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Elliptic Flow Splitting Between Particles and Antiparticles in Au+Au Collisions from the AMPT Model

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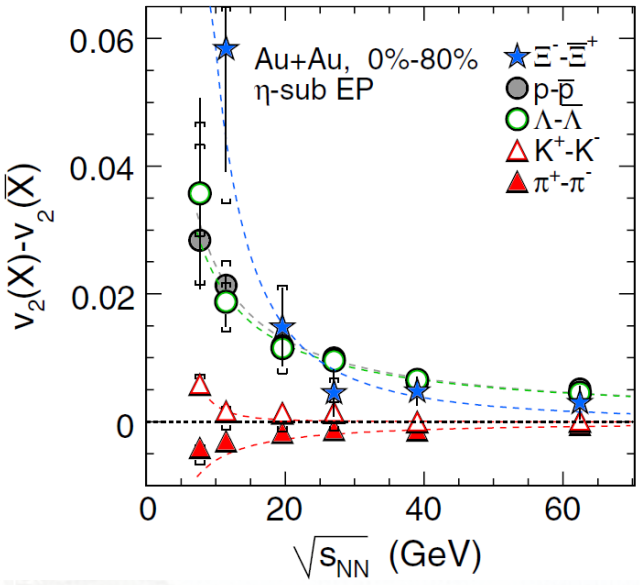
Introduction

Increased Δv_2 with decreasing beam energy

- Larger v_2 values are found for particles than for antiparticles, except for pions
- A monotonic increase of the magnitude of $\Delta v_2 = v_2(X) - v_2(\overline{X})$ with decreasing beam energy is observed
- Works on the origination of Δv_2



Adamczyk L, et al. PRL 110, 142301 (2013)

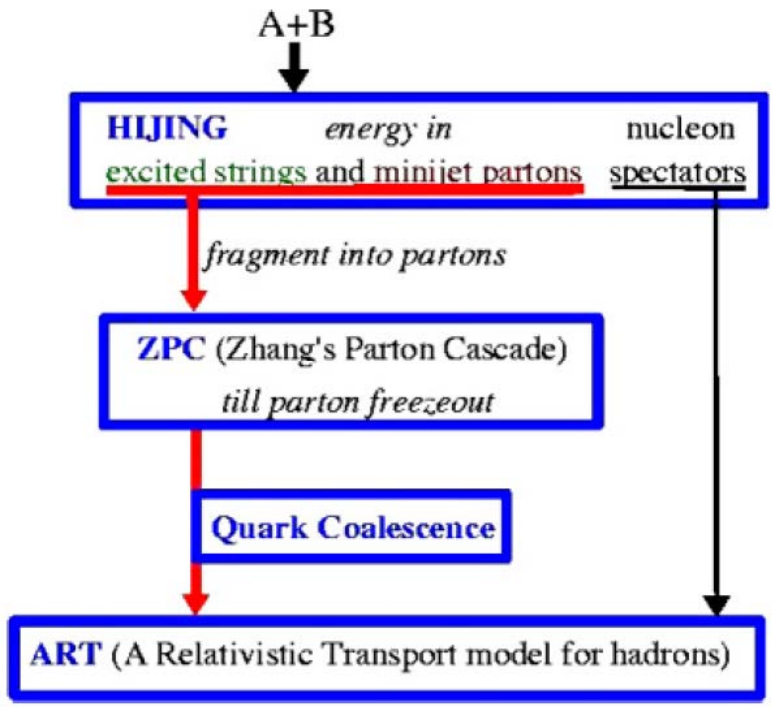
Dunlop J C, et al. PRC 84, 044914 (2011)
Xu J, et al. PRC 85, 041901 (2012)
Ko C M, et al. Nucl. Phys. A 928, 234 (2014)
Xu J, et al. PRL 112, 012301 (2014)
Xu J and Ko C M PRC 94, 054909 (2016)
… …

- A significant difference in the v_2 values between proton and antiproton is observed at all BES energies

Motivation: Search for possible origination of Δv_2 between proton and antiproton

The AMPT model

- The initial conditions are obtained from the HIJING model
- Scatterings among partons are modeled by ZPC
- A quark coalescence model is used in the combination of partons into hadrons
- The dynamics of the hadronic matter is described by a hadronic cascade, which is based on the ART model

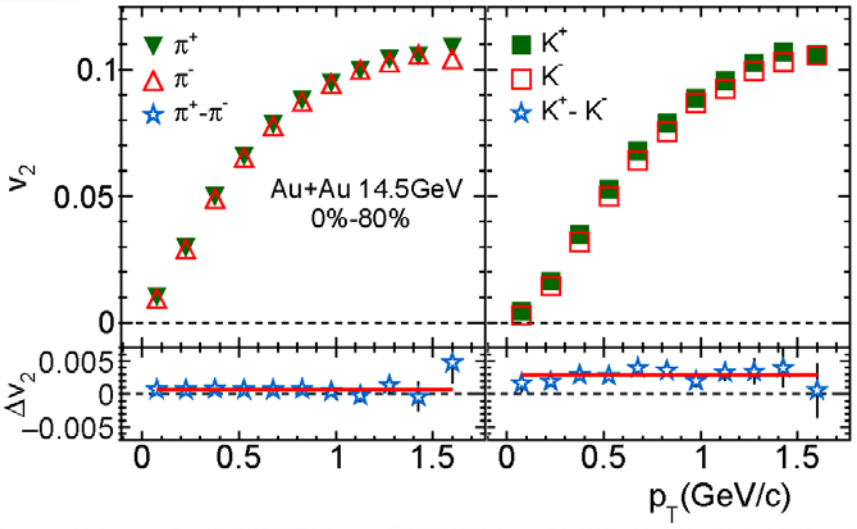


Structure of the AMPT model with string melting

Lin Z W, et al. PRC 72, 064901 (2005)

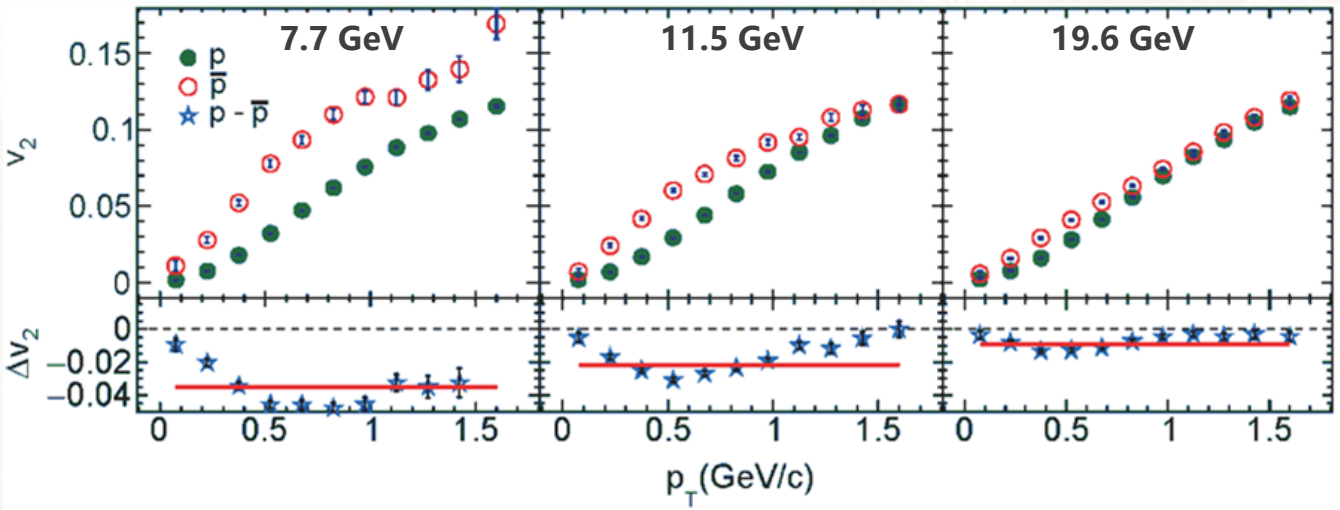
"coordinate coalescence"

- Elliptic flow splitting in the AMPT model



- Real plane is used in the calculation for the effect of event plane fluctuation to Δv_2 is small
- Δv_2 of π^+ and π^-， K^+ and K^- are not obvious
- A significant Δv_2 between p and $\bar{p}$ is observed
- Δv_2 of p and $\bar{p}$ is caused by quark coalescence process

CPL, 2017, 34: 062501



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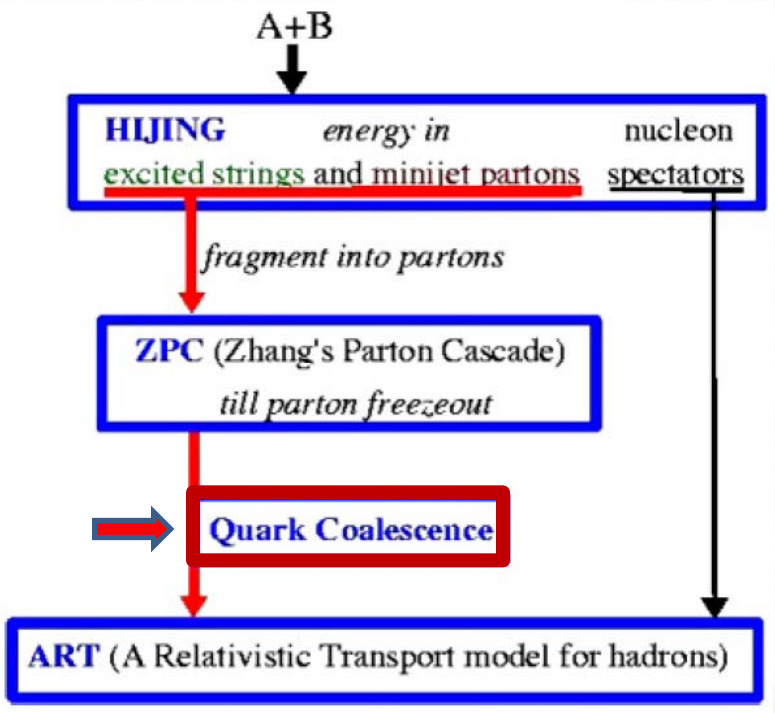
The Changes in the Quark Coalescence Model

- "The current quark coalescence model in AMPT searches for a meson partner before searching for baryon or antibaryon partners"

  He Y, Lin Z W. PRC 96, 014910 (2017)

- Do some changes on the quark coalescence process
  - Adjust the formation order of mesons and (anti)baryons
  - "coordinate coalescence" but with momentum limit Δp_0

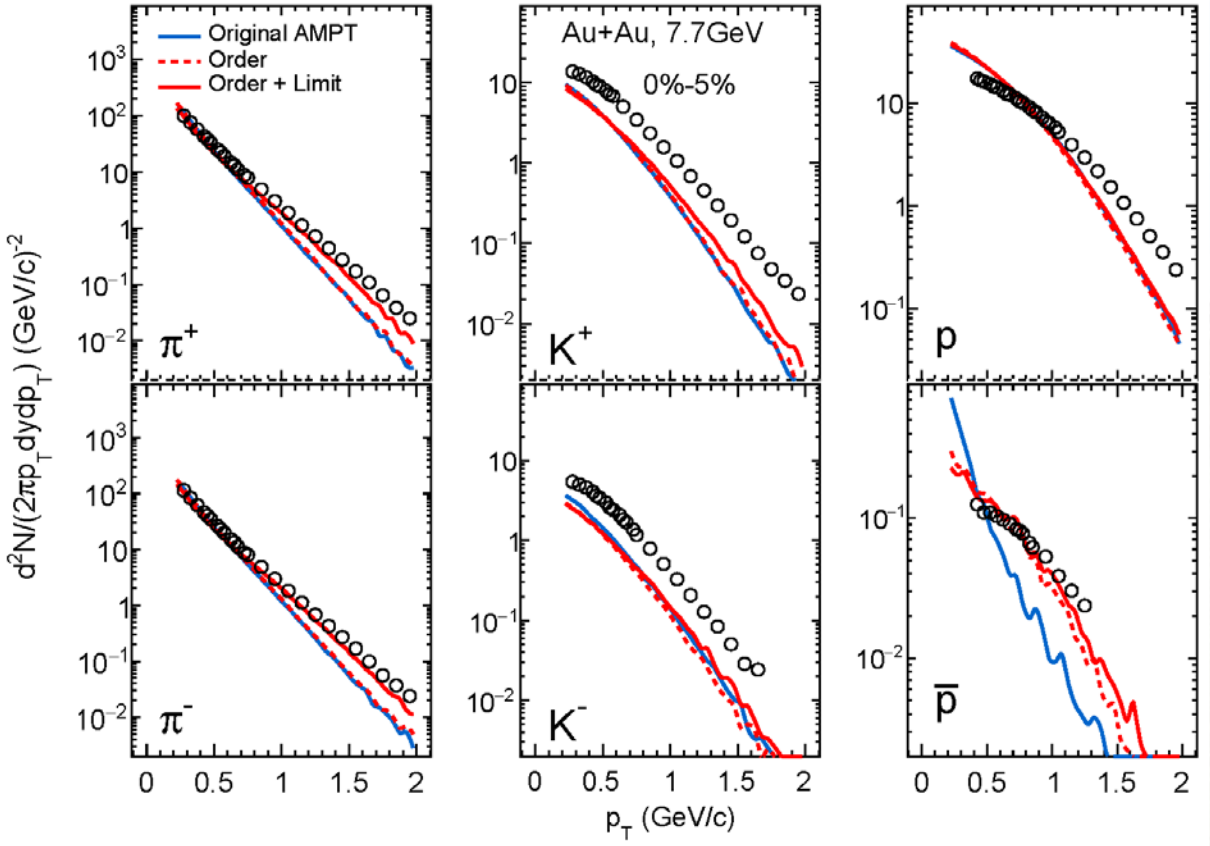
$$\begin{cases} \Delta r_{\text{new}} < \Delta r_{\text{old}} \\ \Delta p_{\text{new}} < \Delta p_0 \end{cases}$$



Structure of the AMPT model with string melting

Results -- Transverse Momentum Spectra

- For charged pions, the slope of the p_T spectra decreases for the yields increases at p_T range of (~0.8, 2GeV)
- The transverse momentum spectra of antiproton is improved



- The charged particle yield and the slopes of the p_T spectra will be affected by Lund symmetric fragmentation function:

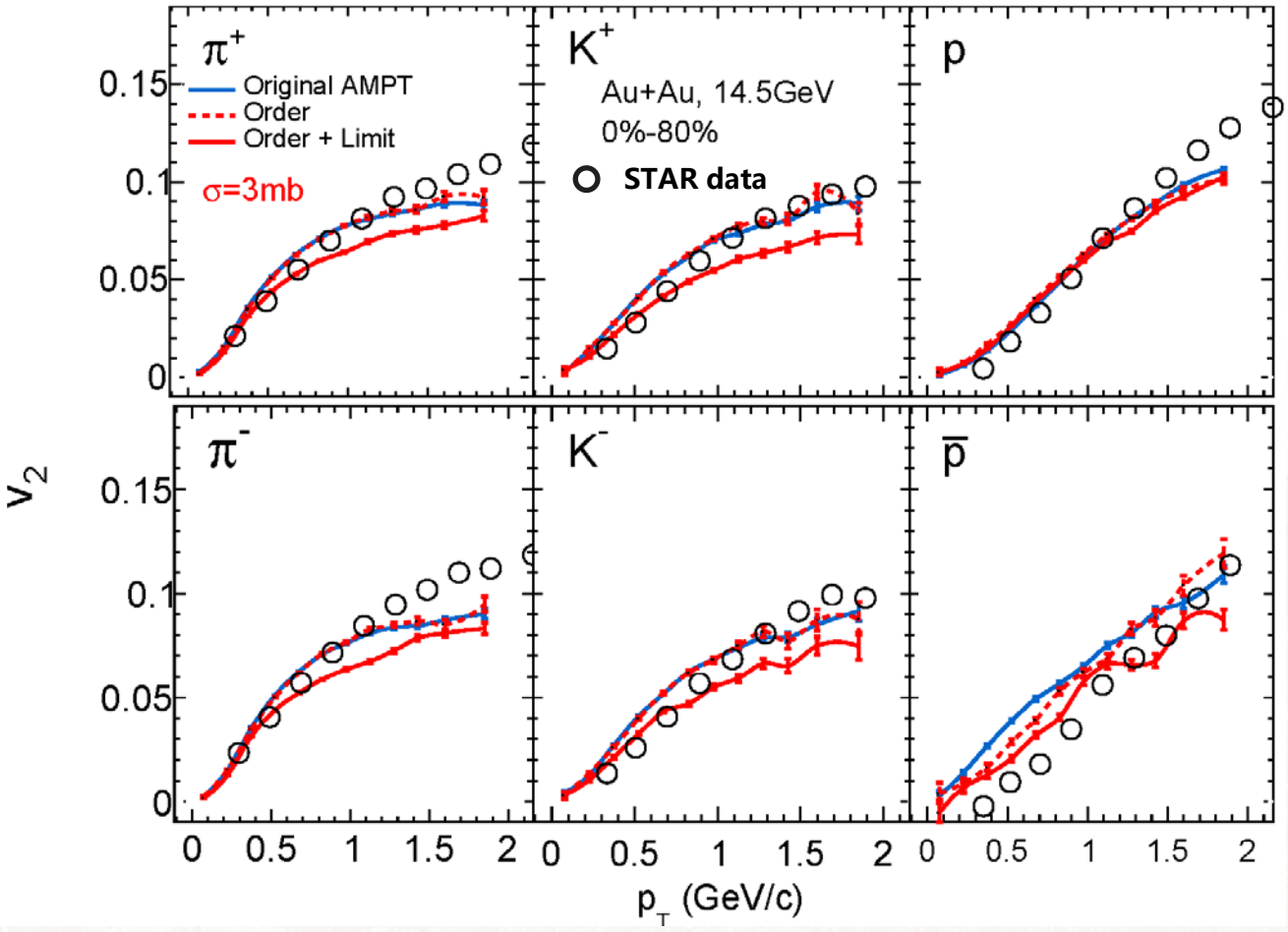
$$f(z) \propto z^{-1}(1-z)^{a}\exp(-b\ m_{\mathrm{T}}^{2}/z)$$

Lin Z W. PRC 90, 014914 (2014)

- Here we use the value of a=2.2, b=0.5

Results -- Elliptic flow

- v_2 of hadrons are not rely on the formation order of mesons and (anti)baryons
- v_2 become small when formation order and momentum limit are added into the quark coalescence process



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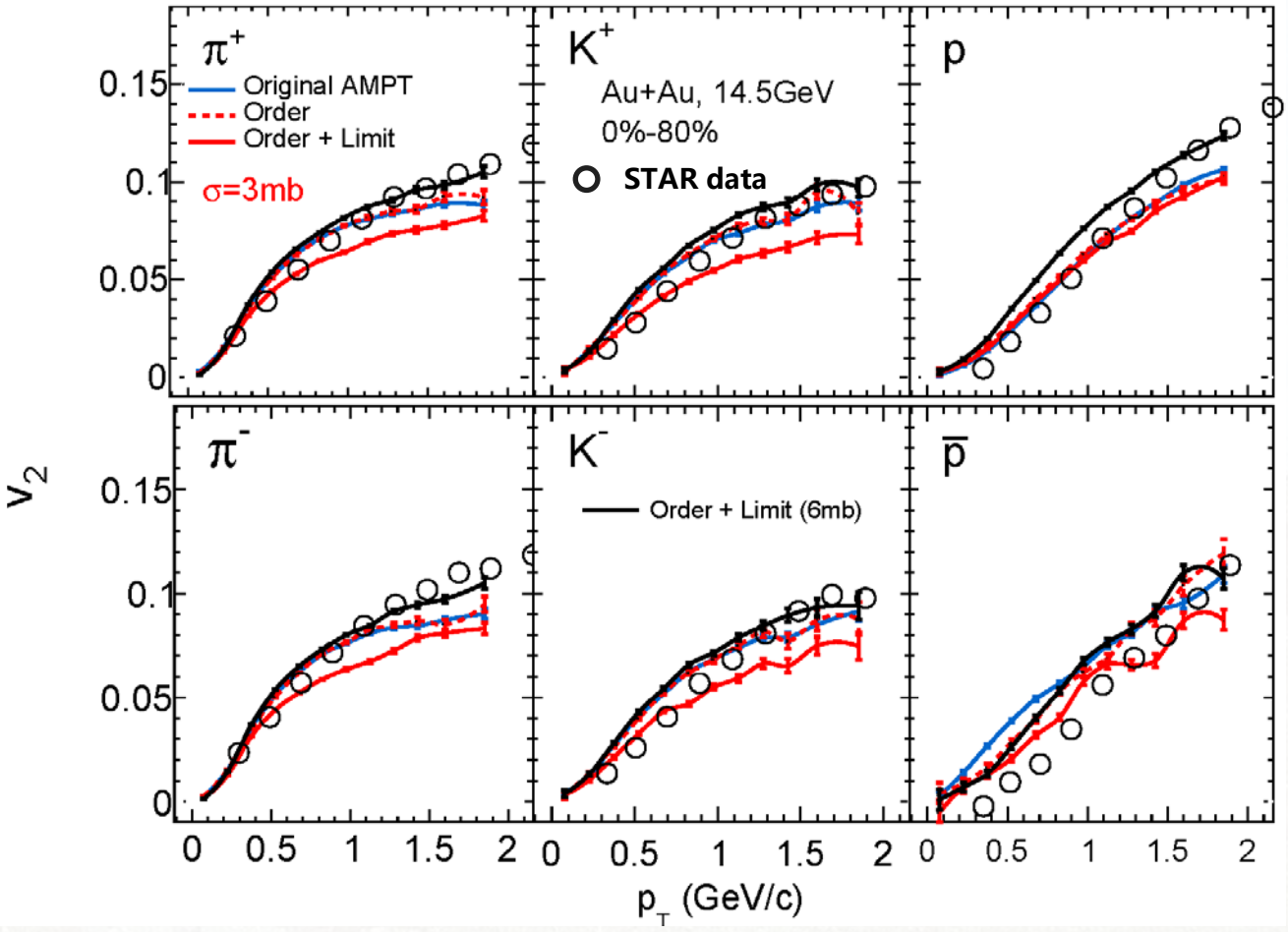
Results -- Elliptic flow

- v_2 results for charged pions and kaons from the changed model (6mb) are generally consistent with the experimental data



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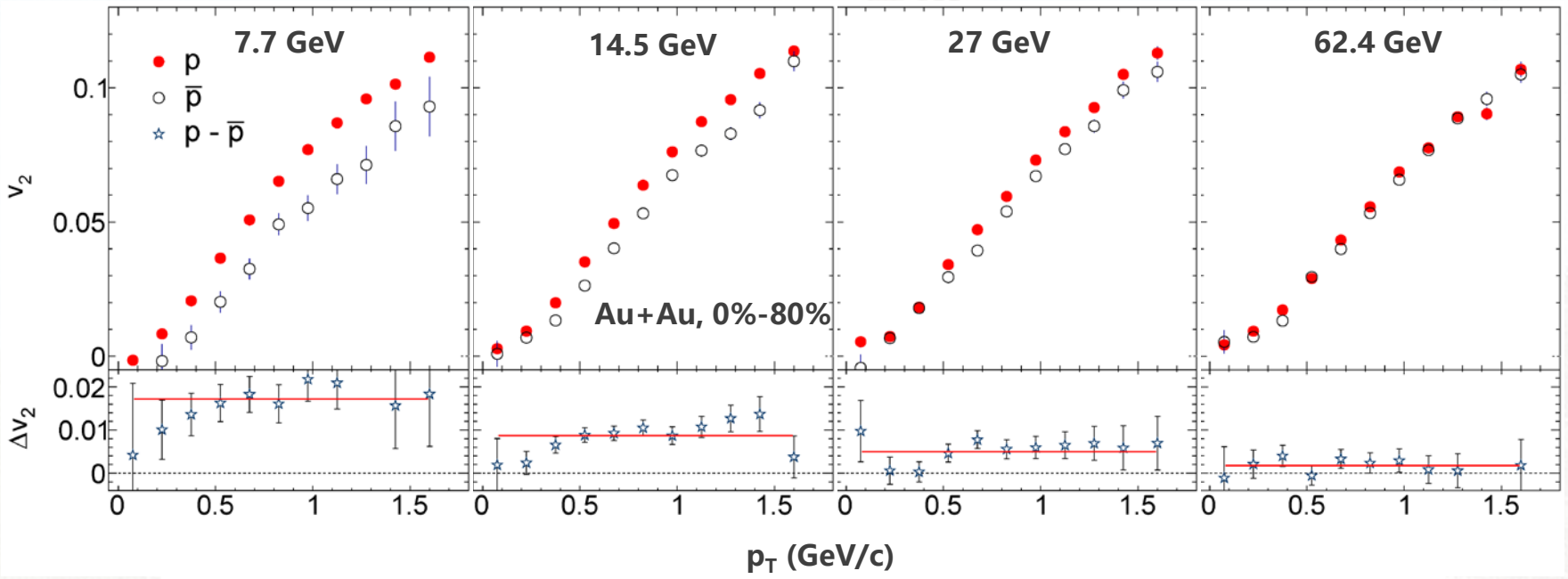
Results -- Δv_2

- Δv_2 from the AMPT with the change of formation order and momentum limit
- Elliptic flow of proton is larger than antiproton
- Δv_2 of proton and antiproton is increasing with the decreasing energy
- Shows consistent tendency with experimental result



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Summary

- Transverse momentum spectra of charged pions and antiproton are generally consistent with experimental data after changing the quark coalescence model in the AMPT model
- Elliptic flow of changed pions, charged kaons and antiproton become smaller with the changed model
  - For changed pions, v_2 values are more close to the results of experiment at p_T range of (~0.8, 2GeV)
- With a smaller v_2 of antiproton, elliptic flow difference Δv_2 of proton and antiproton shows consistent trend to the experimental result

Future work

- Why Δv_2 between proton and antiproton will behave like this, future study needs to be done
- Quark pairs with $\Delta p > \Delta p_0$ must be treated properly to make the coalescence process more physical

Thank you!

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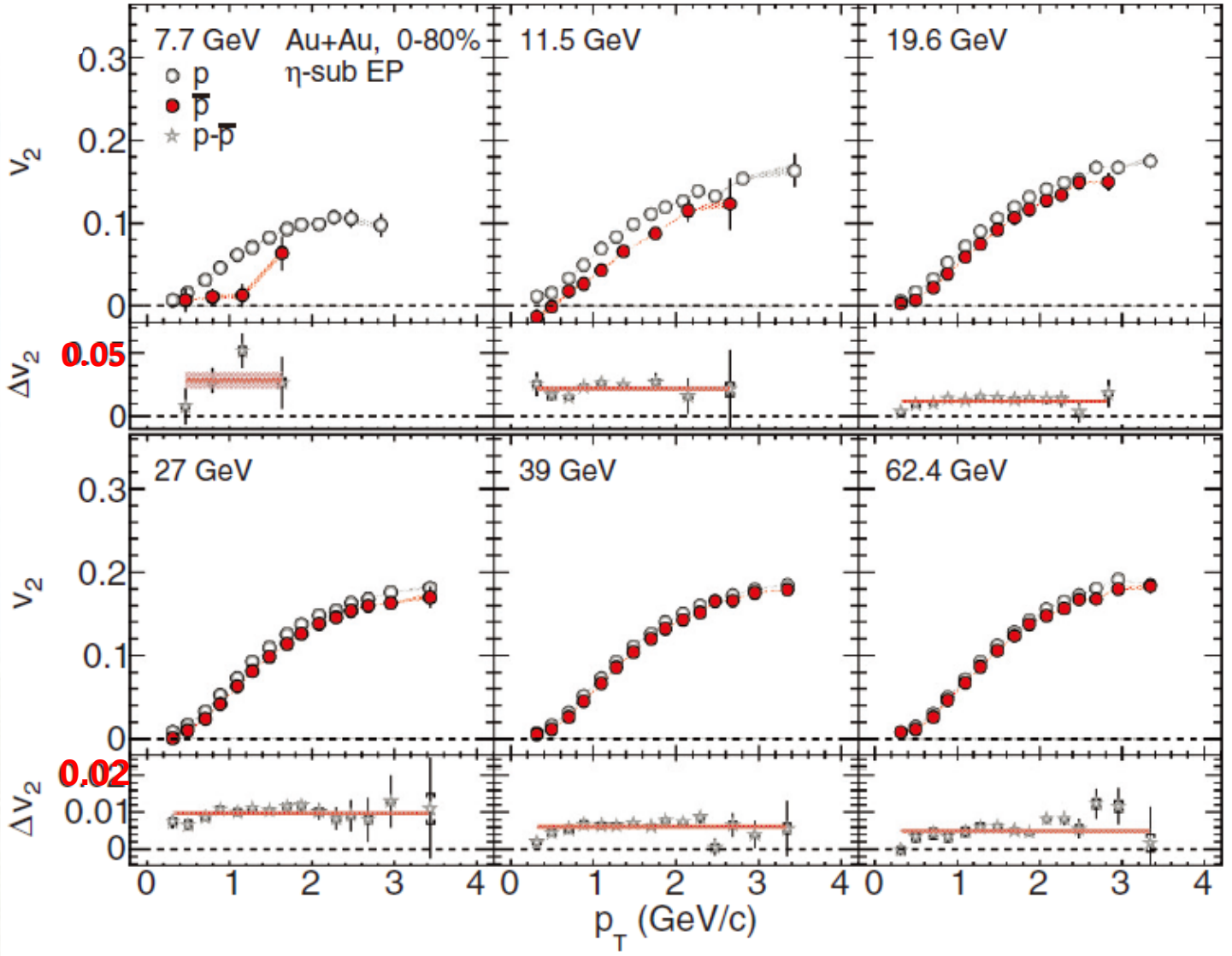
Back-up

- Experimental data @STAR



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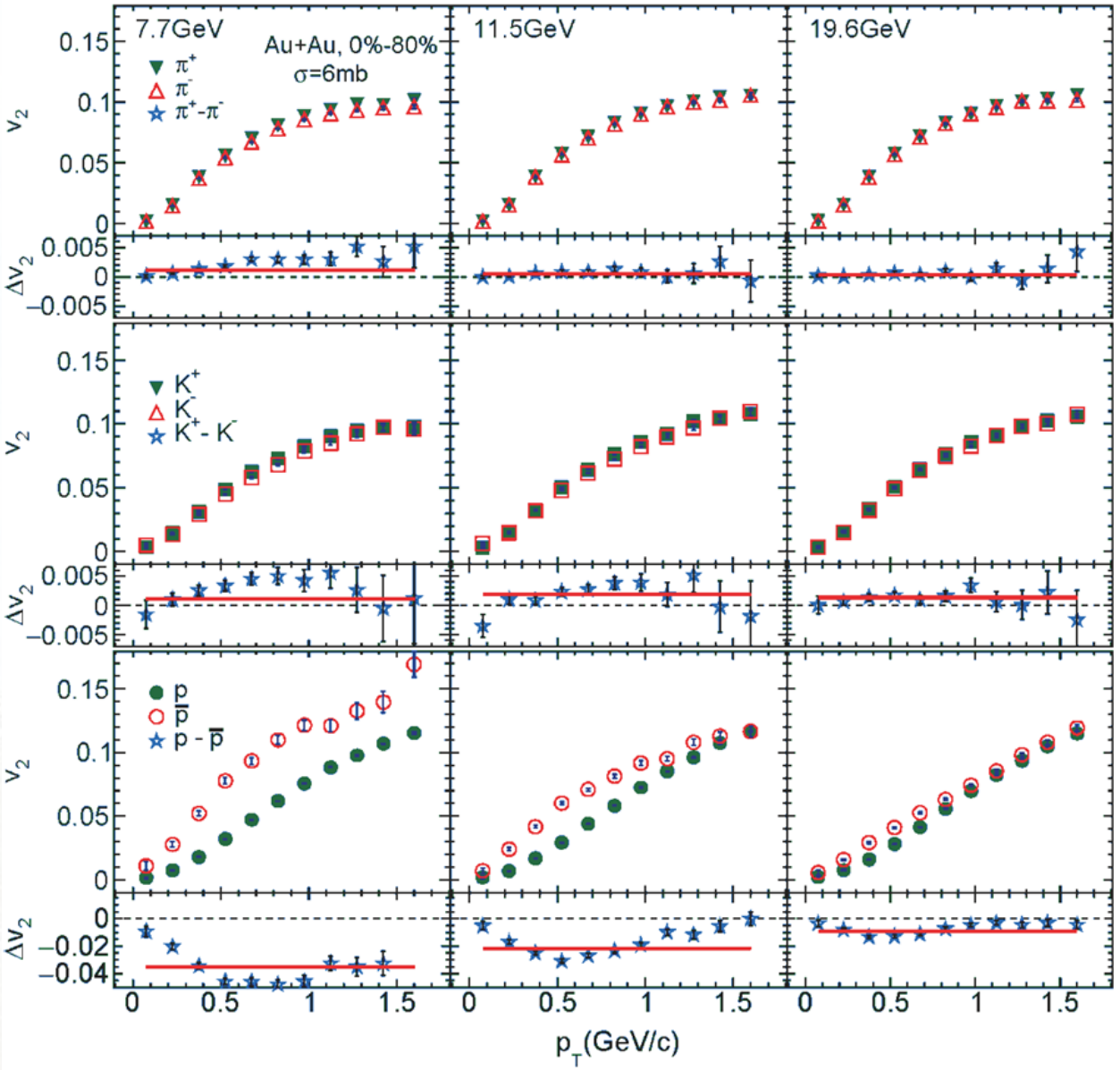
Back-up

- Elliptic flow splitting in the present AMPT model



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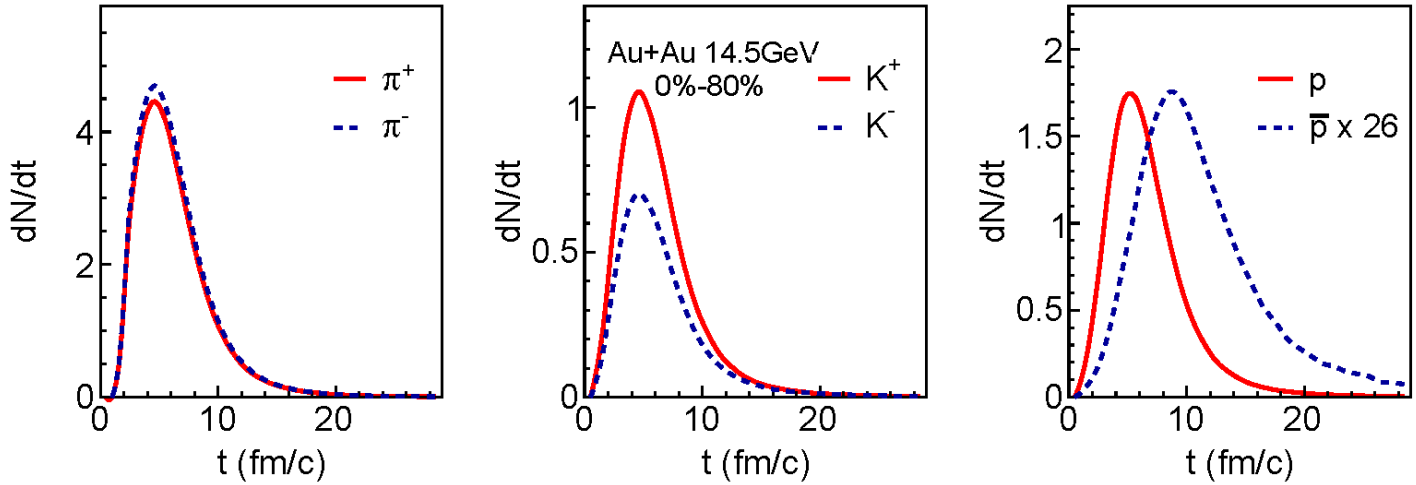
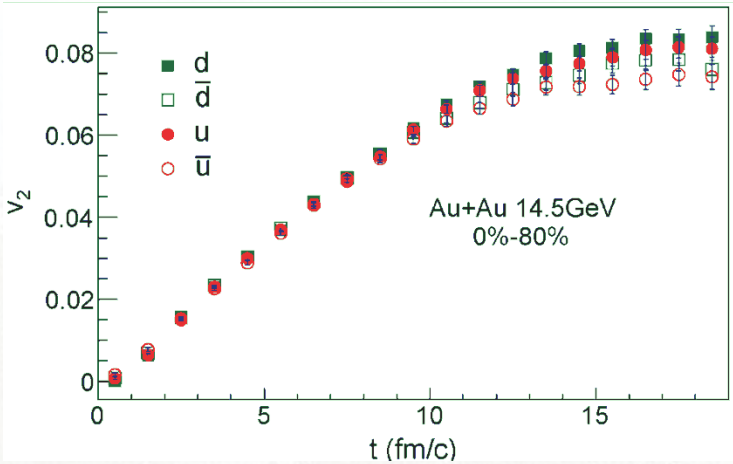
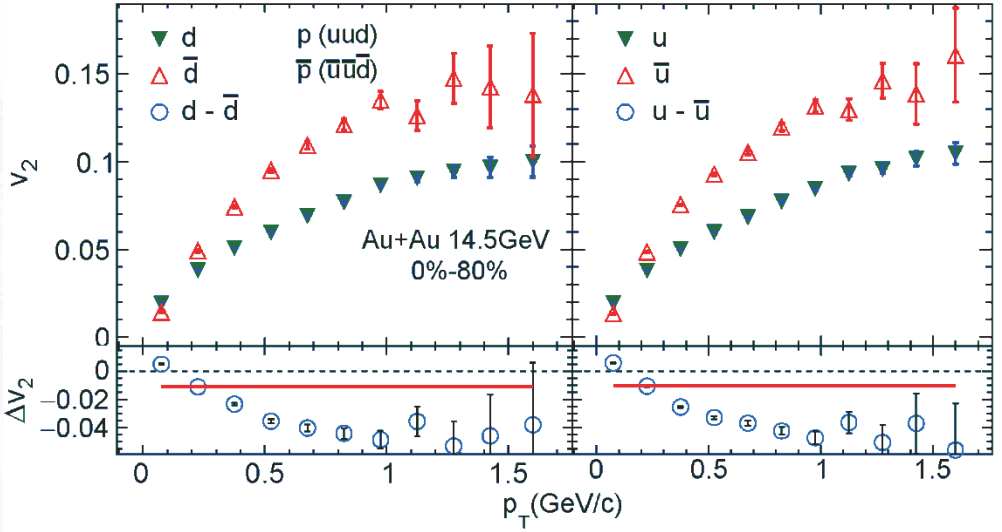
Back-up

- Chemical freeze out time







- Elliptic flow of constituent quarks of proton and antiproton

Results – Mass ordering of v_2