PID with the ALICE TOF detector and a few physics results

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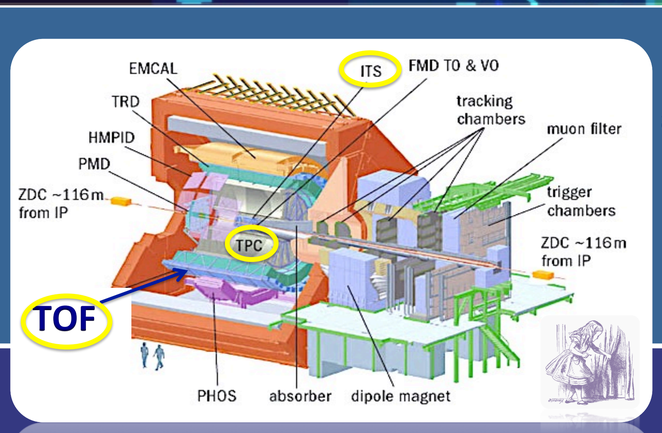
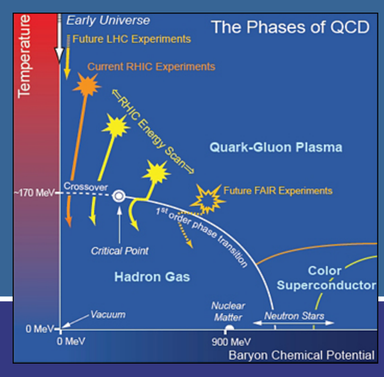
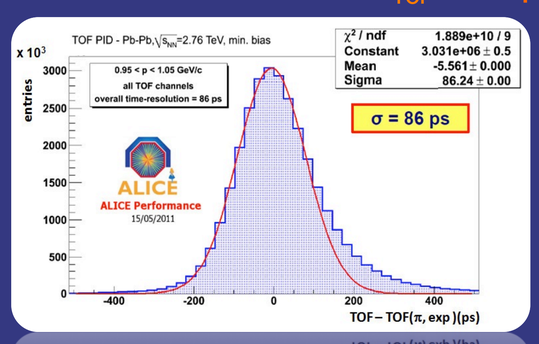


The ALICE experiment[1] at the LHC is devoted to study the QCD phase transition and the hot and dense medium which is produced in ultra-relativistic heavy-ion collisions, the so-called Quark Gluon Plasma. ALICE is designed and optimized to study Pb-Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV with a particular focus on Particle Identification (PID). The Time-Of-Flight (TOF) detector contributes to PID in ALICE central barrel via time-of-flight measurement and its PID capabilities are exploited in several analysis.

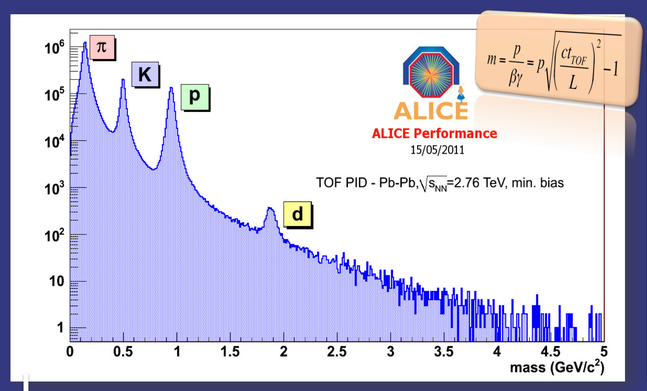


ALICE Time-Of-Flight

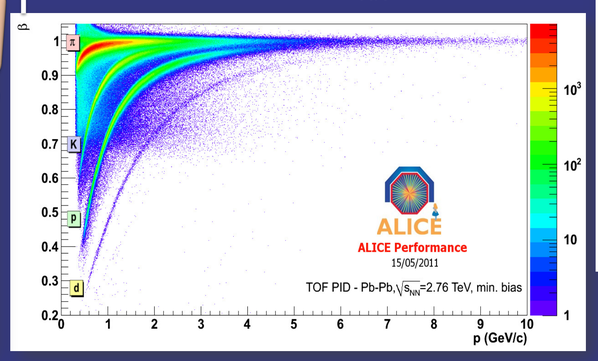
- Based on Multi-Gap Resistive Plate Chamber
- Acceptance: 0°≤ϕ≤360°, |η|< 1
- Inner radius r_{in} = 370 cm
- 18 azimuthal sectors x 91 MRPCs
- >153,000 readout channels
- Intrinsic MRPC's resolution σ_{MRPC} < 50 ps
- Time-Of-Flight resolution (including also the electronics effect and TDCs resolution) as measured in Pb-Pb collisions σ_{TOF} = 86 ps

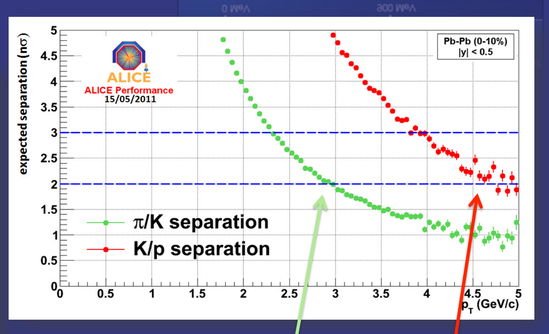


PID with TOF



β of particles identified by TOF vs. their momentum in minimum bias Pb-Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV.

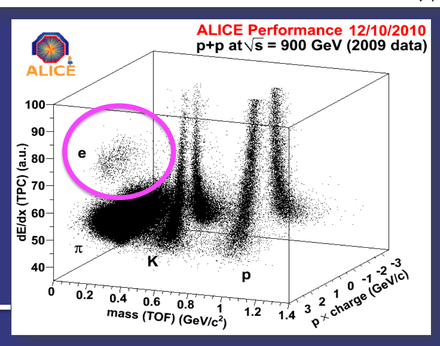




2σ separation for π/K up to p_T=3.0 GeV/c

2σ separation for K/p up to p_T=5.0 GeV/c.

Mass spectrum of the particles identified by TOF in minimum bias Pb-Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV.

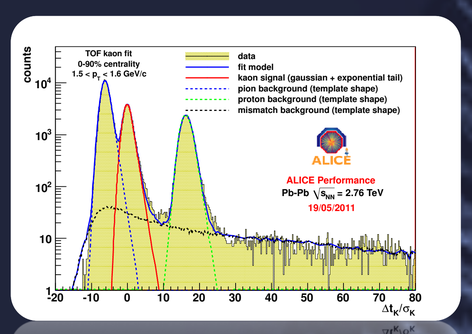


Electron identification is performed combining TPC dE/dx measurement with mass from the Time Of Flight measurement.

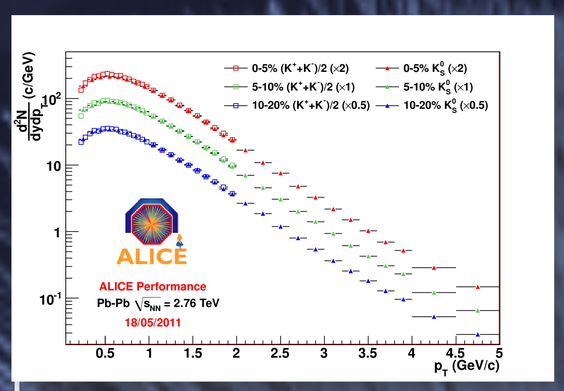
Production of identified hadrons

The study of transverse momentum spectra of identified hadrons in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV gives information about the kinetic freeze-out properties of the medium produced in such collisions. This measurement exploits the excellent central barrel detectors PID capabilities: the specific energy loss dE/dx is measured by the Inner Tracking System (ITS) and by the Time Projection Chamber (TPC), PID via Time Of Flight measurement is provided by TOF.

TOF PID: Gaussian unfolding of TOF signal for matched tracks extrapolated from TPC.

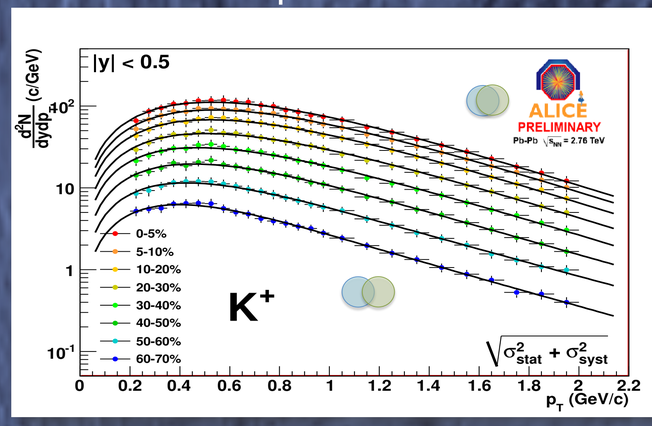


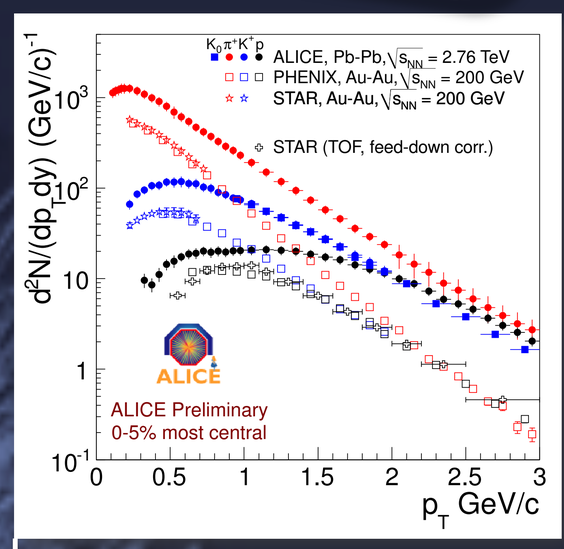
Example of signal extraction for K in central (0-5%) Pb-Pb collisions, 1.5<p_T<1.6 GeV/c



Charged K spectra identified by TOF, ITS+TPC and TPC+TOF and K^0_s spectra identified via V^0 decay topology in Pb-Pb collisions, show very good agreement for different centralities.

Transverse momentum spectra of positive Kaons in Pb-Pb collisions in ALICE as function of centrality (statistical and systematical errors combined). The curves represent blast wave fits[2].

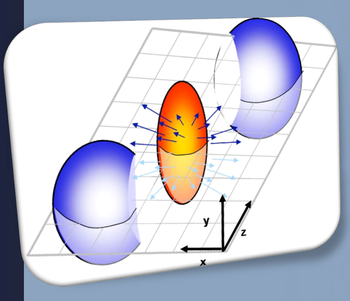




Transverse momentum spectra (feed-down corrected) of positive hadrons in Pb-Pb collisions in ALICE compared to the RHIC spectra exhibit a significant variation in slope.

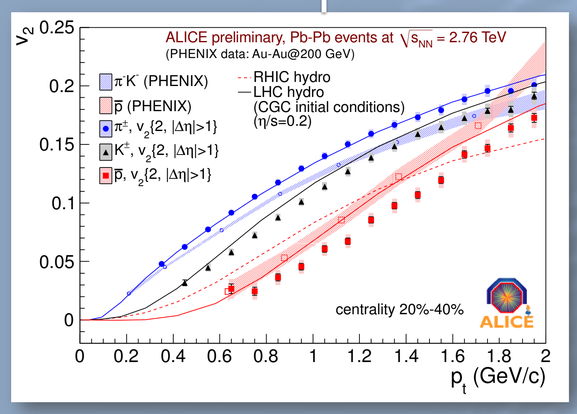
Flow of identified particles

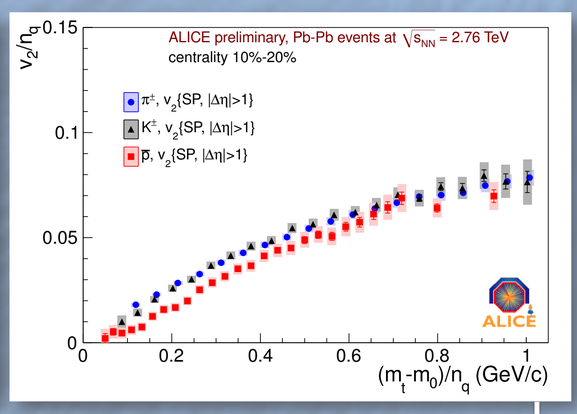
has been studied in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV by measuring the v_2 coefficient of the Fourier expansion of the azimuthal dependence of identified particle yield:



$$E\frac{d^3N}{d^3p} = \frac{1}{2\pi}\frac{d^2N}{p_t dp_t dy}\left(1 + \sum_{n=1}^{\infty} 2v_n \cos[n(\phi - \Psi_R)]\right)$$

v_2 for π/K/p is compared with results from PHENIX[3] at RHIC in the 20-40% centrality bin and with hydrodynamical models[4].





v_2 scaling with the number of constituent quarks, n_q, as observed in more central collisions (here 10-20% central) in ALICE. Scaling seem to break for protons.

Resonances

are being studied in ALICE in pp collisions at $\sqrt{s}$ = 7 TeV and in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV. ϕ->K^+K^- and K*->Kπ analysis, in particular, benefit from the π/K separation provided by TOF.

Corrected p_T spectra of K^{0*}(896), ϕ(1020) and Ξ*(1530) resonances in pp collisions at $\sqrt{s}$ =7 TeV fitted with a Levy function.

Signal extraction strategy for ϕ(1020) resonance in Pb-Pb collisions. The signal is fitted with a Voigtian + a 3rd order Chebychev polynomial function.

Outlook

- TOF PID is extensively exploited in analysis of particle production and flow in Pb-Pb and pp collisions in ALICE.
- First results on identified spectra and comparison with RHIC show that higher radial flow is produced at LHC while elliptic flow as function of p_T seem not to change much from RHIC energies.
- The comparison with theoretical predictions shows that π and K production is well described by existing hydrodynamical models, which however need to be further improved in order to describe p production.
- TOF PID is crucial for the investigation of the medium produced in heavy ions collisions at the LHC!

References

[1] ALICE Collaboration, JINST 3 (2008) S08002
[2] E. Schnedermann, J. Solifrank, U. Heinz, Phys. Rev. C 48, 2462–2475 (1993)
[3] PHENIX Collaboration, Phys. Rev. Lett. 91, 182301 (2003)
[4] C. Shen, U. Heinz, P. Huovinen, H. Song, arXiv:1105.3226

Physics At LHC 2011 – PERUGIA, Italy, June 6-11th, 2011

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