From hydro to jet quenching, coalescence and hadron cascade

A coupled approach to solving the $R_{AA} \otimes v_2$ puzzle

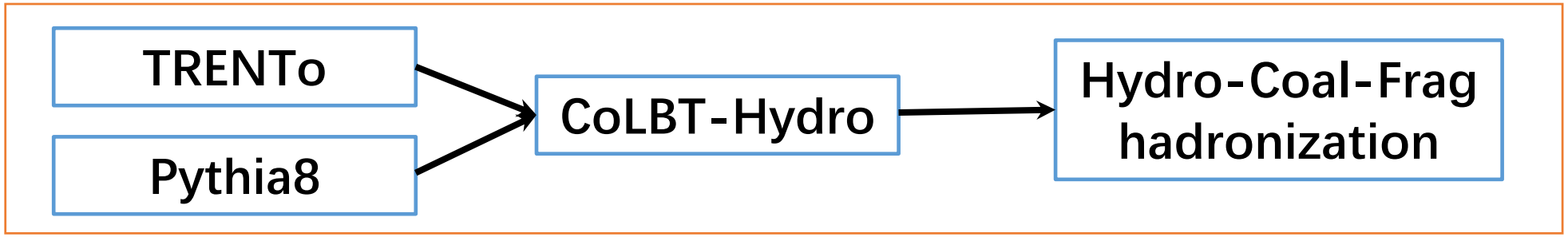
Wenbin Zhao (zhaowenb@pku.edu.cn)

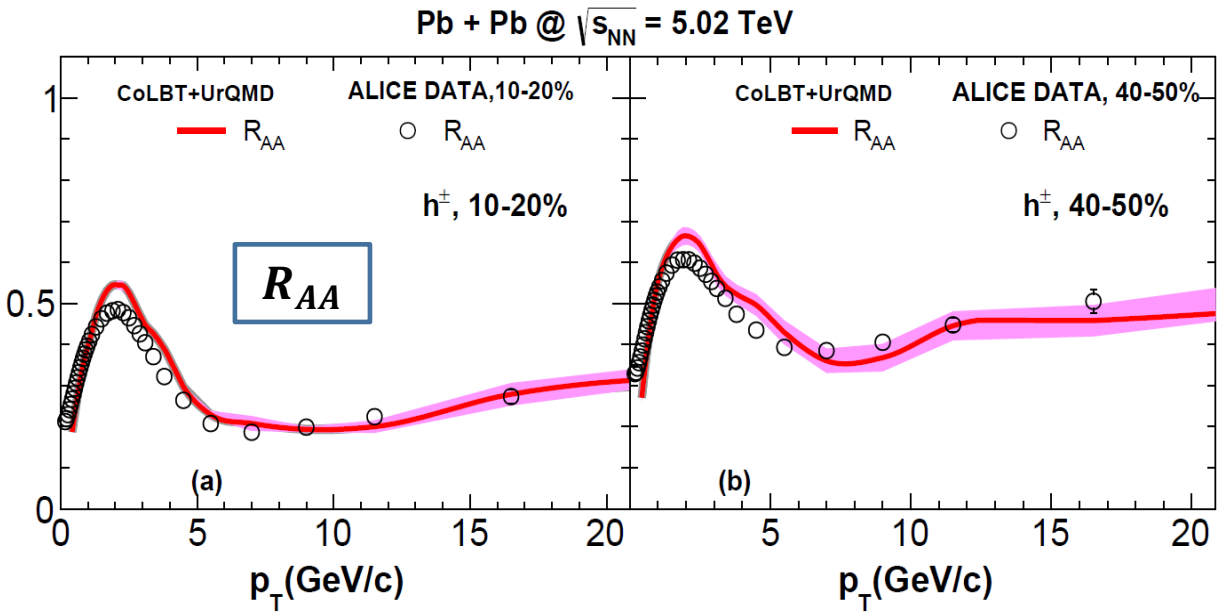
Wayne State University, Central China Normal University

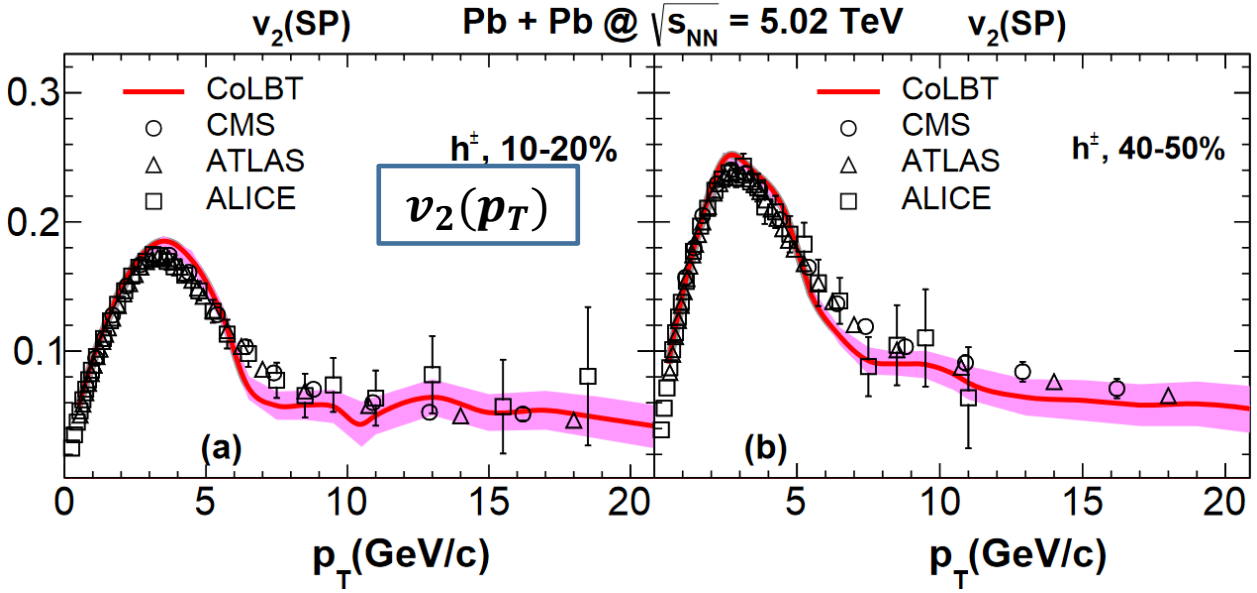
QM 2022

Based on: W. Zhao, W. Ke, W. Chen, T. Luo and X. N.Wang, Phys.Rev.Lett. 128 (2022) 2, 022302.

R_{AA} v.s. $v_2(p_T)$ from low p_T to high p_T



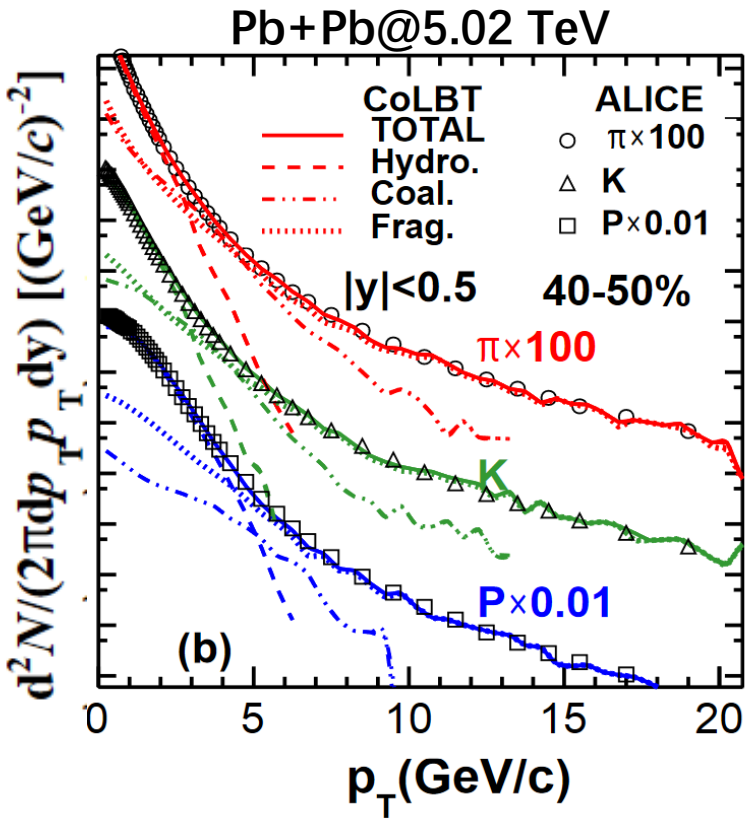


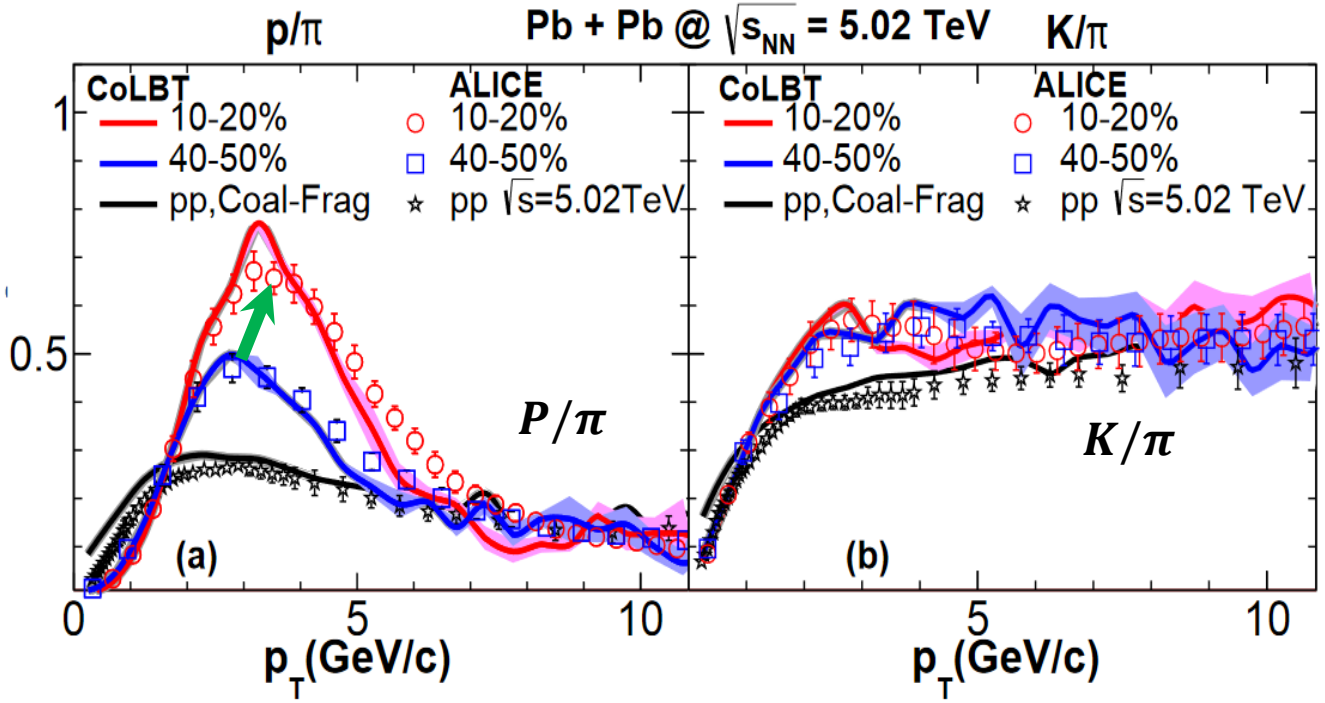


W. Zhao, W. Ke, W. Chen, T. Luo and X. N.Wang, arXiv:2103.14657 [hep-ph].

- CoLBT-hydro with Hydro-Coal-Frag hadronizations can simultaneously describe the R_{AA} and collective flow from low p_T to high p_T regions in Pb+Pb collisions.

Transverse momentum spectra of identified hadrons





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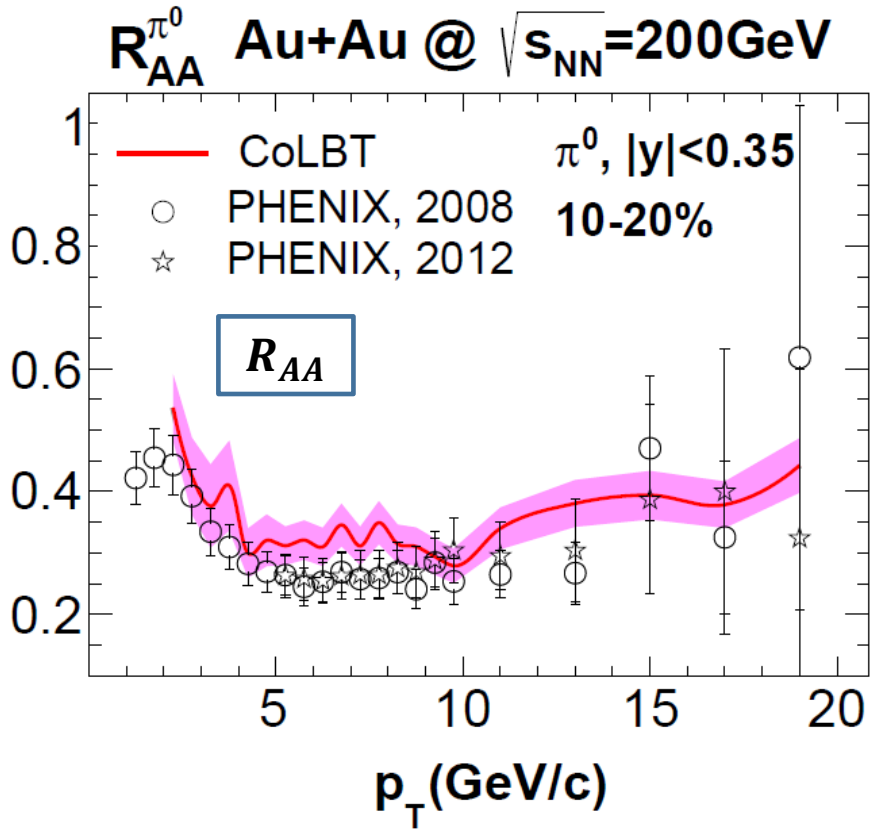
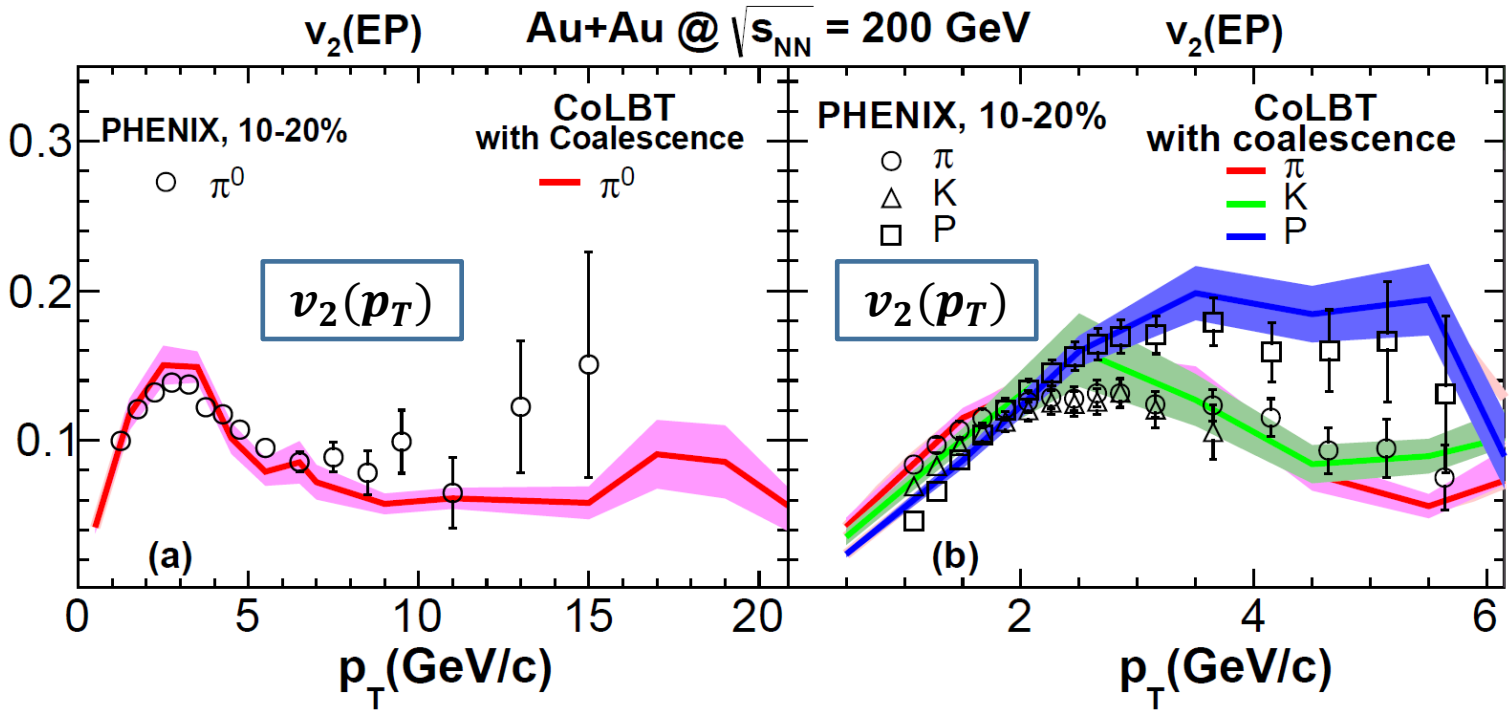
- CoLBT-hydro nicely describes the spectra of identified hadrons, $\boldsymbol{P/\pi}$ and $\boldsymbol{K/\pi}$ from 0 to 20 GeV.
- $\boldsymbol{P/\pi}$ in Pb+Pb is higher than pp; $\boldsymbol{P/\pi}$ peak moves to higher p_T in central collision.
- $\boldsymbol{P/\pi}$ and $\boldsymbol{K/\pi}$ approach to the p-p value at high p_T.

R_{AA} and v_2 (p_T) at Au-Au at RHIC

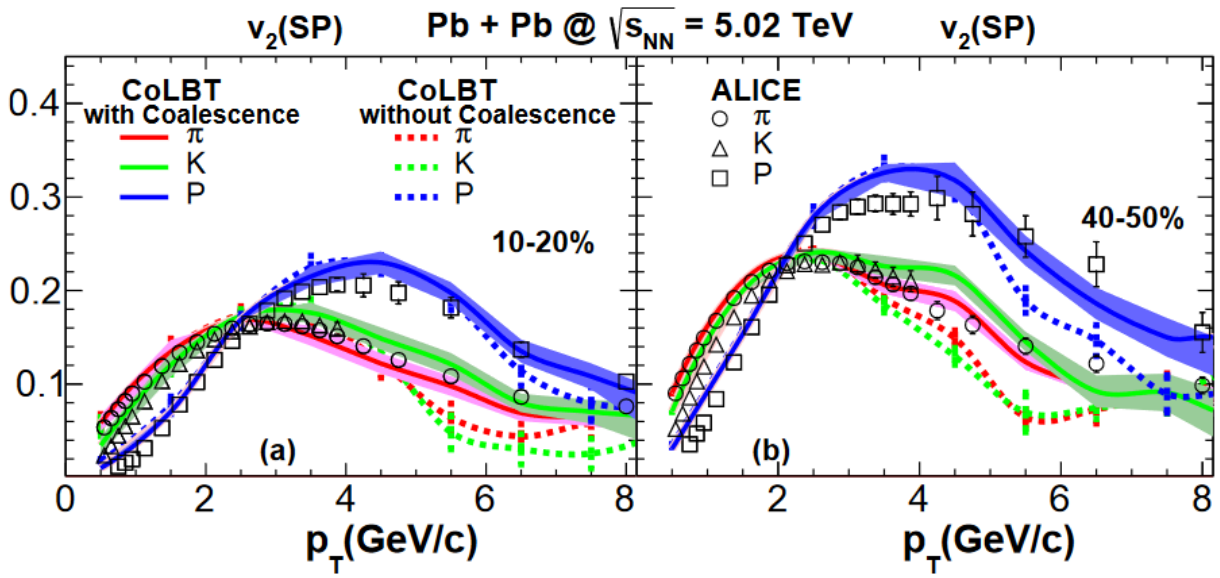


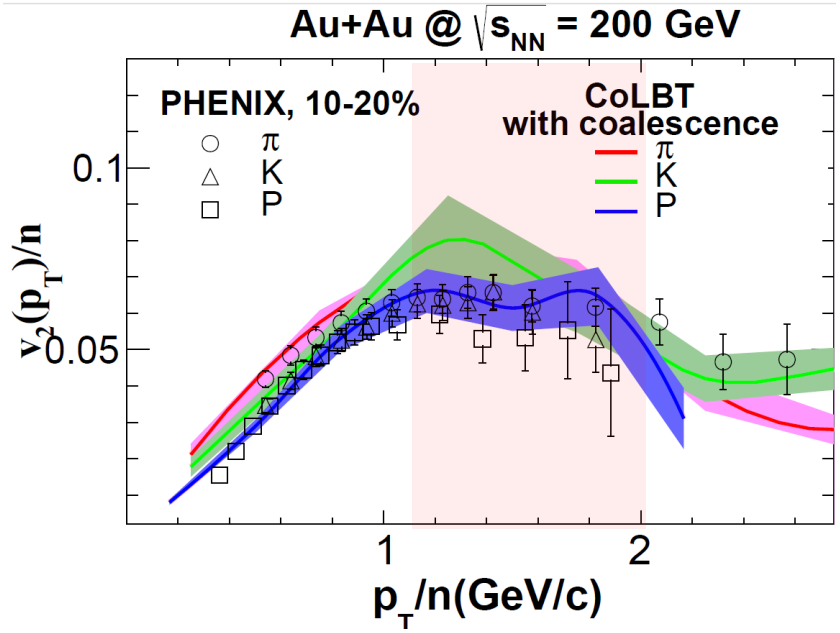


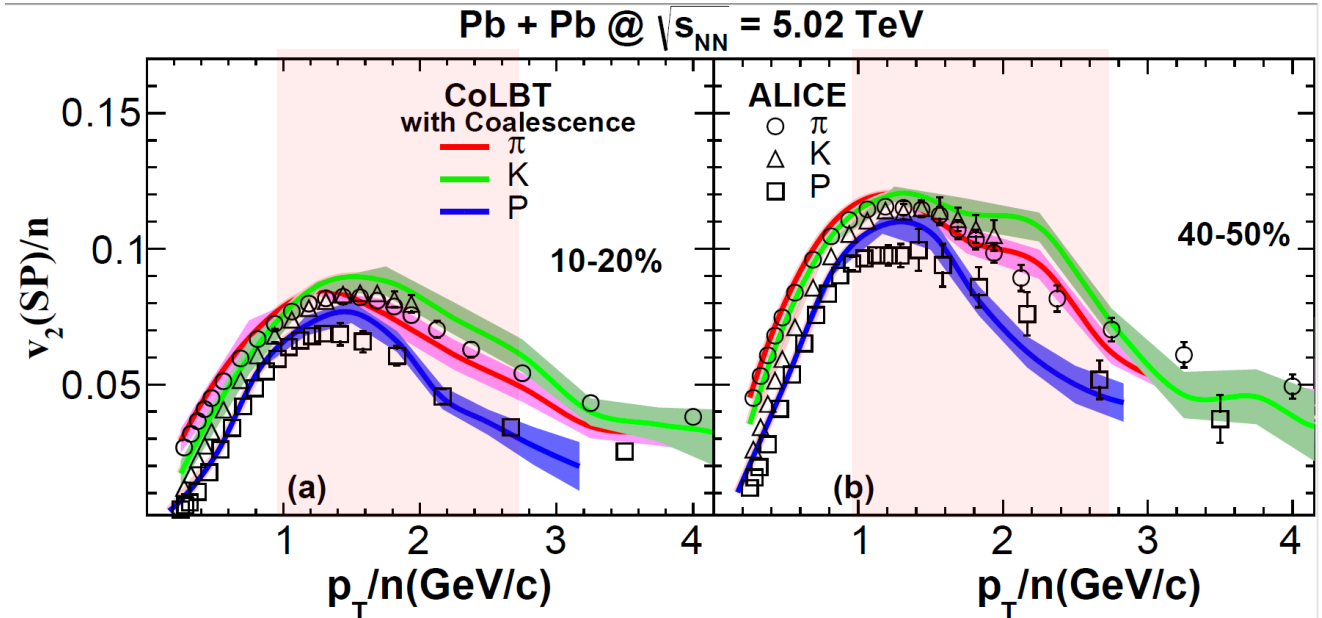
- With parameters fixed at LHC, CoLBT-hydro nicely predicts the R_{AA} and $v_2(p_T)$ from 0 to 20 GeV in Au-Au at 200 GeV.
- CoLBT-hydro nicely predicts the $v_2(p_T)$ of π, K and P from 0 to 6 GeV in RHIC.

W. Zhao, W. Ke, W. Chen, T. Luo and X. N.Wang, arXiv:2103.14657.
W. Zhao, W. Ke, W. Chen, T. Luo and X. N.Wang, in preparation.

Collective flow of identified hadrons







- CoLBT-hydro with Hydro-Coal-Frag works well for PID flow from 0 to 8 GeV.
- Quark coalescence is important for Pb+Pb collisions at intermediate p_T range.
- NCQ scaling at intermediate p_T are caused by interplay of hydro, coal. and frag.

W. Zhao, W. Ke, W. Chen, T. Luo and X. N.Wang, arXiv:2103.14657 [hep-ph].

Summary

- CoLBT-hydro with Hydro-Coal-Frag hadronization simultaneously describe the R_{AA} and collective flow from low p_T to high p_T in Pb+Pb collisions.
- CoLBT-hydro also nicely describes the collective flow of identified hadrons with p_T from 0 to 8 GeV.
- Quark coalescence is important in heavy-ion collisions.
- With parameters fixed at LHC, CoLBT-hydro excellently predicts the R_{AA} and collective flow from low p_T to high p_T in Au+Au collisions at RHIC.

Coalescence-Fragmentation hadronization code is available here:
https://github.com/wenbin1501110084/Coalescence_Fragmentation_code

Thanks for Your Attention

Back Up

Framework of calculations

Hydro-Coal-Frag hadronization

Thermal hadrons, low p_T (CLVis):

- generated by hydro. with Cooper-Frye.
  Meson: $p_T < 2p_{T1}$; baryon: $p_T < 3p_{T1}$.

-initial shower partons from pythia8 with $p_T > p_{T2}$

Coalescence hadrons (Coal Model):

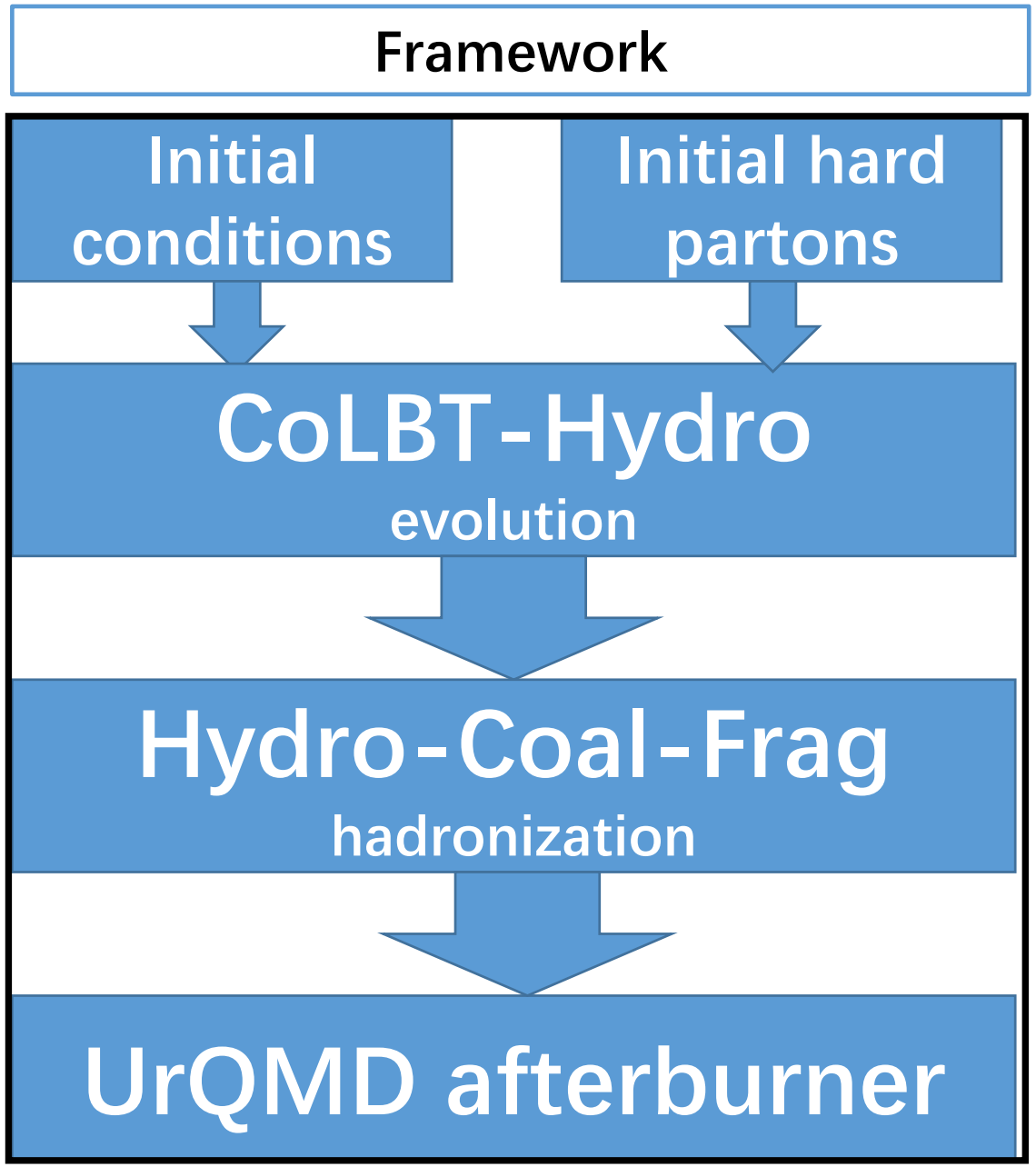
-generated by coalescence model including thermal-thermal, thermal-hard & hard-hard coalesence.

Fragmentation hadrons :

-the remnant hard quarks feed to fragmentation.

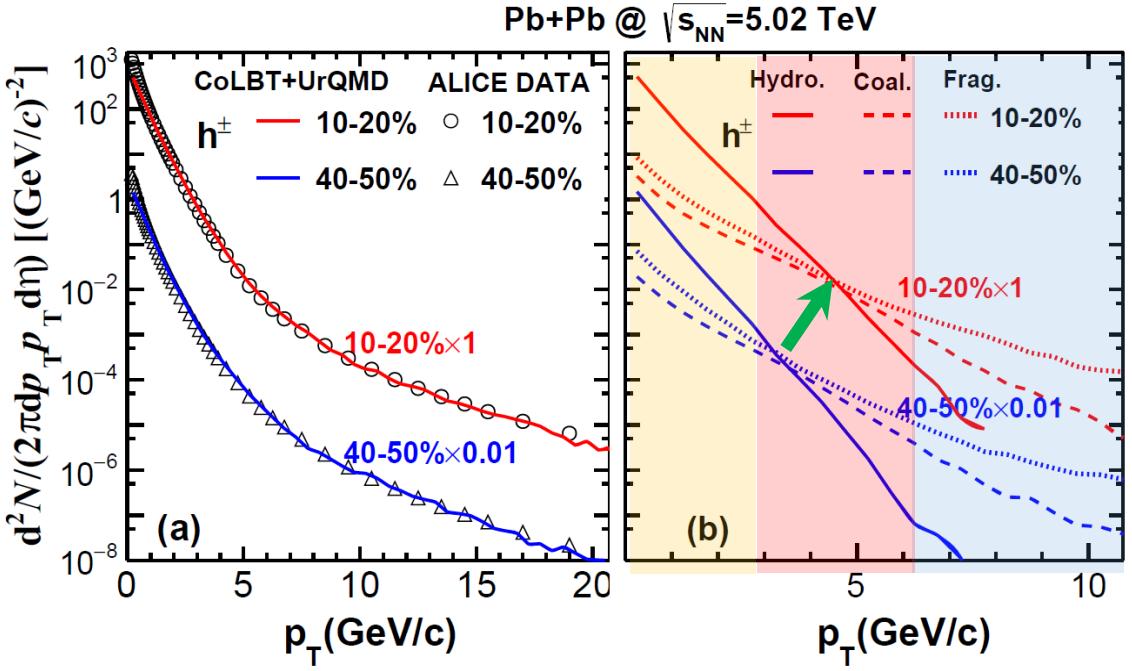
UrQMD afterburner:

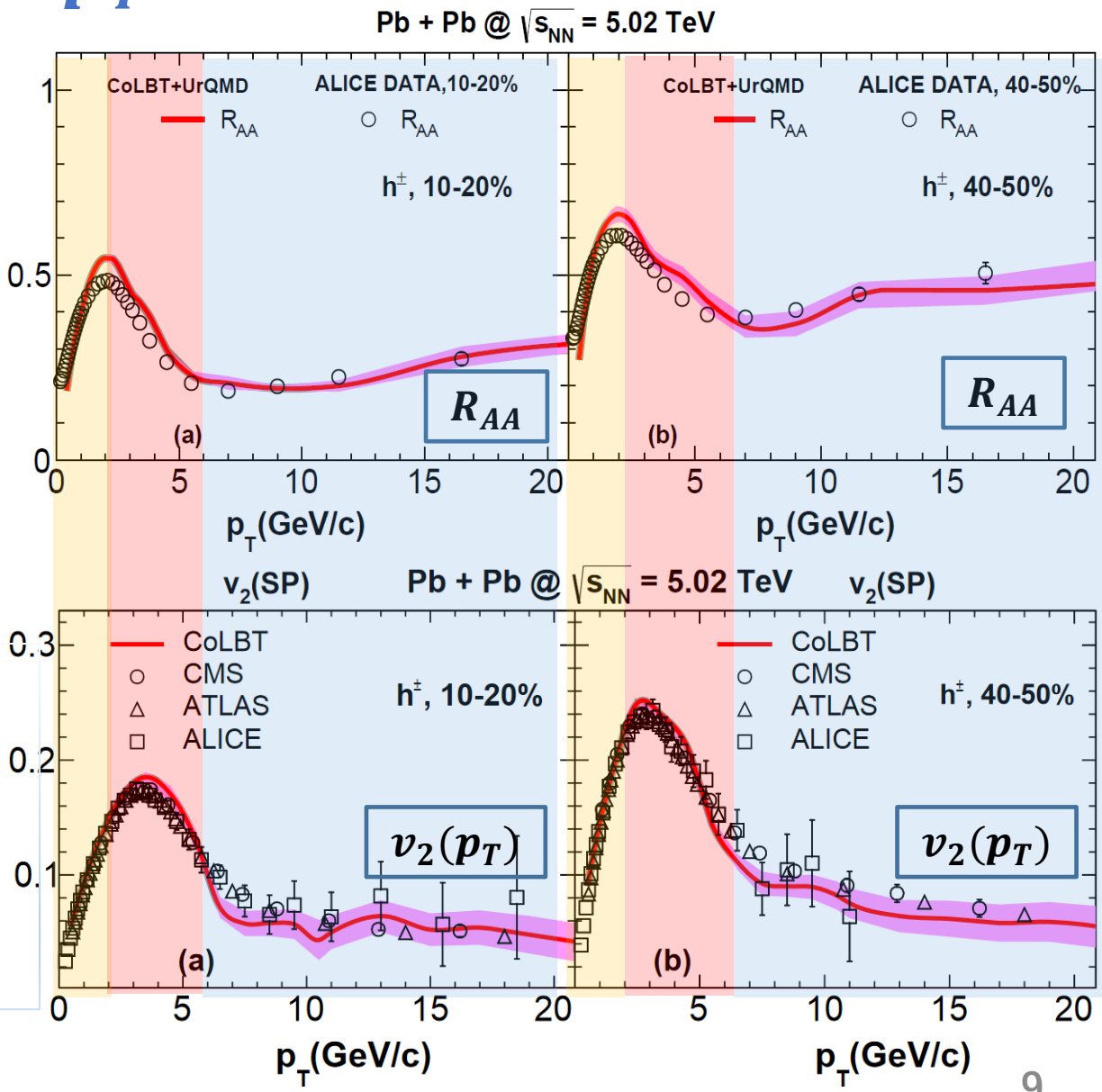
-All hadrons are feed into UrQMD for hadronic evolution, scatterings and decays



W. Zhao, Ko, Liu, Qin and Song, PRL. 125, 072301 (2020). W. Zhao, W. Ke, W. Chen, T. Luo and X. N.Wang, arXiv:2103.14657.

Transition from low p_T to high p_T

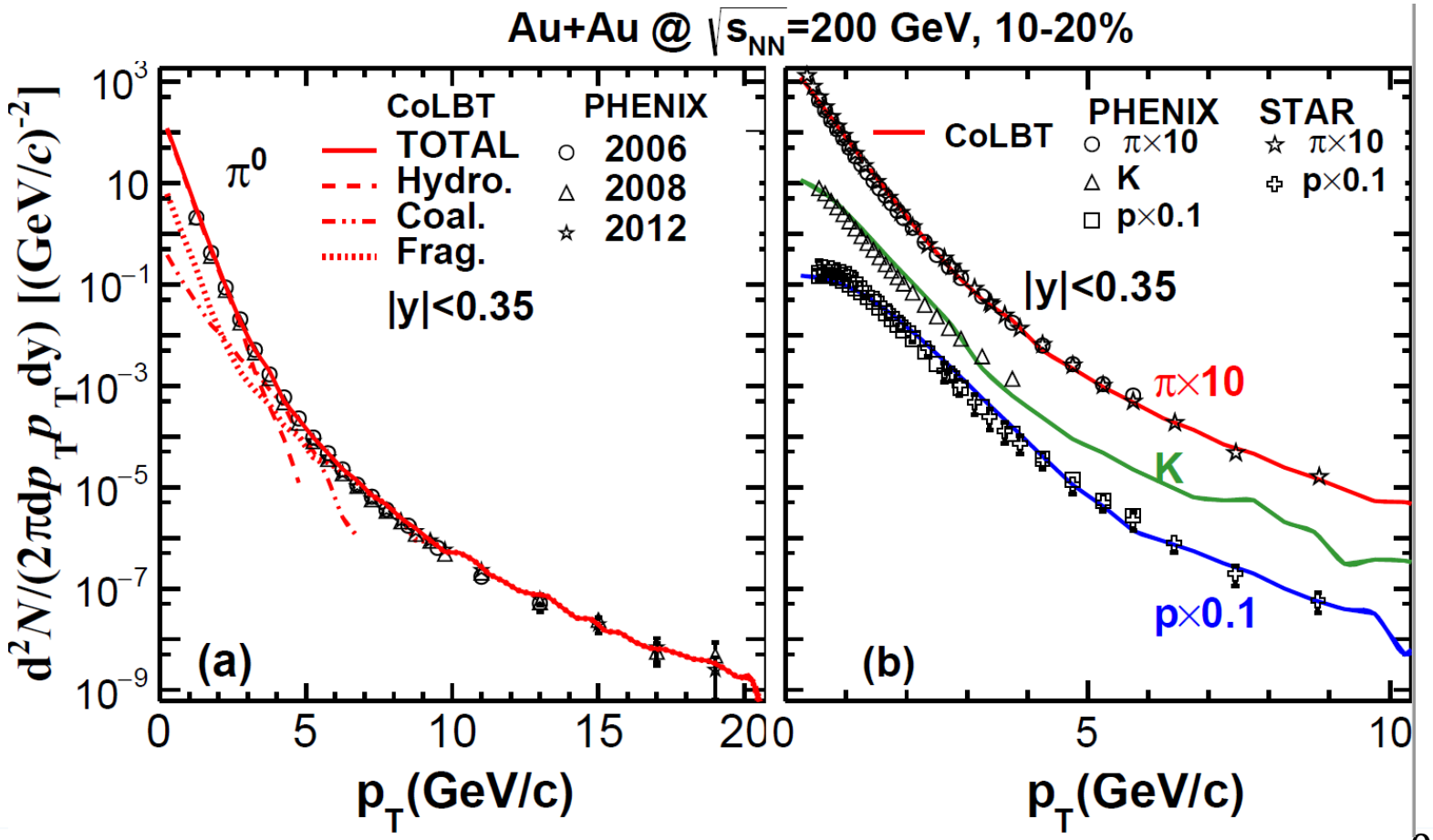




- CoLBT-hydro nicely describes the spectra of charged from 0 to 20 GeV.
- Low p_T: hydro; Intermediate p_T: transition regime; High p_T: jet physics.
- Transition p_T is higher in central collisions.

W. Zhao, W. Ke, W. Chen, T. Luo and X. N.Wang, arXiv:2103.14657.

Spectra at Au-Au at RHIC



- With parameters fixed at LHC, CoLBT-hydro nicely predicts the spectra of π^0 and of $\pi^{\pm}$, K and P from low p_T to high p_T in Au-Au at 200 GeV.
- Low p_T: hydro; Intermediate p_T: transition region; High p_T: fragmentation.

W. Zhao, W. Ke, W. Chen, T. Luo and X. N.Wang, arXiv:2103.14657.
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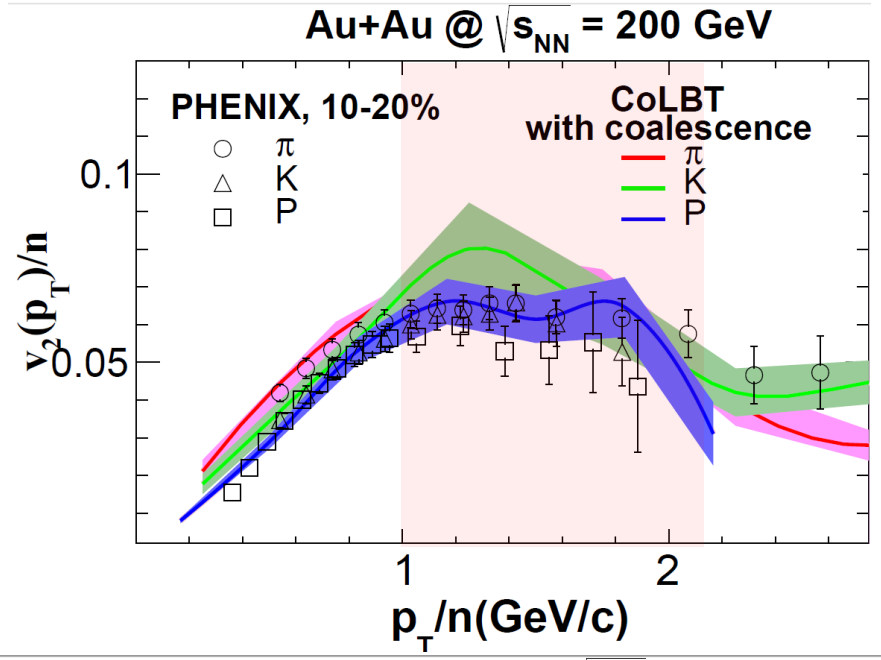
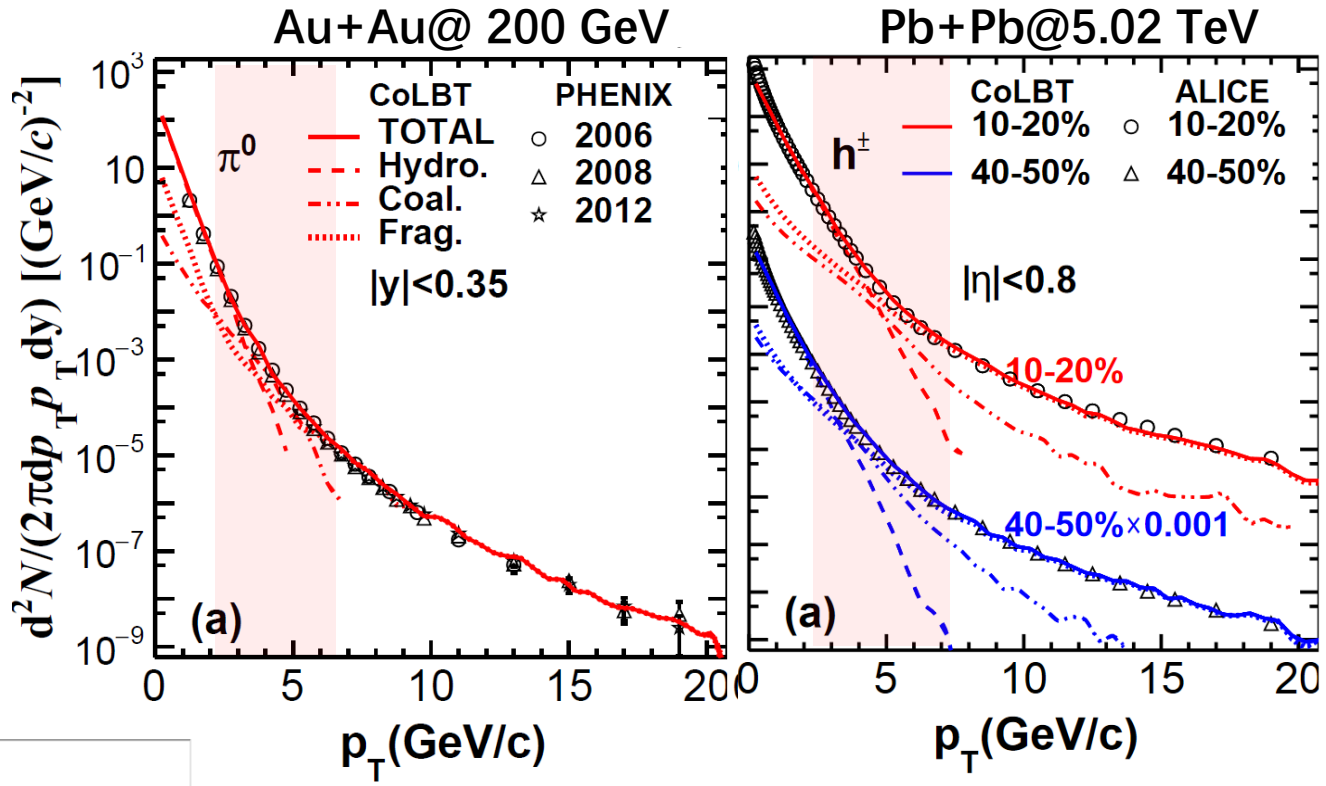
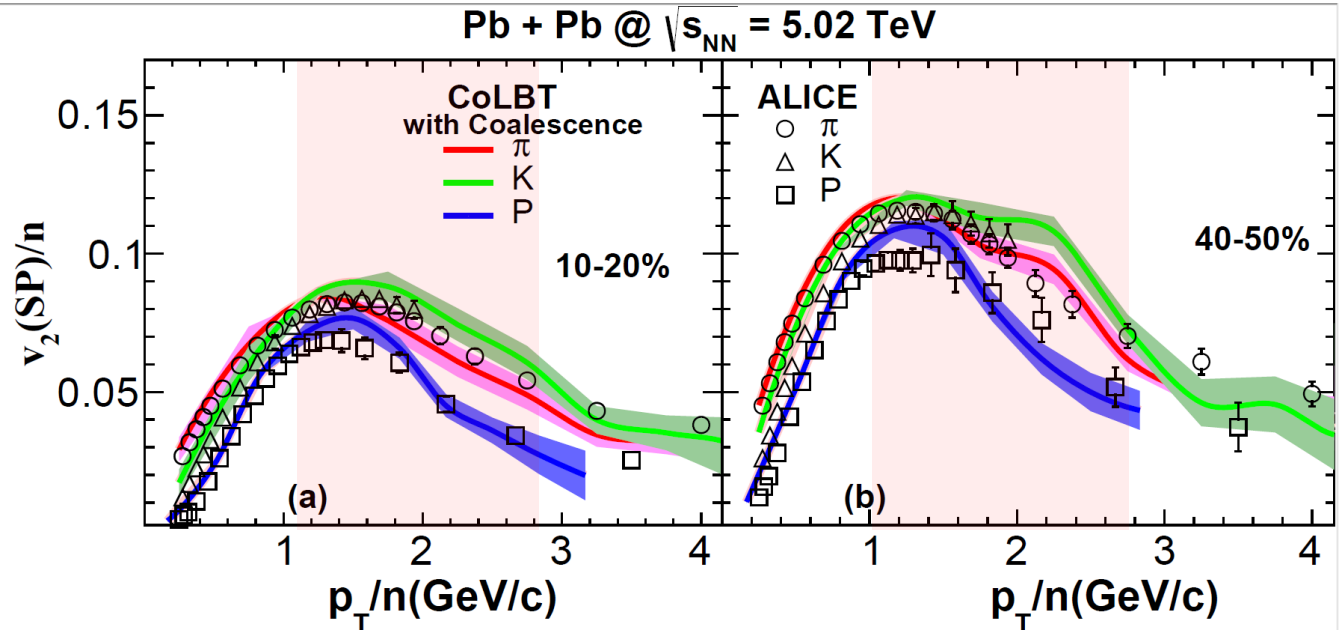
NCQ scaling at RHIC and LHC







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