1st highlight:
Stat model for small systems

Multiplicity dependence of particle production at the LHC in (canonical) statistical model

Volodymyr Vovchenko

Goethe University Frankfurt & Frankfurt Institute for Advanced Studies

In collaboration with B. Doenigus and H. Stoecker, paper in preparation

COST Workshop on Interplay of hard and soft QCD probes for collectivity in heavy-ion collisions

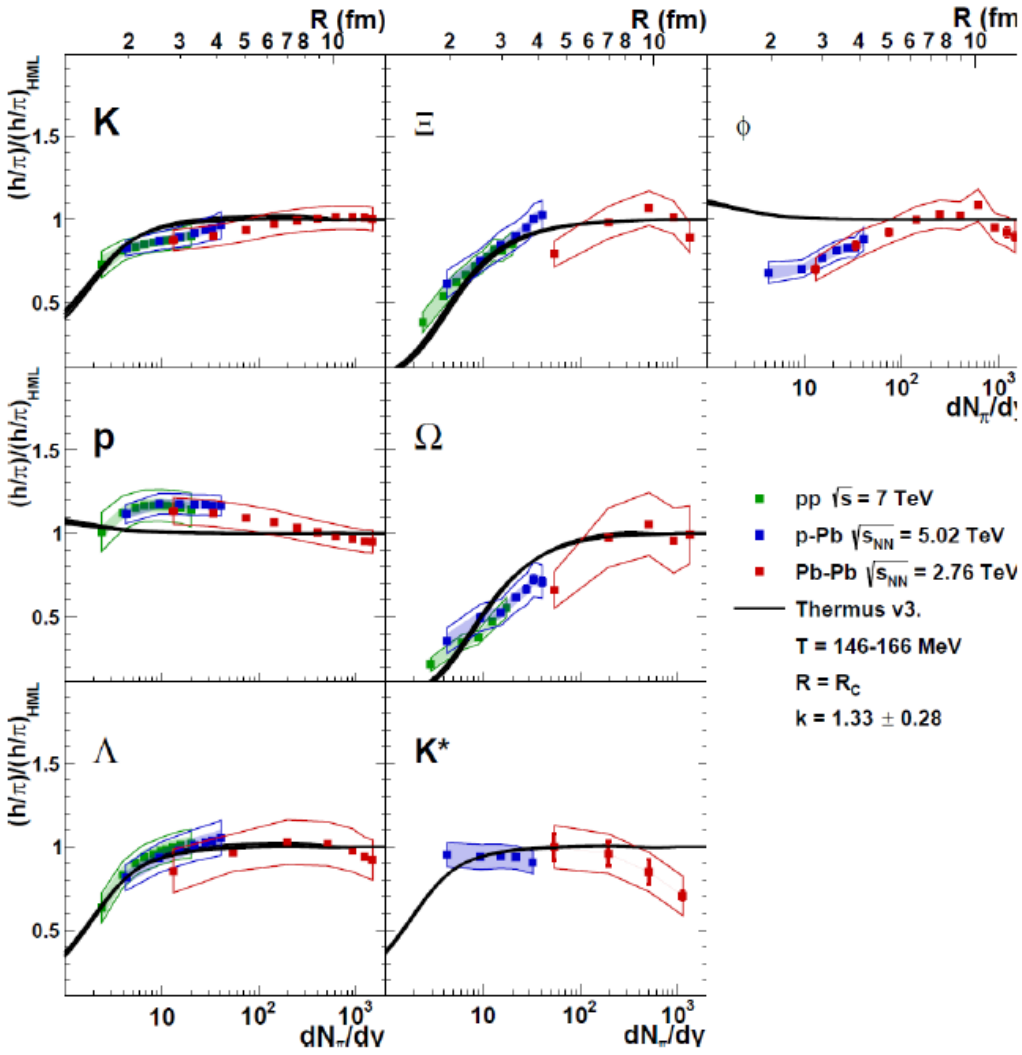
Lund, Sweden, October 25 – March 1, 2019

FIAS Frankfurt Institute for Advanced Studies

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

CSM at LHC: strangeness-canonical ensemble

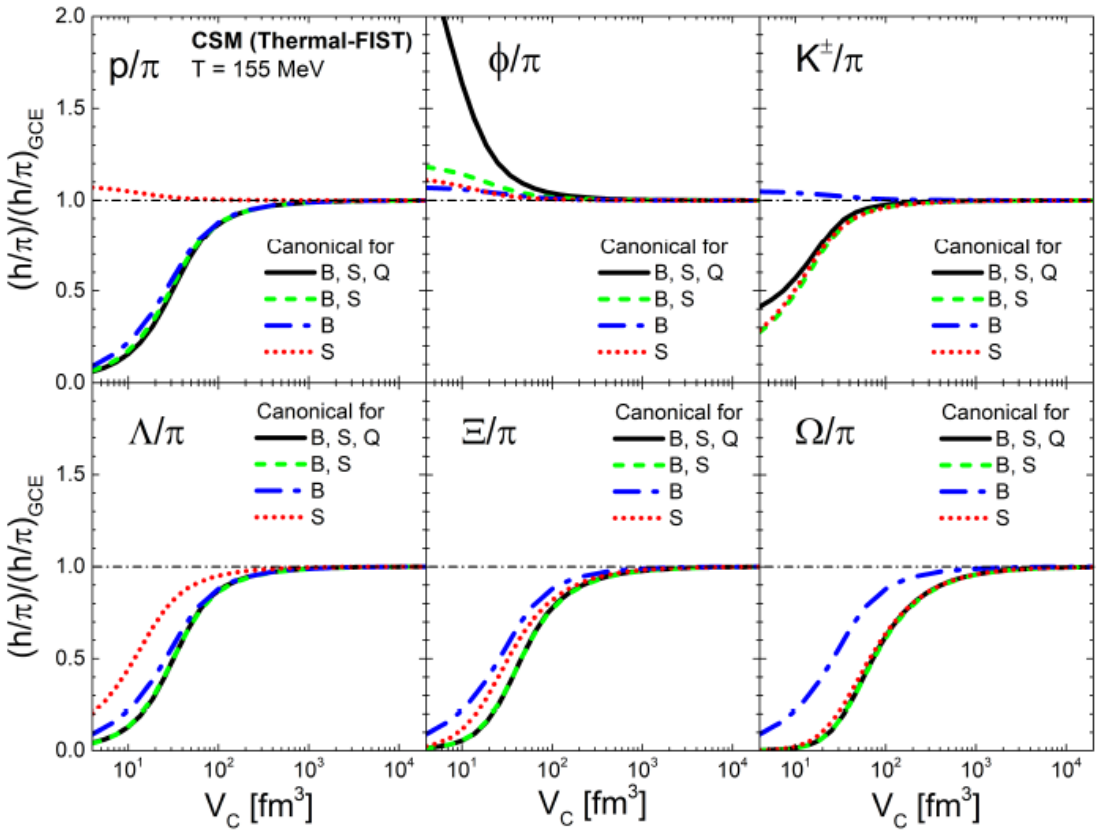


[ALICE collaboration, 1807.11321]

- Strangeness-canonical picture: S is canonical, B & Q grand-canonical
  [Vislavicius, Kalweit, 1610.03001]
- Describes trend for most yield ratios, but not ϕ
- What is the role of baryon and electric charge conservation?

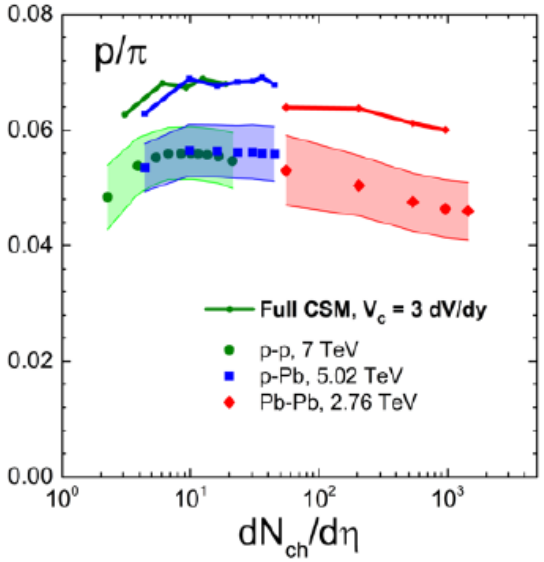
CSM at LHC: yield ratios to pions

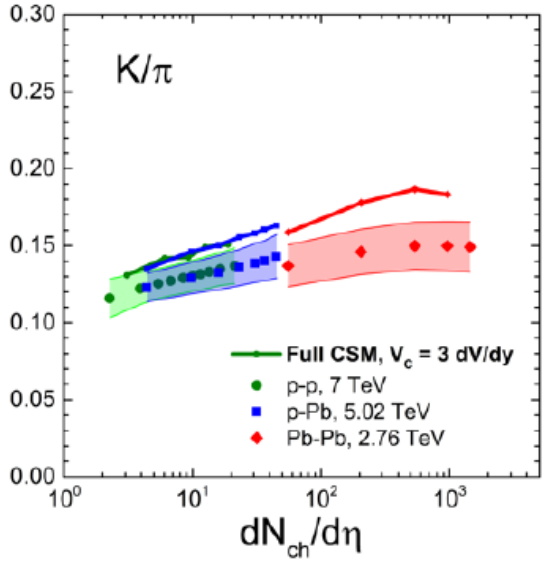
V_C dependence of yield ratios to pions

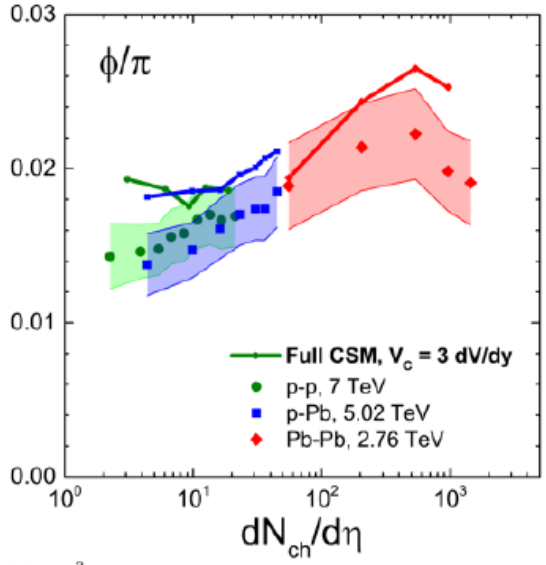


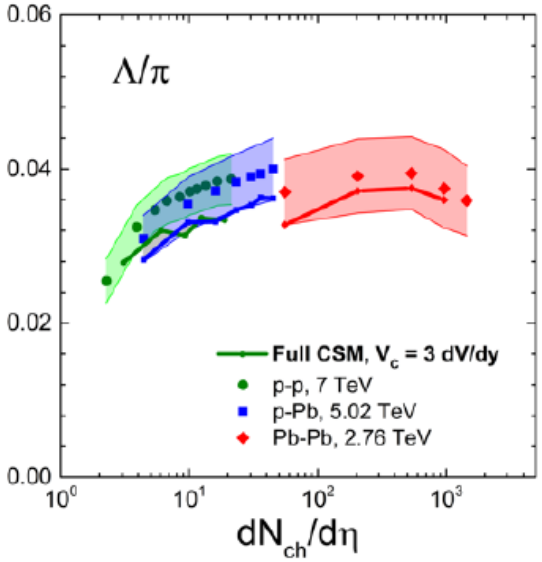
- SCE appropriate for K, Ω, Ξ, less so for Λ, totally off for p and ϕ
- Baryon-strangeness-CE appropriate for most observables, except ϕ/π and π
- In general, full canonical treatment of B,Q,S required

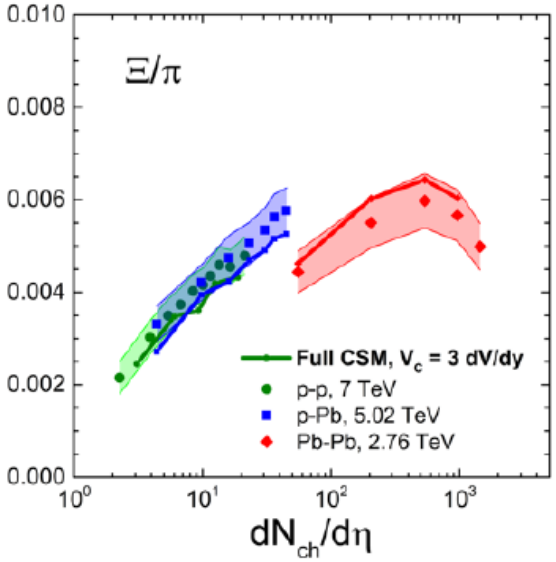
CSM at LHC: data description

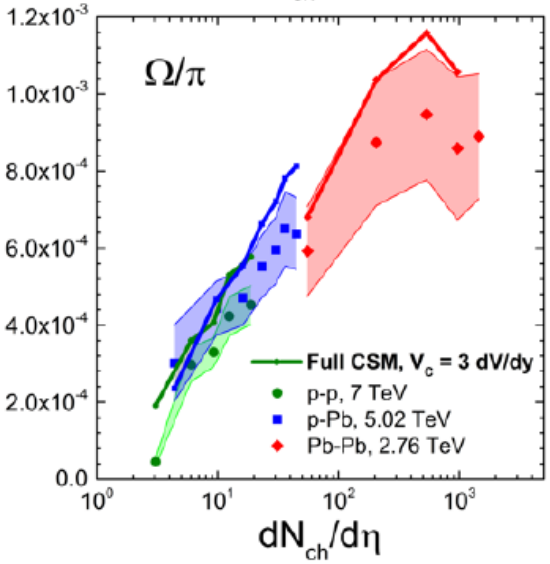




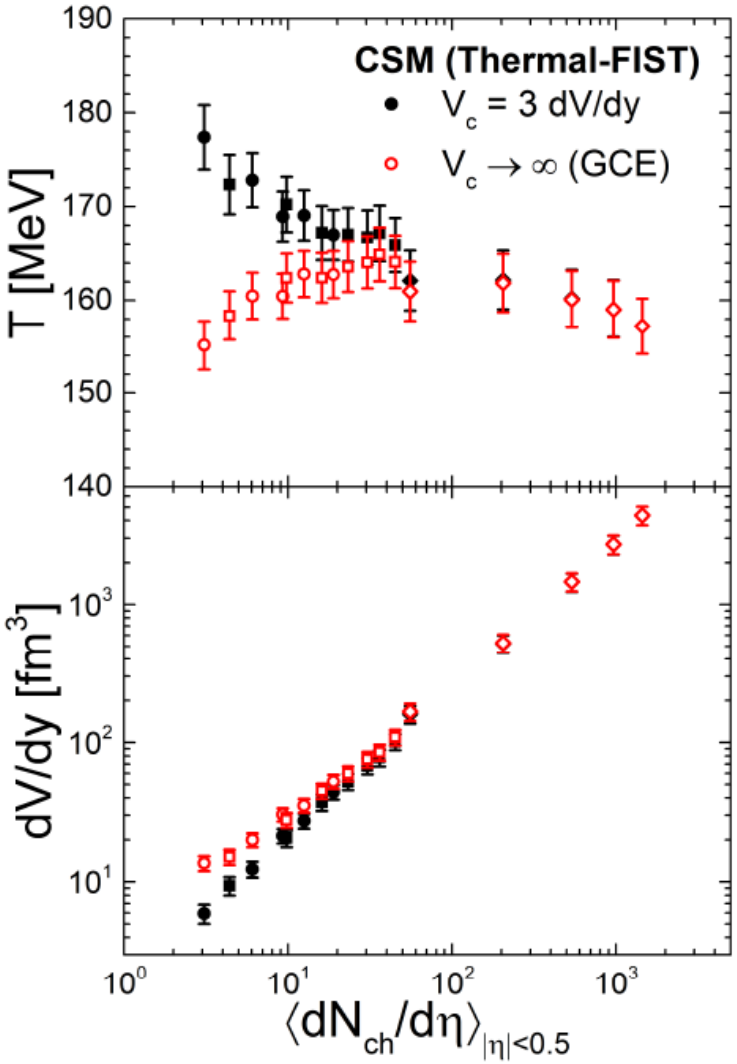


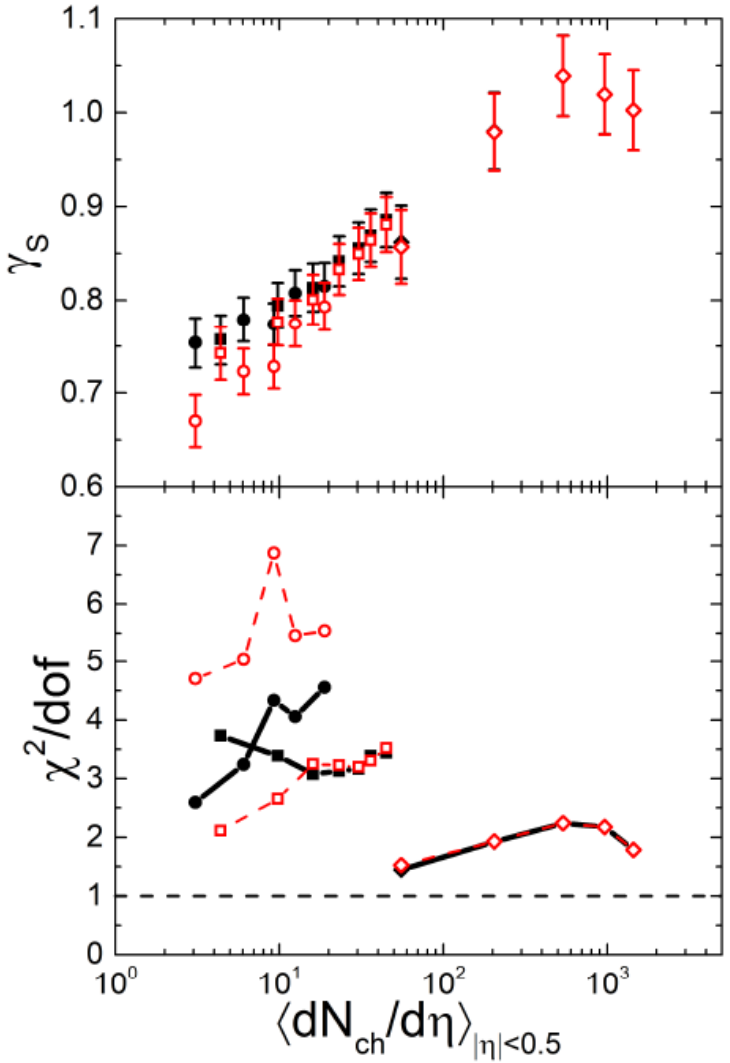






Full CSM: Extracted parameters





2^{nd} highlight:
V1 in p-Pb?

QUARK GLUON PLASMA DROPLETS WITH THREE DIFFERENT GEOMETRIES

T. Csörgő [1,2] and M. Csanád [3]
for the PHENIX Collaboration

[1] MTA Wigner FK, Budapest, Hungary
[2] EKE KRC, Gyöngyös, Hungary
[3] ELTE, Budapest, Hungary

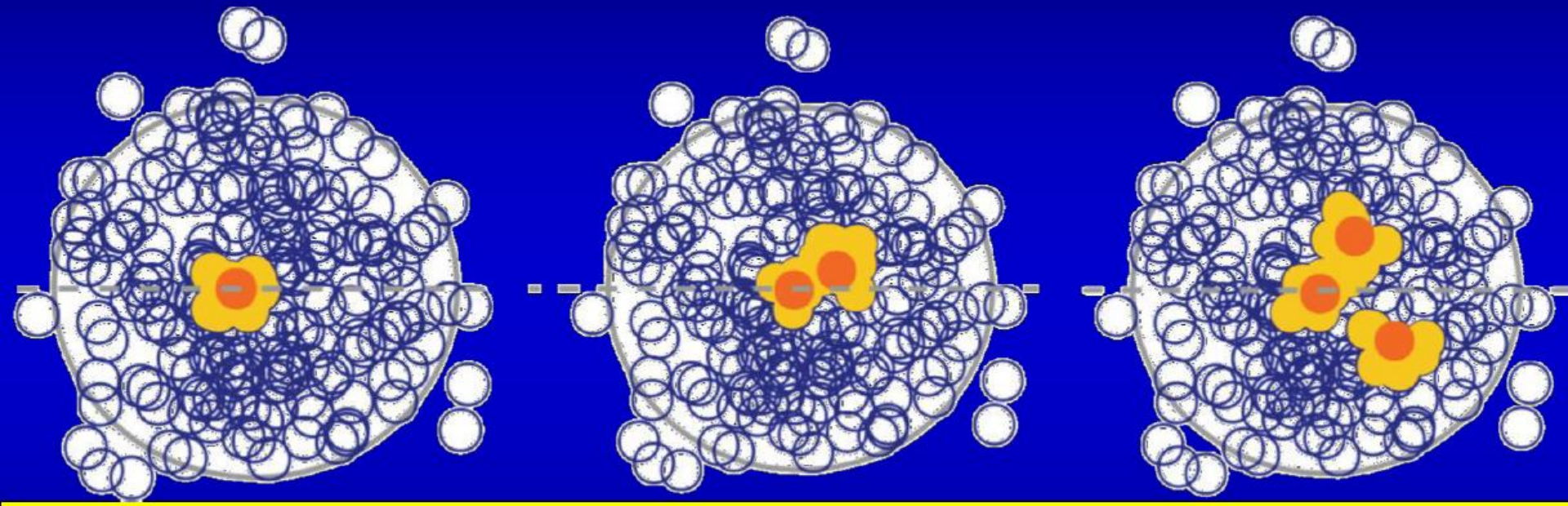
Based on: arXiv:1807.11928, PRL 121 (2018) 222301
arXiv:1805.02973, Nature Physics, v15 (2019) (3)

RHIC geometry scan
p/d/^{3}He+Au: v_2, v_3
Hydrodynamic predictions
CGC postdictions
QGP droplets engineered
Summary

Based on M. Csanád's PHENIX talk at Zimányi 2018, Sylvia Morrow's talk at DNP-JSPS18 talk and Xiao Qu's talk at WWND 2019

GEOMETRY SCAN: 3 DIFFERENT SHAPES

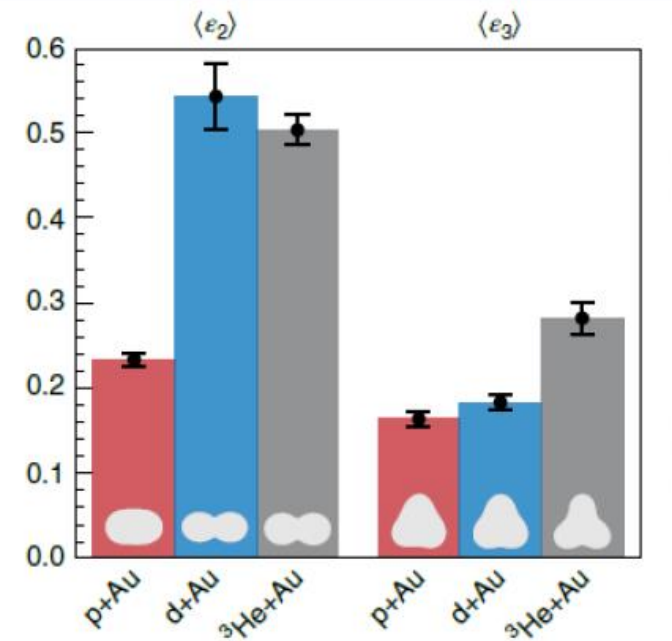
Is it hydrodynamics?



RHIC operations: versatility.
Geometry scan: p+Au, d+Au and ^{3}He+Au at $\sqrt{s}$ =200 GeV

p+Au	d+Au	^{3}He+Au
2015	2016	2014

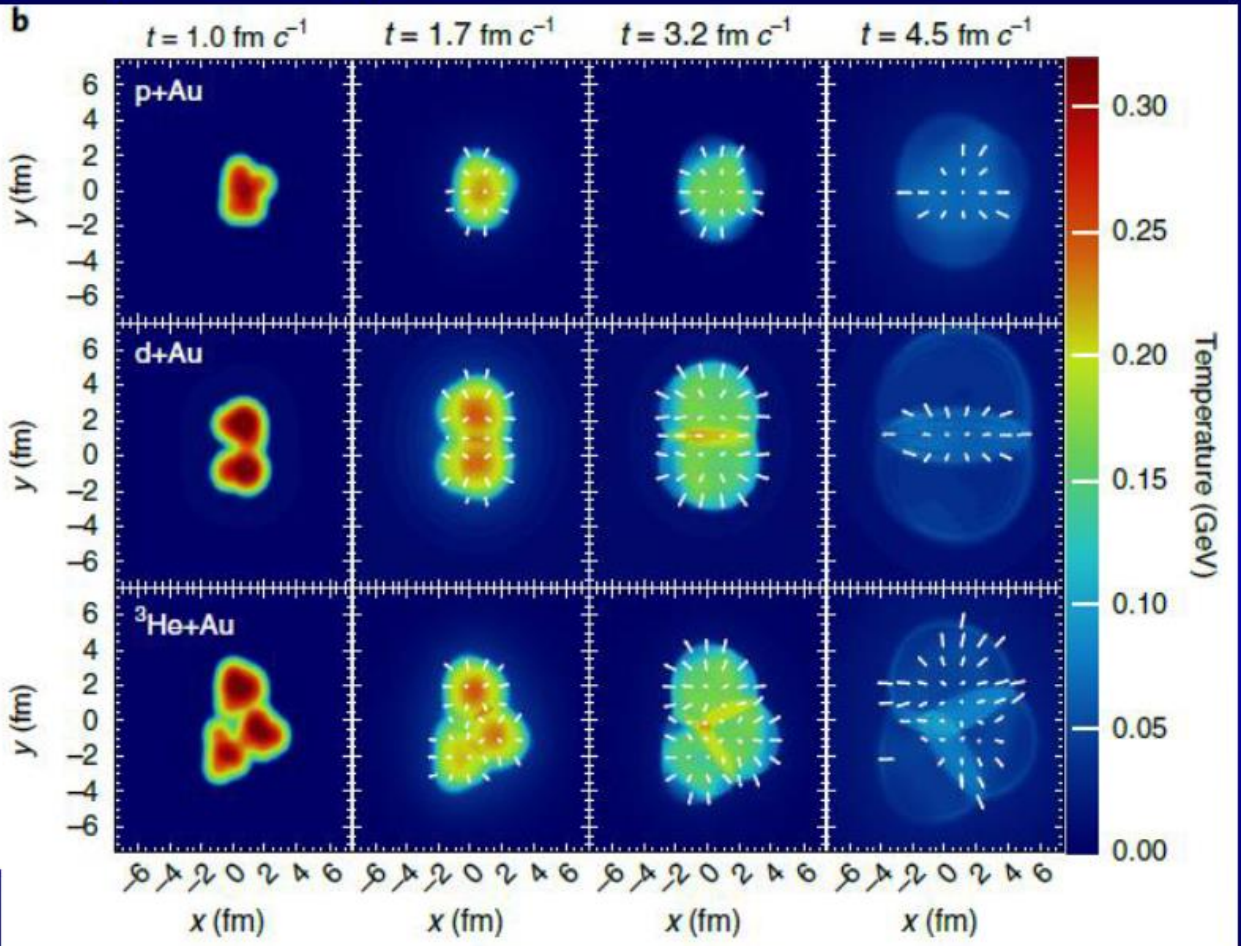
GEOMETRY SCAN: 3 DIFFERENT SHAPES
Is it hydrodynamics?



$$\varepsilon_2^{p+\mathrm{Au}} < \varepsilon_2^{d+\mathrm{Au}} \approx \varepsilon_2^{^3\mathrm{He}+\mathrm{Au}}$$

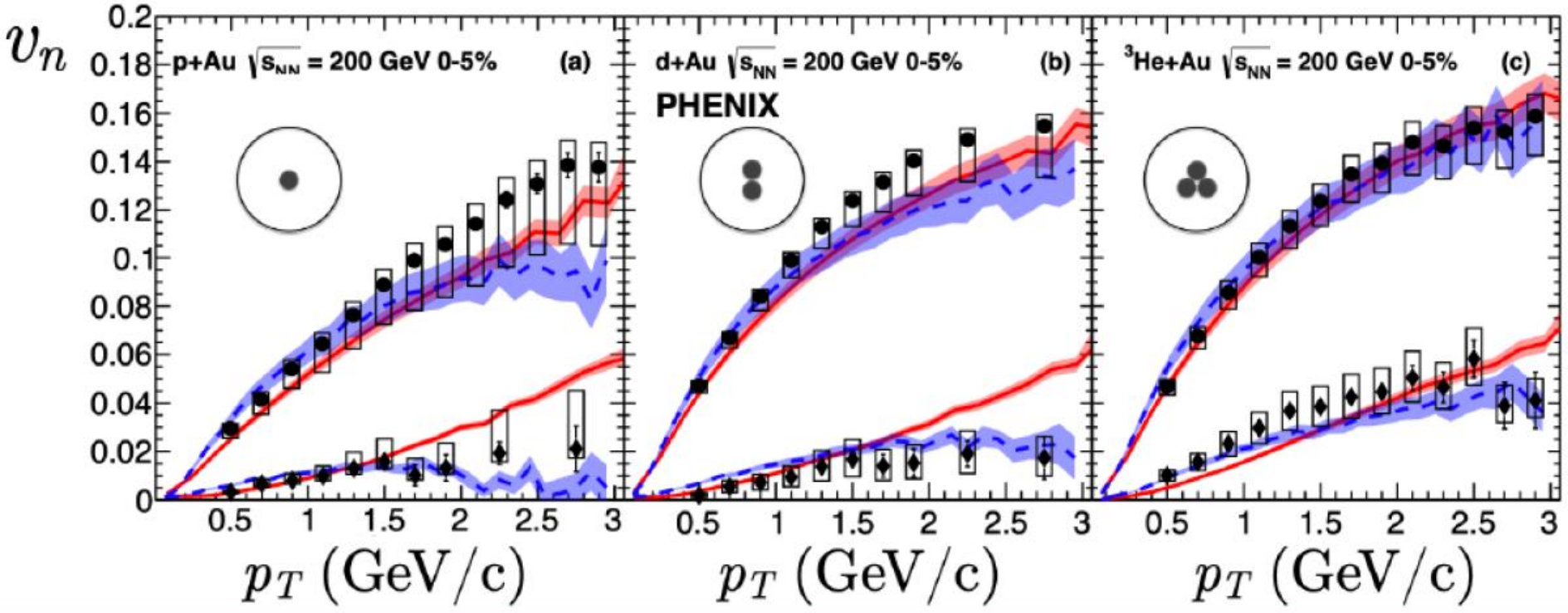
$$\varepsilon_3^{p+\mathrm{Au}} \approx \varepsilon_3^{d+\mathrm{Au}} < \varepsilon_3^{^3\mathrm{He}+\mathrm{Au}}$$

$$\varepsilon_n = \frac{\sqrt{\langle r^n \cos(n\phi)\rangle^2 + \langle r^n \sin(n\phi)\rangle^2}}{\langle r^n \rangle}$$



Hydrodynamics (SONIC, lQCD EoS, 1+2d):
Different initial geometry /energy deposition translated by ∇p
to *different* final state momentum space correlations

GEOMETRY SCAN VS HYDRO PREDICTIONS

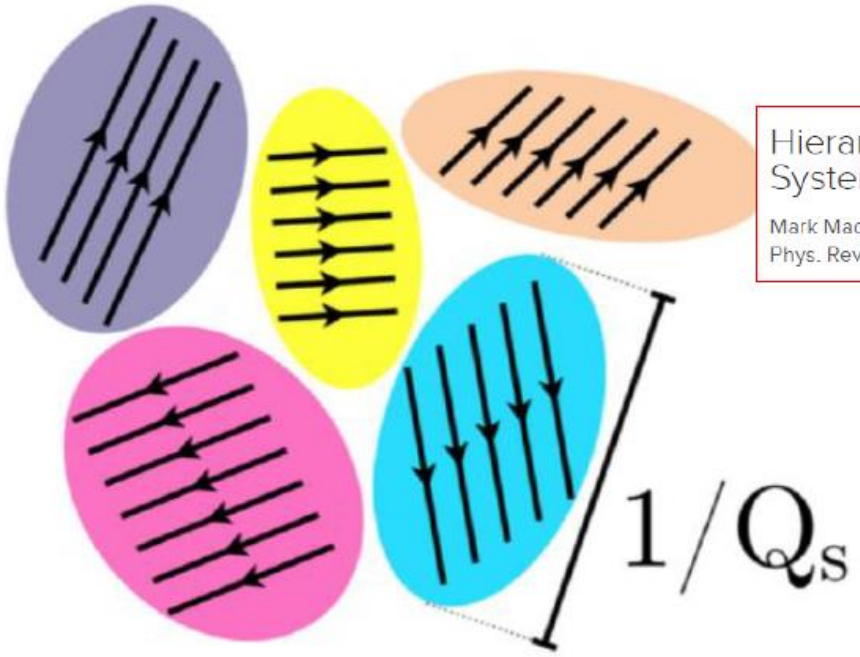


- v_2 Data
- v_3 Data
- v_n SONIC *Eur. Phys. J. C 75, 15 (2015)*
- v_n iEBE-VISHNU *PRC 95, 014906 (2017)*

- Both use η/s=0.08, MC Glauber initial conditions, 2+1D viscous hydrodynamic evolution
- Different hadronic rescattering packages

v_2, v_3 : Data within syst errors quantitatively consistent with *2 different* detailed hydro model predictions: SONIC/iEBE-VISHNU

ALTERNATIVE EXPLANATION: SATURATION?



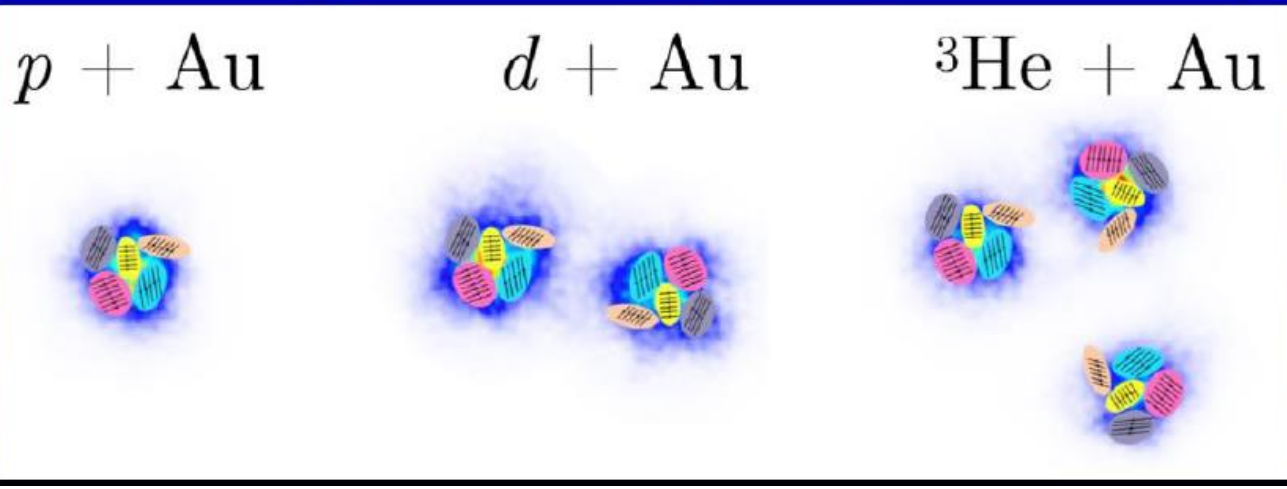
https://arxiv.org/abs/1805.09342 (MSTV)

Hierarchy of Azimuthal Anisotropy Harmonics in Collisions of Small Systems from the Color Glass Condensate

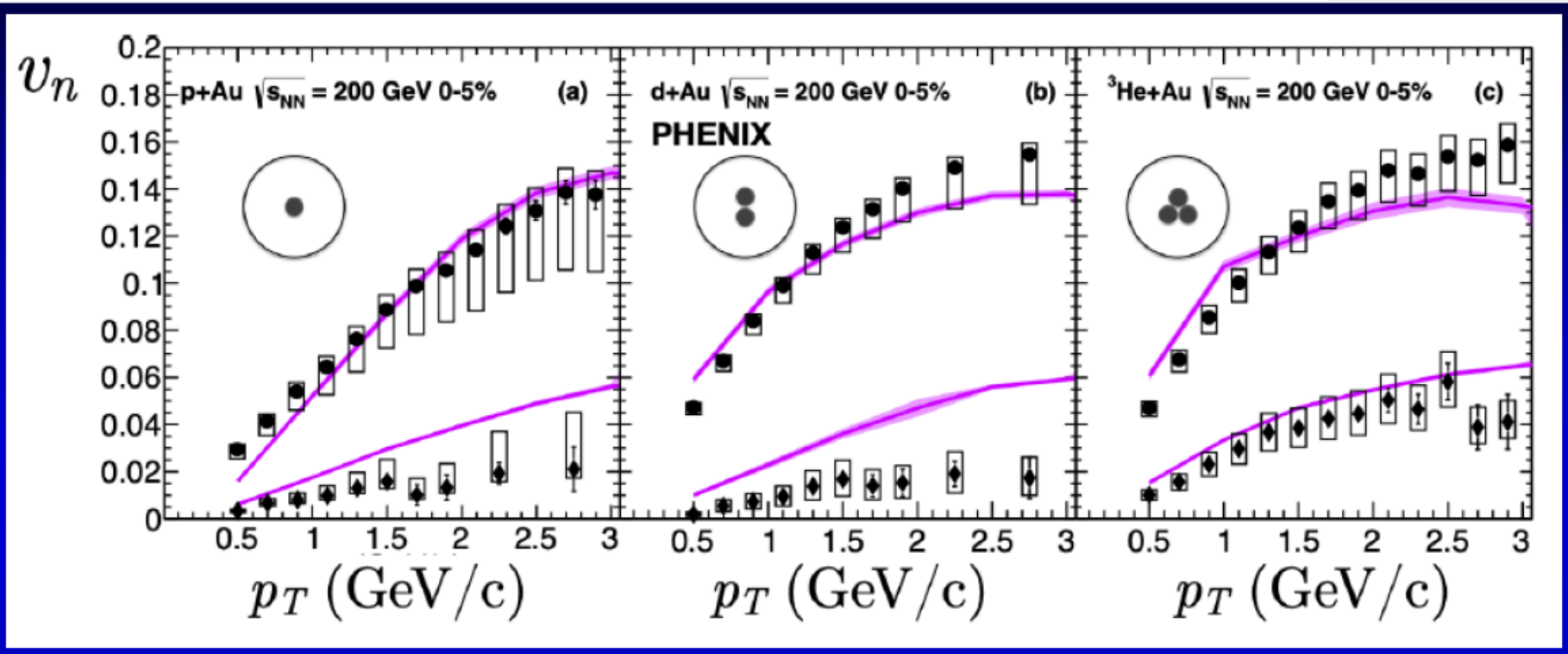
Mark Mace, Vladimir V. Skokov, Prithwish Tribedy, and Raju Venugopalan
Phys. Rev. Lett. **121**, 052301 – Published 31 July 2018

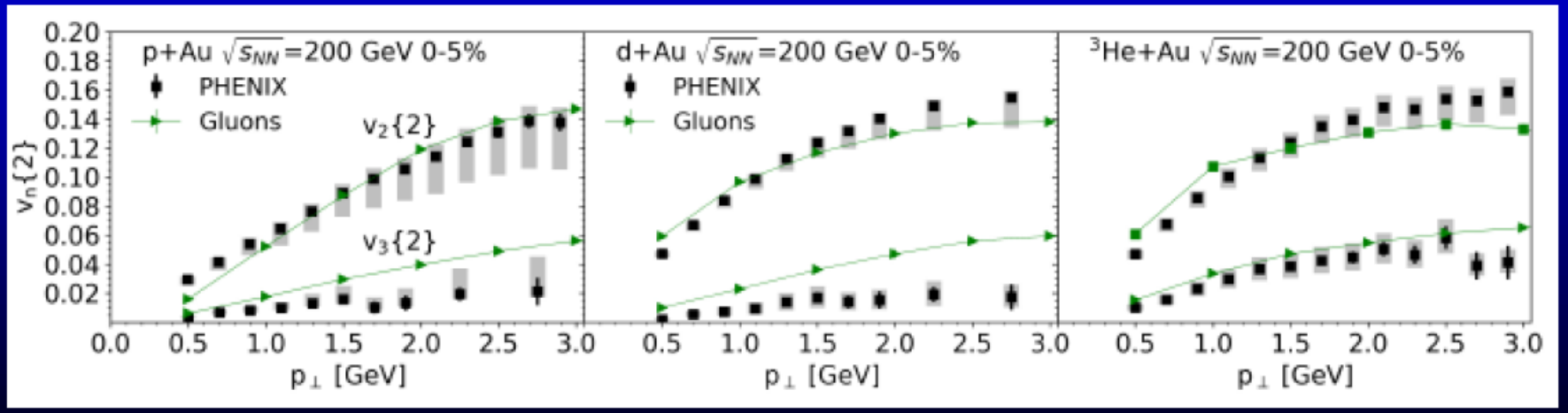
$$v_n^{p+\mathrm{Au}} > v_n^{d+\mathrm{Au}} > v_n^{^3\mathrm{He}+\mathrm{Au}}$$

Domains not resolved individually
Q_s (deuteron) > Q_s (proton) (Q_s = saturation scale)



GEOMETRY SCAN VS MSTV CGC SATURATION





COST Workshop on
Interplay of hard and soft QCD probes
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Lund, Sweden
25 February – 1 March 2019

Influence of the electromagnetic fields on hadronic observables in proton-induced collisions

Lucia Oliva

Collaborators: Elena Bratkovskaya, Wolfgang Cassing, Pierre Moreau, Olga Soloveva, Taesoo Song

PHSD

GSI Helmholtzzentrum für Schwerionenforschung GmbH

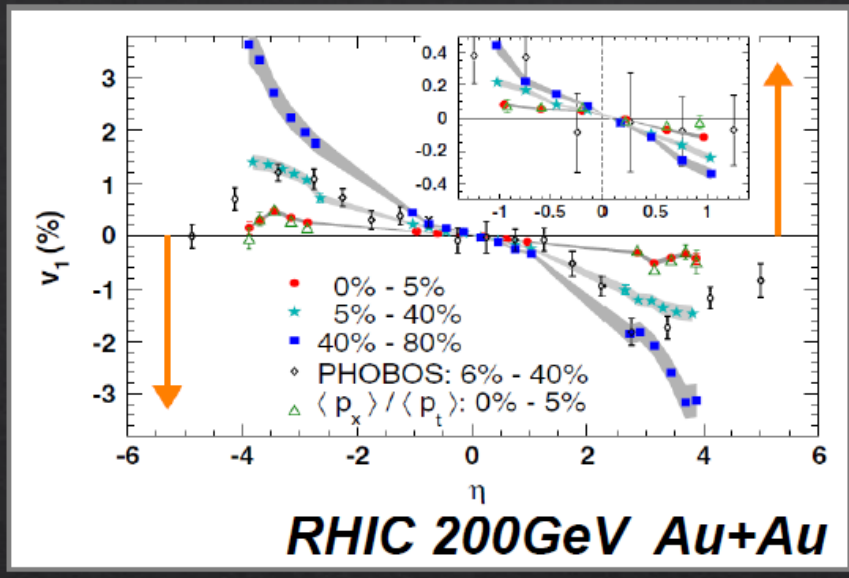
GOETHE UNIVERSITÄT FRANKFURT AM MAIN

p+Au collisions @ RHIC 200 GeV

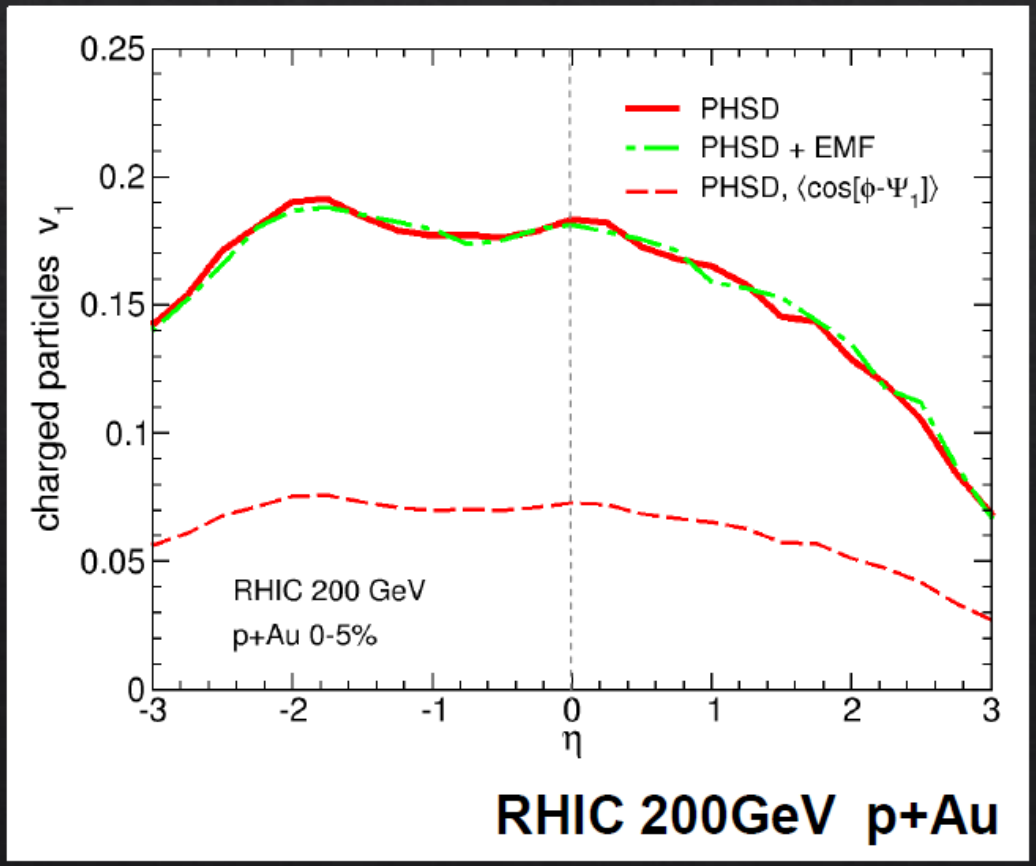
PRELIMINARY

pseudorapidity dependence of the DIRECTED FLOW OF CHARGED PARTICLES

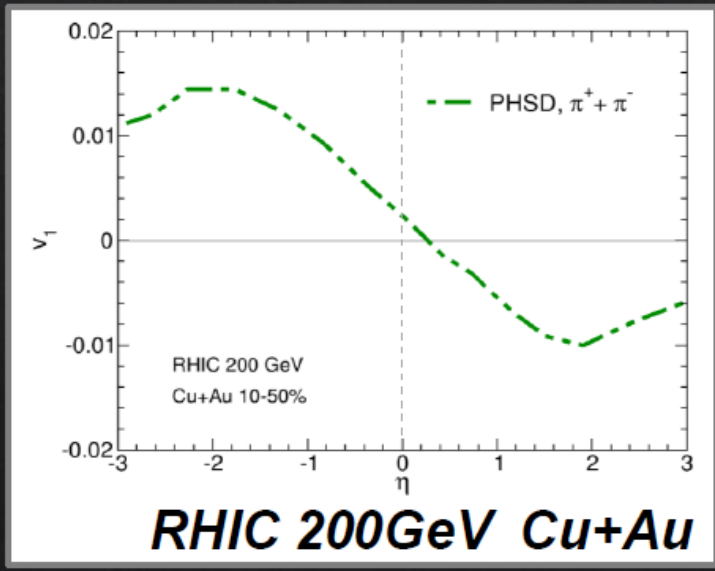
STAR Collaboration, PRL 101 (2008) 252301



RHIC 200GeV Au+Au



RHIC 200GeV p+Au



RHIC 200GeV Cu+Au

Voronyuk *et al.*, PRC 90 (2014) 064903

Toneev *et al.*, PRC 95 (2017) 034911

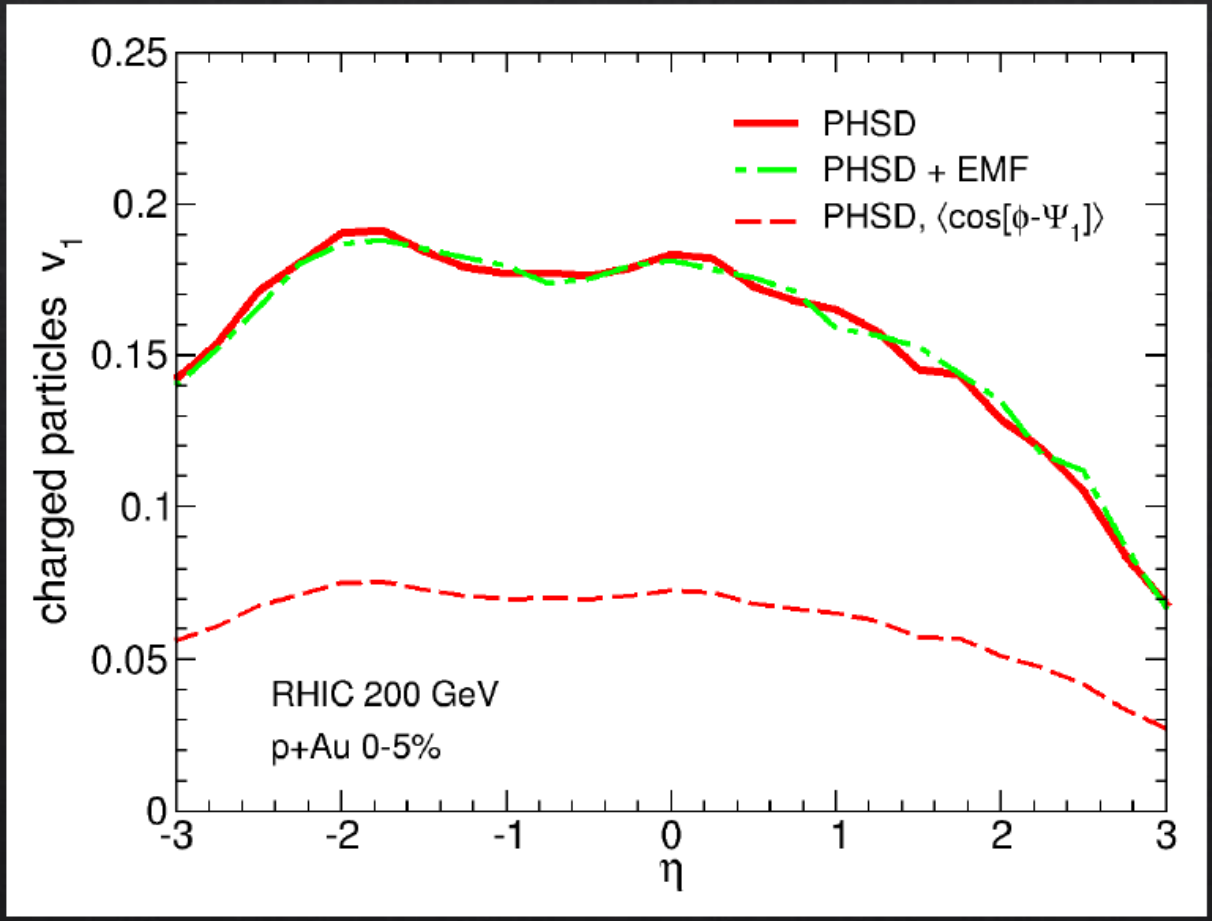
p+Au collisions @ RHIC 200 GeV

PRELIMINARY

pseudorapidity dependence of the DIRECTED FLOW OF CHARGED PARTICLES

$$v_1(\eta) = \frac{\langle \cos[\varphi(\eta) - \Psi_1] \rangle}{Res(\Psi_1)}$$

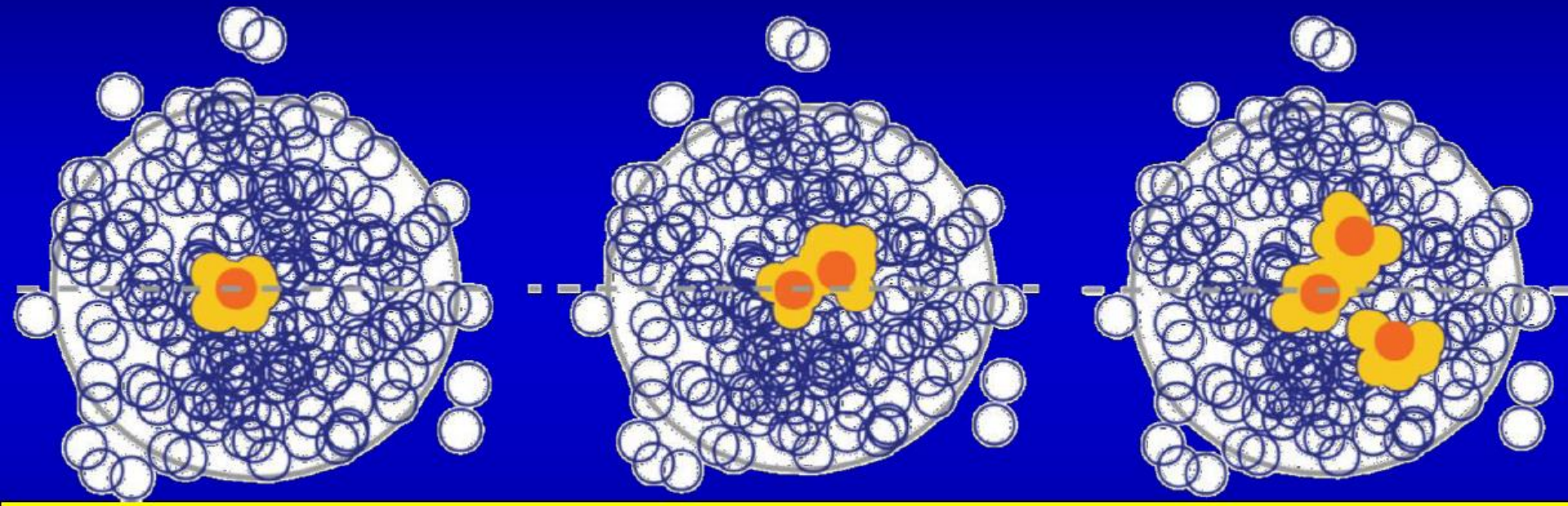
Event-plane angle in $-4 < \eta < -3$:
$Res(\Psi_1^{PHSD}) = 0.397$



- Magnitude correlated with the determination of the reaction plane
- Stronger with respect to heavy ion collisions
- mainly due to initial-state fluctuations
- probably no effect of vorticity

GEOMETRY SCAN: 3 DIFFERENT SHAPES

Is it hydrodynamics?



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2015	2016	2014

Is v1 a CGC killer?

- It seems there should be an e1 for semi-central p-Pb collisions
  - Could be checked
- But how would it manifest itself?
  - It is clear that Sum pTvec = 0 so how can I built up a global v1 asymmetry?
- I would be curious to look at this with someone else

3rd highlight
Ropes vs QGP in dense systems

- A comment from Elena BRATKOVSKAYA
- Dense Angantyr: strings -> ropes => struing tension increases
- QGP on lattice: dense QCD matter string tension decreases due to screening