Study of Λ(1520) resonance production with the ALICE experiment at the LHC

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Abstract

We report on the Λ(1520) production in pp collisions at $\sqrt{s}$ = 7 TeV and 2.76 TeV and in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with the ALICE apparatus at the LHC. The study of the Λ* production is important because its lifetime is comparable to the lifetime of the fireball and it contains all the three light quarks (uds) as valence quarks. The study of the Λ* production can also be used to investigate the medium between chemical and thermal freeze-out, since its decay products may interact with the hadronic medium. Time Projection Chamber (TPC) and Time of Flight (TOF) detectors are being used to identify decay daughters (p & K) of the Λ* to reconstruct the signal in the mid-rapidity region ($|y| < 0.5$) for pp and in the rapidity region ($-0.5 < y < 0$) for p-Pb in the center-of-mass frame.

1. Introduction

- Resonance production in pp collisions provides a reference for nuclear collisions and also data for tuning event generators inspired by quantum chromodynamics. In heavy-ion collisions, the in-medium effects can modify the properties of short-lived resonances such as their masses, widths, and even their spectral shapes [1]. Moreover, due to the short lifetime the regeneration and rescattering effects become important and can be used to estimate the time scale between chemical and kinetic freeze-out [2] in heavy ion collisions.
- We are extracting the Λ* signal by invariant mass reconstruction from the p, K channel (BR 22.5%). We are able to extract a signal starting from low p_T to intermediate p_T in the central rapidity region ($|y| < 0.5$) for pp and in the rapidity region ($-0.5 < y < 0$) for p-Pb in the center-of-mass frame.

2. A Large Ion Collider Experiment

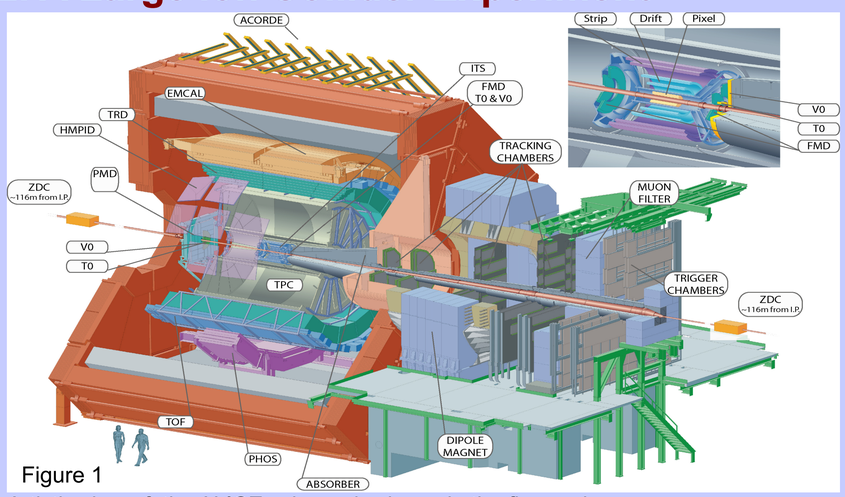

Figure 1

Artistic view of the ALICE scheme is shown in the figure above.

3. Analysis Details

Collision Type	Center of Mass Energy (TeV)	Total Minimum Bias Events (x10^6)
pp	2.76	42
pp	7	135
p-Pb	5.02	110

◆ The specific energy loss of different tracks in TPC is shown in figure 2.

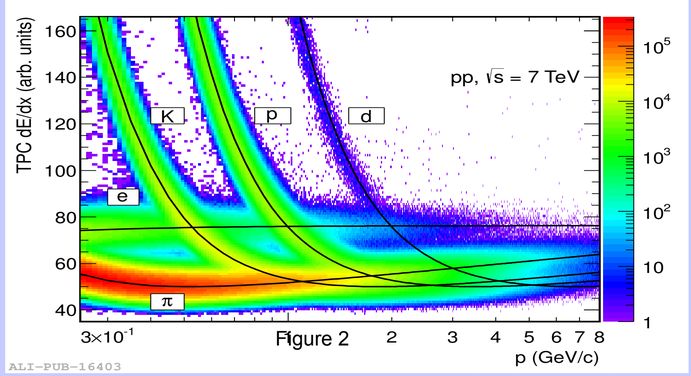

Figure 2

ALI-PUB-16403

◆ The particles used for the analysis (p, K) are required to be in a 2σ band on TOF signal in the full momentum range.
◆ If the track is not present in the TOF, then it is required to be in 2σ band on TPC signal..
◆ Tracks in TPC are only used if they can be clearly identified as Proton or Kaon. For this we restrict the momentum of Protons from 0.15 to 1.1 GeV/c and for Kaons from 0.15 to 0.6 GeV (0.7 GeV/c for pp at √s = 7 TeV).

✧ **Invariant mass reconstruction:**

$$m_0 = \sqrt{\left(\sum E\right)^2 - \left|\left(\sum \vec{p}c\right)^2\right|}$$

$\sum E$ = Sum of the energy of the particle

$\sum \vec{p}$ = Vector sum of the momentum of the particles

✧ **Combinatorial background subtraction:**

✧ **Signal fitting with Voigtian function on top of a polynomial function.**

The Voigtian Function (Breit-Wigner convoluted with Gaussian):

$$\frac{dN}{dm} = A\int \frac{\Gamma/2\pi}{(m-m')^2+\Gamma^2/4}\,\frac{e^{-(m'-m_0)^2/2\sigma^2}}{\sigma\sqrt{2\pi}}\,dm'$$

Where A, m_0, Γ, σ are the area under the peak, mass of Λ*, the FWHM of the peak and the resolution parameter, respectively.

4. Figures

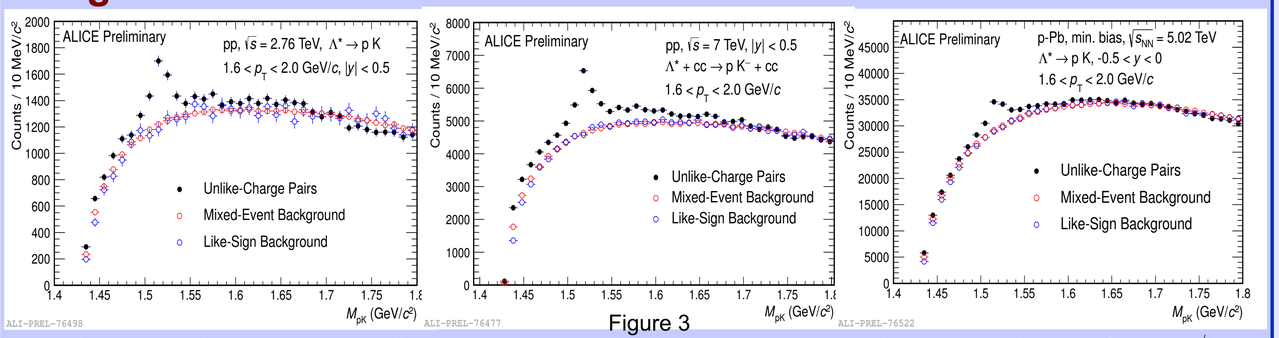

Figure 3

Figure 3 shows the invariant mass distributions, normalized mixed-event background and like-sign background for pp at $\sqrt{s}$ = 2.76 TeV and 7 TeV, and p-Pb at $\sqrt{s_{NN}}$ = 5.02 TeV (Left to right) for the $1.6 < p_T < 2.0$ GeV/c bin.

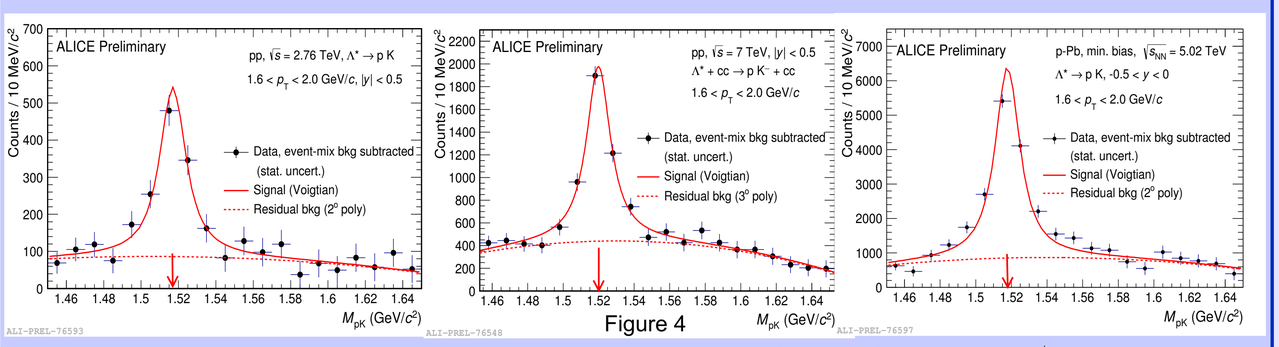

Figure 4

Figure 4 shows the Λ(1520) signals fitted with Voigtian function on top of a 2nd order (3rd order for pp at $\sqrt{s}$ = 7 TeV) polynomial for pp at $\sqrt{s}$ = 2.76 TeV and 7 TeV, and p-Pb at $\sqrt{s_{NN}}$ = 5.02 TeV (Left to right) for the $1.6 < p_T < 2.0$ GeV/c bin.

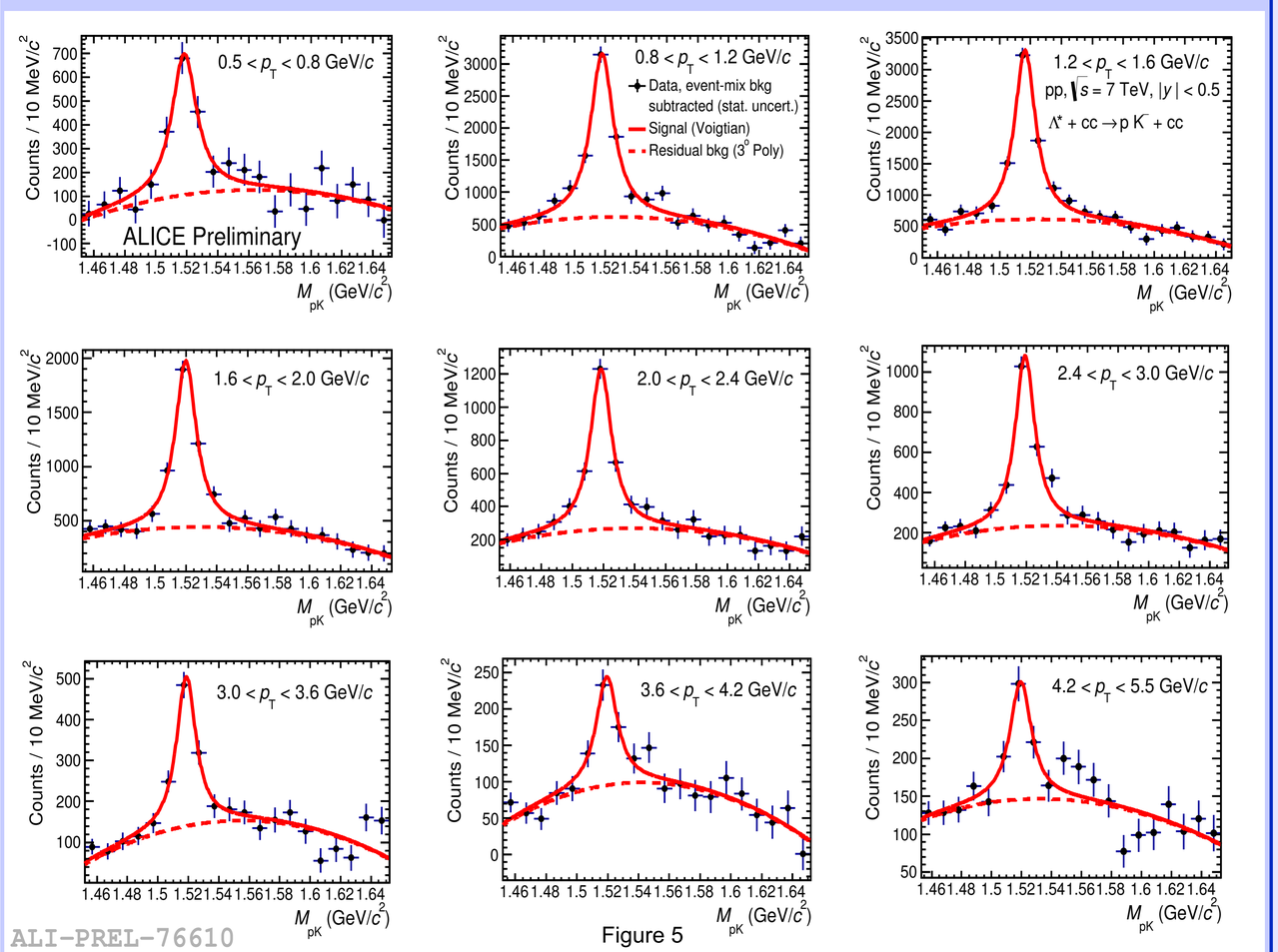

Figure 5

Figure 5 shows signal of Λ* fitted with Voigtian function on top of a 3rd order polynomial in 9 different p_T bins for pp collisions at √s = 7 TeV.

5.Summary

◆ There is a clear signal of the Λ(1520) visible in all systems pp (√s = 2.76 TeV and √s = 7 TeV) and p-Pb (√s = 5.02 TeV) from lower to intermediate p_T region.
◆ Figure 4 shows a good agreement of the mean value of the invariant mass peak and the PDG value.
◆ Work on producing efficiency corrected spectra is underway. From the range in p_T shown in figure 5, we expect that extracting the dN/dy and $\langle p_T \rangle$ will be possible, and these can be compared to Λ(1115) and also other resonances.
◆ These measurements in pp and p-Pb will serve as a baseline for the Pb-Pb measurement.

6.References

[1] G. E. Brown and M. Rho, Phys. Rev. Lett. **66**, 2720 (1991). R. Rapp, Nucl. Phys. **A 725**, 254 (2003). E. V. Shuryak and G. Brown, Nucl. Phys. **A 717**, 322 (2003).
[2] G. Torrieri and J. Rafelski, Phys. Lett. **B 509**, 239 (2001).