Studies of Λ_c production in pp and p-Pb collisions with ALICE at the LHC

XII Quark Confinement and the Hadron Spectrum

29 August - 3 September, Thessaloniki, Greece

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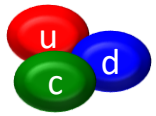
on behalf of the ALICE Collaboration

ALICE detectors used in this analysis

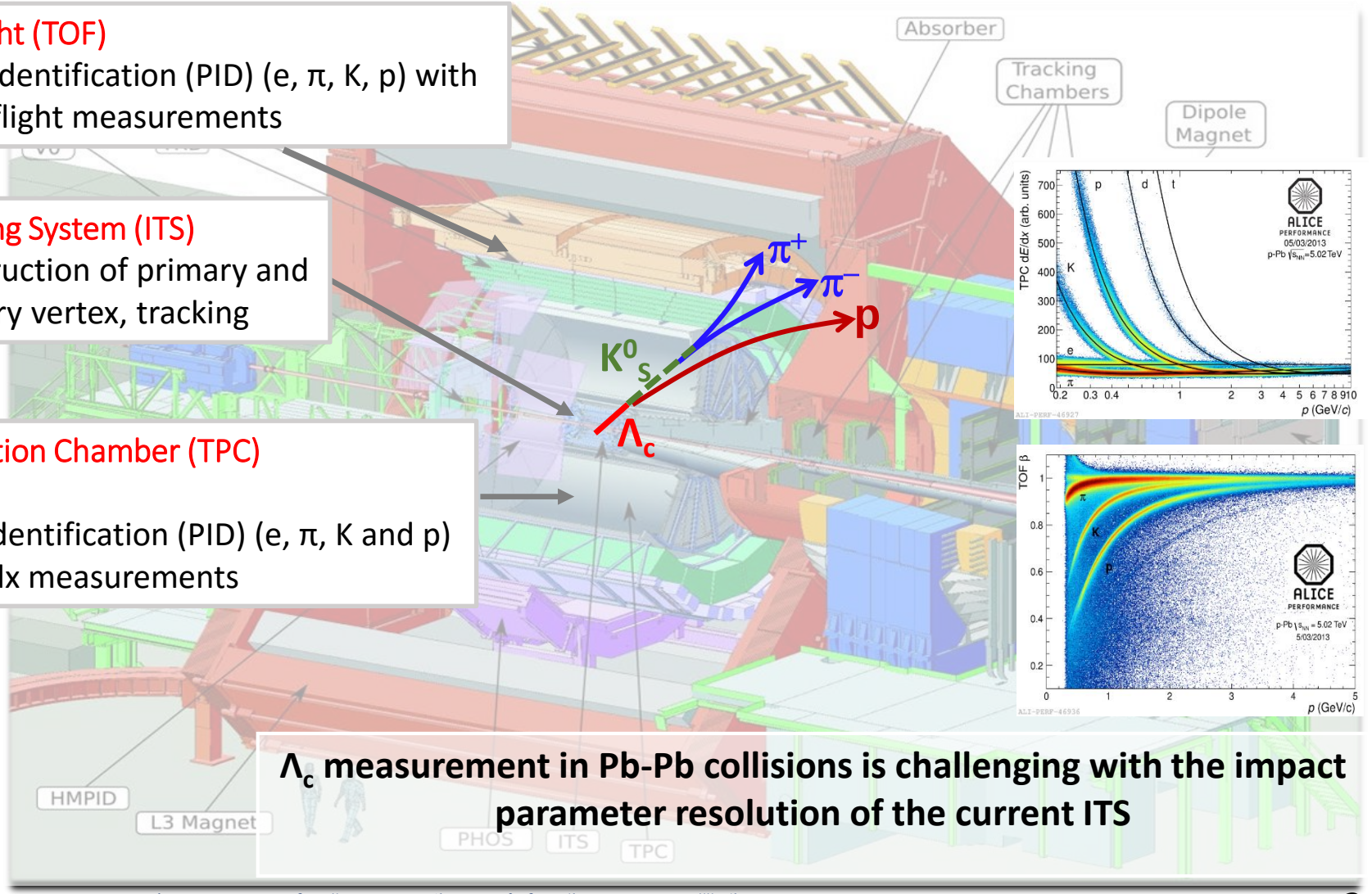


$\Lambda_c^+ \rightarrow pK^-\pi^+$ ($c\tau$ = 60 μm, BR = $6.84^{+0.32}_{-0.40}$%)
$\Lambda_c^+ \rightarrow pK^0_S$ ($c\tau$ = 60 μm, BR = 1.1 ± 0.1%)

Time-Of-Flight (TOF)
- Particle Identification (PID) (e, π, K, p) with time-of-flight measurements

Inner Tracking System (ITS)
- Reconstruction of primary and secondary vertex, tracking

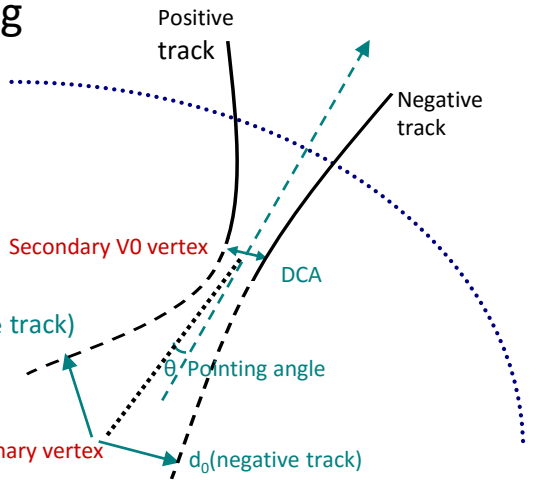
Time Projection Chamber (TPC)
- Tracking
- Particle Identification (PID) (e, π, K and p) with dE/dx measurements

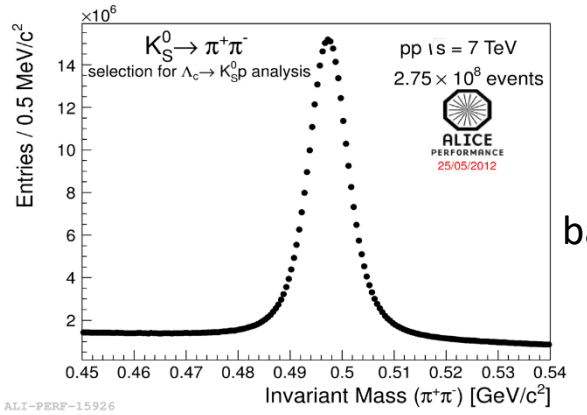


Λ_c measurement in Pb-Pb collisions is challenging with the impact parameter resolution of the current ITS

$\Lambda_c \rightarrow pK^0_S$ analysis in pp and pPb collisions

- K^0_S candidate reconstructed from pairs of opposite-sign tracks forming a vertex displaced from the interaction vertex, according to track selection, topological cuts:
  Distance of closest approach (DCA), Cosine of pointing angle, $p_T(K^0_S \text{ daughters}), d_0(K^0_S \text{ daughters})$,
  $|m_{inv}(\pi^+ \pi^-) - m(K^0_S)| < 7.5 \text{MeV/c}^2$)



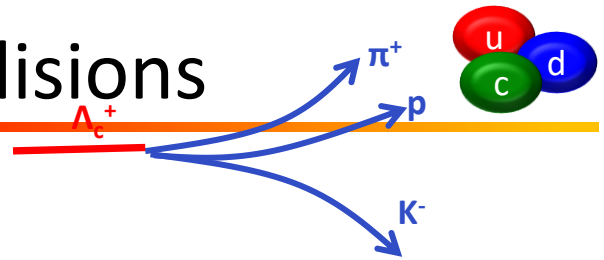


A clear K^0_S signal in $m_{inv}(\pi^+,\pi^-)$ limits the combinatorial background, despite the low B.R.

- Proton tracks candidates are selected, according to track selection and PID (main selection for protons, using TPC and TOF, number of sigma cut approach)

  - Built Λ_c candidate, combining K^0_S and protons, according to loose topological cuts

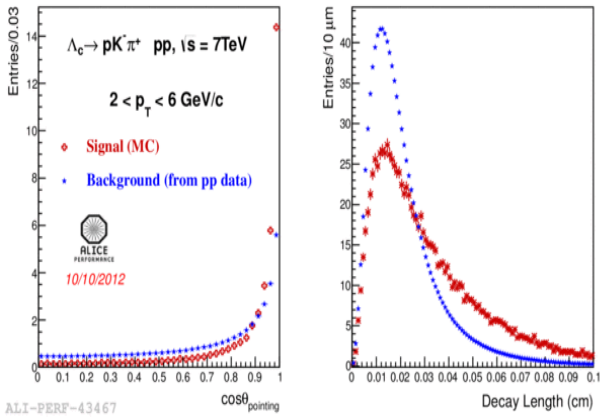
$\Lambda_c \rightarrow pK\pi$ analysis in pp and pPb collisions



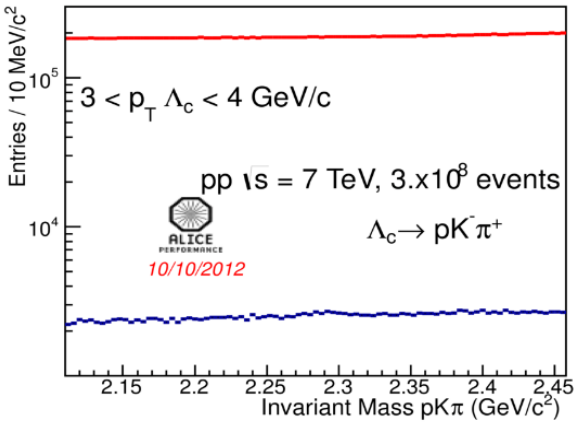
- **pKπ candidates building**

Pairs of opposite charge tracks selected. Third track added to build a triplet and secondary vertex of the triplet estimated.

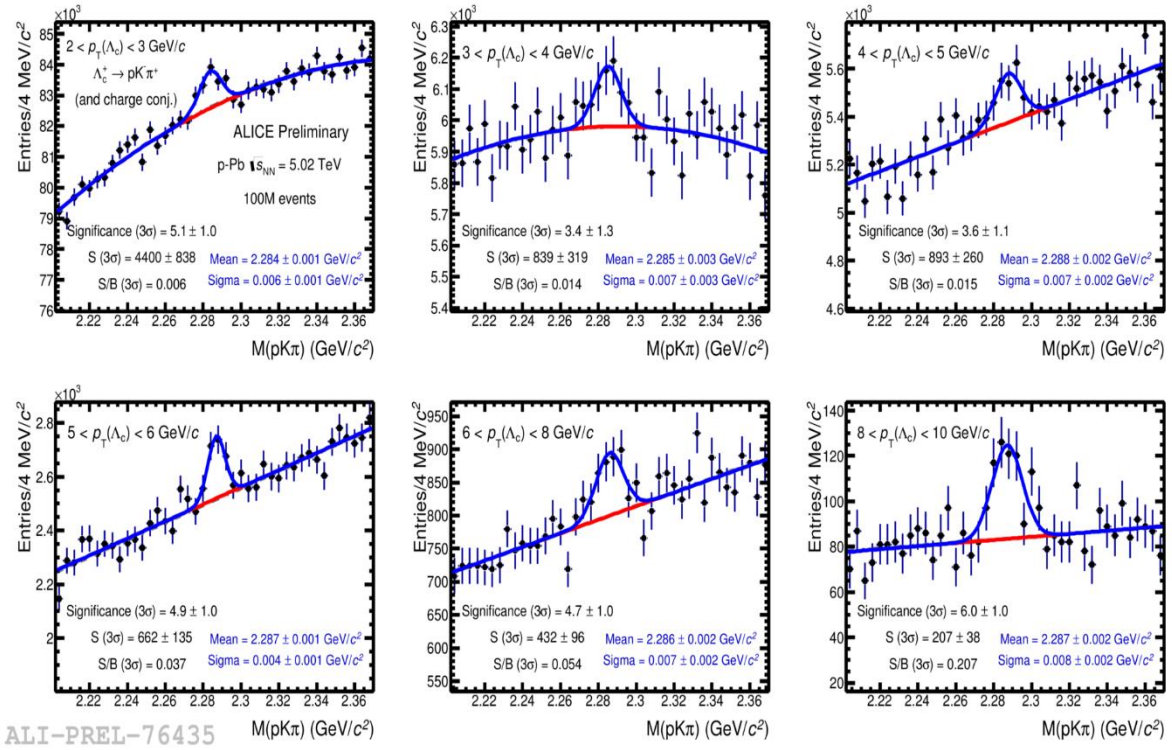
Cuts applied: high-quality single tracks cuts,
cuts on daughter p_T , quality of reconstructed vertex,
DCA (distance of closest approach between tracks),
cosine of Λ_c pointing angle (angle between the Λ_c flight line and the momentum of the reconstructed Λ_c candidates).



- **Particle Identification (PID)**
  - PID is essential to identify protons, kaons and pions
  - Detector used: TOF and TPC.
  - Used approach: Bayesian PID (maximum probability criterion).
  - Using PID the background is suppressed by a factor 100!



Λ_c signal extraction in pp and p-Pb collisions

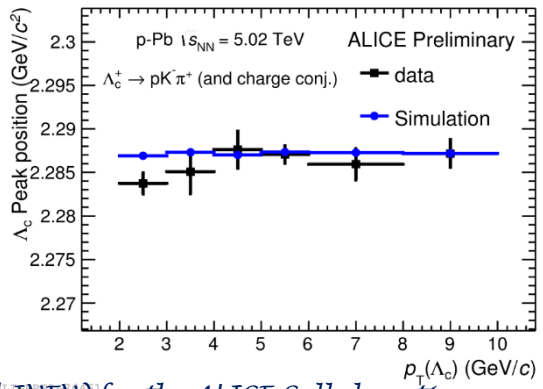


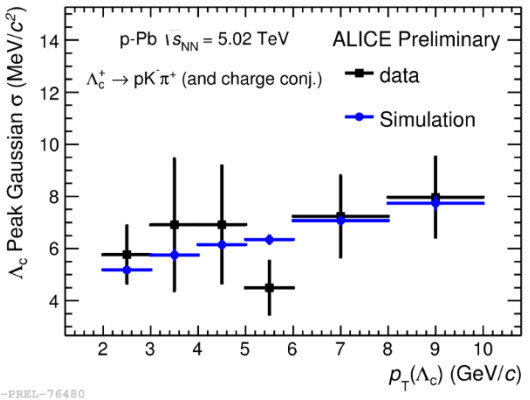
In both analyses:

- Λ_c is reconstructed in a wide momentum range

In both analyses:

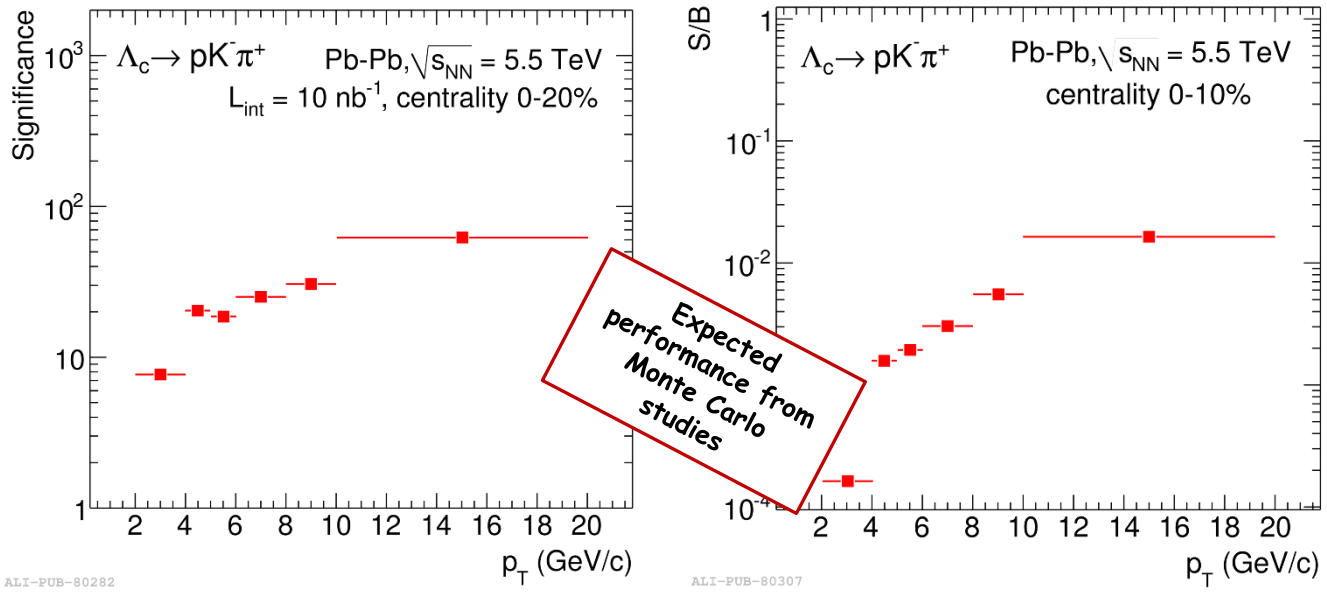
- **Good agreement with MC expectations is observed**





Perspectives for future measurements of Λ_c

- Main goals of the ALICE ITS Upgrade after the second LHC long shutdown (2019))
  - Improve impact parameter resolution (~ factor 3)
  - Improve tracking efficiency and p_T resolution at low p_T
  - Fast readout for data take
- These new features of ALICE will allow to measure charmed hadrons, and in particular Λ_c, in Pb-Pb collisions.



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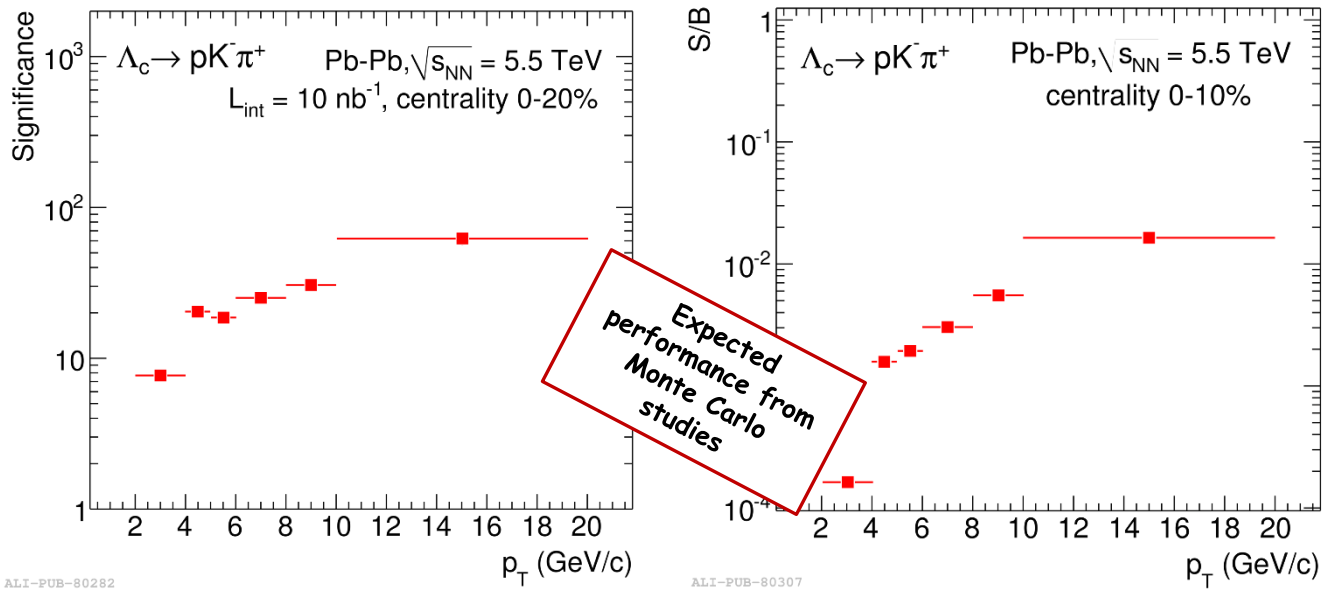


Thank you for your attention

Back up

Λ_c analysis in pp and p-Pb collisions

- Λ_c in pp collisions:
  - Fundamental reference for Pb-Pb
  - Useful test for perturbative Quantum Cromo Dynamics (pQCD)
  - Total cross section of charm production at the LHC with ALICE

    Baryon cross section needed in addition to the D-meson cross section
- Λ_c^+ in p-Pb collisions
  - Rreference for Pb-Pb
  - Study of cold nuclear matter effects (not due to QGP formation, such as modification of the Parton Distribution Functions (PDF), k_T *broadening*)

Decay channels studied in ALICE:

$\Lambda_c^+ \rightarrow p\, K^-\, \pi^+$ and charge conjugate (c.c.)

not resonant: B.R.=(**3.8 ± 0.4**)%

resonant: p K*(892): B.R.=(**2.13 ± 0.30**)%

$\Lambda(1232)^{++}\, K^-$: B.R.=(**0.86 ± 0.30**)%

$\Lambda(1520)\, \pi^+$: B.R.=(**2.4 ± 0.6**)%

B.R. tot=(**6.84** $^{+\,0.32}_{-\,0.40}$)%

$\Lambda_c^+ \rightarrow K^0\, p$ and c. c: B.R. tot =(**3.21 ± 0.30**)%

K^0_S (50%)

$\pi^+\, \pi^-$: B.R.=(69.20 ± 0.05)%

B.R. tot=(**1.11 ± 0.10**)%

$\Lambda_c^+ \rightarrow e^+\, \Lambda \nu_e$ and c. c. B.R.=(2.9 ± 0.5)%

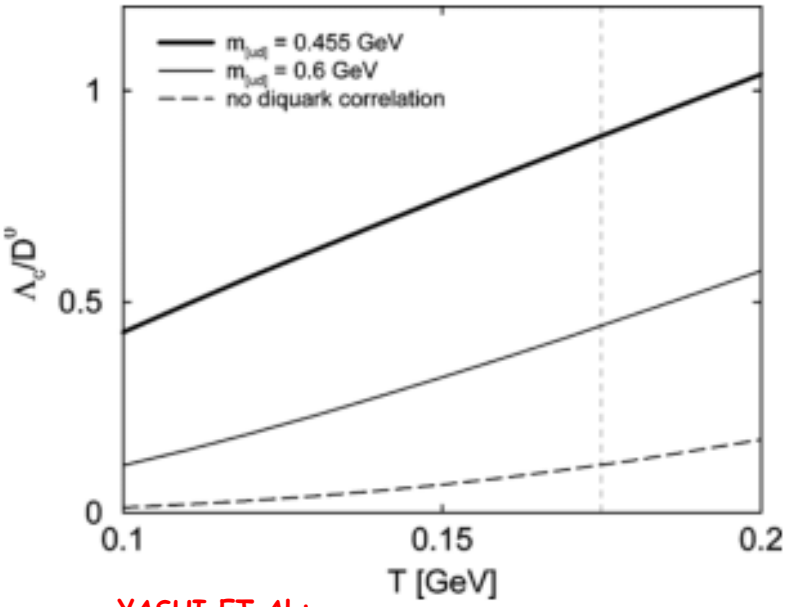
Λ_c analysis in pp and pPb collisions

Motivations in Pb-Pb collisions

- Charm is a very sensitive probe of the *Quark-Gluon-Plasma* (QPG), produced in heavy-ion collisions
- Together with charmed-mesons, the measurement of Λ_c in Pb-Pb collisions could give an insight into the hadronization mechanisms in QGP

Measurement of the baryon over meson ratio in the heavy-quark sector

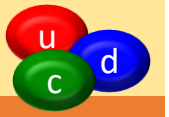
The existence of stable bound diquark in QGP, would lead to a significant enhancement of Λ_c/D ratio in heavy ion collisions



YASUI ET AL;
INDIAN J.PHYS. 85 (2011) 1043-1046)

Yield of Λ_c estimated using coalescent model

$\Lambda_c \rightarrow pK^0_S$ analysis in pp and pPb collisions



Analysis strategy

Next steps:

- Further selection to improve signal extraction, via topological cuts on several variables
- Signal extraction via invariant mass distributions
- Feed down correction
- Efficiency and acceptance corrections
- **Cross section estimate**

$$\left.\frac{d\sigma^{\Lambda_c^{\pm}}}{dp_T}\right|_{|y|<0.5} = \frac{1}{2}\frac{1}{\Delta y \cdot \Delta \mathrm{p_T}}\frac{f_{prompt}\cdot \mathrm{N}^{\Lambda_c^{\pm}\,\mathrm{raw}}}{(\mathrm{Acc}\times\varepsilon)_{prompt}\cdot \mathrm{BR}_{\Lambda_c\rightarrow p\pi^+\pi^-(\leftarrow K^0_S)}\cdot \mathrm{L_{int}}}$$

L_{int} = integrated luminosity
f_{prompt} = fraction of prompt Λ_c, after b feed-down subtraction

N^{Λ_c} raw = raw yield

$BR_{\Lambda_c\rightarrow p\bar{K}^0}$ (2015 PDG)