IL NUOVO CIMENTO Vol. 34 C, N. 6 Novembre-Dicembre 2011
DOI 10.1393/ncc/i2011-11104-8

Colloquia: IFAE 2011

Physics results with the ALICE TOF detector

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(ricevuto il 29 Luglio 2011; pubblicato online il 21 Dicembre 2011)

Summary. — The ALICE experiment collected collisions at LHC at $\sqrt{s} = 0.9\,\text{TeV}$ and $\sqrt{s} = 7.0\,\text{TeV}$ with proton-proton and at $\sqrt{s_{NN}} = 2.76\,\text{TeV}$ with lead-lead. ALICE, compared with other LHC experiments, has several detectors with Particle IDentification (PID) capabilities. Physics results involving PID will be presented, with special emphasis on the Time-Of-Flight (TOF) analysis.

PACS `29.40.Cs` – Gas-filled counters: ionization chambers, proportional, and avalanche counters.

1. – Introduction

At LHC Pb-Pb collisions will be produced at center of mass energies up to $\sqrt{s_{NN}} = 5\,\text{TeV}$. At such high energies theory predicts the formation of a new state of matter, the Quark Gluon Plasma (QGP) whose study requires detectors with enhanced tracking and particle identification capabilities. The ALICE experiment has been designed to study in details these collisions. A silicon vertex detector (ITS) and a large Time Projection Chamber (TPC) will deal with the expected high track multiplicity providing also, via $\mathrm{d}E/\mathrm{d}x$ measurement, PID in the low momentum range. The PID system in the central rapidity region is completed by a Transition Radiation Detector (TRD) and a Time Of Flight System (TOF) which will cover the intermediate momentum regions. ALICE studies also pp interactions as they provide reference data for heavy ion collisions.

Hereafter the TOF performance will be described in more details and first results in pp collisions will be reported.

2. – TOF PID performance

The TOF detector covers a pseudorapidity range $-1 < \eta < 1$ and full azimuth. It consists of about 1500 Multigap Resistive Plate Chambers (MRPC) for a total of 152918 readout pads each of $10\,\text{cm}^2$ [1-3]. The TOF detector is able to measure the arrival time of the particle. If the start time is known, the time of flight t is known so the mass can be defined in terms of momentum, track length and time of flight.

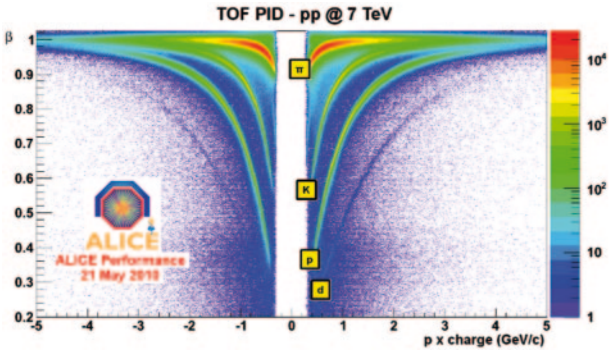

Fig. 1. – Dependence of the particle velocity (β) measured by TOF on the particle momentum (p) in pp collisions at $\sqrt{s} = 7\,\text{TeV}$ for positive and negative particles.

The lower is the total time resolution, that is determined by the intrinsic time resolution of the TOF detector and by the start time resolution, the better is the PID capability allowing identification at higher p_t. The total resolution is about 88 ps in Pb-Pb and 120 ps in pp collisions [3]. In fig. 1 the TOF PID capabilities are shown in terms of dependence of the particle velocity β measured by TOF on the particle momentum p in pp collisions at $\sqrt{s} = 7\,\text{TeV}$. A usefull method to identify particles with TOF is gaussian fit of the difference between Time-of-Flight measured by TOF (t_{TOF}) and time calculated during the tracking procedure (t_{calc}) assuming different mass hypothesis (fig. 2).

3. – Physics results with TOF

Thanks to its excellent PID performance the TOF detector is used in a large number of analysis which are based on particle identification like primary hadron transverse momentum spectra, reconstruction of invariant masses, reconstruction of transverse momentum spectra of electrons coming from Heavy Flavour (HF) decays, anti-alpha candidates research, etc… Hereafter a few results on transverse momentum spectra, resonances and HF will be shown.

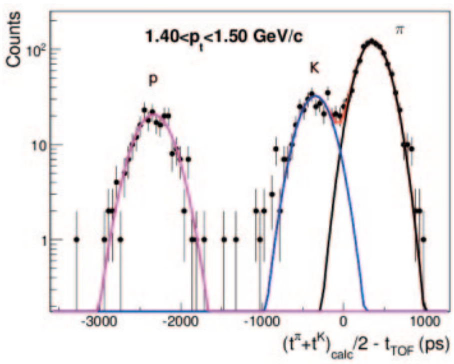

Fig. 2. – Distribution of the time difference between the measured TOF signal and the average of the calculated times for pions and kaons. The fits are performed using gaussian shapes [4].

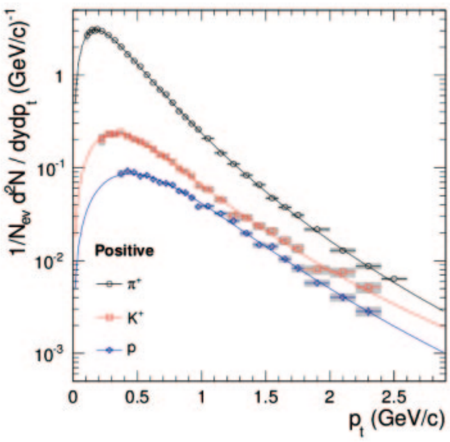

Fig. 3. – Transverse momentum spectra of positive hadrons from pp collisions at $\sqrt{s} = 900\,\mathrm{GeV}$. Grey bands: total p_t-dependent error (systematic plus statistic). The curves represent fits using Levi function [4].

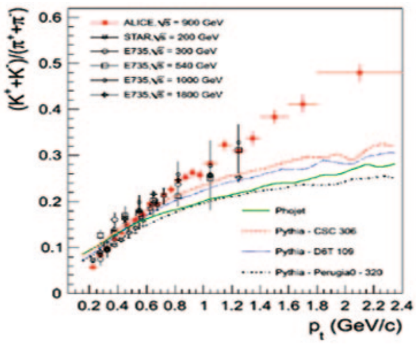

Fig. 4. – K/π ratio as a function of p_t. Comparison between data from different experiments and energies and MC productions [4].

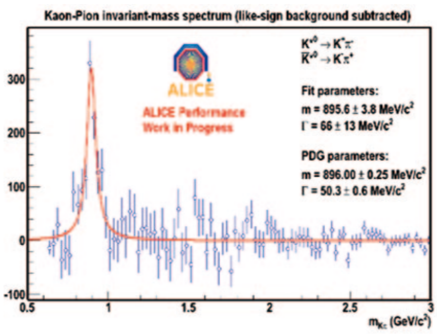

Fig. 5. – K-π invariant mass spectrum for pp collisions at $\sqrt{s} = 0.9\,\mathrm{TeV}$. TOF PID used.

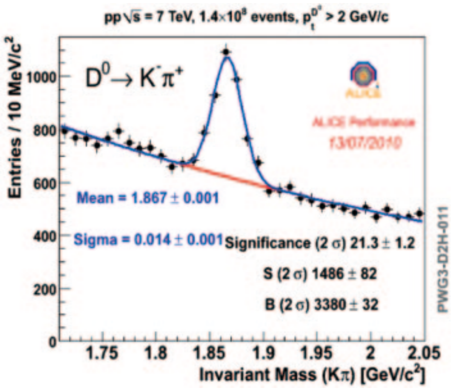

Fig. 6. – K-π invariant mass for pp collisions at $\sqrt{s} = 7\,\text{TeV}$. TOF and TPC PID applied.

In the $\sqrt{s} = 900\,\text{GeV}$ analysis on primary hadrons transverse momentum spectra [4], the TOF detector was used to identify π with $0.5\,\text{GeV}/c \leq p_t \leq 2.5\,\text{GeV}/c$, K with $0.5\,\text{GeV}/c \leq p_t \leq 2.2\,\text{GeV}/c$ and p with $0.7\,\text{GeV}/c \leq p_t \leq 2.2\,\text{GeV}/c$ (see [4] for details). To cover a wider momentum range, TOF spectra have been combined with spectra identified by ITS and TPC via the specific energy loss $\text{d}E/\text{d}x$. The spectra have been averaged using the systematic errors as weights. The final combined spectra shown in fig. 3 are fitted with a Levi function [4]. Final spectra are usefull to calculate $\langle p_t \rangle$, K/π and p/π ratios, to be compared with pp collisions at different energies and with Pb-Pb collisions and to tune Monte Carlo generators. For example in fig. 4 the K/π ratios of the various MC's understimate the real data result for $p_t \geq 0.6\,\text{GeV}/c$.

Another field in which TOF PID is strongly involved is the invariant mass reconstruction. As an example, in fig. 5 a K-π invariant mass spectrum based on TOF PID for pp collisions at $\sqrt{s} = 0.9\,\text{TeV}$ is shown. After subtraction of the background a $K^\star$ peak is clearly visible. TOF is strongly involved also in Heavy Flavour analysis for both invariant mass reconstruction (*i.e.* Λ_c, D^0 fig. 6) and transverse momentum spectra of electrons.

REFERENCES

[1] Akindinov A. *et al.*, *Nucl. Instrum. Methods A*, **615** (2010) 3741.
[2] Akindinov A. *et al.*, *Eur. Phys. J. C*, **68** (2010) 601607.
[3] Agostinelli A. (ALICE Collaboration), these proceedings.
[4] Aamodt K. *et al.*(ALICE Collaboration), *Eur. Phys. J. C*, **71** (2011) 1655.