Measurement of prompt D^0, Λ_c^+, and $\Sigma_c^{0,++}(2455)$ production in proton–proton collisions at $\sqrt{s}$ = 13TeV

Marco Giacalone
for the ALICE Collaboration

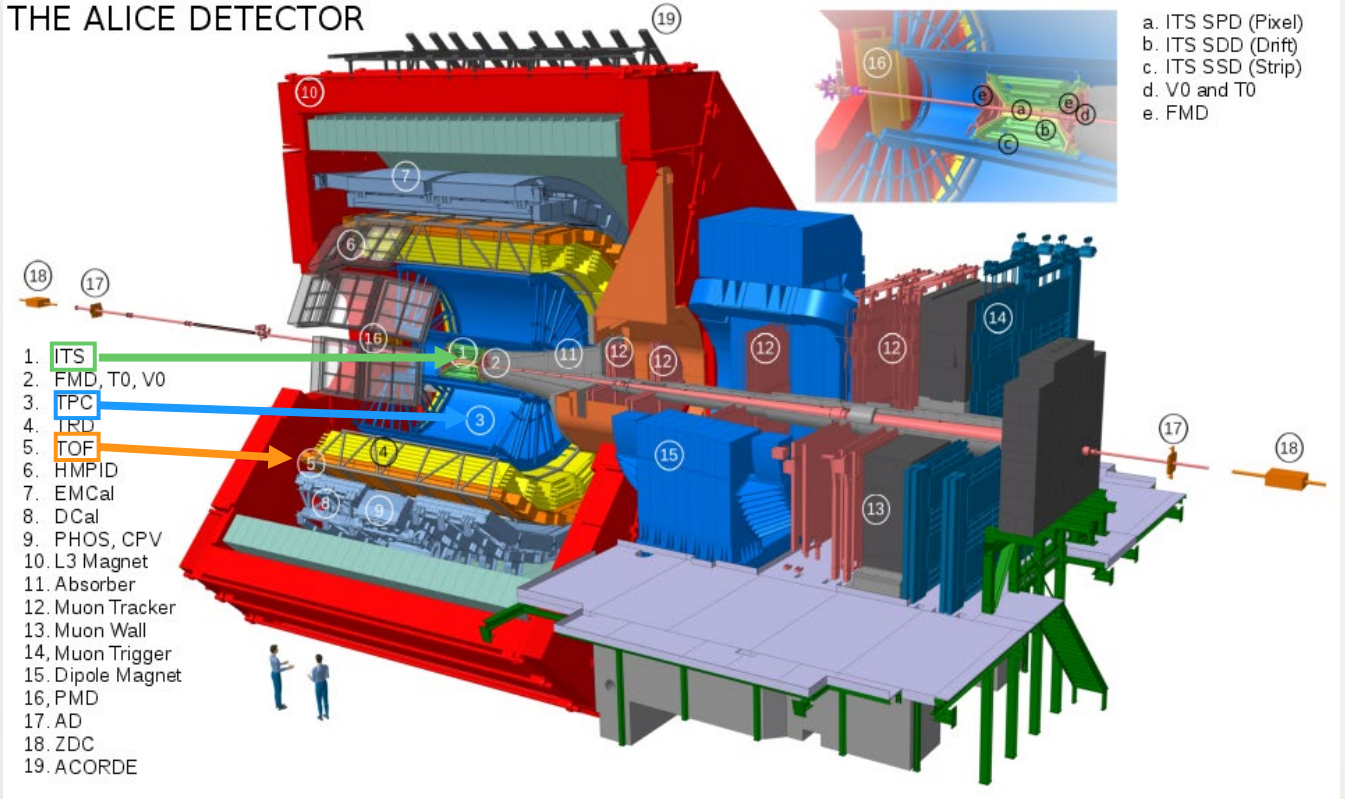
29th International conference on ultra–relativistic nucleus-nucleus collisions
April 4-10, 2022
Kraków, Poland

Physics Motivation

Measurements of		**Lead us to**
Heavy flavour hadron production measurements	→	Test pQCD calculations
Relative production rates of different charm hadrons	→	Study hadronization mechanisms of charm quarks

Detector setup

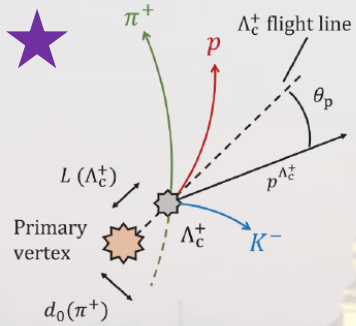
- D^0, Λ_c^+, and $\Sigma_c^{0,++}$ decays reconstructed in the central barrel → $|\eta| < 0.9$
- Inner Tracking System (ITS) and Time Projection Chamber (TPC) → charged particles tracking
- TPC and Time Of Flight (TOF) → Particle Identification (PID)
- Selected events correspond to an integrated luminosity of 31.9 ± 0.5 nb^{-1} of *pp* collisions at $\sqrt{s}$ = 13 TeV

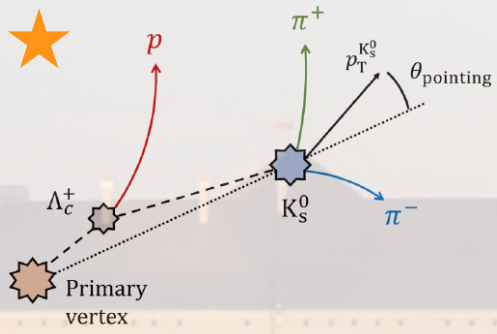


Phys.Rev.Lett. 128 (2022) 1, 012001

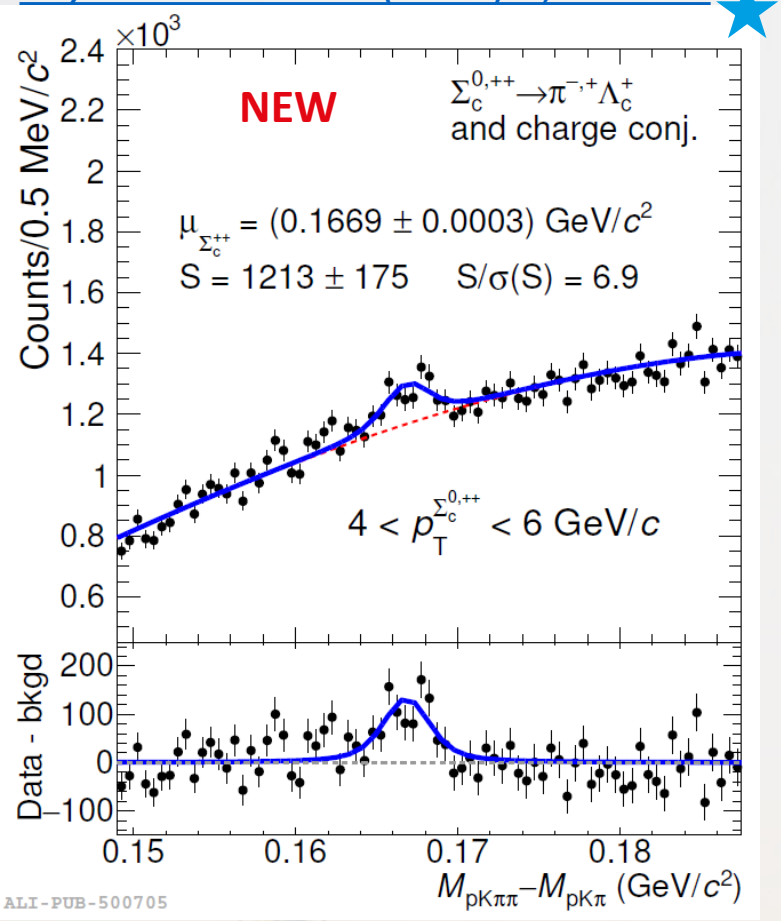
Analysis strategy

Hadrons analysed	Reconstruction decays	BR %
D^0	$K^- \pi^+$	3.95 ± 0.03
$\Sigma_c^{0,++}$	$\pi^{-,+} \Lambda_c^+$	≈100
Λ_c^+	$pK^- \pi^+$ ★	6.28 ± 0.32
	$pK^0_s \rightarrow p \pi^+ \pi^-$ ★	1.59 ± 0.08
	K^0_s	(69.20 ± 0.05)





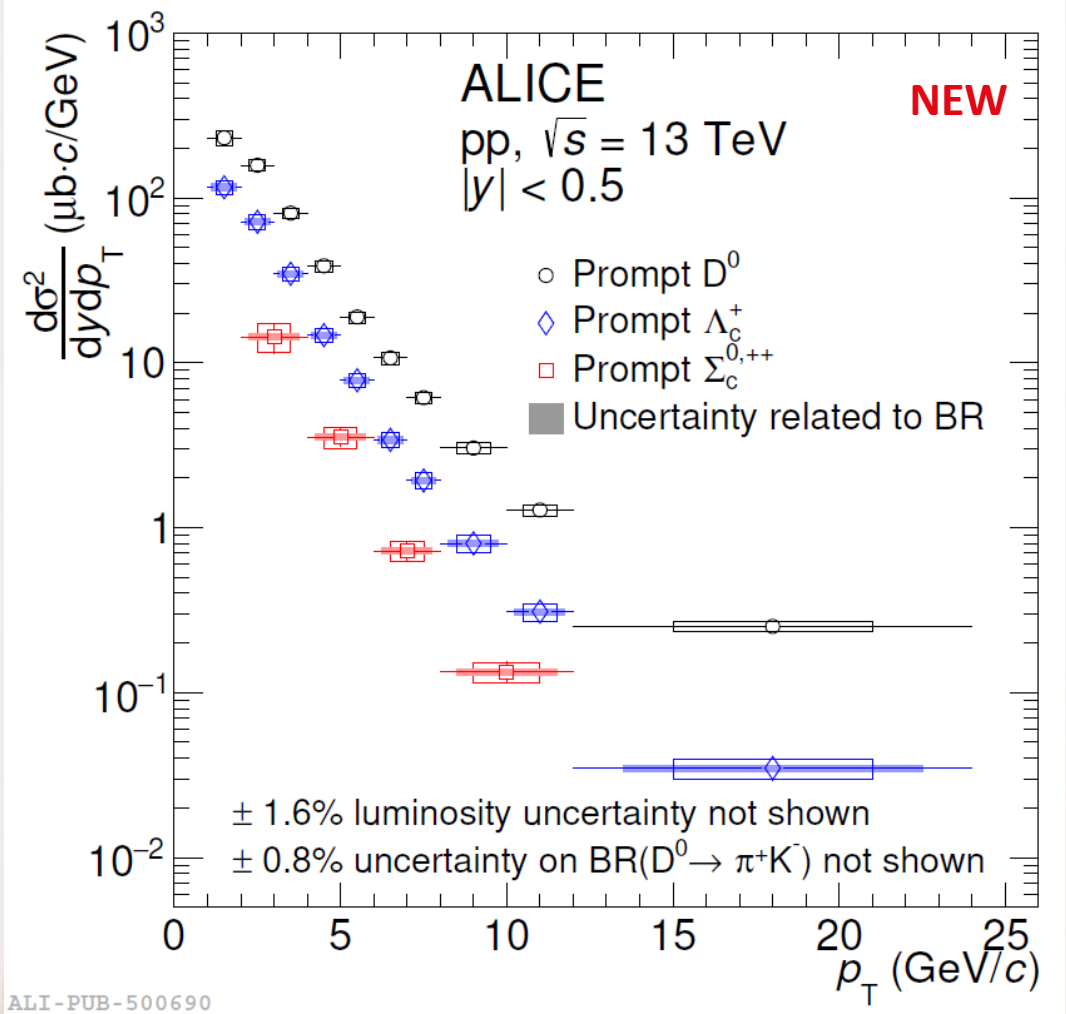
[Phys.Rev.Lett. 128 (2022) 1, 012001](#)



Cross section measurements based on invariant-mass analysis → selection based on PID of daughter-particles and decay topology

Cross section measurement

- D^0 candidates formed by combining pair of tracks with $|\eta| < 0.9$ and $p_T > 0.3$ GeV/c which are selected with PID techniques
- Λ_c^+ from pKπ decay reconstructed using a Bayesian probabilistic PID approach. Λ_c^+ from pK^0_s exploits machine-learning with Boosted Decision Trees algorithm
- $\Sigma_c^{0,++}$ production is reconstructed in the two Λ_c^+ decay channels
  - Both Λ_c^+ and $\Sigma_c^{0,++}$ are averaged for the results using the studied decay channels
- $\Sigma_c^{0,++}$ production is the first measurement in hadronic collisions

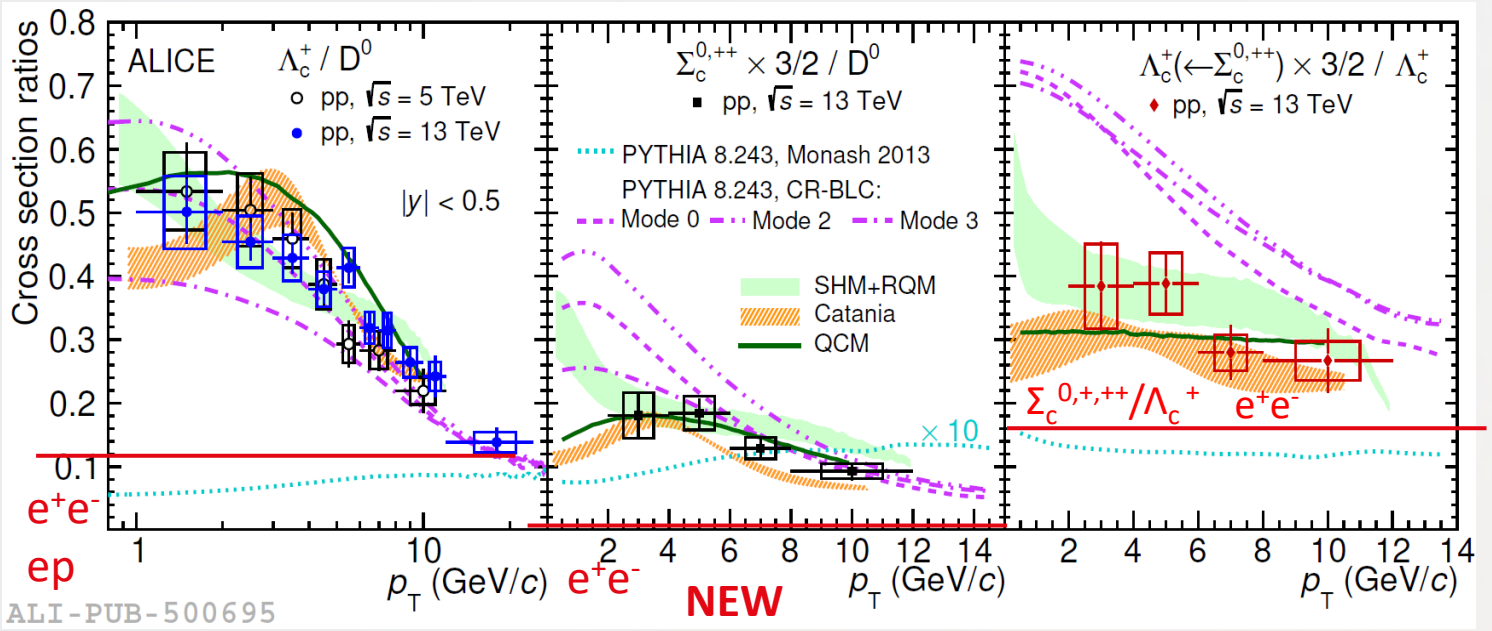


Charm hadron ratios and comparison with models

- Λ_c^+/D^0 decreasing with p_T → larger than e^+e^- and ep at different energies (≈ 0.17) *
- $\Sigma_c^{0,++}/D^0$ halves from lowest to highest p_T interval → larger results than Belle e^+e^- measurements (≈ 0.02) *

*Phys. Rev. D 97 no. 7, (2018) 072005

- Λ_c^+ feed-down quantified via ratio $\Lambda_c^+ \leftarrow \Sigma_c^{0,+,++}/\Lambda_c^+$ → p_T integrated measurement is 0.38 ± 0.06(stat) ± 0.06(syst)



- PYTHIA8 Monash 2013 tune, employing Color Reconnection (CR) at leading order, underestimates ALICE results → reproduces results from e^+e^- data
- PYTHIA8 CR Beyond Leading Colour (CR-BLC) model, Statistical Hadronization Model combined with prediction of the Relativistic Quark Model (SHM+RQM), Quark (re-)Combination Model (QCM) and Catania model, which uses a quark coalescence plus fragmentation approach, describe the Λ_c^+ to D^0 ratio

*P. Skands et al., arXiv:1404.5630 *Christiansen and Skands, JHEP 08 (2015) 003 *He and Rapp, Phys. Lett. B 795 (2019) 117–121

*Song et al, Eur. Phys. J. C 78 no. 4, (2018) 344 *V. Minissale et al, arXiv:2012.12001

Thank you