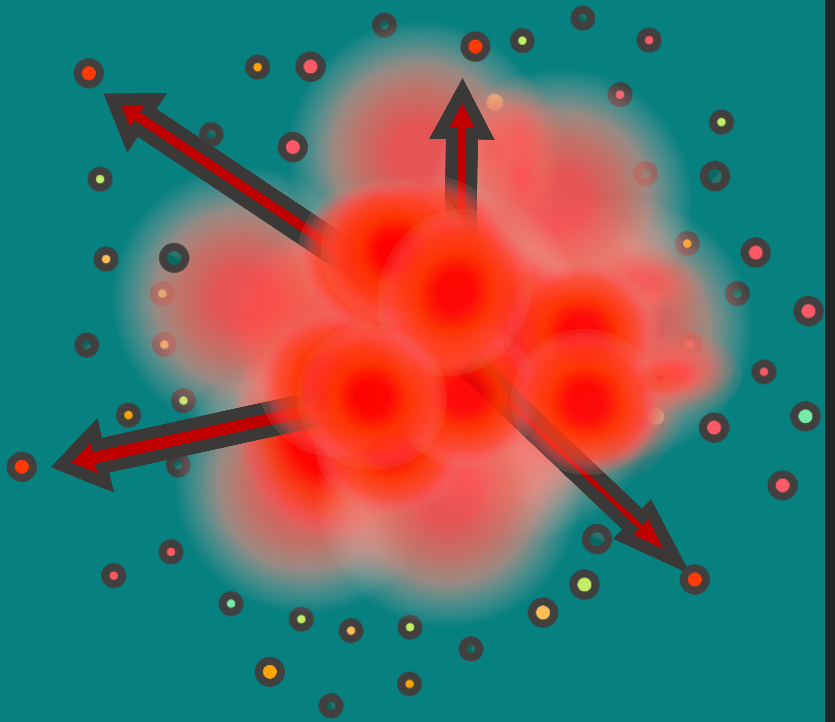
Dynamical core-corona picture from small to large colliding systems



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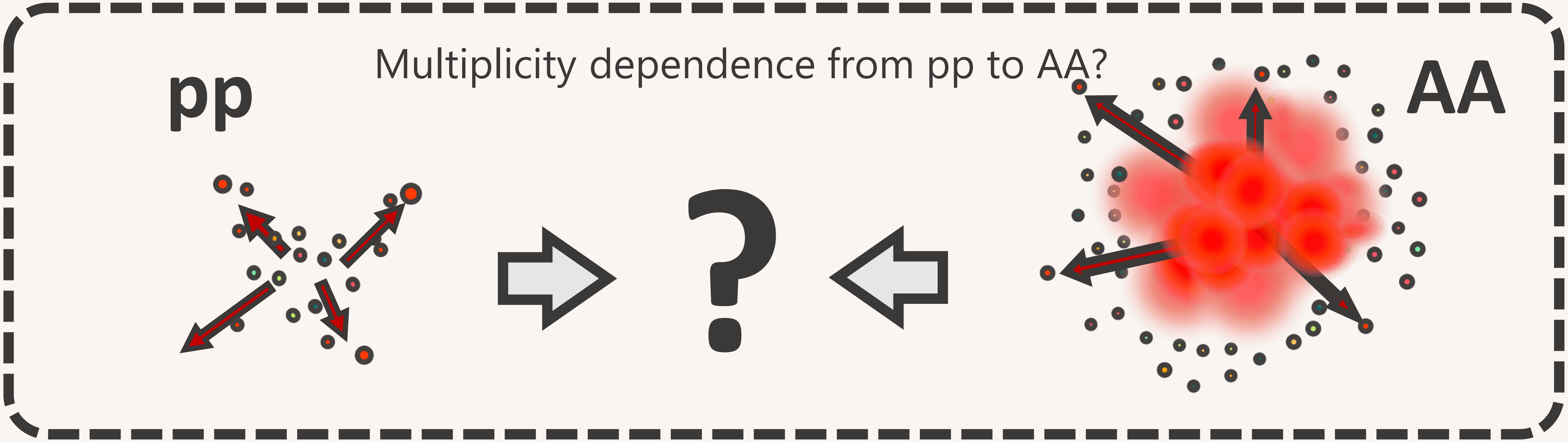
2021/04/13 9th workshop of the APS Topical Group on Hadronic Physics

Introduction

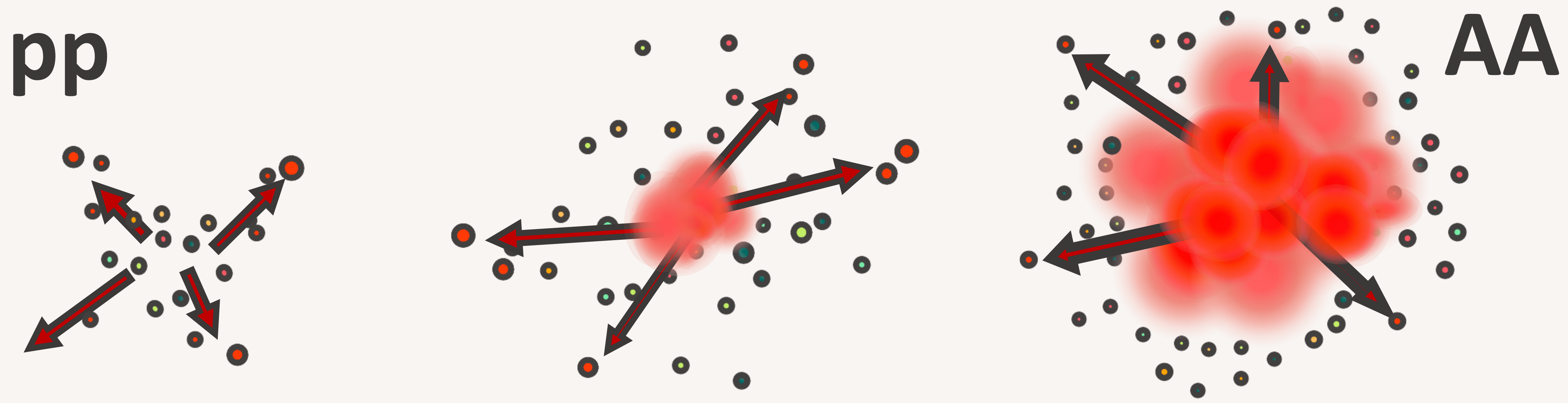
Towards hydro-based MC event generator

Comprehensive understandings from pp to AA



Towards hydro-based MC event generator

Comprehensive understandings from pp to AA



Dynamical core-corona initialization model

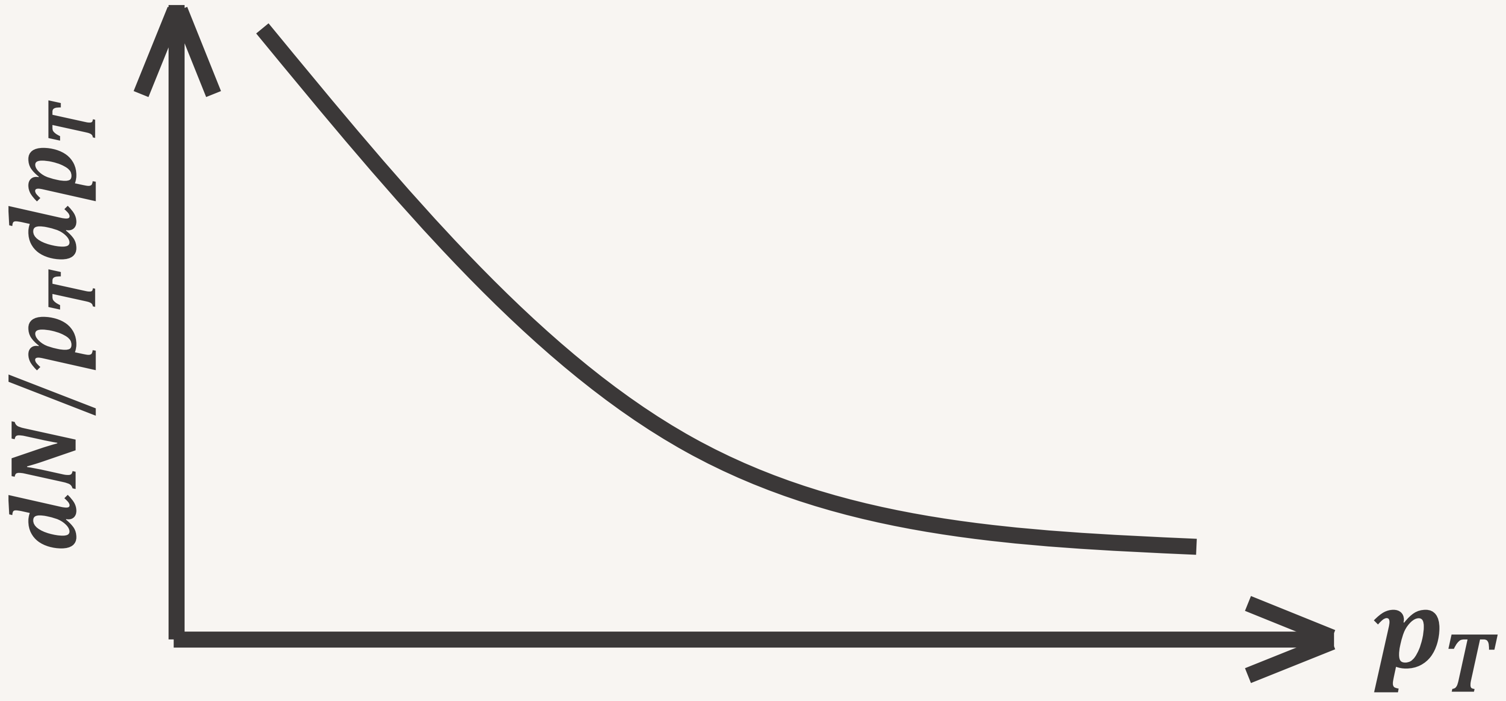
Y. Kanakubo *et al.*, PTEP 2018 12, 121D01 (2018); Phys. Rev. C 101 2, 024912 (2020)

Core: thermalized matter (hydrodynamics)

Corona: non-thermalized partons (string fragmentation)

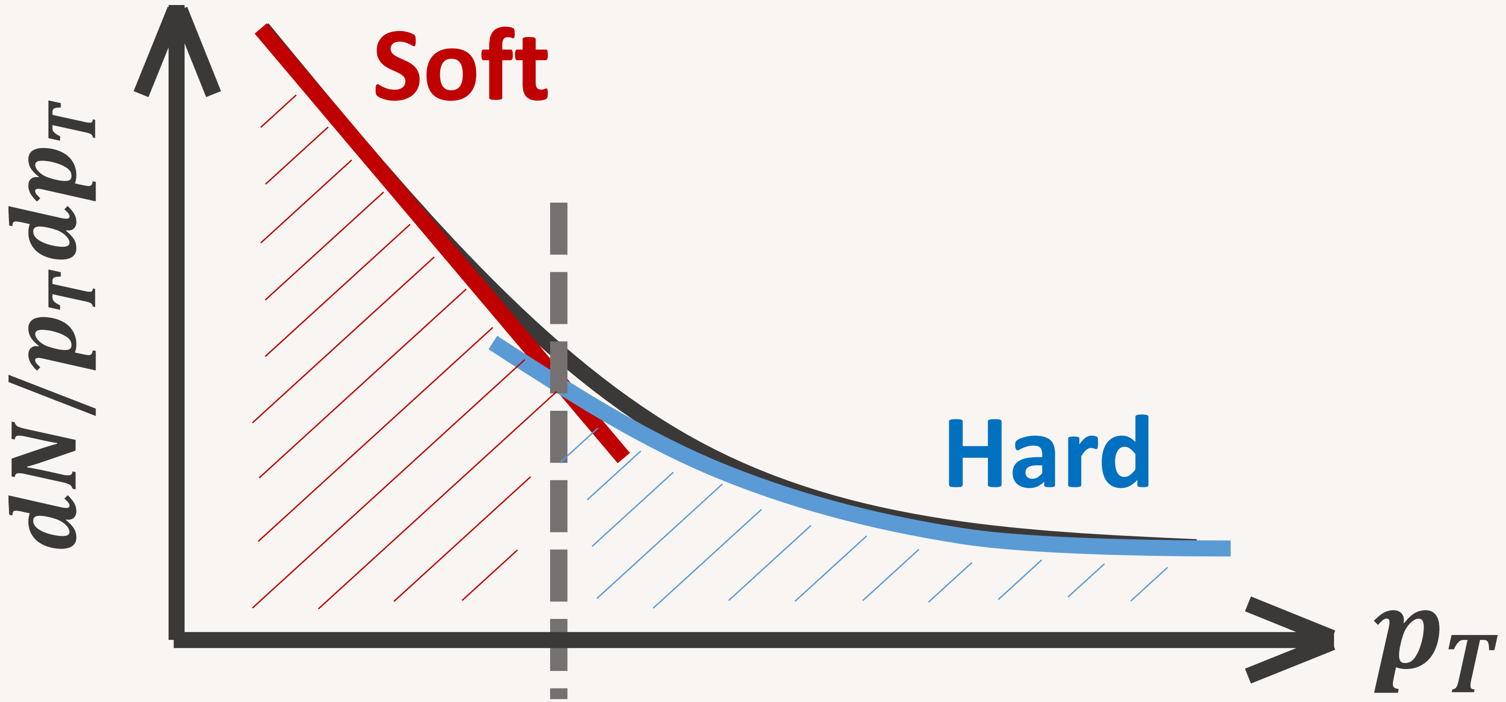
Take home message!

How do we interpret this p_T spectrum ?



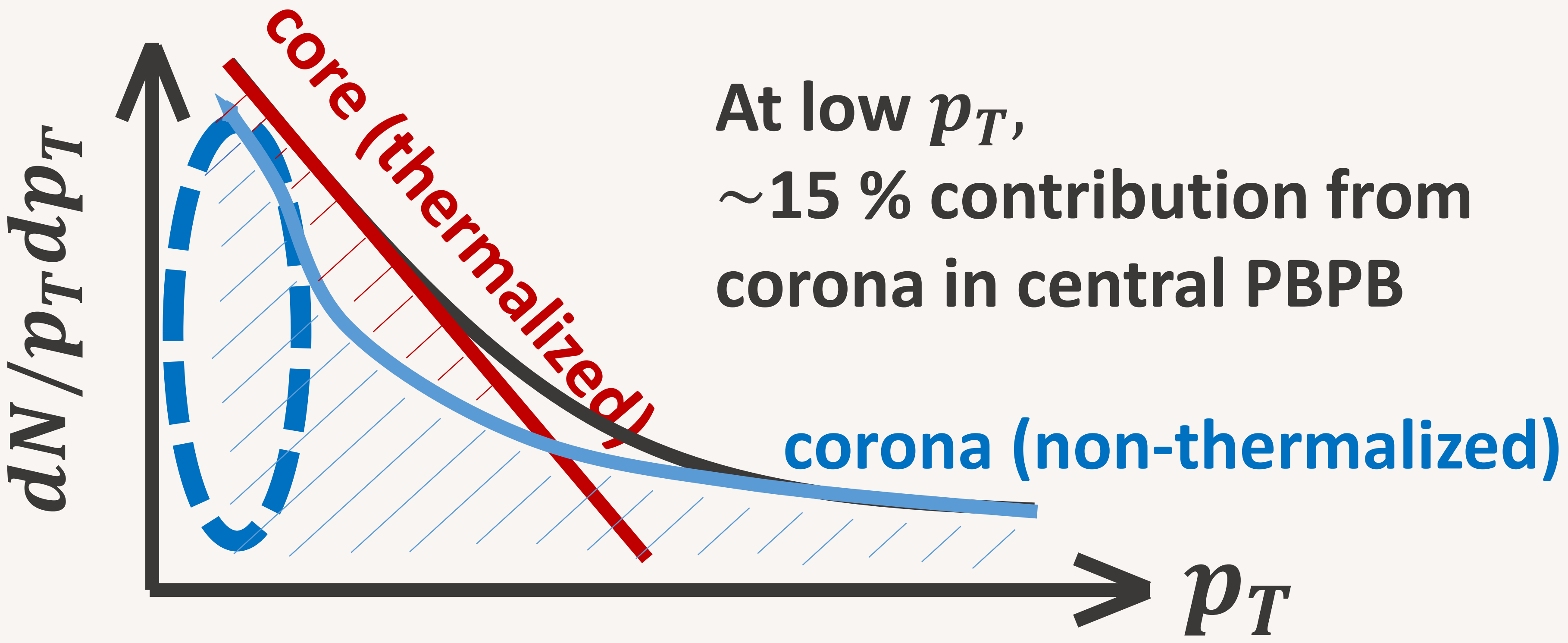
Take home message!

One might think…



Take home message!

Instead of soft/hard, we separate system into core/corona.



At low p_T,
~15 % contribution from corona in central PBPB

A sizable correction to hydro (core) results

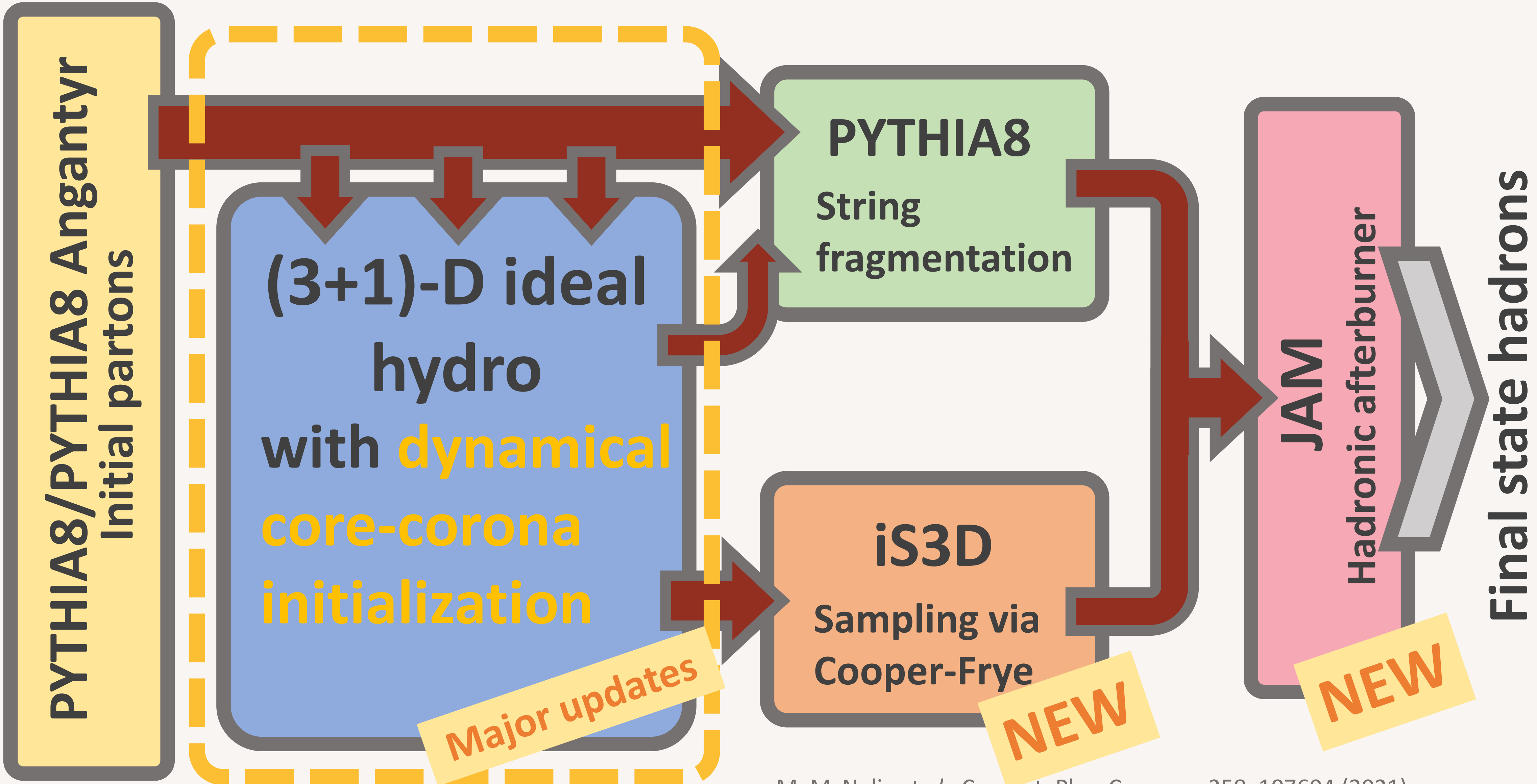
Keep in mind soft from corona!

NEW

Dynamical Core-Corona Initialization model 2

Model flowchart of DCCI2

Y. Kanakubo *et al.*, in preparation



T. Sjöstrand *et al.*, Comput. Phys. Commun. 191, 159 (2015)
C. Bierlich *et al.*, JHEP 1610 139 (2016)

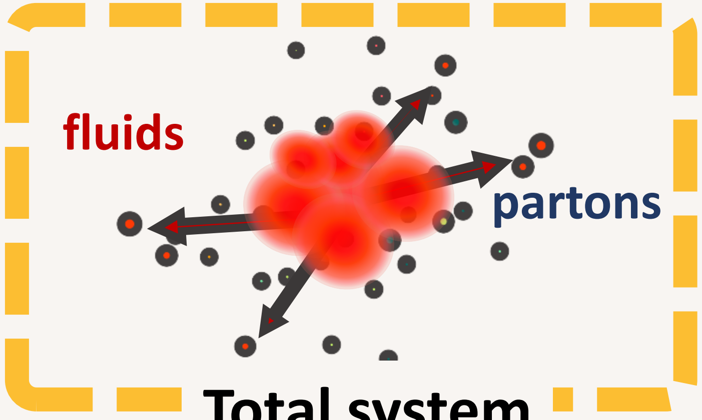
M. McNelis *et al.*, Comput. Phys.Commun.258, 107604 (2021)

Y. Nara *et al.*,Phys. Rev. C61, 024901 (2000)

Dynamical initialization framework

M. Okai *et al.*, Phys. Rev. C 95, 054914 (2017)

Energy & momentum conservation of a total system,
thermalized matter (fluids) + non-thermalized partons



Continuum eq. for fluid+parton

$$\partial_\mu \left(T^{\mu\nu}_{\mathrm{fluid}} + T^{\mu\nu}_{\mathrm{parton}} \right) = 0$$

Hydrodynamic eq. with source term

$$\partial_\mu T^{\mu\nu}_{\mathrm{fluid}} = J^\nu$$

Assuming Gaussian profile/straight trajectory for a parton…

$$J^\nu \rightarrow -\sum_i \frac{d{p_i}^\nu(t)}{dt} G\left(\boldsymbol{x} - \boldsymbol{x}_i(t)\right)$$

G: Gaussian function

"Source" =
"Four-momentum deposition rate of partons"

Dynamical core-corona initialization

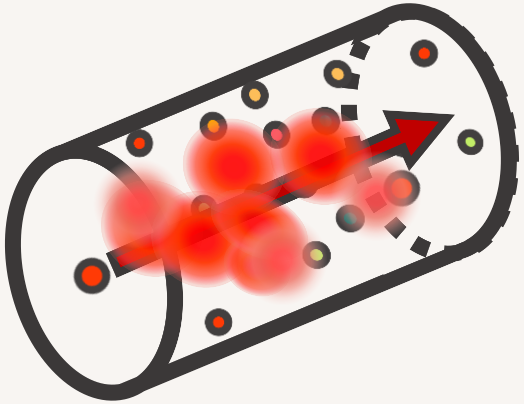
Core-corona picture

$\sim$ EoM with a drag force due to secondary scatterings

$$\frac{dp_i{}^{\mu}}{dt} = -\sum_{j}^{N_{\mathrm{scat}}} \rho_{i,j}\sigma_{i,j}\left|v_{\mathrm{rel},i,j}\right| p_i{}^{\mu}$$

Defined at a co-moving frame with $\eta_{s,i}$

N_{scat} : **# of (thermalized and non-thermalized) partons scattered with *i*th parton**



Low p_T and/or dense region

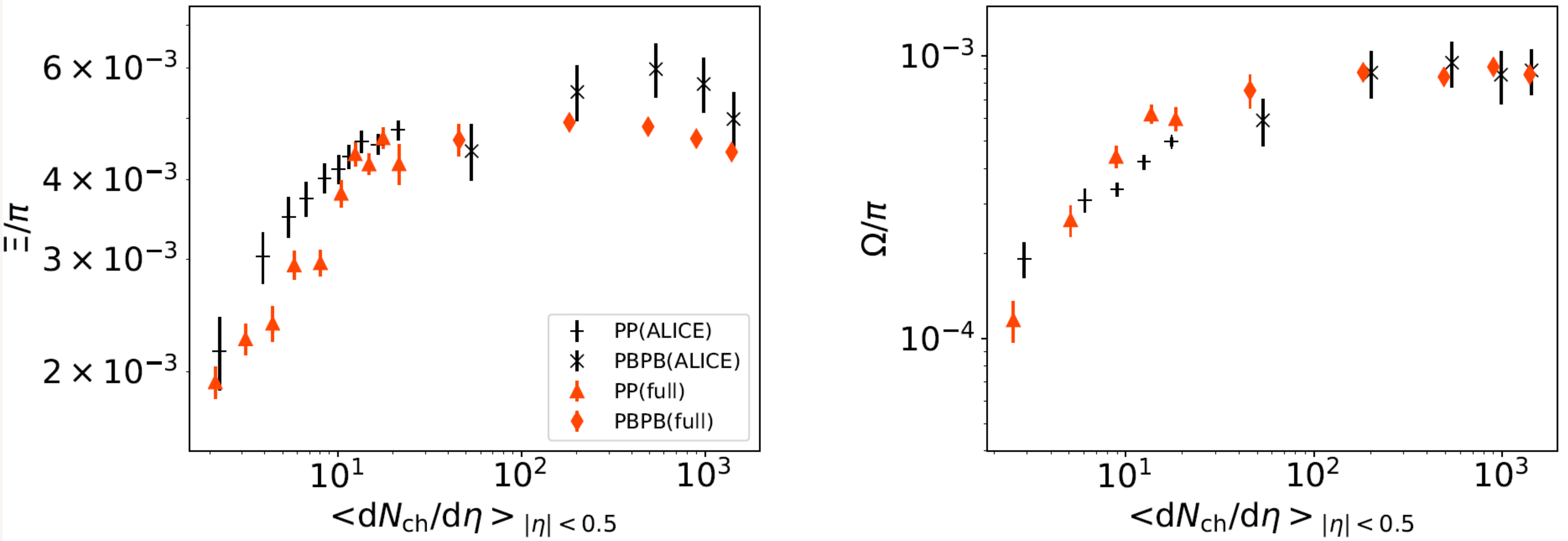
⇒ **Core (hydro)**

High p_T and/or dilute region

⇒ **Corona (string fragmentation)**

Results from DCCI2

Particle ratios: multi-strange hadrons



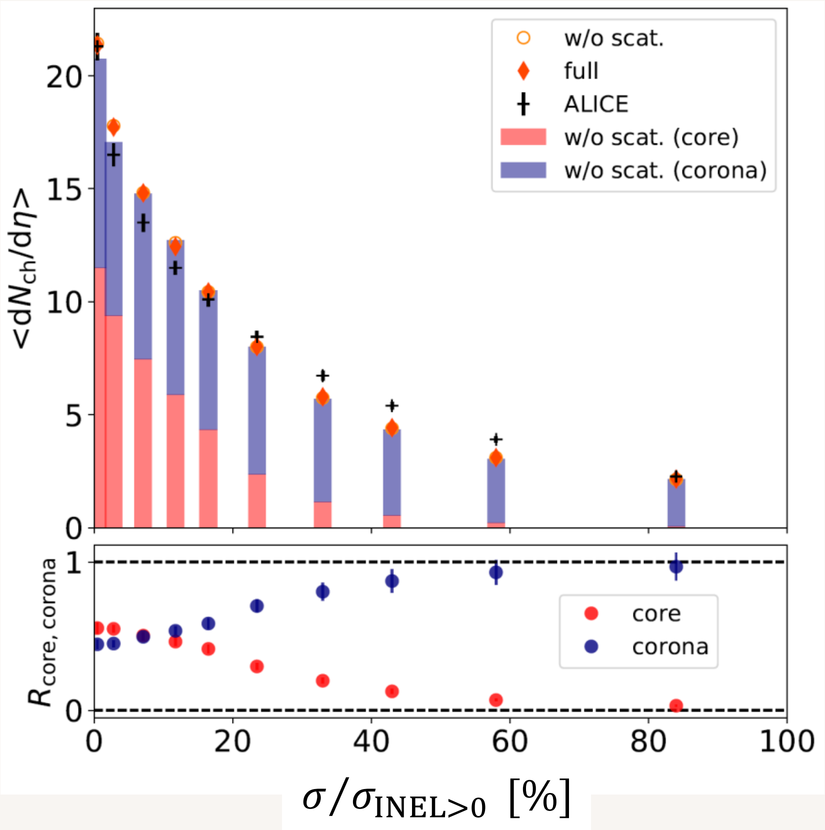
J. Adam *et al.*, (ALICE Collaboration), Nature Phys. 13 535-539 (2017)
B. Abelev *et al.* (ALICE Collaboration), Phys. Lett. B 728, 216-227 (2014); erratum 734, 409-410 (2014)

Particle ratios of multi-strange hadrons
→ reasonably described by DCCI2 for both pp and PBPB.

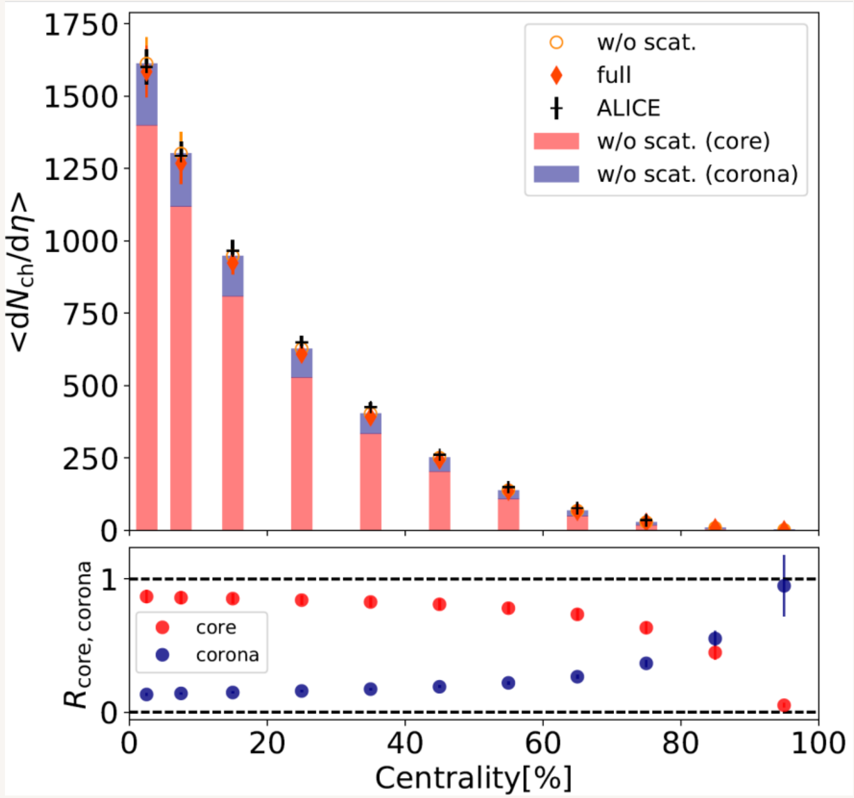
Parameter determination in DCCI is done! Let's see outputs :)

Multiplicity of charged particle

pp 7 TeV



PbPb 2.76 TeV

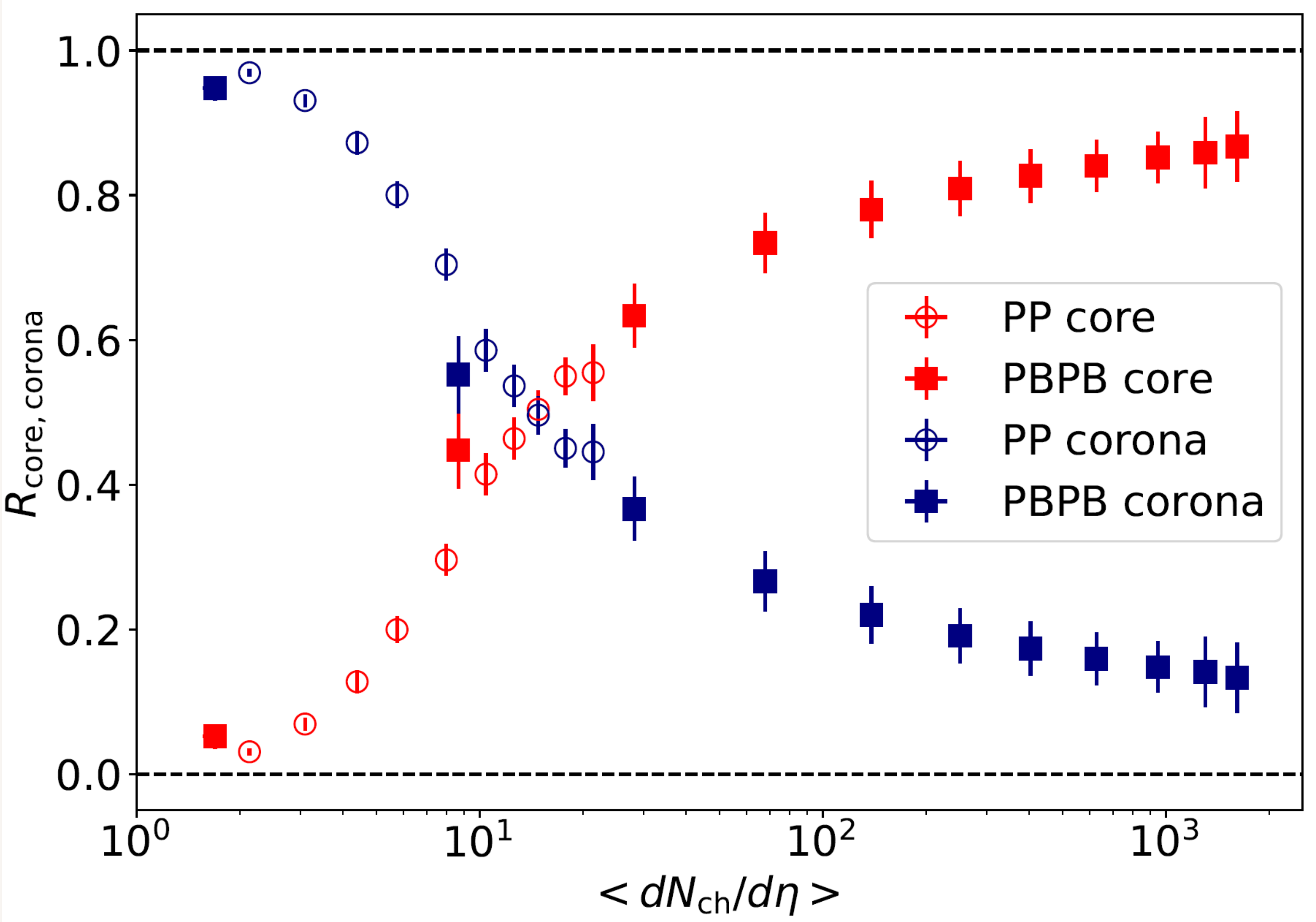


J. Adam *et al.*, (ALICE Collaboration), Nature Phys. 13 535-539 (2017)

K. Aamodt *et al.*, (ALICE Collaboration), Phys. Rev. Lett. 106 032301 (2011)

- Smooth transition of each contribution as a function of multiplicity
- Dominant contribution flips at ~ 5 % in pp and ~ 85 % in PbPb.

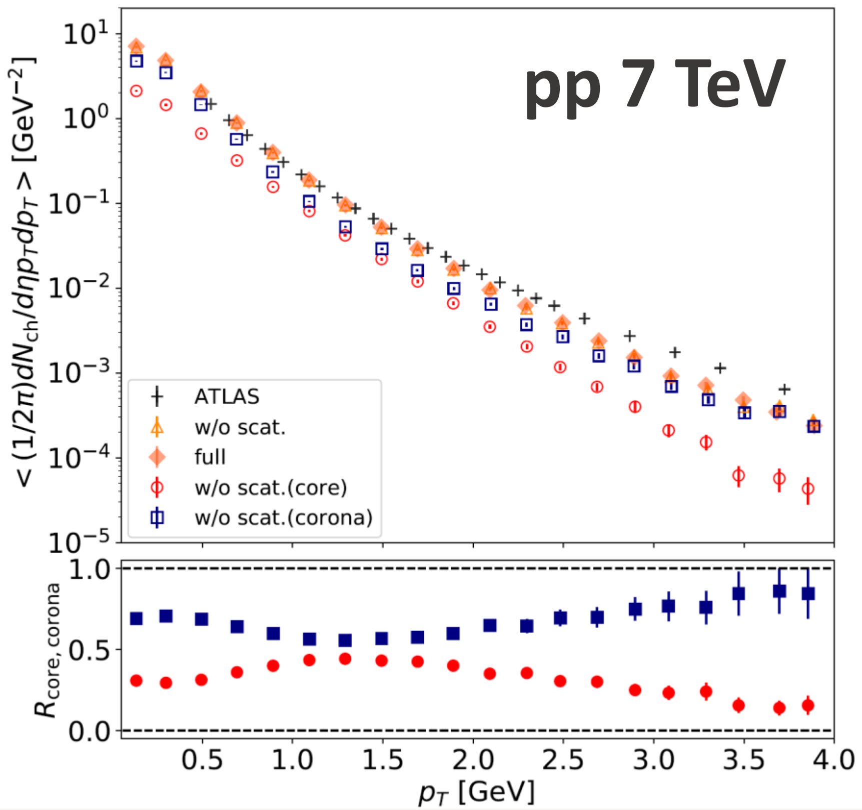
Fraction of core/corona vs. $\langle dN_{\mathrm{ch}} / d\eta \rangle$ from pp to PbPb

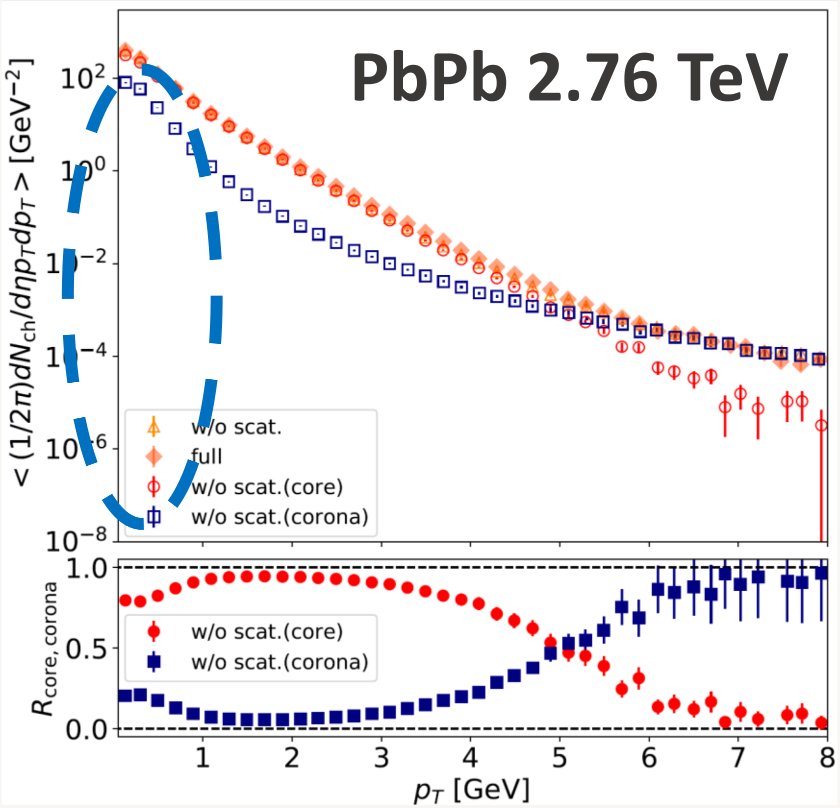


Clear scaling with multiplicity

- Change of dominant contribution at $\langle dN_{\mathrm{ch}}/d\eta \rangle \sim 15$
- Even in central PbPb, **$\sim$ 15 % of corona contribution**

Transverse momentum spectra in MB





pp: corona is dominant for entire pt.

PbPb:

- dominant contribution flips at ~ 5 GeV.

- At low p_T, ~ 20 % corona contribution

G. Aad *et al.*, (ATLAS Collaboration), New J. Phys. 13 053033 (2011)

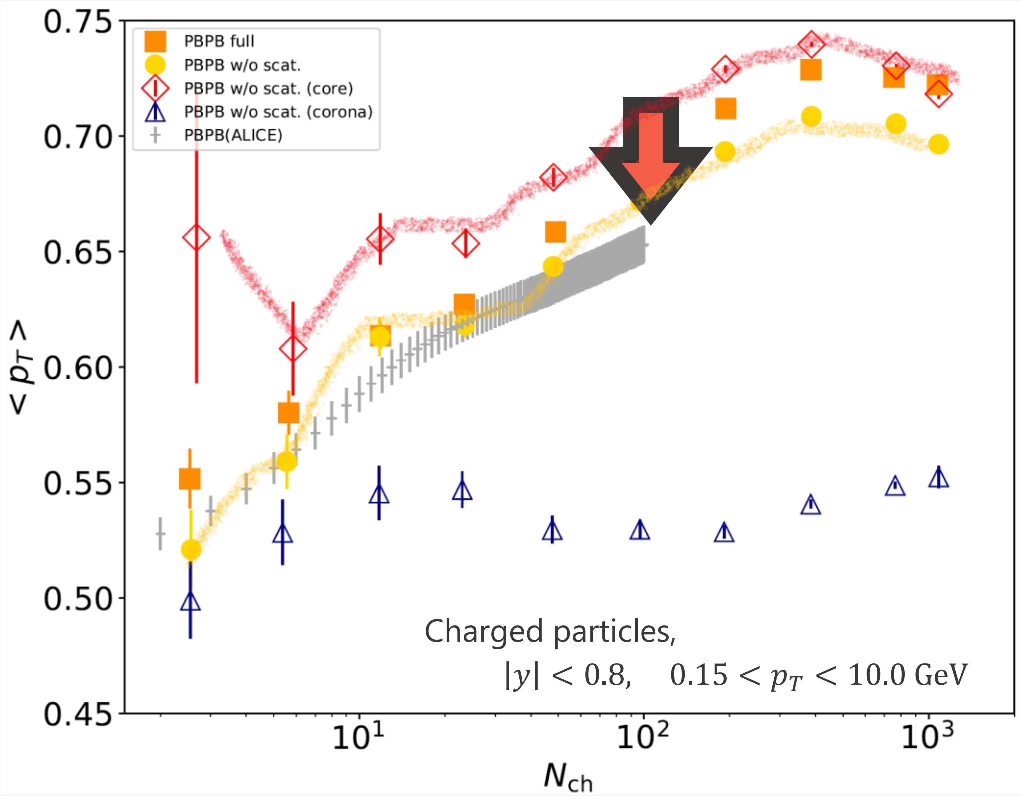
Remember the take-home message…

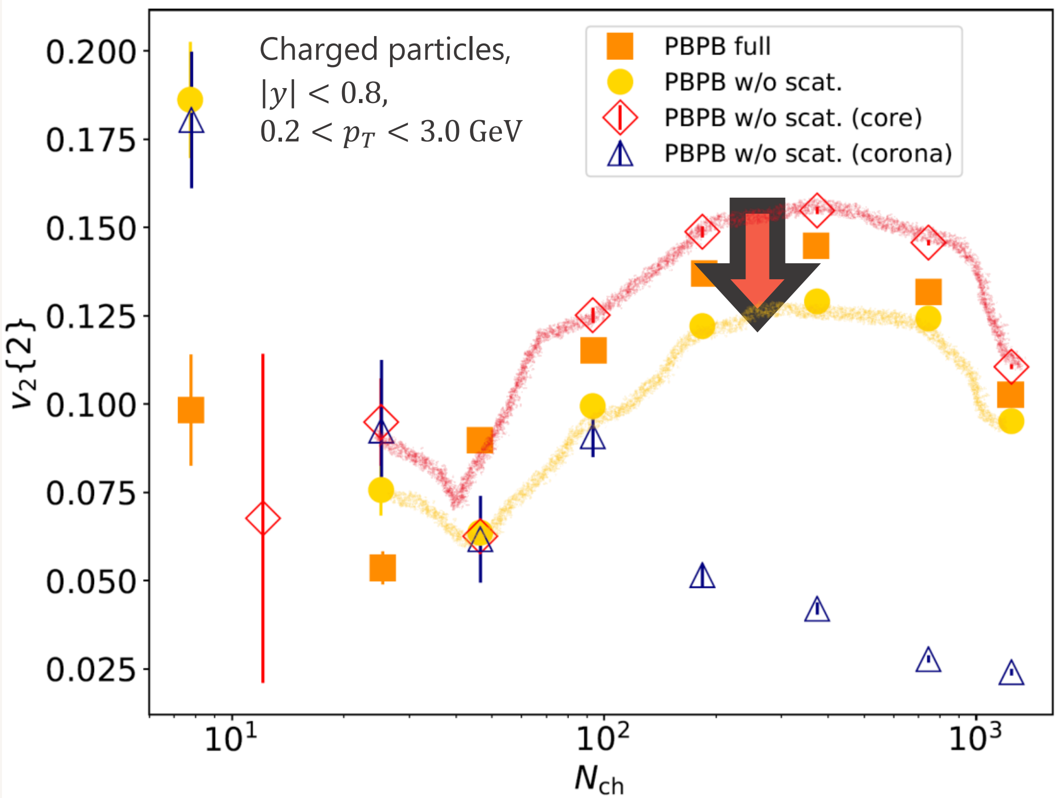
A sizable correction to hydro (core) results

Keep in mind soft from corona!

Corona correction in PbPb

B. Abelev *et al.*, (ALICE Collaboration), Phys. Lett. B 727 371-380 (2013)





Corona correction dilute $\langle p_T \rangle$ by ~5-6%

Corona correction dilute $v_2\{2\}$ by ~15-20 %

Summary

Summary

New results from updated dynamical core-corona initialization model (DCCI2)

As a result of modeling of hydro-based MC event generator to explain pp to AA…

- Clear multiplicity scaling of core/corona fraction
- Core contribution become dominant above $\langle dN_{\mathrm{ch}}/d\eta \rangle \sim 15$
- pp: core contribution gets dominant only at very high multiplicity ($\lesssim 5\%$)
- (Central)PbPb: **$\sim$ 15% of corona contribution** remains
- Corona correction reduces $\langle p_T \rangle$ **by ~5-6%,** $v_2\{2\}$ **by ~15-20% in PbPb**

Take home message!

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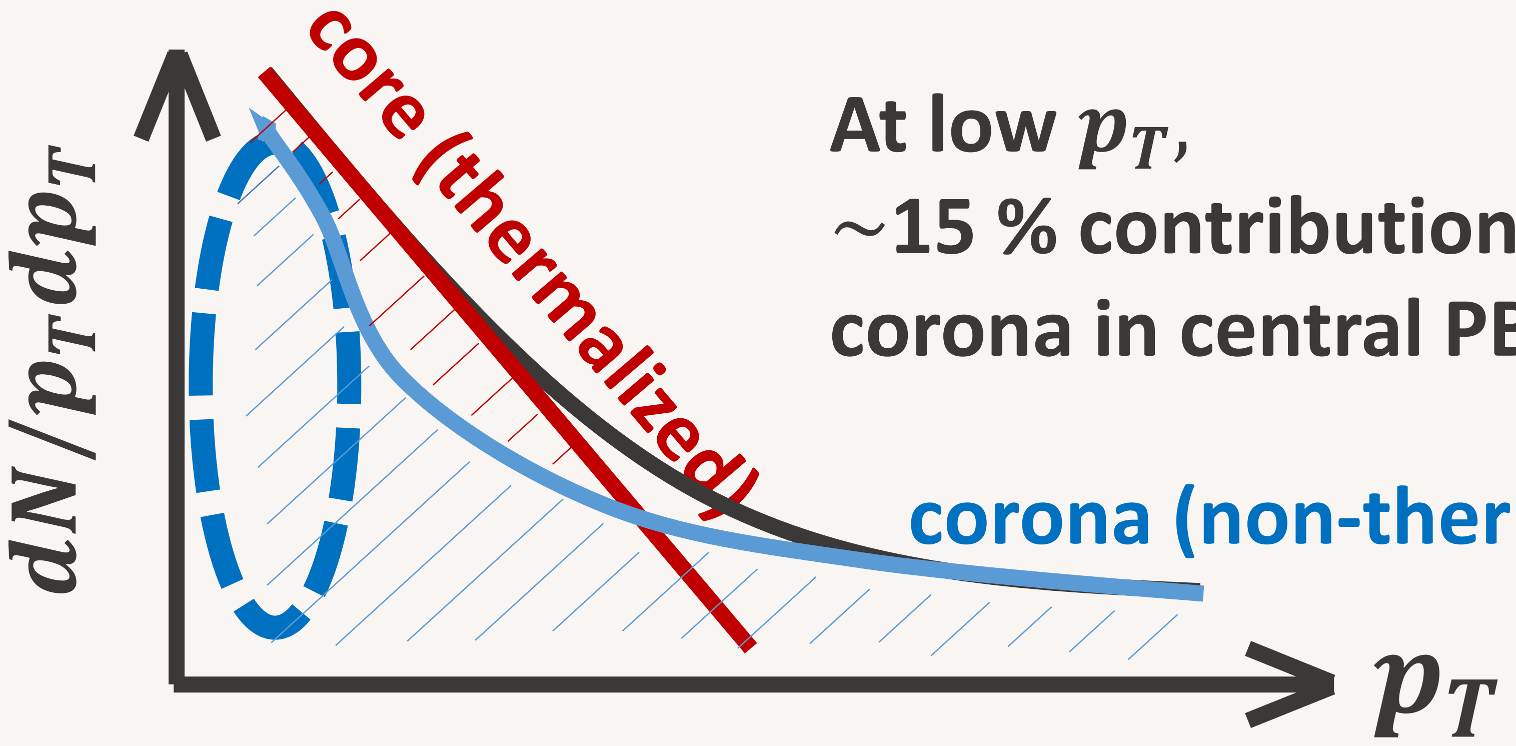

At low p_T,
$\sim$15 % contribution from corona in central PBPB

A sizable correction to hydro (core) results

Keep in mind soft from corona!

Thank you! 🙂