Observables and status of heavy ion physics

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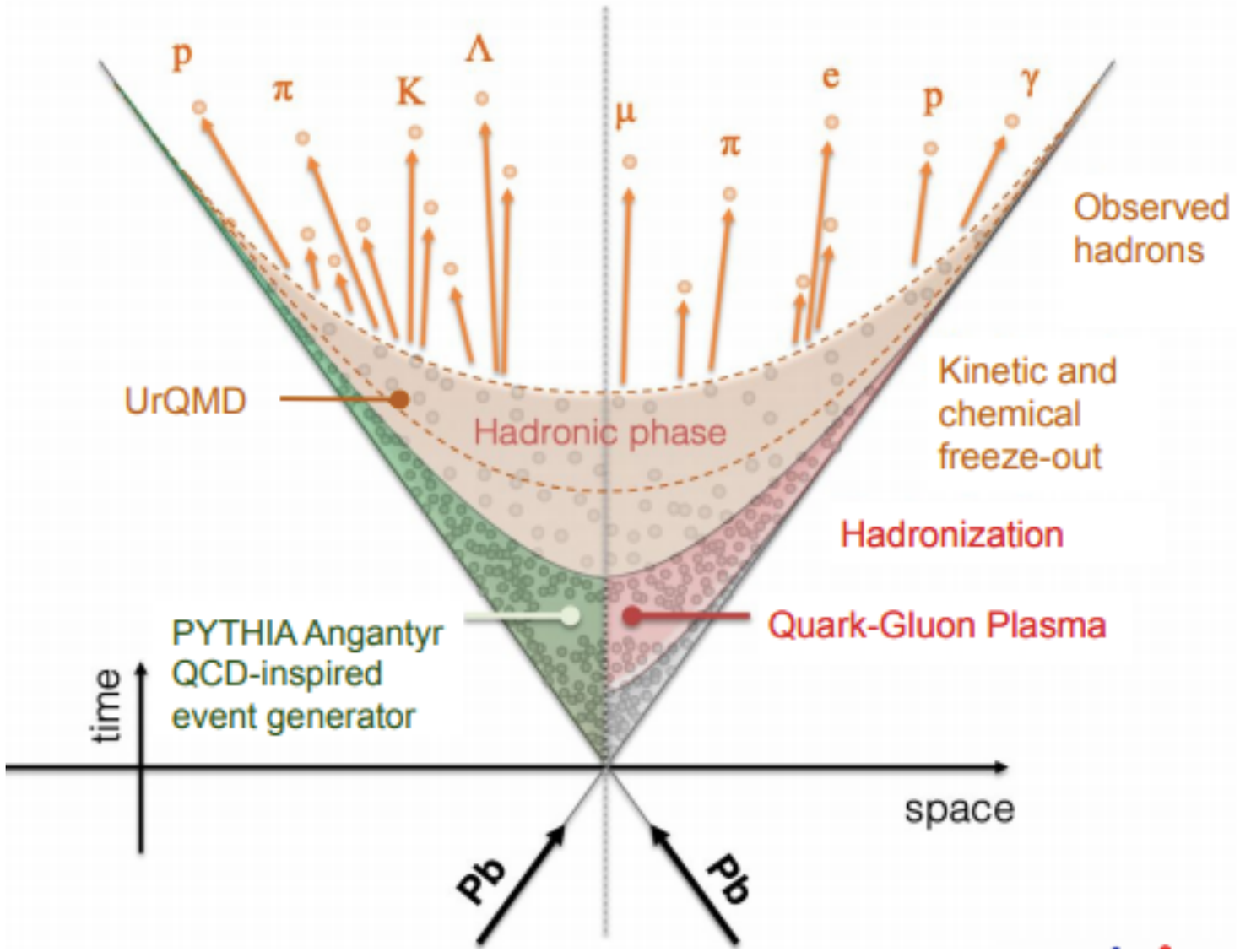
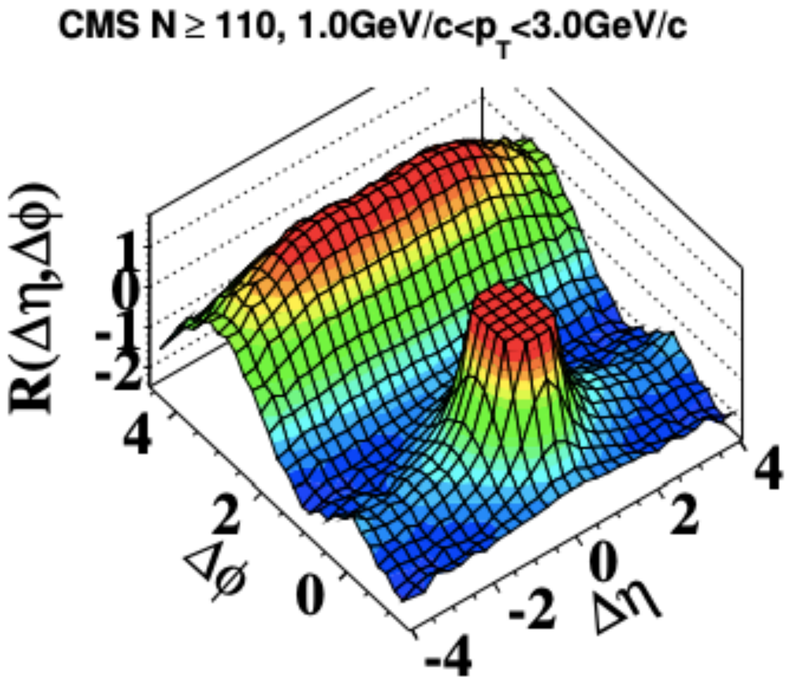
Outline

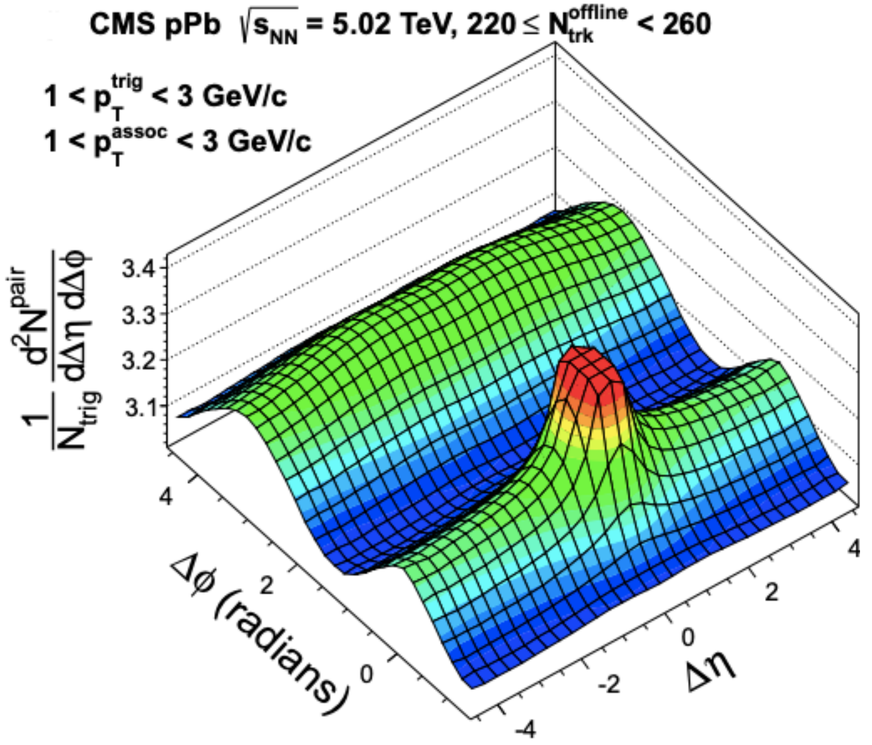
- Scenario in heavy-ion community
- pp ⟶ pA ⟶ AA
- Jet quenching
- Pythia: Angantyr and further

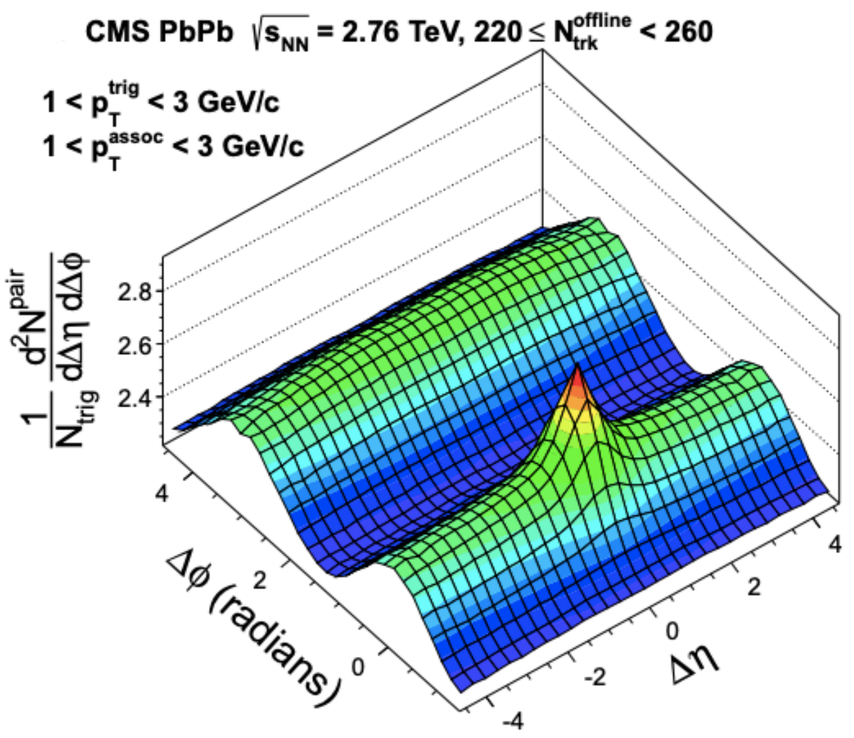
Stages of a heavy-ion collision: current view



p-p ⟶ p-A ⟶ A-A







[1] CMS, arXiv:1305.0609v3 [nucl-ex] 12 Jul 2013
[2]CMS, arXiv:1009.4122v1 [hep-ex] 21 Sep 2010

p-p → p-A → A-A

QCD

- Are QCD inspired models more important for small systems?
- Is there jet quenching in small systems?
- For AA: is energy loss mechanism described by BDMPS-Z models?

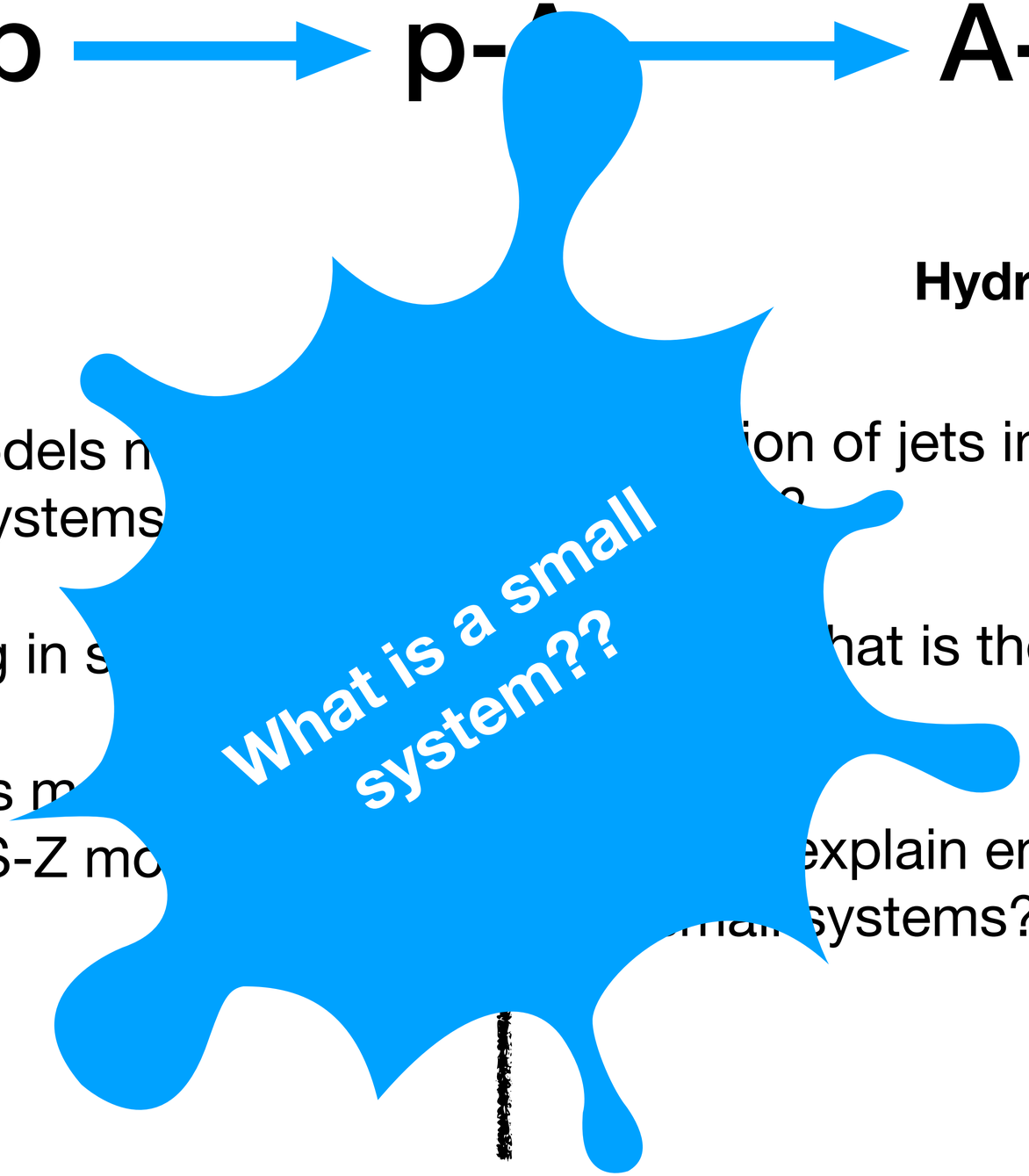
Hydrodynamics

- Inclusion of jets in hydrodynamic models?
- Where/What is the medium in small systems?
- How to explain energy loss mechanism in small systems?

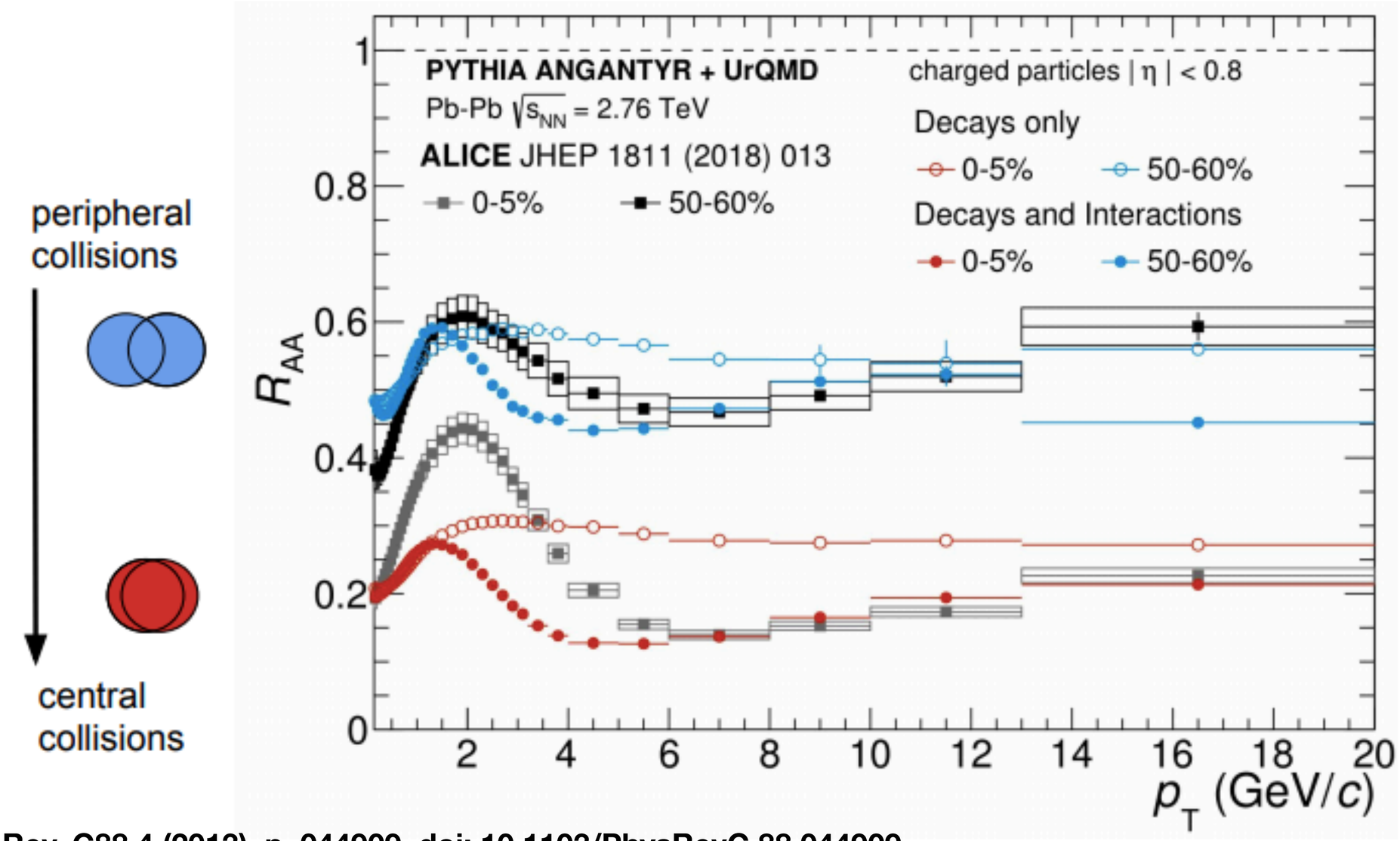
p-p → p-A → A-A

QCD **Hydrodynamics**

- Are QCD inspired models n ion of jets in hydrodynamic important for small systems ?
- Is there jet quenching in s hat is the medium in small
- For AA: is energy loss m described by BDMPS-Z mo explain energy loss mechanism systems?

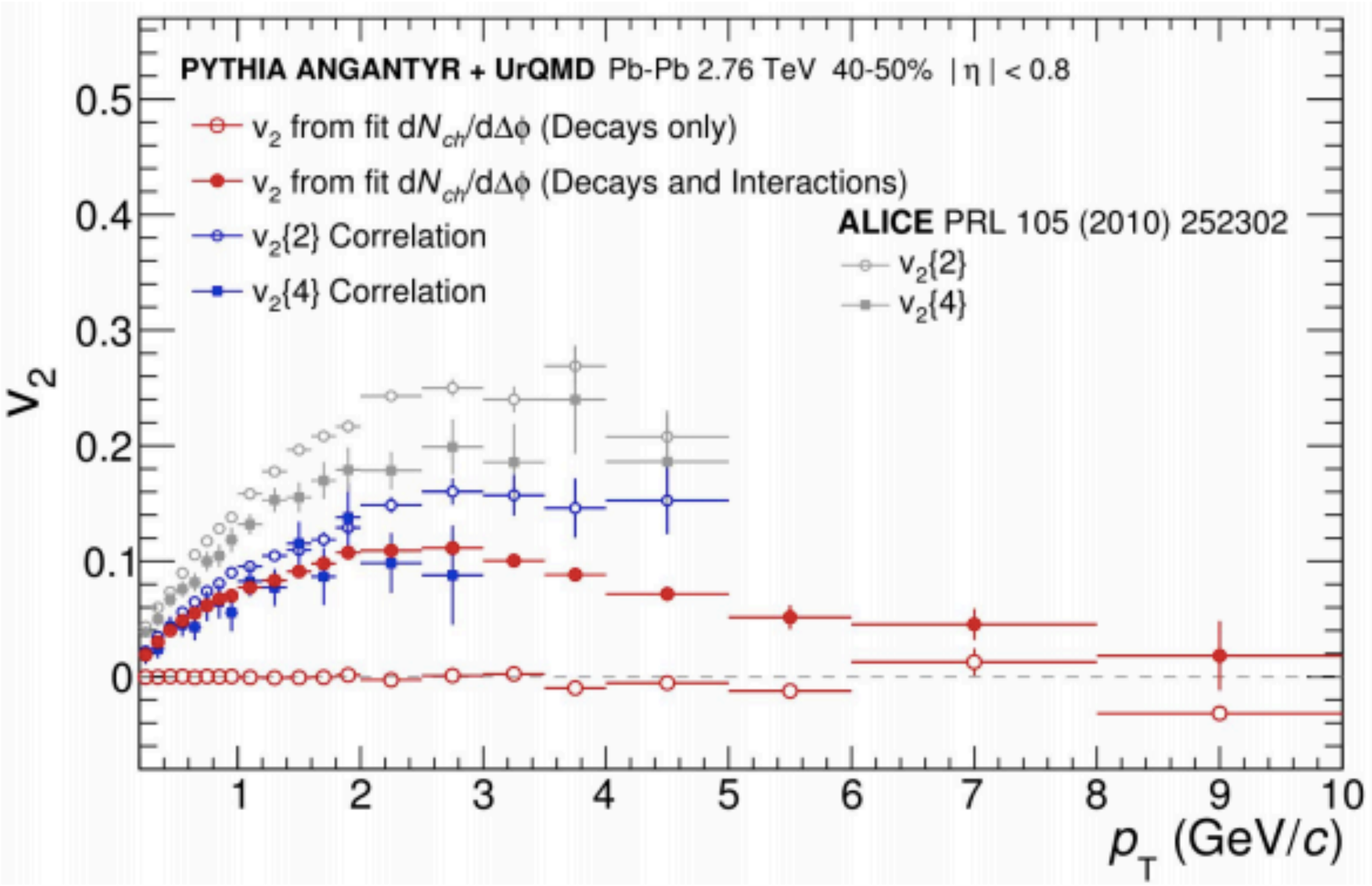


Nuclear modification factor R_{AA}



[1] ALICE, Phys. Rev. C88.4 (2013), p. 044909. doi: 10.1103/PhysRevC.88.044909
[2] Poster by André V. da Silva, Universidade Estadual de Campinas, São Paulo, Brazil

Elliptic flow coefficients v_2



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Jet quenching

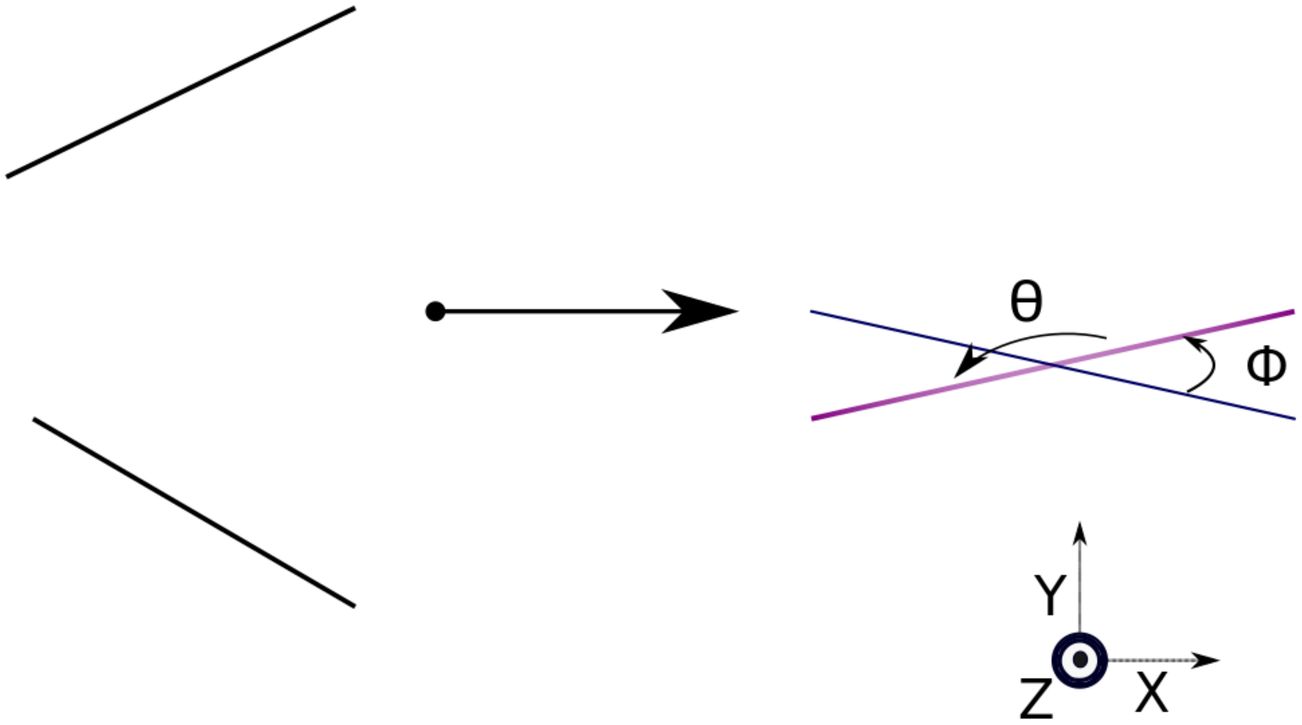
Small systems

- Short-distance physics of partons, which is process-dependent but perturbatively calculable
- Are there effects of initial state in final state observables?
- Finite collective effect observations and no JQ observed till date ⟶ implications?
- Is high-multiplicity in these systems generated by same processes as in AA?

Large systems

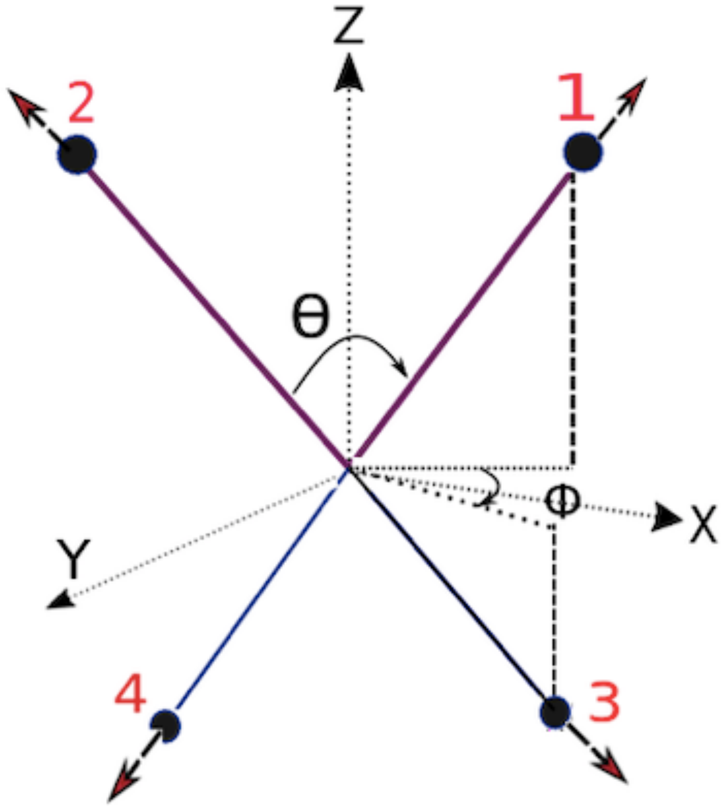
- Factorisation theorems which include the medium-modifications relevant for heavy-ion collisions, are not known
- Study of high-pT photon spectra modification with nuclear modification factor is required
- Medium modified splitting functions for parton evolution needed
- Quenching parameter: estimates for pp, pA and AA systems needed

String shoving: Parallel frames

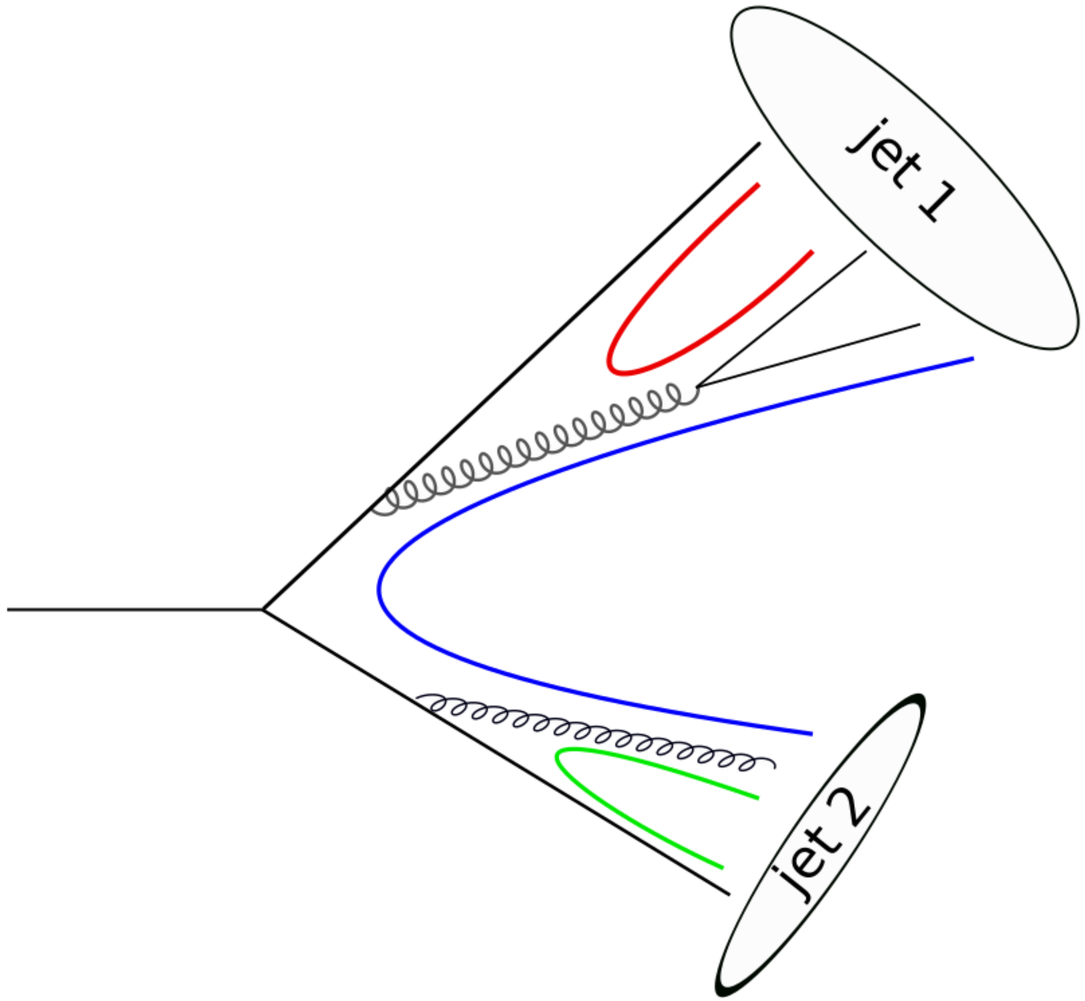


Lab frame

Parallel frame



Jet quenching



- Jets ⟶ quarks and gluons
- Each parton in a jet form *colour connected strings* with the partons around them following rule of least string length
- Pair of such strings interact by shoving, rope hadronization and colour reconnection - over and over again
- This modifies *initial energy of jets*

Observed effects in high-multiplicity pp and AA collisions

- **Long range near-side angular correlation in p-p & AA collisions**
- **Jet quenching effects in A-A collisions**
- **Strangeness enhancement in pp & A-A collisions**

Observed effects in high-multiplicity pp and AA collisions

- **Long range near-side angular correlation in p-p collisions**

  → **String shoving mechanism**

- **Jet quenching effects in A-A collisions**

  → **Colour reconnection**

- **Strangeness enhancement in A-A collisions**

  → **Rope hadronization**

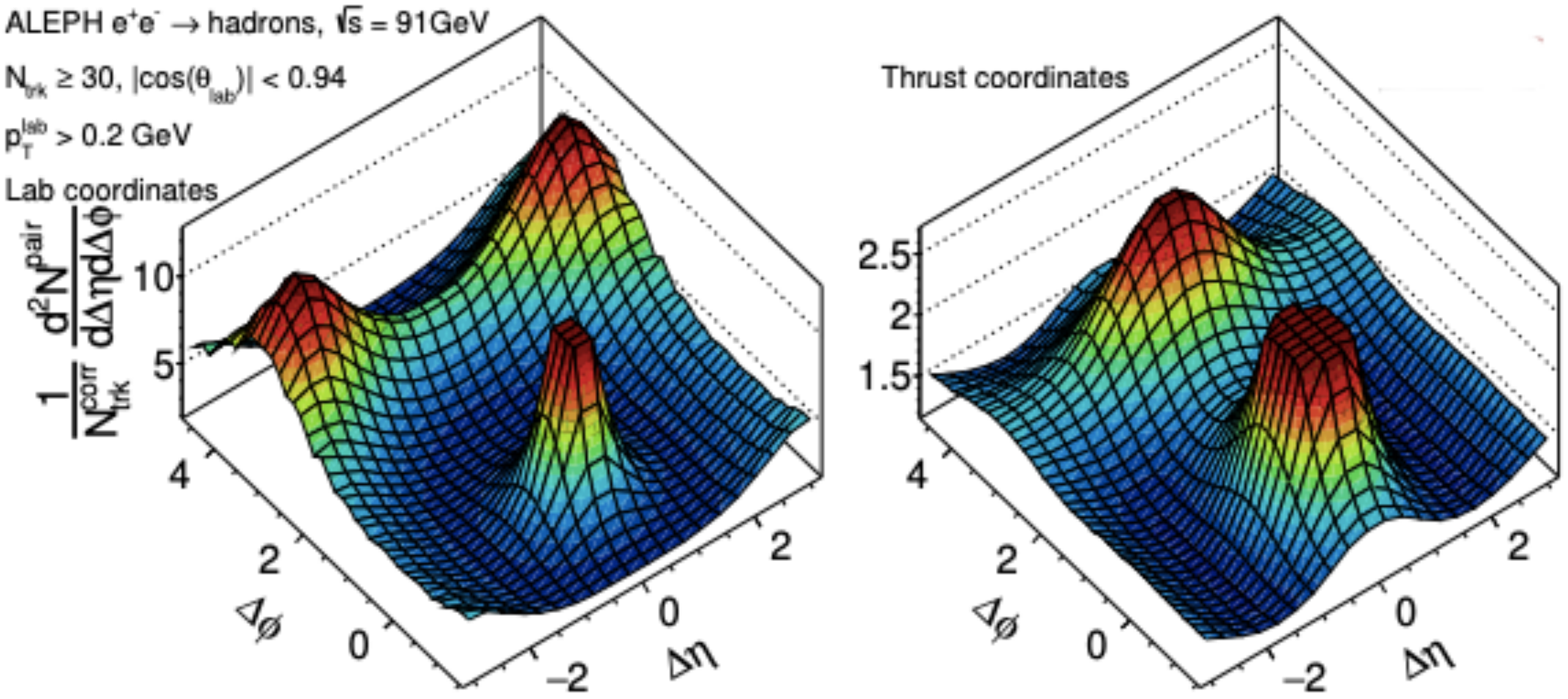
Food for thought: Should we look at e^+e^- ?

- *" Measurements of two-particle correlations in e +e − collisions at 91 GeV with ALEPH archived data"*, arXiv:1906.00489v4 [hep-ex] 22 Aug 2019

- Two-particle angular correlations of charged particles emitted in hadronic Z decays

- The archived e^+e^- annihilation data at a center-of-mass energy of 91 GeV collected with the ALEPH detector at LEP between 1992 and 1995

Food for thought: Should we look at e^+e^- ?



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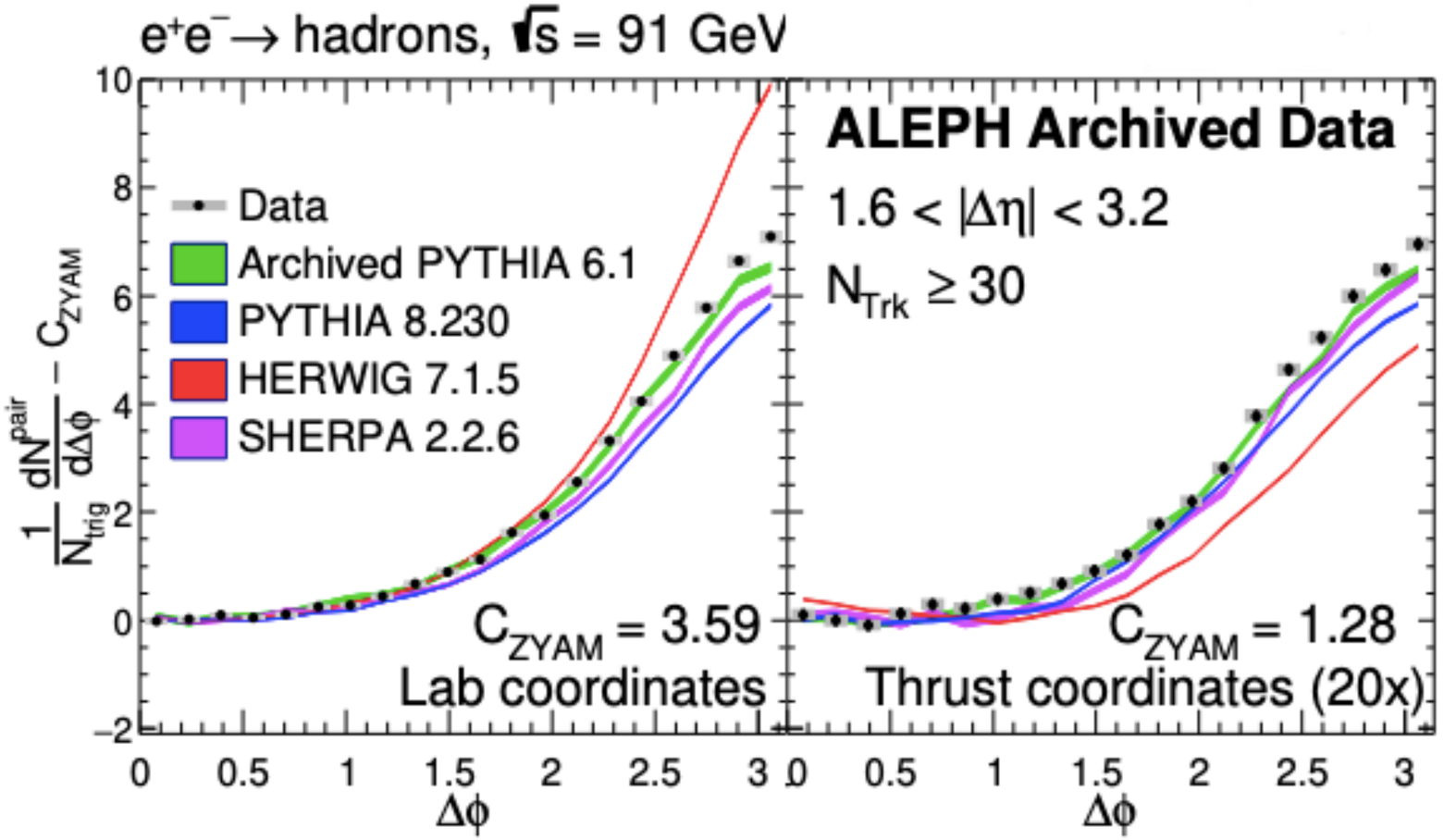

- **Results**: **No significant long-range correlation** is observed in either the lab coordinate analysis or the thrust coordinate analysis