Elliptic flow of light nuclei in Au+Au collisions at $\sqrt{s_{NN}}$ = 14.6, 19.6, 27, and 54.4 GeV using the STAR detector

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DAE HEP 2022
Hosted by IISER Mohali

Supported in part by:
U.S. DEPARTMENT OF ENERGY | Office of Science

Outline

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- ★ The STAR experiment
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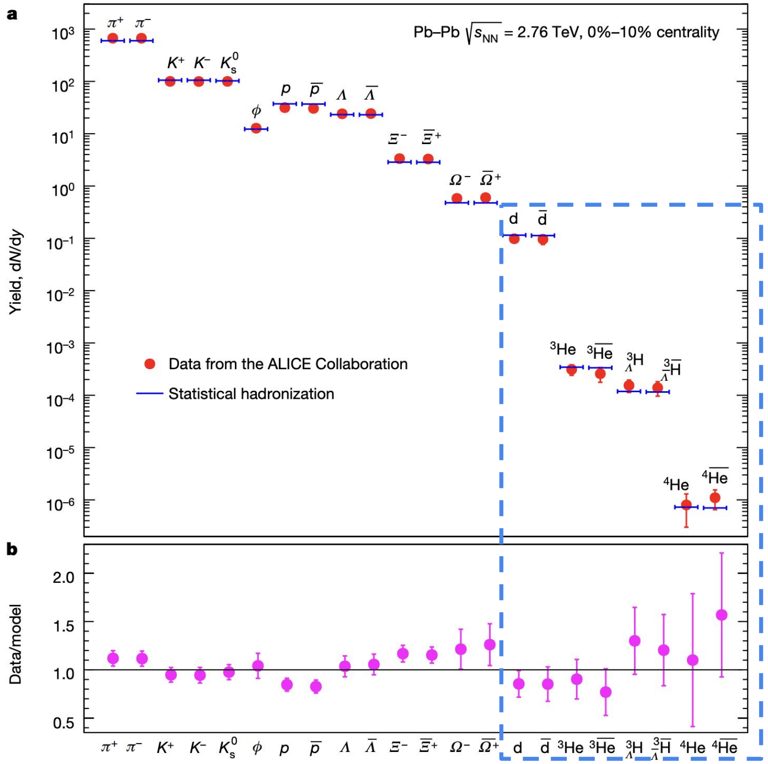
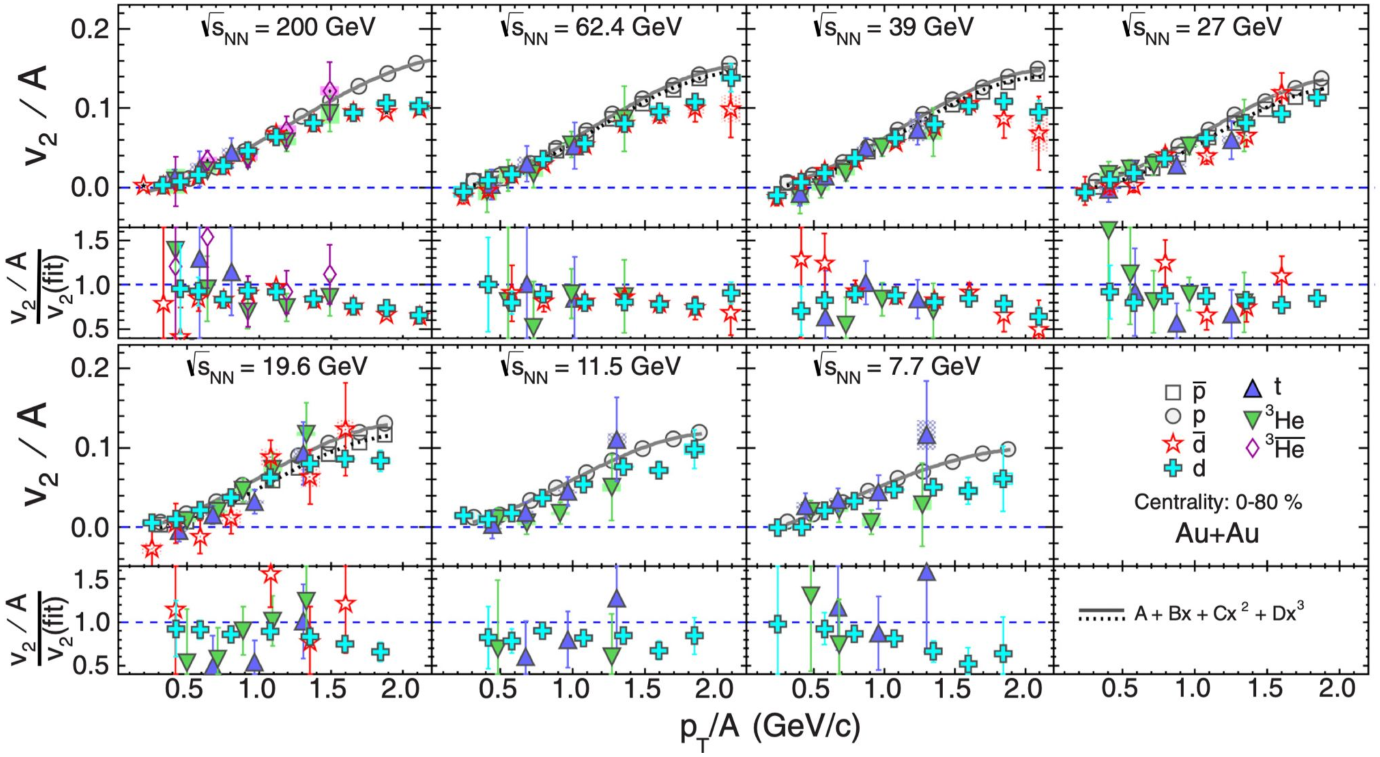
- ★ Results
  - ○ p_T and centrality dependence of elliptic flow of d, t, and ^{3}He
  - ○ Mass number scaling of elliptic flow
- ★ Summary

Motivation



A. Andronic *et al.*, Nature 561 321–330 (2018)



STAR, PRC 94, 034908 (2016)

★ **Thermal model**: Light nuclei are produced near the chemical freeze-out (CFO) surface along with other hadrons

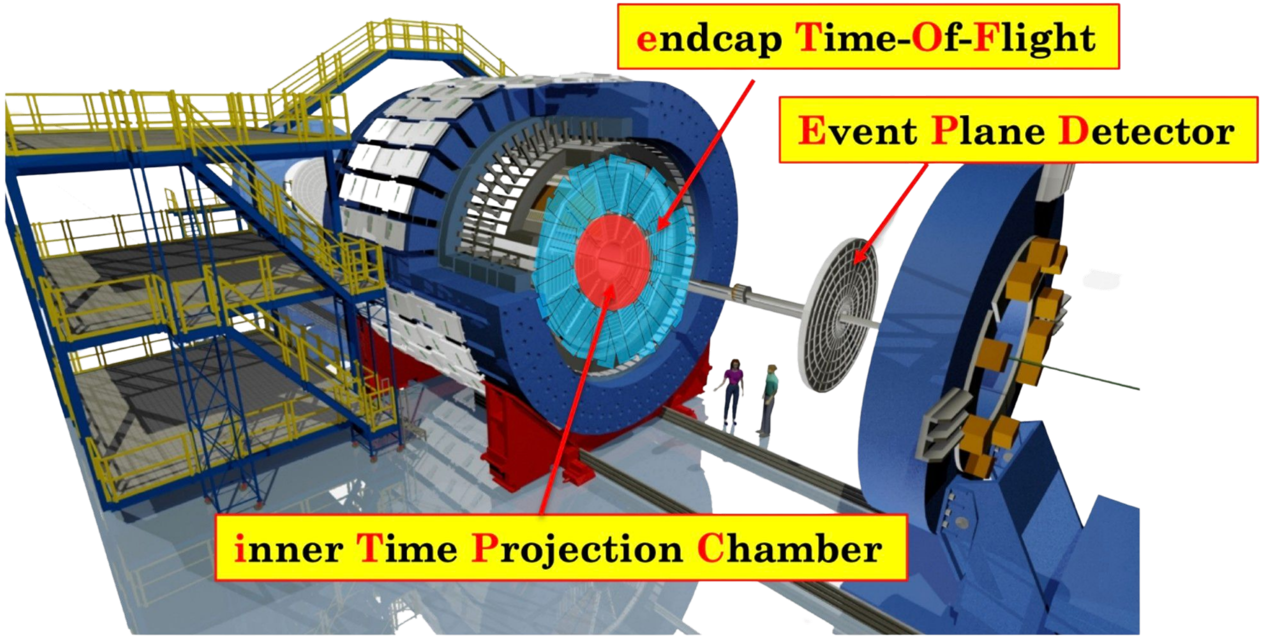
★ **Coalescence model**: Light nuclei are produced near the kinetic freeze-out (KFO) surface by the coalescence of final state nucleons

→ **Mass number scaling** of light nuclei v_2

★ v_2/A of light nuclei was observed to be close to v_2 of protons for $p_T/A < 1.5$ GeV/c in BES-I data

★ Higher statistics dataset in BES-II program will allow us to better understand the production mechanism of light nuclei

The STAR Experiment

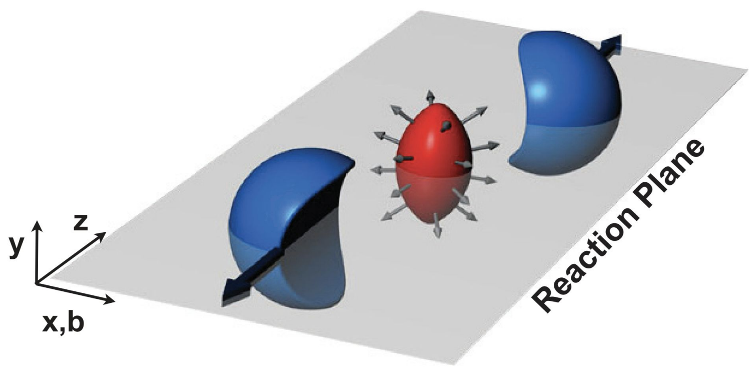


C. Yang *et al.*, JINST 15 C07040 (2020)

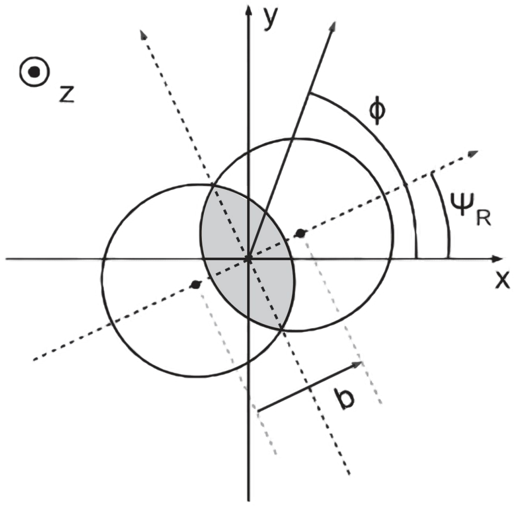
Solenoidal Tracker At RHIC

- ★ Particle identification is performed using
  - ○ *dE/dx* information from **Time Projection Chamber (TPC)**
  - ○ m^2 information from **Time of Flight (TOF)**
- ★ BES-II upgrades:
  - ○ iTPC: Large pseudorapidity coverage ($|\eta| < 1.5$)
  - ○ Better track and event plane resolution
- ★ Datasets
  - ○ **BES-II**: Au+Au collisions at $\sqrt{s_{NN}}$ = 14.6, 19.6, 27, and 54.4 GeV

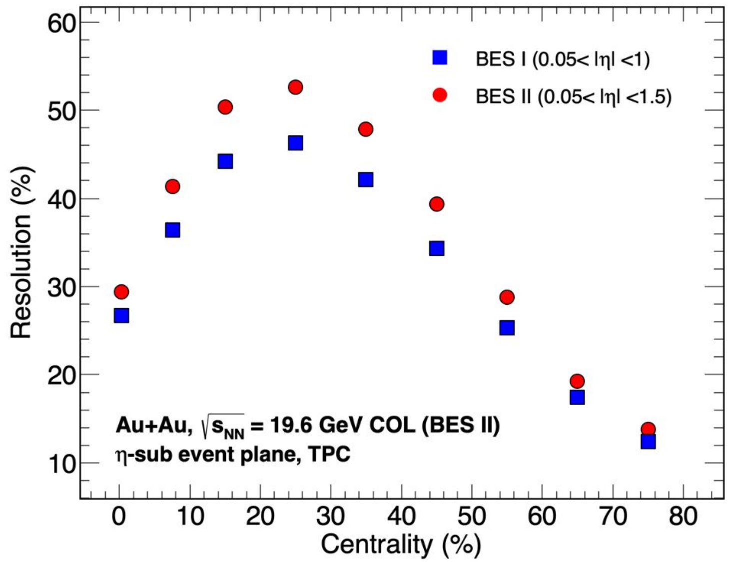
Analysis Details



R. Snellings, New J.Phys.13:055008 (2011)



CMS, PRC 87 014902 2013)



Improvement of resolution by ~10% from BES-I

★ The particle azimuthal distribution can be written as:

$$E\frac{d^3N}{d^3p} = \frac{1}{2\pi}\frac{d^2N}{p_T dp_T dy}\{1+\sum_{n=1}^{\infty} 2v_n \cos(n(\phi-\Psi_R))\} \qquad v_n = \langle\cos(n(\phi-\Psi_R))\rangle$$

★ n^{th} harmonic plane is calculated using the Q-vector:

$$Q_x = Q_n\cos(n\Psi_n) = \sum_i w_i \cos(n\phi_i)$$

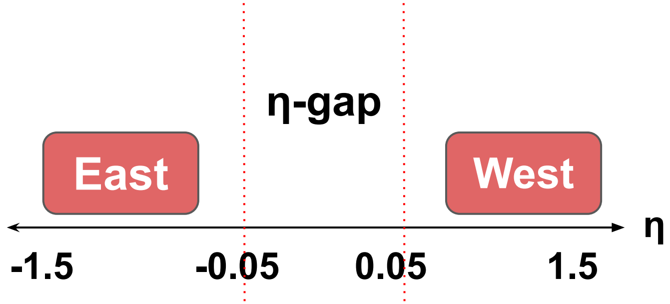
$$Q_y = Q_n\sin(n\Psi_n) = \sum_i w_i \sin(n\phi_i)$$

$$\Psi_n = \frac{1}{n}\tan^{-1}\frac{Q_y}{Q_x}$$

To suppress non-flow contributions

★ η-sub event plane is used

★ η-gap of 0.1 is taken between two subevents



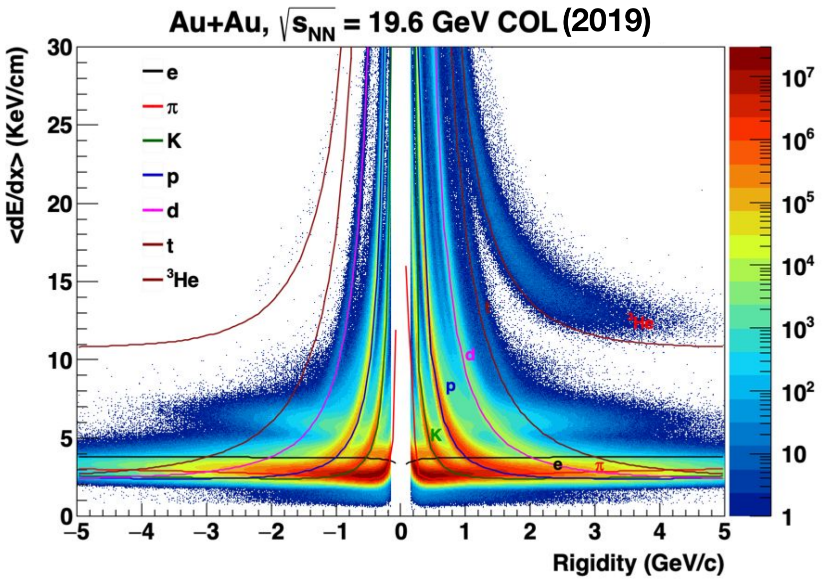
Particle Identification

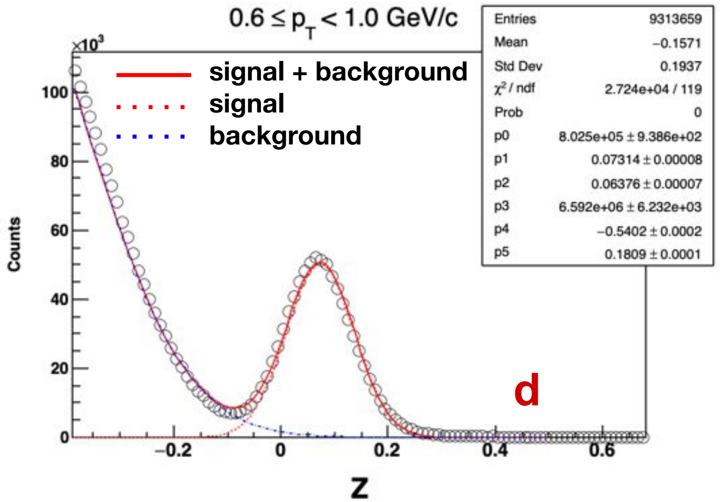
★ Particles are identified using dE/dx information from TPC in the range $|\eta| \leq 1.0$

$$z = \ln\left(\frac{\langle dE/dx\rangle_{\text{measured}}}{\langle dE/dx\rangle_{\text{theory}}}\right)$$

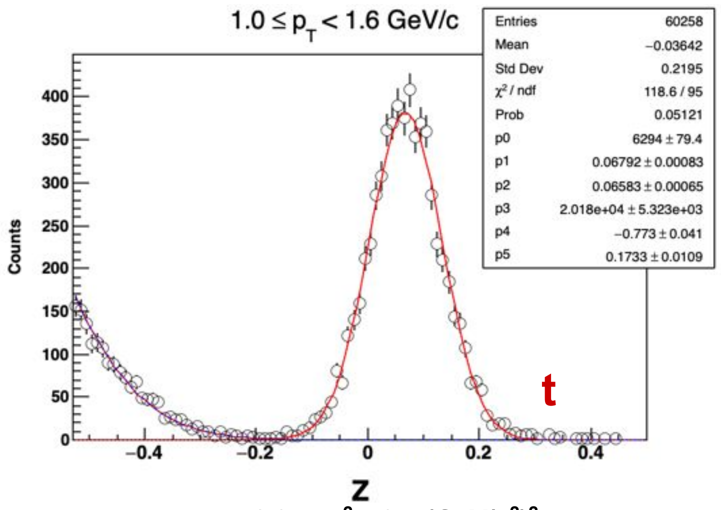
★ $\langle dE/dx\rangle_{\text{theory}}$ is calculated using Bichsel function

★ Double Gaussian fit is done to calculate yield in each p_T and $\phi-\Psi_2$ bin

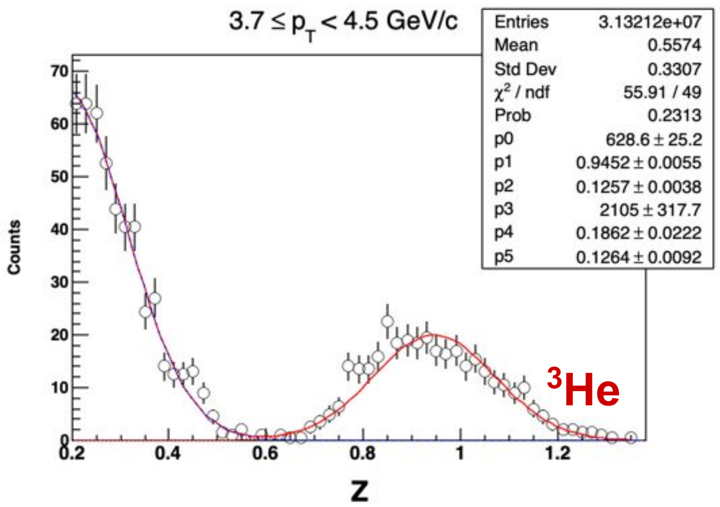




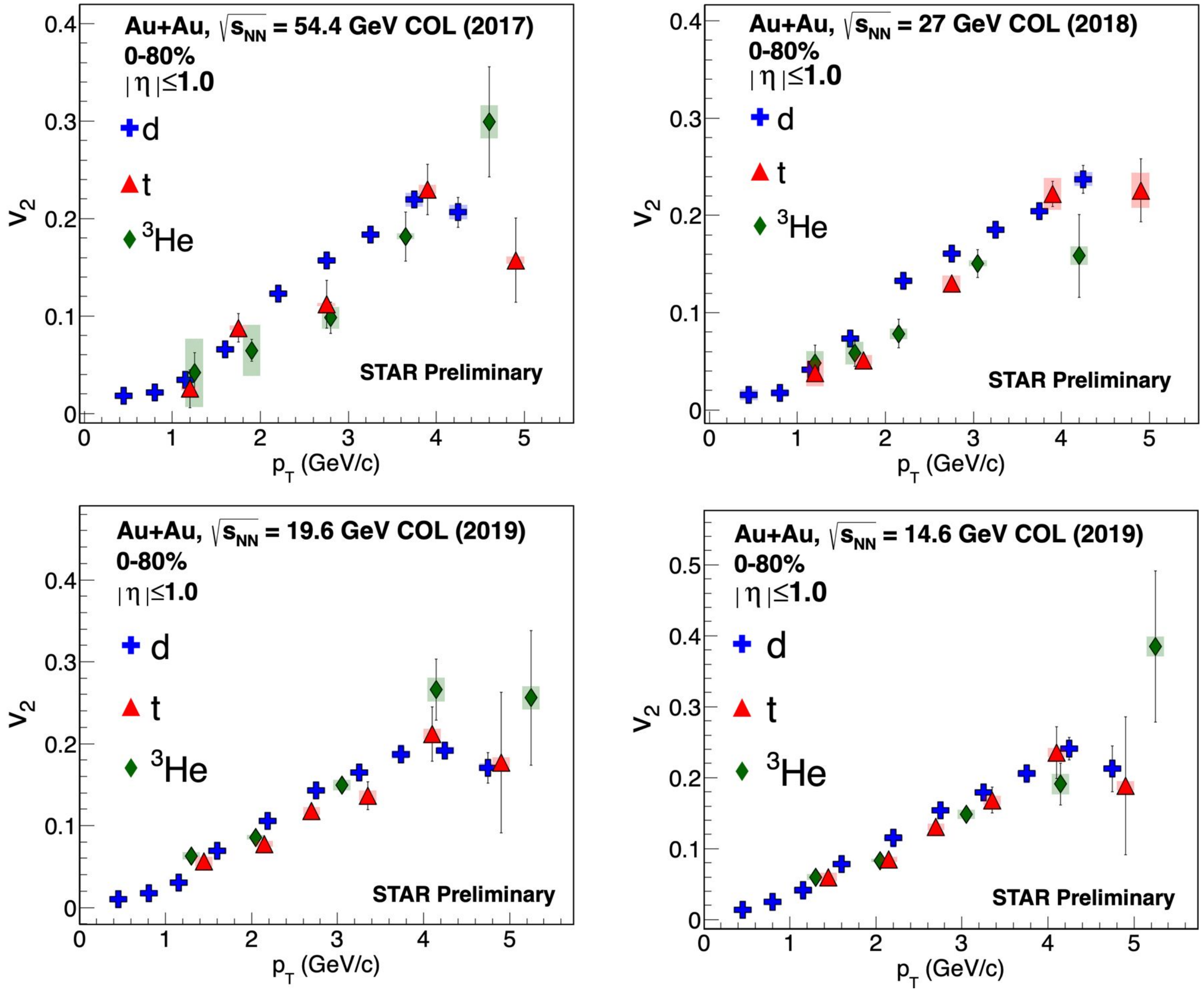
2.8 < m^2 < 4.2 $(GeV/c^2)^2$



6.3 < m^2 < 9.5 $(GeV/c^2)^2$

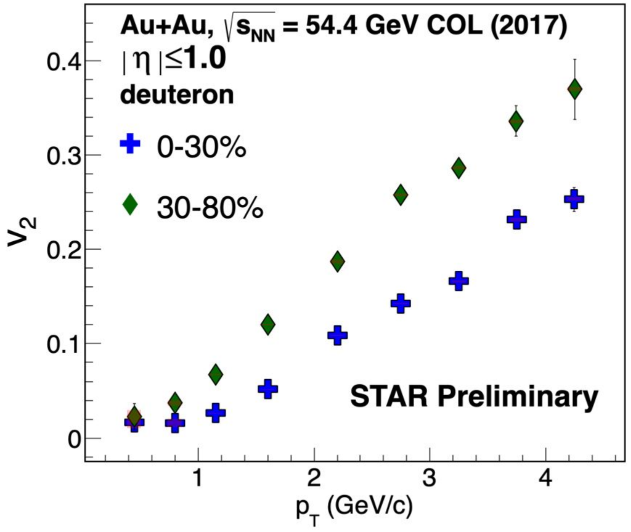


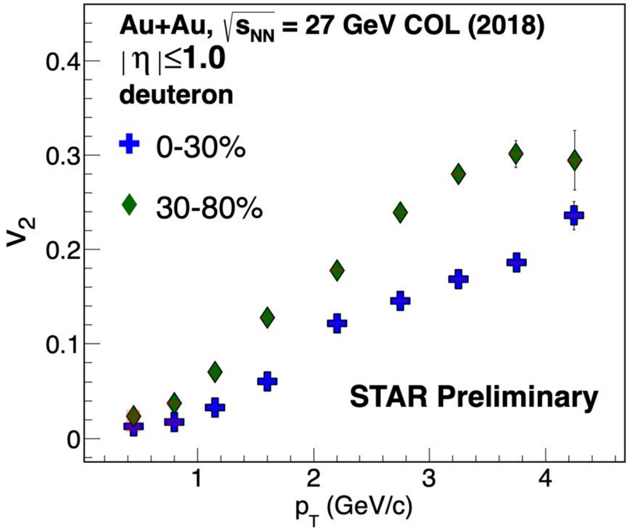
Elliptic flow of light nuclei

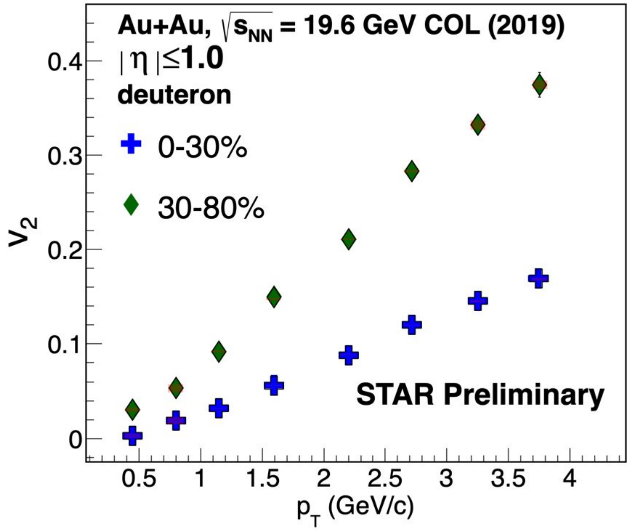


★ The $v_2(p_T)$ for all nuclei species increases with increasing p_T for all collision energies

Centrality dependence

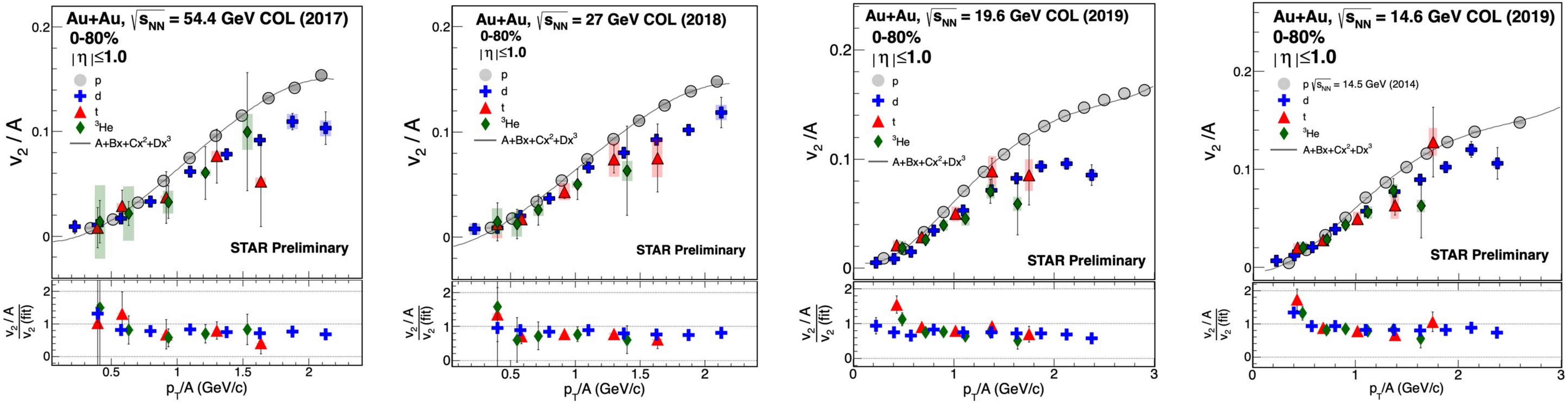






- ★ v_2 of deuterons shows a strong centrality dependence
  - ○ Peripheral collisions have relatively larger v_2 due to their larger initial spatial anisotropy

Mass number scaling



*lines correspond to 3rd order fit to the proton v_2 data

★ v_2 of light nuclei obeys the mass number scaling within 20-30%

Summary

★ v_2 of d, t, and ^{3}He is measured in Au+Au collisions at $\sqrt{s_{NN}}$= 14.6, 19.6, 27, and 54.4 GeV (Collider)

- Clear centrality dependence is observed for deuterons for all collision energies
- Light nuclei v_2 seems to be obeying mass number scaling within 20-30%

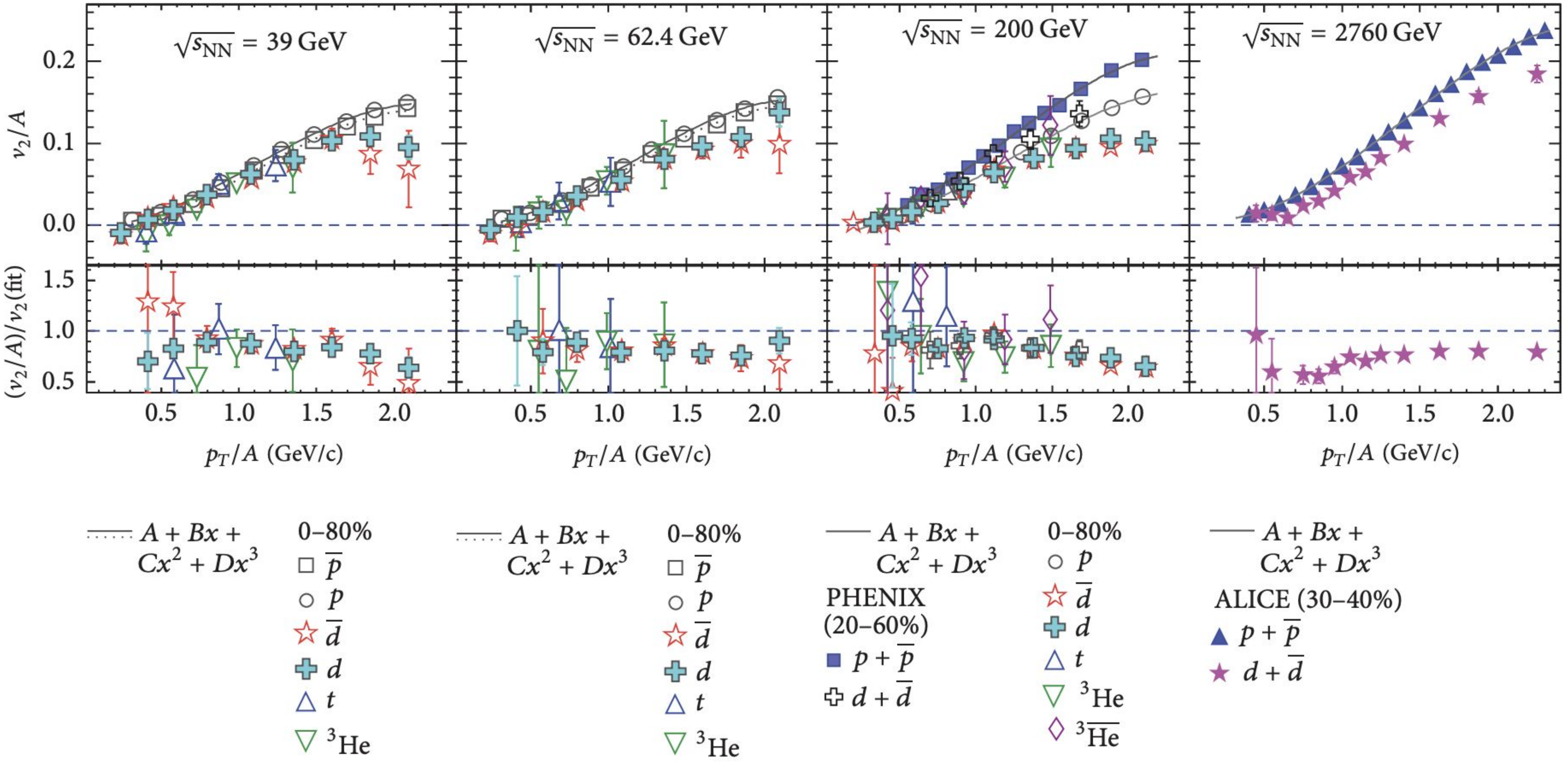
Outlook

★ Stay tuned for more exciting results on light nuclei flow from BES II energies

Thank you

Backup

Summary



Ref. Advances in High Energy Physics, Volume 2017, Article ID 1248563