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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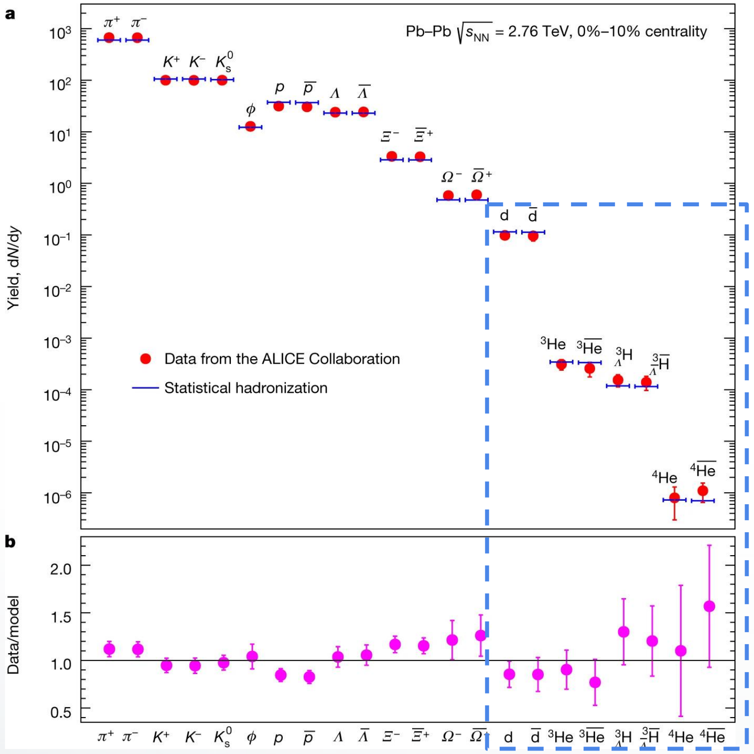
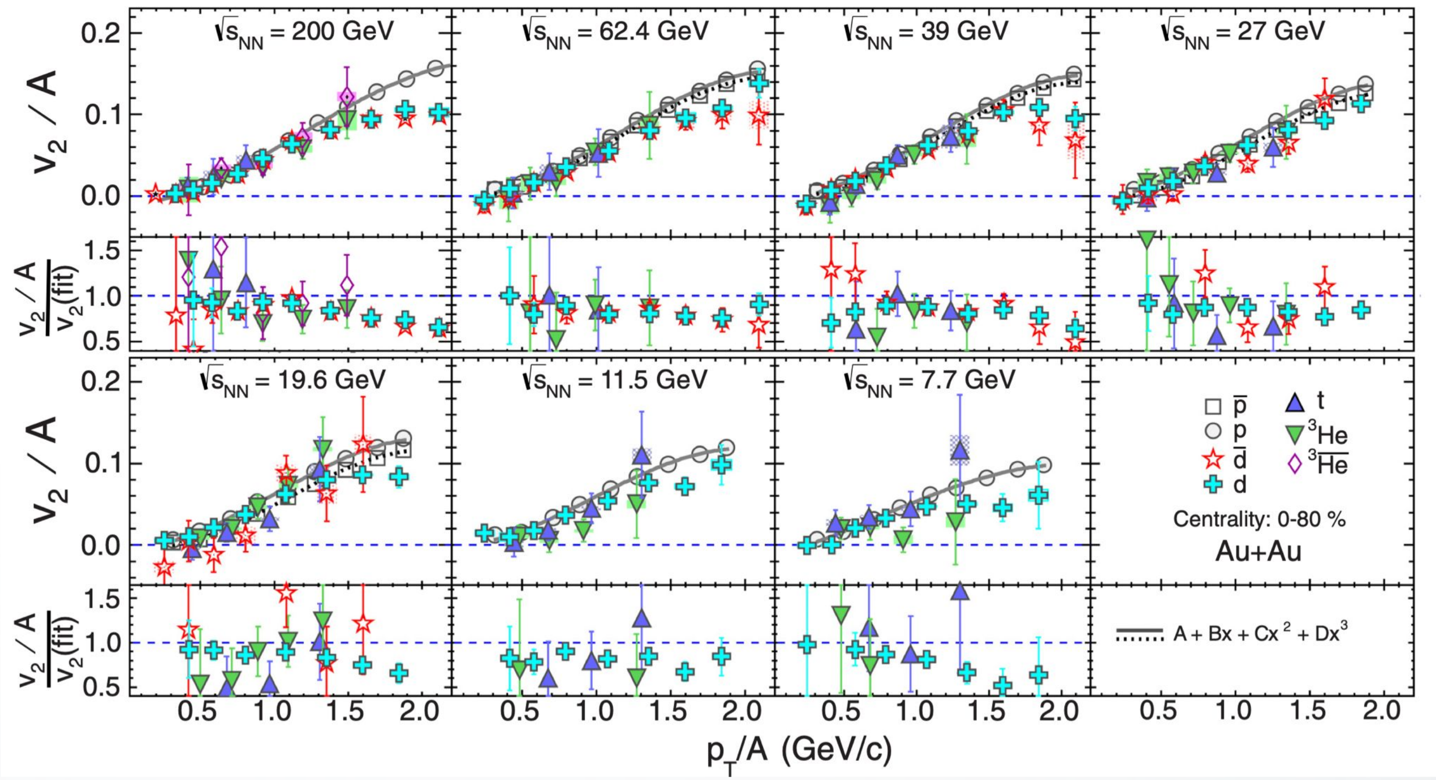
Motivation



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



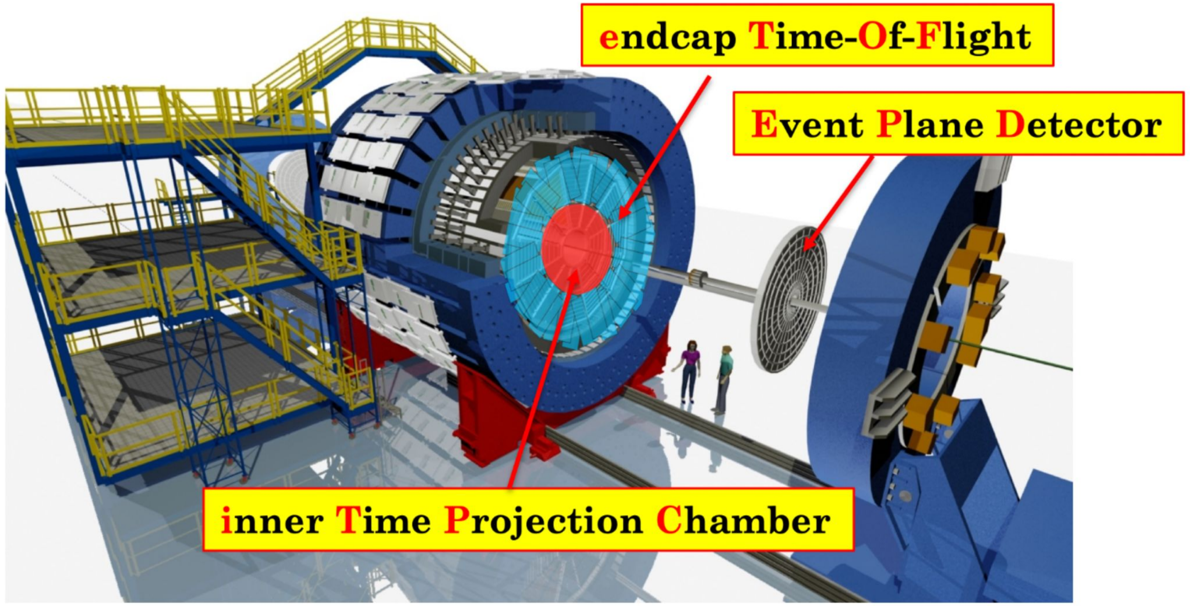
STAR, PRC 94, 034908 (2016)

★ Light nuclei production in heavy-ion collisions can be explained either by the **thermal** model or the final-state **coalescence** of nucleons

★ 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 revisit and better understand the production mechanism of light nuclei

The STAR Experiment



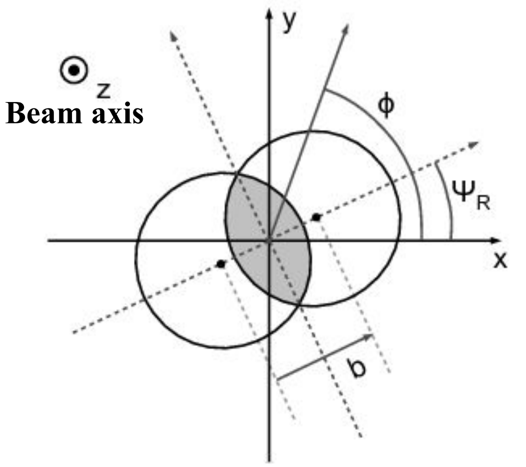
C. Yang *et al.*, JINST 15 C07040 (2020)

- ★ 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

★ The particle azimuthal distribution can be written as:

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



CMS, PRC 87 014902 (2013)

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

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

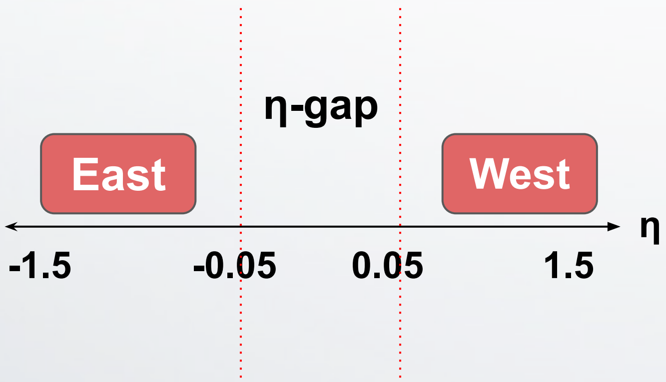
$$Q_n\sin(n\Psi_n) = \sum_i w_i\sin(n\phi_i)$$

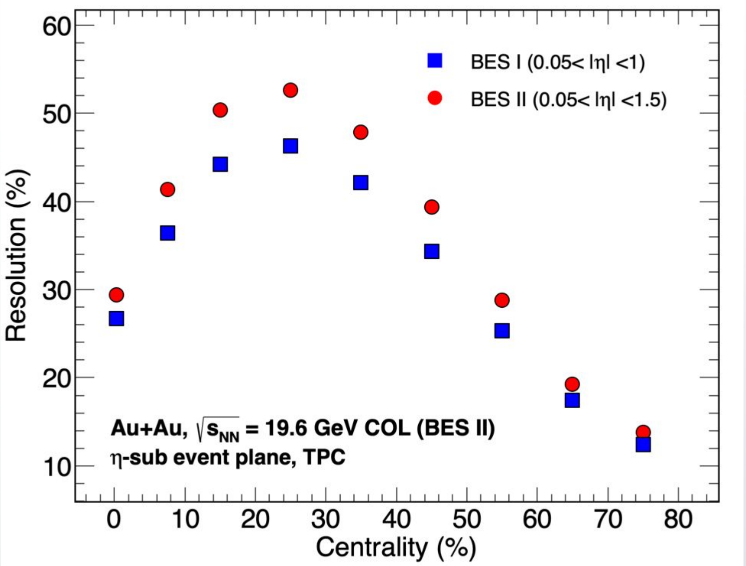
$$\Psi_n = \left(\tan^{-1}\frac{\sum_i w_i\sin(n\phi_i)}{\sum_i w_i\cos(n\phi_i)}\right)/n$$

To suppress non-flow contributions

★ η-sub event plane is used

★ η-gap of 0.1 is taken between two subevents





We observe an improvement of resolution by ~10% from BES I owing to higher TPC acceptance and track resolution

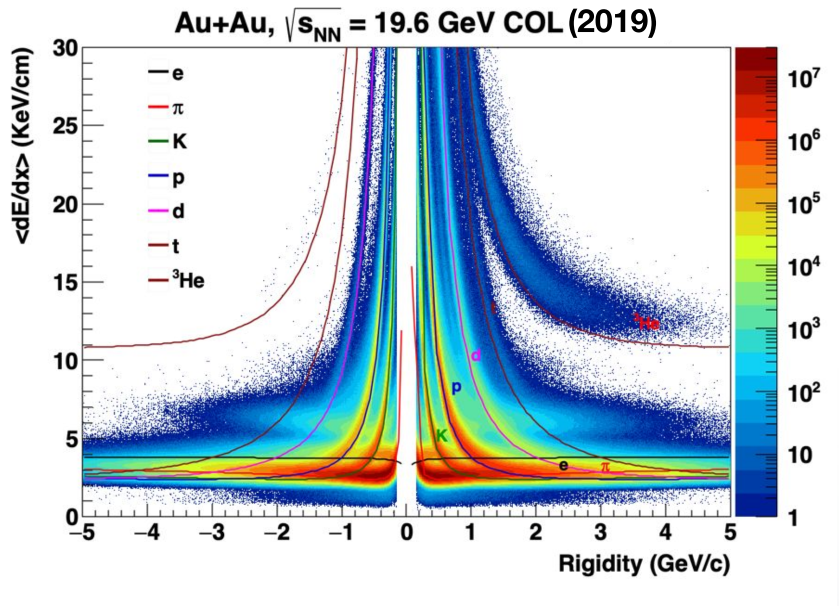
Particle identification

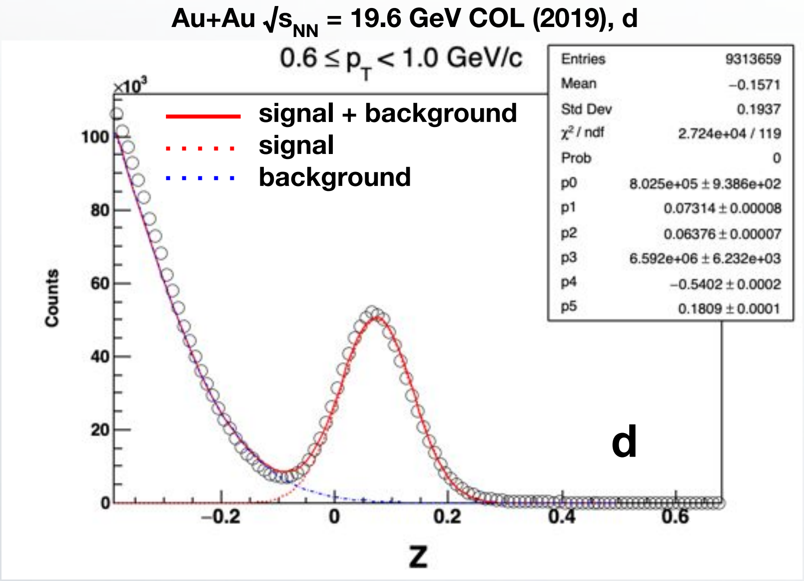
★ Particles are identified using **dE/dx information from TPC** in the range $|\eta| \leq 1.0$

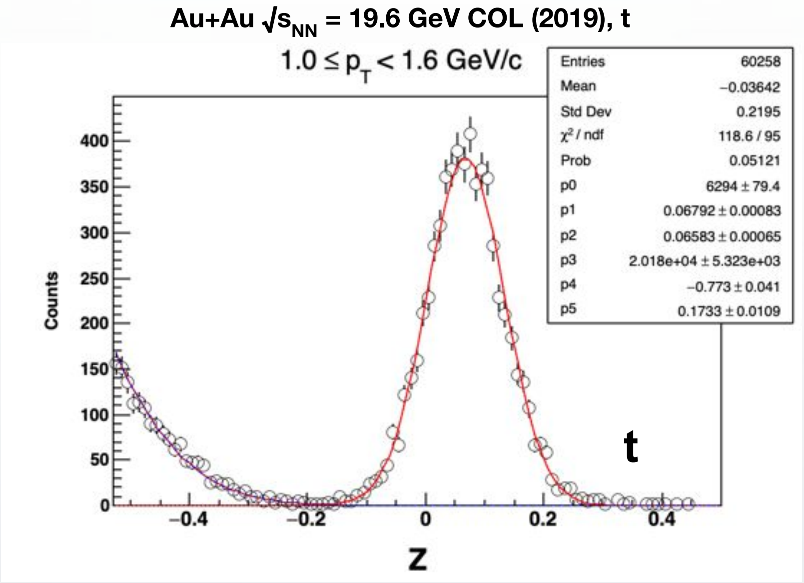
$$z_i = \ln\left(\frac{\langle dE/dx\rangle_{measured}}{\langle dE/dx\rangle_{theory}}\right)$$

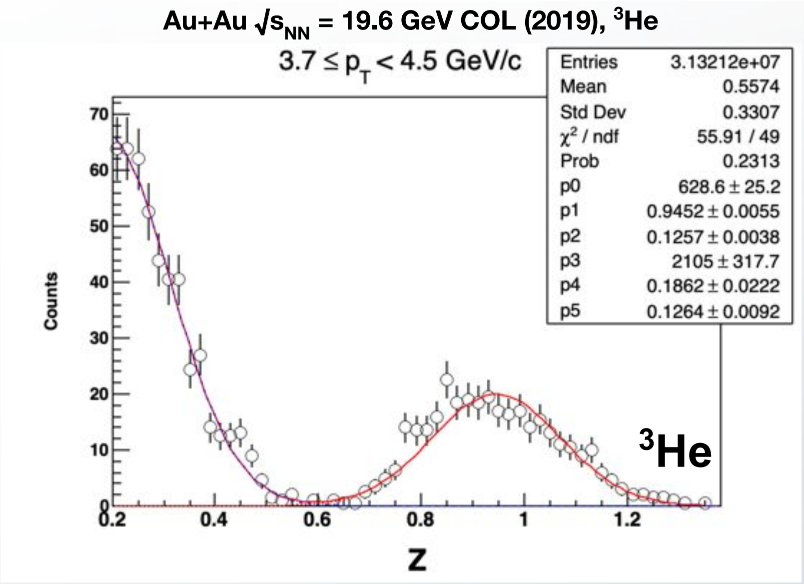
★ $\langle dE/dx\rangle_{theory}$ is calculated using Bichsel function

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

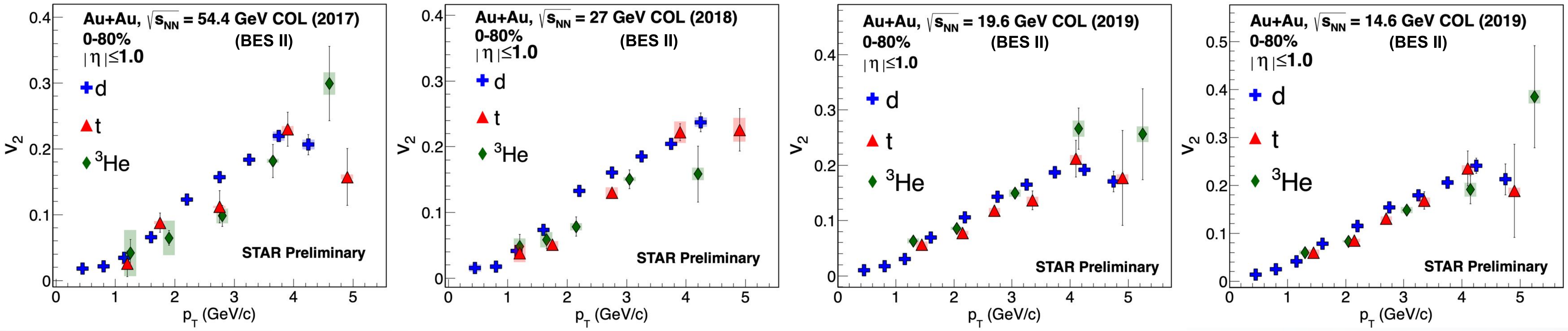






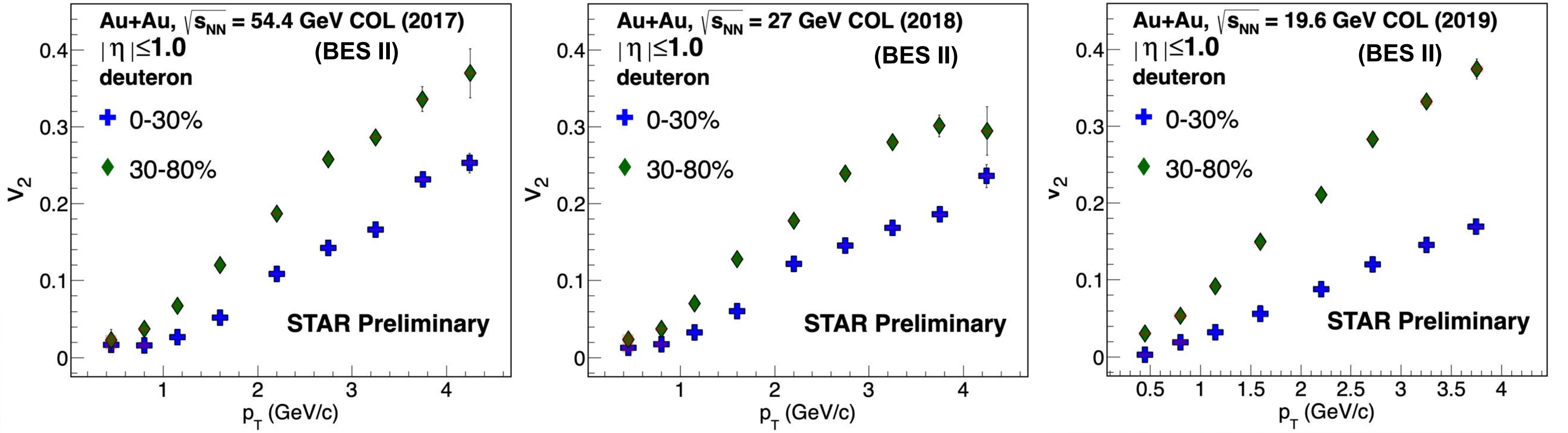


Elliptic flow of light nuclei



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

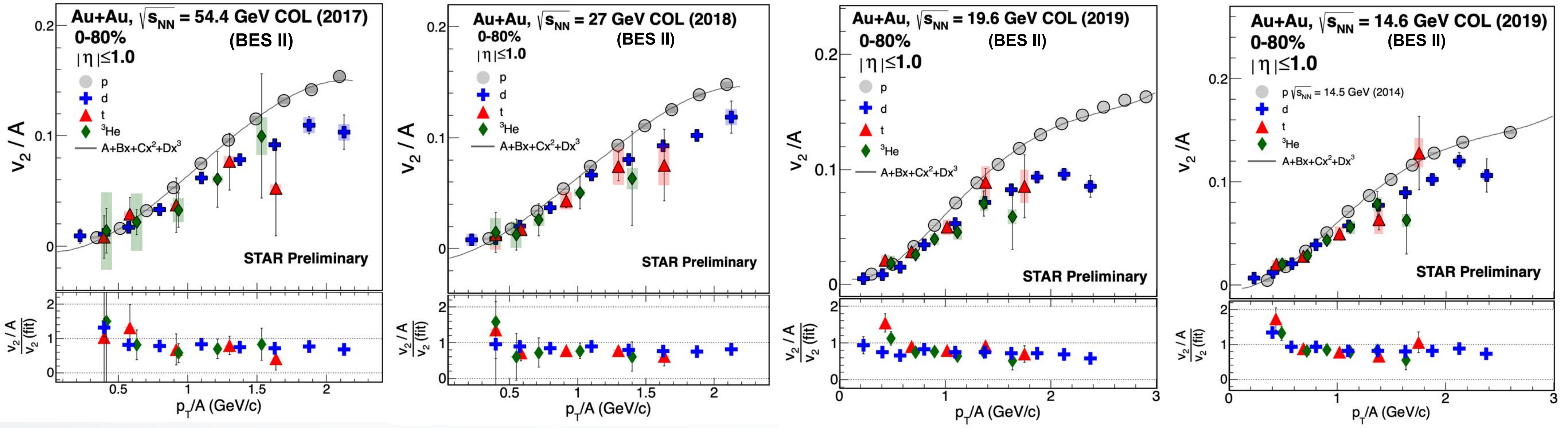
Centrality dependence



★ 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



3^{rd} order polynomial fit to the proton v_2 data

- ★ v_2/A of light nuclei is compared to the v_2 of protons to test mass number scaling
- ★ v_2 of light nuclei obeys the mass number scaling within 20-30%

Summary

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

- v_2 shows a clear centrality dependence
- Light nuclei v_2 seems to be obeying mass number scaling within 20-30%

Outlook

★ More exciting results to follow on light nuclei flow from BES-II energies

Thank you