Charm R_{AA} in Pb - Pb collisions at the LHC via $D^0 \rightarrow K^+\pi^-$ reconstruction in ALICE

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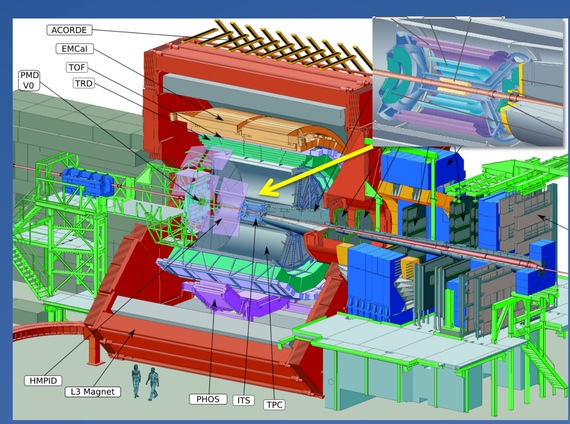
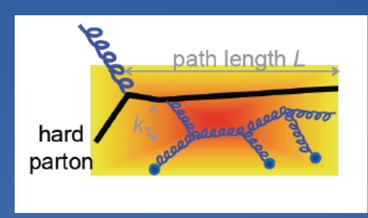
ALICE: A Large Ion Collider Experiment.

The main goal of the ALICE experiment is the characterization of the high-density state of strongly interacting matter formed in the ultrarelativistic heavy-ion collisions. To do so ALICE will study Pb-Pb as well as p-Pb and p-p collisions at LHC.





$$R_{AA}(p_t, y) = \frac{1}{T_{AA}} \frac{d^2N_{AA}/dp_t dy}{d^2\sigma_{pp}/dp_t dy}$$

HEAVY FLAVOUR in ALICE

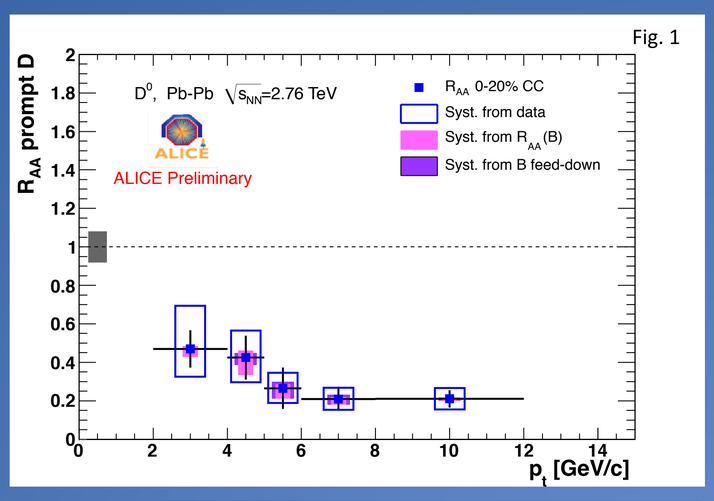
Heavy flavour quarks are important probes to test the medium formed in Pb-Pb collisions. Being produced in the early stage of the collision in hard scatterings, heavy quarks can interact with the medium via collisional and radiative energy loss. The nuclear modification factor (R_{AA}) quantifies this effect, comparing Pb-Pb spectra to the p-p ones, after scaling the latter by the number of collisions.

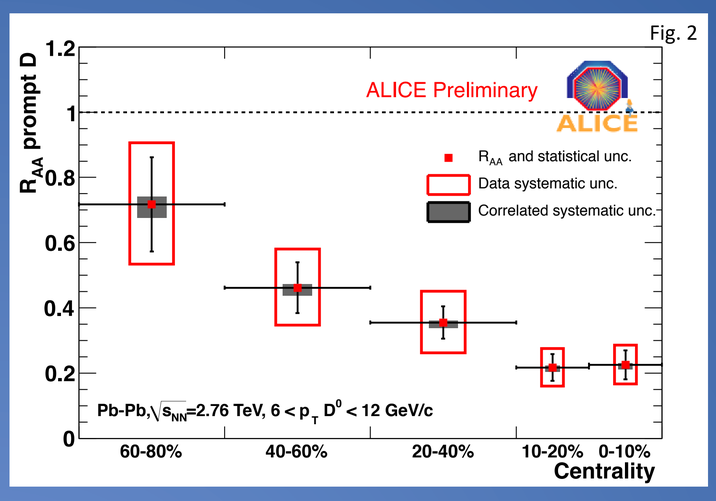
RESULTS

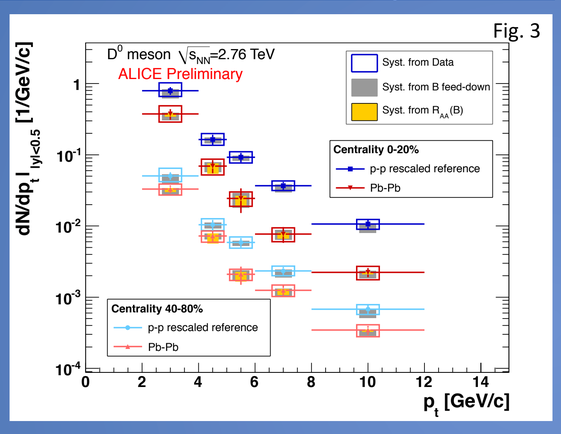
D^0 R_{AA} vs p_t

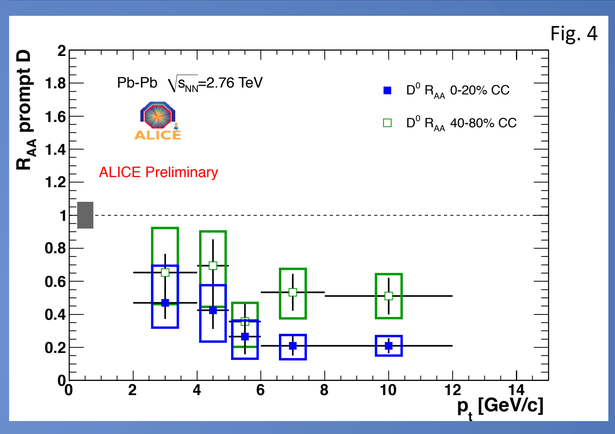
The D^0 reconstruction in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV has been used to measure the nuclear modification factor of the charm quark as a function of transverse momentum.
In central collisions (0-20% centrality) a clear suppression has been observed. This effect is smaller at low p_t and it increases in size at higher transverse momentum (Fig.1).

Fig. 3 shows dN/dp_t compared in Pb-Pb and p-p collisions. The latter is scaled from $\sqrt{s}$ = 7 TeV data using FONLL predictions and taking into account the number of binary collisions.







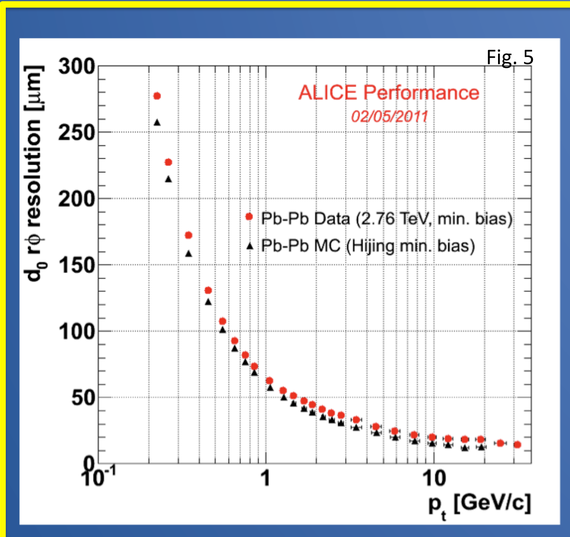


D^0 R_{AA} vs CENTRALITY

The nuclear modification factor has been studied also as a function of centrality in the D^0 p_t 6-12 GeV/c bin. The suppression is smaller in the most peripheral centrality class (60-80%) and it increases towards smaller impact parameters of the collisions (Fig. 2). The largest suppression is measured in the most central events (0-10% -10-20%).

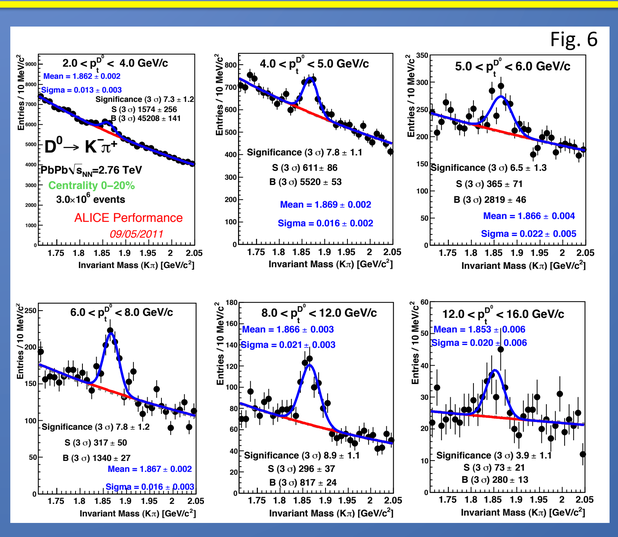
Fig 4. shows a comparison of R_{AA} for central (0-20%) and peripheral (40-80%) events as a function of p_t.

ANALYSIS DESCRIPTION



SIGNAL EXTRACTION

TOPOLOGICAL CUTS: charm hadrons are characterized by a decay vertex displaced from the primary by about ~ 150 μm. The ALICE Inner Tracking System (ITS) allows a precise measurement of the impact parameter of single tracks (Fig. 5). To exctract the $D^0 \rightarrow K\pi$ signal two main topological cuts have been used: one on the impact parameter of the tracks, the other on the angle between the flight line and the momentum of the meson.



INVARIANT MASS ANALYSIS

The D^0 signal has been observed in 6 bins of p_T from 2 up to 16 GeV/c, with a significance greater than 5 (Fig. 6).
A two steps fit procedure is used. First the background is fit to an exponential (or 2nd degree polynomial) function in the side bands. Then the signal is extracted with a gaussian (signal) + exponential (background) fit in the full mass range.

PID SELECTION

The Particle Identification (PID) is used in the analysis to reduce combinatorial background especially in Pb-Pb collisions.

The Time Projection Chamber (TPC) allows to separate pions and kaons up to 0.6 GeV/c using dE/dx measurements. The Time Of Flight (TOF) separates pions and kaons up to 2 Gev/c in Pb-Pb collisions (Fig. 7), measuring the time it takes them to reach the detector.

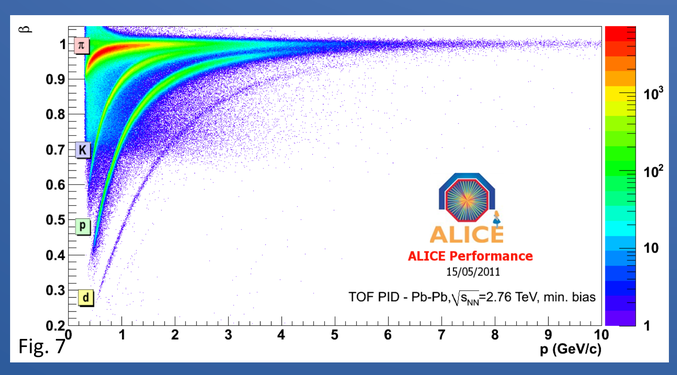
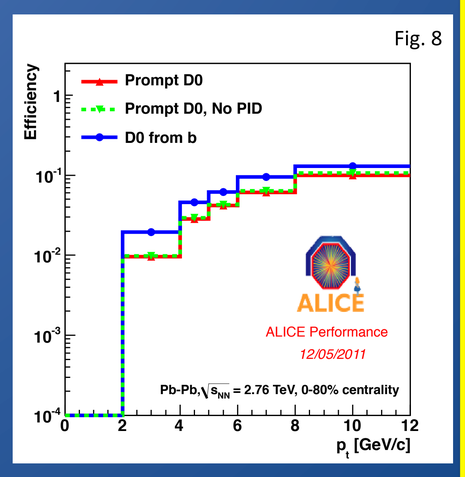


Fig. 7

RECONSTRUCTION AND ANALYSIS CUTS EFFICIENCIES

The reconstruction efficiency is estimated using a Monte Carlo sample, tuned in order to reproduce the data and the ALICE detector conditions.
In Fig. 8 the reconstruction efficiency for prompt D^0 (in red) are shown, after the topological cuts are applyed. The PID efficiency is also shown (green). The efficiencies for D^0 coming from beauty hadrons (blue) are larger due to the fact that their vertices are more displaced than the prompt D^0.



SYSTEMATIC STUDIES

The sources of data systematic uncertatainties are shown in Fig. 9.
The total systematic error is ~ 20% for p_t >5; at low p_t it's larger due to uncertainties on the p_t distribution in the Monte Carlo.
The systematic error due to the beauty feed down and energy loss is shown in Fig. 1.

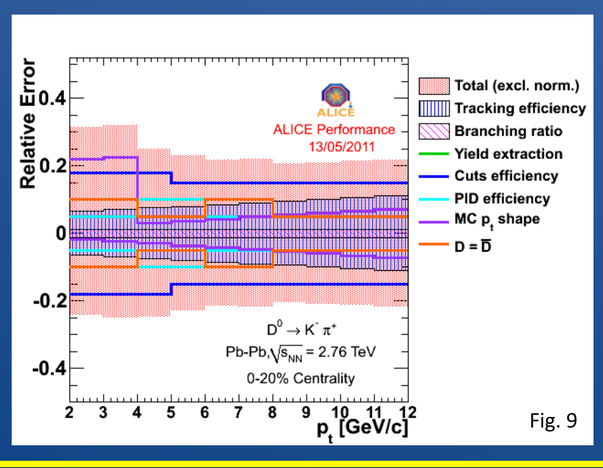


Fig. 9

FEED DOWN CORRECTION

The prompt D^0 cross section is obtained after subtracting the contribution from beauty decays. This is estimated using the FONLL predictions for D and B differential p_t cross sections, weighted with the corresponding direct and feed down reconstruction and analysis efficiencies (Fig. 8).
The R_{AA} of prompt D^0 is obtained considering that beauty loses as much energy as the charm. The systematic uncertainties arising from this assumption are computed varying the hypotesis on R_{AA} from B feed down (Fig. 10).

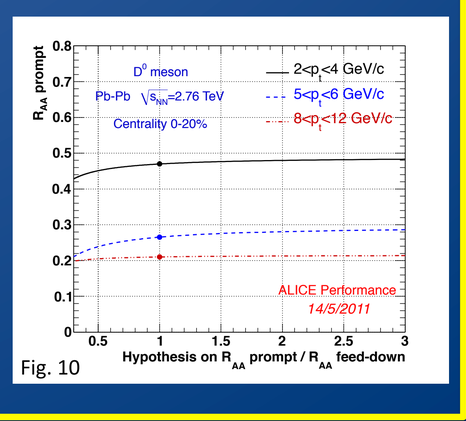


Fig. 10