Light Nuclei v_1 and v_2 in Au+Au Collisions at $\sqrt{s_{NN}}$ = 3 GeV from STAR

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Outline

I. Introduction

II. STAR fixed-target experiment and light nuclei identification

III. Results and discussions

IV. Summary

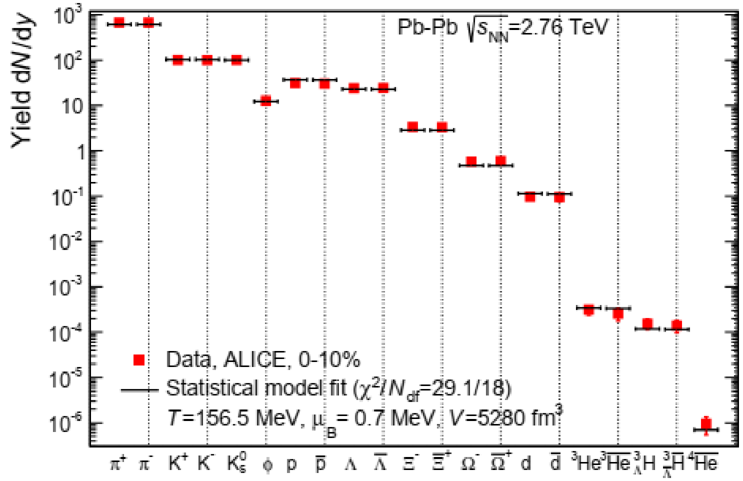
Light nuclei in heavy-ion collisions

Light nuclei : nucleon-nucleon correlation

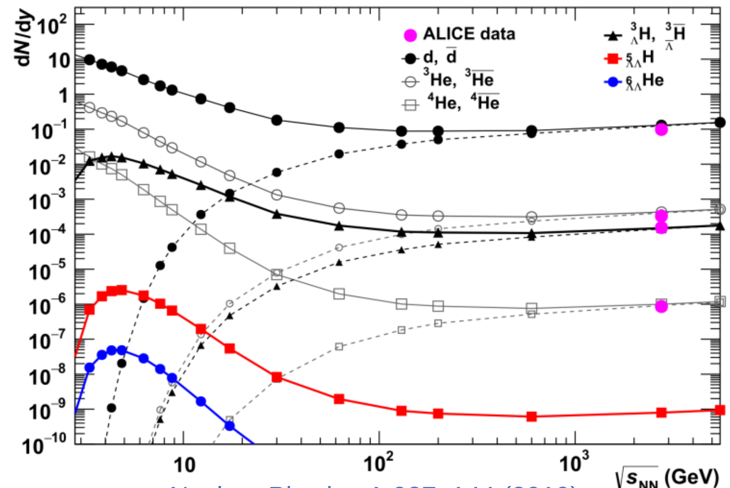
affecting the chemical composition, thermodynamical properties

When and how are light nuclei formed in heavy-ion collisions?

Thermal model Formed early (before chemical freeze-out).



arXiv:1611.01347(2016)



Nuclear Physics A 987, 144 (2019)

Coalescence model Combination of nucleons with close position and momentum.

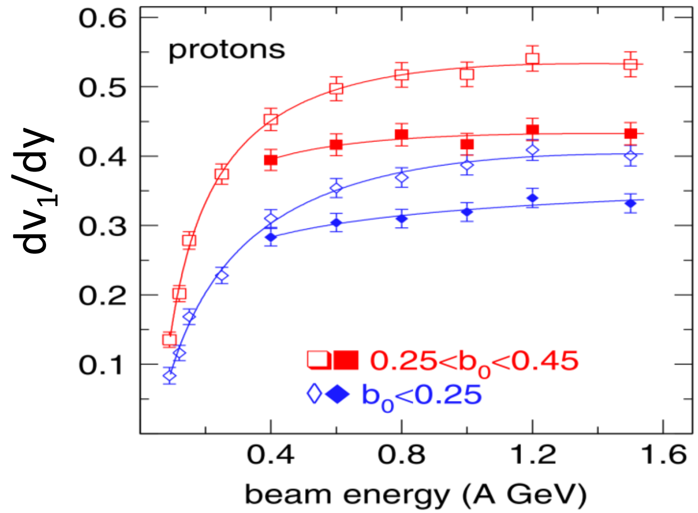
Atomic mass number scaling of collective flow v_n : $v_n^A(p_T, y) \approx A v_n^p\left(\frac{p_T}{A}, y\right)$

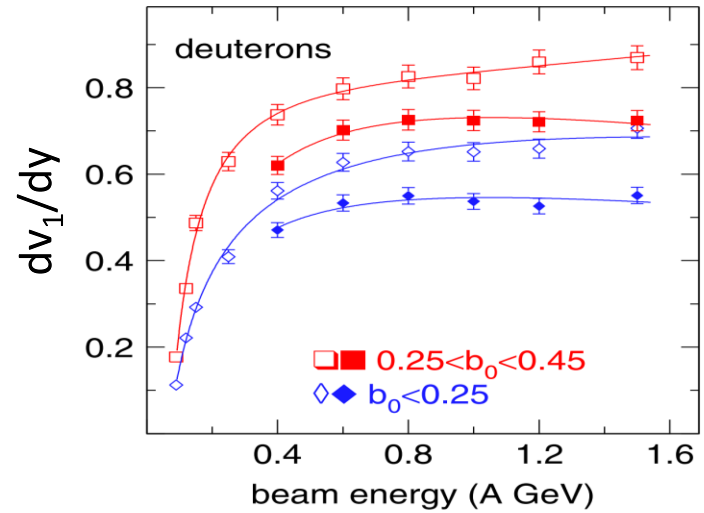
Deuteron v_1 slope at midrapidity

FOPI collaboration $\sqrt{s_{NN}}$ ~ 1.9-2.4 GeV

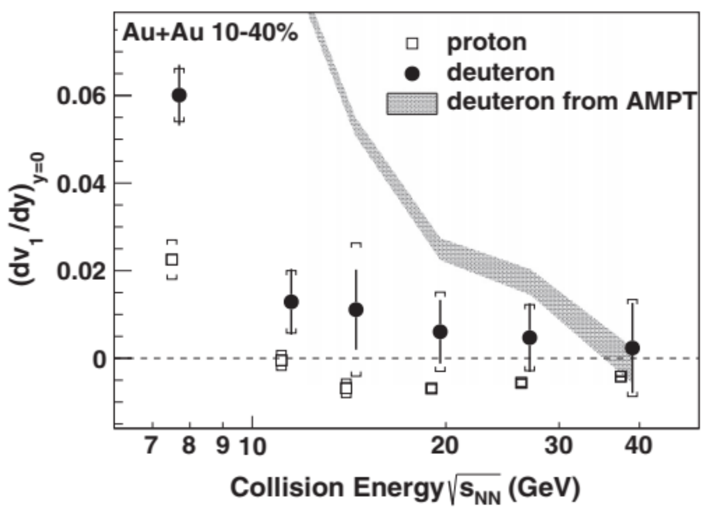
Au+Au

Nuclear Physics A 1, 876 (2012)





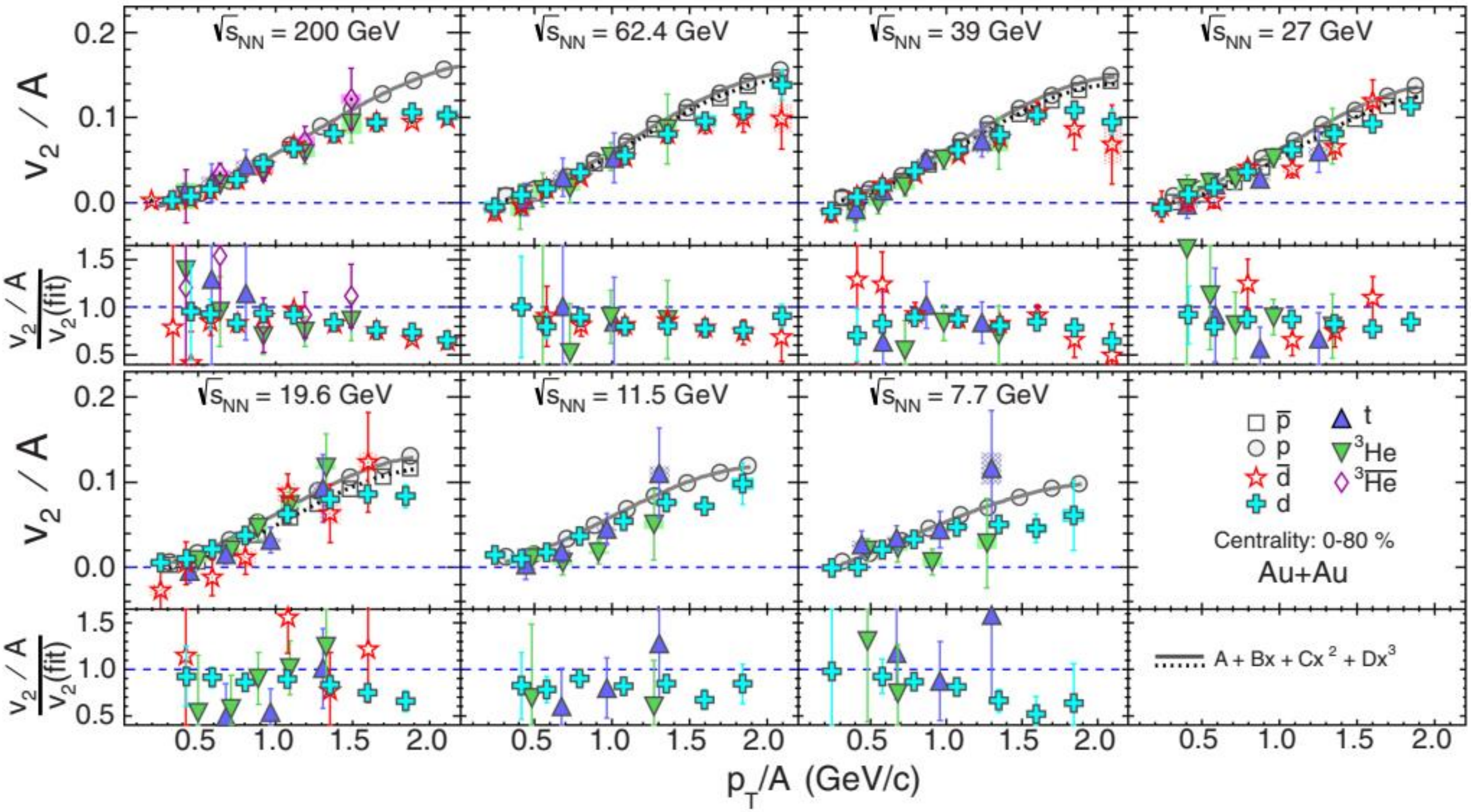
Phys. Rev. C 102, 044906 (2020)



- Deuteron dv_1/dy are always positive
- Do not follow the atomic-mass-number scaling at higher energies
- May imply change of dominated interactions

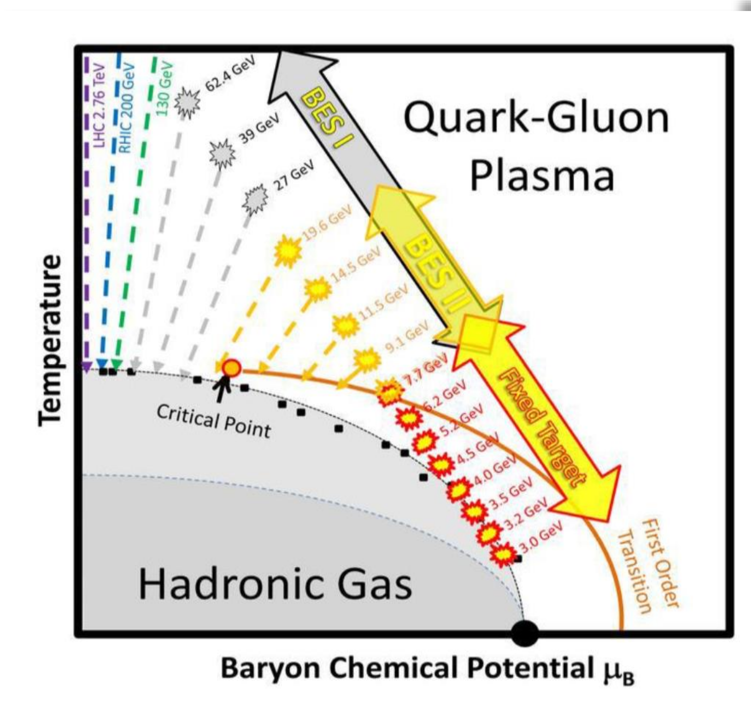
Light nucleus v_2 from STAR

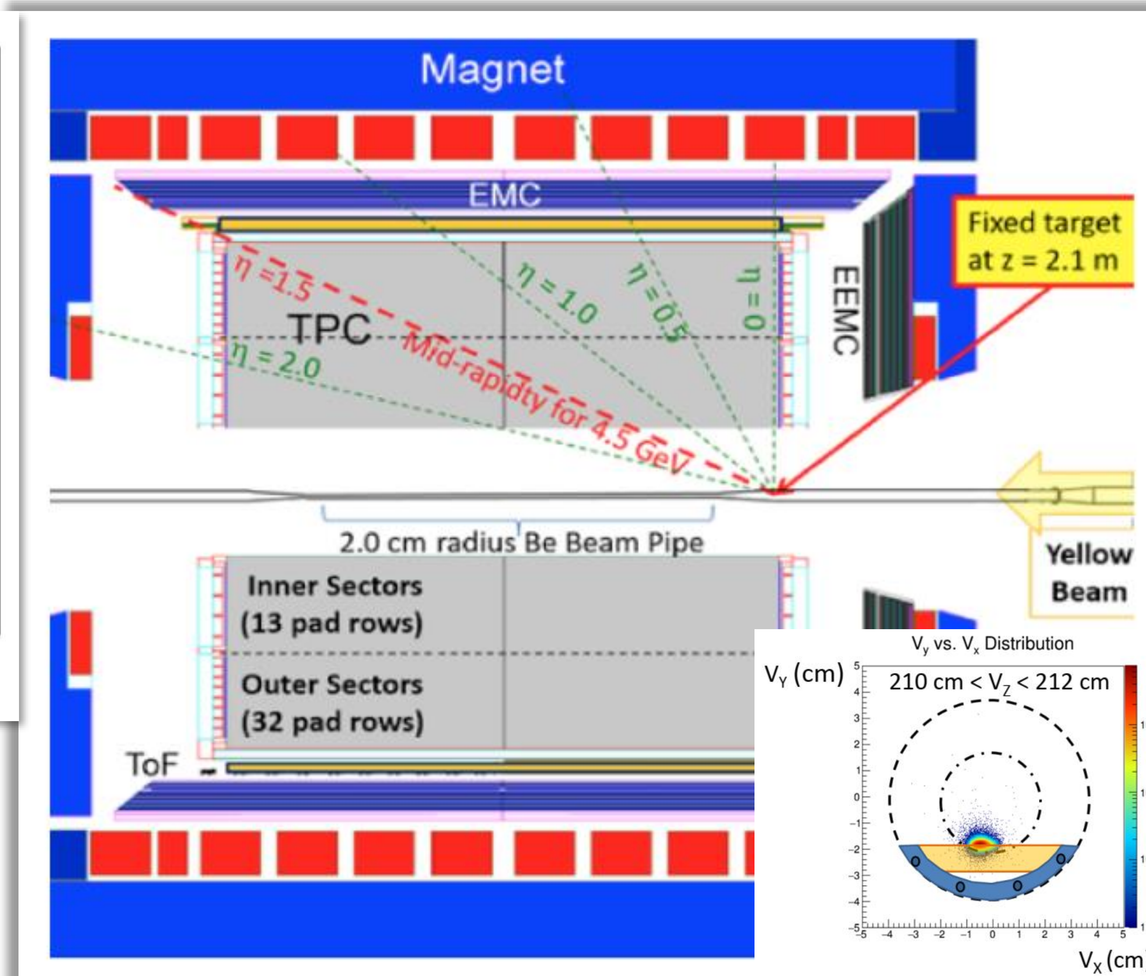
Phys. Rev. C 94, 034908 (2016)



Atomic-mass-number scaling of v_2 at low p_T, favored by coalescence production model.

Fixed target experiment at STAR

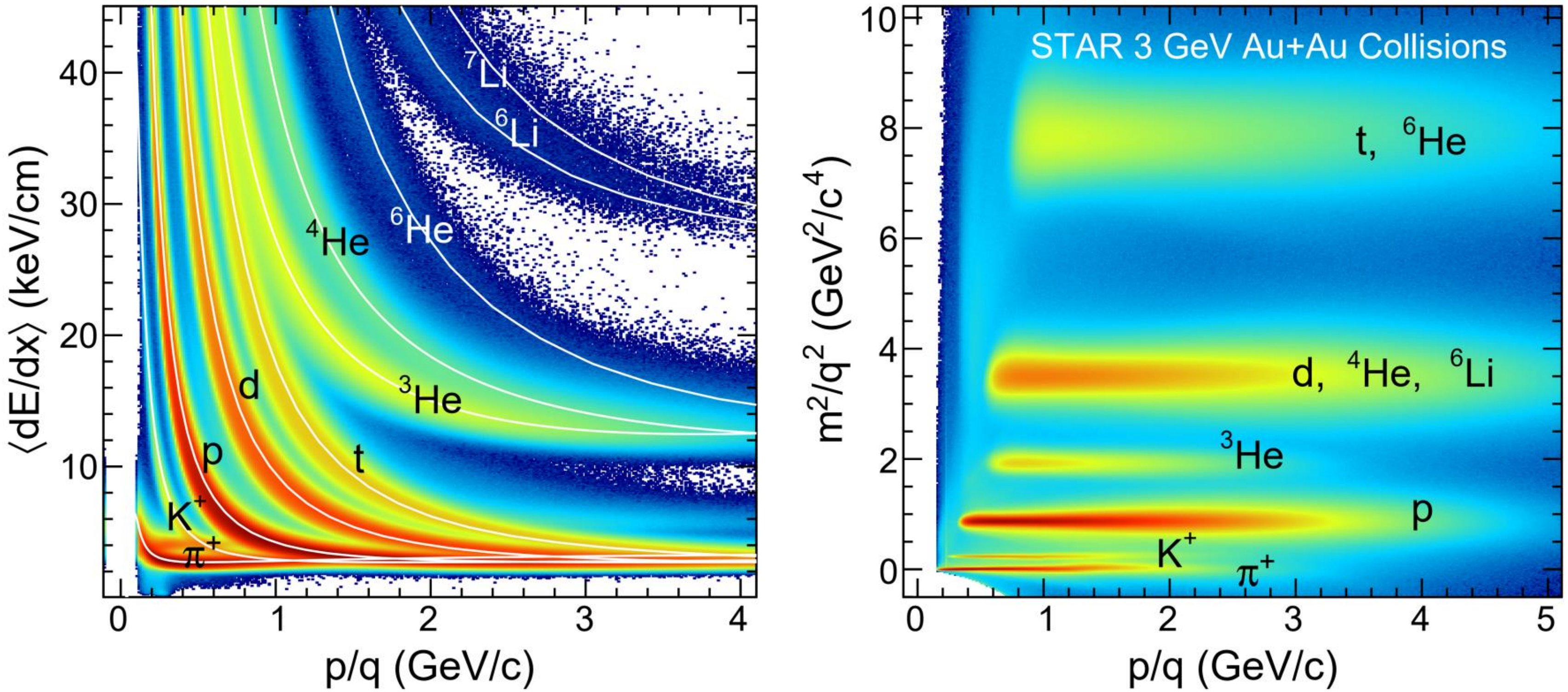




STAR's FXT extends the coverage of baryon chemical potential from 400 MeV to 720 MeV.

Light nuclei selection

Data recorded in 2018, ~250M events.

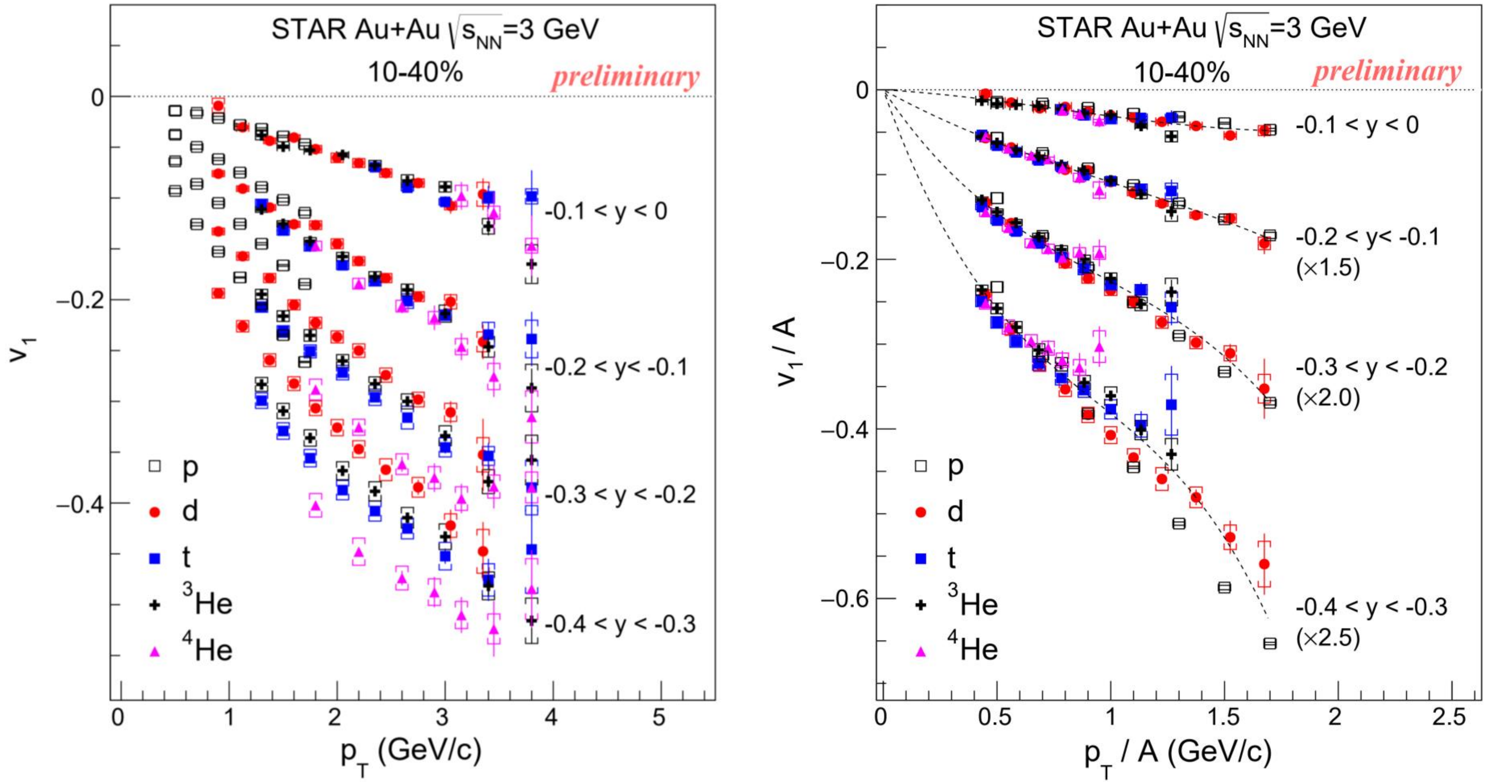


Light nuclei : d, t, ^{3}He, and ^{4}He

$$z = \ln\left(\frac{(dE/dx)_{measured}}{(dE/dx)_{expected}}\right)$$

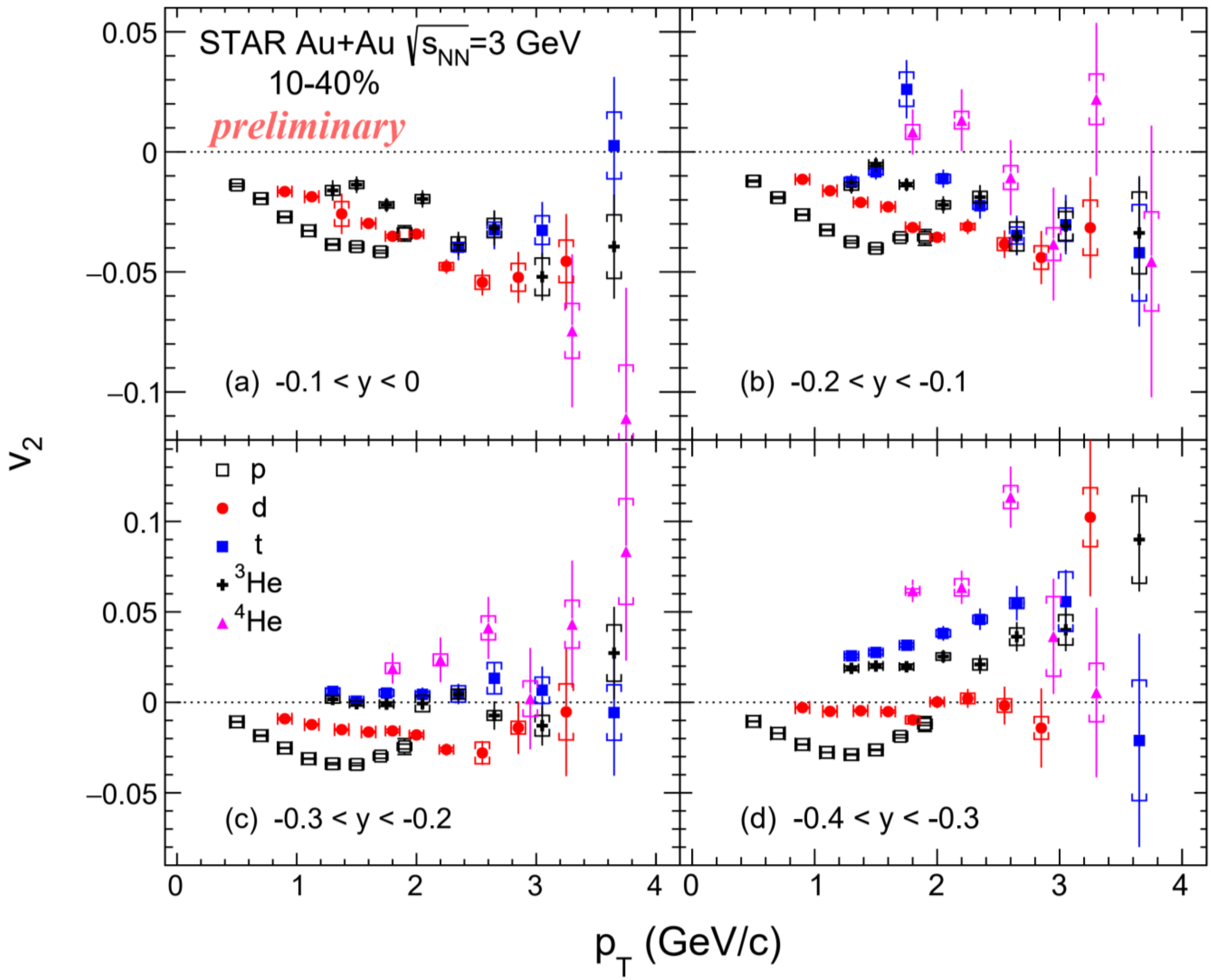
Momentum dependence PID, the TOF was used at high momentum.

p_T dependence of light nucleus v_1



Light nucleus $v_1(p_T)$ follow atomic-mass-number scaling at different rapidity bins.

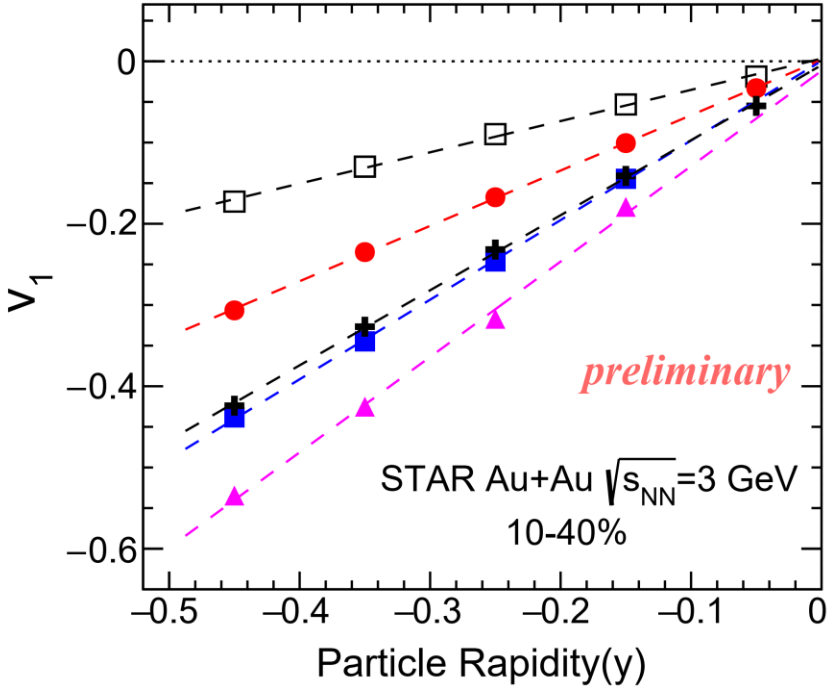
p_T dependence of light nucleus v_2

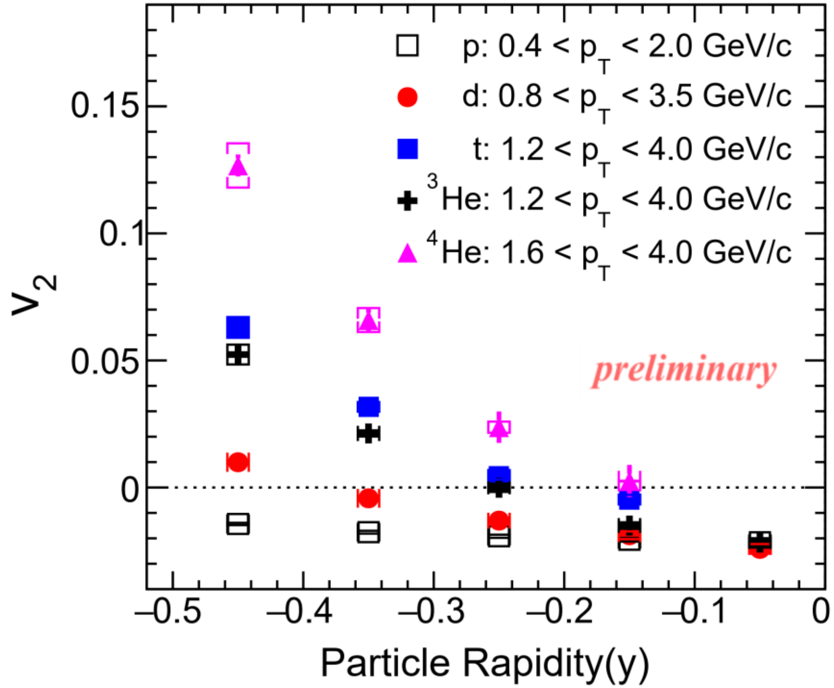


The p_T dependence of proton v_2 is non-monotonic, do not follow mass-number scaling.

Rapidity dependence of v_1 and v_2

Mass ordering of both v_1 and v_2.



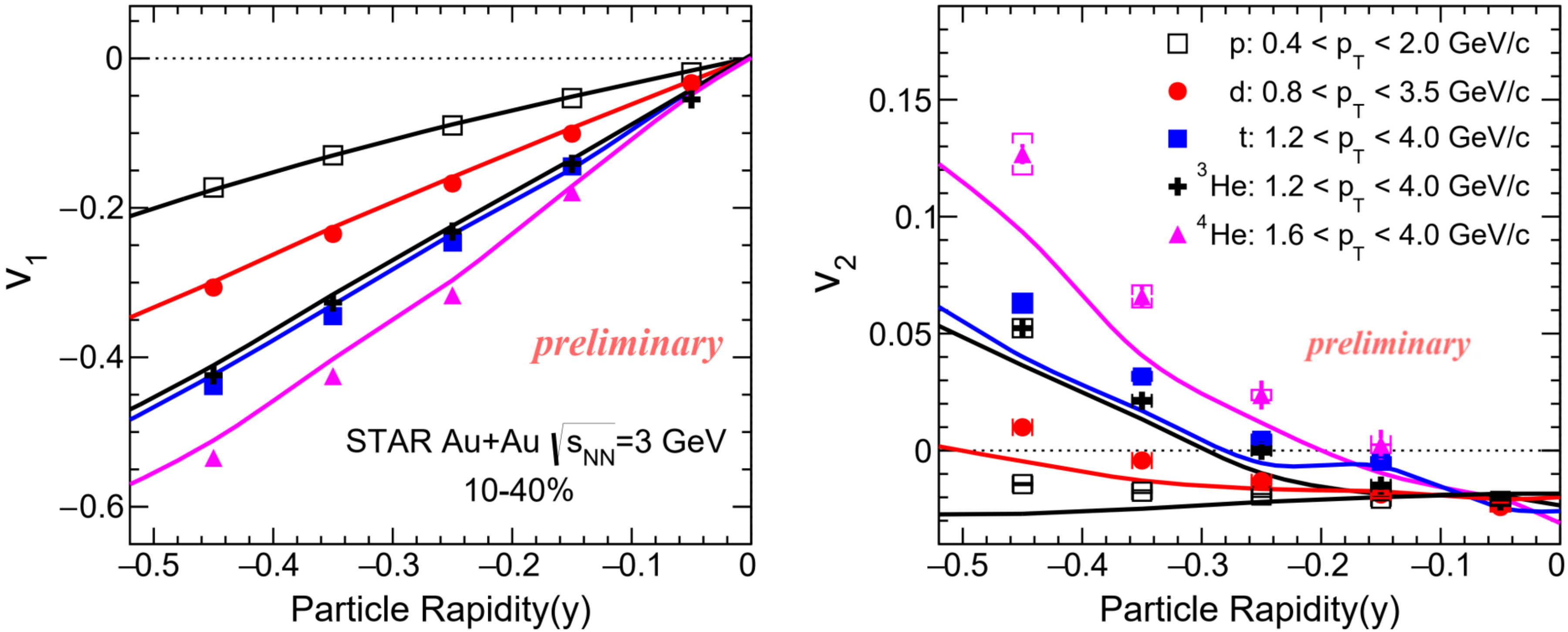


coalescence : can negative proton v_2 produce positive light nucleus v_2?

JAM+ nucleon coalescence

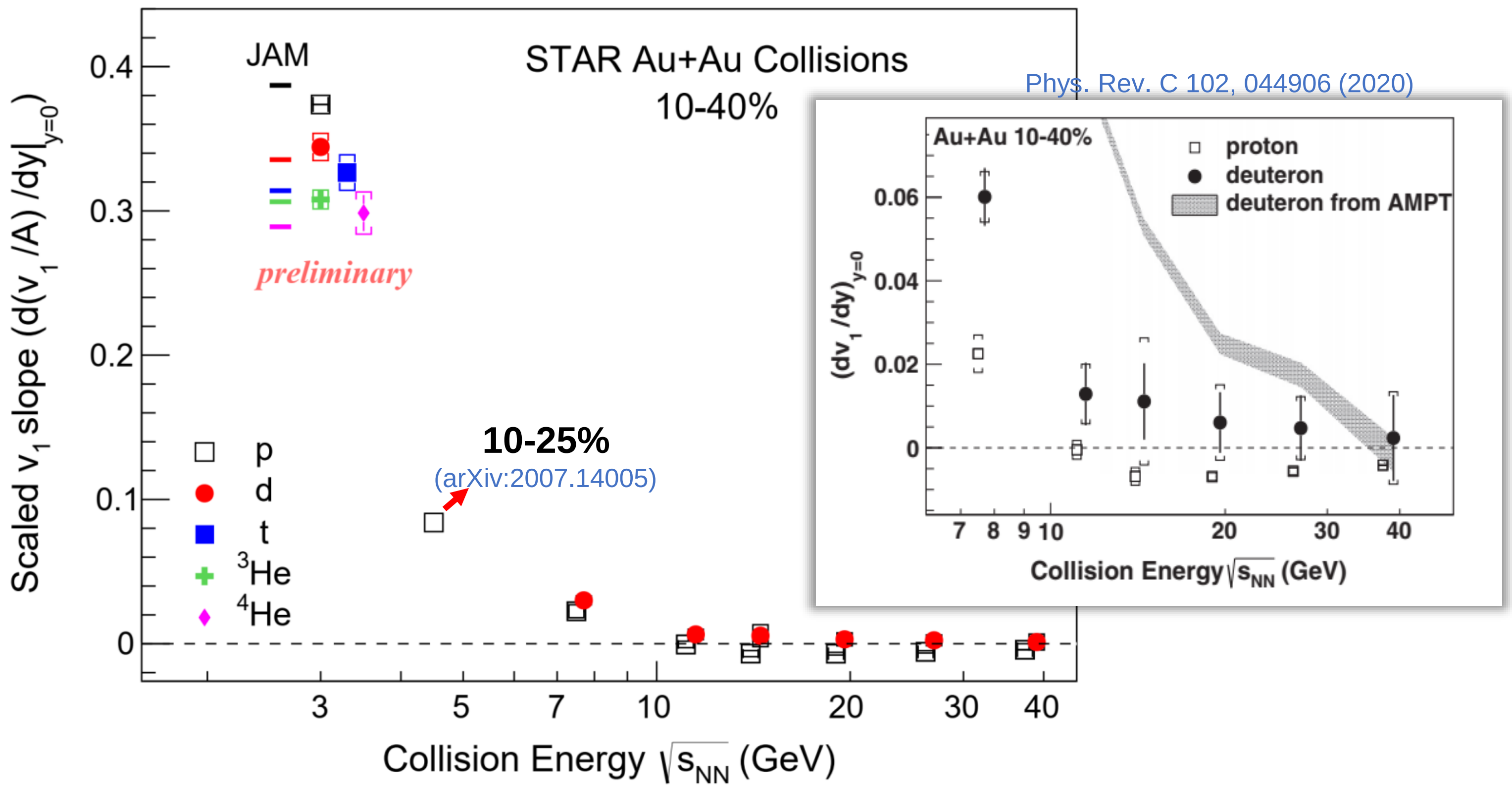
JAM : Jet AA Microscopic transport Model, **meanfield**

Coalescence of two nucleons:
relative coordinate and momentum distances Δr<4.0 fm, Δp<0.3 GeV/c



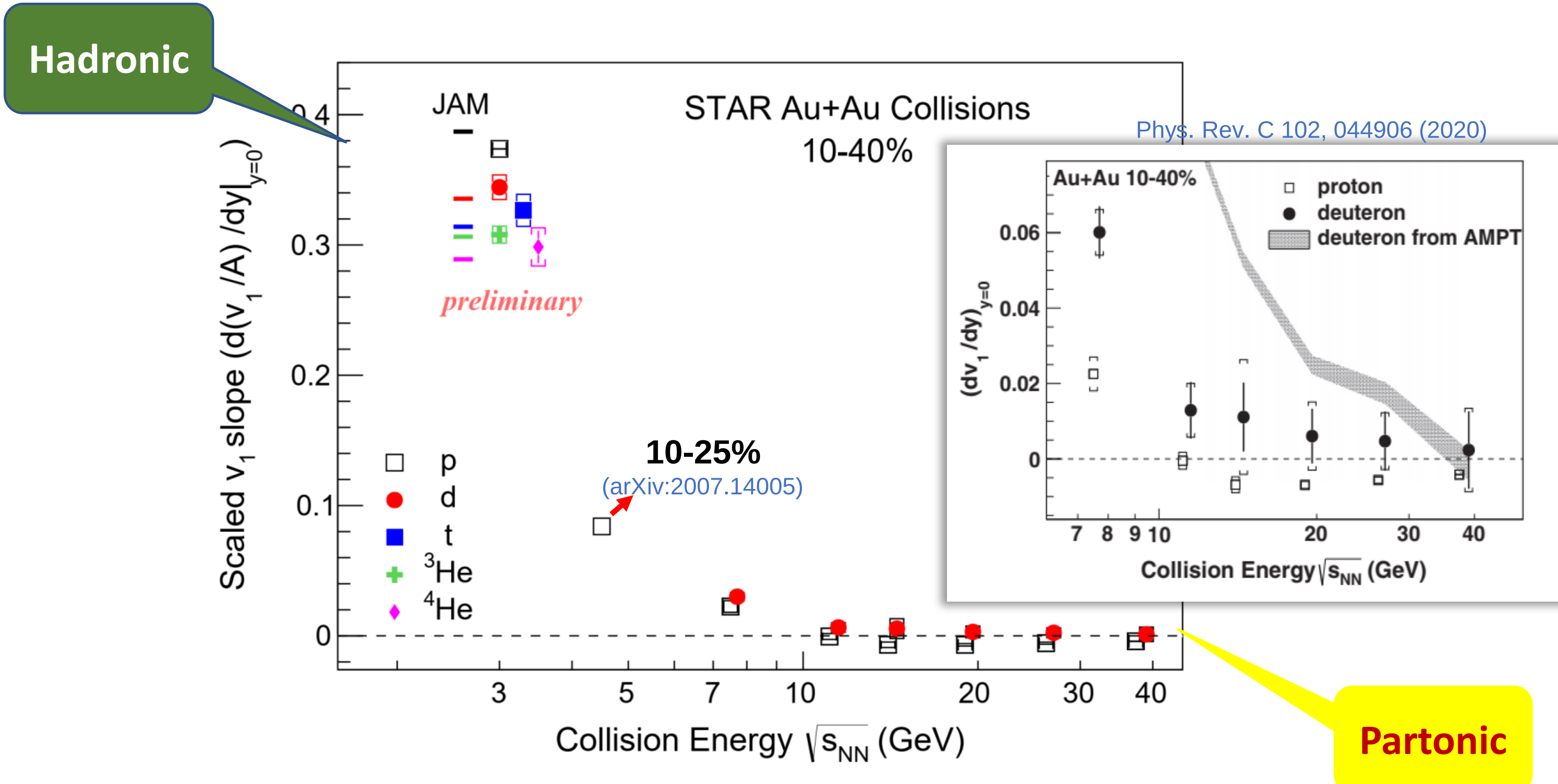
Can qualitatively describe the data.

Energy dependence of dv_1/dy



At $\sqrt{s_{NN}}$ = 3 GeV, the light nucleus v_1 slopes roughly follow the atomic-mass-number scaling.

Energy dependence of dv_1/dy



- Hadronic model JAM reproduces light nuclei v_1 at 3 GeV
- Different scaling behavior at low and high collision energies → change of dominant interactions

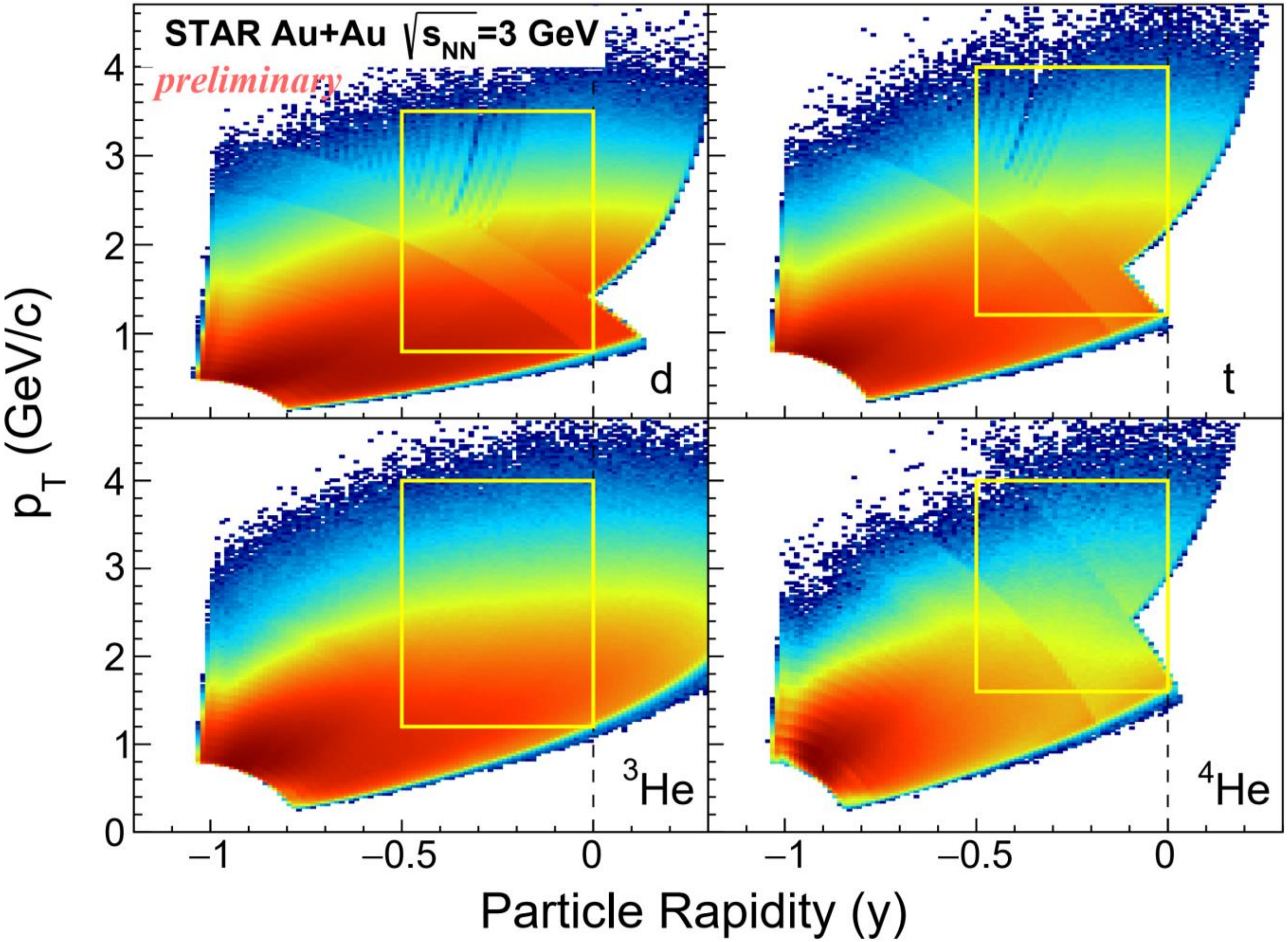
Summary

- v_1 and v_2 measurements for *d, t, ³He,* and *⁴He* from Au+Au collisions at $\sqrt{s_{NN}}$= 3 GeV
  - At midrapidity, light nucleus $v_1(y)$ slope and $v_1(p_T)$ follow the atomic-mass-number scaling, as expected in coalescence scenario
  - v_2 values at midrapidity ($|y|<0.1$) are negative and the scaling doesn't hold
- Simple coalescence picture qualitatively describes the light nucleus v_1 and the sign change of $v_2(y)$, as a function of rapidity
- From high collision energy, $\sqrt{s_{NN}}$ > 15 GeV, to low energy, < 8 GeV, atomic mass scaling for light-nuclei v_1 and v_2 is different, which may imply different dominant interactions。

Thank you for your attention!

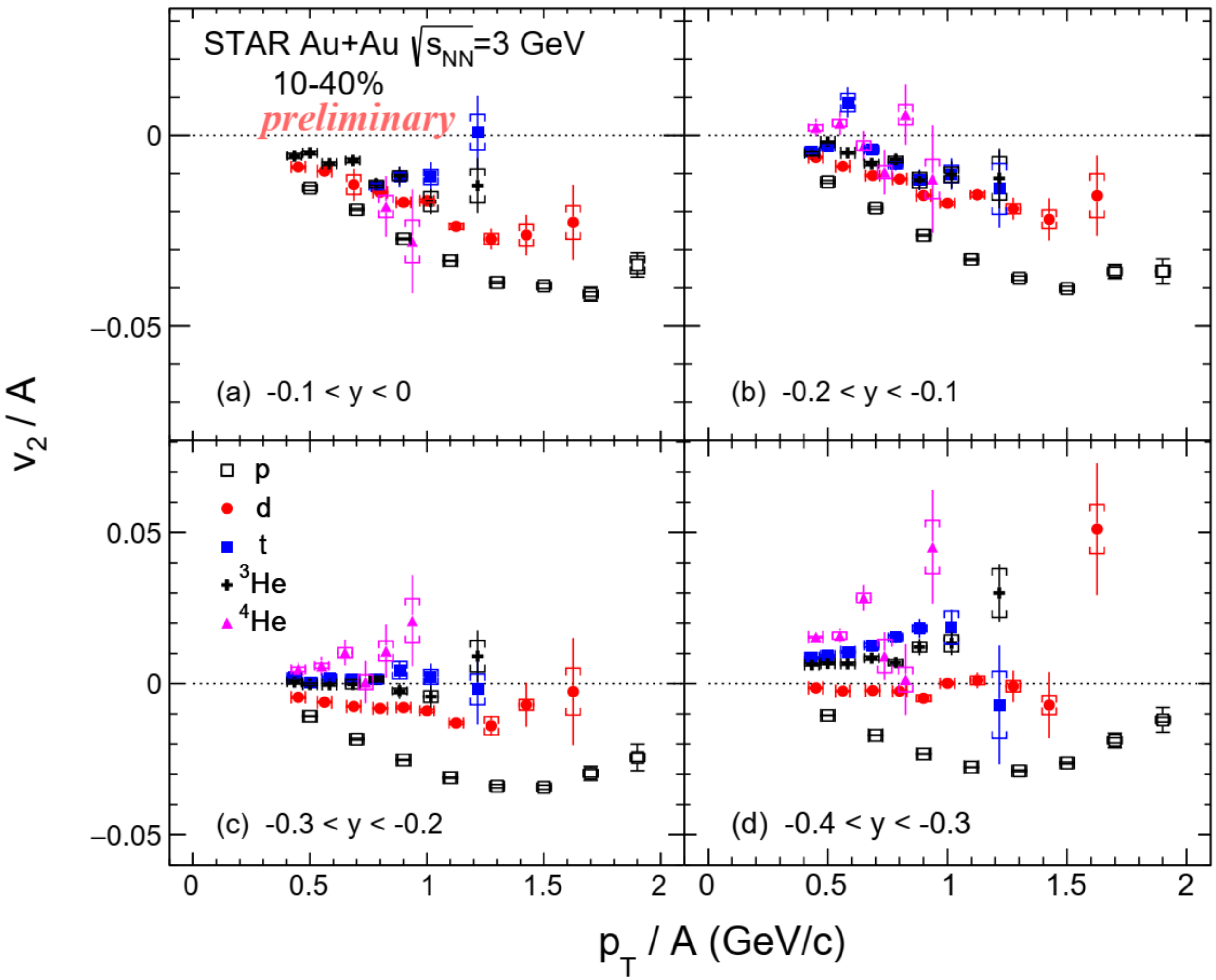
Back up

Light nuclei acceptance



- p_T range (GeV/c) : d [0.8, 3.5], t [1.2, 4.0], ^{3}He [1.2, 4.0], ^{4}He [1.6, 4.0]
- Part of the tritons and ^{4}He within -0.1<y<0 can't be covered due to the TOF acceptance

p_T dependence of light nucleus v_2



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