Strange and multi-strange particle production in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE at the LHC

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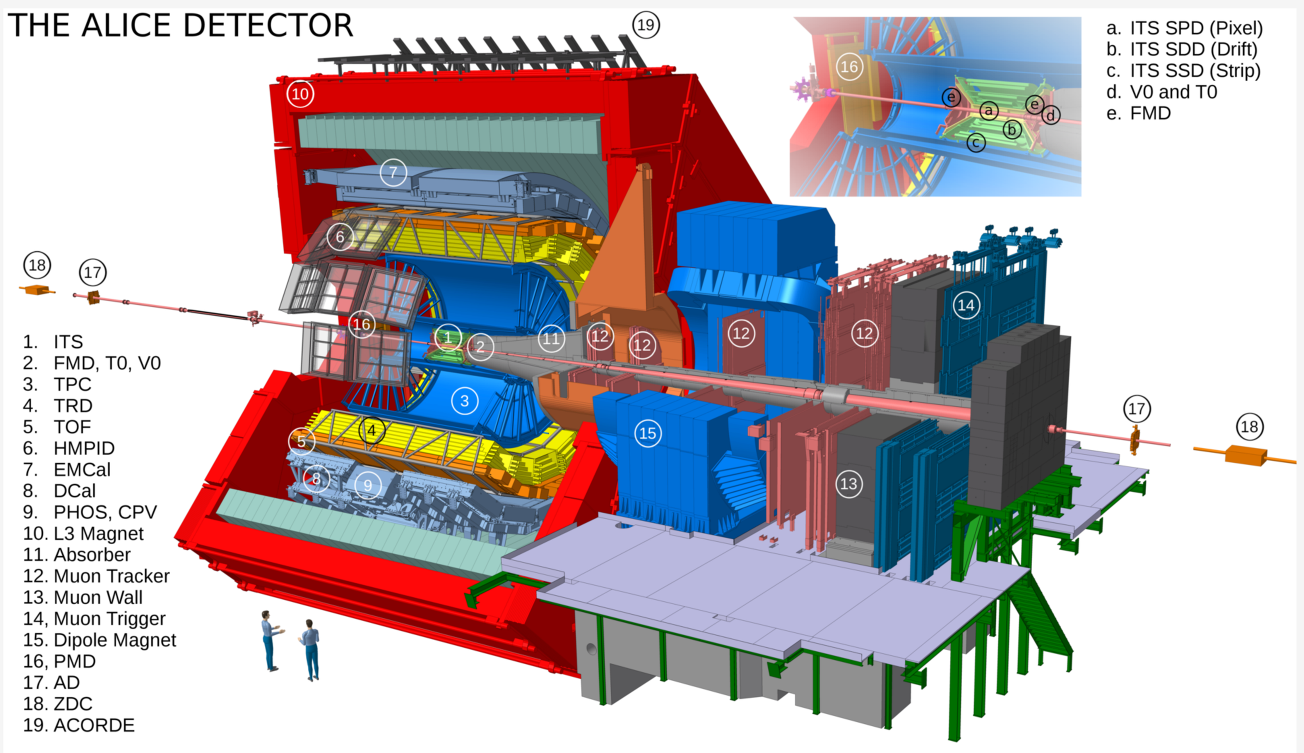
Motivation

Strangeness production plays crucial role in the understanding of the formation and the evolution of a fireball created in heavy-ion collisions. To better understand the effects of the collectivity and their interplay with the particle production mechanisms it is also necessary to study pp and p-Pb collisions. We report the measurements of the production of K^0_S mesons and Λ, Ξ and Ω hyperons with the ALICE detector at the LHC energy $\sqrt{s}$ = 13 TeV for minimum bias pp collisions. The results include Λ/K^0_S spectra ratio, p_T-differential yields, $\langle p_T \rangle$ and particle yield ratios compared to the measurements at lower energies. The results serve as the support for the multiplicity dependent measurements.

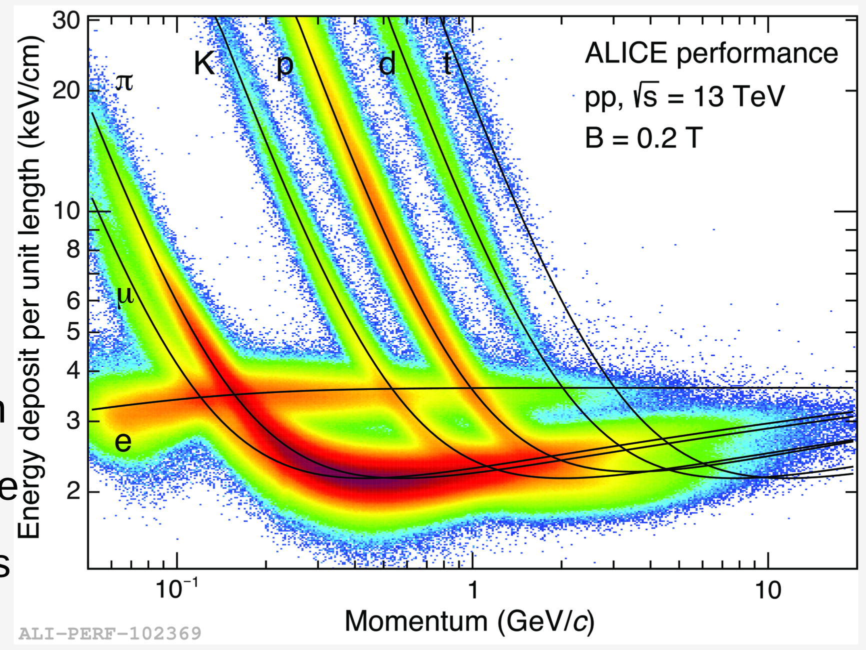


Experimental setup

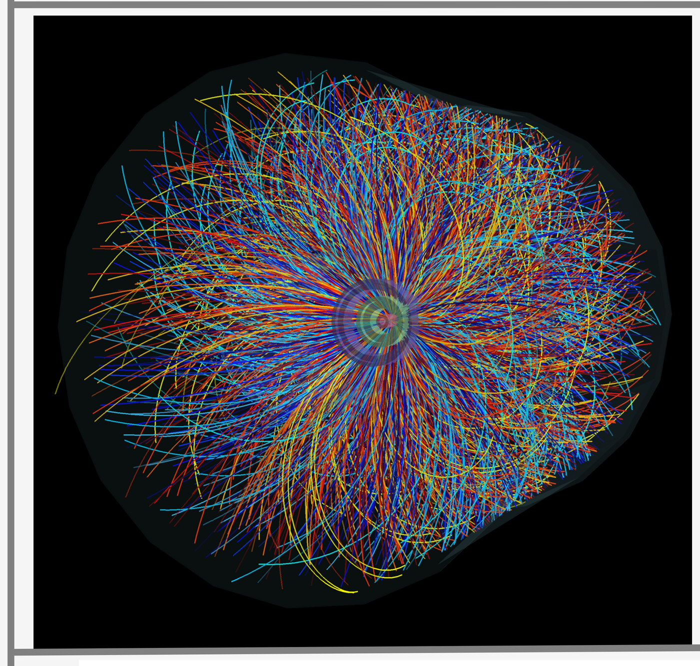
- **Central barrel** detectors with excellent tracking capabilities [1]
- **TPC** (Time-Projection Chamber) is main tracking detector. Operates within the rapidity window |η|<0.9 . Detector is situated inside of the solenoid magnet with the magnetic field 0.5T which allows to measure the momentum of the particles. Also serves as particle identification detector due to specific energy losses dE/dx of a particles.
- **V0** scintilator gives signal proportional to the multiplicity of the event (centrality of the collision)
- **ITS** (Inner Tracking System) -high precission vertex reconstruction and dE/dx capabilities

Particle dE/dx identification

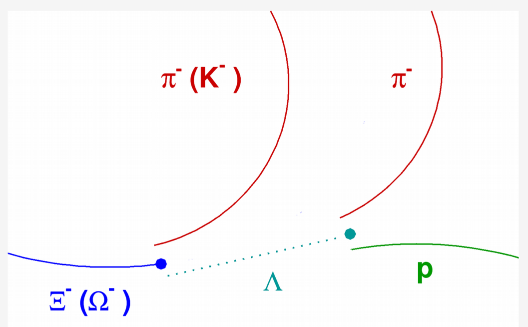
- **TPC** provides particle identification due to the specific energy losses of charged particles in a gas mixture of the detector (Ar-C02)
- Detector allows particle identification in the low momentum region (~up to three GeV/c)
- Identification method uses the Bethe-Bloch parametrization of dE/dx vs. particle momentum
- **The background reduction** due to this method is significant mostly for multi-strange particles



Topological identification



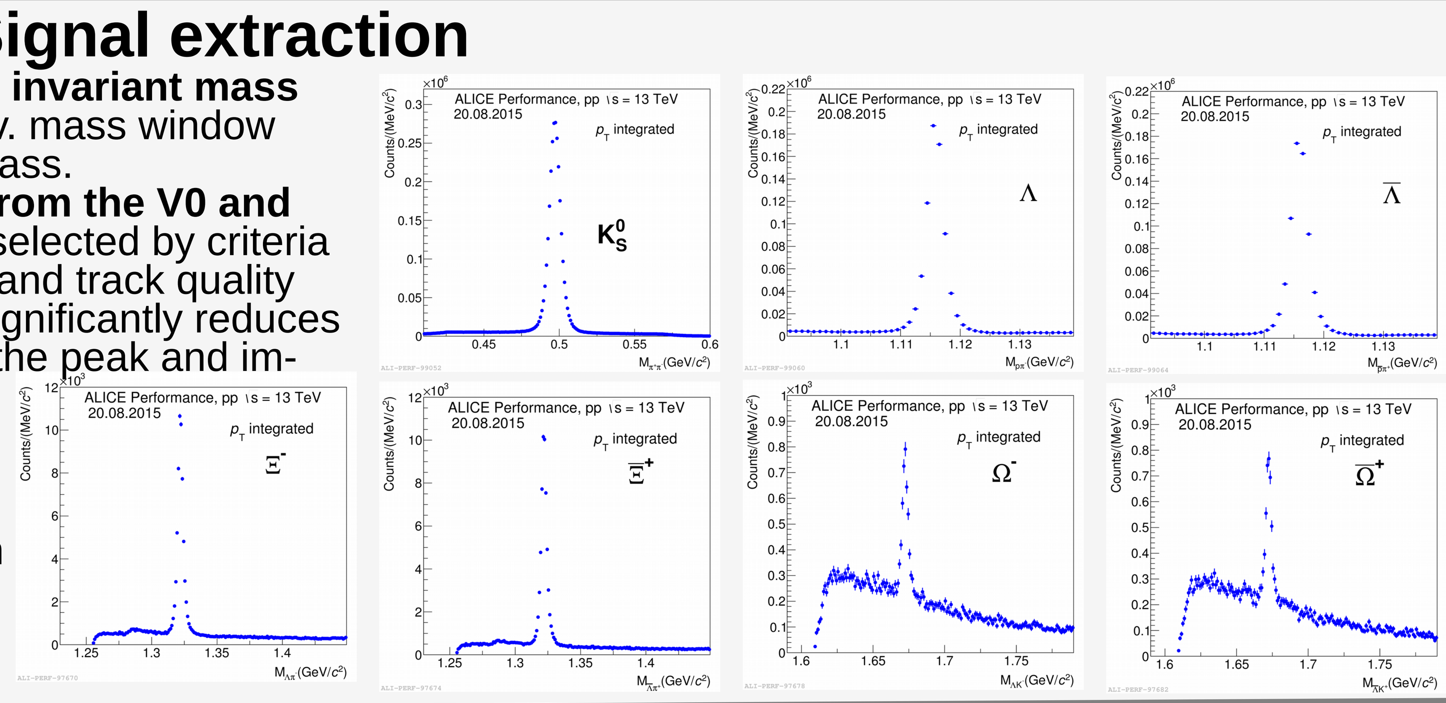
- **High density of tracks** (up to 8000 charged tracks per collision in Pb-Pb collisions)
- **Strange and multi-strange particles identification** is based on their decay topology
- Oppositely charged tracks creates "V" structures



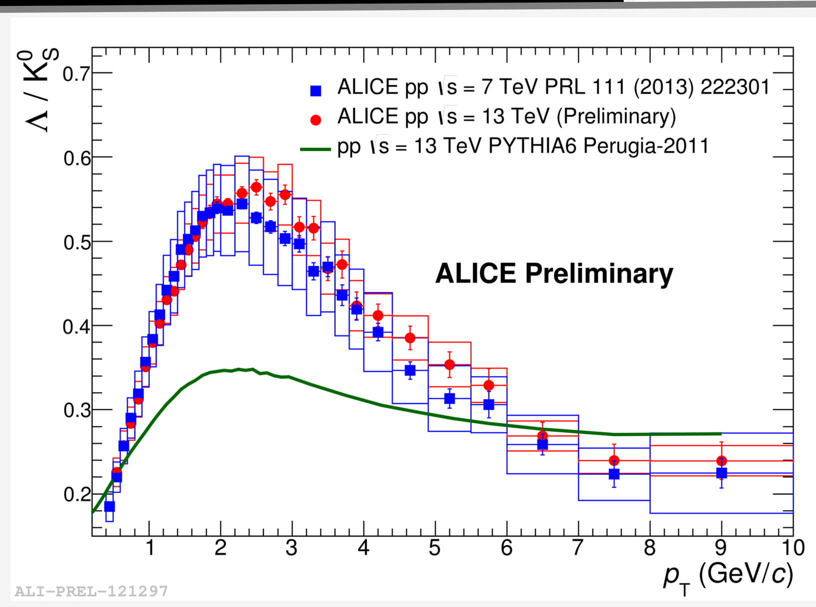
- **V0 topology** (Λ, K^0_S)
  - $K^0_S \to \pi^+ + \pi^-$
  - $\Lambda \to p + \pi^-$
- **Cascade-like topology** (Ξ,Ω)
  - $\Xi^- \to \Lambda + \pi^-$, $\Lambda \to p + \pi^-$
  - $\Omega^- \to \Lambda + K^-$, $\Lambda \to p + \pi^-$

Signal extraction

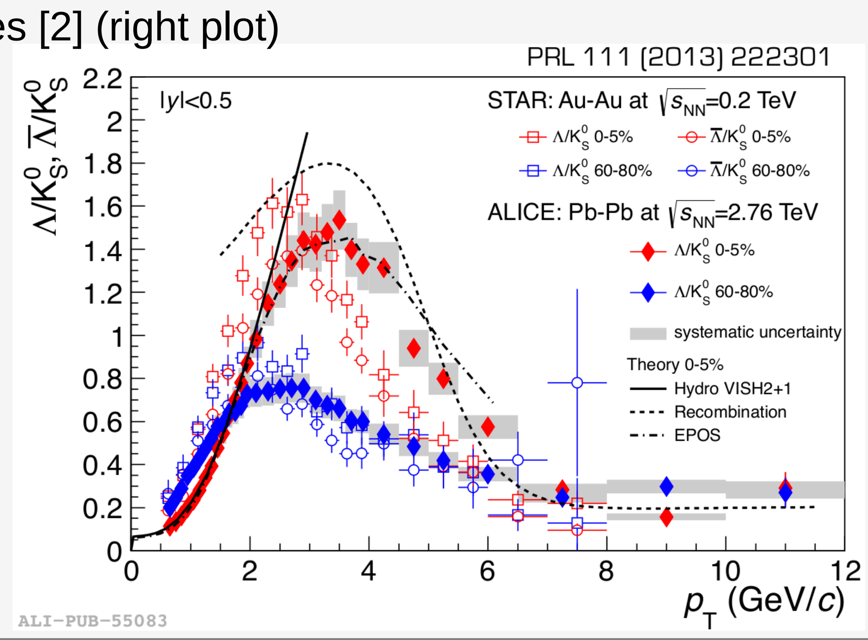
- **Signal extracted from invariant mass distributions** within inv. mass window around PDG particle mass.
- **Inv. Mass computed from the V0 and Cascade candidates** selected by criteria on their deay topology and track quality
- **TPC dE/dx** selection significantly reduces the bacgkround under the peak and improves the background shape.
- **Peak position and width** acquired from the fit of the distribution using Gauss + linear fit function assuming linear background.



Λ/K^0_S spectra ratio



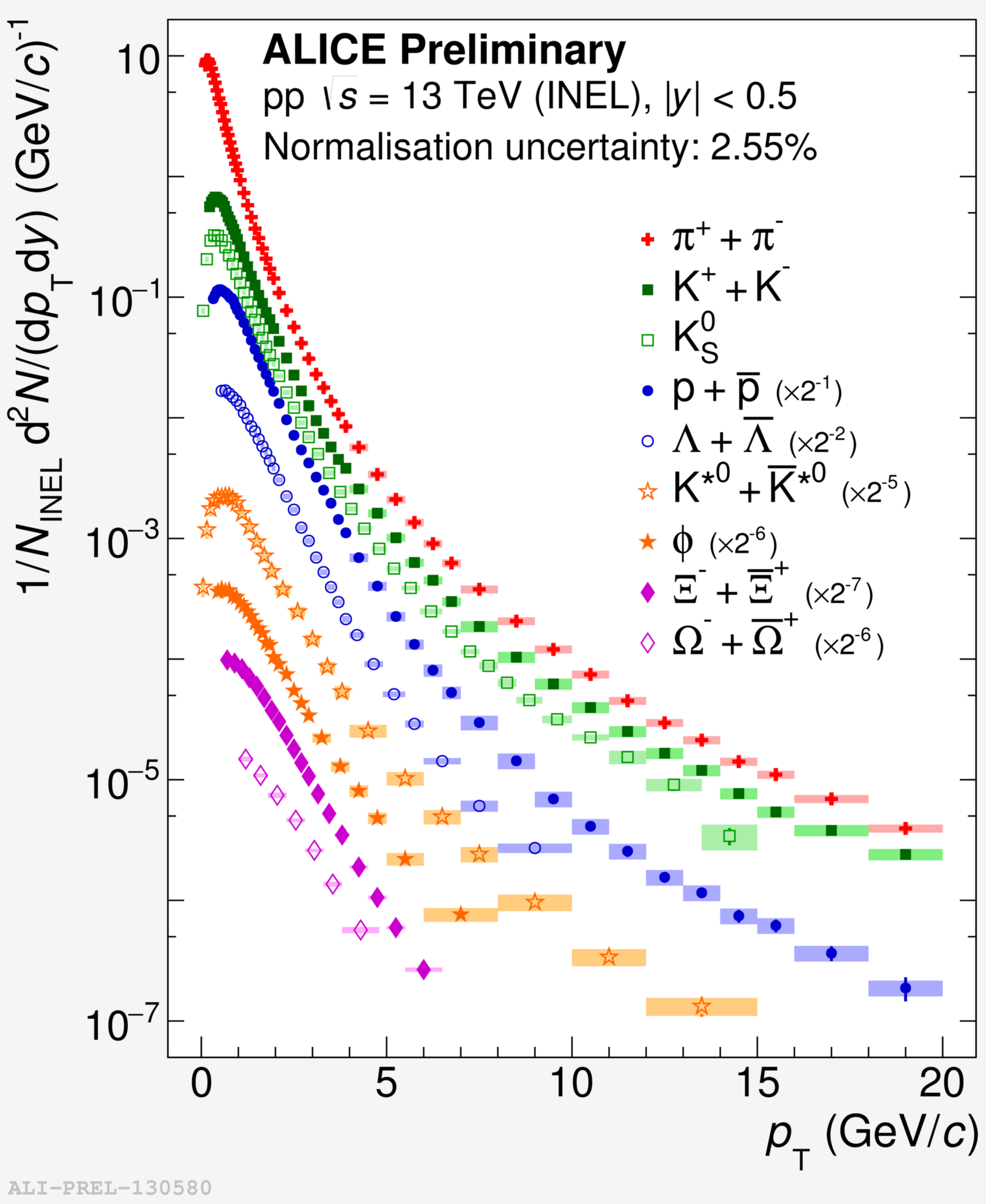
- Comparison of Λ/K^0_S ratio to 7 TeV Λ/K^0_S (left plot) ratio shows the shift of the peak position towards higher p_T (radial flow, quark recombination)
- Similar behavior observed for Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV in central and peripheral centrality classes [2] (right plot)

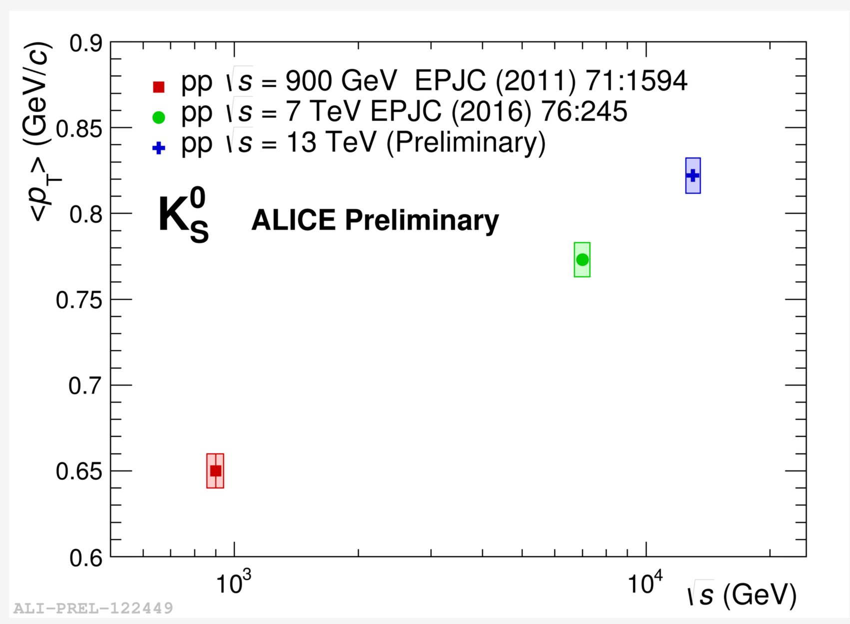


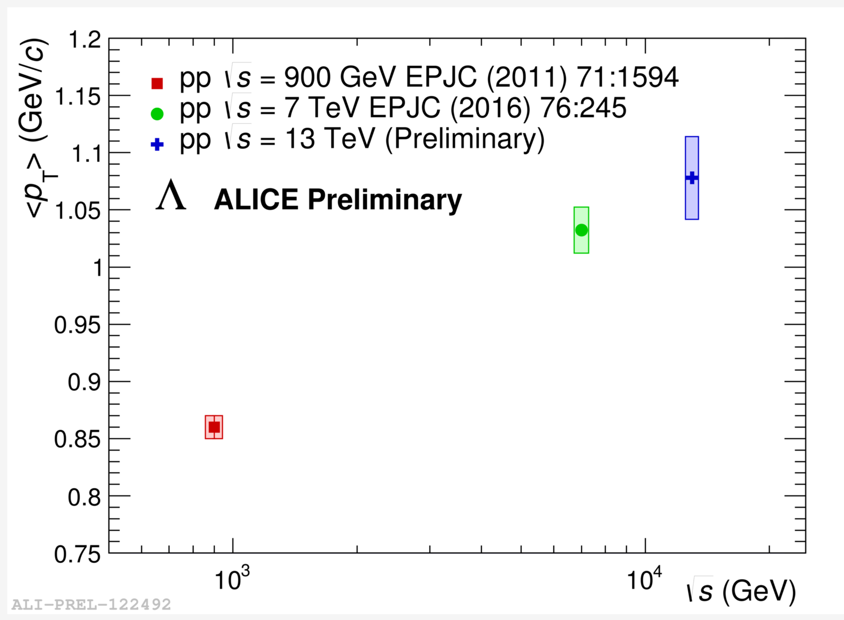
- High p_T region – no medium effects on particle composition (vacuum-like relative fragmentation into Λ and K^0_S)
- Intermediate p_T region described with hydro [3] and EPOS models [4](right plot)
- Intermediate and high p_T region described by recombination model [5] (right plot)

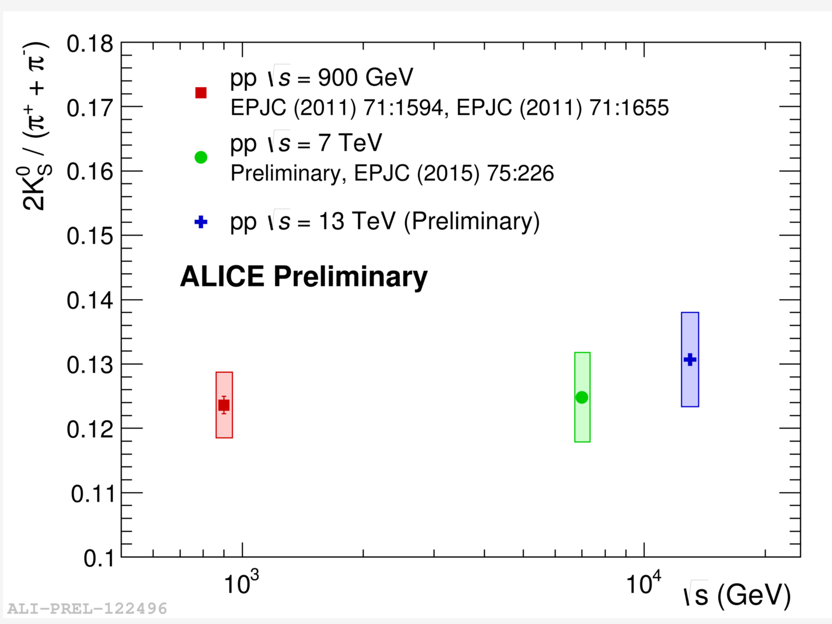
p_T-differential spectra

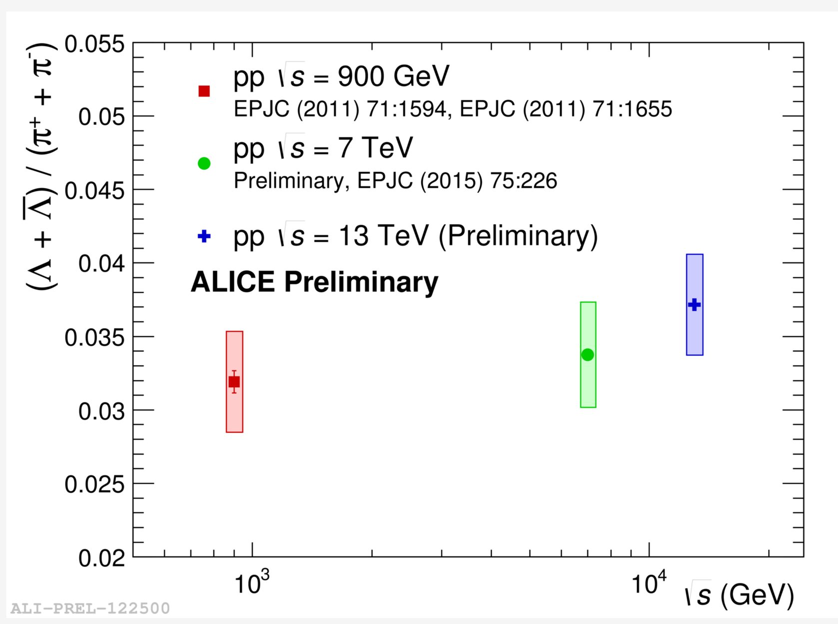
- **p_T differential spectra** corrected for detector acceptance and reconstruction efficiency (using Monte Carlo simulations) measured within rapidity interval |y| < 0.5
- **Normalized** to the number of inelastic events
- Λ and $\bar{\Lambda}$ corrected for the **feed-down** using MC information and measured Ξ spectra
- **The spectra hardening** is more pronounced for heavier than for lighter particles (as expected from the radial flow)



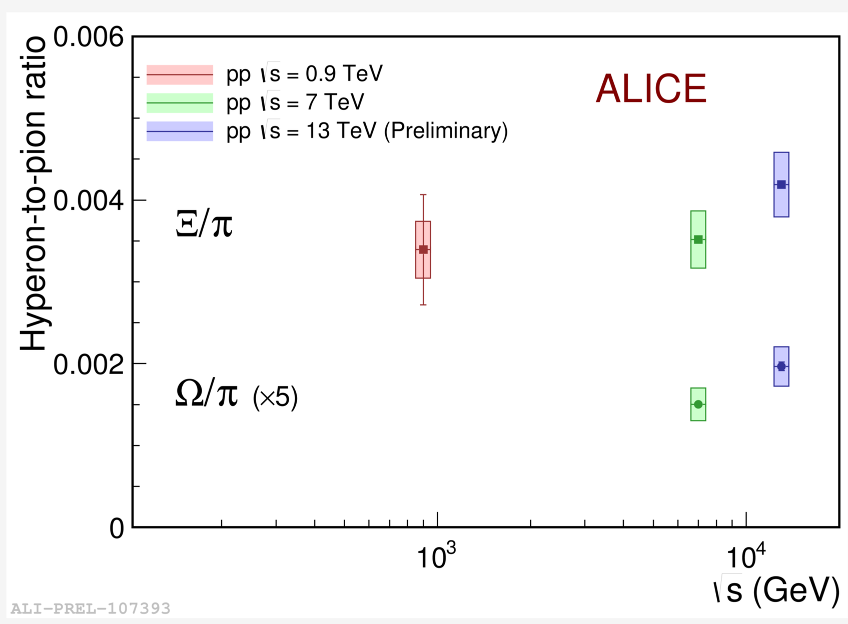








$\langle p_T \rangle$ and integrated minimum bias yields



- The 13 TeV measurement of $\langle p_T \rangle$ follows the trend of lower energy measurements (7 TeV and 900 GeV) (growth of radial flow) for both Λ and K^0_S
- Extrapolation of the spectra used for low p_T regions (except K^0_S) using Lévy-Tsallis function
- Extrapolated low-p_T region represents 14% (Λ), 20% (Ξ) and 35% (Ω) of total yield.
- Increase of hyperon-to-pion ratio in 13TeV.

Summary:

- Λ/K^0_S follow the trends of lower energies and smaller systems, shift of the peak position towards higher p_T . Possible interplay of few mechanisms (flow, quark recombination).
- Observed spectra hardening with increasing of particle mass. (Ξ, Ω)
- $\langle p_T \rangle$ increase follows the trends of measurements for smaller energies (increase of radial flow)
- Observed increase of hyperon-to-pion ratios for collision energy 13TeV (more pronounced for multi-strange hyperons)

References:

[1] J. Phys. G: Nucl. Part. Phys. 30 (2004) 1517-1763
[2] Phys. Rev. Lett. 111,(2013) 222301
[3] Phys. Rev. C 78 , 024902 (2008)
[4] Phys. Rev. Lett. 109 , 102301 (2012)
[5] Phys. Rev. C 83, 054912 (2011)

Related contributions at QM 2018:

D. Albuquerque; Strangeness in AA coll.
L. Tropp; Mult. Dep. Of strang. Prod.
P. Cui; Strange. Prod in Jets