Performance Report of the ALICE for the first $p+p$ collisions at $\sqrt{s} = 0.9$ and 7 TeV

T. Gunji, H. Hamagaki, S. Sano Y. Hori, for the ALICE Collaboration

Center for Nuclear Study, Graduate School of Science, University of Tokyo, Japan

1. Introduction

The Large Hadron Collider (LHC) at CERN is the largest accelerator in the world and the LHC sheds light on new era for the elementary particle physics and nuclear physics.

ALICE (A Large Ion Collider Experiment) is one of the experiments performed at LHC and is dedicated for the study of strongly interacting matter created in heavy ion collisions at the LHC. The ALICE experiment consists of a larger number of detectors [1]. Central barrel detectors measuring hadrons, electrons and photons at $|\eta| \leq 0.9$ are composed of an Inner Tracking System (ITS) of high-resolution silicon detectors, a cylindrical Time-Projection Chambers (TPC), a Transition Radiation Detectors and a Time-Of-Flight (TOF) detector. A single arm detectors of lead-scintillation Electromagnetic Calorimeter (EMCal), a lead-tungsten crystal calorimeter (PHOS), and a ring imaging Cherenkov hodoscope (HMPID) complement the central barrel of ALICE. The forward muon arm consists of a complex of absorbers, a dipole magnet, and tracking and triggering muon chambers. Several smaller detectors (T0, ZDC, FMD, PMD) are also installed at forward rapidity in ALICE for the global event characterization and trigger. At present, the central barrel detectors ITS, TPC and TOF are completely installed. 7 out of 18 TRD super-modules have been installed and EMCal and PHOS are partially installed. Trigger detectors such as ZDC, V0 and T0 are fully installed. A High Level Trigger (HLT) is available to trigger the events on the basis of on-line reconstruction, select physics region of interest within event and reduce the data size without loss of physics information.

CNS has an activity for the commissioning of the TRD, especially taking a leading role for the development of the slow control system, surface testing of the super-module and installation in the experimental area [2,3].

2. First $p+p$ collisions at LHC-ALICE

On 23rd Nov. in 2009, two counter-rotating proton bunches with the LHC injection energy of 450 GeV were circulated for the first time at the LHC. Although the intensity was low, with only one bunch per beam and no systematic attempt for optimization of the collisions optics, the ALICE measured a number of collisions candidates. Proton-proton collisions with $\sqrt{s} = 900$ GeV had been conducted until Dec. 14th and followed by the 2.36 TeV proton-proton collisions, which lasted on Dec. 16th. During this period, the ALICE measured roughly 0.4 M events, which correspond to 10 $\mu$b$^{-1}$ as an integrated luminosity. Commissioning of 2010 proton-proton collisions started from January and physics data taking with $\sqrt{s} = 7$ TeV proton-proton collisions started from 30th March. Data taking is successfully continued and the ALICE has collected 50 M events in 7 TeV proton-proton collisions corresponding to 1 nb$^{-1}$ by the end of April.

3. Detector Performance

In this section, the detector performance of ALICE in 0.9 and 7 TeV proton-proton collisions at LHC is described. Figure 1 shows $dE/dx$ measured by TPC as a function of momentum. $dE/dx$ for electrons, pions, Kaons and protons are clearly separated. The momentum resolution measured with TPC is 7% at 10 GeV/$c$ from 2009 cosmic ray experiments. Figure 2 shows the correlation between transverse momentum and measured $\beta$ by TOF. Signals from p/K/proton are clearly separated. Upper of Fig 3 shows the mean pulse height of electrons and pions measured by TRD and right shows the signal spectrum for electrons and pions. The pion rejection factor with the TRD is studied by projecting $dE/dx$ distribution measured with TPC as shown in Fig. 4, where TPC $dE/dx$ signals relative to the electron Bethe-Bloch line with and without electron tagging in the TRD are shown. Pion rejection factor of 90 is achieved at the electron efficiency of 50%.

Figure 5 shows the resolution of transverse impact parameter measured with the ITS as a function of the transverse momentum, which is crucial for the measurement of displaced decay vertex of heavy quarks. The achieved resolution is less than 50 $\mu$m for $p_T \geq 3$ GeV/$c$ and compatible to that obtained in the simulation.
Figure 2. Particle velocity measured by TOF as a function of momentum in $p + p$ collisions at $\sqrt{s} = 900$ GeV.

Figure 3. Response of the TRD to $\pi$ from $K_0^s$ decays and to electrons from conversion. Upper shows the spectra of energy-deposit in the TRD and bottom shows pulse height as a function of drift time [100 nsec/bin].

Figure 4. TPC $dE/dx$ signal relative to the electron Bethe Bloch line for 2 GeV/$c$, with and without electron tagging in the TRD.

Figure 5. Transverse impact parameter resolution with respect to primary vertex as a function of the transverse momentum measured by ITS.

first $p + p$ collisions at $\sqrt{s}$ of 900 GeV, ALICE measured charged particle multiplicities and published the results to Ref. [4], where the results are in good agreement with the results from UA5 collaboration. The charged particle multiplicity at 7 TeV has been also measured and multiplicity dependence of particle production ($p_T$ distribution, strangeness particles, resonances, ratio of particle yield, high $p_T$ and jet production, heavy quark production) are under studying [5,6]. Around the end of 2010, first Pb+Pb collisions will be performed with the center of energy per nucleon ($\sqrt{s_{NN}}$) of 2.76 TeV, which is 13 times larger than at RHIC. Due to the limited luminosity planned, the ALICE will measure the soft particle production such as multiplicities, integrated elliptic flow, and $p_T$ distribution of charged particles in the first Pb+Pb collisions.

5. Summary and Outlook

The first proton+proton collisions at $\sqrt{s}$ of 0.9, 2.36 and 7 TeV were conducted at the LHC-ALICE and the ALICE detectors are successfully commissioned. Analysis of the detector performances has been conducted and the ALICE demonstrated the excellent capability for the measurement of various particles with a wide kinematic range. The analysis in 7 TeV proton+proton is going, especially multiplicity dependence of soft particle production and hard probes such as high $p_T$ particles, jets and heavy quarks. The first Pb+Pb collisions with the center of mass energy per nucleon of 2.76 TeV will start around the end of October in 2010. The ALICE is ready for the first Pb+Pb collisions.

References