Measurement of the full probability density function for the production of (multi-)strange hadrons in pp collisions at √s = 5.02 TeV with ALICE

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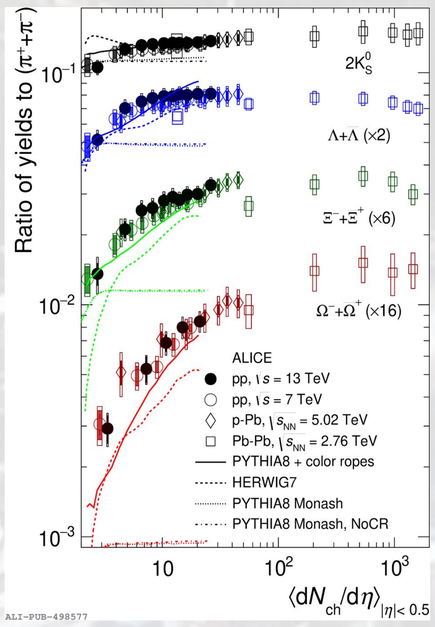
Physics Motivation

Strangeness Enhancement (SE): [1]

- S/π increases as a function of multiplicity compatible across √s and collision systems
- Enhancement proportional to the strangeness content in the hadron

→ More insightful information about the production of (multi-)strange particles: full **Probability Density Function (PDF)**

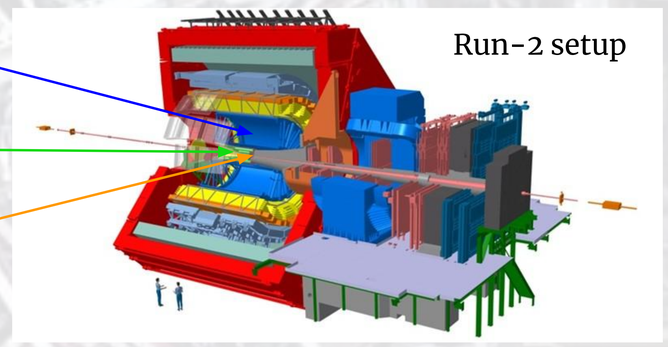
- Extend beyond the average of the distribution
- Unique opportunity to test the connection between charged and strange particle multiplicity production



Time Projection Chamber (TPC)
Gas filled detector
tracking, PID (dE/dx)

Inner Tracking System (ITS)
6 layers of silicon detectors
triggering, tracking, vertexing, PID

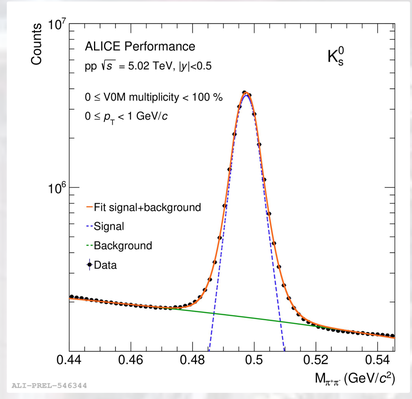
V0 detectors (V0A, V0C)
Forward-rapidity arrays of scintillators
triggering, particle multiplicity estimation

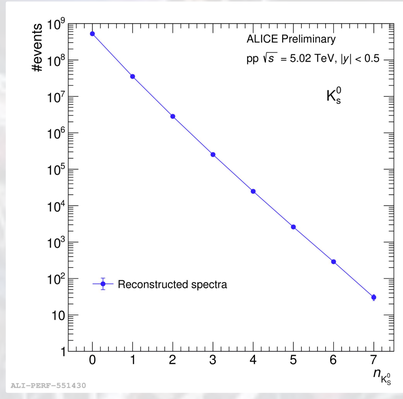


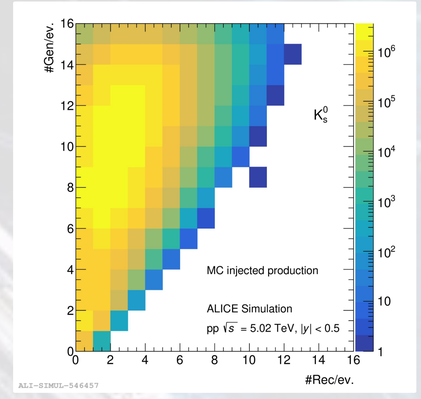
Analysis technique

Analysis based on counting the number of strange particles event-by-event in pp collisions at √s = 5.02 TeV

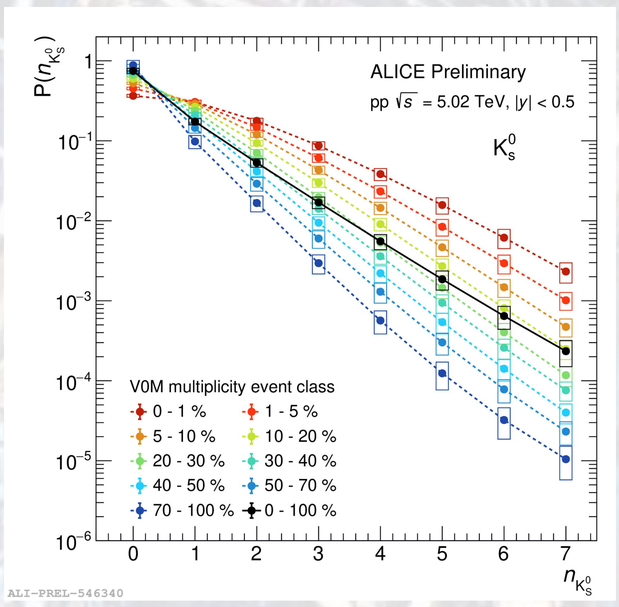
- Each candidate weighted by *P*(S) or *P*(B) estimated by 1D invariant mass fit in p_T/multiplicity bins
- Weights associated to each candidate in the event combined to obtain: P(all-sig), … , P(all-bkg) → For each event: full probability spectrum spanning from 0 to N
- Correction for detector response (MC production featuring realistic p_T distribution for the particles under study) → Bayesian unfolding procedure applied

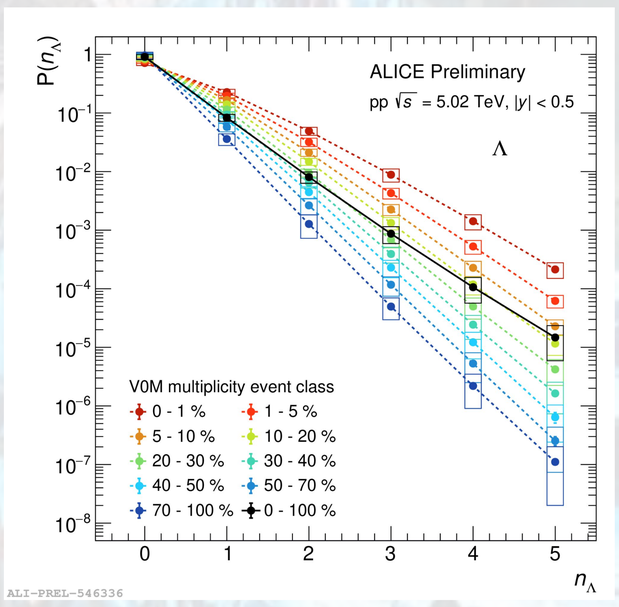


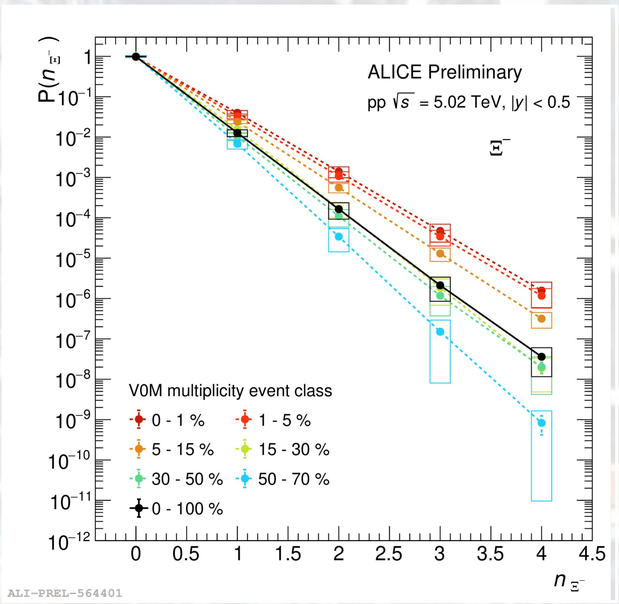


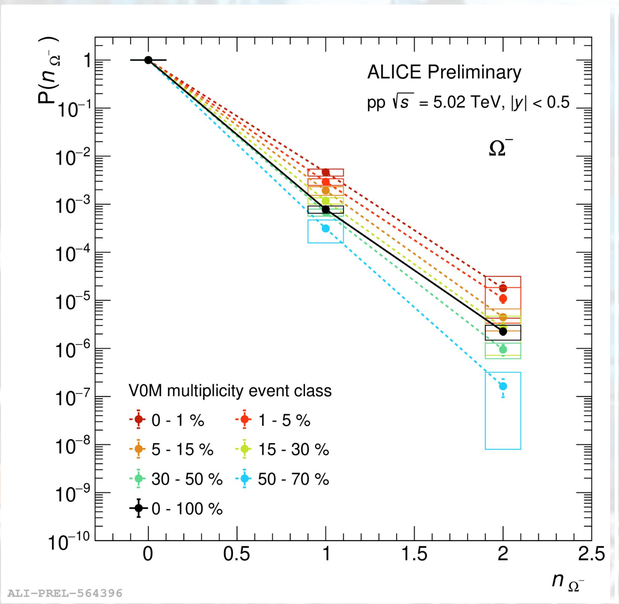


Measurement of the PDF









- Probability to produce *n* particles of a given species per event
- The probability to produce more than one particle per event (e.g. 2) increases with the event charged-particle multiplicity
- **Measurement spanning across large variations between strange-particle production and <multiplicity>, reaching very "extreme" situations**
  (e.g. 7 K^0_S at low average charged-particle multiplicity,
  0 K^0_S at high average charged-particle multiplicity)

NOTE: in each V0M bin multiplicity can fluctuate and $\langle dN_{ch}/d\eta \rangle$ can significantly change for events with small/large n_S

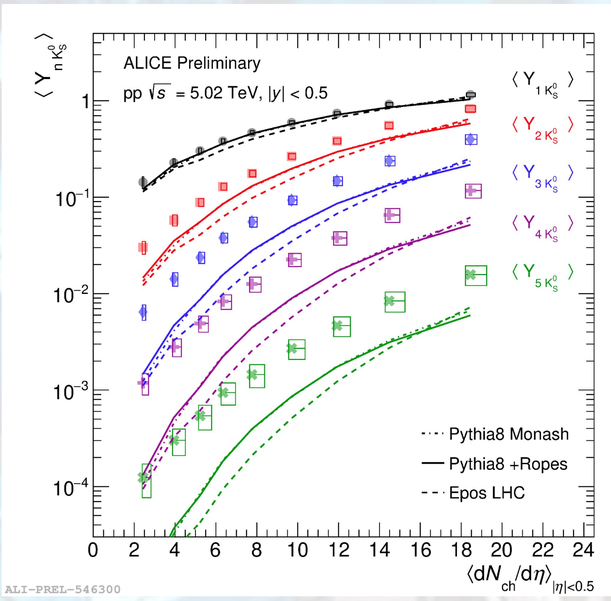
Outlook: Run-3

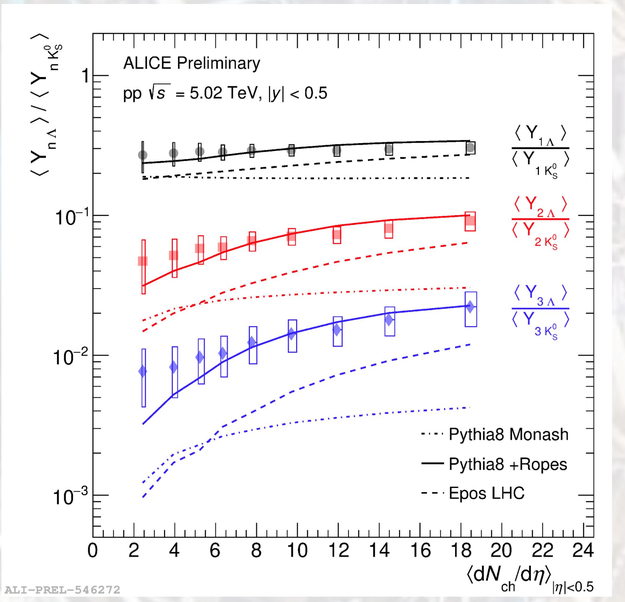
- Larger statistics useful for cascade analyses: a factor ~10^3 with 1 Ω, ~10^5 with ≥ 3 Ξ per event
- Extend PDF study to higher number of particles/event

Average probability for production yields

The PDF allows to calculate the production yield of 1, 2, 3, … particles/event:

$$< Y_{k-part} >= \sum_{n=k}^{\infty} \frac{n!}{k!(n-k)!} P(n)$$





- The increase with multiplicity of the probability for multiple strange hadrons is more than linear
- Very good agreement between $\langle Y_{1\text{-}part} \rangle$ and previous results ([1],[2])
- No difference between Pythia8 Monash [3] and Ropes [4] for K^0_S: Pythia8 + Ropes (with QCD-CR) tends to increase baryons
- Increase of Λ/K^0_S VS multiplicity when looking at multiple production
- Possibly in all strange-hadron/π VS multiplicity plots we have a strangeness-related AND a baryon-related contribution to the enhancement
- Baryon-related effect well reproduced by Ropes (with QCD-CR) at high multiplicity

References

[1] ALICE, Eur.Phys.J.C 80 (2020) 2, 167
[2] ALICE, Nature Phys. 13 (2017) 535-539
[3] C.Bierlich, G.Gustafson, L.Lonnblad, A. Tarasov, JHEP 03, no 148 (2015)
[4] C. Bierlich, *EPJ Web Conf.* 171 (2018) 14003