Measuring system-size and event-topology dependence of (multi-)strangeness production

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for the ALICE collaboration

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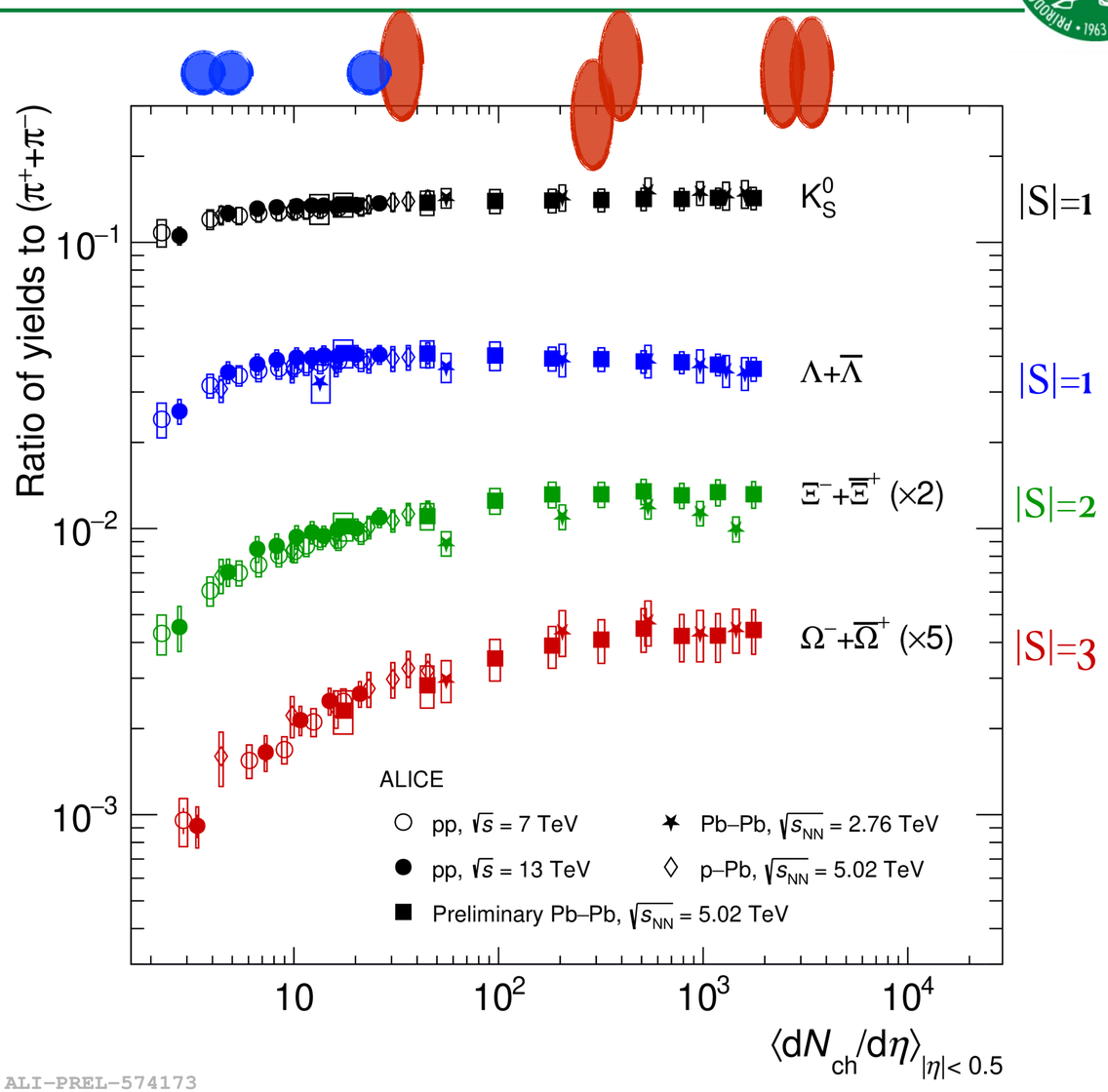
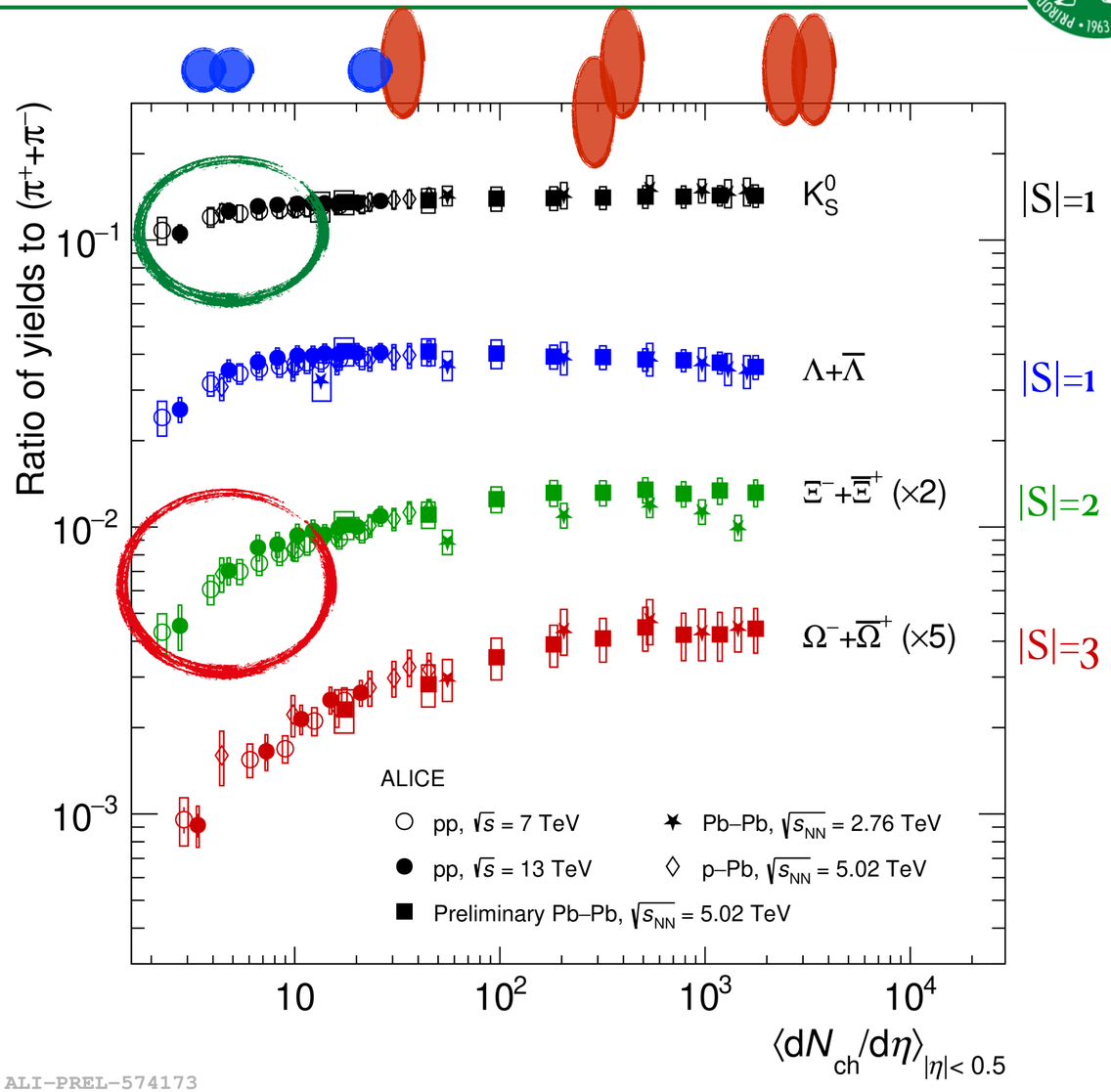
Strangeness enhancement

- Relative increase of relative strangeness production with increasing event activity
  - Smooth evolution across different collision systems
  - Larger for particles with larger strangeness content
- Origin of the increase in pp collisions?



Strangeness enhancement

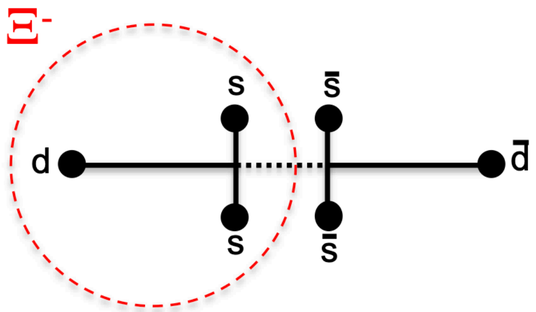
- Relative increase of relative strangeness production with increasing event activity
  - Smooth evolution across different collision systems
  - Larger for particles with larger strangeness content
- Origin of the increase in pp collisions?
  - How big is the contribution of jet hadronisation?
  - Is there a difference between **mesons** and **baryons**?
  - What is the hadronisation mechanism?



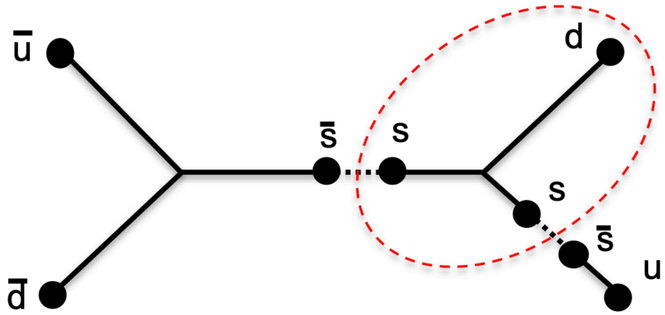
Production mechanisms

- Different models - different strangeness and baryon production mechanisms

PYTHIA8 Monash

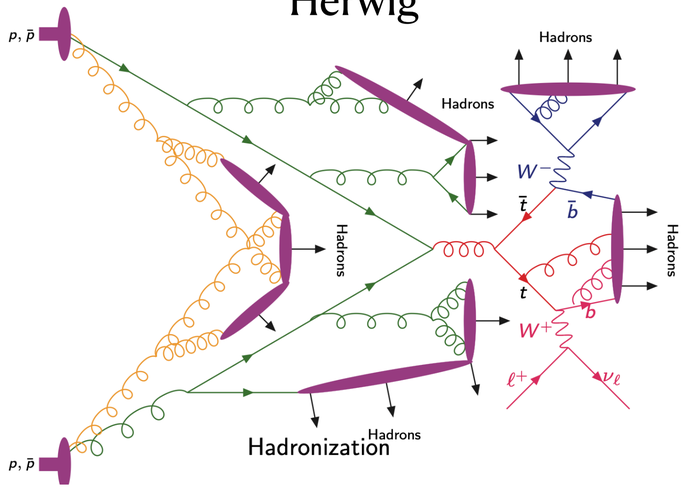


PYTHIA8 Junctions



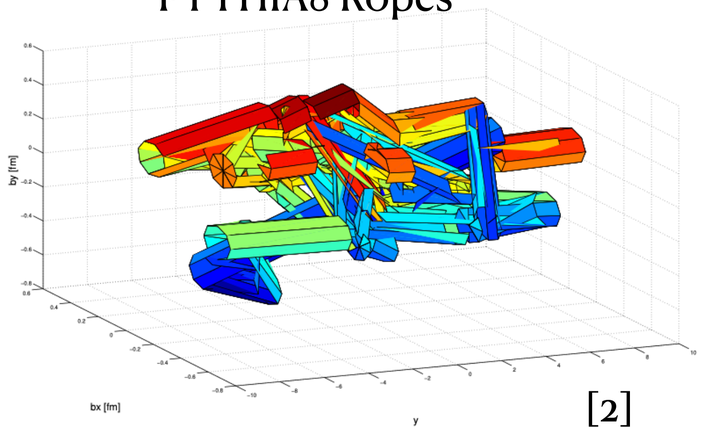
[1]

Herwig



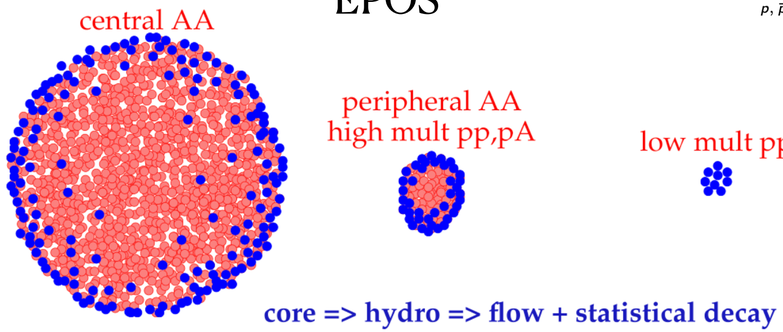
[4]

PYTHIA8 Ropes



[2]

EPOS



[3]

[1] J. Adolfsson et al. Eur. Phys. J. A 56, 288 (2020)

[2] C. Bierlich et al. J. High Energ. Phys. 2015, 148

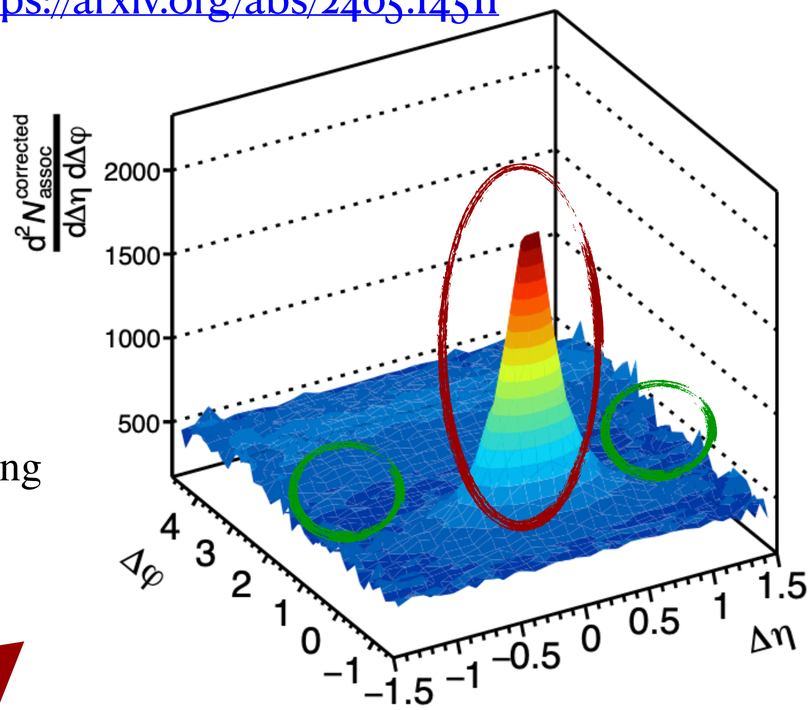
[3] K. Werner. hal-02434245 (2019)

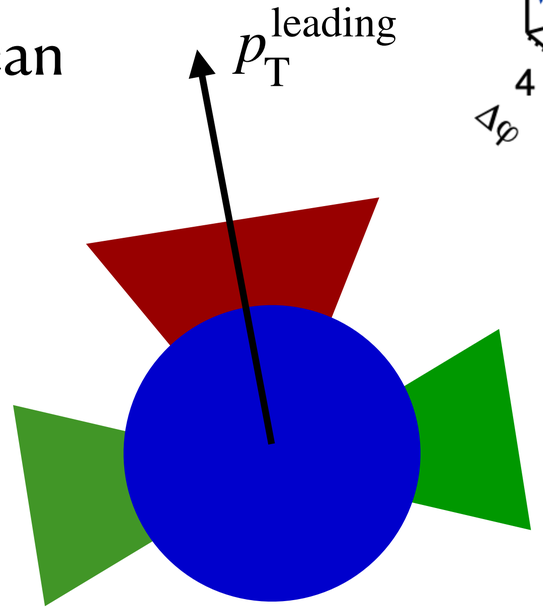
[4] P. Richardson https://indico.cern.ch/event/438776/

Event topology method

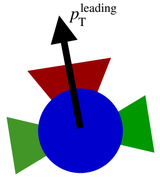
https://arxiv.org/abs/2405.14511

- Event divided into regions w.r.t. the leading track
- Strangeness production measured in all regions
- Contribution from the jet fragmentation can be evaluated





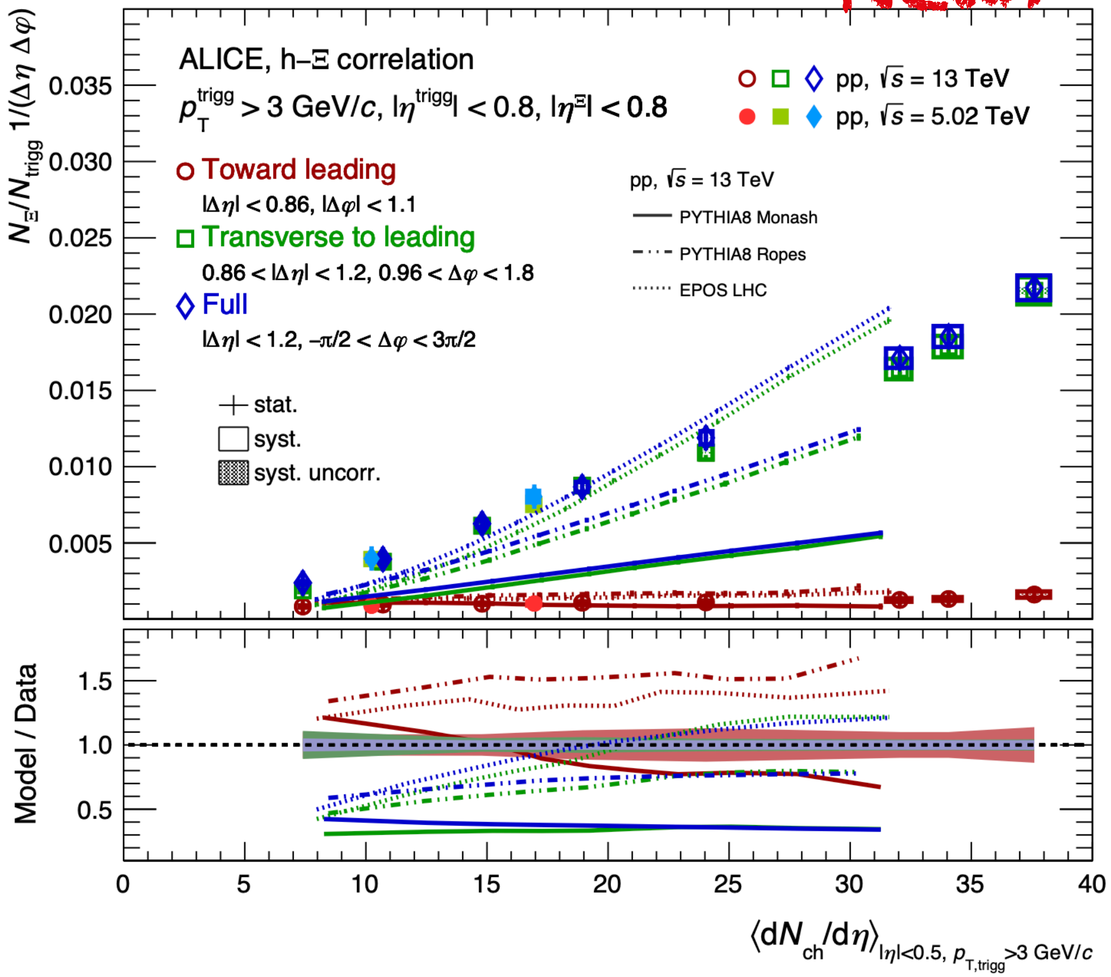
Ξ production w.r.t. leading track



- Transverse to leading production contributes almost exclusively to the full production
- Increase of the transverse to leading and full production qualitatively described by the models
  - EPOS - steeper increase
  - PYTHIA8 underpredicts the data
- Toward leading production overpredicted by EPOS and PYTHIA8 Ropes

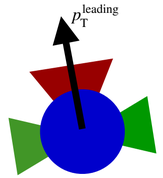
https://arxiv.org/abs/2405.14511

New!



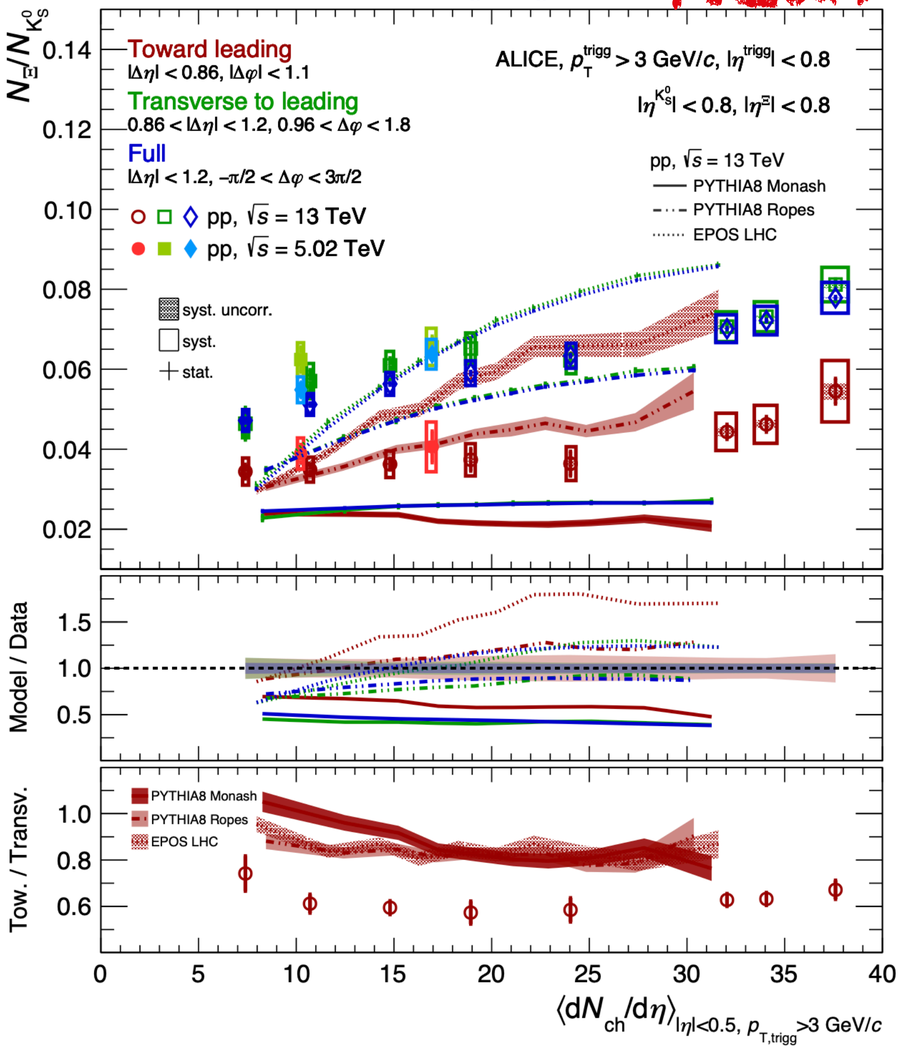
Strangeness enhancement w.r.t. leading track

$$\frac{\Xi}{K^0_S} : \frac{|S| = 2}{|S| = 1}$$



https://arxiv.org/abs/2405.14511

New!



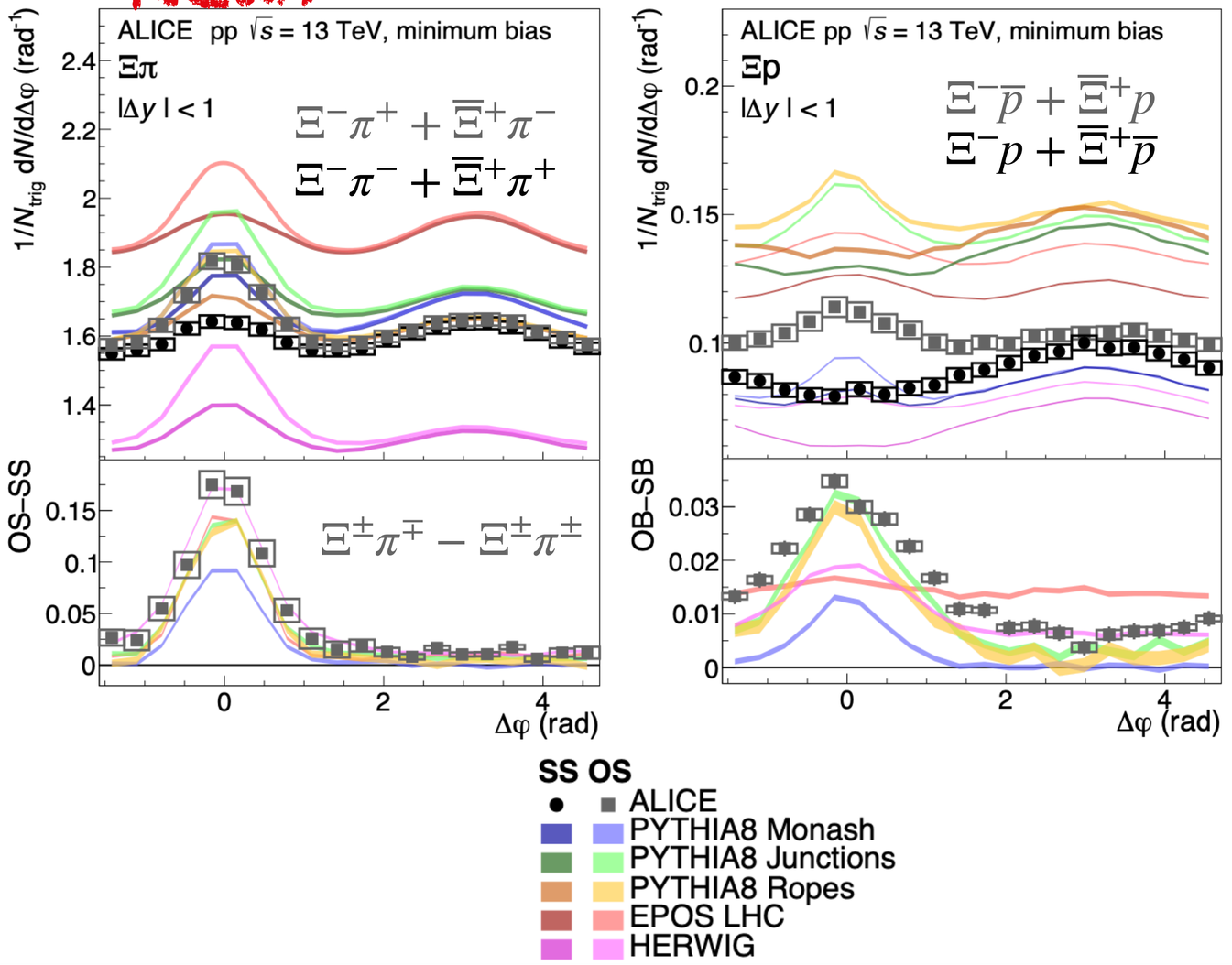
- Increasing trend in all regions
- The increase is similar in toward and transverse to leading region
- PYTHIA8 Monash - constant ratio with multiplicity
- EPOS and PYTHIA8 Ropes - steeper enhancement with multiplicity in the toward region

Ξ-hadron correlations

- Study of hadron production associated to Ξ
- Same sign resp. same baryon number correlations
- Opposite sign resp. same baryon number correlations
- Difference - proxy for Balance function
  - The uncorrelated part is subtracted
  - Show how the Q and B is balanced

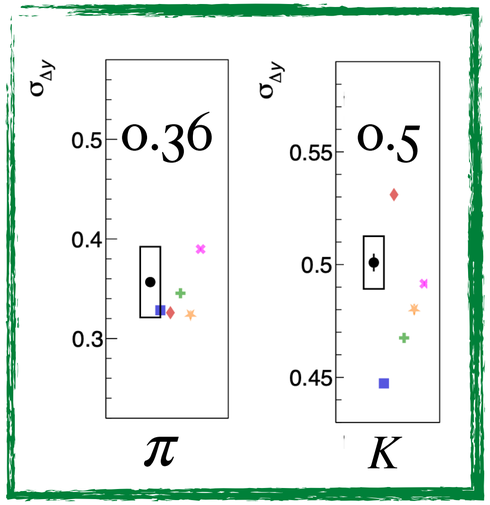
New!

https://arxiv.org/abs/2308.16706



Ξ-meson correlations

- HERWIG can describe the balance of Q and S
- EPOS - full decorrelation of S, but local balance of Q
- Near side peak of $\Xi^{\pm}K^{\mp}$ is **wider** than $\Xi^{\pm}\pi^{\mp}$
  - Diffusion of *s* quark?
  - Quark mass difference?



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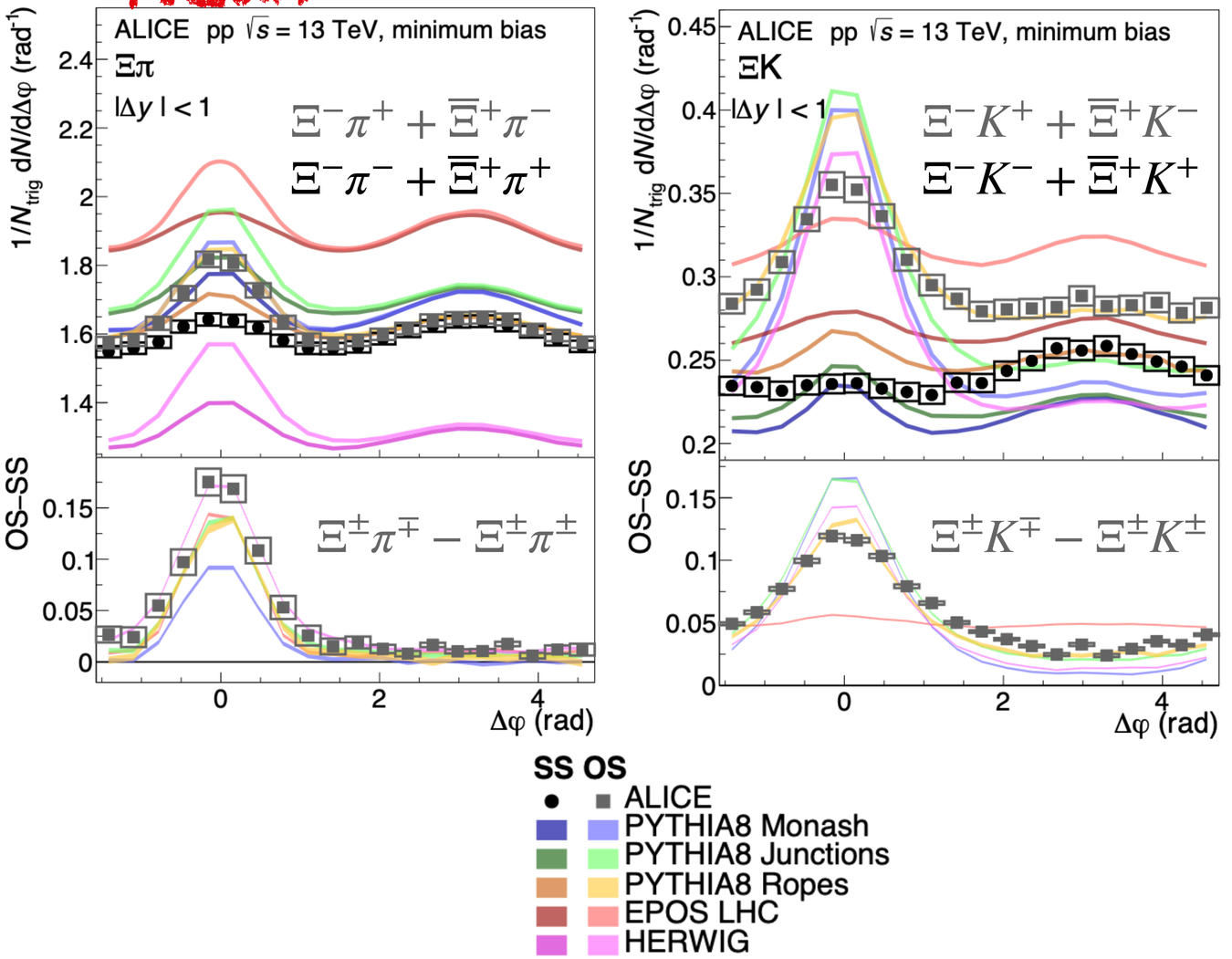
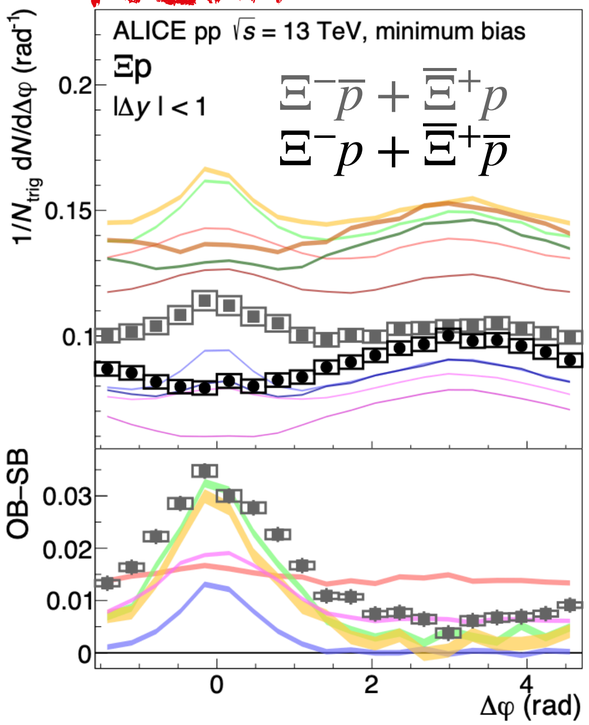
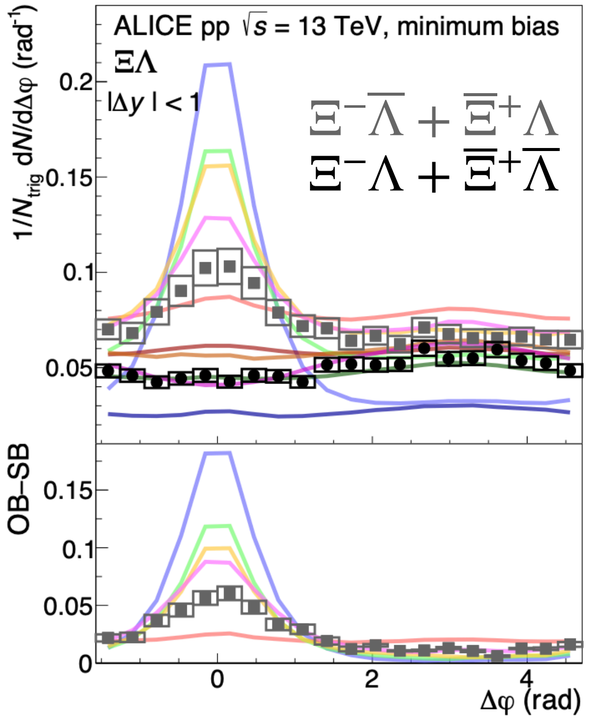


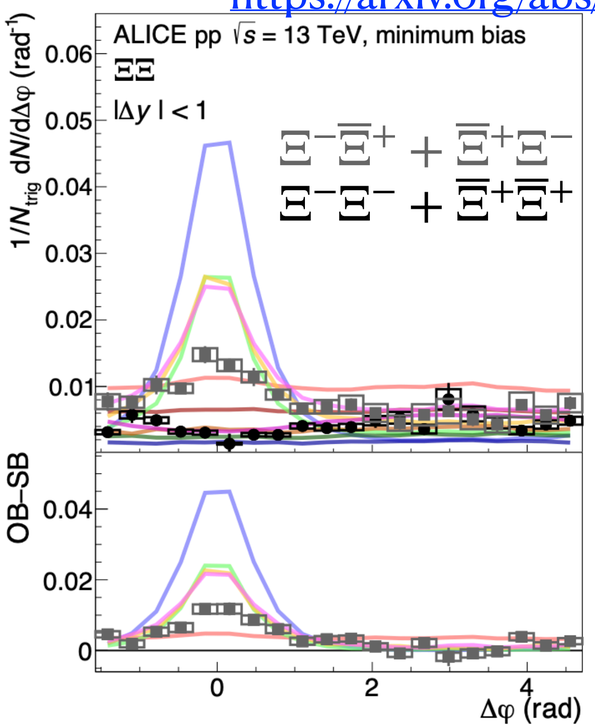
Ξ-baryon correlations

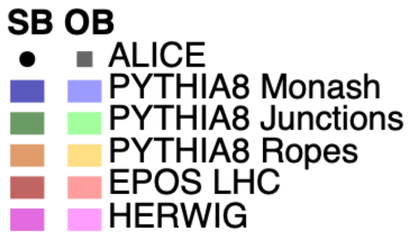
New!

https://arxiv.org/abs/2308.16706









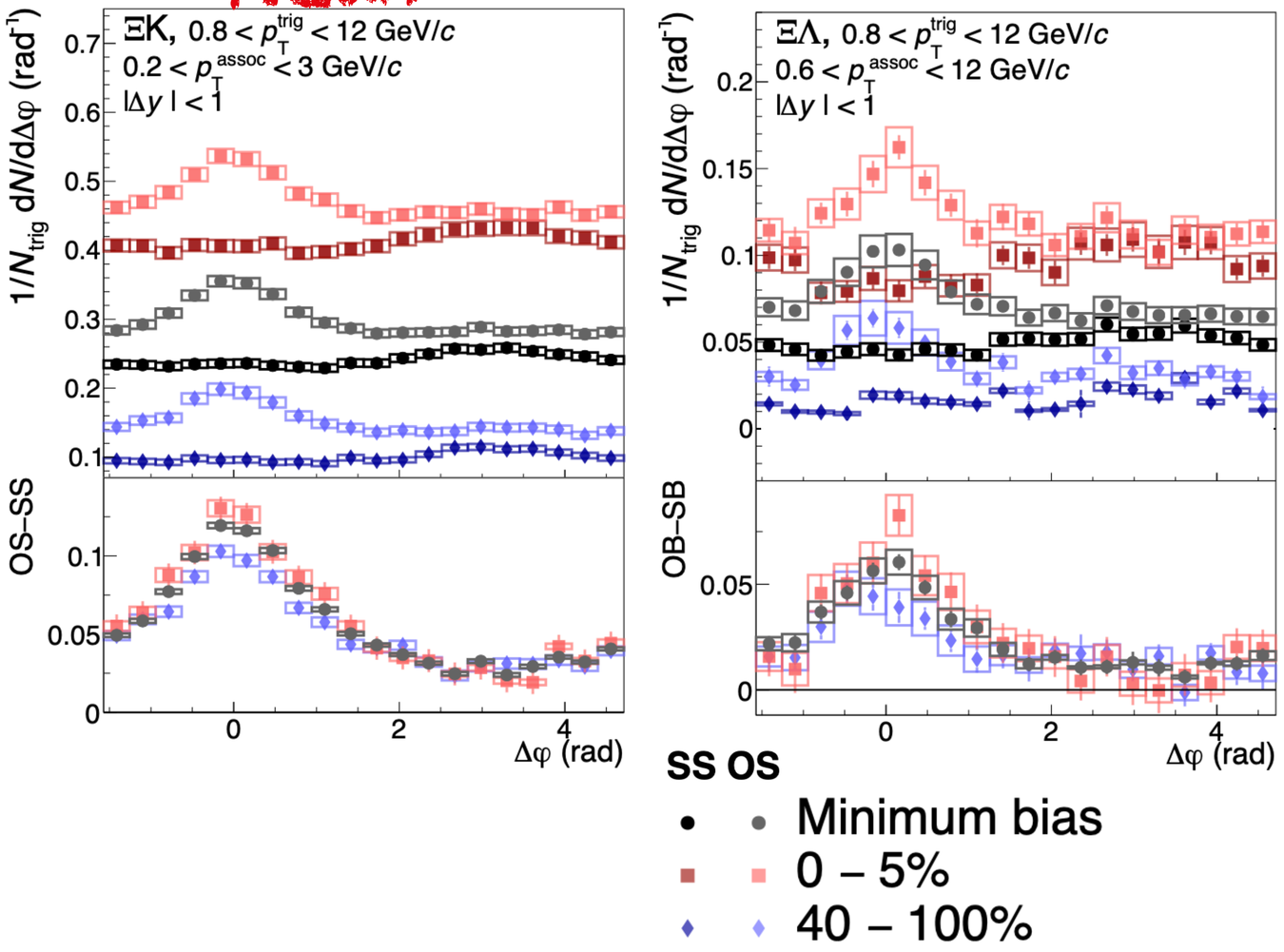
- PYTHIA8 Monash - more short-range correlations of S
- EPOS - full decorrelation: B and S
- Junctions and Ropes - good balancing of B, but not S
- Depletion for SB (observed also for pp) - described only with Herwig

Ξ correlations vs multiplicity

- Strangeness and charge is more balanced by mesons
- With multiplicity:
  - The uncorrelated production increases
  - Only tiny increase of the correlated production
  - Similar for mesons and baryons
- **No evidence** of multiplicity dependence

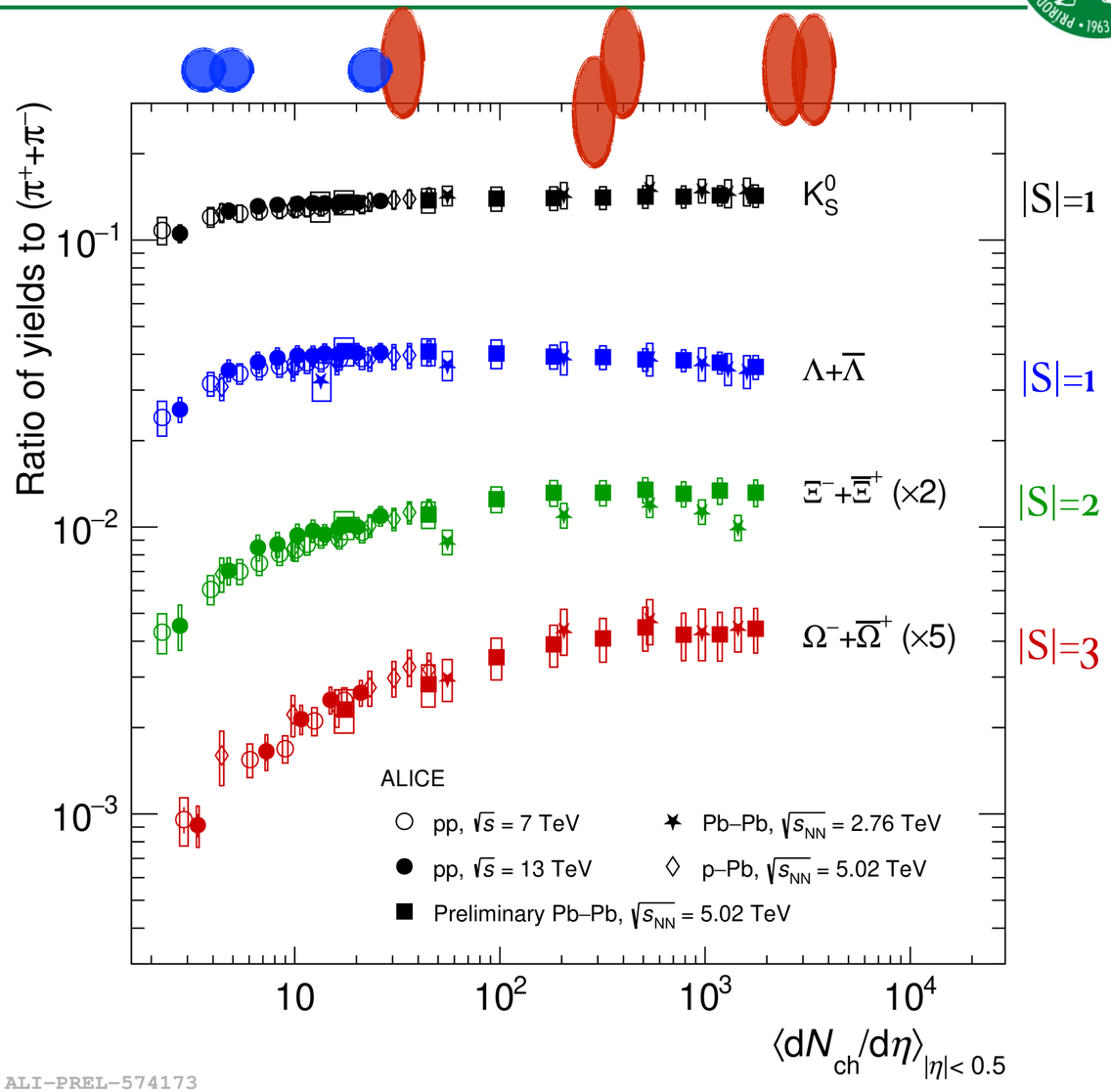
New!

https://arxiv.org/abs/2308.16706



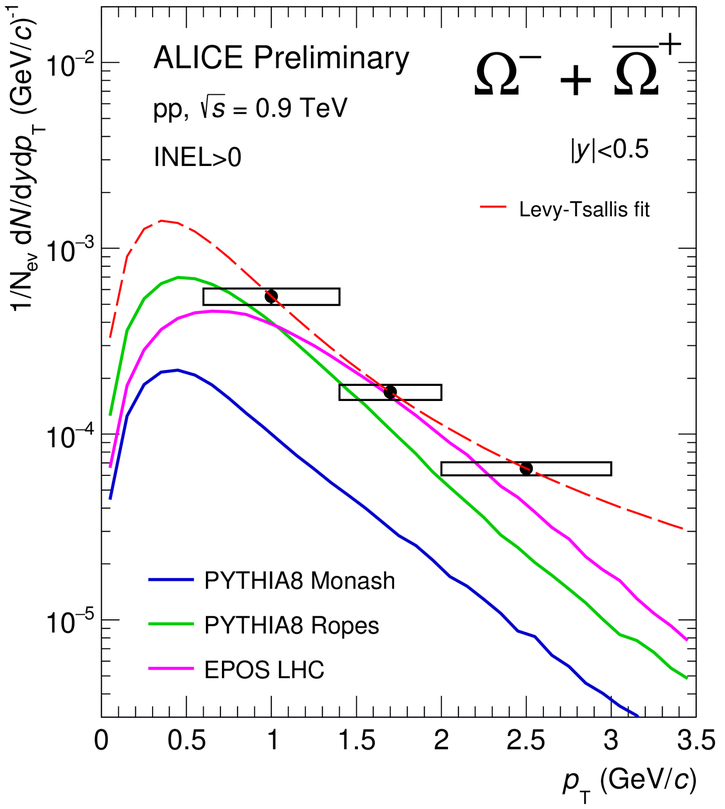
Strangeness enhancement II

- Filling the gaps at other energies and multiplicities is important for the full picture
- With Run 3 - unprecedented statistics
  - 800 times more for pp



Ω production in pp collisions

- **First** Ω yield measurement in INEL>0 pp collisions at 900 GeV at the LHC
  - Completing results from Run 1
- **Unprecedented** multiplicity differential study of Ω production in pp collisions at 13.6 TeV
- **Hardening** of the Ω p_T spectra with increasing multiplicity



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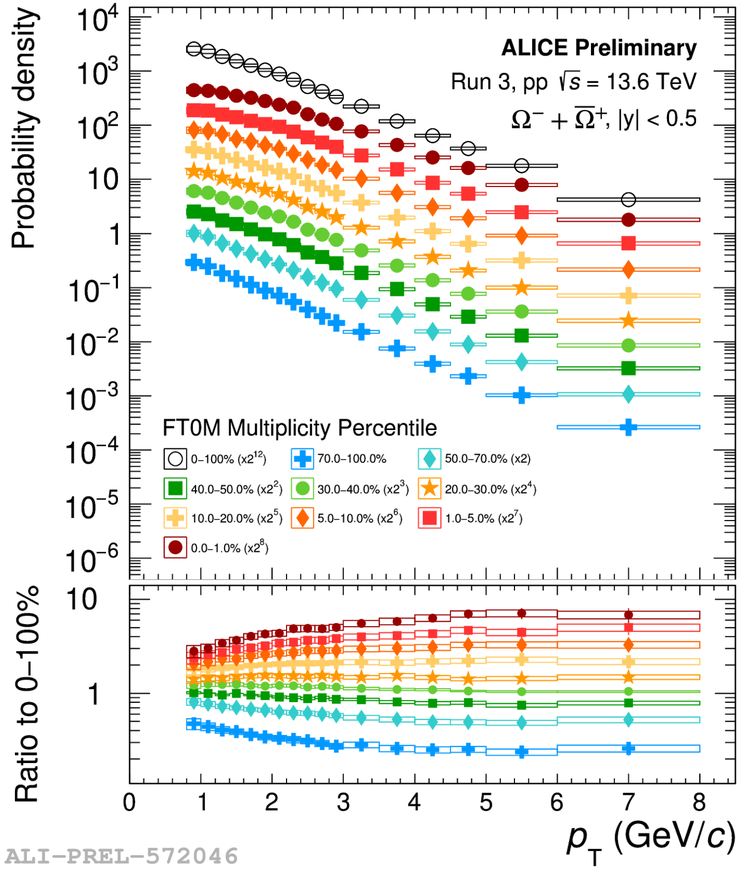
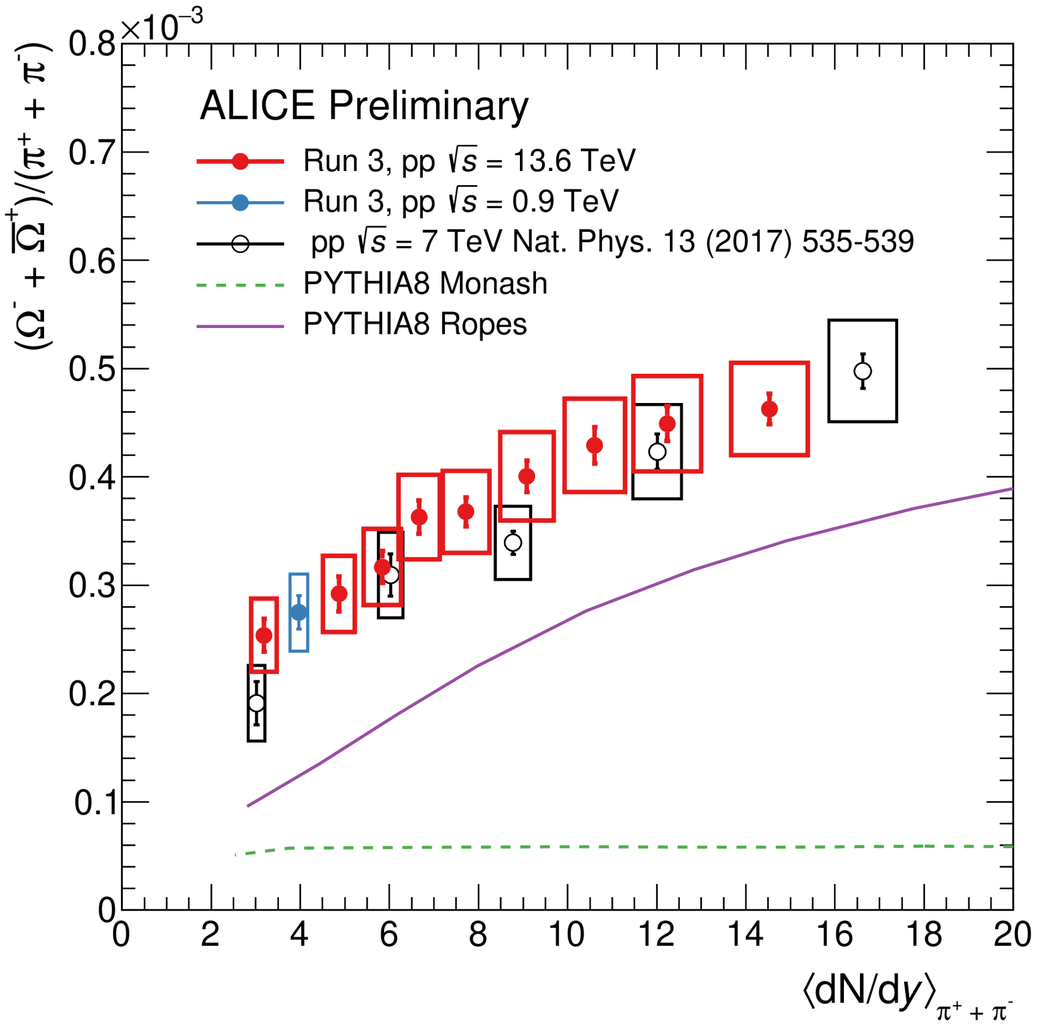


ALI-PREL-572046

Ω/π vs multiplicity

- New results aligned with the Run 1 results
- Qualitative description by the PYTHIA8 Ropes
- No enhancement predicted by PYTHIA8 Monash
- **Run 3 statistics** will allow to extend this study to even higher multiplicities!
  - MB pp sample (these results) + software triggers to select events containing multi-strange hadrons



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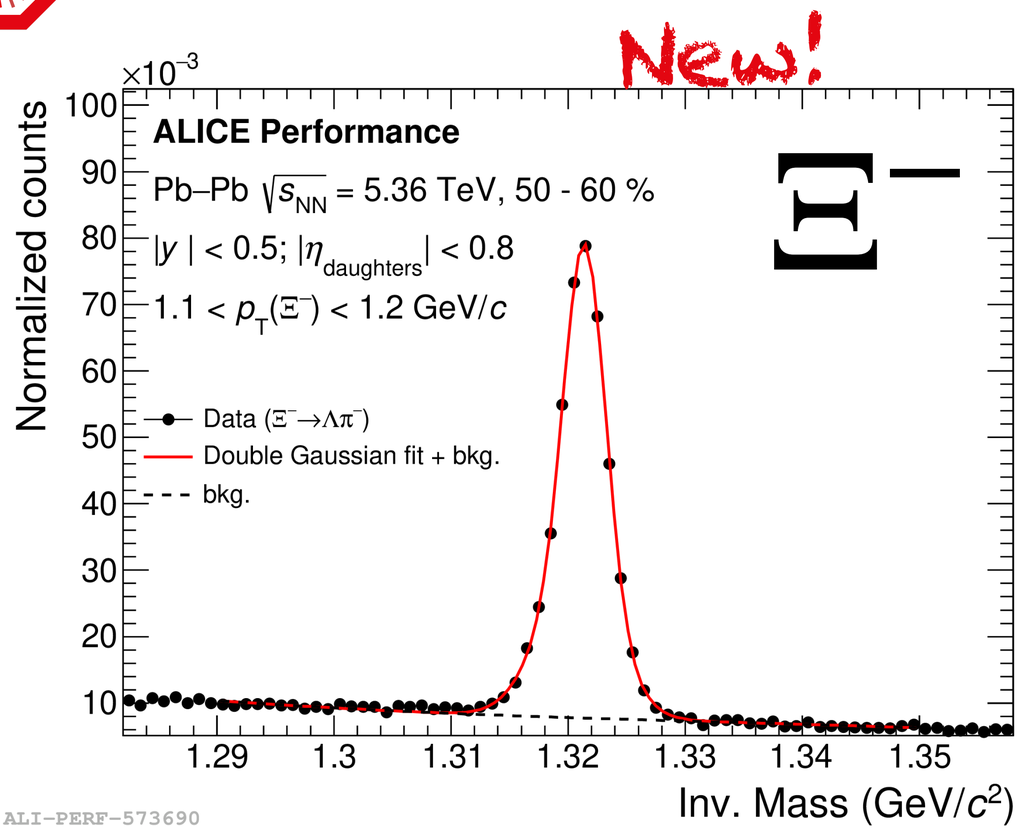
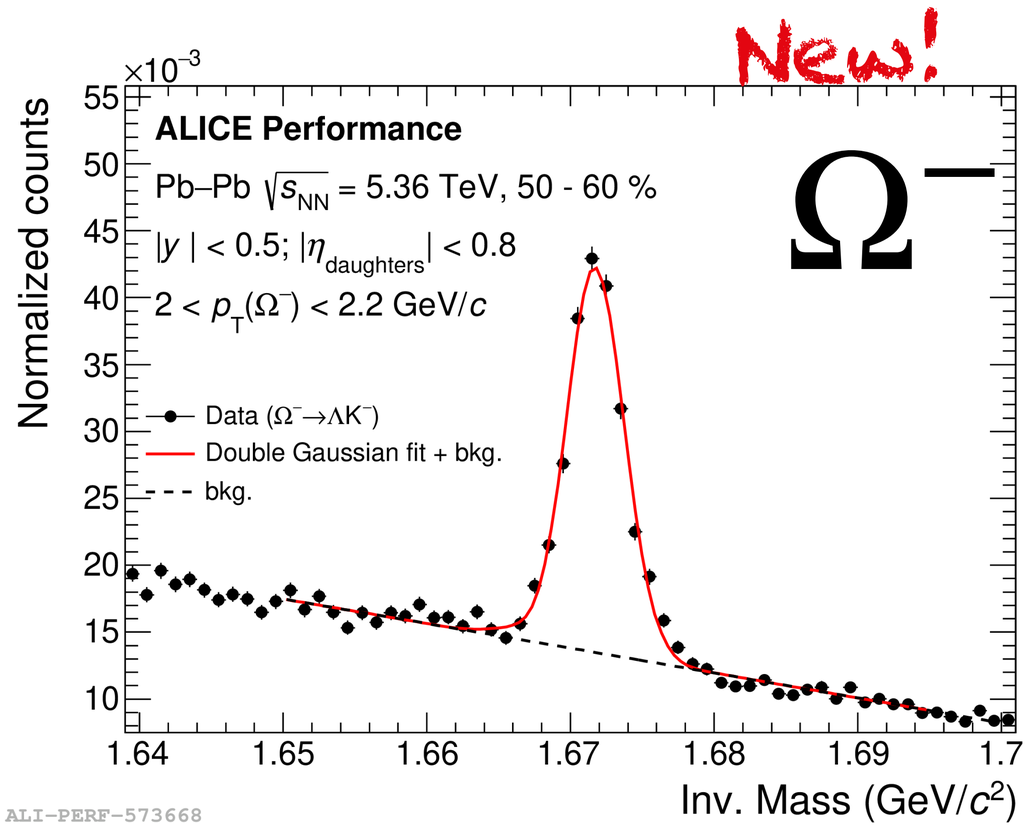
Increased precision in Pb—Pb





- **Excellent performance** for strange hadron reconstruction with ALICE in Run 3!
- **Wealth of statistics** allows performing fine p_T- and centrality-differential studies in Pb—Pb collisions

Conclusion and Outlook

- Strangeness production measurements continue at new energies with Run3 data
- **Strangeness enhancement** with multiplicity is observed both in the **toward-leading** and **transverse-to-leading** regions
  - **Transverse-to-leading** region is the dominant for the full production
- Locally correlated $s\bar{s}$ production in pp collisions overestimated by **string breaking** models and underestimated by models with **thermalised medium**
  - No clear production mechanism established yet

New measurements profiting from the large amount of data that ALICE is collecting during Run 3 continue.

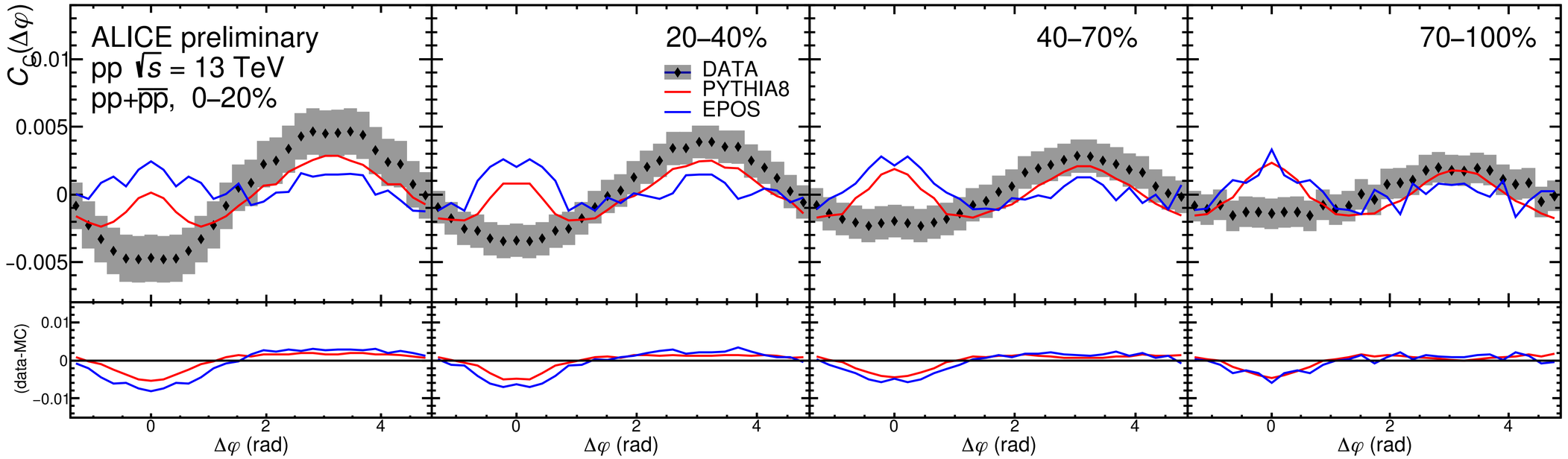
Stay tuned!

Thank you for your attention!

Questions

Back up

Proton-proton correlations



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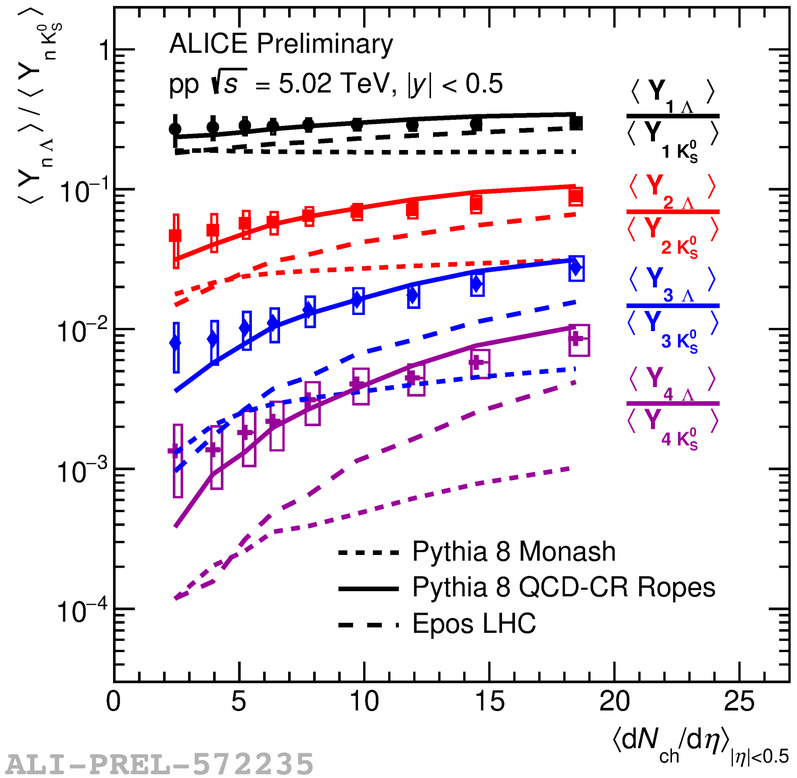
- The near-side depletion can not be described neither by PYTHIA nor EPOS

Baryon/meson production

- Test of hadron production at fixed S and with different light quark content
- **High multiplicity**: it is simpler to pair *s*-quarks with light quarks (very abundant)
- **Low multiplicity**: the shortage of light quarks enhances the probability of multi-strange baryon formation



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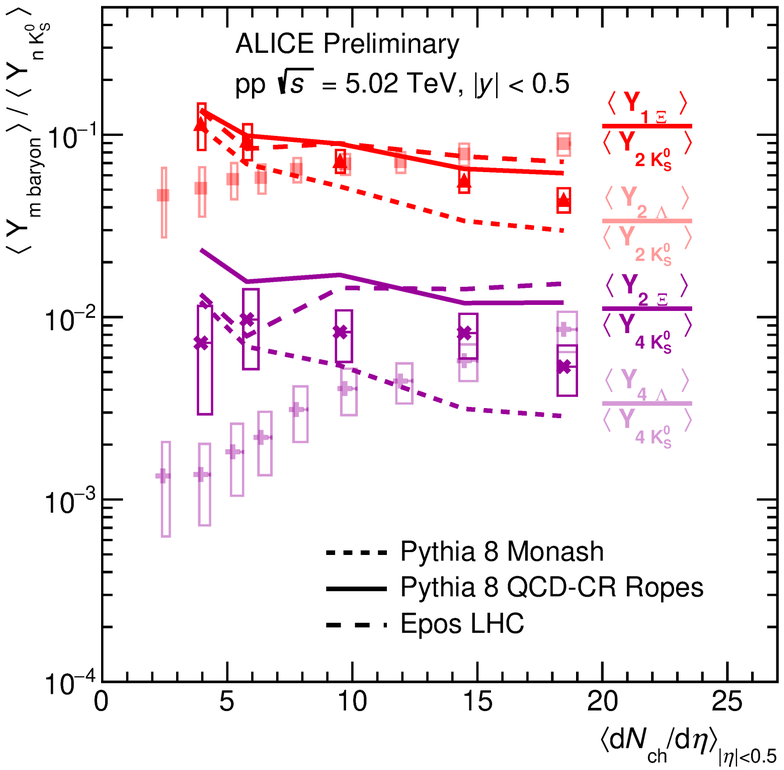

- All trends are rather well reproduced by Pythia 8 QCD-CR Ropes
- Would partonic coalescence be a viable approach here?