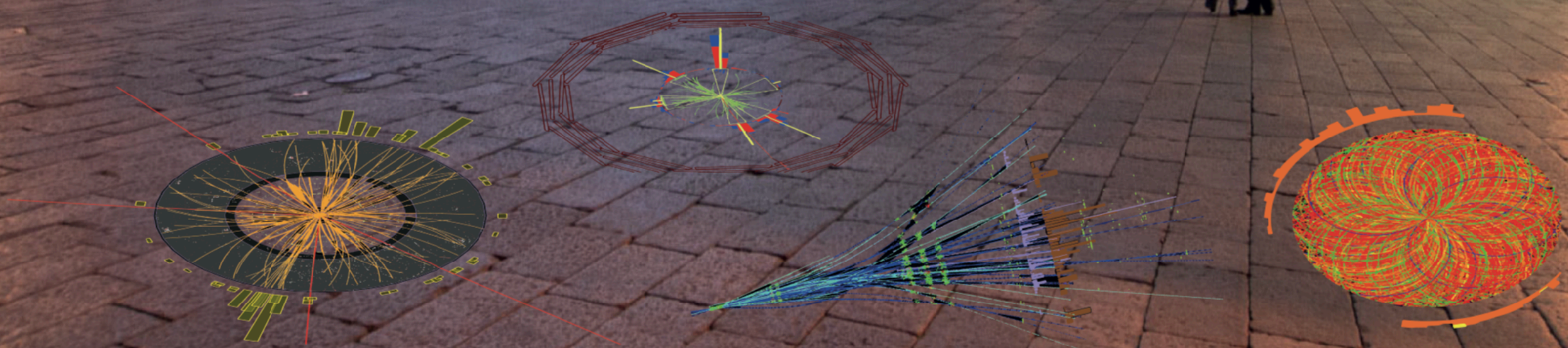
LHCP
Bologna
2018

Soft probes in ALICE

Chiara Oppedisano
for the ALICE Collaboration



LHCP
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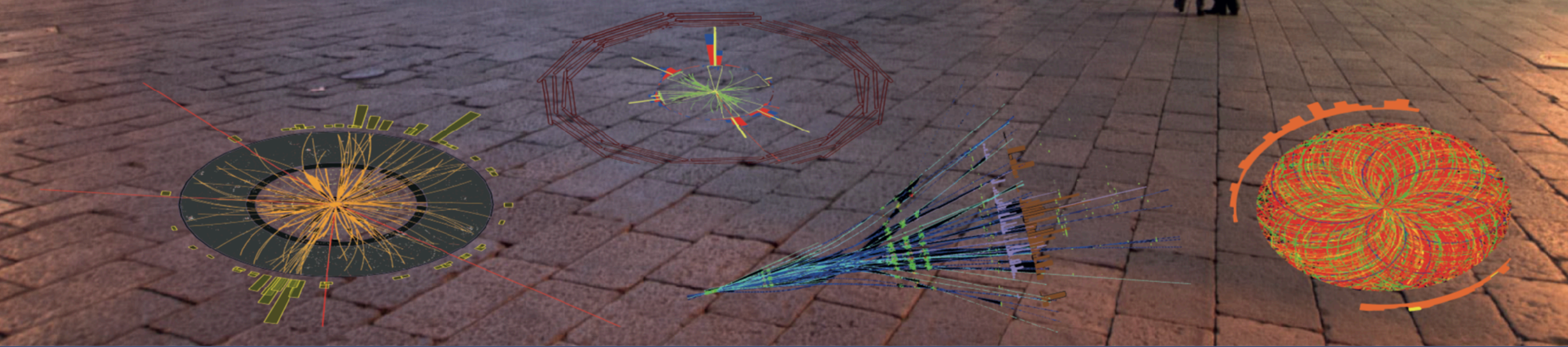
2018

Selection of soft probes in ALICE

Chiara Oppedisano
for the ALICE Collaboration

INFN

ALICE

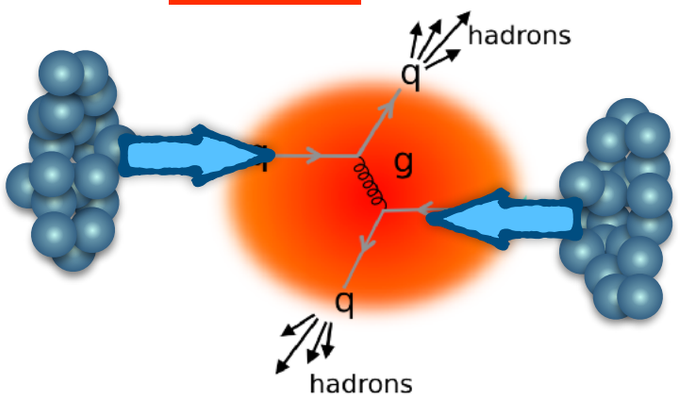


Soft probes

Soft probes ➧ low transverse momentum, p_T < few GeV/c ➧ non-perturbative phenomenological models, statistical treatment, effective theories...

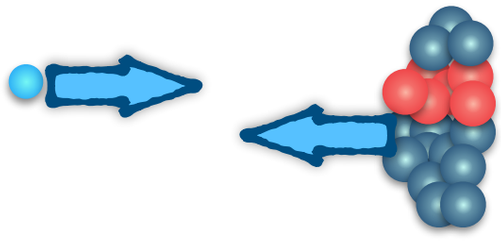
Bulk particle production in different colliding systems

A-A



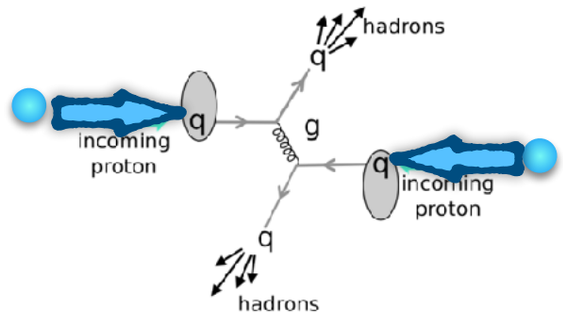
Dense medium (QGP) formation

p-A



Cold Nuclear Matter effects

pp



Fragmentation in vacuum

Soft probes

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Bulk particle production in different colliding systems

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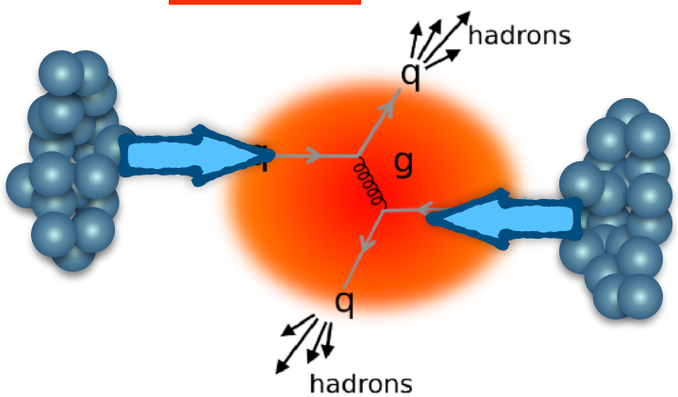

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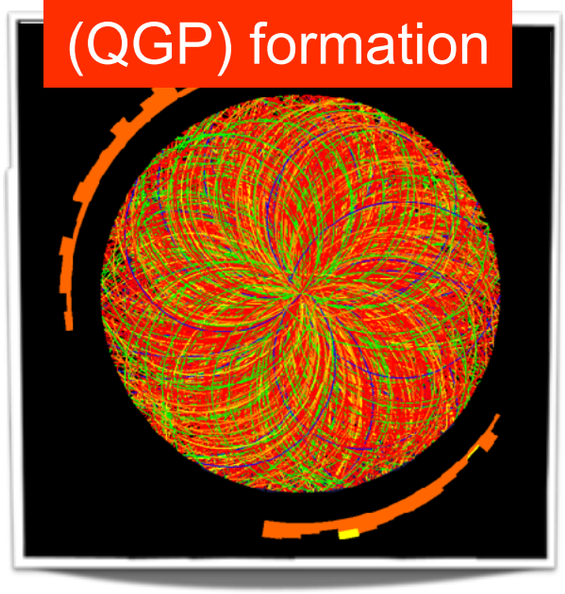
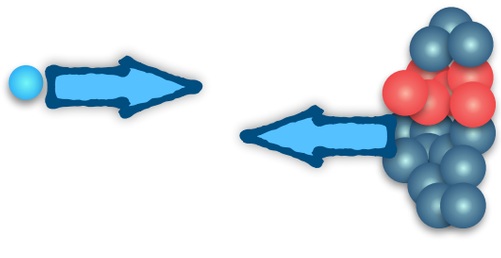
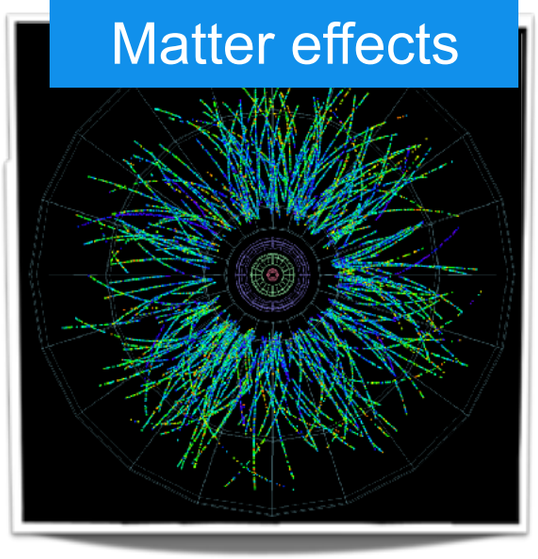


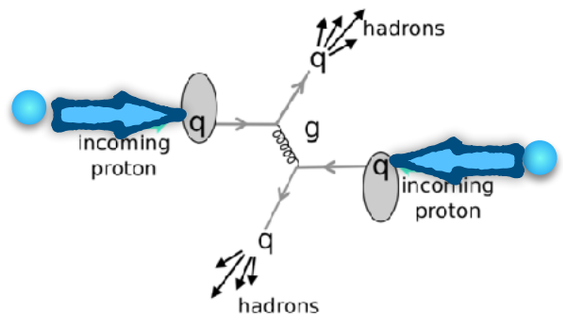
p-A



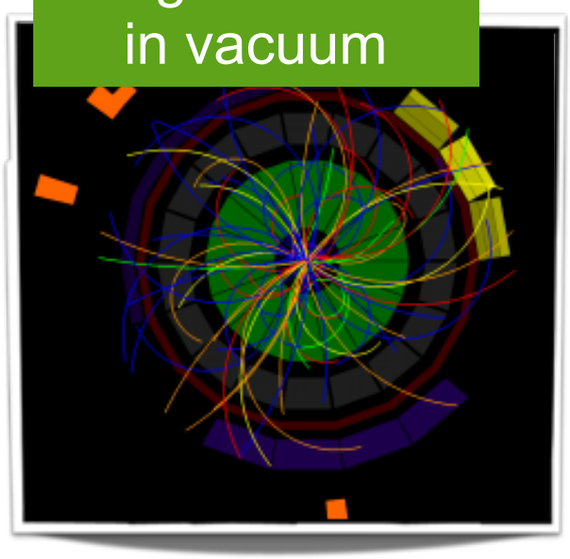
Cold Nuclear Matter effects



pp



Fragmentation in vacuum



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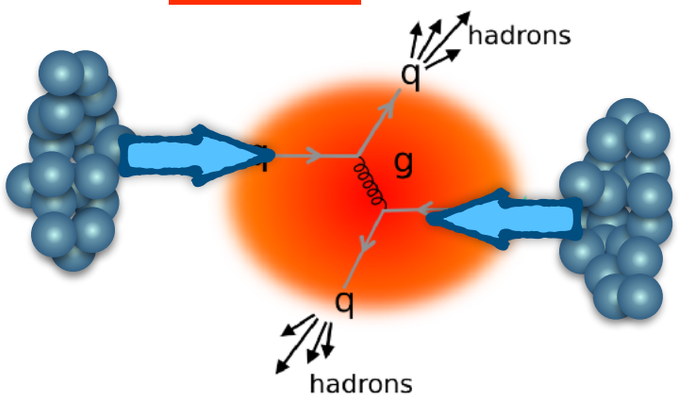
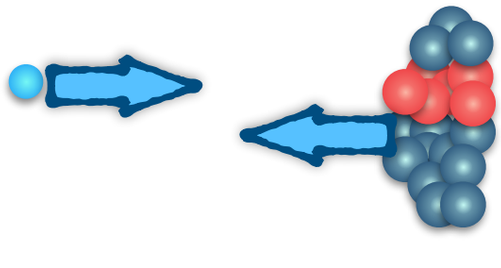
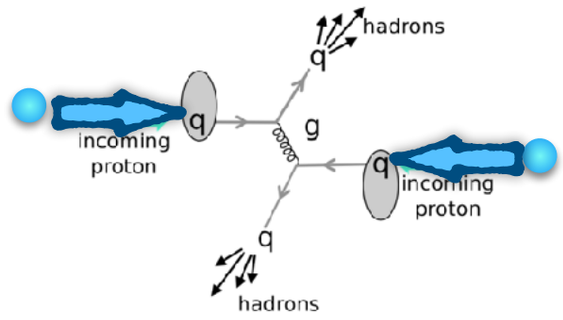


p-A



pp



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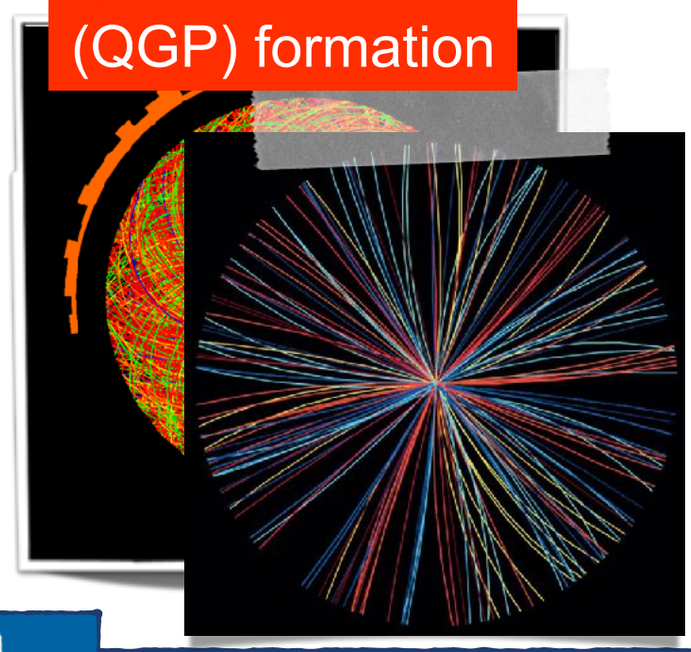
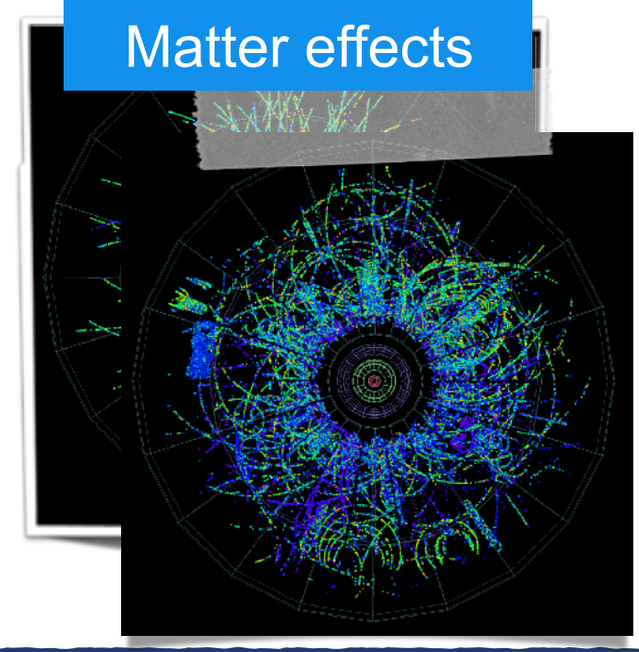
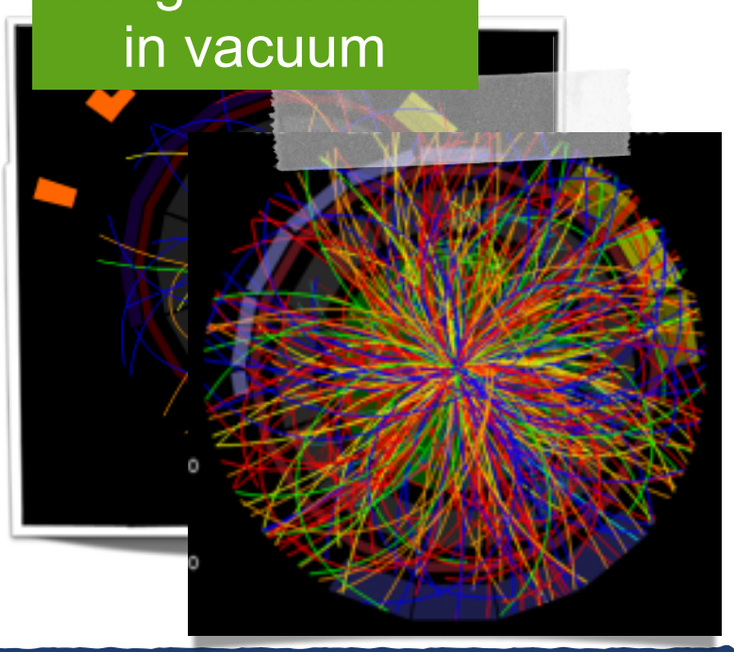


Cold Nuclear Matter effects

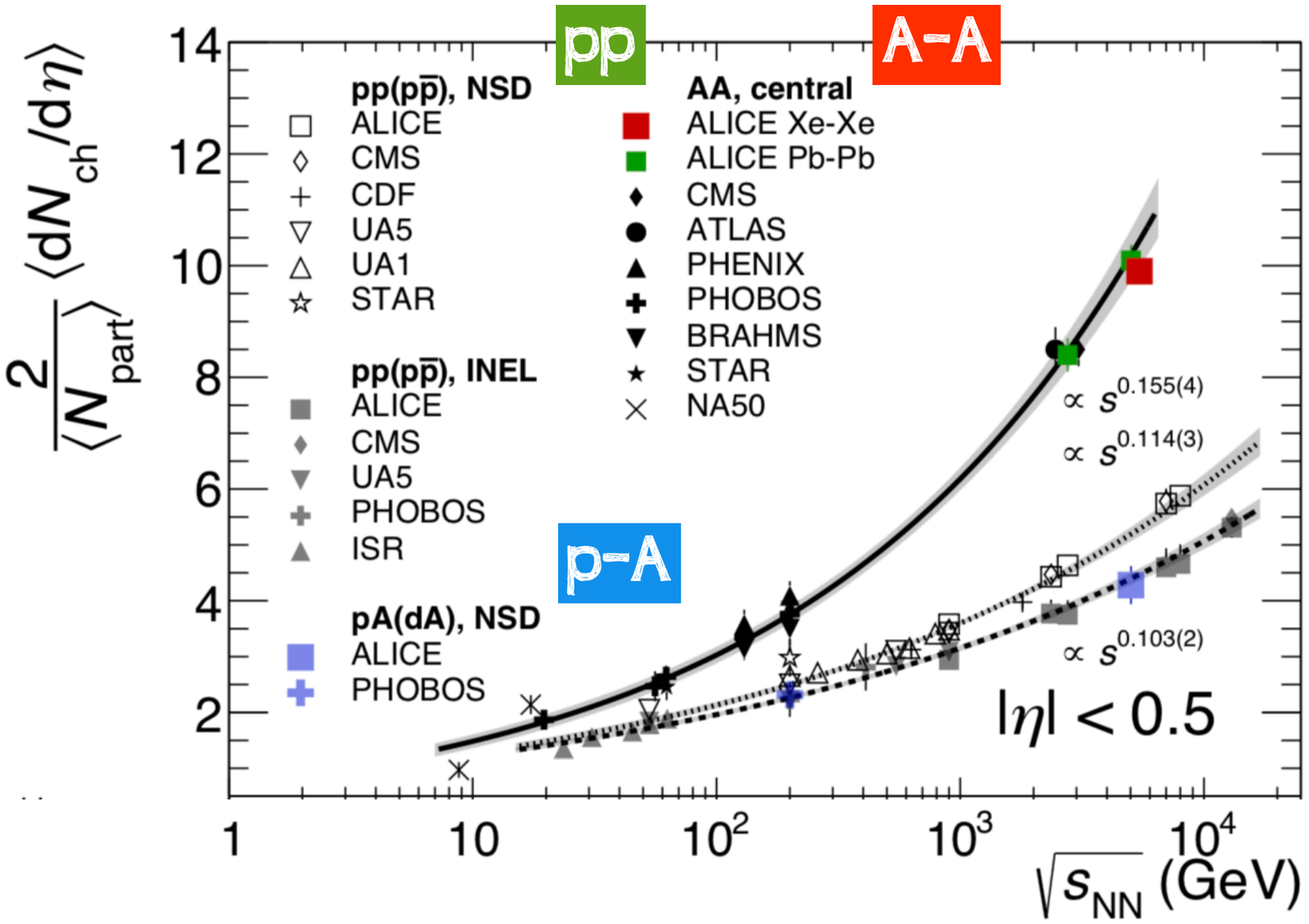


Fragmentation in vacuum



Particle production

Study charged particle production varying collision systems and energies to shed light on particle production mechanism



[ALICE Coll., arXiv:1805.04432]

Particle production

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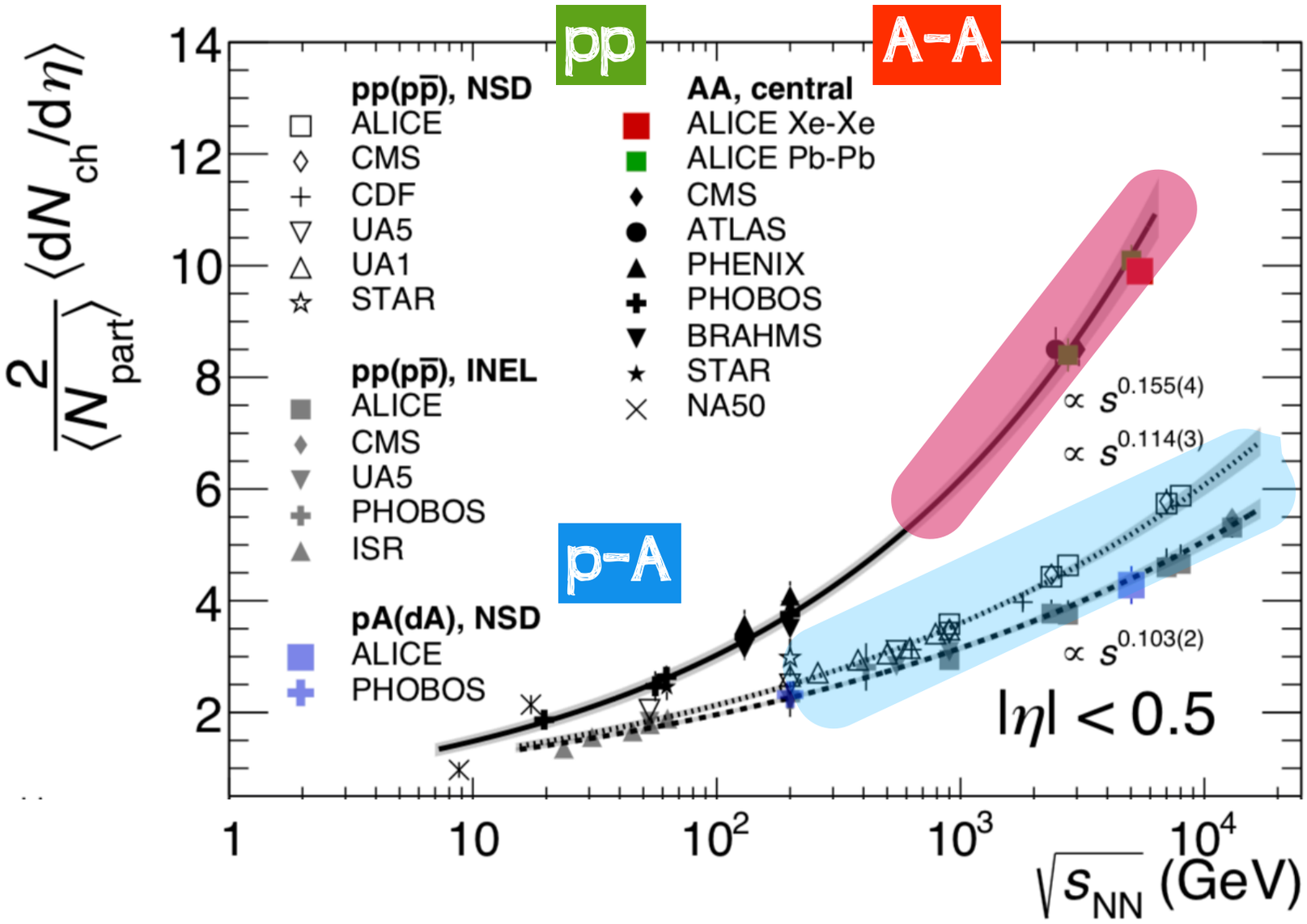
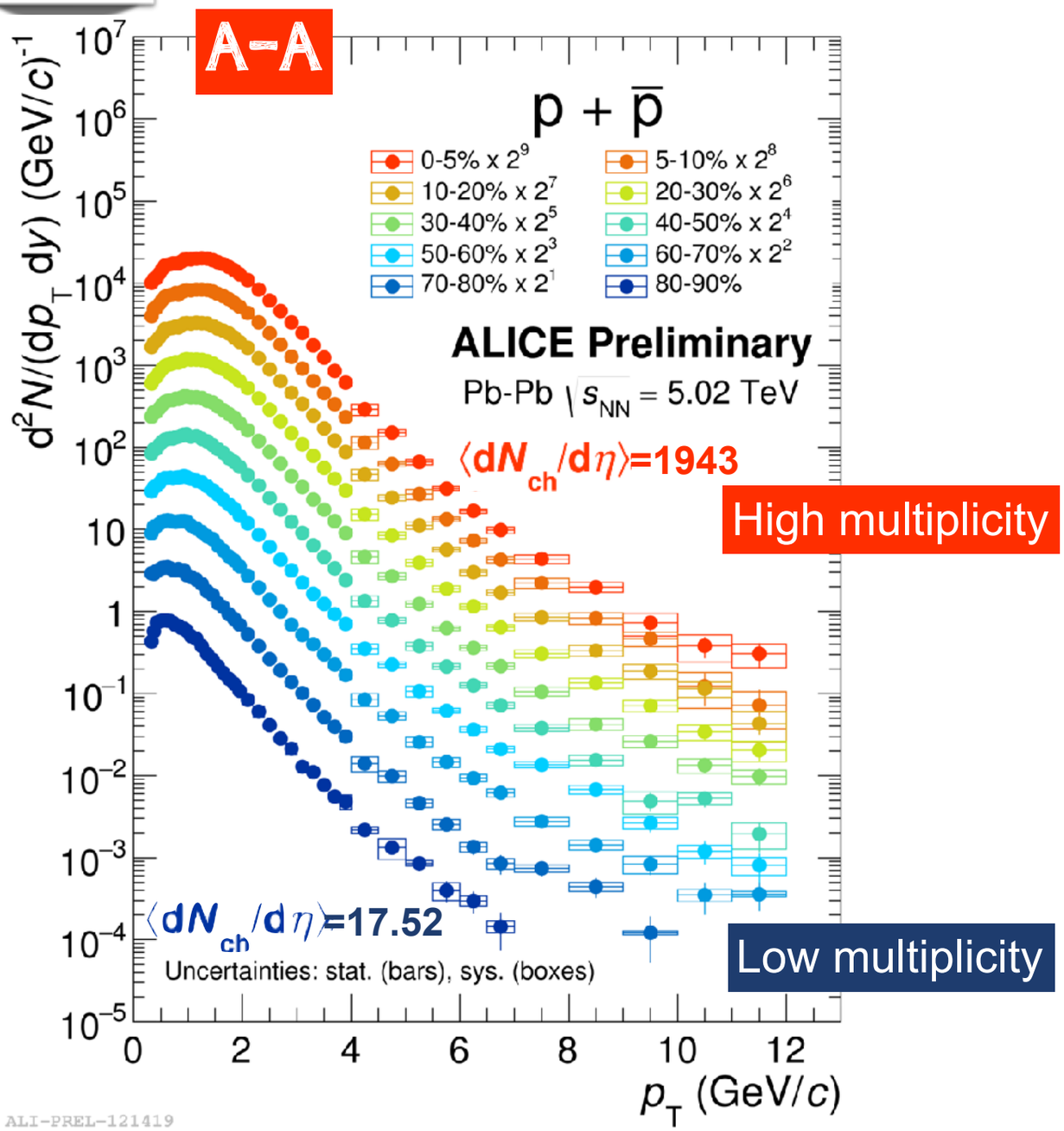


[ALICE Coll., arXiv:1805.04432]

Stronger rise with √s for A-A particle production per participant pair than for p-A and pp collisions

Particle spectra

A-A



High multiplicity

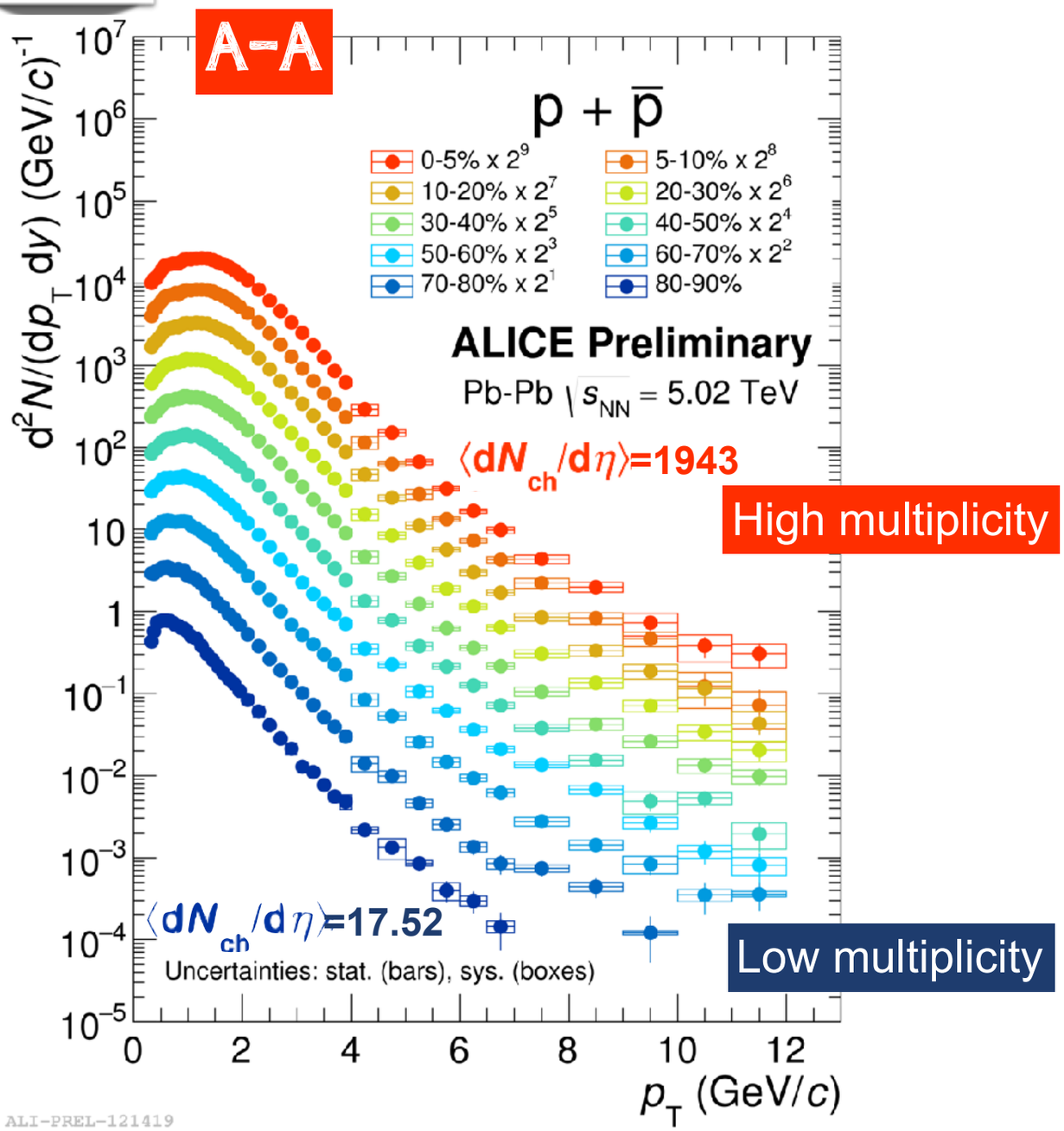
Low multiplicity

Harder spectra in central A-A collisions

- collective expansion (radial flow) of medium in local thermodynamic equilibrium

Particle spectra

A-A



ALI-PREL-121419

High multiplicity

Low multiplicity

Harder spectra in central A-A collisions

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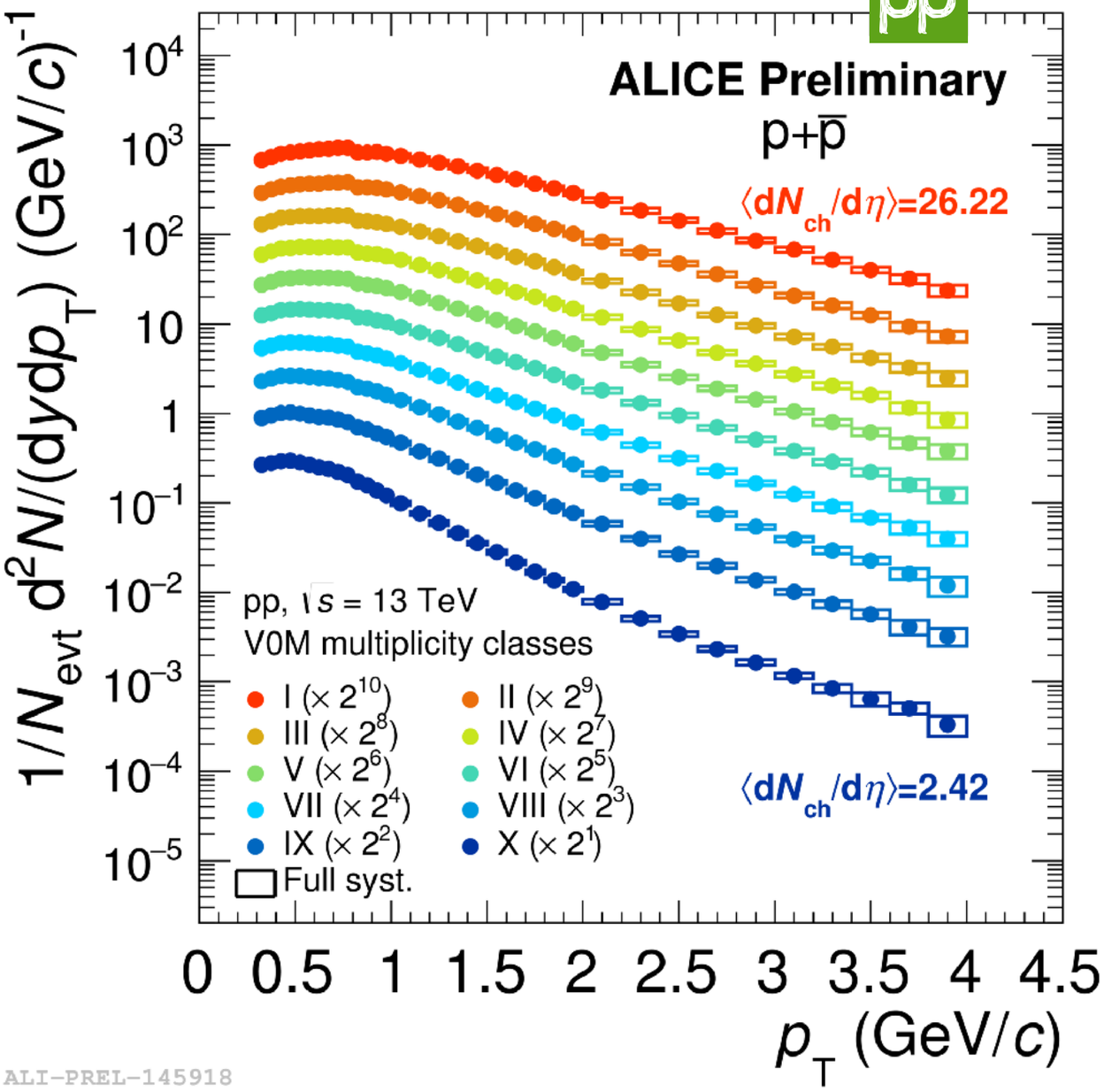
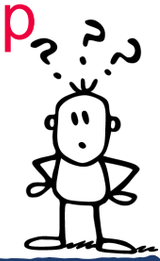
pp



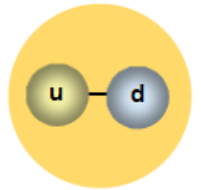
ALI-PREL-145918

- hardening of spectra observed in pp collisions with increasing multiplicity

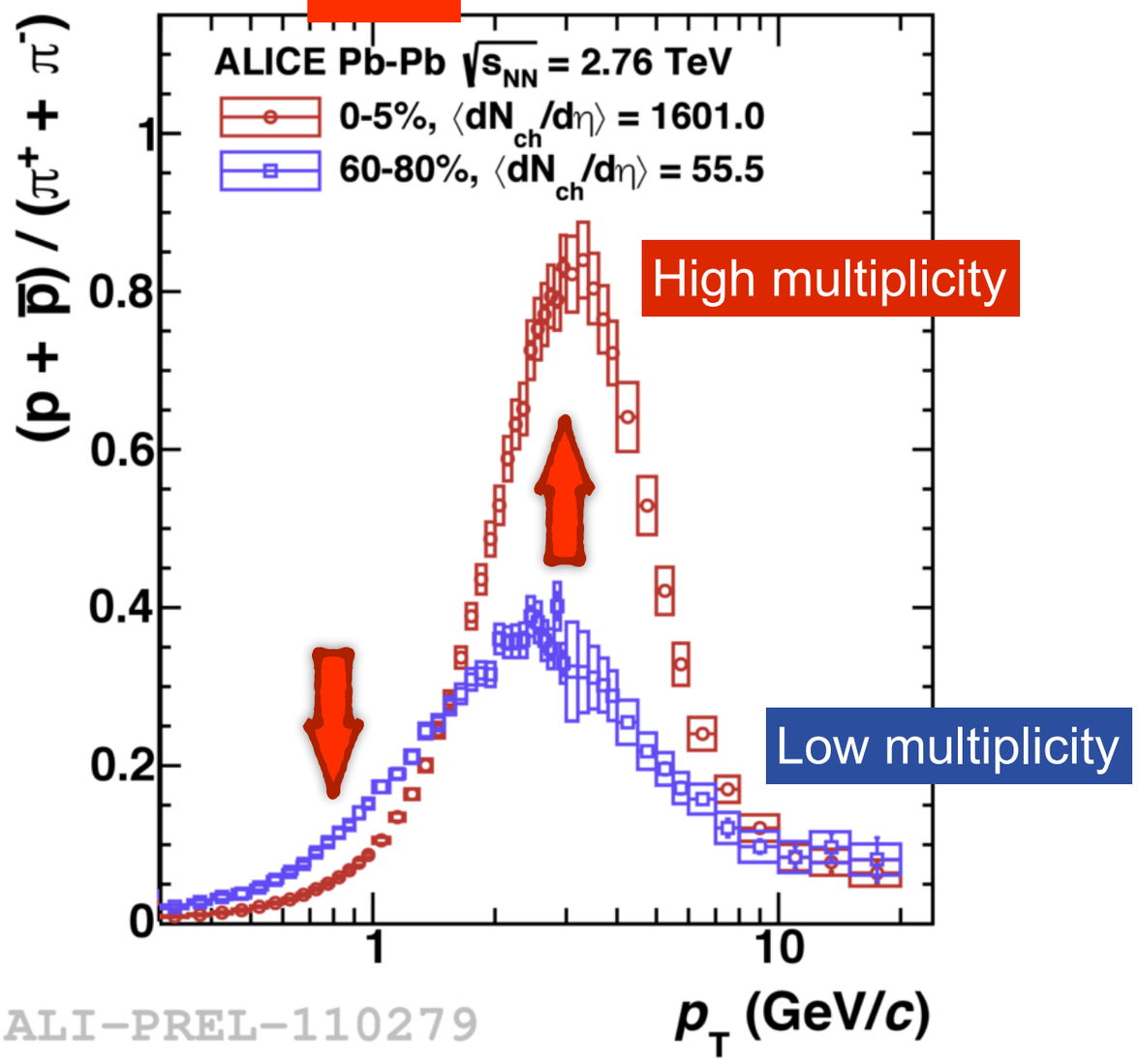


Baryons vs. Mesons

At low p_T ⏵ hydrodynamics expansion of the fireball
At intermediate p_T ⏵ quark recombination



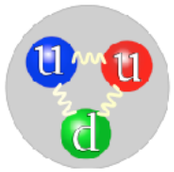
A-A

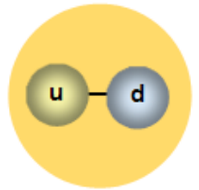


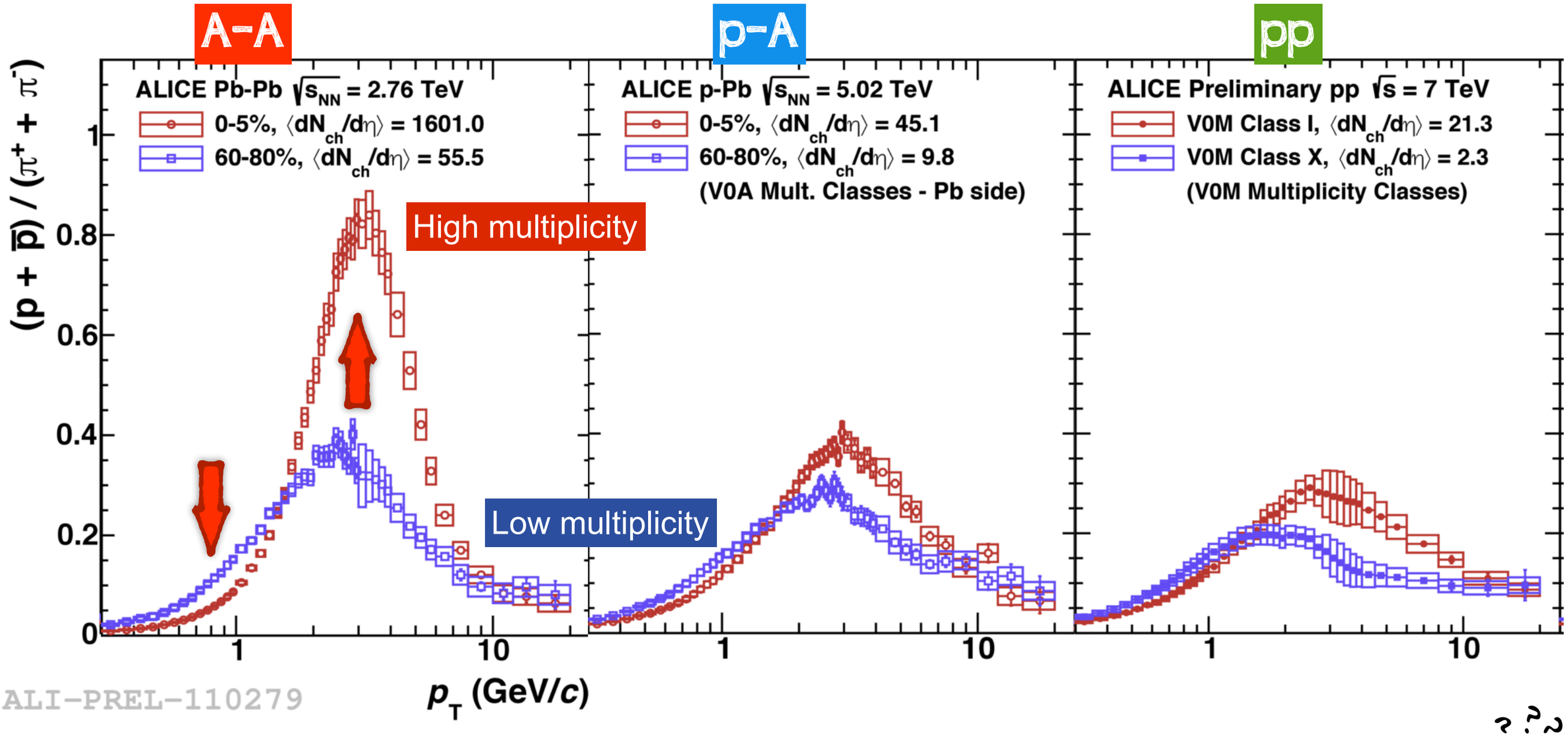
ALI-PREL-110279

Baryons vs. Mesons

At low p_T ➧ hydrodynamics expansion of the fireball
At intermediate p_T ➧ quark recombination







➧ qualitatively similar behaviour in smaller systems

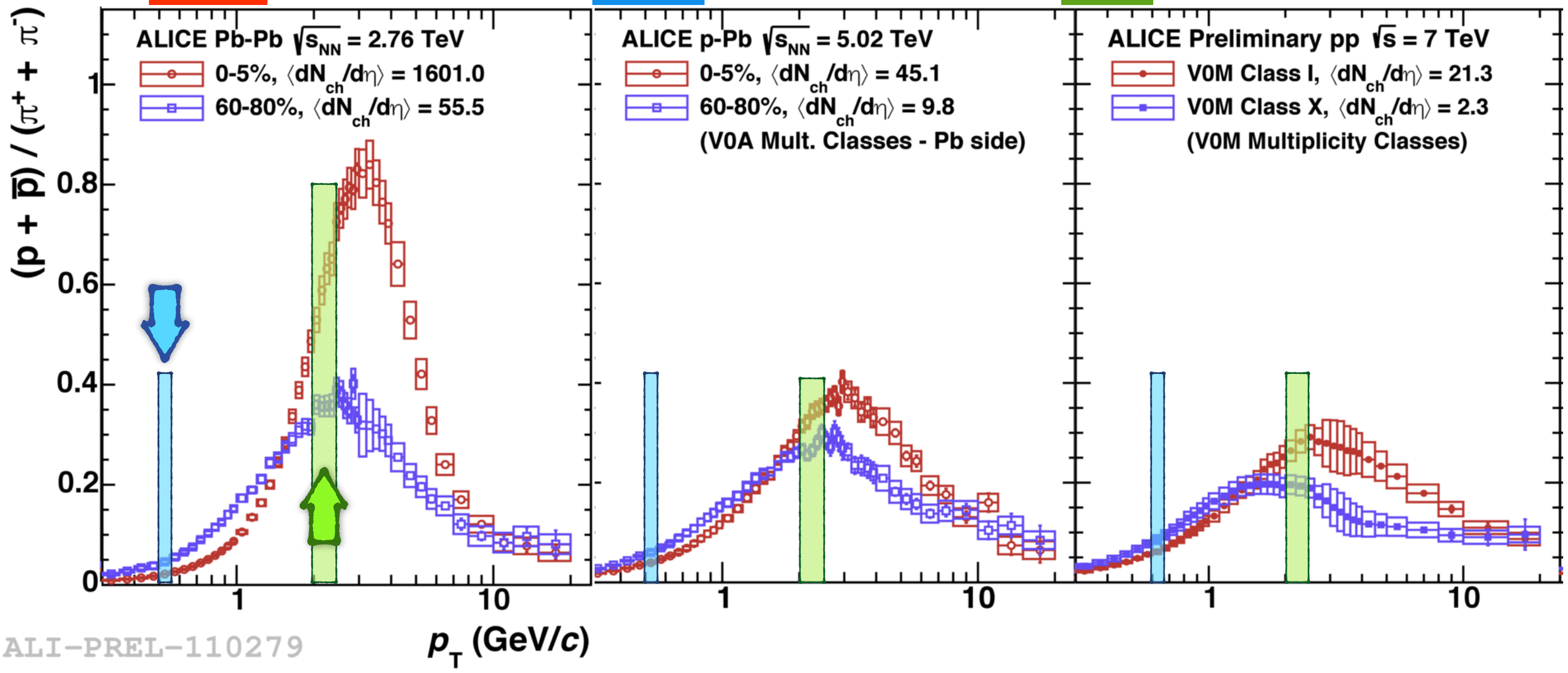
Baryons vs. Mesons

Depletion at low p_T, enhancement at intermediate p_T

A-A

p-A

pp



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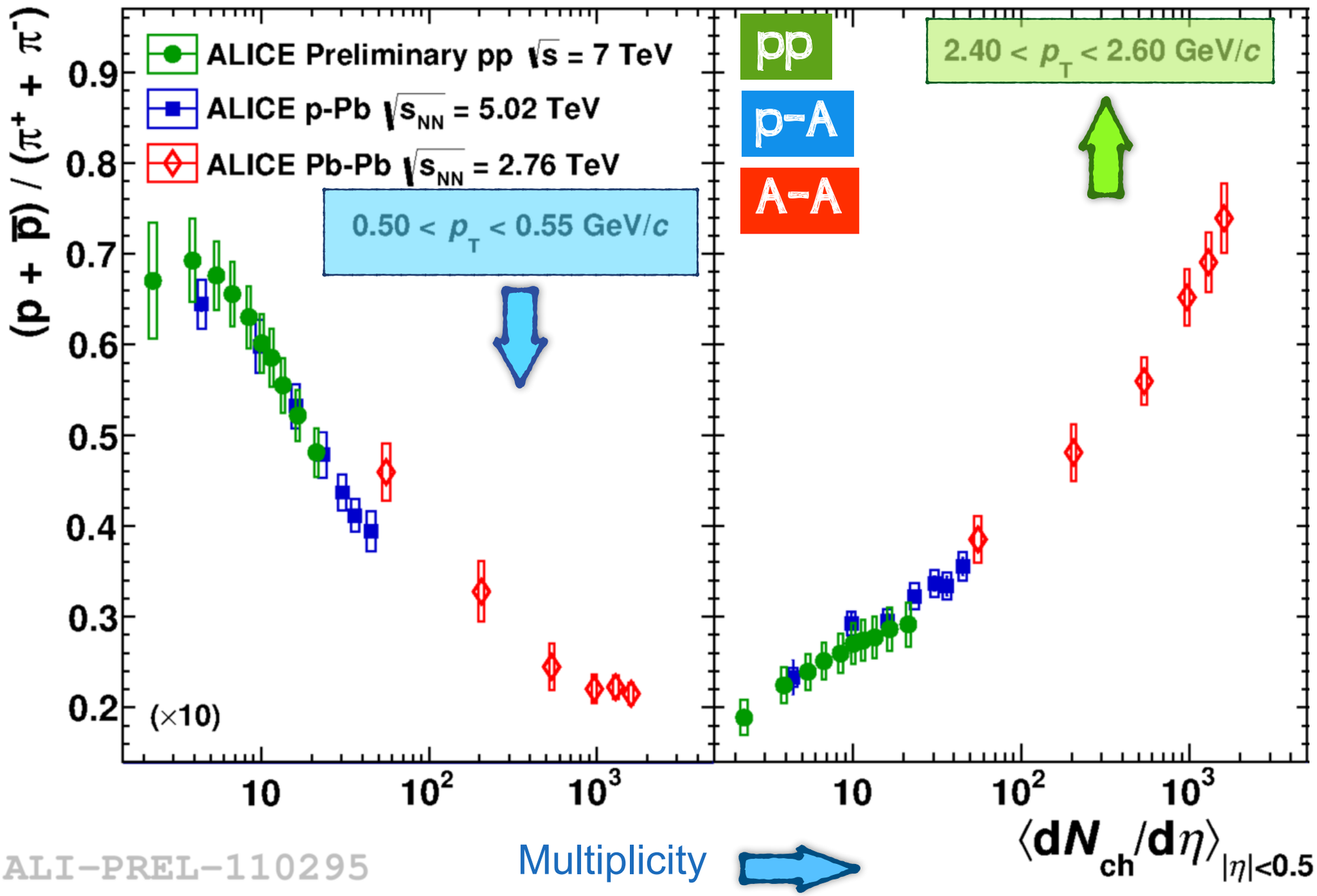
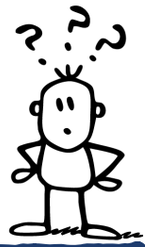


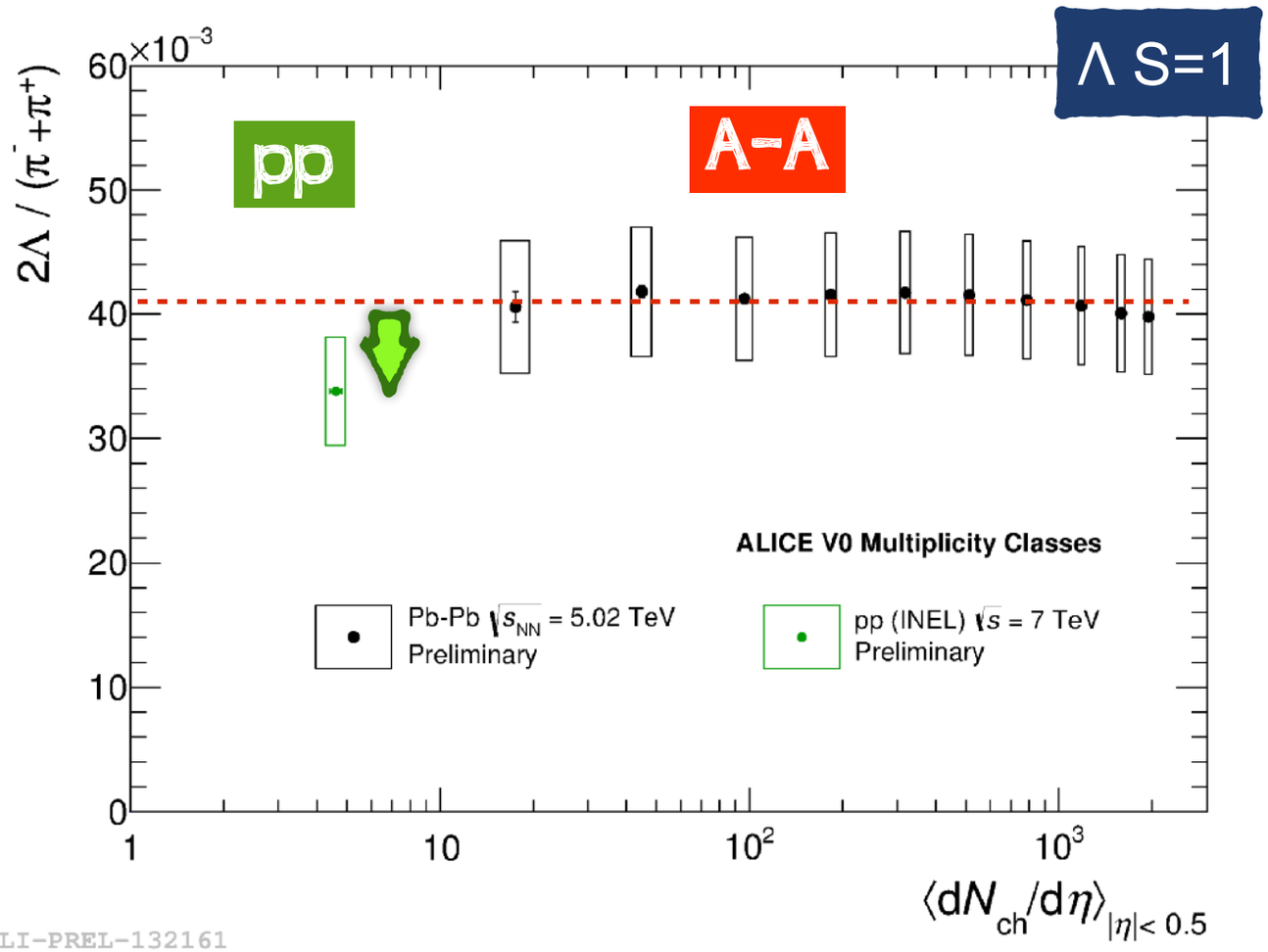
- smooth trend vs. multiplicity across different colliding systems
- common driving mechanism?



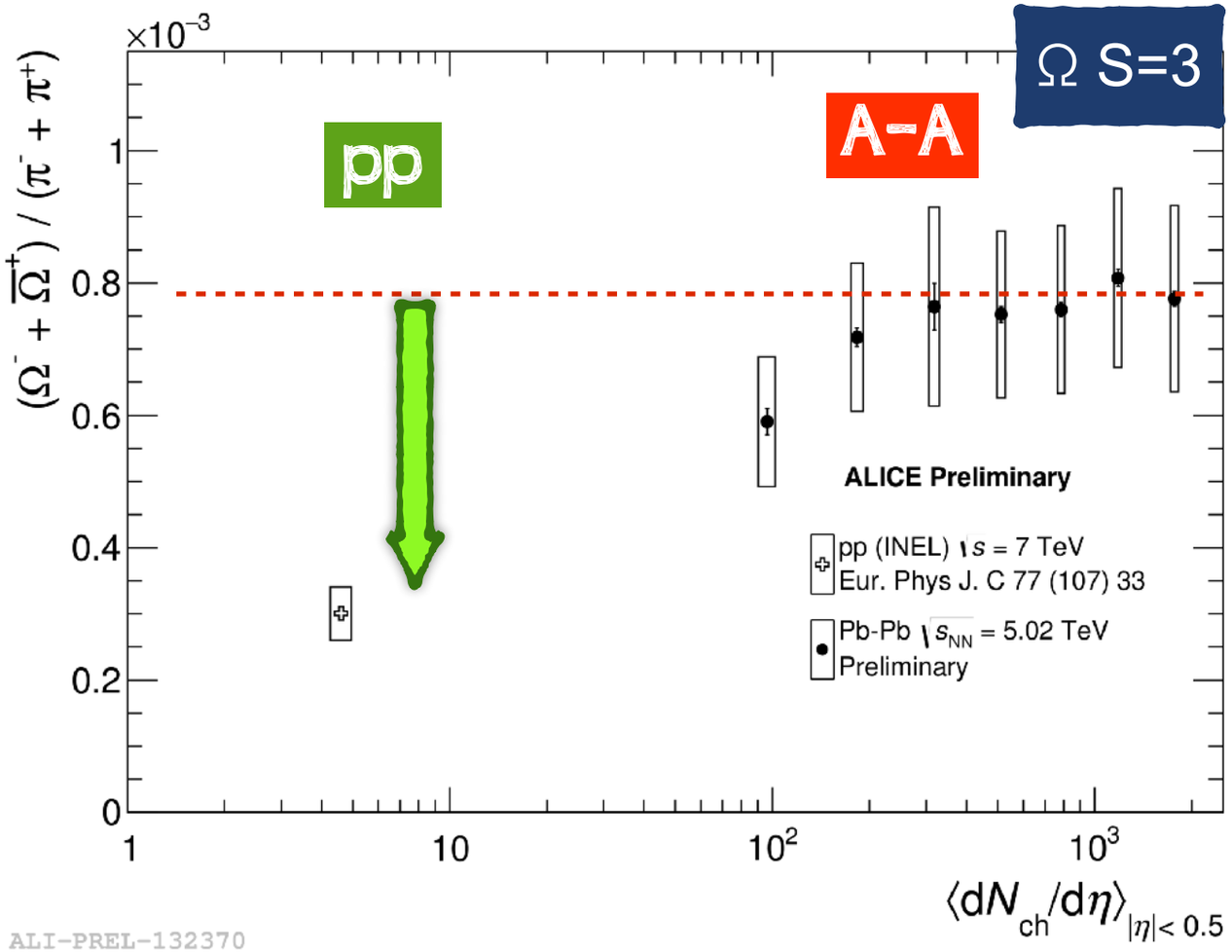
Strangeness

Enhanced strange particle production in A-A relative to pp, p-A collision increasing with s quark content ◗ QGP signature

[Rafelski & Muller, PRL 48 (1982) 1066]



ALI-PREL-132161



ALI-PREL-132370

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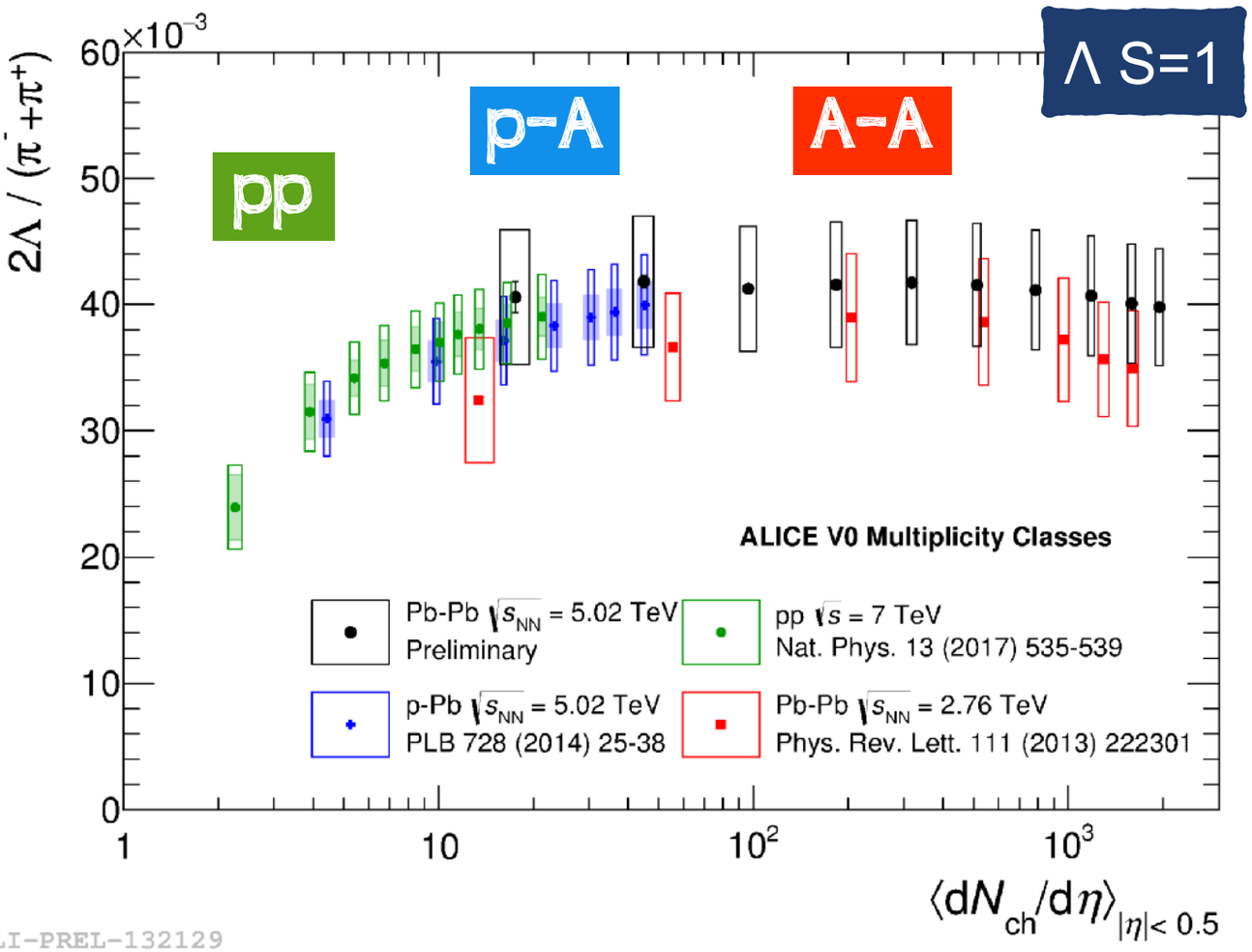
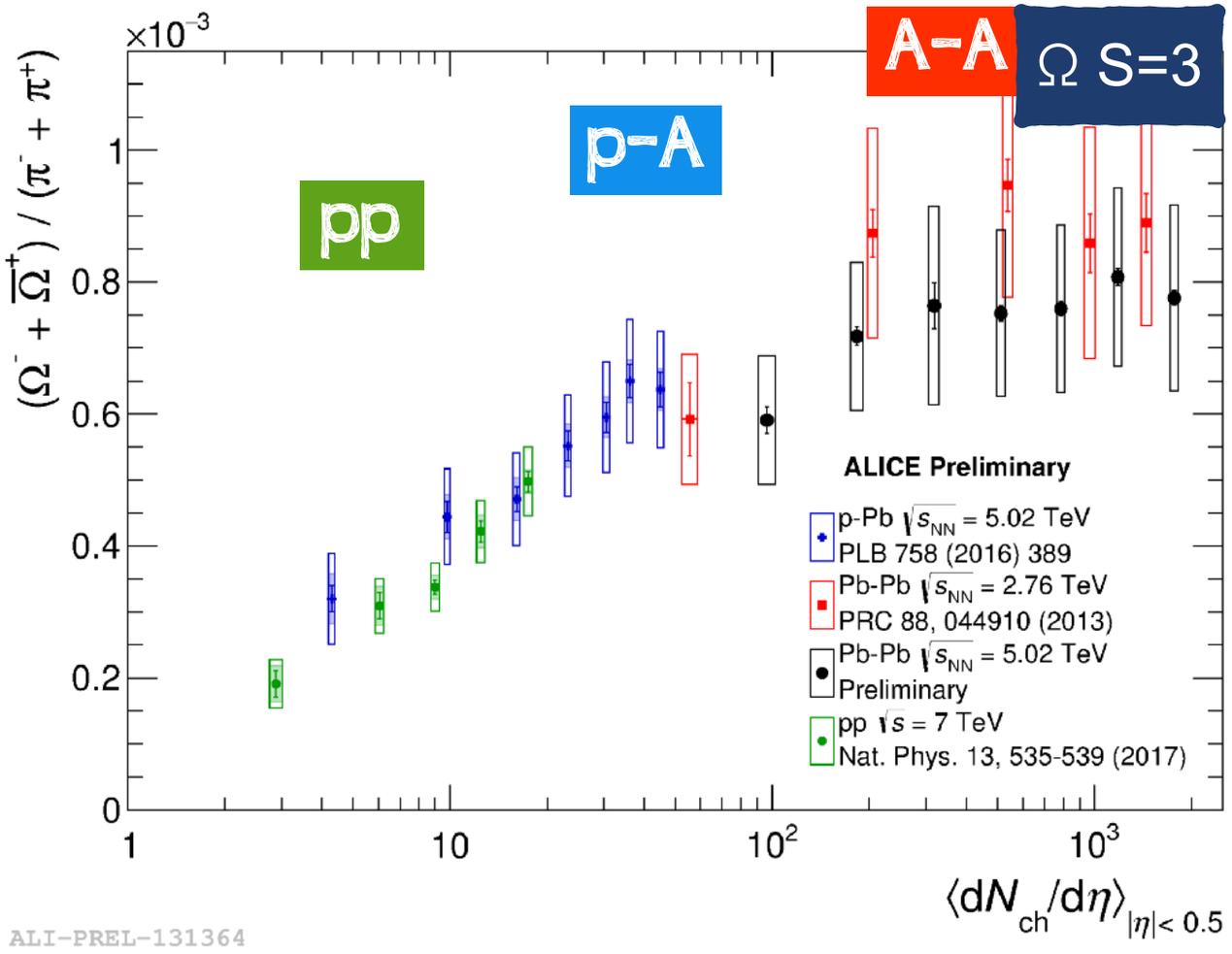
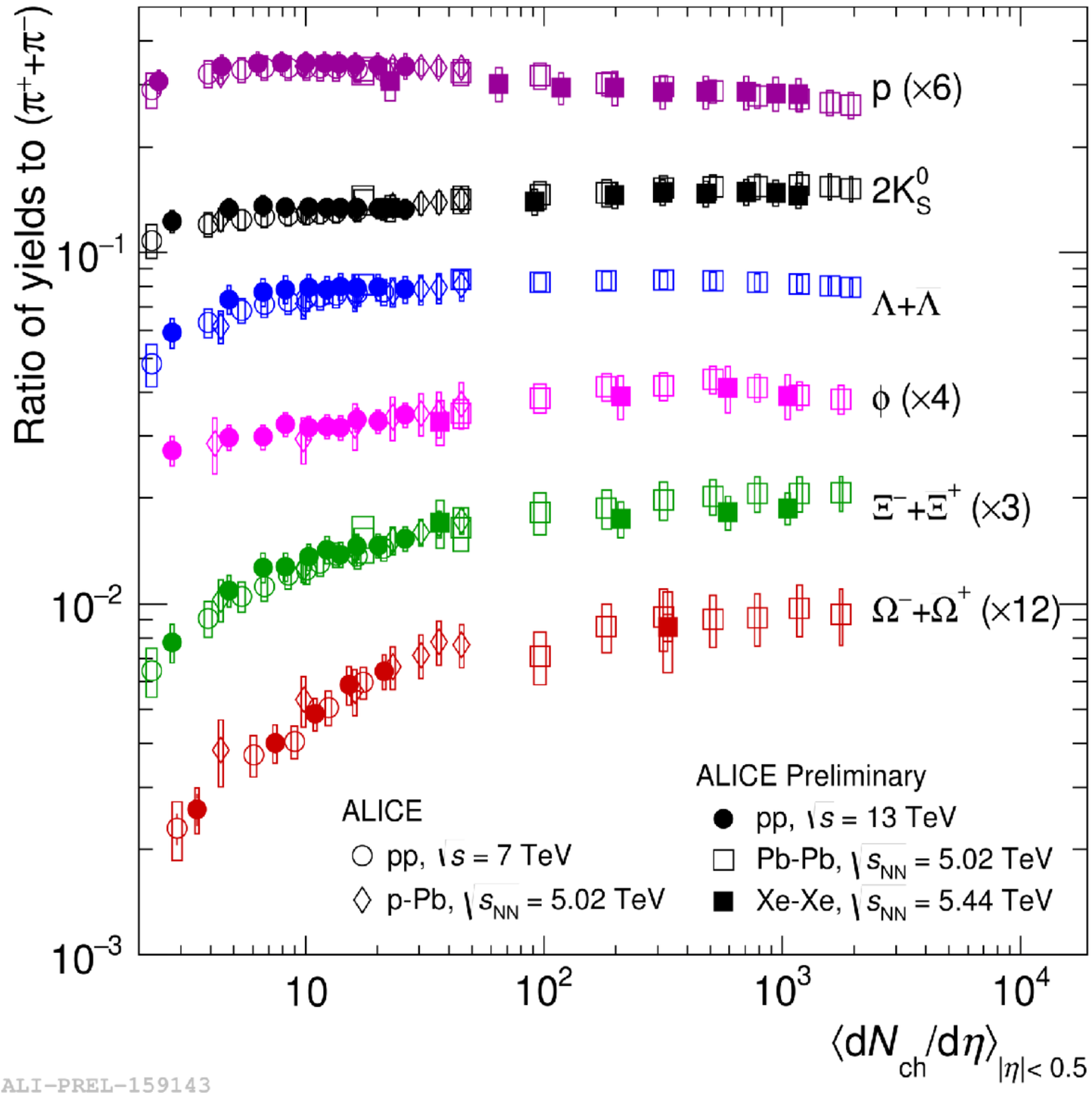
[Rafelski & Muller, PRL 48 (1982) 1066]





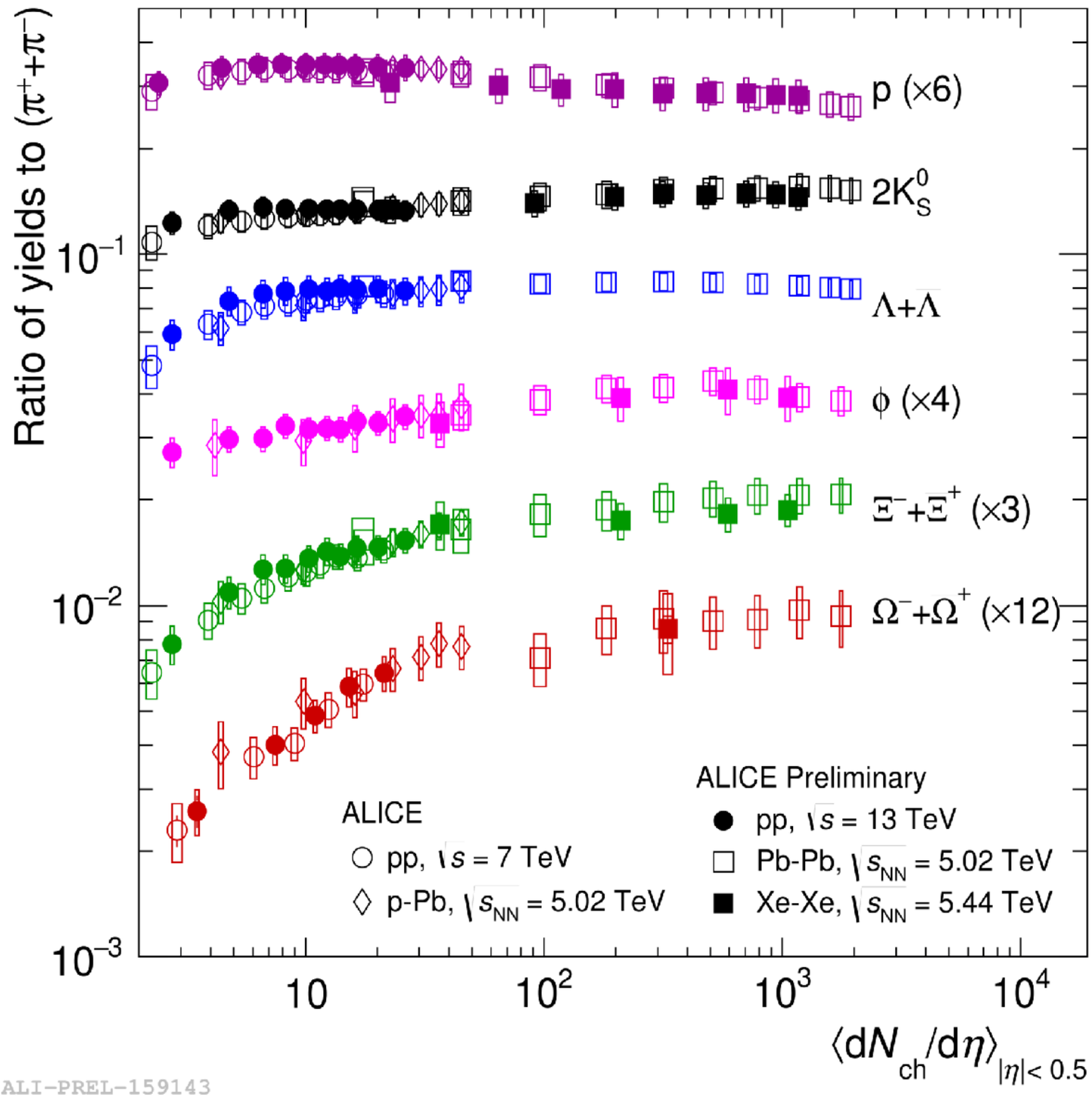
Identical particle chemistry for fixed multiplicity independently of energy or collision system ➧ strangeness production driven by final-state multiplicity

Multiplicity matters



ALI-PREL-159143

Multiplicity matters



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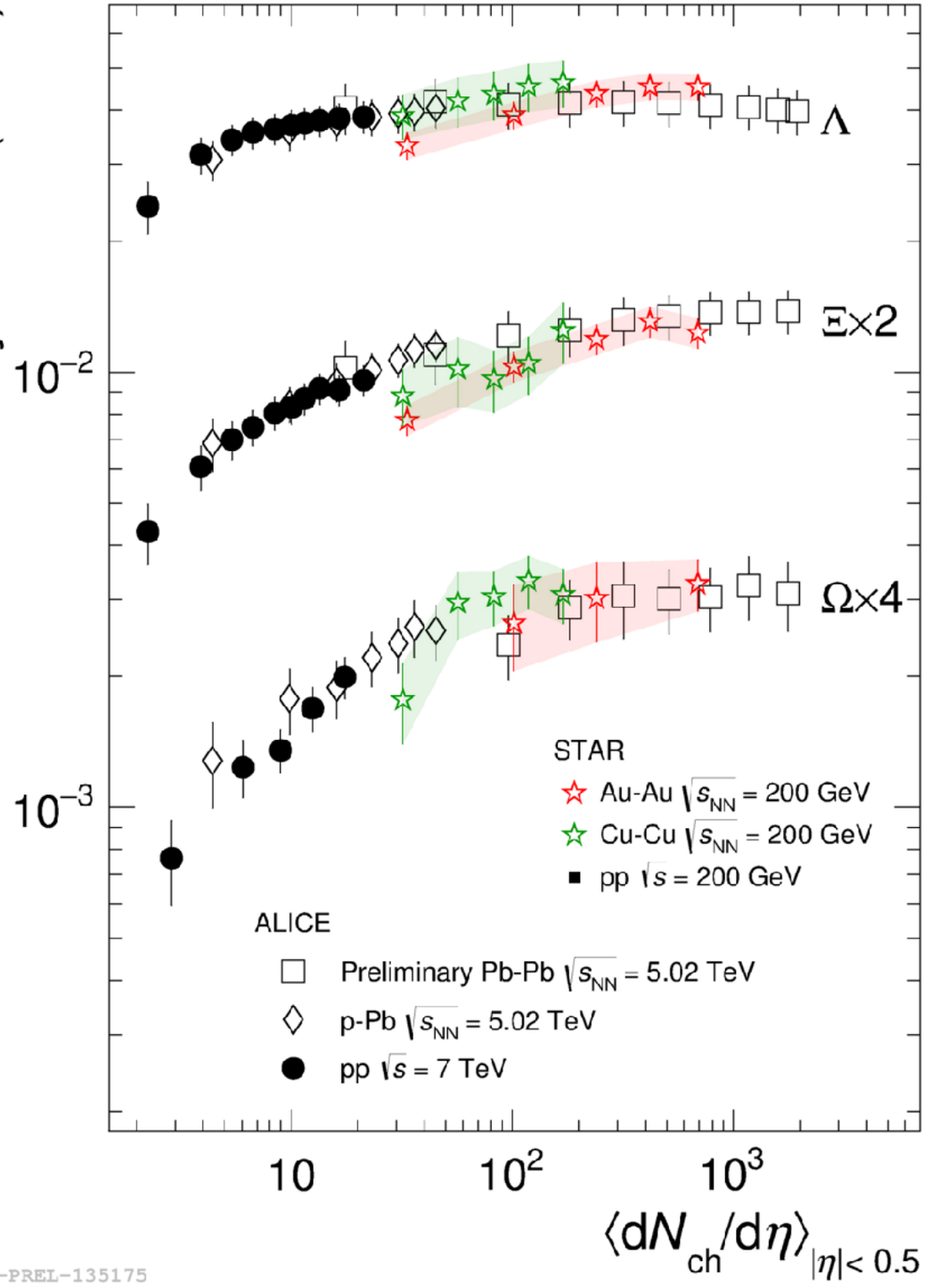
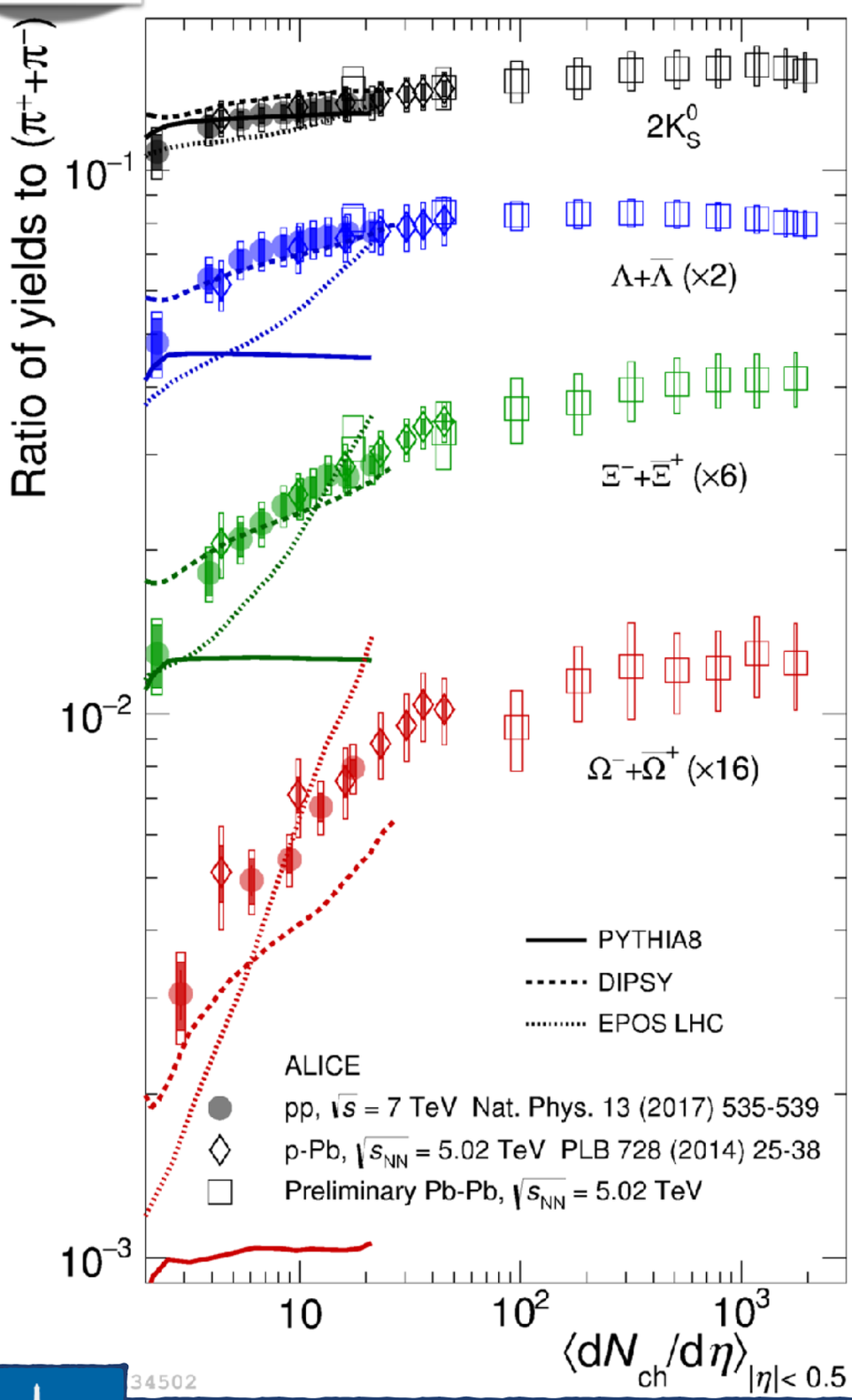


ALI-PREL-135175

Testing QCD models



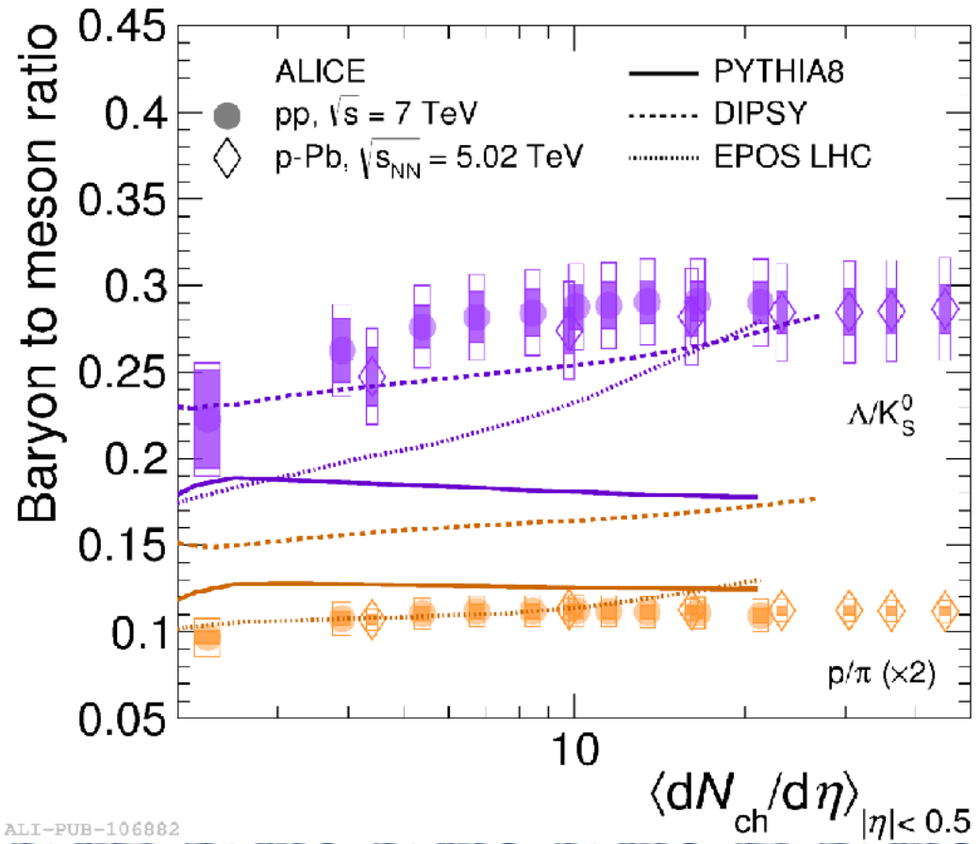
Test QCD-inspired models

PYTHIA8 (Color Reconnection) ruled out

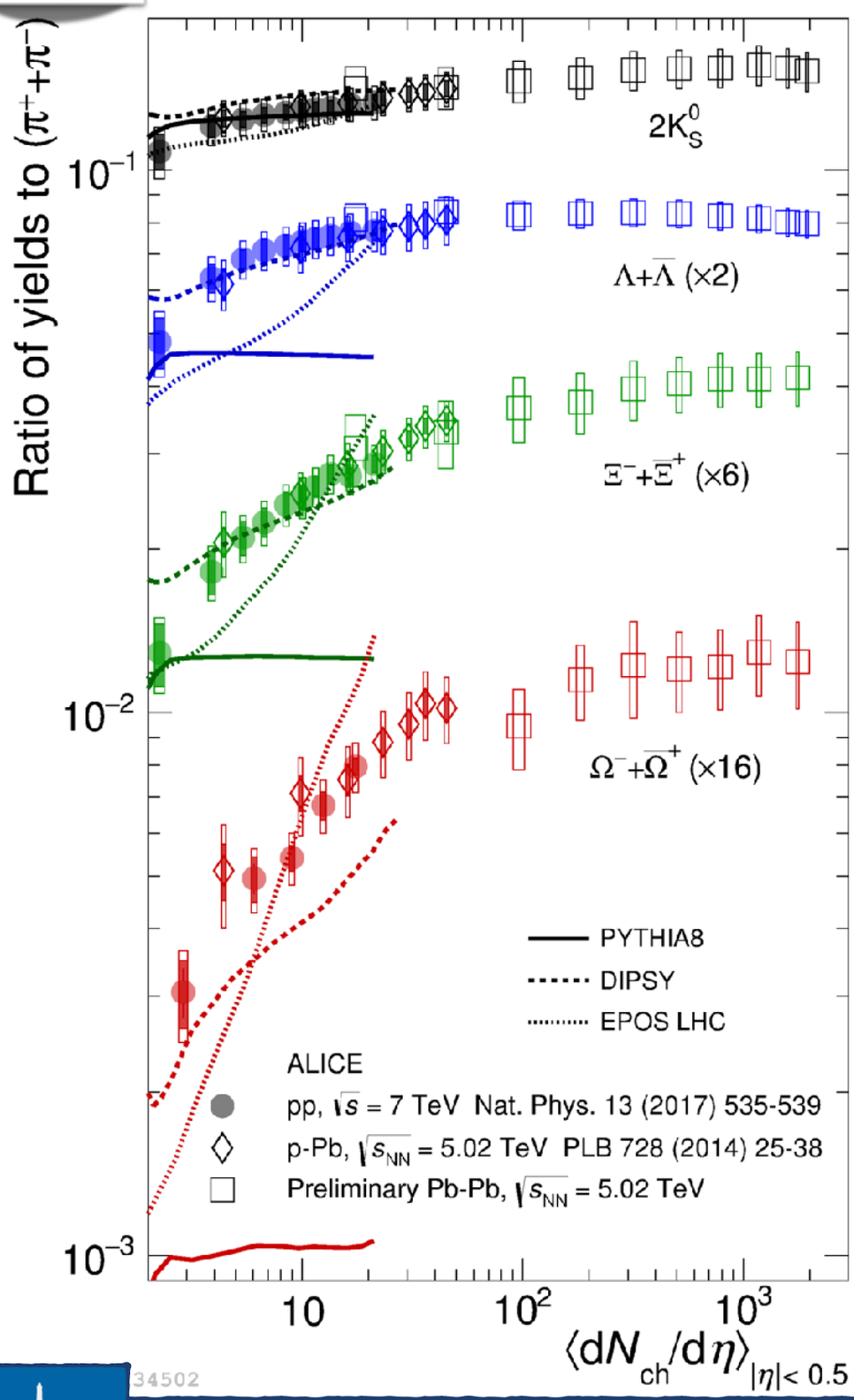
DIPSY (Color ropes) original version cannot simultaneously reproduce the observed enhancement for all measured hadrons

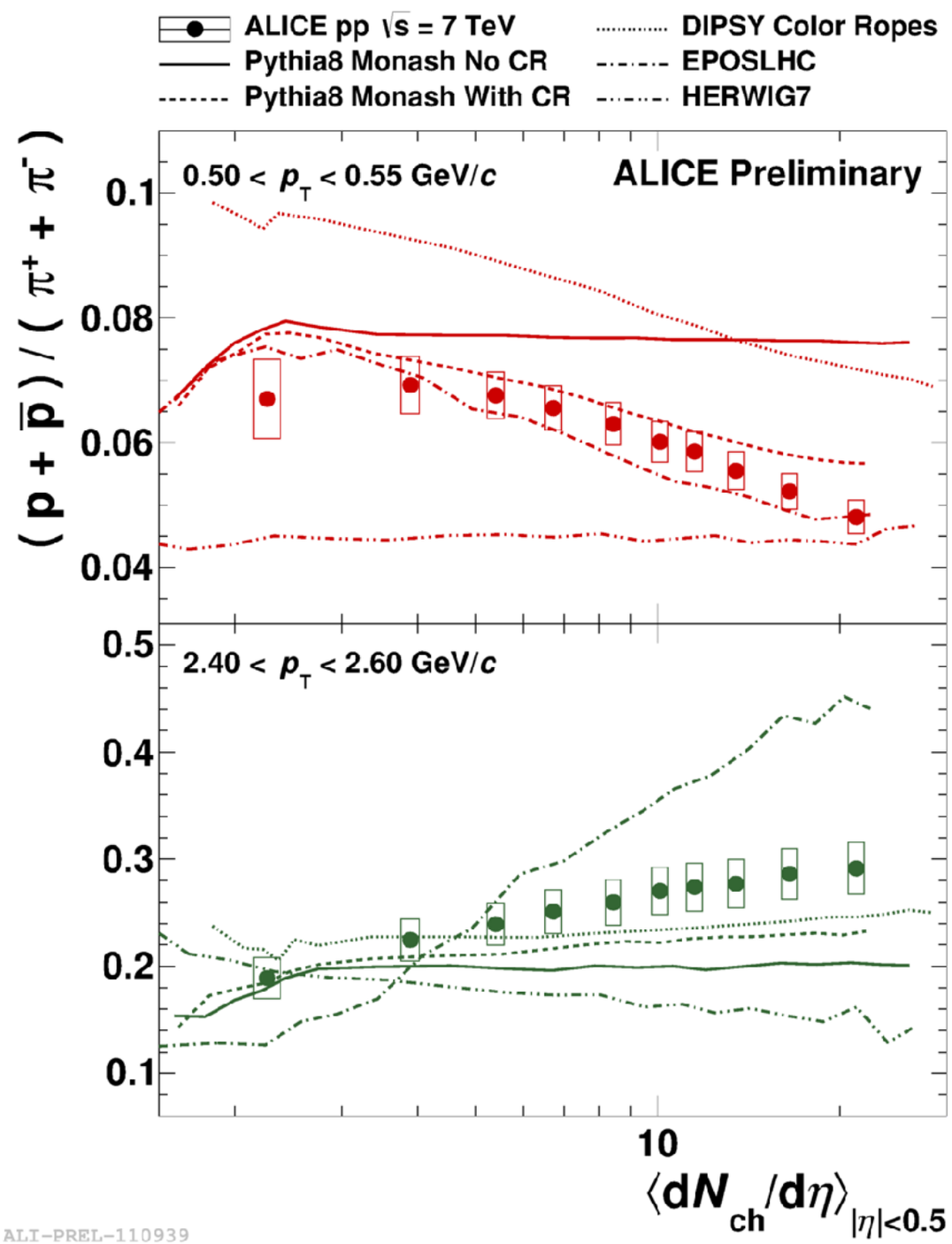
EPOS LHC (Core-corona approach) describes the trend only qualitatively

- fail to describe all available data



Testing QCD models





- tool to constraint models

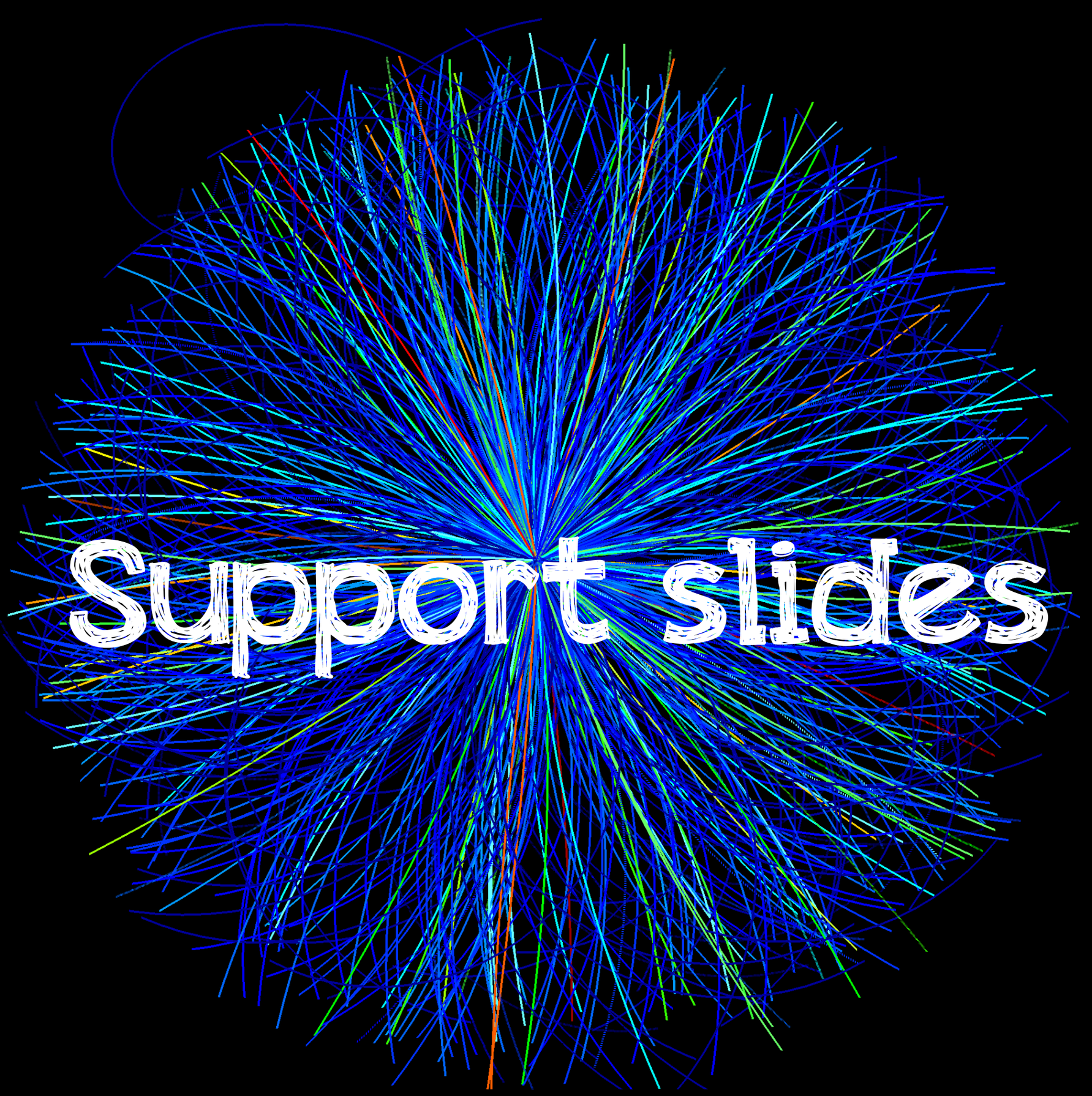
Summary

Observations that were attributed to the creation of a dense medium in thermal and kinematic equilibrium in heavy ion collisions are observed in high multiplicity pp and p-A collisions

Are QGP droplet formed in smaller systems? Do we need a thermalized and equilibrated medium to explain the observed features?

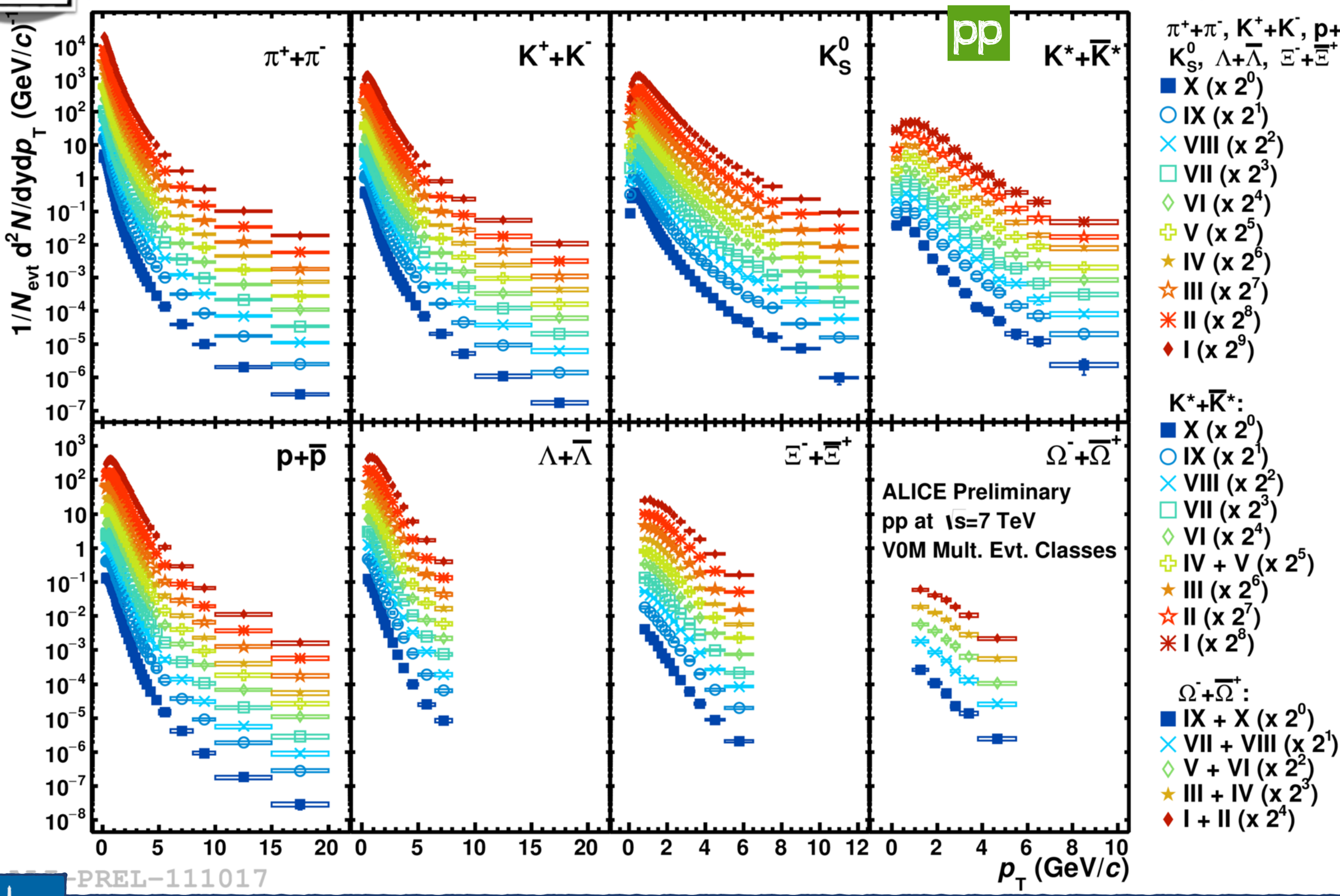
Evidence of a continuous transition across colliding systems pp ➧ p-A ➧ A-A versus final state multiplicity at different $\sqrt{s}$

Can QCD inspired model provide microscopic descriptions to explain the observed features (string shoving, rope formation)?



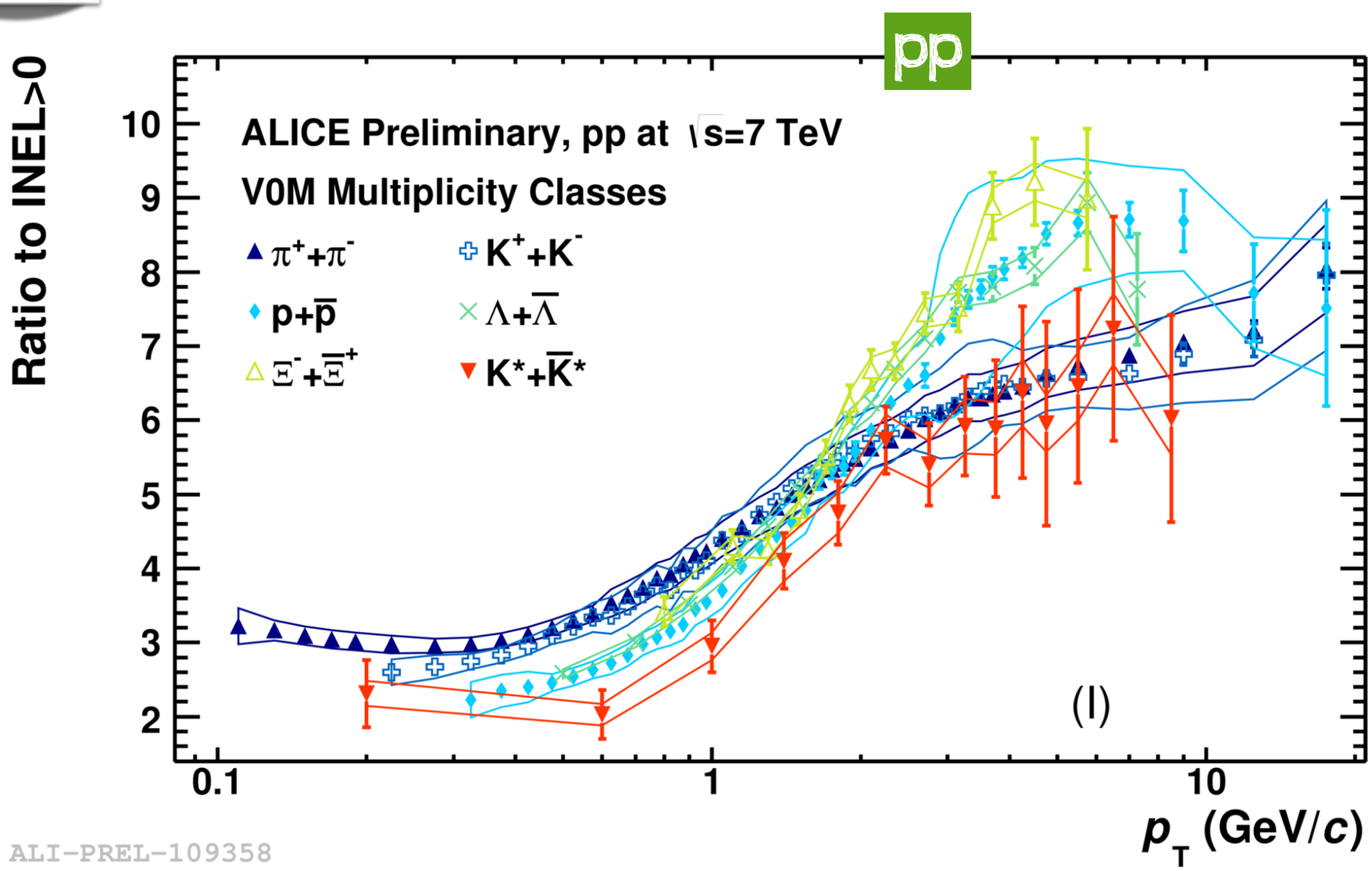
Support slides

Particle spectra



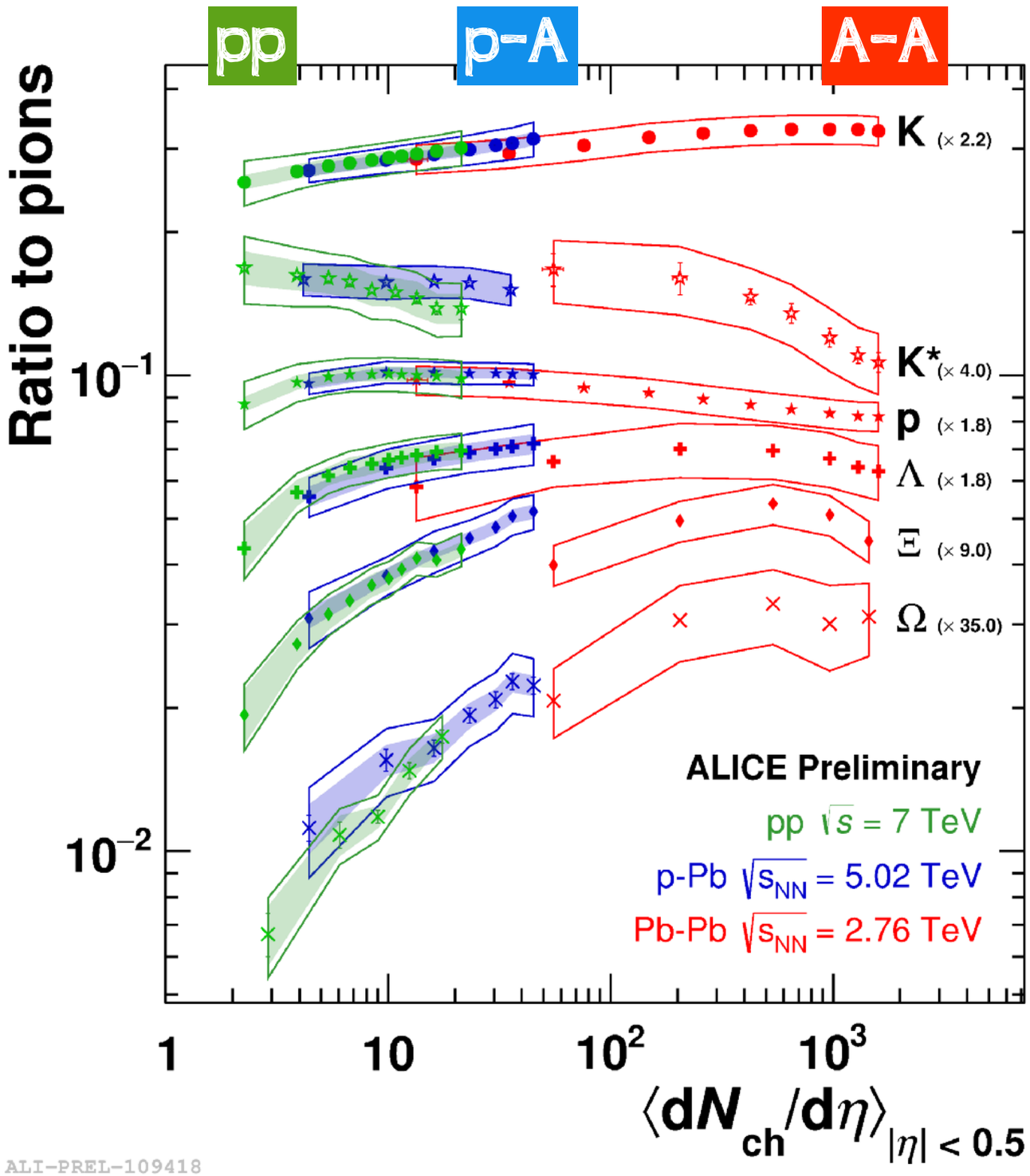
ALICE-PREL-111017

Particle spectra



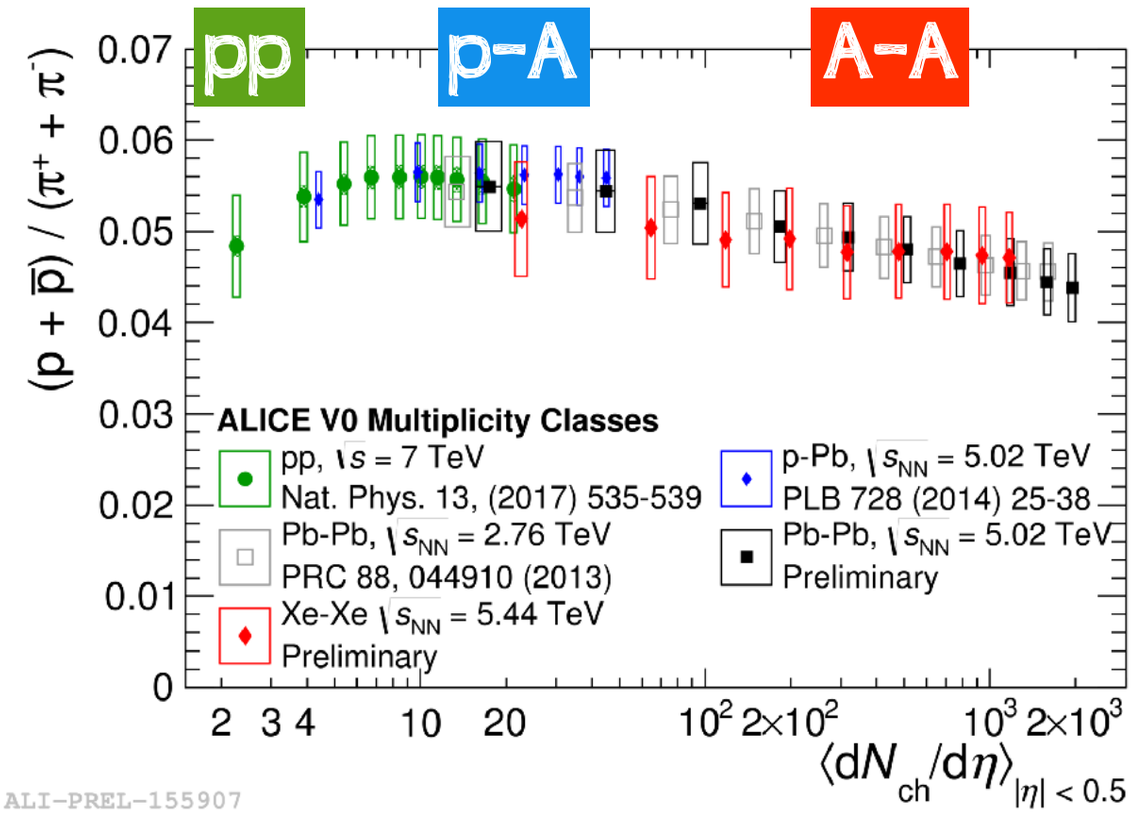
Ratio to INEL>0 spectra ➧ spectra evolution seems to be driven by no. of constituent quarks at high p_T (baryon-meson grouping)

Yield ratios

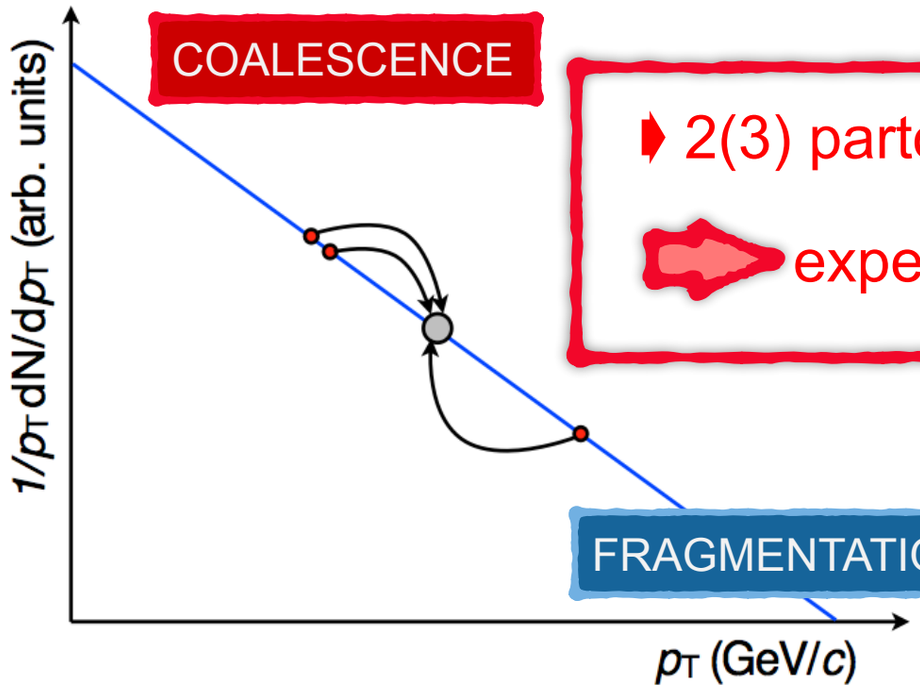


- strangeness enhancement with multiplicity
- p/π ratio constant

➧ hyperon/π enhancement connected to strangeness content



Hadronization

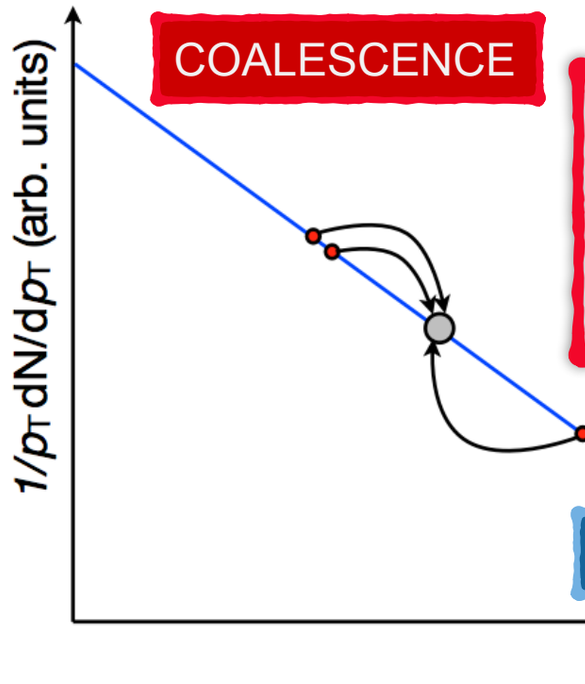


- 2(3) partons combine with p_T(hadron)~2(3)* p_T

  ⇒ expect baryon(qqq)/meson(q-antiq) enhancement

- single parton fragments with p_T(hadron)< p_T

Hadronization



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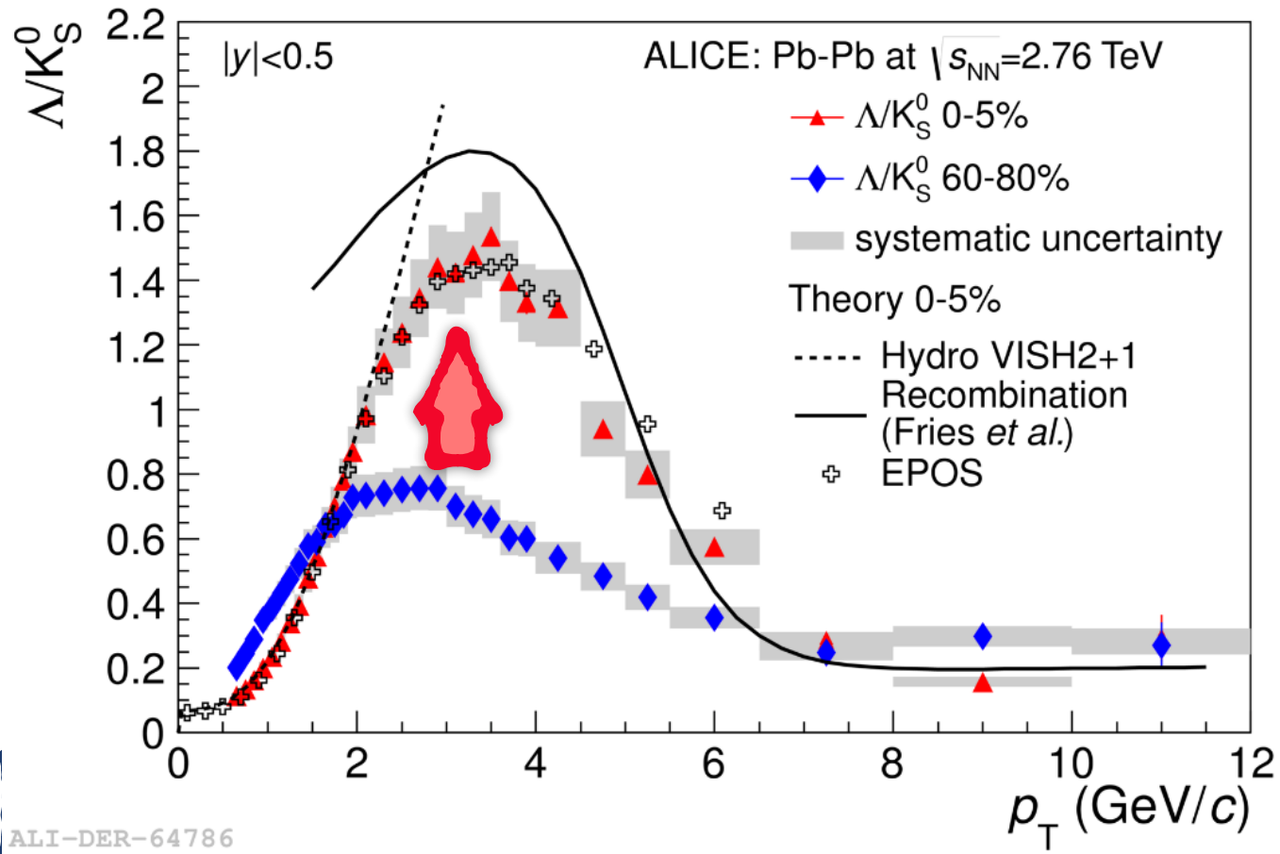
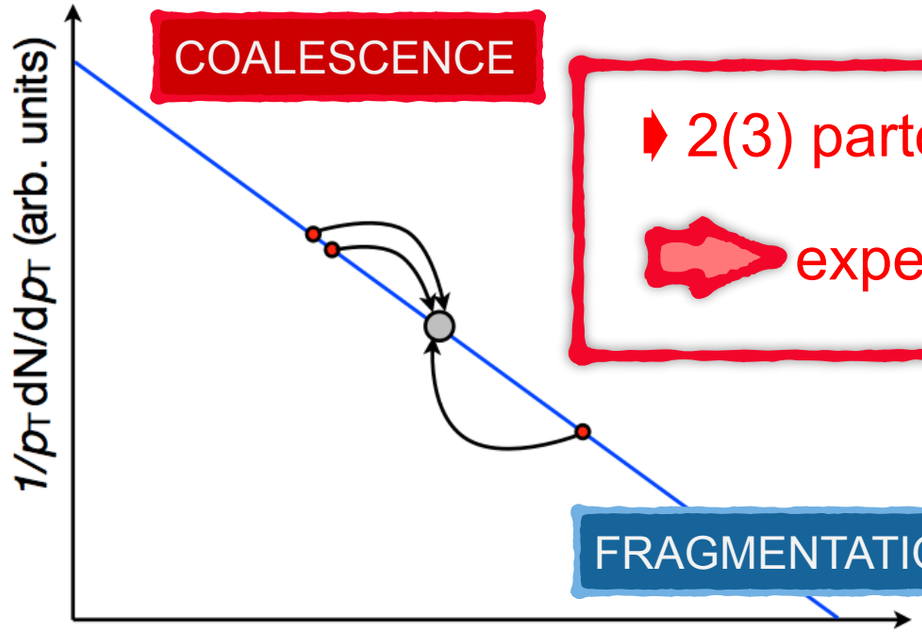
PRL 111(2013) 22301



- baryon/meson enhanced in central A-A collisions at intermediate p_T
- hydrodynamics at low p_T
- coalescence+fragmentation or hydrodynamics+jets (EPOS) able to reproduce data

T.Pierog et al., Phys. Rev. C 92, 034906 (2015)

Hadronization



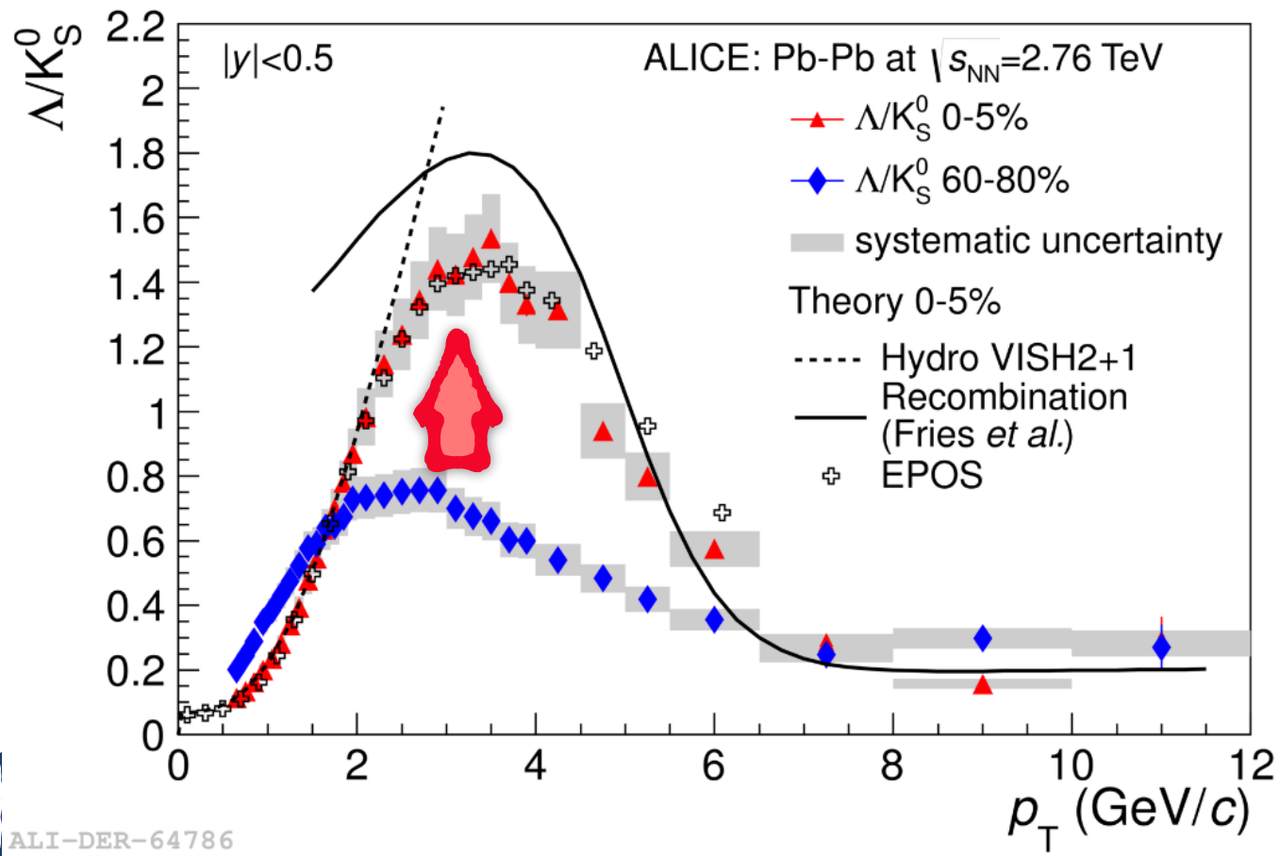
COALESCENCE

- 2(3) partons combine with p_T(hadron)~2(3)* p_T
- expect baryon(qqq)/meson(q-antiq) enhancement

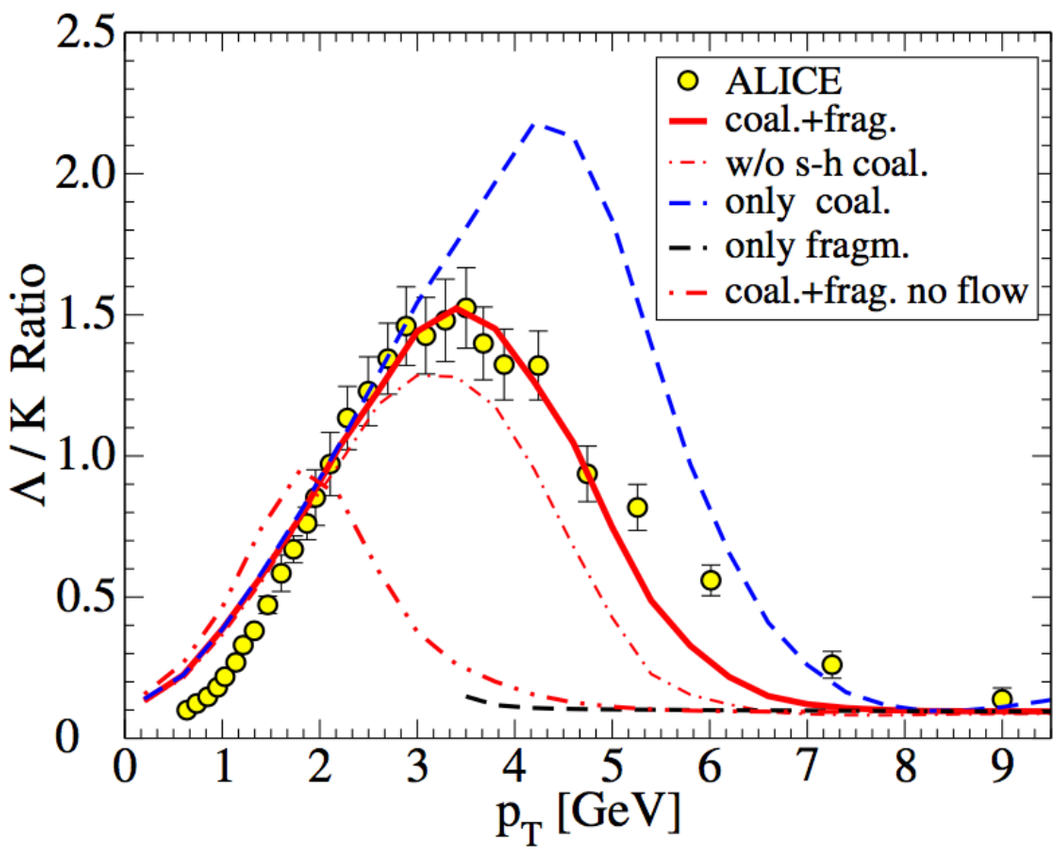
FRAGMENTATION

- single parton fragments with p_T(hadron)< p_T

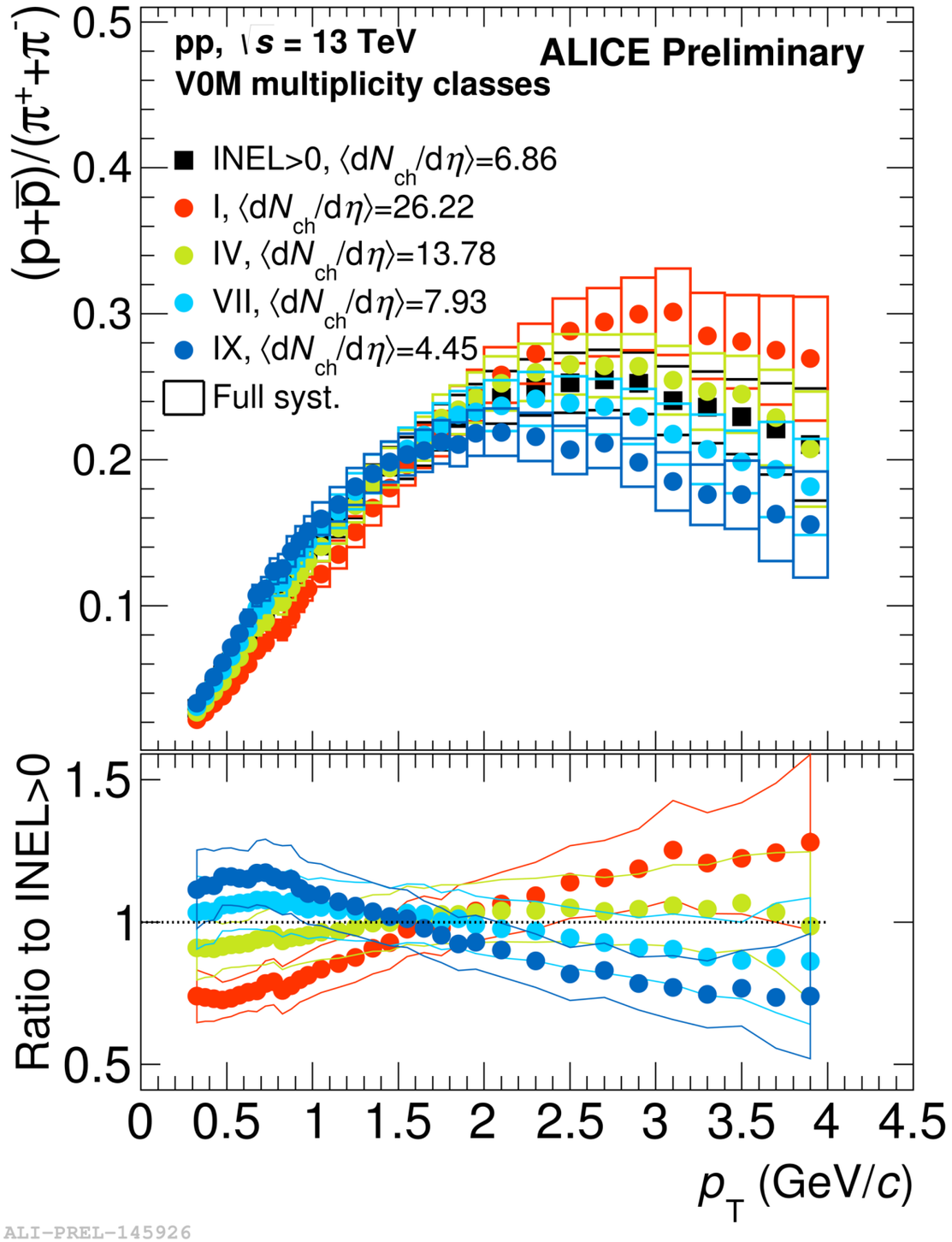
PRL 111(2013) 22301



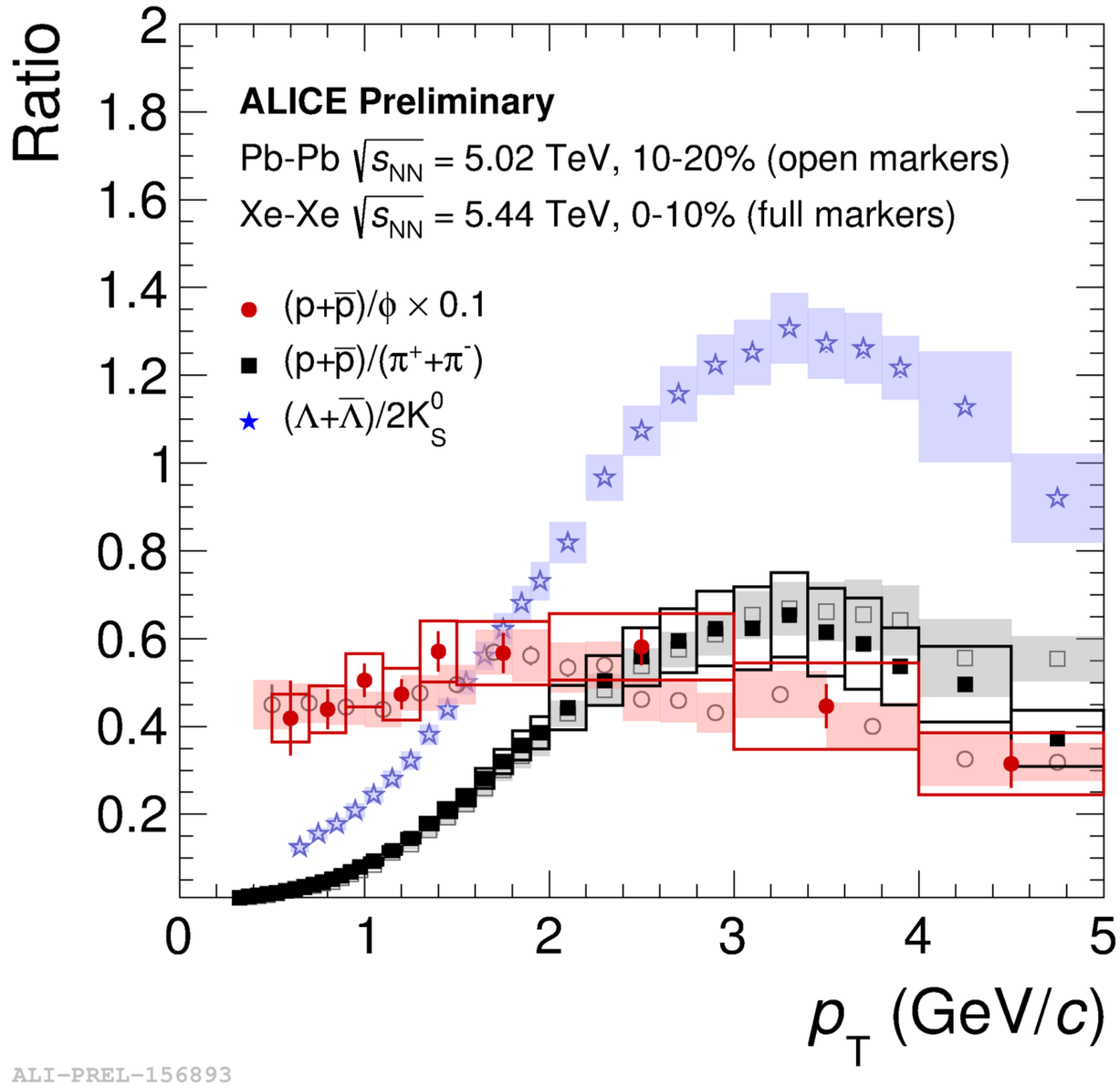
V.Minissale et al., Phys.Rev. C92 (2015) no.5, 054904



Baryons vs. Mesons



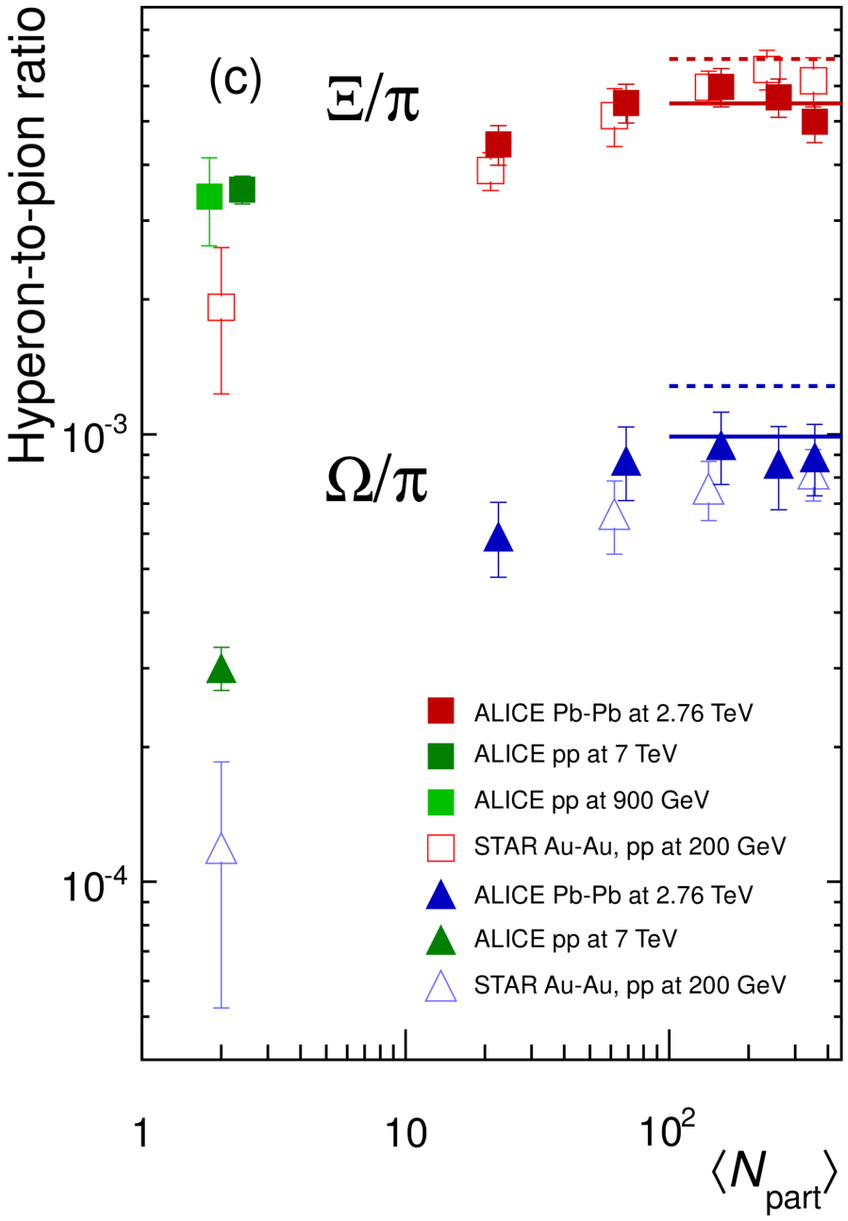
ALI-PREL-145926



ALI-PREL-156893

p and ϕ have similar p_T spectra in central A-A collisions ➧ expected from hydrodynamic mass dependent radial flow BUT also reproduced by models including recombination

Strangeness



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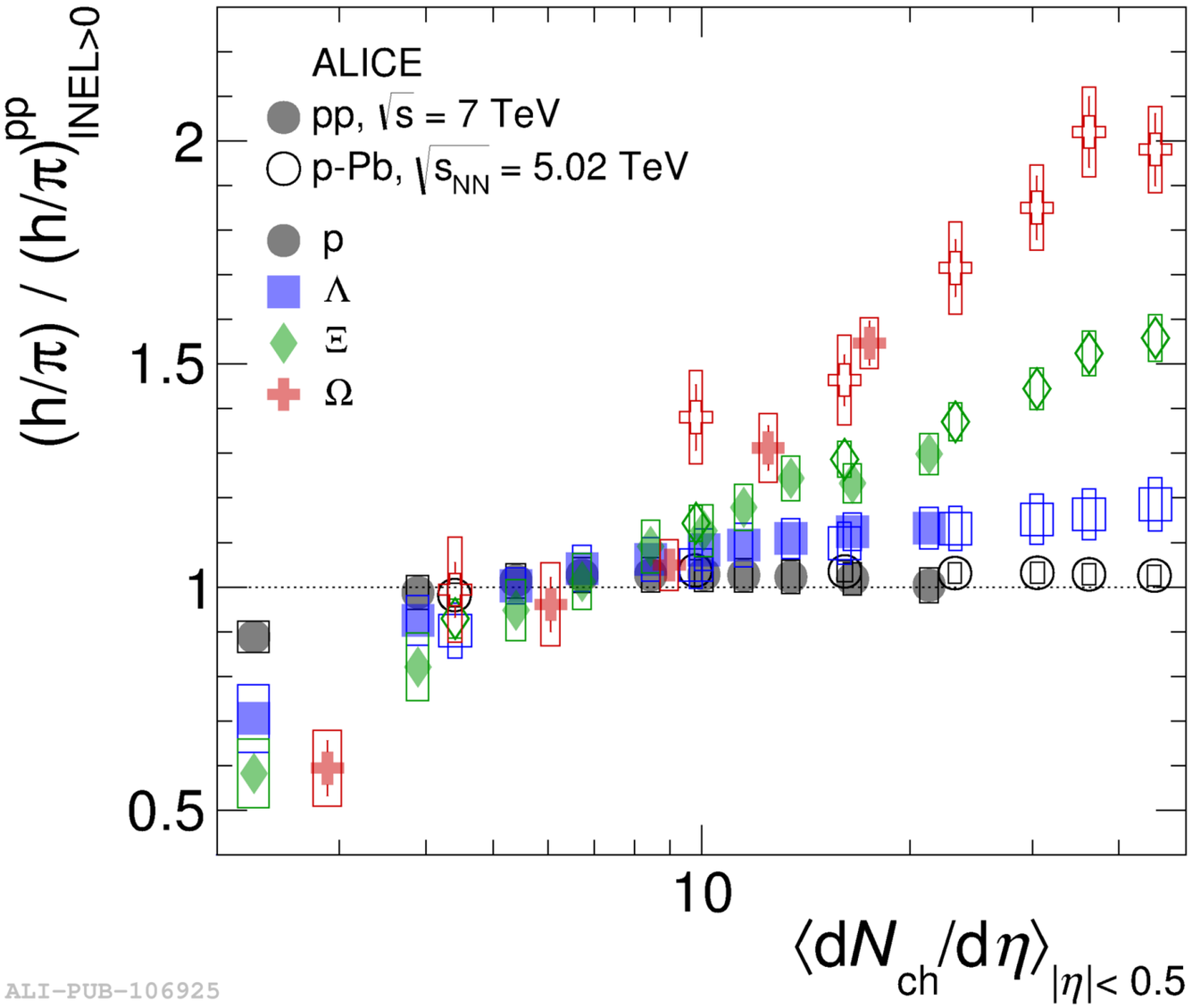

ALI-PUB-106925