Entering the precision era for the measurement of strangeness production with ALICE in Run 3

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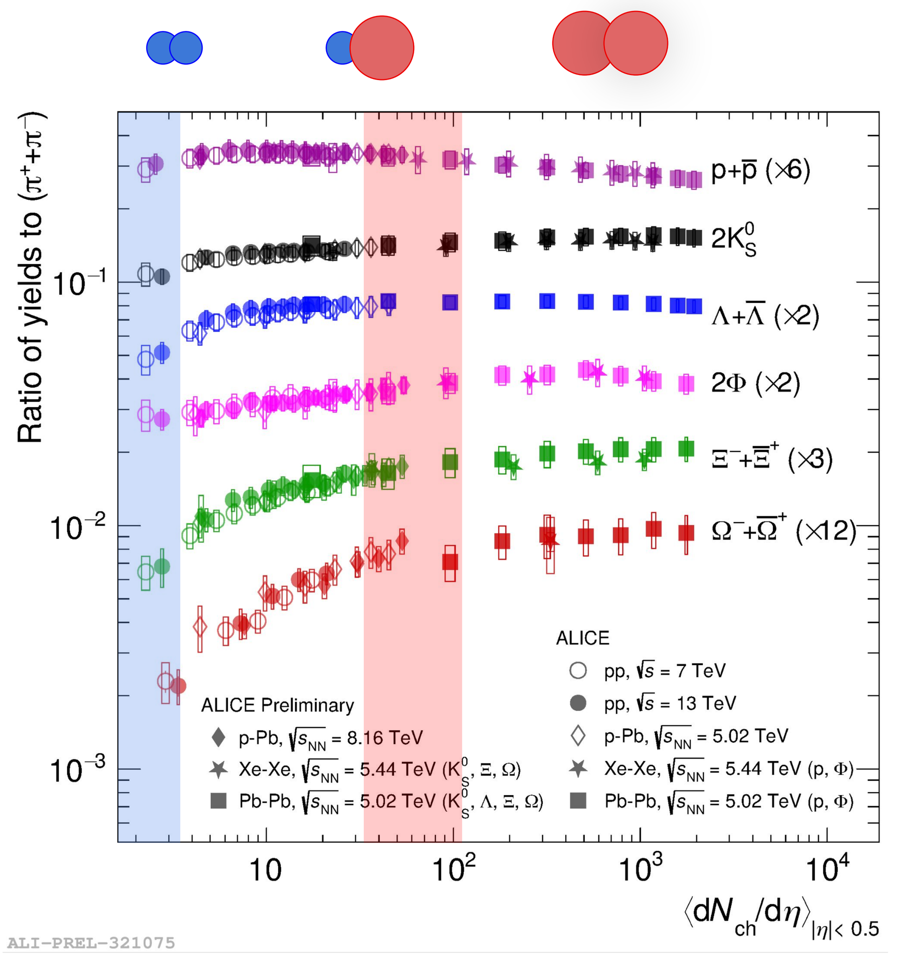
PHYSICS MOTIVATION



Continuous evolution of strange hadron yield ratios to pions **with the charged-particle multiplicity** observed at the LHC, smoothly connecting different collision systems and energies [1–10]

The strange hadron yield ratio to pions **increases with** the particle **multiplicity** wrt MB pp, saturating for central Pb–Pb collisions

Strange content **hierarchy**: $|S_{\Omega^\pm}| > |S_{\Xi^\pm}| > |S_\Lambda| \approx |S_{K^0_S}|$

With Run 3 data, the measurement of strange hadron production can be extended to:

- **high multiplicity** → pp data sample at $\sqrt{s}$ = 13.6 TeV (×1000 more events wrt Run 2)
- **low multiplicity** → pp data sample at $\sqrt{s}$ = 900 GeV (×300 more events wrt Run 1)

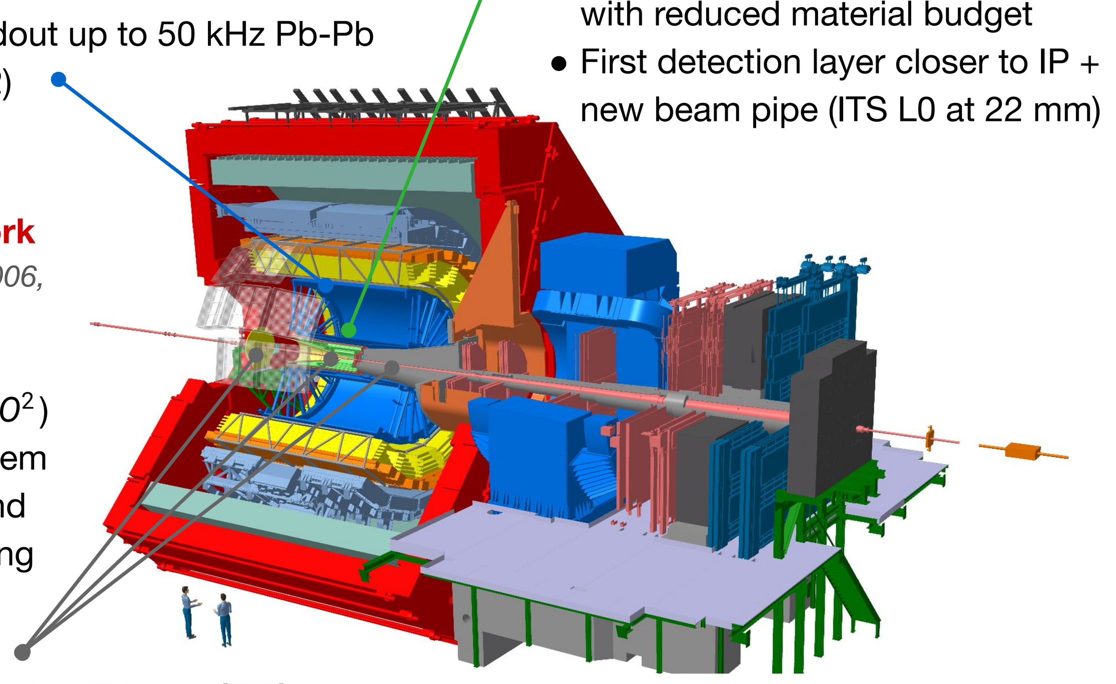
Focus on Ω (S = 3) → the most sensitive to strangeness enhancement

ALICE IN RUN 3

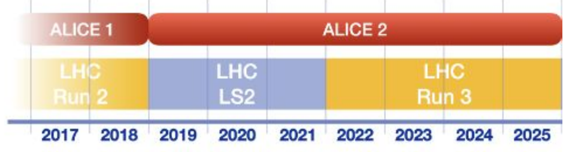
TPC Upgrade *JINST 16, P03022 (2021)*
- MWPCs replaced with GEMs
- Continuous readout up to 50 kHz Pb-Pb (×50 wrt Run 2)

ITS Upgrade *NIM 1032, 166632 (2022)*
- 7 layers of silicon pixel detectors with reduced material budget
- First detection layer closer to IP + new beam pipe (ITS L0 at 22 mm)

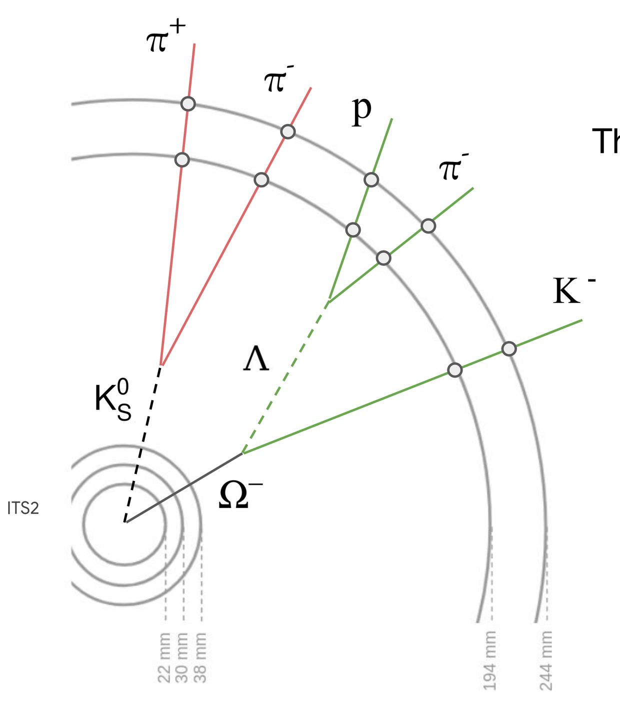
NEW O^2 framework
CERN-LHCC-2015-006, ALICE-TDR-019
- One common Online Offline (O^2) computing system
- Faster online and offline processing



NEW Fast Interaction Trigger (FIT)
NIM 1039, 167021 (2022)
- 4 arrays of Cherenkov detectors and scintillators
- Triggering, collision time, centrality estimation



STRANGE HADRON RECONSTRUCTION

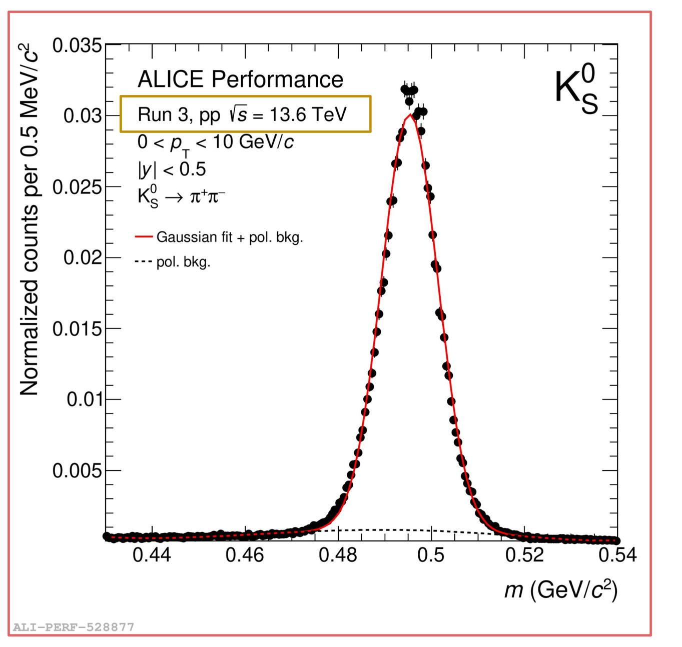


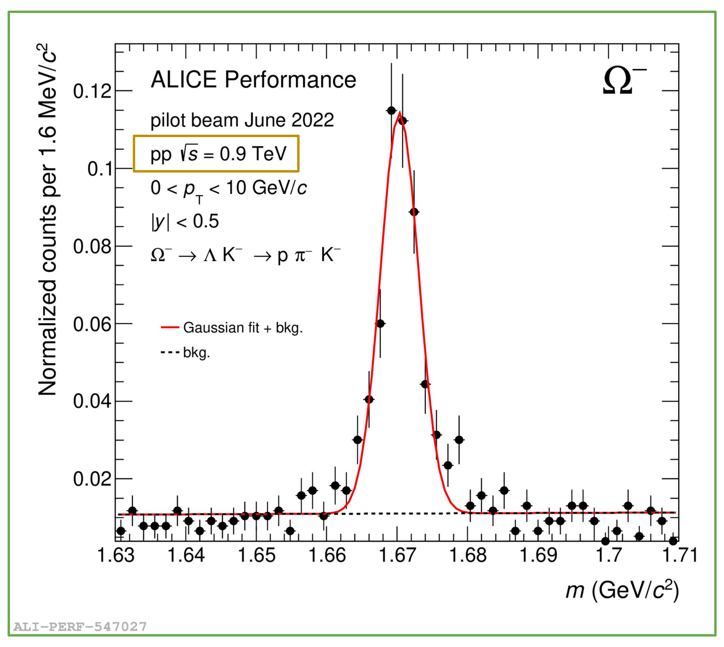
Excellent performance for strange hadron reconstruction with ALICE in Run 3!

The identification of (multi-)strange hadrons is based on kinematical and topological criteria

V^0 → neutral particle weakly decaying into a pair of charged particles (V-shaped)

Cascade → charged particle weakly decaying into a V^0 + charged particle





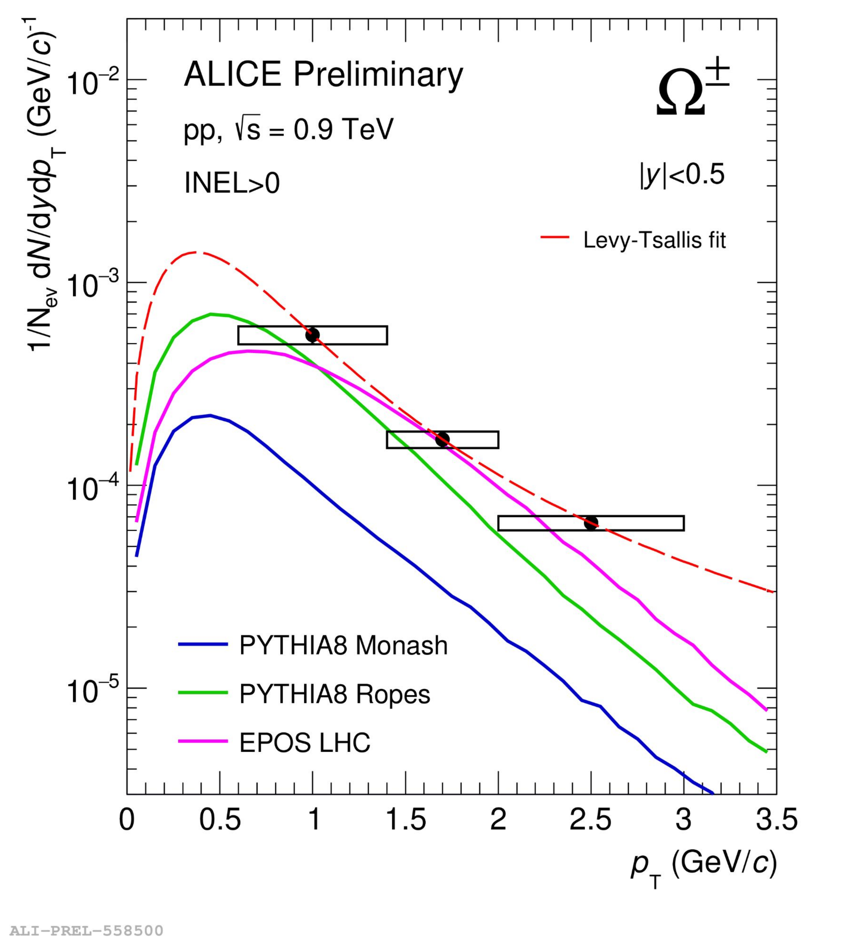
FIRST MEASUREMENT OF Ω PRODUCTION AT 900 GeV

This is the first measurement of Ω production in **pp collisions at 900 GeV** (86×10^6 events)

This result **complements ALICE measurements** in the strange hadron sector at 900 GeV from **Run 1** (K^0_S, φ, Λ, Ξ) [12]

The data sample also allows for a multiplicity differential analysis (two multiplicity classes)

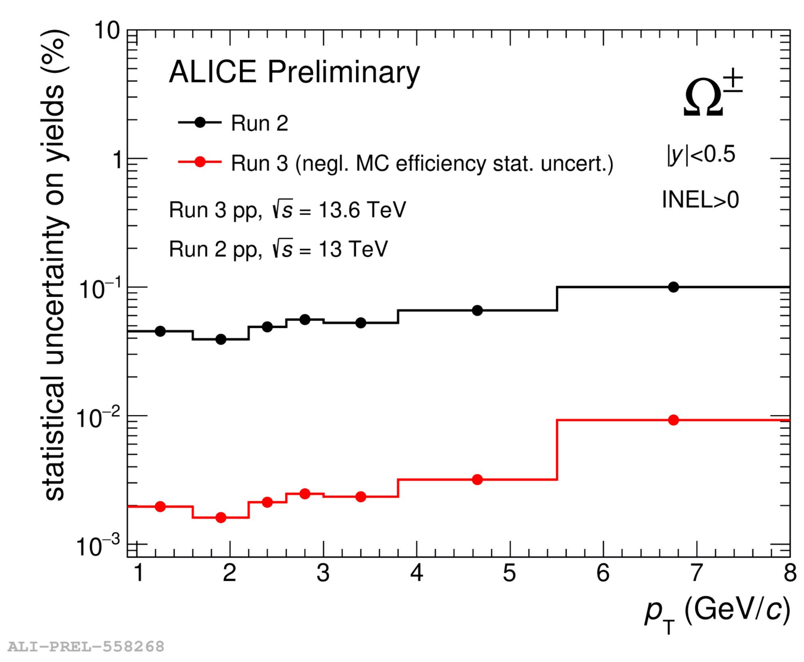
Phenomenological models such as PYTHIA 8 and EPOS-LHC overall underestimate the yields

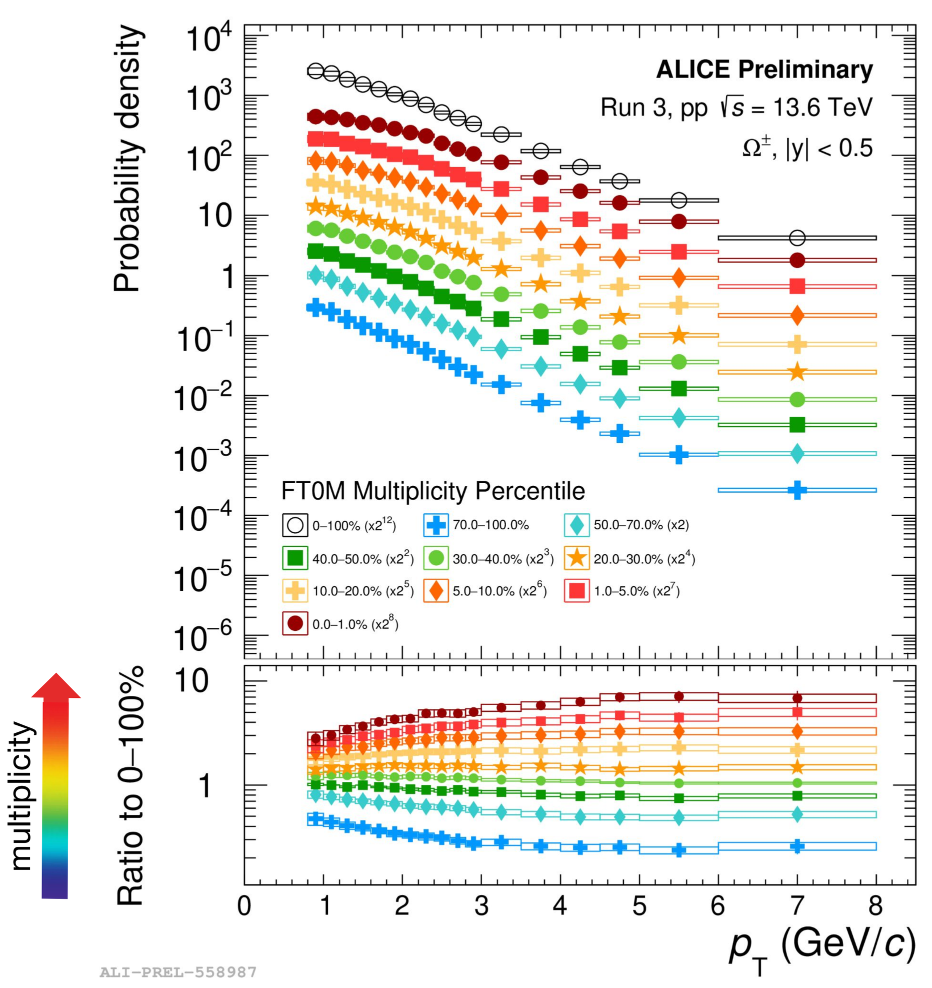


Ω PRODUCTION AT 13.6 TeV

This analysis exploits the **large MB data sample** of **pp collisions at 13.6 TeV** collected by ALICE in 2022
80×10^9 events → ×1000 more wrt ALICE Run 2 analysis at 13 TeV [2,3]

Improvement of the statistical precision up to a factor 20 in the low p_T region and up to a factor 10 at high p_T





The Ω p_T-spectra are measured with **unprecedented precision and granularity in multiplicity**

Multiplicity classes are based on the signal amplitude measured in the **FT0 arrays** of the FIT detector (FT0A + FT0C)

Hardening of the Ω p_T-spectra **with increasing multiplicity**

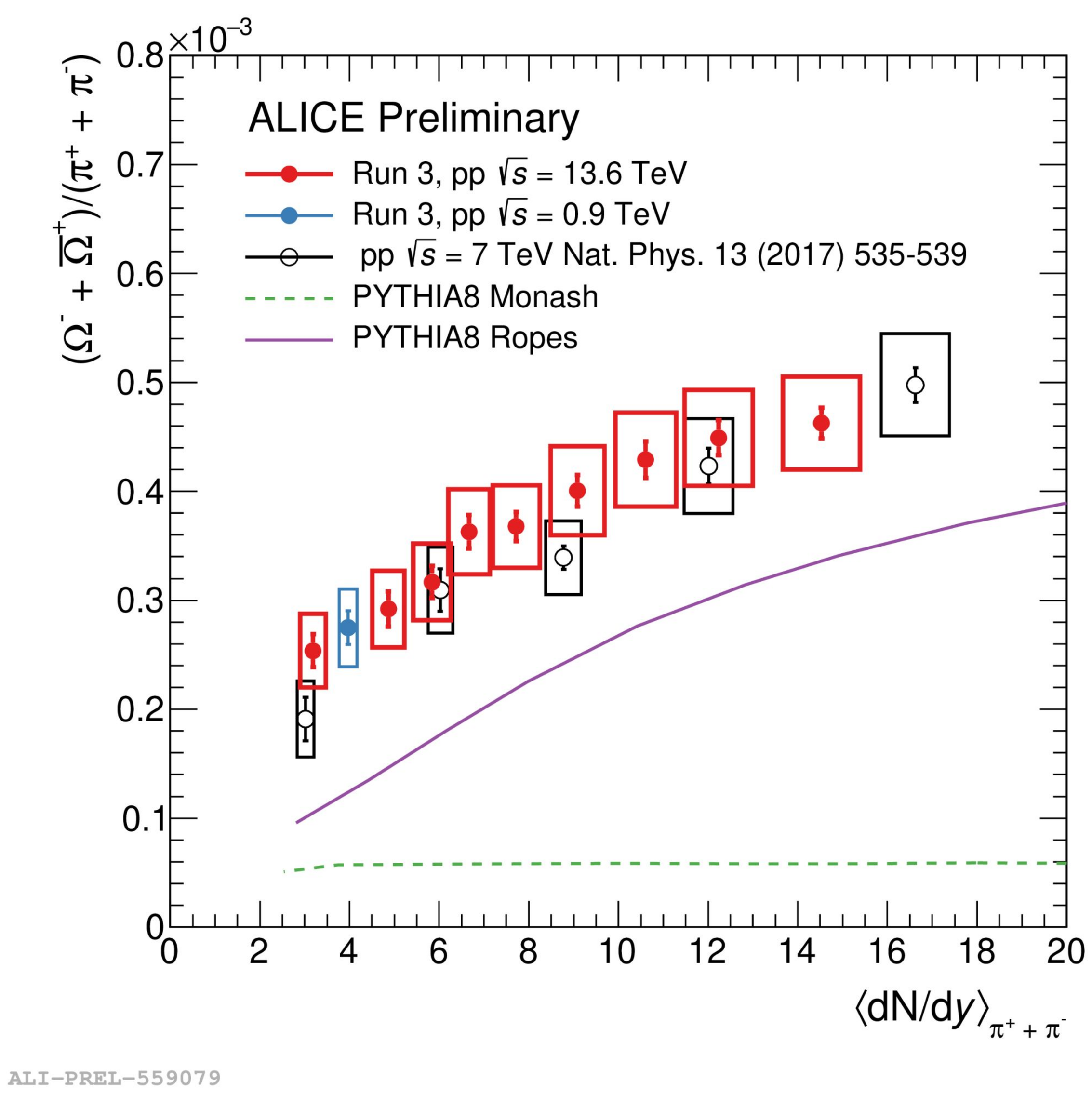
> ALICE in Run 3 plans to collect **O(10^{12}) pp collisions** at $\sqrt{s}$ = 13.6 TeV (×3000 more wrt the full Run 2 sample)
>
> **Minimum-bias sample + software triggers** based on specific physics cases (e.g. events with Ω candidates)

Ω/π RATIO AT MIDRAPIDITY

The Ω/π ratio measured in pp data at $\sqrt{s}$ = 13.6 TeV increases with the charged pion multiplicity at midrapidity → the trend is **consistent with previous ALICE results** [1–3]

The **first measurement of Ω yields** in pp collisions at **900 GeV** is **consistent** with the results obtained at **higher energies**

PYTHIA 8 with Ropes qualitatively describes the increase with multiplicity, whereas **PYTHIA 8 Monash** predicts no enhancement with multiplicity



SUMMARY

The production of multi-strange Ω baryons is studied **for the first time using Run 3 pp collisions at 13.6 TeV and 900 GeV**
This is the first Ω measurement in pp collisions at 900 GeV, complementing ALICE results from Run 1

The Ω/π ratio increases with multiplicity in pp collisions at 13.6 TeV consistently with previous results obtained by ALICE, reaching a **higher statistical precision** (by a factor 10–20) and an **unprecedented multiplicity granularity**

The first Ω yield measurement at 900 GeV is consistent with results obtained at higher energies → **Ω/π at the lowest centre-of-mass energy at the LHC follows the same trend with multiplicity** observed for higher energies

THIS IS JUST THE BEGINNING...

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