IL NUOVO CIMENTO Vol. 33 C, N. 6 Novembre-Dicembre 2010
DOI 10.1393/ncc/i2011-10712-6

Colloquia: IFAE 2010

Status of the ALICE detector and first results

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(ricevuto l'8 Ottobre 2010; pubblicato online il 10 Gennaio 2011)

Summary. — The status of the ALICE detector at the CERN LHC is reviewed. First physics results from proton-proton collisions recorded during the 2009 data-taking period are presented.

PACS 25.40.Ep – Inelastic proton scattering.

1. – Introduction

The ALICE experiment has been designed to study heavy-ion collisions at high energy at the CERN LHC [1]. The search for quark-gluon plasma requires great capabilities to measure the event characteristics in a high-multiplicity enviroment (from 5000 to 8000 particles per unit rapidity), more specifically particle flows, event shapes, jet quenching etc. Moreover precise particle identification capabilities are needed to detect the expected increase in strange quark abundance.

As a consequence the ALICE experiment has chosen detectors capable to fulfill the above requirements, being complementary to the other LHC experiments, more devoted to the study of very hard interactions. The central detectors are placed inside the large L3 magnet which provides a uniform solenoidal field up to 0.5 tesla (fig. 1). The inner berillium beam pipe is surrounded by the Inner Tracking System (ITS) made of 6 layers of silicon detectors: 2 with pixels (SPD), 2 with drift (SDD) and 2 with strips (SSD) with $r\phi$ and z resolutions of 12, 35 and 20 μm and 100, 25 and 830 μm, respectively. A large Time Projection Chamber (TPC) provides accurate tracking and $\mathrm{d}E/\mathrm{d}x$ measurement. A Transition Radiation Detector (TRD) gives electron identification above 1 GeV/c. A Time-of-Flight system (TOF) made of Multigap Resistive Plate Chambers (MRPC) allows particle identification up to 2.5 GeV/c. Three detectors with partial angular coverage complete the particle identification system: the High Momentum Particle Identification RICH detector (HMPID) identifies particles up to 5 GeV/c; the Photon calorimeter (PHOS) provides photon identification via PbW crystals; the Electromagnetic Calorimeter (EMCAL), placed opposite to the PHOS, extends photon, electron

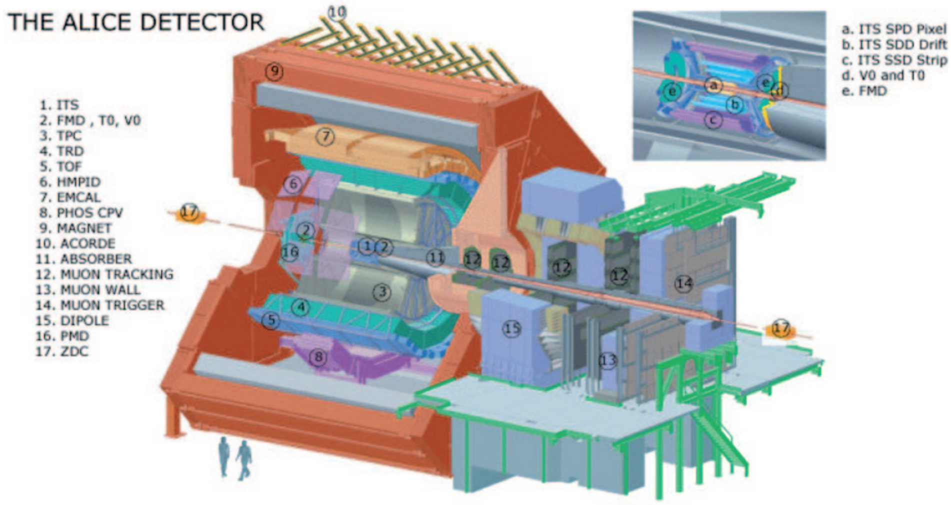

Fig. 1. – The ALICE experiment.

and jet energy measurements. A muon detection arm (MUON) identifies muons in the forward region. Several detectors along the beam pipe provide information on vertex position, beam background, interaction time (V0, T0) and global event characterization (FMD and PMD). At 116 m from the interaction point, on both sides, two Zero Degree Calorimeters (ZDC) provide measurement of the proton, neutron and nuclei remnant in the forward direction.

The performance of the various ALICE detectors has been measured both with cosmics and with real data during the 2009. More details may be found in [2].

2. – Results from the 2009 data taking

During the 2009 ALICE collected data at 0.9 and 2.36 TeV. The trigger was defined requiring at least one hit in the SPD in coincidence with the signals from the two beam pick-up counters indicating the presence of two passing proton bunches. At 0.9 TeV the SPD trigger was OR-ed with a signal from the V0 detector.

The charged particle density was measured at 0.9 TeV with the first 284 events collected on the 23rd November [3]. This measurement was based on tracks reconstructed only by the SPD and has been refined including the full statistics of the 2009 and the higher-energy data. The preliminary result is shown in fig. 2 for both inelastic events (INEL) and non–single-diffractive events (NSD). The first sample includes all inelastic interactions collected by the trigger, *i.e.* single-diffractive, double-diffractive and non-diffractive. The beam background fraction has been evaluated to be $\approx 10\%$ by visual scan of the events and comparison with MC simulations. The selection efficiencies were evaluated using different MCs: as an example at 2.36 TeV they were found to be 86–90% for the INEL sample and 94–97% for the NSD, depending on the event generator used.

In fig. 2 the measurements from UA5 and CMS [4] are also included: the three experiments show good agreement. Comparison with different Monte Carlo generators

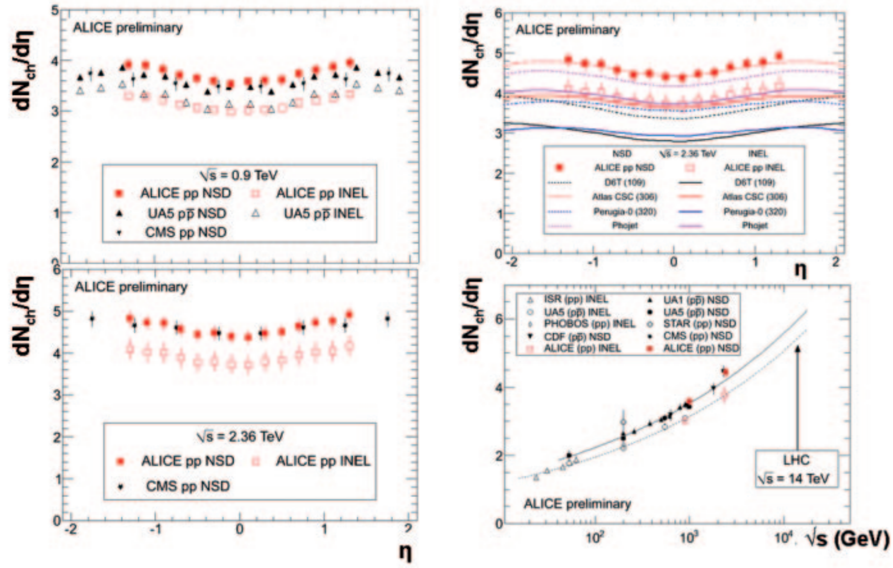

Fig. 2. – Left: the charged-particle density as a function of the pseudorapidity for 0.90 and 2.36 TeV compared with UA5 and CMS data. Upper right: comparison of the particle density at 2.36 TeV with different MCs. Lower right: energy dependence of the particle density, the lines represent power-law fits to the data.

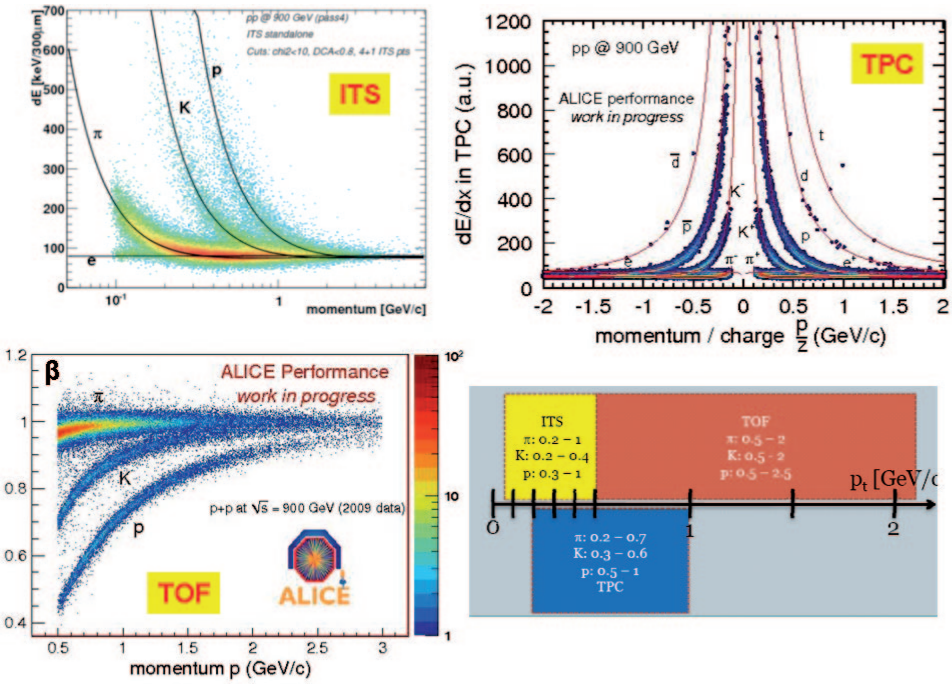

Fig. 3. – The correlation dE/dx *versus* momentum for the ITS and TPC detectors (upper plots) and the β-*versus*-momentum plot for TOF (lower-left plot). The momentum coverage for PID for the three ALICE detectors is shown in the lower-right part.

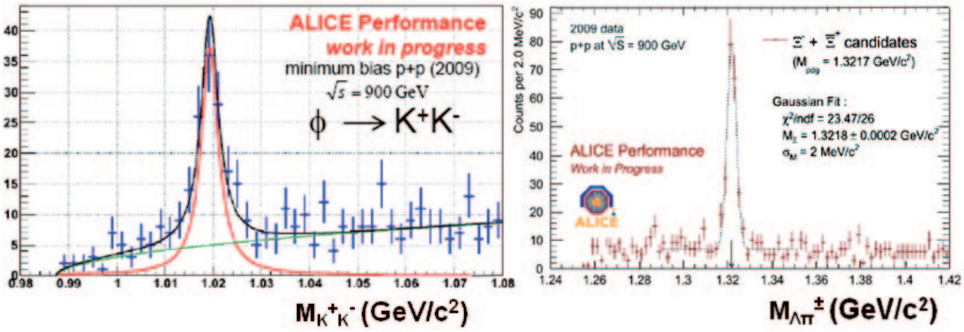

Fig. 4. – Left: $\mathrm{K}^{+}\mathrm{K}^{-}$ invariant-mass plot with a clear ϕ signal. Right: Λ π invariant-mass plot with a clear Ξ signal.

gives already indication of a general underestimation of the density in the MCs, with PHOJET [5] and PYTHIA ATLAS-CSC [6] somehow nearer to the data. The same conclusion could be obtained from the multiplicity distributions (not shown). The energy dependence of the charged-particle density is reported in the same figure, showing the steady increase with energy.

The good capability to identify particles in ALICE is well described in fig. 3. Here the ITS and TPC $\mathrm{d}E/\mathrm{d}x$ measurements are shown together with the β-momentum plot from TOF: a clear accumulation of points in correspondance of the various particle species is visible in all three cases. For the TPC and ITS the lines correspond to the ALEPH parametrization of the Bethe-Bloch curve. In fig. 3 the momentum coverage of the three detectors is also reported, showing the different intervals for particle indentification and the overlapping regions which will ensure cross-calibrations.

Turning to resonance production, fig. 4 shows two examples of the preliminary results from ALICE. In the left one the invariant mass $\mathrm{K}^{+}\mathrm{K}^{-}$ is reported with K identified by TOF: the data are fitted with a background plus a Breit-Wigner and show a large ϕ signal. In the second one Λ particles are reconstructed from secondary vertex analysis and are combined with an extra pion to obtain a clear Ξ signal.

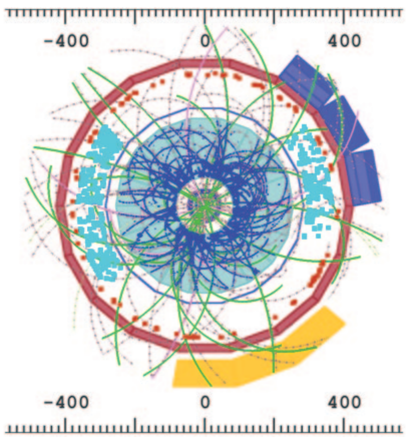

Fig. 5. – A 7 TeV proton-proton interaction as recorded in ALICE.

3. – Conclusions

With the data collected at 0.9 and 2.36 TeV the ALICE experiment has already provided measurements of charged-particle density and multiplicity distributions which point to an underestimate of the MCs with the current parametrizations. Particle identification in ALICE has proved to be within the design specifications and several resonances have been already observed. Data taking at 7 TeV has recently started (see fig. 5) and the ALICE experiment is ready to study this new energy frontier.

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