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Identified particle spectra measured by the ALICE experiment in pp collisions at $\sqrt{s} = 0.9$ and 7 TeV.

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ALICE will study the physics of the strongly interacting matter produced in nucleus-nucleus collisions at the LHC where the formation of a Quark Gluon Plasma is expected. However, the physics program of ALICE has already started with the study of proton-proton collisions at unprecedented high energies. These collisions also allow us to calibrate and prepare our detectors for the future heavy-ion collisions and, more importantly, the measured properties of the pp collisions will set the baseline for the nucleus-nucleus collisions. In this presentation, we will present some of the first results from the current pp data taking, in particular identified particle spectra.

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1. Introduction

The main goal of ALICE is to study the physics of the strongly interacting matter, the Quark Gluon Plasma, that will be produced in nucleus-nucleus collisions at the LHC, and therefore, the design of the experiment was driven by this goal. Its main features are high-precision tracking and particle identification in a very high particle density environment and over a large range of momentum.

The physics program of ALICE has already started with the study of proton-proton collisions at unprecedented high energies. These collisions serve first of all to calibrate and prepare our detectors for the future heavy-ion collisions; to measure the properties of these collisions that will set the hadronic reference for nucleus-nucleus collisions; to understand particle production in a new energy domain; and finally to search for collective effects at partonic level. In the following sections we will briefly describe the ALICE experiment and present some of the results from pp collisions at $\sqrt{s} = 0.9$, 2.36 and 7 TeV: charged particle multiplicity, transverse momentum spectra, and identified charged hadrons.

2. ALICE

The ALICE detector is described in [1]. The results presented here use data from the Inner Tracking System (ITS), the Time Projection Chamber (TPC), the Time Of Flight (TOF), and the VZERO counters. The ITS is composed of three high resolution silicon tracking detectors. It consists of two cylindrical layers of silicon pixel detector (SPD), two of silicon drift detector (SDD), and two of silicon strip detector (SSD). It allows precision tracking in the pseudorapidity region of $|\eta| < 0.9$. The TPC is a large cylindrical drift detector, optimized for large track densities, that allows reconstruction of particle tracks with a transverse momentum resolution better than 5% up to $p_T = 10$ GeV/c in $|\eta| < 0.9$. The TOF consists of 18 supermodules optimized for charged particle identification with a detection efficiency in excess of 99%. The two VZERO counters are located at distances $z = 3.3$ m and $z = -0.9$ m of the nominal interaction point and they cover the pseudorapidity ranges $2.8 < \eta < 5.1$ and $-3.7 < \eta < -1.7$, respectively. They are used for triggering and for discriminating beam-gas interactions.

3. Charged particle multiplicity

Charged particle multiplicity was studied in pp collisions at three different energies $\sqrt{s} = 0.9$, 2.36, and 7 TeV for inelastic (INEL) and non-single-diffractive (NSD) events. For the INEL sample a trigger requiring a signal in either the SPD or one VZERO side was used. This trigger is sensitive to $95-97\%$ of the inelastic cross section (shown by simulations [2]). For the NSD sample a trigger to reduce the amount of single diffractive events while retaining most of the NSD events is used. It requires a signal on both VZERO sides.

The results on pseudorapidity charged particle density at midrapidity indicate an increase on this density of about 24% from 0.9 to 2.36 TeV collisions [3] and of about 57% from 0.9 to 7 TeV collisions [4]. These results are above Monte Carlo model predictions such as PYTHIA [5] and PHOJET [6]. The measured multiplicity distributions in 0.9 and 2.36 TeV collisions and in limited η-regions are well described by negative binomial distributions (NBD) that have shown to fit

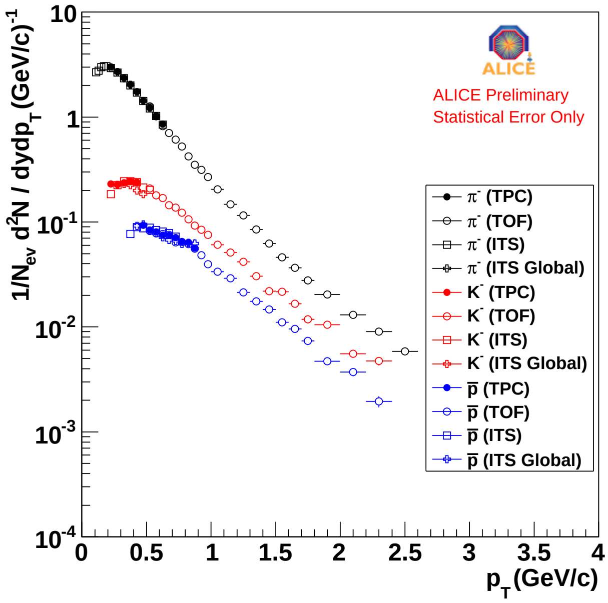

Figure 1: Identified charged hadron spectra for negative hadrons: pions, kaons and antiprotons, as measured in the ITS, the TPC and the TOF.

distributions at lower energies [7]. At 7 TeV, the NBD fit slightly underestimates the data at low multiplicities ($N_{ch} < 5$) and overestimates it at large multiplicities ($N_{ch} > 25$).

4. Transverse momentum distribution

The inclusive charged particle transverse momentum distribution is measured in pp collisions at $\sqrt{s} = 0.9$ TeV, in the central pseudorapidity region ($|\eta| < 0.8$) over the transverse momentum range $0.15 < p_T < 10$ GeV/c. The average transverse momentum is $< p_T >_{\rm INEL}= 0.483 \pm 0.001(\text{stat.}) \pm 0.007(\text{syst.})$ [8]. Our results exhibit a harder momentum spectrum of primary charged particles than other measurements at the same energy and we argue that this is most likely due to our smaller pseudorapidity interval. None of the models and tunes investigated simultaneously describes the p_T spectrum and the correlation between $< p_T >$ and N_{ch}.

5. Identified charged hadrons

Figure 1 shows the identified charged hadron spectra for negative hadrons in pp collisions at $\sqrt{s} = 0.9$ TeV. Notice that error bars correspond only to statistical uncertainties. The results shown combine the measurement of identified particles in three different detectors: ITS, TPC, and TOF. This allows us to measure the spectra of identified hadrons from very low p_T (~ 200 MeV) up to $p_T \simeq 2.5$ GeV. This figure also shows the good agreement between the measurement of identified particles in the different detectors.

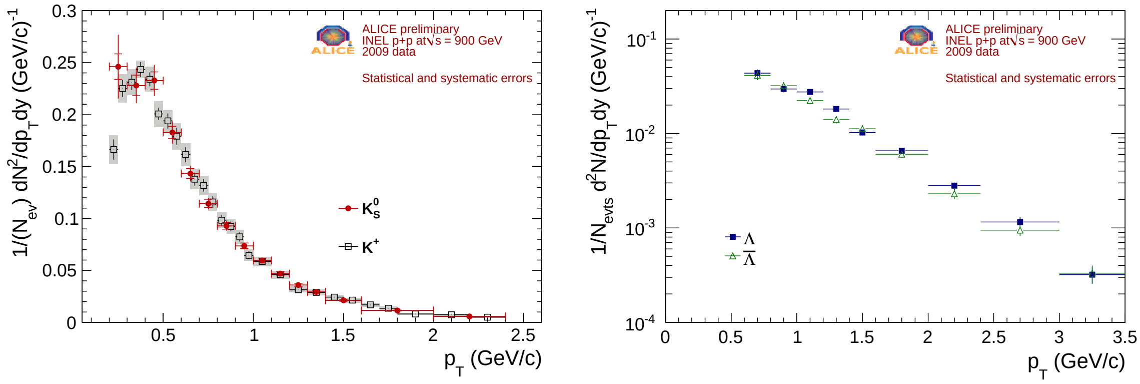

Figure 2: K^0_S and K^+ p_T spectra (left) and Λ^0 and $\bar{\Lambda}$ p_T spectra left in pp collisions at 900 GeV.

The measurement of strange particles (particles containing at least one s quark) reconstructed through their topological decays will allow to extend the hadron spectrum to higher values of p_T. Figure 2, left, shows the p_T spectrum of K^0_S reconstructed through V_0 reconstruction: $K^0_S \to \pi^+\pi^-$, with pions reconstructed in the TPC, and of K^+ reconstructed through particle identification in the TPC. Figure 2, right, shows the p_T spectrum of Λ^0 and $\bar{\Lambda}^0$ reconstructed through V_0 reconstruction: $\Lambda^0 \to p\pi^-$ and $\bar{\Lambda}^0 \to \bar{p}\pi^+$ respectively, with protons and pions reconstructed in the TPC.

6. Conclusions

ALICE has measured the charged particle density, the charged particle transverse momentum distribution and the identified charged hadron spectra for pions, charged and neutral kaons, protons and lambdas, in pp collisions at different energies. The measured particle multiplicity is higher than predicted by Monte Carlo model calculations. These models are not able to simultaneously describe the p_T spectrum and the correlation between $< p_T >$ and N_{ch}. Measurements of hadron spectra is ongoing for a lot of different hadron species using very different techniques in different detectors and final results will be available soon.

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