Exploiting intrinsic triangular geometry in relativistic He3+Au collisions to disentangle medium properties

J. Nagle, P. Romatschke

Based on arXiv:1312.4565 by

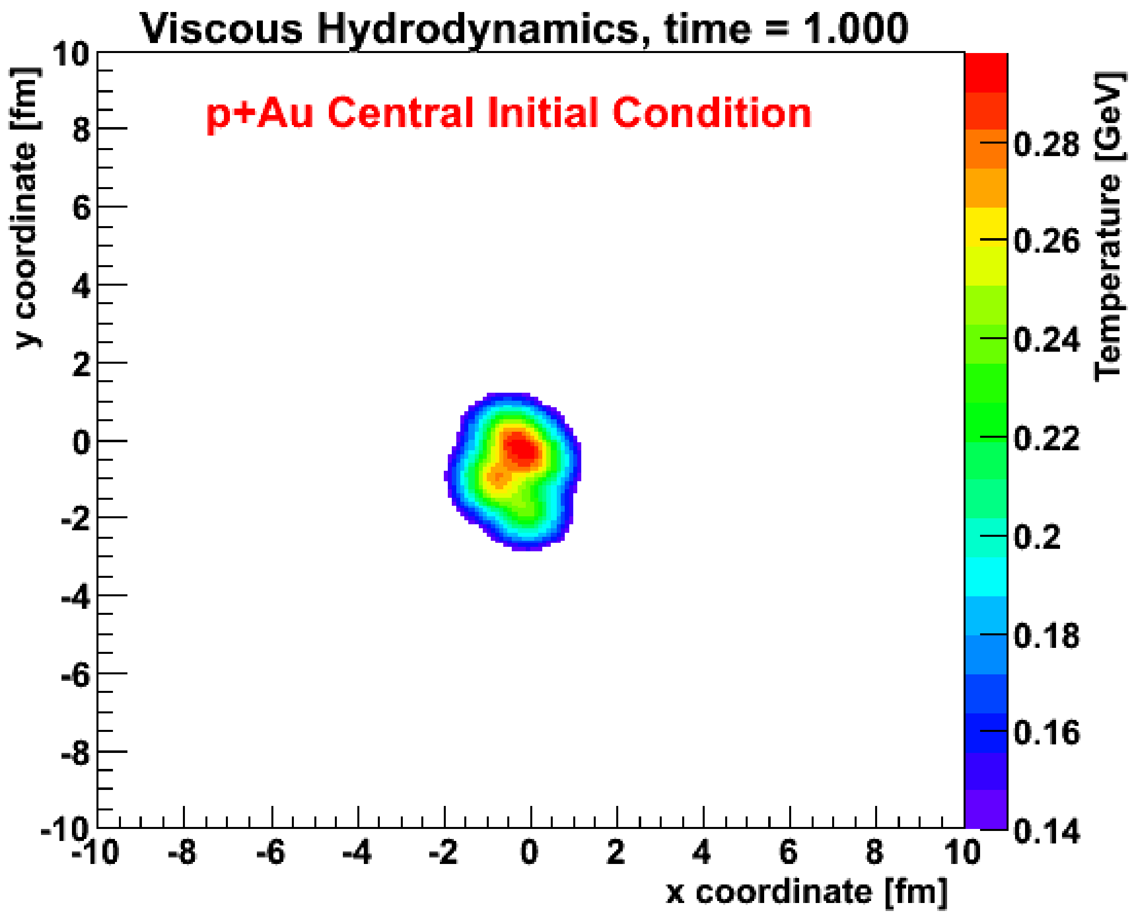
J. Nagle, A. Adare, S. Beckman, T. Koblesky, J. Orjuela Koop, D. McGlinchey, P. Romatschke, J. Carlson, J. Lynn, M. McCumber

Initial geometry in pA,dA and He^3A

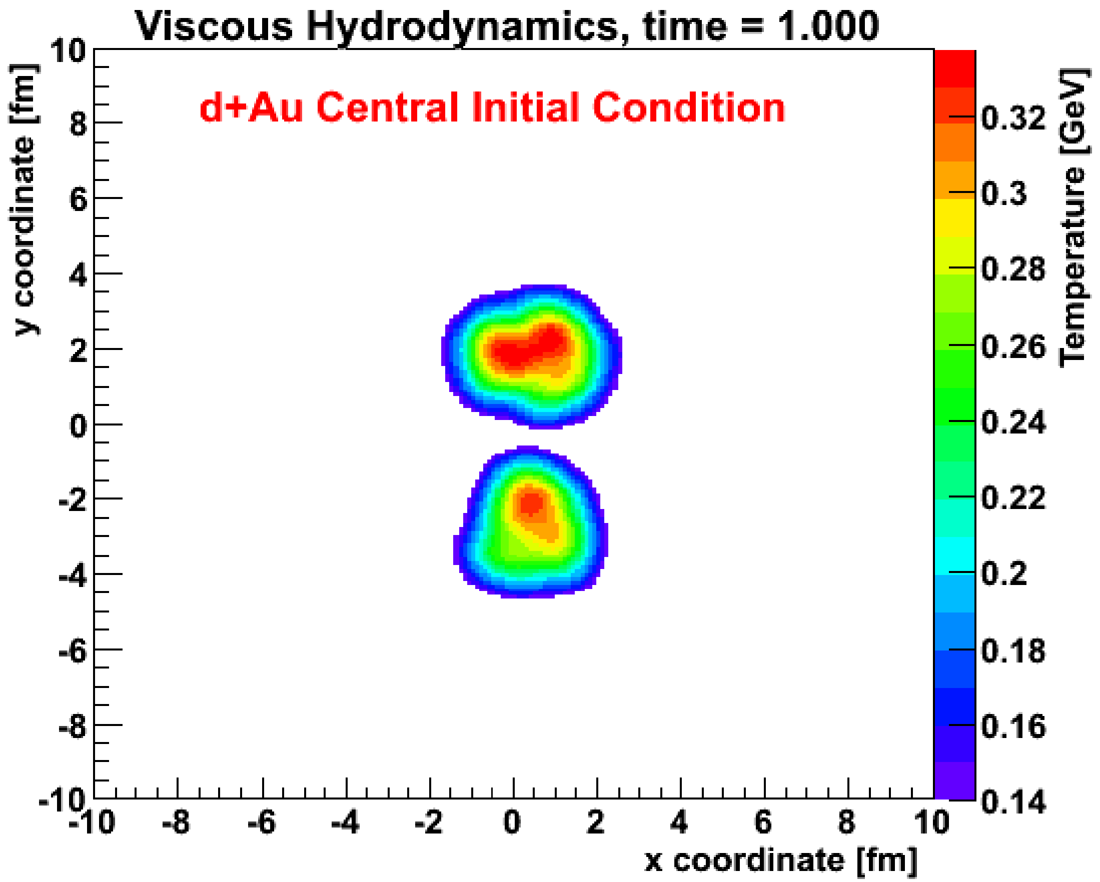
- Use Glauber model for position of nucleons for A
- Use Hulten/GFMC wavefunction to obtain nucleon positions for d and He^3

  GFMC:[Carlson & Schiavilla, 1998]
- Calculate position of participating nucleons
- Each participating nucleon deposits energy in form of a Gaussian with width σ=0.4 fm

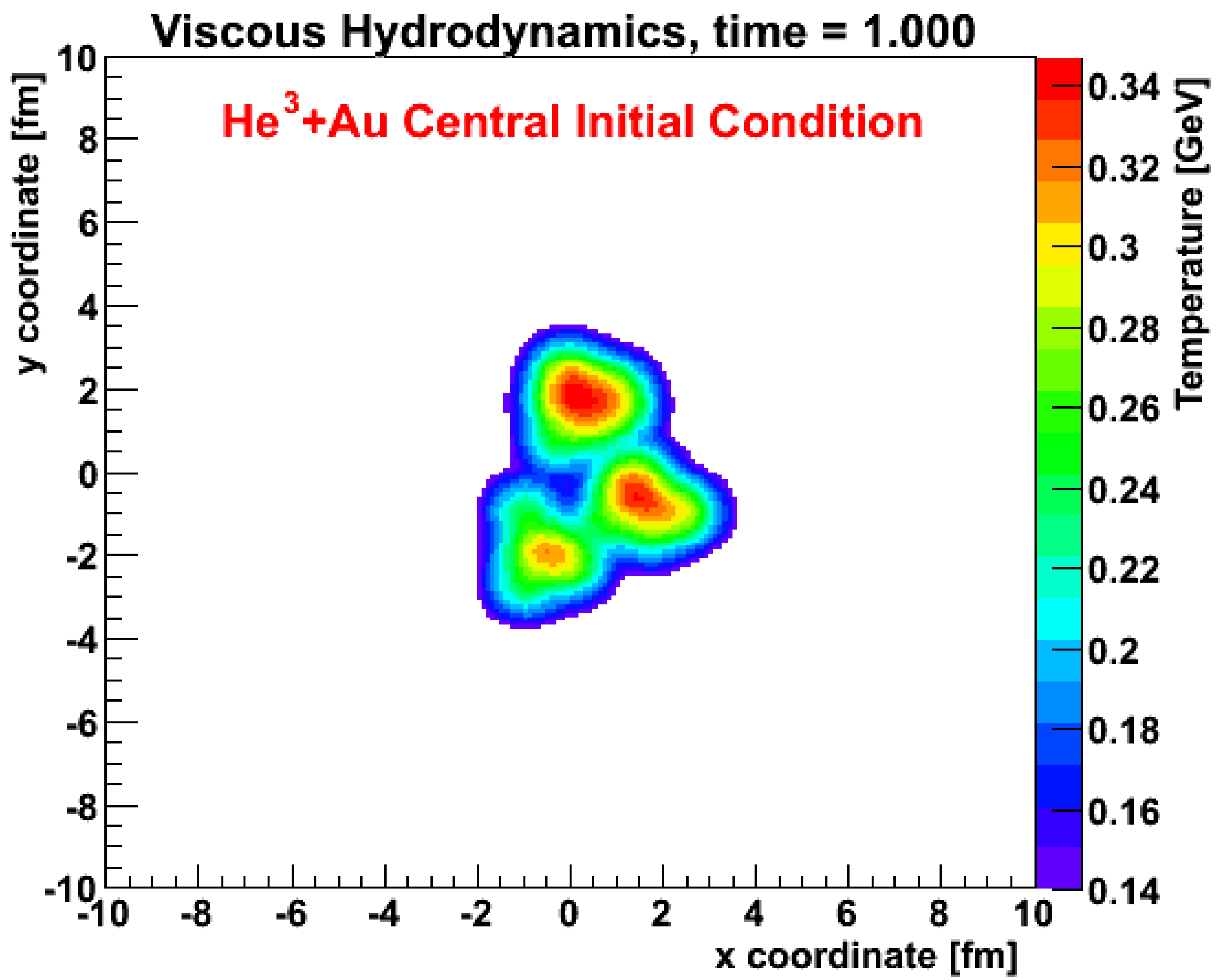
Initial geometry in pA,dA and He^3A



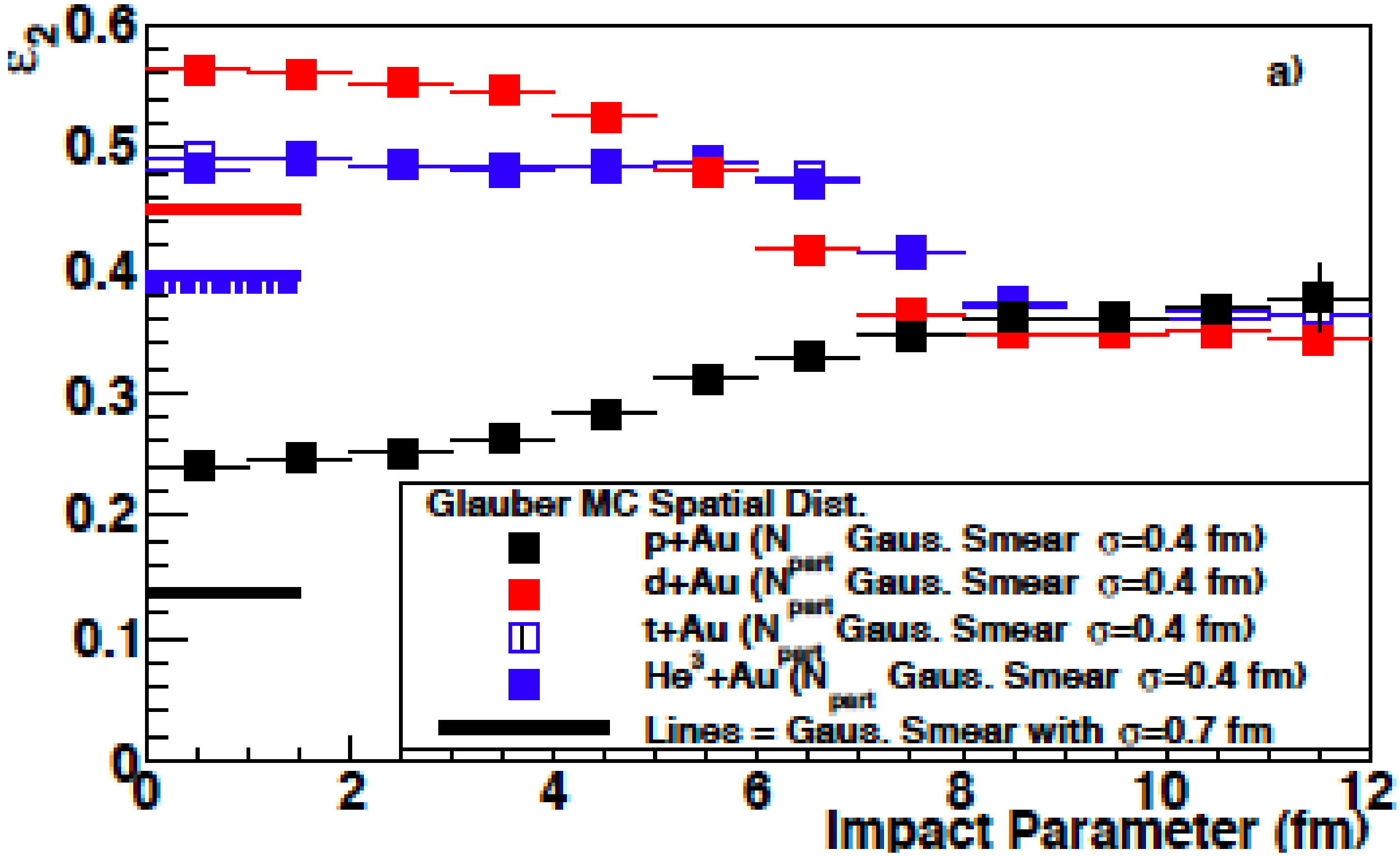
Initial geometry in pA,dA and He^3A



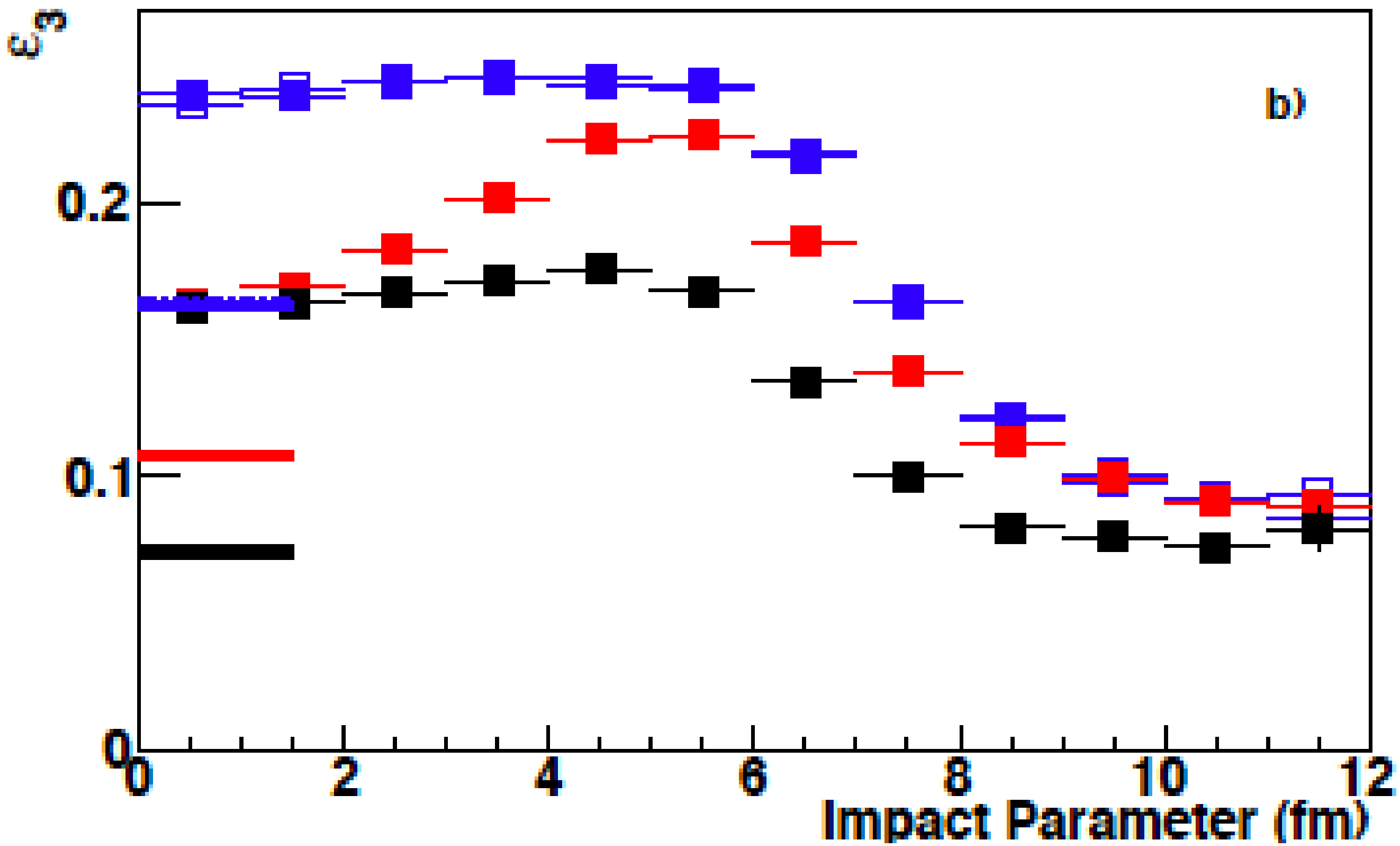
Initial geometry in pA,dA and He^3A



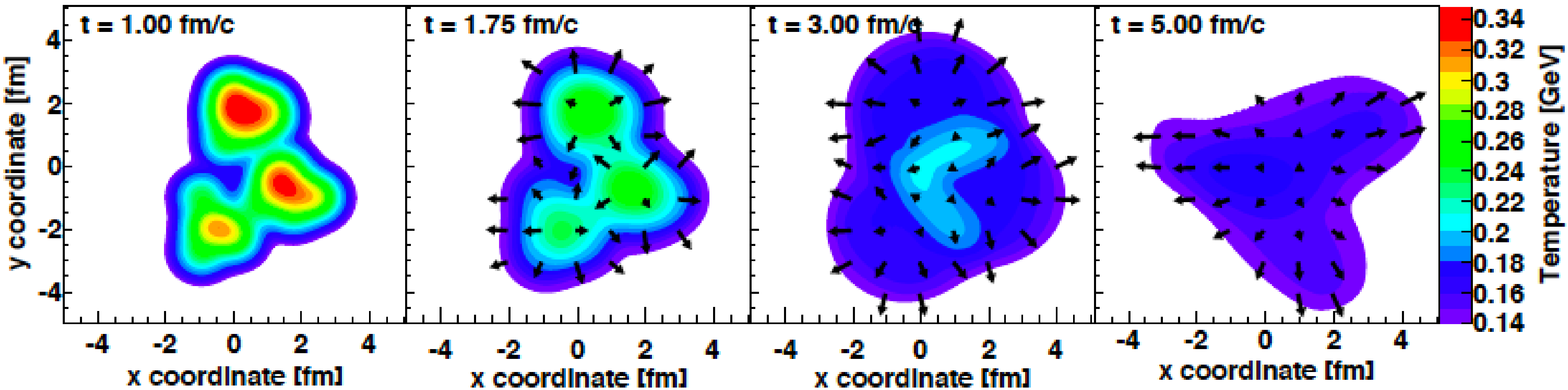
ε_2 in pA,dA and He^3A



ε_3 in pA,dA and He^{3}A



Spatial to Momentum Conversion via viscous hydro



Standard viscous hydro (vh2+1, Luzum/Romatschke); well tested

Primordial pions,

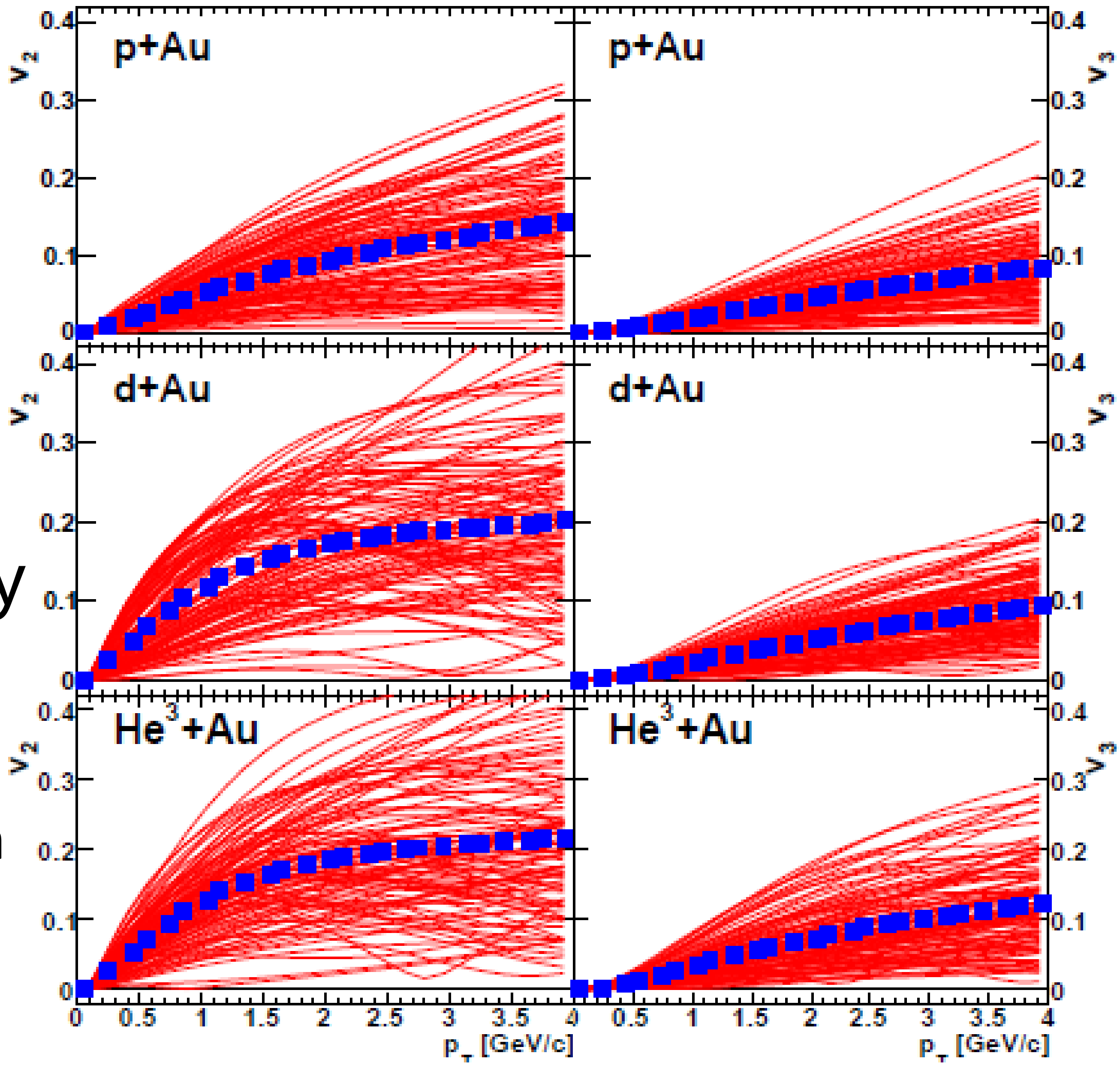
pure hydro,

$\eta/s=1/4\pi$

τ_0=1 fm/c

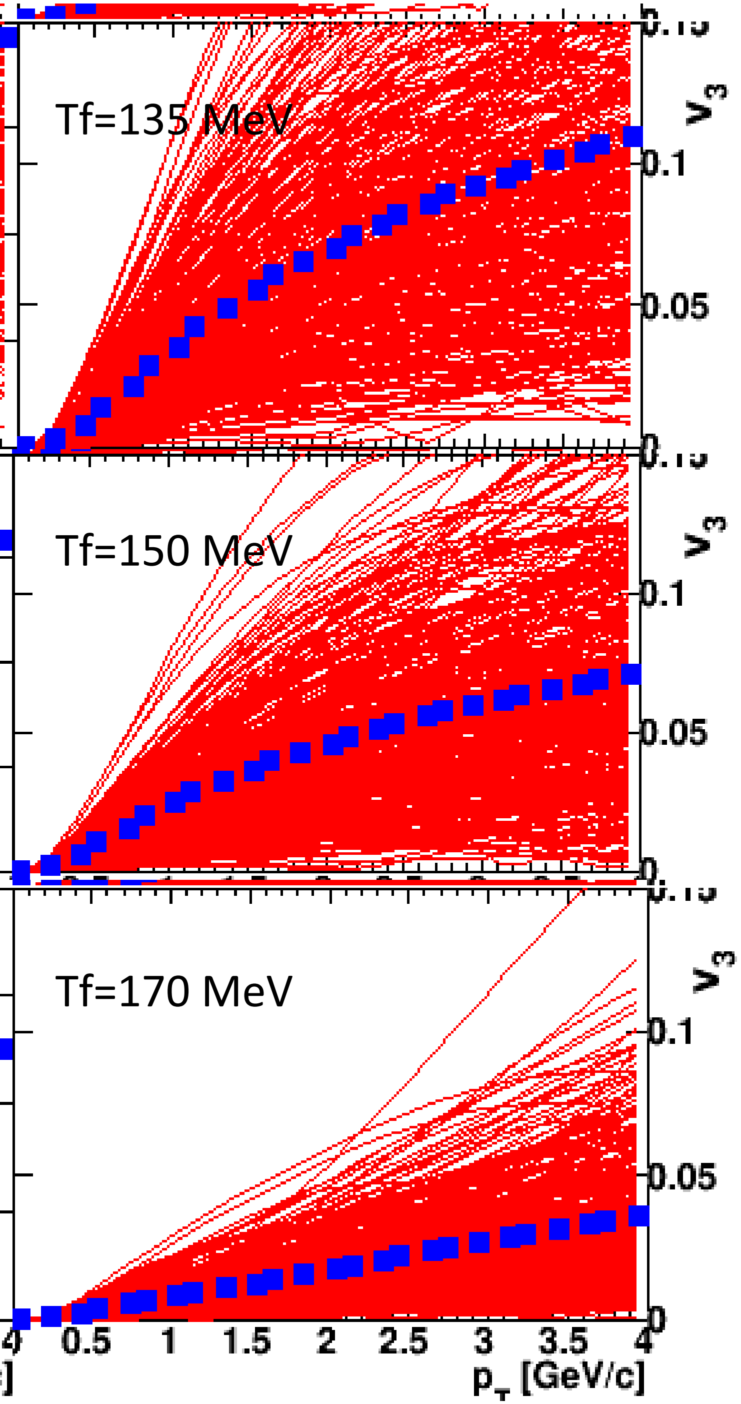
T_F=150 MeV,

high multiplicity



consistent with P. Bozek's results

arXiv:1312.4565



He3 + Au

Strong T_F dependence of v_3 in pure hydro: if system does not live long enough, triangularity not translated into v3

Try to remediate by running hadron cascade after hydro (with Tf=170 MeV transition)

Finding: cascade does not boost the v3 much (large η/s!)

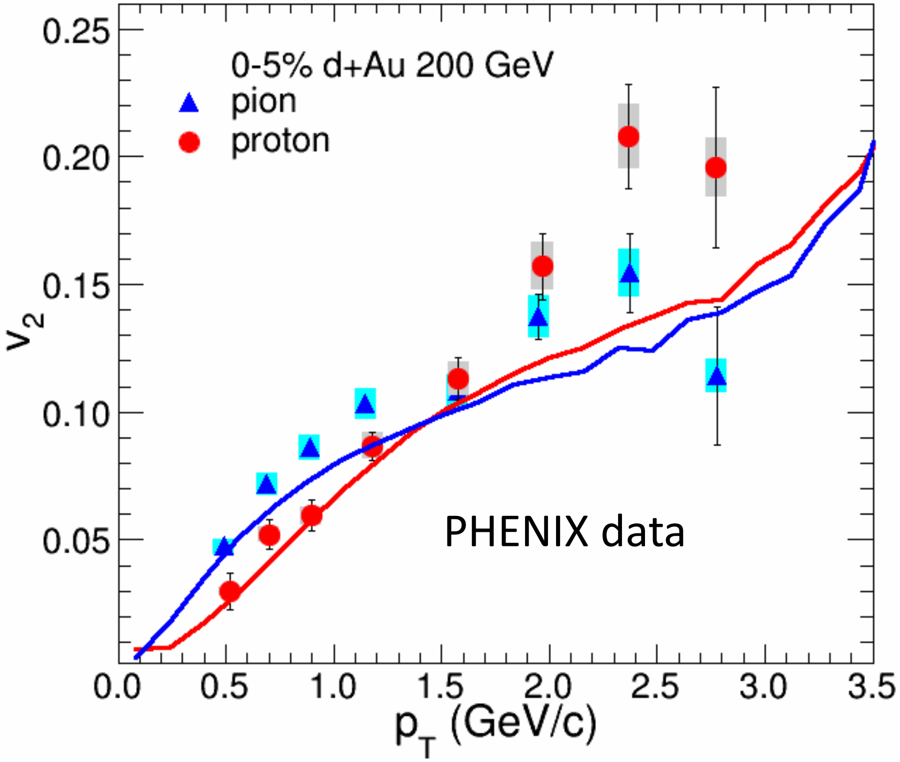
System does not have enough time, expect small (but measureable) v3 values!

Hydro+cascade model vs. data

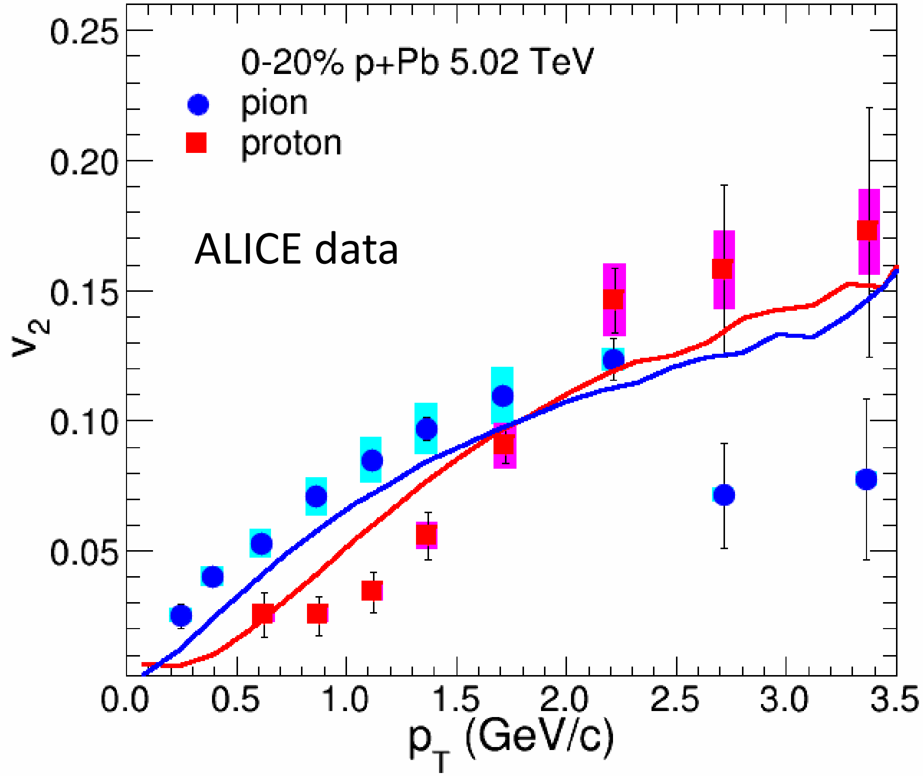
Using **hydro η/s=1/4π, τ0=0.5fm/c, <u>Tfreeze = 170 MeV</u>, then cascade** and the right initial energy deposited, we get reasonable d+Au (RHIC) and p+Pb (LHC) v2 results.

All other groups run pure hydro

RHIC d+Au

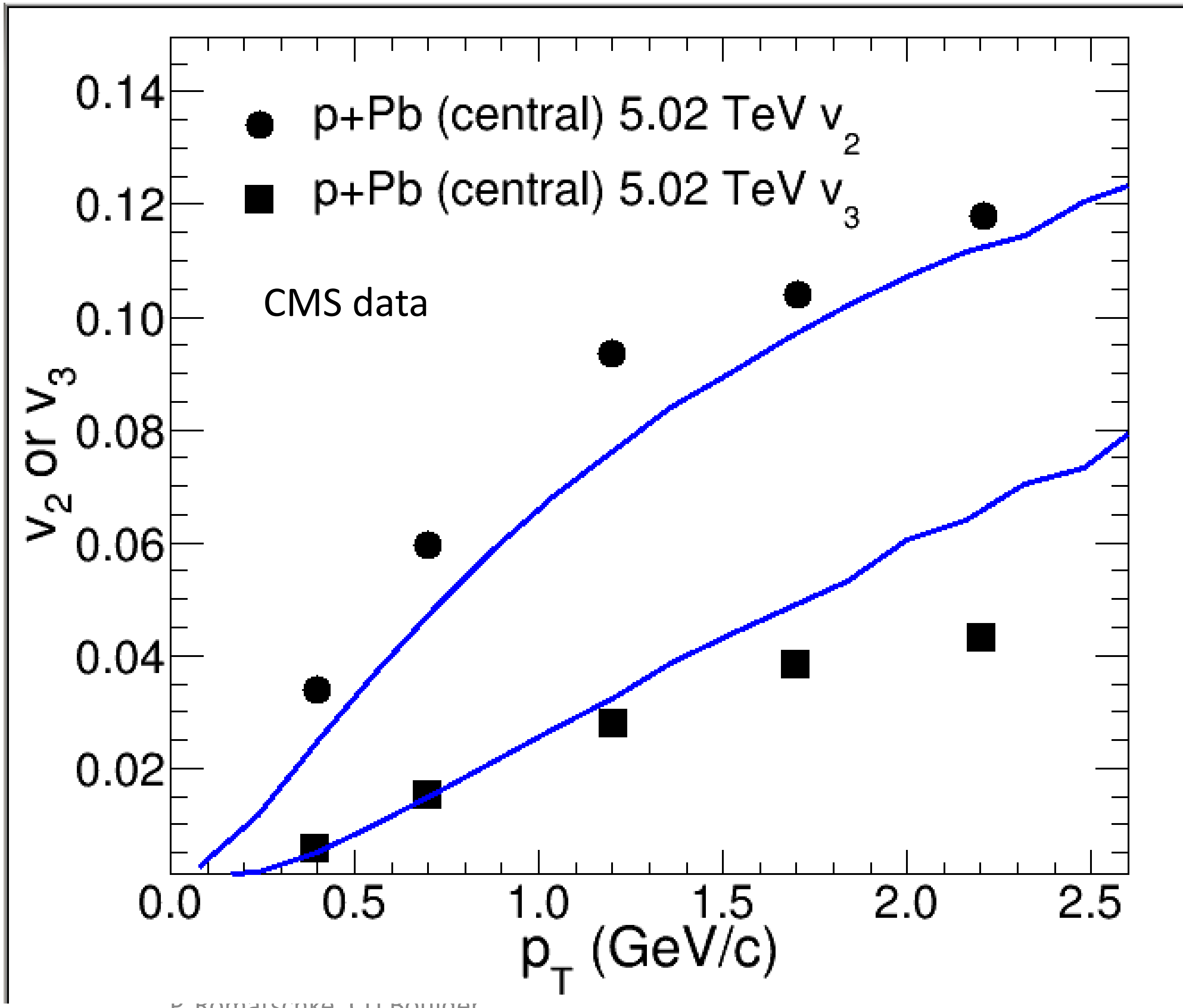


LHC p+Pb



Hydro+cascade model vs. data

Model gives reasonable agreement with LHC v2 and v3 data for p+Pb

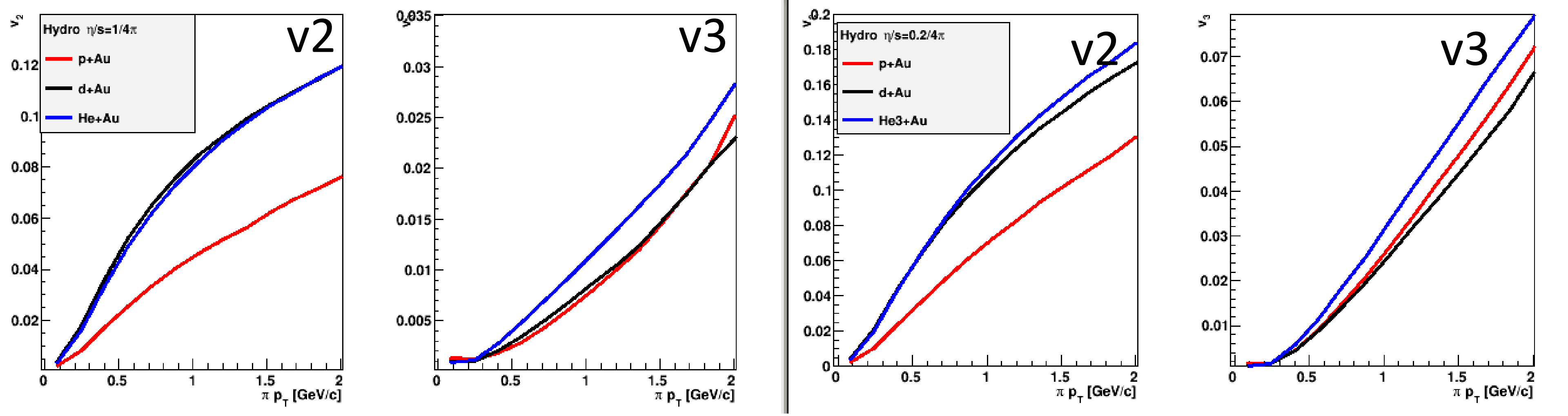


Note: IP-Glasma+MUSIC does not!

Full viscous hydro (T_F=170 MeV) + hadronic cascade

Now for He3+Au, d+Au, p+Au

Hydro $\eta/s = 1/4\pi$ Hydro $\eta/s = 0.2/4\pi$



Ordering between systems is preserved, but the v_3 values are smaller than in the original arXiv paper where hydrodynamics was run down to T_{fo} = 150 MeV

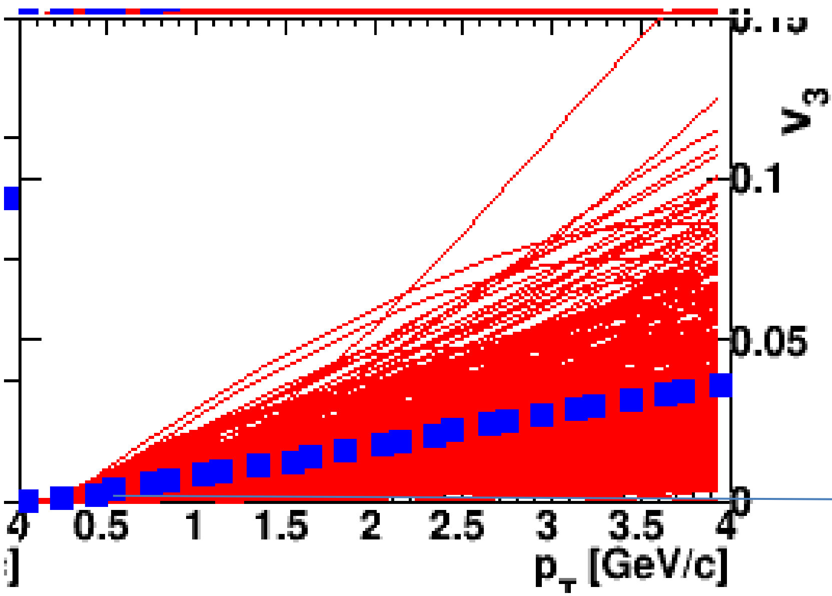
For $\eta/s=1/4\pi$, He3+Au v_3 at p_T=2GeV is 3% instead of original 7% (in pure hydro from arXiv)

Boosting v3: ultra-central

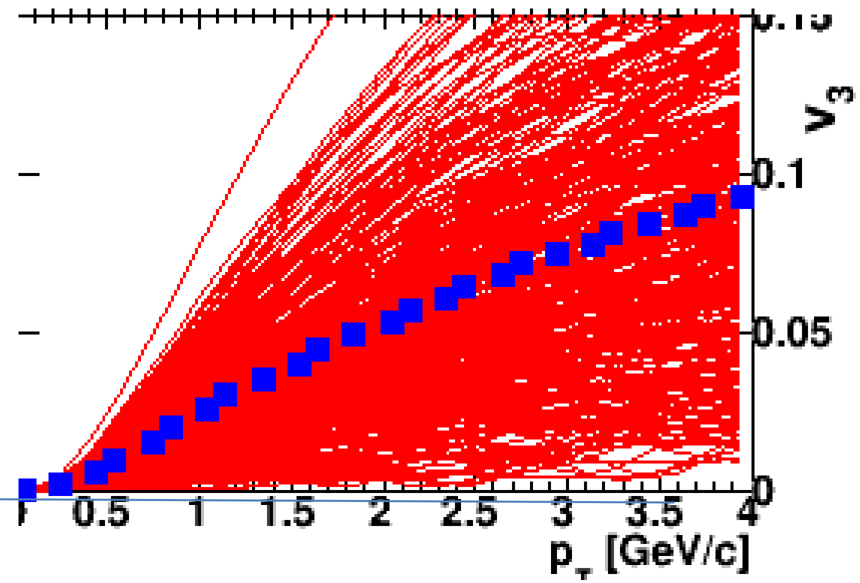
Instead of selecting on most central 5% He3+Au, select on top 1%

Pure hydrodynamic results for He3+Au with T_{fo} = 170 MeV:

0-5% He^3+Au Central

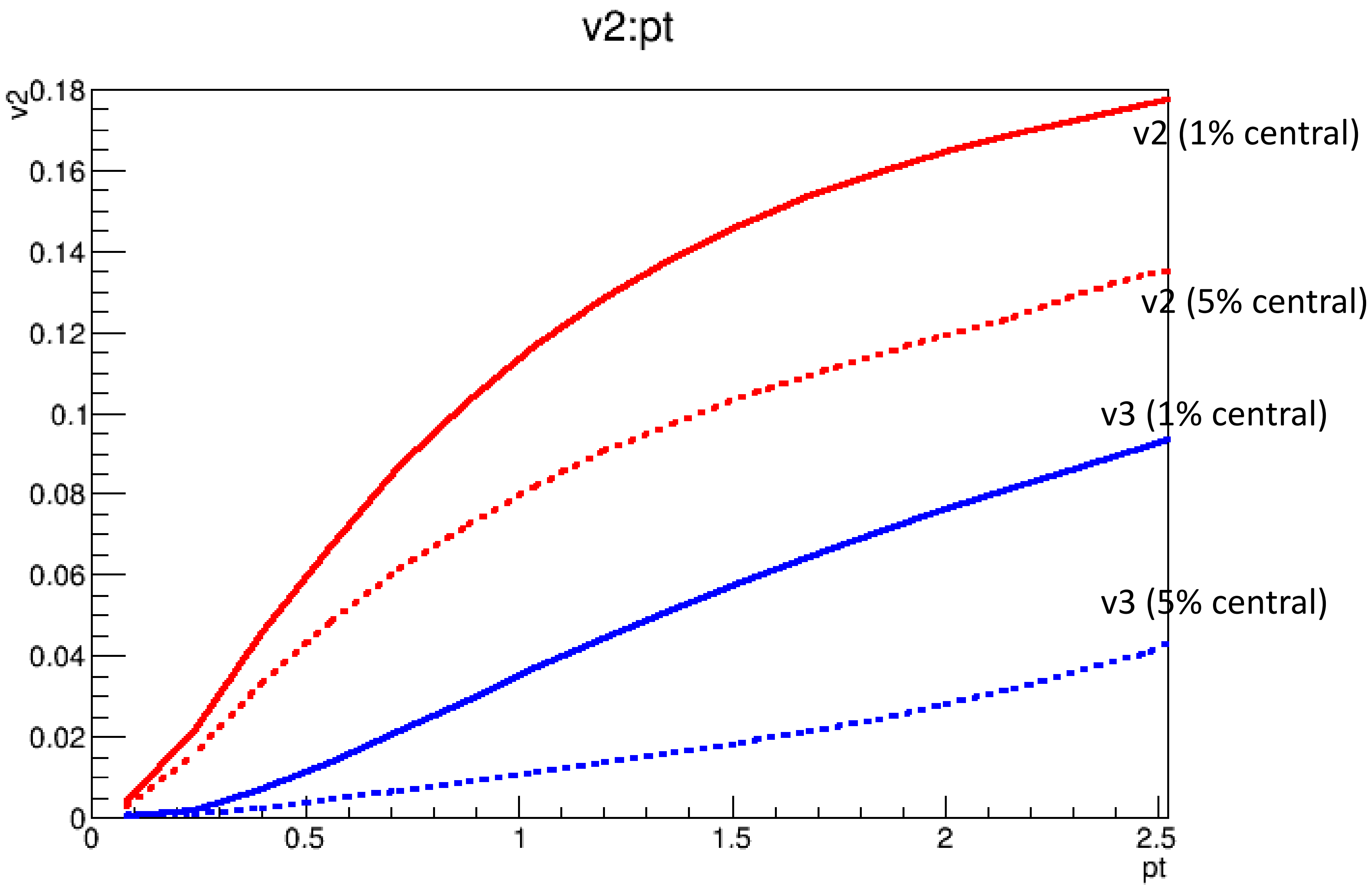


0-1% He^3+Au Central



More than doubling of v3 (interesting to check experimentally).

Hydro + Cascade He3+Au



Conclusions

- Small systems flow if hot enough (‘high’ dN/dY)
- Hydro models strained, signals of hydro breaking down?
- Comparing p+A, d+A and He^3+A may help unfold initial state/medium ambiguities
- He^3+A maybe at the end of Run-14 @ RHIC (next month?)

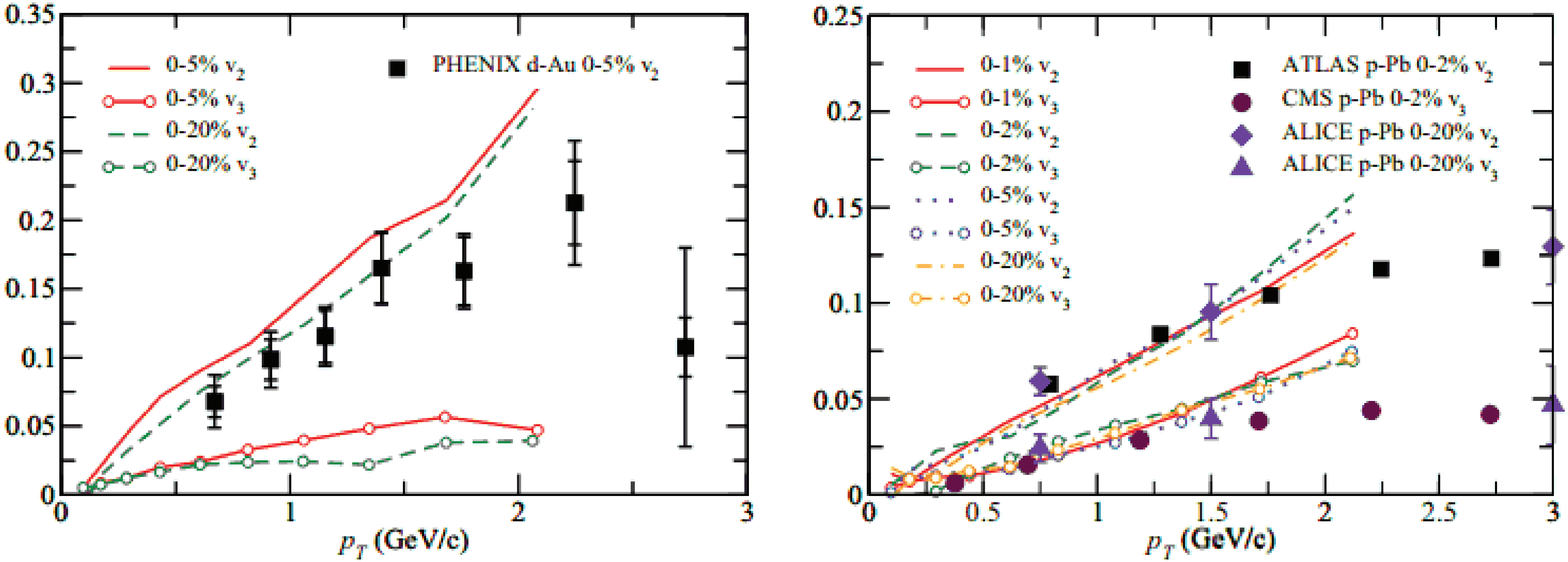
Bonus Material

Details cascade

- Written by S. Pratt
- All resonances in PDB (masses < 2.2 GeV)
- Switching temperature T=170 MeV (too high?)
- Implements decays under strong force

Flow not only in high dN/dY

Ideal hydro with multi. flucts. & pre-equilibrium flow (Qin and Müller, PRC89 (2014) 044902 (2014))



From U. Heinz's talk @ ECT* 2014