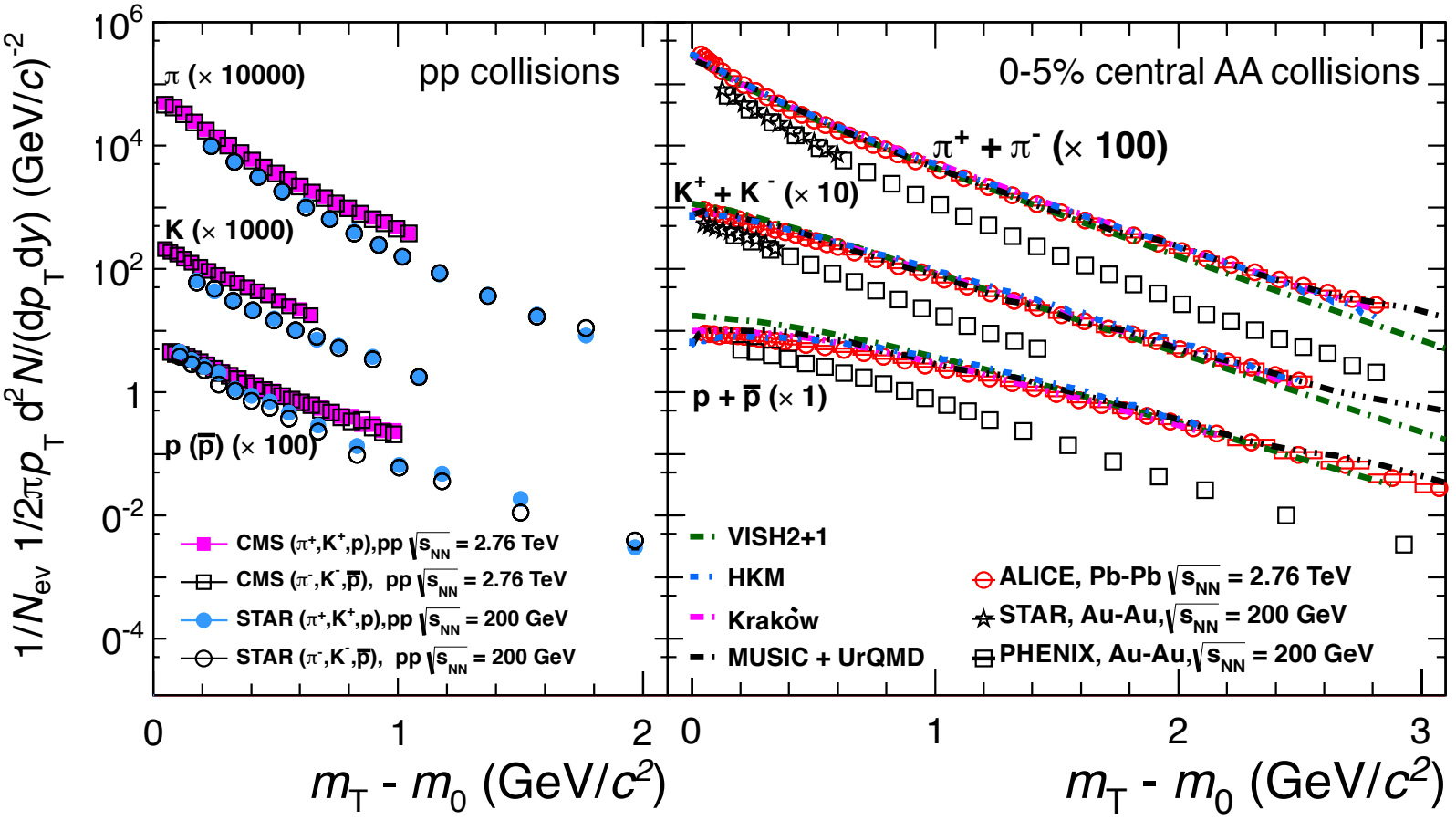
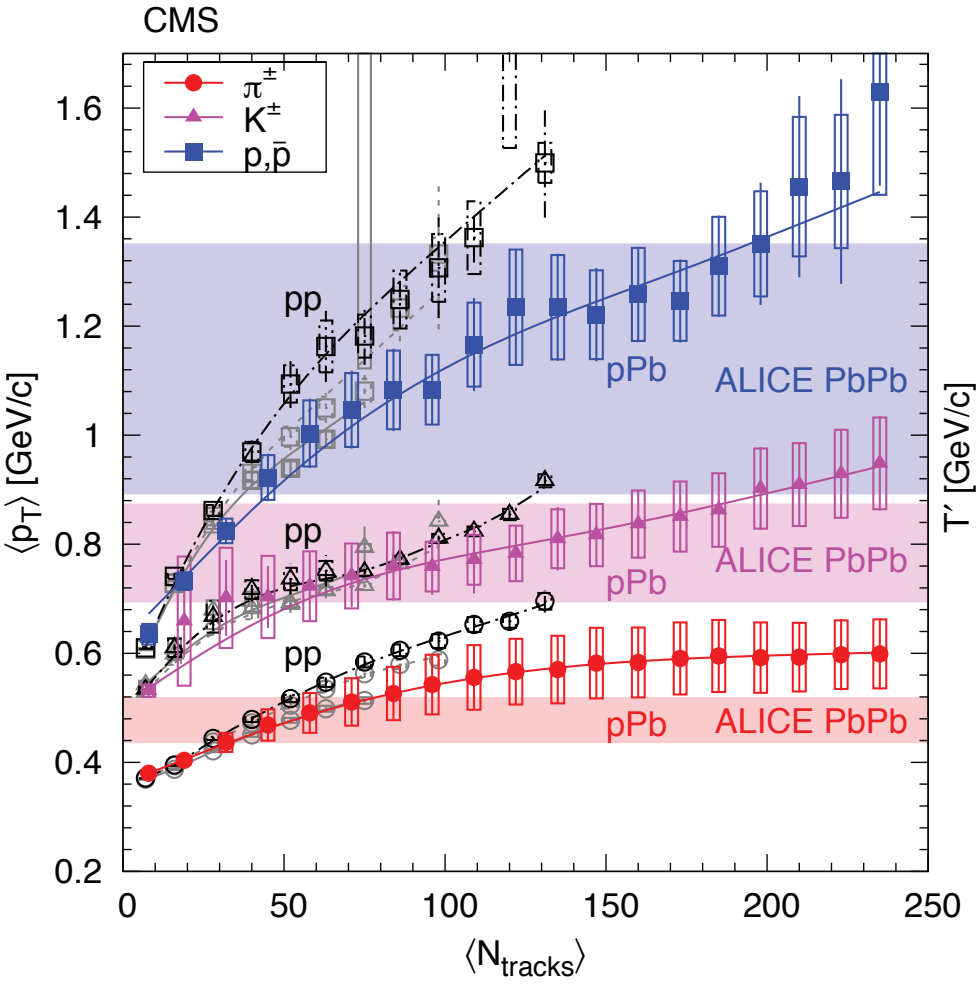
1. What is the experimental evidence for hydrodynamics in heavy-ion collisions?

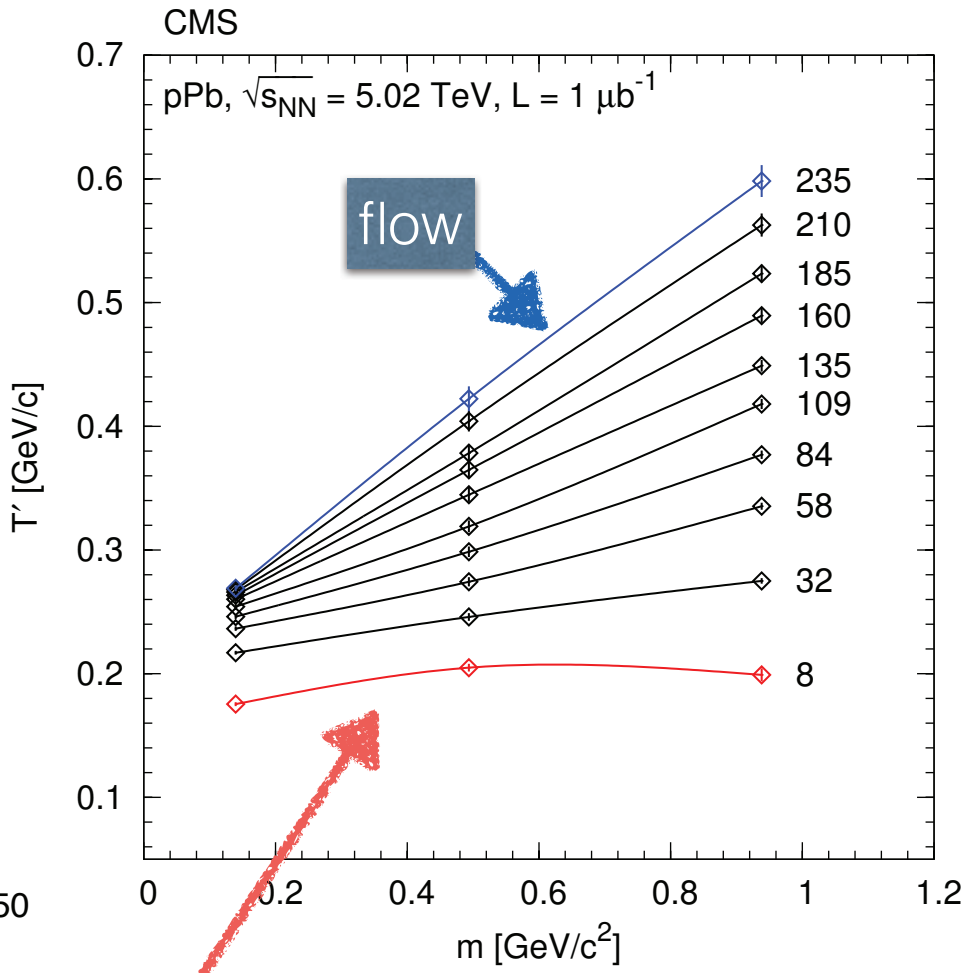
2. Are there any observables that are sensitive to the process of thermalization?

Mass dependence of m_T slopes due to radial flow blue shift



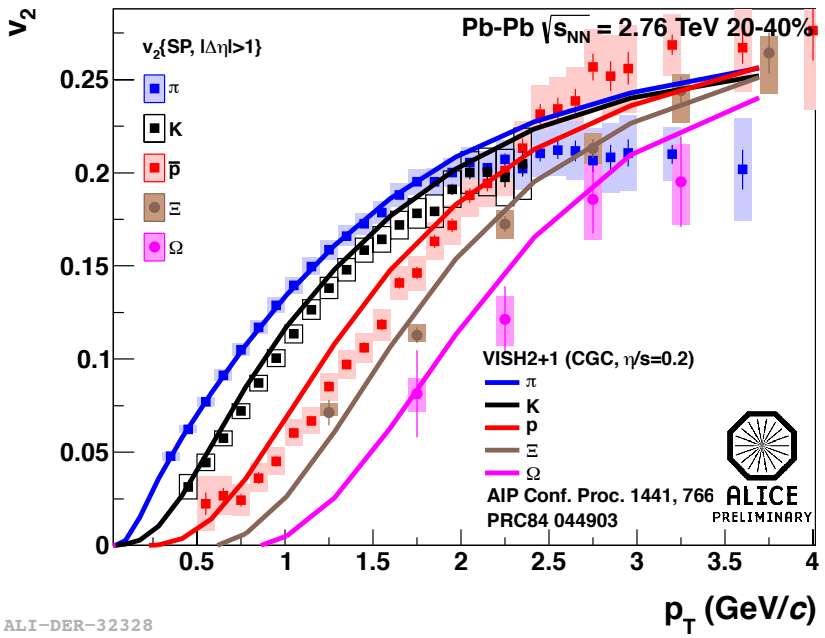
Radial flow: Mass dependence of mean p_T and m_T slopes

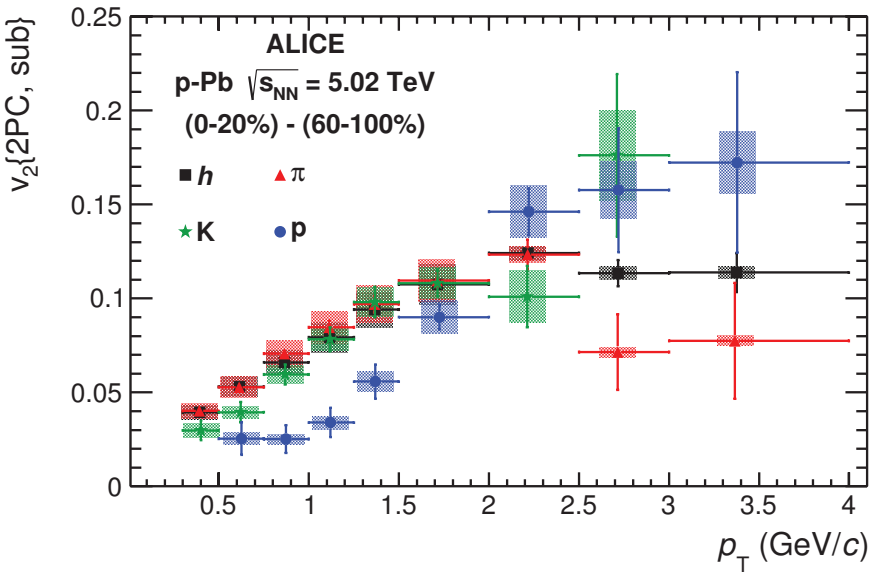


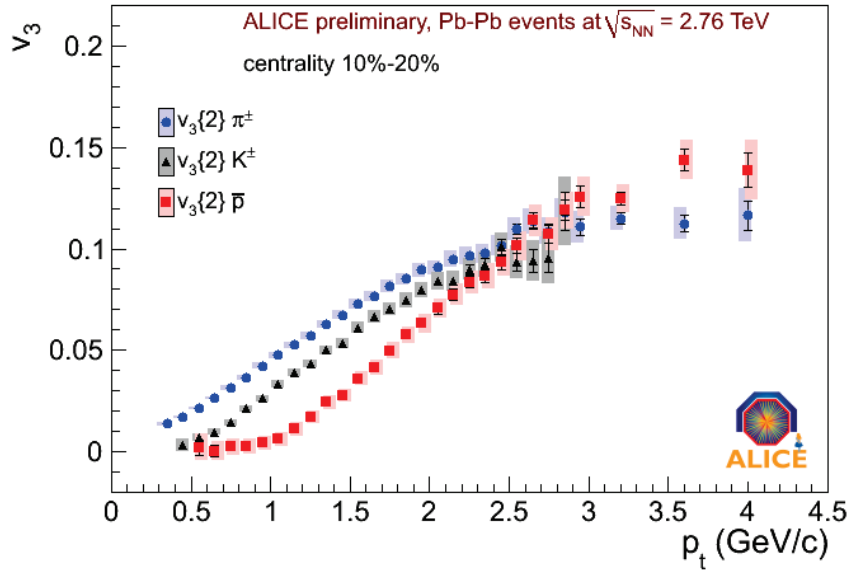


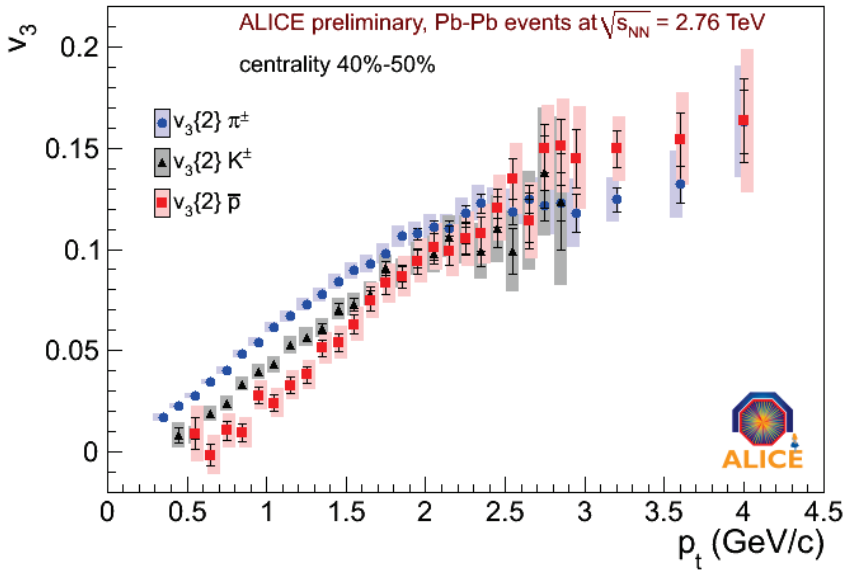
mt scaling, no flow

Mass dependence of $v_{2,3}(p_T)$

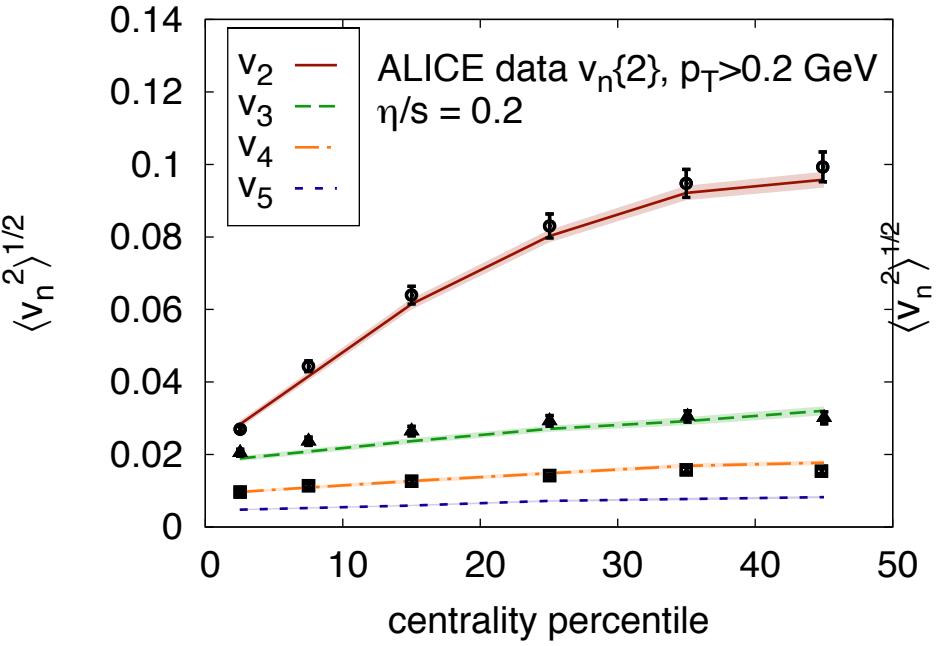


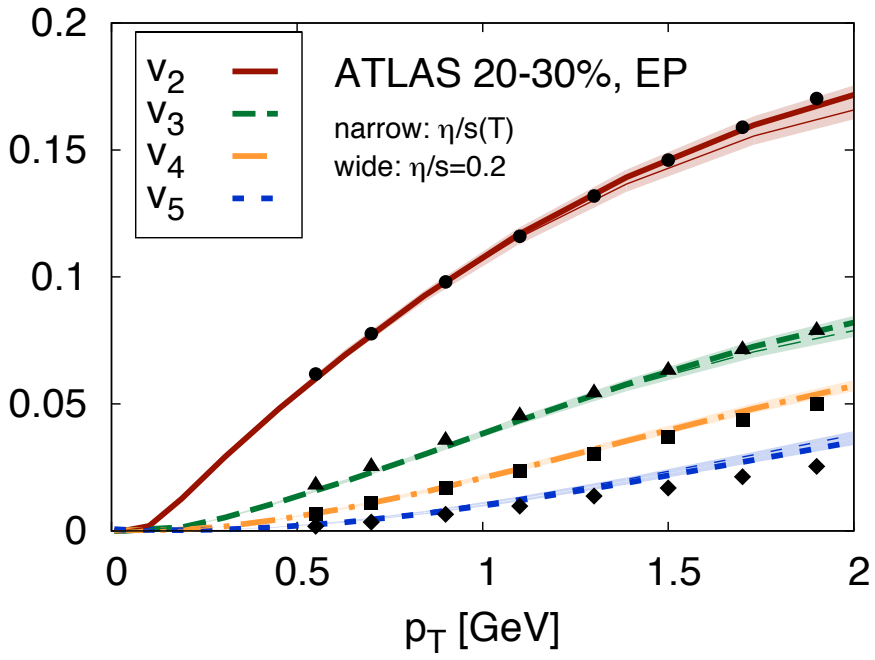




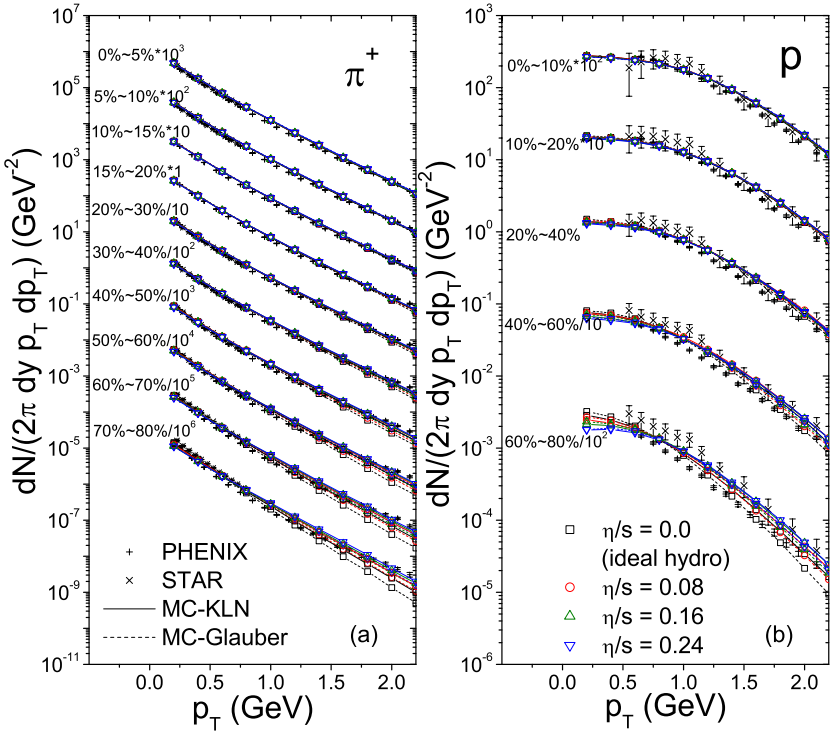


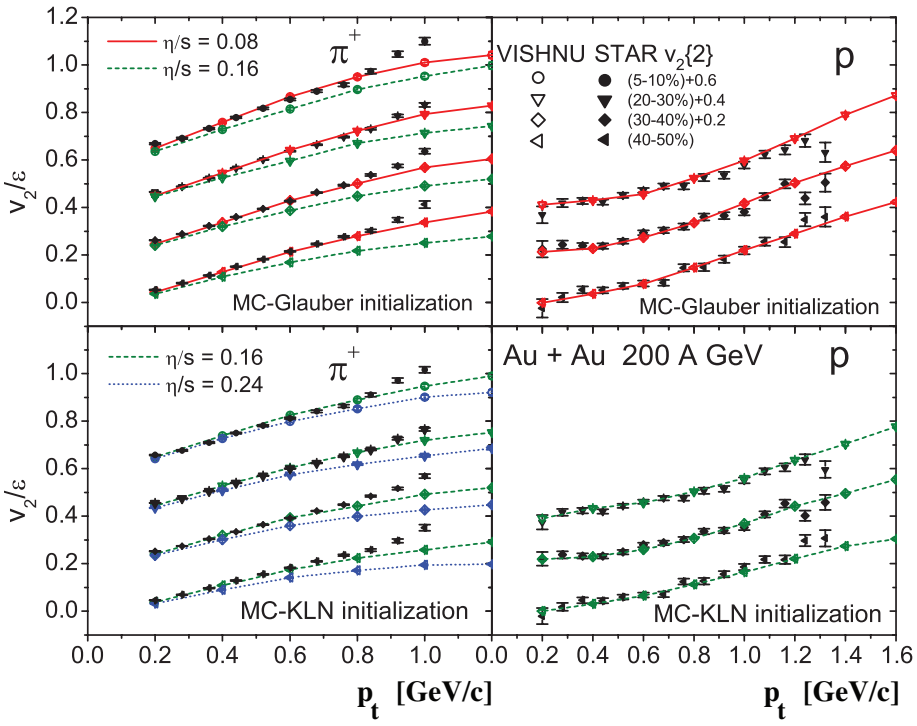
Simultaneous description of all v_n





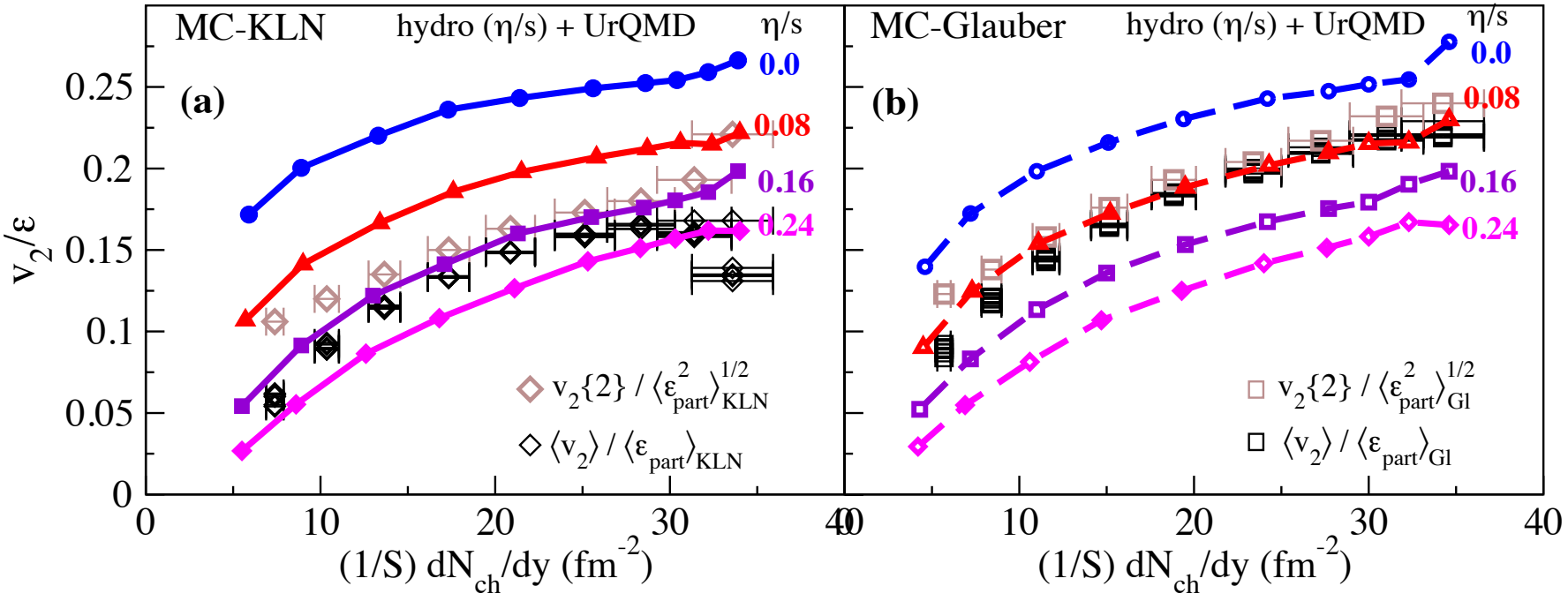
Simultaneous description of all soft hadron data



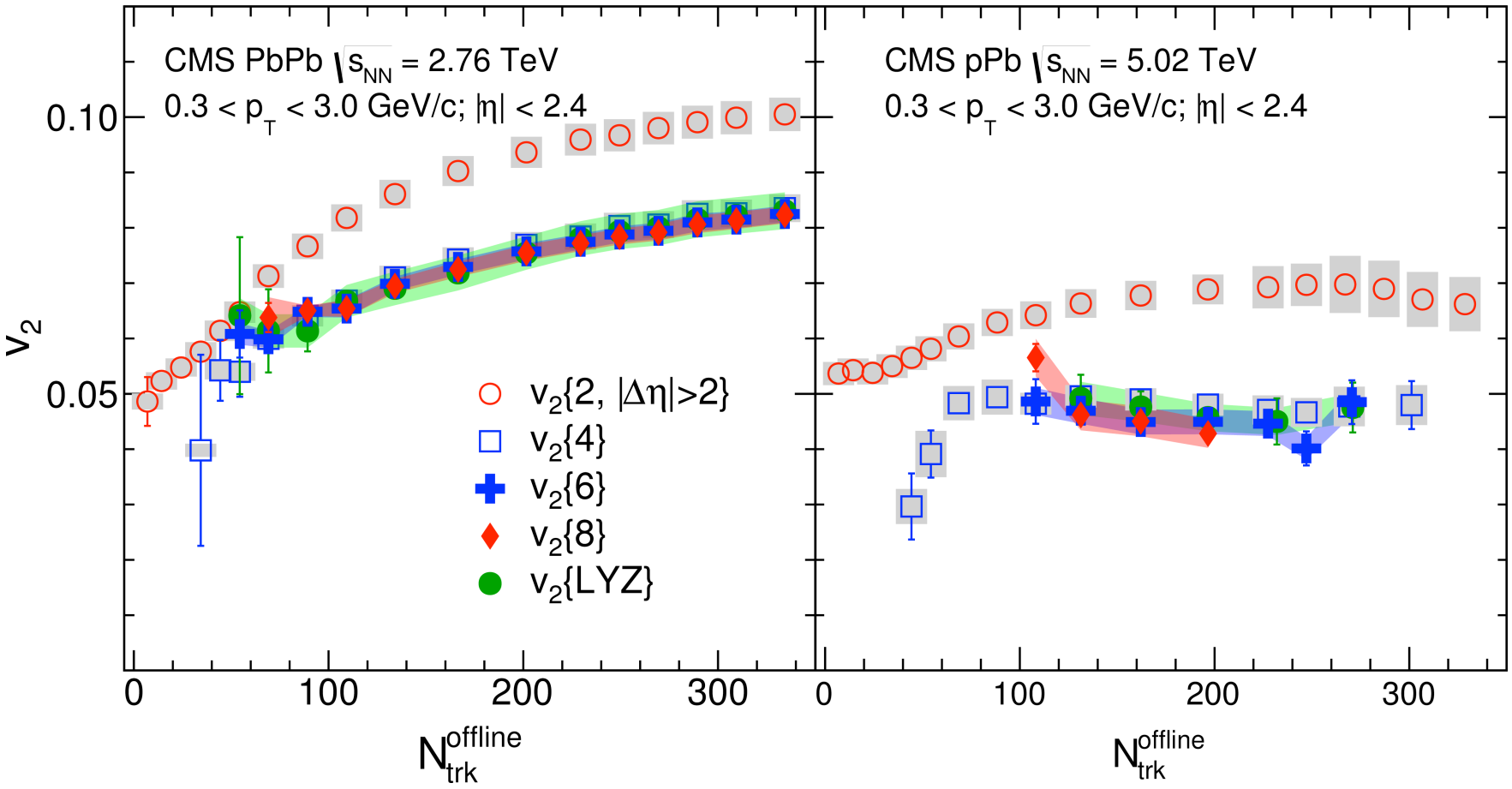


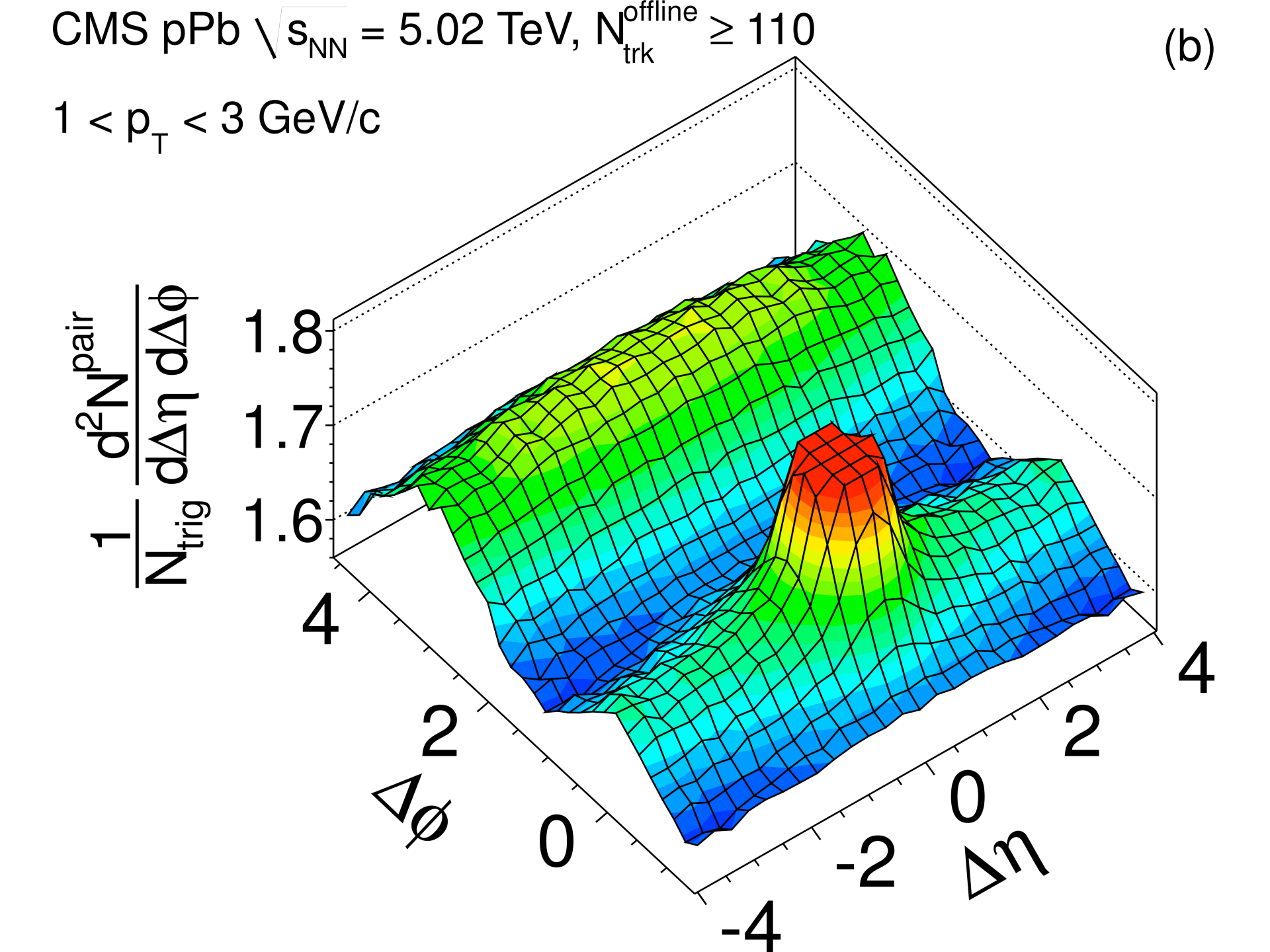
plus many more….

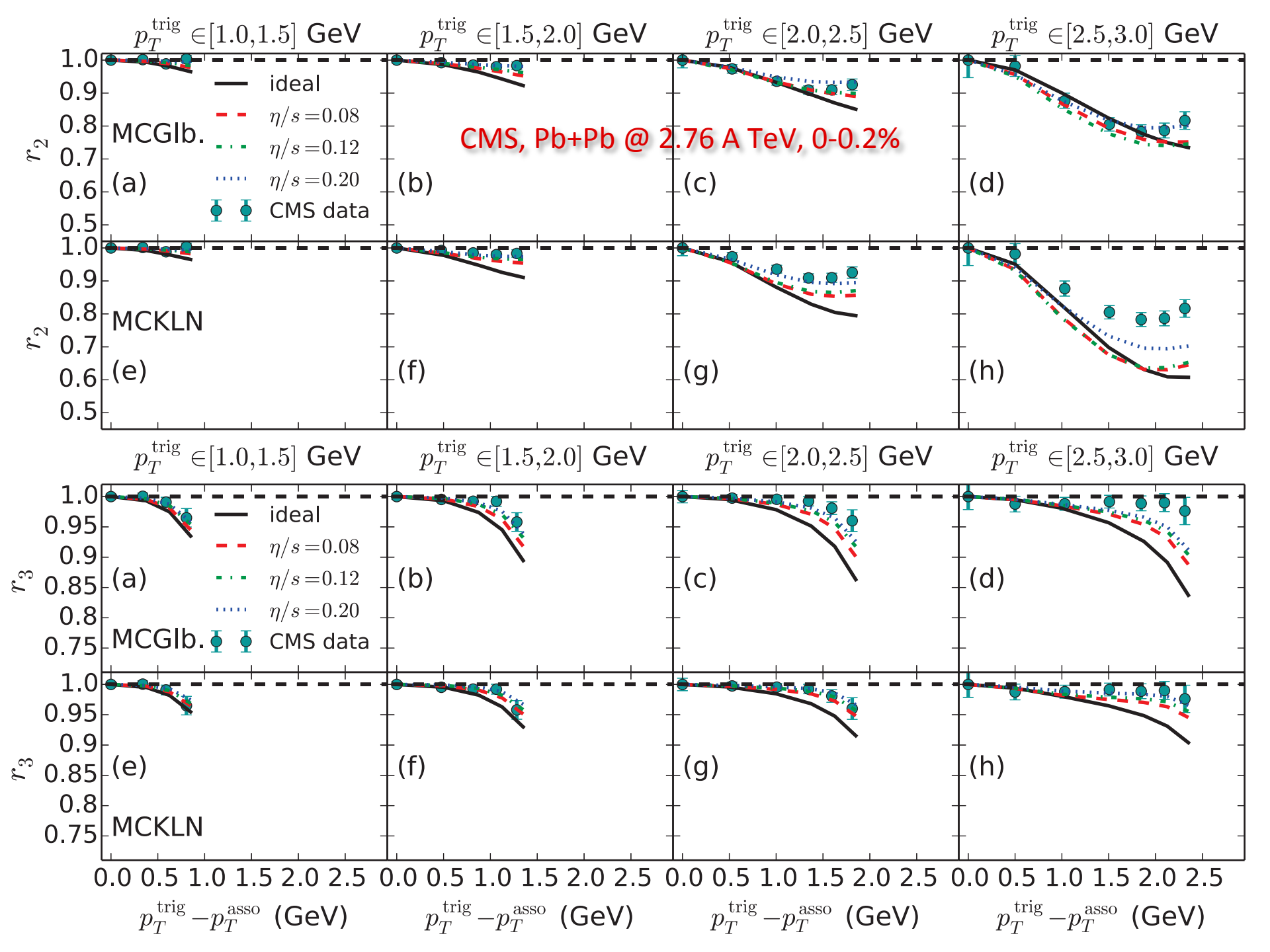
Dynamical response to geometry: elliptic flow as function of centrality

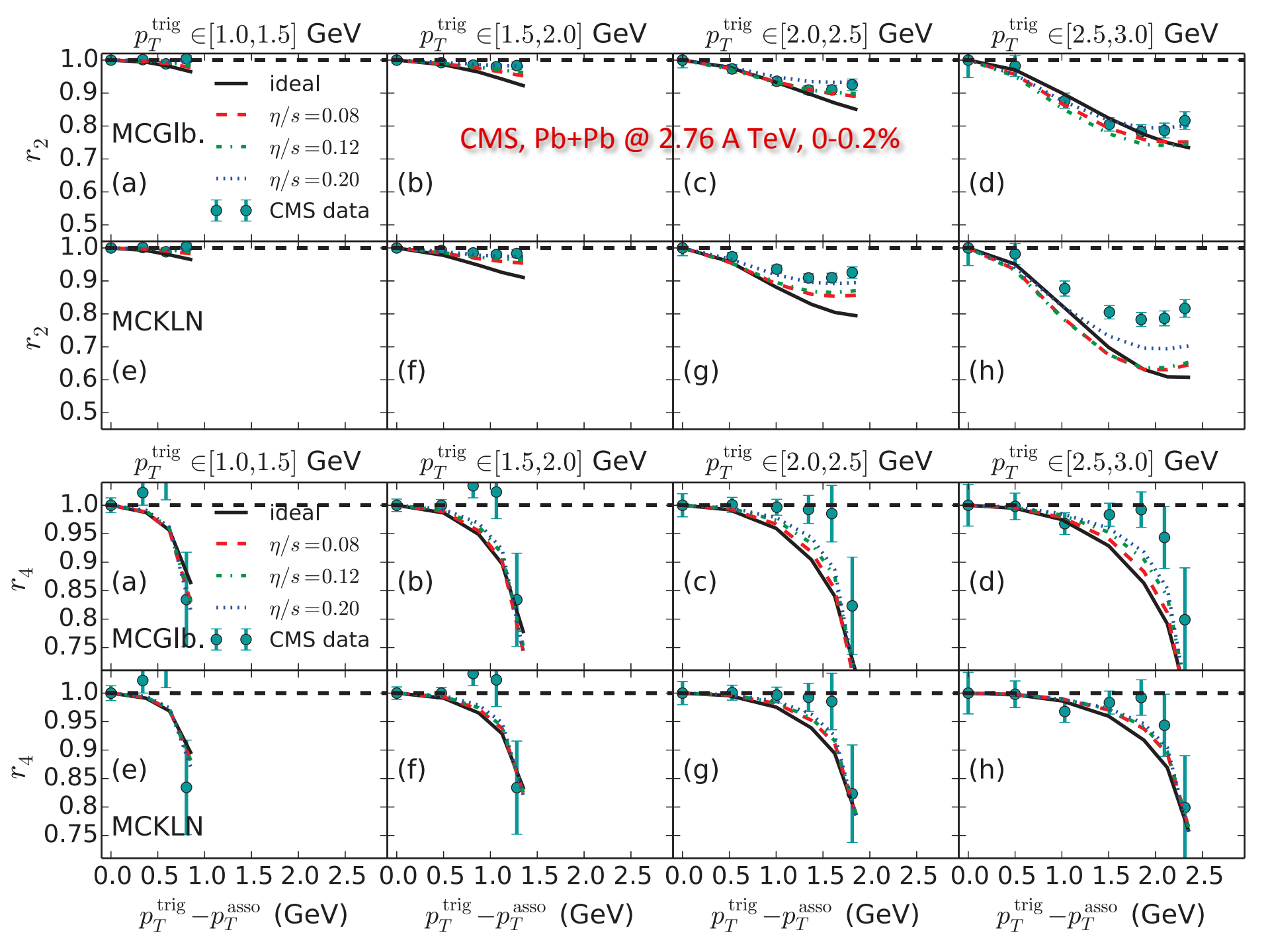


Collectivity




CMS pPb $\sqrt{s_{NN}}$ = 5.02 TeV, $N_{trk}^{offline} \geq 110$
(b)
$1 < p_T < 3$ GeV/c
$\frac{1}{N_{trig}} \frac{d^2N^{pair}}{d\Delta\eta\, d\Delta\phi}$
1.8
1.7
1.6
4
2
0
-2
-4
$\Delta\phi$
$\Delta\eta$


$p_T^{\rm trig} \in [1.0,1.5]$ GeV
$p_T^{\rm trig} \in [1.5,2.0]$ GeV
$p_T^{\rm trig} \in [2.0,2.5]$ GeV
$p_T^{\rm trig} \in [2.5,3.0]$ GeV
CMS, Pb+Pb @ 2.76 A TeV, 0-0.2%
ideal
$\eta/s = 0.08$
$\eta/s = 0.12$
$\eta/s = 0.20$
CMS data
MCGlb.
MCKLN
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
r_2
r_3
$p_T^{\rm trig} - p_T^{\rm asso}$ (GeV)


$p_T^{\rm trig} \in [1.0,1.5]$ GeV
$p_T^{\rm trig} \in [1.5,2.0]$ GeV
$p_T^{\rm trig} \in [2.0,2.5]$ GeV
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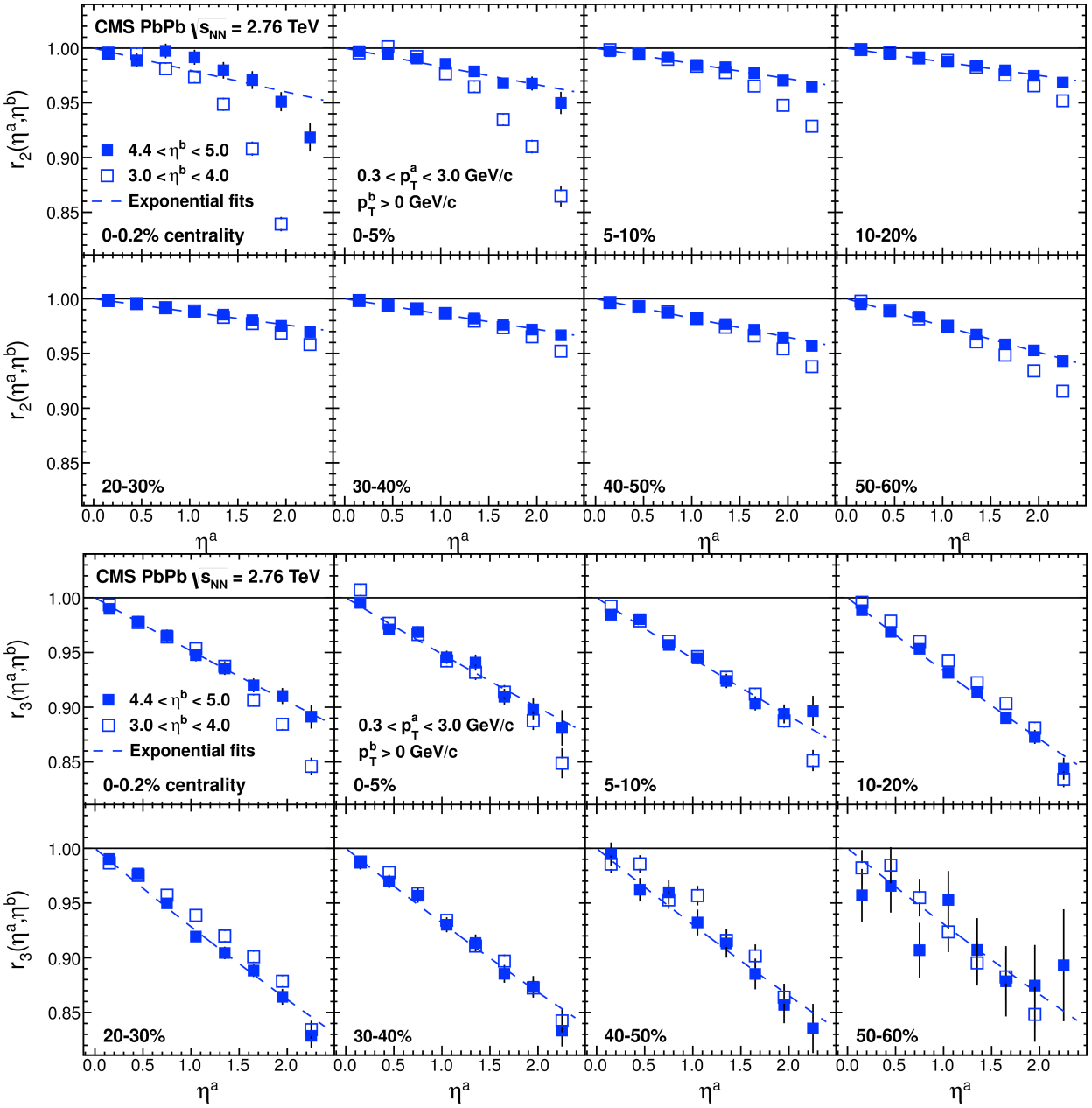
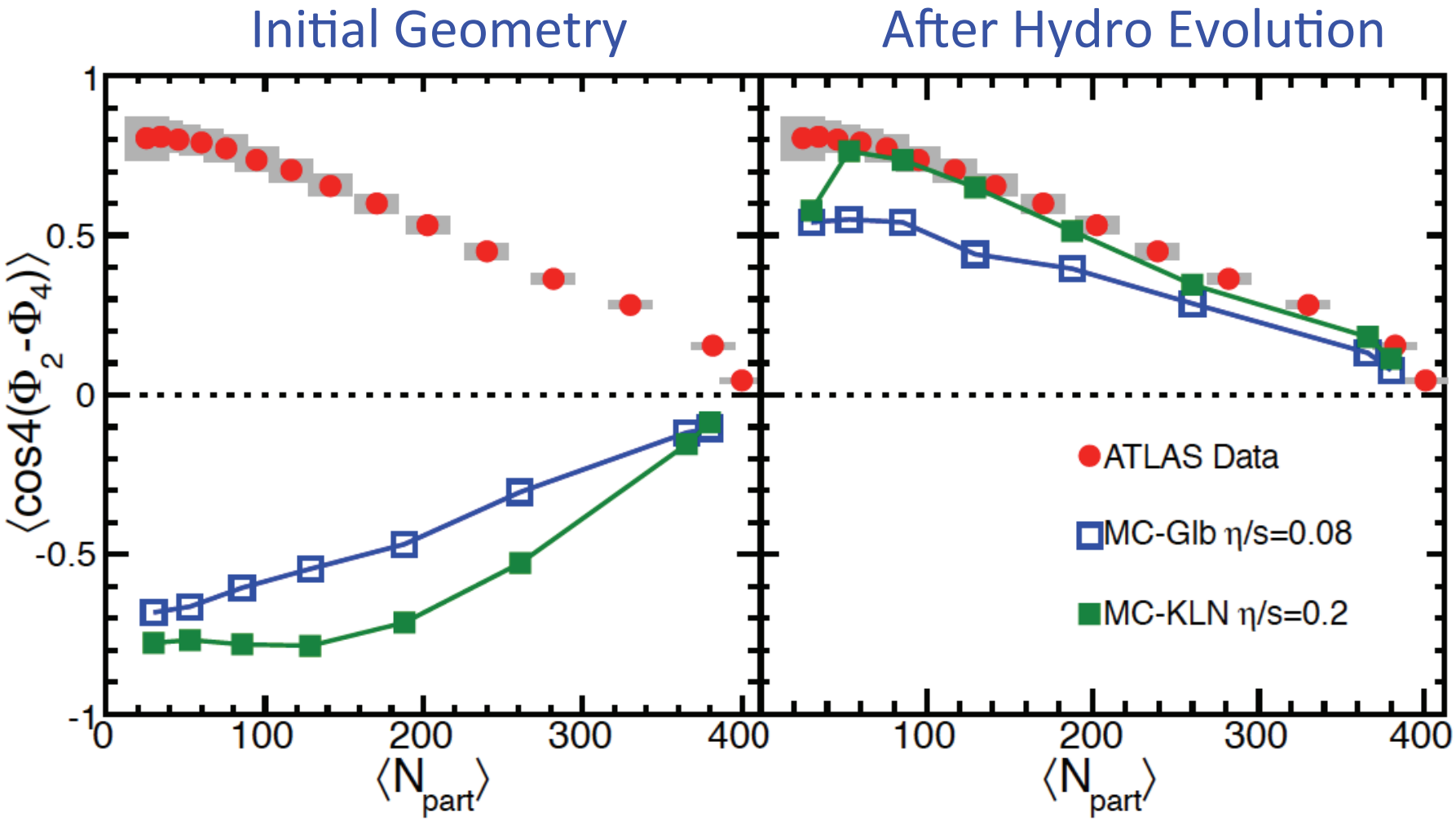
CMS, Pb+Pb @ 2.76 A TeV, 0-0.2%
ideal
$\eta/s = 0.08$
$\eta/s = 0.12$
$\eta/s = 0.20$
CMS data
MCGlb.
MCKLN
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
r_2
r_4
$p_T^{\rm trig} - p_T^{\rm asso}$ (GeV)

Event-plane decorrelation in rapidity



Bozek (arXiv: 1506.04362) showed how to to describe these with hydrodynamics

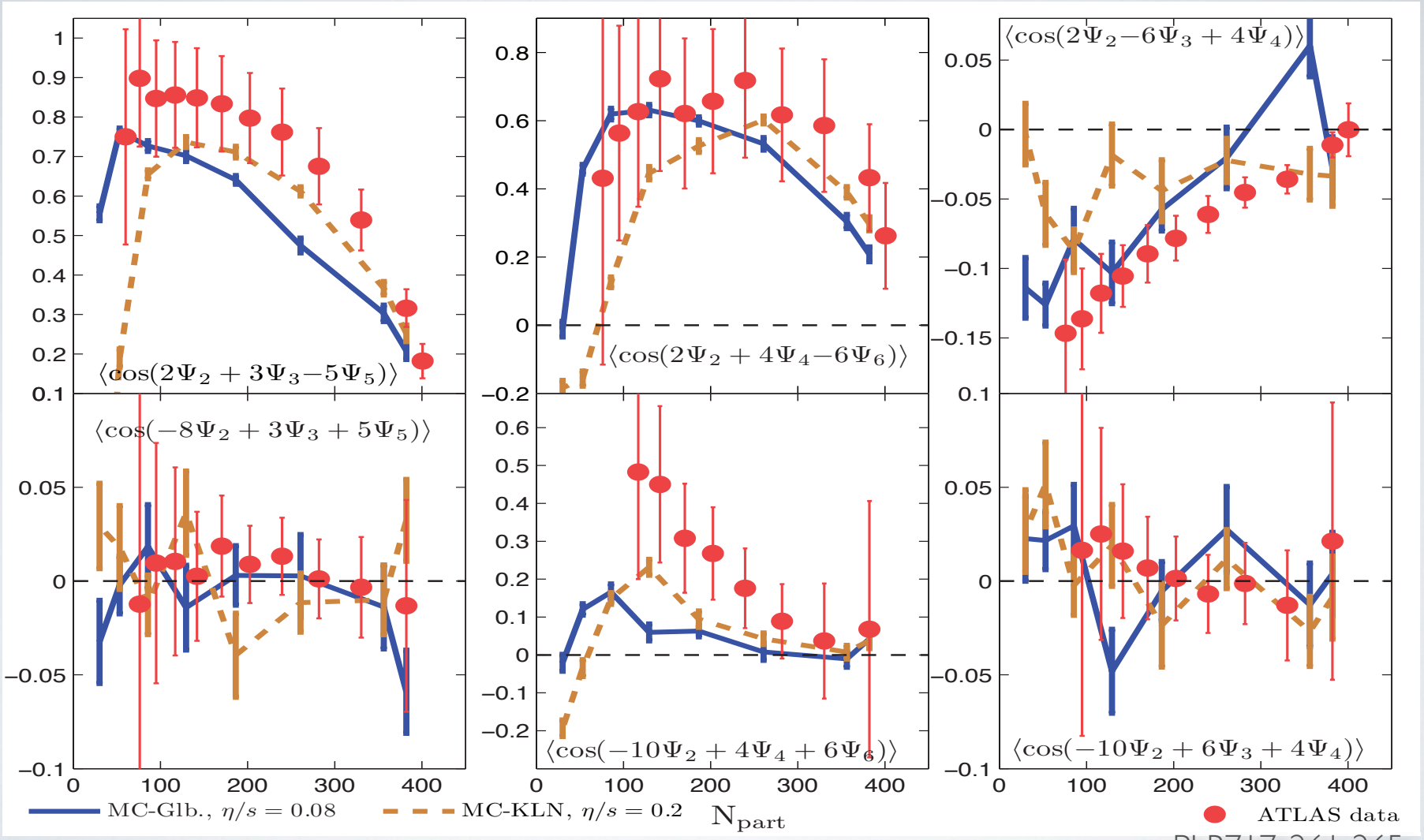
Event-plane correlations



THE OHIO STATE UNIVERSITY DEPARTMENT OF PHYSICS

Correlation of EP angles

JET Collaboration



PLB717, 261-265

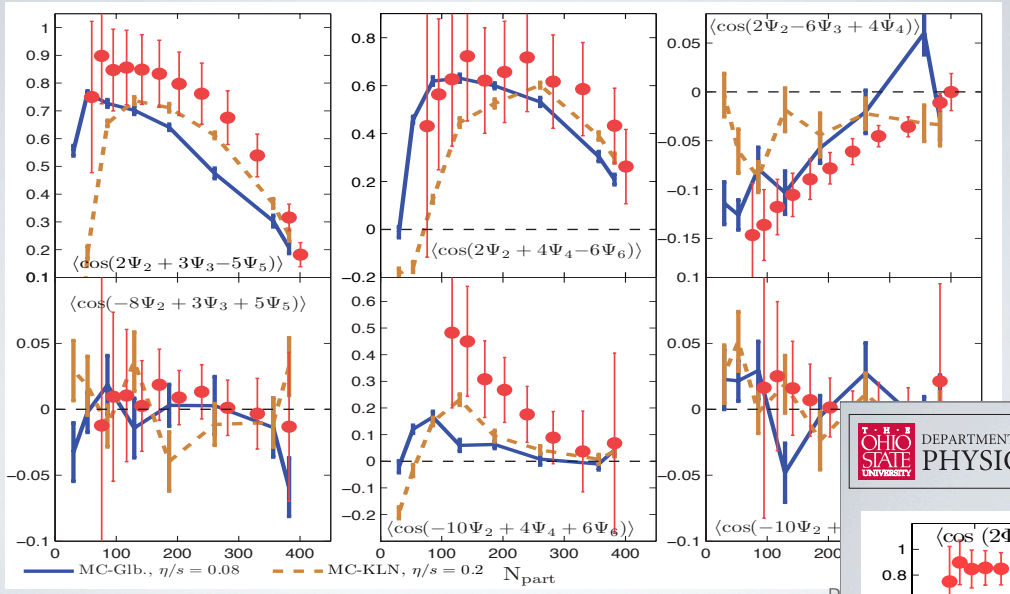
✶Hydrodynamical three event-plane angle correlations describe data.

Event-plane correlations

DEPARTMENT OF PHYSICS

Correlation of EP angles

JET Collaboration



✳Hydrodynamical three event-plane angle correlations descr

Thursday, March 28, 13

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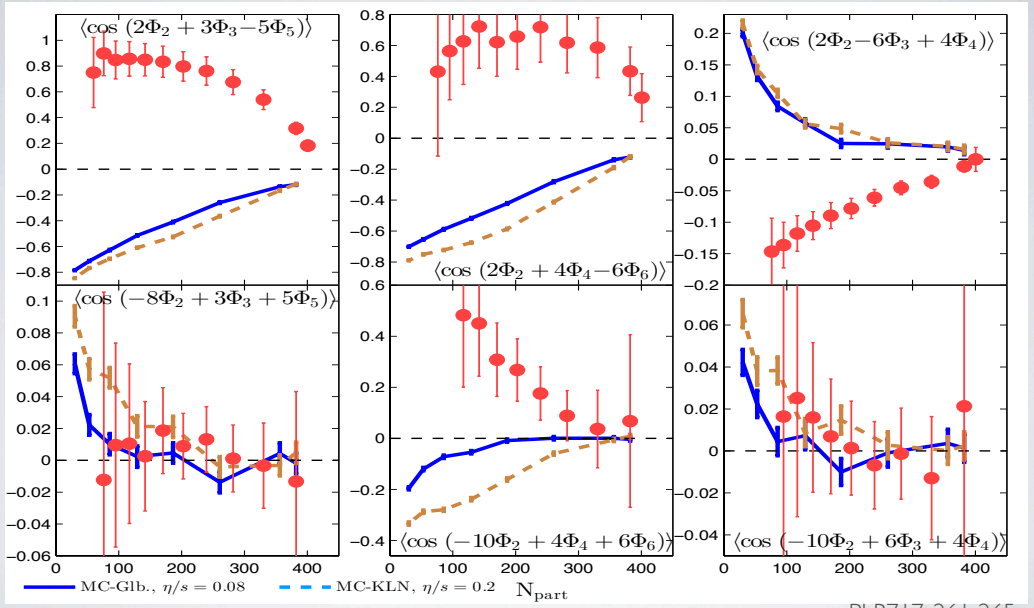
Correlation of EP angles

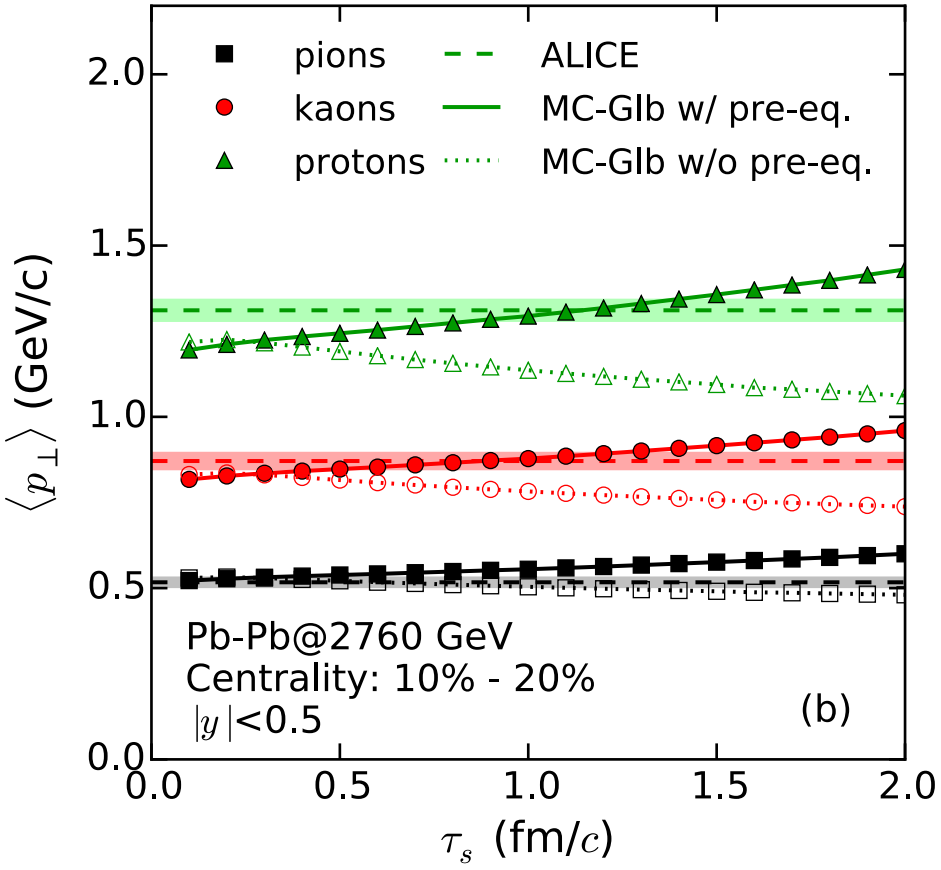
JET Collaboration

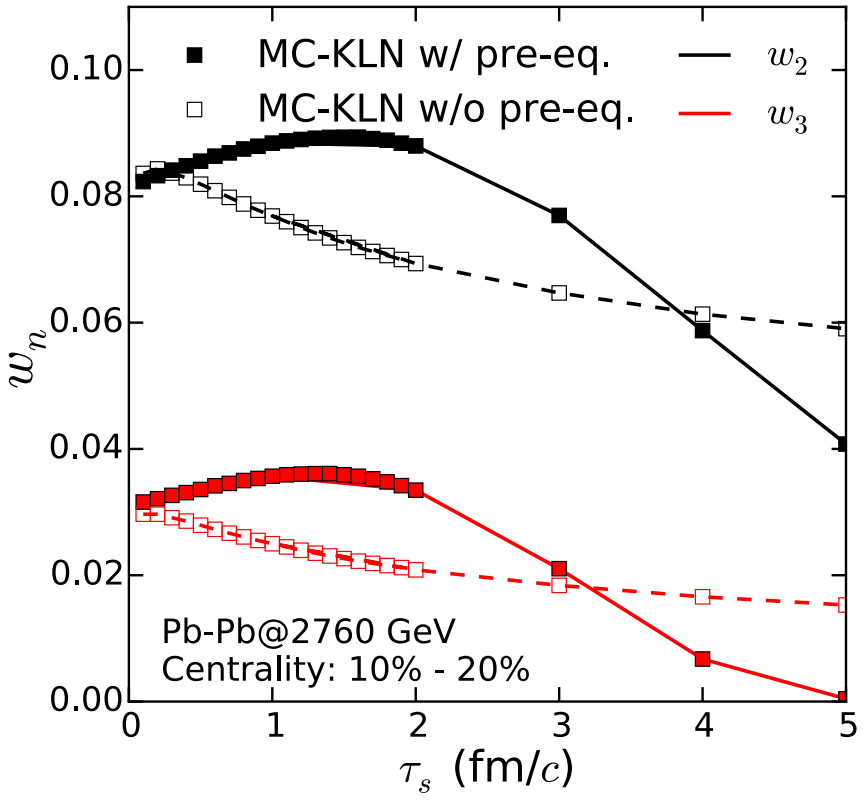


PLB717, 261-265

✳Initial three participant-plane angle correlations cannot describe data.

Sensitivity of observables to thermalization time:





Need combination of observables to pin down duration of thermalization stage.