Directed flow of charm and light flavor with initial vorticity in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV from a multiphase transport model

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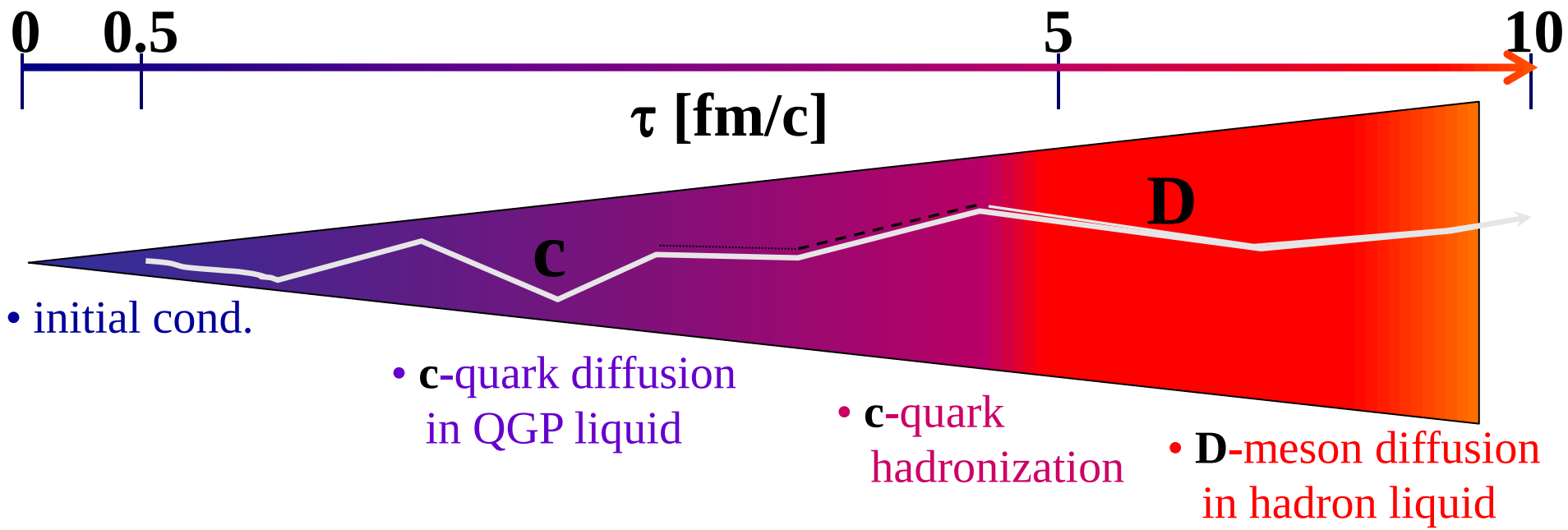
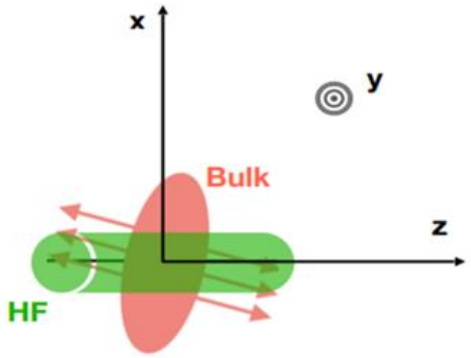
Open Charm Transport in URHICs



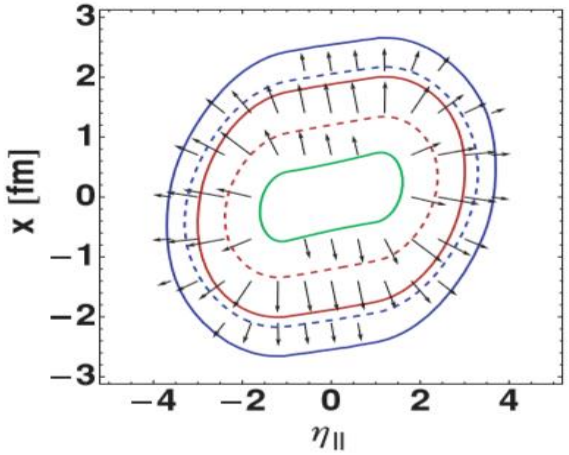
- Produced predominantly in initial hard-scatterings
- Experience the whole evolution of the system
- sensitive probe to the QGP because of their large masses

Charm quark directed flow



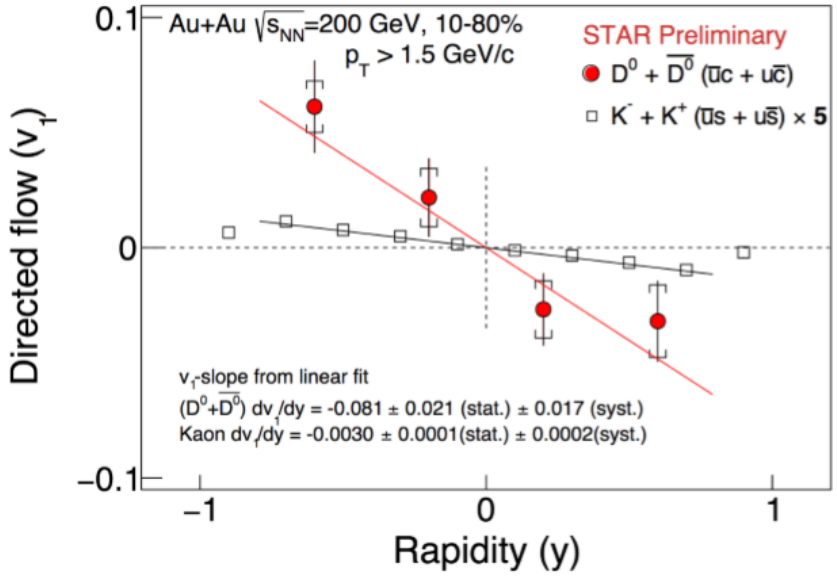
$$\frac{dN}{d\phi} \propto 1 + 2\sum_{n=1}^{\infty} v_n \cos n(\phi - \Phi_n)$$

Phys. Rev. C 81, 054902 (2010)



initial fireball energy density

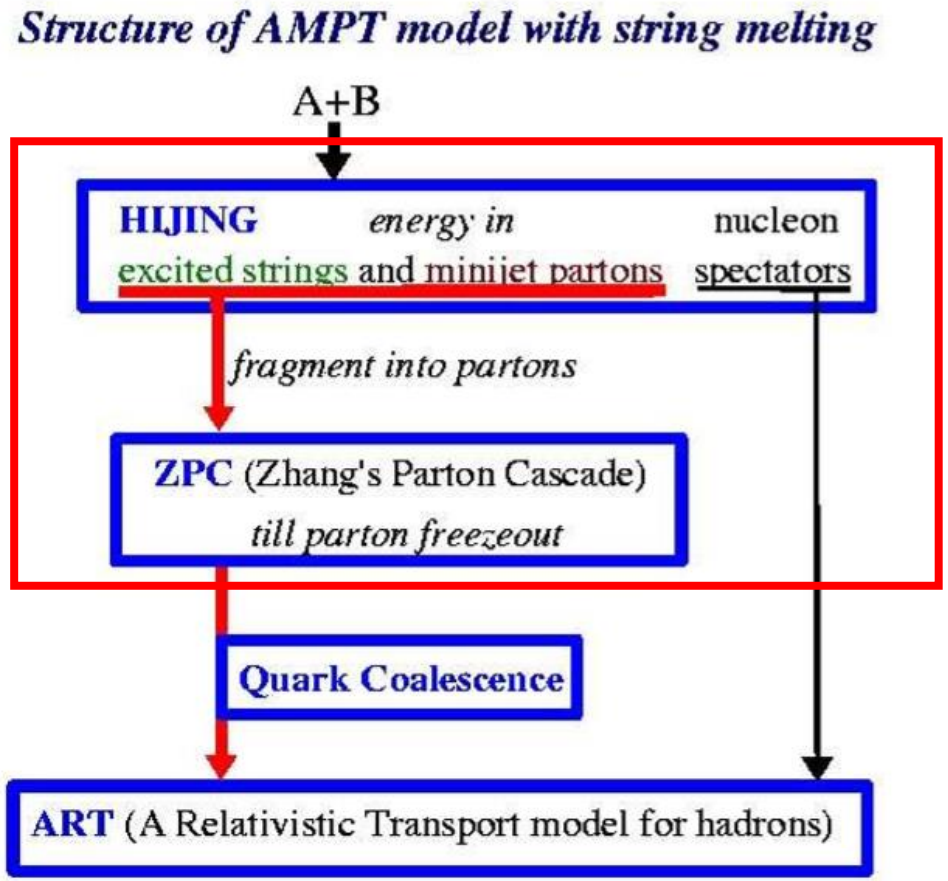
Phys. Rev. Lett. 120, 192301(2018)



- Symmetric production density of charm quarks combined with a drag by initially tilted bulk result in a large anti flow
- The measurement of charm quark v1 can be used to constrain the drag coefficients of the tited bulk

AMPT model

a multi-phase transport (AMPT) model with string melting



initial partons is generated by melting hadrons produced by elastic and inelastic scatterings of participant nucleons in HIJING

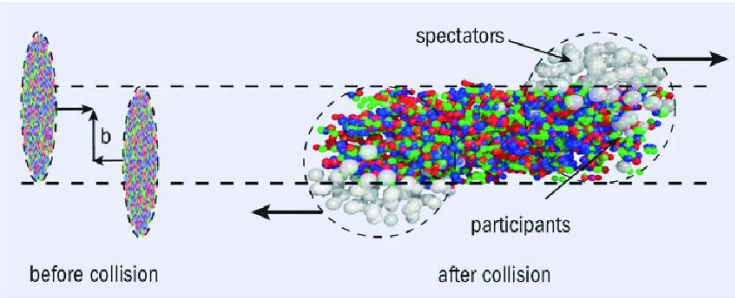
partonic interaction in the ZPC model is described by the partonic two-body elastic scatterings with the differential cross section:

$$\frac{d\sigma}{dt} \approx \frac{9\pi\alpha_s^2}{2(t-\mu^2)^2}$$

Version: ampt-v1.26t9b

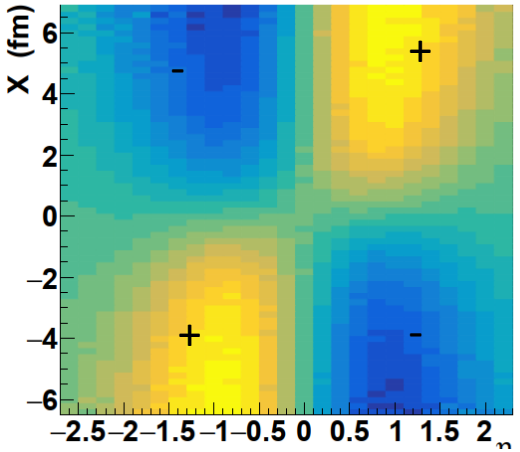
α_s =0.4714 , μ = 2.265 fm^{-1}, total cross section ~ 6mb

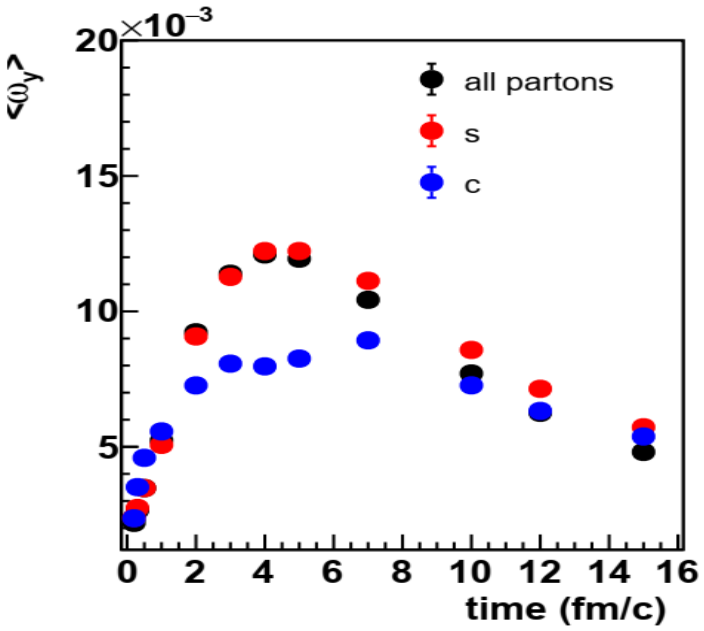
Vorticity in AMPT model – x η plane

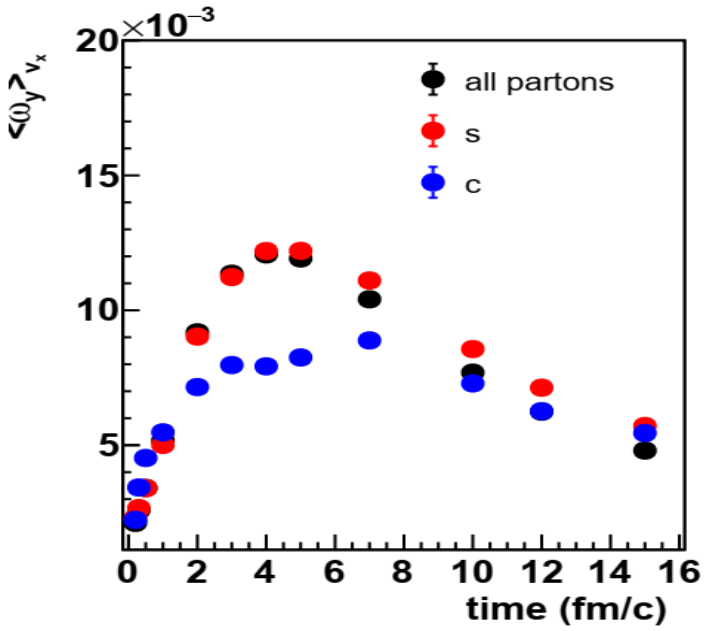


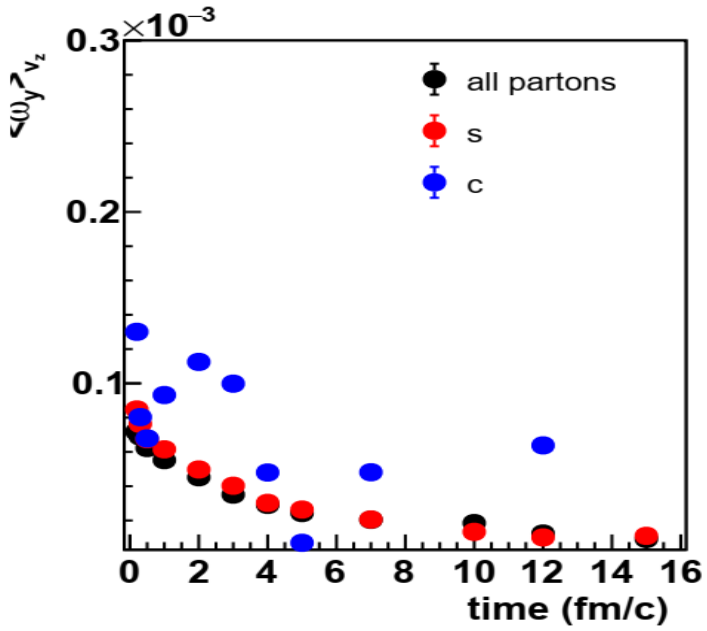
$$\omega = -\nabla \times \boldsymbol{v}$$

Vorticity are calculated from the velocity profile
<ω> are weighted by the energy density

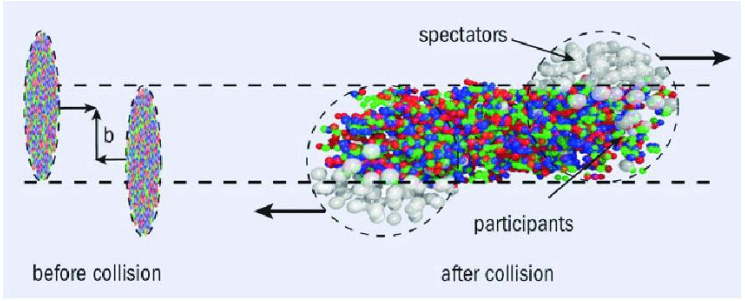




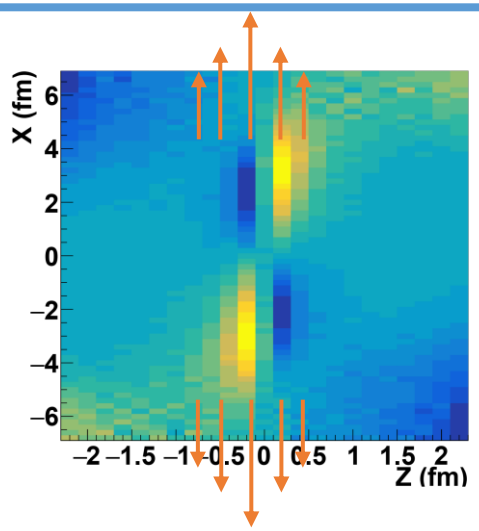




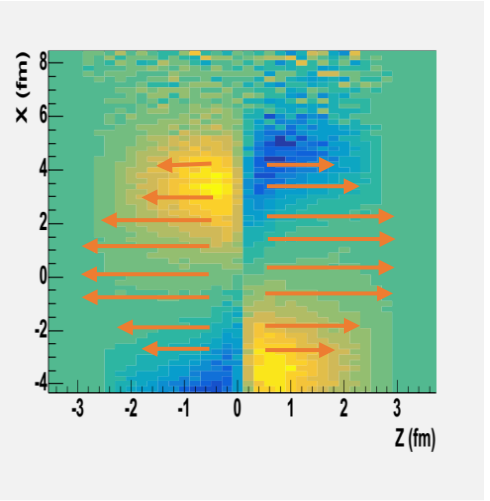
Vorticity in AMPT model – x z plane

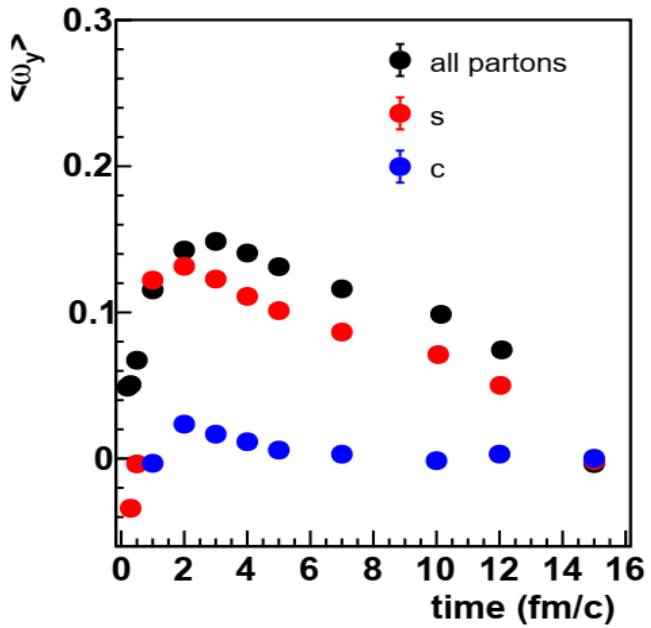


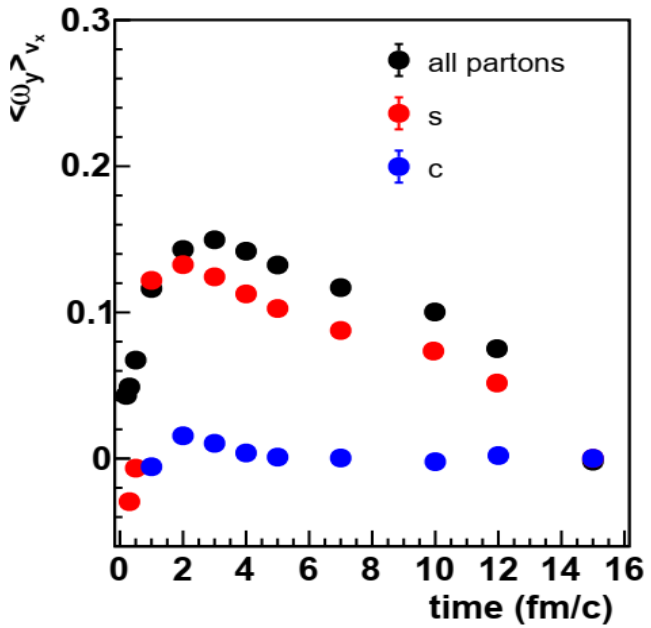
$\frac{\partial v_x}{\partial z}$

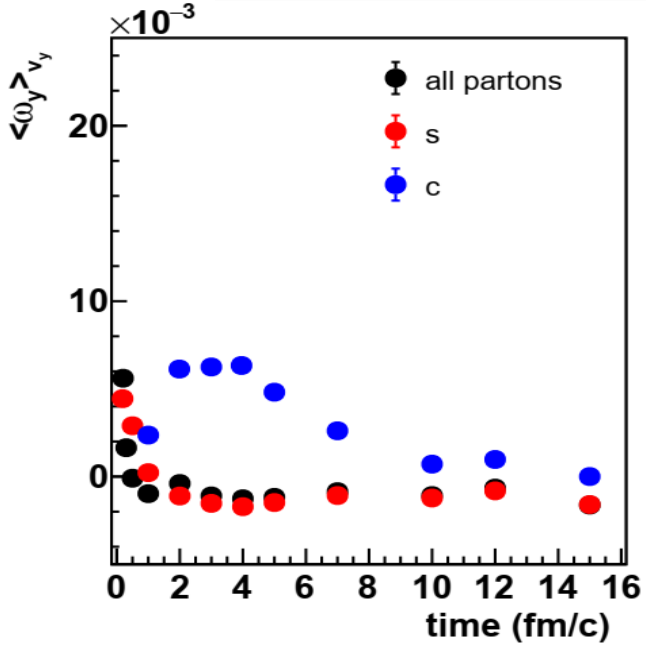


$\frac{\partial v_z}{\partial x}$



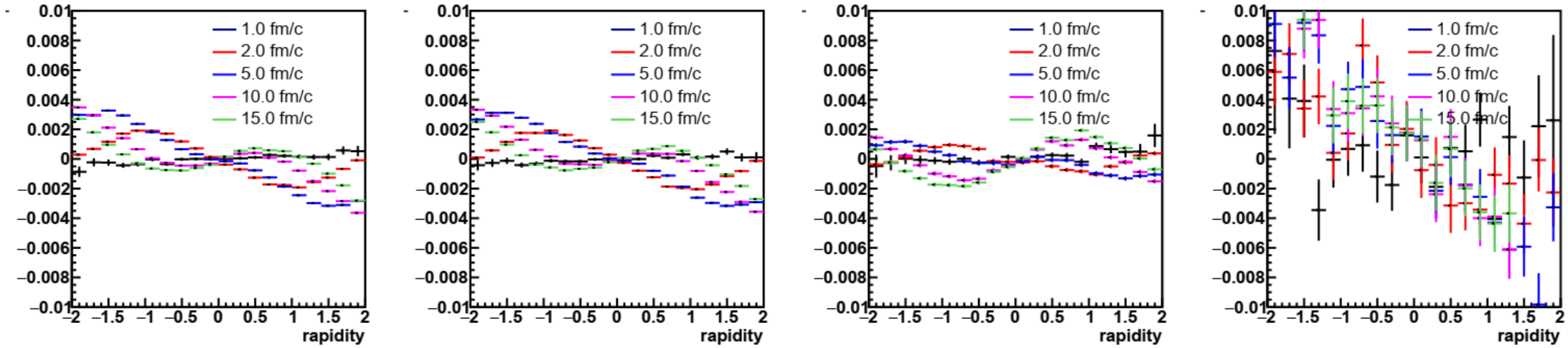


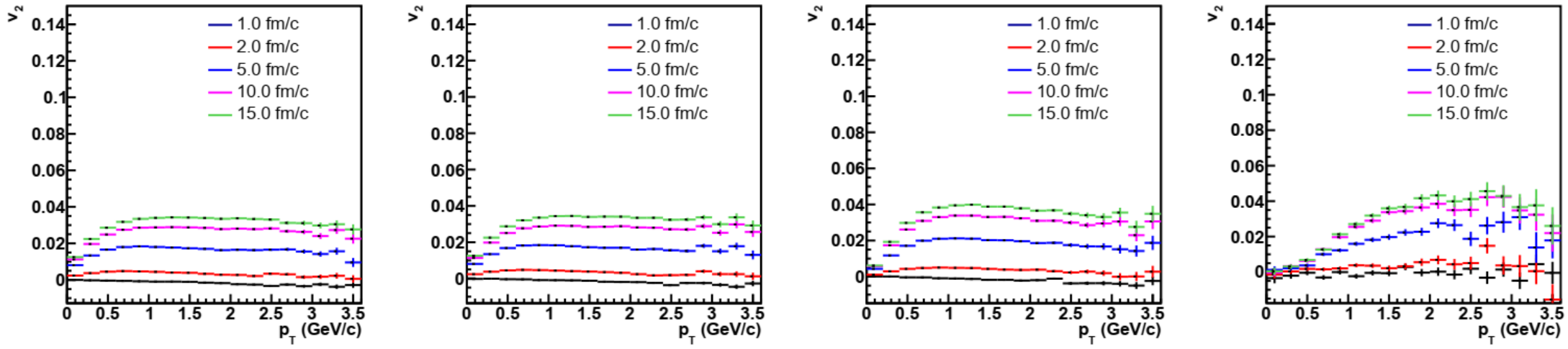




Parton v_1 v_2 time development in AMPT model

u d s c

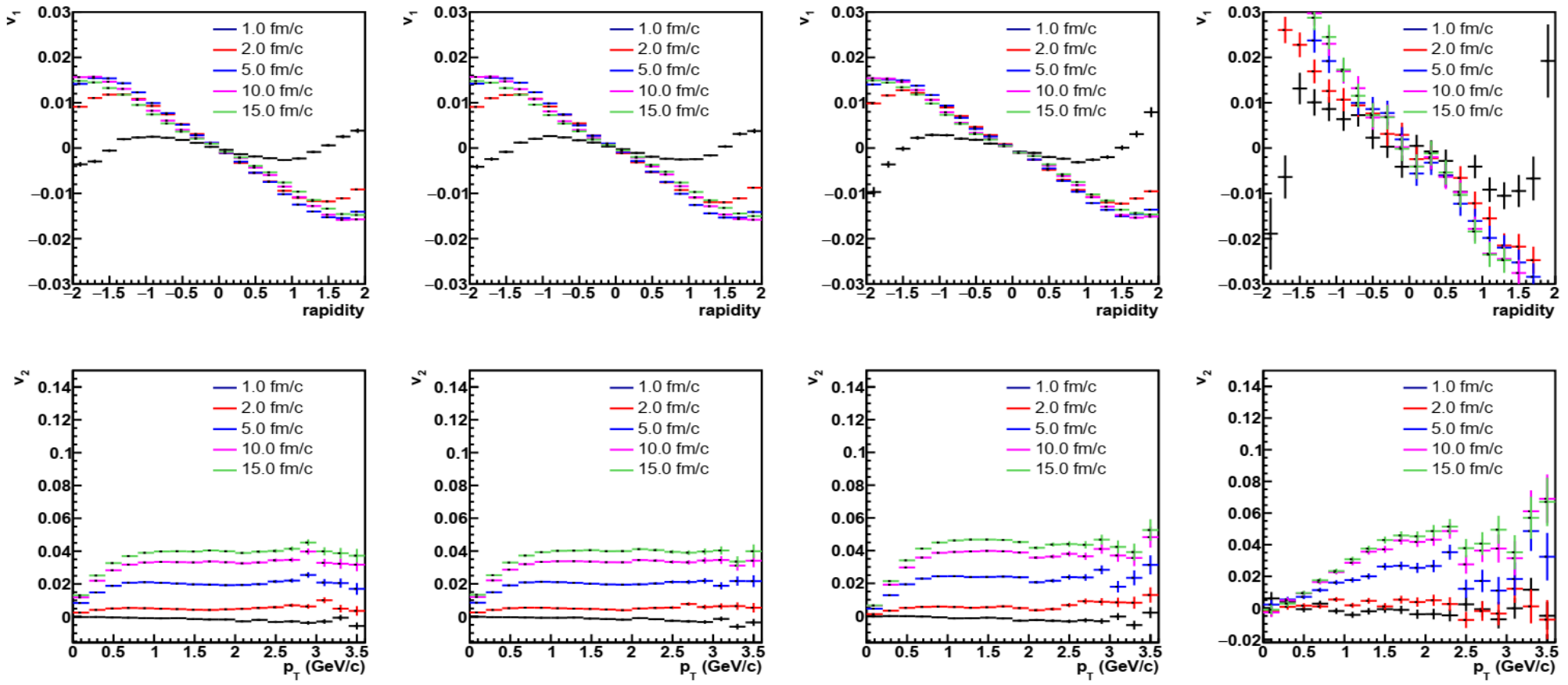




Parton v_1 v_2 time development in AMPT model with addition initial $<\omega_y>$

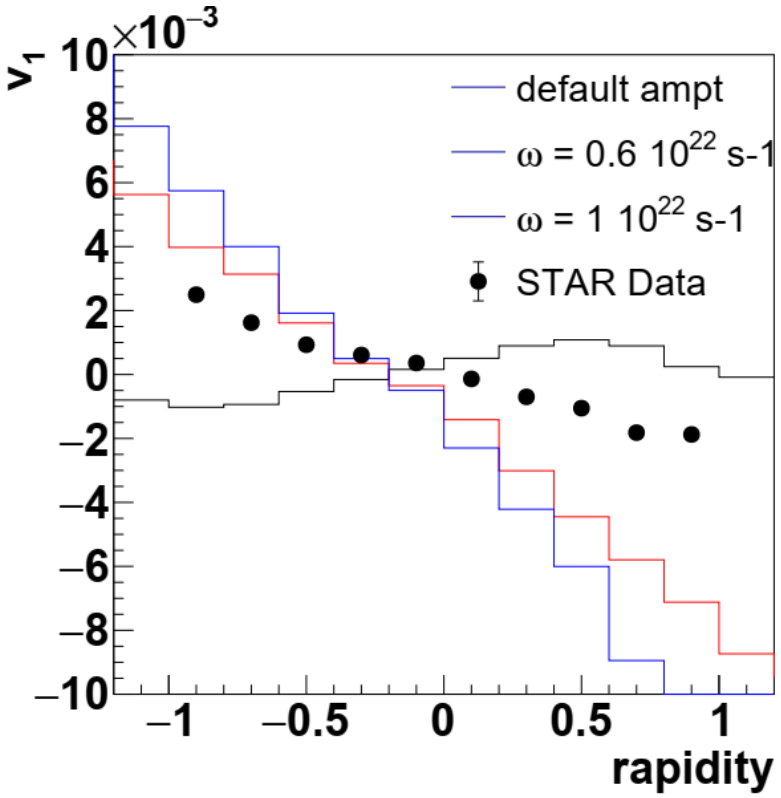
Adding additional $-<\omega_y> = 1 \cdot 10^{22}$ s^{-1} to initial parton distribution

u d s c

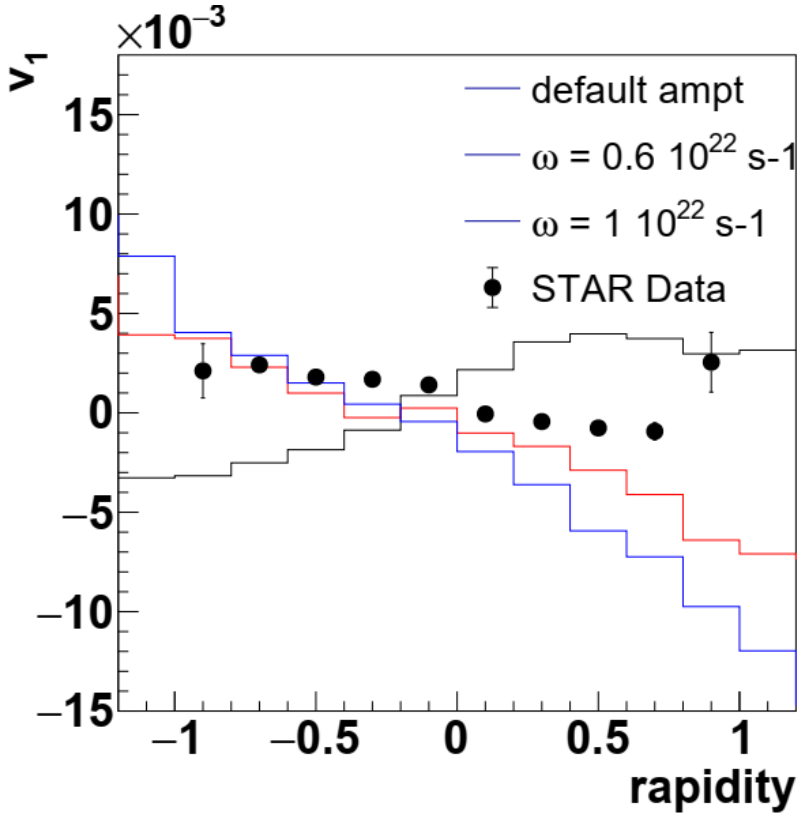


Particle dv_1/dy in AMPT model with addition initial $<\omega_y>$

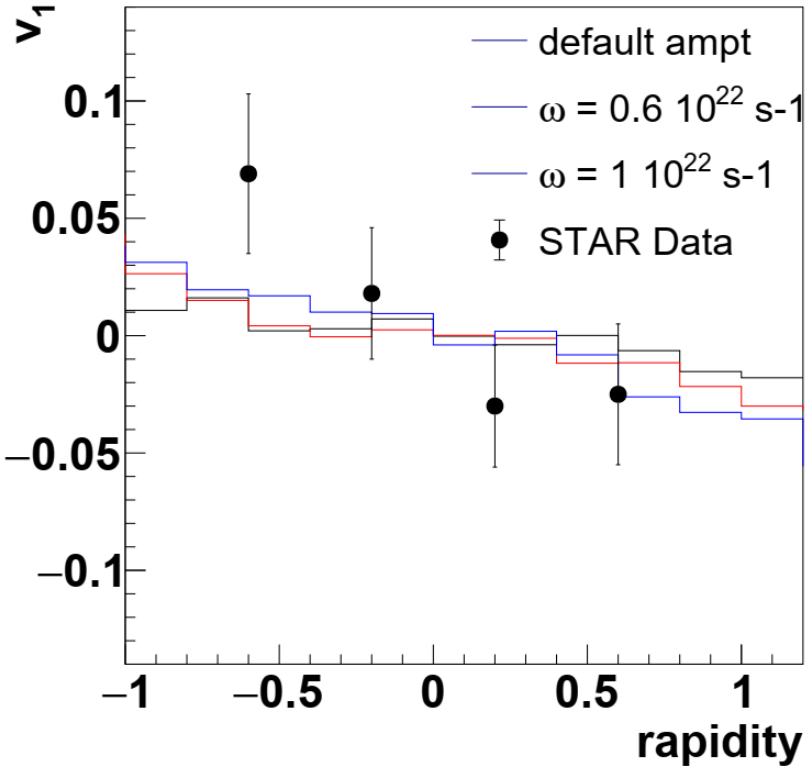
pion



kaon



D^0



Summary

- Vorticity from the ampt model are calculated. The effective vorticity are mainly from the thermal expansion and shows a falvor denpendence.

- By adding the additional initial $\langle\omega_y\rangle$, We find that the dv1/dy as a function of rapidity for pion and kaon are reversed compared to the default AMPT setting and are comparable to the measured value at RHIC energy. And the dv1/dy slope of D0 meson increased by more than 2 times at mid rapidity.