復旦大學
现代物理研究所|核科学与技术系

Partonic effect on the charm correlation in a multi-phase transport model

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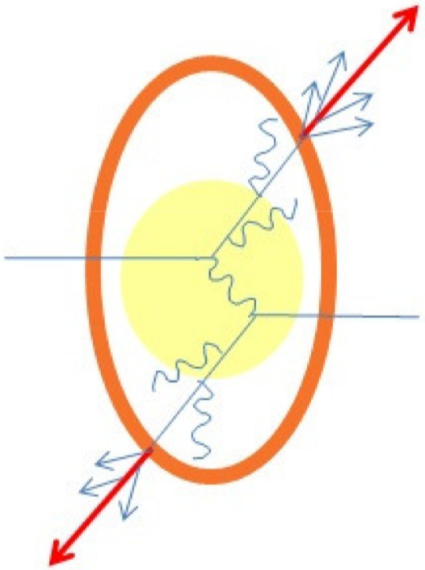
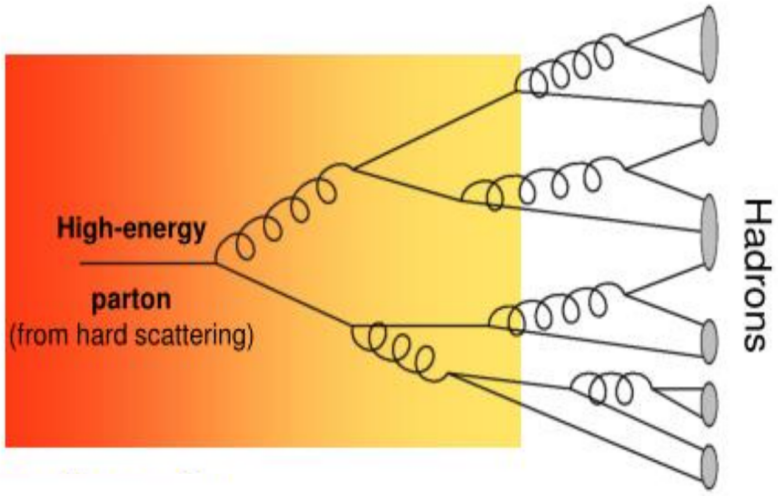
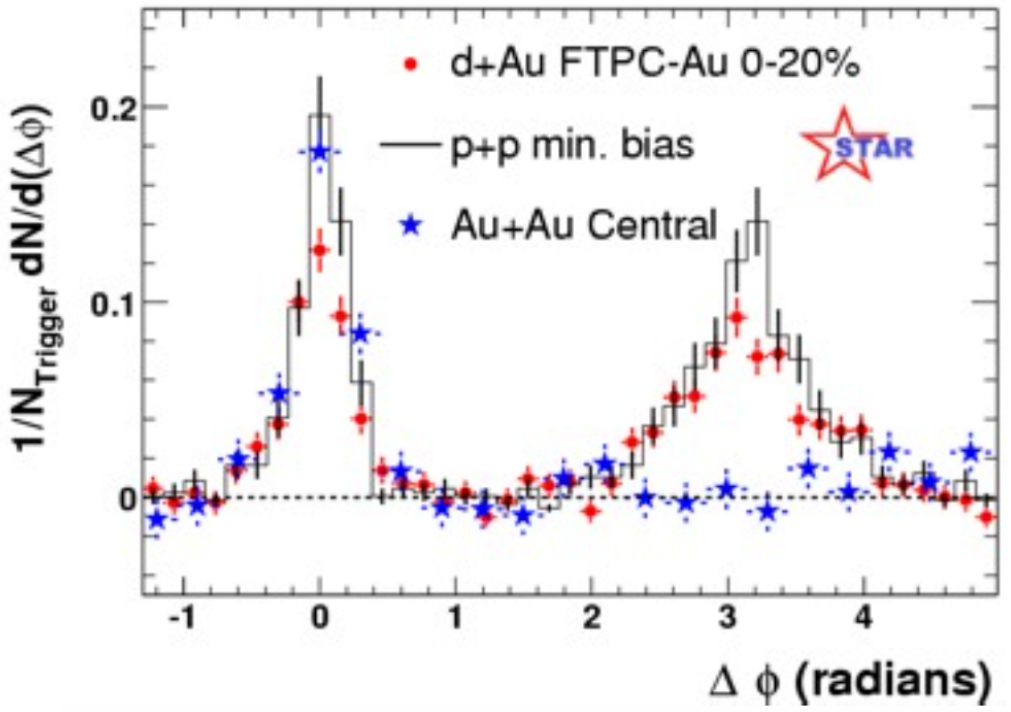
USTC-PNP-Nuclear Physics Mini Workshop

Partonic interaction and energy loss in HIC





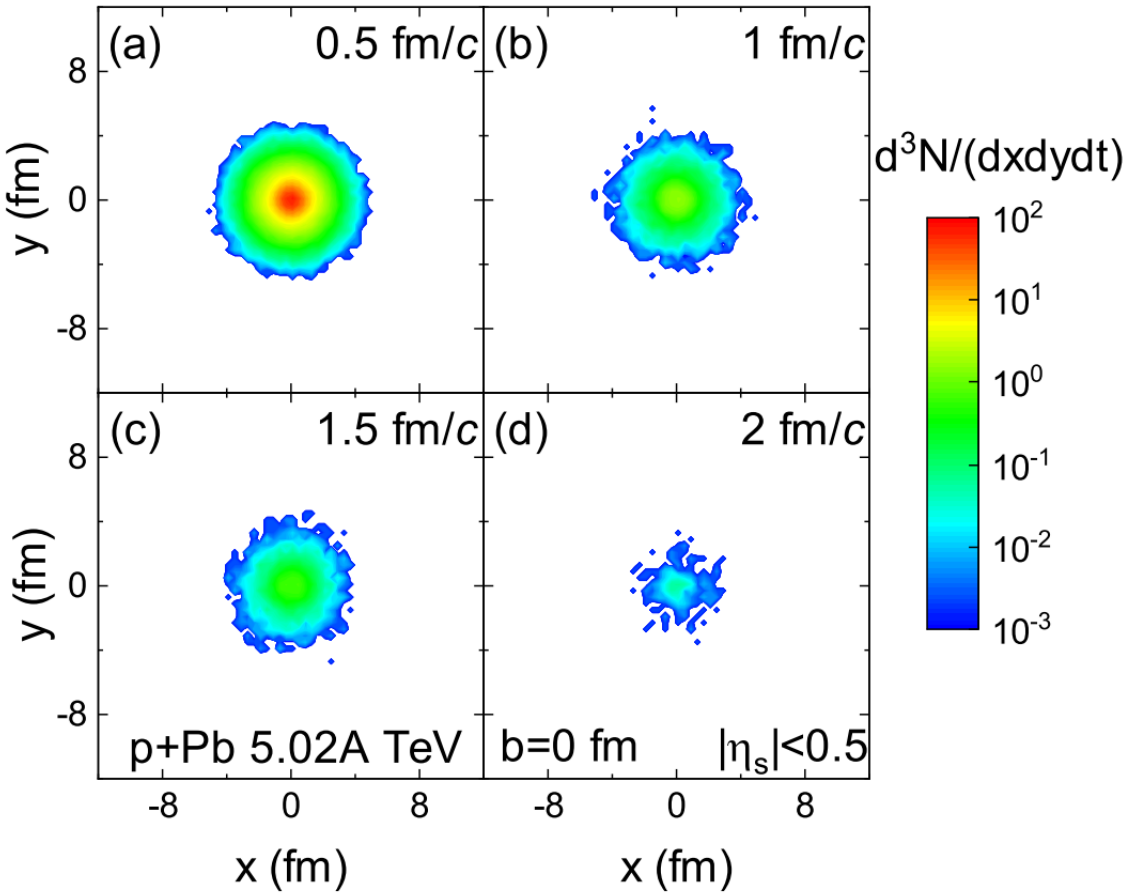


- Dihadron azimuthal correlation
  => probes medium effect
- Energy loss inside medium
  => partonic interaction

Outline

- Partonic effect on azimuthal anisotropy observables
- Partonic effect on charm correlation

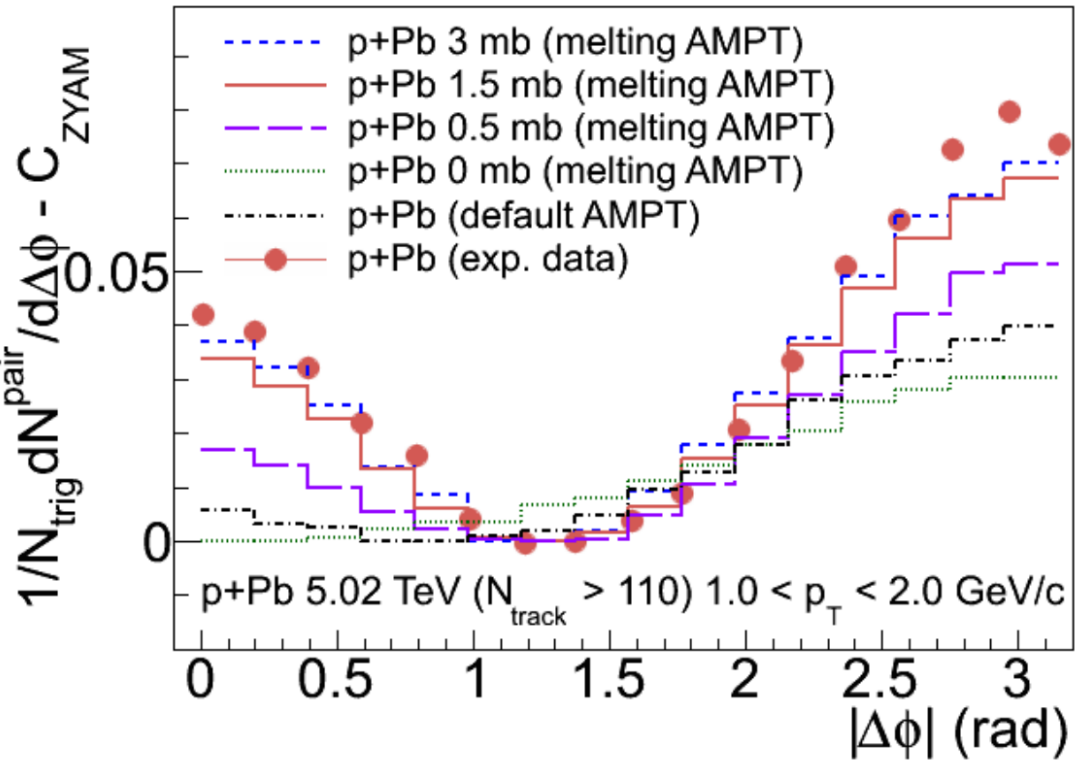
Partonic interactions in small system



- Early evolution of the active initial partons in the transverse plane in p+Pb 5.02 TeV collisions simulated by a multiphase transport model (AMPT)

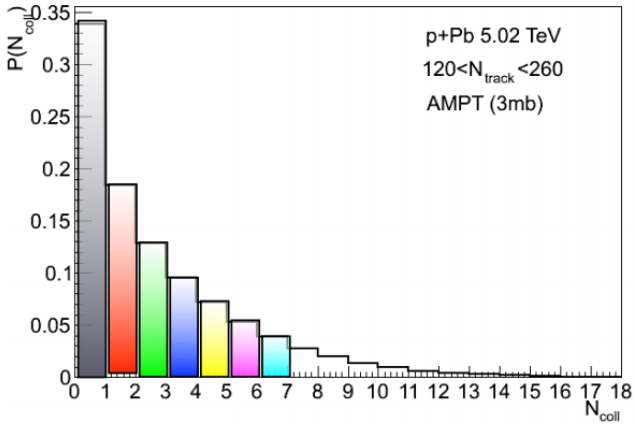
Partonic interactions in small system

G.-L. Ma and A. Bzdak, Phys.Lett. B 739 (2014) 209.

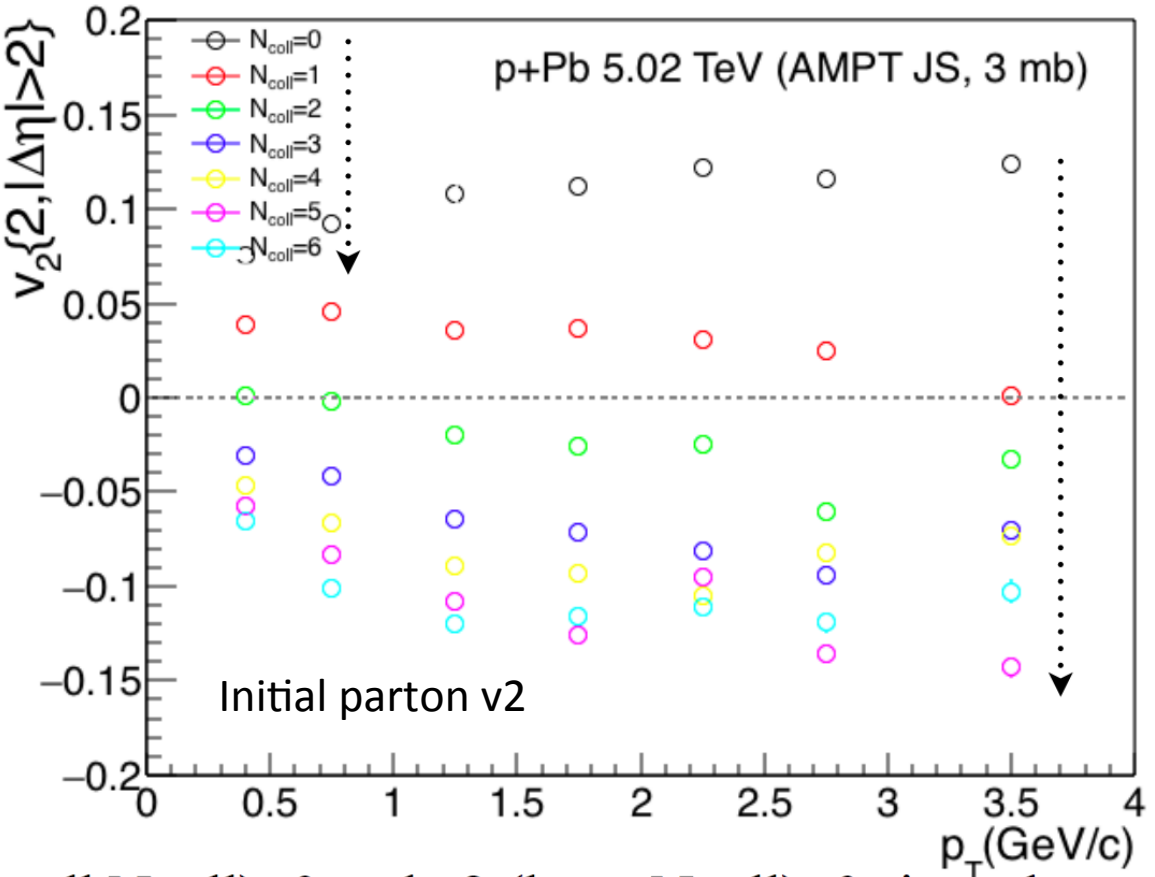


- Two particle correlations in p+Pb (AMPT)
- The strength of the signal increases with growing partonic x-section

Partonic interactions in small system



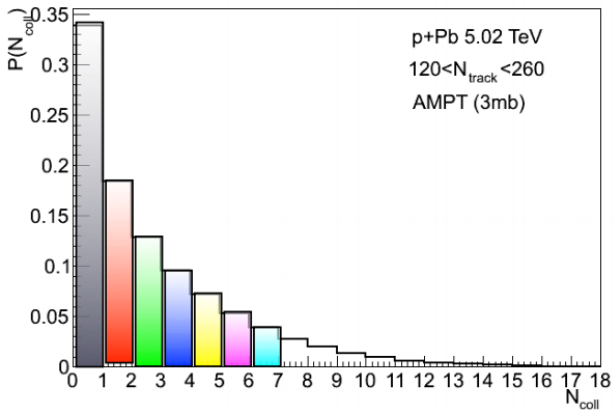
partons = Ncoll=0 + Ncoll=1 + Ncoll=2 + Ncoll=3 + Ncoll=4 + Ncoll=5 + Ncoll=6 + ...



- In the initial state, v2 (small Ncoll)>0 and v2 (large Ncoll)<0 since the average v2 must be zero.

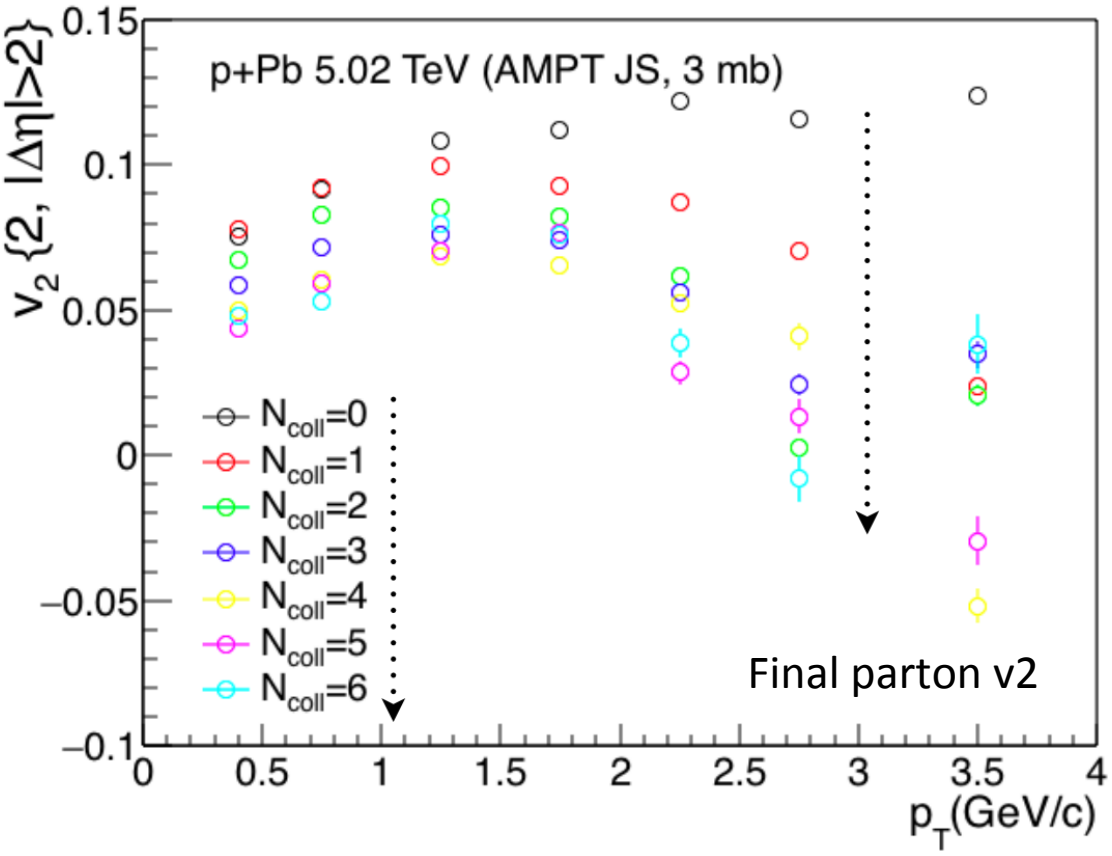
Guo-Liang Ma, Adam Bzdak, Nucl. Phys. A 956, 745–748

Partonic interactions in small system



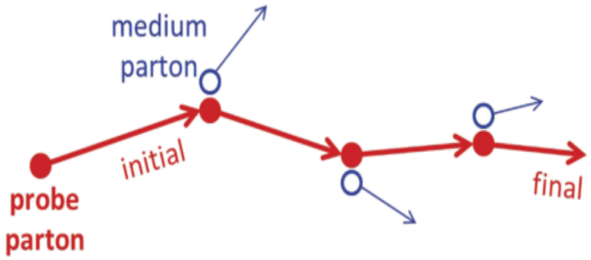
partons = Ncoll=0 + Ncoll=1 + Ncoll=2 + Ncoll=3 + Ncoll=4 + Ncoll=5 + Ncoll=6 + ...

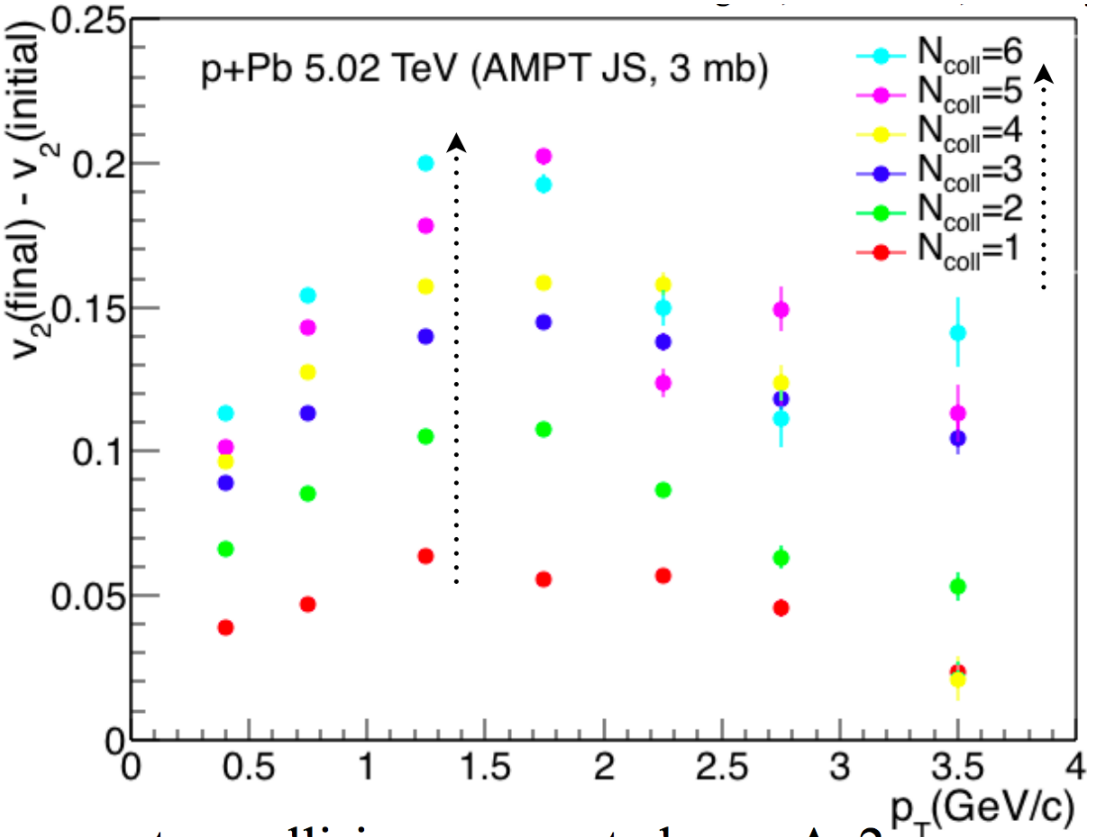
Final partons (freezeout)



- Final partons' v2 decreases with Ncoll.

Partonic interactions in small system

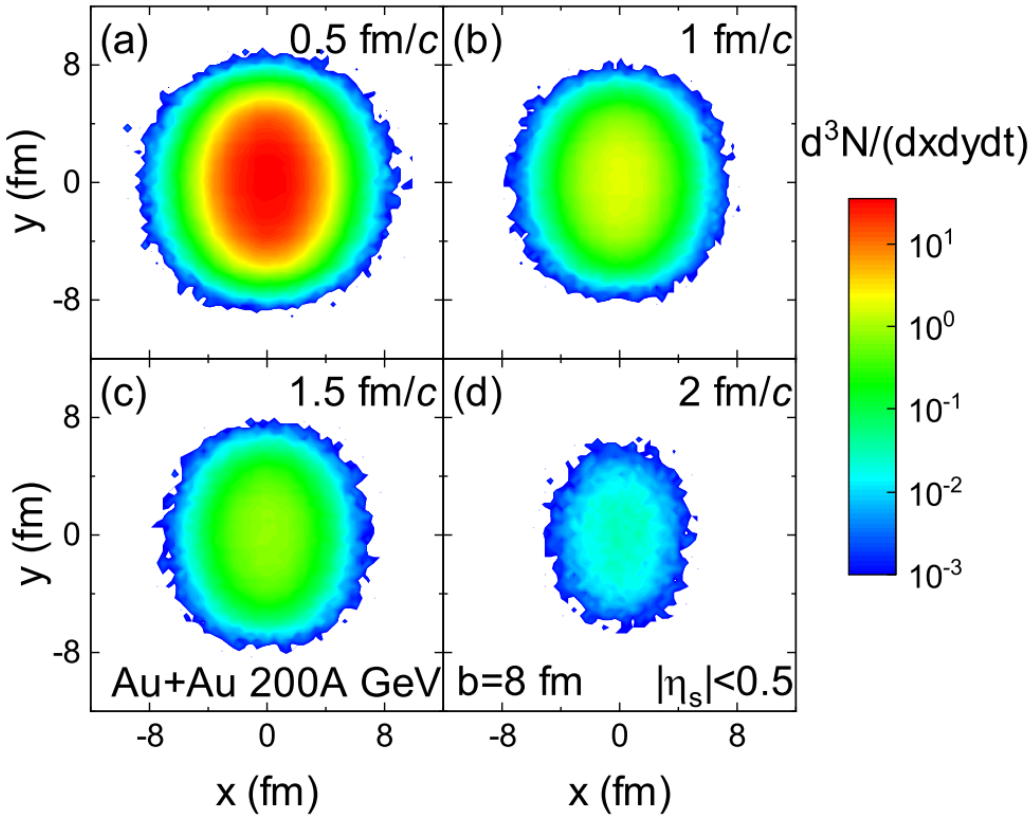




- More parton collisions generate larger Δv2.

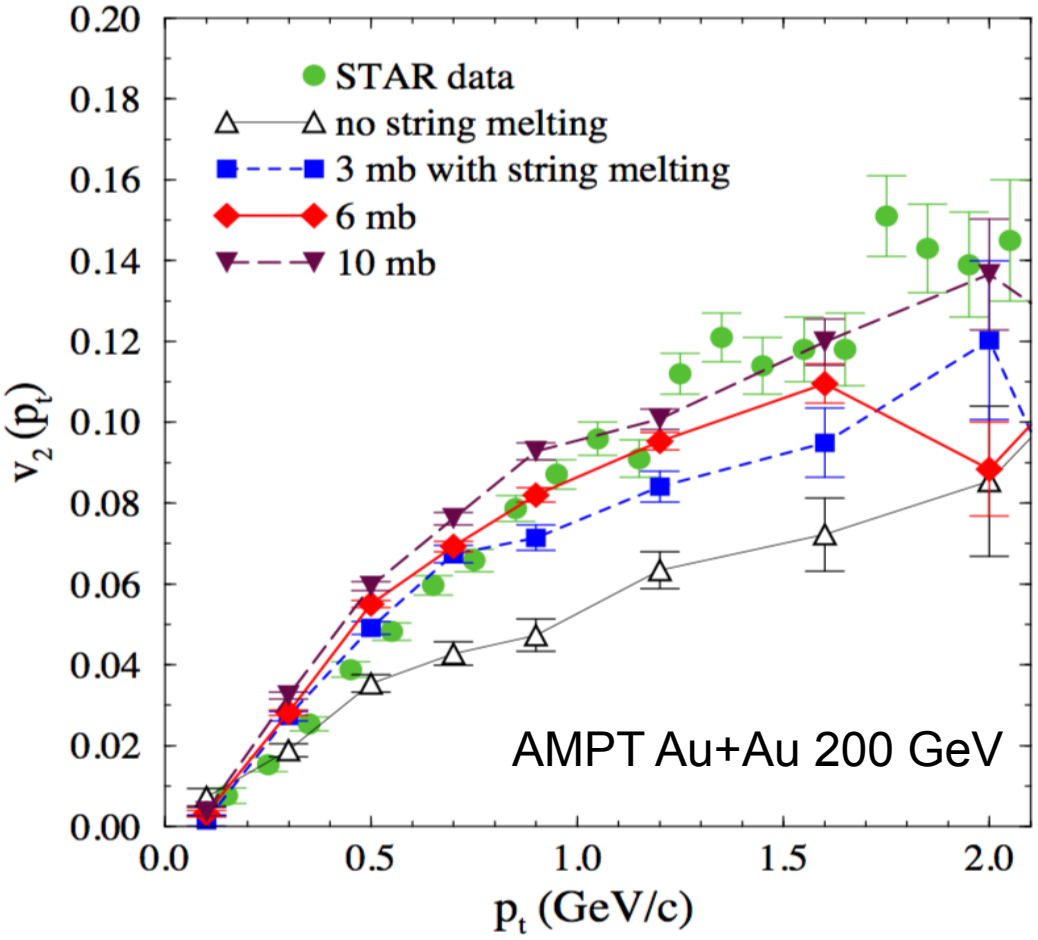
Partonic interactions in large system

Initial stage of the A+A system



- Early evolution of the active initial partons in the transverse plane in Au+Au 200 GeV mid-central collisions simulated by AMPT

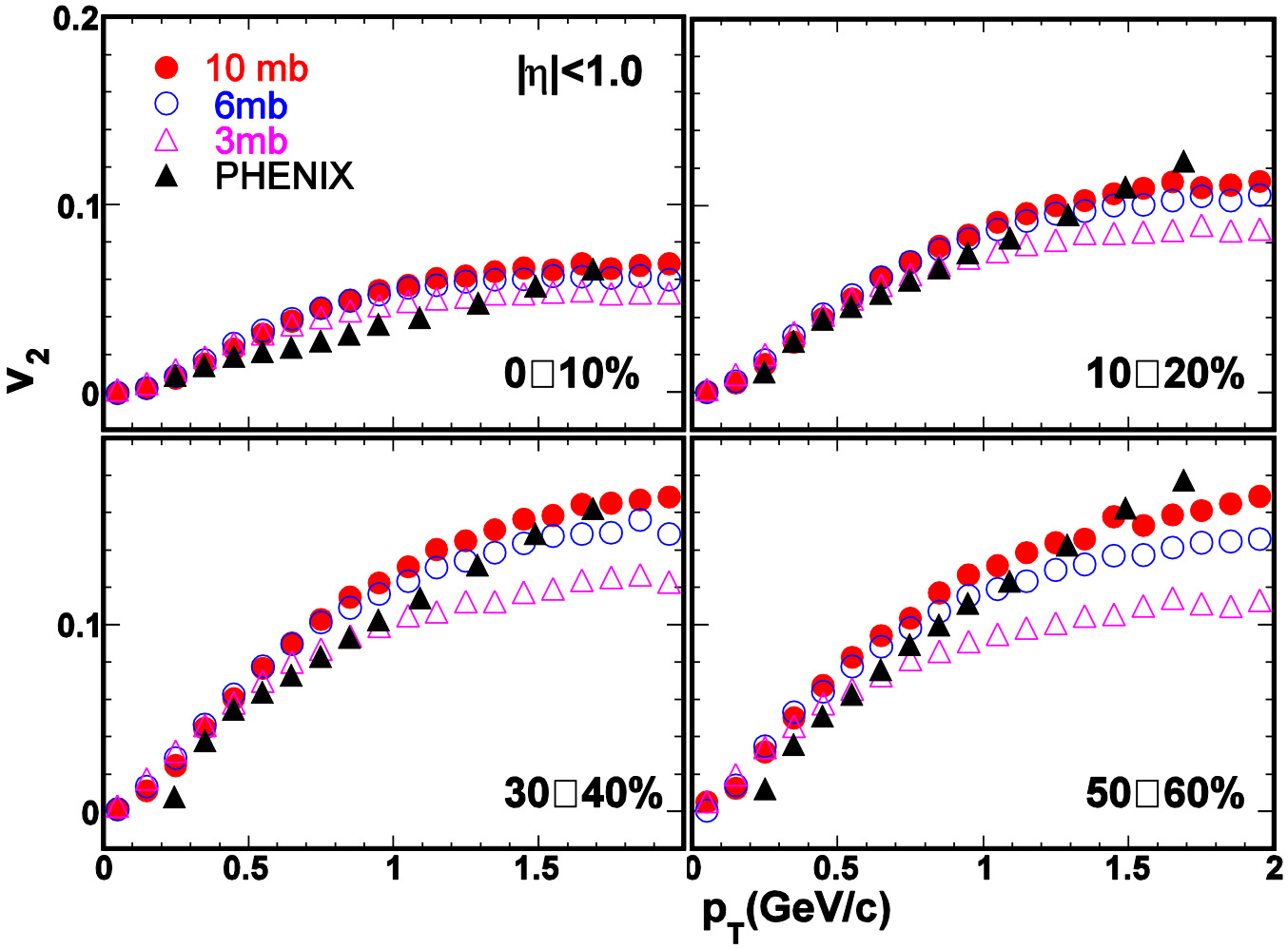
Partonic interactions in large system



- Flow observable: partonic x-sec dependent ordering

ZW Lin et al, Phys Rev C. 65. 034904

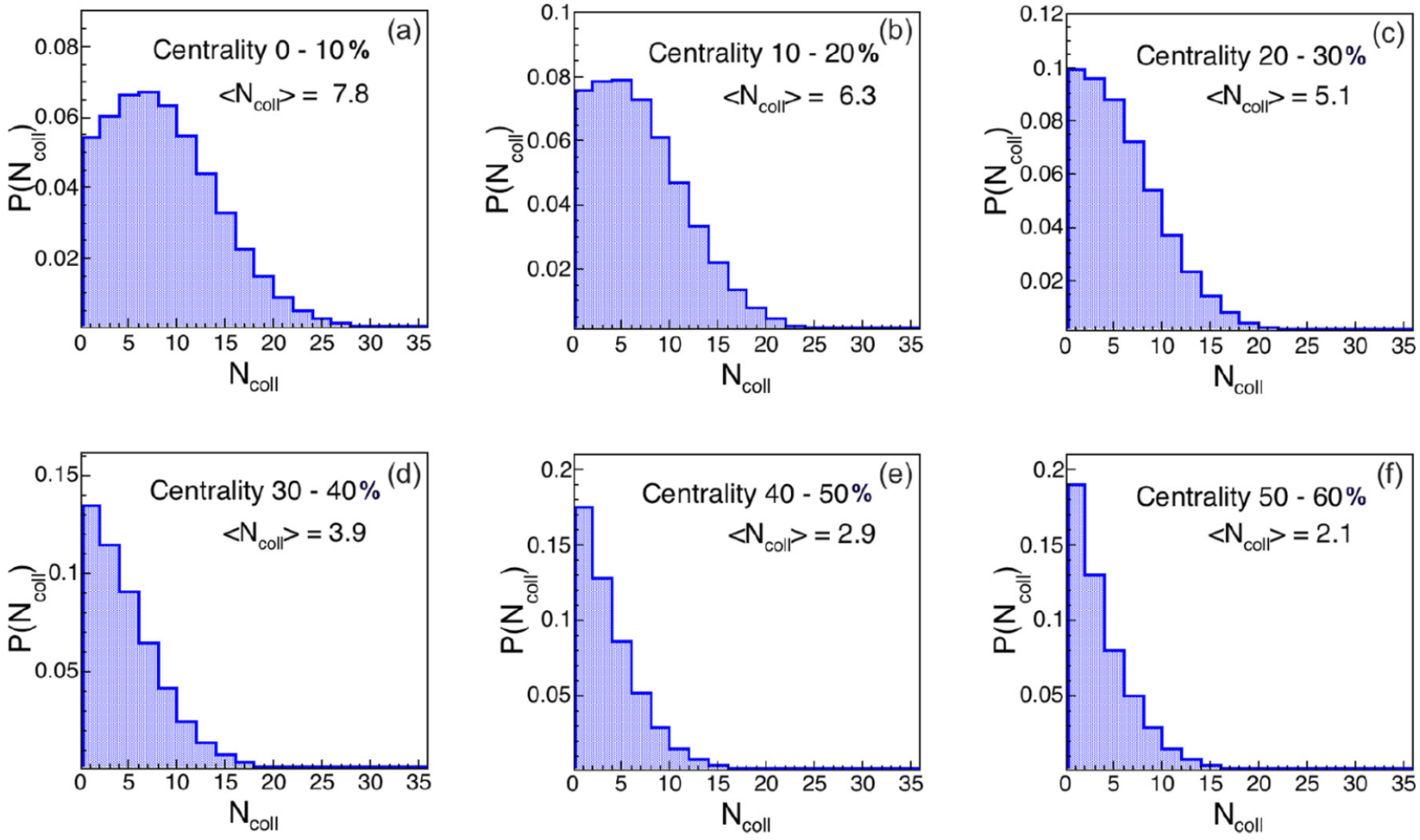
Partonic interactions in large system



- Flow observable: centrality dependence

LX Han et al, Phys. Rev. C 84, 064907

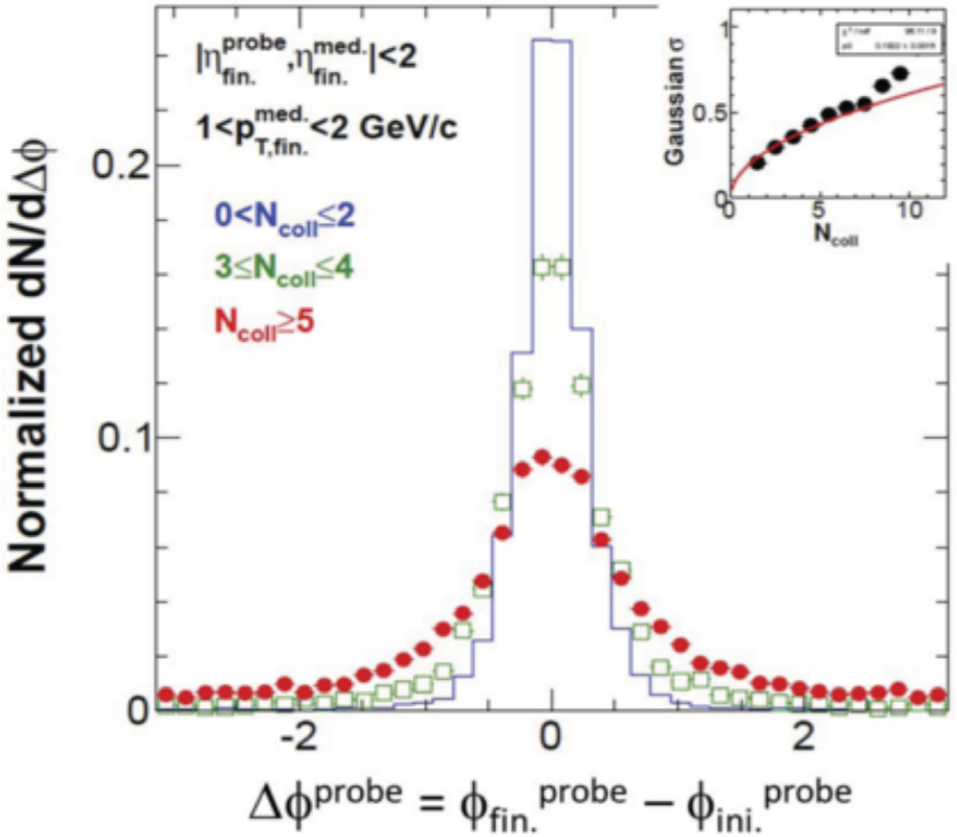
Partonic interactions in large system



- Probability distribution of the N_{coll} of freezeout partons

L Ma, GL Ma et al, PhysRevC.103.014908

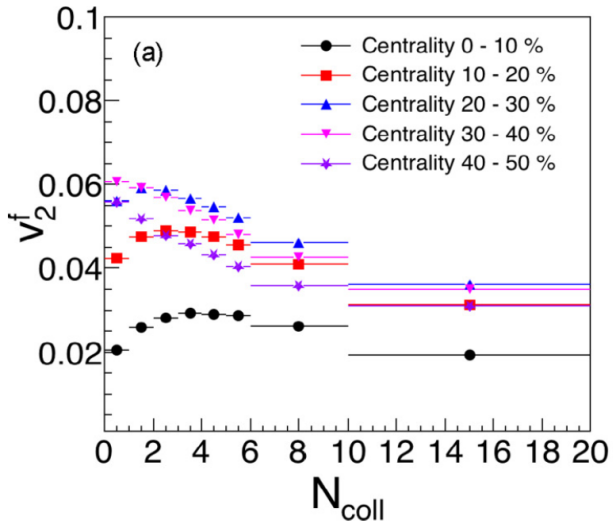
Partonic interactions in large system

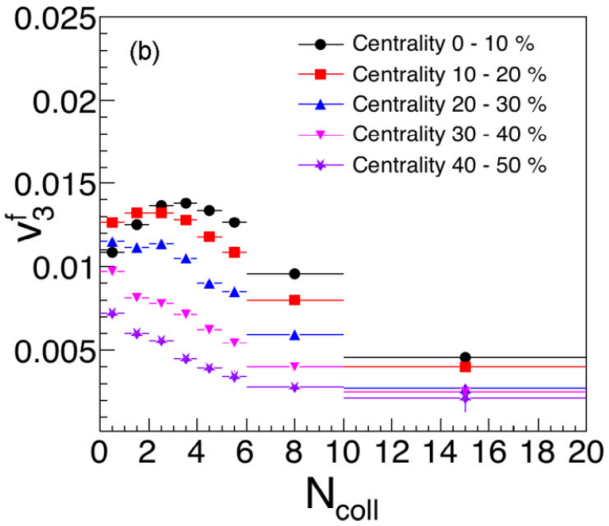


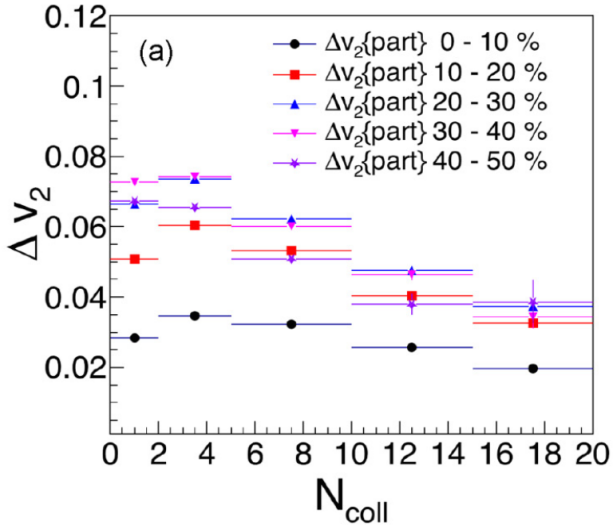
- Partonic collision effect on particle correlations in A+A collisions

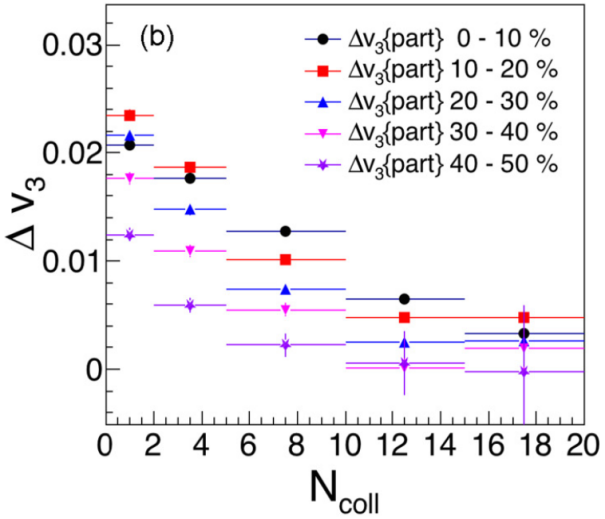
F. Wang et al. NPPP 289–290, 325–328

Partonic interactions in large system



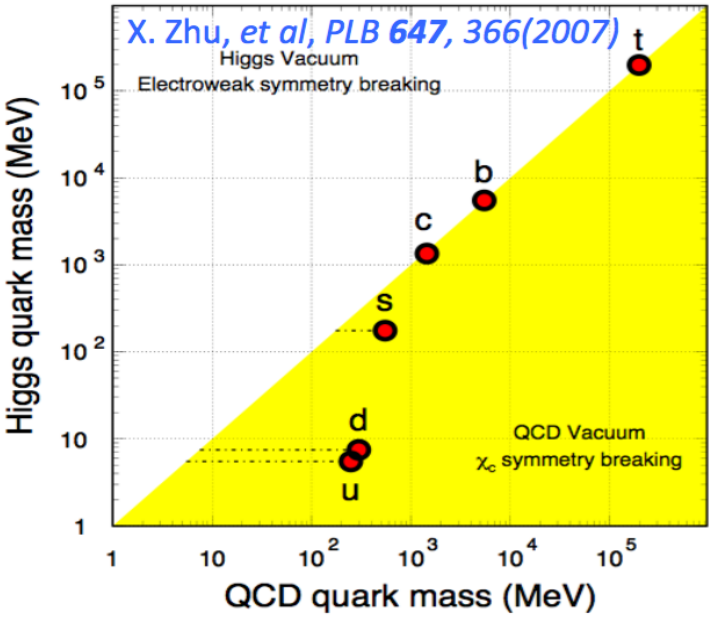


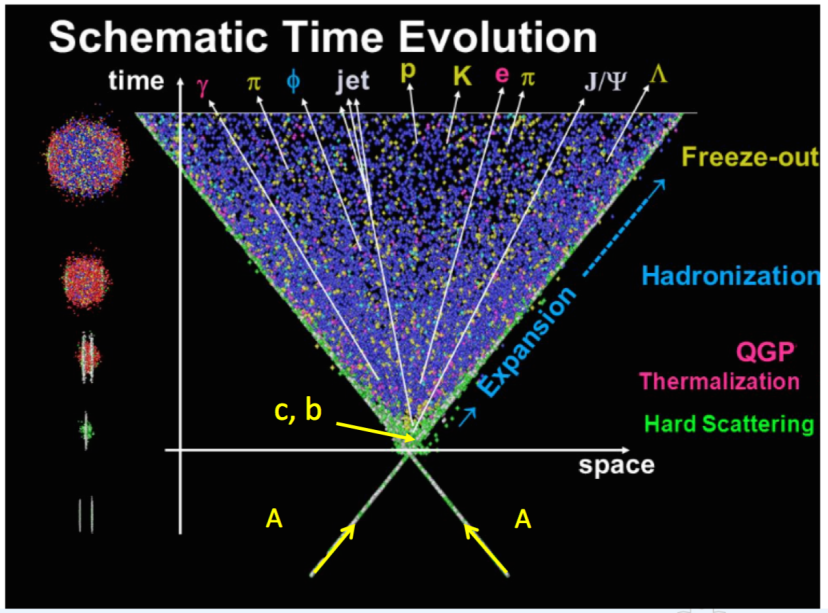




L Ma, GL Ma et al, Phys. Rev. C103,014908

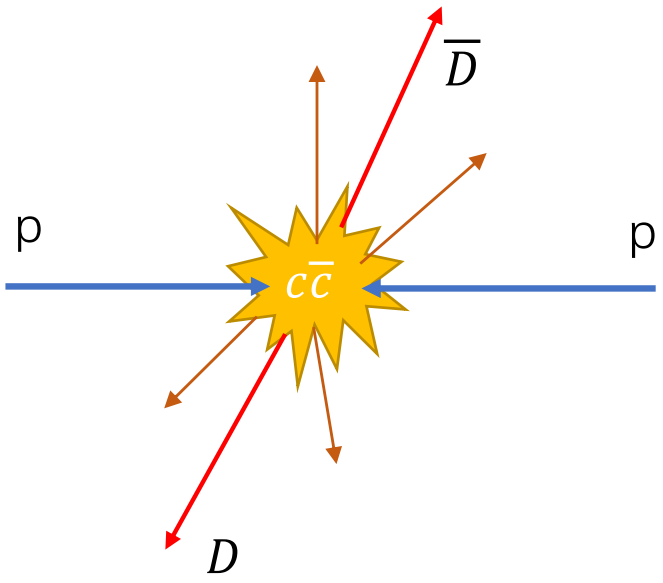
Heavy flavor probes

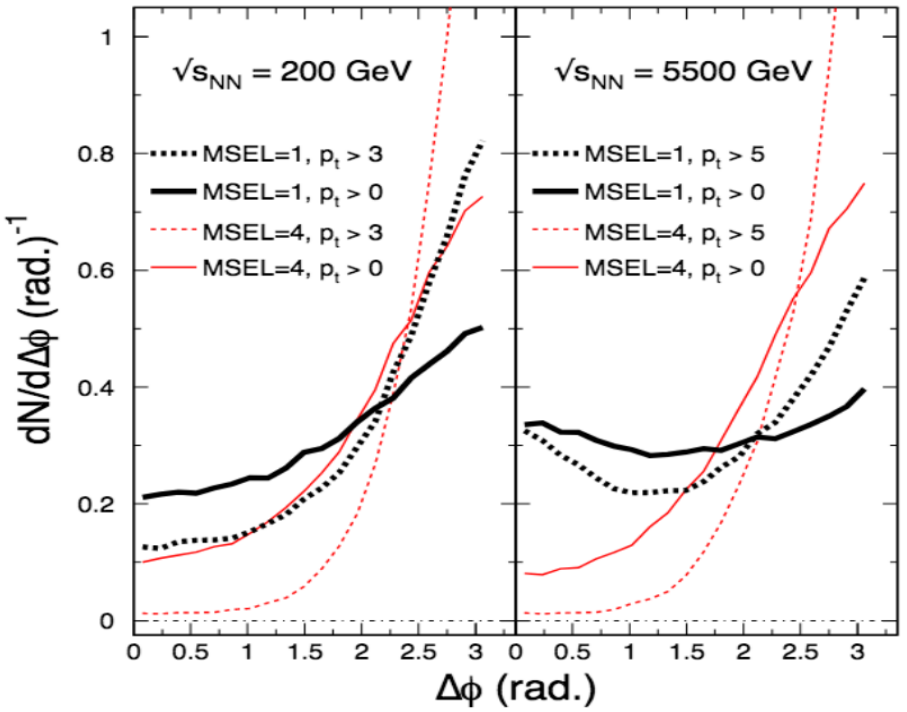




- Heavy quark produced in initial hard process => sensitive to the initial gluon density and distribution (pp/pA/AA)
- Couple differently with the medium than light quarks => reveal critical features of the medium (G. Greco, QM2017)

Heavy flavor probes





4: LO (pair production) , 1: NLO (E-loss, FE,GS)

- The D-meson azimuthal correlation inherit initial charm pair correlation
- Correlation function broadened by higher order pQCD and non-perturbative processes => sensitive probes of the partonic effect

XL Zhu, N. Xu, PF Zhuang,Phys. Rev. Lett 100.152301

Simulation setup

- Parton generation : PYTHIA (v8.3) :
- pQCD based MC
- generate hadrons as AMPT input

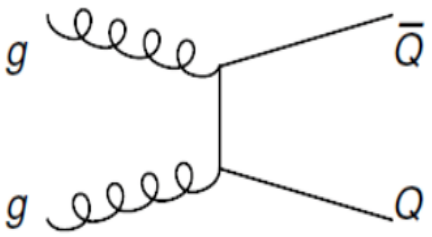
- Partonicd evoluation : AMPT(v2.26)
- hadrons are converted to partons according to their valence configurations with the string melting mechanism
- subsequential processes

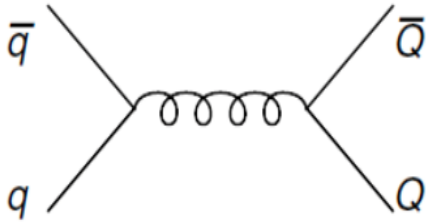
Heavy flavor production

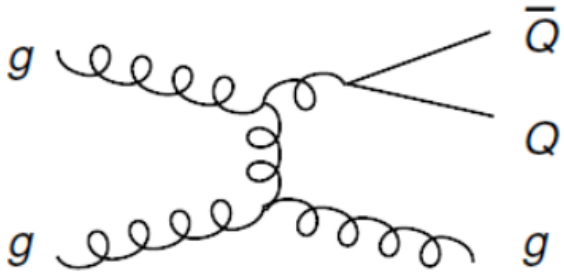
- HF production (PYTHIA):

$$\frac{d\sigma^{Q\bar{Q}}}{dp_{\mathrm{T}}^2 dy_1 dy_2} = K \sum_{a,b} x_1 f_a(x_1,\mu_F^2) x_2 f_b(x_2,\mu_F^2) \frac{d\sigma^{ab\to Q\bar{Q}}}{d\hat{t}}$$

LO vs NLO





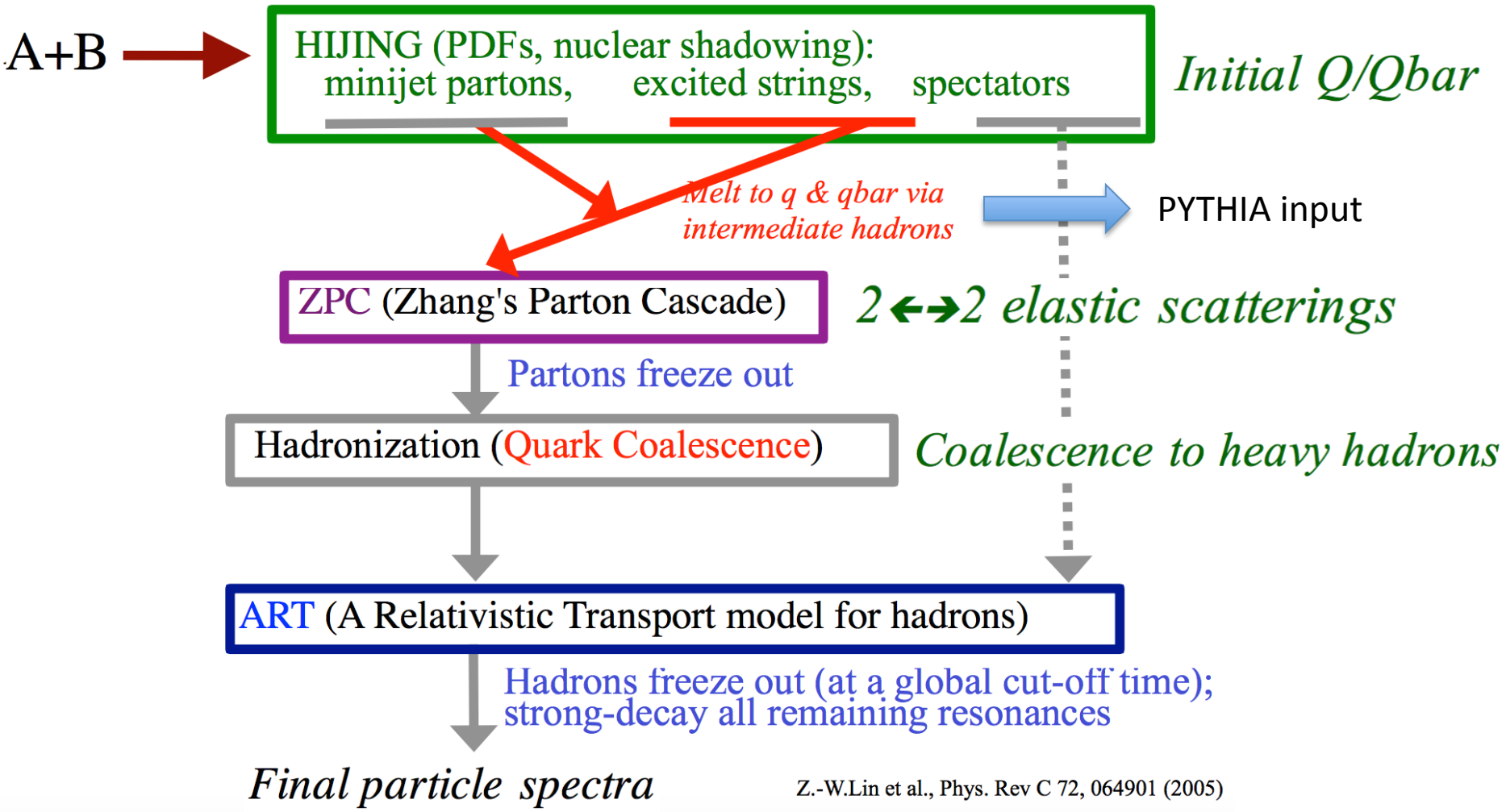


$$g + g \to Q + \bar{Q}$$
$$q + \bar{q} \to Q + \bar{Q}$$

$$g \to Q + \bar{Q}$$
$$g + Q \to g + Q$$

Z.W. Lin, C.M. Ko, Phys. Rev. C 65, 034904

AMPT with String Melting



AMPT with String Melting

- Partonic interaction/evolution in AMPT => Zhang's Parton Cascade (ZPC) model

- two-body elastic scattering process through the parton cascade mold
- 2↔2 parton cascade: gg↔gg, gg↔qqbar, gq↔gq

- Leading order pQCD interactions:

$$\frac{d\sigma}{d\hat{t}} = \frac{9\pi\alpha_s^2}{2}\left(1+\frac{\mu^2}{\hat{s}}\right)\frac{1}{(\hat{t}-\mu^2)^2},$$

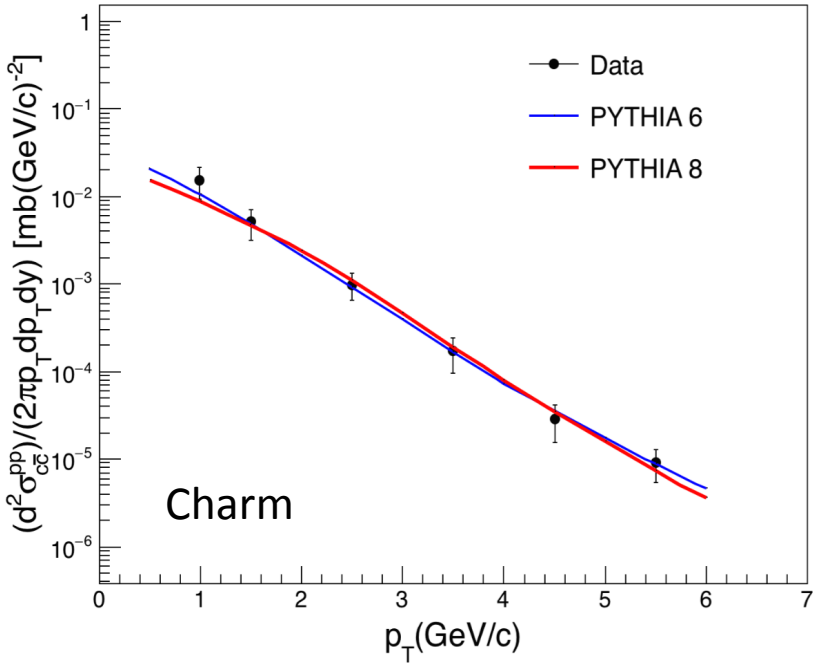
$s=(p_i+E_i)^2=(p_f+E_f)^2$

$t=(p_f-p_i)^2=(E_f-E_i)^2$

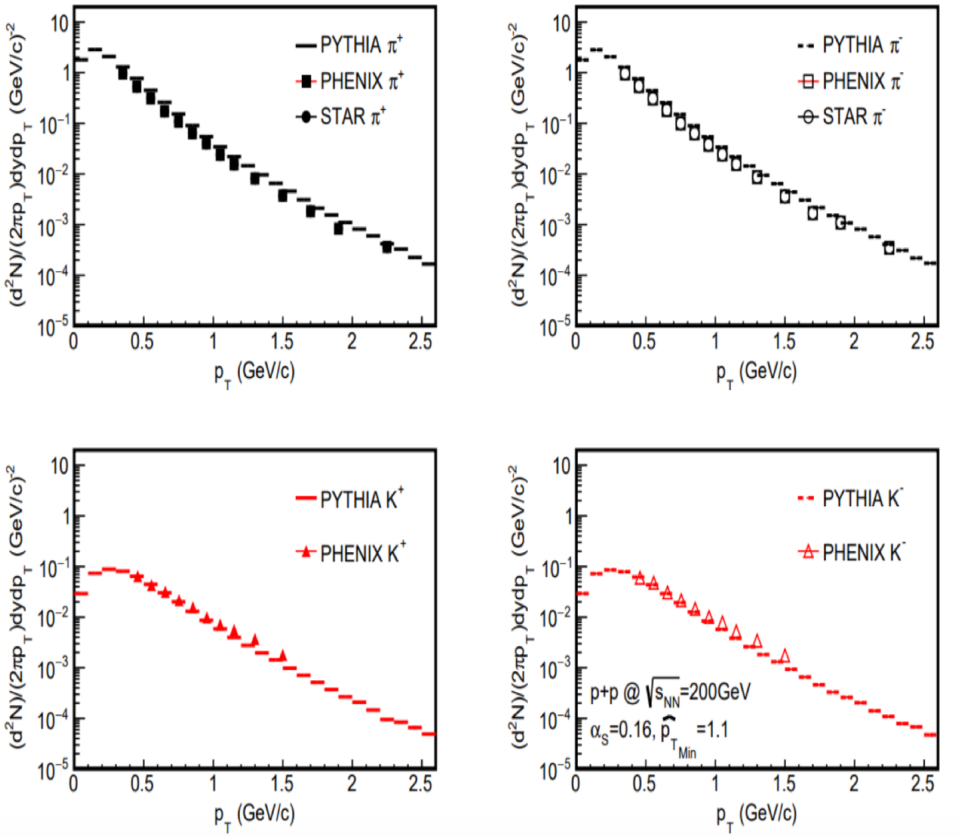
μ : Debye screening mass

B. Zhang, Comput. Phys. Commun. 109, 193 (1998)

PYTHIA tune

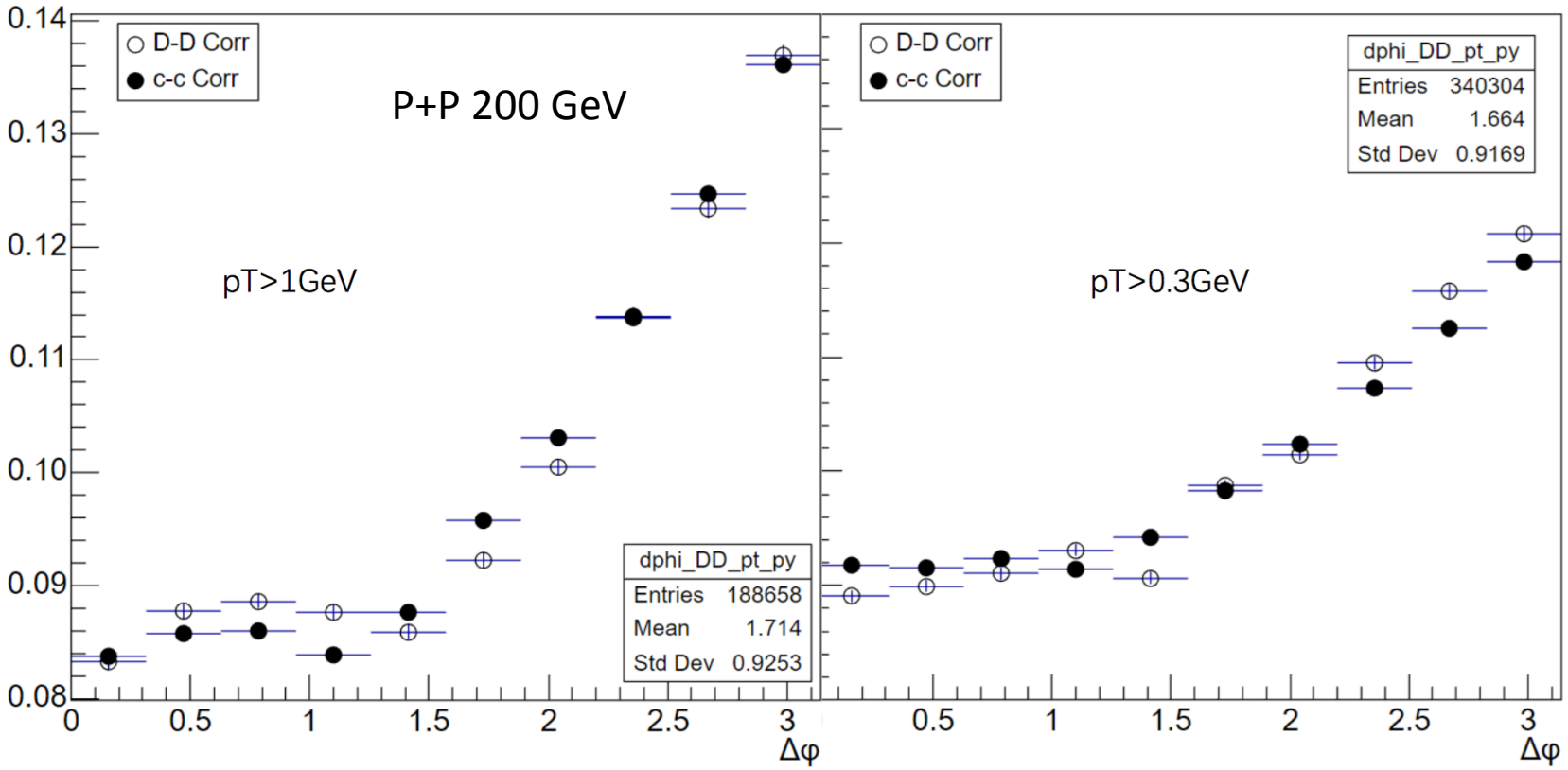


Light Flavor



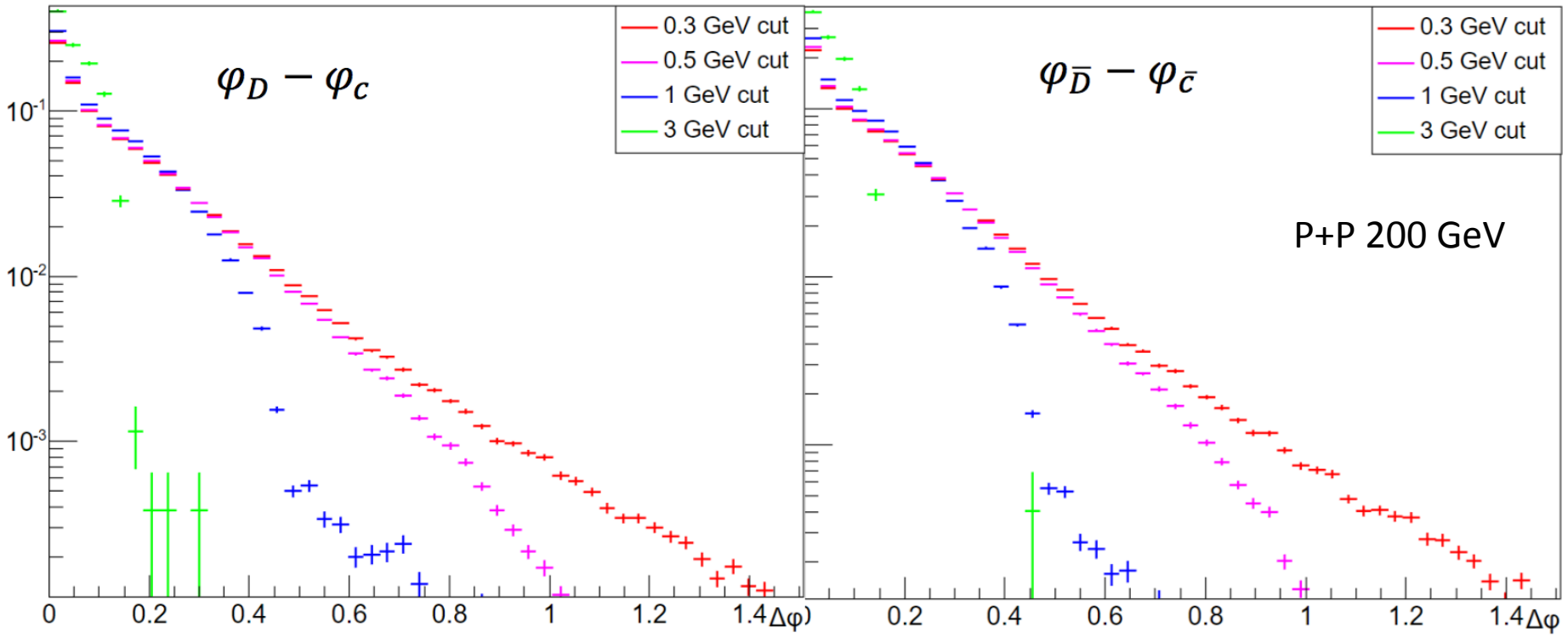
Reference: T. Sjöstrand and M. van Zijl, Phys. Rev. D 36, 2019

Charm correlation

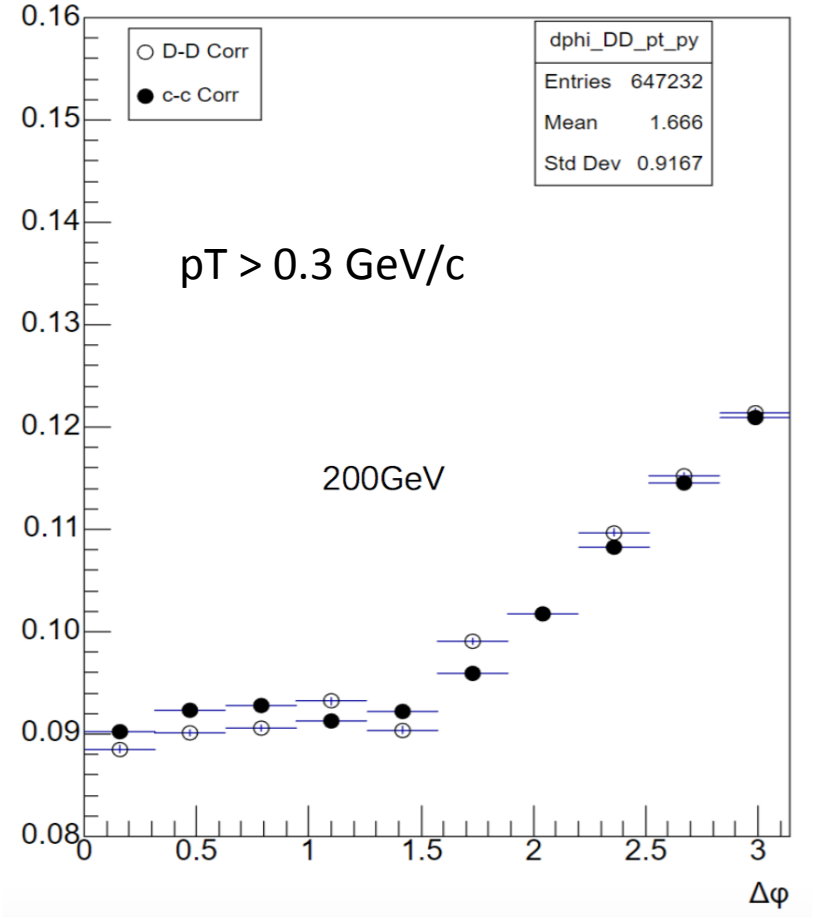


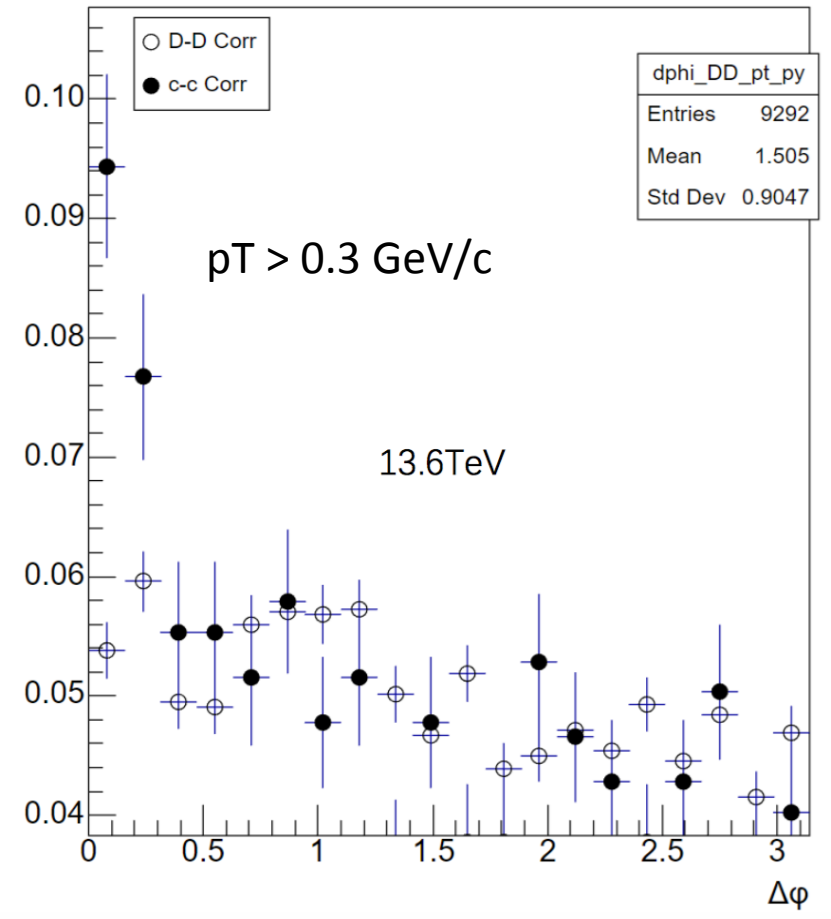
- Clear triggered/associated particle pT dependence
- Considerable hadronization effect

Charm correlation



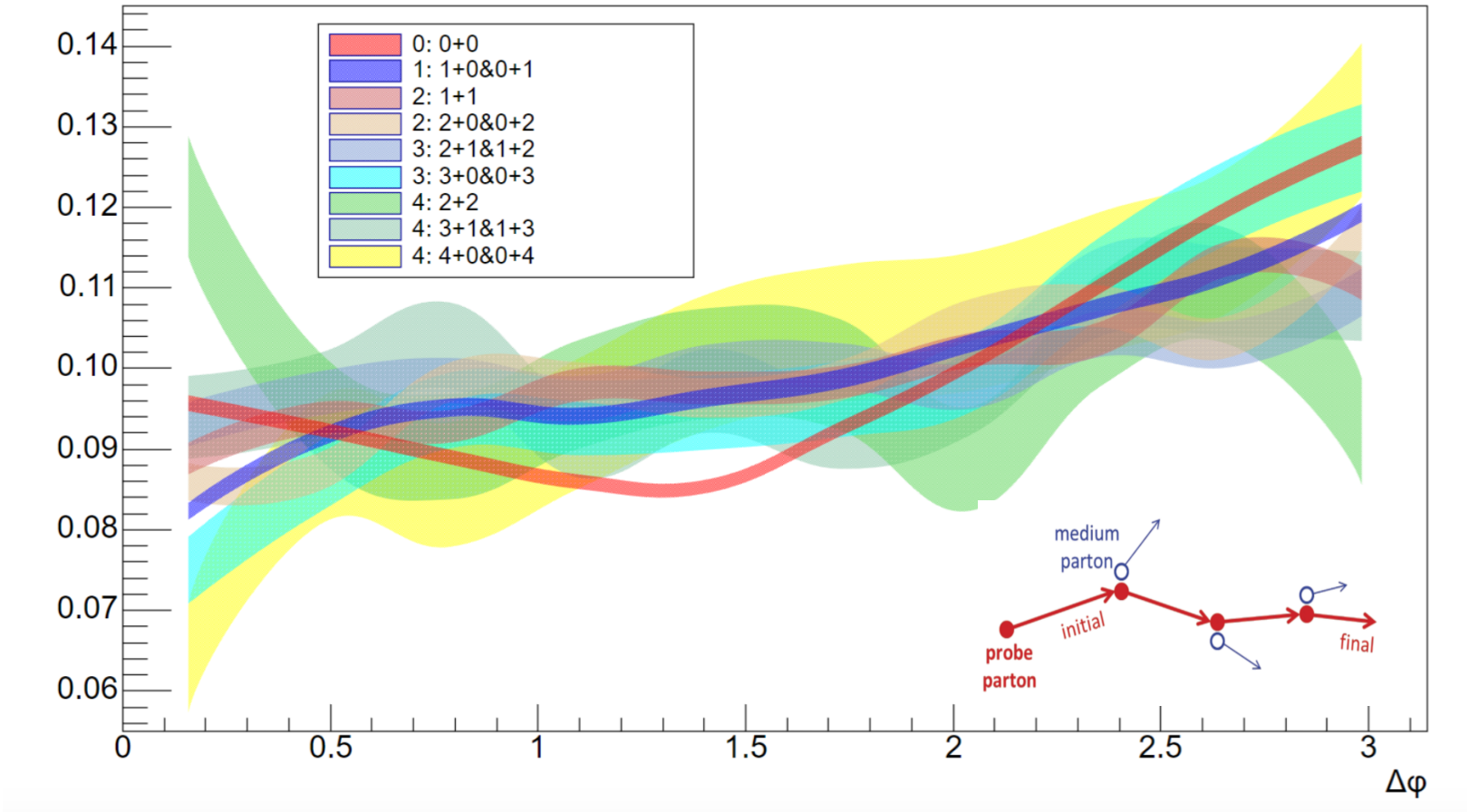
Charm correlation





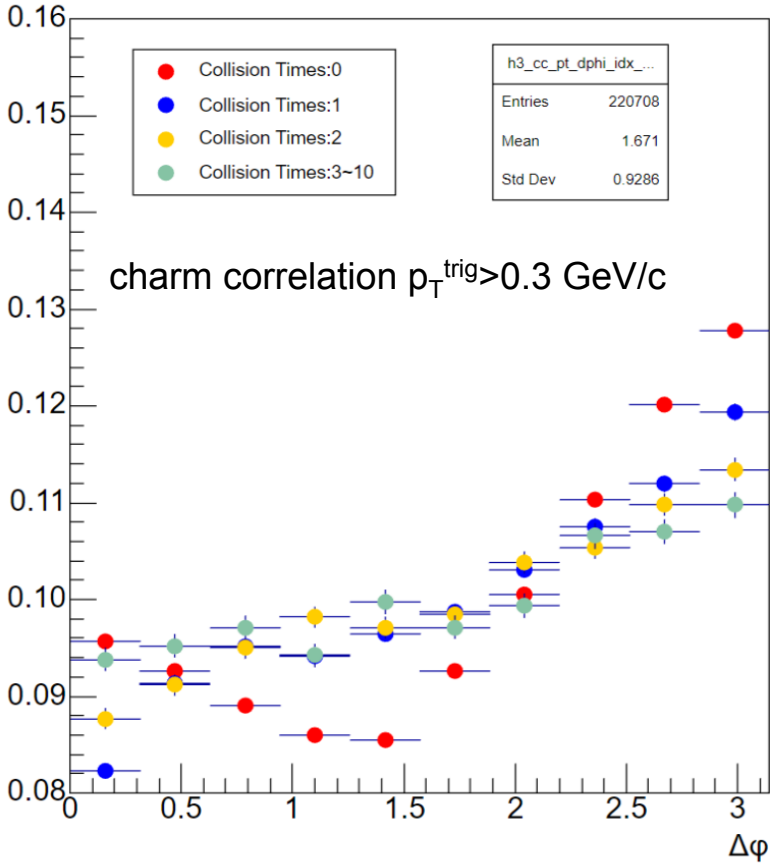
- Energy dependence : RHIC vs LHC

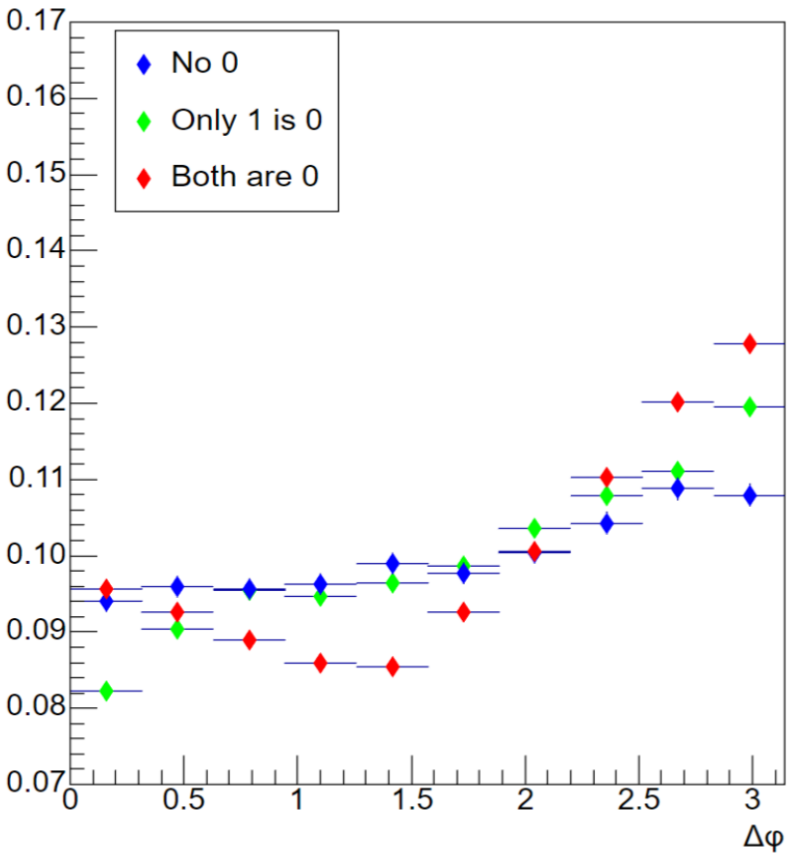
Charm correlation



- Categorizing the cc_bar pairs

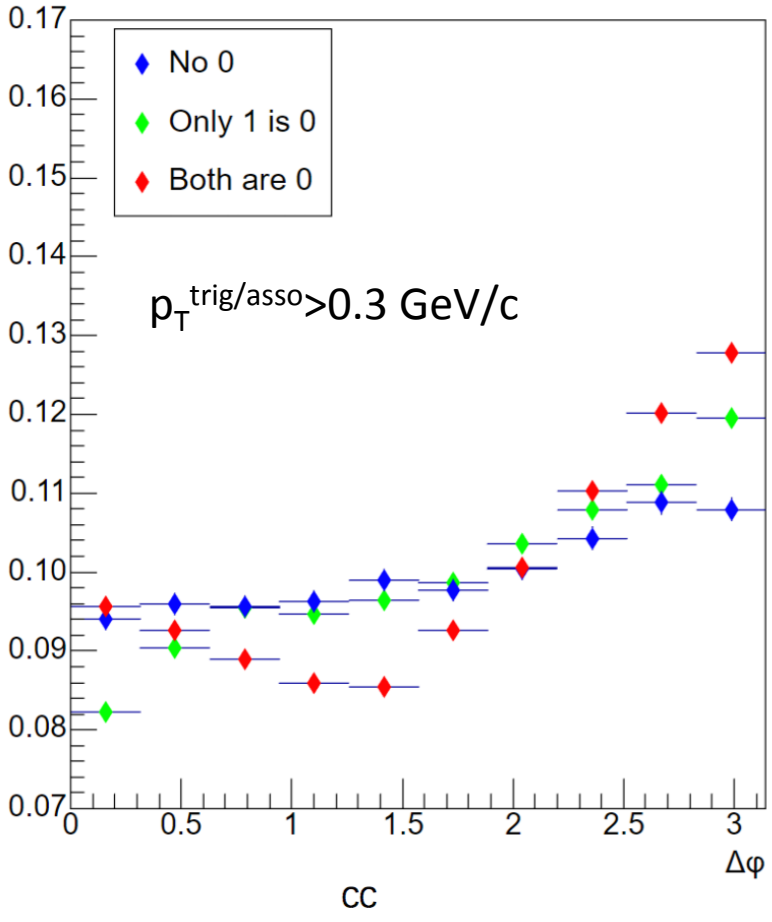
Charm correlation

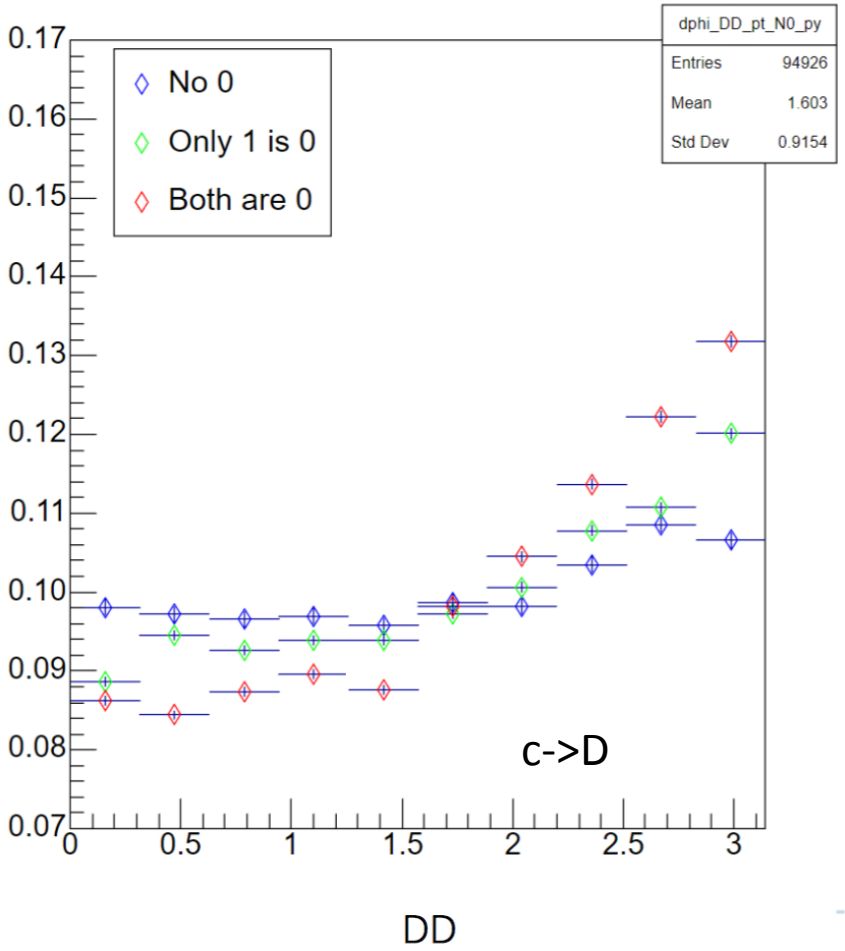




- Partonic effect on charm correlation

Charm correlation

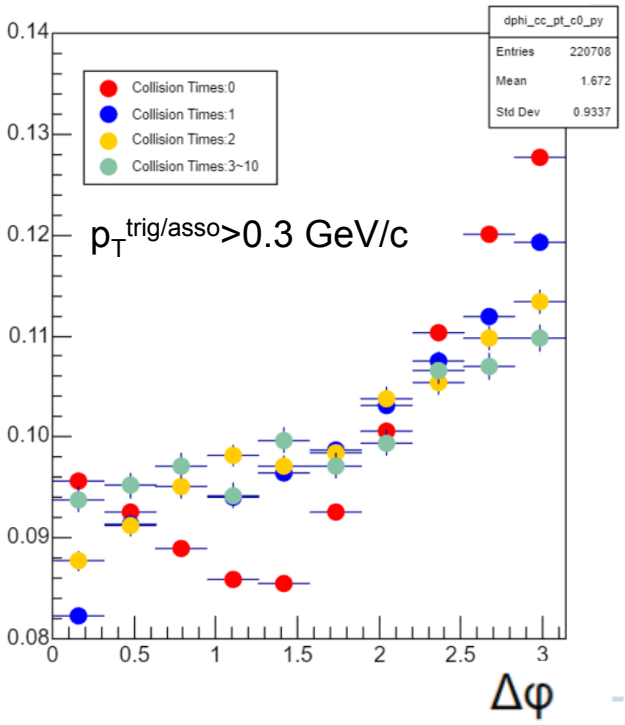


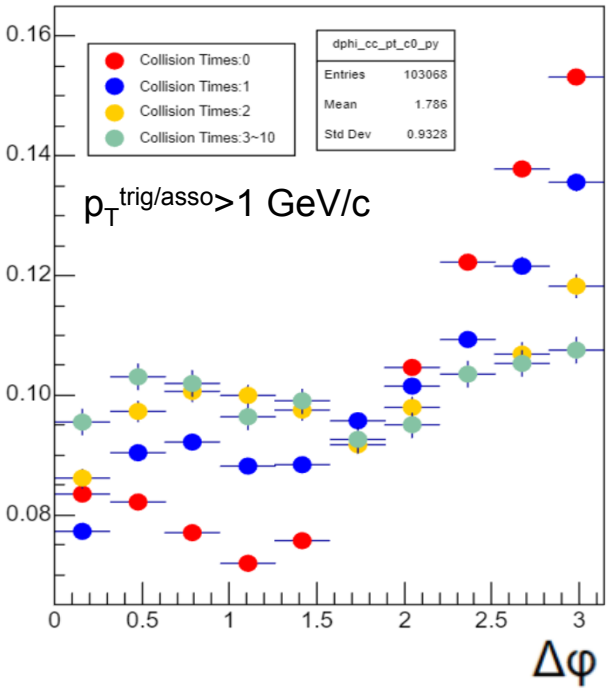


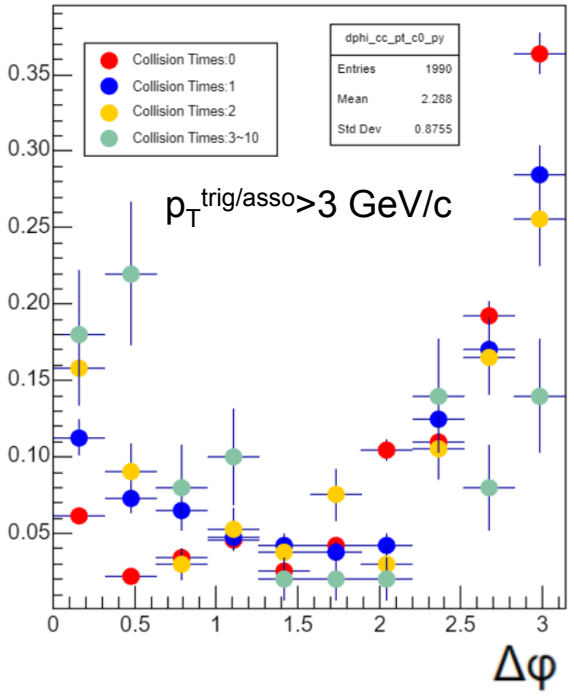
- Hadronization => significant effect on “zero collision” partons

Charm correlation

p+p 200 GeV

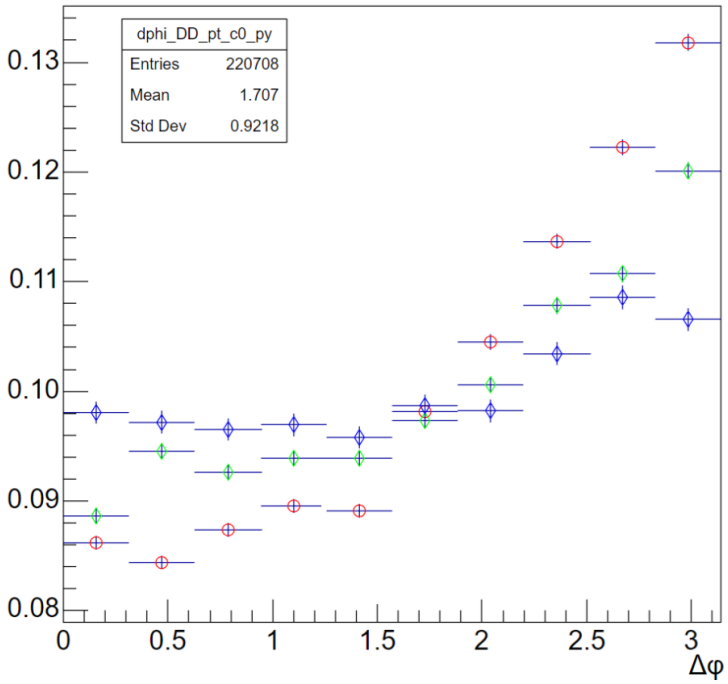


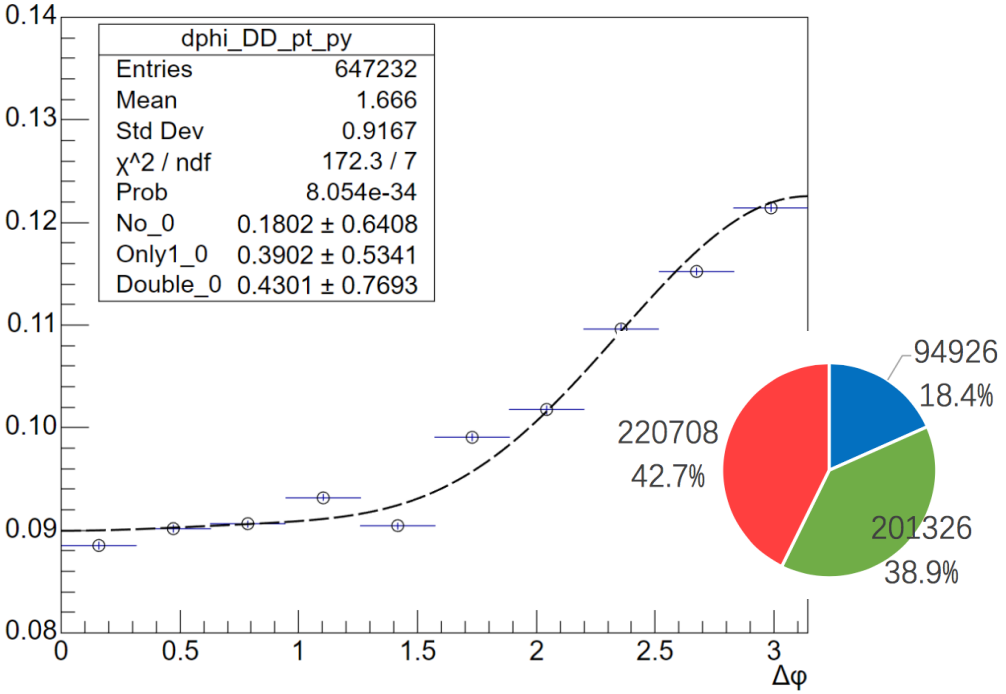




- Triggering pT dependence

Charm correlation



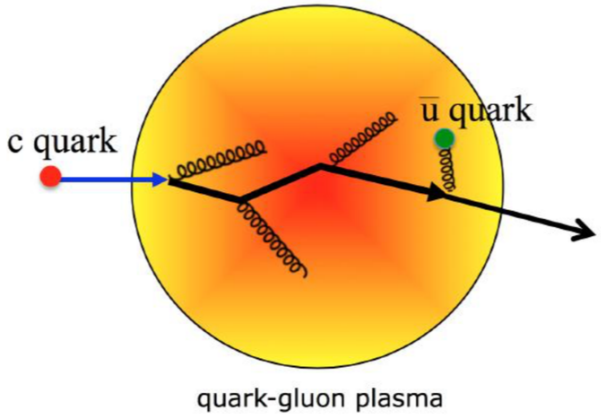


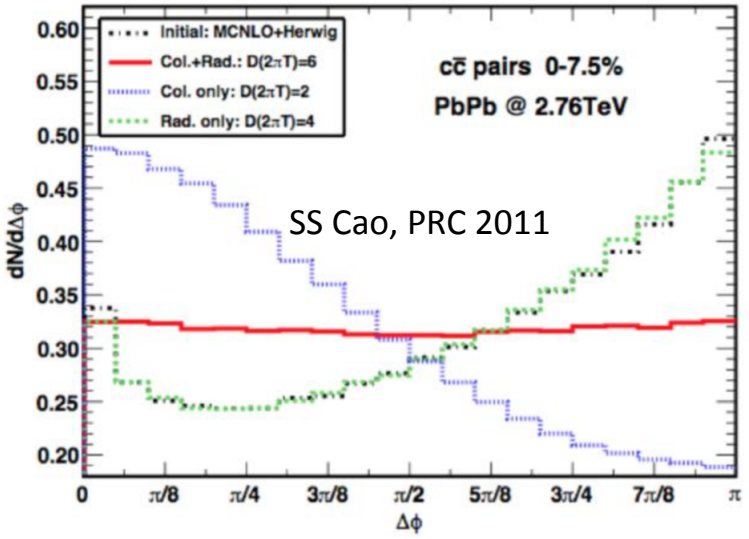
$$\frac{\mathrm{d}^2 N}{\mathrm{d}(\varphi-\Psi_n)\mathrm{d}p_{\mathrm{T}}} = \frac{\mathrm{d}N}{2\pi\,\mathrm{d}p_{\mathrm{T}}}\left\{1+2\sum_{n=0}^{\infty} v_n(p_{\mathrm{T}})\cos[n(\varphi-\Psi_n)]\right\}$$

$$f = k_{xx}f_{xx} + k_{x0}f_{x0} + k_{00}f_{00}$$

- Template fitting to the correlation function => quantify the partonic effect

Summary and outlook





- ➢ HF correlation in p+p / p+A
- • test pQCD and fragmentation (non-perturbtive process)
- ➢ HF correlation in A+A
- • energy loss mechanism (RHIC: Au+Au, LHC: Pb+Pb / O+O)

- ➢ Data vs model => quantify initial partonic effect

Thanks!