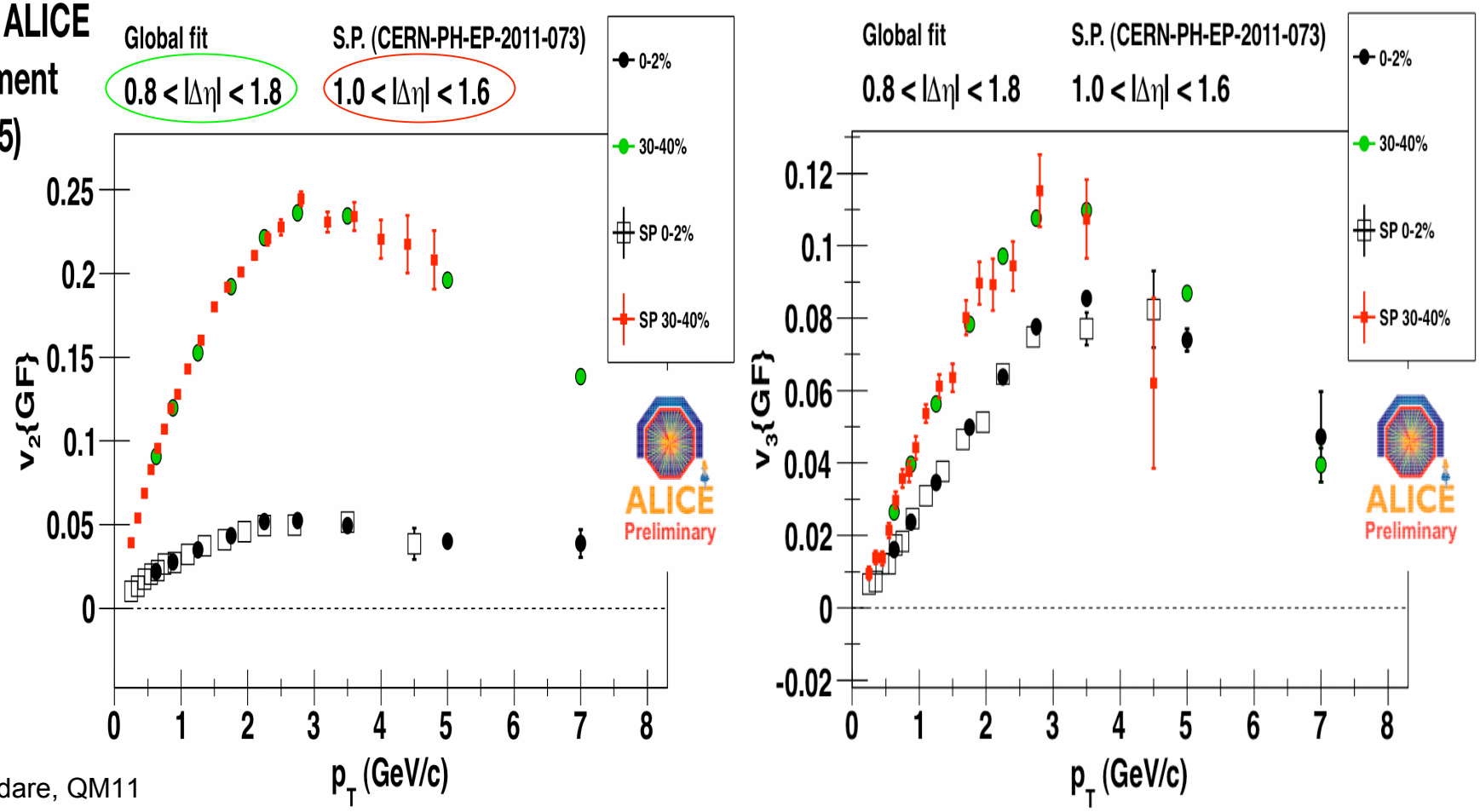


PLB708 249-264

Variation of v_n results with different p_T range for the global fit

$v_n\{C_2$ global fit$\}$ ~ $v_n\{2, |\Delta\eta|>1\}$

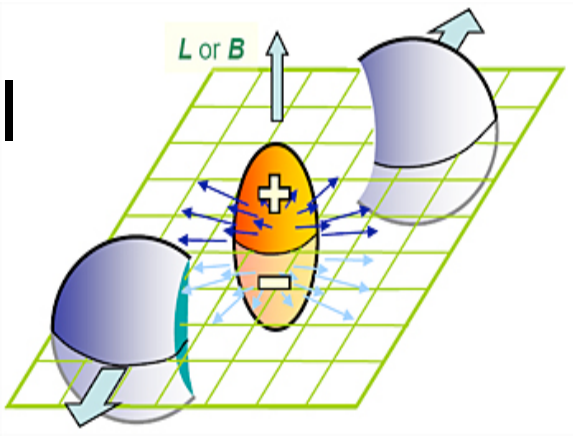
With new ALICE measurement (1105.3865)



A. Adare, QM11

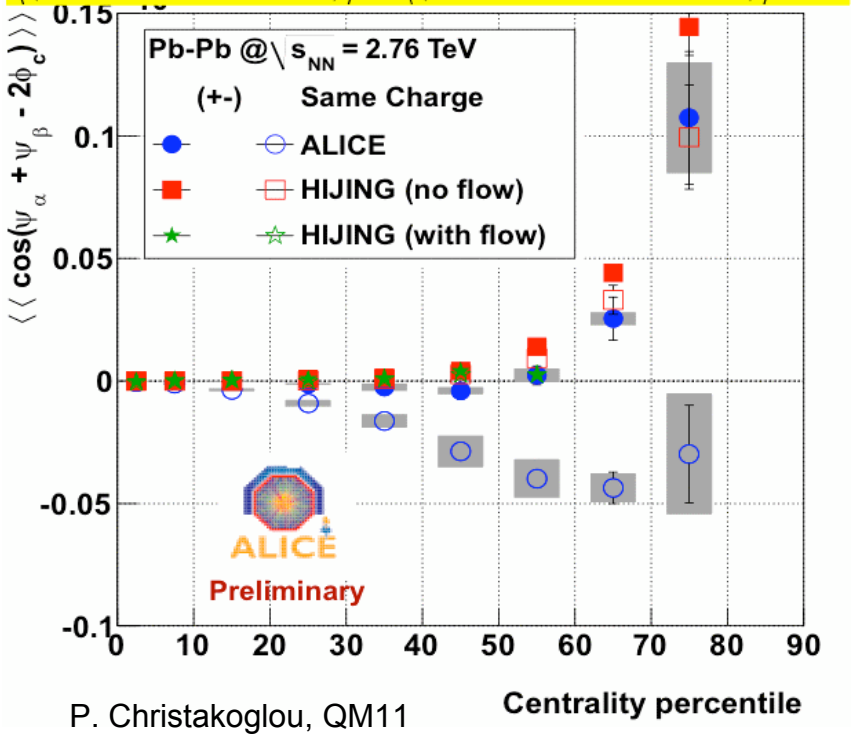
good agreement of v_n even towards higher p_T coming from (low x high) p_T combinations in C_2

Possible charge asymmetry signal from Local Parity Violation



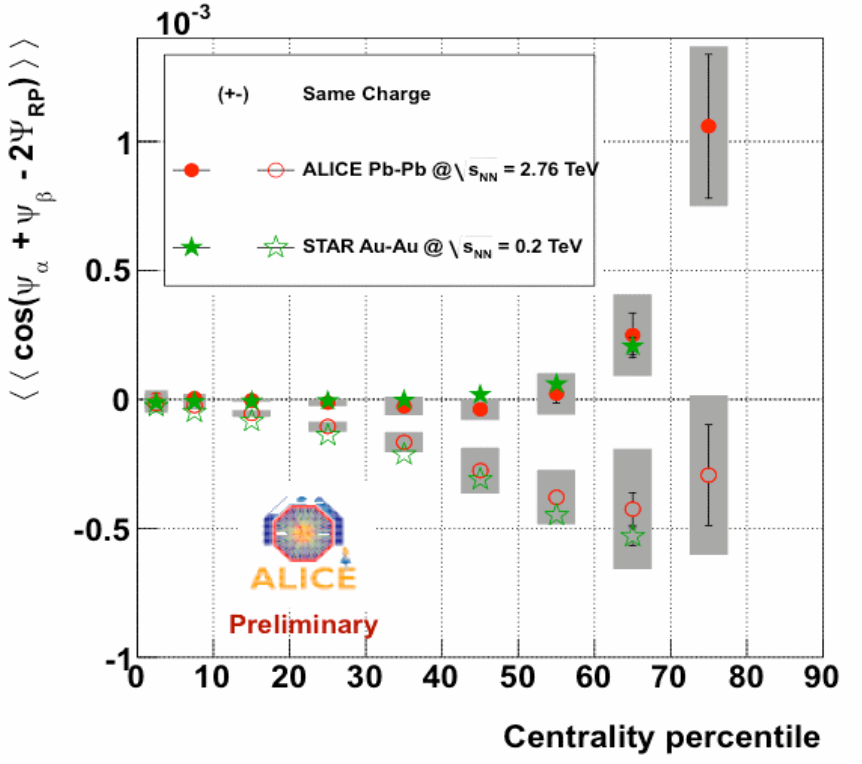
S. A. Voloshin, Phys. Rev. *C* **70**, 057901 (2004).

$$\left\langle\left\langle \cos\left(\psi_a + \psi_b - 2\phi_c\right)\right\rangle\right\rangle = \left\langle\left\langle \cos\left(\psi_a + \psi_b - 2\Psi_{RP}\right)\right\rangle\right\rangle \; v_{2,c}$$

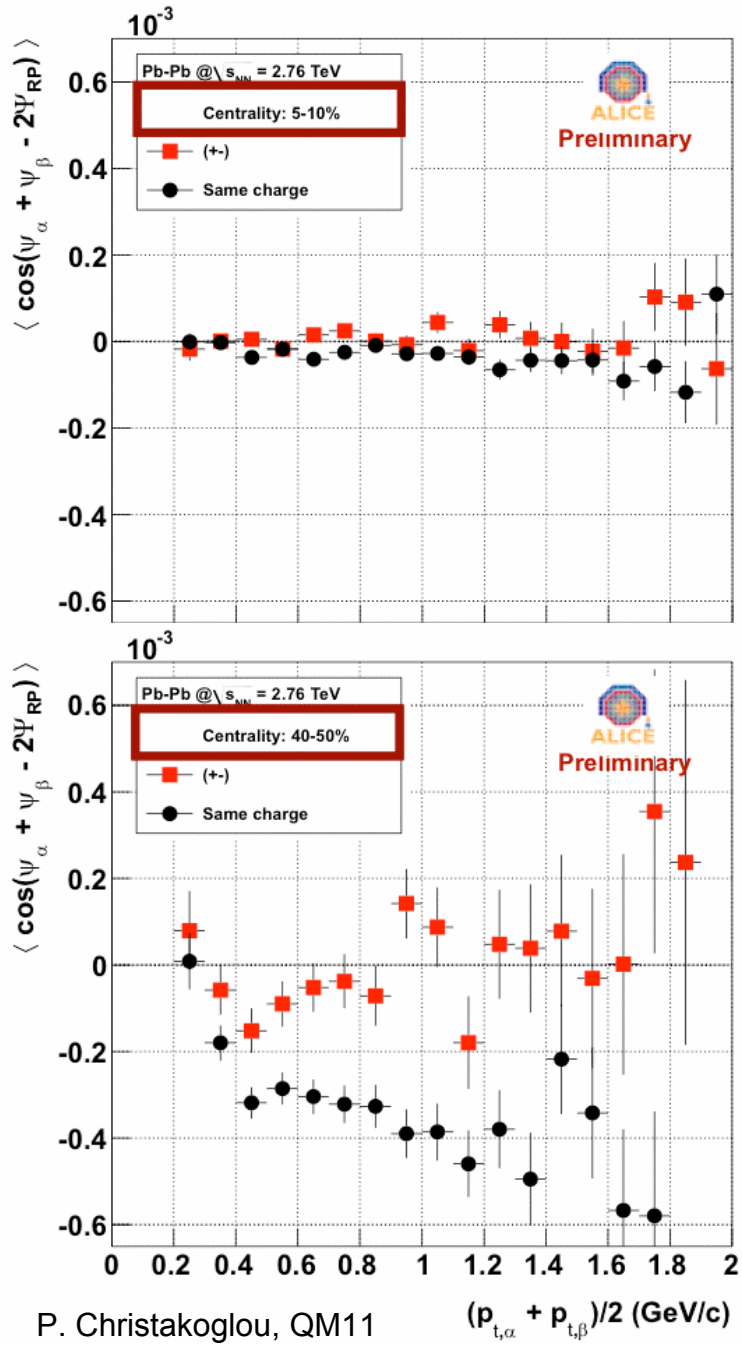


P. Christakoglou, QM11

STAR Collaboration: Phys. Rev. Lett. **81**, 251601 (2009)
STAR Collaboration: Phys. Rev. ***C*81**, 054908 (2010)



p_T dependence of the observed asymmetry signal



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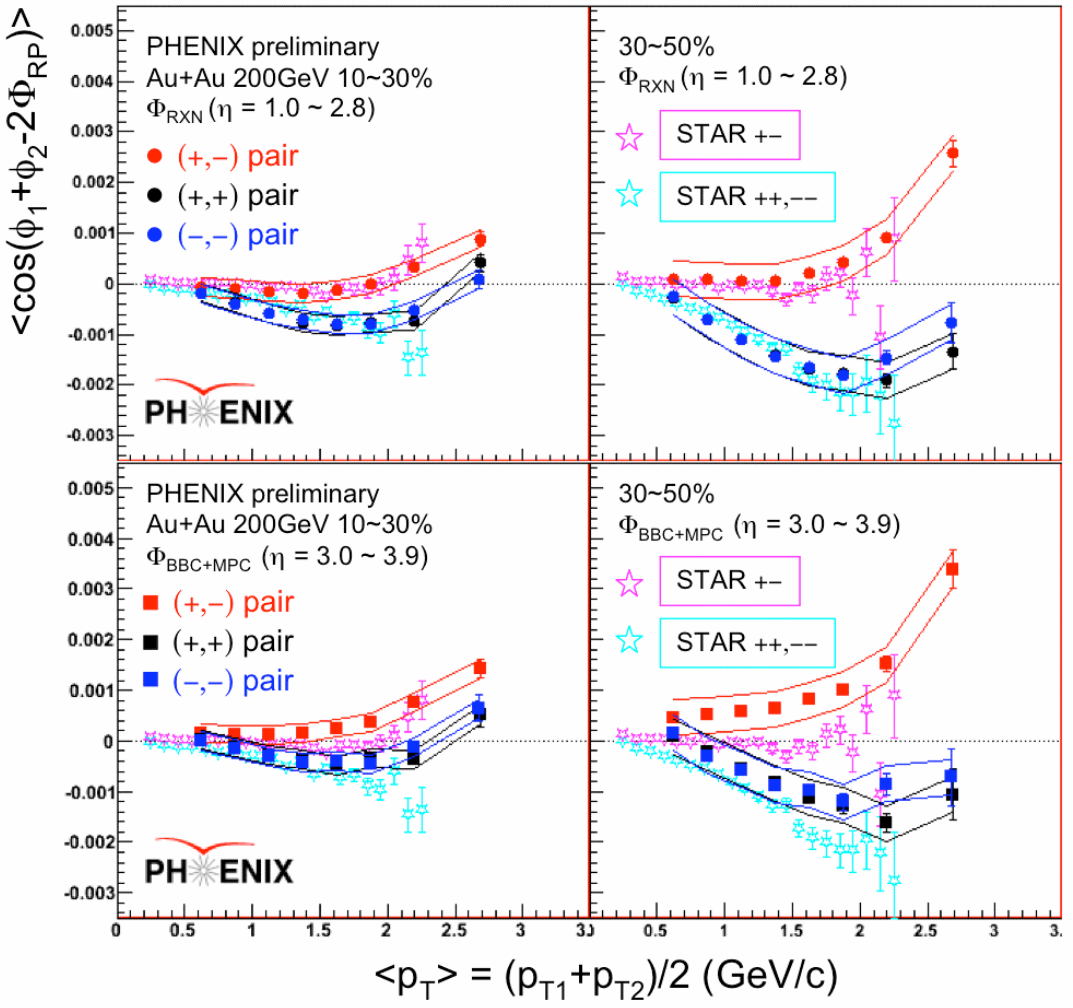
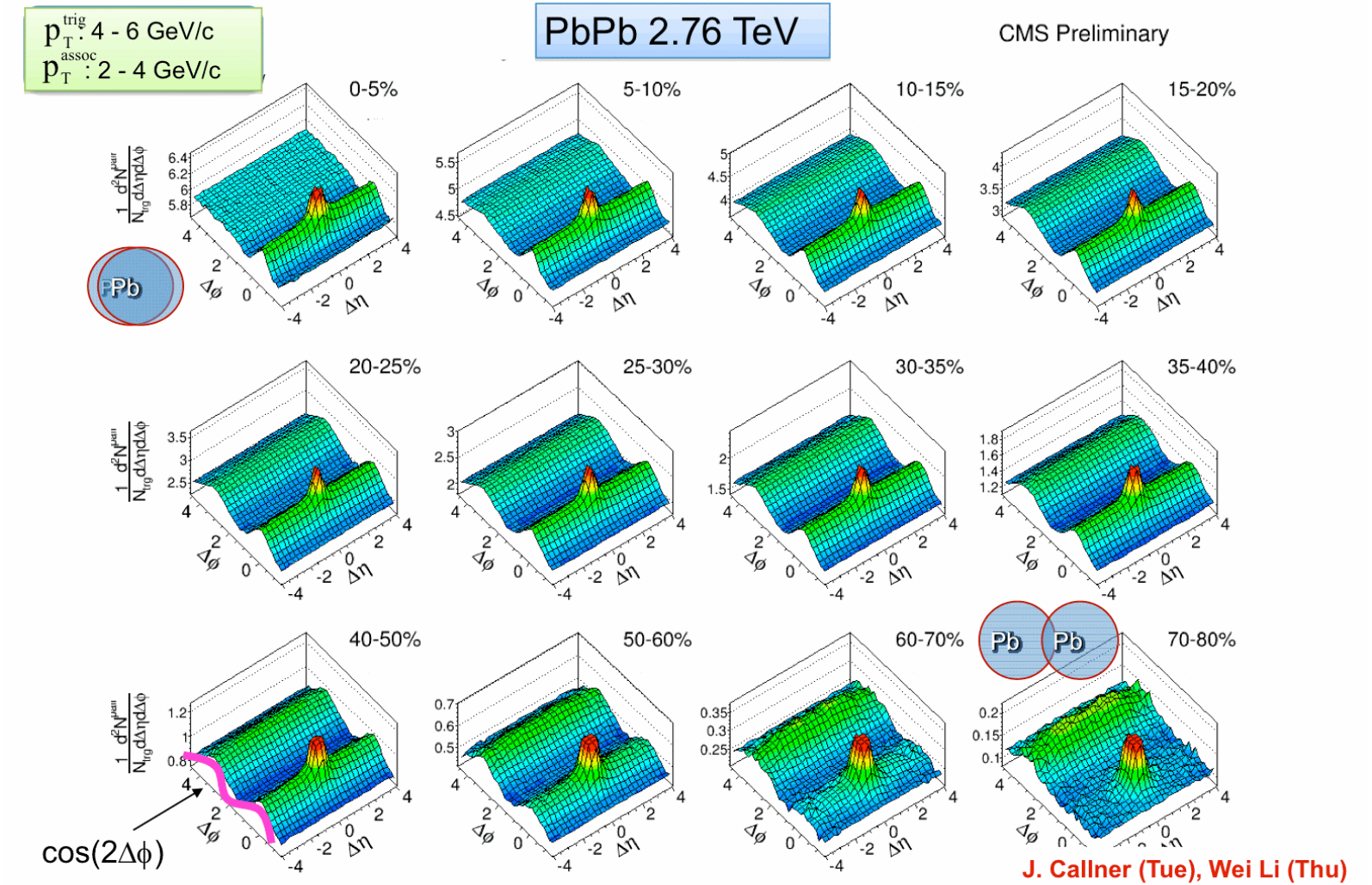


Triggered dihadron centrality dependence in PbPb



Rise and fall of “ridge/cone”—Centrality evolution

Pay attention to how long-range structures disappear and clear jet-related peaks emerge on the away-side

Strength of soft component increase and then decrease

Near-side jet peak is truncated from top to better reveal long range structure