Light Nuclei Flow

in $\sqrt{s_{NN}}$=3.2, 3.5, 3.9GeV Au+Au Collisions

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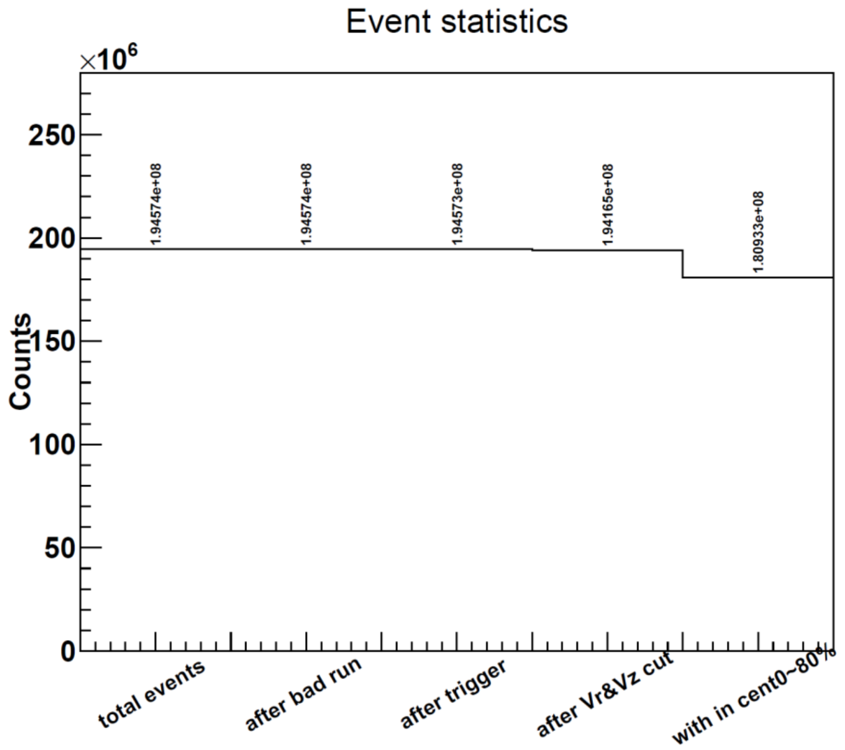
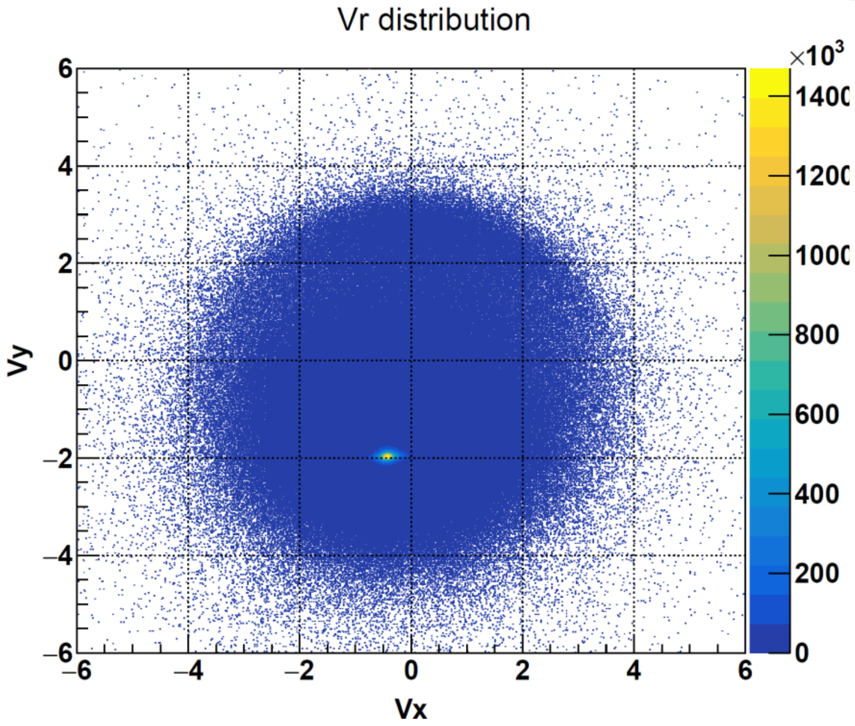
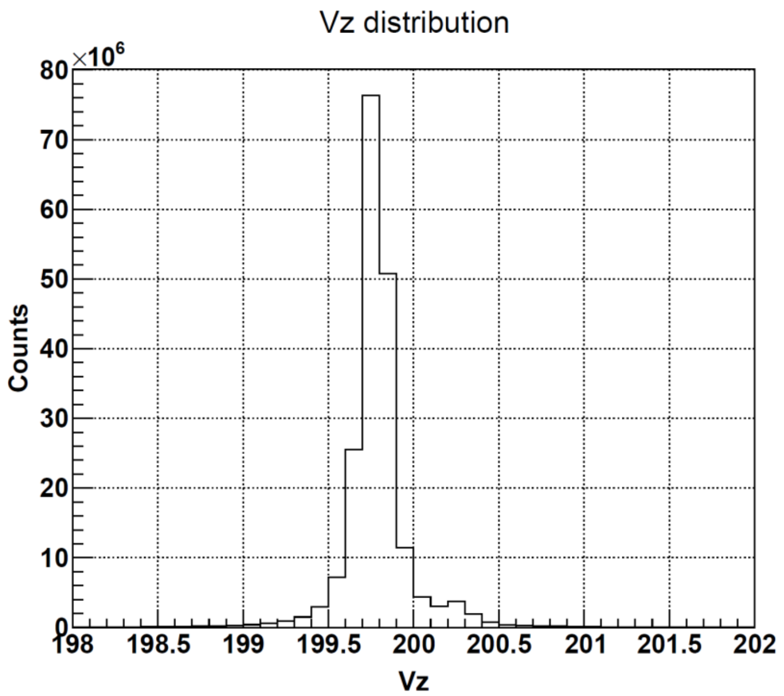
Outline

- **Dataset and event cuts**
- **Centrality definition and event plane reconstruction**
- **v_1 vs rapidity in 3.2, 3.5, 3.9GeV**
- **v_1 slope in 3.0, 3.2, 3.5, 3.9GeV**
- **v_2 vs rapidity in 3.2, 3.5, 3.9GeV**
- **Summary**

Dataset and event cuts (3.2GeV)







Systyem: Run 19, Au+Au 3.2GeV
Run number: 20179040-20183025(90 runs)
Bad run number: 20180005, 20180006, 20180019, 20180025, 20181016, 20182034, 20183001, 20183013, 20183014, 20183019

$$198\text{cm} < V_z < 202\text{cm}$$

$$\sqrt{V_x^2 + (V_y - 2)^2} < 2\text{cm}$$

$$DCA \leq 3\text{cm}$$

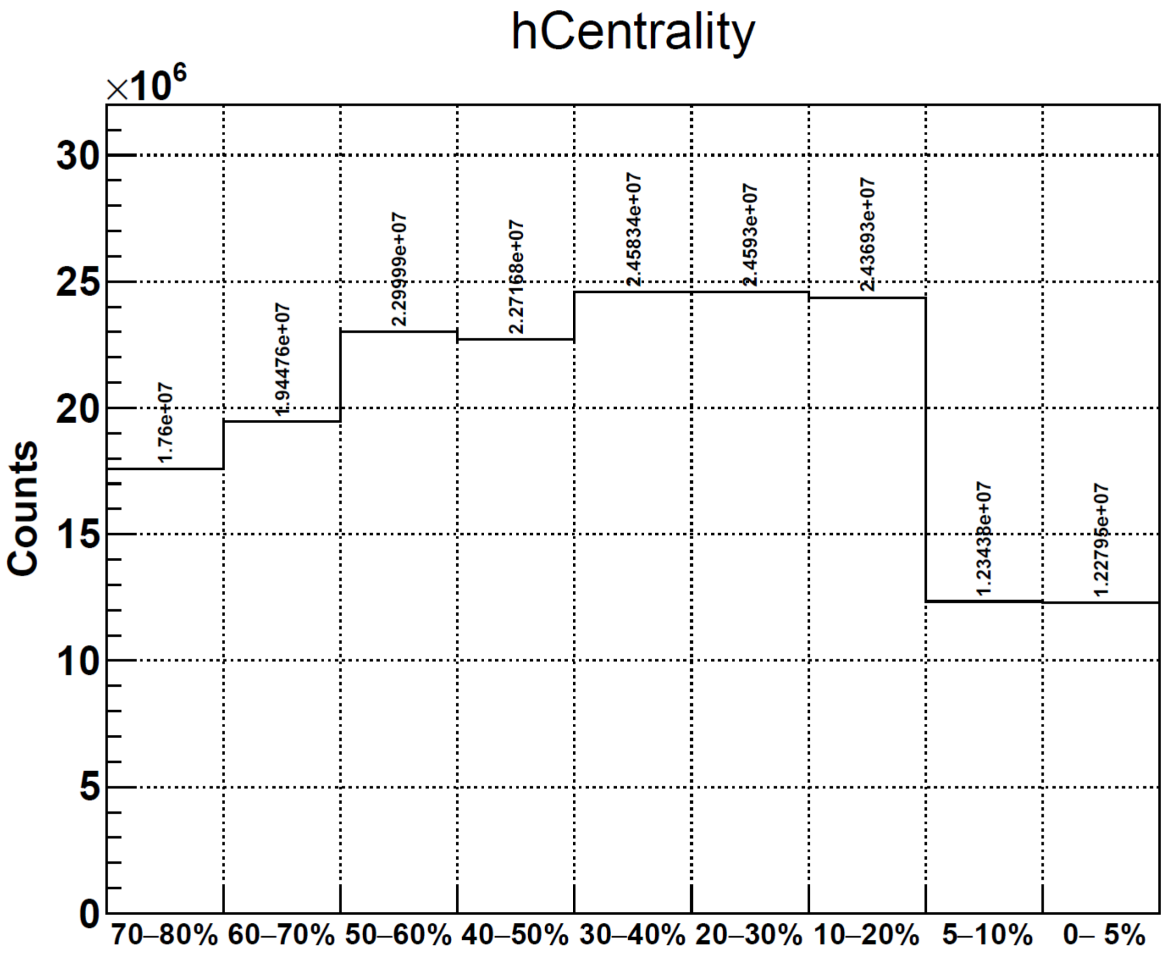
$$N_{Hits} \geq 15$$

$$N_{Hits}^{Fit} / N_{Hits}^{Max} > 0.52$$

Centrality definition in 3.2GeV(Done by Shaowei)

Centrality	RefMult cut
0 – 5%	198-290
5 – 10%	167-178
10 – 20%	120-167
20 – 30%	84-120
30 – 40%	56-84
40 – 50%	36-56
50 – 60%	21-36
60 – 70%	12-21
70 – 80%	6-12

From Shaowei Lan



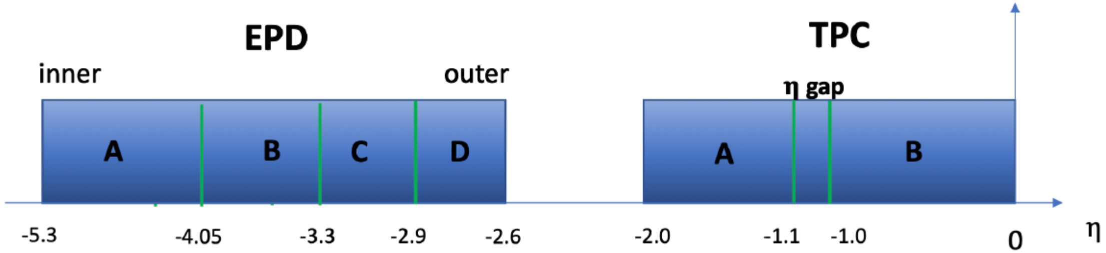
Event plane reconstruction in 3.2GeV (Done by Li-Ke)

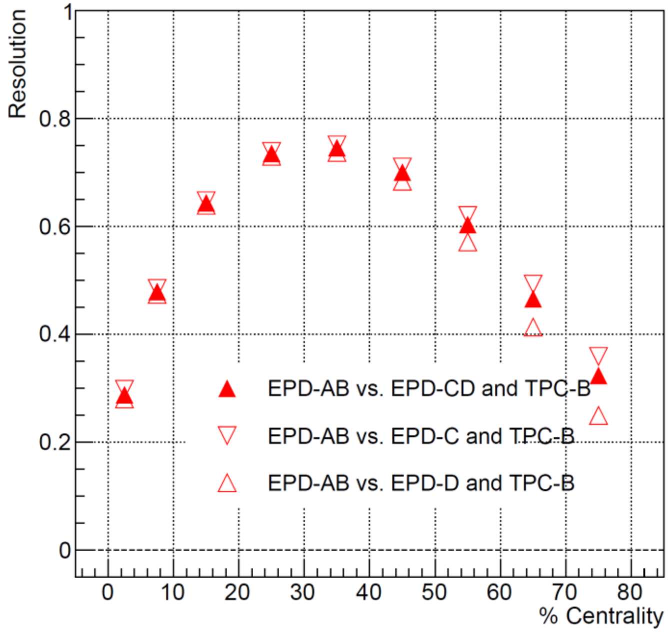
https://drupal.star.bnl.gov/STAR/system/files/Kaons_flow_FCV_0629.pdf

Event plane reconstruction

- ➢ EP reconstrution : Q vector method
- ➢ Re-centering and shift calibration
- ➢ Event plane resolution : three sub-events method (EPD-AB vs. EPD-C and TPC-B)

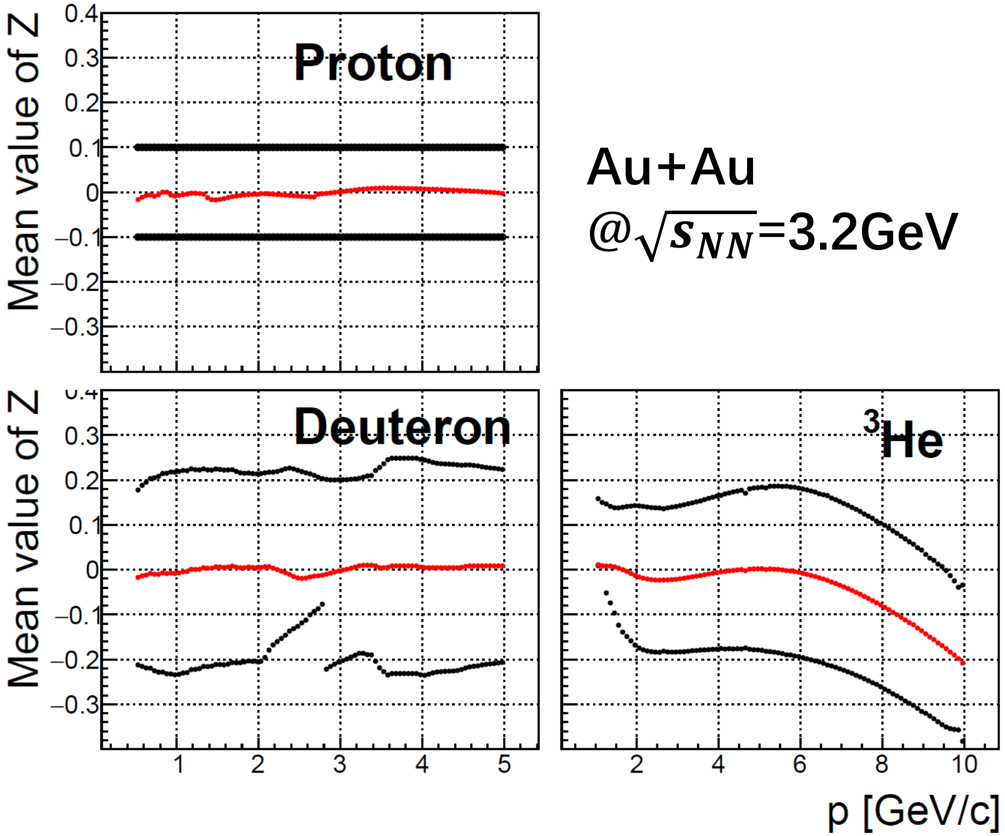
- Signal with centrality in 40-80% have very little counts;
- Choose events with a centrality range: 10-40%;





The light nuclei z distribution in different momentum bins

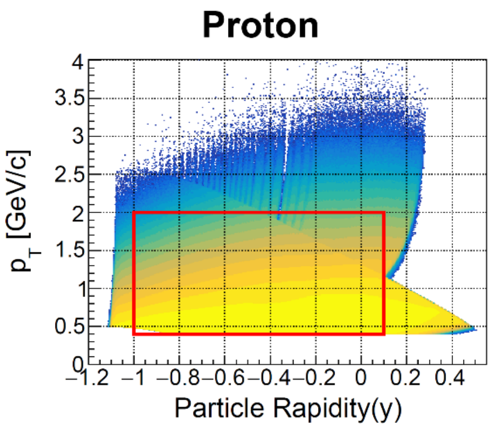
- We used a momentum dependent z cut to guarantee the high purity (>98%)
- The m^2 values used in the selection of the light nuclei

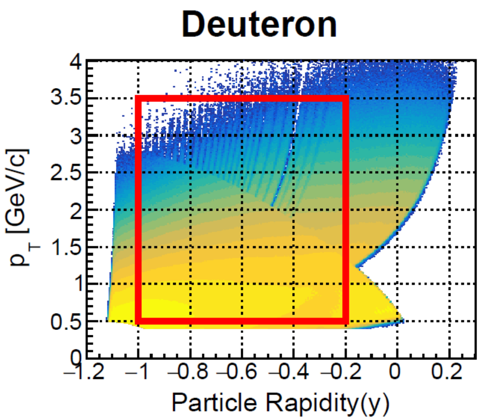


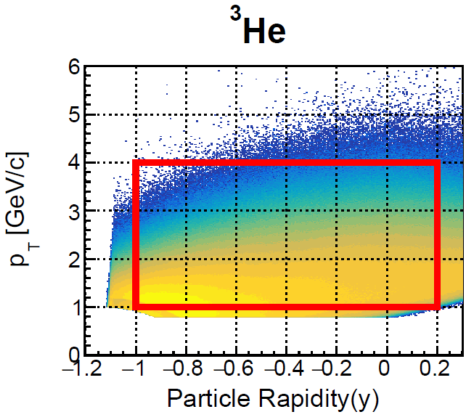
proton	$0.6 < m^2/q^2 < 1.2$ ($p > 2.6GeV$)
deuteron	$2.8 < m^2/q^2 < 4.8$ ($p > 2.8GeV$)
^3He	/

Acceptance

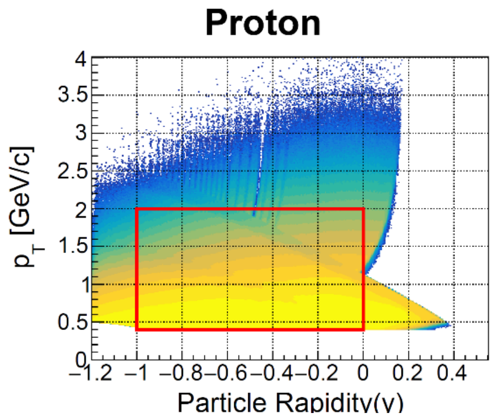
Au+Au
@$\sqrt{s_{NN}}$=3.2GeV

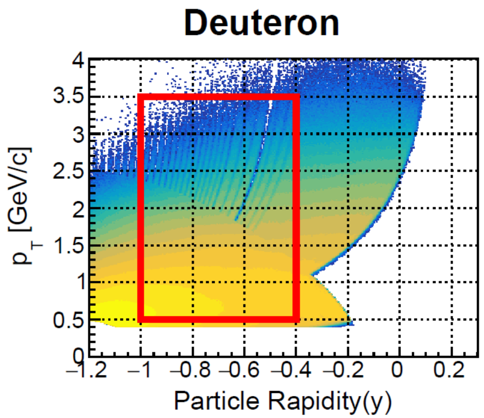


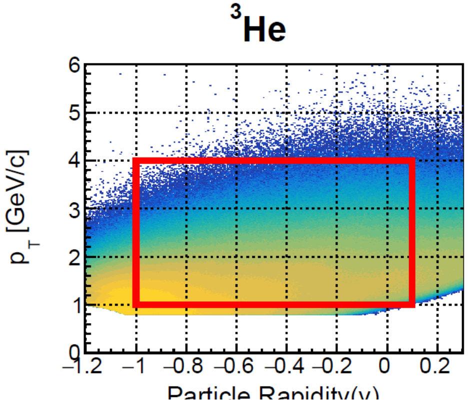




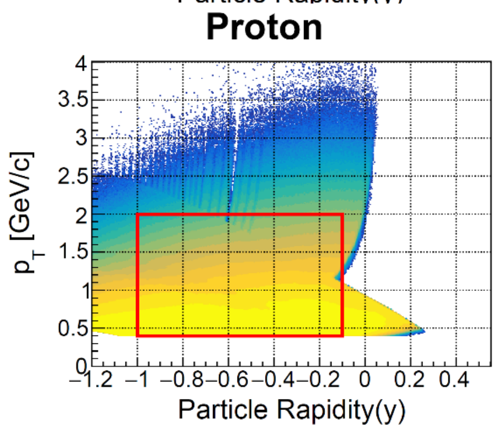
Au+Au
@$\sqrt{s_{NN}}$=3.5GeV

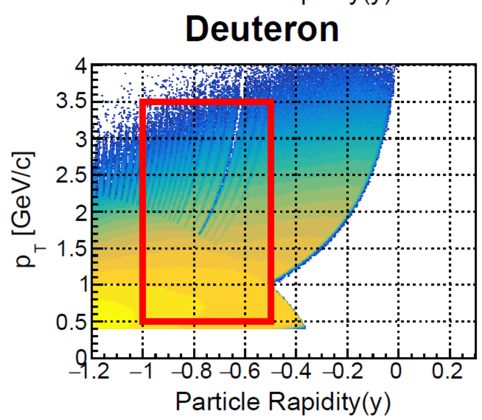


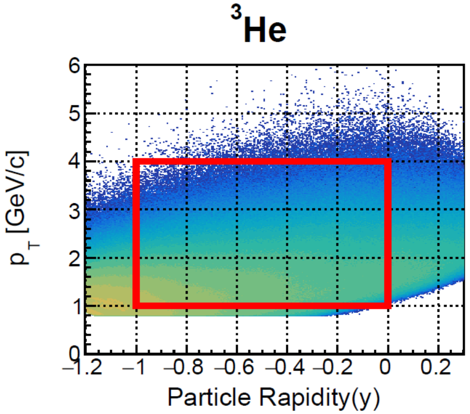




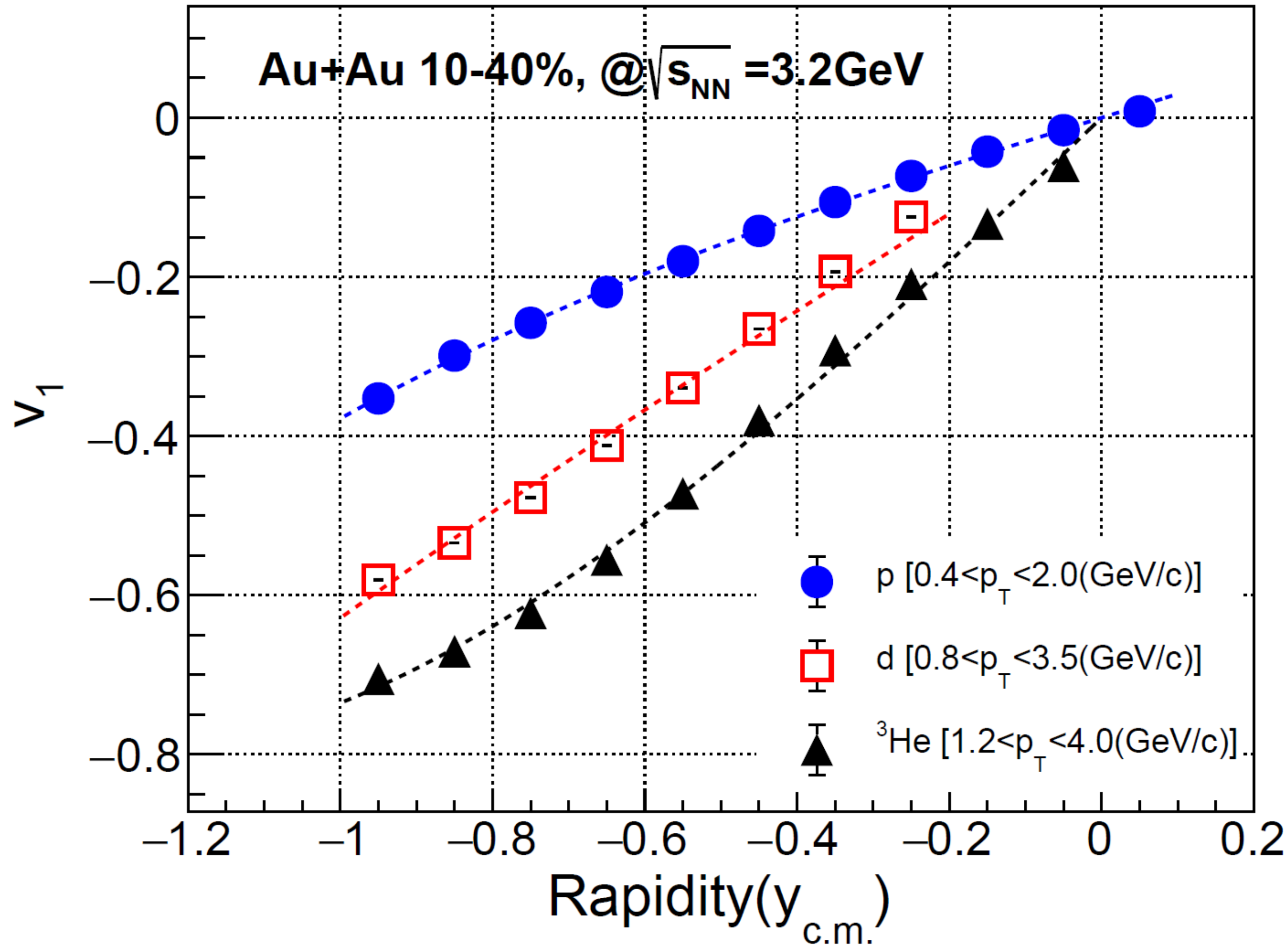
Au+Au
@$\sqrt{s_{NN}}$=3.9GeV







v_1 vs rapidity in 3.2GeV

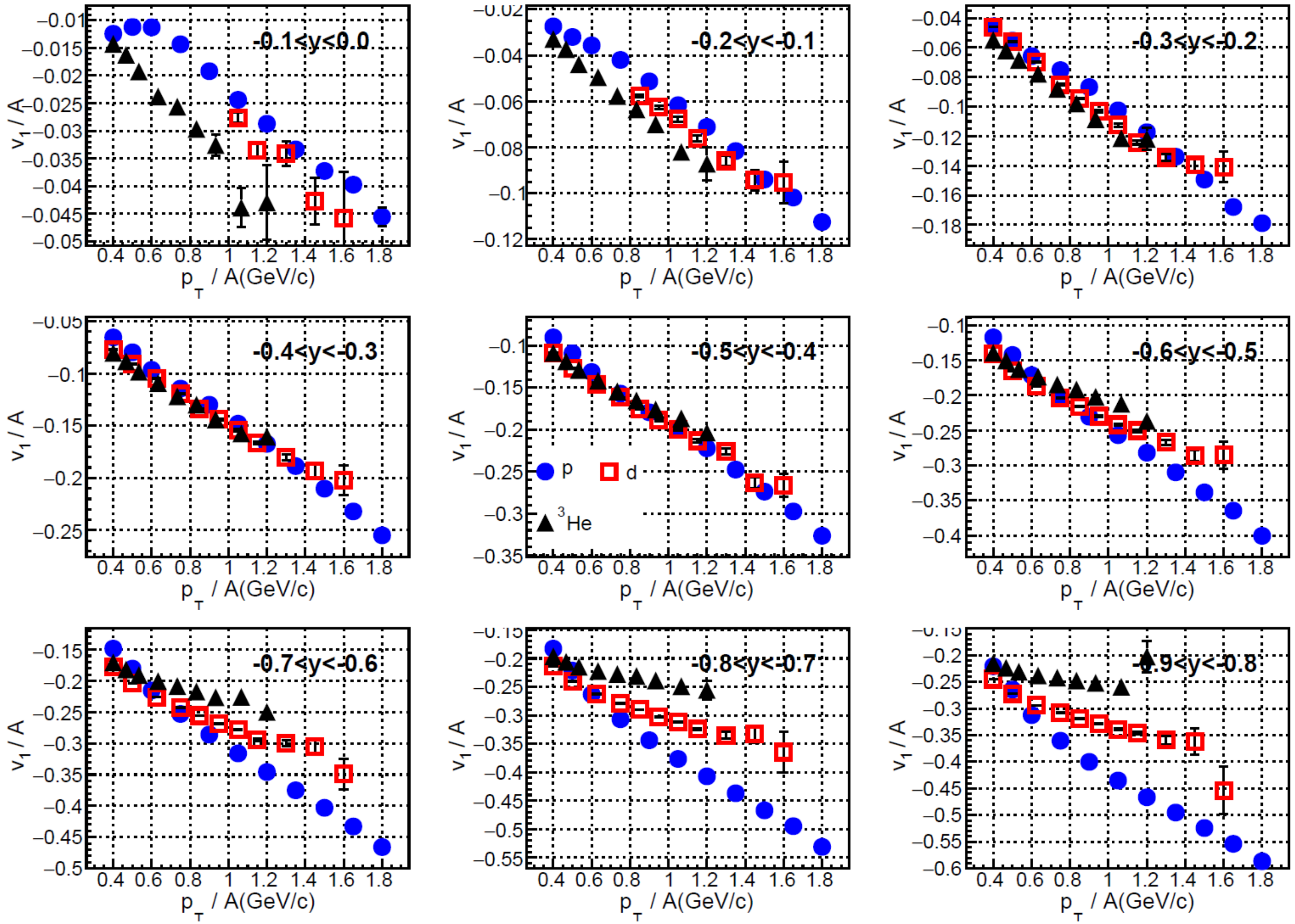


Fit function : f(x) $= ax^3 + bx$

3.2GEV		
Particle	p_T/A range	v_1/A
p	(0.4,2.0)	0.2982±0.00012
d	(0.4,3.5/2)	0.3013±0.00014
^3He	(0.4,4.0/3)	0.3038±0.00034

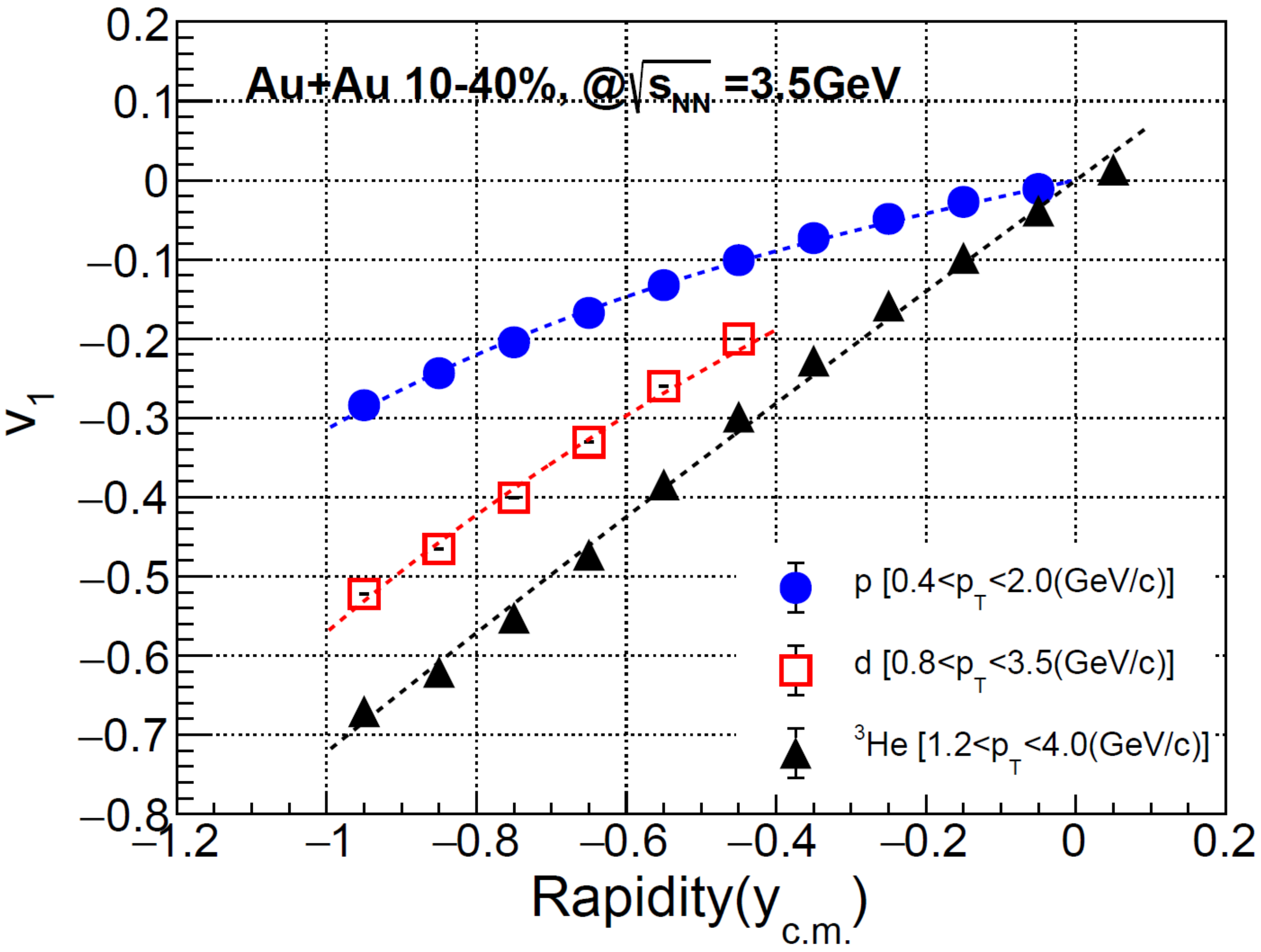
With the increase of nucleus mass, the v_1 slope becomes larger, compatible with A scaling.

v_1 vs p_T in 3.2GeV



- The slope of v_1 is compatible with A scaling for p, d and ^{3}He only in -0.5<y<-0.2.
- In -0.1<y<0, the value of v_1 of proton does not approach to 0 when p_t tends to 0. This may be due to the lower purity in low p_t.

v_1 vs rapidity in 3.5GeV

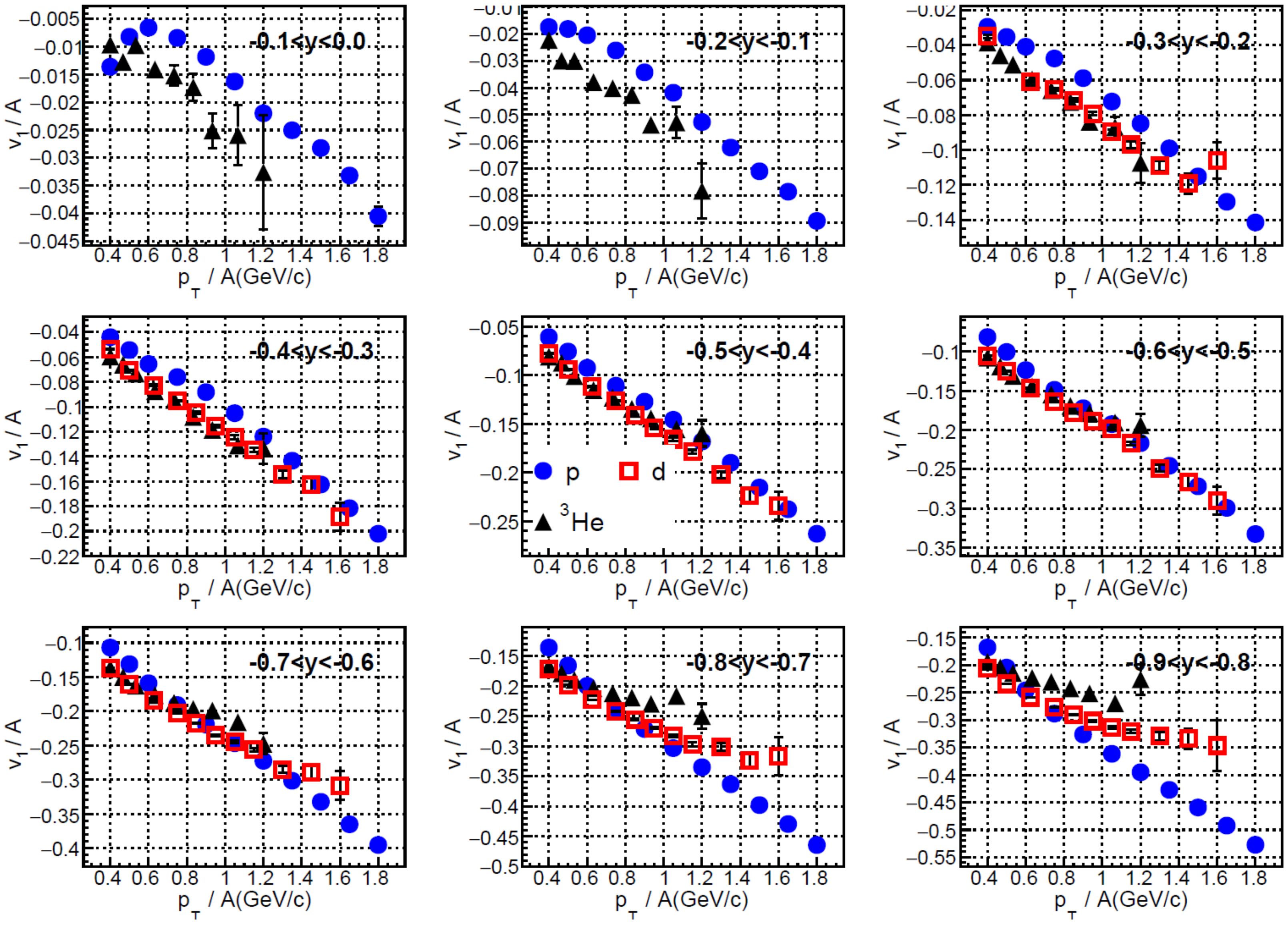


Fit function : $f(x) = ax^3 + bx$

3.5GEV		
Particle	p_T/A range	v_1/A
p	(0.4,2.0)	0.2062±0.00015
d	(0.4,3.5/2)	0.2265±0.00027
^3He	(0.4,4.0/3)	0.2335±0.00060

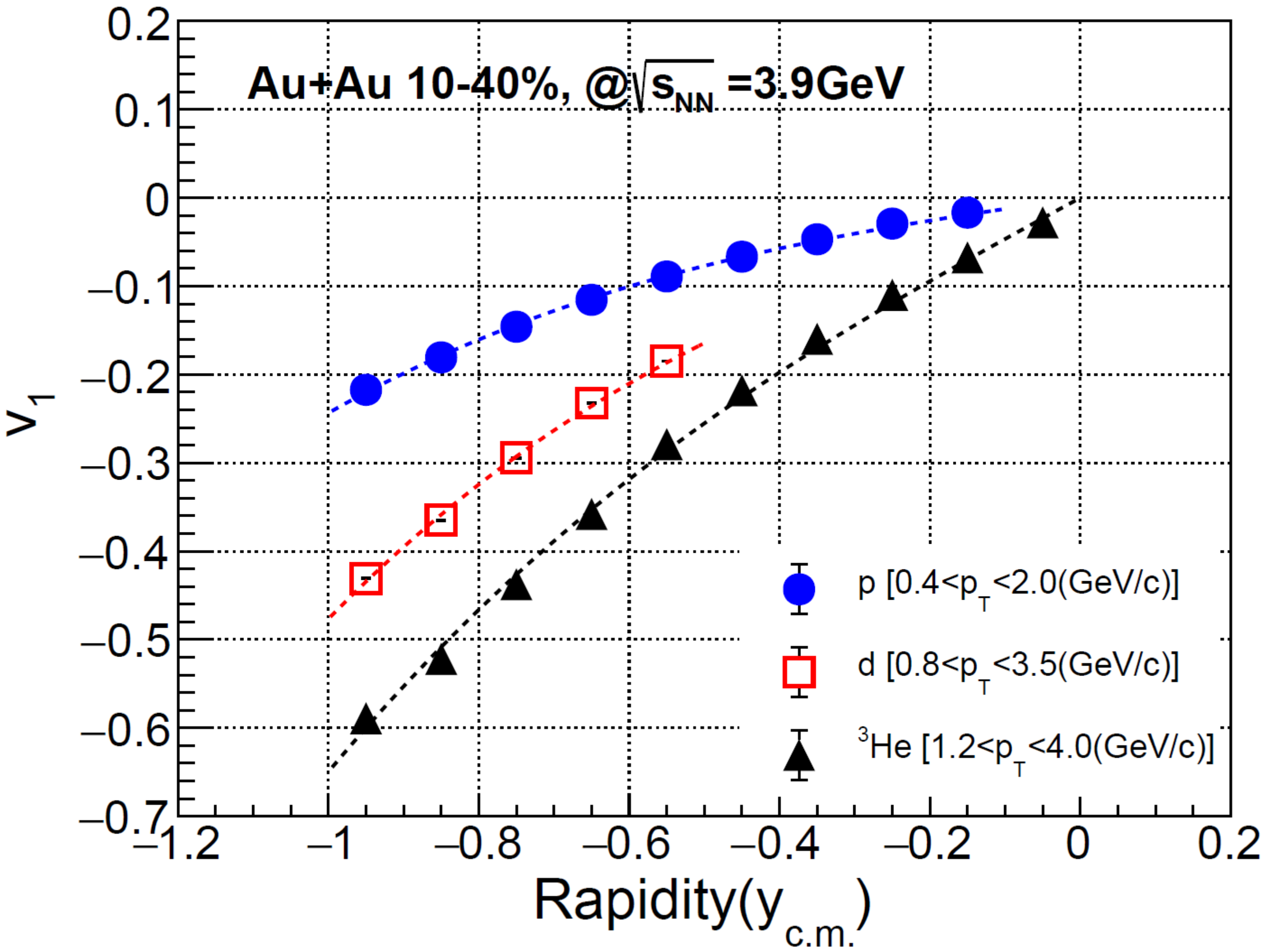
With the increase of nucleus mass, the v_1 slope becomes larger, compatible with A scaling.

v_1 vs p_T in 3.5GeV



- The slope of v_1 is compatible with A scaling for p, d and ^{3}He only in -0.7<y<-0.2.
- In -0.1<y<0, the value of v_1 of proton does not approach to 0 when p_t tends to 0. This may be due to the lower purity in low p_t.

v_1 vs rapidity in 3.9GeV

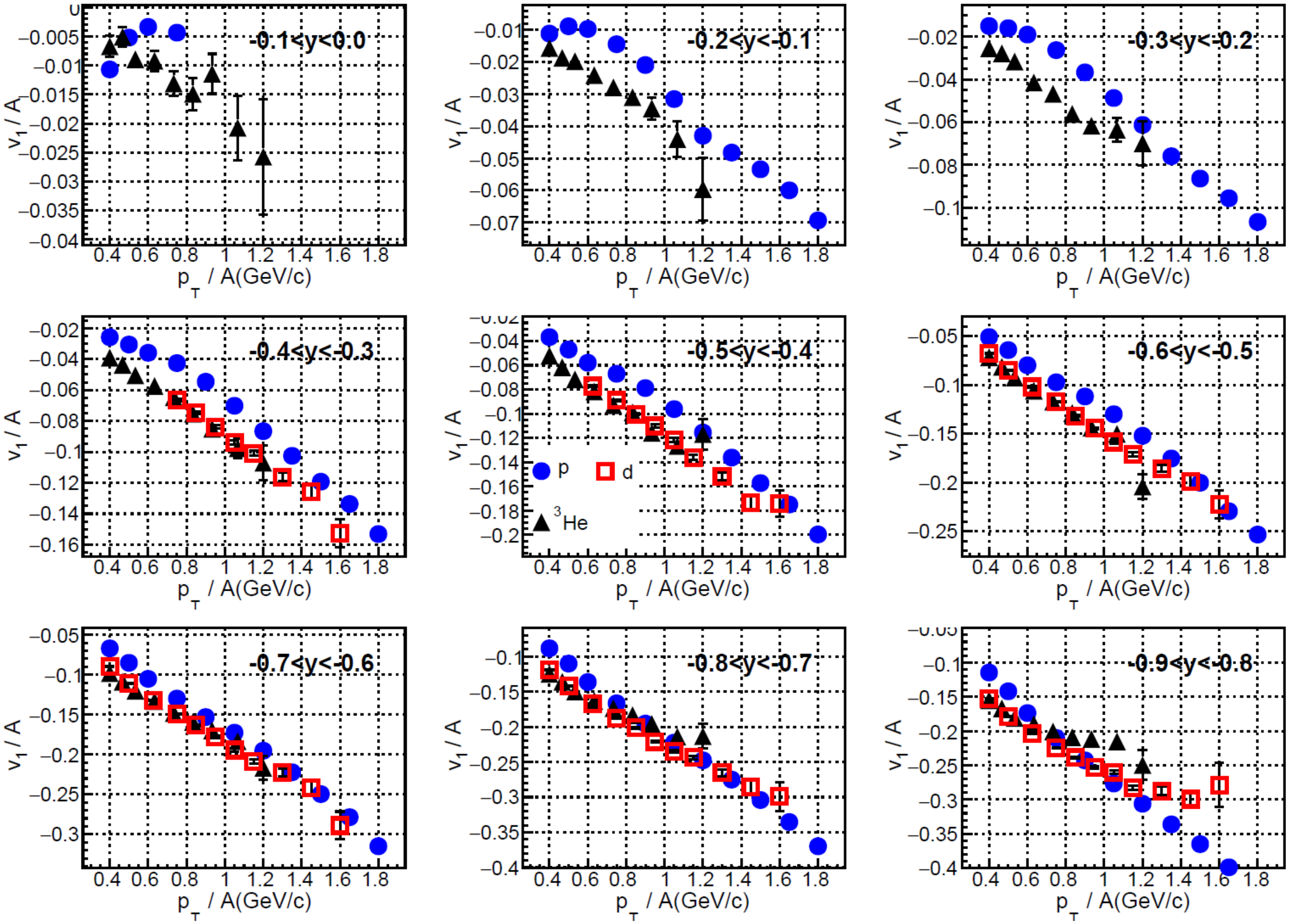


Fit function : $f(x) = ax^3 + bx$

3.9GEV		
Particle	p_T/A range	v_1/A
p	(0.4,2.0)	0.1244±0.00017
d	(0.4,3.5/2)	0.1398±0.00039
^3He	(0.4,4.0/3)	0.1548±0.00081

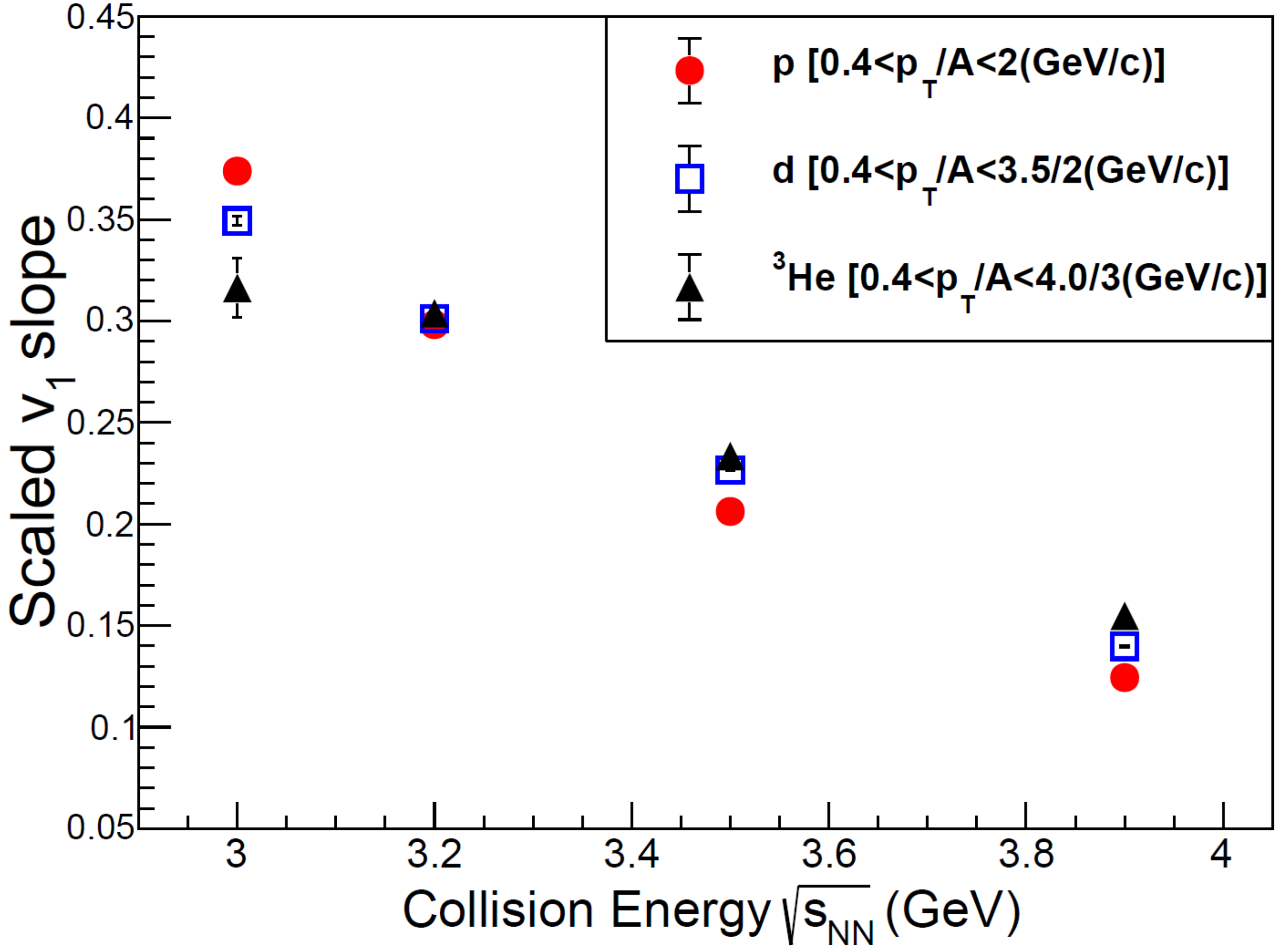
- With the increase of nucleus mass, the v_1 slope becomes larger, compatible with A scaling.
- The trend of v_1 vs rapdity is different from lower collison.

v_1 vs p_T in 3.9GeV



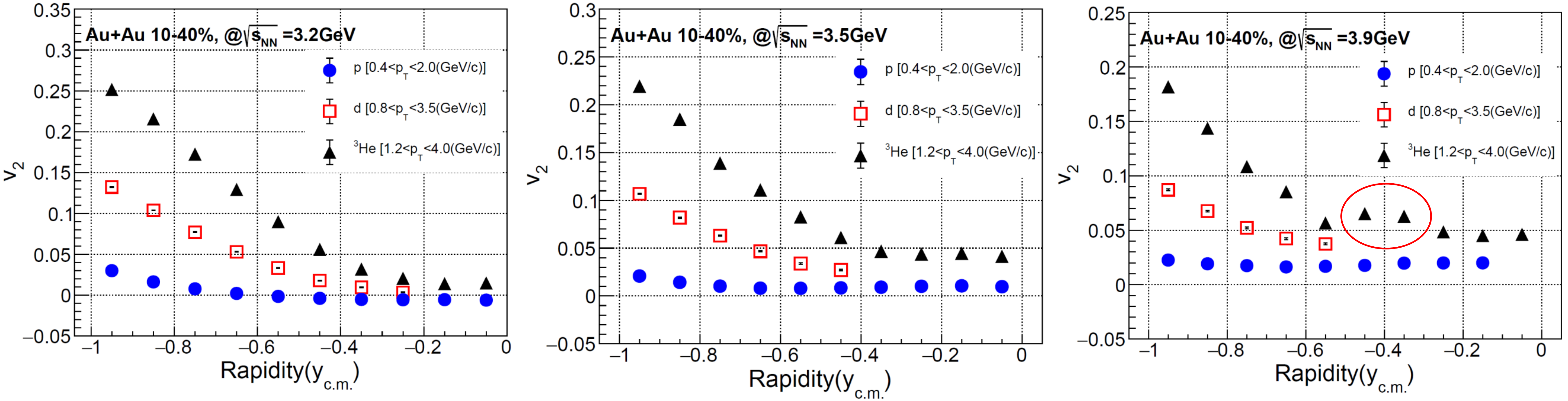
- The slope of v_1 is compatible with A scaling for p, d and ^{3}He only in -0.8<y<-0.4.
- In -0.2<y<0, the value of v_1 of proton does not approach to 0 when p_t tends to 0. This may be due to the lower purity in low p_t.

v_1 slope in 3.0, 3.2, 3.5, 3.9 GeV



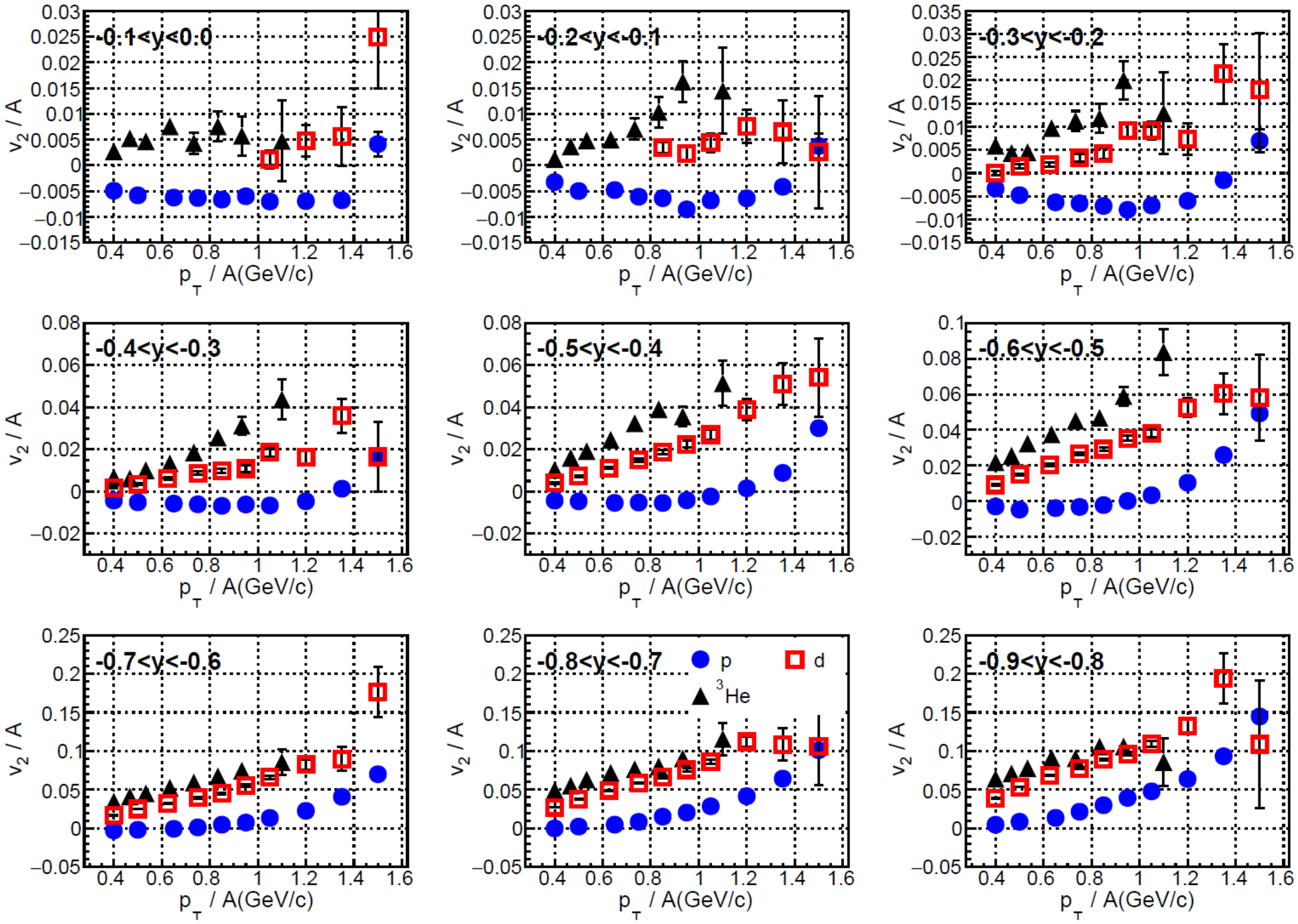
The v_1 slope of protons and light nuclei decreases with increasing energy.

v_2 vs rapidity in 3.2, 3.5, 3.9GeV

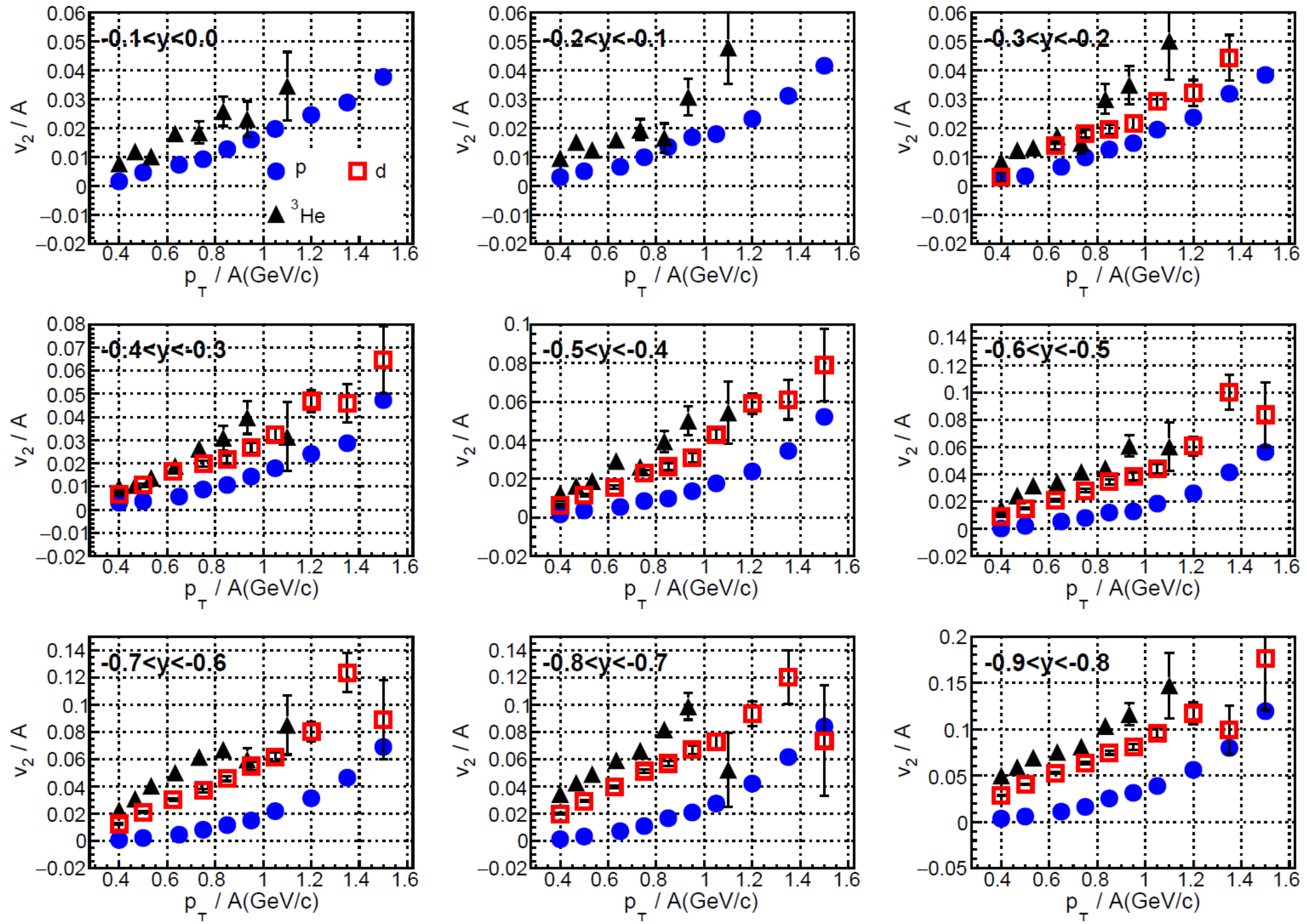


- For proton, the values of v_2 are negative in mid-rapidity at 3.2GeV, while the values turn to be positive in mid-rapidity at 3.5, 3.9GeV
- For ^{3}He, the values of v_2 are positive in mid-rapidity at 3.2, 3.5, 3.9GeV.
- For ^{3}He, there is a jump in -0.5<y<-0.3 at 3.9GeV.

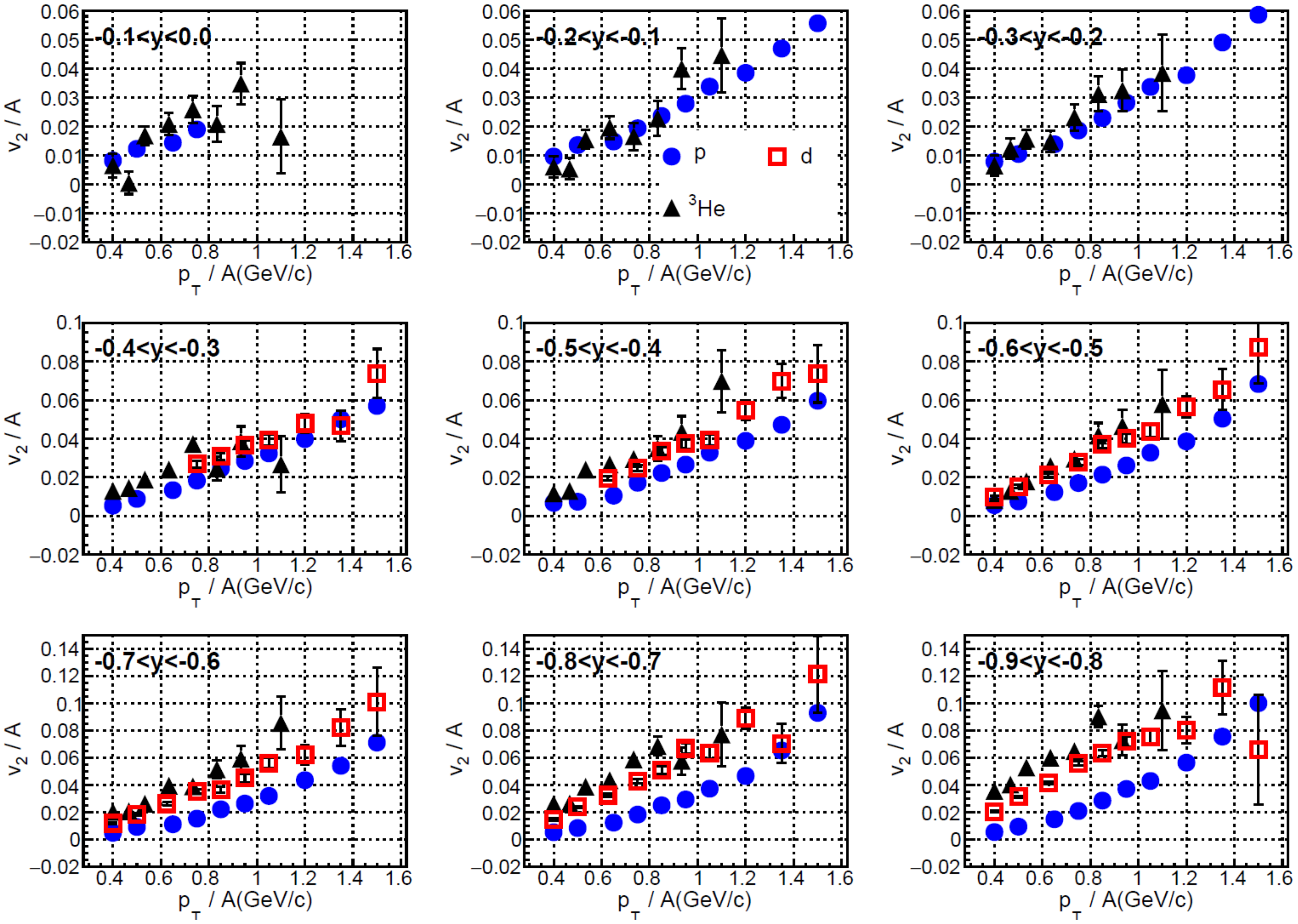
v_2 vs p_T in 3.2GeV



v_2 vs p_T in 3.5GeV



v_2 vs p_T in 3.9GeV



Summary

- **v_1 vs rapidity in 3.2, 3.5, 3.9GeV**
  - With the increase of nucleus mass, the v_1 slope becomes larger, compatible with A scaling
- **v_1 slope in 3.0, 3.2, 3.5, 3.9GeV**
  - The v_1 slope of protons and light nuclei decreases with increasing energy
- **v_2 vs rapidity in 3.2, 3.5, 3.9GeV**
  - For proton, the values of v_2 are negative in mid-rapidity at 3.2GeV, while the values turn positive in mid-rapidity at 3.5, 3.9GeV
  - For ^{3}He, the values of v_2 are positive in mid-rapidity at 3.2, 3.5, 3.9GeV

Next

- **Calculate the systematic uncertainty**
- **Efficiency correction (need embedding data)**

Thank you!

Embedding requests for light nuclei in AuAu3.5GeV 2020 and AuAu3.9GeV 2020

Yue Xu

2023.1.4

Embedding requests for light nuclei in AuAu3.5GeV 2020

Embedding request shoule be:

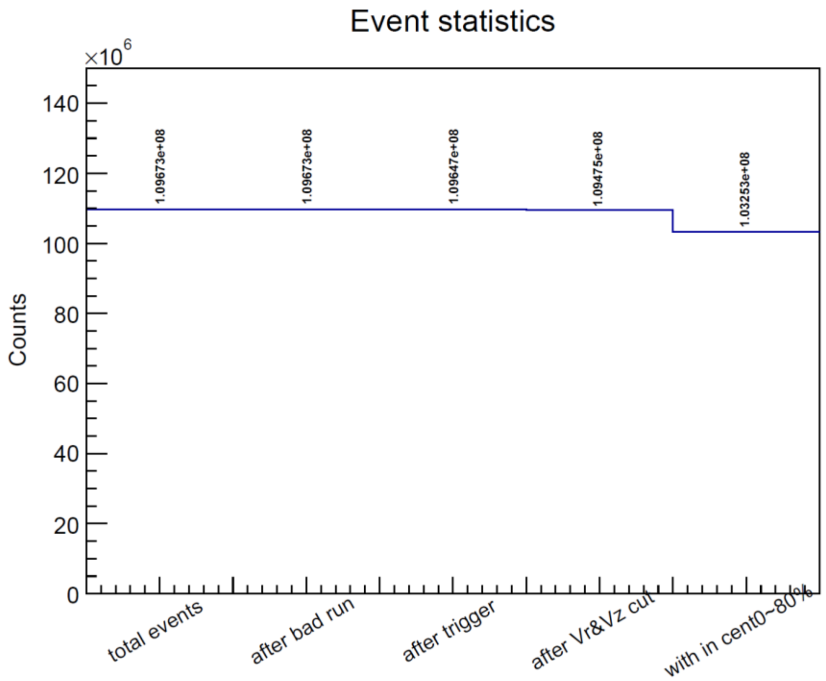
- Real data: 2020 FXT 5.75GeV ($\sqrt{s_{NN}}$=3.5GeV)
- Trigger Id = 720000
- Production tag: P21id
- Particle: proton, deuteron, triton, helium3 and helium4
- Particles per event 5% mult
- $198\text{cm} < V_z < 202\text{cm}$, $\sqrt{V_x^2 + (V_y - 2)^2} < 2\text{cm}$
- Kinematic: flat p_t: [0,5]GeV/c; flat y: [-1.2,0.8]; flat phi: [0,2π]
- Statistics requested: 2.5 M for each particle
- Other event cuts: no

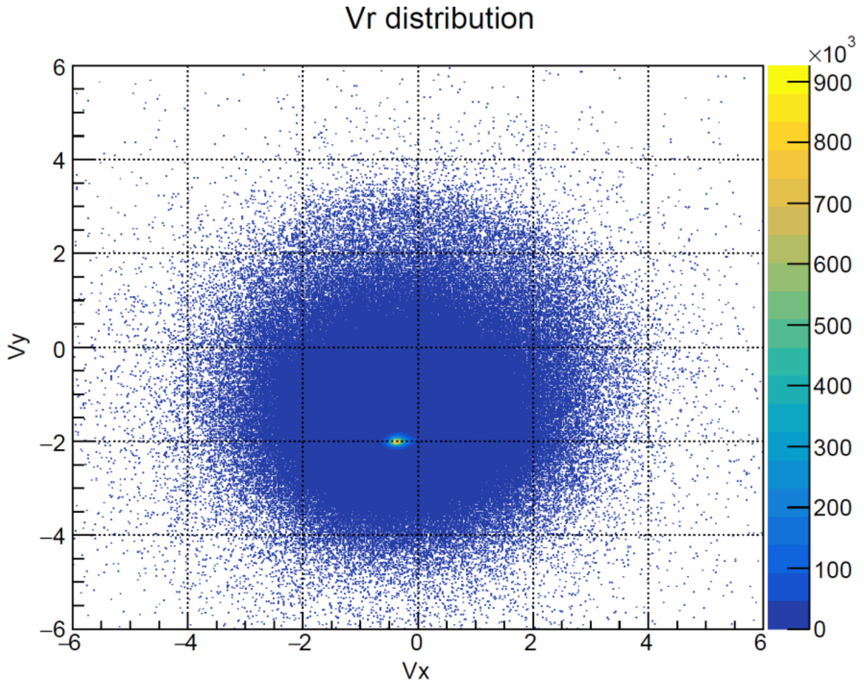
Embedding requests for light nuclei in AuAu3.9GeV 2020

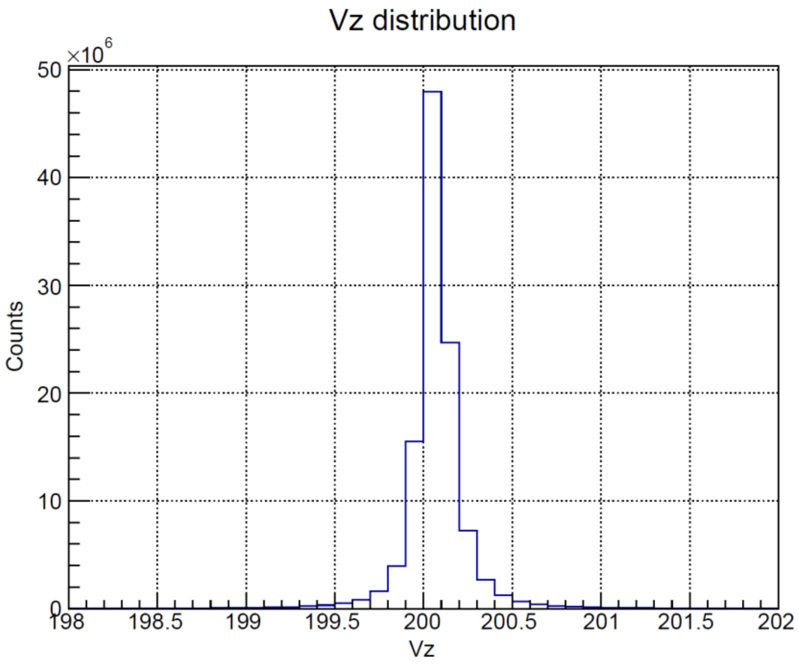
Embedding request shoule be:

- Real data: 2020 FXT 7.3GeV ($\sqrt{s_{NN}}$=3.9GeV)
- Trigger Id = 730000
- Production tag: P21id
- Particle: proton, deuteron, triton, helium3 and helium4
- Particles per event 5% mult
- $198cm < V_z < 202cm$, $\sqrt{V_x^2 + (V_y - 2)^2} < 2$cm
- Kinematic: flat p_t: [0,5]GeV/c; flat y: [-1.2,0.8]; flat phi: [0,2π]
- Statistics requested: 2.5 M for each particle
- Other event cuts: no

Backup -Dataset and event cuts (3.5GeV)



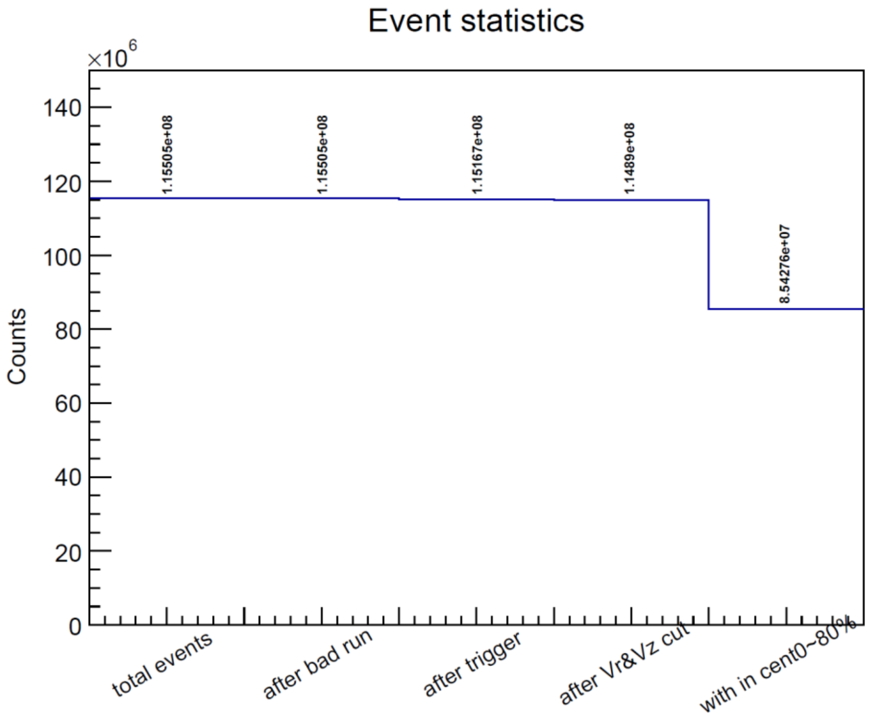


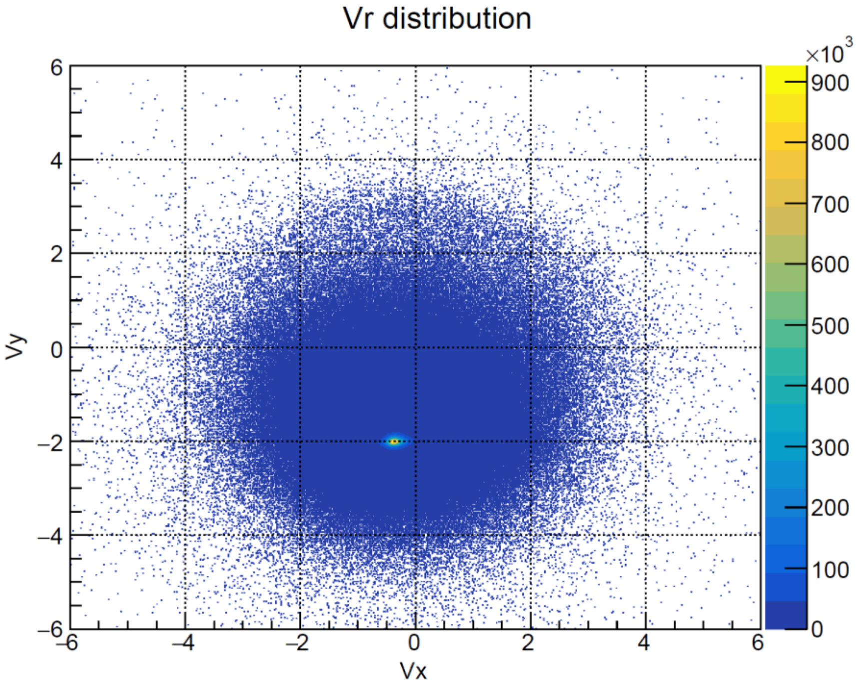


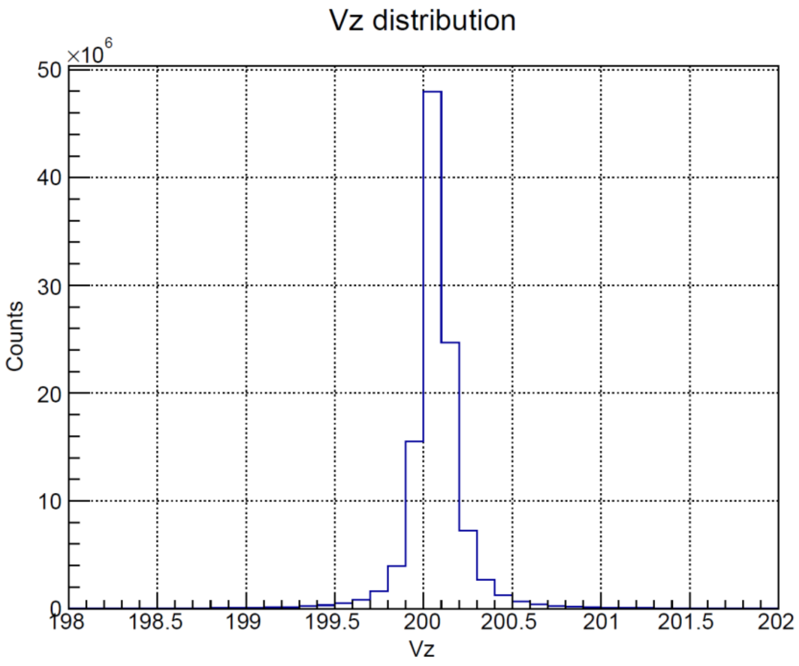
Systyem: Run 20, Au+Au 3.5GeV
Run number:20355020-21045011 (31 runs)
Bad run number: 20355021, 21044023, 21045011

$$198 < V_z < 202$$
$$\sqrt{V_x^2 + (V_y - 2)^2} < 2$$
$$DCA \leq 3cm$$
$$N_{Hits} \geq 15$$
$$N_{Hits}^{Fit}/N_{Hits}^{Max} > 0.52$$

Backup -Dataset and event cuts (3.9GeV)





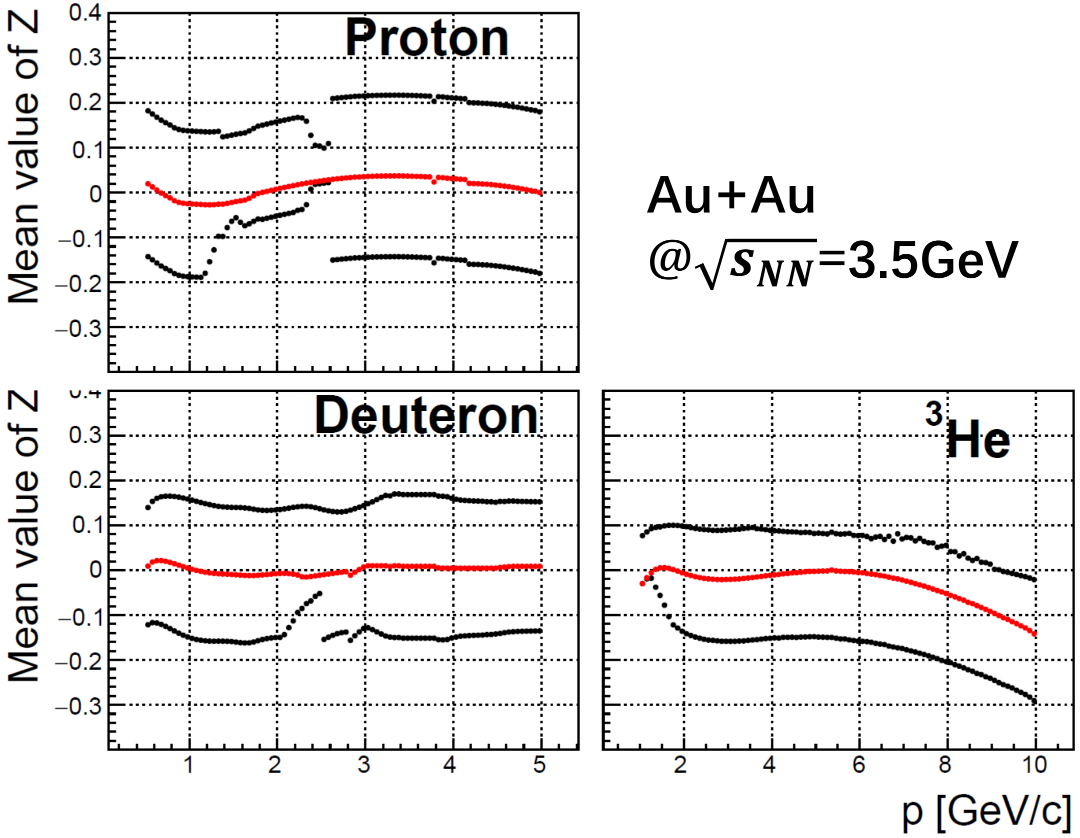


Systyem: Run 20, Au+Au 3.9GeV
Run number: 21035004-21036013 (32 runs)
Bad run number:
21035006,21035025,21035031,21036007

$$198 < V_z < 202$$
$$\sqrt{V_x^2 + (V_y - 2)^2} < 2$$
$$DCA \leq 3cm$$
$$N_{Hits} \geq 15$$
$$N_{Hits}^{Fit} / N_{Hits}^{Max} > 0.52$$

Backup - The light nuclei z distribution in different momentum bins

- We used a momentum dependent z cut to guarantee the high purity (>98%)
- The m^2 values used in the selection of the light nuclei



proton	$0.6 < m^2/q^2 < 1.2$ $(p > 2.6GeV)$
deuteron	$2.8 < m^2/q^2 < 4.8$ $(p > 2.5GeV)$
^3He	/

Backup - The light nuclei z distribution in different momentum bins

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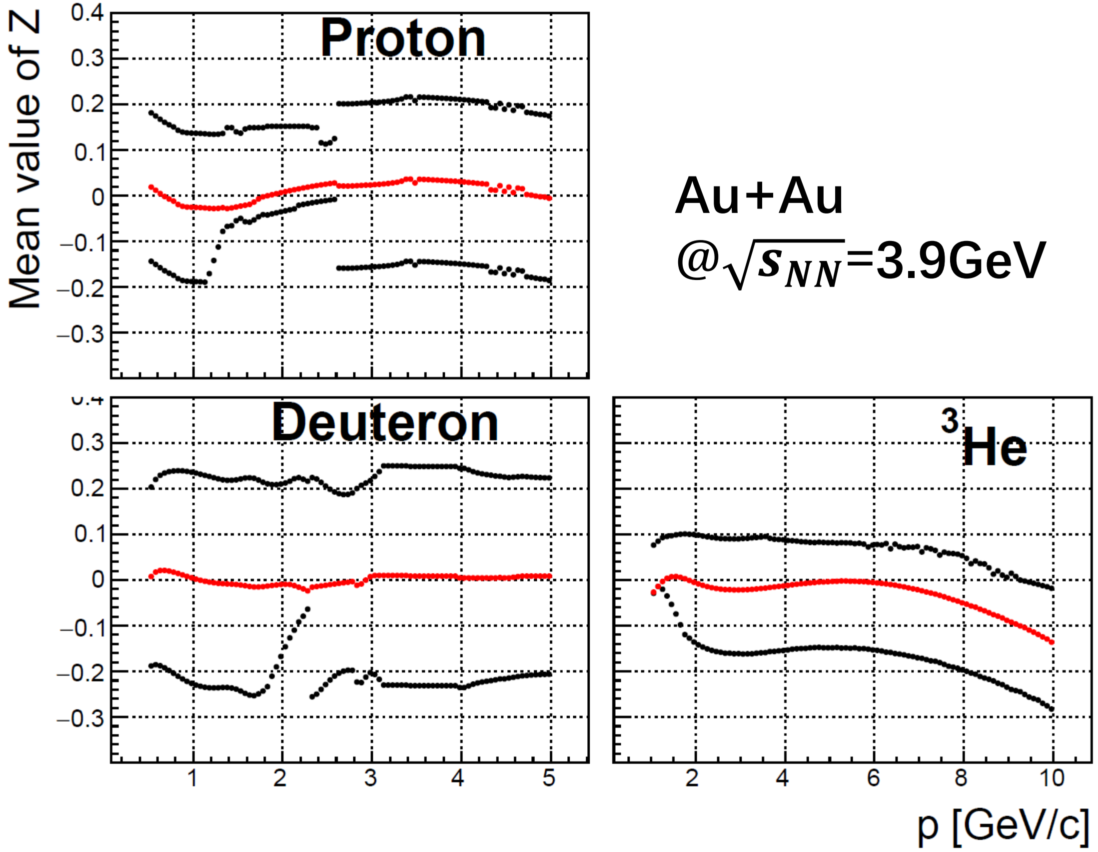

proton	$0.6 < m^2/q^2 < 1.2$ $(p > 2.6GeV)$
deuteron	$2.8 < m^2/q^2 < 4.8$ $(p > 2.3GeV)$
^{3}He	/

v_2 vs rapidity in 3.0GeV