LF hadronization summary

LF hadronization summary (P. Christiansen, Lund)

Universität Münster

International Workshop "QCD challenges from pp to AA collisions"

Ideas for new measurements

Baryon-baryon dip

LF hadronization summary (P. Christiansen, Lund)

ALICE, EPJC 77 (2017) 569
arXiv:1612.08975 [nucl-ex]

(c) pp + p̄p̄ pairs

ALICE Preliminary
High-Mult. (0-0.072% INEL)
pp √s = 13 TeV
- pp + p̄p̄
- ΛΛ + Λ̄Λ̄
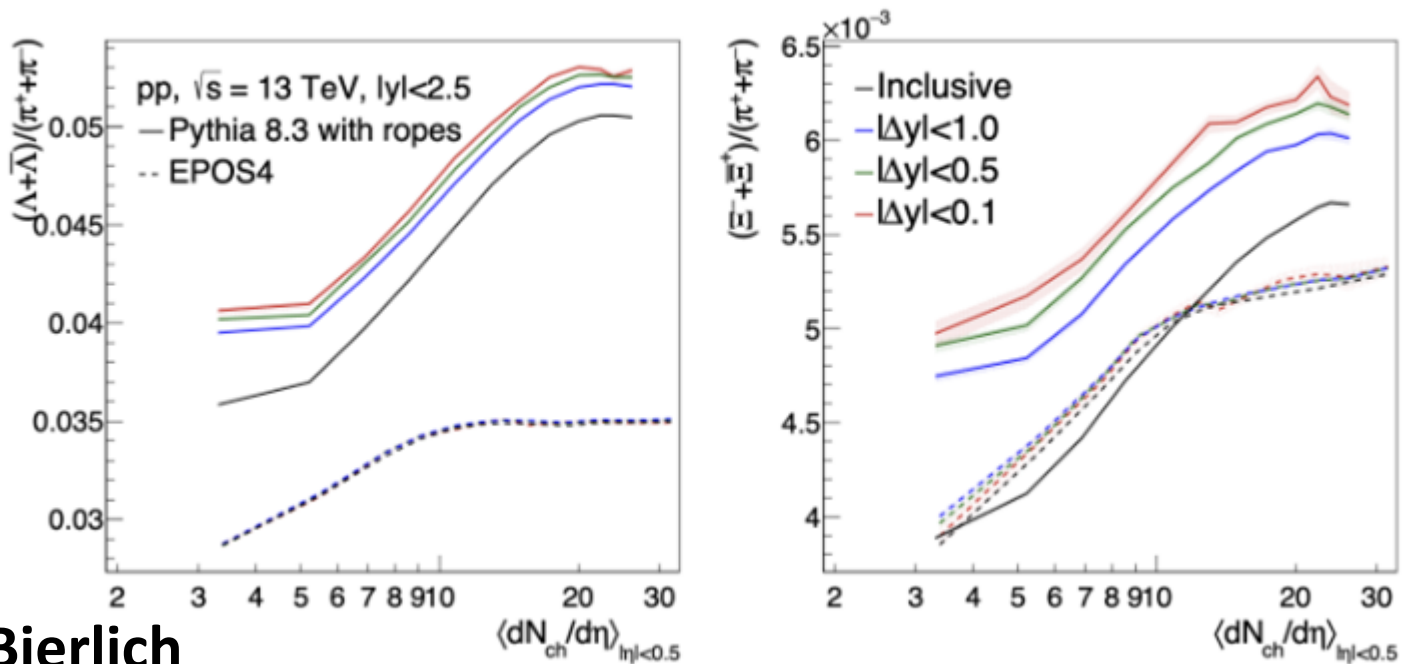- pΛ + p̄Λ̄
- pΞ + p̄Ξ̄
$|\Delta\eta| < 1.3$

ALI-PREL-342616
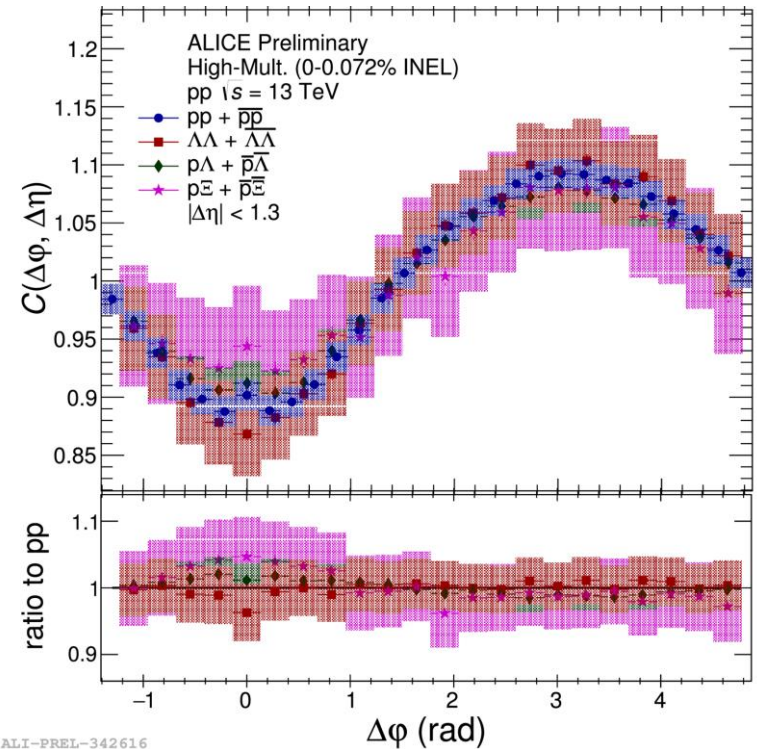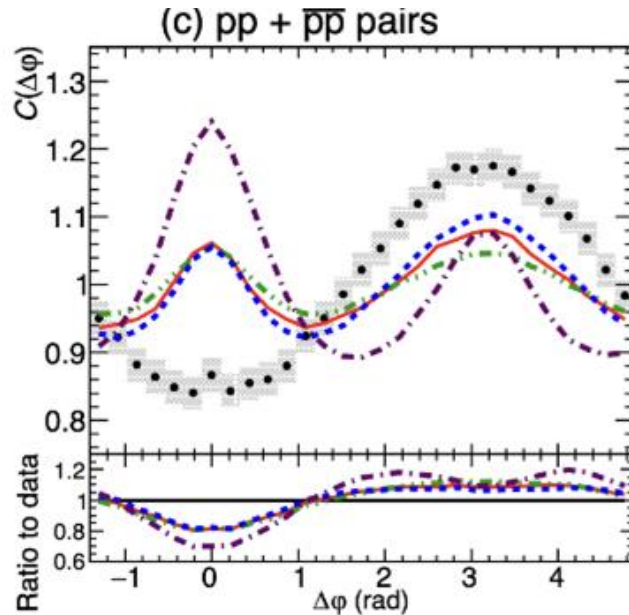
- Appears to be the same for all LF baryon-baryon combinations

- Reduced at high multiplicity?

- Action: Measure this for Λc-protons

- Action: Measure this in e^+e^- if possible!?

Trigger on ɸ and test if it changes other particle reatios

Large deviations — Qualitative, cannot be "tuned away"

C. Bierlich

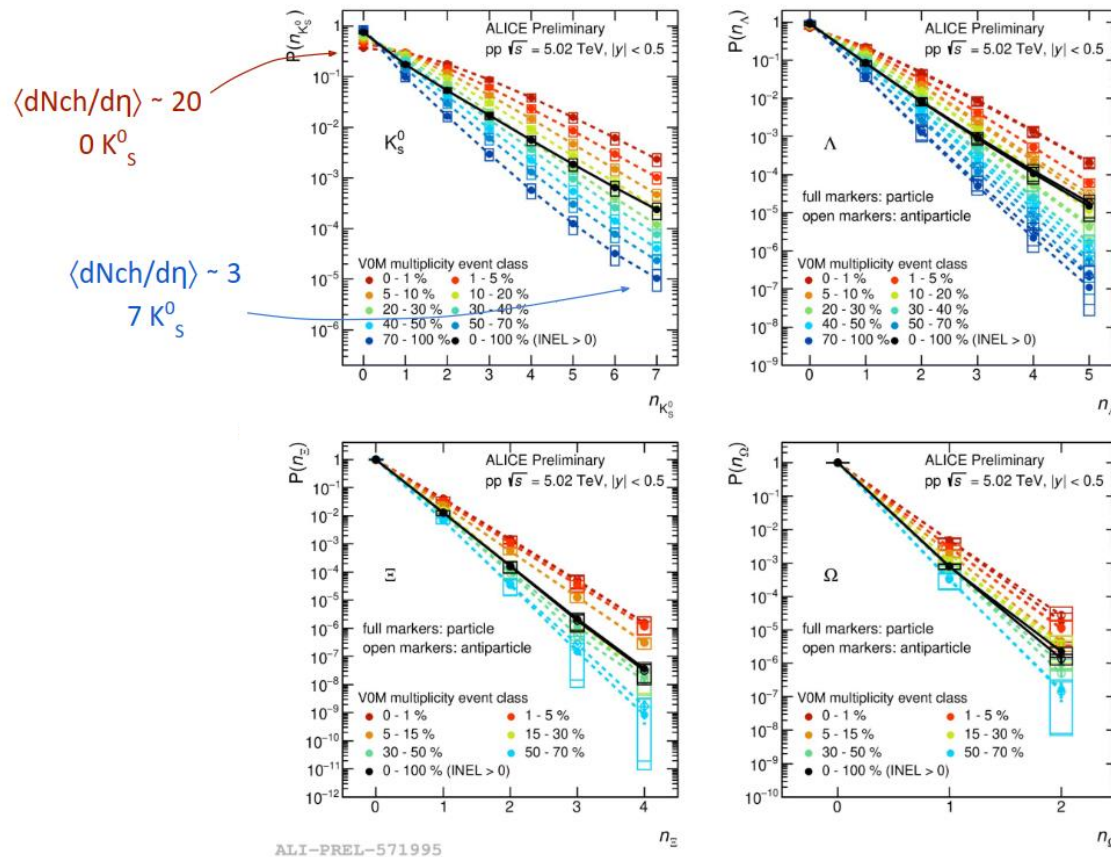With S. Cannito and V. Zaccolo (Trieste), (2403.00511)

- Action: Measure this!
- Action: Can we use this idea for other particles?

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Help needed

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Strange hadron multiplicity vs event multiplicity

LF hadronization summary (P. Christiansen, Lund)

⟨dNch/dη⟩ ~ 20

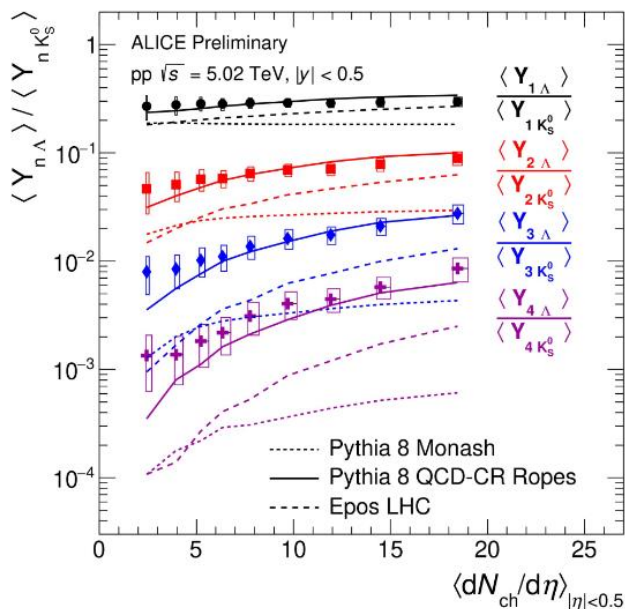0 K⁰ₛ

⟨dNch/dη⟩ ~ 3

7 K⁰ₛ

ALI−PREL−571995

- **Action: How can we extract the most physics from the data?**

Ratios of strange hadrons vs event multiplicity

LF hadronization summary (P. Christiansen, Lund)


ALI-PREL-570749

ALI-PREL-570764

Again, good description by Pythia 8 QCD-CR Ropes which does a good job in re-connecting strange to lighter quarks

Is it all played by QCD-CR or ropes actually plays a role?

Many more ratios to come!

Enhancement with multiplicity not connected to strangeness unbalance (mass? baryon number? ...)

Very well described by Pythia 8 QCD-CR Ropes
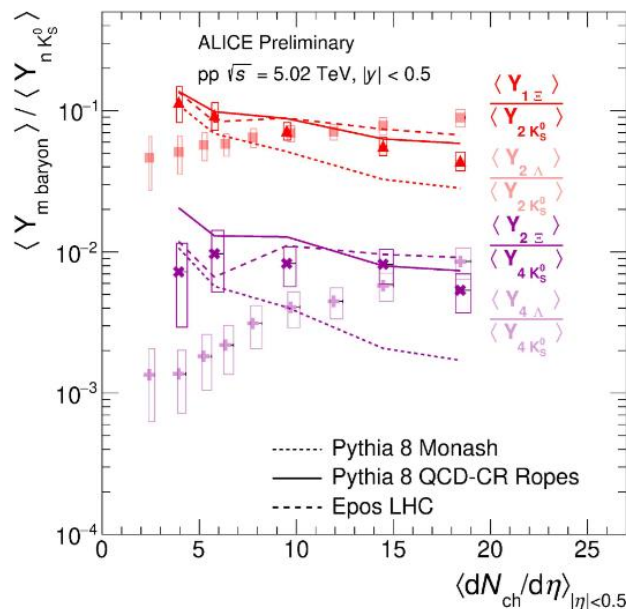
Not mass ($m_\Xi > 2 \cdot m_{K0S}$)
Not baryon number

number of light quarks involved!

- ==Action: What are the best ratios to look at?==

Strangeness enhancement vs S_O (top 1% multiplicity)

LF hadronization summary (P. Christiansen, Lund)
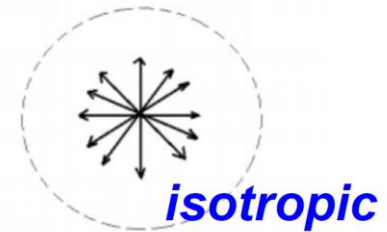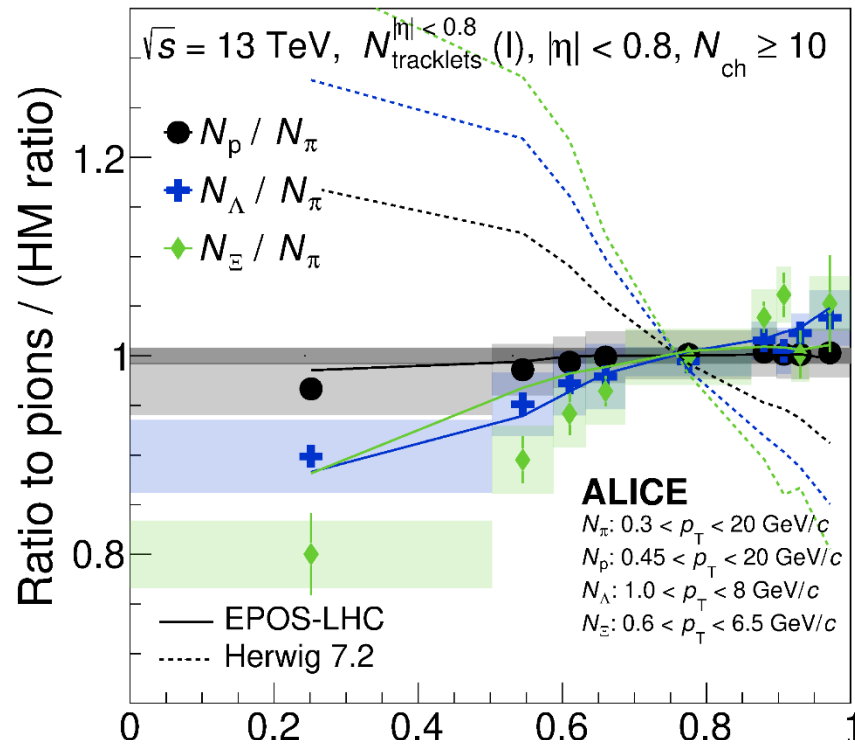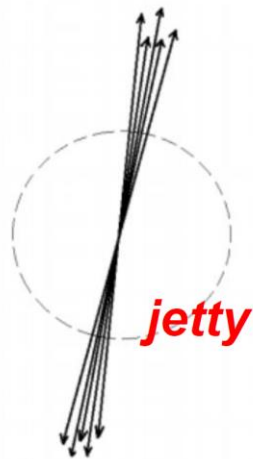
Jetty   Isotropic

- HERWIG has opposite trend?! (explanation on next slide)

Why Herwig is wrong

LF hadronization summary (P. Christiansen, Lund)

S. Gieseke,
P. Kirchgaeßer,
S. Plätzer
Eur.Phys.J.C 78
(2018) 2, 99

jetty   *isotropic*

$0 \longleftarrow S_0^{p_T=1} \longrightarrow 1$
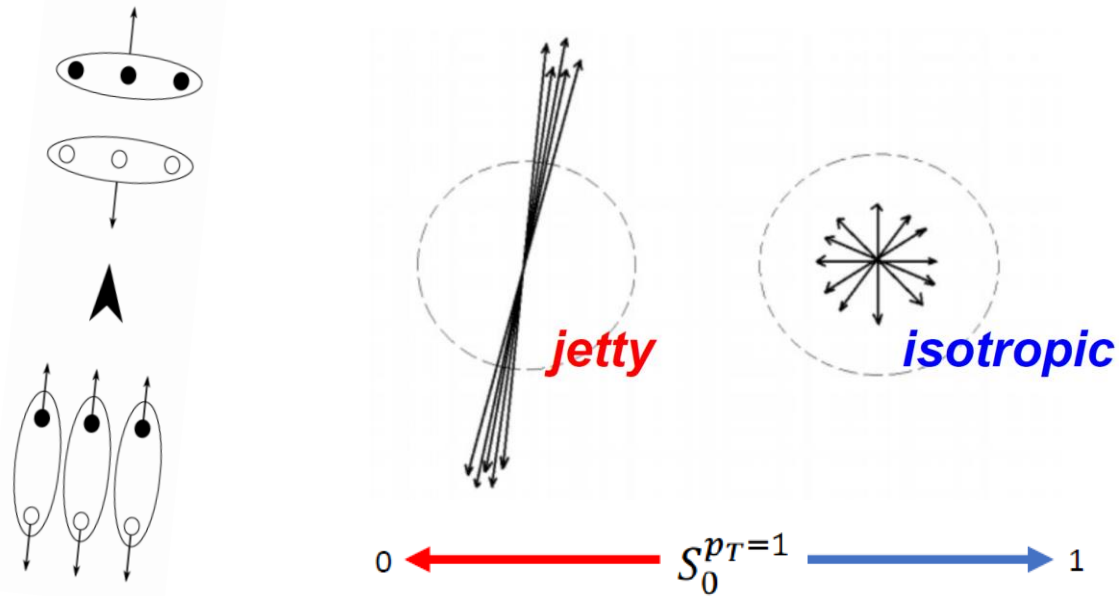
- Herwig produces a baryon enhancement by allowing 3 mesons close in phase space to form a baryon-antibaryon pair
  - But this will be more likely to happen in pencil-like events!
  - Action: What about quark coalescence models?
    - Can we get postdictions for LF and predictions for HF?

Flattenicity a new tool

QpPb → RpPb with flattenicity?

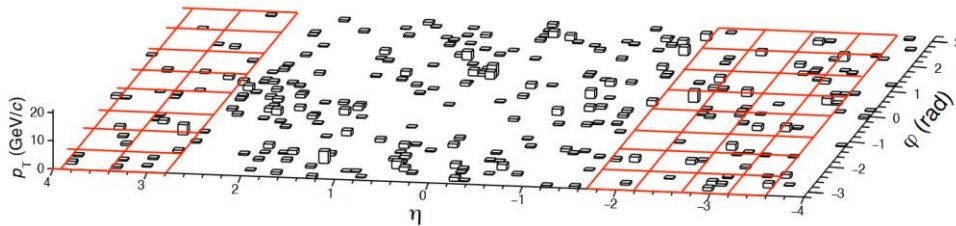LF hadronization summary (P. Christiansen, Lund)

Flattenicity

Event-by-event selection based on the relative standard deviation of the multiplicity measured in the 64 V0 channels, $N^{(ch.i)}$
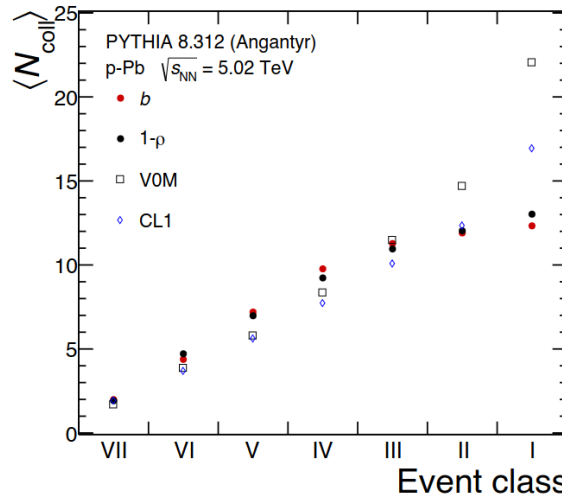
A. Ortiz et al., Phys. Rev. D107 (2023) 7, 076012

$$\rho = \sqrt{\sum_{i}^{64} \left(N^{(ch.i)} - \langle N^{(ch)} \rangle \right)^2 / 64^2} \Big/ \langle N^{(ch)} \rangle$$

PYTHIA 8.303 (Monash 2013), pp $\sqrt{s}$ = 13 TeV, N_{mpi}=24

Flattenicity in p-Pb collisions?

PYTHIA 8.312 (Angantyr)
p-Pb $\sqrt{s_{NN}}$ = 5.02 TeV
- b
- 1-ρ
- V0M
- CL1

Flattenicity in p-Pb seems to be a good candidate to classify the collisions in terms of the centrality

More studies will come

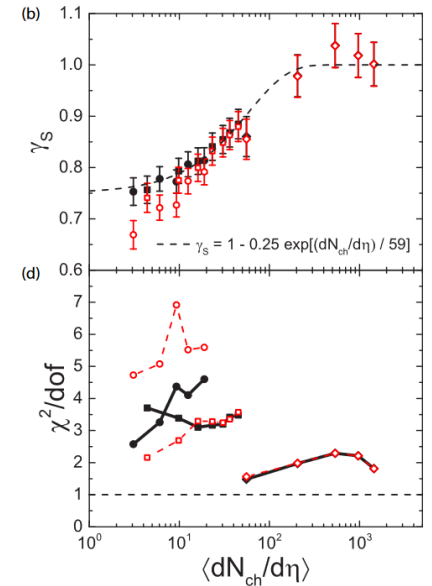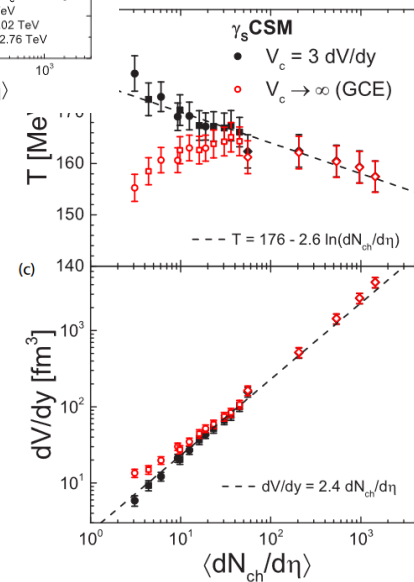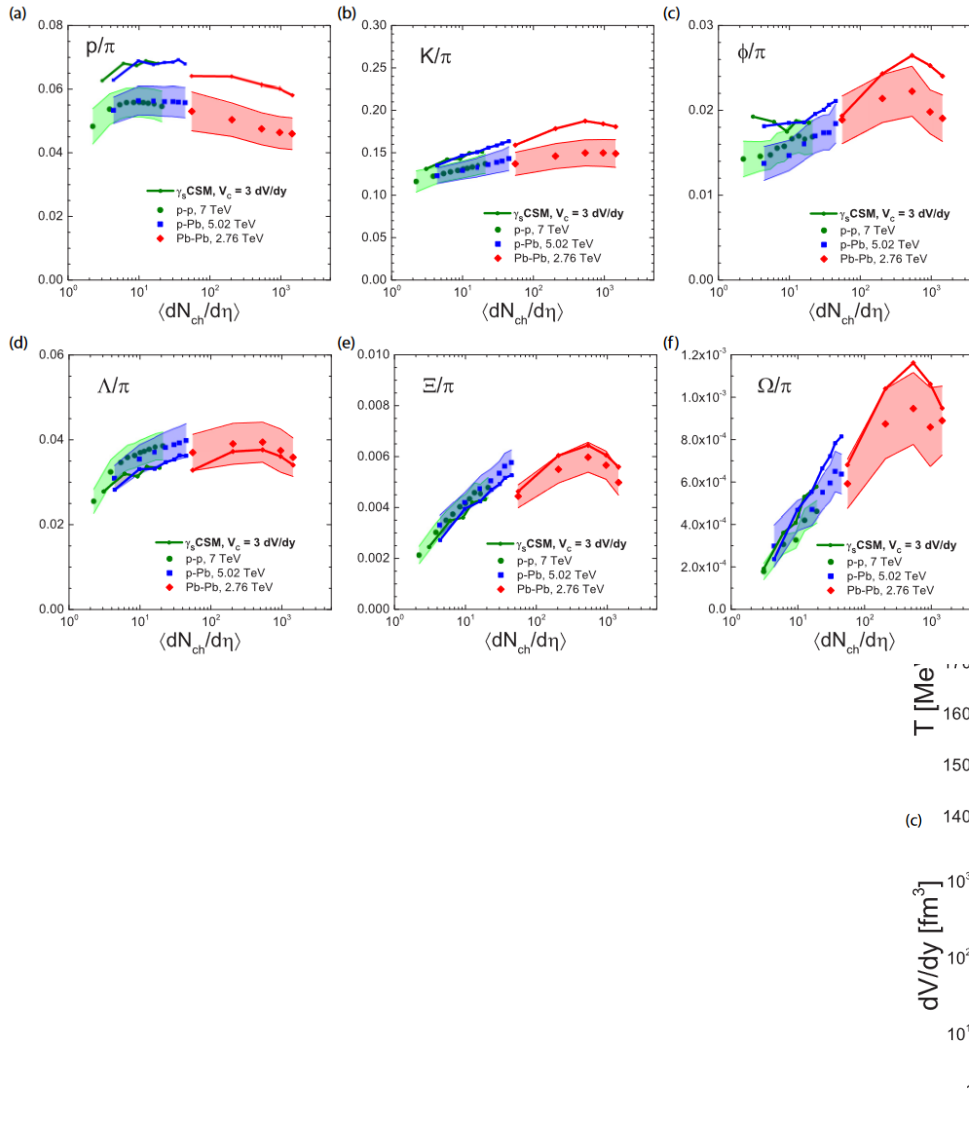- **Action: Can we unlock bias free RpPb and RdAu?**

Antonio Ortiz (ICN, UNAM)

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Is strangeness suppressed in small systems or enhanced in large systems?

FIST: canonical description with γ_s

LF hadronization summary (P. Christiansen, Lund)
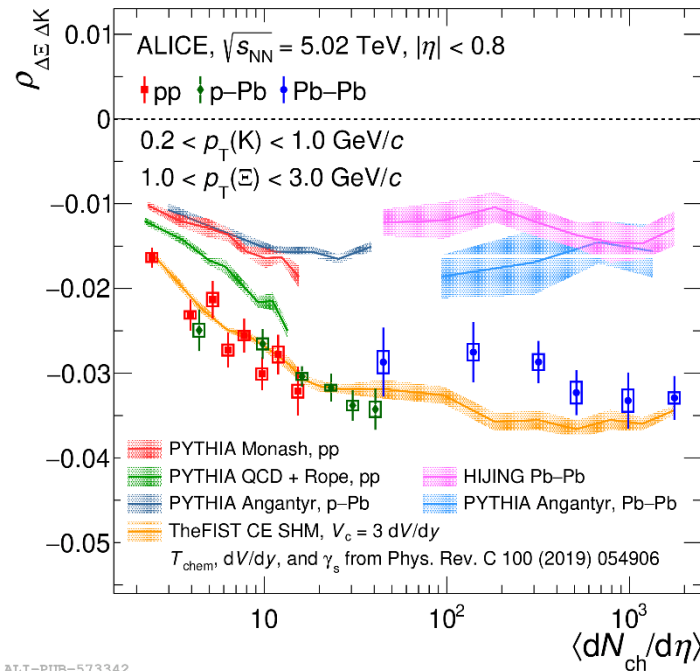

V. Vovchenko,
B. Dönigus,
H. Stoecker ,
Phys.Rev.C 100 (2019)
5, 054906

FIST can also describe correlations between net-Ξ and net-K

ALICE, arXiv:2405.19890

ALI-PUB-573342

- Need wide correlation volume in rapidity!
- Can it describe recent ALICE balance functions?
- Use the same simulations as done in paper above.
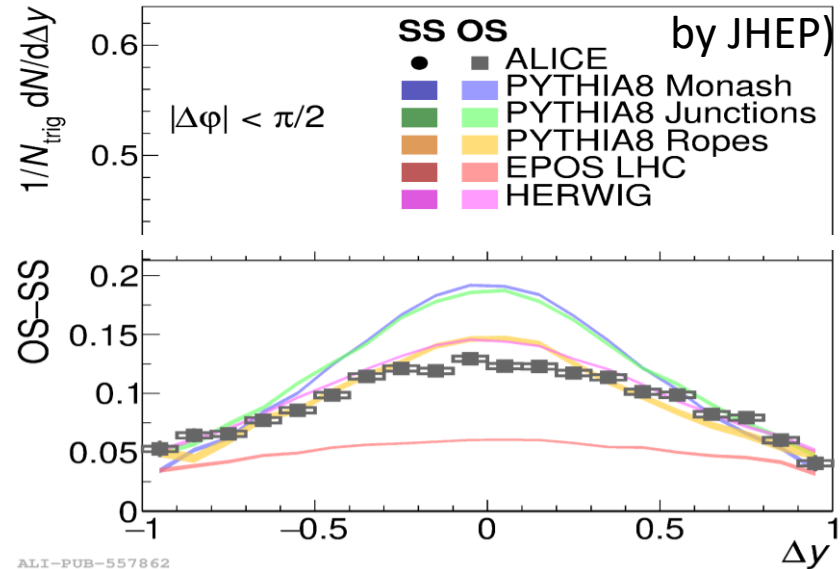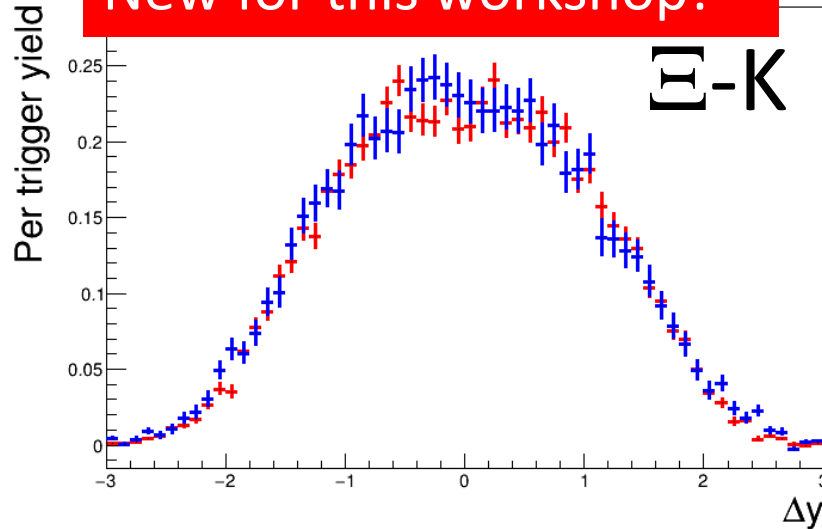 - Trigger on Ξ (same|η| and p_T cuts). No η or p_T cut on balancing particle.

LF hadronization summary (P. Christiansen, Lund)

Ξ-K balance functions:
0-1% vs 40-50% pp 13 TeV

LF hadronization summary (P. Christiansen, Lund)

New for this workshop!

Ξ-K

SS OS
● ■ ALICE
  PYTHIA8 Monash
  PYTHIA8 Junctions
  PYTHIA8 Ropes
  EPOS LHC
  HERWIG

$|\Delta\varphi| < \pi/2$

ALI-PUB-557862

- No multiplicity dependence as in data (not shown) even if the ratio Ξ/K grows by factor 2

- But much wider than in data

  – In fact, more like normal thermal volume

- Action: can we understand this? Better handling of rapidity in model?

Future prospects

LF hadronization summary (P. Christiansen, Lund)

Future prospects: balance functions with charm

Balance function, D⁰D̄⁰

Pythia

Balance function, D⁺D̄⁰

Pythia

LU Bachelors thesis by T. Bonneview Wallstedt

- In minimum bias Pythia, c-cbar pairs are more likely produced through gluon splittings, appear in a nearside peak
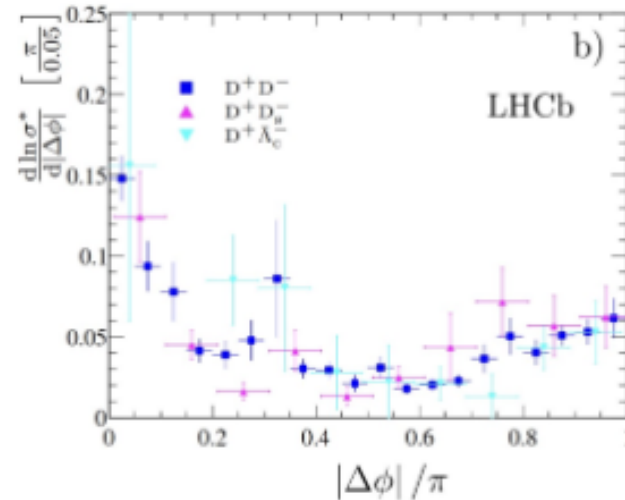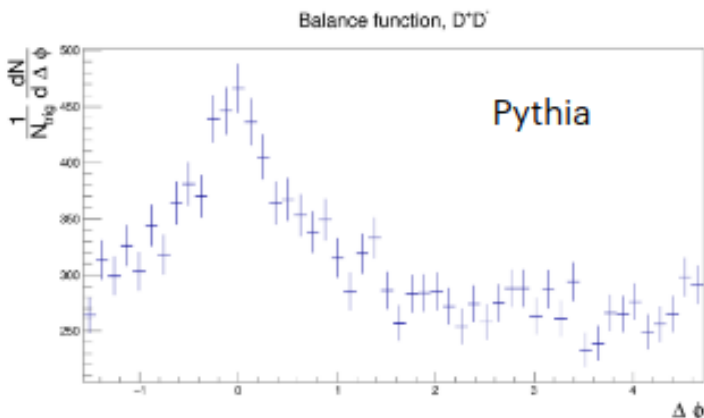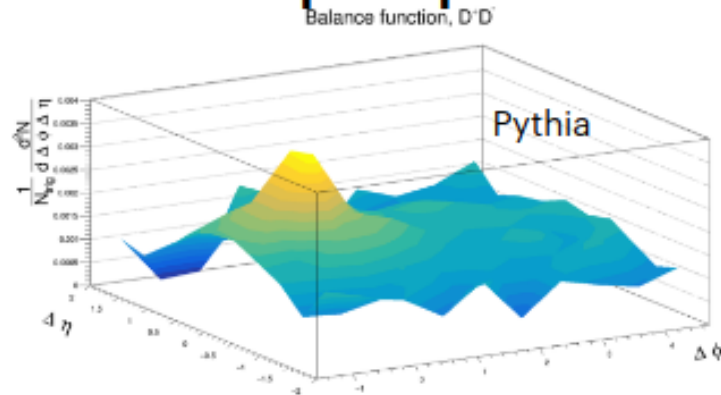
LHCb

LHCb, JHEP 06 (2012) 141
arXiv:1205.0975 [hep-ex]   16

- Action: can we get predictions from coalescence models?

Other ideas

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- Baryon to meson ratios:
  - Can we learn something from the mult depence of LF and HF
  - Can we use the peak behavior vs multiplicity to get a timescale for thermalization for HF?
- Measure particle ratios in jets vs multiplicity?
  - arXiv:2408.06340