RESONANCE RESULTS FROM THE ALICE DETECTOR IN 7 TeV pp COLLISIONS AT THE LHC*

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The study of resonances in $\sqrt{s} = 7$ TeV pp collisions provides a test of QCD in a new energy domain as well as a baseline for heavy-ion collisions. The resonances $K^*(892)^0$, $\phi(1020)$, $\Lambda(1520)$, $\Sigma(1385)^{\pm}$, and $\Xi(1530)^0$ are reconstructed at mid-rapidity from their hadronic decay using data collected by the ALICE detector. We compare the $\phi(1020)$ and $\Sigma(1385)^{\pm}$ p_{T} spectra to perturbative QCD models such as PHOJET and different PYTHIA tunes. We also search for the $\Phi(1860)$ pentaquark for which we find no evidence.

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1. Introduction

The study of resonance production in pp collisions is important in two noteworthy ways. By comparing the measured spectra of resonances to PYTHIA predictions we can improve our understanding of hadronization. Also, the measured spectra in pp provide a baseline for particle production enhancement/suppression studies in Pb–Pb, R_{AA}.

2. Results

Data for the results presented here were taken during the 2010 $\sqrt{s} =$ 7 TeV pp run at the LHC using minimum bias collisions with the ALICE detector. The number of events used ranged from 24 to 150 M events depending on the resonance. The resonances were reconstructed using their main hadronic decay channels:

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$$\begin{aligned} K^*(892)^0 &\rightarrow K^- + \pi^+(+cc)\,, \\ \phi(1020) &\rightarrow K^{+-} + K^{-+}\,, \\ \Sigma(1385)^{+-} &\rightarrow \Lambda + \pi^{+-}\,, \\ \Lambda(1520) &\rightarrow p^+ + K^-(+cc)\,, \\ \Xi(1530)^0 &\rightarrow \Xi^- + \pi^+(+cc)\,, \end{aligned} \tag{1}$$

where the weak decays of the Ξ^{+-} and Λ were reconstructed through their main charged hadronic decay channels, $\Xi^{+-} \rightarrow \Lambda + \pi^{+-}$ and $\Lambda \rightarrow p^+ + \pi^-$, respectively. Particle tracking was done using the Inner Tracking System (ITS) and the Time Projection Chamber (TPC) [1]. Particle identification was done via the measured energy loss in the TPC as well as the timing information from the Time-of-Flight (TOF) detector. Identical track quality assurance cuts were applied to the decay daughters of all resonances. These include cuts on: number of TPC clusters used for tracking, and $p_T > 0.15$ GeV/c for instance. The chosen rapidity range was $|y| < 0.5$ for the $K^*(892)^0$, $\phi(1020)$, and $\Xi(1530)^0$. While for the $\Sigma(1385)^{+-}$ and $\Lambda(1520)$ it was $|y| < 0.8$ and $|y| < 0.9$, respectively.

All resonances for which we present a p_T spectrum are compared to two QCD inspired models: PHOJET [2] and PYTHIA [3]. For PYTHIA we use three different tunes: D6T, ATLAS-CSC, and Perugia 2011. It is worth mentioning that the latest PYTHIA tune, Perugia 2011, already contains some input from the LHC experiments for the measured multiplicity distributions and strangeness production.

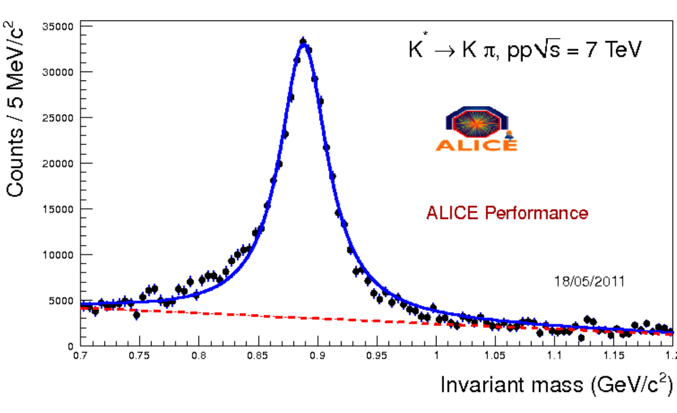

Fig. 1. $K^*(892)^0$ invariant mass distribution in $\sqrt{s} = 7$ TeV pp collisions. The same charge pion–kaon invariant mass distribution is used to subtract the background. The resulting distribution is fit with a Breit–Wigner + 1$^{\text{st}}$ degree polynomial.

The $K^*(892)^0$ invariant mass distribution is shown in Fig. 1. The same charge background estimation is subtracted from the opposite charge signal distribution and the resulting peak is fitted with a Breit–Wigner function. The p_{T} spectrum for the $K^*(892)^0$ is underway.

The $\phi(1020)$ p_{T} spectrum compared to the various models is shown in Fig. 2. Here, we observe that the D6T tune of PYTHIA provides very good agreement for $p_{\mathrm{T}} < 2.0$ GeV/c while for higher p_{T} PHOJET seems to give a better description of the data. The latest tune, Perugia 2011, does not provide a good description of the data.

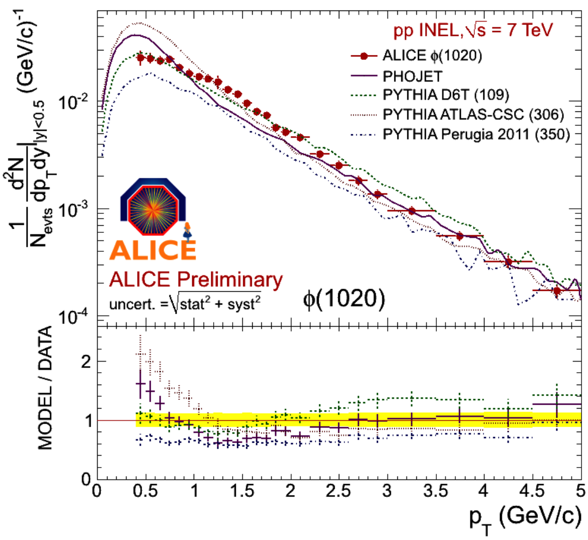

Fig. 2. $\phi(1020)$ p_{T} spectrum compared to various PYTHIA tunes and PHOJET in $\sqrt{s} = 7$ TeV pp collisions. The bottom panel displays the ratio to the models.

The $\Sigma(1385)^-$ and $\Sigma(1385)^+$ p_{T} spectra compared to the various models are shown in Fig. 3 and Fig. 4, respectively. For these two baryon resonances we see that all models underpredict the data with PHOJET being the furthest off.

The $\Xi^\pm + \pi^\pm$ invariant mass distribution is shown in Fig. 5. Clearly visible is the $\Xi(1530)^0$ peak for opposite charge combinations in black (blue). Also shown is the same charge combination in grey (red). Both combinations may contain the decay of the hypothetical doubly-charged and neutral $\Phi(1860)$ pentaquark. Evidence for this particle was found by the NA49 Collaboration in $\sqrt{s} = 17.2$ GeV pp collisions at the SPS [4]. Here we do not see any visible peak. To further quantify this observation we took the ratio of the $\Xi(1530)^0$ yield to the maximum possible excess yield in the $\Phi(1860)$ (the same-charge) mass range above the background while accounting for 3σ (99% confidence level) statistical fluctuations. An identical procedure was done by the COMPASS Collaboration [5]. The ratio for NA49 is 4.2 while for ALICE it is greater than 31 indicating stronger evidence against this hypothetical particle at the LHC.

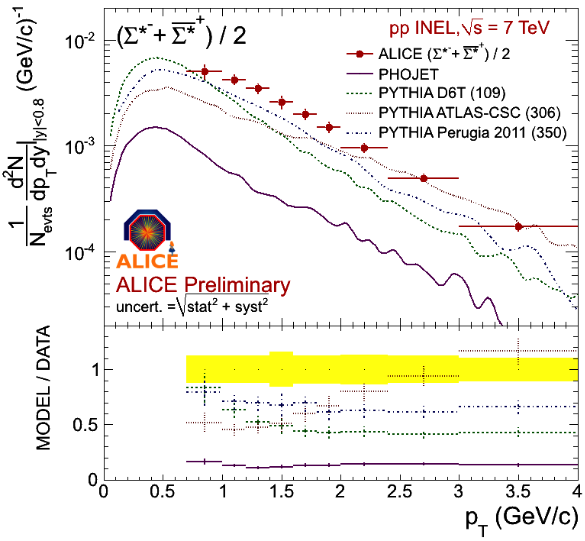

Fig. 3. $\Sigma(1385)^-$ p_{T} spectrum compared to various PYTHIA tunes and PHOJET in $\sqrt{s} = 7$ TeV pp collisions. The bottom panel displays the ratio to the models.

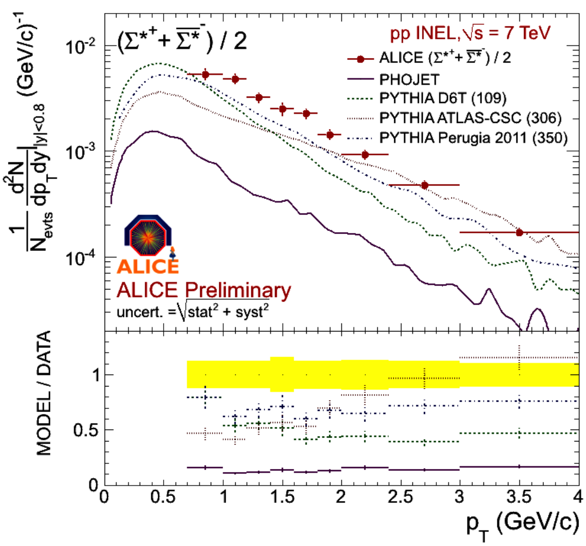

Fig. 4. $\Sigma(1385)^+$ p_{T} spectrum compared to various PYTHIA tunes and PHOJET in $\sqrt{s} = 7$ TeV pp collisions. The bottom panel displays the ratio to the models.

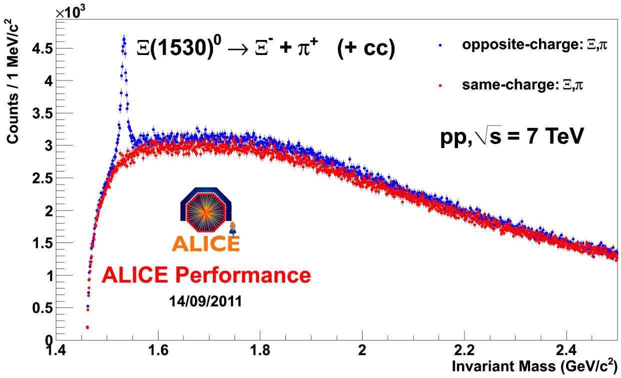

Fig. 5. Charged $\Xi + \pi$ invariant mass distribution in $\sqrt{s} = 7$ TeV pp collisions. Black (blue) points are opposite charge combinations and grey (red) are the same charge combinations. The $\Xi(1530)^0$ peak is clearly visible while the hypothetical $\Phi(1860)$ pentaquark is not visible.

The $\Lambda(1520)$ as well as the doubly charged $\Delta(1232)$ can be reconstructed with the ALICE detector as well. Figure 6 shows the $\Lambda(1520) \rightarrow p^{+-} + K^{-+}$ invariant mass distribution for candidates with $1.25 < p_{\mathrm{T}} < 1.50$ GeV/c and $|\eta| < 0.9$. The peak is fit with a Breit–Wigner function and the combinatoric background with a polynomial. The p_{T} spectra for these particles are underway.

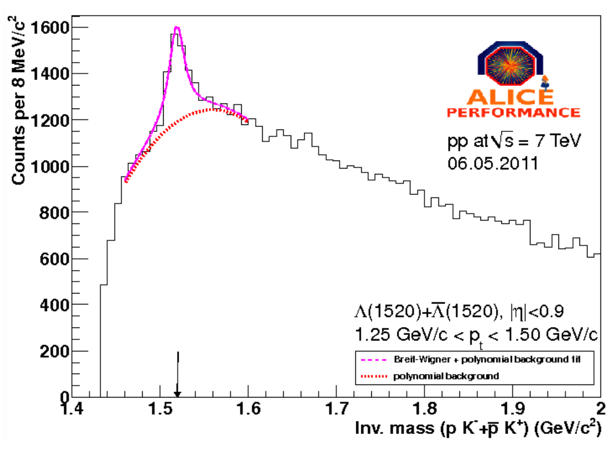

Fig. 6. $\Lambda(1520)$ invariant mass distribution for $1.25 < p_{\mathrm{T}} < 1.50$ GeV/c and $|\eta| < 0.9$ in $\sqrt{s} = 7$ TeV pp collisions.

3. Conclusions

We find that none of the QCD inspired models simultaneously describe all of the resonance spectra presented here. In particular, the latest PYTHIA tune, Perugia 2011, does not generally provide a good description of resonance production despite its input from the early LHC results. We also observe quite a significant $K^*(892)^0$, $\Xi(1530)^0$, and $\Lambda(1520)$ invariant mass peak for which p_{T} spectra are underway. Finally, we see no evidence for the hypothetical $\Phi(1860)$ pentaquark.

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